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Post-Remediation Operation and Maintenance Manual for the Perfection Plating Company, Inc., Site, Watervliet, New York

Site Number 4-01-037

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Prepared for:

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Acronyms

ASC	Analytical Services Center
ASP	Analytical Services Protocol
BGS	below ground surface
CLP	Contract Laboratory Program
E & E	Ecology and Environment Engineering, P.C.
ELAP	Environmental Laboratory Approval Program
mg/L	milligrams per liter
MS/MSD	matrix spike/matrix spike duplicate
MSDS	Material Safety Data Sheet
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O & M Manual	Operation and Maintenance Manual
PSC	Philip Services Corporation
QA/QC	quality assurance/quality control
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
TSP	trisodium phosphate
VTSR	verified time of sample receipt

1 Introduction

Ecology and Environment Engineering, P.C. (E & E), has prepared this post-remediation operation and maintenance manual (O&M Manual) for the New York State Department of Environmental Conservation (NYSDEC) for the Perfection Plating Company, Inc., site (No. 4-01-037) in Watervliet, Albany County, New York (see Figure 1-1).

This section describes the Perfection Plating project and the purpose of this manual; Section 2 provides background information on the site; Section 3 discusses the monitoring process; Section 4 describes the groundwater monitoring system and how it is to be maintained and operated; Section 5 discusses the groundwater treatment system operation, maintenance, and monitoring; and Section 6 provides a contingency plan.

1.1 Project Description

The construction phase of this project included the following major components: installation of a groundwater collection trench, providing a groundwater treatment system on site, excavation, and off-site disposal of contaminated soils. The major contaminants of concern are hexavalent chromium and total chromium.

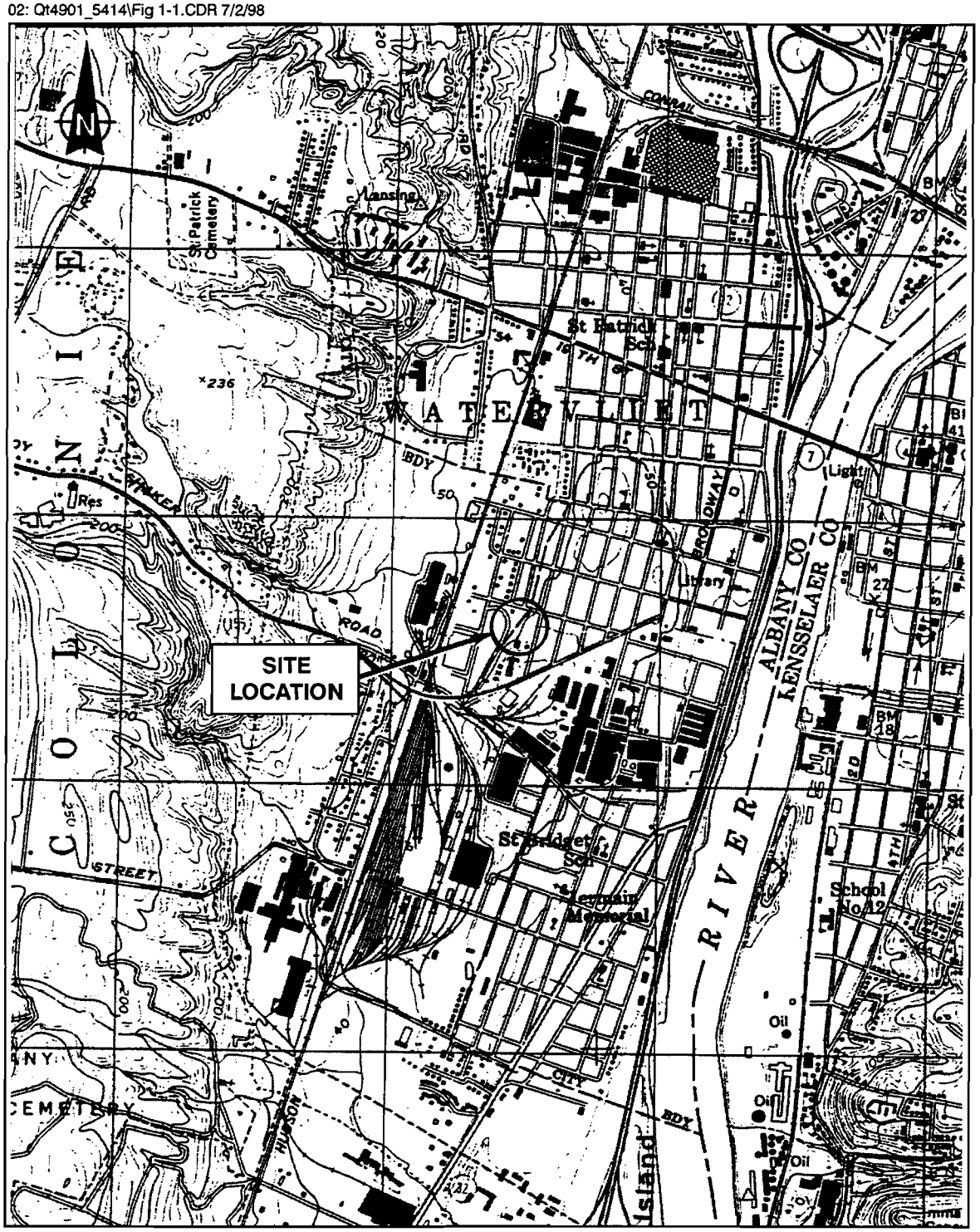
1.2 Purpose of the O&M Manual

The main purpose of this O&M Manual is to evaluate the performance and effectiveness of the completed remedial action (source removal) by monitoring groundwater contamination. The manual is intended to guide individuals unfamiliar with the site through the processes of:

- Sampling;
- Analysis;

- Inspection of wells.
- Inspection and operation and maintenance of the treatment system; and
- Maintenance.

02: Qt4901_5414\Fig 1-1.CDR 7/2/98



SOURCE: USGS 7.5 Minute Series (Topographic) Quadrangle: Troy South, NY 1953, Photorevised 1980.

SCALE 1:24,000

0 ½ 1 Mile

0 .5 1 Kilometer

Figure 1-1 PERFECTION PLATING COMPANY, INC., SITE LOCATION MAP

2 Background Information

2.1 Site Location and Description

The Perfection Plating site is a 1.7-acre inactive plating facility located at 911 11th Street in the City of Watervliet, New York (see Figure 1-1). Watervliet is located approximately 5 miles north of the City of Albany. The site is situated in an urban area approximately 0.5 mile west of the Hudson River. It is bordered to the north and east by a residential area, to the south by commercial and residential properties, and to the west by the "Siberia Area" of the Watervliet Arsenal (arsenal).

The Perfection Plating facility consists of two single-story buildings: the plating building on the west side of the property and a storage warehouse on the east side of the property (see Figure 2-1). The plating building, which has been abandoned since September 1990, contains numerous plating tanks and other machinery used in the plating and finishing processes. The central portion of the warehouse is currently leased as a storage area.

The area between the buildings is mostly unpaved, and the area to the north is an open field separating the buildings from the residential area. A fence is located along the northern, western, and eastern boundaries of the site. New fencing, constructed during the remedial investigation (RI), secured gaps along the perimeter of the site. The site is accessed by vehicles from the east along 11th Street or from the south along 9th Avenue. The site and the surrounding areas are serviced by a municipal water supply and sanitary sewer system.

The soils beneath the site consist of 2 to 15 feet of sandy fill material underlain by dense clay. Bedrock underlying the soil is a highly fractured, steeply dipping shale. Groundwater beneath the site is approximately 5 to 8 feet below ground surface (BGS) and flows north-northwest.

2.2 Site History

The site was used as a plating facility from 1965 to 1990. Prior to that, the site reportedly was undeveloped land. The original plating operation was known as Watervliet Plating and was owned by John Robb from 1965 to 1973. At that time, the facility performed chrome and nickel bumper plating. In 1974, Peter Spiak and Vincent Ingenoso purchased the property and operated under the name of Perfection Plating Company, Inc. At first, the primary operation was zinc and cadmium plating, but it later changed to chrome and copper plating of brake parts.

These plating processes included the use of sulfuric acid, chromic acid flakes (in chromic acid tanks), potassium cyanide (in copper plating tanks), potassium hydroxide, sodium hypochlorite (in pretreatment systems), muriatic acid (in parts stripping/cleaning processes), methyl ethyl ketone (in parts cleaning), powdered copper (in copper plating tanks), nitric acid, zinc cyanide (for zinc plating), caustic potash, caustic soda flake, copper and zinc brighteners, and other corrosive cleaning compounds.

The plating tanks are underlain by a containment system that consists of concrete troughs approximately 6 inches deep. During operations, wastewater was discharged from open plating rinse tanks to the containment system and was pumped to a cyanide pretreatment system. The cyanide was converted to cyanate by an alkaline chlorination process (i.e., a hypochlorite and hydroxide solution was added to the wastewater to raise the pH and oxidize the cyanide to cyanate). Treated wastewater was then discharged to the sanitary sewer. Allegedly, no sludge was generated from this process; however, the pretreatment system had never been cleaned out. Parts from the chrome plating tank were rinsed over the tank, and no wastewater or other waste was generated from the chrome plating process. However, a vapor collection system from the chromic acid tank was vented outside through the west wall of the plating building.

On October 24, 1989, a consent order was issued to the owners of Perfection Plating requiring submission and implementation of a remedial investigation/feasibility study (RI/FS). On September 1, 1989, the plating facility was leased to Mr. Norman Zielonko. It then operated under the name of Pinnacle Plating until September 1, 1990, when it was abandoned. Pinnacle Plating predominantly performed copper and chromium plating with some zinc and cadmium plating. Containment systems were cleaned out and upgraded (i.e., piping was installed to connect each containment trough to the sump on the west side of the building).

During operations, a significant leak in the chromic acid tank was noted. The tank was removed, and a new tank was installed adjacent to the former location. Chromic acid had apparently dissolved the concrete foundation beneath the tank. During Pinnacle Plating's operations, a second consent order was issued to Perfection Plating and Pinnacle Plating on December 12, 1989, requiring submission of an application for an air contamination source permit, submission of an industrial hazardous waste management plan, and construction of a fence to isolate the area on the west side of the plating building. The industrial hazardous waste management plan was submitted by Pinnacle Plating later that month, and the required fence was constructed. On May 4, 1990, Perfection Plating submitted, in compliance with the consent order (File No. R4-0641-89-03), an RI/FS work plan prepared by Clough, Harbour, and Associates. The work plan was approved by NYSDEC on October 9, 1990; however, the plan was never implemented.

On June 24, 1991, an emergency removal action was requested by the Bureau of Construction Services of NYSDEC's Division of Hazardous Waste Remediation. Among other actions, NYSDEC wanted the plating and rinse tanks to be emptied and disposed of and at least six drums of plating waste stored in the warehouse to be removed and disposed of. On June 26, 1991, NYSDEC sent a certified letter to McNamee, Lochner, Titus, and Williams, P.C., (Perfection Plating's consultant) requesting removal of the above-mentioned wastes. Because of the lack of response, an emergency removal action was performed by Clean Harbours under contract to NYSDEC in late 1991 and early 1992.

E & E was tasked by NYSDEC to conduct an RI of the site and prepare an FS later in 1992.

The final RI and FS reports were completed in August 1994 and August 1995, respectively. Based on the FS, a Record of Decision (ROD) was issued in December 1995. The ROD called for:

- Excavation of contaminated soils and off-site disposal;
- Construction of a groundwater cutoff trench to intercept and collect the plume of contaminated groundwater;
- Operation and maintenance of a groundwater treatment system on site; and
- Discharge of treated wastewater to a local storm drain.

Bidding documents for remedial activities were completed by E & E in July 1997. Philip Services Corporation (PSC) was awarded the construction contract in November 1997. Construction was initiated in December 1997 and completed in June 1998. After conclusion of the demonstration period in September 1998, the groundwater treatment system was turned over to NYSDEC for operation.

OF4S003B



MW-GTI-1

MW-GTI-3

LEGEND

- EXISTING MONITORING WELL
- UTILITY POLE
- DECIDUOUS TREE
- APPROX. PROPERTY LINE
- CHAIN-LINK FENCE
- STOCKADE FENCE
- EDGE OF LIGHT WOODS
- 1 FT. GROUND CONTOUR
- 55 5 FT. GROUND CONTOUR
- CTM = WELLS INSTALLED BY C.T. MALE ASSOCIATES, P.C., IN 1988
- EA = WELLS INSTALLED BY E.A. SCIENCE AND TECHNOLOGY IN 1988.
- ESE = WELLS INSTALLED BY ENVIRONMENTAL SCIENCE AND ENGINEERING, INC., IN 1990.
- GTI = WELL INSTALLED BY GROUNDWATER TECHNOLOGY, INC., IN 1987.

SCALE IN FEET

0 100 200

ecology and environment

Figure 2-1 EXISTING SITE PLAN (PRECONSTRUCTION) PERFECTION PLATING SITE WATERVLIET, NEW YORK

BUFF Plotted: 07/18/97

3 Groundwater Monitoring, Testing, and Records

This section describes the processes by which groundwater at the Perfection Plating site will be monitored. For the first year, the wells and a nearby residence's (912 12th Street) basement will be sampled and analyzed quarterly for hexavalent chromium and total chromium.

3.1 Monitoring Plan Elements

3.1.1 Monitoring Wells

The initial groundwater monitoring network will consist of nine of the existing monitoring wells at the site (see Figure 3-1): MW-CTM-4, MW-EE-4D, MW-EE-5D, MW-EE-5S, MW-EE-6S, MW-EE-6D, MW-EA-7, MW-EA-8, and MW-ESE-9, and a nearby residence's basement (912 12th Street). The groundwater monitoring network is intended to be dynamic, and a periodic (i.e., annual) evaluation should be made of the usefulness of the data derived from the network. If it is determined that the water quality data from a well do not change significantly from one sampling event to another, that well could be considered for removal from the network.

A summary of the physical characteristics of the monitoring wells is provided in Table 3-1. Appendix A contains the construction logs for all of the monitoring wells.

3.1.2 Sampling Schedule

Groundwater samples from the monitoring network will be collected and analyzed quarterly for a period of one year beginning at substantial completion of the groundwater treatment and disposal separable part of the work. After the first year's results have been analyzed and evaluated by NYSDEC and the New York State Department of Health

(NYSDOH), a determination will be made to either continue sampling at the same or a different frequency.

3.1.3 Groundwater Analyses

Analytical parameters for the first year of sampling will include total chromium (including metals digestion) and hexavalent chromium. These parameters will be analyzed by NYSDEC's Analytical Services Protocol (ASP) Methods 6010B and 7196, respectively. A standard 28-day turnaround will be provided on all analyses from the verified time of sample receipt (VTSR) at the laboratory.

3.1.4 Laboratory Qualifications

The analytical laboratory to be used for the analyses must maintain NYSDOH Environmental Laboratory Approval Program (ELAP) certification for all subcategories of solid and hazardous waste. Certification is also required for ASP Contract Laboratory Program (CLP) metals, since this category is part of the ELAP program. The ELAP quality assurance objectives should be met for all analyses.

3.1.5 Data Reporting and Record Keeping

Data collected during groundwater sampling activities should be reported in letter report format to both NYSDEC and NYSDOH. Reports should be sent to:

Gerald Rider, P.E.
Chief, Operation & Maintenance Section
Bureau of Hazardous Site Control
DHWR
NYSDEC
50 Wolf Road
Albany, NY 12233-7010

Eric Hamilton
RHWE
NYSDEC, Region 4
1150 N. Wescott Road
Schenectady, NY 12306

Michael Rivara
Environmental Exp. Invest.
NYSDOH
2 University Place
Albany, NY 12203-3399

The reports should include a brief introduction and discussions of the field activities, sampling results, and quality assurance/quality control (QA/QC) results.

Field activities should be documented in a field sampling log book, a copy of which should be submitted with the data report. The full analytical data packages should also be submitted with their respective data reports.

A summary report of groundwater quality and flow direction will be provided at the end of the one-year O&M period.

3.2 Groundwater Sampling and Procedures

Sampling of the monitoring wells will consist of:

- Measurement of depth to water level and total depth of the well (to calculate well volume);
- Evacuation of static water (purging); and
- Sample collection.

These activities are described below. Sampling of the nearby residence's basement will be collected from a floor sump.

3.2.1 Water Level Measurement and Well Volume Calculation

Water level measurements will be collected from each of the nine monitoring wells prior to purging and sampling. Water level measurements will also be collected from eight monitoring wells on site that are not being sampled (MW-CTM-1, MW-EE-1S, MW-CTM-2, MW-EE-2D, MW-CTM-3, MW-EA-5, MW-EA-6, and MW-ESE-8) and the groundwater collection sump. The measurements will be recorded using the following procedures:

- Record date, time, weather conditions, and any other well-specific pertinent information;
- Locate reference mark at the top of the well casing;
- Lower electronic water level indicator probe into well, making sure the cord attached to the probe does not scrape the sides of the well casing;
- When an audible signal is detected, stop lowering the probe;

- Pull on the probe until the audible signal ceases;
- Lower probe slowly again, stopping as soon as an audible signal is detected;
- Hold cord to side of well casing where reference mark is etched;
- Record measurement (to the nearest 0.01 foot) as depth to water in field logbook;
- Repeat procedure three times for consistency; measurement should remain constant;
- Record the total depth of the well (to the nearest 0.01 foot) by lowering the probe to the bottom of the well and positioning the cord next to the reference mark on the well casing and measuring; and
- After completing both measurements at each well, decontaminate the probe to avoid any possible cross-contamination.

3.2.2 Purging

Before a groundwater sample is collected, the static water must be purged from the well to ensure that a representative groundwater sample is obtained. Three to five well volumes must be purged before collecting a sample. Prior to sampling each well, the bailers or pump must be properly decontaminated to prevent contamination from previous sampling events (see Section 3.2.5). Water removed during purging should be drummed and treated by the groundwater treatment system.

The volume of water in the well is calculated using the formula:

$$V = T r^2 (0.163)$$

Where:

V = Volume of water in the well (gallons);

T = Water column height (feet);

r = Inside radius of the well casing (inches); and

0.163 = A constant conversion factor that compensates for the πr^2 x T well-volume calculation and converts the volume from cubic feet to gallons.

3.2.3 Sampling

Groundwater temperature, pH, specific conductance, and turbidity will be measured during sampling. Sample collection procedures are as follows:

- Place polyethylene sheeting (or similar covering) on the ground to avoid surface contamination, if necessary;
- When transferring water from the bottom loading bailer to sample containers, care will be taken to avoid agitating the sample;
- All observable physical characteristics (e.g., color, sheen, odor, turbidity) of the groundwater at the time of sampling will be recorded; and
- Weather conditions (i.e., air temperature, sky conditions, recent precipitation, drought conditions) at the time of sampling will be recorded.

Required sample volumes and containers are presented in Table 3-2. Required sample preservation and holding times are presented in Table 3-3. Please note that hexavalent chromium samples require analysis within 24 hours. Analysis for metals will be performed on unfiltered samples only.

3.2.4 QA/QC Samples

Field QA/QC samples will include one trip blank per daily sample shipment, which will be analyzed for hexavalent chromium. In addition, one field duplicate and one matrix spike/matrix spike duplicate (MS/MSD) sample set will be collected and analyzed for the same parameters as the groundwater samples.

3.2.5 Decontamination

Sampling methods and equipment have been chosen to minimize decontamination requirements and prevent the possibility of cross-contamination. Sampling equipment used at more than one location (including the water level indicator) will be decontaminated between locations using the following procedure:

- Washing in a trisodium phosphate (TSP) solution;
- Rinsing with potable water; and
- Air drying.

All waters generated by decontamination procedures will be disposed of with well purge waters, and all expendable materials (e.g., Tyvek, gloves, etc.) generated during sampling will be bagged and properly disposed of as solid waste.

3.3 Evaluation of Monitoring Reports

The nine wells and nearby residence's basement that make up the initial groundwater monitoring network and the analyses of samples from these locations will provide comprehensive data about the quality of the groundwater at the Perfection Plating site. After the fourth quarter sampling data have been received, NYSDEC and NYSDOH should perform an evaluation of the usefulness of the data derived from the network. This evaluation should review the data on an analytical level as well as from a location point of view. If it is apparent that an analyte or group of analytes consistently meets the cleanup goals (groundwater standards), then these analytes should be removed from future sampling efforts. If it is determined that the water quality data from a well do not change significantly from one sampling event to another, and if the water quality meets the cleanup goals, that well could be considered for removal from the network.

NYSDEC and NYSDOH should make a determination from the monitoring well data to either continue sampling at the same or a different frequency. If monitoring is continued at the site past the initial year, an annual evaluation of the data should be conducted, as described above.

Once the site is delisted completely, the monitoring wells should be properly decommissioned following appropriate decommissioning procedures to prevent possible future groundwater degradation due to vandalism of the wells. The NYSDEC *Groundwater Site Monitoring Well Decommissioning Procedures*, 1996, is available for guidance in decommissioning method selection.

Table 3-1

WELL CONSTRUCTION INFORMATION
PERFECTION PLATING SITE

Well Number	TOIC Elevation (feet above MSL)	Ground Elevation (feet above MSL)	Total Depth of Well (feet BGS)	Depth to Bedrock (feet BGS)	Thickness of Bedrock Cored or Drilled (feet)	Outer Carbon Steel Casing		Inner Casing		Screen		Well Construction Material	Sand Pack Interval (feet BGS)	Bentonite Seal Interval (feet BGS)
						ID Size (inches)	Depth (feet BGS)	ID Size (inches)	Length (feet)	ID Size (inches)	Interval (feet BGS)			
MW-CTM-1	56.72	54.18	14.5	14.5	--	--	--	2	12	2	9.5 - 14.5	PVC	8.0 - 14.5	6 - 8
MW-EE-1S	52.02	49.90	17.0	10.8	6.2	--	--	2	9.0	2	6.5 - 16.5	Stainless steel	4.5 - 17.0	2.5 - 4.5
MW-CTM-2	56.79	57.00	15.0	3.8	11.2	--	--	2	6	2	6 -14	PVC	4 - 15	2 - 4
MW-EE-2D	58.87	56.93	50.8	3.0	38.3	5	12.5	2	41	2	39 - 49	PVC	37 - 50.8	33.5 - 37
MW-CTM-3	58.07	54.81	14.0	4.0	10.0	--	--	2	6.25	2	3 - 13	PVC	2 - 14	1.5 - 2
MW-CTM-4	56.24	52.46	16.0	4.0	12.0	--	--	2	6.78	2	6 - 16	PVC	5 - 16	3 - 5
MW-EE-4D	54.19	51.82	49.1	2.5	30.1	5	19	2	40	2	38 - 48	PVC	36 - 49.1	33.5 - 36
MW-EA-5	54.21	52.01	5.80	5.8	--	--	--	2	5.33	2	3 - 5.5	PVC	3 - 5.8	2.5 - 3
MW-EE-5S	57.71	55.90	17.5	7.0	--	--	--	2	8	2	6 - 16	PVC	5.2 - 17.5	2.8 - 5.2
MW-EA-5D	57.43	55.89	53.5	7.0	38.5	5	14.75	2	44	2	42 - 52	PVC	40 - 53.5	38 - 40
MW-EA-6	53.23	51.30	8.30	8.3	--	--	--	2	4.88	2	3 - 8	PVC	3 - 8.3	2.5 - 3
MW-EE-6S	48.48	46.77	16.5	8.5	--	--	--	2	8.5	2	6 - 16	Stainless steel	5 - 16.5	3 - 5
MW-EE-6D	49.83	46.85	53.9	8.5	40.9	6	13	2	45.75	2	43.75 - 53.75	Stainless steel	41.5 - 53.9	39.5 - 41.5
MW-EA-7	54.00	51.13	5.70	5.7	--	--	--	2	5.47	2	2.5 - 5.5	PVC	2.5 - 5.7	2 - 2.5
MW-EA-8	52.72	49.88	10.3	10.3	--	--	--	2	5.90	2	3 - 10	PVC	3 - 10.3	2.5 - 3
MW-ESE-8	49.23	46.89	15.0	7.0	8.0	--	--	2	11.0	2	8.5 - 13.5	PVC	7.0 - 15.0	5 - 7
MW-ESE-9	53.20	51.20	17.3	9.0	8.3	--	--	2	13.5	2	11 - 16	PVC	9.8 - 17.3	7.9 - 9.8

Key at end of table.

Table 3-1 (Cont.)

Key:

-- = Construction material or method not used.
MSL = Mean sea level.
BGS = Below ground surface.
ID = Inner diameter.
NA = Not available.
TOIC = Top of inner casing.
▒ = Monitoring network well.

Table 3-2

SAMPLE CONTAINERS, VOLUMES, AND PRESERVATION AND HOLDING TIMES FOR WATER SAMPLES

Type of Analysis	Type and Size of Container	Number of Containers and Sample Volume (per sample)	Preservative	Maximum Holding Time
Total chromium (metals digestion)	1-liter polyethylene bottle with polyethylene-lined cap	One; fill 7/8 full	HNO_3 to pH <2, cool to 4°C	6 months[a]
Hexavalent chromium	1-liter polyethylene bottle with polyethylene-lined cap	One; fill 7/8 full	HNO_3 to pH <2, cool to 4°C	24 hours[b]

[a] Holding time is based on verified time of sample receipt (VTSR).

[b] Holding time is based on time of sample collection.

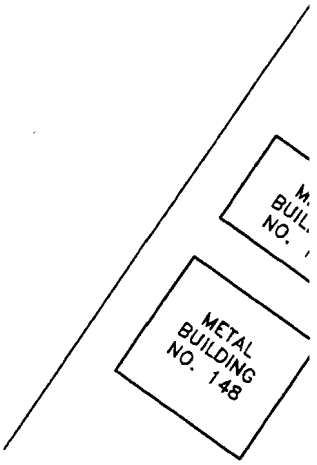
Source: NYSDEC Analytical Services Protocol, December 1994.

OF4S004B



MONITORING WELL ELEVATIONS	
DESCRIPTION	GROUND ELEVATION (Feet AMSL)
MW-CTM-1	54.18
MW-EE-1S	49.90
MW-CTM-2	57.00
MW-EE-2D	56.93
MW-CTM-3	54.81
MW-CTM-4	52.46
MW-EE-4D	51.82
MW-EA-5	52.01
MW-EE-5D	55.89
MW-EE-5S	55.90
MW-EA-6	51.30
MW-EE-6D	46.85
MW-EE-6S	46.77
MW-EA-7	51.13
MW-ESE-8	46.89
MW-EA-8	49.88
MW-ESE-9	51.20

ALL COORDINATES ARE ON AN ASSUMED SYSTEM.
ELEVATIONS BASED ON USGS 7.5 MINUTE SERIES QUADRANGLE TROY SOUTH NY. 1983.
CONTOUR 50 THAT CROSSES JUST WEST OF EIGHTH AVENUE AND TWELFTH STREET INTERSECTION.



LEGEND

- INTERFACE AQUIFER POTENTIOMETRIC SURFACE CONTOUR
- DIRECTION OF GROUNDWATER FLOW
- PHASE I RI MONITORING WELL
- EXISTING MONITORING WELL
- UTILITY POLE
- PL APPROX. PROPERTY LINE
- —X— CHAIN LINK FENCE
- STOCKADE FENCE
- CTM = WELLS INSTALLED BY C.T. MALE ASSOCIATES, P.C. IN 1988
- EA = WELLS INSTALLED BY E.A. SCIENCE AND TECHNOLOGY IN 1988.
- EE = WELLS INSTALLED BY ECOLOGY AND ENVIRONMENT, INC. IN 1993
- ESE = WELLS INSTALLED BY ENVIRONMENTAL SCIENCE AND ENGINEERING, INC. IN 1990.

SCALE IN FEET

0 100 200

ecology and environment

re 3-1 INTERFACE AQUIFER POTENTIOMETRIC SURFACE MAP - JANUARY 11, 1994
PERFECTION PLATING SITE
WATERVLIET, NEW YORK

Plotted: 07/18/97

4 Groundwater Monitoring System Maintenance

4.1 Maintenance

Maintenance of the groundwater monitoring system will occur each time the wells are sampled. These inspections will consist of the following:

- Assessing the condition of each well for all items listed on the Well Inspection Checklist (see section 4.1.1);
- Note all problems for each well, detailing all discrepancies and items requiring maintenance; and
- Ensuring each well is labeled properly with a paint stick to aid crews in identifying the wells.

4.1.1 Physical Inspection

The inspection of all wells should note the following criteria, which should be recorded on Table 4-1:

- Which, if any, wells require painting;
- Which, if any, wells require new locks;
- Which, if any, wells require protective casings;
- Which, if any, wells require new well caps;
- Which, if any, wells have an obstruction inside the well (may need replacing);
- Which, if any, wells have water in the annulus (need drainage hole);
- Which, if any, wells require new concrete pads; and
- Which, if any, wells require protective posts to be installed.

4.2 Monitoring Report

This letter report shall be produced each time a round of sampling is performed. It will contain a concise summary of all findings of the sampling event. The Well Inspection Checklist table shall be filled out completely and all discrepancies/comments regarding the condition of each well should be properly noted. This checklist will be part of the monitoring report.

Table 4-1

WELL INSPECTION CHECKLIST
PERFECTION PLATING SITE

Well Number	Stickup (ft/AGS)	TOIC Elevation (ft/ASL)	TOIC Current Depth (feet)	TOIC Water Level (feet)	WELL INSPECTION (Good/Fair/Poor or Yes/No)								Comments	Three Volumes (gallons)
					Well Marking (G/F/P)	Casing Lock (G/F/P)	Protective Cover (G/F/P)	Well Cap (G/F/P)	Obstructions In Well (Y/N)	Water in Annulus (Y/N)	Concrete Pad (G/F/P)	Inspection Date		
CTM-1	2.54	56.72	17.04											
EE-1S	2.12	52.02	19.12											
CTM-2	(0.21)	56.79	14.79											
EE-2D	1.94	58.87	52.74											
CTM-3	3.26	58.07	17.26											
CTM-4	3.78	56.24	19.78											
EE-4D	2.37	54.19	51.47											
EA-5	2.20	54.21	8.00											
EE-5S	1.81	57.71	19.31											
EA-5D	1.54	57.43	55.04											
EA-6	1.93	53.23	10.23											
EE-6S	1.71	48.48	18.21											
EE-6D	2.98	49.83	56.88											
EA-7	2.87	54.00	8.57											
EA-8	2.84	52.72	13.14											
ESE-8	2.34	49.23	17.34											
ESE-9	2.00	53.20	19.30											

Key at end of table.

Table 4-1 (Cont.)

Key:

AGS = Above ground surface.
ASL = Above sea level.
TOIC = Top of inner casing.
▒ = Monitoring network well.

INSPECTION RATINGS

Good = Good condition, no action required.
Fair = Fair condition, minor repair(s) may be required.
Poor = Poor condition, repairs and replacement advised.

5 Treatment Facility Operation and Maintenance

5.1 Groundwater Treatment System Description

The groundwater treatment system is designed to be operated continuously, without attendance of an operator, for approximately two weeks or longer before routine maintenance (e.g., cleaning or replacing filter plates, replacing ion-exchange units, replenishing chemicals). The system has the capability to notify the operator, through the automatic dialing alarm unit system, when predetermined alarm conditions exist. These alarms indicate that there may be malfunctions in the groundwater treatment system or that maintenance of the system may be required.

The groundwater treatment system includes a collection trench, a collection sump, and the active treatment system. The system includes the following major components:

- Submersible groundwater pump;
- Aerator with blower;
- Iron removal filter;
- Acidic pH adjustment accessories;
- Base mounted transfer pump;
- Three-stage ion exchange units (plus one spare unit);
- Alkaline pH adjustment accessories;
- Treatment building;
- Utilities connection; and
- Control systems.

Contaminated groundwater collected in the trench is pumped from the collection sump to an aerator followed by a plate filter unit for removal of suspended solids and oxidized iron. As a preparation for the ion-exchange process, the water is adjusted to a pH of 4.5 to 5.0. Three ion-exchange units containing disposable anionic exchange resin are then used to remove hexavalent chromium from solution. The first two units provide the primary treatment, and the

third unit is used for polishing and as a safety factor. The treated water then flows to a pH adjustment tank to raise the pH to between 6.2 and 6.5 prior to final disposal, by gravity, to a storm water catch basin located on 12th Street.

The effluent of the first stage ion-exchange unit is monitored by a specific conductivity meter/controller. When the specific conductivity readings reach a preset level, which correlates to 80% of the discharge criterion for hexavalent chromium concentrations (i.e., 0.4 mg/L), the first stage ion-exchange unit should be removed and disposed and a new unused unit should be added as the third stage unit (see Table 5-1 for the correlation of conductivity readings to hexavalent chromium concentrations). The original second and third stage units should be reconfigured as the first and the second stage units, respectively. The specific conductivity meter/controller shall be reconfigured to always monitor the effluent of the second stage ion-exchange unit. The spent ion-exchange unit must be kept wet until final disposal, otherwise the strong oxidizing nature of the chrome could cause the resin to smolder.

Manufacturer operating instructions for the equipment listed below are included in Appendix C. The PSC Operational Manual includes the following:

- Chapter 1, Submersible Pump,
- Chapter 2, Water Meter,
- Chapter 3, Air Diffuser,
- Chapter 4, Iron Filter,
- Chapter 5, pH Adjust (Acid and Alkaline),
- Chapter 6, Transfer Pump,
- Chapter 7, Ion Exchangers,
- Chapter 8, Building Sump Pump, and
- Chapter 9, Control Panel (includes pH and conductivity meter).

5.2 Groundwater Treatment System Performance Requirements

5.2.1 Groundwater Influent Characteristics and Effluent Criteria

The influent flow rate should be 5 gallons per minute. The anticipated contaminant concentrations for the recovered groundwater in the trench are approximately 4 to 25 milligrams per liter (mg/L) of total chromium and 7 mg/L of total iron. The groundwater treatment is designed to remove hexavalent chromium and iron from the groundwater and have an effluent quality meeting the criteria specified in Figure 5-1. According to PSC, the effluent quality met the criteria throughout the demonstration period.

5.2.2 Normal Control and Monitoring System Operation

See Figure 5-2 for the treatment system layout.

Collection Sump

Groundwater flow from the treatment system is regulated by activating the submersible pump at a rate of 5 gpm in the collection sump. In the automatic mode, the submersible pump will run unless it receives a low current signal (CL-102) from current switch CS-102 (indicating a low water level in the collection sump) or the interlock signal (see Table 5-2. Alarms and Interlocks). If the submersible pump is deactivated by CL-102, it will restart after receiving a signal from timing switch TS-103. TS-103 has been programmed to allow a sufficient interval (5 minutes) for the collection trench to recharge. Groundwater flow rate from the collection sump will be measured by a rotameter and total volume of groundwater by flow totalizer FQ-201.

Aerator and Blower

The groundwater flows into an aerator that operates unless it receives an interlock signal caused by low air flow or water in the blower, indicating blower failure (see Table 5-1). The aerator discharge is vented through a flexible air duct to the outside of the treatment building.

Iron Removal Filter

From the aerator, the groundwater flows through six 50-micron filter plates to remove iron that has been oxidized in the aerator. Water flows through the filter plates until the plates become clogged. A clogged filter plate can be identified by the sign of overflowing or submergence (as opposed to flow-through pattern for clean filter plates). Clogging of the six filter plates should occur sequentially from the first plate to the sixth plate. When water overflows all six filter plates, the system shall be shut off for replacing or cleaning the filter fabric in these plates. High level alarm LAH-203 will trigger when the water level is at bottom of inflow from aerator sump, indicating clogged filters or a downstream backup. The filter plates were replaced approximately once per week during the demonstration period. Maintain spare fabric in the treatment building for future filter replacements.

If the filter plates are clogging too frequently, are not removing sufficient suspended solids, or if the transfer pump is cavitating, filter modifications may be necessary. A finer mesh can be installed in the filter plates and a bag filter can be placed after the transfer pump if this does not cause too much increase to the head on the pump. Tees and ball valves are set up

for future bag filter installation. Obtain approval from NYSDEC prior to making any changes to the system.

The spent filter fabric must be characterized by TCLP methods. The proper disposal method shall then be followed for the spent filter fabric according to the results of the TCLP analysis.

Sludge from bottom of filter tank should also be removed when changing filter, if necessary. Characterize the sludge by TCLP methods and dispose accordingly.

Acidifying pH Adjustment System

The pH must be lowered to allow effective chromium removal in the ion-exchange units. The pH level in the ion-exchange unit influent will be maintained between 4.5 and 5.0 by adding acid to the pH adjustment tank. pH controller OIC-205 monitors the pH level in the tank and automatically activates the metering pump (M-206) as necessary to add sufficient acid to bring the pH within the design limits noted above. In the automatic mode, the metering pump is controlled by a pH indicating controller OIC-205 while the mixer (M-212) runs continuously. The metering pump and mixer are de-energized by the interlock signal. Switch LS-204 in the acidifying pH adjustment tank controls the operation of Pump No. 1 as described below. Float switches in the pH adjustment tank were installed during construction to regulate the flow balance in Pump No. 1. The float switches are within the limits of the level sensors and do not tie into the interlock signal. The low pH alarm can be tripped when the water level is low in the acid pH adjustment tank. The float switches can be adjusted to remedy this problem. However, the distance between the upper and lower float switches is fixed.

Ion-exchange Systems

Groundwater flow from the acidifying pH adjustment tank to the effluent discharge point through the ion-exchange unit will be regulated by Pump No. 1. In the automatic mode, Pump No. 1 will run unless it receives a low level signal (LL-204) from level switch LS-204 (indicating low level in the acidifying adjustment tank) or the interlock signal. After receiving an LL-204 signal, Pump No. 1 will remain off until it receives a high level (LH-204) signal. Operation of the interlock system is described in "Alarms and Interlock" below.

The conductivity of the groundwater leaving the second stage ion-exchange unit will be monitored by conductivity controller KIC-301. KIC-301 will activate interlock alarm KAH-301 if conductivity readings equal the equivalent of 0.4 mg/L for hexavalent chromium. The resin replacement operation consists of the following steps:

- When the specific conductivity reading of the second stage ion-exchange effluent corresponds to a concentration of 0.4 mg/L for hexavalent chromium or a laboratory analytical result indicates that the second stage ion-exchange effluent exceeded the discharge criterion for hexavalent chromium (0.5 mg/L), the first stage ion-exchange unit needs to be replaced.

- Shut off the system and disconnect piping or hose from the first stage unit. Use the spare unit stored on site in the building to replace the original first stage unit.

- Close and open appropriate valves to make the original second and the third stage units new first and the second stage units, respectively (see Table 5-3). The new unit becomes the third stage unit. Identify the new first, second, and third stage unit with a placard, magnet, or other means. (Note: The physical locations of the units do not change.)

- Disconnect the specific conductivity meter probe from the original second stage unit effluent and connect to the new second stage effluent.

- Restart the system. Check and record all pressure gauges to make sure the valves are opened and closed correctly.

- Keep the spent ion-exchange unit wet, otherwise the strong oxidizing nature of chrome could smolder the dried resin.

- Arrange for a new resin unit to be delivered to the building and to dispose of the spent unit properly.

Alkaline pH Adjustment System

The pH level in the groundwater treatment system effluent is increased to between 6.2 and 6.5 by adding alkali to the pH adjustment tank. pH controller OIC-402 monitors the pH level in the tank and automatically activates the metering pump (M-403) as necessary to add sufficient alkali to bring the pH within the design limits noted above. In the automatic mode, the metering pump is controlled by OIC-402 while the mixer (M-405) runs continuously. The metering pump and mixer are de-energized by the interlock signal. Effluent flows, by gravity, from the pH adjustment tank to a discharge point at the catch basin. Level switch LS-401 activates interlock alarm LAH-401 if groundwater levels in the alkaline pH adjustment tank rise above the overflow invert. The pH controller OIC-404 monitors the pH level in the effluent line and guards against high or low pH levels in the alkaline adjustment tank.

Motor Control

The submersible pump, blower, mixers, metering pumps, and Pump No. 1 are controlled by three-way hand-off-automatic switches (HOA-103, 211, 213, 406, 214, 407, and 208, respectively) on the control panel. Each motor has a green "run" pilot light and a red "stop" pilot light on the control panel. In the automatic mode, the pumps, blower, and mixers are controlled as described in earlier paragraphs and deactivated by interlock UC-01. In the hand mode, the pumps, blower, and mixers are energized and any automatic control or interlock signals are overridden. The hand or manual mode is intended for start-up or debugging operations when alarm conditions or control signals may be present, but can be safely ignored.

Alarms and Interlock

Alarm conditions in the groundwater treatment system are monitored by flow switches, level switches, or probes. The signals are transmitted to a programmable logic controller or other control system in the control panel. The control system activates the interlock, an alarm pilot light on the control panel for each alarm condition, and sends signals for each interlock alarm to the automatic telephone dialing unit. The interlock alarms are combined into four groups to correspond to the four input channels for the alarm unit. Interlock UC-01 deactivates the submersible pump, Pump No. 1, the blower, and both mixers and metering pumps. The alarm conditions for the interlock system remain latched until the alarm condition is relieved and an acknowledge button on the control panel is activated. The alarm conditions for interlock UC-01 are as follows (see Table 5-2):

- High current at M-101 indicates clogging of the submersible pump (CAH-102). The current is measured by current sensor CS-102;
- Low air flow at the aerator as measured by air flow switch FSA-202 (FAL-202);
- Water in the blower hose (blower failure) as measured by LS-215 (LAH-215);
- High level in the filter unit as measured by LS-203 (LAH-203);
- High or low pH level in the effluent from the acidic adjustment tank (OAH-209 and OAL-209) as measured by OIC-209;
- High conductivity in groundwater leaving the second stage ion-exchange unit as measured by KIC-301 (KAH-301);

- High level in the alkaline pH adjustment tank as measured by level switch LS-401 (LAH-401);
- High or low pH level in the effluent from the alkaline adjustment tank (OAH-404 and OAL-404) as measured by OIC-404; and
- High level in the building sump as measured by level switch LS-501 (LAH-501).

Automatic Dialer

A microprocessor-based automatic telephone dialing alarm unit is installed at the treatment building. Upon sensing an alarm or alarms, the system will dial the first of a maximum of eight user-selected telephone numbers. The dialer should be checked occasionally to see if it is in proper operation. Contact New York Telephone if necessary. Update the following eight contact numbers as necessary:

Contact #1: TBA
Contact #2: TBA
Contact #3: TBA
Contact #4: TBA
Contact #5: TBA
Contact #6: TBA
Contact #7: TBA
Contact #8: TBA

Building Sump

A sump with a submersible sump pump is installed in the treatment building. The building sump is connected to the alarm/interlock system with level switch (LS-501). An alarm condition with this level switch would indicate a high level of water in the building sump and a possible release of water in the building.

Discharge from the building sump feeds into the groundwater treatment system at a point upstream of the iron removal filter.

5.3 System Operation and Maintenance

During normal operation, collect grab samples from the effluent discharge point weekly and have them analyzed for: pH, total suspended solids, oil and grease, amenable cyanide, total arsenic, total cadmium, hexavalent chromium, total chromium, total copper, total iron, total lead, total nickel, total selenium, total zinc, total 1,2-dichloroethylene, and vinyl chloride (see Figure 5-1). Recording system inspection data is presented in Table 5-4.

Additional inspection/operational requirements are as follows:

- Record flow rates (collection sump rotameter) and the cumulative total volume of water treated (totalizer FQ-201) whenever a maintenance visit to the facility is conducted.
- Collect grab samples of the influent monthly and have them analyzed for the same parameters as the effluent samples.
- Monthly, collect a sample from the effluent of the second ion exchanger drum, analyze for hexavalent chromium, and make sure the hexavalent chromium concentration and its corresponding reading fit the correlation curve; otherwise, update the curve as necessary.
- Follow the maintenance procedures specified in the manufacturer's manuals for all equipment.
- Replenish all spare parts or supplies with the same type of parts and amounts of chemicals as those used.
- Empty the sump pump as necessary.
- Replace iron removal filter fabric and remove filter sludge as necessary.
- Replace ion exchange vessels as necessary including resequencing of groundwater flow via valve adjustments.
- Inspect catch basin at intersection of 9th Avenue and 12th Street monthly for sediment buildup.
- Inspect collection sump monthly and record condition of lock, concrete pad, and overall sump appearance in logbook.
- Test the eye-wash station every six months.
- Test the fire extinguisher once each year.
- Replenish first-aid kit supplies after use.

- Have a NYSDOH-certified backflow prevention device tester test the backflow prevention device in the treatment building once a year. Report results to the Latham Water District

5.4 Miscellaneous Items

Lockout/Tagout

There are multiple electrical supplies to the groundwater treatment system. Complete electrical shutdown cannot be achieved with only one switch. Deactivate the power in the electrical panel on the wall (located adjacent to door) and then deactivate the power in the alarm control panel (located across from the electrical panel) to achieve electrical lockout.

Sink

The sink may be used for hand washing and general cleaning. Do not dump anything into the sink for disposal because the sink is connected to the treatment system by way of the building sump.

Building Sump

The building sump is used to collect any spillage/leakage in the treatment building and waste from the sink, and the liquid is fed back through the system (see Figure 5-3).

Table 5-1 Conductivity to Concentration Correlation Table (landscape)

Note: Table to be developed by O&M contractor.

Table 5-2

TREATMENT SYSTEM ALARMS, SET POINTS, AND INTERLOCKS

Treatment System Unit	Measurement	Alarm	Set Point	Interlock Connection (Y/N)	Indicates
Submersible Pump Motor (M101)	Current (CS-102)	Low (CL-102)	80 to 90% (field adjusted) rated full load current	N	Low groundwater level in the collection sump
		High (CAH-102)	110 to 125% (field adjusted) rated full load current	Y	Clogging of submersible pump
Aerator/Blower	Air Flow (FSA-202)	Low FAL-202	100 CFM	Y	Blower failure
	Water Level (LS-215)	High (LAH-215)	Installed at 3 o'clock or 9 o'clock on rigid portion of blower tube	Y	Blower failure or water backup
Iron Removal Filter	Water Level (LS-203)	High (LAH-203)	Bottom of inflow from aerator sump	Y	Clogged filters or downstream backup
Acid Adjustment Tank	Water Level (LS-204)	Low (LL-204)	3 inches above top of bulkhead fitting for Pump No. 1 (float level low)	N	Deactivate Pump No. 1
		High (LH-204)	3 inches below bottom of overflow invert from iron removal filter (float level high)	N	Reactivate Pump No. 1
	Effluent pH (OIC-209)	Low (OAL-209)	3.5	Y	pH level in tank effluent too low
		High (OAH-209)	5.2	Y	pH level in tank effluent too low
Ion-exchange Unit (second stage)	Conductivity (KIC-301)	High (KAH-301)	Equivalent of 0.4 mg/L hexavalent chromium	Y	Resin change required

Table 5-2

TREATMENT SYSTEM ALARMS, SET POINTS, AND INTERLOCKS

Treatment System Unit	Measurement	Alarm	Set Point	Interlock Connection (Y/N)	Indicates
Alkali Adjustment Tank	Water Level (LS-401)	High (LAH-401)	3 inches above top of overflow invert	Y	Downstream backup
	Effluent pH (QIC-404)	Low (QAL-404)	6.2	Y	pH level in tank effluent too low
		High (QAH-404)	8.5	Y	pH level in tank effluent too high
Building Sump	Water Level (LS-501)	High (LAH-501)	6 inches above bottom of building sump	Y	Release inside building

Table 5-3

ANION EXCHANGER VALVE SEQUENCING CHART*

VALUE	1 into 2 into 3	2 into 3 into 1	3 into 1 into 2
V15	Open	Closed	Closed
V19	Closed	Open	Open
V16	Closed	Open	Closed
V25 (Probe)	Closed	Closed	Open (Probe)
V28 (Sample)	Closed	Closed	Closed
V31 (psi)	Open	Open	Open
V21	Open	Closed	Open
V23	Closed	Open	Closed
V17	Closed	Closed	Open
V26 (Probe)	Open (Probe)	Closed	Closed
V29 (Sample)	Closed	Closed	Closed
V32 (psi)	Open	Open	Open
V22	Open	Open	Closed
V24	Closed	Closed	Open
V18	Open	Closed	Closed
V27 (Probe)	Closed	Open (Probe)	Closed
V30 (Sample)	Closed	Closed	Closed
V33 (psi)	Open	Open	Open
V20	Closed	Open	Open

Note: The probe is always placed after the second unit in series

1. #1 - #2 - #3: **Probe after the #2 unit.** When conductivity indicates remove #1 and put a fresh exchanger in its place. Now #2 will become the primary and #3 is the secondary and #1 is the final.
2. #2 - #3 - #1: **Probe after the #3 unit.** When conductivity indicates remove #2 and put a fresh exchanger in its place. Now #3 is the primary.
3. #3 - #1 - #2: **Probe after the #1 unit.** When conductivity indicates remove #3 and put a fresh exchanger in its place. The flow is now back to the original #1 into #2 into #3.

* From Philip Services Corporation

Table 5-4

QUARTERLY TREATMENT SYSTEM OPERATIONAL CHECKLIST

Quarter No. _____

Period Covered: _____ **to** _____

Item Description	Required Frequency	Unit	Date of Inspection										
Effluent sample collected	Weekly	Yes or no											
Influent sample collected	Monthly	Yes or no											
Second ion exchange drum effluent sample collected	Monthly	Yes or no											
Flow rate	Weekly	gpm											
Volume treated	Weekly	gal											
Specific conductivity reading	Weekly	ms/cm											
Performed required equipment maintenance	Manufacturer's recommendations	Yes or no											
Noted spare parts of supplies needed	Weekly	Yes or no											
Empty sump pump	As necessary	Yes or no											
Replace iron removal filter fabric and remove filter sludge	As necessary	Yes or no											
Replace ion exchange vessels/make valve adjustments	As necessary	Yes or no											
Inspected catch basin for sediment	Monthly	Yes or no											
Inspected collection sump and recorded condition in log book	Monthly	Yes or no											
Tested eye-wash station	Bi-annually	Yes or no											
Tested fire extinguisher	Yearly	Yes or no											
Replenished first-aid kit supplies	After use	Yes or no											
Tested the backflow preventer	Yearly	Yes or no											
Reported backflow preventer test results to Latham Water District	Yearly	Yes or no											

Key:

gal = Gallon.
gpm = Gallons per minute.
ms/cm = Milliseconds/centimeter.

Figure 5-1

91-20-2a (1/89)

DER Site No.: 4-01-037

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EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning Startup of remedial activities

and lasting until Completion of treated wastewater discharge

the discharges from the treatment facility to the Hudson River via the Watervliet storm sewer shall be limited and monitored by the operator as specified below:

Outfall Number & Effluent Parameter	Discharge Limitations Daily Avg.	Daily Max.	Units	Minimum Monitoring Requirements Measurement Frequency	Sample Type
Outfall 001: Remediation System Discharge					
Flow	Monitor	Monitor	GPM	Weekly	Meter
pH (Range)	NA	6.0 - 9.0	SU	Weekly	Grab
Solids, Total Suspended	Monitor	50	mg/l	Weekly	Grab
Oil & Grease	Monitor	15	mg/l	Weekly	Grab
Cyanide, Amenable	Monitor	1.1	mg/l	Weekly	Grab
Arsenic, Total	Monitor	0.15	mg/l	Weekly	Grab
Cadmium, Total	Monitor	0.03	mg/l	Weekly	Grab
Chromium, Hexavalent	Monitor	2.7	mg/l	Weekly	Grab
Chromium, Total	Monitor	0.5	mg/l	Weekly	Grab
Copper, Total	Monitor	0.5	mg/l	Weekly	Grab
Iron, Total	Monitor	4	mg/l	Weekly	Grab
Lead, Total	Monitor	0.4	mg/l	Weekly	Grab
Nickel, Total	Monitor	1.3	mg/l	Weekly	Grab
Selenium, Total	Monitor	0.07	mg/l	Weekly	Grab
Zinc, Total	Monitor	0.4	mg/l	Weekly	Grab
1,2-Dichloroethylene, total	Monitor	0.003	mg/l	Weekly	Grab
Vinyl chloride	Monitor	0.005	mg/l	Weekly	Grab

Special Conditions:

(1) Discharge is not authorized until such time as an engineering submission showing the method of treatment is approved by the Department. The discharge rate may not exceed the effective treatment system capacity. All monitoring data, engineering submissions and modification requests must be submitted to the following DER contact person: Craig Lapinski.

(2) Only site generated wastewater is authorized for treatment and discharge.

(3) Authorization to discharge is valid only for the period noted above but may be renewed if appropriate. A request for renewal must be received 6 months prior to the expiration date to allow for a review of monitoring data and reassessment of monitoring requirements.

(4) Both concentration (mg/l or µg/l) and mass loadings (lbs/day) must be reported to the Department for all parameters except Flow and pH .

(5) Samples and measurements, to comply with the monitoring requirements specified above, shall be taken from the treatment system effluent prior to discharge to the Hudson River, Class C.

(6) The minimum measurement frequency for all the parameters (except flow) shall be monthly following a period of 24 consecutive weekly sampling events showing no exceedances of the stated discharge limitations. If a discharge limitation for any parameter is exceeded the measurement frequency for all parameters shall again be weekly, until a period of 8 consecutive sampling events shows no exceedances at which point monthly monitoring may resume.

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Short - term high intensity monitoring (STHIM) program

a) The operator shall comply with the following monitoring schedule:

Outfall Number(s)	STHIM program	Due Date
001	The operator shall conduct a short term high intensity monitoring program for the following parameter, using the EPA Method and optimal MDL indicated in parentheses: PCBs, Aroclor 1242 (EPA Method 608, 0.065 µg/l). The program shall consist of both grab and composite samples taken on three (3) separate operating days. The operator shall report both the results of the analysis, as well as the MDL achieved during the analysis. The results shall be forwarded to the contact persor listed in Special Condition 1 on Page 1 of this discharge authorization.	Start of discharge + 90 days

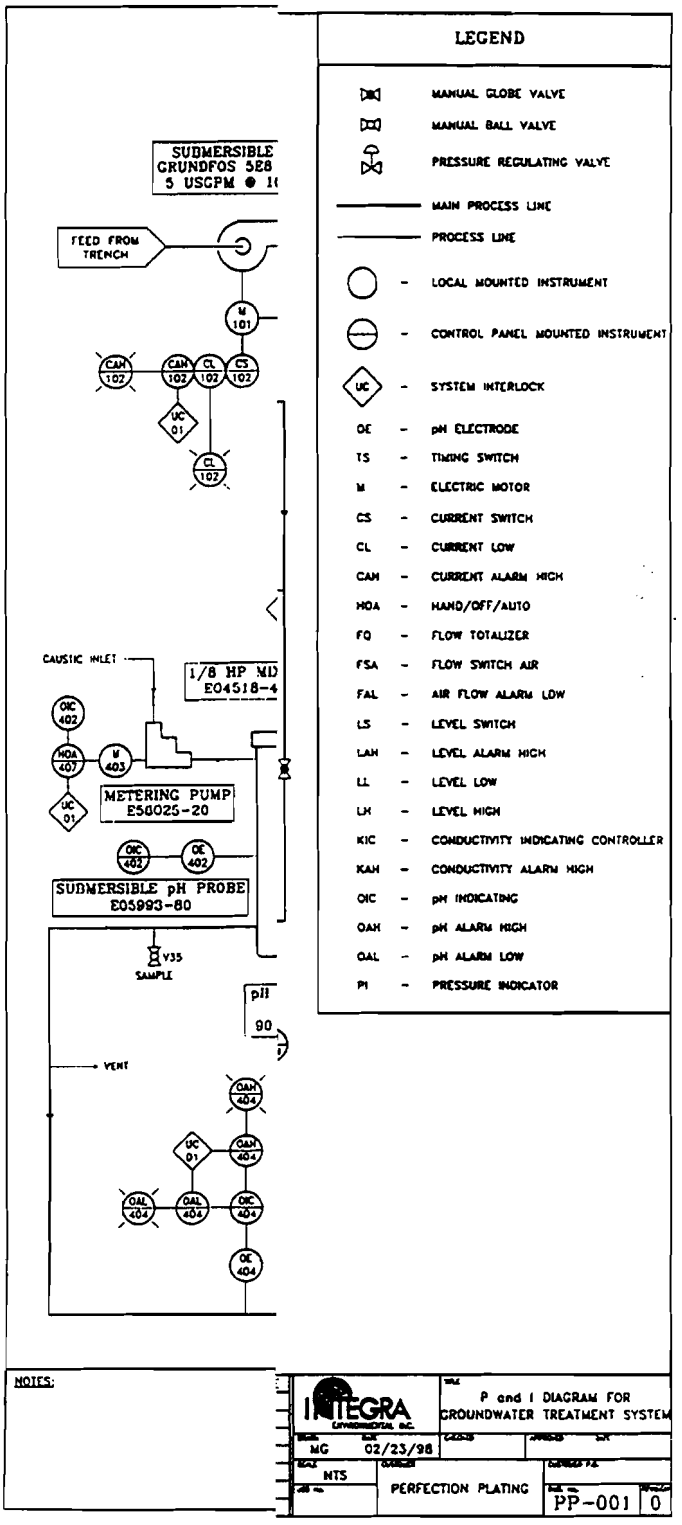


Figure 5-2 PIPING AND INSTRUMENTATION DIAGRAM FOR GROUNDWATER TREATMENT SYSTEM

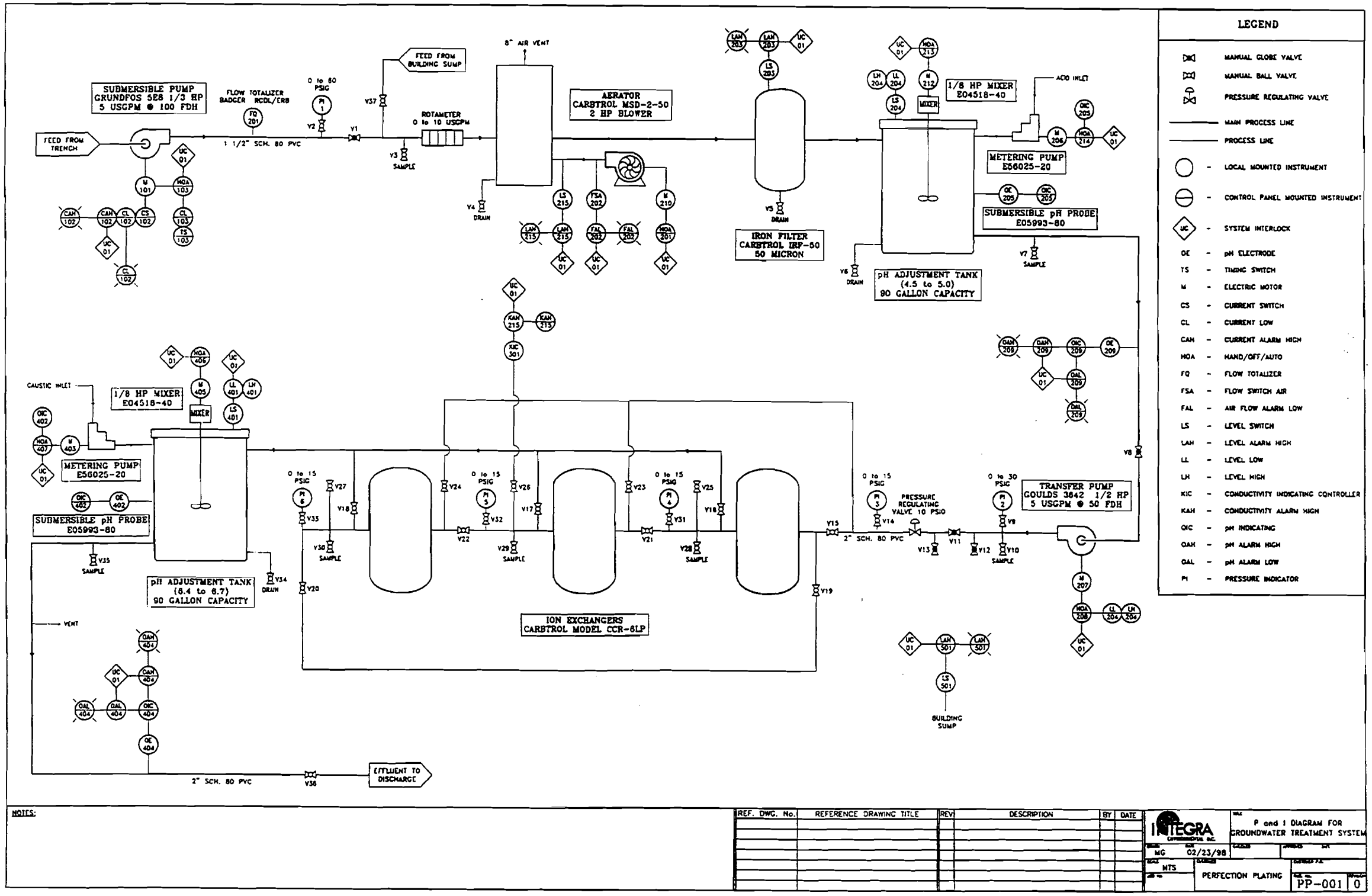
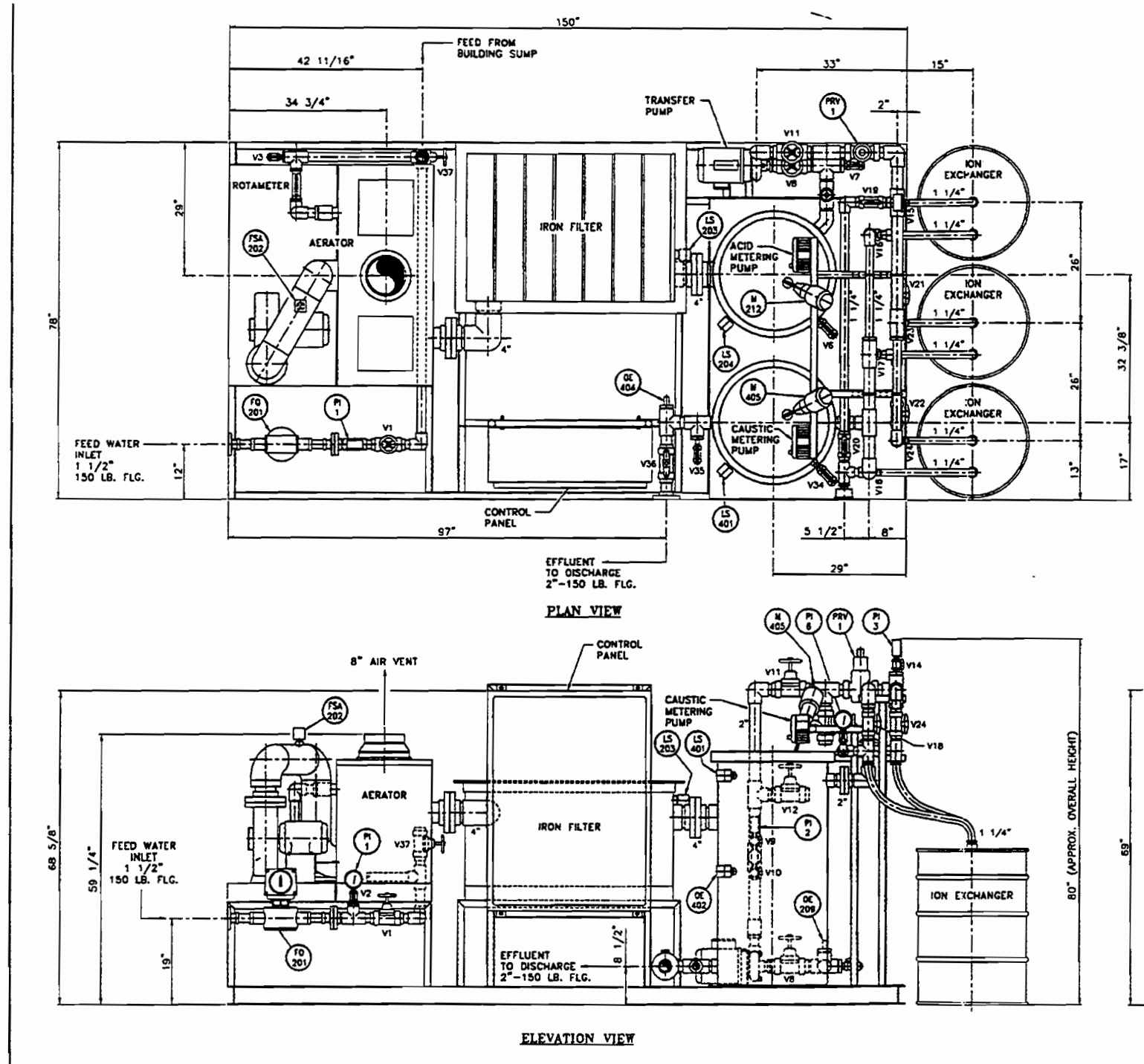
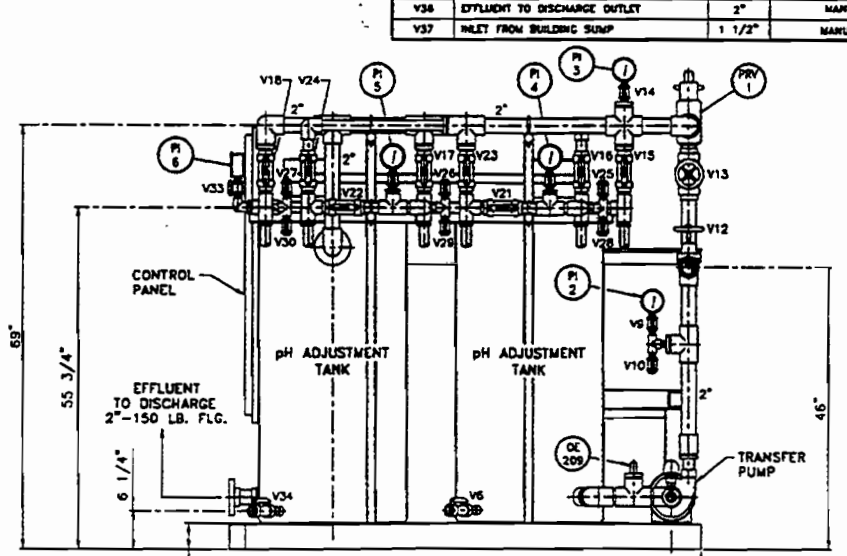


Figure 5-2 PIPING AND INSTRUMENTATION DIAGRAM FOR GROUNDWATER TREATMENT SYSTEM



PLAN VIEW

ELEVATION VIEW



RIGHT SIDE END VIEW
(ION EXCHANGERS OMITTED FOR CLARITY)

VALVE SCHEDULE

TAG	DESCRIPTION	SIZE	VALVE TYPE
V1	FEED WATER INLET	1 1/2"	MANUAL GLOBE
V2	PI-1 ISOLATOR	1/2"	MANUAL BALL
V3	SAMPLE VALVE	1/2"	MANUAL BALL
V4	AERATOR DRAIN	1"	MANUAL BALL
V5	IRON FILTER DRAIN	1 1/4"	MANUAL BALL
V6	pH ADJUSTMENT TANK DRAIN	3/4"	MANUAL BALL
V7	SAMPLE VALVE	1/2"	MANUAL BALL
V8	TRANSFER PUMP INLET	2"	MANUAL GLOBE
V9	PI-2 ISOLATOR	1/2"	MANUAL BALL
V10	SAMPLE VALVE	1/2"	MANUAL BALL
V11	TRANSFER PUMP DISCHARGE	2"	MANUAL GLOBE
V12	BLEED VALVE	2"	MANUAL GLOBE
V13	BLEED VALVE	2"	MANUAL GLOBE
V14	PI-3 ISOLATOR	1/2"	MANUAL BALL
V15	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V16	ION EXCHANGER OUTLET	1 1/4"	MANUAL BALL
V17	ION EXCHANGER OUTLET	1 1/4"	MANUAL BALL
V18	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V19	ION EXCHANGER BYPASS	1 1/4"	MANUAL BALL
V20	ION EXCHANGER BYPASS	1 1/4"	MANUAL BALL
V21	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V22	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V23	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V24	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V25	TO CONDUCTIVITY INDICATING CONTROLLER	1/2"	MANUAL BALL
V26	TO CONDUCTIVITY INDICATING CONTROLLER	1/2"	MANUAL BALL
V27	TO CONDUCTIVITY INDICATING CONTROLLER	1/2"	MANUAL BALL
V28	SAMPLE VALVE	1/2"	MANUAL BALL
V29	SAMPLE VALVE	1/2"	MANUAL BALL
V30	SAMPLE VALVE	1/2"	MANUAL BALL
V31	PI-4 ISOLATOR	1/2"	MANUAL BALL
V32	PI-5 ISOLATOR	1/2"	MANUAL BALL
V33	PI-6 ISOLATOR	1/2"	MANUAL BALL
V34	pH ADJUSTMENT TANK DRAIN	3/4"	MANUAL BALL
V35	SAMPLE VALVE	1/2"	MANUAL BALL
V36	EFFLUENT TO DISCHARGE OUTLET	2"	MANUAL BALL
V37	INLET FROM BUILDING SUMP	1 1/2"	MANUAL GLOBE

NOTES:
1) ALL PIPING IS SCH. 80 PVC PIPE AND SOCKETWELD PVC FITTINGS.

REF. DWG. No.	REFERENCE DRAWING TITLE

REV	DESCRIPTION	BY	DATE

INTEGRA ENVIRONMENTAL INC.

GENERAL ARRANGEMENT FOR GROUNDWATER TREATMENT SYSTEM

Drawn: MG Date: 03/17/97 Checked: Approved: Date:

Scale: 1"=1'-0" Customer: PERFECTION PLATING Customer P.O.

Job No. PP-002 Revision: 0

Figure 5-3 GENERAL ARRANGEMENT FOR GROUNDWATER TREATMENT SYSTEM

6 Contingency Plan

6.1 Emergency Contacts

The following phone numbers are provided for use in the event of an emergency at the site:

Fire:	City of Watervliet	(518) 270-3826 (Headquarters)
		(518) 273-6622 (to report a fire)
Police:	City of Watervliet	(518) 270-3833
Hospital:	Samaritan Hospital	(518) 271-3300
NYSDEC:	Ben Loredo	(518) 457-0927 (Office)
NYSDOH:	Richard Fedigan	(518) 458-6306

6.2 Hospital Route

From the site, proceed east on 12th Street; turn left onto Troy Shaker Road (Route 155); turn left onto Broadway (Route 32); turn right onto 19th Street (Route 2E); proceed across the Hudson River. Continue straight until the intersection with 15th Street; turn left onto 15th Street (past Rensselaer Polytechnic Institute [RPI]). Follow signs for hospital. Samaritan Hospital is on right side, at 2215 Burdett Avenue.

6.3 Safety Equipment

Various pieces of safety equipment are present in the treatment building. A first-aid kit is attached to the wall near the sink. A fire extinguisher and eye-wash station are to be kept and maintained in the building. Material Safety Data Sheets (MSDS) are attached to the wall next to the electrical panel.

6.4 Utilities

Contact utility providers in the event of a service outage or problem.

A Well Construction Logs

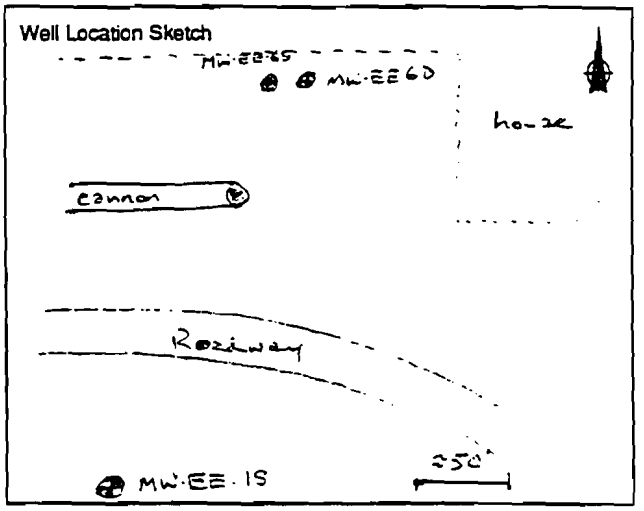
DRILLING LOG FOR MW-EE-1S

Project Name: Perfection Plating
Site Location: Waterviet, NY

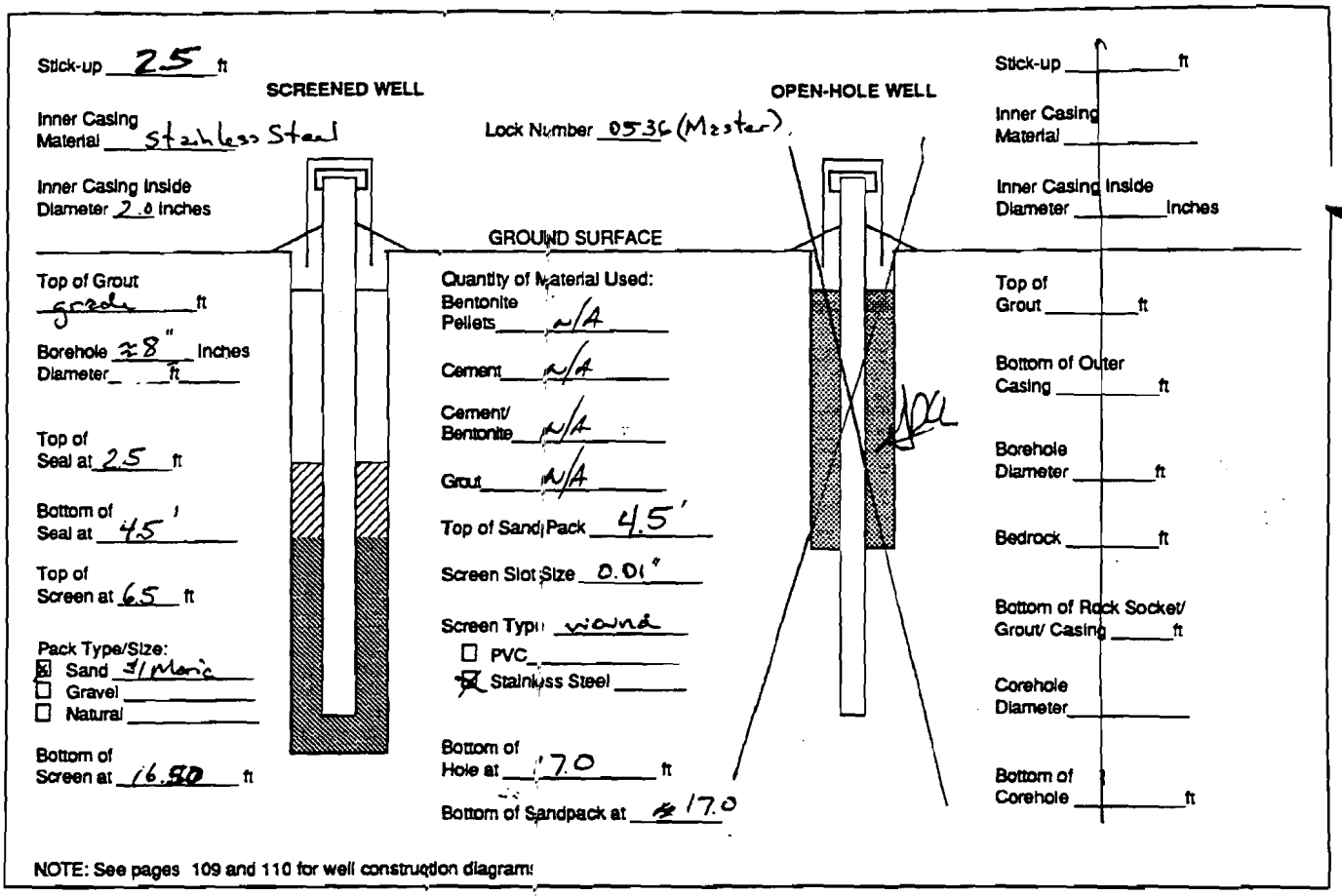
Date Started/Finished: 12/16/93 / 12/16/93
Drilling Company: Empire Drilling
Driller's Name: Rich Comfort
Geologist's Name: Greg Anders
Geologist's Signature:
Rig Type (s): CME-55
Drilling Method (s): HSA
Bit Size (s): — Auger Size (s): 4 1/4
Auger/Split Spoon Refusal: 10.8' spoon refusal
Total Depth of Borehole is: 17.5
Total Depth of Corehole is: n/a

Water Level (TOIC)		
Date	Time	Level(Feet)
1/11/94	09:49	5.28' p.t.c.

Well Location Sketch



Depth(Feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
1	1	5 | 2								n/a/n/a	(used both HNu & OVA)
2		9 | 10									[HNu/OVA]
3	2	10 | 9								n/a	
4		15 | 10								10.7ppm	
5	3	6 | 6								n/a	
6		4 | 2								5.7ppm	
7	5	3 | 2								n/a	
8		1 | 2								35.7ppm	
9	6	3 | 3								n/a	
10		4 | 6								100ppm	
11 (9.5')	7	3 | 100/3"								n/a	
12		/ /								n/a	
13			— no samples, (drilled rock socket from 17.5' to 19.5')								
14			- used 4"4" augers to install rock socket								



NOTE: See pages 109 and 110 for well construction diagrams

Depth-ft.	NARRATIVE LITHOLOGIC DESCRIPTION MW-EE-15	Moisture Content: Dry	Moist	Wet
1	1	brown cmf SAND and SILT, little fine GRAVEL - mottled appearance	○	○	○
	2	includes some apparent fill material + organic matl / shale fragments	○	⊗	○
	3	~~similar soil~~ tan-brown cmf SAND and cmf GRAVEL (shale frag.)	○	○	○
2	4	some SILT, more shale frag, less fill + organic matl	○	⊗	○
	5	brown cmf SAND and cmf GRAVEL (shale frag) little SILT	○	○	○
3	6	3/4 of analytical sample obtained	○	○	○
	7	similar soil to 7.5' b.g.s.: then dk brown CLAY and SILT trace little	○	○	○
4	8	mf SAND 1/4 of analytical sample obtained (volatiles)	○	⊗	○
	9	brown-grey CLAY & some SILT, trace mf SAND	○	○	○
5	10		○	⊗	○
	11	grey-brown SILT and CLAY, little mf SAND, little larger (shale)	○	○	○
6	12	shale frags @ bottom of spoon upon withdrawal from augers (Atterberg sample)	○	○	⊗
	13	- bedrock encountered @ 12.0' b.g.s.	○	○	○
	14	- no samples (drilled rock socket to ≈17.0' b.g.s.)	○	○	○
		used 4 1/4" augers to install rock socket	○	○	○

Depth(feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
16			no sample - drilled rock socket using 4¼" augers								
17			bottom of borehole = 17'0" b.g.s.								
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											

Depth(feet).	NARRATIVE LITHOLOGIC DESCRIPTION	Moisture Content: Dry	Moist	Wet
	MW-EE-15			
16	- no samples - drilled rock socket	○	○	○
	using 14¼" augers	○	○	○
17	- bottom of borehole = 17'0" b.g.s.	○	○	○
18		○	○	○
19		○	○	○
20		○	○	○
21		○	○	○
22		○	○	○
23		○	○	○
24		○	○	○
25		○	○	○
26		○	○	○
27		○	○	○
28		○	○	○
29		○	○	○
30		○	○	○
31		○	○	○
32		○	○	○
33		○	○	○
34		○	○	○
35		○	○	○
36		○	○	○
37		○	○	○
38		○	○	○
39		○	○	○
40		○	○	○
41		○	○	○
42		○	○	○
43		○	○	○
44		○	○	○

WELL DEVELOPMENT RECORD

SITE Rafeton Plating Site no 4-01-037 DATE 12-22-93

LOCATION Watervliet Arsenal property WELL NO. MW-EE-15
Sibson Ave Watervliet NY

MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2(0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for r^2h factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = 1.47 gallons.

Volume of Water in Casing or Hole

Diameter of Casing or Hole (in)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth	Liter per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509×10^{-3}
11/2	0.092	0.0123	1.142	1.142×10^{-3}
2	0.163	0.0218	2.024	2.024×10^{-3}
21/2	0.255	0.0341	3.167	3.167×10^{-3}
3	0.367	0.0491	4.558	4.558×10^{-3}
31/2	0.500	0.0668	6.209	6.209×10^{-3}
4	0.653	0.0873	8.110	8.110×10^{-3}
41/2	0.826	0.1104	10.260	10.260×10^{-3}
5	1.020	0.1364	12.670	12.670×10^{-3}
51/2	1.234	0.1650	15.330	15.330×10^{-3}
6	1.469	0.1963	18.240	18.240×10^{-3}
7	2.000	0.2673	24.840	24.840×10^{-3}
8	2.611	0.3491	32.430	32.430×10^{-3}
9	3.305	0.4418	41.040	41.040×10^{-3}
10	4.080	0.5454	50.670	50.670×10^{-3}
11	4.937	0.6600	61.310	61.310×10^{-3}
12	5.875	0.7854	72.960	72.960×10^{-3}
14	8.000	1.0690	99.350	99.350×10^{-3}
16	10.440	1.3960	129.650	129.650×10^{-3}
18	13.220	1.7670	164.180	164.180×10^{-3}
20	16.320	2.1820	202.680	202.680×10^{-3}
22	19.750	2.6400	245.280	245.280×10^{-3}
24	23.500	3.1420	291.850	291.850×10^{-3}
26	27.580	3.6870	342.520	342.520×10^{-3}
28	32.000	4.2760	397.410	397.410×10^{-3}
30	36.720	4.9090	456.020	456.020×10^{-3}
32	41.780	5.5850	518.870	518.870×10^{-3}
34	47.160	6.3050	585.680	585.680×10^{-3}
36	52.880	7.0690	656.720	656.720×10^{-3}

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 37.785 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = 12.419×10^{-3} cubic meters per meter of depth

INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 7.46
WELL DEPTH (TD) 11.47
COLOR Gray
ODOR N/A
CLARITY >200

FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 8.0 - est
WELL DEPTH (TD) 16.50 - est
COLOR dark gray
ODOR none
CLARITY poor

DESCRIPTION OF DEVELOPMENT TECHNIQUE hand bailed w/ PVC bailer

WELL DEVELOPMENT - PARAMETER MEASUREMENTS

TIME	TOTAL VOL. WITHDRAWN		pH	COND. (umhos/cm)	TEMP. (C) F	TURB. (NTU)	COMMENTS
	GALS.	BORE VOL.					
12-22-93 1015	0.5	0.3	9.40	1670	44°	>>200	
1022	4.0	2.7	9.17	1360	43°	>>200	
1105	5.5	3.9	9.15	1370	43°	>>200	
1305	6.5	4.4	9.33	1510	47°	>>200	
12-28-93 1453	6.75	4.6	10.28	1700	50.7°	>>200	
1458	9.5	6.5	9.9	1660	46°	>>200	
12/20 —							
0825	12.0	8.16	10.4	1210	47°	>>200	
1019	~~15.0~~ EXIT	10.2	8.46	1393	52°	>>200	
12:52	17.5	11.9	10.25	1185	51.0°	>>200	
14:05	18.0	10.9	10.9	1620	51.0°	>>200	sufficiently developed per DEC

DEVELOPED BY: [signature] DATE 12/22-30/93

DATE
STARTED 10/12/88
FINISHED 10/12/88
SHEET 1 OF 1

EMPIRE SOILS INVESTIGATIONS INC. SUBSURFACE LOG

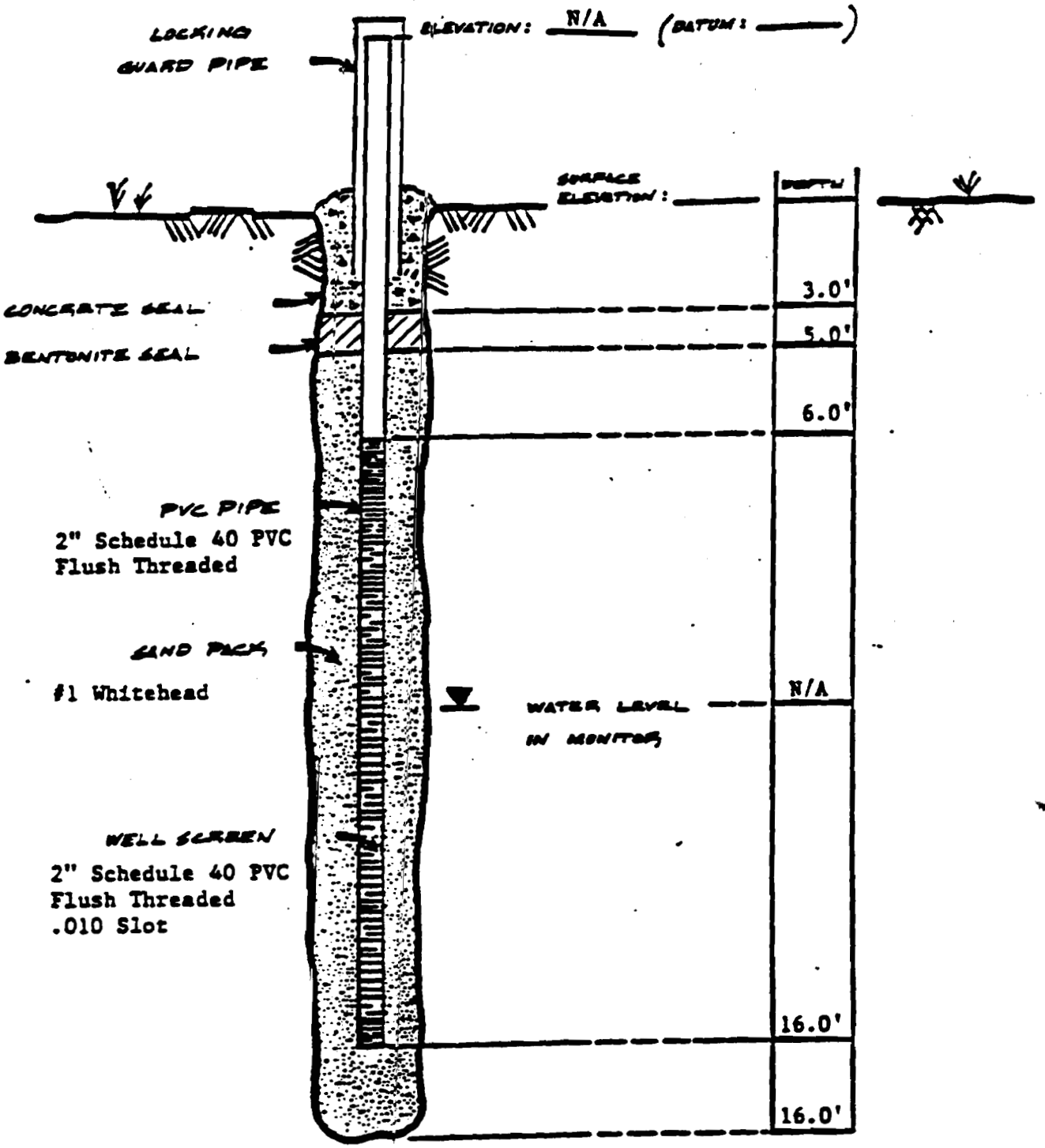
(MW-CTM-4)
HOLE NO. MW-4
SURF. ELEV.
G. W. DEPTH See Note #1

PROJECT Perfection Plating
LOCATION Watervliet, N.Y.

DEPTH	SAMPLES	SAMPLE NO	BLOWS ON SAMPLER 0/6	6/12	12/18	N	BLOW ON CASING C	SOIL OR ROCK CLASSIFICATION	NOTES
0		1	3	5		10		Misc. Fill	Note #1: At completion of boring, a 2" PVC groundwater monitor well, with ten (10) feet of .010 inch slot screen, was installed to a depth of 16.0'. Filter sand pack 16.0-5.0'. Bentonite seal 5.0'-3.0'. Locking guard pipe installed @ ground surface.
			5	7					
		2	12	11		21		-No recovery	
			10	12				(Damp-Loose to Firm)	
5		3	22	31		68		Brown Glacial TILL; grade weathered shale (Damp-Very Compact)	
			37	66					
		4	100/.4					Grey SHALE	
10								Note: Tri-Cone roller bit advanced 6.0-16.0'.	
15									
								END OF BORING @ 16.0'.	
20									

N = No blows to drive 2 " spoon 12 " with 140 lb pen wt. falling 30 "per blow
C = No blows to drive " casing " with lb. weight falling "per blow
METHOD OF INVESTIGATION 4 1/4" I.D. Hollow Stem Auger, 3 7/8" Tri-Cone Button Bit.

CLASSIFICATION Visual by Driller



WELL No.

MW-4

(MW-CTM-4)

EMPIRE SOILS INVESTIGATION, INC.

MONITORING WELL DETAILS

PERFECTION PLATING
WATERVLIET, N.Y.

DR BY	RWD	SCALE	N.T.S.	PROJ NO	AD-8
CK'D BY		DATE	11/2/88	DRWG NO	—

WELL DEVELOPMENT RECORD

SITE Perfection Plating DATE 8/2 + 3/93

LOCATION Watervliet NY WELL NO. MW-CTM-4

MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2(0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for r^2h factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = 1.90 gallons.

Volume of Water in Casing or Hole

Diameter of Casing or Hole (in)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth	Liter per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509×10^{-3}
11/2	0.092	0.0123	1.142	1.142×10^{-3}
2	0.163	0.0218	2.024	2.024×10^{-3}
21/2	0.255	0.0341	3.167	3.167×10^{-3}
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31/2	0.500	0.0668	6.209	6.209×10^{-3}
4	0.653	0.0873	8.110	8.110×10^{-3}
41/2	0.826	0.1104	10.260	10.260×10^{-3}
5	1.020	0.1364	12.670	12.670×10^{-3}
51/2	1.234	0.1650	15.330	15.330×10^{-3}
6	1.469	0.1963	18.240	18.240×10^{-3}
7	2.000	0.2673	24.840	24.840×10^{-3}
8	2.611	0.3491	32.430	32.430×10^{-3}
9	3.305	0.4418	41.040	41.040×10^{-3}
10	4.080	0.5454	50.670	50.670×10^{-3}
11	4.937	0.6600	61.310	61.310×10^{-3}
12	5.875	0.7854	72.960	72.960×10^{-3}
14	8.000	1.0690	99.350	99.350×10^{-3}
16	10.440	1.3960	129.650	129.650×10^{-3}
18	13.220	1.7670	164.180	164.180×10^{-3}
20	16.320	2.1820	202.680	202.680×10^{-3}
22	19.750	2.6400	245.280	245.280×10^{-3}
24	23.500	3.1420	291.850	291.850×10^{-3}
26	27.580	3.6870	342.520	342.520×10^{-3}
28	32.000	4.2760	397.410	397.410×10^{-3}
30	36.720	4.9090	456.020	456.020×10^{-3}
32	41.780	5.5850	518.870	518.870×10^{-3}
34	47.160	6.3050	585.680	585.680×10^{-3}
36	52.880	7.0690	656.720	656.720×10^{-3}

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 37.785 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = 12.419×10^{-3} cubic meters per meter of depth

INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 7.85
WELL DEPTH (TD) 19.46
COLOR Gray
ODOR -
CLARITY -

FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC)
WELL DEPTH (TD)
COLOR
ODOR
CLARITY

DESCRIPTION OF DEVELOPMENT TECHNIQUE Hand bailing, Development began on 8/2/93 and was completed on 8-3-93

WELL DEVELOPMENT - PARAMETER MEASUREMENTS

MW-CTM-4

TIME	TOTAL VOL. WITHDRAWN		pH	COND. (umhos/cm)	TEMP. (Ø)F	TURB. (NTU)	COMMENTS
	GALS.	BORE VOL.					
1455	1.5	0.79	7.18	1139	70°	>200	8/2/93
1515	5.0	2.65	7.41	880	64°	>200	↓
730	5.25	2.78	8.19	877	63°	>200	8/3/93
740	10	5.26	7.81	870	62°	>200	
912	12.5	6.58	7.79	9.21	68°	>200	
916	15	7.89	7.50	8.73	66°	>200	
923	17.5	9.26	7.54	9.01	67°	>200	
928	22.5	11.84	7.60	9.07	65°	>200	↓

DEVELOPED BY: Buffalo well Drilling / JCL DATE 8/2, 3/93

DRILLING LOG FOR MW-EE-4D

Project Name Perfection Plating

Site Location NYSDEC Site no. 4-01-037
Watervliet NY

Date Started/Finished 7-22-93 / 8-3-93

Drilling Company Buffalo Well Drilling

Driller's Name Larry Schroeder

Geologist's Name Jim MacKerchaie

Geologist's Signature James D. MacKerchaie

Rig Type (s) Truck Mounted CME-55

Drilling Method (s) Hollow stem Auger/core

Bit Size (s) HQ Auger Size (s) 4.25"

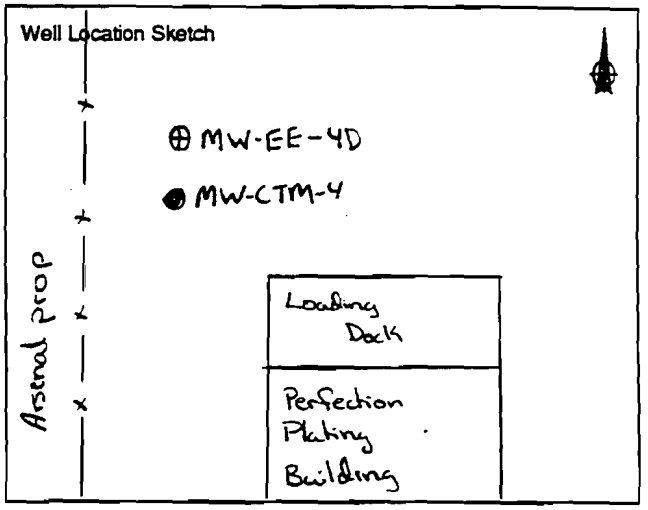
Auger/Split Spoon Refusal 19' Auger / 4.75' split spoon

Total Depth of Borehole is 19.0'

Total Depth of Corehole is 49.1

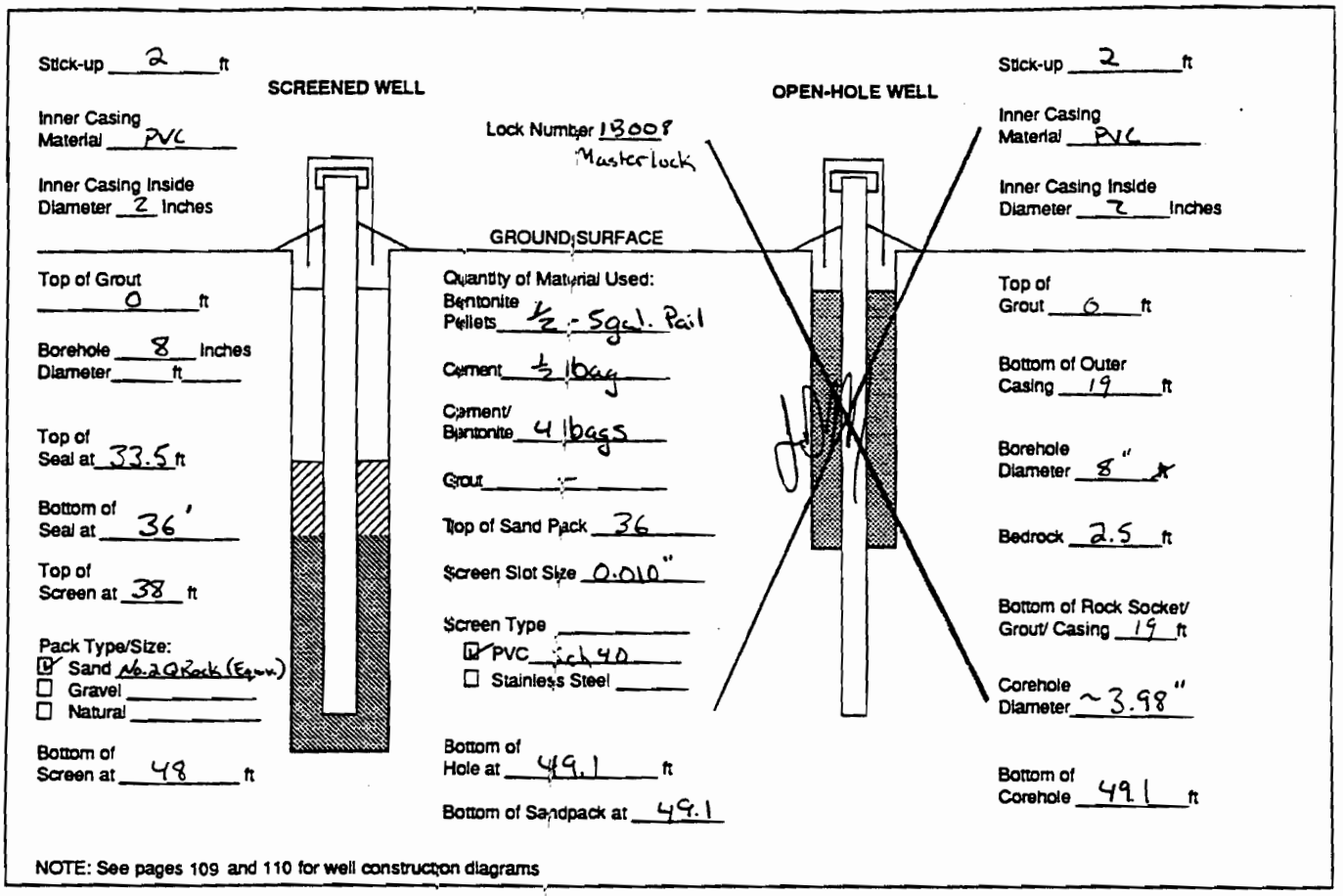
Water Level (TOIC)		
Date	Time	Level(Feet)
8-4-93	0852	7.81'
1-11-94	1418	6.55'

Well Location Sketch



Depth(Feet)	Sample Number	Blows on Sampler		Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	~~HNU~~/OVA (ppm)	Comments
1	1	5	9								ND	Retained 0-2' for chemical analysis
2		12	5									
3	2	7	12								ND	Retained 3-4'6" for geotechnical analysis
4		20	39									
5	3	51	100/3"								ND	(4'-4'6")
6												Auger to 19' and set a 5" I.D. carbon steel casing at 19' and grouted into place.
7												
8												
9												
10												
11												
12												
13												
14												

recycled paper



NOTE: See pages 109 and 110 for well construction diagrams

Depth-ft.	NARRATIVE LITHOLOGIC DESCRIPTION MW-EE-40	Moisture Content: Dry	Moist	Wet
1	0' - 0.25' Organic rich Soil	⊗	○	○
2	0.25' - 2.5' brown GRAVEL and SILT some SAND - fill material	⊗	○	○
3	bricks present.	⊗	○	○
4	2.5' - 5' Severely weathered blackish Gray Shale with	⊗	○	○
5	near vertical fractures, highly friable	⊗	○	○
6	5'-19' no samples obtain - severely weathered blackish	○	○	○
7	gray shale.	○	○	○
8		○	○	○
9		○	○	○
10		○	○	○
11		○	○	○
12		○	○	○
13		○	○	○
14		○	○	○

MW-EE-4D

Depth(feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
16											
17											
18											
19											
20											Core Run 1
21						1	95%	72%		ND	19.0'-24.5'
22											
23											
24											
25											Core run 2
26						2	100%	92%		ND	24.5'-29.5'
27											
28											
29											
30											Core Run 3
31						3	100%	80%		ND	29.5'-34.5'
32											
33											
34											
35											Core run 4
36						4	100%	82%		ND	34.5'-39.5'
37											
38											
39											
40											Core Run 5
41						5	100%	90%		ND	39.5'-44.5'
42											
43											
44											

Depth(feet).	NARRATIVE LITHOLOGIC DESCRIPTION MW-EE-4D	Moisture Content Dry Moist Wet
16		○ ○ ○
17		○ ○ ○
18		○ ○ ○
19		○ ○ ○
20	19.5'-24.5' dark gray shale slightly metamorphosed with	○ ○ ○
21	beds ~60° post horizontal appears to be	○ ○ ○
22	competent.	○ ○ ○
23		○ ○ ○
24		○ ○ ○
25	24.5-29.5 Same (dk gray shale)	○ ○ ○
26	26' secondary pyrite present in ~60° fractures	○ ○ ○
27	along bedding plane.	○ ○ ○
28		○ ○ ○
29		○ ○ ○
30	29.5-34.5 Same (dk gray shale) with secondary pyrite at 33.3'.	○ ○ ○
31		○ ○ ○
32		○ ○ ○
33		○ ○ ○
34	34' fractures along bedding planes become very close	○ ○ ○
35	(<2 inches apart)	○ ○ ○
36	34.5-39.5 same (dk gray shale)	○ ○ ○
37	35.5' secondary pyrite in ~60° fractures along bedding planes	○ ○ ○
38	37.8' Same	○ ○ ○
39	38.6 same	○ ○ ○
40	39.2 same	○ ○ ○
41	39.5-44.5 Same (dk gray shale)	○ ○ ○
42	39.5 Secondary pyrite in ~60° fractures along bedding planes	○ ○ ○
43	41.6 Secondary pyrite in ~60° fractures along bedding planes	○ ○ ○
44	also discontinuous bedding planes appears to have	○ ○ ○
	been fractures that filled with a quartz cement.	○ ○ ○

MW-EE-40

Depth(feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNU/OVA (ppm)	Comments
46											Core Run 6
47						6	100%	90%		ND	44.5-49.1
48											
49											
50											Total Depth 49.1
51											
52											
53											
54											
55											
56											
57											
58											
59											
60											
61											
62											
63											
64											
65											
67											
68											
69											
70											
71											
72											
73											
74											
75											

Depth(feet)	MW-EE-4D NARRATIVE LITHOLOGIC DESCRIPTION	Moisture Content Dry	Moist	Wet
46	44.5 - 49.1 Similar dk gray shale with parting present			
47	44.9 secondary pyrite in fractures.			
48				
49				
50	— Total Depth Core 49.1'. —			
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65				
67				
68				
69				
70				
71				
72				
73				
74				
75				

WELL DEVELOPMENT RECORD

SITE Perfection Plating DATE 8/4/93

LOCATION Wakefield NY WELL NO. MW-EF4(D)

MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2(0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for r^2h factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = 6.85 gallons.

Volume of Water in Casing or Hole

Diameter of Casing or Hole (in)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth	Liter per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509×10^{-3}
11/2	0.092	0.0123	1.142	1.142×10^{-3}
2	0.163	0.0218	2.024	2.024×10^{-3}
21/2	0.255	0.0341	3.167	3.167×10^{-3}
3	0.367	0.0491	4.558	4.558×10^{-3}
31/2	0.500	0.0668	6.209	6.209×10^{-3}
4	0.653	0.0873	8.110	8.110×10^{-3}
41/2	0.826	0.1104	10.260	10.260×10^{-3}
5	1.020	0.1364	12.670	12.670×10^{-3}
51/2	1.234	0.1650	15.330	15.330×10^{-3}
6	1.469	0.1963	18.240	18.240×10^{-3}
7	2.000	0.2673	24.840	24.840×10^{-3}
8	2.611	0.3491	32.430	32.430×10^{-3}
9	3.305	0.4418	41.040	41.040×10^{-3}
10	4.080	0.5454	50.670	50.670×10^{-3}
11	4.937	0.6600	61.310	61.310×10^{-3}
12	5.875	0.7854	72.960	72.960×10^{-3}
14	8.000	1.0690	99.350	99.350×10^{-3}
16	10.440	1.3960	129.650	129.650×10^{-3}
18	13.220	1.7670	164.180	164.180×10^{-3}
20	16.320	2.1820	202.680	202.680×10^{-3}
22	19.750	2.6400	245.280	245.280×10^{-3}
24	23.500	3.1420	291.850	291.850×10^{-3}
26	27.580	3.6870	342.520	342.520×10^{-3}
28	32.000	4.2760	397.410	397.410×10^{-3}
30	36.720	4.9090	456.020	456.020×10^{-3}
32	41.780	5.5850	518.870	518.870×10^{-3}
34	47.160	6.3050	585.680	585.680×10^{-3}
36	52.880	7.0690	656.720	656.720×10^{-3}

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 37.785 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = 12.419×10^{-3} cubic meters per meter of depth

INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 7.81
WELL DEPTH (TD) 50.01
COLOR (Gray)
ODOR —
CLARITY ~~>2200~~ 48.8 NTU

FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 45.22 (top of Bailer)
WELL DEPTH (TD) 45.23 (top of Bailer)
COLOR (Gray)
ODOR —
CLARITY >2200

DESCRIPTION OF DEVELOPMENT TECHNIQUE Hand bailing
- Bailer became lodged in well unable to remove bailer

WELL DEVELOPMENT - PARAMETER MEASUREMENTS

MW-EE-4D

TIME	TOTAL VOL. WITHDRAWN		pH	COND. (umhos/cm) x100	TEMP. (Ø) F	TURB. (NTU)	COMMENTS
	GALS.	BORE VOL.					
852	0	–	9.51	5.48	70.0	48.8	
856	4.0	0.58	6.50	5.46	71.3	46	
0943	5.5	0.80	6.50	5.84	70.0	>7200	
1020	5.75	0.84	9.5	5.5	70.4	>200	
1400	5.85	0.85	10.0	7.42	69.5	>200	Bailer became stuck in well. Due to slow recovery development was stopped

DEVELOPED BY: B. [redacted] Well Drilling DATE 8-4-93

(MW-EA-5)

EA ENGINEERING, SCIENCE AND TECHNOLOGY, INC.

LOG OF SOIL BORING

JOB NO.	CLIENT	LOCATION
WVA-81A	WATERVLIET ARSENAL	S. Berlin

DRILLING METHOD: UNIMOG CME-45 Truck Mounted Drill Rig: 4¼ I.D. and 6¾ OD. Augers

SAMPLING METHOD: 2" Ø x 2' Split Spoon Driven w/ 140 lbs hammer and 30" Throw

BORING NO.: MW-5

SHEET: 1 of 1

DRILLING	START	FINISH
TIME	1135	
DATE	4/5/88	

	TIME	DATE
WATER LEVEL		
REFERENCE		

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description:

180' from corner 8' ∞

DRILLING CONTR: Empire So. Ill Inc.

DRILLER: Mike Lenahan

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/6 in SAMPLER	DEPTH IN FEET	GRAPHIC LOG
				3	0	
SS	24/12		1/0-2'	4	1	
				4		
				3	2	
				5		
SS	41'/16"		2/2-4	6	3	
				9		
				5	4	
				2		
SS	24/18"		3/4-6	8	5	
				22		
				25	6	
				31		
SS	08"/18"		4/6-7.5	70	7	
				70		
				63/1"	8	
					9	
					10	
					11	
					12	
					13	
					14	
					15	
					16	
					17	
					18	
					19	
					20	

SURFACE CONDITIONS:

DK BRN SILTY SOIL w/ roots little gravel

Lt BRN silt w/ red brick shale fragments cement dry. Blocks of cement had to be dug out by drillers. Advance Auger first 2'.

As Above w/ glass metal

6" BRN clayey silt w/ shale frag. wet

14" Blue/grey - BLK weathered shale some clay and silt dry Clay balls coming up auger @ 4'

weathered shale As above Spoon refusal 63/1" at 7.5'

Auger refusal @ 5.5'

DRILLED BY: Tom Ruth

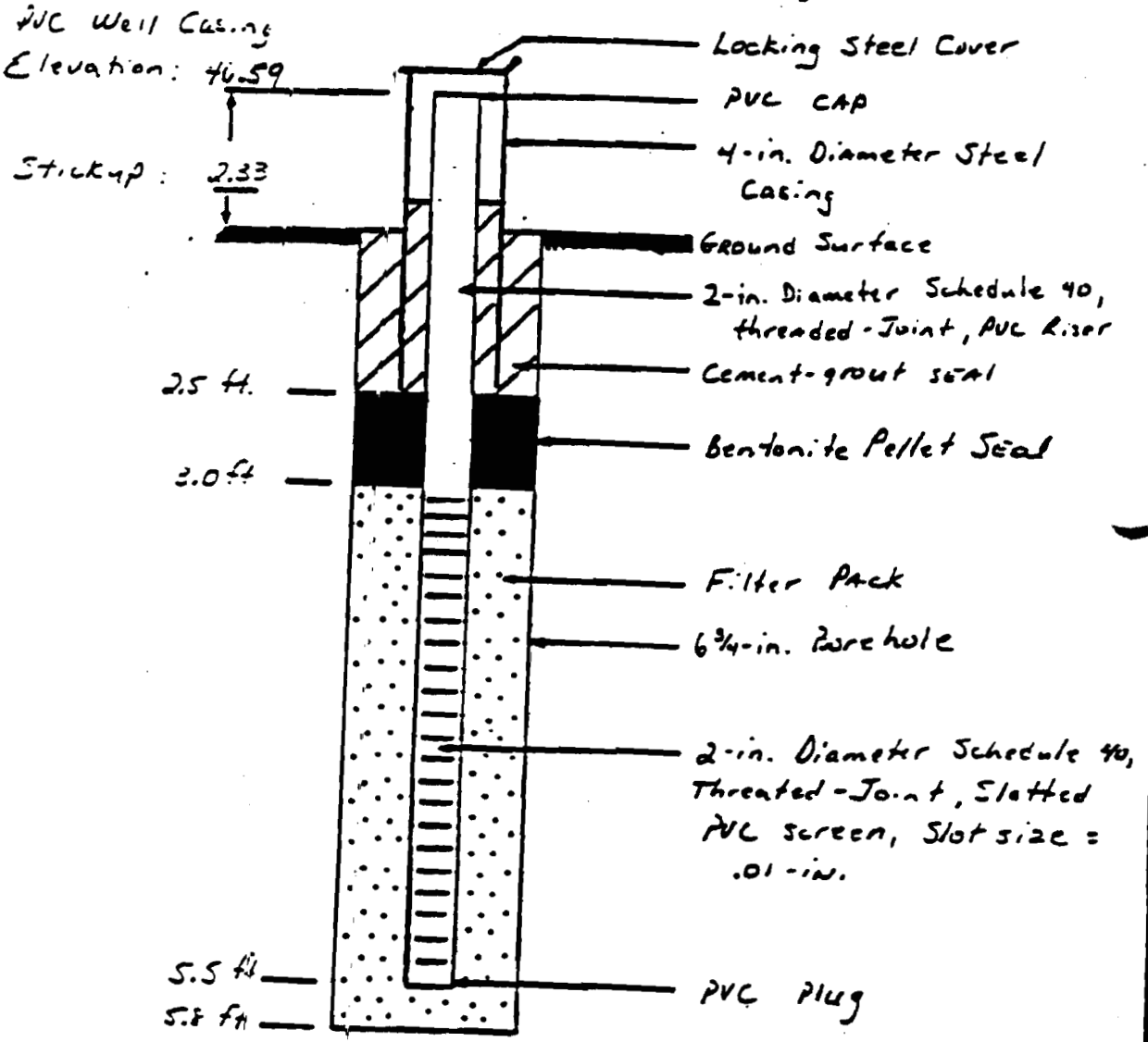
DATE:

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COMPLETION DIAGRAM

WELL MW-5 (MW-EA-5)



DRILLING LOG FOR MW-EE-55

Project Name Perfection Plating

Site Location NYSDEC Site # 4-01-037

Watervliet NY

Date Started/Finished 7-22-93 / 7-23-93

Drilling Company Buffalo Well Drilling

Driller's Name Larry Schroeder

Geologist's Name Jim MacKecknie

Geologist's Signature

Rig Type (s) Truck mounted, CME-55

Drilling Method (s) Hollow Stem Augers

Bit Size (s) — Auger Size (s) 4.25"

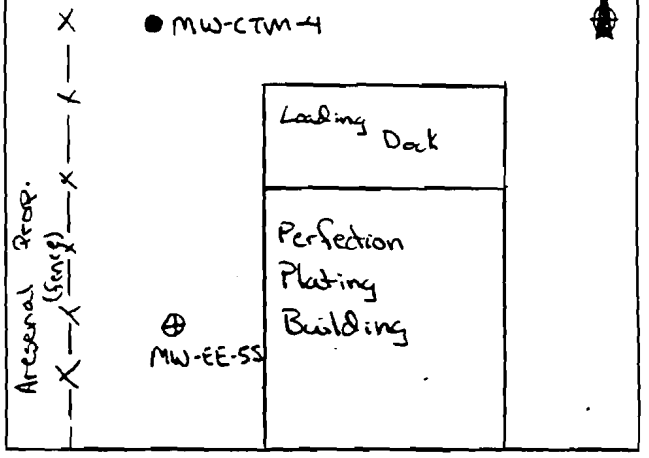
Auger/Split Spoon Refusal 17.5' Auger / 7'10" Split Spoon

Total Depth of Borehole Is 17.5'

Total Depth of Corehole Is —

Water Level (TOIC)		
Date	Time	Level (Feet)
7-28-93	1147	10.19'
1-11-94	1442	9.97

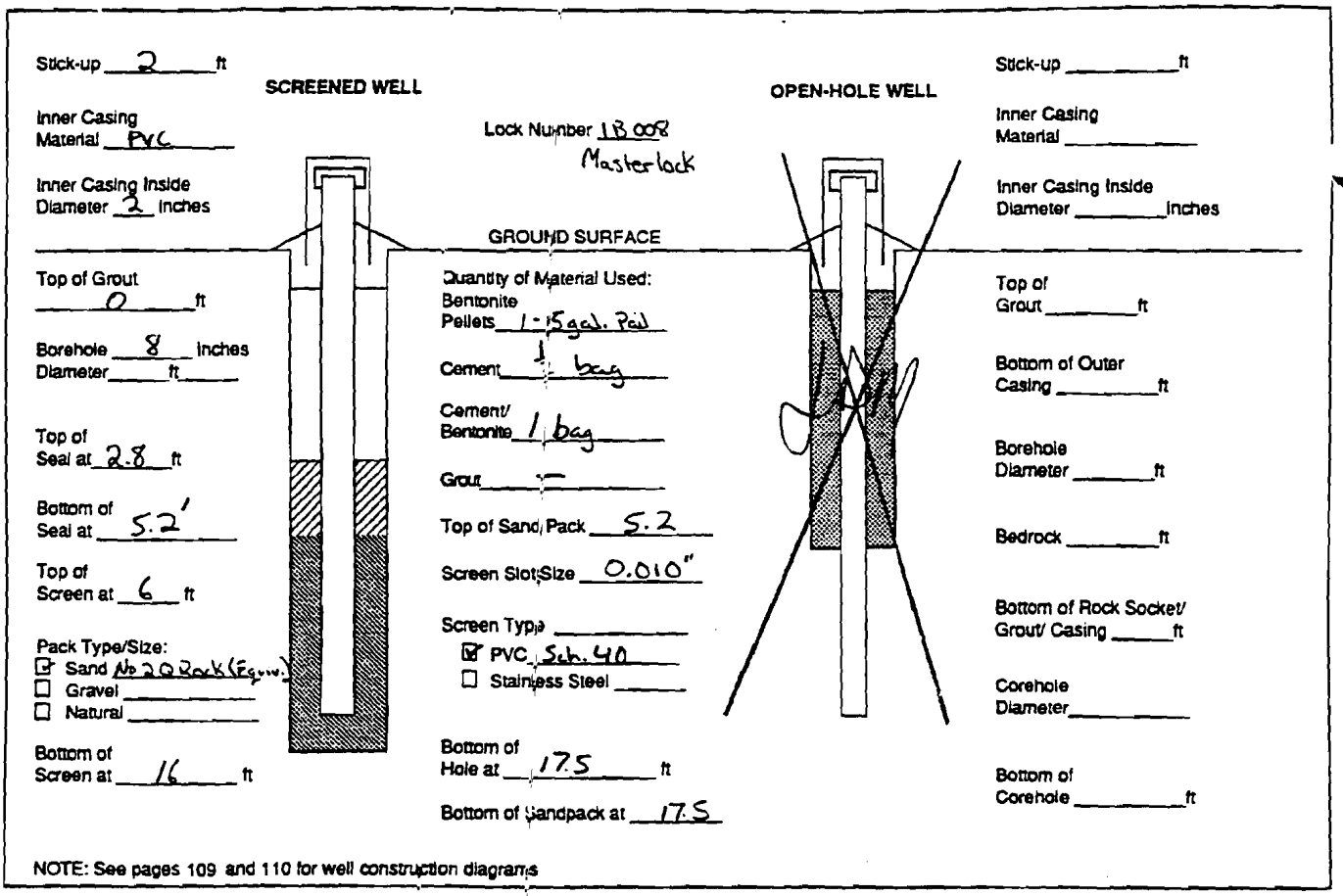
Well Location Sketch MW-EE-40



Depth (Feet)	Sample Number	Blows on Sampler		Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
1	1	4	6								ND	
2		7	8									
3	2	8	10								ND	Retained 3'-5' for Geotechnical analysis
4		18	18									
5	3	12	10								ND	
6		8	8									
7	4	8	35								ND	
		76	100/4"									
8												
9												
10												
11												
12												
13												
14												

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ecology and environment



NOTE: See pages 109 and 110 for well construction diagrams

Depth-ft.	NARRATIVE LITHOLOGIC DESCRIPTION MW-EE-55	Moisture Content Dry	Moist	Wet
1	0-2' brown mf SAND, GRAVEL and SILT - poorly sorted -	⊗	○	○
2		⊗	○	○
3	2-3' brown mf SAND, GRAVEL and SILT - Fill material brick present	⊗	○	○
4	3-6' brown GRAVEL, some SILT, little SAND	⊗	○	○
5	(brick present at 5'6")	⊗	○	○
6		⊗	○	○
7		○	○	○
8	7-8' Severely weathered shale (grayish-black)	○	○	○
9		○	○	○
10	- No additional Split Spoon Samples -	○	○	○
11	Visual inspection of drilling spoils indicate	○	○	○
12	shale to 17.5 auger refusal	○	○	○
13				
14		○	○	○
		○	○	○

MW-EE-5S

Depth(feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
16											
17											
18											Total Depth 17.5'
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											

WELL DEVELOPMENT RECORD

SITE Perfection Plating DATE ~~3DM~~ 7/28/93

LOCATION Watervliet NY WELL NO. MW-EE-55

MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2(0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for r^2h factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = 1.26 gallons.

Volume of Water in Casing or Hole

Diameter of Casing or Hole (in)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth	Liter per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509×10^{-3}
1 1/2	0.092	0.0123	1.142	1.142×10^{-3}
2	0.163	0.0218	2.024	2.024×10^{-3}
2 1/2	0.255	0.0341	3.167	3.167×10^{-3}
3	0.367	0.0491	4.558	4.558×10^{-3}
3 1/2	0.500	0.0668	6.209	6.209×10^{-3}
4	0.653	0.0873	8.110	8.110×10^{-3}
4 1/2	0.826	0.1104	10.260	10.260×10^{-3}
5	1.020	0.1364	12.670	12.670×10^{-3}
5 1/2	1.234	0.1650	15.330	15.330×10^{-3}
6	1.469	0.1963	18.240	18.240×10^{-3}
7	2.000	0.2673	24.840	24.840×10^{-3}
8	2.611	0.3491	32.430	32.430×10^{-3}
9	3.305	0.4418	41.040	41.040×10^{-3}
10	4.080	0.5454	50.670	50.670×10^{-3}
11	4.937	0.6600	61.310	61.310×10^{-3}
12	5.875	0.7854	72.960	72.960×10^{-3}
14	8.000	1.0690	99.350	99.350×10^{-3}
16	10.440	1.3960	129.650	129.650×10^{-3}
18	13.220	1.7670	164.180	164.180×10^{-3}
20	16.320	2.1820	202.680	202.680×10^{-3}
22	19.750	2.6400	245.280	245.280×10^{-3}
24	23.500	3.1420	291.850	291.850×10^{-3}
26	27.580	3.6870	342.520	342.520×10^{-3}
28	32.000	4.2760	397.410	397.410×10^{-3}
30	36.720	4.9090	456.020	456.020×10^{-3}
32	41.780	5.5850	518.870	518.870×10^{-3}
34	47.160	6.3050	585.680	585.680×10^{-3}
36	52.880	7.0690	656.720	656.720×10^{-3}

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 37.785 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = 12.419×10^{-3} cubic meters per meter of depth

INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 10.19'
WELL DEPTH (TD) 17.95
COLOR yellow
ODOR —
CLARITY ~~silty~~ 2205

FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC)
WELL DEPTH (TD) 17.95
COLOR yellow
ODOR —
CLARITY 2200

DESCRIPTION OF DEVELOPMENT TECHNIQUE Hand Bailing

WELL DEVELOPMENT - PARAMETER MEASUREMENTS

MW-EE-5S

TIME	TOTAL VOL. WITHDRAWN		pH	COND. (umhos/cm)	TEMP. (℃)	TURB. (NTU)	COMMENTS
	GALS.	BORE VOL.					
1156	30	2.34	7.04	1368	62°F	>200	
1207	9.6	7.14	6.70	1540	6.2°	>200	
1335	13.5	10.71	7.0	1845	6.2°	>200	
1347	17.5	13.81	6.93	1892	6.2°	>200	
1443	22.0	17.46	7.26	1475	6.3°	>200	
1455	26.5	21.03	6.69	1486	6.4°	>200	
1510	30.5	24.21	6.16	1850	6.2°	>200	
1545	35.0	27.78	6.08	1972	6.2°	>200	
1602	39.0	30.95	6.14	1912	6.1°	>200	
1614	43.0	34.13	6.25	1850	6.1°	>200	

DEVELOPED BY: B Hale Dillon / TCL DATE 7-28-93

DRILLING LOG FOR MW-EE-55

Project Name Perfection Plating

Site Location NYSDEC Site no. 4-01-037
Waterdict NY

Date Started/Finished 7-23-93 / 7-29-93

Drilling Company Buffalo Well Drilling

Driller's Name Larry Schroeder

Geologist's Name Jim MacKecknie

Geologist's Signature [signature]

Rig Type (s) Truck mounted CME-55

Drilling Method (s) Hollow Stem Auger/core

Bit Size (s) HQ Auger Size (s) 4.25'

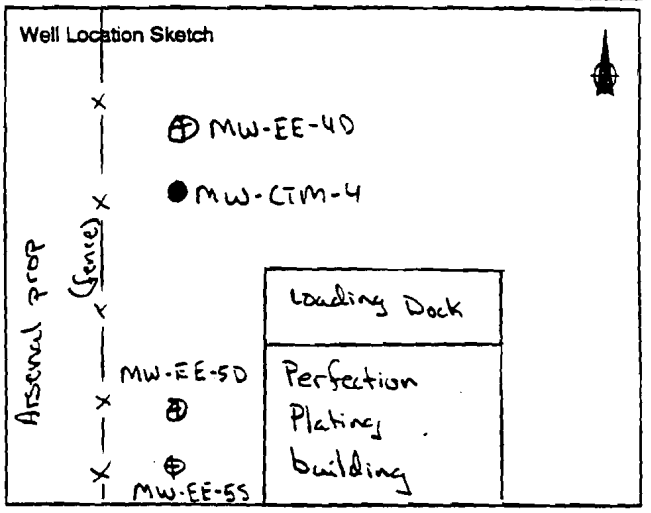
(Auger)/~~Split Spoon~~ Refusal 15.0'

Total Depth of Borehole Is 15.0'

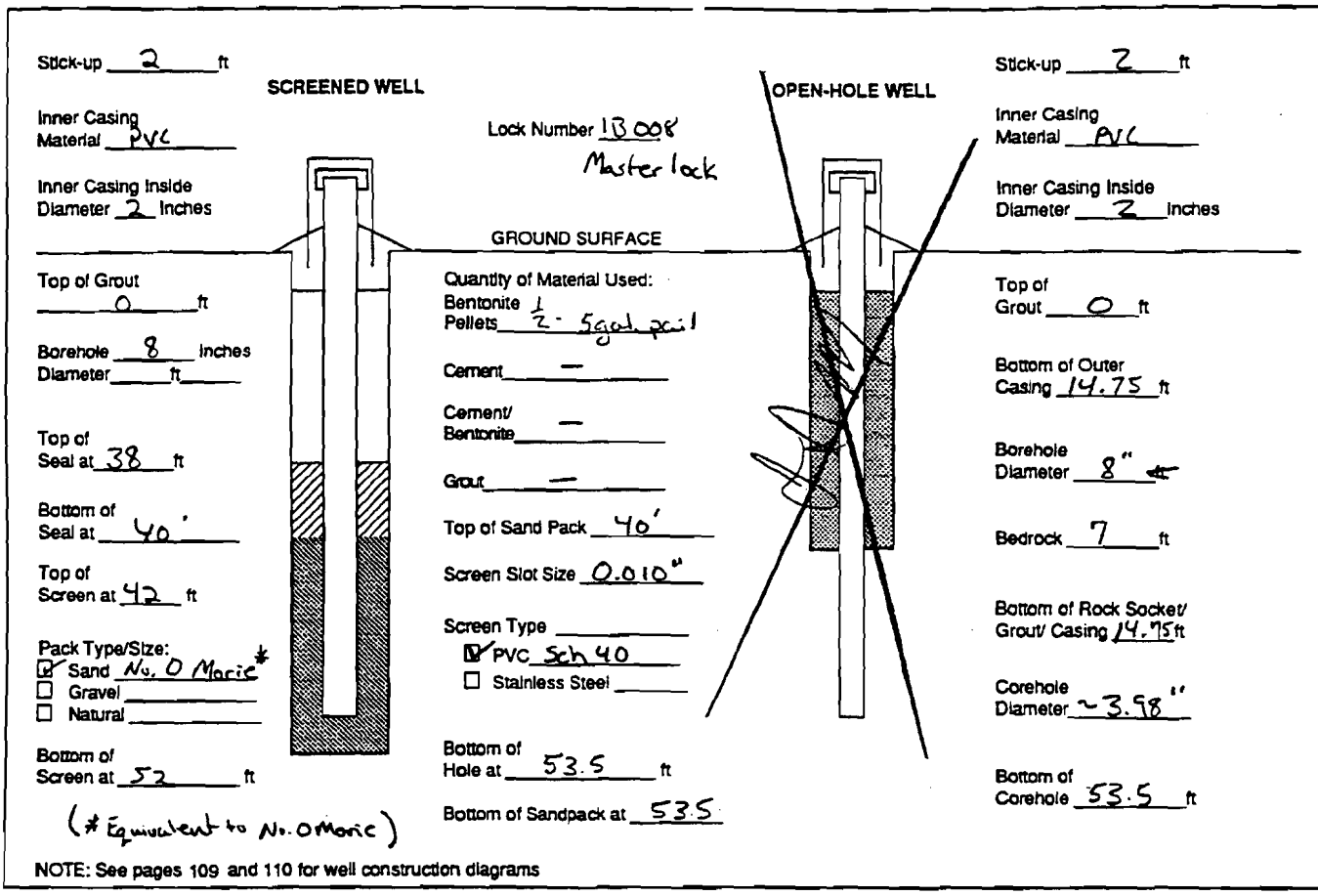
Total Depth of Corehole Is 53.5'

Water Level (TOIC)		
Date	Time	Level(Feet)
8-3-93	0945	1.30'
1-11-94	1438	11.57

Well Location Sketch



Depth(Feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
1			See Drill Log for MW-EE-5S								Augered to 15'0" Set 5" ID carbon Steel casing at 14'9" grouted in place.
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											



NOTE: See pages 109 and 110 for well construction diagrams

Depth-ft.	NARRATIVE LITHOLOGIC DESCRIPTION MW-EE-5D	Moisture Content Dry	Moist	Wet
1		○	○	○
2	– See MW-EE-5S for Soils description –	○	○	○
3		○	○	○
4		○	○	○
5		○	○	○
6		○	○	○
7		○	○	○
8		○	○	○
9		○	○	○
10		○	○	○
11		○	○	○
12		○	○	○
13		○	○	○
14		○	○	○
		○	○	○

MW-EE-50

Depth(feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
16–19						1	93%	26%		ND	Core Run 1 15'-20'
20–24						2	100%	74%		ND	Core Run 2 20'-24.2'
25–29						3	97%	80%		ND	Core Run 3 24.2'-29.3'
30–34						4	98%	82%		ND	Core Run 4 29.3'-34.3'
35–39						5	100%	82%		<0.1 ppm	Core Run 5 34.3'-39.8'
40–44						6	100%	84%		<0.1 ppm	Core Run 6 39.3'-44.3'
						7			Severely fractured		

Depth(feet).	NARRATIVE LITHOLOGIC DESCRIPTION MW-EE-5D	Moisture Content Dry Moist Wet
16	15'-20' Dark gray shale with prominent fractures along	○ ○ ○
17	dipping bedding planes at ~60° beyond horizontal.	○ ○ ○
18	Slightly weathered with iron staining in fractures	○ ○ ○
19	shale slightly metamorphosed.	○ ○ ○
20		○ ○ ○
21	20'-24.2' same (close 2in-foot to very close <2in fractures	○ ○ ○
22	along apparent bedding planes)	○ ○ ○
23	22'9" yellow staining in fractures (bedding planes)	○ ○ ○
24		○ ○ ○
25	24.2'-29.3' same	○ ○ ○
26		○ ○ ○
27		○ ○ ○
28		○ ○ ○
29		○ ○ ○
30	29.3-34.3 same	○ ○ ○
31		○ ○ ○
32		○ ○ ○
33		○ ○ ○
34		○ ○ ○
35	34.3-39.3 same	○ ○ ○
36	36'- white sandstone beds 1/8" thick	○ ○ ○
37	(confirmed bedding plane orientation)	○ ○ ○
38		○ ○ ○
39		○ ○ ○
40	39.3-44.3 Dark gray shale slightly metamorphosed	○ ○ ○
41	with ~60° fractures apparently along bedding planes	○ ○ ○
42		○ ○ ○
43	43.4-44.3 Severely fractured (along and nearly ⊥	○ ○ ○
44	to bedding planes)	○ ○ ○
	44.3-49.3 Same	

MW-EE-5D

Depth(feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
46									Severely fractured		Core Run 7
47						7	100%	36%		ND	44.3'-49.3'
48											
49									Severely fractured		
50											Core Run 8
51						8	91%	28%		ND	49.3'-53.3'
52											2.75ppm in hole
53											
54											Total depth 53.3'
55											
56											
57											
58											
59											
60											
61											
62											
63											
64											
65											
67											
68											
69											
70											
71											
72											
73											
74											
75											

Depth(feet)	MW-EE-5D NARRATIVE LITHOLOGIC DESCRIPTION	Moisture Content Dry Moist Wet
46	44.3-46.3 Severely fractured (along and ⊥ to bedding planes)	○ ○ ○
47		○ ○ ○
48	48.3-49.3 Severely fractured (along and ⊥ to bedding planes)	○ ○ ○
49		○ ○ ○
50	49.3'-53.3' Dark gray shale slightly metamorphosed close fractures along apparent bedding planes at ~60° past horizontal	○ ○ ○
51		○ ○ ○
52		○ ○ ○
53		○ ○ ○
54	— Total Depth 53.3' —	○ ○ ○
55		○ ○ ○
56		○ ○ ○
57		○ ○ ○
58		○ ○ ○
59		○ ○ ○
60		○ ○ ○
61		○ ○ ○
62		○ ○ ○
63		○ ○ ○
64		○ ○ ○
65		○ ○ ○
67		○ ○ ○
68		○ ○ ○
69		○ ○ ○
70		○ ○ ○
71		○ ○ ○
72		○ ○ ○
73		○ ○ ○
74		○ ○ ○
75		○ ○ ○

WELL DEVELOPMENT RECORD

SITE Paterson Plating DATE 8-3-93

LOCATION Waterford NY WELL NO. MW-FE5D

MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2(0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches; and 0.163 = A constant conversion factor which compensates for r^2h factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = 6.67 gallons.

Volume of Water in Casing or Hole

Diameter of Casing or Hole (in)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth	Liter per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509×10^{-3}
11/2	0.092	0.0123	1.142	1.142×10^{-3}
2	0.163	0.0218	2.024	2.024×10^{-3}
21/2	0.255	0.0341	3.167	3.167×10^{-3}
3	0.367	0.0491	4.558	4.558×10^{-3}
31/2	0.500	0.0668	6.209	6.209×10^{-3}
4	0.653	0.0873	8.110	8.110×10^{-3}
41/2	0.826	0.1104	10.260	10.260×10^{-3}
5	1.020	0.1364	12.670	12.670×10^{-3}
51/2	1.234	0.1650	15.330	15.330×10^{-3}
6	1.469	0.1963	18.240	18.240×10^{-3}
7	2.000	0.2673	24.840	24.840×10^{-3}
8	2.611	0.3491	32.430	32.430×10^{-3}
9	3.305	0.4418	41.040	41.040×10^{-3}
10	4.080	0.5454	50.670	50.670×10^{-3}
11	4.937	0.6600	61.310	61.310×10^{-3}
12	5.875	0.7854	72.960	72.960×10^{-3}
14	8.000	1.0690	99.350	99.350×10^{-3}
16	10.440	1.3960	129.650	129.650×10^{-3}
18	13.220	1.7670	164.180	164.180×10^{-3}
20	16.320	2.1820	202.680	202.680×10^{-3}
22	19.750	2.6400	245.280	245.280×10^{-3}
24	23.500	3.1420	291.850	291.850×10^{-3}
26	27.580	3.6870	342.520	342.520×10^{-3}
28	32.000	4.2760	397.410	397.410×10^{-3}
30	36.720	4.9090	456.020	456.020×10^{-3}
32	41.780	5.5850	518.870	518.870×10^{-3}
34	47.160	6.3050	585.680	585.680×10^{-3}
36	52.880	7.0690	656.720	656.720×10^{-3}

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 37.785 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = 12.419×10^{-3} cubic meters per meter of depth

INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 6.13
WELL DEPTH (TD) 53.5
COLOR Yellowish Cloudy
ODOR -
CLARITY >200

FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) -
WELL DEPTH (TD) 53.5
COLOR Grey
ODOR -
CLARITY 7200

DESCRIPTION OF DEVELOPMENT TECHNIQUE Hand bailed

WELL DEVELOPMENT - PARAMETER MEASUREMENTS

MW-EE-5D

TIME	TOTAL VOL. WITHDRAWN		pH	COND. (umhos/cm) (x100)	TEMP. (F)	TURB. (NTU)	COMMENTS
	GALS.	BORE VOL.					
0955	2.5	0.36	7.96	9.62	~~63.1~~ 64.1	>>200	
1020	10	1.43	9.45	7.19	63.5	>>200	
1049	13.0	1.87	10.01	7.53	61.7	>>200	
1140	16.5	2.37	9.92	7.68	62.6	>>200	
1234	19.0	2.73	9.73	7.91	63.5	>200	
1420	22.0	3.16	9.51	8.07	63.1	>200	
1431	25.0	3.59	9.31	7.77	62.4	>200	
1600	28.0	4.02	9.30	8.12	63.1	>200	
1605	30.0	4.30	9.24	8.17	61.4	>200	
1837	32.5	4.66	9.63	8.41	63.8	>200	
1850	37.0	5.31	9.86	8.53	63.5	>200	

DEVELOPED BY: Buffalo Drilling / JCC DATE 8-3-95

(MW-EH-10)

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Description: _____

330' from corner
55' west from Fence.

JOB NO.	CLIENT	LOCATION
WVA-81A	Watervliet Arsenal	Albany

DRILLING METHOD: Unimat CME-45 Truck Mounted Drill Rig using 4¼ I.D. and 6¾ OD Augers

SAMPLING METHOD: 2" Ø x 2' Split Spoon Driven by 140 lbs. hammer and 30" Throw

BORING NO. SB-04 / MW-6

SHEET 1 of

WATER LEVEL	3.70				
TIME	1630				
DATE	4/5/88				
REFERENCE	BGS				

DRILLING START: TIME 15:30 DATE 4/5/88

DRILLING FINISH: TIME _____ DATE _____

DRILLING CONTRACTOR: Empire Soil Inc.
DRILLER: Mike Lenahan

BY: Tom McEl

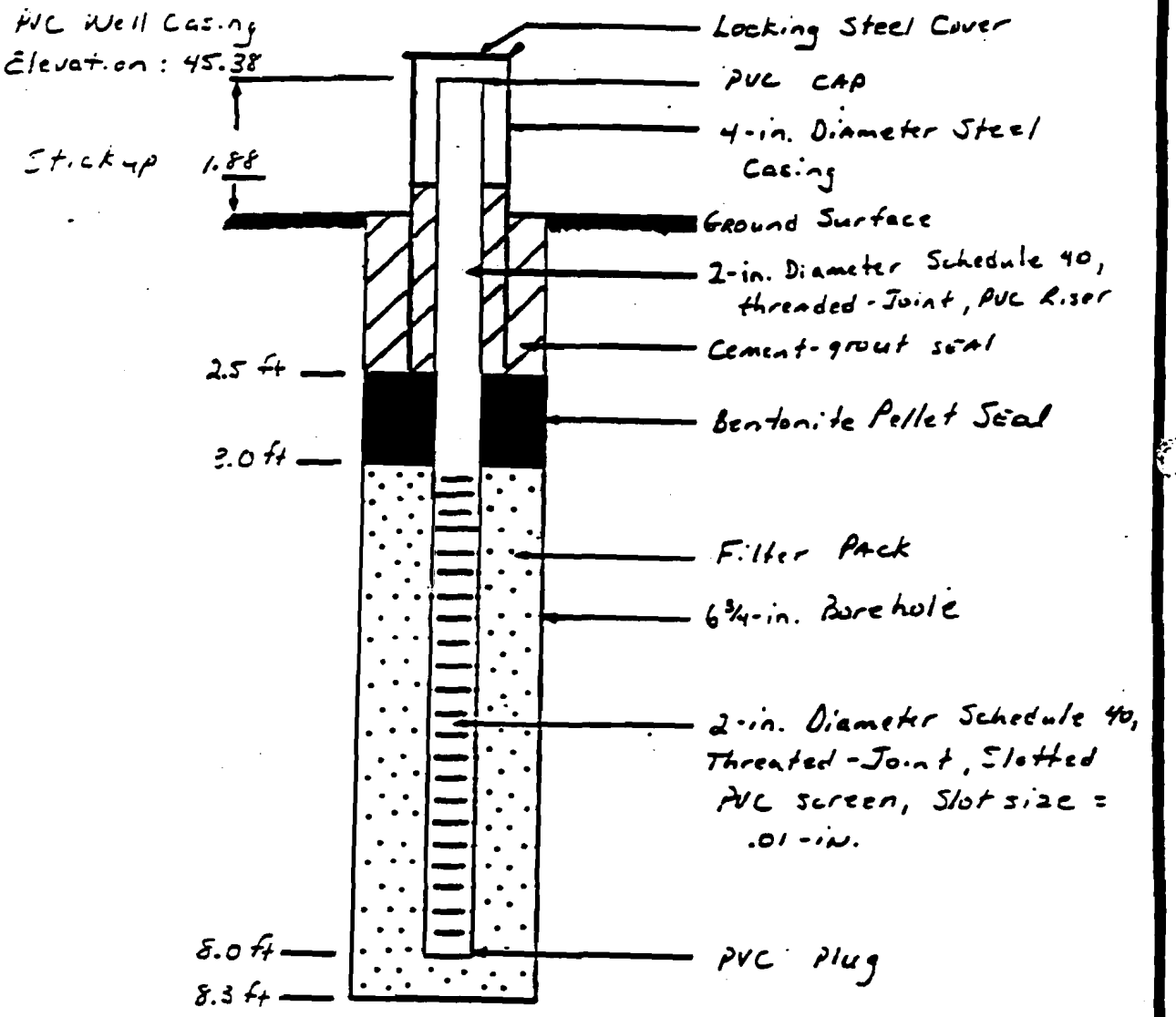
DATE: _____

SURFACE CONDITIONS:

SAMPLER TYPE	SAMPLER (inches) / (inches recovered)	DEPTH OF CASING	SAMPLER (no.) / (depth)	BLOWS/6 in. SAMPLER	DEPTH IN FEET	GRAPHIC LOG	
					0		Fill: Crushed stone blue grey 4" 5" dark run gravel below membrane
				20	1		Dk brn silty soil w/ roots, glass, ash and concrete Dry
SS	18" / 16"		1	17			
			1-2.5	27	2		10" Dk brn silty sand w/ ash concrete glass slag
				24			
				12	3		6" blk weathered shale moist
SS	24" / 1.7'		2	14			1" Blk shale fractured wet
				9	4		12" SHALE AS ABOVE
				10			
				6	5		
SS	24" / 1.5'		3	3			8" Green clay w/ some silt mottled plastic dry
				4	6		2" Clay as above
				4			weathered shale (clay and shale)
				10	7		light mottled rust colored
SS	24" / 1.3'		4	21			
				70	8		
							Advanced Augers to 5.0' and set 5' of well screen.
					9		Sand to 3' ABS
							Bentonite Pellets to 2.5'
					0		
					1		
					2		
					3		
					4		
					5		
					6		
					7		
					8		
					9		
					0		

COMPLETION DIAGRAM

WELL MW-6 (MW-EA-6)



DRILLING LOG FOR MW-EE-6S

Project Name Perfection Plating

Site Location Watervliet NY
-(Original Property)

Date Started/Finished 12/14/93 / 12/14/93

Drilling Company Empire Soil

Driller's Name Rich Comfort

Geologist's Name Gray Andrus

Geologist's Signature

Rig Type (s) CME 55

Drilling Method (s) HST

Bit Size (s) n/a Auger Size (s) 4¼

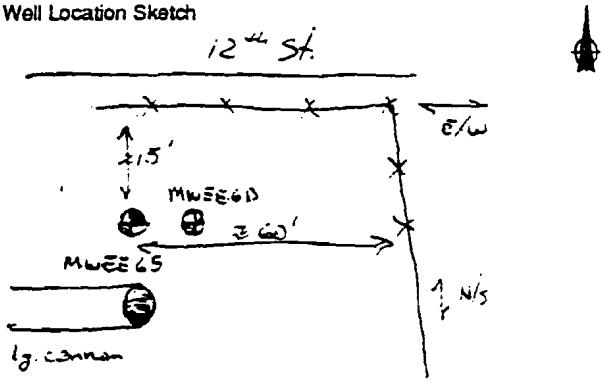
Auger/Split Spoon Refusal N/A

Total Depth of Borehole is 16.5'

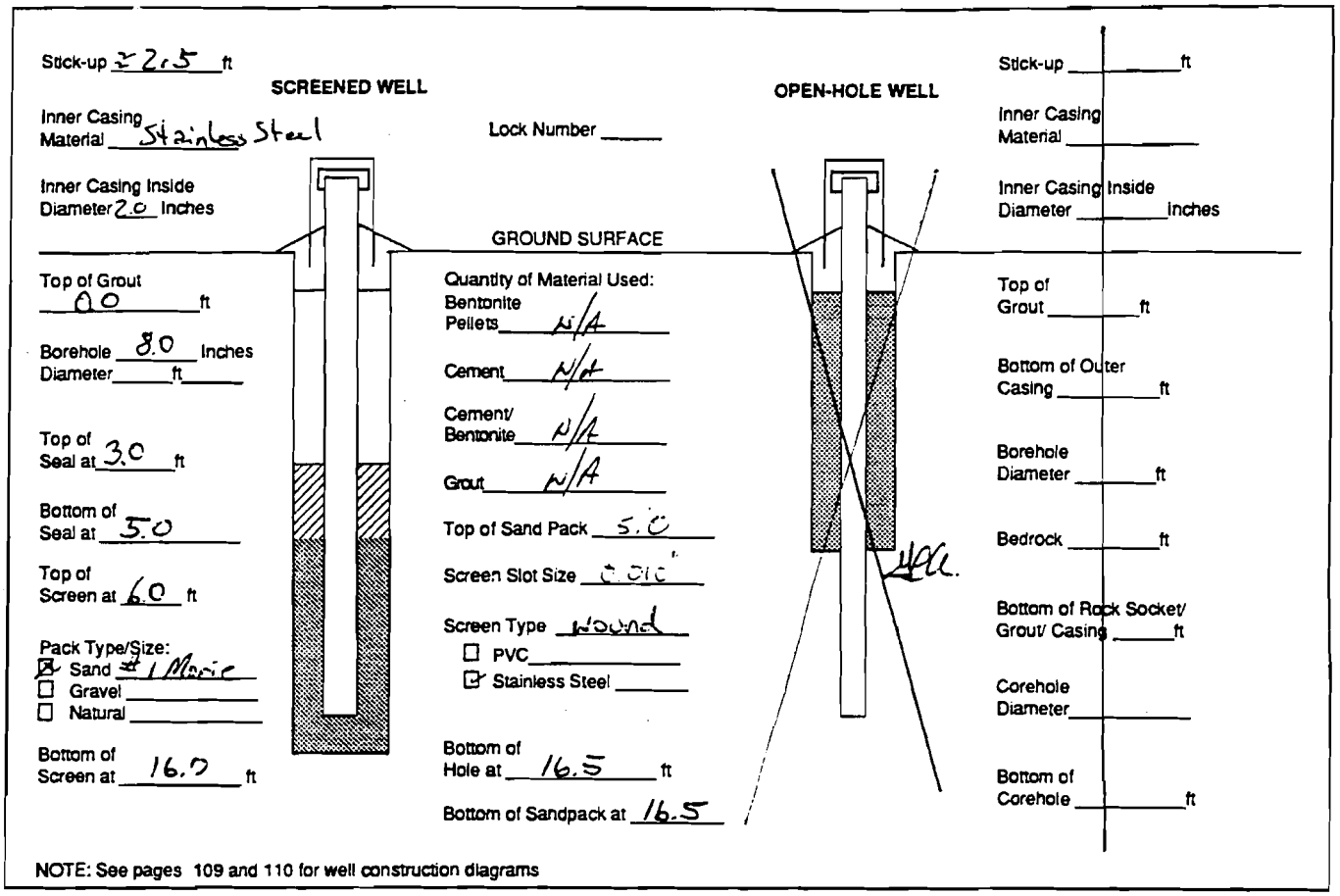
Total Depth of Corehole is —

Water Level (TOIC)		
Date	Time	Level(Feet)
1/11/94	09:52	589.44

Well Location Sketch



Depth(Feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
1			no samples (see MW-EE-6D)								
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											



NOTE: See pages 109 and 110 for well construction diagrams

Depth-ft.	NARRATIVE LITHOLOGIC DESCRIPTION MW-EE-6S	Moisture Content Dry	Moist	Wet
1	See MW-EE-6D log for narrative soils/rock description	○	○	○
2		○	○	○
3		○	○	○
4		○	○	○
5		○	○	○
6		○	○	○
7		○	○	○
8		○	○	○
9		○	○	○
10		○	○	○
11		○	○	○
12		○	○	○
13		○	○	○
14		○	○	○

recycled paper

ecology and environment

WELL DEVELOPMENT RECORD

SITE Perfection Plating DATE 12-28-93

LOCATION Watervliet Arsenal, S. beam crew WELL NO. MW-EE-65

MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2(0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for r^2h factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = 2.11 gallons.

Volume of Water in Casing or Hole

Diameter of Casing or Hole (in)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth	Liter per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509×10^{-3}
11/2	0.092	0.0123	1.142	1.142×10^{-3}
2	0.163	0.0218	2.024	2.024×10^{-3}
21/2	0.255	0.0341	3.167	3.167×10^{-3}
3	0.367	0.0491	4.558	4.558×10^{-3}
31/2	0.500	0.0668	6.209	6.209×10^{-3}
4	0.653	0.0873	8.110	8.110×10^{-3}
41/2	0.826	0.1104	10.260	10.260×10^{-3}
5	1.020	0.1364	12.670	12.670×10^{-3}
51/2	1.234	0.1650	15.330	15.330×10^{-3}
6	1.469	0.1963	18.240	18.240×10^{-3}
7	2.000	0.2673	24.840	24.840×10^{-3}
8	2.611	0.3491	32.430	32.430×10^{-3}
9	3.305	0.4418	41.040	41.040×10^{-3}
10	4.080	0.5454	50.670	50.670×10^{-3}
11	4.937	0.6600	61.310	61.310×10^{-3}
12	5.875	0.7854	72.960	72.960×10^{-3}
14	8.000	1.0690	99.350	99.350×10^{-3}
16	10.440	1.3960	129.650	129.650×10^{-3}
18	13.220	1.7670	164.180	164.180×10^{-3}
20	16.320	2.1820	202.680	202.680×10^{-3}
22	19.750	2.6400	245.280	245.280×10^{-3}
24	23.500	3.1420	291.850	291.850×10^{-3}
26	27.580	3.6870	342.520	342.520×10^{-3}
28	32.000	4.2760	397.410	397.410×10^{-3}
30	36.720	4.9090	456.020	456.020×10^{-3}
32	41.780	5.5850	518.870	518.870×10^{-3}
34	47.160	6.3050	585.680	585.680×10^{-3}
36	52.880	7.0690	656.720	656.720×10^{-3}

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 37.785 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = 12.419×10^{-3} cubic meters per meter of depth

INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 5.03 (12/22/93)
WELL DEPTH (TD) 17.98
COLOR dark grey
ODOR none
CLARITY very poor

FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 6.02 - est
WELL DEPTH (TD) 17.98 - est
COLOR dark-med grey
ODOR none
CLARITY poor

DESCRIPTION OF DEVELOPMENT TECHNIQUE PVC bailer - hand bailed

MW-BE-65

WELL DEVELOPMENT - PARAMETER MEASUREMENTS

TIME	TOTAL VOL. WITHDRAWN		pH	COND. (umhos/cm)	TEMP. (C) F	TURB. (NTU)	COMMENTS
	GALS.	BORE VOL.					
1213	0	0	9.33	1400	44.3	>>200	
1533	5	2.4	9.06	1700	39.1	>>200	
1545	10	4.8	8.91	1266	40°F	>>200	
1543	15	7.1	9.37	1450	41°F	>>200	
12/30 —							
08:39	20	4.5	9.29	1260	50.9°F	>>200	
08:51	25	11.9	8.86	1313	50.0°F	>200	clearing up slightly
08:59	30	14.2	8.76	1185	49.0°F	>200	some silt >200
09:05	35	16.6	8.72	1148	48°F	>200	
09:12	40	19.0	8.64	1130	50°F	>200	
09:18	45	21.3	8.62	1122	52°	>200	
09:25	50	23.7	8.63	1129	52.0°	>200	
09:32	55	26.1	8.50	1177	54°	>200	
09:38	60	28.4	8.51	1123	52°	>200	
09:46	65	30.8	8.32	1107	49°	>200	
09:52	70	33.2	8.33	1101	49°.	>200	
10:01	75	35.5	8.31	1181	49°	>200	Stopped development per DEC
1/10/94							
15:25	77.5	36.73	9.49	1450	41.5°F	>>200	
15:37	80	37.91	8.1	1632	45.5°	>200	

DEVELOPED BY: Guy Adams / J.M. Kokis / Enviro DATE 12/30 + 1/10/94

DRILLING LOG FOR MW-EE-6D

Project Name Remediation Drilling

Site Location Watervliet (Arsenal), NY

Date Started/Finished 12/14/93 / 12/30/93

Drilling Company Empire

Driller's Name Rich Comfort

Geologist's Name Greg Andrus

Geologist's Signature

Rig Type (s) CME 55

Drilling Method (s) HSA / Core-(NX) reamed to 4" w/ b.t

Bit Size (s) 4" (3.9") Auger Size (s) 4¼"

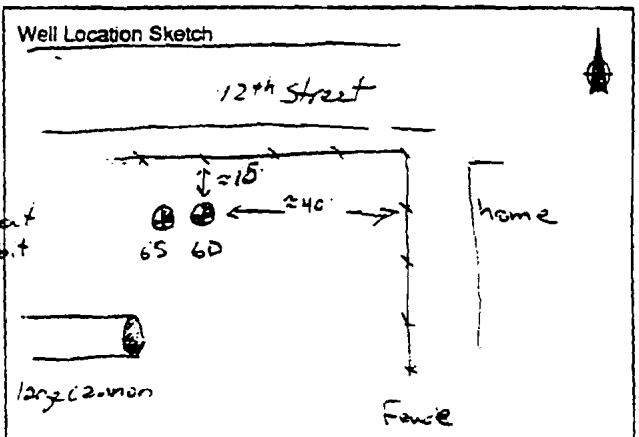
Auger/Split Spoon Refusal 8.9 b.g.s

Total Depth of Borehole is ≈13.0'

Total Depth of Corehole is 53.9'

Water Level (TOIC)		
Date	Time	Level(Feet)
1/11/94	0950	7.71 btc.

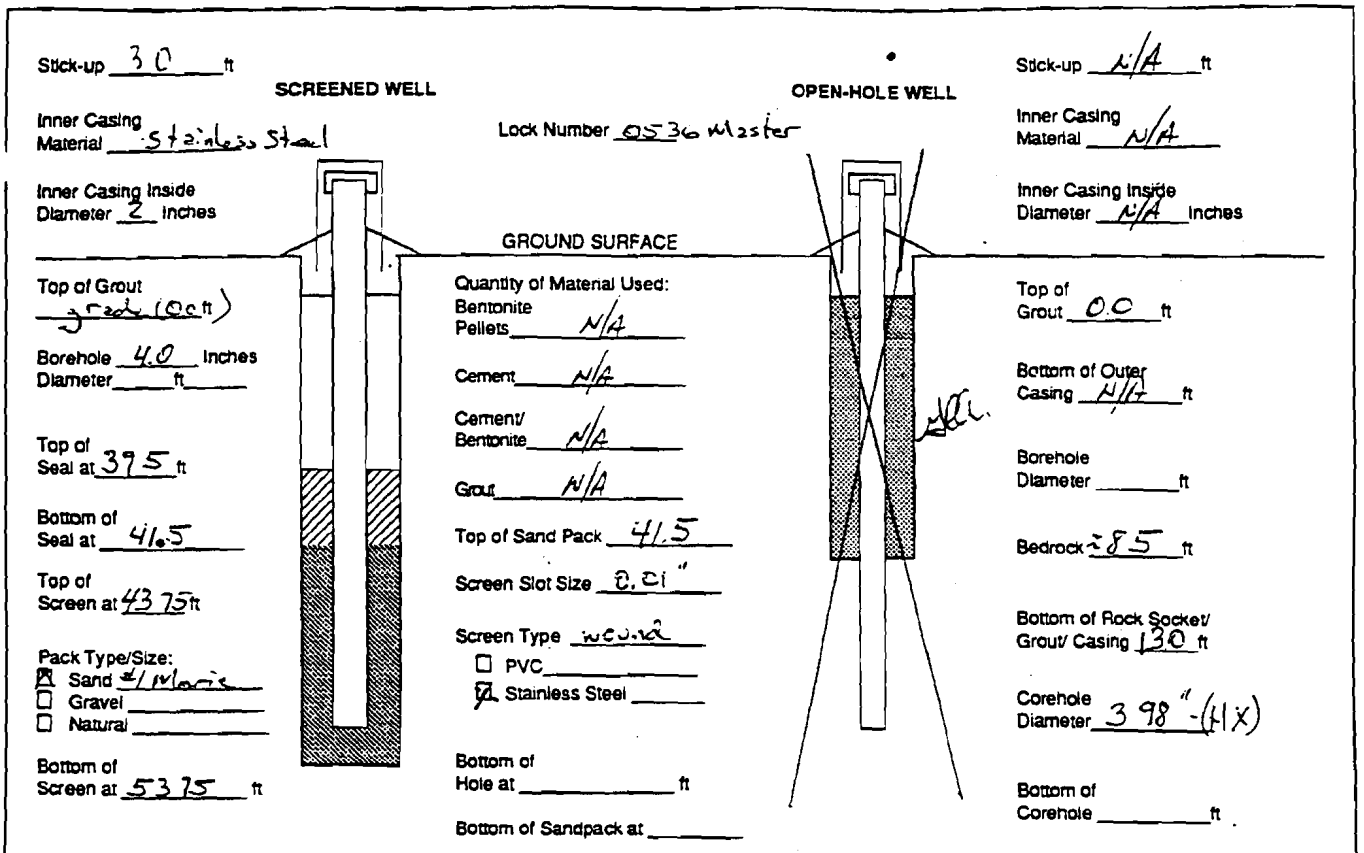
Well Location Sketch



Depth(Feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
1	1	2 3 / 5 5								NV / 0.2 ppm	
2											
3	2	6 5 / 4 4								NV / 100 ppm	
4											
5	3	1 1 / 3 4								ND / 3 ppm	
6											
7	4	7 8 / 7 6								ND / 10 ppm	
8											
9	5	24 100/.4								NV / 4 ppm	
10											Augered to 13.0 open augers 0.2 ppm / 350 ppm
11											
12											
13											
14											

no core due to poor consolidation of cuttings (3" diameter open casing to approx 15' b.g.s) during initial NX coring. * 4.7-15.5

*(during subsequent reaming, a 4" diameter open casing was installed to approx 15' b.g.s after removal of 3" casing)



NOTE: See pages 109 and 110 for well construction diagrams

Depth-ft.	NARRATIVE LITHOLOGIC DESCRIPTION	Moisture Content: Dry	Moist	Wet
	MW-EE-61			
1	lt brown/black sl. f. sand, some fill mtl.	○	⊗	○
2	CONT SAND and SILT, some mf GRAVEL trace CLAY	○	○	○
3	lt green mot SAND (shale frag.) and SILT, little clay, little mf GRAVEL	○	⊗	○
4	MS/MSI water at 4'	○	○	○
5	dk gray CLAY and SILT, little CONT SAND MS/MSI	○	⊗	○
6		○	○	○
7	lt blue-gray/green SILT some CLAY, little mf SAND (shale frags)	○	○	○
8	some traces of Fe staining	○	⊗	○
9	similar soil to 8.5' bgs / below 8.5' shale bedrock	○	○	○
10	dipping approx 35 to 45° bedrock surface @ 8.5 bgs, at 9.5' rock socket	○	○	○
11		○	○	○
12	— no samples 10' → 13' — (rock socket)	○	○	○
13	— no samples 13' → 15.5' due to installation			
14	of spun casing — (1st recovered bedrock @ 15.5' bgs)	○	○	○
		○	○	○

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Depth(feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
15.5						1	50%	0%		N/D/N/D	- overcored -
16											
16.5						2	90%	0%		N/D N/A	15.5-16.5
17											
17.7						3	75%	0%		N/D	16.5-17.7
18											
19						4	94%	21%		N/D N/A	17.7-22.7
20											
21											
22											
22.7						5					
23											
23.8							91.7%	0%		N/D	22.7-23.8
24											
25						6	91.7%	38%		N/D	23.8-27.3
26											
27											
27.3											
28											
29						7	96%	63%		N/A	27.3-32.3
30											
31											
32											
32.3											
33											
34						8	89.2%	46%		N/D	32.3-36.0
35											
36											
36.0											
37						9	100%	36%		N/D	36.0-40.1
38									(37.5 to 38.0)		vertical fracture
39									(39.3 to 40.1)		
40											
40.1											
41						10	100%	76%		N/D	40.1-45.1
42											
43											
44											
45.1											

Depth(feet).	NARRATIVE LITHOLOGIC DESCRIPTION MW-EE-6D	Content Dry	Moist	Wet
	-black shale w/ bedding planes @ 85° w/ fractures predom.			
	following bedding planes			
	-shale has been slightly metamorphosed into slate and shows			
	some conchoidal fracturing and shiny surfaces on fractures			
	-no significant lithologic changes noted with increasing			
	depth other than general increase of RQD w/ depth			
	General descriptions as follows:			
	[Dark Grey / Black Shale medium hard unweathered			
	(Fresh) [redacted], laminated to thinly bedded w/			
	closely spaced fractures w/ low porosity]			
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37	- Vertical fractures noted, not clear whether mechanical or			
38	natural			
39				
40	- vertical fractures - possibly mechanical			
41				
42				
43				
44				

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Depth(feet)	Sample Number	Blows on Sampler	Soil Components CL SL S GR	Rock Profile	Penetration Times	Run Number	Core Recovery	RQD	Fracture Sketch	HNu/OVA (ppm)	Comments
45.1						11	91%	31%		N/D N/D	45.1-48.4
46											
47											
48											
48.4											
49						12	96%	63%		N/D N/D	48.4-49.4
49.4											
50						13	100%	11%		N/D N/D	49.4-53.4
51											
52											
53											
53.4											
54			Bottom of Corehole								
			53.9'								
55											
56											
57											
58											
59											
60											
61											
62											
63											
64											
65											
67											
68											
69											
70											
71											
72											
73											
74											
75											

Depth(feet)	NARRATIVE LITHOLOGIC DESCRIPTION	Moisture Content: Dry	Moist	Wet
46	- significant increase in RQD	○	○	○
47	- lithology remains same as described on previous page	○	○	○
48		○	○	○
49		○	○	○
50		○	○	○
51		○	○	○
52		○	○	○
53	Total Depth of Corehole 53.9' b.g.s.	○	○	○
54		○	○	○
55		○	○	○
56		○	○	○
57		○	○	○
58		○	○	○
59		○	○	○
60		○	○	○
61		○	○	○
62		○	○	○
63		○	○	○
64		○	○	○
65		○	○	○
67		○	○	○
68		○	○	○
69		○	○	○
70		○	○	○
71		○	○	○
72		○	○	○
73		○	○	○
74		○	○	○
75		○	○	○

WELL DEVELOPMENT RECORD

SITE Perfection Plating DATE 12/30/93

LOCATION Watervliet Arsenal - Siberia Area WELL NO. MW EE 6D

MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2(0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for r^2h factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = 8.0 gallons.

Volume of Water in Casing or Hole

Diameter of Casing or Hole (in)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth	Liter per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509×10^{-3}
1 1/2	0.092	0.0123	1.142	1.142×10^{-3}
2	0.163	0.0218	2.024	2.024×10^{-3}
2 1/2	0.255	0.0341	3.167	3.167×10^{-3}
3	0.367	0.0491	4.558	4.558×10^{-3}
3 1/2	0.500	0.0668	6.209	6.209×10^{-3}
4	0.653	0.0873	8.110	8.110×10^{-3}
4 1/2	0.826	0.1104	10.260	10.260×10^{-3}
5	1.020	0.1364	12.670	12.670×10^{-3}
5 1/2	1.234	0.1650	15.330	15.330×10^{-3}
6	1.469	0.1963	18.240	18.240×10^{-3}
7	2.000	0.2673	24.840	24.840×10^{-3}
8	2.611	0.3491	32.430	32.430×10^{-3}
9	3.305	0.4418	41.040	41.040×10^{-3}
10	4.080	0.5454	50.670	50.670×10^{-3}
11	4.937	0.6600	61.310	61.310×10^{-3}
12	5.875	0.7854	72.960	72.960×10^{-3}
14	8.000	1.0690	99.350	99.350×10^{-3}
16	10.440	1.3960	129.650	129.650×10^{-3}
18	13.220	1.7670	164.180	164.180×10^{-3}
20	16.320	2.1820	202.680	202.680×10^{-3}
22	19.750	2.6400	245.280	245.280×10^{-3}
24	23.500	3.1420	291.850	291.850×10^{-3}
26	27.580	3.6870	342.520	342.520×10^{-3}
28	32.000	4.2760	397.410	397.410×10^{-3}
30	36.720	4.9090	456.020	456.020×10^{-3}
32	41.780	5.5850	518.870	518.870×10^{-3}
34	47.160	6.3050	585.680	585.680×10^{-3}
36	52.880	7.0690	656.720	656.720×10^{-3}

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 37.785 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = 12.419×10^{-3} cubic meters per meter of depth

INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 7.56
WELL DEPTH (TD) 56.5
COLOR dk. grey
ODOR none
CLARITY poor

FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 9.6 — est
WELL DEPTH (TD) 56.5 — est
COLOR med. grey
ODOR none
CLARITY poor

DESCRIPTION OF DEVELOPMENT TECHNIQUE 1½" diameter PVC bailer

WELL DEVELOPMENT - PARAMETER MEASUREMENTS

TIME	TOTAL VOL. WITHDRAWN		pH	COND. (umhos/cm)	TEMP. (C)	TURB. (NTU)	COMMENTS
	GALS.	BORE VOL.					
11:19	initial	X	9.66	601	52°	>200	clearer than MW EE 6S
11:24	5.0	0.63	9.69	701	46°	>200	clearing
11:31	10.0	1.25	10.32	890	53°	>>200	much clearer
1138	15.0	1.88	10.5	1643	56°	>>200	- good recharge
1307	20.0	2.50	9.83	1043	49.5°	>200	
1314	25.0	3.13	9.86	1050	48.9	>200	somewhat clearer
1322	30	3.75	9.78	995	48°	>200	
1352	40	5.00	9.48	1480	49°	>200	
14:10	42.5	5.31	9.50	1635	48°	>200	Sufficiently developed (1/2 - DEC)
1/19/94							
14:50	42.75	5.34	10.8	1700	57°F	>200	continue dev. per Sue Benjamin
15.25	~~32.5~~ ~~42.75~~	6.56	~~9.56~~	~~1825~~ 1825	46°F	>>200	S.F. development
15:52	53.5	6.69	9.8	1600	56°F	>200	↓

DEVELOPED BY: Greg Anders/Jim Wilds/Gabrielle/Engineers DATE 12/30/93 + 1/10/94

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(MW-EA-7)

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

LOG OF SOIL BORING

JOB NO.	CLIENT	LOCATION
WVA-81A	WATERVLIET ARSENAL	S. Iberia

DRILLING METHOD: UNIMOG CME-45 Truck Mounted Dr. 11 Rig: 4x4 9 ID. and 6 3/4 OD. Augers

SAMPLING METHOD: 2" Ø x 2' Split Spoon Driven w/ 140 lbs hammer and 30" Throw

BORING NO.: MW-7

SHEET: 1 of 1

WATER LEVEL				
TIME				
DATE				
REFERENCE				

DRILLING START: TIME 1200, DATE 4/6/88

DRILLING FINISH: TIME 1310, DATE 4/6/88

Co-ordinates:

Surface Elevation:

Casing Above Surface:

Reference Elevation:

Reference Description: 130' from corner 4' out

DRILLING CONTR: Empire Soils Inc. Driller: Mike Lenahan

BY: Tom Rutz CHKD BY: DATE:

SURFACE CONDITIONS:

SAMPLER TYPE	NUMBER & DEPTH INTERVAL RECOVERED	DEPTH OF CASING	SAMPLE NO. & SAMPLE DEPTH	BLOWS/6 IN. SAMPLER	DEPTH IN FEET	GRAPHIC LOG
				2	0	
SS	24/16"		1/0-2	5	1	
				7		
				8	2	
				6		
SS	24/12"		2/2-4	7	3	
				6		
				14	4	
				25		
SS	18/18		3/4-5.5	52	5	
				76		

5" DK BRN Silty soil w/ roots and gravel.
BRN Silty w/ shale frag. bricks concrete and cinders. Dry.
BRN Silty As Above Dry
last 6" highly weathered shale Silty wet

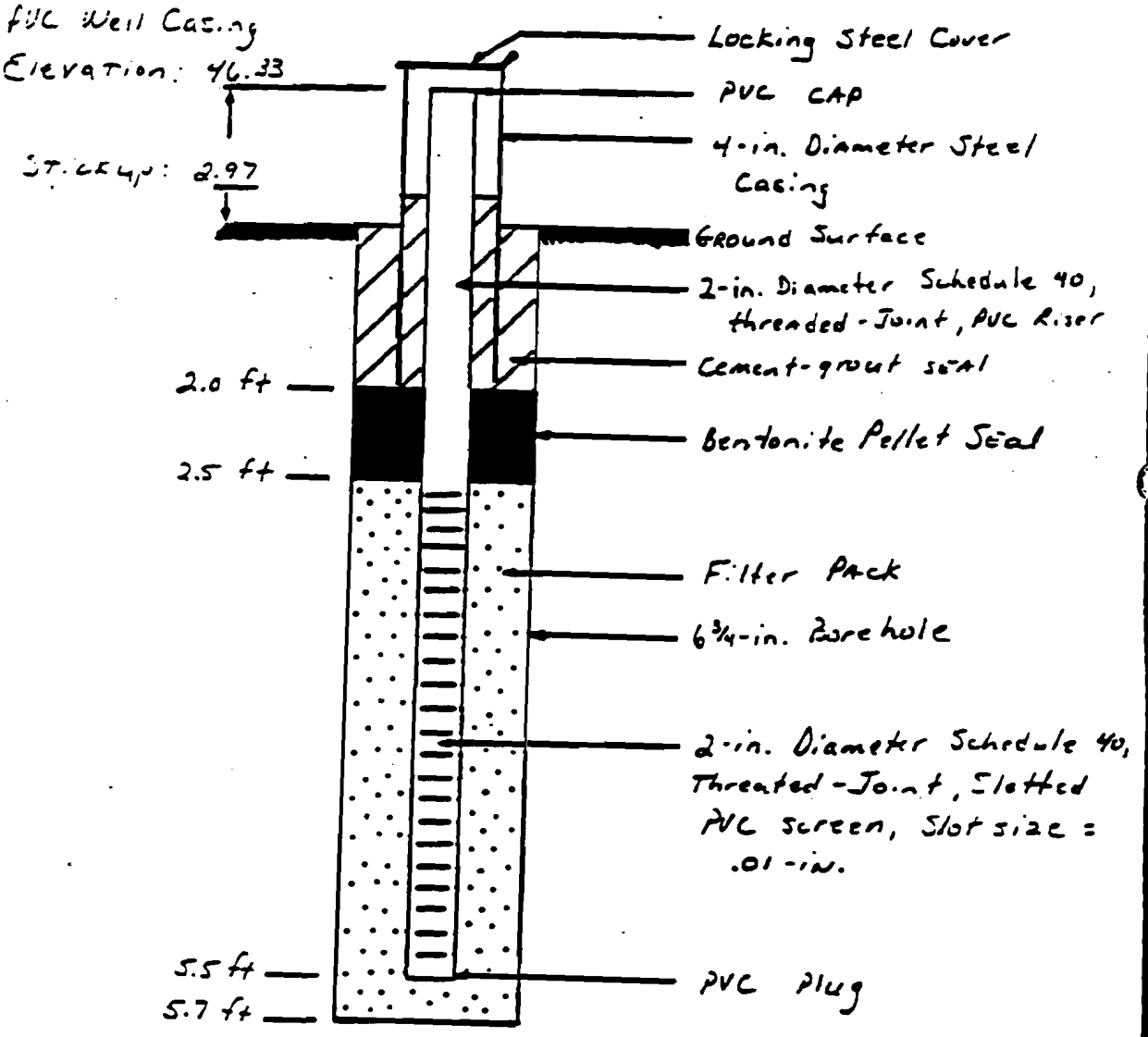
Weathered shale As Above 1st 6" wet - moist
last 12" Dry.

and Auger Spoon refu @ 5.5'

SET 3.0' of screen @ 5.5' TAND TO 2.5' Bentonite to 2'

COMPLETION DIAGRAM

WELL MW-7 (MW-EA-7)



(MW-EA-8)

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

LOG OF SOIL BORING

Co-ordinates: _____

Surface Elevation: _____

Casing Above Surface: _____

Reference Elevation: _____

Reference Desription: _____

JOB NO.	CLIENT	LOCATION
WVA-81A	WATERVLIET ARSENAL	S. Berlin

DRILLING METHOD: UNIMOG CME-45 Truck Mounted Drill Rig: 4¼ ID. and 6¼ OD. Augers.

SAMPLING METHOD: 2" Ø x 2' Split Spoon Driven w/ 140 lbs hammer and 30" Throw

BORING NO.: MW-8

SHEET: 1 of

DRILLING START: TIME 1035 DATE 4/13/88

DRILLING FINISH: TIME _____ DATE 4/23/88

WATER LEVEL				
TIME	1450			
DATE	4/13/88			
REFERENCE	Top PVC			

DRILLING CONTR: Empire Soils Inc. DRILLER: Mike Keegan

HT Tom Kutz DATE _____ CHKD BY _____

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO / SAMPLE DEPTH	BLOWS/6 in. SAMPLER	DEPTH IN FEET	GRAPHIC LOG
	/		/	1	0	
SS	24" / 14"		#1 / 0-2	3	1	
	/		/	3		
	/		/	15	2	
	/		/	7		
SS	24" / 9"		#2	5	3	
	/		/	3		
	/		/	4	4	
	/		/	2		
SS	24" / 12"		#3	2	5	
	/		/	4		
	/		/	11	6	
	/		/	2		
SS	24" / 3"		#4	2	7	
	/		/	2		
	/		/	4	8	
	/		/	2		
SS	24" / 24"		#5	2	9	
	/		/	4		
	/		/	3	10	
	/		/			
	/		/		1	
	/		/			
	/		/		2	
	/		/			
	/		/		3	
	/		/			
	/		/		4	
	/		/			
	/		/		5	
	/		/			
	/		/		6	
	/		/			
	/		/		7	
	/		/			
	/		/		8	
	/		/			
	/		/		9	
	/		/			
	/		/		0	

SURFACE CONDITIONS:

Grass covered area near garden

3-7" Dk brn silty soil w/ grass roots little sand, trace gravel

Cement lined iron pipe 3' in ground. Fill in pipe

Fill: lt brn silty clay w/ shale or lt. wood ins + 8" Blk cinders w/ white flakes, iron slag mostly.

Top 4" as above

lay 8" weathered shale

v. silty brn/grey bottom of spoon wet

Blk shale frag in top. Spoon completely wet.

3" Brn sandy gravel

4" Blk organic silt w/ clay and roots

to. Grades to: Tan silty clay

4" Then to grey stiff clay clay

#3 last 6" w/ spoon wet

Auger chatter from 5-6'

7' of screen set @ 10'

Sand to 3'

Bentonite Pellets to 2.

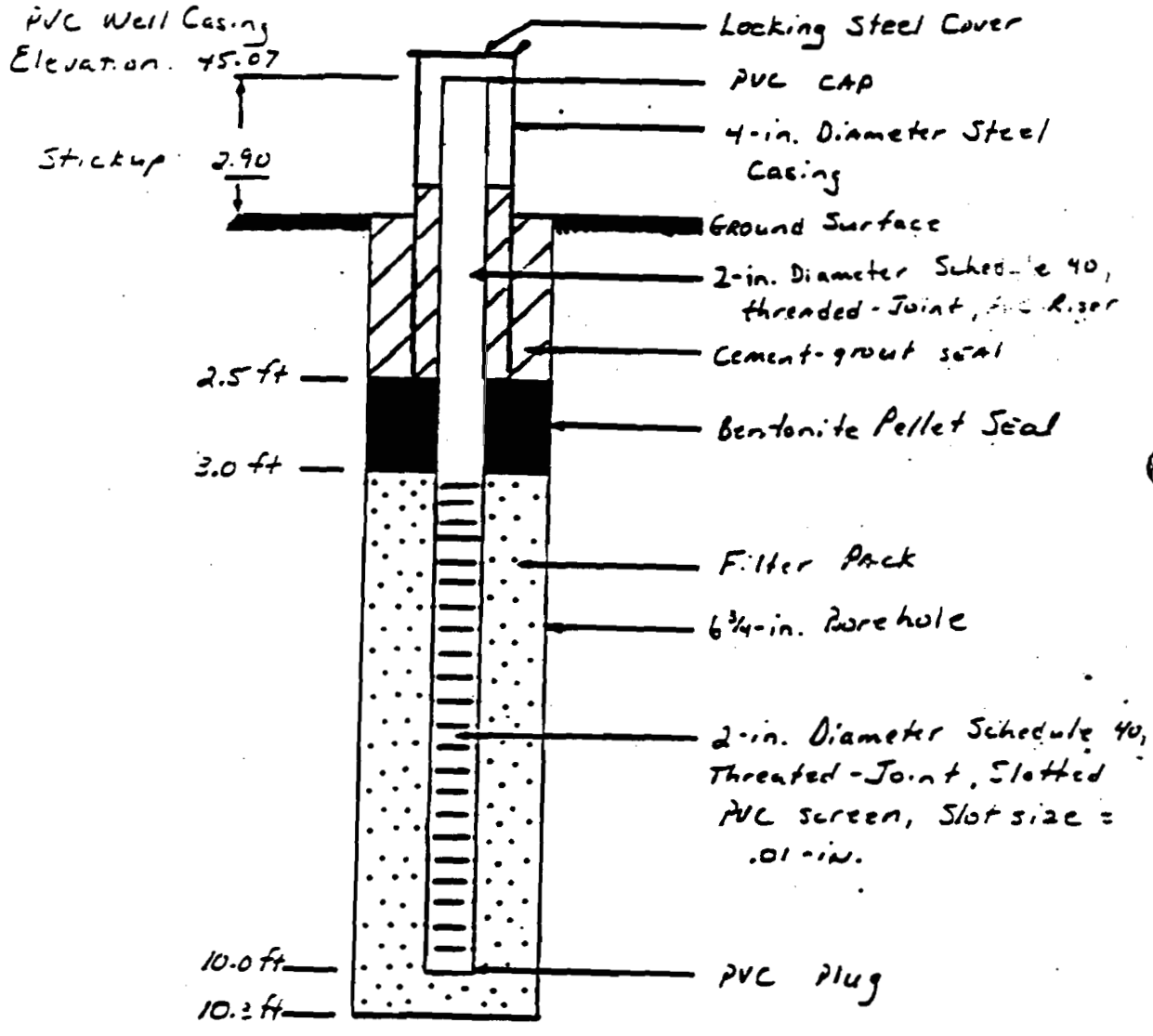
Steel Casing cemented/grouted in to surface.

AT ~~AM~~ 1415 hrs. well was Developed for one hour bailed ~42 gals.

STARTED off v. silty w/ trees & cleared somewhat and much less s. lt and fine sand.

COMPLETION DIAGRAM

WELL MW-8
(MW-EA-8)



SOIL SAMPLING REPORT FORM	ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

BORING NO. mw-3 SED mw-3/ESE-8 PAGE 1 OF 1
BORING LOCATION. NE of Refuse Loading Ramp DATE: 6/5/90
SAMPLER(S): Sandy Beattie CONTRACTOR: Dartmouth Env. Ser.
SAMPLING METHOD: Split Spoon DRILLER: Harold Smith
DRILL TYPE: Mobile Drill B-57

SAMPLE NO.	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	PID (ppm)	STANDARD PENETRATION BLOW COUNT	NOTES
(0.9/2.0) SS1	0	Fill: dry silt, bricks, rocks, no odor, dk brown	0.0	8/10/8/10	
	1				
	2				
(1.4/2.0) SS2	3	D-0.9: fill, sl. moist, black, all fill material.	0.1	9/10/9/11	
	4	0.9-2.4 clay: grades into fat mottled grey/green/orange, v. stiff, sl. moist, sm. pieces of shale fragments throu.	0.0		Stopped because I don't want to break through clay. Set Sur. casing @ ~ 4.5'
(1.5/2.0) SS3	5	clay: dry, fat, some shale fragments, grey/green, no odor	0.0	11/13/17	
	6				
	7				
	8				
	9				
	10				

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Figure 2-7
SOIL SAMPLE FORM

SOURCE: HUNTER/ESE, 1988.

Prepared for:
U.S. Army Corps of Engineers,
Huntsville Division

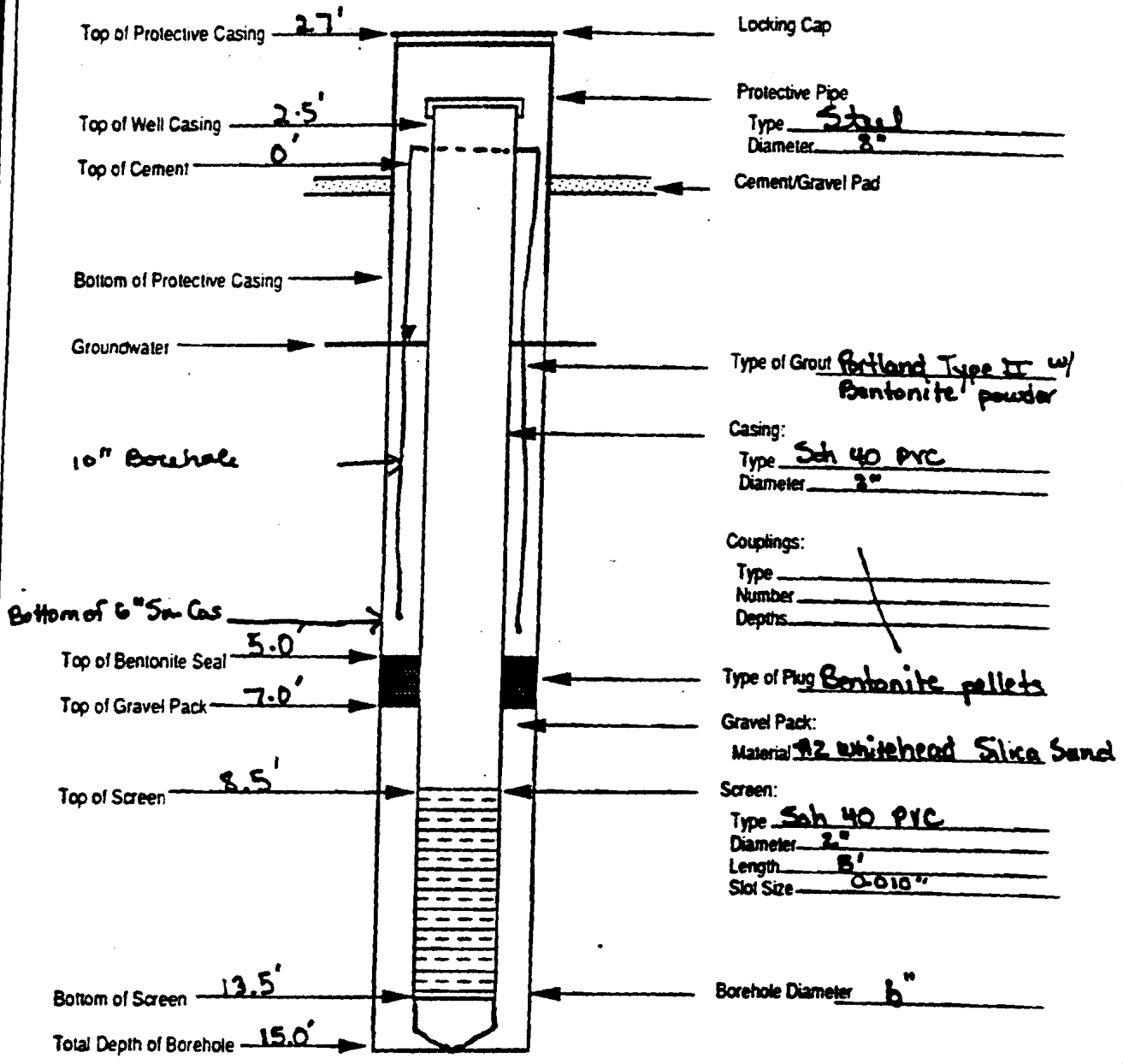
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WATERVLIET/SP/
Master Well 1200h

MONITOR WELL CONSTRUCTION

Logged By: Sandy Beattie — Client: WVA
Drilling Contractor: Dameremouth Env. Ser. — Location: Watervliet, NY
Driller's Name: Harold Smith — Job Number: 3905031
Well Number: MW-8 SCD MW-ESE-15 — Date/Time: Start 6/5/90 Finish 6/8/90
Comments: (Lost circulation interval, water level changes, hole collapse interval, etc.)

Depths in Reference to Ground Level



NOT TO SCALE

Figure 2-6
MONITOR WELL CONSTRUCTION LOG

SOURCE: HUNTER/ESE, 1989.

Prepared for:
U.S. Army Corps of Engineers,
Huntsville Division

SOIL SAMPLING REPORT FORM	ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

BORING NO.: MW-9 SED MW-9TESE-9 PAGE 1 OF 1
BORING LOCATION: NE corner of Sharon Area
DATE: 6/6/90
CONTRACTOR: Dartmouth Env. Sec.
SAMPLER(S): Sandy Beattie
DRILLER: Harold Smith
SAMPLING METHOD: Split spoon
DRILL TYPE: Mobile Drill B-57

SAMPLE NO.	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	OVM (ppm)	STANDARD PENETRATION BLOW COUNT	NOTES
(0.9/2.0) SS1	0–1	Fill: silt, clay, bricks, slag, lots of rock fragments, dry, crumbly, black / brown, no odor	2.2	6/5/12/12	Took comp. sample here SS1 VOA's SS1-2 SS's
(0.7/2.0) SS2	2–3	as above but w/ areas of dry orange soil	0.0	6/12/4/4	
N.R. SS3	4–5	as above but w/ more rock fragments ∴ no real recovery	—	4/2/1/3	from cuttings, it appears to be more fill, but w/ lots of rocks.
(0.8/2.0) SS4	6–7	top- clay: black, moist, sl. plastic, no odor,	0.0	3/2/5/9	will take one more spoon - if clay, will set surface casing in it.
		bottom- clay: fat, stiff, no odor, olive green,			
(1.0/2.0) SS5	8–9	clay: fat, stiff, olive green, no odor		6/14 —	stopped at 9' & thinking we might be out of clay
	9	weathered shale			Set sur. cas. at 8.8'-8.5'
	10				

87554 1

Figure 2-7
SOIL SAMPLE FORM

SOURCE: HUNTER/ESE, 1989.

Prepared for:
U.S. Army Corps of Engineers,
Huntsville Division

WATERVLIET WP 5.1[illegible]

WATERVLIET/FSP/
Monitor Well 1249h

MONITOR WELL CONSTRUCTION

Logged By: Sandy Beattie — Client: WVA
Drilling Contractor: Dameremuth Env. Ser. — Location: Watervliet, NY
Driller's Name: Harold Smith — Job Number: 3903081
Well Number: Duryea mw-17ESE-9 — Date/Time: Start 6/6/90 Finish 6/8/90
Comments: (Lost circulation interval, water level changes,hole collapse interval, etc.)

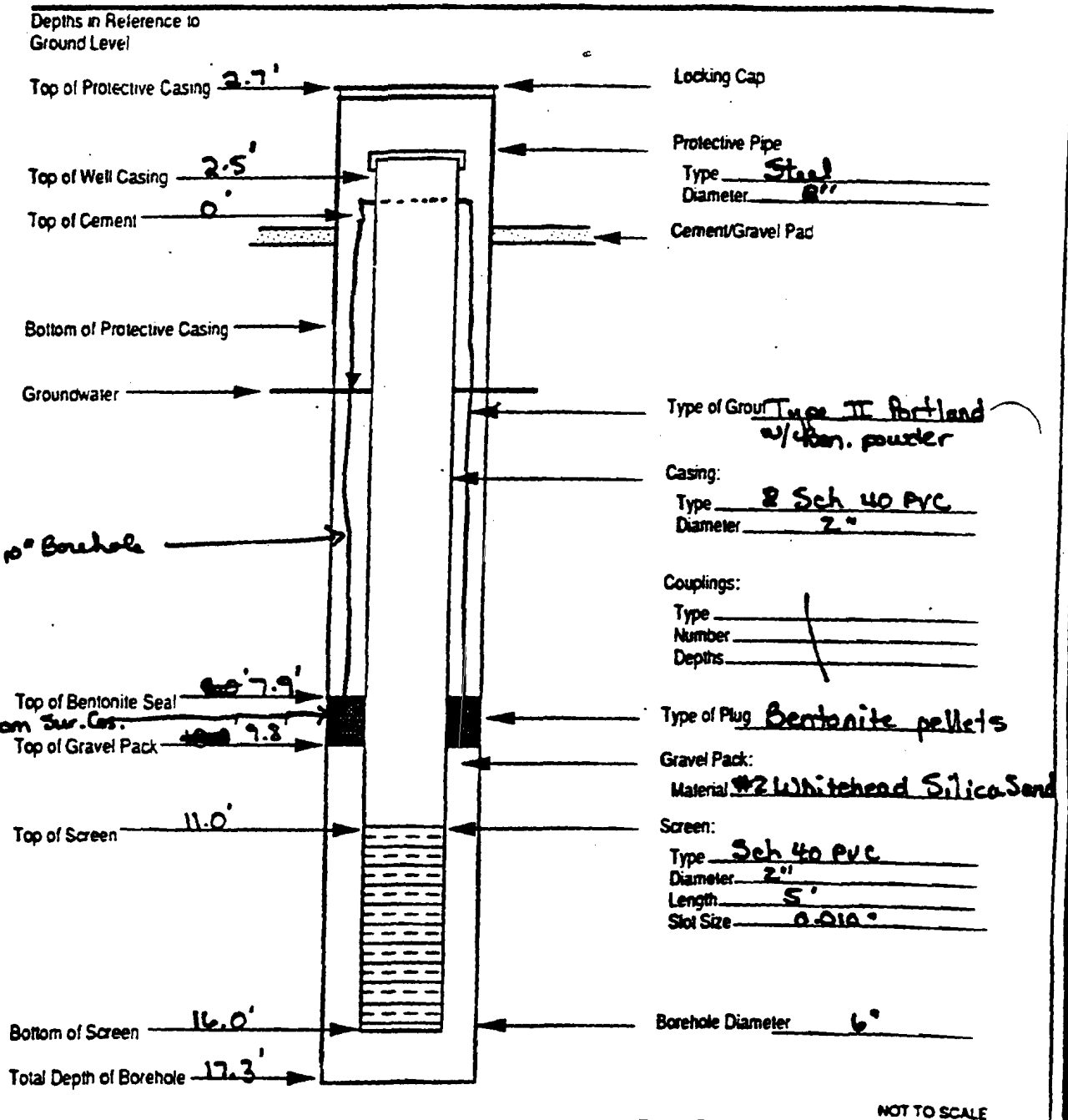


Figure 2-6
MONITOR WELL CONSTRUCTION LOG

SOURCE: HUNTER/ESE, 1989.

Prepared for:
U.S. Army Corps of Engineers, Huntsville Division

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B Groundwater Analytical Data

SUMMARY OF CONVENTIONAL GROUNDWATER PARAMETERS
PERFECTION PLATING SITE
(MAY 1996)

Parameter	Well ID[a]							
	MW-CTM-4	MW-EE-4D[b]	MW-EE-5S	MW-EE-5D	MW-EE-6S	MW-EA-7	MW-EA-8	MW-ESE-9
Total Alkalinity (mg/L as $CaCO_3$)	43	—	120	270	240	75	210	150
Chloride (mg/L)	270	97	150	310	170	280	120	190
Total Hardness (mg/L as $CaCO_3$)	130	52	460	12	340	320	250	400
pH (S.U.)	6.3	—	6.2	8.3	6.4	6.3	7.1	6.6
Dissolved Solids (mg/L)	680	440	1,100	870	570	810	550	760
Suspended Solids (mg/L)	360	200	220	42	130	25	55	ND (4)

[a] MW-EE-6D was purged dry, insufficient recharge to sample.

[b] Alkalinity and pH could not be performed because of limited sample volume.

Key:

ND (4) = Not detected at a detection limit of 4 mg/L.

FINAL
SUMMARY OF INORGANIC RESULTS FOR GROUNDWATER FROM MONITORING WELLS
PERFECTION PLATING SITE
(µg/L)

Parameter	NYSDEC Class GA Groundwater Standard[a]	Well I.D.: / Sampling Date:	MW-CTM-1 1-13-94	MW-EE-1S 1-12-94	MW-CTM-2 1-12-94	MW-EE-2D 1-12-94	MW-CTM-3 1-12-94
Aluminum	NA		642	4,340	624	256	1,230
Arsenic	25		<1.0	6.1 J	1.2 J	<1.0	<1.0
Barium	1,000		195 J	955	190 J	2,500	213
Beryllium	NA		<0.31	<0.31	<0.31	<0.31	<0.31
Cadmium	10		<2.3	<2.3	<2.3	<2.3	<2.3
Calcium	NA		52,600	89,100	46,400	46,600	81,600
Chromium	50		<4.4	66.1	<4.4	<4.4	8.7 J
Cobalt	NA		14.7 J	8.6 J	130	<7.0	<7.0
Copper	200		8.3 J	31.5	4.1 J	<2.8	11.9 J
Iron	300		1,130	11,200	5,670	497	2,590
Lead	25		<1.0	11.5	2.1 J	<1.0	3.1
Magnesium	NA		31,500	30,200	26,200	18,000	26,600
Manganese	300		1,440	2,550	15,700	529	178
Nickel	NA		29.5 J	31.5 J	90.0	5.4 J	31.8 J
Potassium	NA		5,150	19,300	2,800 J	8,490	4,190 J
Selenium	10		<1.0	<1.0	<1.0	<1.0	<1.0
Silver	50		<4.5	<4.5	<4.5	<4.5	<4.5
Sodium	20,000		31,300	77,900	72,000	113,000	143,000
Thallium	NA		<1.0	1.8 B	1.0 B	2.1 B	1.4 B
Vanadium	NA		<6.3	8.8 J	<6.3	<6.3	<6.3
Zinc	200		182	82.4	81.8	45.5	52.4
Cyanide	100		<10.0	<10.0	<10.0	<10.0	36.0
Mercury	2		NT	NT	NT	NT	NT

Key at end of table.

FINAL
SUMMARY OF INORGANIC RESULTS FOR GROUNDWATER FROM MONITORING WELLS
PERFECTION PLATING SITE
(µg/L)

Parameter	NYSDEC Class GA Groundwater Standard[a]	Well I.D.:	MW-CTM-4			MW-EE-4D		
		Sampling Date:	1-12-94	5/96	5/96 (filtered)	1-13-94	5-96	5-96 (filtered)
Aluminum	NA		1,310	7,050	ND(21.0)	6,730	2,140	122
Arsenic	25		<1.0	ND(3.7)	ND(3.7)	33.9	21.3	23.0
Barium	1,000		92.9 J	357	73.6	1,730	1,870	1,440
Beryllium	NA		<0.31	ND(0.60)	ND(0.60)	0.35 J	ND(0.60)	ND(0.60)
Cadmium	10		<2.3	ND(4.6)	ND(4.6)	<2.3	ND(4.6)	ND(4.6)
Calcium	NA		35,200	52,500	50,900	48,900	13,800	5,720
Chromium	50		227	225	158	44.9	11.0	ND(6.3)
Cobalt	NA		<7.0	17.0	ND(8.3)	<7.0	ND(8.3)	ND(8.3)
Copper	200		9.7 J	25.4	ND(6.9)	124	32.6	ND(6.9)
Iron	300		2,820	14,600	57.2	11,700	3,550	77.3
Lead	25		3.2	10.3	ND(2.1)	26.5	2.4	ND(2.1)
Magnesium	NA		15,200	25,600	22,100	6,610	2,800	1,490
Manganese	300		125	663	45.8	446	175	19.6
Nickel	NA		14.3 J	33.1	ND(14.0)	29.4 J	15.6	ND(14.0)
Potassium	NA		4,290 J	5,900	4,510	3,460 J	5,410	4,900
Selenium	10		<1.0	ND(4.9)	ND(4.9)	<1.0	ND(4.9)	ND(4.9)
Silver	50		<4.5	ND(5.4)	ND(5.4)	<4.5	ND(5.4)	ND(5.4)
Sodium	20,000		88,400	122,000	123,000	106,000	150,000	152,000
Thallium	NA		<1.0	ND(3.8)	ND(3.8)	<1.0	ND(3.8)	ND(3.8)
Vanadium	NA		<6.3	11.4	ND(9.2)	34.8 J	10.7	ND(9.2)
Zinc	200		107	60.7	ND(4.8)	337	53.9	5.9
Cyanide	100		23.0	NT	NT	<10.0	NT	NT
Mercury	2		NT	0.15	ND(0.10)	NT	ND(0.10)	ND(0.10)

Key at end of table.

FINAL
SUMMARY OF INORGANIC RESULTS FOR GROUNDWATER FROM MONITORING WELLS
PERFECTION PLATING SITE
(µg/L)

Parameter	NYSDEC Class GA Groundwater Standard[a]	Well I.D.:	MW-EA-5	MW-EE-5S			MW-EE-5D		
		Sampling Date:	1-12-94	1-12-94	5/96	5/96 (filtered)	1-13-94	5/96	5/96 (filtered)
Aluminum	NA		62.2 J	5,440	4,680	80.3	1,600	2,340	26.9
Arsenic	25		1.1 J	3.7 J	ND(3.7)	ND(3.7)	2.9 J	ND(3.7)	ND(3.7)
Barium	1,000		54.4 J	281	246	73.1	1,240	1,750	1,500
Beryllium	NA		<0.31	0.70 J	ND(0.60)	ND(0.60)	<0.31	ND(0.60)	ND(0.60)
Cadmium	10		3.3 J	<2.3	ND(4.6)	ND(4.6)	<2.3	ND(4.6)	ND(4.6)
Calcium	NA		28,500	80,300	153,000	155,000	2,640 J	2,650	2,310
Chromium	50		5.9 J	173,000	196,000	215,000	1,730	119	87.0
Cobalt	NA		10.8 J	68.3	107	105	15.8 J	9.5	ND(8.3)
Copper	200		51.1	109	123	70.8	7.7 J	ND(6.9)	ND(6.9)
Iron	300		164	12,500	9,300	113	3,210	4,840	90.8
Lead	25		<1.0	8.8	ND(2.1)	ND(2.1)	2.2 J	ND(2.1)	ND(2.1)
Magnesium	NA		7,230	23,300	28,900	27,200	1,320 J	1,980	550
Manganese	300		710	1,140	881	730	79.2	95.4	43.4
Nickel	NA		118	96.4	104	87.1	685	590	582
Potassium	NA		20,700	16,200	16,900	16,800	1,210 J	5,960	5,390
Selenium	10		<1.0	2.0 J	33.2	26.3	<1.0	ND(4.9)	ND(4.9)
Silver	50		<4.5	4.6 J	ND(5.4)	ND(5.4)	<4.5	ND(5.4)	ND(5.4)
Sodium	20,000		98,800	35,900	75,600	79,900	257,000	303,000	316,000
Thallium	NA		1.9 B	1.8 B	37.3	41.0	1.2 B	ND(3.8)	ND(3.8)
Vanadium	NA		<6.3	18.7 J	137	123	<6.3	ND(9.2)	ND(9.2)
Zinc	200		56.0	83.6	112	63.3	103	18.1 B	ND(4.8)
Cyanide	100		22.0	<10.0	NT	NT	<10.0	NT	NT
Mercury	2		NT	NT	0.19	ND(0.10)	NT	0.10	0.10

Key at end of table.

FINAL
SUMMARY OF INORGANIC RESULTS FOR GROUNDWATER FROM MONITORING WELLS
PERFECTION PLATING SITE
(µg/L)

Parameter	NYSDEC Class GA Groundwater Standard[a]	Well I.D.:	MW-EE-5D(D)	MW-EA-6	MW-EE-6S			MW-EE-6D[b]
		Sampling Date:	1-13-94	1-12-94	1-11-94	5/96	5/96 (filtered)	1-12-94
Aluminum	NA		1,400	1,000	1,580	1,310	42.8	885
Arsenic	25		1.2 J	<1.0	2.0 J	3.7	ND(3.7)	4.1 J
Barium	1,000		1,280	110 J	1,800	2,640	2,450	2,590
Beryllium	NA		<0.31	<0.31	<0.31	ND(0.60)	ND(0.60)	<0.31
Cadmium	10		<2.3	<2.3	<2.3	ND(4.6)	ND(4.6)	<2.3
Calcium	NA		2,590 J	41,700	80,600	88,400	86,000	70,700
Chromium	50		1,790	118	9.5 J	ND(6.3)	ND(6.3)	5.3 J
Cobalt	NA		14.3 J	<7.0	7.6 J	ND(8.3)	ND(8.3)	<7.0
Copper	200		5.2 J	4.5 J	7.8 J	ND(6.9)	ND(6.9)	8.3 J
Iron	300		2,860	2,210	21,900	24,800	22,500	15,900
Lead	25		1.6 J	3.5	4.2	ND(2.1)	ND(2.1)	2.6 J
Magnesium	NA		1,250 J	24,600	29,300	32,600	31,300	25,400
Manganese	300		78.3	1,160	4,670	5,630	5,490	3,230
Nickel	NA		704	20.3 J	38.5 J	42.8	33.7	27.4 J
Potassium	NA		5,340	2,670 J	8,250	4,110	4,200	8,280
Selenium	10		<1.0	<1.0	<1.0	ND(4.9)	ND(4.9)	<1.0
Silver	50		<4.5	<4.5	<4.5	ND(5.4)	ND(5.4)	<4.5
Sodium	20,000		267,000	77,000	44,600	54,500	55,200	61,100
Thallium	NA		1.3 B	<1.0	2.1 B	ND(3.8)	ND(3.8)	1.1 B
Vanadium	NA		<6.3	<6.3	6.3 J	ND(9.2)	ND(9.2)	<6.3
Zinc	200		89.4	72.2	34.9	17.9	ND(4.8)	30.7
Cyanide	100		<10.0	<10.0	<10.0	NT	NT	<10.0
Mercury	2		NT	NT	NT	ND(0.10)	ND(0.10)	NT

Key at end of table.

FINAL
SUMMARY OF INORGANIC RESULTS FOR GROUNDWATER FROM MONITORING WELLS
PERFECTION PLATING SITE
(μg/L)

Parameter	NYSDEC Class GA Groundwater Standard[a]	Well I.D.:	MW-EA-7			MW-EA-8		
		Sampling Date:	1-12-94	5-96	5-96 (filtered)	1-12-94	5-96	5-96 (filtered)
Aluminum	NA		5,310	613	35.1	625	936	27.6
Arsenic	25		4.2 J	ND(3.7)	ND(3.7)	<1.0	ND(3.7)	ND(3.7)
Barium	1,000		128 J	118	114	133 J	129	85.9
Beryllium	NA		<0.31	ND(0.60)	ND(0.60)	<0.31	ND(0.60)	ND(0.60)
Cadmium	10		<2.3	ND(4.6)	ND(4.6)	<2.3	ND(4.6)	ND(4.6)
Calcium	NA		67,300	87,100	90,100	95,600	88,400	87,800
Chromium	50		6,130	2,990	3,190	4,700	2,770	2,740
Cobalt	NA		17.1 J	ND(8.3)	ND(8.3)	<7.0	ND(8.3)	ND(8.3)
Copper	200		22.3 J	ND(6.9)	ND(6.9)	18.2 J	32.1	ND(6.9)
Iron	300		10,600	1,190	57.0	1,260	2,340	23.5
Lead	25		10.5	ND(2.1)	ND(2.1)	10.7	18.7	ND(2.1)
Magnesium	NA		24,100	31,300	32,200	16,500	14,800	14,500
Manganese	300		423	333	323	197	275	1.6
Nickel	NA		65.9	42.1	38.3	40.6	30.4	16.2
Potassium	NA		5,280	5,560	5,850	8,580	10,400	10,600
Selenium	10		3.1 J	7.3	ND(4.9)	2.1 J	8.5	7.5
Silver	50		<4.5	ND(5.4)	ND(5.4)	<4.5	ND(5.4)	ND(5.4)
Sodium	20,000		85,300	105,000	111,000	65,500	78,500	79,800
Thallium	NA		1.2 B	ND(3.8)	ND(3.8)	1.2 B	ND(3.8)	ND(3.8)
Vanadium	NA		13.5 J	ND(9.2)	ND(9.2)	<6.3	ND(9.2)	ND(9.2)
Zinc	200		85.8	18.3	ND(4.8)	90.0	65.1	15.1
Cyanide	100		35.0	NT	NT	40.0	NT	NT
Mercury	2		NT	ND(0.10)	ND(0.10)	NT	0.10	ND(0.10)

Key at end of table.

FINAL
SUMMARY OF INORGANIC RESULTS FOR GROUNDWATER FROM MONITORING WELLS
PERFECTION PLATING SITE
(µg/L)

Parameter	NYSDEC Class GA Groundwater Standard[a]	Well I.D.:	MW-ESE-8	MW-ESE-9			MW-EE-5D(D)	MW-EA-6
		Sampling Date:	1-12-94	1-12-94	5/96	5/96 (filtered)	1-13-94	1-12-94
Aluminum	NA		248	419	41.3	26.2	1,400	1,000
Arsenic	25		<1.0	<1.0	ND(3.7)	ND(3.7)	1.2 J	<1.0
Barium	1,000		1,540	104 J	62.8	57.5	1,280	110 J
Beryllium	NA		<0.31	<0.31	ND(0.60)	ND(0.60)	<0.31	<0.31
Cadmium	10		<2.3	<2.3	ND(4.6)	ND(4.6)	<2.3	<2.3
Calcium	NA		142,000	97,700	97,800	97,300	2,590 J	41,700
Chromium	50		<4.4	69,000	36,800	38,700	1,790	118
Cobalt	NA		<7.0	41.0 J	32.7	32.3	14.3 J	<7.0
Copper	200		4.4 J	8.3 J	ND(6.9)	ND(6.9)	5.2 J	4.5 J
Iron	300		908	736	71.7	35.4	2,860	2,210
Lead	25		<1.0	1.6 J	ND(2.1)	ND(2.1)	1.6 J	3.5
Magnesium	NA		54,500	42,300	43,500	43,200	1,250 J	24,600
Manganese	300		8,250	2,220	2,260	2,280	78.3	1,160
Nickel	NA		13.7 J	71.6	63.8	58.5	704	20.3 J
Potassium	NA		7,350	5,300	5,890	6,130	5,340	2,670 J
Selenium	10		1.3 J	3.4 J	10.6	10.4	<1.0	<1.0
Silver	50		<4.5	<4.5	ND(5.4)	ND(5.4)	<4.5	<4.5
Sodium	20,000		85,400	66,500	73,700	75,600	267,000	77,000
Thallium	NA		1.4 B	1.2 B	ND(3.8)	ND(3.8)	1.3 B	<1.0
Vanadium	NA		<6.3	<6.3	20.1	21.1	<6.3	<6.3
Zinc	200		73.3	30.4	ND(4.8)	ND(4.8)	89.4	72.2
Cyanide	100		<10.0	836	NT	NT	<10.0	<10.0
Mercury	2		NT	NT	ND(0.10)	ND(0.10)	NT	NT

Key at end of table.

Summary of Inorganic Results... (Cont.)

Note: Shaded values exceed NYSDEC Class GA Groundwater Standards.

[a] NYSDEC, September 1, 1991, Water Quality Regulations for Surface Waters and Groundwaters. Class GA groundwater is best suited as a potable water supply.

[b] Purged 5/96, insufficient recharge to sample.

Key:

B	=	Analyte is considered not detected due to presence in field/laboratory blank.
J	=	The associated numerical value is an estimated quantity.
NA	=	Not applicable.
ND(0.54)	=	Not detected at a detection limit of 0.54 μg/L.
NT	=	Not tested for.

C Operational Manual (Philip Services Corporation)

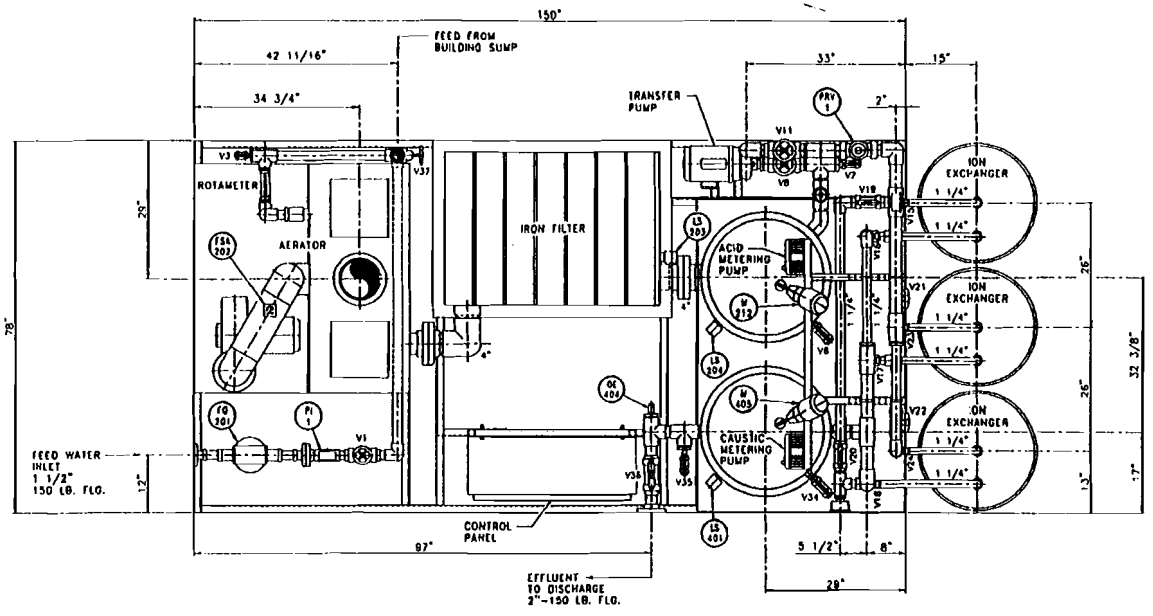
System Overview

Contaminated ground water collected in a trench, is pumped by means of a submersible pump to an aerator at a flow rate of 5GPM. From the aerator the water flows by means of gravity to a plate iron filter for the removal of suspended solids and oxidized iron.

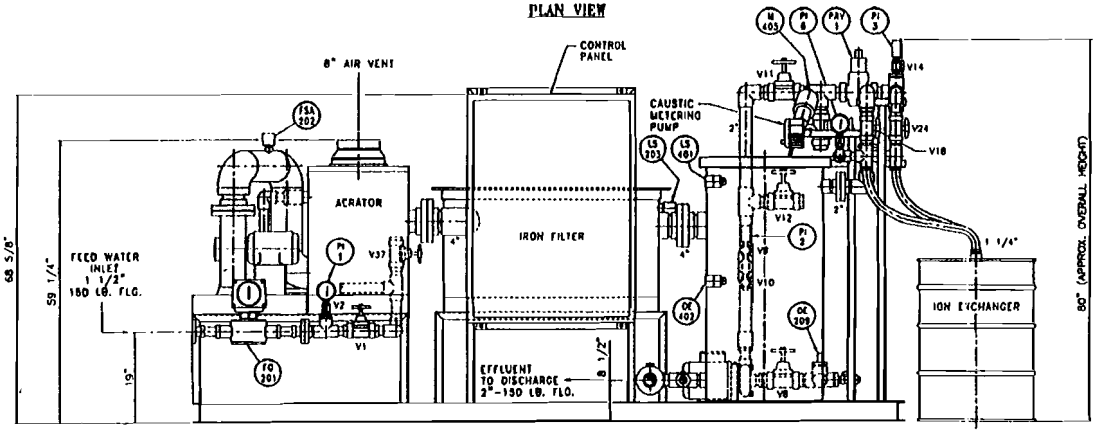
From the iron filter the water flows by means of gravity to a 90-gallon retention tank. In this tank the pH is adjusted to a level of between 4.5 to 5.0. This pH adjustment will enhance the effectiveness of the proceeding anion exchangers.

The water is now transferred form the acid adjustment tank by a centrifugal pump to anion exchangers at a flow rate of 5GPM and a reduced pressure of 10psi. The anion exchangers are plumbed in series. A conductivity sensor is always installed after the second cylinder. When the conductivity reaches a level that has been correlated to a break through of hexavalent chromium (as determined by restart up testing). The first anion exchanger is removed and a fresh one is put in its place. The original second unit is now the first unit followed by the original third and the freshly installed unit.

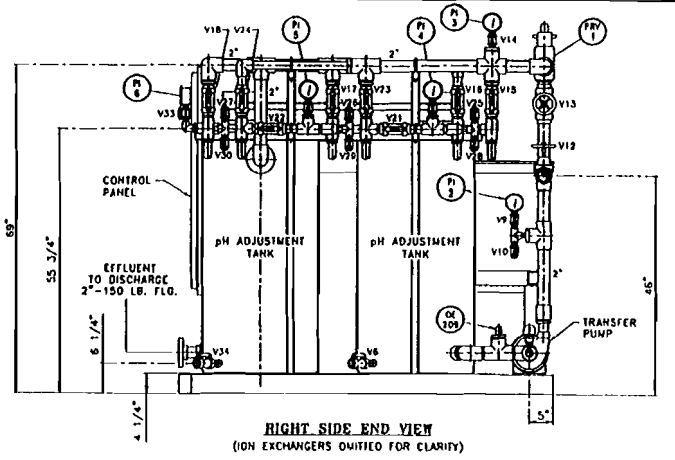
From the anion exchangers the water flows to a 90-gallon retention tank. In this tank the pH is adjusted to a level of between 6.4 – 6.7. The water then flows, by gravity to a storm water catch basin.



PLAN VIEW



ELEVATION VIEW



RIGHT SIDE END VIEW
(ION EXCHANGERS OMITTED FOR CLARITY)

VALVE SCHEDULE

TAG	DESCRIPTION	SIZE	VALVE TYPE
V1	FEED WATER INLET	1 1/2"	MANUAL GLOBE
V2	PI-1 ISOLATOR	1/2"	MANUAL BALL
V3	SAMPLE VALVE	1/2"	MANUAL BALL
V4	ACRATOR DRAIN	1"	MANUAL BALL
V5	IRON FILTER DRAIN	1 1/4"	MANUAL BALL
V6	pH ADJUSTMENT TANK DRAIN	3/4"	MANUAL BALL
V7	SAMPLE VALVE	1/2"	MANUAL BALL
V8	TRANSFER PUMP INLET	2"	MANUAL GLOBE
V9	PI-2 ISOLATOR	1/2"	MANUAL BALL
V10	SAMPLE VALVE	1/2"	MANUAL BALL
V11	TRANSFER PUMP DISCHARGE	2"	MANUAL GLOBE
V12	BLEED VALVE	2"	MANUAL GLOBE
V13	BLEED VALVE	2"	MANUAL GLOBE
V14	PI-5 ISOLATOR	1/2"	MANUAL BALL
V15	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V16	ION EXCHANGER OUTLET	1 1/4"	MANUAL BALL
V17	ION EXCHANGER OUTLET	1 1/4"	MANUAL BALL
V18	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V19	ION EXCHANGER BYPASS	1 1/4"	MANUAL BALL
V20	ION EXCHANGER BYPASS	1 1/4"	MANUAL BALL
V21	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V22	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V23	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V24	ION EXCHANGER INLET	1 1/4"	MANUAL BALL
V25	TO CONDUCTIVITY INDICATING CONTROLLER	1/2"	MANUAL BALL
V26	TO CONDUCTIVITY INDICATING CONTROLLER	1/2"	MANUAL BALL
V27	TO CONDUCTIVITY INDICATING CONTROLLER	1/2"	MANUAL BALL
V28	SAMPLE VALVE	1/2"	MANUAL BALL
V29	SAMPLE VALVE	1/2"	MANUAL BALL
V30	SAMPLE VALVE	1/2"	MANUAL BALL
V31	PI-4 ISOLATOR	1/2"	MANUAL BALL
V32	PI-3 ISOLATOR	1/2"	MANUAL BALL
V33	PI-6 ISOLATOR	1/2"	MANUAL BALL
V34	pH ADJUSTMENT TANK DRAIN	3/4"	MANUAL BALL
V35	SAMPLE VALVE	1/2"	MANUAL BALL
V36	EFFLUENT TO DISCHARGE OUTLET	2"	MANUAL BALL
V37	INLET FROM BUILDING SUMP	1 1/2"	MANUAL GLOBE

NOTES:
1) ALL PIPING IS SCH. 80 PVC PIPE AND SOCKETWELD PVC FITTINGS.

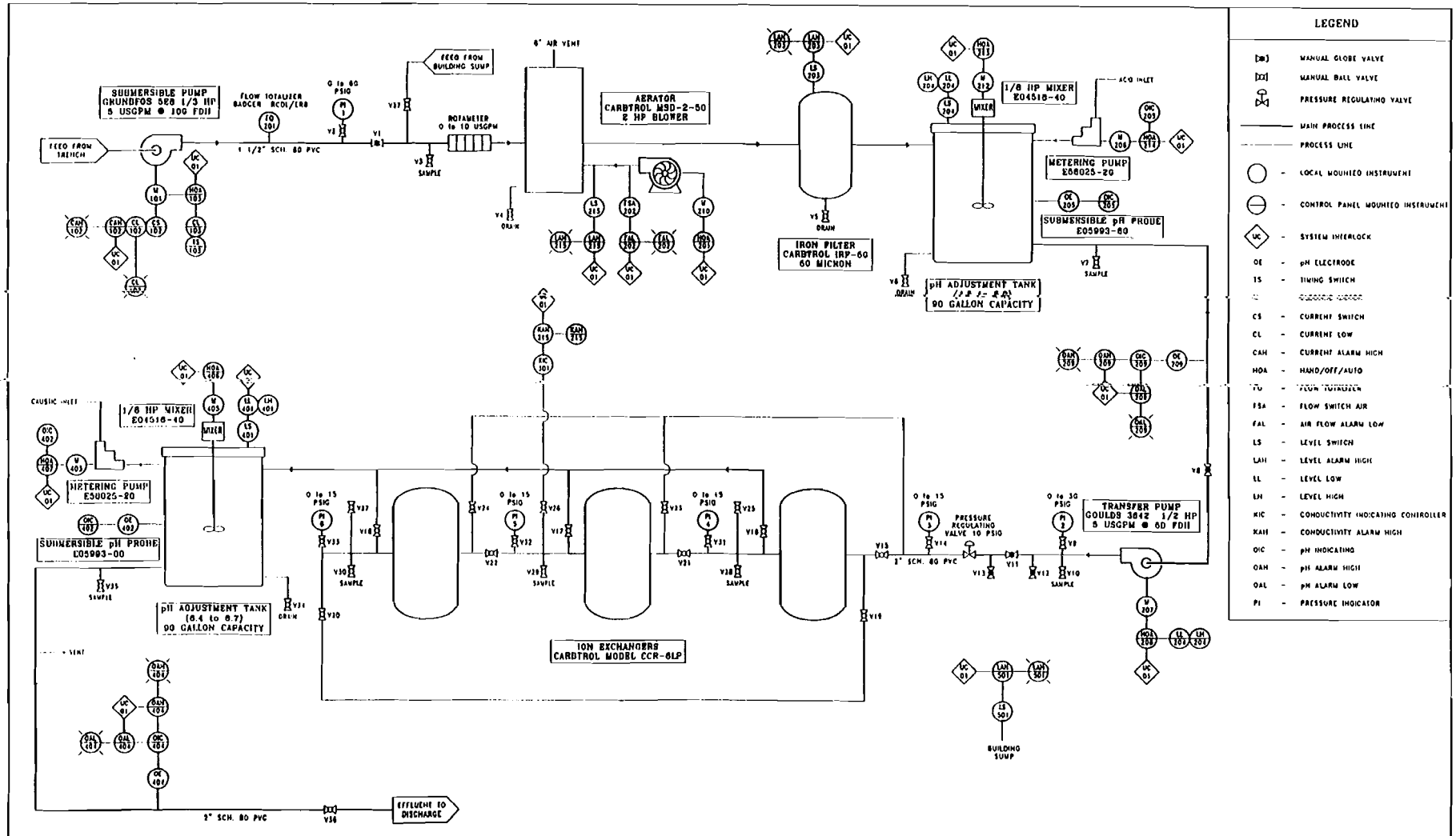
REF. DWG. No.	REFERENCE DRAWING TITLE

REV	DESCRIPTION	BY	DATE

INTEGRA ENVIRONMENTAL INC.

TITLE: GENERAL ARRANGEMENT FOR GROUNDWATER TREATMENT SYSTEM

DRAWN: MO 03/17/97
SCALE: 1"=1'-0"
APPROVED:
PERFECTION PLATING
DWG. No. PP-002
REV. 0



NOTES:

REF. DWG. No.	REFERENCE DRAWING TITLE	REV	DESCRIPTION	BY	DATE

INTEGRA ENVIRONMENTAL INC.

P and I DIAGRAM FOR GROUNDWATER TREATMENT SYSTEM

DRAWN MG 02/23/88

SCALE NTS

PERFECTION PLATING

DRAWING No. PP-001 | 0

Initial system Start Up and Operation

1. Verify that all motor rotations are correct.
2. Verify that all level switches are functioning properly prior to processing any water. Also, set and verify all alarm levels.
3. Inspect the iron filter for the proper installation of the filter fabric. Each plate should contain two layers of fabric cut to 17" x 31".
4. Remove the plastic protective cover from the submersible pH probes.
5. Calibrate all pH probes (per manuf. Specs.)
6. Connect three anion exchangers to the appropriate flexible tubing. Open/close the valves that will allow for 1-2-3 operation (see valve sequencing chart).
7. Install the conductivity probe in the appropriate valve so it monitors the second anion exchanger.
8. Close all sample ports and drain valves.
9. Open all pressure gauge isolation valves.
10. Close system outlet valve #V36. Fill the entire system with potable water and check all components and piping connections for leaks. Repair as necessary.
11. Drain potable water from the system.
12. Open valve #V36 (System discharge valve).
13. Connect the system discharge to a 4,000-gallon storage tank. Connect a drum of acid and caustic to the appropriate chemical pump.
14. Start the system and make all the necessary adjustments and recordings:

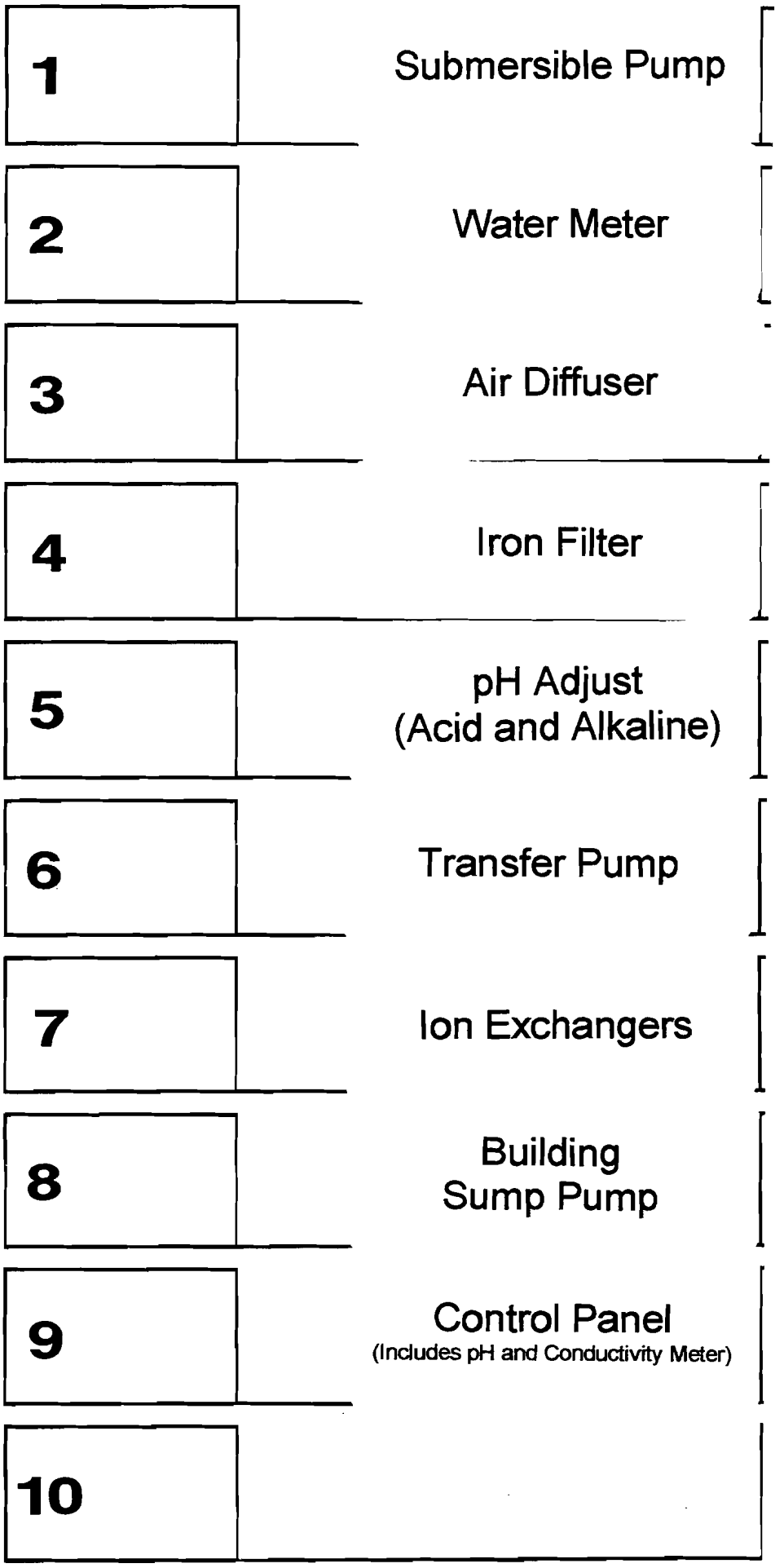
    (**Note:** Aerator tank should be full prior to blower start)

    - Record the flow totalizer reading.
    - Throttle V1 to 5GPM.
    - Aerator blower discharge pressure gauge should read 17 ½" w.c.
    - Record all pressure gauge readings.

      (**Note:** Adjust the pressure-regulating valve prior to the ion exchangers so the pressure is no greater then 10psi !)
    - Observe the iron filter flow.

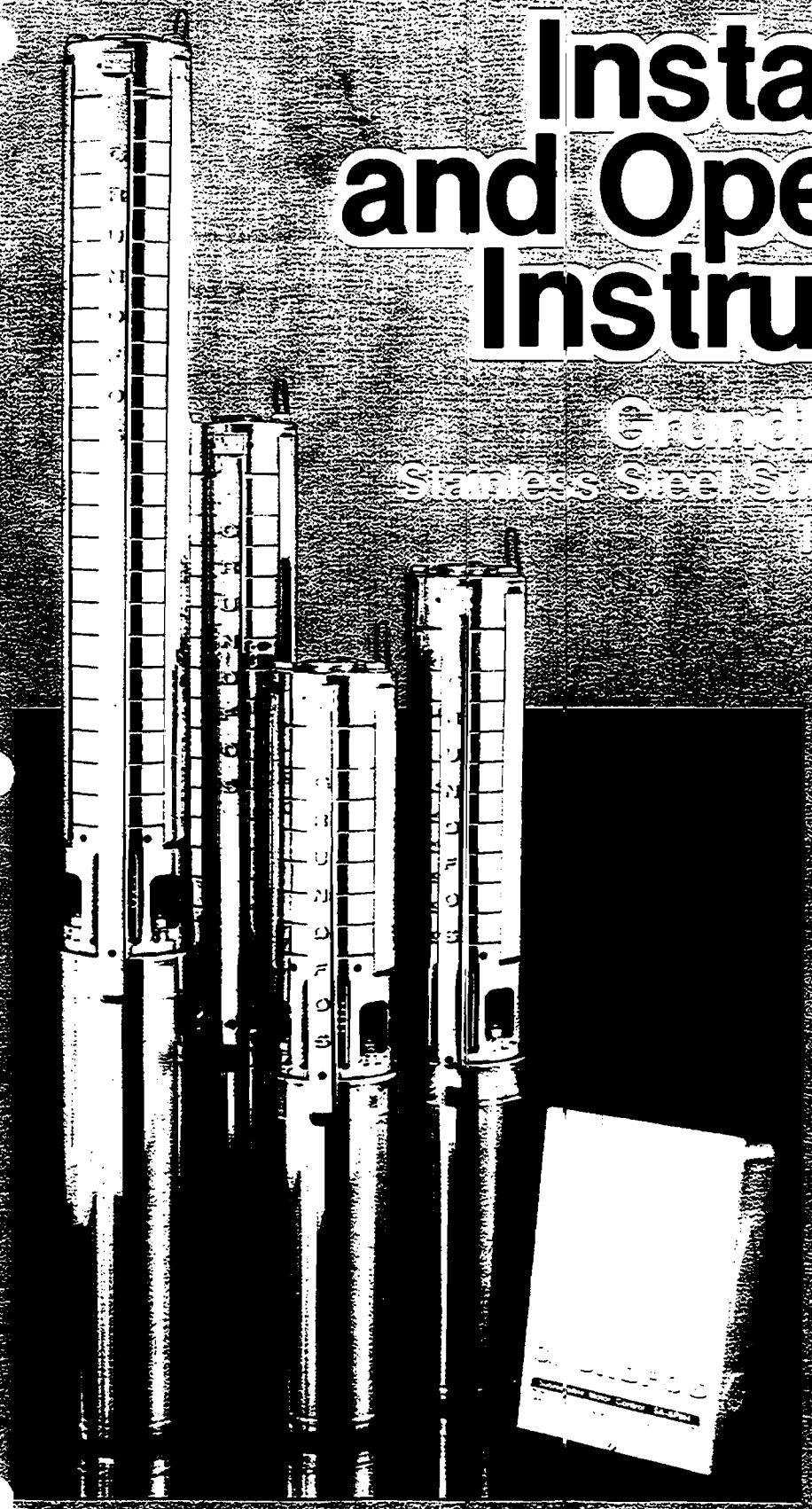
      (**Note:** When the water level in the filter overflows the last filter screen the filter fabric must be replaced.)
    - Adjust the acid pump to allow for a pH of 4.5 to 5.0.
    - Throttle #V11 to allow for 5GPM flow.
    - Adjust the caustic pump to allow for a pH of 6.4 – 6.7.
    - Record the conductivity reading.
15. Once the system is operating, run continuously for four hours. At this time testing will take place. Once the results are received. This procedure will be followed for three successive tests.

    (**Note:** When an ion exchanger is replaced it must be kept wet or the Hexavalent Chrome will smolder the resin.


1
Submersible Pump
2
Water Meter
3
Air Diffuser
4
Iron Filter
5
pH Adjust
(Acid and Alkaline)
6
Transfer Pump
7
Ion Exchangers
8
Building
Sump Pump
9
Control Panel
(Includes pH and Conductivity Meter)
10

Installation and Operating Instructions

Grundfos Sheet Pile Stainless Steel Submersible Pumps for Environmental Applications



1. **Shipment Inspection** Page 1
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Please leave these instructions with the pump

Installation and Operating Instructions

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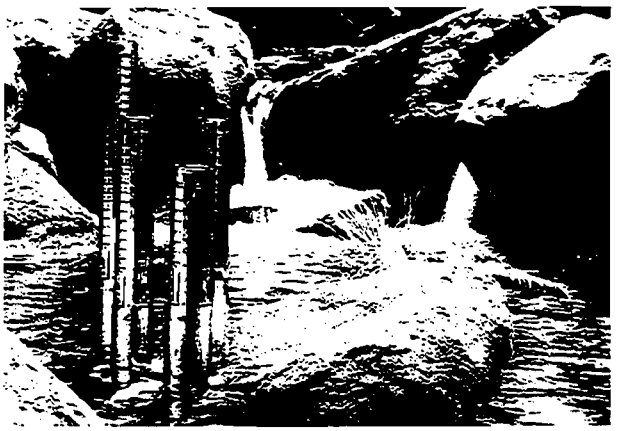
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Installation and Operating Instructions

GRUNDFOS

Redi-Flo4



Your Grundfos Redi-Flo4 Environmental Pump is of the utmost quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

SECTION 1.

Shipment Inspection

Examine the components carefully to make sure no damage has occurred to the pump-end, motor, cable or control box during shipment.

This Grundfos Redi-Flo4 Environmental Pump should remain in its shipping carton until it is ready to be installed. The carton is specially designed to protect it from damage. During unpacking and prior to installation, **make sure that the pump is not contaminated, dropped or mishandled.**

The motor is equipped with an electrical cable. **Under no circumstance should the cable be used to support the weight of the pump.**

You will find a loose data plate wired to the pump. It should be securely mounted at the well or attached to the control box.

SECTION 2.

Pre-Installation Checklist

Before beginning installation, the following checks should be made. They are all critical for the proper installation of this submersible pump.

☑ A. CONDITION OF THE WELL

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. Dispose of discharged materials in accordance with the specific job site requirements. The stainless steel construction of the Redi-Flo4 Environmental Pump makes it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy groundwater.

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

The inside diameter of the well casing should be checked to ensure that it is not smaller than the size of the pump and motor.

☑ B. CONDITION OF THE WATER

Redi-Flo4 pumps are designed for pumping cold groundwater that is free of air or gases. Decreased pump performance and life expectancy can occur if the groundwater is not cold or contains air or gases.

☑ C. INSTALLATION DEPTH

Pumping sand or well sediment can occur when the pump motor is installed lower than the top of the well screen or within five feet of the well bottom. This can reduce the performance and life expectancy of the pump and should be avoided.

If the pump is to be installed in a lake, containment pond, tank or larger diameter well, the water velocity passing over the motor must be sufficient to ensure proper motor cooling. The minimum recommended water flow rates which ensure proper cooling are listed in Table A.

☑ D. ELECTRICAL SUPPLY

The motor voltage, phase and frequency indicated on the motor nameplate should be checked against the actual electrical supply.

SECTION 3.

Wire Cable Type

The type of wire used between the pump and control box should be approved for submersible pump applications. The conductor insulation should have a continuous Teflon® jacket with no splices and must be suitable for use with submersible pumps.

SECTION 4.

Installation

The riser pipe or hose should be properly sized and selected based on estimated flow rates and friction-loss factors.

A back-up wrench should be used when attaching a riser pipe or metallic nipple to the pump. The pump should only be gripped by the flats on the top of the discharge chamber. **The body of the pump, cable guard or motor should not be gripped under any circumstance.**

If steel riser pipe is used:

An approved pipe thread compound should be used on all joints. Make sure the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

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

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

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

The drop cable should be secured to the riser pipe at frequent intervals using an approved clip or tape to prevent sagging, looping and possible cable damage.

If plastic or flexible riser pipe is used:

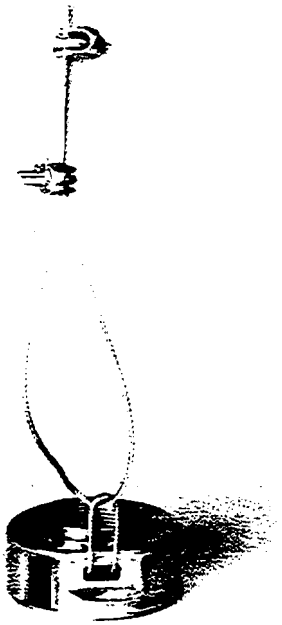
Use the correct compound recommended by the pipe manufacturer or specific job specifications. Besides making sure that joints are securely fastened, the use of a torque arrester is recommended when using these types of pipe.

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

The drop cable should be secured to the riser pipe at frequent intervals using an approved clip or tape to prevent sagging, looping and possible cable damage.

IMPORTANT- Plastic and flexible pipe tend to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave enough slack between clips or taped points to allow for this stretching. This tendency for plastic and flexible pipe to stretch will also affect the calculation of the pump setting depth. If the depth setting is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

When these types of pipe are used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge piece of Redi-Flo4 submersibles is designed to accommodate this cable. (Figure 4)



Protect the well from contamination:

While installing the pump, proper care should be used not to introduce foreign objects or contaminants into the well. The well should be finished off above grade to protect against surface water from entering the well, causing contamination.

NOTE: Teflon® is a registered trademark of DuPont.

SECTION 5.

Electrical

WARNING: To reduce the risk of electric shock during operation of this pump requires the provision of acceptable grounding. If the means of connection to the supply connected box is other than grounded metal conduit, ground the pump back to the service by connecting a copper conductor, at least the size of the circuit supplying the pump, to the grounding screw provided within the wiring compartment.

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

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor voltage, phase, frequency and full-load current information can be found on the nameplate attached to the motor. Motor electrical data can be found in Table C.
If voltage variations are larger than ± 10%, do not operate the pump.
Direct on-line starting is used due to the extremely fast run-up time of the motor (0.1 second maximum), and the low moment of inertia of the pump and motor. Direct on-line starting current (locked rotor amp) is between 4 and 6.5 times the full-load current.

Engine-Driven Generators

If the Redi-Flo4 pump is going to be operated using an engine driven generator, we suggest the manufacturer of the generator be contacted to ensure the proper generator is selected and used. See Table B for generator sizing guide.

Control Box, Single-Phase Motors

Single-phase motors must be connected as indicated in the motor control box. A typical single-phase wiring diagram using a Grundfos control box is shown. (Figure 5-A)

High Voltage Surge Arresters

A high voltage surge arrester should be used to protect the motor against lightning and switching surges. The correct voltage-rated surge arrester should be installed on the supply(line) side of the control box.(Figure 5-B) **The arrester must be grounded in accordance with the National Electric Code, local codes and regulations.**

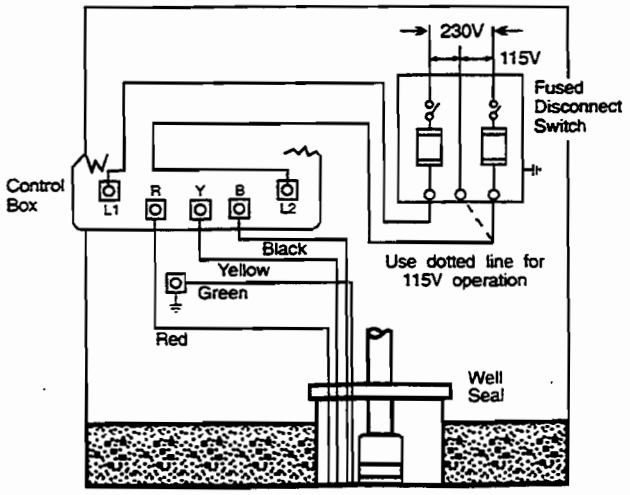
Control Box and Surge Arrester Grounding

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

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

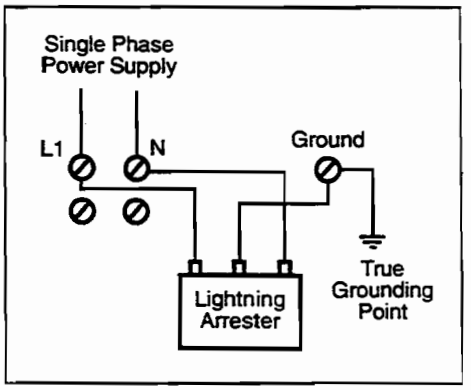
Wiring Checks

Before making the final wiring connections of the drop cable to the control box terminal, it is a good practice to check the insulation resistance to ensure that the cable is good. Measurements for a new installation must be at least 1,000,000 ohm. Do not start the pump if the measurement is less than this. If it is higher, finish wiring and verify that all electrical connections are made in accordance with the wiring diagram. Check to ensure the control box and high voltage surge arrester have been grounded.



Single Phase Wiring Diagram for Grundfos Control Boxes

(Figure 5-A)



Single Phase Hookup

(Figure 5-B)

SECTION 6.

Start-Up

After the pump has been set into the well and the wiring connections have been made, the following procedures should be performed.

A. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.

B. If required, make provisions to capture discharged fluids for disposal.

C. Adjust the gate valve one-third open.

D. Start the pump and let it operate until the water runs clear of sand and silt.

E. As the water clears, slowly open the gate valve in small increments until the desired flow rate of clear water is reached. The pump should not be operated beyond its maximum flow rating and should not be stopped until the groundwater runs clear.

F. If the groundwater is clean and clear when the pump is first started, the valve should still be opened until the desired flow rate is reached.

G. Disconnect the temporary piping arrangements and complete the final piping connections.

H. **Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed.** This can result in motor damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

I. Start the pump and test the system. Check and record the voltage and current draw on each motor lead.

Operation

A. The pump and system should be periodically checked for water quantity, pressure, drawdown, periods of cycling, and operation of controls. **Under no circumstances should the pump be operated for any prolonged periods of time with the discharge valve closed.** This can result in motor and pump damage due to overheating.

A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

B. If the pump fails to operate, or there is a loss of performance, refer to Troubleshooting, Section 7.

SECTION 7.

Troubleshooting

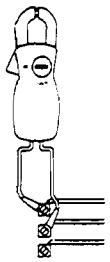
The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following charts cover most of the submersible service work. As with any troubleshooting procedure, start with the simplest solution first; always make all the above-ground checks before pulling the pump from the well.

Usually only two instruments are needed – a combination voltmeter/ammeter, and an ohmmeter. These are relatively inexpensive and can be obtained from most water systems suppliers.

WHEN WORKING WITH ELECTRICAL CIRCUITS, USE CAUTION TO AVOID ELECTRICAL SHOCK. It is recommended that rubber gloves and boots be worn and that care is taken to have metal control boxes and motors grounded to power supply ground or steel drop pipe or casing extending into the well. WARNING: Submersible motors are intended for operation in a well. When not operated in a well, failure to connect motor frame to power supply ground may result in serious electrical shock.

Preliminary Tests

SUPPLY VOLTAGE



How to Measure

By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box. On single-phase units, measure between line and neutral.

What it Means

When the motor is under load, the voltage should be within ± 10% of the nameplate voltage. Larger voltage variation may cause winding damage.

Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected.

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

CURRENT MEASUREMENT



How to Measure

By use of an ammeter, set on the proper scale, measure the current on each power lead at the control box. See the Electrical Data, Table C, for motor amp draw information.

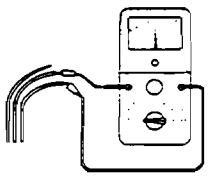
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA), check for the following:

1. Loose terminals in control box or possible cable defect. Check winding and insulation resistances.
2. Too high or low supply voltage.
3. Motor windings are shorted.
4. Pump is damaged causing a motor overload.

WINDING RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohmmeter, set the scale selectors to Rx1 for values under 10 ohms and and Rx10 for values over 10 ohms.

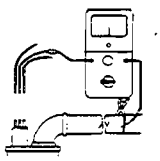
Zero-adjust the meter and measure the resistance between leads. Record the values.

Motor resistance values can be found in the Electrical Data, Table C. Cable resistance values are in Table D.

What it Means

If all the ohm values are normal, and the cable colors correct, the windings are not damaged. If any one ohm value is less than normal, the motor may be shorted. If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open. If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values in Electrical Data, Table C.

INSULATION RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box. Using an ohm or mega ohmmeter, set the scale selector to Rx100K and zero-adjust the meter.

Measure the resistance between the lead and ground (discharge pipe or well casing, if steel).

What it Means

For ohm values, refer to table below. Motors of all Hp, voltage, phase and cycle duties have the same value of insulation resistance.

OHM VALUE	MEGAOHM VALUE	CONDITION OF MOTOR AND LEADS
		Motor not yet installed:
2,000,000 (or more)	2.0	New Motor
1,000,000 (or more)	1.0	Used motor which can be reinstalled in the well.
		Motor in well (Ohm readings are for drop cable plus motor):
500,000 - 1,000,000	0.5 - 1.0	A motor in reasonably good condition.
20,000 - 50,000	0.02 - 0.5	A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.
10,000 - 20,000	0.01 - 0.02	A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will still operate, but probably not for long.
less than 10,000	0 - 0.01	A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced. The motor will not run in this condition.

Troubleshooting Chart

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
A. Pump Does Not Run	1. No power at pump panel.	Check for voltage at panel.	If no voltage at panel, check feeder panel for tripped circuits.
	2. Fuses are blown or circuit breakers are tripped.	Remove fuses and check for continuity with ohmmeter.	Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation and motor must be checked.
	3. Defective controls.	Check all safety and pressure switches for operation. Inspect contact in control devices.	Replace worn or defective parts.
	4. Motor and/or cable are defective.	Turn off power. Disconnect motor leads from control box. Measure the lead to lead resistances with the ohmmeter (Rx1). Measure lead to ground values with ohmmeter (Rx100K). Record measured values.	If open motor winding or ground is found, remove pump and recheck values at the surface. Repair or replace motor or cable.
	5. Defective capacitor.	Turn off the power, then discharge capacitor. Disconnect leads and check with an ohm-meter (Rx100K). When meter is connected, the needle should jump forward and slowly drift back.	If there is no needle movement, replace the capacitor.
B. Pump Runs But Does Not Deliver Water	1. Groundwater level in well is too low or well is collapsed.	Check well drawdown.	Lower pump if possible. If not, throttle discharge valve and install water level control.
	2. Integral pump check valve is blocked.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shut-off. After taking reading, open valve to its previous position. Convert PSI to feet (For water: PSI x 2.31 ft/PSI = _____ ft.), and add to this the total vertical distance from the pressure gauge to the water level in the well while the pump is running. Refer to the specific pump curve for the shut-off head for that pump model. If the measured head is close to the curve, pump is probably OK.	If not close to the pump curve, remove pump and inspect discharge section. Remove blockage, repair valve and valve seat if necessary. Check for other damage. Rinse out pump and reinstall.
	3. Inlet strainer is clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and reinstall.
	4. Pump is damaged.	Same as B.2 above.	If damaged, repair as necessary. Rinse out pump and reinstall.
C. Pump Runs But at Reduced Capacity	1. Drawdown is larger than anticipated.	Check drawdown during pump operation.	Lower pump if possible. If not, throttle discharge valve and install water level control.
	2. Discharge piping or valve leaking.	Examine system for leaks.	Repair leaks.
	3. Pump strainer or check valve are clogged.	Remove pump and inspect.	Clean, repair, rinse out pump and reinstall.
	4. Pump worn.	Same as B.2 above.	If not close to pump curve, remove pump and inspect.

Troubleshooting (continued)

FAULT	POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
D. Pump Cycles Too Much	1. Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts.	Re-adjust switch or replace if defective.
	2. Level control is not properly set or is defective.	Check setting and operation.	Re-adjust setting (refer to manufacturer data). Replace if defective.
	3. Plugged snifter valve or bleed orifice.	Examine valve and orifice for dirt or corrosion.	Clean and/or replace if defective.
E. Fuses Blow or Circuit Breakers Trip	1. High or low voltage.	Check voltage at pump panel. If not within ± 10%, check wire size and length of run to pump panel.	If wire size is correct, contact power company. If not, correct and/or replace as necessary.
	2. Control box wiring and components.	Check that control box parts match the parts list. Check to see that wiring matches wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
	3. Defective capacitor.	Turn off power and discharge capacitor. Check using an ohmmeter (Rx100K). When the meter is connected, the needle should jump forward and slowly drift back.	If no meter movement, replace the capacitor.
	4. Starting relay (Franklin single phase motors only).	Check resistance of relay coil with an ohmmeter (Rx1000). Check contacts for wear.	Replace defective relay.

Table A

Minimum Water Flow Requirements for Submersible Pump Motors

MOTOR DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. FLOW PAST THE MOTOR (GPM)
4"	4	1.2
	5	7
	6	13
	7	21
	8	30

NOTES: 1. A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.

2. The minimum recommended water velocity over 4" motors is 0.25 feet per second.

Table B

Guide for Engine-Driven Generators in Submersible Pump Applications

	MINIMUM KILOWATT RATING OF GENERATOR FOR THREE-WIRE SUBMERSIBLE PUMP MOTORS	
MOTOR HP	EXTERNALLY REGULATED GENERATOR	INTERNALLY REGULATED GENERATOR
0.33 HP	1.5 KW	1.2 KW
0.50	2.0	1.5
0.75	3.0	2.0
1.0	4.0	2.5
1.5	5.0	3.0

NOTES:

1. Table is based on typical 80°C rise continuous duty generators with 35% maximum voltage dip during start-up of single phase motors.
2. Contact the manufacturer of the generator to assure the unit has adequate capacity to run the submersible motor.
3. If the generator rating is in KVA instead of kilowatts, multiply the above ratings by 1.25 to obtain KVA.

Table C

Electrical Data - 60 Hz Submersible Pump Motors

GRUNDFOS MOTORS

4 Inch (Two Wire) Motors - Control Box Not Required

60 Hz

HP	Ph	VOLT	Ser. Fact.	Circ. Brk. or Stnd. Fuse	Dual Element Fuse	AMPERAGE Full Load	AMPERAGE Lock Rotor	AMPERAGE S.F. Amps	FULL LOAD Eff.	FULL LOAD Power Factor	Line-to-Line Resistance(Ohms) Blk-Yel / Red-Yel Delta	KVA Code **	Maximum Thrust (lbs)	GRUNDFOS PART NO.
SINGLE PHASE														
1/3	1	230	1.75	15	5	3.0	25.5	4.4	47.3	63.0	6.8-8.2	S	750	79.952301
1/2	1	230	1.60	15	7	4.3	34.5	5.9	50.6	64.7	5.2-6.3	R	750	79.952302
3/4	1	230	1.50	20	9	6.6	40.5	8.0	57.0	70.0	3.2-3.8	N	750	79.952303
1	1	230	1.40	25	12	8.0	47.4	9.6	59.8	74.3	2.5-3.1	M	750	79.952304
1 1/2	1	230	1.30	35	15	10.6	60.8	13.1	64.3	77.2	1.9-2.3	L	750	79.952305

4 Inch (Three Wire) Motors

SINGLE PHASE

1/3	1	230	1.75	15	5	3.0	14.0	4.4	47.0	63.0	6.8-8.3 17.3-21.1	L	750	79.453301
1/2	1	230	1.60	15	7	4.3	20.0	5.9	50.7	64.6	4.7-5.7 15.8-19.6	L	750	79.453302
3/4	1	230	1.50	20	9	6.6	30.8	8.0	57.3	70.0	3.2-3.9 14-17.2	L	750	79.453303
1	1	230	1.40	25	12	8.0	36.3	9.6	59.8	74.5	2.6-3.1 10.3-12.5	K	750	79.453304
1 1/2	1	230	1.30	30	15	9.7	44.0	11.5	67.5	84.1	1.9-2.3 7.8-9.6	H	750	79.453305

Franklin Motors

(refer to the Franklin Submersible Motors Application Maintenance Manual)

Table D
Total Resistance of Drop Cable (OHMS)

The values shown in this table are for copper conductors. Values are for the total resistance of drop cable from the **Control box to the motor and back.**

To determine the resistance:

1. Disconnect the drop cable leads from the control box.
2. Record the size and length of drop cable.
3. Determine the cable resistance from the table.
4. Add drop cable resistance to motor resistance. Motor resistances can be found in the Electrical Data Chart, Table C.
5. Measure the resistance between each drop cable lead using an ohmmeter. Meter should be set on Rx1 and zero-balanced for this measurement.
6. The measured values should be approximately equal to the calculated values.

Wire Resistances

Distance From Control Box to Pump Motor (FT.)	12 AWG Wire Resistance (OHMS)	14 AWG Wire Resistance (OHMS)
10	0.03	0.05
20	0.06	0.10
30	0.10	0.15
40	0.13	0.21
50	0.16	0.26
60	0.19	0.31
70	0.23	0.36
80	0.26	0.41
90	0.29	0.46
100	0.32	0.51
110	0.36	0.57
120	0.39	0.62
130	0.42	0.67
140	0.45	0.72
150	0.49	0.77
160	0.52	0.82
170	0.55	0.87
180	0.58	0.93
190	0.62	0.98
200	0.65	1.03

Submersible pump 22
2 Black
1 Red
1 White
1 Green
21
12
20
33
Black
Red

Redi-Flo4

LIMITED WARRANTY

Redi-Flo4 Environmental Pumps manufactured by GRUNDFOS Pumps Corporation (GRUNDFOS) are warranted to the original user only to be free of defects in material and workmanship for a period of 18 months from date of installation, but not more than 24 months from date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operating instructions.

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

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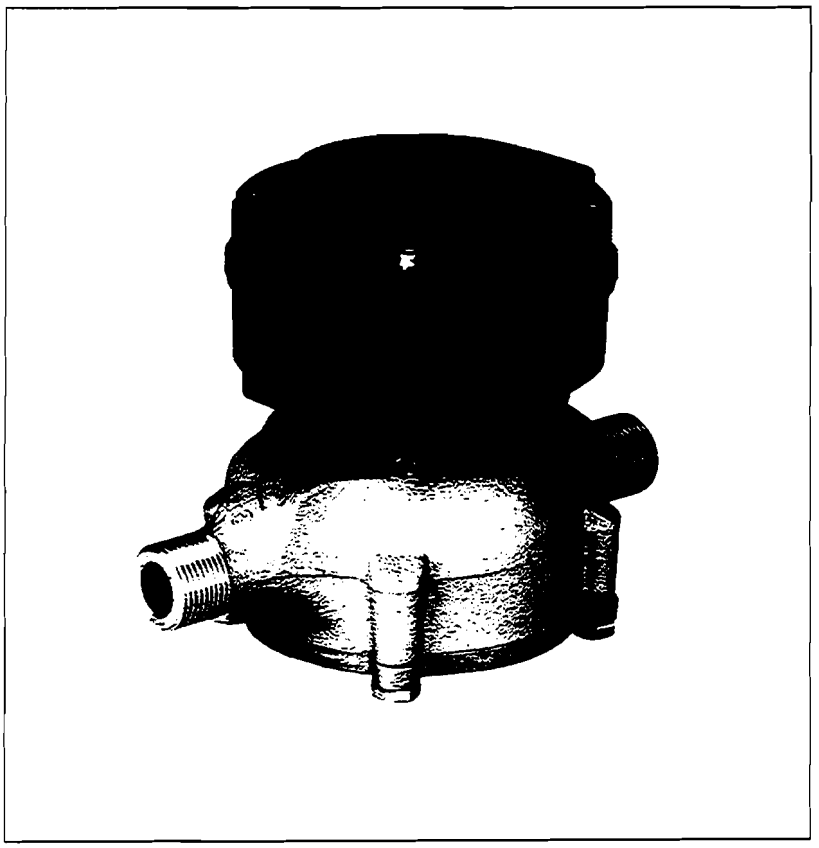
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Model Industrial RCDL Nutating Disc Meters	Installation & Operation Manual



BadgerMeter,Inc.
Industrial Division

Bulletin No. IOM-0[illegible]02
Part No. 53400-06[illegible]
March 199[illegible]

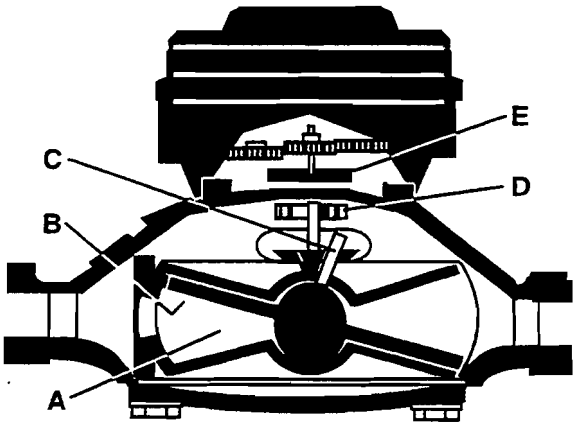
ıger's RCDL positive displacement meters are one of the
st cost effective methods in metering industrial fluids.
: RCDL meter's simple but efficient design assures high
uracy and repeatability over the entire meter flow range.

ıilable in five sizes, 1/2" through 2" for flows up to 170
M, these meters are extremely rugged and reliable.
intenance is seldom required, but if necessary, takes
y a few minutes. All parts are designed and built of
terials to meet your application, providing you with long
and a trouble-free, precision flow meter.

complement the RCDL meter line, Badger offers a
nplete line of accessories that includes totalizers, elec-
mechanical and electronic transmitters, rate of flow
icators and batch/process controllers.

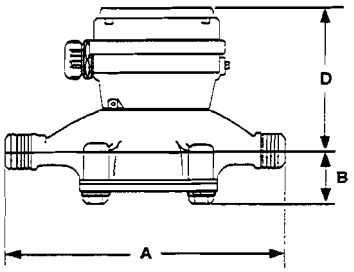
: metering principle, known as positive displacement, is
:ed on the continuous filling and discharging of the
asuring chamber. Controlled clearances between the
c and the chamber insure precise measurement of each
ume cycle. As the disc nutates, the center spindle rotates
ıagnet, whose movement is sensed through the meter
l by a follower magnet or by various sensors. Each
olution of the magnet is equivalent to a fixed volume of
d, which is converted to any engineering unit of measure
totalization, indication or process control.

Figure 1.



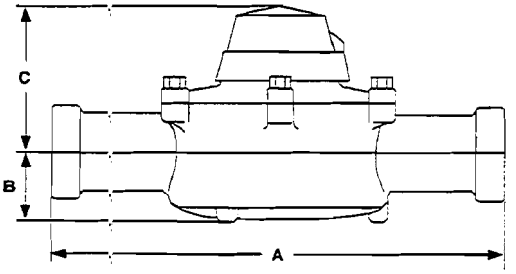
Liquid flowing through the meter chamber (A) causes a disc (B) to nutate or wobble. This motion, in turn, results in the rotation of a spindle (C) and drive magnet (D). Rotation is transmitted through the wall of the meter to a second magnet (E) or varied style of sensor pickup.

Meter with Transmitter



MODEL 25, 35 & 70

Meter with Register



MODEL 120 & 170

Meter Model	Meter Size Inches	Flow Range GPM	Housing Material	End Connections	DIMENSIONS (INCHES) Laying Length A	Center Line to Base B	Register Height C	Transmitter Height D	Approximate Weight Pounds
M 25	5/8	1/2 - 25 1 - 25	BZ or PL Corrosion Resistant Internal	NPT - Male	7.5	1.7	3.3	4.4	5
M 25	3/4	1/2 - 30 1 - 30	BZ or PL Corrosion Resistant Internal	NPT - Male	7.5	1.7	3.3	4.4	5
M 35	3/4	3/4 - 35	BZ	NPT - Male	9.0	1.7	3.6	5.0	6
M 40	1	3/4 - 50	PL	NPT - Male	10.75	1.9	3.8	5.5	5
M 70	1	1 - 70 5 - 70	BZ or PL Corrosion Resistant Internal	NPT - Male	10.75	2.3	4.2	5.6	12
M 120	1 1/2	2 - 120	BZ	NPT - Female	12.62	2.4	4.6	6.0	20
M 170	2	2 - 170	BZ	NPT - Female	15.25	2.9	5.1	6.5	30

= Bronze; PL = Plastic
del 25 and Model 70 are available with optional corrosion resistant internals; temperature limit with this option is increased the bronze housing model to 250° F.

Table 1 - Configuration and Specification Data for Model RCDL Disc Meters

[redacted]

Upon receipt of meter, perform the following:

NOTE: If damage to the shipping container is evident, request the carrier to be present when meter is unpacked.

A. Carefully open the shipping container. Remove all the cushioning material surrounding the meter and carefully lift the meter from the container.

Retain all of the packing material for possible use in reshipment or storage of the meter.

B. Visually inspect the meter and the accessory device for any physical damage such as scratches, loose or broken parts, or any other damage that may have occurred during shipment of the product.

NOTE: If damage is found upon receipt of the equipment, request inspection by the carrier's agent within 48 hours of the delivery. Then file a claim with the carrier. A claim for the equipment damaged in transit is the responsibility of the customer.

[redacted]

Any special instructions required for the installation and/or electrical connection of any meter-mounted or free-standing accessory devices such as registers, pulse transmitters, and remote batch controllers, will be provided as a supplement to this manual.

A. Please read the following instructions to become familiar with the requirements and the recommended procedures involved.

CAUTION: The meter must be operated in an application within the specified temperature range to obtain optimum accuracy and prevent damage to any internal components.

1. Verify the fluid operating temperature range is compatible with the materials of construction of the meter received.

CAUTION: The life of the meter will be impaired if it is operated at flow rates in excess of those indicated in the product specifications.

2. If any solid material is present in the liquid, installation of a strainer is recommended upstream of the meter.

3. Locate the meter installation with consideration for sufficient space for cleaning and maintenance of the meter.

B. Review the overall dimensions (including laying length requirements) of the meter as listed in Table 1 of this manual on page 2. If necessary, consideration may also need to be given for height dimensions including the meter mounted accessory. Then proceed as follows:

1. Measure the overall length of the meter with the connection pieces attached to the inlet and outlet spuds of the meter.

2. Be sure to provide this proper gap length in the facility piping.

CAUTION: Excess gap length may cause excessive strain on connection assemblies.

3. Remove the connections and install one connection piece in each end of the facility pipe gap provided in step #2. Allow for the gaskets at the inlet and the outlet spuds of the meter.

4. Install the meter making sure that the flow arrow marking on the meter housing is in the correct relationship to the direction of the fluid flow in the system.

5. Tighten the meter connections.

Note instructions on packaging from connection assembly when tightening.

6. To relieve any possible strain on the facility piping that might be caused by the weight of any of the large size meters, it is recommended that consideration be given to incorporating a meter support to be placed under the housing of the meter.

To ensure that the meter has been properly installed and operational:

A. Slowly open the upstream valve to apply fluid pressure to the meter. Check the connections for any possible leakage. Retighten the connections as required.

B. Perform a functional test of the meter utilizing the adjustment and calibration procedures that are included later in this manual.

In general, the operation of a Model RCDL disc meter is either manually controlled or accessory controlled. Manual operation applies to the applications employing hand-operated valves or other manually activated, flow-regulating devices that are not functionally controlled by a meter accessory. Accessory controlled operation applies to applications when a meter accessory provides a signal output to activate and/or deactivate a valve or other flow control device.

CAUTION: Valves controlling the fluid flow through the meter should be opened and closed slowly to prevent shock loads that may damage the meter measuring element.

A. MANUAL OPERATION. The following procedures are for use in simple metering applications where the flow of fluid is controlled by hand-operated valves located upstream and downstream of the meter.

1. Slowly open the upstream valve to apply fluid to the meter.

2. Slowly open the downstream valve to initiate the metering operation.

3. Adjust downstream valve so the flow rate of the fluid does not exceed the maximum continuous flow rate specification of the meter. (Refer to Table 1 of this manual.)

NOTE: On meters with an accessory device providing a totalizing indicator, the flow rate of the fluid can be checked by timing the number of gallons registered in one minute.

4. To stop metering, slowly close downstream valve; then close upstream valve.

B. ACCESSORY CONTROLLED OPERATION. Operating procedures for accessory controlled applications are dependent on the specific function of that accessory employed and its electrical interconnection with a flow control device or devices. Refer to the bulletin or bulletins covering the applicable accessories for specific operating instructions (included as a supplement to this manual when required.)

SHUTDOWN INSTRUCTIONS

If the meter is to be shut down for an extended period of time, it is recommended that the measuring chamber of the meter be thoroughly flushed out to prevent the settling out of undissolved solids or the accumulation of corrosive deposits.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of periodic inspection and cleaning procedures. The procedures should be performed at regular intervals and any defects discovered should be corrected before further operation of the meter.

PERIODIC INSPECTION

A. Visually inspect meter and accessory for missing hardware, loose connections, broken register glass, damaged wiring, or other signs of wear or deterioration. Repair or replace components as required.

B. Verify proper flow rate and pressure for meter. A loss in pressure, with the resulting flow rate decrease, may indicate the meter screen is clogged and requires cleaning.

CLEANING

Clean all dust, dirt, grease, moisture, or other foreign material from exterior of meter and applicable accessory.

CALIBRATION CHECK AND ADJUSTMENT

The following instructions are provided to assist in performing on-site calibration check and/or adjustment.

ACCURACY TEST

A. Place a test tank of known volume at output of meter.

B. Fill test tank to calibrated level. Make test run at same flow rate to be used in actual operation.

C. Record quantity indicated on applicable accessory.

D. Repeat test three times and average recorded results.

E. Perform the following calculations to determine percent of accuracy of meter-accessory combination.

$$\frac{\text{Qty. Indicated on Accessory}}{\text{Actual Quantity in Test Tank}} \times 100 = \text{Meter Accuracy}$$

Example 1.

$$\frac{95 \text{ Gallons}}{100 \text{ Gallons}} \times 100 = 95\% \text{ Accuracy}$$

The meter-mounted accessory is slow and reading low so it must be speeded up by a calibration adjustment.

Example 2.

$$\frac{104 \text{ Gallons}}{100 \text{ Gallons}} \times 100 = 104\% \text{ Accuracy}$$

In this example, the meter accessory is fast and running high so it must be slowed down by calibration adjustment.

CHANGE GEAR CALIBRATION

If the accuracy test of a meter-accessory combination indicates that adjustment is required and change gears are the medium; proceed as follows:

A. Remove applicable Driver (Accessory) change gear and Driven (Meter) change gear.

NOTE: The number of teeth and outside diameter is stamped on each gear.

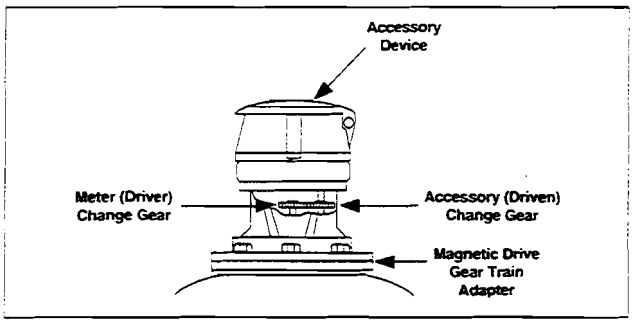


Figure 3 - Change Gear Locations on Model RCDL Meters

B. Calculate ratio of existing change gears as follows:

$$\text{Ratio} = \frac{\text{No. of Teeth on Accessory Change Gear}}{\text{No. of Teeth on Meter Change Gear}}$$

C. Calculate new change gear ratio required by multiplying the ratio of existing change gears by the percent-of-meter accuracy determined in the accuracy test.

Example

$$\text{Existing Change Gear Ratio} = \frac{42 \text{ Teeth}}{43 \text{ Teeth}} = .976$$

Meter Accuracy = 95%

$$\text{Corrected Change Gear Ratio} = .976 \times \frac{95}{100} = .927$$

D. If change gear charts are available, select a new change gear combination that matches corrected change gear ratio. If new gears are not available, submit order for corrective change gears to nearest Badger Meter Representative or contact the Industrial Division of Badger Meter, Inc.

NOTE: When ordering, specify serial number of meter, meter model and size, accessory device employed, number of teeth and diameter of existing change gears, and corrected change gear ratio required.

E. Observe the position of old change gears on spindles before removing. Install new change gears on meter and accessory spindles and assemble accessory to meter. Care should be taken to obtain full mesh when assembling accessory to meter gear train adapter. Note position information from old gears.

ELECTRONIC CALIBRATION

If electronic scaling is the accessory medium for calibration, see accessory technical brief for instructions.

SERVICING

The following instructions are for removal, inspection and installation of meter parts/assemblies. Refer to applicable illustrated parts list for part numbers of components and ordering information. Accessory service and repair procedures are provided in literature specific to that device.

METER ASSEMBLY

These procedures are for disassembly of the meter:

A. Shut off fluid flow to meter. Place container under meter and relieve fluid pressure in the meter by uniformly loosening bolts (bronze meter) or retaining ring (plastic meter). Fluid will run out into container.

B. Remove bolts or retaining ring while holding housing bottom in place. Remove housing bottom. Chamber assembly may drop from housing as bottom is removed.

C. If chamber assembly is out, set aside. If not, first remove chamber strap and then chamber assembly.

D. Remove meter screen. Inspect screen for dirt and corrosion. Clean or replace as necessary.

E. Inspect the chamber assembly:

1. Check the disc in the chamber assembly for warpage, cracks or wear. A severely worn disc can cause over delivery of the fluid being metered.

2. Check the thrust roller and thrust roller insert for excessive wear.

After inspection, clean or replace the chamber assembly as necessary. If chamber is worn or corroded, it is always recommended that the entire chamber and disc assembly be replaced.

F. Re-install housing chamber assembly, screen, chamber strap and bottom as follows:

1. Assemble screen in proper location.

2. Locate chamber assembly in proper orientation. Add chamber strap.

3. Position housing bottom with the correct seal. (Replacement of seal is always recommended.)

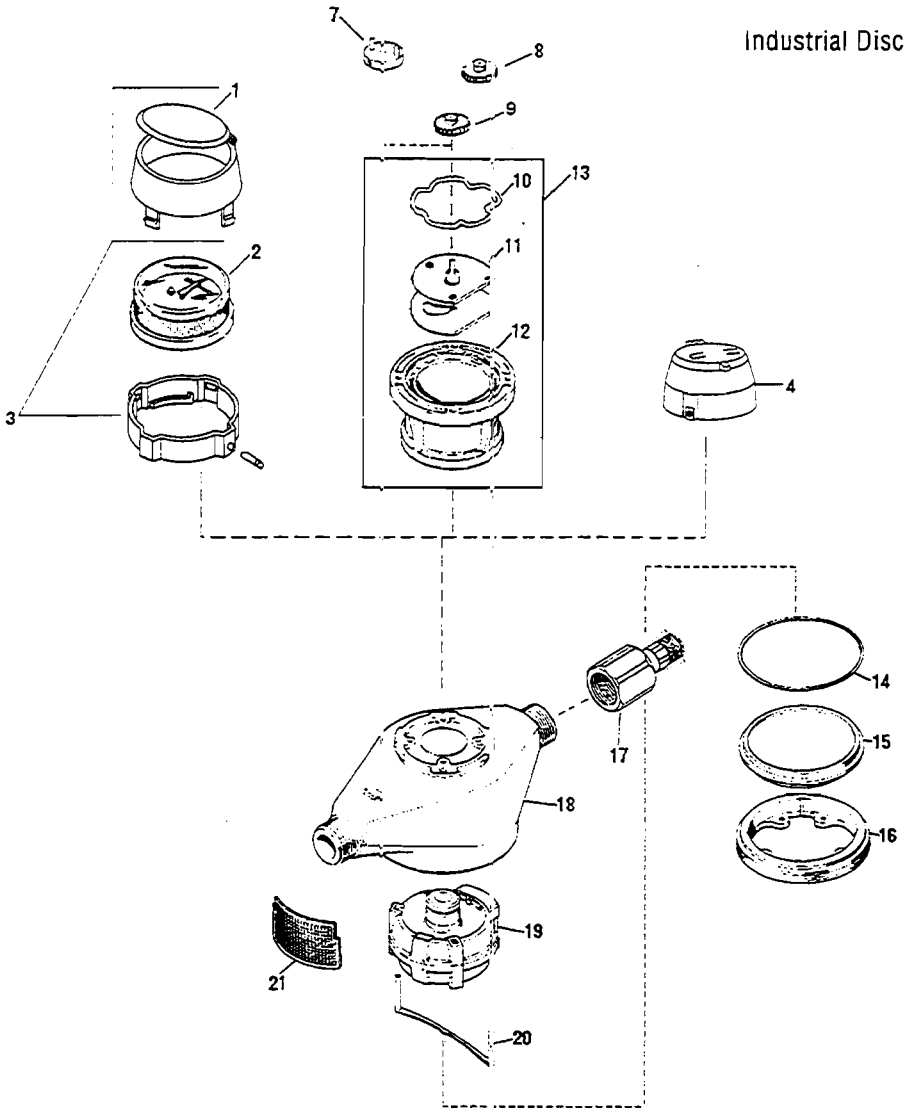
4. Assemble bolts or retaining ring and tighten.

ALTERNATIVE DISASSEMBLY METHOD FOR SERVICE

Loosen connection pieces slightly. Turn meter upside down, putting gravity on your side. This will help eliminate the possibility of the chamber assembly and/or screen component dropping during disassembly and causing damage.

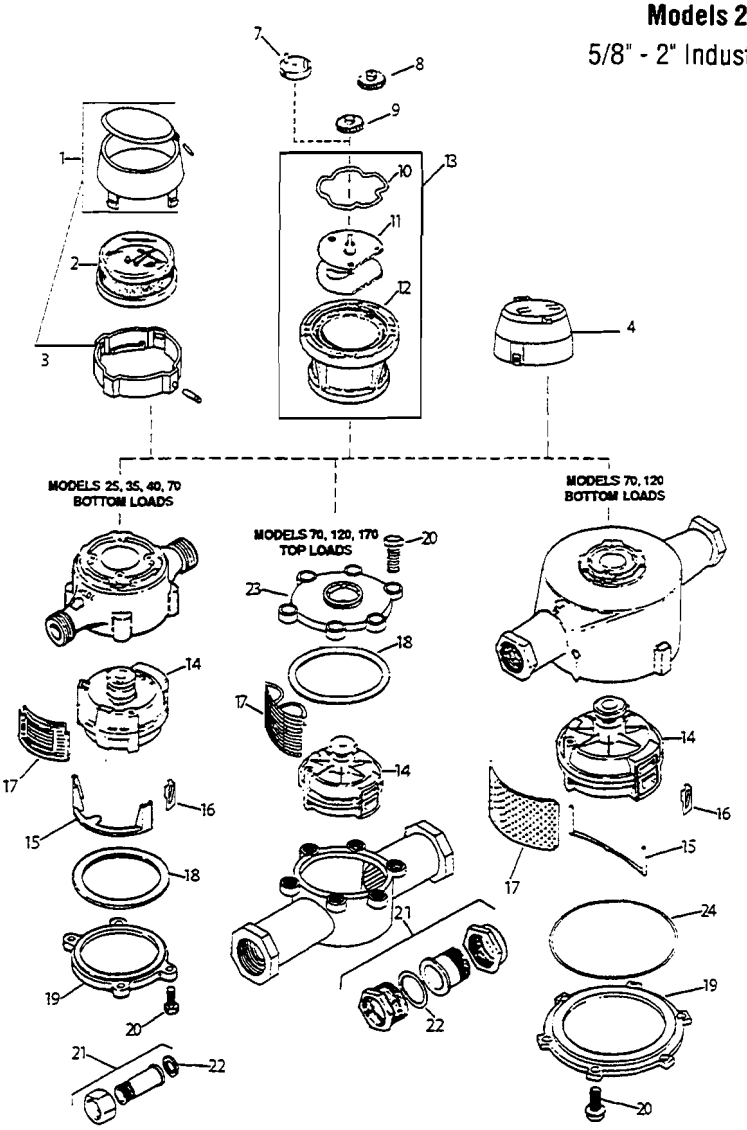
RECALIBRATION

After repair or replacement of a meter component or assembly, perform the calibration check and adjustment procedure to ensure that the meter is properly calibrated and will operate in accordance with published specifications.



Item No.	Part Description
1	Shroud Assembly, Plastic (Cover, top and roll pin, no btm.)
2	Register Assembly, U.S. Gallons
	Register Assembly, Liters/M3
3	Shroud Assembly, Plastic (Cover, top, btm., roll pin)
4	Pulse Transmitter Register RTR
7	Coupling (Series 76 Register)
8	Change Gear, Driver
9	Change Gear, Driven
10	Retaining Ring
11	Gear Train (234:1)
11	Gear Train (30:1)
12	Housing, Mach.
13	Gear Train Assy. (234:1)
13	Gear Train Assy. (30:1)

Item No.	Part Description
14	Housing Bottom "O" Ring Seal
15	Housing Bottom
16	Retaining Ring
17	Connection Assembly, 1/2" Plastic
	Connection Assembly, 3/4" Plastic
	Connection Assembly, 1" Plastic
	Connection Assembly, 1/2" Bronze
	Connection Assembly, 3/4" Bronze
	Connection Assembly, 1" Bronze
18	Housing 5/8" x 1/2", 7 1/2" LL
	Housing 5/8" x 3/4", 7 1/2" LL
	Housing 1" x 1", 10 3/4" LL
19	Chamber and Disc Assembly, Plastic
	Chamber and Disc Assembly, LCP
20	Chamber Retainer Strap
21	Screen

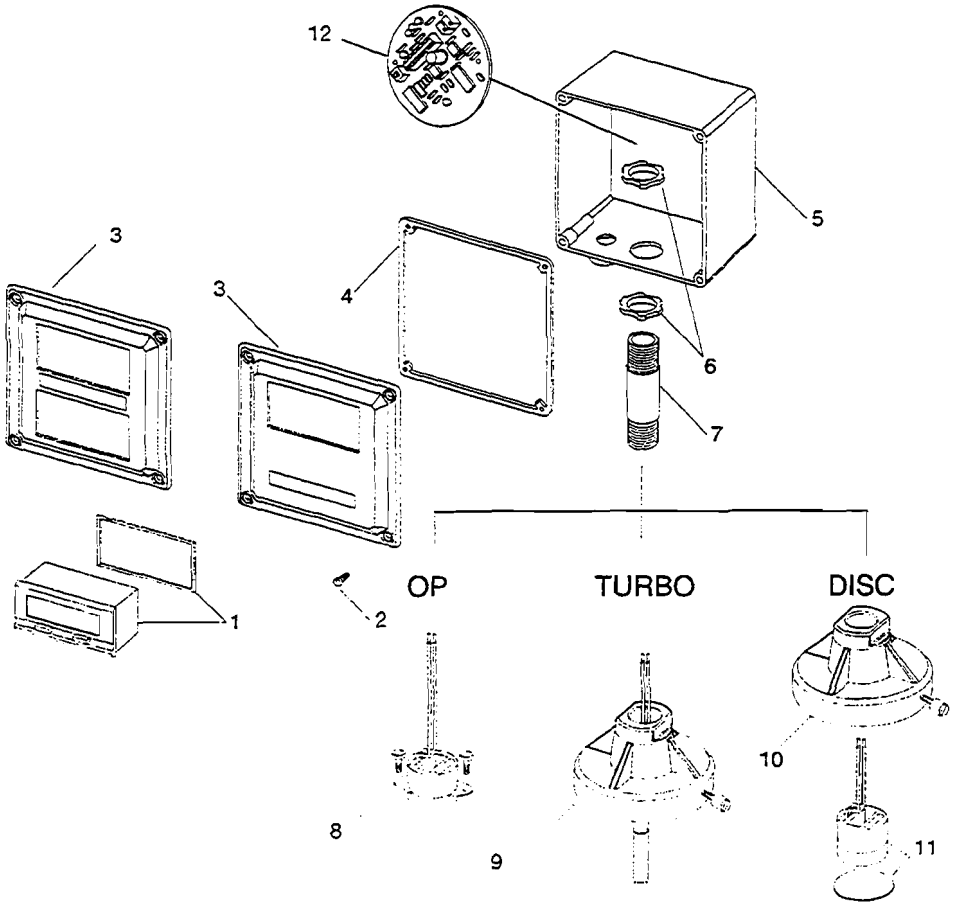


Item No.	Part Description
1	Shroud Assembly, Plastic (Cover, top & roll pin) (No btm.)
2	Register Assembly, Gallons Register Assembly, Liters/M3
3	Shroud Assembly, Plastic (Cover, top, btm. & roll pin)
4	Pulse Transmitter Register RTR
7	Coupling (Series 76 Reg.)
8	Change Gear, Driver
9	Change Gear Driven
10	Retaining Ring
11	Gear Train (234:1)
11	Gear Train (30:1)
12	Housing, Mach.
13	Gear Train Assy. (234:1)
13	Gear Train Assy. (30:1)
14	Chamber & Disc Assy., Std. Chamber & Disc Assy., LCP

Item No.	Part Description
15	Chamber Retainer Strap
16	Spring Clip (High Temp. Only) (Model 25 and 70 Only)
17	Screen
18	Housing Gasket , Buna N Housing Gasket, Viton
19	Housing Bottom
19A	Washers (6 needed)
20	Housing Bolt
21	Conn. Assembly (2) 1/2" Conn. Assembly (2) 3/4" Conn. Assembly (2) 1" Conn. Assembly (2) 1 1/2" Conn. Assembly (2) 2"
22	Conn. Washer (1) 1/2" Conn. Washer (1) 3/4" Conn. Washer (1)
23	Housing Top
24	Bottom Seal "O" Ring

Model ER-6 (Remote Totalizer Only)
Models ER-8 and ER-9 Meter Mount and Remote
Digital Resettable Totalizer and
Digital Rate of Flow Indicator

Repair Parts



ITEM NO.	PART DESCRIPTION	PART NUMBER
1	ER-6 Register (with gasket, remote)	63019-001
1	ER-7 Register (with gasket)	62025-001
1	ER-8 Register (with gasket)	62822-001
1	ER-9 Register (with gasket)	62822-002
	Battery (ER-6, ER-8 & ER-9), 3V Lithium	62576-001
2	Cover Screw	55046-171
3	Cover (Single)	62118-001
3	Cover (Dual)	62118-006
4	Housing Gasket	59833-001
5	Housing (Meter Mount)	62233-002
5	Housing (Remote); including remote screws and bracket	62918-001
6	Conduit Nut	62027-001

ITEM NO.	PART DESCRIPTION	PART NUMBER
7	Drop Pipe	14711-131
8	Reed Switch Assy-1/2" OP	62719-001
8	Reed Switch Assy-1"&2" OP	62704-001
9	Adapter Assy Complete with pickup, 2"&3" Turbo	62897-001
9	Adapter Assy Complete with pickup, 4" Turbo	62897-002
9	Adapter Assy Complete with pickup, 6" Turbo	62897-003
10	Adapter Assy with screw (Disc)	62897-005
11	Reed Switch Pickup Assy (Disc) with pad	62897-004
12	4-20 mA PC Board	58882-002

BadgerMeter,Inc. Industrial Division
4545 W. Brown Deer Road, P. O. Box 23099 Milwaukee, WI 53223-0099
Telephone: (414) 355-0400
Fax: (414) 355-7499

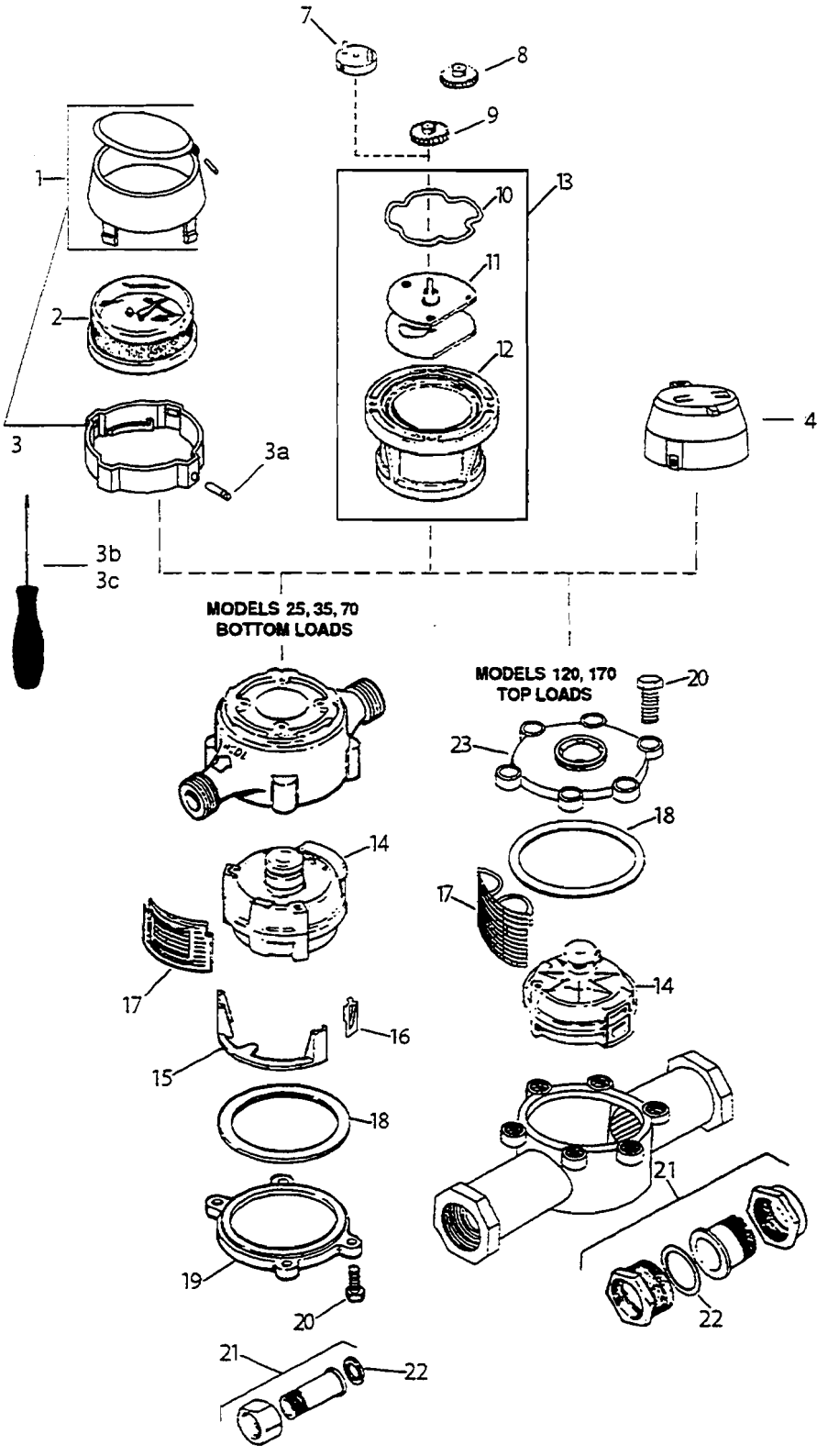
Bulletin No. IRP-070-03
Part No. 53401-070
March 1997

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Models 25, 35, 70, 120 and 170

5/8" - 2" Industrial Disc Meters – Bronze

Repair Parts



BadgerMeter, Inc.
Industrial Division

Bulletin No. IRP-104-05
Part No. 53401-104
November 1997

ORDER INFORMATION: This repair parts bulletin shows an exploded view of the product with specific reference to those items available for replacement. The item number and part number may change at any time; therefore, it is important when placing an order that a complete description of the part, meter size, model and serial number be provided.

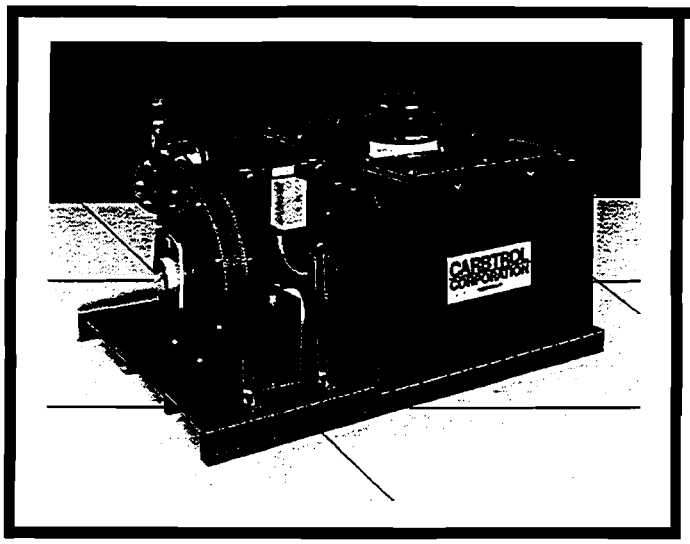
Item	Description	Model 25 1/2" & 3/4"	Model 35 3/4"	Model 70 1"	Model 120 Top Load 1 1/2"	Model 170 Top Load 2"
1	Shroud Assembly, Plastic (Cover, top & roll pin) (No btm.)	62416-001	62416-001	62416-001	62416-001	62416-001
2	Register Assembly, (up to 120° F)					
	U.S. Gallons	33626-002	33626-060	33626-068	33626-011	33626-057
	Cubic Meters	33626-007	33626-062	33626-070	33626-014	33626-059
	Register Assembly, (up to 250° F)					
	U.S. Gallons	58932-002	----------	58932-007	----------	----------
	Liters	58932-005	----------	58932-009	----------	----------
3	Shroud Assembly, Plastic (Cover, top, btm. & roll pin)	62696-001	62696-001	62696-001	62696-001	62696-001
3a	Screw, Tamper-Resistant	62335-001	62335-001	62335-001	62335-001	62335-001
3b	TORX® Seal Screw Driver Bit (Stubby)	62658-001	62658-001	62658-001	62658-001	62658-001
3c	TORX® Seal Screw Driver Bit (Long)	62658-003	62658-003	62658-003	62658-003	62658-003
4	Pulse Transmitter / Register, RTR	Please advise meter size, model and unit of measure.				
7	Coupling (Series 76 Reg.)	56646-001	56646-001	56646-001	56646-001	56646-001
8	Change Gear, Driver	----------	----------	----------	----------	----------
9	Change Gear Driven	----------	----------	----------	----------	----------
10	Retaining Ring	1013-000	1013-000	1013-000	1013-000	1013-000
11	Gear Train (234:1)	56065-004	56065-004	56065-004	56065-004	56065-004
11	Gear Train (30:1)	56065-005	56065-005	56065-005	56065-005	56065-005
12	Housing, Mach.	58091-002	58091-002	58091-002	58091-002	58091-002
13	Gear Train Assy. (234:1)	56066-004	56066-004	56066-004	56066-004	56066-004
13	Gear Train Assy. (30:1)	56066-005	56066-005	56066-005	56066-005	56066-005
14	Chamber & Disc Assy., Std.	33334-009	33334-029	33334-016	33334-017	33334-028
	Chamber & Disc Assy., LCP (Coated Magnet)	58908-006	----------	63079-002	----------	----------
15	Chamber Retainer Strap	58540-001	58540-001	56188-001	----------	56188-001
16	Spring Clip (High Temp. Only)(2 Reqd.)	62695-001	----------	62695-002	----------	----------
17	Screen	34333-001	59805-001	56182-001	59207-001	59720-001
18	Housing Gasket , EPR	11071-033	59782-001	58769-001	59239-001	59722-001
	Housing Gasket, Viton	11071-045	----------	58769-002	----------	----------
19	Housing Bottom	62635-001	59784-001	59703-001	----------	----------
19A	Washers (6 needed)	----------	----------	24991-044	----------	----------
20	Housing Bolt	62777-001	62777-001	59703-001	55029-089	55029-089
21	Conn. Assembly (2) 1/2"	7557-002	----------	----------	----------	----------
	Conn. Assembly (2) 3/4"	7559-002	7559-002	----------	----------	----------
	Conn. Assembly (2) 1"	----------	----------	7561-002	----------	----------
	Conn. Assembly (2) 1 1/2"	----------	----------	----------	7563-000	----------
	Conn. Assembly (2) 2"	----------	----------	----------	7564-000	7564-000
22	Conn. Washer (1) 1/2"	11012-001	----------	----------	----------	----------
	Conn. Washer (1) 3/4"	14143-000	14143-000	----------	----------	----------
	Conn. Washer (1)	----------	----------	18177-000	1331-000/ 1359-000	1359-000
23	Housing Top	----------	----------	----------	62176-001	59719-001

BadgerMeter,Inc. Industrial Division
4545 W. Brown Deer Road, P. O. Box 23099 · Milwaukee, WI 53223-0099
Telephone: (414) 355-0400
Fax: (414) 355-7499

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CARBTROL®

MULTI-STAGE
DIFFUSED AIR STRIPPER
- RESISTANT TO IRON FOULING -



FEATURES

- Easy to clean -
  No trays or packing to plug. Quick removable cleanout cover allows easy access to aeration compartment.
- High efficiency - removals up to 99.99%.
- Multiple stages to handle varying treatment requirements.
- Standard design up to 50 gpm.
- Very low profile.

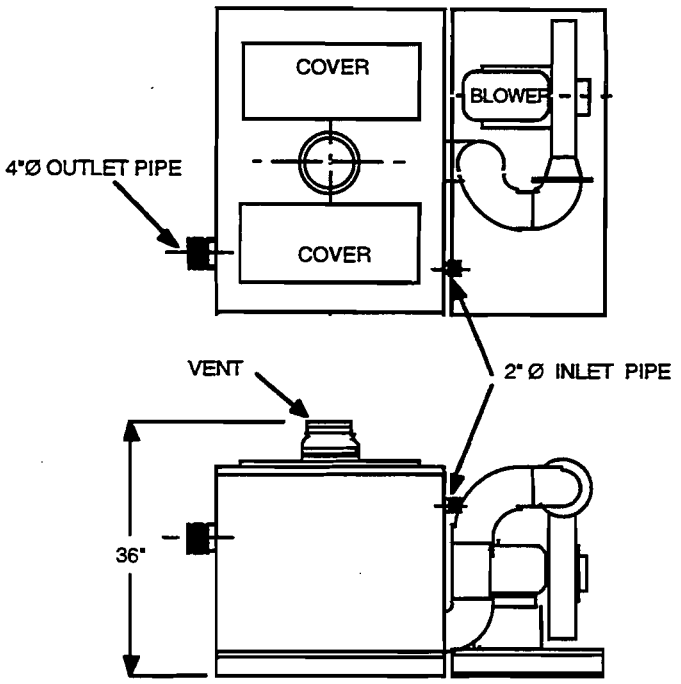
COMPONENTS

- Aeration compartments - PVC Construction with UV protection.
- Blowers - centrifugal type, direct drive, anti-spark.
- Motors and starters - TEFC or Explosion Proof.
- Two skids - one for blower, one for aeration compartment.

SPECIFICATIONS

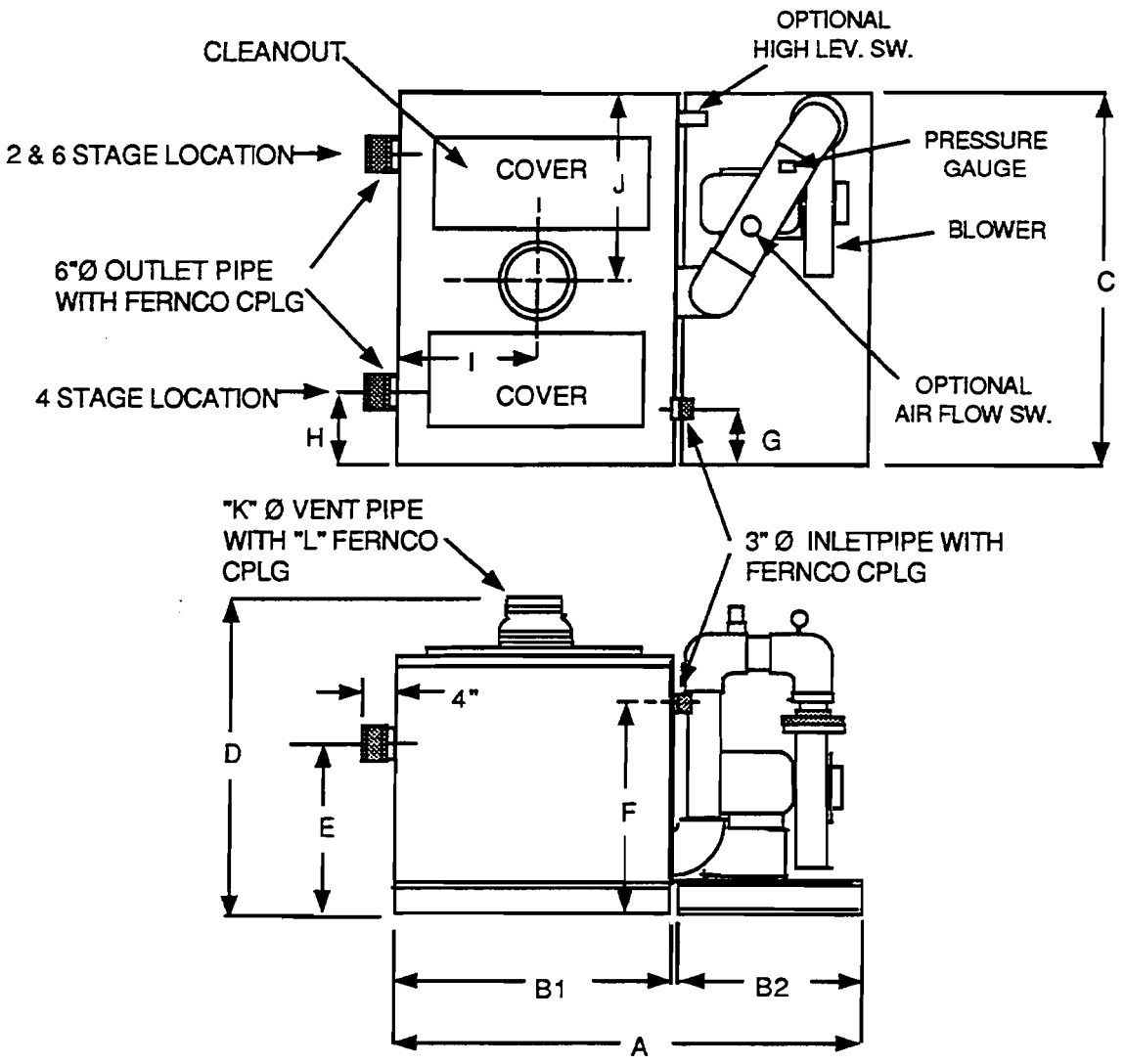
MODEL/ STAGES	CFM*	HP	FOOTPRINT
MSD-2	100 / 200	2 / 2	4' x 3'-9"
MSD-4	200 / 400	2 / 5	4' x 5'-4"
MSD-6	300 / 600	3 / 7.5	4' x 6'-11"
MSD-8	400 / 800	5 / 7.5	4' x 8'-6"
MSD-12	600 / 1200	7.5 / 10	4' x 12'-4"

* Each aeration compartment is designed for either 50 CFM (normal operation) or 100 CFM (high air flow operation).



FOUR STAGE STRIPPER

CARBTROL® CORPORATION
51 Riverside Avenue, Westport, CT 06880 • 1-800-242-1150 • (203) 226-5642
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	DIMENSIONS IN INCHES AT BASE FRAME													
MODEL	A	B1	B2	C	D	E	F	G	H	I	J	K	L	COVERS
MSD2	45 1/4	21	24	48	36 5/8	19 3/8	24 1/2	10 1/2	10 1/2	10 1/2	24	8	6 x 8	12 x 12
MSD4	64 1/4	40	24	48	36 5/8	19 3/8	24 1/2	10 1/2	10 1/2	20	24	10	8 x 10	12 x 28
MSD6	83 1/4	59	24	48	37 5/8	19 3/8	24 1/2	10 1/2	10 1/2	29 1/2	24	10	8 x 10	12 x 46

CARBTROL®
CORPORATION

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

SCALE ____		BY WH
DATE 6-21-93	*wah*	REV 3-13-98

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2,4 & 6 STAGE, MULTI-STAGE DIFFUSER

STANDARD AND HIGH AIR FLOW MODELS

COMPOSITE DIMENSIONS | S | DWG 1894/11

CARBTROL®
CORPORATION

51 Riverside Avenue
Westport, Connecticut 06880
1-800-242-1150 • (203) 226-5642
FAX (203) 226-5322

INSTALLATION AND OPERATING INSTRUCTIONS CARBTROL® WATER TREATMENT SYSTEM

INSTALLATION

The Water Treatment System consists of a 2-stage, Multistage Diffuser System (MSD-2-50), an Iron Removal Filter (IRF) and 4 Ion-Exchange Units (CCR-6LP).

Reference MSD Composite Dimensions Dwg. S-1894/11 and IRF Arrangement Dwg. S-2471/0.

The Multistage Diffuser System is provided with covers and stack connections to minimize local buildup of volatile concentrations around the area of the unit. When the MSD is installed indoors the stack should vent to the outside.

If the MSD and IRF tanks are to be operated in cold climates, they should be located indoors.

Remove the packing material and inspect the pallets, equipment and piping.

Refer to the attached Installation and Operating Instructions CC-605-IRF-LS-12/95 for the Iron Removal Filter.

Refer to the attached Installation and Operating Instructions CC-605-IXL-2/98 for the low-pressure CCR-6LP Ion Exchange Units.

FIELD PIPING CONNECTIONS

Connect the blower discharge pipe to the air inlet of the primary diffuser tank using the flexible coupling provided.

Note: If MSD blower suction piping is required, maintain the blower suction line size and do not install pipe elbows directly on the blower suction.

Connect the MSD water discharge to the inlet of the IRF using the 4"Ø piping assemblies provided.

Connect owner's piping to the MSD bottom drain valves (3/4") and IRF bottom drain valves (1-1/4") for disposal as required.

Pipe the owner's raw water supply to the 2"Ø MSD inlet.

Insert a 6"Ø vent stack as required into each 6" X 8" lid vent connection. If the stack is more than 5'-0" long, provide guy wires to prevent stack swaying.

Note: The MSD lids are designed for a maximum of 2" w.c. of steady backpressure. Intermittent or pulsating backpressure may cause premature failure of the lids. Backpressure in excess of 2" w.c. may cause the units to leak at the lid gaskets.

FIELD ELECTRICAL CONNECTIONS

Reference the attached wiring diagram no. S-3302/0 for suggested wiring of the blower motor to the owner's starter (208V/3Ø/60 Hz.).

Wire the air flow switch normally open contact in series with the high level switch normally closed contact. Wire these leads in series with the owner's raw water feed pump starter coil circuit.

If for any reason the air flow through the unit should stop, the air flow switch will open and the raw water feed pump starter will be de-energized in order to prevent the discharge of inadequately treated water.

If for any reason the high level switch is activated, the raw water feed pump will be de-energized in order to prevent flooding at the site.

The MSD blower should not be automatically started and stopped on alarm conditions, but should run continuously.

Field installation should be in accordance with all local ordinances and the National Electrical Code.

OPERATION

Before turning on power to the system, ensure that the MSD blower motor starter is off. Close the drain valves on the MSD and IRF tanks.

Adjust the water flow to the MSD not to exceed the rated system flow rate.

Allow the MSD diffuser tanks to fill with water.

CAUTION: DO NOT start the MSD blower until the diffuser tanks are filled.

When the diffuser tanks are filled, start the MSD blower. Turn off the bypass switch to the MSD blower low air flow switch.

The slide gate valve at the blower suction has been factory preset and scribed to deliver proper air flow for operation of the system. The blower discharge pressure gauge should read 20" w.c. during operation.

The system air flow was factory set on clean equipment. Higher blower discharge pressure at the same valve setting may indicate sediment buildup, resulting in reduced air flow. Inspect the unit and clean as necessary.

The air diffuser pipes are threaded for easy removal for cleaning. Drain the tanks through the bottom drain back to the head of the system, or dispose of the water in an environmentally safe manner. Remove the diffuser pipes and clear the holes of any blockage. Hose down the tanks to remove any sediment buildup.

If the blower discharge pressure is less than 20" w.c. with the inlet valve at the original, scribed setting, consult Carbtrol.

When the water in the IRF overflows the last filter screen, or the water in the last filter chamber is visibly dirty, the filter media should be changed using the following procedure:

- Shut down the well pump(s).
- Use the drain valve to drain the water from the Iron Removal Filter back to the head end of the system, or dispose of it in an environmentally safe manner.
- Remove the filter screens.
- Hose down the interior of the filter. After removing the water, close the drain valve.
- Remove the clevis pins from the filter screens. Open each screen and remove the filter media. Dispose of the filter media in an environmentally safe manner.
- Replace two layers of filter media, cut to 17" X 31", into each filter screen frame. Replace the removable screen and clevis pins.
- Replace the screens in the runners.
- Start up the system using the above procedure.

The MSD and IRF should be inspected at least once per shift while in operation.

To stop operation of the system, first stop the well pumps and then stop the MSD blower.

If this shutdown is to be for an extended period, the MSD & IRF tanks should be completely drained using the bottom drain valves.

OPERATING & MAINTENANCE INSTRUCTIONS AND PARTS LIST

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

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⚠ DANGER

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

READ ALL OPERATING INSTRUCTIONS CONTAINED HEREIN BEFORE INSTALLING EQUIPMENT.

⚠ DANGER

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

cincinnati fan

PART # 01001
CATALOG # PMK-1293
SUPERSEDES: PMK-992

I GENERAL SAFETY NOTES

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

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

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

II RECEIVING

Receiving Inspection

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

Table #1

TORQUE VALUES FOR TAPERED BUSHINGS		
	MINIMUM RECOMMENDED TORQUE (INCH-LBS)	
Bushing Size	Steel Parts	Alum. Parts
H	95	60
B & P	192	80
Q & R	348	155

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

III HANDLING

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

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

IV GENERAL INSTALLATION INSTRUCTIONS

Foundations

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

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

Table #2

SET SCREW TORQUE VALUES			
SET SCREW SIZE		MINIMUM REQUIRED TORQUE (INCH-LBS)	
Diameter & No. of Threads/Inch	Hex Size Across Flats (Allen Wrench)	Steel Set Screw Into Steel Threads	Steel Set Screw Into Alum. Threads or Stainless Steel Set Into Stainless Steel Threads
1/4-20	1/8"	92	65
5/16-18	5/32"	165	100
3/8-16	3/16"	228	155
7/16-14	7/32"	348	230
1/2-13	1/4"	504	330
5/8-11	5/16"	1104	700

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

OPERATION

Before Connecting Power

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

2. Inspection doors should be tight and sealed.

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

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

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

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

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

V GENERAL MAINTENANCE

CAUTION

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

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

Cast Aluminum & Metal Parts

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

Motor Maintenance

1. Disconnect power to motor.

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

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

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

VI V-BELT DRIVES

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

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

A WORD OF CAUTION

ABOUT MOTORS

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

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

1. Be sure sheaves are locked in position.

2. Key should be seated firmly in keyway.

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

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

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

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

V-belt drive assembly can be mounted as follows:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

VII FAN BEARING MAINTENANCE

Sealed Bearings

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

Relubricatable Bearings

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

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

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

VIII WARRANTY

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

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

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

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

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

IX ORDERING REPLACEMENT PARTS

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

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

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

X FAN TROUBLE SHOOTING

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

1. CAPACITY OR PRESSURE BELOW RATING

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

2. VIBRATION AND NOISE

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

3. OVERHEATED BEARINGS

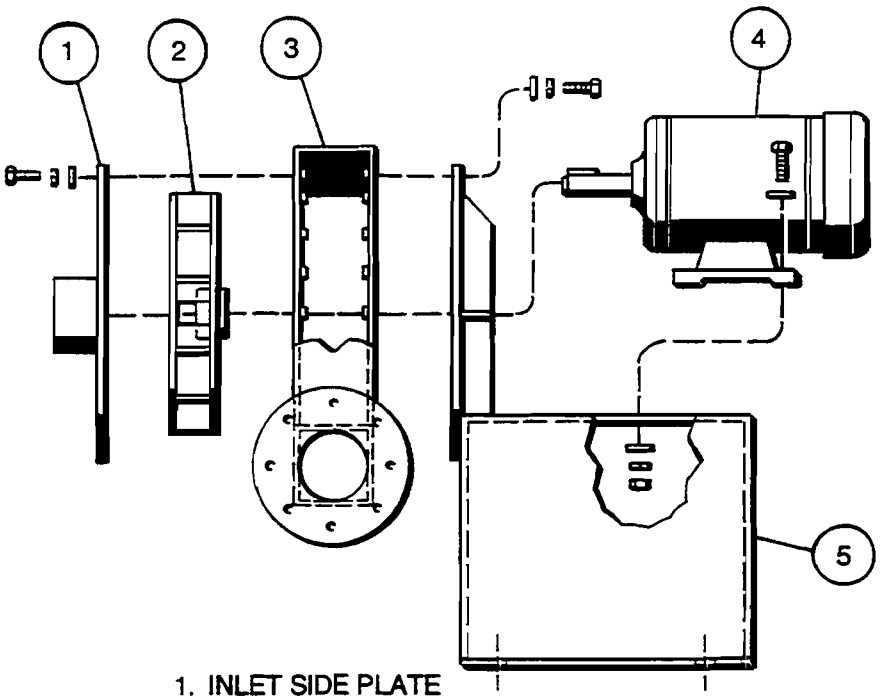
a. Check bearing lubrication.
b. Poor alignment.
c. Damaged wheel or drive.
d. Bent shaft.
e. Abnormal end thrust.
f. Dirt in bearings.
g. Excessive belt tension.

4. OVERLOAD ON MOTOR

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

MODEL HP

ARRANGEMENT 4

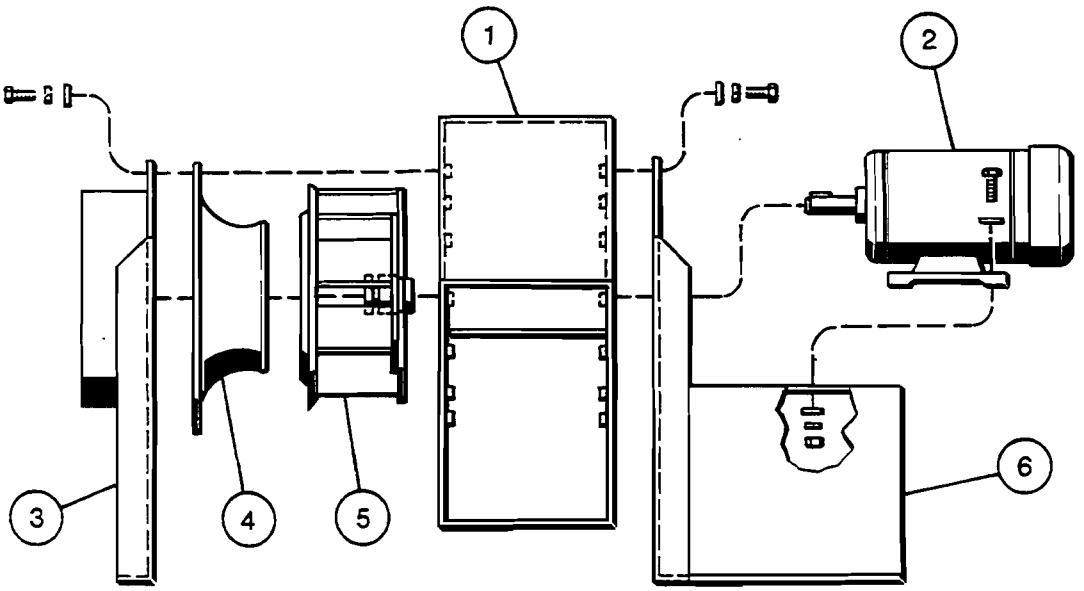


1. INLET SIDE PLATE
2. WHEEL
3. HOUSING
4. MOTOR
5. BASE

NOTE: SHAFT SEAL IS NOT SHOWN.

MODELS HDBI & RBE

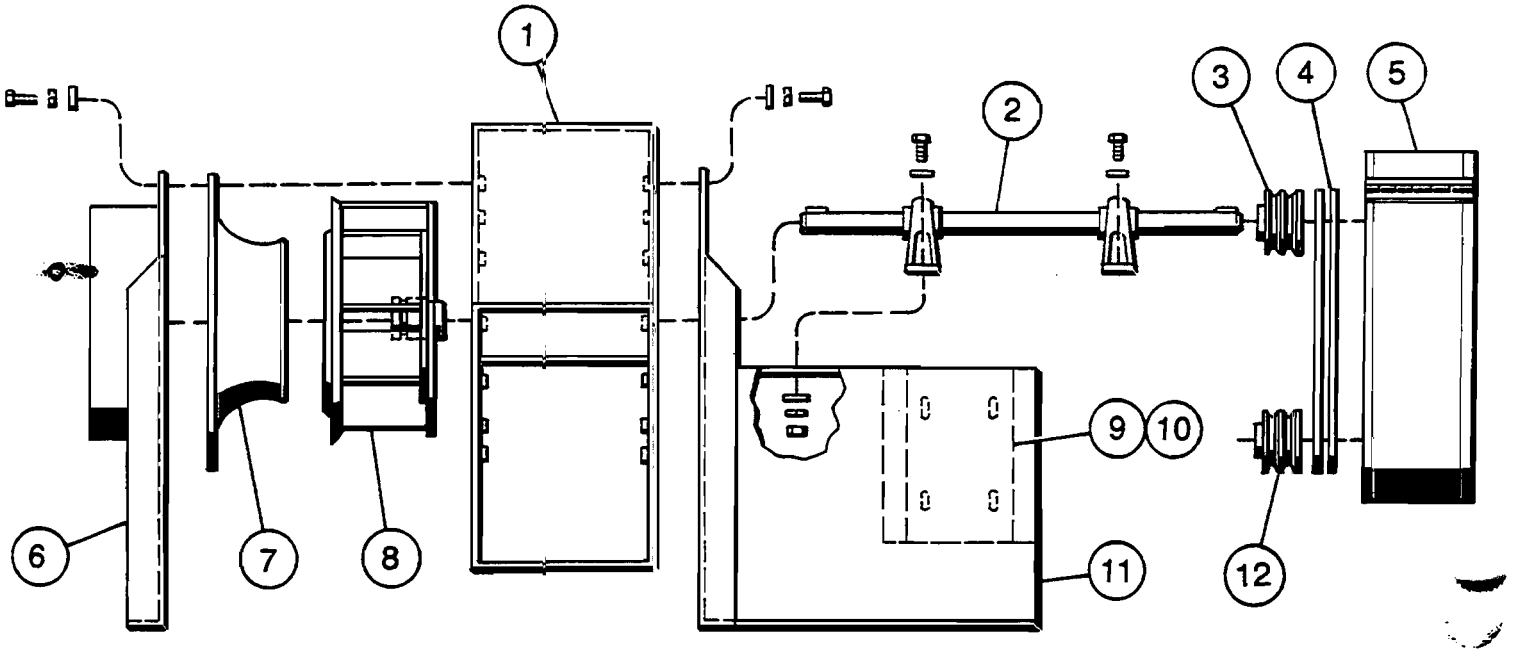
ARRANGEMENT 4



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

MODELS HDBI & RBE

ARRANGEMENT 1 AND 9

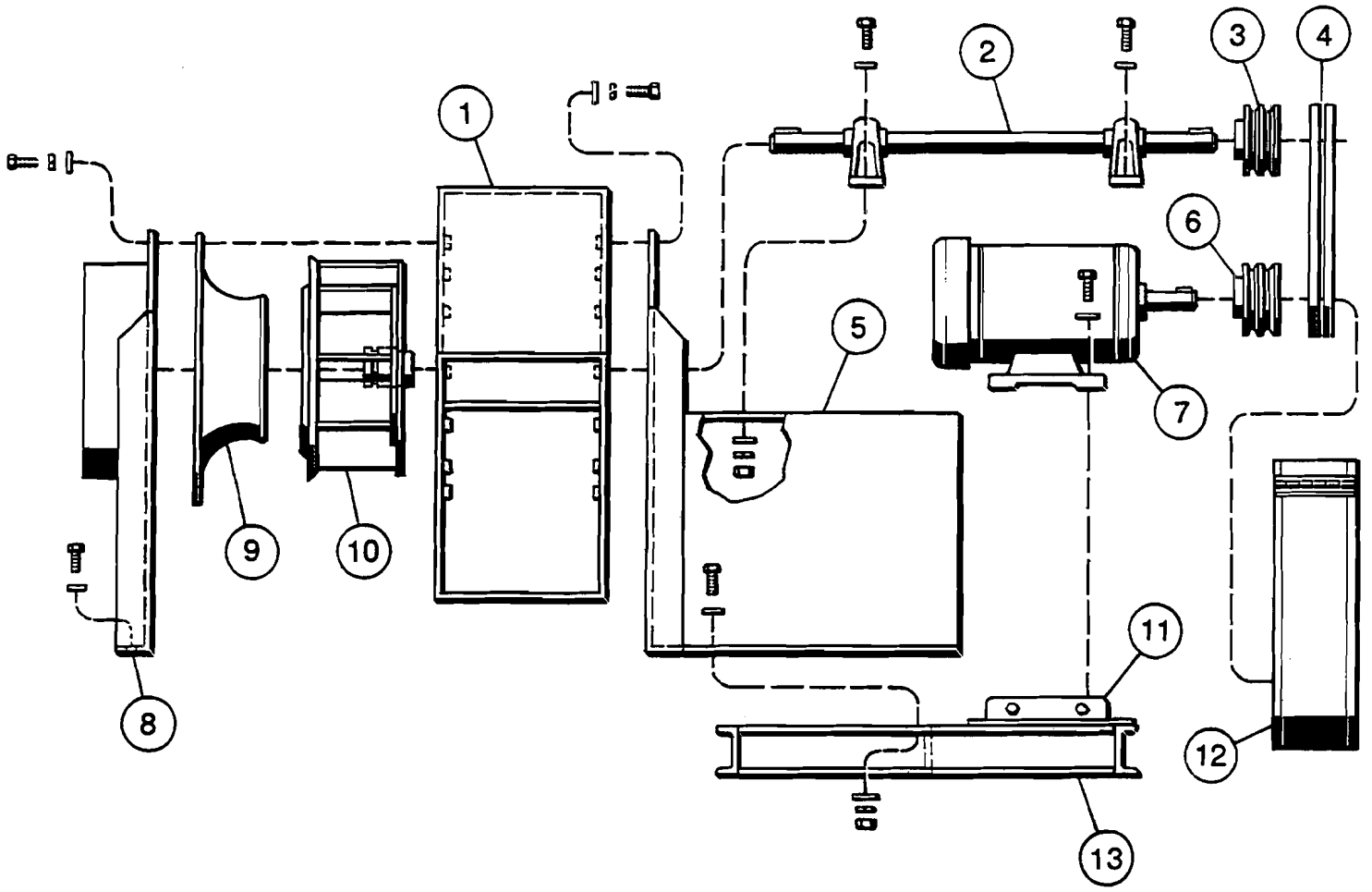


1. HOUSING
2. SHAFT AND BEARING ASSEMBLY
3. FAN SHAFT PULLEY (ARR. 9 ONLY)
4. BELT(S) (ARR. 9 ONLY)
5. BELT GUARD (ARR. 9 ONLY)
6. INLET SIDE PLATE
7. INLET BELL (ON MODEL HDBI ONLY)
8. WHEEL (HDBI WHEEL SHOWN)
9. MOTOR SLIDE BASE (ARR. 9 ONLY)
10. MOTOR (ARR. 9 ONLY) *
11. BASE, FAN
12. MOTOR SHAFT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

* MOTOR NOT SHOWN IN FIGURE

MODELS HDBI & RBE

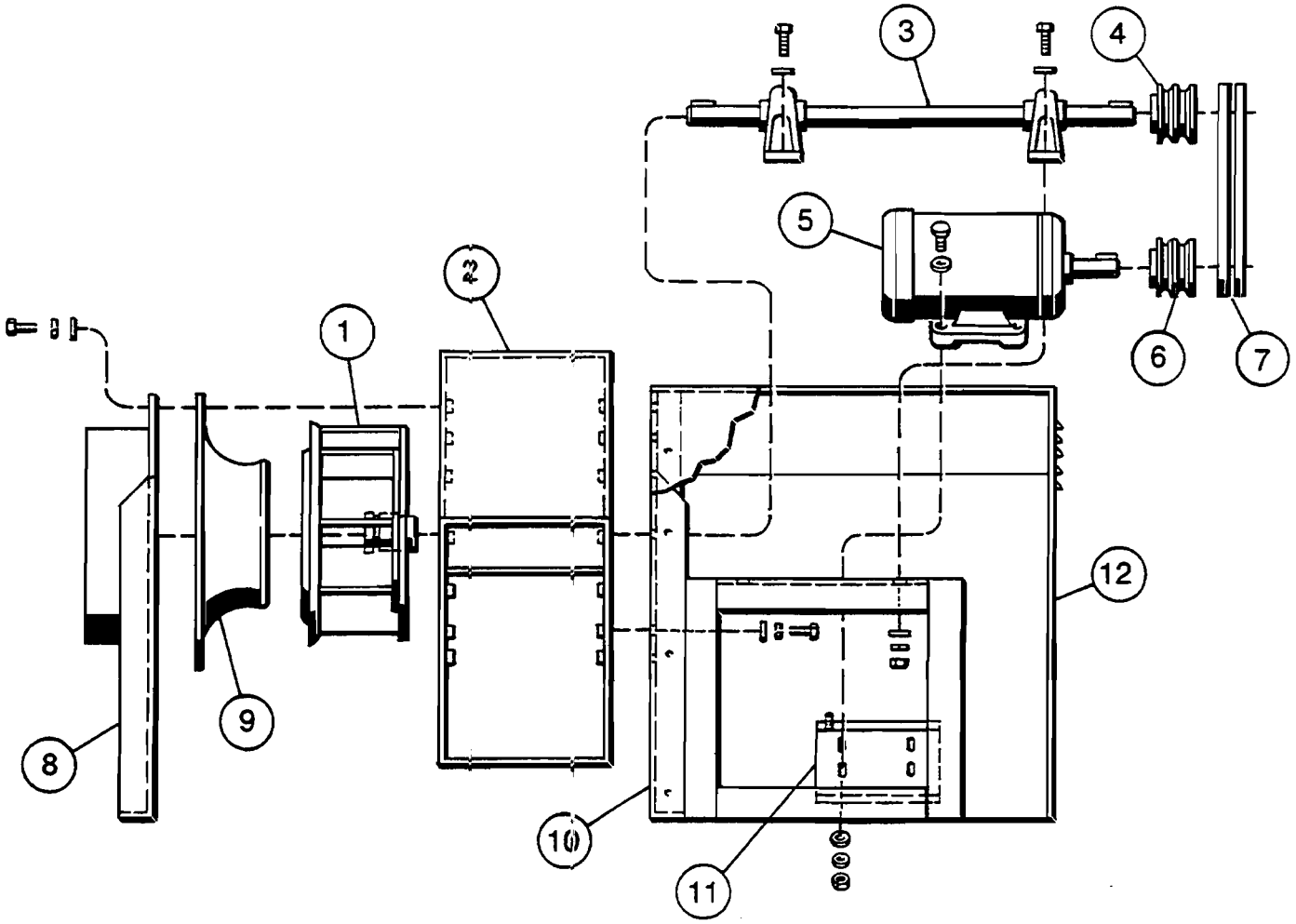
ARRANGEMENT 9CB CHANNEL BASE



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

MODELS HDBI & RBE

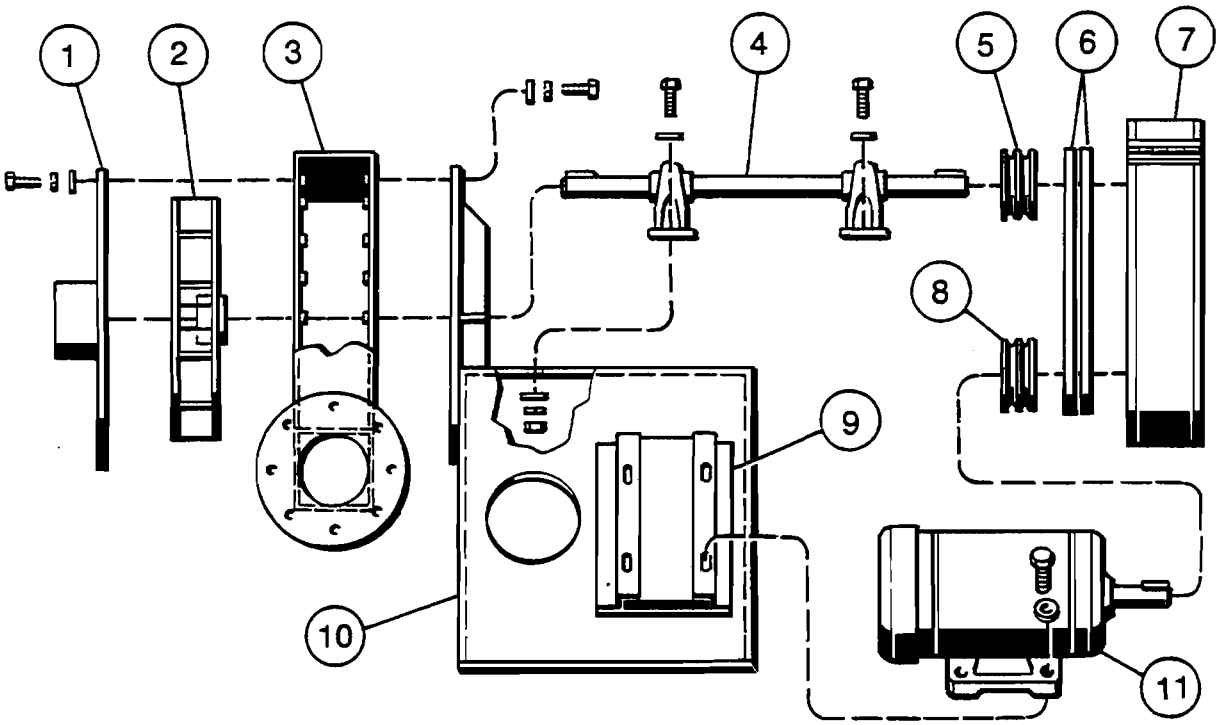
ARRANGEMENT 10



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

MODEL HP

ARRANGEMENT 1 AND 9

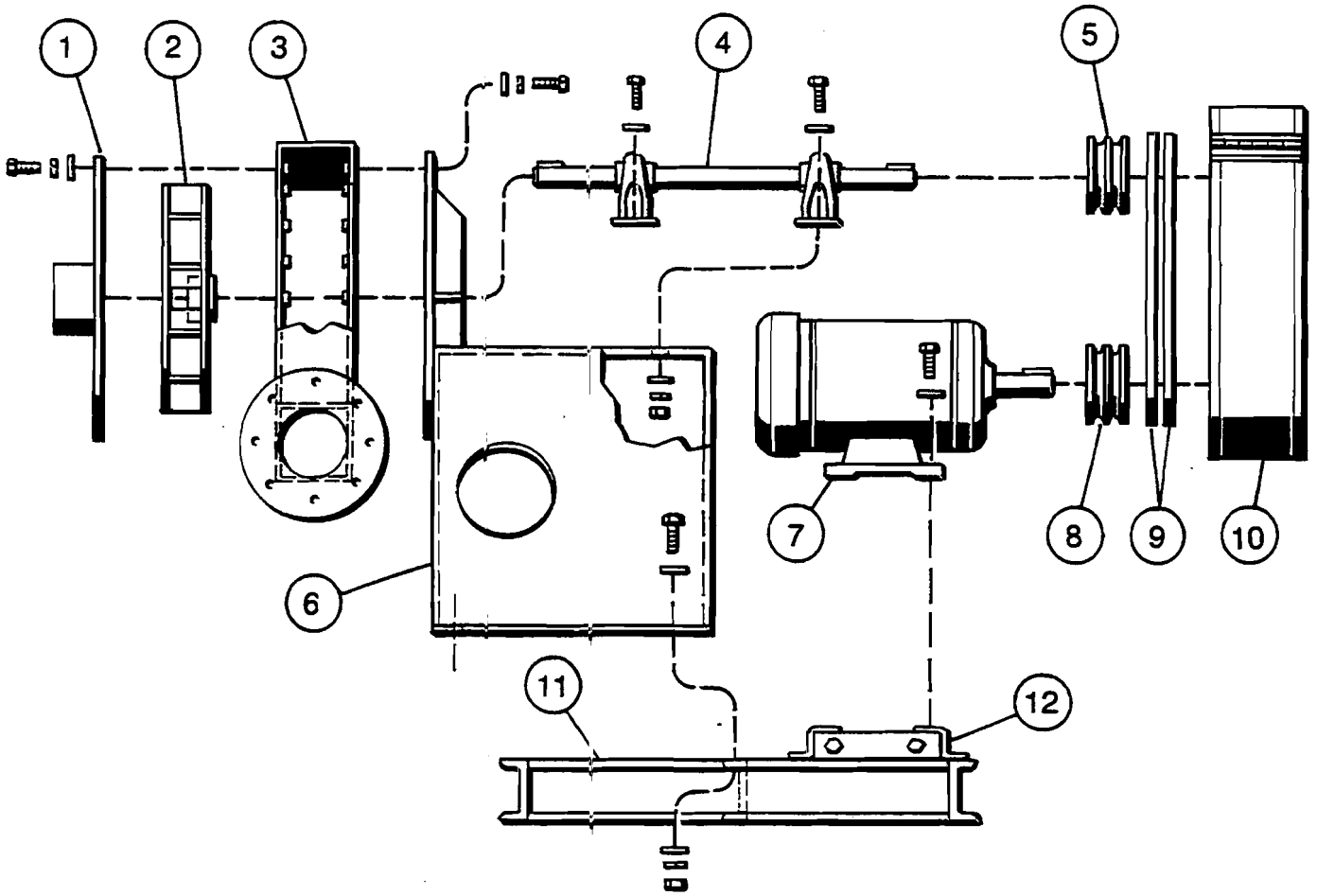


1. INLET SIDE PLATE
2. WHEEL
3. HOUSING
4. SHAFT AND BEARING ASSEMBLY
5. FAN SHAFT PULLEY (ARR. 9 ONLY)
6. BELT(S) (ARR. 9 ONLY)
7. BELT GUARD (ARR. 9 ONLY)
8. MOTOR SHAFT PULLEY (ARR. 9 ONLY)
9. MOTOR SLIDE BASE (ARR. 9 ONLY)
10. BASE, FAN
11. MOTOR (ARR. 9 ONLY)

NOTE: SHAFT SEAL IS NOT SHOWN.

MODEL HP

ARRANGEMENT 9CB CHANNEL BASE

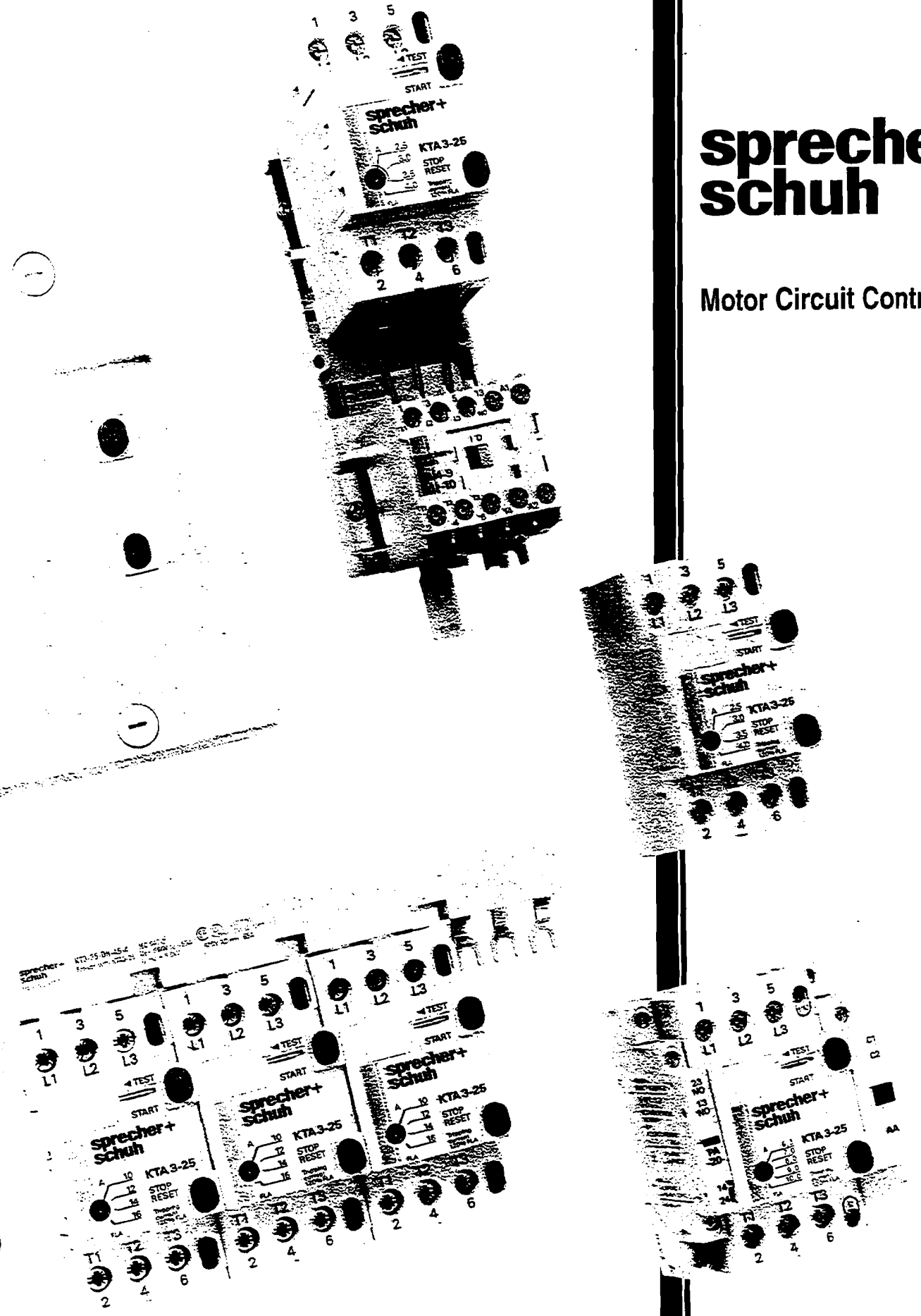


1. INLET SIDE PLATE
2. WHEEL
3. HOUSING
4. SHAFT AND BEARING ASSEMBLY
5. FAN SHAFT PULLEY
6. BASE, FAN
7. MOTOR
8. MOTOR SHAFT PULLEY
9. BELT(S)
10. BELT GUARD
11. BASE, CHANNEL
12. MOTOR SLIDE BASE

NOTE: SHAFT SEAL IS NOT SHOWN.

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Motor Circuit Controllers

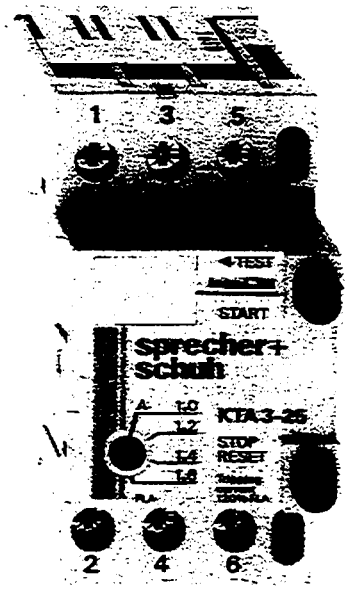


KTA3 Motor Circuit Controller

Reduces panel space and saves money in group motor applications

In one small package, Sprecher + Schuh's KTA3 Motor Circuit Controller combines the functions of:

- Short circuit protection,
- Thermal overload protection,
- Switching, and
- Signaling



Ideal for group motor installations...

The KTA3 can eliminate the need for larger and more expensive fuse blocks and fused disconnects, or circuit breakers. The potential cost savings in group motor installations can be as much as 35% over conventional methods of branch circuit protection. And, because so many features are combined into one small unit, panel space can be slashed by as much as 60%.

In addition, the KTA3 line offers a wide application range from 0.1 to 25 FLA in installations up to 600V. For group motor applications, the KTA3 has a 1200A group installation rating, one of the highest in the industry.

Or as a manual starter

The KTA3 is also an excellent manual motor starter that employs all of the same motor protection features in one compact unit.

Excellent short circuit and thermal overload protection

In the event of a short-circuit, the contacts are opened by magnetic, non-adjusting tripping elements in times approaching 1/1000 of a second. This results in the extremely rapid build-up of an arc voltage which limits the current of the short-circuit to a very low level. Because of this superb current limiting capability, the KTA3 has a short-circuit capacity of up to 42kA at 600V.

Because *each* KTA3 is individually calibrated at the factory for the smallest and largest current, very accurate thermal overload protection is also obtained. In addition, the KTA3 is a Class 10 device ... it trips within 10 seconds under a locked rotor condition (6 x FLA).

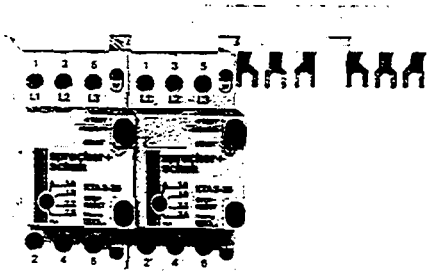
Other protection features

Single-phase protection is provided by the KTA3 at a maximum of 1.25 x FLA. Accurate adjustment of the overload trip ensures effective motor protection even with a phase loss.

Every KTA3 Motor Circuit Controller is also equipped with *automatic* ambient temperature compensation, which continually adjusts to surrounding temperatures. As a result, trip times remain constant.

Accessories add complete versatility

Whether in group motor installations or as a manual motor starter, numerous accessories are available that enhance the KTA3's performance. Auxiliary contact blocks, trip indicators, undervoltage and shunt release modules snap onto the KTA3 without tools. The one pole auxiliary contact block is *internally* mounted, adding no extra dimension to the device. For group motor applications a compact bus bar system is available that speeds installation and provides an extremely clean and efficient panel.



Two compact bus bar systems are available, making installation clean and simple in group motor applications

The KTA3 In Group Motor Applications

NEC article 430-52 states that each motor must have a Branch Circuit Protective Device (BCPD) consisting of a fused disconnect, fuse block, or circuit breaker. A typical circuit is illustrated in Figure 1.

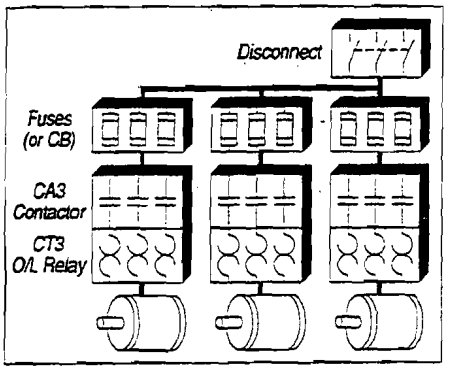


Figure 1
Article 430-52 Circuitry

Even though this method is highly effective, it has several drawbacks.

- Breakers or fuse blocks for each motor circuit are expensive.
- The panel space required to house many components like this is substantial.
- Installations of this type are labor intensive and therefore more costly.

The next article of the code, however (430-53), provides several exceptions to 430-52 that allow you to connect a group of motors under *one* BCPD. These exceptions can be found under: ①

- 430-53(a) – Titled: "For Motors 1 HP or Less"
- 430-53(b) – Titled: "If The Smallest Motor is Protected"
- 430-53(c) – Titled: "In Other Group Installations"

For example, Figure 2 illustrates how a circuit would look utilizing provisions (a) or (b) above. What was once three branch circuits, with three BCPD's, is now one branch circuit with one BCPD.

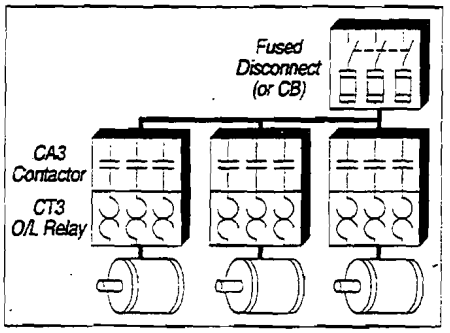


Figure 2
Article 430-53 Circuitry Without KTA3

It appears that the exceptions in 430-53 take care of the expensive drawbacks to having one BCPD for each motor. We have eliminated the expensive fuses (or circuit breakers). We have significantly reduced the panel space, and we have reduced the labor it takes to install the circuit.

Unfortunately, this solution raises a different set of problems.

- To service one motor, the power must be disconnected at the BCPD. This, of course, removes power to all of the other motors.
- The user gives up "close" individual protection against faults that are lower than the BCPD protection rating.
- Few overload relays have the "group installation" label required in 430-53(c).

However, by including the KTA3 in the circuit (Figure 3), the problems associated with 430-53 are now solved.

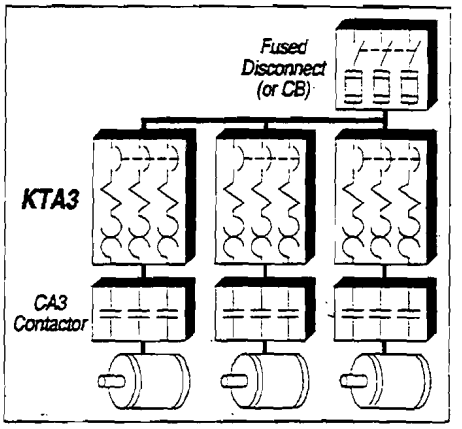
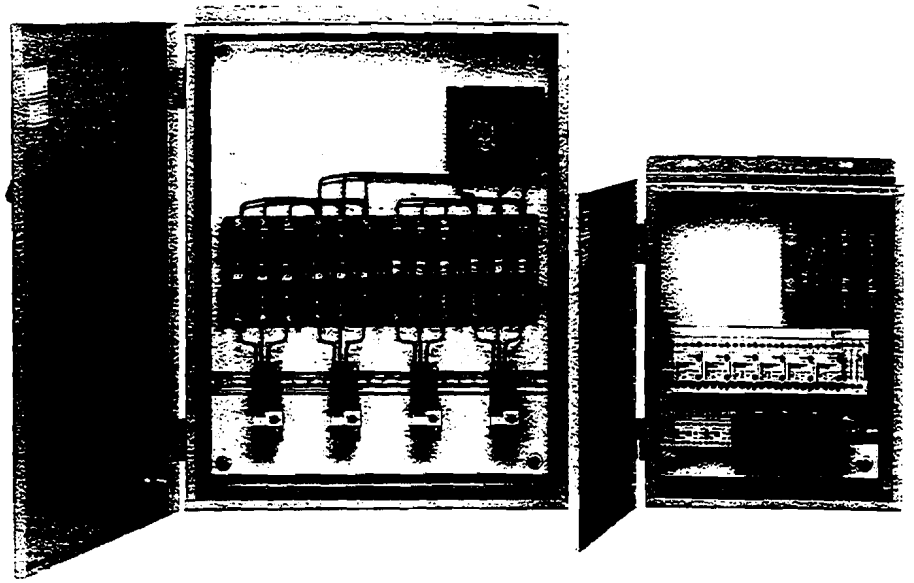


Figure 3
Article 430-53 Circuitry With KTA3

- We have eliminated all but one fuse block (or circuit breaker).
- We have significantly reduced the size of the panel.
- We have decreased the wiring and installation time.
- We have provided an individual disconnect for each motor.
- We have assured protection against faults that are lower than the BCPD.
- We have a product that is labeled for group installations.

Also, the KTA3 is a Class 10 device with ambient temperature compensation, remote signaling, low level fault and single phase protection.



Using the KTA3 in group motor applications can reduce panel space as much as 60%.

① *For more information on applying KTA3 under 430-53, contact your Sprecher + Schuh representative.*

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Motor Circuit Controller

Series KTA3

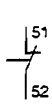
KTA3 Base Unit

Maximum Horsepower						O/L Relay Ampere Range	Magnetic Response Current	Ordering Information		Group Installation			Short Circuit Rating (kA) w/ KTL3-65-N	
Single Ø		Three Ø								Short Circuit Rating (kA)		Max MCB or Fuse (A)		
115V	230V	200V	230V	460V	575V			Catalog Number	Price	480V	600V		480V	600V
1/10	1/6	1/2	1/2	1	1 1/2	0.1 - 0.16	1.8	KTA3-25-0.16A	[illegible]	42	42	1200	~	~
						0.16 - 0.25	2.8	KTA3-25-0.25A	[illegible]	42	42	1200	~	~
						0.25 - 0.4	4.4	KTA3-25-0.4A	[illegible]	42	42	1200	~	~
						0.4 - 0.63	6.9	KTA3-25-0.63A	[illegible]	42	42	1200	~	~
						0.63 - 1	11	KTA3-25-1A	[illegible]	42	42	1200	~	~
						1 - 1.6	18	KTA3-25-1.6A	[illegible]	42	42	1200	~	~
						1.6 - 2.5	28	KTA3-25-2.5A	[illegible]	42	42	1200	~	~
2	3	5	7 1/2	15	20	2.5 - 4	44	KTA3-25-4A	[illegible]	42	42	1200	~	~
						4 - 6.3	69	KTA3-25-6.3A	[illegible]	42	10	1200	42	42
						6.3 - 10	110	KTA3-25-10A	[illegible]	14	10	1200	42	42
						10 - 16	176	KTA3-25-16A	[illegible]	10	5	1200	42	14
						16 - 20	220	KTA3-25-20A	[illegible]	10	5	1200	14	10
						20 - 25	275	KTA3-25-25A	[illegible]	10	5	1200	10	10

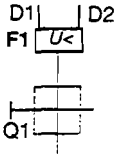
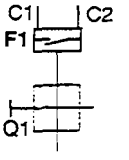
Auxiliary Contact Blocks (1 & 2 Pole)

Aux Contact Block	Diagram	Catalog Number	Price
		KT3-25-PE1-10 *(Internal mount)*	[illegible]
		KT3-25-PE1-01 *(Internal mount)*	[illegible]
		KT3-25-PE-L10 *(Internal mount)*	[illegible]
		KT3-25-PA-11 *(External mount)*	[illegible]
		KT3-25-PA-20 *(External mount)*	[illegible]
		KT3-25-PA-02 *(External mount)*	[illegible]

Trip Indicators (1 Pole) ①

Trip Indicator	Diagram	Catalog Number	Price
		KT3-25-PF-10 ① *(Internal mount)*	[illegible]
		KT3-25-PF-01 ① *(Internal mount)*	[illegible]

Undervoltage & Shunt Release Modules

Module	Wiring Diagram	Catalog Number	Price
 *Undervoltage Module*		KT3-25-UA-*	[illegible]
 *Shunt Release Module*		KT3-25-AA-*	[illegible]

Coil Selection (*)

Coil Code	Coil Voltage
28V	28V60Hz/24V50Hz
127V	127V60Hz/110V50Hz
240V	240-260V60Hz/220-230V50Hz
277V	277V60Hz/240V50Hz
440V	440-460V60Hz/380-400V50Hz
480V	480V60Hz/415V50Hz

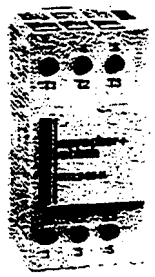
Ordering Instructions

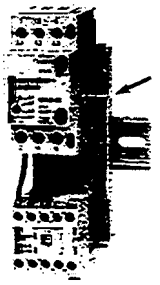
- Specify Catalog Number
- Replace (*) With Coil Code

① KT3-25-PF's provide indication of a short circuit or thermal overload condition. They will not indicate a manually tripped KTA3.

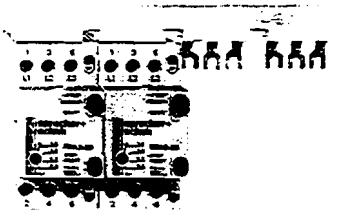
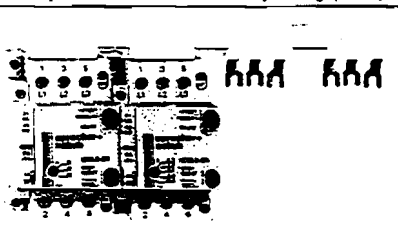
F

Accessory and Replacement Parts

Component	Description	Catalog Number	Price
	**Current Limiter** Increases short circuit capacity of selected KTA3 devices to the following values: KT3-25- 480V 600V 6.3A ..... 42kA 42kA 10A ..... 42kA 42kA 16A ..... 42kA 14kA 20A ..... 14kA 10kA 25A 10kA 10kA	KTL3-65-N	61
	**Enclosures** IP41 (General Purpose) IP55 (Watertight)	KT3-25-KA KT3-25-KAZ	32 54
	**Enclosure Pilot Light** Red - 110/120VAC Red - 220/240VAC Green - 110/120VAC Green - 220/240VAC White - 110/120VAC White - 220/240VAC	 KT3-25-DL-R-110V KT3-25-DL-R-220V KT3-25-DL-G-110V KT3-25-DL-G-220V KT3-25-DL-W-110V KT3-25-DL-W-220V	 16 16 16 16 16 16
	**Padlock Hasp** For use w/ KT3-25-KA(Z) enclosures. Accepts a maximum of three padlocks.	KT3-25-DS	16
	**Locking Bow** Provides capability to directly padlock the KTA3 "START" button. Accepts 1 padlock.	KT3-25-DSB	8
	**Adaptor Plate** Provides capability to panel mount one KTA3.	KT3-25-AS	8

Component	Description	Catalog Number	Price
	**Adaptor Plate** Allows DIN rail mounting of a KTA3 and a CA3 or CA4 contactor as one compact device.	KT3-25-GP12-0	
	**Enclosure Membrane** Replacement membrane for KT3-25-KAZ enclosure. Mounting screws provided.	KT3-25-DM	

Compact Bus Bar System

	**Compact Bus Bar - 45mm Spacing (65 A)**	KT3-25-DB-45-2 *Connects 2 KTA3's* KT3-25-DB-45-4 *Connects 4 KTA3's* KT3-25-DB-45-5 *Connects 5 KTA3's*
	**Compact Bus Bar - 54mm Spacing (65 A)**	KT3-25-DB-54-2 *Connects 2 KTA3's* KT3-25-DB-54-4 *Connects 4 KTA3's* KT3-25-DB-54-5 *Connects 5 KTA3's*
	**Supply Block** Provides cable connection to bus bars.	KT3-25-A2
	**Supply Block** Provides cable connection to bus bars.	KT3-25-A3

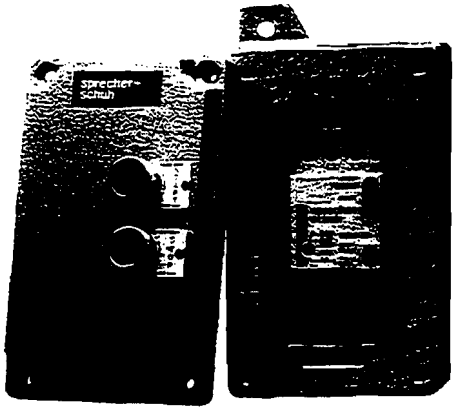
F

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Motor Circuit Controller

Series KTA3

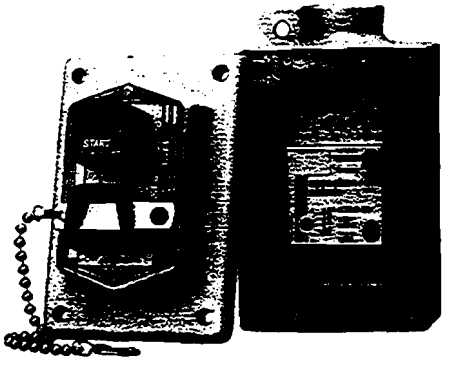
KTA3 Explosion Proof Manual Starter - Type "EX3" ②



Class I, Division 1 & 2, Group C & D
Class II, Division 1 & 2, Group E, F & G
Class III
NEMA 7CD & 9EFG

Maximum Horsepower						O/L Relay Ampere Range	Magnetic Response Current	Ordering Information	
Single Ø		Three Ø							
115V	230V	200V	230V	460V	575V			Catalog Number	Price
1/10	1/6	1/2	1/2	1	1 1/2	0.1 - 0.16	1.8	KTA3-25-0.16A-EX3	
						0.16 - 0.25	2.8	KTA3-25-0.25A-EX3	
						0.25 - 0.4	4.4	KTA3-25-0.4A-EX3	
						0.4 - 0.63	6.9	KTA3-25-0.63A-EX3	
						0.63 - 1	11	KTA3-25-1A-EX3	
						1 - 1.6	18	KTA3-25-1.6A-EX3	
						1.6 - 2.5	28	KTA3-25-2.5A-EX3	
2	3	5	7 1/2	15	20	2.5 - 4	44	KTA3-25-4A-EX3	
						4 - 6.3	69	KTA3-25-6.3A-EX3	
						6.3 - 10	110	KTA3-25-10A-EX3	
						10 - 16	176	KTA3-25-16A-EX3	
						16 - 20	220	KTA3-25-20A-EX3	
						20 - 25	275	KTA3-25-25A-EX3	

KTA3 Explosion Proof Manual Starter - Type "E3" ②



Class I, Division 1 & 2, Group C & D
Class II, Division 1 & 2, Group E, F & G
Class III
NEMA 7CD & 9EFG

Maximum Horsepower						O/L Relay Ampere Range	Magnetic Response Current	Ordering Information	
Single Ø		Three Ø							
115V	230V	200V	230V	460V	575V			Catalog Number	Price
1/10	1/6	1/2	1/2	1	1 1/2	0.1 - 0.16	1.8	KTA3-25-0.16A-E3	
						0.16 - 0.25	2.8	KTA3-25-0.25A-E3	
						0.25 - 0.4	4.4	KTA3-25-0.4A-E3	
						0.4 - 0.63	6.9	KTA3-25-0.63A-E3	
						0.63 - 1	11	KTA3-25-1A-E3	
						1 - 1.6	18	KTA3-25-1.6A-E3	
						1.6 - 2.5	28	KTA3-25-2.5A-E3	
2	3	5	7 1/2	15	20	2.5 - 4	44	KTA3-25-4A-E3	
						4 - 6.3	69	KTA3-25-6.3A-E3	
						6.3 - 10	110	KTA3-25-10A-E3	
						10 - 16	176	KTA3-25-16A-E3	
						16 - 20	220	KTA3-25-20A-E3	
						20 - 25	275	KTA3-25-25A-E3	

F

KTA3 Modifications (Factory Assembled)

Description	Catalog Number Suffix	Price
Auxiliary Contacts		
1 N.O. - Internal	-PE1-10	
1 N.C. - Internal	-PE1-01	
1 N.O. (Early make) - Internal	-PE-L10	
1 N.O. & 1 N.C. - External	-PA-11 ①	
2 N.O. - External	-PA-20 ①	
2 N.C. - External	-PA-02 ①	
Trip Indicators		
1 N.O. - Internal	-PF-10	
1 N.C. - Internal	-PF-01	
Undervoltage Release Module	-UA-* ①	
Shunt Release Module	-AA-* ①	
Enclosure Padlock Hasp	-DS	

① Modification not available on Type "E3" manual starter.
② "Feed Through" type conduit hubs provided as standard.

Ordering Instructions

- Specify Catalog Number
- Replace (*) With Coil Code, Where Applicable.

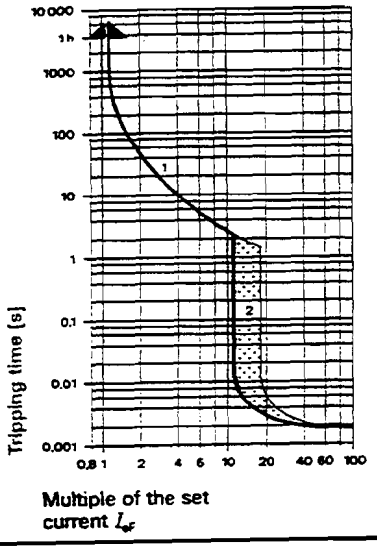
Coil Selection (*)

Coil Code	Coil Voltage
28V	28V60Hz/24V50Hz
127V	127V60Hz/110V50Hz
240V	240-260V60Hz/220-230V50Hz
277V	277V60Hz/240V50Hz
440V	440-460V60Hz/380-400V50Hz
480V	480V60Hz/415V50Hz

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Motor Circuit Controller

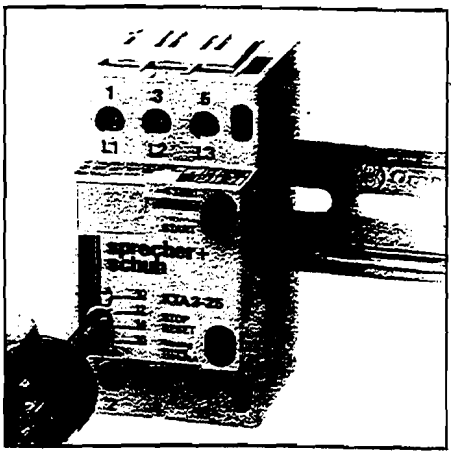
Series KTA3



Time/Current Characteristics

1) Thermal Trip Response Current
This curve shows the mean trip time at a 20°C ambient starting from a cold state. With operationally warm devices the trip time of the thermal trip drops to 1/4 of the values read. Accurate adjustment of the overload ensures effective motor protection, even with the loss of a phase.

2) Magnetic Trip Response Current
The electromagnetic, non-delayed high-speed trip (< 1/1000 of a second) reacts to a fixed response current. At the upper setting of the device this is 11 times the set current; at a lower setting it is correspondingly greater.



Accurate adjustment of the O/L trip ensures effective motor protection, even with a phase loss.

Miscellaneous Technical Information

KTA3 Base Unit

Approvals	IEC 157-1, 292-1, 337-1; SEV 1090-1, 1092-1, 1093-1; VDE 0660 part 101, 104, 200, 0165/83; UL 508, CSA 22.2
Standards	SEV, Germ Lloyd, CEBEC, PTB DEMKO, SEMKO, NEMKO, SETI, UL, CSA, Register of USSR, Bureau Veritas, Lloyd's Register of Shipping
Rated insulation voltage	
IEC, SEV, VDE0660	660 volts
UL, CSA	600 volts
Rated frequency	40...60 Hz
Rated operating current	0.1 to 25A (13 ranges)
Life (mechanical & electrical)	100,000 operating cycles
Switching frequency	30 cycles/hour maximum
Ambient temperature	
Storage	-25°C to +80°C
Operating	-25°C to +60°C
Resistance to climatic change	
Humid heat (40°C @ 92%RH)	56 days
Changing climatic conditions (23°C @ 83%RH/40°C @ 93%RH)	56 cycles
Degree of protection	IP20
Vibration strength	
10 to 150Hz in all directions	>7.5g
Impact resistance	30g, 20ms
Thermal trip	
Tripping time	see time/current curve
Temperature compensation	-20°C to +60°C
Magnetic response	see time/current curve
Terminal connections	
KTA3 base unit	No. 16 to 10 AWG
KTL3-65-N & KT3-25-A2	
L1-L2-L3 terminals	No. 14 to 8 AWG
T1-T2-T3 terminals	No. 14 to 10 AWG
Mounting positions	Any

Auxiliary Contact Blocks

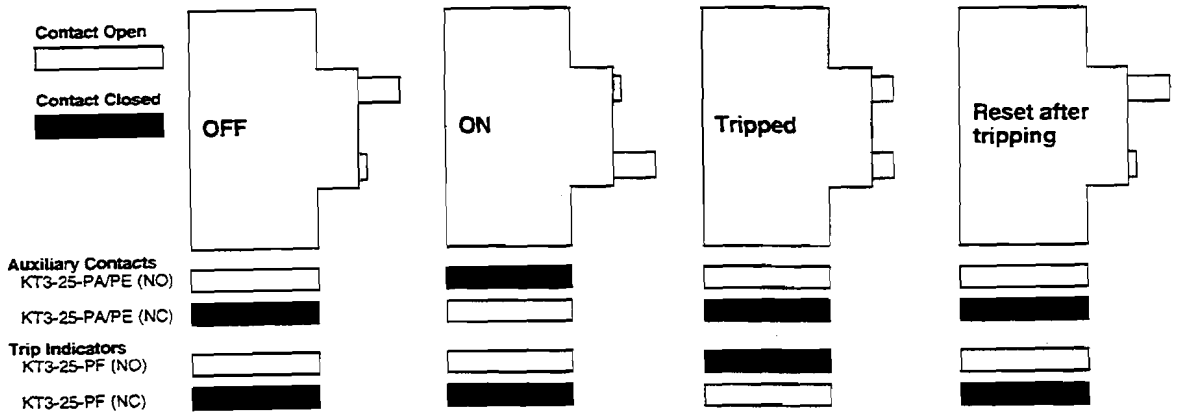
Ampere ratings	
Internal (KT3-25-PE/PF)	To NEMA B600 R300
External (KT3-25-PA)	To NEMA A600 Q600
Terminal connections	No. 18 to 14 AWG
Life (mechanical & electrical)	100,000 operating cycles

Undervoltage & Shunt Release Modules

Maximum coil voltage	110% of rated voltage
Pull-in voltage	80-110% of rated voltage
Drop-out voltage	35-70% of rated voltage
Coil burden	
Pull-in	8.5 VA (6.0 watt)
Seal-in	3.0 VA (1.2 wat)
Terminal connections	No. 18 to 14 AWG
Life (mechanical & electrical)	100,000 operating cycles

F

Auxiliary Contact & Trip Indicator Contact Development



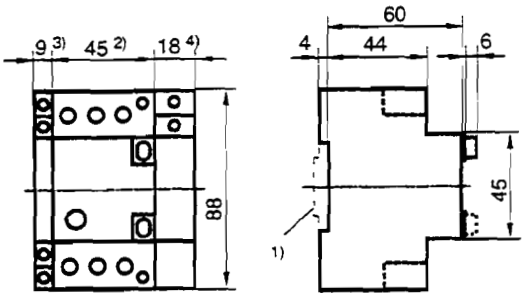
sprecher+schuh

Motor Circuit Controller

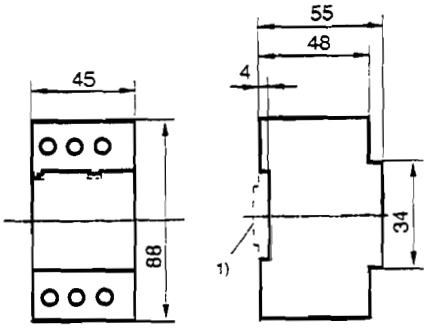
Series KTA3

Dimensions - Millimeters (except where noted otherwise)

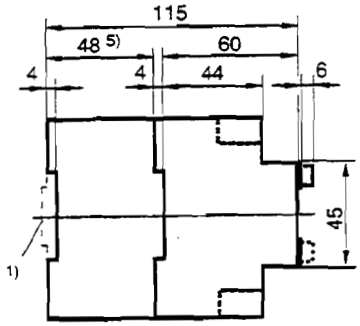
KTA3 Motor Circuit Controller



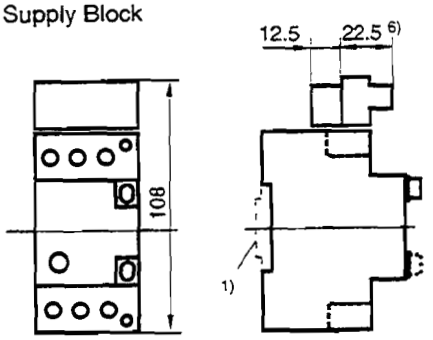
KTL3-65-N Current Limiter or KT3-25-A2 Supply Block



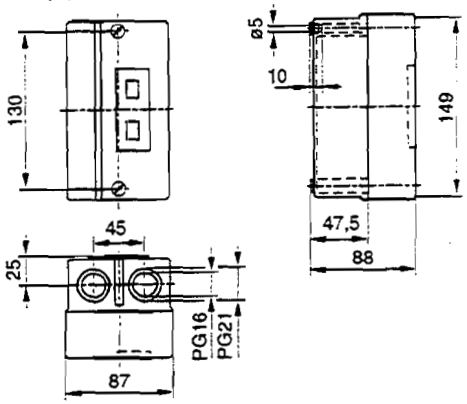
KTL3-65-N Current Limiter & KTA3 Motor Circuit Controller



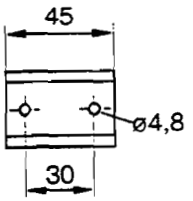
KTA3 Motor Circuit Controller w/KT3-25-DB Bus Bar & KT3-25-A3 Supply Block



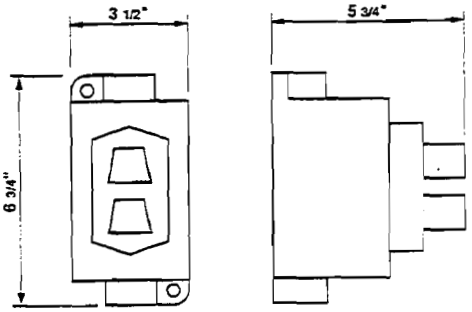
KT3-25-KA(Z) Enclosure



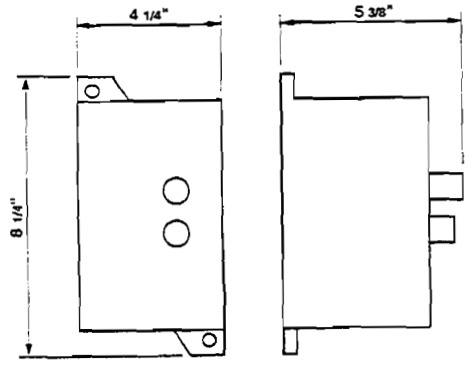
KT3-25-AS Adaptor Plate



KTA3 Explosion Proof Enclosure - Type "E3"



KTA3 Explosion Proof Enclosure - Type "EX3"



1) DIN rail (EN 50022-35) 2) KTA3-25 w/KT3-25-PE or KT3-25-PF 3) KT3-25-PA 4) KT3-25-AA or KT3-25-UA 5) KTL3-65-N 6) KT3-25-A3

F

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Contactor & Starter Catalog Coding

Series CA1, CA3, CA5 & CA6

A

Configuration

CA	*Contactor*
CB	*Contactor (Single Phase)*
CAT	*Starter*
CBT	*Starter (Single Phase)*
CAU	*Reversing Contactor*
CBU...	*Reversing Contactor (Single Phase)*
CAUT	*Reversing Starter*
CBUT...	*Reversing Starter (Single Phase)*
CAZTT	*Multispeed-Two Wind. (Const/Var TQ)*
CAZHT	*Multispeed-Two Wind. (Const HP)*
CAETT	*Multispeed-One Wind. (Const/Var TQ)*
CAEHT	*Multispeed-One Wind. (Const HP)*
CAAT...	*Autotransformer Starter*
CAYT	*Wye-Delta Starter*
CAPWT	*Part Winding Starter*
CAPT	*Pump Panel Starter*
CADPT	*Duplex Pump Starter*

Contactor Series

Series CA1	Series CA3
1-55	3-9(C) ①
1-60	3-12(C) ①
1-100	3-16(C) ①
1-150	3-23 ①
1-250	3-30 ①
1-480	3-37
	3-43
Series CA5	3-60
5-550	3-72
5-700	
5-860	**Series CA6**
5-1000	6-85
5-1200	6-105
	6-140
	6-170

① *Select additional suffix -10 or -01 for CA, CAU, CB & CBU configurations only.*

-10	*N.O. Base Auxiliary*
-01	*N.C. Base Auxiliary*

Coil Code

AC	DC
24	24D
120	48D
208	110D
220	220D
220W	
240	No Coil
277	XXX
380	
480	
575	

For voltage ranges, refer to Coil Codes section of catalog (page A56).

Control Xfmr

Code	Primary	Secondary
XA	*208*	*120*
XB	*240*	*120*
XC	*480*	*120*
XD	*575*	*120*
XE	*240*	*24*
XF	*480*	*24*
XG	*380*	*110*

*For additional **Control Transformer Codes**, refer to Modifications section of catalog (page A67).*

Overload Relay Selection

CA3-9 thru CA3-30	
0.16	*0.10-0.16*
0.24	*0.15-0.24*
0.38	*0.24-0.38*
0.62	*0.38-0.62*
1.0	*0.62-1.0*
1.6	*1.0-1.6*
2.5	*1.6-2.5*
4.0	*2.5-4.0*
6.0	*3.8-6.0*
9.5	*6.0-9.5*
12.5	*8.5-12.5*
17.5	*12-17.5*
23	*16-23*
32	*23-32*

CA3-37 thru CA3-72	
32	*25-32*
42	*32-42*
52	*40-52*
63	*52-63*
72.5	*58-72.5*

CA6-85 thru CA6-170	
90	*68-90*
110	*85-110*
150	*105-150*
200	*140-200*

CA1-55 thru CA1-100	
100	*65-100*
130	*100-130*
150	*100-150*

CA1-150	
100	*65-100*
130	*100-130*
145	*90-145*
150	*100-150*
200	*140-200*

CA1-250	
145	*90-145*
200	*140-200*
290	*180-290*

CA1-480	
200	*140-200*
290	*180-290*
400	*275-400*
500	*320-500*

CA5-550 thru CA5-1200
Contact Factory

Blank *None*

CAT 3-30 - 480 - 23 - B50 G 3 [ ]

Motor Circuit Protector

B3	*3 Amp*
B7	*7 Amp*
B15	*15 Amp*
B30	*30 Amp*
B50	*50 Amp*
B100	*100 Amp*
B150	*150 Amp*
B225	*225 Amp*
B400	*400 Amp*
B600	*600 Amp*

Blank *None*

Fusible Disconnect

F21	*250V/30A*
F22	*250V/60A*
F23	*250V/100A*
F24	*250V/200A*
F25	*250V/400A*
F26	*250V/600A*
F61	*600V/30A*
F62	*600V/60A*
F63	*600V/100A*
F64	*600V/200A*
F65	*600V/400A*
F66	*600V/600A*

Blank *None*

Non Fusible Disconnect

U61	*600V/30A*
U62	*600V/60A*
U63	*600V/100A*
U64	*600V/200A*
U65	*600V/400A*
U66	*600V/600A*

Blank *None*

Enclosure

G	*General Purpose (M1)*
D	*Dusttight (M12)*
W	*Watertight (M4)*
C	*Watertight Corrosion Resistant (F4)*
R	*Raintight (M3R)*
E	*Explosionproof (M7)*
N	*Open Device*

Enclosure Cover Control

Non-Reversing

1	*Pilot Light Only*
2	*Pilot Lights(2) Only*
3	*"Start-Stop" PB*
4	*"On-Off" PB*
5	*"Hand-Auto" S/S*
6	*"On-Off" S/S*
7	*"Hand-Off-Auto" S/S*
0	*None*

Reversing

2	*Pilot Lights(2) Only*
3	*"For-Stop-Rev" PB*
4	*"Up-Stop-Down" PB*
5	*"Open-Stop-Close" PB*
6	*"For-Off-Rev" S/S*
7	*"Up-Off-Down" S/S*
8	*"Open-Off-Close" S/S*
0	*None*

Multi-Speed

2	*Pilot Lights(2) Only*
3	*"High-Stop-Low" PB*
4	*"Fast-Stop-Slow" PB*
5	*"High-Off-Low" S/S*
6	*"Fast-Off-Slow" S/S*
0	*None*

*For additional **Cover Control Codes**, refer to Modifications section of catalog (page A67).*

Options

*For complete listing of **Options Codes**, refer to Modifications section of catalog (page A67).*

This Chart For Reference Only - To Be Used With Sprecher+Schuh Industrial Control Catalog.

Example CAT3-30-480-23-B50G3 Noted Above:
Three phase starter with CA3-30 contactor, 480 volt AC coil, 16-23 amp overload relay, 50 amp Motor Circuit Protector, general purpose M1 enclosure and "Start-Stop" pushbutton.

Non-Reversing CAT3, CAT1 & CAT5 (Open, M1 & M12/M3)

Maximum Horsepower Three Phase				Standard Auxiliary Contacts		Open Type		M1 General Purpose		D I M	M12 (M3②) Industrial Dusttight		D I M
200V	230V	460V	575V	NO	NC	Catalog Number	Price	Catalog Number	Price	①	Catalog Number	Price	①
2	2	5	7.5	1	0	CAT3-9-✱-◆-N0	114	CAT3-9-✱-◆-G0	133	A	CAT3-9-✱-◆-D0	181	L
3	3	7.5	10	1	0	CAT3-12-✱-◆-N0	132	CAT3-12-✱-◆-G0	151	A	CAT3-12-✱-◆-D0	199	L
5	5	10	15	1	0	CAT3-16-✱-◆-N0	144	CAT3-16-✱-◆-G0	163	A	CAT3-16-✱-◆-D0	211	L
7.5	7.5	15	20	1	0	CAT3-23-✱-◆-N0	152	CAT3-23-✱-◆-G0	171	A	CAT3-23-✱-◆-D0	219	L
10	10	20	25	1	0	CAT3-30-✱-◆-N0	178	CAT3-30-✱-◆-G0	197	A	CAT3-30-✱-◆-D0	245	L
10	10	25	30	1	1	CAT3-37-✱-◆-N0	236	CAT3-37-✱-◆-G0	290	B	CAT3-37-✱-◆-D0	382	O
10	15	30	40	1	1	CAT3-43-✱-◆-N0	254	CAT3-43-✱-◆-G0	308	B	CAT3-43-✱-◆-D0	400	O
15	20	40	50	1	1	CAT3-60-✱-◆-N0	277	CAT3-60-✱-◆-G0	331	B	CAT3-60-✱-◆-D0	423	O
20	25	50	60	1	1	CAT3-72-✱-◆-N0	322	CAT3-72-✱-◆-G0	376	B	CAT3-72-✱-◆-D0	472	O
30	30	60	75	1	1	CAT1-55-✱-◆-N0	486	CAT1-55-✱-◆-G0	546	D	CAT1-55-✱-◆-D0	606	Q
40	40	75	100	1	1	CAT1-60-✱-◆-N0	606	CAT1-60-✱-◆-G0	842	D	CAT1-60-✱-◆-D0	1180	Q
50	50	100	125	1	1	CAT1-100-✱-◆-N0	821	CAT1-100-✱-◆-G0	1057	E	CAT1-100-✱-◆-D0	1429	R
60	60	150	150	1	1	CAT1-150-✱-◆-N0	1540	CAT1-150-✱-◆-G0	1940	G	CAT1-150-✱-◆-D0	2438	T
75	100	200	250	1	1	CAT1-250-✱-◆-N0	2014	CAT1-250-✱-◆-G0	2514	H	CAT1-250-✱-◆-D0	3408	H
150	150	350	400	1	1	CAT1-480-✱-◆-N0	3672	CAT1-480-✱-◆-G0	4272	I	CAT1-480-✱-◆-D0	5472	I
200	200	400	500	2	2	CAT5-550-✱-◆-N0	4807	CAT5-550-✱-◆-G0	5457	-	CAT5-550-✱-◆-D0	6656	-
250	300	600	700	2	2	CAT5-700-✱-◆-N0	5770	CAT5-700-✱-◆-G0	6470	-	CAT5-700-✱-◆-D0	7568	-
300	350	700	800	2	2	CAT5-860-✱-◆-N0	7540	CAT5-860-✱-◆-G0	9540	-	CAT5-860-✱-◆-D0	10638	-
350	400	800	1000	1	2	CAT5-1000-✱-◆-N0	8910	CAT5-1000-✱-◆-G0	11410	-	CAT5-1000-✱-◆-D0	42508	-
400	450	900	1100	1	2	CAT5-1200-✱-◆-N0	10000	CAT5-1200-✱-◆-G0	13000	-	CAT5-1200-✱-◆-D0	14098	-

Non-Reversing CAT6 (Open, M1 & M12/M3)

25	30	60	75	1	1	CAT6-85-✱-◆-N0	486	CAT6-85-✱-◆-G0	546	E	CAT6-85-✱-◆-D0	664	Q
40	40	75	100	1	1	CAT6-105-✱-◆-N0	606	CAT6-105-✱-◆-G0	842	E	CAT6-105-✱-◆-D0	1180	R
40	50	100	125	1	1	CAT6-140-✱-◆-N0	821	CAT6-140-✱-◆-G0	1057	F	CAT6-140-✱-◆-D0	1429	T
50	60	125	150	1	1	CAT6-170-✱-◆-N0	1300	CAT6-170-✱-◆-G0	1646	F	CAT6-170-✱-◆-D0	2258	T

Ordering Instructions

- Specify Catalog Number
- Replace (✱) With Coil Code
- Replace (◆) With O/L Relay Code

Refer To Page A56 For Codes

① Refer to page A84 for dimensional information.

② For M3 outdoor applications, replace "D" in catalog number with an "R". Price remains the same, dimensions may change.
Example: CAT3-23-✱-◆-D0 becomes CAT3-23-✱-◆-R0.

Non-Reversing CAT3, CAT1 & CAT5 (M4 & F4)

Maximum Horsepower Three Phase				Standard Auxiliary Contacts		M4 Watertight		DIM	F4 Watertight Corrosion Resistant		DIM
200V	230V	460V	575V	NO	NC	Catalog Number	Price	①	Catalog Number	Price	①
2	2	5	7.5	1	0	CAT3-9-✱-◆-W0	235	N	CAT3-9-✱-◆-C0	354	S1
3	3	7.5	10	1	0	CAT3-12-✱-◆-W0	291	N	CAT3-12-✱-◆-C0	389	S1
5	5	10	15	1	0	CAT3-16-✱-◆-W0	303	N	CAT3-16-✱-◆-C0	781	S1
7.5	7.5	15	20	1	0	CAT3-23-✱-◆-W0	311	N	CAT3-23-✱-◆-C0	231	T1
10	10	20	25	1	0	CAT3-30-✱-◆-W0	337	N	CAT3-30-✱-◆-C0	235	T1
10	10	25	30	1	1	CAT3-37-✱-◆-W0	578	O	CAT3-37-✱-◆-C0	372	U1
10	15	30	40	1	1	CAT3-43-✱-◆-W0	596	O	CAT3-43-✱-◆-C0	393	U1
15	20	40	50	1	1	CAT3-60-✱-◆-W0	679	O	CAT3-60-✱-◆-C0	413	U1
20	25	50	60	1	1	CAT3-72-✱-◆-W0	724	O	CAT3-72-✱-◆-C0	458	U1
30	30	60	75	1	1	CAT1-55-✱-◆-W0	1261	Q	CAT1-55-✱-◆-C0	830	W1
40	40	75	100	1	1	CAT1-60-✱-◆-W0	1556	Q	CAT1-60-✱-◆-C0	1026	W1
50	50	100	125	1	1	CAT1-100-✱-◆-W0	1857	R	CAT1-100-✱-◆-C0	1401	X1
60	60	150	150	1	1	CAT1-150-✱-◆-W0	2834	T	CAT1-150-✱-◆-C0	2378	X1
75	100	200	250	1	1	CAT1-250-✱-◆-W0	3948	H	CAT1-250-✱-◆-C0	3054	Y1
150	150	350	400	1	1	CAT1-480-✱-◆-W0	5973	W	CAT1-480-✱-◆-C0	4872	Y1
200	200	400	500	2	2	CAT5-550-✱-◆-W0	4367	-	CAT5-550-✱-◆-C0	6051	-
250	300	600	700	2	2	CAT5-700-✱-◆-W0	8488	-	CAT5-700-✱-◆-C0	6167	-
300	350	700	800	2	2	CAT5-860-✱-◆-W0	11558	-	CAT5-860-✱-◆-C0	10491	-
350	400	800	1000	1	2	CAT5-1000-✱-◆-W0	13428	-	CAT5-1000-✱-◆-C0	12551	-
400	450	900	1100	1	2	CAT5-1200-✱-◆-W0	15618	-	CAT5-1200-✱-◆-C0	14390	-

Non-Reversing CAT6 (M4 & F4)

25	30	60	75	1	1	CAT6-85-✱-◆-W0	1260	Q	CAT6-85-✱-◆-C0	830	W2
40	40	75	100	1	1	CAT6-105-✱-◆-W0	1556	R	CAT6-105-✱-◆-C0	1026	W2
40	50	100	125	1	1	CAT6-140-✱-◆-W0	1857	T	CAT6-140-✱-◆-C0	1401	X1
50	60	125	150	1	1	CAT6-170-✱-◆-W0	2508	T	CAT6-170-✱-◆-C0	2052	X1

Ordering Instructions

- Specify Catalog Number
- Replace (✱) With Coil Code
- Replace (◆) With O/L Relay Code

Refer To Page A56 For Codes

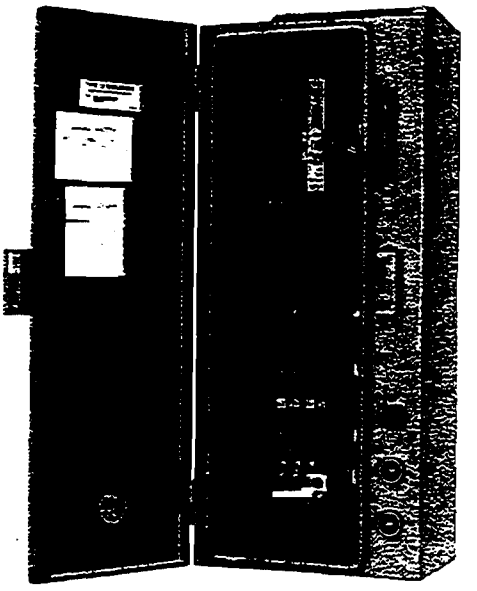
① Refer to page A84 for dimensional information.

② For M3 outdoor applications, replace "D" in catalog number with an "R". Price remains the same, dimensions may change. Example: CAT3-23-✱-◆-D0 becomes CAT3-23-✱-◆-R0.

Combination Starters

Smart and cost effective... for any application

Sprecher + Schuh combination starters are, by design, intended to eliminate the purchase and assembly of a separate disconnect, starter, enclosure and associated wiring. The end result is a cost effective assembly, cleanly wired and ready for installation.



Starting with the best

At the heart of all combination starters is the Sprecher + Schuh CAT3, CAT1, CAT5 and CAT6 line of motor starters. These starters are compact and offer intermediate sizes to better match specific motor requirements. This equates to generous wiring space and less wasted horsepower capacity. Our CT Series Class 10 overload relays provide *full motor overload protection,* including ambient temperature compensation, exact ampere settings and single phase protection.

Circuit protection right for your application

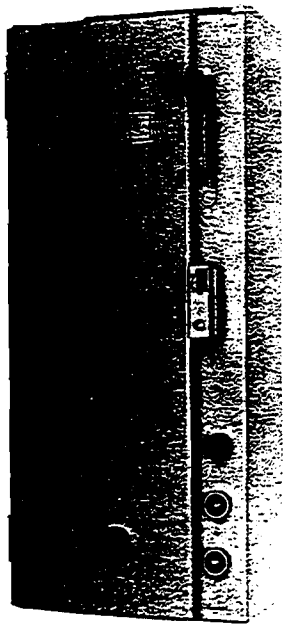
Choices for disconnect include either a Motor Circuit Protector (MCP), or Motor Circuit Switch (MCS), fusible or non-fusible. The Motor Circuit Protector is an adjustable "magnetic trip only" circuit breaker for precise protection of motor circuits. An MCP prevents single phasing by simultaneously opening all three phases when a fault occurs in any one phase. An MCP can also be quickly reset after the fault has been cleared. Interrupting capacity can be increased to 100,000 amperes by adding a current limiter (contact factory for this option).

Motor Circuit Switch disconnects have a quick make/quick break, non-teasing action. The three blades are visible for positive indication of an open circuit. The fusible MCS is suitable for interrupting up to 100,000 amperes when class "R" type fuse clips and fuses are used (contact factory for this option).

Convenience and safety

Disconnect mechanisms are flange-mounted or through-the-door for simple operation during start-up or maintenance. A mechanical door interlock system prevents the door from being opened when the disconnect is closed, and conversely, prevents the disconnect from being closed when the door is open. Both functions can be defeated for test and maintenance purposes. Other safety features include padlock provisions and a high visibility operating handle.

Available enclosures include M1 General Purpose, M3R Raintight, M12 Dusttight and M4/F4 Watertight.



Series CAT3, CAT1 & CAT5 w/Motor Circuit Protector (MCP)

Maximum Horsepower Three Phase				MCP Amps	M1 General Purpose		D I M	M12 (M3②) Industrial Dusttight		D I M	M4 Watertight		D I M	F4 Watertight Corrosion Resist		D I M
200V	230V	460V	575V		Catalog Number	Price	①	Catalog Number	Price	①	Catalog Number	Price	①	Catalog Number	Price	①
					CAT			CAT			CAT			CAT		
0.5	0.5	1	1	3	3-23-✱-◆-B3G0	571	X	3-23-✱-◆-B3D0	676	Y	3-23-✱-◆-B3W0	989	Q	3-23-✱-◆-B3C0	989	V1
1.5	1.5	3	3	7	3-23-✱-◆-B7G0	571	X	3-23-✱-◆-B7D0	676	Y	3-23-✱-◆-B7W0	989	Q	3-23-✱-◆-B7C0	989	V1
3	3	7.5	10	15	3-23-✱-◆-B15G0	571	X	3-23-✱-◆-B15D0	676	Y	3-23-✱-◆-B15W0	989	Q	3-23-✱-◆-B15C0	989	V1
7.5	7.5	15	20	30	3-23-✱-◆-B30G0	593	X	3-23-✱-◆-B30D0	697	Y	3-23-✱-◆-B30W0	1010	Q	3-23-✱-◆-B30C0	1010	V1
10	10	20	25	50	3-30-✱-◆-B50G0	658	X	3-30-✱-◆-B50D0	763	Y	3-30-✱-◆-B50W0	1076	Q	3-30-✱-◆-B50C0	1076	V1
		25	30	50	3-37-✱-◆-B50G0	745	X	3-37-✱-◆-B50D0	871	Y	3-37-✱-◆-B50W0	1276	Q	3-37-✱-◆-B50C0	1276	W1
	15	30	40	50	3-43-✱-◆-B50G0	832	X	3-43-✱-◆-B50D0	980	Y	3-43-✱-◆-B50W0	1476	Q	3-43-✱-◆-B50C0	1476	W1
15	20	40	50	100	3-60-✱-◆-B100G0	1106	X	3-60-✱-◆-B100D0	1297	Y	3-60-✱-◆-B100W0	2228	Q	3-60-✱-◆-B100C0	2228	W1
20	25	50	60	100	3-72-✱-◆-B100G0	1154	X	3-72-✱-◆-B100D0	1345	Y	3-72-✱-◆-B100W0	2276	Q	3-72-✱-◆-B100C0	2276	W1
25	30	60	75	100	1-55-✱-◆-B100G0	1202	E	1-55-✱-◆-B100D0	1393	R	1-55-✱-◆-B100W0	2324	R	1-55-✱-◆-B100C0	2324	X1
30				150	1-55-✱-◆-B150G0	1555	E	1-55-✱-◆-B150D0	1831	R	1-55-✱-◆-B150W0	2755	R	1-55-✱-◆-B150C0	2755	X1
40	40	75	100	150	1-60-✱-◆-B150G0	1908	E	1-60-✱-◆-B150D0	2269	R	1-60-✱-◆-B150W0	3187	R	1-60-✱-◆-B150C0	3187	X1
	50	100	125	150	1-100-✱-◆-B150G0	2615	G	1-100-✱-◆-B150D0	3145	T	1-100-✱-◆-B150W0	4050	T	1-100-✱-◆-B150C0	4050	X1
50				225	1-100-✱-◆-B225G0	3041	G	1-100-✱-◆-B225D0	3593	T	1-100-✱-◆-B225W0	4955	T	1-100-✱-◆-B225C0	4955	X1
60	60	150	150	225	1-150-✱-◆-B225G0	4175	G	1-150-✱-◆-B225D0	4918	T	1-150-✱-◆-B225W0	6723	T	1-150-✱-◆-B225C0	6723	Y1
	75		200	225	1-250-✱-◆-B225G0	5735	I	1-250-✱-◆-B225D0	6691	W	1-250-✱-◆-B225W0	9396	W	1-250-✱-◆-B225C0	9396	Y1
75	100	200	250	400	1-250-✱-◆-B400G0	6039	I	1-250-✱-◆-B400D0	6995	W	1-250-✱-◆-B400W0	9700	W	1-250-✱-◆-B400C0	9700	Y1
100	125	250	300	400	1-480-✱-◆-B400G0	9565	I	1-480-✱-◆-B400D0	10630	W	1-480-✱-◆-B400W0	12482	W	1-480-✱-◆-B400C0	12482	Y1
150	150	350	400	600	1-480-✱-◆-B600G0	9862	-	1-480-✱-◆-B600D0	10927	-	1-480-✱-◆-B600W0	12779	-	1-480-✱-◆-B600C0	12779	-
	200	400	500	600	5-550-✱-◆-B600G0	13091	-	5-550-✱-◆-B600D0	14265	-	5-550-✱-◆-B600W0	15265	-	5-550-✱-◆-B600C0	15265	-

Series CAT6 w/Motor Circuit Protector (MCP)

					CAT			CAT			CAT			CAT		
25	30	60	75	100	6-85-✱-◆-B100G0	1202	E	6-85-✱-◆-B100D0	1393	R	6-85-✱-◆-B100W0	2324	R	6-85-✱-◆-B100C0	2324	X1
40	40	75	100	150	6-105-✱-◆-B150G0	1908	E	6-105-✱-◆-B150D0	2269	R	6-105-✱-◆-B150W0	3187	R	6-105-✱-◆-B150C0	3187	X1
	50	100	125	150	6-140-✱-◆-B150G0	2615	F	6-140-✱-◆-B150D0	3145	T	6-140-✱-◆-B150W0	4850	T	6-140-✱-◆-B150C0	4850	X1
50	60	125	150	225	6-170-✱-◆-B225G0	3655	F	6-170-✱-◆-B225D0	4327	T	6-170-✱-◆-B225W0	5832	T	6-170-✱-◆-B225C0	5832	Y1

Ordering Instructions

- Specify Catalog Number
- Replace (✱) With Coil Code
- Replace (◆) With O/L Relay Code

Refer To Page A56 For Codes

① Refer to page A84 for dimensional information.

② For M3 outdoor applications, replace "D" in catalog number with an "R". Price remains the same, dimensions may change. Example: CAT3-23-✱-◆-B30D0 becomes CAT3-23-✱-◆-B30R0.

Series CAT3 & CAT1 w/Fusible Disconnect (For Use With Dual-Element Fuses)

Maximum Horsepower Three Phase				Fuse Clip Amps	M1 General Purpose		D I M	M12 (M3②) Industrial Dusttight		D I M	M4 Watertight		D I M	F4 Watertight Corrosion Resist		D I M
200V	230V	460V	575V		Catalog Number	Price	①	Catalog Number	Price	①	Catalog Number	Price	①	Catalog Number	Price	①
					CAT			CAT			CAT			CAT		
2	2			30	3-9-✱-◆-F21G0	385	X	3-9-✱-◆-F21D0	478	Y	3-9-✱-◆-F21W0	760	Q	3-9-✱-◆-F21C0	760	V1
		5	7.5	30	3-9-✱-◆-F61G0	385	X	3-9-✱-◆-F61D0	478	Y	3-9-✱-◆-F61W0	760	Q	3-9-✱-◆-F61C0	760	V1
3	3			30	3-12-✱-◆-F21G0	428	X	3-12-✱-◆-F21D0	532	Y	3-12-✱-◆-F21W0	845	Q	3-12-✱-◆-F21C0	845	V1
		7.5	10	30	3-12-✱-◆-F61G0	428	X	3-12-✱-◆-F61D0	532	Y	3-12-✱-◆-F61W0	845	Q	3-12-✱-◆-F61C0	845	V1
5	5			30	3-16-✱-◆-F21G0	439	X	3-16-✱-◆-F21D0	543	Y	3-16-✱-◆-F21W0	856	Q	3-16-✱-◆-F21C0	856	V1
		10	15	30	3-16-✱-◆-F61G0	439	X	3-16-✱-◆-F61D0	543	Y	3-16-✱-◆-F61W0	856	Q	3-16-✱-◆-F61C0	856	V1
7.5	7.5			30	3-23-✱-◆-F21G0	450	X	3-23-✱-◆-F21D0	554	Y	3-23-✱-◆-F21W0	867	Q	3-23-✱-◆-F21C0	867	V1
		15	20	30	3-23-✱-◆-F61G0	450	X	3-23-✱-◆-F61D0	554	Y	3-23-✱-◆-F61W0	867	Q	3-23-✱-◆-F61C0	867	V1
10	10			60	3-30-✱-◆-F22G0	523	X	3-30-✱-◆-F22D0	628	Y	3-30-✱-◆-F22W0	941	Q	3-30-✱-◆-F22C0	941	V1
		20	25	60	3-30-✱-◆-F62G0	523	X	3-30-✱-◆-F62D0	628	Y	3-30-✱-◆-F62W0	941	Q	3-30-✱-◆-F62C0	941	V1
		25	30	60	3-37-✱-◆-F62G0	610	X	3-37-✱-◆-F62D0	736	Y	3-37-✱-◆-F62W0	1141	Q	3-37-✱-◆-F62C0	1141	W1
	15			60	3-43-✱-◆-F22G0	697	X	3-43-✱-◆-F22D0	845	Y	3-43-✱-◆-F22W0	1341	Q	3-43-✱-◆-F22C0	1341	W1
		30	40	60	3-43-✱-◆-F62G0	697	X	3-43-✱-◆-F62D0	845	Y	3-43-✱-◆-F62W0	1341	Q	3-43-✱-◆-F62C0	1341	W1
15				60	3-60-✱-◆-F22G0	843	X	3-60-✱-◆-F22D0	1013	Y	3-60-✱-◆-F22W0	1726	Q	3-60-✱-◆-F22C0	1726	W1
			50	60	3-60-✱-◆-F62G0	843	X	3-60-✱-◆-F62D0	1013	Y	3-60-✱-◆-F62W0	1726	Q	3-60-✱-◆-F62C0	1726	W1
	20			100	3-60-✱-◆-F23G0	989	X	3-60-✱-◆-F23D0	1180	Y	3-60-✱-◆-F23W0	2110	Q	3-60-✱-◆-F23C0	2110	W1
		40		100	3-60-✱-◆-F63G0	989	X	3-60-✱-◆-F63D0	1180	Y	3-60-✱-◆-F63W0	2110	Q	3-60-✱-◆-F63C0	2110	W1
20	25			100	3-72-✱-◆-F23G0	1076	X	3-72-✱-◆-F23D0	1267	Y	3-72-✱-◆-F23W0	2197	Q	3-72-✱-◆-F23C0	2197	W1
		50	60	100	3-72-✱-◆-F63G0	1076	X	3-72-✱-◆-F63D0	1267	Y	3-72-✱-◆-F63W0	2197	Q	3-72-✱-◆-F63C0	2197	W1
25	30			100	1-55-✱-◆-F23G0	1163	E	1-55-✱-◆-F23D0	1354	R	1-55-✱-◆-F23W0	2284	R	1-55-✱-◆-F23C0	2284	X1
		60	75	100	1-55-✱-◆-F63G0	1163	E	1-55-✱-◆-F63D0	1354	R	1-55-✱-◆-F63W0	2284	R	1-55-✱-◆-F63C0	2284	X1
30				200	1-55-✱-◆-F24G0	1258	E	1-55-✱-◆-F24D0	1450	R	1-55-✱-◆-F24W0	2380	R	1-55-✱-◆-F24C0	2380	X1
40	40			200	1-60-✱-◆-F24G0	1689	E	1-60-✱-◆-F24D0	2049	R	1-60-✱-◆-F24W0	2967	R	1-60-✱-◆-F24C0	2967	X1
		75	100	200	1-60-✱-◆-F64G0	1689	E	1-60-✱-◆-F64D0	2049	R	1-60-✱-◆-F64W0	2967	R	1-60-✱-◆-F64C0	2967	X1
50	50			200	1-100-✱-◆-F24G0	2215	G	1-100-✱-◆-F24D0	2745	T	1-100-✱-◆-F24W0	3650	T	1-100-✱-◆-F24C0	3650	X1
		100	125	200	1-100-✱-◆-F64G0	2215	G	1-100-✱-◆-F64D0	2745	T	1-100-✱-◆-F64W0	3650	T	1-100-✱-◆-F64C0	3650	X1
	60			200	1-150-✱-◆-F24G0	2893	G	1-150-✱-◆-F24D0	3615	T	1-150-✱-◆-F24W0	4888	T	1-150-✱-◆-F24C0	4888	Y1
		125	150	200	1-150-✱-◆-F64G0	2893	G	1-150-✱-◆-F64D0	3615	T	1-150-✱-◆-F64W0	4888	T	1-150-✱-◆-F64C0	4888	Y1
60				400	1-150-✱-◆-F25G0	3571	H	1-150-✱-◆-F25D0	4485	H	1-150-✱-◆-F25W0	6125	H	1-150-✱-◆-F25C0	6125	Y1
		150		400	1-150-✱-◆-F65G0	3571	H	1-150-✱-◆-F65D0	4485	H	1-150-✱-◆-F65W0	6125	H	1-150-✱-◆-F65C0	6125	Y1
75	100			400	1-250-✱-◆-F25G0	4939	J	1-250-✱-◆-F25D0	6226	J	1-250-✱-◆-F25W0	8600	J	1-250-✱-◆-F25C0	8600	Z1
		200	200	400	1-250-✱-◆-F65G0	4939	J	1-250-✱-◆-F65D0	6226	J	1-250-✱-◆-F65W0	8600	J	1-250-✱-◆-F65C0	8600	Z1

Series CAT6 w/Fusible Disconnect (For Use With Dual-Element Fuses)

25	30			100	6-85-✱-◆-F23G0	1163	E	6-85-✱-◆-F23D0	1354	R	6-85-✱-◆-F23W0	2284	R	6-85-✱-◆-F23C0	2284	X1
		60	75	100	6-85-✱-◆-F63G0	1163	E	6-85-✱-◆-F63D0	1354	R	6-85-✱-◆-F63W0	2284	R	6-85-✱-◆-F63C0	2284	X1
40	40			200	6-105-✱-◆-F24G0	1689	E	6-105-✱-◆-F24D0	2049	R	6-105-✱-◆-F24W0	2967	R	6-105-✱-◆-F24C0	2967	X1
		75	100	200	6-105-✱-◆-F64G0	1689	E	6-105-✱-◆-F64D0	2049	R	6-105-✱-◆-F64W0	2967	R	6-105-✱-◆-F64C0	2967	X1
	50			200	6-140-✱-◆-F24G0	2215	F	6-140-✱-◆-F24D0	2745	T	6-140-✱-◆-F24W0	3650	T	6-140-✱-◆-F24C0	3650	X1
		100	125	200	6-140-✱-◆-F64G0	2215	F	6-140-✱-◆-F64D0	2745	T	6-140-✱-◆-F64W0	3650	T	6-140-✱-◆-F64C0	3650	X1
50	60			200	6-170-✱-◆-F24G0	2893	F	6-170-✱-◆-F24D0	3615	T	6-170-✱-◆-F24W0	4888	T	6-170-✱-◆-F24C0	4888	Y1
		125	150	200	6-170-✱-◆-F64G0	2893	F	6-170-✱-◆-F64D0	3615	T	6-170-✱-◆-F64W0	4888	T	6-170-✱-◆-F64C0	4888	Y1

Ordering Instructions

- Specify Catalog Number
- Replace (✱) With Coil Code
- Replace (◆) With O/L Relay Code

Refer To Page A56 For Codes

① Refer to page A84 for dimensional information.

② For M3 outdoor applications, replace "D" in catalog number with an "R". Price remains the same, dimensions may change. Example: CAT3-23-✱-◆-F21D0 becomes CAT3-23-✱-◆-F21R0.

Series CAT3 & CAT1 w/Non Fusible Disconnect

Maximum Horsepower Three Phase				Disc Size/ Amps	M1 General Purpose		D I M	M12 (M3②) Industrial Dusttight		D I M	M4 Watertight		D I M	F4 Watertight Corrosion Resist		D I M
200V	230V	460V	575V		Catalog Number	Price	①	Catalog Number	Price	①	Catalog Number	Price	①	Catalog Number	Price	①
					CAT			CAT			CAT			CA		
2	2	5	7.5	30	3-9-✱-◆-U61G0	373	X	3-9-✱-◆-U61D0	466	Y	3-9-✱-◆-U61W0	748	Q	3-9-✱-◆-U61C0	748	V1
3	3	7.5	10	30	3-12-✱-◆-U61G0	416	X	3-12-✱-◆-U61D0	520	Y	3-12-✱-◆-U61W0	833	Q	3-12-✱-◆-U61C0	833	V1
5	5	10	15	30	3-16-✱-◆-U61G0	427	X	3-16-✱-◆-U61D0	531	Y	3-16-✱-◆-U61W0	844	Q	3-16-✱-◆-U61C0	844	V1
7.5	7.5	15	20	30	3-23-✱-◆-U61G0	438	X	3-23-✱-◆-U61D0	542	Y	3-23-✱-◆-U61W0	855	Q	3-23-✱-◆-U61C0	855	V1
10	10	20	25	60	3-30-✱-◆-U62G0	503	X	3-30-✱-◆-U62D0	688	Y	3-30-✱-◆-U62W0	921	Q	3-30-✱-◆-U62C0	921	V1
		25	30	60	3-37-✱-◆-U62G0	590	X	3-37-✱-◆-U62D0	716	Y	3-37-✱-◆-U62W0	1121	Q	3-37-✱-◆-U62C0	1121	W1
	15	30	40	60	3-43-✱-◆-U62G0	677	X	3-43-✱-◆-U62D0	825	Y	3-43-✱-◆-U62W0	1321	Q	3-43-✱-◆-U62C0	1321	W1
15			50	60	3-60-✱-◆-U62G0	801	X	3-60-✱-◆-U62D0	971	Y	3-60-✱-◆-U62W0	1684	Q	3-60-✱-◆-U62C0	1684	W1
	20	40		100	3-60-✱-◆-U63G0	925	X	3-60-✱-◆-U63D0	1116	Y	3-60-✱-◆-U63W0	2046	Q	3-60-✱-◆-U63C0	2046	W1
20	25	50	60	100	3-72-✱-◆-U63G0	1012	X	3-72-✱-◆-U63D0	1203	Y	3-72-✱-◆-U63W0	2133	Q	3-72-✱-◆-U63C0	2133	W1
25	30	60	75	100	1-55-✱-◆-U63G0	1063	E	1-55-✱-◆-U63D0	1255	R	1-55-✱-◆-U63W0	2185	R	1-55-✱-◆-U63C0	2185	X1
30				200	1-55-✱-◆-U64G0	1114	E	1-55-✱-◆-U64D0	1306	R	1-55-✱-◆-U64W0	2236	R	1-55-✱-◆-U64C0	2236	X1
40	40	75	100	200	1-60-✱-◆-U64G0	1545	E	1-60-✱-◆-U64D0	1905	R	1-60-✱-◆-U64W0	2823	R	1-60-✱-◆-U64C0	2823	X1
50	50	100	125	200	1-100-✱-◆-U64G0	2071	G	1-100-✱-◆-U64D0	2601	T	1-100-✱-◆-U64W0	3506	T	1-100-✱-◆-U64C0	3506	X1
	60	125	150	200	1-150-✱-◆-U64G0	2589	G	1-150-✱-◆-U64D0	3411	T	1-150-✱-◆-U64W0	4684	T	1-150-✱-◆-U64C0	4684	X1
60		150		400	1-150-✱-◆-U65G0	3307	G	1-150-✱-◆-U65D0	4221	T	1-150-✱-◆-U65W0	5861	T	1-150-✱-◆-U65C0	5861	Y1
75	100	200	200	400	1-250-✱-◆-U65G0	4675	I	1-250-✱-◆-U65D0	5962	W	1-250-✱-◆-U65W0	8336	W	1-250-✱-◆-U65C0	8336	Y1

Series CAT6 w/Non Fusible Disconnect

					CAT			CAT			CAT			CAT		
25	30	60	75	100	6-85-✱-◆-U63G0	1063	E	6-85-✱-◆-U63D0	1255	R	6-85-✱-◆-U63W0	2185	R	6-85-✱-◆-U63C0	2185	X1
40	40	75	100	200	6-105-✱-◆-U64G0	1545	E	6-105-✱-◆-U64D0	1905	R	6-105-✱-◆-U64W0	2823	R	6-105-✱-◆-U64C0	2823	X1
	50	100	125	200	6-140-✱-◆-U64G0	2071	F	6-140-✱-◆-U64D0	2601	T	6-140-✱-◆-U64W0	3506	T	6-140-✱-◆-U64C0	3506	X1
50	60	125	150	200	6-170-✱-◆-U64G0	2589	F	6-170-✱-◆-U64D0	3411	T	6-170-✱-◆-U64W0	4684	T	6-170-✱-◆-U64C0	4684	X1

Ordering Instructions

- Specify Catalog Number
- Replace (✱) With Coil Code — **Refer To Page**
- Replace (◆) With O/L Relay Code — **A56 For Codes**

① Refer to page A84 for dimensional information.

② For M3 outdoor applications, replace "D" in catalog number with an "R". Price remains the same, dimensions may change.
Example: CAT3-23-✱-◆-U61D0 becomes CAT3-23-✱-◆-U61R0.

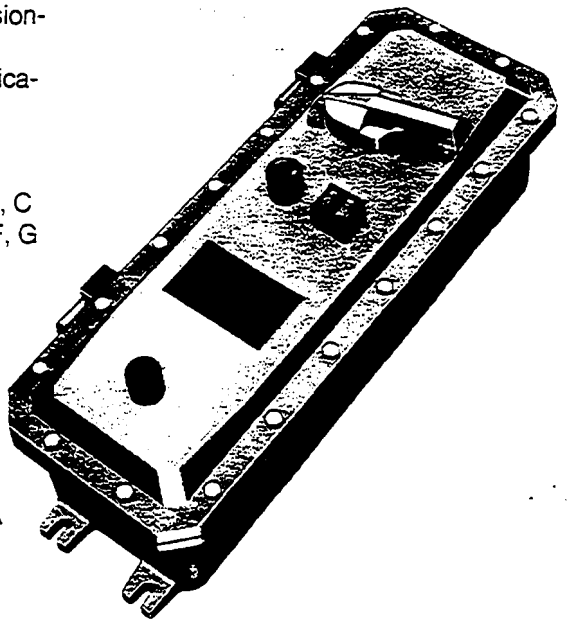
Explosion-proof Starters

Safe and reliable starting in hazardous applications

Sprecher + Schuh offers explosion-proof starters for environments covered by the following classifications:

NEMA: 7BCD, 9EFG
NEC: Class I, Groups B, C, C
Class II, Groups E, F, G
Class III
UL: Standard 1203
Hazardous
(Classified)
Locations
CSA: Standard 22.2

Explosion-proof *combination* starters also comply with NEMA 3, 3R, 4 & 12.



Type 7 and Type 9 protection

Type 7 enclosures are designed to provide protection against an internal explosion when operated in a **hazardous gas environment**. Type 9 enclosures protect from internal explosion in a **hazardous dust environment**.

Both types must also prevent enclosed heat generating mechanisms from causing external surfaces to reach temperatures capable of igniting explosive gas-air mixtures in the surrounding atmosphere. Sprecher + Schuh explosion-proof starters meet all requirements of both classifications.

Starting with the best

At the heart of all explosion-proof starters is the Sprecher + Schuh CAT3, CAT1 and CAT6 line of motor starters. These starters are compact and offer intermediate sizes to better match specific motor requirements. This equates to generous wiring space and less wasted horsepower capacity. Our CT Series Class 10 overload relays provide *full motor overload protection,* including ambient temperature compensation, exact ampere settings and single phase protection.

Combination starters for motor circuit protection and convenience

Explosion-proof combination starters can include either a Motor Circuit Protector or non-fusible disconnect. The Motor Circuit Protector (MCP) is an adjustable "magnetic trip only" circuit breaker for precise protection of motor circuits. An MCP prevents single phasing by simultaneously opening all three phases when a fault occurs in any one phase. An MCP can also be quickly reset after the fault has been cleared. Interrupting capacity can be increased to 100,000 amperes by adding a current limiter (contact factory for this option).

A non-automatic MCP is used in applications requiring a non-fused disconnect.

A

Series CAT3 & CAT1 ②

Maximum Horsepower Three Phase				Without Short Circuit Protection		DIM	MCP Amps	With Motor Circuit Protector (MCP)		DIM	With Non Fusible Disconnect		DIM
200V	230V	460V	575V	Catalog Number	Price	①		Catalog Number	Price	①	Catalog Number	Price	①
0.5	0.5	1	1	CAT3-23-✱-◆-E0		-	3	CAT3-23-✱-◆-B3E0		-	To order, select equivalent Motor Circuit Protector (MCP) catalog number from this chart. Specify on order, *"With non-automatic circuit breaker"*.		
1.5	1.5	3	3				7	CAT3-23-✱-◆-B7E0		-			
3	3	7.5	10				15	CAT3-23-✱-◆-B15E0		-			
7.5	7.5	15	20				30	CAT3-23-✱-◆-B30E0		-			
10	10	20	25	CAT3-30-✱-◆-E0		-	50	CAT3-30-✱-◆-B50E0		-			
		25	30	CAT3-37-✱-◆-E0		-	50	CAT3-37-✱-◆-B50E0		-			
	15	30	40	CAT3-43-✱-◆-E0		-	50	CAT3-43-✱-◆-B50E0		-			
15	20	40	50	CAT3-60-✱-◆-E0		-	100	CAT3-60-✱-◆-B100E0		-			
20	25	50	60	CAT3-72-✱-◆-E0		-	100	CAT3-72-✱-◆-B100E0		-			
25	30	60	75	CAT1-55-✱-◆-E0		-	100	CAT1-55-✱-◆-B100E0		-			
30							150	CAT1-55-✱-◆-B150E0		-			
40	40	75	100	CAT1-60-✱-◆-E0		-	150	CAT1-60-✱-◆-B150E0		-			
	50	100	125	CAT1-100-✱-◆-E0		-	150	CAT1-100-✱-◆-B150E0		-			
50							225	CAT1-100-✱-◆-B225E0		-			
60	60	150	150	CAT1-150-✱-◆-E0		-	225	CAT1-150-✱-◆-B225E0		-			
	75		200	CAT1-250-✱-◆-E0		-	225	CAT1-250-✱-◆-B225E0		-			
75	100	200	250				400	CAT1-250-✱-◆-B400E0		-			
100	125	250	300	CAT1-480-✱-◆-E0		-	400	CAT1-480-✱-◆-B400E0		-			
150	150	350	400				600	CAT1-480-✱-◆-B600E0		-			

Series CAT6 ②

25	30	60	-75	CAT6-85-✱-◆-E0		-	100	CAT6-85-✱-◆-B100E0		-	To order, select equivalent Motor Circuit Protector (MCP) catalog number from this chart. Specify on order, *"With non-automatic circuit breaker"*.		
40	40	75	100	CAT6-105-✱-◆-E0		-	150	CAT6-105-✱-◆-B150E0		-			
	50	100	125	CAT6-140-✱-◆-E0		-	150	CAT6-140-✱-◆-B150E0		-			
50	60	125	150	CAT6-170-✱-◆-E0		-	225	CAT6-170-✱-◆-B225E0		-			

Ordering Instructions

- Specify Catalog Number
- Replace (✱) With Coil Code
- Replace (◆) With O/L Relay Code

① Contact factory for dimensional information.
② Control Circuit Fuses not supplied in control circuit of starters with Control Power Transformer (CPT).

sprecher+schuh

Coil Codes (AC & DC)

All Contactor and Starter Configurations

A

Contactor Coil Code & Voltage Ranges ④

A.C. COIL ⇓ CODES ⇓	CA4-9	CA3-9 CA3-12 CA3-16	CA3-23 Thru CA3-72	CA6-85 CA6-105	CA6-140 CA6-170	CA1-55 CA1-60 CA1-100	CA1-150 CA1-250 CA1-480	CA5-550 thru CA5-860 ⑥
24	24V/60Hz 24V/50Hz	24V/60Hz 21V/50Hz	24V/60Hz 21V/50Hz	24V/60Hz 21V/50Hz	24-28V 50/60Hz	24V/60Hz 21V/50Hz	N/A	N/A
120	110-120V/60Hz 110V/50Hz	120V/60Hz 110V/50Hz	120V/60Hz 110V/50Hz	120V/60Hz 105V/50Hz	110-130V 50/60Hz	120V/60Hz 110V/50Hz	120V/60Hz 110V/50Hz	110-120V 50/60Hz
208	N/A	208V/60Hz 180V/50Hz	208V/60Hz 180V/50Hz	N/A	N/A	208V/60Hz 180V/50Hz	208V/60Hz 180V/50Hz	N/A
220	N/A	220V/60Hz 190V/50Hz	220V/60Hz 190V/50Hz	220V/60Hz 190V/50Hz	N/A	220V/60Hz 190V/50Hz	220V/60Hz 190V/50Hz	N/A
220W ①	N/A	208-240V 60Hz	208-240V 60Hz	N/A	N/A	N/A	N/A	N/A
240	230-240V/60Hz 220-230V/50Hz	240V/60Hz 220V/50Hz	240V/60Hz 220V/50Hz	240V/60Hz 210V/50Hz	185-277V 50/60Hz	240V/60Hz 220V/50Hz	240V/60Hz 220V/50Hz	220-240V 50/60Hz
277	N/A	277V/60Hz 240V/50Hz	277V/60Hz 240V/50Hz	277V/60Hz 240V/50Hz	N/A	277V/60Hz 240V/50Hz	277V/60Hz 240V/50Hz	N/A
380	380-400V/50Hz 400-415V/60Hz	380-400V/50Hz 440-460V/60Hz	380-400V/50Hz 440-460V/60Hz	380-400V/50Hz 440-460V/60Hz	N/A	380V/50Hz 440V/60Hz	380V/50Hz 440V/60Hz	380-415V 50/60Hz
480	N/A	480V/60Hz 440V/50Hz	480V/60Hz 440V/50Hz	480V/60Hz 415V/50Hz	N/A	480V/60Hz 440V/50Hz	480V/60Hz 440V/50Hz	440-480V 50/60Hz
575	N/A	575V/60Hz 500V/50Hz	575V/60Hz 500V/50Hz	575V/60Hz 500V/50Hz	N/A	575V/60Hz 500V/50Hz	575V/60Hz 500V/50Hz	N/A
XXX	N/A	Supplied Without Coil	Supplied Without Coil	Supplied Without Coil	Supplied Without Coil	Supplied Without Coil	Supplied Without Coil	Supplied Without Coil

D.C. COIL ⇓ CODES ⇓	② Voltage	Price Adder	Voltage	Price Adder	Voltage	Price Adder	Voltage	Price Adder	Voltage	Price Adder	Voltage	Price Adder	Voltage	Price Adder	Voltage	Price Adder
24D	24 VDC		24 VDC		24 VDC		24 VDC		23-26 VDC		22-28 VDC		22-28 ⑤ VDC		AC coils above also rated for DC: Code 120: 100-110VDC Code 240: 200-220VDC Code 380: 345-380VDC Code 480: 400-440VDC	
48D	48 VDC		48 VDC		48 VDC		48 VDC		48-72 VDC		44-55 VDC		44-55 VDC			
110D	110 VDC		110 VDC		110 VDC		110 VDC		90-135 VDC		110-140 VDC		110-140 VDC			
220D	220 VDC		220 VDC		220 VDC		220 VDC		170-250 VDC		220-280 VDC		220-280 VDC			

Further modify catalog number by adding a **"C"** after contactor size designation. Example:
CA3-16-10-✱-N0 *becomes*
CA3-16**C**-10-24D-N0
Do this for ***all*** contactor/starter configurations that use these contactors. Price includes special two lead coil and DC magnet frame (AC and DC coils are not interchangeable). ②

Coils have high current "pick-up" winding and a low current "seal-in" winding wired in parallel. The "pick-up winding is taken out of the circuit after the armature pulls in. Price includes three lead coil and a N.C. late break auxiliary contact.

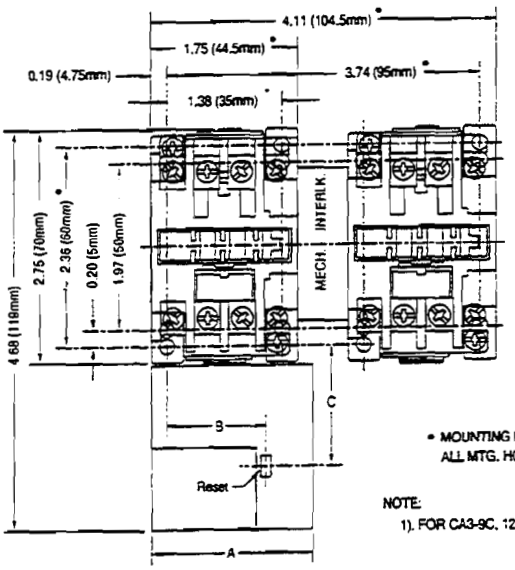
Electronically controlled coil eliminates special DC coil considerations. No special contactor frame or control circuit required.

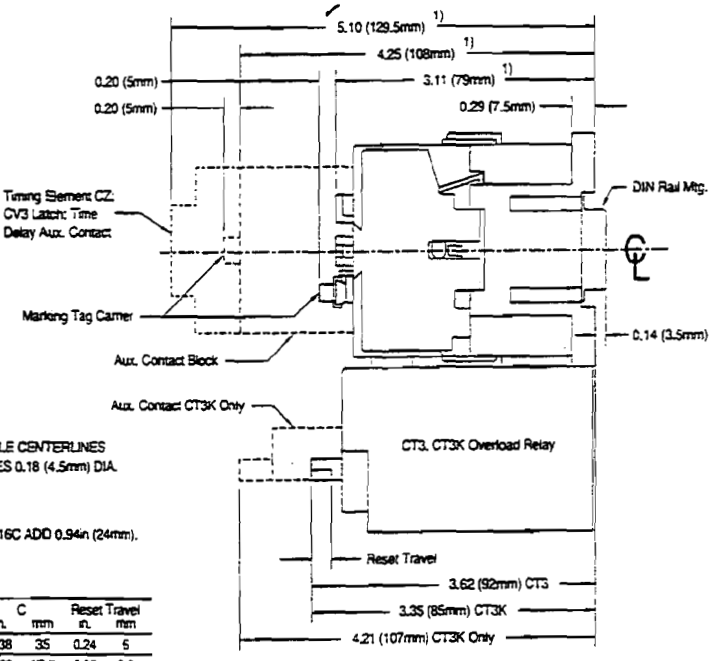
Coil control circuit is designed so that after the armature pulls in, a resistor is connected in series with the coil. Price includes two lead coil, resistor, resistor support and a N.C. late break auxiliary contact. CA1-150/250/480 devices also include a CS1 interposing relay. ③

Please note that the price adders are for each DC coil required for any particular application. For example, a reversing contactor requires two DC coils (Price Adder x 2).

① Wide range coil.
② CA4 contactor/starter configurations requiring mechanical interlock (reversing, etc) not available in DC voltages.
③ Coil available without resistor, resistor support, N.C. late break auxiliary contact and interposing relay (special applications). Contact factory for price deduct.
④ Other coil voltages available. Refer to Replacements Parts section of this catalog, or contact nearest Sprecher+Schuh sales office.
⑤ Not available for CA1-480.
⑥ For CA5-1000 & CA5-1200 Coil Codes and voltage ranges, please refer to Replacement Parts section of this catalog.

Series CA3-9, 12 & 16 (Contactors/Starters)

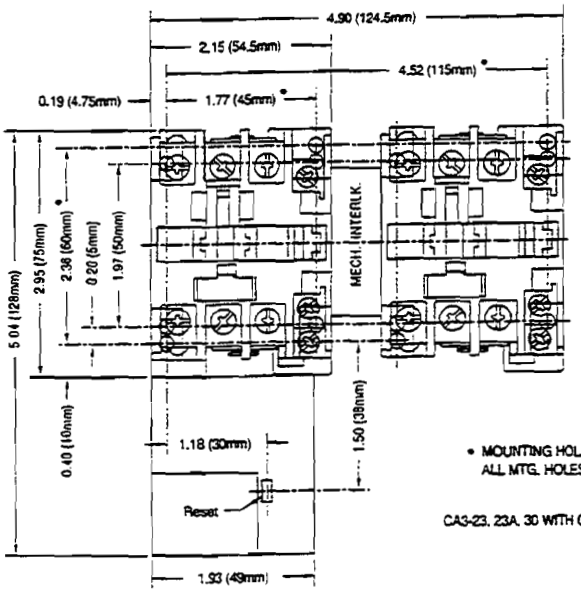


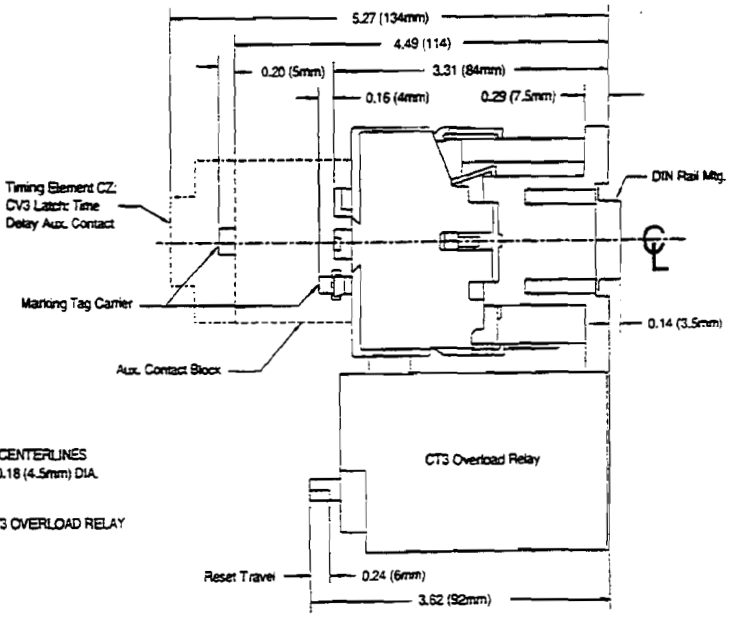


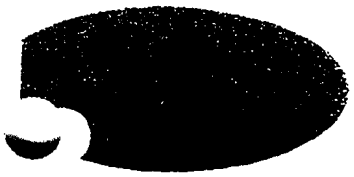
NOTE:
1). FOR CA3-9C, 12C, 16C ADD 0.94in (24mm).

CA3-9, 12, 16	A in.	A mm	B in.	B mm	C in.	C mm	Reset Travel in.	Reset Travel mm
With CT3	1.93	49	1.18	30	1.38	35	0.24	6
With CT3K	1.69	43	0.98	25	0.69	17.5	0.09	2.3

Series CA3-23 & 30 (Contactors/Starters)

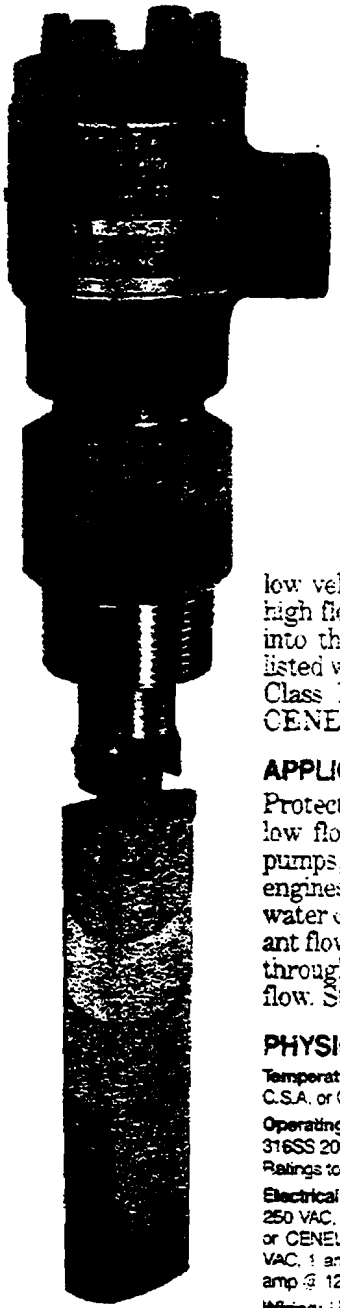






Series V4 FLOTECT® Vane Operated Flow Switch

Field adjustable – 1½ to 20 inch pipe. Leak proof body.



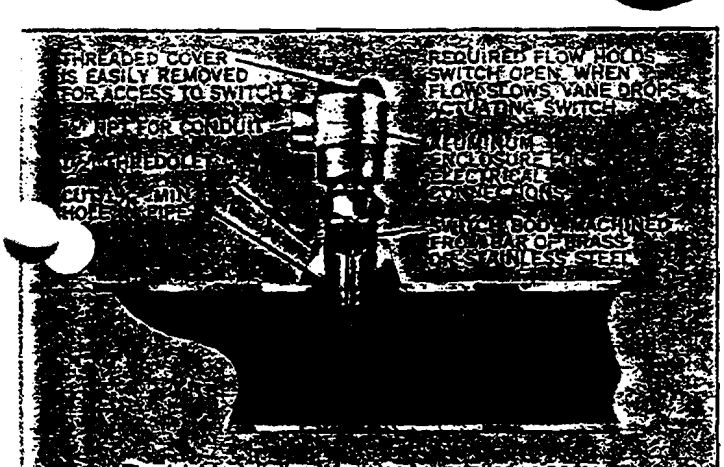
ependable protection against flow riation or stopping in pipelines for uids, gases and flowing solids.

upplied with custom or universal multi-yer vanes for field installation in pipes om 1½". Designed to meet NEMA-4 atertight construction.

Explosion-Proof; U.L. and C.S.A. Listed – Class I, Groups C, D; Class II, Groups E, F, G.
CENELEC: EExd IIB T6 (T amb = 75°C).

ompact and reliable, the Flotect V4 Flow witch operates automatically to protect quipment and pipeline systems against damge from reduction or loss of flow. Installed in housands of pipelines and processing plants round the world, this unique magnetically ctuated switching design gives superior per-rmance. Universal multi-layer vane accom-s pipe sizes from 1½" up. Custom re available with factory calibration. here are no bellows, springs, or seals to fail. nstead, the free-swinging vane attracts a nagnet within the solid metal switch body bove, actuating a snap switch by means of a imple lever arm.

eatures include: Simplicity of design and a eak-proof switch body, machined from bar tock for pressures to 2000 PSIG, (140KG/ CM²), it eliminates the possibility of process luid entering the switch compartment. The hreaded conduit enclosure cover permits asy inspection or replacement of electrical ssembly without shutting down the process, r removing electrical conduit. Power must e disconnected. The unit fits directly into ipeline with tee, thredolet or flange for easy nstallation. Pendulum-like vane action re-sponds accurately to fluid flow rate. The cus-om vane or multi-layer vane is sensitive to low velocity flows, yet it is rugged enough to withstand high flow surges. If desired, a delay timer can be wired into the installation. All units are explosion-proof and listed with U.L. and C.S.A. for Class I, Groups C and D, Class II, Groups E, F, and G or are flame-proof to CENELEC EExd IIB T6 (T amb = 75°C).



APPLICATIONS

Protects motors, pumps and other equipment against low flow and no flow. Controls sequential operation of pumps, etc. Automatically starts auxiliary pumps and engines or actuates alarm and signal systems. Stops water cooled engines, machines and processes when coolant flow is interrupted. Shuts down burner when air flow through heating coil fails. Controls dampers according to flow. Stops machines if cooling oil flow ceases.

PHYSICAL DATA

Temperature Limits: Standard 275°F (135°C) High temperature option (not U.L., C.S.A. or CENELEC), 400°F (205°C) max.

Operating Pressure: Brass 1000 PSIG (70KG/CM²)
316SS 2000 PSIG (140KG/CM²)
Ratings to 5000 PSIG (350KG/CM²) available only SPDT. Only SS body.

Electrical Rating: U.L. AND CENELEC: 10A @ 125/250 VAC C.S.A.: 5A @ 125/250 VAC, 5A resistive, 3A inductive @ 30 VDC. Optional ratings (not U.L., C.S.A. or CENELEC). **MV** option: Gold Contacts for dry circuits. Rated 1 amp @ 125 VAC, 1 amp resistive, ½ amp inductive @ 30 VDC. **MT** option: 400°F (205°C) 5 amp @ 125/250 VAC.

Wiring: U.L., C.S.A. unit: 16 gauge copper wire, 6" (152MM) long, mechanically and solder bonded to switch. CENELEC unit: Terminal board.

Switch body: One piece milled and bored Brass or 316SS. Other materials on request.

Vane: 316SS 1⅜" (40MM) wide. Std. trim includes 430SS and silver solder. Other materials on request.

Piping Connection: ½" NPT std for mounting in 1½" thredolet. For other mounting see next page. Thredolet fittings available.

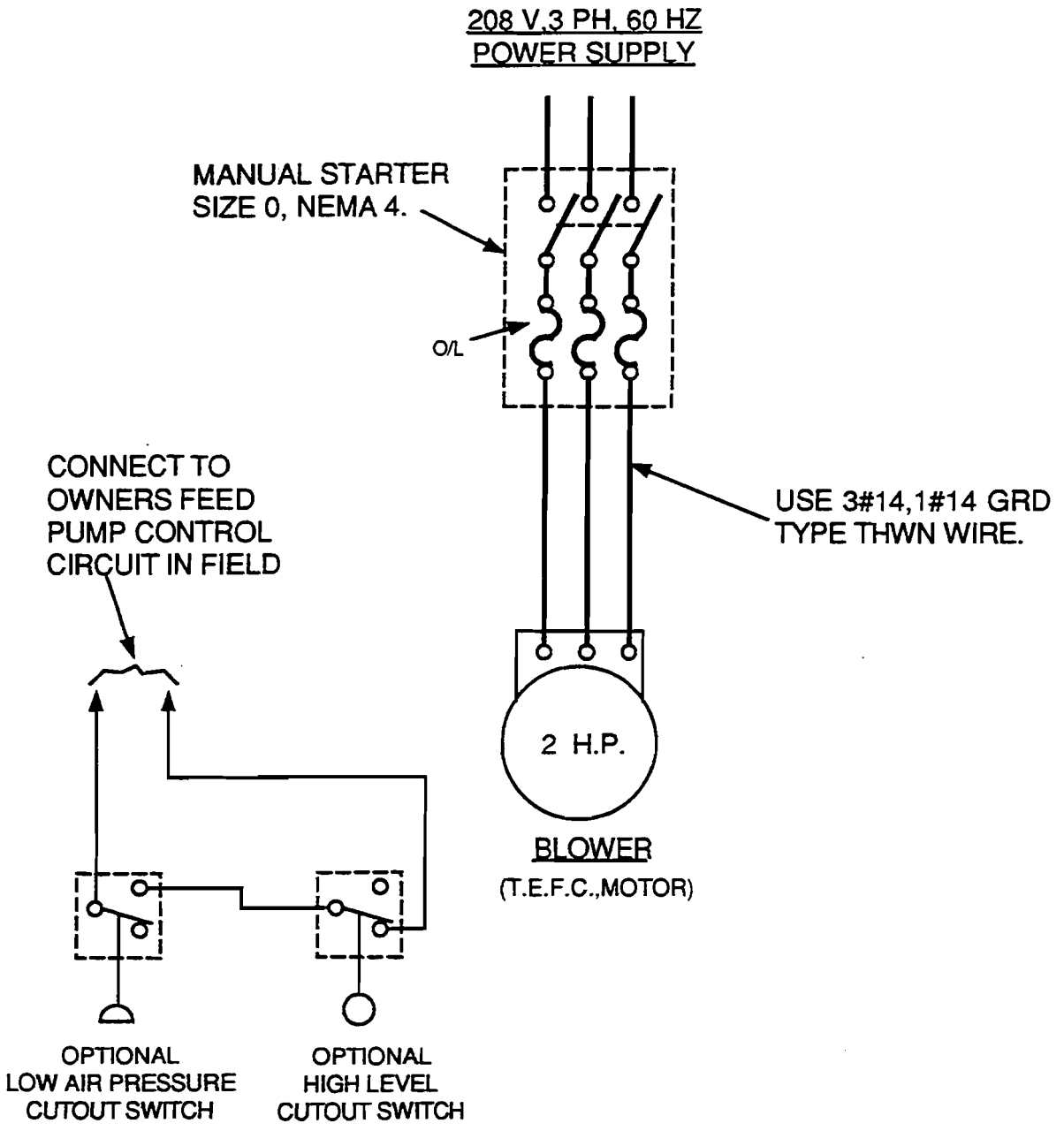
Installation: Within 5° of vertical for proper operation. Units for horizontal installation (vertical pipes) on request.

Weight: 4 lb. 5 oz. (1.96KG)

Options: All 316SS wetted parts. Teflon coated wetted parts. DPDT circuits. Cartridge heater to melt paraffin, etc. Time delay relay.

Suggested Specification:

Automatic explosion-proof flow switches shall be vane operated to actuate one or two single pole double throw snap switches. Motion of the vane shall actuate switch by action of a magnet linked to the switch inside the single-



CARBTROL®
CORPORATION

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

SCALE ---		BY DVB
DATE 6-24-97	*Wah*	REV

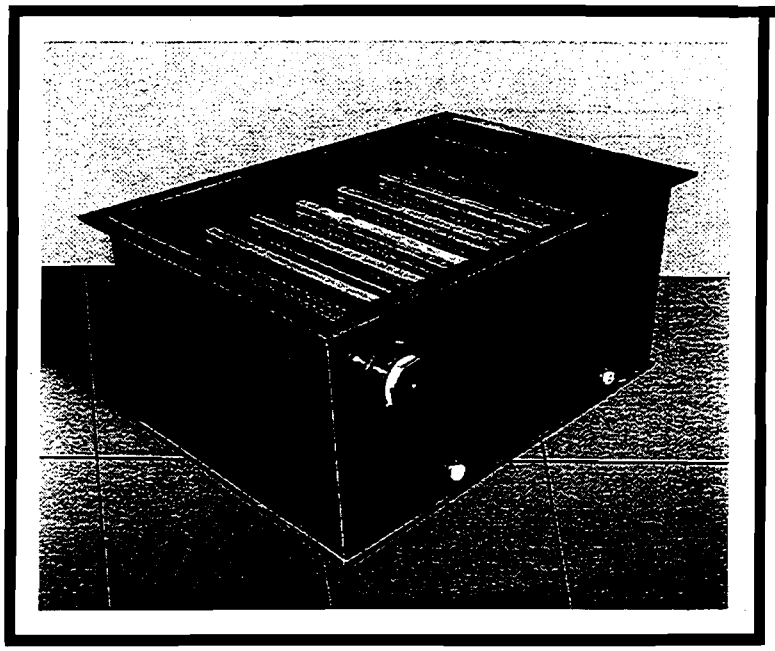
2/4 MULTI-STAGE DIFFUSER SYSTEM

(208 VOLT,3 PHASE)

WIRING DIAGRAM	**S**	DWG **3302/0**

CARBTROL®

IRON REMOVAL FILTER



APPLICATION

Iron and sediment removal prior to carbon adsorption or subsurface injection.

PRODUCT DESCRIPTION

The CARBTROL Iron Removal Filter is designed to remove suspended particulate and iron bacterial residue from contaminated groundwater.

Particulates are removed by a combination of gravity settling and filtration on a series of non-woven fabric filter plates. Each of six filter plates is covered by a special filter media which promotes coagulation of suspended iron particulates and biological growth of iron bacteria.

Groundwater is distributed to the head end of the clarifier through a submerged distribution header. It then passes successively through the vertical filter plates, and then through a skimmer box prior to discharge.

When individual filter plates become blinded, they are easily removed for fabric media replacement. Sediment buildup in the bottom of the unit is removed by wet vacuum.

SPECIFICATIONS

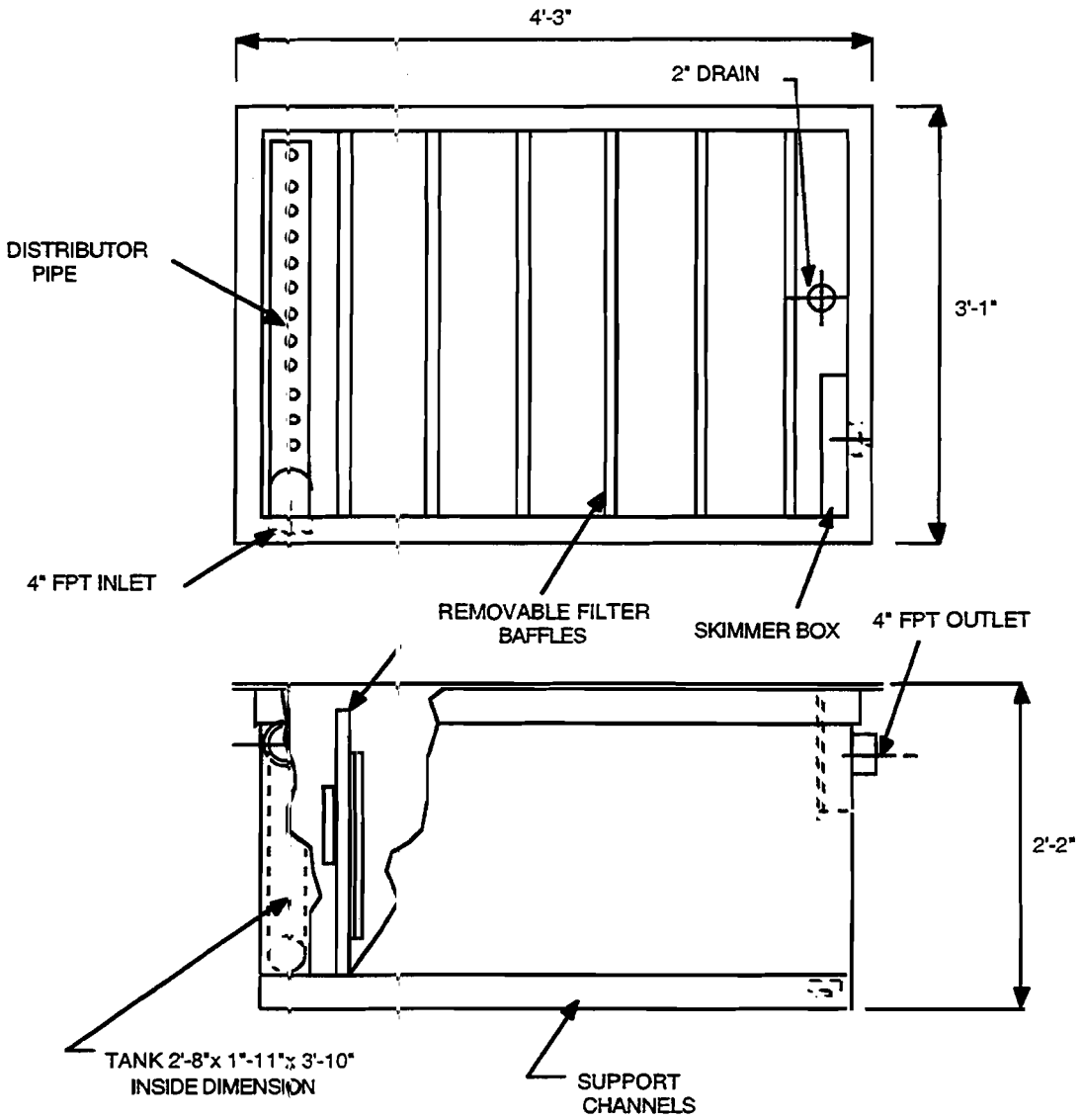
FLOW CAPACITY:	40 gpm Max.
MATERIALS:	UV protected PVC
SHIPPING WEIGHT:	150 lbs.
VOLUMETRIC CAPACITY:	96 gallons
INLET:	4" Pipe stub
OUTLET:	4" Pipe stub
DRAIN:	2" Plug
LID:	FRP
FILTER MEDIA:	Polyester filter fabric. Ten (10) changes supplied with unit.

CARBTROL® CORPORATION

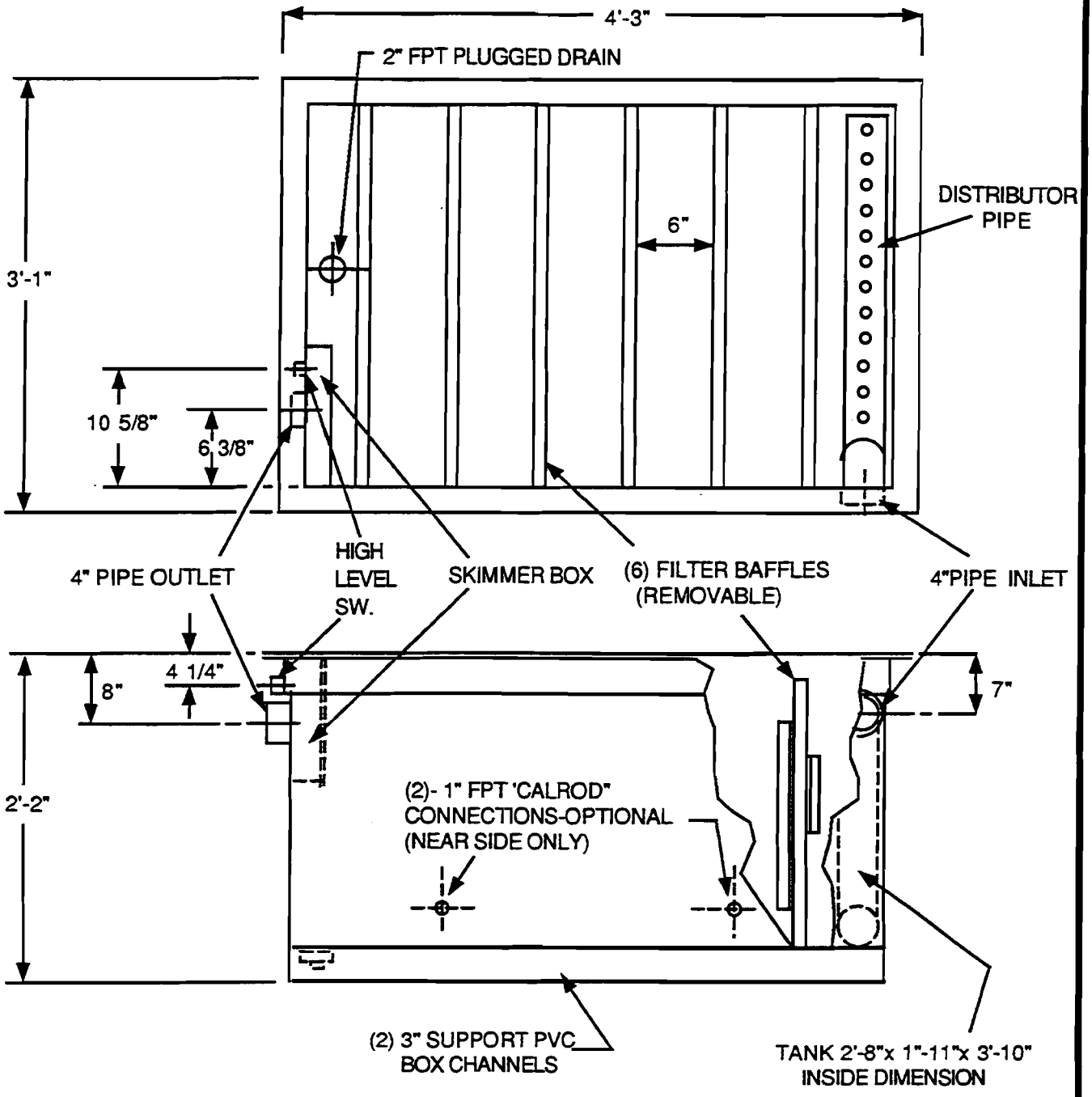
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IRON REMOVAL FILTER



NOTES - DIMENSIONS ARE APPROXIMATE.
- PVC CONSTRUCTION .



NOTES- DIMENSIONS ARE APPROXIMATE.
- PVC CONSTRUCTION THROUGHOUT,EXCEPT FOR FILTER MEDIA ALUMINUM PANELS, AND FIBERGLASS COVER WITH ALUMINUM HANDLES.

CARBTROL®
CORPORATION

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

SCALE —	PN-00800R	BY DVB
DATE 4-20-95		REV

IRON REMOVAL FILTER W/HIGH LEVEL SWITCH UP TO 40 GPM MICROMORGUE

ARRANGEMENT	S	DWG 2471/0

SPECIFICATION

IRON REMOVAL FILTER

Design Flow - maximum (GPM):		40
Design Features:		
No. of Filter Panels:		Six (6)
Construction:	Tank:	Welded PVC construction with PVC channel supports.
	Filter Panels:	Aluminum.
	Filter Media:	Non-woven polyester.
	Lid:	FRP.
Dimensions:	Tank:	4'-3" X 3'-1" X 2'-2" high.
	Filter Panels:	2'-7 3/4" X 1'-6".
Connections:	Inlet:	4" pipe stub
	Outlet:	4" pipe stub
	Drain:	2" FPT
	Auxiliary:	Two (2) 1" FPT connections for optional winterizing heaters.
Filter Media:		One (1) roll of filter media, containing enough for 10 changes.
Options:		- Winterizing Kit, with weatherproof or explosionproof electrical enclosures. - Support stand, of pressure treated lumber construction. - Lid venting connection.
Shipping Weight (lbs.):		150
Availability:		From stock
Drawing Number:		S-1520

6/12/96
*SP-800

INSTALLATION & OPERATING INSTRUCTIONS
CARBTROL® IRON REMOVAL FILTER
WITH LEVEL SWITCH

INSTALLATION

1. Select a level area close to the equipment that discharges into the Iron Removal Filter. Position the Iron Removal Filter so that the equipment discharge is aligned with the inlet of the Iron Removal Filter.

2. Connect the equipment discharge to the Iron Removal Filter inlet using 4"Ø pipe or flexible tubing.

3. Connect a minimum 4"Ø pipe to the Iron Removal Filter gravity discharge coupling and run it to a discharge sump or trench.

4. Wire the level switch normally open contact in series with the owner's raw water feed pump starter coil. If for any reason the Iron Removal Filter level reaches the float, the switch will open and the raw water feed pump starter will be de-energized, in order to prevent flooding. Field installation must be in accordance with all local ordinances and the National Electrical Code.

NOTE: The pilot duty switch supplied for non-explosionproof areas is rated for 250 VAC max. and 1.5 amps max.

The pilot duty switch supplied for explosionproof areas is rated for 5 amps at 125/250 VAC.

5. Install the drain valve (supplied loose) in the drain coupling.

6. Be sure the screens and filter media are in place and the drain valve is shut off.

7. Start the system and allow the Iron Removal Filter to fill with water until it overflows through the discharge pipe.

8. As the filter media becomes blinded and restricts the flow, the water may overflow each of the successive downstream filter screens.

MAINTENANCE

When the water in the Iron Removal Filter overflows the last filter screen, or the water in the last filter chamber is visibly dirty, the filter media should be changed using the following procedure:

1. Shut down the owner's well or feed pump.

2. Use the drain valve to drain the water from the Iron Removal Filter back to the head end of the system, or dispose of it in an environmentally safe manner.

3. Remove the filter screens.

4. Hose down the interior of the Iron Removal Filter. Drain the water to the head end of the system, or dispose of it in an environmentally safe manner. Close the drain valve.

5. Remove the clevis pins from the filter screens. Open each screen and remove the filter media. Dispose of the used filter media in an environmentally safe manner.

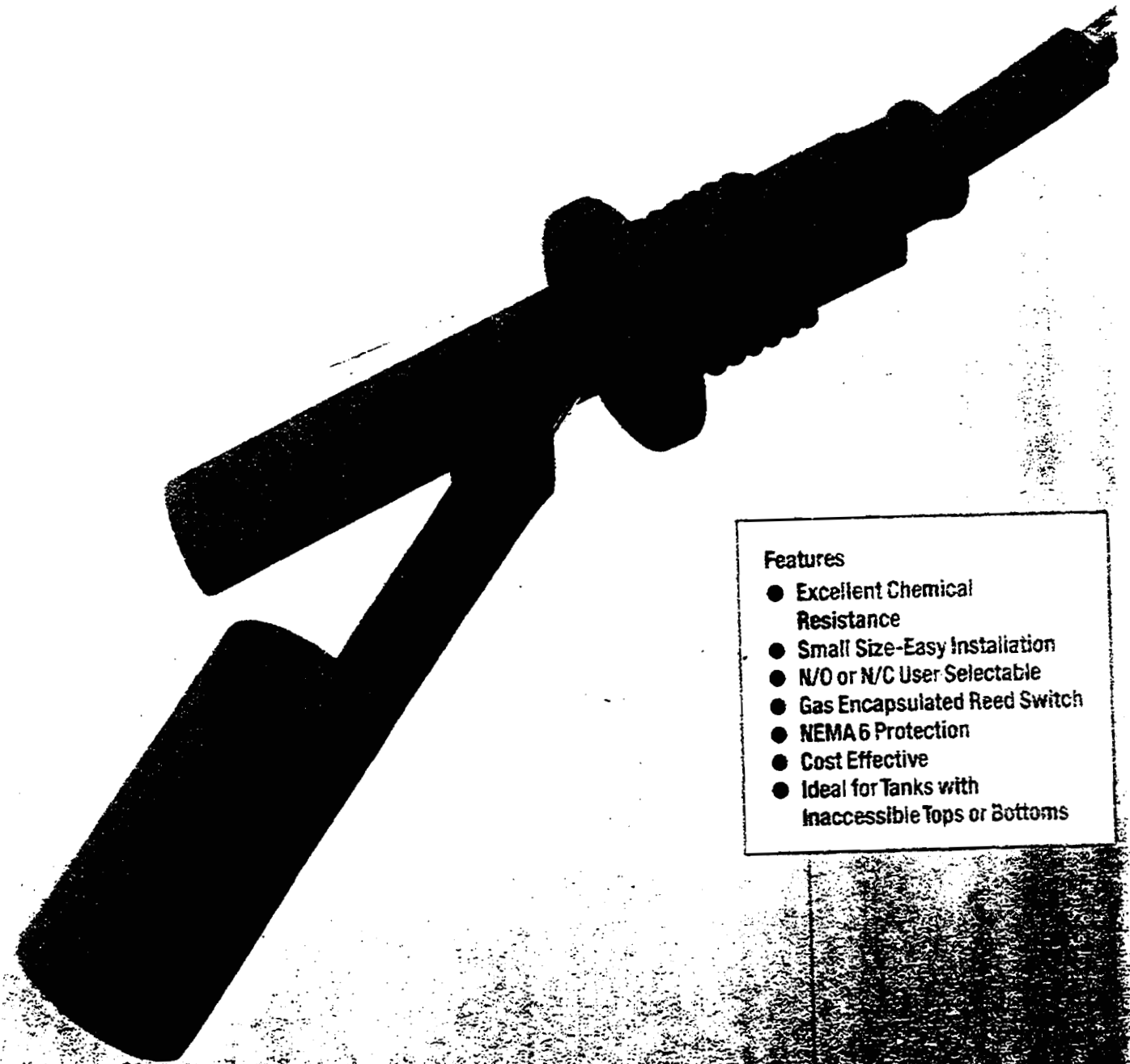
6. Replace two layers of filter media, cut to 17" X 31", into each filter screen frame. Replace the removable screen and clevis pins.

7. Replace the screens in the runners.

8. Start up the system.

LEVEL SWITCH

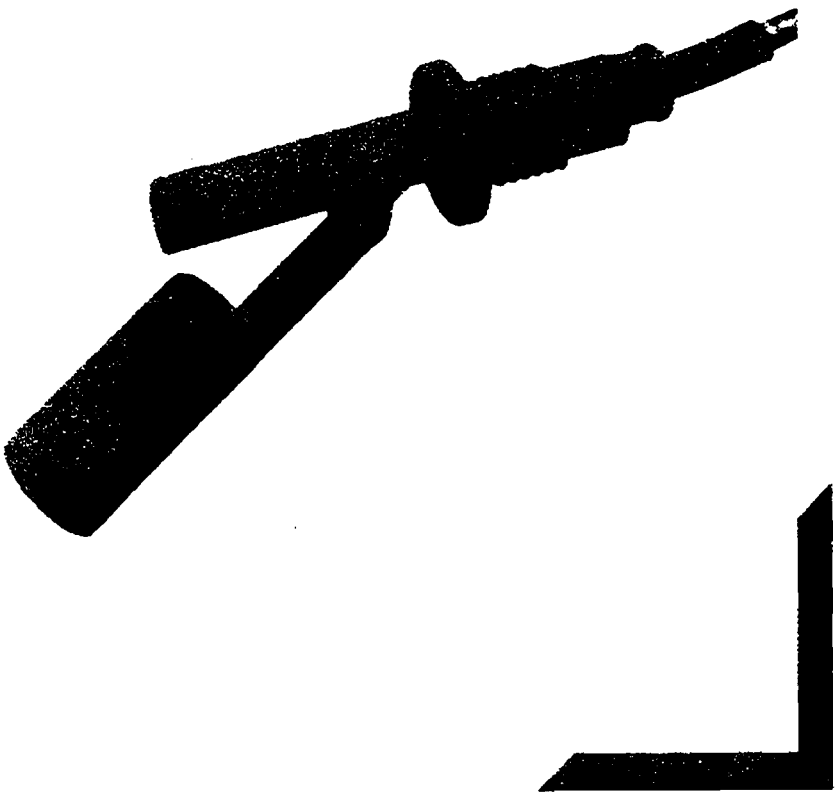
Model NKP



Features

- Excellent Chemical Resistance
- Small Size-Easy Installation
- N/O or N/C User Selectable
- Gas Encapsulated Reed Switch
- NEMA 6 Protection
- Cost Effective
- Ideal for Tanks with Inaccessible Tops or Bottoms

LEVEL SWITCH



Features

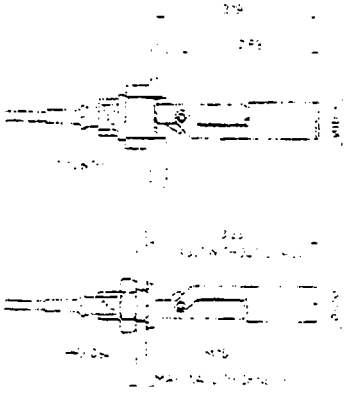
- Excellent Chemical Resistance
- Small Size-Easy Installation
- N/O or N/C User Selectable
- Gas Encapsulated Reed Switch
- NEMA 6 Protection
- Cost Effective
- Ideal for Tanks with Inaccessible Tops or Bottoms
- Virtually Maintenance-Free

Kobold's NKP is a highly cost effective level switch. The unit is available in either polypropylene or PVDF construction for maximum compatibility with aggressive fluids. The NKP is distinguished by its instant response, small footprint and high capacity reed switch.

Operation

The NKP is installed into the sidewalls of tanks. The plastic float contains a magnet which moves as the fluid level rises above or drops below the switch installation point. This movement brings the magnet into close proximity with an encapsulated reed contact, causing it to switch. The contact function may be selected as either normally open or normally closed by rotating the switch 180° about its axis. This simple design makes the NKP virtually maintenance free.

Dimensions

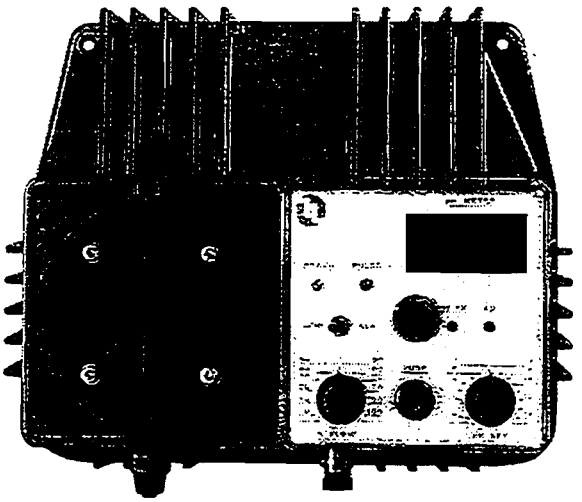


Ordering Data

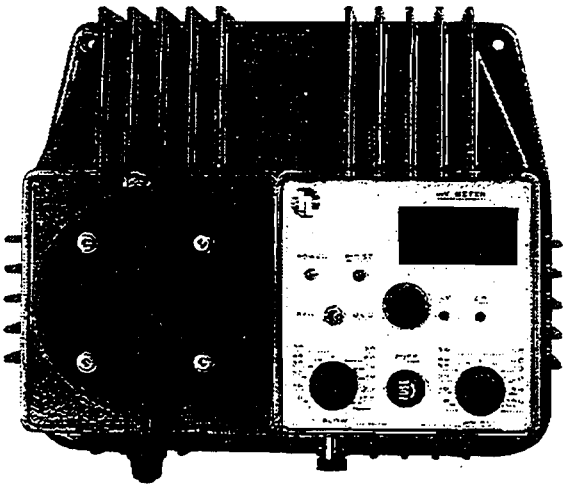
Fittings	PP	PVDF
½" NPT	NKP-2401	NKP-2501
Bulkhead	NKP-6401	NKP-6501

Specifications

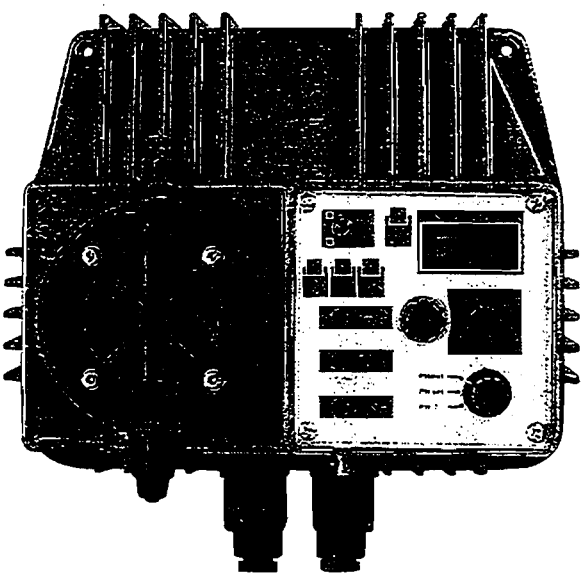
Composition:
Float: Polypropylene, PVDF
Housing: Polypropylene, PVDF
Fittings: ½" NPT or bulkhead
Orientation: Horizontal ± 30
Max. Temperature:
Polypropylene: 175° F
PVDF: 212° F
Max. Pressure: 145 PSIG
Max. Fluid Density:
Polypropylene: 0.6 g/ml
PVDF: 0.95 g/ml
Reed Switch:
Max. Voltage: 250 VAC
Max. Current: 1.5 A
Max. Power: 50 watts
Cabling: 3 ft. PVC clad, AWG 20/2



ISTRUZIONI D'USO
POMPE DOSATRICI



HD-PH
■
HD-RX
■
HD-PH/P



PUMPS
INSTRUCTIONS MANUAL

CE

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Please read the warning notices given in this section very carefully, because they provide important information regarding safety in installation, use and maintenance of the pump.

- *Keep this manual in a safe place, so that it will always be available for further consultation.*
- *After unpacking the pump, make sure it is completely sound. In case of doubt, do not use the pump and contact qualified personnel. The packing materials (especially bags made of plastics, polystyrene, etc.) should be kept out of the reach of children: they constitute potential sources of danger.*
- *Before you connect the pump, make sure that the voltage ratings, etc., correspond to your particular power supply. You will find these values on the rating plate attached to the pump.*
- *The pump should be used only for the purpose for which it has been expressly designed, namely the dosing of liquid additives. Any different use is to be considered improper and therefore dangerous. The makers cannot be held responsible for damage deriving from improper, erroneous or unreasonable use of the pump.*
- *Use of electrical equipment always implies observance of some basic rules: In particular:*

1 - do not touch the equipment with wet or damp hands or feet;
2 - do not operate the pump with bare feet (Example: swimming pool equipment);
3 - do not leave the equipment exposed to the action of the atmospheric agents;
4 - do not allow the pump to be used without supervision by children or incompetent people;

- *Before carrying out any maintenance or cleaning operation, disconnect the pump from the power supply by means of the circuit breaker.*
- *In case of breakdown or improper functioning of the pump, switch it off, but do not touch. Contact our technical assistance for any necessary repairs and insist on the use of original spares. Failure to respect this condition could render the pump unsafe for use.*
- *When you decide to make no further use of an installed pump, make sure to disconnect it from the power supply.*
- *The electrical installation to which the pump is connected must comply with the standards and good practice rule in force in the country under consideration.*
- *The pump complies with EEC directives No.89/336 regarding "electromagnetic compatibility" and No.73/23 regarding "low voltages", as also the subsequent modification No.93/68.*
- *Maximum environmental operating temperature: 40°C.*

Before carrying out any service on the item, check:

1. Disconnect the pins from the mains or by means of a onnipolar switch with 3 mm minimum distance between the contacts.
2. Relieve all the pressure from the pump head and injection tube.
3. Drain or flush all dosing liquid from the pump head. This operation can also be done with the pump disconnected from the plant by turning the pump upside-down for 15 to 30 seconds and without connecting the tubing to the nipples: if this operation is not possible, dismount and remount the pump head using the four mounting screws.

TOXIC AND/OR DANGEROUS LIQUID DOSAGE

To avoid risk from contact with the hazardous liquids or toxic fumes, always adhere to the notes in this instruction manual:

- *Follow the instructions of the dosing liquid manufacturer.*
- *Check the hydraulic part of the pump and use it only if it is in perfect condition.*
- *Use only the correct materials for the tubing, valves and seals to suit the liquid to be dosed; where possible shield the tubing with PVC conduit.*
- *Before disconnecting the metering pump read notes 1, 2 and 3 contained in this leaflet; make sure to flush out and neutralise the pump head with the proper reagent liquid.*

N.B. The pump has been constructed in accordance with best practice. Both its life and it electrical and mechanical reliability will be enhanced if it is correctly used and subjected to regular maintenance.

WARNING: Any intervention or repair in the interior of the pump must be carried out by qualified and authorized personnel. The makers decline all responsibility for the consequences of failure to respect this rule.

1.0 PRESENTATION OF THE PUMP

This type of metering pump, complete with measuring instrument, intervenes by measuring the pH or Rx value prevailing in the plant and then keeps dosing additive until the pH or Rx value set by the operator is effectively attained. More particularly, the HD-RX and HD-PH pumps utilize an ON/OFF system to stop the dosing as soon as the reading on the display coincides with the set point, while the HD-PH/P performs an intervention of the logarithmic proportional type and keeps dosing at the maximum injection rate until the measured pH value comes to lie within two units of the set point. At this stage the pump gradually reduces the injection rate and eventually comes to a complete standstill as soon as the set point is reached.
The pH and Rx measurements are potential difference measurements that can be affected by such factors as temperature, the pressure existing at the point of insertion of the measuring probe, and the efficiency of the electrical insulation of the plant.

1.1 Description

The HD/-PH/RX and HD-PH/P pumps are available in a standard version consisting of a die-cast aluminium case protected with acid-resisting epoxy paint. Upon request these pumps are can also be supplied in a teflonated case. Rearward protection is assured by means of an ABS plastic panel complete with gasket, while the control panel in anodized aluminium is protected by a transparent polycarbonate cover, again complete with gasket. The pumps incorporate a transformer to feed the electronic circuit and the 48 V electromagnet that protect the equipment against possible supply disturbances. The available pumping capacities are set out in Chapter ***2.0 "PRINCIPAL TECHNICAL DATA"*** *and, more precisely, Section 2.2 "Technical data table".*

2.0 PRINCIPAL TECHNICAL DATA

STANDARD POWER SUPPLY:
230 V ac, 50-60 Hz single phase
ALTERNATIVE POWER SUPPLY (on request):
240 V ac, 120 V ac, 24 V ac 50-60 Hz single phase (only PH/RX)
MEASURING RANGE: pH 0-14; Rx -1400 to + 1400
SET POINT (RX):
0 ÷ 1000 mV
TYPE OF ACTION:
ON/OFF (HD-PH/RX); PROPORTIONAL (HD-PH/P)
ON REQUEST:
output current 4-20 mA

COMPLETE WITH:

- *No.1 flexible PVC suction hose, transparent crystal type, length 2 m;*
- *No.1 semirigid polyethylene hose, white, length 2 m;*
- *No.1 injection valve;*
- *No.1 bottom filter;*
- *No.1 insulating screwdriver for calibration operations;*
- *No.1 set of instructions.*

The leading dimensions of the HD-RX/PH and HD-PH/P pumps are shown in Figure 1. The diagrams of Figure 2, on the other hand, show how the maximum discharge of the metering pumps varies with the pressure in the plant to be controlled. These diagrams also allow for the loss of head due to the injection valve pressure (I.V.P.). Due to particular production conditions, the discharge at maximum load of our equipment may vary by 10% (ten percent), but the repeatability remains constant in each case.

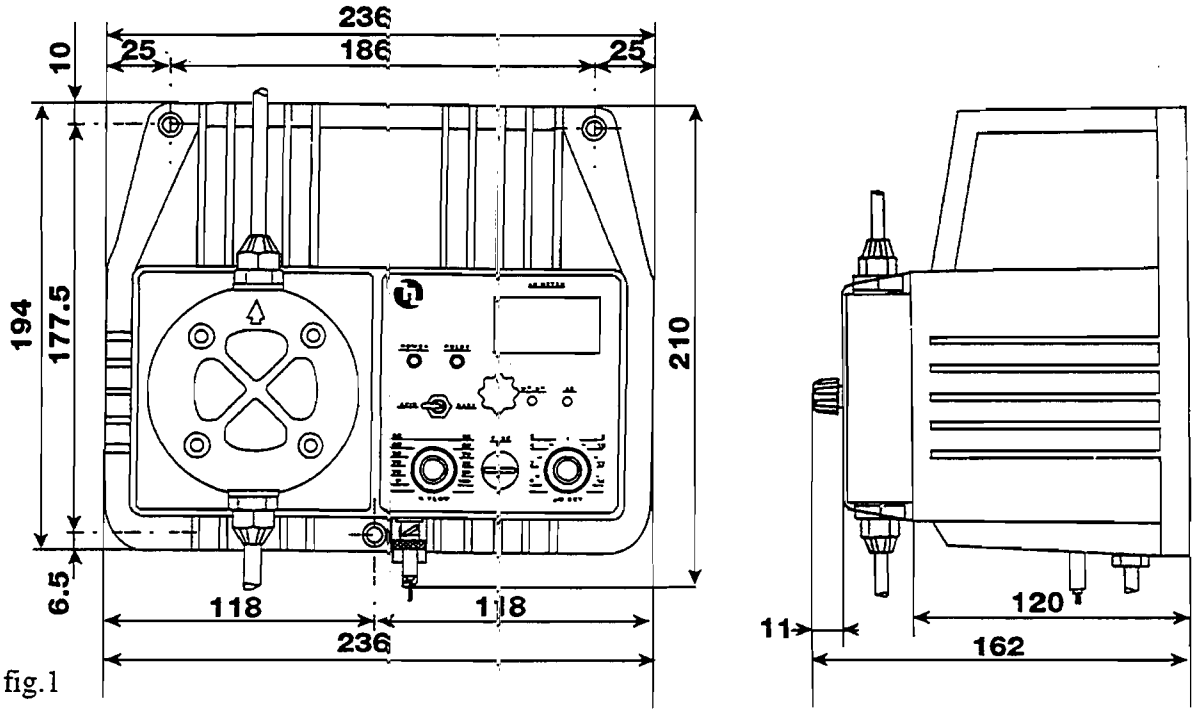


fig.1

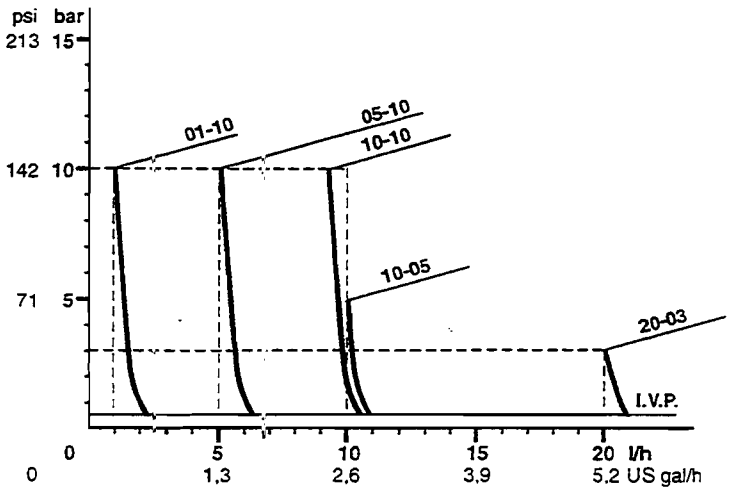


fig.2

GUARANTEE: one year (but exclusive of such normal wearing parts as valves, connectors, hoses, hose clamps, filters and injection valves). Improper use of the equipment terminates the warranty, which is to be understood ex works or authorized distributor.

2.1 Materials in contact with the additive

FILTER: polypropylene®
SUCTION Hose: crystal PVC
DELIVERY Hose: POLYETHYLENE
CONNECTORS: polypropylene®
STANDARD PUMP BODY:polypropylene®
STANDARD VALVES: viton® (duck bill type)
DIAPHRAGM: teflon®
STANDARD PUMP BODY "O" RING: viton®
INJECTION CONNECTOR: polypropylene®
STANDARD INJECTION VALVE: viton®
Pump bodies in PVC, PTFE and AIST 316, duck bill valves in silicone, dutral and nitrile and ball check valves in AISI 316 and PVC are available upon request.

2.2 Technical data chart

model	type	max flow	max press	Max Freq. imp/min	ml or cc x imp.	suction height	electrom. coil resist.	std power supply		power consum.	current consum.
		l/h	bar			m	Ohm	Volt	Hz	Watt	Amp
HD-PH	01-10	1	10	100	0.16	1.5	10.5	230	50-60	70	0.45
HD-RX	05-10	5	10	110	0.75	2	10.5	230	50-60	73	0.47
	10-05	10	05	120	1.4	2	10.5	230	50-60	80	0.50
HD-PH/P	10-10	10	10	150	1.1	2	10.5	230	50-60	95	0.57
	20-03	20	03	170	1.4	2	8	230	50-60	150	0.80

** In the case of pumps bearing the CSA mark, the models of type 10-10 and 20-03 become, respectively, 08-08 and 18-02.*

3.0 PROPER USE OF THE PUMP

The pump is intended to be used solely and exclusively for dosing (batching) clean liquid substances. The pump should not therefore be used for applications that were not allowed for in its design. In case of doubt, please contact our offices for further information about the characteristics of the pump and its proper use.

4.0 RISKS

A risk could derive from possible losses in the hydraulic system of the pump (breakage of the "O" ring gasket, the valves or the hoses). In the event of such failures the pump should immediately be brought to a stop, emptying and depressurizing the delivery hose while taking all due safety precautions (gloves, goggles, overalls, etc.). More particu-

larly, injury to people or damage to objects due to contact with noxious liquids or the inhalation of toxic vapours should be avoided by not only rigorously following the instructions given in the present booklet, but also observing the following more general norms:

- *Always operate in accordance with the recommendations of the liquid that is being used.*
- *Check that the hydraulic parts of the pump have not been damaged and are devoid of leaks; use the pump only if it is in really perfect conditions.*
- *Use hoses suitable for the liquid to be injected and the effective operating conditions of the plant, possibly inserting them in protective PVC sheaths.*
- *Before bringing the pump to a standstill, it is good practice to neutralize the hydraulic parts by flushing them with an appropriate reagent (see Chapter* ***10.0 "MAINTENANCE")****.*

5.0 SHIFTING AND TRANSPORTING THE PUMP

The pump should always be moved in a vertical (and never in a horizontal) position. No matter what the means of transport employed, delivery of the pump, even when free to the purchaser's or the addressee's domicile, is always at the purchaser's risk. Claims for any missing materials must be made within 10 (ten) days of arrival, while claims for defective materials will be entertained up to the 30th (thirtieth) day following receipt. Return of pumps or other materials to us or the authorized distributor must be agreed beforehand with the responsible personnel.

6.0 INSTALLING THE PUMP

a. Install the pump in a dry place and well away from sources of heat and, in any case, at environmental temperatures not exceeding 40°C. The minimum operating temperature depends on the liquid to be batched, bearing in mind that it must always remain in a liquid state.

b. Carefully observe the regulations in force in the various countries as regards electrical installations (figure 3). ***When the supply cable is devoid of a plug, the equipment should be connected to the supply mains by means of a single-pole circuit breaker having a minimum distance of 3 mm between the contacts. Before accessing any of the electrical parts, make sure that all the supply circuits are open.***

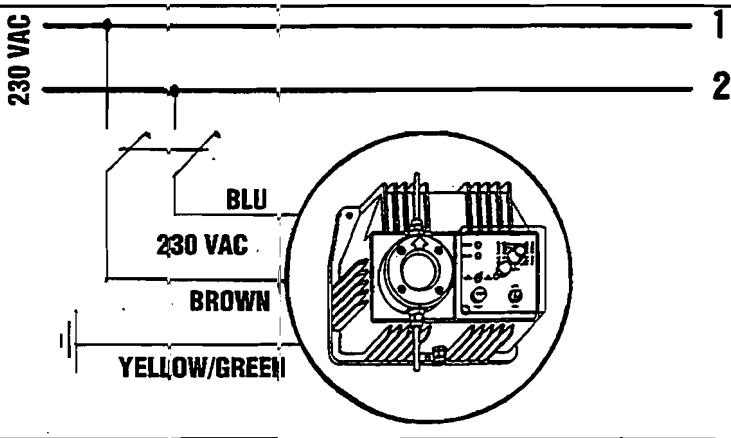


fig.3

c. Locate the pump as shown in Figure 4 bearing in mind that it may be installed either below or above the level of the liquid to be dosed, though the level difference should not exceed 2 metres. When the plant in which the pump is installed is operating at atmospheric pressure (additive freely discharged) and the additive tank is situated above the plant fig. 4a), the condition of the injection valve should be checked at regular intervals, because excessive wear and tear could cause additive to drip into the plant even when the pump is shut down. In the case of liquids that give rise to aggressive vapours, do not install the pump above the storage tank unless the latter is hermetically sealed.

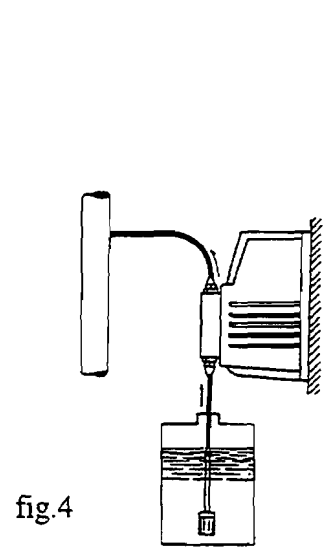


fig.4

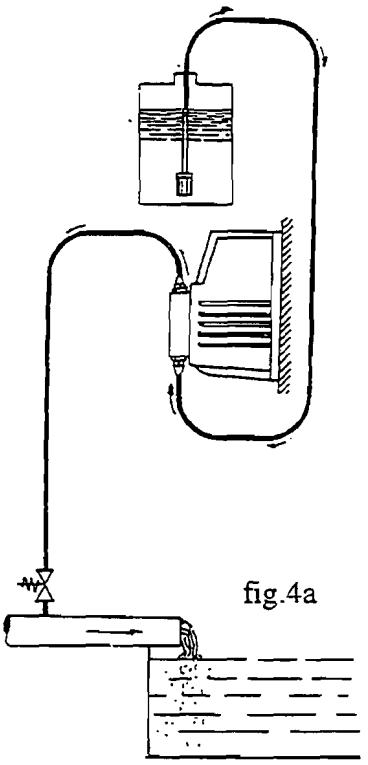


fig.4a

d. Install the pump in position that does not deviate from the vertical by more than 45° (Figure 5), fixing it either to a wall or some other vertical support with the help of screws passing through the 4.5 mm dia. holes provided along the outer rim of the pump body.

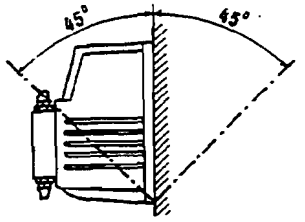
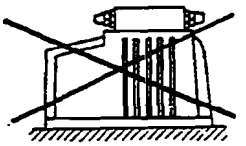


fig.5



e. The delivery connector, starting point of the hose that discharges the additive into the plant, will always remain in the upper part of the pump. The suction connector, which serves to attach the hose (with filter) leading into the liquid storage tank, will therefore always be situated in the lower part of the pump.

f. Remove the protection caps from the two connectors, slide the hoses over the connectors, pushing them right home, and then fix them with appropriate clips (Figure 6). Whenever the pump is dismantled from the plant, you will be well advised to replace

the caps on the connectors to avoid residual liquid being spilled. Before attaching the delivery hose to the plant, prime the metering pump by going through the sequence shown in Figure 7. Before finalizing the installation of the delivery hose, make sure that the pump strokes will not cause it to move and bump into rigid bodies. In case of priming difficulties, use a normal syringe to suck liquid from the delivery connector while the pump is in operation, continuing until you actually see the liquid rise in the syringe. Use a short length of suction hose to connect the syringe to the delivery connector. In case of a pump not equipped with an Etatron run-off valve, follow the specific instructions.

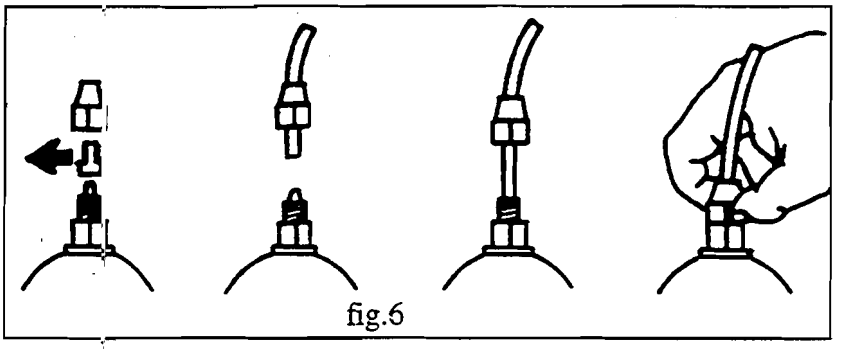


fig.6

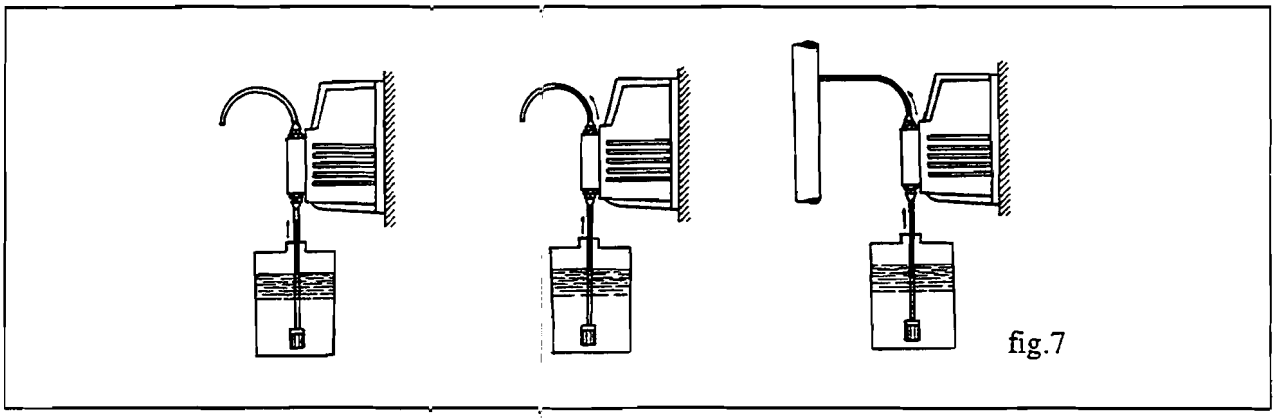


fig.7

g. Try to keep both the suction and the delivery hose as straight as possible, avoiding all unnecessary bends.

h. Select the most appropriate injection point on a pipe of the plant to be treated and there fit a 3/8" female steel gas connector. This connector is not comprised in the supply. Screw the injection valve to the gas connector, inserting a gasket as shown in Figure 8. Then connect the delivery hose to the conical connector on the injection valve and fix it with the supplied clamp G. The injection valve als acts as a non-return valve.

N.B. The gasket ring D must not be removed.

INJECTION VALVE INSTALLATION DIAGRAM FIGURE 8

A - Plant into which the injection is to be made
C - Injection valve
M - Conical connector for attaching the delivery hose
N - 3/8" female steel gas connector
G - Hose attachment clamp
T - Polyethylene hose
D - Gasket ring

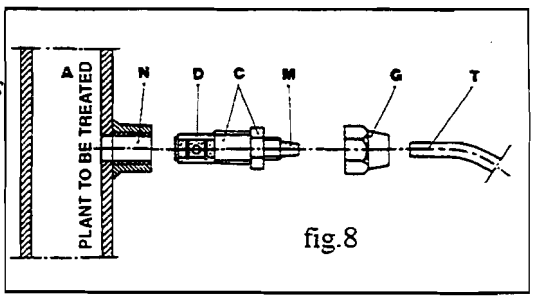
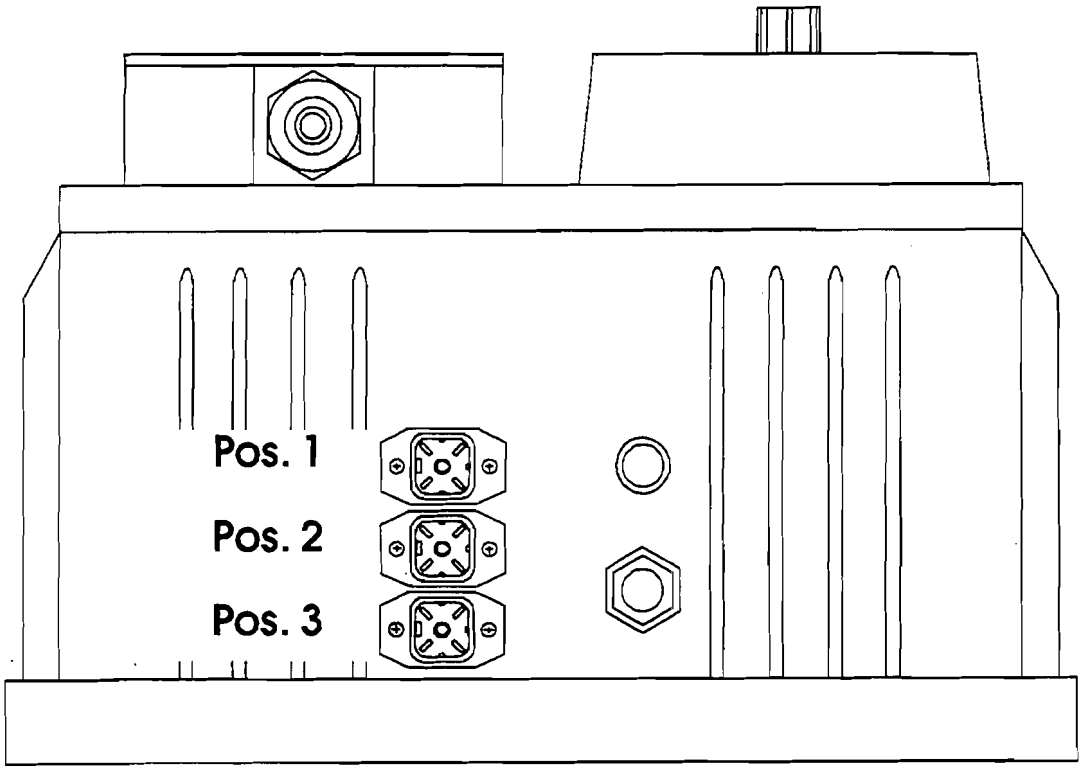
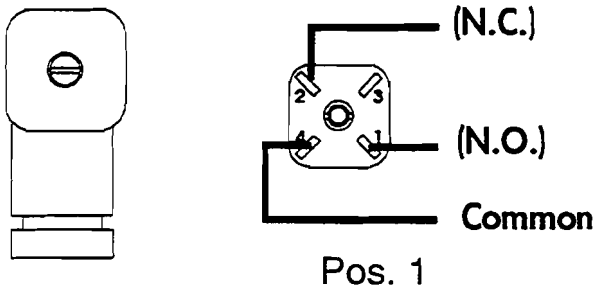
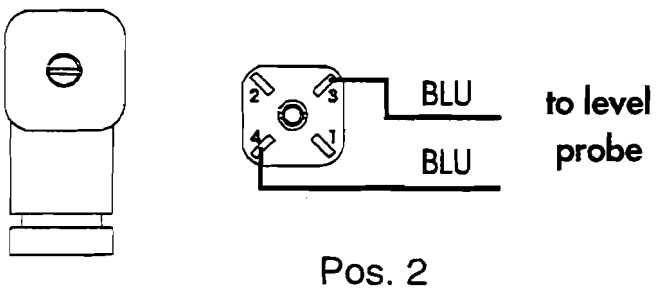
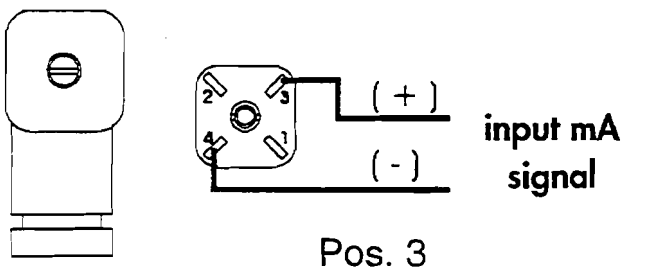


fig.8



Female service connector wire assembly	Functions and technicals information
	**Relay service output** connection Configuration : Pin **1** = Normally open " **2** = Normally closed " **3** = No connection " **4** = Common
	**Level probe** connection Configuration : Pin **1** = No connection " **2** = No connection " **3** = Level probe wire " **4** = Level probe wire
	**Output mA signal** connection Configuration : Pin **1** = No connection " **2** = No connetion " **3** = (+) mA signal wire " **4** = (-) mA signal wire

7.0 ASSEMBLING AND DISMANTLING THE PUMP

7.1 Assembly

All our metering pumps are normally supplied in fully assembled trim. For greater clarity, please consult the exploded view of the pump appended at the end of the manual, which shows all the pump details and the nomenclature used therefor, thus providing a complete overview of all the pump components. These drawings are in any case quite indispensable whenever defective parts have to be re-ordered. For the same purpose, the appendix also contains other drawings showing the hydraulic parts (pump head and valves).

7.2 Dismantlement

Proceed as follows before you dismantle the pump or perform any other operation on it:

a. Make sure that the pump has been completely disconnected from the power supply (both polarities).

b. Paying careful attention, release any pressure that may have been maintained in either the delivery hose or the pump body.

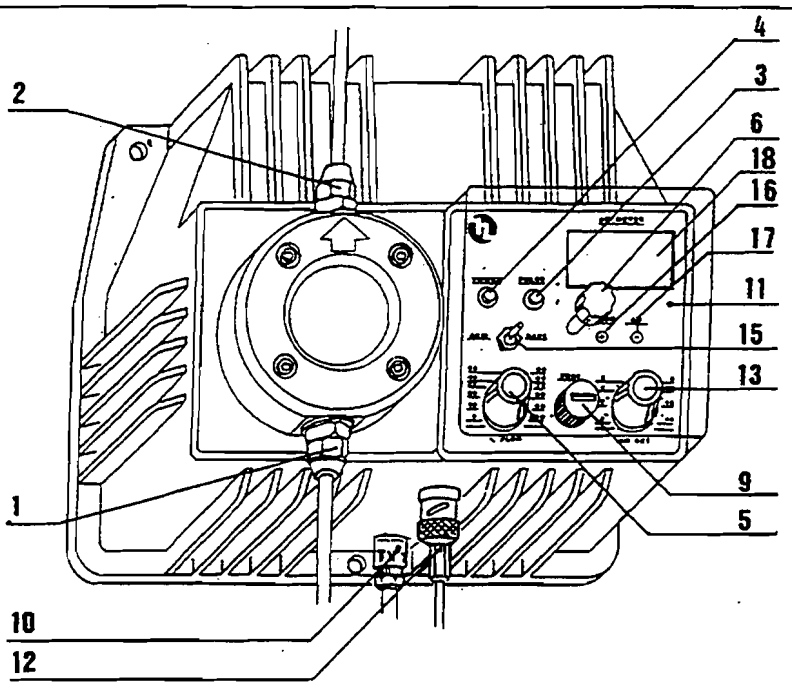
*c. Remove all the liquid still contained in the pump by keeping the pump stroking for 15-30 seconds while in an upside down position (if it has been removed from the plant). If this is not possible, remove and then refit the pump body with the help of the four fixing screws. This operation calls for special attention, and you should therefore consult the drawings in Appendix and Chapter **4.0 "RISKS"** before you commence the work.*

8.0 COMMISSIONING THE PUMP

8.1 HD-PH

1 Suction hose connector nipple
2 Delivery hose connector nipple
3 Stroke Led (red)
4 Power Led (green)
5 Injection frequency regulation knob
6 Front cover fixing screw
9 Fuse
10 Supply cable
11 Control panel
12 Electrode cable connector
13 Set-point selector "pH set"
15 Acid/Alk switch
16 Calibration trimmer "pH/mV"
17 Calibration trimmer "Δ0 "
18 Display

fig.9



a. Install the metering pump as described in Chapter ***6.0 "PUMP INSTALLATION".***

b. Place the electrode in the electrode holder.

c. Connect the electrode to the metering pump by means of the male BNC connector (12), rotating it through 90°C.

d. Position the "pH set" knob (13) to the desired pH value, bearing in mind that the scale dimensions are such as to give rise to a possible discordance between the intervention point and the reading on the display (18). For example, if the "pH set" knob is set to pH 7 and one then notes that pump has not yet come into operation at pH 7.2, it would be desirable to carry out a check and, if necessary, correct the set point by adjusting the "pH set" knob.

e. Use the "ACID/ALK" switch (15) to select the required type of intervention (acid or alkaline). Example: If the intervention point is set at pH 9 and an acidification is required, set the switch to ACID. The pump will then start dosing the additive every time the pH rises above 9. If it is desired to alkalinize the system, set the switch to ALK, in which case the pump will come into operation every time the pH drops below 9.

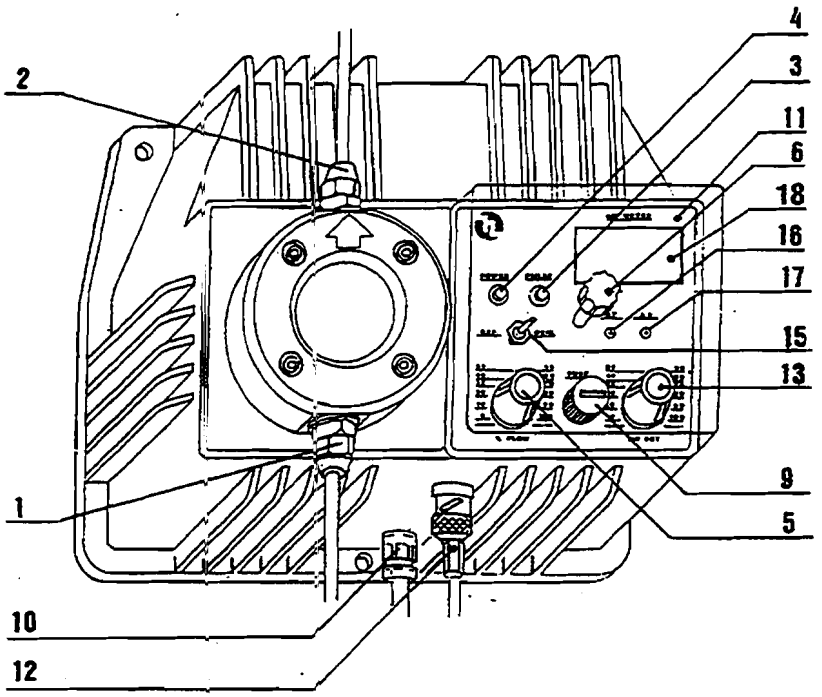
f. Use the FLOW knob (5) to set the number of injections per minute, reducing or increasing the pump discharge according to requirements. In this connection it must not be forgotten that adequate time must be allowed for the additive to become uniformly distributed, otherwise the value read on the display will differ from the real system state.

All our pumps are tested at their maximum working pressure; consequently, if the plant is operating at a lower pressure, the maximum discharge of the pump will be greater than the specified value.

8.2 HD-RX (Commissioning the pump)

1 ***Suction hose connector nipple***
2 ***Delivery hose connector nipple***
3 ***Stroke Led, red***
4 ***Power Led, green***
5 ***Injection frequency regulation knob***
6 ***Front cover fixing screw***
9 ***Fuse***
10 ***Supply cable***
11 ***Control panel***
12 ***Electrode cable connector***
13 ***Set-point selector "mV set"***
15 ***Red/oxid switch***
16 ***Calibration trimmer "/mV"***
17 ***Calibration trimmer "Δ0"***
18 ***Display***

fig.10



a. Install the metering pump as described in Chapter 6.0 "PUMP INSTALLATION".
b. Place the electrode in the electrode holder.
c. Connect the electrode to the metering pump by means of the male BNC connector (12), rotating it through 90°C.
d. Position the "mV set" knob (13) to the desired Rx value, bearing in mind that the scale dimensions are such as to give rise to possible slight discordances between the intervention point and the reading on the display (18). For example, if the "mV set" knob is set to 700 mV and one then notes that pump has not yet come into operation 720 mV, it would be desirable to carry out a check and, if necessary, correct the set point by adjusting the "mV set" knob.
e. Use the "RED/OXID" switch (15) to select the required type of intervention (reduction or oxidation). In this case the following must be taken into account, an oxidant product increase the value and a reductant product decreas the value. Example: If the intervention point is set at 700 mV and an oxidation is required, set the switch to

OXID. The pump will then start dosing the additive every time the solution potential drops below 700 mV. If it is desired to perform a reducing action, set the switch to RED, in which case the pump will come into operation every time the solution potential rises above 700 mV. Bear in mind that Redox measurements are affected by pH variations; if this factor is subject to considerable oscillations, we would advise you either to supplement the HD-RX pump with an HD-PH pump or to use an Etatron pH instrument together with the pump.

f. Use the FLOW knob (5) to set the number of injections per minute, reducing or increasing the pump discharge according to requirements. In this connection it must not be forgotten that adequate time must be allowed for the additive to become uniformly distributed, otherwise the value read on the display will differ from the real system state.

All our pumps are tested at their maximum working pressure; consequently, if the plant is operating at a lower pressure, the maximum discharge of the pump will be greater than the specified value.

8.3 HD-PH/P (Commissioning the pump)

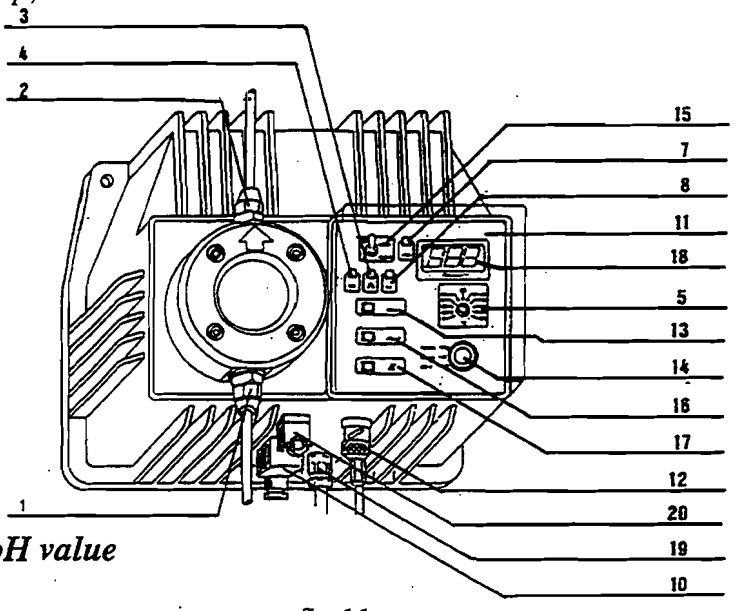


fig.11

1 Suction hose connector nipple
2 Delivery hose connector nipple
3 Stroke Led,red
4 Power Led, green
5 Temperature compensation knob
7 Warning signaling Led, red
8 Level signaling Led, yellow
10 Level probe connector
11 Control panel
12 Electrode cable connector
13 Set-point selector "pH set"
14 Functions selector
"pH mis" display the measured pH value
"pH set" display set-point value
"pH 7" simulate a pH reading of 7.0
15 Acid/Alk switch
16 Calibration trimmer "pH/mV"
17 Calibration trimmer "Δ0"
18 Display
19 Supply cable
20 Auxiliary output connector

*a. Install the metering pump as described in Chapter **6.0 "PUMP INSTALLATION"**.*
b. Place the electrode in the electrode holder.
c. Connect the electrode to the metering pump by means of the male BNC connector (12), rotating it through 90°C.
d. Position the "FUNCTION SELECTOR" (14) at pH set and then use the screwdriver

supplied as part of the kit to adjust the "pH set" trimmer to the desired pH value.

e. *Use the "ACID/ALK" switch (15) to select the required type of intervention (acid or alkaline). Example: If the intervention point is set at pH 9 and an acidification is required, set the switch to ACID. The pump will then start dosing the additive every time the pH rises above 9. If it is desired to alkalinize the system, set the switch to ALK, in which case the pump will come into operation every time the pH drops below 9.*

f. *Since the temperature of the liquid exerts an influence on the measured pH value, set the " temperature compensation trimmer" (5) to the temperature existing in the system to obtain an automatic correction of the pH value ascertained by the probe.*

g. *The function "ALL" (7) is an alarm that comes into operation whenever the measured pH value differs by more than two units from the set value. The alarm is accompanied by the lighting up of the red LED and the closure of an NO/NC (Normally Open / Normally Closed) contact on the output side, which can be used to control external equipment. In this situation the pump will operate at the maximum rate.*

This metering pump is predisposed for LEVEL CONTROL. To this end it is sufficient to connect the level probe (not included in the supply) to the pump by means of the connector 10. Level control is an option that will bring the metering pump to a halt whenever the level of the additive in the storage tank attains a minimum set by the operator.

Plant example

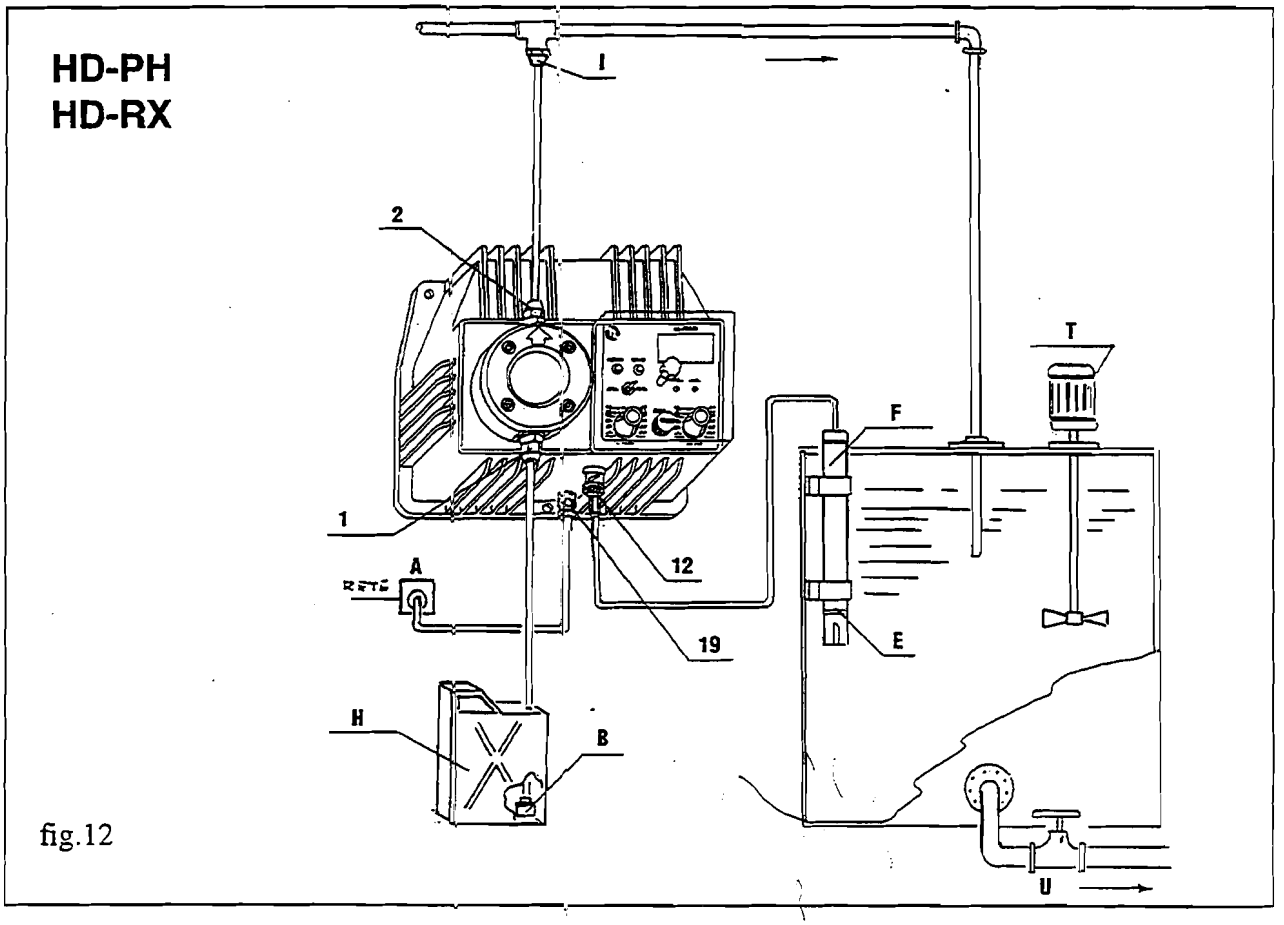


fig.12

Plant example

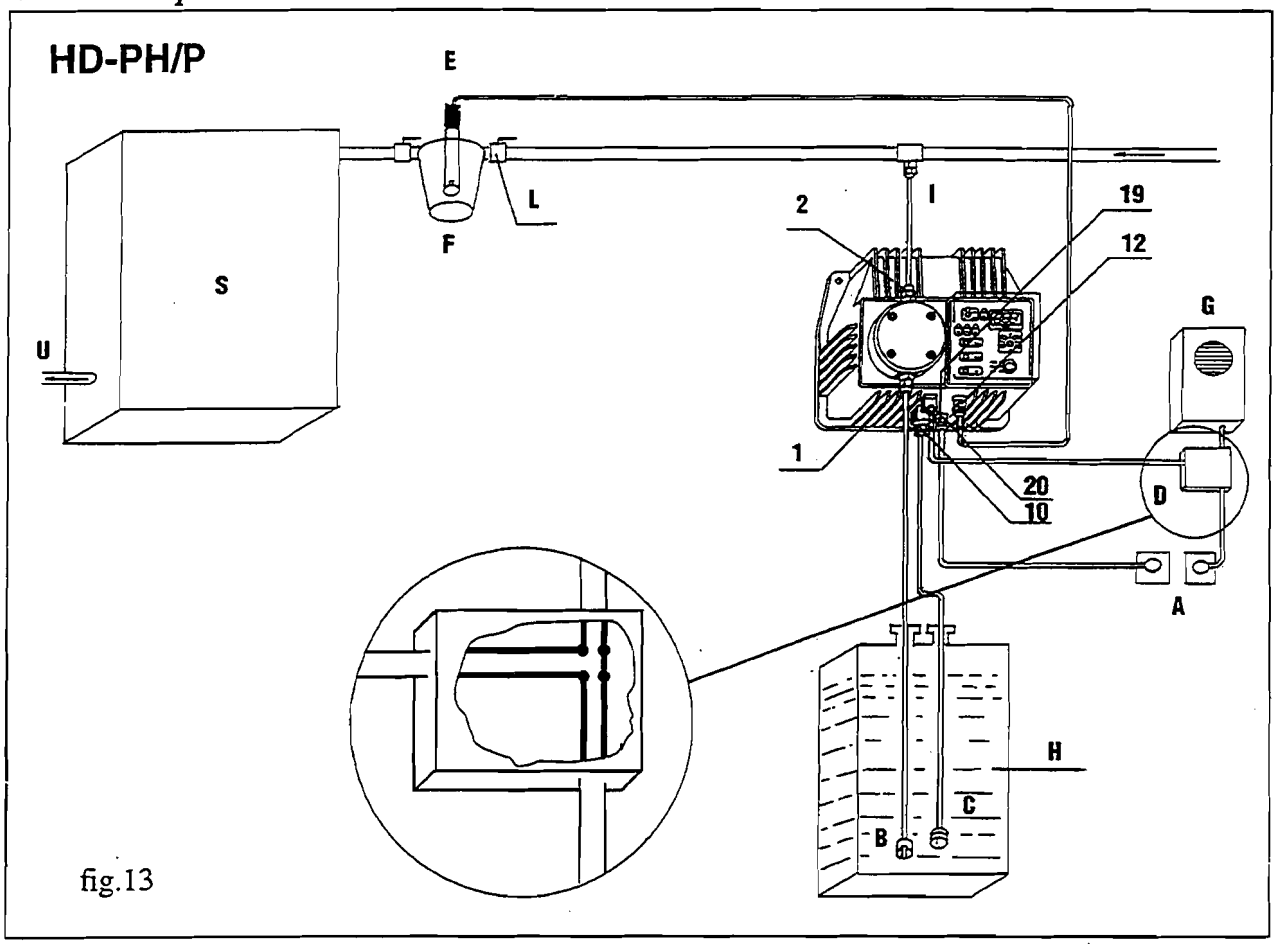


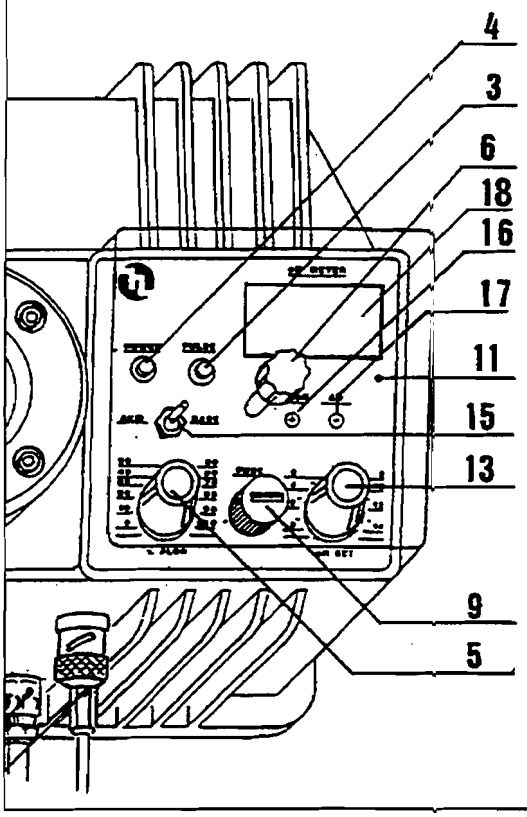
fig.13

1	***Suction hose connection nipple***	*E*	***Electrode***
2	***Delivery hose connection nipple***	*F*	***Electrode holder***
10	***Level probe connector***	*G*	***Warning alarm (optical/sounding)***
12	***Electrode cable connector***	*H*	***Suction tank***
19	***Supply cable***	*I*	***Injection pipe fitting***
20	***Auxiliary output connector (see 8.3 par. g)***	*L*	***Shutoff valve***
A	***Power point***	*S*	***Plant tank***
B	***Filter***	*T*	***Mixer***
C	***Level probe***	*U*	***Drainage***
D	***Auxiliary output electric wiring box***		

8.4 Electrode holders

Etatron produce three different types of electrode holders: monotubular for immersion, electrode cell, and for direct insertion in piping. It is essential to bear in mind that the distance between the injection point and the electrode must never be less than one metre. When this is not possible, an appropriate mixer must be inserted between the injection point and the electrode.

9.1 HD-PH (Calibration)



3 *Stroke Led, red*
4 *Power Led, green*
5 *Injection frequency regulation knob*
6 *Front cover fixing screw*
9 *Fuse*
11 *Control panel*
13 *Set- point selector "pH set"*
15 *Acid/Alk switch*
16 *Calibration trimmer "pH/mV"*
17 *Calibration trimmer "Δ 0"*
18 *Display*

fig.14

All the pH pumps are calibrated at the works, so that only small regulating adjustments are required on the occasion of installation. These are due for the most part to the type of electrode used and the working temperature prevailing in the plant, since especially the latter exerts a considerable influence on the pH value. We would in any case advise that the calibration curve be checked at least once a month, going through the routine described below.

When checking the curve, use two buffer solutions at pH 4 and pH 7 if you wish to work in the acid range or, alternately, pH 9 and ph 7 if you wish to work in the alkaline range.

Before commencing the calibration, please bear in mind that rotation of the potentiometer marked "Δ0" (17) will displace the intersection point of the curve on the Cartesian axes in the vertical direction (up or down), while rotation of the potentiometer marked "mV/pH" (16) will change its slope. The operator may therefore encounter three different situations when the electrode is inserted in the buffer solutions of known pH.

Let us now consider the solutions at pH 7 and pH 9.

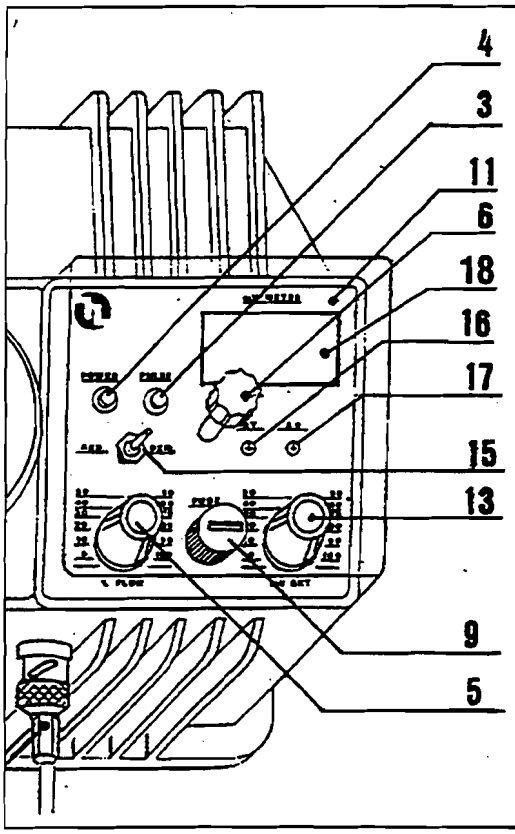
a. When both the readings of the calibration solutions provided by the HD-PH pump differ from the standard value by the same amount (Example: 7.2 and 9.2, or 6.8 and 8.8), it will be sufficient to rotate the potentiometer knob "Δ0" to correct the reading.

b. When the readings diverge from the standard value by the same amount but in opposite directions (Example: 7.2 and 8.8, or 6.8 and 9.2), it will be sufficient to rotate the potentiometer knob "mV/PH" to correct the reading.

c. When the readings differ from the standard value by different amounts, irrespective of

whether the divergence is in the same direction (Example: 7.3 and 9.1, or 6.8 and 8.6) or in opposite directions (Example: 7.3 and 8.1, or 6.7 and 9.1), the two potentiometer knobs have to be rotated in turn and the measurements will have to be repeated several times, thoroughly rinsing the electrode with distilled water on each occasion, until the exact readings are obtained.

9.2 HD-RX (Calibration)



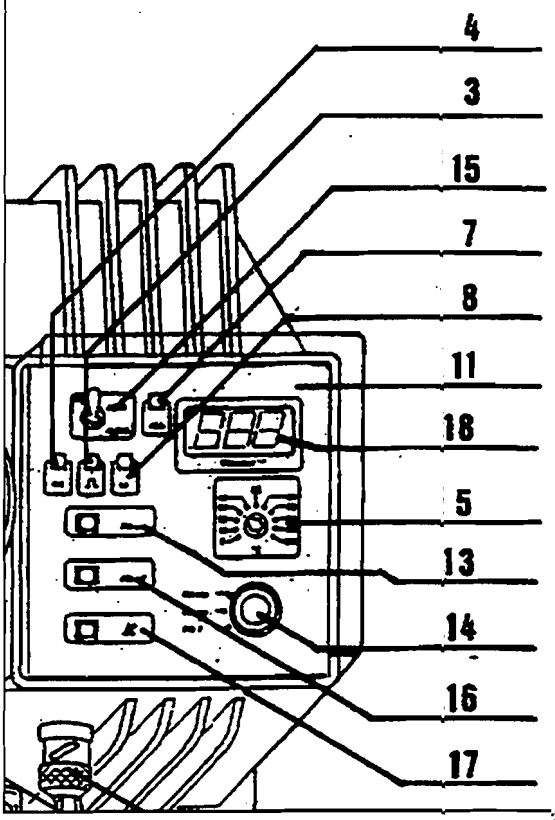
3	***Stroke Led, red***
4	***Power Led, green***
5	***Injection frequency regulation knob***
6	***Front cover fixing screw***
9	***Fuse***
11	***Control panel***
13	***Set-point selector "mV set"***
15	***Red/Oxid switch***
16	***Clibration trimmer "mV"***
17	***Calibration trimmer D0 "***
18	***Display***

fig.15

Disconnect the electrode from the pump and short-circuit the female BNC connector of the pump by the use of copper wire, then use the plastic screwdriver supplied as part of the kit to turn the potentiometer marked "Δ0" (17) until the display reading become 00; if a minus sign appears in front of the zeroes, continue rotating the potentiometer until it disappears. Then connect the electrode and immerse it in a buffer solution of well defined mV value, agitate the solution and after a few seconds rotate the potentiometer "mV" (16) until the correct mV value of the buffer solution is read on the display, bearing in mind that the first digit of the three-figure display is reserved for the sign (positive or negative); when a 300 mV buffer solution is used, for example, you will therefore read 30 on the display.

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9.3 HD-PH/P (Calibration)



3 *Stroke Led , red*
4 *Power Led green*
5 *Temperature compensation knob*
7 *Warning signaling Led, red*
8 *Level signaling Led, yellow*
11 *Control panel*
13 *Set-point selector "pH set"*
14 *Functions selector*
"pH mis" display the measured pH value
"pH set" display set-point value
"pH 7" simulate a pH reading of 7.0
15 *Acid/Alk switch*
16 *Calibration trimmer "pH/mV"*
17 *Calibration trimmer "Δ0 "*
18 *Display*

fig.16

All the HD-PH/P pumps are calibrated at the works at a temperature of 20°C, so that only small regulating adjustments are required on the occasion of installation. These are due for the most part to the type of electrode used and the working temperature prevailing in the plant, since especially the latter exerts a considerable influence on the pH value. The temperature error can readily be compensated by operating on the "temperature compensation trimmer" (5).

The regulators that render calibration possible are located on the front panel. These operations become necessary at regular intervals because the electrodes not only tend to change their physico-chemical composition in the course of time, but will also modify their measuring efficacy.

When checking the curve, use two buffer solutions at pH 4 and pH 7 if you wish to work in the acid range or, alternately, pH 9 and ph 7 if you wish to work in the alkaline range.

We would therefore advise that the calibration curve be checked at least once a month, going through the routine described below.

When checking the curve, use two buffer solutions at pH 4 and pH 7 if you wish to work in the acid range or, alternately, pH 9 and ph 7 if you wish to work in the alkaline range.

Before commencing the calibration, please bear in mind that rotation of the potentiometer marked "Δ0" (17) will displace the intersection point of the curve on the Cartesian axes in the vertical direction (up or down), while rotation of the potentiometer marked "mV/pH" (16) will change its slope. The operator may therefore encounter three different situations when the electrode is inserted in the buffer solutions of known pH.

Let us now consider the solutions at pH 7 and pH 9.

a. When both the readings of the calibration solutions provided by the HD-PH pump differ from the standard value by the same amount (Example: 7.2 and 9.2, or 6.8 and 8.8), it will be sufficient to rotate the potentiometer knob "Δ0" to correct the reading.

b. When the readings diverge from the standard value by the same amount but in opposite directions (Example: 7.2 and 8.8, or 6.8 and 9.2), it will be sufficient to rotate the potentiometer knob "mV/PH" to correct the reading.

c. When the readings differ from the standard value by different amounts, irrespective of whether the divergence is in the same direction (Example: 7.3 and 9.1, or 6.8 and 8.6) or in opposite directions (Example: 7.3 and 8.1, or 6.7 and 9.1), the two potentiometer knobs have to be rotated in turn and the measurements will have to be repeated several times, thoroughly rinsing the electrode with distilled water on each occasion, until the exact readings are obtained.

Electrode test

On completion of the calibration, set the "FUNCTION" selector to "pH 7", which represents the electronic zero of the instrument, and then check the reading on the display. If the shown value is 7, this means that the electrode is still perfectly efficient. Electrodes have a specified zero tolerance of +/-20mV, which corresponds to about 0.4 pH units. Even a certain deviation, for example 7.0 +/- 0.3, would therefore still lie within the acceptable tolerance range.

9.4 Electrode cleaning and maintenance

When the electrode is not used for a lengthy period of time, it is important to preserve it immersed in a 3 M potassium chloride (KCl) solution. The formation of deposits on the electrode will produce erroneous readings. The necessary cleaning action depends on the type of deposit under consideration. In the case of thin deposits, shake the electrode in the manner of a thermometer or use a spray of distilled water. Organic residues or particularly resistant deposits should be removed by chemical means. Mechanical cleaning of the bulb should be resorted to only in extreme cases, but bear in mind that abrasion can lead to irreparable damage. If cleaning does not fully re-establish the efficacy of the electrode, it may be that the electrode has aged. Ageing will show itself in the for of either a measurement error or a slow response. Ageing can be ascertained by thoroughly cleaning the electrode and then measuring a solution of known pH: if the error exceeds 10% (ten percent), reconditioning will have to be resorted to. If even this fails to re-establish correct electrode performance, there is no alternative to replacement.

Reconditioning

The following chemical treatments may be carried out with a view to reconditioning the electrode. We list them in order of increasing aggressiveness as far as the bulb is concerned and would ask you to note that they will not necessarily improve the electrode quality, which in some cases may even be further reduced.

a. Immerse the tip of the electrode in 0.1N hydrochloric acid (Hcl) for 15 seconds, then rinse with water and reimmerse the electrode in a 0.1 N solution of sodium hydroxide (NaOH) for 15 seconds, followed by a second rinsing. Repeat this sequence three

times, and then carry out another check measurement. If the reading remains erroneous, proceed to treatment b).

b. *Immerse the tip of the electrode in a 20% solution of ammonium bifluoride (NH_4F-HF) for two or three minutes, then rinse with water and make another check measurement. If the reading is still unacceptable, proceed to treatment c).*

c. *Immerse the tip of the electrode in 5% hydrofluoric acid (HF) for 10 seconds, then rinse very thoroughly in water and very quickly in 5 N hydrochloric acid (HCl), followed by a second rinsing in water. If the check measurement still produces unacceptable measurements, it only remains to change the electrode.*

10.0 MAINTENANCE

a. *Make periodic checks of the level in the tank containing the additive to avoid the possibility of the pump running empty. Although this will not damage the pump, level checks are strongly advised to avoid possible damage deriving from lack of additive in the system. As an alternative to visual checks, Etatron have perfected an item of accessory equipment (Level Control) that not only gives acoustic and optical alarm signals, but will also interrupt the additive feed to the pump when the residual supply drops below the set minimum level.*

b. *Check the proper functioning of the pump at least once every six months, making sure that all screws and gaskets remain tight. Increase the frequency of these checks when the pump is used to dose particularly aggressive liquids.*

c. *We would also advise periodic cleaning of the hydraulic parts (valves and filter).*

Subject to these general precautions, we would suggest the following maintenance procedure when the pump is working with sodium hypochlorite (as is often the case):

- **a.** *Stop the pump and detach the delivery hose from the plant.*
- **b.** *Detach the suction hose with the filter from the storage tank and immerse it in clean water.*
- **c.** *Feed the metering pump and keep it working for five to ten minutes.*
- **d.** *Stop the pump, immerse the filter in dilute solution of hydrochloric acid and wait for the acid to terminate its cleaning action.*
- **e.** *Feed hydrochloric acid to the pump and keep it working for a further five minutes, realizing a closed circuit with both the suction and the delivery hose connected to the same tank.*
- **f.** *Repeat the last operation with clean water.*
- **g.** *Reconnect the metering pump to the plant.*

11.0 REPAIRS AND BREAKDOWN INTERVENTIONS. TROUBLE-SHOOTING.

Make sure that the pump is completely disconnected from the power supply before undertaking any kind of repair, disconnect the pins from the mains or by means of a onnipolar switch 3 mm minimum distance between the contacts. *Given the robust nature of the pump, mechanical breakdowns in the true sense of the term are extremely*

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unlikely. At times there may be liquid losses, general due to the slackening of a hose clamp or, more simply, a leaking hose, especially on the discharge side. More rarely, such losses may be due to membrane failure or wear and tear of the sealing gasket of the membrane. When this is the case, the defective parts have to be replaced after removing the four screws of the pump body; when replacing these screws, make sure they are tightened in a uniform manner. Once the leak has been eliminated, the pump should be thoroughly cleaned to remove all traces of the additive liquid; if this is not done, the stagnant additive residues could exert an aggressive action on the pump case.

The pump performs its strokes but does not discharge additive into the system:

a. Dismantle both the suction and the discharge valve, clean them and then reassemble them in their original positions. If the valves are found to be swollen, make sure that the additive is chemically compatible with the type of valve fitted in the pump (standard: viton valves).

b. Check the filter and make sure it is not clogged.

N.B. When removing the pump from the plant, use great care in detaching the delivery hose from the connector nipple, because it could well contain some residual additive.

The pump does not start:

a. Check the connections to the power supply.

b. Check that the fuses are intact (only if external).

The pump does not measure correctly:

a. Check the calibration of the instrument.

b. Check the efficacy of the electrode.

The pump fails to dose:

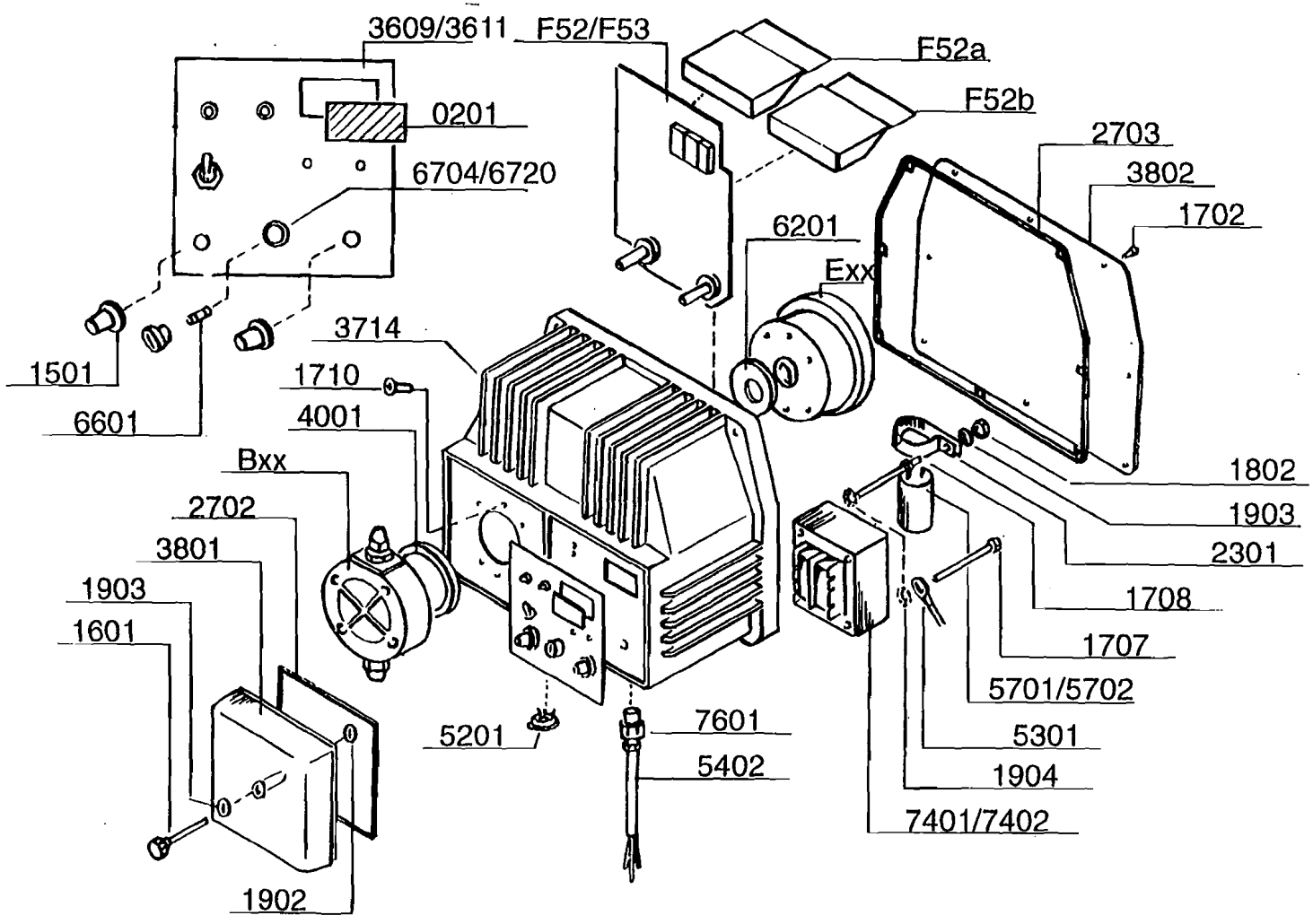
a. Make sure the "set point" has been correctly set.

b. Make sure that the "ACID/ALK" switch is in the right position, i.e. that it concords with the required dosing.

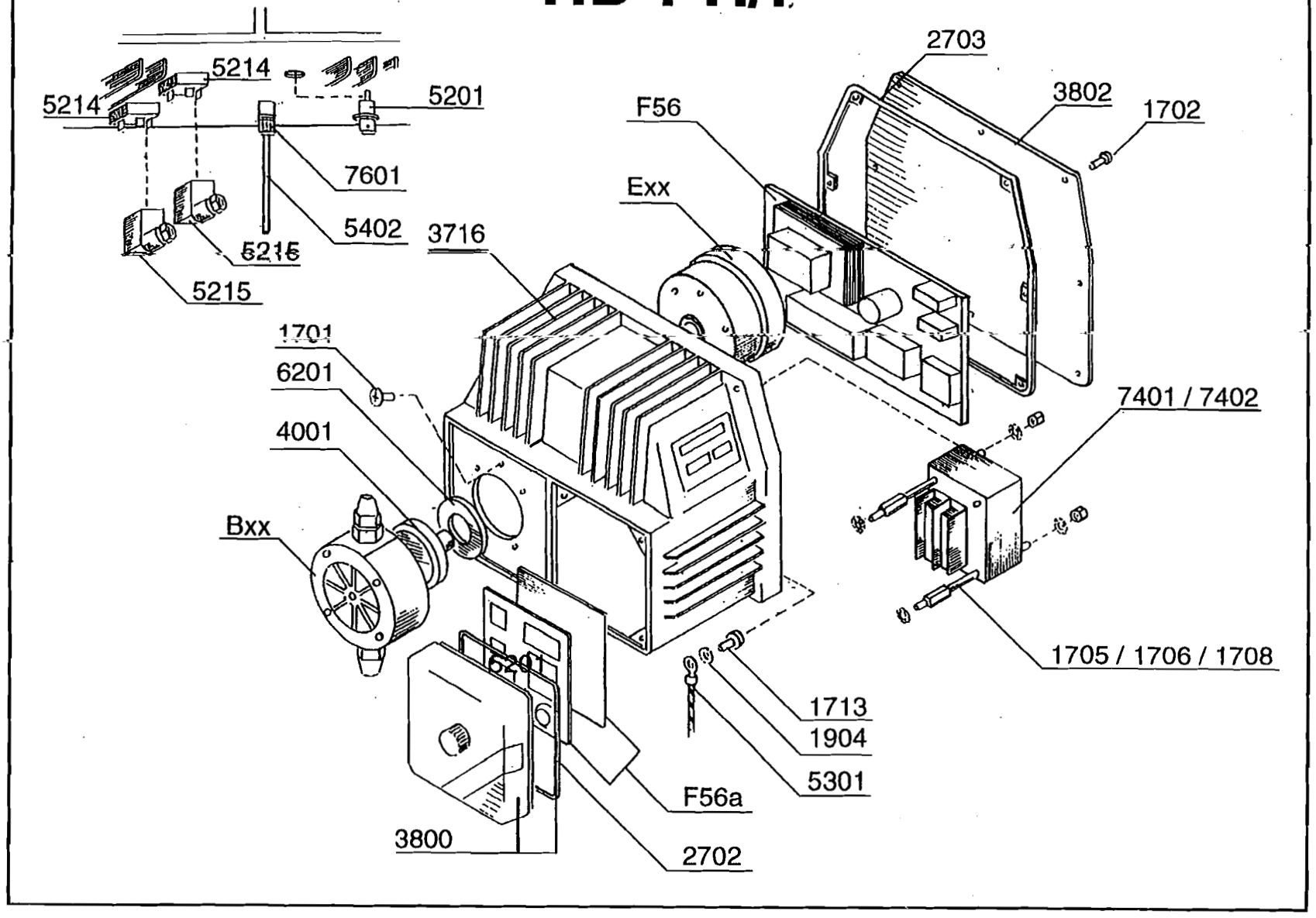
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Drawings

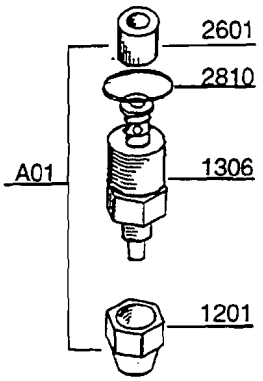
HD-PH/RX


3609/3611
F52/F53
F52a
F52b
0201
6704/6720
2703
3802
1702
6201
Exx
3714
1710
4001
1501
6601
Bxx
2702
3801
1903
1601
1802
1903
2301
1708
1707
5701/5702
5301
1904
7401/7402
5201
7601
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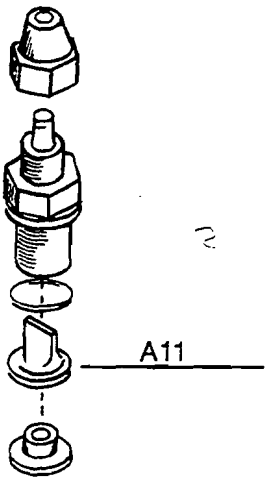
HD-PH/P


5214
5214
5201
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2703
3802
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F56
Exx
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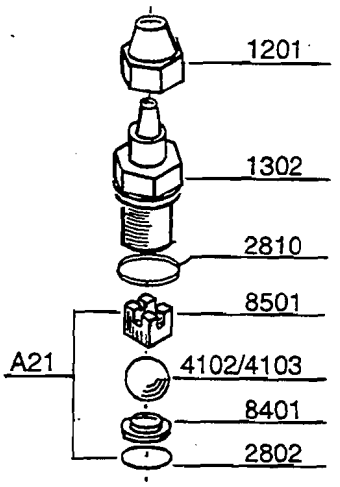
VALVOLA INIEZIONE STD. fino 20l/h
STD. INJECTION VALVE up to 20l/h



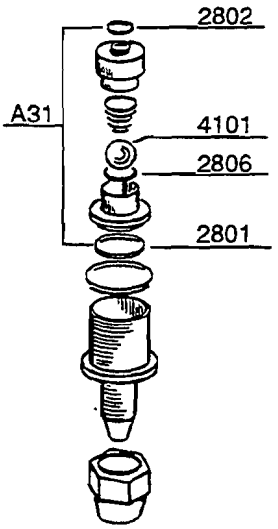
VALVOLA A LABBRO 20l/h
20l/h LIP VALVE



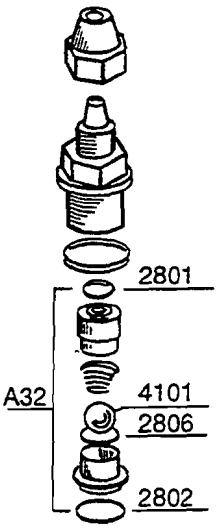
VALVOLA A SFERA GRAVITA'
GRAVITY BALL VALVE



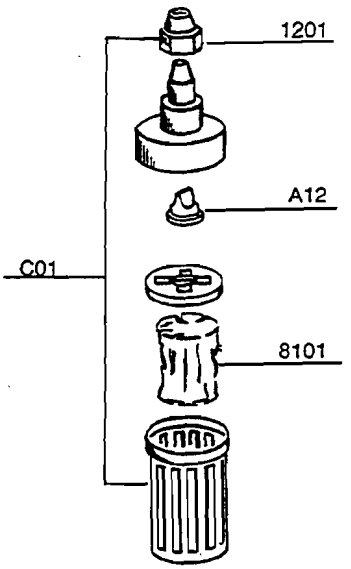
VALVOLA A SFERA ASPIRAZIONE
SUCTION BALL VALVE



VALVOLA A SFERA MANDATA
DISCHARGE BALL VALVE



FILTRO STD. fino a 20l/h
STD. FILTER up to 20l/h



8° Led level control (yellow)
It lights up when the dosing liquid in the tank is below the minimum required

9° Fuse internal the housing

10° Main power supply connector

11° Controls front panel

12° Electrode connector

13° "PH SET" selector
It sets the required pH value measured by the electrode

14° "PH" value functions selector (3 functions):
" PH mis": indicates the pH value measured by the electrode
" PH 7 ": displays the pH value "7" which is also the pump electronic "zero"; it verifies the electrode quality.
" PH set": displays the "pH set" value (selected by selector 13)

15° Switch acid/alk.
Select acid if the pump is dosing acid compound
Select alk if the pump is dosing alkaline compound

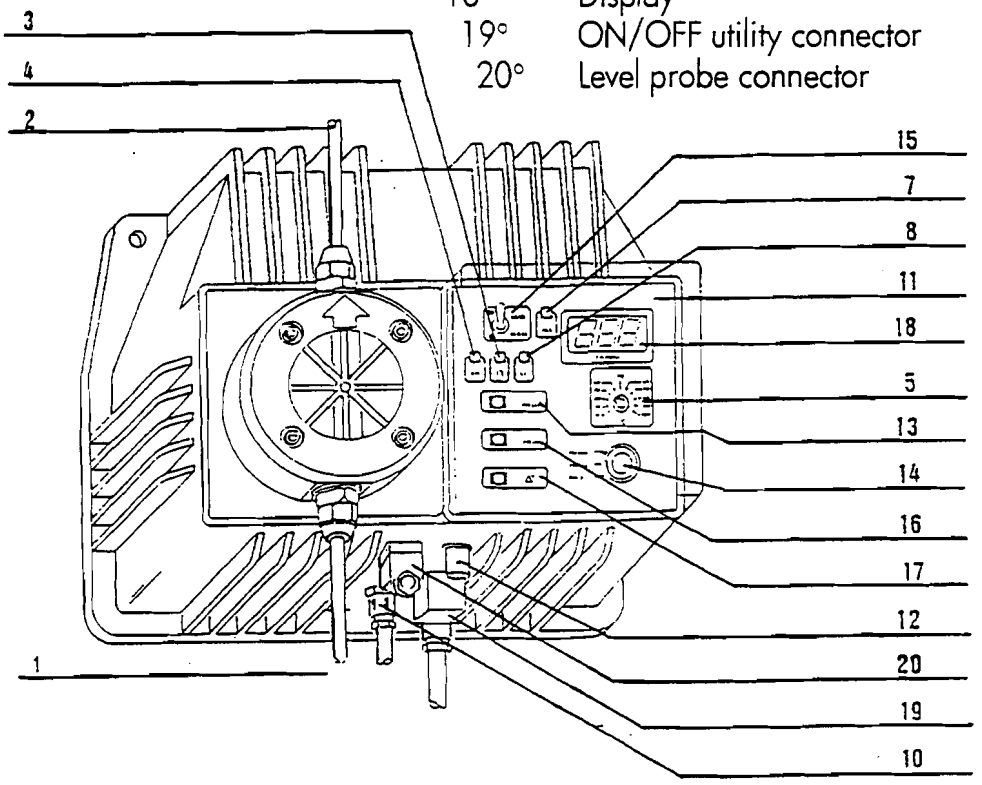
16° "pH / mV" calibration trimmer

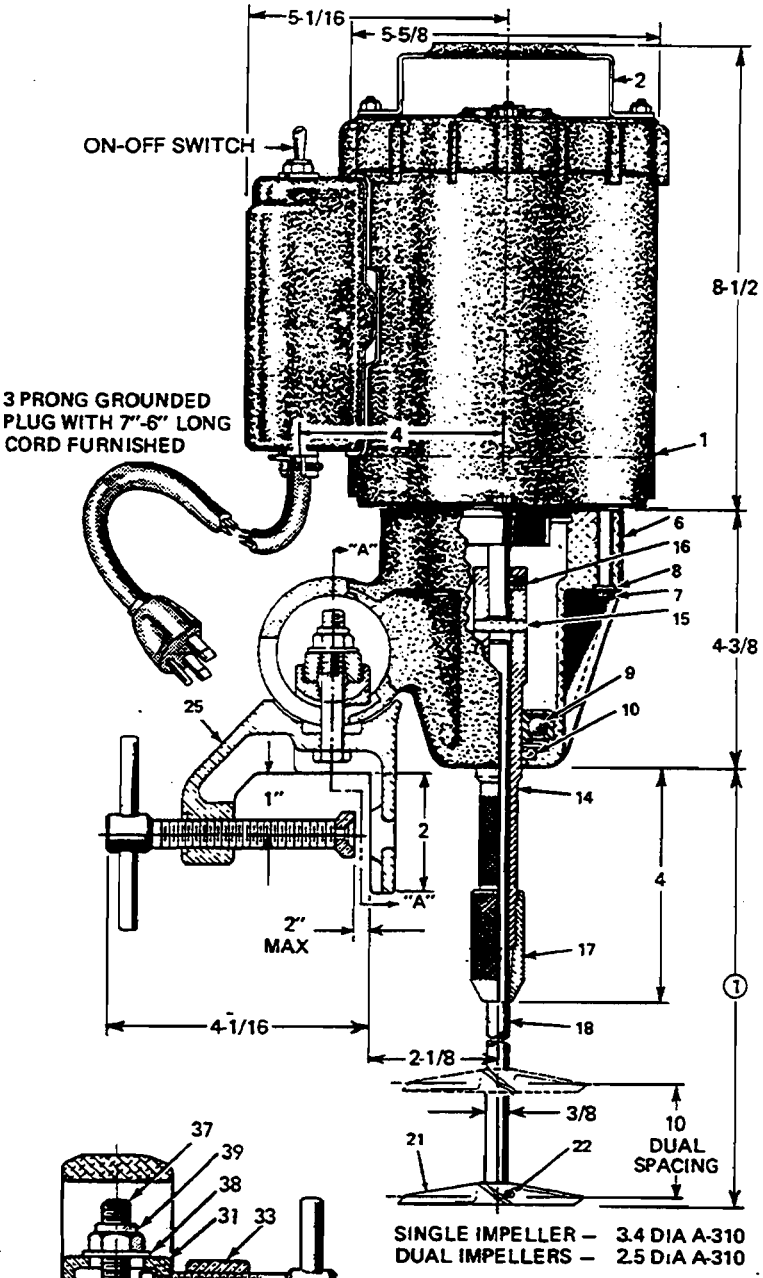
17° "Δ 0" calibration trimmer

18° Display

19° ON/OFF utility connector

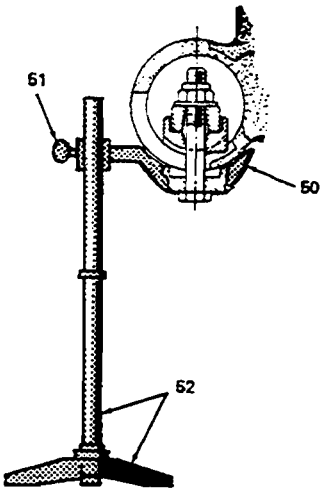
20° Level probe connector





SINGLE IMPELLER – 3.4 DIA A-310
DUAL IMPELLERS – 2.5 DIA A-310

SECTION "A–A"



RING STAND ASSEMBLY
(ITEMS 50, 51 & 52)
AVAILABLE AT EXTRA COST
REPLACES ITEM 25

WHEN ORDERING PARTS,
SPECIFY MACHINE SERIAL NO.,
ITEM NO. AND DRAWING NO.

ITEM	PART NAME
52	RING STAND BASE ASSEMBLY
51	CLAMP THUMB SCREW
50	RING STAND CLAMP
39	LOCKNUT
38	PLAIN WASHER
37	KING BOLT
34	CLAMP WEDGE SCREW ASSEMBLY
33	CLAMP WEDGE SEAT
31	CLAMP WEDGE
25	CLAMP ASSEMBLY
22	SET SCREW ④
21	IMPELLER ③
18	SHAFT
17	CHUCK
16	SET SCREW
15	STOP PIN
14	TUBE
10	FELT WASHER
9	SEALED BALL BEARING
8	LOCKWASHER
7	SOCKET HEAD CAP SCREW
6	BEARING HOUSING
2	HANDLE
1	MOTOR

NOTES:

① SHAFTS ARE AVAILABLE IN LENGTHS OF 12, 18, 24, 30, 36 & 42 INCHES

② TOTAL MIXER WEIGHT – 18 LBS.

③ INCLUDES ITEM 22

④ CAN BE ORDERED SEPARATELY

DIMENSIONS ARE IN INCHES.

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A UNIT OF GENERAL SIGNAL GS

LIGHTNIN

MIXERS AND AERATORS
ASSEMBLY DRAWING

MODEL S1U10 LABORATORY MIXER

GENERAL INSTRUCTIONS
MODELS S1U04X, S1U05T & S1U10

WARNING: DO NOT ATTEMPT TO SERVICE OR ADJUST MIXER WHILE SHAFT/IMPELLER IS ROTATING. DO NOT ALLOW LOOSE CLOTHING OR PARTS OF THE BODY TO COME NEAR THE ROTATING MIXER SHAFT ABOVE OR BELOW THE MIXER BODY. ALWAYS DISCONNECT POWER CORD WHEN SERVICING. POWER CIRCUIT IS LIVE AND ACCIDENTAL START-UP COULD CAUSE PERSONAL INJURY AND OR EQUIPMENT DAMAGE.

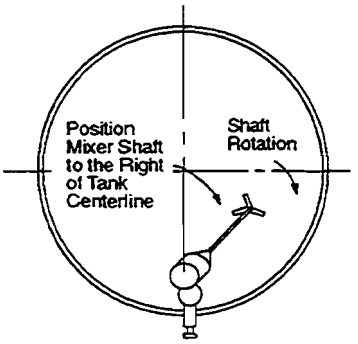
USE ONLY HIGH QUALITY "LIGHTNIN" MIXER SHAFTS IN YOUR "LIGHTNIN" MIXER. THE USE OF NON "LIGHTNIN" MIXER SHAFTS COULD RESULT IN INJURY TO THE OPERATOR OR DAMAGE TO THE MIXER. ALWAYS KEEP THE MIXER SHAFT CLEAN. ACCUMULATION OF FOREIGN MATTER ON THE SHAFT COULD INCREASE THE POTENTIAL FOR PERSONAL INJURY.

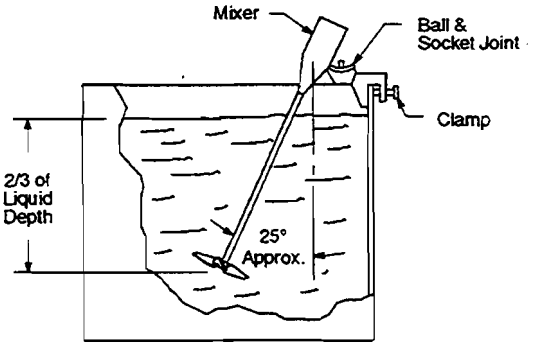
OPERATION IN SMALL MIXING VESSELS COULD CAUSE THE VESSEL CONTENTS TO SPLASH ON PERSONNEL IN THE AREA.

WARNING: DO NOT PLUG POWER CORD INTO POWER RECEPTACLE UNTIL SHAFT AND IMPELLER ARE INSTALLED AND MIXER IS PROPERLY ORIENTED IN VESSEL. ALWAYS DISCONNECT POWER CORD BEFORE ADJUSTING SHAFT OR IMPELLER.

CONNECT POWER CORD THREE PRONG PLUG ONLY TO A 115V OR 230V UL APPROVED GROUNDED RECEPTACLE. DO NOT USE GROUNDING ADAPTERS. USE OF OTHER THAN A PROPERLY GROUNDED RECEPTACLE COULD RESULT IN ELECTRICAL SHOCK HAZARD.

SECTION 1 – INSTALLATION AND OPERATION





1.1 Clamp the mixer on the tank rim or the ***LIGHTNIN*** ring stand (when furnished).

1.2 Rotate the housing ball within the clamp socket vertically and horizontally to the approximate positions shown in the plan and elevation views, and tighten the clamp lever.

1.3 Make sure the impeller extends to at least 2/3 of the liquid depth.

1.4 Plug power cord into the correct voltage supply.

1.5 Before operating, jog the motor to determine the impeller is operating in the correct rotation.

1.6 DO NOT allow the mixer housing to become submerged or subjected to excessive splash or spray.

1.7 If the impeller is removed, it must be replaced with the convex face of the blades facing up.

1.8 REPOSITIONING DURING MIXING CYCLE

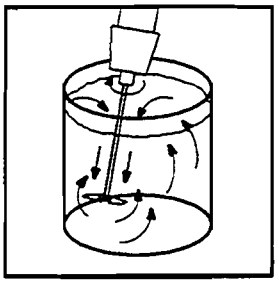
Sometimes, more than one kind of mixing action is needed. For example, you may first need to dissolve light powders, so start with the mixer centered to create a vortex that quickly disperses them into the batch. Then, to maintain a uniform suspension, or to blend in other fluids, reposition the mixer to angular off-center.

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1.9 Motors equipped with sealed ball bearings require no additional lubrication. Special motors equipped with open ball bearings require lubrication periodically. Refer to the motor manufacturer's instructions for details.

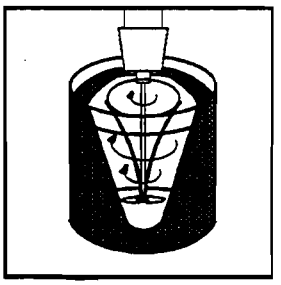
1.10 The mixer bearings are sealed. Additional lubrication is not required for these bearings.

OPTIMUM MOUNTING
ANGULAR OFF CENTER



Aiming the shaft off center as shown avoids vortexing and the need for tank baffles. This position achieves strong top to bottom turnover. Optimal for most mixing and blending.

ON CENTER MOUNTING



Creates vortexing in an unbaffled tank. While undesirable for most work, vortexing speeds up the dispersing and dissolving of light liquids and hard-to-wet powders.

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SAFETY CHECK LIST

IMPORTANT

All *LIGHTNIN* Mixers and Aerators are provided with properly designed lifting devices and safety covers to avoid potential injury and/or eqipment damage. The following SAFETY CHECK LIST should be THOROUGHLY REVIEWED AND ADHERED TO before operating or performing maintenance on the mixer. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS INJURY.

1. Use only the lifting device provided on your unit to install the mixer. Use shouldered eyebolts and tighten securely to handle component parts. We strongly recommend that the hoist rings be of safety swivel type with 360° rotational capability.

2. DO NOT connect the motor to the power source until all components are assembled, the mixer is installed, and all hardware is tightened to the proper torque which is specified in the operation and maintenance manuals supplied by *LIGHTNIN*.

3. DO NOT operate shaft sealing devices at temperatures or pressures higher than those specified in the manual or on the nameplates.

4. DO NOT service the mixer until you have followed your "Control of Hazardous Energy Sources" (lockout, tagout procedure) as required by OSHA 29 CFR Part 1910.

5. DO NOT touch rotating mixer parts.

6. DO NOT operate mixer for service other than its intended use.

7. DO NOT make any field changes or modifications (horsepower, output speed, shaft lengths, impellers, etc.) without reviewing the changes with your *LIGHTNIN* Sales Representative or the *LIGHTNIN* Customer Service Department.

8. DO NOT install an aftermarket Variable Frequency Drive without first consulting your *LIGHTNIN* Sales Representative or the *LIGHTNIN* Customer Service Department to determine the compatibility of the existing motor with the Variable Frequency Drive.

9. DO NOT operate mixer until you have checked the following items:
   - A. Make sure the mixer is properly grounded.
   - B. Ensure all protective guards and covers are installed.
   - C. Ensure all detachable components are securely coupled to the mixer.
   - D. Thoroughly REVIEW and ADHERE TO the mixer operating instructions supplied by *LIGHTNIN*.
   - E. Ensure the mixer output shaft rotates freely by hand.
   - F. Ensure all personnel and equipment are clear of rotating parts.
   - G. Ensure all external connections (electrical, hydraulic, pneumatic, etc.) have been completed in accordance with all applicable codes and regulations.

10. DO NOT enter the mixing vessel UNLESS:
    - A. The mixer power supply is locked out (follow Item number 4).
    - B. The mixer shaft is firmly attached to the mixer drive or the shaft is supported securely from below.
    - C. You have followed applicable confined space regulations.

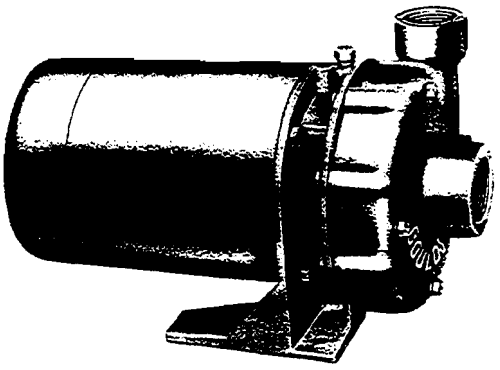
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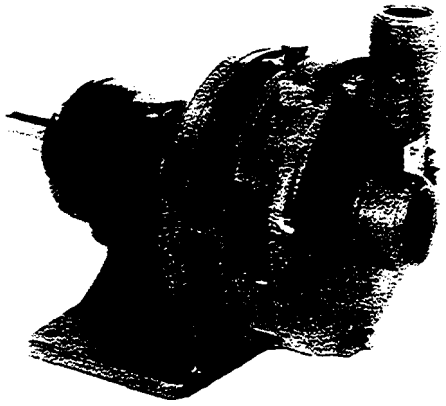
GOULDS PUMPS, INC.
WATER TECHNOLOGIES GROUP
SENECA FALLS, NEW YORK 13148

G&L
A GOULDS PUMPS COMPANY

Installation, Operation and Maintenance Instructions

Series 3642/3742





MODELS	
3642	3742
1 x 1¼ - 5	1 x 1¼ - 5
1¼ x 1½ - 5	1¼ x 1½ - 5

OWNERS INFORMATION

Model Number: _____

Serial Number: _____

Dealer: _____

Dealer Telephone: _____

Date of Purchase: _____ Installation Date: _____

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SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

This is a **SAFETY ALERT SYMBOL.** When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

⚠DANGER Warns of hazards that **WILL** cause serious personal injury, death or major property damage.

⚠WARNING Warns of hazards that **CAN** cause serious personal injury, death or major property damage.

⚠CAUTION Warns of hazards that **CAN** cause personal injury or property damage.

NOTICE: Indicates special instructions which are very important and must be followed.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

NOTICE: INSPECT UNIT FOR DAMAGE AND REPORT ALL DAMAGE TO THE CARRIER OR DEALER IMMEDIATELY.



UNIT NOT DESIGNED FOR USE WITH HAZARDOUS LIQUIDS OR FLAMMABLE GASES.

DESCRIPTION and SPECIFICATIONS

• The 3642 (close-coupled) and 3742 (frame-mounted) are single stage, end suction, centrifugal pumps for water circulation, booster service, liquid transfer, spraying systems, jockey pump and general service pumping. Pumps are available in three different materials of construction: all iron, bronze-fitted and all bronze.

• Pump impellers are enclosed design for high efficiency, threaded directly on the motor shaft.

• Close-coupled units have NEMA standard frame motor with C-face mounting and threaded shaft extensions. Frame mounted units can be coupled to motors through a spacer coupling, or belt driven.

ENGINEERING DATA

• Maximum Liquid Temperature:
212° F (100° C) Standard seal
250° F (120° C) Optional high temp. seal

• Maximum Working Pressure: 125 psi

• Starts per Hour: 20 - Evenly distributed

3642/3742		
Model	**Suction**	**Discharge**
1 x 1¼ - 5	1¼" NPT	1" NPT
1¼ x 1½ - 5	1½" NPT	1¼" NPT

INSTALLATION

Location:

• Locate pump as near liquid source as practical; below level of liquid for repriming capability.

• Allow adequate space for servicing and ventilation. Protect the unit from weather and water damage due to rain or flooding or freezing temperatures.

Close - Coupled Units:

• Units may be installed horizontally, inclined or vertically with motor above pump.

NOTICE: DO NOT INSTALL WITH MOTOR BELOW PUMP. ANY LEAKAGE OR CONDENSATION WILL AFFECT THE MOTOR.

Foundation:

• A flat and substantial foundation surface **MUST** be provided to avoid distortion and/or strain when tightening the foundation bolts. A rubber mounting is acceptable to reduce noise or excessive vibration.

• Tighten motor hold-down bolts before connecting piping to pump.

Frame - Mounted Units:

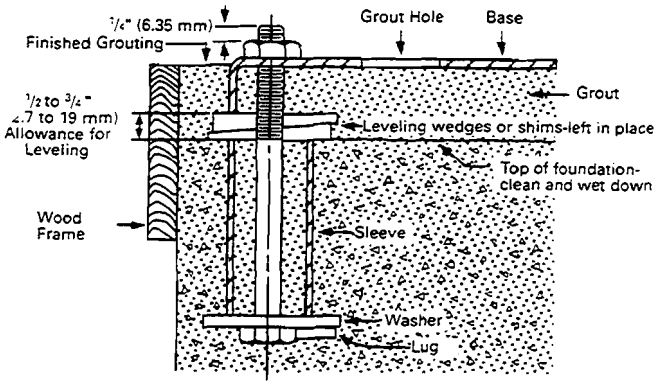


Figure 1

• Bedplate must be grouted to a foundation with solid footing. Refer to Figure 1.

• Place unit in position on wedges located at four points, two below approximate center of driver and two below approximate center of pump. Adjust wedges to level unit. Level or plumb suction and discharge flanges.

• Make sure bedplate is not distorted and final coupling alignment can be made within the limits of movement of motor, or motor shimming, if necessary.

Tighten foundation bolts finger tight and build dam around foundation. Pour grout under bedplate making sure the areas under the pump and motor feet are filled solid. Allow grout to harden 48 hours before fully tightening foundation bolts.

• Tighten pump and motor hold-down bolts before aligning shaft or connecting the piping to pump.

PIPING

• Piping should be no smaller than pump's discharge and suction connections and kept as short as possible, avoiding unnecessary fittings to minimize friction losses.

• All piping **MUST** be independently supported and **MUST NOT** place any piping loads on the pump.

NOTICE: DO NOT FORCE PIPING INTO PLACE AT PUMP SUCTION AND DISCHARGE CONNECTIONS.

• All pipe joints **MUST** be airtight.

Piping - Suction

• For suction lifts over 15 ft. (4.6 m), consult pump performance curve for net positive suction head required ($NPSH_R$).

• If a pipe size larger than pump suction is required, an eccentric pipe reducer, with the straight side up, **MUST** be installed at the pump suction.

• If pump is installed below the liquid source, install a gate valve in the suction for pump inspection and maintenance.

NOTICE: DO NOT USE THE GATE VALVE TO THROTTLE PUMP. THIS MAY CAUSE LOSS OF PRIME, EXCESSIVE TEMPERATURES AND DAMAGE TO PUMP, VOIDING WARRANTY.

• If the pump is installed above the liquid source, the following **MUST** be provided:

- To avoid air pockets, no part of the piping should be above the pump suction connection.
- Slope piping upward from liquid source.
- Use a foot valve or check valve **ONLY** if necessary for priming or to hold prime during intermittent duty.
- The suction strainer or suction bell **MUST** be at least three times the suction pipe diameter area.
- Insure that the size and minimum submergence over suction inlet is sufficient to prevent air from entering through a suction vortex. See Figures 2 through 5.

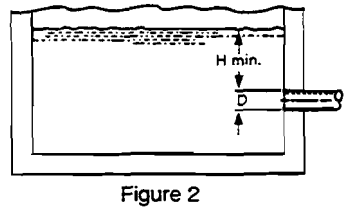


Figure 2

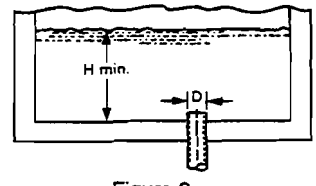


Figure 3

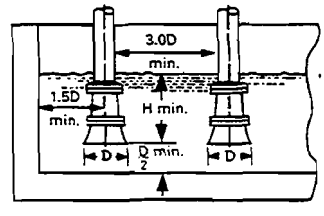


Figure 4

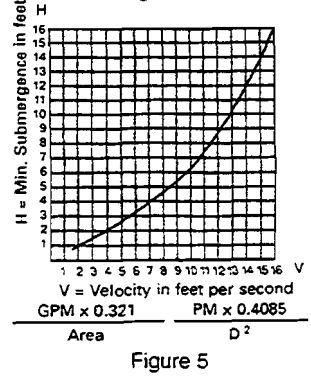


Figure 5

Piping - Discharge

• Install a check valve suitable to handle the flow, liquids and to prevent backflow. After the check valve, install an appropriately sized gate valve to be used to regulate the pump capacity, pump inspection and for maintenance.

• When required, pipe increaser should be installed between the check valve and the pump discharge.

WIRING AND GROUNDING



⚠ Install, ground and wire according to local and National Electrical Code requirements.

⚠ Install an all leg disconnect switch near the pump.

⚠ Disconnect and lockout electrical power before installing or servicing pump.

⚠ Electrical supply **MUST** match pump's name plate specifications. Incorrect voltage can cause fire, damage to the motor and voids warranty.

⚠ Motors not protected **MUST** be provided with contactors and thermal overloads for single phase motors, or starters with heaters for three phase motors. See motor nameplate.

• Use only stranded copper wire to motor and ground. The ground wire **MUST** be at least as large as the wire to the motor. Wires should be color coded for ease of maintenance.

• Follow motor manufacturer's wiring diagram on the motor nameplate or terminal cover carefully.



FAILURE TO PERMANENTLY GROUND THE PUMP, MOTOR AND CONTROLS BEFORE CONNECTING TO ELECTRICAL POWER CAN CAUSE SHOCK, BURNS OR DEATH.

COUPLING ALIGNMENT



FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SEVERE PERSONAL INJURY.

• Alignment **MUST** be checked prior to running. See Figure 6.

• Tighten all hold-down bolts before checking the alignment.

• If realignment is necessary, always move the motor. Shim as required.

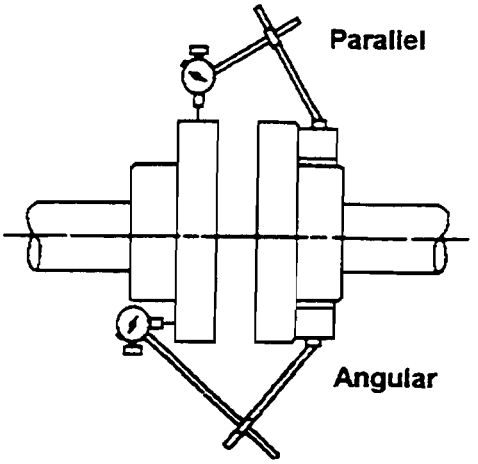


Figure 6

• Parallel misalignment (shafts with axis parallel but not concentric). Place dial indicator on one hub and rotate this hub 360° while taking readings on the outside diameter of the other hub. Parallel alignment is achieved when reading is 0.005" (0.127mm) TIR, or less.

• Angular misalignment (shaft with axis concentric but not parallel). Place dial indicator on one hub and rotate this hub 360° while taking readings on the face of the other hub. Angular alignment is achieved when reading is 0.005" (0.127mm) TIR, or less.

• Final alignment is achieved when parallel and angular requirements are satisfied with motor hold-down bolts tight.

NOTICE: ALWAYS RECHECK BOTH ALIGNMENTS AFTER MAKING ANY MECHANICAL ADJUSTMENTS.

ROTATION

NOTICE: INCORRECT ROTATION MAY CAUSE DAMAGE TO THE PUMP AND VOIDS THE WARRANTY.

• Correct rotation is right-hand, **CLOCKWISE** when viewed from the motor end. Remove motor end plug or cover to observe rotation.

• To reverse three phase motor rotation, interchange any two power supply leads.

OPERATION



DO NOT OPERATE FRAME MOUNTED UNITS WITHOUT SAFETY GUARDS IN PLACE OR SEVERE PERSONAL INJURY MAY RESULT.



SPLASHING OR IMMERSING OPEN DRIP PROOF MOTORS IN FLUID CAN CAUSE FIRE, SHOCK, BURNS OR DEATH.



OPERATION AT OR NEAR ZERO FLOW CAN CAUSE EXTREME HEAT, PERSONAL INJURY OR PROPERTY DAMAGE.

NOTICE: DO NOT RUN PUMP DRY OR SEAL DAMAGE WILL RESULT.

- After stabilizing the system at normal operating conditions, check the piping. If necessary, adjust the pipe supports.

- On frame-mounted units, coupling alignment may have changed due to the temperature differential between pump and motor. Recheck alignment following procedures and hazard warnings in **"COUPLING ALIGNMENT"** section of this manual.

MAINTENANCE



FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SHOCK, BURNS OR DEATH.



FAILURE TO RELIEVE SYSTEM PRESSURE AND DRAIN SYSTEM BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE PROPERTY DAMAGE, PERSONAL INJURY OR DEATH.

Close-Coupled Units:

- Bearings are located in and are part of the motor. For lubrication information, refer to motor manufacturer's instructions.

Frame-Mounted Units:

- Pump bearing frames have greased for life bearings. No lubrication is possible or necessary.

- Follow motor and coupling manufacturer's lubrication instructions.

Seasonal Service

- To **REMOVE** pump from service, remove drain plug and drain all unprotected piping.

- To **RETURN** pump to service, replace drain plug using Teflon™ tape or equivalent

- Reconnect suction line if removed, examine union and repair if necessary.

- Refer to **"OPERATION"** section of manual.

DISASSEMBLY

- Follow ALL warnings and instructions in the **"MAINTENANCE"** section of this manual.

- Close-coupled units, remove motor hold-down bolts.

- Frame-mounted units, remove coupling guard, spacer, coupling and frame hold-down bolts.

Liquid End:

1. Remove casing bolts (370).
2. Remove back pull-out assembly from casing (100).
3. Remove casing gasket (351). Discard.
4. On close-coupled units, remove motor end plug or cover to expose screwdriver slot or flats on end of motor shaft.
5. While restraining shaft with appropriate tool (close-coupled units) or with a strap wrench (frame-mounted units) remove impeller nut (304) by turning **COUNTERCLOCKWISE.** Impeller nut may need to be heated with torch to remove.

NOTICE: EXERCISE CAUTION WHEN HANDLING HOT IMPELLER NUT.

6. While restraining shaft, remove impeller (101) by turning **COUNTERCLOCKWISE**. Impeller may need to be heated to remove.

NOTICE: EXERCISE CAUTION WHEN HANDLING HOT IMPELLER.

7. Using two screwdrivers, pry off rotating section of mechanical seal assembly (383). Discard. See Figure 7.

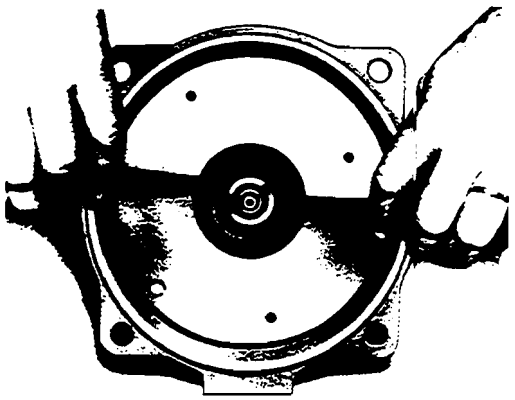


Figure 7

8. Remove adapter bolts (371) and adapter (108), pulling with it the mechanical seal stationary seat.
9. Push out the mechanical seal stationary seat from the motor side of the adapter. Discard.

Bearing Frame:

1. Remove bearing cover (109).
2. Remove retaining ring (361).
3. Remove shaft assembly from frame.
4. If worn or damaged, remove lip seals (138,139) from bearing frame (228) and bearing cover (109).
5. Use bearing puller or arbor press to remove ball bearings (112,168).

REASSEMBLY

• All parts should be cleaned before assembly.

• Refer to parts list for description of replacement items. Specify pump index number when ordering parts.

Bearing Frame:

1. Replace lip seals if removed.
2. Replace ball bearings if loose, rough or noisy when rotated.
3. Check shaft (122) for runout. Maximum permissible is 0.002" (0.051 mm) TIR.

Liquid End:

1. Inspect shaft removing any debris or burrs.
2. Treat shaft threads with LOCQUIC® Primer "T" , or equivalent, following manufacturer's instructions carefully.

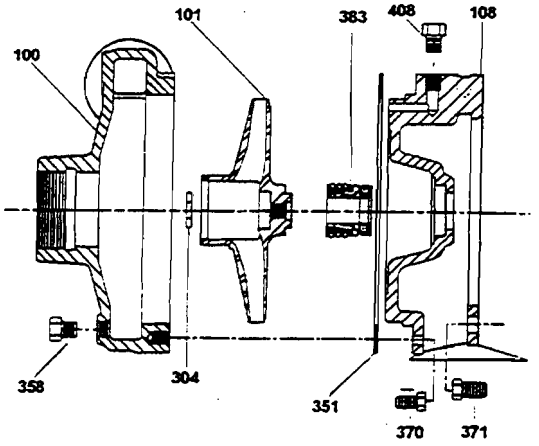
NOTICE: MECHANICAL SEAL MUST BE REPLACED WHENEVER SEAL HAS BEEN REMOVED. FOLLOW MANUFACTURER'S INSTRUCTIONS CAREFULLY

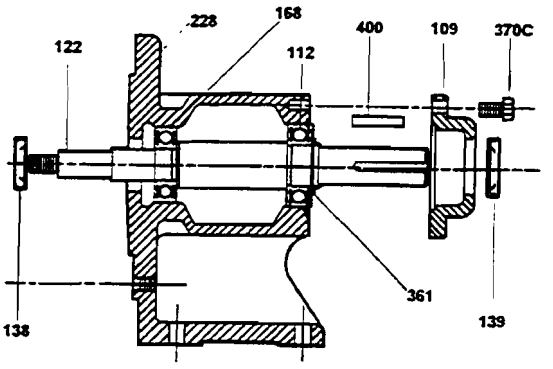
3. Stationary seal seat may be dipped in water or glycerin to ease installation. Place stationary seal seat squarely into adapter seal bore. Cover the polished face of the seat with a thin piece of cardboard or paper towel. Press seat firmly into bore using a round piece of plastic or wood that disperses the force over the entire seal face.
4. Place adapter, concave face pointing up, over motor shaft and lower it onto the motor adapter. Exercise care in that the motor shaft does not dislodge or damage seal seat.
5. Fully and squarely install the rotary assembly of seal against the stationary seat.
6. Apply LOCTITE® #262 or equivalent, to shaft threads and install impeller on shaft by turning **CLOCKWISE** until it bottoms on the motor shaft.
7. Apply LOCTITE® #262 or equivalent, to impeller nut and tighten to 20 lbs. ft. (27 N•m).
8. Replace casing gasket.
9. Replace casing bolts, tightening to 37 lbs. ft (50 N•m) in a crossing sequence.
10. Check reassembled unit for binding by rotating shaft.
11. If rubbing exists, loosen casing bolts and proceed with tightening sequence again.
12. On close coupled units, replace motor end plug or cover and motor hold down bolts.
13. On frame mounted units, replace coupling, spacer, coupling guard and frame hold-down bolts.

NOTICE: ALWAYS RECHECK BOTH COUPLING ALIGNMENTS AFTER MAKING ANY ADJUSTMENTS.

14. Refer to **"COUPLING ALIGNMENT"** section of manual to realign shaft.
15. Assembly is complete.

Repair Parts
Series 3642/3742





LIQUID END COMPONENTS			POWER END COMPONENTS		
Item #	**Description**	**Material**	**Item #**	**Description**	**Material**
100	Casing	Iron/Bronze	109	Bearing Cover	Cast Iron
101	Impeller	Iron/Bronze	112	Ball Bearing (Outboard)	Stainless Steel
108	Adapter	Iron/Bronze	122	Pump Shaft	Stainless Steel
304	Impeller Nut	Stainless Steel	138	Lip Seal-Inboard	BUNA-N/Steel
351	Casing gasket	Composite	139	Lip Seal-Outboard	BUNA-N/Steel
358	Drain Plug	Steel	168	Ball Bearing-Inboard	Stainless Steel
370	Hex Head Cap Screw (Casing to Adapter)	Steel	228	Bearing Frame	Cast Iron
371	Hex Head Cap Screw (Adapter to Motor)	Steel	361	Retaining Ring	BUNA-N/Steel
383	Mechanical Seal	See Chart	370C	Hex Head Cap Screw (Frame to Cover)	Steel
408	Prime Plug-1/4" NPT	Steel/Brass	400	Shaft Key	Stainless Steel

Mechanical Seal Options					
Equipment	**Service**	**Rotary**	**Stationary**	**Elastomers**	**Metal Parts**
Standard	General	Carbon	Ceramic	BUNA-N	300 Series Stainless Steel
Optional	Heavy Duty		Ni-Resist	BUNA-N	
	Hi-Temperature		Ni-Resist	EPR	
	Chemical		Ceramic	Viton	

TROUBLE SHOOTING



FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SHOCK, BURNS OR DEATH.

SYMPTOM:

Motor Not Running
See Probable Causes 1 thru 5

Little or No Liquid Delivered
See Probable Causes 6 thru 13

Excessive Power Consumption
See Probable Causes 3,13,14,15

Excessive Noise & Vibration
See Probable Causes 3,6,7,10,12,14,16 & 17

PROBABLE CAUSES:

1. Motor thermal protector tripped
2. Open circuit breaker or blown fuse
3. Impeller binding
4. Motor improperly wired
5. Defective motor
6. Pump is not primed, air or gases in pumpage
7. Discharge, suction plugged or valve closed
8. Incorrect rotation (3 phase only)
9. Low voltage or phase loss
10. Impeller worn or plugged
11. System head too high
12. $NPSH_A$ too low - Excessive suction lift or losses
13. Incorrect impeller diameter
14. Discharge head too low - excessive flow rate
15. Fluid viscosity, specific gravity too high
16. Worn bearing
17. Pump, motor or piping loose

LIMITED WARRANTY

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

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

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

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

ANION EXCHANGER VALVE SEQUENCING CHART

VALUE	1 into 2 into 3	2 into 3 into 1	3 into 1 into 2
V15	Open	Closed	Closed
V19	Closed	Open	Open
V16	Closed	Open	Closed
V25 (Probe)	Closed	Closed	Open (Probe)
V28 (Sample)	Closed	Closed	Closed
V31 (psi)	Open	Open	Open
V21	Open	Closed	Open
V23	Closed	Open	Closed
V17	Closed	Closed	Open
V26 (Probe)	Open (Probe)	Closed	Closed
V29 (Sample)	Closed	Closed	Closed
V32 (psi)	Open	Open	Open
V22	Open	Open	Closed
V24	Closed	Closed	Open
V18	Open	Closed	Closed
V27 (Probe)	Closed	Open (Probe)	Closed
V30 (Sample)	Closed	Closed	Closed
V33 (psi)	Open	Open	Open
V20	Closed	Open	Open

Note: The probe is always placed after the second unit in series

1. #1 - #2 - #3: **Probe after the #2 unit.** When conductivity indicates remove #1 and put a fresh exchanger in its place. Now #2 will become the primary and #3 is the secondary and #1 is the final.
2. #2 - #3 - #1: **Probe after the #3 unit.** When conductivity indicates remove #2 and put a fresh exchanger in its place. Now #3 is the primary.
3. #3 - #1 - #2: **Probe after the #1 unit.** When conductivity indicates remove #3 and put a fresh exchanger in its place. The flow is now back to the original #1 into #2 into #3.

INSTALLATION & OPERATING INSTRUCTIONS
CARBTROL® ION-EXCHANGE CANISTERS (LOW-PRESSURE)

INSTALLATION

The CARBTROL® canister should be placed in an accessible area, preferably close to the source of liquid to be treated. The plastic inlet and outlet plugs on the canister cover should then be removed.

To prevent air buildup during operation, the canister must be degassed by filling it with water or the liquid to be treated.

This can be accomplished by pumping the liquid at a slow rate (1 - 2 gpm) into the canister outlet port until the canister is filled. The canister should then be allowed to stand for 24 hours with inlet and outlet connections open to permit de-gassing of the ion-exchange resin. Periodically during this time, additional liquid should be added to the canister as the level drops due to gas displacement.

Following the de-gassing period the inlet and outlet piping can be re-connected to the ion-exchange canister. The canister may then be put into operation.

OPERATION

Once the ion-exchange canister is installed, it is designed to operate virtually unattended.

As contaminated liquid flows through the canister, the ion-exchange resin removes the impurities. The treated liquid flows into a collector at the bottom of the resin bed and is directed to the outlet nozzle. As impurities are removed on the resin bed, it will start to become saturated and some impurities will bleed into the effluent. After the resin becomes fully saturated with contaminants, it should be removed from service. (CARBTROL recommends using a minimum of two canisters in series to achieve complete saturation of the ion-exchange resin while continuing to remove contaminants.

The 3/4" bung in the lid of the canister can be used to vent air that may accumulate during operation. To vent the air, shut down the supply pump. Slowly and carefully open the bung to allow the air to vent. Close the bung before starting the supply pump.

Spent L-1 canisters should be drained for transport. Open the 3/4" drain bung on the lower side of the canister, and punch a hole in the polyethylene liner for gravity drain. Alternatively, compressed air at 5 psi maximum can be applied to the inlet connection to force the water out through the outlet connection. Drained liquids should be returned to the upstream feed point for reprocessing. Replace the bung once the canister is drained.

CAUTION

A. Operating pressure for CARBTROL ion-exchange canisters should not exceed 10 psig.

B. Ion-exchange resin has been known to react adversely with some contaminants. If the effect of the contaminant you wish to treat on ion-exchange resin is unknown, then it must be tested.

C. Best results are obtained when suspended solids in the untreated liquid are removed prior to treatment in the canister. This will prevent fouling of the ion-exchange resin, which may result in a reduction of its useful life, and in increased back pressure.

D. Install appropriate shipping plugs and follow all State and Federal EPA Regulations when regenerating or disposing of spent resin canisters.

WARRANTY

This product is designed to remove ionic elements from liquids. However, there is no assurance of its capacity. SELLER WARRANTS THAT THE GOODS ARE AS DESCRIBED, BUT NO OTHER WARRANTY IS GIVEN, WHETHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Seller will not be liable for loss or damage to property or any incidental or consequential loss or expense from property damage due directly or indirectly from the use of the product.

ResinTech, Inc. - SIR-700

Sulfate Form Weakly Basic Gelular Anion Exchange Resin

MATERIAL SAFETY DATA SHEET

RESINTECH, INC. 615 DEER ROAD - CHERRY HILL, NJ 08034 — **EMERGENCY TELEPHONE - (609) 354-1152**

PRODUCT NAME (AS USED ON LABEL):
SIR-700

ICC NMFC #
48515

SECTION 1 - PRODUCT INFORMATION

NAME OF MANUFACTURER
RESINTECH, INC

ADDRESS:
615 DEER ROAD - CHERRY HILL, NJ 08034

DATE PREPARED:
1-3-96

INFORMATION PHONE NUMBER:
(609)-354-1152

SECTION 3 - PHYSICAL/CHEMICAL

EPOXY POLYAMINE ANION = (SULFATE FORM) — CAS# = 069011-15-0 — **TWA/TLV:** NOT ESTABLISHED

WATER = — CAS# = 007732-18-5 — NOT ESTABLISHED

SECTION 3 - PHYSICAL/CHEMICAL

BOILING POINT:
N/A

VAPOR PRESSURE (mm Hg):
N/A

EVAPORATION RATE (WATER = 1):
1

PRODUCT HAZARD RATING	SCALE
TOXICITY = 0	0 = NEGLIGIBLE
FIRE = 0	1 = SLIGHT
REACTIVITY = 0	2 = MODERATE
SPECIAL = N/A	3 = HIGH
	4 = EXTREME

SPECIFIC GRAVITY:
(WATER = 1)
1.2

MELTING POINT (DEG. F):
N.A.

SOLUBILITY IN WATER:
INSOLUBLE

APPEARANCE & ODOR:
LIGHT YELLOW TO AMBER GRANULES
MAY HAVE AMINE ODOR

THERMAL: MAY YIELD OXIDES OF CARBON AND NITROGEN

SECTION 4 - FIRE & EXPLOSION HAZARD DATA

FLAMMABLE LIMITS:
800 DEG. F

EXTINGUISHING MEDIA:
WATER, CO2, TALC, DRY CHEMICAL

UNUSUAL FIRE & EXPLOSION HAZARDS:
TOXIC DECOMPOSITION PRODUCTS

SPECIAL FIRE FIGHTING PROCEDURES:
MSHA/NIOSH APPROVED SELF CONTAINED BREATHING GEAR

SECTION 5 - REACTIVITY DATA

STABILITY:
STABLE

MATERIALS TO AVOID CONTACT WITH:
STRONG OXIDIZING AGENTS (I.E. NITRIC ACID)

CONDITIONS TO AVOID:
TEMPERATURES ABOVE 400 DEG. F

HAZARDOUS POLYMERIZATION:
MATERIAL DOES NOT POLYMERIZE

HAZARDOUS BY PRODUCTS:
CO, CO2, SO2, SO3, NH3, AMINES, FORMALDEHYDE

STORAGE: STORE IN A COOL DRY PLACE

SECTION 6 - HEALTH HAZARDS & SARA (RIGHT TO KNOW)

EMERGENCY FIRST AID PROCEDURES:
CONTACT WITH EYES CAN CAUSE ACUTE IRRITATION
FLUSH EYES WITH WATER FOR 15 MINUTES

CARCINOGENICITY: N.A.

SARA - TITLE 3, SECTIONS 311 & 312 :
ALL INGREDIENTS ARE NON HAZARDOUS

SECTION 7 - CONTROL MEASURES

RESPIRATORY PROTECTION:
NOT REQUIRED FOR NORMAL USES
IF IRRITATION OCCURS FROM BREATHING- GET FRESH AIR!

VENTILATION:
NORMAL

EYE PROTECTION:
SPLASH GOGGLES

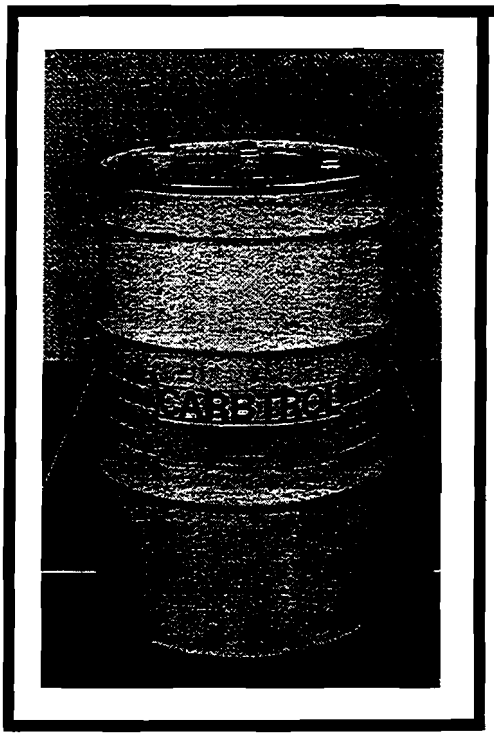
PROTECTIVE GLOVES:
NOT REQUIRED

SECTION 8 - SAFE HANDLING PROCEDURES

IN CASE OF SPILLS: SWEEP UP MATERIAL AND TRANSFER TO CONTAINERS. USE CAUTION- THE FLOOR WILL BE SLIPPERY!

CARBTROL®

CHROMATE REMOVAL CANISTER
CCR-6-LP



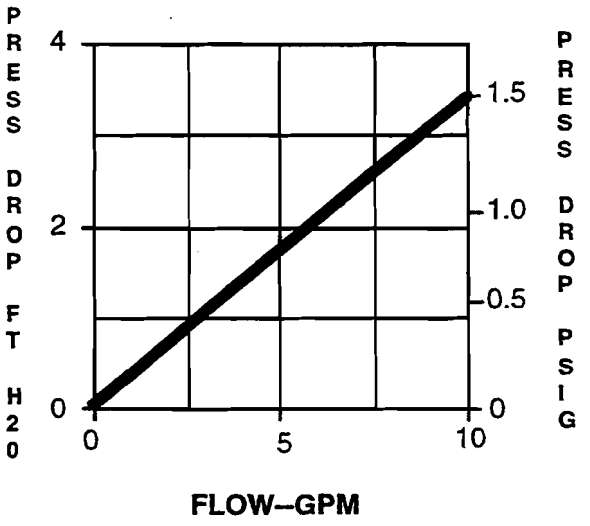
The CARBTROL CCR-6 LP Canister handles up to 10 gpm.

FEATURES

- Six cubic feet of chromate selective resin.
- Large 1 1/4" internal piping. Low pressure drop allows operation of three canisters in series.
- Standard FPT couplings for easy installation - saves time and money.
- Special "no leak" lid gasket.
- Heavy duty steel drums. Acceptable for transport of hazardous spent resin.
- Piping design eliminates channeling.

SPECIFICATIONS

DRUM:	24" Ø x 34" high, mild steel, epoxy phenolic internal coating with polyethylene liner.
RESIN:	230 lbs.
SHIPPING WEIGHT:	280 lbs.
INLET:	1 1/4" FPT, steel
OUTLET:	1 1/4" FPT, steel
INTERNAL PIPING:	1 1/4" PVC
DRAIN:	3/4" bung
PRESSURE DROP:	1.5 psi @ 10 gpm
MAX. OPERATING PRESSURE:	10 psi



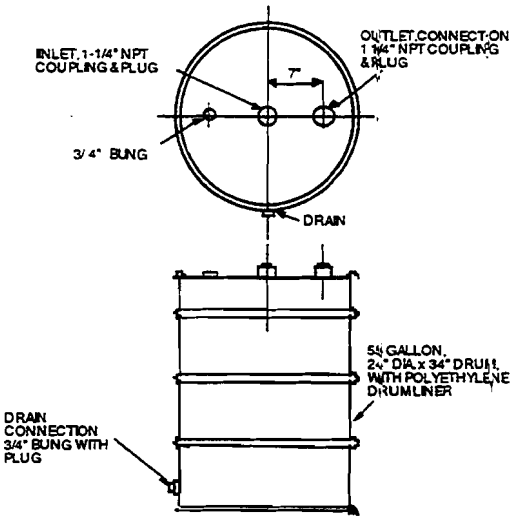
CARBTROL® CORPORATION

51 Riverside Avenue, Westport, CT 06880 • 1-800-242-1150 • (203) 226-5642

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CARBTROL®

CHROMATE REMOVAL CANISTER
CCR-6-LP



OPTIONS

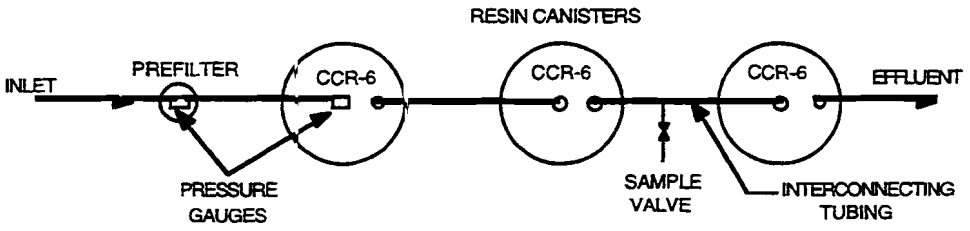
Interconnecting Piping Kit

Flexible 1 1/4" diameter PVC tubing with hose clamps. Includes inlet pressure gauge and intermediate sample valve.

Pre-filter for Suspended Solids Removal

Pre-filter consisting of a basket filter piped and mounted on support frame. Filter is of carbon steel construction.

ARRANGEMENT (3) CCR-6 Canisters in series for 10 gpm flow (Contact time @ 10 gpm - 15 minutes)



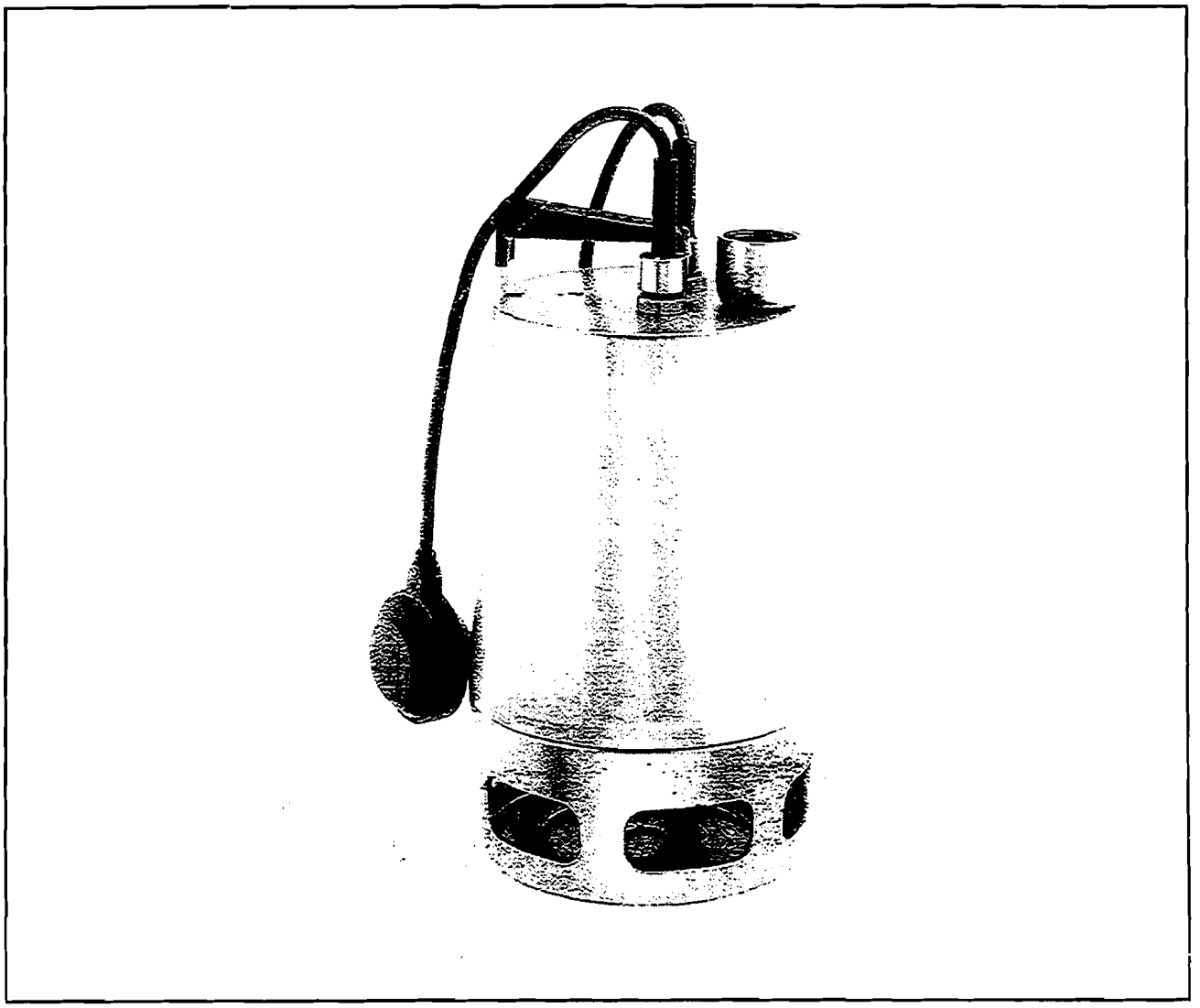
FOR 10 GPM FLOW
(3) CCR-6 CANISTERS
WITH PK-10/3 PIPING

TYPICAL INSTALLATION



AP12, AP35, AP50

(GB) Installation and Operating Instructions
(D) Montage- und Betriebsanleitung
(F) Notice d'installation et d'entretien
(I) Istruzioni di installazione e funzionamento
(E) Instrucciones de instalación y funcionamiento
(P) Instruções de instalação e funcionamento
(GR) Οδηγίες εγκατάστασης και λειτουργίας
(NL) Installatie- en bedieningsinstructies
(S) Monterings- och driftsinstruktion
(SF) Asennus- ja käyttöohjeet
(DK) Monterings- og driftsinstruktion



GRUNDFOS

Declaration of Conformity

We **GRUNDFOS** declare under our sole responsibility that the products **AP12, AP35** and **AP50**, to which this declaration relates, are in conformity with the Council Directives on the approximation of the laws of the EEC Member States relating to

- Machinery (89/392/EEC).
  Standard used: EN 292.
- Electromagnetic compatibility (89/336/EEC).
  Standards used: EN 50 081-1 and EN 50 082-2.
- Electrical equipment designed for use within certain voltage limits (73/23/EEC).
  Standards used: EN 60 335-1 and EN 60 335-2-41.

Konformitätserklärung

Wir **GRUNDFOS** erklären in alleiniger Verantwortung, daß die Produkte **AP12, AP35** und **AP50**, auf die sich diese Erklärung bezieht, mit den folgenden Richtlinien des Rates zur Angleichung der Rechtsvorschriften der EG-Mitgliedstaaten übereinstimmen:

- Maschinen (89/392/EWG).
  Norm, die verwendet wurde: EN 292.
- Elektromagnetische Verträglichkeit (89/336/EWG).
  Normen, die verwendet wurden: EN 50 081-1 und EN 50 082-2.
- Elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen (73/23/EWG).
  Normen, die verwendet wurden: EN 60 335-1 und EN 60 335-2-41.

Déclaration de Conformité

Nous **GRUNDFOS** déclarons sous notre seule responsabilité que les produits **AP12, AP35** et **AP50** auxquels se réfère cette déclaration sont conformes aux Directives du Conseil concernant le rapprochement des législations des Etats membres CEE relatives à

- Machines (89/392/CEE).
  Standard utilisé: EN 292.
- Compatibilité électromagnétique (89/336/CEE).
  Standards utilisés: EN 50 081-1 et EN 50 082-2.
- Matériel électrique destiné à employer dans certaines limites de tension (73/23/CEE).
  Standards utilisés: EN 60 335-1 et EN 60 335-2-41.

Dichiarazione di Conformità

Noi **GRUNDFOS** dichiariamo sotto la nostra esclusiva responsabilità che i prodotti **AP12, AP35** e **AP50** ai quali questa dichiarazione se riferisce sono conformi alle Direttive del Consiglio concernente il ravvicinamento delle legislazioni degli Stati membri CEE relative a

- Macchine (89/392/CEE).
  Standard usato: EN 292.
- Compatibilità elettromagnetica (89/336/CEE).
  Standard usati: EN 50 081-1 e EN 50 082-2.
- Materiale elettrico destinato ad essere utilizzato entro certi limiti di tensione (73/23/CEE).
  Standard usati: EN 60 335-1 e EN 60 335-2-41.

Declaración de Conformidad

Nosotros **GRUNDFOS** declaramos bajo nuestra única responsabilidad que los productos **AP12, AP35** y **AP50** a los cuales se refiere esta declaración son conformes con las Directivas del Consejo relativas a la aproximación de las legislaciones de los Estados Miembros de la CEE sobre

- Máquinas (89/392/CEE).
  Norma aplicada: EN 292.
- Compatibilidad electromagnética (89/336/CEE).
  Normas aplicadas: EN 50 081-1 y EN 50 082-2.
- Material eléctrico destinado a utilizarse con determinadas límites de tensión (73/23/CEE).
  Normas aplicadas: EN 60 335-1 y EN 60 335-2-41.

Declaração de Conformidade

Nós **GRUNDFOS** declaramos sob nossa única responsabilidade que os produtos **AP12, AP35** e **AP50** aos quais se refere esta declaração estão em conformidade com as Directivas do Conselho das Comunidades Europeias relativas à aproximação das legislações dos Estados Membros respeitantes à

- Máquinas (89/392/CEE).
  Norma utilizada: EN 292.
- Compatibilidade electromagnética (89/336/CEE).
  Normas utilizadas: EN 50 081-1 e EN 50 082-2.
- Material eléctrico destinado a ser utilizado dentro de certos limites de tensão (73/23/CEE).
  Normas utilizadas: EN 60 335-1 e EN 60 335-2-41.

Δήλωση Συμμόρφωσης

Εμείς η **GRUNDFOS** δηλώνουμε με αποκλειστική δική μας ευθύνη ότι τα προϊόντα **AP12, AP35** και **AP50** συμμορφώνονται με την Οδηγία του Συμβουλίου επί της σύγκλισης των νόμων των Κρατών Μελών της Ευρωπαικής Ενωσης σε σχέση με τα

- Μηχανήματα (89/392/EEC).
  Πρότυπο που χρησιμοποιήθηκε: EN 292.
- Ηλεκτρομαγνητική συμβατότητα (89/336/EEC).
  Πρότυπα που χρησιμοποιήθηκαν: EN 50 081-1 και EN 50 082-2.
- Ηλεκτρικές συσκευές σχεδιασμένες γιά χρήση εντός ορισμένων ορίων ηλεκτρικής τάσης (73/23/EEC).
  Πρότυπα που χρησιμοποιήθηκαν: EN 60 335-1 και EN 60 335-2-41.

Overeenkomstigheidsverklaring

Wij **GRUNDFOS** verklaren geheel onder eigen verantwoordelijkheid dat de produkten **AP12, AP35** en **AP50** waarop deze verklaring betrekking heeft in overeenstemming zijn met de Richtlijnen van de Raad inzake de onderlinge aanpassing van de wetgevingen van de Lid-Staten betreffende

- Machines (89/392/EEG).
  Norm: EN 292.
- Elektromagnetische compatibiliteit (89/336/EEG).
  Normen: EN 50 081-1 en EN 50 082-2.
- Elektrisch materiaal bestemd voor gebruik binnen bepaalde spanningsgrenzen (73/23/EEG).
  Normen: EN 60 335-1 en EN 60 335-2-41.

Försäkran om överensstämmelse

Vi **GRUNDFOS** försäkrar under ansvar, att produkterna **AP12, AP35** och **AP50**, som omfattas av denna försäkran, är i överensstämmelse med Rådets Direktiv om inbördes närmande till EU-medlemsstaternas lagstiftning, avseende

- Maskinell utrustning (89/392/EC).
  Använd standard: EN 292.
- Elektromagnetisk kompatibilitet (89/336/EC).
  Använda standarder: EN 50 081-1 och EN 50 082-2.
- Elektrisk material avsedd för användning inom vissa spänningsgränser (73/23/EC).
  Använda standarder: EN 60 335-1 och EN 60 335-2-41.

Vastaavuusvakuutus

Me **GRUNDFOS** vakuutamme yksin vastuullisesti, että tuotteet **AP12, AP35** ja **AP50**, jota tämä vakuutus koskee, noudattavat direktiivejä jotka käsittelevät EY:n jäsenvaltioiden koneellisia laitteita koskevien lakien yhdenmukaisuutta seur.:

- Koneet (89/392/EY).
  Käytetty standardi: EN 292.
- Elektromagneettinen vastaavuus (89/336/EY).
  Käytetyt standardit: EN 50 081-1 ja EN 50 082-2.
- Määrättyjen jännite rajoitusten puitteissa käytettävät sähköiset laitteet (73/23/EY).
  Käytetyt standardit: EN 60 335-1 ja EN 60 335-2-41.

Overensstemmelseserklæring

Vi **GRUNDFOS** erklærer under ansvar, at produkterne **AP12, AP35** og **AP50**, som denne erklæring omhandler, er i overensstemmelse med Rådets direktiver om indbyrdes tilnærmelse til EF medlemsstaternes lovgivning om

- Maskiner (89/392/EØF).
  Anvendt standard: EN 292.
- Elektromagnetisk kompatibilitet (89/336/EØF).
  Anvendte standarder: EN 50 081-1 og EN 50 082-2.
- Elektrisk materiel bestemt til anvendelse inden for visse spændingsgrænser (73/23/EØF).
  Anvendte standarder: EN 60 335-1 og EN 60 335-2-41.

Bjerringbro, 1st May 1995



Kaj Kruse
Vice President

AP12, AP35, AP50

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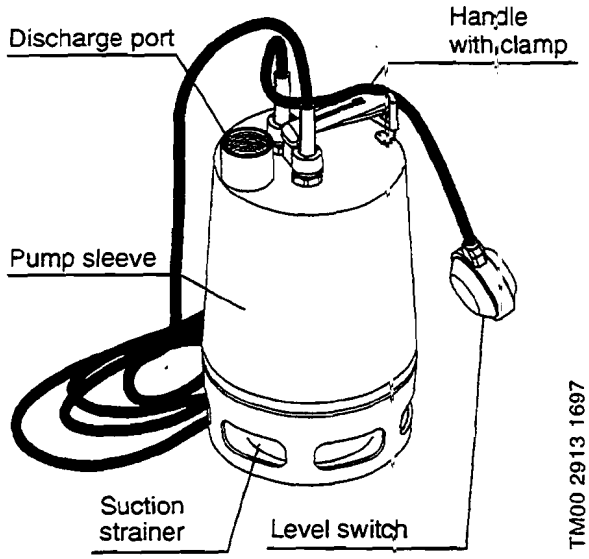
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Before beginning installation procedures, these Installation and Operating Instructions should be studied carefully. The installation and operation should also be in accordance with local regulations and accepted codes of good practice.

1. General Description

Fig. 1



1.1 Applications

The GRUNDFOS AP pump is a single-stage submersible pump designed for the pumping of waste water.

The pump is capable of pumping water which contains a limited quantity of solids, however not stones and similar materials, without being blocked or damaged.

The pump is available for automatic as well as manual operation and can be installed in a permanent installation or used as a portable pump.

The pump is suitable for:

Applications	AP12	AP35	AP50
Groundwater lowering	●	●	●
Pumping in drainage pits	●	●	●
Pumping in surface water pits with inflow from roof gutters, shafts, tunnels, etc.	●	●	●
Emptying of ponds, tanks, etc.	●	●	●
Pumping of fibre-containing waste water from laundries and industries		●	●
Pumping of domestic waste water from septic tanks and sludge treating systems		●	●
Pumping of domestic waste water without discharge from water closets		●	●
Pumping of domestic waste water with discharge from water closets			●
Maximum particle size [mm]	12	35	50

The pump must not be used in or at swimming pools, garden ponds, etc. when there are persons in the water.

Incorrect application of the pump (e.g. resulting in blocking of the pump) and wear are not covered by the warranty.

1.2 Storage and Operating Conditions

Storage Temperature: Down to –30°C.

Minimum Liquid Temperature: 0°C.

Maximum Liquid Temperature: +55°C continuously. Up to +70°C for periods not exceeding 3 minutes. Then the pump must cool down.

Installation Depth: Maximum 10 metres below liquid level.

pH Value: Between 4 and 10.

Density: Maximum 1100 kg/m³.

Viscosity: Maximum 10 mm²/s.

Technical Data: See pump nameplate.

1.3 Sound Pressure Level

The sound pressure level of the pump is lower than the limiting values stated in the EC Council Directive 89/392/EEC relating to machinery.

2. Safety

Pump installation in wells must be carried out by specially trained persons.

3. Electrical Connection

Note: Depending on local regulations, a pump with 10 metres of mains cable must be used if the pump is used as a portable pump for different applications.

The electrical connection should be carried out in accordance with local regulations.

The pump must be connected to an external mains switch. If the pump is not installed close to the switch, this must be of a lockable type.

The operating voltage and frequency are marked on the pump nameplate. Please make sure that the motor is suitable for the electricity supply on which it will be used.

As a precaution, the pump must be connected to a socket with earth connection. The permanent installation must be fitted with an earth leakage circuit breaker (ELCB) with a tripping current < 30 mA.

Three-phase pumps must be connected to an external motor starter with differential release and with a minimum contact gap of 3 mm. The set nominal current of the motor starter must correspond to the electrical data marked on the pump nameplate.

If a level switch is connected to a three-phase pump, the motor starter must be magnetically operated.

Single-phase pumps incorporate thermal overload protection and require no additional motor protection.

Note: If the motor is overloaded, it will stop automatically. When it has cooled to normal temperature, it will restart automatically.

3.1 Checking of Direction of Rotation

(Three-Phase Pumps only)

The direction of rotation should be checked every time the pump is connected to a new installation.

Check the direction of rotation as follows:

1. Position the pump so that the impeller can be observed.
2. Start the pump for a short period.
3. Observe the rotation of the impeller. The correct direction of rotation is indicated by an arrow on the suction strainer (clockwise when seen from the bottom). If the impeller rotates in the wrong direction, reverse the direction of rotation by interchanging two of the phases to the motor.

If the pump is connected to a piping system, the direction of rotation can be checked as follows:

1. Start the pump and check the quantity of water or the discharge pressure.
2. Stop the pump and interchange two of the phases to the motor.
3. Start the pump and check the quantity of water or the discharge pressure.
4. Stop the pump.

Compare the results taken under points 1 and 3. The connection which gives the larger quantity of water or the higher pressure is the correct direction of rotation.

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4. Installation

The installation of the pump must be carried out by specially trained persons.
AP35 and AP50: Care must be taken to ensure that persons cannot come into contact with the pump impeller.

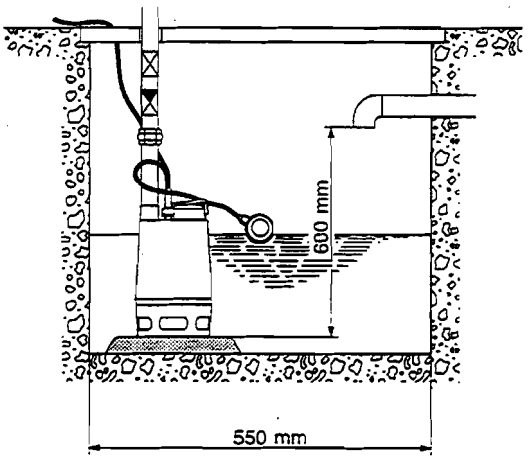
4.1 Connection

For permanent installation, it is recommended to fit a union, a non-return valve and an isolating valve in the discharge pipe.

If the pump is installed in a pit with a minimum free cable length of 100 mm, see fig. 6, the minimum pit dimensions must be as shown in fig. 2.

Furthermore, the pit should be dimensioned according to the relation between the water flow to the pit and the pump capacity.

Fig. 2



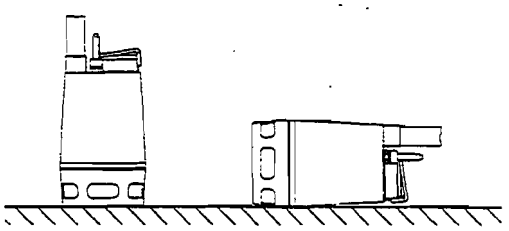
TM00 2918 1697

4.2 Pump Location

The pump can be used in vertical or horizontal position with the discharge port as the highest point of the pump, see fig. 3.

During operation, the suction strainer must always be completely covered by the pumped liquid.

Fig. 3



TM00 2920 0794

When the pipe/hose has been connected, place the pump in its operating position.

Do not lift the pump by means of the electric cable.

Position the pump so that the suction strainer will not be blocked or partly blocked by sludge, mud or similar materials.

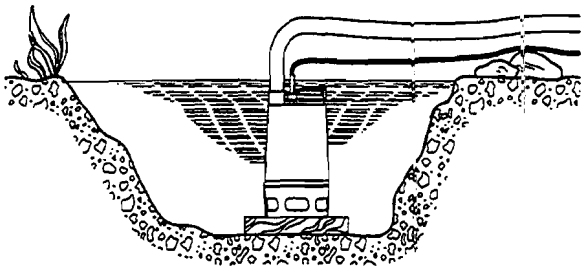
In the case of permanent installation, the pit must be cleared of sludge, pebbles, etc. before the pump is installed.

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It is recommended to place the pump on a solid base, see fig. 4.

The pump must not be installed hanging from the discharge pipe.

Fig. 4



TM00 2922 0794

4.3 Setting of Level Switch

For pumps supplied with a level switch, the difference in level between start and stop can be set by adjusting the free cable between the level switch and the pump handle.

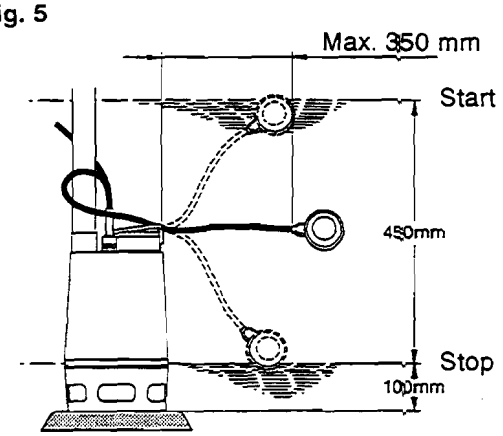
The longer the length of free cable, the larger the difference in level between start and stop.

Maximum length of free cable: 350 mm, see fig. 5.

Minimum length of free cable: 100 mm, see fig. 6.

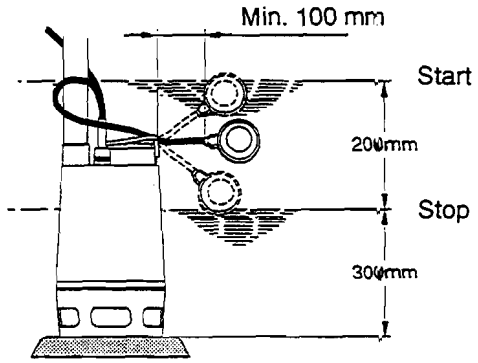
The stop level must be above the suction strainer to prevent the pump from taking in air.

Fig. 5



TM00 2924 1697

Fig. 6



TM00 2926 1697

5. Start-Up

Before starting the pump, check that the suction strainer is fitted to the pump and submerged in the pumped liquid.

Open the isolating valve, if fitted, and check the level switch setting.

Note: The pump may be run briefly to check the direction of rotation without being submerged in the pumped liquid.

6. Maintenance and Service

Before starting work on the pump, make sure that the electricity supply to the pump has been switched off and that it cannot be accidentally switched on.

Before carrying out maintenance and service, it must be ensured that the pump has been thoroughly flushed with clean water. Rinse the pump parts in water after dismantling.

Check the pump and replace the oil once a year. If the pump is used for pumping liquids containing abrasive particles or it is operating continuously, the pump must be checked at shorter intervals.

Out of consideration for the personal safety and health, this work must be carried out by specially trained persons. Furthermore, all rules and regulations covering safety, health and environment must be observed.
During dismantling, caution should be exercised as there will be access to sharp edges, etc. which may cut.

The pump contains approx. 60 ml non-poisonous oil.

Used oil must be disposed of in accordance with local regulations.

If the drained oil contains water or other impurities, the shaft seal should be replaced.

6.1 Pump Construction

The construction of the pump will appear from the table below and figs. A, B and C at the end of these instructions.

Pos.	Description
6	Pump housing
37a	O-ring
49	Impeller
55	Pump sleeve with motor
66	Washer
66b	Lock washer
67	Lock nut
67a	Protective cap
84	Suction strainer
105	Shaft seal
182	Level switch
188a	Screws
193	Screws

7. Fault Finding Chart

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Fault	Cause	Remedy
1. Motor does not start.	a) No electricity supply.	Connect the electricity supply.
	b) Motor switched off by level switch.	Adjust/replace the level switch.
	c) Fuses are blown.	Replace fuses.
	d) Motor protection/thermal relay has tripped out.	Wait until the motor protection trips in again/reset the relay.
	e) Impeller blocked by impurities.	Clean the impeller.
	f) Short-circuit in cable or motor.	Replace the defective part.
2. Motor protection/ thermal relay trips out after short time of operation.	a) Temperature of pumped liquid too high.	Use another pump type.
	b) Impeller blocked or partly blocked by impurities.	Clean the pump.
	c) Phase failure.	Call an electrician.
	d) Voltage too low.	Call an electrician.
	e) Overload setting of the motor starter too low.	Adjust the setting.
	f) Incorrect direction of rotation. See section *3.1 Checking of Direction of Rotation.*	Reverse the direction of rotation.
3. Pump runs constantly or gives insufficient water.	a) Pump partly blocked by impurities.	Clean the pump.
	b) Discharge pipe or valve partly blocked by impurities.	Clean the discharge pipe.
	c) Impeller not properly fixed to the shaft.	Tighten the impeller.
	d) Incorrect direction of rotation. See section *3.1 Checking of Direction of Rotation.*	Reverse the direction of rotation.
	e) Incorrect setting of level switch.	Adjust the level switch.
	f) Pump too small for the application.	Replace the pump.
	g) Impeller worn.	Replace the impeller.
4. Pump runs but gives no water.	a) Pump blocked by impurities.	Clean the pump.
	b) Discharge pipe or non-return valve blocked by impurities.	Clean the discharge pipe.
	c) Impeller not properly fixed to the shaft.	Tighten the impeller.
	d) Air in pump.	Vent the pump and the discharge pipe.
	e) Liquid level too low. The suction strainer is not completely submerged in the pumped liquid.	Submerge the pump in the liquid or adjust the level switch.
	f) Level switch does not move freely.	Make the level switch move freely.

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D

1. Sicherheitshinweise

1.1 Allgemeines

Diese Montage- und Betriebsanleitung enthält grundlegende Hinweise, die bei Aufstellung, Betrieb und Wartung zu beachten sind. Sie ist daher unbedingt vor Montage und Inbetriebnahme vom Monteur sowie dem zuständigen Fachpersonal/Betreiber zu lesen. Sie muß ständig am Einsatzort der Anlage verfügbar sein.

Es sind nicht nur die unter diesem Abschnitt "Sicherheitshinweise" aufgeführten, allgemeinen Sicherheitshinweise zu beachten, sondern auch die unter den anderen Abschnitten eingefügten, speziellen Sicherheitshinweise.

1.2 Kennzeichnung von Hinweisen

Die in dieser Montage- und Betriebsanleitung enthaltenen Sicherheitshinweise, die bei Nichtbeachtung Gefährdungen für Personen hervorrufen können, sind mit allgemeinem Gefahrensymbol "Sicherheitszeichen nach DIN 4844-W9" besonders gekennzeichnet.

Achtung ***Dieses Symbol finden Sie bei Sicherheitshinweisen, deren Nichtbeachtung Gefahren für die Maschine und deren Funktionen hervorrufen kann.***

Hinweis ***Hier stehen Ratschläge oder Hinweise, die das Arbeiten erleichtern und für einen sicheren Betrieb sorgen.***

Direkt an der Anlage angebrachte Hinweise wie z.B.

- Drehrichtungspfeil
- Kennzeichnung für Fluidanschlüsse

müssen unbedingt beachtet und in vollständig lesbarem Zustand gehalten werden.

1.3 Personalqualifikation und -schulung

Das Personal für Bedienung, Wartung, Inspektion und Montage muß die entsprechende Qualifikation für diese Arbeiten aufweisen. Verantwortungsbereich, Zuständigkeit und die Überwachung des Personals müssen durch den Betreiber genau geregelt sein.

1.4 Gefahren bei Nichtbeachtung der Sicherheitshinweise

Die Nichtbeachtung der Sicherheitshinweise kann sowohl eine Gefährdung für Personen als auch für die Umwelt und Anlage zur Folge haben. Die Nichtbeachtung der Sicherheitshinweise kann zum Verlust jeglicher Schadenersatzansprüche führen.

Im einzelnen kann Nichtbeachtung beispielsweise folgende Gefährdungen nach sich ziehen:

- Versagen wichtiger Funktionen der Anlage
- Versagen vorgeschriebener Methoden zur Wartung und Instandhaltung
- Gefährdung von Personen durch elektrische und mechanische Einwirkungen

1.5 Sicherheitsbewußtes Arbeiten

Die in dieser Montage- und Betriebsanleitung aufgeführten Sicherheitshinweise, die bestehenden nationalen Vorschriften zur Unfallverhütung sowie eventuelle interne Arbeits-, Betriebs- und Sicherheitsvorschriften des Betreibers, sind zu beachten.

1.6 Sicherheitshinweise für den Betreiber/ Bediener

Ein vorhandener Berührungsschutz für sich bewegende Teile darf bei sich in Betrieb befindlicher Anlage nicht entfernt werden.

Gefährdungen durch elektrische Energie sind auszuschließen (Einzelheiten hierzu siehe z.B. in den Vorschriften des VDE und der örtlichen Energieversorgungsunternehmen).

1.7 Sicherheitshinweise für Wartungs-, Inspektions- und Montagearbeiten

Der Betreiber hat dafür zu sorgen, daß alle Wartungs-, Inspektions- und Montagearbeiten von autorisiertem und qualifiziertem Fachpersonal ausgeführt werden, das sich durch eingehendes Studium der Montage- und Betriebsanleitung ausreichend informiert hat.

Fig. A: AP12

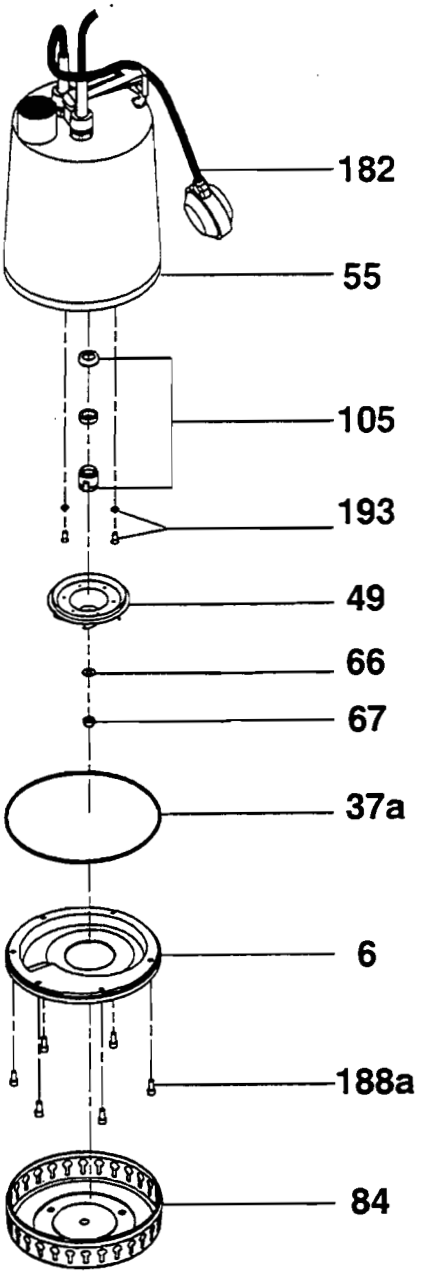


Fig. B: AP35

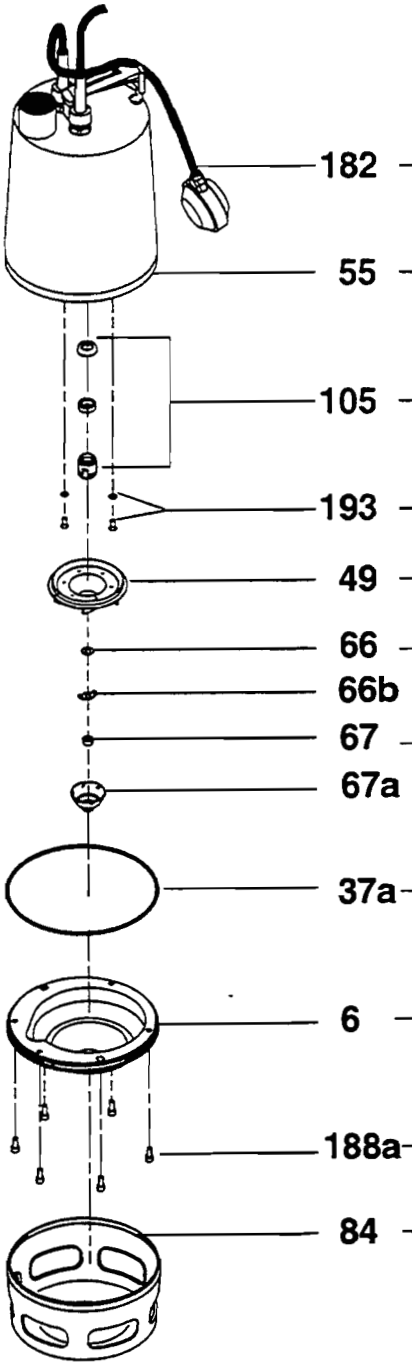
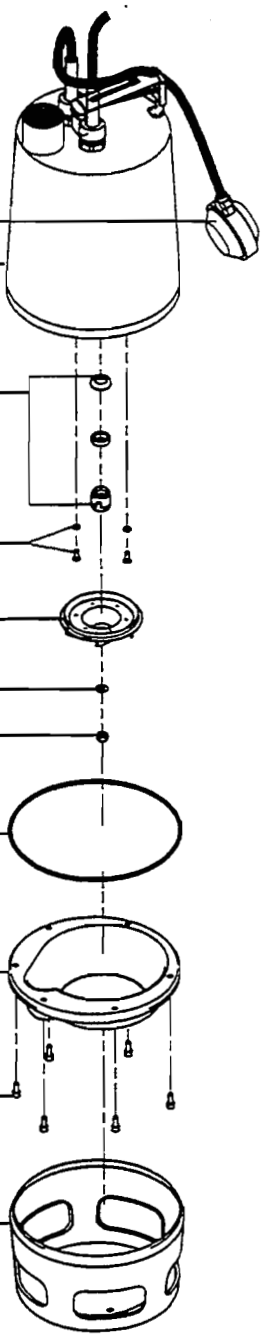


Fig. C: AP50



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PERFECTION PLATING SITE

AUTODIALER ALARM SCHEDULE

ALARM CONTROL RELAY No.1

a. CAH-102 Submersible well pump high current alarm shutdown.
b. FAL-202 Aerator blower low flow alarm shutdown.

ALARM CONTROL RELAY No. 2

a. LAH-203 Iron filter tank high level alarm shutdown.
b. OAL-209 Acid tank low pH alarm shutdown.
c. OAH-209 Acid tank high pH alarm shutdown.

ALARM CONTROL RELAY No. 3

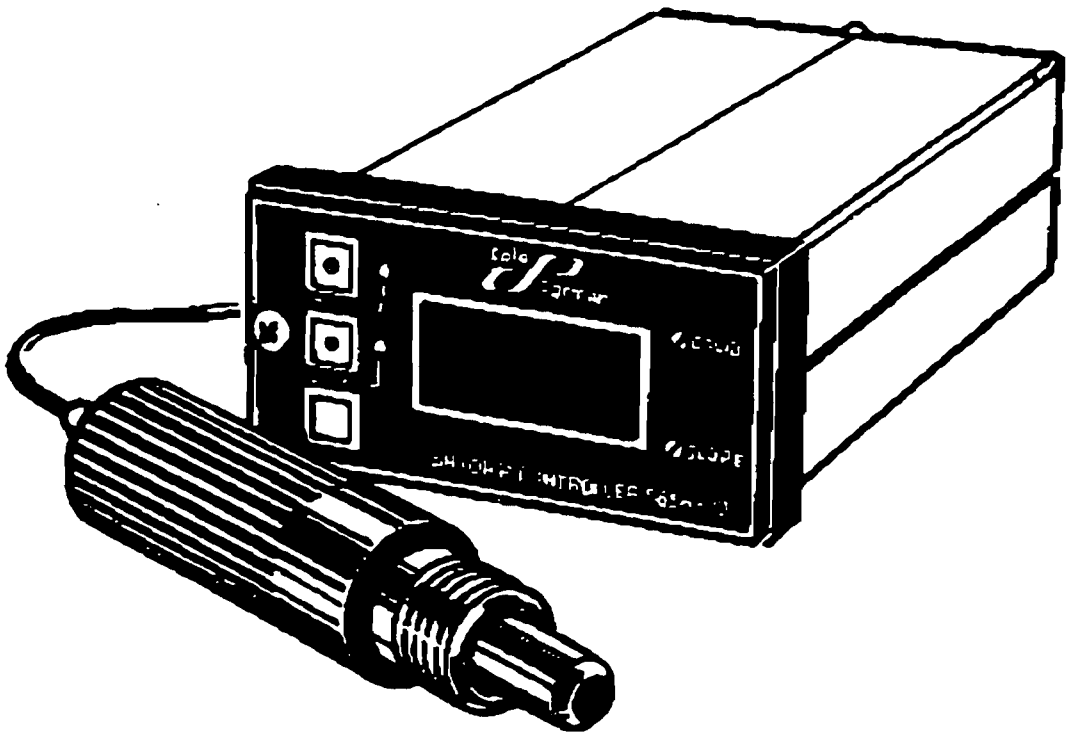
a. LAH-215 Aerator blower tank high level alarm shutdown.
b. KIC-301 Conductivity high alarm shutdown.
c. LAH-401 Alkali tank high level alarm shutdown.

ALARM CONTROL RELAY No.4

a. OAL-404 Effluent low pH alarm shutdown.
b. OAH-404 Effluent high pH alarm shutdown.
c. LAH-501 Building sump high level alarm shutdown.

Operating Instructions

Cole-Parmer Model 05656-00
LED pH/ORP Controller



Cole Parmer®

Printed in the U.S.A. 0995 R1

Cole-Parmer Instrument Company

625 East Bunker Court, Vernon Hills, Illinois 60061-1844
-847-549-7600 or Toll-free 1-800-323-4340
Fax: 1-847-247-2929 Telex: 28-9405

NOTE:

Please take care to use this instrument properly, according to the instructions given in this manual.

Proper caution should always be employed when working with any instrument.

Printed in the U.S.A.

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General Description

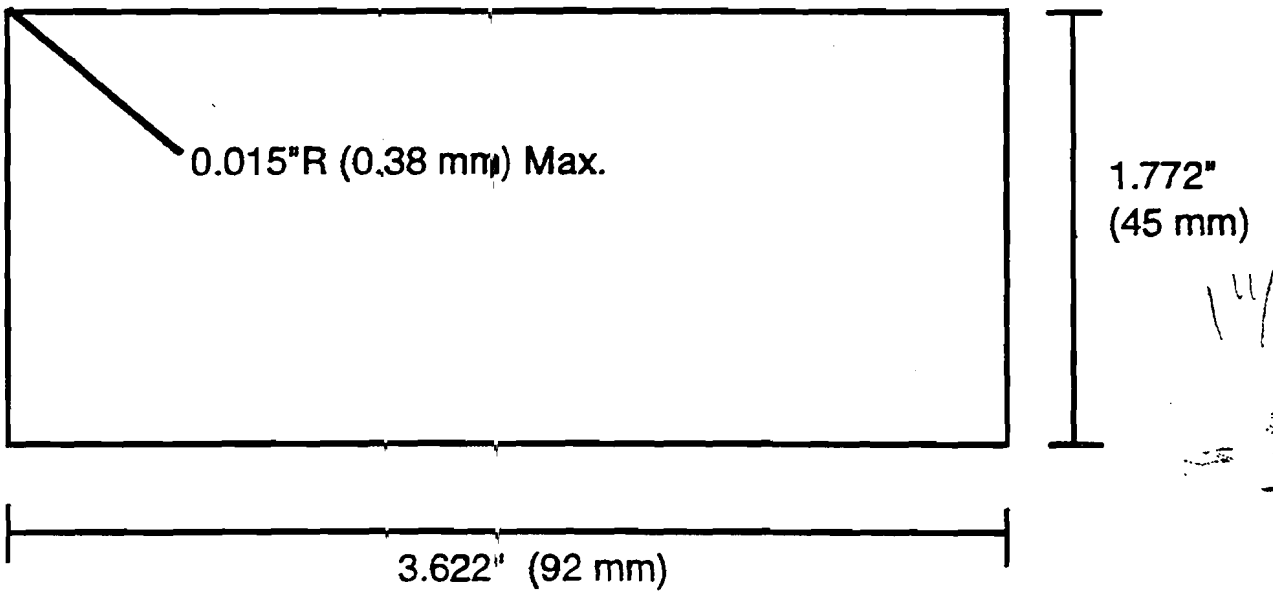
Model 05656-00 is a ⅛ DIN controller for pH or ORP measurement. It features automatic temperature compensation (with use of ATC probe), high and low overrange panel lights plus output relays for high and low pH control and alarms, recorder output and readout for temperature and ORP. Internal switching selects pH or ORP.

Note: You must have a pH electrode with ATC to calibrate this unit or a fixed value resistor 110 Ω for 77°F (25°C).

Specifications

pH:	Range:	0 to 14 pH
	Resolution:	0.1 pH
	Accuracy:	0.1 pH ±1 digit (relative) when standardize
	Recorder output:	1400 mV
mV:	Range:	+1990 to -1990 mV
	Resolution:	10 mV
	Accuracy:	10 mV
	Recorder output:	±1990 mV
°C:	Range:	0° to 100°C
	Resolution:	1°C
	Accuracy:	1°C
	Recorder output:	1000 mV at 100°C
Input impedence:	Greater than 10^{13} ohms	
Relay capacity:	8 amps (117 VAC) or 4 amps (230 VAC)	
Power:	115 or 230 VAC ±15%, 50/60 HZ	
Dimensions:	3.9" x 2" x 7" (9.75 x 5 x17.5cm)	
Weight:	Approx. 1.8 lbs (0.81 kg)	

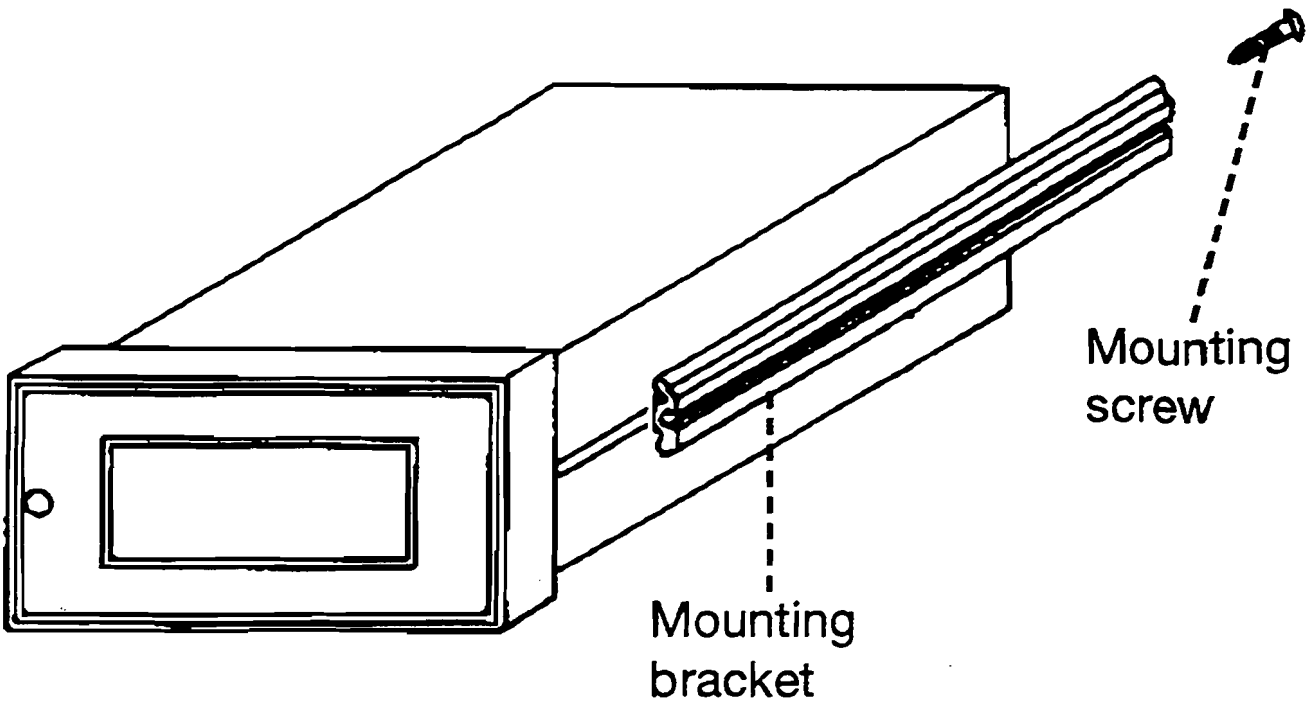
Figure 1-Panel Cutout Dimensions



Mounting Procedure

1. Make a cutout in any panel for the meter, approximately 3.62" x 1.77". (See Figure 1, previous page, for more accurate dimensions. The panel should range from 1/16 to 3/8 inches (1.5 to 9.5mm) in thickness.
2. Remove the mounting screw and mounting bracket from the panel meter and insert the meter into the cutout. (See Figure 2.)
3. Slide the mounting bracket back on to the meter from behind the panel. Fasten the screw to secure the panel meter to the mounting panel.

Figure 2-Mounting



Installation

1. Connect the AC line, high set relay output and low set relay output according to the wiring diagram (Figure 4).
   NOTE: Use the NO (normally open) and COM (common) terminals of the relay for control operations. Most system failures would de-energize the relays, thus disrupting power to the external control devices.
2. Loosen the front panel screw and pull the front panel and circuit board from the housing. Set the internal pH/ORP select switch to the desired mode of operation. (Refer to Figure 5.) Push the front panel back into its housing and replace the screw.
3. For pH mode: Connect a pH combination electrode with BNC connector to the input and a PT100 ATC/TEMP probe with miniature phone jack to the ATC/TEMP input or use a 110 ohm resistor for fixed temperature compensation at 79.3 or 26.3°C.
   NOTE: You must have an ATC probe for pH measurement and calibration.
4. For ORP mode: Connect an ORP combination electrode with BNC connector to the input. Connect a PT100 temperature probe to the ATC TEMP input only if temperature measurement is required.

Figure 3-Front Panel

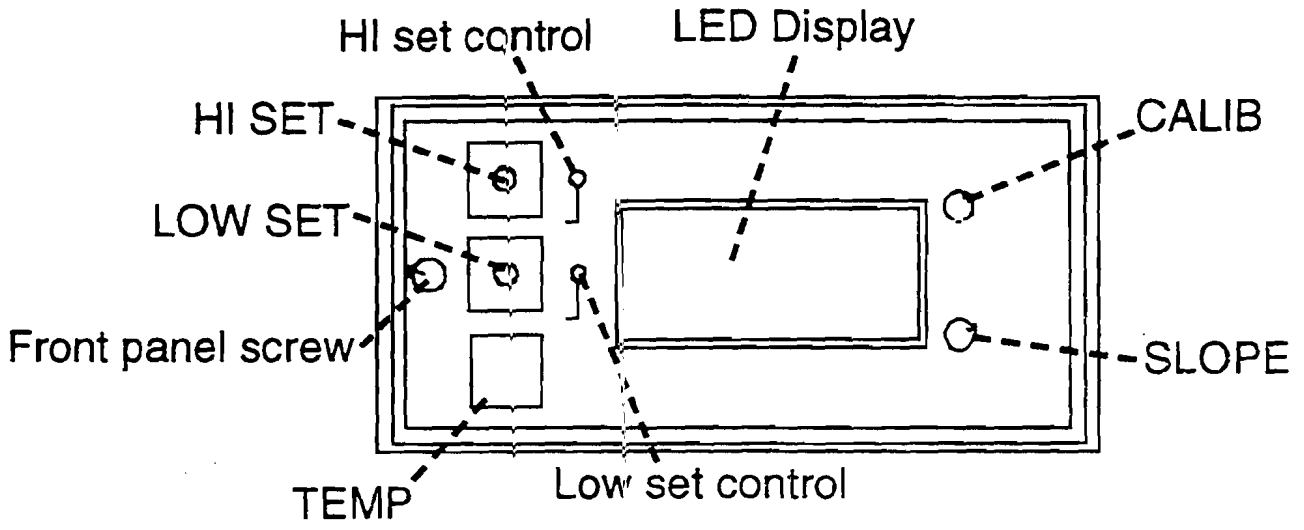


Figure 4-Rear Panel/Wiring

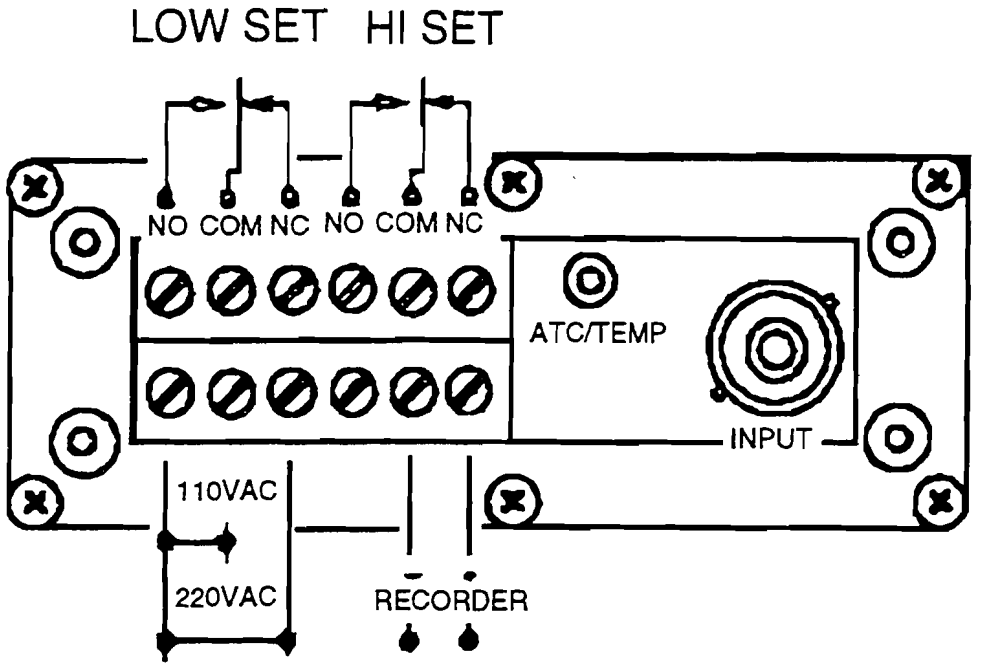
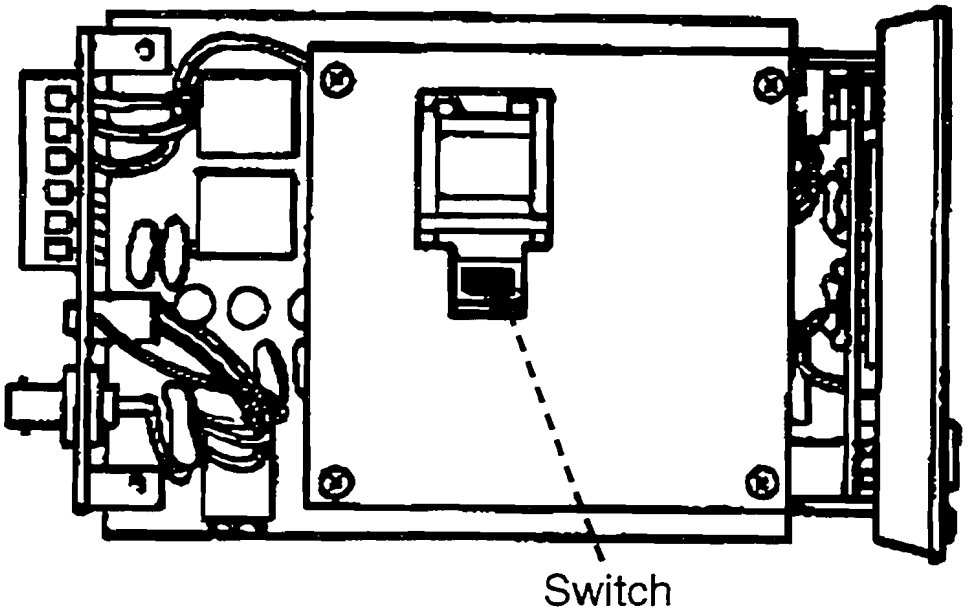


Figure 5-pH/ORP Switch



Up for pH-toward front, Down for ORP

pH and ORP Measurements

For pH standardization:

1. Immerse the pH electrode and ATC/TEMP probe in buffer 7.00.
2. Press the TEMP switch on the front panel. Wait for the temperature reading to stabilize on the display. The meter will then indicate the temperature of the buffer.
3. Release the TEMP switch. Refer to Table 1, page 8, to find the buffer value corresponding to the temperature value in Step 2. Adjust the CALIB control on the front panel to display this buffer value.
4. Rinse the electrode and probe with distilled or deionized water, then immerse both in either buffer 4.01 or buffer 10.00.
5. Repeat Step 2 for the second buffer.
6. Release the TEMP switch. Refer to Table 1, page 8, to find the buffer value corresponding to the temperature value in Step 5.
7. Adjust the SLOPE control to read this buffer value.
8. The meter is standardized and ready for measurements.

For ORP measurements:

In the ORP mode the meter indicates the absolute value of the measured mV. No calibration is necessary.

Controller Set Points

High set: Press the HI SET switch on the front panel to display the value of the high set point. Adjust the HI SET control to reset the pH or mV high set point. Release the HI SET switch and the meter again indicates the process pH or mV values.

Low set: Press the LOW SET switch to display the value of the low set point. Adjust the LOW SET control to reset the pH or mV low set point. Release the LOW SET switch to display the process pH or mV values.

Each of the set points, high and low, has a built-in hysteresis, or dead band, of +1 digit (i.e., +0.1 pH in the pH mode and +10 mV in the ORP mode). Due to this hysteresis, the high and low set points will be at least 0.2 pH or 20 mV apart.

Relay and Front Panel LED Format

1. The HI SET relay and the HI SET indicator on the front panel are energized when the process value is greater than the set value. The LOW SET relay and the LOW SET LED indicator on the front panel are energized when the process value is less than the set value.
2. Use the NO (normally open) and COM (common) terminals of the relay for control operations. Most system failures would de-energize the relays thus disrupting power to the external control devices.

Temperature Measurement

1. Press the TEMP switch on the front panel, and the meter will display the process temperature. The process (pH or mV) value will again be displayed when the TEMP switch is released.

2. While the TEMP switch is depressed, the relays will be de-energized and any external control devices will be de-activated. Therefore, use the temperature mode only for pH standardization or for process measurements before the control loop is established.

Table 1-Temperature/pH value chart

Temperature		Buffer Values (pH)		
°C	(°F)	4.01	7.00	10.00
0	32	4.0	7.1	10.3
5	41	4.0	7.1	10.3
10	50	4.0	7.1	10.2
15	59	4.0	7.0	10.1
20	68	4.0	7.0	10.1
25	77	4.0	7.0	10.0
30	86	4.0	7.0	10.0
35	95	4.0	7.0	9.9
40	104	4.0	7.0	9.9
45	113	4.0	7.0	9.9
50	122	4.1	7.0	9.8
55	131	4.1	7.0	9.8
60	140	4.1	7.0	9.8

Buffers other than 4.01 or 10.01 may be used for standardization.

Make sure to check the buffer temperature value.

Accessories

Optional pH electrodes and ATC probes are available for use with this unit. The following is a partial list. Call Cole-Parmer toll-free at 1-800-323-4340, for ordering information or for further details on our complete line of pH electrodes.

Model no.	Description
MN-05993-70	General purpose pH electrode. With built-in platinum RTD temperature sensor; in-line; disposable.
MN-05993-81	General purpose pH electrode. With built-in platinum RTD temperature sensor; submersible; disposable.
MN-05994-42	Industrial in-line ATC probe. For use with pH electrodes with no built-in temperature sensor. ½ (M)NPT on Kynar® body; 25mm x 112mm, 10-ft connector.
MN-05994-44	Industrial submersion/tank ATC probe. 100 ohm Pt element at the end of a 3-ft ABS tube; 10-ft cable.

Kynar- Reg TM Pennwalt Corp.

Warranty

The Cole-Parmer Instrument Company warrants this product to be free from significant deviations in material and workmanship for a period of 6 months from date of purchase. If repair or adjustment is necessary and has not been the result of abuse or misuse within the 6 month period, please return—freight prepaid—and correction will be made without charge. Cole-Parmer alone will determine if the product problem is due to deviations or customer misuse.
Out-of-warranty products will be repaired on a charge basis.

Return of Items

Authorization must be obtained from our Customer Satisfaction Department before returning items for any reason. When applying for authorization, please include data regarding the reason the items are to be returned.
For your protection, items must be carefully packed to prevent damage in shipment and insured against possible damage or loss. Cole-Parmer will not be responsible for damage resulting from careless or insufficient packing.
A restocking charge will be made on all unauthorized returns.
NOTE: The Cole-Parmer Instrument Company reserves the right to make improvements in design, construction and appearance of our products without notice.

Cole-Parmer Instrument Company

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GLI International

Operating Instruction Manual

Manual No. 672E
Revision 2-896

MODEL 672E
CONDUCTIVITY and
% CONCENTRATION ANALYZER

(for use with electrodeless conductivity sensors)

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e-mail: info@gliint.com

INSTRUMENT SETUP GUIDE

This manual contains detailed instructions for all operating aspects of this instrument. Part One is a general description summary of the Model 672E. Part Two explains how to install and wire the instrument. To familiarize yourself with the basic operation of the 672E, please read Part Three, Sections 1, 2 and 3. The following guide shows you which other sections of Part Three to read when setting up the analyzer to measure conductivity (in µS/cm, mS/cm or S/cm) or % concentration.

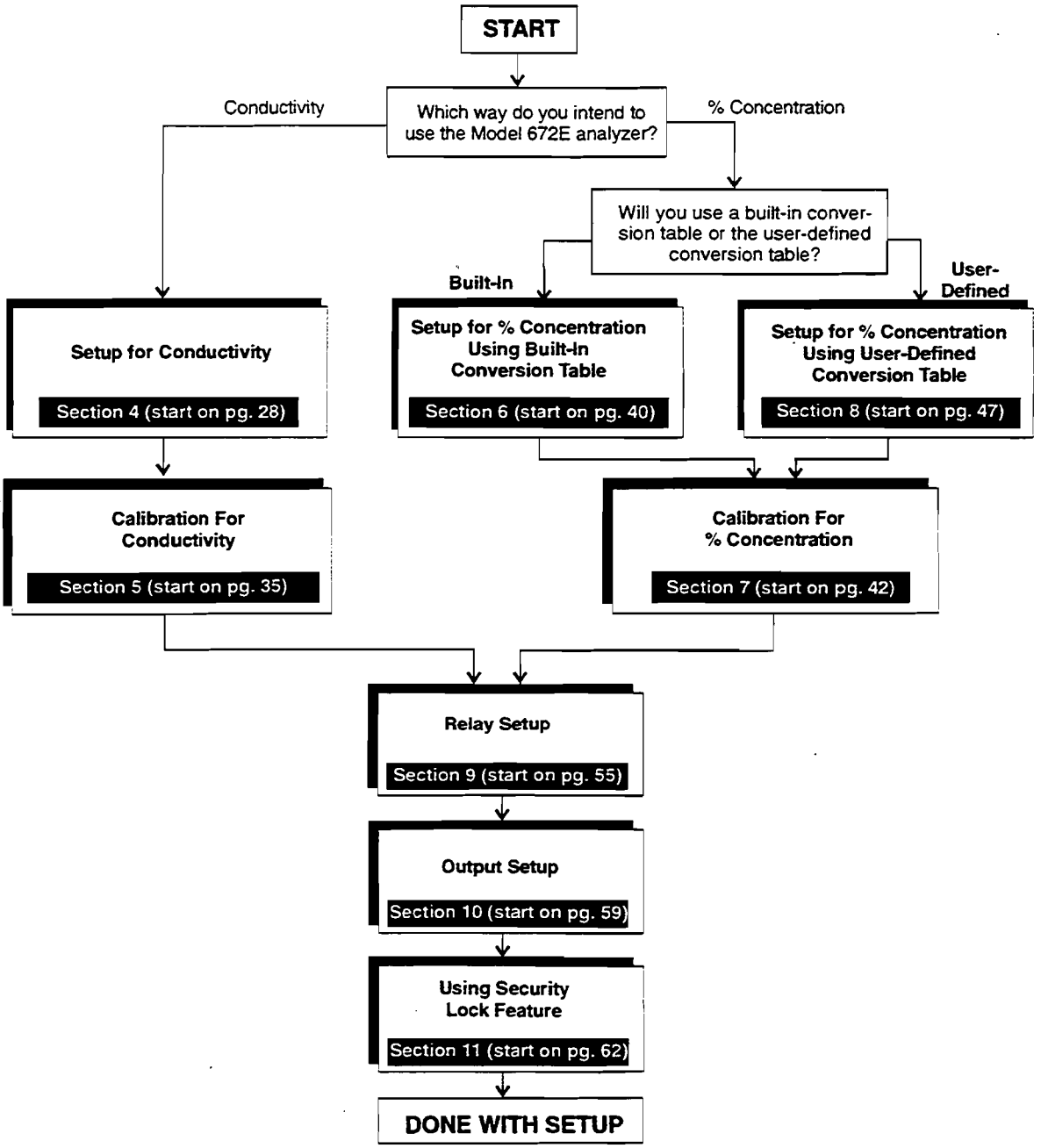


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PART ONE - INTRODUCTION

SECTION 1 - GENERAL INFORMATION

1.1 Instrument Capability

Two Analyzers In One

The 672E analyzer can only be used with a GLI Model 3600E-series electrodeless conductivity sensor. The analyzer can be set up to measure the conductivity or the % concentration of a solution. Built-in conversion tables for some common solutions may be used to conveniently convert measured conductivity to % concentration values. For other solutions, you can create a user-defined table to convert conductivity to % concentration.

Temperature Compensation

The electrodeless conductivity sensor used with the 672E analyzer has a built-in 1000 ohm platinum RTD to sense the temperature of the solution being measured. This temperature input can be used with one of the available temperature compensation methods to provide accurate temperature-compensated conductivity (or % concentration) readings.

Display Readouts

The large liquid crystal display can alternately indicate four measured variables: conductivity, % concentration (only when a conversion table is used to convert measured conductivity), temperature (in °C or °F), or the 4-20 mA instrument output.

Operator Interface

Abbreviated identifiers, along with their related numerical values, provide easy-to-understand readouts for process monitoring. Procedure messages prompt you during instrument setup and calibration. System diagnostic error messages flash whenever the instrument detects an abnormal system operating condition.

Analog Output and Relay Flexibility

Isolated 0-5 VDC, 0-1 mA, and 4-20 mA outputs track the measured conductivity (or % concentration). An output hold feature to conveniently suspend operation of any receiving device maintains the latest output during calibration or instrument setup. A range expand feature enables the outputs to represent any segment of the measuring scale. Also, the outputs may be operated inversely so that they decrease – instead of increase – as the measured conductivity (or % concentration) increases.

The 672E has two SPDT relays for on/off control requirements. Each relay can be independently set to operate in a

control mode or an alarm mode (see Part Three, Section 9 for details). In either mode, both relays can be set for "fail-safe" operation. Lastly, Relay B can be alternately selected to operate as a "system diagnostic alarm" instead of its normal relay operation. Relay B will then transfer to alert the operator whenever the 672E detects a system diagnostic error or power failure.

Operator Safety

Modular construction simplifies field servicing and provides electrical safety for the operator. The LCD board assembly (Figure 3-1) contains voltages no greater than 24 VDC and is completely safe to handle. This assembly is removable to access the terminal strips on the power-supply board. The relays are located on the backside of the power-supply board.

WARNING: REMOVE LINE POWER BEFORE HANDLING THE POWER-SUPPLY BOARD TO AVOID ELECTRICAL SHOCK.

1.2 Battery Back-up

A battery provides power for the volatile memory should an A.C. line power interruption occurs. This "back-up battery" ensures that all outputs and the 672E's operating state are immediately restored to their original status when power is returned This rechargeable nickel-cadmium battery can provide power for up to 5 months (at 25°C). The 10-year battery is continually trickle-charged whenever A.C. line power is applied. A completely discharged battery re-charges fully after 48 hours of instrument operation.

NOTE: *All user-entered values are stored indefinitely in another, separate non-volatile memory. Even if the "back-up" battery becomes depleted, or the jumper is either removed or in the* ***OFF*** *position, these values cannot be lost.*

1.3 Product Identification

The serial # of your Model 672E is located on a label on the backside of the display board (Figure 3-1). Write the serial # in the space provided below for convenient identification referral should technical assistance be required.

Model 672E Serial # _____

SECTION 2 - SPECIFICATIONS

2.1 Operational

Display ..... 4-1/2 digit LCD with measurement unit and setup variable identifiers; 7/8 inch high digits

Measuring Ranges:

Conductivity ..... 0.0-200.0 µS/cm, 0-2000 µS/cm, 0.000-2.000 mS/cm, 0.00-20.00 mS/cm, 0.0-200.0 mS/cm, 0-2000 mS/cm or 0.00-8.00 S/cm; selectable with user-entered full scale value

Concentration..... 0.0-100.0%

Temperature ..... (-)10.0 to (+)200.0°C (14 to 392°F)

Ambient Conditions ... -20 to 60°C (-4 to 140°F), 0 to 95% relative humidity, non-condensing

Relay Function:

Operating Modes.... Control: Setpoint with adjustable deadband; selectable operation in response to increasing or decreasing measured conductivity or % concentration

Alarm: Dual-alarm relay operation with low and high alarm points and fixed deadbands (1.0% of full scale)

Fail-Safe: Reverses normal operation of Relays A and B (in control or alarm mode) to allow pumps, valves, etc. to be powered by an auxiliary source when a main power interruption occurs

System Alarm: Relay B transfers whenever instrument detects a system diagnostic error (this mode overrides normal control or alarm operating mode)

Indicators ..... Relay A and B annunciators flash to indicate respective relay status

Outputs ..... Two SPDT contact outputs; U.L. rating: 5A 115/250 VAC, 5A @ 30 VDC resistive

Temperature Compensation ..... None; user-entered linear % per °C slope; user-entered temperature curve; or automatic over -10 to +200°C when built-in solution concentration conversion table is used. Temperature sensor is 1000 ohm platinum RTD.

Sensor-to-Analyzer Distance ..... Maximum cable length is a function of measuring range and allowable non-linearity. The following schedule is recommended:

Full Scale Range	Max. Length
200 to 2000 microSiemens/cm	200 feet
2000 to 2,000,000 microSiemens/cm	300 feet

Power Requirements..... 100-137 VAC, 50/60 Hz. (less than 6 VA); optional 200-275 VAC, 50/60 Hz.

Remote Output
Hold ..... LSTTL-compatible (active low) or switch closure input

Analog Outputs* ..... Isolated 0-1 mA, 100 ohms maximum load
Isolated 0-5 VDC, 50K minimum load
Isolated 4-20 mA, 600 ohms maximum load

Range Expand -- The analog outputs can be made to represent any segment of the measuring scale.

*Each output is isolated from the input, ground and line power, but not from each other.

2.2 Analyzer Performance (Electrical, Analog Outputs)

Sensitivity ..... 0.3% of span

Stability ..... 0.1% of span per 24 hours, non-cumulative

Non-linearity ..... 0.5% of span

Repeatability ..... 0.2% of span or better

Temperature Drift ..... Zero: 0.025% of span per °C
Span: 0.025% of span per °C

Response Time ..... 0.1, 1, 10, or 30 seconds to 90% of value upon step change, selectable

2.3 Mechanical

Enclosure ..... NEMA 4X, 1/2 DIN, polycarbonate with two 1/2-inch conduit holes and two stainless steel mounting brackets

Mounting Configurations ..... Surface, panel, and horizontal pipe mount; vertical pipe mounting optional

Net Weight ..... 3.5 lbs. (1.58 kg) approx.

PART TWO INSTALLATION

SECTION 1 - UNPACKING

After unpacking, it is recommended to save the shipping carton and packing materials in case the instrument is stored or re-shipped. Inspect the equipment and carton for damage. If there is evidence of shipping damage, notify the carrier immediately.

SECTION 2 - MECHANICAL REQUIREMENTS

2.1 Location

1. Locate the 672E as close as possible to where the sensor is to be installed. The maximum distance between the sensor and analyzer depends upon the full-scale value of the analyzer.

   - **With Full-scale Value Between 200 and 2000 microSiemens/cm:** The analyzer may be located up to 200 ft. (61 m) from the installed sensor.
   - **With Full-scale Value Between 2001 and 2,000,000 microSiemens/cm:** The analyzer may be located up to 300 ft. (91 m) from the installed sensor.

2. Mount the 672E in a location that is:

   ➥ Clean and dry where little or no vibration exists.

   ➥ Protected from corrosive fluids.

   ➥ Within ambient temperature limits (-4 to +140°F; -20 to +60°C).

   CAUTION: MOUNTING THE ANALYZER IN DIRECT SUNLIGHT MAY INCREASE THE AMBIENT TEMPERATURE ABOVE THE MAXIMUM LIMIT.

2.2 Mounting

Refer to Figure 2-1 for enclosure and mounting dimension details. Figure 2-2 illustrates various ways to mount the analyzer using the supplied stainless steel brackets and hardware. Determine how you want to mount the analyzer and attach the hardware in the specific way depicted in the illustration. To panel mount:

1. Place Tinnerman fasteners on each mounting bracket as shown in Figure 2-2.
2. Place instrument into 5.43 x 5.43 inch (138 x 138 mm) square panel cutout and fasten brackets to instrument case with No. 8-32 x 3/8 inch long screws.

NOTE: *Use the appropriate mounting bracket holes (depicted in Figure 2-2 with screw heads) to properly position brackets.*

3. Tighten No. 10-32 x 3/4 inch long screws into Tinnerman fasteners until ends of screws are snugged against the panel.

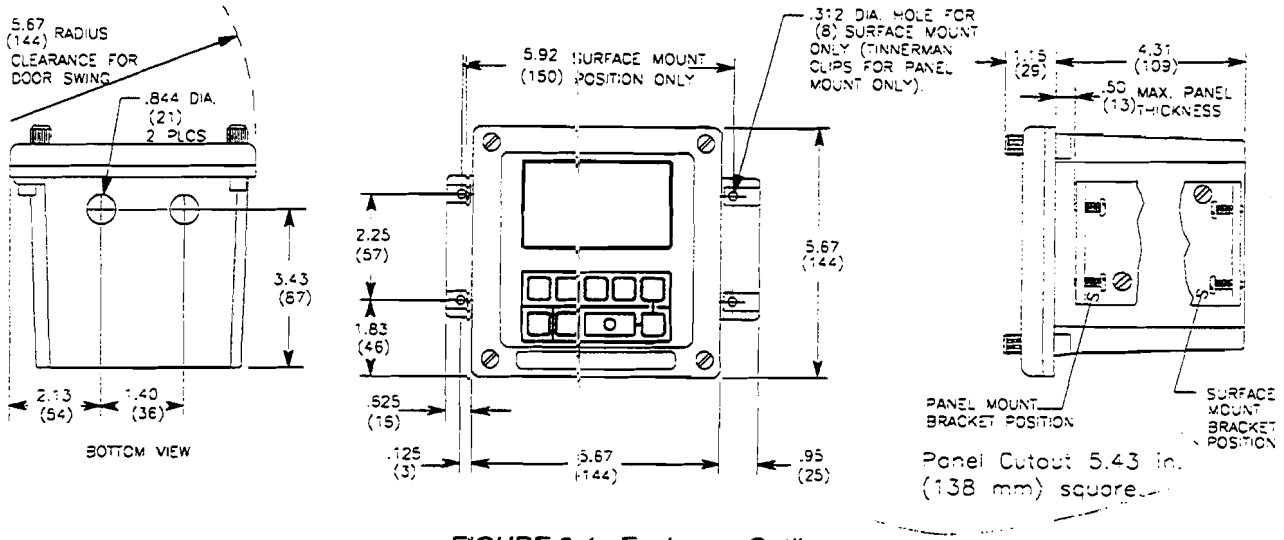


FIGURE 2-1 Enclosure Outline

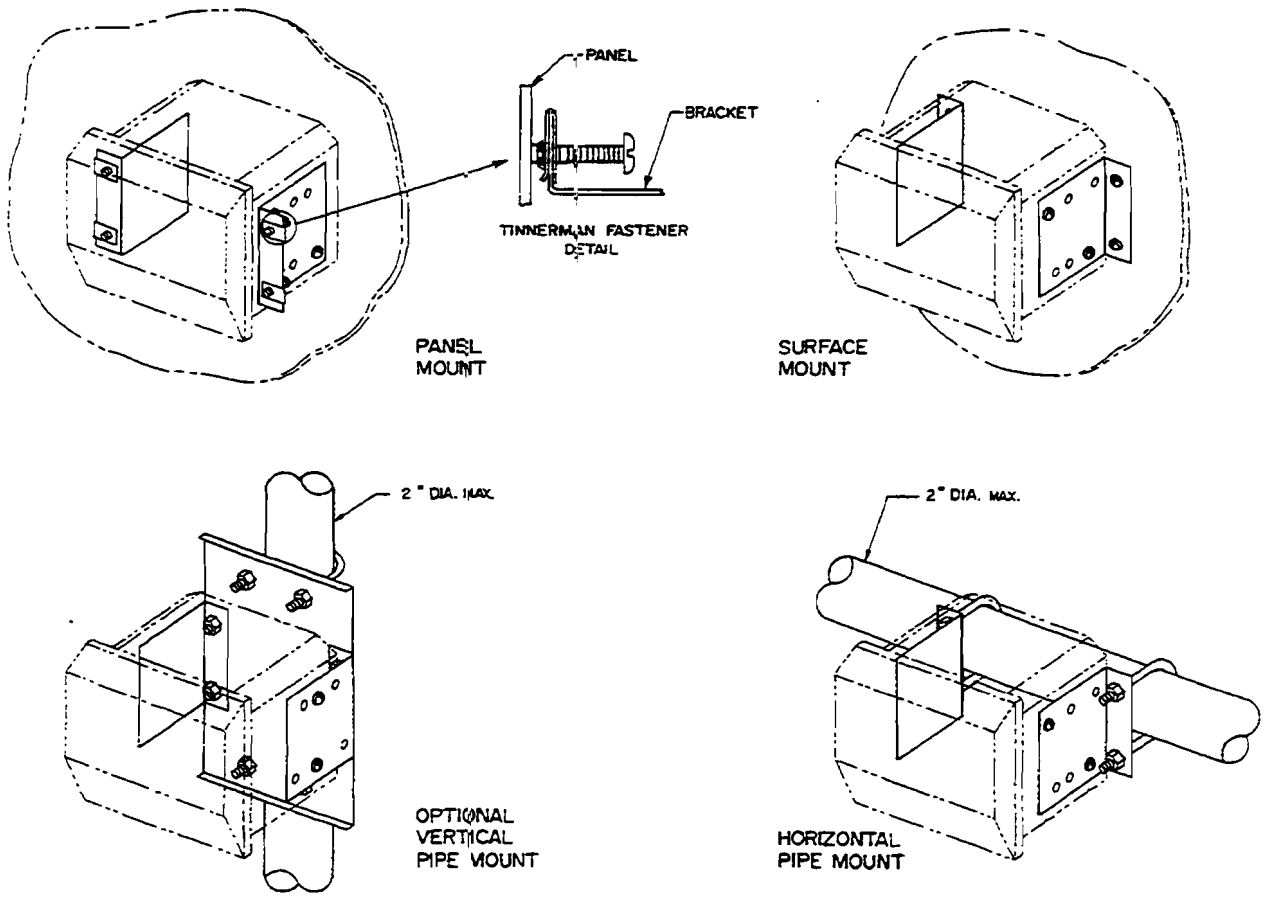


FIGURE 2-2 Mounting Configurations

2.3 Conduit Holes Requirements

Recommendation: Run all wiring to the analyzer in 1/2-inch, grounded metal conduits. If conduit is not used, install appropriate strain reliefs or cable grips (p/n 99X3H1091) and watertight locknuts (p/n 99X3H1230) into cable entry holes. Seal all unused cable entry holes with appropriate plugs.

NOTE: *Use NEMA 4 rated fittings and plugs to maintain the watertight integrity of the NEMA 4 enclosure.*

SECTION 3 - ELECTRICAL CONNECTIONS

To access terminals for electrical connections, loosen the four fasteners and open enclosure door. Carefully remove LCD board assembly (Figure 3-1 on page 17) by loosening the two captive fasteners. Figure 2-3 on the next page shows terminal designations for instrument hookup.

3.1 Sensor

Recommendation: Route sensor and interconnect cable, if used, in 1/2-inch, grounded metal conduit to protect them from moisture, electrical noise, and mechanical damage.

☞ ***NOTE:*** *Do not route sensor or interconnect cable in any conduit containing AC power wiring ("electrical noise" may interfere with the sensor signal).*

CAUTION: WHEN TERMINATING SENSOR OR INTERCONNECT CABLE, USE ONLY THE STANDARD TERMINATION PROCEDURE DESCRIBED IN THE SENSOR INSTRUCTION MANUAL.

Directly Wiring Sensor to 672E Analyzer (no interconnect cable and no junction box)

Refer to Figure 2-3 and connect sensor cable wires to "SENSOR" terminals 1 through 6 on TB2, matching colors as indicated. Always connect the shield wire to the "SHLD" terminal.

Indirectly Wiring Sensor Using Interconnect Cable and Junction Box

- In the junction box, connect the sensor and interconnect cable wires, matching colors and connecting the shield wires together. Do not connect these shield wires to earth ground.
- In the analzer, connect the interconnect cable wires to "SENSOR" terminals 1 through 6 on TB2, matching colors as indicated. Always connect the shield wire to the "SHLD" terminal.

3.2 Analog Outputs

The analog outputs track the measured conductivity or % concentration. The outputs can represent the entire measuring scale or any desired segment of it. To use the range expand feature, refer to Part Three, Section 10.2 for details.

Isolated 0-5 VDC

This output can drive a load of greater than 50,000 ohms. On TB2, connect load (+) to Terminal 8 and load (-) to LO Terminal 9.

Isolated 0-1 mA

This output can drive a load of up to 100 ohms. On TB2, connect load (+) to Terminal 10 and load (-) to LO Terminal 11.

Isolated 4-20 mA

This output can drive a load of up to 600 ohms. On TB2, connect load (+) to Terminal 12 and load (-) to Terminal 13.

3.3 Remote Output Hold

The instrument will accept an LSTTL-compatible (active low) or switch closure input to hold the latest output during calibration or instrument setup to suspend operation of the receiving device. Refer to Part Three, Section 10.3 for complete details.

Connect switch closure wires to HOLD Terminal 14 and LO Terminal 15 on TB2. When an LSTTL input is used, connect signal "low" to LO Terminal 15.

3.4 Relay Outputs

Two sets of SPDT relay outputs are provided at Terminals 1 through 6 on TB1. **They are not powered.** However, the instrument's line power may be used to power control or alarm devices using these outputs. Refer to Figure 2-4 for wiring details. An extra, unfused L1/HOT power source (Terminal 7 on TB1) is provided to connect line power to the relay outputs. Always check control wiring to insure that line power will not be shorted by the switching action of the relay contacts. Refer to Part Three, Section 9 for relay setup instructions.

NOTE: *Because of space limitations within the instrument enclosure, it is recommended that bulky wiring connections (resulting from combinations of multiple*

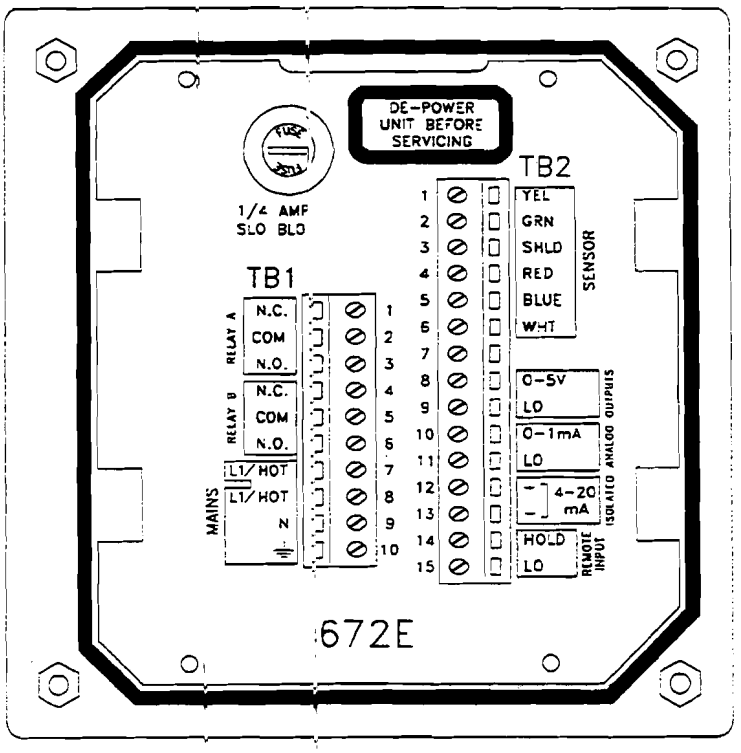


FIGURE 2-3 Electrical Terminal Arrangement and Designations

connections per terminal and large gauge wires) be terminated outside the instrument enclosure, preferably in an external junction box.

CAUTION: Do not exceed each relay's contact rating of 5A 115/230 VAC. If larger currents are to be switched, use an auxiliary relay to extend relay life. When relay outputs are used, the instrument's line power wiring must be adequate to conduct the anticipated load(s).

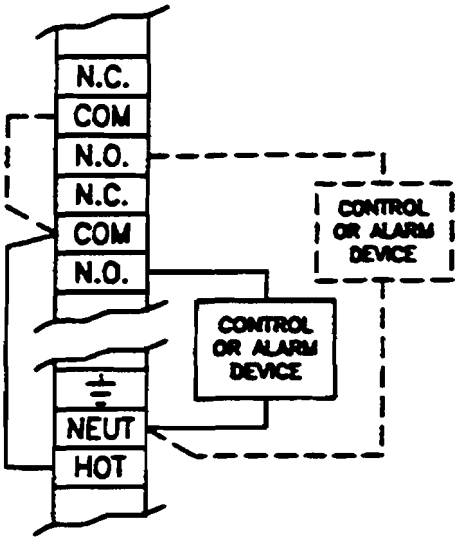


FIGURE 2-4 Connecting Control Or Alarm Device(s) To Relay Outputs

3.5 Line Power

Connect line power to MAINS Terminals 8, 9, and 10 on TB1. The L1 HOT Terminal 8 is fused (1/4 amp. slow-blow) to protect instrument circuits. (NEUT Terminal 9 is also fused on instruments equipped with the 230 VAC dual-fused option.) Use wiring practices which conform to local codes (National Electrical Code Handbook in the U.S.A.). Use only the standard three-wire connection. The ground symbol Terminal 10 grounds the instrument which is mandatory for safe operation.

CAUTION: Any other wiring method may be unsafe or cause improper operation of the instrument.

It is recommended not to run line power or relay outputs powered off the line in the same conduit with the sensor signal wires ("electrical noise" may interfere with sensor signal).

PART THREE - OPERATION

SECTION 1 - OPERATING CONTROLS

Two banks of eight DIP switches each, used for instrument setup, are located at the right edge of the LCD board assembly (Figure 3-1). These switches are easily accessed by opening the enclosure door which can be removed by unsnapping it from its hinge.

The keypad, all switches and status indicators used for instrument operation are described in this section. Familiarize yourself with each item before operating the instrument.

1.1 Keypad Switches

1. **EXAM/CANCEL** key (Figure 3-1)

   Selects the normal "measurement" display mode or an "examination" display mode. Successive key presses alternate the display between these two modes.

   - In measurement mode:

     The display shows measured variable selected with **DISP VAR** key: conductivity, % concentration -- if one of the solution concentration conversion tables is used, temperature, or the 4-20 mA instrument output.

   - In "examination" mode:

     The display shows setup variables and their stored values. Setup data such as calibration values, relay setpoints, etc. are called up in the sequence shown in Figure 3-2 by pressing **NEXT** key (item 2). Values can be changed by using the ⇧ and ⇦ keys (items 3 and 4) and are entered by pressing the **ENTER/CANCEL HOLD** key (item 5). Any entry routine may be canceled by pressing the **EXAM/CANCEL** key which also returns the display to the normal measurement mode.

2. **NEXT** key (Figure 3-1)

   - With display in measurement mode:

     This key has no effect.

   - With display in "examination" mode:

     Scrolls the display to show next setup variable with

each press. After pressing **ENTER/CANCEL HOLD** key (item 5) to enter a specific menu, each press of the **NEXT** key displays the setup variables in sequence for that menu. The setup variables "wrap around" from last to first within the menu. Refer to Table A in Section 3.3 for a complete listing of all setup variables.

3. ⇧ key (Figure 3-1)

   - With display in measurement mode

     This key has no effect.

   - With display in "examination" mode:

     Increases flashing digit value by one with each key press or continually advances digit value from 0 thru 9 by holding key down. This key is used with ⇦ key (item 4) to change displayed value to a new value.

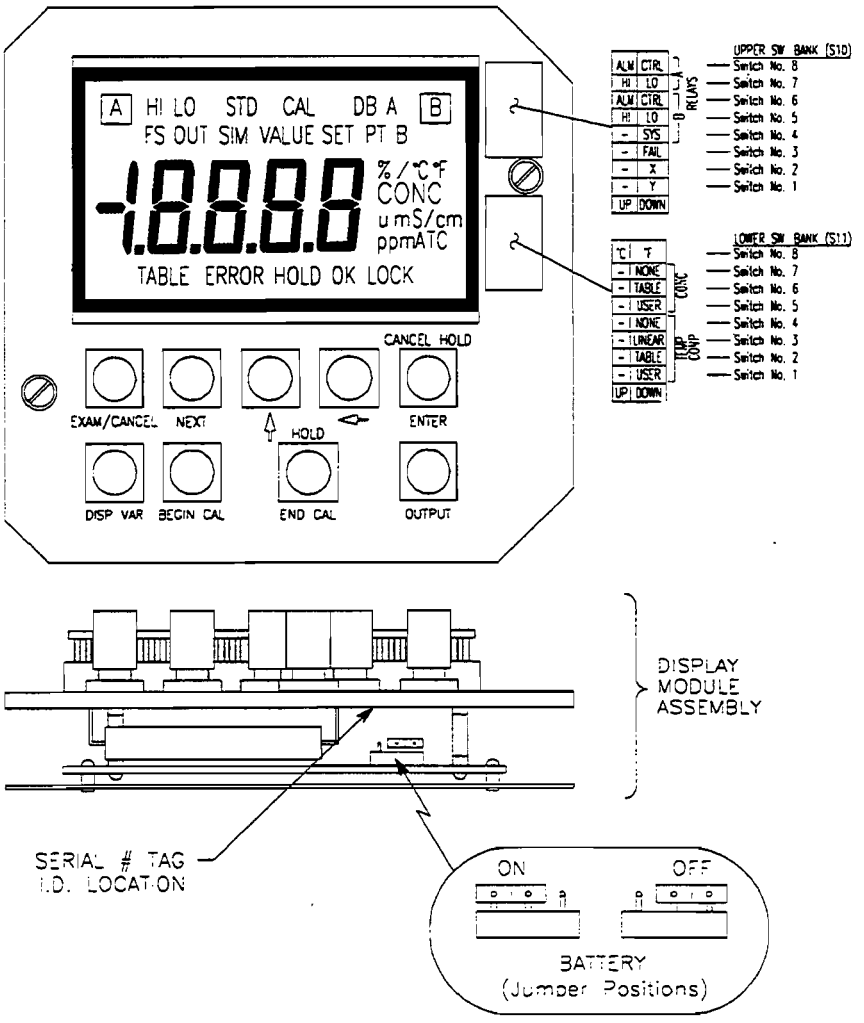


FIGURE 3-1 LCD Board Assembly and Location of Operating and Setup Controls

4. ⇦ key (Figure 3-1)

   - With display in measurement mode:

     This key has no effect.

   - With display in "examination" mode:

     Progressively selects the next digit to the left to flash with each press-and-release so that its value can be changed with ⇧ key (item 3). The flashing digit "wraps around" from far left to far right.

5. **ENTER/CANCEL HOLD** key (Figure 3-1)

   - With display in measurement mode:

     Cancels output hold feature when pressed together with **OUTPUT** key (item 9).

   - With display in "examination" mode:

     A. Enters displayed value into memory (if within acceptable range) for the indicated setup variable. Display flashes "OK" for approximately 5 seconds to confirm entry.

     B. Cancels output hold feature when pressed together with **OUTPUT** key (item 9).

6. **DISP VAR** key (Figure 3-1)

   - With display in measurement mode:

     Scrolls display with each key press to show the following measured variables:

     A. Conductivity in µS/cm, mS/cm or S/cm.

     B. % Concentration -- only when one of the solution concentration conversion tables is used to convert the measured conductivity.

     C. Temperature in °C or °F.

     D. The 4-20 mA instrument analog output.

     NOTE: *As a display check, all indicators light up (as shown in Figure 3-1) when 4-20 mA output variable is displayed and ⇦ key is pressed.*

   - With display in "examination" mode:

     This key has no effect.

7. **BEGIN CAL** key (Figure 3-1)

   - With display in measurement mode:

     A. Displays stored value for LO or HI CAL VALUE setup variable used in "two-key" calibration method. Each key press alternately displays both stored values. **EXAM/CANCEL** key must be pressed to return display to normal indication.

     B. Initiates calibration of a point used in "two-key" calibration method. Specific conductivity (or % concentration) reference solution values should be stored in memory before using this key to initiate calibration. See Part Three, Section 5.4 (or Section 7.4 for % concentration) for details.

   - With display in "examination" mode:

     This key has no effect.

8. **END CAL/HOLD** recessed button (Figure 3-1)

   - With display in measurement mode:

     Activates output hold feature when pressed together with **OUTPUT** key (item 9).

   - With display in "examination" mode:

     A. Completes calibration of a point used in "two-key" calibration method.

     B. Activates output hold feature when pressed together with **OUTPUT** key (item 9).

9. **OUTPUT** key (Figure 3-1)

   With display in measurement or "examination" mode:

   A. Activates output hold feature when pressed together with recessed **END CAL/HOLD** button.

   B. Cancels output hold feature when pressed together with **ENTER/CANCEL HOLD** key.

1.2 DIP Switches

Upper Switch Bank (S10)

10. **RELAY A ALM/CTRL** switch (No. 8, Figure 3-1)

    ALM POSITION (up) - Selects alarm mode of operation for Relay A (dual-alarm point functions).

    CTRL POSITION (down) - Selects control mode of operation for Relay A (setpoint and deadband functions).

11. **RELAY A HI/LO** switch (No. 7, Figure 3-1)

    HI POSITION (up) - Selects Relay A to operate in response to increasing measured conductivity or % concentration.

    LO POSITION (down) - Selects Relay A to operate in response to decreasing measured conductivity or % concentration.

12. **RELAY B ALM/CTRL** switch (No. 6, Figure 3-1)

    ALM POSITION (up) - Selects alarm mode of operation for Relay B (dual-alarm point functions).

    CTRL POSITION (down) - Selects control mode of operation for Relay B (setpoint and deadband functions).

13. **RELAY B HI/LO** switch (No. 5, Figure 3-1)

    HI POSITION (up) - Selects Relay B to operate in response to increasing measured conductivity or % concentration.

    LO POSITION (down) - Selects Relay B to operate in response to decreasing measured conductivity or % concentration.

14. **RELAY B SYS** mode switch (No. 4, Figure 3-1)

    In the **DOWN** position, this switch selects Relay B to operate as a "system alarm" relay which overrides the control or alarm mode selected with **RELAY B** mode switch (item 12). This **SYS** mode switch has no effect in the **UP** position.

15. **FAIL SAFE** switch (No. 3, Figure 3-1)

    In the **DOWN** position, this switch selects fail-safe operation for Relays A and B which reverses normal operation to allow pumps, valves, etc. to be powered by an auxiliary source when a main power interruption occurs. This switch has no effect in the **UP** position.

16. **X** and **Y** switches (No. 2 and No. 1 respectively, Figure 3-1)

    These two response time switches configure the 672E for:

    A. The time it takes for the display and analog outputs to respond to a change in the measured conductivity input.

B. The rate of change that is acceptable for the conductivity input during calibration when using the "two-key" method.

C. The rate of change that is acceptable for the temperature input during calibration when using the "two-key" method.

To select one of the four response times, place **X** and **Y** switches in the positions shown in the following matrix:

Display/Output Response Time	Rate Of Change		Switch Pos.	
	For Cond. Input	For Temp. Input	X	Y
0.1 sec.	10% F.S./6 sec.	1°C/30 sec	**UP**	**UP**
1 sec.	0.1% F.S./2 sec.	1°C/2 min.	**UP**	**DOWN**
10 sec.	0.1% F.S./3 sec.	1°C/3 min.	**DOWN**	**UP**
30 sec.	0.1% F.S./5 sec.	1°C/5 min.	**DOWN**	**DOWN**

Lower Switch Bank (S11)

17. **°C/°F** switch (No. 8, Figure 3-1)

    In the **UP** position, this switch selects measured temperature to be displayed in °C. In the **DOWN** position, the measured temperature is displayed in °F.

18. **CONC NONE** switch (No. 7, Figure 3-1)

    In the **DOWN** position, this switch selects the 672E to be used as a conductivity instrument -- not a % concentration monitor. This switch has no effect in **UP** position.

19. **CONC TABLE** switch (No. 6, Figure 3-1)

    In the **DOWN** position, this switch enables one of the built-in solution concentration conversion tables to be selected to convert measured conductivity to % concentration. This switch has no effect in the **UP** position.

20. **CONC USER** switch (No. 5, Figure 3-1)

    In the **DOWN** position, this switch selects the user-defined solution concentration conversion table to be used to convert measured conductivity to % concentration. This switch has no effect in the **UP** position.

21. **TEMP COMP NONE** switch (No. 4, Figure 3-1)

    In the **DOWN** position, this switch selects no temperature compensation that otherwise would be applied to the measured conductivity. Raw, uncompensated conductivity or % concentration values are displayed. This switch has no effect in the **UP** position.

22. **TEMP COMP LINEAR** switch (No. 3, Figure 3-1)

    In the **DOWN** position, this switch selects the user-entered linear compensation slope value (in % per °C) to be applied to the measured conductivity. This switch has no effect in the **UP** position.

23. **TEMP COMP TABLE** switch (No. 2, Figure 3-1)

    In the **DOWN** position, this switch selects the temperature compensation curve in the selected built-in solution concentration conversion table to be applied to the measured conductivity. This switch has no effect in the **UP** position.

    NOTE: *If no conversion table or the user-defined conversion table is selected with the **CONC NONE** or **CONC USER** switch respectively, the **TEMP COMP TABLE** switch must be in the **UP** position.*

24. **TEMP COMP USER** switch (No. 1, Figure 3-1)

    In the **DOWN** position, this switch selects the user-defined temperature table curve (up to 10 user-entered data points) to be applied to the measured conductivity. This switch has no effect in the **UP** position.

1.3 BATTERY Jumper

25. **BATTERY** jumper (Figure 3-1)

    ON - Connects battery to keep the volatile memory powered when there is a line power interruption. This ensures that all outputs and the 672E's operating state are immediately restored to their original status when line power is returned.

    OFF - Disconnects battery when instrument is not to be used for an extended time.

    NOTE: *All user-entered values are stored indefinitely in another memory which is non-volatile. These values will not be lost even if this battery is depleted, or the jumper is removed or in the **OFF** position.*

1.4 Status Indicators

26. **A** and **B** relay indicators (LCD display)

    Respective indicators flash on and off to indicate that the instrument control state has initiated relay action (for normal or fail-safe relay operation).

27. **HOLD** indicator (LCD display)

    Indicates that output hold feature is in use (instrument output values are maintained and relays configured for control mode are suspended in their "off" state).

    NOTE: *After 30 minutes,* ***HOLD*** *indicator flashes to indicate that output hold feature will be automatically canceled in 30 seconds. Pressing any key extends hold feature for another 30 minutes.*

28. **OK** indicator (LCD display)

    Flashes for approximately 5 seconds to confirm successful entry of a setup variable value.

29. **LOCK** indicator (LCD display)

    Indicates that instrument keypad entry is "electronically locked" to prevent unauthorized tampering of stored setup variable values. Refer to Section 11 for security lock feature details.

    NOTE: *Calibration values can be entered and all stored setup variable values can be displayed when instrument is "locked".*

30. **ERROR** indicator (LCD display)

    Flashes to indicate an incorrect entry or alternately flashes with "Er 1", "Er 2", etc. to up to "Er 12" to indicate a system diagnostic error causing improper system operation.

SECTION 2 - MEASURED VARIABLES

The 672E can display four measured variables. With the display in the measurement mode, each press of the **DISP VAR** key sequentially displays:

- Conductivity in µS/cm, mS/cm or S/cm
- % Concentration -- only when one of the solution concentration conversion tables is used to convert the measured conductivity.
- Temperature in °C or °F.
- The 4-20 mA instrument analog output.

SECTION 3 - SETUP VARIABLES

3.1 Calling Up Setup Variables

1. With the display in the measurement mode, press the **EXAM/CANCEL** key to change the display to the "examination" mode. (This shows the first of five menu identifiers. Each menu contains different setup variables to configure the instrument.)

2. Press the **NEXT** key to scroll the display (shows the identifier for the next menu of setup variables).

3. With the display indicating the identifier for the desired menu, press the **ENTER** key to access the first setup variable within that menu.

4. Press the **NEXT** key to display the next setup variable, in sequence, for that menu. The setup variables "wrap around" from last to first within each menu.

Press the **EXAM/CANCEL** key anytime to return the display to the measuring mode.

3.2 Entering Values

Use the ⇧ and ⇦ keys to change displayed setup values. Each press of the ⇧ key increases the flashing digit value by one. When held down, the ⇧ key continually advances the value. Pressing and releasing the ⇦ key selects the next digit to the left which flashes, indicating that it can be changed using the ⇧ key. After setting the desired value, press the **ENTER** key to store it in memory ("OK" flashes for approximately 5 seconds to confirm that the entry was accepted or "ERROR" flashes if the entry was invalid).

3.3 Setup Variables Call-up Chart and Table of Descriptions

Figure 3-2 on the following page shows the four measured variable display modes (shaded boxes at top left of chart), the five menus of setup variables (across top of chart), and the call-up order of the setup variables within each menu. Depending on selected DIP switch settings, specific setup variables are not displayed and do not apply (see footnotes at bottom of chart).

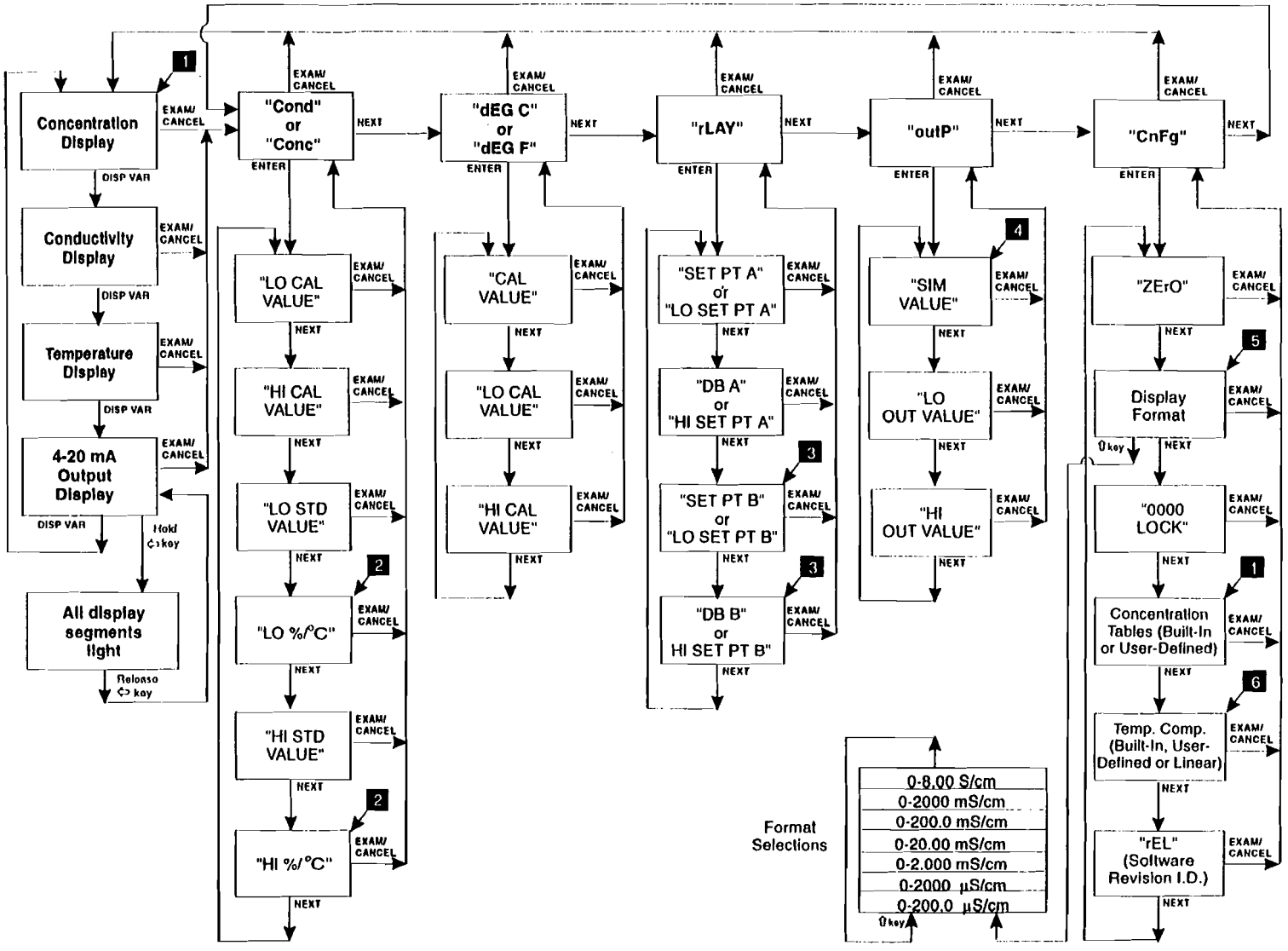


FIGURE 3-2 Display Modes and Call-up Chart Of Setup Variables

1. Displayed only when one of the conversion tables is used to convert conductivity to % concentration.
2. Displayed only when the linear %/°C temperature compensation method is selected and the 672E is in the conductivity measuring mode.
3. Displayed only when Relay B is in normal control or alarm operating mode, not "system diagnostic alarm" mode.
4. Displayed only when the output hold feature is not in use.
5. Displayed only when no conversion table or the user-defined % concentration conversion table is selected. When a built-in conversion table is selected, the correct display format for that table is automatically set.
6. Not displayed when a built-in concentration conversion table is selected.

The following table lists each of the five setup variable menus, the setup variables within each menu in exact order of call-up, and describes their use and entry value range. **Recommendation:** Write the setup values you used into the far right column for convenient referral.

Table A -- DESCRIPTION OF SETUP VARIABLES

Displayed Identifier	Use For This Setup Variable		Entry Value Range Min.	Entry Value Range Max.	Record Entry
"Cond" or "Conc" Menu					↓
"LO CAL VALUE"	Sets the low calibration value used for two-point conventional calibration method.	Cond.	0.0	40.0% F.S.	
		Conc.	0.0%	100.0%	
"HI CAL VALUE"	Sets the high calibration value used for two-point conventional calibration method.	Cond.	20.0% F.S.	1000.0% F.S.	
		Conc.	0.0%	100.0%	
"LO STD VALUE"	Sets the lower conductivity or % concentration reference solution value used for "two-key" calibration method.	Cond.	0.0	90.0% F.S.	
		Conc.	0.0%	97.0%	
"LO %/°C"[1]	Sets the temperature compensation value used for the lower calibration solution in the "two-key" cal method.		0.00%	5.00%	
"HI STD VALUE"	Sets the higher conductivity or % concentration reference solution value used for "two-key" calibration method.	Cond.	10.0% F.S.	1000.0% F.S.	
		Conc.	1.0%	100.0%	
"HI %/°C"[1]	Sets the temperature compensation value used for the higher calibration solution in the "two-key" cal method.		0.00%	5.00%	
"dEG C" or "dEG F" Menu					
"CAL VALUE"	Sets the calibration value used for single-point temperature calibration.	°C	0.0	200.0	
		°F	32.0	392.0	
"LO CAL VALUE"	Sets the low calibration value used for two-point temperature calibration.	°C	0.0	30.0	
		°F	32.0	86.0	
"HI CAL VALUE"	Sets the high calibration value used for two-point temperature calibration.	°C	40.0	200.0	
		°F	104.0	392.0	
"rLAY" (Relay) Menu					
"SET PT A"[2]	Sets the setpoint value at which Relay A transfers (when measured value reaches setpoint value).	Cond.	0.0	100.0% F.S.	
		Conc.	0.0%	100.0%	
"DB A"[2]	Sets the deadband for Relay A.	Cond.	0.0	50.0% F.S.	
		Conc.	0.0%	50.0%	
"LO SET PT A"[3]	Sets the low alarm point at which Relay A transfers (when measured value reaches low alarm point).	Cond.	0.0	100.0% F.S.	
		Conc.	0.0%	100.0%	
"HI SET PT A"[3]	Sets the high alarm point at which Relay A transfers (when measured value reaches high alarm point).	Cond.	0.0	100.0% F.S.	
		Conc.	0.0%	100.0%	
"SET PT B"[2]	Sets the setpoint value at which Relay B transfers (when measured value reaches setpoint value).	Cond.	0.0	100.0% F.S.	
		Conc.	0.0%	100.0%	
"DB B"[2]	Sets the deadband for Relay B.	Cond.	0.0	50.0% F.S.	
		Conc.	0.0%	50.0%	
"LO SET PT B"[3]	Sets the low alarm point at which Relay B transfers (when measured value reaches low alarm point).	Cond.	0.0	100.0% F.S.	
		Conc.	0.0%	100.0%	
"HI SET PT B"[3]	Sets the high alarm point at which Relay B transfers (when measured value reaches high alarm point).	Cond.	0.0	100.0% F.S.	
		Conc.	0.0%	100.0%	

[1] Only provided and displayed when the linear %/°C temperature compensation method is selected and the 672E is in the conductivity measuring mode.

[2] Only provided and displayed when relay is configured for "control" mode of operation.

[3] Only provided and displayed when relay is configured for "alarm" mode of operation.

Table A - DESCRIPTION OF SETUP VARIABLES (continued)

Displayed Identifier	Use For This Setup Variable		Entry Value Range Min.	Entry Value Range Max.	Record Entry
"outP" (Output) Menu					↓
"SIM VALUE"[4]	Sets the simulated conductivity or % concentration value for diagnostic purposes. (The analog output values correspond to the displayed SIM VALUE, and the relays respond as if it was a measured value.)	Cond.	0.0	100.0% F.S.	
		Conc.	0.0%	100.0%	
"LO OUT VALUE"	Sets the low endpoint at which minimum outputs (0 VDC, 0 mA and 4 mA) are provided.	Cond.	0.0	100.0% F.S.	
		Conc.	0.0%	100.0%	
"HI OUT VALUE"	Sets the high endpoint at which maximum outputs (5 VDC, 1 mA and 20 mA) are provided.	Cond.	0.0	100.0% F.S.	
		Conc.	0.0%	100.0%	
"CnFg" (Configuration) Menu					
"ZErO"	Zeros the instrument during startup procedure.		No value is entered.		
"200.0 µS/cm", "2000 µS/cm", "2.000 mS/cm", "20.00 mS/cm", "200.0 mS/cm", 2000 mS/cm", - or - "8.00 S/cm"[5]	Selects the display format (measurement units and decimal point position) during initial instrument setup.		Use ⇧ key to select the desired display format.		
"0000" and "LOCK"	Initiates the security lock feature.		0000	9999	----→
"tb 1%", "tb 2%", "tb 3%", "tb 4%", "tb 5%", "tb 6%", "tb 7%", "tb 8%", "tb 9%", - or - "TABLE Pt 1CONC"[6]	For use when using the analyzer to measure % concentration values instead of conductivity values. Selects one of the built-in conversion tables or the user-defined conversion table to convert conductivity values to % concentration values.		Built-in or user-defined table is selected by DIP switch settings. ⇧ or ⇦ keys further select the desired built-in table (if selected).		
"%/°C", "TABLE tb 1%/°C", "TABLE tb 2%/°C", "TABLE tb 3%/°C", "TABLE tb 4%/°C", "TABLE tb 5%/°C", "TABLE tb 6%/°C", "TABLE tb 7%/°C", "TABLE tb 8%/°C", "TABLE tb 9%/°C", - or - "TABLE Pt 1 TC"[7]	Selects one of the built-in temperature compensation tables to be applied to the measured conductivity.		The actual temperature compensation method is selected by DIP switch settings.		

[4] Only provided and displayed when the output hold feature is not in use.

[5] One of these values is displayed only when no conversion table or the user-defined % concentration conversion table is selected. When a built-in conversion table is selected, the correct display format is automatically set for that table.

[6] One of these identifiers is displayed only when the corresponding built-in conversion table or user-defined conversion table is selected.

[7] One of these identifiers is displayed only when the user-defined conversion table is selected and the linear %/°C or user-defined temperature table compensation method is used.

SECTION 4 - SETUP FOR CONDUCTIVITY

When you want to use the 672E to monitor and display conductivity, follow the setup instructions in this section. For operating the 672E as a % concentration analyzer, disregard this section and use the setup instructions in either Section 6 (when using a built-in conversion table) or Section 8 (when using the user-defined conversion table).

4.1 Checking Battery Back-up Jumper

An internal battery powers the volatile memory in the event that line power is lost. This ensures that all outputs and the 672E's operating state are immediately restored to their original status when line power is returned. The 672E is supplied with its **BATTERY** jumper (Figure 3-1) in the **ON** position. Make sure to set this jumper to **ON** before proceeding.

4.2 Selecting Conductivity Measurement Mode

Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **CONC NONE** switch in **DOWN** position.

NOTE: *The **CONC TABLE** and **CONC USER** switches must be set to their **UP** positions.*

4.3 Selecting Display Format

1. With display in conductivity measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond").
2. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** to access this menu of setup variables (display indicates "ZErO").
3. Press **NEXT** key once to access the display format setup variable (display indicates one of the format selections shown in Figure 3-2).

Setting Measurement Units and Decimal Pt. Position

4. Press ⇧ key until display indicates the desired measurement units and decimal point position you want in the measuring scale.
5. Press **ENTER** key to enter your display format selection (display indicates "FS VALUE" to confirm entry and flashes far right "0" to indicate that you can now set and enter the desired full-scale value).

Setting Full-Scale Value

6. Use ⇧ and ⇦ keys to make display indicate desired full-scale value. It must be less than or equal to the display format value selected in steps 4 and 5.

7. Press **ENTER** key to enter full-scale value ("FS VALUE" disappears and "OK" flashes to confirm entry). Then press **EXAM/CANCEL** key twice to return display to measuring mode.

Setting Temperature Units (°C or °F)

8. Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **°C/°F** switch in the **DOWN** position to display temperature in °F or in the **UP** position for °C.

4.4 Selecting Temperature Compensation Method

When the 672E is used as a conductivity analyzer, one of four temperature compensation methods may be selected.

None

Temperature compensation may be purposely bypassed to provide raw, uncompensated conductivity readings. Typically, "None" compensation is used when the solution temperature remains constant and/or when uncompensated readings are desired. Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **TEMP COMP NONE** switch in **DOWN** position.

NOTE: *The other three **TEMP COMP** switches (**LINEAR, TABLE** and **USER**) must be set to their **UP** positions.*

Linear

Linear compensation is the most frequently used method, since it is sufficient for most applications and is simple to implement. This method provides temperature-compensated conductivity readings referenced to 25°C. Enter the desired temperature compensation slope value in "% per °C" that you want applied to the raw, measured conductivity.

1. Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **TEMP COMP LINEAR** switch in **DOWN** position.

   NOTE: *The other three **TEMP COMP** switches (**NONE, TABLE** and **USER**) must be set to their **UP** positions.*

2. With display in conductivity measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond").

3. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** to access this menu of setup variables (display indicates "ZErO").

4. Press **NEXT** key until display indicates "%/°C" and a value with its far right digit flashing. This indicates that you can now set/change the temp. comp. slope value.

5. Based on raw conductivity versus temperature values, determine the desired slope value to enter for the solution being measured. For most aqueous solutions, the slope value is approximately 2.00%/°C.

6. Use ⇧ and ⇦ keys to make display indicate desired temp. comp. slope value.

7. Press **ENTER** key to enter temp. comp. slope value ("OK" flashes to confirm entry).

Built-in Solution Table

This method provides extremely accurate temperature-compensated readings referenced to the °C temperature of the selected table (typically 25°C). Select one of nine built-in temperature data tables that corresponds with the measured solution. The data in the selected table is then applied to the raw, measured conductivity.

Setting DIP Switches

1. Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **TEMP COMP TABLE** switch in **DOWN** position.

   NOTE: *The other three **TEMP COMP** switches (**NONE, LINEAR** and **USER**) must be set to their **UP** positions.*

Finding Tables

2. With display in conductivity measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond").

3. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** to access this menu of setup variables (display indicates "ZErO").

4. Press **NEXT** key until display indicates "TABLE tb 1%/°C" (or "TABLE tb 2%/°C, etc.).

Selecting A Table

5. Table B lists the built-in temperature compensation tables (by their displayed identifiers), the type of solution each represents and its °C reference temperature.

Table B - BUILT-IN TEMP. COMPENSATION TABLES			
Displayed Identifier	Solution	Concentration	Reference Temp.
"TABLE tb 1 %/°C"	NaCl	0-5%	25°C
"TABLE tb 2 %/°C"	HCl	0-15%	25°C
"TABLE tb 3 %/°C"	HNO_3	0-10%	25°C
"TABLE tb 4 %/°C"	H_2SO_4	0-25%	25°C
"TABLE tb 5 %/°C"	H_2SO_4	96-99.5%	50°C
"TABLE tb 6 %/°C"	NaOH	0-15%	25°C
"TABLE tb 7 %/°C"	NaOH	0-20%	100°C
"TABLE tb 8 %/°C"	$CaCl_2$	0-15%	25°C
"TABLE tb 9 %/°C"	H_3PO_4	0-40%	25°C

Use the ⇧ and ⇦ keys to make display indicate desired table (1, 2, 3, etc.).

6. Press **ENTER** key to enter selected temp. comp. table ("OK" flashes to confirm entry).

User-Defined Temperature Table

This method provides extremely accurate temperature-compensated readings for solutions not handled by one of the built-in temperature compensation tables previously described. Enter up to 10 data points to define a temperature curve for the solution being measured. Each data point on the curve consists of a temperature value and a corresponding calculated compensation factor. This curve is then applied to the raw, measured conductivity.

NOTE: *You need to plan ahead and determine the temperature and compensation factor for each point in the user-defined table before entering the data. The table need not contain all 10 points, but you must enter at least the first two points (Pt. and Pt. 2).*

Determining Data For Entry

Create a temperature curve for the solution by measuring and noting the raw, uncompensated conductivity of the solution at various temperatures, including a reference temperature. You can use the 672E to do this but only when the following provisions are met:

- The **CONC NONE** switch must be set in **DOWN** position and the other two **CONC** switches (**TABLE** and **USER**) must be set to their **UP** positions.
- The **TEMP COMP NONE** switch must be set in **DOWN** position and the other three **TEMP COMP** switches (**LINEAR, TABLE** and **USER**) must be set to their **UP** positions.
- The 672E must be calibrated (refer to Part Three, Section 5 for instructions).

Calculate the compensation factors for each noted temperature by using its noted corresponding conductivity value in the following equation:

$$\text{Compensation Factor For Each Noted Temp.} = \frac{\text{Cond. Value at Ref. Temp.}}{\text{Cond. Value at Noted Temp.}}$$

Example: Suppose the raw conductivity values were 10 mS/cm at a 25°C reference temperature, 12 mS/cm at 50°C, and 7 mS/cm at 15°C. Using the above equation, the compensation factors for each of the temperatures would be:

10 divided by 10 = 1.00 for 25°C
10 divided by 12 = 0.83 for 50°C
10 divided by 7 = 1.43 for 15°C.

The following table shows the data for this example, organized for temperature table entry:

EXAMPLE VALUES FOR USER-DEFINED TEMPERATURE TABLE

Data Point	Temp. (in °C)	Raw Cond. Value	Compensation Factor	Data Point	Temp (in °C)	Raw Cond. Value	Compensation Factor
Pt 1	15°C	7 mS/cm	1.43	Pt 6	0.0°C	----	0.00
Pt 2	**25°C**	**10 mS/cm**	**1.00**	**Pt 7**	**0.0°C**	**—**	**0.00**
Pt 3	50°C	12 mS/cm	0.83	Pt 8	0.0°C	----	0.00
Pt 4	**0.0°C**	**—**	**0.00**	**Pt 9**	**0.0°C**	**—**	**0.00**
Pt 5	0.0°C	----	0.00	Pt 10	0.0°C	----	0.00

Use the following convenient table to write in and organize the entry values for your user-defined temperature table.

NOTE: *You must enter temperature values for each data point in the curve in ascending order. Also, they must be between 0.0 and 200.0°C and they cannot be alike. Compensation factors must be values between 0.00 and 99.99. Last, you must enter "0.0°C" for temperature values and "0.00" for compensation factors for all unused data points in the table.*

Table C - VALUES FOR USER-DEFINED TEMPERATURE TABLE

Data Point	Temp. (in °C)	Raw Cond. Value	Compensation Factor	Data Point	Temp (in °C)	Raw Cond. Value	Compensation Factor
Pt 1				Pt 6			
Pt 2				Pt 7			
Pt 3				Pt 8			
Pt 4				Pt 9			
Pt 5				Pt 10			

Setting DIP Switches

1. Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **TEMP COMP USER** switch in **DOWN** position.

   NOTE: *The other three **TEMP COMP** switches (**NONE, LINEAR** and **TABLE**) must be set to their **UP** positions.*

Finding The Table

2. With display in conductivity measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond").

3. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** to access this menu of setup variables (display indicates "ZErO").

4. Press **NEXT** key until display indicates "TABLE Pt 1 TC" (or "TABLE Pt 2 TC", etc.). If necessary, use ⇧ key to make display indicate "Pt 1".

Entering Temperature and Compensation Factor Values

5. Press **ENTER** key to access the Data Point 1 temperature value entry (display indicates "TABLE °C TC" and flashes far right digit).

   A. Use ⇧ and ⇦ keys to make display indicate desired temperature value for Data Point 1.

   B. Press **ENTER** key to enter °C value ("OK" flashes to confirm entry, "°C" disappears and far right digit flashes to indicate that you can now set/change the corresponding compensation factor).

   C. Use ⇧ and ⇦ keys to make display indicate corresponding compensation factor for Data Point 1.

   D. Press **ENTER** key to enter compensation factor ("OK" flashes to confirm entry and "Pt 2" appears).

6. Press **ENTER** key to access the Data Point 2 temperature value entry (display indicates "TABLE °C TC" and flashes far right digit).

7. Repeat steps 5A, 5B, 5C, and 5D to enter the temperature and corresponding compensation factor for each remaining data point in the table.

8. Enter temperature values of "0.0°C" and compensation factors of "0.00" for any unused data points in the table.

NOTE: *If this step is not done, the 672E recognizes the user-defined temperature table as incomplete (display flashes "Er 8" when analyzer is in conductivity measuring mode).*

If, at a later time, you need to add any new data points to the table, the entry(s) must comply with all of the conditions previously described.

4.5 Zeroing The System

You must "zero" the 672E to compensate for any sensor offset. This zeroing procedure, which takes approximately 90 seconds, only needs to be performed during instrument startup or whenever you replace the sensor or interconnect cable. For best accuracy, zero the 672E with the interconnect cable, if used, installed in place.

1. With display in conductivity measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond").

2. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** key to access this menu of setup variables (display indicates "ZErO").

3. Holding the sensor in air, press **ENTER** key to initiate zeroing (display indicates "buSy" and "HOLD", then returns to "ZErO" when routine is completed).

   NOTE: *During zeroing, the analog outputs are held at their minimum values and relay operation is suspended.*

4.6 Initial Calibration

Before initially calibrating the instrument, read Part Three, Section 5.1 "Summary of Methods To Use". Then calibrate the instrument using the desired method.

SECTION 5 - CALIBRATION FOR CONDUCTIVITY

The instrument must be calibrated periodically with conductivity reference solution(s) to maintain measurement accuracy. **Recommendation:** Establish a maintenance program to keep the sensor clean and the instrument calibrated. The time period between performing maintenance (days, weeks, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience.

5.1 Summary of Methods To Use

You can calibrate the instrument two different ways:

- The "conventional" method (Section 5.3) requires the operator to enter the known reference solution value during calibration.

  NOTE: *The conventional method should always be used for initial calibration or whenever the sensor has been replaced.*

- The "two-key" calibration method (Section 5.4) is especially useful when an inexperienced operator is required to perform the calibration. This method requires a qualified person to "pre-enter" two desired reference solution values. Anytime thereafter, a novice operator can accurately calibrate the instrument for each point by simply pressing two keys. The only operator requirement is that the sensor must be in the appropriate reference solution for each calibration point. The operator doing the calibration does not need to enter actual solution values.

Regardless of the method used, calibration requires a clean sensor and one (or two) fresh, accurate conductivity reference solutions. Normally, the "low" calibration point is entered as zero conductivity with the sensor in air. In this case only one reference solution is needed. It is recommended that the value of this "high" reference solution be close to the normal conductivity value of the process, or between 80% and 100% of the 672E's full-scale value.

NOTE: *For applications requiring high measurement accuracy within a segment of the measuring scale, the 672E should be calibrated with two reference solutions. These "low" and "high" reference solutions should have values approximately equal to the segment's low and high endpoints respectively.*

5.2 Preparing Conductivity Reference Solutions

Prepare conductivity reference solutions using Table D. Add the listed grams of salt to one liter of distilled water to obtain the listed conductivity. Solutions of lower conductivity can be made by dilution with distilled water. Solution temperatures should be as near as possible to 25°C.

Table D - CONDUCTIVITY REFERENCE SOLUTIONS

Desired Solution Value		Grams NaCl To Be Added
µS/cm	mS/cm	
100	0.10	0.05
200	0.20	0.10
500	0.50	0.25
1000	1.00	0.50
2000	2.00	1.01
5000	5.00	2.61
10,000	10.00	5.56
20,000	20.00	11.59
50,000	50.00	31.95
100,000	100.00	72.71

NOTE: *To prepare reference solutions with a value greater than 100,000 µS/cm, call GLI Service for details.*

5.3 Conventional Method

1. With display in conductivity measuring mode, hold clear sensor in air or, if using two reference solutions, place sensor in the lower value solution. (In this latter case, allow display reading to stabilize. The sensor may take several minutes to attain temperature equilibrium with the solution.)

2. Press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond").

3. Press **ENTER** key to access the "Cond" menu of setup variables (display indicates "LO CAL VALUE").

4. Use ⇧ and ⇦ keys to make display indicate either:

   A. Zero conductivity if sensor is held in air, or...

   B. The known value of the lower conductivity reference solution if two solutions are used for calibration.

5. Press **ENTER** key to enter value (display indicates "buSy" for approx. 10 seconds, then flashes "OK" to confirm entry, and returns to the conductivity measuring mode).

6. If a "low" value solution was used, remove sensor from it and rinse sensor in clean water.

7. Place sensor in "high" value reference solution. Allow sensor to attain temperature equilibrium with the solution.

8. Press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond").

9. Press **ENTER** key to access the "Cond" menu of setup variables (display indicates "LO CAL VALUE").

10. Press **NEXT** key once to make display indicate "HI CAL VALUE".

11. Use ⇧ and ⇦ keys to make display indicate the known value of the "high" conductivity reference solution.

12. Press **ENTER** key to enter value (display indicates "buSy" for approx. 10 seconds, then flashes "OK" to confirm entry, and returns to the conductivity measuring mode).

This completes calibration for conductivity using the conventional method.

5.4 "Two-Key" Method

When initially calibrating the 672E, or if the sensor has been replaced, you must first calibrate the instrument using the conventional method (Section 5.3). Anytime thereafter you can then use the "two-key" method.

To set up the 672E for routine "two-key" calibrations, a qualified person must first "pre-enter" one or two desired conductivity reference solution values for use as the calibration points. That person must also select an acceptable response time for the application. The instrument can then be periodically calibrated using the procedure described under the "Performing Calibration" subheading.

Pre-entering Calibration Points (By Qualified Person)

1. With the display in conductivity measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond").

2. Press **ENTER** key to access the "Cond" menu of setup variables (display indicates "LO CAL VALUE").

3. Press **NEXT** key until display indicates "LO STD VALUE".

4. Use ⇧ and ⇦ keys to make display indicate either:

A. Zero conductivity if sensor is to be held in air for the lower calibration point, or...

B. The desired value for the lower calibration point.

5. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

6. Press **NEXT** key until display indicates "HI STD VALUE".

7. Use ⇧ and ⇦ keys to make display indicate the desired value for the higher calibration point.

8. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

9. Press **EXAM/CANCEL** key twice to return display to conductivity measuring mode.

Selecting Response Time

Refer to Part Three, Section 1.2 -- item 16 for details on the response time **X** and **Y** switches and their settings. If you intend to use the "two-key" method for calibration, choosing a response time setting becomes a compromise between calibration accuracy (and the time it takes to calibrate) and display/output response time. The slowest response time setting of 30 seconds provides best calibration accuracy (conductivity and temperature rates of change are slowest). However, it will take more time to calibrate the 672E, and display/output response time will be the slowest. If you plan to use the "conventional" method for calibration, determine the response time setting entirely on desired display/output response time.

Performing Calibration

Only after a qualified person has pre-entered both calibration points can an operator use the "two-key" method to calibrate.

This "two-key" calibration procedure requires a clean sensor and one (or two) fresh, accurate conductivity reference solution(s) with value(s) that are identical to the two pre-entered calibration values.

1. With display in conductivity measuring mode, press **BEGIN CAL** key (display indicates one of the pre-entered values -- "LO CAL VALUE" or "HI CAL VALUE"). If display indicates the higher value, press **BEGIN CAL** key again to display the lower value.

When **BEGIN CAL** is pressed, you have 30 minutes to complete the calibration of this point. During this time, pressing any key except **END CAL** provides another 30 minutes if needed.

2. Hold clean sensor in air or, if using two reference solutions for calibration, place sensor in the "low" value reference solution (display indicates its value). (In this latter case, allow display reading to stabilize. The sensor may take several minutes to attain temperature equilibrium with the solution.)

   The instrument checks the stability of the conductivity and temperature inputs. As each input changes, the respective conductivity measurement unit and °C (or °F) indicator flashes. When each input is stable (changing less than rate selected with **X** and **Y** switches), the respective indicator stops flashing and remains on.

3. When the conductivity measurement unit and °C (or °F) indicators are both on (not flashing), press recessed **END CAL** button using a slender tool. The display flashes "OK" to confirm successful calibration of the low calibration point and returns to the conductivity measuring mode.

   NOTE: *If display flashes "ERROR" and "Er 9", you may have used a solution with an incorrect value, or the sensor may be dirty or defective.*

4. If a "low" value solution was used, remove sensor from it and rinse sensor in clean water.

5. Press **BEGIN CAL** key to initiate calibration of the second calibration point.

6. Place sensor in the "high" value reference solution (display indicates its value). Allow sensor to attain temperature equilibrium with the solution.

   The instrument checks the stability of the conductivity and temperature inputs. As each input changes, the respective conductivity measurement unit and °C (or °F) indicator flashes. When each input is stable (changing less than rate selected with **X** and **Y** switches), the respective indicator stops flashing and remains on.

7. When the conductivity measurement unit and °C (or °F) indicators are both on (not flashing), press recessed **END CAL** button using slender tool. The display flashes "OK" to confirm successful calibration of the high calibration point and returns to the conductivity measuring mode.

   NOTE: *If display flashes "ERROR" and "Er 9", you may have used a solution with an incorrect value.*

This completes calibration for conductivity using the "two-key" method.

SECTION 6 - SETUP FOR % CONCENTRATION USING BUILT-IN CONVERSION TABLE

When you want to use the 672E to monitor and display % concentration of a solution and that solution is represented by one of the built-in conversion tables listed in Section 6.2 -- step 6, follow the setup instructions in this section. For solutions not covered by the built-in tables, refer to Section 8 and use the user-defined table to convert conductivity into % concentration. For operating the 672E as a conductivity analyzer, disregard this section (and Sections 7 and 8) and use the setup instructions in Section 4.

6.1 Checking Battery Backup Jumper

An internal battery powers the volatile memory in the event line power is lost. This ensures that all outputs and the 672E's operating state are immediately restored to their original status when line power is returned. The 672E is supplied with its **BATTERY** jumper (Figure 3-1) in the **ON** position. Make sure to set this jumper to **ON** before proceeding.

6.2 Reviewing Built-in Concentration Tables

Setting Dip Switches

1. Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **CONC TABLE** switch in **DOWN** position.

   NOTE: *The **CONC NONE** and **CONC USER** switches must be set to their **UP** positions.*

2. Place **TEMP COMP TABLE** switch in **DOWN** position.

   NOTE: *The other three **TEMP COMP** switches (**NONE, LINEAR** and **USER**) must be set to their **UP** positions.*

Finding Tables

3. With display in % concentration measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Conc").

4. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** to access this menu of setup variables (display indicates "ZErO").

Selecting A Table

5. Press **NEXT** key until display indicates "tb 1%" (or "tb 2%", etc.).

6. Table E lists the built-in concentration conversion tables (by their displayed identifiers), the type of solution each represents and its °C reference temperature.

Table E - BUILT-IN CONCENTRATION CONVERSION TABLES

Displayed Identifier	Solution	Concentration	Reference Temp.
"tb 1%"	NaCl	0-5%	25°C
"tb 2%"	HCl	0-15%	25°C
"tb 3%"	HNO_3	0-10%	25°C
"tb 4%"	H_2SO_4	0-25%	25°C
"tb 5%"	H_2SO_4	96-99.5%	50°C
"tb 6%"	NaOH	0-15%	25°C
"tb 7%"	NaOH	0-20%	100°C
"tb 8%"	$CaCl_2$	0-15%	25°C
"tb 9%"	H_3PO_4	0-40%	25°C

Use the ⇧ and ⇦ keys to make display indicate desired table (1, 2, 3, etc.).

7. Press **ENTER** key to enter selected concentration conversion table ("OK" flashes to confirm entry).

6.3 Selecting Temperature Display Units (°C or °F)

Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **°C/°F** switch in the **DOWN** position to display temperature in °F or in the **UP** position for °C.

6.4 Zeroing The System

You must zero the 672E to compensate for any sensor offset. This zeroing procedure, which takes approximately 90 seconds, only needs to be performed during instrument startup or whenever you replace the sensor or interconnect cable. For best accuracy, zero the 672E with the interconnect cable, if used, installed in place.

1. With display in % concentration measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Conc").

2. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** key to access this menu of setup variables (display indicates "ZErO").

3. Holding the sensor in air, press **ENTER** key to initiate zeroing (display indicates "buSy" and "HOLD", then returns to "ZErO" when routine is completed).

   NOTE: *During zeroing, the analog outputs are held at their minimum values and relay operation is suspended.*

6.5 Initial Calibration

Before initially calibrating the instrument, read Part Three, Section 7.1 "Summary Of Methods To Use". Then calibrate the instrument using the desired method.

SECTION 7 - CALIBRATION FOR % CONCENTRATION

The instrument must be calibrated periodically with % concentration reference solution(s) to maintain measurement accuracy. **Recommendation:** Establish a maintenance program to keep the sensor clean and the instrument calibrated. The time period between performing maintenance (days, weeks, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience.

7.1 Summary of Methods To Use

You can calibrate the instrument in two different ways:

- The "conventional" method (Section 7.3) requires the operator to enter the known reference solution value during calibration.

  NOTE: *The conventional method should always be used for <u>initial</u> calibration or whenever the sensor has been replaced.*

- The "two-key" calibration method (Section 7.4) is especially useful when an inexperienced operator is required to perform the calibration. This method requires a qualified person to "pre-enter" two desired reference solution values. Anytime thereafter, a novice operator can accurately calibrate the instrument for each point by simply pressing two keys. The only operator requirement is that the sensor must be in the appropriate reference solution for each calibration point. The operator doing the calibration does not need to enter actual solution values.

Regardless of the method used, calibration requires a clean sensor and one (or two) fresh, accurate % concentration reference solutions. Normally, the "low" calibration point is entered as zero % concentration with the sensor in air. In this case only one reference solution need is needed. It is recommended that the value of this "high" reference solution be close to the normal % concentration value of the process, or between 80% and 100% of the 672E's full-scale value.

NOTE: *For 96-99.5% H_2SO_4 and applications requiring high measurement accuracy within a segment of the measuring scale, the 672E should be calibrated with two reference solutions. These "low" and "high" reference solutions should have values approximately equal to the segment's low and high endpoints respectively.*

7.2 Preparing % Concentration Reference Solutions

Prepare reference solution(s) of known % concentration using procedures from handbooks and appropriate chemicals, etc., or determine the % concentration of the process solution and use a grab sample of it. Also, any reference solution(s) you use must correspond to the concentration conversion table you selected (Section 6.2, steps 5 thru 7).

7.3 Conventional Method

1. With the display in % concentration measuring mode, hold clean sensor in air or, if using two reference solutions, place sensor in the lower value solution. (In this latter case, allow display reading to stabilize. The sensor may take several minutes to attain temperature equilibrium with the solution).

2. Press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Conc").

3. Press **ENTER** key to access the "Conc" menu of setup variables (display indicates "LO CAL VALUE").

4. User ⇧ and ⇦ keys to make display indicate either:

   A. Zero % concentration if sensor is held in air, or...

   B. The known value of the lower % concentration reference solution if two solutions are used for calibration.

5. Press **ENTER** key to enter value (display indicates "buSy" for approx. 10 seconds, then flashes "OK" to confirm entry, and returns to the % concentration measuring mode).

6. If a "low" value solution was used, remove sensor from it and rinse sensor in clean water.

7. Place sensor in "high" value reference solution. Allow sensor to attain temperature equilibrium with the solution.

8. Press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Conc").

9. Press **ENTER** key to access the "Conc" menu of setup variables (display indicates "LO CAL VALUE").

10. Press **NEXT** key once to make display indicate "HI CAL VALUE".

11. Use ⇧ and ⇦ keys to make display indicate the known value of the "high" % concentration reference solution.

12. Press **ENTER** key to enter value (display indicates "buSy" for approx. 10 seconds, then flashes "OK" to confirm entry, and returns to the % concentration measuring mode).

This completes calibration for % concentration using the conventional method.

7.4 "Two-Key" Method

When initially calibrating the 672E, or if the sensor has been replaced, you must first calibrate the instrument using the conventional method (Section 7.3). Anytime thereafter you can then use the "two-key" method.

To set up the 672E for routine "two-key" calibrations, a qualified person must first "pre-enter" one or two desired % concentration reference solution values for use as the calibration points. That person must also select an acceptable response time for the application. The instrument can then be periodically calibrated using the procedure described under the "Performing Calibration" subheading.

Pre-entering Calibration Points (By Qualified Person)

1. With the display in % concentration measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Conc").

2. Press **ENTER** key to access the "Conc" menu of setup variables (display indicates "LO CAL VALUE").

3. Press **NEXT** key until display indicates "LO STD VALUE".

4. Use ⇧ and ⇦ keys to make display indicate either:

   A. Zero % concentration if sensor is to be held in air for the lower calibration point, or...

   B. The desired value for the lower calibration point.

5. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

6. Press **NEXT** key until display indicates "HI STD VALUE".

7. Use ⇧ and ⇦ keys to make display indicate the desired value for the higher calibration point.

8. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

9. Press **EXAM/CANCEL** key twice to return display to % concentration measuring mode.

Selecting Response Time

Refer to Part Three, Section 1.2 -- item 16 for details on the response time **X** and **Y** switches and their settings. If you intend to use the "two-key" method for calibration, choosing a response time setting becomes a compromise between calibration accuracy (and the time it takes to calibrate) and display/output response time. The slowest response time setting of 30 seconds provides best calibration accuracy (conductivity and temperature rates of change are slowest). However, it will take more time to calibrate the 672E, and display/output response time will be the slowest. If you plan to use the "conventional" method for calibration, determine the response time setting entirely on desired display/output response time.

Performing Calibration

Only after a qualified person has pre-entered both calibration points can an operator use the "two-key" method to calibrate.

This "two-key" calibration procedure requires a clean sensor and one (or two) fresh, accurate % concentration reference solution(s) with value(s) that are identical to the two pre-entered calibration values.

1. With display in % concentration measuring mode, press **BEGIN CAL** key (display indicates one of the pre-entered values -- "LO CAL VALUE" or "HI CAL VALUE"). If display indicates the higher value, press **BEGIN CAL** key again to display the lower value.

When **BEGIN CAL** is pressed, you have 30 minutes to complete the calibration of this point. During this time, pressing any key except **END CAL** provides another 30 minutes if needed.

2. Hold clean sensor in air or, if using two reference solutions for calibration, place sensor in the "low" value reference solution (display indicates its value). (In this latter case, allow display reading to stabilize. The sensor may take several minutes to attain temperature equilibrium with the solution.)

   The instrument checks the stability of the % concentration and temperature inputs. As each input changes, the respective % and °C (or °F) indicator flashes. When each input is stable (changing less than rate selected with **X** and **Y** switches), the respective indicator stops flashing and remains on.

3. When the % and °C (or °F) indicators are both on (not flashing), press recessed **END CAL** button using a slender tool. The display flashes "OK" to confirm successful calibration of the low calibration point and returns to the % concentration measuring mode.

   NOTE: *If display flashes "ERROR" and "Er 9", you may have used a solution with an incorrect value, or the sensor may be dirty or defective.*

4. If a "low" value solution was used, remove sensor from it and rinse sensor in clean water.

5. Press **BEGIN CAL** key to initiate calibration of the second calibration point.

6. Place sensor in the "high" value reference solution (display indicates its value). Allow sensor to attain temperature equilibrium with the solution.

   The instrument checks the stability of the % concentration and temperature inputs. As each input changes, the respective % and °C (or °F) indicator flashes. When each input is stable (changing less than rate selected with **X** and **Y** switches), the respective indicator stops flashing and remains on.

7. When the % and °C (or °F) indicators are both on (not flashing), press recessed **END CAL** button using slender tool. The display flashes "OK" to confirm successful

calibration of the high calibration point and returns to the % concentration measuring mode.

NOTE: *If display flashes "ERROR" and "ER 9", you may have used a solution with an incorrect value.*

This completes the "two-key" % concentration calibration method.

SECTION 8 - SETUP FOR % CONCENTRATION USING USER-DEFINED CONVERSION TABLE

When you want to use the 672E to monitor and display % concentration of a solution and that solution **is not** represented by one of the built-in conversion tables listed in Section 6.2 -- step 6, follow the setup instructions in this section. For solutions covered by a built-in conversion table, use the setup instructions in Section 6. For operating the 672E as a conductivity analyzer, disregard Sections 6, 7, and 8) and use the setup instructions in Section 4.

8.1 Checking Battery Backup Jumper

An internal battery powers the volatile memory in the event line power is lost. This ensures that all outputs and the 672E's operating state are immediately restored to their original status when line power is returned. The 672E is supplied with its **BATTERY** jumper (Figure 3-1) in the **ON** position. Make sure to set this jumper to **ON** before proceeding.

8.2 Setting DIP Switches

Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **CONC USER** switch in **DOWN** position.

NOTE: *The **CONC NONE** and **CONC TABLE** switches must be set to their **UP** positions.*

8.3 Determining Concentration Versus Conductivity Values

Enter up to 10 data points to convert conductivity to % concentration for the solution being measured. Each data point consists of a % concentration value and a corresponding conductivity value.

NOTE: *You need to plan ahead and determine the % concentration and conductivity values for each point in the user-defined conversion table before entering the data. The table need not contain all 10 points, but you must enter at least the first two points (Pt. 1 and Pt. 2).*

Obtain the appropriate % concentration and conductivity values from chemical handbooks, journals, etc., or from laboratory analysis. (The 672E may be used to obtain conductivity values of known % concentration samples.)

Example: Suppose the solution being measured is sodium chloride (NaCl) and the % concentration and corresponding conductivity values are:

% Concentration	Corresponding Conductivity Value
1.0%	18.0 mS/cm
7.0%	100.0 mS/cm
14.6%	175.0 mS/cm

(For conductivity values in this range, use the 0-200.0 mS/cm display format when setting the 672E measuring scale, described in Section 8.4.)

The following table shows this example's data, organized for concentration conversion table entry:

EXAMPLE VALUES FOR USER-DEFINED CONCENTRATION CONVERSION TABLE					
Data Point	% Concentration Value	Conductivity Value	Data Point	% Concentration Value	Conductivity Value
Pt 1	1.0%	18.0 mS/cm	Pt 6	0.0%	0.0 mS/cm
Pt 2	7.0%	100.0 mS/cm	Pt 7	0.0%	0.0 mS/cm
Pt 3	14.6%	175.0 mS/cm	Pt 8	0.0%	0.0 mS/cm
Pt 4	0.0%	0.0 mS/cm	Pt 9	0.0%	0.0 mS/cm
Pt 5	0.0%	0.0 mS/cm	Pt 10	0.0%	0.0 mS/cm

Use the following convenient table to write in and organize the entry values for your concentration conversion table.

NOTE: *You must enter % concentration values for each data point in ascending order. Also, they must be between 0.0 and 100.0% and they cannot be alike. You must enter corresponding conductivity values for each data point in consecutive order. Last, you must enter "0.0%" for concentration values and "0" for conductivity values (displayed resolution determined by selected display format) for all unused data points in the table.*

Table F - VALUES FOR USER-DEFINED CONCENTRATION CONVERSION TABLE					
Data Point	% Concentration Value	Conductivity Value	Data Point	% Concentration Value	Conductivity Value
Pt 1			Pt 6		
Pt 2			Pt 7		
Pt 3			Pt 8		
Pt 4			Pt 9		
Pt 5			Pt 10		

8.4 Selecting Display Format

1. With display in % concentration measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Conc").

2. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** to access this menu of setup variables (display indicates "ZErO").

3. Press **NEXT** key once to access the display format setup variable (display indicates one of the format selections shown in Figure 3-2).

Setting Measurement Units and Decimal Pt. Position

4. Press ⇧ key until display indicates the measurement units and decimal point position that are appropriate for the conductivity values determined in Section 8.3 for conversion table entry (for that example, 0-200.0 mS/cm was recommended).

5. Press **ENTER** key to enter your display format selection (display indicates "FS VALUE" to confirm entry and flashes far right "0" to indicate that you can now set and enter the desired full-scale value).

Setting Full-Scale Value

6. Use ⇧ and ⇦ keys to make display indicate desired full-scale value which must be less than or equal to the format value selected in steps 4 and 5. (For the example in Section 8.3, "200.0 mS/cm" is acceptable since it is reasonably close to the anticipated maximum measured conductivity of 175.0 mS/cm.) **Recommendation:** Enter a full-scale value that is moderately higher than the maximum conductivity value you entered in the user-defined concentration conversion table in Section 8.3 to accommodate unexpected higher process conductivities.

7. Press **ENTER** key to enter full-scale value ("FS VALUE" disappears and "OK" flashes to confirm entry). Then press **EXAM/CANCEL** key twice to return display to measuring mode.

Setting Temperature Units (°C or °F)

8. Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **°C/°F** switch in the **DOWN** position to display temperature in °F or in the **UP** position for °C.

8.5 Entering Conversion Table Data

1. With display in % concentration measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Conc").

2. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** to access this menu of setup variables (display indicates "ZErO").

3. Press **NEXT** key until display indicates "TABLE Pt 1 CONC" (or "TABLE Pt 2 CONC", etc.). If necessary, use ⇧ key to make display indicate "Pt 1".

4. Press **ENTER** key to access the Data Point 1 % concentration value entry (display indicates "TABLE % CONC" and flashes far right digit).

   A. Use ⇧ and ⇦ keys to make display indicate desired % concentration value for Data Point 1.

   B. Press **ENTER** key to enter % concentration value ("OK" flashes to confirm entry, % disappears and far right digit flashes to indicate that you can now set/change the corresponding conductivity value).

   C. Use ⇧ and ⇦ keys to make display indicate corresponding conductivity value for Data Point 1.

   D. Press **ENTER** key to enter conductivity value ("OK" flashes to confirm entry and "Pt 2" appears).

5. Press **ENTER** key to access the Data Point 2 % concentration value entry (display indicates "TABLE % CONC" and flashes far right digit).

6. Repeat steps 4A, 4B, 4C, and 4D to enter the % concentration and corresponding conductivity value for each remaining data point in the table.

7. Enter concentration values of "0.0%" and conductivity values of "0" (display resolution determined by your selected display format) for any unused data points in the table.

   NOTE: *If this step is not done, the 672E recognizes the user-defined concentration conversion table as incomplete (display flashes "Er 7" when analyzer is in % concentration measuring mode).*

If, at a later time, you need to enter any new data points to the table, the entry(s) must comply with all of the conditions previously described.

8.6 Selecting Temperature Compensation Method

When the 672E is used as a % concentration analyzer and you are using the user-defined concentration conversion table, one of three temperature compensation methods may be selected.

None

Temperature compensation may be purposely bypassed to provide raw, uncompensated % concentration readings. Typically, "None" compensation is used when the solution temperature remains constant and/or when uncompensated readings are desired. Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **TEMP COMP NONE** switch in **DOWN** position.

NOTE: *The other three **TEMP COMP** switches (**LINEAR, TABLE** and **USER**) must be set to their **UP** positions.*

Linear

Linear compensation is the most frequently used method, since it is sufficient for most applications and is simple to implement. This method provides temperature-compensated % concentration readings referenced to 25°C. Enter the desired temperature compensation slope value in "% per °C" that you want applied to the raw, measured and unconverted conductivity.

1. Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **TEMP COMP LINEAR** switch in **DOWN** position.

   NOTE: *The other three **TEMP COMP** switches (**NONE, TABLE** and **USER**) must be set to their **UP** positions.*

2. With display in concentration measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Conc").

3. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** to access this menu of setup variables (display indicates "ZErO").

4. Press **NEXT** key until display indicates "%/°C" and a value with its far right digit flashing. This indicates that you can now set/change the temp. comp. slope value.

5. Based on raw conductivity versus temperature values, determine the desired slope value to enter for the solution being measured,. For most aqueous solutions, the slope value is approximately 2.00%/°C.

6. Use ⇧ and ⇦ keys to make display indicate desired temp. comp. slope value.

7. Press **ENTER** key to enter temp. comp. slope value ("OK" flashes to confirm entry).

User-Defined Temperature Table

This method provides extremely accurate temperature-compensated measurement readings. Enter up to 10 data points to define a temperature curve for the solution being measured. Each data point on the curve consists of a temperature value and a corresponding calculated compensation factor. This curve is then applied to the raw, measured and unconverted conductivity.

NOTE: *You need to plan ahead and determine the temperature and compensation factor for each point in the user-defined table before entering the data. The table need not contain all 10 points, but you must enter at least the first two points (Pt. 1 and Pt. 2).*

Determining Data For Entry

Create a temperature curve for the solution by measuring and noting the raw, uncompensated conductivity of the solution at various temperatures, including a reference temperature. You can use the 672E to do this but only when the following provisions are met:

- The **CONC NONE** switch must be set in **DOWN** position and the other two **CONC** switches (**TABLE** and **USER**) must be set to their **UP** positions.

- The **TEMP COMP NONE** switch must be set in **DOWN** position and the other three **TEMP COMP** switches (**LINEAR, TABLE** and **USER**) must be set to their **UP** positions.

- The 672E must be calibrated for conductivity (refer to Part Three, Section 5 for instructions).

Calculate the compensation factors for each noted temperature by using its noted corresponding conductivity value in the following equation:

$$\text{Compensation Factor For Each Noted Temp.} = \frac{\text{Cond. Value at Ref. Temp.}}{\text{Cond. Value at Noted Temp.}}$$

Example: Suppose the raw conductivity values were 10 mS/cm at a 25°C reference temperature, 12 mS/cm at 50°C, and 7 mS/cm at 15°C. Using the above equation, the compensation factors for each of the temperatures would be:

10 divided by 10 = 1.00 for 25°C
10 divided by 12 = 0.83 for 50°C
10 divided by 7 = 1.43 for 15°C.

The following table shows the data for this example, organized for temperature table entry:

EXAMPLE VALUES FOR USER-DEFINED TEMPERATURE TABLE							
Data Point	Temp. (in °C)	Raw Cond. Value	Compensation Factor	Data Point	Temp. (in °C)	Raw Cond. Value	Compensation Factor
Pt 1	15°C	7 mS/cm	1.43	Pt 6	0.0°C	----	0.00
Pt 2	25°C	10 mS/cm	1.00	Pt 7	0.0°C	----	0.00
Pt 3	50°C	12 mS/cm	0.83	Pt 8	0.0°C	----	0.00
Pt 4	0.0°C	----	0.00	Pt 9	0.0°C	----	0.00
Pt 5	0.0°C	----	0.00	Pt 10	0.0°C	----	0.00

Use the following convenient table to write in and organize the entry values for your user-defined temperature table.

NOTE: *You must enter temperature values for each data point in the curve in ascending order. Also, they must be between 0.0 and 200.0°C; and they cannot be alike. Compensation factors must be values between 0.00 and 99.99. Last, you must enter "0.0°C" for temperature values and "0.00" for compensation factors for all unused data points in the table.*

Table C - VALUES FOR USER-DEFINED TEMPERATURE TABLE							
Data Point	Temp. (in °C)	Raw Cond. Value	Compensation Factor	Data Point	Temp. (in °C)	Raw Cond. Value	Compensation Factor
Pt 1				Pt 6			
Pt 2				Pt 7			
Pt 3				Pt 8			
Pt 4				Pt 9			
Pt 5				Pt 10			

Setting DIP Switches

1. Locate the lower bank of eight switches at right edge of LCD readout (Figure 3-1) and place **TEMP COMP USER** switch in **DOWN** position.

NOTE: *The other three* ***TEMP COMP*** *switches (****NONE, LINEAR*** *and* ***TABLE****) must be set to their* ***UP*** *positions.*

Finding The Table

2. With display in concentration measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicated "Conc").

3. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** to access this menu of setup variables (display indicates "ZErO").

4. Press **NEXT** key until display indicates "TABLE Pt 1 TC" (or "TABLE Pt 2 TC", etc.). If necessary, use ⇧ key to make display indicate "Pt 1".

Entering Temperature and Compensation Factor Values

5. Press **ENTER** key to access the Data Point 1 temperature value entry (display indicates "TABLE °C TC" and flashes far right digit).

   A. Use ⇧ and ⇦ keys to make display indicate desired temperature value for Data Point 1.

   B. Press **ENTER** key to enter °C value ("OK" flashes to confirm entry, "°C" disappears and far right digit flashes to indicate that you can now set/change the corresponding compensation factor).

   C. Use ⇧ and ⇦ keys to make display indicate corresponding compensation factor for Data Point 1.

   D. Press **ENTER** key to enter compensation factor ("OK" flashes to confirm entry and "Pt 2" appears).

6. Press **ENTER** key to access the Data Point 2 temperature value entry (display indicates "TABLE °C TC" and flashes far right digit).

7. Repeat steps 5A, 5B, 5C, and 5D to enter the temperature and corresponding compensation factor for each remaining data point in the table.

8. Enter temperature values of "0.0°C" and compensation factors of "0.00" for any unused data points in the table.

   NOTE: *If this step is not done, the 672E recognizes the user-defined temperature table as incomplete (display flashes "Er 8" when analyzer is in % concentration measuring mode).*

If, at a later time, you need to add any new data points to the table, the entry(s) must comply with all of the conditions previously described.

8.7 Zeroing The System

You must "zero" the 672E to compensate for any sensor offset. This zeroing procedure, which takes approximately 90 seconds, only needs to be performed during instrument startup or whenever you replace the sensor or interconnect cable. For best accuracy, zero the 672E with the interconnect cable, if used, installed in place.

1. With display in % concentration measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Conc").

2. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** key to access this menu of setup variables (display indicates "ZErO").

3. Holding the sensor in air, press **ENTER** key to initiate zeroing (display indicates "buSy" and "HOLD", then returns to "ZErO" when routine is completed).

   NOTE: *During zeroing, the analog outputs are held at their minimum values and relay operation is suspended.*

8.8 Initial Calibration

Before initially calibrating the instrument, read Part Three, Section 7.1 "Summary of Methods To Use". Then calibrate the instrument using the desired method.

SECTION 9 - RELAY SETUP

The instrument has two SPDT relays. Relay A and B can be independently configured to operate in a control mode or an alarm mode.

- In the control mode, the relay can be selected to operate in response to increasing or decreasing measured conductivity (or % concentration) and has a setpoint and deadband.

- In the alarm mode, the relay operates as a "dual-alarm" relay with independent low and high alarm points. The relay will transfer whenever the measured conductivity (or % concentration) decreases below the low alarm point or increases above the high alarm point.

In either mode, both relays can be selected for "fail-safe" operation which reverses normal operation to allow pumps, valves, etc. to be powered by an auxiliary source when a main power interruption occurs.

Lastly, Relay B can be alternately selected to operate as a "system alarm" relay. This will transfer Relay B to alert the operator whenever the 672E detects a system diagnostic error.

9.1 Control Mode of Operation

The procedure to set up a relay for control mode of operation is described with the following example:

> RELAY SET-UP EXAMPLE FOR CONTROL MODE
>
> Suppose the control requirements for Relay A are:
>
> Relay A turns on at 150.0 mS/cm as the conductivity increases.
> Relay A turns off at 145.0 mS/cm as the conductivity decreases.

Selecting Control Mode

Locate the upper bank of eight switches at right edge of LCD readout (Figure 3-1) and place **RELAY A ALM/CTRL** switch in **CTRL** (down) position to set Relay A in the control mode. Use **RELAY B ALM/CTRL** switch to set Relay.

Selecting Relay Response Action

Place **RELAY A HI/LO** switch in **HI** (up) position to make Relay A respond to increasing value for this example. For applications requiring the relay to transfer in response to decreasing value, place switch in **LO** (down) position. Use **RELAY B HI/LO** switch to select Relay B response action.

Entering Relay Setpoints

1. With display in conductivity or % concentration measuring mode (conductivity for this example), press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond" or "Conc").

2. Press **NEXT** key until display indicates "rLAY". Then press **ENTER** key to access the "rLAY" menu of setup variables (display indicates "SET PT A"). To set Relay B setpoint, press **NEXT** key until display indicates "SET PT B".

3. Use ⇧ and ⇦ keys to make display indicate desired setpoint value (150.0 mS/cm for this example).

4. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

# # # #

Entering Relay Deadbands

1. Press **NEXT** key until display indicates "DB A" for this example ("DB B" for Relay B).

2. Use ⇧ and ⇦ keys to make display indicate desired deadband; 5.0 mS/cm for this example (150.0 minus 145.0).

3. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

9.2 Alarm Mode of Operation

The procedure to set up a relay for alarm mode of operation is described with the following example:

> RELAY SET-UP EXAMPLE FOR ALARM MODE
>
> Suppose the alarm requirements for Relay B are:
>
> Relay B turns on at 170.0 mS/cm in response to increasing conductivity and turns on at 120.0 mS/cm in response to decreasing conductivity.

Selecting Alarm Mode

Locate the upper bank of eight switches at right edge of LCD readout (Figure 3-1) and place **RELAY B ALM/CTRL** switch in **ALM** (up) position to set Relay B in the alarm mode. Use **RELAY A ALM/CTRL** switch to set Relay A.

NOTE: *Any relay set in the alarm mode has fixed (non-selectable) HI and LO response action regardless of the position of **RELAY (A or B) HI/LO** switch. Also, each alarm point has a fixed deadband of 1.0% of full scale.*

Entering Relay Dual-Alarm Points

1. With display in conductivity or % concentration measuring mode (conductivity for this example), press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond" or "Conc").

2. Press **NEXT** key until display indicates "rLAY". Then press **ENTER** key to access the "rLAY" menu of setup variables (display indicates "SET PT A").

3. Press **NEXT** key until display indicates "LO SET PT B" for this example ("LO SET PT A" for Relay A).

4. Use ⇧ and ⇦ keys to make display indicate desired low alarm point value (120.0 mS/cm for this example).

5. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

6. Press **NEXT** key once to make display indicates "HI SET PT B" for this example ("HI SET PT A" for Relay A).

7. Use ⇧ and ⇦ keys to make display indicate desired high alarm point value (170.0 mS/cm for this example).

8. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

9.3 Fail-Safe Operation

Relays A and B can be set for fail-safe operation regardless of their mode (control, alarm or system alarm). This reverses the normal operation of both relays.

To set both relays (A and B) for fail-safe operation, locate the upper bank of eight switches at right edge of LCD readout (Figure 3-1) and place **FAIL SAFE** switch in **DOWN** position. For normal relay operation, place this switch in the **UP** position.

9.4 Relay B System Alarm Operation

Relay B can be used to alert the operator whenever the 672E detects a system diagnostic error or power failure. Relay B will transfer if any of these conditions occur. When Relay B is set for "system alarm" operation, all other DIP switch settings for Relay B are ignored including all of its entered setup variable values (setpoint and deadband, or alarm points). Also, if Relay B is set for fail-safe operation, system alarm operation is reversed.

To set Relay B to operate as a "system alarm" relay, locate the upper bank of eight switches at right edge of LCD readout (Figure 3-1) and place **SYS ALM** switch in **DOWN** position. To disable Relay B's "system alarm" operation and return it to normal operation, place this switch in the **UP** position.

SECTION 10 - OUTPUT SETUP

The 672E provides 0-5 VDC, 0-1 mA, and 4-20 mA analog output signals which track the measured conductivity (or % concentration).

NOTE: *The output display mode only indicates the 4-20 mA signal, regardless of which output signals are actually being used.*

10.1 Selecting Response Time

Refer to Part Three, Section 1.2 -- item 16 for details on the response time **X** and **Y** switches and their settings. If you intend to use the "two-key" method for calibration, choosing a response time setting becomes a compromise between calibration accuracy (and the time it takes to calibrate) and display/output response time. The slowest response time setting of 30 seconds provides best calibration accuracy (conductivity and temperature rates of change are slowest). However, it will take more time to calibrate the 672E, and display/output response time will be the slowest. If you plan to use the "conventional" method for calibration, determine the response time setting entirely on desired display/output response time.

10.2 Using Range Expand Feature

The 0-5 VDC, 0-1 mA, and 4-20 mA outputs can represent the entire measuring scale or a desired segment of it. Use the LO OUT VALUE and HI OUT VALUE setup variables to enter the low and high endpoints of the desired segment. Each output will track the measured value within the segment you enter. Note these important points:

- The desired segment, represented by each output, cannot be smaller than 10.0% of the measuring scale.
- The outputs can be inverted (outputs decrease as measured conductivity or % concentration increases) by entering the higher value with LO OUT VALUE and the lower value with HI OUT VALUE.
- When the measured conductivity (or % concentration) is below or above the desired segment, the outputs are limited to their designated minimum and maximum values respectively.

NOTE: *If you used a conversion table to convert measured conductivity to % concentration, the LO and HI OUT VALUE setup variables will be displayed in % concentration.*

The procedure to use the range expand feature is described with the following example:

> RANGE EXPAND SETUP EXAMPLE
>
> Suppose the 4-20 mA output is desired between 30.0 and 70.0 mS/cm, and it is to increase as the measured conductivity increases (non-inverted output).

Setting The Low Endpoint

The low endpoint, entered with the LO OUT VALUE setup variable, is the point at which the minimum outputs (0 VDC, 0 mA and 4 mA) are provided.

1. With display in conductivity or % concentration measuring mode (conductivity for this example), press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond" or "Conc").

2. Press **NEXT** key until display indicates "outP". Then press **ENTER** key to access the "outP" menu of setup variables (display indicates "SIM VALUE").

3. Press **NEXT** key <u>once</u> to make display indicate "LO OUT VALUE".

4. Use ⇧ and ⇦ keys to make display indicate the low endpoint at which the minimum outputs are to be provided (30.0 mS/cm for 4 mA for this example).

5. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

Setting The High Endpoint

The high endpoint, entered with the HI OUT VALUE setup variable, is the point at which the maximum outputs (5 VDC, 1 mA and 20 mA) are provided.

1. With the display still in "examination" mode, press **NEXT** key <u>once</u> to make display indicate "HI OUT VALUE".

2. Use ⇧ and ⇦ keys to make display indicate the high endpoint at which the maximum outputs are to be provided (70.0 mS/cm for 20 mA for this example).

3. Press **ENTER** key to enter value ("OK" flashes to confirm entry).

10.3 Using Output Hold Feature

The 0-5 VDC, 0-1 mA, and 4-20 mA analog outputs can be held while you set up or calibrate the instrument to suspend operation of a connected device such as a recorder.

Keypad Activation

You activate the hold mode feature by simultaneously pressing the **OUTPUT** key and recessed **END CAL/HOLD** button. The **HOLD** status indicator then lights to indicate that "hold" is in effect, and the values for each output are held for 30 minutes (unless you extend this time or cancel the hold feature). Also, relays set in the control mode have their operation suspended and will not transfer (even if the measured value has exceeded their setpoint). Relays set in the alarm mode are unaffected and remain in whatever state they are in when you activate the hold feature. Thirty seconds before the 30-minute hold period expires, the **HOLD** indicator begins flashing to warn you of impending automatic cancellation. Pressing the **OUTPUT** key extends the hold period for another 30 minutes. You may cancel the output hold feature at any time by simultaneously pressing the **CANCEL HOLD** and **OUTPUT** keys.

Remote Activation

You can also activate the output hold feature from a remote location by connecting an LSTTL-compatible (active low) or switch closure input to Terminals 14 and 15 on TB2. When the switch is closed, the outputs are held and the relays are affected in the same way as described in the "Keypad Activation" subsection. Remote activation of the hold feature also causes the **HOLD** status indicator to flash continuously during the entire time "hold" is in effect. When the remote switch is opened, the outputs and control relays resume their normal operation.

SECTION 11 - USING SECURITY LOCK FEATURE

The security lock feature prevents unauthorized alteration of stored values. When the 672E is locked (identified with lit "LOCK" status indicator), stored setup variable values -- including preset calibration points for the "two-key" method -- cannot be changed. However, calibration can be performed using any method and all stored values can be displayed.

11.1 Locking Stored Values

1. With display in conductivity or % concentration measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond" or "Conc").
2. Press **NEXT** key until display indicates "CnFg". Then press **ENTER** key to access the "CnFg" menu of setup variables (display indicates "ZErO").
3. Press **NEXT** key until display indicates "0000" and "LOCK" (identifiers for security lock feature).
4. Use ⇧ key to make display indicate the lock code "0001".
5. Press **ENTER** key to enter lock code ("OK" flashes to confirm code entry and **LOCK** status indicator remains lit).
6. Press **EXAM/CANCEL** key to return display to measuring mode.

# # # #

11.2 Unlocking Stored Values

1. With display in conductivity or % concentration measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond" or "Conc" with **LOCK** status indicator lit).
2. Press **NEXT** key until display indicates "CnFg" and "LOCK". Then press **ENTER** key to access the "CnFg" menu of setup variables (display indicates "ZErO" and "LOCK").
3. Press **NEXT** key until display indicates "0000" and "LOCK" (identifiers for security lock feature).
4. Use ⇧ and ⇦ keys to make display indicate the unlock code "1234".
5. Press **ENTER** key to enter unlock code ("OK" flashes to confirm entry and **LOCK** status indicator remains lit).
6. Press **EXAM/CANCEL** key to return display to measuring mode (**LOCK** status indicator disappears from display).

PART FOUR - OPERATING AIDS

SECTION 1 - PRESERVING MEASUREMENT ACCURACY

1.1 Keeping Sensor Clean

Clean the sensor as required using the recommended procedure described in the sensor operating instruction manual.

1.2 Keeping Instrument Calibrated

Calibrate the 672E as experience dictates, using one of the methods described in Part Three, Section 5 when the analyzer is used to measure conductivity (or Section 7 when the analyzer is used to measure % concentration). Errors in readings may be caused by using a diluted or contaminated reference solution when the instrument was calibrated. For best measurement accuracy, never reuse reference solutions. The system can never be more accurate than the solutions used to calibrate it. Note that reference solutions may change in value with ambient temperature. Therefore, during calibration always allow the sensor and reference solution to attain temperature equilibrium.

1.3 Avoiding Ground Loop Errors

The instrument may be affected by a "ground loop" electrical problem when there is moisture in a junction box. This condition provides a conductive pathway from the sensor connections to earth ground. To prevent a ground loop from occurring, keep terminal connections dry and corrosion-free.

1.4 Avoiding Electrical Interferences

Do not run sensor wires in the same conduit with line power. Excess wire should not be coiled near motors or other equipment that may generate electric or magnetic fields. Cut wires to proper length during installation to avoid unnecessary inductive pick-up ("electrical noise" may interfere with sensor signal).

SECTION 2 - TEMPERATURE CALIBRATION

Typically, the instrument is selected to automatically compensate the conductivity (or % concentration) reading for changes in temperature. The 672E is factory-calibrated for temperature and provides very accurate temperature measurement. However, the 672E has the capabilities to tailor temperature calibration for specific, unusual application conditions, providing the highest possible temperature measurement accuracy. You can temperature calibrate the 672E using a single or two-point method.

2.1 Single-Point Method

This method requires a container of water (or process solution) that has a known temperature value approximately equal to the normal operating temperature of the process.

1. Place conductivity sensor in the water (or process solution) of known temperature value.

2. Press **DISP VAR** key until temperature is displayed, and allow display reading to stabilize. The sensor may take several minutes to attain temperature equilibrium with the solution.

3. Press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond" or "Conc").

4. Press **NEXT** key once to make display indicate "dEG C" (or "dEG F"). Then press **ENTER** key to access this menu of setup variables (display indicates "CAL VALUE").

5. Use ⇧ and ⇦ keys to make display indicate the known temperature value of the solution.

6. Press **ENTER** key to enter value (display indicates "buSy" for approx. 10 seconds, then flashes "OK" to confirm entry, and returns to temperature measuring mode). HI/LO ERROR flashes if the difference between the entry value and actual solution temperature is greater than 5.0°C.

This completes calibration for temperature using the single-point method.

2.2 Two-Point Method

This method requires a container of ice water and a container of boiling water.

1. Place conductivity sensor in the ice water.

2. Press **DISP VAR** key until temperature is displayed, and allow display reading to stabilize. The sensor may take several minutes to attain temperature equilibrium with the water.

3. Press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond" or "Conc").

4. Press **NEXT** key once to make display indicate "dEG C" (or "dEG F"). Then press **ENTER** key to access this menu of setup variables (display indicates "CAL VALUE").

5. Press **NEXT** key once to make display indicate "LO CAL VALUE".

6. Use ⇧ and ⇦ keys to make display indicate "0.0°C" (or "32.0°F").

7. Press **ENTER** key to enter value (display indicates "buSy" for approx. 10 seconds, then flashes "OK" to confirm entry, and returns to temperature measuring mode). If HI/LO ERROR flashes, the difference between the entry value and actual solution temperature is greater than 10.0°C.

8. Place conductivity sensor in the boiling water. Allow sensor to attain temperature equilibrium with the water.

9. Press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond" or "Conc").

10. Press **NEXT** key once to make display indicate "dEG C" (or "dEG F"). Then press **ENTER** key to access this menu of setup variables (display indicates "CAL VALUE").

11. Press **NEXT** key twice to make display indicate "HI CAL VALUE".

12. Use ⇧ and ⇦ keys to make display indicate "100.0°C" (or "212.0°F").

13. Press **ENTER** key to enter value (display indicates "buSy" for approx. 10 seconds, then flashes "OK" to confirm entry, and returns to temperature measuring mode). If HI/LO ERROR flashes, the difference between the entry value and actual solution temperature is greater than 10.0°C.

This completes calibration for temperature using the two-point method.

SECTION 3 - SIMULATING MEASURED VALUES

You can simulate conductivity or % concentration values to verify relay operation, or to help set up external devices (recorders, controllers, etc.) connected to the analog outputs. However, you can only simulate a value when the security lock feature is disabled (unlock mode -- see Part Three, Section 11.2). Accessing the "SIM VALUE" setup variable displays a conductivity or % concentration value. After you enter a simulation value, the respective analog output values will change to correspond with the displayed simulation value. Each time you change the simulation value, the output values will correspondingly change. When you exit the "SIM VALUE" setup variable screen, the outputs return to tracking the measured conductivity or % concentration. You may want to use the output hold feature (Part Three, Section 10.3) after you have entered a simulation value. This allows the outputs corresponding to that simulation value to be held, for example, while setting up a connected control element or when calibrating the 672E.

To simulate a desired value:

1. With display in conductivity or % concentration mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "Cond" or "Conc").

2. Press **NEXT** key until display indicates "outP". Then press **ENTER** to access this menu of setup variables (display indicates "SIM VALUE").

3. Use ⇧ and ⇦ keys to make display indicate the desired simulation value.

4. Press **ENTER** key to enter value ("OK" flashes to confirm entry). The respective output values change from tracking measured conductivity or % concentration to values corresponding with the entered simulation value.

5. To cancel the simulation value, press **EXAM/CANCEL** key.

PART FIVE - PRINCIPLE OF OPERATION

See Figure 5-1 for functional diagram pertaining to these descriptions.

1. The power-supply section converts line power to appropriate voltages for circuit operation.

2. The scaling and analog-to-digital converter sections accept signals from the conductivity sensor. This section converts these analog conductivity and temperature signals to digital signals for use by the microprocessor.

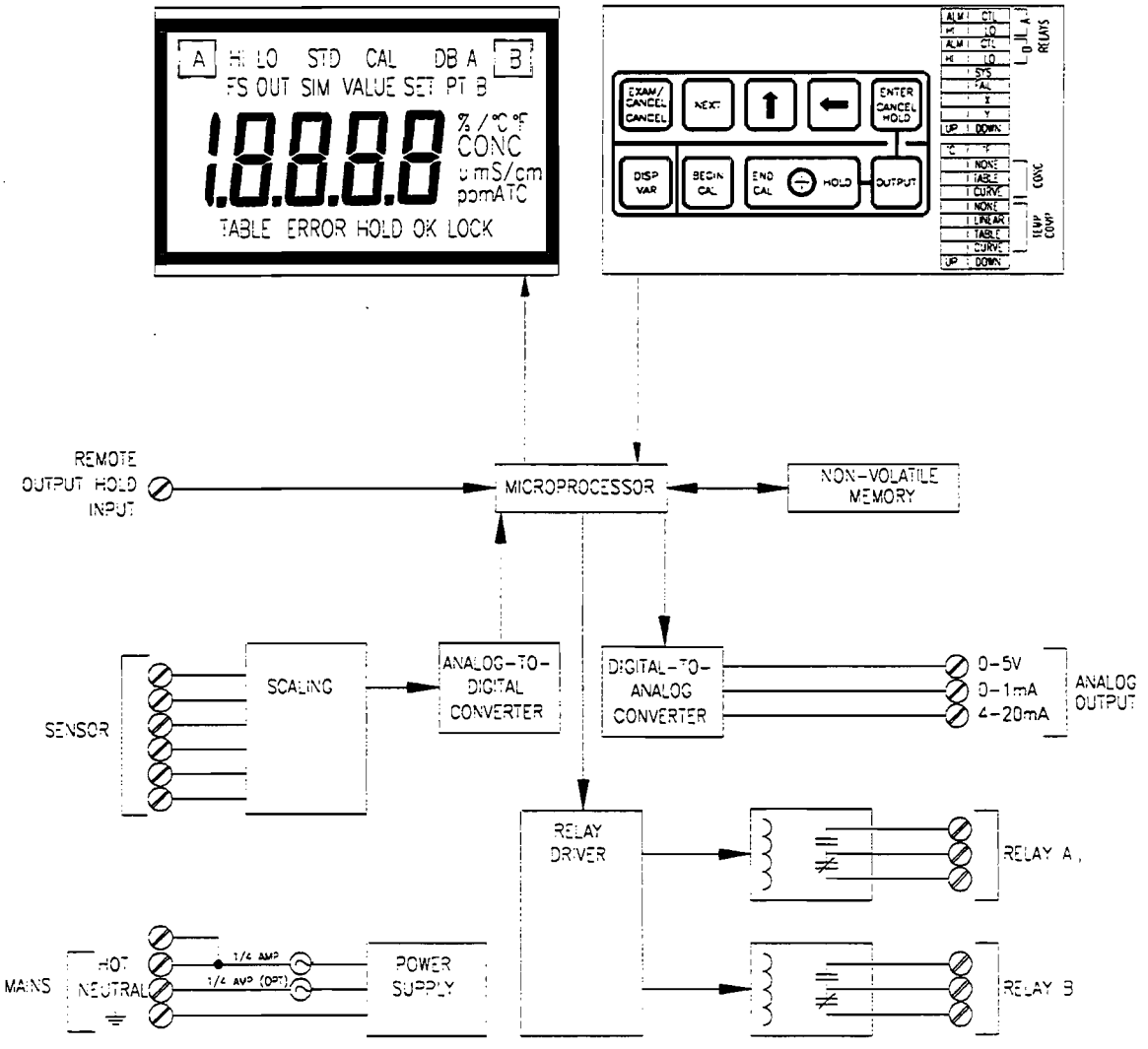


FIGURE 5-1 Instrument Operations Block Diagram

3. The microprocessor uses the conductivity and temperature signals to compute the temperature-compensated conductivity or % concentration value. The microprocessor also performs the various control algorithms, updates the liquid crystal display, monitors the keypad and other configuration switches, and controls the relay status and the analog outputs. All user-entered values for instrument setup and calibration are retained in a non-volatile memory.

4. The liquid crystal display indicates the process-related values (conductivity, % concentration, temperature, and 4-20 mA output value) along with a variety of annunciators to indicate the status of the analyzer. The display also indicates setup variable values, error messages, diagnostic information, and relay status.

5. The microprocessor continuously monitors the keypad, setup DIP switches, and the remote "hold" input. Based on the status of these inputs, the microprocessor immediately initiates the appropriate action.

6. The analog outputs (0-1 mA, 0-5 VDC, and 4-20 mA) are controlled by the microprocessor. The digital output values are sent to the digital-to-analog converter section.

7. The microprocessor controls the relay driver circuitry, based on each relay's configured mode (control or alarm) and selected fail-safe or system alarm operation. The relay driver section operates relays A and B.

PART SIX - SERVICE AND MAINTENANCE

SECTION 1 - GENERAL

1.1 Inspecting Sensor Cable

If a measurement problem exists and the sensor cable is suspected, inspect it for physical damage. If interconnect cable is used, disconnect the cable at the sensor and instrument, and check wires for internal shorts with an ohmmeter.

1.2 Checking System Periodically

You should calibrate the measurement system periodically to maintain measurement accuracy. Frequent checks are suggested until operating experience can determine the optimum time between checks that provides acceptable measurement results.

1.3 Replacing Relays

1. **Disconnect line power.** Remove display module assembly by loosening two captive fasteners and disconnecting ribbon-cable connector.
2. Unfasten four screws that hold power-supply board to bottom of instrument case. Remove power-supply board.
3. Remove black insulator (with terminal designations) to access relay pins.
4. Unsolder defective relay from backside of power-supply board (side opposite terminal strips).
5. Replace relay with GLI relay p/n 99X2T1016. Solder new relay pins into board, and replace black insulator.
6. Mount power-supply board, connect ribbon cable connector, and install display module assembly with captive fasteners.

SECTION 2 - TROUBLESHOOTING

2.1 System Diagnostic Error Messages

Improper operation of the 672E is signaled by a flashing **ERROR** indicator while the display alternates between a measured value and one of the following error messages:

Table G - SYSTEM DIAGNOSTIC ERROR MESSAGES -- MEANINGS/CORRECTION ACTIONS		
Error Message	Meaning	Action To Take
"Er 1"	Faulty conductivity and temperature inputs (open or shorted cable, defective sensor, etc.)	Check wiring and calibrate system.
"Er 2"	Faulty conductivity input ("S" flashes).	Check wiring and calibrate system.
"Er 3"	Faulty temperature input ("°C" or "°F" flashes).	Check wiring and calibrate system.
"Er 4"	Incorrectly set DIP switches in lower bank (wrong combinations selected).	When using the 672E to measure conductivity, refer to Part Three, Section 4. When used to measure % concentration, refer to Part Three, Section 6 or Section 8. In either case, reset switches as described.
"Er 5"	Entry values are not accepted by non-volatile memory (but 672E will still operate).	Call GLI Customer Service Dept. for assistance.
"Er 6"	The measurement system (672E and sensor) has not been "zeroed" during instrument setup.	When using the 672E to measure conductivity, refer to Part Three, Section 4.5. When used to measure % concentration, refer to Part Three, Section 6.4 or Section 8.7. In either case, zero the instrument as desribed.
"Er 7"	Improper user-defined concentration conversion table.	Refer to Part Three, Section 8.3 and 8.5. Review instructions to ensure proper table setup.
"Er 8"	Improper user-defined temperature compensation table.	When using the 672E to measure conductivity, refer to Part Three, Section 4.4. When used to measure % concentration, refer to Part Three, Section 8.6. In the "User-defined Temperature Table Compensation" subsection, carefully follow the table setup instructions.
"Er 9"	Improper calibration (sensor in wrong conductivity reference solution).	Recalibrate with sensor in the correct value reference solution.
"Er 10"	Defective non-volatile memory (672E is inoperable).	Call GLI Customer Service Dept. for assistance.
"Er 11"	Volatile memory failure (battery backup is not in effect).	Make sure **BATTERY** jumper (Figure 3-1) is in **ON** position. Then recharge the battery by operating the 672E for two days (48 hours).
"Er 12"	Warning -- the full-scale value has been changed.	Since this condition affects the instrument setup, carefully review instructions to ensure proper setup. When using the 672E to measure conductivity, refer to Part Three, Section 4. When used to measure % concentration, refer to Part Three, Section 6 or Section 8.

NOTE: Error message indications "Er 10", "Er 11", and "Er 12" do not automatically clear after corrective action is taken. However, you may clear these messages anytime by pressing the **ENTER** key. If the condition that caused the error is not corrected, the error message will reappear.

Error messages are displayed only when the 672E is in the measurement mode. As you set up or calibrate the analyzer, it will not display an error message. An error message is displayed after completing the procedure, unless the condition has been corrected. If two or more problem conditions occur at the same time, the most serious error message takes precedence and will be displayed. When that condition is corrected but others still exist, the error message for the next most serious remaining condition will be displayed.

2.2 Common Problems

To help you in correcting common problems, the following table lists symptoms and their typical causes.

Table H - TROUBLESHOOTING COMMON PROBLEMS	
Symptom	Typical Causes
Display is completely blank.	1. Line power is not present or connected. 2. Line power fuse(s) open. 3. Ribbon-cable plug from display module assembly is not properly connected into power-supply board assembly.
Output values remain fixed when process value is known to be changing.	Output hold feature is temporarily holding outputs. Simultaneously press **CANCEL HOLD** and **OUTPUT** keys to cancel hold feature, or open external switch if held from a remote location (Part Three, Section 10.3).
Relay remains de-energized even though setpoint has been exceeded.	Output hold feature is temporarily suspending relay operation. Simultaneously press **CANCEL HOLD** and **OUTPUT** keys to cancel hold feature, or open external switch if held from a remote location (Part Three, Section 10.3).
Valid setup variable value cannot be entered.	Instrument is in "lock" mode. Enter unlock code to unlock instrument (Part Three, Section 11.2).

2.4 Customer Assistance

If you need spare parts, assistance in troubleshooting, or repair service, please contact your local GLI representative, or the GLI Customer Service Department at:

GLI International, Inc.
9020 West Dean Road
Milwaukee, Wisconsin 53224

Phone: [800] 543-8907
Fax: [414] 355-7797

– GLI SERVICE DEPARTMENT HOURS –

	Eastern Std. Time	Central Std. Time	Mountain Std. Time	Pacific Std. Time
Monday through Thursday	8:30 a.m. to 5:30 p.m.	7:30 a.m. to 4:30 p.m.	6:30 a.m. to 3:30 p.m.	5:30 a.m. to 2:30 p.m.
Friday	8:30 a.m. to 4:00 p.m.	7:30 a.m. to 3:00 p.m.	6:30 a.m. to 2:00 p.m.	5:30 a.m. to 1:00 p.m.

When ordering spare or replacement board assemblies, be sure to use the **complete** assembly part number.

All analyzers or board assemblies returned for repair must be freight prepaid and include the following information:

1. A clearly written description of the malfunction.
2. Name of person to contact and the phone number where they can be reached.

3. Proper return address for shipping analyzer(s) back. Include preferred shipping method (UPS, Federal Express, etc.) if applicable.

4. A purchase order if analyzer(s) or board assemblies are out of warranty to cover costs of repair.

NOTE: *If the analyzer or board assemblies are damaged during return shipment as a result of inadequate packaging, the customer assumes responsibility for repair costs. It is recommended to use the original GLI shipping carton or an equivalent. Also, GLI will not accept instruments returned for repair or replacement unless they are thoroughly cleaned and all process material is removed.*

PART SEVEN - SPARE PARTS AND ACCESSORIES

Description	Part Number
BATTERY Jumper (one)	99X2K1098
Relay (5A contacts, 24 VDC coil)	99X2T1016
Complete Circuit Board Set* (115 V, 50/60 Hz. -- 1 fuse)	672M4G5020-101
Complete Circuit Board Set* (230 V, 50/60 Hz. -- 1 fuse)	672M4G5020-201
Complete Circuit Board Set* (230 V, 50/60 Hz. -- 2 fuses)	672M4G5020-202
Liquid Crystal Display	99X6Q1124
Optional Vertical Pipe-mount Kit	1000A4A1077
1/4 Amp. Slo-blow Fuse (5 mm dia. x 20 mm long)	99X1F1048
Door Assembly	1000M4G1189-103

* Individual boards cannot be separately ordered because they are calibrated as a set. However, the boards may be repaired and recalibrated at our factory.

GLI International

Operating Instruction Manual

Manual No. 201
Revision 6-198

MODEL 3600E-SERIES ELECTRODELESS CONDUCTIVITY SENSORS

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Figure 2-6 CE Termination Details (for CE-only applications) 12

SENSOR WARRANTY/REPLACEMENT PLAN

GLI International, Inc. will replace or repair any sensor which fails due to defects in materials or workmanship for a period of 1 year (12 months) from the date of shipment of this product from our facility. A warranty claim will not be honored if defects are not reported within the warranty period, or if GLI International determines that defects or damages are due to normal wear, misapplication, lack of maintenance, abuse, improper installation, alteration, or abnormal conditions. GLI International's obligation under this warranty shall be limited to, at its option, replacement or repair of this product. The product must be returned to GLI International, freight prepaid, for examination. The product must be thoroughly cleaned and any process chemicals removed before it will be accepted for replacement or repair. GLI International's liability shall not exceed the cost of the product. Under no circumstances will GLI International be liable for any incidental or consequential damages, whether to person or property. GLI International will not be liable for any loss, damage or expense of any kind, including loss of profits, resulting from the installation, use, or inability to use this product.

PART ONE - INTRODUCTION

SECTION 1
GENERAL INFORMATION

1.1 Description

Mounting Styles

The Model 3600E-series electrodeless conductivity sensor measures the conductivity of solutions from 0-200 up to 0-2,000,000 microSiemens/cm. These sensors may be provided in one of two mounting styles:

- **Convertible Style** -- The convertible style sensor can be directly fastened to the end of a pipe for immersion mounting or, by using the GLI union-mount adapter, it can be mounted into any standard 2-inch NPT fitting (tee, weldolet, pipe saddle, etc.). The convertible style sensor can also be insertion mounted into a 2-inch ball valve assembly.
- **Sanitary Style** -- This clean-in-place style sensor is constructed of 3A-approved materials. It has an integral 2-inch sanitary-mount flange which mates to GLI sanitary tee mounting hardware. The sanitary style sensor includes a special cap and EPDM compound gasket. The gasket is also available separately for mounting to a 2-inch sanitary clamp-type ferrule or butt-weld tee.

Wetted Materials

To simplify chemical resistance problems, these sensors are constructed such that only one material is wetted by the process. The convertible and sanitary style sensors may be provided in polypropylene or PVDF material. The convertible style sensor is also available in PEEK material.

1.2 Operating Precautions

Always consider the temperature/pressure ratings of the mounting hardware used to install the sensor. The sensor and hardware combine to become an integrated system. The hardware material usually limits the system's temperature/pressure rating. Refer to Section 2 for complete specifications.

SECTION 2
SPECIFICATIONS

Applicable For All Sensor Styles

Wetted Materials ..... Polypropylene, PVDF, or PEEK

Oper. Temp. Range..... -10 to 125°C (14 to 257°F)

Max. Flow Rate ..... 10 ft. (3 m) per second

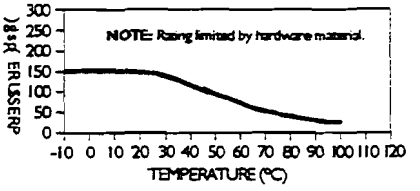
Measuring Range ..... From 0-200 to 0-2,000,000 microSiemens/cm

Temp. Compensator..... Pt 1000 RTD

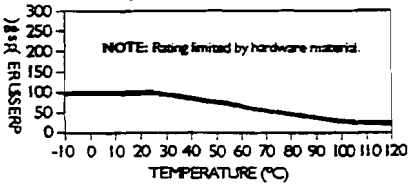
Sensor Cable..... 5 conductor (plus two isolated shields) cable with XLPE (cross-linked polyethylene) jacket; rated to 150°C (302°F); 20 ft. (6 m) long

Pressure/
Temperature Limits* ..... See graphs below for specific GLI sensor and mounting hardware combinations:

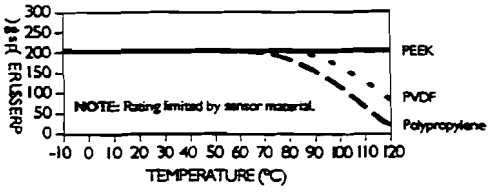
CPVC Mounting Hardware
(All Sensor Materials)



PVDF Mounting Hardware
(All Sensor Materials)

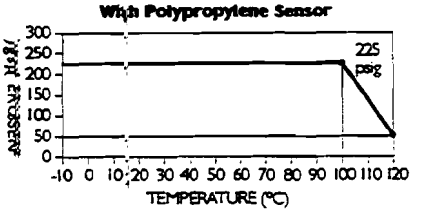


316 Stainless Steel Mounting Hardware

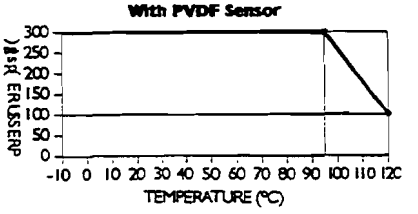


304 Stainless Steel Sanitary Mounting Hardware▲

With Polypropylene Sensor



With PVDF Sensor



* Ratings for the above GLI sensor and mounting hardware combinations are based upon water service. More severe service may require a correction factor.

▲ Sanitary mounting hardware ratings are for MH048S8S hardware using the 9H1132 heavy duty sanitary clamp. Other hardware and clamp combinations may reduce the listed ratings.

PART TWO - INSTALLATION

SECTION 1
LOCATION REQUIREMENTS

Locate the sensor as close as possible to the measuring instrument. Depending on the instrument model and full scale range, the maximum permissible distance between sensor and instrument varies (refer to instrument manual for distances).

☞ ***NOTE:*** *When indirectly wiring the sensor to the instrument with interconnect cable and a junction box, use only GLI cable part number 1W1100. This interconnect cable replaces the 99X1W4000 cable which is no longer available. If a different cable is used, it must have equivalent construction: five conductors and two separate isolated shields -- one shielding the signal, and one shielding the overall cable. These specific cable characterisitics protect the measurement signal from electromagnetic interferences. Using a cable with different construction may interfere with the measurement system's performance.*

SECTION 2
MOUNTING

Regardless of the mounting method, always use Teflon tape on the sensor and mounting hardware threads to avoid leaks. Do not use pipe sealant.

2.1 Immersion (no adapter needed)

The convertible style sensor may be immersion mounted by threading it onto the end of a pipe of an appropriate length (Figure 2-1).

1. Screw a 3/4 x 1/2-inch NPT reducer coupling onto the cable end of the sensor. Use an adjustable or open-end wrench on the flatted section below the sensor threads to carefully tighten the connection to prevent leaks.

CAUTION: DO NOT TIGHTEN THE SENSOR

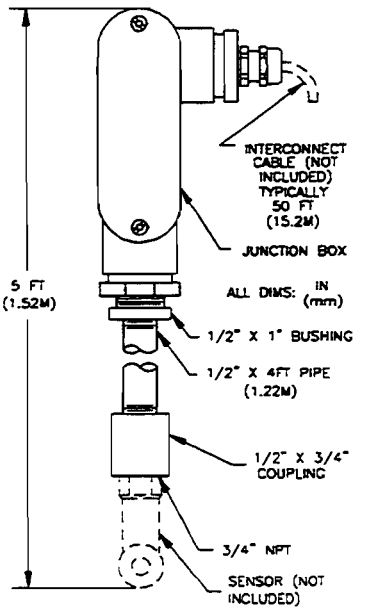


FIGURE 2-1 Immersion Mounting Details

CONNECTION BY HOLDING AND TURNING THE "DOUGHNUT-SHAPED" END OF THE SENSOR. THIS COULD CRACK THE SENSOR BODY.

2. Route the sensor cable through a 1/2-inch diameter mounting pipe of an appropriate length. Screw the pipe onto the reducer coupling.

3. Fasten the pipe-mount junction box onto the 1/2-inch NPT threads of the mounting pipe.

4. Route the sensor cable into the junction box. If the cable is too long, cut it to just the length needed which minimizes electromagnetic interferences. Then very carefully re-terminate the sensor wires and shields by following the procedure described in Section 3.3 or 3.4.

5. Route the interconnect cable from the junction box to the instrument. If the cable is too long, cut it to just the length needed which minimizes electromagnetic interferences. Then very carefully terminate the wires and shields of the interconnect cable by following the procedure described in Section 3.3 or 3.4.

   Recommendation: Run the interconnect cable in 1/2-inch or larger flexible, metal conduit to protect it from moisture and mechanical damage. The flexible conduit must be long enough to allow the sensor to be removed from the process for maintenance and calibration.

   NOTE: *Do not route the interconnect cable in any conduit containing AC power wiring ("electrical noise" may interfere with the sensor signal).*

6. Refer to the instructions in the instrument manual for connecting the sensor and interconnect cable wires in the junction box, and for connecting the other end of the interconnect cable to the instrument.

7. Fasten the cover onto the junction box.

8. Before mounting the sensor/hardware assembly into the process, calibrate the measurement system with conductivity reference solution using the procedure in the instrument instruction manual.

2.2 Tee, Weldolet, Pipe Saddle, etc. (requires GLI union-mount adapter)

The convertible style sensor may be mounted in any standard 2-inch NPT fitting (pipe tee, weldolet, pipe saddle, etc.) by using a special GLI union-mount adapter.

1. Install a standard 2-inch NPT fitting (pipe tee, weldolet, pipe saddle, etc.) into the process line. Preferably, the fitting should be made of a material to provide a suitable maximum pressure/temperature rating for the application. Refer to Part One, Section 2 for specifications.
2. Fasten the special short nipple of the GLI union-mount adapter into the 2-inch NPT fitting. Carefully tighten the threaded connection to prevent leaks. Figures 2-2 and 2-3 respectively show pipe tee and flange mounting details.
3. Route the sensor cable through the cord grip of the GLI union-mount adapter, and tighten the sensor into the adapter's flanged piece.
4. Wire the sensor directly to the instrument or indirectly using interconnect cable and a junction box. In either case, make sure that the sensor or interconnect cable is cut to the proper length to minimize electromagnetic interferences.
   A. Make sure to very carefully terminate the wires and shields of the respective cable(s) by following the procedure described in Section 3.3 or 3.4.
   B. Refer to the instructions in the instrument manual to electrically connect the sensor to the instrument.

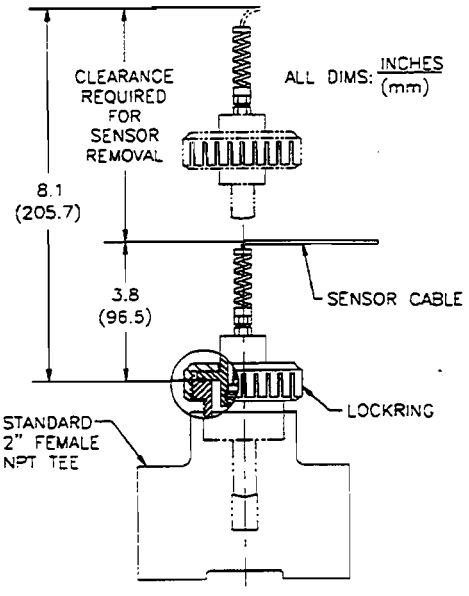


FIGURE 2-2 Tee Mounting Details

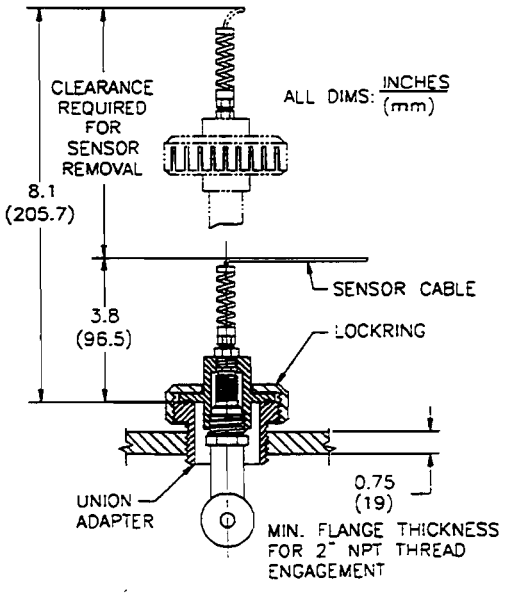


FIGURE 2-3 Flange Mounting Details

5. Before mounting the sensor into the process line or vessel, calibrate the measurement system with conductivity reference solution using the procedure in the instrument instruction manual.

6. After calibration, mount the sensor into the installed 2-inch NPT fitting:

   A. Properly seat the gasket into its mating groove on the special short nipple of the GLI union-mount adapter.

   B. Carefully place the sensor into the short nipple, making sure the gasket is in place and contacting the adapter's flanged surface.

   C. Tighten the union-mount adapter lockring onto the special short nipple to secure the connection.

This completes the sensor mounting using the special GLI union-mount adapter.

2.3 Sanitary Flange

The sanitary style sensor may be clamp-mounted for clean-in-place applications by using a sanitary clamp-type tee or ferrule and a heavy duty clamp (Figure 2-4).

1. Install a 2-inch sanitary clamp-type tee or ferrule into the process line or vessel.

2. Route the sensor cable through the hole in the stainless steel endcap so that the endcap's taper faces towards the top surface of the integral sensor flange.

3. Wire the sensor directly to the instrument or indirectly using interconnect cable and a junction box. In either case, make sure that the sensor or interconnect cable is cut to the proper length to minimize electromagnetic interferences.

   A. Make sure to very carefully terminate the wires and shields of the respective cable(s) by following the procedure described in Section 3.3 or 3.4.

   B. Refer to the instructions in the instrument manual to electrically connect the sensor to the instrument.

4. Before mounting the sensor into the process line or vessel, calibrate the measurement system with conductivity reference solution using the procedure in the instrument instruction manual.

5. After calibration, mount the sensor into the sanitary tee or ferrule:

A. Properly seat the sanitary gasket onto the mating surface of the tee or ferrule.

B. Carefully place the sensor into the tee or ferrule, making sure the gasket is in place and contacting the bottom surface of the integral sensor flange.

C. Place the stainless steel endcap onto the top surface of the integral sensor flange and secure the sensor onto the tee or ferrule with the heavy duty clamp. Tighten wing nut on the heavy duty clamp to 25 inch-lbs. torque. If the sensor is installed in a temperature cycling process, the wing nut may need to be periodically re-tightened.

This completes the sensor mounting using a sanitary clamp-type tee or ferrule and a heavy duty clamp.

CAUTION: STEAM STERILIZATION IS NOT RECOMMENDED FOR CLEANING THE GLI SANITARY STYLE ELECTRODELESS CONDUCTIVITY SENSOR.

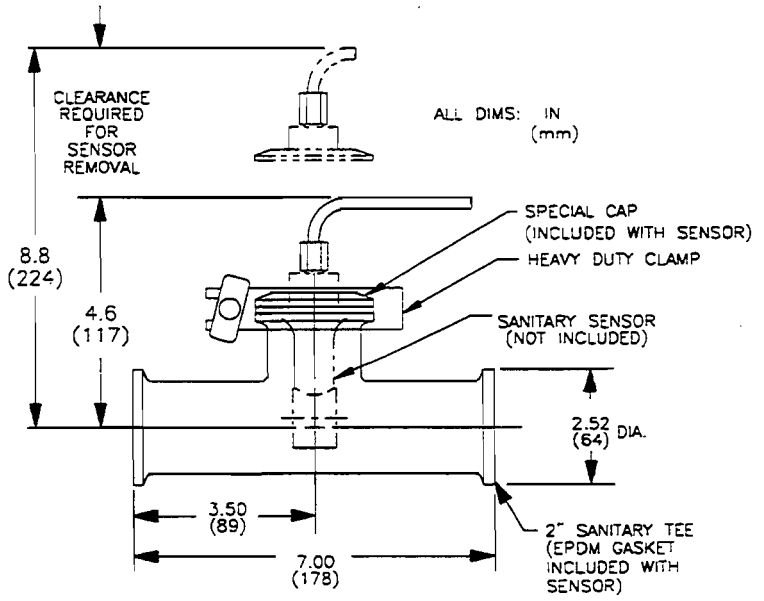


FIGURE 2-4 Sanitary (CIP) Flange Mounting Details

SECTION 3
SENSOR/INTERCONNECT CABLE TERMINATION

CAUTION: IF THE SENSOR OR INTERCONNECT CABLE IS NOT TERMINATED EXACTLY AS DESCRIBED, THE MEASURING SYSTEM WILL NOT MEASURE PROPERLY.

3.1 Sensor Cable Details

The sensor may be provided with its integral cable terminated one of two ways:

- **Standard Termination:** For all applications except those using instruments with the European Community "CE" label. The sensor cable is terminated with five colored wires (red, green, yellow, white, and blue) and one shield wire (the signal shield wire and cable shield wire are electrically common).
- **CE Termination:** Only available by special order for applications using instruments with the European Community "CE" label. The sensor cable is terminated with five colored wires (red, green, yellow, white, and blue), and two separate isolated shield wires (the signal shield wire and cable shield wire are electrically isolated).

In either case, it may be necessary to shorten the sensor cable during installation. When doing this, refer to the appropriate subsection (3.3 or 3.4) for the procedure to re-terminate the sensor cable.

3.2 Interconnect Cable Details

The GLI interconnect cable (part number 1W1100) is provided with unfinished ends since it often needs to be shortened during installation. This interconnect cable replaces the 99X1W4000 cable which is no longer available. The 1W1100 cable is identical to the sensor cable except that it has unfinished ends. Use the appropriate procedure in subsection 3.3 or 3.4 to terminate either cable.



NOTE: *GLI strongly recommends using only its 1W1100 interconnect cable. If a different cable is used, it must have equivalent construction: five conductors, and two separate isolated shields -- one shielding the signal, and one shielding the overall cable. These specific cable characteristics protect the measurement signal from electromagnetic interferences. Using a cable with different construction may interfere with the measurement system's ability to properly measure.*

3.3 Standard Termination Procedure (for all applications except CE)

CAUTION: USE THIS STANDARD TERMINATION PROCEDURE TO TERMINATE THE SENSOR OR INTERCONNECT CABLE UNLESS THE MEASURING INSTRUMENT HAS THE EUROPEAN COMMUNITY "CE" LABEL. IN THIS CASE, THE CE TERMINATION PROCEDURE (SECTION 3.4) MUST BE USED.

1. Strip back the outer cable jacket, outer foil wrap, cellophane wrap, inner foil wrap, and unused black wire to a distance of 3 inches (76 mm) as shown in Figure 2-5. This exposes the signal shield wire, the cable shield wire, and the five colored wires (red, green, yellow, white, and blue).
2. Twist the signal shield wire and cable shield wire together, and insulate the new combined shield wire with shrink wrap or tape.
3. Strip the insulation back from each of the colored wires to a distance of 1/8 inch (3 mm). Then tin each stripped wire.
4. Using shrink wrap or tape, equally cover the outer cable jacket, and the five colored wires/combined shield wire. This secures and completes the terminated assembly.

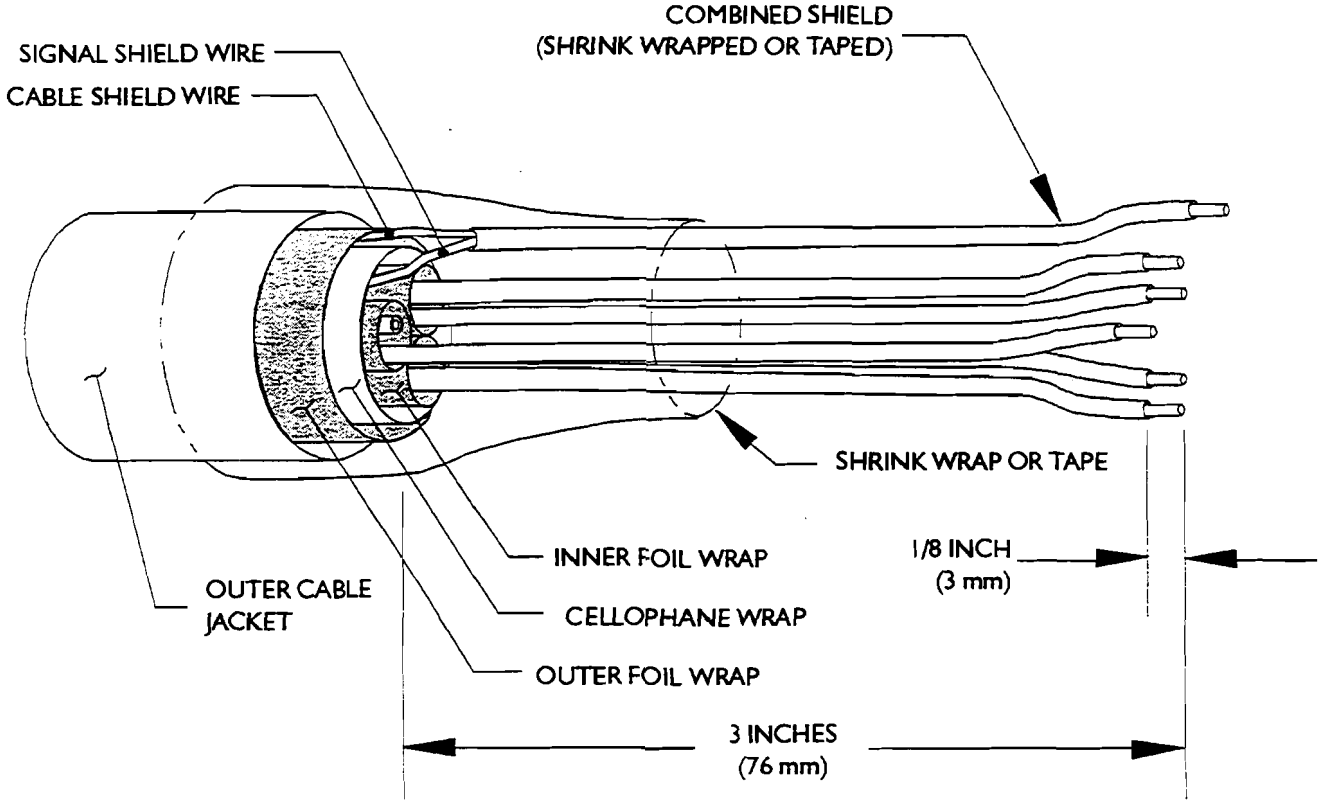


FIGURE 2-5 Standard Termination Details (for All Applications Except CE)

3.4 CE Termination Procedure (for CE-only applications)

CAUTION: WHEN THE MEASURING INSTRUMENT HAS THE EUROPEAN COMMUNITY "CE" LABEL, THIS CE TERMINATION PROCEDURE MUST BE USED. IF THERE IS NO "CE" LABEL ON THE INSTRUMENT, USE THE STANDARD TERMINATION PROCEDURE (SECTION 3.3).

1. Carefully strip back the outer cable jacket and outer foil wrap to an appropriate length. This exposes the signal shield wire, cable shield wire, and cellophane-wrapped wire bundle.
2. Fold back the cable shield wire (see Figure 2-6). Using shrink wrap or tape, equally cover the outer cable jacket, and the exposed cable shield wire/cellophane-wrapped wire bundle.
3. Carefully clip back the cellophane wrap, inner foil wrap, and unused black wire up to the end of the shrink wrap or tape applied in step 2. This exposes the signal shield wire, and the five colored wires (red, green, yellow, white, and blue).
4. Insulate the signal shield wire with shrink wrap or tape.
5. Strip the insulation back from each of the colored wires to a distance of 1/8 inch (3 mm). Then tin each stripped wire.
6. Using an ohmmeter or test light, verify that the signal shield wire is not shorted to the cable shield wire. If okay, shorten the cable shield wire to an appropriate length. If not, clip cable to get a new unfinished end and start over at step 1.
7. Using shrink wrap or tape, equally overlap the existing shrink wrap or tape applied in step 2, and the five colored wires/signal shield wire. This secures and completes the terminated assembly.

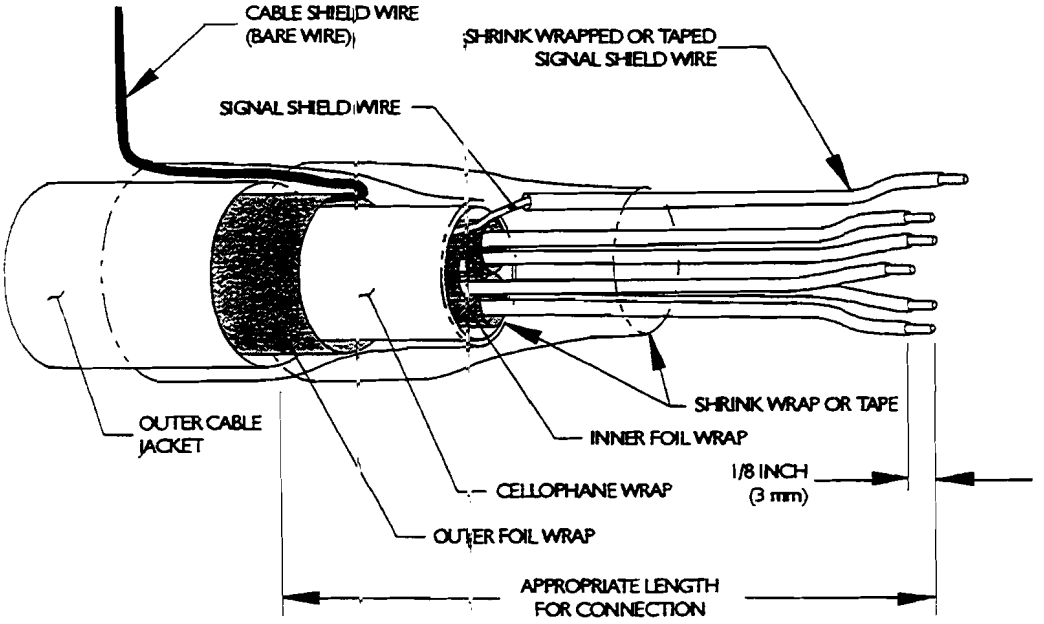


FIGURE 2-6 CE Termination Details (for CE-only Applications)

PART THREE - SERVICE AND MAINTENANCE

SECTION 1
RECOMMENDED CLEANING PROCEDURE

The sensor must be kept reasonably clean to maintain measurement accuracy. The time period between cleanings (days, weeks, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience. For example, a sensor operating in wastewater that contains oil and/or grease may require more frequent cleaning.

1. Rinse the sensor with clean, warm water.
2. Prepare a mild soap solution. Use warm water and dishwashing detergent, Borax hand soap or a similar soap.
3. Soak the sensor for 2 to 3 minutes in the soap solution.
4. Using a small bristle brush, cotton swab (Q-tip) or pipe cleaner, scrub the entire measuring end of the sensor to thoroughly clean the surfaces. If detergent solution cleaning cannot remove deposits on the surfaces, use muriatic acid (or another **dilute acid**) to dissolve the deposits. The acid should be as dilute as possible, but yet strong enough to clean. Experience will help determine which acid to use and how dilute it can be. Some stubborn coatings may require a different cleaning agent. Contact the factory for assistance in these difficult cases.

   Before cleaning with acid, determine if any hazardous reaction products could form. For example, a sensor used in a cyanide bath should not be put directly into a strong acid for cleaning because poisonous cyanide gas could be produced. Acids are hazardous and appropriate eye protection and clothing should be worn in accordance with Material Safety Data Sheet recommendations.

   Soak the sensor in dilute acid for no more than 5 minutes. Rinse the sensor with clean, warm water and then place the sensor back into the mild soap solution for 2 to 3 minutes to neutralize the acid.
5. Rinse the sensor in clean, warm water.
6. Calibrate the system with conductivity reference solution using the procedure in the instrument instruction manual. If calibration cannot be accomplished, check the sensor using the procedure in Part Three, Section 2.1.

SECTION 2
TROUBLESHOOTING

2.1 Checking Sensor Operation

Use the troubleshooting section in the instrument instruction manual to determine whether the sensor or instrument is defective. If the sensor is suspected, check it using the following procedure:

1. Disconnect the sensor from the instrument (or junction box if interconnect cable is used).

2. Clean the sensor using the procedure in Part Three, Section 1.

3. With the sensor at a temperature between 23°C and 27°C measure the resistance between the red and yellow wires with an ohmmeter. The reading should be between 1090 and 1105 ohms.

4. Measure the resistance between the white and blue wires. The reading should be less than 5 ohms. Now measure the resistance between the green and yellow wires. The reading should also be less than 5 ohms.

5. Place the ohmmeter to its highest range and measure the resistance between the shield and white wires. The reading should indicate infinity (open circuit).

6. If any one of the resistance checks in the previous steps is not correct, the sensor is probably defective. Refer to GLI's warranty/replacement plan on page 2 for details on sensor replacement. If the resistance checks are correct, the sensor may still be defective. In this case, more extensive troubleshooting is required. Please consult the GLI Customer Service Department for details.

2.2 Customer Assistance

If you need spare parts, assistance in troubleshooting, or repair servicing, please contact your local GLI representative, or the GLI Customer Service Department at:

GLI International, Inc.
9020 West Dean Road
Milwaukee, Wisconsin 53224

Telephone: [800] 543-8907
Telefax: [414] 355-8346

— GLI SERVICE DEPARTMENT HOURS —

	Eastern Std. Time	Central Std. Time	Mountain Std. Time	Pacific Std. Time
Monday through Thursday	8:30 a.m. to 5:30 p.m.	7:30 a.m. to 4:30 p.m.	6:30 a.m. to 3:30 p.m.	5:30 a.m. to 2:30 p.m.
Friday	8:30 a.m. to 4:00 p.m.	7:30 a.m. to 3:00 p.m.	6:30 a.m. to 2:00 p.m.	5:30 a.m. to 1:00 p.m.

All sensors returned for repair or replacement must be freight prepaid and include the following information:

1. A clearly written description of the malfunction.

2. Name of person to contact and the phone number where they can be reached.

3. Proper return address for shipping sensor back. Include preferred shipping method (UPS, Federal Express, etc.) if applicable.

4. A purchase order if sensor is out of warranty to cover costs of repair.

NOTE: *If the sensor is damaged during return shipment as a result of inadequate packaging, the customer assumes responsibility for repair costs. It is recommended to use the original GLI shipping carton or an equivalent. Also, GLI will not accept sensors returned for repair or replacement unless they are thoroughly cleaned and all process chemicals are removed.*

Microtel Series 250 Dialer
Real Voice Communications System

Installation and Operation Manual

P/N 310167 Rev A
March 1, 1997

CAUTION: Do not ship product with battery installed.

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MSC-250 INSTALLATION AND OPERATION MANUAL

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I. INTRODUCTION

A. GENERAL INFORMATION

The purpose of this manual is to completely explain the function, installation, and operation of the MCS Model 250/Real Voice Communication system. This automatic dialing, synthesized speech, telephone based monitoring system represents a new generation of computer controlled telemetry devices, with features and capabilities not found in any other telephone oriented monitoring system. The device is designed specifically for industrial based equipment monitoring needs, by the engineering staff which invented the concept of synthesized speech dialers. The Real Voice System allows the user to actually train the system to place alarm calls. The system can then inform the called individual of the precise location and nature of the alarm condition using a digitized sample of the user's voice.

The System is configured to accept four channels of normally open or normally closed fault state switches (contacts), such as float switches, pressure switches, temperature switches and similar devices that contain an unpowered contact that changes state whenever a preset condition changes. Fault recognition can be set to respond after 1 second or delayed for up to 99 seconds, programmable on a channel-by-channel basis. Internally, the system monitors its own power supply and will respond to any power outage which persist longer than the user programmable time period.

When the dialer system recognizes an alarm condition, due to the opening or closing of an external contact, it begins to place a series of telephone calls. The dialer system is able to dial up to eight different telephone numbers, in an attempt to make contact with a qualified person to whom it can deliver a combination of digitally stored voice messages, describing the location and the type of alarm condition. These messages are originally programmed by the user at the time of system installation.

The system will continue to call the list of up to 8 telephone numbers, insisting that its message be heard.

The dialer system can be called at any time to check or verify the monitored conditions.

The following instructions generally describe the installation, operation and maintenance of the equipment. Microtel reserves the right to make engineering refinements that may not be described herein.

B. UNPACKING AND INCOMING INSPECTION

Microtel takes all possible precautions in packaging each item to prevent shipping damage. Carefully inspect each package at the time of receipt for signs of physical damage. Report damage claims to the shipping agent involved immediately. Do not install damaged equipment.

All instructions given on any attached labels or tags should be followed. Carefully inspect all packing material before discarding it to prevent the loss of accessories, mounting hardware, spare parts, or instructions.

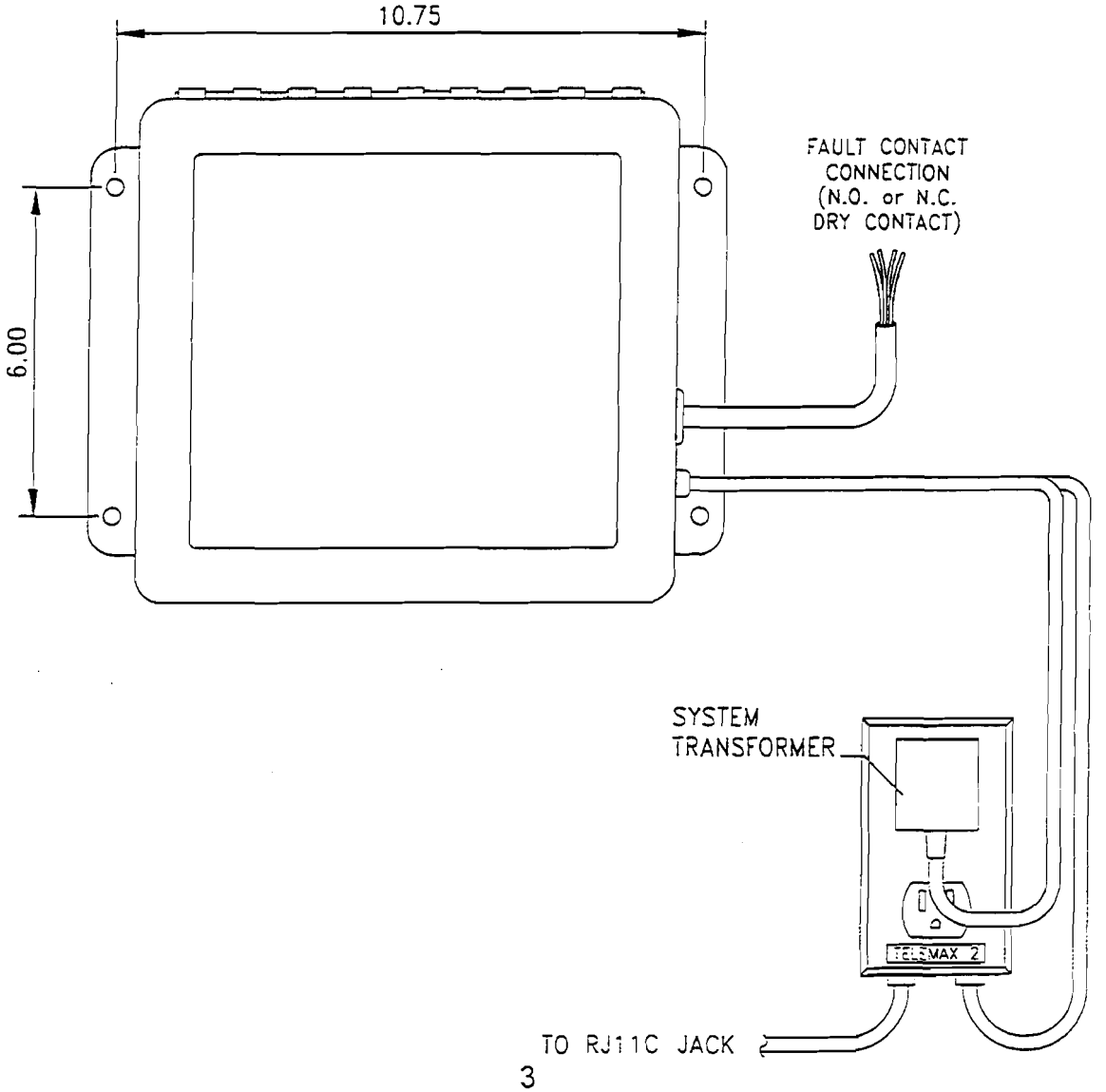
If the unit is not to be installed immediately, repack it in the shipping carton to protect it while in storage.

C. PHYSICAL SYSTEM INSTALLATION

Mount the system on a wall, or other vertical surface, away from and protected from harsh weather extremes. It is also recommended that the unit not be placed in close proximity to high voltage (480 V and higher) electrical equipment. Four mounting holes on the left and right side enclosure flanges are to be used for system mounting. It is recommended that the system be mounted at eye level to facilitate ease of programming and operation.

There are three access holes on the right side of the unit. The top port hole is intended for the system's telephone line connection. The larger hole is intended for routing of the system's fault sensing leads, while the smaller hole is intended for the system's power supply transformer cable.

The following figure shows the recommended dimensions to be used in the physical installation of the system.



D. BATTERY INSTALLATION

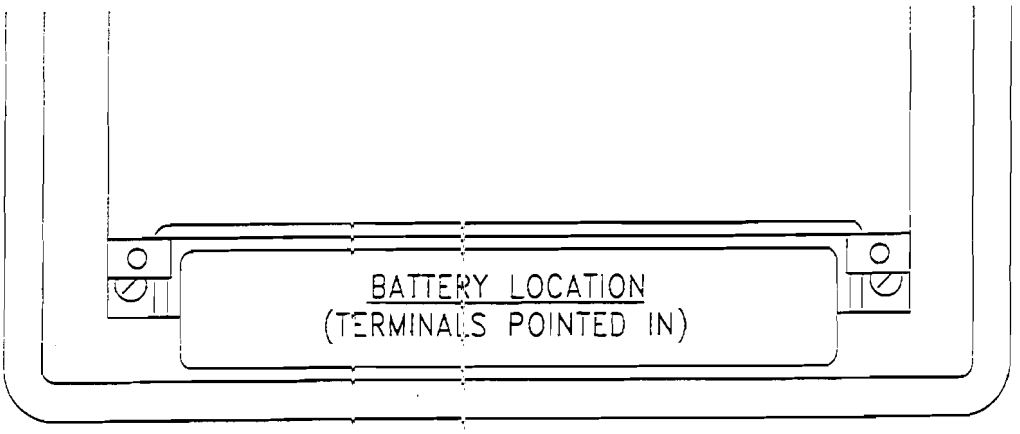
The battery is installed at the bottom of the system in the battery tray, provided as part of the interior chassis assembly.

IMPORTANT!
Before installing the system battery, be certain the power supply transformer **is not** plugged into an electrical outlet.

Remove the four phillips head screws which secure the system's front panel and remove it to expose the system's interior. Note that the panel is still connected to the system's main circuit board, so care must be exercised while the panel is hanging on this "tether". Retrieve the red and black battery leads from within the battery tray. Push the battery lead terminals onto the new battery, BEING CERTAIN that the red lead connects to the positive (+) battery terminal, and the black lead connects to the negative (-) battery terminal.

Slide (do not force) the battery completely into the battery tray with the terminals pointed DOWN into the system. If the battery is not completely seated in the battery tray, the front panel will be obstructed and will not fit properly onto its mounting area.

A new battery will take no longer than 24 hours to gain a full charge, making it capable of powering the dialer system through any power outage up to 6 hours in length. It should be noted that the LOW BATTERY indicator is only valid when the 120 VAC power is off. If the LOW BATTERY indicator stays on for more than eight hours, the battery is in need of replacement.



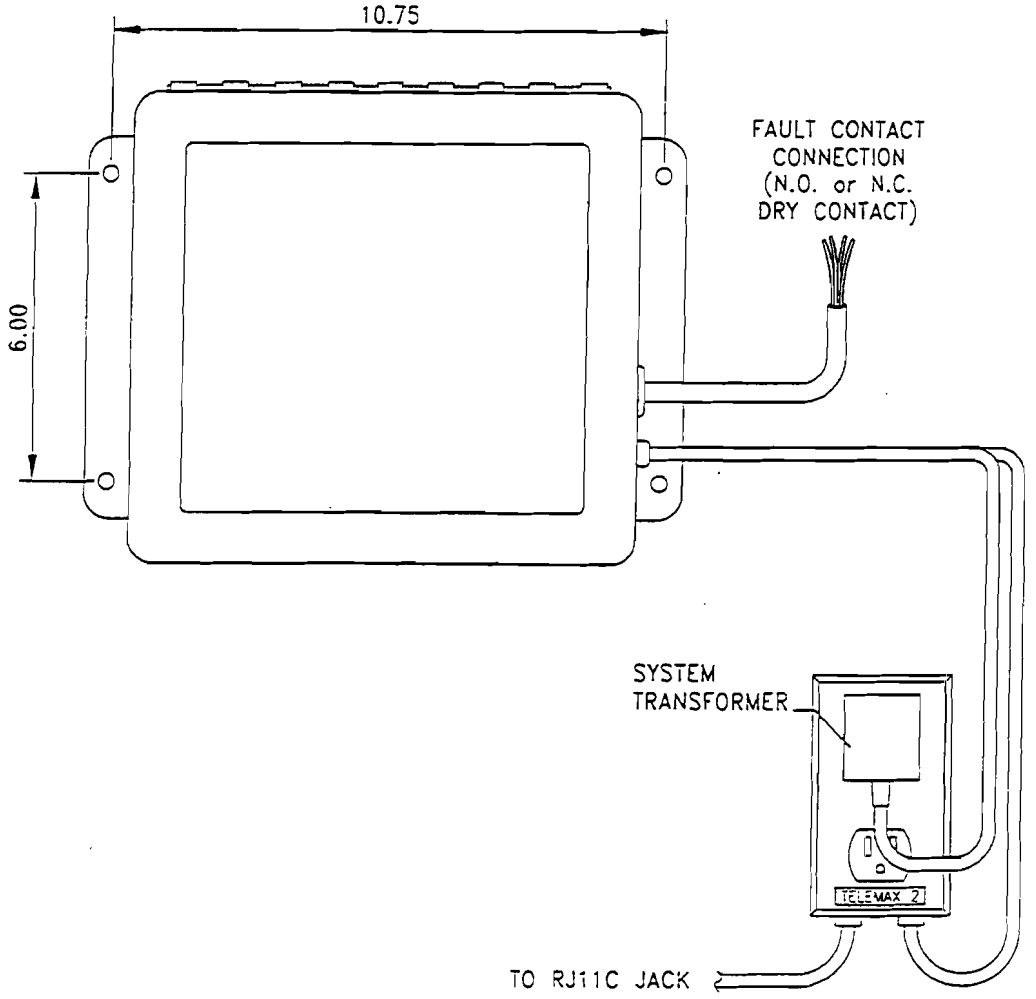
E. ELECTRICAL POWER INSTALLATION

Electrical power may be applied by simply plugging the system transformer into a nearby electrical outlet. If the system's environment has a history of, or has known electrical power line disturbances, then use of a transient protection module, available as an option from MICROTEL, is highly recommended.

If the unit is to be installed in a location where large or high voltage motors are in use, a power line transient suppresser is also recommended to insure that the unit is not affected by surges and spikes in the 120 VAC power to the unit.

It is recommended that a separate circuit breaker be used with the system. Remember that when the breaker is on, and the unit is plugged in, 12 VAC is contained within the system even though the system Power switch may be turned off. This is to allow continued charging of the system's backup battery, and retention of the system's message data, even with the system in a powered down state.

The internal system fuse is a 1 amp fuse (AGC 1), or equivalent. WHEN INSPECTING OR REPLACING THE FUSE, UNPLUG THE SYSTEM OR THROW THE CIRCUIT BREAKER SUPPLYING POWER TO THE UNIT.



F. TELEPHONE LINE INSTALLATION

The connection to the telephone network is a matter of simply plugging the modular jack cable into the telephone line termination provided by the telephone utility (RJ-11C or equivalent).

This section contains important information regarding the installation of the telephone line to be used by the system, and pertinent information for notifying the telephone company of what type of line is to be installed.

The Alarm dialer system is registered for direct connection to the telephone network by the FCC, which placed three restriction on its use:

1. The system cannot connect to a party line or a pay telephone line.

2. The telephone company must be notified that an FCC registered device is being installed.

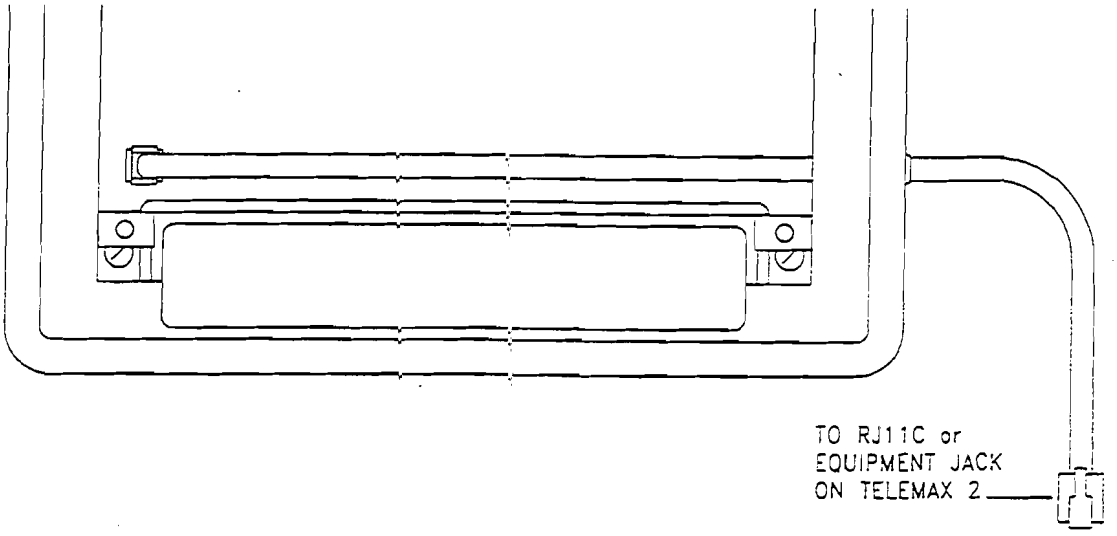
3. If trouble is experienced with the device, it must be immediately disconnected form the telephone network. Microtel must make any repairs which may be necessary in order to maintain the FCC registration status of the device.

THE FOLLOWING INFORMATION WILL BE REQUIRED BY THE TELEPHONE UTILITY WHICH INSTALLS THE TELEPHONE LINE FOR THE SYSTEM:

1. The FCC Registration Number, which is, D4J6M6-13598-AL-E.

2. The Ringer Equivalence, which is 0.2B.

3. The system needs to be connected to an RJ-11C telephone jack.



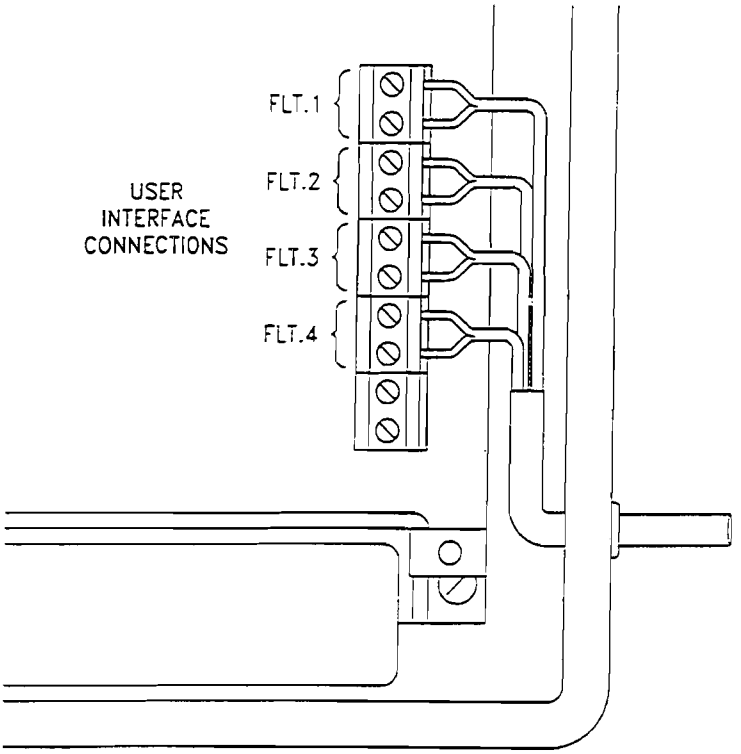
G. FAULT MONITORING INTERFACE CONNECTIONS

The dialer system is designed to accept up to four channels of dry (unpowered), normally open or normally closed signal lines. The system provides a small, pulsed sampling current to determine if the contact is open or closed. Leads from normally open or normally closed switches may be routed through the conduit port at the lower right side of the system. Connect each wire pair to its appropriate channel input terminal pair on the Fault Input Terminal Strip. Shielded, twisted pair, 20 or 22 gauge wire is recommended. Ground the shield at the sensor and leave the shield floating (Disconnected) at the alarm dialer system.

Each channel may be configured to be either normally open or normally closed. A channel will be normally open if the "no fault" (Green) condition consists of an open circuit on that channel's wire pair. A channel is normally closed if the "no fault" (Green) condition consists of a closed circuit on that channel's wire pair.

The programming section of this manual will provide details on how to program the Mode (normally open or normally closed) of each channel as well as setting the Fault Delay time for each channel.

Any unused channel should be left unconnected and programmed to a normally open mode (Green).



H. POWERING UP THE SYSTEM

NOTE: IF THE UNIT ABOUT TO BE POWERED UP FOR THE FIRST TIME CONTAINS HARDWARE FOR OPTIONAL FEATURES, READ THE SUPPLEMENTARY INSTRUCTION MANUAL FOR THOSE FEATURES BEFORE POWERING THE UNIT UP FOR THE FIRST TIME.

After the system has been mounted in a suitable area, the battery installed and power, telephone and fault sensing lines connected, it may be powered up by switching the POWER switch to the ON position. This switch is on the system's front panel. When the unit is powered up, the front panel indicators will flash in sequence [reset flash] for a few moments. If this does not happen, turn the switch to the OFF position, disconnect the power and the telephone line from the unit. Contact a qualified service person or Microtel, Inc. for instructions.

II. PROGRAMMING THE DIALER SYSTEM

For this section, the key stroke entries are CAPITALIZED. The system's response, whether visual or audible, are enclosed within [BRACKETS].

The system must be in the Halt mode [Red run light] to accept programming information. If it is not in the Halt mode, depress the HALT key to force that condition. [reset flash]

A. FAULT MODE PROGRAMMING

The fault status of each of the five channels is shown as a fault (RED) or no-fault (GREEN) condition on the corresponding front panel indicator. The system allows the user to specify whether an open contact condition should be regarded as a no-fault (GREEN), or as a fault (RED) state. To program each channel, first apply a known fault contact state to each input. This means shorting the input if a normally closed contact mode is to be used, or opening the input connections if a normally open contact mode is to be used. The 250 Real Voice system allows you to train the input for the proper mode choice.

For each fault input channel, perform the following programming steps:

1. ENTER, MODE, No.(1,2,3, or 4)
   [indicator No. will flash, verifying selection]

2. The selected indicator will alternate between RED and GREEN at one second intervals. When the indicator for the channel being programmed is in the proper state (RED or GREEN) for the applied input, depressing ENTER again will select that mode.

To verify the proper mode, simulate the opening or closing of the fault input contacts and view the proper state indication (RED or GREEN) on the system front panel.

B. FAULT DELAY TIME PROGRAMMING

Each channel may be programmed for its own fault delay time response, from 1 to 99 seconds. This means that the system will neither display or respond to a fault channel changing from a no-fault to a fault condition for this time period. Changes from a fault to a no-fault condition are, however, instantly detected by the system.

The 250 Real Voice system allows the user to train the fault detection sequence to set the desired fault detection delay.

To program the Delay Time for each fault channel (Channels 1, 2, 3, and 4) and the Power Fault channel (Channel 5), perform the following programming steps:

1. ENTER, DELAY, No.(1, 2, 3, 4, OR 5)
   [Indicator No. will flash, verifying selection]

2. Indicator will flash once each second. When the desired delay time has passed, depressing ENTER again will set that time period for that fault channel.

To verify the proper delay time, simulate the opening or closing of the fault input contacts and view the proper state indication (RED or GREEN) on the system front panel. The fault channel will change from a GREEN to a RED state after the programmed delay. It will change from a RED to a GREEN state almost immediately upon detection of a no-fault state.

To read the Fault Delay for each channel, the following steps should be performed.

1. READ, DELAY, No.(1, 2, 3, 4, or 5)
   [fault No. indicator will flash once each second, for each second programmed]

C. FAULT MESSAGES

The system allows the user to program messages for each event which the system must respond. The unit is shipped with no speech programmed and must be loaded with messages after installation. Voice data is retained using the system battery installed in section 1-D. The following messages must be entered by the user:

Location	Purpose
0	The message indication system or station location
1	The fault message for channel 1
2	The fault message for channel 2
3	The fault message for channel 3
4	The fault message for channel 4
5	The fault message for channel 5 (AC Power Failure)
6	The message for Status Normal –No faults
7	The message used after proper acknowledgment, before entering intercall delay

The system reserves 4 or 8 seconds of message time for each message. The programming sequence used determines the amount of time allotted. Additionally, fault messages may be programmed as a *"Status Only"* channel as described below.

The following programming steps should be performed for the creation of fault channel messages:

1. ENTER, MESSAGE, No.(0, 1, 2, 3, 4, 5, 6, or 7)
   [indicator or combination of indicators will flash, verifying selection]

2. Depress ENTER for a normal 4 second message, or depress # for an extended length (8 seconds) message, or depress * for a "Status Only" assignment message.

   [Message In Process Indicator will turn on, indicating recording is in process]. Begin speaking message. It is necessary to speak directly at the microphone, at a distance of approximately 8 inches. This will minimize background noise which would be picked up by the microphone as part of the message. It is also necessary to turn off loud equipment in the vicinity of the system while recording messages, to maximize clarity.

3. After the expiration of the message time limit, Message In Process Indicator will go out, and the message just programmed will be played back for verification.

To read or verify the message for each channel,

1. READ, MESSAGE, No.(0, 1, 2, 3, 4, 5, 6, or 7)
   [programmed message will be spoken by the system]

   Sample messages are located in Section IV. C.

Status Only Channel Programming

Any fault channel may be programmed as a "*status only*" channel as shown above (i.e. it will not cause call-outs to begin, but will be reported in any status messages).

D. PROGRAMMING TELEPHONE NUMBERS

The system can be programmed with up to eight telephone numbers, which will be called sequentially when an abnormal condition is detected by the system on any fault channel not programmed as a "*status only*" channel. The following programming procedure should be performed to enter telephone numbers into the system. Note that there must be at least one telephone number programmed into the system for it to operate at all. All eight telephone number data locations need not be programmed.

Telephone numbers may be deleted by entering a "0" into the data location for that number in the list.

1. ENTER, No. (1, 2, ...8)
   [indicator or combination of indicators will flash verifying selection]

2. Enter the desired phone number by depressing the numbers on the keypad.

3. Terminate the entry with a second depression of ENTER.

To read this data for verification.

1. READ, No. (1, 2, ...8)
   [telephone number No. will be dialed by the system. Test call may be terminated by depressing HALT]

Up to 16 digits may be entered for each phone number position. If any of the numbers the unit is to call require a pause for a second dial tone, enter the pause by using the DELAY key in place of a digit.

To clear a phone number out of the unit, enter a 0 (zero) as the phone number. The unit ignores any phone number that starts with a 0. If you wish to have the unit call the Operator, enter the phone number as DELAY, 0.

E. OPERATIONAL PARAMETERS

This section describes the procedure for setting 4 operational parameters. All of these parameters are entered into the system using the system's programming keypad.

1. Setting the Ring Count

The ring count is the number of rings the unit will wait before answering a call placed to it. This may be set to any number of incoming rings from 1 to 99.

1. ENTER, *
   [indicator will flash]

2. Enter a two digit number for 01 to 99 representing the desired ring count.

2. Tone or Pulse Dial Selection

The system needs to be set for pulse or tone type dialing. Perform this selection by following these programming steps. Before programming the unit to function in a tone

dialing mode, confirm with the telephone company that services the installation that the line to which the unit is connected to will accept tone dialing.

1. ENTER, MODE, 0
   [indicator will flash]

2. Enter "0" for pulse type dialing, or "1" for tone type dialing.

To verify the dialing mode, cause the system to test dial by selecting

1. READ, No.(1, 2, 3, 4, 5, 6, 7 or 8)
   [telephone number will be dialed]

3. Message Repetitions

The system will repeat its fault status message a number of times in the course of any telephone call which it places. The system is shipped programmed to repeat the message 8 times during each call. If it is necessary to change the number of times the message if repeated, perform the following programming steps.

1. ENTER, #

2. Enter a two digit number corresponding to the desired number of message repetitions (01 to 99).

To verify this data, test dial a number and listen to the number of message repetitions before the system terminates the call attempt.

4. Intercall Delay

When a call placed by the system is acknowledged, (see section III.C for the acknowledgment procedure) it will delay further calls for a programmable period to allow time for the condition to be corrected. The time delay period following an acknowledged call is called the *intercall delay*. The unit is shipped with this delay set to 1 hour. It may be from 1 to 99 hours and is programmed at the system keyboard as follows.

1. ENTER, DELAY, 0
   [indicator will flash]

2. Enter a two digit number corresponding to the desired number of hours of delay.
   (Values less than 10 hours must be entered with a leading 0,
   Example: 01= one hour)

5. Delay Run Programming

The Run Mode may be entered after a programmable delay.

1. DELAY, RUN
   [indicator will flash]

2. Enter the desired two digit delay in minutes (01 to 99 minutes)
   (Values less than 10 minutes must be entered with a leading 0, Example: 01= one minute)

The flashing Run indicator verifies that the system is in the delayed run mode. After the delay is completed, the system will enter the Run Mode and the Run indicator will stay on. (Green)

III. OPERATIONS

A. SYSTEM FAMILIARIZATION AND KEY FUNCTION SUMMARY

The power switch for the system is located on the Front Panel of the system. It is important to note that when power is connected to the system, and the switch is in the off position, it **does not** remove power from the unit. Power is always present unless the circuit breaker (which the INSTALLER must supply) is turned off or the transformer is removed from the A/C outlet.

There are six indictors across the top side of the keyboard assembly on the front panel. These LEDs will indicate the state of the fault channels which the system is intended to monitor, indicating RED for fault condition and GREEN for a no-fault condition. A system status indicator displays RED for the HALT mode and GREEN for the RUN mode.

On the left side of the system front panel is the system speaker. This speaker allows words the system synthesizes to be heard, as well as telephone line sounds when the system is on the telephone line placing an alarm call or during a status call placed to the system.

A Description Of Each Of The System's Keys And Their Functions Now Follows:

HALT
The HALT key will abort any operation in process, and return the system to the Halt mode as indicated by the RED RUN STATUS indicator. In this mode, fault conditions will not be acted upon by the system. However, it is still possible to call the system. The system will answer the call and deliver the appropriate status message.

RUN
The RUN key will place the system in a run mode as indicated by the RED RUN STATUS indicator. If fault conditions exist, the system will begin placing telephone calls (if valid telephone numbers have been programmed into the system). Use of the Delay key in conjunction with the RUN key will cause the system to execute a delayed entry into the RUN mode – which may be programmed to be up to 99 minutes (see the section entitled "Putting the System in Run" later in this section for more information on this feature).

MODE
The MODE key is used in conjunction with other keys to effect certain features in the system programming, including fault modes and tone/dial selection.

SEQUENCE
The SEQUENCE key is a preface key which allows some of the advanced operation features of the system to be activated. Until the purpose and use of this key is explained later in this manual, it is advisable to leave it alone. If this key is randomly operated with others, an unintentional yet valid keystroke combination could occur, deleting portions of programmed telephone numbers and other data.

ENTER
The ENTER key is used to enter data which the system must use in performing its monitoring and alarming functions. Included in this data are telephone numbers, fault messages, the system identification message, the message count, and the intercall delay.

MESSAGE
The MESSAGE key is used in conjunction with others to program the message for each fault channel, and the system identification message. Additionally, depression of the MESSAGE key alone when the system is in the HALT mode, will cause the current ID and status messages to be articulated by the system.

READ
The READ key is used to recall any of the programmed information.

DELAY
The DELAY key has four functions:

1. When used in telephone number programming, it inserts a short pause between digits in a telephone number.

2. When used with the ENTER key, (i.e. ENTER, DELAY, 0) it sets the intercall delay time; that is, the time the system will wait after its call out message has been acknowledged before it begins placing regular calls again (see section II E-4 of this manual for additional information).

3. When the DELAY key is used with the RUN key, (DELAY, RUN) it allows delayed, automatic entry into the RUN mode.

4. When the DELAY key is used for fault delay time programming, it allows the entry of integration or delay times for the detection of each fault condition.

DIGITS 1 THROUGH 0
The digit keys are used for numeric entry of data values and data locations.

*** KEY**
The * key is used as an entry location for ring count programming. The ring count is the number of incoming telephone rings which the system will count before answering and servicing the incoming call. (See Section II E-1 of this manual for more information)

Additionally, the * key is the key used over the telephone for acknowledgment of the system call out message. It is also useable locally (on the system keyboard) for acknowledgment right at the system.

KEY

The # Key is used as an entry location for the message count. This is the number of times that the entire fault status message is repeated in the course of each telephone call placed by the system. (See Section II E-3 of this manual for more information).

B. PUTTING THE SYSTEM IN RUN

After all operational data has been entered into the system, the unit is ready to enter the run mode. Once in the Run mode, any fault channels will be acted upon causing calls to be placed to the programmed telephone numbers.

To place the system in the Run Mode, depress the RUN key on the system's front panel. The Run indicator will verify successful entry into the Run Mode. (Green)

Delayed Entry into the Run Mode

The Run Mode may be entered after a programmable delay.

1. DELAY, RUN
   [Indicator flash]

2. Enter the desired two digit delay in minutes (01 to 99 minutes)
   (Values less than 10 minutes must be entered with a leading 0,
   Example: 01= one minute)

The flashing Run indicator verifies that the system is in the delayed run mode. After the delay is completed, the system will enter the Run Mode and the Run indicator will stay GREEN.

C. RECEIVING AN ALARM

When a valid alarm condition is recognized by the system, it will be indicated locally on the system's front panel. If the system is in the Run Mode, it will immediately begin placing telephone calls to the telephone numbers which have been programmed by the user.

Upon the receipt of an alarm call, the answering party will hear the station identification, followed by the current status messages. This entire message will be repeated the number of times programmed. If the entire message sequence is completed without an

acknowledgment being returned over the telephone line, the system will terminate the call, wait 70 seconds for a call back acknowledgment, and then place a call to the next telephone number in the list. If an acknowledgment is not received from the next call after another 70 second wait, a 3rd call will be placed, and so on. The unit will continue to call repeatedly from the user's programmed list of telephone numbers until it receives an acknowledgment or the fault condition is removed.

If the system is acknowledged during the call, it will not place any further calls for a time programmed as the Intercall Delay. If a new fault condition occurs during that period, the Intercall Delay will abort and calls will begin again. If the entire Intercall Delay expires and the fault conditions still persist, the system will again begin to place telephone calls.

To Acknowledge a Call From the System

Acknowledgment may be accomplished by depressing the * key on the called telephone between message repeats during the alarm call. The * key must be depressed for at least 2 full seconds but not longer than 5 seconds. The system will verify that the acknowledgment has been accepted by saying the recorded voice message for proper alarm acknowledgement [Voice message 7].

If acknowledgment must be returned from a telephone without tone capability, the system may be acknowledged by placing an immediate call back to the system, within 60 seconds after it has completed its call. Again, the system will verify that the acknowledgment has been accepted by saying, [sign off message, in location number 7, as programmed above, will be recited].

D. TEST AND ADVANCED KEYSTROKE SEQUENCES

A number of sequence commands are possible on the system's front panel keyboard. They are as follows:

SYSTEM LEVEL TEST SEQUENCES

SEQUENCE 50 [all messages are recited]

SEQUENCE 52 [flash test all front panel indicators] (HALT to terminate this sequence)

SEQUENCE 55 [Acknowledge tone adjustment self test]

PRESET ALL DATA VALUES TO DEFAULT

NOTE: Do not use these sequences unless you are thoroughly aware of the results which will occur, that is, the resetting of operational data to default values, and deleting any telphone numbers or delays or other programmed data which may have been entered by the user.

SEQUENCE 60 [Preset system variables such as delays, message count, ring count, and fault channel modes.]

SEQUENCE 61 [Presets telephone numbers only.] (All programmed telephone numbers reset to become 0)

IV MAINTENANCE AND TROUBLESHOOTING

In the unlikely event that trouble is suspected with the system, it must be promptly disconnected from the telephone network, and referred to Microtel Inc. or its authorized service representatives.

Periodically inspect the system internally for any evidence of moisture, blown fuses, or battery failure as instructed herein.

A. MAINTENANCE

1. Battery Care

Battery life is dependent upon a number of factors, and will vary depending on the number of outages, and the age of the battery. A new battery will take no longer than 24 hours to gain a full charge, capable of powering the system through any power outage up to four hours in length. It should be noted that the LOW BATTERY indicator is only valid when the 120 VAC power is off. If the LOW BATTERY indicator stays on for more than eight hours, the battery is in need of replacement.

2. Battery Replacement

The battery is installed at the bottom of the system in the battery tray, provided as part of the interior chassis assembly.

NOTE: It is necessary to remove **all power** from the system before replacing the battery.

Refer to Section 1-D - Battery Installation for instructions on installing a new battery.

3. Volume Adjustment

The volume of the system's speech messages delivered to the telephone network is fixed. The volume of the speech heard through the system speaker is, however, adjustable by varying the setting of potentiometer R21, located on the main circuit card in the unit.

4. Acknowledge Tone Adjustment

R33, located on the system's main board, is the adjustment for the frequency detected during the acknowledgment of an alarm call. By activating SEQUENCE 55 (see previous section) the system will deliver a continuos acknowledge tone (* key) to itself, during which the potentiometer R33 may be set. Center the adjustment by varying the setting until the Acknowledge LED on the front panel turns on. There is some amount of hysteresis associated with the detection so the centering of the component must take into account approached from each direction. The continuous tone used for adjustment may be halted by depressing the HALT key after the adjustment is completed.

B. SYSTEM SPECIFICATIONS

ENVIRONMENTAL	
Temperature	-10F to +12OF
Humidity	90% RH, Non-condensing
Surge	2500 V, Per ANSI C37-90A-1974, common and differential mode
EMI/RFI	per FCC part 15C
ELECTRICAL	
Power requirements	120 VAC, 50/60 Hz, 7 watts
Fault sensing current	Less then 10 mA per channel
Battery Backup	6 hours typical
Power outage detection time	1-99 seconds
PHYSICAL	
Dimensions	11 5/8 x 9 7/16 x 4 inches
Weight	10 lbs.
Mounting method	Flange mount, 4 points
Enclosure	NEMA 12 std., others optional
TELEPHONE SYSTEM	
FCC registered for direct interconnect	FCC Registration Number: D4J6M6-13598-AL-E
Dialing capacity	8 numbers, 16 digits each, maximum
Dialing format	Loop disconnect, 10 pps nominal; or tone, 100ms/100ms; user selectable
Answer delay	Programmable, 1 to 99 rings
Acknowledged intercall delay	Programmable, 1 to 99 hours
Unacknowledged intercall delay	70 Seconds
Surge and environmental protection	Per FCC part 68

OPERATIONAL

Fault detection method	Normally open or closed, selectable
Fault integration time constant	One to 99 seconds
Station identification	Synthesized voice, user programmable messages
Message repetitions	One to 99, user programmable
Data retention	Nonvolatile EEPROM
Message retention	Battery Backed DRAM, 1 MBit
Programming	Local keyboard entry

SYSTEM DIAGNOSTICS

Audible indicators	Line monitor Vocal status of all data, fault conditions and parameters
Visual indicators	Fault channels Run status Off hook Incoming call Power on Battery condition Intercall delay in progress Successful acknowledgment

C. SAMPLE MESSAGES

System Identification, location 0

"This is the West Side Treatment Plant, 91st and Oak"
"This is an automatic alarm from Microtel Inc."
"This is station 51"

Fault Messages, locations 1, 2, 3, 4 and 5

"High well level"
"AC Power failure, dispatch crew at once"
"Fire Alarm, activate fire emergency plan"
"Intrusion, call the supervisor and the police"

Status Normal Message, location 6

"Status Normal"
"No fault conditions exist at this time"

Signoff Message, location 7

"Acknowledged accepted, now entering the intercall delay"
"Acknowledged detected, further calls will be delayed for the intercall delay period"

D. PRODUCT WARRANTY

We warrant to the original purchaser the Microtel unit manufactured by us to be free from defects in material and workmanship under normal use and service. Our obligation under this warranty shall be limited to the repair or exchange of any part or parts which may thus prove defective under normal use and service within one year from date of installation by the original purchaser. In no event shall this warranty apply to equipment after the expiration of eighteen (18) months from date of shipping to the original purchaser whether or not the equipment is installed and which our examination shall disclose to our satisfaction to be defective. **THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED INCLUDING THE WARRANTIES OR MERCHANTABLITY AND FITNESS FOR USE AND OF ALL OTHER OBLIGATIONS OR LIABILITIES ON OUR PART, AND WE NEITHER ASSUME, NOR AUTHORIZE ANY OTHER PERSON TO ASSUME FOR US, ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF THIS MICROTEL UNIT OR ANY PART THEREOF WHICH HAS BEEN SUBJECT TO ACCIDENT, NEGLIGENCE, ALTERATION, ABUSE, OR MISUSE. WE MAKE NO WARRANTY WHATSOEVER IN RESPECT TO ACCESSORIES OR PARTS NOT SUPPLIED BY US. THE TERM "ORIGINAL PURCHASER", AS USED IN THIS WARRANTY, SHALL BE DEEMED TO MEAN THAT PERSON FOR WHOM THE MICROTEL UNIT IS ORIGINALLY INSTALLED.**

E. WARNING

Battery circuits remain active at all times. The potential exists for the battery to discharge to a point where the battery cannot be recharged. To prevent an unrecoverable depletion of the internally mounted battery, it is suggested that prior to storage of the dialer unit or in the event of a prolonged interruption of 120 VAC power, the internally mounted battery be disconnected. Disconnection is accomplished by removing the wire termination spade from the positive (+) battery termination point located on the battery.

Battery disconnection should also occur upon low battery indication as detected and enunciated by the dialer unit and remain disconnected until 120 VAC power can be restored.

Disconnection of the battery in an unpowered condition will require reconfiguration of the units prior to placing the units back into service.

Quick Programming & Setup Guide
MCS 250

The intent of this guide is to assist the user in getting the dialer on line in the least amount of time. NOTE: As part of the final assembly procedure the battery was temporarily disconnected thereby erasing all previously recorded voice messages. **For additional, and more complete information refer to the MCS-250 manual.** After turning the dialer ON, follow the steps as they are listed.

HALT Mode: User programming must be done while in **HALT** mode. Pressing the **HALT** key enters the **HALT** mode. In **HALT** mode, the **RUN** light is red.

To Enter Telephone Numbers: **ENTER**, **No.**(1-8), Phone # up to 16 digits (**DELAY** for pauses), **ENTER**
READ, **No.**(1-8) - Makes a test call. **HALT** terminates it. When dialing a number, the Off Hook light comes on.

To Enter Fault Messages:

ENTER, **MESSAGE**, **No.**(0-7), **ENTER**	= 4 sec. fault message -or-
ENTER, **MESSAGE**, **No.**(0-7), #	=8 sec. fault message -or-
ENTER, **MESSAGE**, **No.**(0-7), *	=4 sec. status message

Message 0	= System Identification
Message 1-4	= Fault Messages
Message 5	= AC Power
Message 6	= Message for when all Channels are normal
Message 7	= Message for Proper Acknowledgement

To Read A message: **READ**, **MESSAGE**, **No.**(0-7)
When Entering and Reading messages, the **Message In Progress** light will come on. Once a message is recorded, it is read back to the user.

Fault Delay Program: **ENTER**, **DELAY**, **No.**(1-5), Set for 1...99 Seconds, (Each Blink = 1 Second), **ENTER**
READ, **DELAY**, **No.**(1-5) - Then Count the Number of Blinks

Normally Open/Closed: **ENTER**, **MODE**, **No.**(1-5), wait for Red or Green, **ENTER**.

Operational Parameters

Ring Count: **ENTER**, *, 01...99(Rings)
To test, have someone call the unit.

Tone/Pulse: **ENTER**, **MODE**, **0**, (**0** for pulse, **1** for tone)
To test, have it make a callout.

Message Reps: **ENTER**, #, 01...99(Message Reps)
To test, have it make a callout and count the repetitions.

Intercall Delay: **ENTER**, **DELAY**, **0**, 01...99(Hours)
To test, create a fault, acknowledge it and then time the intercall delay period.

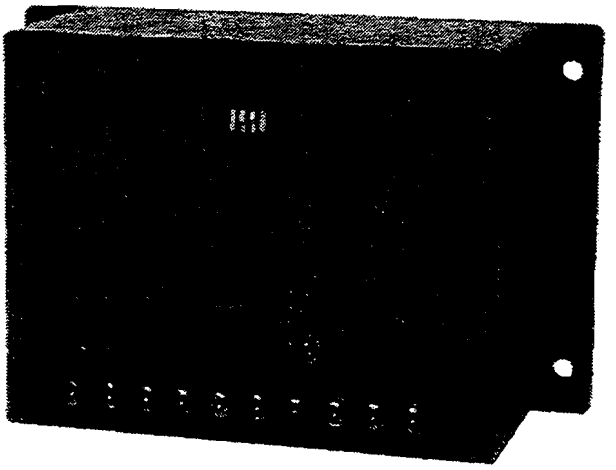
Delayed RUN: **DELAY**, **RUN**, 01...99(Minutes)
This will wait in **HALT** mode for this time period then go into **RUN** mode.

RUN Mode: Enters **RUN** mode when the user presses the **RUN** key. In **RUN** mode, the **RUN** light is green.

Acknowledged Calls: Accomplished by depressing the * key on the called telephone **between message repeats**.
The * key must be held down for at least **2 full seconds** but not longer than 5 seconds.
The * key can be depressed at the dialer in order to acknowledge an alarm.
Call back acknowledgment can be accomplished by calling the dialer within 70 seconds after having been called.

MODEL 422
Submersible Pump Controller

LISTED 5C21 IND CONTROL EQUIP



- **Monitors True Motor Power (volts x current x power factor)**
- **Detects Motor Overload or Underload**
- **Operates on 120 or 240 VAC, Single-phase or 3-phase**
- **Built-in Trip and Restart Delay Options**

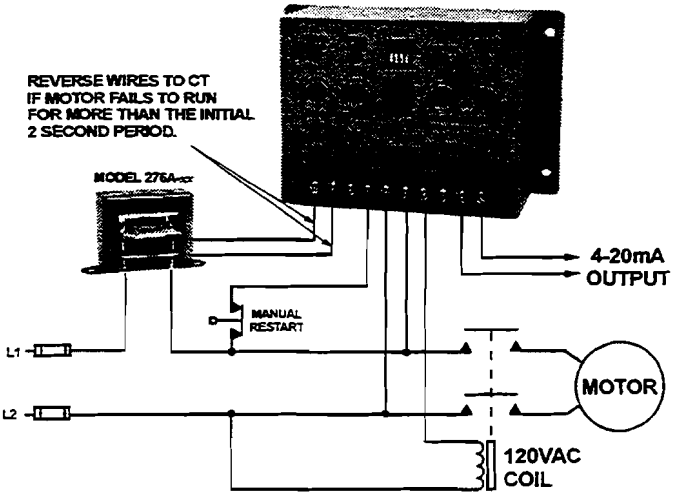
DESCRIPTION

The **Model 422 Submersible Pump Controller** detects an overload or underload condition on all types of running pump motors: suction pumps, submersible pumps, etc.

This Monitor detects the actual power used (voltage x current x power factor) and is more sensitive than simple current monitors. The 422 can be used with single phase pumps or, using the **Model 276C** current transducer, with 3-phase pumps. Matching CT's allow the Model 422 to be used with most pump motor sizes.

Optional trip and restart delays are provided.

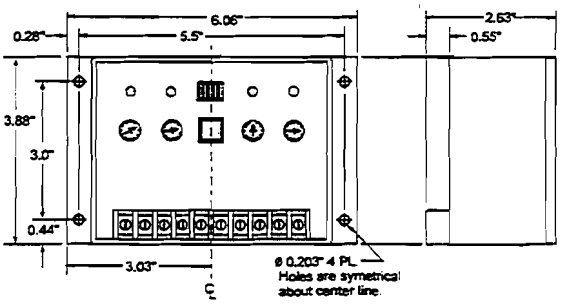
TYPICAL APPLICATION -single-phase monitoring



SPECIFICATIONS

Model	422
Input Voltage Range	100-130 VAC or 200-250 VAC
Frequency	50/60 Hz
Power Consumption	0.5 VA max.
Nominal Current	2.5 amps
Minimum Current	0.25 amps
Current Adjustment	0 - 5 amps x PF
Current Output	4-20mA for chart recorders
Repeat Accuracy	1 % (fixed conditions)
Output	SPDT 10 A at 240 VAC resistive
Expected Relay Life	Mech: 50 million operations Elec: 100,000 operations at rated load
Trip Delay	OFF or 0.3 to 180 seconds
Restart Delay	OFF or 0.1 to 4 hours
Indicators	Red LED: Overload or Underload; tripped Yellow LED: Restart timing
Transient Protection	2500V for 10 msec
Operating Temp	- 40° to 131° F
Humidity Tolerance	97% w/o condensation
Enclosure Material	ABS plastic
Weight	1 lb.
Agency Approvals	UL Listed to US and Canadian safety standards CSA Certified

DIMENSIONS



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Doc No. 87A292 1/98

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MODEL 422 Submersible Pump Controller

READ ALL INSTRUCTIONS BEFORE INSTALLING, OPERATING OR SERVICING THIS DEVICE.
KEEP THIS DATA SHEET FOR FUTURE REFERENCE.

APPLICATION GUIDE

GENERAL

This application guide is written for equipment designers, maintenance personnel, electrical contractors, etc.

It is intended to aid in the installation of the **Model 422 Submersible Pump Controller** into pump protection systems. The notes and diagrams deal with methods of protecting motors in the event of an **underload** condition or an **overload** condition.

THEORY

The need for a system to detect an underload condition other than by the simple monitoring of current becomes clear when examining the following waveforms.

In a purely resistive circuit, as in *Figure 1*, the current (amps) is directly proportional to the power (watts) being consumed. To find the power, multiply the voltage across the load times the current through the load. The result is in watts (V x A = W).

In *Figure 2*, When the load is not resistive, but inductive as it is with a motor, the formula is no longer correct. The inaccuracy occurs because the current and the voltage waveforms are not in phase.

The current waveform lags the voltage waveform by as much as 90 degrees in a completely unloaded condition, or as little as 5 or 10 degrees in a fully loaded condition.

The current, as measured with an ammeter, may only vary a slight amount as the motor changes from a fully loaded condition to a completely unloaded condition. This makes it difficult to detect an unloaded condition by simply monitoring current alone.

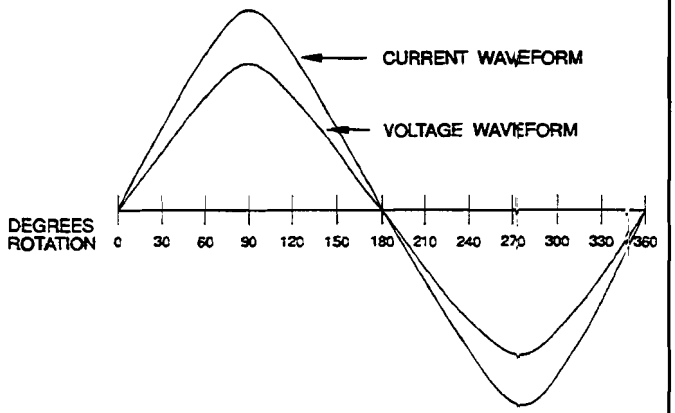
To obtain an accurate picture of real power consumption of any inductive device, such as a motor, the formula V x A x Cosø = W is used.

The Cosø is a multiplication factor derived from the number of degrees of lag between the current and voltage waveforms.

This is called the "power factor" (or "pf"). The power factor is the natural cosine of the degrees of lag:

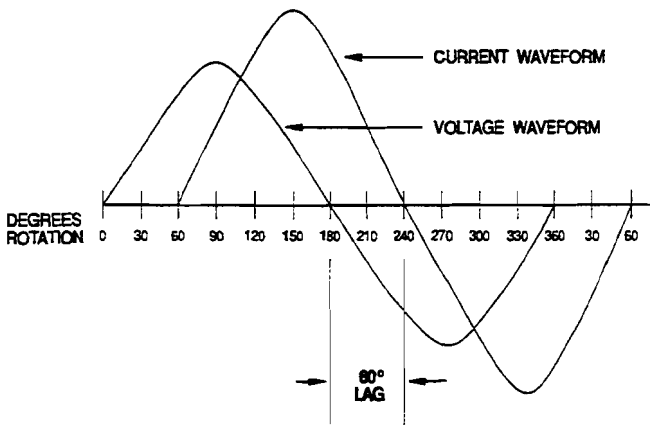
Degrees of lag	Power Factor	Degrees of lag	Power Factor
0	1.000	50	0.643
5	0.996	55	0.574
10	0.985	60	0.500
15	0.966	65	0.423
20	0.940	70	0.342
25	0.906	75	0.259
30	0.866	80	0.174
35	0.819	85	0.087
40	0.766	90	0.000
45	0.707		

Figure 1. **RESISTIVE LOAD**



With a purely resistive load, the current and voltage waveforms are occurring simultaneously.

Figure 2. **INDUCTIVE LOAD**



with an inductive load, the current waveform lags the voltage waveform by 60°.

APPLICATION GUIDE

Example: TRUE POWER CONSUMED BY AN AC MOTOR

For this example we will use a 3-horsepower, 230 volt, single phase motor.

Condition 1 represents the motor being used at near full load, while *Condition 2* represents a drop in motor load.

Example: (V x A x Cosø = Watts)
Condition 1 230 volts x 10 amps x 0.985 pf = 2265.5 watts
Condition 2 230 volts x 9 amps x 0.423 pf = 875.6 watts

Comparing the results of the this example, the motor current decreased only 10% with a drop of 61% in the motor load (input power). A drop in pump motor power cannot be accurately measured by only monitoring the current and voltage.

By monitoring the phase relationship and applying the resultant power factor an accurate and selective method of sensing changes in true power consumption can be obtained.

The Model 422 Controller is based on the above principal of detecting the actual power used, and is more sensitive than simple current monitors.

ADDITIONAL FEATURES

As described previously, the Model 422 would fulfill the basic requirements in most pump motor protection control systems. However, there are situations which would require the pump to restart automatically after a preset time.

The Model 422 has an **adjustable restart timer** for such applications. This timer has a range of 0.1 to 4 hours. If the restart timer is not needed, turn it off with DIP switch 2.

If restart timing is needed for an underload condition only, the overload restart can be turned off with DIP switch 1.

Resetting the Model 422 is accomplished by cycling the power off and back on, pressing the RESET button, or by using the restart timer (DIP switch 2).

Some applications require a trip delay period before shutting down the pump. The Model 422 has a built-in **trip delay timer**. The timing range is from 0.3 to 180 seconds. The trip delay timer can be turned off with DIP switch 4.

Refer to the chart under INSTALLATION (pg 4) for all DIP switch settings.

A **4-20 mA output** is provided for monitoring power consumption. A 4 mA output is equal to 0 watts and a 20 mA output is equal to 600 watts at 120 V or 1200 watts at 240 V.

This signal can be sent to a strip chart recorder, a process controller, computer, etc.

INPUT CURRENT REQUIREMENTS

The CT input of the Model 422 is the isolated winding of a small current transformer within the unit. Ideally, the current range needed should be between 2 and 3.5 amps for a fully loaded motor.

Polarity of the wires connected to the CT terminals is **critical** to achieve the correct phase relationship between the current and voltage waveforms as described earlier.

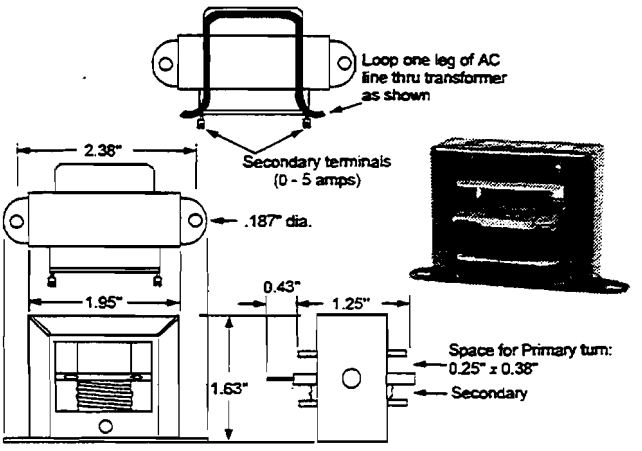
This is simple to determine after the installation is complete (refer to the ADJUSTMENT PROCEDURE, pg 5).

If the full load motor current is 3.5 amps or less, and the pump motor is a single-phase type, connect one leg of the motor current directly into the Model 422.

If full load motor current is more than 3.5 amps, an optional Time Mark CT must be used to reduce the current to the proper range.

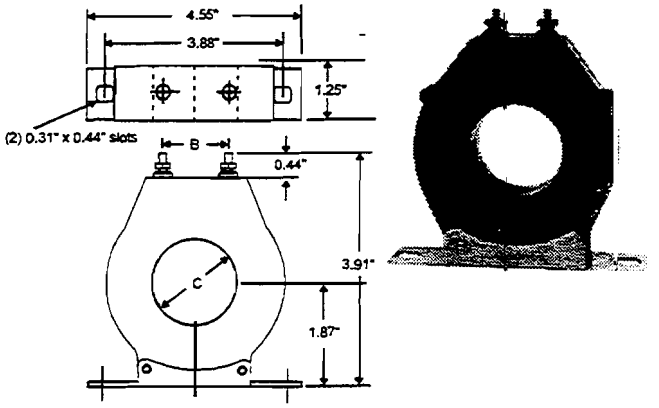
Figures 3 and *4* show the **Models 276A** and **276B Current Transformers**, available from Time Mark.

Figure 3. **MODEL 276A CURRENT TRANSFORMER**



APPLICATION GUIDE

Figure 4. MODEL 276B CURRENT TRANSFORMER



276B	
50 - 500	600 - 1200
B = 1.25"	B = 0.87"
C = 1.56"	C = 2.06"

The Current Transformer Chart in *Figure 5* lists various models available and is referenced to the horsepower ratings of single-phase and 3-phase motors.

Figure 5. CURRENT TRANSFORMER CHART

HP	Single-Phase		3-Phase	
	120VAC	240VAC	240VAC	480VAC
1/4	276A-10	**		
1/3	276A-15	**		
1/2	276A-15	276A-10	*	*
3/4	276A-20	276A-10	*	*
1	276A-25	276A-15	276A-10	*
1 1/2	276A-30	276A-15	276A-10	*
2	276A-35	276A-20	276A-10	*
3	276B-50	276A-25	276A-15	276A-10
5	276B-80	276A-40	276A-25	276A-15
7 1/2	276B-150	276B-60	276A-35	276A-20
10	276B-150	276B-75	276A-40	276A-20
15			276B-60	276A-30
20			276B-80	276A-40
25			276B-100	276B-50
30			276B-150	276B-60
40			276B-150	276B-75
50			276B-200	276B-100
60			276B-250	276B-150
75			276B-300	276B-150
100			276B-400	276B-200
125				276B-250
150				276B-300
200				276B-400
250				276B-500
300				276B-600
350				276B-700
400				276B-750
500				276B-1000

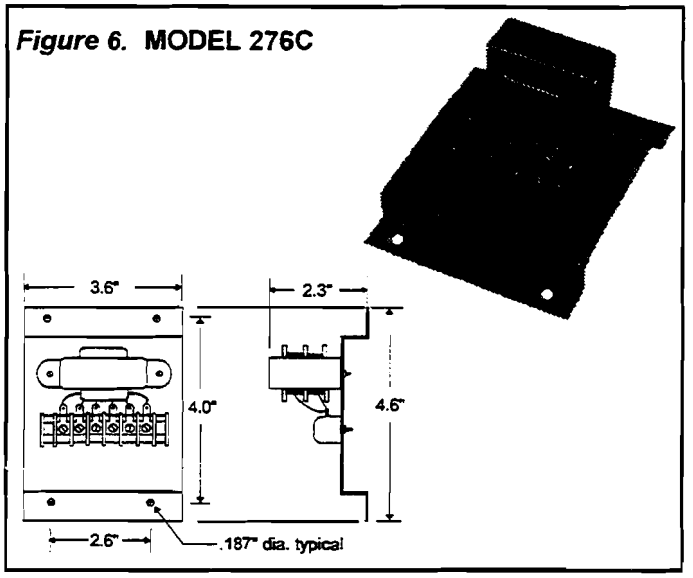
* Direct connection to Model 276C (see page 8)
** Direct connection to Model 422

INSTALLATION INSTUCTIONS

3-PHASE INSTALLATION

The basic Model 422 Controller is designed for use with single-phase pump motors. However, the it can easily be used in 3-phase applications by installing the current cancelling transformer, **Model 276C**. The Model 276C (*figure 6*) monitors two of the three phases, and cancels the effect of the current signal in the third phase, which would otherwise cause a phase shift error in the Model 422.

Figure 6. MODEL 276C



IMPORTANT NOTE:

In 3-phase applications, the current inputs must come from the same phases providing the voltage input. The applications schematics shown on the last page describe the interconnections.

INSTALLATION

Mount the Model 422 in the control panel or in a suitable enclosure. Connect the voltage and current inputs to the appropriate terminals on the Model 422 Monitor.

If the 4-20 mA output is used, connect it across a 300Ω resistive load. Set the four MODE switches on the Model 422 according to the chart below. During the initial setup you may wish to disable all time delays.

DIP SW	MODE	ON	OFF
1	Overload Restart	Disabled	Enabled
2	Restart Delay	Enabled	Disabled
3	Reset Button	Enabled	Disabled
4	Trip Delay	Enabled	Disabled

After the system is completely installed, a simple test and adjustment will insure that the polarity and threshold are correct.

MODEL 422 Submersible Pump Controller

READ ALL INSTRUCTIONS BEFORE INSTALLING, OPERATING OR SERVICING THIS DEVICE.
KEEP THIS DATA SHEET FOR FUTURE REFERENCE.

GENERAL SAFETY

POTENTIALLY HAZARDOUS VOLTAGES ARE PRESENT AT THE TERMINALS OF THE MODEL 422. ALL ELECTRICAL POWER SHOULD BE REMOVED WHEN CONNECTING OR DISCONNECTING WIRING. THIS DEVICE SHOULD BE INSTALLED AND SERVICED BY QUALIFIED PERSONNEL.

INSTALLATION INSTRUCTIONS

ADJUSTMENT

Connect a temporary jumper across the NO contacts on the Model 422 (this keeps the motor running as the Model 422 trips off and resets).

With the correct voltage applied to the system, the motor should start and run continuously. Make sure the motor is running under it's normally loaded condition.

With a clamp-type ammeter, measure the current in one of the wires connected to the CT terminals on the Model 422. A reading between 2 and 3.5 amps should be measured for best results. This current level can be changed by exchanging the CT with a different ratio.

Turn the UNDER adjustment through it's entire range and find the spot where the UNDERLOAD LED just illuminates.

Turn the UNDER adjustment until the LED just goes out. If the UNDERLOAD LED is lit all the time, reverse the two wires connected to the CT terminals and re-adjust.

Repeat this procedure for the OVER adjustment. If the OVERLOAD indicator LED stays on all the time, the current input may be incorrect. Check the CTs for proper sizing.

Set the SECONDS adjustment for the appropriate TRIP delay, and HOURS adjustment for the appropriate RESTART delay, as required for the application.

Remove the jumper from the NO contacts; the motor should continue to run. The adjustment is now complete.

TROUBLESHOOTING

Should the Model 422 Submersible Pump Controller fail to operate, check all connections to the device and its control circuits. Insure that the proper voltage and currents have been applied.

Check all fuses. Should the Model 422 operate improperly, check that the CT is properly sized. Check all DIP switch settings, if problems persist, contact the factory for technical assistance.

OPERATION

When AC voltage is first applied, the output transfers for approximately two seconds, completing the motor control circuit and allowing the motor to come up to speed.

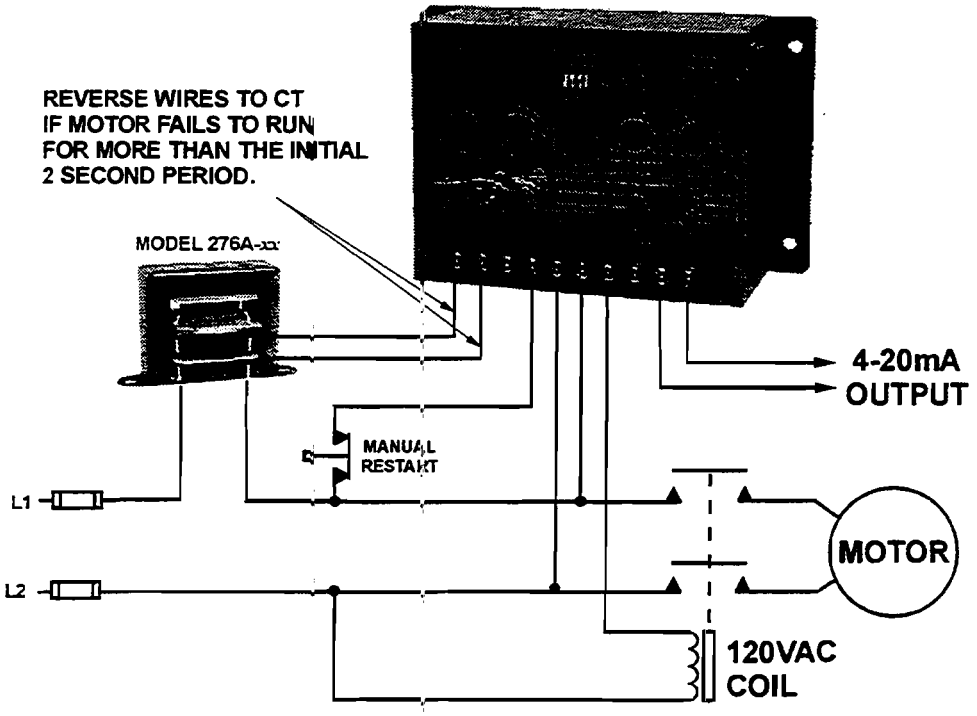
If the power being used is within acceptable limits the contacts remain energized and the motor continues to run. If the power drops or rises outside the limits, the contacts will open.

WARRANTY

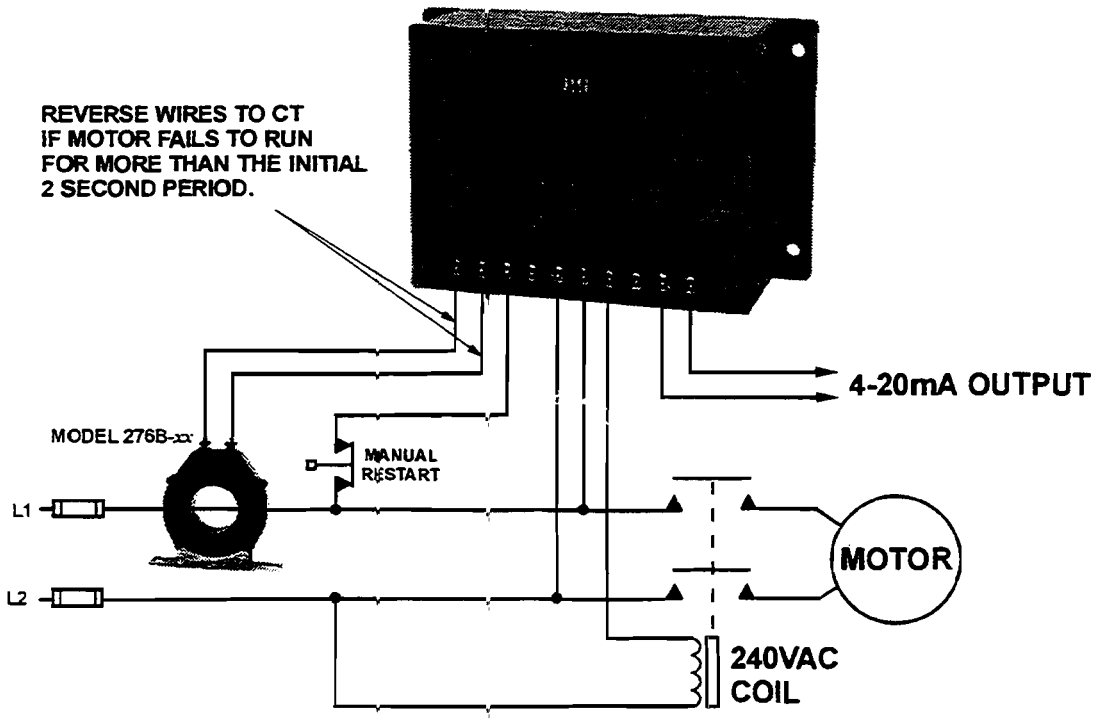
The **Model 422 Submersible Pump Controller** is warranted to be free from defects in materials and workmanship for one year. Should this device fail to operate, we will repair or replace it for one year from the date of purchase. For complete warranty details, see the *Terms and Conditions of Sales* page in front section of the Time Mark catalog.

TYPICAL APPLICATIONS

SINGLE-PHASE, 120V, <3 HP

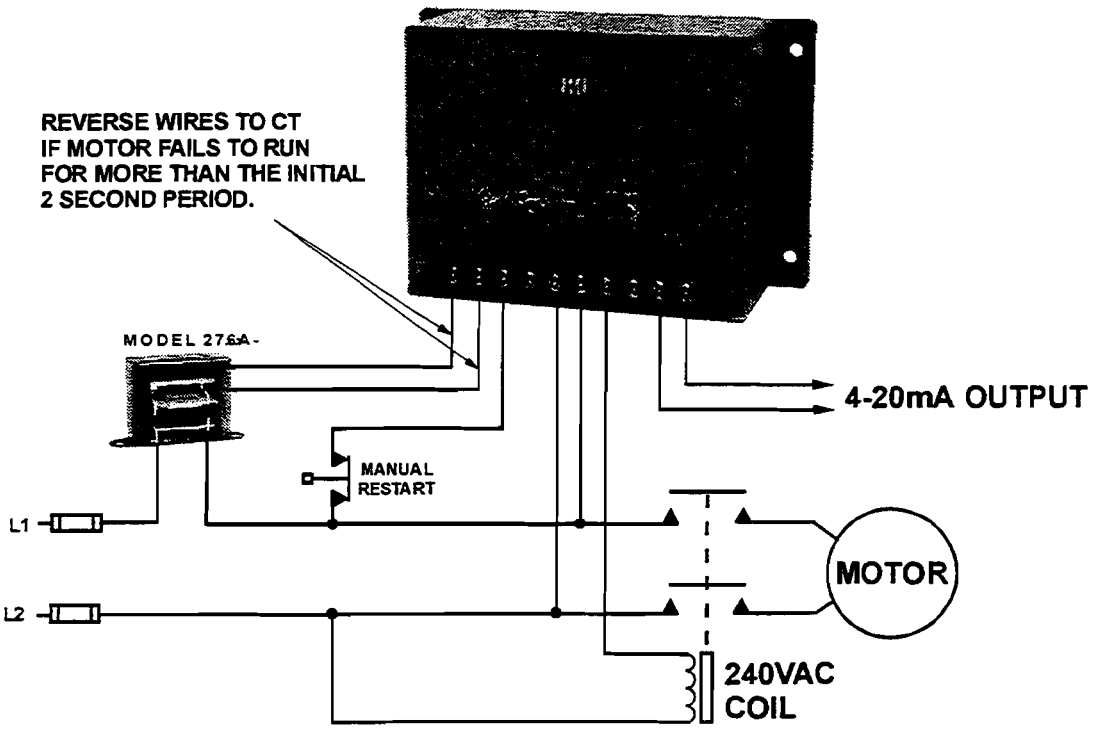


SINGLE-PHASE, 240V, ≥7.5 HP

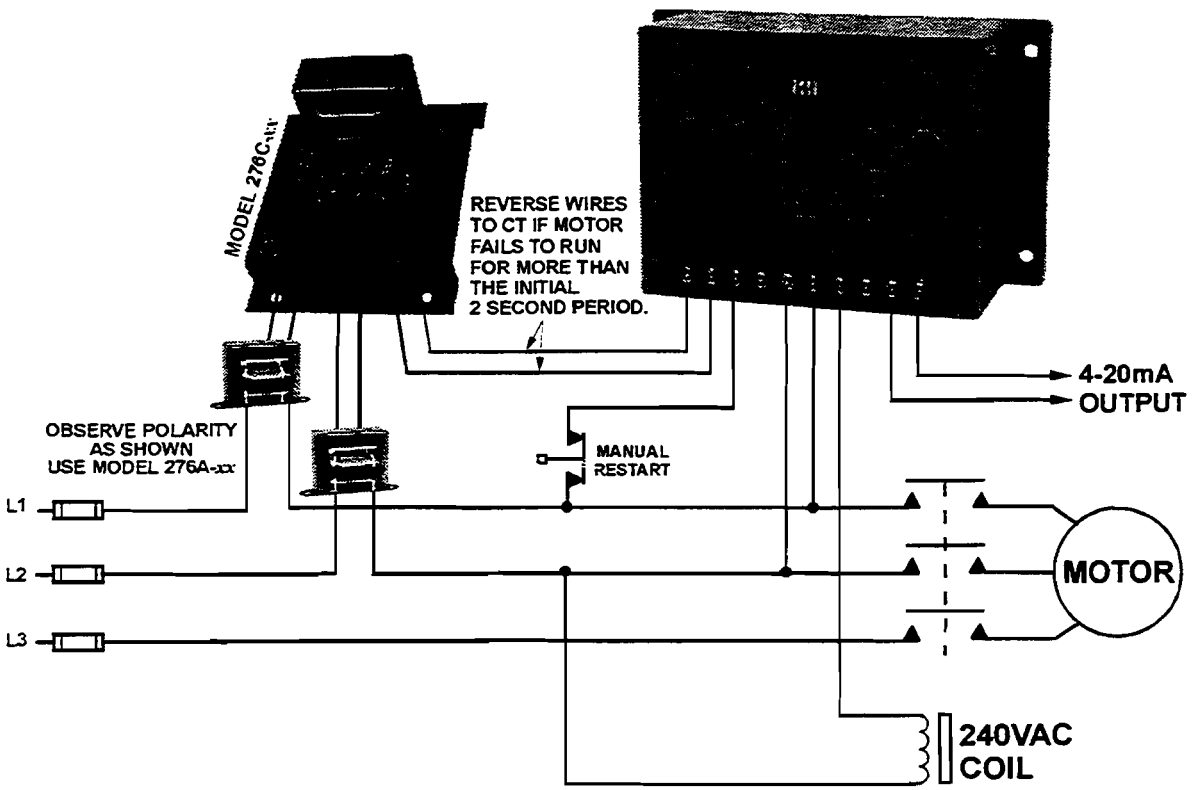


TYPICAL APPLICATIONS

SINGLE-PHASE, 240V, 1/2 TO 5 HP

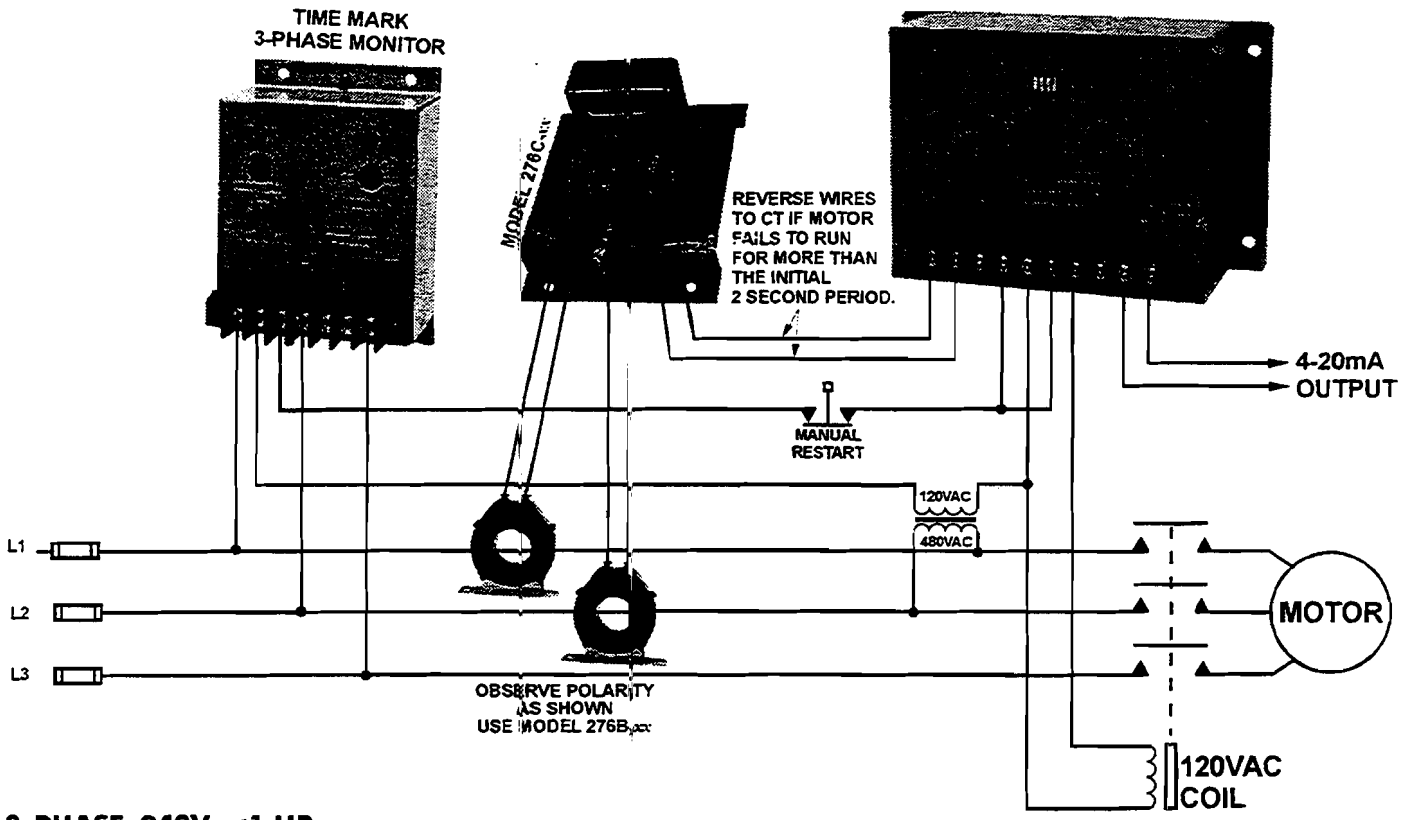


3-PHASE, 240V, 1 TO 10 HP

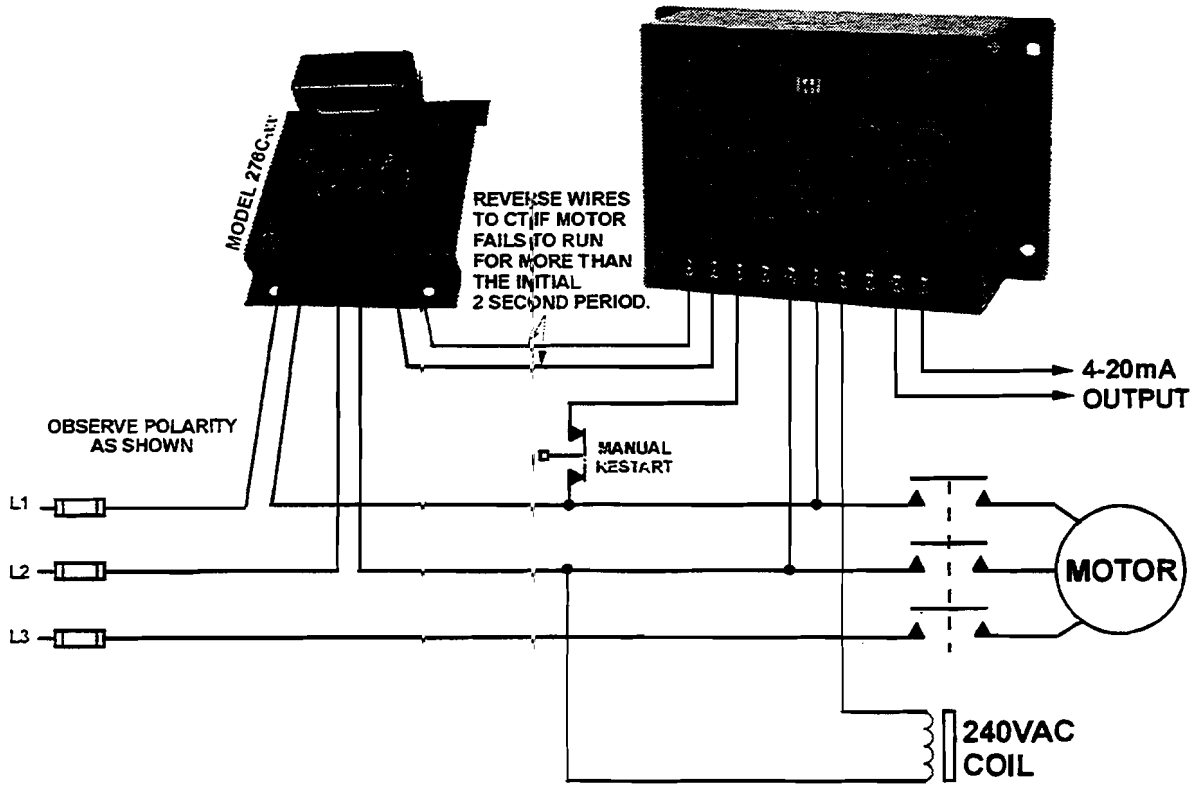


TYPICAL APPLICATIONS

Over/Under Load & Phase Loss Protection

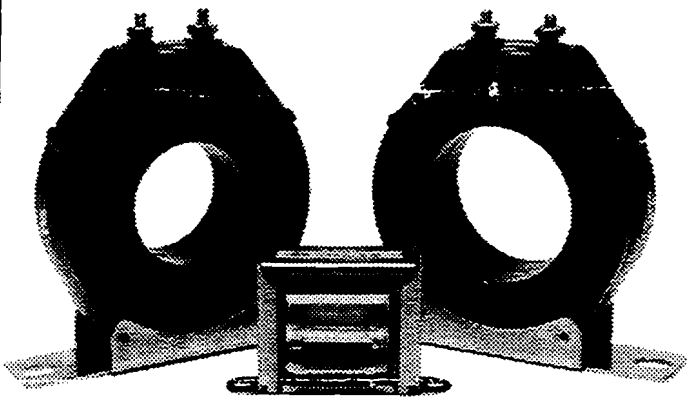


3-PHASE, 240V, <1 HP



The information presented in this guide is correct to the best of our knowledge. However, Time Mark Corporation does not warrant the applications as outlined nor make any offers that the circuits are free from patent infringement. Time Mark Corporation reserves the right to change or alter specifications at any time.

MODEL 276 SERIES
Current Transformers



- 25 to 400 HZ
- 0 to 5 Amp Secondary
- Wide Application Range
- Agency Approved

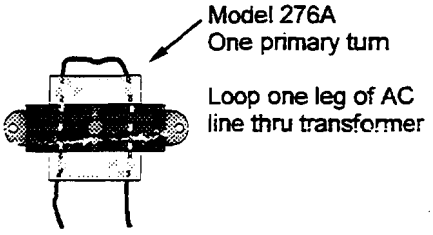
DESCRIPTION

Model 276A Current Transformer - A low cost, open-frame type current transformer (CT). For use with up to 8 gauge wire, and up to 40 amps on the primary. 2500 VMRS insulation is standard. Frequency range is 25-400 Hz. The Model 276A CT is CSA Certified.

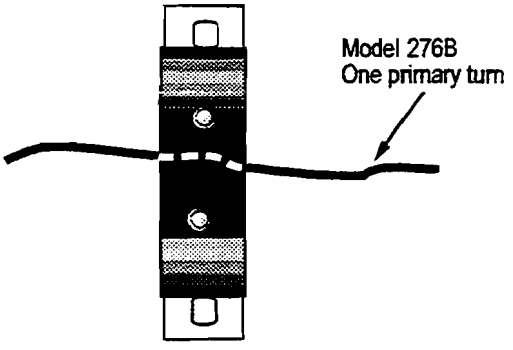
Model 276B Current Transformer - A ring-type current transformer for currents from 50 to 1200 amps. The Model 276B has an accuracy rating of ± 2% for 50-100 amp CT's and ± 1% over 100 amps at 60 Hz.

This CT also features a 25-400 Hz frequency range, #8-32 secondary terminals and mounting brackets. Polarity markings are stamped on the CT. The Model 276B is UL Recognized and CSA Certified.

276A APPLICATION DIAGRAM



276B APPLICATION DIAGRAM

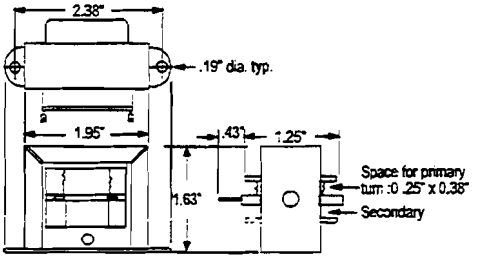


SPECIFICATIONS

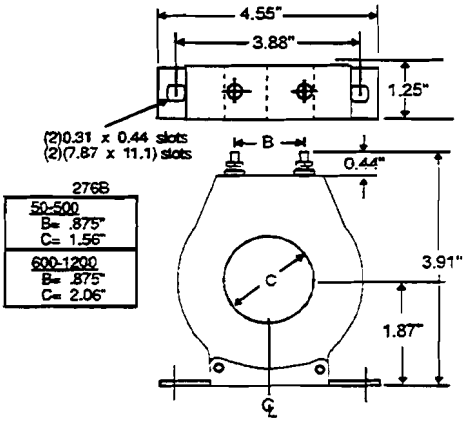
Ratio	Part No.	Ratio	Part No.	Burden	Ratio	Part No.	Burden
		50:5	276B-50	1.0	300:5	276B-300	12.5
10:5	276A-10	60:5	276B-60	1.0	400:5	276B-400	12.5
15:5	276A-15	75:5	276B-75	1.5	500:5	276B-500	25.0
20:5	276A-20	80:5	276B-80	1.5	600:5	276B-600	15.0
25:5	276A-25	100:5	276B-100	2.0	750:5	276B-750	7.0
30:5	276A-30	150:5	276B-150	5.0	800:5	276B-800	8.0
35:5	276A-35	200:5	276B-200	5.0	1000:5	276B-1000	10.0
40:5	276A-40	250:5	276B-250	12.5	1200:5	276B-1200	12.5

Burden VA @ 60 Hz

276A DIMENSIONS



276B DIMENSIONS



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MODEL 276 Current Transformers

Read All Instructions Before Installing, Operating or Servicing This Device.
KEEP THIS DATA SHEET FOR FUTURE REFERENCE

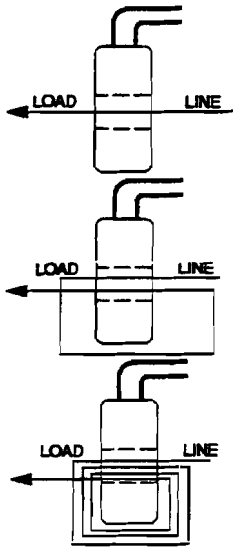
GENERAL SAFETY

POTENTIALLY HAZARDOUS VOLTAGES ARE PRESENT AT THE TERMINALS OF THE MODEL 276. ALL ELECTRICAL POWER SHOULD BE REMOVED WHEN CONNECTING OR DISCONNECTING WIRING. THIS DEVICE SHOULD BE INSTALLED AND SERVICED BY QUALIFIED PERSONNEL.

INSTALLATION INSTRUCTIONS

PRIMARY TURN RATIO MODIFICATION

The nameplate ratio of the current transformer is based on the condition that the primary conductor will be passed once through the transformer window. This rating can be reduced in even multiples by looping the conductor two or more times through the window. A transformer having a rating of 200 to 5 amps will be changed to 50 to 5 amps if four loops or turns are made with the primary cable as illustrated.



1 Primary Turn

Nameplate Ratio	Actual Ratio	Nameplate Ratio	Actual Ratio
100:5	100:5	400:5	400:5
150:5	150:5	500:5	525:5
200:5	200:5	600:5	650:5
300:5	300:5	800:5	800:5

2 Primary Turns

Nameplate Ratio	Actual Ratio	Nameplate Ratio	Actual Ratio
100:5	50:5	400:5	200:5
150:5	75:5	500:5	250:5
200:5	100:5	600:5	300:5
300:5	150:5	800:5	400:5

4 Primary Turns

Nameplate Ratio	Actual Ratio	Nameplate Ratio	Actual Ratio
100:5	25:5	400:5	100:5
150:5	37.5:5	500:5	125:5
200:5	50:5	600:5	150:5
300:5	75:5	800:5	200:5

SECONDARY TURN RATIO MODIFICATION

Formula: $\frac{Ip}{Is} = \frac{Ns}{Np}$

Where:
Ip - Primary amperage
Is - Secondary amperage
Np - Number of primary turns
Ns - Number of secondary turns

Example: A 300:5 current transformer

$$\frac{300p}{5s} = \frac{60s}{1p}$$

(in practicality, one turn is dropped from the secondary as a ratio correction factor).

The ratio of the current transformer can be modified by altering the number of secondary turns by forward or back-winding the secondary lead through the window of the CT.

By adding secondary turns the same primary amperage will result in a decrease in secondary output. By subtracting secondary turns the same primary amperage will result in greater secondary output.

Again using the 300:5 example, adding 5 secondary turns will require 325 amps on the primary to maintain the 5 amp secondary output, or

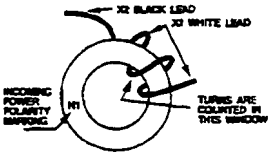
$$\frac{325p}{5s} = \frac{65s}{1p}$$

Deducting 5 secondary turns will only require 275 amps on the primary to maintain the 5 amp secondary output, or

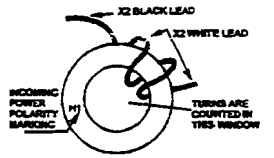
$$\frac{275p}{5s} = \frac{55s}{1p}$$

The above ratio modifications are achieved in the following manner.

- To add secondary turns, the white lead should be wound through the CT from the side opposite the polarity mark.



- To subtract secondary turns, the white lead should be wound through the CT from the same side as the polarity mark.



WARRANTY

The **Model 276 Series Current Transformers** are warranted to be free from defects in materials and workmanship for one year. Should the device fail to operate, we will repair or replace it for one year from the date of purchase. For complete warranty details, see the *Terms and Conditions of Sales* page in the front section of the Time Mark catalog.

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Doc No. 87A013 8/97

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MOORE INDUSTRIES

ECA

Economy Current and Voltage Alarm *(page 1 of 4)*

Users' Instructions November 1994

Introduction

The line-powered ECA Economy Alarm Trip is the low-cost solution in applications where an alarm trip output is needed to indicate a high or low process condition.

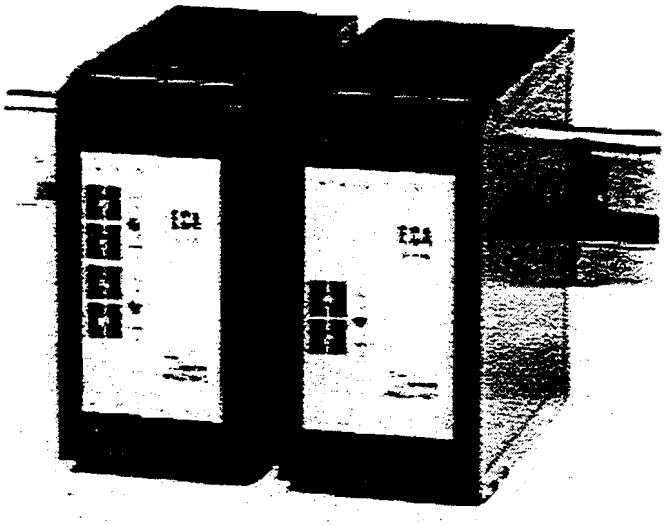
A 4-wire unit that can be powered by either AC or DC voltages, the ECA is available in configurations that accept either current or voltage input from a host of different field devices. When input falls outside of a user-set limit, the ECA provides contact closure output—ideal for indicating a high and/or low condition via a bell, buzzer, light or other annunciating device.

Single and Dual Alarms

The ECA is offered in both single and dual alarm models. The single alarm provides one output when the trip point is exceeded. Each dual alarm unit accepts one input, and provides two, separate trip points and two, individually configurable contact closure outputs.

Universal Mounting Capability

The ECA housing can be snapped on to either 32mm G-type DIN rail (EN50035) or 35mm Top Hat rail (EN50022).



The ECA's compact, thermoplastic housing *snaps quickly and securely on to both standard G-type and Top Hat mounting rails.*

Specifications

The next page lists the specifications for the various types of ECA. Included is the information needed when ordering additonal or replacement ECAs.

Options

Adjustable Deadband potentiometers, 1 per installed relay, provide the capability to vary the reset deadband between 1 and 20% of full scale.

Transmitter Excitation extra connections provide 20mA current output for power to a secondary, 2-wire transmitter.

Externally Mounted Transformer steps down 0-5A AC inputs.

Additional or Replacement Units

To specify an ECA on a Moore Industries order, "construct" a model number from the bold faced selections listed in the Ordering Information section of the specifications listing. For each unit ordered, designate the Unit type / Input range / Output range / Power / any Options, and the [Housing].

Model number example:
ECA / 4-20MA / DH1L2 / 117AC / -AD -TX [ECD]

Specifications

Performance	**Repeatability:** Trip point repeats within ±0.1% of full scale **Deadband:** 1% of span standard (see -AD option for adjustable deadband) **Alarm Response:** 50 milliseconds for a step change of 10-90% beyond trip point(s)	**Performance (continued)**	**Line Voltage Effect:** 0.005% per 10% line change **Isolation:** 1500Vrms between input, output and power **Ambient Temperature** **Range:** –20°C to +70°C (–4°F to +70°F) **Effect:** ±0.015% of span/°C	**Adjustments**	**Trip Points:** Multiturn front panel potentiometers adjust trip point from 0-110% of input range **Indicators** Front panel LED(s) is ON when relay is energized **Weight** 240 grams (8.4 ounces)

Ordering Information

Unit	Input	Output	Power	Options	Housing
ECA Economy Current and voltage Alarm	**4-20mA** into 50 ohms **1-5V** into 1M ohm **0-10V** into 1M ohm **0-150AC** into 150K ohms **0-250AC** into 250K ohms **0-5AAC** into 0.01 ohm (Other ranges also available.)	Alarm Configuration (High or Low and Failsafe or Non-Failsafe are configurable via internal jumpers): **SH1** Single, High, Failsafe **SH2** Single, High, Non-Failsafe **SL1** Single, Low, Failsafe **SL2** Single, Low, Non-Failsafe **DH1L1** Dual, High/Low, Failsafe **DH2L2** Dual, High/Low,Non-Failsafe **DH1H1** Dual, High/High, Failsafe **DH2H2** Dual, High/High, Non-Failsafe **DL1L1** Dual, Low/Low, Failsafe **DL2L2** Dual, Low/Low, Non-Failsafe (SPDT relays rated 5A @ 117Vac non-inductive or 28Vdc) **NOTE:** Failsafe considerations are such that the relay is energized in the normal condition and de-energized either upon alarm or power loss to the unit. Combination of Failsafe and Non-Failsafe for dual alarms are also possible by following the same method of designation	**24DC**, ±10% **117AC**, 50/60Hz, ±15% **230AC**, 50/60Hz, ±15% (117AC and 230AC are jumper-selectable) 1.5Watts, typical; 2.5Watts, typical, with TX option	**-AD** Adjustable deadband, 1-20% **-EM** Externally-mounted input transformer (available with 0-5AAC input type only) **-TX** 20mA excitation (4-20mA input type only)	**ECD** Thermoplastic, economy DIN-style housing mounts on both 32mm G-type (EN50035) and 35mm Top Hat (EN50022) rail

Specifications subject to change. P/N 206-717-00 A

Alarm Terminology

Moore Industries uses a simple system to designate Single, Dual, High, Low, Failsafe, and Non-failsafe alarm configuration in ECA model numbers. Single is "S"; Dual is "D"; High alarm is "H"; Low alarm is "L"; Failsafe relays are "1"; and Non-failsafe relays are "2".

High/Low and Failsafe/Non-failsafe

High alarms (H) trip when the monitored input rises above the trip point setting. Low alarms (L) trip when the input drops to the trip point setting. Failsafe relays (1) are de-energized in an alarm condition or during power loss to the unit. Non-failsafe relays (2) are energized in alarm.

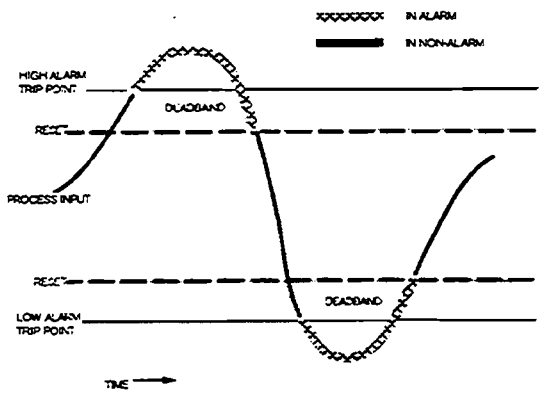
Deadband

An alarm deadband is used to compensate for process input fluctuation around a trip point setting. The deadband setting designates a point the process input must pass before ECA reset.

For High Alarms, the deadband setting is typically below the trip point. For low alarms, it is typically above the trip point. Thus, the process input returning from alarm to non-alarm must pass the trip point setting *and continue* to the deadband point before in order to reset. Refer to Figure 1.

The ECA with the AD option can be calibrated for a deadband of between 1 and 20% of the input span.

Figure 1. Alarm Deadband

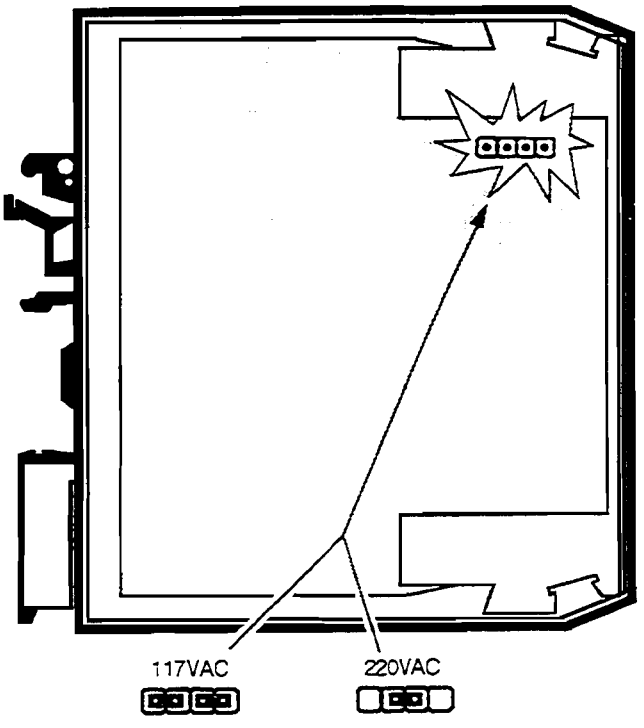


Setting Jumpers

Power

Use a flat-tipped screwdriver to unsnap the halves of the ECA housing. The PC board to the right (when facing the unit front panel) has the jumpers that determine the power supply voltage. There are no jumpers for DC-powered units.Figure 2 shows the location of the jumpers.

Figure 2. ECA Power Setting Jumpers

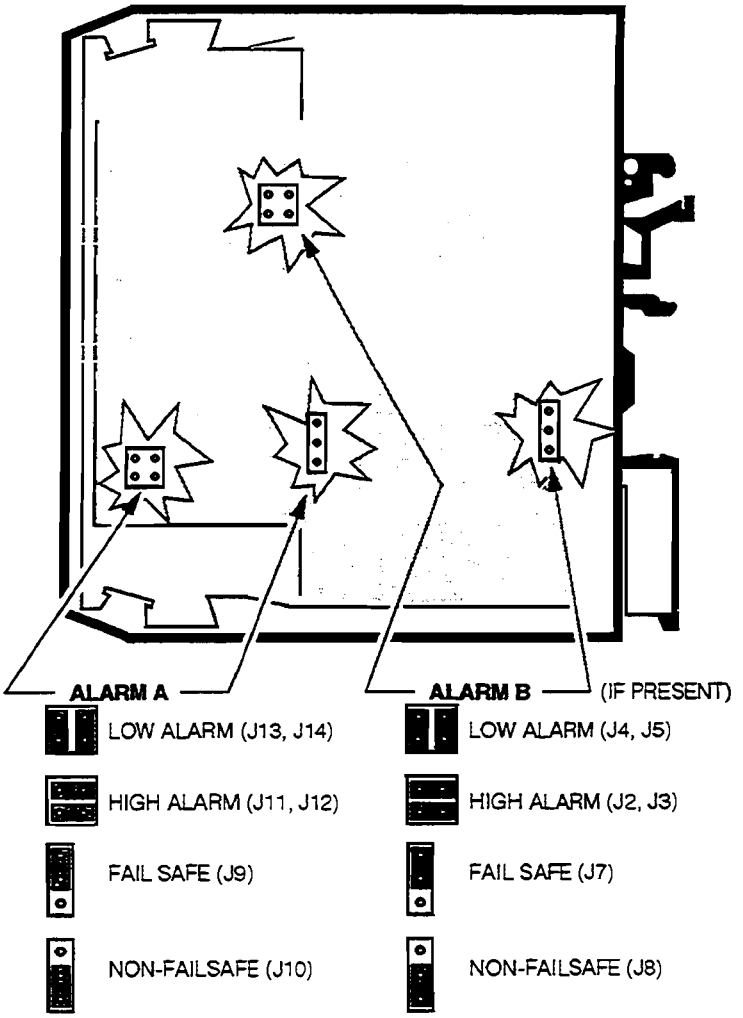


High/Low Alarm and Failsafe/Non-failsafe

With the ECA apart, the PC board with the High/Low and Failsafe/Non-failsafe jumpers is to the left (when facing the unit front panel).

Figure 3 shows the location of both the High and Low alarm setting and the failsafe/non-failsafe jumpers.

Figure 3. ECA Alarm Configuration Jumpers



Installation

Figure 4 shows the outline dimensions of the ECA. Table 1 lists the terminal designations.

Figure 1. *ECA Dimensions*

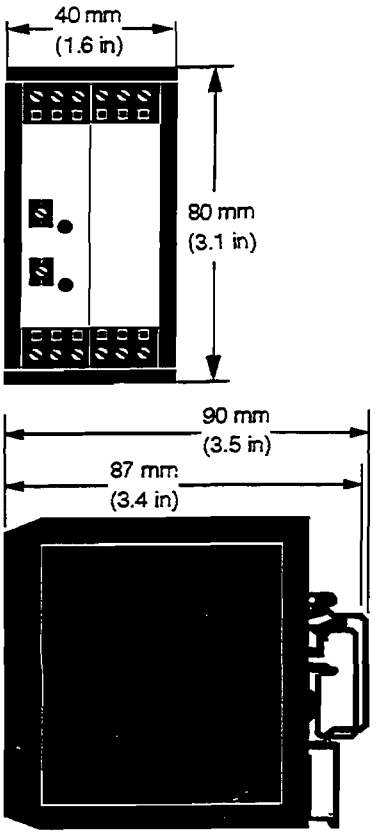
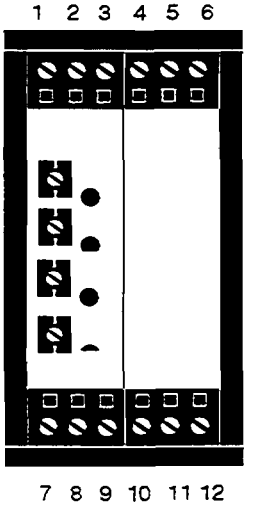


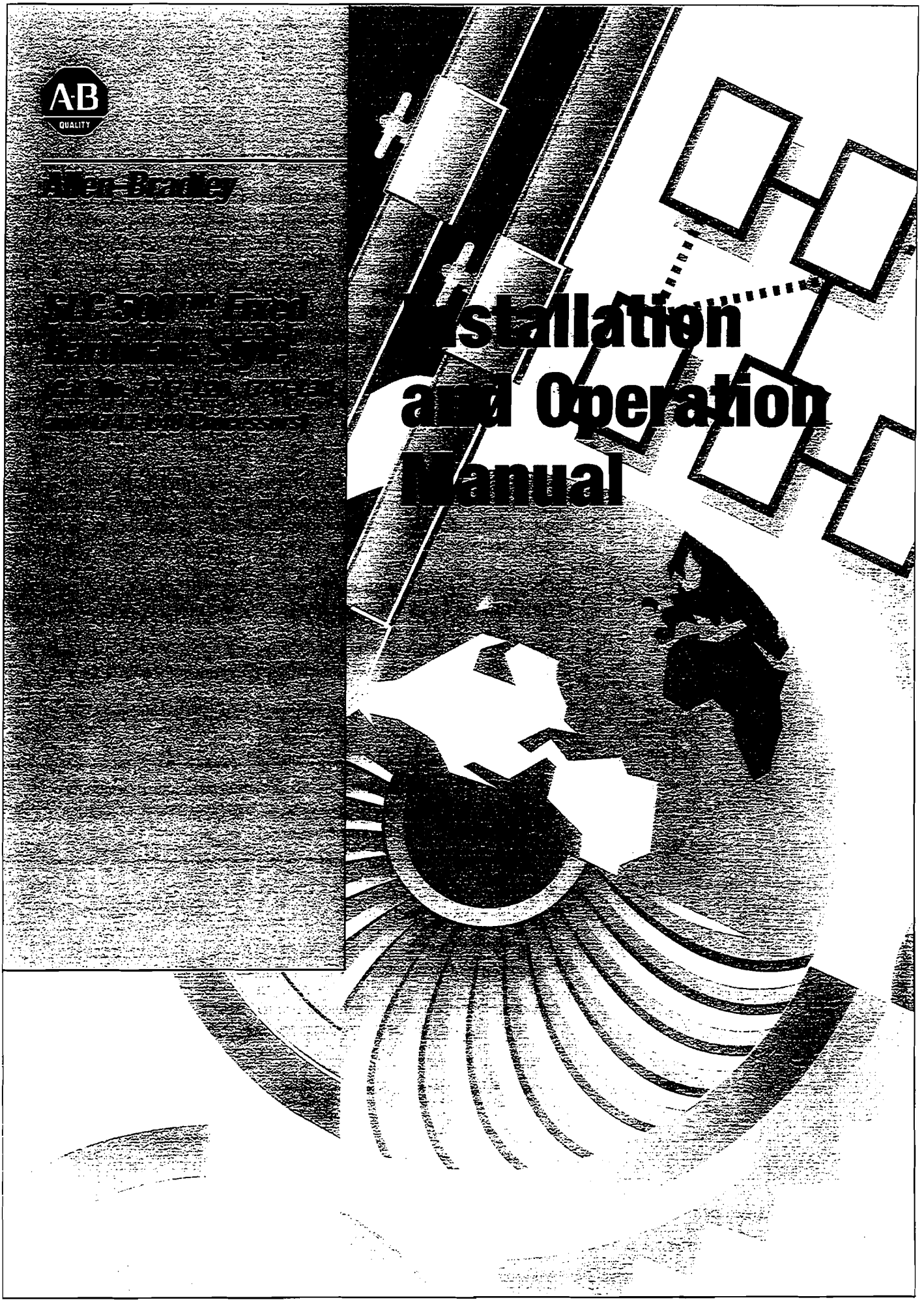
Table 1. *ECA Terminal Designations*

#	Label	Designation
1	TX	**Transmitter Excitation** - Present only when unit is equipped with TX option. Connect this terminal to the + power terminal of the 2-wire transmitter
2	+IN	**Positive Input** - Connect the +OUT of the monitored process variable to this terminal. (Also connect this terminal to the – power terminal of the 2-wire transmitter if the ECA is equipped with the TX option)
3	–IN	**Negative Input** - Connect the –OUT of the monitored process variable to this terminal.
4	NU	Not used
5	AC or DC	Power connection. + for DC.
6	ACC or DCC	Power connection. – for DC.
7	NO1	Normally Open contacts, Trip A
8	CM1	Common, Trip A
9	NC1	Normally Closed contacts, Trip A
10	NO2	Normally Open contacts, Trip B
11	CM2	Common, Trip B
12	NC2	Normally Closed contacts, Trip B



Operation

The ECA sports a front panel LED for each installed alarm. The LED lights whenever the associated relay is energized. It lights whenever the process input is "in alarm" if the relay is non-failsafe. If the relay is failsafe, the LED will light and remain lit as long as the unit has power and the process input is in a non-alarm state.


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Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. "Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls" (Publication SGI-1.1) describes some important differences between solid state equipment and hard–wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will the Allen-Bradley Company be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, the Allen-Bradley Company cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual we use notes to make you aware of safety considerations.



ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Attentions help you:

- identify a hazard
- avoid the hazard
- recognize the consequences

Important: Identifies information that is especially important for successful application and understanding of the product.

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Chapter 6

Starting Up Your Control System

This chapter describes how to start up your control system. To accomplish this, you must go through eight procedures.

Procedures for Starting Up the Control System

Start–up involves the following procedures to be carried out in sequence:

1. Inspect your installation.
2. Disconnect motion–causing devices.
3. Initialize and test your processor.
4. Test your inputs.
5. Test your outputs.
6. Enter and test your program.
7. Observe control motion.
8. Conduct a dry run of your application.

These procedures isolate problems such as wiring mistakes, equipment malfunction, and programming errors in a systematic, controlled manner.

We urge you to go through these procedures very carefully. This will help you avoid possible personal injury and equipment damage.

Important: Do not attempt system start–up until you are thoroughly familiar with the controller components and programming/editing techniques. You must also be thoroughly familiar with the particular application.

For general recommendation concerning installation safety requirements and safety requirements and safety related work practices, refer to NFPA 70E, *Electrical Safety Requirements for Employee Workplaces.*

1. Inspect Your Installation

You can often prevent serious problems in later test procedures by first making a thorough physical inspection. We recommend that you do the following:

1. Make sure that the controller and all other devices in the system are securely mounted. Refer to chapter 3 and chapter 4 for more information.
2. Check all wiring including:
   - connections from the main disconnect to the controller input
   - the master control relay/emergency–stop circuit
   - input device circuits
   - output device circuits

   Make certain that all wiring connections are correct and that there are no missing wires. Check the tightness of all terminals to make certain wires are secure. Refer to chapter 5 for more information.
3. Measure the incoming line voltage. Be certain that it corresponds to controller requirements and that it falls within the specified voltage range. See specifications for input voltage ranges in chapter 1.

2. Disconnect Motion–causing Devices

In the following test procedures, the controller will be energized. As a safety precaution, you must make certain that machine motion will not occur. The preferred way is to disconnect the motor wires at the motor starter or the motor itself. In this way, you can test the operation of the starter coil, verifying that your output circuit is wired correctly and functioning. Similarly, the preferred way to disconnect a solenoid is to disengage the valve, leaving the coil connected.

In some instances, you may not be able to disconnect a device the preferred way. In this case, it will be necessary to open the output circuit at some convenient point.

For circuit testing purposes, it is best to open the circuit at a point as close as possible to the motion–causing device. For example, your output might be a relay coil that in turn energizes a motor starter; if it is impractical to disconnect the motor wires, the next best thing to do is to open the circuit at a point between the motor starter and the relay contact.



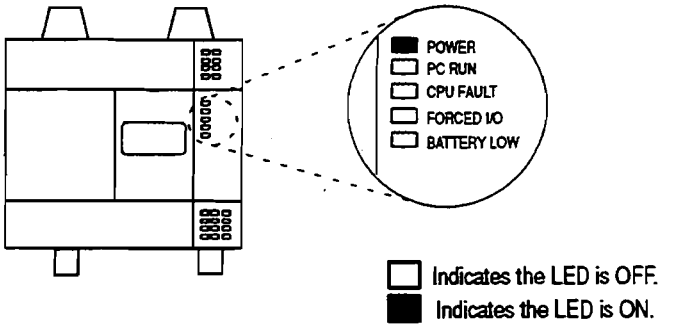
ATTENTION: Machine motion during system checkout can be hazardous to personnel. During the checkout procedures 3, 4, 5, and 6, you must disconnect all devices that, when energized, might cause machine motion.

3. Initialize and Test Your Processor

When you are certain that machine motion cannot occur with the controller energized, you may begin by initializing the processor using the following steps:

1. Energize the controller. If power is supplied to the controller and the installation is correct, then:

   A. The POWER LED turns on as shown in the figure below.



   The CPU FAULT LED also turns on during power–up, but it should go off after a few seconds. If instead this LED starts flashing, it indicates you must clear the processor memory before continuing.

   B. The following processor initial factory conditions apply:

   - Mode = PROGRAM MODE (S:1/0 – S:1/4 = 0 0001)
   - Watchdog values = 100ms (S:3H = 0000 1010)
   - I/O Slot enables = ALL ENABLED (S:11/1 through S:12/14 set to 1)
   - Node address = 1 (S:15L = 0000 0001)
   - Baud Rate = 19.2K baud (S:15H = 0000 0100)
   - Processor Name = DEFAULT

2. Power up the programming device.

   Refer to the *Hand–Held Terminal User Manual*, Catalog Number 1747–NP002, for information on programming your fixed controller with the HHT.

   Refer to the *Advanced Programming Software User Manual*, Catalog Number 1747–NM002 Series C, and the *Advanced Programming Software Reference Manual*, Catalog Number 1747–NR001, for information on programming your fixed controller with APS.

3. Configure the controller.
4. Name the processor file.
5. Program a sample test rung not affecting machine operation.
6. Save the program and the controller configuration.

7. Transfer the controller configuration and the sample test program to the processor. After the new program is transferred to the processor, the processor fault status should clear. (The CPU FAULT LED stops if it was flashing.)
8. Enter the Run mode.

   The processor PC RUN LED should turn on indicating the controller is in the RUN mode with no processor faults. If any other processor status exists, refer to chapter 8.
9. Monitor the sample test rung.

   If the sample test rung operates successfully without processor faults, you have verified that basic processor functions are properly functioning. If any other processor status exists, refer to chapter 8.

4. Test Your Inputs

After successful processor initialization and test, you may begin testing inputs following these steps:

1. Assuming you are still online with the programming device, put the controller into the Continuous Test mode. This allows the processor to scan the I/O and program, but not turn on any physical outputs.
2. Monitor the data in data File 1, the input data file. All configured inputs should be displayed.
3. Make sure the first input slot, slot 0, is shown on the monitor.
4. Select the first input device connected to Input 0 of the fixed I/O chassis.
5. Manually close and open the addressed input device.



ATTENTION: Never reach into a machine to actuate a device, unexpected machine operation could occur.

6. Observe the associated bit status using the programming device monitor function. Also, observe the input status LED on the fixed I/O chassis.

   A. When the input device is closed verify that the voltage at the input terminal is within the specified on–state range, the input status LED is on, and the associated status bit is set to a one.

      If any of these conditions are not satisfied, follow the recommended troubleshooting steps listed below.

   B. When the input device is opened verify that the voltage at the input terminal is within the specified off–state range, the input status LED is off, and the associated status bit is reset to 0.

      If any of these conditions are not satisfied, follow the recommended troubleshooting steps listed below.

7. Select the next input device and repeat steps 5 and 6 until all inputs on the fixed I/O chassis and in the 2–slot expansion rack (if used) have been tested.

Input Troubleshooting Steps

1. Make sure the processor is in the Continuous Test mode.
2. Verify that your inputs and outputs are enabled. Status file bit S:11/0 represents the inputs and outputs of the fixed controller. Status file bits S:11/1 and S:11/2 represent the inputs and outputs (slot 1 and slot 2 respectively) of the 2–slot expansion chassis. These bits must be set to one, enabling all your inputs and outputs.
3. Check your wiring and verify that all connections are tight.

   A. Make sure that power connections have been made to your input device if needed.

   B. Verify that the signal connection has been made from the input device to the correct input circuit of the fixed controller.

   C. Check that all common connections have been made.

4. Check your specifications.

   A. Make sure that the power is within the specified voltage range if your input device requires power.

   B. Verify that your power supply is not overloaded. An overloaded supply can deliver the correct voltage when some of its loads are not energized but the voltage may fall out of range when all of its loads are energized.

   C. Verify that your input device signal contact is specified to deliver sufficient current to the input circuit and any other loads connected to it.

   D. Make certain that your input device does not have a minimum load specification that is greater than the input circuit current specification.

   E. Verify that the input device is on and off longer than the specified turn–on and turn–off times for the input circuit.

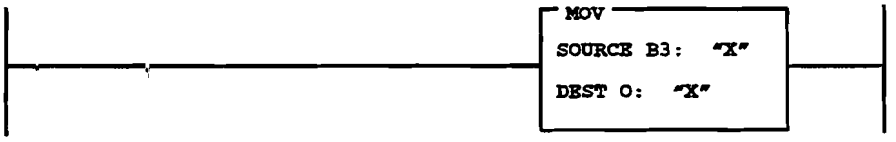
5. Disconnect your input devices from the fixed controller input terminals. Make a direct connection from a power supply to the fixed controller input and common terminals. The power supply voltage must be within the specified on–state voltage range of the input circuit. If you can energize and de–energize the input circuit by turning the power supply on and off, the basic operation of the input circuit is functioning correctly. The problem is likely to be with the input device or wiring. If you cannot operate the the input circuit by a direct connection, the input circuit is not functioning and should be replaced.
6. Connect a different load to your input device. Open and close the input device and measure the voltage at the load. If your input device cannot operate other loads, the input device is not functioning properly and should be replaced.

For more information on input troubleshooting, see page 8–8.

5. Test Your Outputs

After you test all inputs, and have determined that they are functioning properly, test the outputs following these steps.

1. Refer to page 6–2 to insure that no motion will occur when any controller output is energized.
2. Place the controller in the Program mode.
3. Create an output test rung as shown below for each output slot configured. Enter your source and destination address:



Here "X" represents the slot number of the output currently selected. This rung moves a word of data from the bit file to the output file. The slot number is 0 for outputs of the fixed controller. If the 2–slot expansion chassis is used, numbers one and two are used for the outputs in slots 1 and 2 respectively.

4. Save the output test program and controller configuration.
5. Transfer the output test program to the processor.
6. Put the controller in the Run mode.
7. Monitor the data in bit file B3 on the programming device display.
8. Enter `B3: "X"` at the address prompt to select the output slot to be tested.
9. Move the cursor to the bit position that corresponds to the specific output being tested. Set the bit to 1.

10. Observe the output status LED and the output device.

    The output status LED should turn on. The output device should be energized unless you disconnected it to prevent machine motion. It may be necessary to connect a dummy load to the output to complete this test. If the LED does not turn on or if the load is not energized, follow the output troubleshooting steps listed below.

11. Reset the bit value back to zero for the selected address. Both the output status LED and the output device should de–energize. If the LED does not turn off or if the load does not de–energize, follow the output troubleshooting steps listed below.

12. Repeat steps 9 through 11 for all outputs of the selected slot.

13. Repeat steps 8 through 12 for all slots (with outputs) that are a part of the fixed controller configuration.

Output Troubleshooting Steps

1. Make sure the processor is in the Run mode.
2. Verify that the test rung recommended in the previous section has been entered correctly.
3. Check the status file I/O slot enable bits. Status file bit S:11/0 represents the inputs and outputs of the fixed controller. Status file bits S:11/1 and S:11/2 represent the inputs and outputs (slot 1 and slot 2 respectively) of the 2–slot expansion chassis. These bits must be set to one, enabling all your inputs and outputs.
4. Use a programming device to verify that the bit being tested in the output file tracks the on/off status of the corresponding bit in the bit file.

   If the output file does not track the bit file, but your program has been entered correctly and the I/O are enabled, then your processor is not functioning properly and should be replaced.

   If the output file tracks the bit file, then the processor is functioning properly and the output command is being sent to either the I/O section of the fixed controller, or to the output module in the 2–slot expansion chassis.

5. Check the electrical connections.
   A. If the output being tested is in the 2–slot expansion chassis, verify that the expansion chassis connector is properly mated to the expansion connector of the fixed controller.
   B. Turn off power to the I/O circuits. Verify that power and/or common connections are made to the proper output circuit terminals.
   C. Verify that the power connections are made to the output load device if they are required.
   D. Verify that the output terminal being tested is connected to the correct termination point of the load device.
   E. Check the tightness of all terminals to make certain that all wires are secure.

6. Check your specifications.

   A. Verify that all power supplies used are within the specified operating ranges of the I/O circuits and loads.

   B. Check that the specified load current is greater than the minimum load current specified for the output circuit. (Leakage current from the output circuit may prevent you from turning off a low current load.)

   C. Check that the specified load current is less than the maximum load current of the output circuit.

   D. Make sure that the sum of all the load currents is equal to or less than the power supply capacity.

7. Restore power to the I/O circuits and test the output. If the preceding measures have not corrected the problem, turn off the I/O power and disconnect the load. Connect the load directly to the I/O power supply. You should be able to operate the load by turning the power supply on and off.

   If you can operate the load, and the load is within the specified operating range of the output circuit, the output circuit is not functioning properly. Replace the fixed controller or output module as necessary.

   If you cannot operate the load by turning the power supply on and off, the load is not operating properly and it should be replaced.

For more information on output troubleshooting, refer to page 8–10.

6. Enter and Test Your Program

After you test all inputs and outputs and they are functioning properly, we recommend the following steps to safely and successfully enter and test your specific application program. (For extra assistance, see the *Hand–Held Terminal User Manual* or the *Advanced Programming Software User Manual.*)

1. Verify the offline program.

   After the program has been entered in the offline edit file mode, program verification may begin.

   Remaining in the offline edit file mode you may use the cursor keys and/or search function of your programming device to inspect every instruction and rung for errors.

2. Check your written program, rung for rung, against the program entered into the offline memory. The most common errors found in program entry are:
   - incorrect addressing of instructions
   - omission of an instruction
   - more than one output instruction programmed using the same address

3. Transfer the program into the processor.

   A. Place your programming device online.

   B. Place the processor in Program mode.

   C. Select download function when using the Hand–Held Terminal or the restore function when using Advanced Programming Software.

4. Verify the online program transfer.

   A. Select monitor file function.

   B. Cursor through the program to verify that you selected the right program.

5. Conduct a single–scan program test.

   A. Select the monitor file function and place the cursor on the first rung.

   B. Select the Test mode.

   C. Select Single–Scan (SSN) test. In this test mode, the processor executes a single operating cycle, which includes reading the inputs, executing the ladder program, and updating all data without energizing the output circuits. However, the monitor file function will identify the output status as if the outputs were enabled.

      Timers are also incremented a minimum of 10 milliseconds each single scan.

   D. Simulate the input conditions necessary to execute the current monitored rung of the program. If it is not practical to manually activate the input device, use the force function to simulate the proper condition.



ATTENTION: Never reach into a machine to actuate a device, unexpected machine operation could occur.

   E. Activate a single operating scan as outlined in the programming device user manual.

   F. Verify the intended effects on the output instructions for that rung and overall program logic effects.

   G. Select the next program rung and repeat test procedures as listed above until the entire program has been tested.

6. Conduct a continuous scan program test.

   Once the individual single scan rung tests have been completed and proper program operation verified, a continuous scan test might be appropriate before motion checkout.

   This mode simulates the controller Run mode without energizing the external outputs.

7. Observe Control Motion

Now that program execution has been verified, checkout of control motion can begin. All persons involved with the programming, installation, layout design, machine or process design, and maintenance should be involved in making decisions for determining the best and safest way to test the total system.

The following procedures are general in nature. Individual conditions may warrant their modification. The basic approach is to initiate testing with the least amount of machine motion. Only some outputs are allowed to generate machine motion. Then additional machine motion can be gradually added, thereby allowing any problems to be detected more easily under controlled conditions. The following procedure provides the steps for testing machine motion using one output at a time.



ATTENTION: During all phases of checkout, station a person ready to operate an emergency–stop switch if necessary. The emergency–stop switch will de–energize the master control relay and remove power from the machine. This circuit must be hardwired only, it *must not* be programmed.

Use the following procedures:

1. Identify the first output device to be tested and reconnect its wiring.



ATTENTION: Contact with AC line potential may cause injury to personnel. When reconnecting wiring, make sure that AC power disconnect switch is opened.

2. Place the controller in the Run mode and observe the behavior of the output device. To do this, simulate the input conditions necessary to energize the output in the program. If it is not practical to manually activate an input device, use the force function to simulate the proper input condition.



ATTENTION: Never reach into a machine to actuate a device, unexpected machine operation could occur.

3. Repeat steps 1 and 2, testing each output device, one at a time.

8. Conduct a Dry Run



ATTENTION: During all phases of the dry run test, station a person ready to operate an emergency–stop switch if necessary. The emergency–stop switch will de–energize the master control relay and remove power from the machine. This circuit must be hardwired only, it *must not* be programmed.

After thoroughly checking out the controller system and program, proceed with a dry run of the application with all of the output devices enabled. This dry run will vary with the application. For example, a machine tool dry run might test the program with all outputs enabled but without tooling an actual part.

After you check out the entire system, and your dry run has been completed satisfactorily, we recommend that you load your program into an EEPROM memory module for back–up program storage. See chapter 3 for more information. Refer to the *Hand–Held Terminal User Manual*, Catalog Number 1747–NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747–NM002, for directions on loading the EEPROM from RAM.

This step completes the start–up procedures. Your SLC Programmable Controller is now ready for operation.

Chapter 7

Maintaining Your Control System

This chapter covers the following:

- handling, storing, and transporting battery, Catalog Number 1747–BA
- installing or replacing your SLC 500 battery
- replacing the power supply fuse
- replacing retainer clips on a module

Refer to chapter 2 for important information on testing the master control relay circuit and preventive maintenance.

Handling, Storing, and Transporting Battery, Catalog Number 1747–BA

Follow the procedure below to ensure proper battery operation and reduce personnel hazards.

Handling

- Use only for the intended operation.
- Do not ship or dispose of batteries except according to recommended procedures.
- Do not ship on passenger aircraft.



ATTENTION: Do not charge the batteries. An explosion could result or they could overheat causing burns.

Do not open, puncture, crush, or otherwise mutilate the batteries. A possibility of an explosion exists and/or toxic, corrosive, and flammable liquids would be exposed.

Do not incinerate or expose the batteries to high temperatures. Do not attempt to solder batteries. An explosion could result.

Do not short positive and negative terminals together. Excessive heat could build up and cause severe burns.

Storing

Store the lithium batteries in a cool, dry environment, typically +20° C to +25° C (+68° F to +77° F) and 40% to 60% relative humidity. Store the batteries and a copy of the battery instruction sheet in the original container, away from flammable materials.

Transporting

One or Two Batteries – Each battery contains 0.23 grams of lithium. Therefore, up to two batteries can be shipped together within the United States without restriction. Regulations governing shipment to or within other countries may differ.

Three or More Batteries – Procedures for the transportation of three or more batteries shipped together within the United States are specified by the Department of Transportation (DOT) in the Code of Federal Regulations, CFR49, "Transportation." An exemption to these regulations, DOT – E7052, covers the transport of certain hazardous materials classified as flammable-solids. This exemption authorizes transport of lithium batteries by motor vehicle, rail freight, cargo vessel, and cargo–only aircraft, providing certain conditions are met. Transport by passenger aircraft is not permitted.

A special provision of DOT–E7052 (11th Rev., October 21, 1982, par. 8–a) provides that:

> "Persons that receive cell and batteries covered by this exemption may reship them pursuant to the provisions of 49 CFR 173.22a in any of these packages authorized in this exemption including those in which they were received."

The Code of Federal Regulations, 49 CRF 173.22a, relates to the use of packaging authorized under exemptions. In part, it requires that you must maintain a copy of the exemption at each facility where the packaging is being used in connection with shipment under the exemption.

Shipment of depleted batteries for disposal may be subject to specific regulation of the countries involved or to regulations endorsed by those countries, such as the IATA Restricted Articles Regulations of the International Air Transport Association, Geneva, Switzerland.

Important: Regulations for transportation of lithium batteries are periodically revised.



ATTENTION: Do not incinerate lithium batteries in general trash collection. Explosion or violent rupture is possible. Batteries should be collected for disposal in a manner to prevent against short circuiting, compacting, or destruction of case integrity and hermetic seal.

For disposal, batteries must be packaged and shipped in accordance with transportation regulations, to a proper disposal site. The U.S. Department of Transportation authorizes shipment of "Lithium batteries for disposal" by motor vehicle only in regulation 173.1015 of CRF49 (effective January 5, 1983). For additional information contact:

U.S. Department of Transportation
Research and Special Programs Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

Although the Environmental Protection Agency at this time has no regulations specific to lithium batteries, the material contained may be considered toxic, reactive, or corrosive. The person disposing of the material is responsible for any hazard created in doing so. State and local regulations may exist regarding the disposal of these materials.

Installing or Replacing Your SLC 500 Battery

Back-up power for RAM is provided by a capacitor that will retain the contents of the RAM for a period of 5 to 30 days. For applications requiring memory back-up for a longer period of time an optional replaceable battery, Catalog Number 1747–BA, is required. The lithium battery provides back-up for approximately five years. A red BATTERY LOW LED turns on when the battery voltage has fallen below a threshold level.

For battery installation or replacement, do the following:

1. Back up your ladder program.
2. Disconnect power to the processor.

ATTENTION: When power is applied to the controller hazardous electrical potentials exist under the front cover. See page 2–8 for more information.

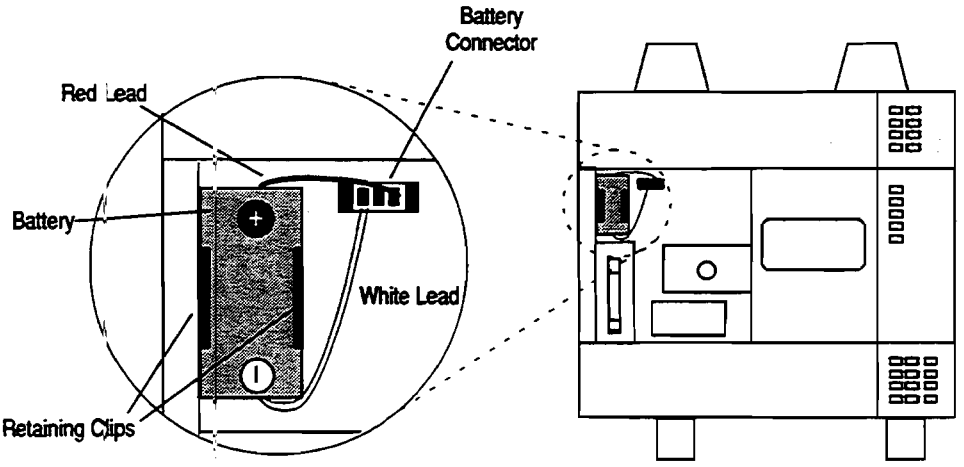
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3. Remove the processor cover.
4. If you are:

   installing a battery in a new processor (battery never installed before), remove the jumper from the battery socket. Store jumper in safe place for possible future use without battery.

   replacing an old battery, unplug the battery connector from the socket. The figure below shows you where to install the battery in a fixed controller.

5. Insert a new or replacement battery in the holder making sure it is held in by the retaining clip.
6. Plug the battery connector into the socket. See the figure below.



7. Replace the cover.

Replacing the Power Supply Fuse

Under normal power–up conditions, the POWER LED turns on. If a power supply fuse is blown, the POWER LED will not turn on. One of the following conditions could cause a blown power supply fuse:

- excessive line voltage
- internal power supply malfunction
- overloading 2–slot chassis

ATTENTION: Contact with AC line potential can cause injury to personnel. Remove system power before attempting fuse replacement.

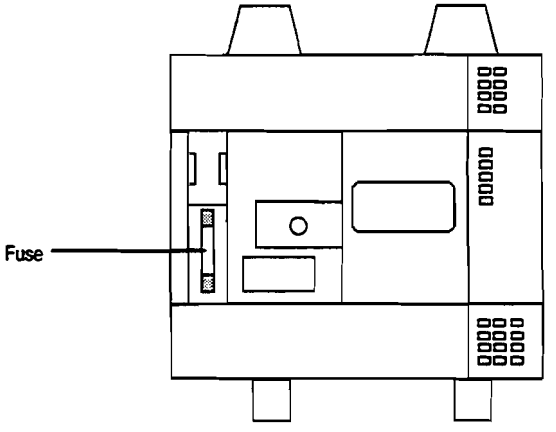
Use only replacement fuses of the type and rating recommended for the unit. Improper fuse selection can result in equipment damage.

After the conditions causing the malfunction have been corrected, you can replace the fuse:

1. Disconnect power to the processor.

ATTENTION: When power is applied to the controller hazardous electrical potentials exist under the front cover. See page 2–8 for more information.

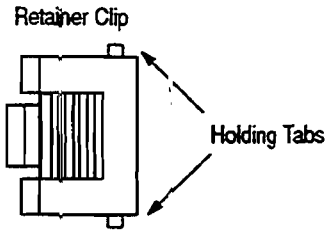
2. Remove the cover on the processor.
3. Locate the fuse. Use a miniature fuse puller to grip the fuse and remove it from its holder.
4. Discard the fuse and replace it with the recommended replacement fuse. (See chapter 9 for more information.)



5. Replace the cover on the processor.
6. Restore power to the processor. The POWER LED should now turn on.

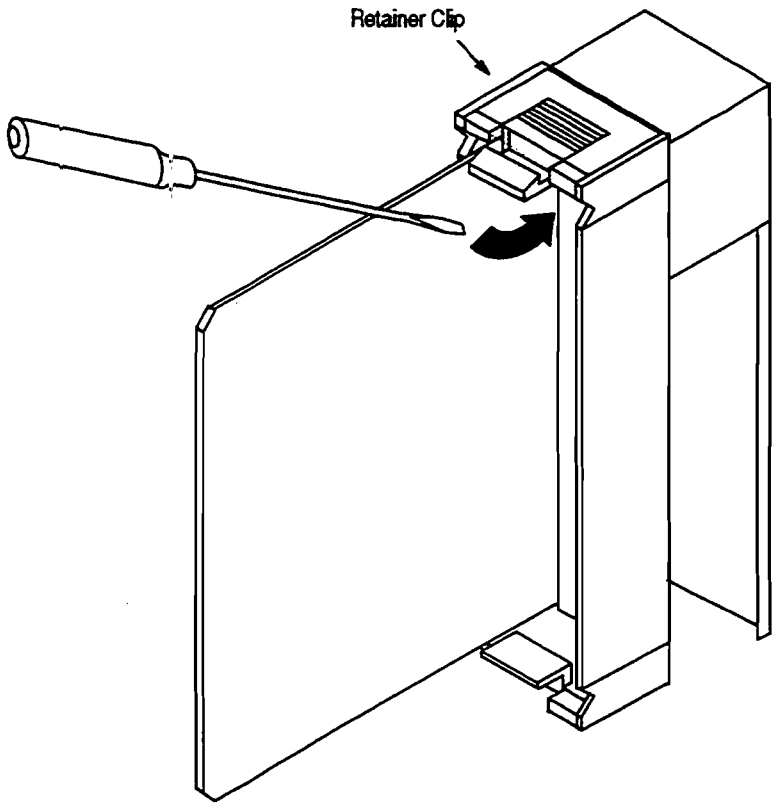
Replacing Retainer Clips on an I/O Module

If it becomes necessary to replace the retainer clip (also called self–locking tab), order Catalog Number 1746–R15 (4 clips per package).



Removing Damaged Retainer Clips

If necessary, pry off the broken retainer clip from the bottom with a screwdriver. Do not twist it off. You can damage the module.



Installing New Retainer Clips

Insert one of the pins of the retainer clip into the hole in the I/O module and then snap the other end in place.

Chapter 8

Troubleshooting

In this chapter, you will learn about:

- calling Allen–Bradley for assistance
- tips for troubleshooting your control system
- troubleshooting your fixed controller
- troubleshooting your input modules
- troubleshooting your output modules

Calling Allen–Bradley for Assistance

If you need to contact Allen–Bradley or your local distributor for assistance, it is helpful to obtain the following (prior to calling):

- processor type, series letter, and firmware (FRN) number (see label on side of processor module)
- processor LED status
- processor error codes (found in S:6 of status file)
- hardware types in system (I/O modules, chassis)
- revision of programming device (on the main menu of the Hand–Held Terminal or Advanced Programming Software)

Tips for Troubleshooting Your Control System

When troubleshooting, pay careful attention to these general warnings:



ATTENTION: Have all personnel remain clear of the controller and equipment when power is applied. The problem may be intermittent and sudden unexpected machine motion could result in injury. Have someone ready to operate an emergency–stop switch in case it becomes necessary to shut off power to the controller equipment. Also, see NFPA 70E Part II for additional guidelines for safety related work practices.

Never reach into a machine to actuate a switch since unexpected machine motion can occur and cause injury.

Remove all electrical power at the main power disconnect switches before checking electrical connections or inputs/outputs causing machine motion.

If installation and start–up procedures detailed in chapters 3, 4, and 5 were followed closely, your SLC controller will give you reliable service. If a problem should occur, the first step in the troubleshooting procedure is to identify the problem and its source.

The SLC 500 controller has been designed to simplify troubleshooting procedures. By observing the diagnostic indicators on the front of the processor unit and I/O modules, the majority of faults can be located and corrected. These indicators, along with error codes identified in the programming device user manual and programmer's monitor, help trace the source of the fault to the user's input/output devices, wiring, or the controller.

Removing Power

Before working on a SLC 500 fixed system, always remove the power supply input power at the main power disconnect switch.

The POWER LED on the power supply indicates that DC power is being supplied to the chassis. This LED could be off when incoming power is present when the:

- fuse is blown
- voltage drops below the normal operating range. Refer to chapter 1 for more information.
- power supply is defective

Replacing Fuses

When replacing a fuse, be sure to remove all power from the system.

Program Alteration

There are several causes of alteration to the user program, including extreme environmental conditions, Electromagnetic Interference (EMI), improper grounding, improper wiring connections, and unauthorized tampering. If you suspect the memory has been altered, check the program against a previously saved program on an EEPROM, UVPROM or Flash EPROM module.

Troubleshooting Your Fixed Controller

To receive the maximum benefit of this troubleshooting section, we recommend you follow these steps:

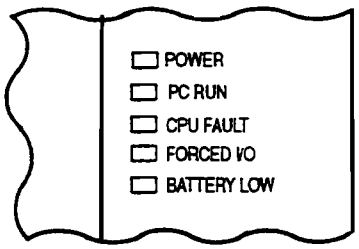
1. Match your processor LEDs with the status LEDs located in the first column in the tables on the following pages.
2. Once the status LEDs are matched to the appropriate table, simply move across the table identifying error description and probable causes.
3. Follow the recommended action steps for each probable cause until the cause is identified.
4. If recommended actions do not identify the cause, contact your local Allen–Bradley sales office or distributor.

Identifying Fixed Controller Errors

Refer to the following key to determine the status of the LED indicators:

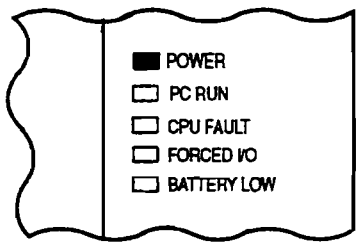
- ☐ Indicates the LED is OFF.
- ■ Indicates the LED is ON.
- ▒ Indicates the LED is FLASHING.

If the LEDs indicate:



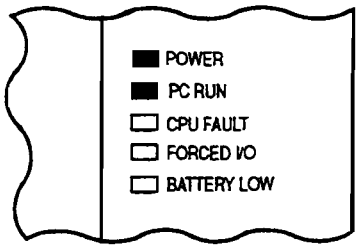
The Following Error Exists	Probable Cause	Recommended Action
Inadequate System Power	No Line Power	Verify proper line voltage and connections on the power terminals.
	Power Supply Fuse Blown	1. Check the incoming power fuse, check for proper incoming power connections. Replace fuse. 2. If fuse blows again, replace the fixed controller.
	Power Supply Overloaded	This problem can occur intermittently if power supply is lightly overloaded when output loading and temperature varies. If you are using a 2-slot chassis, verify the compatibility of the modules to prevent overloading the backplane power.

If the LEDs indicate:



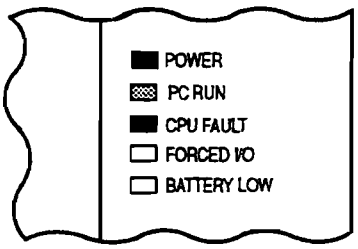
The Following Error Exists	Probable Cause	Recommended Action
Processor Not in Run Mode	Either Improper Mode Selected or User Program Logic Error	1. Verify selected processor mode. 2. If in program/test modes, attempt RUN mode entry. 3. Check user program logic for suspend instructions if in suspend mode. Refer to either the *Hand-Held Terminal User Manual*, Catalog Number 1747-NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747-NM002.
	Line Power Out of Operating Range	1. Check incoming power connections. 2. Monitor for proper line voltage at the incoming power connections.

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
System Inoperable, No Major CPU Faults Detected	User Program Logic Error	Monitor logic in Run mode and verify desired I/O status. Refer to either the *Hand–Held Terminal User Manual*, Catalog Number 1747–NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747–NM002.
	Defective I/O Devices or I/O Wiring	Test inputs and outputs according to I/O troubleshooting procedures starting on page 8–8.

If the LEDs indicate:

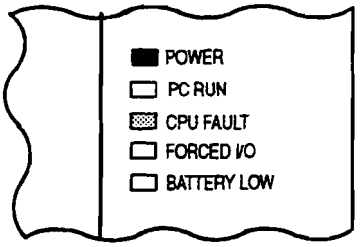


The Following Error Exists	Probable Cause	Recommended Action
CPU Fault	CPU Memory Error	Cycle power.
	Faulty Memory Module	1. Remove power and then remove the memory module from the controller. 2. Re–energize the controller. If steady CPU FAULT LED changes to flashing, replace the existing memory module with a replacement module. Refer to chapter 4 for removing and installing memory modules.
	Processor Firmware Installed Incorrectly	If upgrading the processor to a different firmware level, verify that the firmware chip orientation matches the upgrade kit directions.

Refer to the following key to determine the status of the LED indicators:

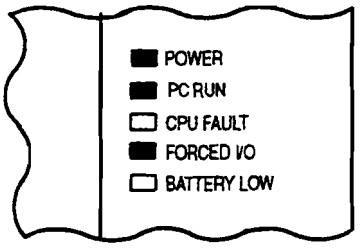
- ☐ Indicates the LED is OFF.
- ■ Indicates the LED is ON.
- ▒ Indicates the LED is FLASHING.

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
CPU Major Fault	Initial CPU Factory Power-up Condition	1. Refer to chapter 6 and follow the start-up procedures. 2. Clear processor memory to get rid of the flashing CPU FAULT LED.
	Hardware/Software Major Fault Detected Erratic repetitive power cycling can cause a processor major hardware fault.	1. Monitor Status File Word S:6 for major error code. 2. Refer to either the *Hand-Held Terminal User Manual*, Catalog Number 1747-NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747-NM002, for error codes and additional troubleshooting information. 3. Remove hardware/software condition causing fault. 4. Clear Status File S:1/13 major error bit, if set. 5. Clear Status File S:5 minor error bits, if set. 6. Clear Status File S:6 major error code (optional). 7. Attempt a processor Run mode entry. If unsuccessful, repeat recommended action steps above.

If the LEDs indicate:

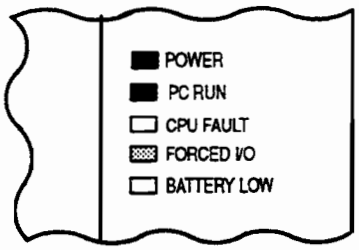


The Following Error Exists	Probable Cause	Recommended Action
System does not operate per ladder logic.	User Forced I/O Disabling Operation	1. Monitor program file online and identify forced I/O. 2. Disable appropriate forces and test system conditions again. Refer to either the *Hand-Held Terminal User Manual*, Catalog Number 1747-NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747-NM002.

Refer to the following key to determine the status of the LED indicators:

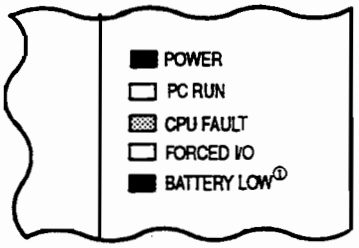
- ☐ Indicates the LED is OFF.
- ■ Indicates the LED is ON.
- ▒ Indicates the LED is FLASHING.

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
System does not operate per programmed forces.	User Programmed Forces are Not Enabled	1. Monitor program file online and identify programmed forces. 2. Enable appropriate forces and test system conditions again. Once forces are enabled, the FORCED I/O LED goes on steady. Refer to either the *Hand–Held Terminal User Manual*, Catalog Number 1747–NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747–NM002.

If the LEDs indicate:



The Following Error Exists	Probable Cause	Recommended Action
CPU Major Error with Low or No Battery Back–up	Loss of RAM during Power Down Period	1. Verify battery is connected. See page 7–4. 2. Replace the battery. See page 7–4. 3. Refer to processor major fault recommended action steps. Refer to either the *Hand–Held Terminal User Manual*, Catalog Number 1747–NP002, or the *Advanced Programming Software User Manual*, Catalog Number 1747–NM002.

Refer to the following key to determine the status of the LED indicators:

- ☐ Indicates the LED is OFF.
- ■ Indicates the LED is ON.
- ▒ Indicates the LED is FLASHING.

① *Regardless of any other LED status indicator conditions, always replace the battery when the BATTERY LOW LED is on if you want RAM battery backup. If you want to back up RAM with a capacitor, add or replace the BATTERY LOW LED jumper.*

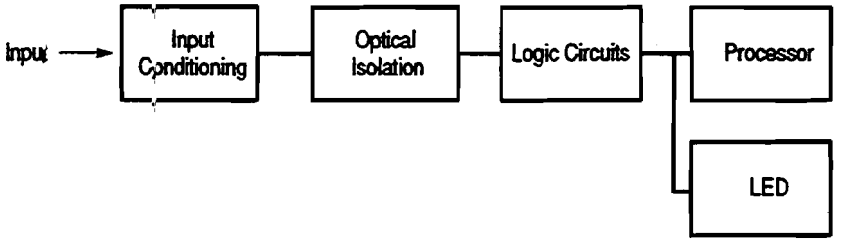
Troubleshooting Your Input Modules

The following will assist you in troubleshooting your input modules.

Input Circuit Operation

An input circuit responds to an input signal in the following manner:

1. An input filter removes false signals due to contact bounce or electrical interference.
2. Optical isolation protects the backplane circuits by isolating logic circuits from input signals.
3. Logic circuits process the signal.
4. An input LED turns on or off indicating the status of the corresponding input device.



5. The processor receives the input status for use in processing the program logic.

Corrective Action

If your Input Circuit LED is	And Your Input Device is	And	Probable Cause	Recommended Action
On	On/Closed/Activated	Your input device will not turn off.	Device is shorted or damaged.	Verify device operation. Replace device.
		Your program operates as though it is off.	Input is forced off in program.	Check the FORCED I/O or FORCE LED on processor and remove forces.
			Input circuit is damaged.	Try other input circuit. Replace module.
	Off/Open/Deactivated	Your program operates as though it is on and/or the input circuit will not turn off.	Input device Off-state leakage current exceeds input circuit specification.	Check device and input circuit specifications. Use load resistor to bleed-off current.
			Input device is shorted or damaged.	Verify device operation. Replace device.
			Input circuit is miswired or damaged.	Verify proper wiring. Try other input circuit. Replace module.
Off	On/Closed/Activated	Your program operates as though it is off and/or the input circuit will not turn on.	Input circuit is incompatible.	Check specification and sink/source compatibility (if DC input).
			Low voltage across the input.	Check the voltage across input circuit and check source voltage.
			Incorrect wiring or an open circuit.	Check wiring and COMmon connections.
			Input signal turn on time too fast for input circuit.	Check timing specifications.
			Input circuit is damaged.	Verify proper wiring. Try other input circuit. Replace module.
	Off/Open/Deactivated	Your input device will not turn on.	Input device is opened or damaged.	Verify operation. Replace device.
		Your program operates as though it is on.	Input is forced on in program.	Check processor FORCED I/O or FORCE LED and remove forces. Verify proper wiring. Try other input circuit.
			Input circuit is damaged.	Verify proper wiring. Try other input circuit. Replace module.

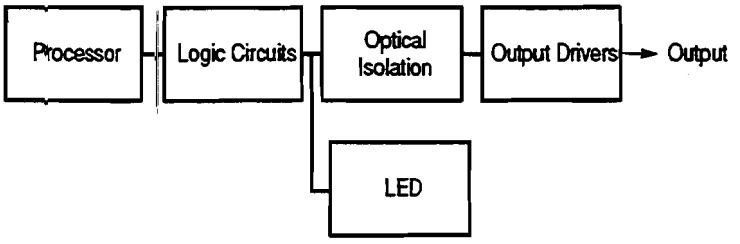
Troubleshooting Your Output Modules

The following will assist you in troubleshooting your output modules.

Output Circuit Operation

An output circuit controls the output signal in the following manner:

1. The processor determines the output status.
2. Logic circuits maintain the output status.
3. An output LED indicates the status of the output signal.
4. Optical isolation separates logic and backplane circuits from field signals.
5. The output driver turns the corresponding output on or off.



Corrective Action

If your Output Circuit LED is	And Your Output Device is	And	Probable Cause	Recommended Action
On	On/Energized	Your program indicates that the output circuit is off or the output circuit will not turn off.	Programming problem.	Check for duplicate outputs and addresses using the search function. If using subroutines, outputs are left in their last state when not executing subroutines. Use the force function to force output off. If this does not force the output off, output circuit is damaged. If the output does force off, then check again for logic/programming problem.
			Output is forced on in program.	Check processor FORCED I/O or FORCE LED and remove forces.
			Output circuit is damaged.	Use the force function to force the output off. If this forces the output off, then there is a logic/programming problem. If this does not force the output off, the output circuit is damaged. Try other output circuit. Replace module.
	Off/De-energized	Your output device will not turn on and the program indicates that it is on.	Low or no voltage across the load.	Measure the source voltage and check specifications.
			Incorrect wiring or open circuit.	Check wiring and COMmon connections.
			Output device is incompatible.	Check specifications and sink/source compatibility (if DC output).
			Output circuit is damaged.	Check wiring. Try other output circuit. Replace module.
Off	On/Energized	Your output device will not turn off and the program indicates that it is off.	Output device is incompatible.	Check specifications.
			Output circuit Off-state leakage current may exceed output device specification.	Check specifications. Use load resistor to bleed off leakage current. See output specifications.
			Incorrect wiring.	Check wiring. Disconnect from SLC and verify device operation.
			Output device is shorted or damaged.	Verify device operation. Replace device.
			Output circuit is damaged.	Check wiring. Try other output circuit. Replace module.
	Off/De-energized	Your program indicates that the output circuit is on or the output circuit will not turn on.	Programming problem.	Check for duplicate outputs and addresses using search function. If using subroutines, outputs are left in their last state when not executing subroutines. Use the force function to force output on. If this does not force the output on, output circuit is damaged. If the output does force on, then check again for logic/programming problem.
			Output is forced off in program.	Check processor FORCED I/O or FORCE LED and remove forces.
			Output circuit is damaged.	Use the force function to force the output on. If this forces the output on, then there is a logic/programming problem. If this does not force the output on, the output circuit is damaged. Try other output circuit. Replace module.

Chapter 9

Replacement Parts

This chapter provides a list of replacement parts and a list of replacement terminal blocks for your SLC 500 controller.

Replacement Parts

This table provides a list of replacement parts and their catalog numbers.

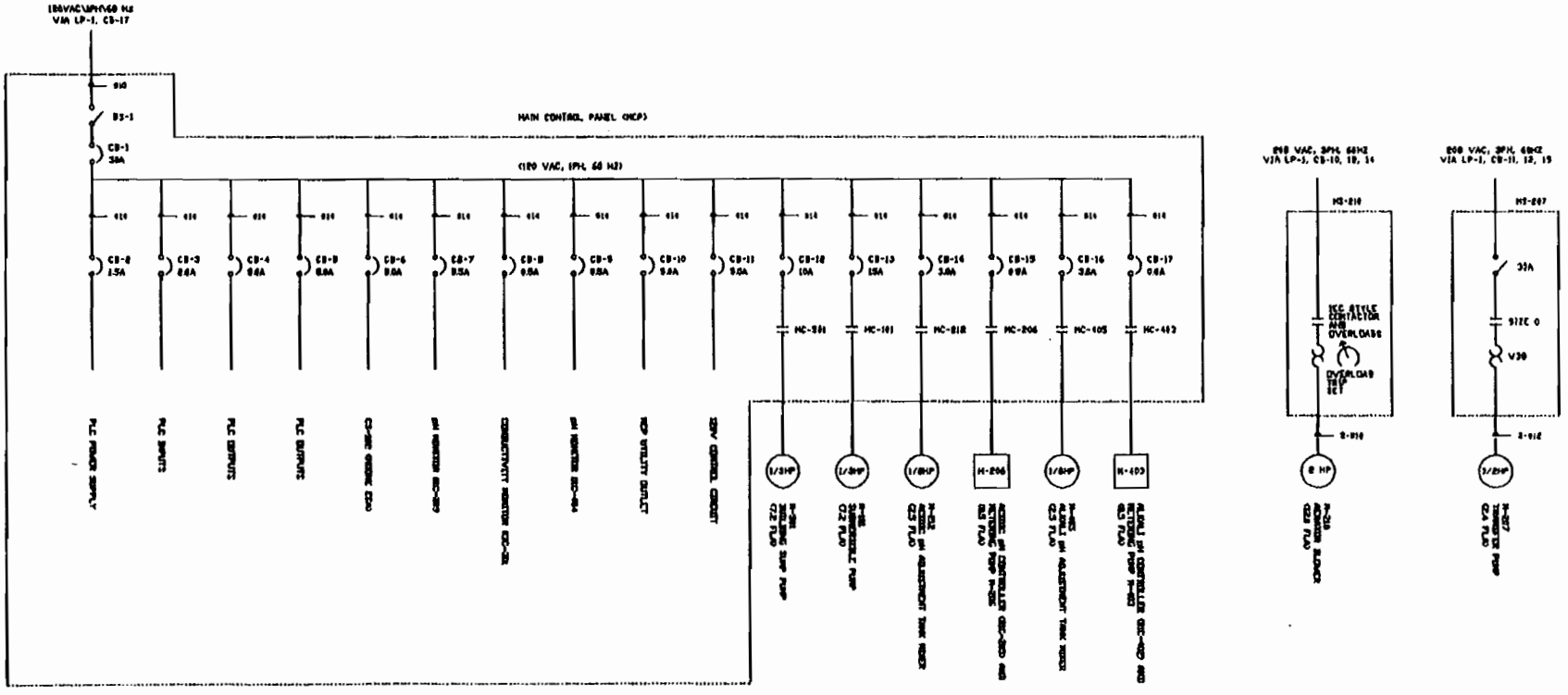
Description	Catalog Number
Pre–wired Interface Cable — Available in 1.0m, 2.5m, and 5.0m lengths.	1492–CABLE[①]H
Replacement Fuses — Five fuses per package. Orders must be for five fuses or multiples of five.	
Replacement fuse for Fixed I/O AC units, MDL 1.25 Ampere	1746–F4
Replacement fuse for Fixed I/O DC units, MDL 1.6 Ampere	1746–F5
Modular Card Slot Fillers — Two fillers per package. Orders must be for two fillers or multiples of two.	1746–N2
Connector — Mating Connector for 32 Point user–made cable	1746–N3
Kit consisting of four replacement terminal covers and labels for 4, 8, 16 I/O modules	1746–R9
Replacement Cover for Specialty I/O Two covers per package. Orders must be for two covers or multiples of two.	1746–R13
Replacement Retainer Clips for Modules Four clips per package. Orders must be for four clips or multiples of four.	1746–R15
Lithium Battery Assembly This is an optional part used for the SLC 500 Fixed and Modular Hardware Style processors and the Hand–Held Terminal. Refer to product documentation for proper storage and handling instructions. For disposal information, consult your nearest Allen–Bradley Sales Office.	1747–BA
Processor to Peripheral Programming/Communication Cable	1747–C10
Processor to Isolated Link Coupler Cable	1747–C11
Specialty Module to Isolated Link Coupler Cable	1747–C13
EEPROM with 1K User Instructions	1747–M1
UVPROM with 1K User Instructions	1747–M3
Adapter Sockets — Orders must be for five sockets or multiples of five.	1747–M5
Replacement Parts Kit for 20 I/O Fixed Hardware Style Processor Two Output Terminal Covers Two Input Terminal Covers Two Prom/Battery Covers One HHT/Comm Connector Cover	1747–R5
Replacement Parts Kit for 30 and 40 I/O Fixed Hardware Style Processors Two Output Terminal Covers Two Input Terminal Covers Two Prom/Battery Covers One HHT/Comm Connector Cover	1747–R7
Replacement Terminal Covers for 4, 8, & 16 I/O Modules This kit contains four blank covers and appropriate labels for replacement of any required I/O module cover.	1747–R9
HHT Keypad Replacement Overlay for English Memory Pak Firmware Releases 1.02, 1.07 and 1.10	1747–R20
HHT Keypad Replacement Overlay for French Memory Pak Firmware Releases 1.10	1747–R20F
HHT Keypad Replacement Overlay for German Memory Pak Firmware Releases 1.10	1747–R20G
HHT Keypad Replacement Overlay for Italian Memory Pak Firmware Releases 1.10	1747–R20I
HHT Keypad Replacement Overlay for English Memory Pak Firmware Releases 2.00 and Later	1747–R21
HHT Keypad Replacement Overlay for French Memory Pak Firmware Releases 2.00 and Later	1747–R21F

① *Insert the cable length code into the catalog number. Cable length codes are as follows: 10=1.0m, 25=2.5m, and 50=5.0m. For example, 1492–CABLE25H is a 2.5m cable.*

Replacement Terminal Blocks

This table provides a list of replacement terminal blocks and their catalog numbers.

Description	Catalog Number
Replacement Terminal Block (Red) — Used with AC I/O modules, Catalog Numbers **1746–IA16, OA16, IM16**	1746–RT25R
Replacement Terminal Block (Blue) — Used with DC I/O modules, Catalog Numbers **1746–IB16, IV16, OB16, OV16, IN16, IG16, OG16**	1746–RT25B
Replacement Terminal Block (Orange) — Used with relay output modules, Catalog Numbers **1746–OW16, OX8**	1746–RT25C
Replacement Terminal Block (Green) — Used with Specialty I/O modules, Catalog Numbers **1746–HSCE, IO12**	1746–RT25G
Replacement Terminal Block — 2 position terminal block used with analog output modules, Catalog Numbers **1746–NO4I, NO4V**	1746–RT26
Replacement Terminal Block — 8 position terminal block used with analog output modules, Catalog Numbers **1746–NO4I, NO4V**	1746–RT27
Replacement Terminal Block — Used with analog input modules, Catalog Numbers **1746–NI4, NIO4I, NIO4V**	1746–RT28
Replacement Terminal Block — Used with RIO Communication Modules, Catalog Numbers **1747–SN, DSN, DCM**	1746–RT29
Replacement Terminal Block — Used with DH–485 Link Coupler, Catalog Number **1747–AIC**	1746–RT30



NOTES:

REF. DWG. No.	REFERENCE DRAWING TITLE

REV	DESCRIPTION	BY	DATE
1	ADDENDA REVISION	MC	7/17/98
2	ADDENDA REVISION	MC	1/11/99
3	AS BUILT	MC	5/17/99

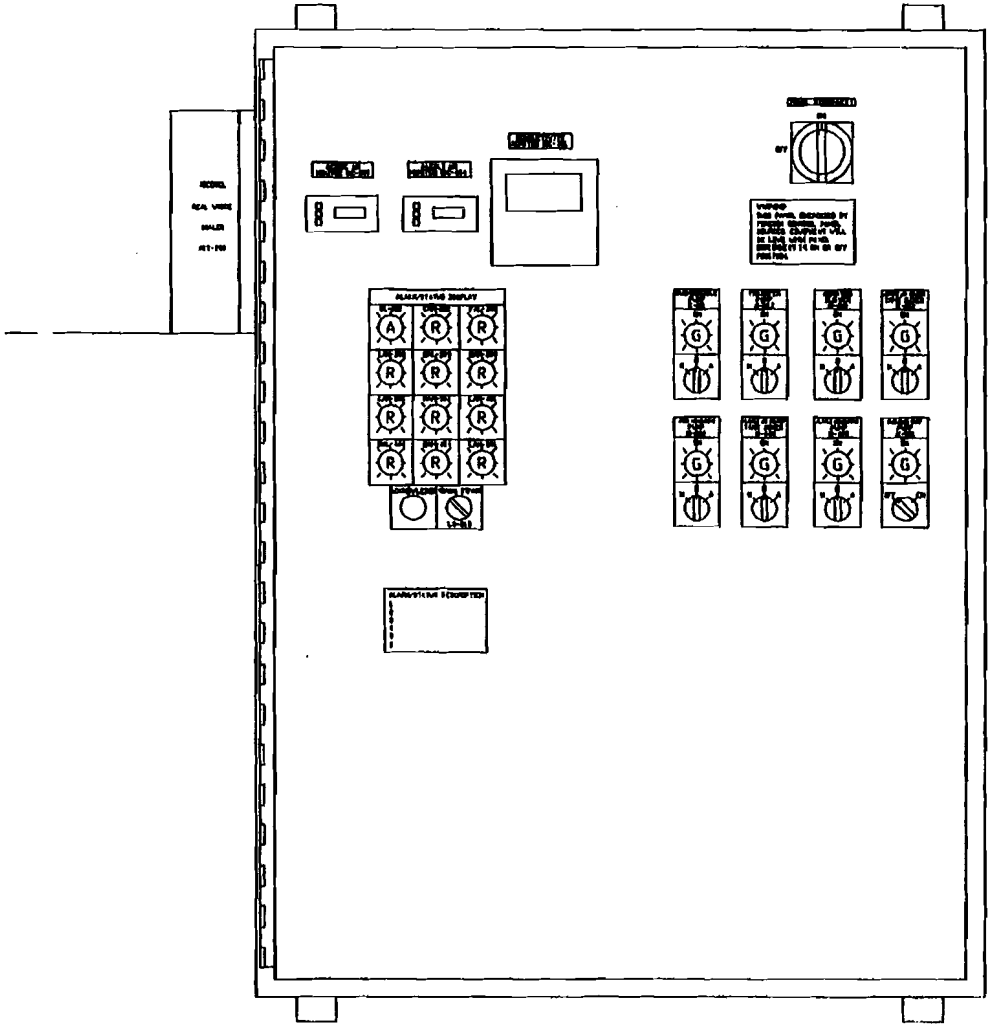
INTEGRA ENGINEERING, Inc.

DRAWN: JAC 2/20/98

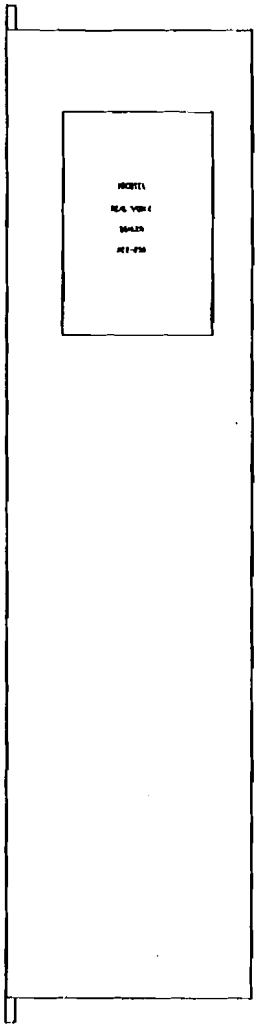
SCALE: NONE

PERFECTION PLATING

SHEET E00



MAIN CONTROL PANEL (MCP)
(DIMENSIONS: 48"H X 36"W X 12"D)
FRONT VIEW



SIDE VIEW

NOTES:

REF. DWG. No.	REFERENCE DRAWING TITLE

REV	DESCRIPTION	BY	DATE
A	GENERAL REVISION	MG	3/17/08
B	GENERAL REVISION	MG	4/17/08
C	AS BUILT	MG	5/13/08

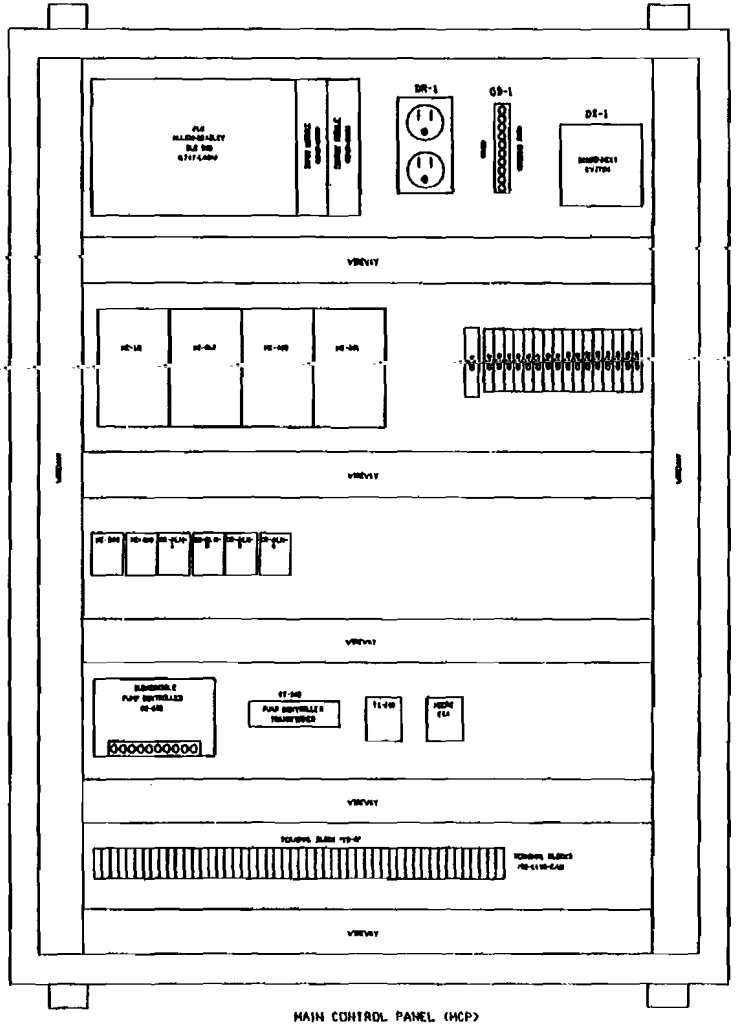
INTEGRA

DRAWN BY: DAG 4/17/08

SCALE: 1/3

PERFECTION PLATING

DWG. NO. E01



MAIN CONTROL PANEL (MCP)
(INTERNAL LAYOUT)

NOTES:

REF. DWG. No.	REFERENCE DRAWING TITLE

REV.	DESCRIPTION	BY	DATE
1		MC	7/17/08

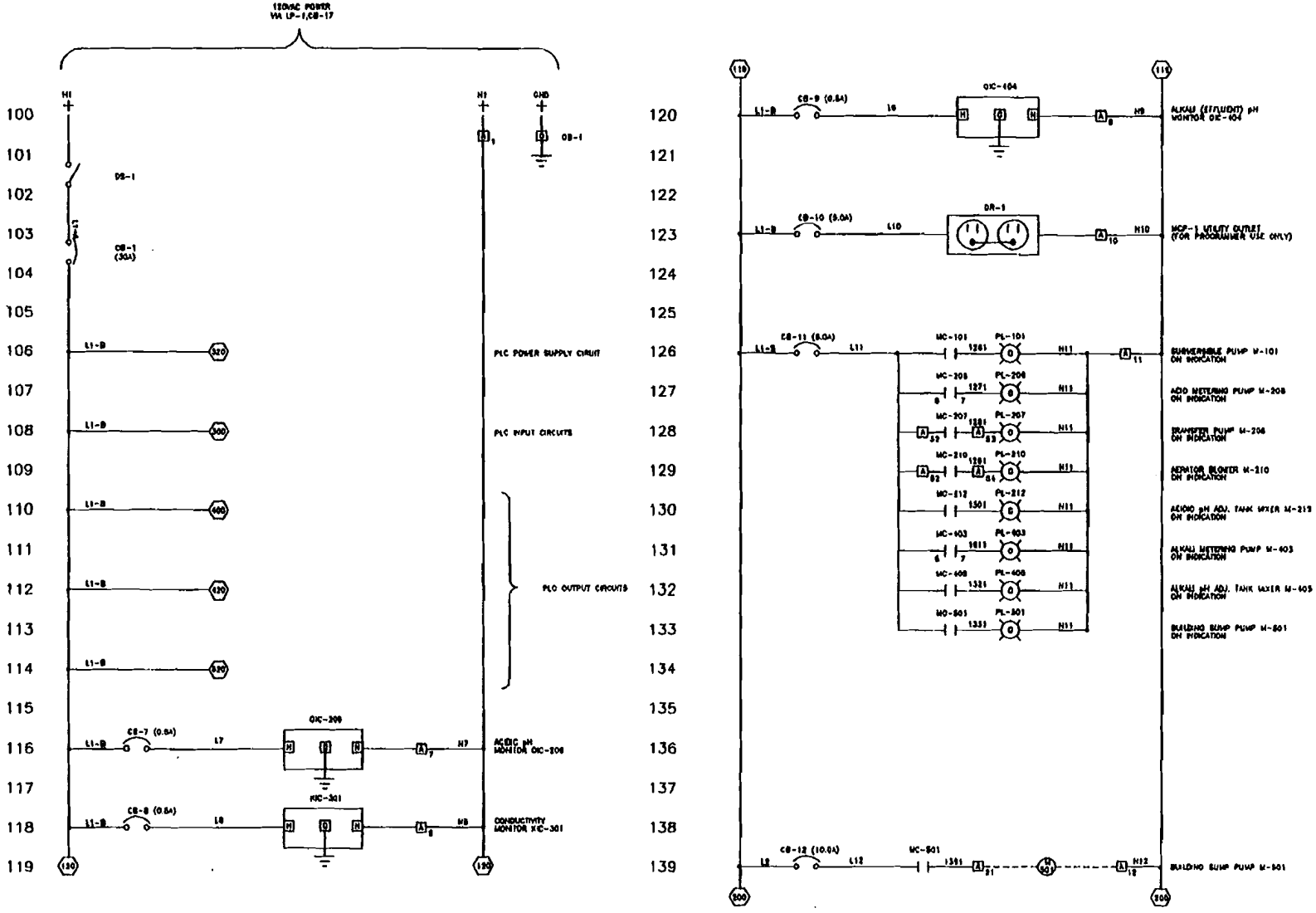
INTEGRA

UAC 2/20/08

1/3

PERFECTINO

E02



NOTES:

REF. DWG. No.	REFERENCE DRAWING TITLE

REV	DESCRIPTION	BY	DATE
1	GENERAL REVISION	MC	1/7/98
2	TERMINAL BLOCK NUMBERS	MC	4/17/98
3	AS BUILT	MC	5/15/98

INTEGRA ENGINEERING, INC.

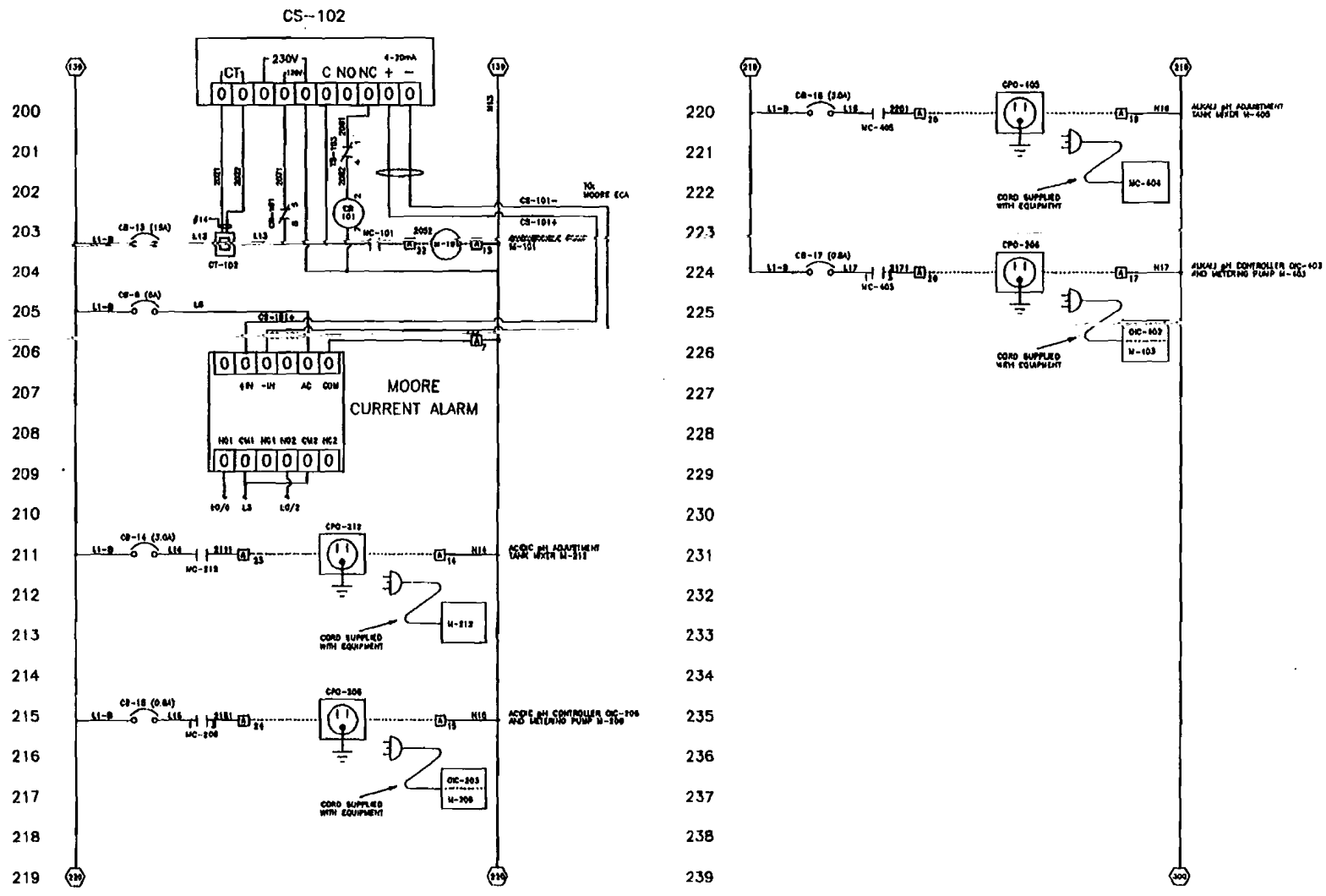
DRAWN: TAC 4/7/97

JOB NO.: HHHH

SCALE: NONE

PERFECTION PLATING

DWG NO.: E03



NOTES:

REF. DWG. No.	REFERENCE DRAWING TITLE

REV	DESCRIPTION	BY	DATE
1	AS BUILT	MC	5/11/98

INTEGRA DIVERSIFIED, INC.

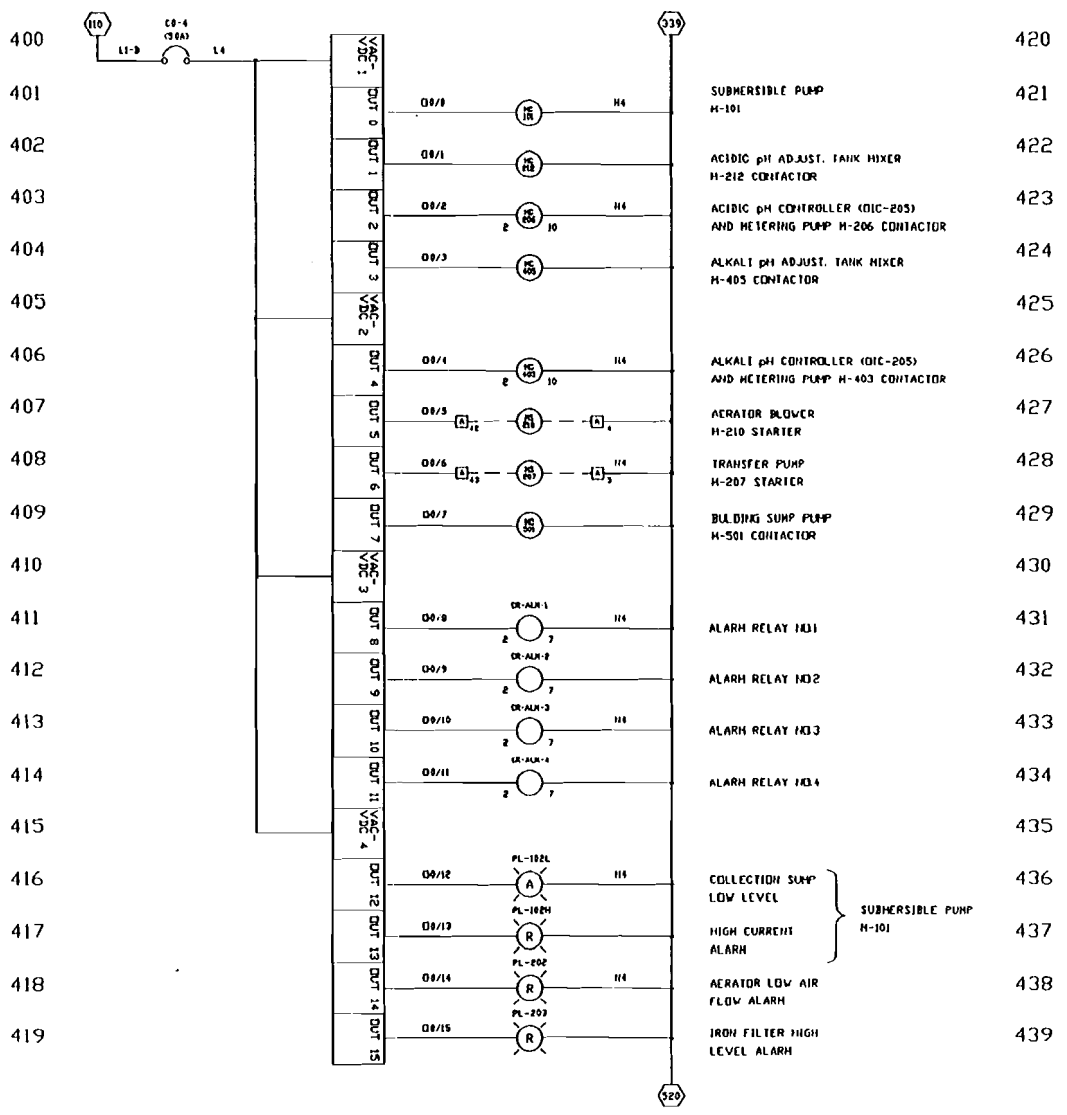
DRAWN TAC 4/17/98

CHECKED NONE

APPROVED PERFECTION

SCALE NONE

DRAWING No. E04



REF. DWG. No.	REFERENCE DRAWING TITLE

REV	DESCRIPTION	BY	DATE
1	GENERAL REVISION	MC	4/7/98
2	GENERAL REVISIONS	MC	4/17/98

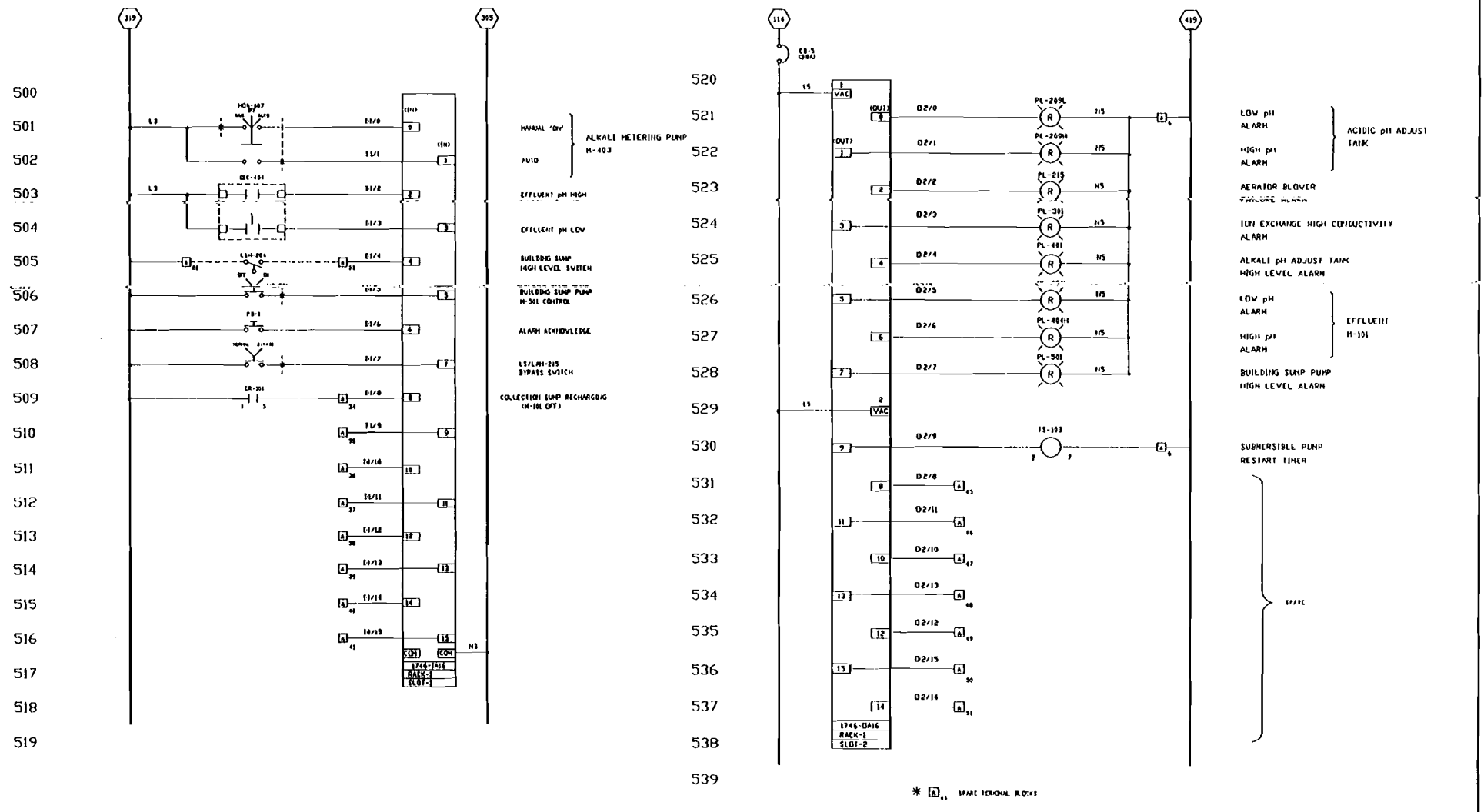
INTEGRA ENVIRONMENTAL INC

DRAWN IAC 4/7/98
CHKD
APPROVED
SCALE NONE
JOB No. #####

GROUND PENETRATION SYSTEM

PERFECTION PLATING

DWG. No. E06
REVISION 2



* [A] SPARE TERMINAL BLOCKS

NOTES:

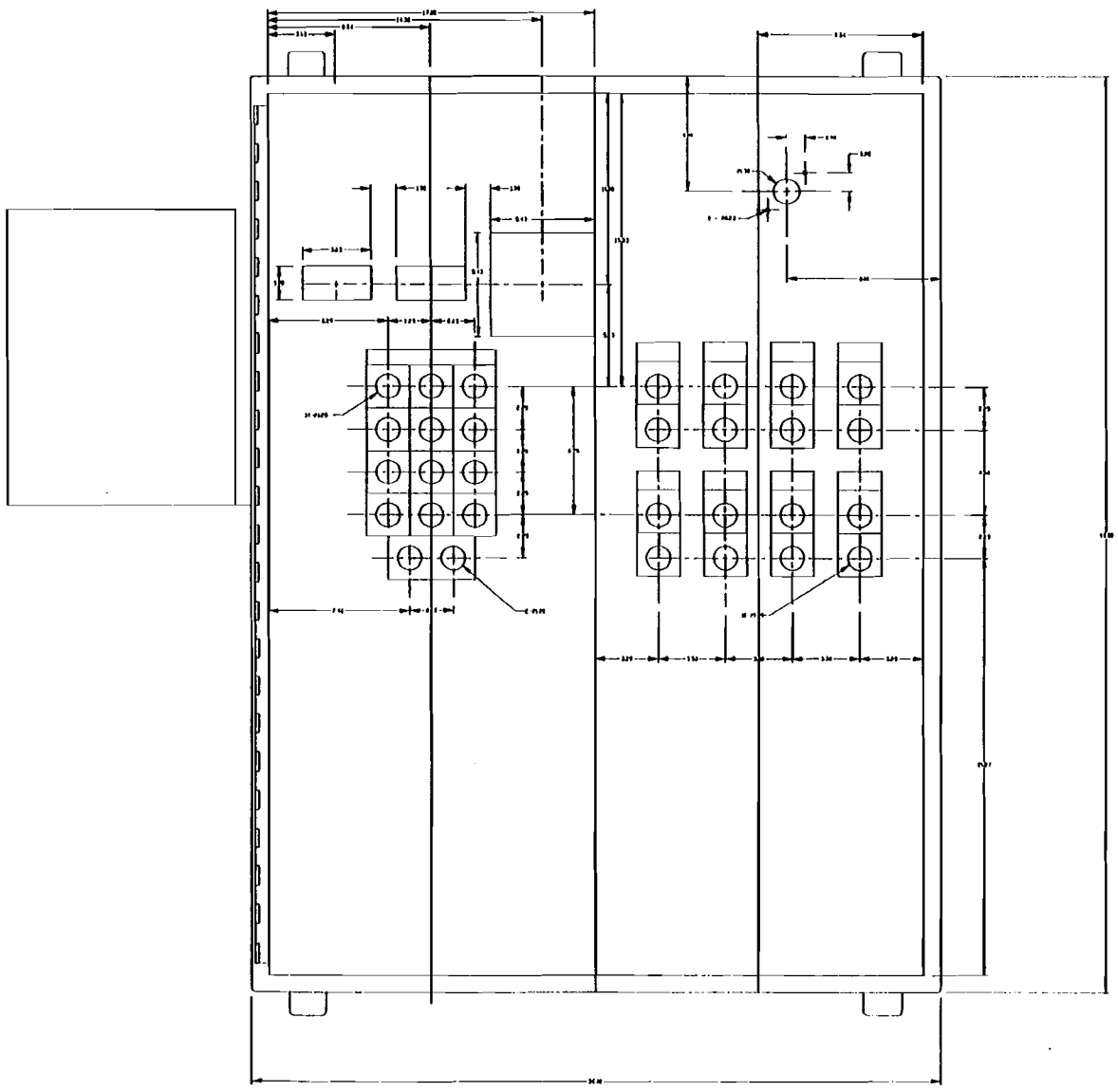
REF. DWG. No.	REFERENCE DRAWING TITLE

REV	DESCRIPTION	BY	DATE
1	GENERAL REVISION	IAC	1/7/98
2	GENERAL REVISION	IAC	4/1/98
3	AS BUILT	IAC	5/11/98

INTEGRA ENVIRONMENTAL INC

GROUND FOUNDATION SYSTEM
MAIN CONTROL PANEL (MCP)
ELECTRICAL SCHEMATIC

DRAWN IAC DATE 4/17/98
SCALE NONE
JOB No. HHHH
SUPERVISOR HHHHHHH
DWG. No. E07
REVISION 3



NOTES:

REF. DWG. No.	REFERENCE DRAWING TITLE

REV	DESCRIPTION	BY	DATE
A	EDITORIAL REVISION	MC	3/17/98

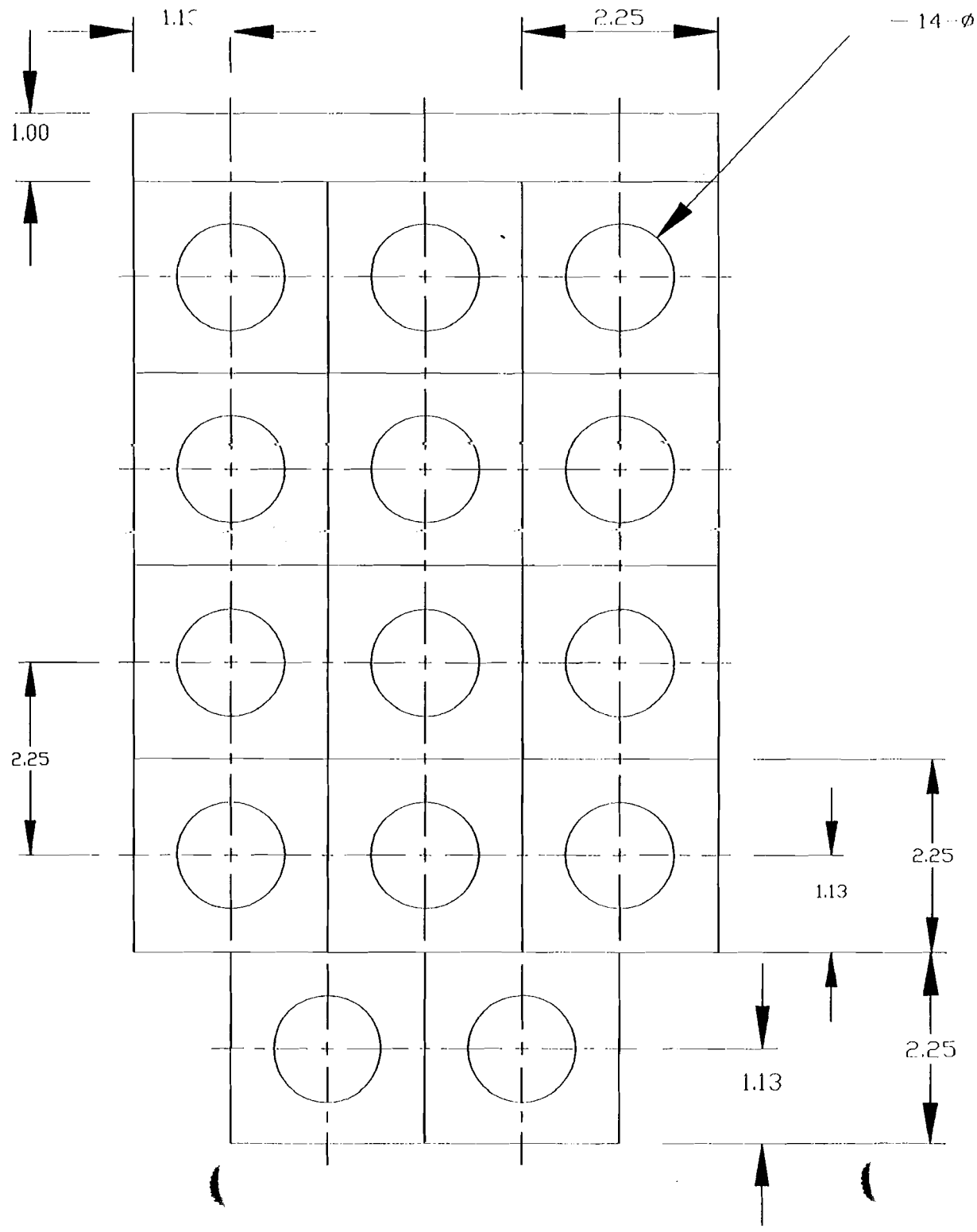
INTEGRA ENVIRONMENTAL INC.

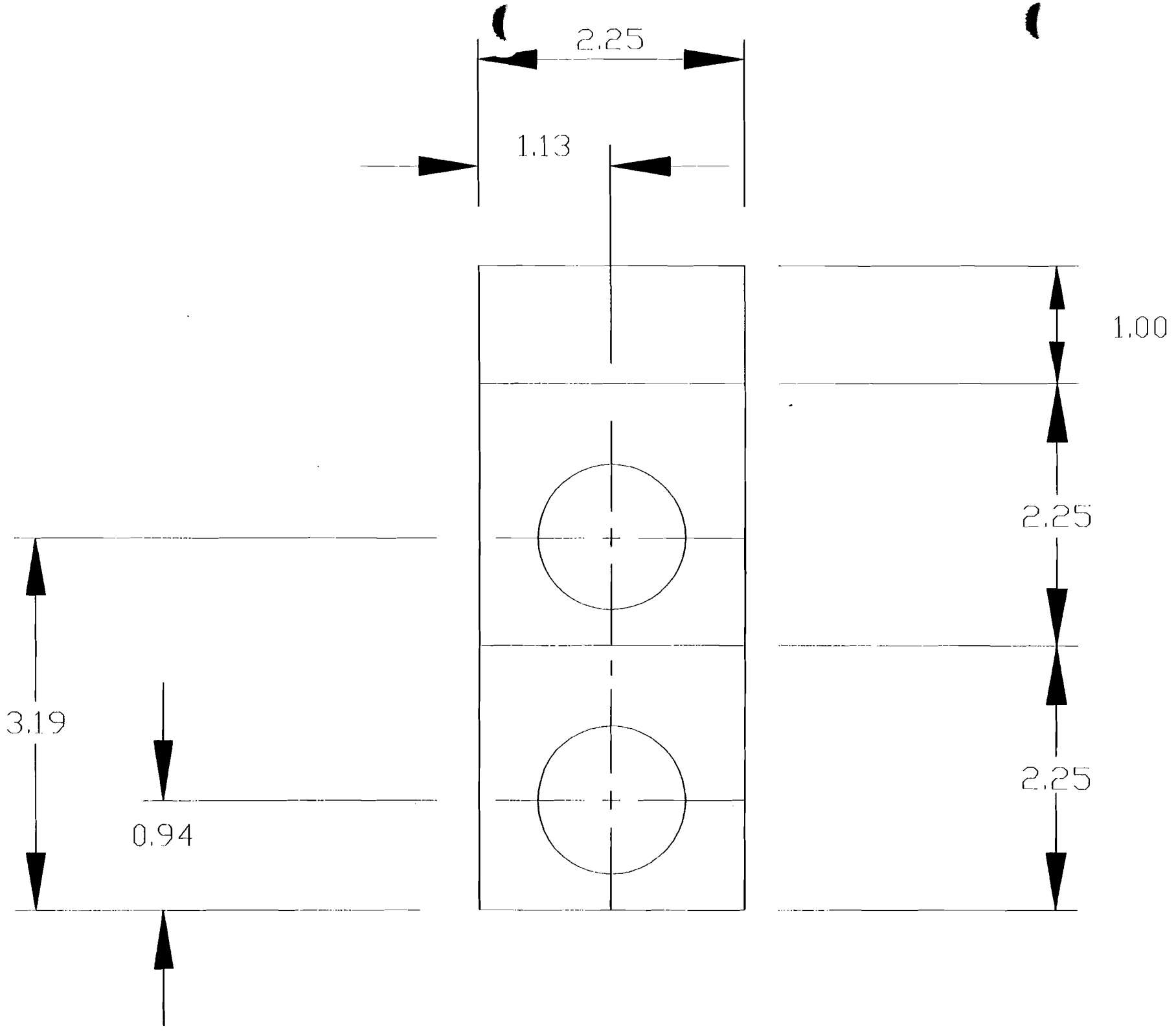
TITLE: GROUND REMEDIATION SYSTEM
SYSTEM ENCLOSURE DIAGRAM

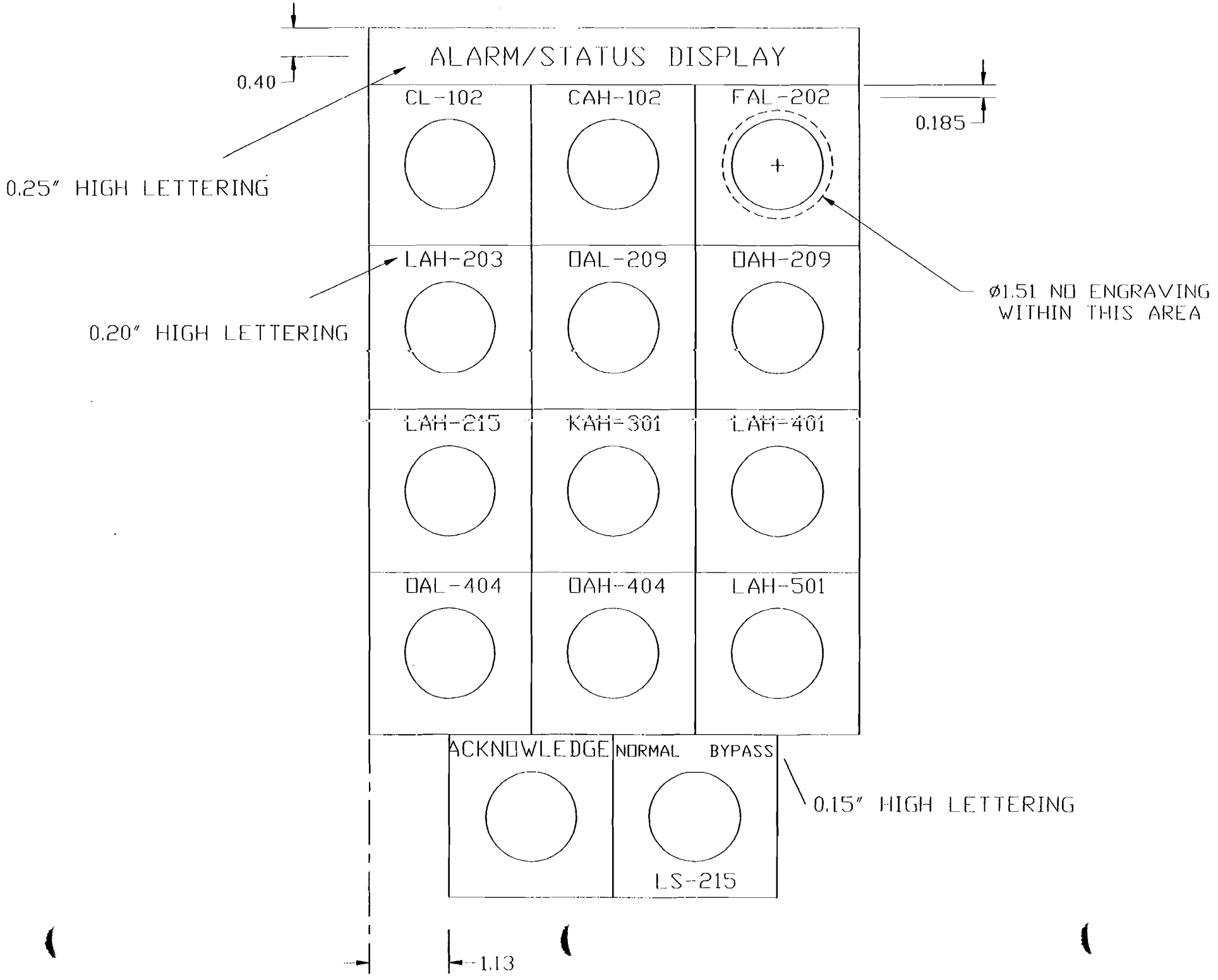
DRAWN: IAC 3/17/98 | CHECKED | APPROVED | DATE

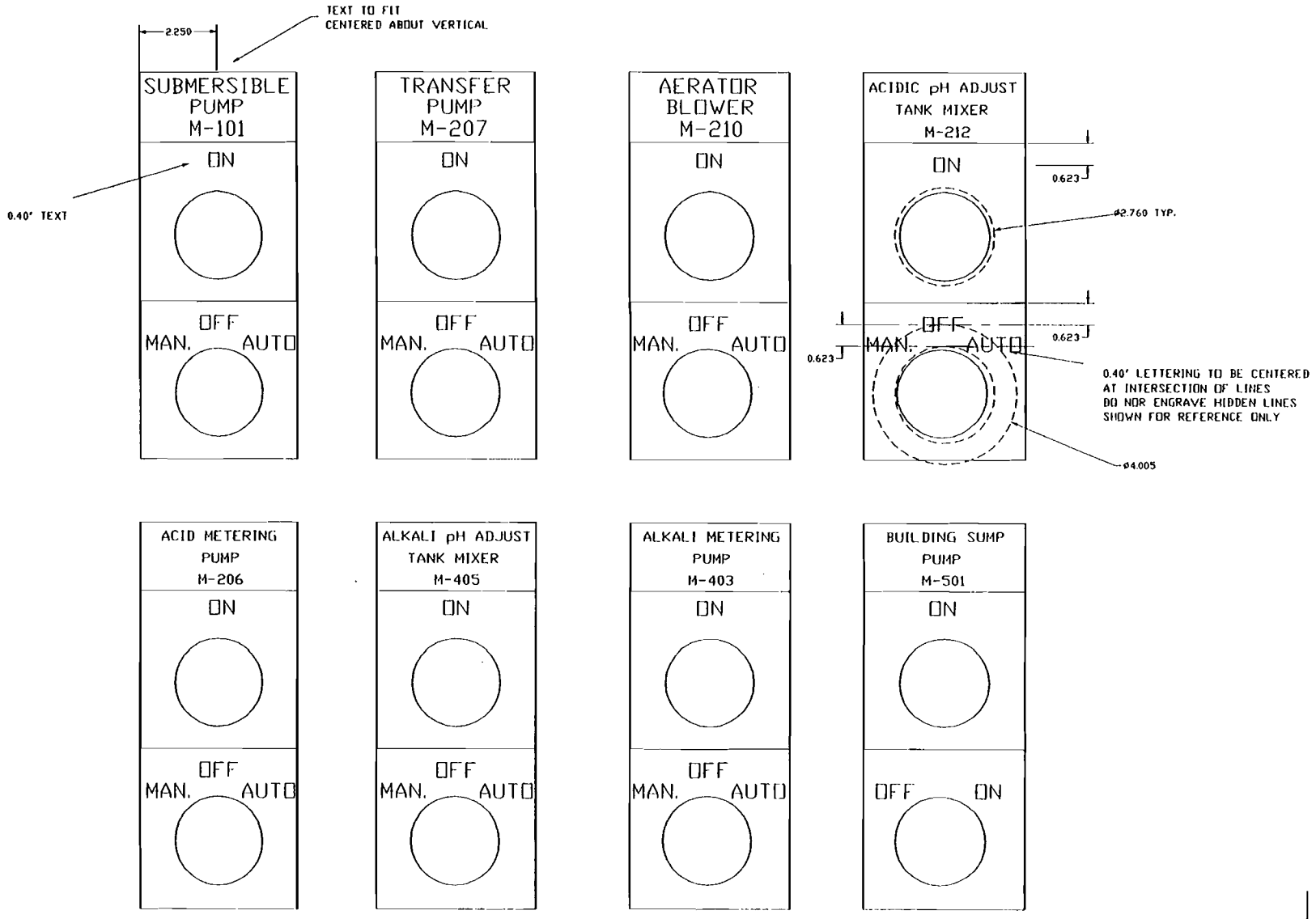
SCALE: 1/3 | REVISED

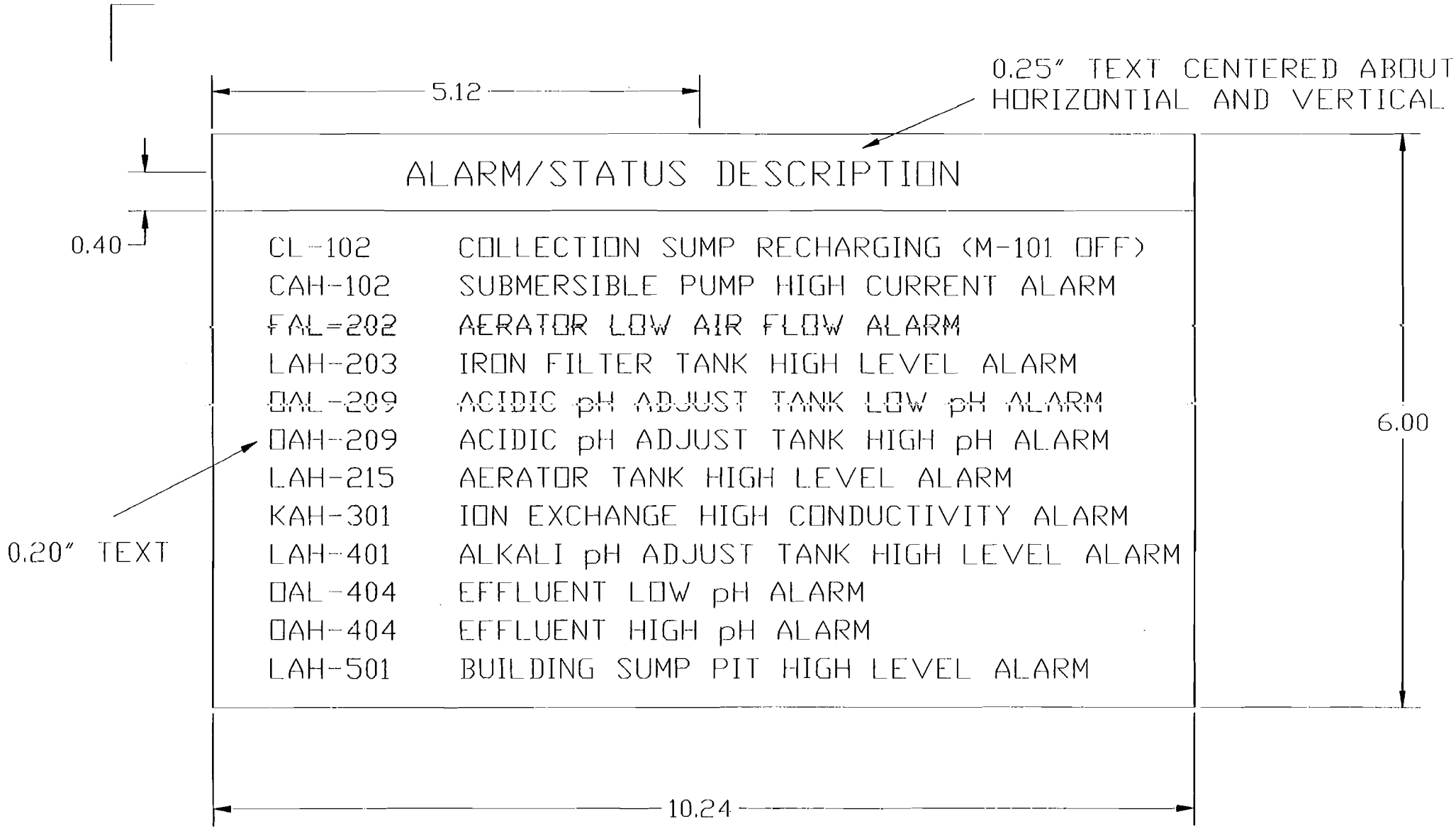
JOB NO: #### | PERFECTION PLATING | DWG NO: E06 | REV: 1

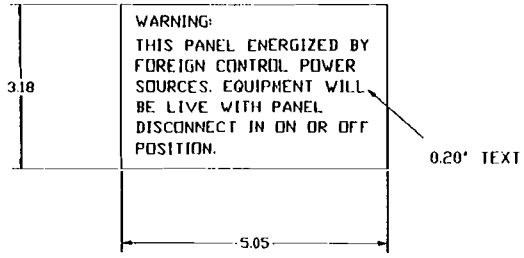

1.13
2.25
14 - ø1.20
1.00
2.25
1.13
2.25
1.13
2.25

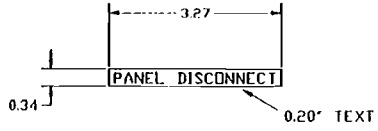

2.25
1.13
1.00
2.25
2.25
3.19
0.94

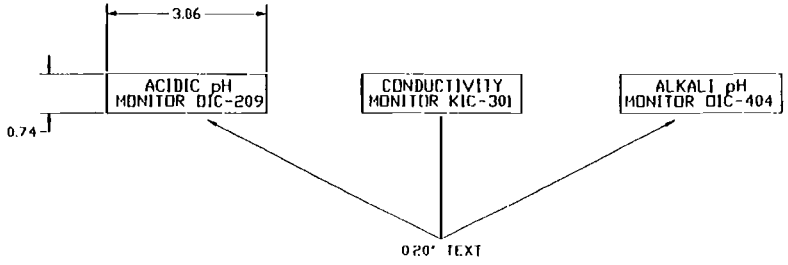

ALARM/STATUS DISPLAY
0.40
0.185
0.25" HIGH LETTERING
0.20" HIGH LETTERING
Ø1.51 NO ENGRAVING WITHIN THIS AREA
CL-102
CAH-102
FAL-202
LAH-203
DAL-209
DAH-209
LAH-215
KAH-301
LAH-401
DAL-404
DAH-404
LAH-501
ACKNOWLEDGE
NORMAL
BYPASS
LS-215
0.15" HIGH LETTERING
1.13

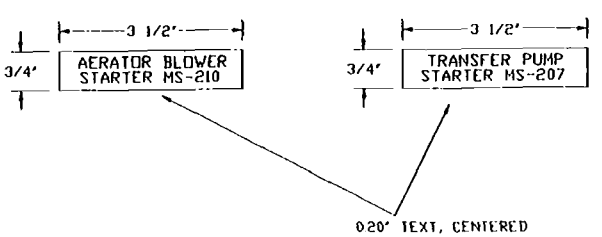

2.250
TEXT TO FIT
CENTERED ABOUT VERTICAL
0.40" TEXT
SUBMERSIBLE PUMP M-101
ON
OFF
MAN.
AUTO
TRANSFER PUMP M-207
ON
OFF
MAN.
AUTO
AERATOR BLOWER M-210
ON
OFF
MAN.
AUTO
ACIDIC pH ADJUST TANK MIXER M-212
ON
0.623
ø2.760 TYP.
OFF
MAN.
AUTO
0.623
0.623
0.40" LETTERING TO BE CENTERED
AT INTERSECTION OF LINES
DO NOR ENGRAVE HIDDEN LINES
SHOWN FOR REFERENCE ONLY
ø4.005
ACID METERING PUMP M-206
ON
OFF
MAN.
AUTO
ALKALI pH ADJUST TANK MIXER M-405
ON
OFF
MAN.
AUTO
ALKALI METERING PUMP M-403
ON
OFF
MAN.
AUTO
BUILDING SUMP PUMP M-501
ON
OFF
ON


5.12
0.25" TEXT CENTERED ABOUT HORIZONTIAL AND VERTICAL
ALARM/STATUS DESCRIPTION
0.40
CL-102 COLLECTION SUMP RECHARGING (M-101 OFF)
CAH-102 SUBMERSIBLE PUMP HIGH CURRENT ALARM
FAL=202 AERATOR LOW AIR FLOW ALARM
LAH-203 IRON FILTER TANK HIGH LEVEL ALARM
OAL-209 ACIDIC pH ADJUST TANK LOW pH ALARM
OAH-209 ACIDIC pH ADJUST TANK HIGH pH ALARM
LAH-215 AERATOR TANK HIGH LEVEL ALARM
KAH-301 ION EXCHANGE HIGH CONDUCTIVITY ALARM
LAH-401 ALKALI pH ADJUST TANK HIGH LEVEL ALARM
OAL-404 EFFLUENT LOW pH ALARM
OAH-404 EFFLUENT HIGH pH ALARM
LAH-501 BUILDING SUMP PIT HIGH LEVEL ALARM
6.00
0.20" TEXT
10.24


WARNING:
THIS PANEL ENERGIZED BY FOREIGN CONTROL POWER SOURCES. EQUIPMENT WILL BE LIVE WITH PANEL DISCONNECT IN ON OR OFF POSITION.
3.18
0.20" TEXT
5.05


3.27
PANEL DISCONNECT
0.34
0.20" TEXT


3.06
ACIDIC pH MONITOR DIC-209
CONDUCTIVITY MONITOR KIC-301
ALKALI pH MONITOR DIC-404
0.74
0.20" TEXT


3 1/2"
3/4"
AERATOR BLOWER
STARTER MS-210
3 1/2"
3/4"
TRANSFER PUMP
STARTER MS-207
.020" TEXT, CENTERED

RSLogix500 Project Report



Processor Information

Processor Type: 1747-L40A 24-115 VAC In, 16-RLY Out

Processor Name: PERFECTP

Total Memory Used: 259 Instruction Words Used - 32 Data Table Words Used

Total Memory Left: 764 Instruction Words Left

Program Files: 10

Data Files: 9

Program ID: 847e

I/O Configuration

0	1747-L40A	24-115 VAC In, 16-RLY Out
1	1746-IA16	16-Input 100/120 VAC
2	1746-OA16	16-Output (TRIAC) 100/240 VAC

Node : 1 (decimal)
Baud: 19200

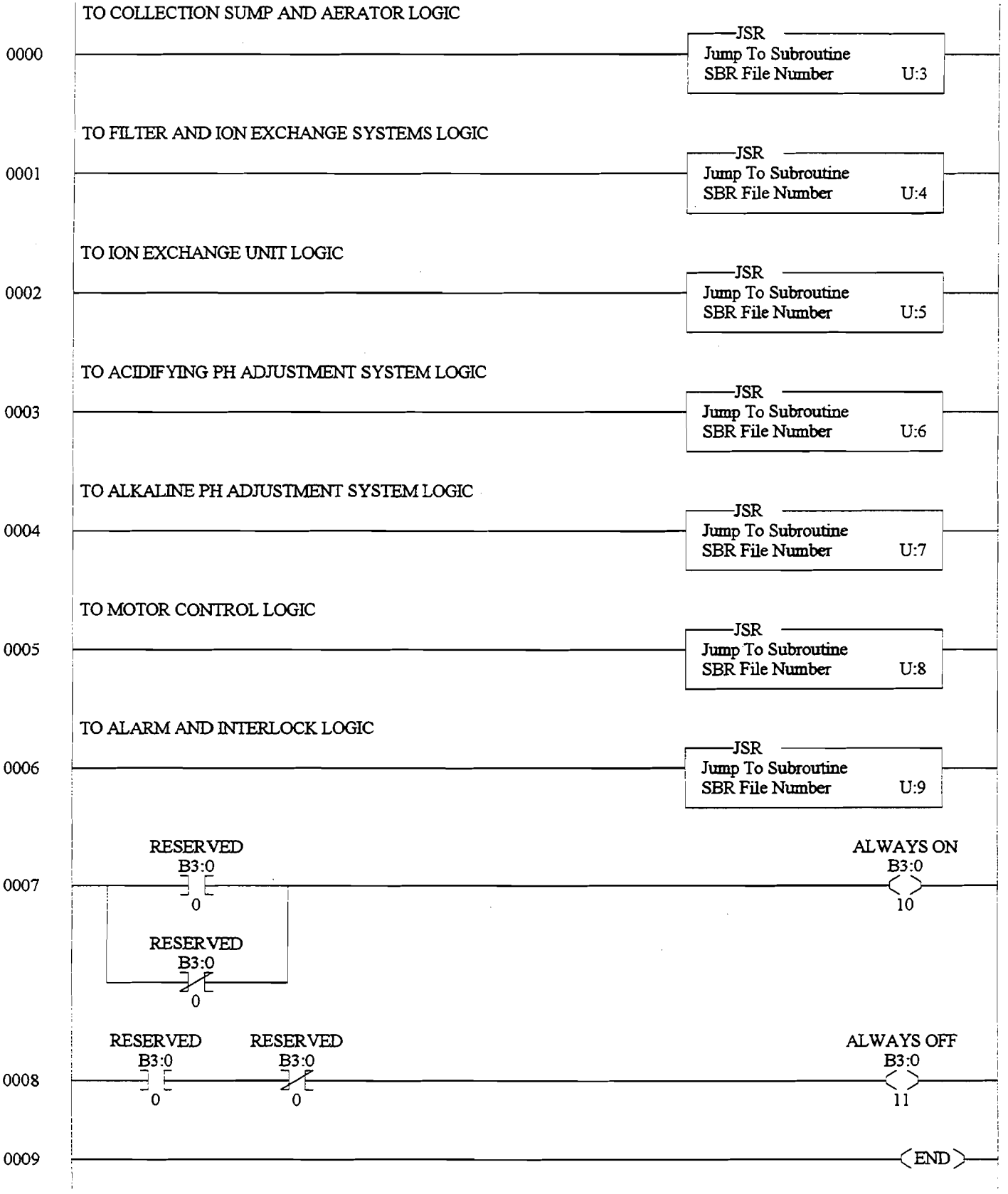
Program File List

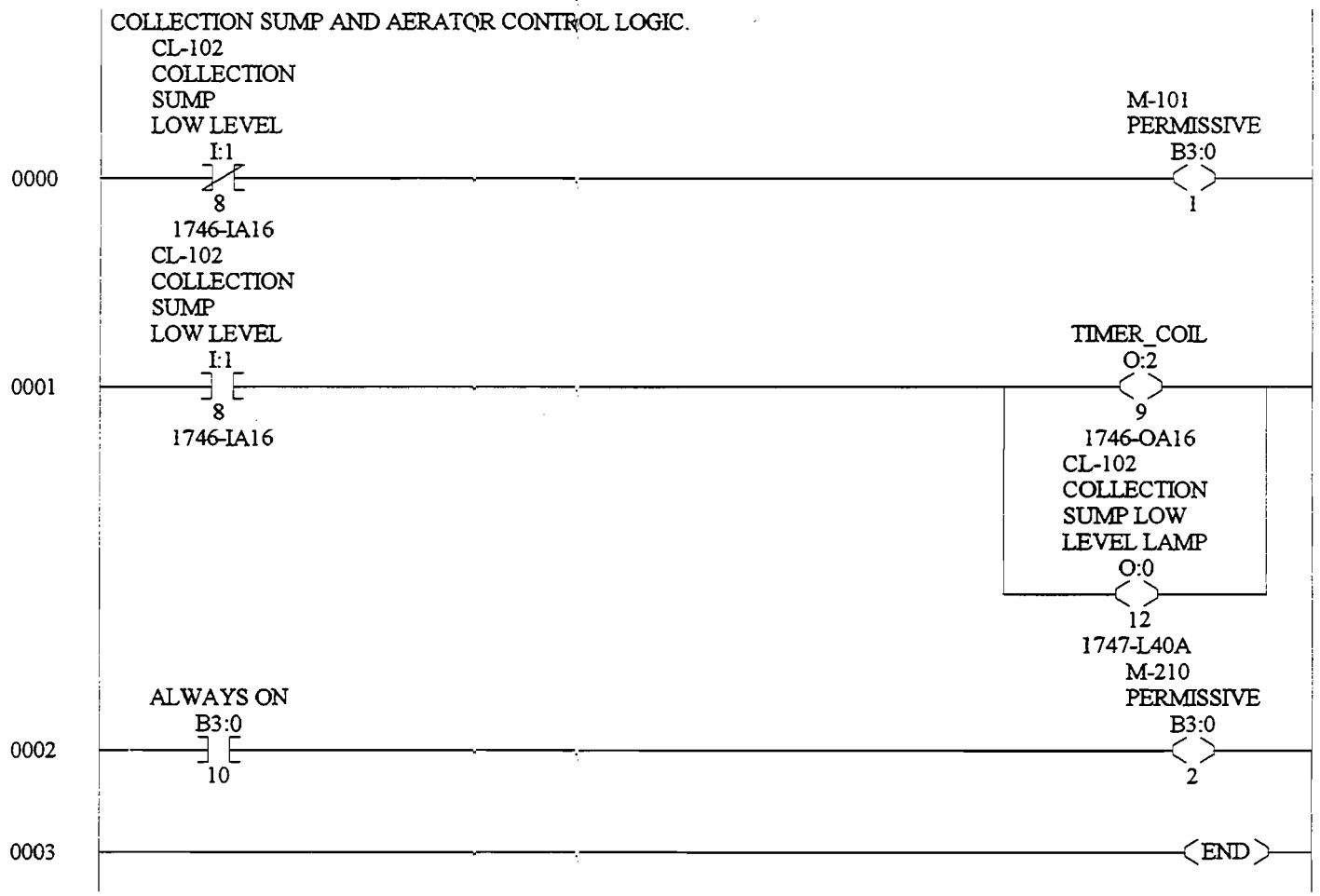
Name	Number	Type	Rungs	Debug	Bytes
[SYSTEM]	0	SYS	0	No	0
	1	SYS	0	No	0
MAIN	2	LADDER	10	No	118
COLLECTION	3	LADDER	4	No	64
FILTER_ION	4	LADDER	2	No	39
ION_EXCHNG	5	LADDER	2	No	19
ACID_PH	6	LADDER	3	No	35
ALKALIN_PH	7	LADDER	3	No	35
MOTOR_CTRL	8	LADDER	9	No	320
ALARMS_IL	9	LADDER	17	No	990

Data File List

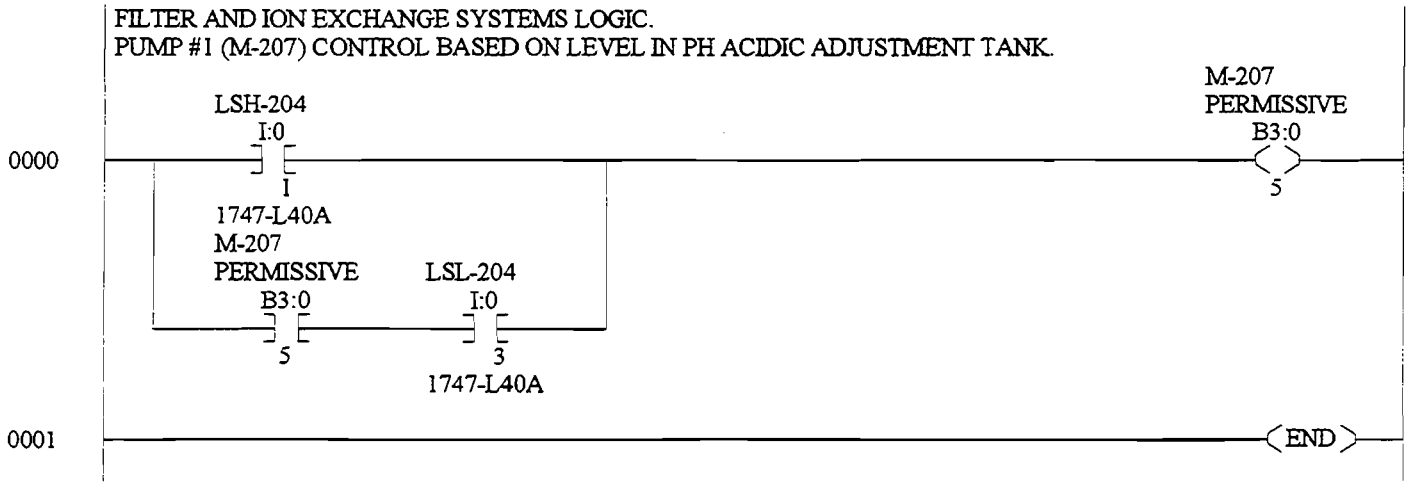
Name	Number	Type	Scope	Debug	Words	Elements	Last
[SYSTEM]	0	O	Global	No	2	2	O:1
	1	I	Global	No	3	3	I:2
	2	S	Global	No	16	16	S2:15
	3	B	Global	No	5	5	B3:4
	4	T	Global	No	6	2	T4:1
	5	C	Global	No	0	0	
	6	R	Global	No	0	0	
	7	N	Global	No	0	0	
	8	r	Global	No	0	0	

LAD 2 - MAIN — Total Rungs in File = 10

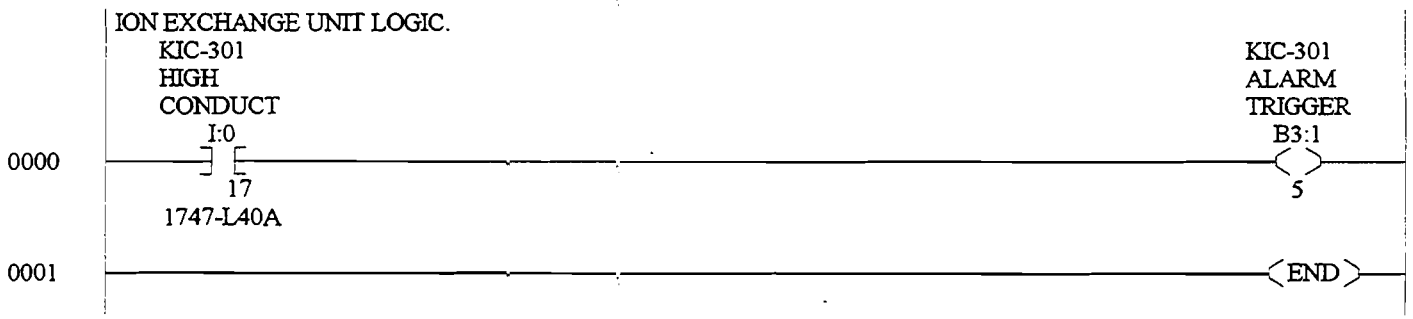



COLLECTION SUMP AND AERATOR CONTROL LOGIC.
CL-102
COLLECTION
SUMP
LOW LEVEL
I:1
8
1746-IA16
M-101
PERMISSIVE
B3:0
1
0000
CL-102
COLLECTION
SUMP
LOW LEVEL
I:1
8
1746-IA16
TIMER_COIL
O:2
9
1746-OA16
CL-102
COLLECTION
SUMP LOW
LEVEL LAMP
O:0
12
1747-L40A
0001
ALWAYS ON
B3:0
10
M-210
PERMISSIVE
B3:0
2
0002
END
0003

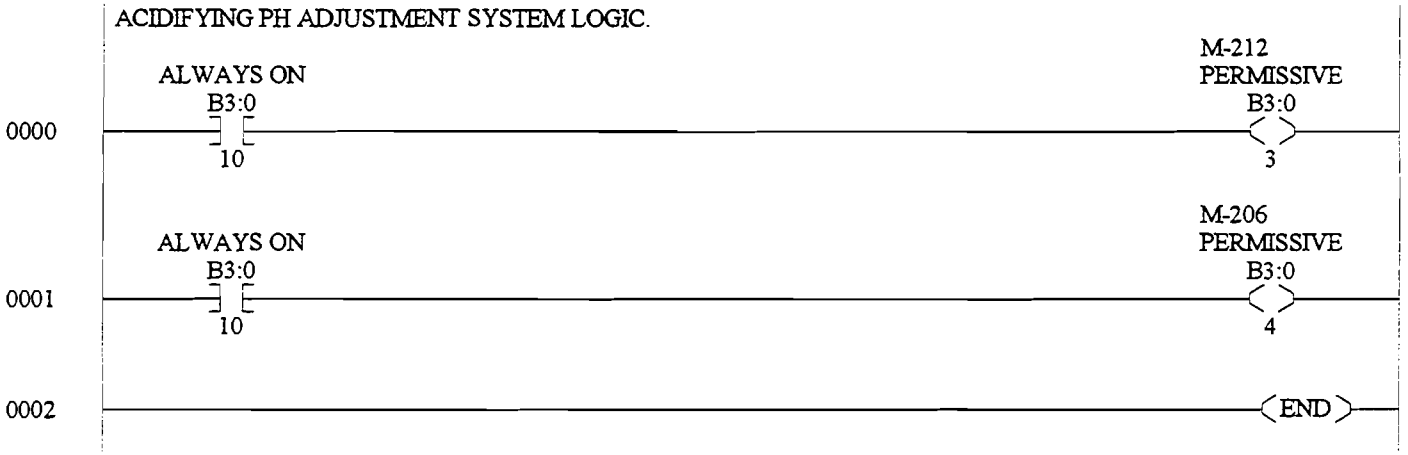
LAD 4 - FILTER_ION — Total Rungs in File = 2



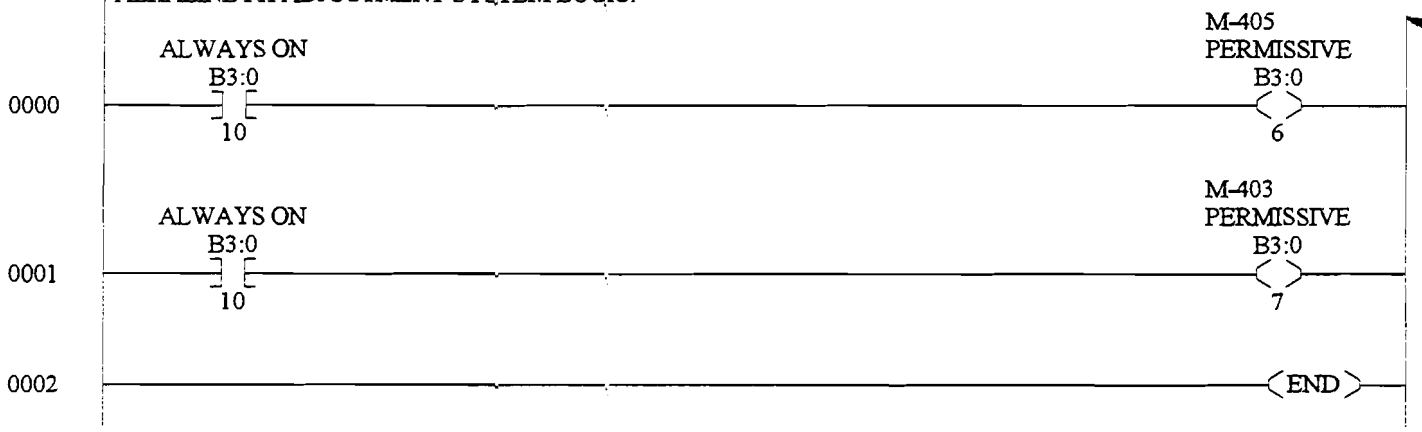
LAD 5 - ION_EXCHNG — Total Rungs in File = 2

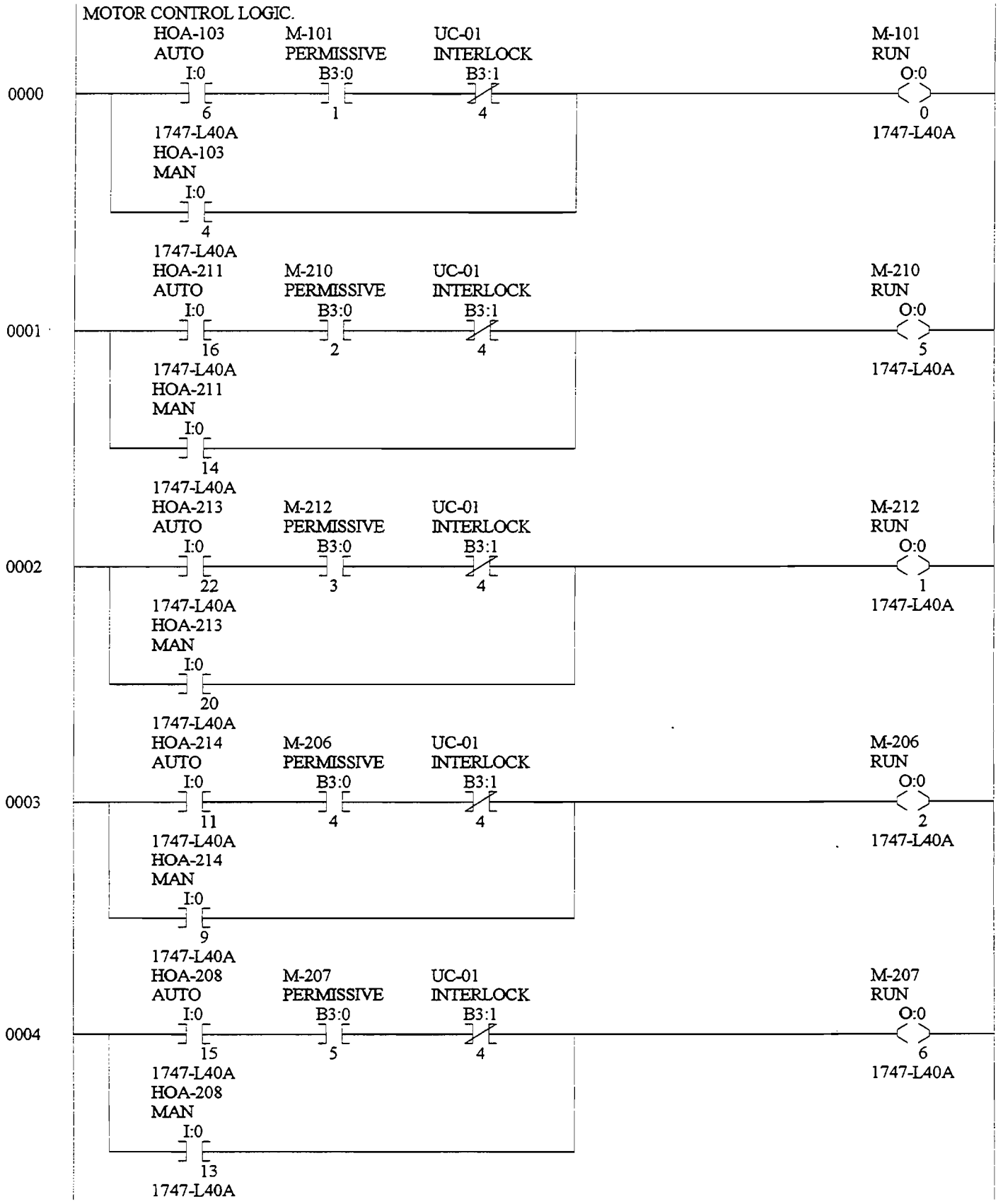


LAD 6 - ACID_PH — Total Rungs in File = 3

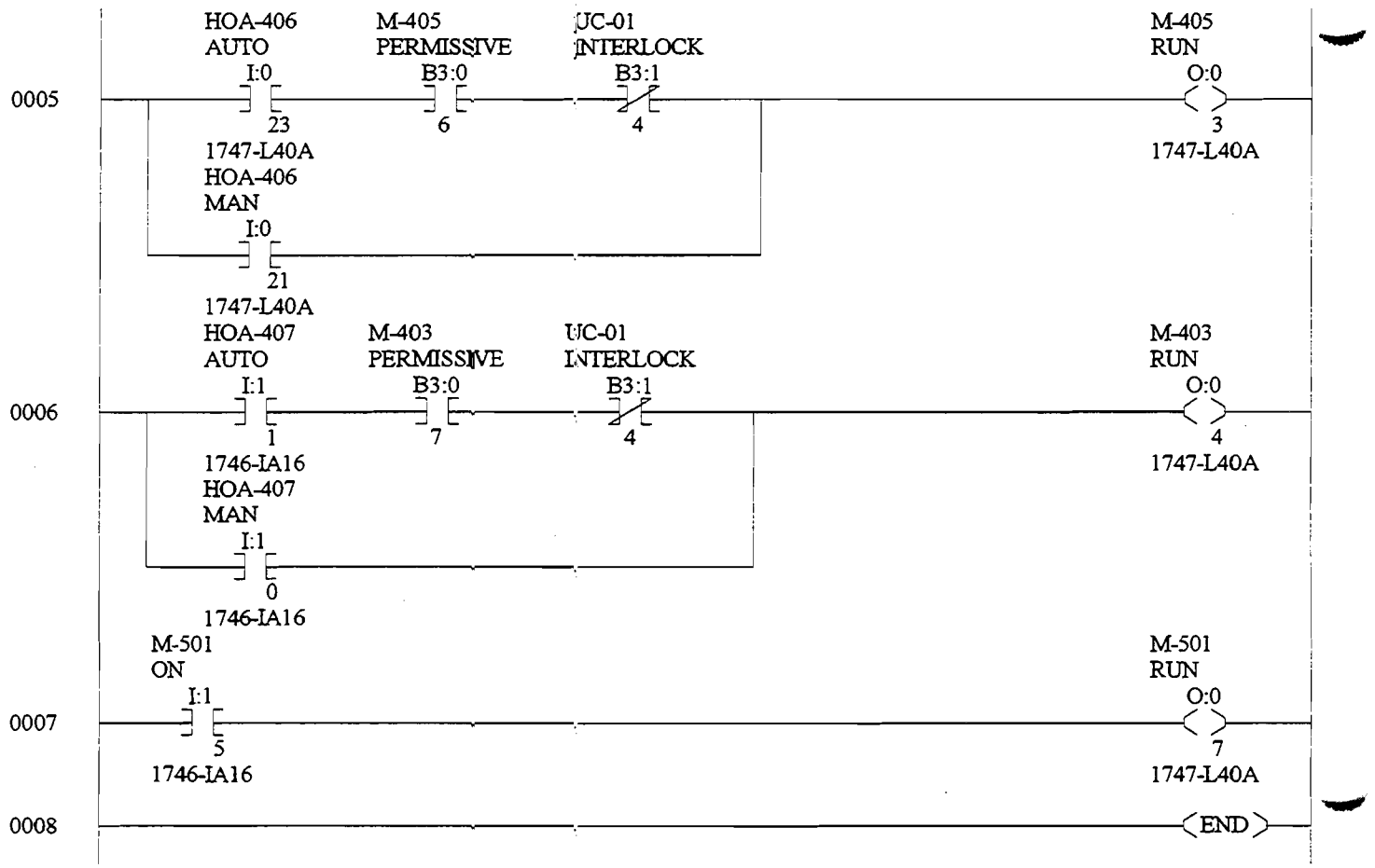


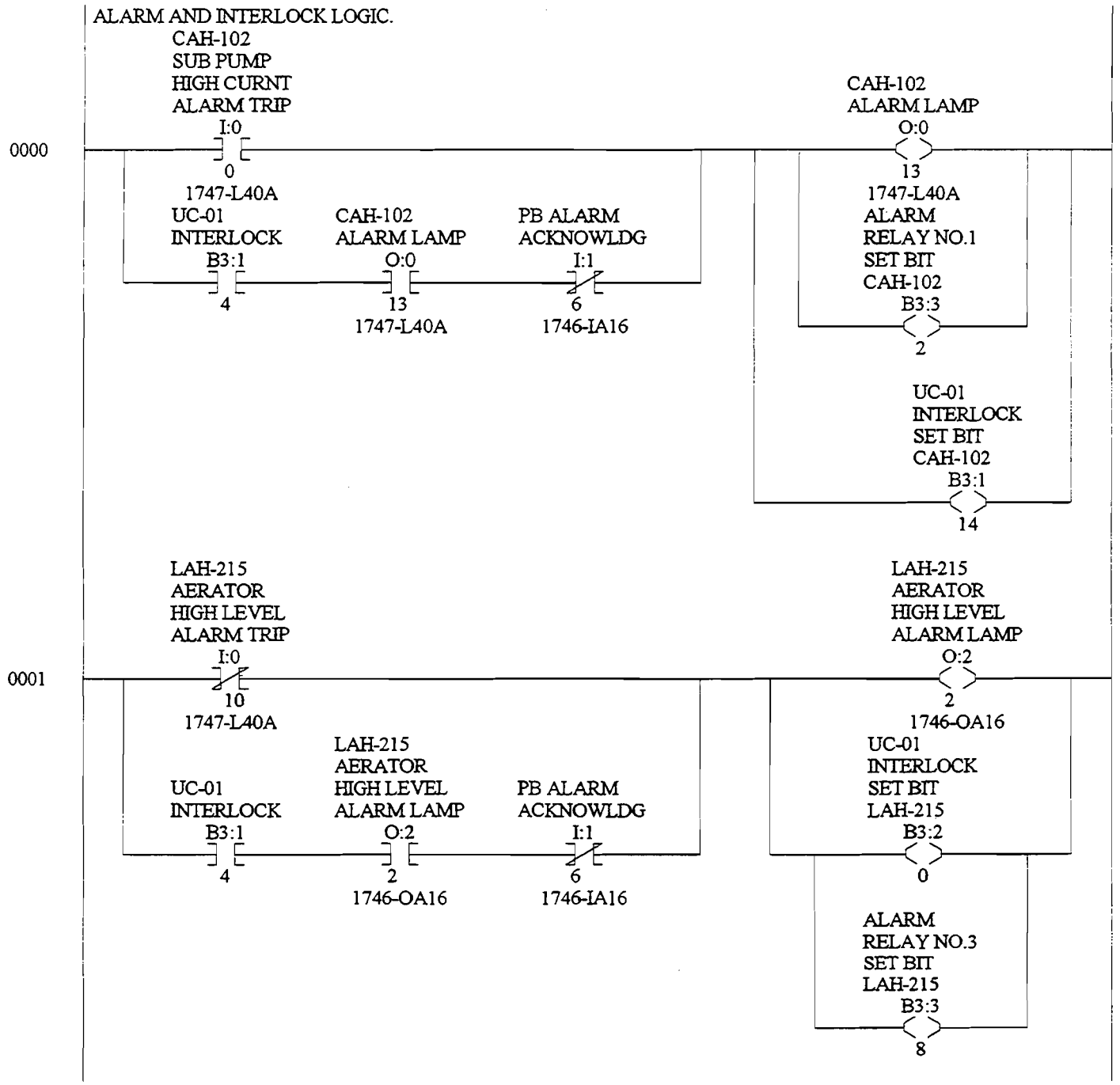
ALKALINE PH ADJUSTMENT SYSTEM LOGIC.

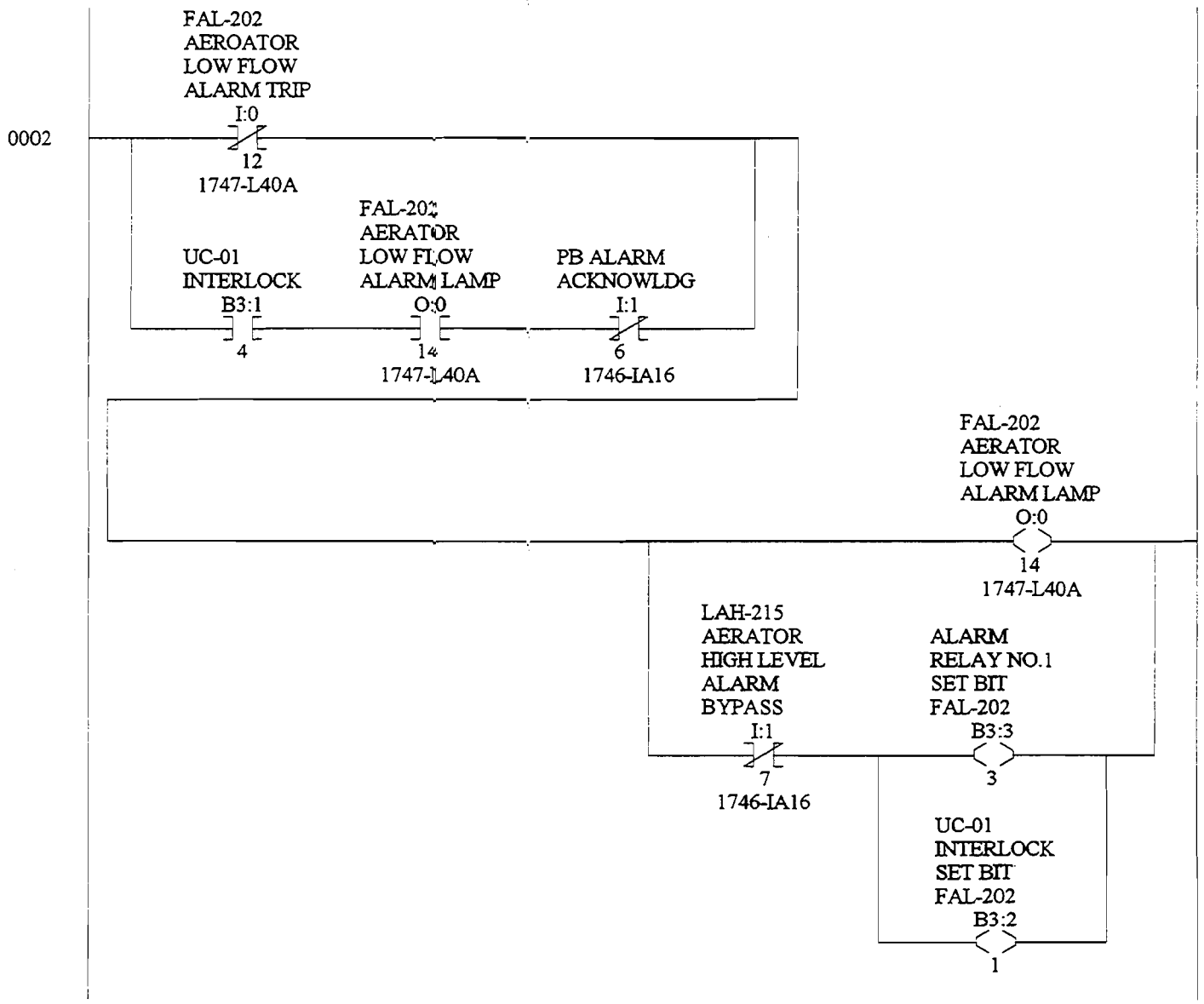


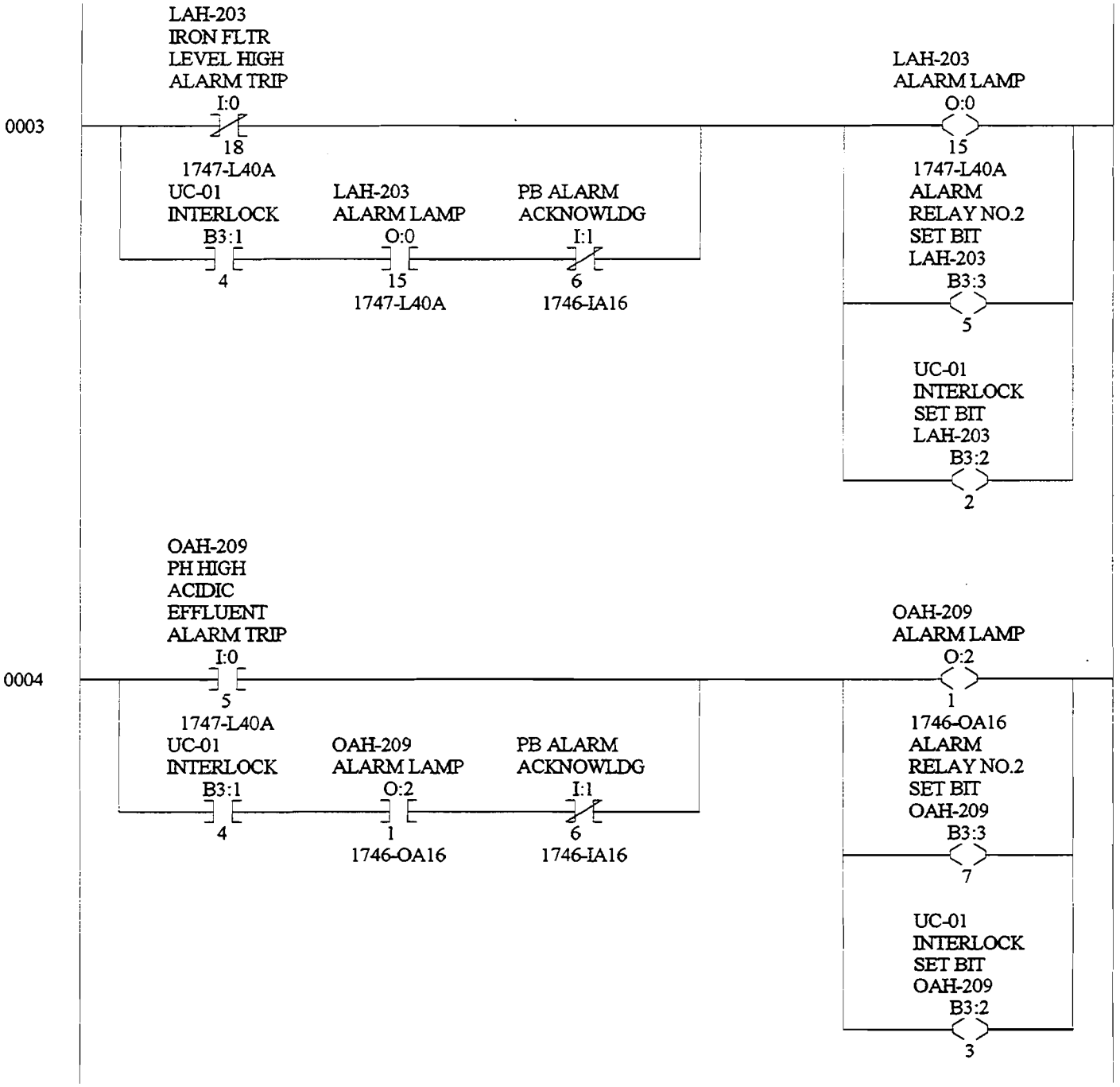

MOTOR CONTROL LOGIC.
0000
HOA-103 AUTO I:0 6
M-101 PERMISSIVE B3:0 1
UC-01 INTERLOCK B3:1 4
M-101 RUN O:0 0
1747-L40A
HOA-103 MAN I:0 4
1747-L40A
0001
HOA-211 AUTO I:0 16
M-210 PERMISSIVE B3:0 2
UC-01 INTERLOCK B3:1 4
M-210 RUN O:0 5
1747-L40A
HOA-211 MAN I:0 14
1747-L40A
0002
HOA-213 AUTO I:0 22
M-212 PERMISSIVE B3:0 3
UC-01 INTERLOCK B3:1 4
M-212 RUN O:0 1
1747-L40A
HOA-213 MAN I:0 20
1747-L40A
0003
HOA-214 AUTO I:0 11
M-206 PERMISSIVE B3:0 4
UC-01 INTERLOCK B3:1 4
M-206 RUN O:0 2
1747-L40A
HOA-214 MAN I:0 9
1747-L40A
0004
HOA-208 AUTO I:0 15
M-207 PERMISSIVE B3:0 5
UC-01 INTERLOCK B3:1 4
M-207 RUN O:0 6
1747-L40A
HOA-208 MAN I:0 13
1747-L40A

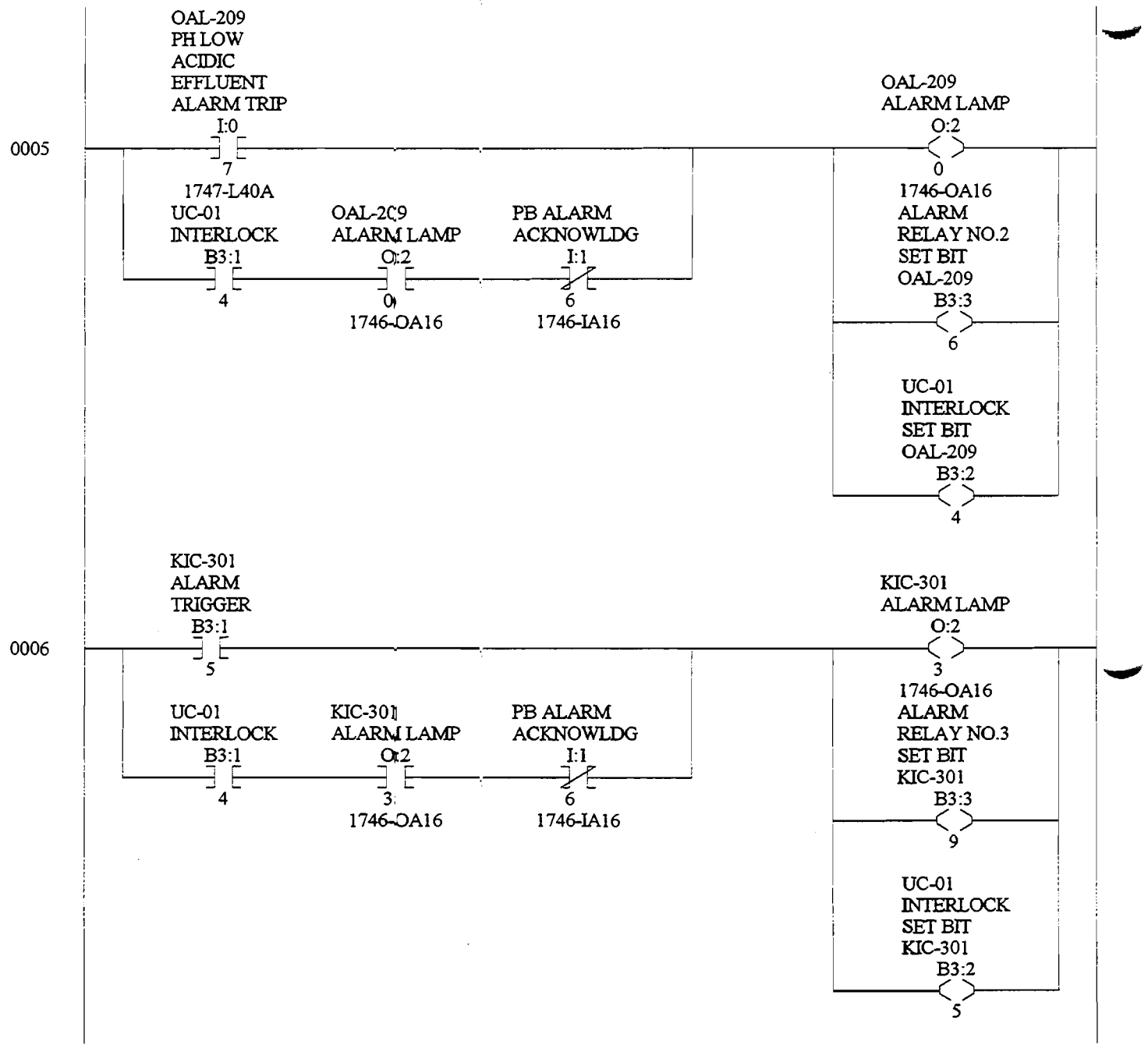
LAD 8 - MOTOR_CTRL — Total Rungs in File = 9

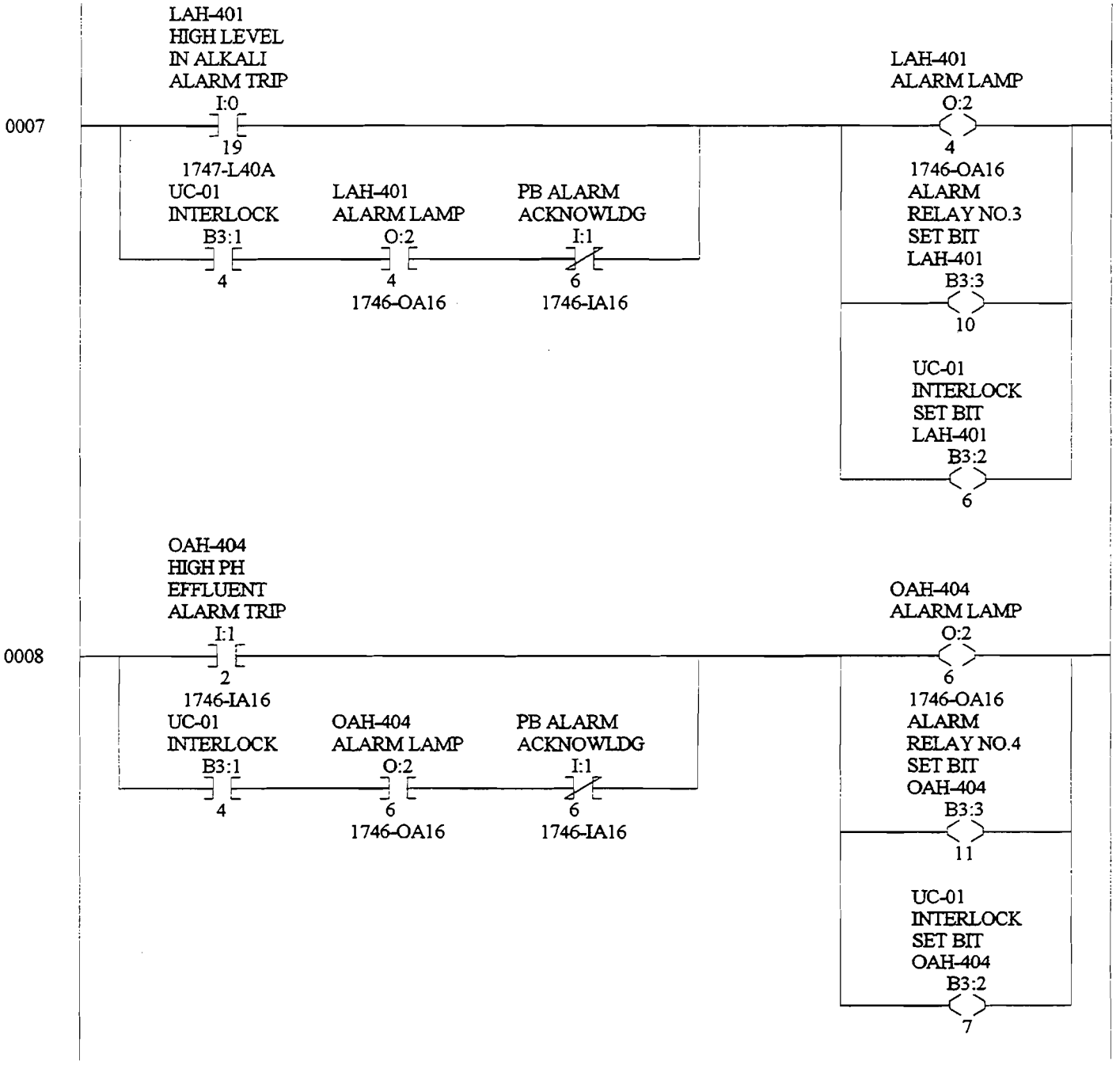


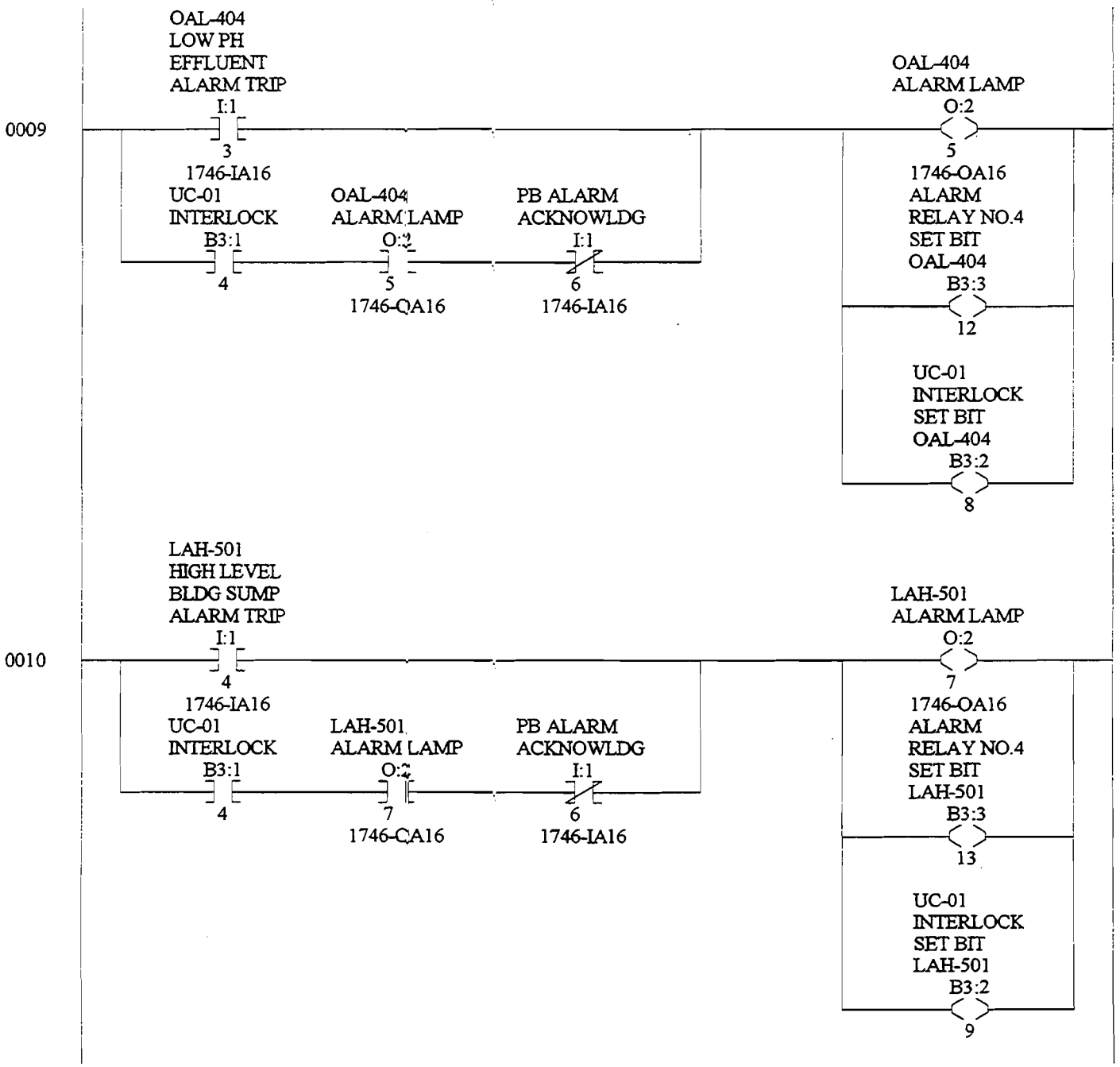

ALARM AND INTERLOCK LOGIC.
0000
CAH-102
SUB PUMP
HIGH CURNT
ALARM TRIP
I:0
0
1747-L40A
UC-01
INTERLOCK
B3:1
4
CAH-102
ALARM LAMP
O:0
13
1747-L40A
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
CAH-102
ALARM LAMP
O:0
13
1747-L40A
ALARM
RELAY NO.1
SET BIT
CAH-102
B3:3
2
UC-01
INTERLOCK
SET BIT
CAH-102
B3:1
14
0001
LAH-215
AERATOR
HIGH LEVEL
ALARM TRIP
I:0
10
1747-L40A
UC-01
INTERLOCK
B3:1
4
LAH-215
AERATOR
HIGH LEVEL
ALARM LAMP
O:2
2
1746-OA16
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
LAH-215
AERATOR
HIGH LEVEL
ALARM LAMP
O:2
2
1746-OA16
UC-01
INTERLOCK
SET BIT
LAH-215
B3:2
0
ALARM
RELAY NO.3
SET BIT
LAH-215
B3:3
8


0002
FAL-202
AEROATOR
LOW FLOW
ALARM TRIP
I:0
12
1747-L40A
UC-01
INTERLOCK
B3:1
4
FAL-202
AERATOR
LOW FLOW
ALARM LAMP
O:0
14
1747-L40A
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
FAL-202
AERATOR
LOW FLOW
ALARM LAMP
O:0
14
1747-L40A
LAH-215
AERATOR
HIGH LEVEL
ALARM
BYPASS
I:1
7
1746-IA16
ALARM
RELAY NO.1
SET BIT
FAL-202
B3:3
3
UC-01
INTERLOCK
SET BIT
FAL-202
B3:2
1


0003
LAH-203
IRON FLTR
LEVEL HIGH
ALARM TRIP
I:0
18
1747-L40A
UC-01
INTERLOCK
B3:1
4
LAH-203
ALARM LAMP
O:0
15
1747-L40A
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
LAH-203
ALARM LAMP
O:0
15
1747-L40A
ALARM
RELAY NO.2
SET BIT
LAH-203
B3:3
5
UC-01
INTERLOCK
SET BIT
LAH-203
B3:2
2
0004
OAH-209
PH HIGH
ACIDIC
EFFLUENT
ALARM TRIP
I:0
5
1747-L40A
UC-01
INTERLOCK
B3:1
4
OAH-209
ALARM LAMP
O:2
1
1746-OA16
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
OAH-209
ALARM LAMP
O:2
1
1746-OA16
ALARM
RELAY NO.2
SET BIT
OAH-209
B3:3
7
UC-01
INTERLOCK
SET BIT
OAH-209
B3:2
3

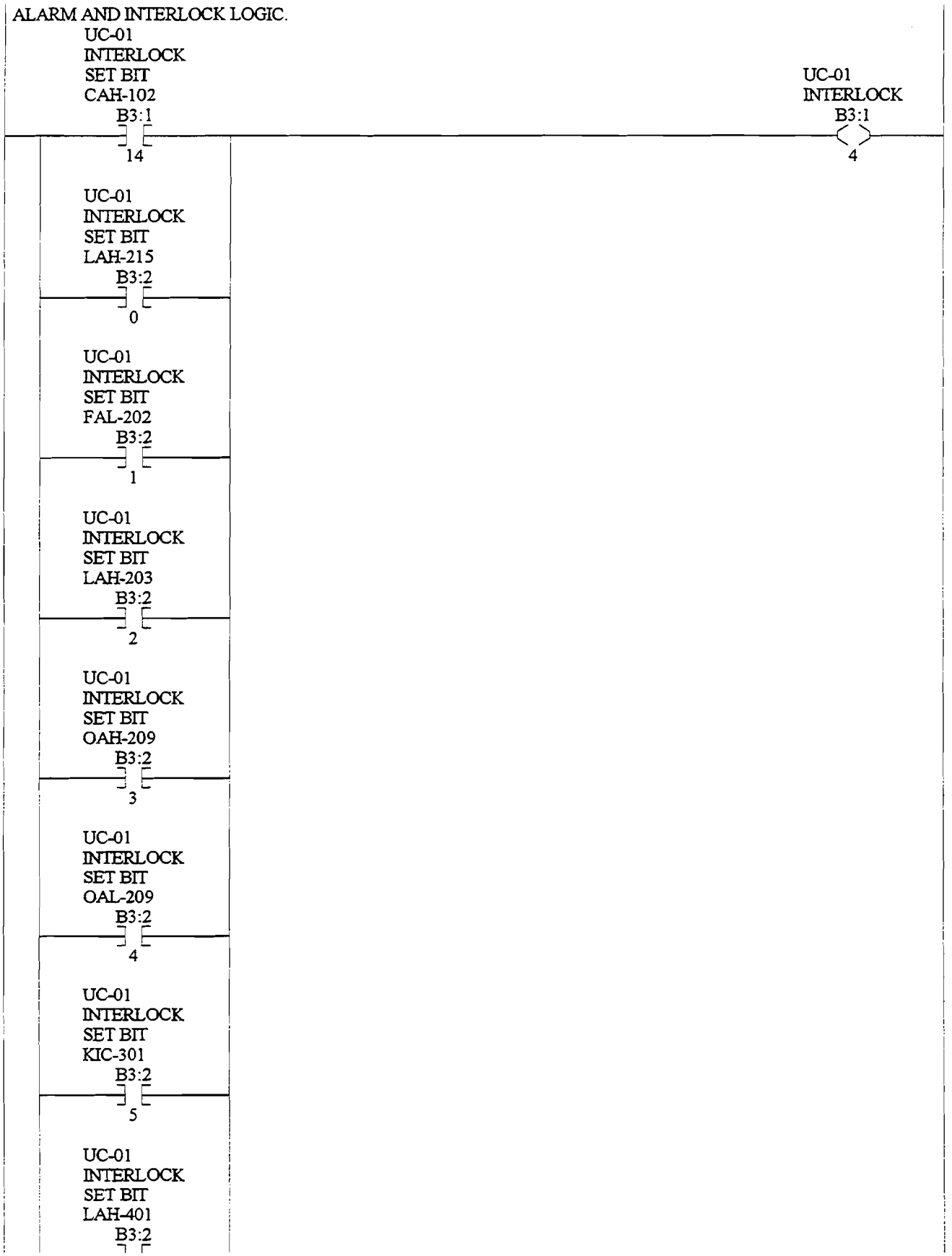

0005
OAL-209
PH LOW
ACIDIC
EFFLUENT
ALARM TRIP
I:0
7
1747-L40A
UC-01
INTERLOCK
B3:1
4
OAL-209
ALARM LAMP
O:2
0
1746-OA16
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
OAL-209
ALARM LAMP
O:2
0
1746-OA16
ALARM
RELAY NO.2
SET BIT
OAL-209
B3:3
6
UC-01
INTERLOCK
SET BIT
OAL-209
B3:2
4
0006
KIC-301
ALARM
TRIGGER
B3:1
5
UC-01
INTERLOCK
B3:1
4
KIC-301
ALARM LAMP
O:2
3
1746-OA16
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
KIC-301
ALARM LAMP
O:2
3
1746-OA16
ALARM
RELAY NO.3
SET BIT
KIC-301
B3:3
9
UC-01
INTERLOCK
SET BIT
KIC-301
B3:2
5

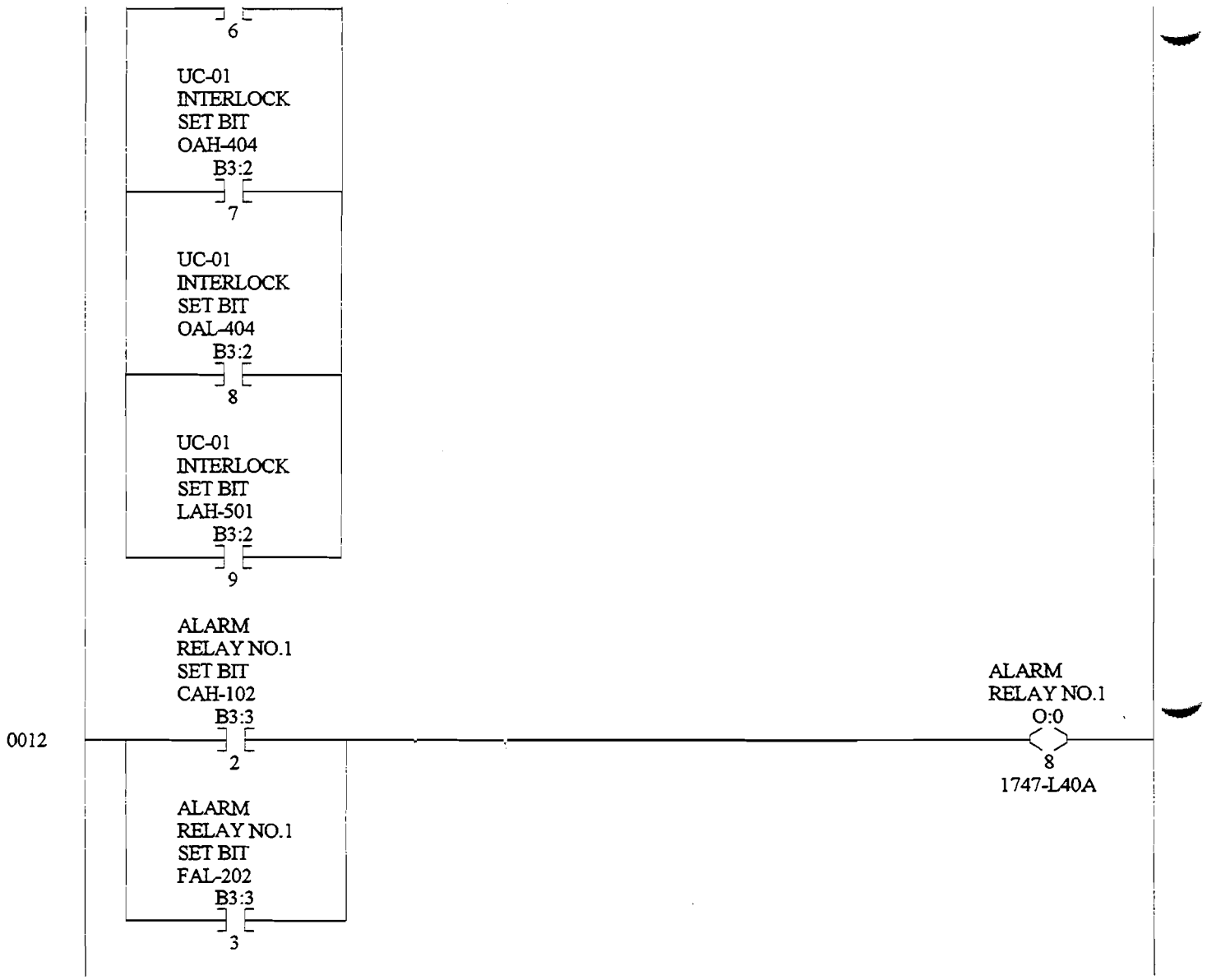

0007
LAH-401
HIGH LEVEL
IN ALKALI
ALARM TRIP
I:0
19
1747-L40A
UC-01
INTERLOCK
B3:1
4
LAH-401
ALARM LAMP
O:2
4
1746-OA16
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
LAH-401
ALARM LAMP
O:2
4
1746-OA16
ALARM
RELAY NO.3
SET BIT
LAH-401
B3:3
10
UC-01
INTERLOCK
SET BIT
LAH-401
B3:2
6
0008
OAH-404
HIGH PH
EFFLUENT
ALARM TRIP
I:1
2
1746-IA16
UC-01
INTERLOCK
B3:1
4
OAH-404
ALARM LAMP
O:2
6
1746-OA16
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
OAH-404
ALARM LAMP
O:2
6
1746-OA16
ALARM
RELAY NO.4
SET BIT
OAH-404
B3:3
11
UC-01
INTERLOCK
SET BIT
OAH-404
B3:2
7

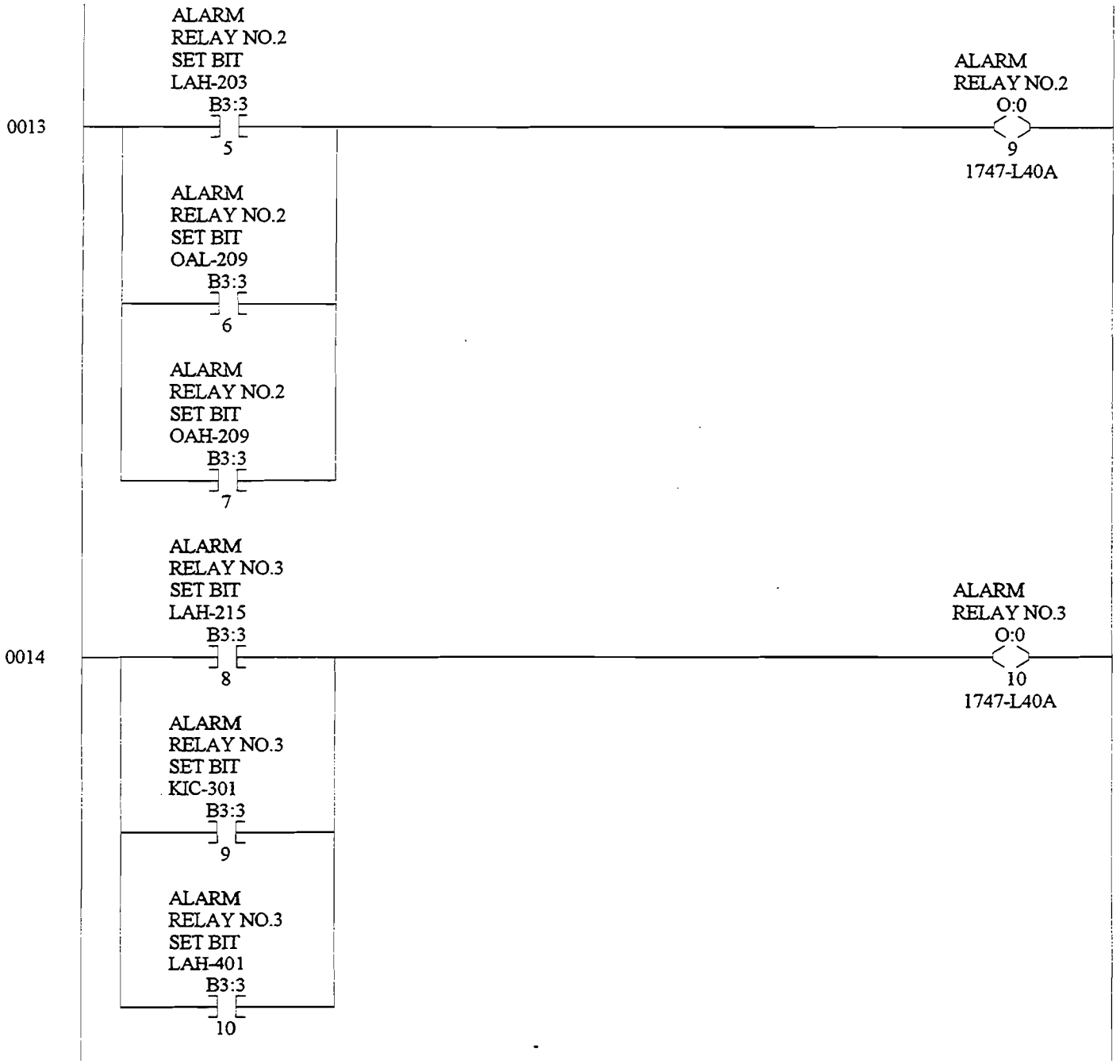

0009
OAL-404
LOW PH
EFFLUENT
ALARM TRIP
I:1
3
1746-IA16
UC-01
INTERLOCK
B3:1
4
OAL-404
ALARM LAMP
O:2
5
1746-OA16
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
OAL-404
ALARM LAMP
O:2
5
1746-OA16
ALARM
RELAY NO.4
SET BIT
OAL-404
B3:3
12
UC-01
INTERLOCK
SET BIT
OAL-404
B3:2
8
0010
LAH-501
HIGH LEVEL
BLDG SUMP
ALARM TRIP
I:1
4
1746-IA16
UC-01
INTERLOCK
B3:1
4
LAH-501
ALARM LAMP
O:2
7
1746-OA16
PB ALARM
ACKNOWLDG
I:1
6
1746-IA16
LAH-501
ALARM LAMP
O:2
7
1746-OA16
ALARM
RELAY NO.4
SET BIT
LAH-501
B3:3
13
UC-01
INTERLOCK
SET BIT
LAH-501
B3:2
9

ALARM AND INTERLOCK LOGIC.

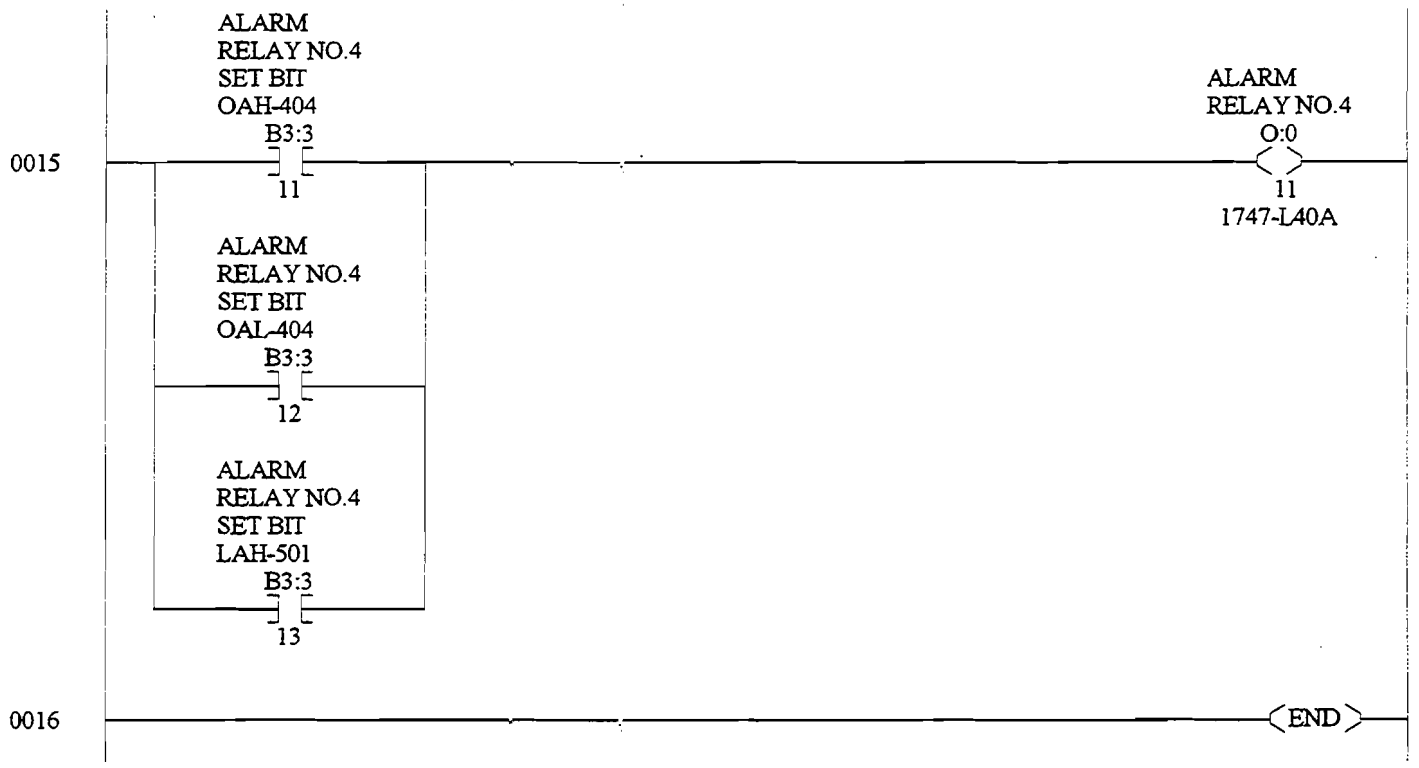
0011




6
UC-01
INTERLOCK
SET BIT
OAH-404
B3:2
7
UC-01
INTERLOCK
SET BIT
OAL-404
B3:2
8
UC-01
INTERLOCK
SET BIT
LAH-501
B3:2
9
ALARM
RELAY NO.1
SET BIT
CAH-102
B3:3
2
ALARM
RELAY NO.1
SET BIT
FAL-202
B3:3
3
0012
ALARM
RELAY NO.1
O:0
8
1747-L40A


0013
ALARM
RELAY NO.2
SET BIT
LAH-203
B3:3
5
ALARM
RELAY NO.2
SET BIT
OAL-209
B3:3
6
ALARM
RELAY NO.2
SET BIT
OAH-209
B3:3
7
ALARM
RELAY NO.2
O:0
9
1747-L40A
0014
ALARM
RELAY NO.3
SET BIT
LAH-215
B3:3
8
ALARM
RELAY NO.3
SET BIT
KIC-301
B3:3
9
ALARM
RELAY NO.3
SET BIT
LAH-401
B3:3
10
ALARM
RELAY NO.3
O:0
10
1747-L40A

LAD 9 - ALARMS_IL — Total Rungs in File = 17



Data File O0 (bin)

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
O:0.0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1747-L40A
O:2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-OA16 - 16-Output (TRIAC) 100/240

Data File I1 (bin)

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
I:0.0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1747-L40A
I:0.1									0	0	0	0	0	1	0	0	1747-L40A
I:1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1746-IA16 - 16-Input 100/120 VAC

Data File S2 (hex)

Offset	0	1	2	3	4	5	6	7	8	9
S2:0	0	86	0	A00	E	0	0	0	0	3
S2:10	0	FFFF	FFFF	0	0	401				

Data File B3 (bin)

Offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
B3:0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1	0
B3:1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B3:2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B3:3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B3:4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Offset	EN	TT	DN	BASE	PRE	ACC
T4:0	0	0	0	.01 sec	0	0
T4:1	0	0	0	.01 sec	500	0

Offset CU CD DN OV UN UA PRE ACC

No data exist for this file.

Offset EN EU DN EM ER UL IN FD LEN POS

No data exist for this file.

Data File N7 (dec)

Offset	0	1	2	3	4	5	6	7	8	9

No data exist for this file.

Data File N7 (dec)

Offset	0	1	2	3	4	5	6	7	8	9

No data exist for this file.

Address/Symbol Database

Address	Symbol	Scope	Description	Sym Group
B3:0/0			RESERVED	
B3:0/1			M-101 PERMISSIVE	
B3:0/2			M-210 PERMISSIVE	
B3:0/3			M-212 PERMISSIVE	
B3:0/4			M-206 PERMISSIVE	
B3:0/5			M-207 PERMISSIVE	
B3:0/6			M-405 PERMISSIVE	
B3:0/7			M-403 PERMISSIVE	
B3:0/10			ALWAYS ON	
B3:0/11			ALWAYS OFF	
B3:1/4			UC-01 INTERLOCK	
B3:1/5			KIC-301 ALARM TRIGGER	
B3:1/14			UC-01 INTERLOCK SET BIT CAH-102	
B3:1/15			UC-01 INTERLOCK SET BIT CL-102	
B3:2/0			UC-01 INTERLOCK SET BIT LAH-215	
B3:2/1			UC-01 INTERLOCK SET BIT FAL-202	
B3:2/2			UC-01 INTERLOCK SET BIT LAH-203	
B3:2/3			UC-01 INTERLOCK SET BIT OAH-209	
B3:2/4			UC-01 INTERLOCK SET BIT OAL-209	
B3:2/5			UC-01 INTERLOCK SET BIT KIC-301	
B3:2/6			UC-01 INTERLOCK SET BIT LAH-401	
B3:2/7			UC-01 INTERLOCK SET BIT OAH-404	
B3:2/8			UC-01 INTERLOCK SET BIT OAL-404	
B3:2/9			UC-01 INTERLOCK SET BIT LAH-501	
B3:3/2			ALARM RELAY NO.1 SET BIT CAH-102	
B3:3/3			ALARM RELAY NO.1 SET BIT FAL-202	
B3:3/4			ALARM RELAY NO.1 SET BIT CL-102	
B3:3/5			ALARM RELAY NO.2 SET BIT LAH-203	
B3:3/6			ALARM RELAY NO.2 SET BIT OAL-209	
B3:3/7			ALARM RELAY NO.2 SET BIT OAH-209	
B3:3/8			ALARM RELAY NO.3 SET BIT LAH-215	
B3:3/9			ALARM RELAY NO.3 SET BIT KIC-301	
B3:3/10			ALARM RELAY NO.3 SET BIT LAH-401	
B3:3/11			ALARM RELAY NO.4 SET BIT OAH-404	
B3:3/12			ALARM RELAY NO.4 SET BIT OAL-404	
B3:3/13			ALARM RELAY NO.4 SET BIT LAH-501	
I:0/0			CAH-102 SUB PUMP HIGH CURNT ALARM TRIP	
I:0/1			LSH-204	
I:0/2			CL-102 SUB PUMP LOW CURNT ALARM TRIP	
I:0/3			LSL-204	
I:0/4			HOA-103 MAN	
I:0/5			OAH-209 PH HIGH ACIDIC EFFLUENT ALARM TRIP	
I:0/6			HOA-103 AUTO	
I:0/7			OAL-209 PH LOW ACIDIC EFFLUENT ALARM TRIP	
I:0/9			HOA-214 MAN	
I:0/10			LAH-215 AERATOR HIGH LEVEL ALARM TRIP	
I:0/11			HOA-214 AUTO	
I:0/12			FAL-202 AEROATOR LOW FLOW ALARM TRIP	
I:0/13			HOA-208 MAN	
I:0/14			HOA-211 MAN	
I:0/15			HOA-208 AUTO	
I:0/16			HOA-211 AUTO	
I:0/17			KIC-301 HIGH CONDUCT	
I:0/18			LAH-203 IRON FLTR LEVEL HIGH ALARM TRIP	
I:0/19			LAH-401 HIGH LEVEL IN ALKALI ALARM TRIP	
I:0/20			HOA-213 MAN	
I:0/21			HOA-406 MAN	
I:0/22			HOA-213 AUTO	
I:0/23			HOA-406 AUTO	
I:1/0			HOA-407 MAN	
I:1/1			HOA-407 AUTO	
I:1/2			OAH-404 HIGH PH EFFLUENT ALARM TRIP	
I:1/3			OAL-404 LOW PH EFFLUENT ALARM TRIP	
I:1/4			LAH-501 HIGH LEVEL BLDG SUMP ALARM TRIP	
I:1/5			M-501 ON	

Address/Symbol Database

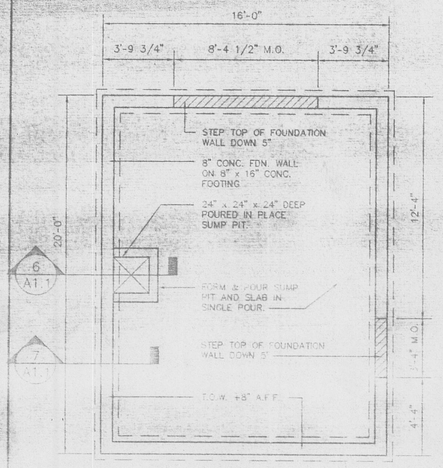
Address	Symbol	Scope	Description	Sym Group
I:1/6			PB ALARM ACKNOWLDG	
I:1/7			LAH-215 AERATOR HIGH LEVEL ALARM BYPASS	
I:1/8			CL-102 COLLECTION SUMP LOW LEVEL	
O:0/0			M-101 RUN	
O:0/1			M-212 RUN	
O:0/2			M-206 RUN	
O:0/3			M-405 RUN	
O:0/4			M-403 RUN	
O:0/5			M-210 RUN	
O:0/6			M-207 RUN	
O:0/7			M-501 RUN	
O:0/8			ALARM RELAY NO.1	
O:0/9			ALARM RELAY NO.2	
O:0/10			ALARM RELAY NO.3	
O:0/11			ALARM RELAY NO.4	
O:0/12			CL-102 COLLECTION SUMP LOW LEVEL LAMP	
O:0/13			CAH-102 ALARM LAMP	
O:0/14			FAL-202 AERATOR LOW FLOW ALARM LAMP	
O:0/15			LAH-203 ALARM LAMP	
O:2/0			OAL-209 ALARM LAMP	
O:2/1			OAH-209 ALARM LAMP	
O:2/2			LAH-215 AERATOR HIGH LEVEL ALARM LAMP	
O:2/3			KIC-301 ALARM LAMP	
O:2/4			LAH-401 ALARM LAMP	
O:2/5			OAL-404 ALARM LAMP	
O:2/6			OAH-404 ALARM LAMP	
O:2/7			LAH-501 ALARM LAMP	
O:2/9	TIMER_COIL	Global		
S2:0			Arithmetic Flags	
S2:0/0			Processor Arithmetic Carry Flag	
S2:0/1			Processor Arithmetic Underflow/ Overflow Flag	
S2:0/2			Processor Arithmetic Zero Flag	
S2:0/3			Processor Arithmetic Sign Flag	
S2:1			Processor Mode Status/ Control	
S2:1/0			Processor Mode Bit 0	
S2:1/1			Processor Mode Bit 1	
S2:1/2			Processor Mode Bit 2	
S2:1/3			Processor Mode Bit 3	
S2:1/4			Processor Mode Bit 4	
S2:1/5			Forces Enabled	
S2:1/6			Forces Present	
S2:1/7			Comms Active	
S2:1/8			Fault Override at Powerup	
S2:1/9			Startup Protection Fault	
S2:1/10			Load Memory Module on Memory Error	
S2:1/11			Load Memory Module Always	
S2:1/12			Load Memory Module and RUN	
S2:1/13			Major Error Halted	
S2:1/14			Access Denied	
S2:1/15			First Pass	
S2:2/0			STI Pending	
S2:2/1			STI Enabled	
S2:2/2			STI Executing	
S2:2/3			Index Addressing File Range	
S2:2/4			Saved with Debug Single Step	
S2:2/5			DH-485 Incoming Command Pending	
S2:2/6			DH-485 Message Reply Pending	
S2:2/7			DH-485 Outgoing Message Command Pending	
S2:2/15			Comms Servicing Selection	
S2:3			Current Scan Time/ Watchdog Scan Time	
S2:4			Time Base	
S2:5/0			Overflow Trap	
S2:5/2			Control Register Error	
S2:5/3			Major Err Detected Executing UserFault Routine	
S2:5/4			M0-M1 Referenced on Disabled Slot	

Address/Symbol Database

Address	Symbol	Scope	Description	Sym Group
S2:5/8			Memory Module Boot	
S2:5/9			Memory Module Password Mismatch	
S2:5/10			STI Overflow	
S2:5/11			Battery Low	
S2:6			Major Error Fault Code	
S2:7			Suspend Code	
S2:8			Suspend File	
S2:9			Active Nodes	
S2:10			Active Nodes	
S2:11			I/O Slot Enables	
S2:12			I/O Slot Enables	
S2:13			Math Register	
S2:14			Math Register	
S2:15			Node Address/ Baud Rate	
S2:16			Debug Single Step Rung	
S2:17			Debug Single Step File	
S2:18			Debug Single Step Breakpoint Rung	
S2:19			Debug Single Step Breakpoint File	
S2:20			Debug Fault/ Powerdown Rung	
S2:21			Debug Fault/ Powerdown File	
S2:22			Maximum Observed Scan Time	
S2:23			Average Scan Time	
S2:24			Index Register	
S2:25			I/O Interrupt Pending	
S2:26			I/O Interrupt Pending	
S2:27			I/O Interrupt Enabled	
S2:28			I/O Interrupt Enabled	
S2:29			User Fault Routine File Number	
S2:30			STI Setpoint	
S2:31			STI File Number	
S2:32			I/O Interrupt Executing	
S2:33			Extended Proc Status Control Word	
S2:33/0			Incoming Command Pending	
S2:33/1			Message Reply Pending	
S2:33/2			Outgoing Message Command Pending	
S2:33/3			Selection Status User/DF1	
S2:33/4			Communicat Active	
S2:33/5			Communicat Servicing Selection	
S2:33/6			Message Servicing Selection Channel 0	
S2:33/7			Message Servicing Selection Channel 1	
S2:33/8			Interrupt Latency Control Flag	
S2:33/9			Scan Toggle Flag	
S2:33/10			Discrete Input Interrupt Reconfigur Flag	
S2:33/11			Online Edit Status	
S2:33/12			Online Edit Status	
S2:33/13			Scan Time Timebase Selection	
S2:33/14			DTR Control Bit	
S2:33/15			DTR Force Bit	
S2:34			Pass-thru Disabled	
S2:34/0			Pass-Thru Disabled Flag	
S2:34/1			DH+ Active Node Table Enable Flag	
S2:34/2			Floating Point Math Flag	
S2:35			Last 1 ms Scan Time	
S2:36			Extended Minor Error Bits	
S2:36/8			Dll Lost	
S2:36/9			STI Lost	
S2:36/10			Memory Module Data File Overwrite Protection	
S2:37			Clock Calendar Year	
S2:38			Clock Calendar Month	
S2:39			Clock Calendar Day	
S2:40			Clock Calendar Hours	
S2:41			Clock Calendar Minutes	
S2:42			Clock Calendar Seconds	
S2:43			STI Interrupt Time	
S2:44			I/O Event Interrupt Time	

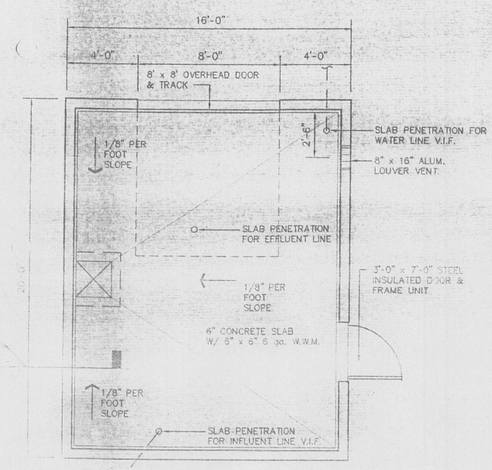
Address/Symbol Database

Address	Symbol	Scope	Description	Sym Group
S2:45			Dll Interrupt Time	
S2:46			Discrete Input Interrupt- File Number	
S2:47			Discrete Input Interrupt- Slot Number	
S2:48			Discrete Input Interrupt- Bit Mask	
S2:49			Discrete Input Interrupt- Compare Value	
S2:50			Processor Catalog Interrupt- Preset	
S2:51			Discrete Input Interrupt- Return Number	
S2:52			Discrete Input Interrupt- Accumulat	
S2:53			Discrete Input Interrupt- Timer	
S2:54			Discrete Input Interrupt- Timer	
S2:55			Last Dll Scan Time	
S2:56			Maximum Observed Dll Scan Time	
S2:57			Operating System Catalog Number	
S2:58			Operating System Series	
S2:59			Operating System FRN	
S2:61			Processor Series	
S2:62			Processor Revision	
S2:63			User Program Type	
S2:64			User Program Functional Index	
S2:65			User RAM Size	
S2:66			Flash EEPROM Size	
S2:67			Channel 0 Active Nodes	
S2:68			Channel 0 Active Nodes	
S2:69			Channel 0 Active Nodes	
S2:70			Channel 0 Active Nodes	
S2:71			Channel 0 Active Nodes	
S2:72			Channel 0 Active Nodes	
S2:73			Channel 0 Active Nodes	
S2:74			Channel 0 Active Nodes	
S2:75			Channel 0 Active Nodes	
S2:76			Channel 0 Active Nodes	
S2:77			Channel 0 Active Nodes	
S2:78			Channel 0 Active Nodes	
S2:79			Channel 0 Active Nodes	
S2:80			Channel 0 Active Nodes	
S2:81			Channel 0 Active Nodes	
S2:82			Channel 0 Active Nodes	
S2:83			DH+ Active Nodes	
S2:84			DH+ Active Nodes	
S2:85			DH+ Active Nodes	
S2:86			DH+ Active Nodes	
U:00003				
U:00004				
U:00005				
U:00006				
U:00007				
U:00008				
U:00009				



FOUNDATION PLAN

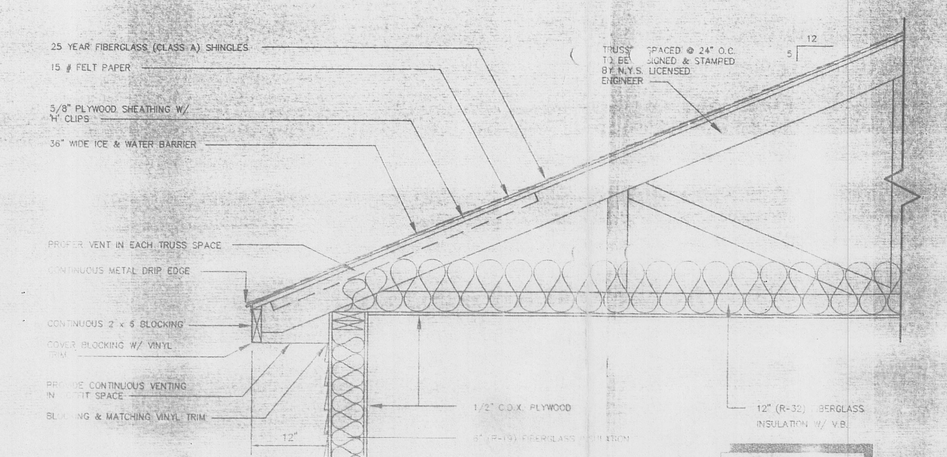
1 A1.1 — 1/4"=1'-0"



FLOOR PLAN

2 A1.1 — 1/4"=1'-0"

PROVIDE 3" RAMP AT OVERHEAD & PERSONNEL DOOR



NORTH ELEVATION

3 A1.1 — 1/4"=1'-0" — SOUTH ELEVATION TYPICAL W/OUT DOOR

EAST ELEV.

4 A1.1 — 1/4"=1'-0"

WEST ELEVATION

5 A1.1 — 1/4"=1'-0"

SUMP DETAIL

6 A1.1 — 1" = 1'-0"

WALL SECTION

7 A1.1 — 1" = 1'-0"

DESIGN DATA

ROOF LIVE LOAD	45 PSF
ADD. COLLATERAL LOAD	5 PSF
WIND LOAD	75 MPH

CODE REVIEW

OCCUPANCY CLASS (SPACE IS UNOCCUPIED)	G3.1 - INDUSTRIAL (LOW HAZARD)
CONSTRUCTION CLASS	5B
BASIC FIRE AREA	5,000 S.F.
ACTUAL FIRE AREA	320 S.F.

INSULATION SCHEDULE

12" FIBERGLASS INSULATION	ROOF
6" FIBERGLASS INSULATION	WALL

PREPARED EXCLUSIVELY FOR:

PHILLIP ENVIRONMENTAL SERVICES CORP.

431 ROUTE 50 SOUTH
SARATOGA SPRINGS, NEW YORK

Matzen Construction Inc.

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PROJECT: TREATMENT BUILDING

DRAWING: PLANS & ELEVATIONS

SCALE:	AS NOTED
DRAWN BY:	KDS
DATE:	3/2/98/98
CHECKED BY:	
ESTIMATED BY:	
REVISIONS:	SUMP PUMP FOUNDATION DETAIL KDS 3/4/98 PLAN REVISIONS KDS 3/25/98

PROJECT NO: 4786

DRAWING NO: A1.1

STATE OF NEW YORK — ANDREW J. DONOHUE — 061118 — LICENSED PROFESSIONAL ENGINEER