#401031

AXELROD INSTITUTE SITE ALBANY, NEW YORK REMEDIAL PROGRAM

OPERATION AND MAINTENANCE MANUAL

10 December 1993

ERM-Northeast, Inc.
501 New Karner Road
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Albany, New York 12205

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1.0 *INTRODUCTION*

This Operation and Maintenance (O&M) Plan (the "Plan") has been developed by ERM-Northeast (ERM) for the New York State Department of Health's (NYSDOH) Axelrod Institute in Albany, New York (the "Site"). The Site was previously investigated as the Wadsworth Center for Laboratories and Research (WCLR). The Site name was changed during the construction of the Remedial Program.

This Plan provides detailed descriptions, schedules, safety plans and reporting/record keeping requirements for the operation and maintenance of the remedial program selected for the Site. The Plan also addresses proposed monitoring requirements for the Site's Remedial Program.

1.1 *GENERAL*

The New York State Department of Environmental Conservation (NYSDEC) has required the NYSDOH to remediate the Site. The Site has been identified by the NYSDEC as an inactive hazardous waste site (Site Identification No. 401031), pursuant to an Order on Consent, Index No. A4-0304-93-07, entered into between NYSDOH and NYSDEC effective August 27, 1993 (the "Consent Order"). Under the requirements of the Consent Order, NYSDOH has developed and implemented a remedial program (Remedial Program) for the Site as set forth in the March, 1992 Record of Decision (ROD) for the Site. The development and implementation of the Remedial Program is referred to in this document as the "Project".

To implement the Remedial Program, ERM prepared a remedial design (the "Remedial Design") dated May, 1993, which was approved by NYSDEC in June, 1993. Construction of the Remedial Design was performed by Barbella Environmental Technology, Inc. from September, 1993 through

November, 1993.

All identified contamination at the Site is in the form of contaminated environmental media, (i.e., ground water, soil and vapors trapped in the vadose zone). The vadose zone is the unsaturated soil zone between the top of the ground water table and the existing grade. All contaminated environmental media encountered at the Site must be managed as if it were hazardous waste. In addition, the recovered ground water must be managed as a hazardous waste in accordance with the United States Environmental Protection Agency's (USEPA) hazardous waste regulations.

1.2 PURPOSE AND SCOPE

This manual has been prepared to provide a comprehensive guide for operating and maintaining the Remedial Program as constructed. Within the manual, the constructed portion of the Remedial Program will be referred to as the "Plant".

The manual is intended to serve as the primary source of reference for procedures relating to Plant administration, monitoring and sampling, record keeping, Plant and equipment maintenance, Plant safety, emergency response, and day-to-day operation.

The manual should be utilized in conjunction with the specific and detailed operating, maintenance, and repair procedures included in the operation and maintenance manual furnished with each major item of equipment by the respective manufacturer. Thus, this manual and the equipment manufacturers' detailed technical publications and bulletins should serve to complement each other in providing the Plant operator with a thorough and technically sound source of information for effective operation and maintenance of the Plant facilities.

1.3 *GUIDE TO MANUAL FORMAT*

This manual is organized into fourteen chapters which cover the following major technical and administrative subject areas:

Chapter 1:	Introduction
Chapter 2:	Permits and Regulatory Requirements
Chapter 3:	Personnel
Chapter 4:	Laboratory Testing
Chapter 5:	Records and Reports
Chapter 6:	Health and Safety
Chapter 7:	Utility and Support Systems
Chapter 8:	Plant Electrical System
Chapter 9:	Unit Process Operation
Chapter 10:	Plant Control System and Instrumentation
Chapter 11:	Troubleshooting
Chapter 12:	Maintenance Management
Chapter 13:	Site Maintenance
Chapter 14:	Emergency Procedures

Each chapter is divided into sections and subsections for ease of access to specific items of information. Refer to the manual's Table of Contents for more detailed information regarding the contents of each chapter.

Although each chapter contains valuable information necessary for the efficient, orderly, and safe operation of the Plant, Chapters 9 and 10 are of particular importance to the Plant operator because these chapters contain detailed information on each major item of Plant equipment and instrumentation.

The other chapters contain important information on permits and/or regulatory requirements, personnel, reports, safety, and other administrative and procedural matters. These chapters must also be carefully read, and thoroughly understood.

Since potentially hazardous chemicals may be present in the Plant process streams (ground water and passively vented vapors) and within the ground at the Site, special attention should also be paid to Chapter 6, "Health and Safety", and the Health and Safety Plan included as Appendix B to this manual.

Chapter 13, "Site Maintenance", discusses specific maintenance requirements for the remedial components of the Site such as the cap, recovery and monitoring wells and fencing.

For ready reference, the appendices also include general information items such as the Plant process and instrumentation diagram and the Plant inspection, maintenance and lubrication schedule. Operation and maintenance manuals provided by the manufacturers of the major Plant equipment items are included as the final appendix to this manual.

1.4 SITE BACKGROUND INFORMATION

The Axelrod Institute facility currently consists of a recently constructed five-story 202,000 square foot building on an approximately five acre site and is located at 120 New Scotland Avenue in Albany, New York. (The facility previously consisted eight smaller buildings.) This location is approximately one and one-half miles west of the Hudson River and one and one-quarter miles from downtown Albany. The Site elevation is approximately 200 feet above mean Sea Level and the property is relatively flat.

The facility was used as a biological laboratory since 1914. Prior to 1914, a County Almshouse, with an associated burial ground in the southern portion of the area, was located on the Site. Historic records indicated this facility disposed of laboratory wastes in a "pit" area in the southwest portion of the property. This is the location where the ground water recovery well has been constructed. Refer to the Record Drawings for the exact location.

Environmental studies conducted by several parties at the Site indicated that hazardous material was present in the soil and shallow ground water within the "pit" area. These findings resulted in the placement of the Site on the New York State Department of Environmental Conservation (NYSDEC) Hazardous Waste Site Registry with a Class 2 designation (Site No. 401031). The NYSDEC determined the required action was to be the development and implementation of a Remedial Investigation/Feasibility Study (RI/FS) of the Site. The NYSDOH retained ERM to design and implement the RI/FS.

ERM performed the Remedial Investigations in 1990 and 1991 with RI field work being conducted from October 8, 1990 to November 19, 1990 and April 8, 1991 to May 31, 1991. Investigative activities included the installation of monitoring wells; and sampling and analysis of surface soil, background soil, subsurface soil and ground water. Field observations and analytical results were evaluated to characterize the hydrogeology and geochemistry of the Site. This information was used to perform a Risk Assessment to determine potential effects of Site conditions on human health and the environment.

The Remedial Investigation determined that soils within the investigated area contain varying concentrations of volatile organic compounds (VOCs) and polynuclear aromatic hydrocarbon compounds.

Shallow ground water south and south east of the "pit" area contains VOCs and semi-volatile organic compounds. The vertical and lateral extent of ground water contamination is confined because of the subsurface geological conditions of the investigated area. Hydrogeologic conditions at the Site result in limited ground water flow, which limits the extent of volatile and semi-volatile concentrations to a maximum of 40 feet south of the property boundary.

The Risk Assessment performed for the Remedial Investigation indicated that the Site does not pose an imminent threat to human health or the environment in its present condition. Therefore, no immediate remedial measures were recommended.

ERM conducted a Feasibility Study (FS) for the Site which was submitted to the NYSDOH on August 22, 1991. The FS was a comprehensive and systematic evaluation of remedial alternatives that culminated in the selection of the most appropriate approach for addressing previously identified soil and ground water contamination at the Site. The FS was conducted in strict conformance with NYSDEC guidelines.

The remedial requirements of the FS were further specified by statute and regulation to include:

- A strong preference for a permanent remedial action that reduces the volume, toxicity and/or mobility of the contamination;

- The requirement to comply with applicable New York State and Federal Standards, Criteria and Guidelines (SCGs); and

- The requirement to protect human health, welfare and the environment.

The scope of the FS included the following tasks:

- define site-specific remedial objectives;
- investigate and screen potentially viable remedial technologies;
- formulate and screen these remedial alternatives; and
- perform a detailed evaluation of the selected approach for addressing Site contamination.

The FS process resulted in the selection of a remedial approach (designated as Alternative No. 4) that will isolate the hazardous material from the environment with ground water treatment being accomplished. The alternative provides the best long term solution to current concerns while minimizing short term, construction related impacts to the surrounding community. A description of the selected remedial approach is included in section 1.4.

1.5 REMEDIAL OBJECTIVES

The overall remedial objective for the Site is the mitigation of the documented contamination in a manner which protects public health and the environment and balances performance, cost and implementability while subsequently permitting the return to productive use of the overall Site and adjoining property.

The remedial action is proposed for the purpose of reducing the environmental or human health risk by preventing the ingestion or inhalation of contaminated soil, reducing the leaching of contaminants from the soil into the ground water and containing the migration of contaminated ground water. The remedial action will also include continued monitoring of the ground water and institutional controls relating to use of the contaminated property.

The specific objectives for ground water remediation at the Site are as follows:

- Prevent ingestion of water having a detectable concentration of carcinogens and a total excess cancer risk of greater than 10^{-4} to 10^{-7};

- Prevent ingestion of water having non-carcinogens in excess of the New York State/Federal Standards, Criteria and Guidelines (SCGs);

- Restore the ground water within the disposal area to appropriate contaminant levels compared to the SCGs; and

- Mitigate the transport of contaminants in the overburden.

The Site specific objectives for soil remediation are as follows:

- Prevent ingestion/direct contact/inhalation of soil having 10^{-4} to 10^{-7} excess cancer risk from carcinogens;

- Prevent ingestion/direct contact/inhalation of soil having non-carcinogens in excess of their reference doses;

- Restore the Site soil to appropriate contaminant levels compared to the SCGs; and

- Prevent migration of contaminants that would result in further ground water contamination.

1.6 DESCRIPTION OF SELECTED REMEDY

The description of the remedy selected for the Site (Alternative No. 4 - Containment with Ground Water Treatment) as described in the ROD is presented below.

- The selected remedy for the New Scotland Avenue Site consists of covering the site with a clay or synthetic cap, ground water treatment and institutional controls.

- The cap will cover areas of both volatile and semi-volatile contamination, a total area of 16,000 square feet. The cap will consist of a gravel venting layer, clay or synthetic impermeable layer topped with either asphalt or a vegetative cover.

- In addition to the cap, the most contaminated area of ground water will be [collected and] treated utilizing a pump and treat method.

- The site will be fenced and will have deed restrictions imposed to prevent future uses of the property that would interfere with the remedial measures.

- Long-term monitoring will be conducted to assess the results of the remediation.

- If the ability to pump and treat the ground water is found to be an infeasible solution to treating the ground water, processes such as vapor extraction or other methods that may be developed in the future will be evaluated as possible methods for mitigating the volatile organic contamination at the site.

As explained in the ROD, the cap would moderate further contamination of the ground water by preventing infiltration of rainwater into the soil, thus reducing the leaching of contaminants from the soil into the ground water. The cap would also prevent the blowing of surficial soil into the air or the possibility of ingestion or inhalation of soil by workers in the area.

The ROD also states:

A pump test was performed during the Feasibility Study which indicated that in areas 10-35 feet below grade that the soils are tightly packed and are not conducive to ground water extraction. However, above 10 feet there is a layer of fill which is more permeable thus, ground water treatment of shallow ground water (4-10 feet) would be included to prevent further migration of heavily contaminated water. Treatment would be accomplished, if feasible, by pumping from shallow wells into a containment vessel and sending the water to either a municipal waste treatment plant or POTW, or treating the waste on-site by filtering it through a carbon treatment unit prior to disposal. Details and evaluation of this removal and treatment method will be performed during the design phase.

Institutional controls will be utilized in the area of the cap . . . . The cap will cover portions of both NYSDOH and CBA [Christian Brothers Academy] property. Institutional controls will also be utilized in the area of ground water contamination beneath both NYSDOH and CBA property.

1.7 GROUND WATER QUALITY AND FLOW RATE CHARACTERISTICS

It should be noted that as indicated in the FS, the recovery of ground water would act as a source control procedure, rather than an attempt to recover and mitigate the existing ground water plume.

A pump test was conducted at the Site on November 19, 1991. (The results of this test were included in the Pump Test Report dated December 13, 1991 which was previously forwarded to NYSDEC.) For this pump test a new well (RW-1) was drilled in the location shown on Figure 1-1. The results of this pump test indicated the well sustainable yield to be approximately 0.25 gallons per minute (gpm). The presence of a sand lens was identified in the location where the well for the pump test was drilled.

It is believed that the sand lens resulted in the sustainable yield for this particular well to be higher than would be anticipated for the well had the sand lens not been encountered. Consequently, it is anticipated that a more accurate estimate of the sustainable ground water yield of the Site is approximately 0.1 gpm. It should be noted that the pump test well was grouted and abandoned after the pump test was completed.

Based on the results of the pump test and the topography and geology (low permeability of the natural silts and clay soil) of the Site, ERM has estimated that once the impermeable cover is placed over the Site, the maximum amount of ground water which will be recovered is from 50,000 to 100,000 gallons.

Information gathered from the 1990 and 1991 Site investigations performed by ERM indicate that chloroform, methylene chloride, acetone, xylene, toluene, benzene, ethylbenzene and trichloroethene as the major VOCs present in the ground water underlying the Site. The highest concentrations are immediately adjacent to and downgradient of the "pit" location in MW-4S. The methylene chloride concentration of 230,000 ppb and acetone concentration of 75,000 ppb at this monitoring well were used as influent concentrations requiring treatment for evaluation purposes.

Methylene chloride was selected since it is the volatile compound which was detected in the highest concentration in the ground water. Acetone was selected since is one of the more difficult volatile compounds to remove from the ground water. As noted above, a total VOC discharge criteria of two ppm (2000 ppb) was also used.

Table 1-1 summarizes the type, media and maximum volatile organic contamination found at the Site. Figures 1-2 and 1-3 show the extent of soil contamination. Figure 1-4 shows the maximum areal extent and direction of contaminant migration found in the ground water. All ground water contaminants are within this plume. The direction of ground water flow is to the southeast.

1.8 REMEDIAL DESIGN COMPONENTS OVERVIEW

This section provides a brief description of the cap design and ground water recovery and storage system operation. The discussion is aided by referring to the piping and instrumentation diagram included as Appendix A.

The approved remedial design for the Site consists of the following:

- cap and passive vapor recovery system
- ground water collection and off-site disposal
- deed restrictions
- Site restrictions (i.e., asphalt pavement, fencing)

1.8.1 Cap and Passive Vapor Recovery System

A portion of the parking lot for the new laboratory building directly overlaps the area which has been capped as part of the NYSDEC approved Remedial Action plan for the Site. The design of the cap and cap protective cover minimizes the impact on the final grade of the parking lot where the overlap occurs. The design includes:

1. utilization of a geonet composite to serve as the media for capturing soil vapors underneath the cap; and

2. incorporation of the parking lot subbase as the cap protective cover.

In order to minimize the impact on the final grade contours of the parking lot, while at the same time providing protection to the cap during parking lot construction, the cap and cap cover was installed as follows:

1. The area to be capped was overlain with a geonet composite consisting of a polypropylene drainage netting installed between two layers of geotextile. The geonet composite serves as the vapor collection media beneath the cap and takes the place of a stone or gravel layer, thereby reducing the overall cross section. The geonet composite is tied into perforated PVC vapor collection headers running along the east and west boundaries of the cap (refer to the record drawings for the project). The PVC headers and associated standpipes allow soil vapor to be passively vented from beneath the cap.

2. The VLDPE cap was placed over the geonet composite, followed by another geotextile layer, geonet and additional layer of geotextile.

3. A nine inch lift of well-graded sand and gravel mixture conforming to the parking lot subbase specifications was placed over the cap.

4. A geogrid was placed over the initial nine inch lift to provide subbase reinforcement.

5. A second nine inch lift of sand and gravel was placed over the geogrid.

The parking lot was then constructed directly over the cap cover without the need to provide additional subbase material.

1.8.2 *Ground Water Collection*

The Plant contains a ground water recovery and storage system and support systems. The ground water storage system and support systems are all located outside, except for the alarm monitoring system which is housed in the nearby Boiler Control Room (Room 1090). All components of these systems are described in detail in Chapters 7, 8 and 9. The Plant is also equipped with several control features which are described in Chapter 10.

The ground water recovery system consists of one ground water recovery well. The operator should refer to Record Drawing C-2 for the location of the recovery well. The ground water recovery well extends to a depth of only 13.5 feet below the preexisting grade to prevent any potential contamination from migrating vertically. Construction details of the ground water recovery well are shown on Record Drawing C-3.

The recovery well contains a submersible pump "environmental grade" pump which pumps ground water to the ground water storage tank located a few feet away. On-Site treatment of the recovered ground water was not provided for in the Remedial Design since evaluations performed during the preliminary design indicated it would not be cost effective. The collected ground water will be transported by tanker truck to an off-site disposal facility.

1.8.3 *Deed Restrictions*

Deed restrictions to be incorporated by NYSDOH will include clauses which will prevent the installation of any future domestic or industrial ground water wells on the Site for any other reason than ground water monitoring. Additionally, no soil excavation or other surface disturbances at the Site will be allowed in the future.

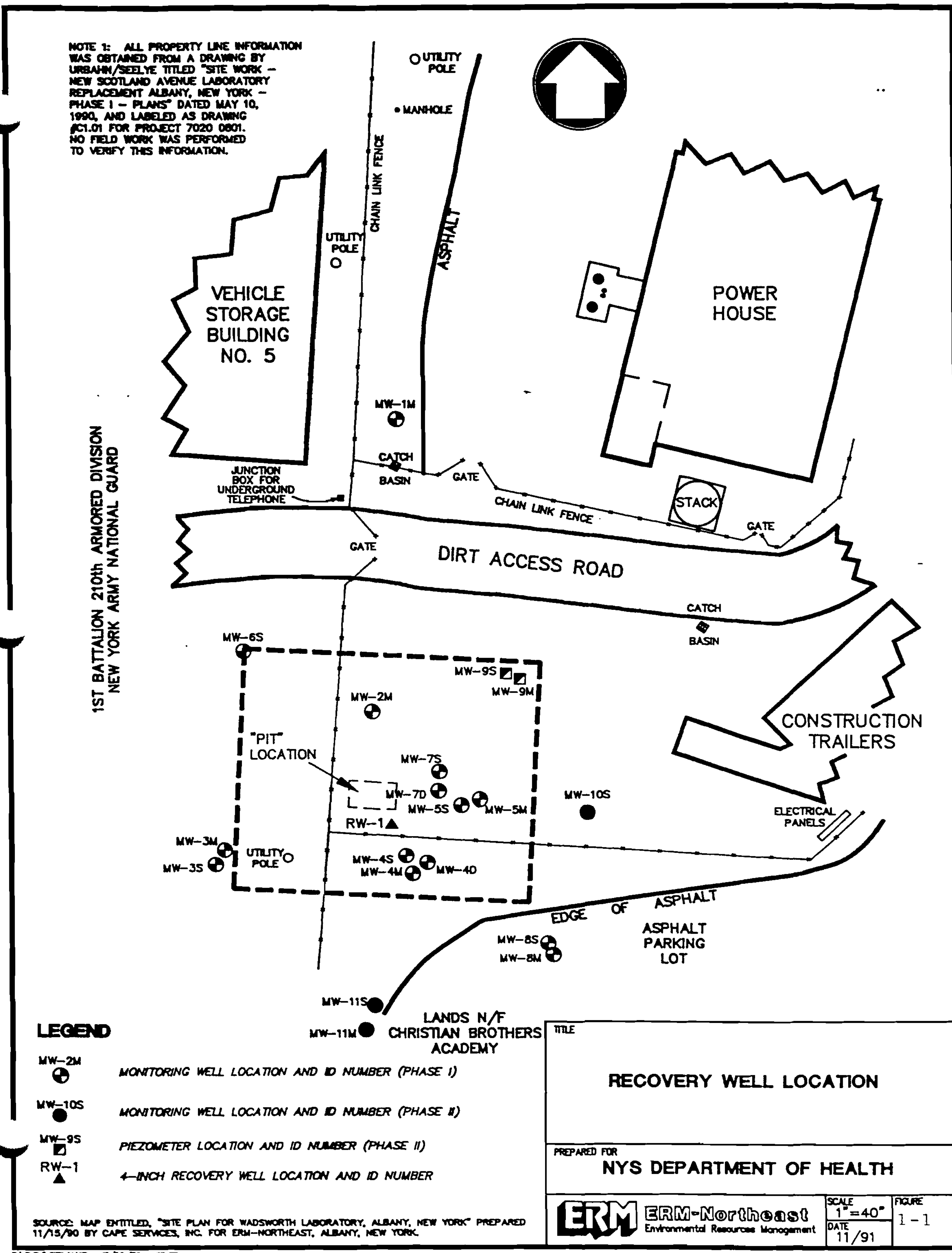
1.8.4 Site Restrictions

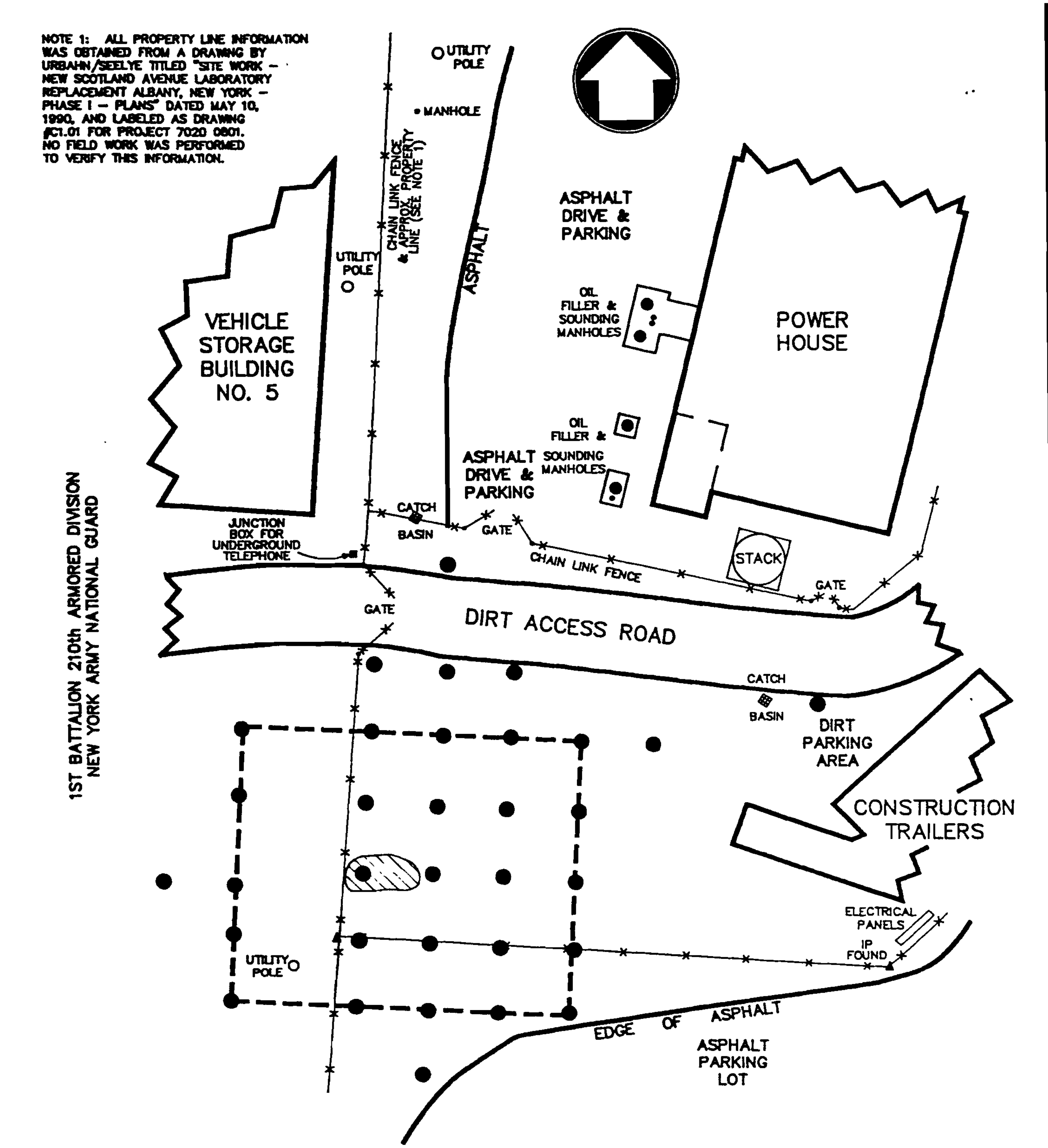
Site restrictions have been achieved through the installation of the proposed parking lot area and fencing. The Site is surrounded with a six foot high fence. The storage area for the recovered ground water is also enclosed by 1 six foot high fence. This fence has a lockable gate for access by authorized personnel. Unauthorized personnel are not to be allowed within the ground water storage area for any reason. The integrity of the Site fencing is to be maintained indefinitely.

TABLE 1-1
SUMMARY OF MAXIMUM CONTAMINANT LEVELS

Substance	Soil (ppb)	Ground Water (ppb)
Acetone	190	75,000
Benzene	65	14,000
Carbon Tetrachloride	ND	1,500
Chloroform	5,800	18,000
Ethylbenzene	76	9,600
Methylene Chloride	ND	230,000
Tetrachloroethane	4,700	750
Toluene	39	24,000
Trichloroethene	130	6,100
Xylene	280,000	40,000

ND - Not Detected


NOTE 1: ALL PROPERTY LINE INFORMATION WAS OBTAINED FROM A DRAWING BY URBAHN/SEELYE TITLED "SITE WORK - NEW SCOTLAND AVENUE LABORATORY REPLACEMENT ALBANY, NEW YORK - PHASE I - PLANS" DATED MAY 10, 1990, AND LABELED AS DRAWING #C1.01 FOR PROJECT 7020 0601. NO FIELD WORK WAS PERFORMED TO VERIFY THIS INFORMATION.
UTILITY POLE
MANHOLE
CHAIN LINK FENCE
ASPHALT
UTILITY POLE
VEHICLE STORAGE BUILDING NO. 5
POWER HOUSE
1ST BATTALION 210th ARMORED DIVISION
NEW YORK ARMY NATIONAL GUARD
MW-1M
CATCH BASIN
GATE
JUNCTION BOX FOR UNDERGROUND TELEPHONE
CHAIN LINK FENCE
STACK
GATE
GATE
DIRT ACCESS ROAD
CATCH BASIN
MW-6S
MW-9S
MW-9M
MW-2M
CONSTRUCTION TRAILERS
"PIT" LOCATION
MW-7S
MW-7D
MW-5S
MW-5M
MW-10S
RW-1
ELECTRICAL PANELS
MW-3M
MW-3S
UTILITY POLE
MW-4S
MW-4M
MW-4D
EDGE OF ASPHALT
ASPHALT PARKING LOT
MW-8S
MW-8M
MW-11S
MW-11M
LANDS N/F CHRISTIAN BROTHERS ACADEMY
LEGEND
MW-2M MONITORING WELL LOCATION AND ID NUMBER (PHASE I)
MW-10S MONITORING WELL LOCATION AND ID NUMBER (PHASE II)
MW-9S PIEZOMETER LOCATION AND ID NUMBER (PHASE II)
RW-1 4-INCH RECOVERY WELL LOCATION AND ID NUMBER
SOURCE: MAP ENTITLED, "SITE PLAN FOR WADSWORTH LABORATORY, ALBANY, NEW YORK" PREPARED 11/15/90 BY CAPE SERVICES, INC. FOR ERM-NORTHEAST, ALBANY, NEW YORK.
TITLE
RECOVERY WELL LOCATION
PREPARED FOR
NYS DEPARTMENT OF HEALTH
ERM
ERM-Northeast
Environmental Resources Management
SCALE 1"=40'
DATE 11/91
FIGURE 1-1



LEGEND

● SOIL BORING LOCATION

TOTAL TCL VOLATILE ORGANIC COMPOUNDS EXCEED 1 ppm FOR SAMPLES 1' TO 4' BELOW GROUND SURFACE

BASED ON 1990 RI DATA

SOURCE: MAP ENTITLED, "SITE PLAN FOR WADSWORTH LABORATORY, ALBANY, NEW YORK" PREPARED 11/15/90 BY CAPE SERVICES, INC. FOR ERM–NORTHEAST, ALBANY, NEW YORK.

TITLE

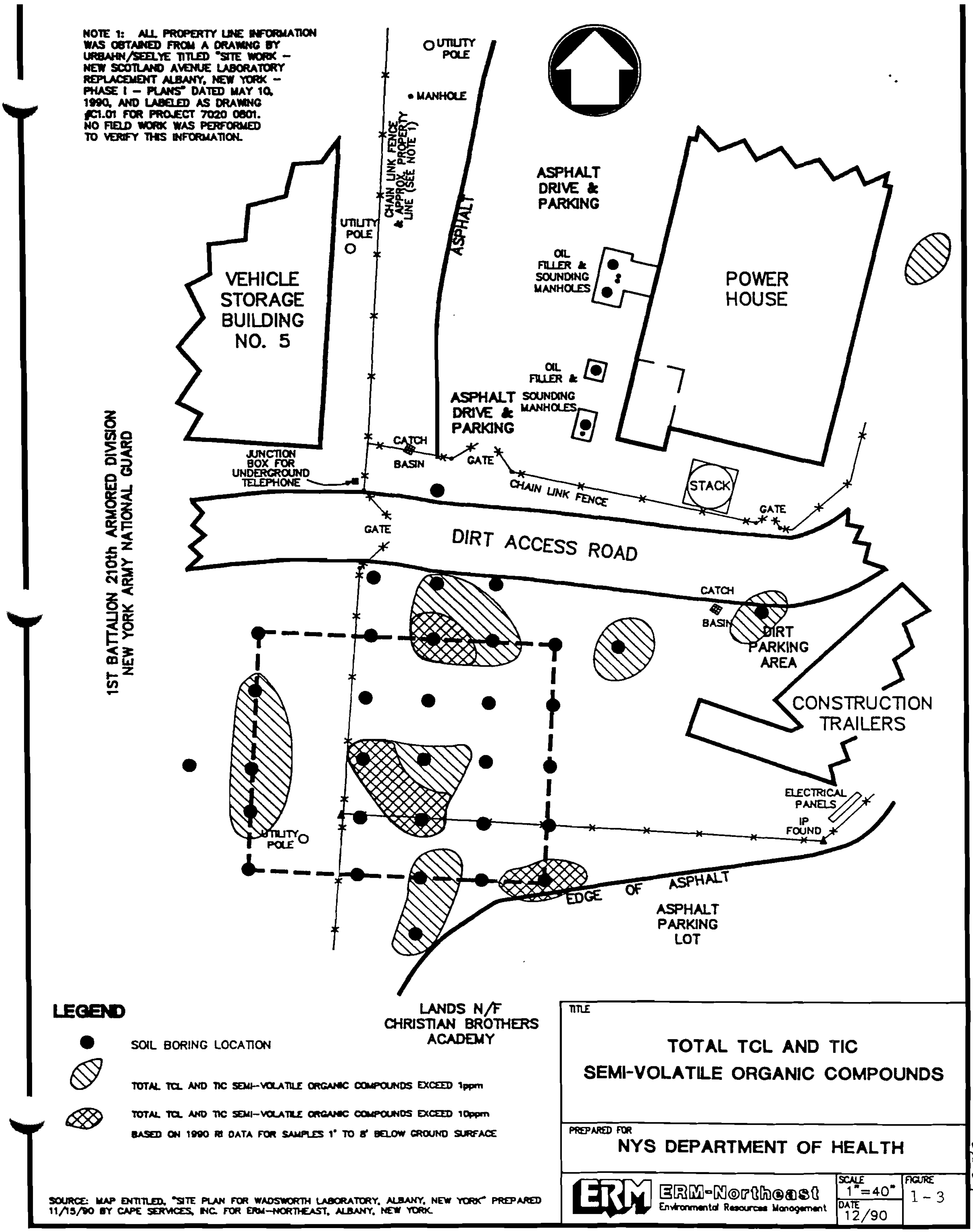
TOTAL TCL VOLATILE ORGANIC COMPOUNDS

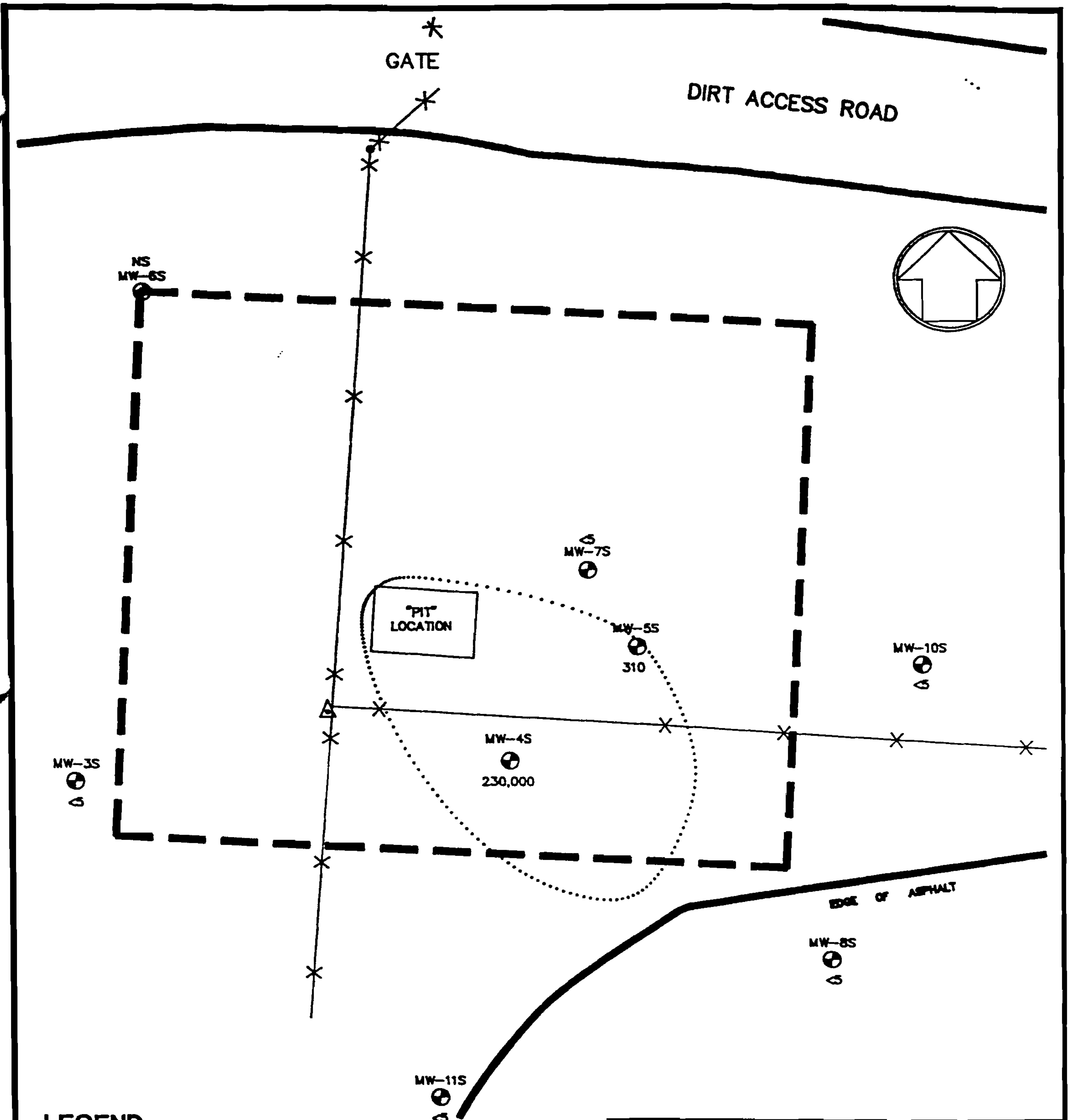
PREPARED FOR

NYS DEPARTMENT OF HEALTH

ERM-Northeast
Environmental Resources Management

SCALE	FIGURE
1"=40"	1 - 2
DATE 12/90	


NOTE 1: ALL PROPERTY LINE INFORMATION WAS OBTAINED FROM A DRAWING BY URBAHN/SEELYE TITLED "SITE WORK - NEW SCOTLAND AVENUE LABORATORY REPLACEMENT ALBANY, NEW YORK - PHASE I - PLANS" DATED MAY 10, 1990, AND LABELED AS DRAWING #C1.01 FOR PROJECT 7020 0601. NO FIELD WORK WAS PERFORMED TO VERIFY THIS INFORMATION.
UTILITY POLE
MANHOLE
CHAIN LINK FENCE & APPROX. PROPERTY LINE (SEE NOTE 1)
ASPHALT
ASPHALT DRIVE & PARKING
VEHICLE STORAGE BUILDING NO. 5
OIL FILLER & SOUNDING MANHOLES
POWER HOUSE
ASPHALT DRIVE & PARKING
1ST BATTALION 210th ARMORED DIVISION NEW YORK ARMY NATIONAL GUARD
JUNCTION BOX FOR UNDERGROUND TELEPHONE
CATCH BASIN
GATE
CHAIN LINK FENCE
STACK
DIRT ACCESS ROAD
DIRT PARKING AREA
CONSTRUCTION TRAILERS
ELECTRICAL PANELS
IP FOUND
EDGE OF ASPHALT
ASPHALT PARKING LOT
LANDS N/F CHRISTIAN BROTHERS ACADEMY
LEGEND
SOIL BORING LOCATION
TOTAL TCL AND TIC SEMI-VOLATILE ORGANIC COMPOUNDS EXCEED 1ppm
TOTAL TCL AND TIC SEMI-VOLATILE ORGANIC COMPOUNDS EXCEED 10ppm
BASED ON 1990 RI DATA FOR SAMPLES 1' TO 8' BELOW GROUND SURFACE
SOURCE: MAP ENTITLED, "SITE PLAN FOR WADSWORTH LABORATORY, ALBANY, NEW YORK" PREPARED 11/15/90 BY CAPE SERVICES, INC. FOR ERM-NORTHEAST, ALBANY, NEW YORK.
TITLE
TOTAL TCL AND TIC SEMI-VOLATILE ORGANIC COMPOUNDS
PREPARED FOR
NYS DEPARTMENT OF HEALTH
ERM-Northeast
Environmental Resources Management
SCALE 1"=40"
DATE 12/90
FIGURE 1-3



LEGEND

MW-8S — MONITORING WELL LOCATION & ID NUMBER

<5 — METHYLENE CHLORIDE CONCENTRATION (in ppb)

Estimated extent of ground water contamination

NS — NOT SAMPLED

ND — NOT DETECTED

BASED ON APRIL 1991 SAMPLING

ESTIMATED EXTENT OF GROUND WATER CONTAMINATION

PREPARED FOR

NYS DEPARTMENT OF HEALTH

ERM-Northeast
Environmental Resources Management

SCALE	FIGURE
1"=20'	1-4
DATE 8/91	

D:\PCM\205CL 11/05/91 0921

2.0 PERMITS AND REGULATORY REQUIREMENTS

2.1 PERMIT REQUIREMENTS

Since the NYSDOH is a State Agency, no permits are required for the work associated with the implementation of the remedial program.

2.2 REGULATORY REQUIREMENTS

NYSDOH must obtain an Environmental Protection Agency (EPA) Identification Number before recovered ground water from the site can be shipped to the selected disposal facility.

NYSDOH has classified the contaminated ground water to be recovered from the site as a hazardous waste. Because the recovered ground water will be disposed of off-site and is regulated under RCRA, NYSDOH was required to file a USEPA Notification of Regulated Waste Activity with NYSDEC. NYSDOH indicated on an existing Notification of Regulated Waste Activity that the ground water would be assigned the RCRA hazardous waste code "F039 Multi-Source Leachate". Prior to this filing, the Site was issued the EPA ID Number NYD 148615263.

In order to properly transport and dispose of any recovered ground water off-Site, NYSDOH must manifest all ground water disposal shipments by including the hazardous waste code and EPA ID Number on all manifest forms.

NYSDOH must also ensure that the transporter and off-Site treatment, storage, and disposal facility operate under all appropriate federal and state hazardous waste regulations, permits and other legal requirements.

Specific issues and requirements regarding manifesting and disposal of ground water and sediments are addressed in Section 5.5.3, in addition to other hazardous waste activity reporting requirements.

3.0 PERSONNEL

3.1 GENERAL DISCUSSION

The successful operation of any facility, be it a factory, office, or treatment plant, is dependant on the quality, competence and personal satisfaction of the people employed to operate and manage the facility, and the manner in which they are organized to perform their necessary and required duties. Regardless of how well a remediation site is designed, the operation can only be as successful as the performance of the personnel and organization operating it.

It is anticipated that the NYSDOH will perform the services required to operate and maintain the Remedial Program for the Plant after ERM has performed the first year of Operations and Maintenance.

This chapter will provide guidelines and requirements for the development of an organizational structure and personnel policy which will provide for successful and reliable operation and maintenance of the Remedial Program for the Plant. Topics to be addressed include personnel certification, staffing and responsibilities.

3.2 ORGANIZATION OF REMEDIAL PROGRAM OPERATIONS

The major functions of the Remedial Program operation include:

- Operations
- Monitoring
- Analytical/Record Keeping and Reporting
- Maintenance

- Mechanical/Technical
- Housekeeping
- Yard Work
- Ground Water Disposal

Although it is essential in the operation of the Remedial Program that there be versatility with all operating personnel for the work of functions identified above, it is considered appropriate that these five functions be the primary responsibility of one individual. This individual will hereinafter be called the "operator".

Given the small size of the Plant and the fact that the required operation and maintenance of the Remedial Program is not labor intensive, the work of the operator is not anticipated to be a full time position.

There will be occasions when the services of qualified mechanical, electrical or instrumentation contractors are required. It is recommended that a list of qualified contractors be compiled and available at the Plant in the event there is work to be performed for which available staff are not qualified. The following contractors were employed by Barbella Environmental Technologies, Inc. (BET), in the construction of the Remedial Design and should be considered for future work at the Plant.

Instrumentation/Hook-up with Plant Monitoring System:

J. Hall Ltd.
99 Central Avenue
Ravena, N.Y. 12143
voice: (518) 756-8235
fax: (518) 756-9695

Contact: Jerome Hall

Electrical:

J. Hall Ltd.
99 Central Avenue
Ravena, N.Y. 12143
voice: (518) 756-8235
fax: (518) 756-9695

Contact: Jerome Hall

Mechanical:

Barbella Environmental Technologies, Inc.
Salem Industrial Park, Bldg. 8
Whitehouse, N.J. 08888
voice: (908) 534-1664
fax: (908) 534-1697

Contact: Frank Barbella

3.3 MANAGERIAL RESPONSIBILITIES (NYSDOH)

As noted above, it is anticipated that the NYSDOH will perform the services required to operate and maintain the Remedial Program for the Plant after the first year of operations and maintenance by ERM-NE.

The NYSDOH will be responsible for the oversight of all aspects of the administration and operation and maintenance of the entire Remedial Program for the Restoration Site including compliance with all requirements of the Consent Order issued for the Site. The specific managerial responsibilities which the NYSDOH will assume for the operation and maintenance of the Remedial Program are outlined in the following list:

1. Maintain efficient Plant operation and maintenance.

2. Maintain adequate Remedial Program operational and management records.

3. Establish staff requirements and assign personnel as appropriate.

4. Prepare an appropriate budget and ensure that costs associated with operation and maintenance of the Remedial Program stay within that budget.

5. Make employees aware of the importance of proper Plant performance.

6. Make periodic inspections of the Plant and associated facilities to discuss mutual problems with the operational personnel and to observe operational practices.

7. Create an atmosphere that will make operational personnel feel that they can bring special problems to management's attention.

8. Maintain good public relations.

9. Submit required reports to NYSDEC in a timely manner.

10. Be responsible for all Plant security. Ensure that fences around Plant are intact and that no unauthorized person enters or remains on Plant property.

11. Perform custodial and grounds keeping chores and any maintenance work or repairs required.

12. Plan for future Plant needs.

3.4 OPERATOR RESPONSIBILITIES (ERM-NE THE FIRST YEAR)

The services required to administer, operate and maintain the Remedial Program for the Plant have been contracted by the NYSDOH to ERM-NE for the first year of Operations and Maintenance (O+M). It has been assumed that the NYSDOH will take over O+M after the first year and subcontract the semi-annual sampling events. The specific responsibilities to be assumed by the Contractor (operator) are outlined in the following list:

1. Exercise direct authority over any subordinate personnel and subcontractors in accordance with approved policies and procedures. Provide training as required.

2. Establish work priorities for Plant personnel, and when necessary, authorize work orders to obtain the services of outside contractors.

3. Schedule and oversee all Plant maintenance including preventative maintenance and lubrication.

4. Direct and supervise the preparation of operating logs and reports, maintenance and repair schedules and reports, requests for contract work, purchase requisitions, equipment files and accident reports. All reports are to be submitted to the NYSDOH.

5. Provide good working conditions, proper tools, and safety equipment for the operational personnel.

6. Analyze and evaluate operation, maintenance and monitoring activities; initiate or recommend new or improved practices.

7. Schedule and implement all ground water disposal and complete associated paperwork.

8. Inspect all facilities regularly.

9. Ensure a safe working environment. Formulate advance planning and take steps to prevent employee injuries and equipment damage; anticipate hazards in new procedures and materials and develop procedures for controlling such hazards. Provide leadership and motivation in a continuing safety program.

10. Implement and enforce all Plant health and safety requirements.

11. Provide regular safety training.

12. Perform monitoring, sampling, and analysis as required or scheduled according to the Order on Consent. Review and perform QA/QC of all laboratory work. Sampling consists of quarterly analyses of the ground water monitoring wells the first year after construction, then semi-annually.

13. Review and approve all process data collected and maintain process data records.

14. Prepare, or review and approve, operation and progress reports.

15. Prepare NYSDEC reports for NYSDOH review.

16. Operate and maintain the Plant equipment.

17. Observe variations in operating conditions and interpret monitoring equipment output and analytic results to determine processing requirements.

18. Maintain all record and reporting forms included in this manual (including maintenance records).

19. Assist in the start-up of new equipment.

3.5 CERTIFICATION AND TRAINING REQUIREMENTS

Although the Plant operator should have previous experience in the operation of industrial facilities, and should be generally knowledgeable about process terminology and equipment, there are no regulatory requirements concerning certification of Plant personnel.

The Plant operator must have participated in a health and safety training program that complies with OSHA regulation 29 CFR 1910.120. Refer to the Health and Safety Plan included as Appendix F to this manual for additional information regarding health and safety training.

In addition to the health and safety training identified above, the Plant operator must also have participated in a hazardous waste training program which complies with the requirements of NYCRR, Title 6, Chapter IV, Subpart B, Subpart 373-3.2(g).

3.6 STAFFING

During initial Plant start-up and operation, it is recommended that the operator or his/her assistant be present on-Site at a minimum of two hours per day for a period of five days. Plant start-up will commence with the written approval of this O+M Manual by the NYSDOH and the NYSDEC.

After the initial start-up period, while a full time presence at the Plant is not required, it is strongly recommended that the operator or his/her assistant visit and check all Plant operations three times a week for the first month, then at least twice a week for the next two months and then at least once a week for the remainder of the first year.

4.0 LABORATORY TESTING

4.1 GENERAL INTRODUCTION

This chapter describes the laboratory analytical parameters associated with the operation and monitoring of the Remedial Program. The discussion focuses on the sampling and analysis procedures which should be followed in the determination of specific parameters. The preparation and frequency of reports generated using the laboratory data are described in Chapter 5. It is essential that Plant operating personnel are familiar with all sample collection methods and laboratory analyses performed, in order to:

1. Collect samples correctly;
2. Make operational decisions based on the results; and
3. Accurately complete reports to regulatory agencies.

4.1.1 Purpose of Laboratory Testing

In this chapter, laboratory testing of Plant ground water and ground water sediments is discussed. The purpose of this laboratory testing is to:

1. Qualitatively characterize the recovered ground water for disposal purposes.

2. Qualitatively characterize the recovered ground water sediments for disposal purposes. Very little accumulation of sediments is anticipated in the ground water storage tanks. Testing of sediments will be necessary on a very infrequent basis, if at all.

3. Verify that contaminated ground water is not migrating off of the Site.

The laboratory test results should be recorded in a manner which facilitates operational decision-making and the preparation of reports. Sampling, testing, and recording must be done accurately in order to preclude operational decisions and reports to regulatory agencies which are based on erroneous data. In addition, laboratory analytical data obtained from samples that are improperly handled may be invalidated by NYSDEC. The required sampling frequencies are presented in Chapter 5.

4.1.2 Scope of Laboratory Analysis

Laboratory analysis of collected samples can be classified as either physical or chemical. Physical analyses include temperature and solids determinations. Chemical analyses are generally more complicated than physical analyses performed on the same sample, and include VOCs, Semi-VOC's and pH determinations.

4.1.3 Laboratory Facilities

The Plant does not contain any environmental laboratory capabilities. All laboratory analytical services must therefore be contracted to off-site laboratories. All ground water and sediment analyses should be performed by a New York State Department of Health (NYSDOH)-certified laboratory.

The operator may choose which labs to contract these services to, subject to the approval of the NYSDOH. The following laboratory has been retained for previous ground water and sediment analytical work at the Site and has been contracted by ERM-NE to perform the analytical work for the first year of operations and maintenance.

Adirondack Environmental Services, Inc.
314 North Pearl Street
Albany, NY 12207
Telephone No. (518) 434-4546
Facsimile No. (518) 434-0891
Contact: Frank Scuderi

4.1.4 Laboratory Analytical Protocols and Procedures

Table 4-1 lists the approved procedures for sample collection, handling, and laboratory analyses for each required analytical parameter. These references are fully identified in Table 4-2, which also lists supplementary reference materials.

4.2 GENERAL SAMPLING REQUIREMENTS

The value of any laboratory analytical result depends upon the integrity of the sample and the competency of the sample collector. The objective of sampling is to collect a portion of material small enough in volume to be conveniently handled in the laboratory, but still representative of the material being analyzed. The sample must be collected in a manner which will assure that nothing is added or lost in the portion, and that no change occurs during the time between the collection and the laboratory analysis of the sample.

All ground water sampling on the Plant will consist of grab samples. A grab sample is an individual sample collected over a period not exceeding 15 minutes.

Sediment sampling, if necessary, will be collected as a composite sample, which is defined as a combination of individual (or continuously taken) samples (aliquots) collected at periodic intervals over a specified time period. In all cases, the samples delivered to the laboratory must be representative of the actual material being sampled.

Several general practices must be followed when collecting samples, and are listed below:

1. All sampling must be performed in accordance with applicable NYSDEC protocols.

2. Ensure that the sample collection container and any sampling equipment which may come in contact with the sample are clean.

3. Ensure that the sample collection container has received any required preparatory treatment for the analysis, including the addition of chemical preservative if required. Refer to Table 4-1 for specific preparatory requirements.

4. Tied-on or affixed labels with an identification number shall be used for labeling all samples.

5. After the sample has been collected, the container label must be completely filled out, identifying the sample no., location, date, time, and name of the sampler. If the label has been removed, it shall be reaffixed or replaced, or the container must be discarded.

6. All sample deliveries to the laboratory must include a completed chain-of-custody form.

7. The chain-of-custody form shall list at a minimum the following information:

    a. Sample number

b. Description of samples
c. Specific location of sample collection
d. Identity of person collecting the sample
e. Date and time of sample collection
f. Date and time of custody transfer to laboratory (if the sample was collected by a person other than laboratory personnel)
g. Name of the laboratory
h. Type and quantity of containers
i. Requested analyses

8. Use only proper sampling equipment and containers.

9. All samples should be stored and transported in a chilled condition. This may be accomplished by use of "blue ice" paks.

10. Implement proper personnel safety and hygiene precautions when collecting and handling samples. Refer to the HASP located in Appendix F to this manual.

4.3 RECOVERED GROUND WATER

4.3.1 Recovered Ground Water Sampling Procedures

Samples of recovered ground water must be collected and analyzed periodically in order to obtain disposal facility acceptance. The sampling frequencies will be established by the disposal facility. Analysis of these samples will also indicate the quality of recovered ground water for NYSDEC reporting purposes.

Recovered ground water should be sampled from the drain valve on the effluent line to the site tank.
Sampling procedures are as follows:

1. The bottles listed in Table 4-1 for recovered ground water sampling must be used to contain the ground water being sampled, and the sampling equipment listed in Table 4-3 must be used to conduct the sampling.
2. It is recommended that a bucket be used to catch any water which is not captured by the sample containers. (Any water captured in the bucket must subsequently be placed back into the ground water requime by dumping back down the recovery well or placed back into the tank through the manhole at the top of the tank.)

3. Open the sample valve slowly while holding a sample container under the valve.

4. Repeat this procedure until all sample bottles are filled. **The VOC sample containers must contain no air spaces or bubbles.**

5. Properly label and pack the sample containers for delivery to the laboratory, making sure to include "ice" packs, and a completed chain-of-custody form.

6. Ship the samples promptly to a NYSDOH-certified laboratory.

Unless directed otherwise, all samples should be grab samples.

4.3.2 *Laboratory Analyses of Recovered Ground Water*

Analytical requirements for recovered ground water must be coordinated through the disposal facility. Although the analytical requirements may change in the future, it is expected that similar parameters to those as listed below will be required for future disposal.

1. Flashpoint

2. pH
3. Total Sulfides and Cyanides
4. Total Suspended Solids
5. Total Organic Carbon
6. Volatile Organic Compounds
7. Total Metals:
   - Arsenic
   - Barium
   - Cadmium
   - Chromium
   - Copper
   - Lead
   - Mercury
   - Nickel
   - Selenium
   - Silver
   - Zinc
8. All F039 (Multi-Source Leachate) wastewater constituents listed in Table CCW in 40 CFR 268.43.

Sample collection, handling, and analytical testing protocols and procedures for recovered ground water are summarized in Table 4-1. Results of all recovered ground water testing should be recorded on Figure 5-4, located at the end of Chapter 5.

4.4 RECOVERED GROUND WATER SEDIMENTS

Low concentrations of suspended solids have been identified in the Site ground water. During normal Site operations, however, these suspended solids will tend to settle to the bottom of the ground water storage tank. If these sediments accumulate on the bottom of the tank, arrangements will have to be made for their disposal. Sediment disposal, if required at all, is expected to be on a very infrequent basis.

4.4.1 *Sediment Sampling Procedures*

Sediment in the ground water storage tank must be sampled by entering the tank through the 24" manhole at the top of the tank. Verify that the tank is empty before removing the manhole.
Sampling procedures are as follows:

1. **The safety procedures regarding tank entry, listed in Section 6.3.5, must be implemented during sediment sampling.** Proper sampling and safety equipment must be worn and used prior to, and during, tank entry.

2. The number and type of sample containers required will be determined by the disposal facility.

3. Collect the sediment samples as either grab or composite samples, depending on instructions from the disposal facility.

4. VOC sample containers, when filled, must contain no air spaces.

5. Properly label and pack the sample containers for delivery to the laboratory, making sure to include "ice" packs and a completed chain-of-custody form. (Refer to Section 4.2.)

6. Ship the samples to a NYSDOH-certified laboratory.

4.4.2 *Laboratory Analyses of Ground Water Sediments*

Until sediment disposal is required, and disposal facilities subsequently contacted, the sediment analytical requirements cannot be finalized. All analytical requirements must be coordinated through the disposal facility.

It is expected that the analytical requirements would be similar to the parameters listed in Section 4.3.2 for recovered ground water, with the addition of a Toxicity Characteristic Leaching Procedure (TCLP) analysis.

4.5 SITE MONITORING WELLS

The Consent Order for the Site requires that ground water quality downgradient of the "pit"/Site be monitored and evaluated periodically through sampling and analysis. This will be accomplished by sampling seven monitoring wells on the Site. The wells selected for downgradient sampling are monitoring wells MW-4S, MW-4M, MW-4D, MW-5S, MW-5M, MW-8S and MW-8M. Refer to Section 5.5.1.1. Results of all sampling must be reported to NYSDEC.

4.5.1 Monitoring Well Sampling Procedures

The monitoring wells should be sampled from "clean" to "dirty". Based on previous RI/FS data, the order of well sampling should be as follows: MW-8M; MW-5M; MW-5S; MW-8S; MW-4D; MW-4M and MW-4S.

The static water in each of the wells must be evacuated prior to sampling. In order to properly evacuate each well, the water volume in each well must be determined using a water level indicator. The volume is calculated according to the formula.

$$\text{Volume} = (\pi \bullet r^2 \bullet h \bullet 7.48\ \text{gal/ft}^3),$$

where:

r = radius of the well in feet

h = height of static water in the well, in feet

The height of static water should be measured to the nearest one-hundredth of a foot. To obtain the static water height, measure the depth from the north side of the top of the well casing to the bottom of the well, and the depth from the north side of the top of the well casing to the ground water surface. The static water height is equal to the well depth minus the depth to water. The water level indicator must be cleaned before use in each well.

In order to simplify the well volume calculations, the following chart is included which combines all equation terms except the static water height.

Well	Radius	Volume (gallons)
MW-4S	2"	.65 h*
MW-4M	2"	.65 h*
MW-4D	2"	.65 h*
MW-5S	2"	.65 h*
MW-5M	2"	.65 h*
MW-8S	2"	.65 h*
MW-8M	2"	.65 h*

* where h = static water height in feet

Three well volumes should be evacuated, using the dedicated Waterra sampling devices presently installed in each well, prior to sample collection. Removal of three volumes should ensure the collection of a representative sample not influenced by stagnant well water. If the well goes dry during evacuation, allow the well to recharge and then continue evacuating the well until at least one and one-half well volumes are purged. All evacuated well water must be containerized and disposed of by emptying the container into the recovery well or the top of the tank through the manhole. After the first round of sampling is completed, containerized ground water from downgradient wells which tested contaminant-free, can be disposed of by dumping on the landscaped portion of the Site.

Once the well has been properly evacuated, the sample should be collected as follows:

1. The dedicated Waterra sampler should be lowered approximately ten feet below the water surface, in order to collect a representative well sample.

2. Sample preservatives indicated in Table 4-1 should be supplied by the laboratory in each of the appropriate sample containers.

3. When transferring the water from the Waterra sampler to the sample container, care must be taken to avoid agitation of the sample, which would promote the loss of chemical constituents due to volatilization. Refer to Table 4-1 for a list of sample collection, handling and analytical procedures.

4. The samples must be collected and packaged quickly, to avoid losses of volatile constituents. **The sample containers must not contain air spaces or bubbles.**

5. Label all containers properly, and then package for delivery to the laboratory. Include a completed chain-of-custody form and "ice" packs.

6. Ship the samples promptly to a NYSDOH-certified laboratory.

In each round of sampling, one trip blank and one duplicate sample must be analyzed in order to achieve QA/QC of all sampling events. The trip blank is filled with analytically pure water by the laboratory, is shipped to the Site, and then shipped back to the laboratory for analysis. The trip blank must not be opened except at the laboratory.

The duplicate sample should be collected from one of the seven wells, and submitted for analysis in order to determine sample representativeness. The duplicate sample should be labeled and presented to the laboratory in a manner so that the laboratory will not be aware that it is a duplicate sample. The duplicate sample must be collected following the procedures described above.

Although the Remedial Design Report requires the collection and analysis of a field blank during all well sampling events, this is not necessary because each well contains a dedicated sampler. Cross-contamination of samples due to field decontamination procedures is not possible since the sampling equipment never requires decontamination.

4.5.2 *Monitoring Well Analytical Requirements*

All monitoring well samples must be analyzed for TCL VOCs and TCL Semi-VOCs in accordance with 1991 NYSDEC ASP guidelines. Sample collection, handling, and testing procedures and protocols for downgradient well sampling are summarized in Table 4-1. Results of this sampling should be recorded on Figure 5-3 located at the end of Chapter 5.

TABLE 4-1
SAMPLE COLLECTION, HANDLING AND TESTING PROTOCOLS AND PROCEDURES

Sample Category	Analytical Parameters	EPA Test Method	Container Type	Size	Preservative
Recovered Ground Water***	VOCs	624	glass	40 ml*	none**
	pH	150.1	polyethylene	500 ml	none
	TSS	160.2	polyethylene	500 ml	none
	TOC	415.1	glass	40 ml	H_2SO_4
	Flashpoint	ASTM D93-77	glass	4 oz.	none
	Sulfides	376.2	polyethylene	500 ml	Zn-acetate
	Cyanides	335.2	polyethylene	1 liter	NaOH
	RCRA Metals + Cu, Ni, Zn	---	polyethylene	500 ml	HNO_3
	F039 Multi-Source Leachate Parameters	Various	***	***	***
Site Monitoring Wells	TCL VOCs	1991 NYSDEC ASP 91-1	glass	40ml*	none**
	TCL Semi-VOCs	1991 NYSDEC ASP 91-2	glass	1 liter	none

* 40 ml glass vials must have teflon caps and septums.
** No preservative is required for these VOC samples since they will be shipped and analyzed by the laboratory within seven days.
*** Coordinate these requirements with disposal facility.

TABLE 4-2
LABORATORY REFERENCES

1. Standard Methods for the Examination of Water and Wastewater - 17th Edition; American Public Health Association, 1015 Fifteenth Street, N.W., Washington, D.C. 20036, 1988.

2. "Microbiological Methods for Monitoring the Environment, Water, and Waste", U.S. Environmental Protection Agency, EPA-600/8-78-017, 1978.

3. "Methods for Chemical Analysis of Water and Wastes", U.S. Environmental Protection Agency, EPA-600/4-79-020, 1979.

4. "Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments", U.S. Department of the Interior, U.S. Geological Survey, Open File Report 85-495, 1986.

TABLE 4-3
SAMPLING EQUIPMENT

Sampling Equipment*	Quantity
Rubber Gloves	1 box
Splash Goggles	2 pairs
Trowels	2
Packing Material	
Chain-of-Custody Forms	

* Refer to Chapter 6 for safety equipment to be worn when entering the ground water storage tanks.

5.0 RECORDS AND REPORTS

5.1 GENERAL DISCUSSION

The purpose of this chapter is to describe in detail the records and reports that serve to document the operation and performance of the Plant. The records have been organized to include operating data which will be available from Plant instrumentation, and data which must be recorded based on Plant inspections. The reporting forms contained in this chapter should be filled out regularly.

5.1.1 *Importance of Plant Records*

The maintenance of complete and accurate records is essential to the proper and efficient operation of the Plant. These records provide a comprehensive and continuous account of Plant performance, from which operational procedures are evaluated and modified as necessary, and from which required reports are prepared. Plant records are also an important source of information for scheduling Plant maintenance and repairs, and for justifying Plant expansions or modifications if needed. To achieve these goals, it is important that entries are made in the Plant operating records routinely and accurately, and that changes in the key control parameters are recognized early through timely evaluation of the recorded data.

In addition, Plant data files created by the Axelrod Security computer should be downloaded regularly to electronic storage media (e.g., floppy disks, tapes). Backup copies of all Plant data should be maintained.

5.1.2 *Use of Graphs and Trend Charts*

Plotting and graphing of the key operational parameters are of great value to the Plant operating personnel in providing an easily recognizable visual indication of changes in Plant efficiency. Such regular plotting of data may reveal unexpected trends which can trigger early corrective action and prevent operational disturbances. Trend charts developed from the plotted data will show short term and long term trends in Plant operation and may be used to justify and support changes or modifications to monitoring or operational procedures.

5.1.3 Storage of Records and Reports

Records and reports must be readily retrievable if they are to be of any value in the operation and control of the Plant. Thus, the establishment of an efficient storage and filing system is essential. The record storage and filing system should be located in the Maintenance Plant of the Axelrod Institute. Files should be maintained in file folders which are stored in filing cabinets. The files should be arranged in accordance with a logically designed filing system to enable rapid retrieval of records, reports, and technical data when needed. Manuals and reference books should be catalogued and stored in an orderly manner on book shelves. Record drawings and other plans should be stored on hanging plan file racks as noted hereafter.

5.2 PHYSICAL RECORDS

5.2.1 Plant Engineering Data

5.2.1.1 Record Drawings

A complete set of Record ("As-Built") Drawings of the Plant should be maintained at the Maintenance Plant of the Axelrod Institute for ready reference by operating personnel. The drawings should be protected by stiff cover sheets, clamped on a hanging plan file, and stored on a plan rack for protection and easy access.

A set of reproducible Record Drawings is maintained by the NYSDOH at their operations offices in the Empire State Plaza.

5.2.1.2 *Construction Specifications*

A bound set of the technical sections of the construction specifications for the Site, including all addenda, should be maintained at the Maintenance Plant of the Axelrod Institute for ready reference by operating personnel.

5.2.1.3 *Permits*

As previously noted in Chapter 2, permits were NOT required for this Site.

5.2.2 *Plant Equipment Data*

5.2.2.1 *Shop Drawing Submittals*

A complete set of approved shop drawings, manufacturers' brochures, O&M manuals, and related submittal data from the Plant construction contractor, and later replacement equipment suppliers, should be maintained at the Maintenance Plant of the Axelrod Institute for reference by operating and maintenance personnel.

Manufacturer O&M manuals for all Plant equipment items are included as Appendix D to this O&M Manual. The manufacturer O&M manuals include the approved shop drawing for the appropriate equipment item.

5.2.2.2 *Equipment History Cards/Forms*

Records of the equipment used at the Plant should be maintained on Equipment History Cards or Forms, as described and illustrated in Chapter 12, or on a computer database.

5.3 *PLANT OPERATING RECORDS*

Plant operating records are the recorded results of observations, tests, and measurements performed during the operation and maintenance of the Plant. Data to be recorded and maintained should be only the data necessary to control the processes, to record the operating conditions, or to provide data for the preparation of the required reports listed hereafter.

Reporting forms for the Plant have been developed using the Microsoft Excel spreadsheet program, and are described in more detail in the following subsections.

5.3.1 *Plant Control Records*

The Plant control records consist of the Process Reports developed specifically for the Plant. The Process Reports should be maintained by the Plant operator and will provide a record of the general Plant operating conditions. Recorded data include equipment operational and control status, flow measurements, instrumentation readings, etc. Unusual conditions and maintenance/repairs should be entered in the comments section of the appropriate operating report and further discussed in the operator's log if warranted.

The Process Reporting Forms listed below have been specifically developed for this Plant, and all applicable Reporting Forms should be filled out as appropriate during operator Plant visits. All of these Reporting Forms are located at the end of this chapter.

Figure No.	Operating Report
5-1	Ground Water Storage Tank Operating Report
5-2	Plant Alarm Log

5.3.2 *Laboratory Records*

All laboratory work will be performed by an outside laboratory. Data from laboratory tests of ground water samples should be maintained in a loose leaf binder or other appropriate filing system as selected by the NYSDOH. Any of the Laboratory Reports developed in accordance with Chapter 4 are also used as Plant control records, insofar as the laboratory test results contained therein are utilized in making adjustments to the process flows.

The Laboratory Reporting Forms listed below summarize the Plant data to be obtained through laboratory sample analyses, and should be used as a supplement to the actual laboratory reports. The Laboratory Reporting Forms are located at the end of this chapter.

Figure No.	Laboratory Analyses Summary Report
5-3	Ground Water Quality in Downgradient Monitoring Wells
5-4	Ground Water Quality in Storage Tank

5.3.3 *Maintenance Records*

The establishment of a good maintenance management system is a necessary supplement to the establishment of proper Plant operating procedures. The details of such a system are set forth in Chapter 12 of this manual. The records and forms associated with the maintenance management system are discussed in detail in that chapter. They are summarized herein for general familiarization:

1. Maintenance Planning Records - Schedule boards, maintenance work orders, standard maintenance procedures, and workload projections used for orderly and scheduled accomplishment of recurring maintenance work.

2. Equipment History Cards or Forms - (Discussed in Chapter 12).

3. Storage Area Records - Inventory cards, purchase order logs, and replenishment schedules required for proper management of spare part and consumable supply inventories.

5.3.4 Site Maintenance Records

The specific requirements for the maintenance of the Site grounds are discussed in Chapter 13 of this manual. The Reporting Forms associated with the implementation of Site maintenance are listed below, and are located at the end of this chapter.

Figure No.	Site Maintenance Report
5-5	Restoration Site Monitoring Well Levels
5-6	Site Maintenance Summary

5.4 PLANT ADMINISTRATIVE RECORDS

The official personnel and fiscal records related to the operation and maintenance of the Plant are maintained by the NYSDOH management. Supplementary local records pertaining to these administrative functions should be maintained by the operator for effective control of day-to-day operations, and to provide information to his supervisor(s) and the NYSDOH. Suggested record formats, contents, and use are discussed below.

5.4.1 *Personnel Records*

The basic types of local personnel records maintained by the Plant supervisory personnel include:

1. Operator Attendance Records

Operator attendance records should be maintained to provide documentation of the amount of time spent at the Plant by the operator and/or his assistants. This information may be required for regulatory authorities. An operator sign-in sheet (Figure 5-7) has been developed for this purpose, and is included at the end of this chapter.

5.4.2 *Operating Cost Records*

The operator should maintain cost records for proper control of expenditures on a daily basis, and to provide current information on Site operating costs. These records serve to supplement the NYSDOH's official accounting and bookkeeping records, and provide a basis for budget preparation and support for capital expenditure requests.

The operator may wish to track the operating costs given in Figure 5-8. It is recommended that the operator develop a form for any additional operating costs he feels warrant tracking. In addition, a monthly operating summary is included as Figure 5-9.

5.5 *REPORTS*

5.5.1 *Required Monitoring & Evaluation of Remedial Program*

The Consent Order requires that the NYSDOH prepare and submit periodic monitoring reports to the NYSDEC, in order to demonstrate that all components of the Remedial Program are operating effectively. These reporting requirements are identified in the Remedial Design Report, and are summarized herein for reference purposes.

This monitoring consists of the following key elements:

1. Monitoring of ground water quality downgradient of the Restoration Site.

It is anticipated that all reports submitted to NYSDEC will be in the form of letter reports, with all laboratory analyses and documentation attached. Several of the reporting forms included at the end of this chapter can also be used for reporting purposes, as backup data. In addition, all reports submitted to NYSDEC should include a completed copy of Figure 5-10, "Site Sampling Locations" which is a site map showing all sampling and monitoring locations. Specific sampling procedures and laboratory analyses required as part of the reports are presented in Chapter 4 of this manual. Actual reporting requirements and frequencies are presented below.

All reports sent to NYSDEC should be addressed to the following:

Bureau of Hazardous Site Control
Operations and Maintenance Section
NYSDEC Regional Office
50 Wolf Road
Albany, NY 12233-7010

Copies of <u>all</u> reports and data submitted to NYSDEC must be retained on-Site by the operator. All reporting requirements are summarized on Table 5-1, which is located at the end of this chapter.

Pursuant to the Consent Order, at least 10 working days advance notice of all sampling to be performed must be given to NYSDEC before the sampling occurs.

5.5.1.1 *Downgradient Monitoring Well Sampling*

The Consent Order requires that ground water quality downgradient of the "pit"/recovery well be monitored and evaluated periodically through sampling and analysis, and the results submitted to NYSDEC. The purpose of this sampling is to verify that downgradient migration of contaminated ground water from the original disposal location is not occurring.

The actual sampling procedures and analytical requirements for these wells are presented in Section 4.5.

The down-gradient wells will be sampled four times the first year (January, April, July and October). Semi-annual sampling of the downgradient wells shall be performed for the years two through five (in June and December of each year). The effects of ground water recovery will be evaluated yearly for the first two years for the quantity of recovered ground water and ground water quality. Due to small recharge rates and limited supply of ground water, additional recovery and disposal of the ground water may not be technically or economically feasible. If ground water recovery is continued after two years, a re-evaluation of the monitoring program will be made every 5 years to determine if a less frequent monitoring schedule is suitable or if monitoring may be discontinued.

The seven wells selected for downgradient sampling are:

MW-4S;
MW-4M;
MW-4D;

MW-5S;

MW-5M;

MW-8S; and

MW-8M.

Each report to be submitted to NYSDEC should consist of the laboratory analytical results, and a properly completed Figure 5-10 (Site Map), showing the location of the seven sampled wells.

5.5.2 Recommended Monitoring and Evaluation of Remedial Program

In addition to the Consent Order reporting requirements discussed in the previous section, the ROD also requires that monitoring and sampling of recovered Site ground water quality be performed on a continuous basis in order to determine the effectiveness of the Remedial Program. Because the ROD does not list any specific sampling requirements, the following sections recommend sampling and analytical procedures and protocols that should be used to implement the general requirements stated in the ROD. The recommended requirements are summarized on Table 5-2, which is located at the end of this chapter.

5.5.2.1 Ground Water Quality Reports

As discussed in Chapter 1, the recovered ground water will be transported to an appropriate off-Site disposal facility. The quality of recovered ground water will be tested for disposal purposes only, and will be sampled from the ground water storage tanks. The sampling procedures and recommended laboratory analyses for the recovered ground water are presented in Sections 4.3 of this manual.

Although the frequency of sampling events is expected to be one sampling event for every 50,000 gallons disposed of, the actual sampling frequency will be determined by the selected disposal facility. **All disposal facilities may not require identical analyses, therefore, sampling and analyses should be carefully coordinated with the selected disposal facilities if applications will be sent to more than one facility.**

The analytical results of any ground water storage tank sampling event should be used to complete Figure 5-4 for Plant record purposes. In addition, copies of all analytical results from a sampling event should be sent to NYSDEC, along with copies of the manifest forms discussed in Section 5.5.3.1.

In the future, should sediments deposit in the bottom of the tank, the sediments should be tested and disposed of in accordance with all applicable NYSDEC and USEPA hazardous waste regulations. Specific analytical parameters would have to be coordinated with the intended disposal facility. Refer to Section 4.4.2 for further discussion of analytical parameters.

5.5.3 NYSDEC Hazardous Waste Activity Reports

There are specific reporting requirements to NYSDEC related to the disposal of hazardous wastes from the Site. These requirements are explained in the following sections.

5.5.3.1 Ground Water Disposal Manifest Forms

Because the ground water has been classified as a RCRA hazardous waste, all shipments of ground water from the site to a RCRA subtitle C disposal facility must be accompanied by a Uniform Hazardous Waste Manifest Form. Blank copies of manifest forms are available from NYSDEC, however, many states require that the generator use manifest forms from the state where the waste will be disposed of. Therefore, the required manifest forms must be coordinated through the disposal facility, to determine the correct forms to use. The manifest form must identify the Site EPA ID Number and the F039 (Multi-Source Leachate) Waste Code. In addition, all shipments must include a completed Land Disposal Notification and Certification Form, which notifies the disposal facility regarding the proper treatment/disposal of the waste. This form is usually available from the disposal facility.

The manifest form contains instructions regarding distribution of copies. Required copies must be sent to NYSDEC's Manifest Section.

In the future, if any sediments are removed from the ground water storage tank, these sediments will also have to be properly disposed of and manifested in accordance with NYSDEC and USEPA regulations. These sediments would be classified as an F039 Multi-Source Leachate Non-wastewater for land disposal restrictions purposes, and the forms described above would have to accompany any shipments off of the Site.

5.5.3.2 *Generator's Annual Report of Disposal Activities*

The NYSDOH is required to complete a Generator's Annual Report of disposal activities, and submit this report to NYSDEC. This report must be submitted by March 1 each year. Forms for this report may be obtained by contacting NYSDEC.

5.5.4 *Monthly Operating Summary Report*

The Operator is responsible for preparing a monthly operating summary report for submittal to the NYSDOH at the beginning of each month. The Operating Summary Report should be a comprehensive statement of the effectiveness of Plant operations for the past month.

The Report should include a written narrative covering the following topics:

1. Operating data summary.

2. Management data summary

3. Compliance with permit requirements.

4. Abnormal events.

5. Major equipment failures.

6. Requirements for capital improvements or maintenance, including budget considerations.

The operating data entries are obtained from the operating reports described in Section 5.3. The management data are essentially cost-oriented. The operating cost records discussed in Section 5.4.2 are the primary source documents for this information.

The operating data should be summarized on the form included as Figure 5-9 and attached with the report narrative, along with a summary of monthly operating costs as outlined in Figure 5-8.

A copy of the complete monthly Operating Report should be sent to Ms Elizabeth Mahoney of the NYSDOH at the following address:

NYSDOH
Empire State Plaza
P.O. Box 509
Albany, N.Y. 12201-0509

TABLE 5-1
SUMMARY OF NYSDEC REPORTING REQUIREMENTS

Report Description	Monitoring Location	Monitoring Parameters	Sampling Frequency*	Proposed Sampling Dates
Slurry Wall Piezometer Well Measurements	Ten slurry wall piezometer wells. See Section 5.5.1.1 and Figure Nos. 5-15 & 5-18	Well level measurements	• Twice per week for first two weeks • Weekly for next six weeks • Monthly for next four months • Quarterly sampling for duration of the remedial program	Future quarterly sampling in March, June, September, and December of each year
Site Monitoring Well Level Measurements	Eighteen site monitoring wells. See Section 5.5.1.1 and Figure Nos. 5-16 & 5-18	Well level measurements	• Monthly for first six months • Quarterly for next eighteen months • Semi-annually for duration of the Remedial Program	Future quarterly sampling in March, June, September, and December of each year.
Downgradient Monitoring Well Sampling	MW-5 MW-6S MW-6D MW-7S MW-8S MW-8D See Section 5.5.1.2 and Figure No. 5-18	VOCs-EPA Method 624	• Semi-annually for first two years. Reevaluate with NYSDEC after two years of operations	June, December of each year

* Assumed Plant startup is April 5, 1993

TABLE 5-2
SUMMARY OF RECOMMENDED REPORTING PARAMETERS

Report Description	Monitoring Location	Monitoring Parameters	Sampling Frequency	Proposed Sampling Dates
Ground Water Quality Reports	TK-500 or TK-501. See Section 4.3.1, Figure 5-18.	See Section 4.3.2	As required by disposal facility	As required by disposal facility
VTS Influent and Effluent Vapor Quality	VTS Sampling Ports: 1. Entrance to oxidation chamber. 2. Exhaust stack above catalytic pod See Section 4.6.1, Figure 5-18	VOCs - EPA Method TO14 Methane - None: Use FID-GC method	Annually	June of each year
Recovered Landfill Vapor Quality	Six-inch headers at VTS pad. See Section 4.5.1, Figure 5-18	VOCs - EPA Method TO14 Methane - None: Use FID-GC method	Each network once per year. One network in conjunction with VTS Sampling	One network in February, one in June, one in October

Figure 5-1
Ground Water Storage Tank Operating Report

Date	Time	Tank Fill			Storage Tank Initial Readings		Storage Tank Final Readings *		Volume Disposed *	Total Volume Disposed *
					Level	Volume	Level **	Volume **		
		Start	Ongoing	Full	%	Gallons *	%	Gallons	Gallons	Gallons

* * If tank is not being drained, do not fill in these columns.

* One percent (1%) is approximately equal to 75 gallons.

DOHS-1.XLS 12/7/93

Figure 5-2
Plant Alarm Log

Date	Time	Plant Alarm	Cause	Operator Response

Figure 5-3
Ground Water Quality in Downgradient Monitoring Wells

Date Sample Collected	Well MW-4S		Well MW-4M		Well MW-4D		Well MW-5S		Well MW-5M		Well MW-8S		Well MW-8M		Comments
	(Total VOC's (ppb) / Total SVOC's (ppb))														

DOH5-3.XLS 12/7/93

Figure 5-4
Ground Water Quality in Storage Tank

Date Sample Collected	TVOCs (ppb)	pH	Flashpoint Deg. F	TOC mg/l	TSS mg/l	List Any Elevated RCRA Metals	Comments

DOH5-4.XLS 12/7/93

Figure 5-5
Restoration Site Monitoring Well Levels

Monitoring Well No.	Top of Casing Elevation Ft	Date: 12/3/93		Date:		Date:		Date:		Date:		Date:		Date:	
		Depth to Water Ft	Water Elev. Ft	Depth to Water Ft	Water Elev. Ft	Depth to Water Ft	Water Elev. Ft	Depth to Water Ft	Water Elev. Ft	Depth to Water Ft	Water Elev. Ft	Depth to Water Ft	Water Elev. Ft	Depth to Water Ft	Water Elev. Ft
2M	220.59	8.39	212.20												
4S	220.95	8.30	212.65												
4M	220.92	9.90	211.02												
4D	220.96	18.07	202.89												
5S	220.71	8.16	212.55												
5M	220.65	12.42	208.23												
7S	220.37	7.55	212.82												
7D	220.55	17.69	202.86												
8S	216.52	4.74	211.78												
8M	216.40	5.98	210.42												
10S	220.40	8.27	212.13												
11S	219.46	6.80	212.66												
11M	219.08	7.60	211.48												

DOH5-5.XLS 12/7/93

Figure 5-6
Site Maintenance Summary

Date	Describe all Site maintenance performed in the field	List all problems identified in the field

DOH5-6.XLS 12/7/93

Figure 5-7
Operator Sign-in Sheet

Name	Date	Time In	Time Out	Hours

DOH5-7.XLS 12/7/93

Figure 5-8
Monthly Operating Costs
Month: Year:

Item	Quantity	Unit Cost	Sub-Total	Comments
1. Electricity				
2. Potable Water				
3. Security				
4. Ground Water Disposal				
5. Sediment Disposal				
6. Maintenance & Repair				
a. Contractor Services				
b. Supplies & Spare Parts				
7. Laboratory Services				
8. Emergency Services				
9. Operator				
10. Operator's Assistant				

Total: ____________

DOH5-8.XLS 12/7/93

Figure 5-9
Monthly Operating Summary
Month: Year:

Item	This Month	Previous Month	Year-to-Date Total
1. Volume of Water Disposed (Gallons)			
2. Volume of Sediment Disposed (Cubic Yards)			
3. Power Usage (Kilowatt hours)			
4. Potable Water Consumption (Gallons)			

DOH5-9.XLS 12/7/93

6.0 HEALTH AND SAFETY

6.1 GENERAL DISCUSSION

The collection and storage of contaminated ground water is an inherently dangerous activity. This process stream contains volatile organic compounds (VOCs) that are carcinogenic (e.g., benzene) and VOCs that may be present in concentrations that would present short-term or long-term exposure hazards (e.g., benzene and toluene).

Other potential hazards associated with operation of the Plant include but are not limited to:

- The working areas adjacent to the tank may present a slipping hazard in the event of a spill.
- Oxygen-deficient and explosive conditions may exist in confined-space areas subject to occasional personnel entry (e.g., the ground water storage tank).
- Electrical hazards may exist where moisture is present adjacent to electrical motors, instrumentation, and control equipment.

Because of these potential hazards, it is extremely important that all personnel engaged in the operation and maintenance of the Plant be well trained in health and safety practices, and in the use of safety equipment.

It is the intent of this chapter to outline the more common hazards involved in the operation and maintenance of the Plant, and to describe the health and safety practices related thereto. The safety and health rules and procedures described herein should be considered as minimum requirements. Supplemental procedures should be developed and promulgated by Plant management where experience demonstrates that more stringent requirements are needed.

A more detailed Health and Safety Plan (HASP) has been developed for the operation of the Plant and is included in this manual as Appendix B. The potential chemical hazards (mainly VOCs) associated with the contaminated ground water and personal protection requirements for handling of this process stream, are addressed in the HASP rather than in this chapter. The HASP has been developed on the basis of data and information collected during the environmental Site investigations, and standard health and safety practices.

A copy of the American Red Cross Standard First Aid Manual is located within the Maintenance Plant of the Axelrod Institute and should be referenced as needed when working on the Plant site.

6.2 HEALTH AND SAFETY PROGRAM

6.2.1 Health and Safety Management

Responsibility for the safe operation of the Plant, and management of the health and safety program, rests with the operator who is responsible for assisting with the development and implementation of a working health and safety program consisting of the following major elements:

1. Providing and maintaining a safe and healthful working environment by frequently inspecting Plant layout, surroundings, equipment, and tools.

2. Properly selecting, hiring, and placing employees to ensure that they are physically and mentally fit to do the work required.

3. Providing adequate training and education for employees in order to preclude personal injuries during operation and maintenance of the Plant.

4. Providing supervision and leadership to make every employee safety-conscious through safety meetings, safety posters, and distribution of articles on safe practices.

5. Immediate reporting of accidents and injuries to ensure full personal and legal protection for both the employee and employer. Figure 6-1 at the end of this chapter shows a sample Accident Report Form, which must be submitted to Ms. Elizabeth Mahoney of the NYSDOH in the event of an accident at the Plant.

6. Thorough investigation of accidents and injuries in order to determine corrective actions, prevent a recurrence of similar events, and to increase the safety awareness of all employees.

7. Checking, cleaning, repairing, or replacing all safety equipment at regular intervals.

6.2.2 Emergency Telephone Numbers

A comprehensive listing of all emergency telephone numbers is contained in the HASP, in Appendix B. This listing should be posted in conspicuous locations at the Plant site. The specific emergency contacts incorporated in the Plant safety program are provided in Table 6-1 for easy access.

6.2.3 Safety and Emergency Equipment

At a minimum, the safety and emergency equipment listed in Tables 6-2, 6-3, and 6-4 should be procured as necessary, stored in the Axelrod Institute

Power Plant area and moved to the Plant area on an as needed basis, unless otherwise noted. This inventory of safety equipment should be inspected frequently by the operator to verify its completeness and proper condition. The listed items are separate from the maintenance tools and equipment described in Chapter 12. They should be maintained as separate inventories and used exclusively in the execution of safety practices. All safety equipment should be OSHA approved.

A portable, eight gallon capacity, combination emergency eye wash/emergency shower is stored within the Maintenance Plant of the Axelrod Institute and should be brought to the Plant area during any site visit for use in the event of a personal injury or exposure that requires rinsing of the body or eyes. The unit can be refilled using potable water from the Axelrod Institute. Refer to the vendor O&M Manuals in Appendix D for further information regarding the safety equipment discussed above.

6.3 HEALTH AND SAFETY PRACTICES

Specific potential hazards and related health and safety practices associated with the operation and maintenance of the Plant can be divided into the following broad categories:

1. General Health Hazards
2. Ground Water Recovery System Hazards
3. Electrical Hazards
4. Chemical Hazards
5. Confined Space Hazards
6. Explosive/Fire Hazards
7. Burn Hazards

Each of these potential hazards and appropriate safety and health procedures are discussed in the following subsections.

6.3.1 *General Health Hazards*

The following are some of the general protective measures and precautions that should be taken during Plant operations:

1. As discussed in Chapter 7, there is NO potable water supply to the Plant.

2. No cut or scratch should be considered too minor to receive attention. A fully stocked first-aid kit must be maintained to treat minor cuts and scratches. Major cuts should receive the attention of a physician.

3. Apparel such as rubberized cotton gloves, rubber boots, or rubber suits must be worn when employees cannot avoid contact with ground water. Refer to the HASP for more detailed information.

4. Smoking should be avoided while on the Site.

5. An excellent rule to observe while performing duties which will require intimate contact with ground water or sediments is to "keep the hands below one's collar".

6. Personnel who have performed any Plant tasks should wash their hands with hot water and soap, especially before eating or smoking.

7. Employees should at all times exercise good judgement in maintaining proper hygiene.

6.3.2 *Ground Water Recovery System Hazards*

Chemical hazards associated with handling of contaminated ground water are addressed in the HASP, which is located in Appendix B.

Potential hazards inherent to the inspection, cleaning, maintenance and repair of the ground water recovery system piping primarily involves oxygen-deficient, explosive and/or VOC contaminated atmospheres. Specific safety practices relating to these hazards are as follows:

1. Extinguish all smoking materials before working on the ground water recovery system. (personnel should not be smoking on-Site).

2. Never enter the tank until the atmosphere has been tested. Refer to the HASP for additional information.

3. If testing indicates that a hazardous atmosphere is present in the tank, allow the tank to air out, and induce fresh air into the tank if required. Retest the tank atmosphere before attempting to reenter the tank.

4. There should always be sufficient manpower available to do the job without hazard to life or limb.

5. Prevent sparking of any kind in the tank.

6. Prior to performing any maintenance on the submersible pump, the following shutdown procedures must be implemented in the order presented:

   a. Turn the H-O-A dial to the O (OFF) position.
   b. Open circuit breaker no. 2 in the Control Panel.

c. Lockout/Tag the disconnect switch in the OFF position. Refer to the lockout and tagging procedures in Section 8.5.4 and in the HASP.

d. Proceed to the vault and open the local disconnect switch.

If these procedures are not implemented correctly, damage to the pump is very probable, and injury may occur due to contact with live circuits.

7. It is necessary that all workers be made aware of all hazards and know all safety precautions in reference to their work.

8. Wear safety shoes when working in the Plant area.

6.3.3 Electrical Hazards

Electrical maintenance and repairs should be performed only by qualified personnel. Specific safe practices for working with electrical equipment are as follows:

1. Do not ground yourself in water or on pipes or drains.

2. Positively "lock-out" and tag appropriate circuit breakers and disconnect switches, and test the circuit, before working on electrical equipment. Refer to Section 8.5.4.

3. Test power leads at the equipment with a voltmeter before contacting any normally energized component.

4. Keep all electrical controls accessible and well marked.

5. Keep wires from becoming a tripping hazard.

6. Work in pairs around electrical equipment.

7. Switches which another person can turn on should be locked out and tagged with "Man on Line" signs when working on electrical equipment.

8. Never use metal ladders around electrical equipment.

9. Handle breaker wires as though they are "live" wires.

10. When there is a question about any electrical hazard, ask an electrician before you expose yourself to it.

11. Do not use any part of your body to test a circuit.

12. Ground all electric tools and equipment.

13. Allow only authorized personnel to work on electrical equipment.

If a person is exposed to severe electric shock and requires assistance, the following first aid procedures should be performed:

1. The rescuer should disconnect the source of power from the equipment by opening the circuit breaker or disconnect switch, if possible.

2. The rescuer should separate the victim from the contact by using a long, very dry pole, a dry rope or length of dry cloth. Be sure hands are dry and that rescuer is standing on a dry surface.

3. If victim is unconscious, call for emergency medical assistance and begin artificial respiration, and treat for shock.

6.3.4 *Chemical Hazards*

Hazards associated with the handling of contaminated environmental media are addressed in the HASP, which is located in Appendix B.

At the present time, no chemicals are used in the Plant processes. Should chemicals be required in the future, appropriate safety precautions will be developed and included in a modified Section 6.3.4.

6.3.5 *Confined Space Hazards*

The ground water storage tank present potential confined space hazards. The potential hazards include oxygen deficient or explosive atmospheres. Specific safety practices related to confined space hazards are as follows:

1. Extinguish all smoking materials before opening the entryway into a tank (personnel should not be smoking on-Site).

2. Test the atmosphere of the confined space for oxygen deficiency and contaminant % LEL levels, before entering the confined space. The atmosphere should be checked frequently once inside the confined space.

3. The tanks should be ventilated with a portable blower before entering. Tests on the tank atmosphere should be repeated and deemed normal before workers enter. ADEQUATE VENTILATION MUST BE MAINTAINED DURING WORK, AND TESTS REPEATED FREQUENTLY.

4. Inspect entry areas before entering the confined space. The ground water storage tank may contain sediments and water, and may therefore be very slippery.

5. Ground water must be drained from the tank to the greatest extent possible before tank entry is attempted by personnel.

6. Workers entering a tank must be under the constant observation of a standby worker outside the tank. All work should be planned out, including the means of evacuation and the standby worker's responsibilities.

7. All workers entering a tank must wear a rescue harness and lifeline, to enable rescue in the event of an emergency.

8. The standby worker must remain in continuous communication with the confined workers. The standby worker must not leave the area, except to report an emergency if no one else is available. Under no circumstances shall the standby worker enter the tank.

9. Use only safety, explosion-proof flashlights and power lighting.

10. All electrical equipment to be used in the tanks must be in perfect condition and properly grounded.

11. Only the manhole at the top of the tank (24" manway) should be used for tank entry.

Use the following first aid procedure if a person has been exposed to oxygen deficient conditions or atmospheric contaminants:

1. Initiate emergency response by notifying ambulance or other emergency service.

2. Do not attempt to rescue the victim without proper respiratory equipment, unless it is possible to ventilate the area thoroughly.

3. Remove the victim to an open area.

4. If the victim is not breathing, administer artificial respiration by the mouth-to-mouth or CPR procedure.

5. After breathing is restored, treat the victim for shock by maintaining victim in a prone position and taking steps to prevent loss of body heat.

6. Obtain medical assistance and transport to hospital for observation and further treatment as required.

6.3.6 *Explosive/Fire Hazards*

Potentially explosive levels of VOCs have been detected in ground water. VOCs will be present in the recovered ground water. It is also expected that VOCs will be present in the headspace of the ground water storage tanks, after volatilizing from the ground water.

Consequently, vapors present in the ground water storage tank may be flammable. When these vapors are mixed with oxygen in the air in correct proportions, explosive conditions exist. Refer to Section 6.3.2 for safety practices relating to these conditions.

The following procedures should be implemented at the Plant to prevent explosive accidents:

1. Use non-sparking tools and explosion-proof flashlights when working in the tank.

2. Wear non-sparking footwear.

3. Post "No Smoking" signs in the Plant area.

4. Instruct employees in preventive action and control procedures in case of a fire.

The NYSDOH should arrange with the Albany Fire Department, if possible, to conduct training sessions for Plant personnel in first aid and fire-fighting techniques, including proper use of early control steps, and personnel evacuation procedures.

All Plant personnel should be instructed in the first aid treatment for burns, which are discussed in the following Section 6.3.7.

6.3.7 Burn Hazards

All Plant personnel must exercise caution when working in the vicinity of any of this equipment and should be instructed in first aid treatment for burns. Burns to personnel are classified as follows:

1. First degree burns - minor burns resulting from momentary contact with hot objects, hot water, or steam. Usual signs are:

   a. Slight redness and discoloration.
   b. Mild swelling and pain.
   c. No skin breakage or open wounds.

2. Second degree burns - moderate burns resulting from more extensive contact with hot objects, hot water, steam, or flash burns from gasoline and other flammable liquids or gases. Second degree burns are characterized by damage to nerve endings at the skin surface. Usual signs are:

a. Red or mottled appearance of skin.
b. Blister development.
c. Considerable swelling which persists for several days.
d. Moist appearance of burned area.

3. Third degree burns - major burns resulting from direct contact with flame, ignited clothing, immersion in hot liquids, prolonged contact with hot objects, or electrical current. Usual signs are:

   a. Deep tissue destruction.
   b. White or charred appearance of burned area.
   c. Complete skin loss in burned area.

First aid treatment for each burn classification is as follows:

1. First degree burns - Apply cold water applications or, if possible, immerse burned area in cool water; apply dry dressing to reduce air contact if necessary.

2. Second degree burns - Immerse burned area in cool water (do not use ice water) until pain subsides; apply moist sterile gauze dressing; do not break blisters or remove damaged tissues; do not use antiseptic ointments or oils; elevate arms or legs, if affected.

3. Third degree burns - Do not remove adhering particles of charred clothing; cover burned area with thick sterile gauze dressing; if hands or arms are involved, elevate above the victim's heart; if feet or legs are involved, keep elevated; if facial burns are involved, maintain victim in a sitting position and observe closely until transported; if respiration problems develop, maintain an open air-way; do not apply ointments; transport to a medical facility as soon as possible.

6.4 *SAFETY REFERENCES*

The references listed in Table 6-5 are available sources for information on hazards incidental to treatment plants and on the safe practices related thereto. Selected publications from this list should be maintained at the Plant to supplement the material in this Section.

FIGURE 6-1
ACCIDENT FORM
NYSDOH RESTORATION SITE

Date ____________________ Time ________________________

Description of incident, including injuries, property damage and emergency action taken and personnel involved. Note specifically the names of any personnel who sustained an injury.

Witness of incident:

Possible or known causes:

What actions are needed to prevent a similar incident?

____
Name of Person
Completing Form

____
Operator

TABLE 6-1
EMERGENCY TELEPHONE NUMBERS

Albany Fire Department			(518) 463-1234
Albany Police Department			(518) 463-4141
Emergency Medical Services (EMS)			(518) 434-4444
Albany Medical Center: Emergency Room New Scotland Avenue, Albany, N.Y.			(518) 445-3125
ERM Northeast:	David Myers Project Manager	Office: Home:	(518) 452-4291 (518) 356-5749
Axelrod Institute: Safety Office - John Doyle			(518) 474-3252
NYSDOH: Empire State Plaza - Bill Mahoney			(518) 473-8034
Local Poison Control Center			(518) 783-2811
National Poison Control Center			(800) 962-1253
NYSDEC Emergency Action Hotline			(800) 457-7362

Directions to Albany Medical Center:

- Cross New Scotland Avenue - Directly Northeast of the site.

TABLE 6-2
EMERGENCY EQUIPMENT

ITEM	INTENDED USE
** Fire Extinguishers	Extinguishing fires
Oxygen deficiency/ combustible and toxic gas indicator devices	Used to detect low oxygen or toxic/combustible gases in confined areas of Plant
Gas masks/air purifying filter respirators with appropriate spare canisters	Used to prevent exposure to contaminated atmospheres which are dangerous to the respiratory system
Portable blower	Used to ventilate enclosed areas such as tank with low oxygen concentrations and/or high concentrations of toxic or combustible gases
Portable pump	Used to remove liquids from areas where entry is required
Explosion proof flashlights, lighting	Used to provide illumination in potentially explosive unlit areas
* Warning Signs	Used to identify potentially dangerous areas or activities (e.g., "No Smoking")
* Eye Wash/ Safety Shower	Used to wash foreign objects or liquids from the eyes and body
** First aid kit	Contains medical supplies used to treat injuries at the site
Self Contained Breathing Apparatus (SCBA)	Used to provide complete respiratory protection in all toxic and oxygen deficient atmospheres
Safety Harness with life line	Designed to maintain a worker in a vertical position. Used when an employee is working in an area where entry for purposes of rescue would be difficult
Fire Blanket	Used to smother fires
Chemical resistant rubber gloves and boots	Used to protect employees from spills and splashes
** Non-metal ladder, rope	Many miscellaneous safety uses
Industrial Protective Goggles	Used to protect eyes from injury from flying objects and liquids

* These items have been provided under the construction contract.

** These items should be available either at the Plant or at the NYSDOH Axelrod facility. Some of these items are expected to be required only when working inside the tank, and may therefore be rented on an as-needed basis (e.g. SCBA equipment.)

TABLE 6-3
INDUSTRIAL FIRST AID KIT

At a minimum, the Plant first aid kit should include the following:

Triangle bandages
Elastic bandage
Ammonia inhalants
Sterile swabs
Butterfly closure
5" x 9" surgical pads
3" x 3" adaptic non-adhering dressing
First aid guide book
Bandaids
Tube of first aid cream/antiseptic ointment
Rescue blanket
First aid cleansing wipes
Sterile Pads
Bottle of eye aid drops
Gauze bandage
Tweezers
Scissors
Wire Splint
Adhesive Tape
Burn ointment

NOTE: All first aid kit items should be replenished as they are used.

TABLE 6-4
EMPLOYEE SAFETY EQUIPMENT

Hard hat
All purpose gloves
Safety glasses with side shields or goggles
Safety shoes
Ear protection
Rain gear - Jacket with hood - Pants - Rubber boots
Protective clothing

TABLE 6-5
SAFETY REFERENCES

1. Water Pollution Control Federation - Manual of Practice (MOP) No. 1 - Safety in Wastewater Works.

2. U.S. Environmental Protection Agency, Technical Bulletin - Safety in the Operation and Maintenance of Wastewater Treatment Works.

3. U.S. Department of Labor - OSHA 2206 - General Industry Safety and Health Standards.

4. New York State Department of Health - Manual of Instruction for Sewage Treatment Plant Operators.

5. Water Pollution Control Federation - Manual of Practice (MOP) No. 18 - Simplified Laboratory Procedures for Wastewater Examination.

7.0 UTILITY AND SUPPORT SYSTEMS

7.1 INTRODUCTION

The utilities and support systems serving the Plant are critical to the continuity of Plant operations. Frequent or prolonged interruptions to utilities or support systems will have significant adverse effects on the Plant. Accordingly, Plant personnel should be aware of the utilities serving the Plant, and should know how to operate and maintain the Plant support systems.

The Plant utility and support systems addressed in this chapter include the following:

- Electric power;
- Telephone service;
- Plant water; and
- Security system

Telephone service and a water supply have not been incorporated into the design of the Plant, however both are available nearby at the NYSDOH's Axelrod Institute complex.

The objective of this chapter is to familiarize Plant personnel with the utilities which serve the Plant, and to describe in detail the operation of the Plant support systems.

7.2 ELECTRIC POWER

Electric power, provided by Niagara Mohawk Power Corporation (NIMO), is brought to the Plant by four #4 underground feeder cables (plus one #4 ground) from a 120/240 volt distribution panel (power box 1-P1) located in the switch gear room (Room No. 11-02) in the nearby Axelrod Institute power plant area (boiler room). Refer to record drawing E-1. Power is provided via a 60 amp three pole circuit breaker (circuits no. 15, 17 and 19) located in power box 1-P1.

From the 120/240 volt distribution panel, electric power is split to a 100 amp power panel (PP-1) which supplies power to the Plant control panel, tank heater and pipe heat tracing, lighting and receptacle and directly to ground water recovery pump P-101 via a combination motor starter. Refer to Record Drawings E-1 and E-2 for diagrams and schematics of the power distribution system.

The main service conductors are run to the Plant area in one, 1-1/4 inch diameter, underground PVC conduit. Electrical power consumption for the Plant is metered as part of the Site usage and is not metered separately

A complete description of the Plant's electric power system is presented in Chapter 8 of this manual.

In the event of a power outage or other operational problems, the Axelrod Institute Plant Engineer, Bill Stone should be contacted at (518) 474-3588.

7.3 TELEPHONE SERVICE

There is no telephone service provided directly to the Plant. Telephone service is available in the nearby Axelrod Institute laboratory building. Access to a telephone can be obtained by contacting the receptionist (Eva Small) or by accessing the Axelrod Institute power plant building from the south door and using the telephone in the control room (Room No. 10-90).

The phone number for the Axelrod Institute's receptionist is (518) 474-4183.

7.4 PLANT WATER SUPPLY

There is no potable or plant water service provided directly to the Plant. Should water be required for Plant maintenance purposes, it can be obtained from the hose connection located inside the south garage door of the power plant area of the Axelrod Institute.

7.5 SECURITY SYSTEM

In order to prevent unauthorized entry, fencing surrounds the entire Axelrod Institute Site, including the Plant. There is one access gate off of New Scotland Avenue through which access to the site is permitted.

In addition, access to the remediated area of the Site has been additional restricted by the installation of six foot high fencing (chain link with barbed wire at top) around the ground water recovery well, piping, storage tank and appurtenances. This fence has a locked gate for access by authorized personnel. In addition this fenced area has been provided with an area lighting fixture and is also monitored by remote camera as part of NYSDOH's entire Site security system.

Security contacts for the Axelrod Institute are:

Donna Lynch	(518) 473-1892
Bill Wallbasser	(518) 473-1892

8.0 PLANT ELECTRICAL SYSTEM

8.1 INTRODUCTION

Virtually the entire Plant utilizes equipment whose operation depends on electricity. Therefore, an understanding of the Plant electrical system is essential to Plant operation and maintenance. In this chapter, the Plant electrical system is described in detail. General electrical safety practices are also described in this chapter.

8.2 ELECTRICAL SYSTEM DESCRIPTION

8.2.1 Power Source

Electric power, provided by Niagara Mohawk Power Corporation (NIMO), is brought to the Plant by four #4 underground feeder cables (plus one #4 ground) from a 120/240 volt distribution panel (power box 1-P1) located in the switch gear room (Room No. 11-02) in the Axelrod Institute power plant area (boiler room). Refer to record drawing E-1. Power is provided via a 60 amp three pole circuit breaker (circuits no. 15, 17 and 19) located in power box 1-P1.

The main service conductors are run to the Plant area in one, 1-1/4 inch diameter, underground PVC conduit. Electrical power consumption for the Plant is metered as part of the Site usage and is not metered separately.

8.2.2 Power Distribution

All electrical equipment is waterproof and is located outdoors mounted on galvanized unistrut supports and poles near the ground water recovery well and storage tank at the western edge of the Site.

From the 120/240 volt distribution panel described above, electric power is split to:

a. a 100 amp power (distribution) panel (PP-1) ; and

b. directly to ground water recovery pump P-101 via a combination motor starter.

Distribution panel PP-1 (240/120 volt, three phase, 4 wire) is manufactured by Square D and is in a NEMA 3R enclosure. This panel distributes power to the circuits listed in Table 8-1. Thirteen (13) spare circuits are available if required in the future.

Refer to Record Drawings E-1 and E-2 for diagrams and schematics of the power distribution system and Plant wiring.

8.3 SYSTEM OPERATION AND CONTROL

8.3.1 Operation

The control switch settings for operation of the Plant equipment are described in detail in Chapters 9 and 10 of this manual.

Before the repair or maintenance of any equipment items is performed, the associated circuit breaker must be opened. For the ground water recovery pump the 60 amp circuit breaker located in the Distribution Panel in the Boiler Control Room must be opened. For all other equipment items, the associated circuit beaker in Distribution Panel PP-1 must be opened.

Care must be taken to make certain that the power is properly disconnected, the appropriate circuit breaker is tagged "Out of Service - Do Not Use", and the unit is locked out of service before any maintenance or repair is attempted on any of the powered equipment. Refer to Section ~~8.5.4~~ for lockout and tagging procedures.

8.3.2 *Controls*

Specific controls for the Plant equipment are discussed in detail in each respective unit's subsection in Chapters 9 and 10. The basic controls and their respective functions are described as follows:

1. Hand-Off-Automatic (H-O-A) Selector Switches:

   Hand-Off-Automatic (H-O-A) selector switches provide manual operation in the "Hand" position and automatic operation in the "Auto" position. The unit is placed out of operation in the "Off" position. Normally, any equipment equipped with an H-O-A selector switch will be in the "Auto" position to allow the unit to be controlled automatically by the Plant instrumentation. The "Hand" and "Off" positions will normally not be used. Placing the switch in the "Hand" position causes a piece of equipment to run continuously until the selector switch position is changed or until the equipment shuts down due to damage. Placing the switch in the "Off" position provides for manual stopping of the equipment.

   When an equipment item must be shut down for maintenance and/or repair, its H-O-A switch (if provided) should be placed in the "Off" position, the appropriate circuit breaker should be opened, and the local disconnect switch (if provided) should be placed in the "Off" position, to disconnect electrical power to the motor. The circuit breaker and disconnect switch should then be locked and tagged. Refer to Section 8.5.4 for lockout and tagging procedures. After the necessary maintenance and/or repairs are completed, the lock and tag should be removed from the circuit breaker and disconnect switch, and these switches should both be placed in the "On" position. The H-O-A switch should be returned to the "Auto" position, unless indicated otherwise in this manual.

2. Circuit Breakers:

Circuit breakers are provided in the electrical distribution panels to protect the equipment against overloads by interrupting the flow of electricity.

3. Fuses:

A five amp control circuit fuse is provided in the combination motor starter for the ground water recovery pump to protect the control equipment against overloads by interrupting the flow of electricity. Two on-half amp fuses are provided for the transformer and three main line fifteen amp fuses to the disconnect are also provided to protect the control equipment against overloads.

4. Indicator Lights:

An indicator light is provided on the front of the combination motor starter for the ground water recovery pump to indicate when the pump motor is running/energized.

8.3.3 Operational (Mechanical Equipment) Problems

Problems associated with the electrical components of the Plant will usually be evidenced by improper and/or lack of operation of the various pieces of equipment. The causes of the most common electrical problems are listed below:

1. Blown fuse. (Replace with fuse of correct size and type.)
2. Disconnected (open) circuit breaker. (Reset breaker.)
3. Corroded or shorted switch contacts. (Clean contacts.)
4. Loose or broken terminal connections. (Tighten or repair.)
5. Switches not set properly for operation. (Check control settings and adjust for proper operation.)
6. Contacts for the controls dirty and arcing. (Clean contacts.)
7. Wiring short-circuited. (Have qualified personnel inspect and repair.)

In all cases, if any major problem is experienced with one of the Plant's electrical components, an experienced electrician should be called in to make the appropriate repairs. The power should be turned off prior to the disassembly of any electrical equipment, and the circuit locked and tagged.

8.4 SYSTEM MAINTENANCE

The procedures for establishing preventive maintenance check lists, scheduling, and performing preventive maintenance and repairs on all Plant equipment are set forth in Chapter 12 of this manual. The specific maintenance considerations for the electrical control equipment are discussed in this section.

8.4.1 Inspection and Preventive Maintenance of Electrical Equipment

All electrical equipment should be visually inspected monthly by the operator, for evidence of the operational problems listed in Section 8.3.3. Each piece of electrical equipment should be checked to be sure that it is operating as intended, and as explained in the applicable sections of

Chapters 9 and 10.

Every six months, the preventive maintenance inspection outlined in Table 8-2 should be conducted for the electrical equipment.

The following general check points and considerations should be addressed when establishing preventive maintenance task lists, schedules, and standard maintenance procedures for electrical systems and equipment:

Control Cabinets

Keep control enclosures free of dust and grease on the face of the panel as well as inside. Dirt can cause faulty relay operation and can be a source of corrosion of metal parts. Connecting wires coming from conduits and cables should be neatly arranged at terminating points and laced into a fanned cable form opposite the terminals they serve. This saves time when looking for a wire during troubleshooting or replacement of circuits.

Cleaning

Keep motor controls clean. Dust, dirt, and grease must be removed periodically from the controller. Dust or grease can become lodged in auxiliary relay contacts or interlocks and may prevent a circuit from functioning. In addition, dust may contain conducting materials, which could form unwanted circuit paths resulting in current leakage, possible grounds, or short-circuits. Blow out dust with dry compressed air and check the surrounding area for sources of dust, or corrosive vapors.

Mechanical Parts

Moving mechanical parts should operate easily without binding or excessive friction. Check operation of each contactor and relay by hand and, at the same time, look for loose pins, bolts, or bearings. Do not lubricate bearings. Bearings on electrical controls are designed to operate without lubrication. Oil or grease on the bearings will cause dirt to accumulate, resulting in sluggish action and possible failure.

Check terminal screws for tightness, since loose connections may develop at any time. Check main line connections and control connections on a regularly scheduled basis.

Contactors

Contactors need the most attention. Be sure contact springs maintain the proper contact pressure. If contacts are allowed to wear too thin, spring pressure decreases and overheating of the contact results. Check spring pressures. If pressure at one pole is considerably lower than that at other poles, the spring is weakened and should be replaced.

Do not file silver contacts. Replace them when they become severely roughened. Silver oxide, which sometimes forms on the contact surfaces, does not have to be removed because it is a good conductor.

Coils

Operating coils for AC contactors function satisfactorily over a range of 85% to 110% of their rated voltage. Higher voltages will cause coils to operate at a higher temperature, which results in a shorter coil life. In addition, the contactor or relay will operate with unnecessary force causing more mechanical wear and bounce when closing.

An excessively low voltage supply to a coil causes contactors and relays to operate sluggishly. Because of the weakened magnetic force, contacts may not "Make" firmly, which could result in overheating and welding together of contacts. Also, if the voltage is too low to allow complete closure of a contactor (or if the contactor or relay is blocked open), the coil will draw an excessively high current resulting in coil burn-out.

Overload Relays

To ensure reliable operation, relays should be tested and calibrated every one to three years. Special equipment is required for relay testing and an outside service company should be called in to perform the relay tests.

Fuses

Fuses are utilized within the Plant at three locations:

1. The combination motor starter for the ground water recovery pump (a five amp control circuit fuse).

2. The transformer (two one-half amp).

3. Main Lines to disconnect (three fifteen amp).

Important steps in fuse maintenance include a periodic check of fuse clips to make sure that ferrules are in good contact with clips. Also look for corrosion or overheating at fuse clip. Hot fuses or clips usually indicate either poor contact or an overloaded fuse that may be close to blowing. A supply of fuses of proper ratings and types should be kept on hand for fast replacement of blown fuses.

Circuit Breakers

Molded case circuit breakers require little maintenance. They should be kept free of dust and grime to ensure proper mechanical operation. Inspect circuit breakers regularly, including dynamic tests. Check the tightness of all connections. Every three to four years, check operating trip settings with special load testing instruments. These tests may be performed by maintenance personnel in accordance with manufacturer's recommended test procedures. When these tests are performed, it is advisable to load-test overload relays.

8.5 SAFETY PRACTICES

8.5.1 General Discussion

Ordinary 120 volt electricity may be fatal. Extensive studies have shown that currents as low as 10 to 15 mA can cause loss of muscle control and that 12 volts may, on good contact, cause injury. **Therefore, all voltages should be considered dangerous.** Most electrical systems at the Plant operate at voltages from 120 to approximately 240. All electricity should be treated cautiously and without guessing as to the nature of the electrical circuit.

Electricity kills by paralyzing the nervous system and stopping muscular action. Frequently, electricity may hit the breathing center at the base of the brain and interrupt the transmission of the nervous impulses to the muscles responsible for breathing. In other cases, the electrical current directly affects the heart, causing it to cease pumping blood. Death follows from lack of oxygen in the body. If contact with a live conductor occurs, the victim must be freed from the live conductor promptly by use of a dry stick or other nonconductor, or by turning off the electricity to the point of contact. Never use bare hands to remove a live wire from a victim or a victim from an electrical source. Next, cardiopulmonary resuscitation or artificial respiration should be applied immediately and continuously until breathing is restored or until a doctor or emergency medical technician arrives.

8.5.2 *General Rules*

Always assume a circuit is live unless it is positively known to be dead. The following are some general rules for electrical maintenance safety:

1. Allow only qualified and authorized people to work on electrical equipment or perform electrical maintenance;

2. Do not ground yourself inadvertently to water piping or other metallic equipment when working on or in contact with electrical equipment or wiring, and do not pass tools to or from, or otherwise touch a person who is grounded;

3. Keep all electrical controls in safe working order, accessible, and well-marked;

4. Keep wires from becoming a tripping hazard;

5. Never use metal ladders, metal tape measures, or other metal tools around electrical equipment;

6. Unless a wire is positively known to be dead, and it is impossible for it to become accidentally live again, handle it as though it were a live wire;

7. When working around electrical equipment, keep your mind on the hazard at all times;

8. Always work from a firm base as loss of balance may cause a fall on energized busses or parts, which should be covered with a good electrical insulator such as a rubber blanket; and

9. No safety device should be made inoperative by removing guards, using oversized fuses, or blocking or bypassing protective devices, unless it is absolutely essential to the repair or maintenance activity, and then only after alerting the operating personnel and maintenance supervisor.

8.5.3 Working in Pairs on Energized Equipment

All electrical work on energized equipment should be performed by two or more workers. When two employees work together, one can double check the other, and there is always one employee available to de-energize circuits, apply first aid, or summon assistance in the event of an accident. Usually, there is sufficient work so that both employees may work simultaneously.

8.5.4 Lockout and Tagging Procedure for Electrical Circuits

The most important safety requirement in electrical maintenance is to have, and adhere to, a good system for locking out and tagging electrical circuits when equipment is being repaired. Unexpected operation of electrical equipment that can be started by automatic or manual remote control may cause injuries to persons in the immediate area of the energized equipment.

A lockout and tagging procedure involves opening circuits to isolate circuits from the energy source, and then placing a lock and tag on these circuits, lines, or equipment so that they are not activated while work is in progress on or inside them. This procedure must be followed by all personnel (employees and contractors) whose duties require them to work on or near electrical circuits; on or inside lines or vessels that contain, or have contained, hazardous material; or on or inside rotating or reciprocating equipment. In some situations, a work permit may be required in addition to locking out and tagging a piece of equipment.

General Procedure

The person who is to perform the work attaches a lock and tag at <u>each</u> control point of any circuit, machine, or unit that could affect the job. Therefore, each person who may do this work must always carry safety padlocks, multiple lockout clamps, and tags.

After a switch has been opened <u>each</u> person on the job must install a lock on the safety control point(s) and affix a tag with all the pertinent information filled in (e.g., circuit description, mechanic's name, time locked out, etc). As individual work is completed, mechanics must remove only their own locks and tags. If an employee is absent, only the missing employee's supervisor may remove the lock and tag. If one worker replaces another (by reason of transfer, shift change, etc.) before a work assignment is complete, the person going off the job removes their personal lock and tag only after the replacement person has attached a lock and tag at each control point.

Only one key should be issued for each lock. This will ensure that locks cannot be removed except by the person who places them. The operator should have a master list of key numbers and should keep an extra key to each lock. **In no case should the operator lend his master key.** Locks may be painted various colors to indicate types of craft or to differentiate assignments. Each lock should be stamped with the employee's name or clock number, or a metal tag should be attached.

The following lockout procedure must be followed by maintenance personnel:

1. Alert the operator that work will be performed and that lockout/tagging will be implemented.

2. Before starting work make sure equipment cannot be energized without your permission;

3. Place your own padlock and tag on the control switch or lever, even if someone has locked the control before you. You will not be protected unless you put your own padlock on it;

4. Stored electrical energy which might endanger personnel must be released. Capacities must be discharged and high capacitance elements must be short-circuited and grounded.

5. Stored non-electrical energy in devices that could re-energize electric circuit parts must be blocked or relieved to the extent that the circuit parts could not be accidentally energized by the device.

6. No work may occur on or near de-energized circuits or equipment until the equipment or circuit is verified to be de-energized by a qualified person.

   a) Verification of equipment de-energizing consists of a qualified person operating equipment controls or otherwise ensuring that the equipment cannot be restarted.

   b) Verification of circuit de-energizing consists of a qualified person using test equipment. The test equipment must be employed to ensure that all circuit elements and electrical parts of equipment are de-energized prior to employee exposure. The test must also determine if any recognized condition exists as a result of inadvertently induced voltage or unrelated voltage back-feed even through specific parts of the circuit have been de-energized and presumed to be safe.

7. All affected personnel must be notified of the status of de-energized equipment during shift changes to ensure continuity of lockout and tagging protection for off-going and on-coming employees.

8. When through working at the end of your shift, remove your padlock and tag, never permit someone else to remove them for you, and be sure you are not exposing another person to danger by removing them; and

9. If you lose the key to your padlock, report the loss immediately to your supervisor and obtain a new padlock.

8.5.5 Backfeed

Precautions should be taken to make certain that there is no possibility of backfeed on a de-energized circuit. Backfeed can occur from the following sources: a tie with another electrical source; a control circuit that is interlocked with a control circuit fed from another source; the high voltage side of a potential or control transformer that is not disconnected from the bus or the low voltage side of the transformer that becomes energized from an extraneous source acting as a step-up transformer and energizing the bus at a high voltage.

8.5.6 Transformers

Transformers may retain lethal energy after the primary disconnect is de-energized. Therefore, transformers shall be tested to assure that they have "unloaded" before attempting to alter or adjust terminal lugs.

TABLE 8-1
CIRCUIT BREAKER DISTRIBUTION PANEL

CIRCUIT BREAKER NO.	DESCRIPTION	AMPS	NO. OF POLES
1, 3, 5	Lightning Surge Protector No. 1	30	3
2	Control Panel	15	1
7	Tank (TK-101) Heater	40	1
4	Site Lighting and Receptacle	20	1
9-18, 20, 22	Spare		13
6,8	Heat Tracing	15	2
19, 21, 23	Main Breaker	50	3

TABLE 8-2
SEMI-ANNUAL PREVENTIVE MAINTENANCE INSPECTION FOR ELECTRICAL EQUIPMENT

WHAT TO INSPECT	WHAT TO INSPECT FOR
Exterior and Surroundings	Dust, grease, oil; high temperature; corrosion; mechanical damage; condition of gaskets, if any.
Interior of Panels	Same as above, plus inspect for loosened and missing enclosure nuts, bolts, and other mechanical connections.
Contactors, relays, solenoids	Check control circuit voltage, inspect for excess heating of parts evidenced by discoloration of metal, charred insulation or odor; check freedom of moving parts; remove dust, grease, and corrosion; tighten loose connections.
Contact tips	Check for excessive pitting and roughness. Do not file silver contacts.
Springs	Check contact pressure. Pressure must be the same on all tips.
Flexible leads	Look for frayed or broken strands; be sure lead is flexible - not brittle.
Arc chutes	Check for breaks or burning.
Bearings	Check for freedom of movement; do not oil.
Coils	Look for signs of overheating, charred insulation, or mechanical injury.
Magnets	Clean faces; check shading coil, inspect for misalignment bonding.
Fuses and fuse clips	Check for proper rating; check fuse clip pressure.
Overload relays	Check for proper heater size; tighten coil connections; inspect for dirt and corrosion.
Push button and selector switches, and pilot devices	Check contacts; inspect for dirt, grease, and corrosion.
Dashpot-timers	Check for freedom of movement.
Resistors	Check for signs of overheating; tighten loose connections; tighten sliders.
Connections	Tighten main line and control conductor connections; look for discoloration of current carrying parts.
Control operation	Check sequence of operation of control relays; check contactors for flash when closing, and adjust to eliminate contact bounce if necessary; check pressure switches, temperature switches, etc.

9.0 *UNIT PROCESS OPERATION*

9.1 *INTRODUCTION*

A general overview of the remedial design components of the Plant is presented in Section 1.8. In this chapter, the remedial design components are described in detail, including the design basis, equipment descriptions, instrumentation and control, start-up, operation, and shutdown. The information provided in this chapter should be used for general guidance concerning the operation of the Plant equipment. This information is intended to supplement, not substitute for, the information contained in the individual operation and maintenance manuals provided by the equipment manufacturers. The manufacturer's manuals are included in Appendix D, which is the last appendix to this manual, and should be consulted for specific equipment operation and maintenance instructions. The Plant personnel must familiarize themselves with each manufacturer's operation and maintenance manual prior to operating any item of equipment.

The interaction of the Plant equipment with the Plant instrumentation is described for each Plant system in the subsections entitled "Instrumentation and Control" included in this chapter. Further details regarding the function of the Plant instrumentation can be found in Section 10, "Plant Control System and Instrumentation". Chapter 10 provides a general overview of the Plant control system and includes tables which summarize the Plant instrumentation and alarms.

The main sections of this chapter are organized by major Plant systems and are presented in the approximate order of the process flow. These sections are as follows:

9.2 Ground Water Recovery System
9.3 Ground Water Storage System

9.4 Passive Vapor Recovery System

Each section of this chapter includes sub-sections which discuss the equipment, instrumentation and control, procedures for start-up, operation, and shutdown, and any special considerations.

Each section also discusses the operating parameters which affect each of the systems. The operator should be aware that the operating parameters may change as the Site ground water level changes. The operator must also learn to anticipate problems and determine appropriate actions in order to correct operating problems as they occur.

9.2 *GROUND WATER RECOVERY SYSTEM*

9.2.1 *Design Basis*

The design basis for the ground water recovery system is described in this section. The ground water recovery system consists of a four inch diameter ground water recovery well in which a submersible pump has been installed. The pump transfers recovered ground water to the ground water storage system via above ground piping and appurtenances.

The ground water recovery well is located in the former disposal "pit" area (refer to section 1.4) where prior soil disturbance has slightly improved soil porosity and permeability. In addition, installing the well in this location ensured that none of the coffins anticipated to have been buried in other locations at the Site were disturbed. Refer to Record Drawing C-2 which shows the exact location of the ground water recovery well.

As noted in section 1.7, the recovery well is intended to act as a source control method, rather than an attempt to recover and mitigate the existing ground water plume.

As indicated in section 1.7, the expected ground water recovery rate (sustainable yield) from the Site, is only approximately 0.10 gallons per minute (gpm), therefore, an "environmental grade", constant speed, submersible pump was selected which can pump at low flow rates (approximately one to seven gpm). A simple ground water level control system was selected to operate the pump.

Due to the nature of the Site ground water contaminants, all equipment and piping materials of construction which will be exposed to ground water are fabricated from 316 stainless steel, teflon or other chemically resistant materials.

9.2.2 *Equipment Description*

As previously explained, the ground water recovery system consists of a four inch diameter ground water recovery well in which a submersible pump has been installed. The pump transfers recovered ground water to the ground water storage system via above ground piping and appurtenances.

The ground water recovery well extends to a depth of only 13.5 feet below preexisting grade (16.5 feet below final grade) to prevent any potential contamination from migrating vertically. The recovery well is constructed from 304 stainless steel and has a prepacked sand screen. Additional construction details of the ground water recovery well are shown on Record Drawing C-3.

The pump is a Redi-Flo4, Model 5E5, four inch pump as manufactured by Grundfos Pump Corporation of Clovis, California. The pump is supplied with a submersible, 1/2 horsepower, 120 volt, 1 phase, 60 Hz Franklin motor with 50 foot teflon motor leads. Detailed information regarding maintenance and repair of the pump can be found in the manufacturer's

O&M manual located in Appendix D to this manual.

The bottom of the submersible pump (the motor end) was installed approximately 24 inches above the bottom of the recovery well casing. Setting the pump at this level allows any solids which enter the well casing to settle at the bottom of the casing without entering the pump's impellers.

All piping, instruments and appurtenances associated with the ground water recovery system are located above ground. The piping which conveys recovered ground water from the well to the storage tank is fabricated from 304L stainless steel. A one inch gate valve to isolate the pump during maintenance activities and a one inch check valve to prevent back flow to the submersible pump has been installed on the transfer line.

In addition to valves, the following equipment items have been installed on the transfer piping:

- Pressure gauge (PI-101);
- Flow meter (FI-101);
- Expansion joint; and
- Check valve.

Refer to Record Drawing PID-1 which shows the schematic layout of the ground water transfer piping and appurtenances. For additional information regarding the instruments refer to sections 9.2.4, 9.3.4 and 10.0.

The above ground transfer piping (including valves and fittings) from the submersible pump to the ground water storage tank is heat traced and insulated. The heat tracing is self regulating heating cable, five watts per foot, Model SRL 5-2 as manufactured by Chromalox. The heat tracing is equipped with an ambient sensing thermostat which has been set for 40 degrees fahrenheit.

9.2.3 *Power and Control*

The submersible well pump is powered directly from power box 1-P1 located in the switch gear room in the Axelrod Institute power plant area via a combination motor starter and motor control box mounted with the Plant electrical equipment near the ground water storage tank. The motor starter is provided with a local disconnect switch. Refer to Section 8.2 and Record Drawing No. E-1 for additional electrical information regarding the submersible pump.

The submersible pump is operated using a "Hand-Off-Automatic" (HOA) selector switch which is a component of the pump motor starter. The H-O-A selector switch provides manual operation of the pump in the "Hand" position and automatic operation in the "Auto" position. The unit is placed out of operation in the "Off" position. Under normal conditions the pump should be run in the "Auto" position to allow the unit to be controlled automatically by the Plant instrumentation. In the "Hand" position the pump will run continuously until the selector switch position is changed or until it shuts down due to damage.

An indicator light is provided on the front of the combination motor starter for the ground water recovery pump to indicate when the pump motor is running/energized.

9.2.4 *Instrumentation and Control*

The submersible pump is only controlled by the Plant instrumentation when the pump selector switch referenced above is in the "Auto" position.

The operation of the submersible pump is controlled by the ground water level in the recovery well. Refer to Chapter 10 for a summary description of all Plant instruments and control setpoints.

Level Controls

The pump is automatically turned on and off by electrical conductance activated liquid level controls (LS-101) manufactured by Warrick Controls, Inc. The control system consists of two corrosion resistant electrodes suspended within the well casing. The well casing itself is also wired to take the place of a reference probe. The level(s) at which these probes are placed within the casing determines the low and high level pump control settings . The electrodes are wired to a solid state controller designed for differential level service. The controller is installed in the NEMA 4X control panel mounted with the remainder of the Plant electrical equipment next to the ground water holding tank.

When the pump is in the automatic mode, the controller shuts off the pump when the level of the ground water in the well is lowered to a predetermined setpoint (LSL). When the ground water rises to a higher predetermined setpoint level (LSH), the pump is automatically turned back on.

The levels of the electrodes were set during Plant start-up. The LSL (off) electrode has been positioned 14.9 feet below final grade, just above the pump intake and the LSH (on) electrode has been positioned approximately 10 feet below final grade. The normal (static) ground water elevation at the well location is approximately 8.0 feet below final grade. High (on) and low (off) level settings for the well/pump as initially set during start-up are identified in the following table.

Top of Casing	Static Water Level	High (On) Level	Low (Off) Level
17'-6"	9'-6"	7'-6"	2'-7"

Note: All elevations given relative to elevation of bottom of well casing which is established to be 0'-0".

It is anticipated that any changes to the initial settings implemented during the Plant start-up will be relatively minor. The operator will have to lower the elevation of the reset probe as ground water is recovered from the Site and the ground water table is lowered. The operator, however, should occasionally monitor pump running times and volumes to make sure the pump motors are not cycling too quickly.

Interlocks

In addition to the level control parameters discussed above, the operation of the submersible pump is also controlled through an interlock circuit. This interlock circuit incorporates two normally closed contacts in the pump motor starter which are tripped (opened) by a tank high level or alarm condition. The high level and alarm condition contacts are configured in series. This configuration does not allow the pump to be run in the automatic mode until the high level or alarm condition is corrected. The specific mechanical interlocks are as follows:

1. LSH-101: High water level in tank TK-101.

2. LSHH-101: High-High water level in tank TK-101 (alarm).

3. XS-101: Leak detection in tank TK-101 (alarm).

The operator should refer to Section 9.3.4 for a more detailed explanation of the ground water holding tank and tank interlocks.

9.2.5 *Start-up*

The procedure for start-up of the submersible pump is as follows:

1. Verify that the ground water level in the tank is below high level.

2. Verify that the valves on the transfer line from the submersible pump to the ground water holding tank are in the open position. Verify that the valves on the ground water holding tank drain line annular space drain line are in the closed position.

3. Verify that the submersible pump well level cutoff and reset electrodes are at the proper levels.

4. Turn the HOA switch at the motor starter to the "Automatic" position.

5. If pump does not start, verify that none of the interlocks has been tripped. Also verify that the Plant circuit breakers in power box 1-P1 in the Axelrod Institute switch gear room are in the "On" position, as well as the local disconnect switch at the pump motor starter.

9.2.6 *Operation*

The Plant is designed for year-round operation.

The submersible pump is designed to operate automatically, unless the ground water level in the well falls and remains below the level of the reset electrode. As the ground water level below the Site decreases it will be necessary to periodically lower this electrode.

Pumping Rates

The pumping rate of the well should be maximized to optimize source control of the contaminated ground water at the Site. If possible, the water level in the well should not be allowed to return to static level. In order to optimize source control, the extraction rate of the pump should be set as close as possible to the sustainable yield of the well. (This may not always be possible due to the low anticipated yield of the well.)

During start-up the pump was set as close as possible to the sustainable yield of the well which was 0.1 gpm. Depending on Site conditions, the pumping rate may require modification in the future.

The discharge rate of the pump can be adjusted using one or both of the gate valves on the ground water transfer line. By adjusting or throttling the valve(s) the discharge pressure of the pump can be increased which will result in a decreased flow rate. To increase the flow rate the valve(s) should be adjusted so that the pump discharge pressure is decreased.

A flow meter (FI-101) has been provided on the ground water transfer line to aid the operator in establishing the optimum discharge flow rate. FI-101 gives an instantaneous indication of the pump discharge rate. The calibrated range of the flow meter is from one to ten gpm. The discharge flow rate can also be estimated using the pressure gage (PI-101) installed in the ground water transfer line in conjunction with the pump curve provided by the manufacturer which is located in Appendix D of this O&M manual. The calibrated range of the pressure gauge is from 0 to 100 psi. The pressure setting established during start-up is 5 psi.

The pump may also be run in manual mode, although this is <u>not</u> recommended. since the pump would have no level control and could run dry, destroying the pump. The operator should consult the manufacturer's operating manual for further instructions if manual operation must be implemented.

9.2.7 *Shutdown*

Normal

The pump should be shut down by turning the HOA switch at the motor starter to the "Off" position.

If maintenance is required on the pump, the operator should also:

1. Open the appropriate circuit breakers in power box 1-P1 in the Axelrod Institute switch gear room and implement the lockout and tagging procedure described in Section 8.5.4.

2. Open the local disconnect switch at the submersible pump motor starter and implement the lockout and tagging procedure described in Section 8.5.4.

3. All valves on the pump discharge line must be closed.

Emergency

In an emergency condition the pump can be shut down by turning the HOA switch to the off position, as identified above, or by opening the disconnect switch at the motor starter or by opening the appropriate circuit breakers in power box 1-P1 in the Axelrod Institute switch gear room.

9.3 GROUND WATER STORAGE SYSTEM

9.3.1 Design Basis

All ground water recovered from the Site will be transported off-site for disposal at an appropriately permitted facility. The recovered ground water will be temporarily stored on-site in the ground water holding tank until transported off-site.

As stated in Section 9.2, the expected ground water recovery rate from the Site is only approximately 0.10 gallons per minute. The ground water holding tank size was chosen so that one tank volume would approximately correspond to the volume of a full disposal tanker truck (approximately 5,500 gallons). At a flow rate of 0.1 gallon per minute, 5,500 gallons would correspond to approximately 38 days of continuous ground water recovery.

The ground water recovery and storage system is designed for year-round operation.

9.3.2 Equipment Description

The ground water storage system consists of one 6,400-gallon, double-wall, high density, cross-linked polyethylene tank (TK-101). The tank is molded in one piece and has no seams or joints. All fittings are fabricated from high density polyethylene (HDPE). The tank is fabricated in accordance with ASTM D-1998-91. Additional design criteria for the tank are summarized below.

- Design Specific Gravity: 1.35
- Design Pressure: Atmospheric
- Design Temperature: 100 degrees F.

The tank stores ground water that has been pumped from under the Site by the submersible pump until the required sampling and analyses are performed, and disposal arrangements can be made.

As indicated above, the ground water holding tank is double-walled. In the event that the integrity of the inner wall is compromised, the outer wall is designed to contain the tank contents.

The tank contains eight nozzles for process piping and instrumentation connections. Table 9-1 summarizes the tank nozzles and associated process connections. The operator should also refer to the tank Record Drawings for additional tank fabrication information and nozzle designations.

The tank is provided with a "U" vent connected to nozzle D at the top of the tank. The "U" vent allows air within the tank to escape when the tank is being filled and allows air to enter the tank when it is being drained thus preventing the tank from becoming pressurized or subject to a vacuum.

The control and interaction of the tank instrumentation with the ground water recovery pump is described in section 9.3.4.

Since the ground water recovery system is designed to operate under year round conditions, the tank is equipped with a freeze protection system. The system consists of 110 volt, 3 KW, 30 amp heat trace system with control box and indicating lights. The tank is enclosed in two inch thick polyurethane insulation with a weatherproof coating.

9.3.3 Power and Control

As discussed above, the ground water holding tank is equipped with a freeze protection system consisting of heat tracing and insulation. Power to the tank heat tracing is supplied via circuit breaker Nos. 6 and 8 (15 amps, two poles) in distribution panel PP-1 mounted with Plant electrical equipment near the ground water holding tank. Refer to the manufacturer's shop drawing submittal for additional information regarding the operation of the tank heat tracing.

9.3.4 *Instrumentation and Control*

The instrumentation associated with the operation of ground water holding tank (TK-101) is discussed below. Refer to Table 10-1 and 10-2 for a summary of all Plant instrumentation setpoints and alarm setpoints, and the P&I Record Drawings for a schematic representation of all tank piping and instrumentation.

As previously indicated, the ground water holding tank's storage capacity is 6,400 gallons. During start-up, the tank instrumentation was calibrated and set so that at a nominal volume of 5,300 gallons of water, a high level switch LSH-101) will shut down the submersible pump. The tank design includes a high-high interlock to prevent the tank volume from exceeding its design capacity in the event the high level switch fails.

The LSH-101 setpoint is programmed in level indicator LI-101, discussed below. The level probe for LI-101 is mounted approximately two inches above the bottom of the ground water holding tank. Therefore, the level that the indicator senses is less than the true level by two inches. This discrepancy has been corrected in LI-101 during calibration, so that the true tank level (indicated in percent) is displayed by the indicator. The operator should refer to the manufacturer's O&M manual if this discrepancy ever has to be calibrated out of the displays in the future. Table 9-2 shows the correlation between the tank level displayed by LI-101, the water depth (level) in feet and the actual volume in gallons.

All further discussions in this Section regarding tank levels will pertain to the actual tank water level.

The instruments associated with the ground water holding tank are described below.

LI-101: Level Indicator LI-101 is a digital level indicator for Tank TK-101, and is installed in the control panel mounted near the ground water holding tank. LI-101 receives 120 VAC power from Circuit Breaker No. 2 in Power Panel PP-1 via the control panel. LI-101 receives a 4-20 mA signal from a level probe mounted on nozzle K of the ground water holding tank. A setpoint for the tank high level switch (LSH-101) activation level (70%) has been programmed into LI-101. When LSH-101 is activated, the ground water recovery pump is automatically deactivated.

LE-101 Level Element (sensor) LE-101 is a reed switch float assembly mounted on nozzle J of the ground water holding tank. When the water level in the tank reaches the LE-101 setpoint, the switch associated with LE-101 (LSHH-101) is closed. The leak detection (alarm) panel is wired to this switch. The setpoint for the tank high-high level switch (LSHH-101) is 12'-2'' above the bottom of the tank. LSHH-101, if activated, shuts down the ground water recovery pump, activates a local visual and audible alarm and sends and alarm signal to the Axelrod Institute control system.

XE/XS-101: Leak Element/Controller XE/XS-101 consists of a leak detection probe attached to Nozzle No. G of TK-101. This probe is designed to detect fluid between the inner and outer shells of the tank, indicating that a leak has occurred in the inner shell. XS-101 (the leak detection panel) receives 120

1. VAC power from Circuit Breaker No. 2 in Power Panel PP-1 via the control panel. XS-101, if activated, shuts down the ground water recovery pump, activates a local visual and audible alarm and sends and alarm signal to the Axelrod Institute control system.

Refer to section 10.0 which discusses the Plant alarms in greater detail.

Interlocks

The ground water recovery pump is interlocked to the various tank level setpoints and alarms. These interlocks are describe above and in section 9.2.4.

Modification of Setpoints

The LSH and LSHH level setpoints have been established to allow optimum performance of the Plant, and should not be changed. All setpoints are established relative to the bottom of the tank (true level). In the event that these setpoints should ever have to be changed, LSHH-101 must always be set at least six inches above LSH-101.

9.3.5 *Start-up*

Tank Fill

Since the ground water storage tank only stores recovered ground water, there is no actual start-up or shutdown of the tank. General operating parameters that should be implemented prior to implementing tank fill procedures outlined in the following section are identified below.

1. Verify that pipe and tank heat tracing is operational.

2. Verify that all tank instrumentation is operating properly.

3. Verify that all start-up procedures for the submersible pump described in section 9.2.5 have been performed.

When the tank level reaches the LSH-101 setpoint, the submersible pump will be automatically shut down. Since the activation of LSH-101 does not trigger an alarm, the operator should monitor the tank level during each visit to the Site. Once the LSH-101 setpoint is reached, the operator should promptly arrange for disposal of TK-101 contents.

Disposal of Tank Contents

All recovered ground water stored in the ground water holding tank will be shipped off-site for disposal, by tanker truck. The tanker truck will be filled by using a pump supplied with the tanker truck.

It should be noted that tanker truck pumps are normally rated at a flow rate of approximately 275 gallons per minute. Consequently, it would take approximately 20 minutes to drain 5,500 gallons from the tank using the tanker truck pump.

The operator should make arrangements to use tanker trucks with the following features:

1. Tanker capacity must be 5,500 to 6,000 gallons.

2. Tanker truck suction hose must be a equipped with a two inch male camlock end fitting, for connection to the tank two inch female camlock hose connection.

When the tanker truck has arrived, the operator should perform the following tasks in the order they are presented:

1. Verify that tanker truck is located close enough to the tank hose connection so that no undue stress is placed on the Plant piping.

2. Verify that tanker truck is empty.

3. Turn the H-O-A switch for the submersible pump from "auto" to "off" (if this has not already been done).

4. Unlock tank hose connection and connect tanker truck hose to this connection.

5. Open two inch valve on tank drain line piping.

6. Instruct the tanker truck operator to turn on tanker pump. (TK-101 contents may begin to gravity feed to the tanker since the water level in the full tank is a few feet higher than the tanker.)

7. Empty tank TK-101 as completely as possible and have truck operator turn truck pump off. The operator should periodically check the tank level indicator to verify that the transfer is progressing properly.

8. Close the two inch valve on tank drain line piping.

9. Disconnect the tanker hose from connection and lock the connection.

10. Turn the H-O-A switch for the submersible pump from "off" to "auto".

9.4 *PASSIVE VAPOR RECOVERY SYSTEM*

As described in section 1.0, the design of the cap for the Site includes the utilization of a geonet composite to serve as the media for capturing soil vapors underneath the cap.

The area to be capped was overlain with a geonet composite consisting of a polyethylene drainage netting installed between two layers of a permeable geotextile. The geonet composite serves as the vapor collection media beneath the cap. The geonet composite is tied into perforated PVC vapor collection headers running along the east and west boundaries of the cap (refer to the Record Drawings for the project). The PVC headers and associated standpipes allow soil vapor to be passively vented from beneath the cap.

Since the vapor recovery system is a passive system it has no operational requirements.

TABLE 9-1
TANK NOZZLES

Nozzle	Description	Size (in.)	Connection	Nozzle Valve	Adjacent Device
A	Manway (side)	24	Flange	None	Blind Flange
B	Tank fill line with internal HDPE down pipe	2	NPT	None	Piping
C	Tank drain line with internal HDPE down pipe	2	NPT	None	Piping
D	U-Vent	2	None	None	None
G	Secondary shell monitor (tank leak detection)	1-1/2	NPT	None	XE-101
H	Secondary shell drain	2	NPT	Yes	Piping
J	Tank High-High level alarm	2	NPT	None	LE-101
K	Tank Level Probe/Indicator	3/4	NPT	None	LI-101

TABLE 9-2
TANK LEVEL CALIBRATION

LI-101 READOUT (%)	DEPTH OF WATER IN TANK (feet)	VOLUME OF WATER IN TANK (gallons) (1)
0%	.15	0
10%	1.4	750
20%	2.8	1,500
30%	4.2	2,300
40%	5.6	3,000
50%	7.0	3,750
60%	8.4	4,500
70%	9.8	5,300
80%	11.2	6,000
88%	12.2	6,500

(1) Volumes are approximate

10.0 PLANT CONTROL SYSTEM AND INSTRUMENTATION

10.1 GENERAL DISCUSSION

The instrumentation system for the Plant monitors and controls the ground water collection system including indication of the ground water flow rate from the submersible pump to the holding tank. Measured and monitored data are used for Plant operating records, automatic process controls and safety warnings. Alarm conditions are interlocked with the recovery pump motor controls to automatically deactivate the pump in the event of certain alarm conditions. Layouts of the control and alarm (leak detection) panels are shown on Record Drawing E-1. Electrical wiring diagrams are located on Record Drawing E-2.

The majority of the instrumentation equipment was provided by J. Hall, Ltd. (a subcontractor to Barbella Environmental Technology, Inc.). J. Hall's address and telephone number are:

99 Central Avenue
Ravena, NY 12143
(518) 756-8235
Contact: Jerome Hall

A discussion of the Plant instrumentation and associated alarms is presented in this chapter. The following tables are presented in this chapter for reference purposes, and are located at the end of the chapter in numerical order.

- Table 10-1: Instrumentation and Control Points
- Table 10-2: Plant Alarms

10.2 INSTRUMENTATION

The instrumentation system includes a control panel and alarm (leak detection) panel as well as field mounted meters, gauges and transmitters. The instruments and their locations and settings are summarized in Table 10-1 "Instrumentation and Control Points". The information in this table includes:

- The instrument identification number;
- A description and identification of the purpose of the device;
- The location in the Plant where the instrument is installed;
- The manufacturer and model number of the device;
- The set points, range and calibration of the device (as applicable); and
- Identification of the Plant's automatic response to activation of the device, associated alarms and general remarks.

The control panel is mounted with the Plant electrical equipment near the ground water holding tank. The following instruments are located in the control panel:

- LI/LSH-101;
- LS-101; and
- lightning surge protector #2.

LI/LSH-101 provides continuous monitoring and indication of the water level in the ground water holding tank.

Refer to the Inspection, Maintenance, and Lubrication Schedule, included as Appendix C, and the manufacturer O&M manuals, included as Appendix D, for specific information regarding instrumentation maintenance and operation of the Plant instrumentation.

10.3 ALARMS

The Plant instrumentation is responsible for activating all alarms. An alarm is an indication that a condition exists, which if not addressed, could threaten operating efficiency, operator safety or the environment. Automatic alarm capability is essential because it is impossible for operating personnel to monitor every aspect of Plant operation simultaneously or to be present at all times.

A summary of the Plant alarms is included as Table 10-2. The following information is included in this table:

- The alarm identification number;
- The conditions which activates the alarm;
- The monitoring instrument which activates the alarm;
- The alarm set point (and reset point if applicable);
- The automatic Plant response; and
- The appropriate response action(s) the Plant operator should take.

The alarm (leak detection) panel is mounted with the Plant electrical equipment near the ground water holding tank. The panel (LSHH/XS-101) is a self contained unit manufactured by Warrick Controls. In the event of an alarm condition (refer to Table 10-2) the corresponding light (Alarm No.1 or Alarm No. 2) will be illuminated and an audible alarm will be sounded. A silence button is provided to acknowledge and silence the audible. The alarm light, however, will not go out until the alarm condition is corrected.

All alarm conditions are indicated on the Axelrod Institute control system located in the switch gear room in the power plant area (boiler room). An alarm indication will continue to be relayed to the control system until the alarm condition is corrected.

The Plant operator must identify key contacts to be notified in the event of an alarm condition. The names and telephone numbers of these contact persons must be given to Bill Stone, the Axelrod Institute Plant Engineer (518) 474-3588 before operation of the Plant in automatic mode is initiated.

In the event of an alarm condition the Plant operator or designee should silence the audible alarm and investigate the condition which caused the alarm to be activated at his or her earliest convenience and take appropriate response actions as necessary. Refer to Table 10-2 for additional information regarding response actions.

TABLE 10-1
INSTRUMENTATION AND CONTROL POINTS

INSTRUMENT NO.	DESCRIPTION	LOCATION	MANUFACTURER/ MODEL NO.	SETPOINTS, RANGE, AND CALIBRATION	REMARKS
FI-101	Flow meter for recovery well pump	Installed in discharge piping from recovery well	Erdco SEE-FLO Model: 3261-04T0	1-10 gpm	1' NPT, 316 SS, Mechanical
LE-101	Ground water holding tank high-high level sensor	In ground water holding tank	Warrick FE2A3C2A	12'-2" above bottom of tank	Reed switch float assembly See LAHH-101 in Plant Alarm Table (Table 10-2)
LI/LSH-101	Ground water holding tank continuous level indicator and high level switch for automatic pump shutdown	Receiver/controller is contained in control panel mounted near ground water holding tank. The transmitter is connected to the level probe mounted in the ground water holding tank.	Great Lakes Receiver/controller: 672L1-A-1-A-0-N Transmitter: 699L Level probe: 4000-4-A-0-D-0-K	R: 0.15 - 14 ft water C: calibration in % LSH-101 = 70% (1)	120 VAC power supply High level (LSH) shuts down pump via interlock 168" insertion length Cable: 99X1W0980, 30 ft
LS-101	Recovery well pump shutoff/reset level switch	Electrode located in recovery well. Switch/control located in control panel mounted with electrical equipment near ground water holding tank	Warrick Control: 16MB1A4 Electrodes: (2) 3Y1C5	Shutoff probe: 14.9 ft below grade Reset probe: 10 feet below grade (2)	Switch opens when level falls to shutoff probe; closes when level rises to reset probe
LSHH/XS-101	Ground water holding tank high-high level and leak detection (alarm) panel	Mounted with electrical equipment near ground water holding tank	Warrick: DMS-474-A-2		See XA-101 in Plant Alarm Table (Table 10-2)
PI-101	Pressure gauge	Installed in discharge piping from recovery well	Campbell: Part PG-1	0 to 100 psi	
XE-101	Ground water holding tank annular space leak detection sensor	Installed in secondary containment shell of ground water holding tank	Warrick: Model DLP-1 Cap: DSC-115A	On/Off Setpoint: 4 inches above bottom of tank	Dry contact output to LSHH/XS-101

NOTES:

(1) 70% = 9.8' = 5,300 GALLONS
(2) RESET PROBE SET POINT WILL REQUIRE ADJUSTMENT IN THE FUTURE. AS OF THE WRITING OF THIS MANUAL IT TAKES 2 DAYS FOR THE GROUND WATER LEVEL TO RETURN TO THE 10' LEVEL.

TABLE 10-2
PLANT ALARMS

ALARM ID NO.	ALARM CONDITION	MONITORING INSTRUMENT	SET POINT	AUTOMATIC RESPONSE	OPERATOR ACTION
LAHH-101 (1)	High-High level in ground water holding tank	LSHH-101	S: 12'-2"	1. Alarm activation in Boiler Room control system 2. Submersible pump shutdown	1. Make arrangements for disposal of tank contents. 2. Turn submersible pump off. 3. Appraise Axelrod Institute Plant Engineer of situation.
XA-101 (2)	Leak detection in ground water holding tank primary shell	XS-101	On/Off	1. Alarm activation in Boiler Room control system 2. Submersible pump shutdown	1. Verify that leak is contained within tank secondary shell. 2. Turn submersible pump off. 3. Make arrangements for immediate disposal of tank contents. 4. Troubleshoot tank to find leak. 5. Arrange for tank repairs. 6. Appraise Axlerod Institute Plant Engineer of situation.

NOTES:

(1) ALARM NO. 1 ON ALARM (LEAK DETECTION) PANEL
(2) ALARM NO. 2 ON ALARM (LEAK DETECTION) PANEL

11.0 TROUBLESHOOTING

11.1 INTRODUCTION

Troubleshooting refers to the process of identifying a problem in the operation of the Plant, and finding and implementing a solution. Equipment problems or treatment process difficulties can be the result of any one of a number of causes. The purpose of this chapter is to provide Plant operating personnel with guidance on identifying the causes of equipment and treatment process difficulties, and to provide suggested remedies for rectifying these difficulties.

In this chapter, symptoms and solutions for many of the common operating problems likely to be encountered at the Plant are presented. It is not possible, however, to foresee all problems and solutions. Therefore, if a problem is not corrected by the given solution, or if a problem exists which is not identified in this chapter, the operator should consult the individual equipment manufacturer's operation and maintenance manuals, or seek expert advice, prior to undertaking a corrective course of action.

11.2 TROUBLESHOOTING TABLES

Troubleshooting guidance for the major components of the Plant is presented in the tables listed on the following page. For ease of reference, the tables are organized in approximately the order of the process flow.

Any troubleshooting guidelines for instruments and equipment not listed in the following tables is contained in the vendor O&M Manuals included as Appendix D to this manual.

Table No.	Title
11- 1	Submersible Pumps and Speed Controllers
11- 2	Level Indicator

It is recommended that these troubleshooting tables be updated periodically based on actual Plant operating experience.

TABLE 11-1
SUBMERSIBLE PUMP

	Problem	Possible Cause	Suggested Remedy
1.	Submersible Pump is not operative.	No power to the pump.	Verify that Circuit Breaker 2 is closed, and that the disconnect switch is closed.
		Interlocks have been opened due to an alarm condition.	Verify that the following possible alarms are in normal status: 1. LAHH-101 2. XA-101
		The tank is at High Level.	Dispose of tank contents.
		Water level in the well has fallen below the upper Well Level Setpoint.	Re-establish the upper Well Level Setpoint below the existing water level in the well.
2.	Submersible Pumps is operative, but low or no flow into storage tank.	Water level in the well has fallen below the upper Well Level Setpoint.	Re-establish the upper Well Level Setpoint below the existing water level in the well.
		One or more ground water recovery valves are closed.	Open all ground water recovery valves shown as open on the P&I Record Drawings.
		Submersible Pump impellers are clogged.	Clean and inspect Submersible Pump in accordance with Manufacturer's O&M manual.
3.	Other	Refer to Manufacturer's O&M Manual.	

TABLE 11-2
LEVEL INDICATOR

	Problem	Possible Cause	Suggested Remedy
1.	No level indication on screen.	Screen is not operational.	Refer to O+M Manual.
		No power to Level Indicator.	Verify that Indicator is receiving power from the Control Panel.
2.	Level indication on screen is zero or too low.	Indicator tube is not positioned in tank correctly.	Inspect the Indicator tube.
3.	Level indication on screen is too high.	Indicator tube is kinked or blocked.	Inspect the Indicator tube.
4.	Other	Refer to Manufacturer's O&M Manual.	

12.0 MAINTENANCE MANAGEMENT

12.1 INTRODUCTION

The successful and economical operation of the Plant depends on the regular and systematic maintenance of Plant equipment, piping systems and grounds. Routine preventive maintenance of mechanical equipment, such as pumps, will ensure optimum equipment performance and reduce the frequency of equipment breakdown and interruptions to the Plant processes. Cleanliness of facilities and grounds contributes to the safety and health of the operating personnel, and presents a favorable impression to visitors and regulatory personnel. Proper maintenance requires the establishment of, and adherence to, a realistic maintenance program and schedule.

This chapter is intended to provide the Plant operating personnel with the basic systems and procedures necessary to maintain the Plant in a good operating condition. It does not attempt to show step-by-step inspection, disassembly, adjustment, lubrication, or other maintenance details for specific items of equipment. The manufacturer's operation and maintenance manuals located in Appendix D should be consulted for these details. The systems and procedures outlined in this chapter, when properly implemented and routinely followed, will ensure that the Plant performs its design functions at maximum efficiency and with minimum interruptions or breakdowns.

12.2 EQUIPMENT RECORD SYSTEM

12.2.1 Equipment Numbering

Each major item of equipment is assigned an equipment number for ease of identification and to ensure that the maintenance performed on the item is properly recorded. The equipment number is alpha-numeric (e.g., P-101).

The first one, two, or three letters are an abbreviation of the equipment name (e.g., P for pump). The first number which follows the alphabetic abbreviation corresponds to the process and instrumentation (P&I diagram) Record Drawing number on which the item of equipment appears. (e.g., P-101 is shown on PID-1.) The next two numbers, are assigned sequentially for similar equipment items on the same "PID" drawing. Each equipment identification number is unique to the assigned item of equipment.

12.2.2 *Instrument Numbering*

All instrumentation in the Plant is shown schematically on the P&I diagram (PID) Record Drawings. Instrument identification is based on the function of the instrument and the PID drawing number on which it appears. Each identification number consists of a two to four letter acronym and a three to four digit number. The acronym summarizes the type of instrument in accordance with the instrument identification table shown on Drawing PID-1 (e.g., LSH = Level Switch High). The first digit of the three digit number corresponds to the PID drawing number on which the instrument appears. For example, LSH-101 is shown on Drawing PID-1. The second digit is always zero. The last digit of the number is used to differentiate between the same type of instrument on the same PID drawing. All instrument numbers are unique.

A complete listing of all Plant instrumentation is given in Table 10-1.

12.2.3 *Equipment History Cards/Forms*

Equipment History Cards/Forms should be prepared for each item of equipment in the Plant. These cards contain all the information needed to identify the equipment, including the manufacturer, model, size, capacity, serial number, electrical requirements, etc. They also contain coded entries defining the preventive maintenance service required as discussed in Section

12.3.2.2. The reverse side of the Equipment History Card or second page of the Form is used to maintain a running history of the maintenance and repairs performed on each equipment item. A suggested format for the Equipment History Card/Form is included as Figure 12-1.

In lieu of hand written cards or forms, the equipment history information could also be tracked using a database on a personal computer.

12.3 PLANNING AND SCHEDULING

12.3.1 General Discussion

Plant maintenance work may be either preventive or corrective. Preventive maintenance consists of routine, recurring tasks performed periodically on facilities and equipment. These tasks include inspection, lubrication, adjustment, cleaning, minor repairs, painting, etc. Corrective maintenance, synonymous with repair, is the restoration of equipment to its original design capacity and efficiency through parts replacement, component reprocessing, overhaul, or rebuilding.

Planning and scheduling are essential to the effective implementation of a maintenance management system regardless of whether preventive maintenance or corrective maintenance is involved. Without planning and scheduling, maintenance work will be haphazard, costly, and ineffective.

12.3.2 Preventive Maintenance Program

The preventive maintenance program consists of a preventive maintenance task list and schedule for each item of Plant equipment and for each non-equipment Plant component, i.e., structures, piping systems, grounds maintenance etc., requiring periodic servicing. Guidelines for the development of these two preventive maintenance program components are contained in this section.

12.3.2.1 *Preventive Maintenance Task List*

The preventive maintenance task list is prepared from data sources available to the Plant operator. These sources include inspection, maintenance, and lubrication schedules prepared for the Plant, manufacturers' operation and maintenance manuals, the equipment history card files, and the Plant Record Drawings. Certain tasks, such as exterior painting, fertilization of seeded areas, and cap inspection and repair, are seasonal. Other items, such as the draining of tank for inspection must be related to predictable periods of Plant shutdown. Tasks should be related to a preventive maintenance standard or to a lubrication standard, as described in Section 12.3.4, where applicable.

The basic steps required to prepare the preventive maintenance task list are as follows:

Step 1 - List all equipment, structures, and systems requiring preventive maintenance using the manufacturer's operation and maintenance manuals, equipment history cards, the Plant Record Drawings, and the Plant inspection reports.

Step 2 - Determine the preventive maintenance requirements and their respective frequencies for each item of equipment, each structure, and each system listed.

Step 3 - Using the preventive maintenance or lubrication standards described in Section 12.3.4, estimate the time and skills required to perform each preventive maintenance task.

Step 4 - Total the man hour requirements for all preventive maintenance tasks and compare to the available man hours for preventive maintenance work.

12.3.2.2 Preventive Maintenance Schedule

The preventive maintenance schedule is prepared by balancing the man hour requirements developed from the preventive maintenance task list against the man hours available for preventive maintenance work. Equipment, structures, and systems must be rated as to their criticality in the Plant operation, and to their value, life expectancy, and replacement cost. The assigned priority rating is then used to determine the items on which the available preventive maintenance man hours will be scheduled and used. A suggested ranking system for making these priority determinations is presented below:

Priority A - Equipment where failure of a minor part or neglect of normal lubrication requirements may lead to major repairs and/or interruption in the Plant process.

Priority B - Equipment of significant replacement value or other items where an equipment breakdown is not likely to interrupt the Plant processes but may lead to expensive repairs or item replacement.

Priority C - Items of small to moderate dollar value and other items where failure will not interrupt the Plant processes, and where repair or replacement cost is not excessive.

The basic steps required to prepare the preventive maintenance schedule are as follows:

Step 1 - Develop a typical work week schedule from the man hour balancing step (Step 4) in Section 12.3.2.1, preceding.

Step 2 - On a yearly calendar select tentative dates for performing all monthly, quarterly, semi-annual and annual preventive maintenance procedures. Adjust the typical weekly schedule for planned corrective maintenance work, and for the man hours diverted to monthly, quarterly, semi-annual, and annual preventive maintenance procedures.

Step 3 - The typical weekly schedule becomes the basic preventive maintenance schedule from which schedule boards are maintained, weekly work assignments are made, and progress reports are prepared. Preventive maintenance schedules must be adjusted regularly for priority changes, weather related delays, carry over work from prior weeks, delays in replacement parts, and other justifiable reasons.

12.3.2.3 Typical Preventive Maintenance and Lubrication Schedules

The best sources of specific information on the performance of preventive maintenance tasks and recurring lubrication procedures for the Plant equipment are the manufacturer's operation and maintenance manuals and service bulletins provided for each item of equipment (See the last appendix to this manual). Inspection, maintenance, and lubrication schedules are included in each manufacturer's operation and maintenance manual when applicable. The operator should ensure that these technical documents are complete, current, and are properly protected from damage or loss.

Inspection, maintenance, and lubrication requirements for all equipment items are summarized in one Inspection, Maintenance, and Lubrication Schedule included as Appendix C to this manual.

The Lubrication Survey lists all equipment, the manufacturer's lubrication recommendations, and an interchangeable lubricants tabulation, standardizing and consolidating lubricants whenever possible. The Lubrication Survey is included as Appendix C to this manual.

These typical schedules should be used as a general guide only and should not be considered as a substitute for the more comprehensive information contained in the manufacturer's technical documents.

12.3.3 Corrective Maintenance

Corrective maintenance is defined as the work required to accomplish major repairs and non-routine maintenance procedures. Planning and scheduling of maintenance work must make provisions to handle these non-recurring functions.

12.3.3.1 Planning Corrective Maintenance

Although actual equipment breakdown may precede the planning of corrective maintenance, resorting to "break-down" maintenance may cause disruptions in the Plant processes and costly overtime work. Accordingly, it is desirable to use anticipatory methods to plan corrective maintenance. These methods include periodic inspections of equipment, close review of equipment operating records, operator observations, and notations on the Operating Reports, and other analyses for the timely identification of impending problems.

Corrective maintenance planning may include the use of contractors and outside repair shop facilities for major repair work, if required. Man hour requirements for corrective maintenance work are determined by normal estimating procedures. When determined, these requirements are integrated into the weekly work schedule discussed in Section 12.3.2.2, preceding.

Care must be exercised that the lead time necessary to obtain required spare parts is taken into consideration when the corrective maintenance work is integrated into the weekly work schedule.

12.3.3.2 Work Orders

The operator may wish to use a work order system to initiate, schedule, and record the accomplishment of all preventive maintenance and corrective maintenance tasks. There are two basic types of work orders.

(1) A standard work order, involving preventive or corrective maintenance, which can be performed by operator and/or NYSDOH mechanics or technicians.

(2) A job order that requires the services of non-operator or NYSDOH personnel, such as a major equipment repair, equipment vendor services, purchase requisitions, etc.

A standard work order is initiated by the Plant operator using standard NYSDOH procedures. The Plant operator then follows-up and coordinates the work order activities. The operator may wish to document the standard work order using a form such as that given in Figure 12-2. The completed standard work orders are used to make the required maintenance history entries on the Equipment History Cards/Forms. They should be retained for a period of at least five years for use in analyzing cost trends, and for guidance in developing future schedules.

In lieu of hand written forms, the standard work order information could also be tracked using a database on a personal computer.

A job order is initiated by the Plant operator for work, services, or deliveries requiring the use of non-NYSDOH personnel. The operator may wish to document the job order using a form such as that given in Figure 12-3. As with standard work orders, the summary information from completed job orders should be transferred to the applicable Equipment History Cards/Forms. The completed written job orders should be retained for a period of at least five years.

Again, the job order information could be tracked using a database on a personal computer.

12.3.4 Standard Maintenance Procedures

Standard maintenance procedures include preventive maintenance standards and lubrication standards applicable to each item of equipment and to each Plant component, or to each group of similar items. They are intended to provide a guide to the Plant operating personnel for the performance of these recurring maintenance tasks. When used as a check-off list by the performing personnel, they serve to assure that no item on the preventive maintenance task list is overlooked.

12.3.4.1 Preventive Maintenance Standards

Preventive maintenance standards are developed from the manufacturers' operation and maintenance manuals and from observations of the Plant operation over a period of time. They should be specific as to inspection points, measurements, tolerances, torque readings, adjustments, calibration, recurring maintenance and parts replacement requirements.

The labor hours required to perform the standard procedures can be derived initially from operator experience and available maintenance labor guides such as Universal Maintenance Standards (UMS) or the Navy's <u>Engineered Performance Standard Public Works Maintenance</u>. The initial labor standards, developed from these industrial or military standard sources, will usually require adjustment after actual use under local Plant conditions. It is important that the labor hours be a realistic reflection of the actual work requirements for the procedure involved. A significant understatement or overstatement of labor requirements will destroy the validity of the standard system and inhibit the preparation of a workable preventive maintenance schedule.

A locally developed preventive maintenance standard numbering system, based on the equipment numbering system, has been found to be a useful tool for scheduling these recurring maintenance procedures and for recording their accomplishment on the Equipment Record Cards.

12.3.4.2 Lubrication Standards

Lubrication standards are developed from the lubrication recommendations in the manufacturer's operation and maintenance manuals. The standard should be specific as to lubrication point, lubricating method, recommended lubricant, lubricating frequency, and any special lubricating instructions.

A Plant Lubrication Survey has been completed to enable the operator to reduce the number of lubricants required to be stocked at the Plant. A standardized lubricant stocking list can be prepared based on the information contained in the survey. The Lubrication Survey is included as Appendix C to this manual.

12.4 STORAGE AREA AND SPARE PARTS INVENTORY MANAGEMENT

12.4.1 General Discussion

The ready availability of spare parts and materials for the expeditious accomplishment of preventive maintenance procedures and repairs to Plant equipment is critical to an effective maintenance program. This objective is achieved by the establishment and routine maintenance of a spare parts inventory and stock replenishment system.

12.4.2 *Storage Area*

A designated area should be provided for the storage of supplies, repair parts, and emergency tools within the Maintenance Plant of the Axelrod Institute. This area should be clearly marked and labeled to allow rapid access to needed items and to facilitate stock inventory. An additional satellite storage area should be provided for the storage of paints, oils and other flammable materials.

12.4.3 *Storage Inventory Cards*

Because of the small size of the Plant and the limited Plant personnel available, a simple inventory card system can be used for all inventory purposes. The inventory card shows the following information:

- Part or material description (Mfr., Part No., Size, etc.).
- Stocking quantity (Maximum, Minimum, and Reorder).
- Usage information (Date, Quantity, and Person Using).
- Reorder information (Requisition No., Date of Order, and Date of Receipt).

A suggested inventory card format is shown as Figure 12-4.

In lieu of hand written cards or forms, the inventory information could be tracked using a database on a personal computer.

A physical inventory of the storage area contents should be conducted at least annually to reconcile the on-hand quantities of materials and spare parts with the quantities shown on the inventory cards.

12.4.4 *Maintenance Materials*

Maintenance materials to be stocked at small sized Plants are categorized as either consumable supplies or spare parts. Stocking levels for each category of maintenance material must be carefully evaluated in order to achieve an optimum balance between uneconomical overstocking and the loss of operational capability because of a lack of a needed spare part.

12.4.4.1 *Consumable Supplies*

The stocking of consumable supplies for a small sized Plant such as the NYSDOH Plant deserves careful budgetary consideration. Most consumables are subject to pilferage, have short shelf-life, or are readily available from local commercial sources when needed. For reasons of economy, stocking of consumable supplies should be limited to items required for recurring maintenance or housekeeping tasks such as equipment lubrication or to those items needed for rapid response to emergency situations. A suggested list of consumables for the Plant is shown as Table 12-1. Except for emergency recovery supplies, stocking quantities are not shown. These must be established initially and adjusted periodically based on actual usage experience.

12.4.4.2 *Spare Parts*

The stocking of spare parts, like the stocking of consumable supplies, requires careful management attention. Failure to stock an adequate inventory of items which are used on a routine basis can adversely affect Plant operations and the execution of an effective preventive maintenance program. Conversely, the stocking of large and expensive items of replacement equipment as insurance items in some cases can be poor management practice and can unnecessarily reduce critical maintenance and capital funds.

Before making a management decision to stock any large part or replacement component such as a spare pump, an analysis should be made considering the following factors:

1. Off-the-shelf availability of the item from commercial sources;

2. Lead time for manufacture and shipping of the item if it is not regularly stocked at manufacturers' stocking points;

3. Importance of item to the continuity of proper Plant operations;

4. Availability of secure and protected storage facilities for long term storage of major replacement components.

Each manufacturer's operation and maintenance manual contains a parts listing for the covered equipment, a recommended spare part listing for local stocking, and the address and telephone number for ordering non-stocked replacement parts. These manuals are the principal sources available to the Plant operating personnel for spare parts stocking and ordering information and should be referred to in all cases.

Locally stocked spare parts are accounted for on the Storage Inventory Cards, Figure 12-4, which record usage information, stocking levels, and reordering data. Inventories of stocked spare parts should be made annually and the Storage Inventory Cards reconciled with actual quantities on hand.

12.5 MAINTENANCE TOOLS AND EQUIPMENT

12.5.1 Maintenance Tools

Good maintenance depends on the availability of proper tools to do the job.

A standard set of mechanics hand tools, with socket and end wrench sizes to 1-1/4 inches and torque wrench capabilities to 150 foot pounds, should be either provided in a secure and protected location within the Maintenance Plant of the Axelrod Institute for routine Plant maintenance. The standard tool set should be supplemented with the special tools listed in Table 12-2 for the specialized maintenance and repair tasks encountered occasionally in the Plant.

Hand shovels, brooms and other articles necessary for general site maintenance and cleanup should be available on-site.

12.5.2 Maintenance Equipment

Large items of maintenance equipment which are used infrequently should be obtained from equipment rental sources as needed. A listing of more frequently used maintenance equipment to be stored at the Plant is given in Table 12-3. Emergency recovery equipment is listed in Chapter 14 as Table 14-3. Safety equipment is listed in Chapter 6 as Tables 6-2 and 6-4.

TABLE 12-1
CONSUMABLE SUPPLIES

Category	Item	Remarks
Lubricants	Refer to Plant Lubrication Survey	
Housekeeping	Detergent, Industrial Grade	Space and Equipment Cleaning
	Mechanics' Handsoap	Personal Cleanliness
Plant Maintenance Equipment	Mineral Spirits	Cleaning
	PVC Pipe Glue	Joining PVC Pipe
	Pipe Joint	Joining PVC Pipe
	Teflon Tape	Joining PVC or Metal Pipe
	Electric Insulating Tape	Electrical Repairs
Emergency	PVC Pipe - 2" and 6"	1 length each size
	Miscellaneous PVC Fittings	

TABLE 12-2
SPECIAL MAINTENANCE TOOLS

Item	Purpose	Remarks
Megohmeter	Testing Equipment Resistance to Ground	Range 0 to Infinity
Electric Multimeter	Testing Electric Circuits and Equipment	Capacity to 500 VAC
Clamp-on Ammeter	Checking Current Flow	Capacity to 100 amps

TABLE 12-3
MAINTENANCE EQUIPMENT

Item	Purpose	Remarks
Portable blower with hose	Ventilate Tanks	Capacity 750 CFM
Drill, Electric, Reversing and Variable Speed	General Purpose	Capacity to 1/2"
Non-metal Extension Ladder	Tank Maintenance	Extended length 20'
Wheelbarrow	General Purpose	Medium Capacity

Figure 12-1

Front

EQUIPMENT RECORD CARD					
EQUIPMENT		ELECTRICAL			
NAME	I.D. No.	NAME		I.D. No.	
SERIAL No.		SERIAL No.			
MODEL No.		TYPE			
SIZE		VOLTS	AMPS	RPM	
MFGR.		PHASE	FRAME	HP	
		MFGR.			

PROC. No.	PREVENTIVE MAINTENANCE	FREQUENCY

Back

SERVICE RECORD					
DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED

Figure 12-2

STANDARD WORK ORDER

STANDARD No.: ____________ DATE: ____________

STANDARD No.: ______________________________

APPLICABLE TO: (LIST EQUIPMENT NUMBER) ____________

WORK REQUIREMENTS:

EQUIPT. No.	COMPLETION DUE ON OR BEFORE	ESTIMATED WORK HOURS	ACTUAL WORK HOURS

TASK No.	TASK DESCRIPTION

Figure 12-3

JOB ORDER FORM

JOB ORDER NO: ____________________

DATE: ____________________

EQUIPMENT NAME NUMBER

PRIORITY: ____________________

INITIATED BY: ____________________

____

REASON: ____________________

____

WORK DESCRIPTION: ____________________

____

____

____

____

JOB ESTIMATE

LABOR: ____________________

MATERIALS: ____________________

WORK RECORD

PERSONNEL ASSIGNED	MAN/HOURS	DATE	WORK DONE	PART/MAT'LS

TOTAL ________

WORK COMPLETED: ____________________ DATE: ____________
(Signature)

WORK ACCEPTED: ____________________ DATE: ____________
(Signature)

Figure 12-4

STOREROOM INVENTORY CARD

ITEM IDENTIFICATION

PART/ITEM No. : ____________________

EQUIPT./COMPONENT: ____________________

____

ITEM DESCRIPTION: ____________________

____

STORAGE LOCATION

STOCKING INFORMATION (QUANTITY)

MAXIMUM: ____________ MINIMUM: ____________ REORDER: ____________

INVENTORY INFORMATION

QUANTITY USED/STOCKED	DATE	SIGNED	QUANTITY ON HAND	USAGE/RESTOCKING DATA

13.0 SITE MAINTENANCE

13.1 INTRODUCTION

The Remedial Design for the Site incorporates several components other than the process equipment, that require periodic inspection and maintenance. The ongoing maintenance of the following features is critical to the successful implementation of the Remedial Program:

1. Geomembrane cap, vegetative cover and asphalt paving.
2. Recovery and monitoring wells.
3. Fencing.
4. Passive vapor recovery system.
5. Storm drainage system.

Specific inspection and maintenance procedures regarding these components are discussed below. All inspection findings and maintenance performed should be recorded on Figure 5-6, which is located at the end of Chapter 5.

13.2 GEOMEMBRANE CAP, VEGETATIVE COVER, AND ASPHALT PAVING

The surface of the capped area of the Site must be inspected regularly to ensure that the geomembrane cap is being properly protected by the fill materials and the vegetative and asphalt pavement cover. The surface of the remediated area should be visually inspected by the operator on at least a monthly basis, and following major storm events.

13.2.1 Vegetative Cover

The protection provided by the vegetative cover should be complete with no visible bare spots. The operator must look for erosion rivulets on slopes, and any signs of accumulated liquids. In addition, any sign of settling must be noted. Large seedlings, which may eventually impact the integrity of the cap, must be removed, and holes from burrowing animals should also be noted.

Should inspection reveal that the cap or final cover integrity may be compromised in any way, appropriate mitigative actions must be implemented. Repairs to bare soil spots may include reseeding, fertilizer application and soil conditioning, if applicable. Erosion may be reduced by improving vegetation (if appropriate) and altering contours to minimize storm water run-off velocities. Sections of the cover which have subsided must be backfilled, regraded and reseeded as necessary. Measures must also be implemented to control the presence of burrowing animals within the geomembrane capped area.

All vegetative growth, including grass, seedlings and bushes, must be maintained so that the geomembrane integrity is not compromised. **The vegetative cap cover must be mowed as needed to meet this requirement.** The maximum height of vegetative growth is recommended to be approximately one foot.

It is also recommended that areas in the vicinity of the cap be maintained so that monitoring wells remain visible and easily accessible.

13.2.2 Asphalt Paving

Maintenance of the asphalt paving in the parking area in good condition is necessary to the safe passage of tanker trucks and all other vehicles onto and off of the remediated area of the Site.

The asphalt paving should be inspected monthly and after major storm events. All cracks in the paving should be sealed using an asphalt sealant.

Any weeds or seedlings growing out of the paving should be removed.

The operator must also look for any evidence of accumulated liquids or any other signs of pavement settling. Should inspection reveal that the cap or asphalt paving integrity may be compromised in any way, appropriate mitigative actions must be implemented. Sections of the cover which have subsided must be backfilled, regraded and repaved as necessary.

13.3 *RECOVERY AND MONITORING WELLS*

The ground water recovery well and Site monitoring wells must be inspected on a regular basis and maintained as necessary to prevent fouling of the well screens. Fouling may be caused by biological activity (slime), dissolved metals (e.g., iron sludge) chemical reactions, natural siltation, or any combination of the above.

If fouling occurs, the operator must identify the cause and implement corrective measures. These measures may include the introduction of weak chemical or acid solutions into the well, or redevelopment of the well. NYSDOH representatives must be advised and consulted before any chemicals are introduced into the Site soils as a corrective measure. NYSDOH's knowledge of past disposal activities at the Site will be helpful in identifying potential chemical reactions which might occur between any proposed corrective chemicals, and chemicals already present within the contaminated soils.

All wells should be inspected monthly, and the vegetation and soil around the wells maintained so that the wells remain visible and accessible.

The Site monitoring wells are installed within flushmount bolted protective casings. The bolts on the protective casings should be inspected and lubricated monthly. Locking caps have been placed on the top of the 2-inch diameter PVC wells within each flushmounted unit.

13.4 *FENCING*

The fencing around the Site and around the ground water recovery pump, storage tank and appurtenances should be inspected monthly for tears, breaks or other damage. Any damage should be reported immediately to the Axelrod Institute Plant Manger and repaired as soon as possible.

Brush and trees close to the exterior of the fence should be removed to eliminate a means for access to the Site over the fence. The lock on the gate to the ground water recovery area should be inspected and lubricated regularly, and replaced if necessary due to rusting or other damage.

13.5 *PASSIVE VAPOR RECOVERY SYSTEM*

The passive vapor recovery system consists of drainage netting installed between two layers of geotextile. This geonet composite is tied into perforated PVC vapor collection headers running along the east and west boundaries of the cap. The headers are connect to standpipes which allow soil vapors to be passively vented from beneath the cap. The standpipes should be inspected monthly and repaired immediately in the unlikely event of damage.

The implementation of the maintenance and inspection procedures outlined in paragraph 13.2 for the geomembrane cap, vegetative cover and asphalt paving will also ensure that the geonet composite and vapor collection headers membrane are adequately maintained.

13.6 STORM DRAINAGE SYSTEM

The storm drainage system installed at the Site should be inspected seasonally, and cleaned as necessary, to ensure that storm water is properly diverted away from the remediated area of the Site.

14.0 EMERGENCY PROCEDURES

14.1 INTRODUCTION

Emergency preparedness is essential to ensuring the continuous effective operation of the Plant under emergency conditions. The purpose of this chapter is to present an Emergency Response Plan for the Plant. The objectives of the Emergency Response Plan are to:

1. Eliminate or reduce adverse effects to human health and the environment resulting from emergency situations affecting the Plant.

2. Establish procedures for timely and appropriate response to emergency situations.

3. Provide definitive instructions to allow operating personnel to understand and execute their responsibilities.

4. Establish sources of emergency assistance and list emergency supplies and equipment available to recover from emergency situations.

This chapter addresses the Plant safeguards and procedures that should be utilized by Plant personnel in responding to one or more of the emergency situations listed in Table 14-1. Routine health and safety practices are described in Chapter 6.

Effective emergency planning requires substantial coordination and forethought by all individuals involved in the operation of the Plant. This chapter has been prepared to be as complete and comprehensive as possible. However, since Plant personnel may have a better perspective on optimum emergency response and their own capabilities, revisions and additions to the Emergency Response Plan are encouraged.

Equipment malfunction, fires, spills, power failures, and natural disasters are often dramatic, unexpected occurrences which can cause personnel to momentarily forget or ignore basic emergency procedures. Therefore, it is important for Plant personnel to become completely familiar and comfortable with Plant emergency procedures and safeguards.

14.2 EMERGENCY PREVENTION MEASURES

In order to reduce or eliminate the likelihood of emergency events occurring at the Plant, emergency prevention measures have been established for and built into the Plant construction and operation. These prevention measures include the following, and are described below:

- Ground water storage tank.
- Secondary containment of the ground water recovery system.
- Fire protection system.
- Security system.

14.2.1 Ground Water Storage Tank

The purpose of the ground water storage tank is to collect and hold ground water prior to disposal. If there are any Plant emergencies, or if there are any unforeseen delays in arranging for ground water disposal, the ground water can remain in the tanks for an indefinite period of time, without any adverse effects on the Plant or the environment.

The ground water storage tank has a 5,000 gallon working volume, or an approximate 33 day fill time based on the Plant design flow of one-tenth of a gallon per minute. Thus, under normal flow conditions, as much as one month of time is available to rectify alarms or disposal arrangement problems before the ground water recovery system must be shut down.

14.2.2 *Secondary Containment of the Ground Water Recovery System*

The ground water storage tank is a double-walled polyethylene tank. The outer shell of the tank serves as a secondary containment shell to contain the recovered ground water if the primary shell fails. The annular space between the inner and outer shells contains a leak detection probe, which shuts off power to the submersible pump if water is detected in the annular space. Any tank leaks activate an alarm.

14.2.3 *Fire Protection System*

Portable fire extinguishers are located in the Axelrod Institute Power Plant facility. These extinguishers are ABC-class extinguishers which use Halon as an extinguishing agent, to protect the electronic equipment and a dry chemical extinguisher. These extinguishers are located on the floor adjacent to the welding bench near the south entrance door to the Axelrod Institute Power Plant facility.

All Plant personnel should be trained in the use and operation of these portable extinguishers. Portable extinguishers should be used in an upright position. Before approaching a fire, the extinguisher should be checked by removing the safety pin and briefly squeezing the handle or grip. The extinguisher discharge should be directed at the base of the fire, with the nozzle moving in a rapid side-to-side sweeping motion.

The fire extinguishers should be inspected regularly, and recharged immediately following their use, or as needed based on the inspections.

14.2.4 *Security System*

In order to prevent unauthorized entry, barbed wire fencing surrounds the entire plant site. This fencing has a gate which is chained and pad locked at all times to limit access. In addition, remote cameras constantly being used by the Axelrod Institute keep the Plant area under observation.

14.3 *EMERGENCY RESPONSE PLAN*

14.3.1 *General Discussion*

The following sequence of steps should be followed by Plant personnel when responding to an emergency situation:

1. Identify emergency.
2. Perform initial investigation.
3. Take initial action.
4. Take corrective action.
5. Perform follow-up investigation.

Identifying an emergency is usually a simple task because the effects of an emergency are readily apparent. In some cases, the operator may have prior warning of an emergency. For example, weather reports can provide warning of approaching hurricanes, windstorms, blizzards, or other natural occurrences.

Once Plant personnel are aware that an emergency condition exists or is impending, all persons in and around the Plant should be notified and an immediate initial investigation should be performed. The operator is responsible for quickly coordinating the investigation and assigning personnel to investigative duties. The purpose of the initial investigation is to assess the severity of the situation and to collect enough information to make an action decision. The assessment should include identifying any injured persons, observing equipment damage, noting impending damage if corrective action is not taken immediately, and itemizing equipment and materials required to remedy the situation.

Once the extent of the emergency is known, the operator is to then make an immediate decision as to what initial action should be taken in compliance with this Emergency Response Plan. All Plant personnel are responsible for ensuring that any actions taken conform to the procedures in this plan.

In the event of large scale emergencies, usually the initial action would be to contact emergency services and local authorities such as the fire and police departments. These agencies and their telephone numbers are listed in Table 6-1, which should be posted next to the Plant telephone at all times. A route map to the Albany Medical Center on New Scotland avenue in Albany, New York should be posted in a conspicuous location, and in a manner that it can be quickly removed without damage, for use during emergency transportation. If the condition involves a spill or accidental discharge, NYSDEC should be contacted, as well as other emergency services and agencies as deemed appropriate and as required by law.

After all appropriate emergency contacts have been notified, Plant personnel should initiate remedial procedures, within limitation. Personnel should not endanger themselves or others by attempting tasks for which they are not qualified or for which proper equipment is not available. In all cases, if in doubt, wait until qualified help arrives.

When emergency response authorities arrive, Plant personnel should immediately inform them of the details of the situation, including the chemicals and hazards that may be encountered. Corrective action should proceed until the situation is either under control or completely rectified. If remedial action will take considerable time (days or weeks), Plant personnel should consult with the NYSDOH to outline long term efforts to complete the task.

After the emergency situation has been corrected, Plant personnel should critically analyze the events leading up to the emergency, as well as the response. The purpose of the follow-up investigation is to minimize the risk of recurrence and to assess the effectiveness of the emergency response. Steps should then be taken to eliminate identified deficiencies.

The HASP, which is located in Appendix B, is a comprehensive plan for dealing with health and safety issues and emergencies on the Site, including the handling of ground water and associated health concerns and precautions. The following subsections are intended only as general guidelines for emergency procedures during specific situations. Key NYSDOH personnel must be notified of all emergencies.

14.3.2 Injuries to Plant Personnel or Visitors

Early recognition of the symptoms of various injuries and exposures is important for effective treatment and recovery. The signs and symptoms of various injuries, chemical exposure, and shock are listed in Table 14-2.

In the event of minor injuries such as cuts, bruises, or sprains, the injured person should be taken to the Albany Medical Center in Albany, N.Y., if mentally alert and ambulatory. In the event of a serious injury or chemical exposure, the local Emergency Medical Services (EMS)/Poison Control Center should be contacted immediately at (518) 434-4444 or (518) 783-2811, respectively.

The person contacting the local EMS should be prepared to provide the following information:

1. Exact location of the emergency
2. Telephone number he/she is calling from
3. Type of injury(ies)
4. How many persons have been injured
5. What assistance or first aid is being given to the injured person(s)

Do NOT hang up unless told to do so. In most cases, the EMS dispatcher will require the caller to stay on the telephone.

While awaiting the arrival of medical assistance, first aid should be administered. The basic procedures for assisting an injured person are as follows:

1. Remain calm and quickly evaluate the injury.

2. Do not move the injured person unless necessary to avoid a life-threatening situation.

3. If possible, move any physical and chemical hazards from the area of the injured person.

4. Take care of the most serious injuries: stop bleeding, restore breathing, etc.

5. Cover injured person with jackets, coats, or blankets to keep warm.

Detailed descriptions of first aid procedures are given in the American Red Cross Standard First Aid Manual, located within the Maintenance Plant of the Axelrod Institute.

14.3.3 *Fire or Explosion*

Plant emergency and fire-fighting equipment are identified in Table 14-3 at the end of this chapter. All incidents of fire, explosion, or related Plant shutdown must be reported to NYSDOH and NYSDEC.

Portable fire extinguishers are located near the south entrance of the Power Plant to the Axelrod Institute. One tri-class Halon extinguisher and one tri-class dry chemical extinguisher are on the floor adjacent to the welding bench within the Power Plant.

The fire extinguishers must be visually inspected and hydrostatically tested by a fire extinguisher service company on an annual basis.

In the event of a fire or explosion, Plant personnel should take the following steps:

1. Account for all Plant personnel and visitors on the Site, and identify injuries, if any.

2. In the event of a major fire or explosion, evacuate the Building and/or area of fire immediately, and telephone the Albany Fire Department at (518) 463-1234 from a nearby location as soon as possible.

3. In the event of a localized fire, implement step 2 above, and attempt to extinguish the fire if there is no potential for explosion.

4. Initiate the Plant Emergency Shutdown Procedures listed in Section 14.4 if Plant operation is threatened by fire or explosion.

5. Upon arrival of fire fighting personnel, apprise them of the situation,

including the potential chemical and physical hazards within the Plant.

14.3.4 Electrical Power Loss

"Power loss" may be caused by any of the conditions listed below. The operator must quickly inspect the Plant to determine the cause of the power outage, and implement necessary response measures.

1. Loss of Utility (NIMO) power feed to the Site.

2. Utility power feed failure <u>on the Site</u> (e.g., downed power line, transformer failure).

3. Failure or trip of the NIMO breaker inside the Axelrod Institute or failure or trip of the 50 amp breaker within the electrical panel at the Plant site.

4. Blown fuse within the electrical panel at the Plant site.

If the power loss alarm is due to conditions 1, 2 or 3 above (i.e., a "blackout"), the entire Plant processes will shut down. During this shutdown, none of the process streams are capable of being released to the environment. In addition, because the cap and drainage trench installed around the site serve to contain the majority of the contaminated media within the site , it is not critical that recovery portions of the Plant be returned to operational status immediately.

In the event of a power loss alarm, the time of the alarm and any actions taken by the operator should be recorded on the Plant Alarm Log, which is included in this manual as Figure 5-2.

If a power outage occurs during periods of cold weather, the operator must immediately evaluate possible freezing of the ground water pipes associated with the ground water recovery system and the storage tank, and the need to bring in auxiliary heat sources to warm these pipes. The Building is well insulated and should retain a fair amount of heat during a power outage. The secondary containment shell on each ground water storage tank will also help keep the tank contents from freezing, due to the air space around the primary shell.

If a prolonged power loss occurs and freezing of the piping becomes a concern, the operator should shut the system down and allow the pipes to drain back into the recovery well or the tank.

14.3.5 Failure of Plant Equipment

In the event that equipment or controls malfunction, an immediate investigation should be made to determine the cause, and appropriate actions should then be taken. Descriptions of the Plant emergency alarms and conditions for an automatic shutdown of Plant equipment are given in Chapters 7, 8, 9 and 10 of this manual. Emergency procedures for manual Plant shutdown are given in Section 14.4.

14.3.6 Spill or Uncontrolled Release of Ground Water and/or Sediments

All spills or uncontrolled releases of ground water and/or sediments to the environment are to be reported immediately to the NYSDEC Emergency Action Hotline at (800) 457-7362. Additionally, if a major spill occurs that presents a risk to the health or safety of the general public, contact the Albany Police and Fire Departments.

14.3.6.1 *Spill Control Procedures*

Spills of untreated ground water should be immediately pumped into the ground water storage tank. If the leak is due to a breach in a ground water storage tank, the operator must transfer as much of the ground water within the leaking tank as possible to the ground water recovery well. If the spill event and current tank conditions are such that sufficient capacity does not exist for the spilled volume of water, an additional option would include:

Bringing a tanker truck on-Site to pump the spill volume into, while implementing repairs to the Plant.

14.3.7 *Natural Emergencies*

14.3.7.1 *Severe Windstorm, Hurricane, or Tornado*

Plant personnel will typically be alerted to the possibility of severe weather conditions by broadcast, telephone warning, and notices issued by the regional forecasting facilities of the National Weather Service. The NYSDOH should consider implementing communication measures to ensure that Plant personnel are kept apprised of severe weather events that are forecast for the region. In the event of a severe weather warning, protective measures such as securing outside equipment so that it is not blown away should be implemented.

Damage will be predominantly fallen power lines, trees, fences, signs, etc., and damage to equipment and structures from flying debris. If power lines are blown down during the windstorm, electric power to the Site and/or Building will be lost. As soon as the storm has ceased, the operator should assess the damage and inform the NYSDOH as to the nature and extent of the damage. It may be necessary to inform NYSDEC of the nature and extent of the damage. Steps should then be taken to return the Plant to normal operating conditions as quickly as possible.

CAUTION: Plant personnel should be aware that downed power lines on the Site may still be live, and may also interfere with safe operation of the Site gates if the power line is in contact with the fence.

14.3.7.2 Freezing

During the winter months, the possibility of freeze damage to the Plant is a concern. All exposed piping and fittings have been insulated and heat traced.

14.3.7.3 Flooding

The Plant site is located on a topographic high at the southwest side of the Axelrod Institute. Grading modifications were designed and constructed on the basis of the 50-year storm event so that stormwater runoff from the site will be easily diverted to the catch basins within the parking lot areas of the Axelrod Institute.

Due to this regrading, it is not expected that flooding will be a concern to the Plant.

14.4 PLANT EMERGENCY SHUTDOWN PROCEDURES

If the operator must manually shutdown the Plant due to an emergency, the following procedures should be implemented.

1. Turn off the pump by turning the H-O-A switch to the O (OFF) position.

2. Open the local disconnect switch on the motor starter box.

3. Open the 50 amp Circuit Breaker in the Control Box. (Breaker Nos. 19,21 and 23.

14.5 EMERGENCY EQUIPMENT AND MATERIALS

A comprehensive emergency equipment and materials inventory should be prepared and maintained at the Plant. The inventory should list the quantity and location of all items of equipment and of all supplies stocked for recovery from emergency conditions. A suggested stocking list of emergency equipment and materials to be procured in advance and to be stored in a secure, readily accessible location at the Plant is shown in Table 14-3. Additional emergency equipment which should be available at the Plant, and the intended use of this equipment, is included in Tables 6-2, 6-3 and 6-4.

The source, and a telephone contact number, for obtaining additional back-up equipment such as portable generators, compressors, or blowers should be shown on the emergency equipment inventory maintained at the Plant.

It is recommended that the NYSDOH store some duplicate emergency equipment (e.g., respirators, health and safety equipment) at their Axelrod facility, so that in the event of a Plant emergency, additional safety equipment is readily available.

The ready availability of spare parts is an important factor in expediting recovery from emergency conditions which involve equipment breakdown. To assure their availability, spare parts used in normal maintenance and repairs should be reordered immediately after use. Stocking locations for spare parts which are not normally purchased before they are needed, are listed with a contact telephone number and address in the manufacturer's

O&M manuals included as Appendix D to this manual.

TABLE 14-1
POSSIBLE EMERGENCY SITUATIONS

1. Injury to Plant personnel or visitors.

2. Fire or explosion.

3. Loss of electric power.

4. Failure of Plant control system.

5. Spill or uncontrolled release of ground water and/or sediments.

6. Natural emergencies.

TABLE 14-2
SYMPTOMS OF VARIOUS TYPES OF INJURIES, EXPOSURES, AND SHOCK

Type of Injury or Exposure	Symptom
Bone Fracture	Signs and symptoms of fractures include the sound of bone "snapping" a grating sensation of bones burring together, obvious deformities, pain, tenderness, swelling, bruising, and an inability to move the injured part. Victims with fractured ribs may feel pain as they breathe.
Dislocation	Signs and symptoms of a dislocation are similar to those of a fracture. They include swelling, deformity, pain in a joint, loss of movement, and tenderness.
Sprain	Signs and symptoms of sprains include pain at the joint, tenderness when touched, discoloration, and swelling.
Internal Bleeding	Signs and symptoms of internal bleeding are: • Bruised, swollen, tender, or rigid abdomen. • Bruises on chest or signs of fractured ribs. • Blood in vomit. • Wounds that have penetrated the chest or abdomen. • Bleeding from the rectum or vagina. • Fractures of the pelvis. • Abnormal pulse and difficult breathing. • Cool, moist skin.

TABLE 14-2 (CONTINUED)
SYMPTOMS OF VARIOUS TYPES OF INJURIES, EXPOSURES AND SHOCK

Type of Injury or Exposure	Symptom
Shock	Shock has many signs and symptoms. These include confused behavior, very fast or very slow pulse rate; very fast or very slow breathing; trembling and weakness in arms and legs; cool and moist skin; pale or bluish skin, lips, and fingernails; and enlarged pupils.
Chemical Exposure, Ingestion, or Inhalation	Symptoms of chemical exposure, ingestion, or inhalation may include one or more of the following: • Abnormal Pulse • Behavioral changes • Breathing difficulties or abnormal breathing • Changes in complexion or skin color • Convulsions • Coordination difficulties • Coughing • Dizziness or drowsiness • Drooling • Diarrhea • Fatigue and/or weakness • Irritation of eyes, nose, respiratory tract, skin, throat, mouth, or lips • Headache • Itching • Light-Headedness • Nausea/vomiting • Skin irritation or rash • Sneezing • Sweating • Tearing • Tightness in the chest • Unconsciousness

TABLE 14-2 (CONTINUED)
SYMPTOMS OF VARIOUS TYPES OF INJURIES, EXPOSURES AND SHOCK

Type of Injury or Exposure	Symptom
Heat Stroke	Signs and symptoms of heat stroke are hot, red skin; very small pupils; and very high body temperature - sometimes as high as 105 degrees. If the victim was sweating from heavy work or exercise, his or her skin may be wet; otherwise, it will feel dry.
Heat Exhaustion	The usual signs and symptoms of heat exhaustion are cool, pale, and moist skin; heavy sweating; dilated pupils, headache, nausea; dizziness; and vomiting. Body temperature will be nearly normal.
Frostbite	The first sign of frostbite may be that the skin is slightly flushed. The skin color of the frostbitten area then changes to white or grayish yellow and finally grayish blue, as the frostbite develops. Pain is sometimes felt early on but later goes away. The frostbitten part feel very cold and numb. The victim may not be aware of the injury.
Hypothermia	The signs and symptoms of hypothermia include shivering, dizziness, numbness, confusion, weakness, impaired judgement, impaired vision, and drowsiness. The stages are: 1. Shivering 2. Apathy 3. Loss of consciousness 4. Decreasing pulse rate and breathing rate 5. Death As hypothermia progresses, the victim may move clumsily and have trouble holding things. In the later stages, he or she may stop shivering.

TABLE 14-3
SUGGESTED EMERGENCY RECOVERY EQUIPMENT AND MATERIALS

Portable Centrifugal Pump, Gasoline Powered

Gasoline Cans with Reserve Fuel

Portable Ventilating Blower with hose, gasoline powered

Ladders (Step and Emergency)

Rope

Safety Harnesses

Flashlights

Hand Shovels

Hand Saws (Wood and Metal)

Note: Refer to the HASP, located in Appendix D, for a list of general health and safety equipment, including Level C and Level B personal protective equipment.

Appendix A
Process and Instrumentation Diagrams

Appendix B
Health and Safety Plan

EXECUTIVE SUMMARY

ERM-Northeast (ERM) has developed the following Site Specific Health and Safety Plan (HASP) for the Axelrod Institute in Albany, New York. This HASP has been developed on the basis of the information obtained from previous reports and historical data. The intent of this HASP is to designate appropriate health and safety procedures to be followed by site personnel during construction activities at the site. The HASP has been designed for use as a working document that allows the involved health and safety professionals the flexibility to not only achieve compliance but reduce health and safety risks to as low as reasonably achievable. This HASP has been reviewed and authorized by the Director of Environmental Health and Safety for ERM.

The terms "Owner", "Engineer", "Contractor" and "Subcontractor" as used throughout this HASP shall have the same meanings as those used in the Contract Documents and defined in the Terms and Conditions.

1.0 INTRODUCTION

This Health and Safety Plan (HASP) has been developed by ERM-Enviro-Clean-Northeast, Inc. (ERM) for the Axelrod Institute in Albany, New York. This HASP will designate health and safety procedures for all personnel who may be exposed to hazardous materials and conditions that may be present during the site activities.

The procedures set forth in this plan are designed to reduce the risk of exposure to chemical substances and physical or other hazards which may be present in the soil, water and/or air associated with the activities at the site. The procedures described herein were developed in accordance with the provisions of 29 CFR 1910.120-Hazardous Waste Operations and Emergency Response, and in accordance with ERM's experience in similar remedial activities.

The recommended health and safety guidelines within this HASP may be modified as further information is made available through sample analyses and on-site characterization. The activities to be performed during the Project are described in the Contract Documents.

1.1 IMPLEMENTATION

ERM will perform full-time monitoring during intrusive site operations and will be responsible for the Contractor's Health and Safety during any activities where the potential exposure to chemical hazards exists.

All other guidelines and requirements of the HASP must be adhered to by the Contractor, however, ERM will not be responsible for full-time supervision of the Contractor's compliance with these requirements.

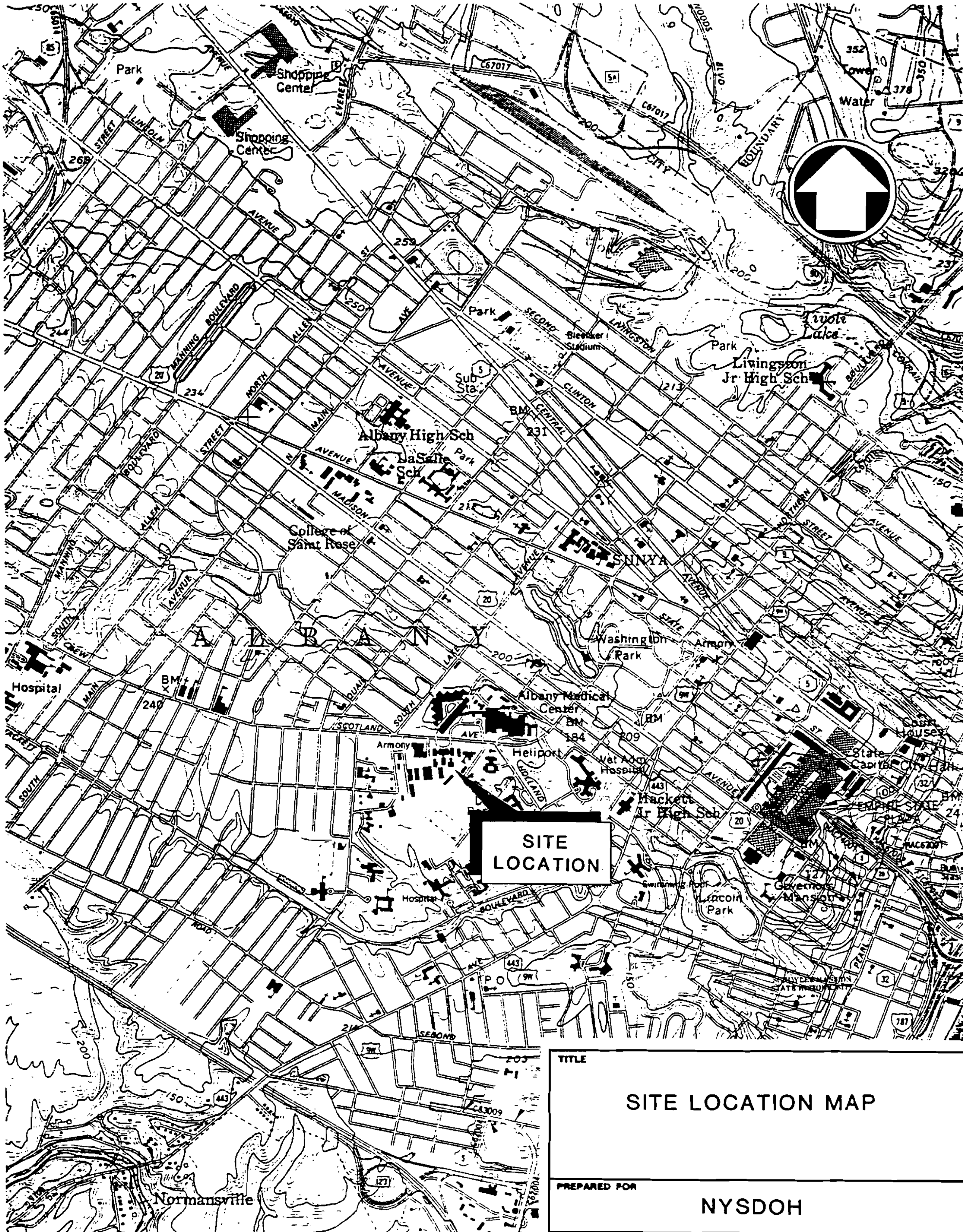
ERM will be authorized by NYSDOH to stop work, if in ERM's opinion, the Contractor is violating this HASP, OSHA regulations, any other applicable regulations concerning safety, or is otherwise conducting work in an unsafe manner.

1.2 SITE LOCATION AND BACKGROUND

The New York State Department of Health (NYSDOH) Axelrod Institute ("the site") is located on New Scotland Avenue in Albany, New York. This location is approximately one and one-half miles west of the Hudson River and one and one-quarter miles from Downtown Albany. Site elevation is approximately 200 feet above mean Sea Level and the property is relatively flat (Figure 1-1).

The facility originally consisted of eight buildings constructed in the early 1900's on approximately five acres. The site is located in an urban area which includes residential, commercial and institutional, as exemplified by the neighboring properties: Albany College of Pharmacy, Christian Brothers Academy, New Scotland Avenue Armory and Albany Medical Center (Refer to Contract Drawing C-1.)

The existing facility was constructed in the early 1900's as a biological laboratory for the NYSDOH. Prior land use included an almshouse; a burial ground associated with the Almshouse is present in the southern portion of the site. The facility was closed from 1976 to 1978, after which time the NYSDOH reoccupied the buildings and continues to operate the facility. Because the facility was inadequate for present-day operations, several on-site buildings were demolished and a five-story, 202,000 square foot building was recently constructed. Refer to Contract Drawing C-1.



SOURCE: NYSDOT 7.5 MINUTE QUADRANGLE ALBANY, N.Y., 1983 EDITION.

TITLE	SITE LOCATION MAP
PREPARED FOR	NYSDOH
ERM-Northeast, Environmental Resources Management	SCALE 1:2000; DATE; FIGURE 1-1

Laboratory operations included the generation of waste solvents. This waste was disposed of by burning in an on-site burn pit from 1942 to 1958 and included the following: xylol, petroleum ether, methanol, ethanol, ether, methyl ethyl ketone, mineral spirits, turpentine and various chlorinated solvents. Approximately 200 gallons of this material was reportedly disposed of in this manner annually. From 1958 to 1976, approximately 100 gallons of waste per year was discarded to a drywell constructed at the former burn pit location. Since 1976, all hazardous waste generated at the site is disposed of off-site by registered waste haulers.

As a result of previous disposal activities, the site is presently listed as a Class 2a Hazardous Waste Disposal Site (Site Number 401031) by the New York State Department of Environmental Conservation (NYSDEC). The NYSDEC has conducted Phase I and Phase II site investigations at the facility. Findings of these studies indicate the following:

- soils in the southwest corner of the site consist of fill overlying thick sequences of relatively impermeable silt and clay;

- soil contamination by several volatile organic compounds exists near the former drywell location (three semi-volatile compounds and barium may also be present in the area in concentrations exceeding background);

- ground water flow proximal to the past disposal area is east-southeast; and

- volatile organic compounds were detected in the ground water sample obtained from the downgradient monitoring well closest to the disposal area.

This information indicates that past disposal practices have degraded soil and groundwater quality in the vicinity of the past disposal area. The areal extent and migration potential of the contamination appears to be limited.

1.3 CHEMICAL AND PHYSICAL HAZARDS

Table 1-1 lists potential chemical hazards which may be encountered during the construction activities.

Table 1-2 lists potential physical hazards that may be encountered at the site. This list has been compiled based on intended construction activities and potential site conditions.

TABLE 1-1
POTENTIAL SITE COMPOUNDS AND ASSOCIATED EXPOSURE INFORMATION

Compound	PEL	Characteristics	Route of Exposure	Symptoms of Overexposure	Target Organs
Acetone	750 ppm	Colorless liquid with a fragrant mint-like odor	Contact Inhalation Ingestion	Irritation of eyes, nose, throat, headaches, dizziness, skin irritation	Respiratory system, skin
Benzene	1 ppm	Colorless liquid with an aromatic odor	Inhalation Absorption Ingestion Contact	Irritation of eyes, nose, respiratory system, headache, nausea, depression	Blood, CNS, skin, bone marrow, eyes, respiratory system
Chloroform	2 ppm	Colorless liquid with a pleasant sweet odor	Inhalation Ingestion Contact	Dizziness, mental dullness, nausea, fatigue, eye & skin irritation	Liver, kidneys, heart, eyes & skin
1,2 Dichloroethene	200 ppm	Colorless liquid with an ether-like, slightly acrid odor like chloroform	Inhalation Ingestion Contact	Eye irritation, CNS depression, respiratory system irritant	Eyes, respiratory system, CNS
Ethylbenzene	100 ppm	Colorless liquid with an aromatic odor	Inhalation Ingestion Contact	Eye irritation, mucous membrane, headache, dermatitis, coma, narcosis	Eyes, upper respiratory system, skin, CNS
Methyl Chloride	50 ppm	Colorless gas with a faint, sweet odor which is not noticeable at dangerous concentrations	Inhalation Contact	Dizziness, nausea, vomiting, convulsions, coma, liver & kidney damage, frostbite	CNS, liver, kidneys, skin
Toluene	100 ppm	Colorless liquid with an aromatic odor	Inhalation Contact Ingestion Absorption	Fatigue, weakness, confusion, euphoria, dizziness, headaches, dilated pupils, muscle fatigue, insomnia, paresthesia, dermatitis, photophobia	CNS, liver, kidneys, skin
Trichloroethene	50 ppm	Colorless liquid with a pleasant sweet odor	Inhalation Ingestion Contact	Headaches, vertigo, visual disturbance, tremors, somnolence, nausea, vomit, irritated eyes, dermatitis, cardiac arrhythmias, paraesthesia, potential carcinogen	Respiratory system, CNS, heart liver, kidneys, skin
Xylene	100 ppm	Colorless liquid with aromatic odors	Inhalation Absorption Ingestion Contact	Dizziness, excitement, drowsiness, uncoordinated, staggering gait, irritated eyes, nose, throat, corneal vacuolization, anorexia, nausea, vomit, abdominal pain, dermatitis	CNS, Eyes, blood, liver, kidneys, skin, gastro-intestinal tract

1. All compounds can be monitored with a flame ionization detector (i.e. OVA).
2. PELs are based on OSHA Final Rule Limits.

TABLE 1-2
POTENTIAL PHYSICAL HAZARDS

Hazard	Description	Location	Procedures Used to Monitor/Reduce Hazard
Heavy equipment	Drill rigs; Excavation equipment	Used throughout construction area	Personnel maintain eye contact with operators; hard hats and safety glasses worn during equipment operation.
Existing Underground Utilities			Verify number and location of utilities prior to site operations.
Power lines	Above ground		Maintain at least 10 feet of total clearance
Noise	During site activities		Hearing protectors with proper noise reduction rating
Temperature extremes	Hot and/or cold weather activities		Protection as designated by Site Safety Officer

2.0 *PERSONNEL RESPONSIBILITIES*

The following responsibilities and authorities have been or will be assigned to designated personnel for the activities at the site.

ERM Project Manager

Person duly appointed by ERM to act in a supervisory capacity over all ERM employees and activities with respect to ERM's contractual agreement with NYSDOH. The Project Manager is responsible for ensuring that ERM Health and Safety responsibilities are carried out in conjunction with this HASP.

ERM Construction Manager

Person duly appointed by ERM, under the supervision of ERM's Project Manager, to conduct construction oversight and related field activities specific to ERM's contractual agreement with NYSDOH. The ERM Construction Manager is not responsible for carrying out ERM Health and Safety responsibilities on the site unless designated in writing by ERM's Project Manager.

Site Safety Officer

Person duly appointed by ERM, under the supervision of ERM's Project Manager, to implement this HASP on behalf of ERM, the Contractor, and subcontractors of appropriate health and safety measures required throughout activities as specified in this HASP and as specified in the contractual agreement between ERM and NYSDOH. The Site Safety Officer (SSO) will assume:

- responsibility for the field implementation, evaluation, and any necessary field modification of this HASP;

- responsibility for calibration and maintenance of all monitoring instruments to ensure their proper operation and reliability;

- authority to suspend construction activities at the site due to any ineffectiveness of this HASP, or non-conformance to this HASP by the Contractor; and

- responsibility to maintain compliance with all applicable state, federal, client, and municipal regulations.

All Health and Safety communications between ERM and the Contractor will be handled exclusively by the SSO.

All site personnel shall have received the appropriate level of training necessary to perform applicable site duties, with said training to be verified by ERM's Director of Environmental Health and Safety.

3.0 MEDICAL MONITORING AND PERSONNEL TRAINING REQUIREMENTS

3.1 MEDICAL MONITORING

The Occupational Safety and Health Administration (OSHA) has established requirements for a medical surveillance program designed to monitor and reduce health risks for employees who may potentially be exposed to hazardous materials. This program has been designed to provide baseline medical data for each employee involved in hazardous waste operations. Each employee must undergo medical surveillance to determine his/her ability to perform assigned duties and wear personal protective equipment, such as chemical resistant clothing and respirators. The medical examinations must be administered on a pre-employment, annual basis and as warranted by the occupational health physician and site conditions.

All site personnel involved with site activities must participate in a medical monitoring program meeting specifications of 29 CFR 1910.120. The examining physician is required to make a report to the employer of any medical condition which would place employees at increased risk of performing assigned duties or wearing a respirator or other personal protection equipment. A physician will also specify respiratory protection clearance. Each employer (i.e., Contractor) engaged in site work shall assume the responsibility of maintaining site personnel medical records as regulated by 29 CFR 1910.20 where applicable.

A medical program is required for all those employees who wear or may wear respiratory protection as regulated by 29 CFR 1910.134 (Note: This does include disposable dust-type respirators). This program must determine an individual's ability to wear respiratory protection while performing designated duties. Each employee required to wear tight fitting respiratory protection will be appropriately fit tested. All elements of the

OSHA respiratory protection standard (29 CFR 1910.134) must be complied with.

3.2 *PERSONNEL TRAINING*

All site personnel associated with potentially hazardous field activities must have participated in a health and safety training program that complies with OSHA regulation, (29 CFR 1910.120) prior to mobilization at the site. This program must instruct employees on the intent of the standard, health and safety principles and procedures, proper operation of monitoring instruments, use of personal protective equipment, decontamination, and site specific emergency plans.

In addition, site employees may be required to undergo site-specific training, as deemed appropriate by the SSO, prior to the start-up of any given task. This training will be performed and documented by the SSO. The site-specific training will address potential hazards and associated risks, site operating procedures, emergency response and site control methods to be employed. A copy of this Health and Safety Plan will be made available to all site personnel.

Any additional specialized training will be provided by the SSO as dictated by the nature of site activities. Specialized training will be provided for activities such as confined space entry and handling of unidentified substances. Employees involved in these types of activities will be given instruction by the SSO regarding the potential hazards involved with site activities and the appropriate health and safety procedures to be followed. All training materials and methods will be reviewed by ERM's Director of Environmental Safety.

Exhibits 1 thru 3 located at the end of this HASP, shall be completed prior to the Contractor mobilizing at the site, as required in the Specifications.

4.0 SITE MONITORING AND PERSONAL PROTECTIVE EQUIPMENT

4.1 SITE MONITORING

Construction activities at the site may create potentially hazardous conditions, such as the release of hazardous substances into the breathing space. These substances may be in the form of mists, vapors, dusts, or fumes that can enter the body through ingestion, inhalation, absorption and/or direct contact. A hazard evaluation of these substances and/or protective measures will be performed at the site continuously, to ensure appropriate personal protection during site activities. Monitoring will be conducted with the use of direct reading equipment such as flame ionization, photo ionization, thermal conductivity, and/or colorimetric tubes.

The following section describes the monitoring parameters to be evaluated during construction activities. Specific analytical instruments to be used are also identified in the discussion. All instruments to be used during site activities will meet the established requirements set forth by OSHA, Mine Safety and Health Administration (MSHA), NIOSH and state agencies where applicable. Action levels based on monitoring results are discussed in the following section.

Atmospheric chemical concentrations will be monitored by ERM as specified by the SSO. Air monitoring results will be used as action level criteria for upgrading or downgrading protective equipment and implementing additional precautions or procedures. Classes of contaminants found at the site mainly include volatile organic compounds (VOCs). These contaminants can be introduced through inhalation, ingestion, absorption or injection into the body, which could create an exposure concern. To address these concerns, field personnel will implement engineering controls (e.g. work upwind, minimize disturbance of sediment, wetting down area and basic hygiene principals) to reduce the risk of exposure. If deemed appropriate by the SSO, a respirator will be utilized to protect against personnel exposure.

All site monitoring will be conducted by, or under the supervision of, the SSO. All readings obtained will be recorded in a dedicated site safety and health log book by the SSO.

4.2 ACTION LEVELS

The following action levels have been established for activity cessation, site evacuation, emergency response, implementation of special procedures, and the upgrade or downgrade in the level of personal protective equipment. The action levels are based upon OSHA Permissible Exposure Limits (PELs) and Action Levels promulgated by 29 CFR 1910.1000, 1910.1028, and chemical or physical characteristics of the contaminants. Level D protection shall be used at a minimum, for all site activities that do not pose a potential threat of exposure to toxic or hazardous substances. The requirements for optional protective equipment will be determined by the SSO. Descriptions of the various levels of personal protection are presented in Section 4.3.

All total volatile organic compound (TVOC) air monitoring will be conducted with a flame ionization detector (FID), such as a Foxboro OVA. Monitoring will be conducted under the direction of the SSO.

Action Levels for Areas Where Benzene and/or Chloroform is Detected

Benzene and chloroform have been identified at the site. Monitoring for benzene and chloroform will be performed whenever air monitoring indicates a TVOC concentration greater than 0.5 ppm above detectable limits. A hand pump with a colorimetric indicator tube for benzene and chloroform will be utilized to detect the presence of these compounds. Where a TVOC concentration is detected in the breathing zone greater than 0.5 ppm above detectable limits, the action levels presented below will apply.

Benzene or Chloroform Concentration (ppm)	*Required Action and/or Level of Personal Protection*
Detection limit to 0.5 ppm of benzene or 2 ppm of chloroform in breathing zone	Level D personal protection.
0.5 ppm to 25 ppm benzene in breathing zone	Evacuate all personnel from area, implement engineering controls and/or upgrade to Level C personal protection with full face organic vapor cartridge respirators.
Above 2 ppm chloroform in breathing zone	Evacuate all personnel from area. Cease work and notify ERM Director of Environmental Health and Safety. Upgrade to Level B personal protective equipment with pressure demand supplied air full face respirators.
Above 25 ppm benzene in breathing zone	Evacuate all personnel from area. Cease work and notify ERM Director of Environmental Health and Safety. Upgrade to Level B personal protective equipment with pressure demand supplied air full face respirators.

-Action level concentrations are based on results of colorometric indicator tubes.

As established by 29 CFR 1910.1028, the OSHA Action Level concentration for benzene in air is 0.5 ppm averaged over an 8-hour work day. If benzene is detected above the action level, these requirements will remain in effect until subsequent site monitoring indicates benzene concentrations below these limits.

Action Levels Where Benzene or Chloroform are not Present

In areas where air monitoring results indicate no potential for exposure to benzene or chloroform, but indicate total volatile organic compound (TVOC) concentrations at or above 25 ppm in the breathing space, all personnel will be evacuated from the area. Engineering controls and/or upgrade to Level C personal protection with full face organic vapor cartridge respirators will be implemented. In addition, TVOC concentrations detected at or above 250 ppm will necessitate work cessation, employee evacuation from the areas and notification of the ERM Director of Environmental Health and Safety. The action levels may be amended as deemed appropriate by the SSO, based on additional information and approval of ERM's Director of Environmental Health and Safety.

4.3 PERSONAL PROTECTIVE EQUIPMENT

Types of protective clothing and equipment to be used during site activities are discussed in this section. The levels of personal protection specified in this section are based upon OSHA guidelines presented in 29 CFR 1910.120.

The SSO, with input from the ERM Director of Environmental Health and Safety as needed, will determine when it is necessary to upgrade, downgrade or modify levels of protection. The SSO will make entries in the dedicated safety and health logbook when protection levels are modified, explaining the reason for the modification.

Each Contractor shall have at least Level C protective equipment available for all employees and subcontractors designated to work in the exclusion zone. Descriptions of Levels D, C, and B personal protective equipment follow:

Level D Protection

a. Coveralls or a work uniform affording protection for nuisance contamination.

b. Steel-toe, steel-shank work boots with disposable chemical-resistant rubber overboots, or steel-toe, steel shank chemical-resistant boot.

c. Safety glasses.

d. Hard hat.

Optional Equipment as required by the SSO

Chemical resistant gloves and inner latex surgical gloves
Hearing protection
Disposable outer coveralls such as Tyveks or equivalent

Level C Protection

a. Full-face air purifying respirator (APR) equipped with appropriate organic vapor canisters and/or other chemical cartridges (all personnel requiring respiratory protection must be "fit-tested" with the respirator model to be used in the field).

b. Chemical-resistant clothing such as standard tyvek, poly-coated tyvek or saranex. Suites will be hooded.

c. Outer chemical-resistant (recommend nitrile or neoprene) gloves and inner latex surgical gloves.

d. Steel-toe, steel-shank work boots with rubber overboots.

e. Chemical-resistant tape over seams in protective clothing (gloves and boots).

f. Hard Hat

Optional Equipment as Required by the SSO

Escape SCBA
Hearing protection
Temperature control systems (such as a cooling vest)

Level B Protection

a. Self-contained breathing apparatus (SCBA) in a pressure demand mode, or supplied air with escape SCBA bottle in the pressure demand mode.

b. Chemical-resistant clothing such as standard tyvek, poly-coated tyveks or saranex. Suites will be hooded.

c. Chemical resistant (recommend nitrile or neoprene) outer gloves and inner latex surgical gloves.

d. Steel-toe, steel-shank work boots with rubber overboots.

e. Chemical-resistant tape over seams in protective clothing (gloves and boots).

f. Hard Hat.

Optional Equipment as Required by SSO

Hearing protection

"Walkie-talkie" or similar two-way radio communication system

Temperature control systems (such as cooling vest)

5.0 DECONTAMINATION

5.1 GENERAL PERSONNEL DECONTAMINATION

Personnel involved with remedial activities may be exposed to contaminants in a number of ways, despite the most stringent protective procedures. While performing site duties, site personnel may come in contact with vapors, gases, mists, particulates in the air, or other media. Monitoring instruments and site equipment may also be exposed to hazardous substances.

In general, decontamination involves scrubbing with a detergent/water solution followed by clean water rinses. All disposable items shall be disposed of in a dry container. Certain parts of contaminated respirators and SCBAs, such as harness assemblies and cloth components, are difficult to decontaminate. If grossly contaminated, they may have to be soaked for a period of time in a chlorine solution (recommended 25-50 ppm solution). Rubber components shall be soaked in detergent water and scrubbed with a brush. In addition to being decontaminated, if they become soiled from exhalation or perspiration, all respirators, non-disposable protective clothing, and other personal articles must be sanitized before they can be used again. The respirator user will be responsible for the proper maintenance, decontamination, and sanitizing of his or her own respirator equipment, and non-disposable personal protective equipment.

5.2 INTERIM DECONTAMINATION PROCEDURES

The following procedures have been established to provide site personnel with minimum guidelines for proper decontamination. These minimum procedures must be followed by personnel leaving the specific areas of construction activities. The decontamination process shall take place at a reasonable distance from any area of potential contamination.

Portable wash stations shall be utilized for easy and efficient access. The wash station shall consist of a potable water supply, hand soap and clean towels. Portable sprayer units filled with detergent water solution and potable water shall also be available to wash and rinse off grossly contaminated boots, gloves and equipment. The SSO will monitor decontamination procedures to ensure their effectiveness. Modifications of the decontamination procedures may be necessary as determined by the SSO's observations.

5.3 DECONTAMINATION PROCEDURES FOR PRESCRIBED LEVELS OF PROTECTION

The following decontamination procedures shall be implemented during site activities for the appropriate level of protection.

Level D - Personal Protection Decontamination Procedure

Step 1 - Segregated Equipment Drop: Deposit contaminated equipment (tools, sampling devices, monitoring instruments, etc.) onto plastic drop cloths.

Step 2 - Boot and Outer Glove Clean: Brush boots, gloves and Tyvek suits free of residual materials. If necessary, wash with soap solution and rinse with potable water.

Step 3 - Disposable Equipment Removal: Remove overboots (if used), outer gloves (if used), and Tyvek suits (if used) in that order. Place contaminated covers, suits and gloves into container with plastic liner. Remove inner gloves (if used) and place in container.

Step 4 - Field Wash: Wash hands and face thoroughly.

Level C - Personal Protection Decontamination Procedure

Step 1 - Segregated Equipment Drop: Previously described.

Step 2 - Overboot and Outer Glove Wash: Overboots and outer gloves shall be scrubbed with a decontamination solution of soap and water.

Step 3 - Overboot and Outer Glove Rinse: Decontamination solution shall be rinsed off overboots and outer gloves using generous amounts of water.

Step 4 - Tape Removal - Remove tape from around boots and gloves and place into container with plastic liner.

Step 5 - Removal of Overboots and Outer Gloves: Remove overboots and place them in a container with a plastic liner. Next, remove outer gloves and place in container.

Step 6 - Removal of Chemical-Resistant Clothing: With care, remove chemical resistant suit. The exterior of the suit shall not come into contact with any inner layers of clothing.

Step 7 - Inner Glove Wash and Rinse (if contaminated): Inner gloves shall be washed with a mild decontamination solution (soap/water) and then rinsed with water.

Step 8 - Remove Respirator: Remove respirator. Attempt to keep face/glove contact to a minimum.

Step 9 - Inner Glove Removal: Remove inner gloves and deposit in plastic-lined container.

Step 10 - Field Wash: Wash hands and face thoroughly. A shower should be taken as soon as possible.

Level B - Personal Protection Decontamination Procedure

Step 1 - Segregated Equipment Drop: Previously described.

Step 2 - Overboot and Outer Glove Wash: Previously described.

Step 3 - Overboot and Outer Glove Rinse: Previously described.

Step 4 - Tape Removal: Previously Described.

Step 5 - Removal of Overboots and Outer Gloves: Previously described.

Step 6 - Chemical-Resistant Clothing Wash : Completely wash splash suit, SCBA, and inner gloves.

Step 7 - Chemical-Resistant Clothing Rinse: Thoroughly rinse off all decontamination solution from protective clothing.

Step 8 - Tank or Canister Changes: This is the last step in the decontamination procedure for those workers wishing to change air tanks and return to the exclusion zone. The worker's air tank or cartridge is exchanged, new outer gloves and overboots are donned, and joints taped.

Step 9 - SCBA Backpack Removal: The SCBA shall be removed and placed on plastic (a table with plastic is preferred). The face piece shall then be disconnected from the remaining SCBA unit before proceeding to the next station.

Step 10 - Chemical-Resistant Clothing Removal: With care, remove chemical-resistant suit. The exterior of the suit shall not come in contact with any inner layers of clothing.

Step 11 - Inner Glove Wash: Inner gloves shall be washed with a mild decontamination solution (soap/water), and rinsed, if contaminated or if the outer gloves failed.

Step 12 - Inner Glove Removal: Remove inner gloves and deposit in container with plastic liner.

Step 13 - Field Wash: Wash hands and face thoroughly. If highly toxic, skin corrosive, or skin-absorbent materials are known or suspected to be present, a shower shall be taken.

5.4 Equipment Decontamination

At a minimum, two primary contamination reduction zones (CRZ) shall be established at the site, as located by the Engineer. These stations shall be used to completely decontaminate all machinery and equipment used by the Contractor. The stations shall include shovels, brushes, a steam jenny and provisions to collect decontamination rinse water. All equipment exiting the site shall be completely decontaminated. All visible materials shall be removed from the backhoes and loaders using shovels and brooms. A high pressure spray shall then be used to remove any residual materials on the machinery. All decontamination waters and solids shall be appropriately containerized by the Contractor.

Decontamination for each work area shall be accomplished on a cell basis. Centralized decontamination cells shall be established to address decontamination at proximate work areas.

At the completion of construction activities at a specific area, personnel wearing appropriate PPE shall remove gross soil contamination from all utilized equipment. The equipment shall then be moved to the cell decontamination station, where brushes and water, if needed, shall be used to remove obvious residual soil particles.

6.0 SITE ACCESS AND SITE CONTROL

6.1 SITE ACCESS

Access to site activity areas will be limited to authorized personnel. Such personnel include ERM employees, designated Contractors, and designated NYSDOH representatives. Access into the work areas will be limited to those authorized personnel wearing appropriate personal protective equipment. The active areas will also be monitored by the SSO to ensure personnel do not enter without proper personal protection.

Sign-in procedures may be implemented to ensure that only authorized personnel will participate in site. The SSO will coordinate this effort and maintain the generated documentation accordingly.

6.2 SITE CONTROL

Certain procedures must be followed to ensure suitable control and limitation of access so that those persons who may be unaware of site conditions are not exposed to inherent hazards. Entrance onto the site will be permitted only for authorized personnel.

6.3 WORK ZONES

In areas where existing soil will be disturbed, both physical and chemical hazards can be minimized by the establishment and maintenance of work zones. The SSO will be responsible for ensuring that the following work zones are established by the Contractor:

Exclusion Zone

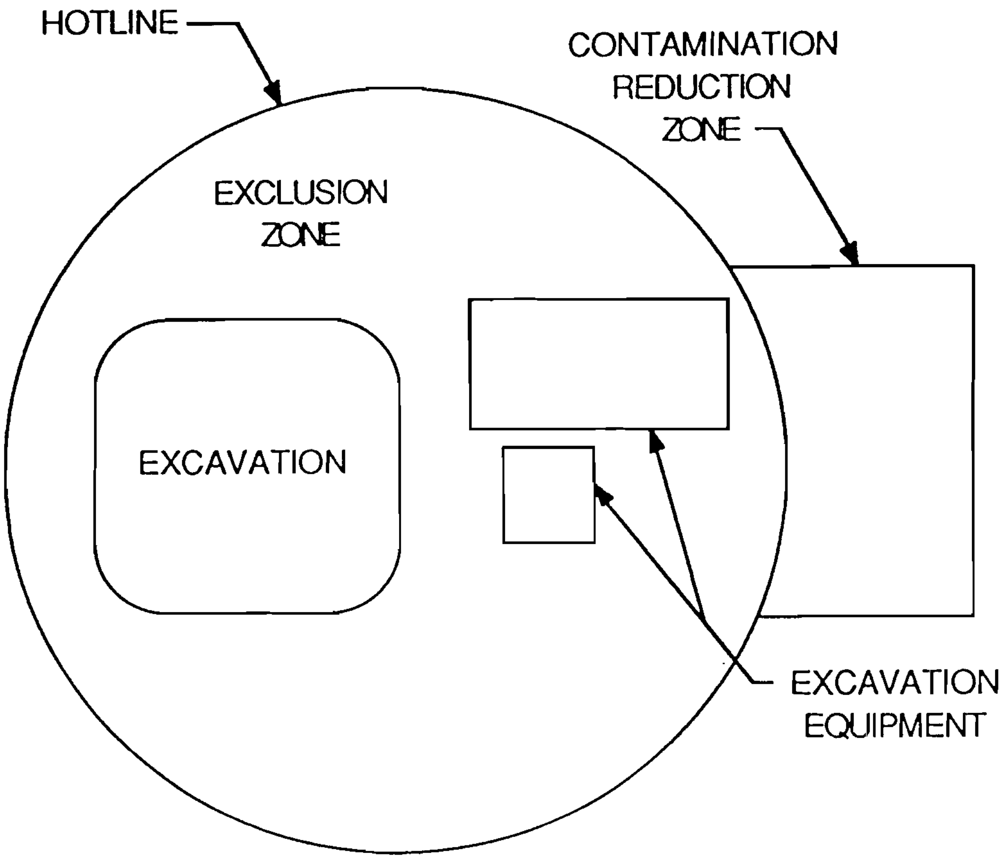
An exclusion zone (EZ) cell shall be established at each work area when construction activities are initiated. The EZ shall be delineated by the Contractor to take into account the limits of the operating area, and the spatial requirements of equipment and personnel. The perimeter (the Hotline) of the EZ shall be established using yellow caution tape. All persons within the EZ shall wear the required level of personal protection. A work area shall remain an exclusion zone until operations are completed and the area is restored.

Contamination Reduction Zone

The contamination reduction zone (CRZ) is the transition area between the exclusion zone area and the support zone (clean area). Preliminary equipment and personnel decontamination shall take place in the CRZ. A CRZ cell shall be established at each exclusion zone cell, and two primary CRZs shall be established for the decontamination of equipment and personnel leaving the site.

Figure 6-1 presents a typical layout of an EZ and adjoining CRZ. Before any equipment leaves the EZ, it shall be decontaminated in accordance with the Contractor's Decontamination Plan, which must be approved by the Engineer. Personnel shall remove protective clothing in the CRZ for disposal or reuse as required.

Primary CRZs shall be established at locations approved by the Engineer. All personnel and equipment that have contacted contaminated soil shall be decontaminated prior to leaving the site. Equipment decontamination within the primary CRZs shall be accomplished using a powered steam system (steam jenny). Detergent solutions shall be used as necessary to properly clean contaminated equipment. All wash and rinse water shall be collected within the decontamination area, and disposed of at an authorized off-site disposal facility.



TITLE
TYPICAL EXCLUSION ZONE AND CONTAMINATION REDUCTION ZONE

PREPARED FOR
NYSDOH

ERM-Northeast
Environmental Resources Management

SCALE	FIGURE
DATE	6-1

Support Zone

The support zone (SZ) is considered to be uncontaminated. Protective clothing and equipment are not required but should be available for use in emergencies. Clean equipment and materials shall be stored and maintained within the SZ. Protective clothing shall be donned in the SZ prior to entering the CRZs. The support zone covers all work areas on the site which are not designated as EZs or CRZs.

7.0 EMERGENCY RESPONSE

7.1 NOTIFICATION OF SITE EMERGENCIES

In the event of an emergency, site personnel shall signal distress with three blasts from an appropriate horn, (car horn, air horn, etc.). All appropriate authorities will then be immediately notified of the nature and extent of the emergency. Medical personnel will be informed of site hazards and activities prior to Project initiation, so that emergency situations can be handled most efficiently.

7.2 RESPONSIBILITIES

The SSO will be responsible for responding to all emergencies, and will:

1. Notify appropriate authorities and/or health care facilities of the activities and hazards of the site work. Table 7-1 provides emergency telephone numbers that will be posted within the support zone.

2. Ensure that a map which details the most direct route to the nearest hospital and the list of emergency telephone numbers are posted on site. Figure 7-1 provides a Hospital Location Map.

7.3 ACCIDENTS AND INJURIES

In the event of a safety or health emergency at the site, appropriate emergency measures must immediately be taken to assist those who have been injured or exposed, and to protect others from hazards. The SSO shall be immediately notified and will respond according to the seriousness of the injury.

TABLE 7-1
EMERGENCY CONTACTS

Emergency Contacts (name and phone numbers):

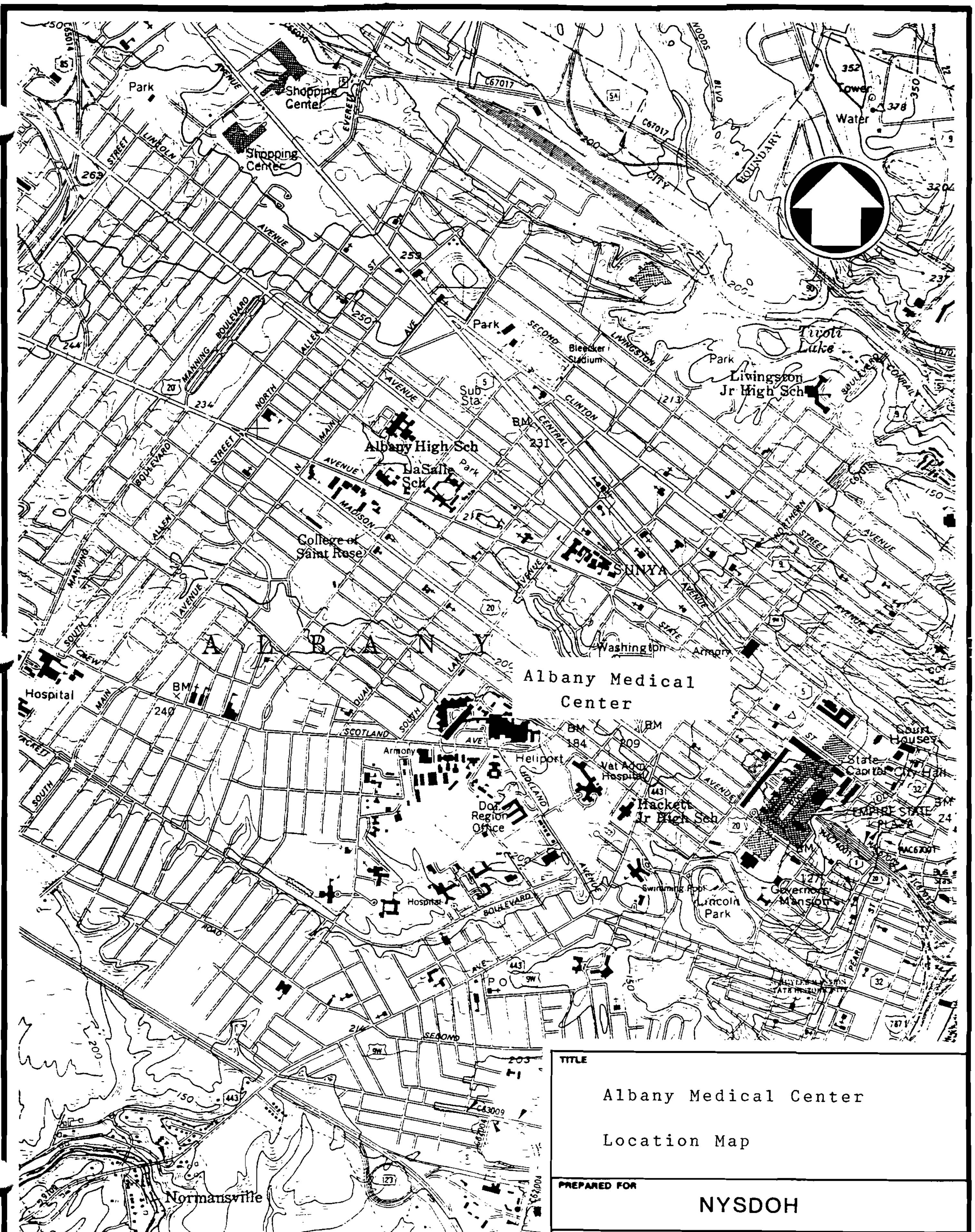
Police:	City of Albany Police Department	(518) 463-4141
Fire:	City of Albany Fire Department	(518) 463-1234
Ambulance:	Capital District	(518) 434-4444
Hospital:	Albany Medical Center	
	New Scotland Ave, Albany	
	General	(518) 445-3131
	Emergency Room:	(518) 445-3125

ERM Director of Environmental Health and

Safety: Jim Testo	Office:	(518) 452-4291
	Home:	(518) 283-2262

Directions to nearest Hospital: Albany Medical Center

- Cross New Scotland Avenue - Directly Northeast of Site.



SOURCE: NYSDOT 7.5 MINUTE QUADRANGLE ALBANY, N.Y., 1983 EDITION.

TITLE	
Albany Medical Center Location Map	
PREPARED FOR	NYSDOH
ERM-Northeast Environmental Resources Management	SCALE 1":2000' DATE 12/10/93 FIGURE 7-1

If the emergency involves personnel injuries, the local Emergency Medical Service (EMS) will be contacted immediately. The SSO, or a person the SSO designates, should be prepared to provide the following information:

1. Exact location of the emergency
2. Phone number he/she is calling from
3. Type of injury(ies)
4. How many persons have been injured
5. What assistance or first aid is being given to the injured person(s)

Do NOT hang up unless told to do so. In most cases, the EMS dispatcher will require the caller to stay on the phone.

When emergency response authorities arrive, site personnel shall immediately inform them of the details of the situation and what type of chemicals and hazards may be encountered on the site. If available, Material Safety Data Sheets should be given to the responders.

The SSO will observe and document any and all recognized symptoms of injury or illness. Table 7-2 can be utilized for reference of common symptoms for the chemicals of concern on the Project.

First Aid

First aid is to be administered only by qualified persons trained in First Aid procedures or by an individual who is directed by EMS personnel or a physician. Table 7-3 lists basic procedures for assisting an injured person.

7.4 SITE COMMUNICATIONS

Telephones will be used as the primary off-site communication network.

TABLE 7-2
REFERENCE OF COMMON SYMPTOMS

Type of Injury or Exposure	Symptom
Chemical Exposure, Ingestion or Inhalation	Symptoms of chemical exposure, ingestion or inhalation may include one or more of the following: Abnormal Pulse Behavioral changes Breathing difficulties or abnormal breathing Changes in complexion or skin color Convulsions Coordination difficulties Coughing Dizziness or drowsiness Drooling Diarrhea Fatigue and/or weakness Irritation of eyes, nose, respiratory tract, skin, throat, mouth, or lips Headache Itching Light-headedness Nausea/vomiting Skin irritation or rash Sneezing Sweating Tearing Tightness in the chest Unconsciousness
Heat Stroke	Signs and symptoms of heat stroke are hot, red skin; very small pupils; and very high body temperature - sometimes as high as 105 degrees. If the victim was sweating from heavy work or exercise, his or her skin may be wet; otherwise, it will feel dry.

TABLE 7-2 CONT'D
REFERENCE OF COMMON SYMPTOMS

Type of Injury or Exposure	Symptom
Heat Exhaustion	The usual signs and symptoms of heat exhaustion are cool, pale, and moist skin; heavy sweating; dilated pupils, headache, nausea; dizziness; and vomiting. Body temperature will be nearly normal.

TABLE 7-3
BASIC FIRST AID PROCEDURES

1. Be calm and quickly evaluate the emergency.
2. Contact EMS.
3. Do not move the injured person unless necessary or instructed to do so.
4. If possible, move any physical and chemical hazards away from the area of the injured person.
5. Take care of the most serious injuries first; bleeding must be stopped, breathing must be restored, etc.
6. Cover injured person to keep warm.

8.0 SPECIAL PRECAUTIONS AND PROCEDURES

8.1 POTENTIAL RISKS

The construction activities at the NYSDOH site pose potential exposure risks from both chemical and physical hazards. The potential for chemical exposure to hazardous substances is significantly reduced through the use of personal protective clothing, engineering controls and implementation of safe work practices.

Physical hazards associated with the remedial activities can be encountered during excavation and construction activities. Physical hazards may be encountered during activities involving heavy equipment, temperature extremes, site refuse, traffic and overhead or underground utilities. This plan establishes precautionary measures to reduce the risks of these hazards. The hazards are addressed below.

8.2 HEAVY MACHINERY/EQUIPMENT

All site personnel must remain aware of those site activities that involve the use of heavy equipment and machinery. Since respiratory protection and eyewear reduces peripheral vision of the wearer, it is essential that all personnel at the site exercise extreme caution during operation of equipment and machinery to avoid physical injury to themselves or others.

8.3 HEAT STRESS

The timing of this Project is such that heat stress may pose a threat to the health and safety of site personnel. Work/rest regimens will be implemented as necessary so that personnel do not suffer adverse effects from heat stress. Special clothing and an appropriate diet and fluid intake will be recommended to all site personnel to further reduce these temperature-related hazards. A good rule of thumb to prevent dehydration from heat stress is that fluid intake should equal fluid loss from the body, which can be accomplished through frequent small intakes of water.

8.4 *TRAFFIC*

Areas of operations may be located along active thoroughfares. Traffic cones, "Men Working" signs or applicable warning tape shall be appropriately located along streets to divert motorists safely around the site activities.

8.5 *UNDERGROUND/OVERHEAD UTILITIES*

All areas where underground utilities may be encountered will be identified. Site personnel shall undertake extreme caution when work activities are required to take place near existing buried utilities.

Buried and overhead utilities such as electrical wires and piping may also be present at the site, during various phases of construction. Site personnel must ensure that equipment and machinery is kept clear of all overhead utilities throughout construction activities.

8.6 *ADDITIONAL SAFETY PRACTICES*

The following are important safety precautions which will be enforced during the Project:

1. Eating, drinking, chewing gum or tobacco, smoking or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in any work area. Note: There will be no smoking allowed on the site unless the SSO designates an exclusion.

2. Hands and face must be thoroughly washed upon leaving the work area and before eating, drinking, or any other activity.

3. Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.

4. No excessive facial hair which interferes with the effectiveness of a respirator will be permitted on personnel required to wear respiratory protection equipment (i.e., personnel must be clean shaven). The respirator must seal against the face so that the wearer receives air only through the air purifying cartridges attached to the respirator.

5. Contact with potentially contaminated surfaces shall be avoided whenever possible. Personnel, wherever possible, shall not walk through puddles, mud, or other discolored surfaces; kneel on ground; lean, sit or place equipment on drums, containers, vehicles or the ground.

6. Medicine and alcohol can increase the effect of exposure to certain compounds. Prescribed drugs and alcoholic beverages shall not be consumed by personnel involved in the Project.

7. Personnel and equipment in the work areas shall be minimized, consistent with effective site operations.

8. Work areas for various construction activities shall be established.

9. Procedures for leaving the work areas must be planned and implemented prior to initiating site activities. Work areas and decontami-

nation procedures must be established on the basis of prevailing site conditions.

10. Respirators shall be issued for the exclusive use of one worker and shall be cleaned after each use. If a respirator is used by more than one user, disinfection is mandated (a chlorine solution of 25 ppm to 50 ppm is recommended).

11. Safety gloves and boots shall be taped to the disposable, chemical-protective suits as necessary.

12. All unsafe equipment left unattended shall be identified by a "DANGER, DO NOT OPERATE" tag.

13. Ear muffs or ear plugs may be required for all site personnel working around heavy equipment. This requirement will be at the discretion of the SSO. Disposable, form-fitting plugs are preferred.

14. Cartridges for air-purifying respirators in use shall be changed on an as-needed basis.

EXHIBIT 1

HEALTH AND SAFETY PLAN REVIEW RECORD

I have read the Site Specific Health and Safety Plan for this Project and have been briefed on the nature, level, and degree of exposure likely as a result of participation in this Project. I agree to conform to all the requirements the Site Specific Health and Safety Plan.

______________________ ______________________

Employee Signature Date

____

Name

______________________ ______________________

Project Manager Signature Date

____

Name

EXHIBIT 2

CONTRACTOR OCCUPATIONAL SAFETY AND HEALTH CERTIFICATION

Project: ______________________________

Contractor: ______________________________

1. Contractor certifies that the following personnel to be employed during site activities have met the following requirements of the OSHA Hazardous Waste Operations Standard (29 CFR 1910.120) and other applicable OSHA standards.

Contractor Personnel	Training	Respirator Type & Make	Medical Examination	Date & Clearance for Resp/HW

2. Contractor certifies that it has received a copy of the Site Specific Health and Safety Plan and ensures that its employees are informed and will comply with the requirements of the Site Specific Health and Safety Plan.

3. Contractor further certifies that it has read, understands, and will comply with all provisions of its contractual agreement with ERM-Northeast, Inc., specifically, the rights assigned to both parties with respect to the implementation Site Specific Health and Safety Plan.

Signed: ______________________________ Date: ____________________

EXHIBIT 3

FIELD MEDICAL DATA SHEET

Name:______________________________________ Phone:________________

Address:____

Date of Birth:______________________ Height:_____ Weight:__________

Allergies:____

Particular Sensitivities:____

Do you wear contact lenses: Note: Contact lenses are not permitted on-site

List exposures to hazardous chemicals if any and resultant illness or symptoms.

____

____

____

List Medications you presently use:_________________________________

____

____

List any other Medical Restrictions:________________________________

____

____

Special Medical or Incident Response Training:______________________

____

Name, Address and phone number of personal physician:

____

____

____

Nearest Relative:______________________ Phone:__________________

____

Employee Signature Date

Appendix C
Inspection, Maintenance, and Lubrication Schedule

INSPECTION, MAINTENANCE, AND LUBRICATION SCHEDULE

EQUIPMENT NAME	ID NO.	ITEM	ACTION	FREQUENCY	COMMENTS
Submersible Pump	P-101	Intake Screen	Inspect and clean	Regulary	---
	---	Motor	Replace motor fluid	Regulary	Replace while intake screen is being inspected.
Level Indicator	LI/LSH-101	Indicator	Inspect	Regulary	Refer to the Manufacturer's Final O&M manual.
All Electronic Instruments	---	---	Recalibrate	Annually	Refer to Chapter 10 of O&M manual.

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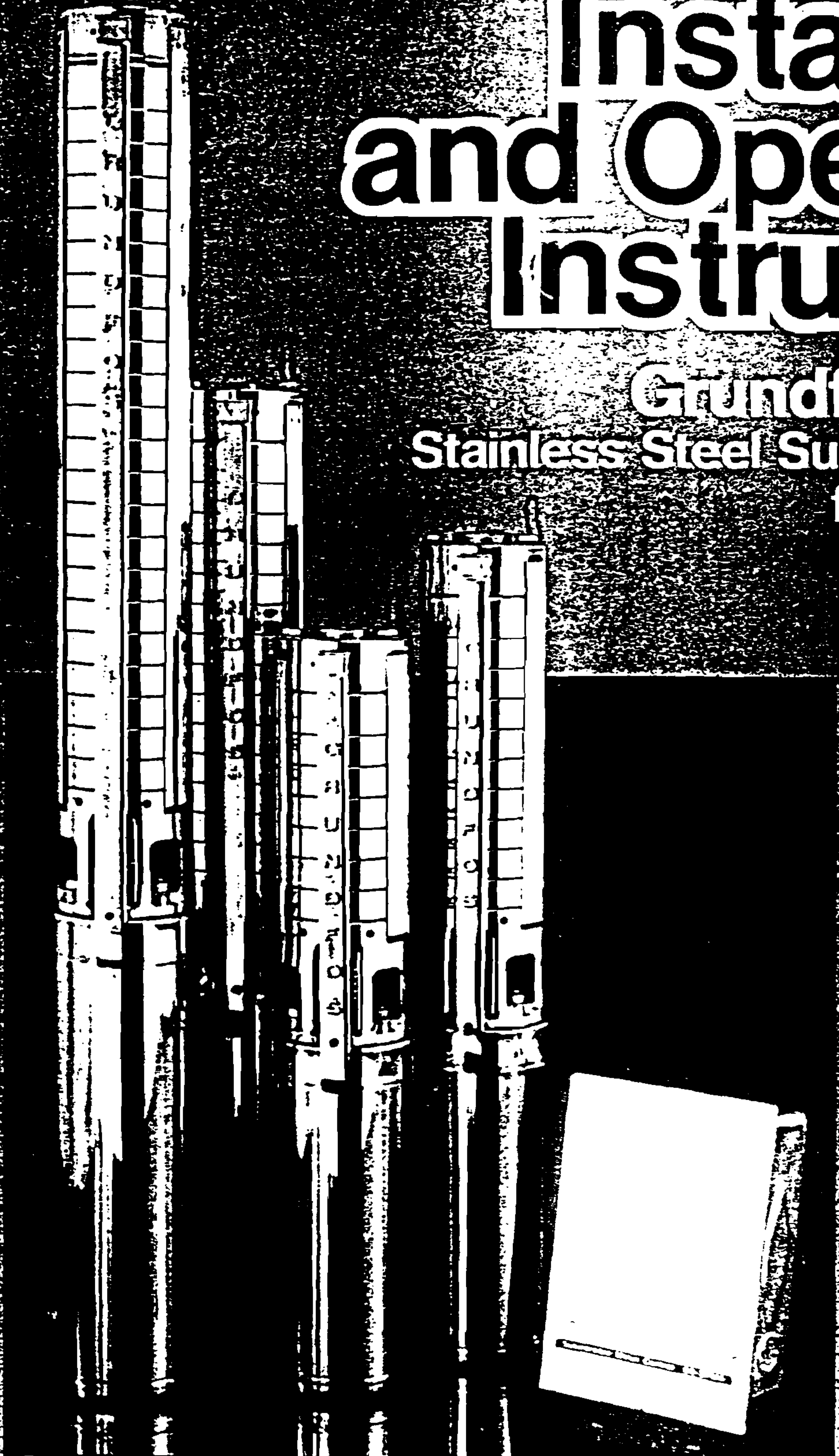
Appendix D
Manufacturer's O&M Manuals

Equipment
1) *Pump*
2) *Eye Wash*

Installation and Operating Instructions

Grundfos Redi-Flo4

Stainless Steel Submersible Pumps for Environmental Applications



Please leave these instructions with the pump

Installation and Operating Instructions

TABLE OF CONTENTS

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 nductor 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 pipe. **Do not clamp the pump.** When raising the pump and er 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:

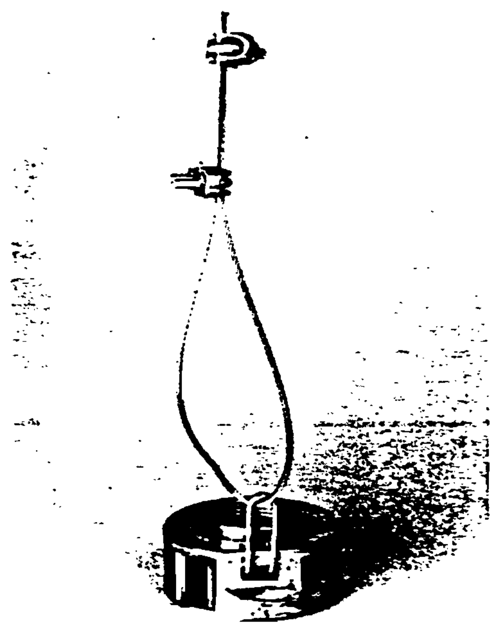
Use the correct compound recommended by the pipe manufacturer or specific job specifications. Besides making sure that joints are securely fastened, the use of a torque arrester is recommended when using these types of pipe.

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 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.

Electrical

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

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

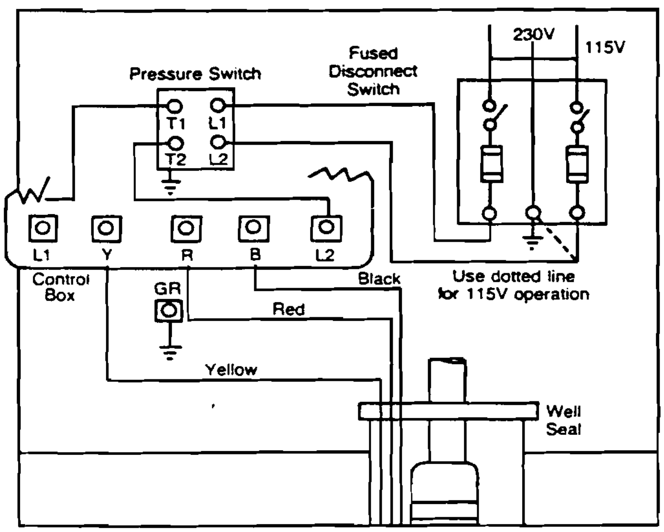
If the Redi-Flo4 pump is going to be operated using an engine driven generator, we suggest the manufacturer of the generator be contacted to ensure the proper generator is selected and used. See Table B for generator sizing guide.

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.



Single Phase Wiring Diagram
for Grundfos Control Boxes
(Figure 5-A)

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

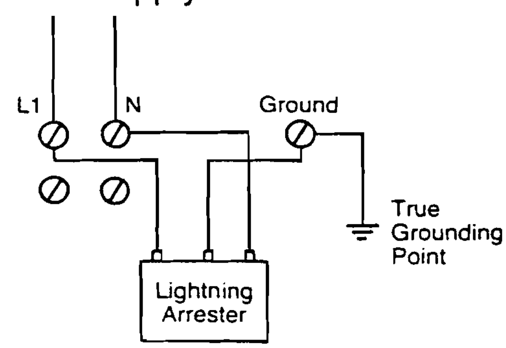
The control box shall be permanently grounded in accordance with the National Electrical Code and local codes or regulations. The ground wire should be a bare copper conductor at least the same size as the drop cable wire size. The ground wire should be run as short a distance as possible and be securely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



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.

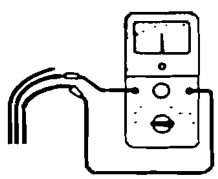
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

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.

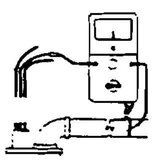
Zero-adjust the meter and measure the resistance between leads. Record the values.

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.

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.

GRUNDFOS MOTORS

INCH (Two Wire)

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)
⅓	230	1	1.75	3.9	4.6	15	6	T	29.0	5.9
½	230	1	1.60	5.3	6.0	15	8	S	35.0	4.1
¾	230	1	1.50	6.4	7.0	20	10	P	42.0	3.5
1	230	1	1.40	7.7	9.3	25	12	M	48.0	2.9
1½	230	1	1.30	10.3	12.4	30	15	L	63.0	2.1

4 INCH (Three Wire)

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms) BY	RY
⅓	230	1	1.75	3.9	4.6	15	6	P	19.0	5.9	15.6
½	230	1	1.60	5.3	6.0	15	8	M	24.0	4.1	11.0
¾	230	1	1.50	6.4	7.0	20	10	K	28.0	3.5	8.4
1	230	1	1.40	7.7	9.3	25	12	K	37.0	2.9	8.3
1½	230	1	1.30	9.0	11.0	30	15	J	46.0	2.1	8.7

FRANKLIN MOTORS

4 INCH (Two Wire)

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

INCH (Three Wire)

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms) BY	RY
⅓	230	1	1.75	3.5	4.4	15	5	N	16.4	6.0-7.4	23.4-28.6
½	230	1	1.60	4.8	5.9	15	7	M	23.1	4.2-5.2	15.5-19.6
¾	230	1	1.50	6.4	8.0	20	9	M	33.1	2.7-3.4	11.0-13.6
1	230	1	1.40	8.0	9.6	25	12	L	42.0	2.2-2.8	9.5-11.7
1½	230	1	1.30	10.0	11.6	30	15	J	52.8	1.5-1.9	6.2- 8.5

Table D

Total Resistance of Drop Cable (OHMS)

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

To determine the resistance:

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

Wire Resistances

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

Redi-Flo

Limited Warranty

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

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

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

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

Attorney's Fees

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

Choice of Law

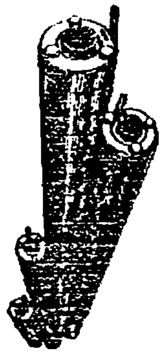
This agreement shall be governed by and construed in accordance with the laws of the State of California. Buyer agrees that all actions or proceedings arising directly or indirectly out of a sale of products from GRUNDFOS to Buyer shall be litigated only in courts located within California, and Buyer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

GRUNDFOS®

Redi-Flo4 Environmental Submersible Pumps

5E

Submittal Data 3450 RPM 60 Hertz



JOB or CUSTOMER:

ENGINEER:

CONTRACTOR:

SUBMITTED BY: DATE:

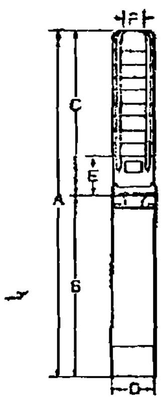
APPROVED BY: DATE:

ORDER NO.: DATE:

SPECIFICATION REF.:

QUANTITY	TAG NO.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1		5E5 w/½HP			115	1ø	2WIRE F/ARM
							+50' TEFLON
							LEAD.

Dimensions



Technical Data

FLOW RANGE: 1.2 to 7 US GPM

MOTORS: Grundfos MS402E Environmental Submersible Motor (Standard)
Maximum Operating Temperature: 104°F (40°C)
Maximum Operating Pressure: 220 PSI
Maximum Number of Starts Per Hour: 100
Minimum Recommended Flow Past Motor: 0.25 ft/sec
(NOTE: Franklin Pollution Recovery motor is optional.)

DISCHARGE SIZE: 1" NPT

PUMP END CONSTRUCTION MATERIALS: Stainless Steel and Teflon®

INSTALLATION: Unit to be installed vertically for submerged operation.

Electrical Data, Dimensions, and Weights ①

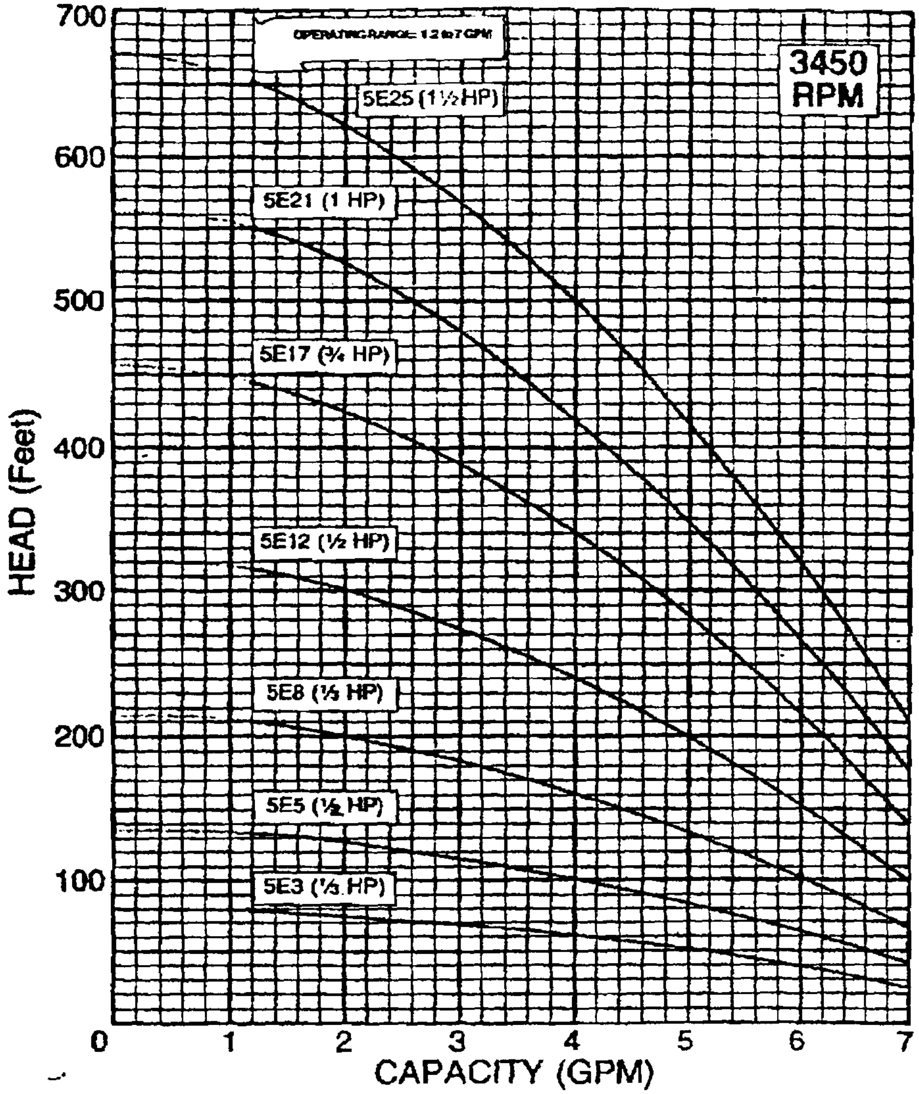
PUMP TYPE	MOTOR HP	MOTOR SF	MOTOR PH	MOTOR VOLTS	DIMENSIONS (In Inches) OVERALL LENGTH A	MOTOR LENGTH B①	PUMP END LENGTH C	MAX. DIA D	INLET E	DISCH. PIPE SIZE (NPT) F	NET WEIGHT (LBS.)②	SHIP. WEIGHT (LBS.)②
5E3	⅓	1.75	1	230	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23	25
5E5	½	1.75	1	230	20 5/16	10	10 5/16	3 31/32	3 ¼	1	24	26
5E8	½	1.75	1	230	22 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	26	28
5E12	½	1.60	1	230	26 13/16	10 13/16	16	3 31/32	3 ¼	1	28	29
5E17	¾	1.50	1	230	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	32
5E21	[illegible]	1.40	1	230	35 7/16	12	23 7/16	3 31/32	3 ¼	1	33	35
5E25	1 ½	1.30	1	230	40 5/16	13 9/16	26 ¾	3 31/32	3 ¼	1	35	37

① Data for Grundfos MS402E motors. ② Does not include motor leads.

5E

Performance Curves

Redi-Flo4 Environmental Pump



Materials of Construction

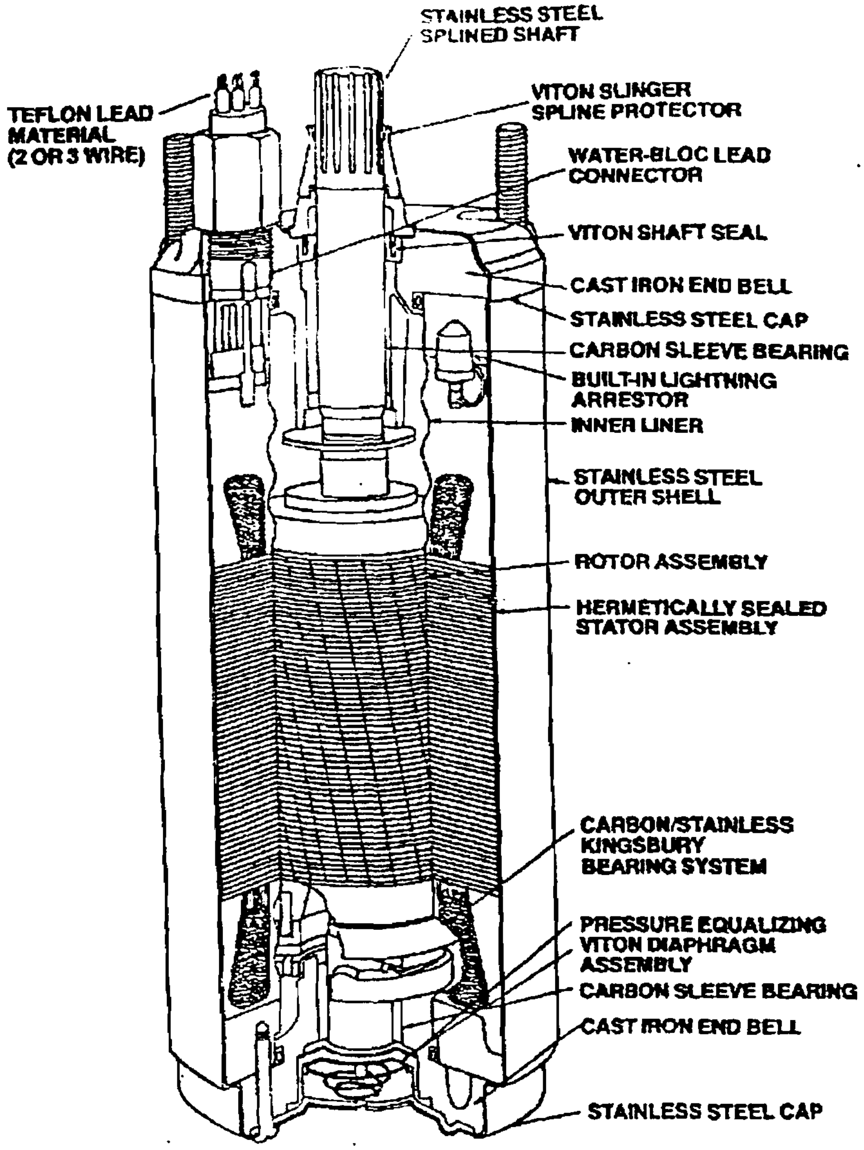
REDI-FLO4 PUMP END	
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Check Valve Seat	304 Stainless Steel & Teflon®
Diffuser Chamber	304 Stainless Steel
Impeller Seal Ring	Teflon®
Impeller	304 Stainless Steel
Suction Interconnector	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	304 Stainless Steel
Coupling	329/420/431 Stainless Steel
Straps	304 Stainless Steel
Cable Guard	304 Stainless Steel
Priming Inducer	304 Stainless Steel
Intermediate Bearings	Teflon®

NOTE: Specifications are subject to change without notice.

GRUNDFOS ENVIRONMENTAL MOTOR	
Nema Top	304 Stainless Steel
Studs & Fasteners	304 Stainless Steel
Nuts	316 Stainless Steel
Sand Slinger	Viton®
Shaft Extension	431 Stainless Steel
Diaphragm	Viton®
Stator Housing	304 Stainless Steel
Fill Plug Screw	304 Stainless Steel
Fill Plug Washer	Teflon®

GRUNDFOS ENVIRONMENTAL MOTOR LEADS	
Connector Sleeve	304 Stainless Steel
Connector Potting	Scotch Cast #4® Epoxy w/Viton® Cap
Connector Plug	Viton®
Lead Insulation	Teflon®

FRANKLIN'S 4" POLLUTION RECOVERY SUBMERSIBLE MOTOR



CONSTRUCTION MATERIALS (4-INCH) SPECIAL PURPOSE

Castings	304 S.S. Over Iron
Shell	201 S.S.
Shaft Extension	303 S.S.
Fasteners	316 S.S.
Seal Cover	Acetal
Seal	Viton
Diaphragm	Viton
Diaphragm Plate	304 S.S.
Diaphragm Spring	302 S.S.
Diaphragm Cover	316 S.S.
Slinger	Viton
Lead Sleeve	Nickel Plated SAE 330 Brass
Lead Jam Nut	316 S.S.
Lead Potting	Epoxy
Lead Bushing	Viton
Lead Wire	Teflon
Coupling	416 S.S.

NOTE: Lead Sleeve, Jam Nut, Potting, Wire and Coupling are sold seperate.

4-INCH WATER WELL SPECIAL PURPOSE MOTORS

H.P.	DOWNWARD THRUST (LBS.)	VOLTS	SERVICE FACTOR
3-WIRE 60 Hz SUPER STAINLESS, 1Ø, CAPACITOR START			
⅓*	300	115	1.75
	300	230	1.75
½*	300	115	1.60
	300	230	1.60
¾*	300	230	1.50
1*	400	230	1.40
1½*	400	230	1.30
2*	400	230	1.25
2-WIRE, SPLIT PHASE, 60 Hz, 3450 RPM			
⅓	300	115	1.75
	300	230	1.75
½	300	115	1.60
	300	230	1.60
¾	300	230	1.50
1	400	230	1.40
1½	400	230	1.30

WARNINGS: Serious or fatal electric shock may result from failure to connect all metal plumbing, and the motor if outside a drilled well, to the power supply grounding terminal with wire no smaller than motor cable wires. Do not use motor in swimming areas.
*REQUIRES CONTROL BOX

Franklin Electric
Bluffton, Indiana 46714

TOTAL P.03

System Trouble Shooting

Motor Does Not Start

Cause of Trouble	Checking Procedure	Corrective Action
A. No Power or incorrect voltage	Using voltmeter check the line terminals Voltage must be ± 10% of rated voltage.	Contact power company if voltage is incorrect.
B. Fuses blown or circuit breakers tripped	Check fuses for recommended size and check for loose, dirty or corroded connections in fuse receptacle. Check for tripped circuit breaker.	Replace with proper fuse or reset circuit breaker.
C. Defective Pressure switch.	Check voltage at contact points. Improper contact of switch points can cause voltage less than line voltage.	Replace pressure switch or clean points.
D. Control box malfunction.	For detailed procedure, see page 29, 30 & 31.	Repair or replace
E. Defective wiring.	Check for loose or corroded connections Check motor lead terminals with voltmeter for power.	Correct faulty wiring or connections
F. Bound Pump.	Locked rotor conditions can result from misalignment between pump and motor or a sand bound pump. Amp readings 3 to 6 times higher than normal will be indicated.	If pump will not start with several trials it must be pulled and the cause corrected. New installations should always be run without turning off until water clears.
G. Defective cable or motor.	For detailed procedure, see pages 26, 27 & 28.	Repair or replace

Motor Starts Too Often

A. Pressure switch.	Check setting on pressure switch and examine for defects.	Reset limit or replace switch.
B. Check valve, stuck open.	Damaged or defective check valve will not hold pressure.	Replace if defective.
C. Waterlogged tank, (air supply)	Check air charging system for proper operation.	Clean or replace.
D. Leak in system.	Check system for leaks.	Replace damaged pipes or repair leaks.

System Trouble Shooting

Motor Runs Continuously

Cause of Trouble	Checking Procedure	Corrective Action
A. Pressure switch.	Switch contacts may be "welded" in closed position. Pressure switch may be set too high.	Clean contacts replace switch, or readjust setting.
B. Low level well.	Pump may exceed well capacity. Shut off pump, wait for well to recover. Check static and drawdown level from well head.	Throttle pump output or reset pump to lower level. Do not lower if sand may clog pump.
C. Leak in system.	Check system for leaks.	Replace damaged pipes or repair leaks.
D. Worn pump.	Symptoms of worn pump are similar to those of drop pipe leak or low water level in well. Reduce pressure switch setting, if pump shuts off worn parts may be at fault. Sand is usually present in tank.	Pull pump and replace worn impellers, casing or other close fitting parts.
E. Loose or broken motor shaft.	No or little water will be delivered if coupling between motor and pump shaft is loose or if a jammed pump has caused the motor shaft to shear off.	Check for damaged shafts if coupling is loose and replace worn or defective units.
F. Pump screen blocked.	Restricted flow may indicate a clogged intake screen on pump. Pump may be installed in mud or sand.	Clean screen and reset at less depth. It may be necessary to clean well.
G. Check valve stuck closed.	No water will be delivered if check valve is in closed position.	Replace if defective.
H. Control box malfunction.	See page 29, 30 & 31 for single phase.	Repair or replace

Motor Runs But Overload Protector Trips

A. Incorrect voltage	Using voltmeter, check the line terminals. Voltage must be within ± 10% of rated voltage.	Contact power company if voltage is incorrect.
B. Overheated protectors.	Direct sunlight or other heat source can make control box hot causing protectors to trip. The box must not be hot to touch.	Shade box, provide ventilation or move box away from heat source.
C. Defective control box.	For detailed procedures, see pages 29, 30 & 31.	Repair or replace
D. Defective motor or cable.	For detailed procedures, see pages 26, 27 & 28.	Repair or replace
E. Worn pump or motor.	Check running current, See pages 11, 14 & 15.	Replace pump and/or motor.

Table 19 Preliminary Tests - All Sizes-Single & Three Phase

What Is to Be Done	The Results	What It Means
Measure resistance from any cable to ground. (Insulation resistance)	Ohms will be per Table 20	1. If the ohm value is normal, the motor windings are not grounded and the cable insulation is not damaged. 2. If the ohm value is below normal, either the windings are grounded or the cable insulation is damaged. Check the cable at the well seal as the insulation is sometimes damaged by being pinched.
Measure winding resistance. (Resistance between leads)	Ohms will be per Tables 8, 12 & 13.	1. If all ohm values are normal, the motor windings are neither shorted nor open, and the cable colors are correct. 2. If any one ohm value is less than normal, the motor is shorted. 3. If any one ohm value is greater than normal, the winding or the cable is open, or there is a poor cable joint or connection. 4. If some ohm values are greater than normal and some less on single phase motors, the leads are mixed. See page 28 to verify cable colors.

How to Measure Insulation Resistance.

1. Set the scale lever to R x 100K and set the ohmmeter on zero.

2. CAUTION
Open master breaker and disconnect all leads from control box or pressure switch (Q-D type control, remove lid) to avoid damage to meter or electric shock hazard. Connect one ohmmeter lead to any one of the motor leads and the other lead to the metal drop pipe. If the drop pipe is plastic, connect the ohmmeter lead to ground.

How to Measure Winding Resistance.

1. Set the scale lever to R x 1 for values under 10 ohms. For values over 10 ohms, set the scale lever to R x10. Zero balance the ohmmeter.

2. CAUTION
Open master breaker and disconnect all leads from control box or pressure switch (Q-D type control, remove lid) to avoid damage to meter or electric shock hazard.

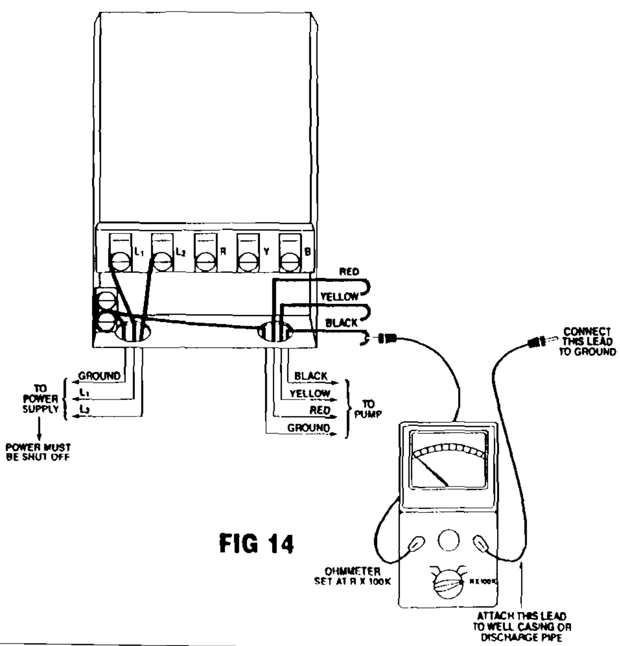


FIG 14

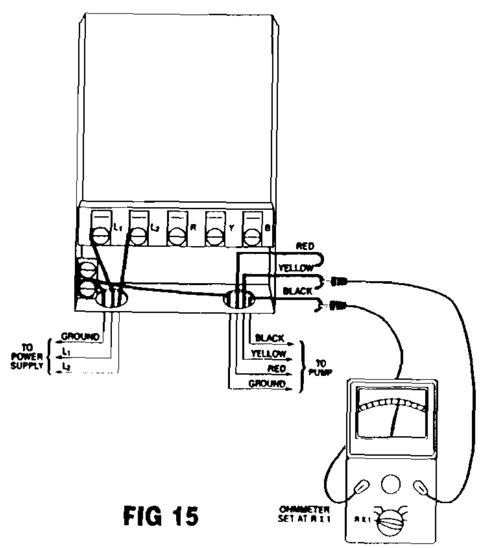


FIG 15

Insulation Resistance Readings

Table 20 Normal Ohm and Megohm Values Between All Leads and Ground

Insulation resistance varies very little with rating. Motors of all HP, voltage, and phase rating have similar values of insulation resistance.

Condition of Motor and Leads	OHM Value	MEGOHM Value
A new motor (without drop cable).	20,000,000 (or more)	20.0
A used motor which can be reinstalled in the well	10,000,000 (or more)	10.0
MOTOR IN WELL. Ohm readings are for drop cable plus motor.		
A new motor in the well.	2,000,000 (or more)	2.0
A motor in the well in reasonably good condition.	500,000 - 2,000,000	0.5 - 2.0
A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.	20,000 - 500,000	0.02 - 0.5
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 not fail for this reason alone, but it will probably not operate for long.	10,000 - 20,000	0.01 - 0.02
A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced.	less than 10,000	0 - 0.01

Resistance of Drop Cable (Ohms)

The values below are for copper conductors. If aluminum conductor drop cable is used, the resistance will be higher for each foot of cable of the same size. To determine the actual resistance of aluminum drop cable, divide the ohm readings from this chart by 0.61. This chart shows total resistance of cable from control to motor and back.

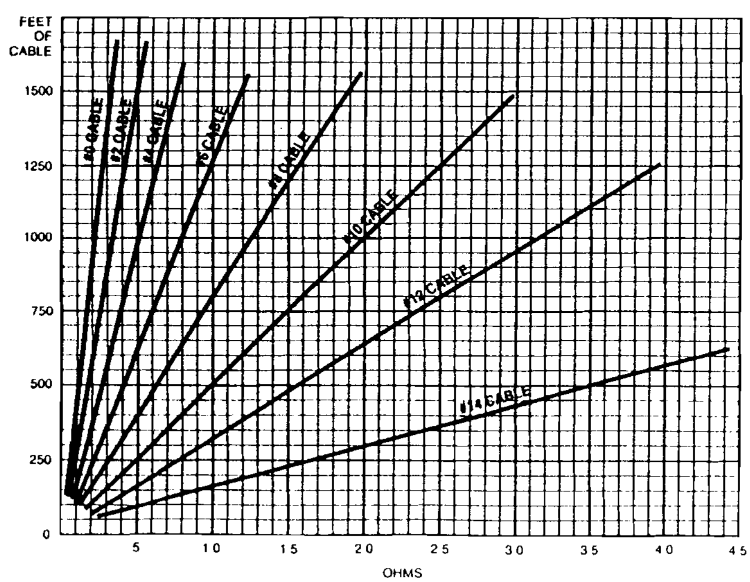


FIG 16

Winding Resistance Measuring

When measured as shown in FIG 15 page 26, motor resistance should fall within the values in Tables 8, 12 & 13. When measured through the drop cable, the resistance of the drop cable as determined from the chart at the left, must be subtracted from the ohmmeter reading to get the winding resistance of the motor.

Meter Connections for Motor Testing

FIG 17

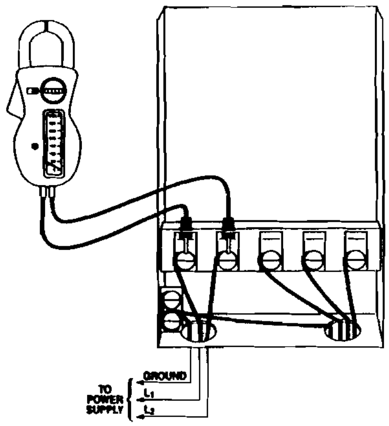
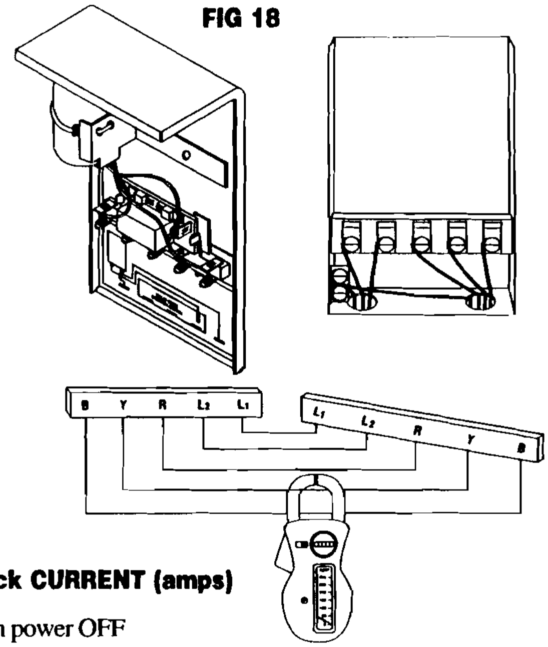


FIG 18



To Check VOLTAGE

1. Turn power OFF
2. Remove QD cover to break all motor connections.

CAUTION: L1 & L2 are still connected to the power supply.

3. Turn power ON.
4. Use voltmeter as shown.

To Check CURRENT (amps)

1. Turn power OFF
2. Connect test cord (No. 150961901) as shown.
3. Turn power ON.
4. Use hook-on type ammeter as shown.

CAUTION: Both voltage and current tests require live circuits with power ON.

Indentification Of Cables When Color Code Is Missing

(FOR SINGLE PHASE 3-WIRE UNITS ONLY)

If the colors on the individual drop cables cannot be found; that is, if no colored threads are visible and no identifying ribs are present and the leads cannot be identified.

With an ohmmeter, measure;
Cable 1 to cable 2
Cable 2 to cable 3
Cable 3 to cable 1

Find the highest resistance reading.

The lead not used in the highest reading is the yellow lead.

Use the yellow lead and each of the other two leads to get two readings:
Highest is the Red lead
Lowest is the Black lead

Example

Suppose that the ohmmeter readings were;
Cable 1 to cable 2---6 ohms
Cable 2 to cable 3---2 ohms
Cable 3 to cable 1---4 ohms

The lead not used in the highest reading (6 ohms) was
Cable 3---Yellow

From the Yellow lead, the highest reading (4 ohms) was
To Cable 1---Red

From the Yellow lead, the lowest reading (2 ohms) was
To Cable 2---Black

Single Phase Control Boxes

Checking and Repairing Procedures (Power On)

CAUTION: Power must be on for these tests. Do not touch any live parts.

A. General Procedures:
1. Establish line power.
2. Check no load voltage (pump not running).
3. Check load voltage (pump running).
4. Check current (amps) in all motor leads.

B. Use of Volt/Amp meter:
1. Meter such as Amprobe Model RS300 or equivalent may be used.
2. Select scale for voltage or amps depending on tests.
3. When using amp scales, select highest scale to allow for inrush current, then select for midrange reading.

C. Voltage Measurements:

Step 1, no load.
1. Measure voltage at L1 and L2 of pressure switch or line contactor.
2. Voltage Reading: Should be ± 10% of motor rating.

Step 2, load.
1. Measure voltage at load side of pressure switch or line contactor with pump running.
2. Voltage Reading: Should remain the same except for slight dip on starting.

D. Current (Amp) Measurements:
1. Measure current on all motor leads. Use 5 conductor test cord for Q.D. control boxes.
2. Amp Reading: Current in Red lead should be momentarily high, then drop within one second to values on page 11. This verifies relay or solid state relay operation. Current in Black and Yellow leads should not exceed values on page 11.

E. Voltage Symptoms:
1. Excessive voltage drop on starting.
2. Causes: Loose connections, bad contacts or ground faults, or inadequate power supply.

F. Current Symptoms:
1. Relay or switch failures will cause Red lead current to remain high and overload tripping.
2. Open run capacitor(s) will cause amps to be higher than normal in the Black and Yellow motor leads and lower than normal or zero amps in the Red motor lead.
3. Relay chatter is caused by low voltage or ground faults.
4. A bound pump will cause locked rotor amps and overloading tripping.
5. Low amps may be caused by pump running at shutoff, worn pump or stripped splines.
6. Failed start capacitor or open switch/relay are indicated if the red lead current is not momentarily high at starting.

CAUTION:

The tests in this manual for components such as capacitors, relays, and solid state switches should be regarded as indicative and not as conclusive. For example, a capacitor may test good (not open, not shorted) but it may have lost some of it's capacitance and may no longer be able to perform its function.

To verify proper operation of solid state switches or relays, refer to operational test procedure described in paragraph D-2.

Single Phase Control Boxes

Checking and Repairing Procedures (Power Off)

CAUTION: Turn power off at the power supply panel and discharge capacitors before using ohmmeter.

A. General Procedures:
1. Disconnect line power.
2. Inspect for damaged or burned parts, loose connections, etc.
3. Check against diagram in control box for misconnections.
4. Check motor insulation and winding resistance.

B. Use of Ohmmeter:
1. Ohmmeter such as Simpson Model 372 or 260. Triplet Model 630 or 666 may be used.
2. Whenever scales are changed, short ohmmeter lead together and "zero balance" meter.

C. Ground (Insulation Resistance) Test:
1. Ohmmeter Setting: Highest scale Rx 10K, or Rx 100K
2. Terminal Connections: One ohmmeter lead to "Ground" terminal or Q.D. control box lid and touch other lead to the other terminals on the terminal board.
3. Ohmmeter Reading: Pointer should remain at infinity (∞).

Ohmmeter Tests Quick Disconnect (QD) Solid State Control Box

A. Start Capacitor
1. Meter Setting: R x 1,000.
2. Connections: Capacitor terminals.
3. Correct meter reading:
   Pointer should swing toward Zero, then back to infinity.

B. Solid State Switch

Step 1, Triac Test
1. Meter Setting: R x 1,000.
2. Connections: R(Start) terminal and orange lead on start switch.
3. Correct meter reading:
   Infinity for all models.

Step 2 Coil Test
1. Meter Setting: R x 1.
2. Connections: Y(Common) and L2.
3. Correct meter reading:
   Zero ohms for all models.

C. Potential (Voltage) Relay

Step 1, Coil Test
1. Meter setting: R x 1,000.
2. Connections: #2 & #5
3. Correct meter readings:
   For 115 Volt Boxes
   .7-1.8 (700 to 1,800 ohms).
   For 230 Volt Boxes
   4.5-7.0 (4,500 to 7,000 ohms).

Step 2, Contact Test
1. Meter setting: R x 1.
2. Connections: #1 & #2.
3. Correct meter reading:
   Zero for all models.

D. Current Relay

Step 1, Coil Test.
1. Meter setting: R x 1.
2. Connections: #1 & #3
3. Correct meter reading:
   Less than 1 ohm for all models.

Step 2, Contact Test
1. Meter setting: R x 1,000.
2. Connections: #2 & #4
3. Correct meter reading:
   Infinity for all models.

Additional Tests Solid State Capacitor Run (CRC) Control Box

E. Run Capacitor
1. Meter setting: R x 1,000
2. Connections: Red and Black leads
3. Correct meter reading:
   Pointer should swing toward zero, then drift back to infinity.

F. Inductance Coil
1. Meter setting: R x 1
2. Connections: Orange leads
3. Correct meter reading:
   Less than 1 ohm.

G. Solid State Switch

Step 1 Triac Test
1. Meter setting: R x 1,000
2. Connections: R(Start) terminal and Orange lead on start switch.
3. Correct meter reading:
   Should be near infinity after swing.

Step 2, Coil Test
1. Meter setting: R x 1
2. Connections: Y(Common) and L2.
3. Correct meter reading:
   Zero ohms.

Ohmmeter Tests
Integral Horsepower Control Box (Power Off)

A. OVERLOADS (Push Reset Buttons to make sure contacts are closed.
1. Meter Setting: R x 1.
2. Connections: Overload terminals.
3. Correct meter reading: Should not be more than 0.5 ohms.

B. CAPACITOR (Disconnect leads from one side of each capacitor before checking.)
1. Meter Setting: R x 1,000.
2. Connections: Capacitor terminals.
3. Correct meter reading: Pointer should swing toward zero, then drift back to infinity, except for capacitors with resistors which will drift back to 15, 000 ohms.

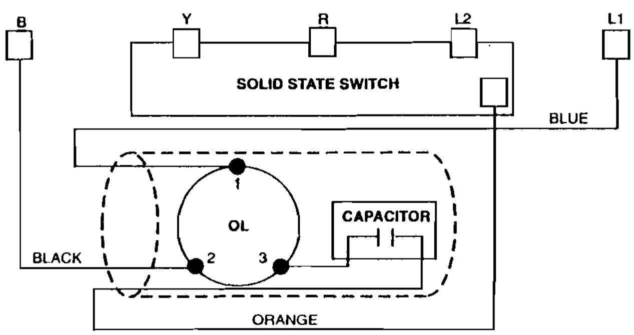
C. RELAY COIL (Disconnect lead from Terminal #5)
1. Meter Setting: R x 1,000.
2. Connections: #2 & #5.
3. Correct meter readings: 4.5-7.0 (4,500 to 7,000 ohms) for all models.

D. RELAY CONTACT (Disconnect lead from Terminal #1)
1. Meter Setting: R x 1.
2. Connections: #1 & #2.
3 Correct meter reading: Zero ohms for all models.

E. CONTACTOR COIL (Disconnect lead from one side of coil)
1. Meter Setting: R x 100.
2. Connections: Coil terminals.
3. Correct meter reading: 180 to 1,400 ohms

F. CONTACTOR CONTACTS
1. Meter Setting: R X 1.
2. Connections: L1 & T1 or L2 & T2.
3. Manually close contacts.
4. Correct meter reading: Zero ohms.

To Replace A Relay (Voltage Or Current) With A Solid State Switch. FIG 19

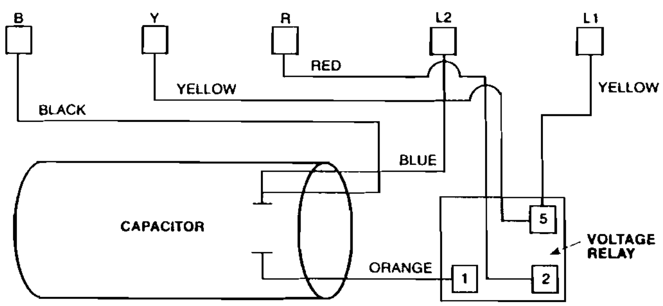


Control Box Wiring Diagram With Solid State Switch

1. Disconnect power to control box.
2. Remove control box cover. Disconnect all leads from the relay and terminal strip. Discard all loose leads.
3. Plug solid state switch into center terminals (Y, R, L2) on the side of the terminal strip nearest to the capacitor.
4. Connect all three leads from capacitor as follows:
   A. Blue lead to the "L1" terminal.
   B. Orange lead to the terminal on the solid state switch.
   C. Black lead to the "B" main terminal.

NOTE: Do not add running capacitors to standard production 1/3 through 1 HP control boxes which use current relays or solid state starting relays. **Adding capacitors will cause failures.** If the control box is converted to use a voltage relay, the specified running capacitance can be added.

To Replace A Solid State Switch With A Voltage Relay. FIG 20



Control Box Wiring Diagram With Voltage Relay

1. Disconnect power to the control box.
2. Remove control box cover. Disconnect orange lead from the solid state switch. Disconnect the blue lead from the "L1" terminal.
3. Remove solid state switch from the three center terminals. Install voltage relay next to capacitor.
4. Connect orange and blue leads from capacitor as follows:
   A. Orange lead to relay terminal #1.
   B. Blue lead to "L2" terminal.
   C. Black lead stays on "B" (main) terminal.
5. Make a red jumper wire and connect it from "R" (start) terminal to relay terminal #2.
6. Make two yellow jumper wires. Connect one jumper from "Y" (common) terminal to relay terminal #5.
   Connect the other jumper from relay terminal #5 to "L1" terminal.
7. Replace cover on the control box and reconnect power.

Note: Voltage relay kits include necessary jumper wires and mounting hardware.

Table 21 QD Control Box Parts

HP	Volts	Control Box Model No.	Solid State Switch	Start Capacitor	MFD	Volts	Run Capacitor	MFD	Volts	Inductance Coil
1/3	115	2801024910	152138905	275464125	159-191	125				
	230	2801034910	152138901	275464126	43-53	250				
1/2	115	2801044910	152138906	275464201	250-300	125				
	230	2801054910	152138902	275464105	59-71	250				
	230	2824055010	152138912	275470115	43-52	220	155328101	15	370	155662901
3/4	230	2801074910	152138903	275464118	86-103	250				
	230	2824075010	152138913	275470114	108-130	220	155327108	23	370	155662901
1	230	2801084910	152138904	275464113	105-126	250				
	230	2824085010	152138914	275470114	108-130	220	155327108	23	370	155662901

FOOTNOTES:

(1) Control boxes supplied with solid state relays are designed to operate on nominal 230v systems. For 208 v systems or where line voltage is between 200v and 210v use cable 2 sizes larger, or use boost transformer to raise the voltage to 230 volts.

(2) Voltage relay kits 115 volt. 155 031 901 and 230 volt. 155 031 902 will replace either current voltage or solid state switch relays.

(3) Q-D control boxes produced H85 or later do not contain an overload in the capacitator. On winding thermal overloads were added to three-wire motors rated 1/3-1 hp in A85. If a control box dated H85 or later is applied with a motor dated M84 or earlier, overload protection can be provided by adding an overload kit to the control box.

Table 22 "QD" OVERLOAD KITS

HP	Volts	Kit Number
1/3	115	305091 901
1/3	230	305091 902
1/2	115	305091 903
1/2	230	305091 904
3/4	230	305091 905
1	230	305091 906

TABLE 23 Integral Horsepower Control Box Parts

Motor Rated HP Dia.	Control Box (1) Model No.	Capacitor Part No.	Capacitor MFD	Capacitor Volts	Capacitor Qty.	Overload (2) Part No.	Relay (1) Part No.	Contactor (2) Part No.
1 1/2-4"	282 3008 110	275 464 113 S	105-126	220	1	275 411 107	155 031 102	
		155 328 102 R	10	370	1			
	282 3007 202 or	275461 107 S	105-126	220	1	151496 922	151 031 102	
	282 3007 102	275 479 102 R (5)	10	370	1	151 033 946 (3)		
	282 3007 203 or	275 461 107 S	105-126	220	1	151 496 922	151031102	
	282 3007 103	155 328 102 R	10	370	1	151 033 946 (3)		
2-4"	282 3018 110	275 464 113 S	105-126	220	1	275 411 107 S	155 031 102	
		155 328 103 R	20	370	1	275 411 113 M		
	282 3018 202	275 464 113 S	104-126	220	1	275 411 107 S	155 031 102	
		275 479 105 R (5)	20	370	1	275 411 112 R		
	282 3018 203 or	275 464 113 S	104-126	220	1	275 411 107 S	155 031 102	
	282 3018 103	155 328 103 R	20	370	1	275 411 113 M		
2-4" DLX	282 3018 310	275 464 113 S	105-126	220	1	275 411 107 S	155 031 102	155 325 102 L
		155 328 103 R	20	370	1	275 411 112 M		
	282 3019 103	275 464 113 S	105-126	220	1	275 411 107 S	155 031 102	155 325 102 L
		155 328 103R	20	370	1	275 411 102R	155 031 102	155 325 102 L
3-4"	282 3028 110	275 463 111 S	208-250	220	1	275 411 108 S	155 031 102	
		155 327 102 R	35	370	1	275 411 115 M		
	282 3028 202	275 463 11 S	208-250	220	1	275 411 108 S	155 031 102	
		275 481 102 R (5)	35	370	1	275 406 120 M		
	282 3028 203 or	275 463 111 S	208-250	220	1	275 411 108 S	155 031 102	
	282 3028 103	155 327 102 R	35	370	1	275 406 120 M		
3-4" DLX	282 302 8310	275 463 111 S	208-250	220	1	275 411 108 S	155 031 102	155 325 102 L
		155 327 102 R	35	370	1	275 411 115 M		
	282 3029 103	275 463 111 S	208-250	220	1	275 411 108 S	155 031 102	155 325 102 L
		155 327 102 R	35	370	1	275 406 120 M		
5-4"	282 113 8110	275 468 118 S	216-259	330	1	275 411 102 S	155 031 102	
		155 327 101 R	30	370	2	275 406 103 M		
	282 1139 202	275 468 118 S	216-159	330	1	275 411 102 S	155 031 102 (6)	
		275 479 103 R (5)	15	370	4	275 406 103 M		
	282 1139 203 or	275 468 118 S	216-259	330	1	275 411 102 S	155 031 102 (6)	
	282 1139 003	155 327 101 R	30	370	2	275 406 103 M		
5-4" & 6" DLX	282 113 8310	275 468 118 S	216-259	330	1	275 411 102 S	155 031 102	155 325 102 L
		155 327 101 R	30	370	2	275 406 103 M		
	282 1139 303 or	275 468 118 S	216-259	330	1	275 411 102 S	155 031 102 (6)	155 325 102L
	282 1139 103	155 327 101 R	30	370	2	275 406 103 M		

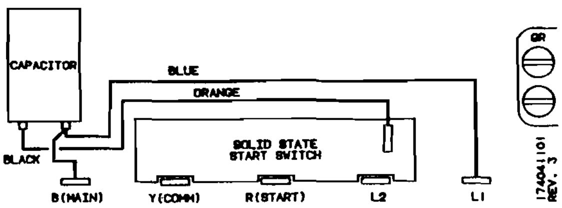
Table 24 Integral Horsepower Control Box Parts

Motor Rating HP, Dia.	Control Box (1) Model No.	Control				Overload (3) Part No.	Relay (7) Part No.	Contactor (2) Part No.
		Part No.	Mfd. Units	Volts	Qty			
5-6"	282 2009 202	275 468 117 S	130-154	330	2	155 249 102	155 031 601	
		275 479 103 R (5)	15	370	2			
	282 2009 203	275 468 177 S	130-154	330	2	155 249 102	155 031 601	
		155 327 101 M	30	370	1			
DLX	282 2009 303	275 468 117 S	130-154	330	2	155 249 102	155 031 601	155 325 102 L
		155 327 101 M	30	370	1			
7 1/2-6"	282 201 9210	275 468 119 S	270-324	330	1	275 411 102 S	155 031 601	
		275 468 117 S	130-154	330	1	275 406 121 M		
		155 327 109 M	45	370	1			
	282 2019 202	275 468 117 S	130-154	330	3	155 249 101	155 031 601	
		275 479 103 R (5)	15	370	3			
	282 2019 203	275 468 117 S	130-154	330	3	155 249 101	155 031 601	
		155 327 101 M	30	370	1			
		155 328 101 M	15	370	1			
DLX	282 201 9310	275 468 119 S	270-324	330	1	275 411 102S	155 031 601	155 326 101 L
		275 468 117 S	130-154	330	1	275 406 121 M		
		155 327 109 M	45	370	1			
DLX	282 2019 303	275 468 117 S	130-154	330	3	155 249 101	155 031 601	155 326 101 L
		155 327 101 M	30	370	1			
		155 328 101 M	15	370	1			
10-6"	282 202 9210	275 468 119 S	270-324	330	2	275 406 103 S	155 031 601	
		155 327 102 M	35	370	2	155 409 101 M		
	282 2029 202	275 468 117 S	130-154	330	4	155 249 103	155 031 601 (4)	
		275 479 103 M (5)	15	370	5			
	282 2029 203	275 468 117 S	130-154	330	4	155 249 103	155 031 601 (4)	
		155 327 101 M	30	370	2			
		155 328 101 M	15	370	1			
DLX	282 202 9310	275 468 119 S	270-324	330	2	275 406 103 S	155 031 601	155 326 102 L
		155 327 102 M	35	370	2	155 409 101 M		
DLX	282 2029 207	275 468 119 S	270-324	330	2	155 409 101	155 031 102 (6)	155 325 102 S
		155 327 101 M	30	370	2			
		155 328 101 M	15	170	1			
DLX	282 2029 303	275 468 117 S	130-154	330	4	155 249 103	155 031 601 (4)	155 326 102 L
		155 327 101 M	30	370	2			
		155 328 101 M	15	370	1			
DLX	282 2029 307	275 468 119 S	270-324	330	2	155 409 101	155 031 102 (6)	155 326 102 L
		155 327 101 M	30	370	2			155 325 102 S
		155 328 101 M	15	370	1			
15-6"	282 203 9310	275 468 119 S	270-324	330	2	275 406 103 S	155 031 601	155 429 101 L
		155 327 109 M	45	370	3	155 409 102 M		
DLX	282 2039 303	275 468 119 S	270-324	330	2	155 409 102	155 031 102 (6)	155 429 101 L
		155 327 101 M	30	370	4			155 325 102 S
		155 327 101 M	15	370	1			

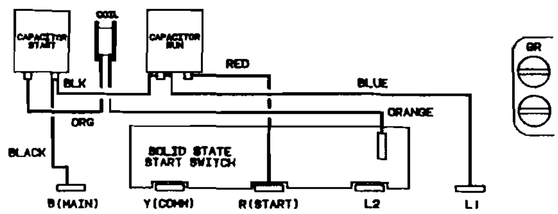
FOOTNOTES:
(1) Lightning arrestor 150 814 902 suitable for all control boxes
(2) S=Start M=Main L=Line
DLX = Deluxe control box with line contactor
(3) Capacitor and overload ass'y
(4) 2 required
(5) These parts may be replaced as follows.

Old	New
275 479 102	155 328 102
275 479 103	155 328 101
275 479 105	155 328 103
275 481 102	155 327 102

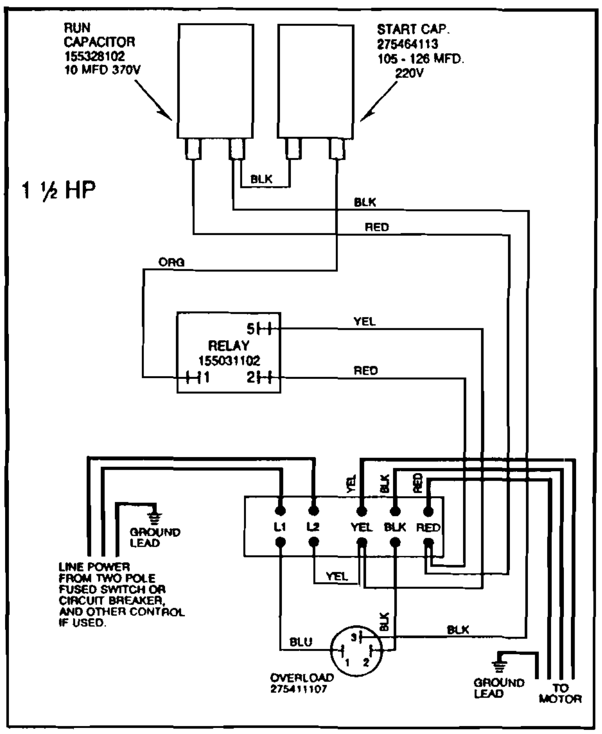
(6) May be replaced with 155 031 601 heavy duty relay.
(7) For 208v systems or where line voltage is between 200v and 210 volts special low voltage relays are required Use relay part 155 031 103 in place of part 155 031 601, use cable 2 sizes larger, or boost transformer, to raise the voltage to 230 volts



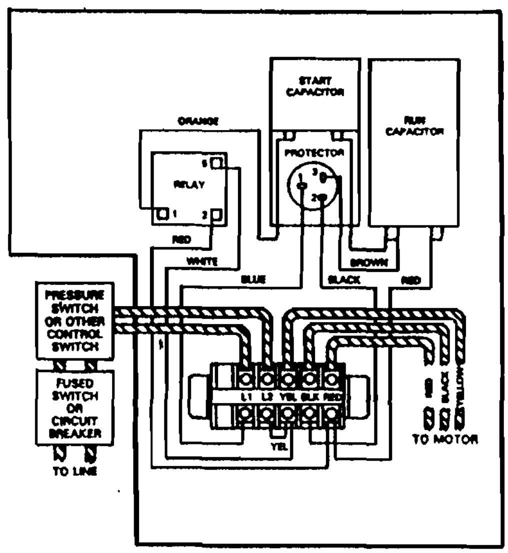
4"
1/3-1 HP Q.D.
280 10-4 910
Sixth digit depends on HP



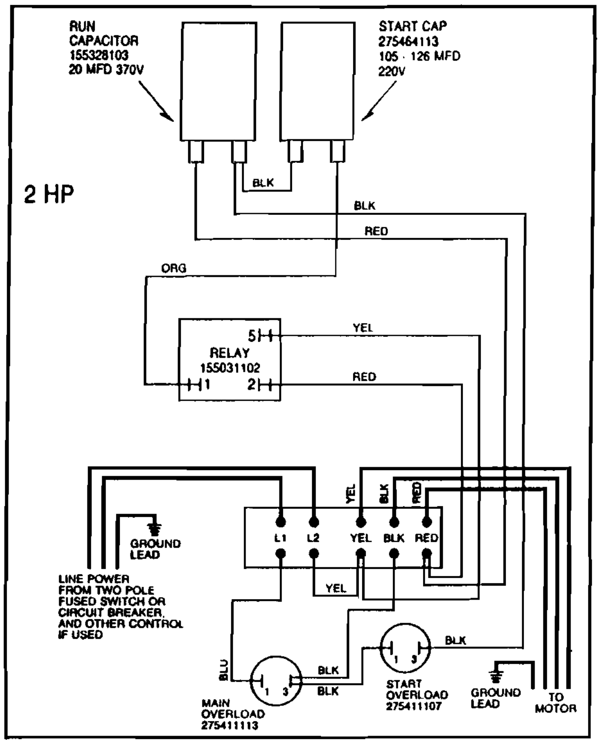
4"
1/2 - 1 HP CRC
282 40-5010
Sixth digit depends on HP



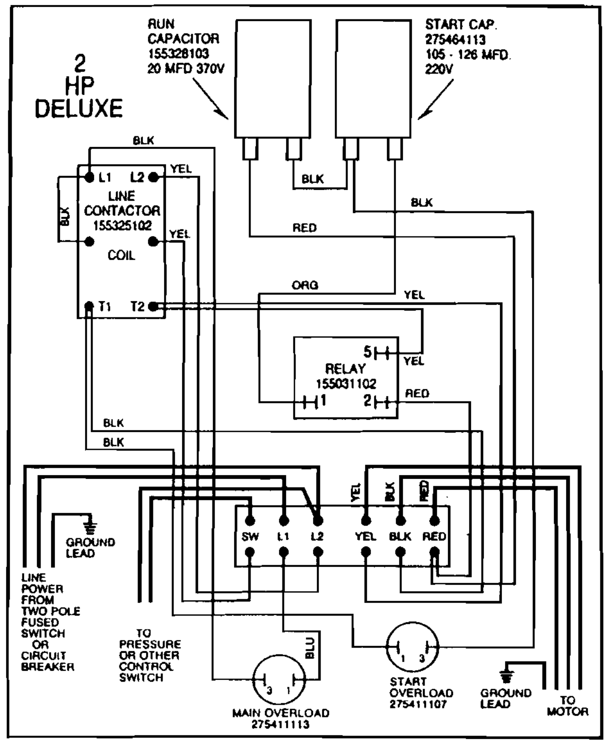
4" STANDARD
1 1/2 HP
282 300 8110



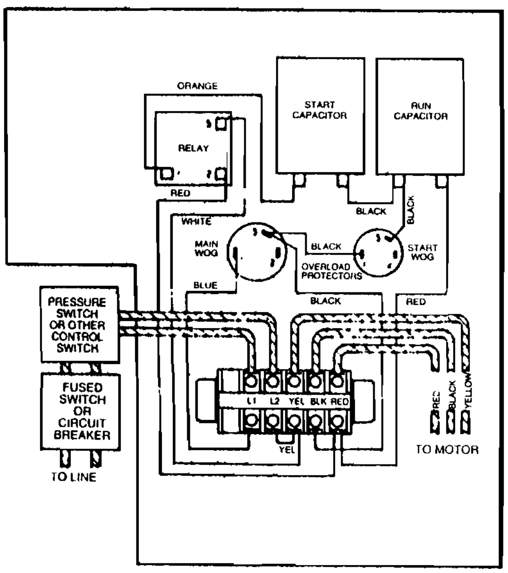
4"
1 1/2 HP
STANDARD
282 3007 103



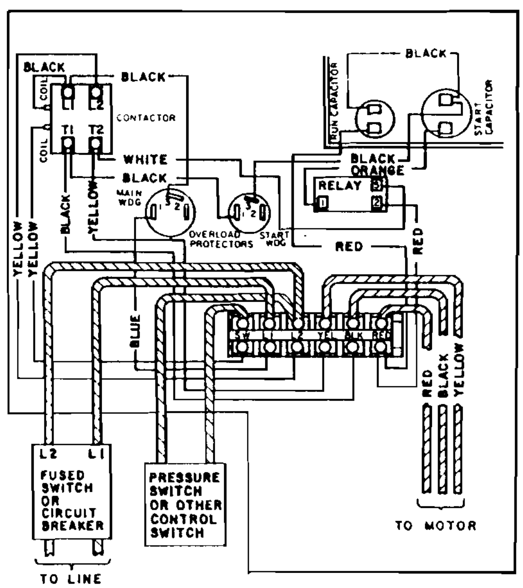
4" STANDARD
2 HP
282 301 8110



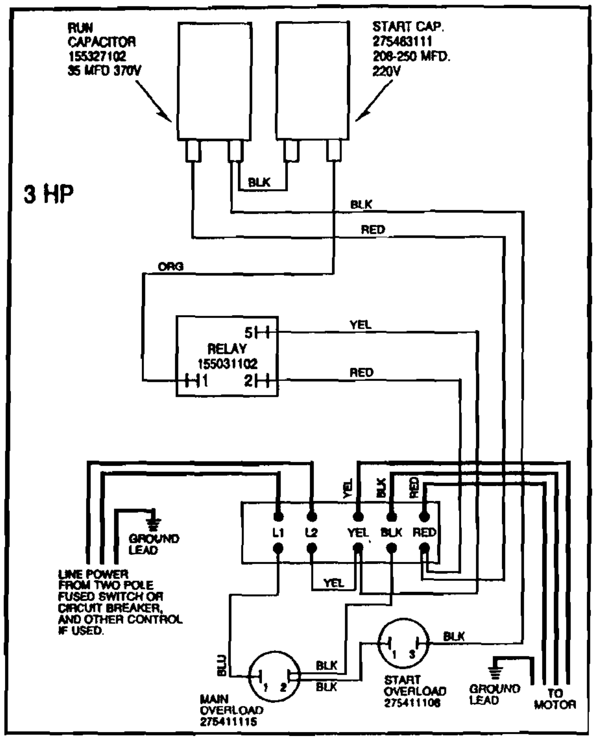
4" DELUXE
2 HP
282 301 8310



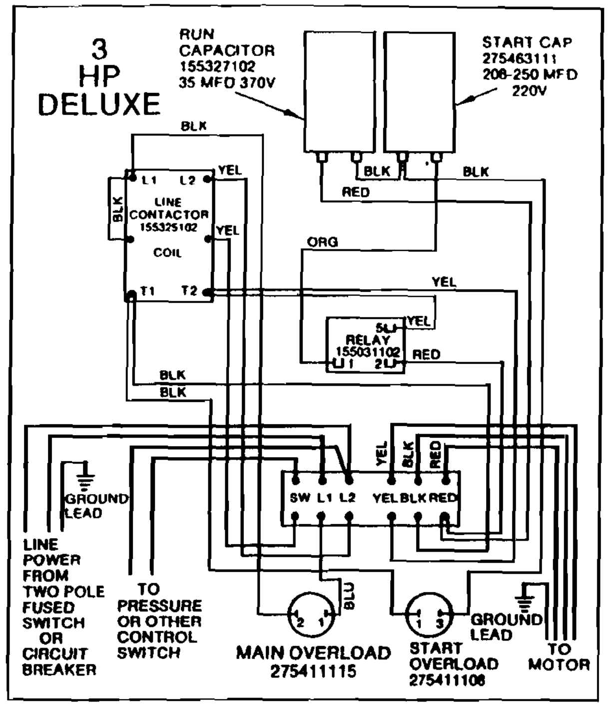
4"
2 AND 3 HP
STANDARD
282 3018 103
282 3028 103



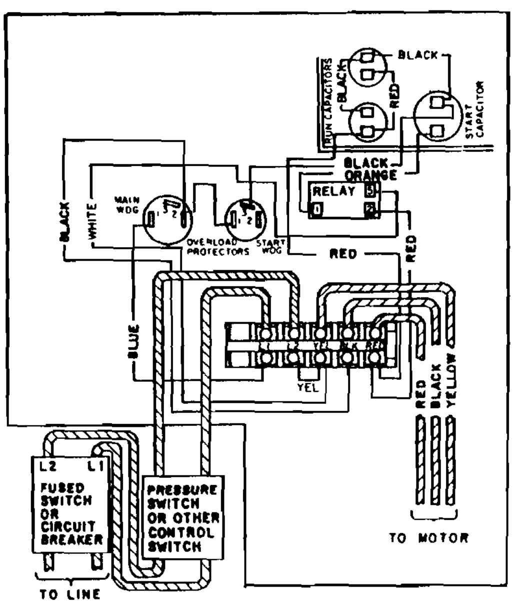
4"
2 AND 3 HP
DELUXE
282 3019 103
282 3029 103



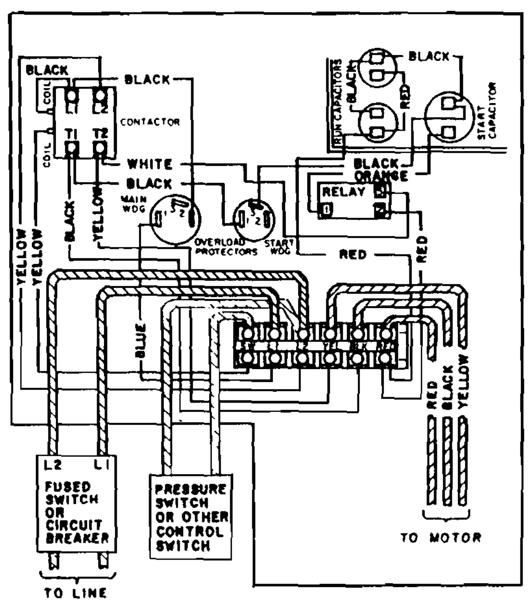
4" STANDARD
3 HP
282 302 8110



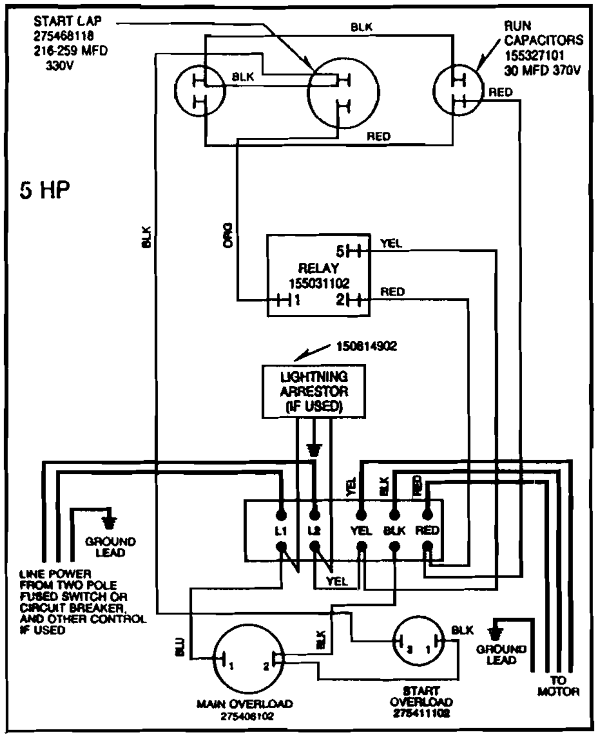
4" DELUXE
3 HP
282 302 8310



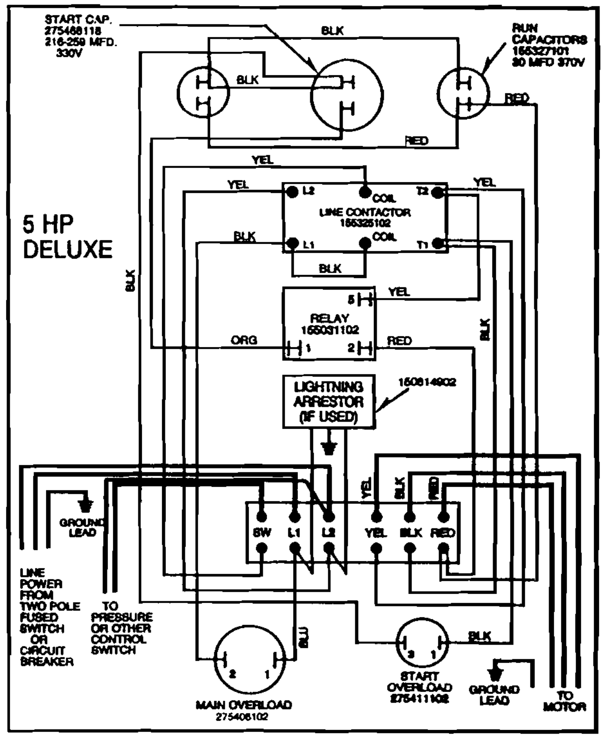
4"
5 HP
STANDARD
282 1139 003



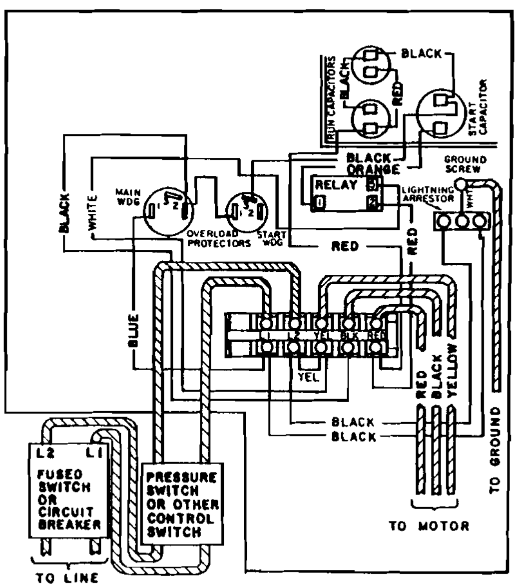
4"
5 HP
DELUXE
282 1139 103



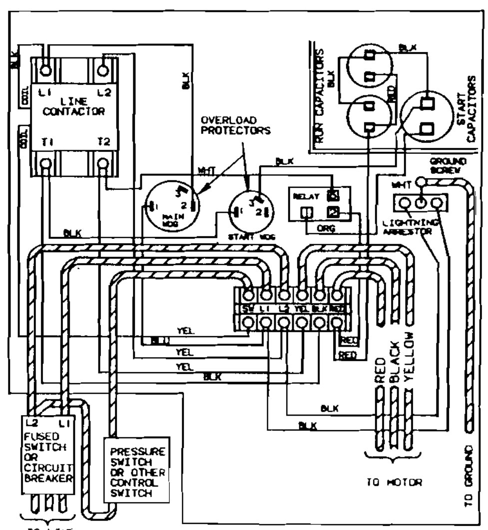
4" AND 6" STANDARD
5 HP
282 113 8110



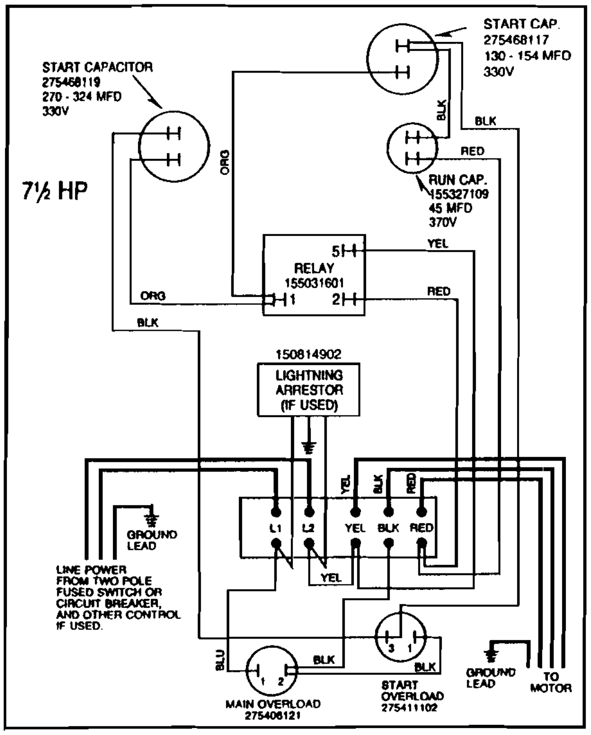
4" AND 6" DELUXE
5 HP
282 113 8310



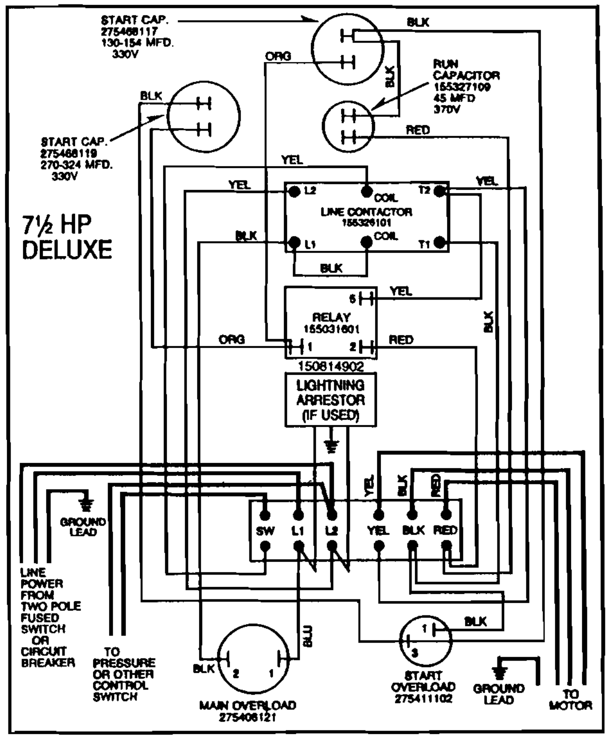
6"
5HP
STANDARD
282 2009 203



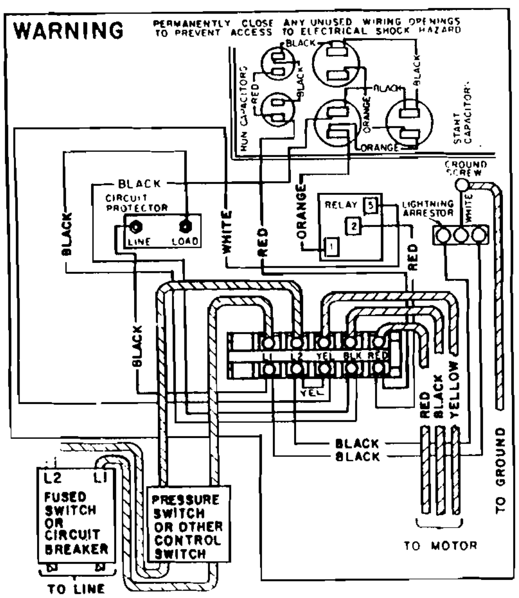
6"
5 HP
DELUXE
282 2009 303



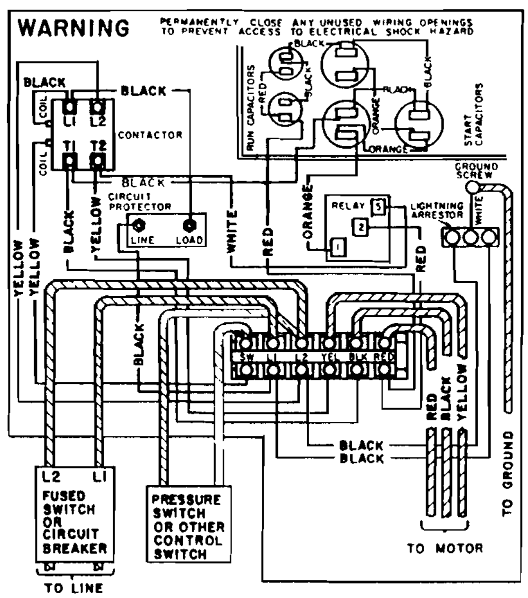
6" STANDARD
7 1/2 HP
282 201 9210



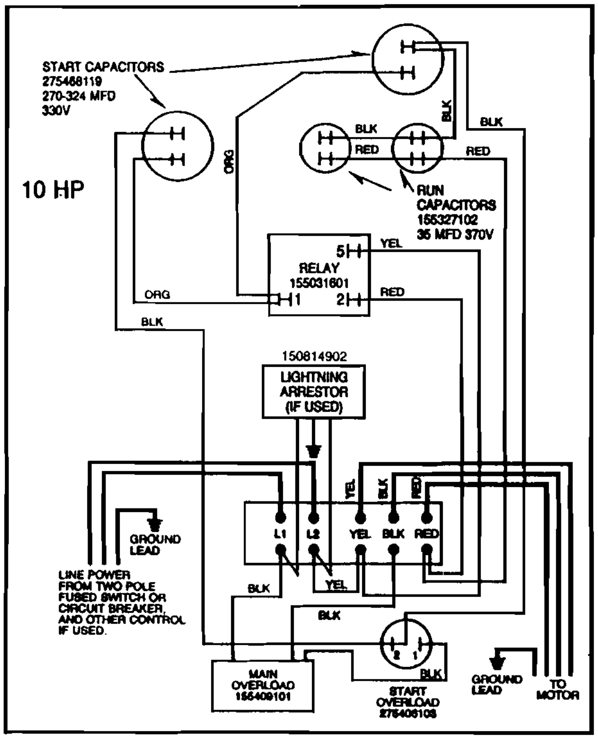
6" DELUXE
7 1/2 HP
282 201 9310



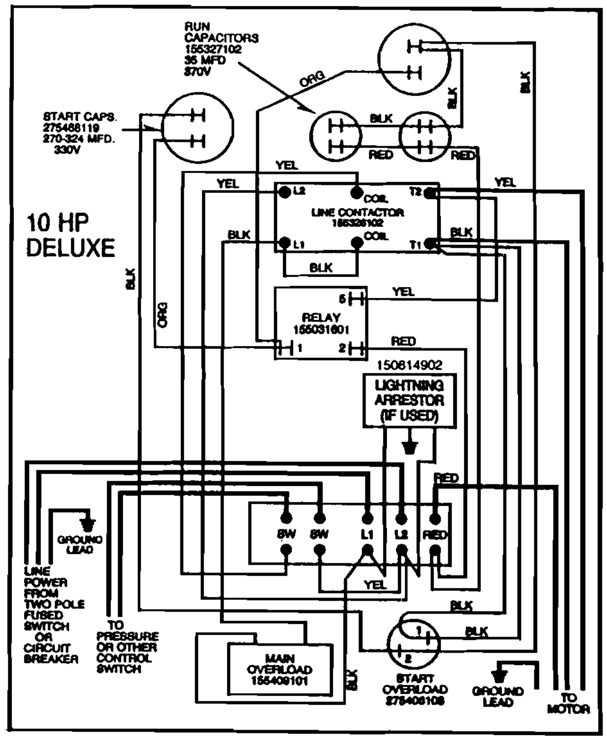
6"
7 1/2 HP
STANDARD
282 2019 203



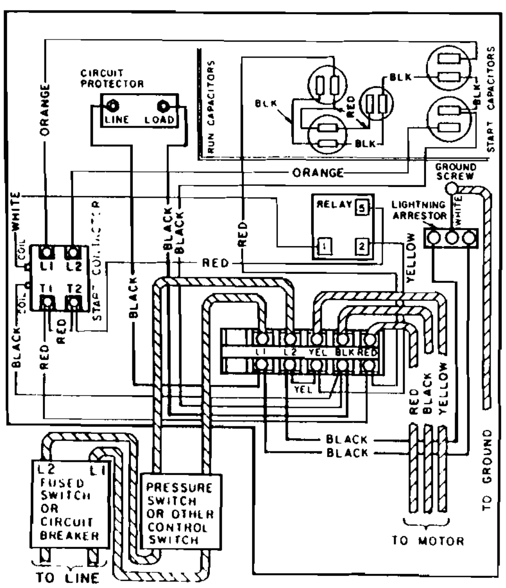
6"
7 1/2 HP
DELUXE
282 2019 303



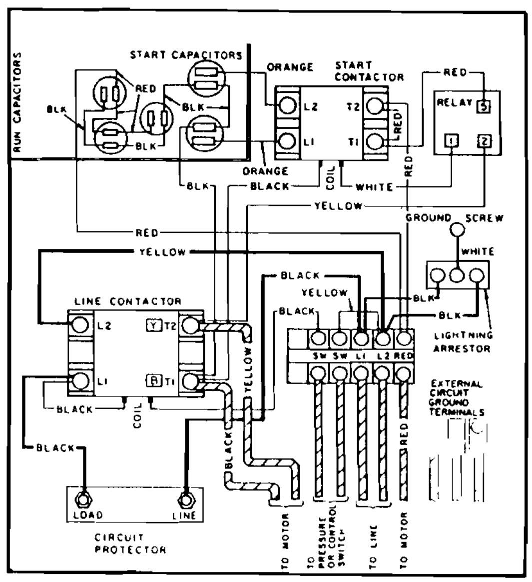
6" STANDARD
10 HP
282 202 9210



6" DELUXE
10 HP
282 202 9310



6"
10 HP
STANDARD
282 2029 207



6"
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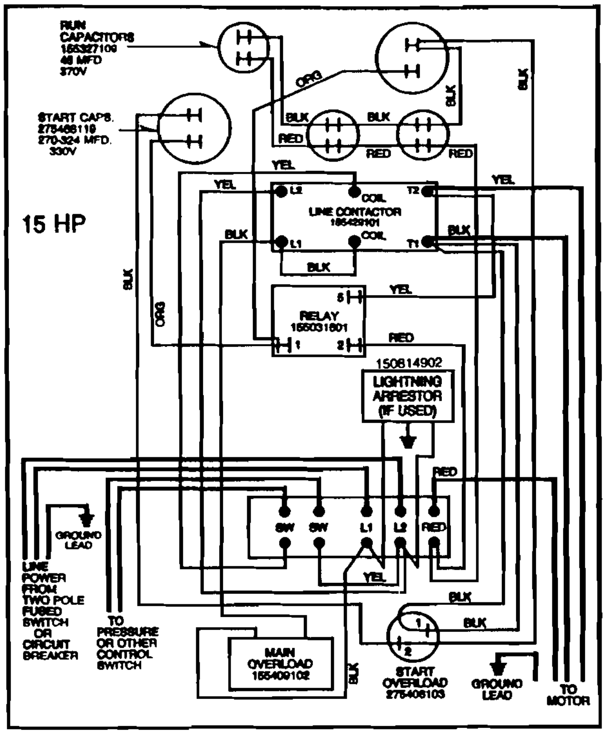
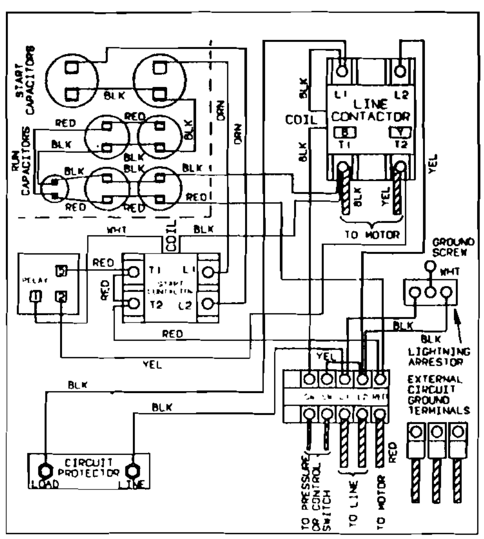
DELUXE
282 2029 307



6"
DELUXE
15 HP
282 203 9310



6"
15 HP
DELUXE
282 2039 303

Franklin Electric

SUBMERSIBLE MOTOR WARRANTY

SCOPE OF POLICY

This service policy applies to all Franklin Electric submersible motors.

LIMITED WARRANTY

Franklin Electric warrants apparatus sold against faulty workmanship or the use of defective materials. Franklin Electric shall in no way be liable for any special, incidental or consequential damages resulting from any cause whatsoever, which might be claimed as the result of the use or malfunction of the apparatus sold.

WARRANTY DETERMINATION

The duration of the warranty period is one year from the date of a product's installation, within two years from the date of its manufacture.
For delayed installation, the warranty period, which applies to motors only, is one year from date of installation, within three years from the date of manufacture.

SUBTROL WARRANTY is three years from date of installation, within four years from date of manufacture.
This warranty is applicable only for water well installations and applies only to Franklin Electric three phase motors equipped with and used with SUBTROL retrofit kits and with a properly grounded lightning arrestor. In order to validate the SUBTROL warranty, the SUBTROL warranty registration card must be completed with all requested information and mailed within 10 days of installation.

WARRANTY SERVICE

A Franklin Electric motor which fails in warranty will be replaced with a new motor. The exception is minor type repairs on an emergency basis. A minor repair may include all repair except rotor and/or stator.

TOLL FREE HELP FROM A FRIEND

Phone Franklin Electric's toll free SERVICE HOTLINE, for answers to your installation questions on submersible pump motors. When you call, a Franklin Electric expert will offer assistance in troubleshooting submersible systems and provide immediate answers to your motor application questions.

Franklin Electric SERVICE HOTLINE 800/348-2420

Franklin Electric
Bluffton, Indiana 46714

M-1311-9/92AW

Submersible Motor Installation Record

Date ____________________ Filled In By ____ RMA No. ____________

Installation

Installer: ____ Telephone (_____) ____________________
Street: ____ City __________________________ State ________ Zip ____________
Owner/User: ____________________________________ City __________________________ State ________ Zip ____________
Well Identification, If Any: ____
Well Is For: Home Farm ______ City/town______ Golf Course______ OR______________________________________
Water Is Pumped To: Overhead Storage Tank ______ Distribution Piping ______ Or ______________________________
New Installation? Yes ______ No ______ . If No, It replaces ____

Well

Well Diameter: ______ In. Well Depth ______ Ft. Cased ______ Or Uncased ______
Casing: ______ In. Length ______ Ft. Screened ______ Or Unscreened ______
Casing Is: Steel ______ Stainless Steel ______ Plastic ______ Or ______________________________
Screen ______ Or Perforated Casing ______ :From ______ Ft. To ______ Ft. & ______ Ft. To ______ Ft.
Static Water Level Is: ______ Ft. Water Temperature Is: ______ °F Or ______ °C
Drawdown Level Is: ______ Ft., After Pumping At ______ GPM Or ______ GPH For ______ Hours
Pump/Motor Is Set At: ______ Ft., On Steel Pipe ______ Rigid Plastic ______
Flexible Plastic ______ Or ____
Flow Sleeve On The Motor? Yes ______ No ______ If Yes, Diameter is ______ In.
heck Valves In The System Yes ______ No ______ If Yes, Built-In ______ And/Or ________________
At The Pump Discharge ______ and ______ Ft. and ______ Ft. and ______ Ft.
Is There A Pump Control Valve? Yes ______ No ______ If Yes,
Mfr. ______________________________ Size ______ Model ______________________________________

Wiring

Transformers: KVA No. 1 ______ , No. 2 ______ No. 3 ______ Connected: Wye ______ Delta ______
Supply Cable: (Service Entrance To Control): ______ Ft. of No. ______ Copper ______ Alum. ______
Drop Cable: (Control To Motor) : ______ Ft. of No. ______ Copper ______ Alum. ______
Cable is: Flat ______ Round ______ Or 3 individual Conductors ______ . Jacketed: Yes ______ No ______
Insulation Is: Neoprone ______ PVC ______ Or ____
Splice Is: Crimped ______ Or Soldered ______ And, Taped ______ Heat Shrink ______ Or ______

Controls and Protective Devices

Subtrol? Yes ______ No ______ If Yes, Warranty Registration No. ______________________________________
If Yes, Overload Set? Yes ______ No ______ Set At ______
Underload Set? Yes ______ No ______ Set At ______
Reduced Voltage Starter? Yes ______ No ______ If Yes, Type ______________________________
Mfr. ______________ Setting ____________________ % Full Voltage In __________ Seconds.
Pump Panel? Yes ______ No ______ If Yes, Mfr. ________________________________ Size ______________
Magnetic Starter/Contactor: Mfr. ____________________ Model ______________________ Size ______________
Heaters: Mfr. ______________ No. ________ If Adjustable; Set At ____
Fuses: Mfr. ______________ Size ________ Type ____
ightning/Surge Arrestor: Mfr. ______________________________________ Model ______________________
Controls Are Grounded: to ____________________________ with No. ______________________ Wire
Phase Converter? Yes ______ No ______ If yes, Mfr. ________________________________ Model ______________

Submersible Motor Installation Record

Motor

Model No. ______________________________ Serial No. __________________________ Date Code ________________
Horsepower ______ Voltage ______ Phase ______ Diameter ______

Pump

Mfr. ______________________ Model __________________ Rated ________ GPM At __________ Ft.

Operating Cycle

Pump/Motor Operates; Continuously (Non-Stop) ______ Or is controlled by:
Manual Switch ______ Pressure Switch ______ Float/Level Control ______ Flow Switch ______
Timer ______ Or ____

On Off

______ Minutes Or ______ Hours ______ Minutes Or ______ Hours

Start Up Data

Insulation Check
Initial Megs: Motor & Lead Only Black ______ Yellow ______ Red ______
Installed Megs: Motor, Lead, & Cable Black ______ Yellow ______ Red ______

Voltage To Motor
Non-Operating: B-Y ______ Y-R ______ R-B ______
At Rated Flow of ______ GPM B-Y ______ Y-R ______ R-B ______
At Open Flow ______ GPM B-Y ______ Y-R ______ R-B ______

Amps To Motor
At Rated Flow Of ______ GPM Black ______ Yellow ______ Red ______
At Open Flow ______ GPM Black ______ Yellow ______ Red ______
At Shut Off* Black ______ Yellow ______ Red ______
*Do NOT Run at Shut Off more Than Two (2) minutes.

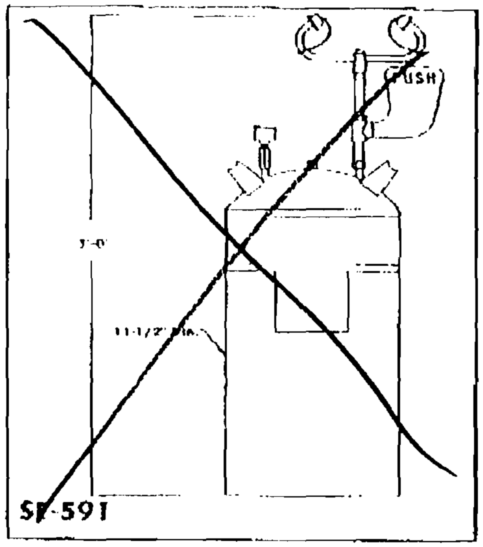
Warranty On Three Phase Submersible Motors Is Void Unless Subtrol Or Proper Quick Trip Ambient Compensated Protection Is Used On All Three (3) Motor Lines.

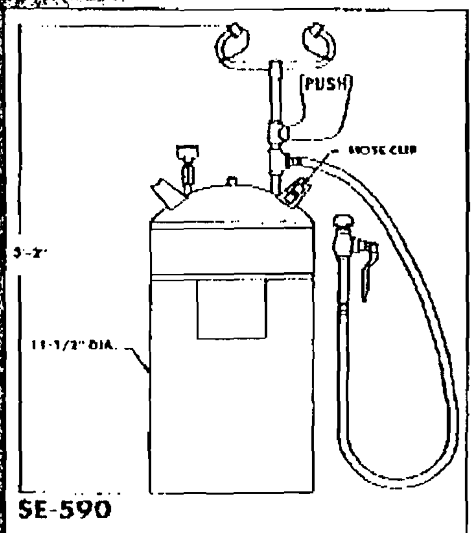
If you have any Questions or Problems, Call The Franklin Electric Toll Free Hot Line: 1-800-348-2420

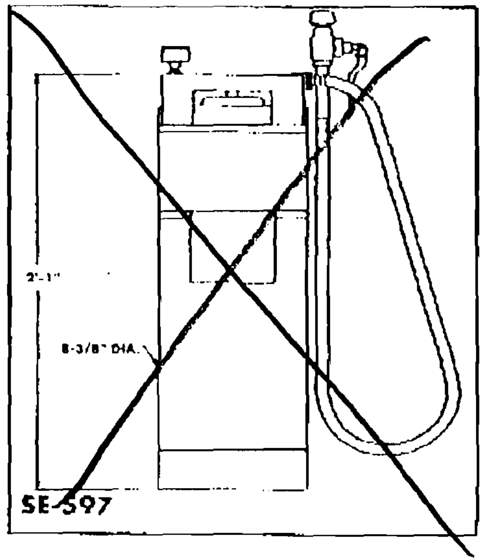
Comments: ____

Eye Wash

ALL DIMENSIONS ARE FOR REFERENCE ONLY (NOT TO BE USED FOR PRE-PLUMBING)







NOTE: All units meet ... ANSI Z358.1- ... Standards and ... Rules. Product ... may ... specification to ... without notice.

PORTABLE EYEWASHES For Use Where a Permanent Water Supply is not Available or as a Temporary Replacement for Inoperable Plumbed In Units or as Additional Treatment After Use of Plumbed In System

■ **SE-590** – Tank: 10 gallon capacity, stainless steel. Designed to hold 8 gallons of water. Complete with pressure gauge, air filler, pressure relief valve. Eyewash valve: 1/2" NPT chrome-plated brass stay-open ball valve. Activated by stainless steel push handle. Eyewash spray heads: Twin spray heads with balance control screw and dust caps. Flow control and special spray heads assure 0.4 GPM for 15 minutes. Drench hose/valve: 3/8" NPTF chrome-plated brass, self-closing squeeze valve. Six' reinforced hose.

■ **SE-591** – Same as SE-590 except without drench hose.

■ **SE-597** – Same as SE-590 except tank is 5 gallon capacity to assure 0.4 GPM for 7 minutes. Eyewash spray heads not included.

SPEAKMAN
THE QUALITY LEADER SINCE 1869

Instruments

1) *Monitoring Panel*
2) *Level Measurement System and Leak Detection*

Form 725-A

SERIES DMS-470
MONITORING PANEL

WARRICK CONTROLS

INSTALLATION AND OPERATING INSTRUCTIONS

Contents

Warrick Controls, Inc. 4237 Normandy Court, Royal Oak, MI 48073, PH 313-545-2512 FAX: (313) 549-4904

Installation: Intrinsically Safe Sensing Circuits

This bulletin should be used by experienced personnel as a guide to the installation of the Series DMS-470. Selection or installation of equipment should always be accompanied by competent technical assistance. We encourage you to contact Warrick Controls, Inc. or its local representative if further information is required.

IMPORTANT: READ AND THOROUGHLY UNDERSTAND THESE INSTRUCTIONS BEFORE PROCEEDING TO INSTALL AND WIRE THE CONTROL PANEL.

When the Series DMS-470 Monitoring Panel is installed according to these instructions, the panel will provide an intrinsically safe sensing circuit for interface into Class I and Class II. Division I, Groups C, D, E, F and G hazardous locations.

Electrical equipment connected to the Series DMS-470 Control Panel should not exceed the ratings marked on the panel.

MOUNTING LOCATION: The panel must be situated in a nonhazardous area where an explosive atmosphere will not exist at any time.

WIRING:

1. **GENERAL INFORMATION:** Intrinsically safe wiring must be kept separate from non-intrinsically safe wiring.
2. Intrinsically safe and non-intrinsically wiring may occupy the same raceway if they are at least 2 inches (50mm) apart and separately tied down.
3. For sensor wiring use #14 or #16 AWG type MTW or THHN wire. By using these wire types in conjunction with the following distance requirements, you will not exceed the maximum capacitance or inductance for field wiring.

Table 1-1

MODEL NUMBER	NUMBER OF SENSOR WIRES	DISTANCE PER CHANNEL
DMS-47X-X-X	ALL 2 WIRE SENSORS	900 FEET
DMS-47X-X-X	ALL 3 WIRE SENSORS	450 FEET

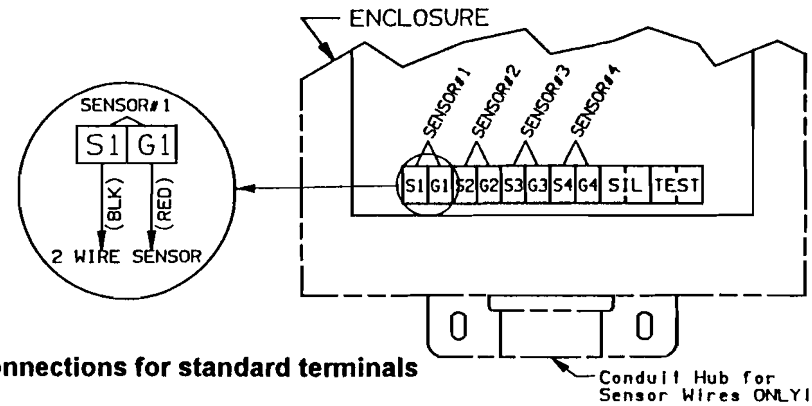
4. Intrinsically safe terminals can be connected to any non-energy generating or storing switch device such as a push button, limit or float type switch or any Warrick sensor, electrode or fitting assembly.
5. All junction boxes and field wire terminations should be waterproof. Refer to appropriate sensor instructions for details on how to install sensors.
6. An approved seal should be used at the point where the intrinsically safe sensor circuit wiring enters the hazardous area.
7. For additional guidance on "Hazardous Location Installations" and "Intrinsically Safe Devices", consult ANSI/ISA standard RP 12-6 or NEC articles 500 through 516.

SENSOR WIRING

SENSORS: Wire the sensor devices to the Series DMS-470 Panel as shown in Figures 3-1 to 3-4. **(A separate rigid metallic conduit must be used to enclose the conductors of the intrinsically safe sensor circuit. A conduit hub is provided on the bottom side of the enclosure for intrinsically safe wiring.)**

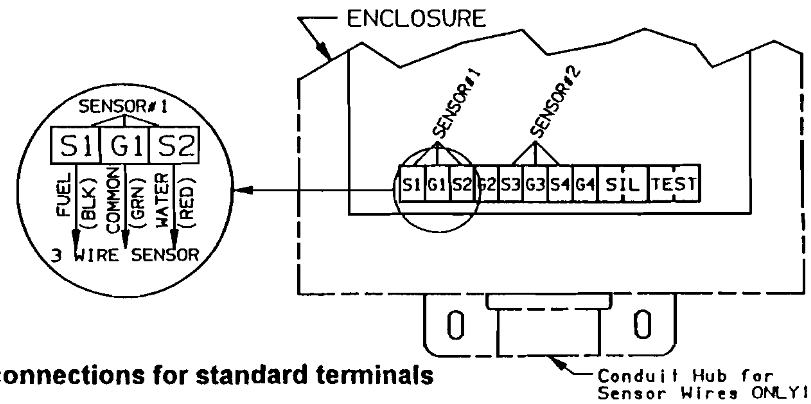
Installation: Intrinsically Safe Sensing Circuits

Figure 3-1



Two (2) wire sensor connections for standard terminals

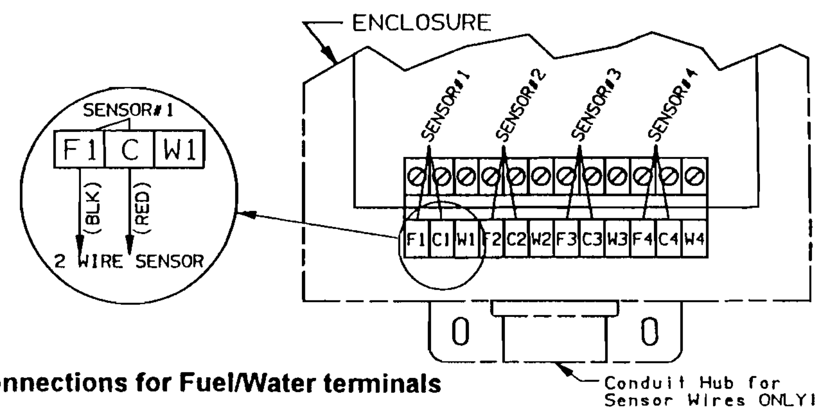
Figure 3-2



Three (3) wire sensor connections for standard terminals

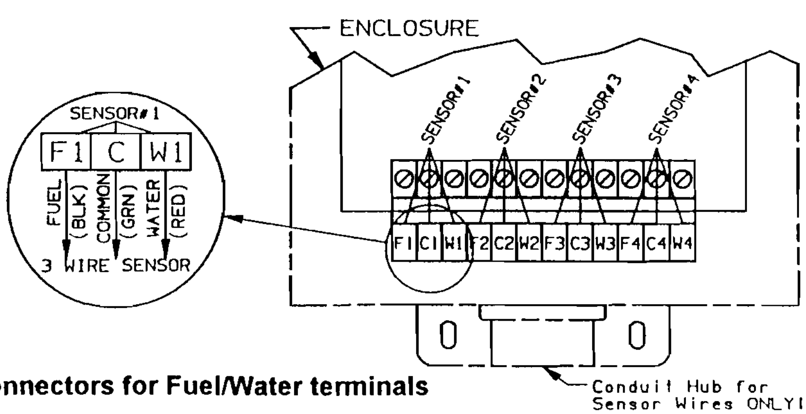
For those models using the optional "check" push buttons, wire sensors per Figures 3-3 and 3-4

Figure 3-3



Two (2) wire sensor connections for Fuel/Water terminals

Figure 3-4



Three (3) wire sensor connectors for Fuel/Water terminals

CONTROL PANEL SETTINGS

Before putting the system into operation, dip switches and potentiometers must be set to correctly match the type of sensor you are using. The dip switches and pots are located directly above the sensor terminal strip. See Figure 4-1.

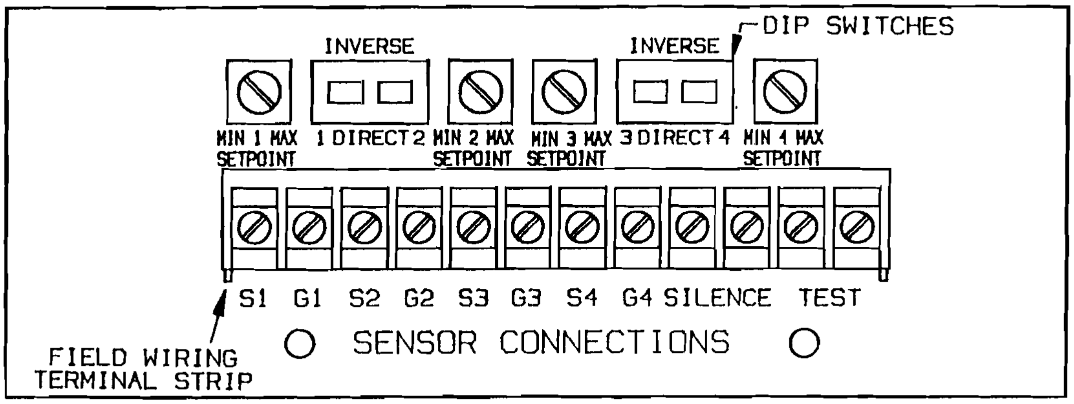


Figure 4-1

SETTING THE DIP SWITCHES

The table below lists applications and appropriate sensors vs. dip switch setting. Each channel should be set to correspond to the type of sensor being used.

Table 4-1

APPLICATION	WARRICK SENSOR	ACTIVATION CONDITION	DIP SWITCH SETTING	SET POINT ADJUSTMENT
Double Wall Fiberglass Fuel Sensing	DFP-25	Closes on Detecting Fuel	Inverse (on)	N.A.
Double Wall Fiberglass Water Sensing	DWP-25	Closes on Detecting Water	Inverse (on)	N.A.
Double Wall Steel Hydrocarbon / Water Sensing	DSP-2	Closes on Detecting Hydrocarbon or Water	Inverse (on)	N.A.
Double Wall Steel Liquid	DLP-2	Closes on Detecting Liquid	Inverse (on)	N.A.
Product Level Alarm (Normally Closed Float)	SERIES FE	Opens on Rising Level	Direct (off)	SEE INSTRUCTIONS ON SET POINT SETTING
Product Level Alarm (Normally Open Float)	SERIES FE	Closes on Rising Level	Inverse (on)	N.A.
Monitoring Well (Hydrocarbon Vapor Detector)	SVP-2	Resistance Increases on Detecting Vapors	Direct (off)	SEE INSTRUCTIONS ON SET POINT SETTING
UNUSED CHANNEL	NONE	N.A.	Inverse (on)	N. A.
UNKNOWN	UNKNOWN NORMALLY OPEN SWITCH	Closes on Fault	Inverse (on)	N.A.
UNKNOWN	UNKNOWN NORMALLY CLOSED SWITCH	Open on Fault	Direct (off)	CONTACT FACTORY

ADJUSTING THE SET POINT POTENTIOMETER

DIP SWITCH SET IN INVERSE (ON) MODE: When using a channel in inverse mode (on), there is no need to adjust the potentiometer. The channel is automatically set to the maximum sensitivity.

DIP SWITCH SET IN DIRECT (OFF) MODE: Turn the pot clockwise until it reaches the end of its rotation. (One turn pots) DO NOT FORCE THE ROTATION. When the pot is adjusted to this position, it is set to the maximum sensitivity. **When using SVP-2 Vapor Sensors, it may be necessary to reduce this sensitivity. Continue with the following instructions.**

THE FOLLOWING ADJUSTMENT APPLIES ONLY TO THOSE CHANNELS USING A SVP-2 VAPOR SENSOR.

This adjustment will allow the alarm point to be set at a level just higher than existing background contamination, thus only indicating a potential new leak or spill condition.

CAUTION: AS THE VAPOR SENSOR REACTS OVER TIME (MONTHS) TO BACKGROUND (EXISTING) CONTAMINATION, A FALSE ALARM MAY OCCUR. IF THIS OCCURS, REPEAT THE ADJUSTMENT PROCEDURE.

1. With all appropriate pots set to full clockwise position, apply power to the panel and observe the state of the indicator lights. Silence the bell if necessary.
2. Upon power up, no warning lights (bell) should be on. If any warning lights are lit, proceed to step 3. Starting with the first channel using a vapor sensor, turn the pot counter-clockwise until the warning light comes on. (Silence the bell). Turn the pot clockwise until the alarm light turns off. Turn the pot an additional 1/8 turn. Repeat this procedure for the remaining channels using vapor sensors.
3. If an alarm light(s) remain lit, determine which channel is activated. Check the position of the dip switch for the sensor being used on that channel. Check the sensor wiring. Check for a true fault condition. Refer to troubleshooting guide for further details.

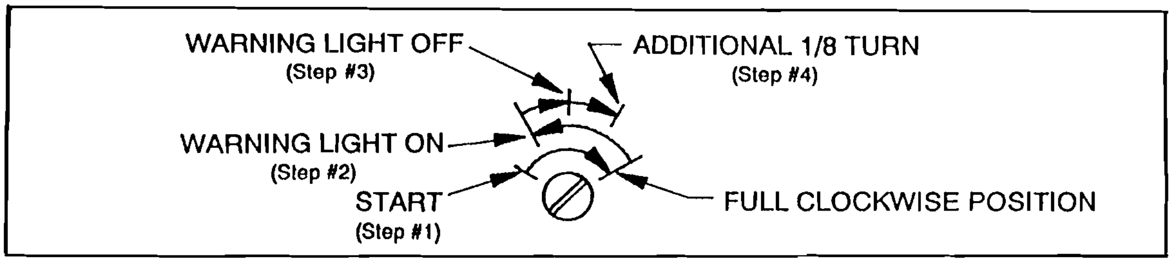


Figure 5-1

SUPPLY POWER

A weather proof conduit hub is provided on the top of the enclosure for supply power wiring. Connect **HOT** lead to L1, **NEUTRAL** lead to L2 and **GROUND** lead to G.

GROUNDING

Terminal G on the supply line/load side terminal strip is a redundant system ground terminal and must be connected to the earth ground buss of the panel's AC supply line feeder.

REMOTE ALARM CONTACT

A set of SPDT dry contacts activates on fault when any one of the four (4) channels alarms. Using the conduit hub on the top of enclosure, wire contacts to remote alarm or indicator, if applicable (terminals 7, 8 and 9). For low voltage circuits, wiring should not be run in the same conduit as high voltage circuits. Conduit should be teed immediately after leaving enclosure.

OPTIONAL AUXILIARY CONTACT BOARD

A SPDT auxiliary set of contacts are available for interfacing to remote alarms, computers, tank gauging systems, etc. One set of contacts per channel are provided. Wire through conduit hub on top of the enclosure. (See Figure 9-1.)

Technical Information

ORDERING INFORMATION

GENERAL

One set of auxiliary contacts is standard with every (4) four channels supplied. A common test button is included as standard for every (4) four channels supplied. The fuel/water check buttons listed below are used to distinguish water or hydrocarbon when three wire sensors are used.

DMS-47X - X - X

NO. OF CHANNELS		FUEL / WATER CHECK PUSH BUTTONS	AUXILIARY CONTACTS
4 — 4	CHANNELS	A - NO CHECK BUTTONS	1 - NO AUX. CTS.
8 — 8	CHANNELS	B - CHECK BUTTONS on 4 Channels	2 - AUX. CTS. 1-4
12 — 12	CHANNELS	C - CHECK BUTTONS on 8 Channels	3 - AUX. CTS. 1-8
16 — 16	CHANNELS	D - CHECK BUTTONS on 12 Channels	4 - AUX. CTS. 1-12
		E - CHECK BUTTONS on 16 Channels	5 - AUX. CTS. 1-16

SPECIFICATIONS

PRIMARY AC SUPPLY LINE: 120 VAC (plus) +10%, (minus) -15%, 60 Hz.

PROBE VOLTAGE: Nominal 12 VAC @ 6ma RMS

SENSITIVITY RANGE: 0 - 50,000 Ohms maximum specific resistance.

TEMPERATURE RANGE: (minus) -40 deg. F. to (plus) +150 deg. F.

REMOTE ALARM CONTACT: (Terminals 7 N.C., 8com, 9N.O.)

CONTACT DESIGN: SPDT (1 form C), one normally open and one normally closed.

CONTACT RATING: 120 VAC or 30 VDC, 5A, 1/10 H.P.

CONTACT LIFE: Electrical @ rated load = 100,000 cycles minimum. Mechanical = 10,000,000 cycles minimum.

ELECTRONIC MODULE: Solid state components enclosed in a molded nylon housing.

MODULE TERMINALS:

SCREW TERMINAL TORQUE RATING: 5 - 6 Inch/Pound

FIELD WIRING: Removable terminal strip, contains a size four (4) pan head screw with clamping plate. Will accept up to a 14 AWG wire.

FACTORY WIRING: Removable terminal strip will accept up to a 14 AWG wire.

OPTIONAL AUXILIARY BOARD:

AUXILIARY CONTACTS: One relay contact per channel.

CONTACT DESIGN: SPDT (1 form C), one normally open, one normally closed.

CONTACT RATING: 120 VAC or 30 VDC, 10A, 1/3 H.P.

CONTACT LIFE: Electrical @ rated load = 100,000 cycles minimum. Mechanical = 100,000,000 cycles minimum.

AUXILIARY BOARD TERMINALS

FIELD WIRING: Removable terminal strip, will accept up to 14 AWG wire.

AUXILIARY BOARD CONNECTION: Eight (8) pin wire harness connector.

OPTIONAL "CHECK" PUSH BUTTON BOARD:

TERMINALS: Size four (4) pan head screw with a clamping plate, will accept up to a 14 AWG wire. "Check" push button board and module terminal strip should be removed as an assembly from electronic module.

Module Replacement

IF THE ELECTRONIC MODULE NEEDS TO BE REPLACED, FOLLOW THE PROCEDURE LISTED BELOW:

1. Turn off power to the control panel.
2. Remove metal barrier located across center of module.
3. Remove all field wiring terminal blocks from electronic module. The field wires do not need to be removed from the terminal blocks to do this. The terminal blocks separate at midpoint on the vertical as shown in Figure 7-1.

MODULE REPLACEMENT DIAGRAM

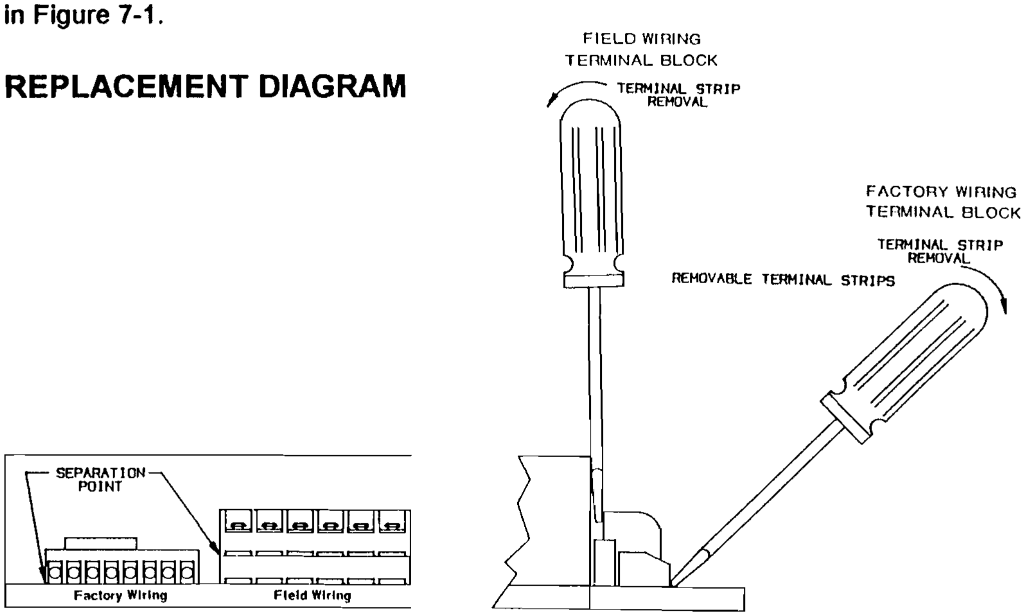


Figure 7-1

4. Remove the factory wiring terminal blocks from the electronic module. The factory wiring does not have to be removed to do this. The terminal blocks separate from the module at the board surface as shown in Figure 7-1.
5. Remove the four (4) machine screws from the base of the electronic module. The module can now be removed from the control panel.
6. Replacement module: 47D1O
7. Install a new module and reinstall all terminal blocks. Make sure that all factory and field wiring is in place.
8. Re-install metal barrier across the center of the module.
9. Set all dip switches and potentiometers according to previous instructions.

Operation Instructions

PANEL OPERATION

With sensors wired to control panel and power applied, the normal light (yellow) should be lit. Individual warning lights (amber) are provided for each channel. If a sensor detects a fault condition, the normal light will de-energize. The appropriate warning light will then energize and the bell will ring. To silence the bell, push the **SILENCE** Push button. The **WARNING** light will remain lit until the fault condition is cleared. If a second fault occurs before the first fault is cleared, the appropriate **WARNING** light will energize and the bell will again ring. Each successive fault will cause the bell to ring.

A **TEST** button is supplied to test the circuitry in the panel. To perform a test, push the **TEST** Push button and hold. The **NORMAL** light will go off. All WARNING lights in that bank will light and the bell will ring. Releasing the **TEST** Push button will return the system to a normal condition.

All panels contain a master fault contact which will activate if any one of the channels sees a fault condition. This can be used to trigger a remote alarm or cash register. The master fault contact will reset when the **SILENCE** Push button is pressed.

If optional auxiliary contacts are used, a SPDT dry contact is provided for each channel. To reset these contacts, the fault condition must be cleared.

FUEL/WATER PUSH BUTTON OPERATION

If the audible alarm is energized, it can be silenced by momentarily depressing the SILENCE Push button. However, to determine if there is a FUEL or WATER leak, continue with the following instructions.

1. **WATER PUSH BUTTON: (When audible alarm is already silenced).** Momentarily depress the WATER Push button. If, after release of the button the audible alarm energizes, this indicates a water leak. The audible alarm can be silenced again by depressing the **SILENCE** Push button. If pushing the water button has no effect, continue to step 2 (FUEL PUSH BUTTON).
2. **FUEL PUSH BUTTON: (When audible alarm is already silenced).** Momentarily depress the FUEL Push button. If after release of the button the audible alarm energizes, this indicates a fuel leak. The audible alarm can be silenced again by depressing the SILENCE Push button.

TROUBLESHOOTING GUIDE:

A test button is used on all models to test the control panel. If the system is powered up and there are no fault conditions, the normal light should be lit. The warning lights and bell should be de-energized. On pushing the test button, the normal light should go off, all warning lights in that bank should light up and the bell should ring. Push the silence Push button to de-energize the bell. Releasing the test push button should return the system to a normal condition.

If a **WARNING** light has been activated and a true fault condition is not found:

1. Re-check position of dip switch (Figure 4-1, Table 4-1). If correct, continue.
2. If the dip switch is in the Inverse Mode (on) position, removing the sensor wiring at the terminal block should deactivate the alarm. Shorting the terminal points should activate the alarm. If this does not happen, replace the electronic module.
3. If the dip switch is in the Direct Mode (off) position, removing the sensor wiring at the terminal block should activate the alarm. Shorting the terminal points should de-activate the alarm. If this does not happen, replace the electronic module.
4. If the above tests show the operation of the module is correct and an alarm condition persists, repeat steps 2 and 3 at all field terminal locations. This should isolate the problem to the appropriate area (field wiring, sensor). Replace or repair appropriate equipment.

Sample Wiring Diagram

DMS-474-A-2

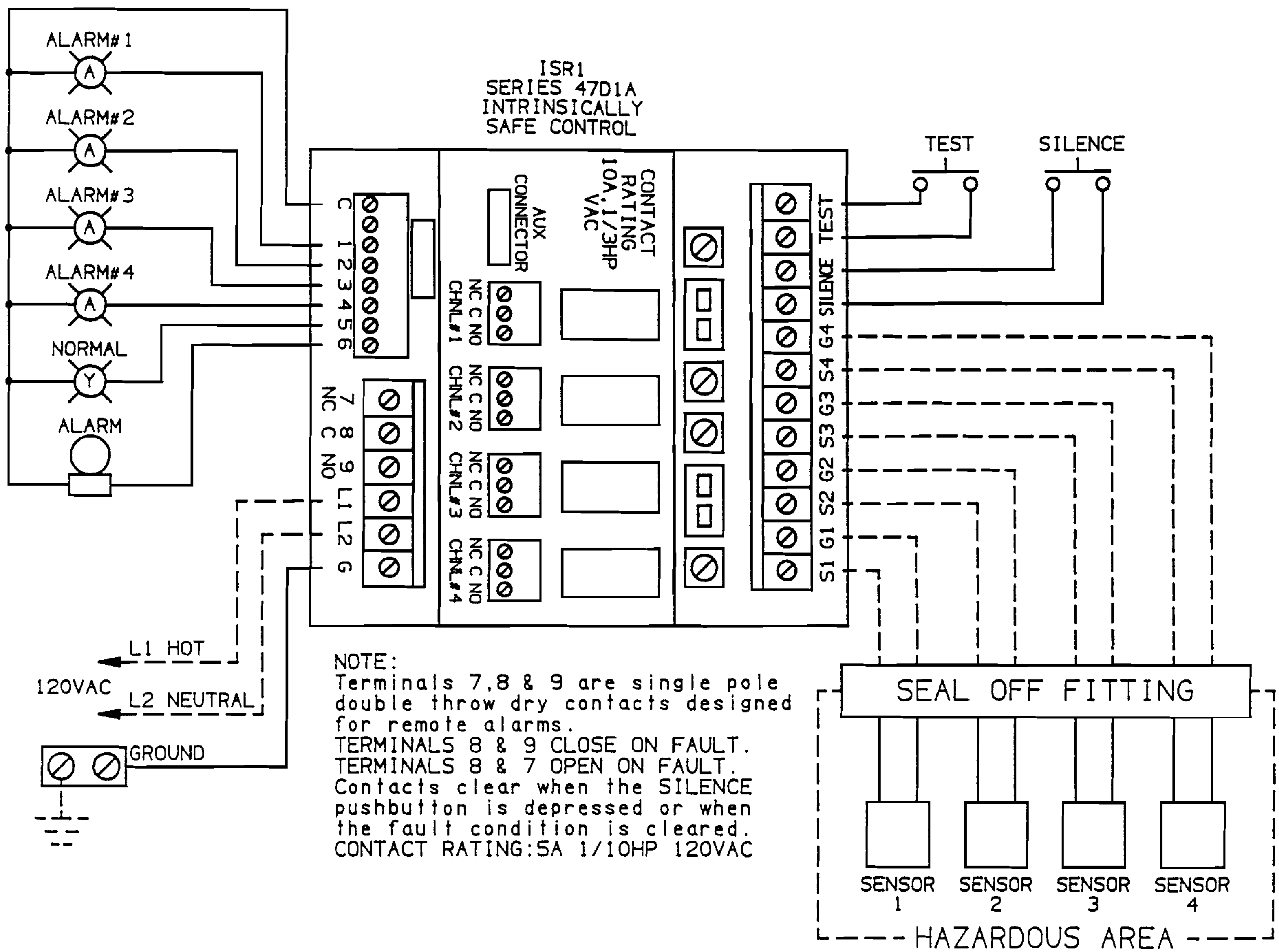


Figure 9-1

Sample Wiring Diagram

DMS-478-A-1

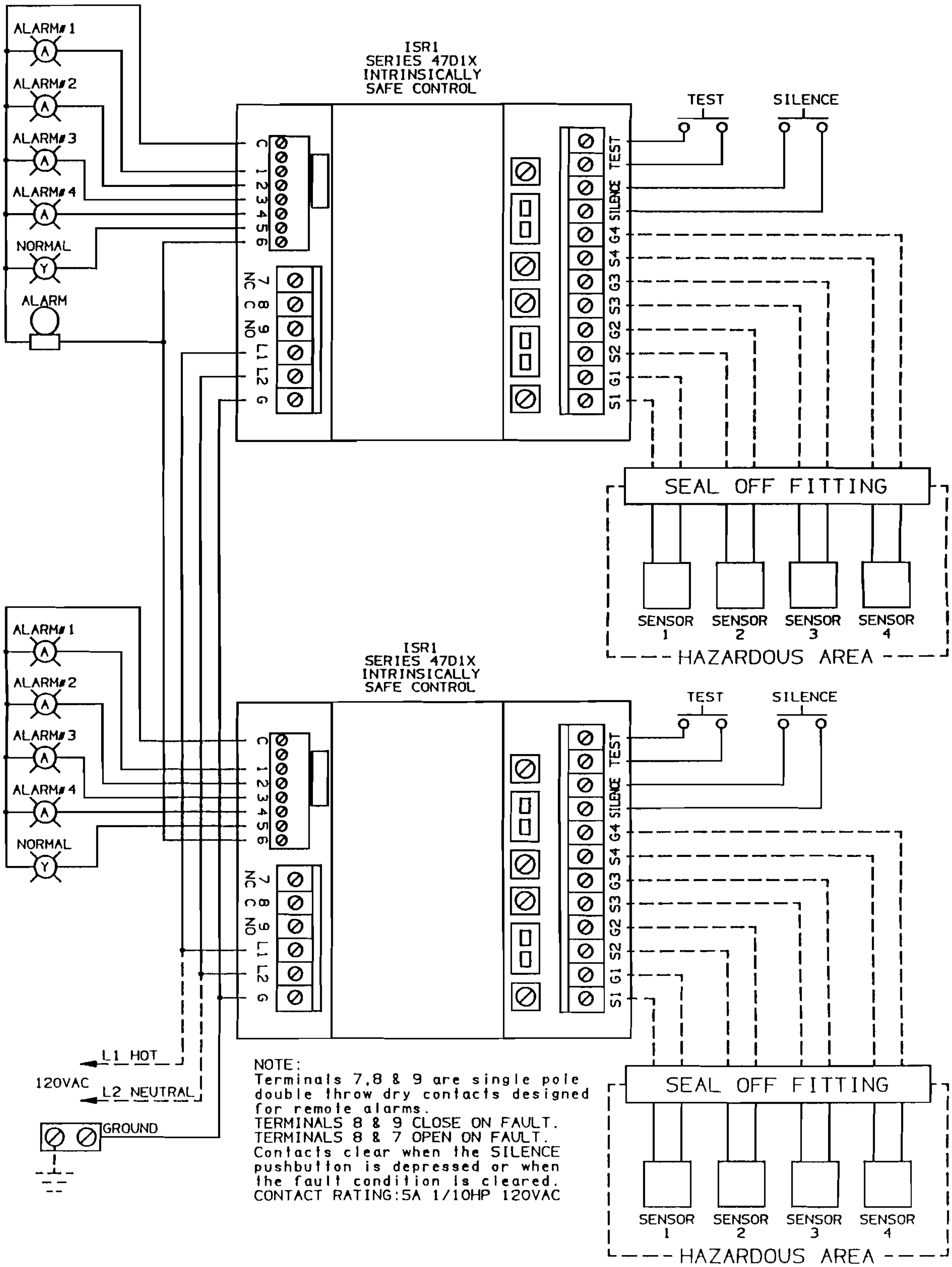


Figure 10-1

Panel Dimensions

DMS-474-A

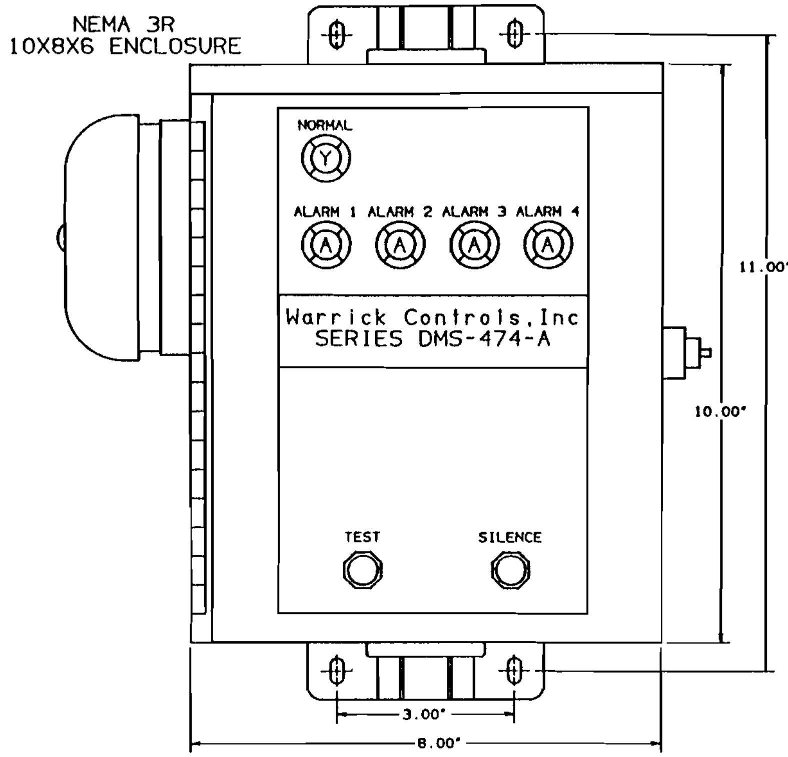


Figure 11-1

DMS-478-A

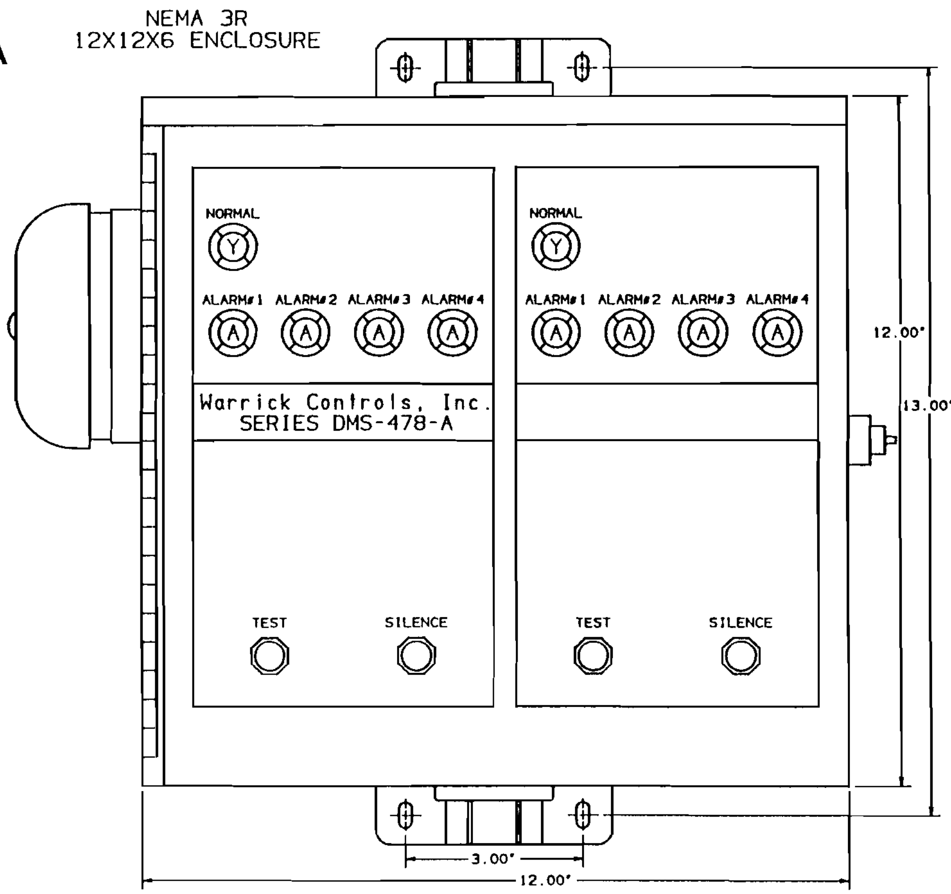


Figure 11-2

NOTES

WARRICK CONTROLS
WARRICK CONTROLS, INC.
4237 NORMANDY COURT
ROYAL OAK, MI 48073
Telephone: (313) 545-2512
FAX: (313) 549-4904

When Control is Absolutely Essential

Level Measurement System and Leak Detection

Model 672L/699L Continuous Level Measurement System

LEVEL

Data Sheet 672L/1092
Supersedes 672L/592

CSA and FM approvals pending

μP Menu-Driven System Simplifies Operation

FEATURES

- Thirty-two point tank strapping table for linearizing measured level in any shaped vessel
- Time saving built-in linearization tables for common vessel shapes and open channel flumes/weirs
- Displays level in % or any desired measurement units
- Simple, remote calibration
- Measures and controls levels of liquids and granulars or interface levels
- Optional level/volume outputs (three) - direct or reverse acting with selectable damping
- Three fully-programmable relays
- Optional PID controller
- Optional bidirectional digital communication output for system networking capability

Introduction

This advanced, microprocessor-based level measurement and control system consists of an RF level transmitter (Model 699L) and a receiver/controller (Model 672L). The system can be used with any GLI continuous level measuring probe to meet your specific application requirements. The 699L uses advanced anti-coating circuitry to significantly reduce the error effect of conductive material buildup on the surface of the level probe.

This transmitter is calibrated remotely. No adjustments are required at the 699L. Calibration is performed through simple keypad entry, using the 672L receiver/controller or a portable computer. The level signal from the 699L two-wire transmitter is an ASCII-coded digital signal, transmitted on a 20 mA current loop via common two-conductor shielded cable.

Comprehensive Readouts

The large, four-digit LCD readout of the 672L can indicate measured level as %, height, volume, weight or flow. The readout can be configured to display 0.0-100.0% or 0-9999 with measurement unit annunciators for gallons, liters, pounds, kilograms, feet, inches, meters and millimeters. The decimal point of the readout may be set at any position or omitted. Selectable multiplier annunciators of "x100" and "x1000" accommodate large measured values.

Concise, understandable messages prompt the operator when calibrating and configuring the system. During operation, status annunciators keep the operator informed of the system's operating state. Preprogrammed diagnostic messages flash automatically whenever system operating problems are detected.

SCHOTT GREAT LAKES INSTRUMENTS

Menu-Driven Operation

The system is simple to operate. The watertight keypad on the enclosure door of the 672L is used to configure and calibrate the system and to display measurement data. When the EXAM/CANCEL key is pressed while the display is in the measurement mode, the readout changes to an "examination" mode to show setup variables and their stored values. The NEXT key is used to call up desired setup variables. The ⬆ and ⬇ keys change the displayed value to a new value. Pressing ENTER stores the displayed value in memory. A press of the EXAM/CANCEL key returns the display to the normal measurement mode without changing the stored value.

The non-volatile memory stores all user-entered values (calibration data, relay setpoints, etc.) indefinitely, even if power is lost or turned off. Battery backup is not required.

A security lock feature prevents unauthorized tampering of stored configuration values. For operator convenience, all stored and measured data may be displayed while keypad entry is locked. Special codes lock and unlock stored values.

Built-In Linearization Tables

Regardless of the geometry of the vessel, the 672L/699L system can provide accurate, linearized level measurement and control. Included in the system software are convenient, built-in linearization tables to linearize the measured level in:

- Horizontal cylindrical vessels with flat ends
- Spherical vessels
- Open channel flumes
- Open channel weirs

Each built-in linearization table will also convert % level so that it can be directly displayed (in desired measurement units) as height, volume, weight, or flow in an open channel.

For any vessel geometry that cannot be handled by one of the built-in tables, the operator can create a user-defined table to linearize the measured level in desired measurement units. Up to 32 data points can be entered via the keypad to define the vessel level in % and in corresponding measurement unit values. This data can be determined by calculation or obtained from a known tank strapping table provided by the vessel manufacturer.

Level/Volume Outputs (Optional)

Analog output signals (0-5 VDC, 0-1 mA and 4-20 mA) are available to integrate the 672L/699L system into a larger control system. These signals track the measured level in % or in the measurement units established with one of the linearization tables. These outputs can represent the entire measuring scale or a desired segment of it and can be configured for direct or reverse-acting control. To facilitate setup and checkout of connected external devices such as recorders and remote indicators, the 4-20 mA output signal can be displayed. Also, simulated output values can be entered to exercise the device(s).

Flexible Relay Control

The 672L receiver/controller is equipped with three fully programmable relays. The configuration flexibility for these relays meets virtually any on/off level control or alarm application requirement in a single instrument. A setpoint, deadband range and response time delay can be assigned to each relay for control or alarm. Also, the relays can be independently configured via slide switch settings to operate in a direct or reverse acting mode. In the direct acting mode, the relay is not energized when the measured level is below the setpoint ("low level fail safe"). In the reverse acting mode, the relay is energized below the setpoint ("high level fail safe").

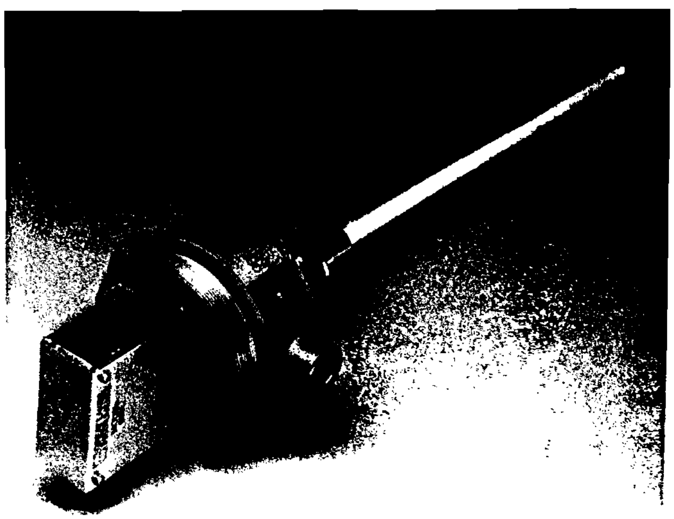
Lastly, one relay can be programmed to function as a "system diagnostic alarm" to alert the operator of improper system operation or power failure. This alarm mode setup overrides the relay's normal operation.

PID Control (Optional)

For applications that require level (or volume) to be controlled to a constant value, a full-range PID controller with 4-20 mA output is available. The controller operates automatically to maintain the desired setpoint value. It can also be placed in a manual mode to adjust the output manually. For convenience, the automatic or manual controller output can be displayed in % on the LCD readout. When returned to automatic operation, the controller output transfer is bumpless.

Digital Communication Output (Optional)

The optional digital communication output links 672L/699L systems in multi-vessel applications and/or



Model 699L Transmitter (shown with cover removed and integrally mounted onto level probe)

can be used to integrate a computer, programmable logic controller, etc. The network can include up to 99 vessels with each being assigned an identifying number. Data from any vessel can then be called up by any computer in the network.

The digital communication output is a serial output, selectable for RS 485 or 20 mA loop. To characterize the signal for system network requirements, baud rate settings (from 300 to 9600) and parity selections are provided.

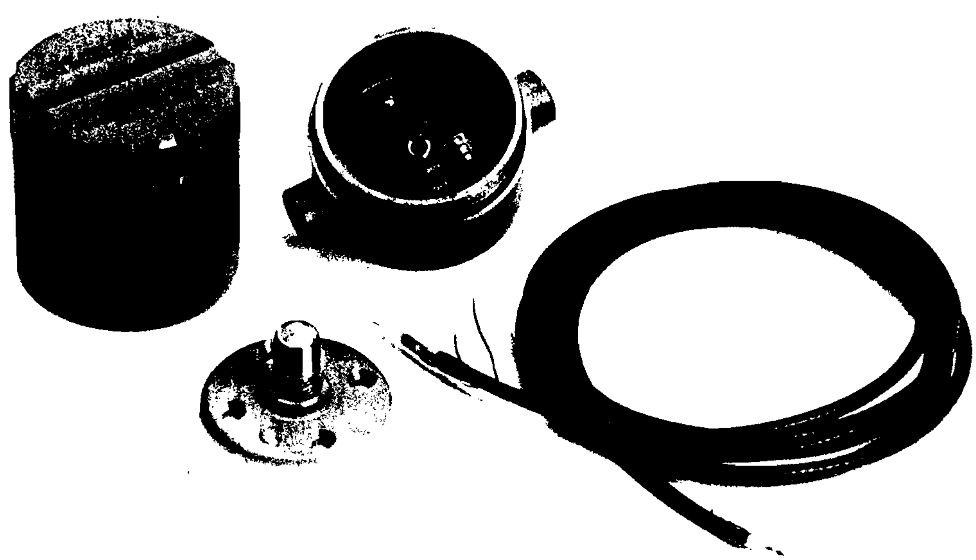
Versatile System Installation

The Model 699L transmitter is housed in a cast aluminum enclosure to meet NEMA 4, 7 and 9 criteria for weatherproof, hosedown, and dust and vapor explosionproof requirements. Certification options are available for this transmitter by FM or CSA as an explosionproof system when used with an insulated type GLI Model 4000L, 4100L, 4200L or 4500L series level probe. This transmitter may be used in Class I and II, Div. 1 hazardous areas.

The 699L is normally mounted directly onto the level probe (integral mounting as pictured on page 2) but can also be mounted remotely up to 50 feet from the level probe. The transmitter requires three accessories for remote mounting:

- A threaded adapter (p/n 1000-3071) that screws into the bottom of the enclosure to surface mount the transmitter in the remote location.
- An explosionproof junction box (p/n 1000-3072) which mounts onto the level probe in place of the transmitter. It has a jack and terminal strip to accommodate electrical connection of the level probe to the transmitter.
- A triaxial interconnect cable of specified length (up to 50 feet) to electrically connect the level probe to the transmitter. Use p/n 1000-3073 where temperatures at the level probe do not exceed 160°F; use p/n 1000-3074 for temperatures up to 392°F. The cable is appropriately terminated at each end.

The Model 672L receiver/controller is housed in a compact NEMA 4X, plastic enclosure which conforms to 1/2 DIN size standards for panel mounting. CSA certification for general purpose use plus use in Class I or II, Div. 2 hazardous areas is available as an option for the 672L. FM certification for general purpose use is also available. The 672L has a corrosion-resistant case with a hinged door which can be opened or easily removed to facilitate installation and servicing. Four thumbscrew-type captive fasteners provide quick access. Two stainless steel brackets are included for surface, panel or horizontal pipe mounting. Optional hardware for vertical pipe mounting is available.



Model 699L Transmitter Remote Mount Accessories (foreground — threaded adapter and triaxial interconnect cable; background — explosionproof junction box with cover removed)

SYSTEM SPECIFICATIONS▲

Operational:

Measuring Range:
- Model 699L .... Zero: 10 to 1000 pF   Span: 10 to 10,000 pF
- Model 672L .... 0.0-100.0% or 0-9999 gallons, liters, pounds, kilograms, feet, inches, meters or millimeters with selectable "x100" or "x1000" multiplier annunciator

Display (Model 672L) .... 4 digit LCD with measurement unit and setup variable identifiers and movable decimal point, 7/8" high digits

Ambient Conditions:
- Model 699L .... -40 to +70°C (-40 to +162°F), 0 to 95% relative humidity, non-condensing
- Model 672L .... -40 to +50°C (-40 to +122°F), 0 to 95% relative humidity, non-condensing

Power Requirements:
- Model 699L .... Powered by Model 672L 20 mA current loop
- Model 672L .... 97.5-137.5 VAC, 50/60 Hz (12 VA max.); 195-275 VAC, 50/60 Hz available

Level Probe-to-Transmitter Distance .... 50 feet maximum (when Model 699L is remote mounted)

Transmitter-to-Receiver Distance .... 1000 feet maximum

Relay Function (Model 672L):
- Setpoints .... Adjustable from 0.0-100.0% of measuring scale
- Deadbands .... Adjustable from 0.1-100.0% of measuring scale
- Response Time .... Adjustable from 0.0-100.0 seconds
- Indicators .... Relay A, B or C annunciator flashes on and off whenever respective relay deenergizes
- Outputs .... Three SPDT contact outputs, U.L. rating: 5A 115/230 VAC, 5A @ 30 VDC resistive

NOTE: *Relays can be independently selected to operate on increasing or decreasing measured level. Also, Relay C can be alternately selected to operate as a "system diagnostic alarm" relay which deenergizes whenever the 672L detects a system diagnostic error or power failure. This mode overrides the normal operation of Relay C.*

Level/Volume Output (optional) .... Three isolated* analog signals:
- 0-5 VDC, 1000 ohms minimum load
- 0-1 mADC, 200 ohms maximum load
- 4-20 mADC, 600 ohms maximum load

* Each output is isolated from the input, ground, the optional PID controller output and line power, but not from each other.

NOTE: *The analog outputs can be set to represent a 10% or larger segment of the measuring scale.*

PID Controller Output (optional) .... One isolated 4-20 mADC signal, 600 ohms maximum load

Hazardous Area Certification (optional):
- Explosionproof for Model 699L (approvals pending) .... FM: Class I, Div. 1, Groups A, B, C and D; Class II, Div. 1, Groups E, F and G. CSA: Class I, Div. 1, Groups B, C and D; Class II, Div. 1, Groups E, F and G
- Division 2 for Model 672L (approval pending) .... CSA: Classes I and II, all groups
- General Purpose for Model 672L (approvals pending) ...... FM and CSA

Performance:

- Sensitivity .... 0.1 pF
- Stability .... 0.1% of span per 24 hrs., non-cumulative
- Linearity .... ±0.2% for spans below 1000 pF inclusive; ±0.5% for spans above 1000 pF
- Temperature Drift .... Greater of ±0.03 pF/°C or ±0.03% of span/°C with Model 699L temperature change
- Repeatability .... ±1 least significant bit (LSB)
- Response Time .... 0.1 second minimum
- Damping .... Adjustable to 100 seconds (first-order time constant)

Mechanical:

Enclosure:
- Model 699L .... NEMA 4, 7 and 9, cast aluminum w/urethane finish — weatherproof, hosedown, dust and vapor explosionproof
- Model 672L .... NEMA 4X, 1/2 DIN, polycarbonate with two 1/2 inch conduit holes and two stainless steel mounting brackets

Mounting Configurations:
- Model 699L .... Integral Mounting – 1/2-inch NPT hole in bottom center of enclosure for direct mounting onto level probe.
  Remote Mounting – Requires triaxial cable, probe-mounted explosionproof junction box and remote mount threaded adapter.
- Model 672L .... Surface, panel and horizontal pipe mount. Vertical pipe mounting optional.

Net Weight .... 3.4 lbs. (1.5 kg) approx. for each unit (Models 672L and 699L)

▲Subject to change without notice.

ORDERING INFORMATION

MODEL NUMBER
672L1: Microprocessor-based receiver/controller in NEMA 4X, 1/2 DIN enclosure w/stainless steel brackets for panel, surface or pipe mounting. Includes three relays with programmable operating modes.

OUTPUTS
- **A** None
- **B** One set of level/volume analog outputs (isolated 0-5 VDC, 0-1 mA and 4-20 mA)
- **C** PID controller output (4-20 mA)
- **D** Same as option "B" plus PID controller output

LINE VOLTAGE
- **1** 115 volts, 50/60 Hz. (single-fused)
- **2** 230 volts, 50/60 Hz. (single-fused)
- **6** 230 volts, 50/60 Hz. (dual-fused)

DIGITAL COMMUNCATION OUTPUT
A0 None **A1** RS 485/20 mA loop serial output

N Standard Instrument **K** Special Instrument

AGENCY CERTIFICATION
- **Blank** No Approval
- **FM** FM Approved (for general purpose use)
- **CSA** CSA Certified (for general purpose use plus Div.2)

672L1 A 1 A0 N – ☐ **Product Number**

Choose one from each category.

MODEL NUMBER
699L0R5: Microprocessor-based transmitter for continuous level measurement using two-way digital communication with 672L receiver/controller over common two-conductor shielded cable. Mounts directly onto level probe or can be remote mounted using accessories listed below.

RESERVED CATEGORIES

N Standard Instrument **K** Special Instrument

AGENCY CERTIFICATION
- **Blank** No Approval
- **FM** FM Approved (for explosionproof, Groups A through G)
- **CSA** CSA Certified (for explosionproof, Groups B through G)

699L0R5 A0 N – ☐ **Product Number**

Choose one from each category.

FM and CSA Certification Usage Guide for Model 699L

GLI Level Probes			
Models 4000L, 4100L, 4200L and 4500L		Model 4300L	
Insulated	Bare	Insulated	Bare
Class I & II, Div. 1	Safe areas only	Class I & II, Div. 1 (Note 1)	Safe areas only

NOTES: 1. The combination of a Model 699L in an aluminum explosionproof enclosure and an insulated Model 4300L-series flexible level probe is available for certification by CSA only.

Model 699L Remote Mount Accessories (order separately):
- 1000-3071 Threaded Adapter
- 1000-3072 Explosionproof J-Box (w/jack and terminals)
- 1000-3073 Triaxial Interconnect Cable‡ (for up to 160°F)
- 1000-3074 Triaxial Interconnect Cable‡ (for up to 392°F)

‡ Cable is appropriately terminated at each end. Specify length up to 50 feet.

— Level Probes —
The Model 699L transmitter can be used with level probes described on data sheets 4000L, 4100L, 4200L, 4300L and 4500L.

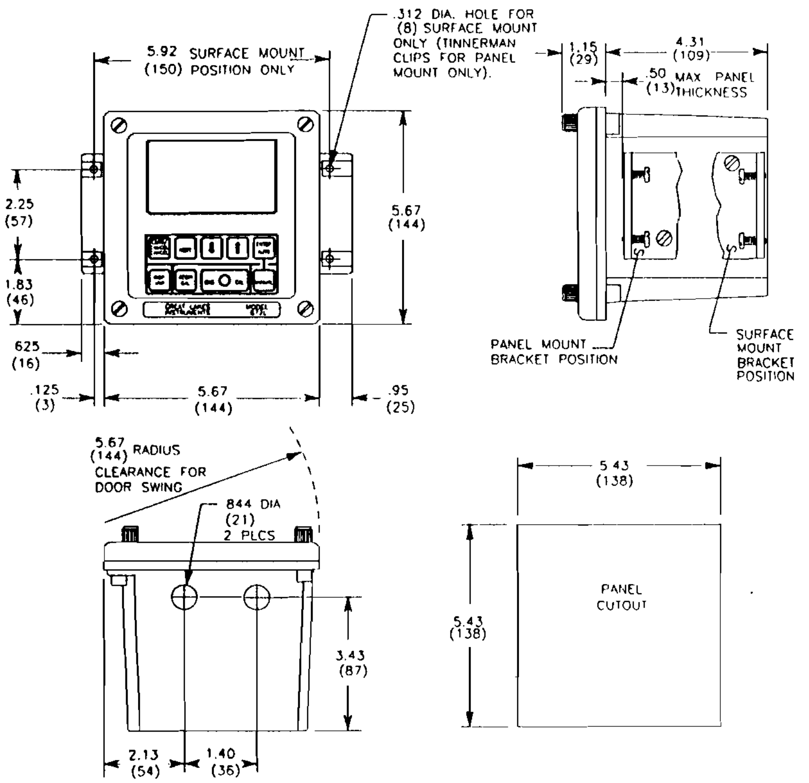
— Signal Transmission Cable —
99X1W0980 Two-conductor plus shield cable for wire runs between the 699L and 672L. Specify required length in feet.

(30 FT)

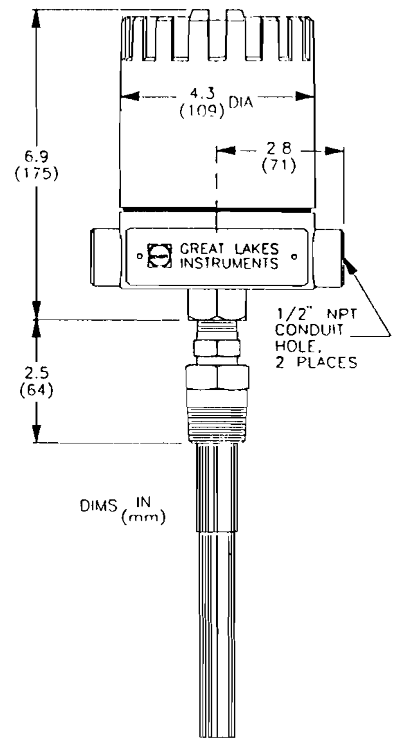
DIMENSIONS AND MOUNTING

Inches (mm)

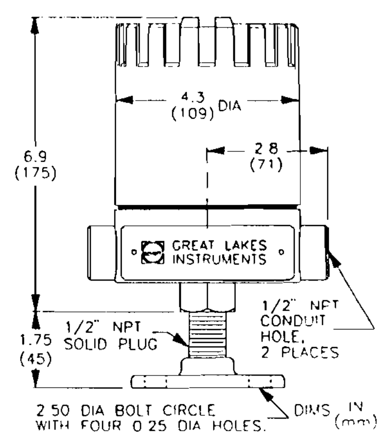
— Model 672L Receiver/Controller —



— Model 699L Transmitter —



Integral Mounting Onto Level Probe



Remote Mounting With Threaded Adapter

— 1001-3072 Explosionproof Junction Box —

Pictured on page 3 and dimensionally identical to outline shown on this page at bottom right.

Represented By:

Great Lakes Instruments, Inc.
8855 N. 55th Street
Milwaukee, WI 53223

Telephone (414) 355-3601
Telefax (414) 355-8346

GREAT LAKES INSTRUMENTS

A Schott Group Company

General Purpose Level Sensing Elements

LEVEL

Data Sheet 4000L/1192
Supersedes 4000L/692

FEATURES

- Bare and insulated types
- Stainless and Teflon® construction — other materials available
- Custom extruded insulation minimizes air encapsulation and capacitance variation
- Captive sensing element for safe operation in pressurized vessels
- Optional flange mounting

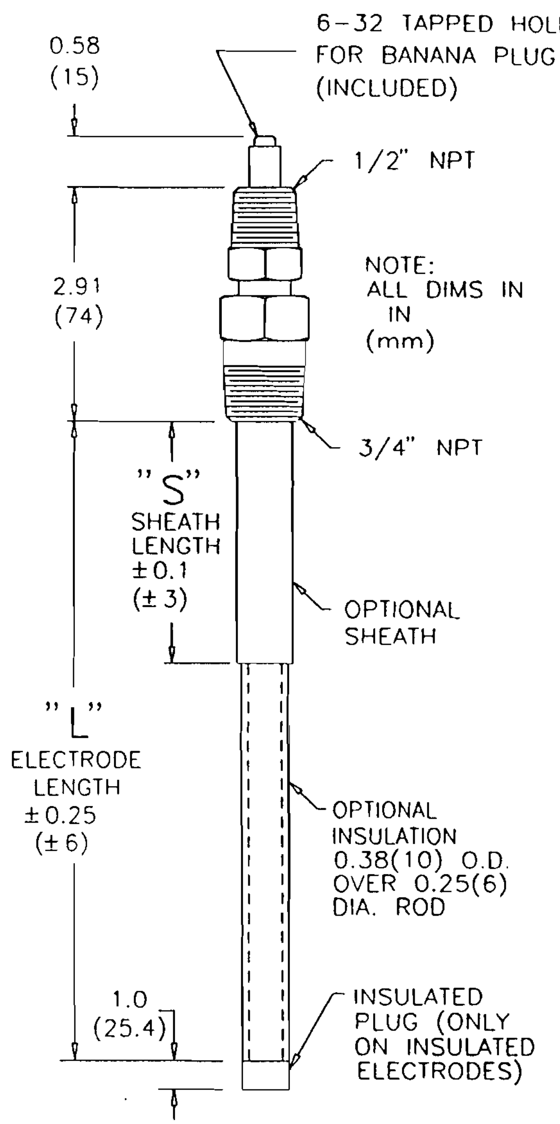
Description:

Model 4000L-series general purpose level sensing elements are used with RF, Capacitance and Admittance type point level switches and continuous level transmitters. They are universally used in general purpose applications in liquid and granular materials. Where agency certification for an explosionproof system is required, this probe must be insulated. The Model 4000L-series is not recommended for use in materials which tend to form a conductive film on the electrode surface. For application information on RF level measurement in lined metal vessels with a grounded shell or in plastic vessels, refer to GLI Application Notes No. L1 and L2 respectively.

The sensing element is held captive in the entrance gland to prevent it from becoming a possible projectile when used in a pressurized vessel.

Wetted parts of 316 stainless steel and TFE Teflon® are standard. Other materials are available. Optional extruded insulation ensures a snug fit on the sensing electrode minimizing air encapsulation and variation in capacitance.

Options include various flange mountings, sheathed (inactive) sections for sensing elements mounted in nozzles or pipe extensions, grounding via a spiral-wrapped wire or solid rod, gland cooling extensions and custom bending per specification.



Probes with agency certification option have longer glands (2.91" increases to 3.6").

Sensing Element Shown With Optional Insulation

SPECIFICATIONS*

Wetted Materials	316 SS and TFE Teflon®, PVDF (Kynar®) or polyethylene — other materials available
Max. Temperature	TFE Teflon®: 450°F PVDF (Kynar®): 250°F Polyethylene: 160°F
Max. Pressure	TFE Teflon®: 1000 psig @ 150°F, derated to 0 psig @ 350°F PVDF (Kynar®): 1000 psig @ 100°F, derated to 0 psig @ 250°F
Max. Pressure (Cont.)	Polyethylene: 1000 psig @ 80°F, derated to 0 psig @ 140°F
Gland Capacitance	25 pF (for TFE Teflon®)
Max. Standard Length	10 ft. — consult factory for longer lengths
Electrode Diameter	Bare: 1/4"; Insulated: 3/8"

GREAT LAKES INSTRUMENTS

ORDERING INFORMATION

MODEL NUMBER

40	General purpose bare and insulated level sensing elements which consist of a 1/4 inch diameter electrode. When insulated, overall diameter is 3/8 inch.

WETTED METAL PARTS MATERIAL

0	316 stainless steel	2	Monel
1	Hastelloy C	9	Special

NOTE - Electrode material for an insulated level element is 316 stainless steel unless otherwise specified.

INSULATION MATERIAL (See Note 1)

0L	None	2L	PVDF (Kynar®)
1L	TFE Teflon®	3L	Polyethylene

ELECTRODE BASIC LENGTH (See Notes 2 and 3)

0	0 to less than 1 foot	3	3 to less than 6 feet
1	1 to less than 2 feet	4	6 to less than 12 feet
2	2 to less than 3 feet	5	Over 12 feet (consult factory)

FLANGE OPTION (150 lb. raised face – See Note 4)

A	None	F	PVDF faced, 316 SS backed
B	316 stainless steel	G	PVDF faced, forged steel backed
C	Forged steel	K	Special

FLANGE SIZE

0	None	3	2 inch	6	6 inch
1	1 inch	4	3 inch		
2	1-1/2 inch	5	4 inch		

SHEATH/GROUND WIRE OR ROD OPTION

A	None	E	Tantalum (Ground Wire)
B	Sheath req'd (See Note 5)	F	Monel (Ground Wire)
C	Hastelloy C (Ground Wire)	H	Hastelloy C (Ground Rod (only with flange option))
D	Stainless Steel (Ground Wire)	J	Stainless Steel (Ground Rod (only with flange option))

BENDING OPTION

0	None
1	Bend required (specify)

N	Standard
K	Special (LENGTH) 168"
W	Gland welded to flange (See Note 4)

AGENCY CERTIFICATION (See Note 1)

Blank	No approval
FM	FM Approved
CSA	CSA Certified

40	0	0L	5	A	0	D	0	K	–		Product Number

Choose one from each category.

Ordering Notes:

1. Agency-certified probes for explosionproof systems must be insulated.
2. Select number in "Electrode Basic Length" category which corresponds with the range containing the required probe length.
3. Specify exact electrode insertion length in inches (dimension "L" on front page drawing).
4. Specify plastic-faced flange material to be the same as the insulation material. Plastic-faced flanges include gland welded to flange.
5. If optional sheath is required, specify sheath length in inches (dimension "S").

Teflon® is a DuPont Co. Trademark
Kynar® is a Pennwalt Corp. Trademark

Represented By:

Great Lakes Instruments, Inc.
8855 N. 55th Street
Milwaukee, WI 53223

Telephone (414) 355-3601
Telefax (414) 355-8346
Telex 26-9685

GREAT LAKES INSTRUMENTS

A Schott Group Company

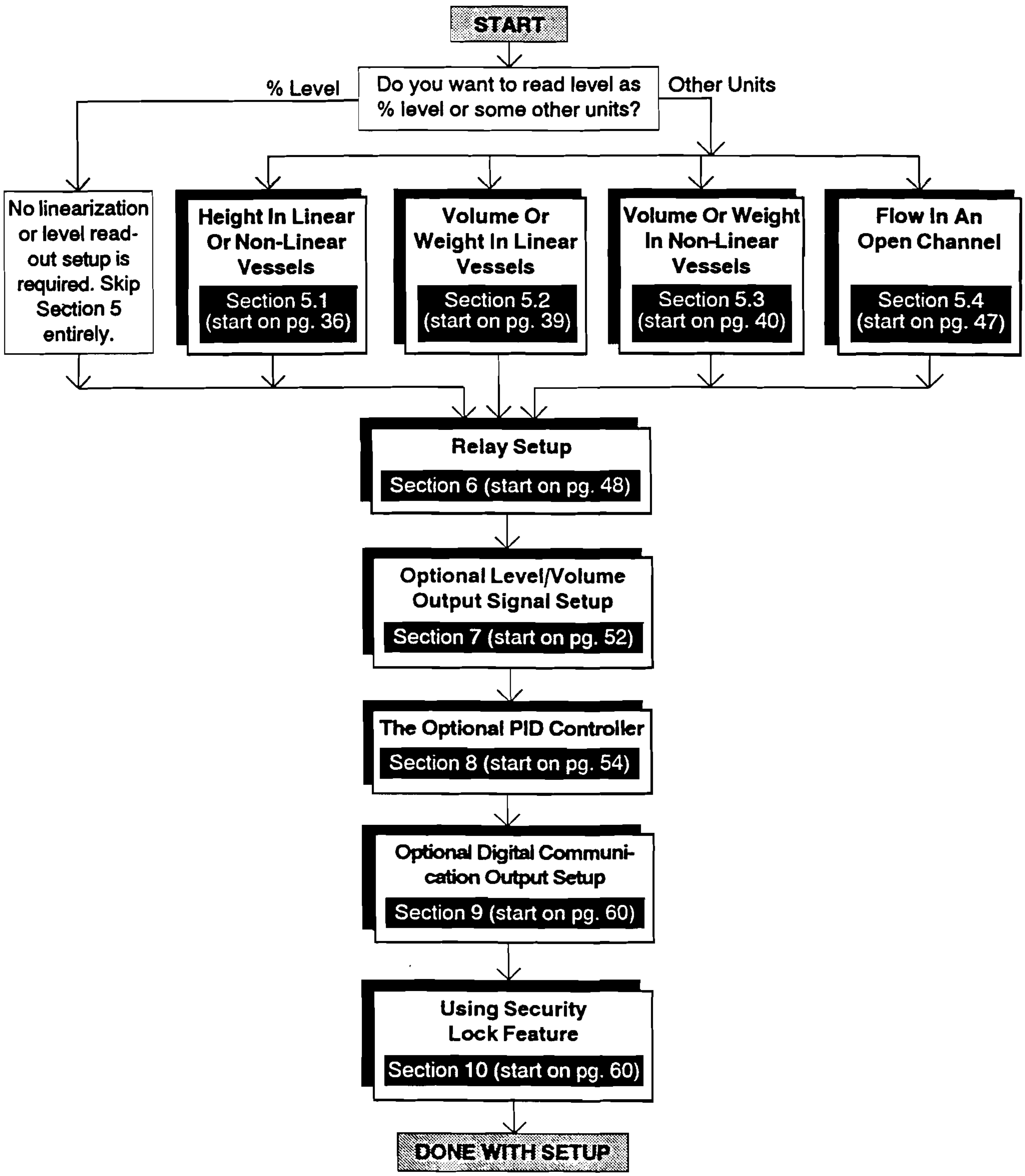
Data Sheet 4000L/Printed in U.S.A.

Manual No. 672L/699L
Rev. 0-1191

MODEL 672L/699L
LEVEL MEASUREMENT
SYSTEM

INSTRUMENT SETUP GUIDE

This manual contains detailed instructions for all operating aspects of this system. Read Part One for a general description of the Model 672L/699L system. Part Two explains how to install and wire the system. To familiarize yourself with basic operation, read Part Three, Sections 1, 2 and 3. Then calibrate the system using the instructions in Section 4. The following guide shows which Section 5 subsections to use for setup to linearize the level for the vessel shape and to read level in desired measurement units. Sections 6 through 10 in Part Three apply to other operating functions depending on equipped options.



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PART ONE - INTRODUCTION

PART TWO - INSTALLATION

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PART THREE - OPERATION

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

PART ONE - INTRODUCTION

SECTION 1 - GENERAL INFORMATION

This system manual describes the operation of the Model 672L receiver/controller when used with a Model 699L RF level transmitter and GLI level probe combination.

1.1 System Description

The 672L/699L level measurement and control system consists of three components:

- A GLI level sensing probe
- Model 699L RF level transmitter (integrally mounted onto level probe or remotely mounted)
- Model 672L microprocessor-based receiver/controller

The measurement signal from the 699L transmitter/level probe is an ASCII-coded digital signal transmitted over two wires. The transmitter is powered by the 672L receiver/controller over the same two wires.

1.2 System Capability

Display Readouts

The large, four-digit LCD readout can indicate measured level as %, height, volume, weight or flow. The readout can be set up to display 0.0-100.0% or 0-9999 with measurement unit annunciators for gallons, liters, pounds, kilograms, feet, inches, meters or millimeters. The decimal point of the readout can be turned off or set at any position. To accommodate large measured values, a "x100" or "x1000" multiplier annunciator can be selected.

Linearization Tables

Built-in linearization tables are provided to conveniently linearize the measured level in horizontal cylindrical vessels with flat ends, spherical vessels, and open channel flumes and weirs. These tables will also convert % level so that it can be directly displayed (in desired measurement units) as height, volume, weight, or flow in an open channel. For any other vessel geometry, the operator can create a user-defined table to linearize the measured level in desired measurement units. Up to 32 data points can be entered via the keypad to define the vessel level in % and in the corresponding measurement unit values. This data can be determined by calculation or obtained from a known tank strapping table provided by the vessel manufacturer.

Optional Outputs

The 672L receiver/controller may provide up to three different optional outputs for transmission to remote receivers, indicators, digital process controllers, mainframe or personal computers, programmable logic controllers, etc. They are:

- LEVEL/VOLUME OUTPUTS (Output A) – These analog outputs track the measured level in % or in the measurement units established with one of the linearization tables. The outputs are 0-5 VDC, 0-1 mA and 4-20 mA. These outputs can represent the entire measuring scale or a desired segment of it.
- PID OUTPUT (Output B) – This 4-20 mA controller output signal is used to regulate a fully modulating valve or pump to control level or volume to a desired setpoint.
- Digital Communication Output – This serial output is user-selectable for RS-485 or 20 mA loop. Tank number, baud rate and parity selections characterize the signal for system network requirements. Refer to SUPPLEMENTAL MANUAL No. 123 for complete details.

Relay Functions

The 672L receiver/controller has three SPDT relays to handle on/off control requirements. Relays A, B and C can be selected to track the measured level in % or in the measurement units established with one of the linearization tables. Relay C can be alternately selected to operate as a "system diagnostic alarm" relay instead of its normal operation. This enables Relay C to deenergize whenever a system diagnostic error or power failure is detected by the 672L to alert the operator.

Each relay has independent setpoint, deadband and response time settings. The response setting establishes a time delay, in seconds, that a trip condition must exist before the relay actually transfers. The time delay resets whenever the trip condition is alleviated. Each relay can be independently set up to operate in response to increasing or decreasing measured level.

Operator Interface

Abbreviated identifiers are shown along with their related numerical values to provide understandable readouts for system setup, calibration and level monitoring. Procedure messages prompt the operator during system setup and calibration. Diagnostic error messages flash whenever the system detects an abnormal condition.

Non-Volatile Memory

All user-entered values (calibration data, relay setpoints, etc.) are retained indefinitely, even if power is lost or turned off. The non-volatile memory does not require battery back-up.

Operator Safety

Modular construction simplifies field servicing and provides electrical safety for the operator. The LCD board assembly of the 672L (Figure 3-1) contains voltages no greater than 24 VDC and is safe to handle. The display board 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 POWER-SUPPLY BOARD TO AVOID ELECTRICAL SHOCK.

1.3 Product Identification

Model 672L Receiver/ Controller

The serial # of your Model 672L is located on the backside of the LCD board assembly. The matrix below lists all of the instrument options. Use it as a handy reference when re-ordering. Write the serial # in the space provided below the matrix for convenient identification should technical assistance be required.

Model 699L Transmitter

The serial # of your Model 699L is located on the electronic chassis above the TB1 terminals. Write the serial # in the space provided below the matrix.

MODEL NUMBER

672L1 Microprocessor-based receiver/controller in NEMA 4X, 1/2 DIN enclosure with stainless steel brackets for panel, surface or pipe mounting. Includes three relays with programmable operating modes.

LEVEL/VOLUME OUTPUT A (tracks measured value)
- **A** None
- **B** One set of analog outputs (isolated 0-5 VDC, 0-1 mA and 4-20 mA)

LINE VOLTAGE
- **1** 115 volts, 50/60 Hz. (single-fused)
- **2** 230 volts, 50/60 Hz. (single-fused)
- **6** 230 volts, 50/60 Hz. (dual-fused)

SUPPLEMENTARY OUTPUT B
- **A** None
- **B** PID controller output (isolated 4-20 mA)

DIGITAL COMMUNICATION OUTPUT
- **0** None
- **1** RS-485/20 mA loop serial output

- **N** Standard Instrument
- **K** Special Instrument

672L1 --- **Product Number**

Model 672L Serial # ____________________

Model 699L Serial # ____________________

SECTION 2 - SYSTEM SPECIFICATIONS

2.1 Operational

Measuring Range:
Model 699L.................. Zero: 10 to 1000 pF
Span: 10 to 10,000 pF

Model 672L.................. 0.0-100.0% or 0-9999 gallons, liters, pounds, kilograms, feet, inches, meters or millimeters with selectable "x100" or "x1000" multiplier annunciator

Display .... 4 digit LCD with measurement unit and setup variable identifiers and movable decimal point, 7/8" high digits

Ambient Conditions:
Model 699L.................. -40 to +70°C (-40 to +162°F), 0 to 95% relative humidity, non-condensing

Model 672L.................. -40 to +50°C (-40 to +122°F), 0 to 95% relative humidity, non-condensing

Power Requirements:
Model 699L.................. Powered by Model 672L 20 mA current loop

Model 672L.................. 97.5-137.5 VAC, 50/60 Hz (12 VA max.), 195-275 VAC, 50/60 Hz available

Level Probe-to-
Transmitter Distance....... 50 feet maximum (when Model 699L is remote mounted)

Transmitter-to-
Receiver Distance........... 1000 feet maximum (500 ft. max. with barriers for hazardous area wiring)

Relay Function (672L):

Setpoints...................... Adjustable from 0.0-100.0% of measuring scale

Deadbands.................. Adjustable from 0.1-100.0% of measuring scale

Response Time .... Adjustable from 0.0-100.0 seconds

Indicators..................... Relay A, B or C annunciator flashes on and off whenever respective relay deenergizes.

Outputs........................ Three SPDT contact outputs, U.L. rating: 5A 115/230 VAC, 5A @ 30 VDC resistive

NOTE: *Relays can be independently selected to operate on increasing or decreasing measured level. Also, Relay C can be alternately selected to operate as a "system diagnostic alarm" relay which deenergizes whenever the 672L detects a system diagnostic error or power failure. This mode overrides the normal operation of Relay C.*

Level/Volume Output....... Three isolated* analog signals:
(Model 672L option)
0-5 VDC, 1000 ohms minimum load
0-1 mADC, 200 ohms maximum load
4-20 mADC, 600 ohms maximum load

* Each output is isolated from the input, ground, the optional PID controller output and line power, but not from each other.

The analog outputs can be set to represent a 10% or larger segment of the measuring scale.

PID Controller Output (Model 672L option) ...... One isolated 4-20 mADC signal, 600 ohms maximum load

Digital Communication Output (Model 672L option) ...... RS-485/20 mA loop serial output

2.2 Performance

Sensitivity ...... 0.1 pF

Stability ...... 0.1% of span per 24 hrs., non-cumulative

Linearity ...... ±0.2% for spans below 1000 pF inclusive; ±0.5% for spans above 1000 pF

Temperature Drift ...... Greater of ±0.03 pF per °C or ±0.03% of span per °C with 699L temperature change

Repeatability ...... ±1 least significant bit (LSB)

Response Time ...... 0.1 second minimum

Damping ...... Adjustable to 100 seconds (exponential time constant)

2.3 Mechanical

Enclosure:

Model 699L ...... Standard: NEMA 4, 7 and 9, cast aluminum w/urethane finish — weatherproof, hosedown, dust and vapor explosion-proof — intrinsically safe for Class I, Div. 1, Groups A, B, C and D and Class II, Div. 1, Groups E, F and G.

Optional: NEMA 4X, PVC for corrosive duty

Model 672L ...... NEMA 4X, 1/2 DIN with two 1/2 inch conduit holes and two stainless steel mounting brackets

Mounting Configurations:

Model 699L ...... Integral Mounting – 1/2-inch NPT hole in bottom center of enclosure for direct mounting onto level probe.

Remote Mounting – Requires triaxial cable, probe-mounted explosionproof junction box and remote mount threaded adapter.

Model 672L ...... Surface, panel and horizontal pipe mount. Vertical pipe mounting optional.

Net Weight:

Model 699L ...... 3.4 lbs. (1.5 kg) approx.

Model 672L ...... 3.4 lbs. (1.5 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 Model 699L Transmitter/ Level Probe

Location

Mounting positions for the 699L transmitter/level probe should be carefully considered. The probe must be installed vertically and its length must be sufficiently long to handle the entire measuring range. Do not locate the level probe in a position where the inflow of measured material could contact it. Also, locations should be well clear of obstructions and agitators. Figure 2-1 illustrates typical mounting locations.

Level probes used in granular material should be located halfway between the vessel wall and the apex of the material pile created by the incoming material. The output will then be representative of the average level.

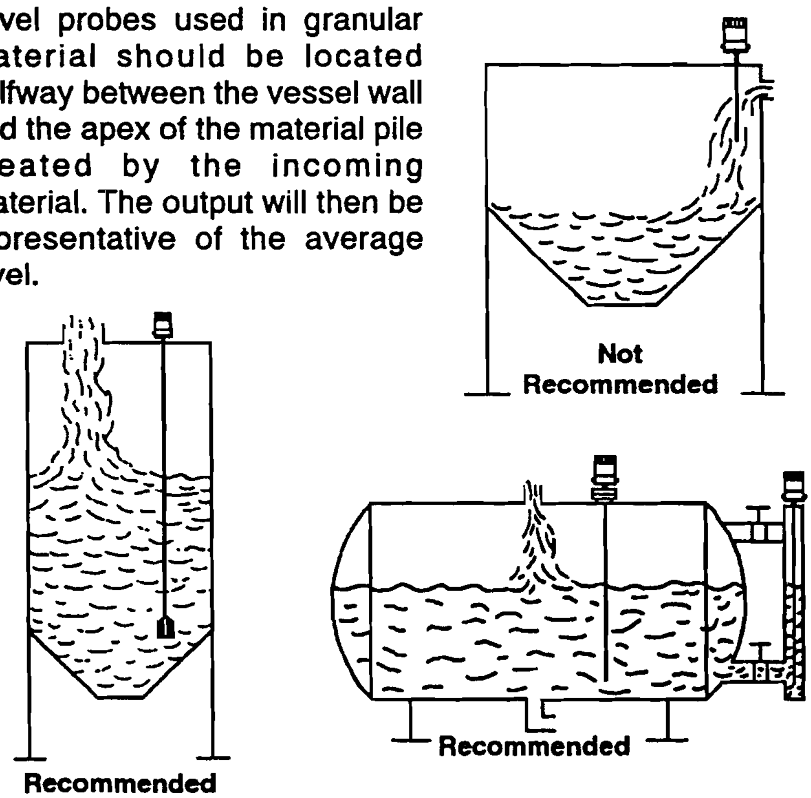


FIGURE 2-1 Typical Level Probe/Transmitter Installation Locations

For applications involving a vessel with non-conductive walls, a ground reference plate or grounded reference level element is required. However, if the measured material is conductive and grounded, this is not necessary.

NOTE: *When measuring a non-conductive material in a non-linear vessel, a concentric shield level probe must be used or the probe must be mounted in a grounded metal standpipe. This is necessary because of the varying distance between the level probe and the vessel wall, which would otherwise cause the probe to generate a non-linear capacitance over its length. If the measured material is conductive and grounded, disregard this note.*

For more in-depth information on conductive material in lined metal vessels or RF level measurement in plastic vessels, refer to GLI Application Notes No. L1 and L2, respectively. Also, the concept of capacitance level measurement is described in GLI Technical Bulletin No. L1.

The Model 699L transmitter may be installed directly onto the level probe (integral mounting) or in a remote location up to 50 feet from the level probe.

NOTE: *Remote mounting is necessary when the temperature at the 699L transmitter exceeds its rated specification (-40 to +162°F) or if severe vibration exists. Triaxial interconnect cable must be used for remote mounting.*

Integral Mounting

The 699L transmitter has a 1/2-inch NPT hole on the bottom center of the enclosure for direct mounting onto the installed level probe. Follow these steps to install the level probe and 699L transmitter.

1. Install level probe into vessel opening without the 699L transmitter mounted on it. Use a wrench on the larger lower hex nut portion only of the two-piece fitting to tighten level probe into vessel.

   CAUTION: Do not tighten or loosen the smaller upper hex nut portion of the two-piece fitting. This is a com-

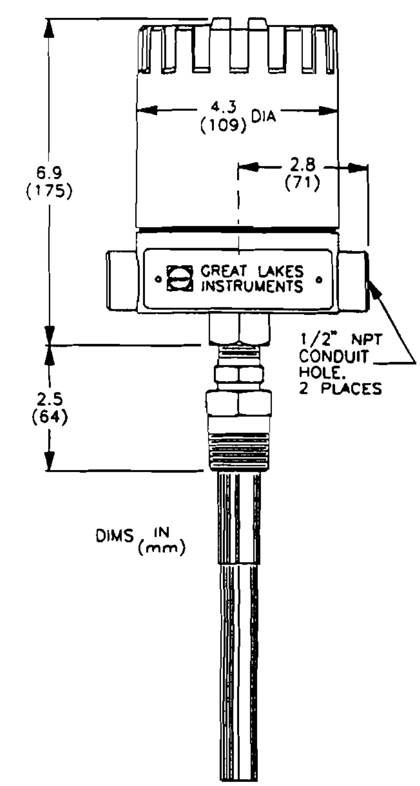


FIGURE 2-2
Integral Mounting — Model 699L Transmitter

pression seal that could be destroyed if the upper portion is turned.

If the level probe is welded into a mounting flange, simply bolt flange to the mating flange on the vessel.

2. Install banana plug onto back end of level probe extension by screwing it into the threaded hole.

   CAUTION: Do not tighten plug with excessive force as it can be easily twisted off.

3. Carefully screw 699L transmitter enclosure casting onto threaded upper portion of fitting on back end of level probe. The banana plug makes the necessary electrical connection to the electronic chassis. Screw until tight, but without excessive force to avoid stripping the aluminum threads.

   NOTE: *It may be necessary to rotate casting to orient wiring entrances to a desired position. Use a wrench to hold the upper smaller hex nut stationary while turning the casting.*

4. For instructions to wire the 699L transmitter to the 672L receiver/controller, refer to Section 3.2.

Remote Mounting

A junction box which mounts onto the level probe, a remote mount threaded adapter and triaxial interconnect cable are required to remotely mount the 699L transmitter.

1. Install level probe into vessel opening or flange mounting as previously described in step 1 of "Integral Mounting" subsection.

2. Install banana plug onto back end of level probe extension by screwing it into the threaded hole.

   CAUTION: Do not tighten plug with excessive force as it can be easily twisted off.

3. Carefully screw explosion-proof junction box (GLI p/n 1000-3072) onto threaded upper portion of fitting on back end of level probe. The same "CAUTION" regarding the compression seal that's described in step 1 of the "Integral Mounting" subsection applies here when tightening and orienting junction box onto top of level probe.

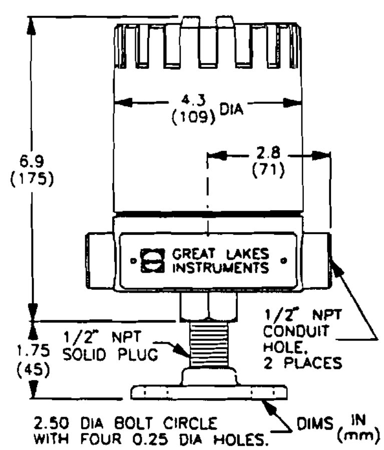


FIGURE 2-3
Remote Mounting — Model 699L Transmitter

4. Install remote-mount threaded adapter (GLI p/n 1000-3071) into 1/2-inch NPT hole in bottom of 699L transmitter enclosure casting.

   NOTE: The adapter must be a solid fitting to preserve the explosionproof rating of the 699L enclosure. (Should adapter become lost, do not use a pipe nipple in explosionproof installations. Also, use only approved explosionproof wiring seal fittings — not provided by GLI — in conduit entrance holes.)

5. Surface mount 699L transmitter with the remote-mount threaded adapter within 50 feet of the installed level probe.

6. For instructions to wire the level probe junction box to the 699L transmitter, refer to Section 3.1 – "Remote Mounting" subsection. To wire the 699L to the 672L receiver/controller, refer to Section 3.2.

Hazardous Area Considerations

The 699L transmitter is housed in a cast aluminum weatherproof and explosionproof enclosure, allowing it to be located in Class I or II, Division 1 hazardous areas. When used with approved barriers (GLI p/n 672M4G4020) which must be located in a safe area along with the 672L receiver/controller, the 699L transmitter is intrinsically safe. Refer to Section 3.2 – "Hazardous Area Wiring" subsection for complete connection details.

2.2 Model 672L Receiver/Controller

Location

1. Locate the 672L receiver/controller within 1000 feet of the installed 699L transmitter.

2. Mount the 672L receiver/controller in a location that is:

   - Clean and dry where little or no vibration exists.
   - Protected from falling corrosive fluids.
   - Within ambient temperature limits (-40 to +122°F, -40 to +50°C).

   CAUTION: MOUNTING IN DIRECT SUNLIGHT MAY INCREASE TEMPERATURE ABOVE MAX. LIMIT.

Mounting

Refer to Figure 2-4 for enclosure and mounting dimension details. Figure 2-5 illustrates various mounting configurations. Use the two stainless steel brackets provided to panel, surface or pipe-mount the instrument. The bracket attachment configuration determines the mounting method.

To panel mount the 672L receiver/controller:

1. Place Tinnerman fasteners on each mounting bracket as shown in Figure 2-5.
2. Place instrument into square panel cutout (5.43 x 5.43", 138 x 138 mm) and fasten brackets to instrument case with No. 8-32 x 3/8" long screws.

   NOTE: *Use appropriate mounting bracket holes (depicted in Figure 2-5 with screw heads) to properly position brackets.*
3. Fasten No. 10-32 x 3/4" long screws into Tinnerman fasteners until ends of screws are snugged against panel.

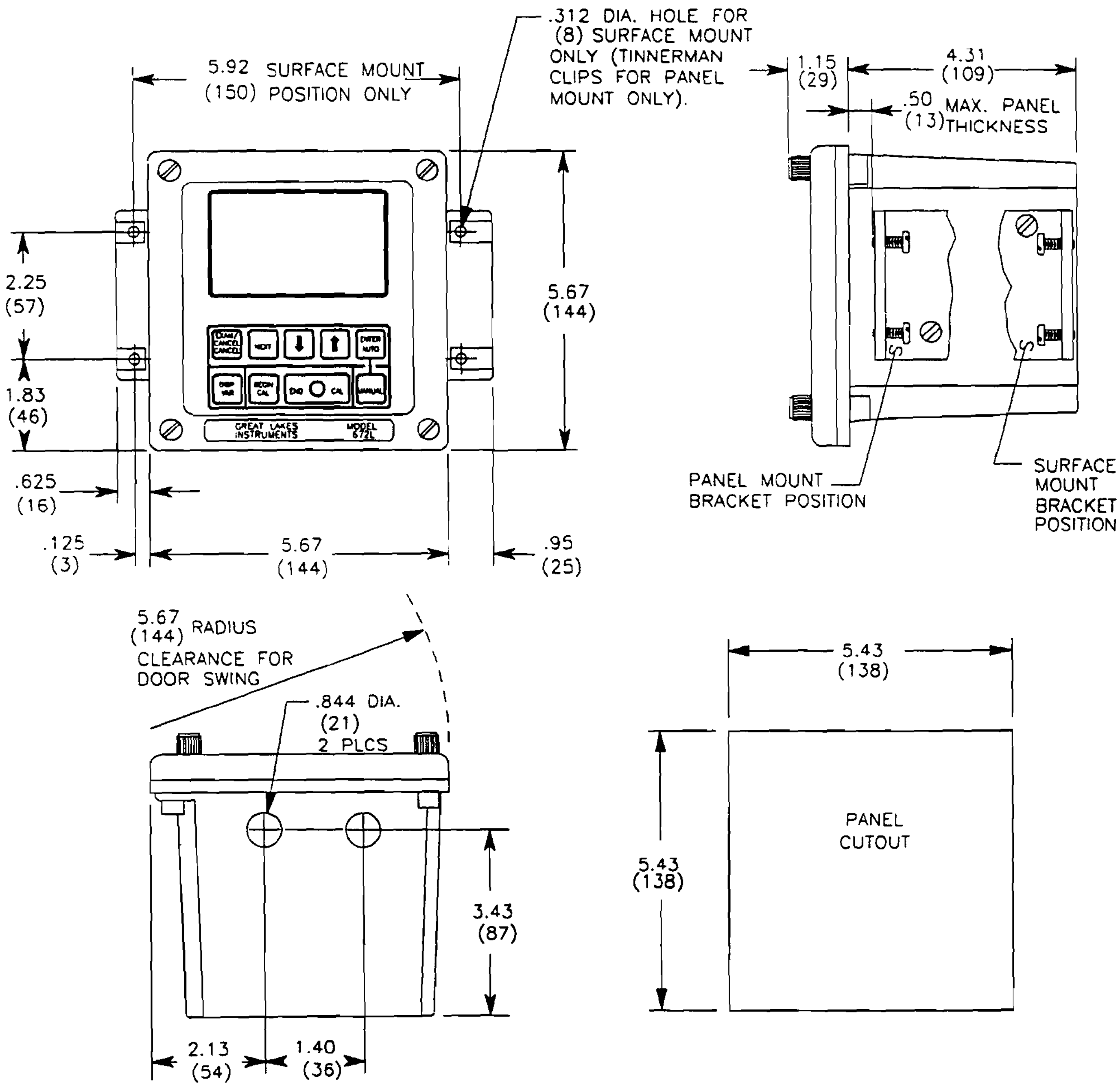


FIGURE 2-4 Model 672L Enclosure Outline

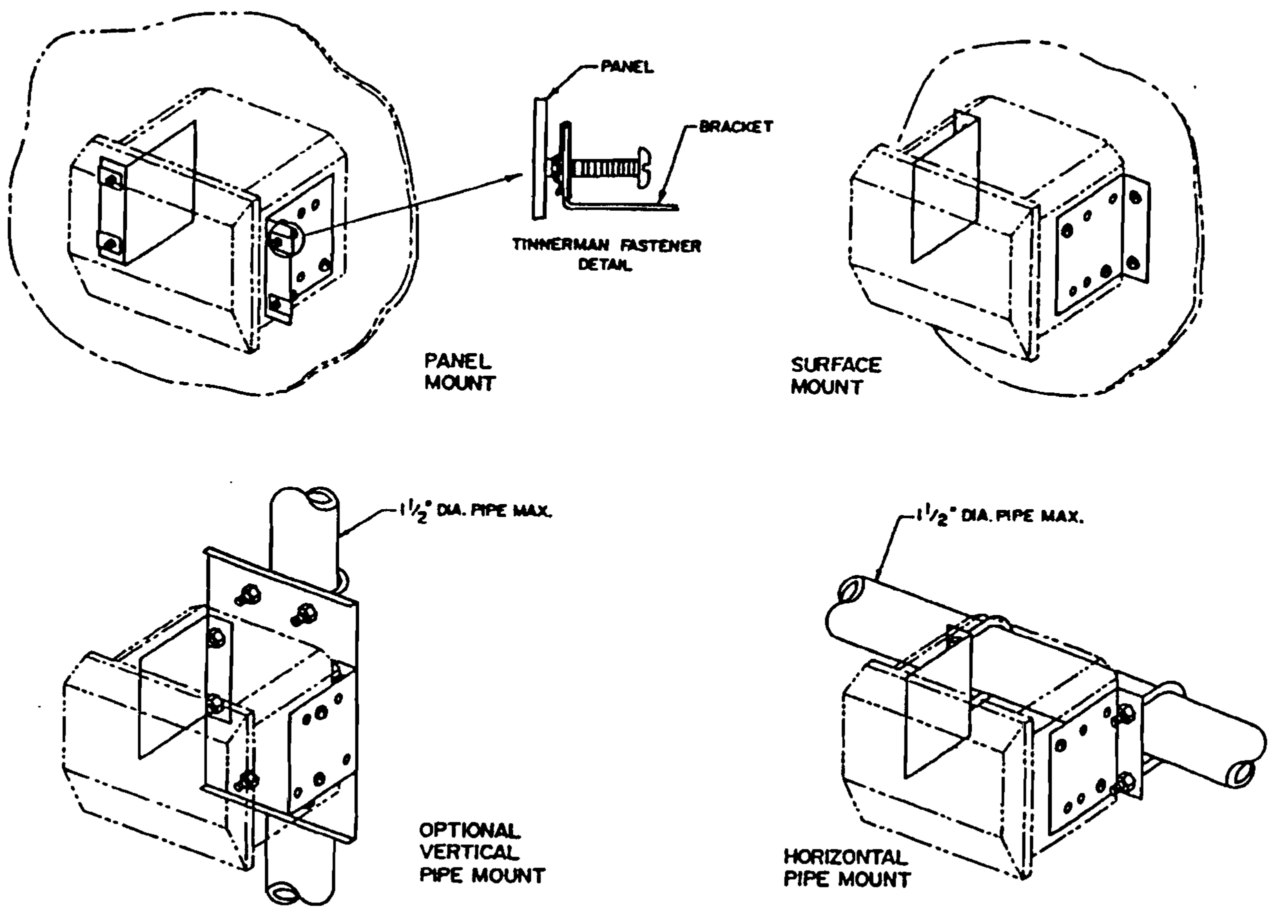


FIGURE 2-5 Model 672L Mounting Configurations

Plugging Conduit Holes

Use conduit hubs or cable feed-thru fittings where cables enter the enclosure. Holes not used for cable entry should be sealed with plugs.

NOTE: *Use NEMA 4 rated fittings and plugs to maintain the watertight integrity of the NEMA 4 enclosure. The left conduit hole (viewed from front) is for power and relay wires; the right conduit hole is for transmitter wires and instrument outputs.*

SECTION 3 - ELECTRICAL CONNECTIONS

3.1 Level Probe

Integrally Mounted

Connect level probe to 699L transmitter via the banana plug installed onto back end of probe. The plug must be securely fastened and not damaged.

Remotely Mounted

Use only triaxial interconnect cable (GLI p/n 1000-3073 for up to 160°F; p/n 1000-3074 for up to 392°F) to connect junction box terminals to TB3 in the 699L transmitter. Any other type cable causes incorrect instrument operation. Refer to Figure 2-6 and connect triaxial cable, matching wires to terminals as follows:

Triaxial Cable Wires	Terminal Designations
Center wire	PROBE
Blue wire (inner braided shield)	SHIELD
Green wire (outer braided shield)	Ground symbol

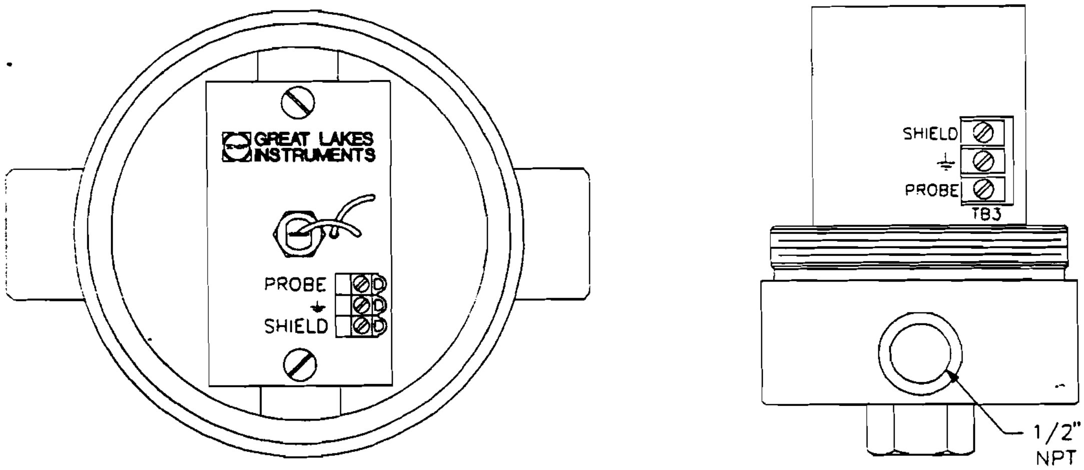


FIGURE 2-6 Triaxial Cable Hook-up Between Level Probe J-Box And Remote-Mounted Model 699L

3.2 Model 699L Transmitter

To access 672L receiver/controller terminal strips for electrical connections, loosen four thumbscrews and open enclosure door. Carefully remove LCD board assembly (Figure 3-1 on page 22) by loosening the two captive fasteners. Figure 2-7 on the next page shows terminal designations for system hook-up.

It is recommended that 699L transmitter signal wires be run in 1/2" metal conduit for protection against moisture and mechanical damage. Do not run signal wires in same conduit with power or control wiring ("electrical noise" may interfere with signal).

NOTE: *Disregard TB1 in the 699L and Terminals 11 and 12 on TB2 in the 672L. They are provided for different level measuring system configurations.*

Safe Area Wiring

1. Connect wires on one end of 2-conductor (plus shield) interconnect cable to 699L transmitter terminals marked "2-WIRE" on TB2, matching polarity as indicated. **Do not connect cable shield to ground symbol terminal.**
2. Connect wires on other end of cable to 672L "SIG" Terminals 9 and 10 on TB2, matching polarity as indicated. Also, connect cable shield to ground symbol Terminal 13.

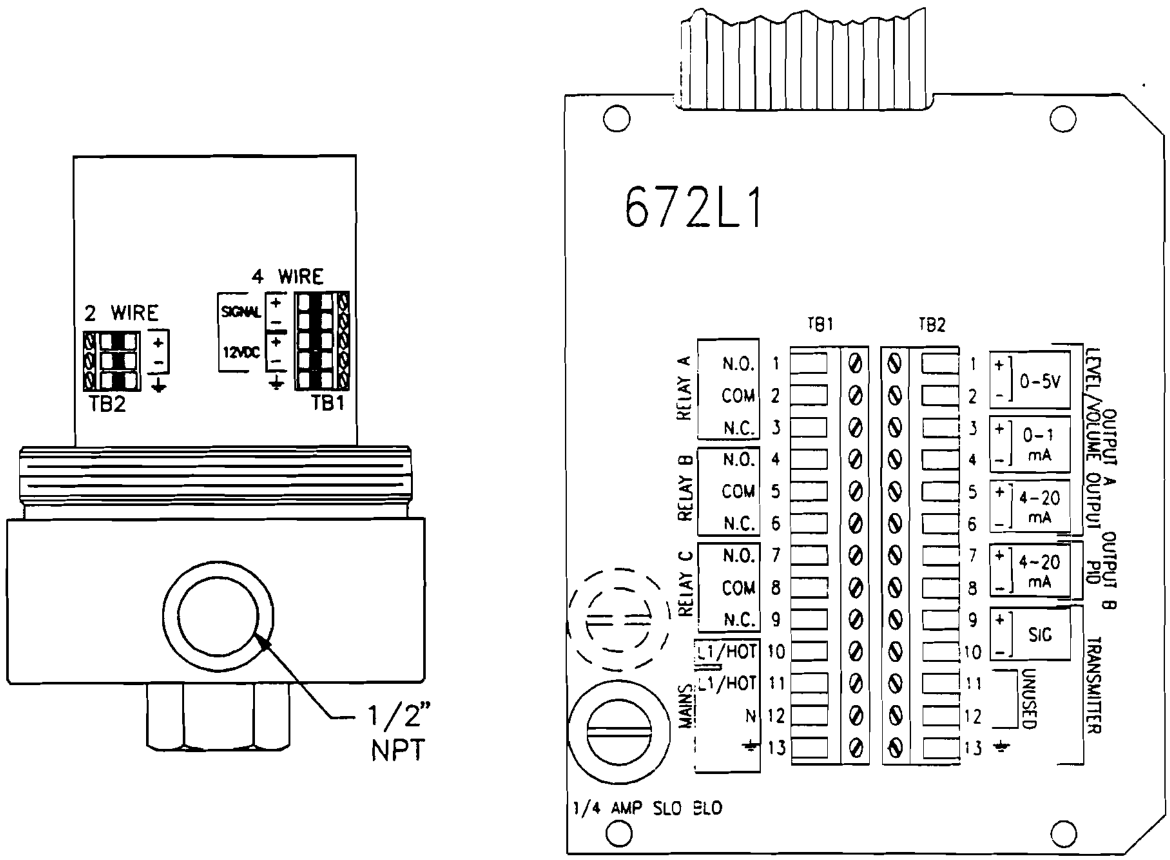


FIGURE 2-7 Model 672L/699L System Hook-up Details

Hazardous Area Wiring

When installing the 699L transmitter and level probe in a hazardous area, two intrinsic safety barriers are required. GLI p/n 672M4G4020 provides these barriers and a handy bus-bar mounting plate assembly. Follow the barrier manufacturer's general instructions and refer to Figure 2-8 for a detailed connection diagram. It is critical that the shield wires of the

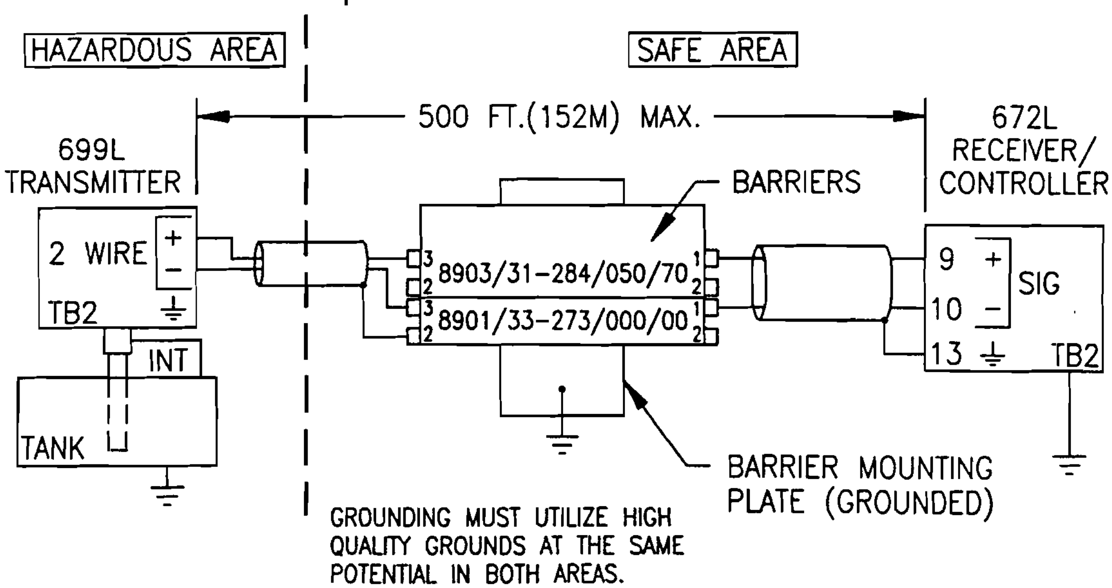


FIGURE 2-8 Hazardous Area Connection Diagram

cables are connected as shown (only at one end of each cable). It is recommended to use GLI two-conductor shielded cable (p/n 99X1W0980). The INT connection shown in Figure 2-8 represents the 699L internal ground connection through the level probe gland to the vessel wall or grounded reference plate. This factory connection must remain intact to ensure intrinsic safety.

NOTE: *Barrier #8903 must be used for the (+) signal connections. Barrier #8901 must be used for the (–) signal and ground wire connections.*

3.3 Relay Outputs

Three sets of SPDT relay outputs are provided at Terminals 1 through 9 on TB1. **They are not powered.** However, the instrument's line power may be used to power control or alarm devices via these relay contacts. Refer to Figure 2-9 for wiring details. An extra, unfused L1/HOT power source (Terminal 10 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 6 for relay setup instructions.

NOTE: *Because of space limitations within the 672L enclosure, it is recommended that bulky wiring connections (resulting from combinations of multiple connections per terminal and large gauge wires) be terminated outside the enclosure, preferably in an external junction box.*

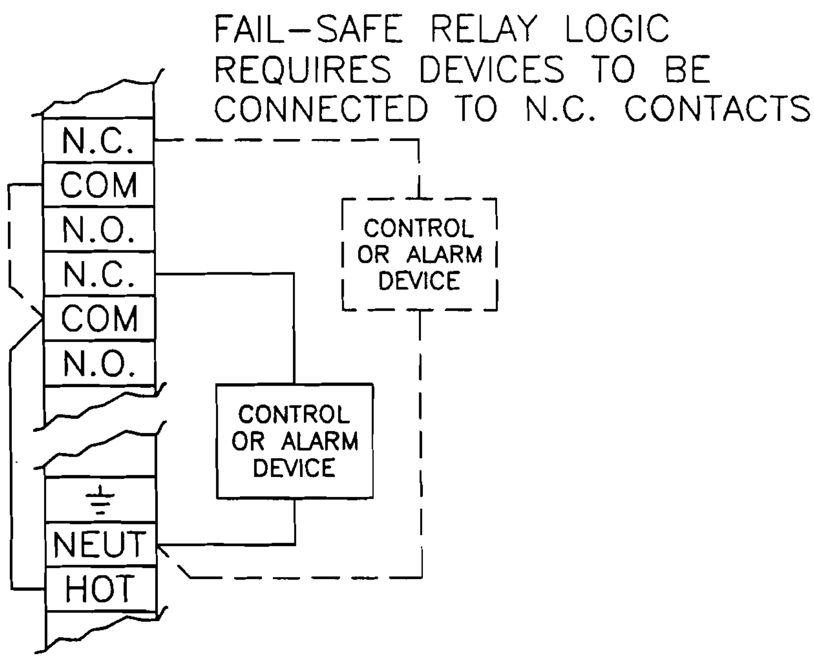


FIGURE 2-9 Connecting Control Or Alarm Device(s) To Relay Outputs

CAUTION: Do not exceed each relay's contact rating of 5A 115/230 VAC. If larger currents are to be switched, use of an auxiliary relay will extend relay life. When relay outputs are used, the instrument's line power wiring must be adequate to conduct the anticipated load(s).

3.4 Optional LEVEL/ VOLUME OUTPUTS (Output A)

These analog output signals track the measured level in % or in the measurement units established with one of the linearization tables. The outputs can represent the entire measuring scale or a desired segment of it. Refer to Part Three, Section 7 for output signal setup instructions.

Isolated 0-5 VDC

This output can drive a load of greater than 1000 ohms. Connect load (+) to Terminal 1 and load (–) to Terminal 2 on TB2.

Isolated 0-1 mA

This output can drive a load of up to 200 ohms. Connect load (+) to Terminal 3 and load (–) to Terminal 4 on TB2.

Isolated 4-20 mA

This output can drive a load of up to 600 ohms. Connect load (+) to Terminal 5 and load (–) to Terminal 6 on TB2.

3.5 Optional PID Controller Output (Output B)

The optional isolated 4-20 mA PID controller output is intended to drive a fully modulating control element (valve or pump). Connect (+) wire of device to Terminal 7 and (–) wire to Terminal 8 on TB2. Refer to Part Three, Section 8 for PID controller setup instructions.

3.6 Optional Digital Communication Output

Refer to SUPPLEMENTAL MANUAL No. 123 for complete details on this option.

3.7 Line Power

Connect line power to MAINS Terminals 11, 12 and 13 on TB1. The L1/HOT Terminal 11 is fused (1/4 amp. slow-blow) to protect instrument circuits. (NEUT Terminal 12 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. GND Terminal 13 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 input signal wires ("electrical noise" may interfere with input signal).

PART THREE - OPERATION

SECTION 1 - OPERATING CONTROLS

An eight-position DIP switch, used for level/volume display mode and relay operating mode setup, is located at the lower right of the LCD board assembly (Figure 3-1). These switches are accessed by opening the enclosure door which can be easily removed by unsnapping it from its hinge.

The keypad and all switches and status indicators used for system operation are described in this section. Familiarize yourself with each item before operating the system.

NOTE: Because the 672L receiver/controller and 699L transmitter use two-way communication between each other, they must be properly connected to enable the switches and status indicators to function correctly as described in this section.

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:

     Display shows level in %. If one of the linearization tables is used and **SWITCH 1** (item 9) is in **VOL** position, the display shows level (in desired measurement units) as height, volume, weight, or flow in an open channel.

   - In "examination" mode:

     Display shows setup variables and their stored values. Setup data such as low and high calibration points, relay setpoints, etc. are called up in the sequence shown in Figure 3-2 by pressing the **NEXT** key (item 2). Values can be changed using the ⬆ and ⬇ keys (item 3) and are entered by pressing the **ENTER/AUTO** key (item 4). An entry routine may be cancelled by pressing **EXAM/CANCEL** key which also returns display to normal measurement mode.

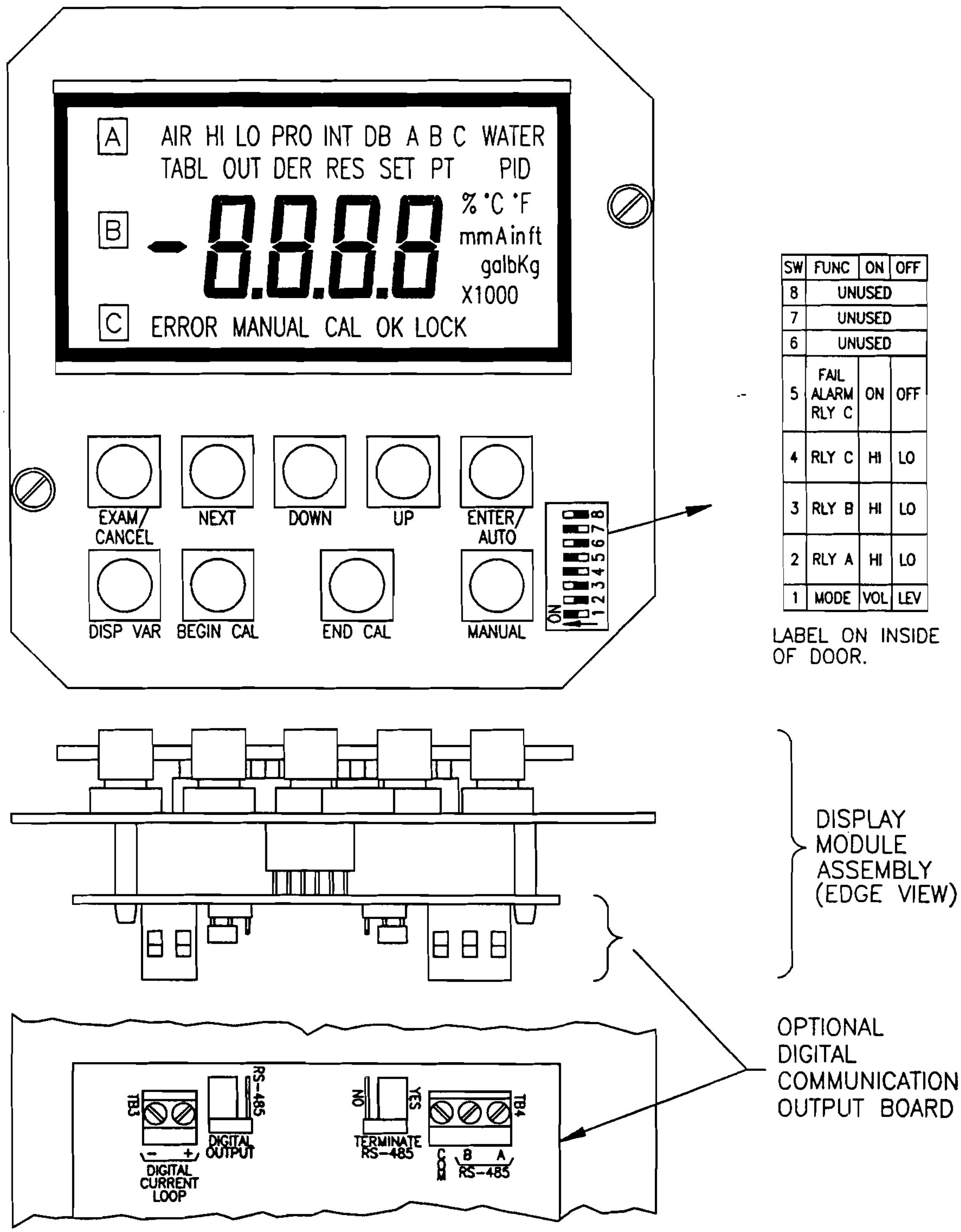
2. **NEXT** key (Figure 3-1)

   - With display in measurement mode:

     This key has no effect.

- With display in "examination" mode:

  Scrolls display to show next setup variable with each press. Refer to Table A in Section 3 for a complete listing of all setup variables.



SW	FUNC	ON	OFF
8	UNUSED		
7	UNUSED		
6	UNUSED		
5	FAIL ALARM RLY C	ON	OFF
4	RLY C	HI	LO
3	RLY B	HI	LO
2	RLY A	HI	LO
1	MODE	VOL	LEV

FIGURE 3-1 Model 672L LCD Board Assembly — Operating And Setup Controls

3. ⬆ and ⬇ keys (Figure 3-1)

- With display in measurement mode:

  These keys have no effect.

- With display in "examination" mode and indicating:

  A. A Setup Variable Value

  Increases/decreases displayed value by one increment with each separate key press or continually increases/decreases value by holding key down. Rate of change increases from slow to rapid while key remains held down until limit of entry range is reached.

  B. "TABL"

  Selects one of the linearization tables by scrolling display forward (with ⬆ key) or backward (with ⬇ key). The call-up sequence is: "TABL OFF", "TABL CYL", "TABL SPH", "TABL FLO3", "TABL FLO5" and "TABL USEr". Refer to Section 5 for complete details on linearization and level readout setup.

4. **ENTER/AUTO** key (Figure 3-1)

- With display in measurement mode:

  Selects automatic mode of operation for optional PID controller.

- With display in "examination" mode:

  Enters displayed value into memory (if within acceptable range) for the indicated setup variable. Display flashes "OK" for approximately 5 seconds to confirm entry.

5. **DISP VAR** key (Figure 3-1)

- With display in measurement mode:

  Scrolls display with each key press to show the following measured variables:

  A. Level in %.

  B. Level (in desired measurement units) as height, volume, weight or flow in an open channel — only when one of the linearization tables is used to convert the measured % level.

  C. Optional 4-20 mA LEVEL/VOLUME output.

  D. Optional PID controller output in %.

The 4-20 mA and PID controller outputs are only displayed when appropriate plug-in cards are installed.

NOTE: As a display check, all indicators light up (as shown in Figure 3-1) when optional 4-20 mA LEVEL/VOLUME OUTPUT or PID controller output is displayed and ***EXAM/CANCEL*** *key is pressed.*

- With display in "examination" mode:

  Recalls and displays measured level in % (or linearized and converted level, if a linearization table is used and **SWITCH 1** - item 9 is in **VOL** position).

6. **BEGIN CAL** key (Figure 3-1)

- With display in % level measurement mode:

  A. Displays stored value, in % level, for LO CAL or HI CAL calibration point. Each key press alternately displays both stored values. Pressing **EXAM/CANCEL** key returns display to normal measurement mode.

  B. Begins calibration procedure by pressing and holding this key for at least 2 seconds. See Part Three, Section 4 for calibration instructions.

- With display in "examination" mode:

  This key has no effect.

7. **END CAL** recessed button (Figure 3-1)

- With display in % level measurement mode:

  Ends calibration of the displayed LO CAL or HI CAL calibration point. See Part Three, Section 4 for calibration instructions.

- With display in "examination" mode:

  This key has no effect.

8. **MANUAL** key (Figure 3-1)

- With display in measurement or "examination" mode:

  Selects manual mode of operation for optional PID controller, displays last manually adjusted controller output in % and provides the corresponding mA output value at Terminals 7 and 8 on TB2. Pressing ⬆ and ⬇ keys adjusts the output value. Pressing **ENTER/AUTO** key returns controller to automatic mode of operation and display to measurement mode.

1.2 Slide Switches

9. **SWITCH 1** (Figure 3-1)

   VOL POSITION (on/left) – Selects relays and instrument outputs to track the linearized and converted level established with one of the linearization tables. Also, selects relay and instrument output setup variable values to be displayed in the converted measurement units.

   LEV POSITION (off/right) – Selects relays and instrument outputs to track the measured % level. Also, selects relay and instrument output setup variable values to be displayed in % level.

10. **SWITCH 2** (Figure 3-1)

    HI POSITION (on/left) – Selects Relay A to operate in response to increasing measured level (or converted level established with linearization table, if used).

    LO POSITION (off/right) – Selects Relay A to operate in response to decreasing measured level (or converted level).

11. **SWITCH 3** (Figure 3-1)

    HI POSITION (on/left) – Selects Relay B to operate in response to increasing measured level (or converted level established with linearization table, if used).

    LO POSITION (off/right) – Selects Relay B to operate in response to decreasing measured level (or converted level).

12. **SWITCH 4** (Figure 3-1)

    HI POSITION (on/left) – Selects Relay C to operate in response to increasing measured level (or converted level established with linearization table, if used).

    LO POSITION (off/right) – Selects Relay C to operate in response to decreasing measured level (or converted level).

    NOTE: *This switch has no effect when* ***SWITCH 5*** *(FAIL ALARM RLY C - item 13) is in the* ***ON*** *(left) position.*

13. **SWITCH 5** (Figure 3-1)

    FAIL ALARM ON POSITION (left) – Selects Relay C to operate as a "system diagnostic alarm" relay which overrides its normal HI or LO operating mode selected with **SWITCH 4**.

    FAIL ALARM OFF POSITION (right) – Selects normal operation for Relay C.

1.3 Status Indicators

14. **A**, **B** and **C** relay indicators (LCD display)

    Respective indicators flash on and off to indicate that relay transfer has occurred and that an alarm condition exists.

15. **ERROR** indicator (LCD display)

    Flashes to indicate an incorrect entry or alternately flashes with "ERR 1", "ERR 2", "ERR 3" or "ERR 4" to indicate a system diagnostic error causing improper system operation.

16. **MANUAL** indicator (LCD display)

    Indicates that optional PID controller is in manual mode of operation (selected by pressing **MANUAL** key – item 8).

17. **OK** indicator (LCD display)

    Flashes for approximately 5 seconds to confirm successful entry of a setup variable value.

18. **LOCK** indicator (LCD display)

    Indicates that instrument keypad entry is "locked" to prevent unauthorized alteration of stored setup variable values. Refer to Section 10 for security lock feature instructions.

    NOTE: Setup variable values cannot be entered, but they can be displayed when the instrument is "locked".

1.4 Programmable Jumpers

19. **DIGITAL OUTPUT** jumper (on optional digital communications board, Figure 3-1)

    RS-485 – Selects RS-485 serial output to be provided at "RS-485" terminals on TB4.

    LOOP – Selects 20 mA loop serial output to be provided at "DIGITAL CURRENT OUTPUT" terminals on TB3.

    Refer to SUPPLEMENTAL MANUAL No. 123 for details.

20. **TERMINATE RS-485** jumper (on optional digital communications board, Figure 3-1).

    The RS-485 bus connecting all 672L's must be terminated at both ends to prevent impedance mismatches. This jumper configures each 672L for its place on the RS-485 bus.

    YES — Selects this 672L to be last on the RS-485 bus.

    NO — Selects this 672L to not be last on the RS-485 bus.

    Refer to SUPPLEMENTAL MANUAL No. 123 for details.

The 672L/699L system can display four measured variables. With the display in the measurement mode, each press of the **DISP VAR** key sequentially displays:

- Measured level in %.
- Measured level (in desired measurement units) as height, volume, weight, or flow in an open channel — only when one of the linearization tables is used to convert the measured % level.
- *Optional 4-20 mA LEVEL/VOLUME OUTPUT (Output A) which tracks measured level.
- *Optional PID controller output (Output B) in %.

*Displayed only when 672L receiver/controller is equipped with this option.

SECTION 3 - SETUP VARIABLES

3.1 Calling Up Setup Variables

1. Pressing the **EXAM/CANCEL** key while the display is in the measurement mode changes the readout to an "examination" mode to show setup variables to configure the system.
2. Each press of the **NEXT** key scrolls the display to show the next setup variable.

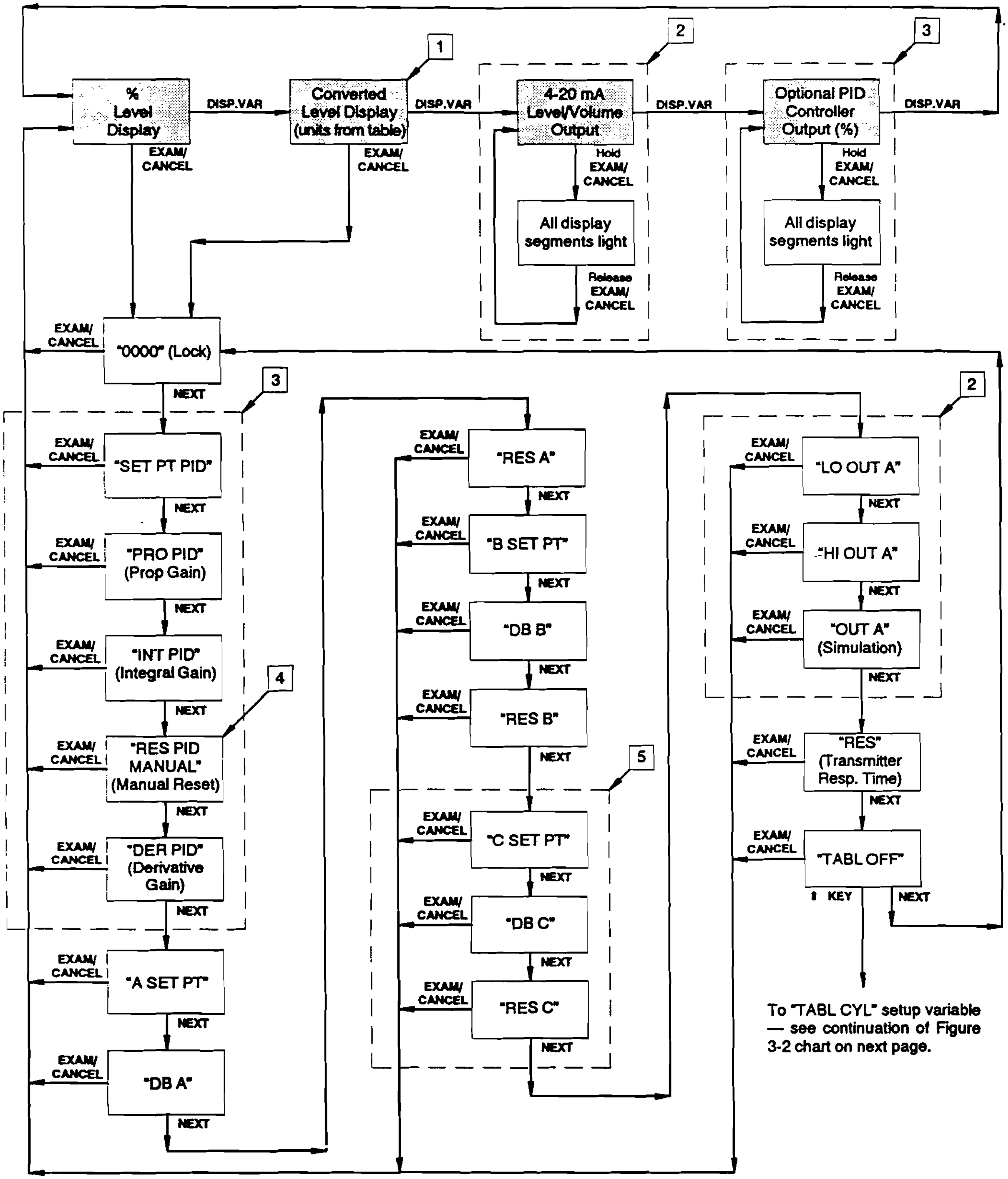
The **EXAM/CANCEL** key may be pressed anytime to return the display to the measuring mode.

3.2 Entering Values

The ⬆ and ⬇ keys are used to change displayed setup variable values or to select a desired linearization table. When held down, the ⬆ and ⬇ keys adjust the value slowly, and then more rapidly after a few seconds. After establishing the desired value, it flashes to remind you to then press the **ENTER/AUTO** key to store the flashing value in memory. Thereafter, "OK" flashes for approximately 5 seconds to confirm that the entry was accepted or "ERROR" flashes if the entry was invalid.

3.2 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 of chart) and the call-up order of all setup variables. Depending on the equipped options, specific setup variables are not displayed and do not apply (see footnotes at bottom of chart).



[1] Displayed only when one of the linearization tables is used to convert the measured % level.

[2] Displayed only when Model 672L is equipped with optional LEVEL/VOLUME OUTPUTS.

[3] Displayed only when Model 672L is equipped with optional PID controller.

[4] Displayed only when stored PID integral gain is "0.00".

[5] Displayed only when Relay C is in normal operating mode (SWITCH 5 set to OFF), not "system diagnostic alarm" mode.

[6] Displayed only when Model 672L is equipped with optional digital communication output.

FIGURE 3-2 Display Modes And Call-up Chart Of Setup Variables

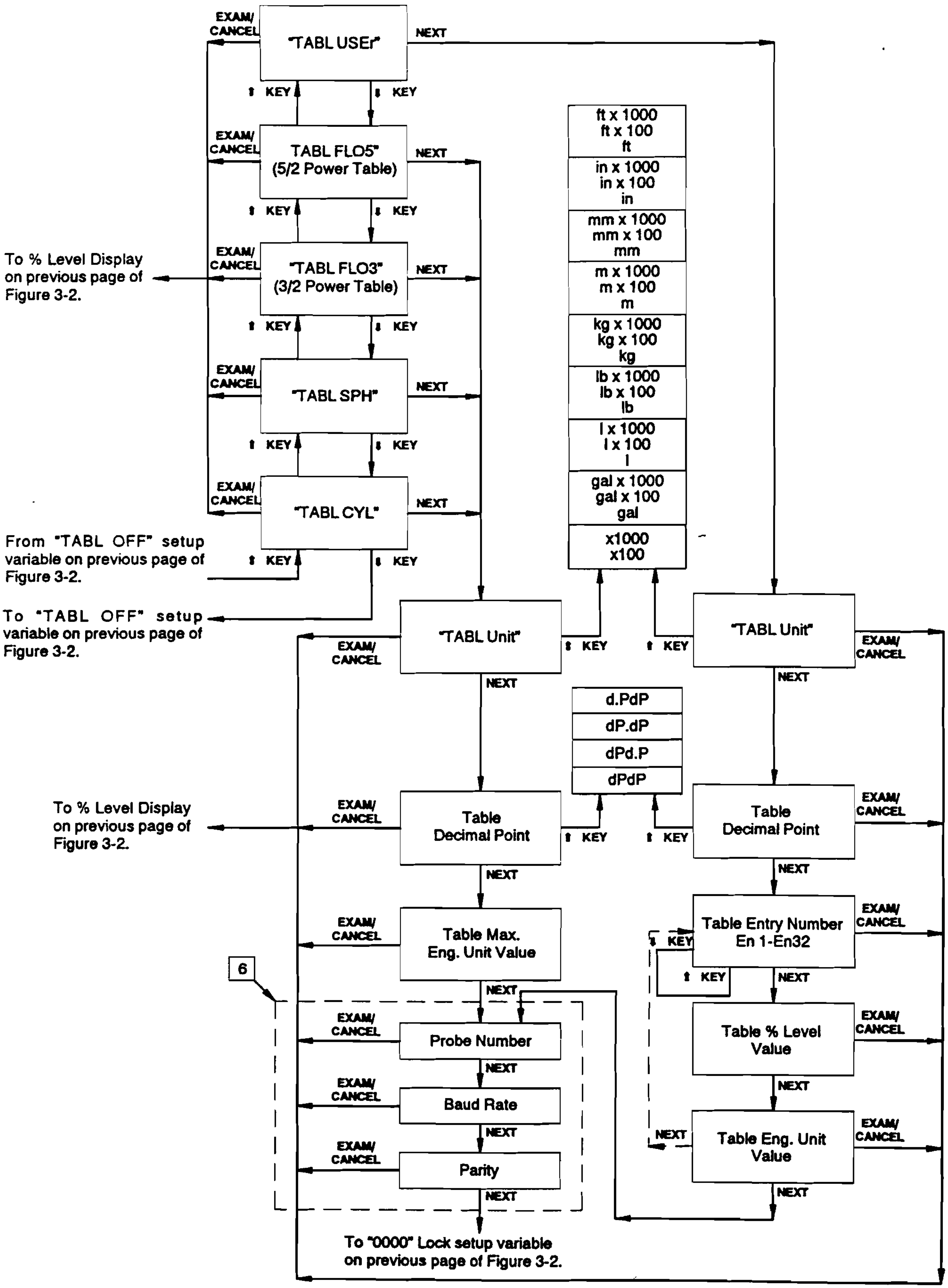


FIGURE 3-2 Call-up Chart (Continued)

The following table lists all setup variables, in exact order of call-up, and describes their use and entry value range. The far right column can be used to write in entered setup values for convenient referral.

Table A — DESCRIPTION OF SETUP VARIABLES

Displayed Identifier	Use		Entry Value Range Min.	Entry Value Range Max.	Record Your Entry ⬇
"0000"	Activates the security lock feature.		0000	1234	
"SET PT PID"[1]	Sets setpoint for optional PID controller. When **SWITCH 1** is in	LEV	0.0%	100.0%	
		VOL	0	9999*	
"PRO PID"[1]	Sets proportional gain for optional PID controller.		−99.99	+99.99	
"INT PID"[1]	Sets integral gain (in rep/minute) for reset action of optional PID controller.		0.00	99.99	
"RES PID MANUAL"[1,2]	Sets offset value to be added to calculated result of control action of optional PID controller.		−100.0%	+100.0%	
"DER PID"[1]	Sets derivative gain (in minutes) for rate action of optional PID controller.		0.000	9.999	
"A SET PT"	Sets setpoint at which Relay A transfers. When **SWITCH 1** is in	LEV	0.0%	100.0%	
		VOL	0	9999*	
"DB A"	Sets deadband for Relay A. When **SWITCH 1** is in ..	LEV	0.1%	100.0%	
		VOL	1	9999*	
"RES A"	Sets time delay (in seconds) for Relay A actuation.		0.0	100.0	
"B SET PT"	Sets setpoint at which Relay B transfers. When **SWITCH 1** is in	LEV	0.0%	100.0%	
		VOL	0	9999*	
"DB B"	Sets deadband for Relay B. When **SWITCH 1** is in ..	LEV	0.1%	100.0%	
		VOL	1	9999*	
"RES B"	Sets time delay (in seconds) for Relay B actuation.		0.0	100.0	
"C SET PT"[3]	Sets setpoint at which Relay C transfers. When **SWITCH 1** is in	LEV	0.0%	100.0%	
		VOL	0	9999*	
"DB C"[3]	Sets deadband for Relay C. When **SWITCH 1** is in ..	LEV	0.1%	100.0%	
		VOL	1	9999*	
"RES C"[3]	Sets time delay (in seconds) for Relay C actuation.		0.0	100.0	
"LO OUT A"[4]	Sets low endpoint at which minimum LEVEL/VOLUME OUTPUTS (0 VDC, 0 mA and 4 mA) are provided. When **SWITCH 1** is in	LEV	0.0%	100.0%	
		VOL	1	9999*	
"HI OUT A"[4]	Sets high endpoint at which maximum LEVEL/VOLUME OUTPUTS (5 VDC, 1 mA and 20 mA) are provided. When **SWITCH 1** is in	LEV	0.0%	100.0%	
		VOL	1	9999*	
"OUT A"[4]	Sets simulated value for LEVEL/VOLUME OUTPUTS (Output A) to manually exercise other equipment in 4-20 mA loop.		4.00 mA	20.00 mA	

1 Only provided and displayed when 672L receiver/controller is equipped with optional PID controller.
2 Only provided and displayed when stored integral gain value is "0.00".
3 Only provided and displayed when Relay C is selected to operate normally (**SWITCH 5** in **OFF** position), not as a "system diagnostic alarm" relay.
4 Only provided and displayed when 672L receiver/controller is equipped with optional LEVEL/VOLUME OUTPUTS (Output A).
* This value is the maximum value (up to 9999) entered into one of the linearization tables that defines 100.0% level. Displayed measurement units are the same as those set in the linearization table.

Table A — DESCRIPTION OF SETUP VARIABLES (Continued)				
Displayed Identifier	Use	Entry Value Range		Record Your Entry
		Min.	Max.	
"RES"	Sets time constant (in seconds) to damp level input for turbulent applications.	0.0	100.0	
"TABL"	Selects linearization table for linearizing the measured % level and converting it so that it can be displayed (in desired measurement units) as height, volume, weight, or flow in an open channel.	TABL OFF TABL CYL TABL SPH TABL FLO3 TABL FLO5 TABL USEr		
"TABL En"[5]	Adds or deletes data points for user-defined linearization table (TABL USEr) or accesses these points for examination or change.	1	32	
"TABL"[5]	Sets the % level value for each data point entered in user-defined linearization table (TABL USEr).	0.0%	100.0%	
"TABL"[5]	Sets the known measurement unit value that corresponds with each % level value data point entered in user-defined linearization table (TABL USEr).	0000	9999	
"TABL"[6]	Sets the known measurement unit value (for height, volume, weight, or flow in an open channel) that corresponds with 100.0% level for one of the built-in linearization tables.	0000	9999	
"PnXX"[7]	Assigns a probe number address in a system network to characterize the digital output for that tank.	Pn01	Pn99	
"br03"[7]	Sets the baud rate for optional digital communication output.	br03 br06 br12 br24 br48 br96		
"P nO"[7]	Sets the parity for optional digital communication output.	P nO P O P E		

5 Only provided and displayed when user-defined linearization table (TABL USEr) is selected.
6 Only provided and displayed when one of the built-in linearization tables is selected (TABL CYL, TABL SPH, TABL FLO3 or TABL FLO5).
7 Only provided and displayed when 672L receiver/controller is equipped with optional digital communication output.

SECTION 4 - CALIBRATION

The system must be calibrated in the % level measuring mode (not in the converted level display mode) using two known levels in the vessel. It is recommended that these low and high level points be located anywhere along the measuring probe. Calibrating at levels below the probe tip will result in a small measurement error. The low and high level points must be separated by at least 20.0% of the full measuring scale. This is desirable in the event that the vessel cannot be emptied or completely filled due to lack of sufficient material. Best accuracy is obtained when the low and high levels are as far apart as possible (0.0% empty and 100.0% full).

Pressing and holding the **BEGIN CAL** key for two or more seconds while the display is reading % level initiates the calibration mode, when the 672L is not locked. The calibration mode is cancelled by completing calibration of a point, pressing the **EXAM/CANCEL** key, or by not pressing any key for 30 minutes.

The values used for calibration are stored in the 699L transmitter. If the system was previously calibrated, the former values are displayed when initiating the calibration mode. If not, "0.0%" and "100.0%" default values are shown for the LO CAL and HI CAL values respectively.

4.1 Initial Setup

1. Disconnect any control devices from the relays and optional PID controller output to ensure that they aren't unintentionally actuated during startup and calibration.
2. Check to make sure that the 699L transmitter is properly wired to the 672L receiver/controller.
3. Apply power to the system. The display will light. Disregard all display readings except "LOCK" if it appears.

   - If "LOCK" is not indicated —

     The 672L is not locked and calibration may be performed (refer to Section 4.2).

   - If "LOCK" is indicated —

     The 672L must be unlocked before calibration can be accomplished. Refer to Section 10.2 for unlocking instructions before performing the procedure in Section 4.2.

4.2 Procedure To Use

The low and high level calibration points may be entered in either order, but they must both be entered for a valid calibration.

Establishing/Entering Low Level Calibration Point

1. Manually lower the level in the vessel to the desired low point on the level measuring probe. This may not be possible due to lack of a storage facility to transfer the material from the vessel. In this case, determine the percentage of actual level relative to the desired zero and full level points on the probe. Note this relative low level % value. (For best accuracy, the low level point should be no more than 20.0% of the full measuring span.)

2. With display in % level measuring mode, press and hold **BEGIN CAL** key for at least two seconds.

   The display indicates "LO CAL" or "HI CAL" and a % value. If the system has been previously calibrated, the indicated % was the value used for the last calibration. If "HI CAL" is shown, press the **BEGIN CAL** key again to display "LO CAL". When **BEGIN CAL** is pressed, the operator has 30 minutes to complete the calibration of this point. During the routine, pressing any key except **END CAL** provides another 30 minutes. This may be repeated as often as needed.

3. Use the ⬆ and ⬇ keys to display "0.0%" if the actual level is at the desired low point on the level measuring probe. If it's not, adjust the reading to indicate the noted relative low level % value determined in step 1.

4. Press recessed **END CAL** button using a slender tool. The display will go blank for several seconds and then flashes "OK" to confirm entry was accepted or "ERROR" if the difference between the entry value and any previously stored HI CAL value is less than 20.0%

Establishing/Entering High Level Calibration Point

1. Manually raise the level in the vessel to the desired high point on the level measuring probe. This may not be possible if there isn't enough material available. In this case, raise the level as far as possible. (The high level point must be at least 20% above the low level point.) Now determine the percentage of actual level relative to the desired zero and full level points on the probe. Note this relative high level % value. (For best accuracy, the high level point should be at least 80.0% of the full measuring span.)

2. Press and hold **BEGIN CAL** key for at least two seconds to initiate calibration of the second calibration point. The display indicates "HI CAL" and a % value. If the system has been previously calibrated, the indicated % was the value used for the last calibration.

3. Use the ⬆ and ⬇ keys to display "100.0%" if the actual level is at the desired high point on the level measuring probe. If it's not, adjust the reading to indicate the noted relative high level % value determined in step 1.

   NOTE: *If entering "100.0%" for a non-linear vessel, the actual level must be at maximum vessel capacity.*

4. Press recessed **END CAL** button using a slender tool. The display will go blank for several seconds and then flashes "OK" to confirm entry was accepted or "ERROR" if the difference between the entry value and the stored LO CAL value is less than 20.0%.

Calibration of the 699L transmitter is now completed. The low and high level calibration values are stored in the 699L's non-volatile memory. They are retained indefinitely even if power is lost or turned off.

4.3 Calibration "ERR 3" Message

There are situations in which both the LO CAL and HI CAL calibration points are individually valid (display flashes "OK" confirming an acceptable entry), but the combination of the two values is not valid. The cause for this may be that between the two points:

- The differential distance is less than 20.0% of the level span.
- The calculated capacitance span is less than 10 pF.
- The calculated capacitance span is greater than 10,000 pF.

In these cases, "ERR 3" is continuously displayed until corrections are made to conform to the above limits for valid calibration.

SECTION 5 - LINEARIZATION AND LEVEL READOUT SETUP

If linearization is not required and the % level readout is acceptable for your application, disregard this section. If linearization and/or a converted readout is required, built-in linearization tables are provided to conveniently linearize the measured level in horizontal cylindrical vessels with flat ends, spherical vessels, and in open channel flumes and weirs. These tables can also convert % level so that it can be directly displayed (in desired measurement units) as height, volume, weight, or flow in an open channel. For any other vessel geometry, the operator can create a user-defined table to linearize the measured level in desired measurement units. A "TABL Unit" menu (shown on second page of Figure 3-2) is used during table setup to select measurement units with or without a "x100" or "x1000" multiplier. If a desired measurement unit is not included in the menu, a unitless display can be selected so that an appropriate units label can be put onto the display.

5.1 Height In Linear Or Non-Linear Vessels

Since height measurement is unaffected by the vessel shape, linearization is not necessary. However, to display height in units other than % level, the user-defined table (TABL USEr) must be used.

NOTE: *Determine the desired measurement unit values that correspond with the calibrated 0.0% and 100.0% level (Section 4) before beginning table data entry.*

The procedure to set up the user-defined table to convert % level to height is described with the following example:

HEIGHT READOUT SETUP EXAMPLE
Suppose the height readout is known to be 0.00 ft. when the measured level is at the calibrated 0.0% level and 85.00 ft. when at the calibrated 100.0% level.

Selecting User-Defined Table

1. With display in % level measuring mode, press **EXAM/ CANCEL** key to place display in "examination" mode.

2. Press **NEXT** key until display indicates "TABL" and either "OFF", "CYL", "SPH", "FLO3", "FLO5" or USEr".
3. Use ↑ and ↓ keys to make display indicate "TABL USEr".
4. Press **ENTER/AUTO** key to select the user-defined table ("OK" flashes to confirm entry).

Selecting Readout Measurement Units

1. Press **NEXT** key <u>once</u> to make display indicate "TABL Unit".
2. Use ↑ and ↓ keys to make display indicate the desired measurement unit and multiplier annunciator, if any ("ft" without x100 or x1000 annunciator for this example).
3. Press **ENTER/AUTO** key to enter selected measurement unit ("OK" flashes to confirm entry).

Selecting Decimal Point Position

1. Press **NEXT** key <u>once</u> to make display indicate "dPdP".
2. Use ↑ and ↓ keys to make display indicate the desired decimal point position, if any ("dP.dP" for this example).
3. Press **ENTER/AUTO** key to enter selected decimal point position ("OK" flashes to confirm entry).

Entering Table Data For Low Level Point

1. Press **NEXT** key <u>once</u>. The display will read "Add" or "En 1". If "En 1" appears, the table contains previously entered data which must be deleted before proceeding. To do this:

   A. With display indicating "En 1", press ↓ key to make display indicate "Init". The table is now in an initialize mode.

   B. Press **ENTER/AUTO** key. The display flashes "OK" to confirm that the existing table has been erased and then indicates "Add" to prompt operator to enter a new table.

2. With "Add" being displayed, press the **ENTER** key.

   The display flashes "OK" to confirm that a new table can be entered and then indicates "En 1" to inform operator that entry for Data Point 1 can begin.

3. Press **NEXT** key <u>once</u>.

   The display will read "TABL 0.0%". This is the point on the level probe at which the table begins and corresponds with the calibrated 0.0% level.

4. Press **ENTER/AUTO** key ("OK" flashes to confirm % level value entry for Data Point 1 which, for this example, is 0.0% at the tip of the level probe.

   NOTE: *To begin the table at a point above the calibrated 0.0% level, use ⬆ and ⬇ keys to make display indicated the desired % level point before pressing the **ENTER/AUTO** key. For example, the display should read "25.0%" if the table is to begin one-fourth up the level probe from the tip.*

5. Press **NEXT** key <u>once</u>.

   The display will read "TABL" and, depending on previously selected decimal point position, "0.000", "00.00", "000.0" or "0000" with selected measurement unit and multiplier annunciators (if used).

6. Use ⬆ and ⬇ keys to make display indicate the known height value corresponding to the 0.0% level entry for Data Point 1 (0.00 ft. for this example).

7. Press **ENTER/AUTO** key ("OK" flashes to confirm height value entry for Data Point 1).

Entering Table Data For High Level Point

1. Press **NEXT** key <u>once</u>. With "Add" being displayed, press **ENTER** key.

   The display flashes "OK" to confirm that another data point can be entered and then indicates "En 2" to prompt operator to enter a 100.0% level for Data Point 2.

2. Press **NEXT** key <u>once</u>.

   The display will read last entered level value <u>plus 0.1%</u>. If last level entry was 0.0% as in this example, the display will read "0.1%". The instrument software automatically ensures that each successive level entry is higher than the last.

3. Use ⬆ and ⬇ keys to make display indicate a 100.0% level value for Data Point 2.

4. Press **ENTER/AUTO** key ("OK" flashes to confirm % level value entry for Data Point 2).

5. Press **NEXT** key <u>once</u>.

   The display will read last entered height value <u>plus one digit</u>. If last height entry was 0.00 ft. as in this example, the display will read "0.01 ft". The instrument software automatically ensures that each successive height entry is higher than the last.

6. Use ⬆ and ⬇ keys to make display indicate the known height value corresponding to the 100.0% level entry for Data Point 2 (85.00 ft for this example).
7. Press **ENTER/AUTO** key ("OK" flashes to confirm height value entry for Data Point 2).

Ending/Storing The Table

The table is now complete. To end the table after entering the values for these two data points:

1. Press the **NEXT** key once, disregarding the "Add" display indication.
2. Press **EXAM/CANCEL** key to return to the % level measuring mode.
3. The table data is now stored. With display reading % level, press **DISP VAR** key once to display the measured and converted % level as height.

Changing An Existing Table

The % level and/or height values may be changed for either data point in an existing table. To do this:

1. With display in % level or converted level measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "TABL USEr".
3. Press **NEXT** key until display indicates "En 1". If the value(s) for Data Point 2 need to be changed, use the ⬆ key to make display indicate "En 2".
4. Press **NEXT** key to display existing % level value for that data point. If it's to remain the same, perform step 5. If not, use ⬆ and ⬇ keys to change the value and press **ENTER/AUTO** key to store it ("OK" flashes to confirm entry).
5. Press **NEXT** key to display existing height value for that data point. Use ⬆ and ⬇ keys to change the value and press **ENTER/AUTO** key to store it ("OK" flashes to confirm entry.
6. If the other data point in the table needs changing , repeat steps 3, 4 and 5 to change and store entry values in the table.
7. When changes are completed, press **EXAM/CANCEL** key to return to the measurement mode.

5.2 Volume Or Weight In Linear Vessels

When measuring volume or weight in a linear vessel, linearization is not necessary. If the vessel is non-linear, an appropriate linearization table must be used (see Section 5.3). To display volume or weight in units other than % level in linear vessels, use the same precedures in the "Selecting User-Defined

Table" and "Changing An Existing Table" subsections in Section 5.1, except enter appropriate volume or weight values instead of height values.

5.3 Volume Or Weight In Non-Linear Vessels

Because volume or weight measurements are affected by the vessel shape, one of the following linearization tables must be used to linearize the measurement:

- TABL CYL* – Only for horizontal cylindrical vessels with flat ends.
- TABL SPH* – Only for spherical vessels.

*These tables use the appropriate equation expressing the respective vessel shape and only require entering one volume or weight value that corresponds with the calibrated 100.0% level. Refer to "Using TABL CYL Or TABL SPH Tables" subsection for instructions.

- TABL USEr – For any other shaped vessels. This user-defined table allows the operator to create a custom table. Refer to "Using TABL USEr Table" subsection for instructions.

NOTE: *When measuring a non-conductive material in a non-linear vessel, a concentric shield level probe must be used or the probe must be mounted in a grounded metal standpipe. This is necessary because of the varying distance between the level probe and the vessel wall, which would otherwise cause the probe to generate a non-linear capacitance over its length. If the measured material is conductive and grounded, disregard this note.*

Using TABL CYL Or TABL SPH Tables

The TABL CYL and TABL SPH tables are provided to conveniently linearize these two common vessel shapes. Only one volume or weight value needs to be entered into the table. These same vessel shapes could also be handled by the user-defined table, but would require many more data point entries to achieve the same linearization.

The procedure to set up either of these two tables to linearize the measurement and convert % level to volume or weight is described with the following example:

> TABL CYL OR TABL SPH SETUP EXAMPLE
>
> Suppose the vessel is a horizontal cylinder with flat ends and it is desired to display measured level as volume. Also, it is known that 6000 gallons corresponds to the calibrated 100.0% level in the vessel.

Selecting Desired Table

1. With display in % level measuring mode, press **EXAM/ CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "TABL" and either "OFF", "CYL", "SPH", "FLO3", "FLO5" or "USEr".
3. Use ⬆ and ⬇ keys to make display indicate the desired linearization table ("TABL CYL" for this example).
4. Press **ENTER/AUTO** key to enter selected table ("OK" flashes to confirm entry).

Selecting Readout Measurement Units

1. Press **NEXT** key <u>once</u> to make display indicate "TABL Unit".
2. Use ⬆ and ⬇ keys to make display indicate the desired measurement unit and multiplier annunciator, if any ("gal" without x100 or x1000 annunciator for this example).
3. Press **ENTER/AUTO** key to enter selected measurement unit ("OK" flashes to confirm entry).

Selecting Decimal Point Position

1. Press **NEXT** key <u>once</u> to make display indicate "dPdP".
2. Use ⬆ and ⬇ keys to make display indicate the desired decimal point position, if any ("dPdP" for this example since no decimal point is needed).
3. Press **ENTER/AUTO** key to enter selected decimal point position ("OK" flashes to confirm entry).

Entering Maximum Vessel Volume Or Weight

Enter known volume or weight value (maximum vessel capacity) that corresponds with the calibrated 100.0% level. To do this:

1. Press **NEXT** key <u>once</u> to make display indicate "TABL".
2. Use ⬆ and ⬇ keys to make display indicate the known volume or weight value when measured level is 100.0% full (6000 gallons for this example).
3. Press **ENTER/AUTO** key to enter known volume or weight value ("OK" flashes to confirm entry).

Storing The Table

1. Press **EXAM/CANCEL** key to return display to the % level measuring mode.
2. The table data is now stored. With display reading % level, press **DISP VAR** key <u>once</u> to display the linearized and converted % level as volume or weight.

Using TABL USEr Table

This table is used to linearize the measurement in any shaped vessel and convert % level to volume or weight. Up to 32 data points, each defining a calibrated % level and corresponding known volume or weight value, may be permanently stored in this table. Even if power is lost or turned off, this data remains stored. Battery backup is not required. At any time, this table may be changed or completely deleted so that a new table can be entered.

Before using this table, the volume or weight value for each calibrated % level point must be determined by calculation, or obtained from a known tank strapping table typically provided by the vessel manufacturer. Vessels for which the user-defined table is commonly used are horizontal cylinders with dished ends and upright cylinders and bins with cone-shaped bottoms.

Although you may use fewer than 32 data points, best accuracy is obtained when all 32 points of the table are entered. This is because each set of two data points defines one segment for linearization. More data points provide more segments, allowing each segment to be smaller for more precise linearization.

NOTE: *It is recommended that the operator plan ahead and obtain values for each point in the table before beginning data entry.*

Use this convenient table to write in and organize values for the data points you're using in the user-defined linearization table.

Table B – VALUES FOR USER-DEFINED LINEARIZATION TABLE

Data Point	Calibrated % Level Value (relative to total measuring span)	Corresponding Known Volume Or Weight Value	Data Point	Calibrated % Level Value (relative to total measuring span)	Corresponding Known Volume Or Weight Value
En 1 En 2 En 3 En 4			En17 En18 En19 En20		
En 5 En 6 En 7 En 8			En21 En22 En23 En24		
En 9 En10 En11 En12			En25 En26 En27 En28		
En13 En14 En15 En16			En29 En30 En31 En32		

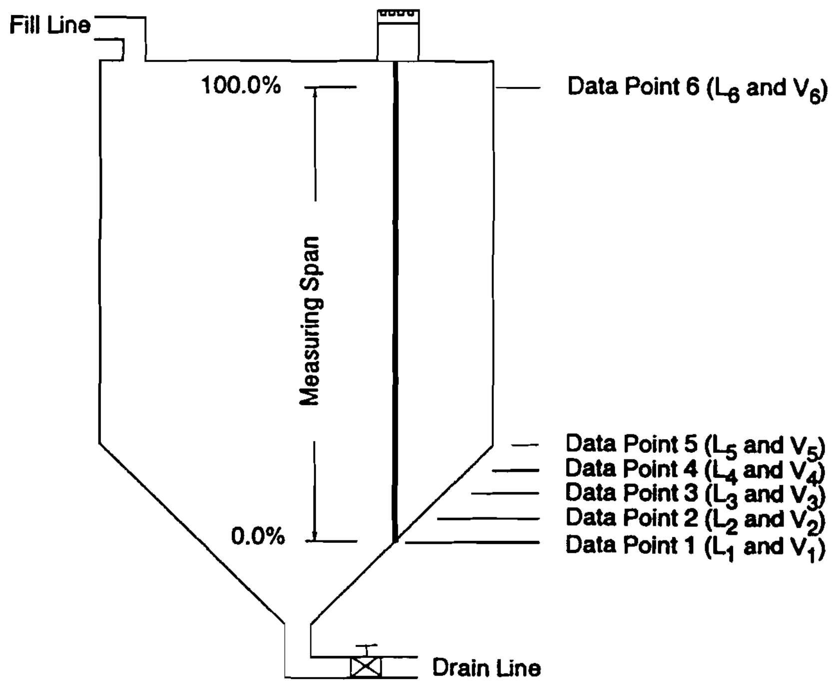
-The procedure to set up a user-defined linearization table is described with the following example:

TABL USEr SETUP EXAMPLE

Suppose the vessel is an upright cylinder with cone-shaped bottom and it is desired to display measured level as volume. Other operational requirements are:

- The level probe measures from 1 ft. below the vessel top (100.0% full) to half the distance into the conical bottom (0.0% empty) due to probe mounting limitations.
- A 6-point linearizing table is sufficient to obtain desired accuracy, with 5 points defining the volume in the conical section. The known volume values for the 6 level points are:

Level Point		Known Volume	
L_1	0.0%	V_1	30 gal
L_2	5.0%	V_2	38 gal
L_3	10.0%	V_3	50 gal
L_4	15.0%	V_4	65 gal
L_5	20.0%	V_5	87 gal
L_6	100.0%	V_6	1500 gal



Selecting User-Defined Table

1. With display in % level measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "TABL" and either "OFF", "CYL", "SPH", "FLO3", "FLO5" or "USEr".
3. Use ⬆ and ⬇ keys to make display indicate "TABL USEr".
4. Press **ENTER/AUTO** key to enter user-defined table ("OK" flashes to confirm entry).

Selecting Readout Measurement Units

1. Press **NEXT** key <u>once</u> to make display indicate "TABL Unit".
2. Use ⬆ and ⬇ keys to make display indicate the desired measurement unit and multiplier annunciator, if any ("gal" without x100 or x1000 annunciator for this example).
3. Press **ENTER/AUTO** key to enter selected unit ("OK" flashes to confirm entry).

Selecting Decimal Point Position

1. Press **NEXT** key <u>once</u> to make display indicate "dPdP".
2. Use ⬆ and ⬇ keys to make display indicate the desired decimal point position, if any ("dPdP" for this example since no decimal point is needed).
3. Press **ENTER/AUTO** key to enter selected decimal point position ("OK" flashes to confirm entry).

Entering A New Table

1. Press **NEXT** key <u>once</u>. The display will read "Add" or "En 1". If "En 1" appears, the table contains previously entered data which must be deleted before proceeding. To do this:

   A. With display indicating "En 1", press ⬇ key to make display indicate "Init". The table is now in an initialize mode.

   B. Press **ENTER/AUTO** key. The display flashes "OK" to confirm that the existing table has been erased and then indicates "Add" to prompt the operator to enter a new table.

2. With "Add" being displayed, press the **ENTER** key.

   The display flashes "OK" to confirm that a new table can be entered and then indicates "En 1" to inform operator that entry for Data Point 1 can begin.

3. Press **NEXT** key <u>once</u>.

   The display will read "TABL 0.0%". This is the point on the level probe at which the table begins and corresponds with the calibrated 0.0% level.

4. Press **ENTER/AUTO** key ("OK" flashes to confirm % level value entry for Data Point 1 which, for this example, is 0.0% for L_1 at the tip of the level probe).

   *NOTE: To begin the table at a point above the calibrated 0.0% level, use ⬆ and ⬇ keys to make display indicate the desired % level point before pressing the **ENTER/AUTO** key. For example, the display should read "25.0%" if the table is to begin one-fourth up the level probe from the tip.*

5. Press **NEXT** key once.

   The display will read "TABL" and, depending on previously selected decimal point position, "0.000", "00.00", "000.0" or "0000" with selected measurement unit and multiplier annunciators (if used).

6. Use ⬆ and ⬇ keys to make display indicate the known volume value corresponding to the 0.0% level entry for Data Point 1 (30 gal for V_1 in diagram for this example).

7. Press **ENTER/AUTO** key ("OK" flashes to confirm volume value entry for Data Point 1).

8. Press **NEXT** key once. With "Add" being displayed, press **ENTER** key.

   The display flashes "OK" to confirm that another data point can be entered and then indicates "En 2" to prompt operator to enter a % level value for Data Point 2.

9. Press **NEXT** key once.

   The display will read last entered level value plus 0.1%. If last level entry was 0.0% as in this example, the display will read "0.1%". The instrument software automatically ensures that each successive level entry is higher than the last.

10. Use ⬆ and ⬇ keys to make display indicate the level value for Data Point 2 (5.0% for L_2 in this example).

11. Press **ENTER/AUTO** key ("OK" flashes to confirm % level value entry for Data Point 2).

12. Press **NEXT** key once.

    The display will read last entered volume value plus one digit. If last volume entry was 30 gal as in this example, the display will read "31 gal". The instrument software automatically ensures that each successive volume entry is higher than the last.

13. Use ⬆ and ⬇ keys to make display indicate the known volume value corresponding to the % level entry for Data Point 2 (38 gal for V_2 in diagram for this example).

14. Press **ENTER/AUTO** key ("OK" flashes to confirm volume value entry for Data Point 2).

15. Repeat steps 8 through 14 for each remaining data point in the table to enter % level and corresponding volume values.

    NOTE: For each successive data point, the displayed number increases by one (En 2, En 3, En 4, etc. up to En 32).

Ending/Storing The Table

For this example, the table is complete after entering the sixth set of values. To end the table after entering all data point values:

1. Press the **NEXT** key <u>once</u>, disregarding the "Add" display indication.

2. Press **EXAM/CANCEL** key to return to the % level measuring mode.

3. The table data is now stored. With display reading % level, press **DISP VAR** key <u>once</u> to display the linearized and converted % level as volume or weight.

Changing An Existing Table

The % level and/or volume or weight values may be changed for any data point in an existing user-defined table. To do this:

1. With display in % level or converted level measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.

2. Press **NEXT** key until display indicates "TABL USEr".

3. Press **NEXT** key until display indicates "En 1". Use the ⬆ key to make display indicate the data entry point (En 5 for example) whose value(s) are to be changed.

4. Press **NEXT** key to display existing % level value for that data point. Use ⬆ and ⬇ keys to change the value and press **ENTER/AUTO** key to store it ("OK" flashes to confirm entry).

5. Press **NEXT** key to display existing volume or weight value for that data point. Use ⬆ and ⬇ keys to change the value and press **ENTER/AUTO** key to store it ("OK" flashes to confirm entry).

6. Repeat steps 3, 4, and 5 to change and store entry values for any other data point in the table.

7. When changes are completed, press **EXAM/CANCEL** key to return to the measurement mode.

5.4 Flow In An Open Channel

Determining Which Linearization Table To Use

When measuring open channel flow in a flume or weir, one of the built-in flow linearization tables must be used to linearize the measurement. Find your type of flume or weir in the following list to determine which linearization table to use:

Type Of Flume Or Weir	Linearization Table To Use
Parshall flume	FLO 3
Palmer-Bowlus flume	FLO 3
V-notch weir (all angles)	FLO 5
Rectangular weir (with or without end contractions)	FLO 3
Cipolletti weir	FLO 3

If these convenient 3/2 or 5/2 power tables do not apply to your flume or weir, the user-defined table can be used to linearize the flow. Refer to the "Using TABL USEr Table" subsection in Section 5.3 for details on setting up a table.

The procedure to set up the "FLO 3" or "FLO 5" tables to linearize the flow is described with the following example:

> TABL FLO 3 OR TABL FLO 5 SETUP EXAMPLE
>
> Suppose a Parshall flume is used and it is known that 300.0 GPM maximum flow corresponds to the calibrated 100.0% level in the channel.

Selecting Desired Table

1. With display in % level measuring mode, press **EXAM/ CANCEL** key to place display in "examination" mode.

2. Press **NEXT** key until display indicates "TABL" and either "OFF", "CYL", "SPH", "FLO 3", "FLO 5" or "USEr".

3. Use ⬆ and ⬇ keys to make display indicate the desired linearization table ("TABL FLO 3" for this example).

4. Press **ENTER/AUTO** key to enter selected table ("OK" flashes to confirm entry).

Selecting Readout Measurement Units

1. Press **NEXT** key once to make display indicate "TABL Unit".

2. Use ⬆ and ⬇ keys to make display indicate the desired measurement unit and multiplier annunciator, if any (no unit

annunciator for this example since GPM is not available from the menu).

3. Press **ENTER/AUTO** key to enter selected measurement unit ("OK" flashes to confirm entry).

Selecting Decimal Point Position

1. Press **NEXT** key once to make display indicate "dPdP".
2. Use ⬆ and ⬇ keys to make display indicate the desired decimal point position, if any ("dPd.P" for this example).
3. Press **ENTER/AUTO** key to enter selected decimal point position ("OK" flashes to confirm entry).

Entering Maximum Flow Rate

Enter known open channel maximum flow rate that corresponds with the calibrated 100.0% level. To do this:

1. Press **NEXT** key once to make display indicate "TABL".
2. Use ⬆ and ⬇ keys to make display indicate the known open channel maximum flow rate value when measured level is 100.0% full (300.0 GPM flow for this example).
3. Press **ENTER/AUTO** key to enter known maximum flow value (display flashes "OK" to confirm entry).

Storing The Table

1. Press **EXAM/CANCEL** key to return display to the % level measuring mode.
2. The table data is now stored. With the display reading % level, press **DISP VAR** key once to display the linearized and converted % level as flow in an open channel.

SECTION 6 - RELAY SETUP

6.1 Operating Descriptions

The 672L receiver/controller is equipped with three SPDT relays, each having settings for a setpoint, deadband and response time which are entered via the keypad. Each relay can be independently set up via slide switch settings for a LO or HI operating mode.

- In the LO operating mode, the relay operates in response to decreasing measured level. The relay will transfer at the setpoint and will reset when the measured level rises above the setpoint plus the entered deadband.
- In the HI operating mode, the relay operates in response to increasing measured level. The relay will transfer at the setpoint and will reset when the measured level falls below the setpoint minus the entered deadband.

NOTE: *If the appropriate relay operating mode is not correctly selected for the application (LO mode for level that is* *typically above the setpoint and HI mode for the opposite condition), the relay will not operate as described.*

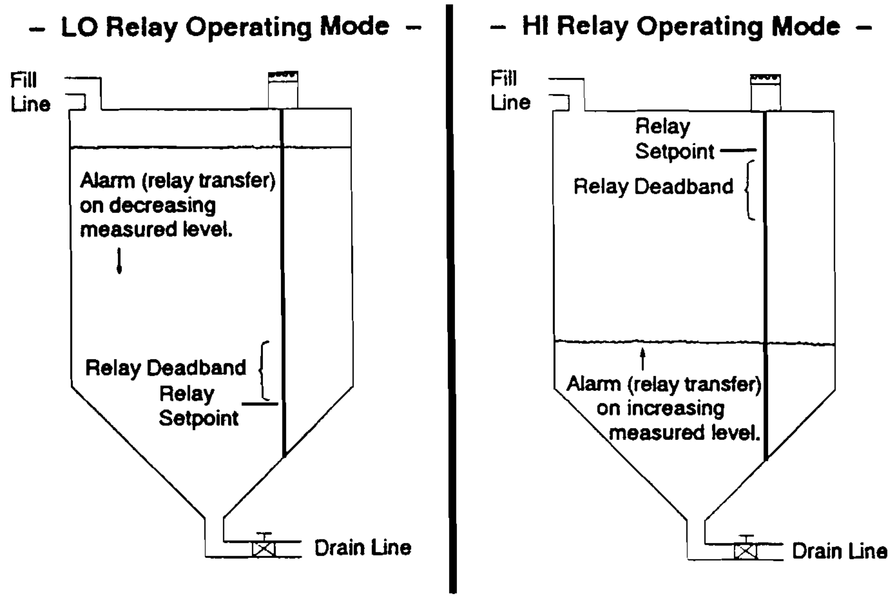


FIGURE 3-3 Relay Operating Mode Setup Diagrams

If a response time setting is entered, this time begins to elapse when the measured level reaches the setpoint, regardless of whether the relay is set to a LO or HI operating mode. In effect, this provides a time delay added to when the relay transfer would normally occur.

Lastly, Relay C may be alternately selected to operate as a "system diagnostic alarm" relay. This configuration overrides the normal LO or HI relay operating mode, enabling Relay C to deenergize whenever the 672L detects a system diagnostic error or power failure to alert the operator.

The 672L relay logic is purposely designed for fail-safe operation so that if normal operation is interrupted by a power failure or internal system failure, the relays will default to a safe condition. That is, the normally open and normally closed contacts will transfer.

NOTE: *If one of the linearization tables is being used and it is desired to have the relays track the converted level instead of % level, locate the group of eight switches at lower right of the LCD board assembly (Figure 3-1) and place **SWITCH 1** in **VOL** (on/left) position. Also, the relay setpoint and deadband setup variable values will then be displayed in the converted measurement units.*

*Switching **SWITCH 1** does not automatically convert values. Once table values are set, if switch is changed, table values need to be reset.*

The procedure to set up a relay for the LO operating mode is described with the following example.

LO OPERATING MODE RELAY SETUP EXAMPLE
Suppose the operational requirements for Relay A are: – Relay A transfers at 20.0% of full scale as the measured level decreases. – When the 20.0% relay setpoint is reached, a response time delay of 2.5 seconds must elapse before Relay A transfers. – Relay A resets at 30.0% of full scale as the measured level increases above the setpoint.

6.2 Selecting Relay Operating Mode

Locate the group of eight switches at lower right of the LCD board assembly (Figure 3-1) and place **SWITCH 2** in **LO** (off/right) position to make Relay A operate in response to decreasing level for this example. For applications that require the relay to operate in response to increasing level, place switch in **HI** (on/left) position. Use **SWITCH 3** and **SWITCH 4** to select operating response modes for Relay B and Relay C respectively.

6.3 Entering Relay Setpoint

1. With display in % level or converted level measuring mode (% level for this example), press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "A SET PT" for this example (B SET PT for Relay B, etc.)
3. Use ⬆ and ⬇ keys to make display indicate desired setpoint value at which relay is to transfer (20.0% for this example).
4. Press **ENTER/AUTO** key to enter value ("OK" flashes to confirm entry).

6.4 Entering Relay Deadband

1. Press **NEXT** key until display indicates "DB A" for this example (DB B for Relay B, etc.).
2. Calculate the deadband entry:

   A. For LO Operating Mode

   Subtract the point at which the relay transfers from the desired point at which the relay is to reset. For this example, the deadband is 10.0% (30.0% minus 20.0% or 10.0%).

B. For HI Operating Mode

Subtract the desired point at which the relay is to reset from the point at which the relay transfers. For example, 90.0% minus 75.0% or 15.0% deadband.

NOTE: If the calculated deadband is less than 0.1% or more than 100.0% of full scale, it falls outside the entry range of the instrument and cannot be entered.

When LO/HI mode switch for respective relay is set to **LO** position, the relay will reset at the deadband above the setpoint. When set to **HI** position, the relay will reset at the deadband below the setpoint.

3. Use ⬆ and ⬇ keys to make display indicate calculated deadband from step 2.
4. Press **ENTER/AUTO** key to enter value ("OK" flashes to confirm entry).

6.5 Entering Relay Response Time

1. Press **NEXT** key until display indicates "RES A" for this example (RES B for Relay B, etc.).
2. Use ⬆ and ⬇ keys to make display indicate desired response time (2.5 seconds for this example).
3. Press **ENTER/AUTO** key to enter value ("OK" flashes to confirm entry).

6.6 Relay C System Diagnostic Alarm Operation

Relay C can be used to alert the operator if the 672L detects a system diagnostic error (displayed as "ERR 1", "ERR 2", "ERR 3" or "ERR 4") or power failure. When any of these conditions occurs, Relay C will deenergize. When Relay C is set up to operate as a "system alarm" relay, all other Relay C slide switch settings are ignored including all entered Relay C setup variable values (setpoint, deadband and response time).

To setup Relay C to operate as a "system diagnostic alarm" relay, locate the group of eight switches at lower right of the LCD board assembly (Figure 3-1) and place **SWITCH 5 in ON** (left) position. To disable the "system alarm" capability and return Relay C to its normal operation, place this switch in the **OFF** (right) position.

The 672L receiver/controller may provide the optional LEVEL/VOLUME OUTPUTS (Output A). These 0-5 VDC, 0-1 mA and 4-20 mA analog signals track the measured level in % or in the measurement units established with one of the linearization tables.

NOTE: *The output display mode indicates the 4-20 mA signal only, regardless of which output signals are actually being used.*

The LEVEL/VOLUME OUTPUTS can represent the entire measuring scale or a desired segment of it. The LO OUT A and HI OUT A setup variables are used to enter the low and high endpoints of the segment at which the minimum and maximum values of these outputs are provided. 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 level or volume increases) by entering the higher value with LO OUT A and the lower value with HI OUT A.

— When the measured level (or volume) is below or above the desired segment, the outputs are limited to their designated minimum and maximum values respectively.

NOTE: *If one of the linearization tables is being used and it is desired to have the outputs track the converted level instead of % level, locate the group of eight switches at lower right of the LCD board assembly (Figure 3-1) and place **SWITCH 1** in **VOL** (on/left) position. Also, the LO and HI OUT A setup variable values will then be displayed in the converted measurement units.*

*Switching **SWITCH 1** does not automatically convert values. Once table values are set, if switch is changed, table values need to be reset.*

The procedure to set up the LEVEL/VOLUME OUTPUTS is described with the following example.

LEVEL/VOLUME OUTPUTS SETUP EXAMPLE
Suppose the 4-20 mA output is desired between 30.0 and 70.0% of the measuring scale and that it is to increase as the measured level increases (non-inverted output).

7.1 Setting The Low Endpoint

The low endpoint, entered with the LO OUT A setup variable, is the point at which the minimum outputs (0 VDC, 0 mA and 4 mA) are provided.

1. With display in % level or converted level measuring mode (% level for this example), press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "LO OUT A".
3. Use ⬆ and ⬇ keys to make display indicate the low endpoint at which the minimum outputs are to be provided (30.0% for 4 mA for this example).

   NOTE: *Entry must be at least 10.0% away from any high endpoint previously entered with HI OUT A.*

4. Press **ENTER/AUTO** key to enter value (display flashes "OK" to confirm entry or flashes "ERROR" if difference between entry value and HI OUT A is less than 10.0%).

7.2 Setting The High Endpoint

The high endpoint, entered with the HI OUT A 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 the "examination" mode, press **NEXT** key once to make display indicate "HI OUT A".
2. Use ⬆ and ⬇ keys to make display indicate the high endpoint at which the maximum outputs are to be provided (70.0% for 20 mA for this example).

   NOTE: *Entry must be at least 10.0% away from LO OUT A endpoint.*

3. Press **ENTER/AUTO** key to enter value (display flashes "OK" to confirm entry or flashes "ERROR" if difference between entry value and LO OUT A is less than 10.0%).

7.3 Simulating A LEVEL/VOLUME Output Value

To aid in setting up external devices (recorders, controllers, etc.) connected to the LEVEL/VOLUME OUTPUTS (Output A), the values for these outputs may be simulated. This can only be accomplished when the security lock feature is in the unlock mode (Section 10.2). Scrolling to the "OUT A" setup variable displays and holds the 4-20 mA signal representing the last measured level when this variable is called up. The corresponding 0-5 VDC and 0-1 mA signals are also held constant. When scrolling past this variable to another variable, the outputs are only held momentarily. To simulate a desired output:

1. With display in "examination" mode, press **NEXT** key until display indicates "OUT A" and a numerical mA value. This

value and the other corresponding LEVEL/VOLUME OUTPUT values are now provided and held for 30 minutes unless they are changed.

2. Use ⬆ and ⬇ keys to make display indicate the desired output in mA.

3. Press **ENTER/AUTO** key to enter value (display flashes "OK" to confirm entry). At this time, each LEVEL/VOLUME output signal is held for 30 minutes at the value that corresponds with the set mA entry, unless cancelled by pressing **EXAM/CANCEL** or **NEXT** keys. Pressing any other key extends the hold period for another 30 minutes. After the hold period expires, the instrument automatically returns to the measurement mode of operation and provides output signals corresponding to the measured level.

SECTION 8 - THE OPTIONAL PID CONTROLLER

8.1 Introduction

PID (Proportional-Integral-Derivative) control refers to a controller whose output is a sum of three terms derived from operations on the difference between the process variable (PV), level in this case, and the desired value at which the process is to be controlled (setpoint). The controller output is connected to a final control element, such as a modulating valve, that can act to bring the process to the desired state.

There are many forms of PID controllers. The one implemented in the 672L is referred to as the ISA standard non-interacting type. The following equation defines the relationship between controller functions:

$$m = P\left[(pv - r) + I\int (pv - r)\,dt + D\frac{dpv}{dt} \right]$$

where m	=	Controller output	r	=	Setpoint
P	=	Proportional gain	I	=	Integral gain
pv	=	Measured process variable (level)	D	=	Derivative gain

Gain Factors

- Proportional gain increases or decreases the controller output in direct proportion to the control error (pv – r, in the preceding equation). The entry value range for proportional gain is from –99.99 to +99.99. Entering "–" values provides reverse acting control; "+" values direct acting control.

- Integral gain increases or decreases the controller output in direct proportion to the time integral of the error. If the error is constant, the correction increases with time. It is an inherent property of proportional control that it does not bring the process to setpoint all the time. Integral action forces the process to the setpoint (unless the controller is improperly tuned). The entry value range for integral gain is from 0.00 to 99.99 repeats/minute.

The action of the controller varies with the integral gain value. If integral gain is set to some value other than 0.00, then the integral action is automatic. If set to 0.00, the controller has "manual reset", which allows a fixed offset to be added to the controller output.

- Derivative gain increases or decreases the controller output in direct proportion to the rate of change of the process value. This is used to compensate for second order effects in the process. Most processes have one dominant response time, such as the response to mixing in a tank. If there are two response times in the process, derivative gain will help compensate for the second one. If a process has only one dominant response time, derivative gain will not help. It is best to start tuning the controller without any derivative gain. The entry value range for derivative gain is 0.000 to 9.999 minutes.

Modes Of Operation

The controller can be transferred between an automatic mode, where the program calculates the output, and a manual mode, where the operator determines and manually sets the output. To put the controller in the manual mode, press and hold **MANUAL** key for at least 2 seconds. The output can be set to any value within its range. The controller has "bumpless transfer", meaning that when transferring between auto and manual modes, the output changes smoothly without abrupt jumps that could damage a final control element.

In addition, the controller has "anti-reset windup" software so that the output does not remain saturated at one endpoint if the process is recovering from an upset condition.

8.2 Tuning Guidelines

In practice, most controllers are actually tuned by setting gain factors to some initial, typical values. Settings are then readjusted by experimentation on the basis of observed response. Typical controller gain settings are:

Proportional Gain — From +5.00 to +99.99
Integral Gain — From 4.00 to 20.00 repeats/minute
Derivative Gain — From 0.010 to 0.050 minutes

Level applications commonly require that the controller be detuned (proportional gain increased and derivative gain decreased) because of excessive process noise. Selection of control element and measurement spans is important for successful control. A full-scale stroke should provide a full-scale change in measurement signal for self-regulating processes. Level applications typically have an integrating response. Avoid using integral gain unless derivative gain can also be used. Neither of these gains are needed if proportional gain is more than 90.00. Distillation column liquid level applications (shrink) and boiler drum applications (swell) may be noisy and have an inverse response where initial response is opposite to the final response. These applications may require a small amount of proportional gain.

After establishing the controller setpoint and controlling the level manually, the Ultimate Oscillation Tuning Method (Section 8.3) may be used to tune the controller.

Establishing Controller Setpoint

The controller setpoint is the desired value at which the level is to be controlled, based on application requirements. To enter a controller setpoint:

1. With display in level (or volume) measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.
2. Press **NEXT** key until display indicates "SET PT PID".
3. Use ⬆ and ⬇ keys to make display indicate desired setpoint value.
4. Press **ENTER/AUTO** key to enter value (display flashes "OK" to confirm entry).

Controlling Level Manually

Before tuning the controller to process dynamics, control the level manually. By doing so, the system control element can be checked for proper sizing and a "feel" for control system capability can be obtained.

1. A strip chart recorder should be used to observe the control effect on the level (or volume). Connect recorder across appropriate OUTPUT A terminals to monitor the measured level.
2. With display in level (or volume) measuring mode press and hold **MANUAL** key for at least 2 seconds to place controller in manual operating mode (display flashes "MANUAL" to confirm mode status). Use ⬆ and ⬇ keys to manually control the level to the desired setpoint value.
3. Note the controller output at this time. If controller output is less than 10%, the control element may be oversized. If output is greater than 90%, the control element may be undersized. A well-designed system typically requires a controller output of 50% when level is at the setpoint value. If level can be controlled manually, the controller should be able to automatically control it.

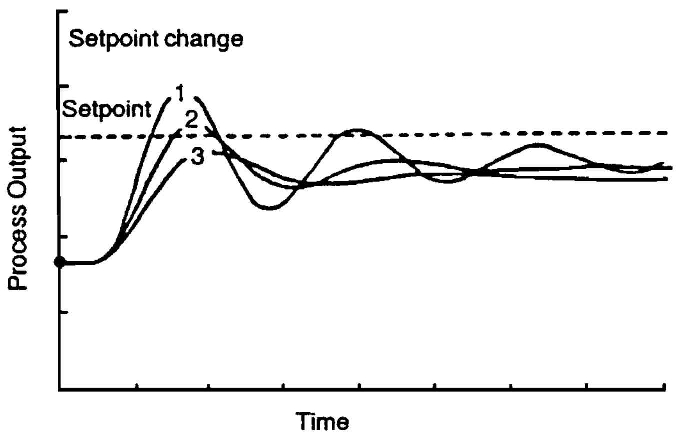
8.3 Ultimate Oscillation Tuning Method

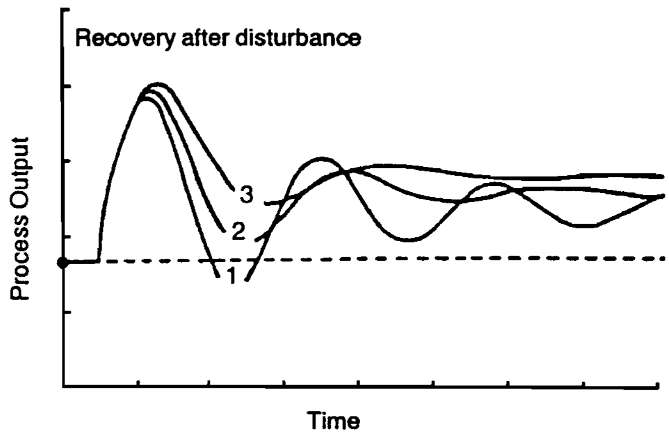
This method requires that the loop response develops undamped oscillations that may be undesirable from an operational or safety viewpoint. These oscillations may be difficult to prevent from growing or from reaching some physical limit.

Proportional Gain Effects On Response

By increasing proportional gain, the setpoint offset (sustained error) decreases but reponse becomes more oscillatory. The following diagrams illustrate this effect, where curves 1, 2 and 3 use proportional gain settings of +75.00, +65.00 and +50.00 respectively. An entered gain of 0.00 disables the controller.

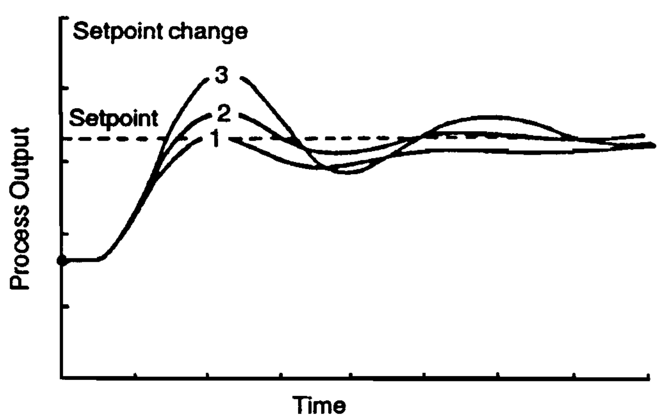
NOTE: *Proportional gain is the inverse of proportional band. That is, increasing proportional gain is equivalent to decreasing proportional band.*

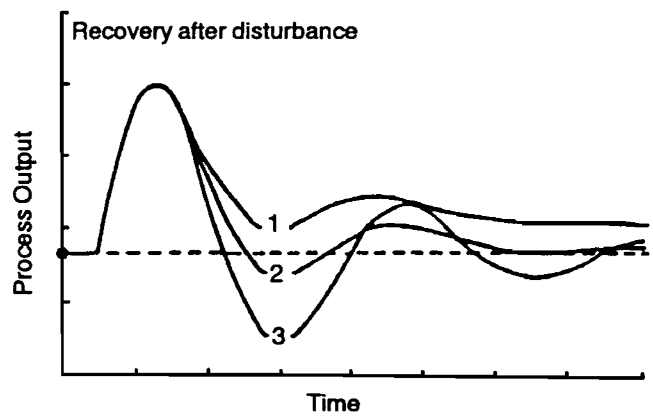




Integral Gain Effects On Response

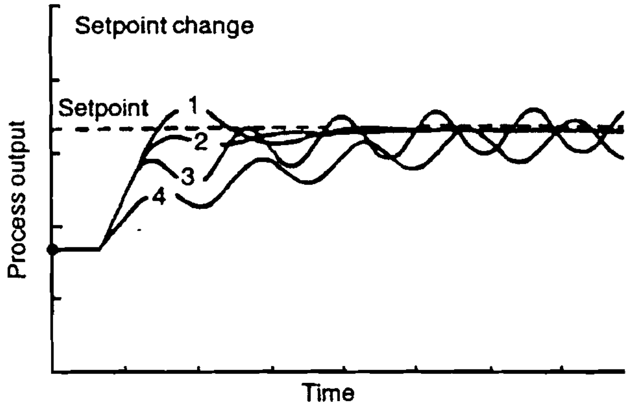
By increasing integral gain, the offset from setpoint is eliminated faster but the response becomes more oscillatory. If integral gain is increased too much, oscillations develop into a reset cycle whose period is much longer than the "ultimate" period. The following diagrams illustrate this effect, where curves 1, 2 and 3 use integral gain settings of 0.02, 0.05 and 0.10 repeats/minute respectively. An entered gain of 0.00 provides manual reset, allowing a fixed offset to be added to the controller output.

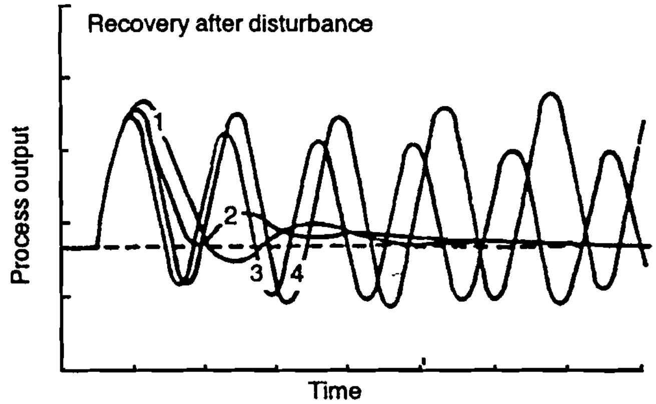




Derivative Gain Effects On Response

By increasing derivative gain, the overshoot for setpoint changes and peak error for load disturbances is reduced but response becomes more oscillatory. If response turns back as level approaches setpoint before crossing the setpoint, derivative time is longer than normal. If derivative gain is increased too much, oscillations develop into a rate cycle whose period is shorter than the "ultimate" period. The following diagrams illustrate this effect, where curves 1, 2, 3 and 4 use derivative gain settings of 2.000, 5.000, 10.000 and 20.000 minutes respectively. An entered gain of 0.000 disables the derivative response.





Tuning Procedure

1. Enter "0.00" for proportional gain setting:

   A. With display in % level or converted level measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode.

   B. Press **NEXT** key until display indicates "PRO PID".

   C. Use ⬆ and ⬇ keys to make display indicate "0.00".

   D. Press **ENTER/AUTO** key to enter value (display flashes "OK" to confirm entry).

2. Enter "0.00" for integral gain setting:

   A. With display still in the "examination" mode, press **NEXT** key <u>once</u> to make display indicate "INT PID".

   B. Use ⬆ and ⬇ keys to make display indicate "0.00".

   C. Press **ENTER/AUTO** key to enter value (display flashes "OK" to confirm entry).

3. Enter "0.000" for derivative gain setting:

   A. With display still in the "examination" mode, press **NEXT** key <u>twice</u> to make display indicate "DER PID".

B. Use ⬆ and ⬇ keys to make display indicate "0.000".

C. Press **ENTER/AUTO** key to enter value (display flashes "OK" to confirm entry).

4. Adjust controller output manually to obtain a measurement as close to mid-scale as possible:

   A. With display in % level or converted level measuring mode, press and hold **MANUAL** key for at least two seconds to place controller in manual operating mode.

   B. Observe the recorder trace to monitor the level. Use ⬆ and ⬇ keys to bring level to mid-scale.

5. Switch controller to the automatic mode by pressing **ENTER/AUTO** key.

6. Increase "PRO PID" setting in small steps (5.00 increments) until observed oscillations neither grow nor diminish in amplitude. If oscillations saturate at either extreme, repeat step 4 to stabilize the response. If there are not enough disturbances to start the oscillations, jog the setpoint.

   NOTE: *Oscillations only have to be approximately equal in amplitude, not exact.*

7. Note "PRO PID" setting, referred to as the ultimate proportional gain (PG_U) for this tuning method, and measure the time period between the oscillations, referred to as the ultimate time (T_U). If recorder chart speed is too slow, time the interval between the first and third measurement trace past the controller setpoint.

8. Use the PG_U setting and T_U time period noted in step 7 to calculate <u>estimated</u> controller gain settings. Depending on which gains the operator intends to apply, use the following equations:

   A. When using proportional gain only —

      Estimated "PRO PID" Setting = 0.55 x PG_U

   B. When using proportional plus integral gains (PI) —

      Estimated "PRO PID" Setting = 0.45 x PG_U
      Estimated "INT PID" Setting = 0.83 x T_U

   C. When using proportional plus integral plus derivative gains (PID) —

      Estimated "PRO PID" Setting = 0.60 x PG_U
      Estimated "INT PID" Setting = 0.50 x T_U
      Estimated "DER PID" Setting = 0.125 x T_U

9. Enter each estimated gain based on the calculations in step 8.

10. Readjust gain setting(s) by experimentation on the basis of observed response.

SECTION 9 - OPTIONAL DIGITAL COMMUNICATION OUTPUT SETUP

Refer to SUPPLEMENTAL MANUAL No. 123 for complete details on this option.

SECTION 10 - USING SECURITY LOCK FEATURE

A security lock feature is provided to prevent unauthorized alteration of stored values. When the 672L receiver/controller is locked (identified with lit "LOCK" status indicator), stored setup variable values—including low and high level calibration points—cannot be changed. However, all stored values can be displayed.

10.1 Locking Stored Values

1. With display in % level or converted level measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "0000" — the identifier for security lock feature).
2. Use ⬆ and ⬇ keys to make display indicate the lock code "0001."
3. Press **ENTER/AUTO** key to enter lock code ("LOCK" status indicator lights and display flashes "OK" to confirm lock code entry).
4. Press **EXAM/CANCEL** key to return display to measuring mode.

10.2 Unlocking Stored Values

1. With display in % level or converted level measuring mode, press **EXAM/CANCEL** key to place display in "examination" mode (display indicates "0000" and "LOCK" — the identifiers for security lock feature).
2. Use ⬆ and ⬇ keys to make display indicate the unlock code "1234".
3. Press **ENTER/AUTO** key to enter unlock code ("LOCK" status indicator turns off and display flashes "OK" to confirm unlock code entry).
4. Press **EXAM/CANCEL** key to return display to measuring mode.

PART FOUR - OPERATING AIDS

SECTION 1 - PRESERVING MEASUREMENT ACCURACY

1.1 Avoiding Ground Loop Errors

The system may be affected by a "ground loop" electrical problem when there is moisture in a junction box. This conditon 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.

1.2 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).

PART FIVE - PRINCIPLE OF OPERATION

See Figure 5-1 for functional diagram pertaining to these descriptions:

1. The power-supply section (not shown) converts line power to appropriate voltages for circuit operation.

2. The analog-to-digital converter section in the 699L transmitter accepts signals from the level sensor. This section converts these analog level signals to digital signals for use by the microprocessor in the 672L receiver/controller.

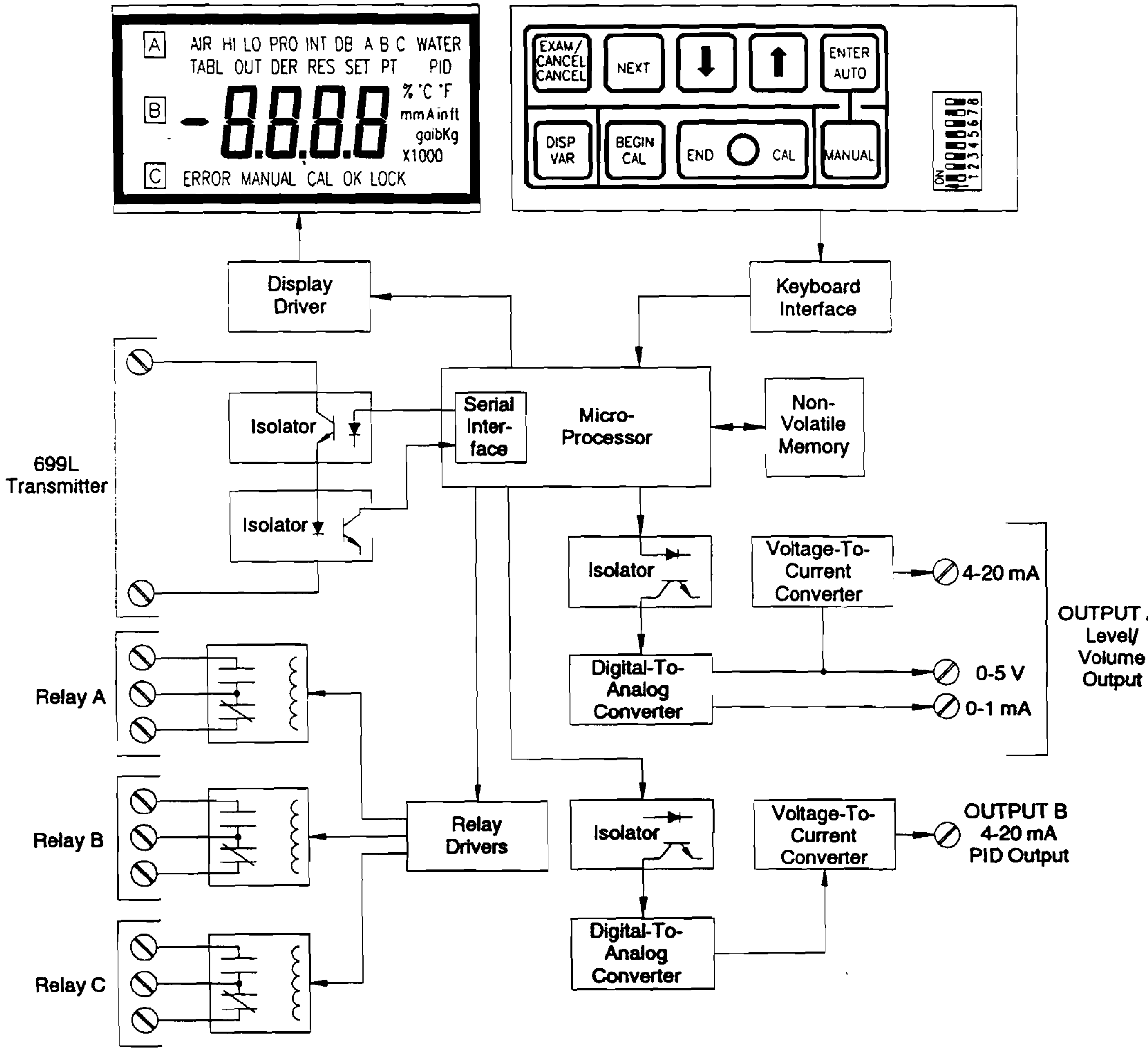


FIGURE 5-1 Instrument Operations Block Diagram

3. Using the level sensor signal, the 699L transmitter computes the % level (or converted level) in the vessel. The microprocessor in the 672L receiver/controller performs the various control algorithms, updates the liquid crystal display, monitors the keypad and other configuration switches, and controls the relay status and the instrument outputs. The user-entered calibration and configuration values are retained in a non-volatile memory.

4. The liquid crystal display indicates the process-related values (% level, converted level, optional 4-20 mA output value and optional PID controller output) along with a variety of annunciators to indicate system status. The display also indicates configuration constant values, error messages, diagnostic information and relay status.

5. The keypad and configuration switches are continuously monitored by the microprocessor. Based on the status of these inputs, the microprocessor immediately initiates the appropriate action.

6 The LEVEL/VOLUME OUTPUTS (0-5 VDC, 0-1 mA and 4-20 mA) are controlled by the microprocessor. The output values are sent through an optical isolator for isolation and then to the digital-to-analog converter section. The analog outputs are all isolated from the inputs, but not from each other.

7. The microprocessor controls the relay driver circuitry, based on each relay's configured mode (DIR or REV) and system alarm operation selection. The relay driver section operates relays A, B and C.

PART SIX - SERVICE AND MAINTENANCE

SECTION 1 - GENERAL

1.1 Inspecting Cables

If a measurement problem exists and any of the cables are suspected, inspect them for physical damage. If triaxial cable is used, disconnect cable at the sensor junction box and 699L transmitter and check wires for internal shorts with an ohmmeter.

1.2 Checking System Periodically

Depending on the application, system calibration should be performed 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 relay from backside of power-supply board (side opposite terminal strips).
5. Replace relay with equivalent relay (GLI p/n 99X2T1030). Solder 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 system operation is signaled by a flashing "ERROR" indicator while the display alternates between a measured value and one of the following error messages:

Table C – SYSTEM DIAGNOSTIC ERROR MESSAGES/MEANINGS

Error Message	Meaning
"ERR1"	**Transmitter Not Responding:** Indicates defective 699L, incorrect system wiring, or an operating problem with the 672L.

Table C (Continued)	
Error Message	Meaning
"ERR 2"	**Transmitter Cannot Measure:** Indicates 699L measurement circuit failure. The 699L may be defective or incorrectly wired to a remote-mounted level probe.
"ERR 3"	**Calibration Error:** Indicates system has never been calibrated or that calibration is not valid. Refer to Part Three, Section 4.3 for details.
"ERR 4"	**Invalid Capacitance Value:** Indicates capacitance value measured by the 699L caused an under or over range condition or that the 699L could not measure the value. This may be caused by a shorted probe, an open probe circuit, or a defective 699L.

NOTE: Whenever any error message is flashed, all relays will deenergize, all LEVEL/VOLUME OUTPUTS will decrease to their minimum values, and the PID controller output will decrease to 0% (4 mA). After the error condition is corrected, these functions will resume their normal operation.

These error messages are only displayed in the measurement mode except "ERR 3" which is displayed during calibration. Upon completing the procedure, an error message will be displayed if the condition has not been corrected.

2.2 Common Problems

The following table lists symptoms and their typical causes to aid in correcting common problems.

Table D – TROUBLESHOOTING COMMON PROBLEMS	
Symptom	Typical Causes
Display is completely blank.	1. Line power is not present or connected. 2. Line fuse(s) open. 3. Ribbon-cable plug from display module assembly is not properly connected into power-supply board assembly.
Display flashes "ERR 1" message.	The 699L transmitter may be defective, the system may be incorrectly wired, or the 672L receiver/controller may have an operating problem.
Display flashes "ERR 2" message.	The 699L transmitter may be defective or incorrectly wired to a remote-mounted level probe.
Display flashes "ERR 3" message.	The system may never have been calibrated or calibration is not valid (Part Three, Section 4.3).
Display flashes "ERR 4" message.	The level probe may be shorted or have an open circuit; the input capacitance may be out of range (level too high or too low); or the 699L transmitter may be defective.
Valid setup variable values cannot be entered.	The 672L receiver/controller is locked. Enter unlock code to unlock the instrument (Part Three, Section 10.2).

2.3 Customer Assistance

Should service, parts or assistance in troubleshooting or repair be required, please contact your GLI representative or the GLI Customer Service Department:

Great Lakes Instruments, Inc.
8855 North 55th Street
Milwaukee, Wisconsin 53223

Telephone: 414/355-3601
Telefax: 414/355-8346

— SERVICE HOURS —

	Eastern Std. Time	Central Std. Time	Mountain Std. Time	Pacific Std. Time
Monday through Thursday	9:00 a.m. to 5:30 p.m.	8:00 a.m. to 4:30 p.m.	7:00 a.m. to 3:30 p.m.	6:00 a.m. to 2:30 p.m.
Friday	9:00 a.m. to 2:00 p.m.	8:00 a.m. to 1:00 p.m.	7:00 a.m. to 12:00 p.m.	6:00 a.m. to 11:00 a.m.

When ordering spare or replacement board assemblies, be sure to use the **complete** assembly part number.

All instrument or board assemblies returned for repair, freight prepaid, should also 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 instrument(s) back. Include preferred shipping method (UPS, Federal Express, etc.) if applicable.
4. A purchase order if instrument(s) or board assemblies are out of warranty to cover costs of repair.

NOTE: *If the instrument 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
Model 699L Transmitter	Electronic Chassis Assembly	699-1005
	Accessories For Remote Mounting:	
	Threaded Adapter	1000-3071
	Explosionproof Junction Box (with jack and terminal strip)	1000-3072
	Triaxial Interconnect Cable* (for temperatures up to 160°F)	1000-3073
	Triaxial Interconnect Cable* (for temperatures up to 450°F)	1000-3074
	*Cable has stripped and tinned wires at each end. It connects 699L to level probe j-box. Specify length up to 150 feet.	
Model 672L Receiver/Controller	Relay, 5A Contacts, 12 VDC Coil	99X2T1030
	Power-Supply Board Assembly* (115 V, 50/60 Hz - 1 fuse)	672M4G4001-101
	Power-Supply Board Assembly* (230 V, 50/60 Hz - 1 fuse)	672M4G4001-201
	Power-Supply Board Assembly* (230 V, 50/60 Hz - 2 fuses)	672M4G4001-202
	Display Board Assembly (includes LCD, but not software)	672M4G4002-101
	Software PROM Module	672M4G1010-110
	Liquid Crystal Display	99X6Q1117
	Optional Vertical Pipe-mount Kit	1000A4A1077
	1/4 Amp. Slo-blow Fuse (5 mm dia. x 20 mm long)	99X1F1048
	Door Assembly	1000M4G1210

*Power-supply board assembly includes appropriately marked terminal block insulator.

RL Stone company inc
257 Osborne Rd., Albany, NY 12211-1894 ▪ Tel: 518-459-7900 ▪ Fax: 518-459-0001
Est. 1923
Representatives & Distributors

DATE:	AUGUST 24, 1993
PROJECT:	DEPT. OF HEALTH NEW SCOTLAND AVENUE ALBANY, NY
CONTRACTOR:	J. R. HALL LTD. 99 CENTRAL AVENUE RAVENA, NY
SUBMITTED BY:	R. L. STONE COMPANY INC. 257 OSBORNE ROAD ALBANY, NY
CONTACT:	GREG BLANCHARD SALES ENGINEER

115 Ainsley Dr., Syracuse, NY 13210-4284 ▪ Tel: 315-479-7979 ▪ Fax: 315-479-5402
1215 Mt. Read Blvd., Rochester, NY 14606-2817 ▪ Tel: 716-254-2100 ▪ Fax: 716-254-0889
630 Cleveland Dr., Buffalo, NY 14225-1098 ▪ Tel: 716-834-2525 ▪ Fax: 716-834-4082

AUGUST 24, 1993

BILL OF MATERIALS:

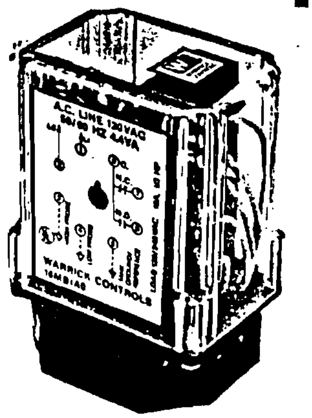
QUANTITY	DESCRIPTION
1	WARRICK CONTROL MODEL 16MB1A4 WITH TWO 3Y1C5 ELECTRODES TAG: LS-101
1	WARRICK FLOAT ASSEMBLY MODEL FE2A3C2A TAG: LE-101
~~1~~	~~MAGNETROL LEVEL TRANSMITTER~~ ~~MODEL 82-5021-813 WITH~~ ~~INDICATING/CONTROL PANEL~~ ~~MODEL 41-5106-014 14 FT FLEXIBLE~~ ~~PROBE WITH 032-8902-001 PROBE WEIGHT~~ ~~TAG: LT/LSH-101~~
1	WARRICK LIQUID LEAK SENSOR MODEL DLP-1 WITH DSC-115A CAP TAG: XE-101
1	WARRICK ALARM PANEL MODEL DMS-474-A-2 TAG: LSHH/XS-101

Controls.

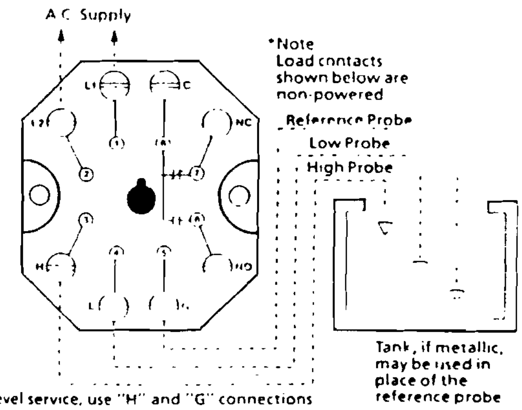
CAUTION: When the atmosphere surrounding the electrodes and/or associated wiring to the control is, or may become potentially explosive, an intrinsically safe control should be used. (See page 18 for intrinsically safe Series 17, 27 and 37.)

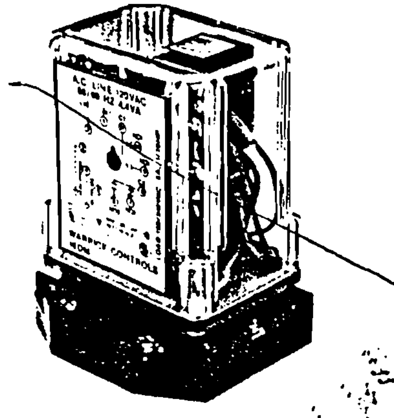
- **U.L. approval.** To simplify approval of OEM equipment, models are available with "Motor Controller" (U.L. 508) and/or "Limit Control" (U.L. 353) recognitions.
- **Compact, low-cost design.** Reduces necessary panel space.
- **LED indication.** Quick, easy monitoring of control status. Easy troubleshooting.
- **Optional time delays.** Provide splash protection, minimize cycle rate and eliminate need for external timers.
- **Built-in surge protection.** Momentary power surges will not affect operation or damage circuitry.
- **Low-voltage sensing circuit.** Eliminates the shock hazard to personnel.

Solid state—plug-in modules.

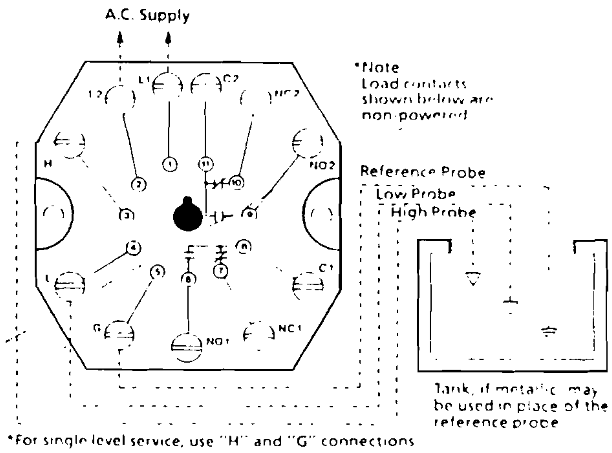


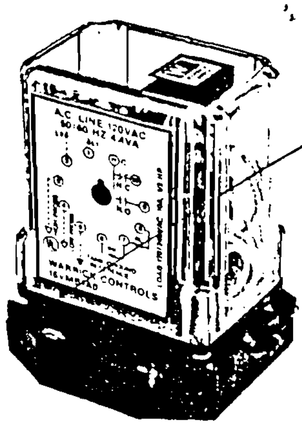
Series 16M. Designed for either differential or single-level service. U.L. "Motor Controller" listing, CSA. 8-pin socket with screw-type connections makes the unit easy to install and service. Sensitivity of up to 1 million OHMS-centimeter. The Series 16 is also available in a high-sensitivity version (Series 16HM-5.5 MOHM sensitivity).



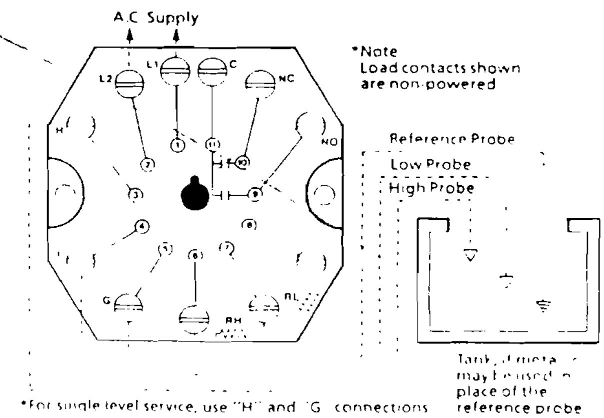


Series 16DM. Similar to Series 16M but with DPDT load contacts. Eliminates the need for slave relays. 11-pin socket. Requires little panel space. General use applications. U.L., CSA listed.





Series 16VM. Similar to the Series 16M but with the added flexibility of field changeable sensitivity, made possible through external setpoint resistors. Uses 11-pin socket. U.L., CSA listed.



Series 16HM Controls
Module Design

ORDER BY COMPONENT NUMBER ———————— 16HMXXXX-X-XX-XX

5TH PLACE SYMBOL

Mode of Operation

Direct	Sensitivity:	Inverse
H	3M	T
J	5.5M	W

6TH PLACE SYMBOL

	Supply Voltage:
1	120 VAC
2	240 VAC
3	24 VAC

7TH PLACE SYMBOL

	Socket Style:
A	Octal
B	DIN mount
M	None, module only

8TH PLACE SYMBOL

	Enclosure:
0	None
1	NEMA 1
4	NEMA 4
7	NEMA 7
12	NEMA 12

11TH PLACE SYMBOL
Time Delay (decreasing level) 1-20 sec

10TH PLACE SYMBOL
Time Delay (increasing level) 1-20 sec.

9TH PLACE SYMBOL
Optional Character

Series 16M and 16DM Controls
Module Design

ORDER BY COMPONENT NUMBER ———————— 16MXXXX-X-XX-XX AND 16DM

4TH PLACE SYMBOL

Mode of Operation

Direct	Sensitivity:	Inverse
A	4.7K	K
B	10K	L
C	26K	M
D	50K	N
E	100K	P
F	470K	R
G	1M	S

5TH PLACE SYMBOL

	Supply Voltage:
1	120 VAC
2	240 VAC
3	24 VAC

6TH PLACE SYMBOL

	Socket Style:
*A	Octal
B	DIN mount
M	None, module only

*Note
16M 8 Pin Octal Socket
16DM— 11 Pin Octal Socket

7TH PLACE SYMBOL

	Enclosure:
0	None
1	NEMA 1
4	NEMA 4
7	NEMA 7
12	NEMA 12

10TH PLACE SYMBOL
Time Delay (decreasing level) 1-20 sec

9TH PLACE SYMBOL
Time Delay (increasing level) 1-20 sec

8TH PLACE SYMBOL
Optional Character

Series 16VM Controls
Module Design/Field Changeable Sensitivity

ORDER BY COMPONENT NUMBER ———————— 16VMXXXXX-X-XX-XX

5TH PLACE SYMBOL

Mode of Operation

Direct	Sensitivity:	Inverse
A	4.7K	K
B	10K	L
C	26K	M
D	50K	N
E	100K	P
F	470K	R
G	1M	S

6TH PLACE SYMBOL

	Supply Voltage:
1	120 VAC
2	240 VAC
3	24 VAC

7TH PLACE SYMBOL

	Socket Style:
A	11 Pin Octal
B	DIN mount
M	None, module only

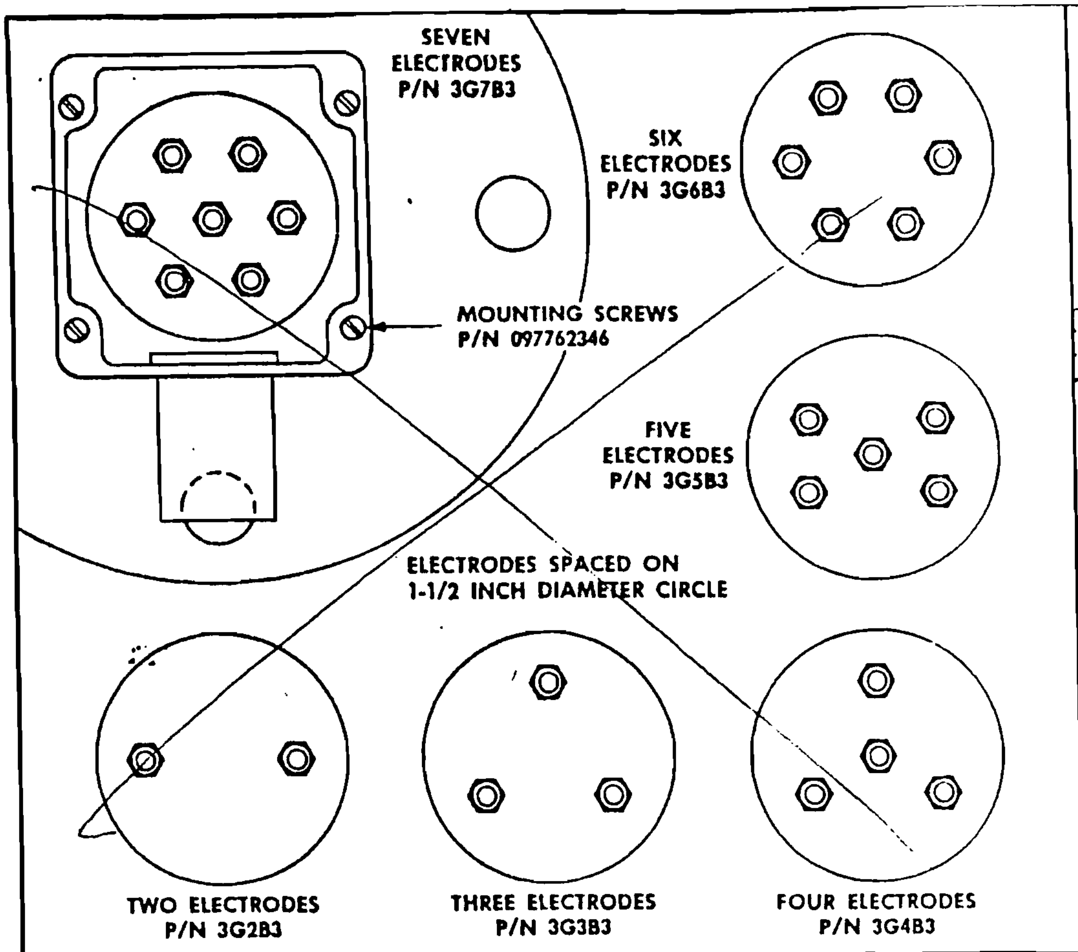
8TH PLACE SYMBOL

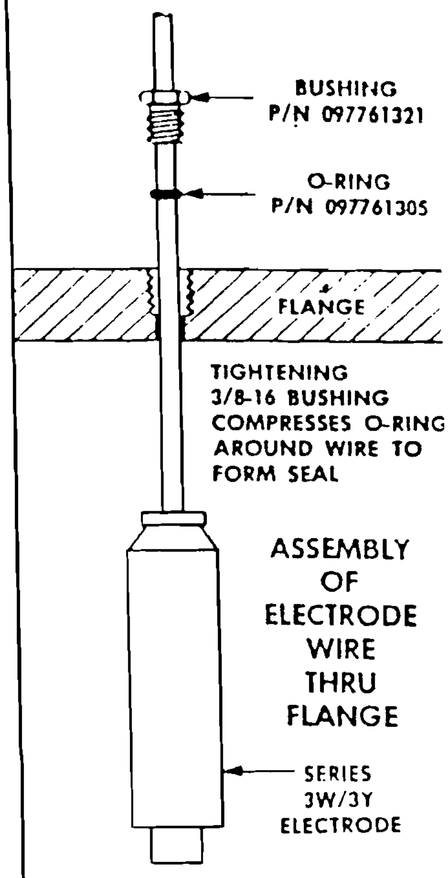
	Enclosure:
0	None
1	NEMA 1
4	NEMA 4
7	NEMA 7
12	NEMA 12

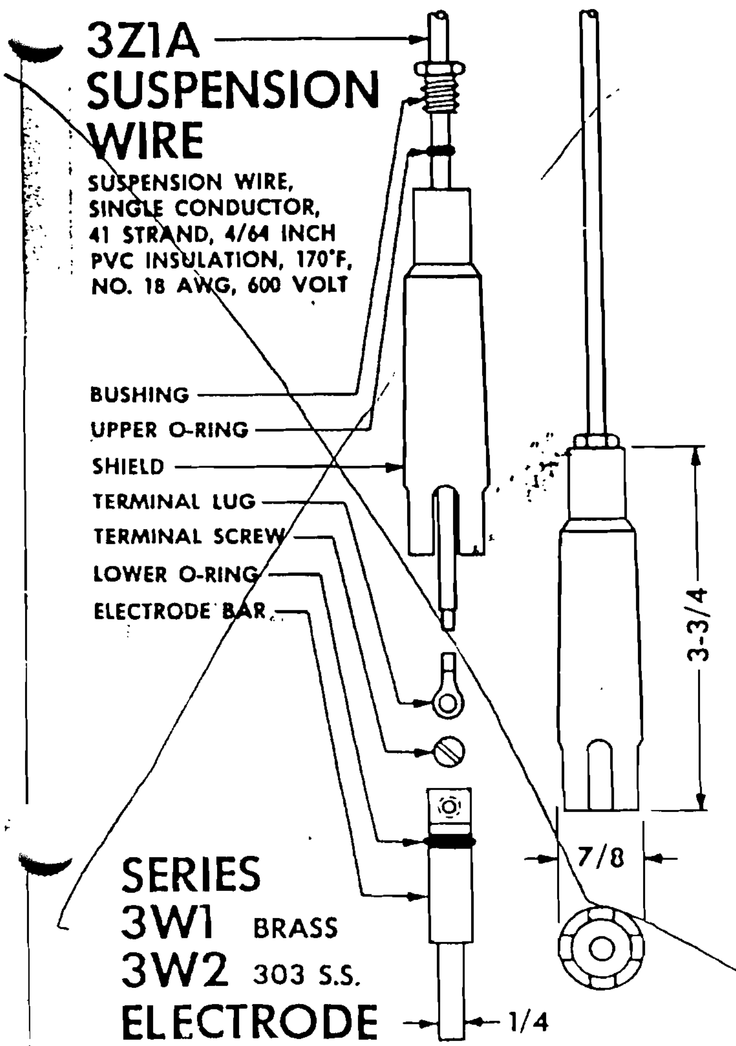
11TH PLACE SYMBOL
Time Delay (decreasing level) 1-20 sec

10TH PLACE SYMBOL
Time Delay (increasing level) 1-20 sec

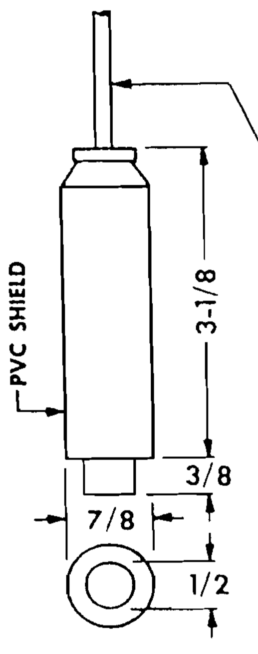
9TH PLACE SYMBOL
Optional Character







SERIES 3Y1XX ELECTRODES



SUSPENSION WIRE,
SINGLE CONDUCTOR,
41 STRAND, 4/64 INCH
PVC INSULATION, 170°F,
NO. 18 AWG, 600 VOLT

3Y1 C 5 ELECTRODE

•	ELECTRODE TIP MATERIAL
C	316 S.S.
D	CARPENTER 20
E	HASTELLOY B
F	HASTELLOY C

•	LENGTH OF WIRE
1	10 FEET
2	20 FEET
3	30 FEET
ET CETERA	

5 = 50'

SYSTEM REQUIREMENTS

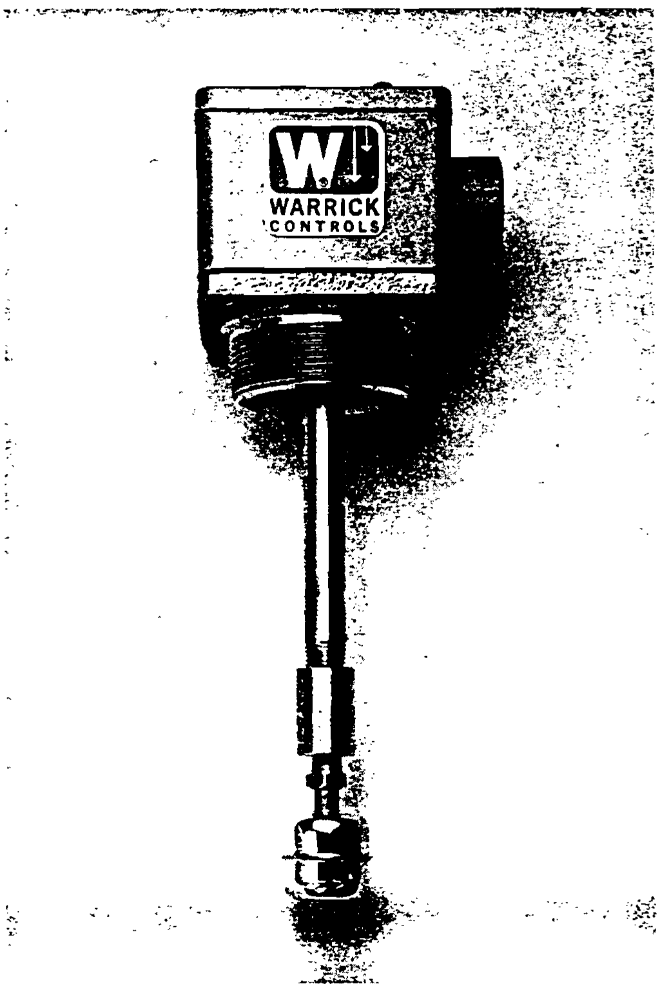
REQ'D	COMPONENT NUMBER	TAG NUMBER

Bulletin No. 703

WARRICK CONTROLS

SERIES FE REED SWITCH FLOAT ASSEMBLY

Warrick brings you point level control of non-conductive liquids



SERIES FE

APPLICATIONS:

Models are available with one, two or three floats. Point level control for clean non-conductive liquids of specific gravity over .6.

Light Loads: Can be used to directly interface with microprocessor or miniature panel lamps.

Heavy Loads: To handle heavier loads such as motor starters, bells, etc., amplifying relays are available. (Request bulletin 200.)

Hazardous locations: For level control in day tanks, underground fuel storage tanks or any potentially explosive application, the FE Series ***must*** be interfaced with an intrinsically safe control. (Series 17, 27, 37, request bulletin 271.)

BENEFITS

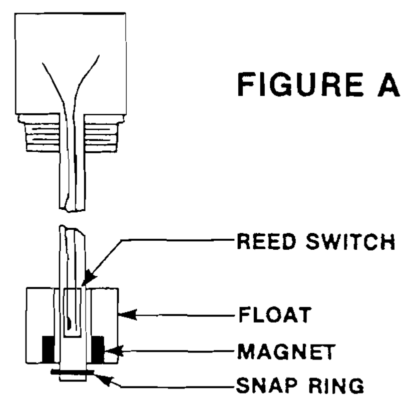
Flexible: Float, rod and threaded base materials can be selected to match the liquid being controlled. Floats can be field changed to provide normally open or normally closed contact operation.

Ease of Installation: Combines float, 2 inch NPT threaded connection and NEMA 4 integrity housing into one unit. No extra junction box is necessary.

Reliable: Each float/reed switch is contained in a separate rod. The failure of one float/reed switch will not affect the operation of remaining float/reed switches.

PRINCIPLE OF OPERATION

FIGURE A



A SPST dry reed switch is potted into the float stem. The float, which contains a small magnet, is lifted by the liquid. As the magnet passes the reed switch, the switch will close.

The operation can be reversed by removing the snap ring, reversing the float and reinstalling the snap ring. The reed switch will be closed when the float is in the down position. Lifting the float will cause the magnet to move away from the reed switch causing it to open.

NOTE: *Assemblies shipped in normally open position; closes on liquid.*

SERIES FE SPECIFICATIONS

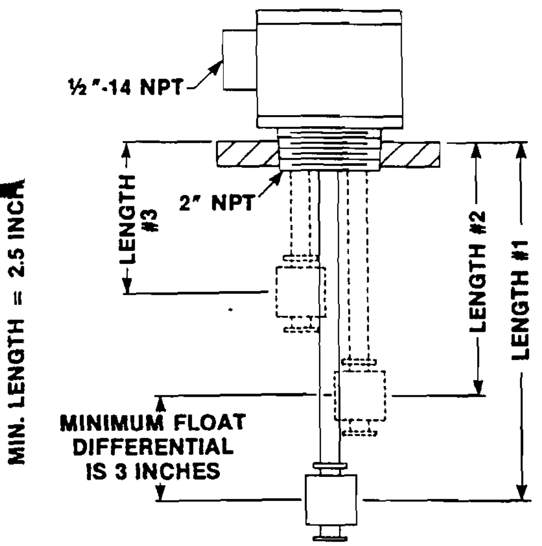


FIGURE B

SPECIFICATIONS:

HOUSING: Epoxy coated die cast aluminum, NEMA 4 integrity
HOUSING GASKETS: Neoprene
THREAD SIZE: 2" - 11 1/2 NPT
PRESSURE: 125 psig.
TEMPERATURE: Buna-N float + 180° F
S. S. float + 240° F
CONTACT RATING: 50 watts (1/2 amp max switching current)
SPECIFIC GRAVITY: Buna-N float - liquid over .6
S. S. float - liquid over .8
MATERIALS: See ordering information

NOTE: *Stilling well should not be used with multiple float assemblies*

ORDERING INFORMATION

OPTIONS
EXACT FLOAT LENGTHS (inches)
See Figure B

FE X X X X X X **OPTIONS 1-______ 2-______ 3-______**

- **# OF FLOATS: A**-one, **B**-two, **C**-three
- **TOTAL FLOAT LENGTH: 1**-one, **2**-two, etc. Round up each float length to nearest foot and add together
- **FITTING MATERIAL: A**-cast iron, **B**-brass, **C**-316 stainless steel
- **ROD MATERIAL: 1**-galvanized, **2**-brass, **3**-304 stainless steel
- **FLOAT STEM MATERIAL: A**-316 stainless steel, **B**-brass
- **FLOAT MATERIAL: 1**-buna-N, **2**-316 stainless steel
- **SERIES FE FLOAT** / threaded connection

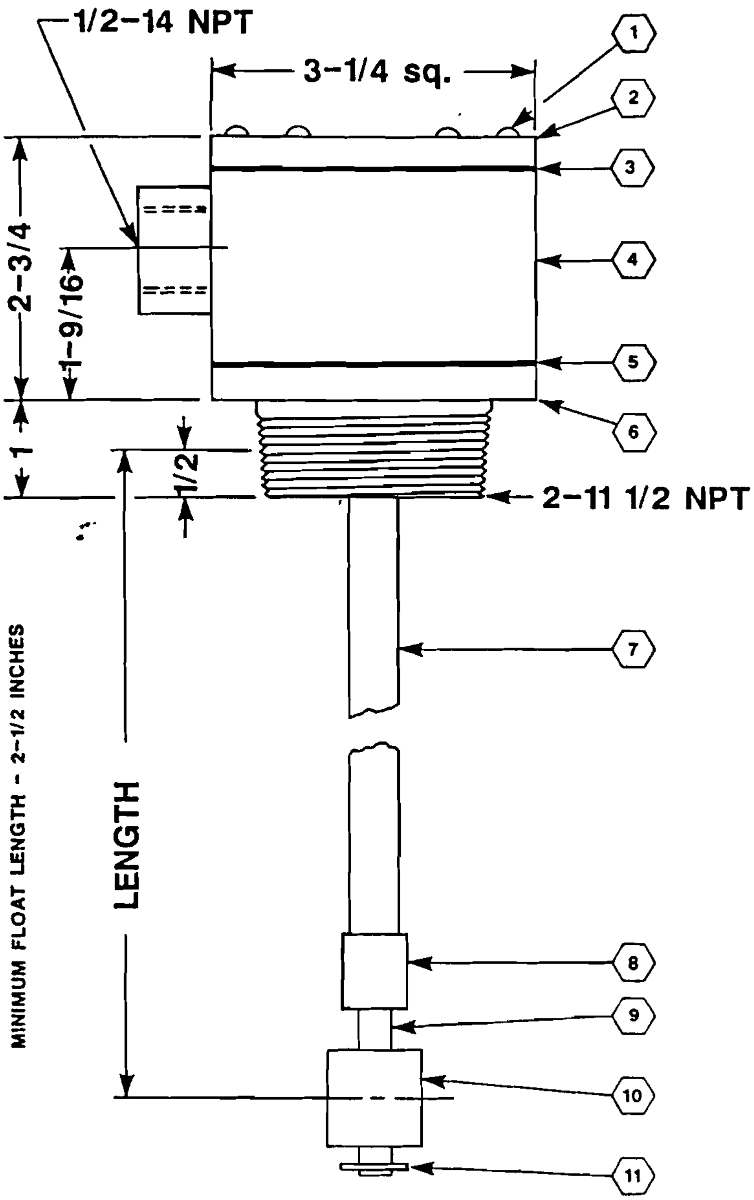
NOTE: *Not all material combinations are available from stock, see price list 232 for standard combinations and material recommendations.*

WARRICK CONTROLS

WARRICK CONTROLS, INC.
4237 Normandy Court
Royal Oak, MI 48073
Telephone: (313) 545-2512
FAX: (313) 549-4904

Represented By:

A Subsidiary of Armstrong International
When Level Control is Absolutely Essential



BILL OF MATERIAL			
	COMPONENT	MATERIAL	PART NO.
1	SCREW	S.S.	7762424
2	LID	EPOXY-ALUM	7760565
3	GASKET	NEOPRENE	7762434
4	HOUSING	EPOXY-ALUM	7760566
5	GASKET	NEOPRENE	7762436
6	FITTING	CAST IRON	7760865
		BRASS	7760870
		316 S.S.	7760875
7	ROD	GALVANIZED	7755755
		BRASS	7755759
		304 S.S.	7755757
8	COUPLING	GALVANIZED	7760963
		BRASS	7760962
		304 S.S.	7760961
9	STEM	BRASS	N.A.
		316 S.S.	N.A.
10	FLOAT	BUNA-N	7760970
		316 S.S.	7760972
11	SNAP RING	S.S.	7760974

PRESSURE: 125 psig

TEMPERATURE: Buna-N Float + 180 °F,
S.S. Float + 240 °F, Min. -40 °F

CONTACT RATING: 50 watts
(1/2 amp max switching current)

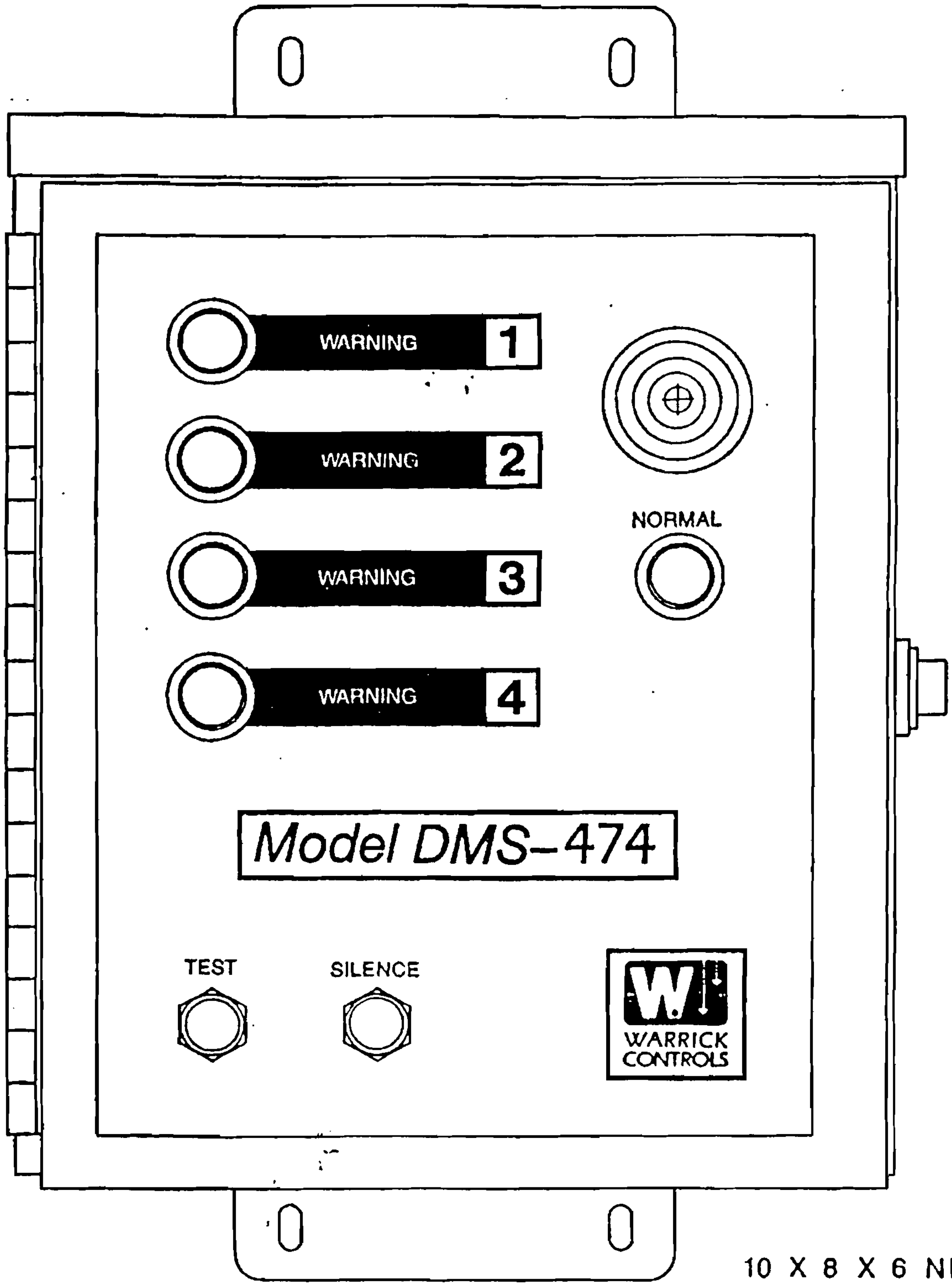
SPECIFIC GRAVITY: Buna-N Float - >.6,
S.S. Float - >.8

SERIES FE | | | | | | A |

OPTIONS: 1- _______ EXACT FLOAT LENGTH (inches)

- # OF FLOATS: A-One,
- TOTAL FLOAT LENGTH (ft): 1-One, 2-Two, etc., Round Up Float Length to Nearest Foot
- FITTING MATERIAL: A-Cast Iron, B-Brass, C-304 Stainless Steel
- ROD MATERIAL: 1-Galvanized, 2-Brass, 3-304 Stainless Steel
- FLOAT STEM MATERIAL: A-316 Stainless Steel, B-Brass
- FLOAT MATERIAL: 1-Buna-N, 2-316 Stainless Steel

DATE: 23 FEB 1988	DRWN BY:	TITLE SERIES FEXXXXXA
SHEET NO 1	CHKD BY:	REED SWITCH FLOAT ASSEMBLY
Warrick Controls, Inc.		DRWG NO



10 X 8 X 6 NEMA TYPE 3R

WARRICK CONTROLS

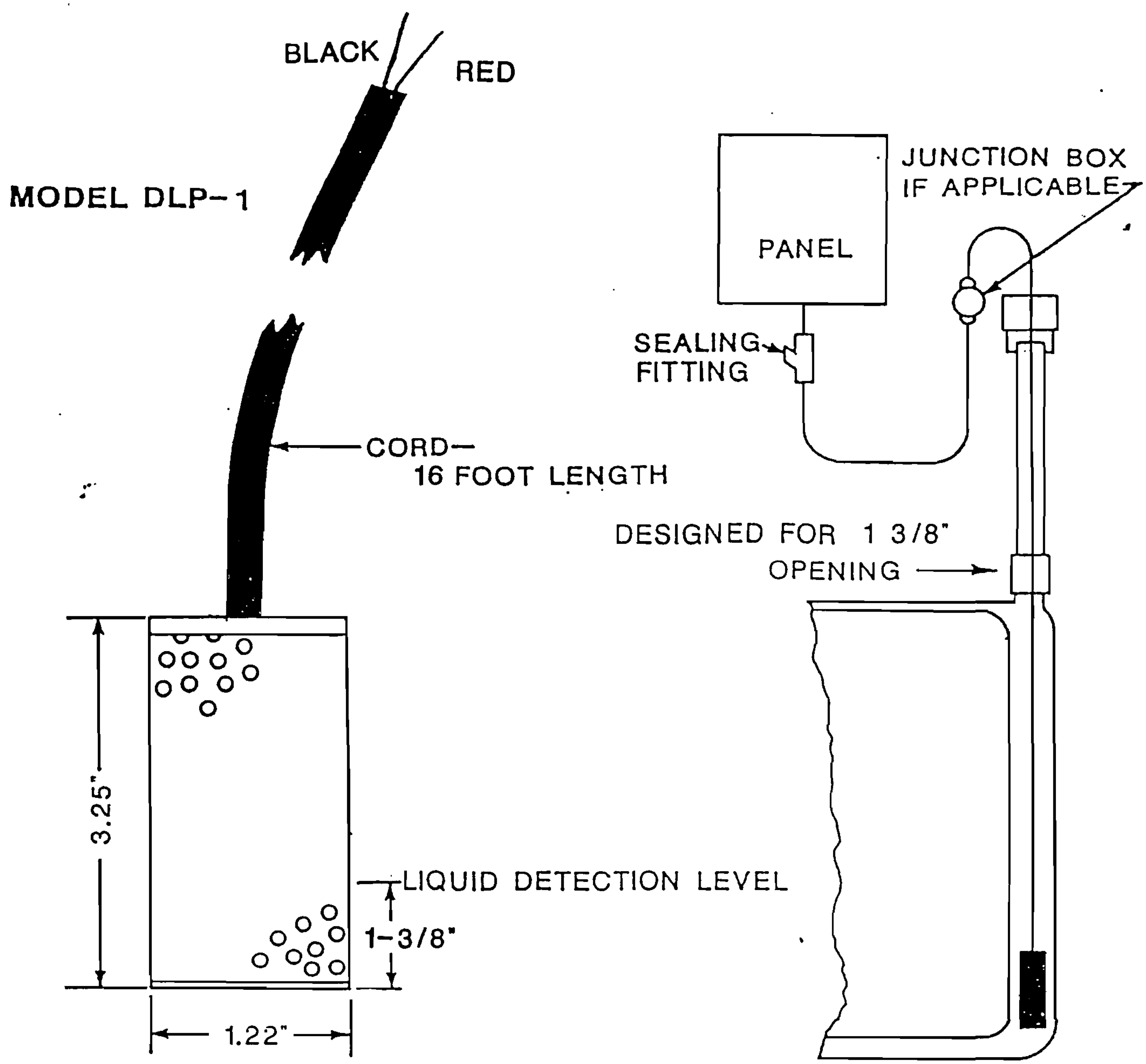
DATE: 12/9/88	DRWN BY: F.R.
SHEET NO: 1	CHKD BY:

WARRICK CONTROLS, INC.
4237 Normandy Court (Zip 48073)
P.O. Box 460
Royal Oak, Michigan 48068-0460
313/545-2512—Telex 23-0454

TITLE:

MODEL DMS–474

DRWG NO: SA0951



MATERIAL:
BODY: PVC

CORD: 22 GAUGE STRANDED
2 CONDUCTOR
SCREEN: STAINLESS STEEL; PERFORATED

WARRICK
CONTROLS

DATE: 11-5-90	DRWN BY: WCL
SHEET NO: 1 OF 1	CHKD BY:

WARRICK CONTROLS, INC.
4237 Normandy Court (Zip 48073)
P.O. Box 460
Royal Oak, Michigan 48068-0460
313/545-2512—Telex 23-0454

TITLE: LIQUID SENSOR
Leak Detector
MODEL DLP-1

DRWG NO: SA1615

Gauges

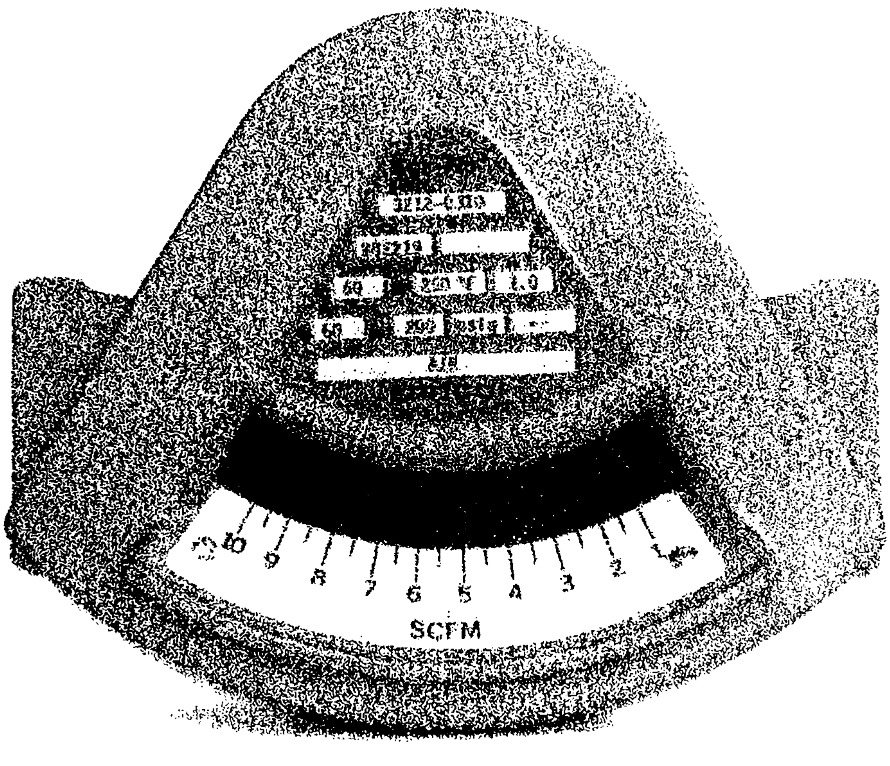
1) *Flow*

2) *Pressure*

ERDCO Engineering Corporation

MODEL # 326104-TO

See-Flo®



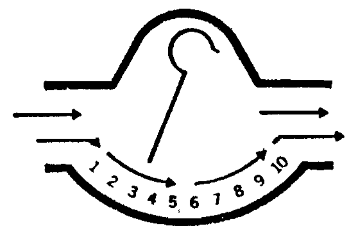
M. S. JACOBS & ASSOCIATES, INC.
EQUIPMENT ENGINEERS
P.O. BOX 93
BATAVIA, NEW YORK 14021
PH. (716) 344-0102

Rugged vane flowmeters and sight flow indicators that measure process fluids in vertical or horizontal pipelines.

See-Flo® benefits

1 Simple design

See-Flo® is available as a direct reading flowmeter or as a sight flow indicator. Both include a tempered glass window for visual inspection of fluid color, clarity and flow. The alloy vane indicator moves in proportion to flow rate and is not affected by mounting orientation.

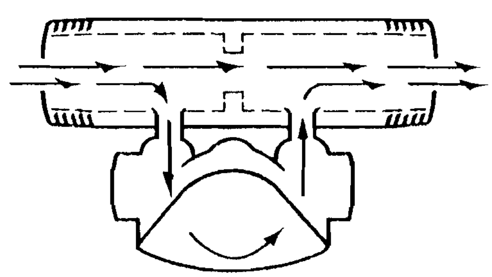


2 Rugged construction

Cast housings with corrosion resistant 316 stainless steel fittings stand up to harsh conditions. Sight windows are full air tempered soda lime glass. There are no floats to get stuck, tubes to break or shaft seals to leak. ERDCO® variable area vane flowmeters are shock qualified and meet the stringent requirements of MIL-S-901B.

3 Low installed cost

Ready to use. Install in-line without saddle clamps, hot taps or electricity. Connection sizes larger than 1 inch include an integral shunt that eliminates the need for special piping.



3100 See-Flo® indicators

See-Flo® sight flow indicators show you at a glance, the color, clarity and flow of liquids in process lines. The large tempered glass window permits easy observation of fluid conditions and vane indicator position for a wide range of fluids in vertical or horizontal piping runs.

The wedge shape of the meter housing makes See-Flo® practically self-cleaning. Where periodic maintenance might be necessary, the window is easily removed and replaced. **As it is intended to be used as a flow indicator, the scale is not calibrated.**

Write-on scale

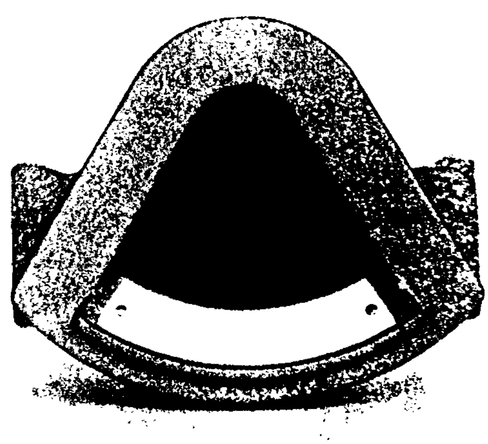
Vane position is a relative indication of flow rate. A special write-on surface is provided along the sweep of the indicator on which system reference points may be marked. This can help you establish normal operating limits, rate efficiency or balance a process system.

Connections

½", ¾" and 1" have female NPT threaded ends. Sizes from 1½" through 12" are available with male NPT threaded ends or 150# ANSI flanges and include an integral shunt. Special sizes and connection types are available on request.

Important features

- Large tempered glass sight window for all sizes.
- Use in vertical or horizontal piping systems.
- Unique write-on scale.
- Relative rate indication.
- Economical for pipe connections ½" to 12".



Specifications

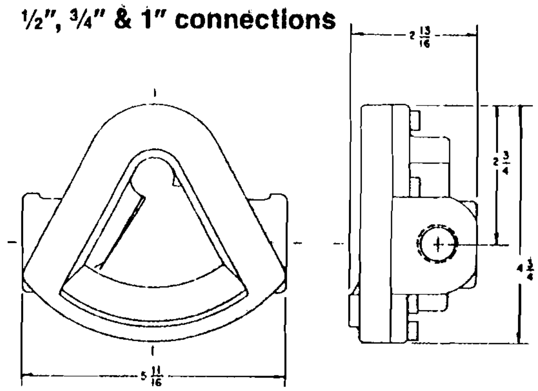
See-Flo® indicators are sight flow indicators for liquids in industrial applications. A full air tempered soda lime sight glass permits process fluid observation. Vane position indicates relative flow rate.

Characteristics

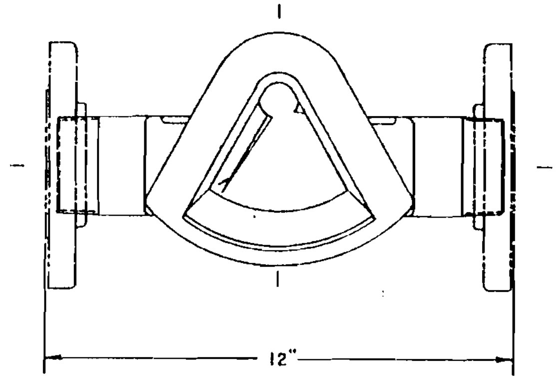
Materials of construction:	(wetted parts)
Housing:	Aluminum, brass or 316 stainless steel
Shunt:	Carbon steel
Window:	Tempered glass
Vane:	17-7 ph stainless steel
"O" rings:	Buna-n, ethylene propylene, Viton® or Teflon®.
Piping connections:	½" to 1" NPT Female 1½" to 12" NPT Male ½" to 1" Tri-clamp 1½" to 12" Grooved 1½" to 12" Beveled ½" to 12" 150#/300#, RF/FF ANSI Flanges (carbon stl) ½" to 12" 150# RF ANSI Flanges (stainless stl) ½" to 6" 150# RF ANSI Flanges (aluminum) ½" to 6" 150# FF ANSI Flanges (brass) 15 to 25 mm DIN 2999/BS21/ ISO R7 Female threaded 15 to 150 mm DIN PN 10/16 Flanges (316 stainless stl & carbon stl)
Pressure limits:	200 psig (1.3 MPa)
Temperature limits:	32° to 250°F (0° to 120°C) 400°F (204°C) with Viton® or ethylene propylene o-ring
Installation:	In-line

Not intended for use with opaque liquids or steam. ERDCO reserves the right to alter design and/or specifications without notice. Viton® and Teflon® are registered trademarks of E.I. duPont de Nemours and Co.

3100 Series
½", ¾" & 1" connections



3100 Series
1½" to 12" connections



3200 See-Flo® meters

See-Flo® meters indicate flow rate and permit visual inspection of water, air or other transparent fluids. For general purpose industrial service, See-Flo® meters handle a wide range of process fluids in vertical or horizontal piping runs.

The wedge shape of the meter housing makes See-Flo® practically self-cleaning. Where periodic maintenance might be necessary, the tempered glass window is easily removed and replaced.

Direct reading

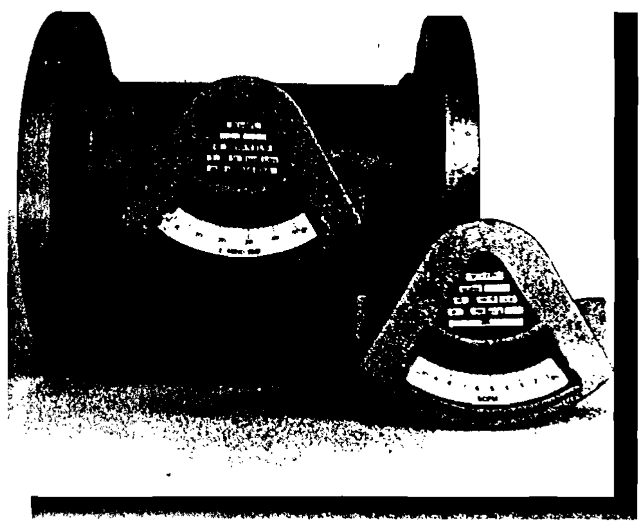
Each flowmeter is calibrated to be direct reading for a liquid or gas at its operating conditions. 10:1 turndown scale ranges may be selected within the capacity limits by connection size shown on page 7. Scales with special engineering units and dual units of measure are available.

Important features

- Instantaneous rate measurement.
- Use in vertical or horizontal piping systems.
- Specify the flow range/units of measure best for your application.
- Economical for pipe connections ½" to 12".
- Observe fluid conditions.

Connections

½", ¾" and 1" female NPT threaded ends. Sizes from 1½" through 12" are available with male NPT threaded ends or 150# ANSI flanges and include an integral shunt. Special sizes and connection types are available on request.



Specifications

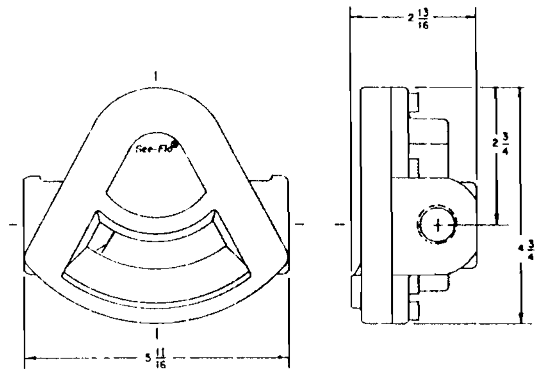
See-Flo® meters are variable area/differential pressure flow rate indicators for general purpose industrial application. A sight glass is incorporated in the design to permit process fluid observation. The tempered vane is displaced through the variable area of the triangular meter housing in direct proportion to changes in flow rate/differential pressure. Vane position directly indicates flow rate.

Characteristics

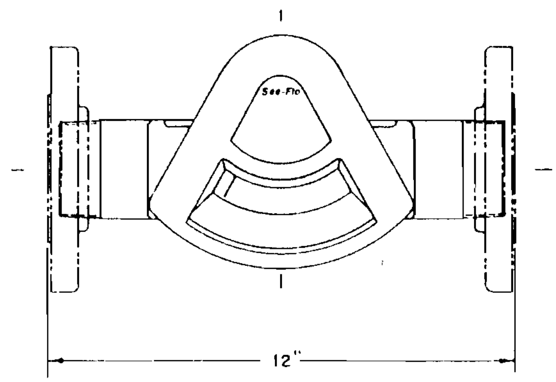
Accuracy:	± 2% full scale
Repeatability:	± 1% full scale
Scales:	Direct reading
Resolution:	Maximum-30 divisions Minimum-15 divisions
Rangeability:	10 to 1 turndown
Materials of construction:	(wetted parts)
Housing:	Aluminum, brass or 316 stainless steel
Shunt:	As housing or carbon steel
Window:	Tempered glass or polycarbonate
Vane:	17-7 ph stainless steel — (aluminum & brass housings) Cobalt/chromium/nickel alloy — (316 ss housings)
"O" rings:	Buna-n, ethylene propylene, Viton® or Teflon®.
Piping connections:	½" to 1" NPT Female 1½" to 12" NPT Male ½" to 1" Tri-clamp 1½" to 12" Grooved 1½" to 12" Beveled ½" to 12" 150#/300#, RF/FF ANSI Flanges (carbon stl) ½" to 12" 150# RF ANSI Flanges (stainless stl) ½" to 6" 150# RF ANSI Flanges (aluminum) ½" to 6" 150# FF ANSI Flanges (brass) 15 to 25 mm DIN 2999/BS21/ ISO R7 Female threaded 15 to 150 mm DIN PN 10/16 Flanges (316 stainless stl & carbon stl)
Pressure limits:	200 psig (1.3 MPa) other sizes
Temperature limits:	32°F to 250°F (0° to 120°C) 400°F (204°C) with Viton® or ethylene propylene o-ring
Installation:	In-line
Options:	Liquid calibration NIST traceable Cleaning for oxygen service

Not intended for use with opaque liquids or steam. ERDCO reserves the right to alter design and or specifications without notice. Viton® and Teflon® are registered trademarks of E.I. duPont de Nemours and Co.

3200 Series
½", ¾" & 1" connections



3200 Series
1½" to 12" connections



Meter rangeability

Liquid applications

— specify 10:1 range at or between —

pipe size	lowest range gpm water @ 60°F	lowest range pressure drop (psi/gpm rate)	highest range gpm water @ 60°F	highest range pressure drop (psi/gpm rate)
½" - 15 mm	0.4-4	.4/4	1.5-15	3/15
¾" - 20 mm	0.5-5	1/5	3-30	5/30
1" - 25 mm	0.8-8	1.5/8	5-50	6/50
1½"	3-30	2/30	20-200	8/200
2"	4-40	2/40	25-250	8/250
3"	5-50	2/50	50-500	8/500
4"	10-100	2/100	100-1000	8/1000
5"	15-150	2/150	150-1500	8/1500
6"	25-250	2/250	200-2000	8/2000
8"	50-500	2/500	200-2000	8/2000
10"	80-800	2/800	200-2000	8/2000
12"	100-1000	2/1000	200-2000	8/2000

Gas applications

— specify 10:1 range at or between —

pipe size	lowest range scfm air @ 60°F	lowest range pressure drop (inches H_2O/scfm rate)	highest range scfm air @ 60°F	highest range pressure drop (inches H_2O/scfm rate)
½" - 15 mm	1-10	2/10	2-20	3/20
¾" - 20 mm	1-10	2/10	3-30	4/30
1" - 25 mm	1-10	2/10	5-50	6/50
1½"	1.5-15	2/15	20-200	8/200
2"	2-20	2/20	25-250	8/250
3"	4-40	2/40	50-500	8/500
4"	5-50	2/50	100-1000	8/1000
5"	6-60	2/60	150-1500	8/1500
6"	8-80	2/80	200-2000	8/2000
8"	10-100	2/100	200-2000	8/2000
10"	15-150	2/150	200-2000	8/2000
12"	20-200	2/200	200-2000	8/2000

Notes:
- Units of measure other than gpm and scfm can be specified.
- When specifying a calibration range consider that the nominal flow value should be approximately at mid-scale
- Pressure drop data are typical for maximum flow reading of the range indicated. A flow that causes a midrange reading will have a pressure drop that is a square root function of the pressure drop at full range. Example: An instrument for a 6" piping system that has a range of 200 to 2,000 gpm will have a pressure drop of 8 psi at 2,000 gpm flow and a pressure drop of $\sqrt{8}$ or 2.828 psi at 1,000 gpm on the same scale
- Typical pressure drop declines in value in a linear relationship between the maximum of the highest range and maximum of the lowest range. Example: An instrument for a 4" piping system that requires a calibrated range of 40 to 500 gpm will have a typical pressure drop at 500 gpm of 5 psi.
- Sizes designated mm (millimeters) are available with metric thread in accordance with DIN 2999/BS21/ISO R7

Model number system

The example **3221-12F5** describes a 3200 Series See-Flo® meter with a brass body/carbon steel shunt for left to right flow. Connections are 3" 150# raised carbon steel flanges.

32	2	1	-	12	F	5
Series	Housing Material	Flow Direction		Size	Type	Shunt Material
31 — 3100	**1** — Aluminum	**1** — L to R		**02** — ½" (15 mm)	**T** — NPT End	**0** — None
32 — 3200	**2** — Brass	**2** — R to L		**03** — ¾" (20 mm)	**R** — NPT Back	**1** — Aluminum
	6 — Stainless Steel	**3** — Up		**04** — 1" (25 mm)	**S** — Tri-clamp	**2** — Brass
		4 — Down		**05** — 1¼" (32 mm)	**G** — Grooved	**5** — Carbon Steel
				06 — 1½" (40 mm)	**X** — Beveled	**6** — Stainless Steel
				08 — 2" (50 mm)	**W** — Socket End ½"-1"	
				10 — 2½" (65 mm)	**F** — Flange 150#RF	
				12 — 3" (80 mm)	**H** — Flange 150#FF	
				16 — 4" (100 mm)	**J** — Flange 300#RF	
				20 — 5" (125 mm)	**K** — Flange 300#FF	
				24 — 6" (150 mm)	**L** — Flange DIN PN 10/16	
				32 — 8"	**M** — Metric Thread End	
				40 — 10"	**N** — Metric Thread Back	
				48 — 12"		

M.S. JACOBS & ASSOC., INC
EQUIPMENT ENGINEERS
P.O. BOX 93
BATAVIA, NY 14020
(716) 344-0102

ERDCO®

ERDCO Engineering Corporation
Box 6318, 721 Custer Avenue
Evanston, Illinois 60202 USA

Telephone: 708-328-0550
Telefax: 708-328-3535

FM-869-4
Printed in U.S.A.

Pressure Gauge

general service pressure gauges

series 23K

Application

An economical, general purpose gauge for pressure measurement to 1000 psi. Typically used where vibration or pressure pulsations are not encountered. Suited to water, oil, air, gas or other fluids which do not attack phosphor bronze.

Operating Specifications

Accuracy—ANSI Grade B - 2%

Ranges—Ten ranges from 0-15 psi through 0-1000 psi in standard increments, with corresponding kiloPascal (kPa) ranges.

Temperature Limit—Ambient temperature and temperature of the operating medium should not exceed 160°F (71°C). Install protective syphon when used on steam. Minimum temperature at −40°F (−40°C).

Design Features

Dial Sizes—1½", 2", 2½", 3½" & 4½".

Bourdon Tube/Socket—Phosphor bronze Bourdon tube soft-soldered to brass socket.

Movement—Brass in 1½" and 4½". Sizes 2", 2½" and 3½" feature a Polyglide® movement: Polycarbonate side plates with brass sector and pinion. Polyglide movement offers greater shock and wear resistance than conventional designs.

Case—Drawn steel, phosphatized for rust resistance and finished with baked black enamel.

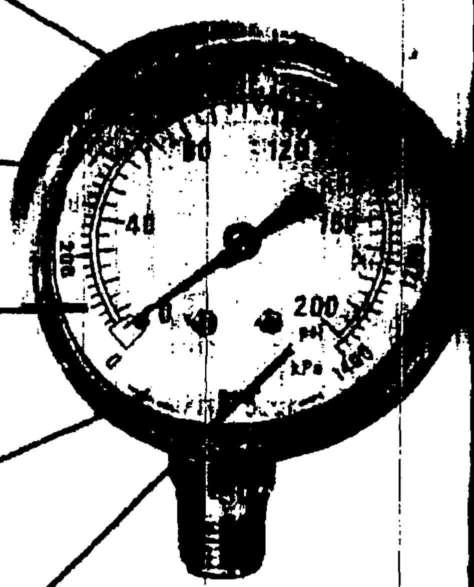
Window—Clearlok® twist-on design (indicated by suffix K) furnished on all 1½", 2", 2½" and 3½" case styles. Acrylonate R570. Glass window furnished on the 4½" Fig. 23.

Dial—White coated aluminum with black scales. Corresponding English and metric scales are printed on the dial as standard. Metric pressure scale is expressed in kiloPascal (KPa) units.

Pointer—Black coated aluminum.

End Connection—¼" NPT or ⅛" NPT (as detailed in part number tables).

Restrictor—Available on request; minimum order quantity applies. Specify .008 size for air; .013 for water or light oil; .016 for oil. Brass.



Case Styles

23 & 23K—Stem mounted; bottom connection.

23B & 23KB—Panel mount design utilizing U-clamp; center back connection.

23KC—Stem mounted; center back connection.

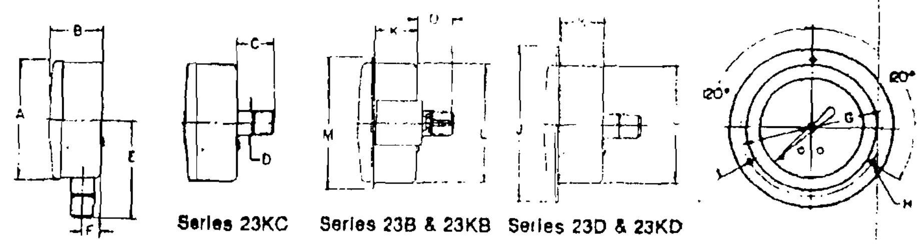
23D & 23KD—Front flange mounted; center back connection.

How To Order

To order, simply provide the part number which corresponds to the required gauge construction and pressure range. Maximum gauge accuracy and extended gauge life can be gained by selecting a pressure range that is twice the normal operating pressure of the application.

Dimensions

Dimensions shown in inches. See dimension table on next page.



Series 23 & 23K Series 23KC Series 23B & 23KB Series 23D & 23KD

Bulletin 26-3

Dimension Table

Gauge Size	A	B	C	D	E	F	G	H	J	K	L	M	O
1½	1 21/32	7/8	23/32	7/16	1½	9/32							
2	2 5/32	1⅛	13/16	9/16	1 15/16	11/32	2½	5/32	2 27/32	15/16	2 1/16	2¼	⅞
2½	2⅝	1 5/32	13/16	9/16	2 3/16	11/32	3 1/32	5/32	3 15/32	15/16	2 19/32	2 29/32	⅞
3½	3 11/16	1 5/16	13/16	9/16	2¾	13/32	4 13/32	7/32	4¾	29/32	3 21/32	4	⅞
4½	4 25/32	1 7/16			3⅜	13/32							

Part Numbers

Series 23K

Fig. No.	Psi	kPa	⅛" NPT 1½" Dial Part No.	⅛" NPT 2" Dial Part No.	⅛" NPT 2½" Dial Part No.	¼" NPT 2" Dial Part No.	¼" NPT 2½" Dial Part No.	¼" NPT 3½" Dial Part No.	¼" NPT 4½" Dial Part No.
23K	15	100	G10831	G14419	G14632	G14381	G14490	G23864	G10168
	30	200	G10832	G14420	G14633	G14382	G14491	G23865	G10169
	60	400	G10833	G14421	G14634	G14383	G14492	G23866	G10170
	100	700	G10834	G14422	G14635	G14384	G14493	G23867	G10171
	160	1100	G10835	G14423	G14636	G14385	G14494	G23868	G10172
	200	1400	G10836	G14424	G14637	G14386	G14495	G23869	G10173
	300	2000	.....	G14425	G14638	G14387	G14496	G23870	G10174
	400	3000	.....	.....	G14639	G14388	G14497	G23871	G10175
	600	4000	.....	G14427	.....	G14389	G14498	G23872	G10176
	1000	7000	.....	G14429	.....	G14391	G14500	G23874	G10178
23KB	15	100	.....	G10053	G10131	G10045	G10123	G23886	.....
	30	200	.....	G10054	G10132	G10046	G10124	G23887	.....
	60	400	.....	G10055	G10133	G10047	G10125	G23888	.....
	100	700	.....	G10056	G10134	G10048	G10126	G23889	.....
	160	1100	.....	G10057	G10135	G10049	G10127	G23890	.....
	200	1400	.....	G10058	G10136	G10050	G10128	G23891	.....
	300	2000	.....	G10059	G10137	G10051	G10129	G23892	.....
	400	3000	.....	G10872	G14570	G10852	G14458	G23893	.....
	600	4000	.....	G10873	.....	G10853	G14459	G23894	.....
	1000	7000	.....	.....	.....	G10855	G14461	G23896	.....
23KC	15	100	G10840	G14431	G14644	G14393	G14502	G24426	.....
	30	200	G10841	G14432	G14645	G14394	G14503	G24427	.....
	60	400	G10842	G14433	G14646	G14395	G14504	G24428	.....
	100	700	G10843	G14434	G14647	G14396	G14505	G24429	.....
	160	1100	G10844	G14435	G14648	G14397	G14506	G24430	.....
	200	1400	G10845	G14436	G14649	G14398	G14507	G24431	.....
	300	2000	.....	G14437	G14650	G14399	G14508	G24432	.....
	400	3000	.....	G14438	.....	G14400	G14509	G24433	.....
	600	4000	.....	G14439	G14652	G14401	G14510	G24434	.....
	1000	7000	.....	.....	G14654	G14403	G14512	G24436	.....
23KD	15	100	.....	.....	.....	G10919	.....	G23875	.....
	30	200	.....	G10939	.....	.....	G14464	G23876	.....
	60	400	.....	G10940	.....	G10921	G10138	G23877	.....
	100	700	.....	G10941	.....	G10922	G10139	G23878	.....
	160	1100	.....	G10942	.....	G10923	G10140	G23879	.....
	200	1400	.....	G10943	.....	G10924	G14465	G23880	.....
	300	2000	.....	G10944	G14602	G10925	G10141	G23881	.....
	400	3000	.....	.....	G14603	.....	.....	.....	.....
	600	4000	.....	.....	.....	.....	G14467	G23883	.....
	1000	7000	.....	.....	.....	.....	G14469	.....	.....

Note: For correct use and application of pressure gauges, refer to the ANSI standard B40 1-1980 entitled "Gauges—Pressure Indicating Dial Type—Elastic Element." This document is available from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017.

The conversion of all dials from single scale to dual scale (English & metric units) is an ongoing program at Marshalltown Instruments, Inc. This means that in very few instances a particular gauge size and pressure range will not yet be available in dual scale and will be furnished with a single scale dial.

All product data presented herein was accurate at time of publication. However, Marshalltown Instruments, Inc. reserves the right to change product designs and specifications without notice.

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