AECOM Environment

Prepared for:
Superfund Standby Program
NYSDEC
625 Broadway
Albany, New York 12233

Prepared by:
AECOM
Latham, New York
Project 60276639
March 2014

Site Management Plan
Former NOW Corporation Facility
NYSDEC Site No. 3-14-008
Clinton, Dutchess County, New York

Revisions to Final Approved Site Management Plan:

Revision #	Submitted Date	Summary of Revision	DEC Approval Date

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Lindsay Mitchell

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List of Acronyms

AECOM	AECOM Technical Services Northeast, Inc.
AWQS	Ambient Water Quality Standards
bgs	Below Ground Surface
CAMP	Community Air Monitoring Plan
COC	Contaminant of Concern
1,1-DCE	1,1-Dichloroethene
1,2-DCE	1,2-Dichloroethene
DER-10	Technical Guidance for Site Investigation and Remediation (NYSDEC, 2010)
EC	Engineering Control
ERS	Earth Remediation Services
ES	Engineering Science, Inc.
EWP	Excavation Work Plan
fbgs	Feet Below Ground Surface
GAC	Granular Activated Carbon
GPM	Gallons per Minute
GWETS	Groundwater Extraction and Treatment System
HASP	Health and Safety Plan
IC	Institutional Control
IIWA	Immediate Investigation Work Assignment
IRM	Interim Remedial Measure
MDL	Method Detection Limit
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	Operation and Maintenance
OM&M	Operation, Maintenance and Monitoring
ORP	Oxidation-Reduction Potential
OU	Operable Unit
PCE	Tetrachloroethene
P&ID	Process and Instrumentation Diagram
POE	Point-of-Entry
PPB	Parts per Billion
PPE	Personal Protective Equipment

PPM	Parts per Million
PRR	Periodic Review Report
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance
QAPP	Quality Assurance Project Plan
RAO	Remedial Action Objective
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
SCG	Standards, Criteria and Guidance
SSDS	Sub-Slab Depressurization System
SMP	Site Management Plan
SVE	Soil Vapor Extraction
SVI	Soil Vapor Intrusion
1,1,1-TCA	1,1,1-Trichloroethane
TCE	Trichloroethene
TCL	Target Compound List
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
TVH	Total Volatile Hydrocarbon
µg/L	Micrograms per Liter
$\mu g/m^3$	Micrograms per Cubic Meter
US EPA	United States Environmental Protection Agency
UV	Ultraviolet
VC	Vinyl chloride
VFD	Variable Frequency Drive
VOC	Volatile Organic Compound

Engineering Certification

I certify that I am currently a New York State registered professional engineer and that this Site Management Plan for the Former NOW Corporation Facility (Site No. 3-14-008) was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the *DER Technical Guidance for Site Investigation and Remediation* (*DER-10*) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

Respectfully submitted,
AECOM Technical Services Northeast, Inc.

March 21, 2014

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Registered Professional Engineer
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Date

1.0 Introduction and Description of Remedial Program

1.1 Introduction

This document is required as an element of the remedial program at the former NOW Corporation facility (hereinafter referred as the “Site”) under the New York State Superfund Standby Program administered by the New York State Department of Environmental Conservation (NYSDEC). The Site was remediated in accordance with the Record of Decision (ROD) issued in March 1995 for impacted groundwater, denoted as Operable Unit (OU) 1, and in March 1996 for impacted soil, denoted as OU2. The primary sources of contamination were removed or remain controlled with a groundwater extraction and treatment system (GWETS), which became operational in 1998.

1.1.1 General

Allegations of improper management and disposal of tank rinsing solutions and firefighting efforts resulted in the identification of chlorinated solvent contamination associated with the Site. Pursuant to the ROD, excavation and on-site treatment of contaminated soil and weathered bedrock and groundwater treatment system design and construction were all carried out under the Superfund Standby Program. A Site Location Map is included as **Figure 1**.

Following completion of the remedial work described in the RODs, residual groundwater contamination remained. This Site Management Plan (SMP) was prepared to manage remaining contamination at the Site until the NYSDEC determines that either adequate attenuation of contamination has been achieved, or there is sufficient evidence that a threat of off-site migration of contaminants no longer exists. All reports associated with the Site can be viewed by contacting the NYSDEC or its successor agency managing environmental issues in New York State.

This SMP is prepared by AECOM Technical Services Northeast, Inc. (AECOM), on behalf of the NYSDEC, in accordance with the requirements in *DER-10/Technical Guidance for Site Investigation and Remediation* (NYSDEC, May 2010) and other guidelines provided by the NYSDEC. This SMP addresses the means for implementing the Institutional Controls (ICs) and Engineering Controls (ECs) that are required by the ROD.

1.1.2 Purpose

The Site contains contamination left after completion of the remedial action. ECs have been incorporated into the Site remedy to control exposure to remaining contamination during the use of the Site, to ensure protection of public health and the environment. An IC in the form of a deed restriction/environmental easement is required per the ROD; however, no recorded easement has been identified as of August 2012. Upon acceptance of this SMP, an environmental easement will be recorded, which will be certified during periodic reviews.

An easement granted to the NYSDEC and recorded with the Dutchess County Clerk will require compliance with this SMP and all ECs and ICs placed on the Site. The IC places restrictions on Site use, and mandate operation, maintenance, monitoring and reporting measures for all ECs and ICs. This SMP specifies the methods necessary to ensure compliance with all ECs and ICs required by the ROD. Once this plan is approved by the NYSDEC and compliance with this plan is required by the grantor of the ROD and the grantor's successors and contractors, this SMP may only be revised with the approval of the NYSDEC.

This SMP provides a detailed description of all procedures required to manage remaining contamination at the Site after completion of the Remedial Action, including: (1) implementation and management of all EC/ICs; (2) media monitoring; (3) operation and maintenance of all treatment, collection, containment, or recovery systems; (4) performance of periodic inspections, certification of results, and submittal of Periodic Review Reports (PRRs); and (5) defining criteria for termination of treatment system operations.

To address these needs, this SMP includes three plans: (1) an Engineering and Institutional Control Plan for implementation and management of EC/ICs; (2) a Monitoring Plan for implementation of Site monitoring; (3) an Operation and Maintenance (O&M) Plan for the GWETS.

This plan also includes a description of PRRs for the periodic submittal of data, information, recommendations, and certifications to NYSDEC.

It is important to note that:

- This SMP details the Site-specific implementation procedures required by the ROD and environmental easement. Failure to properly implement the SMP is a violation of the ROD and environmental easement; and
- Failure to comply with this SMP is also a violation of *New York State Environmental Conservation Law 6 NYCRR Part 375* (NYSDEC, December 2006) and thereby subject to applicable penalties.

1.1.3 Revisions

Revisions to this plan will be proposed in writing to the NYSDEC's project manager. In accordance with the environmental easement for the Site, the NYSDEC will provide a notice of any approved changes to the SMP, and append these notices to the SMP retained in NYSDEC files.

1.2 Site Background

1.2.1 Site Location and Description

The Site is located at an active manufacturing facility in the Town of Clinton, County of Dutchess, New York and is identified as Section 6267, Block 00, Lot 272452 on the Clinton, Dutchess County Tax Map. The Site is classified as Class 4, meaning it has been properly closed but requires continued monitoring. The Site consists of approximately 9 acres of a 94.5-acre parcel, and is located at 2092 NYS Route 9G, near the intersection of Route 9G and South Creek Road (**Figure 2**). **Figure 2** also displays the approximate property boundary in the vicinity of the groundwater treatment system. The metes and bounds of the full property are defined in the current deed (**Appendix A1**), which was recorded in May 1957 with the Dutchess County Clerk. Crum Elbow Creek is present to the northwest of the Site, north of Route 9G. The current tenant of the Site is UNIFUSE/B&R Specialties, Inc., which manufactures plastic containers.

The site remedial goals as established in the ROD include groundwater remediation to less than the applicable state and federal guidelines and soil remediation to contaminant levels that would prevent further degradation of groundwater.

1.2.2 Site History

The Site was identified after allegations of improper on-site disposal of tank rinsing solutions were reported to the NYSDEC. Concerns about contamination associated with the Site increased after a warehouse fire at the Site in February 1989. Consequently, samples of runoff water and groundwater from three nearby residential wells were collected. The runoff samples contained low concentrations of benzene, toluene, ethylbenzene, trichloroethene and 1,1,1-trichloroethane; however, no volatile organic compounds (VOCs) were detected in the homeowner well samples. Subsequent residential well sampling in April 1989 indicated that VOCs were present in two of the wells. In October 1989, the NYSDEC began sending bottled water to House #1 and House #4, and in February 1990, granular-activated carbon (GAC) systems were installed on their water systems (refer to **Figure 2**). Point-of-entry (POE) GAC treatment systems were also installed for a residence on Route 9G further southwest of the Site in the mid-1990s, for House #3 (located on South Creek Road; not shown on **Figure 2**) in 1996 and for House #2 in 2002.

In August 1990, the Site was reclassified to Class 2, signifying that the Site presents a significant threat to public health and/or the environment and action is required. A remedial investigation (RI) at the Site was conducted in two phases, beginning in July 1992. The first phase (July 1992 to April 1994) consisted of a review of historical documents, magnetic survey, site-wide soil gas survey, test pitting, soil boring program, monitoring well installation and sampling, sediment and surface water sampling, and nearby homeowner well sampling. This phase identified the primary contaminants of concern (COCs) related to the Site, as well as their approximate concentrations. The second phase of the RI was initiated in April 1994, for the purpose of gathering information for the development of remedial alternatives. This work consisted of a treatability study for groundwater via GAC, and a separate treatability study involving a soil vapor extraction (SVE) pilot system for treating subsurface soil contamination.

The Draft Final Remedial Investigation and Feasibility Study (RI/FS) Report was completed by Engineering-Science, Inc. (ES) in January 1995 under the State Superfund Program. RODs were subsequently issued in March 1995 for OU1 (**Appendix A2**) and in March 1996 for OU2 (**Appendix A3**).

The selected remedy for groundwater contamination per the ROD for OU1 consisted of:

- Groundwater extraction and treatment, and vapor recovery and treatment from impacted bedrock;
- Reinfiltration of a portion of the treated groundwater;
- Institutional controls and restrictions on groundwater use;
- Maintenance of existing “point-of-entry” carbon filters on impacted homeowner wells; and
- Long-term monitoring.

VOCs identified as primary COCs and listed in the ROD for OU1 include:

- Benzene
- Chloroethane
- 1,1-Dichloroethene (1,1-DCE)
- 1,2-Dichloroethene (1,2-DCE)

- Tetrachloroethene (PCE)
- 1,1,1-Trichloroethane (1,1,1-TCA)
- Trichloroethene (TCE)
- Vinyl chloride (VC).

The selected remedy for soil contamination per the ROD for OU2 consisted of:

- Excavation of soil containing more than 700 parts per billion (ppb) of TCE located near the northeast corner of the building (Area A on **Figure 3**), along the drainage ditch near the northern corner of the building (Area B), and the south corner of the concrete pad (Area C);
- Excavation of weathered bedrock containing more than 700 ppb of TCE in Areas A and B; and
- On-site treatment of excavated soils and weathered bedrock by low temperature thermal desorption or comparable technology.

The COCs listed in the ROD for OU2 include chlorinated compounds, specifically TCE and DCE. The results of soil sampling performed at the Site prior to issuance of the ROD for OU2 and the locations of the areas of interest are presented on **Figure 3**.

The remediation of both operable units was implemented concurrently under a single set of contract documents. Earth Remediation Services (ERS) began construction of the groundwater remediation system in August 1997. In accordance with the ROD, highly impacted soils and weathered bedrock were removed from several areas and treated on-site via low temperature thermal desorption between September 1997 and January 1998. According to the Final Remediation Report (Rust Environment and Infrastructure, March 1999), a total of 1,013 tons of contaminated soil was excavated, treated on-site and reused on-site as backfill.

In February 1998, an SVE system and a GWETS became operational. In 1999, the Site was reclassified to Class 4.

1.2.3 Geologic Conditions

The Site is located in a broad northeast-trending valley, with bedrock outcrops exposed along the eastern portion of the valley. The depth to bedrock ranges from 0 to approximately 35 feet below ground surface (bgs). The bedrock consists of dark gray phyllite and metamorphosed dark gray sandstone of the Austin Glen Formation. Published geologic maps and reports indicate that the rocks in the area have undergone extensive folding and faulting. Where observed, the phyllite appears highly fractured with generally closely spaced fractures along bedding and cleavage planes (ES Draft Final Remedial Investigation and Feasibility Study [RI/FS] Report, 1995).

Locally, the unconsolidated materials are variable in thickness and composition. In the southern portion of the Site, a relatively thin brown silt and clay unit (5 to 10 feet thick) overlies approximately 20 feet of fine to coarse sand and gravel. Throughout the central and northern portions of the Site, a brown silt unit overlies a dense, gray till of variable thickness of 0 to 14 feet (ES RI/FS, 1995). According to the RI, all unconsolidated materials were observed to be unsaturated.

Groundwater flow at the Site occurs under semi-confined conditions along zones of secondary porosity in the fractured bedrock aquifer. The natural direction of groundwater flow is generally from the relatively high elevations and hillsides in the eastern portion of the Site to the lower western portion (**Figure 4**). The Rust Environment & Infrastructure Design Investigation Report (1996) confirms that the natural flow of groundwater is from the east to the west across the Site. Pumping test data indicated that the groundwater flow direction is strongly influenced by the occurrence and orientation of the fractures in the bedrock, especially under pumping/drawdown conditions.

Crum Elbow Creek is present to the northwest of the Site, north of Route 9G.

1.3 Summary of Remedial Investigation Findings

An RI was performed to characterize the nature and extent of contamination at the Site. The results of the RI and supplemental investigations are described in detail in the following submittals:

- Engineering-Science, Inc. of New York, P.C. 1995. “Remedial Investigation/Feasibility Study Report, Former NOW Corporation Site, Clinton, New York, Volumes I, II and III.” February 1995.
- New York State Department of Environmental Conservation. 1995. “New York State Superfund Record of Decision, Former NOW Corporation Site Operable Unit 1, Dutchess County, New York, Site Number 3-14-008.” March 1995.
- New York State Department of Environmental Conservation. 1996. “New York State Superfund Record of Decision, Former NOW Corporation Site Operable Unit 2, Dutchess County, New York, Site Number 3-14-008.” March 1996.

The results of the RI, which was not available during preparation of this SMP, are summarized in the following subsections based on available documentation.

1.3.1 Site-Related Soil and Weathered Bedrock

According to the ROD addressing OU2, four areas of concern were identified at the Site **(Figure 3)**. Soil borings were advanced through the overburden to the weathered bedrock and samples were collected for analysis. Two areas (Area A and Area B) were located near the northeast corner of the building. More specifically, Area A was located between the building’s wall and the access road, and Area B was located along the drainage ditch. The third area (Area C) was located along the south corner of the concrete pad, and the fourth area (Area D) was located between the loading docks and the concrete pad. Area D extended southwest of the manufacturing building into the parking lot. Remediation efforts in Area D were not considered to be cost-effective, as discussed in the ROD for OU2. The COCs identified in the soil and weathered bedrock at these areas of concern are chlorinated compounds, specifically TCE and DCE.

1.3.2 Site-Related Groundwater

Chlorinated VOCs and benzene have been identified as primary COCs for the Site, based on groundwater monitoring well sampling results. Refer to Section 1.2.2 and to **Table 1** for pre-remedial (baseline) groundwater concentrations from 1993 to 1994.

Per the ROD for OU1, during the RI in 1994 the highest concentrations of VOCs were detected in samples collected from monitoring wells MW-1, MW-6, MW-6D, MW-7, and MW-7D, and ranged from 11 ppb to 2,800 ppb for TCE and 12 ppb to 82 ppb for 1,2-DCE (**Figure 5**). These concentrations exceed the levels established in the *Division of Water Technical and Operational Guidance Series (1.1.1) Class GA Ambient Water Quality Standards and Guidance Values (AWQS) and Groundwater*

Effluent Limitations (NYSDEC, June 1998). The NYS drinking water standard for each of these compounds is 5 ppb.

Also per the ROD, groundwater was collected from nearby private drinking wells and the same compounds were detected in these samples. The reported concentrations of these compounds exceeded the drinking water standards as well. The concentrations ranged from 27 ppb to 730 ppb for TCE, 21 ppb to 700 ppb for 1,1,1-TCA, and 35 ppb to 1,838 ppb for total VOCs.

As a result of the initial results of the RI, which specifically identified soil and weathered bedrock as source material and identified a direct pathway of exposure to groundwater contamination via private wells, Interim Remedial Measures (IRM) were implemented. The IRM included the installation of carbon filtration systems on three private residences and supplying residences with potable water.

Per the NOW Corporation Immediate Investigation Work Assignment (IIWA), Site 3-14-008 Final 2008-2010 Project Summary Report (AECOM, June 2010), a supplemental investigation of tap water was conducted for several residences in the vicinity of the site between 2008 and 2009. No site-related compounds of concern were reported in the two tap water samples collected in March 2008. Follow-up sampling between November 2008 and February 2009 revealed that no compounds on the Target Compound List were detected at concentrations above the Method Detection Limits (MDL < 1 micrograms per liter (µg/L) for most compounds).

1.3.3 Site-Related Soil Vapor

During the first phase of the RI/FS, a soil gas survey was conducted at 145 sampling locations. The survey was performed to delineate the areas of soil and groundwater contamination near and downgradient of the source areas. The results of the survey in conjunction with chemical analysis of subsurface soils identified four areas with elevated levels of soil vapor concentrations (refer to Section 1.3.1). A treatability study was performed in Area D to determine the effectiveness of an SVE system as part of OU2. The study did not extend to the other three areas (Area A, B, and C) due to the shallow depth of the bedrock and fine grained soil in these areas (see **Appendix A3)**. Ultimately, based on the results, it was concluded that no SVE system would be installed at Area D. However, as part of the GWETS pilot test, significant vapors were observed coming from the test wells; SVE was later included as a selected remedy for OU1 and a system was operated at the site between 1998 and 1994 to address bedrock impacts in the vicinity of Areas A &B.

NYSDEC Program Policy *DER-13 (Strategy for Evaluating Soil Vapor Intrusion at Remedial Sites in New York, October 2006)* requires that vapor intrusion evaluations are performed at all remedial sites with known or likely subsurface VOC contamination where remedial decisions were made prior to January 1, 2003. Therefore, to delineate the extent of vapor phase contaminants present within the investigation area, AECOM conducted a soil vapor investigation at the Site and several privately owned structures adjacent to it between 2008 and 2009. NYSDEC, in consultation with the New York State Department of Health (NYSDOH), selected locations to collect vapor samples during the multiple phases of the investigation. This data was presented in the NOW Corporation Immediate Investigation Work Assignment (IIWA), Site 3-14-008 Final 2008-2010 Project Summary Report (AECOM, June 2010).

Samples were collected and analyzed for VOCs via United States Environmental Protection Agency (US EPA) Method TO-15. The air sampling results were compared to mean outdoor air concentrations from a study of VOCs in air of fuel oil heated homes (*NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York, Appendix C,* NYSDOH, October 2006). Indoor air data indicated that PCE was the only site-related compound found at elevated concentrations in any of the structures; however, the indoor air results alone did not warrant mitigation per NYSDOH guidance. Outdoor air sample results contained several chlorinated compounds at concentrations greater than the NYSDOH Background Concentrations. With the exception of PCE, all of the elevated concentrations in outdoor air samples were within one order of magnitude of the New York State Background Concentration for that analyte.

The results of this investigation reported concentrations of site-related VOCs (namely TCE, at a concentration of 720 micrograms per cubic meter [$\mu g/m^3$]) requiring mitigation in the sub-slab sample at one residence (House #4). As a result, a sub-slab depressurization system (SSDS) was installed at House #4 (refer to Section 2.2.1 for details).

In April 2009, AECOM submitted an interim memo to the NYSDEC presenting sub-slab and indoor air sampling results (all data except for House #4) and tap water sampling results for homes on South Creek Road and West Pine Road. An additional round of sub-slab vapor, indoor air, and tap water sampling took place at House #2 in December 2009. Based on the sample results, SSDSs are not required for any other residences at this time. AECOM submitted a letter report summarizing all of the work performed under the IIWA, including the air and tap water sampling program, in June 2010.

1.4 Summary of Remedial Actions (1997-2012)

The Site was remediated in accordance with the following design and construction documents:

- Rust Environment and Infrastructure of New York, Inc. 1996. “Work Plan, NOW Corporation Site, Work Assignment No. D004445-4, Site 3-14-008, Dutchess County, New York.” January 1996.
- Rust Environment and Infrastructure of New York, Inc. 1999. “Final Remedial Report, NOW Corporation Site Number 3-14-008, Volumes I.” March 1999.
- Earth Tech Northeast, Inc. 2006. “Operation, Maintenance and Monitoring Plan, NOW Corporation Site, Work Assignment No. D004445-4, Site 3-14-008, Dutchess County, New York.” May 2006.
- The selected remedies for OU1 and OU2 are listed in Section 1.2.2.

1.4.1 Removal of Contaminated Materials from the Site

Site Soils and Weathered Bedrock

In accordance with the ROD, highly impacted soils and weathered bedrock were removed from several areas and treated on-site via low temperature thermal desorption between September 1997 and January 1998. According to the Final Remediation Report (Rust Environment and Infrastructure, March 1999), a total of 1,013 tons of contaminated soil was excavated and treated on-site, not including test burns. All of the treated soil was used on-site as backfill.

1.4.2 Site-Related Treatment Systems

Groundwater Treatment System

The groundwater treatment system at the Site began operation in February 1998. Influent VOC concentrations from the first two years of GWETS operation (1998 and 1999) are presented in **Figure 6**. A standby submersible well pump, effluent sump pumps and float switch are maintained in the treatment building so that if the equipment fails the spare unit is installed, minimizing interruptions.

With the exception of a ten-month period in 2001 and a seven-month period between 2011 and 2012, the treatment system has generally run without significant downtime. The GWETS was not operational beginning in October 2011 due to repeated malfunctions of the air stripper. The air stripper was replaced with a refurbished unit and placed back on-line in June 2012.

Soil Vapor Extraction System

The SVE system was installed in 1998 as part of the remedy for OU1, to address impacts to bedrock. Information is provided in the 1999 Final Remediation Report. The system consisted of a small pre-engineered skid system equipped with a moisture separator, air filter, blower, instrumentation, and controls for the blower and air emissions. The unit was installed inside the treatment building and vented to the outside where the exhaust was treated via vapor phase GAC adsorption. The system used two existing wells (TW-1A and TW-2A) in addition to two new wells (VE-1, and VE-2) which were installed in bedrock between Areas A and B.

Extraction wells VE-1 and VE-2 (**Figure 2**) have not been operational since February 2004, when the well screens were inundated by a high water table. On November 2, 2005, the SVE system was completely shut down when the vapor blower motor ceased operation. The system was taken off-line permanently with NYSDEC approval, because the system was not significantly reducing VOC concentrations. The carbon vessels associated with the SVE system were also removed from the process in November 2005. Refer to the Site's initial PRR (AECOM, November 2010) for additional information.

While no longer used for vapor extraction, TW-1 and TW-2A continue to act as groundwater treatment (recovery) wells.

1.4.3 Remaining Contamination

Based on reviewed data, no contaminated source material (e.g. soil, septic, drywell, etc.) remains on-site. Groundwater on-site remains contaminated and groundwater has been monitored on an ongoing basis for assessment of overall trends in contaminant concentrations. **Table 1** presents groundwater monitoring data from 1998 and 1999 to provide a post-remediation baseline for groundwater quality. Data has been provided to NYSDEC in periodic Groundwater Monitoring Reports.

2.0 Engineering and Institutional Control Plan

2.1 Introduction

2.1.1 General

Since contaminated groundwater exists beneath the Site, EC/ICs are required to protect human health and the environment. This Engineering and Institutional Control Plan (EC/IC Plan) describes the procedures for the implementation and management of all EC/ICs at the Site. The EC/IC Plan is subject to revision by the NYSDEC.

2.1.2 Purpose

The purpose of the EC/IC Plan is to provide:

- A description of all EC/ICs on the Site;
- The basic implementation and intended role of each EC/IC;
- A description of the key components of the ICs as set forth in the ROD and environmental easement;
- A description of the features to be evaluated during each required inspection and periodic review;
- A description of plans and procedures to be followed for implementation of EC/ICs; and
- Any other provisions necessary to identify or establish methods for implementing the EC/ICs required by the Site remedy, as determined by the NYSDEC.

2.2 Engineering Controls

The Site has the following ECs:

- A GWETS;
- A sub-slab depressurization system at House #4;
- Several off-site residential POE GAC potable water treatment systems; and
- A locked groundwater treatment building.

2.2.1 Engineering Control Systems

<u>Groundwater Extraction and Treatment System</u>

The groundwater extraction system consists of three groundwater treatment wells (TW-1, TW-2A and TW-3), from which contaminated groundwater is pumped to a treatment building containing an air stripper for removal of VOCs (refer to **Figure 2**). In January 2000, the air stripper discharge treatment train was modified to eliminate the carbon polish by directing exhaust through an 8-inch polyvinyl chloride (PVC) stack on the roof of the building. The air stripper exhaust manifold is fitted with a single mist eliminator to prevent water from being drawn by vacuum into the exhaust system. The GAC adsorbers were taken off-line and the carbon was disposed off-site, leaving the empty carbon vessels in-place.

Treated groundwater is collected in a three-chamber precast concrete settling tank, which is located beneath metal grates in the floor of the treatment building. The treated water was formerly pumped to a 30-inch diameter by 72-inch multi-media particulate filter, manufactured by Miami Tank Manufacturing, Inc., to remove any solids prior to discharge. The multi-media filter was packed with seven components which included three sizes of filter gravel, two sizes of garnet sand, one size of silica sand and one size of anthracite sand. This filter has been offline for years. The pumping system uses a close-coupled submersible pump controlled by high and low level indicators in the third chamber of the settling tank.

Prior to circa 2005, treated effluent was pumped to a distribution pit from which water flowed by gravity to two injection wells (IW-1 and IW-2). A portion of the treated groundwater was reinjected into the subsurface via the injection wells. The discharge lines were equipped with independent flow meters and control valves to allow tracking and control of the flows to the injection wells and to surface water discharge. When effluent flow exceeded the infiltration capacity of the two wells, water would rise to the distribution pit and overflow by gravity via subsurface piping to an outfall on Crum Elbow Creek (**Figure 2**). However, the injection wells are not currently operational due to the accumulation of scale within the distribution pit and injection wells. Effluent from the treatment system currently flows through the distribution pit to the outfall.

Treatment of the recovered groundwater is achieved using a QED E-Z Tray® 4.4 Sliding Tray Air Stripper, located inside the treatment building. The E-Z Tray® unit consists of four trays (arranged in series). Air is provided to the stripper through a 7.5 HP blower, which is controlled manually with a variable frequency drive (VFD). The blower was fitted with a Cerus Industrial P-Series, 7.5 HP VFD in June 2012. The exhaust gases flow via an 8" PVC pipe manifold and exhausts to the atmosphere. The air stripper exhaust manifold is fitted with a single mist eliminator to prevent water from being drawn by vacuum into the exhaust system.

The on-site GWETS began operation in 1998, and has been performing effectively to date, with the exception of two extended periods of downtime (refer to Section 1.4.2). While concentrations of the COCs in the treatment wells have decreased since 1998, groundwater analytical data shows that contaminant concentrations still exceed the *s*tandards, criteria and guidance (SCGs). Therefore, the GWETS must continue to operate in order to meet the remedial goals established in the ROD for the Site. Procedures for operating, maintaining, and monitoring the GWETS are described in the Operation and Maintenance Plan (Section 4.0). Additionally, an O&M Manual containing information regarding the GWETS components and monitoring system is provided in **Appendix B**.

Off-Site Residential Potable Water Treatment Systems

Following the determination that several residential wells near the Site contained contamination (**Appendix C**), POE water treatment systems were installed. The NYSDOH recommends treatment with two carbon tanks connected in series for removal of organics from drinking water. This configuration provides a primary and secondary GAC unit and allows for monitoring water quality between these units. The systems are also typically equipped with ultraviolet (UV) treatment units for bacterial disinfection.

In 1990, the NYSDEC requested that a POE water treatment system be installed on the water supply well at House #1. Culligan Water Conditioning (Culligan) of Poughkeepsie installed and maintained the system that consisted of two one-cubic-foot capacity GAC tanks. The NYSDEC rented the unit from Culligan until July 1994, at which time RUST Environment & Infrastructure (RUST) replaced the Culligan system with larger capacity (14” x 47”) tanks.

NYSDEC also requested that a GAC system be installed on the well at House #3, which RUST installed in June 1996. The installation included an Ideal Horizon UV unit.

In response to a request from NYSDEC, Earth Tech Northeast, Inc. (Earth Tech) installed a GAC system at House #2 in July 2002. The system consists of two 14” x 47” tanks, connected in series and a Trojan model 708 UV unit.

A fourth contaminated well, whose water supply has also apparently been impacted by historic operations at the former NOW Corporation facility, is located at a commercial property (Business #1) to the north of the Site. It is not equipped with a POE system; as such, the NYSDEC provides workers in the building with bottled water.

Sub-Slab Depressurization System

As discussed in Section 1.3.3, based on concentrations of site-related VOCs found in a sub-slab sample at House #4 (located immediately west of the Site on Route 9G), an SSDS was installed on November 11, 2008 by GeoLogic NY, Inc. in order to mitigate indoor VOC vapors. The system prevents vapors or gases from accumulating beneath the slab and possibly entering the home, and is comprised of an electrically-powered exhaust fan mounted on the outside of the building, vacuum gauges (“U-tubes”) attached at one or more suction points, system piping, and labels identifying the system and providing contact information. The levels of the liquid in the U-tube(s) should be uneven to demonstrate differential pressure and effective operation.

Procedures for operating and maintaining the GWETS, POE, and SSDS systems are documented in the Operation and Maintenance Plan (Section 4.0), while procedures for monitoring the systems are included in the Monitoring Plan (Section 3.0). The Monitoring Plan also addresses severe condition inspections in the event that a severe condition occurs.

In June 2009, HDR, Inc. of Pearl River, New York was subcontracted by the NYSDEC to inspect and maintain the SSDS at House #4. A post-inspection letter from HDR to the residents of House #4 has been included as **Appendix D.** The letter instructs the residents to notify the NYSDEC if they observe operational issues.

2.2.2 Criteria for Completion of Remediation/Termination of Remedial Systems

Generally, remedial processes are considered to be completed when effectiveness monitoring indicates that the remedy has achieved the remedial action objectives (RAOs) identified in the ROD. The framework for determining when remedial processes are complete is provided in Section 6.6 of *DER-10* (NYSDEC, May 2010).

Site RAOs consist of the SCGs derived from the AWQS for the COCs, which are summarized below:

Contaminant	AWQS (µg/L)
Benzene	1
Chloroethane	5
1,1-Dichloroethene (1,1-DCE)	5
cis-1,2-Dichloroethene (cis-1,2-DCE)	5
trans-1,2-Dichloroethene (trans-1,2-DCE)	5
Tetrachloroethene (PCE)	5
1,1,1-Trichloroethane (1,1,1-TCA)	5
Trichloroethene (TCE)	5
Vinyl Chloride	2

The GWETS treats approximately 6.6 million gallons of groundwater per year, removing approximately 50 pounds of VOCs per year in recent years. Groundwater data indicates that additional remediation will be required to meet the SCGs for individual compounds. Therefore, the anticipated date of completion is currently unknown.

Operation and maintenance of the GWETS and residential POE systems will not be discontinued unless prior written approval is granted by the NYSDEC. In the event that monitoring data indicates that the GWETS is no longer required, then the NYSDEC will evaluate a proposal to discontinue operation. Conditions that warrant discontinuing the GWETS include contaminant concentrations in groundwater that: (1) reach levels that are consistently below ambient water quality standards; (2) have become asymptotic to a low level over an extended period of time as accepted by the NYSDEC; or (3) the NYSDEC has determined that the GWETS has reached the limit of its effectiveness. This assessment will be based in part on post-remediation contaminant levels in groundwater collected from monitoring wells located throughout the Site. The system will remain in place and operational until permission to discontinue its use is granted in writing by the NYSDEC. In the event of GWETS shutdown, the NYSDEC may require continual monitoring of raw water VOC concentrations at residences and businesses for a specified period of time.

If the NYSDEC determines that the GWETS will be decommissioned, collection of sub-slab samples within buildings in the vicinity of the site and/or sampling of the existing SSDS at House #4 may be required in order to evaluate the potential for risks associated with remediation system shutdown. The SSDS may also be decommissioned if sampling results indicate that there is no longer a potential for contamination of indoor air by site-related compounds.

2.3 Institutional Controls

Per the ROD, the site remedy includes "institutional controls and restrictions to restrain the future use of groundwater at the Site." The intent of the ICs is to:

- Implement, maintain and monitor EC systems;
- Prevent future exposure to remaining contamination by containing and controlling disturbances of the subsurface contamination; and,
- Limit the use and development of the Site to those activities which do not interfere with the effectiveness of the remedy or allow for exposure to contaminants.

Adherence to ICs on the Site is a requirement of the ROD and environmental easement and will be implemented under this SMP. The ICs for the Site include:

- Compliance with the environmental easement and this SMP by the Grantor and the Grantor's successors and assigns;
- All ECs must be operated and maintained as specified in this SMP;
- All ECs on the Controlled Property must be inspected at a frequency and in a manner defined in the SMP;
- Groundwater, residential potable water, soil vapor, and other environmental or public health monitoring must be performed as defined in this SMP;
- Maintaining restricted access to the Site remedial components and posting of warning notifications and contact information; and

- Data and information pertinent to Site Management of the Controlled Property must be reported at the frequency and in a manner defined in this SMP.

ICs identified in the SMP may not be discontinued without an amendment to or extinguishment of the environmental easement for the Controlled Property.

Additionally, site restrictions that apply to the Controlled Property are:

- All future activities on the property that will disturb remaining contaminated material must be conducted in accordance with this SMP. No intrusive activities or excavation may be conducted at the Site without the consent of the NYSDEC;
- The use of the groundwater underlying the property is prohibited without treatment rendering it safe for intended use;
- The potential for vapor intrusion must be evaluated for any buildings developed at the Site or in the surrounding area, and any potential impacts that are identified must be monitored or mitigated; and
- Vegetable gardens and farming are prohibited on the Site.

2.3.1 Excavation Work Plan

In the event that any intrusive work which may encounter or disturb remaining contamination (i.e., impacted groundwater or soils) at the Site is proposed in the future, an excavation work plan (EWP) must be submitted to the NYSDEC. Any work conducted pursuant to the EWP must also be conducted in accordance with the procedures defined in the Health and Safety Plan (HASP) and Community Air Monitoring Plan (CAMP) prepared for the Site in accordance with applicable Federal, State and local regulations. Any intrusive construction work will be performed in compliance with these documents and included in the periodic review reports per Section 3.4.3.

The EWP must include provisions for the structural integrity of excavations, proper disposal of excavation de-watering liquid, control of runoff from open excavations into remaining contamination, and for structures that may be affected by excavations (such as building foundations and bridge footings). The Site owner will ensure that Site development activities will not interfere with, or otherwise impair or compromise, the ECs described in this SMP.

2.3.2 Soil Vapor Intrusion (SVI) Evaluation

Prior to the construction of any new enclosed structures located over areas of remaining groundwater contamination (see **Figure 7**), an SVI evaluation may need to be performed to determine whether mitigation measures are necessary to eliminate potential exposure to vapors in the proposed structure. Alternatively, an SVI mitigation system may be installed as an element of the building foundation without first conducting an investigation. This mitigation system will include a vapor barrier and passive sub-slab depressurization system that is capable of being converted to an active system.

Prior to conducting an SVI investigation or installing a mitigation system, a work plan will be developed and submitted to the NYSDEC and NYSDOH for approval. This work plan will be developed in accordance with the most recent NYSDOH “Guidance for Evaluating Vapor Intrusion in the State of New York”. Mitigation measures will be evaluated, selected, designed, installed, and maintained based on the SVI evaluation, the NYSDOH guidance, and construction details of the proposed structure.

Preliminary (i.e., not validated) SVI sampling data will be forwarded to the NYSDEC and NYSDOH for initial review and interpretation. Upon validation, the final data will be transmitted to both agencies, along with a recommendation for follow-up action, such as mitigation. Validated SVI data will be transmitted to the property owner within 30 days of validation. If any indoor air test results exceed NYSDOH guidelines, relevant NYSDOH fact sheets will be provided to all tenants and occupants of the property within 15 days of receipt of validated data.

Any SVI sampling results, evaluations, and/or follow-up actions that occur will be summarized in the subsequent PRR.

2.4 Inspections and Notifications

2.4.1 Inspections

Inspections of all remedial components installed at the Site will be conducted at the frequency specified in the SMP Monitoring Plan schedule (Section 3.0). A comprehensive Site-wide inspection will be conducted annually, regardless of the frequency of the PRR. The inspections will determine and document the following:

- Whether ECs continue to perform as designed;
- If these controls continue to be protective of human health and the environment;
- Compliance with requirements of this SMP and the environmental easement;
- Achievement of remedial performance criteria;
- Sampling and analysis of appropriate media during monitoring events;
- If Site records are complete and up-to-date; and
- If any changes have been made to the remedial or monitoring system, or if changes are necessary.

Inspections will be conducted in accordance with the procedures set forth in the Monitoring Plan (Section 3.0) and Operation and Maintenance Plan (Section 4.0).

If an emergency, such as a natural disaster or an unforeseen failure of any of the ECs occurs, an inspection of the Site will be conducted within 5 days of the event to verify the effectiveness of the EC/ICs implemented at the Site by a qualified environmental professional as determined by the NYSDEC.

2.4.2 Notifications

Notifications will be submitted by the property owner and/or an entity responsible for Site maintenance to the NYSDEC as needed for the following reasons:

- 60-day advance notice of any proposed changes in Site use that are required under the terms of 6 NYCRR Part 375 and/or the Environmental Conservation Law.

- Notice within 48 hours of any damage or defect to the foundations or structures that reduces or has the potential to reduce the effectiveness of other ECs and likewise any action to be taken to mitigate the damage or defect.
- Verbal notice by noon of the following day of any emergency, such as a fire, flood, or earthquake that reduces or has the potential to reduce the effectiveness of ECs in place at the Site, with written confirmation within 7 days that includes a summary of actions taken, or to be taken, and the potential impact to the environment and the public.
- Follow-up status reports on actions taken to respond to any emergency event requiring ongoing responsive action shall be submitted to the NYSDEC within 45 days and shall describe and document actions taken to restore the effectiveness of the ECs.
- 30-day advance notice of any proposed ground intrusive activities that may disturb material below the water table, so that an appropriate excavation plan may be developed.

Any change in the ownership of the Site or the responsibility for implementing this SMP will include the following notifications:

- At least 60 days prior to the change, the NYSDEC will be notified in writing of the proposed change. This will include a certification that the prospective purchaser has been provided with all approved work plans and reports, including this SMP.
- Within 15 days after the transfer of all or part of the Site, the new owner’s name, contact representative, and contact information will be confirmed in writing.

Notifications will be made to Carl Hoffman, Remedial Bureau E, Section D, NYSDEC DER, 625 Broadway, Albany, New York 12233. In the event that NYSDEC develops a centralized notification system, that system will be used instead.

2.4.3 Evaluation and Reporting

The results of inspections and Site monitoring data will be evaluated as part of the EC/IC certification to confirm that the:

- EC/ICs are in place, are performing properly, and remain effective;
- Monitoring Plan is being implemented;
- O&M activities are being conducted properly; and
- Site remedy continues to be protective of public health and the environment.

2.5 Contingency Plan

Emergencies may include injury to personnel, fire or explosion, environmental release, or serious weather conditions.

No development is allowed within the limits of the Site without NYSDEC coordination. No intrusive activities will be allowed that will disturb the remedy. If development is proposed, NYSDEC personnel will require notice at least 60 days in advance of the proposed change in site use and a work plan will be required 30 days in advance for assessing and managing any potentially impacted material.

If previously unidentified contaminant sources are found during post-remedial subsurface excavations or development-related construction, excavation activities will be suspended until the appropriate equipment is mobilized to address the condition, and any new health and safety issues are addressed.

In such event, sampling will be performed on appropriate media as necessary to determine the nature of the material and proper disposal method. A sampling and analysis plan must be provided to NYSDEC for review and approval.

If any area of the Site is to be developed or excavated and dewatered, the NYSDEC must be informed at least 30 days in advance. The extracted groundwater must be analyzed for the COCs and treated via the existing treatment system or transported off-site for proper disposal. Depending on the estimated volume of groundwater to be generated from the dewatering activities, modification to the current discharge permit may be necessary. The Site developer will be responsible for obtaining or modifying the permit or for installation and maintenance of a new treatment system.

Identification of unknown or unexpected contaminated media identified by screening during invasive Site work will be promptly communicated by telephone to the NYSDEC Project Manager. Reportable quantities of petroleum product will also be reported to the NYSDEC spill hotline. These findings will be included in daily and periodic reports.

2.5.1 Emergency Telephone Numbers

In the event of any environmental situation or unplanned occurrence requiring assistance, the Owner or Owner's representative(s) should contact the appropriate party from the contact list below. For emergencies, appropriate emergency response personnel should be contacted. Prompt contact should also be made to the qualified environmental professional. These emergency contact lists must be maintained in an easily accessible location at the Site. Contact numbers are provided in the below tables.

Emergency Contact Numbers	
Police/Fire:	911
DigSafely New York:	(800) 962-7962 or 811
Poison Control Center:	(800) 222-1222
National Response Center:	(800) 424-8802
NYSDEC Spills Hotline	(800) 457-7362
Town of Clinton Town Clerk	(845) 266-5853

Note: Contact numbers are subject to change and should be updated as necessary.

Site Contact Numbers	
Carl Hoffman, NYSDEC Project Manager	(518) 402-9812
Steve Choiniere, AECOM Project Manager (Qualified Environmental Professional)	(518) 951-2262

Note: Contact numbers are subject to change and should be updated as necessary.

2.5.2 Maps and Directions to Nearest Health Facility

The hospital nearest the Site is Northern Dutchess Hospital, located in Rhinebeck, New York. The hospital is approximately 8.8 miles from the Site.

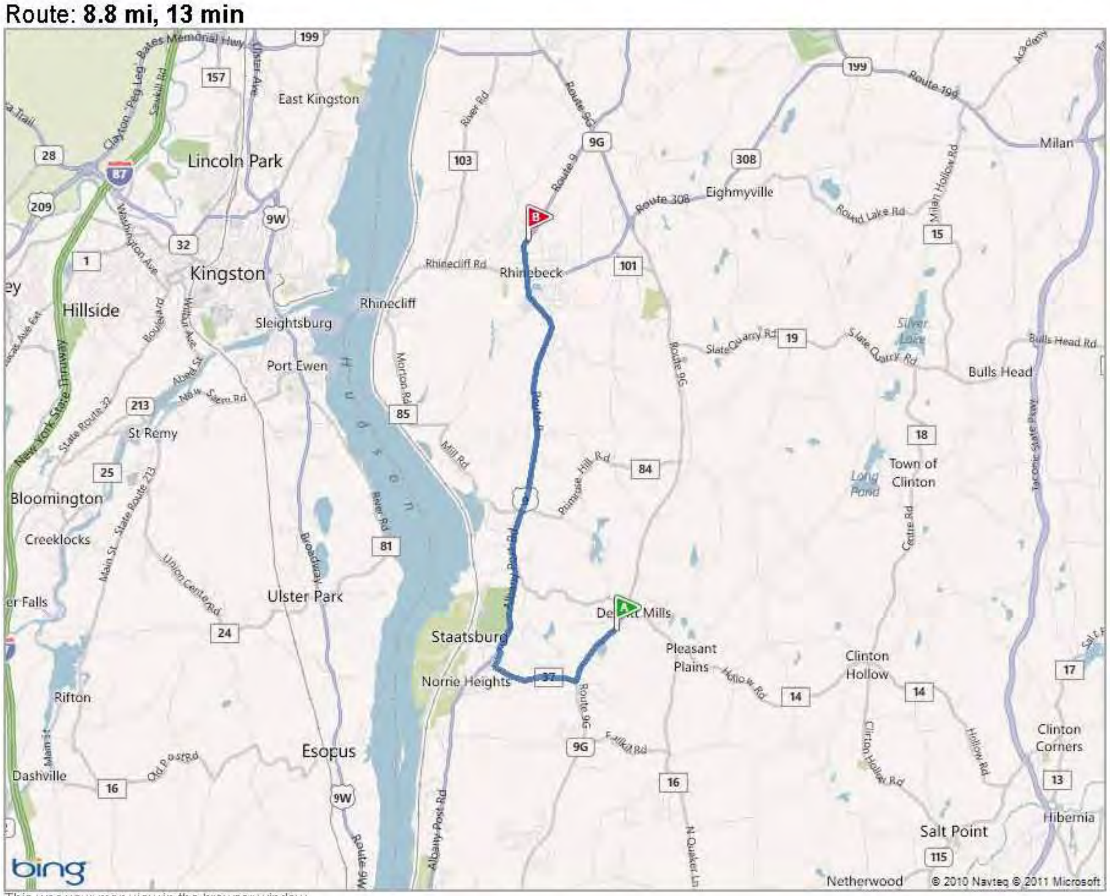
Site Location: 2092 Route 9G, Staatsburg, NY 12580 (Mailing address)
Nearest Hospital Name: Northern Dutchess Hospital
Hospital Location: 6511 Springbrook Avenue, Rhinebeck, New York 12572
Hospital Telephone: (845) 876-3001 or 1-877-729-2444

Total Distance: 8.8 miles
Total Estimated Time: 13 minutes

Driving directions and a map to the hospital are provided below:

	2092 Route 9G, Staatsburg, NY 12580	**A–B: 8.8 mi** 13 min
1.	Depart **RT-9G / Route 9G** toward Fieldstone Rd	1.0 mi
2.	Turn **right** onto **N Cross Rd / CR-37**	1.3 mi
3.	Turn **right** onto **Prospect St**	0.3 mi
4.	Bear **right** onto **US-9 / Albany Post Rd** *Pass Getty in 3.1 mi*	6.3 mi
5.	Arrive at **6511 Spring Brook Ave, Rhinebeck, NY** *The last intersection is Locust Grove Rd* *If you reach Mulberry St, you've gone too far*	

Route: **8.8 mi, 13 min**



This was your map view in the browser window.

A: **2092 Route 9G, Staatsburg, NY 12580**

B: **6511 Spring Brook Ave, Rhinebeck, NY**

2.5.3 Response Procedures

In the event of any release of material or other emergency, the fire department and other emergency response groups will be notified immediately by telephone and provided with site hazard information. The emergency telephone number list is found in Section 2.5.1. The Site contacts listed in the same section will also be notified. Local responders will be notified through 911. The Fire Department would be the first responders. If the incident requires Hazardous Materials response, 911 should be called and the appropriate emergency response personnel will be contacted.

Evacuation Plan

In the event of an explosion and/or fire, all site personnel shall assemble at a safe distance upwind of the affected area. Minimum response procedures include notification of emergency services and site contacts. Re-entry should not occur until site conditions are deemed safe. Subsequent to the event, an incident investigation should be performed and any recommended corrective actions addressed. If breathing zone/perimeter monitoring activities determine that consistent VOC readings of greater than 5 ppm are indicated on a photoionization detector, then site personnel will cease operations and immediately evacuate the site, consult with a health and safety professional, and revisit health and safety protocols to properly protect themselves from site hazards prior to re-entry to the Site (e.g., increase level of personal protective equipment).

Spills

Based on site conditions, a spill situation of material other than treated or untreated groundwater is considered unlikely. In the event of a petroleum release (e.g. equipment leak from contractor), the release will be cleaned up in a timely fashion per applicable guidance and reported to the NYSDEC Spill Hotline. In the event of a system leak, the system will be taken offline until repaired and the building will be cleaned, as necessary. Appropriate personal protective equipment (PPE) will be worn for the hazards presented, consistent with the site-specific HASP.

Amendments to the Contingency Plan

Amendments to the contingency plan should be made subsequent to any incident investigation and changes should be approved by NYSDEC personnel.

Medical Emergencies

Medical emergencies are addressed in the site HASP. Appropriate first aid will be administered, and if necessary, the injured individual will be sent to the designated medical facility. An ambulance will be summoned, if needed. The cause of the accident will be determined and corrected prior to continuing operations. First aid kits are maintained in all AECOM-owned or leased vehicles at all times.

Training

All individuals performing work on-site will attend an initial 40-hour health and safety training course and annual 8-hour refresher training for conducting work at hazardous waste sites. These courses satisfy the initial and follow-up training requirements of 29 CFR 1910.120 (OSHA regulation of hazardous waste site activities). Other required task-specific training will be provided as appropriate based on task hazard analysis and training needs assessments.

All individuals are required to read, sign and comply with the site HASP at all times when performing work on the Site.

3.0 Site Monitoring Plan

3.1 Introduction

3.1.1 General

The Monitoring Plan describes the measures for evaluating the performance and effectiveness of the remedy to reduce or mitigate contamination at the Site and all affected Site media identified below. Monitoring of ECs is described in Section 4.0, Operation and Maintenance Plan. This Monitoring Plan may only be revised with the approval of the NYSDEC.

3.1.2 Purpose and Schedule

This Monitoring Plan describes the methods to be used for:

- Sampling and analysis of all appropriate media;
- Assessing compliance with applicable NYSDEC standards, criteria and guidance, particularly ambient groundwater standards;
- Assessing achievement of the remedial performance criteria;
- Evaluating Site information periodically to confirm that the remedy continues to be effective in protecting public health and the environment; and
- Preparing the necessary reports for the various monitoring activities.

To adequately address these issues, this Monitoring Plan provides information on:

- Sampling locations, protocol, and frequency;
- Information on all designed monitoring systems (e.g., well logs);
- Analytical sampling program requirements;
- Reporting requirements;
- Quality Assurance/Quality Control (QA/QC) requirements;
- Inspection and maintenance requirements for monitoring wells;
- Monitoring well decommissioning procedures; and
- Annual inspection and periodic certification.

Monitoring of the performance of the remedy and overall reduction in contamination on-site will be conducted according to the schedule provided below. Trends in contaminant levels in groundwater in the affected areas will be evaluated to determine if the remedy continues to be effective in achieving remedial goals. The monitoring program is summarized in the table below and outlined in detail in Section 3.2 below.

Monitoring Program	Frequency*	Matrix	Analysis
Groundwater (MW-1, MW-4S, MW-6S, MW-6D, MW-7S, MW-7D, MW-12S, MW-12D)	Annually	Water	TCL VOCs 8260C

* The frequency of events will be conducted as specified until otherwise approved by NYSDEC and NYSDOH.

3.2 Media Monitoring Program

The following sections describe the details of the Media Monitoring Program procedures for affected media at the Site. The primary affected media is groundwater. The following summarizes the current media monitoring program:

- Collection of select monitoring well depth-to-groundwater measurements and collection of groundwater samples for analysis of VOCs utilizing US EPA SW 846 protocol, more specifically US EPA Method 8260C.
- Collection and analysis of soil vapor and/or indoor air samples (for VOCs via US EPA Method TO-15) and tap water samples (for Target Compound List [TCL] VOCs via US EPA SW 846 Method 524.2 drinking water) from residences and local businesses, at the request of and at a frequency specified by the NYSDEC and NYSDOH.
- In the event that new buildings are erected above the contaminated area at the Site, the NYSDEC or NYSDOH may require completion of additional soil vapor intrusion evaluation activities, in accordance with NYSDOH guidance.

3.2.1 Groundwater Monitoring

Groundwater monitoring will be performed annually to assess the performance of the remedy.

The network of 23 monitoring wells has been installed to monitor both upgradient and downgradient groundwater conditions at the Site. The network of on-site and off-site wells has been designed primarily based on the following criteria:

- Historical analytical results identifying contamination in excess of standards;
- Anticipated contaminant plume migration; and
- Adequate assessment of overburden and bedrock groundwater conditions and contaminant distribution.

Based on the site definition in Section 1.2.1, the following wells are considered to be on-site wells: MW-1, MW-2, MW-3S, MW-3D, MW-4S, MW-4D, MW-6S, MW-6D, MW-7S, MW-7D, MW-8, MW-11, OW-1, OW-2, OW-3, OW-4, OW-5 and OW-6. Off-site monitoring wells include MW-5, MW-9, MW-10, MW-12S and MW-12D. The locations of on-site and off-site wells are shown on **Figure 2**. The suffixes S and D are used to differentiate screened intervals in the same location (shallow and deep [bedrock]). If new wells are installed, then the SMP should be updated. Available boring logs and well construction diagrams for limited Site wells are contained in **Appendix D**, while well construction details are summarized in **Table 2** along with groundwater elevations collected in 2011.

A discussion of site geology is presented in Section 1.2.3. In general, overburden wells are stick-up wells screened within a relatively thin layer of unconsolidated material. Wells located within the southern section of the site screen a brown silt and clay unit (5 to 10 feet thick) and a fine to coarse sand and gravel unit approximately 20 feet thick. Wells located in the central and northern portions of the Site screen a brown silt unit that superimposes a dense, gray till of variable thickness (ES RI/FS, 1995). Specific well details for the groundwater wells installed during the RI, including TW-1, were not available at the time this report was drafted due to the inability to locate a copy of the RI. Prior to installation of the treatment wells, the natural direction of groundwater flow was generally from the relatively high elevations and hillsides in the eastern portion of the Site to the lower western portion towards Crum Elbow Creek.

Bedrock wells are generally stick-up wells as well and are screened or consist of an open borehole beginning near the top of the bedrock surface. Again, specific well details for the wells installed during the RI, including TW-1, were not available at the time this report was drafted due to the inability to locate a copy of the RI. During the Design Investigation, five additional wells, consisting of two treatment wells (TW-2 and TW-3), two injection wells (IW-1 and IW-2), and an observation well (OW-6), were installed. Boring logs for these five wells are included in **Appendix D.** The injection and treatment wells are open borehole wells, for which depth-to-bottom elevations range from 75.2 feet below ground surface (fbgs) (IW-1) to 160.5 fbgs (TW-2). During the Design Investigation, pumping tests were performed on the newly installed wells. TW-2 did not yield an adequate amount of water for efficient operation of the groundwater treatment system; therefore, another treatment well (TW-2A) was installed. The tops of the bedrock open boreholes ranged from 6 fbgs (TW-3) to 18.3 fbgs (IW-2). OW-6 is a bedrock well, with a 2" riser and screen installed within the open borehole from 11.5 fbgs to the well bottom (91.5 fbgs). See **Table 2** for available construction details for wells installed during the Design Investigation phase.

In September 2011, the depth to water in monitoring and injection wells ranged from 3.4 to 42.6 feet bgs. The observation wells have not been included in these values due to their close proximity to the treatment wells, which cause significant drawdown of groundwater. The overall groundwater flow direction in September 2011 was toward the treatment wells at the center of the Site (**Figure 8**).

<u>Sampling Frequency</u>

All accessible, on-site wells and off-site wells (listed above) in good condition and expected to contain reportable levels of VOCs are currently included in the sampling program except the three treatment wells (TW-1, TW-2A and TW-3), which are included in monthly O&M monitoring events. Monitoring wells will be sampled at the frequency specified in Section 3.1.2 until the criteria for completion of remediation are met, per Section 2.2.2. The sampling frequency may be modified with the approval of the NYSDEC. The SMP will be modified to reflect changes in sampling plans approved by the NYSDEC. Deliverables for the groundwater monitoring program are specified below.

Sampling Protocol

Monitoring well sampling will be conducted in a manner that allows consistent repetition of groundwater monitoring events and data comparison. Adhering to a consistent sampling schedule and protocol will provide data that can be properly evaluated for measurable changes in reported concentrations at a particular location or between locations.

All monitoring well sampling activities will be recorded in a field book and on the Monitoring Well Purging/Sampling Forms presented in **Appendix E**. Other observations (e.g., well integrity, etc.) will also be noted on the sampling forms and/or the Operation, Maintenance & Monitoring Checklist in (**Appendix E**).

Prior to sampling each well, a depth-to-water measurement and a depth-to-bottom measurement will be taken using a water level indicator. The instrument shall be sprayed down with a mixture of spring water and Liquinox® and then rinsed with distilled water before each use. Each monitoring well will be purged of three times the volume of water present in the water column at the time of measurement. Based on the VOC concentrations found within the wells that are currently included in the annual groundwater monitoring program, only the purge water from nearby well MW-7D must be transported to the GWETS for treatment, until such point that total VOC concentrations are less than 200 ppb. Purge water from the other wells sampled may be discharged directly to the ground. This is based on a directive from the NYSDEC which states that, generally, purge water containing less than 200 ppb of VOCs may be discharged to the ground unless it is prudent to discharge the water to a treatment system based on the well's location in a paved or residential area.

Wells will be purged and sampled using a Waterra® inertial pump (or equivalent) and dedicated, Teflon-lined polyethylene tubing and dedicated, polyethylene check valve. A dedicated, disposable polyethylene bailer can be substituted depending on the volume of water to be removed prior to sampling. Dedicated tubing and/or bailers do not have to be decontaminated and may remain in the wells for future reuse. Following sampling, the water level meter will be decontaminated between each use in a Liquinox® bath and distilled water rinse.

During purging and prior to collecting groundwater samples, the following minimum water quality parameters must be recorded on the Monitoring Well Purging/Sampling Forms (**Appendix E**): temperature, conductivity, specific conductance, pH, dissolved oxygen, oxidation-reduction potential (ORP), turbidity, color and odor of the water, well construction, and well condition. Samples will be collected in bottles provided by the NYSDEC ELAP-certified analytical laboratory. All samples shall be packed on ice and submitted to the laboratory with a completed Chain of Custody for analysis of VOCs by US EPA Method 8260C.

All documents and data will be submitted in electronic format to the NYSDEC Division of Environmental Remediation. The Department will not approve a final report unless, and until, all documents and data generated in support of that report have been submitted in accordance with the electronic submission protocols.

Information on the format of data submissions can be found at:

http://www.dec.ny.gov/chemical/62440.html

Information on document submissions can be found at:

http://www.dec.ny.gov/regulations/2586.html.

Monitoring Quality Assurance/Quality Control

All sampling and analyses will be performed in accordance with the requirements of the Generic Quality Assurance Project Plan (QAPP; AECOM, May 2010), except as noted below:

- A trip blank will be collected and analyzed for each annual groundwater monitoring event;
- A duplicate sample will be collected from one monitoring well during each annual groundwater monitoring event;
- No Category B deliverables will be requested and no data validation will be performed on site management data unless necessary to support a site closure recommendation.
- No matrix spikes or matrix spike duplicates will be collected as part of the sampling event.
- Sample identification will include the monitoring well ID and a reference to the sample date (e.g., MW- # MMDDYY or MW-DUP MMDDYY [for monitoring well duplicates]).
- Sample identification for trip blanks will include a reference to the sample date (e.g., TRIP BLANK MMDDYY or TB MMDDYY.

Monitoring Well Repairs, Replacement, and Decommissioning

If excessive biofouling or silt accumulation occurs in the on-site or off-site monitoring wells, which will be assessed by the depth-to-groundwater and depth-to-bottom changes over time, the wells will be physically agitated/surged and redeveloped. Additionally, monitoring wells will be properly decommissioned and replaced (as per the Monitoring Plan) if an event renders the wells unusable or if they are eliminated from the Monitoring Program with NYSDEC approval.

Repairs and/or replacement of wells in the monitoring well network will be performed based on assessments of structural integrity, overall performance, and unforeseen events such as well destruction due to local redevelopment of the Site.

The NYSDEC will be notified prior to any repair or decommissioning of monitoring wells for the purpose of replacement, and the repair or decommissioning and replacement process will be documented in the subsequent periodic report. Well decommissioning without replacement will be done only with the prior approval of the NYSDEC. Well abandonment will be performed in accordance with the *Groundwater Monitoring Well Decommissioning Policy* (NYSDEC, November 2009). Monitoring wells that are decommissioned because they have been rendered unusable will be replaced with a similar well at a nearby location approved by NYSDEC.

3.2.2 Other Media

If any other media (e.g. surface water, sediment, soil vapor) is to be collected and analyzed as a result of periodic review or discovery of new information or development, then a sampling and analysis plan shall be presented to NYSDEC. For example, soil vapor intrusion and private drinking water samples are collected at the request of the NYSDEC and NYSDOH. As a result, a work plan and an addendum were submitted with the NYSDEC for the performance of an IIWA in March 2008 and September 2008, respectively. The soil vapor samples will be analyzed for VOCs via US EPA Method TO-15 and the drinking water samples will be analyzed for TCL VOCs via US EPA Method 524.2. If routine monitoring occurs, the SMP should be modified to incorporate the requirements.

3.3 Media Monitoring and Site-Wide Inspection Schedule

The schedule of monitoring events is provided in the table below. See Section 4.0 for discussion of the O&M event schedule. The frequency of events will be maintained as specified until otherwise approved by NYSDEC and NYSDOH. Unscheduled inspections and/or sampling may take place when a suspected failure of the remedial systems has been reported or an emergency occurs that is deemed likely to affect the operation of the EC/ICs. Features to be monitored include, but are not limited to, the following:

Media Monitoring and Site-Wide Inspection Schedule

Monitoring Program	Frequency	Matrix/System	Analysis/ Assessment
Media/EC	Annually	Groundwater (MW-1, MW-4S, MW-6S, MW-6D, MW-7S, MW-7D, MW-12S, MW-12D)	TCL VOCs 8260C
ECs	Annually	Groundwater Monitoring Network Inspection	Integrity (Visual)
ECs/ICs	Annually	Comprehensive Site-wide Inspection	Visual

3.4 Reporting Requirements

Forms and any other information generated during regular monitoring events and inspections will be kept with the project file. See Section 4.0 for discussion of O&M reporting requirements related to the GWETS. All forms, and other relevant reporting formats used during the monitoring/ inspection events, will be (1) subject to approval by the NYSDEC and (2) submitted on a periodic basis in the PRR or separate status reports. The table below provides information on the reporting frequency.

Schedule of Monitoring/Inspection Reports

Task	Reporting Frequency
Groundwater Monitoring Report	Annually – Included with corresponding monthly Operation, Maintenance and Monitoring Report
Site-Wide Inspection	Annually – Included in the Groundwater Monitoring Report, unless corrective actions are required
Periodic Review Report	Triennially
IC/EC Certification	Triennially – Includes contacting county clerk to confirm easement is still in place; findings included in PRR

3.4.1 Annual Site-Wide Inspection

Site-wide inspections will be performed once per year and after all severe weather conditions that may affect ECs or ICs. During these inspections, an inspection form will be completed (**Appendix E**). The form will be included in the annual groundwater monitoring report. The form will compile sufficient information to assess the following:

- Compliance with all ICs, including Site usage;
- An evaluation of the condition and continued effectiveness of ECs;
- General site conditions at the time of the inspection;
- Site management activities being conducted including, where appropriate, confirmation sampling and a health and safety inspection;
- Compliance with permits and schedules included in the Operation and Maintenance Plan; and
- Confirmation that site records are up-to-date.

If an emergency, such as a natural disaster or an unforeseen failure of any of the ECs occurs, an inspection of the Site will be conducted within 5 days of the event to verify the effectiveness of the EC/ICs implemented at the Site by a qualified environmental professional as determined by the NYSDEC.

3.4.2 Groundwater Monitoring Data Reporting

Groundwater monitoring reports will be prepared and submitted subsequent to each groundwater monitoring event. This report will include, at a minimum:

- Date of event;
- Personnel conducting sampling;
- Description of the activities performed;
- Type of samples collected and list of wells sampled;
- Copies of all field forms completed (e.g., sampling logs, chain-of-custody documentation, etc.);
- Sampling results in comparison to appropriate standards/criteria;
- A figure illustrating sample type and sampling locations;
- Copies of all laboratory data sheets and the required laboratory data deliverables required for all points sampled (to be submitted electronically in the NYSDEC-identified format);
- Any observations, conclusions, or recommendations; and
- A determination as to whether the groundwater quality and/or conditions have changed since the last reporting event where groundwater monitoring well data was provided.
- All documents and data are to be submitted in electronic format to the NYSDEC Division of Environmental Remediation. The Department will not approve a final report unless, and until, all documents and data generated in support of that report have been submitted in accordance with the electronic submission protocols.

3.4.3 Periodic Review Reporting

PRRs will be submitted to the NYSDEC in accordance with the schedule outlined above. In the event that the Site is subdivided into separate parcels with different ownership, a single PRR will be prepared that addresses the Site as described in the RODs.

The report will be prepared in accordance with NYSDEC *DER-10* and submitted 45 days prior to the end of each certification period. Media sampling results will also be incorporated into the PRR. The report will include:

- Identification, assessment and certification of all ECs/ICs required by the remedy for the Site;
- Results of the required annual site inspections and severe condition inspections, if applicable;
- All applicable inspection forms and other records generated for the Site during the reporting period in electronic format;
- A summary of any discharge monitoring data and/or information generated during the reporting period with comments and conclusions;
- Data summary tables and graphical representations of contaminants of concern by media (groundwater, soil vapor), which include a listing of all compounds analyzed, along with the applicable standards, with all exceedances highlighted. These will include a presentation of past data as part of an evaluation of contaminant concentration trends;
- Results of all analyses, copies of all laboratory data sheets, and the required laboratory data deliverables for all samples collected during the reporting period will be submitted electronically in a NYSDEC-approved format;
- A site evaluation, which includes the following:
    - The compliance of the remedy with the requirements of the Site-specific ROD;
    - The operation and the effectiveness of all treatment units, etc., including identification of any needed repairs or modifications;
    - Any new conclusions or observations regarding Site contamination based on inspections or data generated by the Monitoring Plan for the media being monitored;
    - Recommendations regarding any necessary changes to the remedy and/or Monitoring Plan; and
    - The overall performance and effectiveness of the remedy.
- A performance summary for the GWETS during each calendar year, including information such as:
    - The number of days the system was run for the reporting period;
    - The average, high, and low flows per day;
    - The contaminant mass removed;
    - A description of breakdowns and/or repairs along with an explanation for any significant downtime;

- o A description of the resolution of performance problems;
- o A summary of the performance, effluent and/or effectiveness monitoring; and
- o Comments, conclusions, and recommendations based on data evaluation.

The PRR will be submitted, in electronic format, to the NYSDEC Central Office.

3.5 Corrective Measures Plan

If any component of the remedy is found to have failed or is no longer protective of human health or the environment, a corrective measures plan will be submitted to the NYSDEC for approval. This plan will explain the problem and provide the details and schedule for performing work necessary to correct it. Unless an emergency condition exists, no work will be performed unless the corrective measures plan is approved by the NYSDEC.

4.0 Operation and Maintenance Plan

4.1 Introduction

This Operation and Maintenance (O&M) Plan describes the measures necessary to operate, monitor and maintain the mechanical components of the remedy selected for the Site. This O&M Plan:

- Includes the steps necessary to allow individuals unfamiliar with the Site to operate and maintain the GWETS system, the SSDS, and the POE GAC units; and
- Will be updated periodically to reflect changes in Site conditions or the manner in which the remedial systems are operated and maintained.

Information on monitoring and inspection of non-mechanical site features is provided in Section 3.0 - Monitoring Plan. A copy of this SMP will be kept in the system building. This O&M Plan is not to be used as a stand-alone document, but as a component document of the SMP.

4.2 Engineering Control System Operation and Maintenance

4.2.1 Groundwater Treatment System

4.2.1.1 Scope

Operation and maintenance of the GWETS began in January 1998. A Process and Instrumentation diagram (P&ID) of the current GWETS is provided as **Figure 9**. Equipment shown in red on the drawing is no longer in use for groundwater treatment.

Equipment specifications, system layout drawings and as-built drawings are included in the O&M Manual (**Appendix B)**, along with installation and maintenance documentation provided by manufacturers for specific system components. Information is excerpted within the body of this SMP as appropriate. Since the scope of this SMP includes operation and maintenance of the GWETS, the following information is intended to provide an overview of system characteristics and O&M procedures; however, it should not supersede the O&M Manual.

4.2.1.2 GWETS Start-Up and Testing

Prior to starting up the GWETS, the following should be checked:

1. Check all piping and fittings to confirm that connections are tight and that there are no leaks;
2. Visually inspect all components of the system for any signs of damage;
3. Check all piping fasteners, making sure all pipes and equipment are secure;
4. Confirm that all valves are closed or open in a manner which will produce the desired flow path. Valves are labeled as normally open or closed;
5. Check that all sample ports are tightly closed;
6. Check all components that have any lids or other openings and confirm that they are sealed properly;

7. Inspect all electrical wires and connections for fraying or other types of damage; and
8. Inspect all connections within the three well boxes and check for any damage.

When starting the GWETS, the following steps should be followed:

1. Make sure the system circuit breaker is turned on in the main breaker panel;
2. Check and if necessary reset the circuit breakers and thermal overload protectors located within the system control panel;
3. Check all system control parameters located on the interior of the system control panel (i.e., water levels, line pressures);
4. Confirm that the control unit is programmed properly and set to “auto”;
5. Turn on the main power switch, labeled “Main Disconnect”, located on the interior door of the system control panel;
6. Close and secure the exterior door of the control panel using the handle;
7. Individual pumps can be tested by switching each pump control switch to “Hand” for approximately 1-2 seconds;
8. Switch each of the pump control switches to “Auto”, always starting with the settling tank pump to ensure that the settling tank cannot overflow;
9. Set the air stripper to “Auto”;
10. After a short delay, the three well pumps will begin to pump. This can be verified with the “pump run” lights located on the control panel, and also with the flow meter display units, mounted on the left side of the control panel. It may take a few minutes for water to reach the flow sensors before there will be any reading on the display units; and
11. Adjust the brass gate valves to obtain the desired flow rates.

The following procedures should be implemented for GWETS shut-down:

1. Turn the three well pump control switches to the “off” position, followed by the air stripper after a set amount of time, and lastly the effluent pump. It is necessary to turn the effluent pump off last to compensate for any residual flow into the third settling tank after power to the well pumps and sump pump has been turned off; and
2. In situations where the system may be shut off for long periods of time, it is a good practice to turn off the main circuit breakers in order to prevent the system from being accidentally turned on.

The system testing described above will be conducted if the system requires restarting (e.g. power outage, shutdown during maintenance, substantial modifications, etc.).

4.2.1.3 GWETS Operation: Routine Operation Procedures

The system operates continuously upon startup, allowing the pumps within the three treatment wells to remove groundwater at an approximate rate of 3 to 14 gallons per minute (gpm) and convey it to the treatment building via subsurface piping. Pressure and level sensors control operation of the pumps. Within the building, the groundwater passes through the flow meter/totalizer. Water is pumped through the air stripper to remove the VOC contaminant mass through volatilization. Treated effluent is contained in a in a three-chamber, precast concrete settling tank, located in the floor of the treatment building. The third chamber is equipped with a submersible pump and water level sensors. Upon reaching the high level, the pump turns on and conveys the effluent to the precast concrete effluent distribution and meter pits and then drains by gravity to the creek (**Figure 2**).

The system operation is electronically controlled via a programmable system controller and system conditions are monitored remotely (e.g. status of level sensors, flow, pressure differentials, pumps, alarm indicators, etc.). Real-time details are recorded and the system controls can be remotely turned on or off based on conditions.

4.2.1.4 GWETS Operation: Routine Equipment Maintenance

Generally, maintenance requirements include the following:

- Clean pressure/level sensors and probes;
- Pump cleaning/repair/replacement;
- Keeping stripper intake free of debris and insects;
- Desiccant tube replacement;
- Cleaning the three-chamber, precast concrete settling tank;
- De-scaling the air stripper;
- Water vapor trap replacement;
- Confirm no abnormal heating or abnormal vibration from VFD;
- Gutter cleaning for treatment building;
- Keeping stripper motor lubricated; and
- Well lock lubrication (no solvent-based lubricants).

4.2.1.5 GWETS Operation: Non-Routine Equipment Maintenance

In the event of a system malfunction, the ProControl Series II will trigger an alarm condition and is programmed to generate a facsimile and/or output an alphanumeric message. Details on programming the controller are provided in the ProControl Series manual (refer to **Appendix B**).

Alarm conditions currently programmed to generate facsimile notifications and responses to the alarms are outlined in the "ProControl Series 2Plus User Manual" section of the O&M Manual in **Appendix B**.

Non-routine maintenance may include timely coordination of the removal of scale from the air stripper and granulated scale and settled sediment from the three-chamber, precast concrete settling tank and repair or replacement of pumps, transducers, and control system components.

4.2.1.6 GWETS Operation: Troubleshooting

System troubleshooting is discussed in the "ProControl Series 2Plus User Manual" section of the O&M Manual.

4.2.2 Residential Point of Entry (POE) Water Treatment Systems

4.2.2.1 Scope

The residential POE systems were installed in 1990, the mid-1990s and 2002; however, a P&ID of these units is not available. Further detail is provided in Section 2.2.1.

4.2.2.2 POE GAC System Start-Up and Testing

Prior to turning the water back on, the following should be checked:

- Ensure all residential valves are open;
- Check that sample ports are tightly closed;
- Make sure all connections are tight and properly sealed (e.g., the 14” X 47” GAC tanks);
- Confirm the UV light is working properly;
- Turn valve to main water supply for the residence water back on; and
- Look for leaks and loss of pressure.

The following procedures should be implemented for system shut-down:

- If resident is home at the time, inform the resident that the water will have to be temporarily shut off; and
- Turn valve off for main water supply to the residence.

The system testing described above will be conducted if the system requires restarting (e.g. power outage, shutdown during maintenance, substantial modifications, etc.).

4.2.2.3 POE GAC System Operation: Routine Operation Procedures

The system operates continuously upon startup, allowing potentially contaminated water pumped from the private wells into the residences to be continuously treated before exposure to the residents. Pressure sensors control operation of the private well pumps and control the amount of flow through the GAC systems and through the residence. Within the building, the groundwater passes through the flow meter/totalizer sensor, which records the volume of water flowing through the GAC systems. Water is pumped through the GAC tanks to remove the VOC contaminant mass. Treated effluent is transmitted through the building’s plumbing system for potable use.

4.2.2.4 POE GAC System Operation: Routine Equipment Maintenance

Specific routine and preventive maintenance procedures conducted in conjunction with the semiannual compliance sampling include the following:

- Confirm system is performing as designed (e.g., no leaks, proper water flow, etc.);
- Check pressure gauges; and
- Clean or replace UV bulbs.

4.2.2.5 POE GAC System Operation: Non-Routine Equipment Maintenance

In the event of a system malfunction or when volatiles are detected in the intermediate (mid-carbon) or final (treated) water sample collected from a POE system non-routine equipment maintenance may include, but is not limited to activities like carbon change outs and UV bulb replacement.

4.2.3 Residential Sub-Slab Depressurization System

4.2.3.1 Scope

The residential SSDS was installed in House #4 in November 2008 and operates continuously, as discussed below. Further detail is provided in Section 2.2.1. Although NYSDEC commissioned system installation and an initial inspection of the system, the responsibility for continued inspection of the system lies with the property owner. If issues are encountered, then the owner is responsible for contacting the NYSDEC.

4.2.3.2 Operation, Maintenance and Troubleshooting

While the system is designed to operate continuously, there may be instances when the system needs to be repaired or modified. In any of the following situations, please contact the NYSDEC at the toll-free number listed above in 2.5.1 and on the system label:

- If the exhaust fan is not operating or is making excessive, unusual noise;
- If the liquid levels in any U-tube are even (no difference in levels);
- If any new construction or structural changes occur that affect the footprint of the building or the basement or crawl space including penetrations through the slab;
- If there is standing water or flooding observed in the basement;
- If any new combustion appliance or exhaust system is installed; or
- If the property is sold.

4.3 Engineering Control System Performance Monitoring

4.3.1 Groundwater Treatment System

4.3.1.1 Performance Monitoring

The Monitoring Plan for the existing groundwater monitoring well network is described in Section 3.0. This section specifically addresses performance monitoring of the GWETS components. Performance monitoring consists of:

- Remote system monitoring via computer link;
- Collection of combined influent VOC, oil, grease, total dissolved solids (TDS), total suspended solids (TSS), total cyanide, and metal samples;
- Collection of individual treatment well VOC samples;
- Collection of influent and effluent pH readings;
- Collection of combined effluent VOC, oil, grease, total dissolved solids (TDS), total suspended solids (TSS), total cyanide, and metal samples;

The treatment system is controlled remotely with an EOS ProControl Unit via computer link. A telemetry network provides information relating to system pressures from critical points, filters, tanks and discharge lines, as well as flow rates and volumes from the treatment wells. System failures trigger an alarm code, which provides notice to the O&M contractor that corrective action is required.

The GWETS should be monitored on a daily basis using a remote sensing system. If an issue related to system operation is identified, a field inspection may be required to replace, maintain or restart the troubled component of the system. The system should be checked during the monthly site visits. A complete list of components to be checked during the monthly inspections is provided in the Operation, Maintenance and Monitoring (OM&M) Checklist in **Appendix E**. If any equipment readings are not within their typical range, any equipment is observed to be malfunctioning, or the system is not performing within specifications, maintenance and/or repairs will be performed immediately and the system will be restarted.

4.3.1.2 Monitoring Schedule

Performance monitoring will be conducted at the frequency summarized in the table provided below. Influent from each of the three treatment wells are sampled on a monthly basis as part of the GWETS O&M program. Other wells in the monitoring network will be sampled as described in Section 3.0 of this SMP. The inspection and sampling frequencies may be modified with the approval of the NYSDEC. The SMP will be modified to reflect changes in sampling plans approved by the NYSDEC.

Unscheduled inspections and/or sampling may take place when a suspected failure of the GWETS has been reported or an emergency occurs that is deemed likely to affect the operation of the system. Details on EC monitoring deliverables for the GWETS are specified later in this section.

Monitoring Program	Frequency	Matrix	Analysis
Remote System Monitoring	Daily	--	--
System Treatment Wells, Combined Influent, and Effluent Sampling	Monthly	Water	pH (in field) VOCs – 8260C Oil and Grease – 1664A TDS – 2540C TSS – 2540D Total Cyanide – 9012B Metals – 6010C/7470A

4.3.1.3 General Equipment Monitoring

A visual inspection of the complete system will be conducted during the monthly monitoring event. The GWETS components to be monitored include, but are not limited to, the following:

- Building utilities (phone, heat, fans, doors, etc.);
- Piping systems and tanks, including connections;
- Functionality of gauges, sensors, transducers, pumps, flow meters, filters, blowers, electrical, etc.;
- Totalizer readings from treatment wells;

- Discharge pressure from treatment wells;
- Flow rate (gpm);
- Air Stripper and blower pressures and temperatures; and
- pH of influent and effluent.

A complete list of components to be checked is provided in the OM&M Checklist provided in **Appendix E**. If any equipment readings are not within their typical range, any equipment is observed to be malfunctioning, or the system is not performing within specifications, maintenance and repair are required immediately, and the GWETS must be restarted.

4.3.1.4 System Monitoring Devices and Alarms

The GWETS has warning devices to indicate (during remote monitoring or on-site inspection) that the system is not operating properly. In the event that a warning device is activated, applicable maintenance and/or repairs will be performed immediately and the system will be restarted. Operational problems will be noted in the subsequent PRR.

4.3.1.5 Sampling Event Protocol

Treatment system O&M samples are collected on a monthly basis to assess the effectiveness of the GWETS and to ensure that the effluent discharge limitations are being met. Monthly samples will be collected from the three treatment wells, the combined influent, and the effluent. Combined influent samples are collected when all treatment wells are pumping. Samples will be collected from the sampling ports.

As indicated in Section 4.2.4, all monthly monitoring samples will be analyzed for TCL VOCs via EPA Method 8260C. The effluent and combined influent samples will also be analyzed for oil and grease (Method 1664A), TDS (Method 2540C), TSS (Method 2540D), total cyanide (Method 9012B), and metals (Methods 6010C and 7470A). The effluent discharge limitations for these compounds and water quality parameters are provided in **Appendix F**.

All samples are to be collected in bottles provided by the NYSDEC ELAP-certified analytical laboratory. All samples shall be packed on ice and submitted to the laboratory with a completed Chain of Custody. Sample preservation, holding times, and other laboratory and quality assurance information are outlined in AECOM's Generic QAPP for the NYSDEC Superfund Standby Contract (May 2010).

<u>Quality Assurance/Quality Control</u>

All sampling and analyses will be performed in accordance with AECOM's Generic QAPP for the NYSDEC Superfund Standby Contract (May 2010), except as noted below:

- A trip blank will be collected and analyzed for each monthly GWETS and semiannual POE sampling event;
- No Category B deliverables will be requested and no data validation will be performed on site management data unless necessary to support a site closure recommendation;
- No field duplicates, matrix spikes, or matrix spike duplicates will be collected as part of the sampling events; and

- Sample identification will be as follows, with the addition of the sample collection date (MMDDYY) to the sample identification as a suffix:
    - TW-1, TW-2A, TW-3 (for treatment wells)
    - INF (for influent samples)
    - EFF (for effluent samples)
    - Trip Blank or TB (for trip blanks).

4.3.2 Residential POE Water Treatment Systems

4.3.2.1 Performance Monitoring

Performance monitoring of the residential POE GAC systems consists of:

1) Inspection of particle filter condition;
2) Sampling of final, intermediate, and raw water for VOCs; and
3) Sampling of water for Coliform bacteria.

4.3.2.2 Monitoring Schedule

All semi-annual compliance samples (raw, intermediate, and final) will be analyzed for VOCs via EPA Method 524.2. Only the final sample collected after the GAC system will be analyzed for Coliform and *E. Coli* via Colisure analysis. Details on monitoring deliverables for the POE Systems are listed below.

Monitoring Program	**Frequency**	**Matrix**	**Analysis**
POE Raw (influent), Intermediate (between carbons), and Final (effluent) Sampling	Semi-annually	Water	VOCs – 524.2 (All) Total Coliform and E. Coli - Colisure (Final samples only)
GAC Breakthrough	Semi-annually	Water	VOCs – 524.2

4.3.2.3 General Equipment Monitoring

A visual inspection of the complete system will be conducted during the monthly monitoring event. The POE system components to be monitored include, but are not limited to, the following:

- Piping systems, including connections;
- Functionality of gauges, sensors, electrical, etc.;
- Flow rate (gpm);

If any equipment readings are not within their typical range, any equipment is observed to be malfunctioning, or the system is not performing within specifications, maintenance and repair are required immediately, and the POE system must be restarted.

4.3.2.4 System Monitoring Devices and Alarms

The POE system does not have warning devices to indicate that the system is not operating properly. Six-month compliance sampling and inspections are performed to evaluate effectiveness.

4.3.2.5 Sampling Event Protocol

POE samples are collected on a semi-annual basis to ensure each system is effectively removing contaminants from the water to be used by the residence. POE samples will be collected from sample ports or taps before the primary GAC unit, between the two GAC units, and after the secondary GAC unit and analyzed for VOCs via EPA Method 524.2. Additionally, the effluent water will be sampled for Total Coliform and *E. Coli* via the Colisure test method.

All samples are to be collected in bottles provided by the NYSDEC ELAP-certified analytical laboratory. All samples shall be packed on ice and submitted to the laboratory with a completed Chain of Custody. Sample preservation, holding times, and other laboratory and quality assurance information are outlined in AECOM's Generic QAPP for the NYSDEC Superfund Standby Contract (May 2010).

Quality Assurance/Quality Control

All sampling and analyses will be performed in accordance with AECOM's Generic QAPP for the NYSDEC Superfund Standby Contract (May 2010), except as noted below:

- A trip blank will be collected and analyzed for each semiannual POE sampling event;
- No Category B deliverables will be requested and no data validation will be performed on site management data unless necessary to support a site closure recommendation;
- No field duplicates, matrix spikes, or matrix spike duplicates will be collected as part of the sampling events; and
- Sample identification will be as follows, with the addition of the sample collection date (MMDDYY) to the sample identification as a suffix:
    - Residential street address, date and carbon phase (for POE samples) (e.g., House #1 R or I or F, where R is raw water, I is between carbons, and F is final sample)
    - Trip Blank or TB (for trip blanks).

4.3.3 Residential Sub-slab Depressurization System

4.3.3.1 Performance Monitoring

Though NYSDEC commissioned system installation and an initial inspection of the system, the responsibility for continued inspection of the system lies with the property owner. If issues are encountered, then the owner is responsible for contacting the NYSDEC.

If any of the below conditions are noted by the homeowner or by the site representative during site visits, then NYSDEC must be contacted immediately so that repair can occur:

- If the exhaust fan is not operating or is making excessive, unusual noise;
- If the liquid levels in any U-tube are even (no difference in levels);

- If any new construction or structural changes occur that affect the footprint of the building or the basement or crawl space including penetrations through the slab;
- If there is standing water or flooding observed in the basement; or
- If any new combustion appliance or exhaust system is installed.

4.3.3.2 Monitoring Schedule

NYSDOH recommends annual inspection of an SSDS by homeowners.

4.3.3.3 Sampling Event Protocol

At this time, routine monitoring of indoor air quality is not included as part of this SMP; however, if indoor air or sub-slab vapor sampling becomes necessary, then sampling should be performed in accordance with current NYSDOH Guidance and the SMP updated to reflect ongoing or routine sampling events.

4.4 Maintenance and Performance Monitoring Reporting Requirements

Maintenance reports and any other information generated during regular operations at the Site will be maintained by the qualified environmental professional (i.e., NYSDEC contractor). All reports, forms, and other relevant information generated will be available upon request to the NYSDEC and submitted as part of the PRR, as specified in Section 3.4.3 of this SMP.

4.4.1 Routine Maintenance Reports

Checklists or forms (see **Appendix E**) will be completed during each routine maintenance event. Checklists/forms will include, but not be limited to, the following information:

- Date of event;
- Name, company, and position of personnel conducting maintenance activities;
- Description of the maintenance activities performed;
- Any modifications to the system;
- Where appropriate, color photographs or sketches showing the approximate location of any problems or incidents noted (included either on the checklist/form or on an attached sheet); and
- Other documentation such as copies of invoices for maintenance work, receipts for replacement equipment, etc. (attached to the checklist/form).

4.4.2 Non-Routine Maintenance Reports

During each non-routine maintenance event, a form will be completed which will include, but not be limited to, the following information:

- Date of event;
- Name, company, and position of personnel conducting maintenance activities;
- Presence of leaks;
- Date of leak repair;
- Other repairs or adjustments made to the system;

- Where appropriate, color photographs or sketches showing the approximate location of any problems or incidents noted (included either on the checklist/form or on an attached sheet); and
- Other relevant supporting documentation, as appropriate.

4.4.3 Monthly O&M Reports

OM&M reports will be submitted to the NYSDEC on a monthly basis and will include the following:

- Volume of water treated during period and total water volume treated to date;
- Influent and effluent data generated during the reporting period, including the laboratory report;
- Periods of downtime and/or noted performance issues; and
- Description of inspections, maintenance, and/or repairs completed during the period.

4.4.4 Semi-Annual POE Reports

On a semi-annual basis, reports will be generated to summarize the results of the POE potable water treatment system sampling events. These reports will be submitted to the NYSDEC and the Dutchess County Health Department and will include the following:

- Site description and description of systems;
- Description of sampling methodology and list of analytes;
- Summary of VOC and bacteria analytical results for the current period, including the laboratory report (unless provided under separate cover);
- Summary of historical VOC analytical results;
- Summary of flow totalizer readings;
- Description of maintenance and/or modifications/repairs completed during the six-month inspection and sampling event. This includes noting whether the data suggests GAC breakthrough has occurred; and
- The month of the next sampling event.

In addition, a brief letter will be sent to each property owner providing the analytical results.

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Tables

Table 1
Pre-Remedial and Post-Remedial VOC Concentrations in Groundwater
Former NOW Corporation Facility
Site 3-14-008
Town of Clinton, New York

Analyte	NYSAWQS**	MW-1				MW-2				MW-3D				MW-3S				MW-4S				MW-4D			MW-5			
		4/27/93	1/12/94	5/8/98	8/1/99	4/27/93	1/12/94	5/8/98	8/1/99	4/27/93	1/12/94	5/8/98	8/1/99	1/12/94	5/8/98	5/8/98	8/1/99	4/27/93	1/12/94	5/8/98	8/1/99	1/12/94	5/8/98	8/1/99	4/27/93	1/12/94	5/8/98	8/1/99
1,1,1-Trichloroethane	5	**75**	**150**	**57**	**33**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	1	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND
1,1-Dichloroethane	5	**50**	**50**	**30**	**66**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**4**	**5**	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	5	**6**	**6**	**5**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	0.6	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND
Benzene	1	ND	*N/A*	ND	ND	ND	*N/A*	ND	ND	ND	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	*N/A*	ND	ND	*N/A*	ND	ND	ND	*N/A*	ND	ND
Chlorobenzene	5	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND
Chloroethane	5	**8**	**6**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	5	**27**	**32**	**20**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	5	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND
m&p-Xylene	5	ND	*N/A*	ND	ND	**3**	*N/A*	ND	ND	ND	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	*N/A*	ND	ND	*N/A*	ND	ND	**2**	*N/A*	ND	ND
o-Xylene	5	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND
Tetrachloroethene	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	5	**2**	*N/A*	ND	ND	**3**	*N/A*	ND	ND	**1**	*N/A*	ND	ND	*N/A*	ND	ND	ND	**1**	*N/A*	ND	ND	*N/A*	ND	ND	**2**	*N/A*	ND	ND
trans-1,2-Dichloroethene	5	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND
Trichloroethene	5	**88**	**200**	**100**	**130**	ND	**2**	ND	ND	**0.7**	**3**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**2**	ND	ND
Vinyl Chloride	2	*N/A*	**2**	**1**	ND	*N/A*	ND	ND	ND	*N/A*	ND	ND	ND	ND	ND	ND	ND	*N/A*	ND	ND	ND	ND	ND	ND	*N/A*	ND	ND	ND
Total VOCs		256	446	213	229	6	2	0	0	1.7	3	0	0	0	0	0	0	1	4	5	0	0	0	0	4	2	0	0

Notes:
1) Detected concentrations are shown in **bold typeface**, in units of µg/L.
2) **New York State Ambient Water Quality Standards (AWQS) and Guidance Values (GV), June 1998.
3) Concentrations exceeding the AWQS are highlighted in gray.
4) ND = Not Detected.
5) *N/A* = Not Analyzed (well was effectively dry on sample date, or indicated analyte was not reported).
6) VOCs = Volatile Organic Compounds.
7) Data from 1993 and 1994 represent groundwater quality during the Remedial Investigation, prior to Remedial Actions, while data from 1998 and 1999 represent groundwater quality subsequent to remedial action.

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Table 1
Pre-Remedial and Post-Remedial VOC Concentrations in Groundwater
Former NOW Corporation Facility
Site 3-14-008
Town of Clinton, New York

Analyte	NYSAWQS**	MW-6S				MW-6D			MW-7S	MW-7D	MW-8				MW-9				MW-10				MW-11		
		4/27/93	1/12/94	5/8/98	8/1/99	1/12/94	5/8/98	8/1/99	5/8/98	5/8/98	4/27/93	1/12/94	5/8/98	8/1/99	4/27/93	1/12/94	5/8/98	8/1/99	4/27/93	1/12/94	5/8/98	8/1/99	1/12/94	5/8/98	8/1/99
1,1,1-Trichloroethane	5	**710**	**510**	**23**	**27**	**160**	**13**	ND	**34**	**15**	ND	ND	ND	ND	ND	ND	ND	ND	**2**	**2**	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	1	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND
1,1-Dichloroethane	5	**57**	**39**	**3**	**68**	**140**	**20**	**52**	**11**	**34**	ND	ND	ND	ND	ND	ND	ND	ND	**17**	**9**	ND	ND	ND	ND	ND
1,1-Dichloroethene	5	**11**	**3**	ND	ND	**1**	ND	ND	ND	**4**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	0.6	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND
Benzene	1	ND	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	ND	*N/A*	ND	ND	ND	*N/A*	ND	ND	ND	*N/A*	ND	ND	*N/A*	ND	ND
Chlorobenzene	5	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND
Chloroethane	5	**3**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	5	**17**	**12**	**2**	ND	**0.7**	**2**	ND	**17**	**8**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	5	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND
m&p-Xylene	5	ND	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	**0.8**	*N/A*	ND	ND	**1**	*N/A*	ND	ND	ND	*N/A*	ND	ND	*N/A*	ND	ND
o-Xylene	5	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND
Tetrachloroethene	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	5	ND	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	ND	*N/A*	ND	ND	**2**	*N/A*	ND	ND	**1**	*N/A*	ND	ND	*N/A*	ND	ND
trans-1,2-Dichloroethene	5	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	*N/A*	ND	ND	*N/A*	ND	ND
Trichloroethene	5	**610**	**460**	**43**	**100**	**11**	**13**	**6**	**280**	**340**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	2	*N/A*	ND	ND	ND	ND	ND	ND	ND	ND	*N/A*	ND	ND	ND	*N/A*	ND	ND	ND	*N/A*	ND	ND	ND	ND	ND	ND
Total VOCs		1408	1024	71	195	312.7	48	58	342	401	0.8	0	0	0	3	0	0	0	20	11	0	0	0	0	0

Notes:
1) Detected concentrations are shown in **bold typeface**, in units of µg/L.
2) **New York State Ambient Water Quality Standards (AWQS) and Guidance Values (GV), June 1998.
3) Concentrations exceeding the AWQS are highlighted in gray.
4) ND = Not Detected.
5) *N/A* = Not Analyzed (well was effectively dry on sample date, or indicated analyte was not reported).
6) VOCs = Volatile Organic Compounds.
7) Data from 1993 and 1994 represent groundwater quality during the Remedial Investigation, prior to Remedial Actions, while data from 1998 and 1999 represent groundwater quality subsequent to remedial action.

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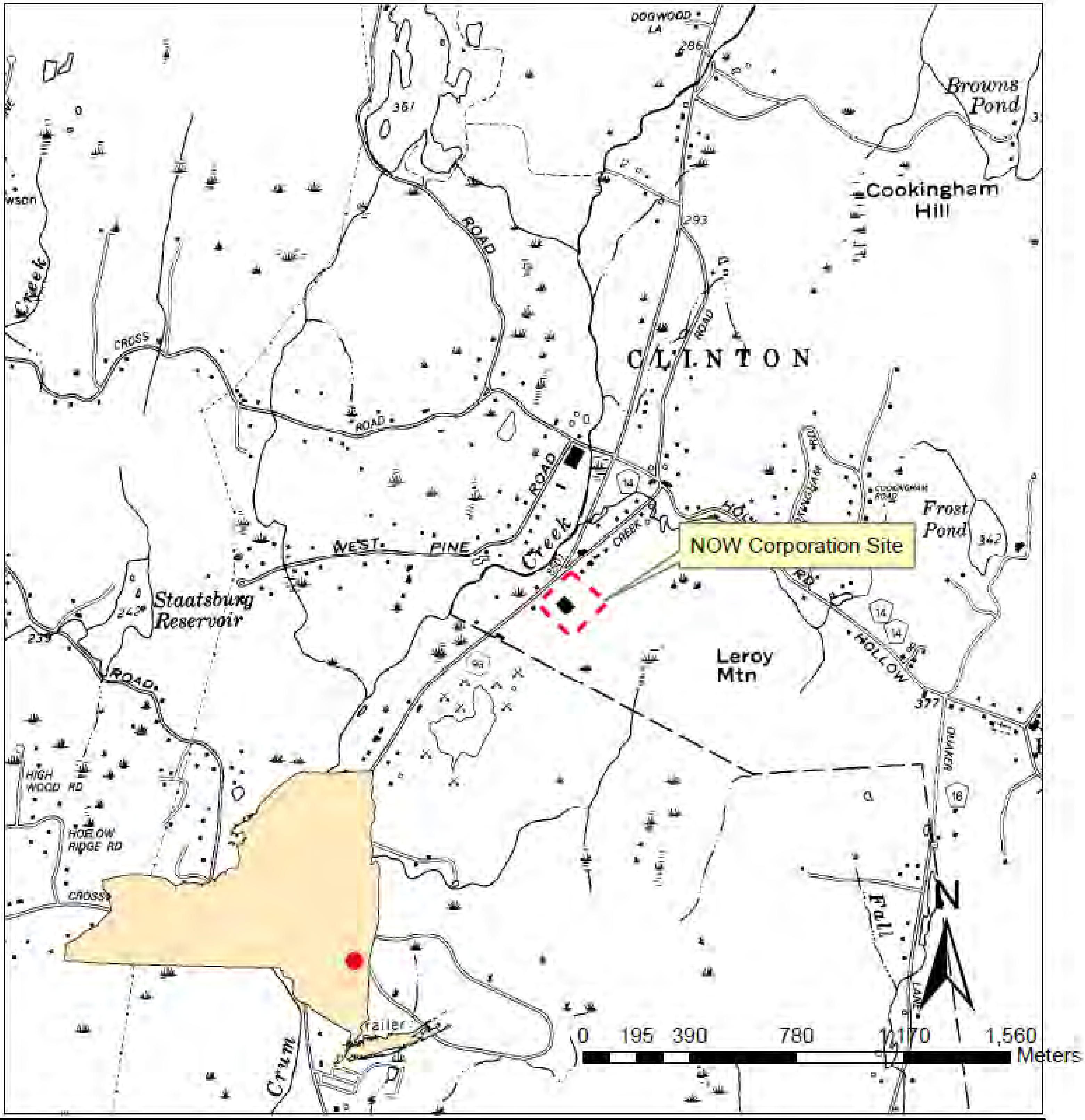
Table 2
Monitoring Well Construction Summary and Groundwater Elevations (2011)
Former NOW Corporation Facility
Clinton, New York
Site # 3-14-008

Well Identification	Purpose	Location	Well Diameter & Construction	Surface Completion	Screened Interval (ft. bgs)	Surface Elevation (ft.)	TOC Elevation (ft.)	Sept. 2011 Depth to Water (ft. bgs)	Sept. 2011 Groundwater Elevation (ft.)
MW-1	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	289.5	9.35	280.15
MW-2	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	332.51	25.88	306.63
MW-3D	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	312.83	23.57	289.26
MW-3S	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	312.51	21.77	290.74
MW-4S	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	298.29	19.89	278.4
MW-4D	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	298.16	19.61	278.55
MW-5	Monitoring Well	Off-site	2" PVC	Standpipe	DNA	DNA	285.48	17.38	268.1
MW-6S	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	287.9	3.38	284.52
MW-6D	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	287.25	5.42	281.83
MW-7S	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	292.12	15.48	276.64
MW-7D	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	292.54	42.6	249.94
MW-8	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	283.65	11.96	271.69
MW-9	Monitoring Well	Off-site	2" PVC	Standpipe	DNA	DNA	275.37	3.97	271.4
MW-10	Monitoring Well	Off-site	2" PVC	Standpipe	DNA	DNA	280.92	9.42	271.5
MW-11	Monitoring Well	On-site	2" PVC	Standpipe	DNA	DNA	283.72	19.45	264.27
MW-12S	Monitoring Well	Off-site	2" PVC	Standpipe	DNA	DNA	DNA	DNA	DNA
MW-12D	Monitoring Well	Off-site	2" PVC	Standpipe	DNA	DNA	DNA	DNA	DNA
OW-1	Observation Well	On-site	2" PVC	Standpipe	DNA	DNA	307.75	46.01	261.74
OW-2	Observation Well	On-site	2" PVC	Standpipe	DNA	DNA	305.96	70.09	235.87
OW-3	Observation Well	On-site	2" PVC	Standpipe	DNA	DNA	307.35	72.01	235.34
OW-4	Observation Well	On-site	2" PVC	Standpipe	DNA	DNA	308.3	39.39	268.91
OW-5	Observation Well	On-site	2" PVC	Standpipe	DNA	DNA	307.41	45.94	261.47
OW-6	Observation Well	On-site	2" PVC	Standpipe	11.5-91.5	293.27	294.81	3.16	291.65
IW-1	Injection Well	On-site	8" Open Hole	Standpipe	DNA	309.68	312.46	26.81	285.65
IW-2	Injection Well	On-site	8" Open Hole	Standpipe	DNA	302.18	304.56	36.42	268.14
TW-1	Treatment Well	On-site	8" Open Hole	Standpipe	11-111 (Open Hole)	DNA	306[1]	97.18	208.82
TW-2	Treatment Well	On-site	8" Open Hole	Standpipe	DNA	300.33	301.62	NM	DNA
TW-2A	Treatment Well	On-site	8" Open Hole	Standpipe	DNA	DNA	291.5[1]	74.31	217.19
TW-3	Treatment Well	On-site	8" Open Hole	Standpipe	DNA	288.51	290.52	60.91	229.61

Notes:
[1] TOC Elevation is estimated.
ft. bgs - Feet below ground surface
TOC - Top of Casing
PVC - Polyvinyl Chloride
DNA - Data Not Available
NM - Not Measured

Figures



Source: NYSGIS Clearinghouse

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Latham, NY 12110
T: (518) 951-2200
F: (518) 951-2300

FIGURE 1
SITE LOCATION MAP

Former NOW Corporation Facility
Site #3-14-008

January 2014

60135676

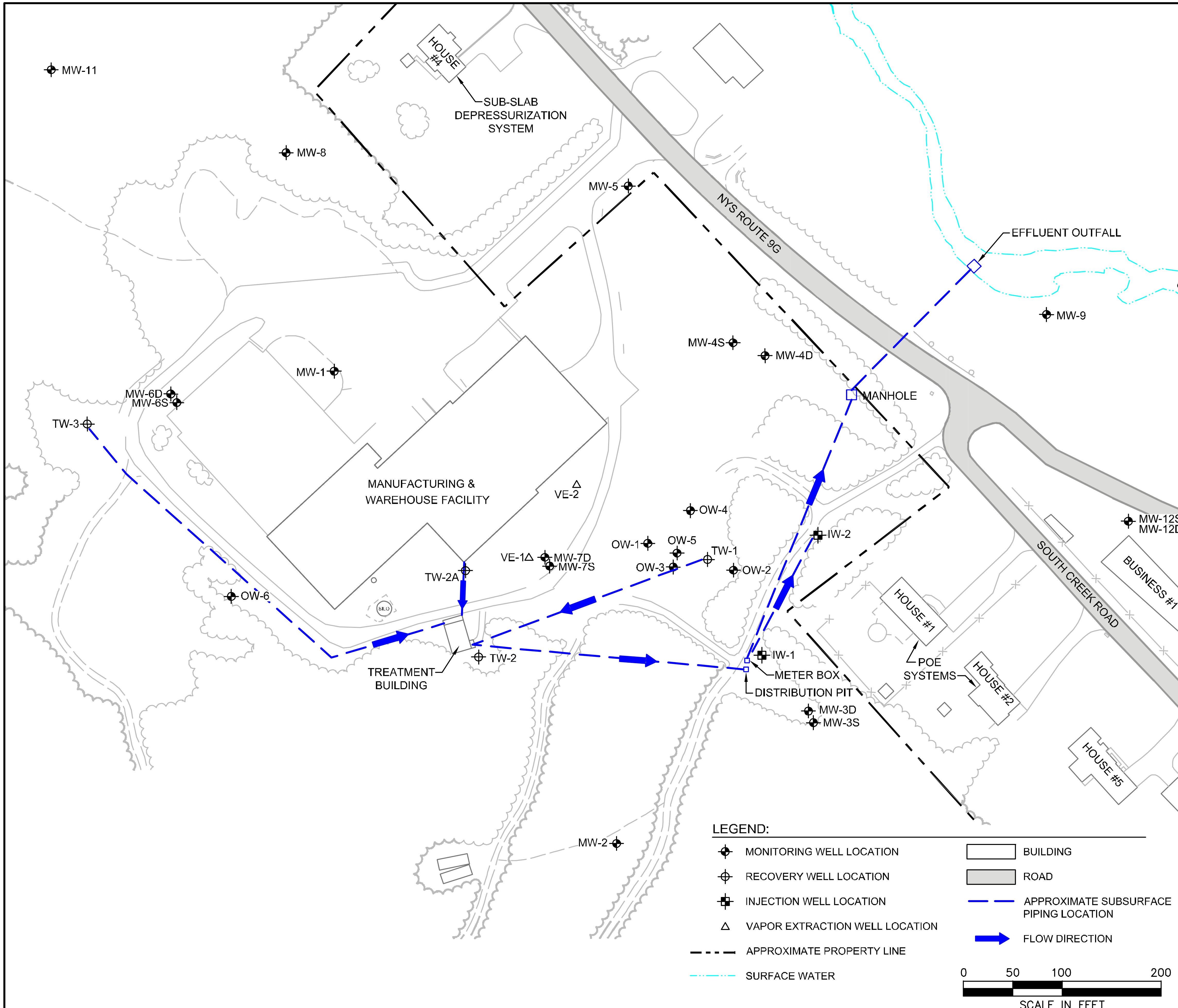

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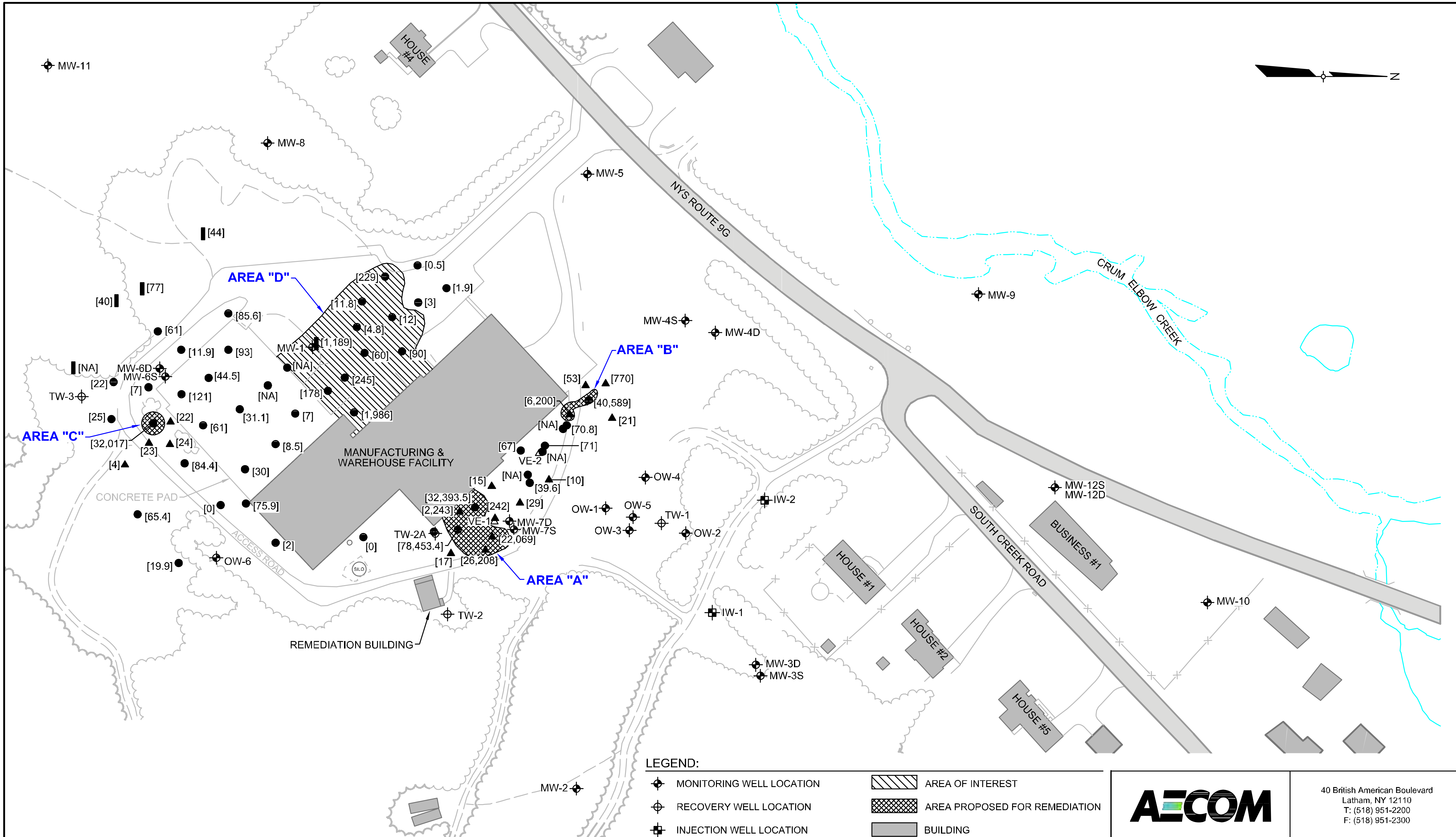
FIGURE 2

SITE PLAN AND TREATMENT SYSTEM DETAILS

NYSDEC
FORMER NOW CORPORATION FACILITY
TOWN OF CLINTON - DUTCHESS COUNTY, NEW YORK

JANUARY 2014

60135676



0 50 100 200
SCALE IN FEET

NOTE:

1. SOIL SAMPLE RESULTS BASED ON ENGINEERING-SCIENCE FIGURE "SUBSURFACE SOIL ANALYTICAL DATA TOTAL VOC CONCENTRATIONS (ppb)".

LEGEND:

- MONITORING WELL LOCATION
- RECOVERY WELL LOCATION
- INJECTION WELL LOCATION
- VAPOR EXTRACTION WELL LOCATION
- SOIL BORING LOCATION
- SOIL BORING LOCATION (JUNE 1995)
- TEST PIT LOCATION
- AREA OF INTEREST
- AREA PROPOSED FOR REMEDIATION
- BUILDING
- ROAD
- SURFACE WATER
- [0.5] VOC CONCENTRATION (ppb)
- NA NOT ANALYZED

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FIGURE 3
PRE-REMEDIAL SOIL CONDITIONS
TOTAL VOC CONCENTRATIONS (1998)

NYSDEC
FORMER NOW CORPORATION FACILITY
TOWN OF CLINTON - DUTCHESS COUNTY, NEW YORK

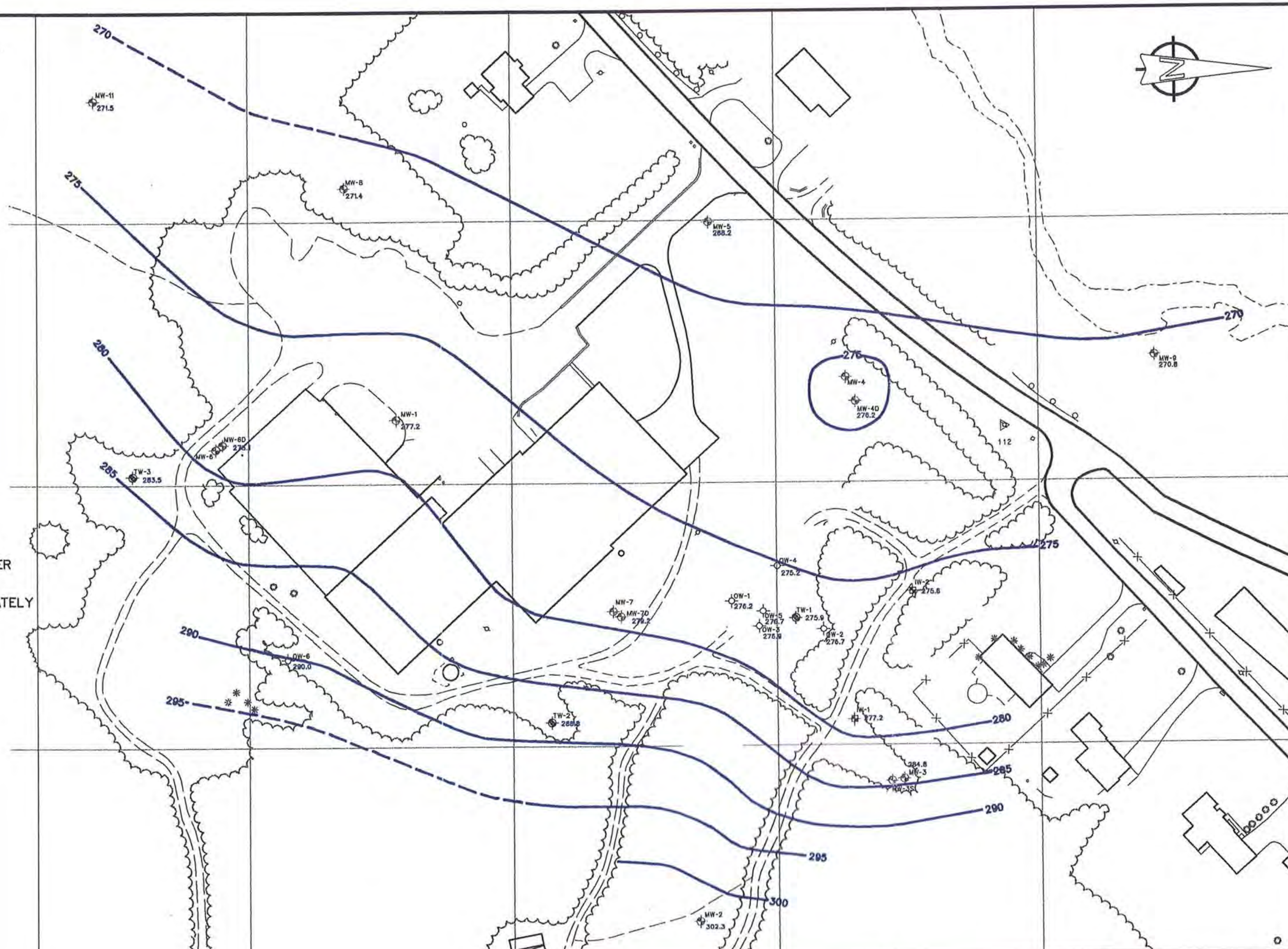
JANUARY 2014 60135676

LEGEND:

- RECOVERY TEST WELL
- OBSERVATION WELL
- MONITORING WELL
- INJECTION WELL
- 275 GROUNDWATER ELEVATION CONTOUR (DASHED WHERE INFERRED)

NOTES:

1. GROUNDWATER CONTOURS BASED ON GROUNDWATER ELEVATIONS (in feet) ABOVE SEA LEVEL.
2. GROUNDWATER ELEVATIONS OBSERVED APPROXIMATELY 3 HOURS PRIOR TO 48 HOUR PUMPING TEST.



100 0 100 200

SCALE: 1" = 100'

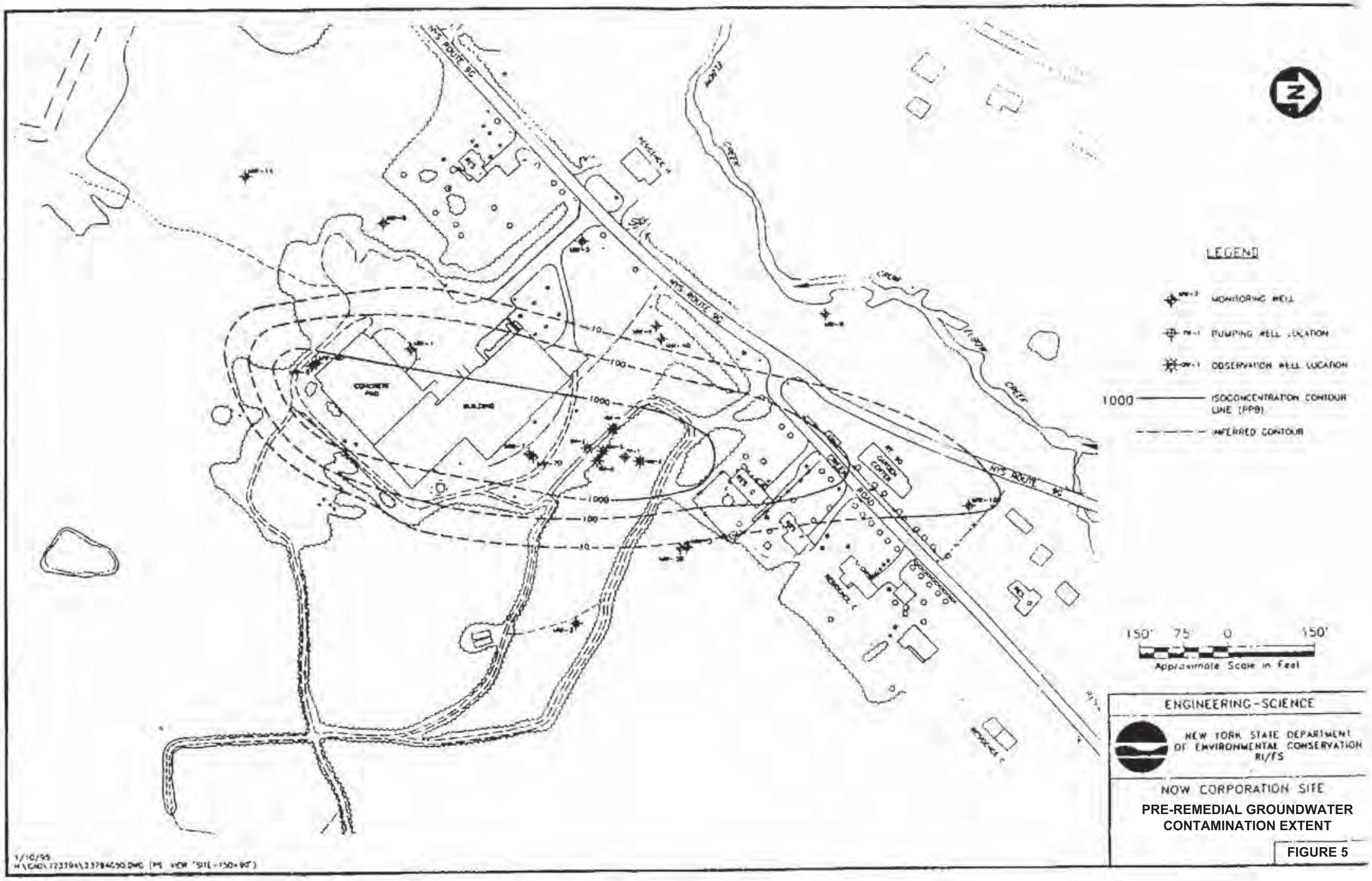
RUST ENVIRONMENT & INFRASTRUCTURE

NYSDEC
NOW CORPORATION

PRE-PUMPING TEST GROUND WATER ELEVATIONS - 1/16/96

PROJECT No. 34288	DATE 2/19/96	DWG. No. 34288gw1	SCALE AS SHOWN	FIGURE No. 4

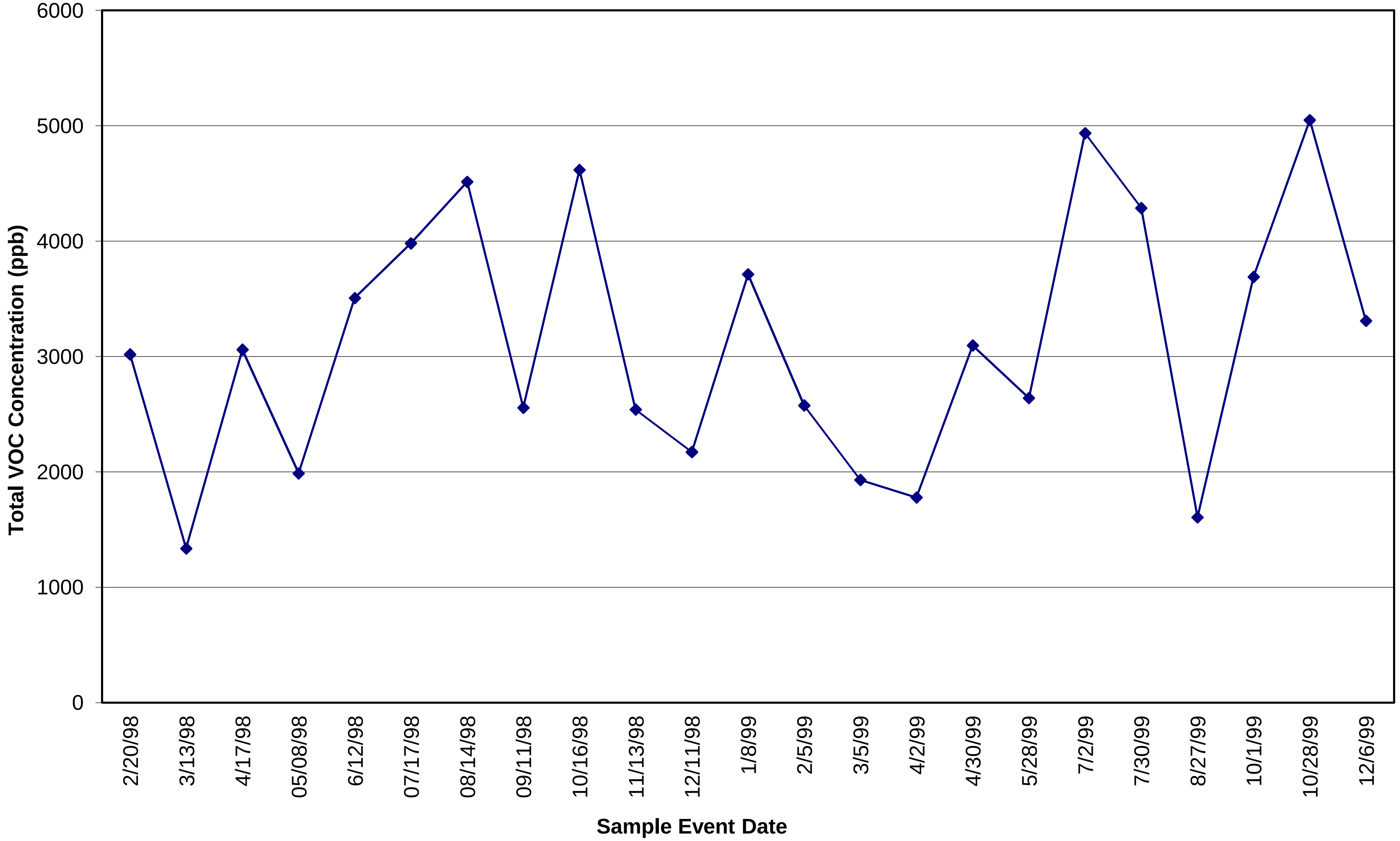
PLOT DATE: 14 MAR 96



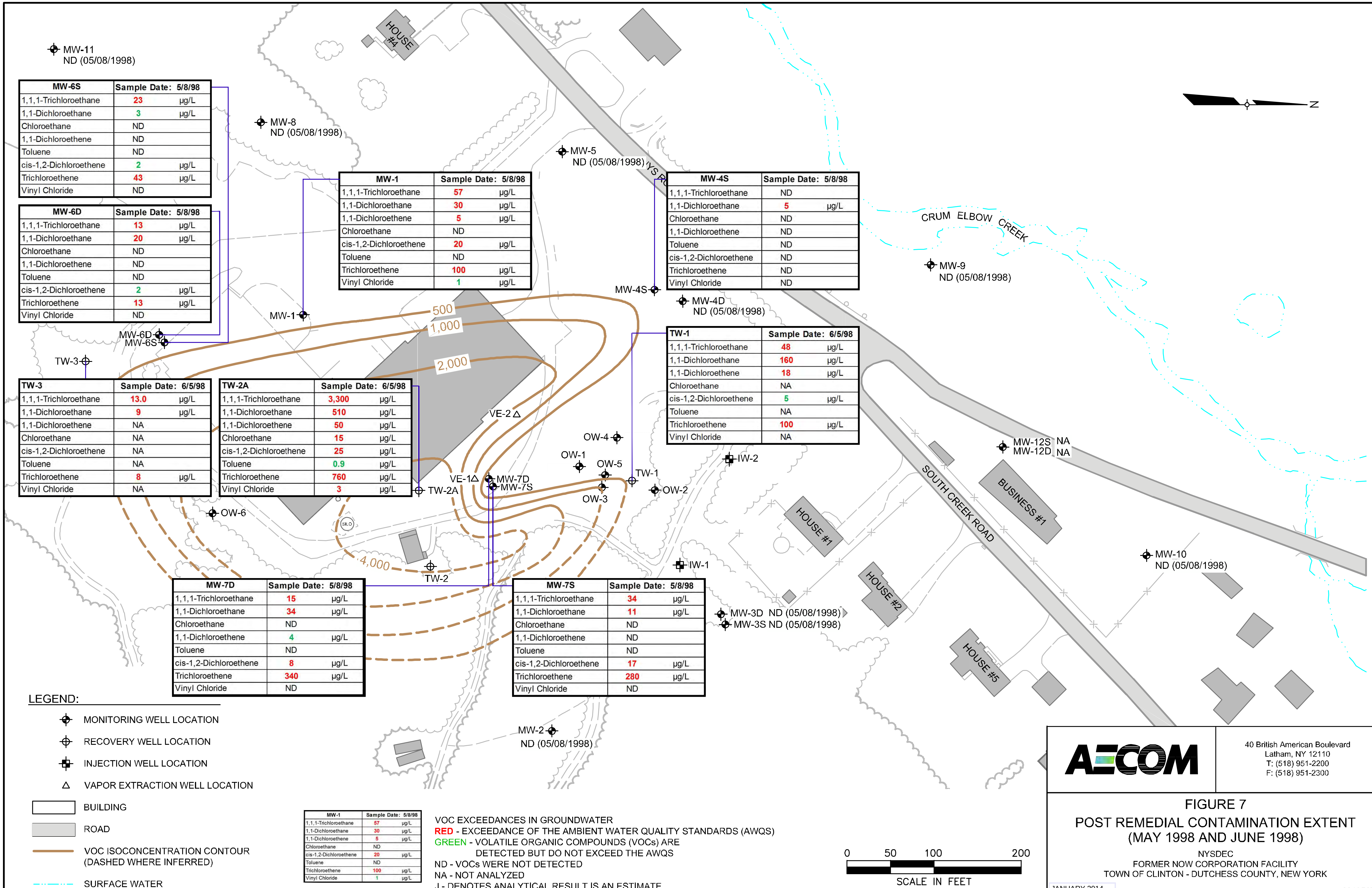
PRE-REMEDIAL GROUNDWATER CONTAMINATION EXTENT

FIGURE 5

Figure 6
Post-Remedial Influent Sampling Results (1998-1999)



AECOM



MW-6S	Sample Date: 5/8/98	
1,1,1-Trichloroethane	23	µg/L
1,1-Dichloroethane	3	µg/L
Chloroethane	ND	
1,1-Dichloroethene	ND	
Toluene	ND	
cis-1,2-Dichloroethene	2	µg/L
Trichloroethene	43	µg/L
Vinyl Chloride	ND	

MW-6D	Sample Date: 5/8/98	
1,1,1-Trichloroethane	13	µg/L
1,1-Dichloroethane	20	µg/L
Chloroethane	ND	
1,1-Dichloroethene	ND	
Toluene	ND	
cis-1,2-Dichloroethene	2	µg/L
Trichloroethene	13	µg/L
Vinyl Chloride	ND	

MW-1	Sample Date: 5/8/98	
1,1,1-Trichloroethane	57	µg/L
1,1-Dichloroethane	30	µg/L
1,1-Dichloroethene	5	µg/L
Chloroethane	ND	
cis-1,2-Dichloroethene	20	µg/L
Toluene	ND	
Trichloroethene	100	µg/L
Vinyl Chloride	1	µg/L

MW-4S	Sample Date: 5/8/98	
1,1,1-Trichloroethane	ND	
1,1-Dichloroethane	5	µg/L
Chloroethane	ND	
1,1-Dichloroethene	ND	
Toluene	ND	
cis-1,2-Dichloroethene	ND	
Trichloroethene	ND	
Vinyl Chloride	ND	

TW-1	Sample Date: 6/5/98	
1,1,1-Trichloroethane	48	µg/L
1,1-Dichloroethane	160	µg/L
1,1-Dichloroethene	18	µg/L
Chloroethane	NA	
cis-1,2-Dichloroethene	5	µg/L
Toluene	NA	
Trichloroethene	100	µg/L
Vinyl Chloride	NA	

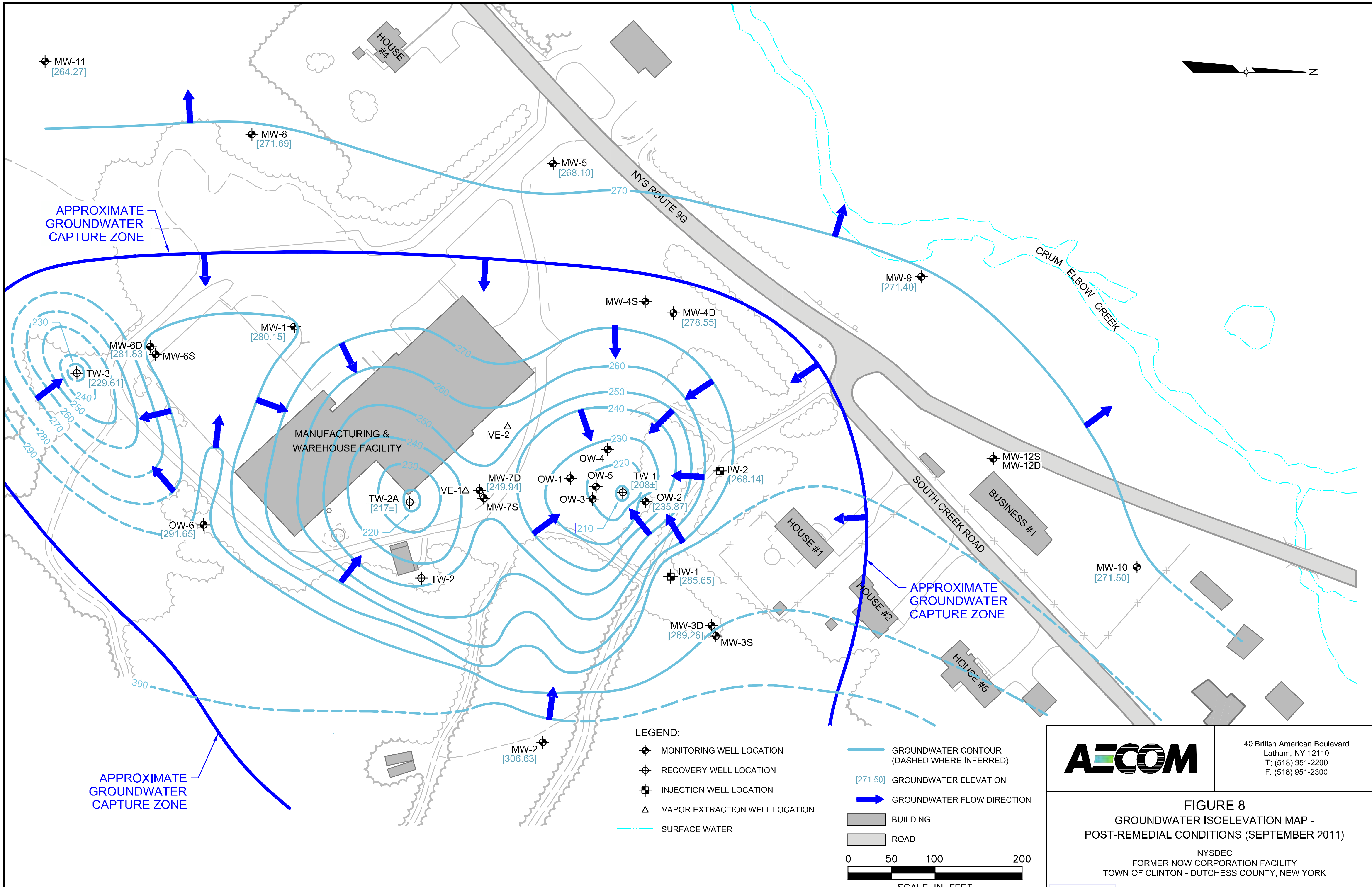
TW-3	Sample Date: 6/5/98	
1,1,1-Trichloroethane	13.0	µg/L
1,1-Dichloroethane	9	µg/L
1,1-Dichloroethene	NA	
Chloroethane	NA	
cis-1,2-Dichloroethene	NA	
Toluene	NA	
Trichloroethene	8	µg/L
Vinyl Chloride	NA	

TW-2A	Sample Date: 6/5/98	
1,1,1-Trichloroethane	3,300	µg/L
1,1-Dichloroethane	510	µg/L
1,1-Dichloroethene	50	µg/L
Chloroethane	15	µg/L
cis-1,2-Dichloroethene	25	µg/L
Toluene	0.9	µg/L
Trichloroethene	760	µg/L
Vinyl Chloride	3	µg/L

MW-7D	Sample Date: 5/8/98	
1,1,1-Trichloroethane	15	µg/L
1,1-Dichloroethane	34	µg/L
Chloroethane	ND	
1,1-Dichloroethene	4	µg/L
Toluene	ND	
cis-1,2-Dichloroethene	8	µg/L
Trichloroethene	340	µg/L
Vinyl Chloride	ND	

MW-7S	Sample Date: 5/8/98	
1,1,1-Trichloroethane	34	µg/L
1,1-Dichloroethane	11	µg/L
Chloroethane	ND	
1,1-Dichloroethene	ND	
Toluene	ND	
cis-1,2-Dichloroethene	17	µg/L
Trichloroethene	280	µg/L
Vinyl Chloride	ND	

MW-1	Sample Date: 5/8/98	
1,1,1-Trichloroethane	57	µg/L
1,1-Dichloroethane	30	µg/L
1,1-Dichloroethene	5	µg/L
Chloroethane	ND	
cis-1,2-Dichloroethene	20	µg/L
Toluene	ND	
Trichloroethene	100	µg/L
Vinyl Chloride	1	µg/L



AECOM

40 British American Boulevard
Latham, NY 12110
T: (518) 951-2200
F: (518) 951-2300

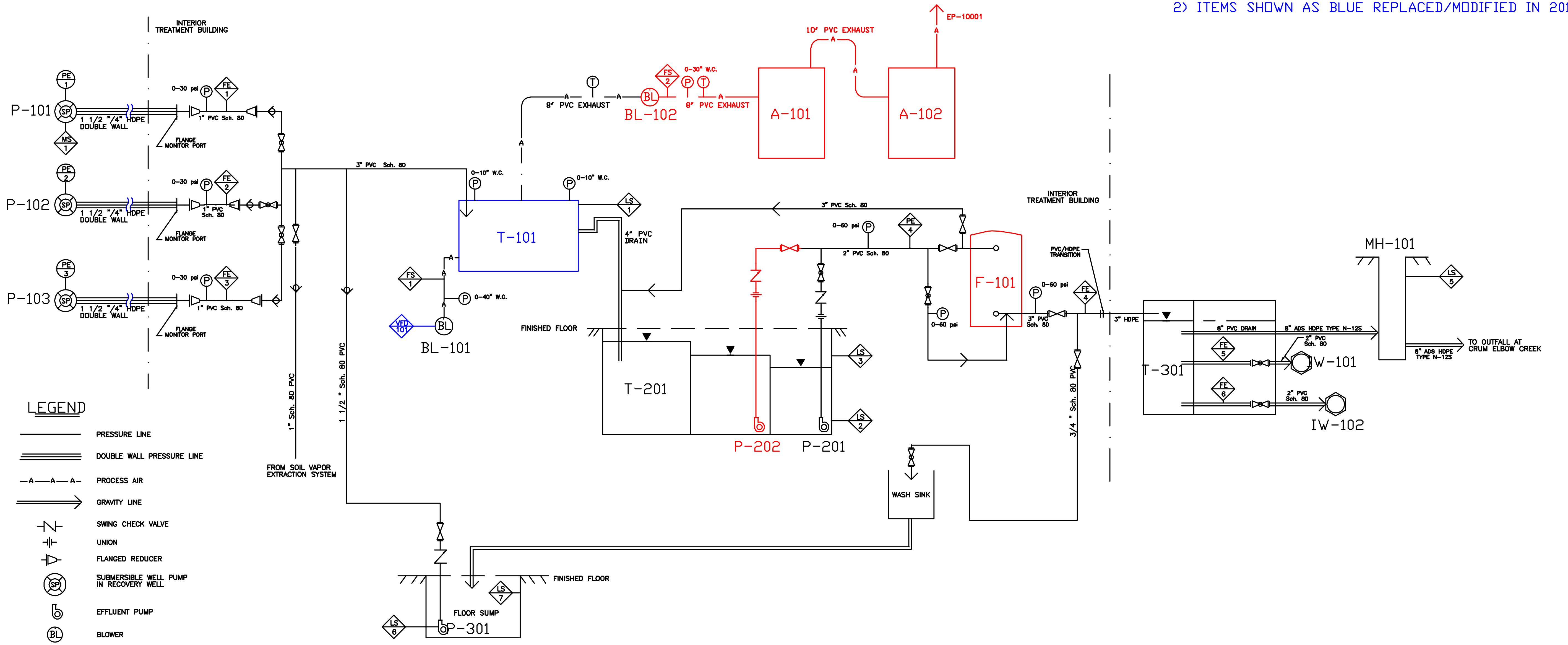
FIGURE 8
GROUNDWATER ISOELEVATION MAP - POST-REMEDIAL CONDITIONS (SEPTEMBER 2011)

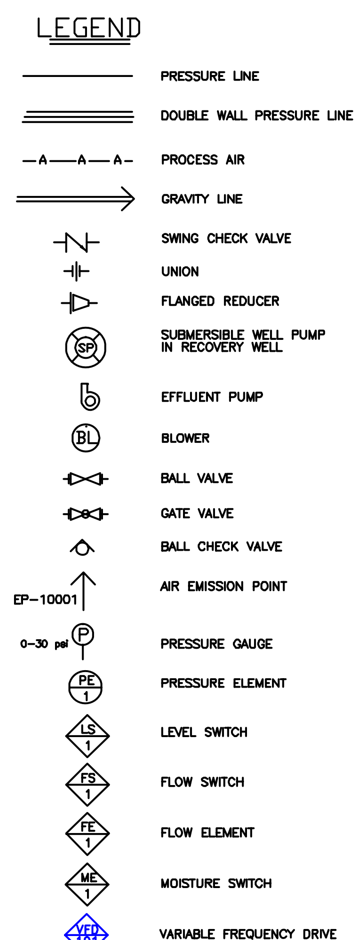
NYSDEC
FORMER NOW CORPORATION FACILITY
TOWN OF CLINTON - DUTCHESS COUNTY, NEW YORK

JANUARY 2014

60135676

NOTES: 1) ITEMS SHOWN AS RED ARE ARE NO LONGER IN USE
2) ITEMS SHOWN AS BLUE REPLACED/MODIFIED IN 2012





INSTRUMENTATION AND CONTROL EQUIPMENT SCHEDULE – GROUNDWATER TREATMENT

PE-1	Pressure transducer, Well TW-1	In-Situ PTX-161D, 50psig, with Junction Vent Box	Signal to display and limit switch operator P-101
PE-2	Pressure transducer, Well TW-2A	In-Situ PTX-161D, 50psig	Signal to display and limit switch operator P-102
PE-3	Pressure transducer, Well TW-3	In-Situ PTX-161D, 50psig	Signal to display and limit switch operator P-103
FE-1	Influent flow element, Well TW-1	Hersey Mod 433 bronze turbine meter, 1-inch, totalizer, pulse output	Display rate and total at LCD on pump panel & data logging on process controller
FE-2	Influent flow element, Well TW-2A	Hersey Mod 433 bronze turbine meter, 1-inch, totalizer, pulse output	Display rate and total at LCD on pump panel & data logging on process controller
FE-3	Influent flow element, Well TW-3	Hersey Mod 433 bronze turbine meter, 1-inch, totalizer, pulse output	Display rate and total at LCD on pump panel & data logging on process controller
FE-4	Flow meter, main effluent	Hersey Mod 433 bronze turbine meter, 2-inch, totalizer, pulse output	Display rate and total at LCD on pump panel & data logging on lprocess controller
FE-5	Flow meter, IW-101	Hersey Mod 433 bronze turbine meter, 3/4-inch, totalizer, pulse output	Display rate and total at LCD on pump panel & data logging on process controller
FE-6	Flow meter, IW-102	Hersey Mod 433 bronze turbine meter, 3/4-inch, totalizer, pulse output	Display rate and total at LCD on pump panel & data logging on process controller
FS-1	Flow switch, Air stripper inlet	W.E. Anderson, Flotect V4, Stainless Steel, sized for duct	Low air flow shuts down recovery wells, P-101, 102, 103, Signal Alarm
FS-2	Flow switch, blower BL-102 exhaust	W.E. Anderson, Flotect V4, 316SS, sized for duct	Low air flow shuts down recovery wells, P-101, 102, 103, Signal Alarm
LS-1	High level switch, Air stripper	W.E. Anderson, Flotect V4, 316SS	High water shuts down recovery wells, P-101, 102, 103, Signal Alarm
LS-2	Operator switch, Pump P-201	Mercury float switch, N.O. pump down switch	Connect to HOA in MCC #1
LS-3	Alarm switch, Tank TK-201	Mercury float switch, N.O. alarm on high water level	High water shuts down recovery wells, P-101, 102, 103, Signal Alarm
LS-4	Alarm switch, Tank TK-301	Mercury float switch, N.O. alarm on high water level	High water shuts down recovery wells, P-101, 102, 103, Signal Alarm
LS-5	Alarm switch, Tank MH-101	Mercury float switch, N.O. alarm on high water level	High water shuts down recovery wells, P-101, 102, 103, Signal Alarm
LS-6	Operator switch, Floor sump	Mercury float switch, N.O. pump down switch	Local control, connect through Run/Stop mounted on wall over pump
LS-7	Alarm switch, Floor sump	Mercury float switch, N.O. alarm on high water level	High water shuts down recovery wells, P-101, 102, 103, Signal Alarm
PE-1	Pressure transmitter	Dwyer Pressure transmitter 0-100 psi, Model 636-2	Over pressure signal Alarm
P	Pressure gauge	Ashcroft, Buordon tube, liquid filled, 2-1/2" SS case	Direct manual read
T	Temperature gauge	Ashcroft, bimetal gage, 2" SS case, 30-130 degrees F scale	Direct manual read
MS-1	Moisture Switch	BW Controls, Type MSA	Alarm Condition Moisture at P-101

EQUIPMENT

PUMPS

P-101	Submersible Well Pump (Well TW-1) Gould Model 18GS10412, 1 HP, 1-Ph, 230 V or Approved Equal
P-102	Submersible Well Pump (Well TW-2A) Gould Model 18GS10412, 1 HP, 1-Ph, 230 V or Approved Equal
P-103	Submersible Well Pump (Well TW-3) Gould Model 18GS10412, 1 HP, 1-Ph, 230 V or Approved Equal
P-201	Sump Pump Gould Model 2ED11F1GA, 1.5 HP, 1-Ph 230 V, 5.5 In Dia. Impeller or Approved Equal
P-202	Sump Pump Gould Model 2ED11F1GA, 1.5 HP, 1-Ph 230 V, 5.5 In Dia. Impeller or Approved Equal
P-301	Floor Sump Pump Gould Model 2ED12BOEA, 1/3 HP, 1-Ph 120 V or Approved Equal

TANKS

T-101	Low Profile Air Stripper QED EZ Tray Model 4.4SS
T-201	Settling Tank Series Precast Concrete 3 Chamber, 1000 Gal ea.
T-301	Distribution/Metering Pit Precast Concrete

BLOWERS

BL-101	Air Stripper Blower Centrifugal Type, 880 CFM, 7.5 HP, 3-Ph 480 V, TEFC, to be supplied with T-101
BL-102	Exhaust Booster Blower Centrifugal Type, 880 CFM, 10 HP, 3-Ph 480 V, TEFC, to be supplied with T-101

MOTOR ACCESSORIES

VFD-101	Variable Frequency Drive Cerus Industrial VFD 7.5 HP, 3 Phase, 480 V, 50/60 Hz, Stand Alone

ADSORBERS

A-101	Vapor Phase Granular Activated Carbon Adsorbers Carbtrol Model G-5, 2000 Lb, 4x8 Mesh Mild Steel or Approved Equal
A-102	Vapor Phase Granular Activated Carbon Adsorbers Carbtrol Model G-5, 2000 Lb, 4x8 Mesh Mild Steel or Approved Equal

FILTER

F-101	Multi-Media Filter US Filter Model DM30072, 30" Dia. Steel Tank 40 to 60 gpm, 12" x 16" Manway and Cleanout

AECOM

FIGURE 9
CURRENT PROCESS AND INSTRUMENTATION

NYSDEC SITE NO. 314008
NOW CORPORATION
CLINTON, NY

JANUARY 2014 | DRWN: SAC

Appendix A1

Deed

FORM 381X N. Y. DEED—Full Covenant, with Lien Covenant

This Indenture,

Made the 13th *day of* May

Nineteen Hundred and Fifty-seven

Between ALLENE J. BASKIN, 35 Wilbur Boulevard, Poughkeepsie, N.Y. and ANNE WOOLFORD BRAW, 66 Montgomery Street, Rhinebeck, N.Y.

parties of the first part, and

ROBERT P. FRIED, residing at Staatsburg (no designated street address), New York,

Witnesseth *that the part of the first part, in consideration of* ------------ TEN and 00/100-- *Dollar* ($10.00) *lawful money of the United States,* and other good and valuable considerations *paid by the part of the second part, do hereby grant and release unto the part of the second part,* *and assigns forever, all* those lots or parcels of land, with the buildings and improvements thereon, in the Towns of Hyde Park and Clinton, Dutchess County, New York, bounded and described as follows:

PARCEL I: BEGINNING at a point on the east bank of Crum Elbow Creek and at or near to the north side of the east abutment of a former bridge over said creek, said point of beginning being on or near to the town line between the towns of Clinton and Hyde Park; thence north 27° 58' east 113.7 feet to a point on the east bank of the aforesaid creek in line with a wall running westerly from the west side of the creek; thence crossing the creek and along the aforementioned wall north 85° 45' west 665.7 feet to an angle in the wall; thence along the said wall the following courses and distances; north 84° 17' west 652.8 feet; south 88° 05' west 176.7 feet; south 65° 21' west 27.5 feet; north 81° 56' west 332.1 feet; north 87° 22' west 1068.1 feet; north 84° 16' west 573.0 feet; partly along said wall and to a white oak tree the southwest corner of the herein described parcel; thence north 36° 09' east 1783.6 feet along a fence to an intersection with a wall running east and west, said point being the northwest corner of the herein described parcel; thence along the said intersecting wall the following courses and distances; south 85° 42' east 913.6 feet; south 86° 00' east 1291.9 feet; south 84° 30' east 269.8 feet; south 87° 02' east 526.9 feet to a wall corner; thence along a wall running northeasterly the following courses and distances; north 26° 06' east 59.0 feet; north 42° 20' east 124.5 feet; north 3-° 14' east 161.9 feet; north 43° 09' east 101.7 feet; north 45° 15' east 382.9 feet; north 50° 54' east 173.0 feet to an intersection with a fence on the south side of the Endekill Road; thence along the south side of the Endekill Road the following courses and distances; south 46° 45' east 82.3 feet; south 33° 13' east 219.8 feet; south 43° 01' east 134.1 feet; south 47° 10' east 322.4 feet; south 59° 17' east 107.5 feet to an intersection with a fence on the west side of the Crum Elbow Creek; thence south 11° 27' west 284.0 feet along said fence on the west side of the creek to a point; thence south 3° 31' east 64.2 feet along the westerly or southerly side of the original location of the Crum Elbow Creek; thence continuing along the southerly side of the original location of said creek south 55° 45' east 140.7 feet to a concrete monument on the west side of the East Park-Pleasant Plains-Wurtemburg State Highway No. 8507; thence along the west side of the said highway south 36° 27' west 537.2 feet to a concrete monument on the north shore of the creek; thence along the creek south 78° 44' west 52.6 feet to a point on the north or west bank of the original Crum Elbow Creek location, said point being on the westerly extension of the north line of the parcel conveyed by James H. Link and wife to Ruth Mills, wife of Ogden Mills; thence along said north line south 32° 34' east 57.0 feet to the west boundary of the East Park-Pleasant Plains-Wurtemburg State Highway No. 8507; thence along the westerly side of said highway the following courses and distances; south 38° 07' west 285.7 feet to a concrete monument; south 44° 39' west 272.5 feet to a concrete monument; south 52° 59' west 223.4 feet; south 61° 51' west 311.9 feet; north 27° 13' west 9.0 feet to a concrete monument; south 62° 47' west 199.0 feet to a concrete monument; south 62° 39' west 409.2 feet to a concrete monument at the end of a wall; thence leaving said highway and along a wall north 48° 18' west 497.0 feet to the place of beginning. Containing one hundred eighty and one one hundredths (180.01) acres more or less.

PARCEL II: BEGINNING at the northwest corner at a point in the east side of the East Park-Pleasant Plains-Wurtemburg State Highway No. 8507; said point being in the line with a fence running southeasterly; thence along said fence south 32° 34' east 175.8 feet to an iron pin in the wall on the westerly side of the public road running to Pleasant Plains; thence south 62° 12' west along the west side of said road 327.4 feet to a concrete monument near the intersection of the said road running to Pleasant Plains and the East Park-Pleasant Plains-Wurtemburg State Highway No. 8507; thence north 53° 17' west 37.3 feet to a concrete monument on the east side of the aforesaid state highway thence along the east side of the aforesaid state highway north 38° 55' east 358.0 feet to the place of beginning. Containing eighty one-hundredths (0.80) acres more or less.

Being the property shown on survey of "property to be acquired by Walter Duncan", made by Harold R. Dean and Dated December 1938 revised January 1939.

Being the same premises conveyed from Gladys Phipps to Walter I. L. Duncan dated March 25, 1939 and recorded in the Dutchess County Clerk's Office in Liber 573 of Deeds at page 14 and transferred from Walter I.L. Duncan to Walter I.L. Duncan and Doris Duning Duncan, his wife, by deed dated June 25, 1940 and recorded in the Dutchess County Clerk's Office in Liber 582 of Deeds at page 357.

PARCEL III: ALL that lot or parcels of land, with the buildings and improvements thereon, in the Town of Clinton, Dutchess County, New York, bounded and described as follows:

BEGINNING AT a concrete highway monument on the southeasterly side of the East Park-Pleasant Plains-Wurtemburg State Highway No. 8507, said point being the northeast corner of a triangular parcel of land now or formerly the property of School District No. 10 and is 238.0 feet northeasterly of a fence corner in the southwest corner of said triangular parcel as measured along the highway; thence northeasterly along the southeasterly side of the highway, the following courses and distances: north 64° 12' east 323.0 feet; north 62° 23' east 642.3 feet; north 55° 32' east 102.7 feet to a monument on the old road leading to Pleasant Plains; thence along the southeasterly side of the old road leading to Pleasant Plains, north 62° 36' east 534.1 feet to the northwest corner of the herein described parcel and the southwest corner of the property now or formerly Jacob Z. Frost; thence along the northeasterly bounds of the herein described parcel and along a stone wall south 46° 18' east 494.2 feet, and south 60° 40' east 19.3 feet to a wall corner; thence continuing along the wall the following courses and distances; south 10° 10' west 53.9 feet; south 80° 30' east 98.1 feet south 26° 44' west 28.6 feet to a wall corner; thence continuing along the wall the following courses and distances; south 48° 29' east 89.9 feet; south 39° 58' east 313.3 feet; south 55° 10' east 162.7 feet; south 58° 46' east 75.3 feet; thence continuing along the wall and a prolongation of the wall and crossing over LeRoy Mountain south 46° 35' east 1231.2 feet to an iron pin marked O. M. on the easterly slope of the mountain; the northeast corner of the herein described parcel; thence along a wire fence running from tree to tree the southeasterly boundary of the herein described parcel the following courses and distances; south 60° 22' west 66.2 feet; south 28° 15' west 133.8 feet; south 17° 54' east 37.2 feet; north 76° 17' west 53.6 feet; south 44° 37' west 198.2 feet; south 29° 58' west 167.3 feet; south 33° 32' west 201.4 feet; south 42° 26' west 146.1 feet; south 53° 46' west 135.3 feet; south 41° 57' west 324.0 feet to an iron pin marked O. M. the southeast corner of the herein described parcel; thence along a wire fence running from tree to tree the southwesterly boundary of the herein described parcel the following courses and distances; north 46° 12' west 183.5 feet; north 52° 28' west 605.8 feet; north 43° 24' west 156.6 feet; north 56° 40' west 108.0 feet to an iron pin near a wall corner; thence continuing along a stone wall north 50° 44' west 1152.3 feet; thence continuing along the wall north 48° 59' west 820.8 feet to the southwesterly corner of the herein described parcel which is in intersection [illegible] easterly line of the property now or formerly School District No. 10, said point being 136.5 feet southeasterly from a fence corner the southwest corner of the former School District No. 10 property; thence along the division line of the herein described parcel and the property now or formerly School District No. 10, north 29° 03' east 221.6 feet to the place of beginning. Containing ninety-nine and thirteen one-hundredths (99.13) acres more or less.

Being the property shown on survey of "property to be acquired by Alan Kent", made by Harold R. Dean and dated January 1939.

Being the same premises conveyed from Alan Kent to Walter I.L. Duncan and Doris Dunning Duncan, his wife, dated June 19, 1940 and recorded in the Dutchess County Clerk's Office in Liber 582 of Deeds at page 435.

EXCEPTING AND RESERVING from the above three parcels so much as has been sold of by the following deeds:

1. To Phileteus G. Burger as recorded in theDutchess County Clerk's Office in Liber 716 of Deeds at page 409;

2. To James Elliott as recorded in the Dutchess County Clerk's Office in Liber 716 of Deeds at Page 634;

3. To Raymond N. Inglis as recorded in the Dutchess County Clerk's Office in Liber 721 of Deeds at Page 68;

4. To Charles Donlon as recorded in the Dutchess County Clerk's Office in Liber 756 of Deeds at Page 440;

5. To John H. Myers, Jr. as recorded in the Dutchess County Clerk's Office in Liber 797 of Deeds at Page 467;

6. To Lorin H. Kipp and Shirley A. Kipp as recorded in the Dutchess County Clerk's Office in Liber 826 at page 165;

7. To Earl Tallmadge and Ellen Tallmadge as recorded in the Dutchess County Clerk's Office in Liber 846 of Deeds at Page 99;

8. To Alvin L. Eignor and Elsie V. Eignor as recorded in the Dutchess County Clerk's Office in Liber 924 of Deeds at Page 490 and Liber 924 of Deeds at Page 493;

9. To Chauncey Gold as recorded in the Dutchess County Clerk's Office in Liber 924 of Deeds at Page 584 and in Liber 924 of Deeds at Page 588.

10. To Henry Barton and Lois R. Barton as recorded in the Dutchess County Clerk's Office in Liber 926 of Deeds at Page 8 and in Liber 926 of Deeds at Page 11.

11. To Albert E. Webb and Helen V. Webb as recorded in the Dutchess County Clerk's Office in Liber 936 of Deeds at Page 20, and in Liber 936 of Deeds at Page 17.

SUBJECT to rights of way of public utilities as recited in said rights of way recorded in the Dutchess County Clerk's Office in Liber 574 of Deeds at Page 488 and in Liber 725 of Deeds at Page 288 and in Liber 895 of Deeds at Page 390.

SUBJECT to conditions, covenants, easements and restrictions of record, if any.

BEING portion premises conveyed by Herman Haskin and Eileene C. Haskin to Benjamin T. Braw by deed dated April 21, 1953, which deed was recorded in the Dutchess County Clerk's Office on April 28, 1953 in Liber 829 of Deeds at Page 163. The said Benjamin T. Braw died on February 19, 1956 leaving a Last Will and Testament which was duly admitted to probate in the Dutchess County Surrogate Court.

Together *with the appurtenances and all the estate and rights of the part*ies *of the first part in and to said premises,*

To have and to hold *the premises herein granted unto the part* *of the second part,* *and assigns forever.*

DUTCHESS COUNTY
AUG 1 11 27 AM '57
COUNTY CLERK'S OFFICE

And *said* ALLENE J. BASKIN and ANNE WOOLFORD BRAW *covenant*s *as follows:*

First, *That said* ALLENE J. BASKIN and ANNE WOOLFORD BRAW are

seized of said premises in fee simple, and have *good right to convey the same;*

Second, *That the part* *of the second part shall quietly enjoy the said premises;*

Third, *That the said premises are free from incumbrances;* except as aforesaid,

Fourth, *That the part*ies *of the first part will execute or procure any further necessary assurance of the title to said premises;*

Fifth, *That said* ALLENE J. BASKIN and ANNE WOOLFORD BRAW

will forever **Warrant** *the title to said premises.*

Sixth, *That, in Compliance with Sec. 13 of the Lien Law, the grantor*s *will receive the consideration for this conveyance and will hold the right to receive such consideration as a trust fund to be applied first for the purpose of paying the cost of the improvement and will apply the same first to the payment of the cost of the improvement before using any part of the total of the same for any other purpose.*

DOCUMENTARY
UNITED STATES INTERNAL REVENUE
10 TEN DOLLARS 10

DOCUMENTARY
UNITED STATES INTERNAL REVENUE
5 FIVE DOLLARS 5

In Witness Whereof, *the part*ies *of the first part have* *hereunto set* their *hand*s *and seal*s *the day and year first above written.*

In Presence of

DEED	OR SUPPLEMENTAL INSTRUMENT
FEE PD. 4	NO. 3387
STAMPS PD. 18.15	INDEXED BY

Individual and as Executrix of the Estate of Benjamin F. Braw. Allene J. Baskin L.S.

widow Anne W. Braw L.S.

L.S.

L.S.

Rosen & Rosen

State of New York, County of Dutchess } ss. *On this* 15th *day of* May *Nineteen Hundred and* fifty-seven *before me, the subscriber, personally appeared*

ALLENE J. BASKIN

to me personally known and known to me to be the same person *described in and who executed the within Instrument, and* he *acknowledged to me that* he

Dutchess County Clerk's Office
Recorded on the 1 day of Aug
at 11.27 A.M.
Book No. 950 of Deeds
at page ...... and examined
FREDERIC A. SMITH, CLERK
Frederic A. Smith

Merrill S. Effron
Notary Public
MERRILL S. EFFRON
Notary Public of New York State
Residing Dutchess Co. # 328
Cert. Filed Co. #
Commission Expires March 30 19 59

STATE OF NEW YORK
COUNTY OF DUTCHESS

On this 15th day of May 1957, before me, the subscriber, personally appeared ANNE WOOLFORD BRAW, to me personally known and known to me to be the same person described in and who executed the within instrument, and she duly acknowledged to me that she executed the same.

James E. Carroll, Jr.
Notary Public of New York State
Residing Dutchess Co.
Commission Expires March 30, 1958

James E. Carroll Jr.
NOTARY PUBLIC

DOCUMENTARY
UNITED STATES INTERNAL REVENUE

DOCUMENTARY

DOCUMENTARY

Appendix A2

Record of Decision – Operable Unit 1 (March 1995)

Department of Environmental Conservation

Division of Hazardous Waste Remediation

Record of Decision

NOW Corporation Site
Town of Clinton, Dutchess County
Site Number 3-14-008
Operable Unit 1

March 1995

New York State Department of Environmental Conservation
GEORGE PATAKI, *Governor* MICHAEL ZAGATA, *Commissioner*

DECLARATION STATEMENT - RECORD OF DECISION

NOW CORPORATION Inactive Hazardous Waste Site
Clinton, Dutchess County, New York
Site No. 3-14-008
Operable Unit 1

Statement of Purpose and Basis

The Record of Decision (ROD) presents the selected remedial action for the Now Corporation inactive hazardous waste disposal site which was chosen in accordance with the New York State Environmental Conservation Law (ECL). The remedial program selected is not inconsistent with the National Oil and Hazardous Substances Pollution Contingency Plan of March 8, 1990 (40CFR300).

This decision is based upon the Administrative Record of the New York State Department of Environmental Conservation (NYSDEC) for the Now Corporation Inactive Hazardous Waste Site and upon public input to the Proposed Remedial Action Plan (PRAP) presented by the NYSDEC. A bibliography of the documents included as a part of the Administrative Record is included in Appendix B of the ROD.

Assessment of the Site

Actual or threatened release of hazardous waste constituents from this site, if not addressed by implementing the response action selected in this ROD, presents a current and a potential future threat to public health and the environment.

Description of Selected Remedy

Based on the results of the Remedial Investigation/Feasibility Study (RI/FS) for the Now Corporation site, the NYSDEC issued a PRAP on February 15, 1995. The preferred remedy detailed in the PRAP for this site consisted of a groundwater pump and treat system, and the excavation and off-site disposal of highly contaminated soil. A public meeting was subsequently held on February 22, 1995 to present this proposed remedial program to the public for comment.

Upon review of the comments received at the meeting and in correspondence during the associated comment period, it was discovered that the cost of the off-site disposal for the contaminated soils was significantly under estimated and the previously proposed remedy may no longer be cost effective. Hence, the NYSDEC will reevaluate the remedial alternatives for the contaminated soil at the site. Upon completion of the reevaluation of the remedial alternatives, a cost effective remedy will be proposed to address the contamination in the soil.

However, in order to address the public health threat presented by the groundwater contamination, the NYSDEC has decided to separate the site into two operable units. An operable unit (OU), is defined as a portion of the site that can be remediated independently of the remainder of the site. Operable Unit 1 will address the groundwater contamination and Operable Unit 2 will be the remainder of the site.

This Record of Decision for OU1 will allow the NYSDEC to proceed immediately with the remedy for the groundwater contamination.

The selected remedy for the groundwater contamination includes:

- Implementation of a groundwater pump and treatment system that will reduce, to the extent practical based on technological limitations, the impacts of contaminated groundwater to the environment. This system will also capture and treat vapors present in the bedrock. These actions will serve to control the migration of contaminants off-site.

- Reinfiltration of a portion of the treated groundwater to help flush contamination from the upper bedrock zone and to reduce the impacts of the groundwater withdrawal on neighboring homeowner wells.

- Institutional controls and restrictions to restrain the future use of groundwater at the site. Such controls would be required until the groundwater has been restored to drinking water standards.

- Continue the maintenance or future addition of carbon filters on impacted homeowner wells, until the groundwater meets New York State drinking water standards.

- Long-term monitoring would be carried out to assess the effectiveness of the selected remedy.

New York State Department of Health Acceptance

The New York State Department of Health concurs with the remedy selected for this site as being protective of human health.

Declaration

The selected remedy is protective of human health and the environment, is designed to comply with State and Federal requirements that are designed to be applicable or relevant and appropriate to the remedial action to the extent practicable, and is cost effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies, to the maximum extent practicable, and satisfies the statutory preference for remedies that reduce toxicity, mobility, or volume as a principal element.

The groundwater directly beneath the site may not achieve New York State drinking water standards. This is due to technical difficulties associated with the removal of volatile organic contamination from a fractured bedrock aquifer. The selected groundwater remedy will reduce the impacts of contaminated groundwater to the environment.

3/31/95
Date

Michael J. O'Toole, Jr.
Michael J. O'Toole, Jr., Director
Division of Hazardous Waste Remediation

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RECORD OF DECISION

"Now Corporation Site"
Clinton, Dutchess County, New York
Site No. 3-14-008
Operable Unit 1
March, 1995

SECTION 1: SITE LOCATION AND DESCRIPTION

The Now Corporation site consists of the developed portion of a 94.5 acre parcel of property owned by Mr. Robert Fried in the Town of Clinton, Dutchess County (see Figure 1). This developed portion of the property consists of approximately 15 acres along Route 9G. It contains one industrial building and an adjacent concrete pad where a warehouse destroyed by fire in 1989, once stood. This portion of the property, "the site", is bordered by route 9G and residential homes on the north-northwest and an inactive sand and gravel pit on the south. The east and west sides are bound by overgrown fields and woods.

The site is geographically located within the upland section of the Appalachian Highlands. Valley and ridge topography is the dominant feature in this region, with the valleys being deeply incised bedrock which have been filled with thick alluvial and glacial deposits. Typical among these deposits are clays, silts, gravels and till. These deposits tend to form gently sloping floors with steep, to moderately steep ridges along the valley walls. Along these valley walls bedrock outcrops are common, whereas the depth to bedrock along the centers of the valleys may be greater than 100 feet.

The bedrock in this region is typically shale, which has undergone extensive folding and fracturing. These fractures typically dip steeply and strike to the northeast. Regionally groundwater flows toward the Hudson River. However, local flow is controlled by the fracturing.

The Now Corporation site is located on the eastern edge of a valley. The bedrock is found at the surface to approximately thirty-five feet below grade. The bedrock is a shale which is partially covered by till, sand and gravel. Groundwater flow occurs at the site along preferential fracturing on a northeast-southwest trend. These conditions are consistent with the known regional conditions.

The groundwater flow in the bedrock aquifer is the primary source of drinking water in the area.

SECTION 2: SITE HISTORY

2.1: Operational/Disposal History

The property was purchased by Mr. Robert Fried in August 1957. Since the early 1960s, various businesses have operated on the site including: Modern Machine and Tools (1961-1971), Virginia Chemicals, Inc. (1969-1977, bought out by Hoechst Celanese in 1981), Now

Corporation (1970s and 1980s), Now Plastics (1982-1988 according to Mr. Fried), K&K Carpet, Tiffany Marble of New York, South American Development Corporation, and B&R Specialties, Inc. (current tenant).

The first investigation of the site, in 1975, consisted of sampling an on-site well by the Dutchess County Health Department (DCHD). The samples collected were analyzed for metals and general water chemistry parameters only. Sample results showed only manganese at levels exceeding the State Sanitary Code. This manganese is naturally present in the groundwater due to the surrounding soils.

The site was added to the registry in December, 1983, as a class 2a site due to allegations of on-site disposal of tank rinsing solutions.

A Phase I investigation was conducted in 1983 by NYSDEC. This Phase I investigation attempted to establish a Hazard Ranking Score (HRS) to better evaluate the site. A Phase II investigation was recommended to complete the HRS accurately, since the Phase I investigation did not include any groundwater, soil or air sampling.

In February, 1989, following a fire in the warehouse, samples of runoff water and water from three nearby homeowner wells were collected. The runoff water contained low levels of benzene, toluene, ethylbenzene, trichloroethene and 1,1,1-trichloroethane.

In this initial sampling no volatile organic compounds were detected in the nearby homeowner wells. However, follow up sampling in April, 1989, detected the presence of several VOCs in two residential wells. From 1989, to the present, one of these wells has consistently shown contamination with VOCs. For the locations of these residences and their historical contaminant levels, please refer to Figure 2 and Table 1.

In October 1989, the department began sending bottled water to residences G and I. In February 1990, granular activated carbon systems were installed on their water systems.

In August 1990, the NYSDEC reclassified this site to a class 2. A class 2 site presents a significant threat to public health and/or the environment. In July 1992, a work assignment was issued to perform a Remedial Investigation and Feasibility Study (RI/FS) under the State Superfund Program.

In April, 1994 another granulated activated carbon system was also installed on residence K.

SECTION 3: CURRENT STATUS

The NYSDEC, under the State Superfund Program, has conducted a Remedial Investigation/ Feasibility Study (RI/FS) to address the contamination at the site. This Record of Decision (ROD) presents a summary of this RI/FS and the selected remedy for the groundwater contamination. On-site soil contamination will be addressed in a separate ROD.

3.1: Summary of the Remedial Investigation

The purpose of the RI was to define the nature and extent of any contamination resulting from previous activities at the site.

The RI was conducted in two phases. The first phase was conducted between July 1992 and April 1994, the second phase between April 1994 and January 1995. A report entitled Draft Final RI/FS Report, January 1995, has been prepared detailing the field activities and findings of the RI.

The first phase of the RI activities consisted of the following:

- Review of historical documents and aerial photographs, to determine potential disposal areas on and near the site.

- A magnetic survey was conducted in the area of alleged waste disposal. This survey was intended to determine the potential for buried drums and/or tanks which may contain waste in this area.

- A site wide soil gas survey was conducted at 145 locations. These locations were selected near and downgradient of suspected source areas to identify areas of soil and possibly groundwater contamination. See attached Figure 3.

- Six test pits were completed to investigate anomalies detected during the soil gas and magnetometer surveys. Composite soil samples were taken in conjunction with these test pits to better define any contamination present in these areas. See attached Figure 4.

- Soil borings were also installed to collect subsurface soils for chemical analysis. Please refer back to Figure 4.

- Fifteen groundwater monitoring wells were installed to determine the chemical analysis of groundwater, as well as the physical properties of on site hydrogeologic conditions. Please see attached Figure 5.

- The sampling of several nearby homeowner wells to determine the presence and levels of groundwater contamination off-site. Please see attached Figure 6 and Table 1.

- Surface water and surface soil sampling was also performed to define the condition of on-site surface soils and intermittent water.

- Surface water and sediment samples were taken from Crum Elbow Creek, to further assess the possibility of any impact on this water body by the NOW Corporation site. Please refer back to attached Figure 5.

After a preliminary assessment of the first phase RI results, a second phase was conducted to gather information necessary to develop remedial alternatives.

During the second phase of the RI, the following additional work was performed:

- A treatability study was performed. This study was to determine how successful a pump and treat groundwater system would be at remediating the contamination in the fractured bedrock beneath the site. This study included the implementation of a treatment utilizing granulated activated carbon on a small scale to determine its effectiveness so that the appropriate size and cost of the equipment to remediate the entire site by this method could be established. A pumping well and five observation wells on the ridge to the north of the industrial building were also installed.

- A separate treatability study was performed to determine how effective a soil vapor extraction system would be at treating the subsurface soil contamination in the parking lot area of the site.

The analytical data obtained from the RI were compared to applicable Standards, Criteria, and Guidance (SCGs) in determining remedial alternatives. Groundwater, drinking water and surface water SCGs identified for the Now

Corporation site were based on NYSDEC Ambient Water Quality Standards and Guidance Values and Part V of NYS Sanitary Code.

Based upon the results of the remedial investigation in comparison to the SGGs and potential public health and environmental exposure routes, it was determined that the groundwater requires remediation.

GROUNDWATER

The investigation found several of the on-site monitoring wells to be contaminated with benzene, chloroethane, 1,1 dichloroethene (1,1 DCE), 1,2 DCE, tetrachloroethane (PCE), 1,1,1 trichloroethane (1,1,1 TCA), TCE and vinyl chloride. Monitoring wells MW-1, MW-6, MW-6D, MW-7, and MW-7D have shown the highest contamination levels. The concentrations for TCE and 1,2 DCE in these wells range from 11 to 2800 ppb and 12 to 82 ppb respectively. These all exceed the state drinking water standards of 5 ppb for these compounds as stated in Chapter I, Subpart 5-1 of the State Sanitary Code. See Figure 6 for an illustration of the extent and concentration of groundwater contamination.

Additionally, nearby homeowner wells have shown contamination with the same VOCs. The concentration levels in the most contaminated of these wells fluctuate based on the seasonal groundwater cycles. However, the detected VOCs are continually well above drinking water standards as they range from 27 to 730 ppb for TCE, 21 to 700 ppb for TCA, and 35 to 1,838 for total VOCs.

Based on this information, a treatability study was performed to evaluate the effectiveness of a pump and treat system to remediate groundwater contamination. The study consisted of pumping a constant flow of 17.3 gallons per minute from an on site extraction well for 72 hours. The water was then treated with a granular activated carbon filter. This water was sampled prior to and after treatment for VOCs. During the study, total VOC levels as high as 6,900 ppb were present in the pumping well. Contaminant levels did not drop significantly during the test and averaged 5,000 ppb over the entire test. These levels were effectively reduced to non detect by the carbon filtration unit used during the test. Significant vapors were also observed escaping from the test well during this phase of the study. Sampling of these vapors found a total of 190,000 ppb of non methane hydrocarbons present.

3.2 Interim Remedial Measures:

An Interim Remedial Measure (IRM) is implemented when a source of contamination or an exposure pathway can be effectively addressed before completion of the RI/FS. A direct pathway of exposure was established between contaminated groundwater from the site and the impacted homeowner wells. Based on this finding, an IRM was conducted at the site.

Carbon filtration units were installed on three private wells at residences G, I and K to prevent exposure to the contaminated groundwater. (See Figure 2) Bottled water has also been provided to residence G and the Route 9G Garden Center. The Garden Center only uses its well seasonally for irrigation purposes. Residence G is on a carbon filtration unit, but due to the high levels of contaminants in their well, they have experienced breakthrough on occasion. The carbon filtration unit at residence K was subsequently removed at the request of the owner. Responsibility for the carbon filtration unit at residence I was turned over to Mr. Fried in August of 1991, as this well was no longer showing contamination.

3.3 Summary of Human Exposure Pathways:

Based on the results of the remedial investigation, an evaluation of this site's impact on human health was performed. This evaluation, referred to as the baseline risk assessment in the RI/FS report, reached the following conclusion: that noncarcinogenic (systematic) and carcinogenic health effects may impact in both current and hypothetical future residents.

In the human health evaluation (HHE), the likelihood of noncarcinogenic effects is indicated by the hazard index, while the risk of carcinogenic effects is presented as a probability. A hazard index greater than one indicates that adverse noncarcinogenic effects may occur. A risk greater than the New York State Department of Health's remediation risk goal of $1x10^{-6}$ indicates that there is an unacceptable excess risk of carcinogenic effects.

For current residents, the noncarcinogenic hazard index ranges from 0.4 to 2. For hypothetical future residents, the hazard index ranges from 4 to 14. The elevated hazard indices are primarily due to the presence of arsenic, chromium, and manganese in soil, and manganese in groundwater. It should be noted, however, that the presence of these metals is not considered to be a result of hazardous waste disposal. The increased levels of manganese in groundwater can be explained by the high natural ranges of this metal in soils and variations in bedrock mineralogy in the area.

For carcinogenic effects, the risks for the current residents ranged from $5x10^{-6}$ to $2x10^{-5}$. Current exposures to the contaminated groundwater were not considered in this risk evaluation as they are presently prevented through the use of carbon filtration units. For hypothetical future residents, the risks ranged from $4x10^{-5}$ to $2x10^{-4}$. Without further remedial activities on this site, additional exposures will occur as the contaminated groundwater migrates to unprotected surrounding homeowner wells and potential future residences.

Risks for all receptor groups exceeded the NYSDOH remediation risk goal of $1x10^{-6}$. The increased risk to these receptors is primarily due to the presence of 1,1 dichloroethene and trichloroethene in groundwater.

The fact that carcinogenic risk exceeds the DOH goal of $1x10^{-6}$ denotes an increased cancer risk of one in a million and indicates that remediation is warranted to protect future residents.

3.4 Summary of Environmental Exposure Pathways:

Adverse ecological effects as a result of exposure of biota to contaminants at the site are minimal.

SECTION 4: ENFORCEMENT STATUS

The Potential Responsible Parties (PRP) for the site include:

Robert P. Fried
Hollow Road
Straatsburg, N.Y. 12580

Hoescht/Celanese Corp.
Route 202-206
P.O. Box 2500
Sommerville, N.J. 08876-1258

The PRPs failed to implement the RI/FS at the site when requested by the NYSDEC. After the remedy is selected, the PRPs will again be contacted to assume responsibility for the remedial program. If an agreement cannot be reached with the PRPs, the NYSDEC will refer the site for further action under the State Superfund Program. The PRPs are subject to legal actions by the State for recovery of all response costs the State has incurred.

SECTION 5: SUMMARY OF THE REMEDIATION GOALS

Goals for the remedial program have been established through the remedy selection process stated in 6NYCRR 375-1.10. These goals are established under the guideline of meeting all standards, criteria, and guidances (SCGs) for protecting human health and the environment.

The remedy selected should eliminate or mitigate all significant threats to public health and the environment presented by the hazardous waste disposed of at the site through the proper application of scientific and engineering principles.

The goals selected for this operable unit are:

- *Reduce, to the extent practical based on technological limitations, the impacts of contaminated groundwater to the environment.*
- *Reduce, to the extent possible, migration of contaminants in the groundwater.*
- *Provide for attainment of groundwater quality as close to SCGs for groundwater within the practical limits of remedial technology.*

Groundwater remediation for the site will be based on the effectiveness of the selected groundwater pump and treat system. This system will be operated until it no longer significantly reduces the contaminant levels in the groundwater.

SECTION 6: SUMMARY OF THE EVALUATION OF ALTERNATIVES

Upon review of the comments received at the meeting and in correspondence during the associated comment period for the PRAP, it was discovered that the off-site disposal costs for the contaminated soil was significantly under estimated and the previously proposed remedy may no longer be cost effective. Hence, the NYSDEC will reevaluate the remedial alternatives for the contaminated soil at the site. Upon completion of the reevaluation of the remedial alternatives a cost effective remedy will be proposed to address the contamination in the soil.

However, in order to address the public health threat presented by the groundwater contamination, the NYSDEC has decided to separate the site into two operable units. An operable unit is defined as a portion of the site that can be remediated independently of the remainder of the site. Operable unit 1 will address the groundwater contamination and Operable Unit 2 will be the remainder of the site.

A summary of the detailed analysis follows.

6.1: Description of Alternatives

The following alternatives are intended to address the contaminated groundwater on site and to prevent the further migration of contaminants from the site via the groundwater. Present worth values are calculated for a discount rate of four percent.

Alternative 1: No Further Action

Present Worth:	$ 378,000
Capital Cost:	0
Annual O & M:	$ 22,000
Time to Implement:	30 years

The no further action alternative is evaluated as a procedural requirement and as a basis for comparison to other actions. This alternative recognizes that carbon filtration units have been installed on impacted homeowner wells. It requires continued monitoring only.

Alternative 2 - Groundwater Pump and Treat

Present Worth:	$ 1,800,000
Capital Cost:	$ 486,000
Annual O&M:	$ 163,000
Time to Implement:	7 to 10 years

This alternative would address the groundwater contamination by installing a system that would withdraw and treat the heavily contaminated groundwater. The goal of this system would be to reduce, to the extent possible based on technological limitations, the impacts of the contaminated groundwater on human health and the environment.

The groundwater pumping system as conceptually designed in the RI/FS would consist of five pumping wells in two rows to the northeast and southwest of the building and concrete pad. These wells would withdraw a combined flow of approximately 25 gallons per minute. This contamination would then be treated by passing the extracted groundwater through a treatment unit. The contaminants would then be removed by carbon filtration, or an equivalent treatment technology. Some of these extraction wells would also be equipped with vapor extraction equipment to treat vapors from the bedrock.

This treated water would then be divided into two flows. A small fraction of the treated water would be reinfiltrated on site to help flush the contaminants from the bedrock around the concrete pad and to minimize groundwater effects of the extraction wells off site. The remainder of the treated water would be piped and discharged into the Crum Elbow Creek. Both flows would be monitored regularly to assure that the treatment unit is operating effectively.

The system would be operated until it is no longer significantly reducing the contaminant levels in the groundwater or until groundwater standards are reached.

This conceptual design would be reevaluated and modified as needed in the remedial design to meet the stated objective of hydrologically isolating and treating the groundwater contamination from the site.

6.2 Evaluation of Remedial Alternatives

The criteria used to compare the remedial alternatives are defined in the regulation that directs the remediation of inactive hazardous waste sites in New York State (6NYCRR Part 375). For each of the criteria, a brief description is provided followed by an evaluation of the alternatives against that criterion. A detailed discussion of the evaluation criteria and comparative analysis is contained in the Feasibility Study.

The first two evaluation criteria are termed threshold criteria and must be satisfied in order for an alternative to be considered for selection.

1. Compliance with New York State Standards, Criteria, and Guidance (SCGs). Compliance with SCGs addresses whether or not a remedy would meet applicable environmental laws, regulations, standards, and guidance.

The no further action, alternative 1, would not comply with New York State SCGs, primarily due to the continuing exceedances of NYS Groundwater Standards 6NYCRR Part 702.

Alternative 2 would treat the groundwater contamination at this site by a pump and treat system. VOC contamination in fractured bedrock contamination has proven to be mitigated most readily by pump and treat systems as proposed in Alternative 2. However, attainment of Class GA groundwater standards may not be possible. This is primarily due to the presence of VOCs that are heavier than water in a fractured bedrock aquifer.

2. Protection of Human Health and the Environment. This criterion is an overall evaluation of the health and environmental impacts to assess whether each alternative is protective.

Alternative 1 would not be protective of human health and the environment. This is due to the continuing exceedances of VOCs in the groundwater, which is used as the primary drinking water source in the area.

Alternative 2 may not be protective of human health due to the technical difficulties associated with the removal of all of the VOC contamination in the groundwater. However, the levels and associated risks from the VOC contaminated groundwater in nearby residential wells would be greatly reduced through the containment and withdrawal of the VOC plume by a groundwater pump and treat system.

The next five "primary balancing criteria" are used to compare the positive and negative aspects of each of the remedial strategies.

3. Short-term Impacts and Effectiveness. The potential short-term adverse impacts of the remedial action upon the community, the workers, and the environment during the construction and implementation are evaluated. The length of time needed to achieve the remedial objectives is also estimated and compared with the other alternatives.

Alternative 1 would pose no additional adverse impacts. However, as this alternative would not include active remediation, nor would it reduce the contamination or the risks that are associated with that contamination.

Construction activities for alternative 2 include soil excavation needed for the construction of the pump and treatment system and well drilling. This should not pose a risk to the community or workers as long as action-specific SCGs for these activities are adhered to. Air monitoring would be performed to ensure that dust and/or VOCs are not causing a risk to residents or workers in the on-site building. Additionally, access limitations, protective clothing, monitoring equipment and decontamination procedures would be used in accordance with the site Health and Safety Plan.

Impacts to the environment would consist of the potential for contaminated soil or groundwater to reach Crum Elbow Creek. Plans for controlling soil and sediment from site construction activities would be prepared as part of the remedial design activities.

Similarly, during the operation of the remedy monitoring will be performed to insure that any water discharged to Crum Elbow Creek does not exceed surface water standards.

4. Long-term Effectiveness and Permanence. This criterion evaluates the long-term effectiveness of alternatives after implementation of the response actions. If wastes or treated residuals remain on site after the selected remedy has been implemented, the following items are evaluated: 1) the magnitude of the remaining risks, 2) the adequacy of the controls intended to

limit the risk, and 3) the reliability of these controls.

Alternative 2 would permanently treat the contaminated groundwater by passing the extracted groundwater contamination through activated carbon filters or an equivalent treatment method. However, due to the nature of the groundwater contamination, it is anticipated that some contamination would remain. This contamination should only pose a potential threat if groundwater on the site was used as a potable water source without treatment. This can be effectively managed by institutional controls and long term monitoring of the site.

Alternative 1 does not contain any permanent remedies. Over the course of time, it is expected that the levels of contamination in the groundwater would reduce through natural attenuation. However, this attenuation would not reduce the risks in a reasonable time. Institutional controls and restrictions would be needed indefinitely.

5. Reduction of Toxicity, Mobility or Volume

Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility or volume of the wastes at the site.

Alternative 1 would not reduce the toxicity, mobility or volume of the wastes in the groundwater.

Alternative 2 would reduce the toxicity, mobility and volume of the contamination. This would be accomplished by the treatment systems concentrating and permanent treatment of the contamination by activated carbon or an equivalent technology.

6. Implementability. The technical and administrative feasibility of implementing each alternative is evaluated. Technically, this includes the difficulties associated with the construction, and the ability to monitor the effectiveness of the remedy. Administratively, the availability of the necessary personnel and material is evaluated along with potential difficulties in obtaining specific operating approvals.

Both of the alternatives considered for this site are implementable.

Alternatives 1 would only require annual sampling to monitor the site's condition and personnel to maintain the necessary site restrictions. The materials and personnel for these tasks would be readily available.

Alternative 2 would require the design, construction, and operation of the groundwater treatment system. This system would need to meet all quantitative requirements for the discharge of treated groundwater and air emissions from the treatment unit. The vapor extraction system to be included on the groundwater extraction wells would also need to meet all emission requirements.

The necessary materials and personnel to construct, start up and maintain this system should be readily available.

7. Cost. Capital, and operation and maintenance costs are estimated for each alternative and are compared on a present worth basis. Although cost is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the remaining criteria, cost effectiveness can be used as the basis for the final decision.

The present worth cost of the no further action, alternative 1, is $378,000.

The present worth cost of the groundwater pump and treat system, alternative 2, is $1,800,000. The cost can be broken down into $486,000 in capital costs and $163,000 in annual operations and maintenance costs. Both of these subcomponents are in present worth dollars.

8. Community Assessment - Concerns of the community regarding the RI/FS report and the February 15, 1995 PRAP have been evaluated. A responsive summary describing these concerns and detailing how the Department will address these concerns has been prepared. This responsive summary is attached as Appendix A.

Due to comments on the proposed remedy the Department decided to issue a Record of Decision for the groundwater and reevaluate the remedial alternatives for the on-site soil contamination.

SECTION 7: SUMMARY OF THE SELECTED REMEDY

Based upon the results of the RI/FS, and the evaluation presented in Section 7, the NYSDEC is selecting Alternative 2, as the remedy for the groundwater, operable unit 1.

Alternative 1 is considered unacceptable as human health and the environment would not be adequately protected. Additionally, human health would not be protected in the future from the groundwater if the contamination migrates to wells without carbon filtration units.

Alternative 2 was selected as the preferred remedy. This alternative will effectively remove the VOC contamination while limiting migration of contaminants outside the site boundary. This alternative will also greatly mitigate the impacts from the contamination to the environment.

The estimated present worth cost to implement the proposed remedy is $1,800,000. The cost to construct the remedy, capital cost, is estimated to be $486,000 and the estimated annual operation cost for 7 to 10 years will be a maximum of $163,000.

The elements of the selected remedy, are as follows:

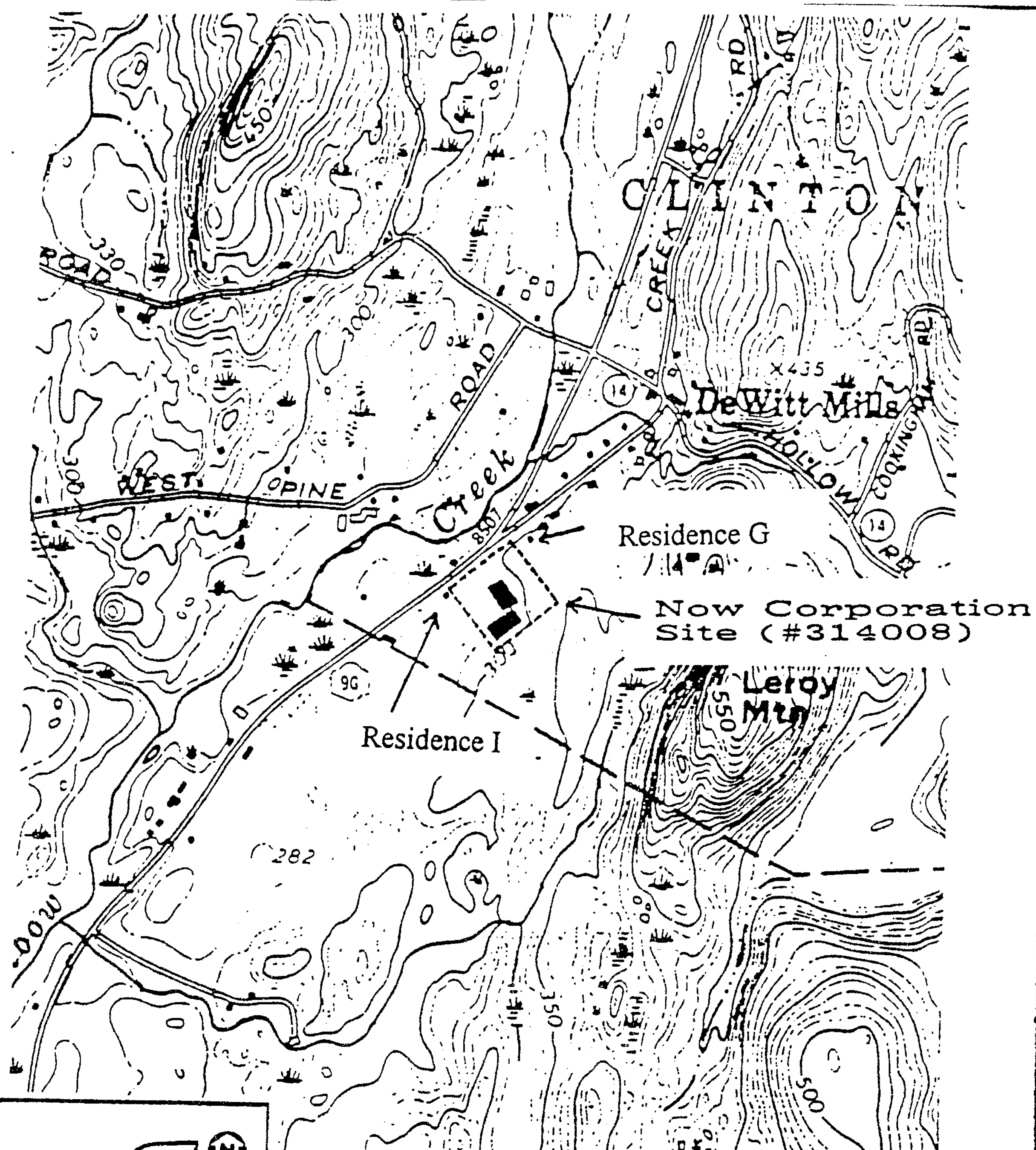
- Implementation of a groundwater pump and treatment system that will reduce, to the extent practical based on technological limitations, the impacts of contaminated groundwater to the environment. This system will also capture and treat vapors present in the bedrock. These actions will serve to control the migration of contaminants off-site.

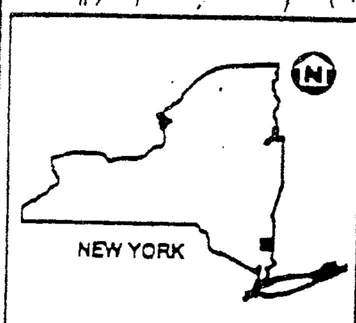
- Reinfiltration of a portion of the treated groundwater to help flush contamination from the upper bedrock zone and to reduce the impacts of the groundwater withdrawal on neighboring homeowner wells.

- Continue the maintenance and addition of carbon filters on impacted homeowner wells. Institutional controls and restrictions to restrain the future use of groundwater at the site.

The selected remedy, Alternative 2, will leave hazardous waste remaining in the groundwater. As such, a long term monitoring program will be instituted. This is due to the inherent difficulty in removing all of the VOC contamination from a fractured bedrock aquifer. This program will allow the effectiveness of the selected remedy to be monitored. This long term monitoring program will be a component of the operations and maintenance plan for the site and will be developed as part of the remedial design.

The selected remedy represents a sound balancing of cost considerations with the need to protect public health and environment by reducing or controlling risk through treatment, engineering or institutional controls.



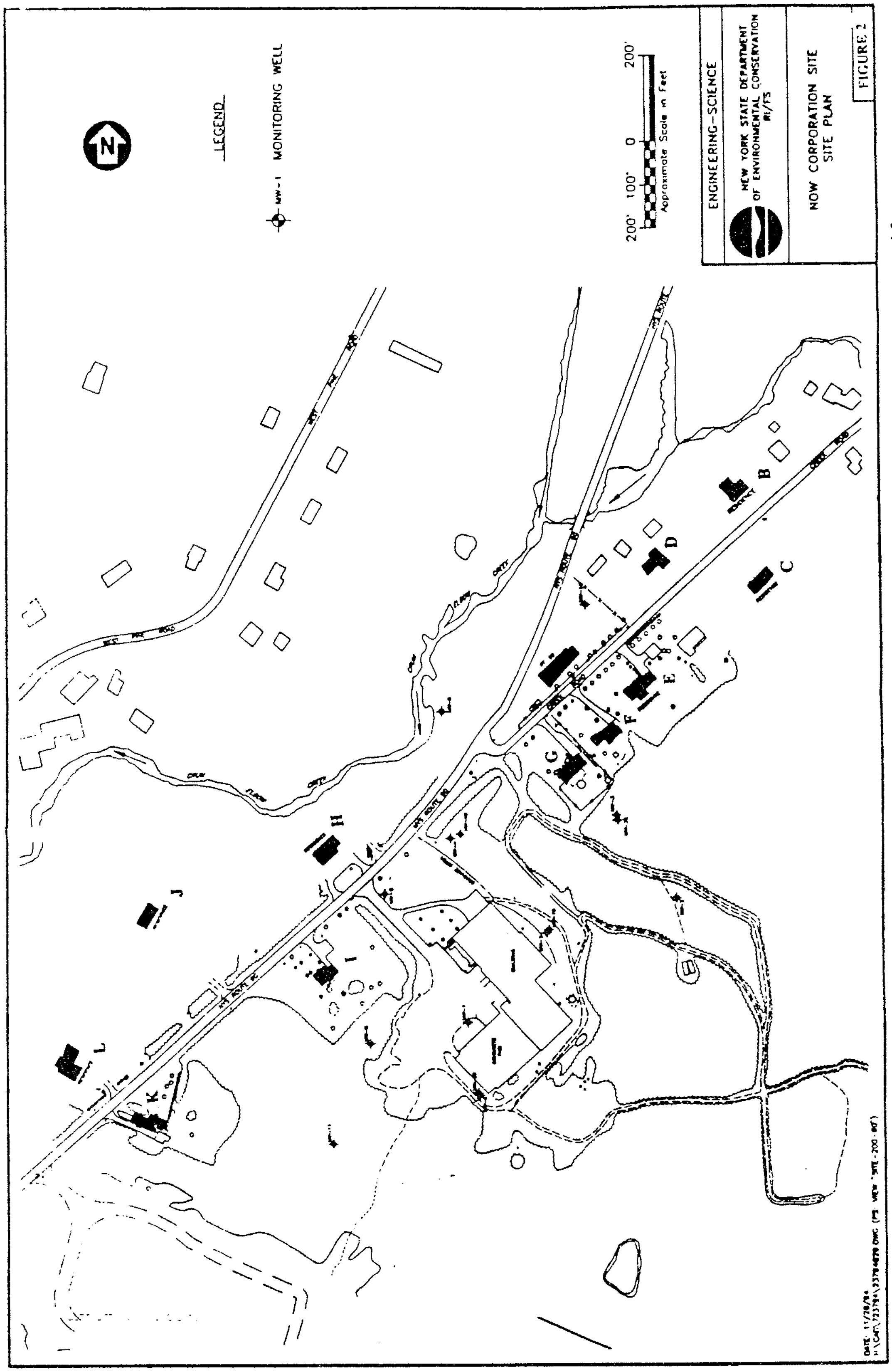


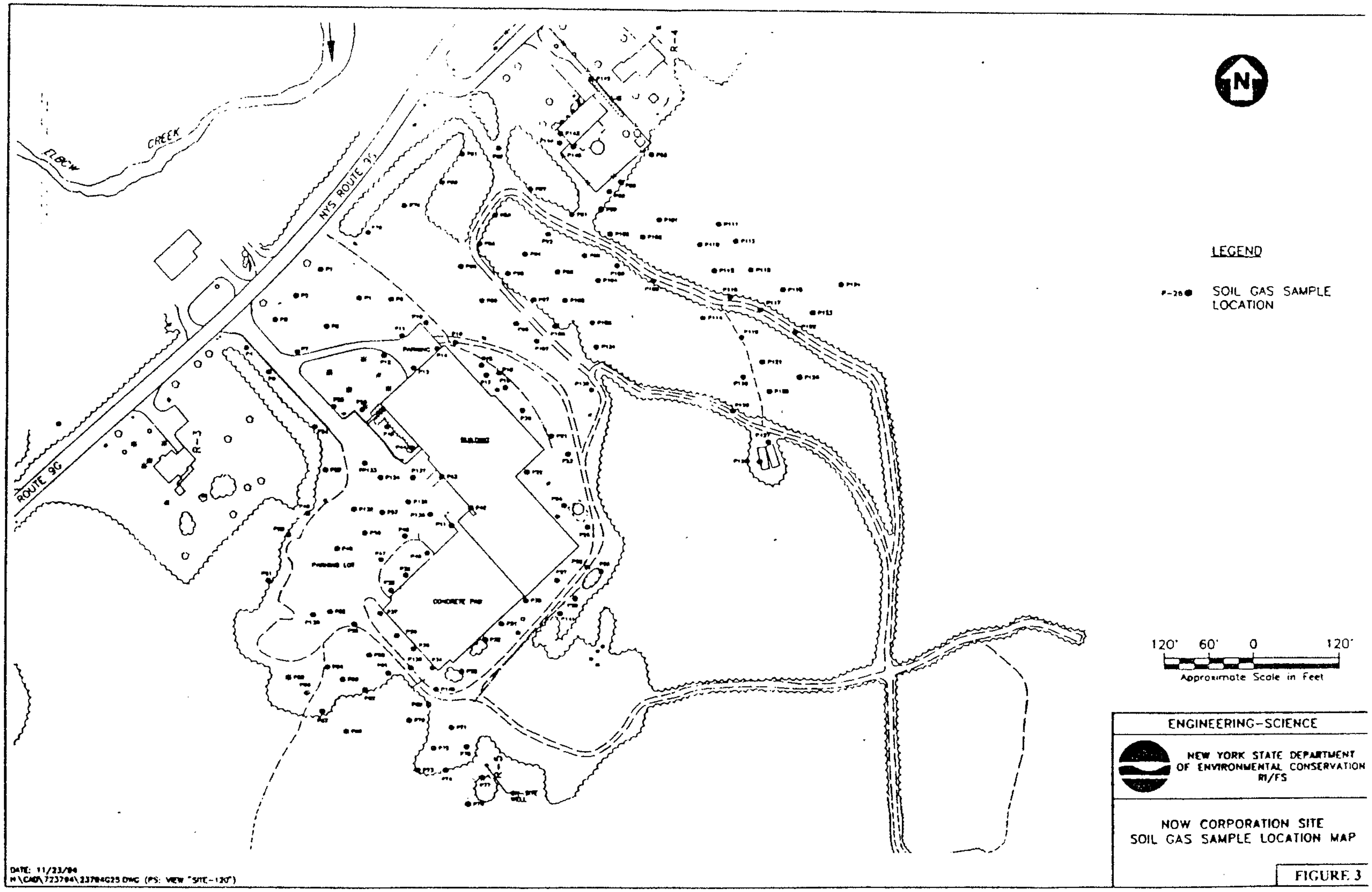
LATITUDE: 41°51'00"
LONGITUDE: 73°52'45"

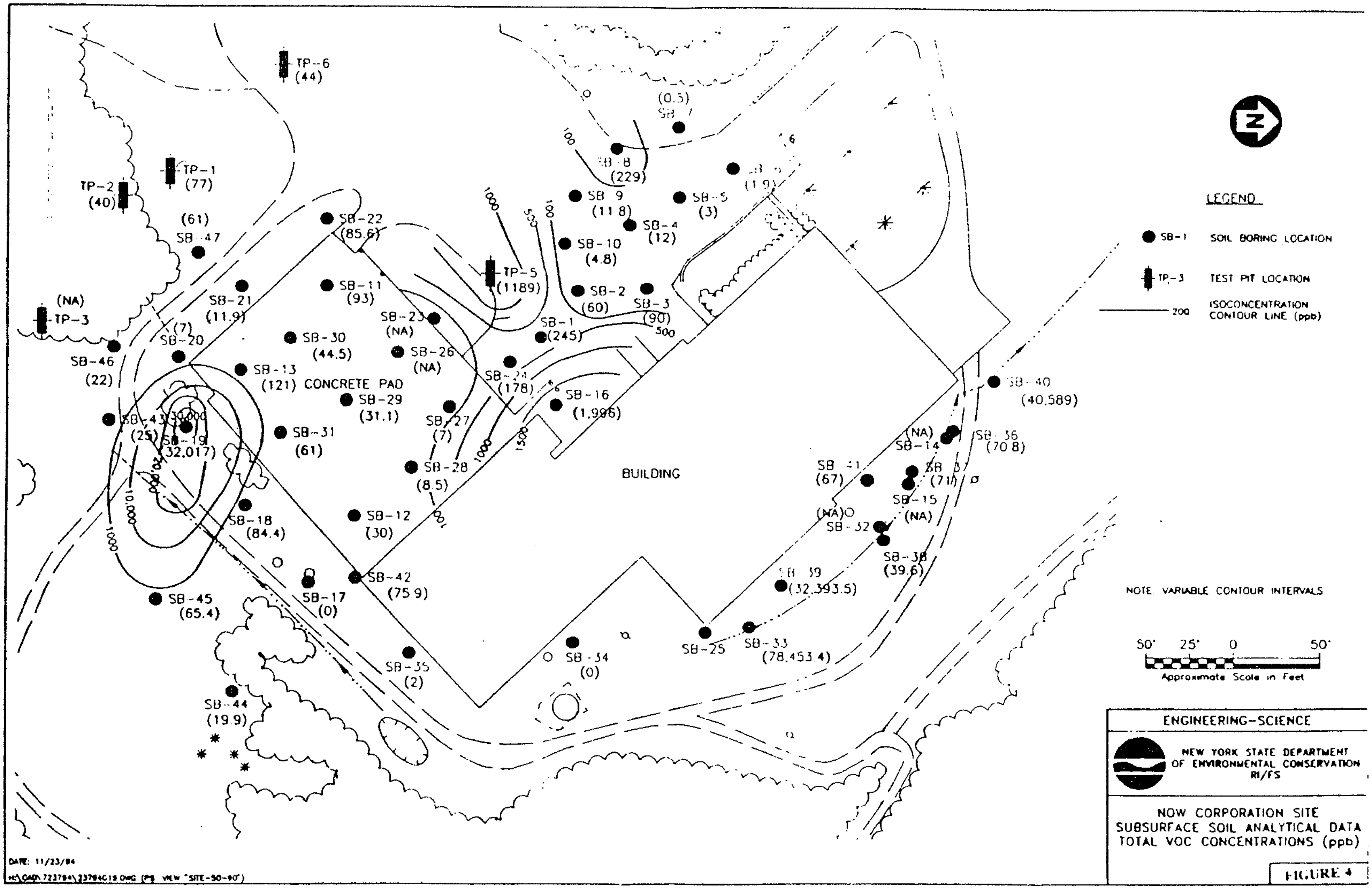
ENGINEERING-SCIENCE

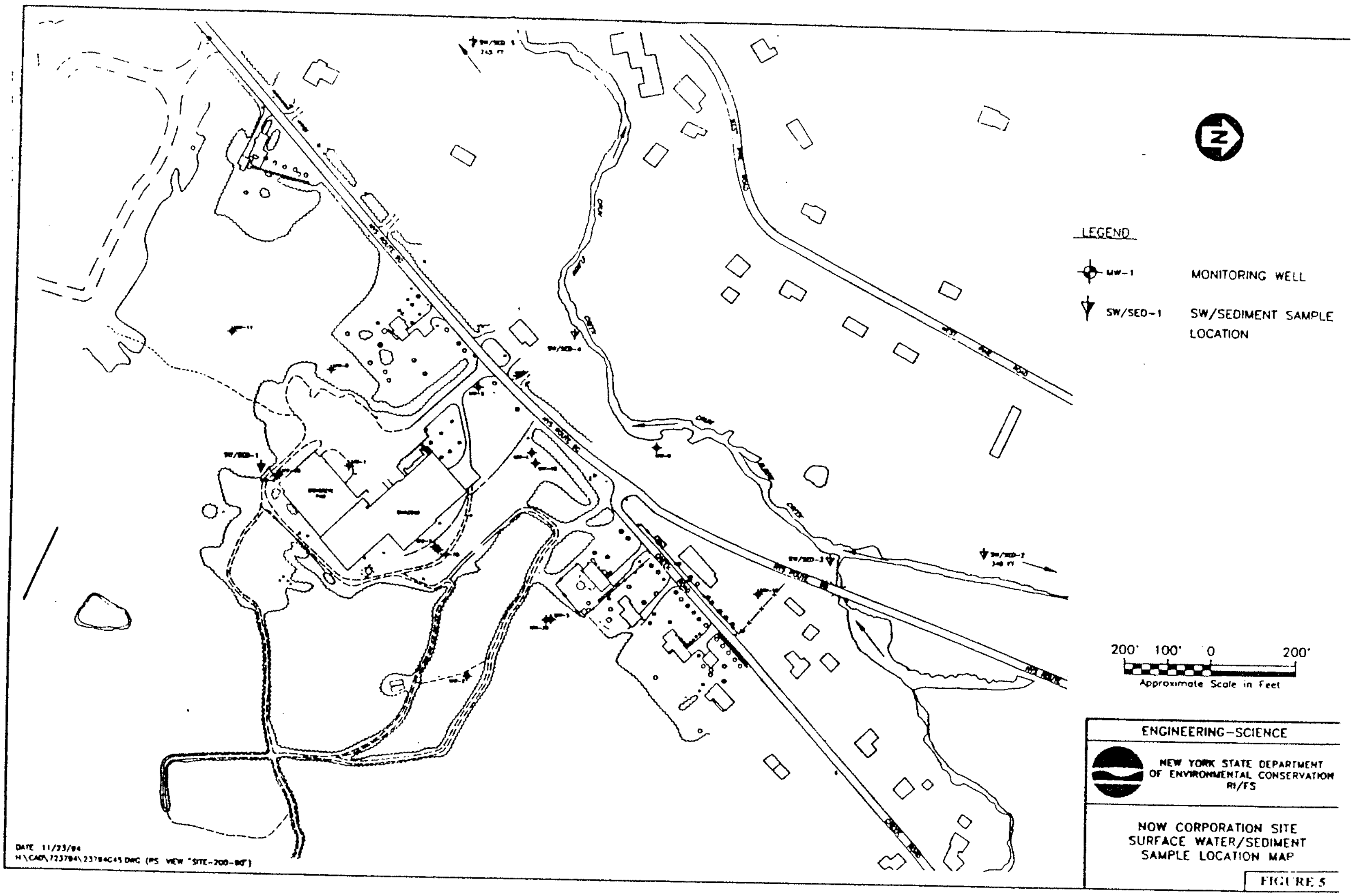
NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
RI/FS INVESTIGATION

FIGURE 1
SITE LOCATION MAP
NOW CORPORATION SITE


LEGEND
MW-1 MONITORING WELL
200' 100' 0 200'
Approximate Scale in Feet
ENGINEERING-SCIENCE
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
RI/FS
NOW CORPORATION SITE
SITE PLAN
FIGURE 2
B
C
D
E
F
G
H
I
J
K
L


ELBOW CREEK
NYS ROUTE 9G
ROUTE 9G
R-3
R-4
BUILDING
PARKING LOT
CONCRETE PAD
LEGEND
SOIL GAS SAMPLE LOCATION
120' 60' 0 120'
Approximate Scale in Feet
ENGINEERING-SCIENCE
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION RI/FS
NOW CORPORATION SITE
SOIL GAS SAMPLE LOCATION MAP
FIGURE 3


LEGEND
SB-1 SOIL BORING LOCATION
TP-3 TEST PIT LOCATION
200 ISOCONCENTRATION CONTOUR LINE (ppb)
NOTE: VARIABLE CONTOUR INTERVALS
50' 25' 0 50'
Approximate Scale in Feet
CONCRETE PAD
BUILDING
TP-1 (77)
TP-2 (40)
TP-3 (NA)
TP-5 (1189)
TP-6 (44)
SB-1 (245)
SB-2 (60)
SB-3 (90)
SB-4 (12)
SB-5 (3)
SB-8 (229)
SB-9 (11.8)
SB-10 (4.8)
SB-11 (93)
SB-12 (30)
SB-13 (121)
SB-14 (NA)
SB-15 (NA)
SB-16 (1,996)
SB-17 (0)
SB-18 (84.4)
SB-19 (32,017)
SB-20 (7)
SB-21 (11.9)
SB-22 (85.6)
SB-23 (NA)
SB-25
SB-26 (NA)
SB-27 (7)
SB-28 (8.5)
SB-29 (31.1)
SB-30 (44.5)
SB-31 (61)
SB-32 (NA)
SB-33 (78,453.4)
SB-34 (0)
SB-35 (2)
SB-36 (70.8)
SB-38 (39.6)
SB-39 (32,393.5)
SB-40 (40,589)
SB-41 (67)
SB-42 (75.9)
SB-43 (25)
SB-44 (19.9)
SB-45 (65.4)
SB-46 (22)
SB-47 (61)
10,000
1000
500
100
DATE: 11/23/94
ENGINEERING-SCIENCE
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION RI/FS
NOW CORPORATION SITE
SUBSURFACE SOIL ANALYTICAL DATA
TOTAL VOC CONCENTRATIONS (ppb)
FIGURE 4


LEGEND
MW-1 MONITORING WELL
SW/SED-1 SW/SEDIMENT SAMPLE LOCATION
200' 100' 0 200'
Approximate Scale in Feet
ENGINEERING-SCIENCE
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION RI/FS
NOW CORPORATION SITE
SURFACE WATER/SEDIMENT
SAMPLE LOCATION MAP
FIGURE 5

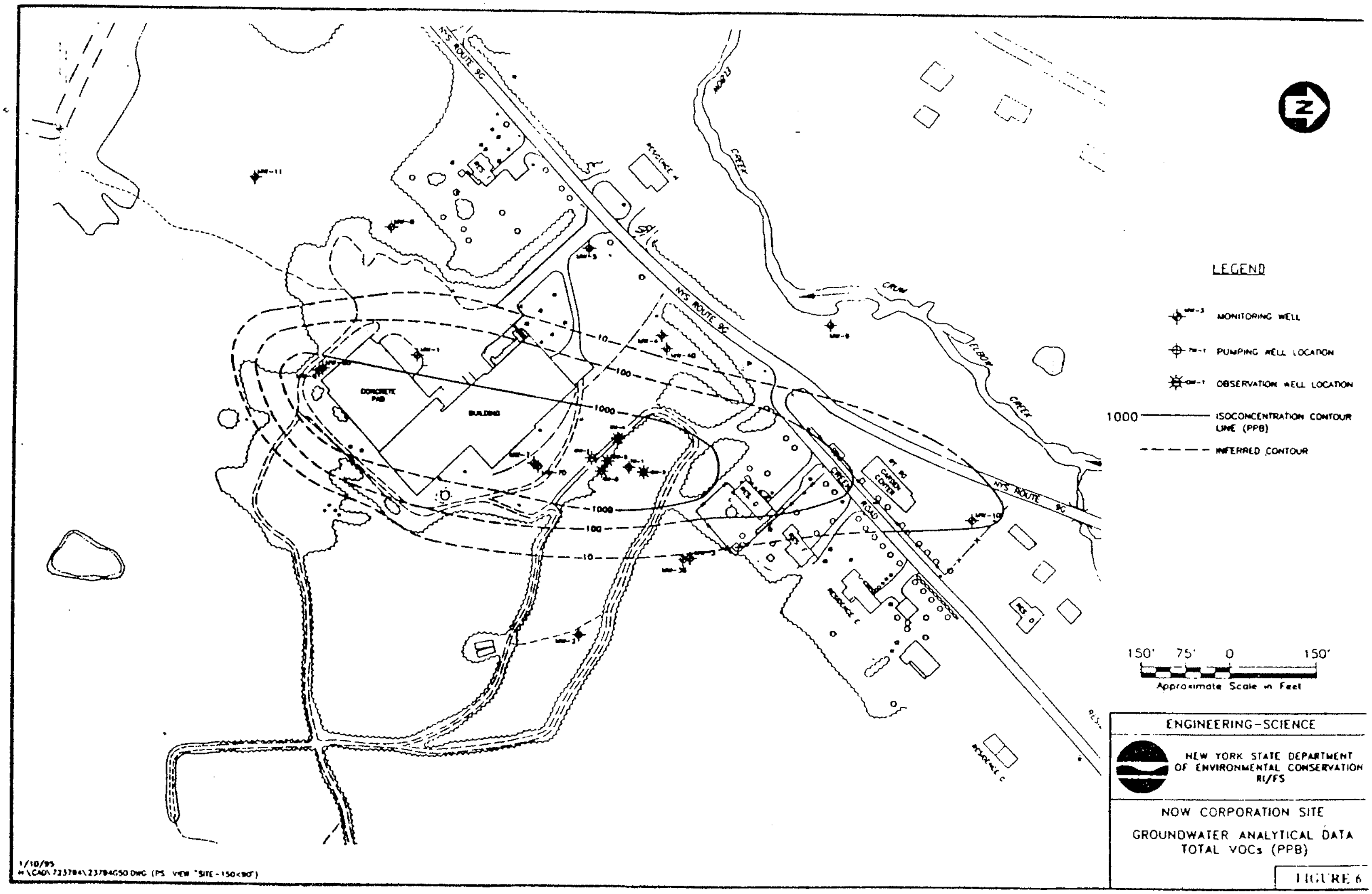

LEGEND
MONITORING WELL
PUMPING WELL LOCATION
OBSERVATION WELL LOCATION
1000 ISOCONCENTRATION CONTOUR LINE (PPB)
INFERRED CONTOUR
150' 75' 0 150'
Approximate Scale in Feet
ENGINEERING-SCIENCE
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION RI/FS
NOW CORPORATION SITE
GROUNDWATER ANALYTICAL DATA
TOTAL VOCs (PPB)
FIGURE 6
NYS ROUTE 9C
CONCRETE PAD
BUILDING
CREEK
ELBOW CREEK
10
100
1000
1/10/95

TABLE 1
NOW CORPORATION SITE
RESIDENTIAL WELL ANALYTICAL RESULTS SUMMARY

		COMPOUNDS DETECTED (ug/L)										
		1,1-DCA	1,1-DCE	1,1,1-TCA	TRANS-1,2 DCE	CIS-1,2 DCE	TCE	VINYL CHLORIDE	ACETONE	CARBON TETRACHLORIDE	TOTAL (1,2-DCE)	TOTAL VOC'S
(1) NYSDEC CLASS GA WATER QUALITY STANDARD/GUIDELINES		5	5	5	5	5	5	2	50 (G)	5	5	
RESIDENCE	SAMPLE DATE											
G	4-19-89	10	1	21	ND	1	66	ND	ND	ND	ND	99.0
G	8-21-89	290	56	420	8	ND	330	ND	ND	ND	ND	1104.0
G	2-21-90	NA	NA	NA	NA	NA	35	NA	ND	ND	ND	35.0
G	3-21-90	NA	NA	NA	NA	NA	86	NA	ND	ND	ND	86.0
G	8-9-90	79	12	83	ND	2	200	ND	ND	ND	ND	375.6
G	5-28-91	11	ND	27	ND	38	75	ND	ND	ND	ND	151.0
G	7-15-91	110	7	250	11	ND	550	ND	ND	ND	ND	928.0
G	10-28-91	310	8	700	13	ND	480	3	ND	ND	ND	1,514.0
G	1-3-92	20	3	27	4	ND	27	ND	ND	ND	ND	81.0
G	4-13-92	22	ND	32	ND	ND	150	ND	ND	ND	ND	204.0
G	7-18-92	73	4.9	140	3.3	ND	230	ND	ND	ND	ND	451.2
G	10-19-92	ND	220	600	NA	ND	780	NA	NA	ND	ND	1,600.0
G	1-7-93	130	7.2	380	NA	3.4	370	NA	NA	ND	ND	890.6
G	4-8-93	4	ND	6.1	NA	ND	28	NA	NA	ND	ND	38.1
G	8-3-93	59	ND	120	NA	6.9	400	NA	NA	ND	ND	585.9
G	11-8-93	350	16	840	NA	4.9	540	NA	NA	81	4.9	1,836.8
G	2-17-94	130	6.7	230	NA	7.1	320	NA	NA	NA	ND	693.8
G	6-21-94	71	ND	140	NA	ND	270	NA	NA	NA	ND	481.0
I	2-16-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
I	4-19-89	ND	ND	ND	ND	ND	ND	ND	94	ND	ND	94.0
I	8-25-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
I	2-21-90	NA	NA	NA	NA	NA	ND	NA	ND	ND	ND	0
I	3-21-90	NA	NA	NA	NA	NA	ND	NA	ND	ND	ND	0
I	5-16-90	NA	NA	NA	NA	NA	ND	NA	ND	ND	ND	0
I	11-19-90	ND	ND	ND	ND	NA	ND	NA	NA	ND	ND	0
I	3-1-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
I	4-3-91	ND	ND	ND	ND	NA	ND	NA	NA	ND	ND	0
I	4-28-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
H	2-16-89	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	0
H	9-14-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
H	7-7-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
F	9-13-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
F	10-23-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
F	3-15-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
F	4-28-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
F	11-4-93	ND	ND	1.6	ND	ND	2	ND	ND	ND	ND	3.6
J	2-16-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
J	9-13-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
J	4-27-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
E	9-13-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
E	4-29-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
NOW WELL	4-6-89	1600	95	2600	160	ND	960	2	ND	ND	ND	5617.0
NOW WELL	4-28-93	ND	ND	ND	ND	ND	0.8	ND	ND	ND	ND	0.8
K	4-29-93	ND	ND	4	ND	ND	9	ND	ND	ND	ND	13.0
K	7-7-93	1	ND	4	ND	2	8	ND	ND	ND	ND	15.0
K	4-22-94	ND	ND	4	ND	0.9	6	ND	ND	ND	ND	10.9
K	6-21-94	2.3	ND	5.5	ND	ND	11	ND	ND	ND	ND	18.8
B	4-28-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
B	11-4-93	1.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.7
D	4-28-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
9G GARDEN CTR	10-1-92	72	21	62	ND	2	20	ND	ND	ND	ND	177.0
9G GARDEN CTR	4-29-93	ND	5	53	ND	1	28	ND	ND	ND	ND	87.0
M	4-29-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
N	4-29-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
L	7-7-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
C	7-7-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
A	11-4-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0

(1) NYSDEC WATER QUALITY STANDARDS AND GUIDANCE VALUES (11/91)
(G) GUIDANCE VALUE
SEE FIGURE 4.1 FOR SAMPLE LOCATIONS
ND NOT DETECTED
NA NOT ANALYZED
NOTE DATA NOT VALIDATED

APPENDIX A

Responsiveness Summary
Now Corporation Site
Site ID: 3-14-008
Operable Unit 1

This document summarizes the comments and questions received by the New York State Department of Environmental Conservation (NYSDEC) regarding the Proposed Remedial Action Plan (PRAP) for the Now Corporation site. A public comment period was held between February 13, 1995 and March 15, 1995 to receive comments on the PRAP. A public meeting was also held on February 22, 1995 in the Clinton Town Hall to present the results of the Remedial Investigation and Feasibility Study (RI/FS) and to describe the PRAP. In addition to this meeting, two other public meetings were held on October 14, 1992 and August 24, 1993 to discuss the RI workplan and the results of the Phase 1 RI, respectively.

This Responsiveness Summary is comprised of verbal comments and questions voiced during the February 22, 1995 public meeting and written comments received during the associated comment period. Written comments were received from the following during the comment period and are available in the document repository.

Janet C. Mills, February 20, 1995
Raymon Oberly, March 15, 1995
Robert S. McEwan, Jr., March 15, 1995
Frederick Loneker, March 15, 1995
Marian Zeilinski, March 15, 1995
Daniel J. Lowenstein, March 15, 1995

Upon review of the comments received at the meeting and in correspondence during the associated comment period, it was discovered that the off-site disposal cost for the contaminated soils was significantly under estimated and the previously proposed remedy may no longer be cost effective. Hence, the NYSDEC will reevaluate the remedial alternatives for the contaminated soil at the site. Upon completion of the reevaluation of the remedial alternatives, a cost effective remedy will be proposed to address the contamination in the soil.

However, in order to address the public health threat presented by the groundwater contamination, the NYSDEC has decided to separate the site into two operable units. An operable unit (OU), is defined as a portion of the site that can be remediated independently of the remainder of the site. Operable unit 1 will address the groundwater contamination and operable unit 2 will be the remainder of the site.

The following comments and questions are paraphrased from the written comments that were received during the comment period or from the public meeting.

1. C: Would my well continue to be tested two seasons a year to be assured that no traces of VOC's have infiltrated my drinking water?

R: The New York State Department of Health will continue to monitor potentially affected homeowner wells on an annual basis.

2. C: If left untreated, would the groundwater contamination keep expanding?

R: The groundwater contamination is presently being contained because the groundwater is being extracted by neighboring homeowner wells, and NYSDEC does not anticipate the significant expansion of groundwater contamination. However, the NYSDEC does not consider the containment of the plume by homeowner drinking wells an acceptable remedy.

3. C: Upon review of the data, we believe that the number of wells required to remediate the site could be reduced to 2, or 3 at most.

R: As stated in the PRAP, the described groundwater pumping system is only a conceptual design. The Department agrees that the system as presented in the RI/FS is not optimal. During the design, the number, location and withdrawal rates for the wells will be reevaluated and modified as necessary to optimize the operation of the treatment system.

4. C: I wonder how this (pump and treat system) might affect the water levels of private wells in the vicinity, particularly in a dry season. Most of the local wells are shallow. Can I assume there will be little or no effect?

R: The pump and treat system should have little or no effect on neighboring homeowner wells. The low withdrawal rate (a total of approximately 25 gallons per minute for all of the extraction wells) should only affect the groundwater level slightly over a small area. This area should be reduced further by the on-site reinfiltration of a portion of this withdrawn water. Additionally, the pump test held in October 1994, withdrew 17.5 gallons per minute for 3 days without any significant impacts on any neighboring homeowner wells.

5. C: I am afraid this pumping (the pump and treatment system) will affect my well in some way, either by drying it up or making it go sulfur again?

R: The pump and treatment system should not cause your well to go dry as explained above. Similarly, the system should not cause the reappearance of sulfur in your well either.

6. C: How deep are the northern most wells?

R: Monitoring well pair 3/3S are the northern most wells at the site. They are 88 and 50 feet deep respectively.

7. C: How much were these wells impacted during the pump test (72 hour constant rate test)?

   R: Both of these were only minimally impacted by the test. The water level in these wells actually rose due to rainfall that occurred during that test.

8. C: Why wasn't a pump test performed for the southern portion of the site?

   R: A second pump test was considered; however, it was determined that the one performed was adequate to characterize the bedrock beneath the entire site.

9. C: Does the casing in the monitoring wells go all the way down to the bedrock?

   R: Yes, all of the on-site monitoring wells are cased all the way down to the bedrock.

10. C: What are the wells in the parking lot (flush mounted ones)?

    R: These are soil vapor extraction wells. They are constructed similarly to groundwater wells, but they contain no water as they do not go down into the groundwater table. They were used to extract vapors out of the ground during the soil vapor extraction treatability study, conducted in October 1994.

11. C: Which wells are of a large diameter?

    R: Monitoring well TW-1 is the only large diameter well presently at the site. It is 6 inches in diameter.

12. C: Why not use the uncontaminated wells on the site as a substitute drinking water source for the affected homeowners?

    R: The use of any monitoring wells as a drinking water well would be difficult due to their construction. Additionally, pumping these wells may draw the contamination into them. It is more practical and safer to continue to use carbon filtration units on the affected homeowner wells until the remedial action is complete.

13. C: Why not pump out of the Residence G Well?

    R: The pumping wells used in a pump and treat system are constructed differently than those used for a household. Additionally, the New York State Department of Health prefers that homeowner wells do not become part of a remedy.

14. C: How often and how long will residence G continue to be sampled?

R: The present practice of sampling residence G quarterly will continue until we have evidence clearly indicating that it can be sampled at a longer interval.

15. C: How long would it take to remediate the site if you simply bought the impacted properties since you will not be able to get all of the contamination out of the bedrock aquifer?

R: New York State law does not allow us to buy out properties unless the property is needed to physically construct a remedy. If the Residence G well was removed from service, the contamination would most likely migrate and impact the next well downgradient. Presently, the contamination is confined to a small area, and can be greatly reduced by a groundwater pump and treat system. This remediation should not only prevent the contamination from spreading, but greatly reduce the levels in the Residence G well.

16. C: Will that well (Residence G) clear up?

R: The pump and treat system is expected to greatly reduce the levels in that well. Over time, the contamination levels in this well should become non detectable.

17. C: Where were the highest concentrations of soil contamination located?

R: The highest concentrations of soil contamination were in soil borings 33, 40, 39 and 19. Soil boring 33, 40 and 39 are located just north of the manufacturing building and soil boring 19 is located near the south east corner of the concrete pad. These borings all exhibited contamination by several volatile organics, notably, trichloroethene and dichloroethene.

18. C: What is the areal (horizontal) extent of the soil contamination along the North side of the building?

R: This contamination is between the north wall of the building and the access road that circles the building.

19. C: Why were borings advanced through the concrete pad that the warehouse use to sit on?

R: These borings were advanced to confirm the geology beneath the concrete pad. These borings also allowed the sampling of these soils to assess any contamination beneath the pad. These samples showed the contamination was predominantly around the edges of the concrete pad.

20. C: Why are we reinfiltrating water in an area where we do not have any soil contamination (along the SE side of the concrete pad)?

R: The reinfiltrated water is intended to mainly flush the contamination out of the underlying bedrock. This area was chosen as the place where the small amount of reinfiltrated water would create the greatest flushing affect, considering the induced groundwater flow direction from the extraction wells and the natural groundwater flow direction in the bedrock. This location and the amount of water introduced will be reevaluated in the remedial design and modified as necessary to optimize the overall remedy.

21. C: Won't there be a certain amount of natural infiltration and flushing?

R: Yes, but the introduction of additional water should considerably speed up this natural flushing.

22. C: You are not going to cap it?

R: No, the proposed remedy did not include capping the parking area or the area of the reinfiltration gallery. The capping of the parking lot was considered in the Remedial Investigation and Feasibility Study report, but was not included in the selected remedy.

23. C: What did the magnetometer survey find?

R: The data produced by the magnetometer survey indicated 5 areas with anomalous readings. These anomalies represented locations that were likely to contain surface or subsurface metallic objects, which could have included buried drums and/or tanks. Based on this data, and visual observations, test pits were dug which revealed various subsurface metallic debris and one partially filled, intact drum. The sampling of this drum indicated that it contained no hazardous material.

24. C: What can the Department of Environmental Conservation do to prevent the subdivision or the development of the remaining acreage of the property the site is on?

R: The Department will not allow any activities on the site (15 acres of the property) that will impede the remediation of the site. However, the development of the remaining acreage of the property or the adjoining properties would fall under the jurisdiction of the Dutchess County Department of Health and the Town of Clinton Zoning Board.

25.C: How would the NYSDEC prevent such activities (that would impede the remedy), could the Department place a lien or deed restrictions on the property?

R: Unless the owner consents to a deed restriction, any legal restriction by the Department would be pursuant to court action.

26. C: What can the Department do to prevent the site owner from contaminating the site again?

R: The Department can initiate an enforcement action to stop any activities that are recontaminating the site.

27. C: What is the time frame for the completion of this remedy?

R: The Potentially Responsible Parties (PRPs) were contacted again, and asked to undertake the selected remedy. Assuming no significant delays in their acceptance, the design should begin by early summer 1995. If the PRPs are unwilling or unable to implement the remedy, the NYSDEC will start the design in the summer of 1995 using a state superfund consultant. This design would then be completed by the winter of 1995 in anticipation of starting construction in the spring of 1996.

28. C: Since the proposed remedy is so expensive, who will pay for it, and if the state pays for it, will it be funded throughout or could monies be withdrawn before completion?

R: If the PRPs are unwilling or unable to undertake the selected remedy, the funds for the selected remedy will come from the State Superfund. At this time, there is sufficient money in the Superfund to cover the anticipated cost of this project.

29. C: Will there be any cost to the local government with regards to the remedy?

R: No, there will be no costs to the local government.

30. C: The Town of Clinton, would like to be provided a copy of the DEC rules, regulations and laws pertaining to the current and future use of the property, a plate showing the identified fifteen acres of the site and the placement of markers on the boundaries of the site.

R: The NYSDEC will provide a copy of the regulations pertaining to the current and future usage of the site to the Town, as well as the local repository. Similarly, a map outlining the site boundaries will be provided. This boundary will be surveyed in and marked during the construction phase of the remediation.

31. C: Who will be the contact person for the project during the remedial design and construction?

R: Erin O'Dell-Keller, the Region 3 citizen participation specialist, will be the contact person, and will be able to direct you to the project manager. She can be reached at (914) 256-3154, or by mail at the New York State Department of Environmental Conservation, Region 3 Office, 21 South Putts Corner Road, New Paltz, NY 12561-1696.

32. C: What was the original volume of the contaminants that are now causing this groundwater contamination?

R: This is difficult to estimate due to uncertainties in the volume of groundwater in the bedrock and the possibility of highly concentrated contaminants in some of the bedrock fractures. By using engineering assumptions and mass balance equations, it is estimated that a few hundred gallons of product or waste could have caused this contamination.

33. C: What are present worth, capital costs and operation and maintenance costs?

R: Present worth is the total cost of the remedy if all future costs were discounted and paid in the present. Capital costs are costs associated with the purchase of equipment or construction of the remedy. Operation and Maintenance costs are future costs that will be paid to operate and maintain the remedy.

A number of questions and comments were raised regarding remedial alternatives (off-site land disposal and low temperature thermal desorption) for soil contamination as presented in the PRAP and the RI/FS report. Upon completion of the reevaluation of the remedial alternatives, responses to these comments will be presented in the ROD for Operable Unit 2.

APPENDIX B

Now Corporation Site
ID: 3-14-008

ADMINISTRATIVE RECORD

1. Phase I Investigation Report, Now Corporation site, Wehran Engineering, November 1983.

2. Remedial Investigation/Feasibility Study Workplan , Now Corporation site, Engineering-Science, October 1992.

3. Phase II - Remedial Investigation/Feasibility Study Workplan, Now Corporation site, Engineering-Science, July 1994.

4. Remedial Investigation/Feasibility Study Report Volume I, Now Corporation site, Engineering-Science, January 1995.

5. Remedial Investigation/Feasibility Study Report Volume II, Now Corporation site, Engineering-Science, January 1995.

6. Remedial Investigation/Feasibility Study Report Volume III, Now Corporation site, Engineering-Science, January 1995.

Appendix A3

Record of Decision – Operable Unit 2 (March 1996)

Department of Environmental Conservation

Division of Hazardous Waste Remediation

Record of Decision

Now Corporation Site
Town of Clinton, Dutchess County
Site Number 3-14-008
Operable Unit 2

March 1996

New York State Department of Environmental Conservation
GEORGE E. PATAKI, *Governor* MICHAEL D. ZAGATA, *Commissioner*

DECLARATION STATEMENT - RECORD OF DECISION

Now Corp. Inactive Hazardous Waste Site
Clinton (T), Dutchess County, New York
Site No. 3-14-008
Operable Unit 2

Statement of Purpose and Basis

The Record of Decision (ROD) presents the selected remedial action for the Now Corp. inactive hazardous waste disposal site which was chosen in accordance with the New York State Environmental Conservation Law (ECL). The remedial program selected is not inconsistent with the National Oil and Hazardous Substance Pollution Contingency Plan of March 8, 1990 (40CFR300).

This decision is based upon the Administrative Record of the New York State Department of Environmental Conservation (NYSDEC) for the Now Corp. inactive hazardous waste site and upon public input to the November, 1995, Proposed Remedial Action Plan (PRAP) presented to the public by the NYSDEC on Janurary 11, 1996. A bibliography of the documents included as a part of the Administrative Record is included in Appendix B of the ROD.

Assessment of the Site

Actual or threatened release of hazardous waste constituents from this site, if not addressed by implementing the response action selected in this ROD, presents a current or potential threat to public health and the environment.

Description of Selected Remedy

Based upon the results of the Remedial Investigation and Feasiblity Study (RI/FS) for the Now Corp. site and the criteria identified for evaluation of alternatives, the NYSDEC has selected to complete the remediation of this site with a limited soil removal and the on site treatment of these soils. The components of this remedy are as follows:

- The excavation and on site treatment of soils with over 700 ppb of trichloroethene, located near the northeast corner of the building (area A), along the drainage ditch near the northern corner of the building (area B), and the south corner of the concrete pad (area C).

- The excavation and on site treatment of the weathered bedrock with over 700 ppb of trichloroethene, located near the northeast corner of the building (area A), and along the drainage ditch near the northern corner of the building (area B).

- The on site treatment of these soils and weathered bedrock by a low temperature thermal desorption unit or a comparable technology.

New York State Department of Health Acceptance

The New York State Department of Health (NYSDOH) concurs with the remedy selected for this site as being protective of human health.

Declaration

The selected remedy is protective of human health and the environment, is designed to comply with State and Federal requirements that are legally applicable or relevant and appropriate to the remedial action to the extent practicable, and is cost effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable, and satisfies the preference for remedies that reduce the toxicity, mobility, or volume of the wastes.

3/29/94
Date

Michael J. O'Toole, Jr., Director
Division of Hazardous Waste Remediation

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RECORD OF DECISION

"Now Corporation Site"
Clinton, Dutchess County, New York
Site No. 3-14-008
Operable Unit 2
March, 1996

SECTION 1: SITE LOCATION AND DESCRIPTION

The Now Corporation site consists of the developed portion of a 94.5 acre parcel of property owned by Mr. Robert Fried in the Town of Clinton, Dutchess County (see Figure 1). This developed portion of the property consists of approximately 15 acres along Route 9G. It contains one industrial building and an adjacent concrete pad where a warehouse destroyed by fire in 1989, once stood. This portion of the property, "the site", is bordered by route 9G and residential homes on the north-northwest and an inactive sand and gravel pit on the south. The east and west sides are bound by overgrown fields and woods.

The site is geographically located within the upland section of the Appalachian Highlands. Valley and ridge topography is the dominant feature in this region, with the valleys being deeply incised bedrock which have been filled with thick alluvial and glacial deposits. Typical among these deposits are clays, silts, gravels and till. These deposits tend to form gently sloping floors with steep, to moderately steep ridges along the valley walls. Along these valley walls bedrock outcrops are common, whereas the depth to bedrock along the centers of the valleys may be greater than 100 feet.

The bedrock in this region is typically shale, which has undergone extensive folding and fracturing. These fractures typically dip steeply and strike to the northeast. Regionally groundwater flows toward the Hudson River. However, local flow is controlled by the fracturing.

The Now Corporation site is located on the eastern edge of a valley. The bedrock is found at the surface to approximately thirty-five feet below grade. The bedrock is a shale which is partially covered by till, sand and gravel. Groundwater flow occurs at the site along preferential fracturing on a northeast-southwest trend. These conditions are consistent with the known regional conditions.

The groundwater flow in the bedrock aquifer is the primary source of drinking water in the area.

SECTION 2: SITE HISTORY

2.1: Operational/Disposal History

The property was purchased by Mr. Robert Fried in August 1957. Since the early 1960s, various businesses have operated on the site including: Modern Machine and Tools (1961-1971), Virginia Chemicals, Inc. (1969-1977, bought out by Hoechst Celanese in 1981), Now Corporation (1970s and 1980s), Now Plastics (1982-1988 according to Mr. Fried), K&K Carpet, Tiffany Marble of New York, South American Development Corporation, and B&R Specialties, Inc. (current tenant).

The first investigation of the site, in 1975, consisted of the sampling of an on-site well by the Dutchess County Health Department (DCHD). The samples collected were analyzed for metals and general water chemistry parameters only. Sample results showed only manganese at levels exceeding the State Sanitary Code. This manganese is naturally present in the groundwater due to the surrounding soils.

The site was added to the registry in December, 1983, as a class 2a site due to allegations of on-site disposal of tank rinsing solutions.

A Phase I investigation was conducted in 1983 by NYSDEC. This Phase I investigation attempted to establish a Hazard Ranking Score (HRS) to better evaluate the site. A Phase II investigation was recommended to complete the HRS accurately, since the Phase I investigation did not include any groundwater, soil or air sampling.

In February, 1989, following a fire in the warehouse, samples of runoff water and water from three nearby homeowner wells were collected. The runoff water contained low levels of benzene, toluene, ethylbenzene, trichloroethene and 1,1,1-trichloroethane.

In this initial sampling no volatile organic compounds were detected in the nearby homeowner wells. However, follow up sampling in April, 1989, detected the presence of several VOCs in two residential wells. From 1989, to the present, one of these wells has consistently shown contamination with VOCs.

In October 1989, the department began sending bottled water to residences G and I (see Figure 2). In February 1990, granular activated carbon systems were installed on their water systems.

In August 1990, the NYSDEC reclassified this site to a class 2. A class 2 site presents a significant threat to public health and/or the environment. In July 1992, a work assignment was issued to perform a Remedial Investigation and Feasibility Study (RI/FS) under the State Superfund Program.

In April, 1994 a granulated activated carbon system was also installed on residence K.

SECTION 3: CURRENT STATUS

The NYSDEC, under the State Superfund Program, has conducted a Remedial Investigation/ Feasibility Study (RI/FS) to address the contamination at the site. The NYSDEC presented a Proposed Remedial Action Plan (PRAP) to the public at a January 11, 1996 meeting. The PRAP outlined the remedy the NYSDEC proposed for on site soil contamination at the Now Corporation Site. This contamination has been designated Operable Unit 2 of the site.

This operable unit was created in response to public comments on the PRAP that was originally presented to the public. That PRAP, dated February 15, 1995, dealt with both the groundwater and on site soil contamination related to the site. During the public comment period on that plan, significant concern was raised regarding the appropriateness of the recommended soil remedy. To properly reevaluate the soil remedy without delaying the remediation of the contaminated groundwater, a Record of Decision (ROD) for the groundwater contamination (Operable Unit 1) was issued in March 1995. The Remedial Design for the groundwater remedy is on-going and expected to be completed in the spring of 1996.

3.1: Summary of the Remedial Investigation

The purpose of the RI was to define the nature and extent of any contamination resulting from previous activities at the site.

The RI was conducted in two phases. The first phase was conducted between July 1992 and April 1994, the second phase between April 1994 and January 1995. A report entitled Draft Final RI/FS Report, January 1995, has been prepared detailing the field activities and findings of the RI.

The first phase of the RI activities consisted of the following:

- Review of historical documents and aerial photographs, to determine potential disposal areas on and near the site.
- A magnetic survey was conducted in the area of alleged waste disposal. This survey was intended to determine the potential for buried drums and/or tanks which may contain waste in this area.
- A site wide soil gas survey was conducted at 145 locations. These locations were selected near and downgradient of suspected source areas to identify areas of soil and possibly groundwater contamination. See attached Figure 3.
- Six test pits were completed to investigate anomalies detected during the soil gas and magnetometer surveys. Composite soil samples were taken in conjunction with these test pits to better define any contamination present in these areas. See attached Figure 4.
- Soil borings were also installed to collect subsurface soils for chemical analysis. Please refer back to Figure 4.
- Fifteen groundwater monitoring wells were installed to determine the chemical analysis of groundwater, as well as the physical properties of on site hydrogeologic conditions.
- The sampling of several nearby homeowner wells to determine the presence and levels of groundwater contamination off-site.
- Surface water and surface soil sampling were also performed to define the condition of on-site surface soils and intermittent water.
- Surface water and sediment samples were taken from Crum Elbow Creek, to further assess the possibility of any impact on this water body by the NOW Corporation site.

After a preliminary assessment of the first phase RI results, a second phase was conducted to gather information necessary to develop remedial alternatives.

During the second phase of the RI, the following additional work was performed:

- A treatability study was performed. This study was to determine how successful a pump and treat groundwater system would be at remediating the contamination in the fractured bedrock beneath the site. This study included the implementation of a treatment utilizing granulated activated carbon on a small scale to determine its effectiveness so that the appropriate size and cost of the equipment to remediate the entire site by this method could be established. A pumping well and five observation wells on the ridge to the north of the industrial building were also installed.

- A separate treatability study was performed to determine how effective a soil vapor extraction system would be at treating the subsurface soil contamination in the parking lot area of the site.

Additionally, sixteen soil samples were taken in June 1995, to better delineate the areas of soil contamination detected in the RI investigation.

The analytical data obtained from the RI and subsequent sampling were compared to applicable Standards, Criteria, and Guidance (SCGs) in determining remedial alternatives. Groundwater, drinking water and surface water SCGs identified for the Now Corporation site were based on NYSDEC Ambient Water Quality Standards and Guidance Values and Part V of NYS Sanitary Code.

Based upon the results of the remedial investigation in comparison to the SGGs and potential public health and environmental exposure routes, it was determined that in addition to the groundwater, certain on site soils also require remediation.

ON SITE SOILS

The remedial investigation revealed that in certain areas of the site there are soils contaminated by chlorinated compounds. Notable of these chlorinated compounds are trichloroethene (TCE) and 1,2 dichloroethene (DCE). Generally, this soil contamination is present in four areas. These areas are shown on Figure 5.

Two of these areas are located along the northern side of the present industrial building, between the building's wall and the access road. During the RI investigation there were two "hot spots" detected in this area, one located near the building's northern corner and another near the building's northeastern corner. Samples from soil boring SB-33 contained 78,000 (ppb) of TCE and 400 ppb of 1,2 dichloroethene, soil boring SB-39 contained 32,000 ppb of TCE, and SB-40 contained 40,000 ppb of TCE. All of these values exceed DHWR guidance cleanup objectives of 700 ppb for TCE and 300 ppb for 1,2 DCE. However, based on field observations, the contamination was believed to exist not only in these locations but throughout this general area and to extend into the underlying weathered bedrock. The bedrock throughout this area is very shallow and weathered, very loose and easily broken up. During the RI investigation this zone was reported to have a strong solvent odor, but could not be analyzed because of its nature.

To better determine the extent of the contamination through this area, additional samples were taken in June, 1995. The locations and results of these samples are shown on Figure 5, along with those from the RI, and indicate that the contamination is confined to two distinct locations in this area. The first is near the northeast corner of the building and includes samples SB-33, SB-39, SB-53, SB-54 and SB-52. This area is outlined on Figure 5 and labeled area A. Sample SB-53 contained 25,000 ppb of TCE and 1,200 ppb of Cis-1,2-dichloroethene (Cis-1,2-DCE), SB-54 contained 22,000 ppb of TCE and SB-52 contained 2,200 ppb of TCE.

The second area is along the drainage ditch near the northern corner of the building. This area is labeled area B on Figure 5 and includes samples SB-40 and SB-60. Sample SB-60 contained 6,200 ppb of TCE.

All of these values exceeded DHWR guidance cleanup objectives of 700 ppb for TCE and 250 ppb for Cis-1, 2-DCE.

This additional fieldwork also included the sampling of the underlying weathered bedrock. This sampling found that the contamination was greater in the overlying surface soils than in the weathered bedrock. However, it is believed that in some places the weathered bedrock underlying areas A and B, has contamination above standards, i.e. SB-52 with 2,200 ppb of TCE.

The third area is located near the south corner of the concrete pad around soil boring SB-19. This area is labeled area C and is also shown on Figure 5. The TCE concentration in soil boring SB-19 was 32,000 ppb, which greatly exceeds the soil cleanup objective of 700 ppb. The contamination in this area was and still is believed to be localized around SB-19, as none of the adjacent borings taken during the RI investigation or in June, 1995, showed significant contamination. Furthermore, these additional samples showed that the levels in the underlying bedrock were significantly lower than those present in the overlying surface soils. The weathered shale bedrock is very clayey and would be expected to retain a significant portion of the contamination as it migrates downward. However, the weathered bedrock interface here was dessicated and has been disturbed.

The fourth area is located between the loading docks of the current industrial building and the concrete pad, and extends west into the parking lot. During the RI investigation the concentration of 1,2 DCE in Test Pit 5 was 750 ppb and xylene in soil boring SB-16 was 1,300 ppb. These levels slightly exceed the DHWR guidance levels of 300 ppb and 1200 ppb, respectively. The soils in the parking lot ranged from 0.5 to 1,200 ppb for total VOCs, with an average concentration of 310 ppb, excluding SB-16. No additional sampling was done in this area in June, 1995.

The contamination in the parking lot appears to be limited to a depth of 5 feet or less below grade, except in the area of SB-16. Soil sampling also detected the presence of benzene, ethylbenzene and toluene in this area suggesting that reported underground fuel oil tanks in this area may be leaking or were involved in overfills, leaks and spills in the past. Five tanks, in this area, are believed to have been excavated by the site owner Mr. Fried. However, the complete details of this action have not been verified.

The soil contamination appears to be limited to these four areas. The source(s) of the VOC contamination are believed to be related to the disposal of chlorinated organic compounds in limited areas and possibly disposal into sinks and drains which subsequently drained to the leachfield located under the main parking lot (area D). Another likely source of the contamination may have been the warehouse where the chemicals were stored. During the fire, chemicals were released and washed into the soil. The contamination in the soils has migrated into the groundwater found in the fractured bedrock beneath the site. It is believed that precipitation infiltrating through the overlying unsaturated and unconsolidated soils has carried the contaminants with it. This migration could also be occurring by means of the on-site septic system that is near or in direct contact with the bedrock.

Treatability Study

Based on this information, a treatability study was performed to determine the effectiveness of a soil vapor extraction system (SVE) to remove the contamination in the parking lot area (area D). This technology was not considered for remediating the soils in areas A, B and C due to their shallow depth to bedrock and fine grained nature. During the test, the levels of oxygen (O_2), carbon dioxide (CO_2) and total volatile hydrocarbons (TVH) were monitored in the vapor extraction well and several surrounding monitoring points. The O_2 concentration levels showed significant increases during the test. Subsequently, the CO_2 levels showed significant increases too. These results, combined with a steady decline in the TVH levels in the extraction well (from 94 ppm to 37 ppm) throughout the test indicate that volatization and aerobic biodegradation of the VOCs were occurring. The effective radius of the SVE system during this study was estimated to be 65 feet.

One week after the test, the system was turned on again. Additional soil gas samples were immediately taken and retaken after the system was allowed to run an additional 3.5 hours. The first sample, when the system was turned on, contained 6 ppm, and the second sample contained 42 ppm of total volatile organics. The increase is due to the influx of soil gas from less remediated soils around the wells. The results of these samples, showed that the soil gas concentrations had returned to a high level, but had not reached the concentrations that were present before the initial SVE test.

This study indicates that the use of a soil vapor extraction system in area D would be affective in removing the contaminants from these soils. However, it was determined that the marginal increase in the overall remediation of the site would not warrant the expenditure of additional efforts on this area.

3.2 Interim Remedial Measures:

An Interim Remedial Measure (IRM) is implemented when a source of contamination or an exposure pathway can be effectively addressed before completion of the RI/FS. A direct pathway of exposure was established between contaminated groundwater from the site and the impacted homeowner wells. Based on this finding, an IRM was implemented at the site.

Carbon filtration units were installed on three private wells at residences G, I and K to prevent exposure to the contaminated groundwater (See Figure 2). Bottled water has also been provided to residence G, F, B and the Route 9G Garden Center. The Garden Center only uses its well seasonally for irrigation purposes. Residence G is on a carbon filtration unit, but due to the high levels of contaminants in their well, they have experienced breakthrough on occasion. The carbon filtration unit at residence K was subsequently removed at the request of the owner. Responsibility for the carbon filtration unit at residence I was turned over to Mr. Fried in August of 1991, as this well was no longer showing contamination. Bottled water is being provided to residences B and F due to recent increases of contaminant levels in their wells.

3.3 Summary of Human Exposure Pathways:

Based on the results of the remedial investigation, an evaluation of this site's impact on human health was performed. This evaluation, referred to as the baseline risk assessment in the RI/FS report, reached the following conclusion: that noncarcinogenic (systematic) and carcinogenic health effects may impact both current and hypothetical future residents.

In the human health evaluation (HHE), the likelihood of noncarcinogenic effects is indicated by the hazard index, while the risk of carcinogenic effects is presented as a probability. A hazard index greater than one indicates that adverse noncarcinogenic effects may occur. A risk greater than the New York State Department of Health's remediation risk goal of 1×10^{-6} indicates that there is an unacceptable excess risk of carcinogenic effects.

For current residents, the noncarcinogenic hazard index ranges from 0.4 to 2. For hypothetical future residents, the hazard index ranges from 4 to 14. The elevated hazard indices are primarily due to the presence of arsenic, chromium, and manganese in soil, and manganese in groundwater. It should be noted, however, that the presence of these metals is not considered to be a result of hazardous waste disposal. The increased levels of manganese in groundwater can be explained by the high natural ranges of this metal in soils and variations in bedrock mineralogy in the area.

For carcinogenic effects, the risks for the current residents ranged from 5×10^{-6} to 2×10^{-5}. Current exposures to the contaminated groundwater were not considered in this risk evaluation as they are presently prevented through the use of carbon filtration units. For hypothetical future residents, the risks ranged from 4×10^{-5} to 2×10^{-4}.

Risks for all receptor groups exceeded the NYSDOH remediation risk goal of 1×10^{-6}. The increased risk to these receptors is primarily due to the presence of 1,2 dichloroethene and trichloroethene in the groundwater and on site soils.

The fact that carcinogenic risk exceeds the DOH goal of 1×10^{-6} denotes an increased cancer risk of one in a million and indicates that remediation is warranted to protect current and future residents.

3.4 Summary of Environmental Exposure Pathways:

Adverse ecological effects as a result of exposure of biota to contaminants at the site are minimal.

SECTION 4: ENFORCEMENT STATUS

The Potential Responsible Parties (PRP) for the site include:

Robert P. Fried
Hollow Road
Straatsburg, N.Y. 12580

Hoescht/Celanese Corp.
Route 202-206
P.O. Box 2500
Sommerville, N.J. 08876-1258

The PRPs failed to implement the RI/FS at the site when requested by the NYSDEC. This work was then performed under the State Superfund Program. The PRPs were requested to implement the remedial design for the site prior to the designation of these operable units. They declined to undertake this responsibility, but they are still subject to legal actions by the State for the recovery of all of the costs the State has incurred.

SECTION 5: SUMMARY OF THE REMEDIATION GOALS

Goals for the remedial program have been established through the remedy selection process stated in 6NYCRR 375-1.10. These goals are established under the guideline of meeting all standards, criteria, and guidances (SCGs) for protecting human health and the environment.

The remedy selected should eliminate or mitigate all significant threats to public health and the environment presented by the hazardous waste disposed of at the site through the proper application of scientific and engineering principles.

The goals selected for this operable unit are:

- *Reduce or eliminate the volume of contaminated soil at the site, in order to reduce or eliminate any additional exposure to the public health.*

- *Eliminate the long term migration of contaminants into the groundwater.*

Groundwater remediation for the site will be based on the effectiveness of the selected groundwater pump and treat system. This system will be operated until it no longer significantly reduces the contaminant levels in the groundwater or it meets the New York State groundwater standards Although this groundwater remediation will address the primary threat to the public health and the environment, the levels of contamination in the soils warrants remediation as well. Not only are the levels high enough to be a risk to public health and the environment, but they will also act as a continuing source of contamination that would impede groundwater remediation.

SECTION 6: SUMMARY OF THE EVALUATION OF ALTERNATIVES

Upon review of the comments received at the meeting and in correspondence during the associated comment period for the original PRAP (dated February 15, 1995), it was discovered that the off-site disposal costs for the contaminated soil was significantly under-estimated and would no longer be cost effective. Hence, the NYSDEC decided to reevaluate the remedial alternatives for the contaminated soil at the site.

A summary of the detailed analysis of the alternatives for Operable Unit 2 is presented below.

6.1: Description of Alternatives

The following alternatives are intended to address the contaminated soil on the site and to prevent the further migration of contaminants from the soil into the groundwater.

Present worth values for these alternatives are the same as capital costs since no annual operation and maintenance cost will be necessary. O&M cost is already included in the selected remedy for OU1, groundwater remediation.

Alternative 1: No Further Action

Present Worth:	$	0
Capital Cost:		0
Annual O & M:	$	0
Time to Implement:		

The no further action alternative for soil contamination is evaluated as a procedural requirement and as a basis for comparison to other actions. This alternative recognizes that carbon filtration units have been installed on impacted homeowner wells and groundwater will be remediated as outlined in the ROD for Operable Unit O1. It only requires continued monitoring of the groundwater. The result of no cost for this alternative assumes that the annual cost of $22,000 dollars for the groundwater monitoring would be funded by Operable Unit 01.

Alternative 2- Limited Removal and Disposal of Contaminated Areas A, B and C

Present Worth:	$	258,000
Capital Cost:	$	258,000
Annual O&M:	$	0,000
Time to Implement:		4 Months

This plan would consider the contamination to the north and east of the building as two distinct areas. The first area, area A, is located near the northeastern corner of the building. This area includes sampling locations SB-33, SB-39, SB-53, SB-54 and SB-52. This area is outlined on Figure 5. The second area, area B, is along the drainage ditch near the northern corner of the building. This area is also included on Figure 5 and includes sampling points SB-40 and SB-60. This alternative would require the top 2 feet of contaminated soil throughout these designated areas to be excavated and disposed of off site. The highly contaminated soil near the south corner of the concrete pad, area C, would be excavated as well. The soil would be excavated for a ten foot radius around sampling point SB-19, and to a depth of 2 feet.

The contaminated soil from these three areas would then be sampled and disposed of at an appropriate facility. Based on samples taken previously, it is anticipated that the excavated soil (263 cubic yards) would be disposed of off site at a permitted hazardous waste landfill.

It would be the goal of this removal to remove all of the soils that contain 700 ppb or more of trichloroethylene from the top 2 feet in areas A, B and C. Confirmatory samples would be taken to insure the effectiveness of this removal. These excavations would then be backfilled with clean soil.

Alternative 3 - Removal and Disposal of Hot Spot Areas A, B and C

Present Worth:	$	450,000
Capital Cost:	$	450,000
Annual O&M:	$	0,000
Time to Implement:		4 Months

This plan would consider the contamination to the north and east of the building as two distinct areas of contamination . The first area, area A, is located near the north eastern corner of the building. This area includes sampling locations SB-33, SB-39, SB-53, SB-54 and SB-52. This area is outlined on Figure 5. The second area, area B, is along the drainage ditch near the northern corner of the building. This area is also included on Figure 5 and includes sampling points SB-40 and SB-60. This alternative would require the contaminated soil throughout these designated areas to be excavated and disposed of off site. The areas to be excavated are those areas that contain over 700 ppb of trichloroethene. These areas are expected to be excavated to the weathered bedrock. It is estimated that the weathered bedrock is at three feet below the surface for area A and four and a half feet below the surface for area B.

The highly contaminated soil near the south corner of the concrete pad, area C, would be excavated as well. The soil would be excavated for a ten foot radius around sampling point SB-19, and is expected to proceed down to the bedrock which is located at approximately four feet below the surface.

The contaminated soil from these three areas would then be sampled and disposed of at an appropriate facility. Based on samples taken previously, it is anticipated that the excavated soil (492 cubic yards) would be disposed of off site at a permitted hazardous waste landfill.

Post excavation samples would also be taken to assess the remediation's achievement of the goal of removing all of the soils with 700 ppb or more of trichloroethene.

<u>Alternative 4 - Removal and Disposal of Contaminated Soil and Underlying Weathered Bedrock in Areas A, B and C</u>

Present Worth:	$ 687,000
Capital Cost:	$ 687,000
Annual O&M:	$ 0,000
Time to Implement:	4 Months

This alternative is the same as alternative 3 except that the top 2 feet of the underlying weathered bedrock would also be removed. This would assure the removal and treatment of all of the heavily contaminated soils and weathered bedrock. It is anticipated that about 752 cubic yards of contaminated soil and weathered bedrock would be disposed of at a hazardous waste disposal facility.

Post excavation samples would also be taken to assess the remediation's achievement of the goal of removing all of the soils and weathered bedrock with 700 ppb or more of trichloroethene.

<u>Alternative 5 - Excavation and Removal of All of the soil along the northeast side of the Building and Area C</u>

Present Worth:	$ 1,250,000
Capital Cost:	$ 1,250,000
Annual O&M:	$ 0,000
Time to Implement:	4 Months

This alternative would excavate and dispose of the soils between the access road to the north of the building and the building's north wall. These areas would be excavated to the weathered bedrock. It is estimated that the depth to bedrock ranges from 2 to 4 feet throughout this area.

The remaining soil contamination near the south corner of the concrete pad would be excavated as well. However, this contamination would be treated as an isolated area. The soil would be excavated for a ten foot radius around sampling point SB-19, and would proceed down to the bedrock. The bedrock is anticipated to be approximately four feet below the surface.

The contaminated soil from these three areas would then be sampled and disposed of at an appropriate facility. Based on samples taken previously, it is anticipated that the excavated soil (1,380 cubic yards cy) would be disposed of off site at a permitted hazardous waste landfill.

Post excavation samples would also be taken to assess the remediation's achievement of the goal of removing all of the soils with 700 ppb or more of trichloroethene.

Alternative 6 - Excavation and On Site Treatment of Contaminated Soil and Underlying Weathered Bedrock in Areas A,B and C

Present Worth:	$ 339,000
Capital Cost:	$ 339,000
Annual O&M:	$ 0,000
Time to Implement:	7 Months

This alternative would treat the soils to the north and east of the building as two distinct areas of contamination. These areas are the same as those shown on Figure 5, for alternative 4. However, these soils would be treated on site by low temperature thermal desorption or a comparable technology. These treated soils and weathered bedrock would then be returned to the excavated areas.

The remaining contaminated soil near the south corner of the concrete pad would be excavated and treated on site as well. However, this contamination would be treated as an isolated area. The soil would be excavated for a ten foot radius around sampling point SB-19, and is expected to proceed down to the bedrock. The bedrock is anticipated to be approximately four feet below the surface.

It is estimated that approximately 492 cubic yards of contaminated soil and 260 cubic yards of weathered bedrock would be excavated and treated by this alternative.

Confirmatory samples would be taken from both the bottom of the excavations and the soils passing through the treatment process to assure the effectiveness of the remedy. This effectiveness would be evaluated in comparison to the remediation's goal of eliminating all of the soils contaminated with 700 ppb or more of TCE.

6.2 Evaluation of Remedial Alternatives

The criteria used to compare the remedial alternatives are defined in the regulation that directs the remediation of inactive hazardous waste sites in New York State (6NYCRR Part 375). For each of the criteria, a brief description is provided followed by an evaluation of the alternatives against that criterion. A detailed discussion of the evaluation criteria and comparative analysis is contained in the Feasibility Study.

The first two evaluation criteria are termed threshold criteria and must be satisfied in order for an alternative to be considered for selection.

1. Compliance with New York State Standards, Criteria, and Guidance (SCGs). Compliance with SCGs addresses whether or not a remedy would meet applicable environmental laws, regulations, standards, and guidance.

The no further action alternative 1, would not comply with New York State SCGs, primarily due to the continuing exceedances for trichloroethene in on site soils. Current guidelines recommend 700 ppb as an acceptable level. Presently, there are levels up to 78,000 ppb on the site.

Alternative 2 would remove some of the TCE contamination, but would leave some of the contaminated soils untreated along the northern wall of the industrial building. These soils would not meet NYSDEC chemical specific SCGs for soils. Alternatives 3, 4, 5 and 6 would eliminate all of the soils contaminated with TCE in excess of NYSDEC SCGs.

However, only alternatives 4 and 6 would significantly affect the contamination within the weathered bedrock zone underlying these soils.

All of the alternatives would leave some soils that slightly exceed NYSDEC soil cleanup criteria for xylene and 1,2 DCE in the parking lot area.

2. Protection of Human Health and the Environment. This criterion is an overall evaluation of the health and environmental impacts to assess whether each alternative is protective of these charges.

Alternative 1 would not be protective of human health and the environment. This is due to the continuing exceedances of soil guidelines for VOCs in the soils on site. These contaminants, especially TCE, are present at levels high enough to not only pose a risk to the public health and the environment, but would also act as a continuing source of groundwater contamination and impede the remediation of the groundwater to levels protective of public health and the environment. Alternatives 2, 3, 4, 5 and 6 would all reduce these risks to different extents. Alternatives 3, 4, 5 and 6 would be protective of human health and the environment.

The next five "primary balancing criteria" are used to compare the positive and negative aspects of each of the remedial alternatives.

3. Short-term Impacts and Effectiveness. The potential short-term adverse impacts of the remedial action upon the community, the workers, and the environment during the construction and implementation are evaluated. The length of time needed to achieve the remedial objectives is also estimated and compared with the other alternatives.

Alternative 1 would pose no additional adverse impacts. Construction activities for alternative 2, 3, 4, 5, and 6 all include soil excavation to different extents. This should not pose a significant risk to the community or workers as long as action-specific SCGs for these activities are adhered to. Air monitoring would be performed to ensure that dust and/or VOCs would not cause a risk to residents or workers in the on-site building. Additionally, access limitations, protective clothing, monitoring equipment and decontamination procedures would be used in accordance with the site Health and Safety Plan.

Impacts to the environment would consist of the potential for contaminated soil or runoff to reach Crum Elbow Creek. Plans for controlling soil erosion and runoff from site construction activities would be prepared as part of the remedial design activities.

4. Long-term Effectiveness and Permanence. This criterion evaluates the long-term effectiveness of alternatives after implementation of the response actions. If wastes or treated residuals remain on site after the remedy has been implemented, the following items are evaluated: 1) the magnitude of the remaining risks, 2) the adequacy of the controls intended to limit the risk, and 3) the reliability of these controls.

Alternative 2, 3, 4, 5, and 6 would all permanently remove the TCE contamination from the site soils. However, each alternative would remove a different amount of this contamination. Alternative 2 would leave some of the TCE contaminated soils in place. Alternative 3 and 5 would remove all the TCE soil contamination above TAGM clean-up levels and alternatives 4, and 6 would remove all of the TCE contaminated soil above TAGM clean-up levels and mitigate contamination in the bedrock. A remedial program that eliminates the risk posed to the environment and the public health from the surface soils, and balances the amount of sub surface contamination left in place against the groundwater remedial program is appropriate. Alternatives 4 and 6 best fit this criteria, as they would remediate all of the highly contaminated soils and weathered bedrock and would allow the groundwater remedy to focus on the contamination already present in the acquifer.

5. Reduction of Toxicity, Mobility or Volume

Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility or volume of the wastes at the site.

Alternative 1 would not reduce the toxicity, mobility or volume of the wastes in the soil.

Alternatives 2, 3, 4, 5 and 6 would permanently reduce the volume and toxicity of the contamination at the site.

6. Implementability. The technical and administrative feasibility of implementing each alternative is evaluated. Technically, this includes the difficulties associated with the construction, and the ability to monitor the effectiveness of the remedy. Administratively, the availability of the necessary personnel, equipment, and material is evaluated along with potential difficulties in obtaining specific operating approvals.

All of the alternatives considered for this site are implementable.

Alternative 1 would only require annual sampling to monitor the site's condition and personnel to maintain the necessary site restrictions. The materials and personnel for these tasks would be readily available.

Alternatives 2, 3, 4, 5 and 6 would require excavations which can be performed by conventional earth moving equipment which should be readily available in this area. Some difficulty would be encountered in the excavation of soils along the northeastern corner of the industrial building due to the presence of power lines. However, the rerouting of these lines is not anticipated to be difficult.

Alternative 6 would also implement a proven technology, low temperature thermal desorption. However, the availability of this technology for this relatively small volume of soil is limited and hence, the use of a comparable technology may be necessary.

7. Cost. Capital, and operation and maintenance costs are estimated for each alternative and are compared on a present worth basis. Although cost is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the remaining criteria, cost effectiveness can be used as the basis for the final decision.

The present worth cost of the no further action, Aternative 1, is $0. The annual cost of $22,000 for groundwater monitoring is already included in the costs for Operable Unit 1.

Alternative 2 is the least costly alternative at $258,000. This alternative is followed by Alternate 3 at $450,000, Alternative 4 at $687,000, and alternative 5 at $1,250,000. These alternatives increase in cost as the volume of soil removed from the site increases. Alternative 6 would be $339,000, which would only surpass alternatives 1 and 2 in cost.

8. Community Assessment - Concerns of the community regarding the PRAP were evaluated. A responsive summary describing these concerns and detailing how the

Department addressed or will address these concerns is attached as Appendix A.

The remedy contained in this Record of Decision (ROD) is identical to the remedy in the Proposed Remedial Action Plan (PRAP) presented to the public on January 11, 1996.

SECTION 7: SUMMARY OF THE SELECTED REMEDY

Based upon the results of the RI/FS and the evaluation presented in Section 6, the NYSDEC is selecting Alternative 6, as the remedy for the on site soil contamination, operable unit 2.

Alternatives 1 and 2 were undesirable as human health and the environment would not be adequately protected. Additionally, they would leave contamination in place that would hinder the remediation of the site's groundwater.

Alternatives 3, 4, 5, and 6 were all protective of human health and the environment. However, Alternative 6 is the only one that will permanently reduce the volume and toxicity of the contamination by treatment. Alternative 6 was also the most cost effective of these four remedies. These benefits outweigh the slightly longer time that will be required to implement this remedy instead of the others. Hence, Alternative 6 presents the best remedy for the site.

The estimated present worth cost to implement the selected remedy is $339,000. The cost to construct the remedy, capital cost, accounts for the entire amount as no annual operation and maintenance will be necessary. The time to implement this remedy is estimated to be 7 months.

The major elements of the selected remedy are:

- The excavation and on site treatment of soils with over 700 ppb of trichloroethene, located near the northeast corner of the building (area A), along the drainage ditch near the northern corner of the building (area B), and the south corner of the concrete pad (area C).

- The excavation and on site treatment of the weathered bedrock with over 700 ppb of trichloroethene, located near the northeast corner of the building (area A), and along the drainage ditch near the northern corner of the building (area B).

- The on site treatment of these soils and the weathered bedrock by low temperature thermal desorption or a comparable technology.

During the remedial design, the availability of a low temperature thermal desorption unit will be reassessed. Should this technology or a comparable technology prove to be unavailable, or there is a lack of competitive bids for the construction of the remedy, Alternative 4 will become the remedy. Alternative 4 is the removal and off site disposal of the soil and weathered bedrock in areas A, B and soil only in area C.

Table 1
Summary of Contaminants in Areas A, B, C, and D

Area	Sampling Point	Sample Depth (feet)	Bedrock Depth (feet)	Contaminants of Concern (ug/kg)				
				PCE	TCE	1,1,1 TCA	1,2 DCE	Acetone
AREA A	SB-33	0.5	2	4 J	78000 D	11 U	130	11 U
	SB-39	2 - 0	2	80 J	32000	15 U	47	85
	SB-52	1.8	1.8	5 U	2200	35	8	5 U
	SB-53	1.2	>1.4	5 U	25000	5 U	1200	5 U
	SB-54	1.8	>2	5 U	22000	5 U	60	5 U
AREA B	SB-40	0 - 2	2	370 J	40000	1500 U	210 J	1500 U
	SB-60	1	>1	5 U	6200	5 U	5 U	5 U
AREA C	SB-19	2.5	4	53 U	32000	17 J	53 U	53 U
AREA D	SB-1	6	>6	11 U	3 J	11 U	160	58
	SB-2	6.5	>10	11 U	1 J	11 U	32	18
	SB-4	2.5	>10	11 U	10 J	11 U	11 U	11 U
	SB-9	0 - 4.5	>6	12 U	10 J	12 U	1 J	12 U
	SB-10	0 - 4.5	>6	11 U	4 J	11 U	11 U	11 U
	SB-16	8.5	>10	11 U	1 J	11 U	21	97
	SB-24	4.5	8	1 J	12	12 U	5 J	120
	TP-5	4-7	>17	11 U	130	1 J	750 D	55 J

NOTES:

Numbers in bold indicate an exceedance of the recommended soil cleanup objective for this compound.

J	indicates that this is an estimated value.
D	indicates that this value was obtained on a diluted analysis.
U	indicates that this chemical was not detected above the indicated level.
PCE	Tetrachloroethene, recommeded soil cleaup level is 1,400 ppb.
TCE	Trichloroethene, recommeded soil cleaup level is 700 ppb.
1,1,1 TCA	1,1,1 Trichloroethane, recommeded soil cleaup level is 800 ppb.
1,2 DCE	Total 1,2 Dichloroethene, recommeded soil cleaup level is 250 ppb for cis and 300 ppb for trans 1,2 Dichloroethene. Table exceednances are based on the isomer levels.

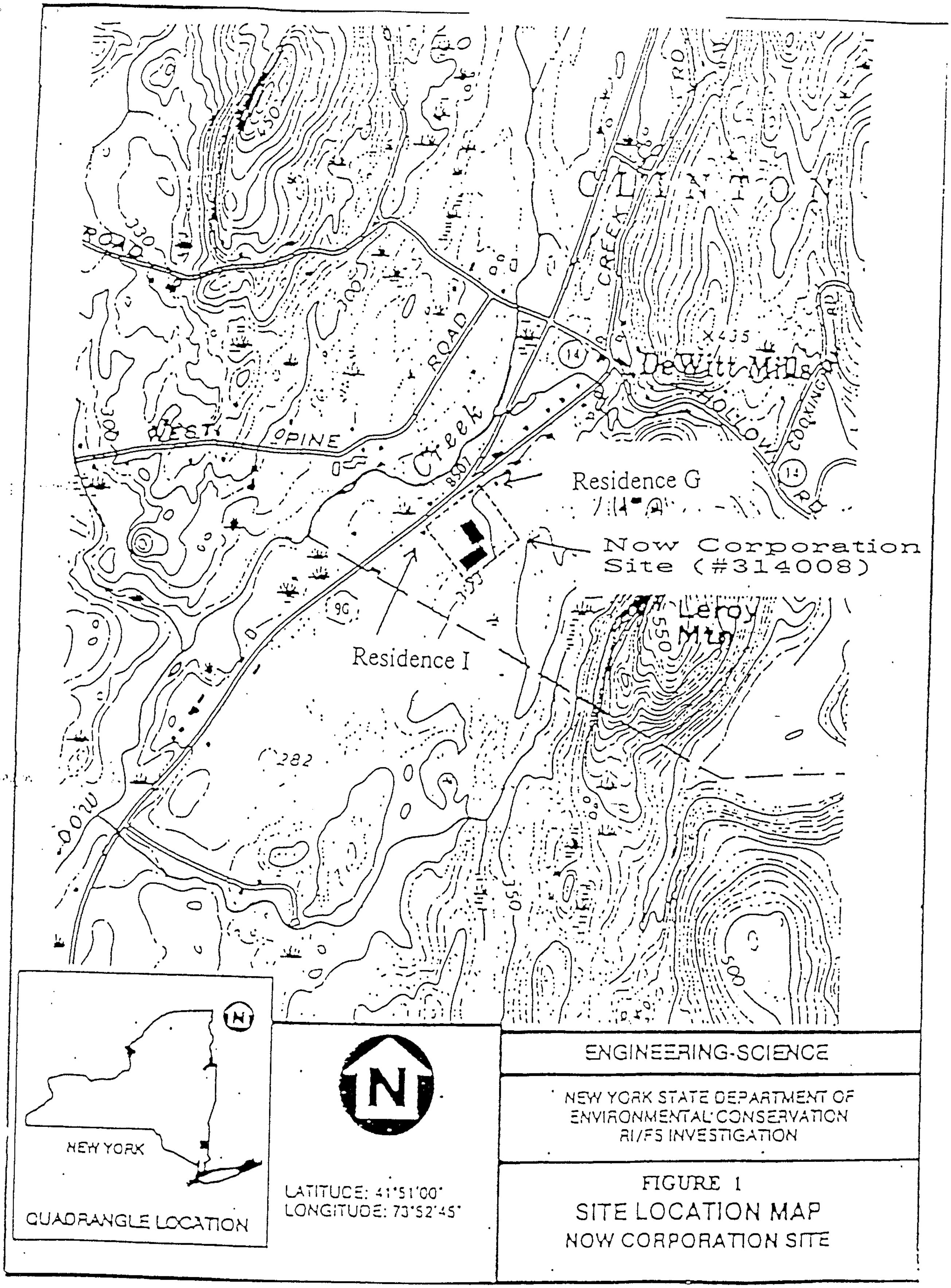
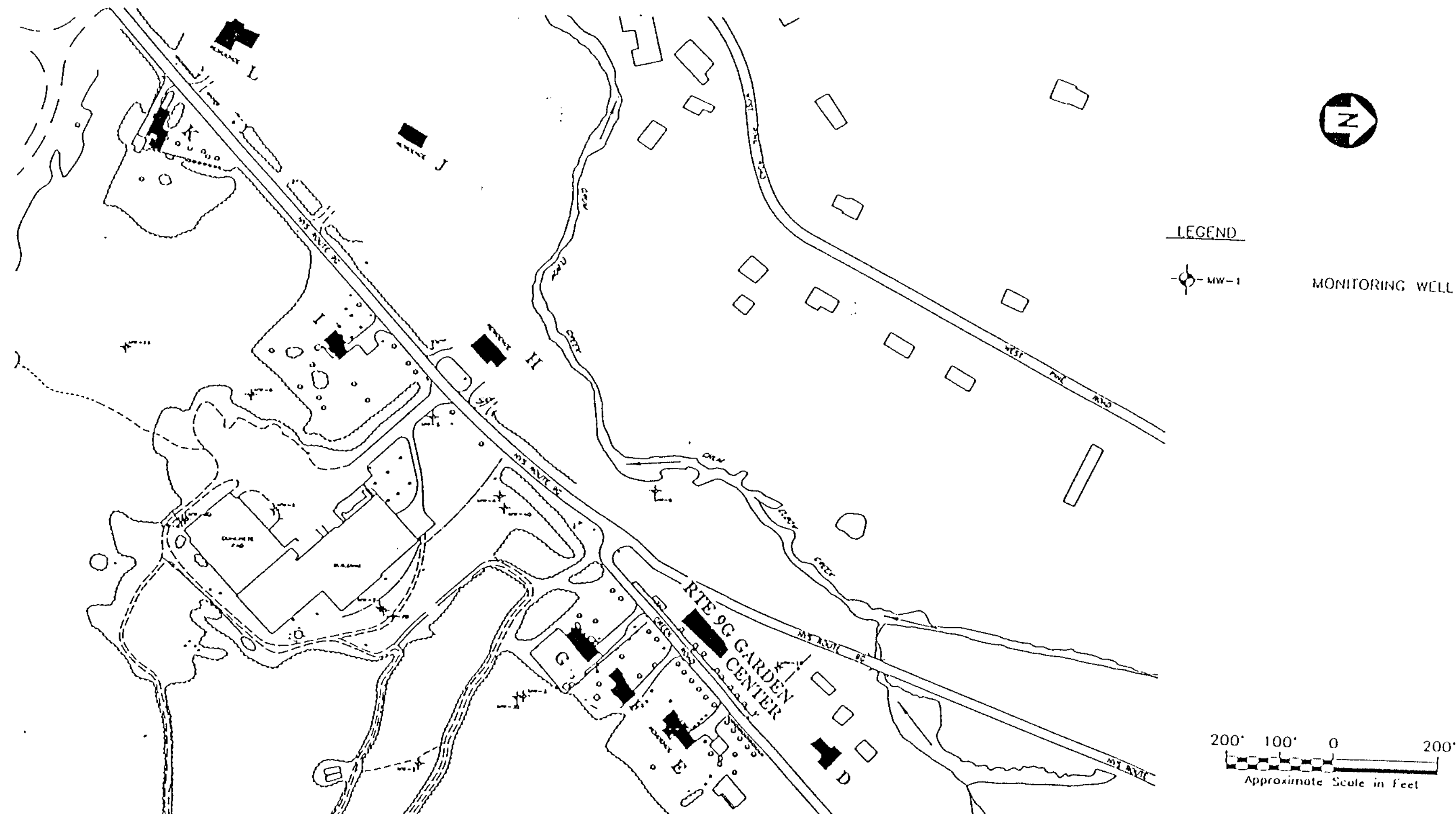


FIGURE 1
SITE LOCATION MAP
NOW CORPORATION SITE

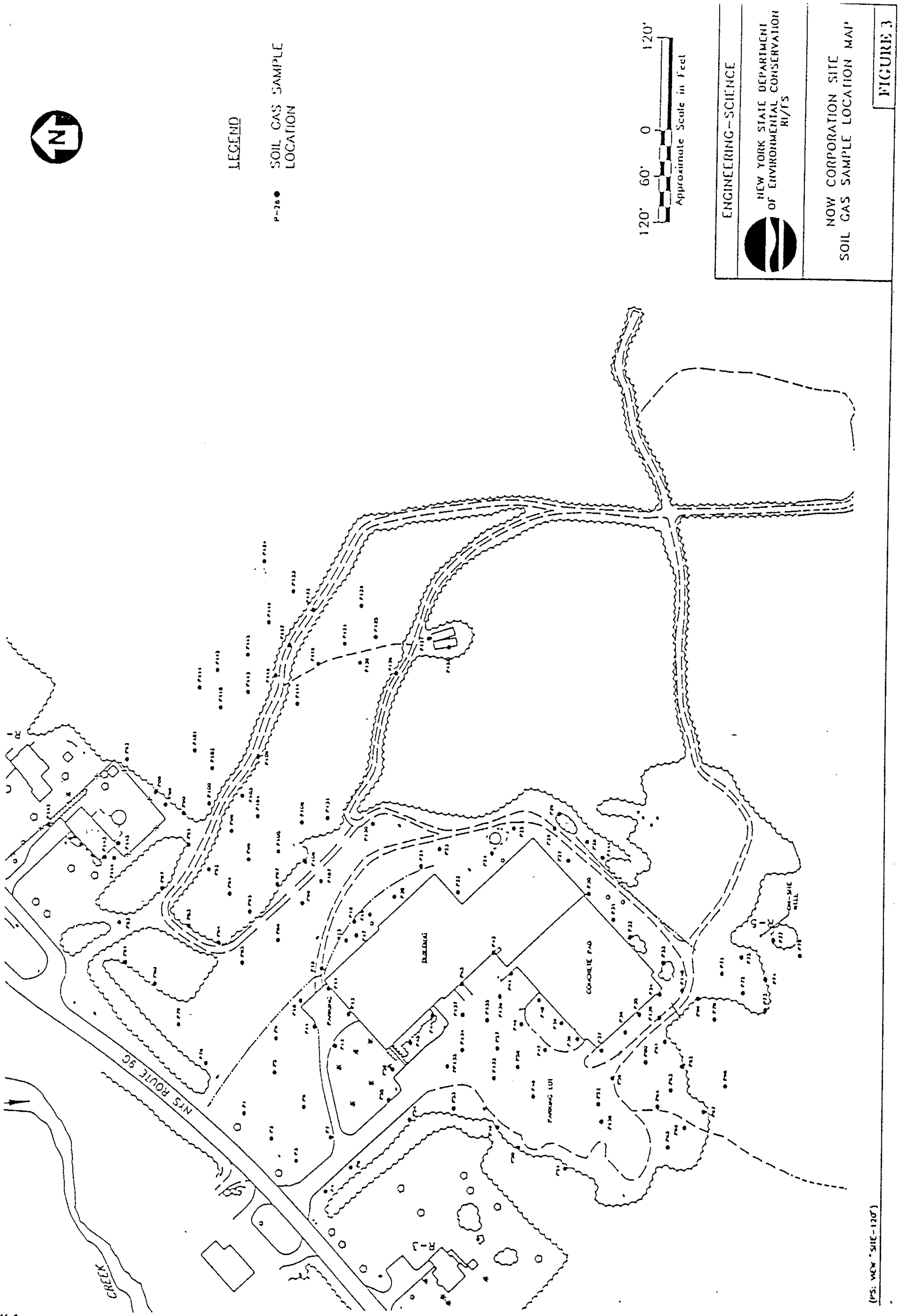


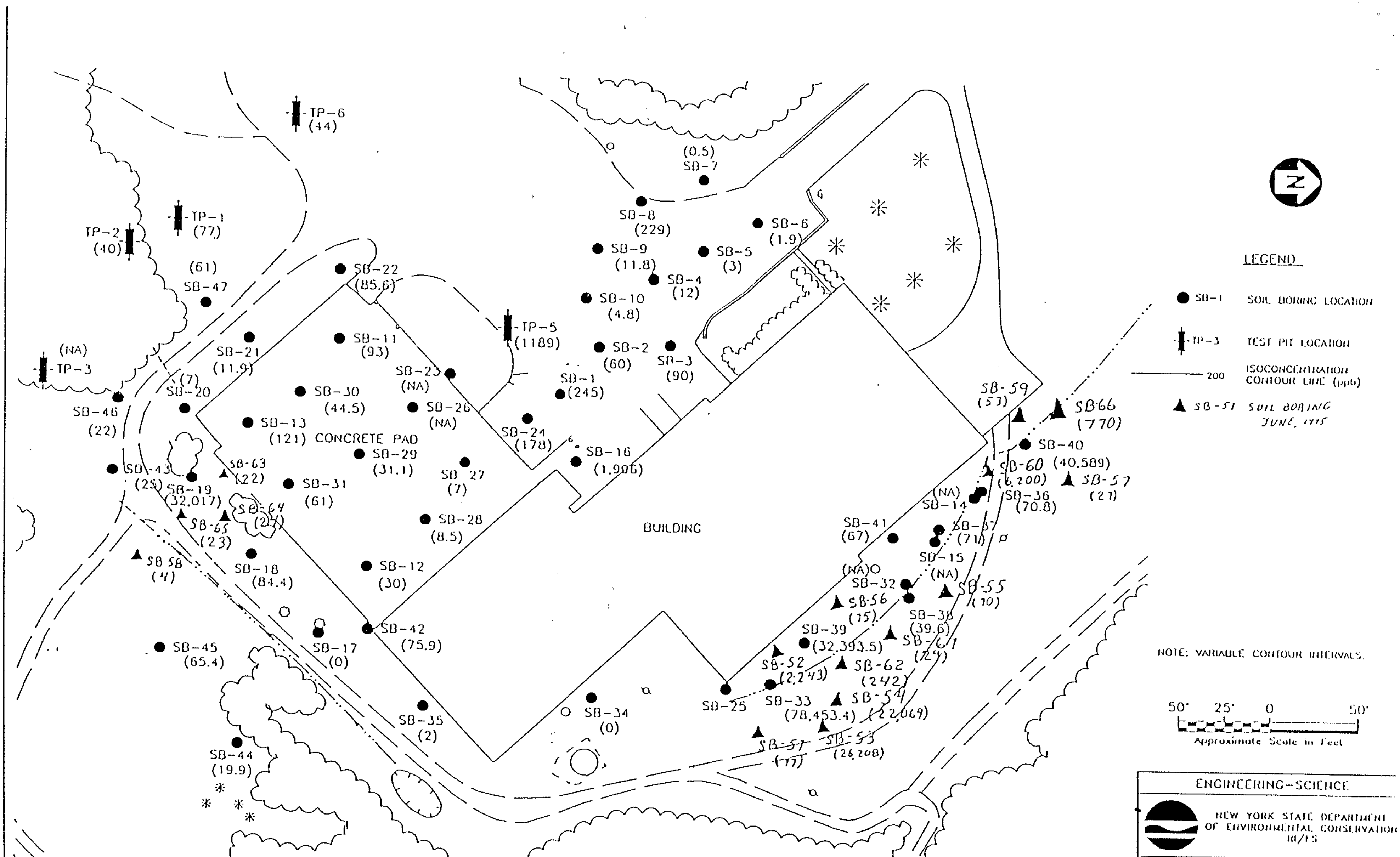
ENGINEERING-SCIENCE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION RI/FS

NOW CORPORATION SITE
MONITORING WELL LOCATION MAP

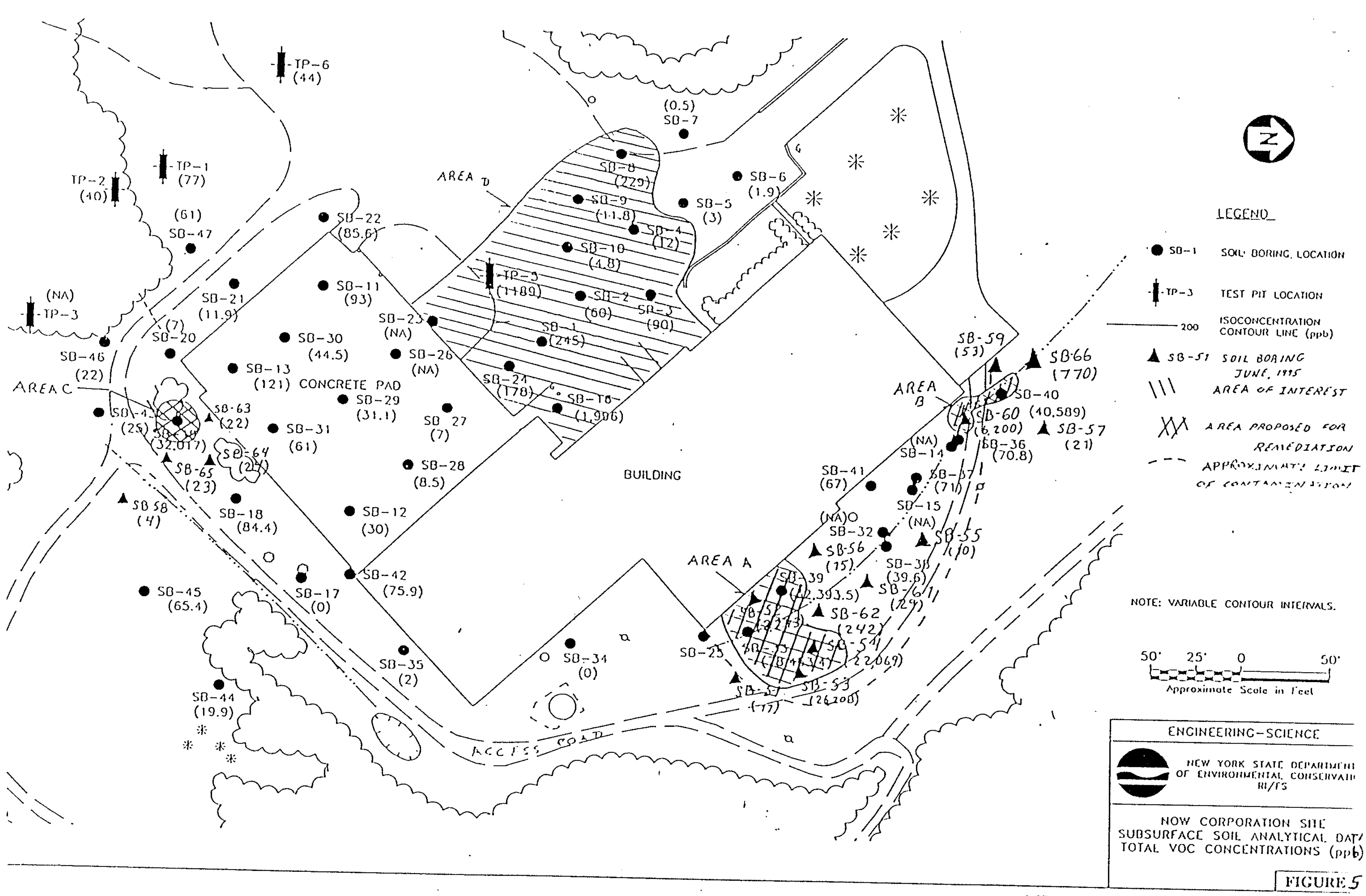
FIGURE 2


ENGINEERING-SCIENCE
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION RI/FS
NOW CORPORATION SITE
SOIL GAS SAMPLE LOCATION MAP
FIGURE 3
LEGEND
SOIL GAS SAMPLE LOCATION
120' 60' 0 120'
Approximate Scale in Feet
N/S ROUTE 9G
CREEK
CONCRETE PAD
PARKING LOT



NOW CORPORATION SITE
SUBSURFACE SOIL ANALYTICAL DATA
TOTAL VOC CONCENTRATIONS (ppb)

FIGURE 4


LEGEND
SB-1 SOIL BORING LOCATION
TP-3 TEST PIT LOCATION
200 ISOCONCENTRATION CONTOUR LINE (ppb)
SB-51 SOIL BORING JUNE, 1995
AREA OF INTEREST
AREA PROPOSED FOR REMEDIATION
APPROXIMATE LIMIT OF CONTAMINATION
NOTE: VARIABLE CONTOUR INTERVALS.
50' 25' 0 50'
Approximate Scale in Feet
ENGINEERING-SCIENCE
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION RI/FS
NOW CORPORATION SITE
SUBSURFACE SOIL ANALYTICAL DATA
TOTAL VOC CONCENTRATIONS (ppb)
FIGURE 5
BUILDING
CONCRETE PAD
ACCESS ROAD
AREA A
AREA B
AREA C
AREA D
TP-6 (44)
TP-1 (77)
TP-2 (40)
TP-3 (NA)
TP-5 (1489)
SB-7 (0.5)
SB-8 (229)
SB-6 (1.9)
SB-9 (11.8)
SB-5 (3)
SB-4 (12)
SB-10 (4.8)
SB-2 (60)
SB-3 (90)
SB-1 (245)
SB-24 (178)
SB-16 (1,906)
SB-22 (85.6)
SB-11 (93)
SB-23 (NA)
SB-26 (NA)
SB-47 (61)
SB-21 (11.9)
SB-20 (7)
SB-46 (22)
SB-30 (44.5)
SB-13 (121)
SB-29 (31.1)
SB 27 (7)
SB-63 (22)
SB-31 (61)
SB-64 (24)
SB-65 (23)
SB-19 (32,017)
SB-4? (25)
SB 58 (4)
SB-18 (84.4)
SB-28 (8.5)
SB-12 (30)
SB-42 (75.9)
SB-17 (0)
SB-45 (65.4)
SB-35 (2)
SB-44 (19.9)
SB-34 (0)
SB-25
SB-59 (53)
SB-66 (770)
SB-40 (40,589)
SB-60 (6,200)
SB-57 (21)
SB-36 (70.8)
SB-14 (NA)
SB-37 (71)
SB-41 (67)
SB-15 (NA)
SB-32 (NA)
SB-55 (10)
SB-56 (15)
SB-38 (39.6)
SB-61 (129)
SB-39 (12,393.5)
SB-62 (242)
SB-54 (22,069)
SB-53 (26,200)
SB-52 (77)

Appendix A

Responsiveness Summary
Now Corp. Site
Operable Unit 2
3-14-008

This document summarizes the comments and questions received by the New York State Department of Environmental Conservation (NYSDEC) regarding the Proposed Remedial Action Plan (PRAP) for operable unit 2 of the subject site. A public comment period was held between December 10, 1995 and January 19, 1996 to receive comments on the proposal. A public meeting was also held on January 11, 1996 in the Clinton Town Hall to present the results of the investigation and to present the PRAP.

This Responsiveness Summary is comprised of verbal comments and questions obtained during the comment period. Written comments were received from Mr. Raymond Oberly, Supervisor, Town of Clinton and Mr. Robert S. McEwan, Jr., of Nixon, Hargrave, Devans and Doyle, Albany, NY.

The following comments and questions are taken directly or paraphrased from the meeting and from written comments received during the comment period. Comments on the soil remedy that were received during the comment period for operable unit one that are still applicable or relevant have also been included in this responsiveness summary.

1C. What is a Class 2 site?

R. Inactive hazardous waste disposal sites are classified according to the threat to public health or the environment that each site represents. This classification system establishes a process that helps determine the order in which sites will be remediated. The classes are listed below with a brief description of the criteria for each.

Class 1. Are sites that are causing or presenting an imminent danger of causing irreversible or irreparable damage to the public health or the environment --- immediate action required.

Class 2. Are sites that pose a significant threat to the public health and/or the environment. Timely action is required.

Class 2a. This is a temporary classification for sites that have inadequate and/or insufficient data for inclusion in any of the other classifications.

Class 3.	Does not present a significant threat to the environment or public health --- action may be deferred.
Class 4.	Site properly closed -- requires continued management.
Class 5.	Site properly closed, no evidence of present or potential adverse impact -- no further action required.

2C. The three underground storage tanks at the site, what was in them?

R. We believe the tanks were used for gasoline and fuel oil, but we are not certain. Our sampling results were consistent with gasoline and fuel oil spillage.

3C. Should the Town be able to issue a special permit for the site since it is a hazardous waste site?

R. That is a decision up to the local government authorities. The Department of Environmental Conservation would not become involved unless it would interfere with the implementation of the remedy for the site or it would greatly exacerbate the contamination at the site.

4C. The Zoning Enforcement Officer (ZEO), building inspector, planning board and zoning board advisor (ZBA) have been instructed to solicit the NYSDEC's comment on any proposed new activity or activity change at the site.

R. The Department must approve any change in use of the site that can affect the remediation of the site. It is the responsibility of the local town and zoning board to decide appropriate activities near or at a hazardous waste site. However, the Department appreciates the Town's concern for the proper management of the site and will be happy to provide technical support and information with respect to any activities that would affect the contamination at the site or the remediation of the site.

5C. All operations (by the property owner) at the site should be stopped. He is using the Department of Environmental Conservation and is taking advantage of the Town through the Department's presence.

R. The Department of Environmental Conservation does not have the legal authority to stop normal business operations at the site. We can only do that if the operations would interfere with the implementation of the remedy or the operations would greatly exacerbate the contamination at the site. However, the Town has the authority to regulate normal business activity at the site. The

Department of Environmental Conservation can verify any information or any claims made by the land owner to the Town that would influence their determination of appropriate activities for the site.

6C. It appears that the regulatory notice for a significant change in use at the site was not given by the Department.

R. The Department has not authorized any change in use at the site. During the public meeting, several activities by the tenants and/or owners of the site were discussed. None of these activities were in the areas of soil contamination but are associated with other portions of the property. These activities also do not appear to present a hindrance to the remediation of the site.

7C. Who is using the recently delivered tank at the site?

R. The tank on the top of the hill to the north of the building was used in conjunction with the recent pump test on the recovery wells.

8C. The machines that were on the hill today (January 11, 1996), what were they doing? Where they pumping the recovery wells?

R. Yes, the machines were there in support of a pump test that was being performed on the recovery wells.

9C. The Department should explore whether the potentially responsible parties (PRPs) for the site would be eligible for participation in the voluntary cleanup program

R. At this time, eligibility of PRPs to participate in the voluntary cleanup program for class 2 sites is unresolved.

10C. Can Hoescht-Celanese be considered a PRP, even though releases of hazardous waste occurred at the site after their predecessor (Virginia Chemicals) departed from the site.

R. Even though additional releases of chemicals occurred after Virginia Chemicals' tenure at the site, as the successor to Virginia Chemicals, Hoechst-Celanese is responsible for any contamination at the site that resulted from the actions of Virginia Chemicals. This would include Virginia Chemicals' agents and subcontractors who participated in the operation of the facility. During Virginia Chemicals' tenure at the site sporadic dumping of chemical cleaning tank solutions occurred. This is why the site was listed as a hazardous waste site.

11C. A comparable technology is not defined in the second PRAP.

R. It is difficult to define a comparable technology to low temperature thermal desorption due to various technical differences between the various treatment processes available, some of which are very fine in nature. Comparable technology in this PRAP was meant to mean a technology that would employ the same operating principles to remove the volatile organic contamination from the soil.

12C. Some of the comments on the previous PRAP were not responded to in the Record of Decision for operable unit 1, nor were they included in this PRAP.

R. Comments concerning the soil remedy proposed in the previous PRAP were not all directly addressed by the ROD for Operable Unit 1 since the soil portion of the remedy was removed from that ROD. During the review of the comments for the previous PRAP, it was discovered that the cost of off site disposal was significantly underestimated. Hence, the NYSDEC decided to reevaluate the proposed remedy for the contaminated soils at the site. The soil portion of the site was designated as Operable Unit 2 in order to allow for a full reevaluation of all soil remedy alternatives. The March 1995 ROD was for Operable Unit 1, contaminated groundwater, and hence, comments concerning the contaminated soil were deferred until OU2. All of the comments received on the previous PRAP regarding soil contamination and remediation were considered in this reevaluation and the selection of the revised soil remedy. Comments that are still valid have been included in this Responsiveness Summary.

13C. I would like to have the adjacent landowners afforded an opportunity to see the locations targeted for remediation after they are marked by the DEC.

R. The NYSDEC would consider an open tour of the site provided access is granted by the property owner. The Department also will photograph and flag the targeted areas. The adjacent landowners and local government officials can contact the DEC project manager directly to discuss this further.

14C. How many cubic yards of soil and how many cubic yards of bedrock will be removed from each area?

R. Approximately 294 yd^3 of soil and 218 yd^3 of bedrock will be removed from area A, 93 yd^3 of soil and 42 yd^3 of bedrock will be removed from area B, and 105 yd^3 of soil and no bedrock will be removed from area C.

15C. What is the depth to bedrock in the areas of soil contamination?

R. The depth to bedrock in area A is approximately 3 feet, in area B it is approximately 4.5 feet, and in area C it is approximately 4 feet.

16C. Why was a horizontally configured, pneumatically fractured soil vapor extraction system not considered for areas A, B and C.

R. A soil vapor extraction system utilizing pneumatic fracturing of the soils was considered but was screened out in the detailed analysis of remedial alternatives due to several potential problems with this technology that could not be confidentially answered without additional field testing. It was assumed that the pneumatic fracturing included the introduction of some material, such as sand, to maintain the fracture openings as the native soils would not have enough strength to maintain the openings. However, short circuiting of these fractures was a significant concern due to the shallow nature of the soils (as little as 2 feet) and the presence of numerous preferential pathways from abandoned borings, soil gas points, underground utilities and foundation walls. The introduction of vertical fractures was also a concern as this would enhance vertical migration of the contaminants. The installation of the vapor extraction wells was also a problem. Installation by trenching was undesirable as this would volatilize a significant amount of the contamination into the atmosphere. Additionally, it was unclear how this technology would work on the weathered bedrock layer. Several other problems were also anticipated, but are not discussed here for the sake of brevity.

17C. In the PRAP there is no discussion of whether there is a need, based on health risks, to remediate the site soils considering the implementation of a groundwater remedy at the site.

R. The PRAP is only intended to highlight the Remedial Investigation and Feasibility Study (RI/FS) report and summarize the Proposed Remedial Action Plan. The RI/FS report considered public health risk based on soil and groundwater separately and found that the soil by itself presented a risk in excess of health risk guidelines. The risk assessment to current resident receptors was based on ingestion and dermal contact with surface soils and would not be significantly reduced by the groundwater remedy.

18C. There also is no discussion in the PRAP on whether the groundwater remediation will have an impact upon the type of soil remediation that is selected.

R. The groundwater remediation is not expected to significantly affect the contamination in the site soils above the groundwater table. Additionally, if the source of contamination in the site soils is not remediated, the contaminated soils will continue to impact the groundwater and actually prolong the groundwater remedy.

19C. The RI/FS report does not recommend the excavation of bedrock.

R. The RI/FS report recommended alternative called for the excavation of an estimated 2,400 yd^3 of soil and possibly the underlying weathered bedrock as it would be cost effective to remove this layer if it was contaminated with the trichloroethene (TCE) exceeding soil criteria. It is also noted that the extent of VOCs closer to and in the top layers of weathered bedrock was unknown at that time. The recommended alternative also planned to reinject the treated groundwater along the building to further aid the groundwater remedy by flushing out the VOC contamination in the shallow bedrock underlying these soils.

20C. The second PRAP calls for excavation of weathered bedrock from at least two locations at the site where contamination above standards is only suspected.

R. Sample SB-52 (refer to Table 1) is from the weathered bedrock in Area A. This sample contains 2,200 ppb of Trichloroethene, which is above the soil cleanup criteria of 700 ppb. Other data in the RI/FS report and collected during June 1995, indicate that contamination in the weathered bedrock is also found in Area B. The full extent of the contamination in the weathered bedrock will be determined during the remediation of these areas.

21C. Have there been any other Records of Decision that included excavation of weathered bedrock as a remedial selection?

R. There have been no other Record of Decisions that call for the excavation of weathered bedrock, however, the remedial program at each site is designed to address the unique conditions of each site.

22C. There can be no certainty that removal of weathered bedrock will improve the health risk for potential human receptors. A cost benefit analysis should be undertaken to determine if excavation and treatment or disposal of bedrock provides sufficient return for the proposed expenditures.

R. The removal of any source areas, even small areas, will have significant benefit for the remediation of the site and in improving the health risk to the public. The additional cost of the treatment or disposal for this material was considered in the selection of the alternatives. Furthermore, remediation of this source area will increase the efficiency of the groundwater treatment.

23C. Will there be any blasting associated with the removal of the bedrock?

R. No, the bedrock that will be removed is weathered and can be removed with the typical excavation equipment we will have on site to remove the contaminated soil.

24C. We question whether the site clean up goals should be for an industrial\ commercial use.

R. Although the site is presently being used as an industrial site, the potential for the site to be used in a residential scenario in the future is likely. As such, residential cleanup goals are appropriate for this site.

25C. Since thermal desorption would permanently reduce the volume and toxicity of the contamination, its use should be evaluated for treatment of the excavated soils in alternatives 2 and 3.

R. Alternative 2 called for the excavation and off site disposal of the top 2 feet of soil in Area A, B and C. Alternative 3 called for the excavation and off site disposal of the soils to the top of the weathered bedrock in Areas A, B and C. Please refer back to pages 9 and 10 of this ROD for a detailed description of these alternatives.

The inclusion of thermal desorption in alternative 2 would not have changed the alternative's failure to adequately protect human health and the environment due to the contamination that would remain in the underlying soils and bedrock. The treatment of the soils under alternative 3 by low temperature thermal desorption was considered in the preliminary analysis of the alternatives. However, this alternative was not carried into the detailed analysis, Only those that undergo the detailed analysis are included in the PRAP, as this alternative was very similar to alternative 6. The inclusion of treating the weathered bedrock in alternative 6 is expected to provide a significant benefit at a very small increase in cost. The excavation equipment and treatment system would already be on site, as such, the additional cost for excavation and treatment would be small.

26C. Why was Alternative 4 selected as the remedy in the event that thermal desorption or a comparable technology was unavailable.

R. Alternative 4 is selected as a contingency remedy, in the event that an adequate number of bids are not be received for the remediation of soil using thermal desorption. Alternative 4 was determined to be the next best cost-effective remedial program for the site in this event.

27C. Consideration should have been given to other proven treatment methods before resorting to off site disposal.

R. Consideration was given to other treatment methods, both in the RI/FS and the development of the PRAP. The rationale for the selection of Alternative 6, excavation of contaminated soils and on site treatment is also detailed in both documents.

28C. Will the excavations of contaminated soil be left open?

R. No, the excavations will be backfilled with the treated soils and clean soil.

29C. I also presume, since the soils are contaminated, that pains would be taken to assure a minimum of dust and that the soils would be carefully contained.

R. Throughout the remedial process, care will be taken to properly containerize any contaminated soils. Additionally, measures such as proper decontamination procedures, fugitive dust control and monitoring, and standard health and safety monitoring will be performed at the site. Corrective actions, such as the wetting down or covering of soils to reduce dust, will be implemented as necessary.

30C. How does the cost for treatment by low temperature thermal desorption compare to the cost for the excavation and off site disposal of the soils?

R. It is approximately twice as expensive to remove and dispose of the soils as to treat them onsite by low temperature thermal desorption. The high cost of offsite disposal is largely due to the regulatory restrictions that these soils would have to meet for off site disposal. Due to the high levels of contaminants present in these soils, these regulations would require treatment before disposal.

31C. What is the size and distance of the soil area to be excavated along the north side of the building? How far up the hill does this excavation go?

R. All of the areas to be excavated are between the building and the dirt access road that goes around the building and the concrete pad. The excavations along the north side of the building will stop at the access road which is at the base of the hill.

32C. At the next meeting, will we know who will do the soil excavating?

R. The excavating work will be done by a contractor or his subcontractor who will be competitively procured. If this information is available by our next public meeting, it will be provided during the meeting.

33C. What kind of trucks will take away the soil?

R. The proposed remedy will not take any of the soil off of the site. To move the soils around on the site, a backhoe with a front end loader is expected to be sufficient.

34C. How will the necessary equipment access the site, will they use any residential roads?

R. It is expected that all of the equipment will enter and leave the site from Route 9G by the main entrance to the Route 9G Industrial Center.

35C. What good will it do to treat just a little of the soil at the site?

R. By removing the contamination source in the soil, we can prevent any more contamination from migrating into the bedrock aquifer. Even a minor amount of contamination in the soil can contaminate the groundwater and once this contamination is in the bedrock aquifer it becomes much more difficult to remove.

36C. When will the remedy be implemented?

R. This remedial program will be included as a task for the State standby consultant who is already at work on the remedial program for the groundwater at the site. It is expected that the design aspect of this remedy would be finished during the early spring so that the actual construction of the remedy can begin in the late spring of 1996.

37C. How does the contamination get down into the wells?

R. As precipitation, i.e. rainwater, runs through the soils it dissolves and carries enough of the contamination in the soils to contaminate the groundwater beneath the site. The wells receive their water from the groundwater beneath the site.

38C. How can such small areas of soil cause so much groundwater contamination?

R. The contamination in the soil primarily moves in a downward direction with the water infiltrating though the soil.. This downward migration then impacts the groundwater beneath the contaminated soil. Once the groundwater is contaminated, it migrates to and contaminates a larger area.

39C. Would on site treatment of soils affect the residents? What method was considered, would it be smelly or noisy?

R. The on-site treatment method considered was thermal desorption. This method involves the heating of the soil to high temperatures. At these temperatures, the contamination readily volatizes off of the soil particles. These vapors are then collected and treated. Measures would be taken to assure the complete collection of these vapors. As such, there should be no odors. Additional measures would also be taken to minimize any other impacts, such as noise to the surrounding community.

40C. Treating the volatile organic contamination so close to people's homes could expose them to the fumes from the compounds. What kind of testing would be done to protect the residents from these fumes?

41C. All of the alternatives, including the selected remedy, considered the closeness of the adjoining homes. Each of the alternatives included various measures to prevent any exposures to these residents from occurring. The exact details of these measures and any associated testing will be worked out during the remedial design, but they would likely include air monitoring in and around the work zone area.

42C. Will the residents be notified if the levels get too high?

R. Yes, the Department of Environmental Conservation would notify the residents if a problem occurs.

43C. What about the time lapse if we need to get equipment to remediate the problem?

R. During the remediation we will have contingency plans in place and the necessary equipment available for immediate use to address these problems. It is our intention to resolve any problems that occur before they pose an exposure risk to the local residents. After the remedial design is complete, we will hold another public meeting to discuss the health and safety measures we will undertake and our contingency plans.

44C. When NOW plastics operates, I smell a very strong odor.

R. Any odor complaints should be reported to the Department of Environmental Conservation Region 3 office in New Paltz. Their telephone number is (914)256-3000 or the Dutchess County Health Department of Health should be contacted at (914) 486-3400.

45C. Which will be done first, the soil remedy or the groundwater remedy?

R. Work on the groundwater remedy design and construction is already under way. Once the ROD for the soil remedy is issued, work on the soil design will begin. It is expected that the groundwater remedy will be operating before the soil remedy construction begins and the soil remedial program will be completed first.

46C. At the first public meeting the Department showed a map of the plume and impacted wells that basically ended at the Route 9G Garden Center. How is it that Residence B's well , which is not in this plume area, is now seeing increasing levels of contamination?

R. Although we have a good understanding of the extent of groundwater contamination, it is extremely difficult to precisely map a contaminant plume in a fractured bedrock aquifer as we have no real way of predicting the groundwater flow through each fracture. Additionally, volatile organic contamination is a fairly common problem and the contamination in this well may or may not be related to the site. The most practical approach we can take at this time is to continue this residence supply her with bottled water and to continue to monitor the residential wells in the area.

47C. If the groundwater remedy begins first, wouldn't the pumping draw more contamination into the groundwater?

R. No, the primary way the contamination moves down into the groundwater is with precipitation. The pumping will not affect this.

48C. We received lots of snow this winter, will this affect the amount of contamination that migrates into the groundwater?

R. This additional water will cause some of the contamination to migrate into the groundwater. However, this should not affect the overall remedial program.

49C. What wells are going to be pumped as part of the groundwater remedial program.

R. Three recovery wells have been installed as part of the groundwater remedy. One is to the south of the concrete pad, one is right next to the northeast corner of the building and the third one is on top of the hill just to the north of the building.

50C. Will these wells be like those big ncisy pumps used on oil wells?

R. No, these pumps will be similar to the pumps that many homeowners have in the basements of their homes.

51C. During the remediation, what will happen if the residential wells go dry?

R. This was a consideration during the remedial design, and that is largely why we will be reinfiltrating a portion of the treated water. We will be monitoring the water elevations in the monitoring wells at the site, so that we can detect any larger than expected drawdown. We are confident that we will not cause any wells to dry up. However, if this does happen please notify immediately as we have prepared several options, such as reducing the pumping rate, to address this potential problem.

52C. What is the average depth of the wells at the site?

R. The well depths range from 20 to 100 feet below the ground surface.

53C. How will the pumped water be treated?

R. The details of the groundwater treatment system are still being worked out. The system will likely be an air stripper tower with carbon polishing for the vapors. This system volatizes the compounds out of the water and then traps them onto a carbon filter.

54C. Has this system been used at other sites?

R. Yes, it has been used at other sites and has been found to be more effective than simply passing the water through a carbon filter.

55C. Once the carbon filter is saturated with contaminants, what is the proper disposal method?

R. The filter will likely have to be disposed of as hazardous waste. Although the filter and contaminants are very similar to the ones on several of the local homeowner wells, this filter will not fall under the household exemption for hazardous waste.

56C. Can a field representative for the standby consultant who is designing this system be present at the next public meeting?

R. Yes, a design engineer will be present at the next public meeting.

57C. How long will the site be monitored?

R. There will be no need to monitor the soil since remedial program will remove all of the soil contamination to the extent practical. The groundwater remedy is expected to operate for a period of seven to ten years, after which monitoring would occur. The length of this monitoring period would be directly related to the groundwater contaminant levels that will remain after the remedy stops.

58C. Will you also be monitoring Crum Elbow Creek?

R. We will be monitoring the water discharged into Crum Elbow Creek. The treated water will meet all necessary discharge permit requirements and appropriate standards, criteria and guidelines.

59C. Why is some water being piped to Crum Elbow Creek and not reinfiltrated to the groundwater.

R. Some of the groundwater that will be extracted and treated will be reinfiltrated back into the groundwater table to limit the amount the groundwater will be drawn down by the remedy. However, it would be extremely difficult to reinfiltrate all of this water back into the groundwater table. Therefore, most of it will be discharged into Crum Elbow Creek after it is treated.

60C. How will the water that is to be discharged to Crum Elbow Creek get from the site to the creek?

R. The details of that will be determined in the remedial design for Operable Unit 1. It is very likely that an underground pipe will be used.

61C. Will this pipe go through the culvert on Ingell's property?

R. That is still under consideration.

62C. What about the ditch along the northeast side of the building, is the soil or the runoff in this ditch a concern?

R. The soil in this ditch was sampled and found to decrease to levels below soil cleanup guidelines outside of the area to be excavated. The soil contaminant levels in this ditch were considered when the areas for excavation were developed. The runoff water from this ditch is not a concern since this runoff is minimal and does not leave the site.

63C. Will we attempt to recoup expenses from the property owner, Mr Fried.

R. Yes, I believe the state will seek cost recovery from Mr. Fried, and other potentially responsible parties.

64C. Why do we have to wait, why not initiate the litigation now?

R. The NYSDEC will begin to initiate cost recovery activities immediately after the completion of this ROD. Since the PRP has already refused to implement the ROD, the NYSDEC will implement the remedy and include these costs in our cost recovery action.

65C. Is Mr. Fried still liable if he sells the property?

R. Yes, he would still be liable.

66C. What if he dies, would he still be liable?

R. The Department of Environmental Conservation could pursue his estate.

Appendix B

Now Corporation Site
ID: 3-14-008

ADMINISTRATIVE RECORD

1. Phase I Investigation Report, Now Corporation site, Wehran Engineering, November 1983.

2. Remedial Investigation/Feasibility Study Workplan, Now Corporation site, Engineering-Science, October 1992.

3. Phase II - Remedial Investigation/Feasibility Study Workplan, Now Corporation site, Engineering-Science, July 1994.

4. Remedial Investigation/Feasibility Study Report Volume I, Now Corporation site, Engineering-Science, January 1995.

5. Remedial Investigation/Feasibility Study Report Volume II, Now Corporation site, Engineering-Science, January 1995.

6. Remedial Investigation/Feasibility Study Report Volume III, Now Corporation site, Engineering-Science, January 1995.

7. Record of Decision, NOW Corporation site, Operable Unit 1, New York State Department of Environmental Conservation, March 1995.

8. Letter dated March 15, 1995 from Robert S. McEwan, Jr. (Nixon, Hargrave, Devans & Doyle) to John Helmeset (New York State Department of Environmental Conservation), Re: Comments on the PRAP (February 15, 1995) for the NOW Corporation Site.

9. Letter dated March 15, 1995 from Daniel J. Lowenstein and Bruce R. Nelson (Malcolm Pirnie Inc.), to John Helmeset (New York State Department of Environmental Conservation), Re: Comments on the PRAP (February 15, 1995) for the NOW Corporation Site.

10. Letter dated March 15, 1995 from Frederick Loneker to John Helmeset (New York State Department of Environmental Conservation), Re: Comments on the PRAP (February 15, 1995) for the Now Coporation site.

Appendix B

Operation and Maintenance Manual

Operation and Maintenance Manual

Soil and Groundwater Remediation System

FORMER NOW CORPORATION SITE
1182 ROUTE 9G
DUTCHESS COUNTY
STAATSBURG, NEW YORK

NYSDEC SITE I.D. 3-14-008

Prepared for:
New York State Department of Environmental Conservation
50 Wolf Road
Albany, New York

RUST Environment and Infrastructure
12 Metro Road
Albany, New York

Prepared by:
Earth Remediation Services
21 Business Park Drive
Branford, CT 06405
(203) 488-6713

ERS PROJECT NUMBER E-239

*EARTH REMEDIATION SERVICES
IS A DIVISION OF EARTH ENGINEERS, INC.*

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QED Environmental Systems

EZ-Tray Air Stripper

Patent No. 5518668

System Operation & Maintenance Manual

P/N 95168 8/16/11

QED Environmental Systems

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QED Environmental Systems

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Other Manuals Included (In Order of Appearance):

1. New York Blower Manual

2. G&L Pump Manual

3. Dwyer Gauge Manual

4. Gem Sensors Float Switch Manual

Thank you for relying on QED Environmental Systems to handle your water treatment needs. After reading the Operation and Maintenance Manual, if you have any questions regarding the startup or operation of your system, please contact the ***QED Service and Repair Department at 1-800-624-2026.***

PLEASE NOTE!

Read the QED Operation and Maintenance Manual First!
The manual will assist you in equipment hookups, installation, startup, maintenance, and troubleshooting.

It is Important That a Qualified, Licensed Electrician Perform All Electrical/Wiring Installation Work.
Please see “Equipment Set-Up” in the Operating Instructions section of this manual.

Follow the Manufacturers Instructions
All the mechanical equipment that was supplied with your air stripper system should include the respective manufacturer’s instruction manual for each piece of equipment.The documentation will either be found with the actual piece of equipment (if shipped loose) or found within a QED Operation and Maintenance manual that includes all relevant manufacturers’ instruction sheets.

Follow Safe Work Practices
Be sure to follow all associated safety practices.

EZ-TrayTM systems are fabricated from rugged stainless steel. Each system is pre-assembled and factory tested before shipment to your site. EZ-TrayTM low profile air strippers are built to meet site and project specifications, which can include a number of standard or optional pieces of equipment. Depending upon the specifics of your order, the equipment described in this manual may or may not be included with your system configuration. Please refer to your sales order for the equipment that should be included with your system. Equipment information will be found either within this O&M manual or in separate documentation provided in addition to this manual.

Air Pressure Gauge (Standard)

The standard pressure gauge reads the differential pressure between the sump pressure and atmospheric pressure, in inches of water column (" wc). The gauge is connected to the system via tubing that is attached to a pressure port on the air stripper sump. The air tubing from the sump leads to the "high" pressure port on the gauge. The "low" pressure port is left open to the atmosphere.

Demister (Standard)

A demister pad is installed beneath the air discharge stack located on the top cover of the unit. The purpose of the demister pad is to remove entrained water droplets that would have blown through the discharge stack. It is possible, though unlikely, that the demister pad may become plugged or fouled. If this occurs the demister pad is easily removed. Disconnect the vent line, take off the demister cap, and remove the demister. The demister pad can be cleaned with a pressure washer or replaced with a new one.

Gaskets (Standard)

Various gaskets are used in the EZ-TrayTM air stripper units. One gasket is installed in the air discharge stack flange, one gasket is used to form an air tight seal between the front hatch and aeration trays, and a felt gasket is located on the underside of each aeration tray and a gasket is used under each downcomer flange. Through the course of regular maintenance, these gaskets will eventually wear and will not seal effectively. When the gaskets are ripped, worn, or do not seal properly, these gaskets should be replaced. Contact QED for replacement gaskets and adhesive. *Please contact QED prior to making any gasket repairs or adjustments.*

Sight Tube (Standard)

The sight tube provides a means of easily viewing the water level in the sump tank.

Blower

The blowers on the EZ-TrayTM low profile air stripper units are typically cast aluminum type B spark resistant, direct drive @ 3450 rpm, with motor options of TEFC or EXP. Each blower is selected to meet the proper air flow requirements (cfm) at the anticipated working pressures (inches of water column) of each system.

It is critical that the blower damper be opened wide enough to provide the unit with the designated minimum flow. If the damper is opened too wide, however, high air flow can cause water entrainment, with water droplets caught up in the airstream and sent out of the air stripper discharge stack.

It is also critical that water does not enter the blower housing while the blower is in operation; this will damage your blower and void the warranty. The high water level alarm switch prevents this from happening. Make sure it is installed correctly. If not installed by QED, it is recommended that the blower piping be of an inverted-U design,capable of collecting water within the blower piping and minimizing the potential for blower flooding. Please refer to **Figure 3** for a typical blower piping configuration.

If water does accumulate in the blower, it must be removed from the blower housing before continuing operation. A small drain hole may be drilled and plugged on the bottom side of the blower housing to provide a means of discharging any water that may accumulate. Remove the plug temporarily to drain any water or take off the front panel of the fan housing and remove the water.

When starting the unit for the first time, check that the blower wheel is rotating in the direction of the arrow on the blower housing. If you hear the blower wheel rubbing or any odd sounds, shut down the system immediately and call QED.

Damper

The standard QED blowers normally have a damper on the discharge side of the blower. The damper is used to make adjustments to the air flow rate (cubic feet per minute) of your system. The air flow rate is increased by opening the damper, and decreased by closing the damper.

Use the damper to adjust the sump pressure to its proper operating value. By adjusting the sump pressure, the proper operating air flow through the air stripper will be achieved. Follow the instructions given in the earlier “Air Pressure Gauge” section to obtain the correct sump operating pressure. Using an air flow meter and an air pressure gauge together is desirable for confirming air flow and sump pressure, especially when attempting to troubleshoot any problems encountered with the air stripper operation. It is also recommended that you keep a log book of pressure readings so you can determine the frequency of cleaning required to minimize system fouling.

Air Blower Silencer

The air blower silencer reduces the dynamic noise level of the blower. The size of the silencer and the type of connection used to mount it is dictated by the size of the blower and the choice of options. If a silencer is purchased through QED, they are typically shipped loose, for customer installation. The silencer can be mounted either horizontally or vertically (through the use of an elbow) must be properly supported to avoid over-stressing the blower housing. Silencers exposed to high wind velocities must be properly secured.

Air Flow Meter

The air flow meter measures the amount of air flowing through the system. If it is a pitot tube-type, two air tubes lead from the air piping to a meter/gauge. To operate effectively, the pitot tube must be located a minimum required distance upstream and downstream from elbows, valves, etc. Refer to manufacturer’s installation instructions for proper installation procedures.

The air flow meter typically gives readings in feet per minute (FPM), which is then multiplied by the cross sectional area, (square feet), of the vent line to give cubic feet per minute (CFM). As stated in the damper section, the air flow meter is needed to make damper adjustments, especially after initial start-up.

Control Panel

The control panel serves two basic functions required for the safe operation of the system. The first is to provide the required electrical safety components for each motor (blowers and pumps) per NEC standards. These components consist of fuses,motor starters, and overload relays.

The second function is to provide the required process safety alarm components. The alarm circuit monitors the low air pressure switch and the high water level alarm switch. If either of these alarms occur, the alarm contacts will shut off the incoming water source (feed or well pumps) if the appropriate connections have been made. A qualified, licensed electrician should perform any and all electrical connections.

Control Panel Intrinsically Safe Components

EZ-TrayTM low profile air stripper systems that process potentially explosive concentrations of vapors require intrinsically safe (IS) signals to all electrical components housed in non-explosion proof enclosures. The IS signal does not have enough energy to ignite the concentration of any NEC classified explosive vapor. Typical components that need IS signals are the float switches and well probes. Determination of when IS signals are required is generally the responsibility of the ground water remediation engineer who has placed the order for a system. A qualified,licensed electrician should perform any and all electrical connections.

Water Flow Indicators and Totalizers

The digital water flow indicator, typically installed in the incoming process water line or shipped loose, reads the rate of flow (GPM) and the totalized flow (gallons). The flow meters are selected to exceed the maximum flow of your system while providing a wide working range. The digital face plate is battery operated and intrinsically safe. The mechanical components of the meter consists of a “turbine style” rotor which spins around a shaft that is axial to the flow of water.

The standard “nutating disc” meters have a totalizing function only. They operate on the positive-displacement principle, where the flow of water through the meter moves a disc which in turn rotates a magnet. Every magnet rotation corresponds to a fixed volume of fluid which is then added to the summed total of flow.

Feed and Discharge Pumps

Any transfer pumps included in the air stripper order have been selected by our engineering staff to meet all known flow and pressure requirements. The standard pumps are typically stainless steel centrifugal-type with motor options of EXP or TEFC. The standard pumps are not self-priming; they must be primed before starting by filling either the discharge port or the priming port with clean water until the entire pump chamber is full. The pipe/hose leading into the pump should also be full of water. Install throttle valves on the discharge lines for adjusting water flow rate. The valve should be throttled back until the motor draws “full-load amps” (refer to the current rating on the nameplate).

Warning: *If the pump is running wide open and it is not pumping against the required head, the pump will cavitate and adversely affect pump performance and pump life.*

Centrifugal transfer pumps used by QED typically must be throttled back if they are not pumping against the required head. Before initial system startup, double check the pump rotation. A pump shaft rotating in the wrong direction could spin off the pump impeller and cause serious damage to the pump. Pumps operating in the wrong rotation will show poor performance. Systems using pumps should have the flow rates tuned so that the discharge is keeping up with the feed pump.

High Water Level Alarm Switch

The high water level alarm switch is one of the two alarm interlocks that must be properly connected by a licensed electrician prior to the system's initial start-up. Please see the “Special Precautions” at the beginning of the “Equipment Setup” section for more information. The purpose of the high water level alarm switch is to prevent water from flooding the blower by shutting off the incoming contaminated water once it has reached a designated level. The high water level switch will send an alarm signal when it is approximately 3½ inches above the coupling from which its cord emerges.

Line Sampling Ports

The line sampling ports provide a quick and easy means to take a water sample of both incoming contaminated water and outgoing clean water. The sampling ports are the ball valves located on both the inlet and outlet piping. When starting the unit for the first time, double check that the valves on the sample ports are closed.

When taking a water sample, open the valve and let the water flow for at least 1 minute prior to taking the sample. This purges the sample port of any stagnant water. When purging the sample port on the contaminated water line, make sure the contaminated water is collected in some sort of storage container and then properly dispose of the water after sampling.

Low Air Pressure Alarm Switch

The low air pressure alarm switch is one of the two alarm interlocks that must be properly connected by a licensed electrician prior to the system's initial start up. Please see the “Special Precautions” at the beginning of “The Equipment Setup” section for more information. The low air pressure alarm switch monitors the blower for continuous water treatment.

Should the blower fail, the low air pressure switch should be wired to shut off all incoming water. It, like the air pressure gauge, is connected to the system via an air hose which is attached to a pressure port on the sump tank. The air hose is connected to the "high" pressure port on the switch. The "low" pressure port is open to the atmosphere. Periodically inspect and remove any water which may have accumulated in the tubing. The presence of water can affect proper switch operation.

Test the switch, at initial start up, by removing the air hose from the pressure port on the sump tank once the system is in full operation. This should set the system into an alarm condition and shut off the incoming contaminated water.

Main Disconnect Switch

The main disconnect switch removes power from the EZ-Tray™ low profile air stripper. A disconnect is required by the National Electric Code (NEC) and must be installed. Some control panels, not supplied by QED, contain an internal disconnect or circuit breaker to remove power. Disconnects supplied by QED are external to the control panel, providing flexibility in situations where a site already contains a disconnect for the air stripper system. A qualified, licensed electrician should perform any and all electrical connections.

Intermittent Operation

Some systems are ordered with the intermittent operation option. EZ-Tray™ low profile air stripper systems can be designed to run intermittently when continuous blower operation is a concern. When the feed water is flowing into the system, the blower will be in operation and the outlet pump (if provided) will maintain proper sump tank levels. When the feed water is shut down, the blower will run for an additional period of time to treat the water that had previously entered the air stripper before shutting down. When the feed water is restored, the blower will start up to treat the new incoming water. The benefits of intermittent operation are lower operating costs, better control of noise, and longer motor life.

Water Temperature Gauge

The temperature gauges can be installed on both the inlet and outlet piping. The water temperature represents an important factor when estimating the system's performance since it directly effects removal efficiency. Temperature gauges provided by QED typically have a range of 0-140º F.

Water Pressure Gauge

Water pressure gauges can be installed on both the inlet and outlet water lines. The gauges can be used to determine the water pressures entering and exiting the system. Excessively high readings could signal that something in your system is plugged. Large fluctuations in the pressure readings could be a sign that the water flow rate is varying.

Special Precautions!

Use a Licensed, Qualified Electrician for Any and All Electrical/Wiring Work, and Always Use Proper Work Safety Practices!

Follow All Applicable Codes
The plumbing and electrical installations must be performed by qualified personnel. All installations must be done in accordance with local, state and national codes.

Install Adequate Supports on Piping and Ductwork
The external process piping that will connect into and from the QED equipment should be properly supported to minimize stresses and vibration from non-QED equipment. The QED equipment is not designed to support the process water and air lines without proper structural support.

Do Not Run Free Product, Oil or Grease Through the Air Stripper
Free product will contaminate the unit by coating the side walls with a film of free-product. Air strippers are not designed to treat free product, oil, grease, or any other type of immiscible phase.

Equipment Setup Steps

Depending upon how the system was ordered, some of the following instructions may not apply.

Setup Step 1. Secure/Mount the Equipment
For shipping purposes, the EZ-Tray™ unit may come either already skid-mounted or the equipment shipped loose. If shipped loose, locate the equipment as required and firmly secure to the floor, base, etc.

Setup Step 2. Install the Blower Piping
If the blower is not already pre-piped on a QED skid, install the blower piping to connect the blower outlet to the air inlet nozzle on the air stripper sump. Refer to **Figure 3** for an example of a blower piping configuration.

Setup Step 3. Level the EZ-Tray™ Unit
Level the EZ-Tray™ unit. This is a critical step in the proper assembly and installation of the equipment. The aeration trays must be level for proper operation.

Setup Step 4. Install Discharge Piping, either gravity-discharge or pump-discharge.

Install the Gravity Discharge Pipe (For Gravity Discharge Units Only)
Refer to the outlet piping drawing in **Figure 4** to assemble the piping kit and vacuum breaker. Customers providing their own gravity discharge piping must ensure that proper water sump levels are maintained during operation. It is essential that the piping be mounted vertically and that it be properly supported. Install outlet piping from the pump's discharge port. Use proper pipe sealant, PVC cement, and proper plumbing practices and techniques as necessary.

Caution: *The vertical height of the piping should not be changed from that provided in the kit unless air stripper conditions have changed dramatically from the originally-specified flows. The piping kit includes flexible couplings to allow easy vertical height adjustment, should it be necessary.*

Install the Pump Discharge Pipe (For Pump Discharge Units Only)
For a unit with a discharge pump that has not come mounted to a QED skid, install the water line from the air stripper sump to the pump inlet. If customer has purchased a QED pump kit, the components will be found in a separate box. Install outlet piping from the pump's discharge port. Use proper pipe sealant, PVC cement, and proper plumbing practices and techniques as necessary.

Prime the pump. Allow the inlet line and pump chamber to fill completely.

Setup Step 5. Install the Sump Drain Valve and the Sight Tube
(if not already installed at the factory). Make sure all fittings and hose clamps are tight and secure.

Setup Step 6. Connect the Water Lines
Connect the process water lines to the inlet and discharge piping. *Firmly support the process water lines to prevent excessive stress on the piping. The piping is not designed to support the weight of the customer's process water lines.*

Use proper pipe sealant, PVC cement, and proper plumbing practices and techniques as necessary.

Setup Step 7. Connect the Tubing Between Pressure Gauges, Pressure Switch(es), and Air Stripper Sump
Connect the air line tubing from the hose barb located on the top of the sight tube to the high pressure ports on both the air pressure gauge and the air pressure switch(es). Keep the low pressure ports open to the atmosphere (remove plugs or caps).

Setup Step 8. Install Air Discharge Stack
Install any necessary extension to the air stripper air discharge stack as necessary.

Caution: *Any added extension should have an inner diameter at least as large as the air stripper stack.*

Connect the stack extension to the exhaust stack using a flexible rubber coupling or other suitable means. Support the extension independently of the air stripper so that it can be easily disconnected if the demister element must be removed for maintenance purposes, and to prevent damage to top of air stripper housing.

Setup Step 9. Wire the Electrical Components
Have a qualified, licensed electrician wire up the electrical components in compliance with local, state, and national codes.

IMPORTANT! *Make sure the safety interlocks are connected properly!*

To avoid damage to the blower and flooding of the equipment with contaminated feed water, install the high water level and low air pressure interlock switches. If the water level in the sump tank rises beyond the maximum level water could flood the blower. This will destroy the blower and void the warranty. The high water level interlock switch will shut off the feed water pump in an emergency situation. The low air pressure interlock switch will shut off the feed water pump in the event of a blower failure. This reduces the risk of having untreated water passing through the air stripper.

If QED is supplying the control panel, refer to the appropriate wiring diagrams.

Setup Step 10. Install Optional Items
Refer to manufacturers' installation instructions for all equipment and properly support all equipment in an appropriate manner. This also applies to the optional air stripper blower silencer which requires support to avoid overstressing the air stripper blower housing.

Please refer to **Figures 1 and 2** at the end of this manual for a general drawing of an E-Z Tray air stripper and its aeration tray. Upon completion of the equipment set-up procedure, mechanical and electrical installation (including float switches, air pressure switches, etc.), proceed as follows:

Startup Step 1. Turn Off Electrical Components Using the Site's Appropriate "Lock-Out" Procedure. Close Drain and Sample Valves.
Check that all electrical components associated with the unit are turned off,and all drain and sample valves are closed.

Startup Step 2. *IMPORTANT!* Fill the Inlet Chambers with Clean Water.
Each downcomer (**see Figures 1 and 2**) must be sealed by having its end immersed in the seal pot water of the tray below it. Failure to do so may create a situation where not enough back pressure is provided upon blower startup, causing the blower motor overload to trip.

Startup Step 3. *IMPORTANT!* Fill the Sump Tank with One Foot of CleanWater.
On initial start-up, the sump tank must be filled with clean water to a height of about one foot. The sump tank can be filled by taking off the front hatch and filling the sump directly or by disconnecting the water inlet piping and using a hose applied through the water inlet connection. The water level should be seen in the sight tube.

Startup Step 4. Power May Now Be Supplied to the System.

Startup Step 5. *IMPORTANT!* Check the Blower Rotation (*IMPORTANT* for proper air stripper operation)
Check the blower rotation by momentarily turning the Hand-Off-Auto (HOA) Switch to the "Hand" position ("bumping" the motor). Verify that the fan turns in the direction of the arrow on the blower casing. If rotation is incorrect:

1. Have a licensed electrician correct the wiring per manufacturer's instructions.

2. Check and correct the rotation of the other motor(s) in the system. *(This is a common oversight and very often is the reason for inadequate blower operation. If the blower is not providing the expected air flow or backpressure, please double-check this step).*

Startup Step 6. Connect A Clean Water Line To The Air Stripper Inlet. Trial-run Air Stripper System Using Clean Feed Water At The Expected Flow Rate.
Start the QED Air Stripper System by closing the Blower Damper and Placing the Appropriate HOA Switches in the "Auto" Position. Carefully open the damper to achieve the desired tray pressure or air flow rate at the anticipated water flow rate for the system.

Blower throttling is not always possible at unattended and/or intermittent operation sites when the system restarts. Our testing shows that the new seal pots maintain seal water for up to 10 minutes once they are filled. If your system frequently shuts down for longer than 10 minutes, or you've experienced water blow off on start-up, we've created plastic insert pans that sit in the seal pots and ensure that the pot will maintain its water seal.

QED's recommendation is to use the pans on systems that operate intermittently and/or systems where an operator is not present on start up to throttle the blower at the beginning until the seal pots have filled. Reference **Figure 2**.

Startup Step 7. Monitor the Trial Run and Adjust the System Accordingly.
The following items should be monitored as water builds up on each tray:

1. Proper sump pressure. This may require 15-30 minutes for the water to reach the proper depth on each tray. Once the blower has reached its operational speed and water flow is steady, the blower can be throttled to adjust air flow to optimal conditions. QED wet-tests every EZ-Tray unit for proper sump pressures at the customer's expected water flow rates for "clean tray" and "fouled tray" conditions. These values are normally printed on a label and affixed to the side of the air stripper. Adjustments should be made first by referring to these wet-test pressure values. If no values are given, refer to the table below. The values are estimates, and vary depending upon the influent water flow rates. The table assumes there is no additional pressure from equipment downstream of the air stack. If down stream equipment adds back pressure, these values may not be accurate.

	Typical Sump Operating Pressures (Approximate*)
1 Tray System	4-6" wc
2 Tray System	8-12" wc
3 Tray System	12-18" wc
4 Tray System	16-24" wc
5 Tray System	20-30" wc
6 Tray System	24-36" wc

IT IS RECOMMENDED THAT A BOOSTER BLOWER BE USED IF IT IS EXPECTED THAT THE COMBINED PRESSURE LOSS OF THE QED AIR STRIPPER AND ANY DOWN STREAM EQUIPMENT EXCEEDS 40" WC.

Be careful when making damper adjustments—fouling of the system over time will affect the air flow rate. A "fouled" system will have lower air flow at the same sump pressure reading than a clean system. A severely fouled air stripper will not produce the minimum air flow the system requires for proper performance. The blower damper should therefore be adjusted to the proper sump pressure after the trays have been properly cleaned. Refer to the "Equipment Maintenance Instructions" for proper cleaning procedures.

2. Check for any leaks and correct.

Note: *If the blower overload trips, the system will shut down. This overload may indicate that the damper needs to be parially* closed. Reset the overload and try to start the system again.

Once **Step 7** is successfully completed, turn HOA switches to "Off" and proceed to **Step 8**.

Startup Step 8. Replace the Clean Water Feed Line with the Contaminated or Process Feed Line.
Install the inlet piping according to proper plumbing practices. Use proper pipe sealant and PVC cement where necessary.

Startup Step 9. Initiate Full Operation.
Switch all air stripper system HOA switches to "Auto".

Please Note: The blower damper should now already be in its proper position to provide the desired air flow for the system's anticipated influent water flow rate; however, the air flow through the air stripper upon initiating "full operation" will be greater until water builds up on the trays. If this increased air flow is a concern, it is advised to close the damper slightly to throttle the air flow until the water has built up to its final height on each tray.

Startup Step 10. Inspect and Record Unit's Operation Data
Inspect the unit's operation at regular intervals and take pertinent instrument readings. Record readings and performance data in an operations log book.

Startup Step 11. Set the Throttle Valve on Discharge Pump
Units with a discharge pump are supplied with a throttle valve. The valve should be set so that the pump matches the influent flow rate without cavitation and draws no more than the rated full load amps stamped on the pump motor.

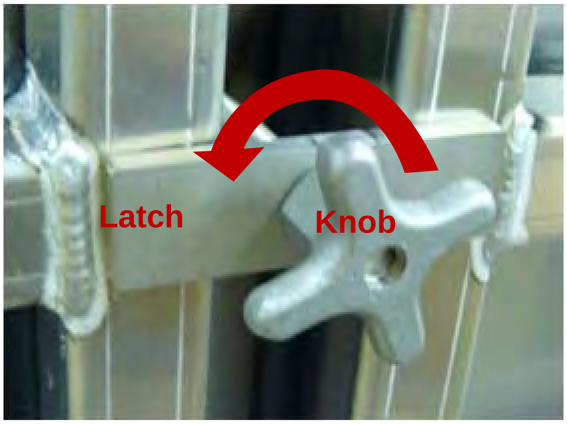
Shutdown Step 1. Shut Water Off
Shut off the water feed to the system.

Shutdown Step 2. Wait 5 Minutes Before Blower Shut Off
Wait 5 minutes to allow the water in the aeration trays to be completely treated, then shut off the blower.

Shutdown Step 3. Shut Power Off
Shut off power at the main disconnected switch if more than a temporary shutdown is anticipated.

Caution: *If proper shutdown procedures are not followed contaminated water will drain into the sump and contaminate the water that has collected in the sump. Allow the blower to run the additional 5 minutes after the feed water is shut off.*

Tray Removal (for strippers with hinged doors)



1. Loosen the door knobs by turning them counterclockwise.

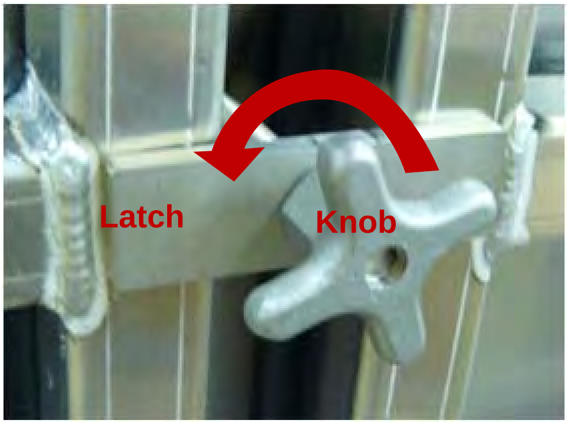
2. Remove the knobs and latches from the bolts above and below the door.

3. Loosen the side knobs until the latches can be rotated to the vertical position. The knobs and latches can be left in place on the two outside door sides. The knobs and latches must be completely removed from all of the door sides in the middle of the stripper.
Swing the hinged doors open to gain access to the trays.

4. Remove the trays starting with the top tray and working down. Each downcomer will need to be raised to allow enough clearance to slide the tray out. The downcomer will need to be completely removed on the bottom-most tray. If "seal pots" (shallow black plastic pots) are being used at the base of the downcomers, gently raise the front end of the "seal pot" to pour the water out of it prior to sliding the tray out. Emptying the "seal pots" prevents water from splashing onto personnel.

5. Pull the tray straight out and remove it for cleaning. QED can provide specialty tools that make tray removal easier. After cleaning the trays and the other internal surfaces of the stripper, replace everything in reverse order.

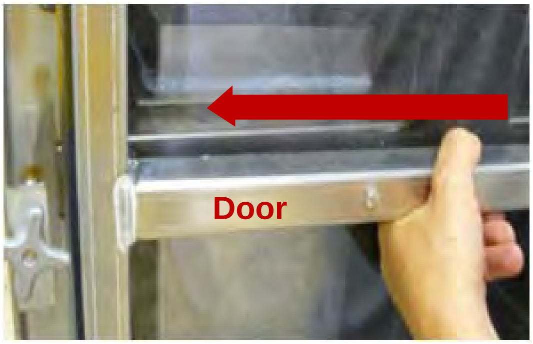
Tray Removal (for strippers without hinged doors)



1. Loosen the door knobs by turning them counterclockwise.

2. Remove the knobs and latches from the bolts above and below the door.

3. Loosen the knobs on the sides of the door until the latches can be rotated to the vertical position.



4. Slide the door slightly to the left, turn it on an angle and remove the door by pulling it outward. The knobs may need to be turned to the "X" position to provide enough clearance for door removal.

5. Remove the trays starting with the top tray and working down. Each downcomer will need to be raised to allow enough clearance to slide the tray out. The downcomer will need to be completely removed on the bottom-most tray. If "seal pots" (shallow black plastic pots) are being used at the base of the downcomers, gently raise the front end of the "seal pot" to pour the water out of it prior to sliding the tray out. Emptying the "seal pots" prevents water from splashing onto personnel.

6. Pull the tray straight out and remove it for cleaning.
QED can provide specialty tools that make tray removal easier.
After cleaning the trays and the other internal surfaces of the stripper, replace everything in reverse order.

Tray and Downcomer Weights

Standard Trays	Tray Only (Lbs.)	Tray with Short Downcomer (Lbs.)	Tray with Bottom Downcomer (Lbs.)
4 Series	19	24	30
6 Series	24	30.5	37.5
8 Series	32	38.5	45.5
12 Series	46.5	54.5	63.5
16 Series	32	38.5	45.5
24 Series	46.5	54.5	63.5
36 Series	46.5	54.5	63.5
48 Series	46.5	54.5	63.5
72 Series	46.5	54.5	63.5
96 Series	46.5	54.5	63.5

Split Trays

12 Series Front	27	35	44
12 Series Back	25		

Downcomers

4 Down	5
4 Down Bottom	11
6 Down	6.5
6 Down Bottom	13.5
12 Down	8
12 Down Bottom	17

This information describes how to clean the QED EZ-Tray™ Air Stripper unit. Please refer to the manufacturer's instructions for maintenance on the non-air stripper equipment.

Tray Fouling
With normal operation of the air stripper, the sump pressure will typically increase over time. This typically indicates that the air stripper trays are becoming fouled. If this occurs, shut down the system. Remove the door and visually inspect for signs of fouling and clean the air stripper as outlined in the "Maintenance" section of this manual. Occasionally inspect the pressure gauge tubing for water build up. Water trapped in the air tubing could produce an erroneous reading. A pinch clamp is provided on the tubing and should be closed when no one is at the site in order to prevent potential condensate accumulation. Condensation buildup will ruin the pressure gauge.

Dealing with High Mineral Concentrations
Minerals, dissolved in high concentrations, tend to precipitate out of ground water during aeration processes. These minerals form insoluble deposits commonly referred to as "fouling". Deposits from iron-rich or mineral-rich feed water can be reduced by pre-treating it with sequestering agents or possibly other types of technologies. There are a number of sequestering suppliers that should be able to offer recommendations or suggestions. The recommended cleaning procedure is pressure-washing. Follow the instructions detailed below.

Cleaning the Air Stripper

Recommended cleaning equipment:

Pressure Washer with Washer Wand
2 GPM minimum flow at 900 PSI maximum. Equipment rental companies can usually supply such a unit on a daily rental basis.

Clean Water Supply
Clean water supply with a capacity of at least 2 GPM at 20 PSI, connected to the pressure washer by means of an ordinary garden hose.

Cleaning the Unit.
The QED air stripper is designed for easy cleaning. Trays can either be removed for cleaning or left in the unit and cleaned. Another option would be for the customer to purchase a spare set of trays which would allow maintenance personnel to replace the fouled trays with clean trays and reduce air stripper down time and allow the maintenance personnel to clean the trays at their convenience.

Cleaning Step 1. Turn Off Equipment, Perform Electrical "Lockout"Procedure
Turn off the feed water supply and all associated electrical equipment.

Cleaning Step 2. Provide for Waste Disposal
Make provisions for disposing of the sludge and waste generated during cleaning.

Cleaning Step 3. Remove Front Cover(s). Either remove the traysfrom the air stripper unit or leave them in for cleaning.

Cleaning Step 4. Turn On Water and Pressure Washer
Turn on the water supply to the pressure washer. Then, turn on the pressure washer itself. Wear protective goggles while spraying.

Cleaning Step 5. Insert Wand into Air Stripper
(This step is for cleaning trays while they remain in the air stripper unit. If trays have been removed for cleaning, skip step 5 and proceed to step 6.)

Insert the wand all the way into the door opening. Point the spray nozzle up towards the bottom of the lowest tray.

Cleaning Step 6. Clean Bottom Side of Tray
Holding the wand tightly, pull the trigger to start the pressurized water flow. Expect the wand to kick back as flow starts. Move the wand side to side at a rate of about 1" per second. Be sure to cover the entire tray bottom area. The tray holes must be cleaned of all deposits. Periodically stop the cleaning operation and inspect the cleaned area. The area is clean when there are no deposits around the aeration holes.

Cleaning Step 7. Clean Top Side of Tray
Move the wand to the top side of the tray. Continue spraying with the nozzle pointed down onto the top surface of the tray. Also clean the downcomer and sealpot areas. Remove all visible deposits from the tray baffles and the walls of the unit. Inspect the cleaned area for deposits.

Cleaning Step 8. Repeat for all Trays
Repeat the procedure for all trays, working up to the top-most tray.

Cleaning Step 9. Spray the Ceiling and Walls of the Air Stripper.
Cleaning the walls and ceiling are not necessarily required for proper air stripper operation.

Cleaning Step 10. Rinse
After the cleaning operation is finished, rinse the ceiling, trays, baffles,and walls with the pressure washer. Work down from the top down to the sump tank. Make sure the surfaces are clean and the holes are not blocked by loosened debris.

Cleaning Step 11. Check the Demister Pad and Replace as Necessary
Inspect the demister pad and clean as needed. Use the pressure sprayer to remove debris, deposits and gummy residues sometimes found on the demister pad. Demister pads that are excessively plugged should be replaced.

Cleaning Step 12. Inspect the Air Stripper
Visually inspect the air stripper box for the following:

1. Gasket integrity
2. Inspect the air stripper for any damage and repair as necessary.
3. Aeration tray integrity. Inspect trays for structural damage.
4. Inspect the internal piping (typically PVC piping) and replace as necessary.

Problem 1. Blower Won't Start or Run

No Power to Blower
Check that all switches are in "ON" or "AUTO" position.

Position main disconnect switch to "ON" position. Turn control switches to"ON" or "AUTO".

Blown Fuse
Check to see if fuses are okay. Check fuses in main disconnect switch and in control panel.

If blown, replace with fuse of same size and rating.

Overload Relay Trips
Locate reset button on blower overload relay. Push reset button in. Reasons for tripping: incorrect line voltage, motor wired incorrectly, loose wire connections, inadequate ventilation, bearings are bad.

Tubing to Pressure Switch Plugged with Water or Debris
Remove tubing from pressure switch and blow into it towards tank.

Clean or replace tubing if plugged or kinked.

Blower Wheel Jammed Against Side of Housing
TURN OFF ALL power to the system. Try to spin wheel by hand. Wheel should rotate freely. See blower manual for more details. Call QED.

Problem 2. Discharge Pump Won't Shut Off

Suction or Discharge Piping for Pump is Clogged
Check water flow from discharge pipe. Piping should be clean inside. Look for narrowing caused by scale or iron accumulation.

Remove piping, inspect and clean or replace as necessary.

Float Switch in Tank is Stuck in Down Position
Look into sump and check that all floats are free moving and floating on the water.

Clean all deposits from float. Replace float as necessary.

Normal Operation - Water Level in Sump is Okay
Pump will stop when water level reaches pre-determined height in tank (low level).

Allow water level to decrease until pump turns off.
Let water level reach pre-determined lower level, which will cause discharge pump to turn off.

Problem 3. Discharge Pump Won't Start or Run

No Power to Pump
Check that all switches are in "ON" or "AUTO" position.

Position main disconnect switch to "ON" position. Turn control switches to "ON" or "AUTO".

Blown Fuse
Check to see if fuses are okay. Check fuses in main disconnect switch and in control panel.

If blown, replace with fuse of same size and rating.

Overload Relay Trips
Locate reset button on pump contactor overload relay.

Push reset button in. Reasons for tripping: incorrect line voltage, motor wired incorrectly, inadequate ventilation, obstruction in piping, bearings are bad.

Normal Operation - Water Level in Sump is Okay
Pump will start when water level reaches pre-determined height in tank.

Allow water level to increase until pump turns on. Be sure pump switch is in "Auto" position.

Let water level reach pre-determined upper level, which will cause discharge pump to turn on.

Level Switch in Tank is Wired Incorrectly in Control Panel
Check wiring circuit against diagram. See that all connections are tight and no short circuits exist because of worn insulation, crossed wires, etc.

Rewire any incorrect circuits. Tighten connections, replace defective wires.

Impeller, Seal or Bearing Damaged
TURN OFF POWER. Try to turn impeller by hand.

If impeller won't turn, remove housing and locate source of binding, or obstruction.

Problem 4. Low Air Pressure in Stripper Tank

Blower Damper Closed
Visually check position of damper near discharge of blower.

Open damper to get proper reading on pressure gauge. Firmly tighten screws.

Motor Rotation Backwards
Watch rotation of blower wheel at slow speed.

Reconnect for proper rotation as per motor diagram.

Gravity Discharge Trap Installed Incorrectly
Tray should be positioned vertically.

Install discharge trap per outlet plumbing drawings provided in **Figure 4**.

Inlet Chamber (Sealpot) in each Tray is Not Full of Water
Follow inlet chambers fill up procedures above in Initial Start Up.

Front Cover not in Place
Front cover must be secured during operation.

Tubing to Pressure Gauge Plugged with Water or Debris
Remove tubing from pressure gauge and blow into it towards tank.

Clean or replace tubing if plugged or kinked.

Debris Blocking Blower Intake
Look at blower intake. Remove any accumulated debris.

Normal Operation in Automatic Mode
When inlet pump starts, blowers will start, air pressure will rise to operational level.

No action necessary.

Problem 5. High Pressure in Stripper

Air Exhaust Piping is Restricted
Check vent piping for obstructions. Check that vent pipe diameter does not decrease.

Vent piping diameter must be the same as the outlet vent diameter on the cover.

Air Holes in Bottom of Trays are Plugged
Remove front cover and visually inspect holes.

For iron fouling, clean out unit with a 1000 PSI pressure washer. For scaling, scrape or tap scale from all surfaces, then use a pressure washer to open holes. Consider using sequestering agent or other technology to reduce scaling.

Demister Pad is Plugged
Inspect the bottom of the demister pad in the cover. Clean and/or replace as necessary.

Problem 6. Water Won't Flow Into Unit

Inlet/Well Pump Functioning Properly
Allow water level to rise in well pump, which will turn on inlet pump to system.

No action necessary.

Tank Air Pressure is Low. System is in Alarm Condition
Read tank air pressure from pressure gauge. System should be in alarm condition if pressure is below about 2 inches w.c.

Check that blower is operating properly.

Inlet Piping is Plugged
Remove inlet piping and inspect for debris and buildup.

Clean or replace clogged parts.

Problem 7. Iron Fouling is a Problem

Iron Precipitates Out of Water When Treated with an Air Stripper Causing Iron Build Up in Unit
Remove the front door(s) and inspect inside of tray for buildup/fouling.

Clean out unit with 1000 PSI pressure washer on routine basis.

Pretreat incoming water using sequestering agents or other appropriate technology.

QED Environmental Systems Inc. (QED) warrants to the original purchaser of its products that, subject to the limitations and conditions provided below, the products, materials and/or workmanship shall reasonably conform to descriptions of the products and shall be free of defects in materials and workmanship. Any failure of the products to conform to this warranty will be remedied by QED in the manner provided herein.

QED warrants the equipment components of its manufacture for a period of one (1) year from date of delivery. Our sole obligation during this warranty will be to repair or replace (at our option) the defective components. We are not responsible for consequential damages. Labor costs are not included.

Purchaser's exclusive remedy for breach of said warranty shall be as follows: if, and only if, QED is notified in writing within the applicable warranty period of the existence of any such defects in the said products, and QED upon examination of any such defects, shall find the same to be within the term of and covered by the warranty running from QED to Purchaser, QED will, at its option, as soon as reasonably possible, replace or repair any such product, without charge to Purchaser. If QED for any reason, cannot repair a product covered hereby within four (4) weeks after receipt of the original Purchaser's notification of a warranty claim, then QED's sole responsibility shall be, at its option, either to replace the defective product with a comparable new unit at no charge to the Purchaser, or to refund the full purchase price. In no event shall such allegedly defective products be returned to QED without its consent, and QED's obligations of repair, replacement or refund are conditioned upon the Purchaser's return of the defective product to QED.

IN NO EVENT SHALL QED ENVIRONMENTAL SYSTEMS INC. BE LIABLE FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF SAID WARRANTY.

The foregoing warranty does not apply to major subassemblies and other equipment, accessories, and other parts manufactured by others, and such other parts, accessories, and equipment are subject only to the warranties supplied by their respective manufacturers. In the event of failure of any such product or accessory, QED will give assistance to Purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in light of the manufacturer's own warranty.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY (INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANT ABILITY AND FITNESS FOR A PARTICULAR PURPOSE), WHICH OTHER WARRANTIES ARE EXPRESSLY EXCLUDED HEREBY, and of any other obligations or liabilities on the part of QED, and QED neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with said products, materials and/or workmanship.

It is understood and agreed that QED shall in no event be liable for incidental or consequential damages resulting from its breach of any of the terms of this agreement, nor for special damages, nor for improper selection of any product described or referred to for a particular application.

This warranty will be void in the event of unauthorized disassembly of component assemblies. Defects in any equipment that result from abuse, operation in any manner outside the recommended procedures, use and applications other than for intended use, or exposure to chemical or physical environment beyond the designated limits of materials and construction will also void this warranty.

The equipment is warranted to perform as specified under the conditions specified here and within the air stripper model or QED will make the necessary changes at no cost to the owner. Some restrictions apply. Requirements for warranty consideration include, (but are not limited to):

1. Current operating conditions do not differ from the previously-modeled conditions.
2. The system should be cleaned regularly to maintain system performance.
3. The equipment is installed, operated and maintained according to QED's instruction or non-QED manufactured subassembly manufacturer's instructions.
4. Air stripper influent air is not "dirty" (does not contain VOC's, etc.).
5. No surfactants, oils, greases, immiscible phases or other Henry's constant altering water additions present in the water.
6. Each influent contaminant does not exceed 25% of its maximum solubility under modeled conditions.

QED shall be released from all obligations under all warranties if any product covered hereby is repaired or modified by persons other than QED's service personnel unless such repair by others is made with the consent of QED. If any product covered hereby is actually defective within the terms of this warranty, Purchaser must contact QED for determination of warranty coverage. If the return of a component is determined to be necessary, QED will authorize the return of the component, at owner's expense. If the product proves not to be defective within the terms of this warranty, then all costs and expenses in connection with the processing of the Purchaser's claim and all costs for repair, parts and labor as authorized by owner hereunder shall be borne by the Purchaser.

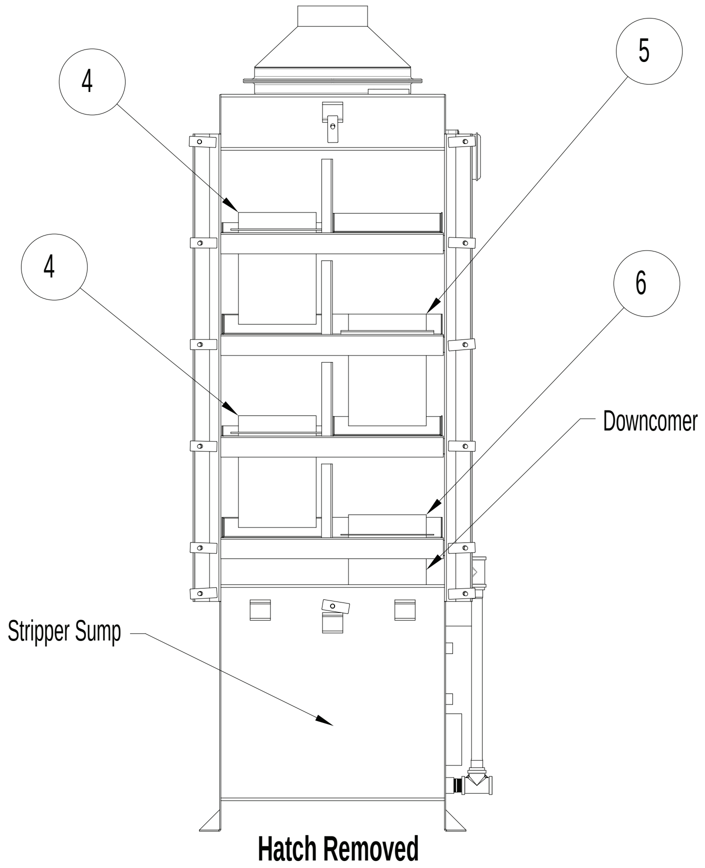
In the event of air stripper performance issues, QED may require customer to conduct a variety of troubleshooting steps. These include, but are not limited to, modifying operational parameters, cleaning air stripper system, modifying (temporarily or permanently) process piping, and obtaining reasonable and necessary influent/effluent samples. These steps are the responsibility of the customer and will be conducted by customer prior to consideration by QED for a site visit. These steps and the associated costs incurred are the responsibility of the customer, regardless of future action. Should customer request a site visit by QED or accept a site visit offer by a QED-trained technician, the visit and associated costs: a) will be the responsibility of the customer at $750/day, plus travel, lodging, and meals, if the visit finds improper sampling, process piping installation, or equipment operation inconsistent with QED's Operation and Maintenance Manual; or b) will be the responsibility of QED if the visit finds QED responsible for the performance issue(s) raised.

The original Purchaser's sole responsibility in the instance of a warranty claim shall be to notify QED of the defect, malfunction, or other manner in which the terms of this warranty are believed to be violated. You may secure performance of obligations hereunder by contacting the Customer Service Department of QED and:

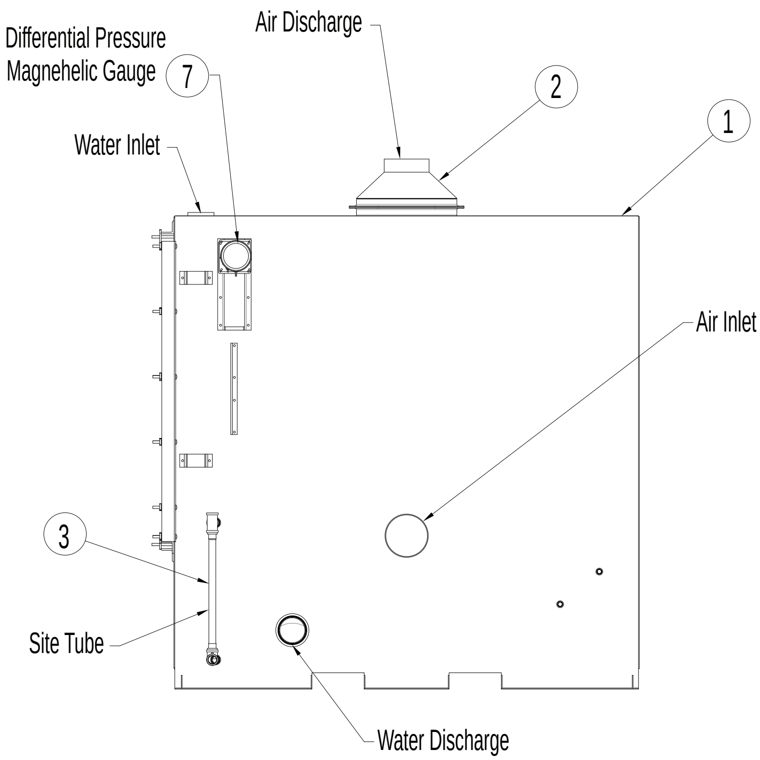
1. Identify the product or system involved by job number or QED order number.
2. Specifying where, when, and from whom the product was purchased.
3. Describing the nature of the defect or malfunction covered by this warranty.
4. If applicable, send the malfunctioning component, after receiving a Return Authorization Code (RAC) Number from the QED Service Department, to:

QED Environmental Systems Inc.
6241 Jackson Road
Ann Arbor, MI 48103
Attn: RAC Number
(RAC provided by QED Service Dept.)

Figure 1 General Drawing of E-Z Tray Air Stripper

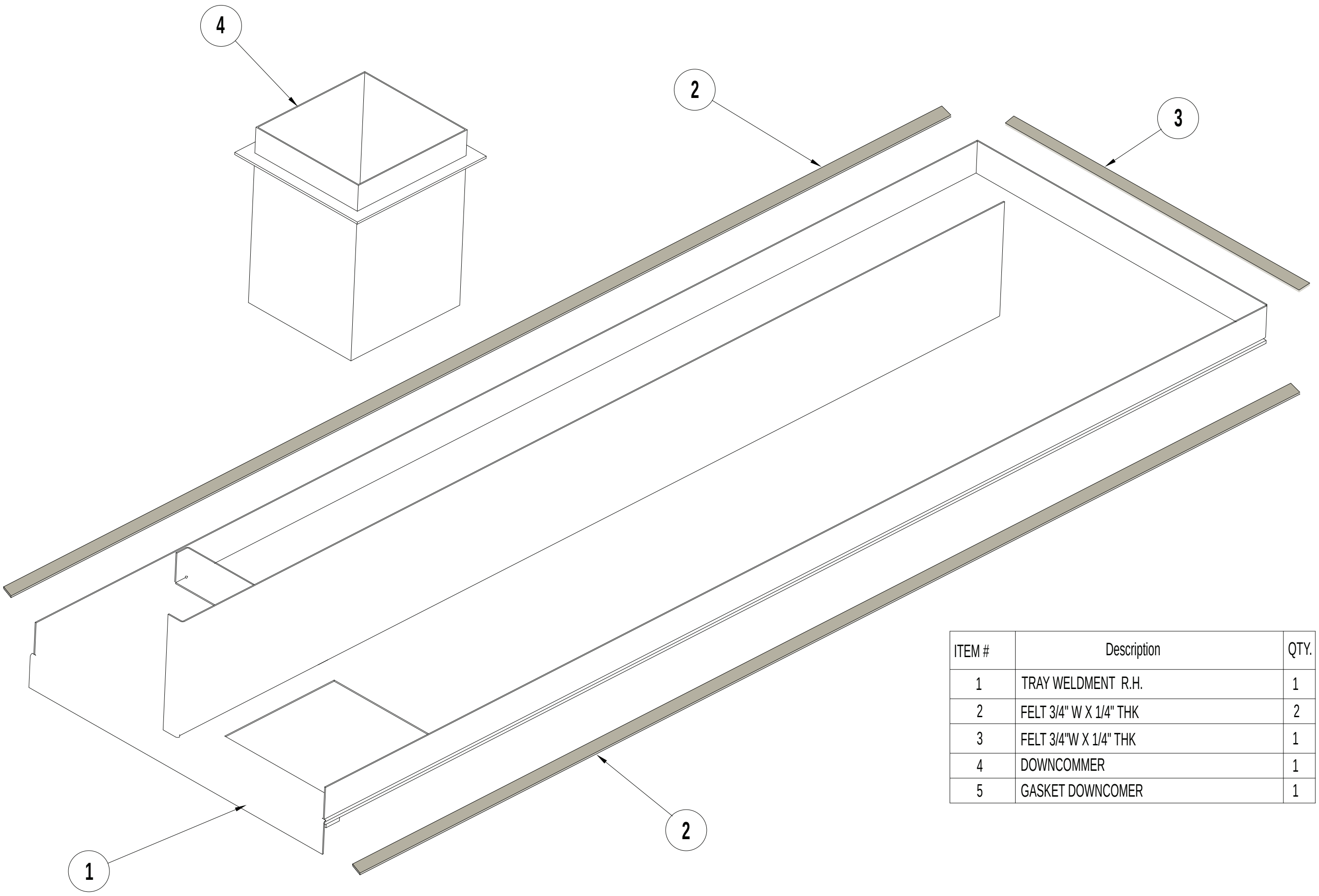


ITEM NO.	Description	QTY.
1	EZ TRAY AIR STRIPPER	1
2	DEMISTER HOUSING	1
3	SIGHT TUBE	1
4	TRAY L.H.	2
5	TRAY R.H.	1
6	TRAY R.H. BOTTOM	1
7	GAUGE MAGNEHELIC	1



QED Environmental Systems

Figure 2 Typical Tray Assembly



ITEM #	Description	QTY.
1	TRAY WELDMENT R.H.	1
2	FELT 3/4" W X 1/4" THK	2
3	FELT 3/4"W X 1/4" THK	1
4	DOWNCOMMER	1
5	GASKET DOWNCOMER	1

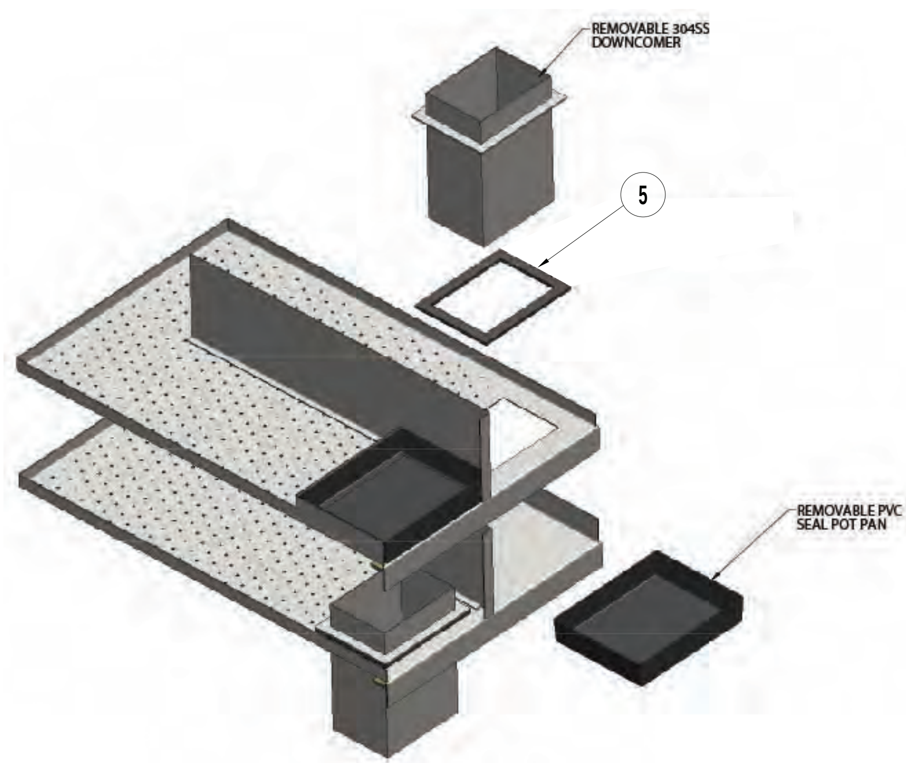


Figure 3 Typical Blower Piping

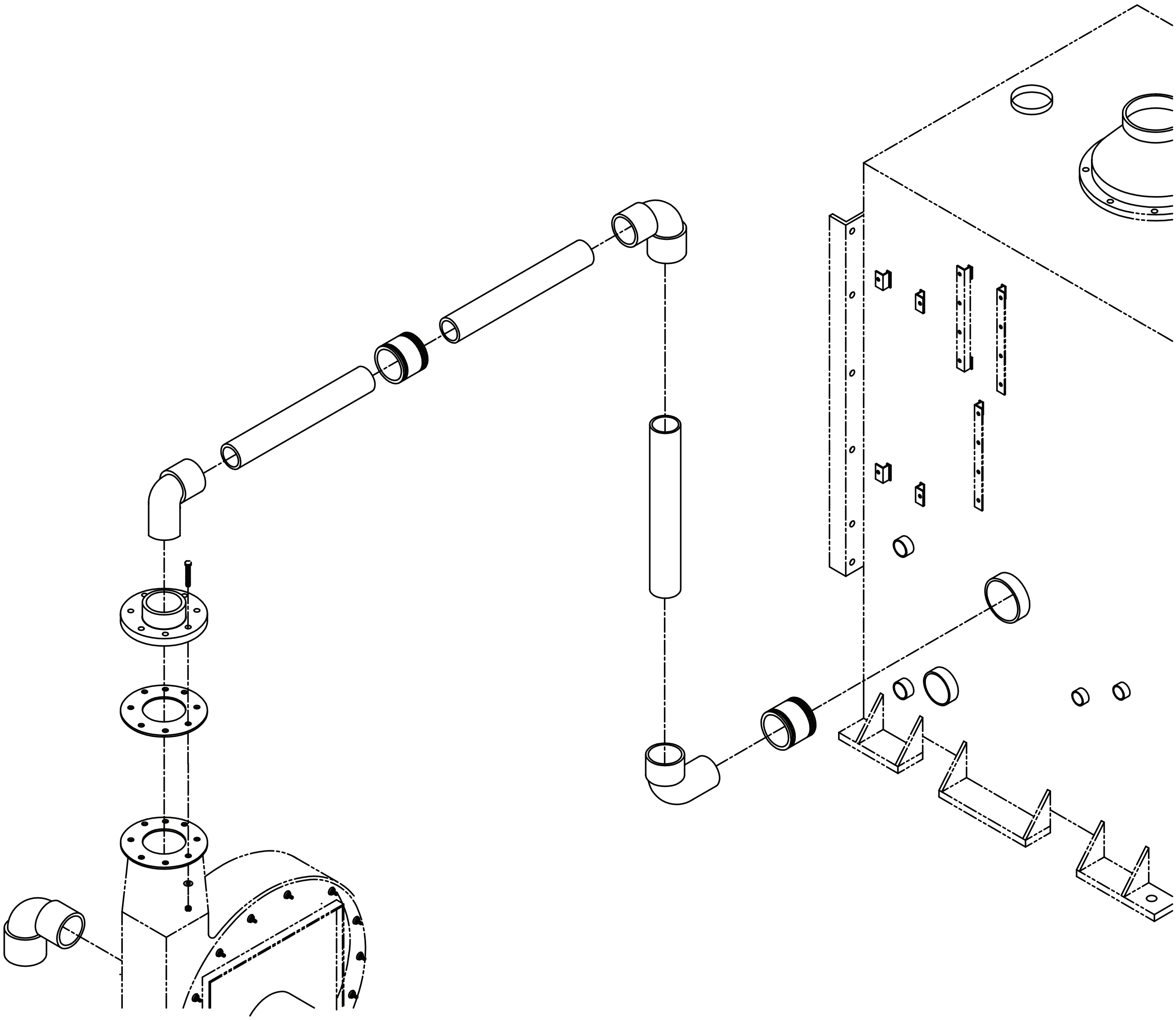
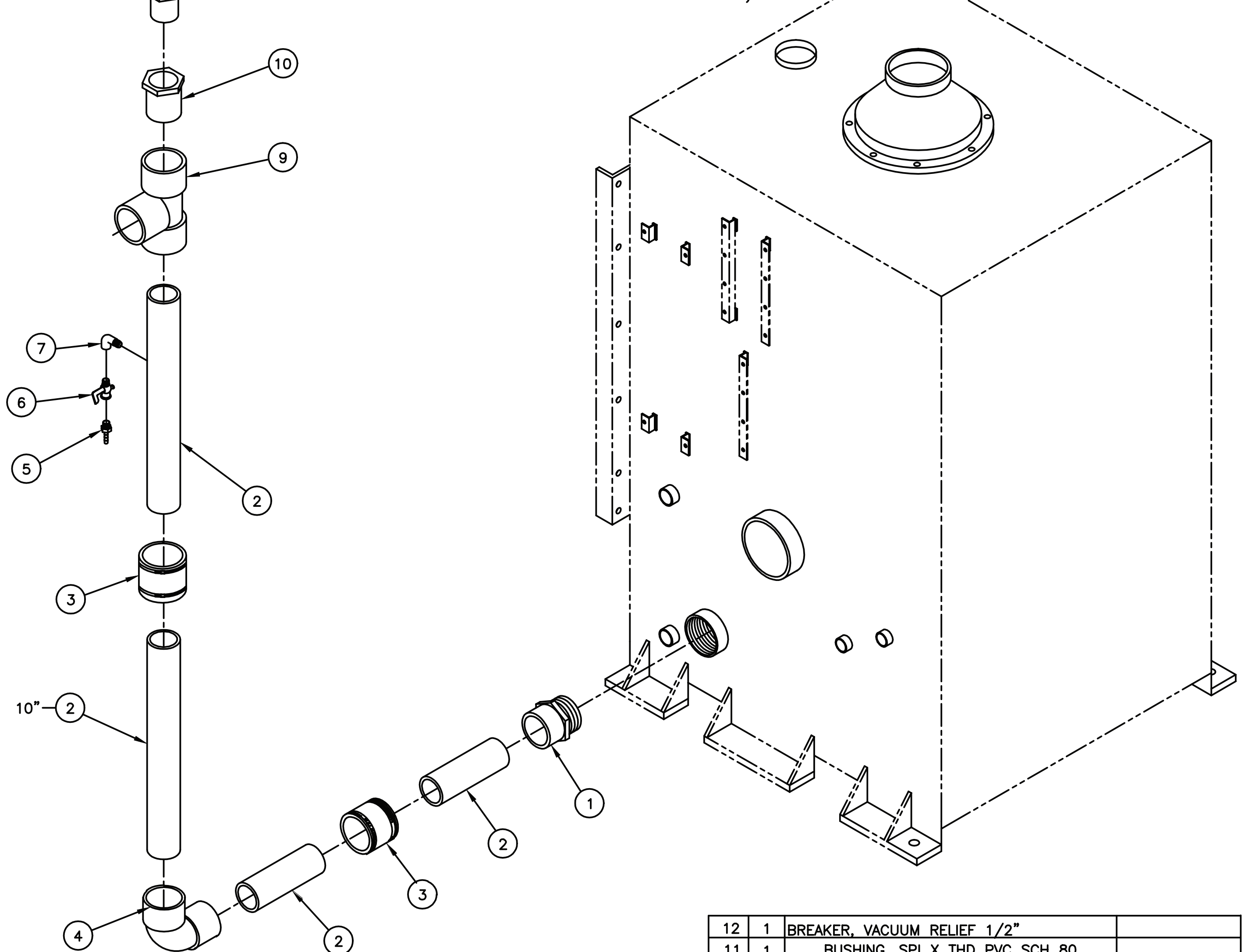


Figure 4 Typical Gravity Discharge Piping

NOTE:
1. CENTER LINE OF WATER OUT (ITEM 1) TO CENTER LINE OF DRAIN CONNECTOR (ITEM 9) TO BE 27" – 6 TRAY
18" – 4 TRAY

(DIMENSIONS ARE APPROXIMATE––REQUIRES SOME ADJUSTMENT AS NECESSARY BASED UPON SUMP PRESSURES AND WATER FLOWS. ASSUMES STANDARD OPERATING CONDITIONS.)



ITEM	QTY	DESCRIPTION	PART #
12	1	BREAKER, VACUUM RELIEF 1/2"	
11	1	BUSHING, SPI X THD PVC SCH 80	
10	1	BUSHING, REDUCER SPI. X SOC.	
9	1	TEE, SOCKET PVC SCH 80	
8			
7	1	ELBOW, STREET 1/8" FPT BRASS	
6	1	COCK, SHUTOFF 1/8"MPT X 1/8"FPT BRASS	
5	1	BARB, 1/8"MPT X 3/16" BARB	
4	1	ELBOW, 90 DEGREE PVC SCH 80 SOCKET	
3	2	FERNCO, FLEXIBLE PVC	
2	TBD	PIPE, PVC SCH 80	
1	1	ADAPTER, PVC SCH 80	

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES AND INCLUDE PLATING
REMOVE ALL BURRS
TOLERANCES
.XX+/-.01 FRACT +/-1/64
.XXX+/-.005 ANGLES+/-1/2
OTHER TOLERANCES AS SPECIFIED
EZ-TRAY (24.X)
NEXT ASS'Y | USED ON

DRAWN BY MEB | DATE 10/29/99
CHECKED BY | DATE
APPROVED BY | DATE
MFG. APPROVAL
MATERIAL
FINISH

QED
ENVIRONMENTAL SYSTEMS INC.
6155 JACKSON ROAD, ANN ARBOR, MI.

TITLE
GRAVITY DRAIN
ASSEMBLY/BOM/KIT

DRAWING NUMBER eztgravdis | REV
SCALE N.T.S. | SHEET 1 OF 1

P-SERIES
USER MANUAL

Thank you for purchasing CERUS Variable Frequency Drives!

SAFETY INSTRUCTIONS

To prevent injury and property damage, follow these instructions during the installation and operation of the inverter.

Incorrect operation due to ignoring these instructions may cause harm or damage. The following symbols are used throughout the manual to highlight important information.

⚠ **DANGER**	**This symbol indicates death or serious injury can occur if you do not follow instructions.**
⚠ **WARNING**	**This symbol indicates the possibility of death or serious injury.**
⚠ **CAUTION**	**This symbol indicates the possibility of damage to the inverter or other components.**

■ **The meaning of each symbol in this manual and on your equipment is as follows.**

⚠ **This is the safety alert symbol.**
Read and follow instructions carefully to avoid a dangerous situation.

⚠ **This symbol alerts the user to the presence of "dangerous voltage" inside the product that might cause bodily harm or electric shock.**

■ **This manual should be placed in a location where it can be accessed by users.**

■ **This manual should be given to the person who actually uses the inverter and is responsible for its maintenance.**

⚠ WARNING

- **Do not remove the cover while power is applied or the unit is in operation.**
  Otherwise, electric shock could occur.

- **Do not operate the inverter with the front cover removed.**
  Otherwise, electric shock can occur due to the exposed terminals and bus bars.

- **Do not remove the cover except for periodic inspections or wiring, even if the input power is not applied.**
  Otherwise, electric shock can occur due to accessing capacitor banks.

- **Wiring and periodic inspections should be performed at least 10 minutes after disconnecting the input power and after checking the DC link voltage is discharged with a meter (below 30VDC).**
  Otherwise, electric shock could occur.

- **Operate the switches with dry hands.**
  Otherwise, electric shock could occur.

- **Do not use the cable when its insulating tube is damaged.**
  Otherwise, electric shock could occur.

- **Do not subject the cables to scratches, excessive stress, heavy loads or pinching.**
  Otherwise, electric shock could occur.

⚠ CAUTION

- **Install the inverter on a non-flammable surface. Do not place flammable materials nearby.**
  Otherwise, fire could occur.

- **Disconnect the input power if the inverter has been damaged.**
  Otherwise, it could result in a secondary accident and fire.

- **Do not touch the inverter after shutting down or disconnecting it. It will remain hot for a couple of minutes.**
  Otherwise, bodily injuries such as skin-burn or damage could occur.

- **Do not apply power to a damaged inverter or to an inverter with parts**

missing even if the installation is complete.
Otherwise, electric shock could occur.

- **Do not allow lint, paper, wood chips, dust, metallic chips or other foreign material into the drive.**
  Otherwise, fire or accident could occur.

OPERATING PRECAUTIONS

(1) Handling and installation

- The P series inverter can be heavy. Lift according to the weight of the product. Use a hoist or crane to move and install the P series inverter if necessary. Failure to do so may result in personal injury or damage to the inverter.
- Do not stack the inverter boxes higher than the number recommended.
- Install the inverter according to instructions specified in this manual.
- Do not open the cover during delivery.
- Do not place heavy items on the inverter.
- Check that the inverter mounting orientation is correct.
- Do not drop the inverter, or subject it to hard impact.
- Verify the ground impedance 100ohm or less for 230 V Class inverters and 10ohm or less for 460V class inverters.
- Take protective measures against ESD (Electrostatic Discharge) before touching the pcb boards during inspection, installation or repair.
- The inverter is designed for use under the following environmental conditions:

Environment	Ambient temp.	- 10 ~ 40 ℃ (14°F ~ 104°F)
	Relative humidity	90% Relative Humidity or less (non-condensing)
	Storage temp.	- 20 ~ 65 ℃ (-4°F ~ 149°F)
	Location	Protected from corrosive gas, combustible gas, oil mist or dust (Pollution Degree 2 Environment)
	Altitude, Vibration	Max. 1,000m (3,300ft) above sea level, Max. 5.9m/sec^2 (0.6G) or less
	Atmospheric pressure	70 ~ 106 kPa (20.67 in Hg ~ 31.3 in Hg)

(2) Wiring

- Do not connect power factor correction capacitors, surge suppressors, or RFI filter to the output of the inverter.
- The connection orientation of the motor output cables U, V, W will affect the direction of rotation of the motor. Verify correct wiring before starting inverter.
- Incorrect terminal wiring could result in inverter and/or equipment damage.
- Reversing the polarity (+/-) of the terminals could damage the inverter.
- Only authorized personnel familiar with CERUS inverter should perform wiring and inspections.
- Always install the inverter before wiring. Otherwise, electric shock or bodily injury can occur.

(3) Trial run

- Check all parameters during operation. Parameter values might require adjustment depending on the application.
- Always apply voltage within the permissible range of each terminal as indicated in this manual. Otherwise, inverter damage may result.

(4) Operation precautions

- When the Auto restart function is selected, the inverter will restart after a fault has occurred.
- The Stop key on the keypad can only be used to stop the inverter when keypad control is enabled. Install a separate emergency stop switch if necessary.
- If a fault reset is made with the run command and /or reference signal present, a sudden start will occur. Check that the run command and /or reference signal is turned off in advance of resetting any faults. Otherwise an accident could occur.
- Do not modify the inverter.
- Depending on the motor specifications and user ETH overload settings, the motor may not be protected by electronic thermal function of inverter.
- The operation of the inverter is intended to be controlled by either keypad command or control input signals. Do not use a magnetic contactor or any other device that routinely disconnects the inverter and reconnects the inverter to the input supply power for the purpose of starting and stopping the motor.
- A noise filter may be installed to reduce the effect of electromagnetic interference. Otherwise nearby electronic equipment may be affected.
- In cases with input voltage unbalances, install an AC input reactor.
- Power Factor capacitors and generators may become overheated and damaged due to harmonics created by the inverter.
- Use an insulation-rectified motor or take measures to suppress the micro surge voltage when driving 460V class motor with inverter. A micro surge voltage attributable to wiring constant is generated at motor terminals, and may deteriorate insulation and damage motor.
- Before operating unit and prior to user programming, reset user parameters to default settings.
- The Inverter can be set to operate a motor at high-speeds. Verify the speed capability of motor and machinery prior to operating inverter.
- Holding torque is not produced when using the DC-Brake function. Install separate equipment when holding torque is required.

(5) Fault prevention precautions

- If required, provide a safety backup such as an emergency mechanical brake to prevent any hazardous conditions if the inverter fails during operation.

(6) Maintenance, inspection and parts replacement

- Do not megger (hi-pot or insulation resistance) test the power or control circuit of the inverter.
- Refer to Chapter 8 for periodic inspection and parts replacement details.

(7) Disposal

- Handle the inverter as an industrial waste when disposing of it.

(8) General instructions

Many of the diagrams and drawings in this instruction manual show the inverter without a cover. Prior to operating the unit, be sure to restore covers and circuit protection according to specifications.

Table of Contents

CHAPTER 1 - BASIC INFORMATION

1.1 Inspection

- Remove the inverter from its packing and inspect its exterior for shipping damage. If damage is apparent notify the shipping agent and your CERUS sales representative.
- Remove the cover and inspect the inverter for any apparent damage or foreign objects. Ensure that all mounting hardware and terminal connection hardware is properly seated, securely fastened, and undamaged.
- Check the nameplate on the P inverter. Verify that the inverter unit is the correct horsepower and input voltage for the application.

1.1.1 Inverter model number

The numbering system of the inverter is as shown below.

CI 007 P – 2 NE

Motor rating	
007	5.5kW
010	7.5kW

Series Name
P

N: No Keypad
O: UL Open Type
E: UL Enclosed Type 1
L: Built-in DC Choke

	Input Voltage
2	200 - 230V
4	380 - 480V

1.1.2 Installation

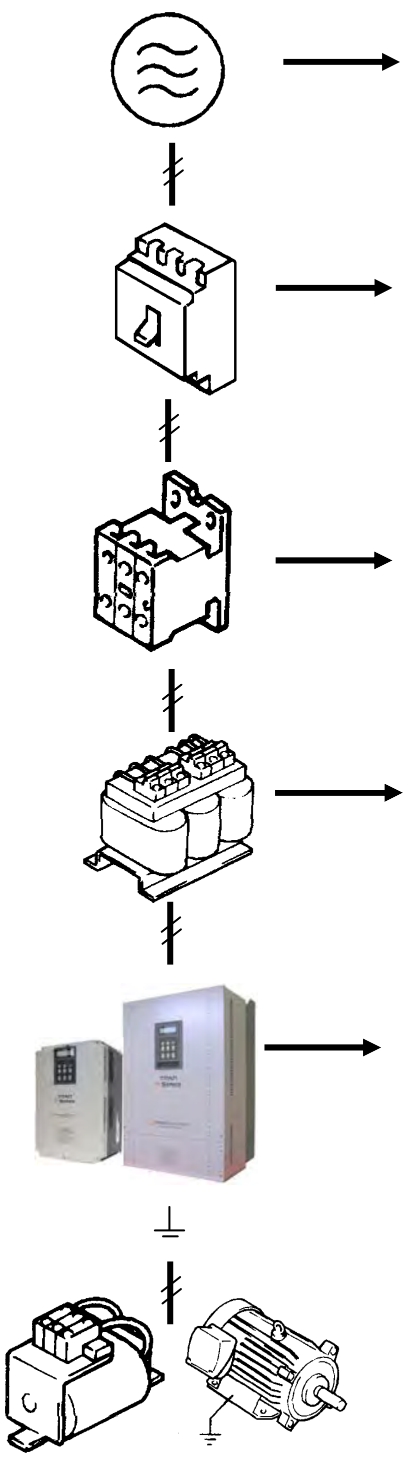
To operate the inverter reliably, install the inverter in a proper place with the correct direction and with the proper clearances.

1.1.3 Wiring

Connect the power supply, motor and operation signals (control signals) to the terminal block. Note that incorrect connection may damage the inverter and peripheral devices.

1.2 Basic configuration

The following devices are required to operate the inverter. Proper peripheral devices must be selected and correct connections made to ensure proper operation. An incorrectly applied or installed inverter can result in system malfunction or reduction in product life as well as component damage. You must read and understand this manual thoroughly before proceeding.



AC Source Supply	Use a power source with a voltage within the permissible range of inverter input power rating.
MCCB or Earth leakage circuit breaker (ELB)	Select circuit breakers or fuses in accordance with applicable national and local codes.
Inline Magnetic Contactor	Install if necessary. When installed, do not use it for the purpose of starting or stopping the drive.
AC Reactor	An AC reactor can be used when the harmonics are to be reduced and power factor is to be improved. One must be used when the inverter is installed on a power source with greater than 10 times the KVA rating of the drive.
Installation and wiring	To reliably operate the drive, install the inverter in the proper orientation and with proper clearances. Incorrect terminal wiring could result in the equipment damage.
DC Reactor	A DC reactor may be used together with or in place of an AC reactor if necessary to reduce harmonics or improve power factor.
To motor	Do not connect power factor capacitors, surge arrestors or radio noise filters to the output side of the inverter.

CHAPTER 2 - SPECIFICATION

2.1 200~230V Class (5.5~30kW / 7.5~40HP)

Model Number (CI-xxx-P2)		007	010	015	020	025	030	040
Std Duty Variable Torque Motro Rating(1)	HP	7.5	10	15	20	25	30	40
	kW	5.5	7.5	11	15	18.5	22	30
	FLA[A]	24	32	46	60	74	88	115
Hvy Duty Variable Torque Motro Rating	HP	5	7.5	10	15	20	25	30
	kW	3.7	5.5	7.5	11	15	18.5	22
	FLA[A]	17	23	33	44	54	68	84
Output ratings	Capacity[kVA](2)	9.1	12.2	17.5	22.9	28.2	33.5	43.8
	Frequency	0.01 ~ 120 Hz						
	Voltage	200 ~ 230 V(3)						
Input ratings	Voltage	3ϕ 200 ~ 230 V (-15% ~ +10 %)						
	Frequency	50/60 Hz (± 5 %)						
Weight [kg (lbs.)]		4.9(10.8)	6(13.2)	6(13.2)	13(28.7)	13.5(29.8)	20(44.1)	20(44.1)

2.2 380~480V Class (5.5~30kW / 7.5~40HP)

Model Number (CI-xxx-P4)		007	010	015	020	025	030	040
Std Duty Variable Torque Motro Rating(1)	HP	7.5	10	15	20	25	30	40
	kW	5.5	7.5	11	15	18.5	22	30
	FLA[A]	12	16	24	30	39	45	61
Hvy Duty Variable Torque Motro Rating	HP	5	7.5	10	15	20	25	30
	kW	3.7	5.5	7.5	11	15	18.5	22
	FLA[A]	8	11	17	22	28	34	44
Output ratings	Capacity[kVA](2)	9.6	12.7	19.1	23.9	31.1	35.9	48.6
	Frequency	0.01 ~ 120 Hz						
	Voltage	380 ~ 480 V(3)						
Input ratings	Voltage	3ϕ 380 ~ 480 V (-15% ~ +10 %)						
	Frequency	50/60 Hz (± 5 %)						
Weight [kg (lbs.)]		4.9(10.8)	6(13.2)	6(13.2)	12.5(27.6)	13(28.7)	20(44.1)	20(44.1)

2.3 380 ~ 480V Class (37~90kW / 50~125HP)

Model Number (CI-xxx-P4)		050	060	075	100	125
Std Duty Variable Torque Motro Rating(1)	HP	50	60	75	100	125
	kW	37	45	55	75	90
	FLA[A]	75	91	110	152	183
Hvy Duty Variable Torque Motro Rating	HP	40	50	60	75	100
	kW	30	37	45	55	75
	FLA[A]	55	66	80	111	134
Output ratings	Capacity [kVA] (2)	59.8	72.5	87.6	121.1	145.8
	Frequency	0.01 ~ 120 Hz				
	Voltage	380 ~ 480 V(3)				
Input ratings	Voltage	3ϕ 380 ~ 480 V (-15% ~ +10 %)				
	Frequency	50/60 Hz (± 5 %)				
Weight [kg (lbs.)]		27(59.5)	27(59.5)	29(64)	42(92.6)	43(94.8)

2.4 380 ~ 480V Class (110~280kW / 150~400HP)

Model Number (CI-xxx-P4)		150	200	250	350	400
Std Duty Variable Torque Motro Rating(1)	HP	150	200	250	350	400
	kW	110	132	160	220	280
	FLA[A]	223	264	325	432	547
Hvy Duty Variable Torque Motro Rating	HP	125	150	200	250	300
	kW	90	110	132	160	220
	FLA[A]	183	223	264	325	432
Output ratings	Capacity [kVA] (2)	178	210	259	344	436
	Frequency	0.01 ~ 120 Hz				
	Voltage	380 ~ 480 V(3)				
Input ratings	Voltage	3ϕ 380 ~ 480 V (-15% ~ +10 %)				
	Frequency	50/60 Hz (± 5 %)				
Weight [kg (lbs.)]		101(222.7)	101(222.7)	114(251.3)	200(441.9)	200(441.9)

Common Specifications

Cooling method			Forced air cooling
Short Circuit Rating			65kA, suitable for use on a circuit capable of delivering not more than 65,000 RMS Symmetrical amperes, 240 (or 480V) volts maximum
Agency Approvals			UL and cUL listed, CE marked
CONTROL	Control Method		V/F, Sensorless Vector, Slip Compensation, Easy Start Selectable
	Frequency Setting Resolution		Digital Reference: 0.01 Hz (Below 100 Hz), 0.1 Hz (Over 100 Hz) Analog Reference: 0.01 Hz / 60 Hz
	Frequency Accuracy		Digital: 0.01 % of Max. Output Frequency Analog: 0.1 % of Max. Output Frequency
	V/F Ratio		Linear, Squared Pattern, User V/F
	Overload Capacity		110 % per 1 min, 120% per 1 min CT standard duty, 150% per 1 min constant torque
	Torque Boost		Manual Torque Boost (0 ~ 15 % settable), Auto Torque Boost
OPERATION	Operation Method		Keypad / Terminal / Communication Operation
	Frequency Setting		Analog: 0 ~ 12V / -12V ~ 12V / 4 ~ 20mA or 0~20mA/ Pulse / Ext-PID Digital: Keypad
	Input Signal	Start Signal	Forward, Reverse
		Multi-Step	Up to 18 Speeds can be set including Jog (Use Programmable Digital Input Terminal)
		Multi Step Accel/Decel Time	0.1~ 6,000 sec, Max 4 types can be set via Multi- Function Terminal. Accel/Decel Pattern: Linear, U-Curve, S-Curve Selectable
		Emergency Stop	Interrupts the Output of Inverter
		Jog	Jog Operation
		Fault Reset	Trip Status is Reset when Protection Function is Active
	Output signal	Operating Status	Frequency Detection Level, Overload Alarm, Stalling, Over Voltage, Low Voltage, Inverter Overheating/ Running/ Stopping/ Constant running, Inverter By-Pass, Speed Searching
		Fault Output	Contact Output (3A, 3C, 3B) – AC 250V 1A, DC 30V 1A
		Indicator	Choose 2 from Output Frequency, Output Current, Output Voltage, DC Link Voltage (Output Voltage: 0 ~ 10V)
	Operation Function		DC Braking, Frequency Limit, Frequency Jump, 2nd Function, Slip Compensation, Reverse Rotation Prevention, Auto Restart, Inverter By-Pass, Auto-Tuning, PID Control, Flying Start, Safety Stop, Flux Braking, Low leakage, Pre-PID, Dual-PID, MMC(6), Easy Start, Pre-heater
PROTECTION	Inverter Trip		Over Voltage, Low Voltage, Over Current, Ground Fault, Inverter Overheat, Motor Overheat, Output Phase Open, Overload Protection, External Fault 1, 2, Communication Error, Loss of Speed Command, Hardware Fault, Option Fault etc
	Inverter Alarm		Stall Prevention, Overload Alarm, Thermal Sensor Fault

DISPLAY	Keypad	Operation Information	Output Frequency, Output Current, Output Voltage, Frequency Set Value, Operating Speed, DC Voltage, Integrating Wattmeter, Fan ON time, Run-time, Last Trip Time
		Trip Information	Trips Indication when the Protection Function activates. Max. 5 Faults are saved. Last Trip Time.
ENVIRONMENT	Ambient Temperature		-10℃ ~ 40℃ (14°F ~ 104°F) (Use loads less than 80% at 50℃)
	Storage Temperature		-20℃ ~ 65℃ (14°F ~ 149°F)
	Ambient Humidity		Less Than 90 % RH Max. (Non-Condensing)
	Altitude – Vibration		Below 1,000m (3,300ft), Below 5.9m/sec^2 (0.6g)
	Application Site		Pollution degree 2, No Corrosive Gas, Combustible Gas, Oil Mist, or Dust

(1) Standard duty VT motor rating based on a 120% overload for 1 minute. Heavy duty motor ratings based on 150% overload for 1 minute. Horsepower ratings based on 4-pole motor specifications at 460(or 230V) input voltage. Operation at lower input voltages ot within motors with 6 or motor poles may require the use of a larger drive depending on actual motor rating.

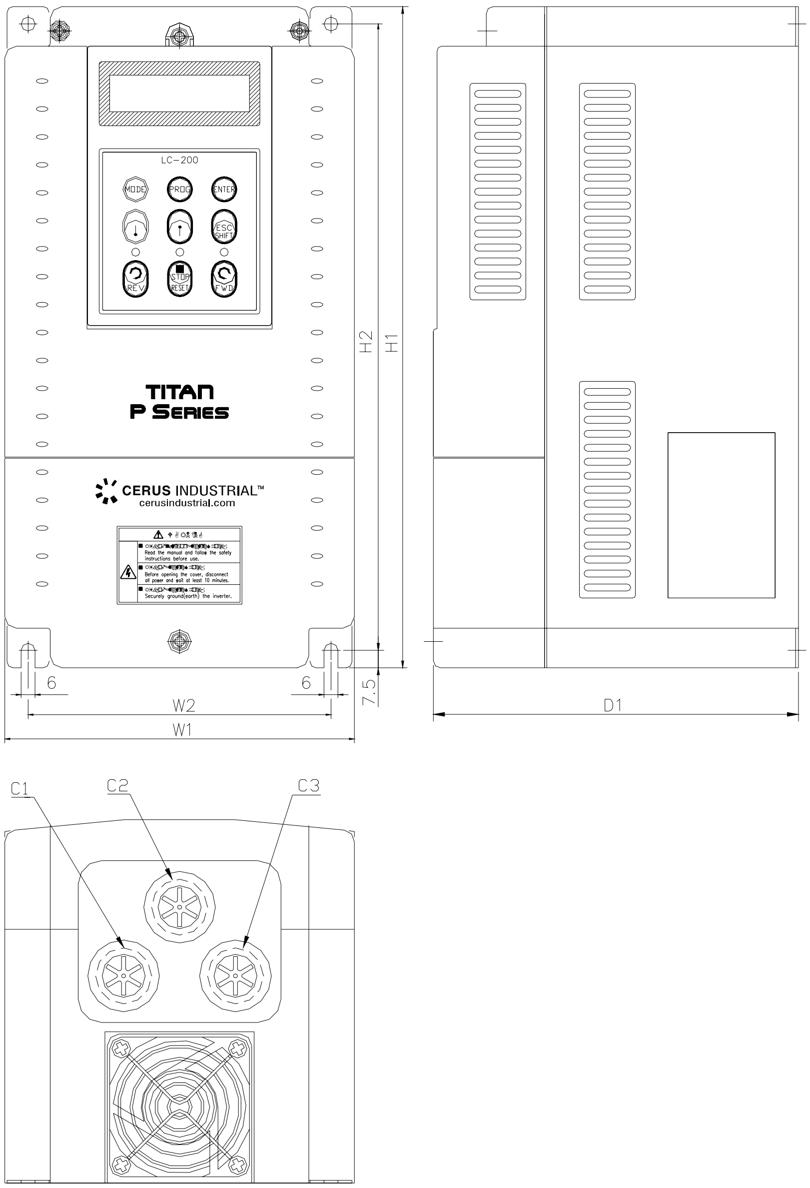
(2) Maximum output voltage will not exceed the input voltage. An output voltage less than the input voltage may be programmed if necessary.

(3) The standard conduit box attachment adds 1.8kg(4lbs.) to the weight of the drive.

(4) MMC(Multi Moter Control) function is applied to the drives only for 7.5 ~125HP.

2.5 Dimensions

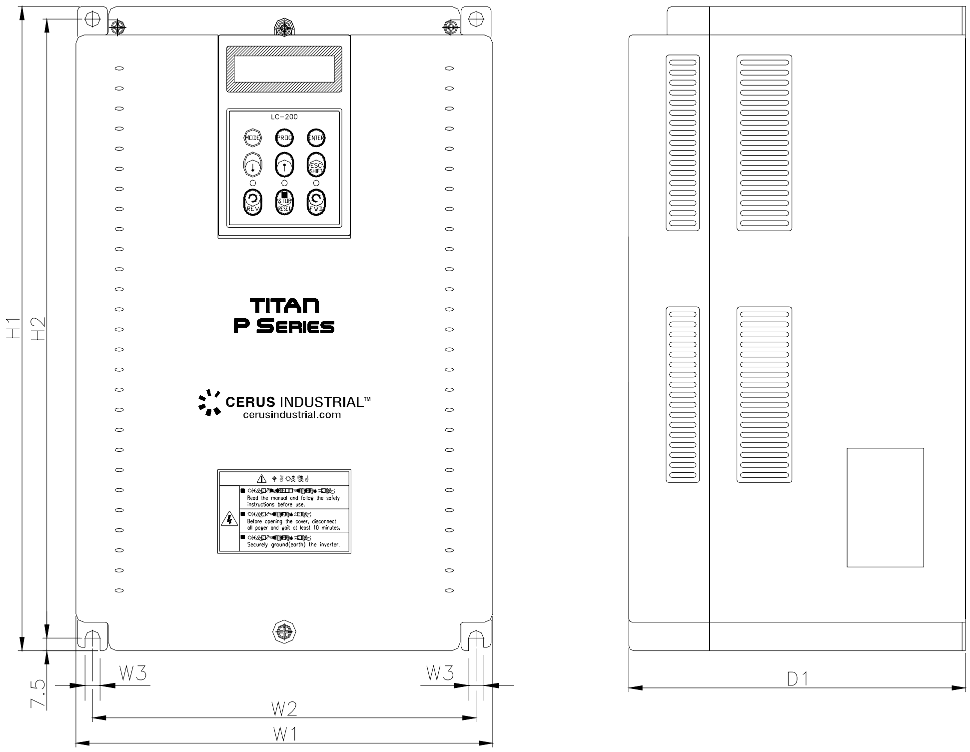
1) CI-007-P2/4 (200/400V Class)

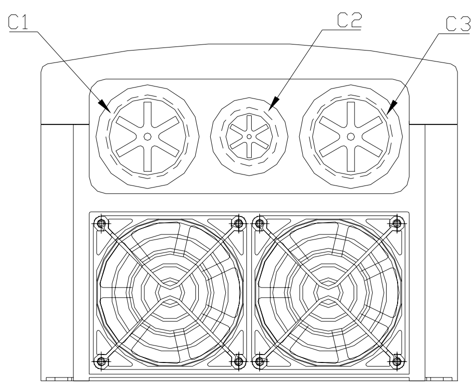


mm (inches)

Model	W1	W2	H1	H2	D1	C1	C2	C3	Enclosure Type
CI-007-P2/4	150 (5.91)	130 (5.12)	284 (11.18)	269 (10.69)	156.5 (6.16)	24 (0.98)	24 (0.98)	24 (0.98)	IP20 UL Type 1

2) CI-010~040-P2/4 (200/400V Class)





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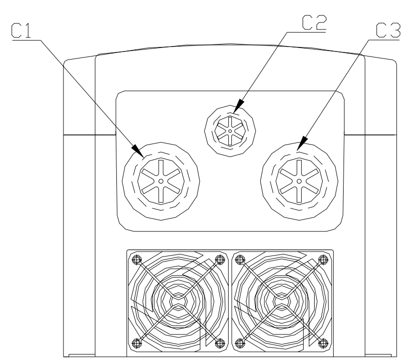
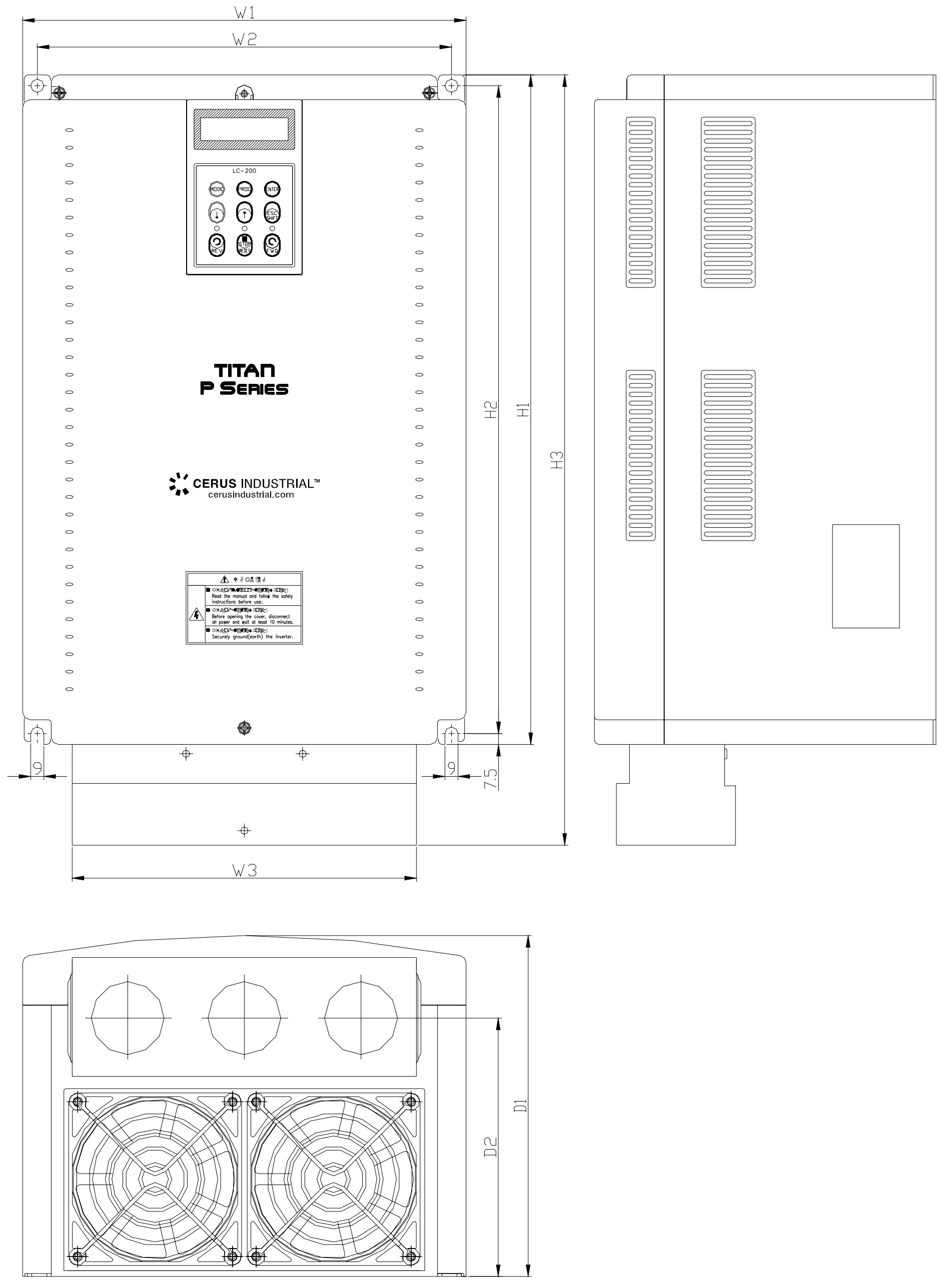


<CI-010~015-P2/4>

mm (inches)

Model	W1	W2	W3	H1	H2	D1	C1	C2	C3	Enclosure Type
CI-010-P2/4	200 (7.87)	180 (7.09)	6 (0.23)	284 (11.18)	269 (10.69)	182 (7.16)	35 (1.37)	24 (0.98)	35 (1.37)	IP20 UL Type 1
CI-015-P2/4	200 (7.87)	180 (7.09)	6 (0.23)	284 (11.18)	269 (10.69)	182 (7.16)	35 (1.37)	24 (0.98)	35 (1.37)	IP20 UL Type 1
CI-020P2/4	250 (9.84)	230 (9.06)	9 (0.35)	385 (15.16)	370 (14.57)	201 (7.91)	-	-	-	IP00 UL Open
CI-025-P2/4	250 (9.84)	230 (9.06)	9 (0.35)	385 (15.16)	370 (14.57)	201 (7.91)	-	-	-	IP00 UL Open
CI-030-P2/4	304 (11.97)	284 (11.18)	9 (0.35)	460 (18.11)	445 (17.52)	234 (9.21)	-	-	-	IP00 UL Open
CI-040-P2/4	304 (11.97)	284 (11.18)	9 (0.35)	460 (18.11)	445 (17.52)	234 (9.21)	-	-	-	IP00 UL Open

3) CI-020~040-P2/4 (UL Type 1 or UL Open Type with Conduit Option used, 200V/400V Class)

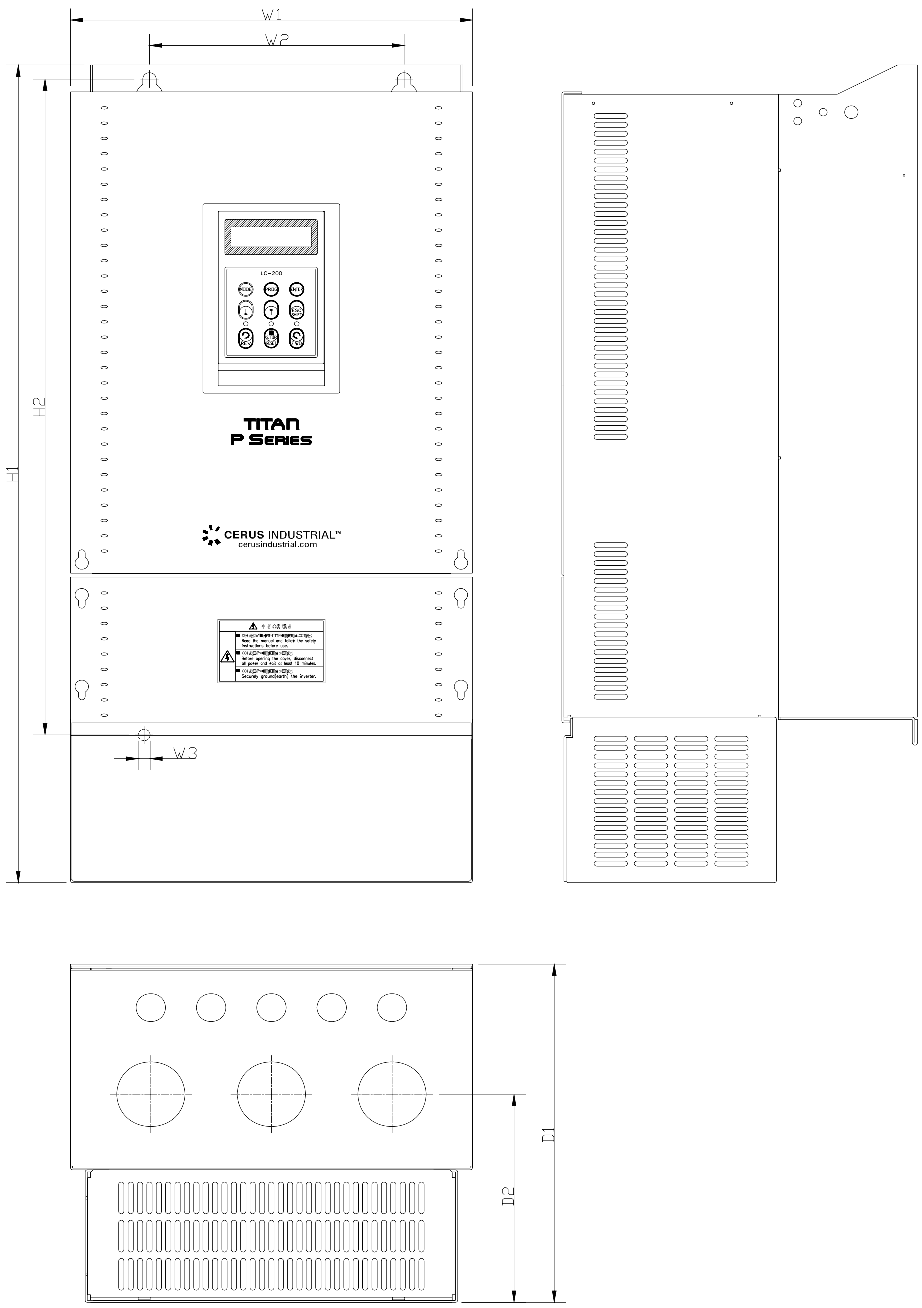


mm (inches)

Model	W1	W2	W3	H1	H2	H3	D1	D2	Enclosure Type
CI-020-P2/4	250 (9.84)	230 (9.06)	200.8 (7.9)	385 (15.16)	370 (14.57)	454.2 (17.88)	201 (7.91)	146 (5.74)	IP20 UL Type 1
CI-025-P2/4	250 (9.84)	230 (9.06)	200.8 (7.9)	385 (15.16)	370 (14.57)	454.2 (17.88)	201 (7.91)	146 (5.74)	IP20 UL Type 1
CI-030-P2/4	304 (11.97)	284 (11.18)	236 (9.29)	460 (18.11)	445 (17.52)	599.2 (23.59)	234 (9.21)	177.5 (6.98)	IP20 UL Type 1
CI-040-P2/4	304 (11.97)	284 (11.18)	236 (9.29)	460 (18.11)	445 (17.52)	599.2 (23.59)	234 (9.21)	177.5 (6.98)	IP20 UL Type 1

Note) Mounting NEMA 1 conduit option to the 15~90Kw(20~125HP) Open Type meets NEMA 1 but does not comply with UL Enclosed Type 1. To that end, please purchase UL Type 1 product.

4) CI-050~075-P (UL Type 1 or UL Open Type with Conduit Option Used, 400V Class)

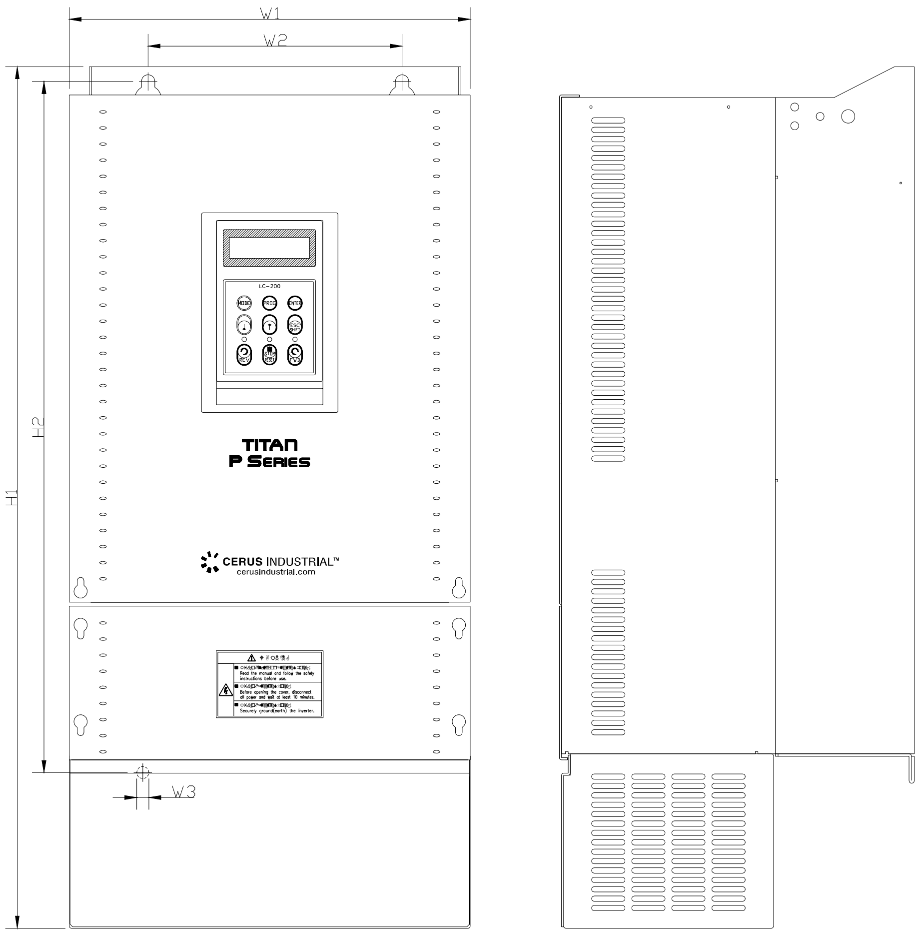


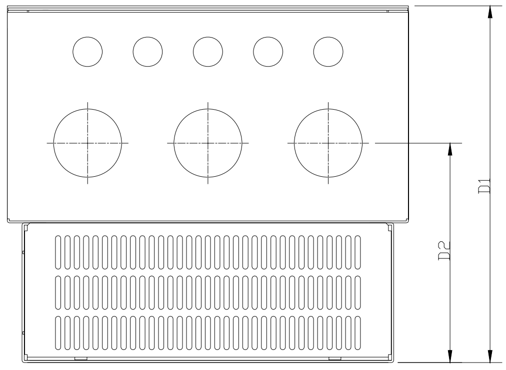
mm (inches)

Model	W1	W2	W3	H1	H2	D1	D2	Enclosure Type
CI-050, 060-P/4	300 (11.81)	190 (7.48)	9 (0.35)	642 (25.28)	515 (20.28)	265.6 (10.46)	163.4 (6.43)	IP20 UL Type 1
CI-075-P/4	300 (11.81)	190 (7.48)	9 (0.35)	642 (25.28)	515 (20.28)	292.6 (11.52)	190.4 (7.5)	IP20 UL Type 1
CI-050, 060-P/4L (Built-in DCL Type)	300 (11.81)	190 (7.48)	9 (0.35)	792 (31.18)	665 (26.18)	265.6 (10.46)	163.4 (6.43)	IP20 UL Type 1
CI-075-P/4L (Built-in DCL Type)	300 (11.81)	190 (7.48)	9 (0.35)	792 (31.18)	665 (26.18)	292.6 (11.52)	190.4 (7.5)	IP20 UL Type 1

Note) Mounting NEMA 1 conduit option to the 15~90Kw(20~125HP) Open Type meets NEMA 1 but does not comply with UL Enclosed Type 1. To that end, please purchase UL Type 1 product.

5) CI-100, 125-P/4 (UL Type 1 or UL Open Type with Conduit Option used, 400V Class)



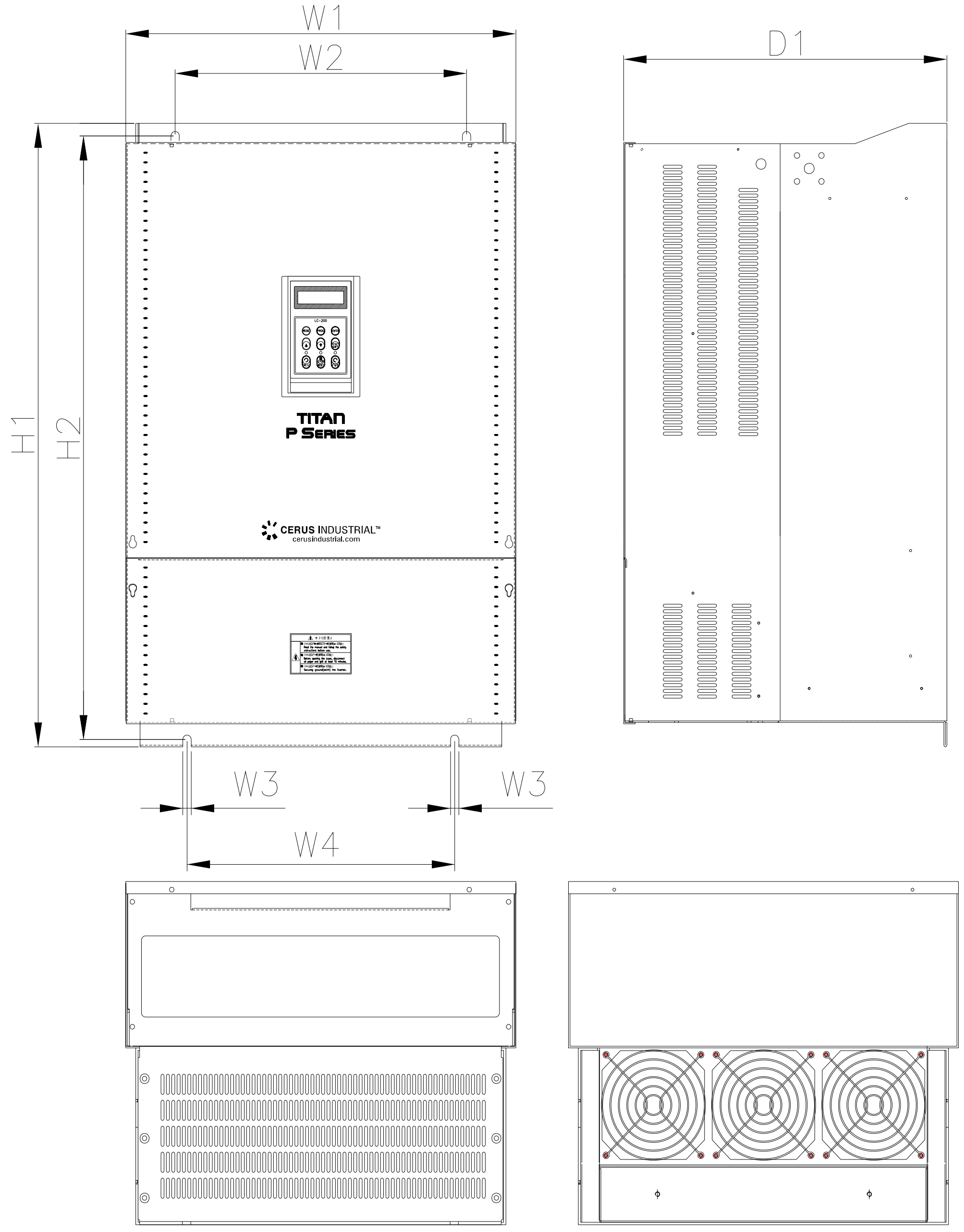


mm (inches)

Model	W1	W2	W3	H1	H2	D1	D2	Enclosure Type
CI-100, 125-P/4	370 (14.57)	220 (8.66)	9 (0.35)	767.5 (30.22)	586.5 (23.09)	337.6 (13.29)	223.4 (8.8)	IP20 UL Type 1
CI-100, 125-P/4L (Built-in DCL Type)	370 (14.57)	220 (8.66)	9 (0.35)	917.5 (36.12)	736.5 (28.99)	337.6 (13.29)	223.4 (8.8)	IP20 UL Type 1

Note) Mounting NEMA 1 conduit option to the 15~90Kw(20~125HP) Open Type meets NEMA 1 but does not comply with UL Enclosed Type 1. To that end, please purchase UL Type 1 product.

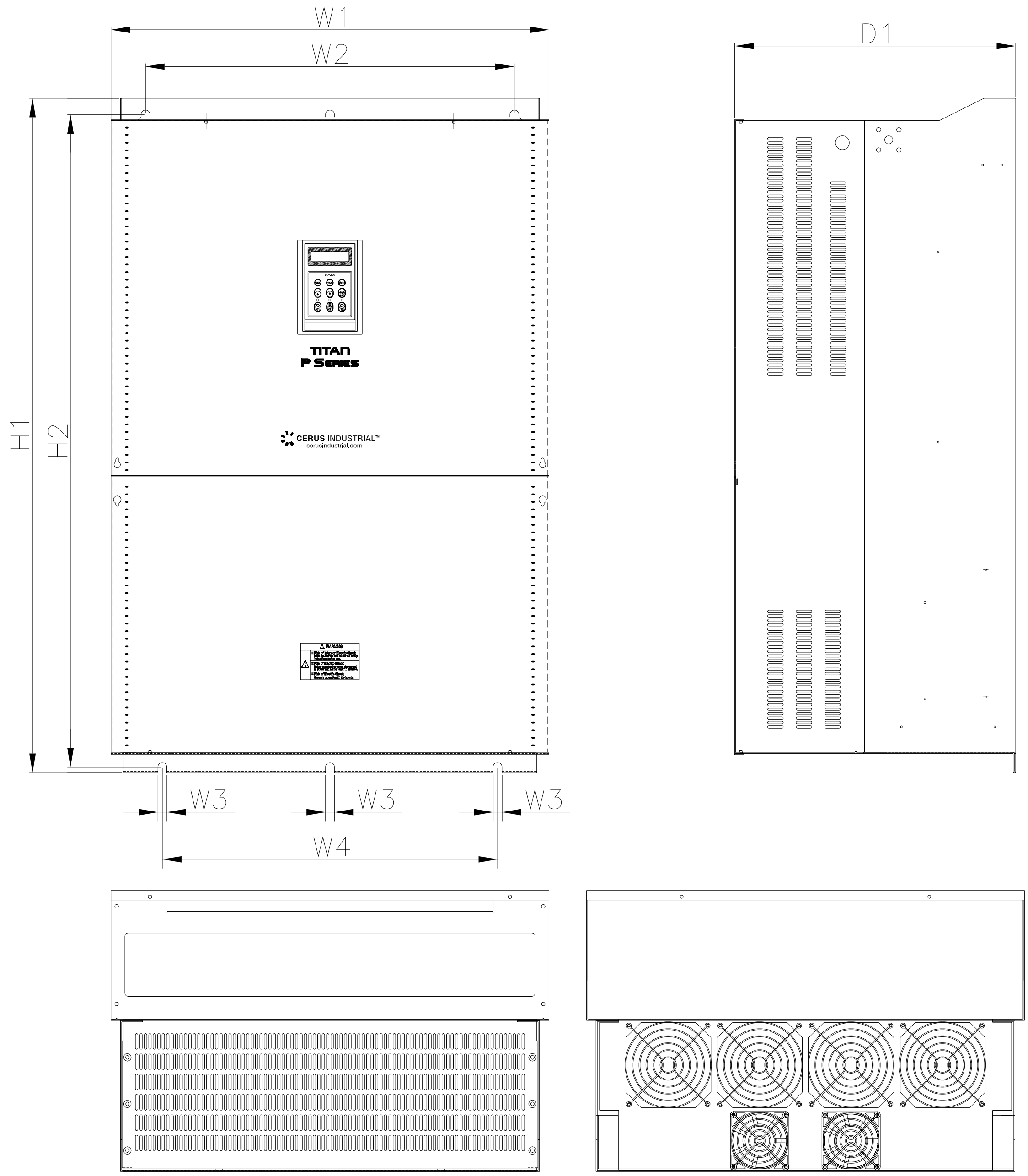
6) CI-150, 200-P4 (400V Class)



mm(inches)

Model	W1	W2	W3	W4	H1	H2	D1	Enclosure Type
CI-150, 200-P/4L	510 (20.08)	381 (15.00)	11 (0.43)	350 (13.78)	784 (30.87)	760 (29.92)	422.6 (16.64)	IP00 UL Open
CI-250-P/4L	510 (20.08)	381 (15.00)	11 (0.43)	350 (13.78)	861 (33.90)	838 (33.00)	422.6 (16.64)	IP00 UL Open

7) CI-350, 400-P/4 (400V Class)



mm(inches)

Model	W1	W2	W3	W4	H1	H2	D1	Enclosure Type
CI-350, 400-P/4L	690 (27.17)	580 (22.87)	14 (0.55)	528 (20.79)	1078 (42.44)	1045 (41.14)	449.6 (17.70)	IP00 UL Open

■ Notes :

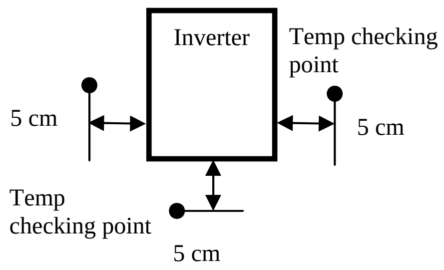
CHAPTER 3 - INSTALLATION

3.1 Installation precautions

1) Handle the inverter with care to prevent damage to the plastic components. Do not hold the inverter by the front cover.

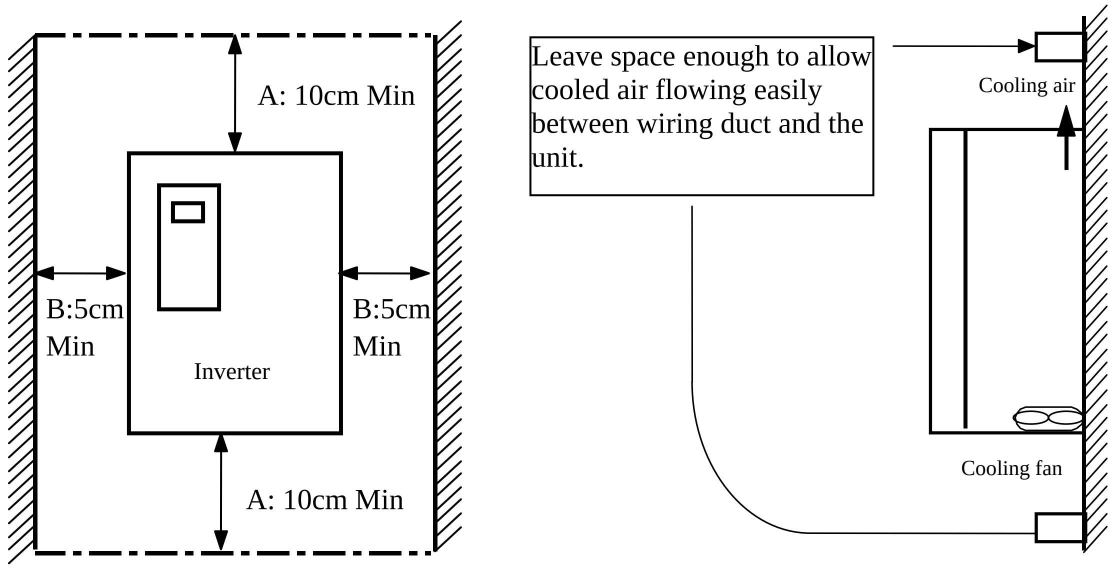
2) Do not mount the inverter in a location where excessive vibration (5.9 m/sec^2 or less) is present such as installing the inverter on a press or other moving equipment.

3) Install in a location where temperature is within the permissible range (-10~40°C).



4) The inverter will be very hot during operation. Install it on a non-combustible surface.

5) Mount the inverter on a flat, vertical and level surface. Inverter orientation must be vertical (top up) for proper heat dissipation. Also leave sufficient clearances around the inverter. However, A= Over 500mm and B= 200mm should be obtained for inverters rated 30kW and above.



6) Do not mount the inverter in direct sunlight or near other heat sources.

7) The inverter shall be mounted in a Pollution Degree 2 environment. If the inverter is going to be installed in an environment with a high probability of dust, metallic particles, mists, corrosive gases, or other contaminates, the inerter must be located inside the appropriate electrical enclosure of the proper NEMA or IP rating.

8) When two or more inverters are installed or a ventilation fan is mounted in inverter panel, the inverters and ventilation fan must be installed in proper positions with extreme care taken to keep the ambient temperature of the inverters below the permissible value. If they are installed in improper positions, the ambient temperature of the inverters will rise.

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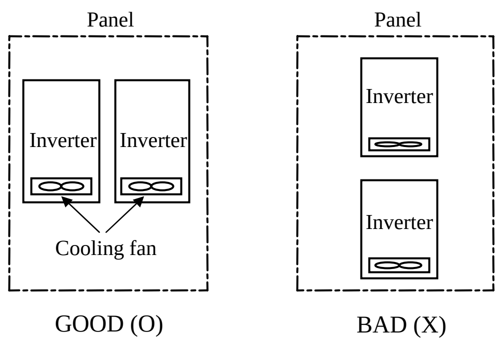
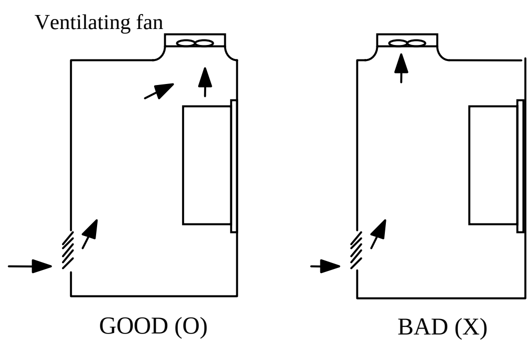


[When installing several inverters in a panel]



[When installing a ventilating fan in a panel]

9) Install the inverter using screws or bolts to insure the inverter is firmly fastened.

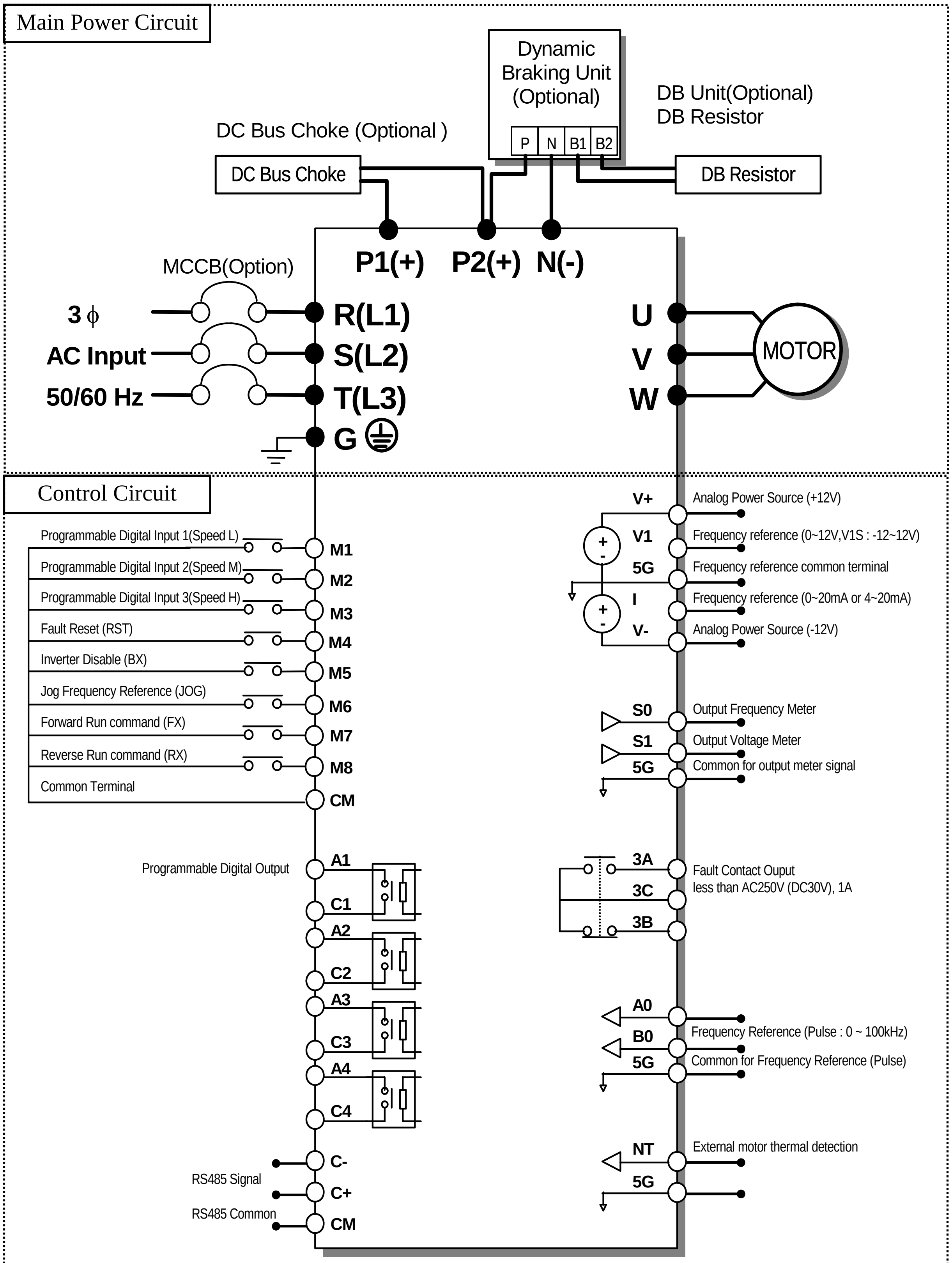
⚠ CAUTION

■ **Risk of Electric Shock**

More than one disconnect switch may be required to de-energize the equipment before servicing.

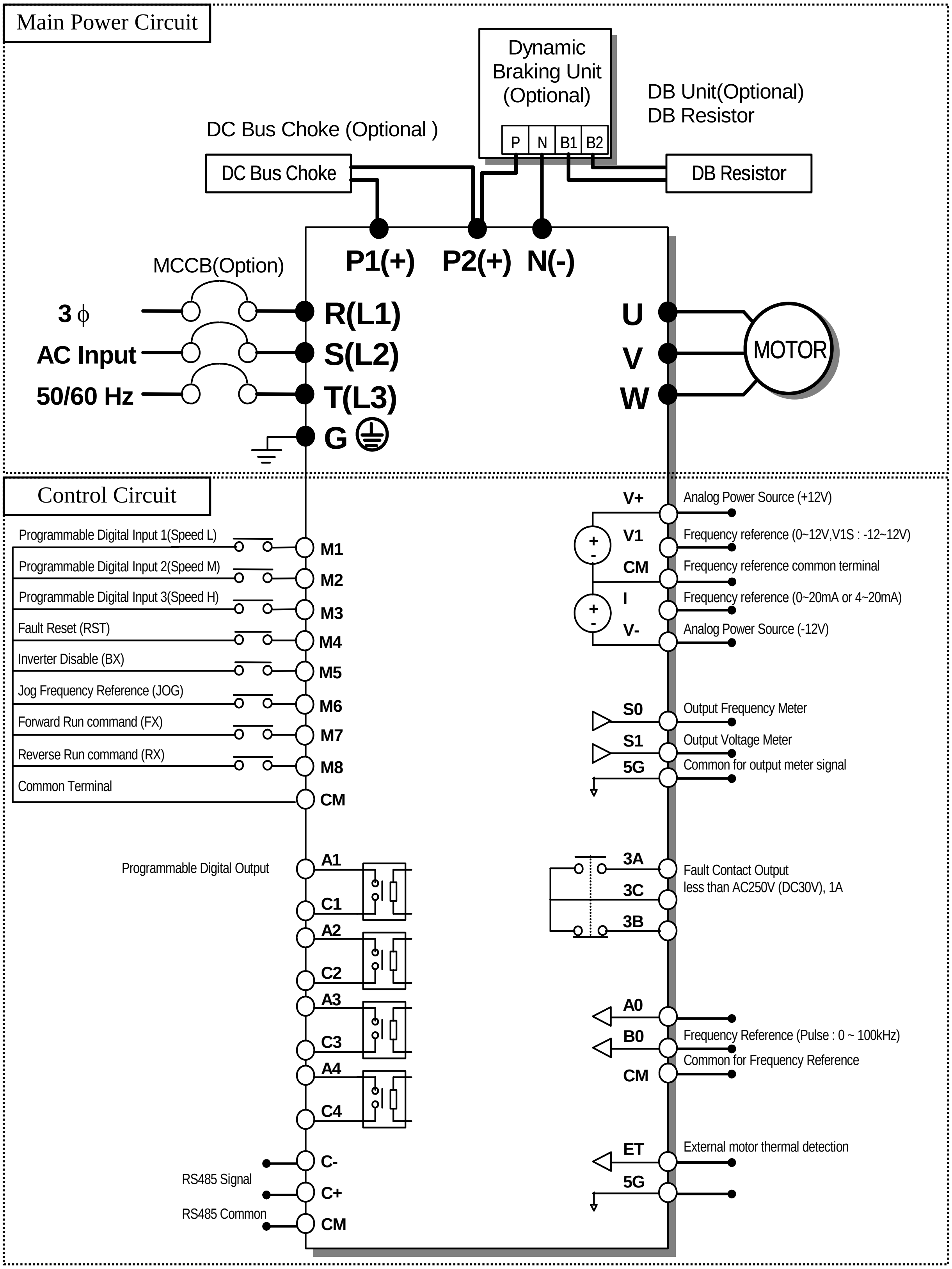
3.2 Wiring
3.2.1 Basic wiring

1) For 5.5~30kW (7.5~40HP)



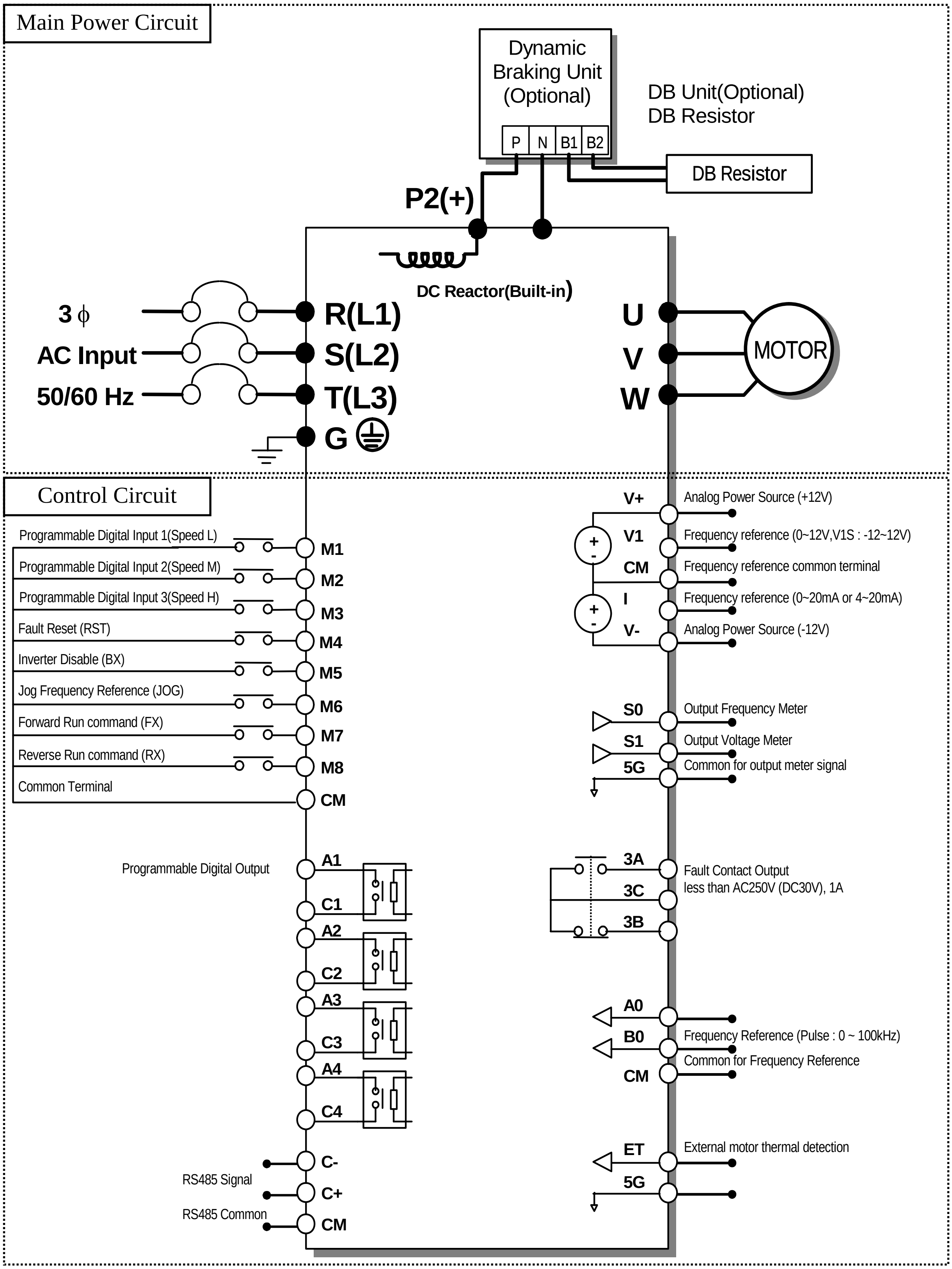
Note : 1) 5G is Common Ground for Analog Input/Output.
2) Use terminal V1 for V1, V1S (0~12V, -12 ~ 12V) input.

2) For 37~90kW (50~125HP)



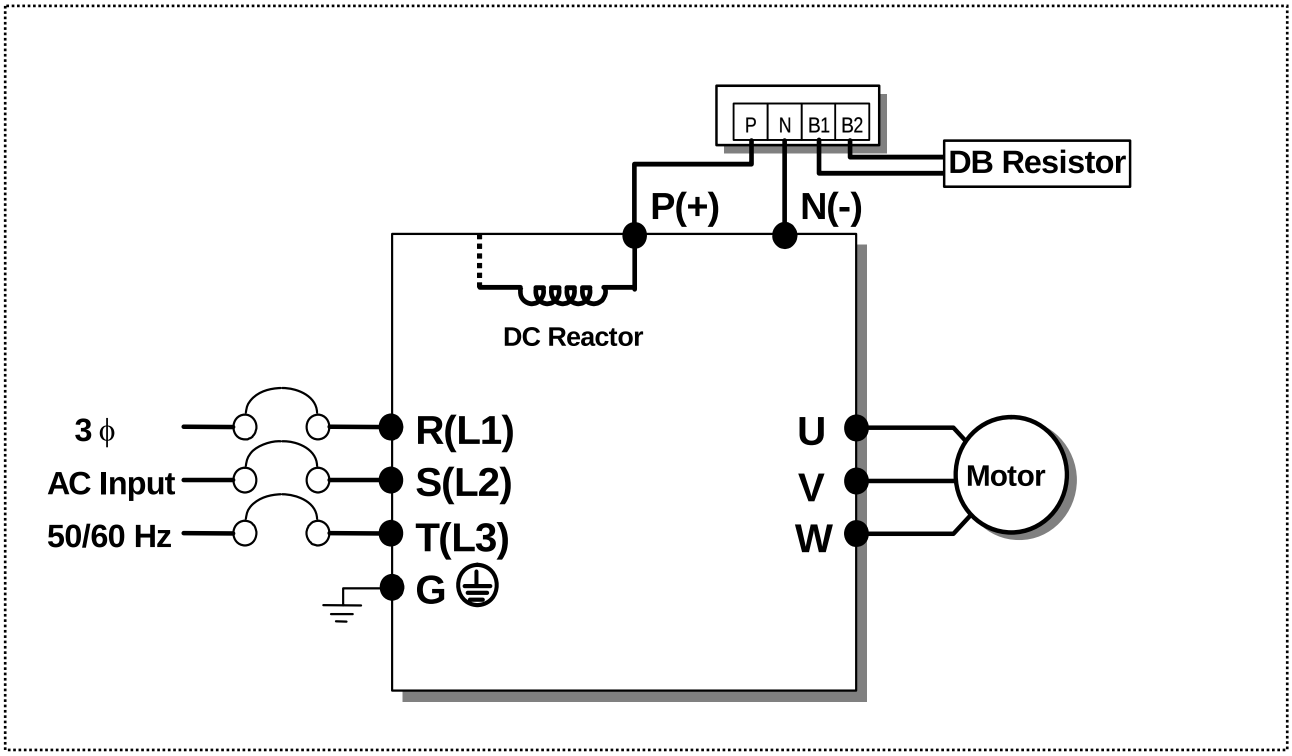
Note : 1) 5G is Common Ground for Analog Meter Output(SO,S1) and External motor thermal detection(ET).
2) Use terminal V1 for V1, V1S (0~12V, -12 ~ 12V) input.

3) For 110~280kW (150~350HP)

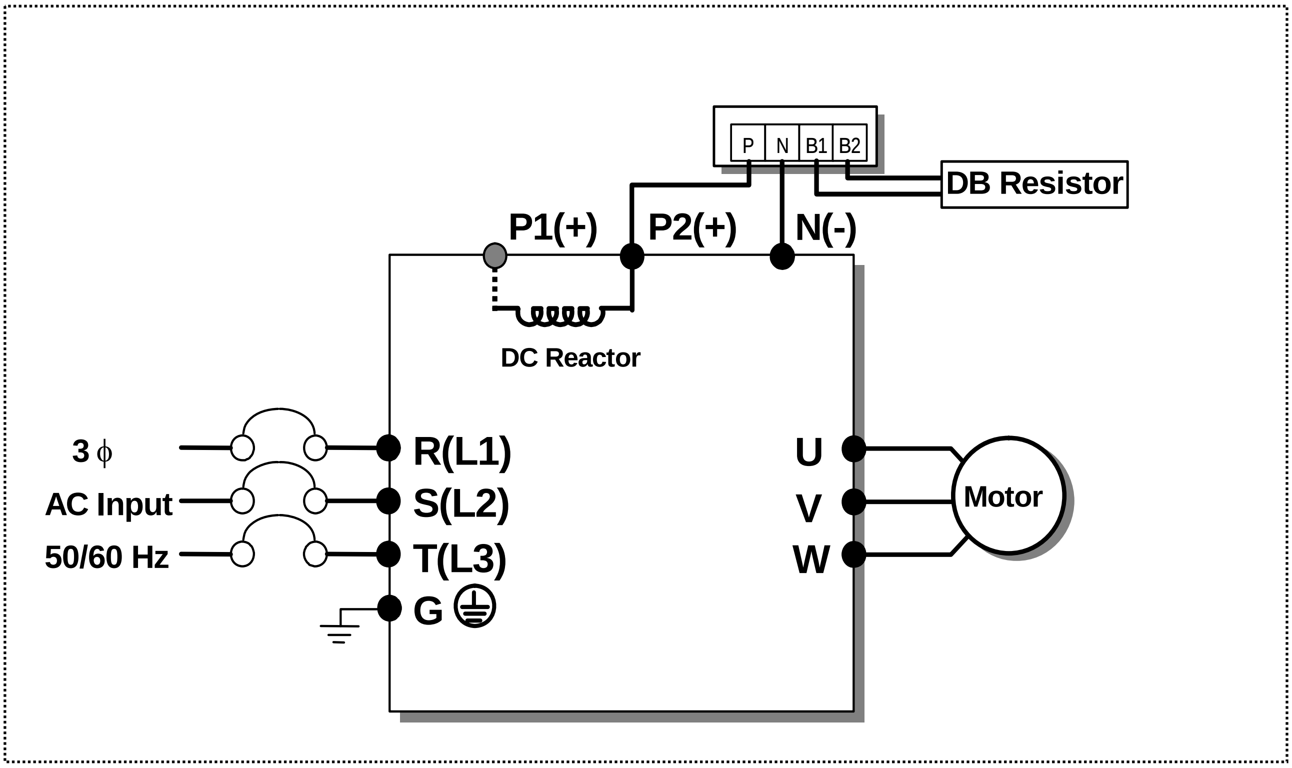


Note : 1) 5G is Common Ground for Analog Meter Output(SO,S1) and External motor thermal detection(ET).
2) Use terminal V1 for V1, V1S (0~12V, -12 ~ 12V) input.
3) DC Reactor is built basically in the inverters for 110~280kW(150~350HP).

4) For 15~30kW (20~40HP) Built-in DCL Type



5) For 37~90kW (50~125HP) Built-in DCL Type



☞ Note : P1(+) is not provided for wiring.

6) Power Terminals:

(1) 5.5 ~ 30 kW (200V/400V Class)

R(L1)	**S(L2)**	**T(L3)**	**G**	**P1(+)**	**P2(+)**	**N(-)**	**U**	**V**	**W**

Jumper

(2) 37~90kW (50~125HP) <400V Class>

R(L1)	**S(L2)**	**T(L3)**	**P1(+)**	**P2(+)**	**N(-)**	**U**	**V**	**W**

Jumper

(3) 15~18.5kW (20~25HP) <Built-in DC Reactor Type, 400V Class>

G ⏚	**R(L1)**	**S(L2)**	**T(L3)**	**P(+)**	**N(-)**	**U**	**V**	**W**	**G** ⏚

(4) 22~30kW (30~40HP) <Built-in DC Reactor Type, 400V Class>

R(L1)	**S(L2)**	**T(L3)**	**P(+)**	**N(-)**	**U**	**V**	**W**

(5) 37~90kW (50~125HP) / 110 ~280kW (150~350HP) <Built-in DC Reactor Type, 400V Class>

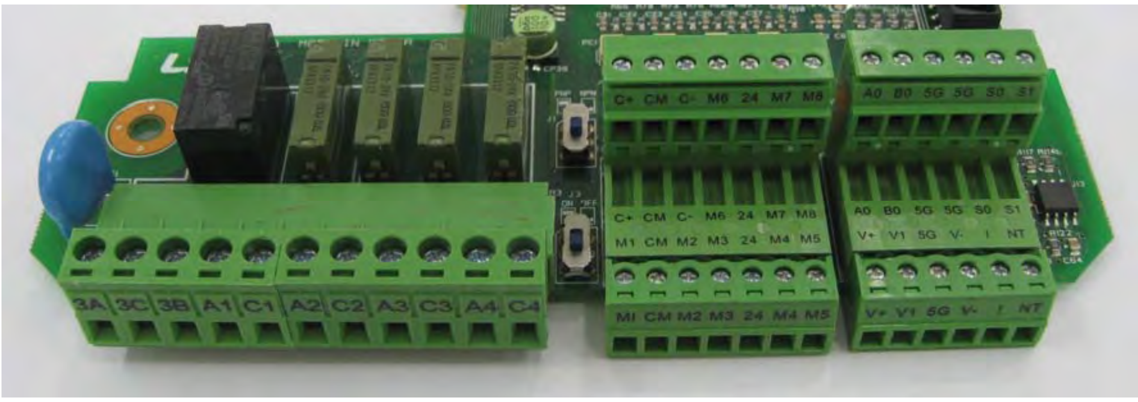
R(L1)	**S(L2)**	**T(L3)**		**P2(+)**	**N(-)**	**U**	**V**	**W**

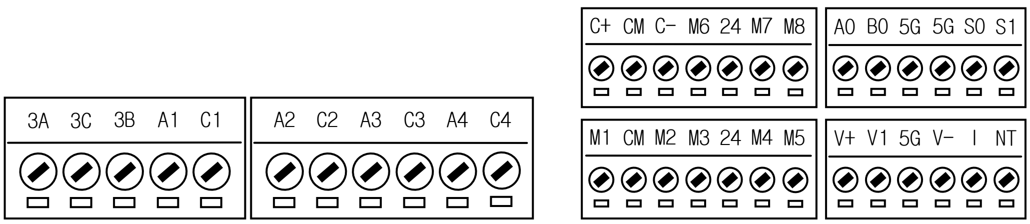
☞ Note : P1(+) is not provided for wiring.

Symbol	Description
R(L1), S(L2), T(L3)	AC Line Voltage Input
G	Earth Ground
P1(+), P2(+)	External DC Reactor (P1(+)-P2(+)) Connection Terminals (Jumper must be removed).
P2(+) ,N(-) or P(+), N(-)	DB Unit (P2(+)-N(-)) Connection Terminals
U, V, W	3 Phase Power Output Terminals to Motor

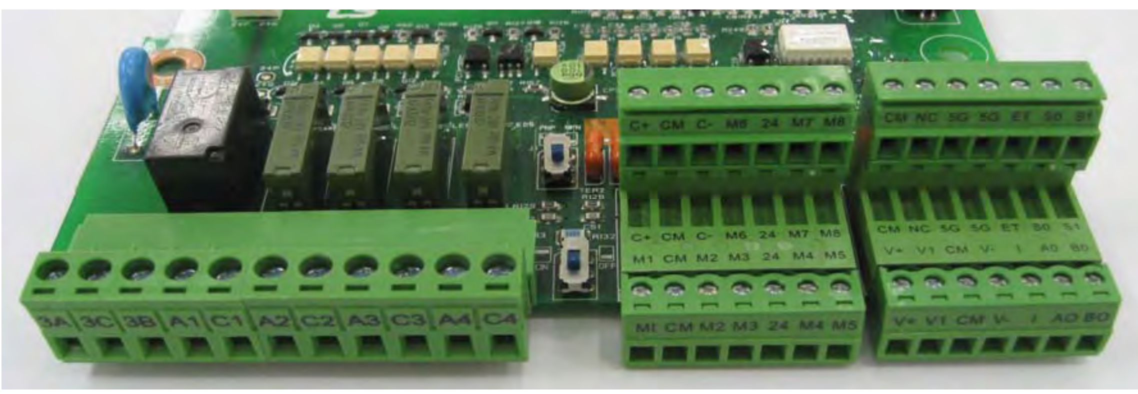
7) Control circuit terminal

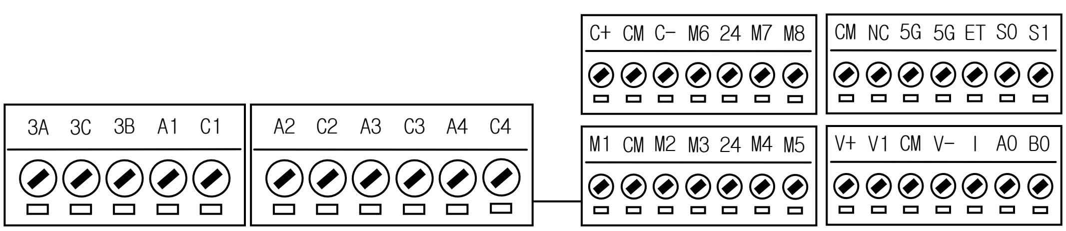
5.5 ~ 30kW/7.5~40HP (200V/400V Class)





37 ~ 280 kW/ 50~400HP (400V Class)





Type	Symbol	Name	Description

Input signal	Starting Contact Function Select	M1, M2, M3	Programmable Digital Input 1, 2, 3	Defines Programmable Digital Inputs. (Factory setting: Multi-Step Frequency 1, 2, 3)
		FX [M7]	Forward Run Command	Forward Run When Closed and Stopped When Open.
		RX [M8]	Reverse Run Command	Reverse Run When Closed and Stopped When Open.
		JOG [M6]	Jog Frequency Reference	Runs at Jog Frequency when the Jog Signal is ON. The Direction is set by the FX (or RX) Signal.
		BX [M5]	Inverter Disable	When the BX Signal is ON the Output of the Inverter is Turned Off. When Motor uses an Electrical Brake to Stop, BX is used to Turn Off the Output Signal. Take caution when BX Signal is OFF (Not Turned Off by Latching) and FX Signal (or RX Signal) is ON. If so, motor continues to Run.
		RST [M4]	Fault Reset	Used for Fault Reset.
		CM	Sequence Common (NPN) / 24V Com.	Common terminal for NPN contact input and also common for the extermal 24V supply.
		24	Sequence Common (PNP) / Ext. +24Vdc supply	Common 24V terminal for PNP contact input. Can also be used as a 24Vdc external power supply (maximum output : +24V, 50mA)
	Analog frequency setting	V+, V-	Analog Power Source (+12V,-12V)	Power supply for Analog Frequency Setting. Maximum Output: +12V, 100mA, -12V, 100mA.
		V1	Frequency Reference (Voltage)	Used by a DC 0-12V or –12~ 12 V input to set the frequency reference. (Input impedance is 20 kΩ)
		I	Frequency Reference (Current)	Used by a 0-20mA input to set the frequency reference. (Input impedance is 249Ω)
		A0, B0	Frequency Reference (Pulse)	Used by a pulse input to set the frequency reference.
		5G (~30kW) CM(37kW~)	Frequency Reference Common Terminal	Common Terminal for Analog Frequency Reference Signal.
	External motor thermal detection	NT (~30kW) ET (37kw ~)	External motor thermal detection	Motor thermal sensor input. Used to prevent motor from overheating by using a NTC or PTC thermal sensor.
		5G	Common for NT(or ET)	Common Terminal for External motor thermal detection.
RS485 terminal		C+, C-	RS485 signal High, Low	RS485 signal (See RS485 communication in the manual for more details.)
		CM	RS485 common	Common Ground. Terminal for RS485 interface.
Output signal	Voltage	S0, S1,5G	Programmable Voltage Output	Voltage output for one of the following: Output Frequency, Output Current, Output Voltage, DC Link Voltage. Default is set to Output Frequency. (Maximum Output Voltage and Output Current are 0-12V and 1mA).
	Contact	3A, 3C, 3B	Fault Contact Output	Energizes when a fault is present. (AC250V, 1A; DC30V, 1A) Fault: 3A-3C Closed (3B-3C Open) Normal: 3B-3C Closed (3A-3C Open)
		A1~4, C1~4	Programmable Digital Output	Defined by Programmable Digital Output terminal settings (AC250V, 1A; DC30V, 1A)

Note) M1~M8 terminals are User Programmable.

3.2.2 Wiring power terminals

◈ **Wiring Precautions**

1) The internal circuits of the inverter will be damaged if the incoming power is connected and applied to output terminals (U, V, W).
2) Use ring terminals with insulated caps when wiring the input power and motor wiring.
3) Do not leave wire fragments inside the inverter. Wire fragments can cause faults, breakdowns, and malfunctions.
4) For input and output, use wires with sufficient size to ensure voltage drop of less than 2%.
5) Motor torque may drop of operating at low frequencies and a long wire run between inverter and motor.
6) The cable length between inverter and motor should be less than 150m (492ft). Due to increased leakage capacitance between cables, overcurrent protective feature may operate or equipment connected to the output side may malfunction. (But for products of less than 30kW, the cable length should be less than 50m (164ft).)
7) The main circuit of the inverter contains high frequency noise, and can hinder communication equipment near the inverter. To reduce noise, install line noise filters on the input side of the inverter.
8) Do not use power factor capacitor, surge killers, or RFI filters on the output side of the inverter. Doing so may damage these components.
9) Always check whether the LCD and the charge lamp for the power terminal are OFF before wiring terminals. The charge capacitor may hold high-voltage even after the power is disconnected. Use caution to prevent the possibility of personal injury.

◈ **Grounding** ⚠

1) The inverter is a high switching device, and leakage current may flow. Ground the inverter to avoid electrical shock. Use caution to prevent the possibility of personal injury. The ground impedance for 200V class is 100 ohm with 400V class 10ohm.
2) Connect only to the dedicated ground terminal of the inverter. Do not use the case or the chassis screw for grounding.
3) The protective earth conductor must be the first one in being connected and the last one in being disconnected.
4) As a minimum, grounding wire should meet the specifications listed below. Grounding wire should be as short as possible and should be connected to the ground point as near as possible to the inverter.

Inverter Capacity		**Grounding wire Sizes, AWG or kcmil (mm^2)**	
kW	**HP**	**200V Class**	**400V Class**
5.5 ~ 7.5	7.5 ~ 10	10 (5.5)	12 (3.5)
11 ~ 15	15 ~ 20	6 (14)	8 (8)
18.5 ~ 30	25 ~ 40	4 (22)	6 (14)
37 ~ 55	50 ~ 75	-	4 (22)
75 ~ 90	100 ~ 125	-	2 (38)
110 ~132	150 ~ 200	-	1/0 (60)
160 ~ 280	250 ~ 350	-	4/0 (100)

3.2.3 Wires and terminal lugs

Refer to below for wires, terminal lugs, and screws used to connect the inverter power input and output.

Inverter capacity		Terminal screw size	Screw torque		Wire size			
					R(L1), S(L2), T(L3)		U, V, W	
			kgf · cm	lb · in	mm^2	AWG or kcmil	mm^2	AWG or kcmil
200V	5.5kW(7.5HP)	M4	7.1 ~ 12.2	6.2~10.6	5.5	10	5.5	10
	7.5kW(10HP)	M5	24.5 ~ 31.8	21.2~27.6	8	8	8	8
	11kW(15HP)	M5			14	6	14	6
	15kW(20HP)	M6	30.6 ~ 38.2	26.6~33.2	22	4	22	4
	18.5kW(25HP)	M6			38	2	38	2
	22kW(30HP)	M8	61.2 ~ 91.8	53.1~79.7	38	2	38	2
	30kW(40HP)	M8			60	1/0	60	1/0
400V	5.5kW(7.5HP)	M4	7.1 ~ 12.2	6.2~10.6	3.5	12	3.5	12
	7.5Kw(10HP)	M4			3.5	12	3.5	12
	11 kW(15HP)	M4			5.5	10	5.5	10
	15 kW(20HP)	M6	30.6~38.2	26.6~33.2	8	8	8	8
	18.5kW(25HP)	M6			14	6	14	6
	22~30kW (30~40HP)	M8	61.2~91.8	53.1~79.7	22	4	22	4
	37~55kW (50~75HP)	M8	67.3~87.5	58.4~75.9	38	2	38	2
	75~90kW (100~125HP)	M10	89.7~122.0	77.9~105.9	60	1/0	60	1/0
	110~132Kw (150~200HP)	M12	182.4~215.0	158.3~186.6	100	4/0	100	4/0
	160kW(250HP)	M12			150	300	150	300
	220kW(350HP)	M12			200	400	200	400
	280kW(400HP)	M12	182.4~215.0	158.3~186.6	250	500	250	500

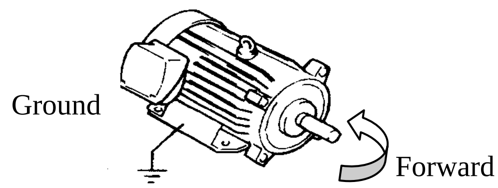
* Apply the rated torque to terminal screws.
* Loose screws can cause of short circuit or malfunction. Tightening the screw too much can damage the terminals and cause a short circuit or malfunction.
* Use copper wires only with 600V, 75℃ ratings. For 7.5~11kW 240V type inverters, R(L1), S(L2), T(L3) and U, V, W terminals are only for use with insulated ring type connector.

Power and Motor Connection Example (5.5~30kW inverters)

R(L1)	S(L2)	T(L3)	G	P1(+)	P2(+)	N(-)	U	V	W

Power supply must be connected to the R(L1), S(L2), and T(L3) terminals.
Connecting it to the U, V, and W terminals causes internal damages to the inverter. Arranging the phase sequence is not necessary

Ground



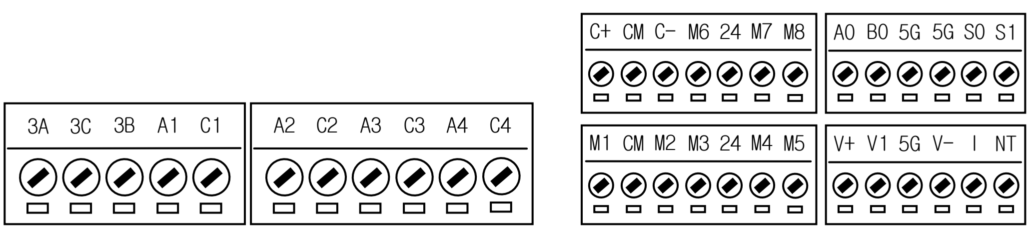
Motor should be connected to the U, V, and W terminals.
If the forward command (FX) is on, the motor should rotate counter clockwise when viewed from the load side of the motor. If the motor rotates in the reverse, switch the U and V terminals.

3.2.4 Control circuit wiring

1) Wiring Precautions
CM and 5G terminals are insulated each other. Do not connect these terminals together or to the power ground.
Use shielded wires or twisted wires for control circuit wiring, and separate these wires from the main power circuits and other high voltage circuits (200V relay sequence circuit).

It is recommended to use the cables of 0.0804mm^2 (28 AWG) ~ 1.25mm^2 (16 AWG) for TER1, TER2 control terminals and the cables of 0.33mm^2 (22 AWG) ~ 2.0mm^2 (14 AWG) for TER3, TER4 control terminals.

2) Control terminal layout



TER4 TER3 TER2 TER1

0.33mm^2 (22 AWG) ~ 2.0mm^2 (14 AWG) 0.08

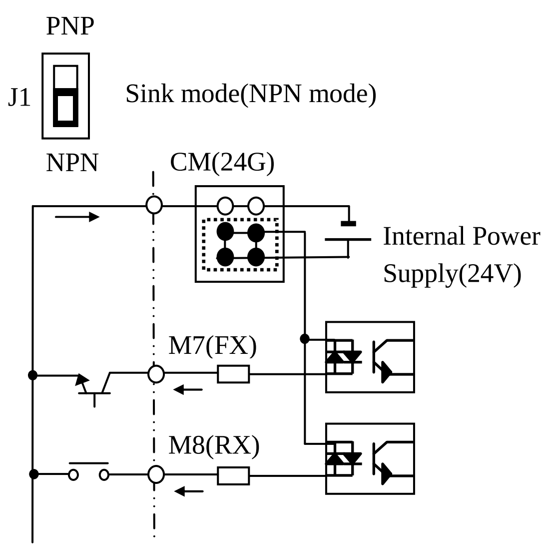
3) Sink mode(NPN mode) / Source mode(PNP mode)

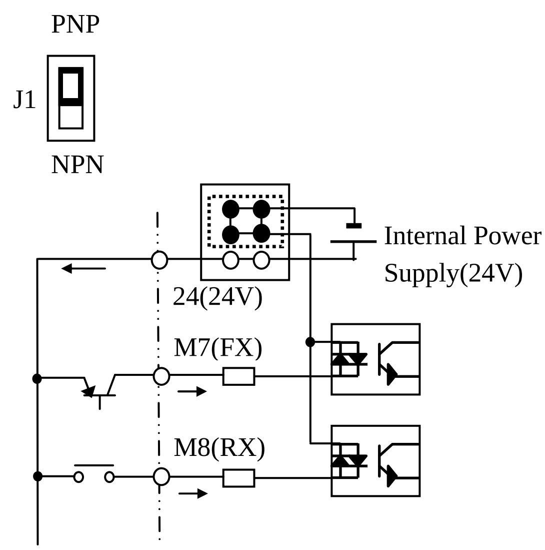
P Series provides Sink/Source(NPN/PNP) modes for sequence input terminal on the control circuit.
The logic of the input terminal is setable to Sink mode(NPN mode) / Source mode(NPN mode) by using the J1 switch. Connection method is shown below.

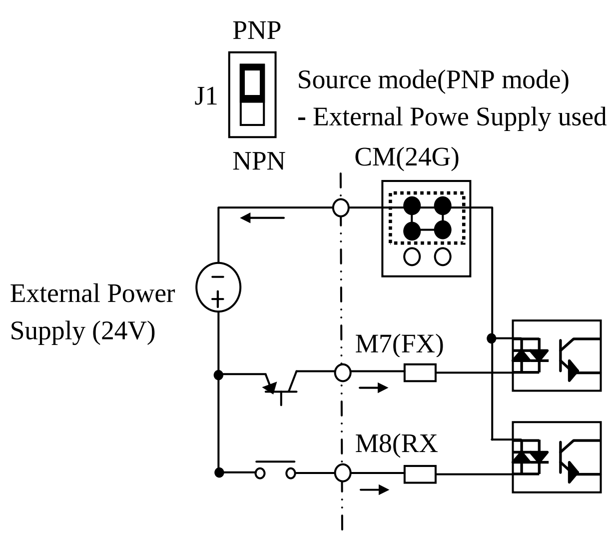
(1) Sink mode(NPN mode)
- Put J1 swich down to set to Sink mode(NPN mode). CM terminal (24V GND) is common terminal for contact signal input.
- The factory default is Sink mode(NPN mode).

(2) Source mode(PNP mode) - Internal Power Supply used
- Put J1 swich up to set to Source mode(PNP mode). Terminal 24 (24V Power Supply) is common terminal for contact input signal.

(3) Source mode(PNP mode) - External Power Supply used
- Put J1 swich up to set to Source mode(PNP mode).
- To use external 24V Power Supply, make a sequence between external Power Supply (-) terminal and CM(24V GND) terminal.



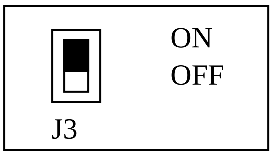




3.2.5 RS485 circuit wiring

TER 2

C+	CM	C-	M6	24	M7	M8
M1	CM	M2	M3	24	M4	M5



Use C+ (RS485 signal High), C- (RS485 signal LOW) in TER 2. Turn the J3 switch ON (Upward) to connect the termination resistor (120 ohm). J3 switch is on the left side of the TER2.

Item	Specification
Transmission type	Bus method, Multi drop Link System
Applicable inverter	P Series
Number of inverters	Max.31
Transmission distance	Within 1200m Max. (700m desired)
Recommendable cable	0.75mm^2(18AWG), Shield Type Twisted-pair Wire

Item	Specification
Installation	C+, C-, CM terminals on the control terminal block
Power supply	Insulated from the inverter power supply

3.2.6 Check points on wiring

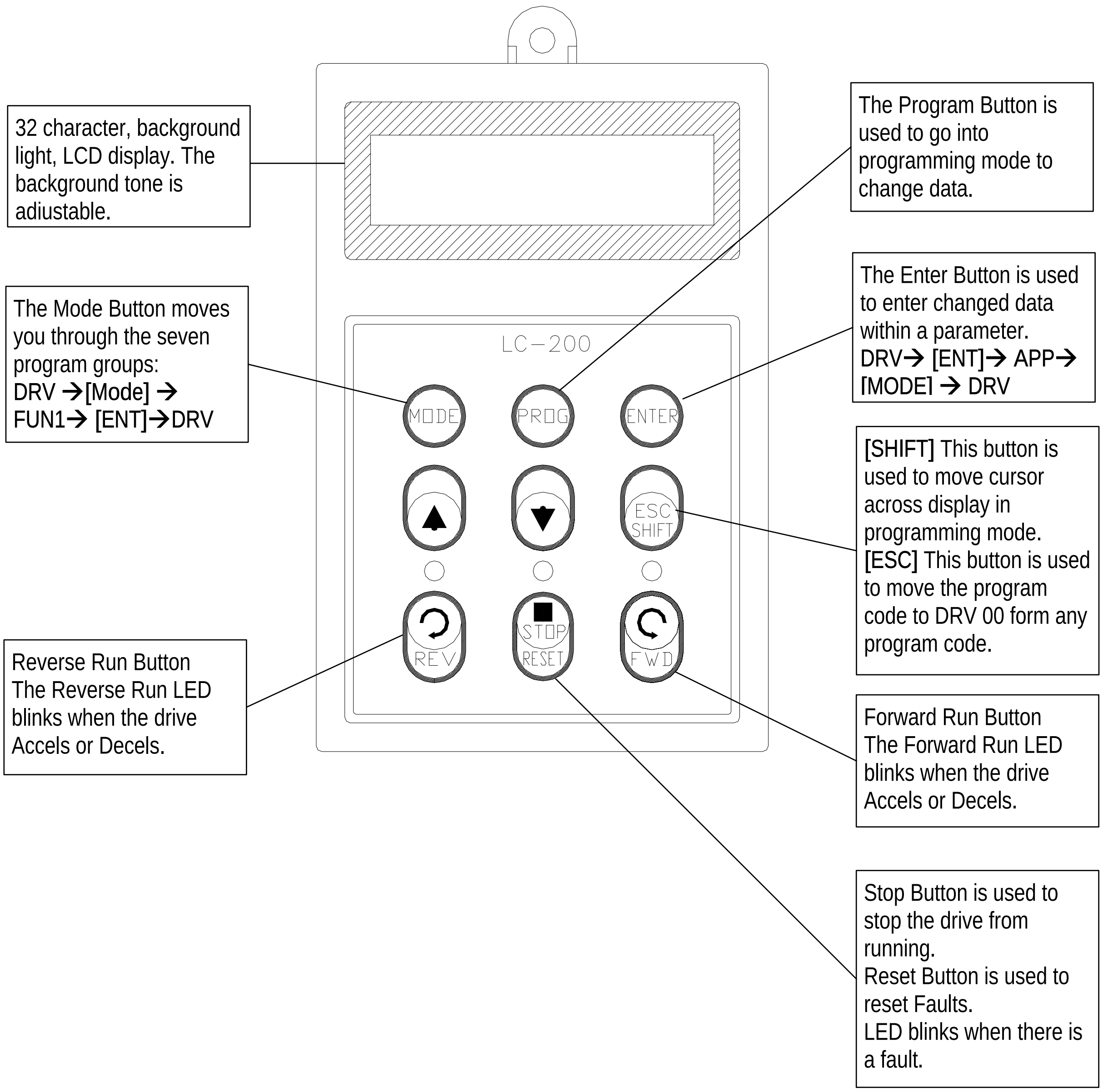
1) Electrical or mechanical interlock of MC1 and MC2 is required for Inverter Bypass Operation. Otherwise, chattering may occur or input power may flow to inverter output, damaging the inverter.
2) Make the sequence to disable the Auto restart after power failure if required. Otherwise, inverter will be automatically restarted.
3) Do not apply the voltage directly to control circuit input terminals such as FX, RX.

CHAPTER 4 - OPERATION

4.1 Programming Keypads

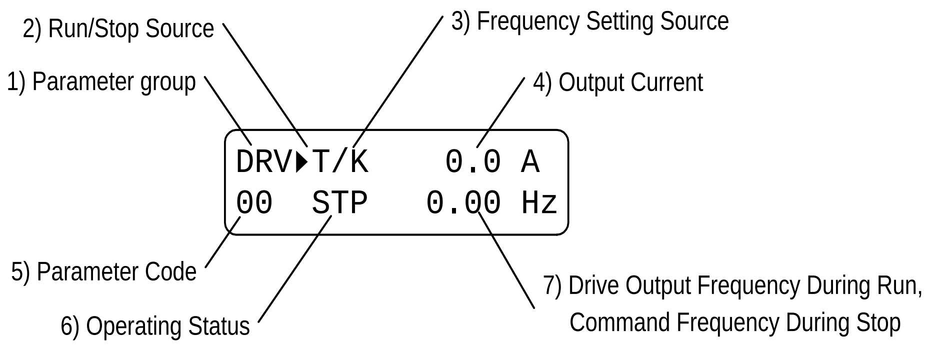
4.1.1 LCD Keypad

LCD keypad can display up to 32 alphanumeric characters, and various settings can be checked directly from the display. The following is an illustration of the keypad.



Detail description

1) LCD Keypad Display



Displays	Description
1) Parameter Group	Displays the parameter group. There are DRV, FU1, FU2, I/O, EXT, COM, APP groups.
2) Run/Stop Source	Displays the source of motor Run and Stop **K**: Run/Stop using FWD, REV buttons on keypad **T**: Run/Stop using control terminal input FX, RX **R**: Run/Stop using RS485 **O**: Run/Stop via option board
3) Frequency Setting Source	Displays the source of command frequency setting **K**: Frequency setting using keypad **V**: Frequency setting using V1 (0 ~12V or -12~ 12V) or V1 + I terminal **I:** Frequency setting using I (4 ~ 20mA) terminal **P**: Frequency setting using Pulse input **R**: Frequency setting using RS485 **U**: Up terminal input when Up/Down operation is selected **D**: Down terminal input when Up/Down operation is selected **S**: Stop status when Up/Down operation is selected **O**: Frequency setting via Option board **X**: Frequency setting via Sub board **J**: Jog terminal input **1 ~ 15**: Step frequency operation (except Jog)
4) Output Current	Displays the Output Current during operation.
5) Parameter Code	Displays the code of a group. Use the ▲(Up), ▼(Down) key to move through 0~99 codes.
6) Operating Status	Displays the operation information. **STP**: Stop Status **FWD**: During Forward operation **REV**: During Reverse operation **DCB**: During DC Braking **LOP**: Loss of Reference from Option Board (DPRAM fault) **LOR**: Loss of Reference from Option Board (Communication network fault) **LOV**: Loss of Analog Frequency Reference (V1: 0~12V, -10~12V) **LOI**: Loss of Analog Frequency Reference (I: 4~20mA) **LOS**: Loss of Reference from Sub-Board
7) Inverter Output Frequency/ Command Frequency	Displays the Output Frequency during run. Displays the Command Frequency during stop.

4.1.2 Parameter setting and changing

1) Press **[MODE]** key until the desired parameter group is displayed.

2) Press **[▲]** or **[▼]** keys to move to the desired parameter code. If you know the desired parameter code, you can set the code number of each parameter group in “Jump code”, except DRV group.

3) Press **[PROG]** key to go into the programming mode, the cursor starts blinking.

4) Press **[SHIFT/ESC]** key to move the cursor to the desired digit.

5) Press **[▲]** or **[▼]** keys to change the data.

6) Press **[ENT]** key to enter the data. The cursor stops blinking.

Note: Data cannot be changed when 1) the parameter is not adjustable during the inverter is running (see the function list), or 2) Parameter Lock function FU2-94 [Parameter Lock] is activated.

EX) Changing Accel time from 10 sec to 15 sec

1) LCD keypad

```
DRV▶ Acc. time
01        10.0 sec
```

Move to the desired code to change.

```
DRV▶ Acc. time
01       ■10.0 sec
```

Press the **[PROG]** key.
A Cursor (■) will appear.

```
DRV▶ Acc. time
01        10.0 sec
```

Use the **[SHIFT]** key to move the cursor.

```
DRV▶ Acc. time
01        15.0 sec
```

Change the data using **[▲]**, **[▼]** keys.

```
DRV▶ Acc. time
01        15.0 sec
```

Press the **[ENT]** key to save the value into memory.
The Cursor will disappear.

4.1.3 Parameter groups

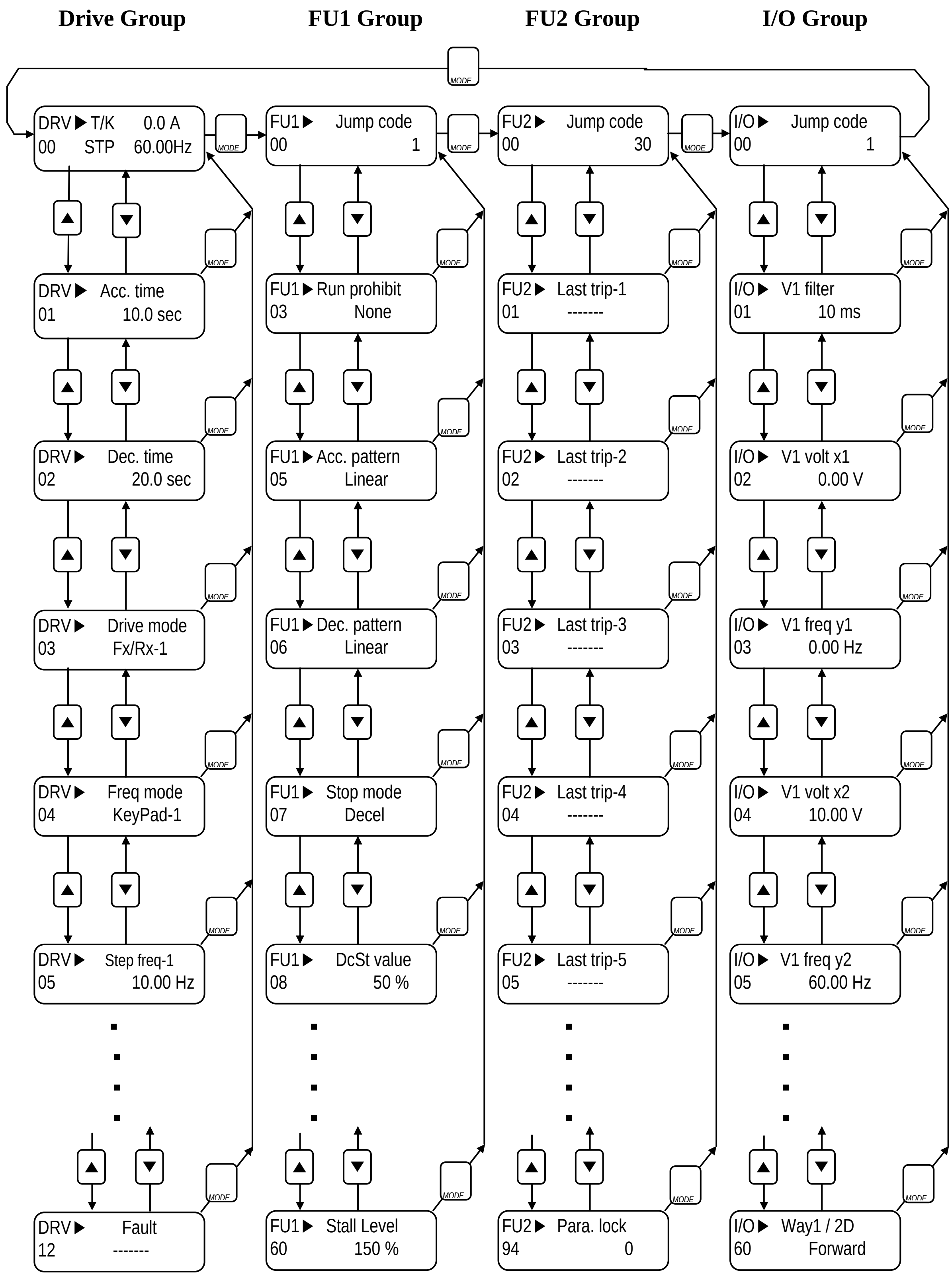
The P Series inverter has 5 parameter groups separated according to their applications as indicated in the following table.
The P Series inverter provides two kinds of keypad. One is 32-character alphanumeric LCD keypad and the other is 7-Segment LED keypad.

Parameter Group	LCD Keypad	Description
Drive Group	DRV	Command Frequency, Accel/Decel Time etc. Basic function Parameters
Function 1 Group	FU1	Max. Frequency, Amount of Torque Boost etc. Parameters related to basic functions
Function 2 Group	FU2	Frequency Jumps, Max/Min Frequency Limit etc. Basic Application Parameters
Input / Output Group	I/O	Programmable Digital Input/Output Terminal Setting, Auto Operation etc. Parameters needed for Sequence Operation
Application Group	APP	PID, MMC (Multi-Motor Control), 2nd motor operation etc. Parameters related to Application function

Refer to the function descriptions for detailed description of each group.

1) Parameter Navigation (LCD Keypad)

The parameter group moves directly to DRV group by pressing [**SHIFT**] key in any parameter code.



☞ **Note:** This figure shows the group and code navigation through LCD display keypad. It can be different from the actual display due to the group addition or code change.

4.2 Operating Example

4.2.1 Easy Start Operation

Easy Start Operation is activated by pressing STOP key on the Keypad for 2~3 seconds and inverter begins operation via Keypad (FWD/REV RUN/STOP). **Drive mode is preset to V/F and reference frequency to JOG.**

4.2.2 Operation via Control terminal + Keypad

Setting: DRV-03 [Drive Mode (Run/Stop method)] = **Fx/Rx-1**
DRV-04 [Frequency Mode (Freq. setting method)] = **Keypad**
With above setting, Freq setting via terminal & Run/Stop via Keypad disabled

1) Check the LCD display when Power ON. Otherwise, change the setting correctly as shown above.

```
DRV▶T/K     0.0 A
00   STP   0.00Hz
```

2) Turn the FX (or RX) terminal ON. Then FWD (or REV) LED will be lit.

```
DRV▶T/K     0.0 A
00   FWD   0.00Hz
```

3) When setting the Ref. Freq to 60 Hz using **PROG/ENT/SHIFT**, ▲ keys, the motor will rotate at 60Hz. FWD (or REV) LED will be flickering during Acceleration/ Deceleration.

```
DRV▶ Cmd. freq        DRV▶ Cmd. freq        DRV▶T/K     5.0 A
00       █ 0.00Hz  →  00         60.00Hz  →  00   FWD  60.00Hz
```

4) Turn the FX (or RX) terminal Off. Then Stop LED will be lit.

```
DRV▶T/K     0.0 A
00   STP  60.00Hz
```

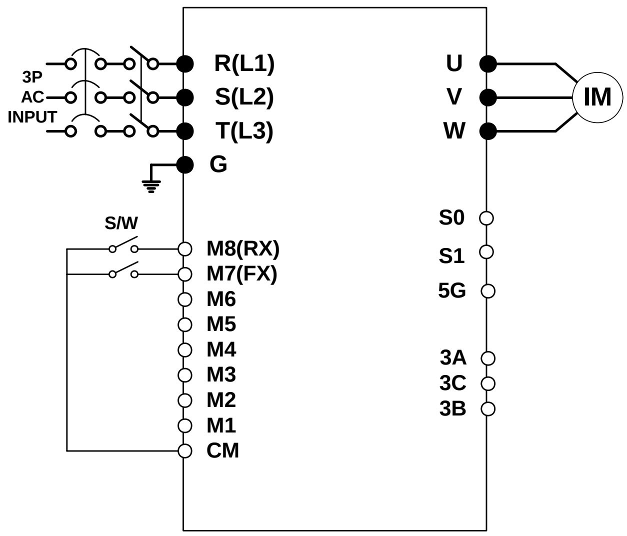
> **Note)** To enable Run/Stop via keypad & Freq setting via control terminal…
> Setting: DRV-03 [Drive Mode (Run/Stop method)] = Keypad
> DRV-04 [Frequency Mode (Freq. setting method)] = V1, V1S or I

Operation Example (1)	Freq Setting via Keypad + Run/Stop via Terminal (FX/RX)

[Operation condition]

-. Control mode: V/F control
-. Ref. Frequency: 50[Hz] setting via keypad
-. Accel/Decel time: Accel – 10 [sec], Decel – 20 [sec]
-. Drive mode: Run/Stop via FX/RX terminal, Control terminal: NPN mode

[Wiring]



Step	Parameter setting	Code	Description
1	Drive Mode	DRV-3	Set it to 1 FX/RX-1.
2	Frequency Mode	DRV-4	Set it to 0 Keypad-1.
3	50[Hz] freq command setting	DRV-0	Set freq command 50[Hz] via Keypad.
4	Accel/Decel time	DRV-1 DRV-2	Set Accel time to 10 [sec] in DRV-1. Set Decel time to 20 [sec] in DRV-2.
5	Terminal FX (M7)	I/O-26	Motor starts to rotate in Forward direction at 50Hz with Accel time 10 [sec] when FX terminal is turned ON. Motor decelerates to stop with Decel time 20[sec] when FX terminal is turned OFF.
6	Terminal RX (M8)	I/O-27	When RX terminal is turned ON motor starts to rotate in Reverse direction at 50[Hz] with Accel time 10 [sec]. When it is OFF, motor decelerates to stop with Decel time 20 [sec].

4.2.3 Operation via Control Terminal

Setting: **DRV-03** [Drive Mode (Run/Stop method)] = **1 (Fx/Rx-1)**
DRV-04 [Frequency Mode (Freq. setting method)] = **2 (V1)**

1) Check the LCD display when Power ON. Otherwise, change the setting correctly as shown above.

```
DRV▶T/V     0.0 A
00   STP   0.00Hz
```

2) Turn the FX (or RX) terminal ON. Then FWD (or REV) LED will be lit.

```
DRV▶T/V     0.0 A
00   FWD   0.00Hz
```

3) Set the frequency using V1 (Potentiometer), Output freq (60Hz). Rotating direction (FWD or REV) and output current (5A) will be displayed on the LCD.

```
DRV▶T/V     5.0 A
00   FWD  60.00Hz
```

4) Output freq value is decreasing when turning the potentiometer counterclockwise. Inverter output stops at 0.00Hz and motor is stopped.

```
DRV▶T/V     0.0 A
00   FWD   0.00Hz
```

5) Turn FX (or RX) terminal OFF.

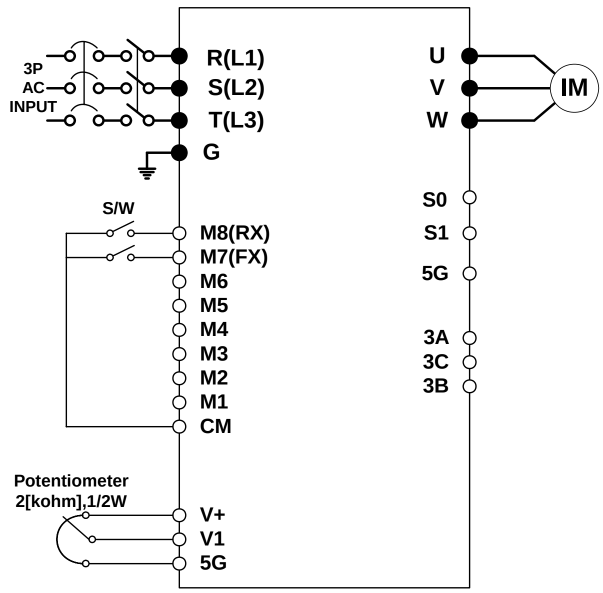
```
DRV▶T/V     0.0 A
00   STP   0.00Hz
```

Operation Example (2)	Analog Voltage Input (V1) + Operation via Terminal (FX/RX)

[Operation condition]

-. Control mode: V/F control
-. Reference Frequency: 50[Hz] analog input via V1 (Potentiometer)
-. Accel/Decel time: Accel – 10 [sec], Decel – 20 [sec]
-. Drive mode: Run/Stop via FX/RX terminal, Control terminal: NPN mode

[Wiring]



Step	Parameter setting	Code	Description
1	Drive Mode	DRV-3	Set it to 1 Fx/Rx-1.
2	Frequency Mode	DRV-4	Set it to 2 V1 Analog input.
3	50[Hz] freq command setting	DRV-0	Set freq command 50[Hz] via V1 (potentiometer).
4	Accel/Decel time	DRV-1 DRV-2	Set Accel time to 10 [sec] in DRV-1. Set Decel time to 20 [sec] in DRV-2.
5	Terminal FX (M7)	I/O-26	Motor starts to rotate in Forward direction at 50Hz with Accel time 10 [sec] when FX terminal is turned ON. Motor decelerates to stop with Decel time 20[sec] when FX terminal is turned OFF.
6	Terminal RX (M8)	I/O-27	When RX terminal is turned ON motor starts to rotate in Reverse direction at 50[Hz] with Accel time 10 [sec]. When it is OFF, motor decelerates to stop with Decel time 20 [sec].

4.2.4 Operation via Keypad

Setting: **DRV-03** [Drive Mode (Run/Stop method)] = **0 (Keypad)**
DRV-04 [Frequency Mode (Freq. setting method)] = **0 (Keypad-1)**

1) Check the LCD display when Power ON. Otherwise, change the setting as shown above.

```
DRV▶K/K     0.0 A
00   STP   0.00Hz
```

2) Set the Ref. Freq to 60 Hz using **PROG/ENT/SHIFT**, **▲** keys. Set freq is displayed during stop.

```
DRV▶K/K     0.0 A
00   STP  60.00Hz
```

3) When pressing **FWD/REV** key, motor starts running and output freq and output current are displayed.

```
DRV▶K/K     5.0 A
00   FWD  60.00Hz
```

4) Press **STOP/RESET** key. Then motor decelerates to stop. Set freq 60Hz is displayed.

```
DRV▶K/K     0.0 A
00   STP  60.00Hz
```

4.3 Various function setting & Description

4.3.1 Basic function parameter setting

It is the basic function setting. All settings are factory defaults unless users make change. It is recommended to use factory setting value unless the parameter change is necessary.

1) Common parameter setting

The following table shows common parameter setting that should be checked before use regardless of control mode.

Parameter Name	Code	Description
Line Freq.	FU1-29	Sets a freq of the inverter input power source.
Base Frequency	FU1-31	Sets the Motor Base Frequency[1)].
Motor Rated Voltage	FU1-50	Sets the Motor Rated Voltage[1)].
Motor Selection	FU2-40	Selects motor and voltage rating suitable to the desired inverter.
Motor parameters	FU2-41 ~ 46	Basic parameter value setting when selecting the motor rating. Note: If there is any discrepancy between parameter preset value and the actual motor parameter value, change the parameter value according to the actual motor.
Drive Mode	DRV-3	Operation via Keypad, Fx/Rx-1, Fx/Rx-2 and Int 485 setting.
Frequency Mode	DRV-4	Frequency reference source setting parameter
Accel/Decel time setting	DRV-1, DRV-2	Accel/Decel time setting

1) If FU1-31 and FU1-50 are set higher than motor nameplate value, it may cause motor overheat and if it is set smaller than that, it may cause Over voltage trip during deceleration. Make sure to enter the actual motor value.

2) V/F control

FU2-60 [Control mode] is set to 0 “V/F” as factory setting. Operation via V/F control is activated after the above common parameter setting is done and the followings are set.

Parameter Name	Code	Description
Starting freq.	FU1-32	Set frequency to start the motor.
Torque boost	FU2-67	Manual or Auto torque boost settable in this parameter
Torque boost value	FU2-68, FU2-69	If FU1-67 [torque boost] is set to “manual”, user sets the desired value and the direction in code FU1-68 and 69.

3) Slip compensation

Operation is done via Slip compensation if FU2-60 is set to 1 {Slip compen}. This control keeps motor speed constant regardless of load change.

4) Sensorless vector control

Set FU2-60 to "Sensorless" to enable Sensorless vector control. It is strongly recommended to perform **Auto-tuning** before starting Sensorless control in order to maximize performance.

Parameter Name	Code	Description
Control method selection	FU2-60	Select Sensorless.
P, I gain for sensorless control	FU2-65, FU2-66	Set gain for Sensorless.
Starting freq	FU1-32	Starting freq of the motor

Note) No-load current for Sensorless control is not entered by auto-tuning. Therefore enter the no-load current value in V/F operation. When other than CERUS standard motor is used, set this value according to the motor in use for better performance.

5) Auto-tuning of motor constant

This parameter enables auto-tuning of the motor constants. If FU2-61 is set to Yes and press the enter key, **Rs, Lsigma** values begin tuning with the motor stopped. Refer to motor nameplate for the rest of other parameters.

Parameter Name	Code	Description
Auto-tuning	FU2-61	No, Yes

Note) Motor no-load current and slip freq should be set correctly for safe and better performance. Be sure to check these values and set them properly. Refer to Chapter 5, FU2-40~66 for more.

4.3.2 Advanced function setting

P Series inverter features advanced function parameters to maximize efficiency and performance of the motor. It is recommended to use the factory setting unless parameter value change is inevitable.

1) V/F control

Parameter Name	Code	Description
V/F Pattern	FU1-40	Use it according to load characteristics. If User V/F is selected, user can select the optimum output V/F characteristic for the application and load characteristics in [FU1-41]~[FU1-48].
Dwell operation	FU2-07 FU2-08	Used to output torque in an intended direction. Inverter stops acceleration for the preset [FU2-08] Dwell time while running at Dwell frequency [FU2-07] and starts acceleration at commanded frequency. Setting [FU2-08] Dwell time to 0 disable the Dwell operation.
Jump Frequency	FU2-10 FU2-11~16	When it is desired to avoid resonance attributable to the natural frequency of a mechanical system, these parameters allow resonant frequencies to be jumped. Up to three areas can be set, with the jump frequencies set to either the top or bottom point of each area. To enable the function, set [FU2-10] to 'Yes' and set the value in [FU2-11]~[FU2-16].
Accel/Decel pattern S-curve	FU1-2, 3 FU1-4, 5	This pattern has an effect on the prevention of cargo collapse on conveyor etc and reduction in an acceleration/ deceleration shock.

2) Sensorless vector control

Related parameters for starting in **Sensorless vector control** when FU2-60 [Control Mode Selection] is set to Sensorless.

Parameter Name	Code	Description
When starting	FU2-64	Pre-excitation time setting
	I/O-20~27	Programmable Digital Input terminals define

3) Parameters to monitor motor and inverter status

Parameter Name	Code	Description
Output current/ motor speed	DRV-8~9	Displays output current and motor rpm.
DC link voltage	DRV-10	Displays DC link voltage.
User display selection (Voltage and watt)	DRV-11 FU2-81	Either output voltage or power selected in FU2-81 is displayed in DRV-11.
Fault display	DRV-12	Displays the current inverter fault.
TAR / OUT Freq. display	DRV-14	Displays Target freq. for Accel/Decel & Output freq during Accel/Decel.
REF/FBK display	DRV-15	Displays PID Reference/ Feedback frequency display.
Speed (Hz / Rpm) selection	DRV-16	Selects inverter output speed unit [Hz or Rpm]
PID parameter	DRV-18	Displays related parameters of PID controller.
AD parameter	DRV-19	Displays inverter analog input value to AD value.
EXT - PID parameter	DRV-20	Displays related parameters of EXT-PID controller.

Note) DRV-15, DRV-18 only displayed when APP-02 [proc PI mode] is set to “Yes.” DRV-20 only displayed when APP-80 [Ext PI mode] is set to “Yes.”

5) Parameter initialize

Parameter Name	Code	Description
Software version	FU2-82	Displays the inverter software version.
Parameter Read/Write/Initialize/ Lock	FU2-91 FU2-92 FU2-93 FU2-94 FU2-95	[FU2-91], [FU2-92]: Copying parameters from other inverter [FU2-93]: Initializing parameters to factory setting values [FU2-94]: Parameter write disabled [FU2-95]: Parameter save

Note: Motor parameters (FU2-40~46, FU2-62~63) returned to factory setting once Parameter Read/Write is executed.

6) Protection & Trip level setting

Parameter Name	Code	Description
Electronic thermal	FU1-60 FU1-61 FU1-62 FU1-63	Protection of the motor from overheating without the use of external thermal relay. Refer to parameter descriptions for more detail.
Overload alarm & trip	FU1-64 FU1-65 FU1-66 FU1-67 FU1-68	Warning alarm outputs and displays the trip message when overcurrent above the threshold value keeps on.
Stall prevention	FU1-70 FU1-71	Set the output current level at which the output freq will be adjusted to prevent the motor from stopping due to over-current etc. It activates during accel/ constant speed/decel to prevent the motor stall.

7) Starting / Accel/ Decel / Stopping pattern setting

Parameter Name	Code	Description
Accel/Decel pattern	FU1-02 FU1-03	2 types of Accel/Decel pattern: ‘S-curve’, ’U-curve’ settable according to application and load characteristic. If ‘S-curve’ is selected, the desired value of [FU1-4], [FU1-5] is settable.
Starting/Stopping method	FU1-20 FU1-23	4 types of stopping method ‘Decel’, ‘DC-brake’, ‘Free-run’, ‘Flux Brake’ selectable. If ‘DC-brake’ is selected, the desired value of [FU1-21, 22], [FU1-24]~ [FU1-27] is settable. See function description of chapter 5 for more details.
Frequency Limit selection	FU1-33 FU1-34 FU1-35	Limits the active frequency. Inverter operates at the freq range between upper freq limit [FU1-35] and bottom freq limit [FU1-34] and higher/ lower freq value is entered, it is automatically replaced by limit value. Setting range: [FU1-30] Maximum freq to [FU1-32] starting freq.

8) Operation-starting method

Parameter Name	Code	Description
Starting method	FU2-20 FU2-21 FU2-25 FU2-26	Motor starting method: [FU2-20]: Power-on run, [FU2-21] Restart after Fault Reset, [FU2-25] Number of Auto Restart Attempt [FU2-26] Delay Time Before Auto Restart See parameter description for more details.
Speed Search Selection	FU2-22 FU2-23 FU2-24	Speed search function is available during Accel, trip, instant power failure, restart after fault reset and Speed search at auto restart. See parameter description for more details.

4.3.3 Application function setting

1) PID operation

Inverter can be used to exercise process control, e.g. flow rate, air volume or pressure via PID feedback control.

Parameter Name	Code	Description
PID control setting	APP-02 ~ APP-17	Parameters for PID control setting

☞ **See Chapter 6. PID feedback operation.**

2) Ext PID operation

It is used for External PID feedback control.

Parameter Name	Code	Description
ExtPID setting	APP-80 ~ APP-97	Parameters for Ext PID

☞ **See Chapter 6. External PID operation.**

3) Pre PID operation

It helps to begin smooth start of the PID control.

Parameter Name	Code	Description
PrePID setting	APP-74 ~ APP-76	Parameters for Pre PID operation

☞ **See Chapter 6. Pre PID operation.**

4) MMC operation

Inverter controls a whole system by controlling Main motor connected directly to the inverter and Aux motors connected to the inverter relays and operated via relay On/Off.

Parameter Name	Code	Description
MMC setting	APP-40 ~ APP-71 I/O-20 ~ I/O-27	Parameters for MMC operation

☞ **See Chapter 6. MMC operation.**

5) Jog and Multi-speed operation

Parameter Name	Code	Description
Multi function input terminal setting	I/O-20 ~27	If I/O-20 ~27 are set to Speed-H, Speed-M, Speed-L, multi- speed operation up to speed 17 is available.
Filter time constant for input terminal	I/O-29	Effective for eliminating noise in the freq. Setting circuit
Speed reference value	DRV-05 ~07 I/O-31 ~ I/O-42	Speed reference value for each step setting
Accel/Decel time setting for each step	I/O-50 ~ 63	Accel/Decel time for each step setting
Jog freq.	I/O-30	Jog freq for jog operation setting

Speed-X	Speed-H	Speed-M	Speed-L	JOG	Speed Command	Parameter value
0	**0**	**0**	**0**	**0**	**Speed 0**	**DRV-00**
0	**X**	**X**	**X**	**1**	**Jog freq.**	**I/O-20**
0	**0**	**0**	**1**	**0**	**Speed –1**	**DRV-05**
0	**0**	**1**	**0**	**0**	**Speed –2**	**DRV-06**
..	**..**	**..**	**..**	**..**	**..**	**..**
..	**..**	**..**	**..**	**..**	**..**	**..**
1	**1**	**0**	**1**	**0**	**Speed –13**	**I/O-40**
1	**1**	**1**	**0**	**0**	**Speed –14**	**I/O-41**
1	**1**	**1**	**1**	**0**	**Speed –15**	**I/O-42**

6) 2nd motor operation

2nd function setting is required to run the two motors by one inverter by exchange. If the terminal defined for 2nd function signal input is turned ON, 2nd motor operation is valid.

Parameter Name	Code	Description
Programmable Digital Input terminals setting	I/O-20 ~27	2nd motor operation is available with Programmable Digital Input terminals M1 ~ M8 set to 7 {2nd Func}.
Parameter setting for 2nd motor operation	APP-20 ~ APP-29	Setting parameters necessary to operate 2nd motor such as base freq., Accel/Decl time, Stall.

7) Energy-saving operation

FU1-51 [Energy Save Level] tunes the inverter output voltage to minimize the inverter output voltage during constant speed operation. Appropriate for energy-saving applications such as fan, pump and HVAC.

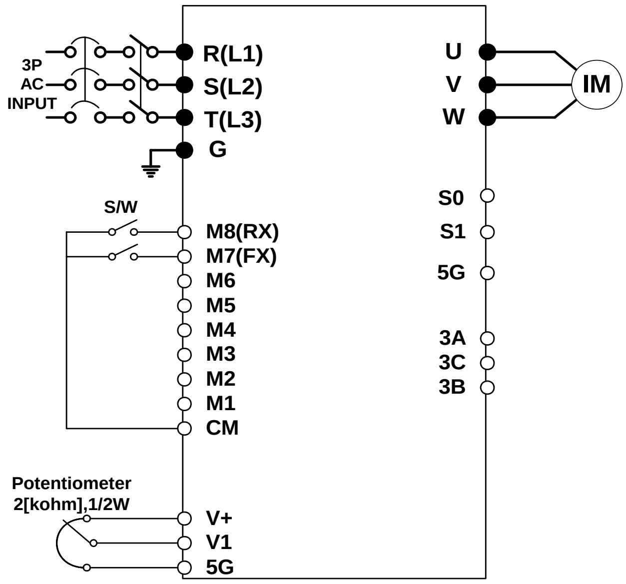
4.4 Operation Example

Operation Example (1)	**V/F Control + Analog Voltage Input (V1) + Operation via Terminal (FX/RX)**

[Operation condition]

-. Control mode: V/F control
-. Frequency command: 50[Hz] analog input via V1 terminal
-. Accel/Decel time: Accel – 15 [sec], Decel – 25 [sec]
-. Drive mode: Run/Stop via FX/RX terminal, Control terminal: NPN mode

[Wiring]



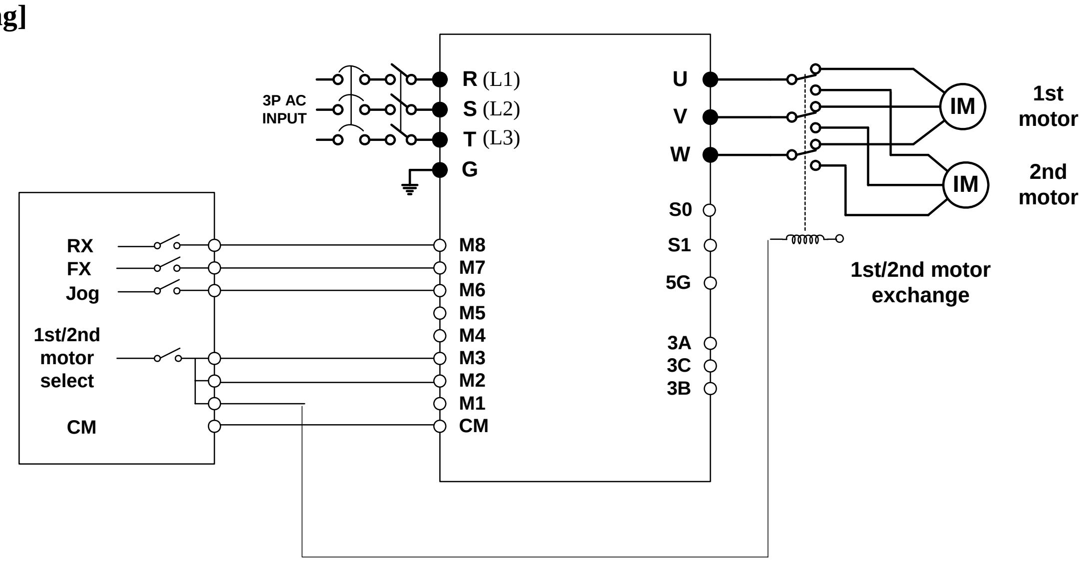
Step	Parameter setting	Code	Description
1	Control Mode Selection	FU2-60	Set it to 0 {V/F}.
2	Drive Mode	DRV-3	Set it to Fx/Rx-1.
3	Frequency Mode	DRV-4	Set V1 Analog input value in frequency mode.
4	50[Hz] freq command setting	DRV-0	Set freq command 50[Hz] via V1 (potentiometer).
5	Accel/Decel time	DRV-1 DRV-2	Set Accel time to 15 [sec] in DRV-2. Set Decel time to 25 [sec] in DRV-3.
6	Terminal FX	I/O-26	Motor starts to rotate in Forward direction at 50Hz with Accel time 15 [sec] when FX terminal is turned ON. Motor decelerates to stop with Decel time 25[sec] when FX terminal is turned OFF.
7	Terminal RX	I/O-27	When RX terminal is turned ON motor starts to rotate in Reverse direction at 50[Hz] with Accel time 15 [sec]. When it is OFF, motor decelerates to stop with Decel time 25 [sec].

Operation Example (2)	2nd motor operation

[Operation condition]

-. Control mode: V/F control
-. 1st motor + 2nd motor Operation by exchange using [2nd Func] (Set Value different)
-. Frequency command: Using Multi-step operation 1st motor --- 50[Hz] as main speed
2nd motor --- 20[Hz] with M1 terminal set as multi- step operation)
-. Accel/Decel time: 1st motor --- Accel time: 15[sec], Decel time: 25 [sec]
2nd motor --- Accel time: 30[sec], Decel time: 40 [sec]
-. Drive mode: Run/Stop via FX/RX, Control terminal: NPN mode

[Wiring]

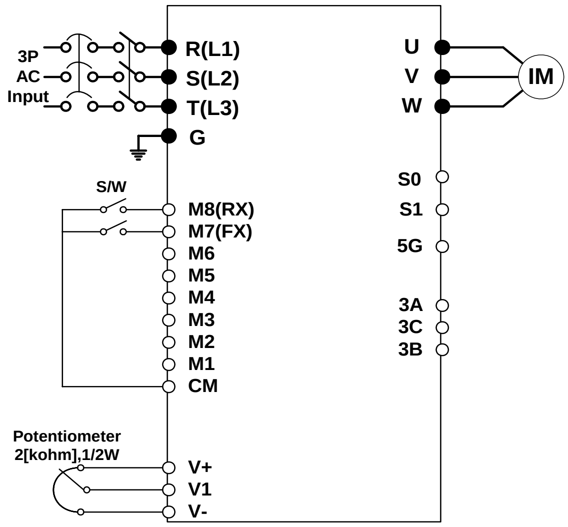


Step	Parameter setting	Code	Description
1	Control Mode Selection	FU2-60	Set it to 0 {V/F}.
2	Drive mode	DRV-3	Set it to Fx/Rx-1.
3	Frequency Mode setting	DRV-4	Set it to 0 {keypad-1}. 1st motor freq setting
4	Programmable digital input terminal M1	I/O-20	Set M1 to 2nd Func.
5	Programmable digital input terminal M2	I/O-21	Set M2 to Speed-L. 2nd motor freq setting
6	Freq setting for 1st motor	DRV-0	Set it to 50[Hz].
7	Accel/Decel time setting for 1st motor	DRV-1, DRV-2	Set Accel/Decel time to 15[sec]/25[sec].
8	Freq setting for 2nd motor	DRV-5	Set it to 10[Hz].
9	Accel/Decel time setting for 2nd motor	APP-20, APP-21	Set Accel/Decel time to 30[sec]/50[sec].
10	1st motor operation		Set it as main motor by turning M1, M2, Output relay OFF. Run the motor in FWD/REV direction using FX/RX terminal.
11	2nd motor operation		Set 2nd motor parameters by turning terminal M1 ON. Change the freq setting to 20[Hz] by turning terminal M2 ON. Change to 2nd motor terminal by turning output relay ON. Run the motor in FWD/REV direction by terminal FX/RX.

Operation Example (3)	**V/F control + Analog input (V1S) + Operation via terminal FX/RX**

[Operation condition]
-. Control mode: V/F control
-. Frequency command: Setting 50[Hz] via Analog input (V1S)
-. Accel/Decel time: Accel time 15 [sec], Decel time 25 [sec]
-. Drive mode: Run/Stop via FX/RX, Control terminal: NPN mode

[Wring]

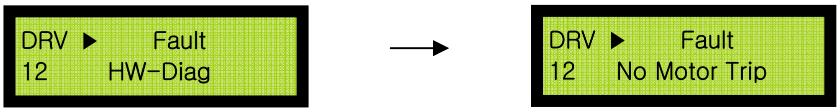


Step	Parameter setting	Code	Description
1	Control mode selection	FU2-60	Set it to 0 {V/F}.
2	Drive mode	DRV-3	Set it to 1 {Fx/Rx-1}.
3	Frequency mode	DRV-4	Set it to 3 {V1S}.
4	Operating frequency command 50[Hz] setting	DRV-0	Set 50[Hz] via potentiometer (V1S).
5	Accel/Decel time setting	DRV-1 DRV-2	Set Accel time to 15[sec] in DRV-1 with decal time to 25[sec] in DRV-2.
6	FX terminal (M7)	IO-26	When FX terminal is turned ON, motor rotating in forward direction starts running at 50[Hz] for 15 [sec]. When FX terminal is turned OFF, motor decelerates to stop for 25[sec].
7	RX terminal (M8)	IO-27	When RX terminal is turned ON, motor rotating in reverse direction starts running at 50[Hz] for 15[sec]. When RX terminal is turned OFF, motor decelerates to stop for 25 [sec].

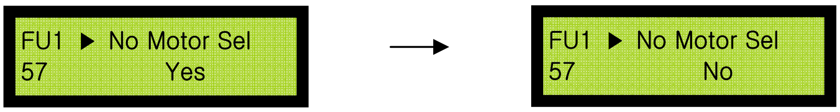
☞ **Note: V1S mode enables Forward/Reverse rotation using ±12V power via Analog input command. Refer to Chapter 6, Parameter description of DRV-00 for details.**

☞ **Note: Use V1 instead of V1S mode when FWD/REV Run Prevention is active. V1S mode enables the motor to run both FWD/REV directions.**

☞ **Note: If the inverter is operated without wiring a motor, trip occurs as below because the protection function is active automatically. In this case, refer to the related parameters(FU1 57 ~ 59). Trip is reset if the invertr is powered down and up once again.**



In case that a simple trial run is needed such as a check on basic operation state without a wiring a motor, FU1-57(No Mortor Sel) should be set to [No] because that FU1-57(No Mortor Sel)'s factory default is [Yes]



CHAPTER 5 - PARAMETER LIST

5.1 Parameter groups

The parameters of P Series are divided into 5 funtion groups in accordance with the application.
Their names, principal contents and LCD keypad displays are shown below.

Name of Group	LCD Keypad Display	Discription
Drive Group [DRV]	DRV ▶T/K 0.0 A 00 STP 0 .00Hz	Target Prequency and Accel/ Decel Time, etc. Basic parameters
Function1 Group [FU1]	FU1 ▶ Jump code 00 1	Maxium Frequency and Protection, etc Parameters regarding basic functions
Function2 Group [FU2]	FU2 ▶ Jump code 00 40	Frequency Jump and Frequency Limit, etc Parameters regarding application functions
Input/Output Group [I/O]	I/O ▶ Jump code 00 1	Programmable Digital terminal Define and Analog Command, etc Parameters necessary for sequence configuration
Application Group [APP]	APP ▶ Jump code 00 1	PID, MMC, and 2^{nd} motor, etc Parameters regarding application functions

5.2 Parameter list

[DRV Group]

CODE	Comm. Addr	Description		LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
DRV-00 (1)	9100	Command Frequency *(Output Frequency during motor run, Reference Frequency during motor stop)*, Output Current (LCD)		Cmd. freq	0 to FU1-30[Hz]	0 [Hz]	O	6-1
DRV-01	9101	Acceleration Time	5.5~90kW (7.5~125HP)	Acc. Time	0 to 6000 [sec]	20 [sec]	O	6-3
			110~280kW (150~400HP)			60 [sec]		
DRV-02	9102	Deceleration Time	5.5~90kW (7.5~125HP)	Dec. time	0 to 6000 [sec]	30 [sec]	O	6-3
			110~280kW (150~400HP)			90 [sec]		
DRV-03	9103	Drive Mode (Run/Stop Method)		Drive mode	0 (Keypad) 1 (Fx/Rx-1) 2 (Fx/Rx-2) 3 (Int. 485)	1 (Fx/Rx-1)	X	6-4
DRV-04	9104	Frequency Mode (Frequency setting method)		Freq mode	0 (Keypad-1) 1 (Keypad-2) 2 (V1) 3 (V1S) 4 (I) 5 (V1+I) 6 (Pulse) 7 (Int. 485) 8 (Ext. PID)	0 (Keypad-1)	X	6-4
DRV-05	9105	Step Frequency 1		Step freq-1	0 to FU1-30[Hz]	10 [Hz]	O	6-5
DRV-06	9106	Step Frequency 2		Step freq-2		20 [Hz]	O	
DRV-07	9107	Step Frequency 3		Step freq-3		30 [Hz]	O	
DRV-08	9108	Output Current		Current	* [A]	* [A]	*	6-5
DRV-09	9109	Motor Speed		Speed	* [rpm]	* [rpm]	*	6-5
DRV-10	910A	DC link Voltage		DC link Vtg	* [V]	* [V]	*	6-6
DRV-11	-	User Display Selection		User disp		Output voltage [V]	*	6-6
DRV-12	-	Current Trip Display		Fault	*	*	*	6-6
DRV-13	-	Motor Direction		Use Only 7-Segment Keypad	0 (**F**orward) / 1 (**r**everse)	0	O	6-7
DRV-14 (2)	-	Target/Output Frequency Display		Tar. Out. Freq.	* [Hz]	* [Hz]	*	6-7
DRV-15 (2)	910F	Reference/Feedback Frequency Display		Ref. Fbk. Freq.	* [Hz]	* [Hz]	*	6-7
DRV-16	-	Speed Unit Selection		Hz/Rpm Disp	Hz or Rpm	Hz	O	6-8
DRV-18 (2)	-	PID Parameter		PidParameter	* [Hz]	* [Hz]	X	6-8
DRV-19	-	AD Parameter		AD Parameter	AD	AD	X	6-8
DRV-20 (3)	-	EXT-PID Parameter		Ext Pid Para	%	%	X	6-9
DRV-91 (4)	915B	Drive mode 2		Drive mode2	0 (Keypad) 1 (Fx/Rx-1) 2 (Fx//Rx-2)	1 (Fx/Rx-1)	X	6-42
DRV-92	915C	Frequency mode 2		Freq mode2	0 (Keypad-1) 1 (Keypad-2) 2 (V1) 3 (V1S) 4 (I) 5 (V1+I) 6 (Pulse)	0 (Keypad-1)	X	6-42

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page

* The gray-highlighted codes are hidden parameters and will appear when the related functions are to be set.

(1) The speed unit is changed from [Hz] to [%] when DRV-16 is set to [Rpm]. Only User Unit will be displayed when APP-02 is set to [Yes] and when APP-06 is set to either I, V1 or Pulse and when one of I/O-86~ I/O-88 is set to either [Speed], [Percent], [Bar], [mBar], [kPa] or [Pa].

Output Frequency is displayed in DRV-00 during the Inverter is running.

User Unit reference is displayed in DRV-00 during the Inverter is not running.

(2) DRV-15, DRV-18 will appear when APP-02 [Process PI Mode] is set to “Yes”. Also User Unit is displayed when one of I/O-86~ I/O-88 is set to either [Speed], [Percent], [Bar], [mBar], [kPa] or [Pa].

(3)DRV-20 will appear when APP-80 [ExtProcess PI Mode] is set to “Yes”.

(4) DRV-91/92 will appear only when one of I/O-20~27 is set to [Main drv] and DRV-03/04 is set to [int485].

[FU1 GROUP]

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range		Factory Default	Adj. During Run	Page
FU1-00	9200	Jump to Desired Code #	Jump code	1 to 74 (Use Only LCD Keypad)		1	O	6-10
FU1-01	9201	Run Prevention	Run prevention	0	(None)	0 (None)	X	6-10
				1	(Fwd prev)			
				2	(Rev prev)			
FU1-02	9202	Acceleration Pattern	Acc. Pattern	0	(Linear)	0 (Linear)	X	6-10
				1	(S-curve)			
				2	(U-curve)			
FU1-03	9203	Deceleration Pattern	Dec. Pattern	0	(Linear)	0 (Linear)	X	6-10
				1	(S-curve)			
				2	(U-curve)			
FU1-04 (5)	9204	Start Curve for S-Curve Accel/Decel Pattern	Start Curve	0 to 100 [%]		50 [%]	X	6-10
FU1-05	9205	End Curve for S-Curve Accel/Decel Pattern	End Curve	0 to 100 [%]		50 [%]	X	
FU1-10	920A	Pre-Heat	Pre-Heat mode	0	(No)	0 (No)	X	6-11
				1	(Yes)			
FU1-11	920B	Pre-Heat Value	Pre Heat level	1 to 50 [%]		30 (%)	X	
FU1-12	920C	Pre-Heat Duty	Pre Heat Perc	1 to 100 [%]		100 (%)	X	
FU1-20	9214	Start Mode	Start mode	0	(Accel)	0 (Accel)	X	6-12
				1	(Dc-start)			
				2	(Flying-start)			
FU1-21 (6)	9115	Starting DC Injection Braking Time	DcSt time	0 to 60 [sec]		0 [sec]	X	6-12
FU1-22	9116	Starting DC Injection Braking Value	DcSt value	0 to 150 [%]		50 [%]	X	
FU1-23	9217	Stop Mode	Stop mode	0	(Decel)	0 (Decel)	X	6-13
				1	(Dc-brake)			
				2	(Free-run)			
				3	(Flux-brake)			
FU1-24 (7)	9218	DC Injection Braking On-delay Time	DcBlk time	0.1 to 60 [sec]		0.1 [sec]	X	6-14
FU1-25	9219	DC Injection Braking Frequency	DcBr freq	0.1 to 60 [Hz]		5 [Hz]	X	
FU1-26	921A	DC Injection Braking Time	DcBr time	0 to 60 [sec]		1 [sec]	X	
FU1-27	921B	DC Injection Braking Value	DcBr value	0 to 200 [%]		50 [%]	X	
FU1-28	921C	Safety Stop	Safety Stop	0	(No)	0 (No)	X	6-14
				1	(Yes)			
FU1-29	921D	Power Source Freq	Line Freq	40 to 120 [Hz]		60 [Hz]	X	6-15
FU1-30	921E	Maximum Frequency	Max freq	40 to 120 [Hz]		60 [Hz]	X	6-15
FU1-31	921F	Base Frequency	Base freq	30 to 120 [Hz]		60 [Hz]	X	6-15
FU1-32	9220	Starting Frequency	Start freq	0.1 to 10 [Hz]		0.5 [Hz]	X	6-15
FU1-33	9221	Frequency Limit selection	Freq limit	0	(No)	0 (No)	X	6-16
				1	(Yes)			

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
FU1-34 (8)	9222	Low Limit Frequency	F-limit Lo	FU1-32 to FU1-35	0.5 [Hz]	O	6-16
FU1-35	9223	High Limit Frequency	F-limit Hi	FU1-34 to FU1-30	60 [Hz]	X	
FU1-40	9228	Volts/Hz Pattern	V/F pattern	0 (Linear) 1 (Square) 2 (User V/F)	0 (Linear)	X	6-16
FU1-41 (9)	9229	User V/F – Frequency 1	User freq 1	0 to FU1-30	15 [Hz]	X	6-17
FU1-42	922A	User V/F – Voltage 1	User volt 1	0 to 100 [%]	25 [%]	X	
FU1-43	922B	User V/F – Frequency 2	User freq 2	0 to FU1-30	30 [Hz]	X	
FU1-44	922C	User V/F – Voltage 2	User volt 2	0 to 100 [%]	50 [%]	X	
FU1-45	922D	User V/F – Frequency 3	User freq 3	0 to FU1-30	45 [Hz]	X	
FU1-46	922E	User V/F – Voltage 3	User volt 3	0 to 100 [%]	75 [%]	X	
FU1-47	922F	User V/F – Frequency 4	User freq 4	0 to FU1-30	60 [Hz]	X	
FU1-48	9230	User V/F – Voltage 4	User volt 4	0 to 100 [%]	100[%]	X	
FU1-49	9231	Input voltage adjustment	VAC 440.0V	73 to 115.0 [%]	100.0 [%]	X	6-17
FU1-50	9232	Motor Rated Voltage	Motor Volt	0 to 600 [V]	0 [V]	X	6-17
FU1-51	9233	Energy Save	Energy save	0 (None) 1 (Manual) 2 (Auto)	0 (None)	X	6-18
FU1-52 (10)	9234	Energy Save %	Manual save%	0 to 30 [%]	0 [%]	O	
FU1-54	9236	Integrating Wattmeter	KiloWattHour	M kWh	*	X	6-18
FU1-55	9237	Inverter Temperature	Inv. Temp.	0 to 160 [degree]	*	X	6-18
FU1-56	9238	Motor Temperature	Motor Temp.	0 to 160 [degree]	*	X	6-18
FU1-57	9239	No Motor Selection	No Motor Sel	0 (No) 1 (Yes)	1 [Yes]	X	6-18
FU1-58	923A	Trip Current Level	No Motor Level	5 to 100 [%]	5 [%]	X	6-18
FU1-59	923B	Trip Time Setting	No Motor Time	0.5 to 10.0 [sec]	3.0 [sec]	X	6-18
FU1-60	923C	Electronic Thermal Selection	ETH select	0 (No) 1 (Yes)	1 (Yes)	O	6-19
FU1-61	923D	Electronic Thermal Level for 1 Minute	ETH 1min	FU1-62 to 200 [%]	150 [%]	O	6-19
FU1-62	923E	Electronic Thermal Level for Continuous	ETH cont	50 to FU1-61 (Maximum 150%))	120 [%]	O	6-19
FU1-63	923F	Characteristic Selection (Motor Type)	Motor type	0 (Self-cool) 1 (Forced-cool)	0 (Self-cool)	O	6-19
FU1-64	9240	Overload Warning Level	OL level	30 to 110 [%]	110 [%]	O	6-20
FU1-65	9241	Overload Warning Time	OL time	0 to 30 [sec]	10 [sec]	O	6-20
FU1-66	9242	Overload Trip Selection	OLT select	0 (No) 1 (Yes)	0 (No)	O	6-21
FU1-67 (11)	9243	Overload Trip Level	OLT level	30 to 150 [%]	120[%]	O	6-21
FU1-68	9244	Overload Trip Delay Time	OLT time	0 to 60 [sec]	60 [sec]	O	6-21
FU1-69	9245	Input/Output Phase Loss Protection	Trip select	000 to 111 (Bit Set)	100	O	6-21
FU1-70	9246	Stall Prevention Mode Selection	Stall prev.	000 to 111(Bit)	000(Bit)	X	6-21
FU1-71	9247	Stall Prevention Level	Stall level	30 to 150 [%]	100[%]	X	6-21
FU1-72	9248	Accel/Decel Change Frequency	Acc/Dec ch F	0 to FU1-30	0 [Hz]	X	6-22
FU1-73	9249	Reference Frequency for Accel and Decel	Acc/Dec freq	0 (Max freq) 1 (Delta freq)	0 (Max freq)	X	6-23
FU1-74	924A	Accel/Decel Time Scale	Time scale	0 (0.01 sec) 1 (0.1 sec) 2 (1 sec)	1 (0.1 sec)	O	6-23

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
FU1-90 (31)	925A	Safety STOP Inertia Rate	STOP Inertia	1 to 9999	10	X	6-23

* The gray-highlighted codes are hidden parameters and will appear when the related functions are to be set.
(5) Only displayed when FU1-02, FU1-03 is set to [S-Curve].
(6) Only displayed when FU1-20 is set to [DC-start].
(7) Only displayed when FU1-23 is set to [DC-break].
(8) Only displayed when FU1-33 is set to [Yes].
(9) FU1-41~48 Only displayed when FU1-40 is set to [User V/F].
(10) Only displayed when FU1-51 is set to [Manual].
(11) Only displayed when FU1-66 is set to [Yes].
(31) Only displayed when FUN-28 is set to [Yes].

[FU2 GROUP]

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range		Factory Default	Adj. During Run	Page
FU2-00	9300	Jump to desired code #	Jump code	1 to 95 (Use Only LCD Keypad)		40	O	6-24
FU2-01	-	Last trip 1	Last trip-1	By pressing [PROG] and [▲] key, the frequency, current, and operational status at the time of fault can be seen.		0 (None)	*	6-24
FU2-02	-	Last trip 2	Last trip-2			0 (None)	*	6-24
FU2-03	-	Last trip 3	Last trip-3			0 (None)	*	6-24
FU2-04	-	Last trip 4	Last trip-4			0 (None)	*	6-24
FU2-05	-	Last trip 5	Last trip-5			0 (None)	*	6-24
FU2-06	9306	Erase trips	Erase trips	0	(No)	0 (No)	O	6-24
				1	(Yes)			
FU2-07	9307	Dwell Frequency	Dwell time	0 to 10 [sec]		0 [sec]	X	6-24
FU2-08 (12)	9308	Dwell Frequency	Dwell freq	FU1-32 to FU1-30		5 [Hz]	X	6-24
FU2-10	930A	Frequency Jump Selection	Jump freq	0	(No)	0 (No)	X	6-25
				1	(Yes)			
FU2-11 (13)	930B	Jump Frequency 1 Low	jump lo 1	0 to FU2-12		10 [Hz]	O	6-25
FU2-12	930C	Jump Frequency 1 High	jump Hi 1	FU2-11 to FU1-30		15 [Hz]	O	
FU2-13	930D	Jump Frequency 2 Low	jump lo 2	0 to FU2-14		20 [Hz]	O	
FU2-14	930E	Jump Frequency 2 High	jump Hi 2	FU2-13 to FU1-30		25 [Hz]	O	
FU2-15	930F	Jump Frequency 3 Low	jump lo 3	0 to FU2-16		30 [Hz]	O	
FU2-16	9310	Jump Frequency 3 High	jump Hi 3	FU2-15 to FU1-30		35 [Hz]	O	
FU2-20	9314	Power ON Start Selection	Power-on run	0	(No)	0 (No)	O	6-25
				1	(Yes)			
FU2-21	9315	Restart after Fault Reset	RST restart	0	(No)	0 (No)	O	
				1	(Yes)			
FU2-22	9316	Speed Search Selection	Speed Search	0000 to 1111 (Bit Set)		0000	X	
FU2-23 (14)	9317	P Gain During Speed Search	SS P-gain	0 to 9999		200	O	6-27
FU2-24	9318	I Gain During speed search	SS I-gain	0 to 9999		500	O	6-27
FU2-25	9319	Number of Auto Retry	Retry number	0 to 10		0	O	6-28
FU2-26 (15)	931A	Delay Time Before Auto Retry	Retry delay	0 to 60 [sec]		1 [sec]	O	6-28

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
FU2-40	9328	Rated Motor Selection for 5.5 ~ 280kW Inverter	Motor select	0 (0.75kW) 1 (1.5kW) 2 (2.2kW) 3 (3.7kW) 4 (5.5kW/) 5 (7.5kW/) 6 (11.0kW) 7 (15.0kW) 8 (18.5kW) 9 (22.0kW) 10 (30.0kW) 11 (37.0kW) 12 (45.0kW) 13 (55.0kW) 14 (75.0kW) 15 (90.0kW) 16 (110.0kW) 17 (132.0 kW) 18 (160.0 kW) 18 (220.0 kW) 20 (280.0 kW)	* Depending on the inverter capacity	X	6-28
		* A motor rating same as inverter capacity is automatically set. If different, set the correct value.					
FU2-41	9329	Number of Motor Poles	Pole number	2 to 12	4	X	6-28
FU2-42	932A	Rated Motor Slip	Rated-Slip	0 to 10 [Hz]	* Depending on FU2-40	X	6-28
FU2-43	932B	Rated Motor Current (RMS)	Rated-Curr	1 to 999.9 [A]		X	
FU2-44	932C	No Load Motor Current (RMS)	Noload-Curr	0.5 to 999.9 [A]		X	
FU2-45	932D	Motor Efficiency	Efficiency	70 to 100 [%]		X	
FU2-46	932E	Load Inertia	Inertia rate	0 to 8	0	X	
FU2-47	932F	Gain for Motor Speed Display	RPM factor	1 to 1000 [%]	100 [%]	O	
FU2-48	9330	Carrier Frequency	Carrier freq	5.5~22kW: 0.7~15 [kHz]	5.0 [kHz]	O	6-29
				30kW: 0.7~ 10 [kHz]			
				37~75kW: 0.7 ~ 4 [kHz]	4.0 [kHz]		
				90~280kW: 0.7 ~ 3 [kHz]	3.0 [kHz]		
FU2-49	9331	PWM Type Selection	PWM Mode	0 (Normal 1) 1 (Normal 2) 2 (Low leakage)	0 (Normal 1)	X	6-30
FU2-60	933C	Control Mode Selection	Control mode	0 (V/F) 1 (Slip compen) 2 (Sensorless)	0 (V/F)	X	6-30
FU2-61	933D	Auto Tuning Selection	Auto tuning	0 (No) 1 (Yes)	0 (No)	X	6-32
FU2-62	933E	Stator Resistance of Motor	Rs	0 to (depending on FU2-40) [ohm]	* Depending on FU2-40	X	
FU2-63	933F	Leakage Inductance of Motor	Lsigma	0 to (depending on FU2-40) [mH]	* Depending on FU2-40	X	6-32
	* Automatically set corresponding to motor rating. If different, check the motor rating setting.						

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
FU2-64 (16)	9340	Pre-excitation Time	PreEx time	0 to 60 [sec]	1 [sec]	X	6-32
FU2-65	9341	P Gain for Sensorless Control	SL P-gain	0 to 9999	1000	O	6-33
FU2-66	9342	I Gain for Sensorless Control	SL I-gain	0 to 9999	100	O	6-33
FU2-67	9343	Manual/Auto Torque Boost Selection	Torque boost	0 (Manual) 1 (Auto)	0 (Manual)	X	6-33
FU2-68	9344	Torque Boost in Forward Direction: 5.5~90kW 110~280kW	Fwd boost	0 to 15 [%]	2.0 [%] 1.0 [%]	X	
FU2-69	9345	Torque Boost in Reverse Direction: 5.5~90kW 110~280kW	Rev boost	0 to 15 [%]	2.0 [%] 1.0 [%]	X	
FU2-80	9350	Power On display	PowerOn disp	0 to 12	0	O	6-34
FU2-81	9351	User Display Selection	User disp	0 (Voltage) 1 (Watt)	0 (Voltage)	O	6-34
FU2-82	-	Software Version	S/W Version	Ver X.XX	Ver X.XX	*	6-35
FU2-83	-	Last Trip Time	LastTripTime	X:XX:XX:XX:XX:X		X	6-35
FU2-84	-	Power On Time	On-time	X:XX:XX:XX:XX:X		X	
FU2-85	-	Run-time	Run-time	X:XX:XX:XX:XX:X		X	
FU2-87	9357	Power Set	PowerSet	0.1~400 %	100	O	6-35
FU2-90	-	Parameter Display	Para. disp	0 (Default) 1 (All Para) 2 (Diff Para)	0 (Default)	X	6-35
FU2-91	-	Read Parameter	Para. Read	0 (No) 1 (Yes)	0 (No)	X	6-35
FU2-92	-	Write Parameter	Para. Write	0 (No) 1 (Yes)	0 (No)	X	6-35
FU2-93	935D	Initialize Parameters	Para. init	0 (No) 1 (All Groups) 2 (DRV) 3 (FU1) 4 (FU2) 5 (I/O) 6 (EXT) 7 (COM) 8 (APP)	0 (No)	X	6-36
FU2-94	-	Parameter Write Protection	Para. Lock	0 to 9999	0	O	6-36
FU2-95	-	Parameter Save	Para. save	0 (No) 1 (Yes)	0 (No)	X	6-36

* The gray-highlighted codes are hidden parameters and will appear when the related functions are to be set.
(12) Only displayed when FU2-07 is set to [1~10 sec].
(13) Only displayed when FU2-10 is set to [Yes].
(14) Only FU2-23~24 displayed when FU2-22 [Speed search] is set to [0001~1111]. Also displayed when FU1-20 is ‘Flying Start’.
(15) Only displayed when FU2-25 [Retry number] is set to [1~10].
(16) Only FU2-64~66 displayed when FU2-60 is set to [Sensorless].

[I/O GROUP]

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
I/O-00	9400	Jump to desired code #	Jump code	1 to 98 (LCD Keypad Only)	1	O	6-37
I/O-01 (17)	9401	Filtering Time Constant for V1 Signal Input	V1 filter	0 to 9999 [msec]	10 [msec]	O	6-37
I/O-02	9402	V1 Input Minimum Voltage	V1 volt x1	0 to 12[V]	0 [V]	O	
I/O-03	9403	Frequency Corresponding to V1 Input Minimum Voltage	V1 freq y1	0 to FU1-30 [Hz] 0 to 100.00 [**](18)	0 [Hz]	O	
I/O-04	9404	V1 Input Minimum Voltage	V1 volt x2	0 to 12[V]	10 [V]	O	
I/O-05	9405	V1 Input Maximum Voltage	V1 freq y2	0 to FU1-30 [Hz] 0 to 100.00 [**] (18)	60 [Hz]	O	
I/O-06	9406	Filtering Time Constant for I Signal Input	I filter	0 to 9999 [msec]	10 [msec]	O	6-38
I/O-07	9407	I Input Minimum Current	I curr x1	0 to 20 [mA]	4 [mA]	O	
I/O-08	9408	Frequency Corresponding to I Input Minimum Current	I freq y1	0 to FU1-30 [Hz] 0 to 100.00 [**](18)	0 [Hz]	O	
I/O-09	9409	Filtering Time Constant for I Signal Input	I curr x2	0 to 20 [mA]	20 [mA]	O	
I/O-10	940A	Frequency Corresponding to I Input Maximum Current	I freq y2	0 to FU1-30 [Hz] 0 to 100.00 [**](18)	60 [Hz]	O	
I/O-11	940B	Pulse input method	P pulse set	0 (A+B) 1 (A)	1 (A)	O	6-39
I/O-12	940C	Pulse input filter	P filter	0 to 9999 [msec]	10 [msec]	O	
I/O-13	940D	Pulse input Minimum frequency	P pulse x1	0 to 10 [kHz]	0 [kHz]	O	
I/O-14	940E	Frequency corresponding to I/O-13 Pulse input Maximum frequency	P freq y1	0 to FU1-30 [Hz] 0 to 100.00 [**](18)	0 [Hz]	O	
I/O-15	940F	Frequency corresponding to I/O-15	P pulse x2	0 to 100 [kHz]	10 [kHz]	O	
I/O-16	9410	Pulse input Minimum frequency	P freq y2	0 to FU1-30 [Hz] 0 to 100.00 [**](18)	60 [Hz]	O	
I/O-17	9411	Criteria for Analog Input Signal Loss	Wire broken	0 (None) 1 (half of x1) 2 (below x1)	0 (None)	O	6-40
I/O-18	9412	Operating selection at Loss of Freq. Reference	Lost command	0 (None) 1 (FreeRun) 2 (Stop)	0 (None)	O	
I/O-19	9413	Waiting Time after Loss of Freq. Reference	Time out	0.1 to 120 [sec]	1.0 [sec]	O	

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
I/O-20	9414	Programmable Digital Input Terminal 'M1' Define	M1 define	0 (Speed-L) 1 (Speed-M) 2 (Speed-H) 3 (XCEL-L) 4 (XCEL-M) 5 (XCEL-H) 6 (Dc-brake) 7 (2nd Func) 8 (Exchange) 9 (- Reserved -) 10 (Up) 11 (Down) 12 (3-Wire) 13 (Ext Trip) 14 (Pre-Heat) 15 (iTerm Clear) 16 (Open-loop) 17 (LOC/REM) 18 (Analog hold) 19 (XCEL stop) 20 (P Gain2) 21 (- Reserved -) 22 (Interlock1) 23 (Interlock2) 24 (Interlock3) 25 (Interlock4) 26 (Speed_X) 27 (RST) 28 (BX) 29 (JOG) 30 (FX) 31 (RX) 32 (ANA_CHG) 33 (Pre-Excite) 34 (Ext PID Run)	0 (Speed-L)	O	6-41
I/O-21	9415	Programmable Digital Input Terminal 'M2' Define	M2 define	Same as I/O-20	1 (Speed-M)	O	
I/O-22	9416	Programmable Digital Input Terminal 'M3' Define	M3 define	Same as I/O-20	2 (Speed-H)	O	
I/O-23	9417	Programmable Digital Input Terminal 'M4' Define	M4 define	Same as I/O-20	27 (RST)	O	
I/O-24	9418	Programmable Digital Input Terminal 'M5' Define	M5 define	Same as I/O-20	28 (BX)	O	
I/O-25	9419	Programmable Digital Input Terminal 'M6' Define	M6 define	Same as I/O-20	29 (JOG)	O	

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
I/O-26	941A	Programmable Digital Input Terminal 'M7' Define	M7 define	Same as I/O-20	30 (FX)	O	6-41
I/O-27	941B	Programmable Digital Input Terminal 'M8' Define	M8 define	Same as I/O-20	31 (RX)	O	
I/O-28	-	Terminal Input Status	In status	00000000000 /11111111111	00000000000	*	
I/O-29	941D	Filtering Time Constant for Programmable Digital Input Terminals	Ti Filt Num	2 to 1000 [msec]	15	O	
I/O-30 (19)	941E	Jog Frequency Setting	Jog freq	0 to FU1-30	10 [Hz]	O	6-42
I/O-31	941F	Step Frequency 4	Step freq-4		40 [Hz]	O	
I/O-32	9420	Step Frequency 5	Step freq-5		50 [Hz]	O	
I/O-33	9421	Step Frequency 6	Step freq-6		40 [Hz]	O	
I/O-34	9422	Step Frequency 7	Step freq-7		30 [Hz]	O	
I/O-35	9423	Step Frequency 8	Step freq-8		20 [Hz]	O	
I/O-36	9424	Step Frequency 9	Step freq-9		10 [Hz]	O	
I/O-37	9425	Step Frequency 10	Step freq-10		20 [Hz]	O	
I/O-38	9426	Step Frequency 11	Step freq-11		30 [Hz]	O	
I/O-39	9427	Step Frequency 12	Step freq-12		40 [Hz]	O	
I/O-40	9428	Step Frequency 13	Step freq-13		50 [Hz]	O	
I/O-41	9429	Step Frequency 14	Step freq-14		40 [Hz]	O	
I/O-42	942A	Step Frequency 15	Step freq-15		30 [Hz]	O	
I/O-50	9432	Acceleration Time 1 (for Step speed)	Acc time-1	0 to 6000 [sec]	20 [sec]	O	6-44
I/O-51	9433	Deceleration Time 1 (for Step speed)	Dec time-1	0 to 6000 [sec]	20 [sec]	O	
I/O-52 (20)	9434	Acceleration Time 1 (for Step speed)	Acc time-2	0 to 6000 [sec]	30 [sec]	O	
I/O-53	9435	Deceleration Time 2	Dec time-2	0 to 6000 [sec]	30 [sec]	O	
I/O-54	9436	Acceleration Time 3	Acc time-3	0 to 6000 [sec]	40 [sec]	O	
I/O-55	9437	Deceleration Time 3	Dec time-3	0 to 6000 [sec]	40 [sec]	O	
I/O-56	9438	Acceleration Time 4	Acc time-4	0 to 6000 [sec]	50 [sec]	O	
I/O-57	9439	Deceleration Time 4	Dec time-4	0 to 6000 [sec]	50 [sec]	O	
I/O-58	943A	Acceleration Time 5	Acc time-5	0 to 6000 [sec]	40 [sec]	O	
I/O-59	943B	Deceleration Time 5	Dec time-5	0 to 6000 [sec]	40 [sec]	O	
I/O-60	943C	Acceleration Time 6	Acc time-6	0 to 6000 [sec]	30 [sec]	O	
I/O-61	943D	Deceleration Time 6	Dec time-6	0 to 6000 [sec]	30 [sec]	O	
I/O-62	943E	Acceleration Time 7	Acc time-7	0 to 6000 [sec]	20 [sec]	O	
I/O-63	943F	Deceleration Time 7	Dec time-7	0 to 6000 [sec]	20 [sec]	O	
I/O-70	9446	S0 output selection	S0 mode	0 (Frequency) 1 (Current) 2 (Voltage) 3 (DC link Vtg) 4 (Ext PID Out)	0 (Frequency)	O	6-47

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
I/O-71	9447	S0 output adjustment	S0 adjust	10 to 200 [%]	100 [%]	O	6-47
I/O-72	9448	S1 output selection	S1 mode	Same as I/O-70	2 (Voltage)	O	
I/O-73	9449	S1 output adjustment	S1 adjust	10 to 200 [%]	100 [%]	O	
I/O-74 (21)	944A	Frequency Detection Level	FDT freq	0 to FU1-30 [Hz]	30 [Hz]	O	6-47
I/O-75	944B	Frequency Detection Bandwidth	FDT band	0 to FU1-30 [Hz]	10 [Hz]	O	6-47
I/O-76	944C	Programmable Digital Output Terminal Define (Aux terminal)	Aux mode1	0 (NONE) 1 (FDT-1) 2 (FDT-2) 3 (FDT-3) 4 (FDT-4) 5 (FDT-5) 6 (OL) 7 (IOL) 8 (Stall) 9 (OV) 10 (LV) 11 (OH) 12 (Lost Command) 13 (Run) 14 (Stop) 15 (Steady) 16 (INV line) 17 (COMM line) 18 (SSearch) 19 (Ready) 20 (MMC)	0 (NONE)	O	6-48
I/O-77	944D	Programmable Digital Output Terminal Define	Aux mode2	Same as I/O-76	0 (NONE)	O	
I/O-78	944E	Programmable Digital Output Terminal Define	Aux mode3	Same as I/O-76	0 (NONE)	O	
I/O-79	944F	Programmable Digital Output Terminal Define	Aux mode4	Same as I/O-76	0 (NONE)	O	
I/O-80	9450	Fault Output Relay Setting (3A, 3B, 3C)	Relay mode	000 to 111 [bit]	010 [bit]	O	6-51
I/O-81	-	Terminal Output Status	Out status	00000000/11111111	00000000	*	6-52
I/O-82	9452	Waiting time after Fault Output Relay On	Relay On	0 to 9999	0	X	6-52
I/O-83	9453	Waiting time after Fault Output Relay Off	Relay Off	0 to 9999	0	X	
I/O-84	9454	Fan Con Sel (37 ~ 90kW)	Fan Mode	0 (Power On Fan)	0	X	6-52

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range		Factory Default	Adj. During Run	Page
I/O-84	9454	Fan Con Sel (37 ~ 90kW)	Fan Mode	1 (Run Fan) 2 (Temper-Fan)		0	X	6-52
I/O-85	9455	Fan Temp (37 ~ 90kW)	Fan Temper	0 to 70 [℃]		70 [℃]	O	6-52
I/O-86	9456	Voltage Input User Unit Selection	V1 Unit Sel	0 (Speed) 1 (Percent) 2 (Bar) 3 (mBar) 4 (kPa) 5 (Pa)		0 (Speed)	X	6-52
I/O-87	9457	Current Input User Unit Selection	I Unit Sel	Same as I/O-86		0 (Speed)	X	
I/O-88	9458	Pulse Input User Unit Selection	PulseUnitSel	Same as I/O-86		0 (Speed)	X	
I/O-90	945A	Inverter Number	Inv No.	1 to 250		1	O	6-53
I/O-91 (22)	945B	Baud Rate Selection	Baud rate	0	(1200 bps)	3 (9600 bps)	O	
				1	(2400 bps)			
				2	(4800 bps)			
				3	(9600 bps)			
				4	(19200 bps)			
				5	(38400 bps)			
				6	(57600 bps)			
				7	(76800 bps)			
				8	(115200 bps)			
I/O-92 (23)	945C	Operating method at loss of freq. reference	COM Lost Cmd	0	(None)	0 (None)	O	6-53
				1	(FreeRun)			
				2	(Stop)			
I/O-93	945D	Waiting time after loss of freq. reference	COM Time Out	0.1 to 120 [sec]		1.0 [sec]	O	
I/O-94	945E	Communication Response Delay time	Delay Time	2 to 1000 [msec]		5 [msec]	O	6-53
I/O-95	945F	A or B contact	In No/Nc Set	00000000000 /11111111111		00000000000	X	6-53
I/O-96	9460	Input time	In CheckTime	1 to 1000		1 [msec]	X	6-54
I/0-97	9461	Overheat trip selection	OH Trip sel	000 to 111 [bit]		010 [bit]	X	6-54
I/0-98	9462	Motor overheat trip temperature	MO Trip Temp	0 to 255 [8C]		110 [8C]	X	

* The gray-highlighted codes are hidden parameters and will appear when the related functions are to be set.

(17) When DRV-04 is set to either V1, V1S, I or V1+I or Pulse, only selected item codes are displayed in I/O-1~I/O-19.

(18) Only user unit displayed when APP-02 or APP-80 is set to [Yes], after APP-06 is set to one of I, V, Pulse, after then one of I/O-86 ~I/O-88 is set to either speed, percentage, Bar, mBar, kPa, Pa..

(19) I/O-30 ~ I/O-34 displayed only when one of I/O-20 ~ I/O-27 is set to either JOG, Speed_L, Speed_M, Speed_H. I/O-35 ~ I/O-42 displayed only when one of I/O-20 ~ I/O-27 is set to Speed_X.

(20) I/O-52 ~ I/O-63 displayed only when one of I/O-20 ~ I/O-27 is set to either XCEL_L, XCEL_M, XCEL_H.

(21) I/O-74 ~ I/O-75 displayed only when one of I/O-76 ~ I/O-79 is set to either FDT-1~FDT5

(22) 1200~19200 bps can be set when the internal communication option card is installed.
1200~38400 bps can be set when the external RS-485/Modbus communication option card is installed.
9600~115200 bps can be set when the external BACNet communication option card is installed.

(23) Only I/O-92 ~ I/O-93 displayed when DRV-03/04 is set to [int485].

[APP GROUP]

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
APP-00	9700	Jump to Desired Code #	Jump code	1 to 99 (LCD Keypad Only)	1	O	6-56
APP-01 (24)	9701	Application Mode Selection	App mode	0 (None) 1 (MMC)	0 (None)	X	6-56
APP-02	9702	PID Operation Selection	Proc PI mode	0 (No) 1 (Yes)	0 (No)	X	6-56
APP-03 (25)	9703	PID F Gain Selection	PID F-gain	0 to 999.9[%]	0.0 [%]	O	6-61
APP-04 (256	9704	PID Auxiliary Reference Mode Selection	Aux Ref Mode	0 (No) 1 (Yes)	0 (No)	X	6-61
APP-05 (27)	9705	PID Auxiliary Reference Signal Selection	Aux Ref Sel	0 (Keypad-1) 1 (Keypad-2) 2 (V1) 3 (V1S) 4 (I) 5 (V1+I) 6 (Pulse) 7 (Int. 485) 8 (Ext. PID)	2 (V1)	X	6-61
APP-06	9706	PID Feedback Signal Selection	PID F/B	0 (I) 1 (V1) 2 (Pulse)	0 (I)	X	6-61
APP-07	9707	P Gain for PID Control	PID P-gain	0 to 999.9 [%]	1.0 [%]	O	6-61
APP-08	9708	I Gain for PID Control	PID I-time	0 to 32.0 [sec]	10.0 [sec]	O	6-61
APP-09	9709	D Gain for PID Control	PID D-time	0 to100 [msec]	0.0 [msec]	O	6-61
APP-10	970A	High Limit Frequency for PID Control	PID limit-H	0.00 to FU1-30	60 .00[Hz]	O	6-61
APP-11	970B	Low Limit Frequency for PID Control	PID limit-L	FU1-32 to APP-10	0.5 [Hz]	O	6-61
APP-12	970C	PID Output Scale	PID Out Scale	0.0 to 999.9 [%]	100.0 [%]	X	6-62
APP-13	970D	PID P2 Gain	PID P2-gain	0.0 to 999.9 [%]	100.0 [%]	X	6-62
APP-14	970E	P Gain Scale	P-gain Scale	0.0 to 100.0 [%]	100.0 [%]	X	6-62
APP-15	960F	PID Output Inverse	Out inverse	0 (No) 1 (Yes)	0 (No)	X	
APP-17	9711	PID U curve feedback select	PID U Fbk	0 (No) 1 (Yes)	0 (No)	X	
APP-20 (28)	9714	2nd Acceleration Time	2nd Acc time	0 to 6000 [sec]	5 [sec]	O	6-62
APP-21	9715	2nd Deceleration Time	2nd Dec time	0 to 6000 [sec]	10 [sec]	O	
APP-22	9716	2nd Base Frequency	2nd BaseFreq	30 to FU1-30 [Hz]	60 [Hz]	X	
APP-23	9717	2nd V/F Pattern	2nd V/F	0 (Linear) 1 (Square) 2 (User V/F)	0 (Linear)	X	
APP-24	9718	2nd Forward Torque Boost	2nd F-boost	0 to 15 [%]	2 [%]	X	
APP-25	9719	2nd Reverse Torque Boost	2nd R-boost	0 to 15 [%]	2 [%]	X	
APP-26	971A	2nd Stall Prevention Level	2nd Stall	30 to 150 [%]	100 [%]	X	

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
APP-27	971B	2nd Electronic Thermal Level for 1 minute	2nd ETH 1min	FU2-28 to 200 [%]	130[%]	O	6-62
APP-28	971C	2nd Electronic Thermal Level for continuous	2nd ETH cont	50 to FU2-27 (Max 150%)	120[%]	O	
APP-29	971D	2nd Rated Motor Current	2nd R-Curr	1 to 200 [A]	3.6[A]	X	
APP-40 (29)	9728	Number of Auxiliary Motor Run Display	Aux Mot Run	*	*	*	6-63
APP-41	9729	Aux. Motor Start Selection	Starting Aux	1 to 4	1	O	6-64
APP-42	972A	Operation Time Display on Auto Change	Auto Op Time	*	*	*	6-64
APP-43	972B	The Number of Aux Motor	Nbr Aux`s	0 to 7	4	O	6-64
APP-44	972C	Start Frequency of Aux. Motor 1	Start freq 1	0 to FU1-30	49.99 [Hz]	O	6-64
APP-45	972D	Start Frequency of Aux. Motor 2	Start freq 2		49.99 [Hz]	O	
APP-46	972E	Start Frequency of Aux. Motor 3	Start freq 3		49.99 [Hz]	O	
APP-47	972F	Start Frequency of Aux. Motor 4	Start freq 4		49.99 [Hz]	O	
APP-48	9730	Start Frequency of Aux. Motor 5	Start freq 5		49.99 [Hz]	O	
APP-49	9731	Start Frequency of Aux. Motor 6	Start freq 6		49.99 [Hz]	O	
APP-50	9732	Start Frequency of Aux. Motor 7	Start freq 7		49.99 [Hz]	O	
APP-51	9733	Stop Frequency of Aux. Motor 1	Stop freq 1	0 to FU1-30	20.00 [Hz]	O	6-64
APP-52	9734	Stop Frequency of Aux. Motor 2	Stop freq 2		20.00 [Hz]	O	
APP-53	9735	Stop Frequency of Aux. Motor 3	Stop freq 3		20.00 [Hz]	O	
APP-54	9736	Stop Frequency of Aux. Motor 4	Stop freq 4		20.00 [Hz]	O	
APP-55	9737	Stop Frequency of Aux. Motor 5	Stop freq 5		15.00 [Hz]	O	
APP-56	9738	Stop Frequency of Aux. Motor 6	Stop freq 6		15.00 [Hz]	O	
APP-57	9739	Stop Frequency of Aux. Motor 7	Stop freq 7		15.00 [Hz]	O	
APP-58	973A	Delay Time before Operating Aux Motor	Aux start DT	0.0 to 999.9 [sec]	5.0 [sec]	O	6-65
APP-59	973B	Delay Time before Stopping Aux Motor	Aux stop DT	0.0 to 999.9 [sec]	5.0 [sec]	O	6-65
APP-60	973C	Accel time when the number of pump decreases	Pid AccTime	0 to 600.0 [sec]	2.0 [sec]	O	6-65

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
APP-61	973D	Decel time when the number of pump increases	Pid DecTime	0 to 600.0 [sec]	2.0 [sec]	O	6-65
APP-62	973E	PID Bypass Selection	Regul Bypass	0 (No) 1 (Yes)	0 (No)	X	6-65
APP-63	973F	Sleep Delay Time	Sleep Delay	0.0 to 9999 [sec]	60.0 [sec]	O	6-66
APP-64	9740	Sleep Frequency	Sleep Freq	0 to FU1-30 [Hz]	0.00 [Hz]	O	6-66
APP-65	9741	Wake-Up Level	WakeUp level	0.0 to 100.0 [%]	2.0[%]	O	6-66
APP-66	9742	Auto Change Mode Selection	AutoCh_Mode	0, 1 (Aux), 2 (Main)	0	O	6-67
APP-67	9743	Auto Change Time	AutoEx-intv	00:00 to 99:00	72:00	O	6-67
APP-68	9744	Auto Change Level	AutoEx-level	FU1-32 to FU1-30 [Hz]	20.0 [Hz]	O	6-67
APP-69	9745	Inter-Lock Selection	Inter-lock	0 (No) 1 (Yes)	0 (No)	O	6-68
APP-71	9747	Pressure difference for Aux motor Stop	Actual Pr Diff	0 to100%	2%	O	6-70
APP-74	974A	PrePID Reference Frequency	PrePID freq	0 to FU1-30	0.00 [Hz]	O	6-70
APP-75	974B	PrePID Exit Level	PrePID Exit	0 to 100.0%	0.0 [%]	O	
APP-76	974C	PrePID Stop delay	PrePID dly	0 to 9999	600 [sec]	O	
APP-80	9750	Ext PID Operation Selection	Ext PI mode	0 (No) 1 (Yes)	0 (No)	X	6-70
APP-81 (30)	9751	Ext PID Reference Signal Selection	Ext Ref Sel	0 (I) 1 (V1) 2 (Pulse) 3 (Key-Pad)	3 (Key-Pad)	X	6-70
APP-82	9752	Ext PID Reference Level	Ext Ref Perc	0 to 100.00 [%]	50.00 [%]	X	6-70
APP-83	9753	Ext PID Feedback Signal Selection	Ext Fbk Sel	0 (I) 1 (V1) 2 (Pulse)	0 (I)	X	6-70
APP-85	9755	P Gain for ExtPID	ExtPID Pgain	0 to 999.9 [%]	1.0 [%]	X	6-70
APP-86	9756	I Time for ExtPID	ExtPID Itime	0 to 32.0 [sec]	10.0 [sec]	X	6-70
APP-87	9757	D Time for ExtPID	ExtPID Dtime	0 to 2000 [msec]	0 [msec]	X	6-70
APP-88	9758	High Limit Frequency for ExtPID Control	ExtPID lmt-H	0 to 100.00 [%]	100.00 [%]	X	6-70
APP-89	9759	Low Limit Frequency for ExtPID Control	ExtPID lmt-L	0 to 30.00 [%]	0.00 [%]	X	6-70
APP-90	975A	ExtPID Output Scale	ExtPID Scale	0 to 999.9	100.0 [%]	X	6-70
APP-91	975B	ExtPID P2 Gain	Ext P2-gain	0 to 999.9	100.0 [%]	X	6-70
APP-92	975C	ExtPID P Gain Scale	Ext P Scale	0 to 100.0	100.0 [%]	X	6-70
APP-93	975D	ExtPID F Gain	ExtPID F-gain	0 to 999.9 [%]	0.0 [%]	O	6-70

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
APP-95	975F	ExtPID Output Inverse	ExtOut inverse	0 (No) 1 (Yes)	0 (No)	X	6-70
APP-97	9761	ExtPID Loop Time	Ext Loop Time	50 to 200 [msec]	100 [msec]	X	6-70

* The gray-highlighted codes are hidden parameters and will appear when the related functions are to be set.

(24) MMC(Multi Motor Control) function is applied to the inverters only for 5.5~90kW(7.5~125HP).

(25) Only APP-03 ~ APP-17 displayed when APP-02 is set to [Yes]. (5.5 ~ 90kW / 7.5 ~ 125HP)
Only APP-03 ~ APP-17 and APP-63 ~ APP-65 displayed when APP-2 is set to [Yes]. (110 ~ 280kW / 150 ~ 400HP)

(26) If APP-04 is no set, DRV-04 setting will be reference of processPID. And APP -05 setting will be ignored

(27) If APP-04 is set, APP-04 will appear. And APP -05 setting value will be reference of processPID, DRV-04 setting will be ignored.

(28) Only APP-20 ~ APP-29 displayed only when one of I/O-20 ~ I/O-27 is set to either “2nd Func”.

(29) Only APP-40 ~ APP-71 displayed when APP-01 is set to [MMC].

(30) Only APP-81 ~ APP-97 displayed when APP-80 is set to [Yes].

[EXT GROUP]

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
EXT-00	9500	Jump Code	`Jump code`	1 to 45	1	O	Refer to the correspo-nding option manual
EXT-01	9501	Type of SUB Board	`Sub B/D`	Sub-E	*	*	
EXT-40	9528	Current Output Termianl 1(CO1) Selection	`AM1 mode`	Frequency Current Voltage DC link Vtg Ext PID Out	Frequency	O	
EXT-41	9529	Adjust Gain of Current Output Termianl 1(CO1)	`AM1 adjust`	10 – 200 [%]	100 [%]	O	
EXT-42	952A	Adjust Offset of Current Output Termianl 1(CO1)	`AM1 Offset`	0 – 100 [%]	0 [%]	O	
EXT-43	952B	Current Output Termianl 2(CO2) Selection	`AM2 mode`	Frequency Current Voltage DC link Vtg Ext PID Out	DC link Vtg	O	
EXT-44	952C	Adjust Gain of Current Output Termianl 2(CO2)	`AM2 adjust`	10 – 200 [%]	100 [%]	O	
EXT-45	952D	Adjust Offset of Current Output Termianl 2(CO2)	`AM2 Offest`	0 – 100 [%]	0 [%]	O	

* Only the above EXT group displayed when the corresponding option board is installed.
* Refer to the SUB board option manual for details.

[COM GROUP]

CODE	Comm. Addr	Description	LCD Keypad Display	Setting Range	Factory Default	Adj. During Run	Page
COM-00	9600	Jump Code	Jump code	1 to 60	1	O	Refer to the correspo-nding option manual
COM-01	9601	Type of SUB Board	Opt B/D	RS485 DeviceNet ProfiBus BACnet LonWork	*	*	
COM-02	9602	Option Mode	Opt mode	None Command Freq Cmd + Freq	None	X	
COM-03	9603	Option Version	Opt Version	Ver X.X	Ver X.X	*	
COM-13	960D	DeviceNet Input Instance	In Instance	(70) (71) (110) (111)	70	○	
COM-17	9611	PLC Option Station ID	Station ID	0 - 63	1	○	
COM-20	9614	Profibus ID	Profi MAC ID	1 - 127	1	○	
COM-30	961E	Output Number	Output Num	0 - 8	3	○	
COM-31	961F	Output1	Output 1	0000 – FFFF (HEX)	000A(HEX)	○	
COM-32	9620	Output2	Output 2	0000 – FFFF (HEX)	000E(HEX)	○	
COM-33	9621	Output 3	Output 3	0000 – FFFF (HEX)	000F(HEX)	○	
COM-34	9622	Output 4	Output 4	0000 – FFFF (HEX)	0000(HEX)	○	
COM-35	9623	Output 5	Output 5	0000 – FFFF (HEX)	0000(HEX)	○	
COM-36	9624	Output 6	Output 6	0000 – FFFF (HEX)	0000(HEX)	○	
COM-37	9625	Output 7	Output 7	0000 – FFFF (HEX)	0000(HEX)	○	
COM-38	9626	Output 8	Output 8	0000 – FFFF (HEX)	0000(HEX)	○	
COM-40	9628	Input Number	Input Num	0 - 8	2	○	
COM-41	9629	Input 1	Input 1	0000 – FFFF (HEX)	0005(HEX)	○	
COM-42	962A	Input 2	Input 2	0000 – FFFF (HEX)	0006(HEX)	○	
COM-43	962B	Input 3	Input 3	0000 – FFFF (HEX)	0000(HEX)	○	
COM-44	962C	Input 4	Input 4	0000 – FFFF (HEX)	0000(HEX)	○	
COM-45	962D	Input 5	Input 5	0000 – FFFF (HEX)	0000(HEX)	○	
COM-46	962E	Input 6	Input 6	0000 – FFFF (HEX)	0000(HEX)	○	
COM-47	962F	Input 7	Input 7	0000 – FFFF (HEX)	0000(HEX)	○	
COM-48	9630	Input 8	Input 8	0000 – FFFF (HEX)	0000(HEX)	○	
COM-60	963C	Parity Selection	Parity/Stop	8None/1Stop 8None/2Stop 8Even/1Stop 8 Odd/1Stop	8None/1Stop	○	
COM-61 (32)	963D	Communication Option Common Pararmeter 1	Opt Para-1	0000 – FFFF (HEX)	0000(HEX)	○	
COM-62	963E	Communication Option Common Pararmeter 2	Opt Para-2	0000 – FFFF (HEX)	0000(HEX)	○	
COM-63	963F	Communication Option Common Pararmeter 3	Opt Para-3	0000 – FFFF (HEX)	0000(HEX)	○	
COM-64	9640	Communication Option Common Pararmeter 4	Opt Para-4	0000 – FFFF (HEX)	0000(HEX)	○	
COM-65	9641	Communication Option Common Pararmeter 5	Opt Para-5	0000 – FFFF (HEX)	0000(HEX)	○	
COM-66	9642	Communication Option Common Pararmeter 6	Opt Para-6	0000 – FFFF (HEX)	0000(HEX)	○	
COM-67	9643	Communication Option Pararmeter Update	Comm UpDate	1 (No) 2 (Yes)	1 (No)	X	

* Only the above COM group displayed when the corresponding option board is installed.
* Refer to the communcaion option manual for details.
* LonWork and BACnet communication will be available later.

(32) COM-61~66 is used for LonWork and BACnet communication.

CHAPTER 6 - PARAMETER DESCRIPTION

6.1 Drive group [DRV]

DRV-00: Command Frequency/ Output Current (LCD)

DRV► Cmd. Freq 00 0.00 Hz	F	0.00

Factory Default:	0.00 Hz	0.00

1) **Digital frequency setting**
- When DRV-04 [Frequency Mode] is set to 0 (Keypad-1) or 1 (Keypad-2), command freq is settable less than FU1-30 [Maximum Frequency].

2) **Monitoring function setting**
- Command frequency displayed during stop.
- Output current/frequency displayed during run.

Analog/digital frequency command source setting: DRV-04 [Frequency Mode]

When DRV-04 [Frequency Mode] is set to V1, V1S, I, V1+I or Pulse, frequency command is set via I/O-01~16 [Analog Frequency command]. Refer to I/O-01~16 for detail description.

When setting APP-02 [PID operation selection] and/or APP-80 [Ext. PID operation select] to "Yes", I/O-86~88 parameter settings become available. Changing I/O-86~88 value will affect all of the unit display for reference values such as DRV-00 and I/O-01~16. See the related parameter description on the manual for more.

When APP-02 [PID operation selection] is set to "Yes" with APP-04 [PID Aux speed selection] to "No," the selection made among V1,V1S,I,V1+I,Pulse in DRV-04 [Freq mode] becomes PID reference input value and PID target output value becomes inverter reference frequency. See the PID description on the manual for more.
Set APP-80 [Ext. PID operation selection] to "Yes" and control terminal "I" to "4~20mA", Ext. PID feedback value. Set one of the I/O-20~27 to [Ext PID Run]. When the selected terminal for [Ext PID Run] is turned ON, Ext. PID operation begins and Ext. PID output value becomes inverter command frequency. See APP-80~97 for details.

When DRV-16 [Speed Unit Selection] is set to 1 (Rpm), Hz display is changed to Rpm.

DRV-04 [Frequency Mode] setting guide

Set	DRV-04	Name	Programming Description
0	Key Pad-1	Digital freq. command	1. In DRV-00, press the [PROG] key. 2. Set the desired freq. 3. Press the [ENT] key to write the new value into memory.
1	Key Pad-2		1. In DRV-00, press the [PROG] key. 2. Press the [⇧(Up)] or [⇩(Down)] key to set the desired freq. Speed is reflected to the inverter real time upon pressing the UP/DOWN keys. 3. Press the [ENT] key to write the new value into memory.
2	V1	Analog freq. command	Voltage analog input (0 to 12V) to Control terminal "V1". See the description of I/O-01~05.
3	V1S		Voltage analog input (-12 to 12V, FWD/REV Run) to Control terminal "V1". See the description of I/O-01~05.
4	I		Current analog input (4 to 20mA) to Control terminal "I". See the description of I/O-06~10.
5	V1+I		0-10V/4-20mA Analog input Control terminal "V1","I". See the description of I/O-01~10.
6	Pulse	Pulse command	Set the command frequency (0-100kHz) from control input terminal "A0 or B0". See the I/O-11~16.
7	Int. 485	Communi-cation	Set the command frequency using RS485 (1200~19200bps) from "C+ or C-" control terminals. See the I/O-90~93.
8	Ext. PID	Ext.PID Reference frequency	Set APP-80 [Ext PI Mode] to [Yes]. Apply 4~20mA {Ext.PID feedback value} to control terminal "I". Set one of the I/O-20~27 to [Ext PID Run]. When the defined terminal is ON, inverter starts Ext.PID operation and the Ext.PID output value becomes inverter command frequency. See APP-80~97 for more.

I/O-01~05 [Frequency command setting via Analog Voltage Input " V1"]

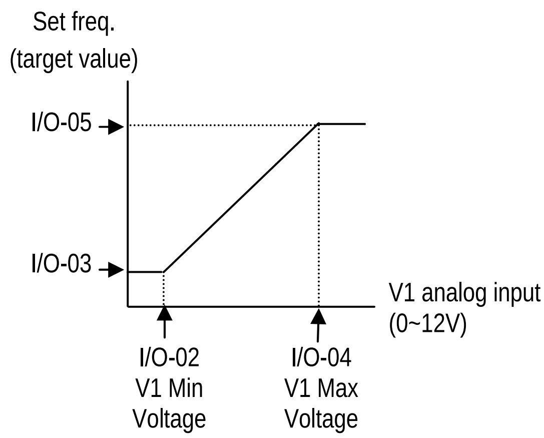
Command Freq. setting via "V1" input terminal when set DRV-04 [Frequency mode] to V1, V1S, or V1+I. A User-selected unit will be displayed in [**] when one of the APP-02[PID operation selection] and APP-80 [Ext. PID operation selection] is set to "Yes," and set the desired unit among Percent, Bar, mBar, kPa, Pa in I/O-86 [Voltage input user unit selection].

Code	Default	Setting range
I/O-01	10 [msec]	0 ~ 9999 [msec]
I/O-02	0 [V]	0 ~ 12 [V]
I/O-03	0 [Hz]	0 ~ Max. freq
	0 [**]	0~100.00[**]
I/O-04	10 [V]	0 ~ 12 [V]
I/O-05	60 [Hz]	0 ~ Max freq
	0 [**]	0~100.00[**]

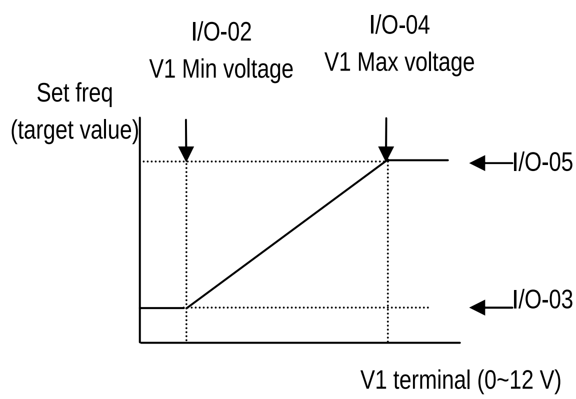
Code	LCD Display	Parameter Name
I/O-01	V1 filter	Filter Time Constant for V1 Input
I/O-02	V1 volt x1	V1 Input Minimum Voltage
I/O-03	V1 freq y1	Frequency Corresponding to V1 Input Minimum Voltage
	V1[**]y1	Target value Corresponding to V1 input minimum voltage.
I/O-04	V1 volt x2	V1 Input Maximum Voltage
I/O-05	V1 freq y2	Frequency Corresponding to V1 Input Maximum Voltage
	V1[**]y2	Target value Corresponding to V1 input maximum voltage.

Important: Increase I/O-01 [Filter Time Constant for V1 Input] if the V1 signal is affected by noise causing unstable operation. Increasing this value makes response time slower.

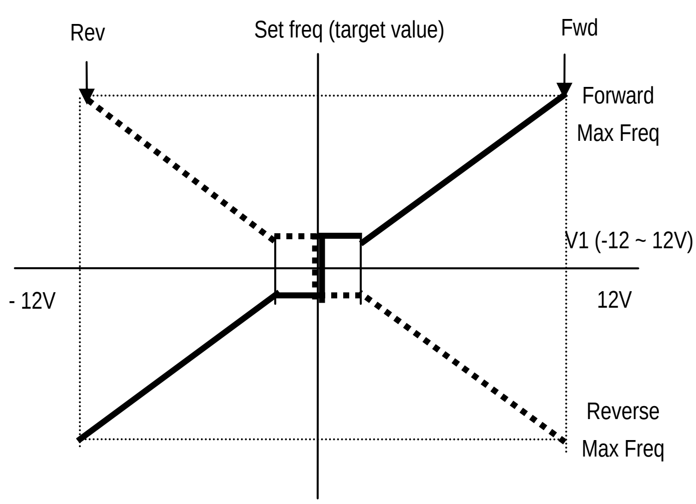
In the case of 0~12V V1 voltage input



In the case of –12~12V V1 voltage input



Setting for Bi-polarity and the uni-polarity is the same as the graph above. Set the positive value for Voltage and frequency and negative value is symmetrical of positive setting. The following graph shows the relationship between voltage input and direction command (Positive/Negative).



To drive the motor in Forward direction, press FWD key and apply 0-12V voltage as frequency command or press REV key and apply –12~0V voltage as frequency command. To drive the motor in Reverse direction, press FWD key and apply –12~0V or press REV key and apply 0~12V.

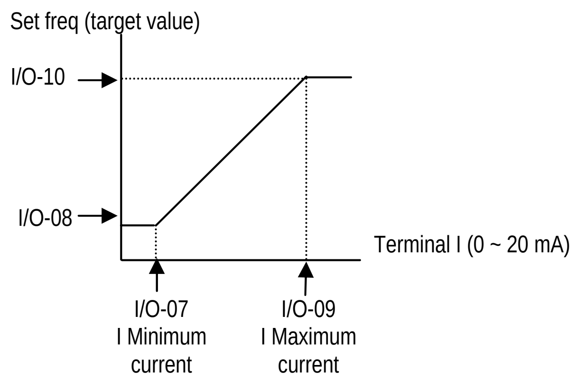
I/O-06~10 [Analog Current Input "I" Signal adjustment]

Command Freq setting via "I" input terminal when set DRV-04 [Frequency mode] to 3 (I) or 4 (V1+I)
A User-selected unit will be displayed in [**] when one of the APP-02[PID operation selection] and APP-80 [Ext. PID operation selection] is set to "Yes," and set the desired unit among Percent, Bar, mBar, kPa, Pa in I/O-87 [Current input user unit selection].

Code	Default	Setting range
I/O-06	10 [msec]	0 ~ 9999 [msec]
I/O-07	4 [mA]	0 ~ 20 [mA]
I/O-08	0 [Hz]	0 ~ Max. freq
	0 [**]	0 ~ 100.00[**]
I/O-09	20 [mA]	0 ~ 20 [mA]
I/O-10	60 [Hz]	0 ~ Max. freq
	0 [**]	0 ~ 100.00[**]

Code	LCD display	Parameter Name
I/O06	I filter	Filter time constant for I signal Input
I/O-07	I curr x1	I Input Minimum Current
I/O-08	I freq y1	Frequency Corresponding to I Input Minimum Current
	I [**] y1	Target value Corresponding to I Input Minimum Voltage
I/O-09	I curr x2	I Input Maximum Current
I/O-1-0	I freq y2	Frequency Corresponding to I Input Maximum Current
	I [**] y2	Target value Corresponding to I Input Maximum Voltage

Important: Increase I/O-06 [Filter time constant for I signal Input] if I signal is affected by noise causing unstable operation. Increasing this value makes response time slower.



DRV-01, 02: Accel/Decel Time 0

DRV► Acc. time 01 20.0 sec	01	20.0

Factory Default: 20.0 sec 20.0

DRV► Dec. time 02 30.0 sec	02	30.0

Factory Default: 30.0 sec 30.0

The inverter targets FU2-73 when accelerating or decelerating. When FU2-73 is set to "Maximum Frequency", the acceleration time is the time taken by the motor to reach FU1-30 from 0 Hz. The deceleration time is the time taken by the motor to reach 0 Hz from FU1-30 [Maximum Frequency]. When FU2-73 is set to "Delta Frequency", the acceleration and deceleration time is the time taken to reach a target frequency (instead the maximum frequency) from a specific frequency.
The acceleration and deceleration time can be changed to a preset time via Programmable digital inputs. By setting M1~M8 to 'XCEL-L', 'XCEL-M', 'XCEL-H' respectively, the 1~7 Accel and Decel time set in I/O-50 to I/O-63 are applied by the binary inputs of the M1~M8.

Note: Set the Accel time more than 0.5 sec for smooth acceleration. Setting it too short may deteriorate the starting performance.
In case of the inverters for 110~280kW(150~400HP), the factory default of Accel/Decel Time is 60.0/90.0[sec] respectively.

Code	LCD display	Name	XCEL -H	XCEL -M	XCEL -L	Default
DRV-01	Acc time	Acc time 0	0	0	0	20 sec
DRV-02	Dec time	Dec time 0	0	0	0	30 sec
I/O-50	ACC-1	Acc time 1	0	0	1	20 sec
I/O-51	DEC-1	Dec time 1	0	0	1	20 sec
I/O-52	ACC-2	Acc time 2	0	1	0	30 sec
I/O-53	DEC-2	Dec time 2	0	1	0	30 sec
I/O-54	ACC-3	Acc time 3	0	1	1	40 sec
I/O-55	DEC-3	Dec time 3	0	1	1	40 sec
I/O-56	ACC-4	Acc time 4	1	0	0	50 sec
I/O-57	DEC-4	Dec time 4	1	0	0	50 sec
I/O-58	ACC-5	Acc time 5	1	0	1	40 sec
I/O-59	DEC-5	Dec time 5	1	0	1	40 sec
I/O-60	ACC-6	Acc time 6	1	1	0	30 sec
I/O-61	DEC-6	Dec time 6	1	1	0	30 sec
I/O-62	ACC-7	Acc time 7	1	1	1	20 sec
I/O-63	DEC-7	Dec time 7	1	1	1	20 sec

FU2-74 [Accel/Decel time scale]

Set the Accel/Decel time unit.

* Up to 6000 sec settable via LE-200 keypad.

Setting	Unit	Description
0	0.01 sec	Minimum 0 sec settable Maximum 60 sec settable
1	0.1 sec	Minimum 0 sec settable Maximum 600 sec settable (Factory setting)
2	1 sec	Minimum 0 sec settable Maximum 6000 sec settable*

DRV-03: Drive Mode (Run/Stop Method)

```
DRV► Drive mode
03    Fx/Rx-1
```

03	1

Factory Default: Fx/Rx-1 1

Select the source of run/stop command.

Setting Range	Description
Keypad	Run/Stop control by Keypad.
Fx/Rx-1	Run/Stop control by Control Terminals FX, RX. (Method 1) FX: Forward Run/Stop RX: Reverse Run/Stop
Fx/Rx-2	Run/Stop control by Control Terminals FX, RX. (Method 2) FX: Run/Stop command RX: Forward/Reverse selection
Int. 485	Run/Stop control by RS485.

DRV-04: Frequency Mode

```
DRV►  Freq mode
04    Keypad-1
```

04	0

Factory Default: Keypad-1 0

If the DRV-04 [Frequency Mode] is set to V1, V1S, I, V1+I, see the description of I/O-01~16 [Analog Voltage/Current input signal adjustment].

Setting Range	Description
Keypad-1	Frequency is set at DRV-00. The frequency is changed by pressing **PROG** key and entered by pressing **ENT** key. The inverter does not output the changed frequency until the **ENT** key is pressed.
Keypad-2	Frequency is set at DRV-00. Press **PROG** key and then by pressing the ▲, ▼ key, the inverter immediately outputs the changed frequency. Pressing the **ENT** key saves the changed frequency.
V1	Apply the frequency reference (0-12V) to the "V1" control terminal. Refer to the I/O-01 to I/O-05 for scaling the signal.
V1S	Apply the frequency reference -12~12V to terminal V1. Refer to the I/O-01 to I/O-05

I	Apply the frequency reference (4~20mA) to the “I” control terminal. Refer to the I/O-06 to I/O-10 for scaling the signal.
1+I	Apply the frequency reference (0~12V, 4~20mA) to the “V1”,“I” control terminals. The ‘V1’ signal overrides the ‘I’ signal. See I/O-01~10.
PULSE	Set the freq command using “A0, B0” terminals. Range: 0~100kHz. See I/O-11~16.
Int. 485	Set the freq command using RS485 communication. See I/O-90~93.
Ext. PID	Set APP-80 [Ext PI Mode] to “Yes.” Apply Ext. PID feedback value “4~20mA” to control terminal “I”. Set one of the I/O-20~27 to [Ext PID Run]. Inverter starts Ext.PID operation when the defined terminal is ON and Ext.PID output value becomes inverter command frequency. See APP-80~97 for details.

DRV-05 ~ DRV-07: Step Frequency 1 ~ 3

DRV▶ Step freq-1 05 10.00 Hz	05	10.00
Factory Default: 10.00 Hz		10.00
DRV▶ Step freq-2 06 20.00 Hz	06	20.00
Factory Default: 20.00 Hz		20.00
DRV▶ Step freq-3 07 30.00 Hz	07	30.00
Factory Default: 30.00 Hz		30.00

The inverter outputs preset frequencies set in these codes according to the Programmable Digital Input terminals configured as ‘Speed-L’, ‘Speed-M’, ‘Speed-H’ and ‘Speed-X’. The output frequencies are decided by the binary combination of M1~M8. The frequency setting method of ‘Speed 0’ is decided by DRV-04.

See I/O-21~27 description for Step Freq 4~7.

Binary Input Combination			Output Frequency	Step Speed
Speed-L	Speed-M	Speed-H		
0	0	0	DRV-00	Speed 0
1	0	0	DRV-05	Speed 1
0	1	0	DRV-06	Speed 2
1	1	0	DRV-07	Speed 3

Note: Speed 0 is the set value in DRV-04.

DRV-04 data	DRV-00, 0 speed	Freq command source
KeyPad-1	Digital command freq	Keypad
KeyPad-2	Digital command freq	Keypad
V1	Analog command freq	Terminal
V1S	Analog command freq	Terminal
I	Analog command freq	Terminal
V1+I	Analog command freq	Terminal
Pulse	Pulse command freq	Terminal
Int. 485	Comm. command freq	Terminal
Ext. PID	Ext.PID reference frequency	Keypad or Terminal

DRV-08: Output Current

DRV▶ Current 08 0.0 A	08	0.0
Factory Default: 0.0 A		0.0

This code displays the output current of the inverter in RMS.

DRV-09: Motor RPM

DRV▶ Speed 09 0rpm	09	0
Factory Default: 0rmp		0

This code displays the motor speed in RPM while the motor is running.

Use the following equation to scale the mechanical speed using FU2-74 [Gain for Motor Speed display] if you want to change the motor speed display to rotation speed (r/min) or mechanical speed (m/min).

Motor speed = 120 * (F/P) * FU2-47

Where, F= Output Frequency and P= the Number of Motor Poles

DRV-10: DC Link Voltage

```
DRV▶ DC link vtg
10     ----- V
```

10	----

Factory Default:	---- V	----

This code displays the DC link voltage inside the inverter.

DRV-11: User Display Selection

```
DRV▶ User disp
11    0.0 V
```

11	0.0

Factory Default:	0.0 V	0.0

This code displays the parameter selected in FU2-81 [User Display]. One of Voltage (factory default, output voltage display) or Watt (output power display) is selectable.

DRV-12: Current Trip Display

```
DRV▶   Fault
12          None
```

12	nOn

Factory Default:	None	nOn

This code displays the current fault (trip) status of the inverter. Use the **PROG**, ▲ and ▼ key before pressing the **RESET** key to check the fault content(s), output frequency, output current, and whether the inverter was accelerating, decelerating, or in constant speed at the time of the fault occurred. Press the **ENT** key to exit. The fault content will be stored in FU2-01 to FU2-05 when the **RESET** key is pressed. For more detail, please refer to Chapter 7. Troubleshooting and Maintenance.

[Fault Contents]

Fault (Trip)	LCD Keypad display
Over-Current 1	Over Current 1
Over-Voltage	Over Voltage
External Trip Input	Ext. Trip
Emergency Stop (Not Latched)	BX
Low-Voltage	Low Voltage
Ground Fault	Ground Fault
Over-Heat on Heat sink	Over Heat
Electronic Thermal Trip	E-Thermal
Over-Load Trip	Over Load
Inverter H/W Fault - EEP Error - ADC Offset - WDOG Error - In-Phase Open	HW-Diag
Over-Current 2	Over Current 2
Output Phase Loss	Phase Open
Inverter Over-Load	Inv. OLT

Note: There are WDOG error, EEP error, Input Phase Open and ADC Offset for the inverter Hardware Fault. Inverter will not reset when H/W fault occurs. Repair the fault before turning on the power.

Note: Only the highest-level fault will be displayed when multiple faults occur. The rest of faults can be monitored in FU2-01~05 [Fault history]. Cycle the power when the fault is cleared.

Up to 5 faults can be saved in FU2-01~05 [Fault history]. The lowest hierarchy fault such as “Last trip 5” is the latest. After pressing [PROG] key, press [⇧(Up)], [⇩(Down)] key to check the operation information at the time of the fault (Output freq., current, Accel/Decel/Constant Run) and fault type. Press the [ENT] key to escape.
FU2-06 [Erase fault history] clears the faults information. However, FU2-83 [Last Trip Time] is automatically reset when a trip occurs.

Code	Display	Description
FU2-01	Last trip-1	Fault history 1
FU2-02	Last trip-2	Fault history 2
FU2-03	Last trip-3	Fault history 3
FU2-04	Last trip-4	Fault history 4
FU2-05	Last trip-5	Fault history 5

FU2-83 [Last Trip Time] shows the total time elapsed after the last trip occurs so it is possible to know the actual trip time by recounting.

DRV-13: Motor Direction Set (7-Segment Keypad)

13	0

Factory Default:	0

This code sets the motor direction when using the 7-Segment keypad.

DRV-14: Command/Output Frequency Display (LCD Keypad)

```
DRV▶TAR   0.00Hz
14  OUT   0.00Hz
```

Factory Default:	0.00Hz

This code shows the Command (Target) Frequency set in DRV00 and inverter Output Frequency.

DRV-15: Reference/Feedback Frequency Display (LCD Keypad)

```
DRV▶REF   0.00Hz
15  FBK   0.00Hz
```

Factory Default:	0.00Hz

This code shows the Reference Frequency and Feedback Frequency while PID operation.
Appears only when 'Yes' is selected in APP-02

Inverter PID controller's reference and feedback value are displayed. When APP-02 [PID operation selection] is set to "YES," reference and feedback values are displayed in Hz. When APP-02 [PID operation selection] is set to "YES," and APP-06 [PID feedback selection] is set (one of the I, V1, Pulse) and the desired unit is set in I/O-86 [V1 Unit Sel], I/O-87 [I Unit Sel], I/O-88 [PulseUnitSel] according to the selection in APP-06, PID reference and feedback value will be displayed in user-selected unit.

Ex1) When [mBar] is set

Ex2) When [kPa] is set

DRV-16: Hz/Rpm Display

DRV▶ Hz/Rpm Disp 16 0 Hz	16	0

Factory Default:	0 Hz	**0**

Set this parameter to 0 [Hz] to display frequency, or to 1[Rpm] to display speed.

DRV-18: PID Parameter (To monitor PID controller’s Reference/Feedback value and Inverter’s Command/output frequency)

Displays PID controller’s reference/feedback value and inverter’s command/output frequency. When APP-02 [PID operation selection] is set to “YES,” reference and feedback values are displayed in Hz. When APP-02 [PID operation selection] is set to “YES,” and APP-06 [PID feedback selection] is set (one of the I, V1, Pulse) and the desired unit is set in I/O-86 [V1 Unit Sel], I/O-87 [I Unit Sel], I/O-88 [PulseUnitSel] according to the selection in APP-06, PID reference and feedback value as well as Inverter command and output frequency will be displayed by percent [%] unit.

DRV-19: AD Parameter (To monitor the AD conversion value of Analog input)

AD value of the Analog input used for Freq mode, PID or Ext. PID reference/feedback can be monitored in DRV-19.

Ex) When using V1 and I

DRV-20: EXT-PID Parameter
(To monitor ExtPID controller's reference/ feedback/ output value)

Displays ExtPID controller's reference/ feedback/ output value.
When APP-80 [Ext. PID operation selection] is set to "YES," reference and feedback are displayed in Percent unit.

When APP-02 [PID operation selection] is set to "YES," and APP-06 [PID feedback selection] is set (one of the I, V1, Pulse) and the desired unit is set in I/O-86 [V1 Unit Sel], I/O-87 [I Unit Sel], I/O-88 [PulseUnitSel] according to the selection in APP-06, PID reference and feedback value will be displayed by percent [%] unit.

DRV-93: FU1 Group Selection (7-Seg.keypad Only)
DRV-94: FU2 Group Selection
DRV-95: I/O Group Selection
DRV-96: EXT Group Selection
DRV-97: COM Group Selection
DRV-98: APP Group Selection

Select the desired group and press the **PROG/ENT** key to move into the desired group. The parameter in the group can be read and written after moving into the desired group.

6.2 Function 1 Group [FU1]

FU1-00: Jump to Desired Code

FU1► Jump code	
00 1	

Factory Default: 1 **1**

Jumping directly to any parameter code can be accomplished by entering the desired code number. This code is available only with LCD keypad.

FU1-01: Run Prevention

FU1► Run prev.	01	0
01 None		

Factory Default: None 0

This function prevents reverse operation of the motor. This function may be used for loads that rotate only in one direction such as fans and pumps.

Setting Range	Description
None	Forward &Reverse run available. (Factory default)
Forward Prev	Forward run prohibited.
Reverse Prev	Reverse run prohibited.

FU1-02: Acceleration Pattern
FU1-03: Deceleration Pattern

FU1►Acc. pattern	02	0
02 Linear		

Factory Default: Linear 0

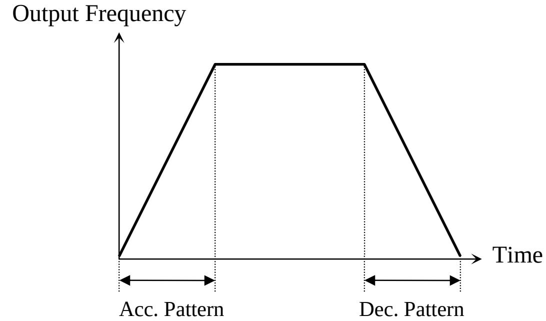
FU1►Dec. pattern	03	0
03 Linear		

Factory Default: Linear 0

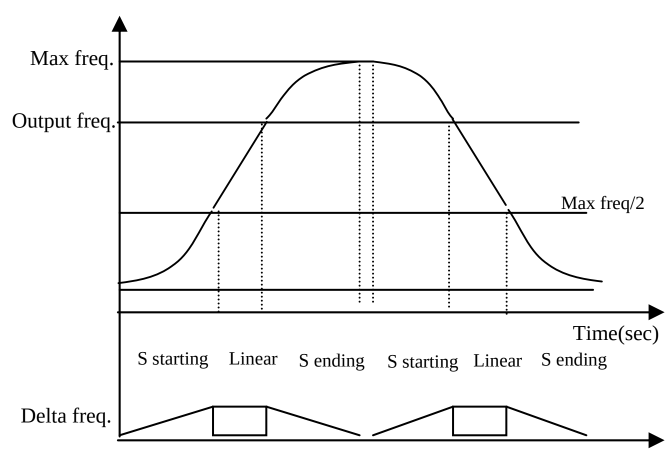
Different combinations of acceleration and deceleration patterns can be selected according to the application.

Setting Range	Description
Linear	A general pattern for constant torque applications. (Factory default)
S-curve	This pattern allows the motor to accelerate and decelerate smoothly. The actual acceleration and deceleration time takes longer- about 40% than the time set in DRV-01 and DRV-02. This setting prevents shock during acceleration and deceleration, and prevents objects from swinging on conveyors or other moving equipment.
U-curve	This pattern provides more efficient control of acceleration and deceleration in typical winding machine applications.

Note: Setting value in DRV-01 and DRV-02 is ignored.



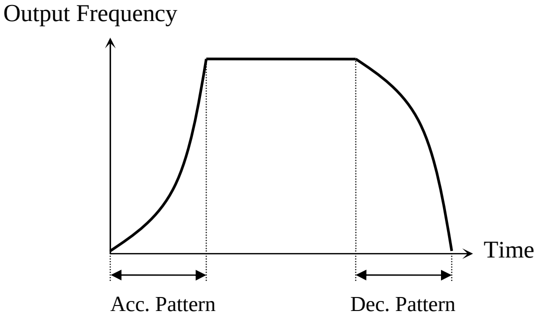
[Accel/Decel Pattern: 'Linear']



[Accel/Decel Pattern: 'S-curve']

Actual accel time = Preset accel time+ Preset accel time *Starting curve ratio/2 + Preset accel time * Ending curve ratio /2
Actual decel time = Preset decel time + Preset decel

time * Starting Curve ratio/2 + Preset decel time * Ending curve ratio/2

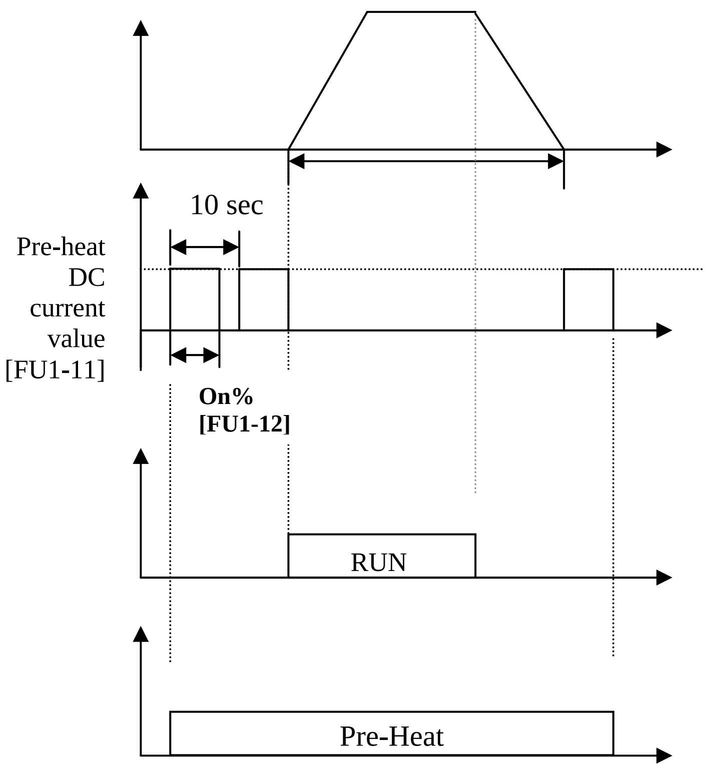


[Accel/Decel Pattern: ‘U-curve’]

FU1-10~12: Pre-heat (to use Pre-heat function)

FU1►Pre-HeatMode 10 No	10	0
Factory Default: No		0

This function enables a motor to prevent moisture from entering and not to develop condensation inside at stop in a humid area by supplying DC current to the motor continuously.



Pre-heat function is activated when FU1-10 [Pre-heat] is set to “Yes”, one of the Programmable digital input terminals in I/O-20~27 set to “Pre-heat” and the defined terminal is turned ON. Only active at inverter stop.

- FU1-11 [Pre-heat value] is set in percent of motor rated current.
- FU1-12 [Pre-heat duty] sets the duty for 10 seconds. At 100% setting, DC current is continuously supplied to the motor.

☞ **Caution**: Parameter change is disabled during pre-heat function. Remove the reference command at the terminal before programming.

☞ **Caution**: Reduce FU1-11 [Pre-heat value] or FU2-12 [Pre-heat duty] when inverter or motor is overheated.

FU1-20: Start Mode
FU1-21: Starting DC Magnetizing Time
FU1-22: Starting DC Magnetizing Value

FU1► DcSt time 21 0.0 sec	21	0.0

Factory Default: 0.0 sec 0.0

FU1► DcSt value 22 50 %	22	50

Factory Default: 50 % 50

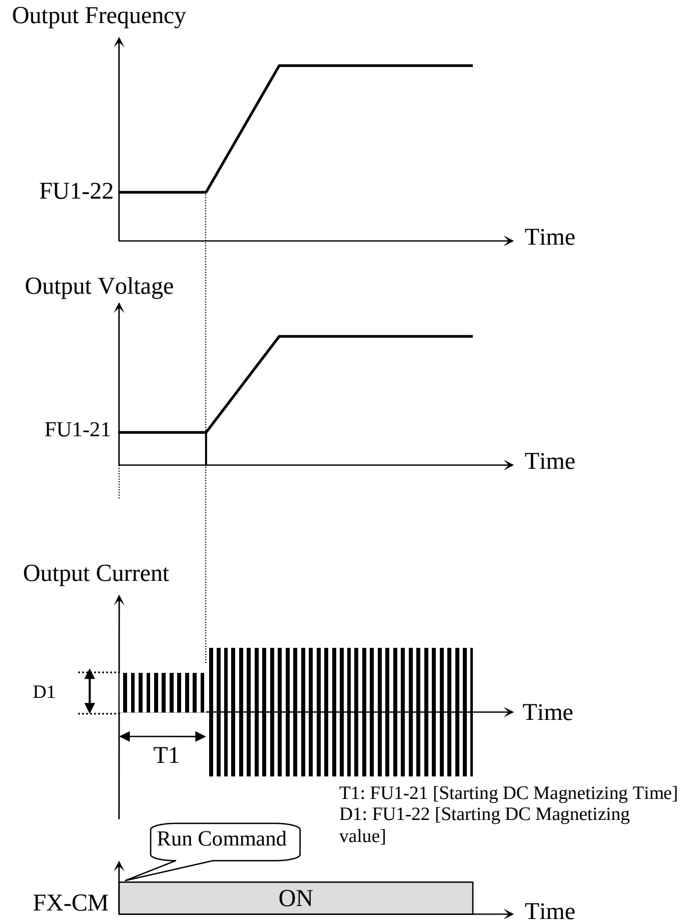
Inverter holds the starting frequency for Starting DC Magnetizing Time. It outputs DC voltage to the motor for FU1-21 [Starting DC Magnetizing Time] with the FU1-22 [Starting DC Magnetizing Value] before accelerating.
Select the starting method of the inverter.

	FU1-20 set data	Function description
0	Accel	Acceleration to start (Factory default)
1	Dc-start	Inverter starts acceleration after magnetizing DC current.
2	Flying-start	Inverter starts RUN while a motor is rotating.

1) The direction of Motor rotation and the command should be set equal to optimum use of Flying-start function. **However, this function is effective with less than 50% to rated rpm when direction of motor rotation and reference command is opposite.**
2) DC-start is disabled when FU1-21 or 22 is set to “0”.
3) DC-start is deactivated in Sensorless mode.
4) It is possible to occur No Motor Trip in case that there is output phase loss when DC-start is operated

Inverter starts acceleration after FU1-21 [Starting DC Magnetizing Time] while FU1-22 [Starting DC Magnetizing Voltage] is operated.

Code	LCD Display	Default	Setting
FU1-21	DcSt time	0 [sec]	0 ~ 60 [sec]
FU1-22	DcSt value	50 [%]	0 ~ 150 [%]



[DC-start Operation]

FU1-22 [Starting DC Magnetizing Value] is the DC Current amount applied to the motor and is set as percent of FU2-43[Motor Rated Current].

Note: Do not set FU1-22 [Starting DC Magnetizing Value] higher than Inverter Rated Current. Otherwise, Motor Overheating or Overload Trip may occur.

FU1-23: Stop Mode

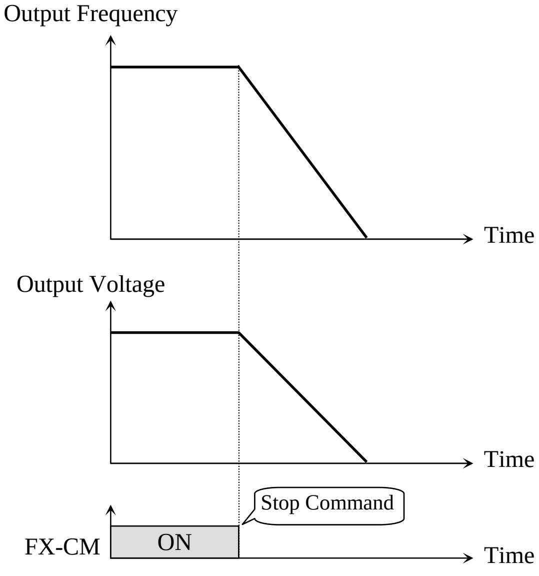
FU1► Stop mode 23 Decel	23	0

Factory Default:	Decel	0

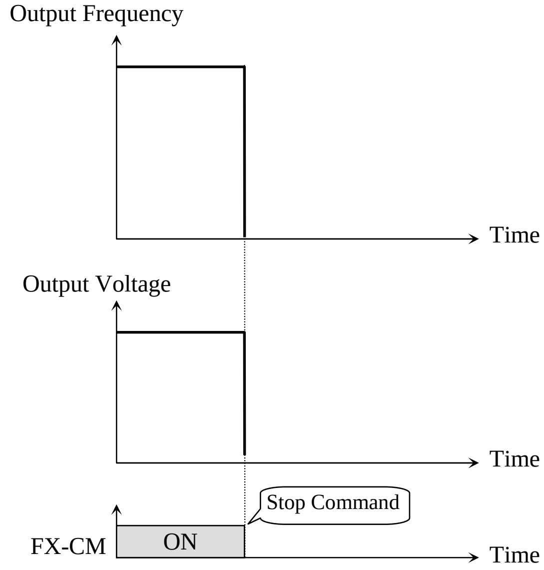
Sets the stopping method for the inverter.

Setting Range	Description
Decel	Inverter stops by the deceleration pattern.
Dc-brake	Inverter stops with DC injection braking. Inverter outputs DC voltage when the frequency reached the DC injection braking frequency during decelerating.
Free-run (Coast to stop)	Inverter cuts off its output immediately when the stop signal is commanded.
Flux brake	Fast stop is available by converting the regenerating energy into heat at the motor.

☞ **Caution: Motor may be overheated due to frequent use of Flux Brake function.**



[Stop Mode: 'Decel']



[Stop mode: Free-run]

FU1-24: DC Injection Braking Hold Time
FU1-25: DC Injection Braking Frequency
FU1-26: DC Injection Braking Time
FU1-27: DC Injection Braking Value

FU1► DcBlk time 24 0.10 sec	24	0.10
Factory Default: 0.10 sec		0.10

FU1► DcBr freq 25 5.00 Hz	25	5.00
Factory Default: 5.00 Hz		5.00

FU1► DcBr time 26 1.0 sec	26	1.0
Factory Default: 1.0 sec		1.0

FU1► DcBr value 27 50 %	27	50
Factory Default: 50 %		50

By introducing a DC voltage to the motor windings this function stops the motor immediately. Selecting 'DC-Brake' in FU1-23 activates FU1-24 through FU1-27.

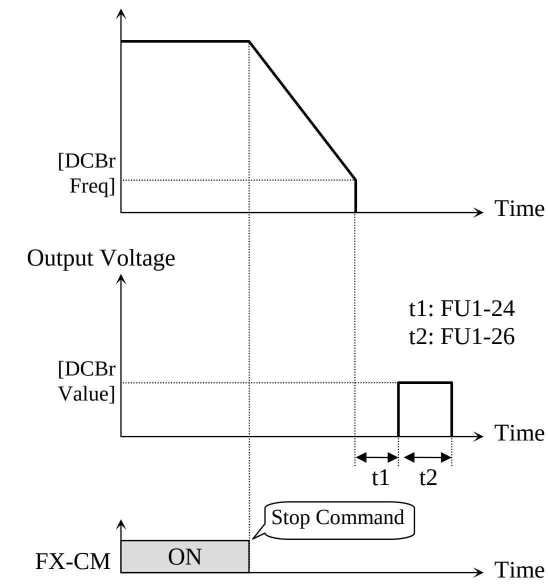
When FU1-23 [Stop mode] is set to "DC Brake", inverter decelerates until FU1-25 [DC Injection Braking Frequency] and begins DC Braking at this frequency.

FU1-24 [DC Injection Braking Hold Time] is the inverter output blocking time before DC injection braking.

FU1-25 [DC Injection Braking Frequency] is the frequency at which the inverter starts to output DC voltage during deceleration.

FU1-26 [DC Injection Braking Time] is the time the DC current is applied to the motor.

FU1-27 [DC Injection Braking Value] is the DC voltage applied to the motor and is based on FU2-43[Rated Current of Motor].



[DC Injection Braking Operation]

Note: Do not set the FU1-27 higher than Inverter rated current. Otherwise, it may lead to motor overheat or overload trip.
Note: Do not set FU1-27 [DC Braking Frequency] too high than its range (between 0~5Hz). Otherwise, it may deteriorate its performance.

FU1-28: Safety Stop

FU1► Safety Stop 28 No	28	0
Factory Default: No		0

This function is used to prevent potential danger from occurring when the whole system is stopped by power outage but the load keeps spinning due to high load inertia.

When momentary power failure occurs while Safety Stop is active, inverter stops the motor by deceleration. Deceleration time depends on load inertia energy.

If the load inertia rate is far different between the factory set value and an actual value, set the proper value in FU2-46 [Load Inertia] for optimum use of the Safety Stop function. When the load inertial is large, trip may occur during this function. In this case, increase the FU2-46 [Load Inertia] value little by little to find the proper value. For more stable Safety

Stop Function, see FU1-90[Safety Stop Inertia Rate].

☞ **Caution: This function is effective for high load inertia.**

FU1-29: Line Frequency

FU1► Line Freq 29 60.00 Hz	29	60.00
Factory Default: 60.00 Hz		60.00

It sets input power frequency. Set 50 or 60Hz in FU1-29 [Line Frequency].
☞ **Caution: If line frequency is changed, related frequencies such as Max frequency, Base frequency are automatically changed. To set the related frequencies different to line, user should set the codes manually.**

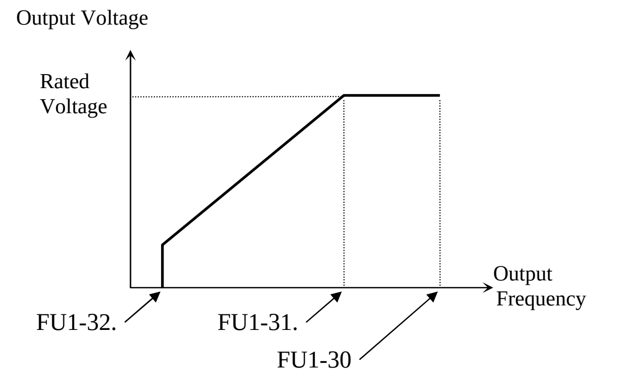
FU1-30: Maximum Frequency
FU1-31: Base Frequency
FU1-32: Starting Frequency

FU1► Max freq 30 60.00 Hz	30	60.00
Factory Default: 60.00 Hz		60.00

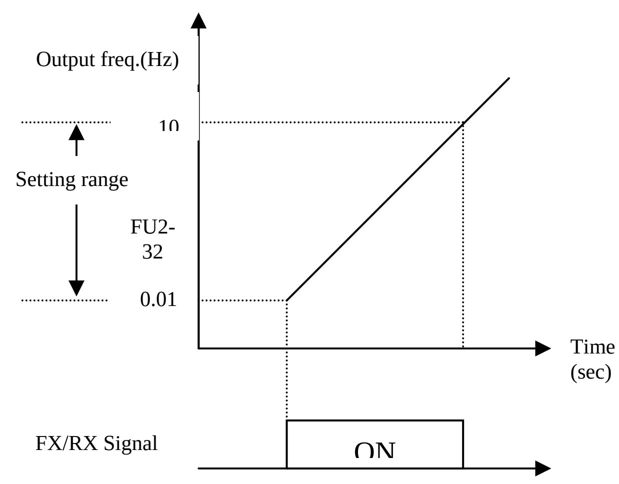
FU1► Base freq 31 60.00 Hz	31	60.00
Factory Default: 60.00 Hz		60.00

FU1► Start freq 32 0.50 Hz	32	0.50
Factory Default: 0.50 Hz		0.50

FU1-30 [Maximum Frequency] is the maximum output frequency of the inverter. Make sure this maximum frequency does not exceed the rated speed of the motor.
FU1-31 [Base Frequency] is the frequency where the inverter outputs its rated voltage. In case of using a 50Hz motor, set this to 50Hz.
FU1-32 [Starting Frequency] is the frequency where the inverter starts to output its voltage. **<u>If it is set to 5Hz, motor starts running from 5 Hz.</u>**



☞ **Caution: Note that these codes setting is automatically changed when FU1-30 and FU1-31 are set before setting FU1-29 [Line Frequency].**
☞ **Caution: Note that Overheat trip or torque shortage may occur if FU1-31 is set different to motor rated frequency.**



Note: Motor starts running at 5Hz when FU2-32 is set to 5Hz.

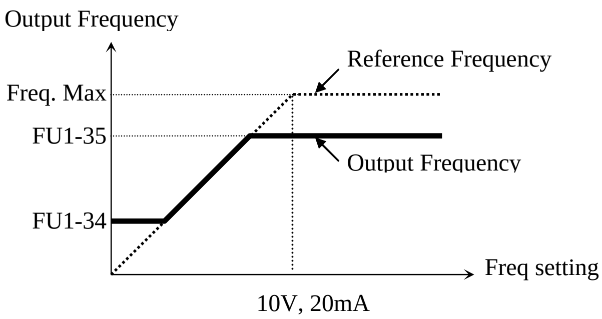
FU1-33: Frequency Limit Selection
FU1-34: Low Limit Frequency
FU1-35: High Limit Frequency

FU1► Freq limit 33 No	33	0
Factory Default: No		0

FU1► F-limit Lo 34 0.50 Hz	34	0.50
Factory Default: 0.50 Hz		0.50

FU1► F-limit Hi 35 60.00 Hz	35	60.00
Factory Default: 60.00 Hz		60.00

FU1-33 selects the limits the inverter operating frequency. If FU1-33 is set to 'Yes', inverter operates within the upper and lower limit setting. The inverter operates at the upper or the lower limit when the frequency reference is outside the frequency limit range.



[Freq. limit: 'Yes']

Note: if freq set value is below freq low limit, inverter operates at the low limit.

Note: Normal Accel/Decel is performed for the range below low limit during Accel/Decel.

FU1-40: Volts/Hz Pattern

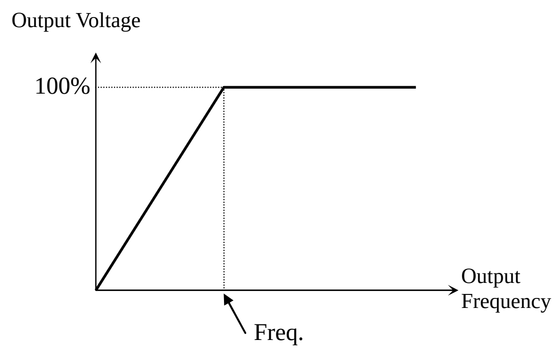
FU1► V/F pattern 40 Linear	40	0
Factory Default: Linear		0

This is the pattern of voltage/frequency ratio. Select the proper V/F pattern according to the load. The motor torque is dependent on this V/F pattern.

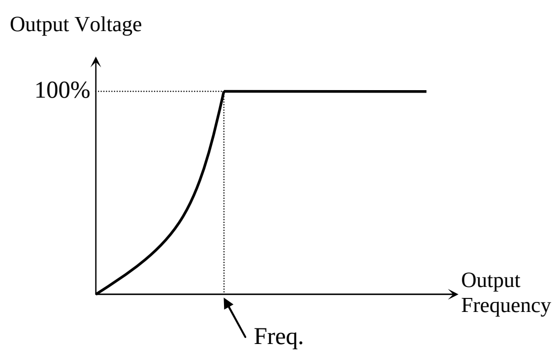
[Linear] pattern is used where constant torque is required. This pattern maintains a linear volts/frequency ratio from zero to base frequency. This pattern is appropriate for constant torque applications. The performance will be improved with the help of FU2-67~69 [Torque boost].

[Square] pattern is used where variable torque is required. This pattern maintains squared volts/hertz ratio. This pattern is appropriate for fans, pumps, etc.

[User V/F] pattern is used for special applications. Users can adjust the volts/frequency ratio according to the application. This is accomplished by setting the voltage and frequency, respectively, at four points between starting frequency and base frequency. The four points of voltage and frequency are set in FU1-41 through FU1-48.



[V/F Pattern: 'Linear']



[V/F Pattern: 'Square']

FU1-41 ~ FU1-48: User V/F Frequency and Voltage

FU1► User freq 1 41 15.00 Hz	41	15.00

Factory Default:	15.00 Hz	15.00

FU1► User volt 1 42 25 %	42	25

Factory Default:	25 %	25

□
□
□

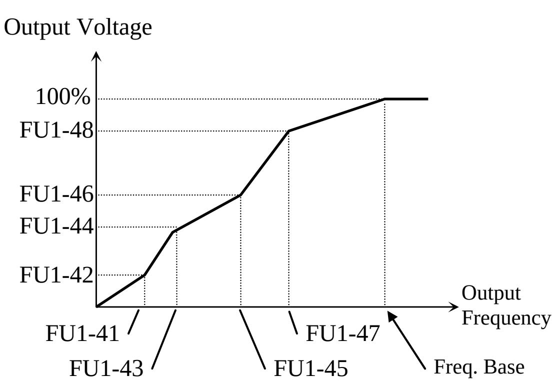
FU1► User freq 4 47 60.00 Hz	47	60.00

Factory Default:	60.00 Hz	60.00

FU1► User volt 4 48 100 %	48	100

Factory Default:	100 %	100

These functions are available only when 'User V/F' is selected in FU1-40 [V/F pattern]. Users can make the custom V/F pattern by setting four points between FU1-32 [Starting Frequency] and FU1-31 [Base Frequency].



[User V/F]

Note: When the 'User V/F' is selected, the torque boost of FU1-67 through FU1-69 is ignored.

FU1-49: AC Input Voltage Adjustment

FU1► VAC 440.0V 49 100.0 %	49	100.0

Factory Default:	100.0 %	100.0

It should be set correctly when inverter input voltage and standard input power rating is far different. Otherwise, it will cause inverter damage. This set value affects inverter LV trip (low voltage trip) level. Used only when line fluctuation exceeds its permissible range or input power far different to its standard value is applied.

Code	LCD Display	Default	Setting
FU1-49	AC Input Volt	100 [%]	73 – 115 [%]

Note: As soon as FU1-49 value is set through a button on the keypad, its set value is applied.

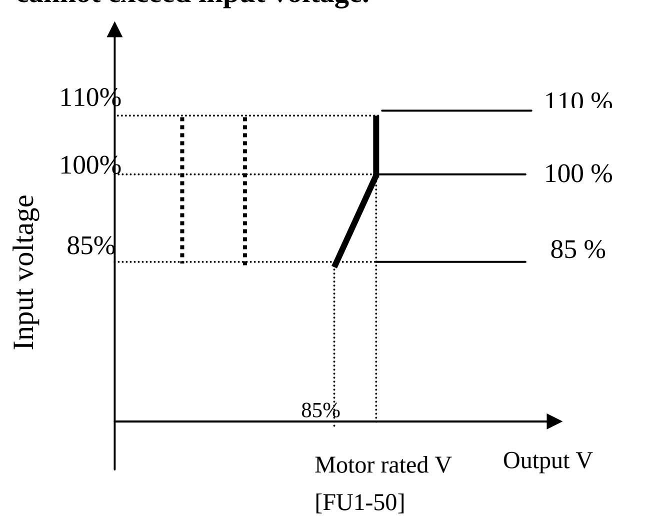
FU1-50: Motor Voltage

FU1► Motor Volt 50 0 V	50	0

Factory Default:	0 V	0

Constant voltage output is possible regardless of input voltage fluctuation by setting this parameter.

☞ **Caution: When input voltage is less than FU1-50 [Motor rated voltage], Max output voltage cannot exceed input voltage.**



FU1-51~52: Energy Save, Energy Save Level

FU1► Energy save 51 None	51	0

Factory Default: 0 0

FU1►Manual save% 52 0 %	52	0

Factory Default: 0 % 0

This function is used to reduce the output voltage in applications that do not require high torque and current at its steady speed. The inverter reduces its output voltage after accelerating to the reference frequency (steady speed) if the energy save level is set at 20%. This function may cause over-current trip due to the lack of output torque in a fluctuating load. When Energy Save is ON, it may take longer during deceleration to stop.

	FU1-51 setting	Description
0	None	Disabled (Factory setting)
1	Manual	Energy save ON by decreasing the output with the value set in FU1-52.
2	Auto	Energy save ON automatically.

Code	LCD	Name	Default	Range
FU1-52	Manual Save %	Energy save %	0 [%]	0~30 [%]

FU1-54: Integrating Wattmeter

- **Displays both MWh and kWh in FU1-54.**

Ex) 1500 kWh

```
FU1▶KiloWattHour
54   1M 00.0kWh
```

- **Max Cumulative value is displayed in FU1-54 as shown below.**

Ex) 9,999,999.9kWh

```
FU1▶KiloWattHour
54  9999M999.9kWh
```

- **Press [PROG] key for 5 sec to reset the value stored in FU1-54.**

☞ **Caution: FU1-54 value may differ from the actual value due to the margin.**

☞ **Caution: Only KWh appears on 7-Segment Keypad.**

FU1-55: Inverter temperature

FU1► Inv. Temp 55 44	55	44

Factory Default: 44 44

IGBT's surface temperature is displayed in FU1-55.

FU1-56: Motor temperature

FU1► Motor Temp 56 0	56	0

Factory Default: 0 0

Motor temperature detected by external thermal sensor terminal (NT) is displayed in FU1-56.

FUN-57: No Motor Sel
FUN-58: No Motor Level
FUN-59: No Motor Time

```
FUN► No Motor Sel
57        Yes
```

Factory Default: Yes

```
FUN► NoMotorLevel
58         5 %
```

Factory Default: 5

```
FU1► NoMotorTime
59     3.0 sec
```

Factory Default: 3.0 sec

These functions can be used to generate Trip in the situation such that there is no actual inverter output but the Main Controller of its hardware does not recognize it. (Damage of SPS for Gate and Damage of Gate, etc.)

When FU1-57 [No Motor Sel] is set to '**Yes**', the current below FU1-58 [No Motor Level] set value flows, and FU1-59 [No Motor Time] set time is passed, HW-Diag Trip is occurred and the message 'No Motor Trip' is displayed on the LCD for this trip. (The current level is based on the set Motor rated current.)

Trip occurs when the inverter is operated without wiring a motor.

Description	LCD Display	Setting Range
No Motor Selection	No Motor Sel	0 (No) 1 (Yes)
Trip Current Level	No Motor Level	5 – 100 [%]
Trip Time Setting	No Motor Time	0.5 – 10.0 [sec]

FU1-60: Electronic Thermal (Motor i²t) Selection
FU1-61: Electronic Thermal Level for 1 Minute
FU1-62: Electronic Thermal Level for Continuous
FU1-63: Electronic Thermal Characteristic (Motor type) selection

These functions protect the motor from overheating without using external thermal relay. Inverter calculates the temperature rise in a motor based on several parameters and determines whether or not the motor is overheated from load current. Inverter will turn off its output and display a trip message when the electronic thermal feature is activated.

```
FU1► ETH select
60  ---  Yes ---
```

60 | 1

Factory Default: Yes 1

This function activates the ETH parameters by setting 'Yes'. ETH level is set as the percentage of FU2-43 [Motor rated current].

```
FU1► ETH 1min
61       150 %
```

61 | 150

Factory Default: 150 % 150

This is the reference current when the inverter determines the motor has overheated. For example, it trips in one minute when 150% of rated motor current in FU2-43 flows for one minute.

Note: The set value is the percentage of FU2-43 [Rated Motor Current].

```
FU1► ETH cont
62       120 %
```

62 | 120

Factory Default: 120 % 120

This is the current at which the motor can run continuously. Generally, this value is set to '100%', which means the motor rated current set in FU2-43. This value must be set less than FU1-61 [ETH 1min].

Note: The set value is the percentage of FU2-43 [Rated Motor Current].

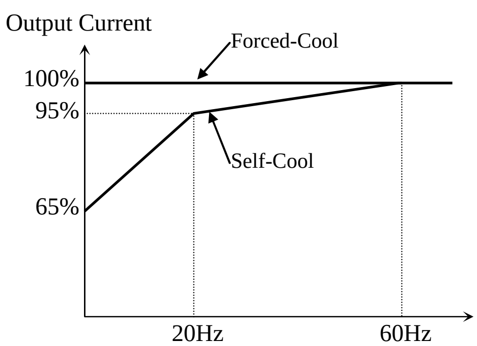
FU1► Motor type 63 Self-cool	63	0

Factory Default:	Self-cool	0

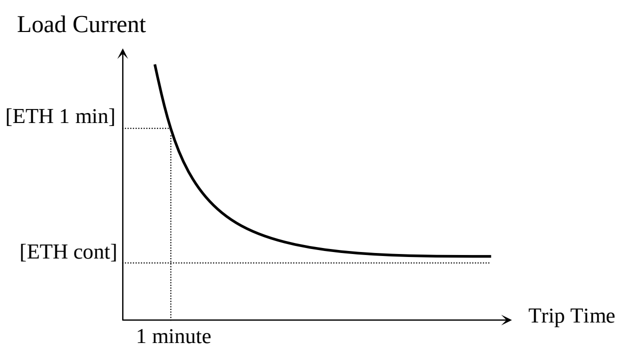
To make the ETH function (Motor i^2t) work correctly, the motor cooling method must be selected correctly according to the motor.

[Self-cool] is a motor that has a cooling fan connected directly to the shaft of the motor. Cooling effects of a self-cooled motor decrease when a motor is running at low speeds. The Motor is easily heated at low speed, compared to the motor at high speed with the same current. The motor current is derated as the motor speed decreases as shown below.

[Forced-cool] is a motor that uses a separate motor to power a cooling fan. As the motor speed changes, the cooling effect does not change. FU1-62 [Electronic thermal level for continuous] set value is applied regardless of operating frequency.



[Load Current Derating Curve]



[Motor i^2t Characteristic Curve]

Note: Despite the motor current changing frequently due to load fluctuation or acceleration and deceleration, the inverter calculates the i^2t and accumulates the value to protect the motor.

FU1-64: Overload Warning Level
FU1-65: Overload Warning Time

FU1► OL level 64 110 %	64	110

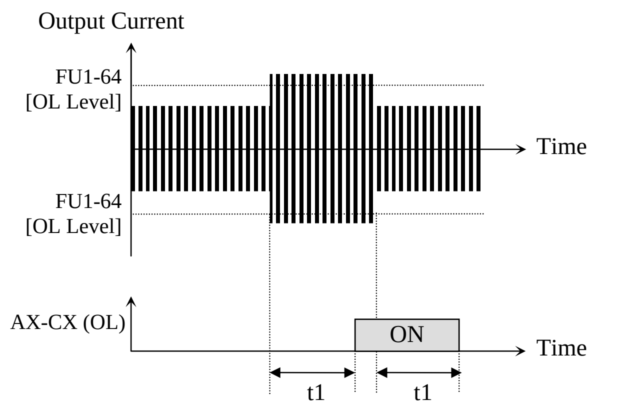
Factory Default:	110 %	110

FU1► OL time 65 10.0 sec	65	10.0

Factory Default:	10.0 sec	10.0

The inverter generates an alarm signal when the output current has reached the FU1-64 [Overload Warning Level] for the FU1-65 [Overload Warning Time]. The alarm signal persists for the FU1-65 even if the current has become the level below the FU1-64. Programmable Digital Output Terminal (AX-CX) is used as the alarm signal output. To output the alarm signal, set I/O-76 [Multifunction Auxiliary Contact Output] to 'OL'.

Note: FU1-64 is set as the percentage of FU2-43 [Rated Motor Current].



t1: FU1-65 [Overload Warning Time]

[Overload Warning]

FU1-66: Overload Trip Selection
FU1-67: Overload Trip Level
FU1-68: Overload Trip Delay Time

FU1► OLT select 66 --- No ---	66	0

Factory Default: No	0

FU1► OLT level 67 120 %	67	120

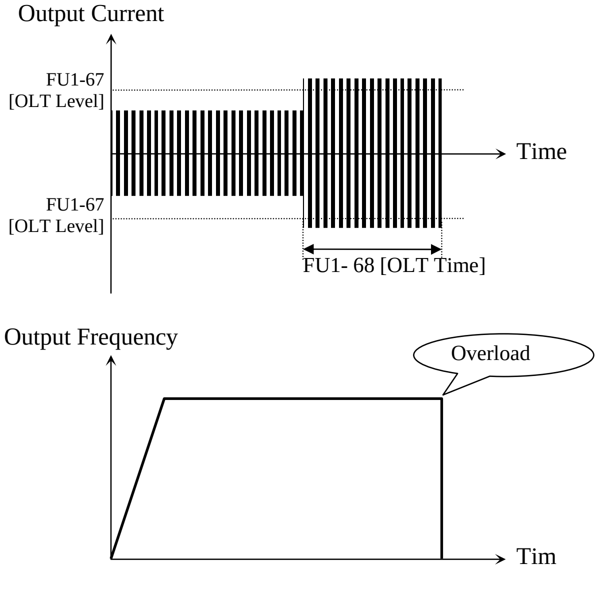
Factory Default: 120 %	120

FU1► OLT time 68 60.0 sec	68	60.0

Factory Default: 60.0 sec	60.0

Inverter cuts off its output and displays fault message when the output current persists over the FU1-67 [Overload Trip Level] for the time of FU1-68 [Overload Trip Time]. This function protects the inverter and motor from abnormal load conditions.

Note: The set value is the percentage of FU2-43 [Rated Motor Current].
Note: Activated only when Heatsink temperature exceeds its preset level.



[Overload Trip Operation]

FU1-69: Input/Output Phase Loss Protection (Bit Set)

FU1► Trip select 69 100	69	100

Factory Default: 100	100

This function is used to cut the inverter output off in case of phase loss in either input power or inverter output.

1st bit: Output phase loss protection Enable/Disable

0: Disabled at Output phase loss protection.
1: Enabled at Output phase loss protection. Inverter output is shut down and stopped.

2nd bit: Input phase loss protection Enable/Disable

0: Input phase loss protection disabled.
1: Input phase loss protection enabled. Inverter output is shut down and stopped.

3rd bit: Protection Enable/Disable selection at Exchange function

0: Disabled at Exchange function (Inverter-Commercial line exchange).
1: Enabled at Exchange function.

FU1-70: Stall Prevention Mode (Bit set)
FU1-71: Stall Prevention Level

FU1► Stall prev. 70 000	70	000

Factory Default: 000	000

This bit set parameter follows the conventions used in I/O-15 and I/O-16 to show the ON (bit set) status.

FU1► Stall level 71 100 %	71	100

Factory Default: 100 %	100

This function is used to prevent the motor from stalling by reducing the inverter output frequency until the motor current decreases below the stall prevention level. This function can be selected for each mode of acceleration, steady speed, and deceleration via bit combination.

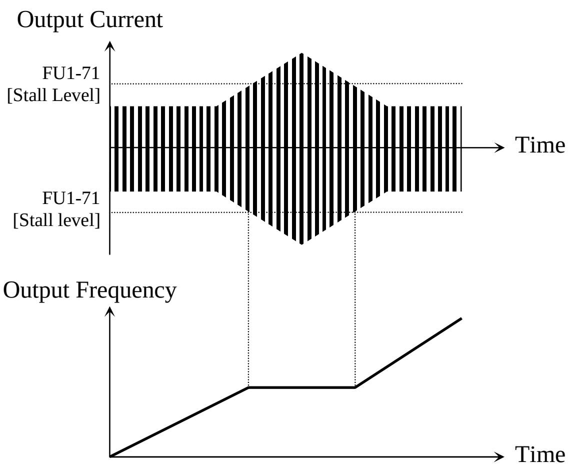
Note: FU1-71 is set as the percentage of FU2-43 [Rated Motor Current].
Note: Do not set the FU1-71 higher than inverter rated current.
Note : Stall level will be automatically reduced if inverter is operated at the frequency higher than base frequency.

FU1-70 [Stall Prevention Mode Selection]

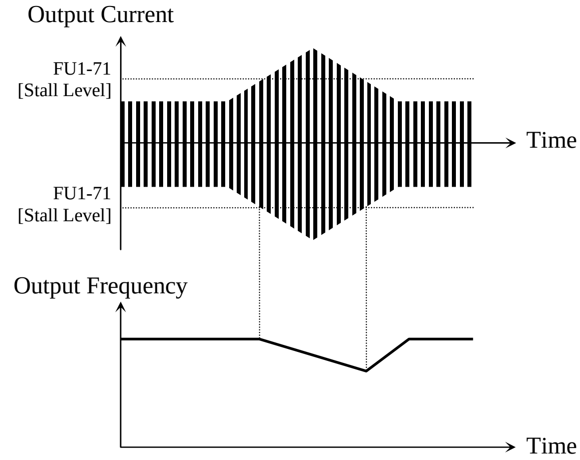
Setting Range			FU1-70	Description
3rd bit	2nd bit	1st bit		
0	0	1	001	Stall Prevention during Acceleration
0	1	0	010	Stall Prevention during Constant Run
1	0	0	100	Stall Prevention during Deceleration

When FU1-70 is set to '111', stall prevention works during accelerating, steady speed and decelerating.

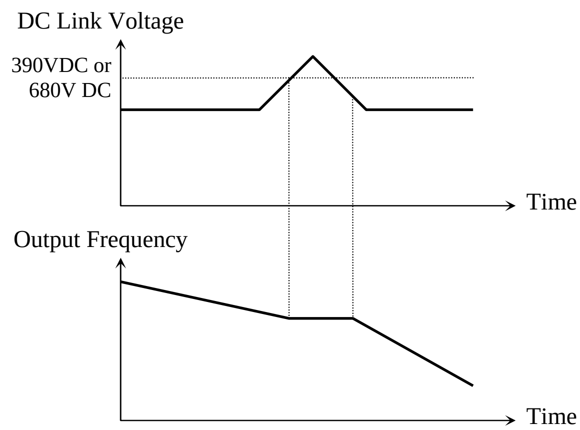
Note: Accel time may get longer due to stall prevention during Accel.
Note: Inverter starts deceleration when Stop command is applied while motor stall state persists.
Note: Output frequency may oscillates due to stall prevention during constant run.
Note: Decel time may get longer due to stall prevention during Decel.



[Stall Prevention during Acceleration]



[Stall Prevention during Constant Run]



[Stall Prevention during Deceleration]

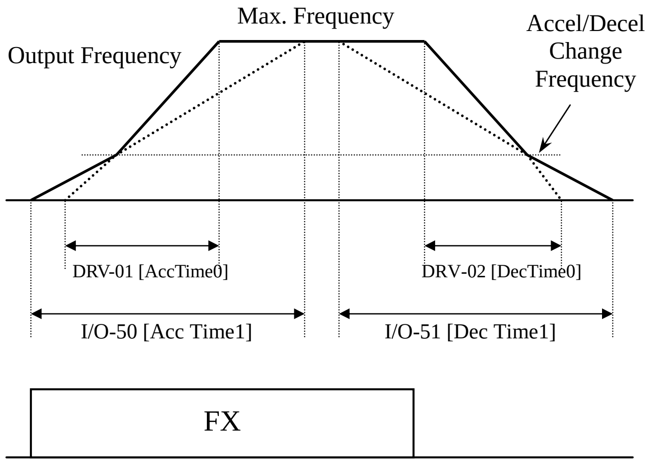
FU1-72: Accel/Decel Change Frequency

FU1►Acc/Dec ch F 72 0.00 Hz	72	0.00

Factory Default:	0.00 Hz	0.00

This function is used to change Accel/Decel ramp at a certain frequency. This is useful in textile machine application. For example, when stop command is ON while inverter runs at 100Hz, inverter swiftly decelerates and changes the ramp at this frequency, leading to soft stop.

Note: If Accel/Decel change frequency is set and 'XCEL-L', XCEL-M', and XCEL-H' defined in Programmable digital terminals are ON, Multi Accel/Decel operation has the priority.



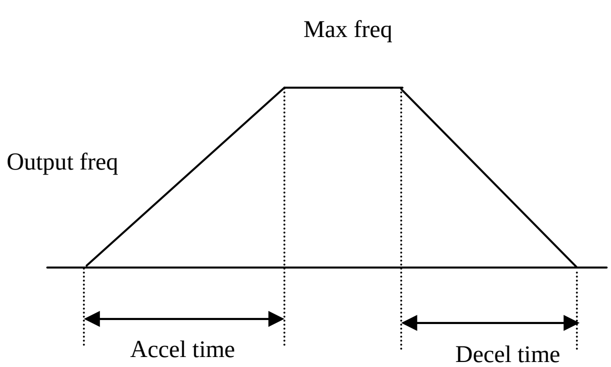
[Accel/Decel Change Operation]

FU1-73: Reference Frequency for Accel/Decel

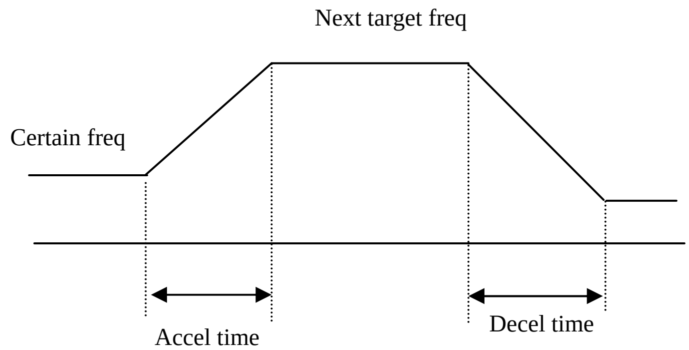
FU1►Acc/Dec freq 73 Max	73	0
Factory Default: Max		0

This is the reference frequency for acceleration and deceleration. If a decided Accel/Decel time from a frequency to a target frequency is required, set this value to 'Delta freq'.

Setting Range	Description
Max freq	The Accel/Decel time is the time that takes to reach the maximum frequency from 0 Hz.
Delta freq	The Accel/Decel time is the time that takes to reach a target frequency from any frequency.



[FU1-73: Max. Freq]



[FU1-73: Delta Freq]

FU1-74: Accel/Decel Time Scale

FU1► Time scale 74 0.1 sec	74	1
Factory Default: 0.1 sec		1

This is used to change the time scale.

Setting Range	Description
0.01 sec	The Accel/Decel time is changed by 10 msec. The maximum setting range is 60 seconds.
0.1 sec	The Accel/Decel time is changed by 100 msec. The maximum setting range is 600 seconds.
1 sec	The Accel/Decel time is changed by 1 sec. The maximum setting range is 6000 seconds.

FU1-90: Safety STOP Inertia Rate

FU1►STOP Inertia 90 10	90	10
Factory Default: 10		10

This is used to find a proper inertia value for Safety STOP function. The suitable value can be found while lowering it when occurring OV Trip or raising it when occurring LV Trip during Safety STOP operation.

6.3 Function 2 Group [FU2]

FU2-00: Jump to desired code #

FU2► Jump code	
00 1	

Factory Default:	1	1

Jumping directly to any parameter code can be accomplished by entering the desired code number. This code is available only with LCD keypad.

FU2-01: Last trip 1
FU2-02: Last trip 2
FU2-03: Last trip 3
FU2-04: Last trip 4
FU2-05: Last trip 5
FU2-06: Erase Trips

FU2► Last trip-1 01 None	01	nOn

Factory Default:	None	nOn

□
□
□

FU2► Last trip-5 05 None	05	nOn

Factory Default:	None	nOn

This code displays up to five previous fault (trip) status of the inverter. Use the **PROG**, ▲ and ▼ key before pressing the **RESET** key to check the fault content(s) such as output frequency, output current, and whether the inverter was accelerating, decelerating, or in constant speed at the time of the fault occurred. Press the **ENT** key to exit.
FU2-83 [Last Trip Time] is the time elapsed after last trip occurs. User can count the last trip time from this value.

Note: There are WDOG error, EEP error, and ADC Offset for the inverter Hardware Fault, and the inverter will not reset when H/W fault occurs. Repair the fault before turning on the power.

FU2► Erase trips 06 --- No ---	06	0

Factory Default:	No	0

This function erases all fault histories of FU2-01 to FU-05 from the memory.
However, FU2-83 [Last Trip Time] cannot be reset.

FU2-07: Dwell Time
FU2-08: Dwell Frequency

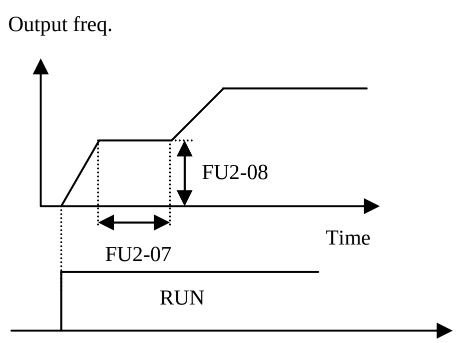
FU2► Dwell time 07 0.0 sec	07	0.0

Factory Default:	0.0 sec	0.0

FU2► Dwell freq 08 5.00 Hz	08	5.00

Factory Default:	5.00 Hz	5.00

Note: If the dwell time is set at '0', this function is not available.
Note: Do not set the Dwell frequency above frequency command. Otherwise, it may lead to operation fault.
Note: this function is disabled in Sensorless control.



FU2-10 ~ FU2-16: Frequency Jump

FU2► Jump freq 10 --- No ---	10	0

Factory Default:	No	0

FU2► jump lo 1 11 10.00 Hz	11	10.00

Factory Default:	10.00 Hz	10.00

FU2► jump Hi 1 12 15.00 Hz	12	15.00

Factory Default:	15.00 Hz	15.00

□
□
□

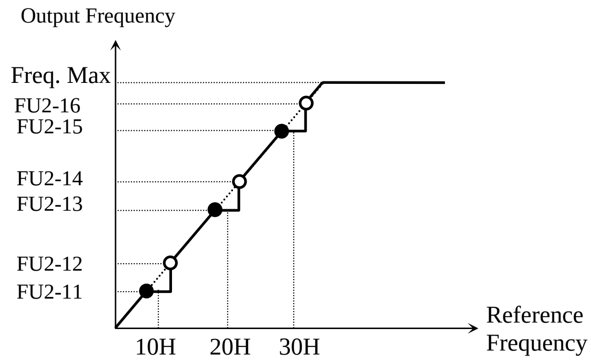
FU2► jump lo 3 15 30.00 Hz	15	30.00

Factory Default:	30.00 Hz	30.00

FU2► jump Hi 3 16 35.00 Hz	16	35.00

Factory Default:	35.00 Hz	35.00

To prevent undesirable resonance and vibration on the structure of the machine, this function locks out the potential resonance frequency from occurring. Three different jump frequency ranges may be set. This avoidance of frequencies does not occur during accelerating or decelerating. It only occurs during continuous operation.



[Frequency Jump]

Note: When the reference frequency is set between the jump frequency low/high limit, it follows the low limit frequency, marked by "•".
Note: If jump range 1 and range 2 are overlapped, lower freq. will become a low limit.
Note: Jump freq. is ignored during Accel/Decel.

FU2-20: Power ON Start Selection

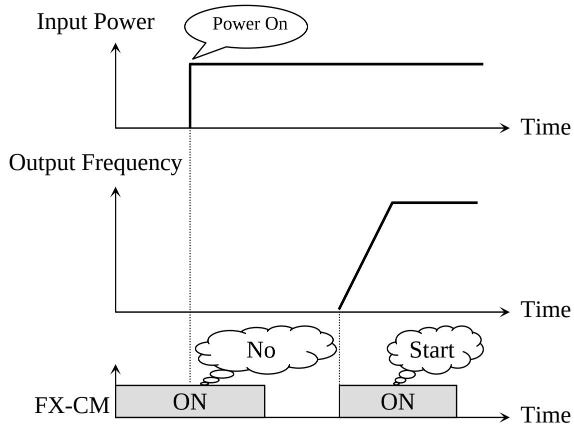
FU2►Power-on run 20 No	20	0

Factory Default:	No	0

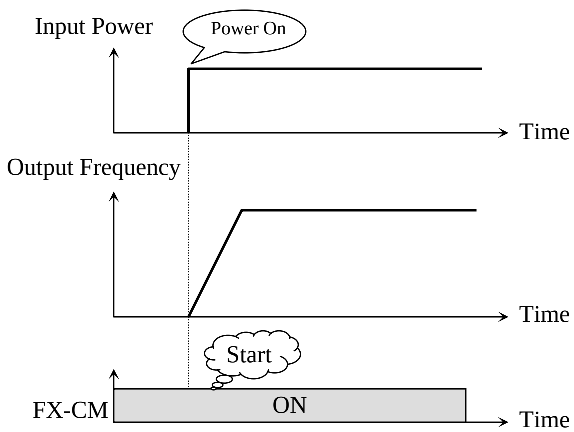
If FUN-20 is set to 'No', turn the terminal off and turn on to restart the inverter even though the FX/RX signal is ON. If FUN-20 is set to 'Yes', the inverter will restart after power is restored. If the motor is rotating by inertia at the time power is restored, the inverter may trip. To avoid this trip, use 'Speed Search' function by setting bit 4 to '1'. If Speed search is not selected, inverter shows normal V/F pattern at acceleration.

⚠ CAUTION

Particular attention must be directed to this function as motor starts to run suddenly upon applying AC input power. Otherwise, it may result in personal damage.



[Power ON Start: 'No']



[Power ON Start: 'Yes']

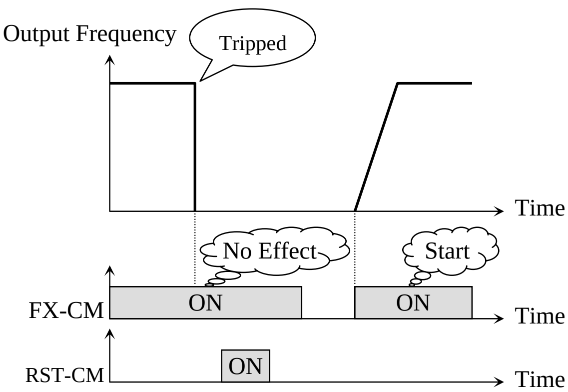
Note: In case of using 'Power ON Start' to 'Yes', make sure to utilize appropriate warning notices to minimize the potential for injury or equipment damage.

FU2-21: Restart After Fault Reset

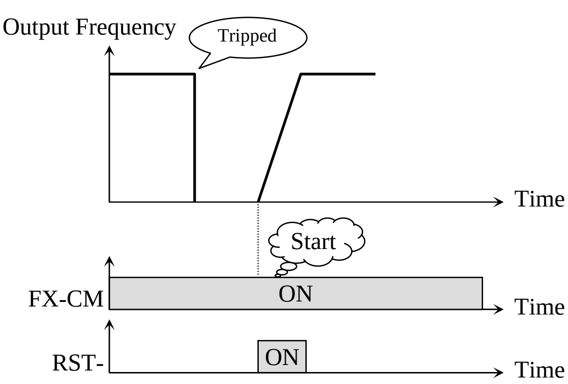
FU2► RST restart 21 No	21	0

Factory Default:	No	0

If FU2-21 is set to 'No', restart the inverter by cycling the FX or RX terminal to CM terminal after the fault has been reset.
If FU2-21 is set to 'Yes', inverter will restart after the RST (reset) terminal has been reset a fault. If the motor is rotating by inertia at the time power is restored, the inverter may trip. To avoid this trip, use 'Speed Search' function by setting bit 2 to 'xx1x'.



[Reset restart: 'No']



[Reset restart: 'Yes']

⚠ CAUTION

Particular attention must be directed to this function as motor starts to run suddenly after the fault is reset. Otherwise, it may result in personal damage.

FU2-22: Speed Search Selection (Bit Set)
FU2-23: P Gain During Speed Search
FU2-24: I Gain During Speed Search

FU2►Speed Search 22 0000	22	0000
Factory Default: 0000		0000
FU2► SS P-gain 23 200	23	200
Factory Default: 200		100
FU2► SS I-gain 24 500	24	500
Factory Default: 500		200

This function is used to permit automatic restarting after Power ON, Fault Reset, and Instant Power Failure without waiting for the motor free run to stop. The speed search gain should be set after considering the inertia moment (GD^2) and magnitude of torque of the load. FU2-46 [Load Inertia] must be set at the correct value to make this function operate correctly.

FU2-22 [Speed Search Select]

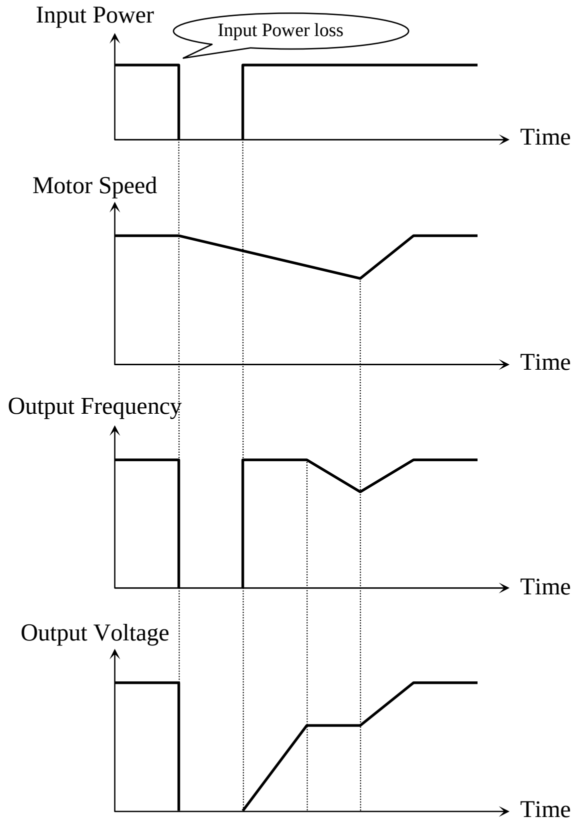
Setting Range (bit)				Description
4th	3rd	2nd	1st	
0	0	0	0	Speed search function does not work.
0	0	0	1	Speed search during Accelerating
0	0	1	0	Speed search during Restart after Fault Reset (FU2-21)
0	1	0	0	Speed search during Restart after Instant Power Failure.
1	0	0	0	Speed search during Power ON start (FU2-20) is set to “Yes”.

When FU2-22 is set to ‘1111’, Speed Search works for all conditions.

FU2-23 [P Gain] is the proportional gain used for speed search. Set this value according to load inertia set in FU2-46.

FU2-24 [I Gain] is the Integral gain used for speed search. Set this value according to load inertia set in FU2-46.

☞ **Caution: If I gain is set too high, Overshoot may occur, leading to OV Trip. In this case, reduce I Gain value.**



[Speed Search Operation]

FU2-25: Number of Auto Retry
FU2-26: Delay Time Before Auto Retry

FU2►Retry number 25 0	25	0

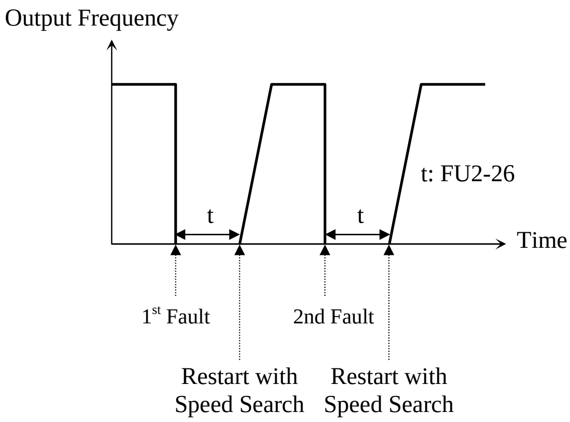
Factory Default: 0 0

FU2►Retry delay 26 1.0 sec	26	1.0

Factory Default: 1.0 sec 1.0

This function is used to allow the inverter to reset itself for a selected number of times after FU2-26 elapses when inverter is tripped. If trip more than FU2-23 occur, inverter shuts down the output and displays a trip message. If the trip persists after FU2-26, number of trip is increased and Auto restart function is disabled. For example, FU2-25 [Retry number] is 1 with FU2-26 [Retry delay] set to 10 sec, if trip persists over 10 seconds and then is reset (cleared), Auto restart is not performed. Inverter may be tripped out in Motor Free-run status when this function is issued. To avoid it, use the speed search function. Set FU2-22 to 'xx1x'. See FU2-22 ~ FU2-24.

Disabled when a low voltage (LV) trip, inverter disable (BX) or Arm short occurs.



Note: Inverter decreases the retry number by one as a fault occurs. If trip does not occur after restarting for 30 seconds, the inverter increases the retry number by one and maximum number is limited by the value set in FU2-25.

⚠ CAUTION

Particular attention must be directed to this function as motor restarts automatically after the fault is reset. Otherwise, it may result in personal damage.

FU2-40: Motor Capacity Selection
FU2-41: Number of Motor Pole
FU2-42: Rated Motor Slip
FU2-43: Rated Motor Current
FU2-44: No Load Motor Current
FU2-45: Motor Efficiency
FU2-46: Load Inertia

If users do not set these values, inverter will use factory default values.

FU2►Motor select 40 5.5kW	40	4

Factory Default: 5.5 kW 4
(This value is set automatically according to the inverter model.)

This parameter sets the motor capacity. FU2-42 [Rated Motor Slip], FU2-43 [Rated Motor Current], FU2-44 [No Load Motor Current], FU2-62 [Stator Resistance], FU2-63 [Rotor Resistance], and FU2-64 [Leakage Inductance] are automatically changed according to motor capacity.
If FU2-44 [Motor No-load Current] is not correct, run the inverter without the load in V/F mode and check the current at the constant run state and enter this value to FU2-44 [No load current].

FU2► Pole number 41 4	41	4

Factory Default: 4 4

This is used to display the motor speed. If you set this value to 2, inverter will display 3600 rpm instead of 1800rpm at 60Hz output frequency. (See motor nameplate) When motor pole number is more than 4, select an inverter one rating higher than that of the motor because motor rated current is large.

FU2► Rated-Slip 42 2.34 Hz	42	2.34

Factory Default: 2.34 Hz 2.34
(This value is set according to the motor capacity set in FU2-40)

This is used in 'Slip Compensation' control. If you set this value incorrectly, motor may stall during slip compensation control. (See motor nameplate)

FU2► Rated-Curr 43 19.7 A	43	19.7

Factory Default: 19.7 A 19.7
(This value is set according to the motor capacity set in FU2-40)

This is very importance parameter that must be set correctly. This value is referenced in many of other inverter parameters. (See motor nameplate)

FU2► Noload-Curr 44 6.6 A	44	6.6

Factory Default: 6.6 A 6.6
(This value is set according to the motor capacity set in FU2-40)

This parameter is only displayed when 'Slip Compen' is selected in FU2-60 [Control Method].

If this value is not right, check the current after operating in V/F mode without load connected and enter that current value.

Note: make sure to use correct value for FU2-44 [Motor No-load Current]. Otherwise, Sensorless performance may be degraded.

Note: Preset motor parameters may differ with user motors. In this case, enter the nameplate value of your motor to the corresponding parameters. If motor rating exceeds inverter capacity, unsatisfactory control performance may result because all other control parameters follow inverter capacity.

FU2► Efficiency 45 86 %	45	86

Factory Default: 86 % 86
(This value is set according to the motor capacity set in FU2-40)

This value is used for calculating the output wattage when FU2-72 is set to 'Watt'.

FU2►Inertia rate 46 0	46	0

Factory Default: 0 0

This parameter is used for sensorless control, Minimum Accel/Decel, Optimum Accel/Decel and Speed search. For better control performance, this value must be set correctly. Install a DB unit or regenerative converter to improve the performance.

Set '0' for loads that has load inertia less than 10 times that of motor inertia.

Set '1' for loads that have load inertia about 10 times that of motor inertia.

Motor rated slip freq [Hz]=(Rated input freq. [Hz] – (Motor rpm * P/120)
P: Number of motor poles

(Ex) In the case of 60Hz, 4 pole, 1730 rpm motor
Motor rated slip freq [Hz]= (60[Hz]-(1750[rpm] * 4/120))
=60[Hz]-58.67[Hz]=1.33[Hz]

FU2-47: Gain for Motor Speed Display

FU2► RPM factor 47 100 %	47	100

Factory Default: 100 % 100

This code is used to change the motor speed display to rotating speed (r/min) or mechanical speed (m/min). The display is calculated by following equation.

Rotating speed (r/min) = 120 * F / P,
Where, F=Output frequency, P= motor pole number

Mechanical speed (m/min) = Rotating speed * Motor RPM Display Gain [FU2-47]

FU2-48: Carrier Frequency

FU2►Carrier freq 48 5.0 kHz	48	5.0

Factory Default: 5.0 kHz 5.0

Code	LCD Display	Factory Default		Setting range
FU2-48	Carrier freq	5.5 ~ 22 kW	5 [kHz]	0.7 ~ 15 [kHz]
		30 kW		0.7 ~ 10 [kHz]
		37 ~ 75 kW	4 [kHz]	0.7 ~ 4 [kHz]
		90 ~ 280 kW	3 [kHz]	0.7 ~ 3 [kHz]

This parameter affects the audible sound of the motor, noise emission from the inverter, inverter termperature, and leakage current. If the ambient temperature where the inverter is installed is high or other equipment may be affected by potential inverter noise, set this value lower. If set above 10kHz, reduce the rated current by 5% per 1kHz. Setting Carrier freqeuncy set below 1.5 [kHz] when the FU2-60 [Control mode selection] is set to Sensorless, the control performance could be weaken.

☞ **Caution: FU2-48 [Carrier freq] setting range varies as inverter capacity.**

FU2-49: PWM Mode Selection (to reduce noise or leakage current by changing PWM method)

FU2► PWM Select 49 Normal 1	49	0

Factory Default:	Normal 1	0

Noise and leakage current can be reduced without changing carrier freqeuncy by decreasing switching cycle.

“Normal 1” is the general PWM method while “Normal 2” is the PWM method when low noise (low motor sound) is needed at motor starting. When Normal 1 is selected at motor starting, inverter changes switching frequency from low to set value. When Normal 2 is selected, inverter starts to operate at the set-value. “Low Leakage” is used to reduce Leakage current by decreasing switching cycle.

No	I/O-86,-87,-88 setting	Description
0	Normal 1	Operation via basic Carrier(switching) frequency.
1	Normal 2	Operation via fixed Carrier(switching) frequency.
2	Low Leakage	Change (Carrier)switching frequency pattern to reduce leakage current.

☞ **Caution: Reducing the Carrier frequency may increase noise.**

☞ **Caution: When 2 {Low leakage} is selected while carrier frequency is set lower than 2.0 kHz in FU2-48, FU2-48 value is automatically set to 2.0kHz.**

FU2-60: Control mode selection

FU2►Control mode 60 V/F	60	0

Factory Default:	V/F	0

Selects the control mode of the inverter

FU2-40 setting	LCD Display	Description
0	V/F	V/F Control
1	Slip compensation	Slip compensation
2	Sensorless	Sensorless vector control speed operation

◈ **V/F control:**

This parameter controls the voltage/frequency ratio constant. It is recommended to use the torque boost function when a greater starting torque is required. Related function: FU1-67~69 [Torque boost]

◈ **Slip compensation:**

This function is used to maintain constant motor speed. To keep the motor speed constant, the output frequency varies within the limit of slip frequency set in FU2-42 according to the load current. For example, when the motor speed decreases below the reference speed (frequency) due to a heavy load, the inverter increases the output frequency higher than the reference frequency to increase the motor speed. The inverter increases or decreases the output by delta frequency shown below.

Delta freq (Slip Comp. Freq.) = Motor Rated slip * (Output current - Motor No load current) / (Motor rated current - Motor No load current)
Output freq = Reference freq + Delta freq

FU2-40~46 [Motor parameters] is automatically determined by FU2-40 [Motor selection]. Most suitable motor capacity corresponding inverter capacity is set as factory setting, but the following parameters can be adjusted if necessary.

FU2-40~46 [Motor related parameters for Slip Compensation]

Code	LCD Display	Description
FU2-40	Motor select	Select motor capacity
FU2-42	Rated-Slip	Motor rated slip (Hz)
FU2-43	Rated-Curr	Motor rated current (rms)
FU2-44	Noload-Curr	Motor no load current (rms)
FU2-45	Efficiency	Motor efficiency (%)
FU2-46	Inertia rate	Motor inertia rate

Note: Incorrectly set FU2-44 [Motor No-load Current] value may weaken the Sensorless control.

◈ **Sensorless (Sensorless vector speed control) operation:**

Use it when 1) high starting torque is needed at low speed 2) load fluctuation is high 3) rapid response is needed. To use this function, set FU2-40~46 [Motor parameters] and FU2-60 [Control mode select] properly.

If not using LG 220V/440V Class motor: Set “Yes” in FU2-61 [Auto tuning] first before using this control.

Related parameters: FU2-40~46, FU2-60, FU2-62~66

Code	LCD display	Parameter
FU2-62	RS	Stator resistance
FU2-63	Lsigma	Leakage inductance
FU2-65	SL P-gain	Sensorless P gain
FU2-66	SL I-gain	Sensorless I gain

[Guide for Optimal Use of Sensorless Vector Control]

For optimal use of the sensorless control, the following conditions should be met. If one of the following conditions is not satisfied, the inverter may malfunction due to insufficient torque, irregular rotation, or excessive motor noise. In this case, it is recommended to use V/F control.

▣ Use a motor capacity that is equal to or one horsepower level lower than the inverter capacity.

▣ Two types of motor parameters can be set for one inverter, but use only one type for sensorless control.

▣ Use a LG 220V/440V(0.4kW~30kW) class motor. If other makers’ motor or a LG 220V/380V dual rating motor is used, utilize the auto tuning feature in FU2-61 [Auto tuning] before starting.

▣ Set appropriate values for the electronic thermal function, the overload limit function and the stall prevention. The set values should exceed 100% of the rated motor current.

▣ When DRV–04 [Frequency Mode] is set to “V1”, “V1S”, “I”, or “V1+I”, wiring should be conducted to eliminate potential noise influence with the frequency reference.

▣ Pole number of the motor should be 2 pole, 4 pole, or 6 pole.

▣ The distance between the inverter and the motor should not exceed 100m (328 ft).

[Cautions on Sensorless Vector Control]

▣ Forced-cooling should be used for the motor when the average operating speed is under 20Hz and more than 100% load is used constantly.

▣ Motor may rotate 0.5% faster than the maximum speed if the motor temperature does not reach normal operating temperature.

▣ Utilize the auto-tuning feature when the motor reaches normal temperature (average temperature where the motor normally operates).

▣ Output torque may be reduced when an output filter option is used between the inverter and the motor.

▣ Overcurrent trip may occur if FU2-62 [Stator resistance] is set twice more than auto-tuned value.

[Detail Tuning Method for Sensorless Vector Control]

▣ Adjust the FU2–44 [No Load Motor Current (RMS)] value larger or smaller by 5% units if the current is larger or smaller than that of V/F control under small load.

▣ Adjust the FU2–42 [Rated Motor Slip] value larger or smaller by 5% units if the speed is faster or slower than that of V/F control with rated load.

FU2-61~63: Auto tuning

FU2► Auto tuning 61 NO	61	0

Factory Default:	NO	0

All of the motor parameters can be tuned by setting “YES (1)”. Auto tuning is deactivated when “No (0)” is selected.

[Parameter display based on Inverter capacities]

Class	Inverter	Motor parameters			
		Rs	Lsigma	Ls	Tr
200V	5.5[kW]	X.XXX ohm	X.XX mH	X.XX mH	XXX ms
	7.5[kW] ~ 30[kW]	X.X mohm	X.XXX mH	X.XX mH	XXX ms
400V	5.5[kW] ~ 15[kW]	X.XXX ohm	X.XX mH	X.X mH	XXX ms
	18.5[kW] ~ 30[kW]	X.X mohm	X.XXX mH	X.XX mH	XXX ms

Note: Unit is not displayed on 7-Segment keypad.

The auto tuning function automatically measures the motor parameters needed for control selected in FU2-60 [Control mode] such as stator resistance, rotor resistance, leakage inductance, no-load current and Encoder feedback frequency.

The rated current, voltage, efficiency and slip described in the motor nameplate should be entered before performing auto tuning. If efficiency is not indicated on the nameplate, use the preset value.

.

FU2-64: Pre-excitation Time

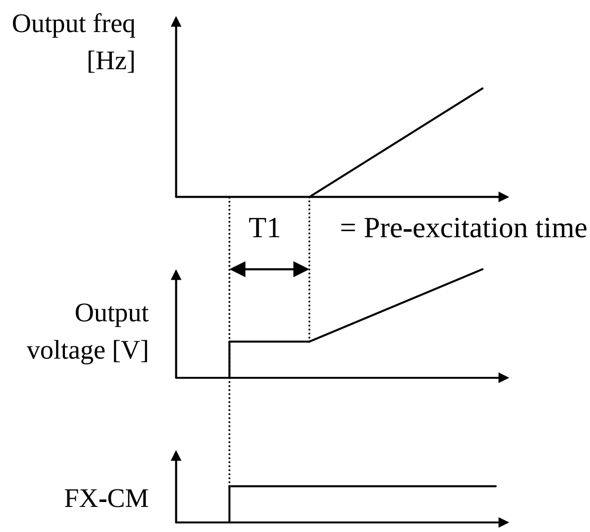
FU2► PreExTime 64 1.0 sec	64	1.0

Factory Default:	1.0 sec	1.0

When the operation command (FWD, REV) is issued, the inverter conducts pre-exciting automatically for the time specified by this parameter.

After FU2-64 [Pre-excitation Time] elapses the inverter starts normal operation shown in the following graph.

Code	LCD display	Default	Setting range
FU2-64	PreExTime	1 [sec]	0 ~ 60 [sec]



FU2-65: P Gain for Sensorless Control
FU2-66: I Gain for Sensorless Control

FU2► SL P-gain 65 1000	65	1000

Factory Default: 1000 1000

SL P-gain is the proportional gain of speed controller. If this value is set high, you can get fast speed response characteristic. However, if this value is set too high, the steady state characteristics may become unstable. Set the proper value for your application.

FU2► SL I-gain 66 100	66	100

Factory Default: 100 100

SL I-gain is the integral gain of speed controller. If this value is set low, you can get better transient response characteristic and steady state characteristic. However, if this value is set too low, there may be an overshoot in speed control.

Note: The response time of a system is affected by the load inertia. For better control performance, set the FU2-46 [Load Inertia] correctly.

FU2-67: Manual/Auto Boost Selection
FU2-68: Torque Boost in Forward Direction
FU2-69: Torque Boost in Reverse Direction

FU2►Torque boost 67 Manual	67	0

Factory Default: Manual 0

FU2► Fwd boost 68 2.0 %	68	2.0

Factory Default: 2.0 % 2.0

FU2► Rev boost 69 2.0 %	69	2.0

Factory Default: 2.0 % 2.0

This function is used to increase the starting torque at low speed by increasing the output voltage of the inverter. If the boost value is set too high than required, it may cause the motor flux to saturate, causing over-current trip. Increase the boost value when there is excessive distance between inverter and motor.

[Manual Torque Boost]

When FU2-67 [Manual/Auto torque boost select] is set to “Manual”, FU2-68 [Forward torque boost] and FU2-69 [Reverse torque boost] set values are applied. FU2-68 [Forward torque boost] is used for Forward rotation and FU2-69 [Reverse torque boost] is used for Reverse rotation.

Code	LCD display	Default	Setting range
FU2-67	Torque boost	Manual	Manual/Auto
FU2-68	Fwd boost	2.0 [%]	0~15 [%]
FU2-69	Rev boost	2.0 [%]	0~15 [%]

Note: The torque boost value is to be set as the percentage of inverter rated voltage.

Note: When FU1-40 [Volts/Hz Pattern] is set to ‘User V/F’, FU2-67~69 [Torque boost] is ignored.

Note: Do not set the torque boost too high. Otherwise, motor may be over-magnetized.

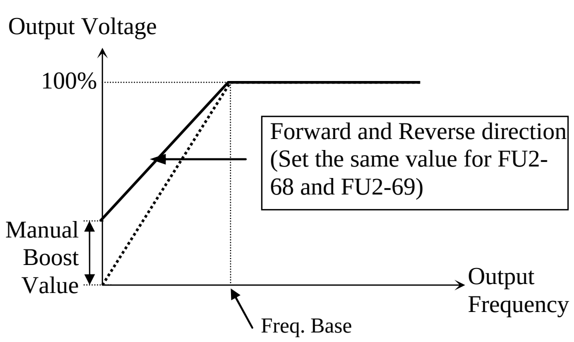
Note: Increase this value when torque shortage happens or inverter-motor wiring is distant. If this value is set too high, Overcurrent trip may be triggered.

Note: It is possible to occur No Motor Trip in case that the torque boost value is 0 when DC Start is operated.

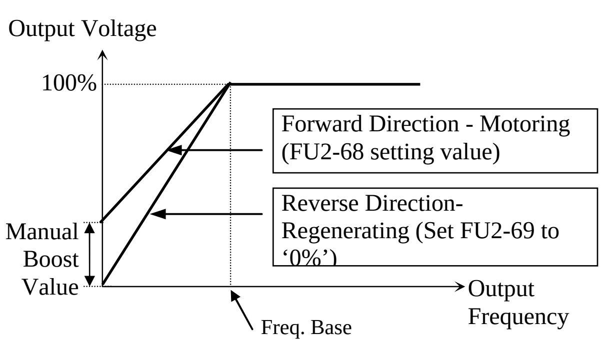
[Auto Torque Boost]

When FU2-67 [Manual/Auto torque boost select] is set to "Auto", inverter outputs high starting torque by automatic boosting according to the load characteristic.

Note: Auto torque boost is only applied to the 1st motor. Only Manual torque boost is available for the 2nd motor.
Note: Auto torque boost is not available when FU2-60 [Control Mode] is set to 'Sensorless'.
Note: Conduct Auto tuning in FU2-61 [Auto tuning] first to use Auto torque boost effectively.



[Constant Torque Loads: Conveyor, Moving Equip. etc.]



[Ascending and Descending Loads: Parking, Hoist etc.]

Related Functions: FU1-40 [Volts/Hz Pattern]
FU2-60 [Control Mode selection]

FU2-80: Power On Display

FU2►PowerOn disp 80 0	80	0
Factory Default: 0		0

This code selects the parameter to be displayed first on keypad (DRV-00) when the power is turned on.

Setting Range	Description
0	DRV-00 [Command Frequency]
1	DRV-01 [Acceleration Time]
2	DRV-02 [Deceleration Time]
3	DRV-03 [Drive Mode]
4	DRV-04 [Frequency Mode]
5	DRV-05 [Step Frequency 1]
6	DRV-06 [Step Frequency 2]
7	DRV-07 [Step Frequency 3]
8	DRV-08 [Output Current]
9	DRV-09 [Motor Speed]
10	DRV-10 [DC link Voltage
11	DRV-11 [User Display selected in FU2-73]
12	DRV-12 [Fault Display]

FU2-81: User display selection

FU2► User Disp 81 Voltage	81	0
Factory Default: 0		0

Related Function: DRV-11 [User display selection]
Select the display as shown below.

Setting	FU2-81	Name	Description
0	Voltage	Output voltage	Display output voltage of the inverter (Factory setting)
1	Watt	Output power	Display output power of the inverter

Note: The displayed value of "Watt" is approximate value.

FU2-82: Software Version

```
FU2► S/W Version
82      Ver X.X
```

82 | X.X

Factory Default: Ver. X.X   X.X

Displays the software version. This will vary depending on software version integrated.

FU2-83, 84, 85: Last Trip Time, On-time, Run-time

```
FU2►LastTripTime
83  0:00:00:00:00
```

83 | 00.00

Factory Default: 0:00:00:00:00   00.00

Displays time elapsed after last trip occurs.

Note: it is reset automatically upon trip occurs.

```
FU2►  On-time
84  0:00:00:00:00
```

84 | 00.00

Factory Default: 0:00:00:00:00   00.00

Displays time after Power is turned ON.

Note: it is not reset automatically.

```
FU2►  Run-time
85  0:00:00:00:00
```

85 | 00.00

Factory Default: 0:00:00:00:00   00.00

Displays time for inverter to be run.

Note: it is not reset automatically.

FU1-83~85 display→ X : XX : XX : XX : XX
(Year:Month:Day:Hour:Minute)

FU2-87: PowerSet

```
FU2►  PowerSet
87          100
```

87 | APP ► Jump code

Factory Default: 100%   100

Used to adjust the current inverter output power and FU1-54 [KiloWattHour].

FU2-90: Parameter Display

```
FU2►  Para. disp
90    Default
```

90 | 1

Factory Default: Default   1

It is used to change the parameters to be viewed.

No	FU2-90 Set data	Description
0	Default	Displays basic parameters. (factory default)
1	All Para	Displays all parameters.
2	Diff Para	Displays parameters set differently from factory setting.

FU2-91: Parameter Read
FU2-92: Parameter Write

```
FU2► Para. read
91  ---  No ---
```

Factory Default: No

```
FU2► Para. write
92  ---  No ---
```

Factory Default: No

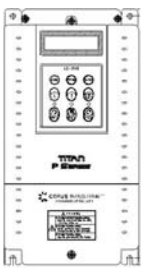
This is useful for programming multiple inverters to have same parameter settings. The LCD keypad can read (upload) the parameter settings from the inverter memory and can write (download) them to other inverters. This function is only available with LCD keypad.

Note: When FU2-91, 92 is used, motor parameters such as FU2-40~46, FU2-62~63 will be initialized. Perform Auto-tuning first before using Sensorless mode.

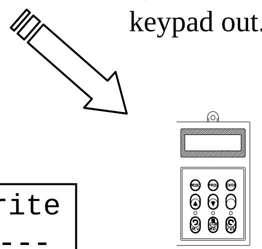
Note: Perform FU2-95 [Parameter save] first before FU2-91 [Parameter Read].

1) Set FU2-91 to “Yes” and press Enter key to read the parameters.

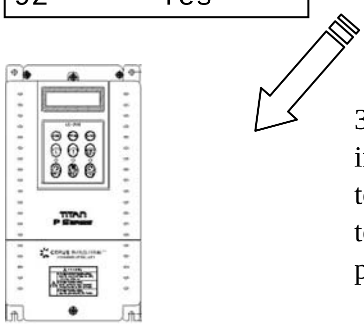
```
FU2► Para. read
91  ---  Yes ---
```



2) Take the LCD keypad out.



```
FU2► Para. write
92  ---  Yes ---
```



3) Install it to the subject inverter and set FU2-92 to “Yes” and press Enter to download the parameters.

FU2-93: Parameter Initialize

```
FU2► Para. init
93      No
```

93	0

Factory Default: No 0

This is used to initialize parameters back to the factory default values. Each parameter group can be initialized separately.

Note: Set FU2-40~46 [Motor parameters] again after this function.

Note: Parameter initialize cannot clear trip information. Instead, use FU2-06 [Erase trips].

Setting Range	Description
No	Displayed after initializing is finished.
All Groups	All parameter groups initialized to factory default value.
DRV	Only Drive group initialized.
FU1	Only Function 1 group initialized.
FU2	Only Function 2 group initialized.
I/O	Only Input/Output group initialized.
EXT	Only External group initialized.
COM	Only Communication group initialized.
APP	Only Application group initialized.

FU2-94: Parameter Lock

```
FU2► Para. lock
94          0
```

94	0

Factory Default: 0 0

This function is used to lock the parameters from being changed. When the parameters are locked, the display arrow changes from solid to dashed line. The lock and unlock code is ‘12’.

FU2-95: Parameter Save (Manual Save)

```
FU2► Para. save
95         No
```

95	0

Factory Default: 0 0

When FU2-95 is set to “Yes”, the changed parameter value is saved into memory.

FU2-99: Return Code (7-Segment Keypad)

99	1

Factory Default: 1

This code is used to exit a group when using a 7-segment keypad. After pressing **PROG/ENT** key, set the value to ‘1’ and press the **PROG/ENT** key again to exit.

6.4 Input/Output Group [I/O]

I/O-00: Jump to Desired Code

```
I/O▶ Jump code
00          1
```

Factory Default: 1

Jumping directly to any parameter code can be accomplished by entering the desired code number. This code is available only with LCD keypad.

I/O-01 ~ I/O-05: Analog Voltage Input (V1) Signal Adjustment

This is used to adjust the analog voltage input signal when the frequency is referenced by the control terminal 'V1'. This function is applied when DRV-04 is set to 'V1', 'V1S', or 'V1+I'. Reference frequency versus Analog voltage input curve can be made by four parameters of I/O-02 ~ I/O-04. User-selected Unit appears in [**]. To change the unit, more than one in APP-02 [PID operation selection] and APP-80 [Ext. PID operation selection] is set to "Yes" and then select the desired unit Percent, Bar, mBar, kPa, and Pa among in I/O-86 [V1 user unit selection].

Code	Factory Default	Setting Range
I/O-01	10 [msec]	0~9999 [msec]
I/O-02	0 [V]	0 ~ 12 [V]
I/O-03	0 [Hz]	0 ~ Max Freq
	0 [**]	0 ~ 100.00 [**]
I/O-04	10 [V]	0 ~ 12 [V]
I/O-05	60 [Hz]	0 ~ Max Freq
	0 [**]	0 ~ 100.00 [**]

```
I/O▶ V1 filter
01       10 ms
```

01 | 10

Factory Default: 10 ms   10

This is the filtering time constant for V1 signal input. Increase this value if the V1 signal is affected by noise causing unstable operation of the inverter. Increasing this value makes response time slower.

```
I/O▶ V1 volt x1
02      0.00 V
```

02 | 0.00

Factory Default: 0.00 V   0.00

This is the minimum voltage of the V1 input at which inverter outputs minimum frequency.

```
I/O▶ V1 freq y1
03       0.00 Hz
```

03 | 0.00

Factory Default: 0.00 Hz   0.00

This is the inverter output minimum frequency (or target value) when there is the minimum voltage (I/O-02) on the V1 terminal.

```
I/O▶ V1 volt x2
04       0.00 V
```

04 | 10.00

Factory Default: 10.00 V   10.00

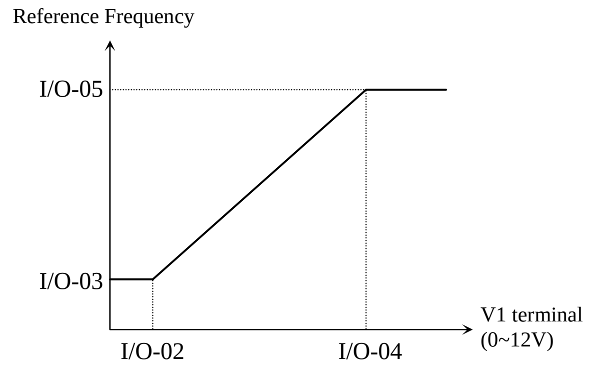
This is the maximum voltage of the V1 input at which inverter outputs maximum frequency.

```
I/O▶ V1 freq y2
05      60.00 Hz
```

05 | 60.00

Factory Default: 60.00 Hz   60.00

This is the inverter output maximum frequency (or target value) when there is the maximum voltage (I/O-03) on the V1 terminal.



[Reference Frequency vs Analog Voltage Input (0 to 12V)]

I/O-06 ~ I/O-10: Analog Current Input (I) Signal Adjustment

This is used to adjust the analog current input signal when the terminal 'I' references the frequency. This function is applied when DRV-04 is set to 'I', or V1+I'. Reference frequency versus Analog current input curve can be made by four parameters of I/O-07 ~ I/O-10. User-selected Unit appears in [**]. To change the unit, more than one in APP-02 [PID operation selection] and APP-80 [Ext. PID operation selection] is set to "Yes" and then select the desired unit Percent, Bar, mBar, kPa, and Pa among in I/O-87 [I user unit selection].

Code	Default	Setting	Code	Default	Setting
I/O-07	4 [mA]	0 ~ 20 [mA]	I/O-09	20[mA]	0 ~ 20 [mA]
I/O-08	0 [Hz]	0 ~ Max freq	I/O-10	60[Hz]	0 ~ Max freq
	0 [**]	0~100.00[**]		0 [**]	0~100.00[**]

```
I/O▶  I filter
06        10 ms
```
06 | 10

Factory Default: 10 ms 10

This is the filtering time constant for 'I' signal input. If the 'I' signal is affected by noise causing unstable operation of the inverter, increase this value. Increasing this value makes response time slower.

```
I/O▶  I curr x1
07      4.00 mA
```
07 | 4.00

Factory Default: 4.00 mA 4.00

This is the minimum current of the 'I' input at which inverter outputs minimum frequency.

```
I/O▶  I freq y1
08      0.00 Hz
```
08 | 0.00

Factory Default: 0.00 Hz 0.00

This is the inverter output minimum frequency (or target value) when there is minimum current (I/O-07) input on the 'I' terminal.

```
I/O▶  I curr x2
09     20.00 mA
```
09 | 20.00

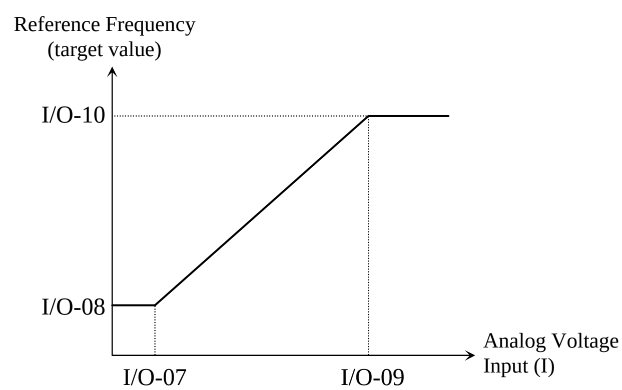
Factory Default: 20.00 mA 20.00

This is the maximum current of the 'I' input at which inverter outputs maximum frequency.

```
I/O▶  I freq y2
10     60.00 Hz
```
10 | 60.00

Factory Default: 60.00 Hz 60.00

This is the inverter output maximum frequency (or target value) when there is the maximum current input (I/O-09) on the 'I' terminal.



[Reference Frequency vs Analog Current Input (4 to 20mA)]

I/O-11~16: Frequency command setting via pulse (A0/B0)

I/O▶ P pulse set 11 (A)	11	1

Factory Default: (A) 1

I/O▶ P filter 12 10 msec	12	10

Factory Default: 10 msec 10

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I/O▶ P pulse x2 15 10.00 KHz	15	10

Factory Default: 10.0 KHz 10.0

I/O▶ P pulse y2 16 60.00 Hz	16	60.00

Factory Default: 60.00 Hz 60.00

Set the frequency command from control terminal A0 or B0. It is settable when DRV-04 [Frequency mode] is set to “Pulse”.

User-selected Unit appears in [**]. To change the unit, more than one in APP-02 [PID operation selection] and APP-80 [Ext. PID operation selection] is set to “Yes” and then select the desired unit Percent, Bar, mBar, kPa, and Pa among in I/O-88 [Pulse Input user unit selection].

Code	Factory setting	Setting range
I/O-11	(A)	(A), (A)+(B)
I/O-12	10 [msec]	0 ~ 9999 [msec]
I/O-13	0 [KHz]	0 ~ 10 [KHz]
I/O-14	0 [Hz]	0 ~ Max frequency
	0 [**]	0 ~ 100.00[**]
I/O-15	10 [KHz]	10 ~ 100 [KHz]
I/O-16	60 [Hz]	0 ~ Max frequency
	0 [**]	0 ~ 100.00[**]

Note: Do not apply pulse to both A0, B0 terminals when I/O-12 set value is A.

Pulse information

T/N	Default	Setting range
A0	A Pulse Input	High: +3~+12V Max Low: +2.5V Max Max Input Freq.: 100KHz
B0	B Pulse Input	High: +3~+12V Max Low: +2.5V Max Max Input Freq.: 100KHz

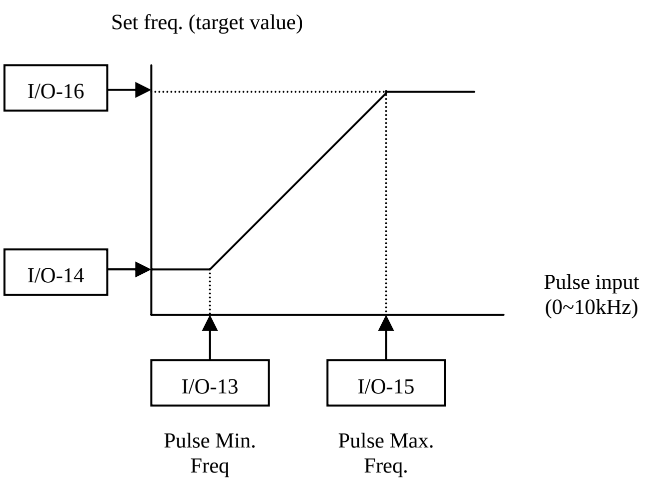
Note: Use Open Collector type encoder for Pulse input with Max. 12 V Power supply.

Code	LCD Display	Description
I/O-11	P Pulse Set	Set one of the frequency setting input method either A or A+B.
I/O-12	P filter	Set the embedded filter constant for P Pulse input.
I/O-13	P Pulse x1	Set the Minimum frequency for P Pulse input.
I/O-14	P freq y1	Set the output frequency corresponding to P Pulse input minimum frequency (I/O-13).
	P [**] y1	Set the target value corresponding to P Pulse input minimum frequency (I/O-13)
I/O-15	P Pulse x2	Set the Maximum frequency for P Pulse input.
I/O-16	P freq y2	Set the output frequency corresponding to P Pulse input Maximum frequency (I/O-15).
	P [**] y2	Set the target value corresponding to P Pulse input maximum frequency (I/O-15)

Note: Increase filter time constant when the noise interference deteriorates stable operation. Increasing that makes response time slower.
Note: When setting P Pulse Input Min/Max Freq. via motor encoder, set the value for encoder pulse as the following;

EX) To give 60Hz (1800 rpm) command from 1000 Pulse encoder

I/O-15 [Max Freq of P Pulse Input]=Rated rpm/60 sec * Number of Encoder Pulse
= 1800 [rpm]/60[sec]*1000=3000Hz,
Therefore, set I/O-15 to 3.0KHz



I/O-17, 18, 19: Criteria for Analog Input Signal Loss

```
I/O▶ Wire broken
17      None
```

17	0

Factory Default: None 0

```
I/O▶Lost command
18      None
```

18	0

Factory Default: None 0

```
I/O▶ Time out
19      1.0 sec
```

19	1.0

Factory Default: 1.0 sec 1.0

This is to set the criteria for analog input signal loss when DRV-04 [Frequency Mode] is set to 'V1', 'V1S' 'I', 'V1+I' or 'Pulse'. However, for "V1+I", main speed is V1 so inverter does not respond when I signal is missing. Following table shows the setting value.

Setting Range	Description
None	Disabled.
half of x1	The inverter determines that the frequency reference is lost when the analog input signal is less than half of the minimum set value (I/O-02, I/O-07, I/O-13).
below x1	The inverter determines that the frequency reference is lost when the analog input signal is less than the minimum set value (I/O-02 or I/O-07, I/O-13).

I/O-18 [Operating method after loss of analog freq. command] selects the operation after determining the loss of frequency reference.
The following table shows the selection in I/O-18.

Setting Range	Description
None	Continuous operating after loss of frequency reference.
FreeRun	Inverter cuts off its output after determining loss of frequency reference.
Stop	Inverter stops by its Decel pattern and Decel time after determining loss of frequency reference.

When the analog input signal is lost, inverter displays the following table.

Setting Range	Description
LOV	Loss of analog input signal, V1
LOI	Loss of analog input signal, I
LOA	Loss of pulse reference frequency

I/O-19 [Time out] sets the waiting time before determining the loss of reference signal. Inverter waits to determine the loss of a reference signal until time-out.

Reference frequency can be viewed as Rpm when DRV-16 [Hz/Rpm Display] is set to "rpm".

I/O-20~27: Programmable Digital Input Terminal 'M1, M2, M3', 'M4', 'M5', 'M6', 'M7', 'M8' Define

I/O▶ M1 define 20 Speed-L	20	0

Factory Default: Speed-L 0

I/O▶ M2 define 21 Speed-M	21	1

Factory Default: Speed-M 1

I/O▶ M3 define 22 Speed-H	22	2

Factory Default: Speed-H 2

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Programmable Digital input terminals can be defined for many different applications. The following table shows the various definitions for them.

Code	LCD display	Default	Setting
I/O-20	M1 define	SPEED-L	See the table below
I/O-21	M2 define	SPEED-M	
I/O-22	M3 define	SPEED-H	
I/O-23	M4 define	Reset	
I/O-24	M5 define	BX	
I/O-25	M6 define	JOG	
I/O-26	M7 define	FX	
I/O-27	M8 define	RX	

Note: BX is Emergency Stop key. Parameter setting is disabled when BX is ON.

Selection of M1, M2, M3 M4, M5, M6, M7, M8 in I/O-20~27

Setting Range	Description
Speed-L	Multi-step speed - Low
Speed-M	Multi-step speed - Mid
Speed-H	Multi-step speed - High
XCEL-L	Multi-accel/decel - Low
XCEL-M	Multi-accel/decel - Mid
XCEL-H	Multi-accel/decel - High
Dc-brake	DC injection braking during stop
2nd Func	Exchange to 2nd functions
Exchange	Exchange to commercial line
-Reserved-	Reserved for future use
Up	Up drive
Down	Down drive
3-Wire	3 wire operation
Ext Trip	External trip
Pre-heat	Motor Pre-heat function
iTerm Clear	Used for PID control
Open-loop	Exchange between PID mode and V/F mode
LOC/REM	Exchange between Drv-03, 04 and Drv-91, 92
Analog hold	Hold the analog input signal
XCEL stop	Disable Accel and Decel
P Gain2	Used for PID control
-Reserved-	Reserved for future use
Interlock1	Used for MMC operation
Interlock2	
Interlock3	
Interlock4	
Speed-X	Additional Step frequency selection
Reset	Reset
BX	BX (Emergency stop)
JOG	Jog
FX	Forward Run/Stop
RX	Reverse Run/Stop
Ana Change	Analog input Switch-over
Pre excite	Pre excitation.
Ext.PID Run	External PID Run/Stop

I/O-28: Terminal Input Status

I/O▶ In status 28 00000000000	28	0000

Factory Default: 00000000000 0000

This code displays the input status of control terminals M1-M8, P4-P6. P4, P5, P6 will be only displayed and used when the sub-board is installed.

[LCD Keypad Display]

Input T/M	P6	P5	P4	M8	M7	M6	M5	M4	M3	M2	M1
	10 bit	**9 bit**	**8 bit**	**7 bit**	**6 bit**	**5 bit**	**4 bit**	**3 bit**	**2 bit**	**1 bit**	**0 bit**
OFF status	0	0	0	0	0	0	0	0	0	0	0
ON status	1	1	1	1	1	1	1	1	1	1	1

I/O-29: Programmable Digital Input Terminal filter time constant

I/O▶ Ti Filt Num 29 15 ms	29	15

Factory Default: 15 ms 15

Set the responsiveness of input terminals M1-M8 and P4-P6. It is effective when noise level is high. Increasing this will make response time slower and decreasing faster.

Note: Set it higher than 100msec at Inverter-commercial line exchange operation. This will be useful to prevent chattering and momentary malfunction.

I/O-30: Jog Frequency

I/O▶ Jog freq 30 10.00 Hz	30	10.00

Factory Default: 10.00 Hz 10.00

This code sets the jog frequency. See I/O-31~42, DRV-05~ 07 for details.

I/O-31~42: Step Frequency 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

I/O▶ Step freq-4 31 40.00 Hz	31	40.00

Factory Default: 40.00 Hz 40.00

I/O▶ Step freq-5 32 50.00 Hz	32	50.00

Factory Default: 50.00 Hz 50.00

□
□
□

[Speed-L, Speed-M, Speed-H, Speed-X]
By setting M1, M2, M3 terminals to 'Speed-L', 'Speed-M' and 'Speed-H' respectively, inverter can operate at the preset frequency set in DRV-05 ~ DRV-07 and I/O-20 ~ I/O-27.

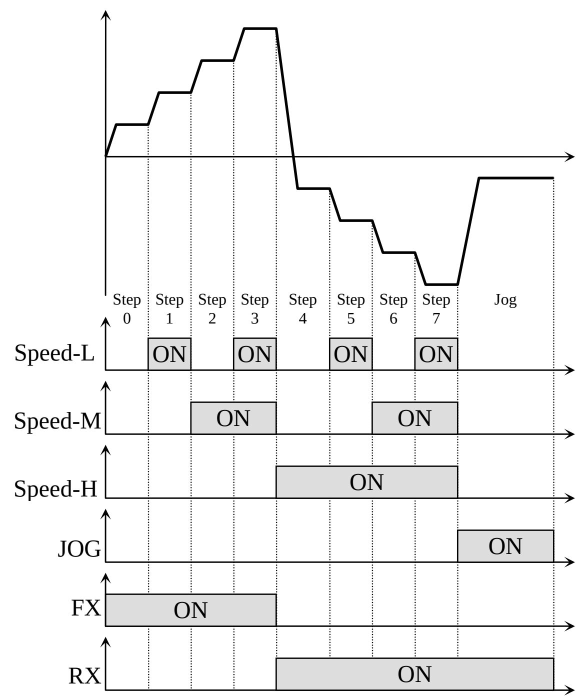
The step frequencies are determined by the combination of M1, M2 and M3 terminals as shown in the following table.

Code	Step speed Frequency	Spd-X	Spd-H	Spd-M	Spd-L	JOG
DRV-00	S. Freq-0 (Zero Spd)	0	0	0	0	0
I/O-30	Jog Freq	X	X	X	X	X
DRV-05	S. Freq-1 (Spd 1)	0	0	0	1	0
DRV-06	S. Freq-2 (Spd 2)	0	0	1	0	0
DRV-07	S. Freq-3 (Spd-3)	0	0	1	1	0
I/O-31	S. Freq-4 (Spd-4)	0	1	0	0	0
I/O-32	S. Freq-5 (Spd-5)	0	1	0	1	0
I/O-33	S. Freq-6 (Spd-6)	0	1	1	0	0
I/O-34	S. Freq-7 (Spd-7)	0	1	1	1	0
I/O-35	S. Freq-8 (Spd-8)	1	0	0	0	0
I/O-36	S. Freq-9 (Spd-9)	1	0	0	1	0
I/O-37	S. Freq-10 (Spd-10)	1	0	1	0	0
I/O-38	S. Freq-11 (Spd-11)	1	0	1	1	0
I/O-39	S. Freq-12 (Spd-12)	1	1	0	0	0
I/O-40	S. Freq-13 (Spd-13)	1	1	0	1	0
I/O-41	S. Freq-14 (Spd-14)	1	1	1	0	0
I/O-42	S. Freq-15 (Spd-15)	1	1	1	1	0

0: OFF, 1: ON, X: Ignored (Jog first)
Speed-L: Lowest bit in Multi-Step speed input
Speed-M: Middle bit in Multi-Step speed input
Speed-H: High bit in Multi-Step speed input
Speed-X: Highest bit in Multi-Step speed input
Note 1: 'Speed 0' is set in DRV-04.
Note 2: If the 'Jog' terminal is ON, inverter operates at Jog frequency regardless of other terminal inputs.

DRV-04 Data	DRV-00 Speed 0	Freq source
Keypad-1	Digital Freq Ref	Keypad
Keypad-2	Digital Freq Ref	Keypad
V1	Analog Freq Ref.	Terminal
V1S	Analog Freq Ref.	Terminal
I	Analog Freq Ref.	Terminal
V1+I	Analog Freq Ref.	Terminal
Pulse	Pulse Freq Ref.	Terminal
Int. 485	Communication	Terminal
Ext. PID	Ext. PID Freq Ref.	Keypad or Terminal

♣ Setting example
M1=Speed-L, M2=Speed-M, M3=Speed-H, M4=Jog
M5=BX, M7=FX, M8=RX
Step speed is to be set in DRV-05~06, I/O-31~42



[Multi-Step Frequency Operation]

I/O-50~63: 1st~7th Accel/Decel Time

I/O► Acc time-1 50 20.0 sec	50	20.0

Factory Default:	20.0 sec	20.0

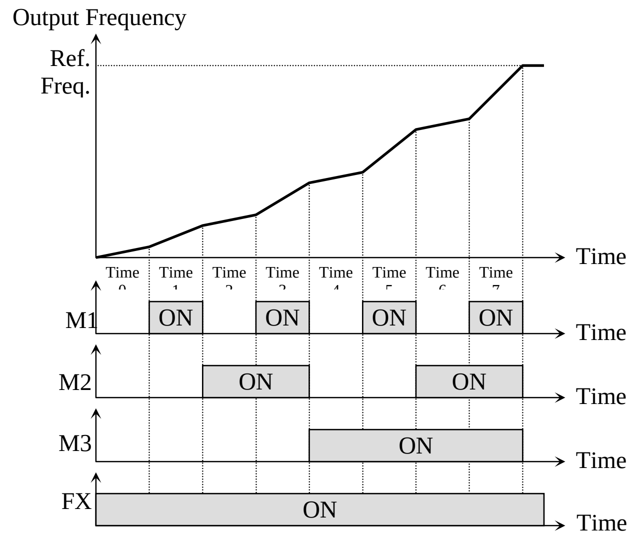
I/O► Dec time-1 51 20.0 sec	51	20.0

Factory Default:	20.0 sec	20.0

[XCEL-L, XCEL-M, XCEL-H]
By setting M1, M2 and M3 terminals to ‘XCEL-L’, ‘XCEL-M’ and ‘XCEL-H’ respectively, up to 8 different Accel and Decel times can be used. The Accel/Decel time is set in DRV-01 ~ DRV-02 and I/O-50 ~ I/O-63.
The Accel/Decel time is determined by the combination of M1, M2 and M3 terminals as shown in the following table.

Parameter Code	Accel/Decel Time	XCEL-H (M3)	XCEL-M (M2)	XCEL-L (M1)
DRV-01	Accel Time-0	0	0	0
DRV-02	Decel Time-0			
I/O-50	Accel Time-1	0	0	1
I/O-51	Decel Time-1			
I/O-52	Accel Time-2	0	1	0
I/O-53	Decel Time-2			
I/O-54	Accel Time-3	0	1	1
I/O-55	Decel Time-3			
I/O-56	Accel Time-4	1	0	0
I/O-57	Decel Time-4			
I/O-58	Accel Time-5	1	0	1
I/O-59	Decel Time-5			
I/O-60	Accel Time-6	1	1	0
I/O-61	Decel Time-6			
I/O-62	Accel Time-7	1	1	1
I/O-63	Decel Time-7			

0: OFF, 1: ON



[Multi-Accel/Decel Time Operation]

[Dc-brake]
DC Injection Braking can be activated during inverter stop by configuring one of the Programmable digital input terminals (M1-M8) to ‘Dc-bake’. The preset DC-start value in FU1-22 is applied. To activate the DC Injection Braking, close the contact of the assigned terminal while the inverter is stopped.

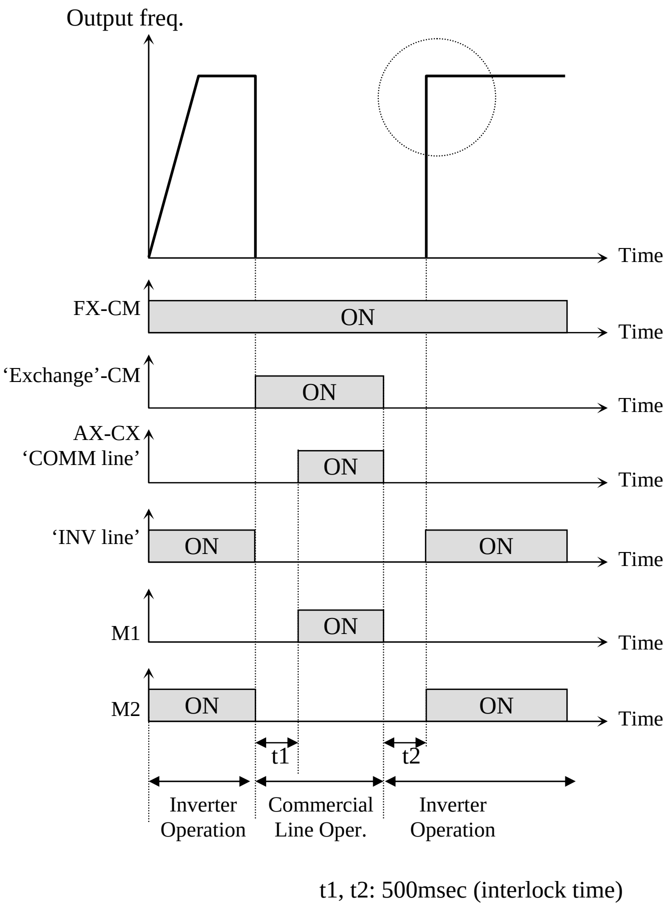
[2nd function]
See APP 20~29 for details.

[EXCHANGE]

Exchange is used to bypass the motor from the inverter line to commercial power or the opposite. To bypass the motor to commercial line, set the ‘Exchange’ function in one of the Programmable digital input terminal in I/O-20~27 and ‘INV line’, ‘COMM line’ function in Programmable digital output terminal(AX-CX) in I/O-76~79.
Speed search function (FU2-22) is activated automatically during exchanging operation, enabling smooth exchange.

The following 3 setting should be made to activate this function;
1) Set one of the Programmable digital input terminal (I/O-20~27) to 8 “Exchange.”
2) Set one of the Programmable digital (Aux. Contact) Output terminal to 16 “INV line.”
3) Set one of the Programmable digital (Aux. Contact) Output terminal to 17 “COMM line.”

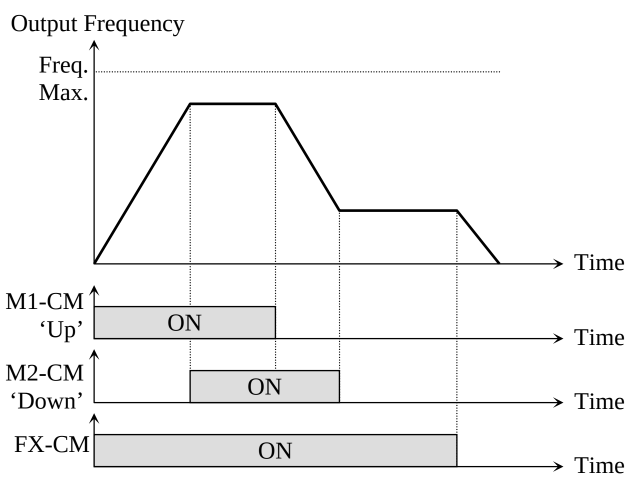
Note: I/O-29 [Filtering Time Constant for Programmable Digital Input Terminals] must be set to more than 100 [msec] to prevent chattering and momentary malfunction during this function.



[Exchanging Sequence]

[Up, Down]

By using the Up and Down function, the drive can accelerate to a steady speed and decelerate down to a desired speed by using only two input terminals. Setting limit is Maximum frequency.

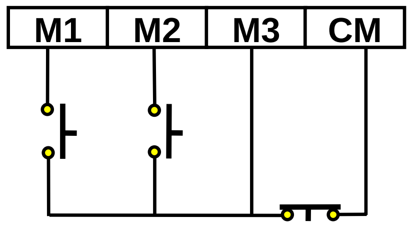


[Up/Down Operation]

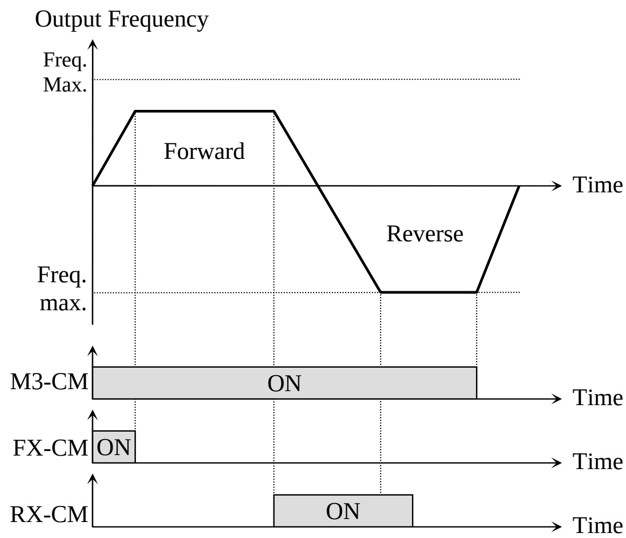
[3-Wire]

This function is for 3-wire start/stop control.

This function is mainly used with a momentary push button to hold the current frequency output during acceleration or deceleration.



[Wiring for 3-Wire Operation, M3 set to '3-Wire']



[3-Wire Operation]

[Ext Trip]

This is a normally open contact input. When a terminal set to 'Ext Trip' is ON, inverter cuts off its output and displays the fault. This can be used as an external latch trip. The logic is programmable in I/O-94 [Normal Open/Normal Close select].

[iTerm Clear]

This function is used for PID control. When this terminal is ON, the accumulated value by I-Gain is set to '0'. Refer to PID Control Block Diagram.

[Open-loop]

This is used to exchange the control mode of inverter from PID mode (Close Loop) to V/F mode (Open Loop).

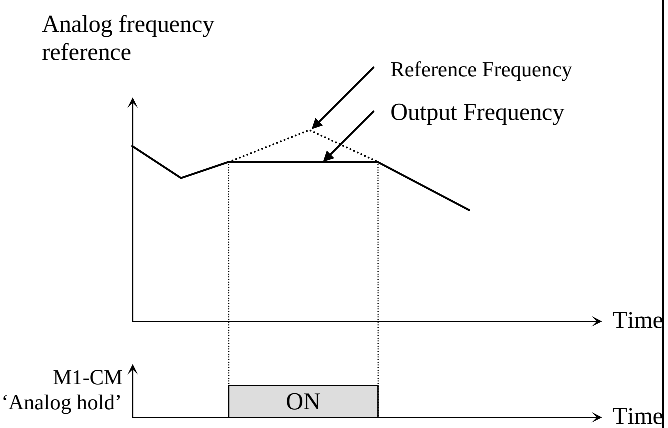
DRV-03 [Drive Mode] and DRV-04 [Frequency Mode] are applied when the mode has been changed.

Note: Only used when the inverter is stopped.

[Main-drive]
When an option board or embeded RS485 communication is used for the frequency setting and the run/stop command setting, and the setting is ON, the inverter operation can be changed to Option (or RS485) operation without changing parameters.
The set values in DRV-92 [Frequency Mode 2] and DRV-91 [Drive Mode 2] are applied to the Option (or RS485) operation.

Note: To switch to RS485 communication operation during Main-drive operation, Stop the inverter first and disable Main-drive and connect RS485 communication.

[Analog hold]
When there is an analog input signal for frequency reference and 'Analog hold' terminal is ON, inverter fixes its output frequency regardless of the frequency reference. When the terminal is OFF, the actual frequency reference will be applied.
This function is useful when a system requires constant speed after acceleration or freq reference is not necessary to be changed.



[Analog hold Operation]

[XCEL stop]
Inverter stops accelerating and decelerating when this terminal is ON.

[P Gain 2]
This function is used to change P-Gain during PID operation. When this terminal is ON, PID controller changes P-Gain to PID P2-Gain.
Refer to PID Control Block Diagram.

[Interlock 1, 2, 3, 4]
This function is used for MMC operation. When MMC is selected in APP-01 and interlock is set, M1, M2, M3 and M4 are automatically assigned for Interlock function. Therefore, these terminals cannot be used for setting other functions when interlock is active. Use M5, M6, M7, and M8 for other function setting. Refer to MMC operation.

[Reset]
This function is set to use it as fault reset terminal when ON.

[BX]
This function is set to use it as Emergency Stop terminal when ON.

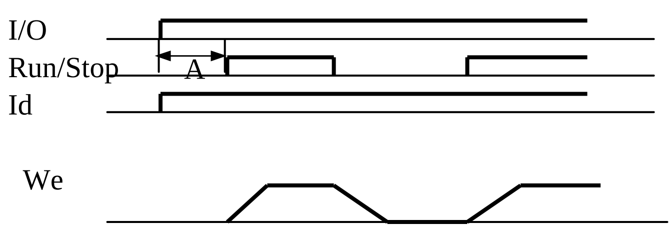
[JOG]
This function is set to use Jog operation terminal when ON.

[FX/RX]
This function is set to issue Forward/Reverse Run.

[Ana Change]
Inverter changes its frequency reference source from V1 to I when ON.

Ex) In the case of V1+I operation, V1 is the default setting and it is changed to I operation when the terminal is turned ON.

[Pre excite]
This setting switches the inverter to pre-excition state. This function applies the DC magnetizing current to a motor to build the flux in Sensorless control. When the operation command is set to ON, the state changes from pre-excitation to normal.



A: Pre-excitating

[Ext.PID Run]
External PID controller begins operation when the defined terminal is turned ON. This can be operated regardless of inverter reference command or used in conjunction with internal PID operation. Refer to External PID operation for details.

I/O-70~73: S0, S1 terminal select

I/O► S0 mode 70 Frequency	70	0
Factory Default: Frequency		0
I/O► S0 adjust 71 100 %	71	100
Factory Default: 100 %		100
I/O► S1 mode 72 Frequency	72	0
Factory Default: Frequency		0
I/O► S1 adjust 73 100 %	73	100
Factory Default: 100 %		100

Analog meter displays the inverter output Frequency, Current, Voltage, DC link voltage and External PID output with pulse signals on the S0, S1 terminal. The average output voltage range is 0V to 10V. I/O-71, 73 are used to adjust the S0, S1 output gain value.

[Frequency]
S0/S1 terminal outputs inverter output frequency. The output value is determined by,
S0/S1 Output Voltage = (Output freq. / Max. freq.) × 10V ×(IO-71 or 73)/ 100

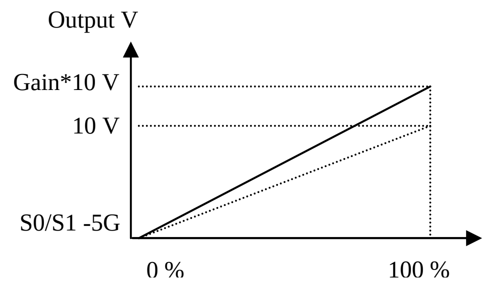
[Current]
S0/S1 terminal outputs inverter output current. The output value is determined by,
S0/S1 Output Voltage = (Output current / Rated current) × 10V × (IO-71 or 73)/ 100

[Voltage]
S0/S1 terminal outputs inverter output voltage. The output value is determined by,
S0/S1 Output Voltage = (Output voltage / Max. output voltage) × 10V × (IO-71 or 73)/ 100

[DC link vtg]
S0/S1 terminal outputs the DC link voltage of inverter. The output value is determined by,
S0/S1 Output Voltage = (DC link voltage/Max. DC link voltage) × 10V × (IO-71 or 73)/100

[Ext.PID Out]
S0/S1 terminal outputs External PID output. The output value is determined by,
S0/S1 output voltage= (External PID output/10000) * 10V * S0,S1 output gain(I/O-71,73) / 100

Note: Maximum DC Link Voltage for 200V class is 410V and for 400V class 820V.



I/O-74: FDT (Frequency Detection) Level
I/O-75: FDT Bandwidth

I/O► FDT freq 74 30.00 Hz	74	30.00
Factory Default: 30.00 Hz		30.00
I/O► FDT band 75 10.00 Hz	75	10.00
Factory Default: 10.00 Hz		10.00

These functions are used in I/O-76-79 [Programmable Digital Auxiliary Output Terminal]. See [FDT-#] in I/O-76~79.

Use Sub-Boards if you need to use Programmable Digital output terminal Q1, Q2, and Q3.

I/O-76~79: Programmable Digital Auxiliary Contact Output mode 1, 2, 3, 4 define (AX-CX)

I/O► Aux mode1 76 None	76	0

Factory Default:	None	0

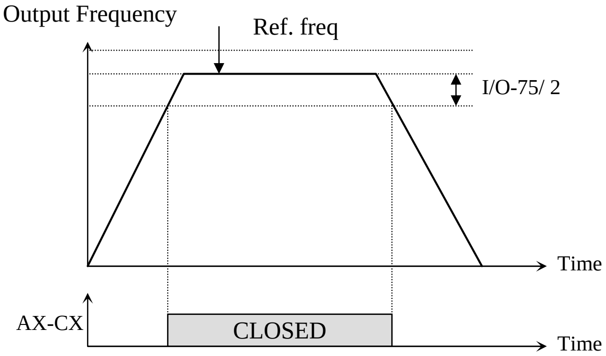
The auxiliary contact works (Close) when the defined condition has occurred.

Setting Range	Description
None	None
FDT-1	Output frequency arrival detection
FDT-2	Specific frequency level detection
FDT-3	Frequency detection with pulse
FDT-4	Frequency detection 1 with contact closure
FDT-5	Frequency detection 2 with contact closure
OL	Overload detection
IOL	Inverter overload detection
Stall	Stalling
OV	Over voltage detection
LV	Low voltage detection
OH	Inverter overheat detection
Lost Command	Lost command detection
Run	Inverter running detection
Stop	Inverter stop detection
Steady	Steady speed detection
INV line	Exchange signal outputs
COMM line	Exchange signal outputs
Ssearch	Speed search mode detection
Ready	Inverter ready detection
MMC	Used for MMC operation

[FDT-1]

When the output frequency reaches the reference frequency (target frequency), AX-CX terminal is CLOSED.

Detecting Condition: Value (Ref. Freq-Output Freq)<= Freq Detection Bandwidth (I/O-75)/2



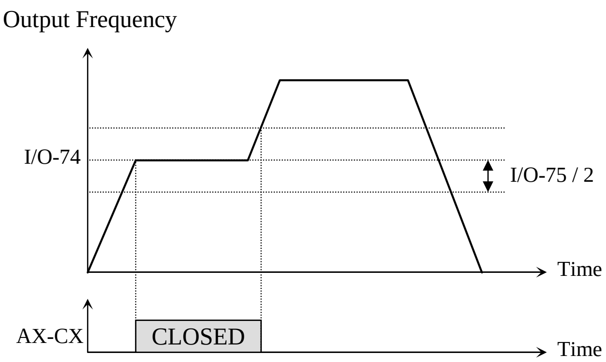
[AX-CX configured as 'FDT-1']

***AX: A1~A4, CX: C1~C4**

[FDT-2]

AX-CX is CLOSED when the reference frequency is in I/O-75 [FDT Bandwidth] centered on I/O-74 [FDT Frequency], and the output frequency reaches I/O-75 centered on I/O-74.

Detecting Condition: FDT-1 condition & (Value (Output Freq- Freq Detection)<= Freq Detection Bandwidth (I/O-75)/2)

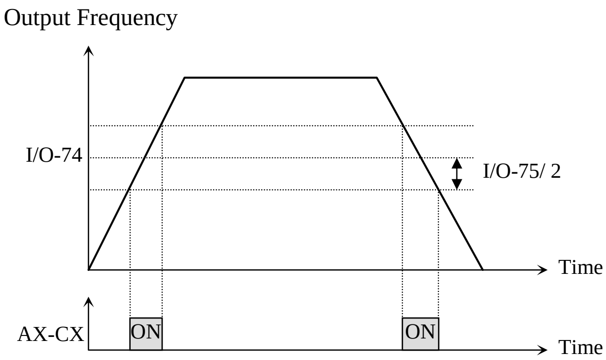


[AX-CX configured as 'FDT-2']

[FDT-3]

AX-CX is CLOSED when the output frequency reaches the band centered on the FDT frequency. The output is OPENED when the output frequency goes outside the FDT bandwidth centered on the FDT frequency.

Detecting Condition: Value (Freq Detection (I/O-74)-Output Freq)<= Freq Detection Bandwidth (I/O-75)/2



[AX-CX configured as ‘FDT-3’]

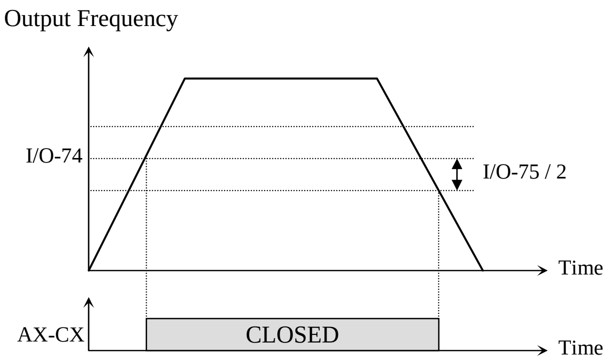
[FDT-4]

AX-CX is CLOSED when the output frequency reaches the FDT frequency. The output is OPENED when the output frequency goes below the FDT bandwidth centered on the FDT frequency.

Detecting Condition:

During Accel: Output freq >= Freq Detection

During Decel: Output freq > (Freq Detection (I/O-74) - Freq Detection Bandwidth (I/O-75)/2)



[AX-CX configured as ‘FDT-4’]

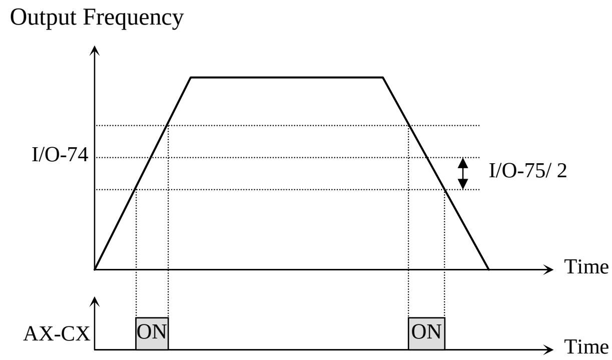
[FDT-5]

This is the inverted output of [FDT-4].

Detecting Condition:

During Accel: Output freq >= Freq Detection

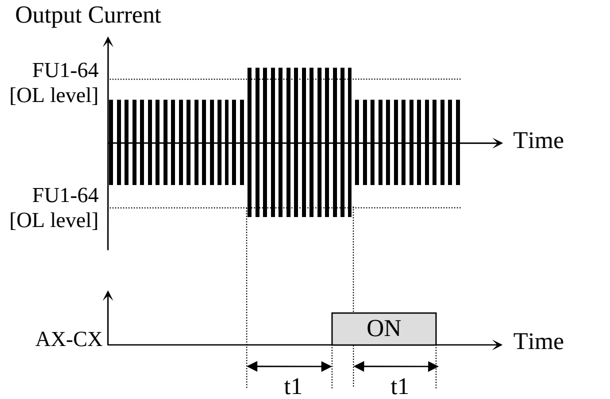
During Decel: Output freq > (Freq Detection (I/O-74) - Freq Detection Bandwidth (I/O-75)/2)



[AX-CX configured as ‘FDT-5’]

[OL]

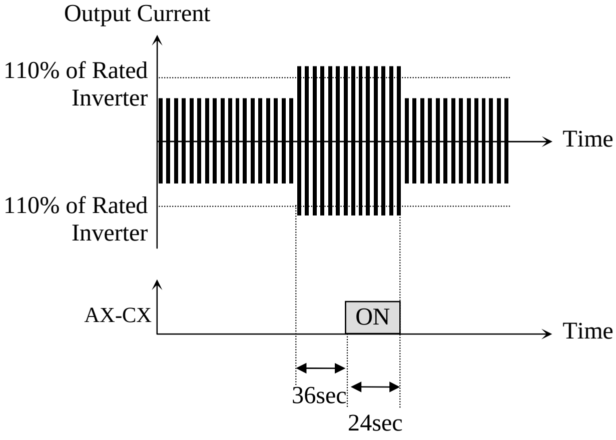
AX-CX is CLOSED when the output current has reached the FU1-64 [Overload Warning Level] for the FU1-65 [Overload Warning Time].



t1: FU1-65 [Overload Warning Time]

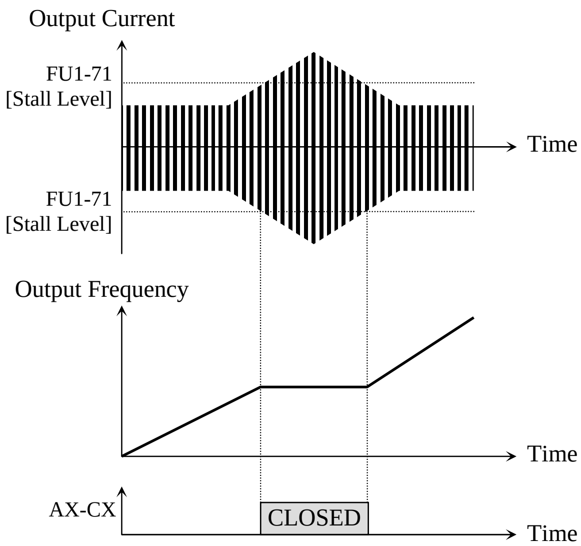
[AX-CX configured as ‘OL’]

[IOL]
AX-CX is CLOSED when the output current is above the 110% of rated inverter current for 60 seconds. If this situation is continued for one minute, the inverter will cut off its output and displays 'IOL' (Inverter overload) Trip. See the nameplate for the rated inverter current.



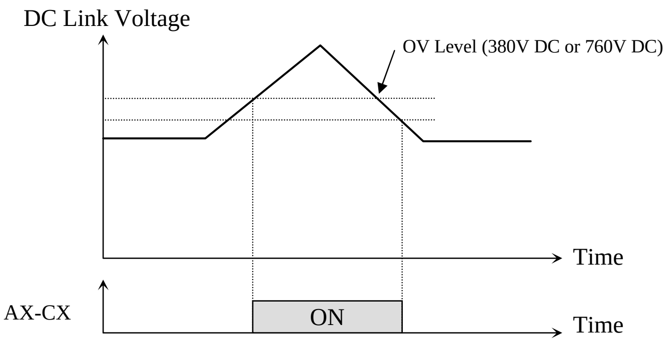
[AX-CX configured as 'IOL']

[Stall]
AX-CX is CLOSED when the inverter is on the stall prevention mode.



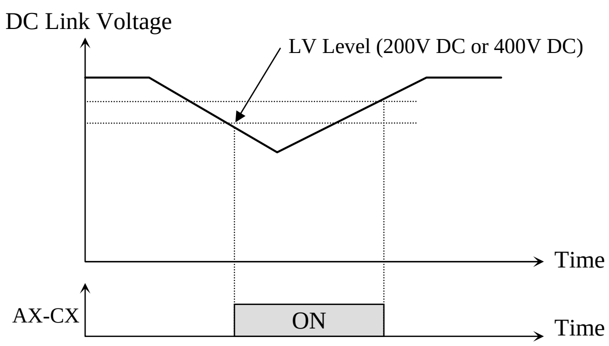
[AX-CX configured as 'Stall']

[OV]
AX-CX is CLOSED when the DC link voltage is above the Over-voltage level.



[AX-CX configured as 'OV']

[LV]
AX-CX is CLOSED when the DC link voltage is below the Low-voltage level.



[AX-CX configured as 'LV']

[OH]
AX-CX is CLOSED when the heat sink of the inverter is above the reference level.

[Lost Command]
AX-CX is CLOSED when frequency reference is lost.

[Run]
AX-CX is CLOSED when the inverter is running.

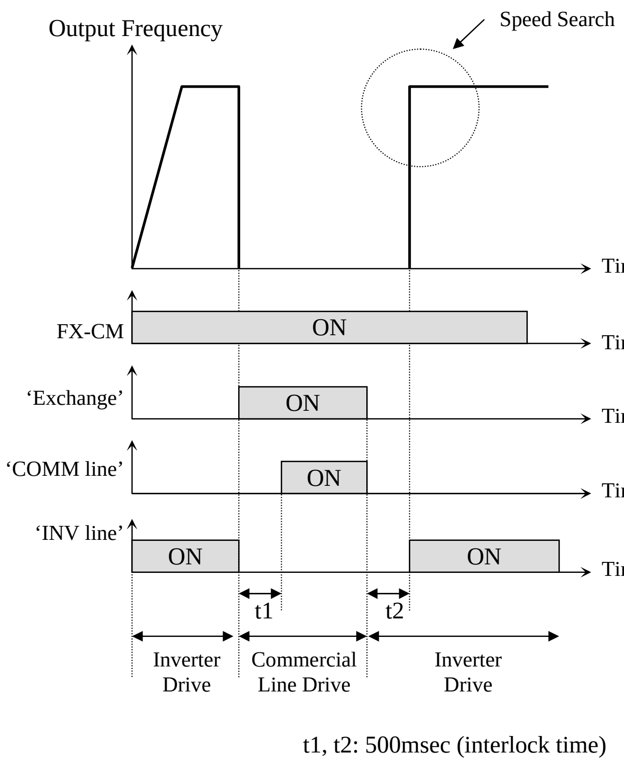
[Stop]
AX-CX is CLOSED when the inverter is stopped.

[Steady]
AX-CX is CLOSED when the inverter is running at constant speed.

[INV line, COMM line]
This function is used in conjunction with 'Exchange' function of Programmable digital input for commercial line exchange.

The following three conditions should be set:
1) Define one of the Programmable digital input terminals to "Exchange".
2) Define one of the Programmable digital output terminals to "INV line".
3) Define one of the Programmable digital output terminals to "COMM line".

Note: Set I/O-29 above 100 msec at Exchange operation. This helps to prevent chattering and momentary malfunction.



[AX-CX configured as 'COMM line', 'Exchange' and INV line']

[Ssearch]
AX-CX is CLOSED during the inverter is speed searching.

[Ready]
AX-CX is CLOSED when the inverter is ready to run.

[MMC]
Automatically set to 'MMC' when 'MMC' is selected in APP-01.

I/O-80: Fault Output Relay (3A, 3B, 3C)

I/O▶ Relay mode	80	010
80 010		
Factory Default: 010		010

This function is used to allow the fault output relay to operate when a fault occurs. The output relay terminal is 3A, 3B, 3C where 3A-3C is a normally open contact and 3B-3C is a normally closed contact.

Bit	Setting	Display	Description
Bit 1 (LV)	0	000	Fault output relay does not operate at 'Low voltage' trip.
	1	001	Fault output relay operates at 'Low voltage' trip.
Bit 2 (Trip)	0	000	Fault output relay does not operate at any fault.
	1	010	Fault output relay operates at any fault except 'Low voltage' and 'BX' (inverter disable) fault.
Bit 3 (Retry)	0	000	Fault output relay does not operate regardless of the retry number.
	1	100	Fault output relay operates when the retry number set in FU2-26 decreases to 0 by faults. Disabled while Auto retry is ON.

When several faults occurred at the same time, Bit 1 has the first priority. (Active order: Bit 1->Bit 2->bit3)

I/O-81: Terminal Output Status

I/O▶ Out status 81 00000000	81	0000

Factory Default: 00000000 0000

This code displays the output status of control terminals.

[LCD Keypad Display]

Output Terminals	3A-3C	Q3	Q2	Q1	AUX 4	AUX 3	AUX 2	AUX 1
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
OFF status	0	0	0	0	0	0	0	0
ON status	1	1	1	1	1	1	1	1

I/O-82, 83: Fault Relay On/Off Delay Time

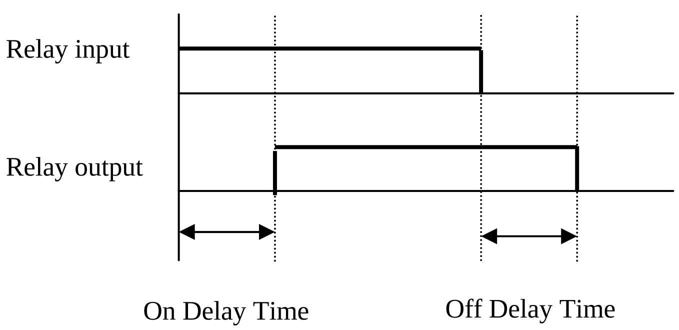
I/O▶ Relay On 82 0.0 sec	82	0.0

Factory Default: 0.0 sec 0.0

I/O▶ Relay Off 83 0.0 sec	83	0.0

Factory Default: 0.0 sec 0.0

Fault relay output is delayed for the set time and it is turned ON/OFF after the set time.



I/O-84: Cooling Fan Control Selection

I/O▶Fan Con. Sel 84 PowerOn_Fan	84	0

Factory Default: PowerOn_Fan 0

I/O-84		Description
0	PowerOn Fan	Fan ON when inverter power is ON.
1	Run Fan	Fan ON when inverter runs (outputs its frequency).
2	Temper Fan	Fan ON when inverter temp exceeds the preset value in I/O-85.

☞ **Caution: I/O-84, 85 are only available for inverters 37kW and higher.**

I/O-86, -87, -88: User Unit selection for V1, I, Pulse input (to change Analog input value display)

I/O▶ V1 Unit Sel 86 Speed	86	0

Factory Default: Speed 0

I/O▶I Unit Sel 87 Speed	87	0

Factory Default: Speed 0

I/O▶PulseUnitSel 88 Speed	88	0

Factory Default: Speed 0

No	I/O-86,-87,-88 set data	Description
0	Speed	Displayed in [Hz]. It is changed to [Rpm] when DRV-16 is set to [Rpm].
1	Percent	Flow rate, pressure and temperature are displayed in [%].
2	Bar	Pressure is displayed in [Bar].
3	mBar	Pressure is displayed in [mBar].
4	kPa	Pressure is displayed in [kPa].
5	Pa	Pressure is displayed in [Pa].

Set “Yes” in more than one code among APP-02

[PID operation selection], APP-80 [Ext. PID operation selection] and APP-62 [PID Bypass selection]. Then, set one of the desired unit among Percent, Bar, mBar, kPa, and Pa in I/O-86, 86, 88. In this case, all unit display related to inverter target frequency are changed.

When APP-02 [PID operation selection], APP-80 [Ext. PID operation selection] and APP-62 [PID Bypass selection] setting value is “0”, I/O-86, -87, -88 are initialized to Speed [Hz]. If DRV-16 is changed to [Rpm], unit display is changed from [Hz] to [Rpm].

I/O-90, 91: Inverter Number, Baud Rate
I/O-92, 93: Operation method when communication signal is lost, Communication Time Out
I/O-94: Communication Delay Time

I/O► Inv No. 90 1	90	1
Factory Default: 1		1
I/O► Baud rate 91 9600 bps	91	3
Factory Default: 9600 bps		3
I/O► COM Lost Cmd 92 None	92	0
Factory Default: None		0
I/O► COM Time Out 93 1.0 sec	93	1.0
Factory Default: 1.0 sec		1.0
I/O► Delay Time 94 5	94	5
Factory Default: 5 ms		5

I/O-90 [Inverter Number] sets the inverter ID to perform RS485 communication with PC. I/O-91 [Baud rate] sets the communication speed. To make the multi-drop system, connect the terminal C+ to other inverter’s C+ and C- to C-.
I/O-92, 93 are only displayed when DRV-03 [Drive mode] or DRV-04 [Frequency mode] is set to 4 “Int. 485”.
In this case, the LCD display shows “LOR”.
I/O-93 [Communication time out] determines whether the signal is lost.
Three types of operating method described on the table below are settable after loss of communication signal.

Setting Range	Description
None	Continuous operation after loss of communication signal.
FreeRun	Inverter cuts off its output after determining loss of communication signal.
Stop	Inverter stops by its Decel pattern and Decel time after determining communication signal.

I/O-94 setting is for communication using 232-485 converter. It should be set properly according to 232-485 converter specification.

I/O-95: Normal Open/ Normal Close select

I/O► In No/NC Set 95 00000000000	95	0000
Factory Default: 00000000000		0000

The input contact logic (Normal Open-A Contact/Normal Close-B Contact) for M1, M2, M3, M4, M5, M6, M7, M8, P4, P5 and P6 can be programmed in this code. P4, P5 and P6 are settable only with Sub-board installed.

[LCD KEYPAD DISPLAY]

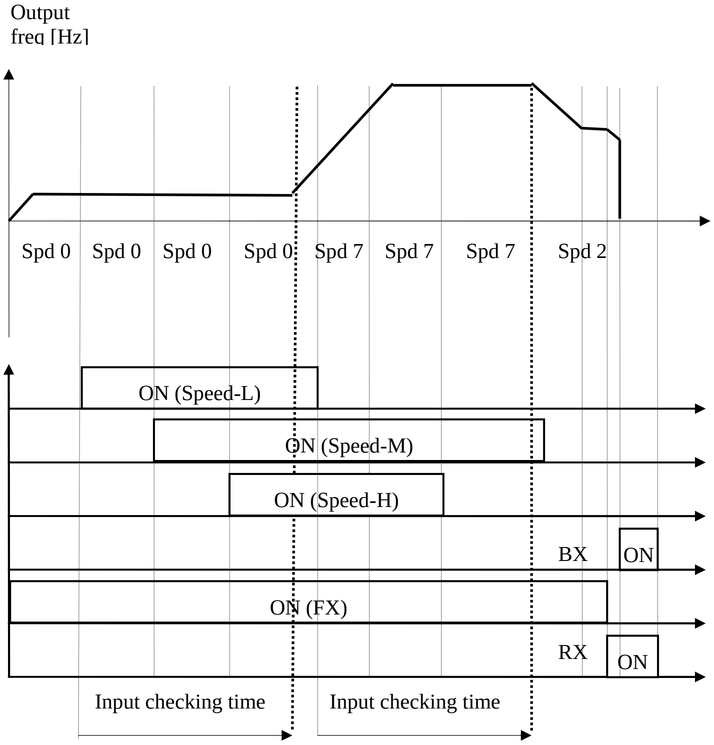
Input T/M	P6	P5	P4	M8	M7	M6	M5	M4	M3	M2	M1
	10 bit	**9 bit**	**8 bit**	**7 bit**	**6 bit**	**5 bit**	**4 bit**	**3 bit**	**2 bit**	**1 bit**	**0 bit**
0: NO 1: NC	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

I/O-96: Input Checking Time

I/O► In CheckTime 96 1 ms	96	1

Factory Default:	1 ms	1

When Multi-step speed or Multi-Accel/Decel operation is active, inverter determines the input to be valid after the I/O-95 [Input checking time] elapses.



[Input checking time]

I/O-97: Overheat Trip Selection

I/O► OH Trip Sel 97 111	97	111

Factory Default:	111	111

I/O► MO Trip Temp 98 110	98	110

Factory Default:	110 [°C]	110

Inverter Overheat protection is activated regardless of motor temp setting condition.

Code	Bit set			Function	On	Off
	3	2	1			
I/O-97			●	Motor overheat trip setting (tripped at I/O-98)	1	0
		●		-Reserved-	1	0
	●			External temperature sensor selection (PTC/ NTC)	1	0

☞ **Caution: Bit 2 is reserved for future use.**

Specification of External PTC/NTC Thermistor

Sensor	Resistance based on 25℃	Resistance by temperature	Measurable Temp range
PTC	1 kΩ(±5%)	R(T)=[1+A*(Measured temp-25)+B *(Measured temp - $25)^2$][kΩ] A=7.635X10^{-3}, B=1.371 X10^{-5}	0~125[℃]
NTC	2.545 kΩ(±5%)	See the table below for NTC resistance by temperature.	0~150[℃]

☞ **Note : Measurable temp range varies by thermal sensors. Select the sensor after checking the measurable temp range specification.**

NTC resistance according to temperature

Temp [℃]	Resistance [kΩ]	Temp [℃]	Resistance [kΩ]	Temp [℃]	Resistance [kΩ]	Temp [℃]	Resistance [kΩ]	Temp [℃]	Resistance [kΩ]	Temp [℃]	Resistance [kΩ]	Temp [℃]	Resistance [kΩ]
80	0.3562	90	0.2649	100	0.2002	110	0.1536	120	0.1195	130	0.0942	140	0.0752
81	0.3455	91	0.2574	101	0.1949	111	0.1497	121	0.1167	131	0.0921	141	0.0736
82	0.3353	92	0.2502	102	0.1897	112	0.1459	122	0.1139	132	0.0900	142	0.0720
83	0.3254	93	0.2432	103	0.1847	113	0.1423	123	0.1112	133	0.0880	143	0.0705
84	0.3158	94	0.2364	104	0.1798	114	0.1387	124	0.1085	134	0.0860	144	0.0690
85	0.3066	95	0.2299	105	0.1751	115	0.1353	125	0.1060	135	0.0841	145	0.0675
86	0.2976	96	0.2236	106	0.1705	116	0.1319	126	0.1035	136	0.0822	146	0.0661
87	0.2890	97	0.2174	107	0.1661	117	0.1287	127	0.1011	137	0.0804	147	0.0647
88	0.2807	98	0.2115	108	0.1618	118	0.1255	128	0.0987	138	0.0786	148	0.0633
89	0.2727	99	0.2058	109	0.1577	119	0.1225	129	0.0965	139	0.0769	149	0.0620
												150	0.0608

☞ **Note: Use the external NTC having the specification above and adjust I/O-98 when the temp difference between inverter and external sensor is occurred.**
☞ **Note: Overheat protection can be monitored by setting one of the I/O-76~79 [Aux mode 1, 2, 3] to "OH".**

6.5 Application group [APP]

APP-00: Jump to desired code

APP▶ Jump code	
00	1

Factory Default: 1

Jumping directly to any parameter code can be accomplished by entering the desired code number. This code is available only with LCD keypad.

APP-01: Application Mode Selection

APP▶ App. mode		01	0
01	None		

Factory Default: None 0

This code sets the application mode.

Setting Range	Description
None	Application mode is not selected.
MMC	MMC (Multi-Motor Control) mode is selected in application group. Related parameters (APP-40~71) are displayed. I/O-76~79 [Programmable digital Aux. relay output] is automatically set to "MMC." If less than 4 aux motors are connected, the remainder relays can be used for other functions.

☞ **Caution: I/O-76~79 value is not initialized automatically even though "None" is set after setting "MMC". In this case, set the I/O-76~79 again for desired selection.**

APP-02: PID Operation Selection

APP▶ Proc PI mode		02	0
02	No		

Factory Default: No 0

This function can be used for Process control like flow, pressure, and air volume control.

To use this function, set APP-02 [proc PI mode] to "Yes". PID control detects the amount of feedback from a sensor and compares it with the target value. If the values differ, this function produces an output to eliminate the deviation. In other words, this control matches the feedback amount with the target value.

For HVAC or Pump applications, the PID control can be used to adjust the actual output by comparing a feedback with a 'Set-point' given to the inverter. This 'Set-point' can be in the form of Speed, Temperature, Pressure, Flow level, etc. The 'Set-point' and the feedback signals are provided externally to the inverter analog input terminals. The inverter compares the signals in calculating 'total-error' which is reflected in the inverter output.

Note: PID control can be bypassed to manual operation temporarily by defining one of the multifunction input terminals (M1~M8, P4~P6) to "Open-loop". The inverter will change to manual operation from PID control when this terminal is ON, and change back to PID control when this terminal is OFF.

[P Control] This is to compensate the error for a system input proportionally. This is used to make the controller to respond fast for an error. When P control is used alone, the system is easily affected by an external disturbance during steady state.

[I Control] This is to compensate the error of a system integrally. This is used to compensate the steady state error by accumulating them. Using this control alone makes the system unstable.

[PI control] This control is stable in many systems. If "D control" is added, it becomes the 3rd order system. In some systems this may lead to system instability.

[D Control] Since the D control uses the variation ratio of error, it has the merit of controlling the error before the error is too large. The D control requires a large control quantity at start, but has the tendency of increasing the stability of the system. This control does not affect the steady state error directly, but increases the system gain because it has an attenuation effect on the system. As a result, the differential control component has an effect on decreasing the steady state error. Since the D control operates on the error signal, it cannot be used alone. Always use it with the P control or PI control.

Parameter setting example for PID operation

① Set APP-02 [PID operation selection] to “Yes.”

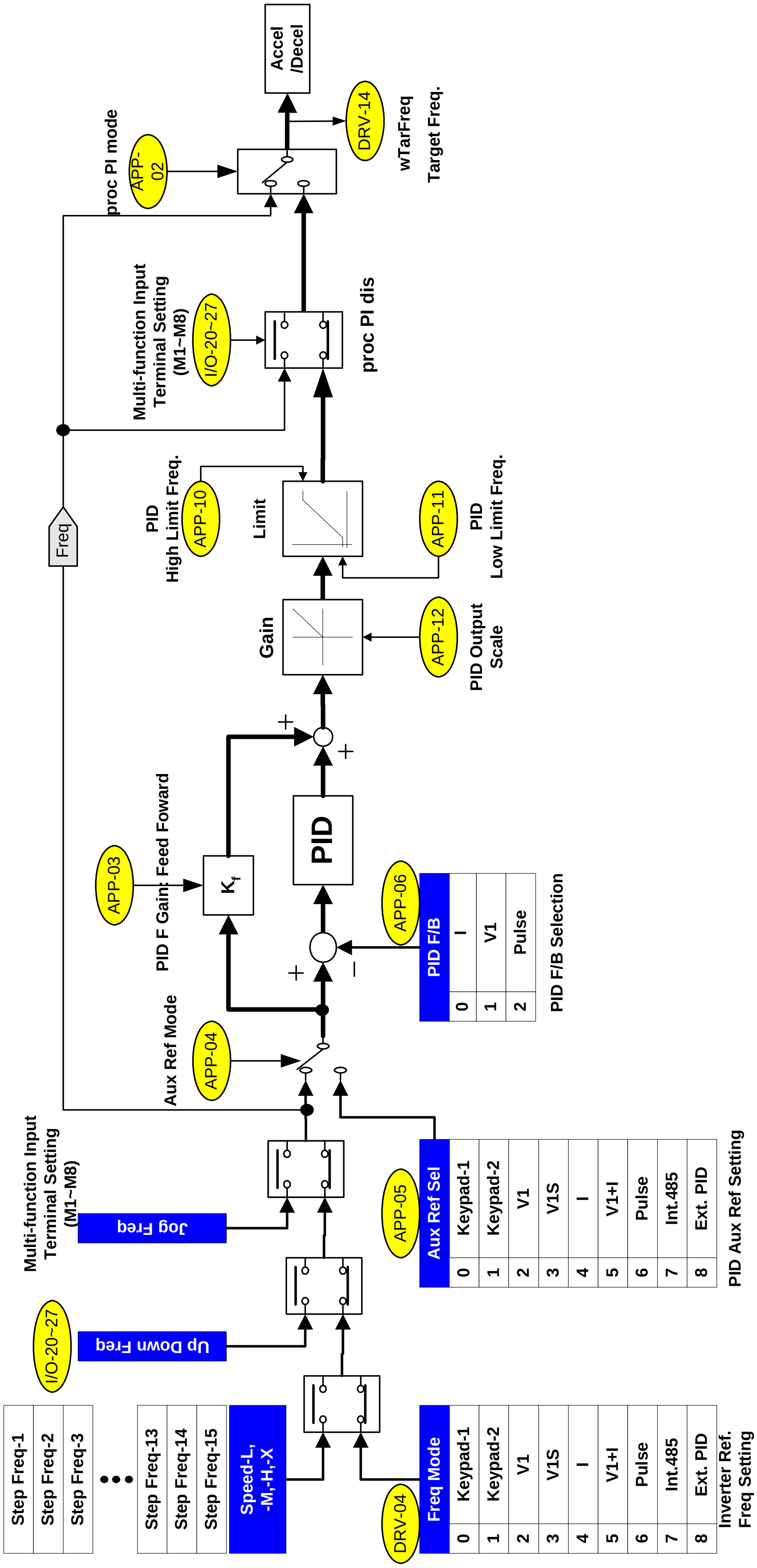
② Set APP-06 [PID feedback selection] among I, V1 and Pulse.

③ Set the unit to view feedback value in I/O-86~88 [User unit selection]. Then, all the unit related to inverter target frequency is changed.

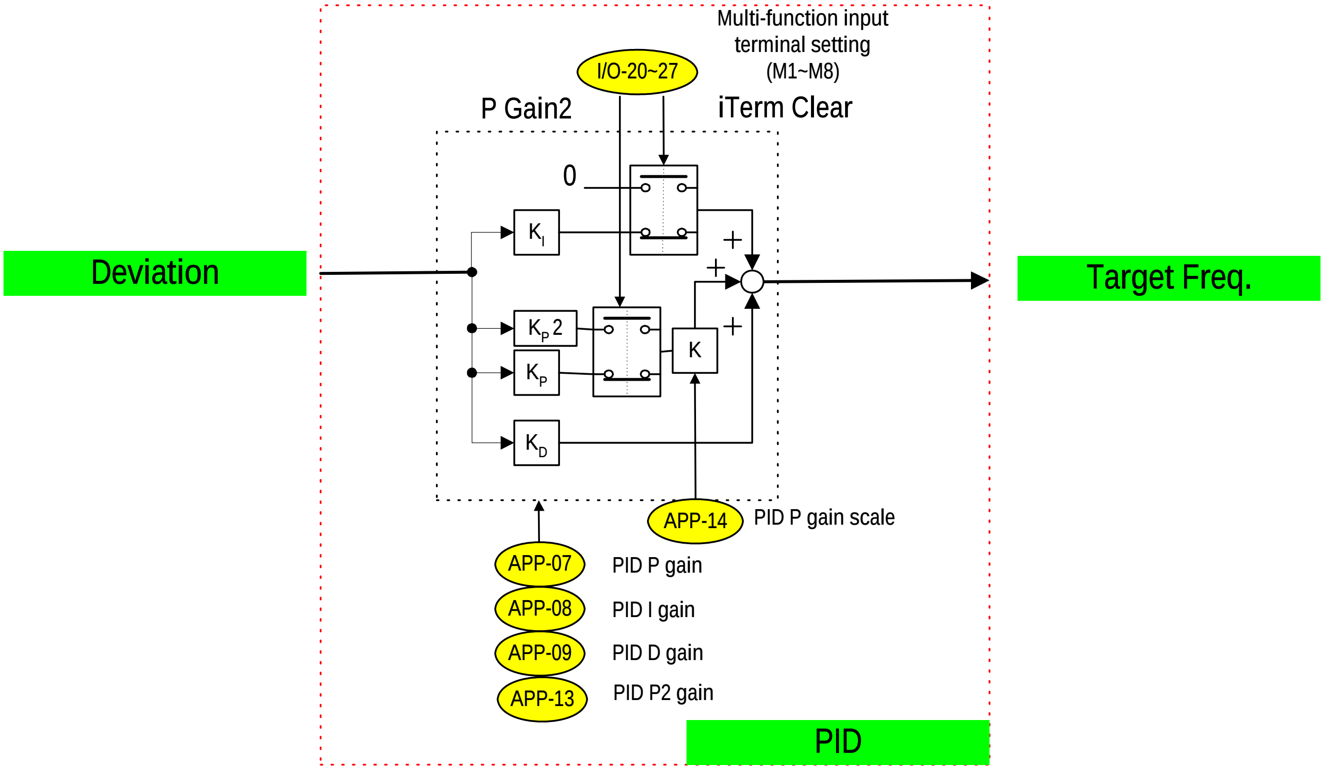
④ Set the appropriate value in APP-04~05 (Refer to the following PID block diagram).

⑤ When APP-04 is set to “No,” DRV-04 [Freq Mode] becomes PID reference. If APP-04 is set to “Yes”, the value set in APP-05 becomes PID reference. If setting one of I/O-20~27 [Programmable digital input terminal selection] to “Open loop” and tuning On/Off the selected terminal, it is decided whether DRV-04 [Freq Mode] becomes Target freq or Target freq becomes PID Output.

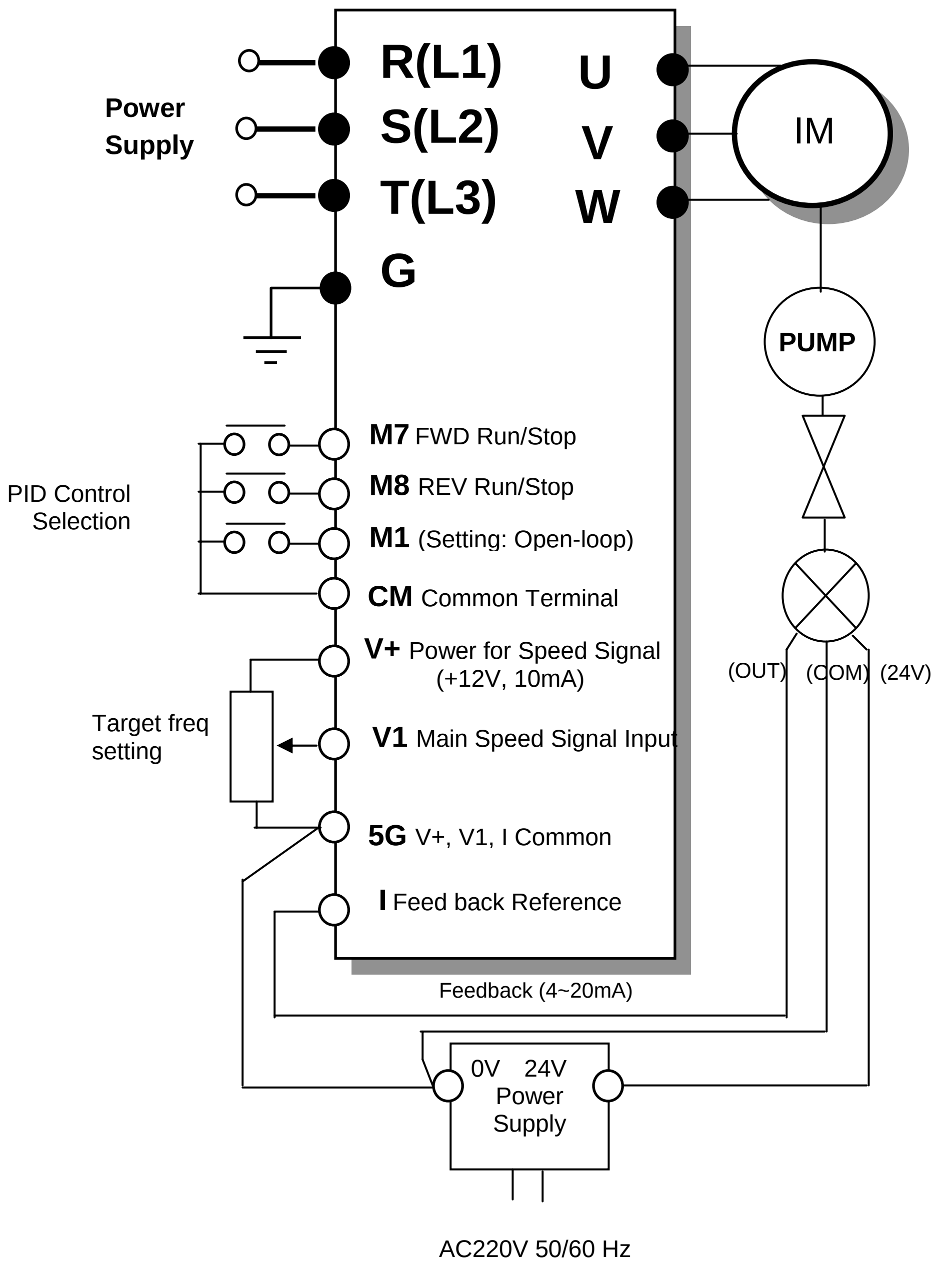
PID Block Diagram



In general, the PID output becomes inverter's "Target Freq". In this case, PID is controlling the whole system and the PID output becomes the target freq of the system and inverter is operating according to Accel/Decel Time. PID control sampling time is 10msec.



PID Wiring Example



APP-03: PID F Gain
APP-04: PID Aux. Reference Mode Selection
APP-05: PID Aux. Reference Selection

APP► PID F-Gain 03 0.0 %	03	0.0

Factory Default: 0.0% 0.0

This code sets F Gain for use in Feed Forward control.
When it is set to 100%, the responsiveness (%) of output F gain from the controller reference value is 100%. Used when fast response is needed.
Caution: Control System output may become unstable if this value is set too high.

APP►Aux Ref Mode 04 No	04	0

Factory Default: No 0

This code selects PID Aux Ref. Input Enable/Disable. See PID Block Diagram for details.

APP► Aux Ref Sel 05 V1	05	2

Factory Default: V1 2

This code sets the source of Aux reference signal.

Caution: When APP-04 is set to "No," DRV-04, Multi-step frequency, UP/DOWN, Jog frequency become PID controller's reference and when set to "Yes," PID reference is issued from the set value in APP-05 [PID Aux Reference signal selection] .

APP-06: PID Feedback Signal Selection
APP-07: P Gain for PID Control
APP-08: I Time for PID Control
APP-09: D Time for PID Control
APP-10: High Limit Frequency for PID Control
APP-11: Low Limit Frequency for PID Control

APP► PID F/B 06 I	06	0

Factory Default: I 0

Select the feedback signal for PID control. This can be set one of 'I' (4-20mA), 'V1', 'V2' and 'Pulse' according to the signal (current or voltage) and the terminal (V1 (0-10V), V2 (Sub-B board)) or Pulse (0~100kHz). Refer to I/O 6-10 for I, I/O1-5 for V1, I/O-11~16 for Pulse and EXT-6-10 [V2 Analog Ref. Freq setting] for V2.

APP► PID P-gain 07 1.0 %	07	1.0

Factory Default: 1.0 % 1.0

Set the proportional gain for PID control. When P-Gain is set at 100% and I-Time at 0.0 second, it means the PID controller output is 100% for 100% error value. P-Gain is set to 50% and I- Time to 0.0 sec, PID controller output becomes 50% for 100% error value.

APP► PID I-time 08 10.0 sec	08	10.0

Factory Default: 10.0 sec 10.0

Set the integral gain for PID control. This is the time the PID controller takes to output 100% for 100% error value. For example, when it is set to 30 sec, 30 sec is taken for PID controller to output 100% for 100% error value. 100% error means feedback value is 0 to the preset reference value.

APP► PID D-time 09 0.0 ms	09	0.0

Factory Default: 0.0 ms 0.0

Set the differential gain for PID control.

APP► PID limit-H 10 60.00 Hz	10	60.00

Factory Default:	60.00 Hz	60.00

This is the frequency upper limit at which the output frequency is limited during PID control.

APP► PID limit-L 11 0.5 Hz	11	0.5

Factory Default:	0.5 Hz	0.5

This is the frequency lower limit at which the output frequency is limited during PID control.

APP-12: PID Output Scale
APP-13: PID P2 Gain
APP-14: P Gain Scale

APP►PID Out Scale 12 100.0 %	12	100.0

Factory Default:	100.0 %	100.0

This code sets the scale of PID controller output.

APP► PID P2-gain 13 100.0 %	13	100.0

Factory Default:	100.0 %	100.0

This code sets the second P-Gain for PID control.

APP►P-gain Scale 14 100.0 %	14	100.0

Factory Default:	100.0 %	100.0

This code sets the conversion scale of P-Gain and P2-Gain.

APP► PID Out Inv. 15 No	15	0

Factory Default:	No	0

APP–15 [Output inversion] sets PID controller's output inversion.

APP► PID U Fbk 17 No	17	0

Factory Default:	NO	0

This code is useful for fan and pumps application. It converts linear pattern of a feedback sensor to the squared pattern without any setting.

PID output value can be set to '0' by setting a Programmable digital input terminals (M1 ~ M8) to 'Open loop' in I/O- I/O-20 ~ I/O-27.

The accumulated value by I-Gain can be set to '0' by setting a Programmable digital input terminal (M1 ~ M8) to 'iTerm Clear' in I/O-20 ~ I/O-27.

The P-Gain 2 can be selected for PID controller by setting a Programmable digital input (I/O-20 ~ I/O-27) to 'Open-loop'.

When APP-02 [PID operation selection] is set to "Yes," a desired display unit in I/O-86, -87, -88 [User Unit selection] is set among Speed, Percent, Bar, mBar, kPa, Pa, which affects value display of APP-06[PID feedback selection], all the parameter unit related to inverter target frequency is changed.

APP-20 ~ APP-29: 2nd Functions

APP►2nd Acc time 20 5.0 sec	20	5.0

Factory Default:	5.0 sec	5.0

APP►2nd Dec time 21 10.0 sec	21	10.0

Factory Default:	10.0 sec	10.0

These functions are displayed only when one of the multifunction inputs in codes I/O-20 to I/O-27 is set at '2nd func'.
When an inverter is controlling two motors by exchanging, different values can be set for the 2nd motor by using the multifunction input terminal. Following a cross reference table shows the 2nd functions corresponding to the 1st functions.

Description	1st Functions	2nd Functions
Acceleration time	DRV-01 [Acc. time]	APP-20 [2nd Acc time]
Deceleration time	DRV-02 [Dec. time]	APP-21 [2nd Dec time]
Base Frequency	FU1-31 [Base freq]	APP-22 [2nd BaseFreq]
Volts/Hz mode	FU1-40 [V/F Pattern]	APP-23 [2nd V/F]
Forward torque boost	FU2-68 [Fwd Boost]	APP-24 [2nd F-boost]
Reverse torque boost	FU2-69 [Rev Boost]	APP-25 [2nd R-boost]
Stall prevention level	FU1-60 [Stall Level]	APP-26 [2nd Stall]
ETH level for 1 minute	FU1-61 [ETH 1min]	APP-27 [2nd ETH 1min]
ETH level for continuous	FU1-62 [ETH cont]	APP-28 [2nd ETH cont]
Motor rated current	FU2-43 [Rated-Curr]	APP-29 [2nd R-Curr]

The 1st functions are applied if the assigned multifunction terminal is not defined as '2nd Func' nor ON. The 2nd function parameters are applied when the multifunction input terminal set to '2nd Func' is ON. Parameters not listed on the table above are same as the 1st function.

Note: Exchange the motor connection from the 1st motor to the 2nd motor or the opposite when the motor is stopped. Over voltage or over current fault may occur when the motor is exchanged during operation.

Note: The 'User V/F' function of FU1-40 [V/F Pattern] is commonly used for the 1st and the 2nd motor.

APP-40: Number of Running Auxiliary Motor Display
APP-40~APP-71: MMC Operation Control

APP► Aux Mot Run 40 0	40	0
Factory Default: 0		0

This code shows how many auxiliary motors are run by MMC control.

[MMC]: The 'PID' control should be selected in APP-02 to use this function.

♦ One inverter can control multiple motors. This function is often used when controlling the rate and pressure of flow in fans or pumps. Built-in PI controller controls a main motor after receiving process control feedback value and keeps the control value constant by connecting auxiliary motors to commercial line when needed.

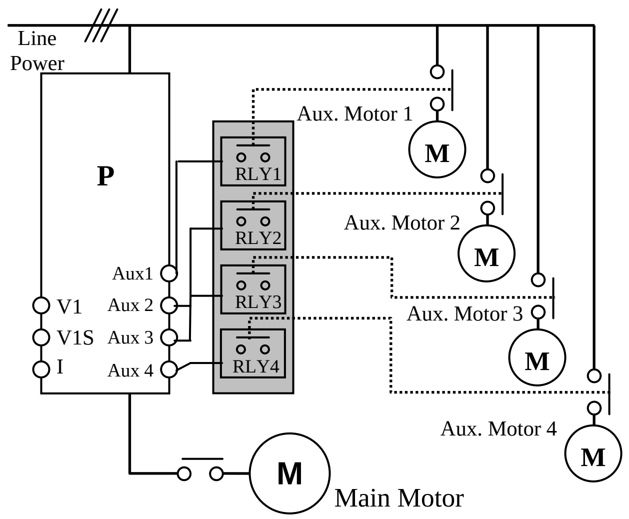
♦ In case that flow rate or flow pressure is beyond or below the reference so the main motor cannot control by itself, auxiliary motors are automatically turned on/off. Maximum four (Aux.1-4 output) auxiliary motors can be run. Each of Starting and Stop Frequency should be set for automatically running four auxiliary motors.

♦ **Auto Change** can be selected to automatically switch the order of the running motors for keeping motor run-time constant. Set mode '1' for automatic changing of auxiliary motors only and set mode '2' for automatic changing of all motors including main motor. For mode '2', APP-67/68 should be set and external sequence (Refer to APP-20~29) should be configured.

♦ Abnormal motor can be skipped from running by using the Programmable digital input terminals (M1, M2, M3, and M4). If a Programmable digital terminal (M1, M2, M3 and M4) is opened, the inverter stops all running motors and restarts operation with only normal motors except the abnormal (Off) motor. (Refer to APP-69)

♦ Sleep function is initiated when flow demand is low. Inverter stops the motor when the motor runs below Sleep Frequency after Sleep Delay Time. While in the sleep state, inverter keeps monitoring and initiates Wake-Up function when the real value (feedback) of the controlling amount has decreased below the Wake-Up level.

Note: Only one auxiliary motor can be connected with AUX terminal on control terminal strip without using MMC Option Board.



[MMC Diagram]

APP-41: Starting Auxiliary Motor Selection

APP▶ Starting Aux 41 1	41	1
Factory Default: 1		1

This code defines the starting auxiliary motor for MMC control.

APP-42: Operation Time Display on Auto Change

APP▶ Auto Op Time 42 00:00	42	00:00
Factory Default: 00:00		00:00

This code displays the operation time after Auto Change is accomplished.

APP-43: The Number of Aux. Motors

APP▶ Nbr Aux's 43 4	43	4
Factory Default: 4		4

Sets the number of auxiliary motors connected to the inverter.

APP-44~50: Start Frequency of Aux. Motor 1~7

APP▶ Start freq1 44 49.99 Hz	44	49.99
Factory Default: 49.99 Hz		49.99
APP▶ Start freq2 45 49.99 Hz	45	49.99
Factory Default: 49.99 Hz		49.99

□

□

APP▶ Start freq6 49 49.99 Hz	49	49.99
Factory Default: 49.99 Hz		49.99
APP▶ Start freq7 50 49.99 Hz	50	49.99
Factory Default: 49.99 Hz		49.99

The inverter turns on AUX1, AUX2, AUX3, and AUX4 if the output frequency is over the frequencies set in APP-44 to APP-50, respectively, the time is over APP-58 and pressure difference between reference and feedback value exceeds the value set in APP-71 [Actual Pr Diff].

APP-51~57: Stop Frequency of Aux. Motor 1~7

APP▶ Stop freq1 51 20.00 Hz	51	20.00
Factory Default: 20.00 Hz		20.00
APP▶ Stop freq2 52 20.00 Hz	52	20.00
Factory Default: 20.00 Hz		20.00

□

□

APP▶ Stop freq3 56 15.00 Hz	56	15.00
Factory Default: 15.00 Hz		15.00
APP▶ Stop freq4 57 15.00 Hz	57	15.00
Factory Default: 15.00 Hz		15.00

The inverter turns off AUX4, AUX3, AUX2 and AUX1 in this order if the output frequency is below the frequencies set in APP-51 to APP-57, respectively, the time is over APP-59 and the pressure difference between reference and feedback value decreases below the set value set in APP-71 [Actual Pr Diff].

APP-58: Delay Time before Starting Aux. Motor
APP-59: Delay Time before Stopping Aux. Motor
APP-60, 61: Accel/Decel time when the number of pumps is increasing/decreasing

APP► Aux Start DT 58 5.0 sec	58	5.0
Factory Default:	5.0 sec	5.0

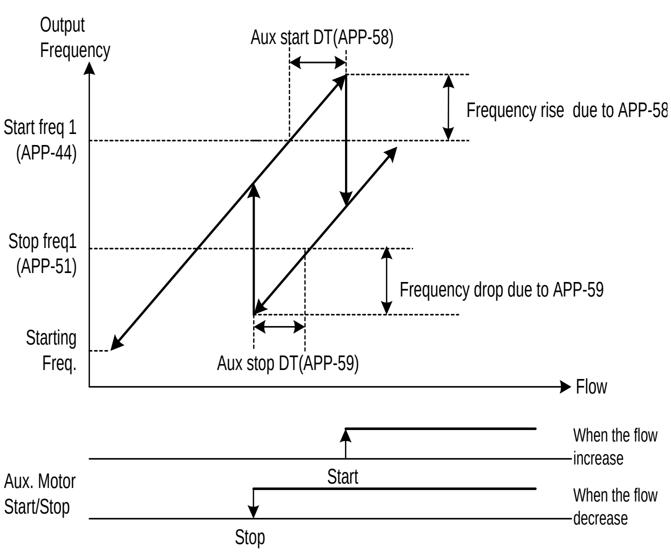
Sets the time the inverter waits before starting the auxiliary motors.

APP► Aux Stop DT 59 5.0 sec	59	5.0
Factory Default:	5.0 sec	5.0

APP►Pid AccTime 60 2.0 sec	60	2.0
Factory Default:	2.0 sec	2.0

APP►Pid DecTime 61 2.0 sec	61	2.0
Factory Default:	2.0 sec	2.0

Sets the time the inverter waits for the input before stopping the auxiliary motors.



[Aux. Motor Start/Stop with MMC]

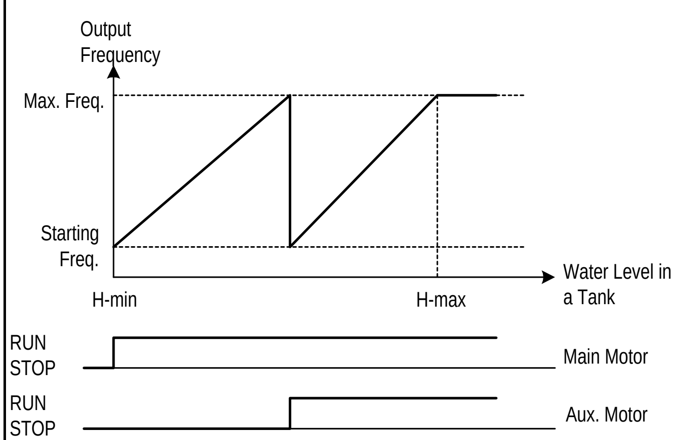
APP-60 and APP-61 sets the acceleration/ deceleration time of the Main motor by 0.1 sec when more/less aux motors are connected.

APP-62: PID Bypass Selection

APP► Regul Bypass 62 No	62	0
Factory Default:	No	0

This is used to bypass the PID operation selected in APP-02. Select this code to 'Yes' when using MMC function without PID control. The frequency is determined by actual value (feedback) of control amount instead of PID controller output. The actual value is also used as the Start/Stop reference of Aux. motors.

The following figure shows the running pattern with this function applied for controlling the flow rate of a tank. To control the flow rate proportional to the water level of a tank, divide the water level in the tank into the region for the number of Aux. motors plus one, and map each region by staring frequency to maximum frequency. The inverter increases output frequency to lower the water level in the tank when the water level in the tank rises. When reaching maximum frequency, inverter connects aux. motors connected directly to commercial line. After connecting aux. motor, inverter starts again from the starting frequency. By selecting APP-61 [Regul Bypass] to 'Yes', PID operation is disabled and Control Mode is changed to 'V/F'. PID Bypass is available only when DRV-04 [Freq. Mode] is set to 'V1', 'I' or 'Pulse'.



[PID bypass with Main motor and Aux. Motor]

To use MMC operation

A. Set MMC in APP-01
B. Set Process PI to Yes in APP-02
C. Set Pre PID operation enable/disable
a. Used for trial operation to check such as pipe damage before operation.
b. Used to know the starting set point before PID operation
c. Related Code: APP-74,75,76
D. Set PID target value input method in APP-04
a. Keypad, V1, I …
b. Set target value
E. Set PID Feedback input method in APP-06
a. Set according to sensor used.
b. Analog input (4~20mA, 0~10V …)
c. Check whether the setting performs well.
i. Pre-operation is needed.
ii. Checks whether output to feedback value is generated.
F. Set Multi-motor driving sequence in APP-66
a. Mode 0,1: Main motor and Aux motor used
i. Available motor: Main motor 1 + Aux motor 4 (+3 when Option is used)
b. Mode 2: Aux motor used
ii. Available motor: Aux motor 4 (+3 when Option is used)
G. Set the number of Aux motor in APP-43
H. Set the starting Aux motor in APP-41
I. Set the start freq of Aux motor in APP-44~50
J. Set the stop freq of Aux motor in APP-51~57
K. Start operation.

Detailed MMC function setting

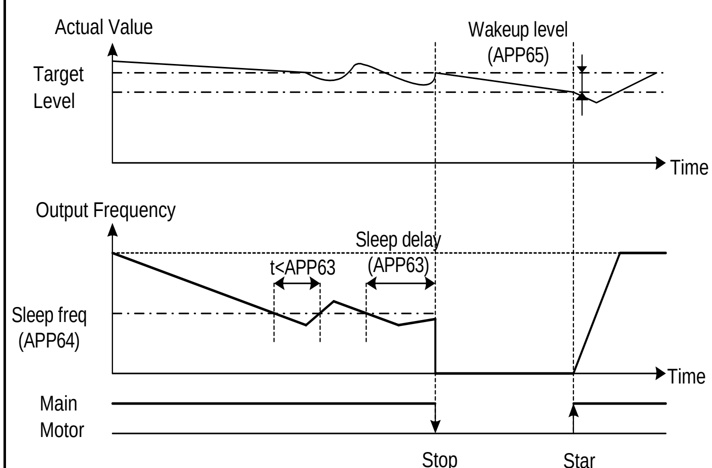
Energy-saving under light load – Sleep, Wake up
B. To easily and effectively use Process PID operation - Pre PID
C. To divide the load to the motor equally - Auto Change
D. To associate other conditions with Aux motor operation – INTERLOCK
E. Adjusting Aux motor ON/OFF condition and output (pressure, air/wind volume) variation
F. To change response characteristics
→ It is related to PID control. Refer to Process PID description.

APP-63: Sleep Delay Time
APP-64: Sleep Frequency
APP-65: Wake-Up Level

APP▶ Sleep Delay 63 60.0 sec	63	60.0
Factory Default: 60.0 sec		60.0
APP▶ Sleep Freq 64 0.00 Hz	64	0.00
Factory Default: 0.00 Hz		0.00
APP▶ WakeUp level 65 2.0 %	65	2.0
Factory Default: 2.0 %		2.0

Sleep function is initiated when flow demand is low. Inverter stops motor when the motor runs below Sleep Frequency (APP-64) during Sleep Delay Time (APP-63). While in the sleep state, the drive keeps monitoring and controlling, and initiates the Wake-Up function when the real value of the controlling amount is greatly different from the Wake-Up level (APP-65) based on Target Level.

Note: Sleep function is not operated if the Sleep Delay Time (APP-63) is set to ‘0’.



[Sleep Operation]

APP-66: Auto Change Mode Selection

APP► AutoCh_Mode 66 0	66	0
Factory Default: 0		0

This function is used to change the running order of the motors to regulate their run-time when multiple motors are connected for MMC.

[0]: Not using Auto Change Function.
The inverter is driving the main motor, and tuning the relays ON to connect Aux motors. For example, starting from the Aux motor 3, inverter turns the relays ON from **RLY3** ⇒ **RLY4** ⇒ **RLY1** ⇒ **RLY2** and turns off the aux motors oppositely from **RLY2** ⇒ **RLY1** ⇒ **RLY4** ⇒ **RLY3**.

[1]: Auto Change Function is applied only to aux. motors. On/Off sequence is the same as **Mode [0]**. However, the difference is that starting Aux motor is fixed in **Mode [0]** but it is automatically changed by inverter in **Mode [1]** to prevent a specific motor from overusing. For example, when Aux motors running order is **RLY1** ⇒ **RLY2** ⇒ **RLY3** ⇒ **RLY4** and then the Auto change condition is met, inverter turns the relay On from **RLY 2**⇒ **RLY3** ⇒ **RLY4** ⇒ **RLY1**.
→ Mode [0], [1] are available when a Main motor is directly connected to the Inverter.

[2]: Auto Change of Main/Aux motors.
All motors are connected to relays and operated via relays. The operation procedure is the same as **Mode [1]**, except that there is no main motor directly connected to Inverter.

APP-67: Auto Change Time
APP-68: Auto Change Level

APP► AutoEx-intv 67 72:00	67	72:00
Factory Default: 72:00		72:00

APP► AutoEx-level 68 20.00 Hz	68	20.00
Factory Default: 20.00 Hz		20.00

This function is used to protect motor from running alone for a long time by changing operation to other motor.

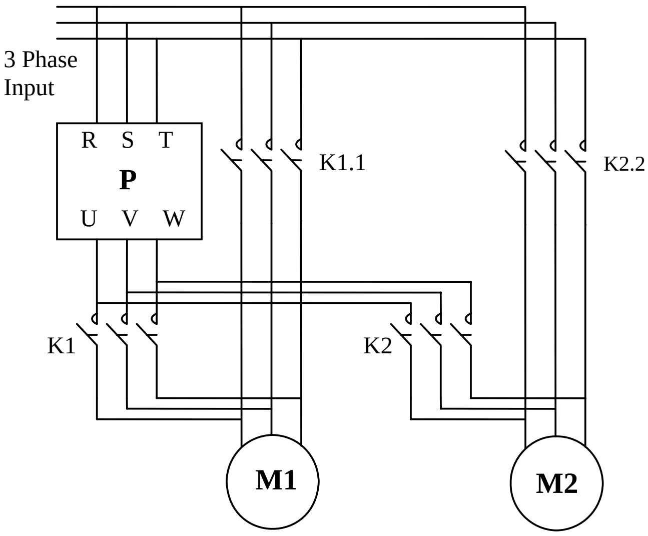
Auto Change is accomplished when the following conditions are satisfied:

1) The time set in APP-67 is over.
2) The actual value of controlling amount is less than the value set in APP-68.
3) All Aux motors Off (in **Mode 1**)
3) One motor is running (in **Mode 2**).

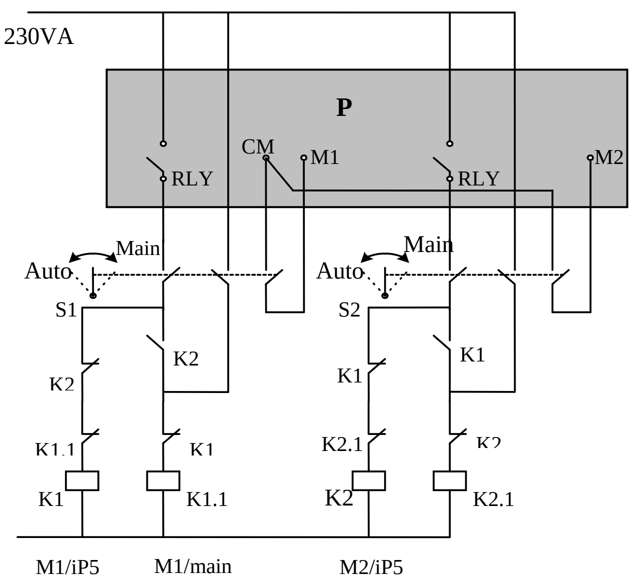
When above three conditions are met, the inverter stops the running motor, and changes motor to run by the order set in APP-66 and then continues operation according to new order. Inverter starts counting only when auxiliary motor is running.

In Mode 2, when inverter output frequency is below Auto Change Level, inverter automatically stops the motor and perform Auto change function and operates next motor.

Please refer to the wiring example below when Interlock is used during Auto change Mode 2.



[Wiring Diagram for Inter-Lock Configuration]



[Sequence Circuit for Inter-Lock Configuration]

APP-69: Interlock Selection

APP▶ Inter-lock 69 No	69	0

Factory Default:	No	0

When APP-69 [Interlock selection] is set to “Yes”, M1~M4 can be used as the same activating condition for AX1~AX4. Programmable digital input terminals are activated when turned ON. If one of them are turned Off, all motors will start running except the motor connected to the off terminal. If the input signal is turned off in the midst of running, inverter stops all the motors and restarts the operation with normal active motors.

Interlock during Stop

When Run signal is input during Stop, MMC operation is started with the Aux motors(Relays) turned ON.

Ex) When Interlock is not selected:

RLY1→RLY2→RLY3→RLY4

When Interlock is active (the terminal defined as Interlock/RLY2 is turned Off):

RLY1→ RLY3→RLY4

Interlock during RUN

When Interlock is active during RUN (the terminal defined as interlock/RLY is turned Off during RUN), inverter stops all motors and restart MMC operation with aux motors except the interlocked one(terminal turned Off).

Ex)Normal operation:

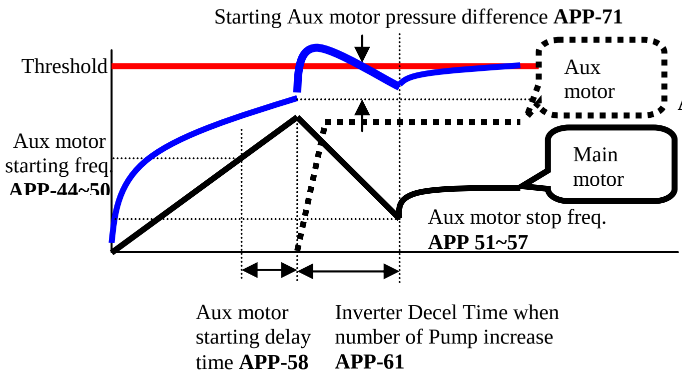
RLY1→RLY2→RLY3→RLY4

When Interlock is active (the terminal defined as Interlock/RLY3 is turned OFF), all Aux motors are turned Off and stopped. MMC operation is restarted except Aux motor 3 (RLY 3 Off).

Aux motors start rotating in the order of **RLY1→RLY2→RLY4.**

Aux motor starting condition and output (Pressure, air volume..) adjustment

Inverter turns Aux motors ON automatically when it is impossible for a main motor to control increased load, causing shortage in flow rate or flow pressure. Maximum 4 Aux motors can be used. To turn on the 4 Aux motors automatically, starting frequency for each motor should be set. (7 motors available with option board).



Aux motor active condition: Main motor speed exceeds Aux motor starting frequency (APP-44~50), for the time over APP-58[Aux motor starting delay time], Difference between PID reference and Feedback value exceeds APP-71 [Starting Aux motor pressure difference].

APP-44~50: Frequency to turn Aux motor ON. It is set the same as main motor frequency outputting equally when aux motor is turned ON.

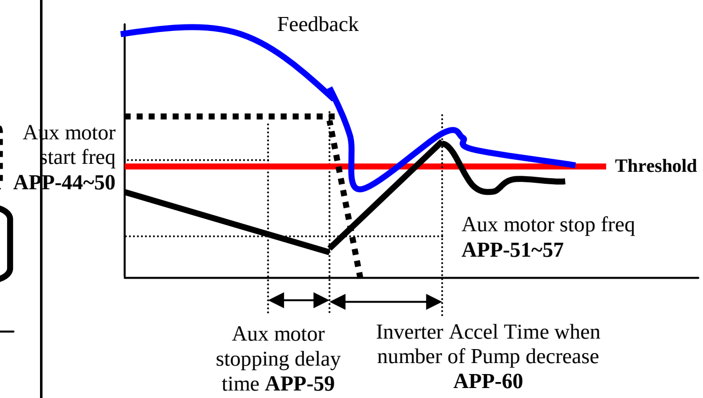
APP-58: It should be set greater than system delay time.

APP-71: It is set by comparing the pressure difference when Aux motor is turned ON and that of Aux motor starting frequency.

APP-61: This is the time inverter frequency is decreased after Aux motor is turned ON. It should be set higher than System delay time but it causes Aux motor ON state to become too long.

Aux motor stopping condition and output (Pressure, air volume..) adjustment

Inverter turns off the Aux motors when flow rate or flow pressure is too large due to decreased load. For Inverter to turn off Max 4 Aux motors automatically, 4 stopping frequency should be set separately. (7 motors available with Option board)



Aux motors are opened when main motor rotates below APP-51~57 [Aux motor stopping frequency] for the time over APP-59 [Aux motor stopping delay time] and pressure difference between PID reference and Feedback value exceeds the set value in APP-71[Aux motor starting /stopping pressure difference].

APP-51~57: The Aux motors are turned off at this frequency. It is set as dF, whose output matches when Aux motor is off.
(dF = Aux motor On Freq – Aux motor Off Freq)

APP-59: It should be set higher than System Delay Time.

APP-60: This is the time inverter frequency is increased after Aux motor is turned OFF. It should be set higher than System delay time but it causes Aux motor OFF state to become too long.

APP-71: Pressure Difference for Aux Motor Stop

APP▶ Aux Pr Diff 71 2%	71	2

Factory Default: 2% 2

It sets the pressure difference between when Aux motors are ON and Aux motor starting frequency.

APP-74, 75, 76: Pre PID Operation (Freq. Exit, Delay)

APP▶ PrePID Freq 74 0.00 Hz	74	0.00

Factory Default: 0.00 Hz 0.00

APP▶ PrePID Exit 75 0.0 %	75	0.0

Factory Default: 0.0 % 0.0

APP▶ PrePID dly 76 600 sec	76	600

Factory Default: 600 sec 600

Pre PID operation is a new function for smooth PID operation. For example, before pump operation is started, Pre PID fills water in the pump and pipe. Or Accel/Decel operation is performed before coil winding machine's speed reaches a certain level.

- APP-74 [Frequency before PID operation begins]

It is the inverter target frequency to be output until Pre PID operation is finished when Inverter Run signal is ON and Pre PID operation is selected.

- APP-75 [condition to activate PID operation]

User sets the value which is considered enough to start PID operation compared to feedback value during Pre PID operation. If the feedback value exceeds the set value in APP-75, Pre PID operation ends and PID operation begins.

- APP-76 [Pre PID delay time]

When feedback value is less than APP-75 value even though time set in APP-76 elapses, inverter signals system malfunction. It is also user-settable to fit for the system in use.

APP-80~97: External PID operation

APP▶ Ext Ref Sel 81 KeyPad	81	3

Factory Default: KeyPad 3

APP▶Ext Ref Perc 82 50.00%	82	50.00

Factory Default: 50.00% 50.00

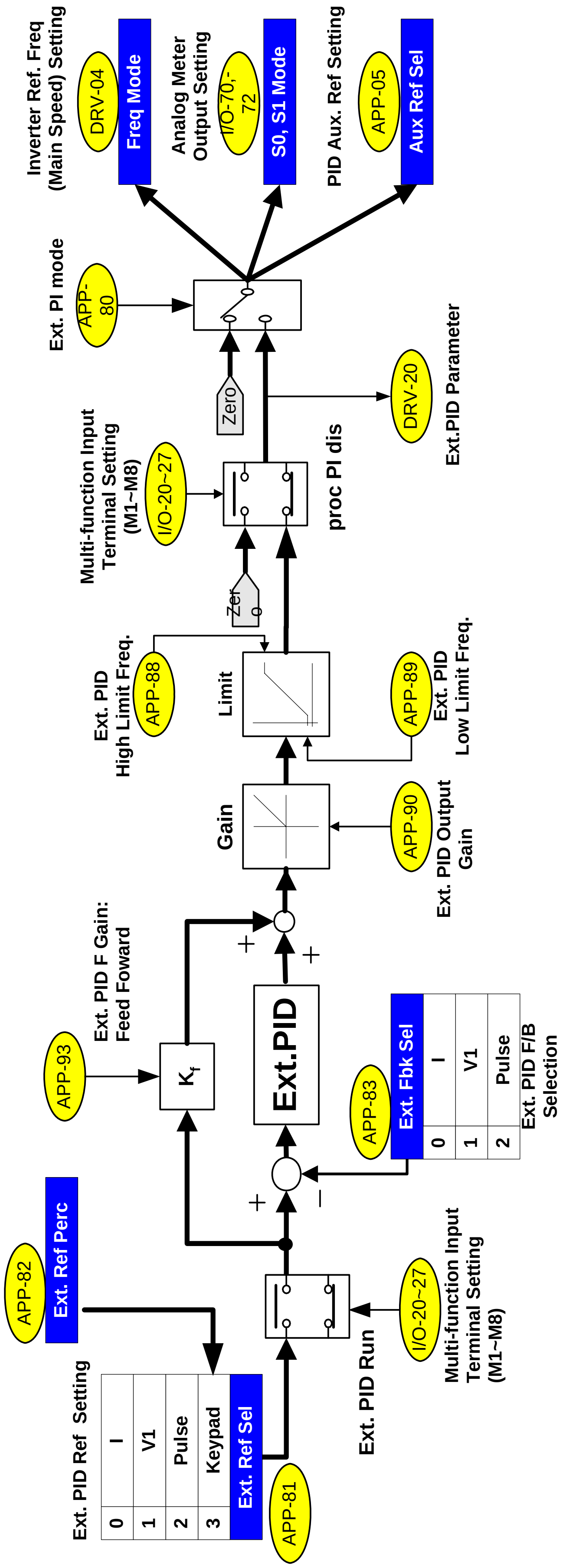
☐
☐
☐

Code	LCD Display	Default	Range
APP-80	Ext PI mode	0 (No)	0 (No) 1 (Yes)
APP-81	Ext Ref Sel	3 (Key-Pad)	0 (I) 1 (V1) 2 (Pulse) 3 (Key-Pad)
APP-82	Ext Ref Perc	50.00 [%]	0 – 100.00 [%]
APP-83	Ext Fbk Sel	0 (I)	0 (I) 1 (V1) 2 (Pulse)
APP-85	ExtPID Pgain	1.0 [%]	0 – 999.9 [%]
APP-86	ExtPID Itime	10.0 [sec]	0 – 32.0 [sec]
APP-87	ExtPID Dtime	0 [msec]	0 – 2000 [msec]
APP-88	ExtPID lmt-H	100.00 [%]	0 – 100.00 [%]
APP-89	ExtPID lmt-L	0.00 [%]	0 – 30.00 [%]
APP-90	ExtPID Scale	100.0 [%]	0 – 999.9
APP-91	Ext P2-gain	100.0 [%]	0 – 999.9
APP-92	Ext P Scale	100.0 [%]	0 – 100.0
APP-93	ExtPID F-gain	0.0 [%]	0 – 999.9 [%]
APP-95	ExtPIDOut Inv	0 (No)	0 (No) 1 (Yes)
APP-97	Ext Loop Time	100 [msec]	50 – 200 [msec]

APP-80~96 setting value is the same as APP-02~17.

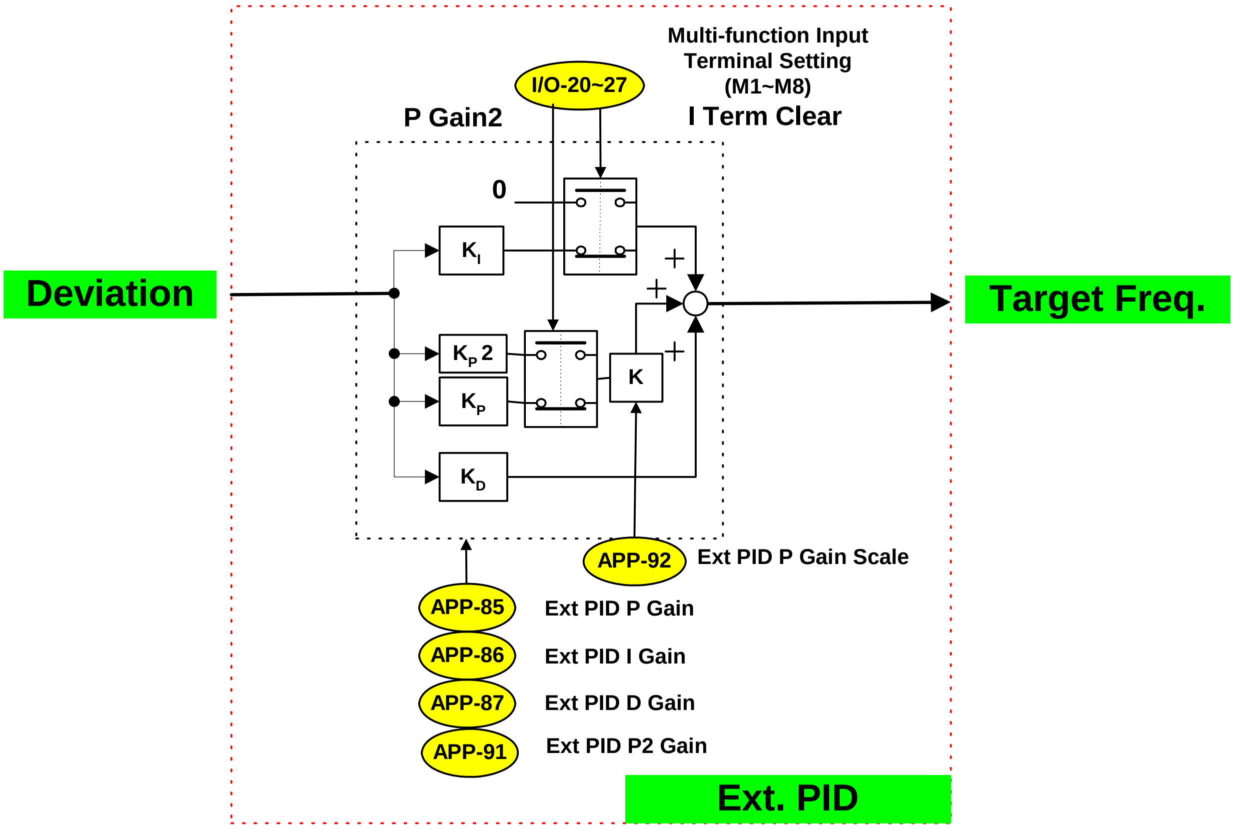
APP –82 [Ext PID Ref value] is settable when APP-81 [Ext PID Ref selection] is set to “Keypad”.
APP–97 [Ext PID Loop Time] sets the time to activate Ext PID controller. Set the desired value according to system.

Ext PID can be used for ①controlling other system independently as an external PID controller ②using both PID controller in APP-02 and External PID controller ③using Ext PID output as an Inverter target frequency. See 10) APP-02, APP-80 (**to use Dual PID operation**) for more details.



[Ext. PID block diagram]

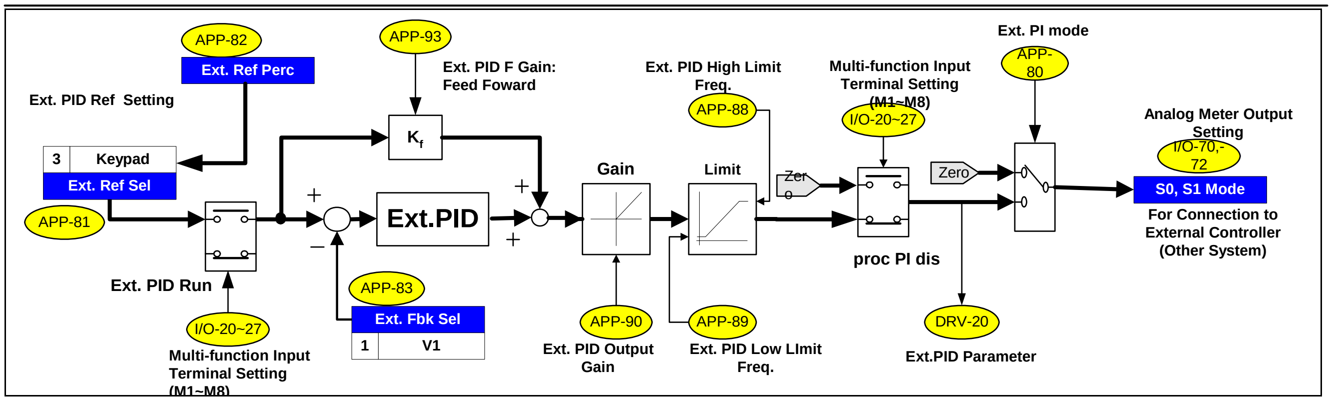
[Ext. PID internal block diagram]



APP-02 , APP-80 (to use Dual PID operation)

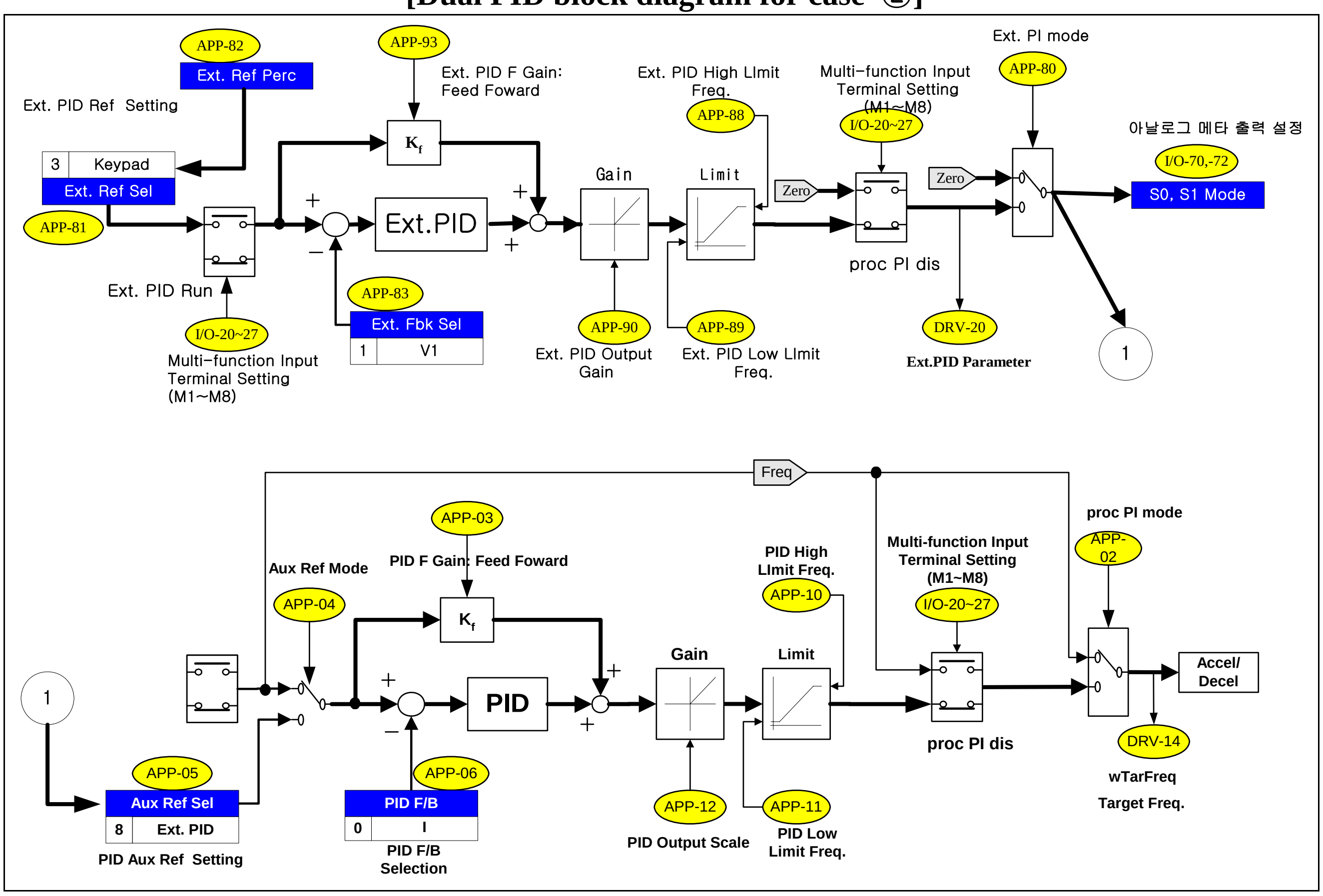
ExtPID can be used in the following three cases; ①controlling other system independently like an external PID controller ②using both PID controller in APP-02 and External PID controller ③using ExtPID output as an Inverter target frequency.

[Dual PID block diagram for case ①]



This illustrates controlling other system independently. Set I/O-70 or 72 [S0/S1 mode] to "Ext PID Out" and connect external system to S0 or S1 terminal. When Ext.PID Run signal is ON at the defined terminal in I/O-20~27, it starts output.

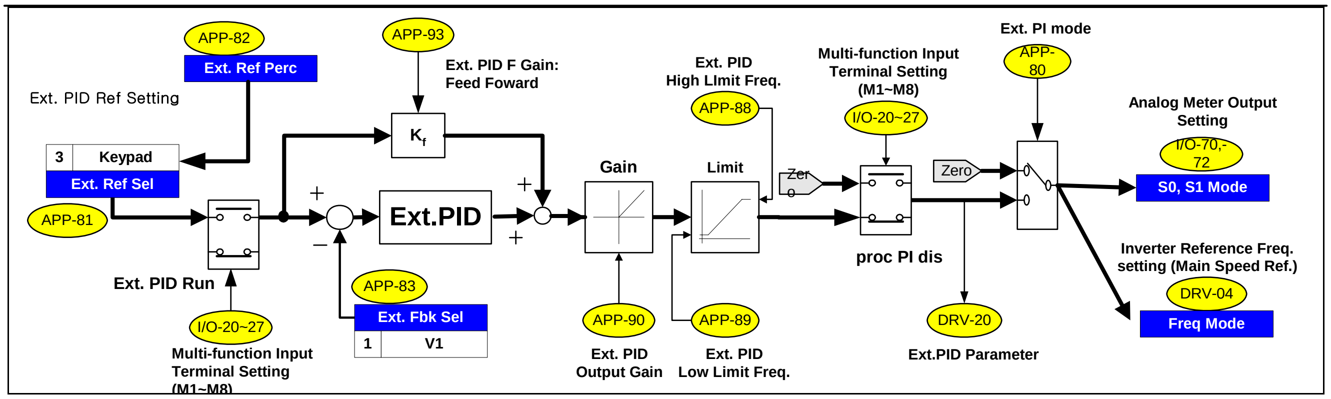
[Dual PID block diagram for case ②]



This illustrates dual use of PID controller (APP-02) and External PID controller. Set APP-81 [Ext. Ref Sel] to

Analog Input (V1, I, or Pulse) and perform terminal wiring for analog input. To give the digital reference, set APP-81 [Ext. Ref Sel] to “Keypad” and set proper value in APP-82 [Ext. Ref Perc]. Set the Ext. PID Feedback among V1, I, Pulse in APP-83 and perform terminal wiring for analog input. External PID Ref. and feedback are connected to PID controller. When Ext.PID Run signal is ON to the defined terminal in I/O-20~27, it starts its output. S0/S1 terminal can be used to connect to other system.

[Dual PID block diagram for case ③]



ExtPID output can be used for inverter target frequency. To activate this function, set analog input (V1, I, Pulse) as a reference value to other system or set APP-81 [Ext. Ref Sel] to “Keypad” and set proper value in APP-82 [Ext. Ref Perc]. Set APP-83 [Ext. Fbk Sel] to Analog input (I, V1, Pulse) and conduct wiring. And set DRV-04 [Freq Mode] to “Ext. PID”, then ExtPID output functions as Inverter main speed reference (target frequency). When Ext.PID Run signal is ON in the defined terminal in I/O-20~27, it starts its output and inverter performs Accel/Decel with output frequency. Other system can be connected via S0/S1 terminal.

■ Notes :

CHAPTER 7 - TROUBLESHOOTING & MAINTENANCE

7.1 Fault Display

When a fault occurs, the inverter turns off its output and displays the fault status in DRV-12. The last 5 faults are saved in FU2-01 through FU2-05 with the operation status at the instance of fault.

Keypad Display	Protective Function	Description
Over Current 1	Over Current Protection	The inverter turns off its output when the output current of the inverter flows more than 200% of the inverter rated current.
Ground Fault	Ground Fault Protection	The inverter turns off its output when a ground fault occurs and the ground fault current is more than the internal setting value of the inverter. Over current trip function may protect the inverter when a ground fault occurs due to a low ground fault resistance.
Over Voltage	Over voltage protection	The inverter turns off its output if the DC voltage of the main circuit increases higher than the rated value when the motor decelerates or when regenerative energy flows back to the inverter due to a regenerative load. This fault can also occur due to a surge voltage generated at the power supply system.
Over Load	Current Limit Protection (Overload Protection)	The inverter turns off its output if the output current of the inverter flows at 120% of the inverter rated current.
Over Heat	Inverter Over Heat	The inverter turns off its output if the heat sink is over heated due to a damaged cooling fan or an alien substance in the cooling fan.
E-Thermal	Electronic Thermal	The internal electronic thermal of the inverter determines the over heating of the motor. If the motor is overloaded the inverter turns off the output. The inverter cannot protect the motor when driving a multi-pole motor or when driving multiple motors, so consider thermal relays or other thermal protective devices for each motor. Overload capacity: 130% for 1 min
Ext. Trip	External Trip	Use this function if the user needs to turn off the output by an external trip signal. (Normal Open Contact) Inverter blocks the output to protect motor overload by detecting through this terminal.
Low Voltage	Low Voltage Protection	The inverter turns off its output if the DC voltage is below the detection level because insufficient torque or over heating of the motor can occurs when the input voltage of the inverter drops.
Over Current 2	IGBT Short	The inverter turns off the output if an IGBT short through or an output short occurs.
Output Phase Open	Output Phase open	The inverter turns off its output when the one or more of the output (U, V, W) phase is open. The inverter detects the output current to check the phase open of the output.
BX	BX Protection (Instant Cut Off)	Used for the emergency stop of the inverter. The inverter instantly turns off the output when the BX terminal is turned ON, and returns to regular operation when the BX terminal is turned OFF. Take caution when using this function.
HW-Diag	Inverter H/W Fault	A fault signal is output when an error occurs to the control circuitry of the inverter. There are the Wdog error, the EEP error, Input phase open, NTC open and the ADC Offset for this fault
COM Error CPU Error	Communication Error	This fault is displayed when the inverter cannot communicate with the keypad.
Inv. OLT	Inverter Overload	The inverter turns off its output when the output current of the inverter flows more than the rated level (110% for 1 minute, 130% for 4 seconds).
NTC open	NTC Open	This fault is displayed when inverter internal NTC is opened.

Keypad Display	Protective Function	Description
LOP LOR LOV LOI LOX	Operating Method when the Frequency Reference is Lost	According to the I/O-48 [Operating Method when the Frequency Reference is Lost] setting, there are three modes: continuous operation, decelerate to stop, and free run, LOP: Displayed when option frequency reference is lost (DPRAM time out) LOR: Displayed when option frequency reference is lost (Communication network fault) LOV: Displayed when ‘V1’ analog frequency reference is lost. LOI: Displayed when ‘I‘ analog frequency reference is lost. LOX: Displayed when sub-board (V2, ENC) analog frequency reference is lost.

To reset fault, Press **RESET** key, close RST-CM terminals or cycle the input power.
If a problem persists, please contact the factory or your local distributor.

7.2 Fault Remedy

Protective Function	Cause	Remedy
Over Current Protection 1	Acceleration/Deceleration time is too short compared to the GD^2 of the load. Load is larger than the inverter rating. Inverter turns output on when the motor is free running. Output short or ground fault has occurred. 5) Mechanical brake of the motor is operating too fast. 6) Components of the main circuit have overheated due to a faulty cooling fan.	1) Increase Accel/Decel time. 2) Increase inverter capacity. 3) Operate after motor has stopped. 4) Check output wiring. 5) Check mechanical brake operation. 6) Check cooling fan. **(Caution)** Operating inverter prior to correcting fault may damage the IGBT.
Ground Fault Current Protection	Ground fault has occurred at the output wiring of inverter. The insulation of the motor is damaged due to heat.	Investigate the output wiring of inverter. Exchange motor.
Over Voltage Protection	Compared to the GD^2 of load. Regenerative load at the output Line voltage high	Increase deceleration time. Use regenerative resistor option. Check line voltage.
Current Limit Protection (Overload Protection)	Load is larger than the inverter rating. Incorrect inverter capacity selected. Set incorrect V/F pattern.	Increase capacity of motor and inverter. Select correct inverter capacity. Select correct V/F pattern.
Inverter Overheat	Cooling fan damaged or an alien substance inserted. Cooling system has faults. Ambient temperature high.	Exchange cooling fans and/or eliminate alien substance. Check for alien substances in the heat sink. Keep ambient temperature under 40 ℃.
Electronic Thermal	Motor has overheated. Load is larger than inverter rating. ETH level too low. Incorrect inverter capacity selected. Set incorrect V/F pattern. Operated too long at low speeds.	Reduce load and/or running duty. Increase inverter capacity. Adjust ETH level to an appropriate level. Select correct inverter capacity. Select correct V/F pattern. Install a cooling fan with a separate power supply.
External Trip	External Trip has occurred.	Eliminate Trip at circuit connected to external trip terminal or remove external trip input.
Low Voltage Protection	Line voltage low. Load larger than line capacity is connected to line. (welding machine, motor with high starting current connected to the commercial line) Faulty magnetic switch at the input side of the inverter	Check line voltage. Increase line capacity. Exchange magnetic switch.
Over Current 2	Short has occurred between the upper and lower IGBT. Short has occurred at the output of the inverter. Acceleration/Deceleration time is too short compared to the GD^2 of load.	Check IGBT. Check output wiring of inverter. Increase acceleration time.
Output Phase Open	Faulty contact of magnetic switch at output Faulty output wiring	Check magnetic switch at output of inverter. Check output wiring.
H/W Fault	Wdog error (CPU fault) EEP error (memory fault) ADC Offset (current feedback circuit fault)	Exchange inverter.
Communication Fault	Faulty connection between inverter and keypad Inverter CPU malfunction	Check connector. Exchange inverter.

Protective Function	Cause	Remedy
Operating Method when the Speed Reference is Lost	LOP (Loss of reference from the Option), LOR (Remote) LOV (V1), LOI (I), LOX (Sub-V2, ENC)	Eliminate cause of fault.
Inverter Overload	Load is larger than inverter rating. Incorrect inverter capacity selected.	Increase motor and/or inverter capacity. Select correct inverter capacity.

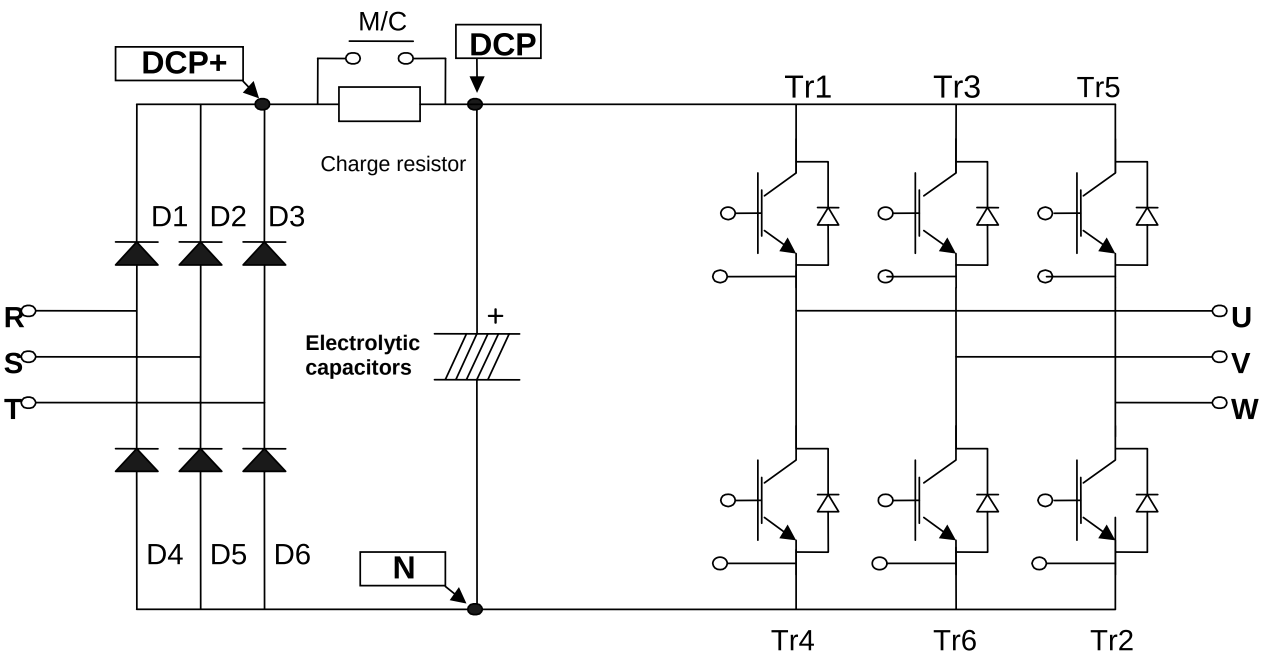
7.3 Troubleshooting

Condition	Checking Point
The Motor Does Not Rotate.	1) Main circuit inspection: Is the input (line) voltage normal? (Is the LED in the inverter is lit?) Is the motor connected correctly? 2) Input signal inspection: Check the operating signal input to the inverter. Check the forward and the reverse signal input simultaneously to the inverter? Check the command frequency signal input to the inverter. 3) Parameter setting inspection: Is the reverse prevention (FU1-01) function set? Is the Drive mode (DRV-03) set correctly? Is the command frequency set to 0? 4) Load inspection: Is the load too large or is the motor jammed? (Mechanical brake) 5) Other: Is the alarm displayed on the keypad or is the alarm LED lit? (STOP LED blinks)
The Motor Rotates in Opposite Directions.	Is the phase sequence of the output terminal U, V, W correct? Is the starting signal (forward/reverse) connected correctly?
The Difference Between the Rotating Speed and the Reference is Too Large.	Is the frequency reference signal correct? (Check the level of the input signal) Is the following parameter setting is correct? Lower Limit Frequency (FU1-34), Upper Limit Frequency (FU1-35), Analog Frequency Gain (I/O-1~10) Is the input signal line influenced by external noise? (Use a shielded wire)
The Inverter Does Not Accelerate or Decelerate Smoothly.	Is the acceleration/deceleration time is set too short a period of time? Is the load too large? Is the Torque Boost (FU2-68, 69) value is too high that the current limit function and the stall prevention function do not operate?
The Motor Current is Too High.	Is the load too large? Is the Torque Boost Value (manual) too high?
The Rotating Speed Does Not Increase.	Is the Upper Limit Frequency (FU1-35) value correct? Is the load too large? Is the Torque Boost (FU1-68, 69) value too high that the stall prevention function (FU1-70, 71) does not operate?
The Rotating Speed Oscillates When the Inverter is Operating.	1) Load inspection: Is the load oscillating? 2) Input signal inspection: Is the frequency reference signal oscillating? 3) Other: Is the wiring too long when the inverter is using V/F control? (over 500m)

7.4 How to Check Power Components

1) Diode module and IGBT module check (5.5~ 30kW)

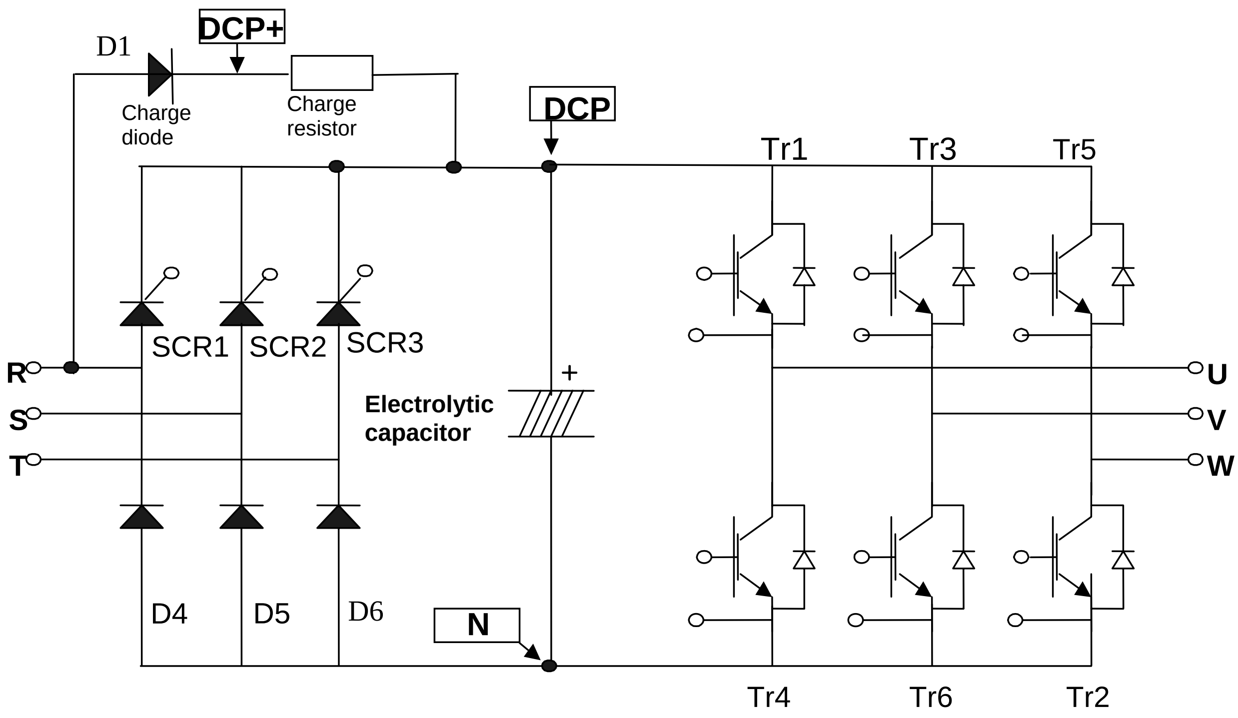
Before checking the power components, be sure to disconnect AC Input supply and wait until the Main Electrolytic Capacitors (DCP-DCN) is discharged.



- Turn the power off and disconnect RST/UVW wiring.
- Determine whether inverter terminals (R,S,T, U, V, W, P1(or P2),N) are energized or not using a tester.
- Wait until the Main Electrolytic Capacitors (DCP-DCN) is discharged to a safe level.
- Enormous amount of value such as Mega will be displayed when Open. When closed, the resistance value ranges from a few ohms to tens of Ω. Sometimes, it seems to be closed due to electrolytic capacitors but soon to be displayed mega value resistance.
- The displayed value is not always the same according to modules and tester types but should be similar.
- Modules number and checking point

Module		Test polarity		Check value	Number	Test polarity		Check value
		+	-			+	-	
Diode	D1	R	DCP+	Closed	D4	R	N	Open
		DCP+	R	Open		N	R	Closed
	D2	S	DCP+	Closed	D5	S	N	Open
		DCP+	S	Open		N	S	Closed
	D3	T	DCP+	Closed	D6	T	N	Open
		DCP+	T	Open		N	T	Closed
IGBT	Tr1	U	DCP	Closed	Tr4	U	N	Open
		DCP	U	Open		N	U	Closed
	Tr3	V	DCP	Closed	Tr6	V	N	Open
		DCP	V	Open		N	V	Closed
	Tr5	W	DCP	Closed	Tr2	W	N	Open
		DCP	W	Open		N	W	Closed

2) Diode module and IGBT module check (37~ 90kW)



- Turn the power off and disconnect RST/UVW wiring.
- Determine whether inverter terminals (R,S,T, U, V, W, P1(or P2),N) are energized or not using a tester.
- Wait until the Main Electrolytic Capacitors (DCP-DCN) is discharged to a safe level.
- Enormous amount of value such as Mega will be displayed when Open. When closed, the resistance value ranges from a few ohms to tens of Ω. Sometimes, it seems to be closed due to electrolytic capacitors but soon to be displayed mega value resistance.
- The displayed value is not always the same according to modules and tester types but should be similar.
- Modules number and checking point

Module		Test polarity		Check value	Number	Test polarity		Check value
		+	-			+	-	
Diode	D1	R	DCP+	Closed	D4	R	N	Open
		DCP+	R	Open		N	R	Closed
	D5	S	N	Open	D6	T	N	Open
		N	S	Closed		N	T	Closed
IGBT	Tr1	U	DCP	Closed	Tr4	U	N	Open
		DCP	U	Open		N	U	Closed
	Tr3	V	DCP	Closed	Tr6	V	N	Open
		DCP	V	Open		N	V	Closed
	Tr5	W	DCP	Closed	Tr2	W	N	Open
		DCP	W	Open		N	W	Closed

7.5 Maintenance

The P series is an industrial electronic product with advanced semiconductor elements. However, temperature, humidity, vibration and aging parts may still affect it. To avoid this, it is recommended to perform routine inspections.

7.5.1 Precautions

☞ Be sure to remove the drive power input while performing maintenance.
☞ Be sure to perform maintenance only after checking that the bus has discharged (The voltage between terminal P1-N (or P2-N) should be less than DC 30V). The bus capacitors in the electronic circuit can still be charged even after the power is turned off.
☞ The correct output voltage can only be measured by using a rectifier voltage meter. Other voltage meters, including digital voltage meters, are likely to display incorrect values caused by the high frequency PWM output voltage of the drive.

7.5.2 Routine Inspection

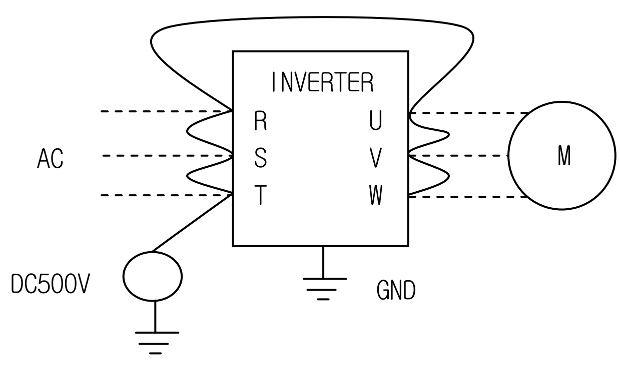
☞ Be sure to check the following before operation:
☞ The conditions of the installation location
☞ The conditions of the drive cooling
☞ Abnormal vibration
☞ Abnormal heating

7.5.3 Periodic Inspection

☞ Are there any loose bolt, nut or rust caused by surrounding conditions? If so, tighten them up or replace them.
☞ Are there any deposits inside the drive-cooling fan? If so, remove using air.
☞ Are there any deposits on the drive's PCB (Printed Circuit Boards)? If so, remove using air.
☞ Are there any abnormalities in the various connectors of the drive's PCB? If so, check the condition of the connector in question.
☞ Check the rotating condition of the cooling fan, the size and condition of the capacitors and the connections with the magnetic contactor. Replace them if there are any abnormalities.

7.5.4 Megger/Dielectric Test

Perform megger test after inverter wiring is disconnected. Test voltage should not be applied to the inverter. Megger test should be conducted only for the main circuit, not the control circuit. Use DC 500V megger. Dielectric test should not be conducted to the inverter. Otherwise, IGBT may be damaged.



7.5.5 Daily and Periodic Inspection Items

Inspection Location	Inspection Item	Inspection	Period: Daily	Period: 1 year	Period: 2 year	Inspection Method	Criterion	Measuring Instrument
All	Ambient Environ-ment	Is there any dust? Is the ambient temperature and humidity adequate?	O			Refer to the precautions.	Temperature: -10~+40 no freezing. Humidity: Under 50% no dew	Thermometer, Hygrometer, Recorder
	Equipment	Is there any abnormal oscillation or noise?	O			Use sight and hearing.	No abnormality	
	Input Voltage	Is the input voltage of the main circuit normal?	O			Measure the voltage between the terminals R, S, T.		Digital Multi-Meter/Tester
Main Circuit	All	Megger check (between the main circuit and the ground) Are any fixed parts removed? Are there any traces of overheating at each component's cleaning?		O O O	O	Undo the inverter connections short the terminals R, S, T, U, V, W and measure between these parts and the ground. Tighten the screws. Visual check.	Over 5MΩ No fault	DC 500V class Megger
	Conductor/ Wire	Is the conductor rusty? Is the wire coating damaged?		O O		Visual check	No fault	
	Terminal	Is there any damage?		O		Visual check	No fault	
	IGBT Module /Diode Module	Check the resistance between each of the terminals.			O	Undo the inverter connection and measure the resistance between R, S, T ⇔ P, N and U, V, W ⇔ P, N with a tester.	(Refer 'How to Check Power Components")	Digital Multi-Meter/Analog Tester
	Smoothing Capacitor	Is there any liquid coming out? Is the safety pin out, and is there any swelling? Measure the capacitance.	O O	O		Visual check Measure with a capacitance-measuring device.	No fault Over 85% of the rated capacity	Capacitance Measuring Device
	Relay	Is there any chattering noise during operation? Is there any damage to the contact		O O		Auditory check Visual check	No fault	
	Resistor	Is there any damage to the resistor insulation? Is the wiring in the resistor damaged (open)?		O O		Visual check Disconnect one of the connections and measure with a tester.	No fault Error must be within ±10% the displayed resistance.	Digital Multi-Meter/Analog Tester
Control Circuit Protective Circuit	Operation Check	Is there any unbalance between each phases of the output voltage? Nothing must be wrong with display circuit after executing the sequence protective operation.		O O		Measure the voltage between the output terminals U, V and W. Short and open the inverter protective circuit output.	The voltage balance between the phases for 200V (400V) class is under 4V (8V). The fault circuit operates according to the sequence.	Digital Multi-Meter/Rectifying Voltmeter
Cooling System	Cooling Fan	Is there any abnormal oscillation or noise? Is the connection area loose?	O	O		Turn OFF the power and turn the fan by hand. Tighten the connections.	Must rotate smoothly. No fault	
Display	Meter	Is the displayed value correct?	O	O		Check the meter reading at the exterior of the panel.	Check the specified and management values.	Voltmeter/ Ammeter etc.
Motor	All	Are there any abnormal vibrations or noise? Is there any unusual odor?	O O			Auditory, sensory, visual check. Check for overheat and damage.	No fault	
	Insulation Resistor	Megger check (between the output terminals and the ground terminal)			O	Undo the U, V and W connections and tie the motor wiring.	Over 5MΩ	500V class Megger

Note: Values in ( ) is for the 400V class inverters.

Note: Life cycle of the Main components indicated above is based on continuous operation with rated load. It may vary with surrounded environment.

7.5.6 Parts replacement

Part name	Period	Comments
Cooling fan	2-3 years	Exchange for a new part after consulting CERUS A/S center.
Electrolytic capacitor	5 years	Check for the periodic inspection for 1 year. Exchange for a new part after consulting CERUS A/S center. The Recommended level to exchange a capacitor in main/control circuit is 85% or less of the initial value.
Relays	-	Exchange for a new part after consulting CERUS A/S center.

The life expectancy of a part depends on the type of part, the environment, and operating conditions.

CHAPTER 8 - OPTIONS

8.1 Option List

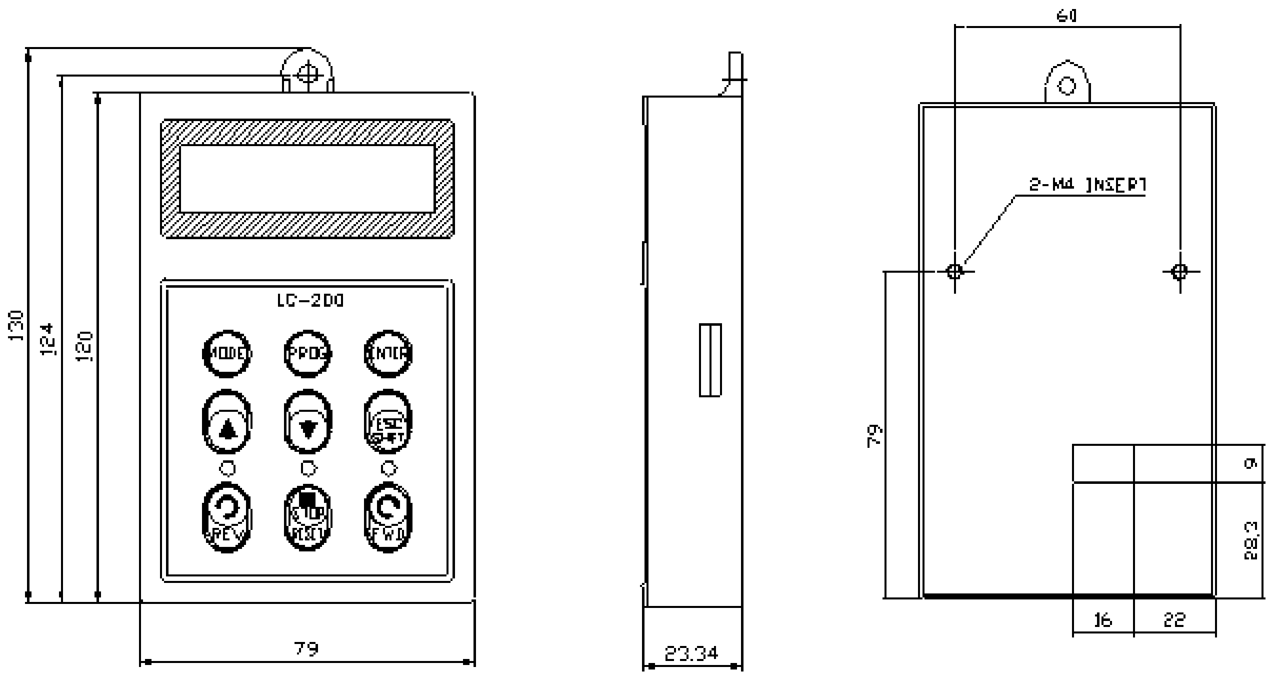
External	Keypad	LCD	32 character display keypad Download and Upload available	All units
	Remote	Remote cable	2m, 3m and 5m long keypad cable enables users to control the inverter from a distant area.	Optional
	Dynamic braking	DB resistor	Enables inverter to decelerate rapidly.	Optional
		DB unit	DB units are provided as an option from 11 kW.	Optional
	Conduit option	Conduit for NEMA TYPE 1	Install it to fit for NEMA TYPE 1 Enclosure.	15~90kW (20~125HP)

Note) Refer to Option manuals for details.

8.2 External options

8.2.1 Keypad dimensions

1) LCD Keypad (Weight: 140 g)



8.2.2 Remote cable

Ordering No.	Description
051050025	Remote cable – 2m
051050026	Remote cable – 3m
051050027	Remote cable – 5m

8.2.3 DB (Dynamic Braking) Unit

Refer to DB Unit option manual for details.

1) DBU Models

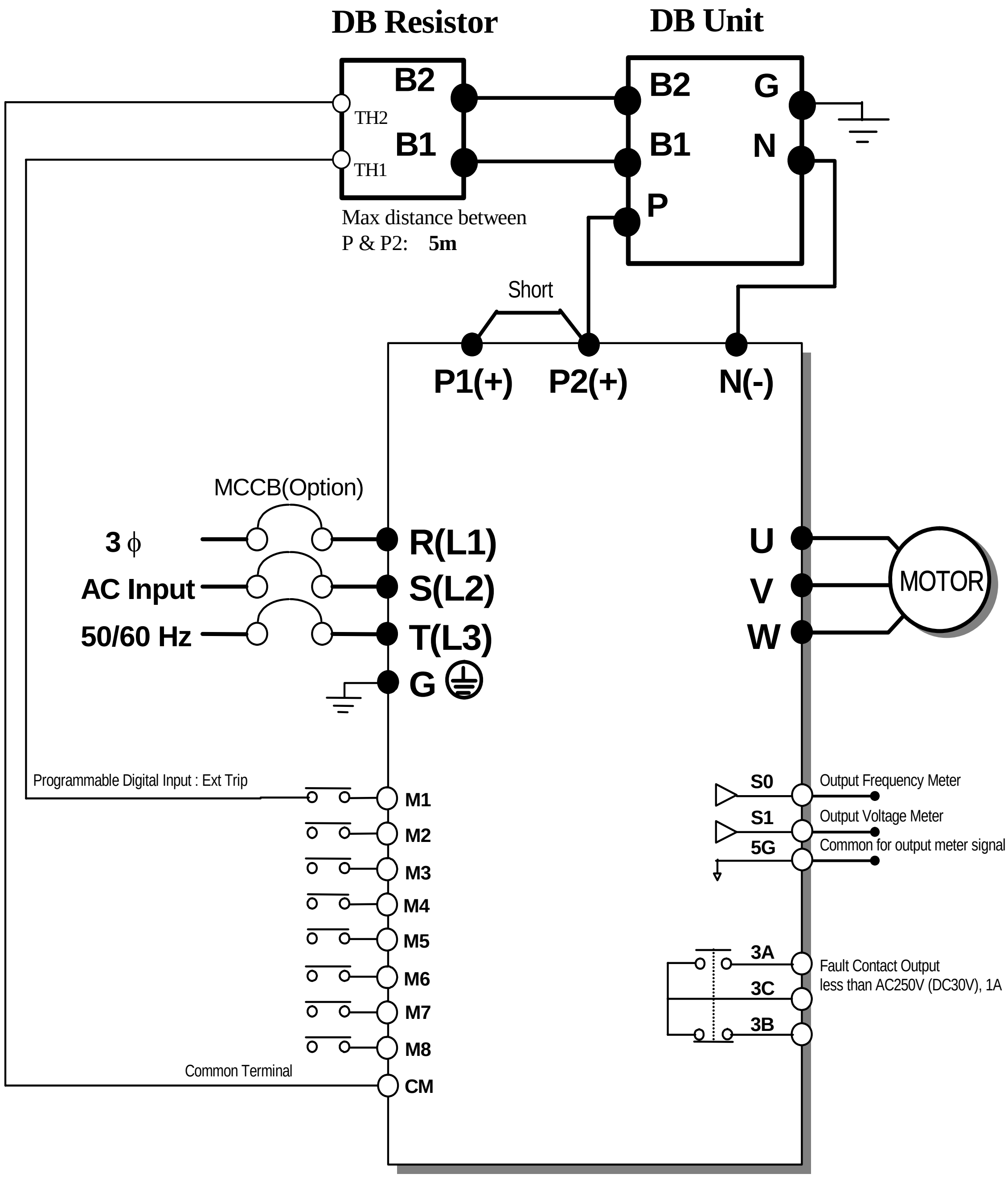
UL	Inverter	Applicable motor rating	DB Unit	Dimension
Non UL type	200V class	11 ~ 15 kW (15 ~ 20 HP)	SV150DBU-2	Group 1. See 4) Dimensions
		18.5 ~ 22 Kw (25 ~ 30 HP)	SV220DBU-2	
		30 ~ 37 kW (40 ~ 50 HP)	SV037DBH-2	Group 2. See 4) Dimensions
		45 ~ 55 kW (60 ~ 75 HP)	SV037DBH-2, 2Set	
	400V class	11 ~ 15 kW (15 ~ 20 HP)	SV150DBU-4	Group 1. See 4) Dimensions
		18.5 ~ 22 kW (25 ~ 30 HP)	SV220DBU-4	
		30 ~ 37 kW (40 ~ 50 HP)	SV037DBH-4	Group 2. See 4) Dimensions
		45 ~ 55 kW (60 ~ 75 HP)	SV075DBH-4	
		75 kW (100 HP)		
UL Type	200V class	11 ~ 15 kW (15 ~ 20 HP)	SV150DBU-2U	Group 3. See 4) Dimensions
		18.5 ~ 22 kW (25 ~ 30 HP)	SV220DBU-2 U	
		30 ~ 37 kW (40 ~ 50 HP)	CI-050DBU-2 U	
		45 ~ 55 kW (60 ~ 75 HP)	SV550DBU-2 U	
	400V class	11 ~ 15 kW (15 ~ 20 HP)	SV150DBU-4 U	
		18.5 ~ 22 kW (25 ~ 30 HP)	SV220DBU-4 U	
		30 ~ 37 kW (40 ~ 50 HP)	CI-050DBU-4 U	
		45 ~ 55 kW (60 ~ 75 HP)	SV550DBU-4 U	
		75 kW (100 HP)	SV750DBU-4 U	
		90~110 kW (125 ~ 150 HP)	SV550DBU-4, 2Set	
		132~160 kW (200 ~ 250 HP)	SV750DBU-4, 2Set	
		220 kW (300 HP)	SV750DBU-4, 3Set	
		280~315 kW (350 ~ 400 HP)	-	

2) Terminal Configuration

- Group 1: **CM** **OH**   **G** **B2** **B1** **N** **P**
- Group 2: **G** **N** **B2** **P/B1**
- Group 3: **P** **N** **G** **B1** **B2**

Terminals	Description	Terminals	Description
G	Ground terminal	N	Connect to inverter terminal N
B2	Connect to DB Resistor's B2	P	Connect to inverter terminal P1
B1	Connect to DB Resistor's B1	CM	OH Common
N	Connect to inverter terminal N	OH*	Over Heat Trip output terminal (Open Collector output: 20mA, 27V DC)
P	Connect to inverter terminal P1		

3) Wiring for DB unit and DB resistor (for 5.5~90kW/7.5~125HP inverters)

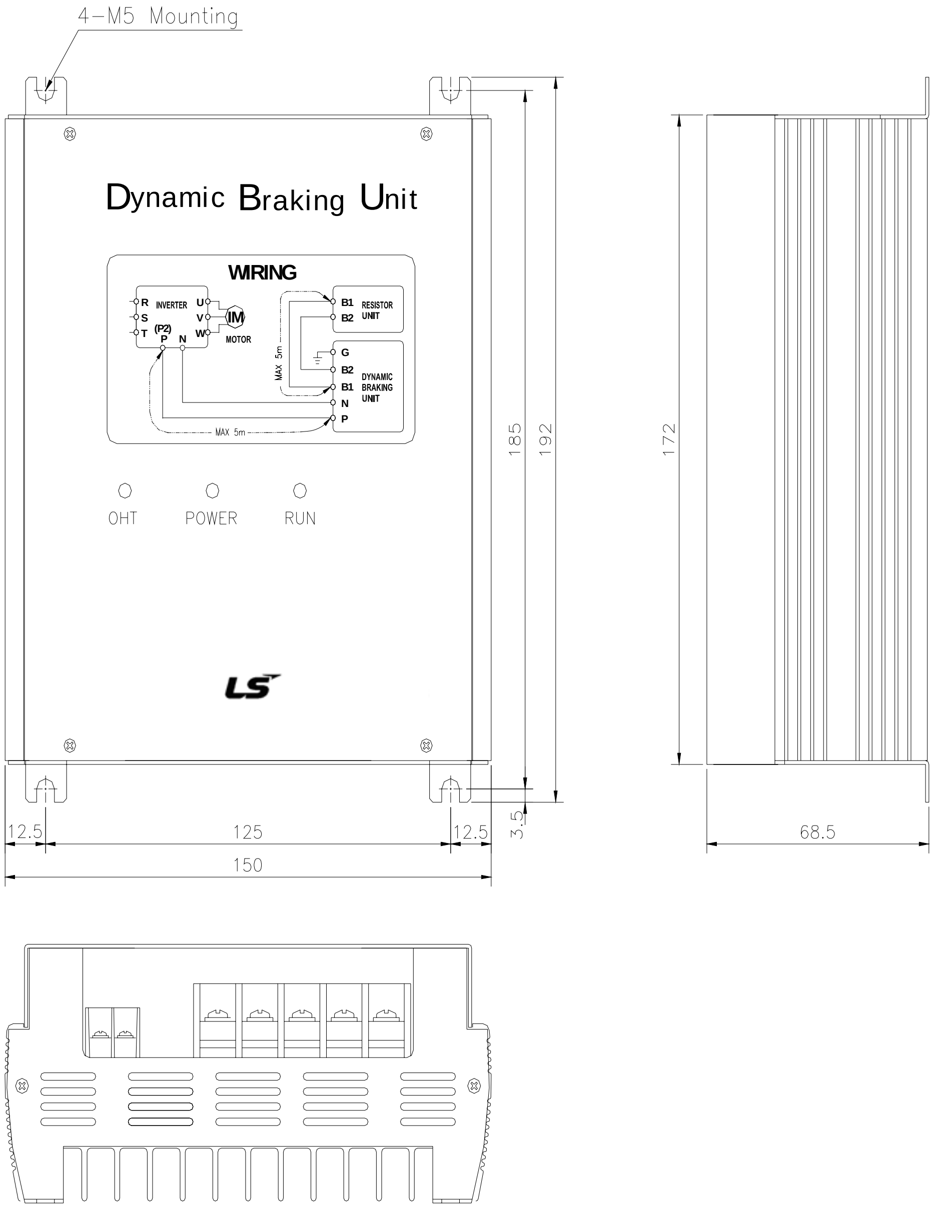


DB resistor terminal	Description
B1, B2	Wire the terminal properly based on wiring block diagram. Connect a DB resistor to the DB Unit's B1, B2 terminals.
TH1,TH2	Thermal sensor terminal of DB resistor. Normal temperature (Ambient): Contact ON (TH1-TH2 closed) DB resistor overheated: Contact OFF (TH1-TH2 Open). Wire it to the inverter terminal defined as External Trip.

4)Dimensions

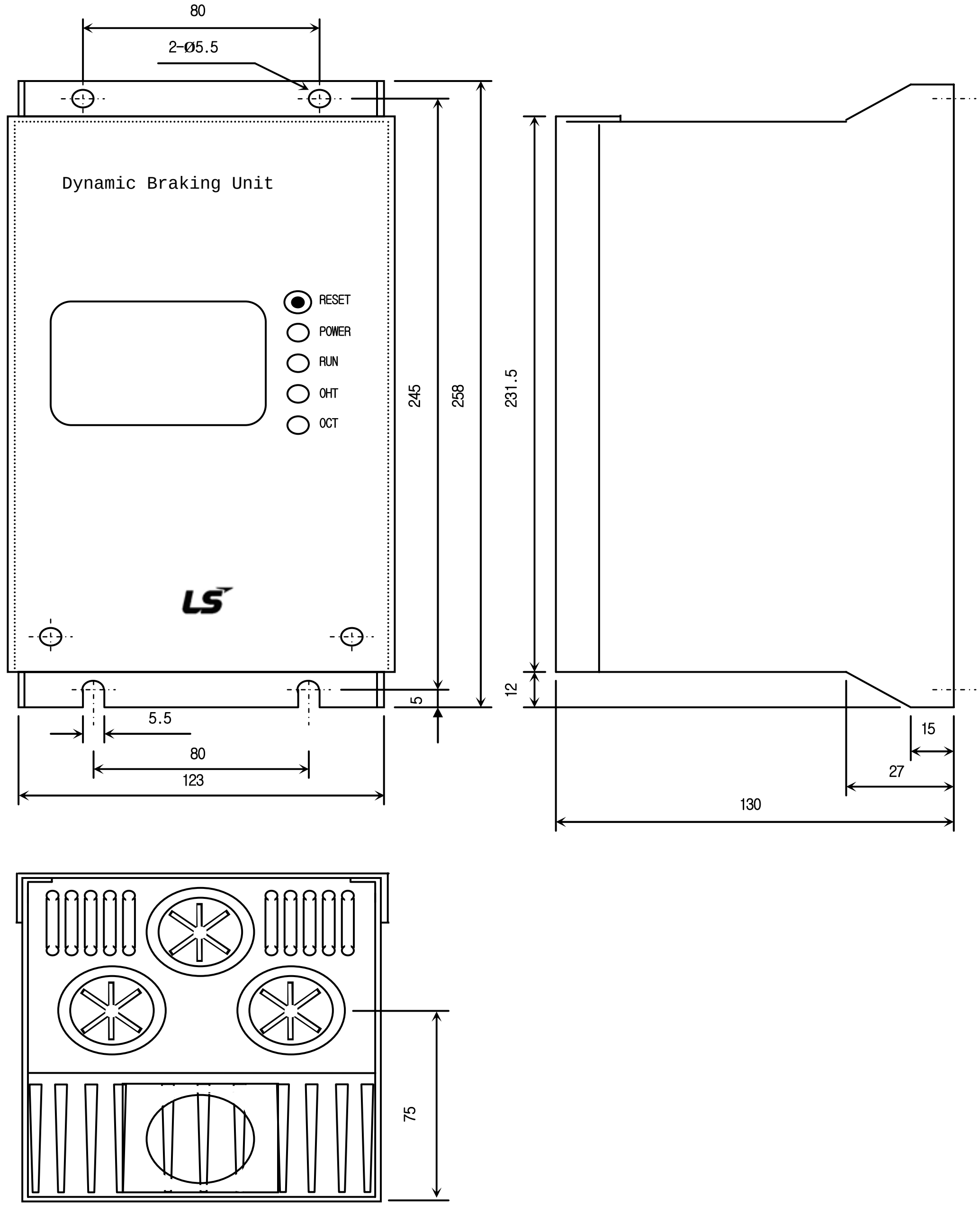
- Group 1

(Unit: mm)



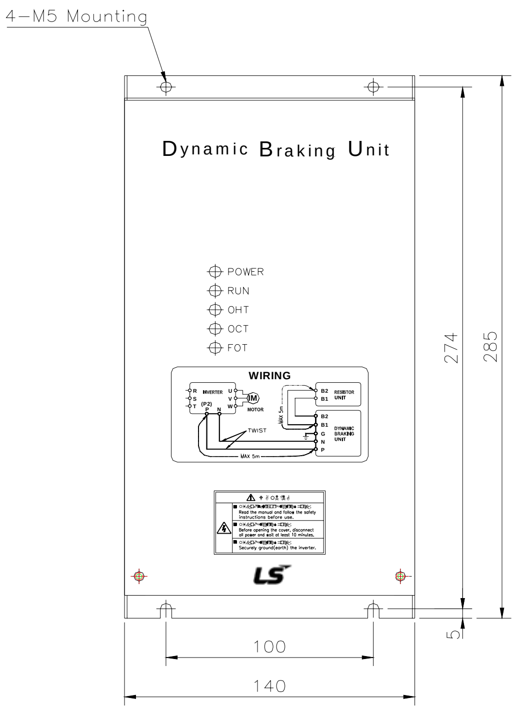
- Group 2

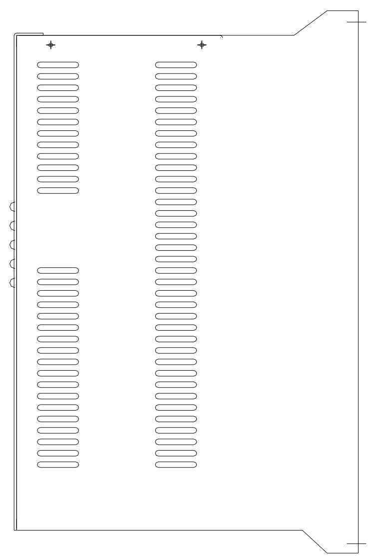
(Unit: mm)

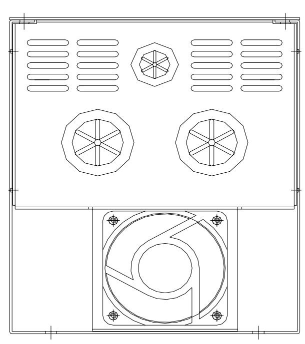


- Group 3

(Unit: mm)

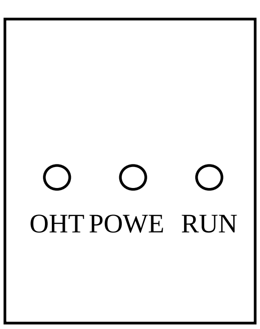






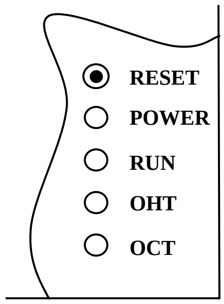
5) Monitoring LEDs

*   Group 1



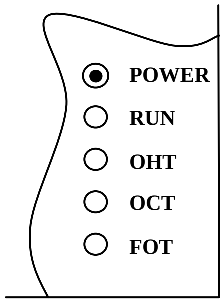
LED	Description
OHT (GREEN, LEFT)	When heat sink is overheated and the level exceeds its setting limit, overheat protection is activated and OHT LED is turned ON after DBU’s signal is shut off.
POWER (RED)	POWER LED is turned ON upon inverter Power ON because normally it is connected to the inverter.
RUN (GREEN, RIGHT)	RUN LED is blinking while DBU is operating normally by motor regenerating energy.

*   Group 2



LED	Description
RESET	Press this switch to release OCT FAULT status. Pressing this turns the OCT LED off.
POWER (GREEN)	POWER LED is turned ON upon inverter Power ON because normally it is connected to the inverter.
RUN (GREEN)	RUN LED is blinking while DBU is operating normally by motor regenerating energy.
OHT (RED)	When heat sink is overheated and the level exceeds its setting limit, overheat protection is activated and OHT LED is turned ON after DBU's signal is shut off.
OCT (RED)	Over current trip signal. When overcurrent is flowed to the iGBT, protection function shuts off the operating signal and OCT LED is tured ON.

*   Group 3



LED	Description
POWER (RED)	POWER LED is turned ON upon inverter Power ON because normally it is connected to the inverter.
RUN (GREEN)	RUN LED is blinking while DBU is operating normally by motor regenerating energy.
OHT (RED)	When heat sink is overheated and the level exceeds its setting limit, overheat protection is activated and OHT LED is turned ON after DBU's signal is shut off.
OCT (RED)	Over current trip signal. When overcurrent is flowed to the iGBT, protection function shuts off the operating signal and OCT LED is tured ON.
FOT (RED)	FOT LED is turned ON when fuse is opened to shut the overcurrent during braking.

8.2.4 DB Resistor

1) External DB Resistor

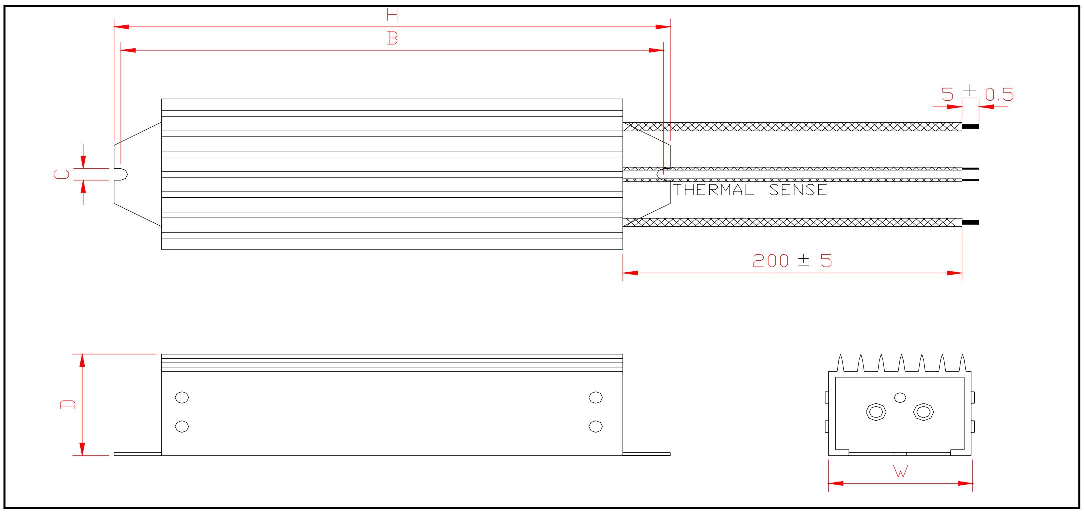
P Series inverters do not built-in DB resistor on Power stack as factory installation. External DB Unit and Resistor (Optional) should be installed. See the following table for more details (ED: 5%, Continuous Braking Time: 15 sec). If Enable duty (%ED) is increased to 10%, use the external DB resistor having twice Wattage rating.

	Applied motor capacity (kW / HP)	Operating rate (ED/Continuous Braking Time)	100 % Braking Torque			150% Braking Torque		
			[ohm]	[W]	Type	[ohm]	[W]	Type
200V	5.5 / 7.5	5% / 15 sec	30	700	TYPE 3	20	800	TYPE 3
	7.5 / 10	5% / 15 sec	20	1000	TYPE 3	15	1200	TYPE 3
	11 / 15	5% / 15 sec	15	1400	TYPE 3	10	2400	TYPE 3
	15 / 20	5% / 15 sec	11	2000	TYPE 3	8	2400	TYPE 3
	18.5 / 25	5% / 15 sec	9	2400	TYPE 3	5	3600	TYPE 3
	22 / 30	5% / 15 sec	8	2800	TYPE 3	5	3600	TYPE 3
	30 / 40	10% / 6 sec	4.2	6400	-	-	-	-
400V	5.5 / 7.5	5% / 15 sec	120	700	TYPE 3	85	1000	TYPE 3
	7.5 / 10	5% / 15 sec	90	1000	TYPE 3	60	1200	TYPE 3
	11 / 15	5% / 15 sec	60	1400	TYPE 3	40	2000	TYPE 3
	15 / 20	5% / 15 sec	45	2000	TYPE 3	30	2400	TYPE 3
	18.5 / 25	5% / 15 sec	35	2400	TYPE 3	20	3600	TYPE 3
	22 / 30	5% / 15 sec	30	2800	TYPE 3	20	3600	TYPE 3
	30 / 40	10% / 6 sec	16.9	6400	-	-	-	-
	37 / 50	10% / 6 sec	16.9	6400	-	-	-	-
	45 / 60	10% / 6 sec	11.4	9600	-	-	-	-
	55 / 75	10% / 6 sec	11.4	9600	-	-	-	-
	75 / 100	10% / 6 sec	8.4	12800	-	-	-	-
	90 / 125	10% / 6 sec	8.4	12800	-	-	-	-

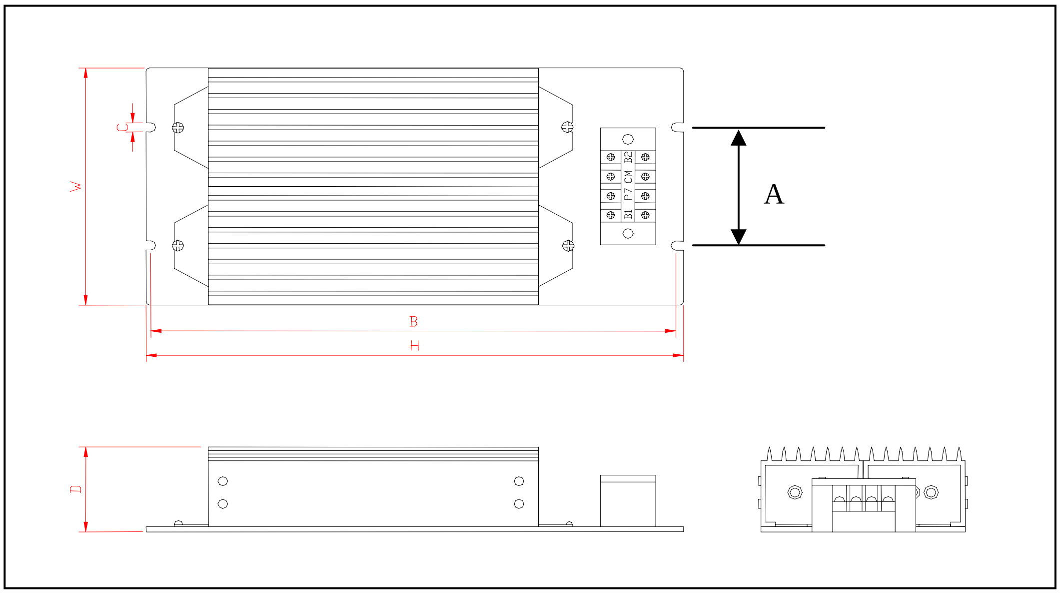
2) Dimensions of the DB Resistor

Model	Inverter	Type	Dimension [mm]					
			W	H	D	A	B	C
BR0800W020J	CI- 007-P/2	3	220	345	93	140	330	7.8
BR1200W015J	CI- 010-P/2	3	220	345	93	140	330	7.8
BR2400W010J	CI- 015-P/2	3	220	445	93	140	430	7.8
BR2400W008J	CI- 020-P/2	3	220	445	93	140	430	7.8
BR3600W005J	CI- 025-P/2	3	220	445	165	140	430	7.8
BR3600W005J	CI- 030-P/2	3	220	445	165	140	430	7.8
BR3600W005J	CI- 040-P/2	3	220	445	165	140	430	7.8
BR1000W085J	CI- 007-P/4	3	220	345	93	140	330	7.8
BR1200W060J	CI- 010-P/4	3	220	345	93	140	330	7.8
BR2000W040J	CI- 015-P/4	3	220	445	93	140	430	7.8
BR2400W030J	CI- 020-P/4	3	220	445	93	140	430	7.8
BR3600W020J	CI- 025-P/4	3	220	445	165	140	430	7.8
BR3600W020J	CI- 030-P/4	3	220	445	165	140	430	7.8

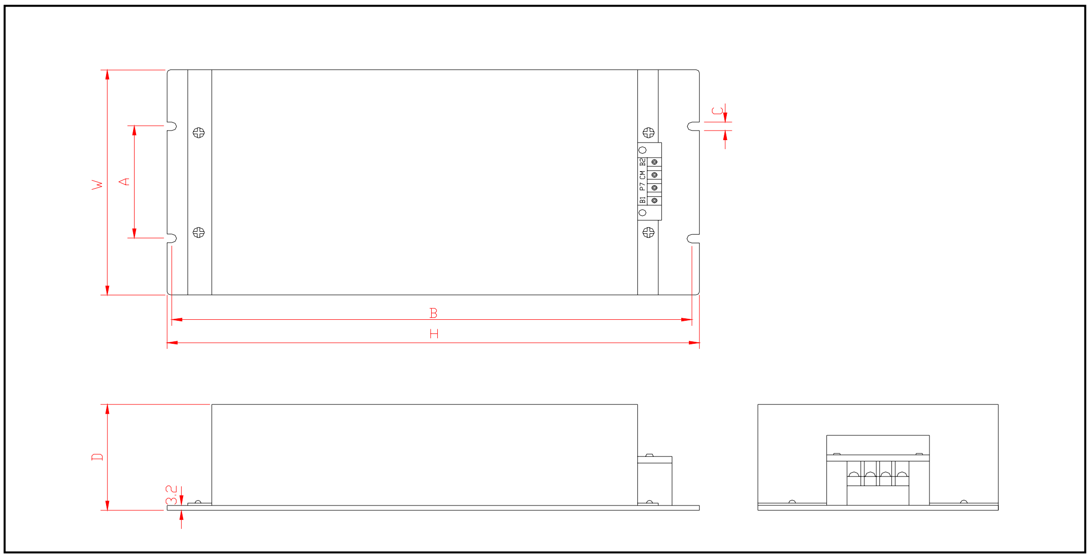
* Type 1 (Max 400 Watt)



* Type 2 (Max 600 Watt)



* Type 3



8.2.5 Micro surge filter (Designed for Inverter-driven 400V Class motor)

In the PWM type inverter, a surge voltage attributable to wiring constants is generated at the motor terminals. Especially for a 400V class motor, the surge voltage may deteriorate the insulation. When the 400V class motor is driven by the inverter, consider the following measures:

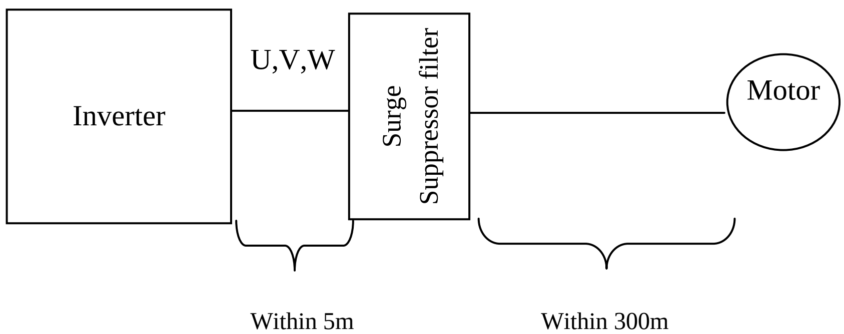
■ **Rectifying the motor insulation**

For the 400V class motor, use an insulation-rectified motor. Specifically, the "400V class inverter-driven, insulation-rectified motor".
For the dedicated motor such as the constant-torque motor and low-vibration motor, use the "inverter-driven, dedicated motor".

■ **Suppressing the surge voltage on the inverter output side**

On the secondary side of the inverter, connect the optional surge voltage suppression filter.

■ **Wiring**



■ **Caution**

Check the Input/Output when wiring the filter.
Wiring distance from inverter output to filter input should not exceed 5 meter.
Wiring distance from filter to motor should not exceed 300 meter.

8.2.6 NEMA TYPE 1 Optional Conduit Box

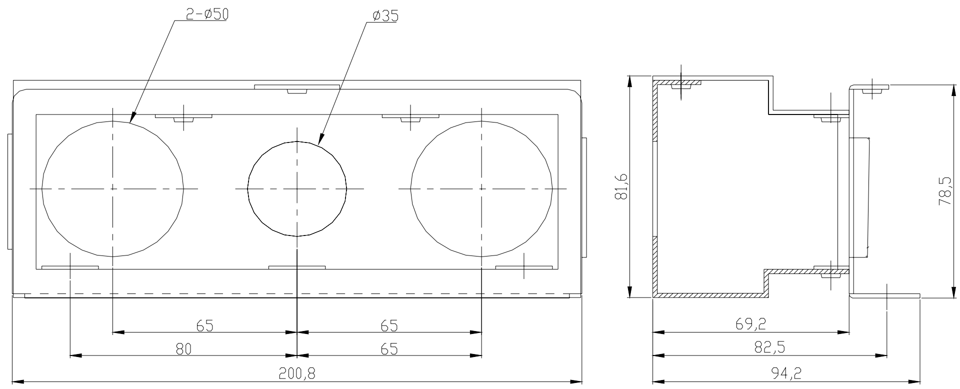
1) NEMA TYPE 1 Enclosure for conduit connection

■ General

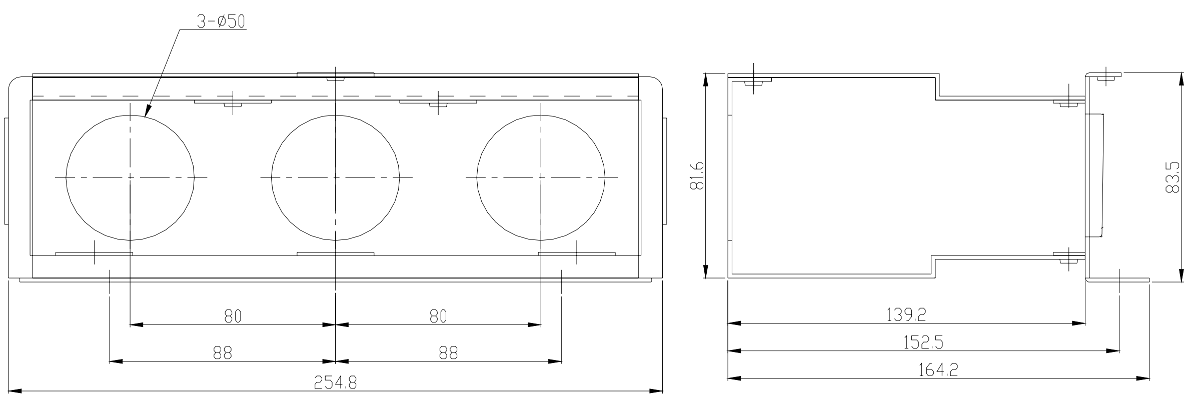
NEMA TYPE 1 Conduit Box: This kit enables an inverter to be installed on the wall without the inverter panel and meets NEMA Type 1. It should be installed to meet NEMA 1 for 15~90kW UL Open Type inverters. However, installing this option does not mean UL Type 1. Please purchase Standard UL Type 1 models if needed.

■ Installation:

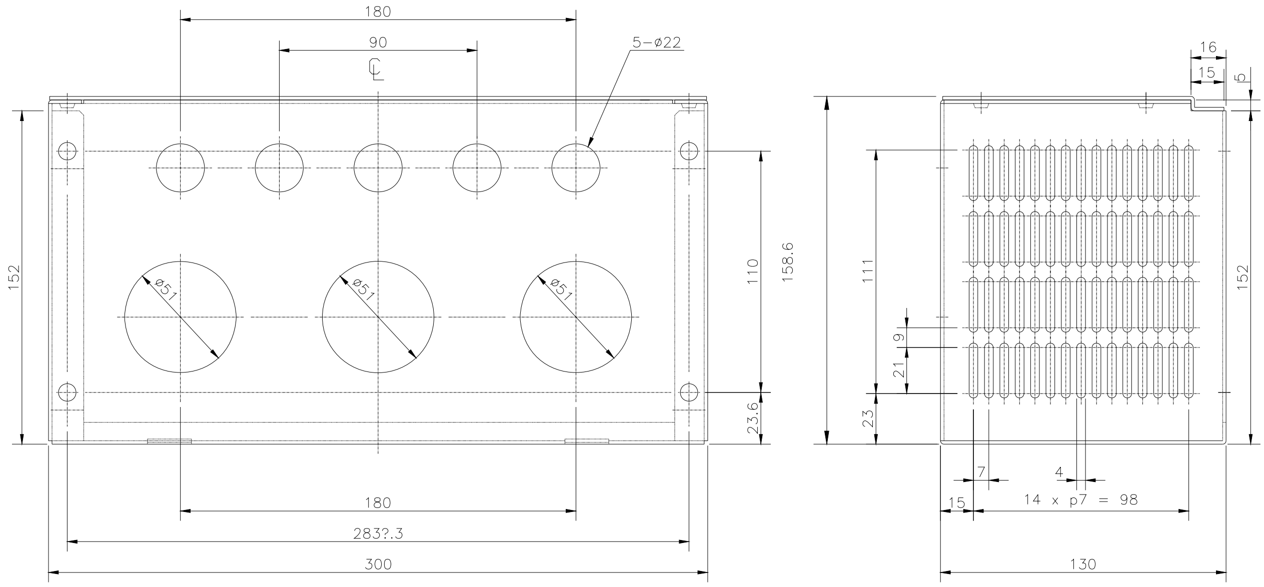
Remove the metal plate on the bottom with the driver and install this kit on to the same place by the screws from the metal plate.



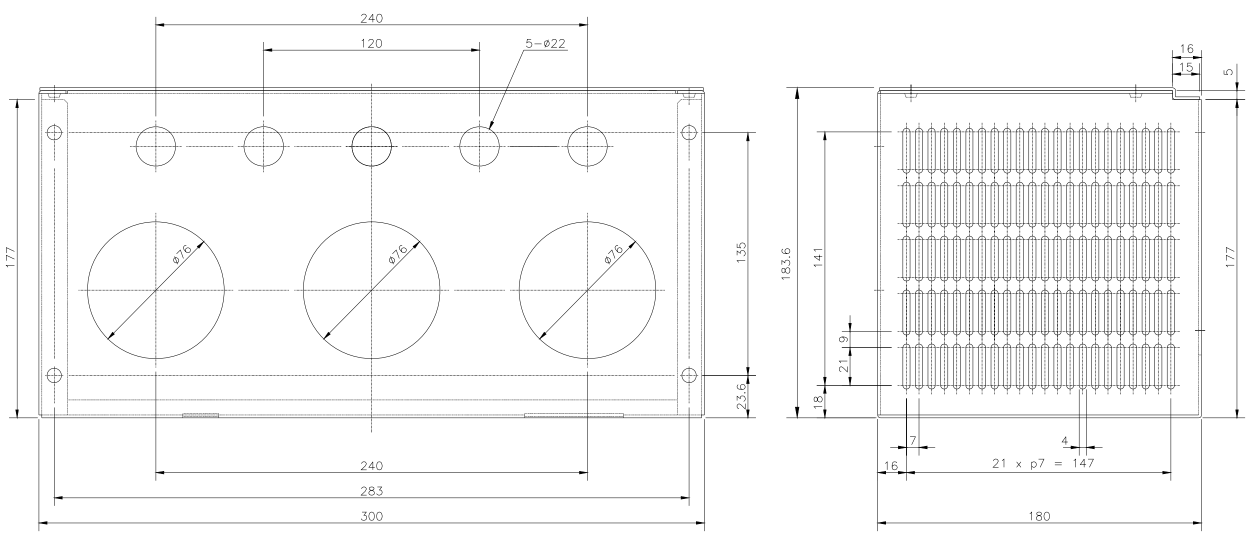
[Conduit box for 020~025 P Series]



[Conduit box for 030~040 P Series]



[Conduit box for 050~075 P Series]



[Conduit box for 100~125 P Series]

■ Conduit Hole Size

mm(inches)

Inverter	Conduit hole for control terminal / Conduit hole for power terminal	Trade Size of the Conduit
CI-007-P2/4	24 (0.98)	16 (1/2)
	24 (0.98)	16 (1/2)
CI-010-P2/4	24 (0.98)	16 (1/2)
	35 (1.37)	27 (1)
CI-015-P2/4	24 (0.98)	16 (1/2)
	35 (1.37)	27 (1)
CI-020-P2/4	35 (1.37)	27 (1)
	50 (1.96)	41 (3/2)
CI-025-P2/4	35 (1.37)	27 (1)
	50 (1.96)	41 (3/2)
CI-030-P2/4	50 (1.96)	41 (3/2)
	50 (1.96)	41 (3/2)
CI-040-P2/4	50 (1.96)	41 (3/2)
	50 (1.96)	41 (3/2)
CI-050-P2/4	22(0.86)	16(1/2)
	51(2.00)	41(3/2)
CI-060-P2/4	22(0.86)	16(1/2)
	51(2.00)	41(3/2)
CI-075-P2/4	22(0.86)	16(1/2)
	51(2.00)	41(3/2)
CI-100-P2/4	22(0.86)	16(1/2)
	76(2.99)	63(5/2)
CI-125-P2/4	22(0.86)	16(1/2)
	76(2.99)	63(5/2)

☞ **Note: Choose the proper size of the Locknut, Bushing corresponding to trade size of the Conduit in use.**

CHAPTER 9 - MODBUS-RTU COMMUNICATION

9.1 Introduction

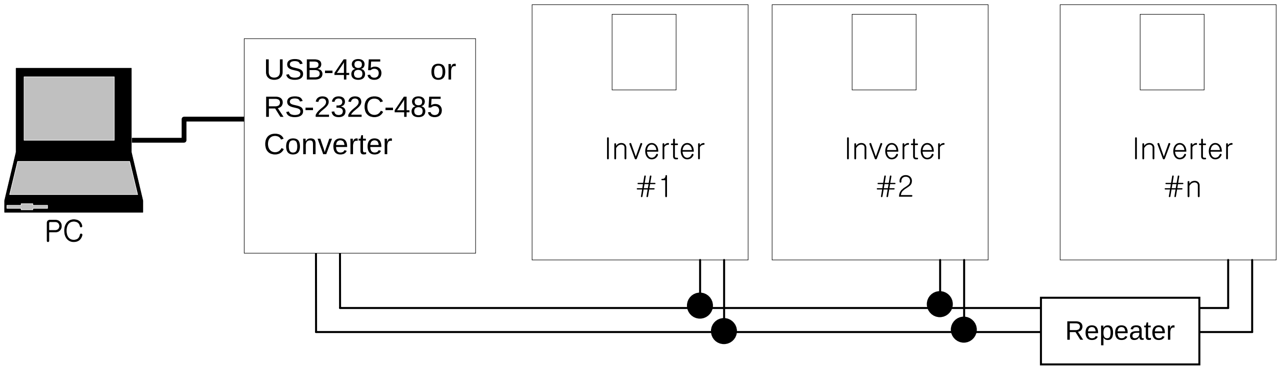
Inverter can be controlled and monitored by the sequence program of the PLC or other master module.
Drives or other slave devices may be connected in a multi-drop fashion on the Modbus-RTU network and may be monitored or controlled by a single PLC or PC. Parameter setting and change are available through PC.
When master sends Write Request to Inverter address 0X00, all inverters perform Write action but do not return a Acknowledge response. This is used to drive multiple inverters at the same time via Modbus-RTU.

9.1.1 Features

Inverter can be easily applied for Factory automation because Operation and monitoring is available by User-program.

* Parameter change and monitoring is available via computer.
(Ex: Accel/Decel time, Freq. Command etc.)
* Interface type of RS485 reference:
1) Allows the drive to communicate with any other computers.
2) Allows connection of up to 31 drives with multi-drop link system.
3) Noise-resistant interface.

9.1.2 Connection guide for Modbus-RTU communication with PC , PLC and RS-232C/485



* REPEATER is not a required item but helps communication in long-distance communication or high noise environment.

9.1.3 Before installation

Before installation and operation, this should be read thoroughly. If not, it can cause personal injury or damage to other equipment.

9.2 Specification

9.2.1 Performance specification

Item	Specification
Transmission form	Bus method, Multi-drop Link System
Applicable inverter	P series
Connectable drives	Max 31
Transmission distance	Max. 1,200m (Within 700m Recommended)
Recommended wire	0.75mm^2(12AWG), Shield Type Twisted-Pare Wire

9.2.2 Hardware specification

Item	Specification
Installation	Use C+, C-,CM terminals on control terminal block
Power supply	Use Insulated power from the inverter power supply

9.2.3 Communication specification

Item	Specification
Communication speed	19,200/9,600/4,800/2,400/1,200 bps selectable
Communication system	Half duplex system
Character system	Binary (8 bit)
Stop bit length	1 bit
Error check(CRC16)	2 bytes
Parity bit	None
Protocol supported	Parameter Read/Write, Monitoring parameter register/execution Broadcasting

9.2.4 Installation

▣ Connecting the communication line

1) Connect the Modbus-RTU communication line to the inverter's (C+), (C-) and CM terminals of the control terminals.
2) Connect the CM terminal among inverters for stable communication.
3) Check the connection and turn ON the inverter.
4) If the communication line is connected correctly set the communication-related parameters as the following:
5) Install a repeater to upgrade the communication speed or longer than 1200mm communication line is used. Repeater is required for upgrading communication quality in the noise-high environment.

▣ **Communication parameters**

Code	Display	Name	Set value	Unit	Default
DRV_03	Drive mode	Drive mode	Int. 485		Fx/Rx-1
DRV_04	Freq mode	Freq mode	Int. 485		KeyPad-1
DRV_91	Drive mode2	Drive mode 2	KeyPad Fx/Rx-1 Fx/Rx-2		Fx/Rx-1
DRV_92	Freq mode2	Freq mode 2	KeyPad-1 KeyPad-2 V1 V1S I V1+I Pulse		KeyPad-1
I/O_20~27	M1 ~ M8	Programmable Digital Inputs	Main-drive		
I/O_90	Inv No	Inverter number	1~250		1
I/O_91	Baud rate	Communication speed	1200 bps 2400 bps 4800 bps 9600 bps 19200 bps		9600 bps
I/O_92	COM Lost Cmd	Operating mode when communication signal is lost	None FreeRun Stop		None
I/O_93	COM Time Out	Time to determine whether Communication signal is lost.	0.1~120.0	sec	1.0

9.3 Operation

9.3.1 Operating steps

1) Check whether the computer and the inverter are connected correctly.
2) Turn ON the inverter. But, do not connect the load until stable communication between the computer and the inverter is verified. Start the operating program for the inverter from the computer.
3) Operate the inverter using the operating program for the inverter.
4) Refer to “13.8 Troubleshooting” if the communication is not operating normally.
5) Turn the inverter J3 switch ON to connect the terminating resistor for the end of network.

*** Connect to C+,C-,CM terminal on the control terminal. Be careful for the polarity(+, -).**

*** Max connectable inverter is 31.**

9.4 Communication protocol (Modbus-RTU)

Use Modbus-RTU protocol (Open protocol).
Computer or other hosts can be Master and Inverters Slave. Inverter responds to Read/Write command from Master.

Supported function code

Function code	Description
0x03	Read Hold Register
0x04	Read Input Register
0x06	Preset Single Register
0x10	Preset Multiple Register

Exception code

<table>
<tr><th colspan="2">Function code</th><th>Description</th></tr>
<tr><td colspan="2">0x01</td><td>ILLEGAL FUNCTION</td></tr>
<tr><td colspan="2">0x02</td><td>ILLEGAL DATA ADDRESS</td></tr>
<tr><td colspan="2">0x03</td><td>ILLEGAL DATA VALUE</td></tr>
<tr><td colspan="2">0x06</td><td>SLAVE DEVICE BUSY</td></tr>
<tr><td>User define</td><td>0x14</td><td>1. Write Disable (Address 0x0004 value is 0)
2. Read Only or Not Program during Running.</td></tr>
</table>

9.5 Parameter code list

<Common area>: Area accessible regardless of inverter models (Note 3)

Address	Parameter	Unit	Unit	R/W	Data value
0x0000	Inverter model			R	9 : P series
0x0001	Inverter capacity			R	4: 5.5kW, 5: 7.5kW 6: 11kW, 7: 15kW, 8: 18.5kW 9: 22kW, A: 30kW B: 37kW, C: 45kW D: 55kW, E: 75kW F: 90kW 10: 110kW, 11: 132kW, 12: 160kW, 13: 220kW, 14: 280kW
0x0002	Inverter Input Voltage			R	0 : 220V Class 1 : 400V Class
0x0003	S/W Version			R	(Ex) 0x0100 : Version 1.00 0x0101 : Version 1.10
0x0005	Frequency Reference	0.01	Hz	R/W	
0x0006	Run Command (Note 1)			R/W	BIT 0: Stop (S) BIT 1: Forward run (F) BIT 2: Reverse run (R) BIT 3: Fault reset (0->1) BIT 4: Emergency stop BIT 5: Not used
				R	BIT 6, BIT 7: Run/Stop command source 0(Terminal), 1(Keypad), 2(Option) 3: Int. 485
					BIT 8 ~12: Freq. reference 0 ~ 16: Multi-step speed freq. (0, 2~16) 17 ~ 19: UpDown (Up, Down, UD Zero) 20 ~ 21: RESERVED 22 ~ 25: Analog (V1, V1S, I, V1I) 26: Pulse 27: Sub 28: Int. 485 29: Option, 30: Jog, 31 : PID
					BIT 15: set when Network error
0x0007	Acceleration Time	0.1	sec	R/W	
0x0008	Deceleration Time	0.1	sec	R/W	
0x0009	Output Current	0.1	A	R	
0x000A	Output Frequency	0.01	Hz	R	
0x000B	Output Voltage	0.1	V	R	
0x000C	DC Link voltage	0.1	V	R	
0x000D	Output power	0.1	kW	R	
0x000E	Operating status of Inverter			R	BIT 0: Stop BIT 1: Forward running BIT 2: Reverse running BIT 3: Fault (Trip) BIT 4: Accelerating BIT 5: Decelerating BIT 6: speed arrival BIT 7: DC Braking BIT 8: Stopping Bit 9: not Used BIT10: Brake Open

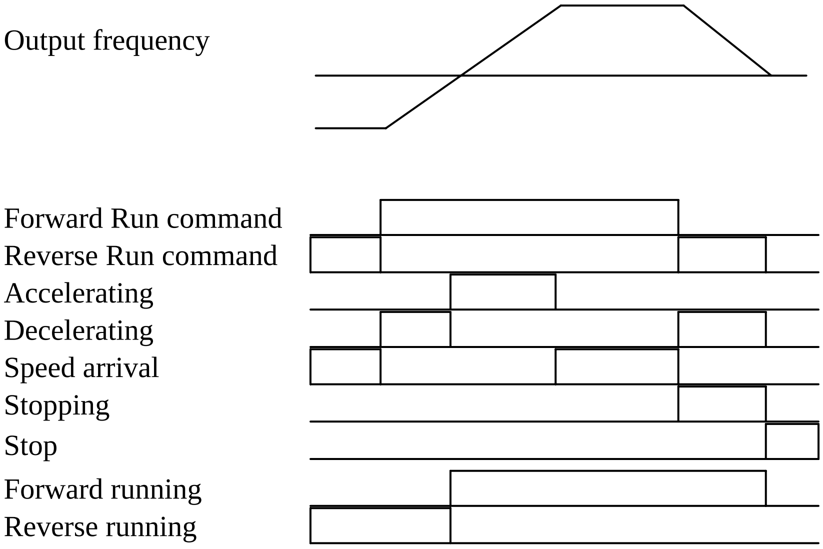
Address	Parameter	Unit	Unit	R/W	Data value
					BIT11: Forward run command BIT12: Reverse run command BIT13: REM. R/S (Int. 485, OPT) BIT14: REM. Freq. (Int. 485, OPT)
0x000F	Trip information			R	BIT 0 : OCT1 BIT 1 : OV BIT 2 : EXT-A BIT 3 : BX BIT 4 : LV BIT 5 : RESERVE BIT 6 : GF(Ground Fault) BIT 6: OHT (Inverter overheat) BIT 7: ETH (Motor overheat) BIT 8: OLT (Overload trip) BIT10: HW-Diag BIT11: RESERVE BIT12: OCT2 BIT13: OPT (Option error) BIT14 : PO (Phase Open) BIT15: IOLT
0x0010	Input terminal status			R	BIT 0 : M1 BIT 1 : M2 BIT 2 : M3 BIT 3 : M4 BIT 4 : M5 BIT 5 : M6 BIT 6 : M7 BIT 7 : M8 BIT 8 : RESERVED BIT 9 : RESERVED BIT 10 : RESERVED
0x0011	Output terminal status			R	BIT 0 : AUX1 BIT 1 : AUX2 BIT 2 : AUX3 BIT 3 : AUX4 BIT 4 : RESERVED BIT 5 : RESERVED BIT 6 : RESERVED BIT 7 : 30AC
0x0012	V1	0~10V		R	
0x0013	V2	0~10V		R	
0x0014	I	0~20mA		R	
0x0015	RPM			R	
0x001A	Unit display			R	0 : Hz, 1 : Rpm
0x001B	Pole number			R	
0x001C	Custom Version			R	

Note 1) Detail description on Common area address 0x0006

Bit	Value	R/W	Name	Description
0	0x01	R/W	Stop	Issue a Stop command via communication (0->1)
1	0x02	R/W	Forward run	Issue a Forward run command via communication (0->1)
2	0x04	R/W	Reverse run	Issue a Reverse run command via communication (0->1)
3	0x08	R/W	Fault reset	Issue a Fault reset command via communication (0->1)
4	0x10	R/W	Emergency stop	Issue a Emergency stop command via communication (0->1)
5			Not used	Not Used
6~7		R	Operating command	0(Terminal),1(keypad),2(option),3(Int. 485)
8~14		R	Frequency command	A. When operating command is issued via Terminal, Keypad or Option 0: DRV-00, 1: Not used, 2 : Multi-step speed 1, 3 : Multi-step speed 2, 4 : Multi-step speed 3 5 : Multi-step speed 4, 6 : Multi-step speed 5, 7 : Multi-step speed 6 8 : Multi-step speed 7, 9 : Multi-step speed 8, 10 : Multi-step speed 9 11: Multi-step speed 10, 12: Multi-step speed 11, 13: Multi-step speed 12 14: Multi-step speed 13, 15 : Multi-step speed 14 , 16 : Multi-step speed 15, 17 :Up, 18 : Down, 19: Up/Down Zero 20~21 : RESERVE 22 : V1, 23 : V1S, 24 : I, 25 : V1+I 26 : Pulse 27 : Sub 28 : Int. 485 29 : Option 30 : Jog 31 : PID
15	0x8000	R	Network error	Network malfunction

Data (including decimal point) displayed in Keypad are real inverter parameter values.

9.5.1 P series operating status in Address E, Common area



< Address usage area by groups >

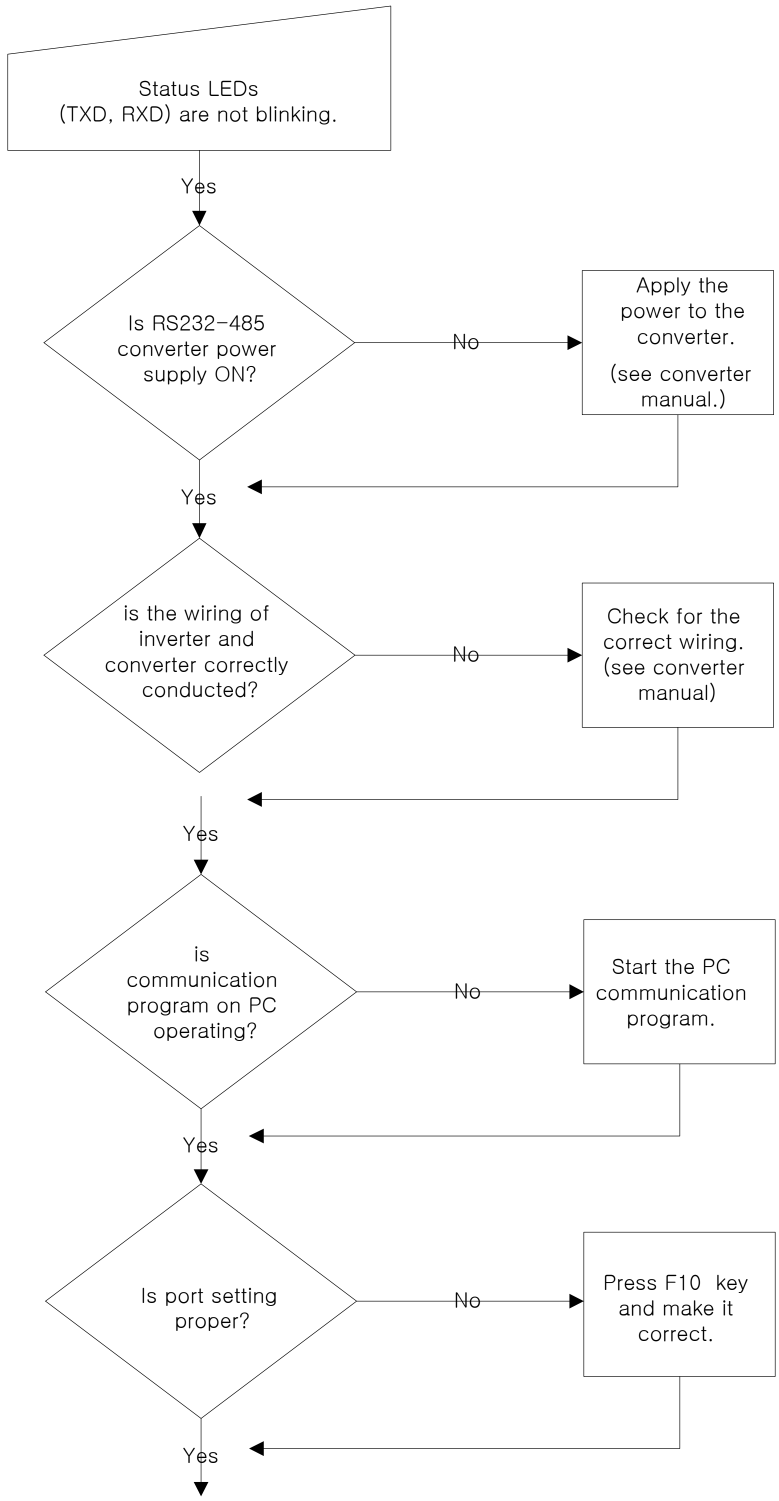
DRV	9100 - 91FF
FU1	9200 – 92FF
FU2	9300 – 93FF
I/O	9400 - 94FF
EXT	9500 - 95FF
COM	9600 - 96FF
APP	9700 - 97FF

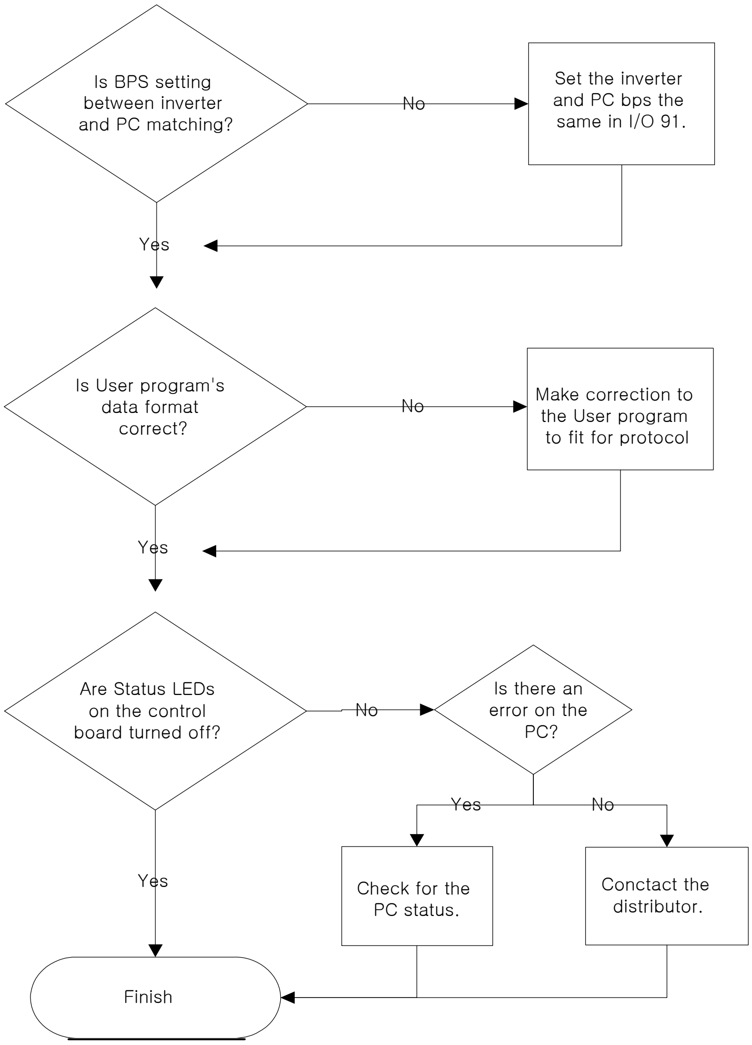
Address setting method to access the parameter using RS485: area assigned by inverter+ Address usage area by groups + Code no. (Hex).

Ex) To check the content of I/O-93 [COM Time Out], perform Read or Write the address 0x945D.

9.6 Troubleshooting

Refer to the below chart when Modbus-RTU communication error occurs.





Is BPS setting between inverter and PC matching?
No
Set the inverter and PC bps the same in I/O 91.
Yes
Is User program's data format correct?
No
Make correction to the User program to fit for protocol
Yes
Are Status LEDs on the control board turned off?
No
Is there an error on the PC?
Yes
No
Yes
Check for the PC status.
Conctact the distributor.
Finish

APPENDIX A- UL MARKING

1. SHORT CIRCUIT RATING

"Suitable For Use On A Circuit Capable Of Delivering Not More Than Table1 RMS Symmetrical Amperes, 240V for 240V rated inverters, 480V for 480V rated inverters Volts Maximum,"
"Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes", or the equivalent.
"When Protected By A Circuit Breaker Having An Interrupting Rating Not Less Than 100,000 rms Symmetrical Amperes, 240 or 480 Volts Maximum."

Table 1. RMS Symmetrical Amperes for P Series.

Model	Rating
CI-007-P/2, CI-007-P/4, CI-010-P/2, CI-010-P/4, CI-015-P/2, CI-015-P/4, CI-020-P/2, CI-020-P/4, CI-025-P/2, CI-025-P/4, CI-030-P/2, CI-030-P/4, CI-040-P/2, CI-040-P/4, CI-050-P/4, CI-060-P/4, CI-075-P/4, CI-100-P/4, CI-125-P/4, CI-150-P/4, CI-200-P/4, CI-250-P/4, CI-350-P/4, CI-400-P/4,	100,000A

2. SHORT CIRCUIT FUSE/BREAKER

Use Class H or K5 UL Listed Input Fuse and UL Listed Breaker Only. See the table below for the Voltage and Current rating of the fuses and the breakers.

Input Voltage	Motor [kW]	Inverter	External Fuse		Breaker		Internal Fuse			
			Current [A]	Voltage [V]	Current [A]	Voltage [V]	Current [A]	Voltage [V]	Manufacturer	Model Number
200V Class	5.5	CI-007-P/2	40	500	50	230				
	7.5	CI-010-P/2	60	500	60	230				
	11	CI-015-P/2	80	500	100	230				
	15	CI-020-P/2	100	500	100	230				
	18.5	CI-025-P/2	125	500	225	230				
	22	CI-030-P/2	150	500	225	230				
	30	CI-040-P/2	200	500	225	230				
400V Class	5.5	CI-007-P/4	20	500	30	460				
	7.5	CI-010-P/4	30	500	30	460				
	11	Ci-015-P/4	40	500	50	460				
	15	CI-020-P/4	60	500	60	460				
	18.5	CI-025-P/4	70	500	75	460				
	22	CI-030-P/4	80	500	100	460				
	30	CI-040-P/4	100	500	125	460				
	37	CI-050-P/4	125	500	125	460	160	660	Hinode	660GH-160SUL
	45	CI-060-P/4	150	500	150	460	160	660	Hinode	660GH-160SUL
	55	CI-075-P/4	175	500	175	460	200	660	Hinode	660GH-200SUL
	75	CI-100-P/4	250	500	225	460	250	660	Hinode	660GH-250SUL
	90	CI-125-P/4	300	500	300	460	315	660	Hinode	660GH-315SUL
	110	CI-150-P/4	350	700	400	460	200×2P	660	Hinode	660GH-200SUL×2P
	132	CI-200-P/4	400	700	500	460	250×2P	660	Hinode	660GH-250SUL×2P
	160	CI-250-P/4	450	700	600	460	315×2P	660	Hinode	660GH-315SUL×2P
	220	CI-350-P/4	700	700	800	460	250×3P	660	Hinode	660GH-250SUL×3P
	280	CI-400-P/4	800	700	1000	460	315×3P	660	Hinode	660GH-315SUL×3P

3. OVER LOAD PROTECTION

IOLT: IOLT(inverter Overload Trip) protection is activated at 110% of the inverter rated current for 1 minute and greater.

OLT : Inverter shuts off its output when inverter output current exceeds its overload trip level for overload trip time. OLT is selected when FU1-66 is set to “Yes” and activated at 120% of FU1-67 [Motor rated current] for 60 sec set in FU1-68.

4. OVER SPEED PROTECTION

Not Provided With Overspeed Protection.

5. FIELD WIRING TERMINAL

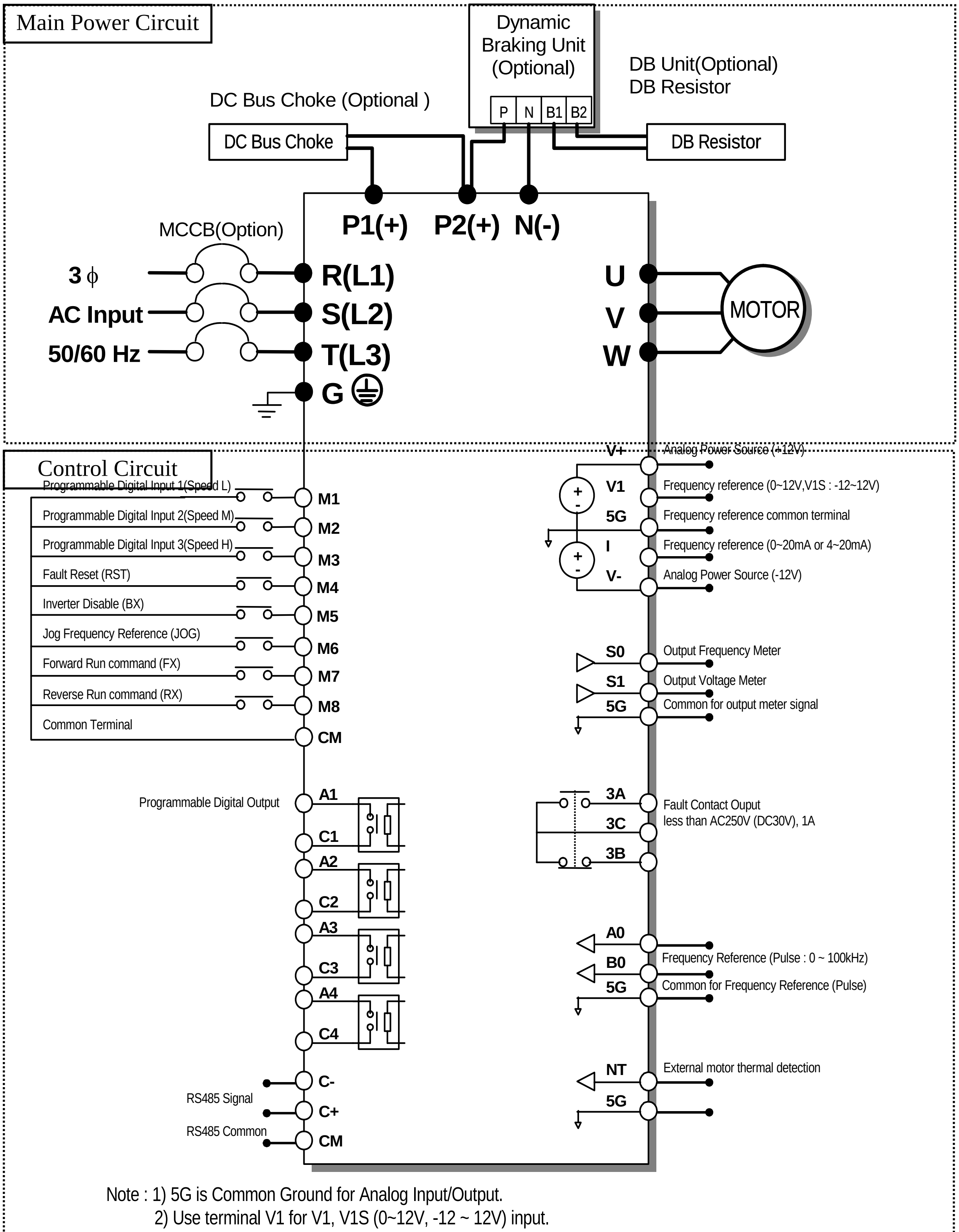
1) Use copper wires only with 600V, 75℃ ratings
2) Tightening torque of power terminal blocks

Inverter Capacity [kW]		Terminal Screw Size	Screw Torque[1]		Wire[2]			
			Kgf·cm	lb-in	mm^2		AWG or kcmil	
					R,S,T	U,V,W	R,S,T	U,V,W
200V Class	5.5	M4	7.1 ~ 12.2	6.2~10.6	5.5	5.5	10	10
	7.5	M5	24.5 ~ 31.8	21.2~27.6	8	8	8	8
	11	M5			14	14	6	6
	15	M6	30.6 ~ 38.2	26.6~33.2	22	22	4	4
	18.5	M6			38	38	2	2
	22	M8	61.2 ~ 91.8	53.1~79.7	38	38	2	2
	30	M8			60	60	1/0	1/0
400V Class	5.5	M4	7.1 ~ 12.2	6.2~10.6	3.5	3.5	12	12
	7.5	M4			3.5	3.5	12	12
	11	M4			5.5	5.5	10	10
	15	M6	30.6~38.2	26.6~33.2	8	8	8	8
	18.5	M6			14	14	6	6
	22	M8	61.2~91.8	53.1~79.7	22	22	4	4
	30	M8			22	22	4	4
	37	M8	67.3~87.5	58.4~75.9	38	38	2	2
	45	M8			38	38	2	2
	55	M8			38	38	2	2
	75	M10	89.7~122.0	77.9~105.9	60	60	1/0	1/0
	90	M10			60	60	1/0	1/0
	110	M12	182.4~215.0	158.3~186.6	100	100	4/0	4/0
	132	M12			100	100	4/0	4/0
	160	M12			150	150	300	300
	220	M12			200	200	400	400
	280	M12	182.4~215.0	158.3~186.6	250	250	500	500

[1] Apply the rated torque to terminal screws. Loose screws can cause of short circuit or malfunction. Tightening the screws too much can damage the terminals and cause a short circuit or malfunction.

3) For 7.5~11kW 240V type inverters, Input and motor output terminal blocks are intended only for use with ring type connectors.

6. BASIC WIRING



Note : 1) 5G is Common Ground for Analog Input/Output.
2) Use terminal V1 for V1, V1S (0~12V, -12 ~ 12V) input.

⚠ CAUTION	
	■ Risk of Electric Shock More than one disconnect switch may be required to de-energize the equipment before servicing.

APPENDIX B- PERIPHERAL DEVICES

1. MCCB(Molded Case Circuit Breaker) and MC(Magnetic Contector)

Voltage	Mortor [kW]	Inverter Model	MCCB	MC
200V Class	5.5	CI-007-P/2	ABS53b/50A	GMC-40
	7.5	CI-010-P/2	ABS63b/60A	GMC-40
	11	CI-015-P/2	ABS103b/100A	GMC-50
	15	CI-020-P/2	ABS103b/100A	GMC-85
	18.5	CI-025-P/2	ABS203b/125A	GMC-100
	22	CI-030-P/2	ABS203b/150A	GMC-100
	30	CI-040-P/2	ABS203b/175A	GMC-150
400V Class	5.5	CI-007-P/4	ABS33b/30A	GMC-22
	7.5	CI-010-P/4	ABS33b/30A	GMC-22
	11	CI-015-P/4	ABS53b/50A	GMC-40
	15	CI-020-P/4	ABS63b/60A	GMC-50
	18.5	CI-025-P/4	ABS63b/60A	GMC-50
	22	CI-030-P/4	ABS103b/100A	GMC-65
	30	CI-040-P/4	ABS103b/100A	GMC-75
	37	CI-050-P/4	ABS203b/125A	GMC-100
	45	CI-060-P/4	ABS203b/150A	GMC-125
	55	CI-075-P/4	ABS203b/175A	GMC-150
	75	CI-100-P/4	ABS203b/225A	GMC-180
	90	CI-125-P/4	ABS403b/300A	GMC-220
	110	CI-150-P/4	ABS403b/400A	GMC-300
	132	CI-200-P/4	ABS603b/500A	GMC-300
	160	CI-250-P/4	ABS603b/600A	GMC-400
	220	CI-350-P/4	ABS803b/700A	GMC-600
	280	CI-400-P/4	ABS803b/800A	GMC-600

2. AC Input Fuse and AC / DC Reactor

Voltage	Mortor [kW]	Inverter Model	AC Input Fuse [A]	AC Reactor		DC Reactor	
				[mH]	[A]	[mH]	[A]
200V Class	5.5	CI-007-P/2	40	0.39	30	1.37	29
	7.5	CI-010-P/2	60	0.28	40	1.05	38
	11	CI-015-P/2	80	0.20	59	0.74	56
	15	CI-020-P/2	100	0.15	75	0.57	71
	18.5	CI-025-P/2	125	0.12	96	0.49	91
	22	CI-030-P/2	150	0.10	112	0.42	107
	30	CI-040-P/2	200	0.07	160	0.34	152
400V Class	5.5	CI-007-P/4	20	1.22	15	5.34	14
	7.5	CI-010-P/4	30	1.14	20	4.04	19
	11	CI-015-P/4	40	0.81	30	2.76	29
	15	CI-020-P/4	60	0.61	38	2.18	36
	18.5	CI-025-P/4	70	0.45	50	1.79	48
	22	CI-030-P/4	80	0.39	58	1.54	55
	30	CI-040-P/4	100	0.287	80	1.191	76
	37	CI-050-P/4	125	0.232	98	0.975	93
	45	CI-060-P/4	150	0.195	118	0.886	112
	55	CI-075-P/4	175	0.157	142	0.753	135
	75	CI-100-P/4	250	0.122	196	0.436	187
	90	CI-125-P/4	300	0.096	237	0.352	225
	110	CI-150-P/4	350	0.081	289	Built-in	
	132	CI-200-P/4	400	0.069	341	Built-in	
	160	CI-250-P/4	450	0.057	420	Built-in	
	220	CI-350-P/4	700	0.042	558	Built-in	
	280	CI-400-P/4	800	0.029	799	Built-in	

APPENDIX C- RELATED PARAMETERS

Use	Related parameter codes
Accel/Decel time, Pattern Adjustment	DRV-01 [Acceleration Time], DRV-02 [Deceleration Time], FU1-02 [Acceleration Pattern], FU1-03 [Deceleration Pattern]
Reverse Rotation Prevention	FU1-01 [Forward/Reverse Prevention]
Accel/Decel at Continuous Rating Range	FU1-02 [Acceleration Pattern], FU1-03 [Deceleration Pattern]
Braking Operation Adjustment	FU1-20 [Starting Mode], FU1-21~22 [DC Injection Braking at Starting] FU1-23 [Stop Mode], FU1-24~27 [DC Injection Braking],
Operations at freq. Over 60 Hz	FU1-30 [Max. Frequency], FU1-35 [Frequency High Limit], I/O-05 [Frequency Corresponding to V1 Max Voltage], I/O-10 [Frequency Corresponding to I Max Current], I/O-16 [Frequency Corresponding to I Max Pulse]
Selecting an Appropriate Output Characteristics for the Load	FU1-30 [Max. Frequency], FU1-31 [Base Frequency]
Motor Output Torque Adjustment	FU1-32 [Starting Frequency], FU1-70~71[Stall Prevention], FU2-67~69 [Torque Boost], FU2-40 [Motor Rating]
Output Frequency Limit	FU1-33~35[Frequency High/Low Limit], I/O-01~16 [Analog Frequency Setting]
Motor Overheat Protection	FU1-60~62 [Electronic Thermal], FU2-40 [Motor Rating] I/O-97, 98 [External Thermal Sensor]
Multi-step Operation	I/O-20~27 [Programmable Digital Input Define], DRV-00, 05~07,I/O-31~42 [Multi-step Frequency], FU1-34~35 [Frequency High/Low Limit]
Jog Operation	I/O-30 [Jog Frequency]
Frequency Jump Operation	FU2-10~16 [Frequency Jump]
Electronic Brake Operation Timing	I/O-74~75 [Frequency Detection], I/O-76~79 [Programmable Digital Output Define]
Rotating Speed Display	DRV-09 [Motor Rpm], FU2-47 [Motor Rpm Display Gain]
Function Change Prevention	FU2-94 [Parameter Lock]
Energy Saving	FU1-51~52 [Energy Saving]
Auto Restart Operation after Alarm Stop	FU2-20~21 [Auto Restart]
2nd Motor Operation	APP-20~29 [2nd Function]
PID Feedback Operation	APP-02~17 [PID Operation]
Adjusting Frequency Reference/Output	I/O-01~16 [Analog Frequency Setting]
Commercial Line<-> Inverter Switchover	I/O-20~27 [Programmable Digital Input Terminal], I/O-76~79 [Programmable Digital Output Terminal]
Frequency Meter Calibration	I/O-70~73 [S0/S1 Analog Output]
Operation via Communication with a PC	I/O-90 [Inverter Number], I/O-91 [Communication Speed], I/O-92~93 [Lost Command]

DECLARATION OF CONFORMITY

Council Directive(s) to which conformity is declared:

CD 73/23/EEC and CD 89/336/EEC

Units are certified for compliance with:

EN 61800-3/A11 (2000)
EN 61000-4-2/A2 (2001)
EN 61000-4-3/A2 (2001)
EN 61000-4-4/A2 (2001)
EN 61000-4-5/A1 (2001)
EN 61000-4-6/A1 (2001)
EN 55011/A2 (2002)
IEC/TR 61000-2-1 (1990)
EN 61000-2-4 (2002)
EN 60146-1-1/A1 (1997)
EN 50178 (1997)

Type of Equipment:	**Inverter (Power Conversion Equipment)**
Model Name:	**P Series**
Trade Mark:	**LS Industrial Systems Co., Ltd.**
Representative:	**LG International (Deutschland) GmbH**
Address:	**Lyoner Strasse 15, Frankfurt am Main, 60528, Germany**
Manufacturer:	**LS Industrial Systems Co., Ltd.**
Address:	**181, Samsung-ri, Mokchon-Eup, Chonan, Chungnam, 330-845, Korea**

We, the undersigned, hereby declare that equipment specified above conforms to the Directives and Standards mentioned.

Place: **Frankfurt am Main** **Germany**	**Chonan, Chungnam,** **Korea**
I. S. Yang 20/03/04 (Signature / Date)	2005/04/26 (Signature/Date)
Mr. Ik-Seong Yang / Dept. Manager (Full name / Position)	**Mr. Jin Goo Song / General Manager** (Full name / Position)

TECHNICAL STANDARDS APPLIED

The standards applied in order to comply with the essential requirements of the Directives 73/23/CEE "Electrical material intended to be used with certain limits of voltage" and 89/336/CEE "Electromagnetic Compatibility" are the following ones:

• EN 50178 (1997)	“Electronic equipment for use in power installations”.
• EN 61800-3/A11 (2000)	“Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific methods”
• EN 55011/A2 (2002)	“Industrial, scientific and medical (ISM) radio-frequency equipment. Radio disturbances characteristics. Limits and methods of measurement”
•EN 61000-4-2/A2 (2001)	“Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 2: Electrostatic discharge immunity test.
• EN 61000-4-3/A2 (2001)	“Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 3: Radiated, radiofrequency, electromagnetic field immunity test.
• EN 61000-4-4/A2 (2001)	“Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 4: Electrical fast transients / burst immunity test.
• EN 61000-4-5/A1 (2000)	“Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 5: Surge immunity test.
• EN 61000-4-6/A1 (2001)	“Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques. Section 6: Immunity to conducted disturbances, induced by radio-frequency fields.
• CEI/TR 61000-2-1 (1990)	“Electromagnetic compatibility (EMC). Part 2: Environment. Environment description for low-frequency conducted disturbances and signalling in public low voltages supply systems”
• EN 61000-2-4 (1997)	“Electromagnetic compatibility (EMC). Part 2: Environment. Compatibility level in industrial plants for low-frequency conducted disturbances”
• EN 60146-1-1/A1 (1997)	“Semiconductor convertors. General requirments and line commutated convertors. Part 1-1: Specifications of basic requirements”

EMI / RFI POWER LINE FILTERS

LS inverters, iP5A Series

RFI FILTERS

THE L.S. RANGE OF POWER LINE FILTERS FF (Footprint) - FE (Standard) SERIES, HAVE BEEN SPECIFICALLY DESIGNED WITH HIGH FREQUENCY LS INVERTERS. THE USE OF L.S. FILTERS, WITH THE INSTALLATION ADVICE OVERLEAF HELP TO ENSURE TROUBLE FREE USE ALONG SIDE SENSITIVE DEVICES AND COMPLIANCE TO CONDUCTED EMISSION AND IMMUNITY STANDARS TO EN 50081 -> EN61000-6-3:02 and EN61000-6-1:02

CAUTION

IN CASE OF A LEAKAGE CURRENT PROTECTIVE DEVICES IS USED ON POWER SUPPLY, IT MAY BE FAULT AT POWER-ON OR OFF. IN AVOID THIS CASE, THE SENSE CURRENT OF PROTECTIVE DEVICE SHOULD BE LARGER THAN VALUE OF LAKAGE CURRENT AT WORST CASE IN THE BELOW TABLE.

RECOMMENDED INSTALLATION INSTRUCTIONS

To conform to the EMC directive, it is necessary that these instructions be followed as closely as possible. Follow the usual safety procedures when working with electrical equipment. All electrical connections to the filter, inverter and motor must be made by a qualified electrical technician.

1-) Check the filter rating label to ensure that the current, voltage rating and part number are correct.

2-) For best results the filter should be fitted as closely as possible to the incoming mains supply of the wiring enclousure, usually directly after the enclousures circuit breaker or supply switch.

3-) The back panel of the wiring cabinet of board should be prepared for the mounting dimensions of the filter. Care should be taken to remove any paint etc... from the mounting holes and face area of the panel to ensure the best possible earthing of the filter.

4-) Mount the filter securely.

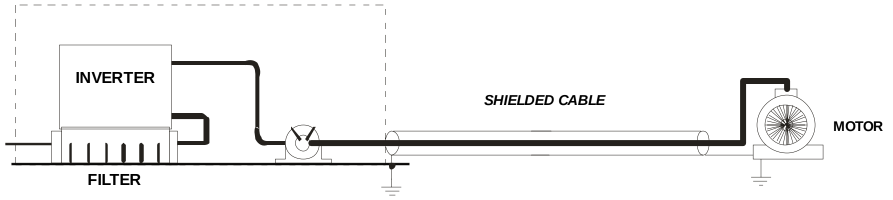
5-) Connect the mains supply to the filter terminals marked LINE, connect any earth cables to the earth stud provided. Connect the filter terminals marked LOAD to the mains input of the inverter using short lengths of appropriate gauge cable.

6-) Connect the motor and fit the ferrite core (output chokes) as close to the inverter as possible. Armoured or screened cable should be used with the 3 phase conductors only threaded twice through the center of the ferrite core. The earth conductor should be securely earthed at both inverter and motor ends. The screen should be connected to the enclousure body via and earthed cable gland.

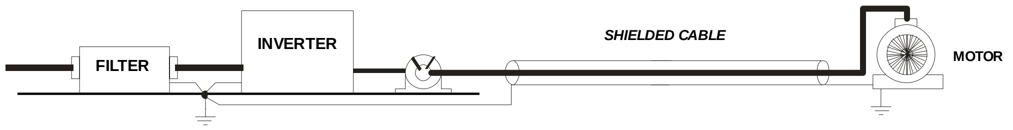
7-) Connect any control cables as instructed in the inverter instructions manual.

IT IS IMPORTANT THAT ALL LEAD LENGHTS ARE KEPT AS SHORT AS POSSIBLE AND THAT INCOMING MAINS AND OUTGOING MOTOR CABLES ARE KEPT WELL SEPARATED.

FF SERIES (Footprint)



FE SERIES (Standard)

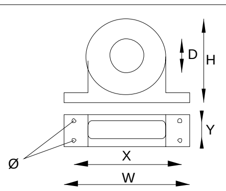


iP5A series / Footprint Filters										
INVERTER	POWER	CODE	CURRENT	VOLTAGE	LEAKAGE CURRENT	DIMENSIONS L W H	MOUNTING Y X	WEIGHT	MOUNT	OUTPUT CHOKES
THREE PHASE					NOM. MAX.					
SV055-P/2	5.5kW	FFP5-T030-(x)	30A	250VAC	0.3mA 18mA	329x149.5x50	315x120	2 Kg.	M5	FS – 2
SV075-P/2	7.5kW	FFP5-T050-(x)	50A	250VAC	0.3mA 18mA	329x199.5x60	315x160	2.5 Kg.	M5	FS – 2
SV110-P/2	11kW		100A	250VAC	0.3mA 18mA					FS – 3
SV150-P/2	15kW									
SV180-P/2	18kW		120A	250VAC	0.3mA 18mA					FS – 3
SV220-P/2	22kW									
SV300-P/2	30kW		150A	250VAC	0.3mA 18mA					FS – 3
SV055-P/4	5.5kW	FFP5-T030-(x)	30A	380VAC	0.5mA 27mA	329x149.5x50	315x120	2 Kg.	M5	FS – 2
SV075-P/4	7.5kW	FFP5-T031-(x)	31A	380VAC	0.5mA 27mA	329x199.5x60	315x160	2.5 Kg.	M5	FS – 2
SV110-P/4	11kW	FFP5-T050-(x)	50A	380VAC	0.5mA 27mA	329x199.5x60	315x160	2.5 Kg.	M5	FS – 2
SV150-P/4	15kW	FFP5-T060-(x)	60A	380VAC	0.5mA 27mA	466x258x65	440.5x181	2.8 Kg.	M5	FS – 2
SV180-P/4	18kW									
SV220-P/4	22kW	FFP5-T070-(x)	70A	380VAC	0.5mA 27mA	541x312x65	515.5x235.3	6.1 Kg.	M8	FS – 2
SV300-P/4	30kW									

iP5A series / Standard Filters										
INVERTER	POWER	CODE	CURRENT	VOLTAGE	LEAKAGE CURRENT	DIMENSIONS L W H	MOUNTING Y X	WEIGHT	MOUNT	OUTPUT CHOKES
THREE PHASE					NOM. MAX.					
SV055-P/2	5.5kW	FE-T030-(x)	30A	250VAC	0.3mA 18mA	270x140x60	258x106	2.4 Kg.	---	FS – 2
SV075-P/2	7.5kW	FE-T050-(x)	50A	250VAC	0.3mA 18mA	270x140x90	258x106	3.2 Kg.	---	FS – 2
SV110-P/2	11kW	FE-T100-(x)	100A	250VAC	0.3mA 18mA	420x200x130	408x166	13.8 Kg.	---	FS – 3
SV150-P/2	15kW									
SV180-P/2	18kW	FE-T120-(x)	120A	250VAC	0.3mA 18mA	420x200x130	408x166	13.8 Kg.	---	FS – 3
SV220-P/2	22kW									
SV300-P/2	30kW	FE-T150-(x)	150A	250VAC	0.3mA 18mA	490x200x160	468x166	15 Kg.	---	FS – 3
SV055-P/4	5.5kW	FE-T030-(x)	30A	380VAC	0.5mA 27mA	270x140x60	258x106	2.4 Kg.	---	FS – 2
SV075-P/4	7.5kW									
SV110-P/4	11kW	FE-T050-(x)	50A	380VAC	0.5mA 27mA	270x140x90	258x106	3.2 Kg.	---	FS – 2
SV150-P/4	15kW									
SV180-P/4	18kW	FE-T060-(x)	60A	380VAC	0.5mA 27mA	270x140x90	258x106	3.5 Kg.	---	FS – 2
SV220-P/4	22kW	FE-T070-(x)	70A	380VAC	0.5mA 27mA	350x180x90	338x146	7.5 Kg.	---	FS – 3
SV300-P/4	30kW									
SV370-P/4	37kW	FE-T100-(x)	100A	380VAC	1.3mA 150mA	425x200x130	408x166	13.8 Kg.	---	FS – 3
SV450-P/4	45kW	FE-T120-(x)	120A	380VAC	1.3mA 150mA	425x200x130	408x166	13.8 Kg.	---	FS – 3
SV550-P/4	55kW									
SV750-P/4	75kW	FE-T170-(x)	170A	380VAC	1.3mA 150mA	480x200x160	468x166	16 Kg.	---	FS – 3
SV900-P/4	90kW	FE-T230-(x)	230A	380VAC	1.3mA 150mA	580x250x205	560x170	22.6 Kg.	---	FS – 4
SV1100-P/4	110kW	FE-T400-(x)	400A	380VAC	1.3mA 150mA	392x260x116	240x235	10.3 Kg.	---	FS – 4
SV1320-P/4	132kW									
SV1600-P/4	160kW	FE-T600-(x)	600A	380VAC	1.3mA 150mA	392x260x116	240x235	11 Kg.	---	FS – 4
SV2200-P/4	220kW									
SV2800-P/4	280kW	FE-T1000-(x)	1000A	380VAC	1.3mA 150mA	460x280x166	290x255	18 Kg.	---	FS – 4

(x) (1) Industrial environment EN50081-2 (A class) -> EN61000-6-4:02

(3) Domestic and industrial environment EN50081-1 (B class) -> EN61000-6-3:02



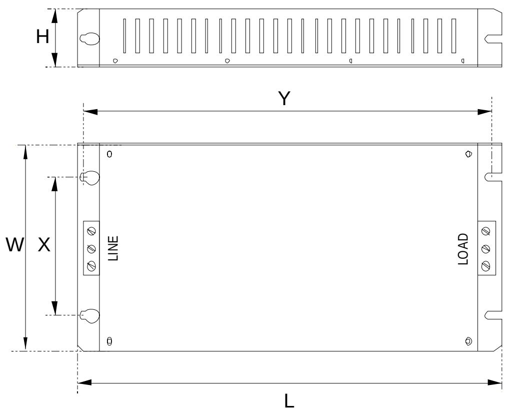
FS SERIES (output chokes)

CODE	D	W	H	X	Ø
FS 2	28.5	105	62	90	5
FS 3	48	150	110	125 x 30	5
FS 4	58	200	170	180 x 45	5

DIMENSIONS

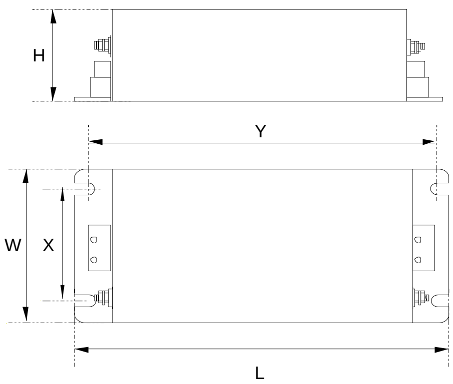
FF SERIES (Footprint)

FFP5-T030-(x) ~ FFP5-T070-(x)

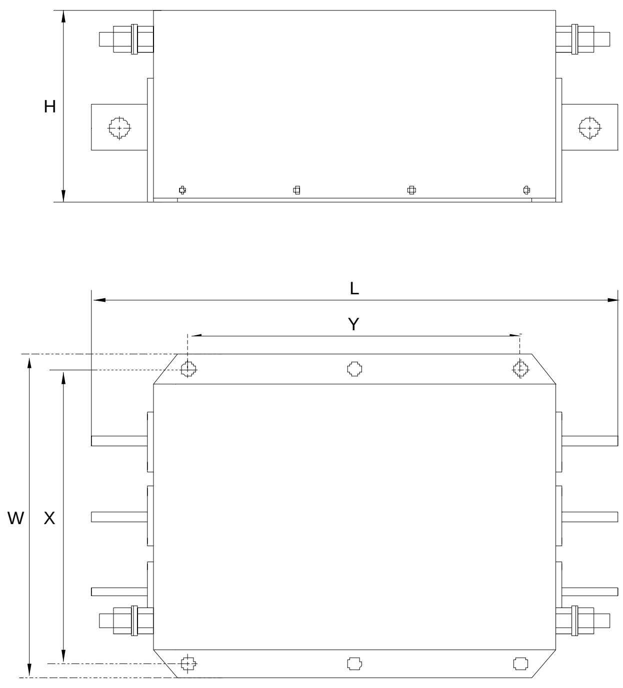


FE SERIES (Standard)

FE-T030-(x) ~ FE-T230-(x)



FE-T400-(x) ~ FE-T1600-(x)



Polígono Industrial de Palou
08400 Granollers (Barcelona)
SPAIN / ESPAÑA
Tel: +34 - 93 861 14
Fax: +34 - 93 879 26 64

E-mail: info@lifasa.com

http: www.lifasa.com

Warranty

Maker	CERUS		Installation (Start-up) Date	
Model No.	P Series		Warranty Period	
Customer Information	Name			
	Address			
	Tel.			
Sales Office (Distributor)	Name			
	Address			
	Tel.			

Warranty period is 60 months after date of invoice when used in a variable torque application. Detailed warranty terms and conditions are available from Cerus Industrial or can be found at www.cerusind.com.

- **IN-WARRANTY service information**

If the defective part has been identified under normal and proper use within the guarantee term, contact your local authorized CERUS distributor or CERUS Service center.

- **OUT-OF WARRANTY service information**

The guarantee will not apply in the following cases, even if the guarantee term has not expired.

- Damage was caused by misuse, negligence or accident.
- Damage was caused by abnormal voltage and peripheral devices' malfunction (failure).
- Damage was caused by improper repair or altering by other than CERUS authorized distributor or service center.
- Damage was caused by an earthquake, fire, flooding, lightning, or other natural calamities.
- When CERUS nameplate is not attached.
- When the warranty period has expired.

nyb | The New York Blower Company®

7660 QUINCY STREET–WILLOWBROOK, ILLINOIS 60527-5530

TEL: [630] 794-5700•FAX: [630] 794-5776• WEB: http://www.nyb.com •E-MAIL: nyb@nyb.com

INSTALLATION, MAINTENANCE, OPERATING INSTRUCTIONS

IM-140

PRESSURE BLOWERS
TYPE HP PRESSURE BLOWERS

⚠ WARNING

THIS FAN HAS MOVING PARTS THAT CAN CAUSE SERIOUS BODILY INJURY. BEFORE OPERATING OR STARTING MAINTENANCE READ THE INSTALLATION AND MAINTENANCE INSTRUCTIONS AND THE AMCA SAFETY PRACTICES MANUAL PROVIDED WITH THIS FAN.

DURING OPERATION

1. KEEP BODY, HANDS, AND FOREIGN OBJECTS AWAY FROM THE INLET, THE OUTLET, AND THE OTHER MOVING PARTS OF THE FAN SUCH AS SHAFTS, BELTS, AND PULLEYS.

2. DO NOT OPERATE AT EXCESSIVE SPEEDS OR TEMPERATURES.

BEFORE STARTING MAINTENANCE WORK:

LOCK POWER SUPPLY IN OFF POSITION AND IMMOBILIZE FAN WHEEL.

98-0250

A WORD ABOUT SAFETY

The above **WARNING** decal appears on all **nyb** fans. Air moving equipment involves electrical wiring, moving parts, sound, and air velocity or pressure which can create safety hazards if the equipment is not properly installed, operated and maintained. To minimize this danger, follow these instructions as well as the additional instructions and warnings on the equipment itself.

All installers, operators and maintenance personnel should study AMCA Publication 410, "Recommended Safety Practices for Air Moving Devices", which is included as part of every shipment. Additional copies can be obtained by writing to New York Blower Company, 7660 Quincy St., Willowbrook, IL 60527.

ELECTRICAL DISCONNECTS

Every motor driven fan should have an independent disconnect switch to isolate the unit from the electrical supply. It should be near the fan and must be capable of being locked by maintenance personnel while servicing the unit, in accordance with OSHA procedures.

MOVING PARTS

All moving parts must have guards to protect personnel. Safety requirements vary, so the number and type of guards needed to meet company, local and OSHA standards must be determined and specified by the user. Never start a fan without having all safety guards installed. Check regularly for damaged or missing guards and do not operate any fan with guards removed. Fans can also become dangerous because of potential “windmilling”, even though all electrical power is disconnected. Always block the rotating assembly before working on any moving parts.

SOUND

Some fans can generate sound that could be hazardous to exposed personnel. It is the responsibility of the system designer and user to determine sound levels of the system, the degree of personnel exposure, and to comply with applicable safety requirements to protect personnel from excessive noise. Consult **nyb** for fan sound power level ratings.

AIR PRESSURE AND SUCTION

In addition to the normal dangers of rotating machinery, fans present another hazard from the suction created at the fan inlet. This suction can draw materials into the fan where they become high velocity projectiles at the outlet. It can also be extremely dangerous to persons in close proximity to the inlet, as the forces involved can overcome the strength of most individuals. Inlets and outlets that are not ducted should be screened to prevent entry and discharge of solid objects.

⚠ DANGER

DO NOT OPEN UNTIL THE POWER SUPPLY HAS BEEN LOCKED OFF AND THE SHAFT HAS STOPPED ROTATING.
FAILURE TO DO THIS CAN RESULT IN SERIOUS BODILY INJURY.

98-0249

ACCESS DOORS

The above DANGER decal is placed on all **nyb** cleanout doors. These doors, as well as access doors to the duct system, should never be opened while the fan is in operation. Serious injury could result from the effects of air pressure or suction.

Bolted doors must have the door nuts or fasteners securely tightened to prevent accidental or unauthorized opening.

RECEIVING AND INSPECTION

The fan and accessories should be inspected on receipt for any shipping damage. Turn the wheel by hand to see that it rotates freely and does not bind. If dampers or shutters are provided, check these accessories for free operation of all moving parts.

F.O.B. factory shipping terms require that the receiver be responsible for inspecting the equipment upon arrival. Note damage or shortages on the Bill of Lading and file any claims for damage or loss in transit. **nyb** will assist the customer as much as possible; however, claims must be originated at the point of delivery.

HANDLING AND STORAGE

Fans should be lifted by the base, mounting supports, or lifting eyes only. Never lift a fan by the wheel, shaft, motor, motor bracket, housing inlet, outlet, or any fan part not designed for lifting. A spreader should always be used to avoid damage.

On a direct drive Arrangement 8 fan, lifting holes are provided in the motor base to assist in handling the fan assembly. These lifting holes should be used in conjunction with the lifting eyes when lifting and positioning the fan onto its foundation. A heavy round steel bar or appropriate fixture can be passed through the lifting holes to simplify attachment of the lifting device. Be sure to follow all local safety codes when moving heavy equipment.

Whenever possible, fans and accessories should be stored in a clean, dry location to prevent rust and corrosion of steel components. If outdoor storage is necessary, protection should be provided. Cover the inlet and outlet to prevent the accumulation of dirt and moisture in the housing. Cover motors with waterproof material. Refer to the bearing section for further storage instructions.

Check shutters for free operation and lubricate moving parts prior to storage. Inspect the stored unit periodically. **Rotate the wheel by hand every two weeks to redistribute grease on internal bearing parts.**

FAN INSTALLATION

nyb wheels are dynamically balanced when fabricated. Complete assembled fans are test run at operating speeds to check the entire assembly for conformance to **nyb** vibration limits. Nevertheless, all units must be adequately supported for smooth operation. **Ductwork or stacks should be independently supported as excess weight may distort the fan housing and cause contact between moving parts.** Where vibration isolators are used, consult the **nyb** certified drawing for proper location and adjustment.

Slab-Mounted Units

A correctly designed and level concrete foundation provides the best means of installing floor-mounted fans. The mass of the base must maintain the fan/driver alignment, absorb normal vibration, and resist lateral loads. The overall dimensions of the concrete base should extend at least six inches beyond the base of the fan. The weight of the slab should be two to three times the weight of the rotating assembly, including the motor. The foundation requires firmly anchored fasteners such as the anchor bolts shown in Figure 1.

Move the fan to the mounting location and lower it over the anchor bolts, leveling the fan with shims around the bolts. Fasten the fan securely. When grout is used, shim the fan at least 3/4-inch from the concrete base. (See Figure 1.) When isolation is used, check the **nyb** certified drawing for installation instructions.

Elevated Units

When an elevated or suspended structural steel platform is used, it must have sufficient bracing to support the unit load and prevent side sway. The platform should be of welded construction to maintain permanent alignment of all members.

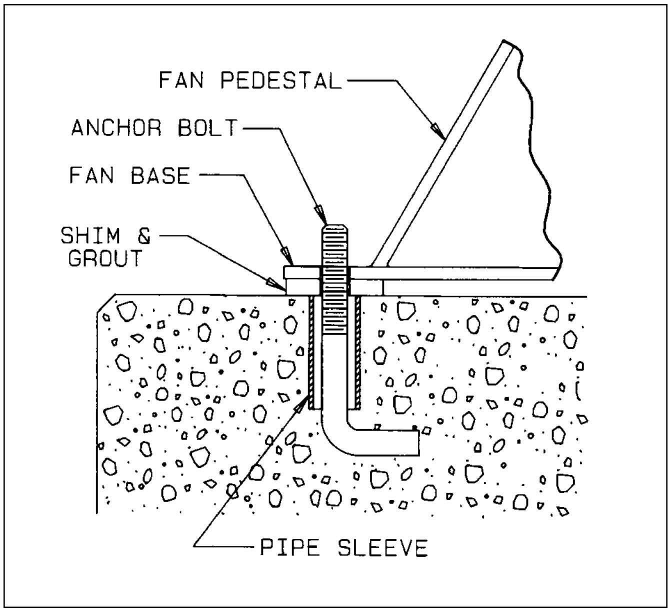


Figure 1

V-BELT DRIVE

Installation

1. Remove all foreign material from the fan and motor shafts. Coat shafts with machine oil for easier mounting. Mount the belt guard backplate at this time if partial installation is required prior to sheave mounting.
2. Mount sheaves on shafts after checking sheave bores and bushings for nicks or burrs. Avoid using force. If resistance is encountered, lightly polish the shaft with emery cloth until the sheave slides on freely. Tighten tapered bushing bolts sequentially so that equal torque is applied to each.
3. Adjust the motor on its base to a position closest to the fan shaft. Install belts by working each one over the sheave grooves until all are in position. Never pry the belts into place. On **nyb** packaged fans, sufficient motor adjustment is provided for easy installation of the proper size belts.
4. Adjust sheaves and the motor shaft angle so that the sheave faces are in the same plane. Check this by placing a straightedge across the face of the sheaves. Any gap between the edge and sheave faces indicates misalignment. Important: This method is only valid when the width of the surface between the belt edge and the sheave face is the same for both sheaves. When they are not equal, or when using adjustable-pitch sheaves, adjust so that all belts have approximately equal tension. Both shafts should be at the right angles to the center belt.

Belt Tensioning

1. Check belt tension with a tensioning gage and adjust using the motor slide base. Excess tension shortens bearing life while insufficient tension shortens belt life, can reduce fan performance and may cause vibration. The lowest allowable tension is that which prevents slippage under full load. Belts may slip during start-up, but slipping should stop as soon as the fan reaches full speed. For more precise tensioning methods, consult the drive manufacturer’s literature.
2. Recheck setscrews, rotate the drive by hand and check for rubbing, then complete the installation of the belt guard.

3. Belts tend to stretch somewhat after installation. Recheck tension after several days of operation. Check sheave alignment as well as setscrew and/or bushing bolt tightness.

COUPLING

Coupling alignment should be checked after installation and prior to start up. Alignment is set at the factory, but shipping, handling, and installation can cause misalignment. Also check for proper coupling lubrication. For details on lubrication and for alignment tolerances on the particular coupling supplied, see the manufacturer's installation and maintenance supplement in the shipping envelope.

Installation

Most **nyb** fans are shipped with the coupling installed. In cases where the drive is assembled after shipping, install the coupling as follows:

1. Remove all foreign material from fan and motor shafts and coat with machine oil for easy mounting of coupling halves.
2. Mount the coupling halves on each shaft, setting the gap between the faces specified by the manufacturer. Avoid using force. If mounting difficulty is encountered, lightly polish the shaft with emery cloth until the halves slide on freely.

Alignment

1. Align the coupling to within the manufacturer's limits for parallel and angular misalignment (see Figure 2). A dial indicator or laser can also be used for alignment where greater precision is desired. Adjustments should be made by moving the motor to change shaft angle, and by the use of foot shims to change motor shaft height. Do not move the fan shaft or bearing.
2. When correctly aligned, install the flexible element and tighten all fasteners in the coupling and motor base. Lubricate the coupling if necessary.
3. Recheck alignment and gap after a short period of operation, and recheck the tightness of all fasteners in the coupling assembly.

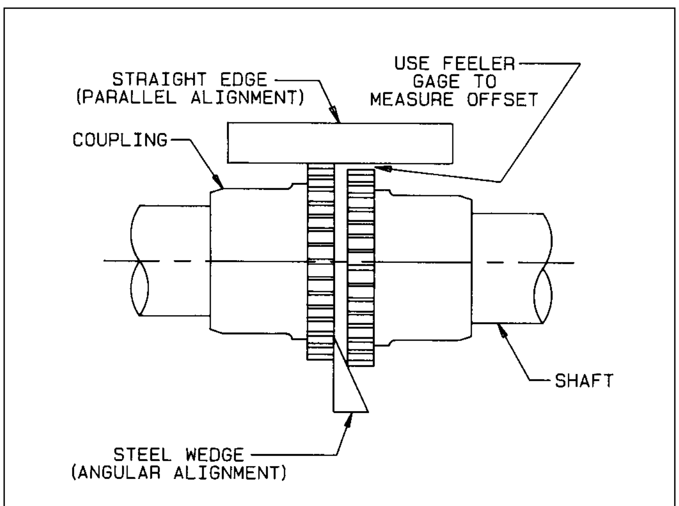


Figure 2

START-UP

Safe operation and maintenance includes the selection and use of appropriate safety accessories for the specific installation. This is the responsibility of the system designer and requires consideration of equipment location and accessibility as well as adjacent components. All safety accessories must be installed properly prior to start-up.

Safe operating speed is a function of system temperature and wheel design. Do not under any circumstances exceed the maximum safe fan speed published in the **nyb** engineering supplement, which is available from your **nyb** field sales representative.

⚠ CAUTION

BEFORE INITIAL OPERATION:

1. **TIGHTEN ALL SET SCREWS IN FAN WHEEL.**
2. **TIGHTEN ALL SET SCREWS IN BEARINGS.**
3. **REPEAT AFTER 8 HOURS OF OPERATION.**
4. **REPEAT AGAIN AFTER TWO WEEKS OPERATION.**

98-0271

Procedure

1. If the drive components are not supplied by **nyb**, verify with the manufacturer that the starting torque is adequate for the speed and inertia of the fan.
2. Inspect the installation prior to starting the fan. Check for any loose items or debris that could be drawn into the fan or dislodged by the fan discharge. Check the interior of the fan as well. Turn the wheel by hand to check for binding.
3. Check drive installation and belt tension.
4. Check the tightness of all setscrews, nuts and bolts. When furnished, tighten hub setscrews with the wheel oriented so that the setscrew is positioned underneath the shaft.
5. Install all remaining safety devices and guards. Verify that the supply voltage is correct and wire the motor. “Bump” the starter to check for proper wheel rotation.
6. Use extreme caution when testing the fan with ducting disconnected. Apply power and check for unusual sounds or excessive vibration. If either exists, see the section on Common Fan Problems. To avoid motor overload, do not run the fan for more than a few seconds if ductwork is not fully installed. On larger fans, normal operating speed may not be obtained without motor overload unless ductwork is attached. Check for correct fan speed and complete installation. Ductwork and guards must be fully installed for safety.
7. Setscrews should be rechecked after a few minutes, eight hours and two weeks of operation (see Tables 1 & 2 for correct tightening torques).

NOTE: Shut the fan down immediately if there is any sudden increase in fan vibration.

Table 1 - WHEEL SETSCREW TORQUES

Setscrew Size Diameter (in.)	Carbon Steel Setscrew Torque*	
	lb.-in.	lb.-ft.
1/2	600	50
5/8	--	97
3/4	--	168

*** Stainless Steel setscrews are not hardened and should not be tightened to more than 1/2 the values shown.**

Table 2 - BEARING SETSCREW TORQUE, lb.-in.

Setscrew Diameter	Manufacturer				
	Link-Belt	Sealmaster	SKF	McGill	Dodge
1/4	90	65	50	85	--
5/16	185	125	165	165	160

Note: Split pillow block bearings are fixed to the shaft with tapered sleeves and generally do not have setscrews.

FAN MAINTENANCE

nyb fans are manufactured to high standards with quality materials and components. Proper maintenance will ensure a long and trouble-free service life.

Do not attempt any maintenance on a fan unless the electrical supply has been completely disconnected and locked. In many cases, a fan can windmill despite removal of all electrical power. The rotating assembly should be blocked securely before attempting maintenance of any kind.

The key to good fan maintenance is regular and systematic inspection of all fan parts. Inspection frequency is determined by the severity of the application and local conditions. Strict adherence to an inspection schedule is essential.

Regular fan maintenance should include the following:

1. Check the fan wheel for any wear or corrosion, as either can cause catastrophic failures. Check also for the build-up of material which can cause unbalance resulting in vibration, bearing wear and serious safety hazards. Clean or replace the wheel as required.
2. Check the V-belt drive for proper alignment and tension (see section on V-belt drives). If belts are worn, replace them as a set, matched to within manufacturer's tolerances. Lubricate the coupling of direct-drive units and check for alignment (see section on couplings).
3. Lubricate the bearings, but do not over lubricate (see the bearing section for detailed specifications).
4. Ceramic-felt shaft seals require no maintenance, although worn seals should be replaced. When lip-type shaft seals are provided, lubricate them with "NEVER-SEEZ" or other anti-seize compound.
5. During any routine maintenance, all setscrews and bolts should be checked for tightness. See the table for correct torques.
6. When installing a new wheel, the proper wheel-to-inlet clearance must be maintained (see Figure 3).

WHEEL BALANCE

Airstreams containing particulate or chemicals can cause abrasion or corrosion of the fan parts. This wear is often uneven and can lead to significant wheel unbalance over time. When such wear is discovered, a decision must be made as to whether to rebalance or replace the wheel.

The soundness of all parts should be determined if the original thickness of components is reduced. Be sure there is no hidden structural damage. The airstream components should also be cleaned to remove any build-up of foreign material. Specialized equipment can be used to rebalance a cleaned wheel that is considered structurally sound.

Balance weights should be rigidly attached at a point that will not interfere with the housing nor disrupt airflow. Remember that centrifugal forces can be extremely high at the outer radius of a fan wheel. Welding is the preferred method of balance weight attachment. Be sure to ground the welder directly to the fan wheel. Otherwise, the welding current could pass through the fan bearings and damage them.

WHEEL-INLET CLEARANCE

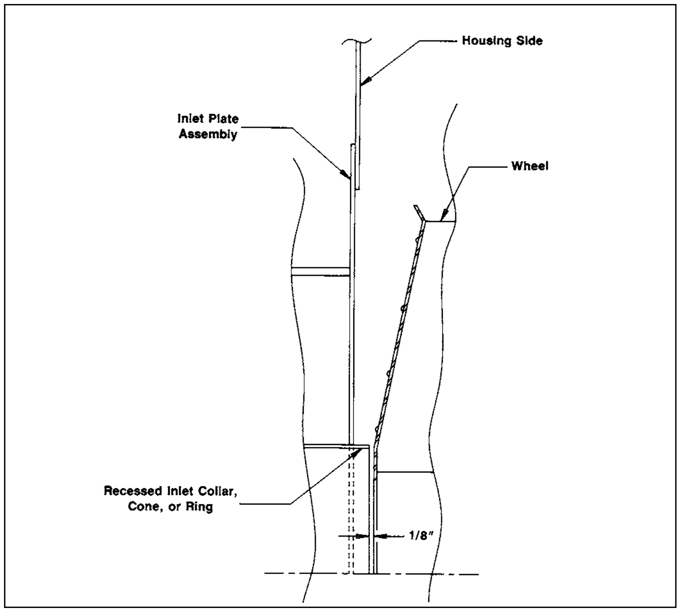


Figure 3

BEARINGS

Storage

Any stored bearing can be damaged by condensation caused by temperature variations. Therefore, **nyb** fan bearings are filled with grease at the factory to exclude air and moisture. Such protection is adequate for shipment and subsequent immediate installation.

For long term or outdoor storage, mounted bearings should be regreased and wrapped with plastic for protection. **Rotate the fan wheel by hand at least every two weeks to redistribute grease on internal bearing parts.** Each month the bearings should be purged with new grease to remove condensation, since even a filled bearing can accumulate moisture. Use caution when purging, as excessive pressure can damage the seals. Rotate the shaft while slowly adding grease.

Operation

Check the setscrew torque before start-up (see table for correct values). Since bearings are completely filled with grease at the factory, they may run at an elevated temperature during initial operation. Surface temperatures may reach 180°F. and grease may bleed from the bearing seals. This is normal and no attempt should be made to replace lost grease. Bearing surface temperatures will decrease when the internal grease quantity reaches a normal operating level. Relubrication should follow the recommended schedule.

Lubrication

Use the table for relubrication scheduling according to operating speed and shaft diameter. Bearings should be lubricated with a premium quality lithium-based grease conforming to NLGI Grade 2. Examples are:

Mobil	- Mobilith AW2	Chevron	- Amolith #2
Texaco	- Premium RB	Shell	- Alvania #2

These greases are for bearing surface temperatures of 40°F. to 180°F. For surface temperatures of 181°F. to 230°F. use Mobilith SHC220.

Do not use "high temperature" greases, as many are not formulated to be compatible with fan bearings.

Add grease to the bearing while running the fan or rotating the shaft by hand. Be sure all guards are in place if lubrication is performed while the fan is operating. Add just enough grease to cause a slight purging at the seals. Except on split pillowblocks. Completely filled bearings will run hotter until a sufficient amount of grease is purged out of the seals.

Split pillowblock bearings (Link-Belt P-LB6800 & P-LB6900, SKF SAF 22500, Dodge SAF-XT) should be cleaned and repacked at approximately every eighth lubrication interval. This requires removal of the bearing cap. Clean out old grease and repack the bearing with fresh grease. Pack the bearing fully and fill the housing reservoir to the bottom of the shaft on both sides of the bearing. Replace the bearing cap, being careful not to mix caps as they are not interchangeable from one bearing to another. **Do not over lubricate.**

BEARING LUBRICATION INTERVAL [months]

RPM / Shaft	1 - 500	501- 1000	1001- 1500	1501- 2000	2001- 2500	2501- 3000	3001- 3500	3501- 4000
1 7/16	6 / 6	6 / 4	5-6 / 4	4-6 / 2	4-6 / 2	3-5 / 1	2-4 / 1	2-4 / 1
1 11/16	6 / 6	6 / 4	4-6 / 2	4-6 / 1	2-4 / 1	2-4 / 1	2 / 1-2	1-2 / 1-2
2 3/16			6	4-6	4	2-4	2	--
2 7/16			6	4-6	4	2-4	2	--
2 15/16			4-6	4-6	2-4	2	1-2	--

Ball Bearings & Split Split Pillowblock Spherical Roler Bearings → ⟋ ← **Non- Split Pillowblock Spherical Roller Bearings**

NOTE:

1. **These are general recommendations only; specific manufacturer's recommendations may vary slightly.**
2. **Assumes clean environment, -20°F. to 120°F.**
   a. **Consult The New York Blower Company for operation below -20°F. ambient.**
   b. **Ambient temperatures greater than 120°F. will shorten bearing life.**
   c. **Under extremely dirty conditions, lubricate more frequently.**
3. **Assumes horizontal mounting configuration. For vertically mounted applications, lubricate twice as frequently.**

COMMON FAN PROBLEMS

Excessive Vibration

A common complaint regarding industrial fans is "excessive vibration". **nyb** is careful to ensure that each unit is precisely balanced prior to shipment; however, there are many other causes of vibration including:

1. Loose mounting bolts, setscrews, bearings or couplings.
2. Misalignment or excessive wear of couplings or bearings.
3. Misaligned or unbalanced motor.
4. Bent shaft due to mishandling or material impact.
5. Accumulation of foreign material on the wheel.
6. Excessive wear or erosion of the wheel.
7. Excessive system pressure or restriction of airflow due to closed dampers.
8. Inadequate structural support, mounting procedures or materials.
9. Externally transmitted vibration.

Inadequate Performance

1. Incorrect testing procedures or calculations.
2. Fan running too slowly.
3. Fan wheel rotating in wrong direction or installed backwards on shaft.
4. Wheel not properly centered relative to inlet cone.
5. Damaged or incorrectly installed cut off sheet or diverter.
6. Poor system design, closed dampers, air leaks, clogged filters, or coils.
7. Obstructions or sharp elbows near inlets.
8. Sharp deflection of airstream at fan outlet.

Excessive Noise

1. Fan operating near "stall" due to incorrect system design or installation.
2. Vibration originating elsewhere in the system.
3. System resonance or pulsation.
4. Improper location or orientation of fan intake and discharge.
5. Inadequate or faulty design of supporting structures.
6. Nearby sound reflecting surfaces.
7. Loose accessories or components.
8. Loose drive belts.
9. Worn bearings.

Premature Component Failure

1. Prolonged or major vibration.
2. Inadequate or improper maintenance.
3. Abrasive or corrosive elements in the airstream or surrounding environment.
4. Misalignment or physical damage to rotating components or bearings.
5. Bearing failure from incorrect or contaminated lubricant or grounding through the bearings while arc welding.
6. Excessive fan speed.
7. Extreme ambient or airstream temperatures.
8. Improper belt tension.
9. Improper tightening of wheel setscrews.

REPLACEMENT PARTS

It is recommended that only factory-supplied replacement parts be used. **nyb** fan parts are built to be fully compatible with the original fan, using specific alloys and tolerances. These parts carry a standard **nyb** warranty.

When ordering replacement parts, specify the part name, **nyb** shop and control number, fan size, type, rotation (viewed from drive end), arrangement and bearing size or bore. Most of this information is on the metal nameplate attached to the fan base.

For assistance in selecting replacement parts, contact your local **nyb** representative or visit: http://www.nyb.com.

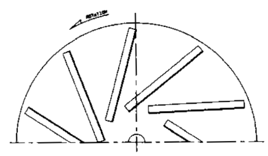
Example: Part required: Wheel/shaft assembly
Shop/control number: B-10106-100
Fan description: Size 2206A10 Pressure Blower
Rotation: Clockwise
Arrangement: 4

Suggested replacement parts include:

Wheel	Component parts: Damper
Shaft •	Motor
Bearings*	Coupling*
Shaft Seal*	Sheaves*
	V-Belts*

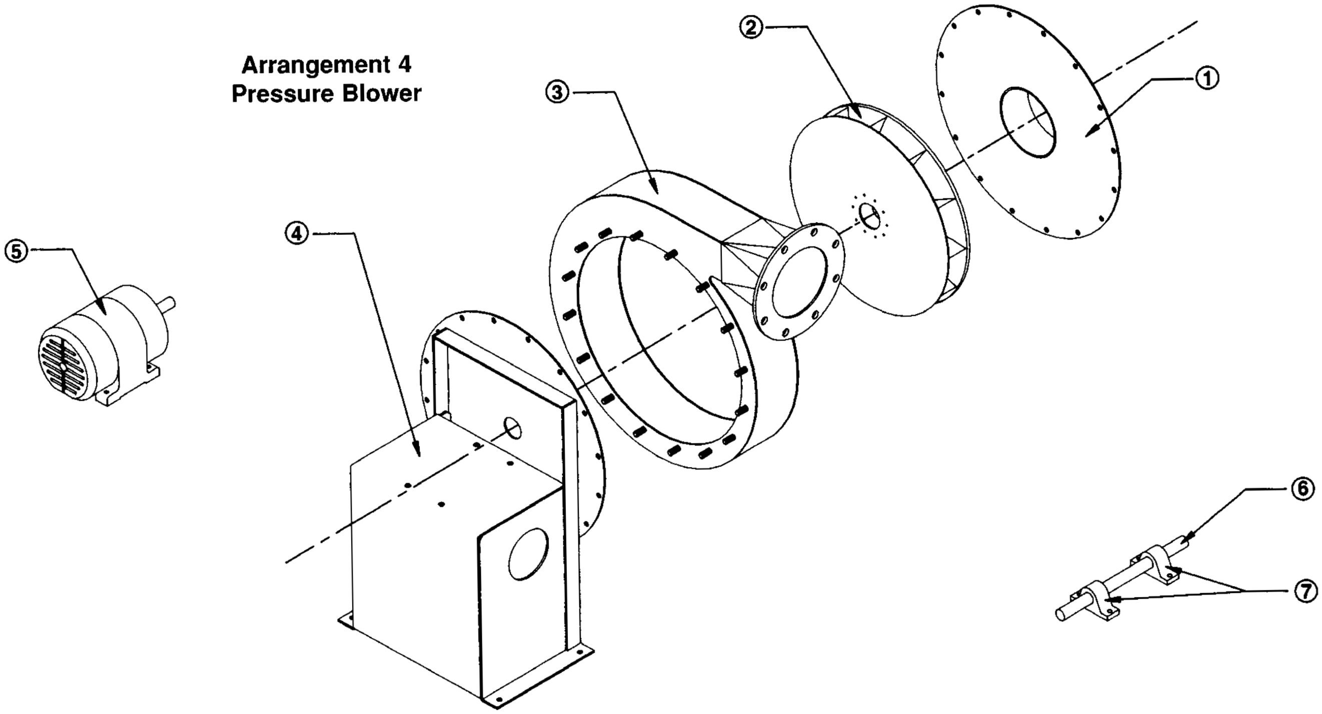
• For Arrangement 1/8 fan only.

SPECIFY ROTATION AS VIEWED FROM DRIVE SIDE

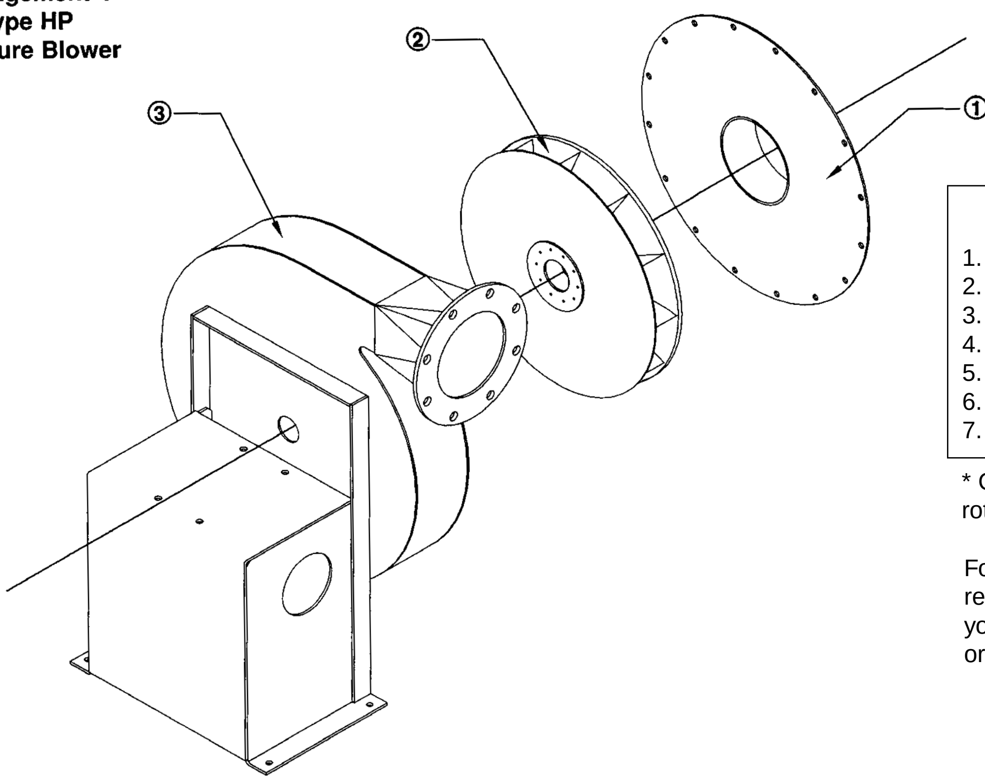


ARROW INDICATES COUNTER CLOCKWISE ROTATION

Arrangement 4
Pressure Blower



Arrangement 4
Type HP
Pressure Blower



Parts List

1. Inlet Plate Assembly
2. Wheel*
3. Housing*
4. Pedestal Assembly
5. Motor
6. Shaft
7. Bearings

* Order for parts must specify rotation.

For assistance in selecting replacement parts, contact your local **nyb** representative or visit: http://www.nyb.com.

Form 300 GPB SW
Printed in U.S.A.

Using Performance Curves

Performance is shown according to outlet sizes for quick reference to duct diameter and velocity. Brake horsepower increments are identified on each curve. Recommended standard blower size and motor combinations are based on the most efficient area of operation and are indicated by the arrows. Nonstandard combinations are generally available, but are usually less efficient than the standard combinations.

SIZING NOMENCLATURE

7-digit model number designates the wheel diameter, outlet size, wheel type, and nominal motor horsepower.

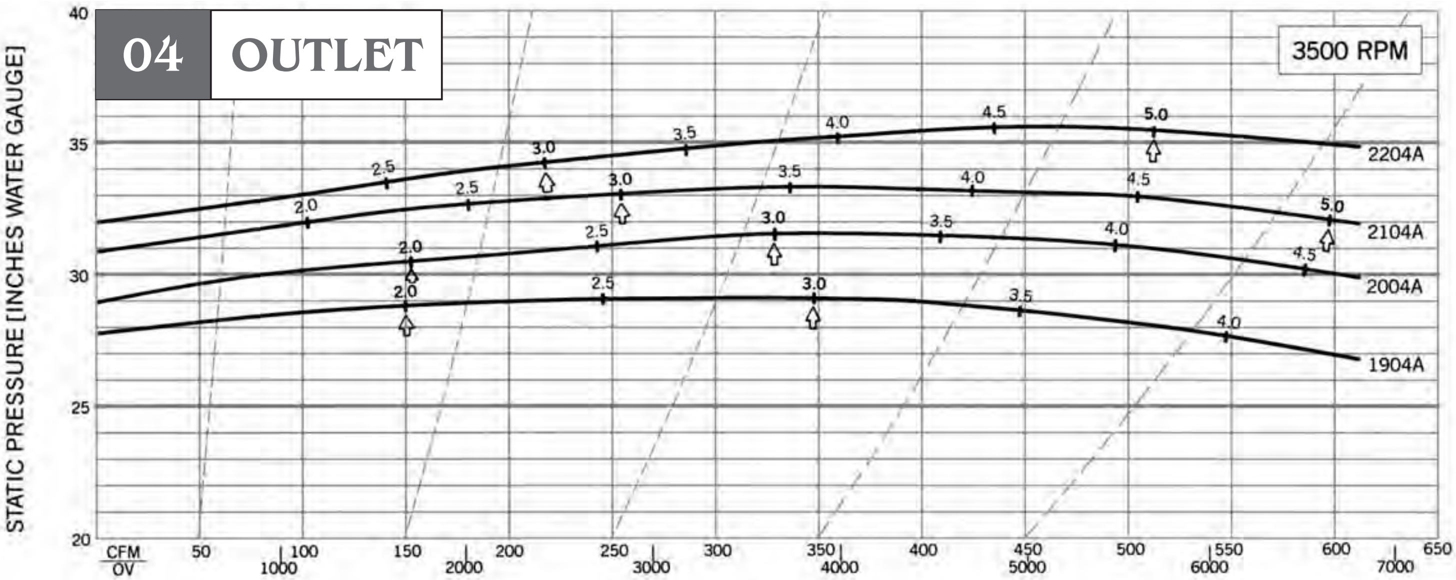
Note: the last two digits showing motor horsepower are not required for Arrangement 1 Pressure Blowers.

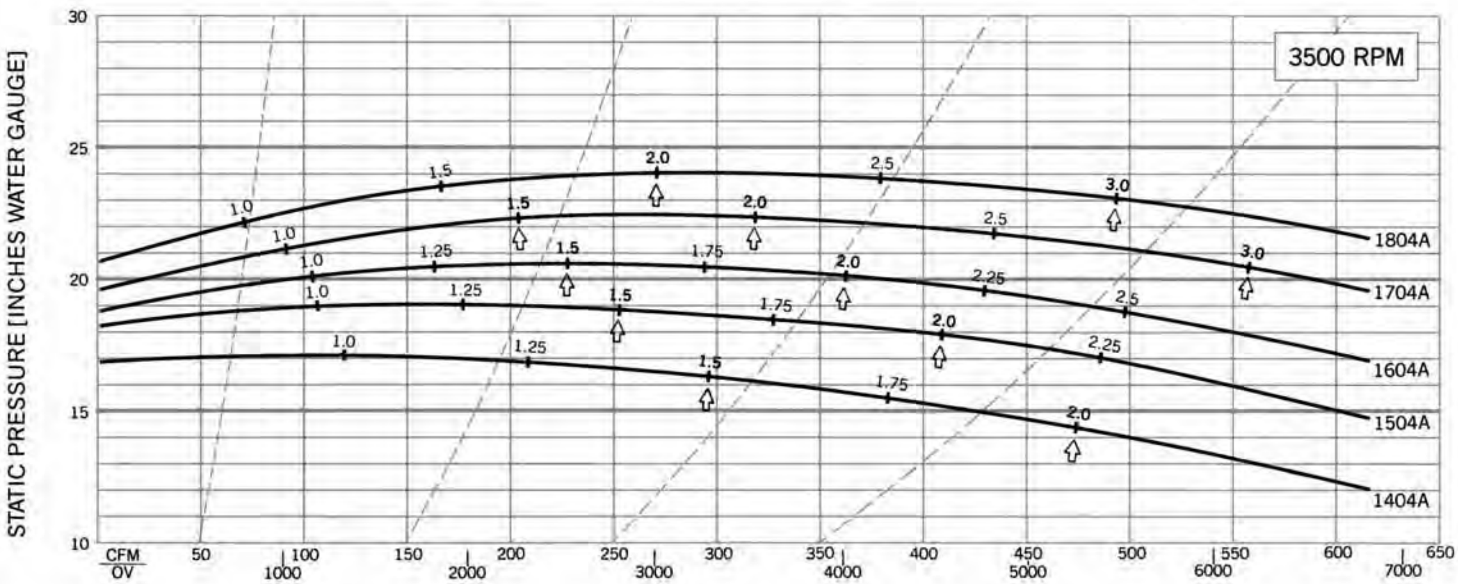
EXAMPLE

21	06	A	7½
Wheel diameter	Outlet size [inches]	Wheel type A = aluminum S = steel/ stainless steel	Nominal horse-power

PROCEDURE	STEPS	EXAMPLE
Determine the appropriate outlet size.	1	The 06 outlet is selected for 800 CFM at 32″SP.
Plot the CFM and SP [standard] and follow a projected system line up to the pressure curve that meets or slightly exceeds the required performance.	2	A Size 2106A will provide 820 CFM at 33.6″SP.
Determine the BHP required for the point of operation . . . see page 4 for steel or stainless-steel wheel factors.	3	2106A requires 6.3 BHP. 2106S requires 7.2 BHP [6.3 x 1.15].
Read to the right to select motor horsepower.	4	A 7½ HP motor will cover both wheel types.

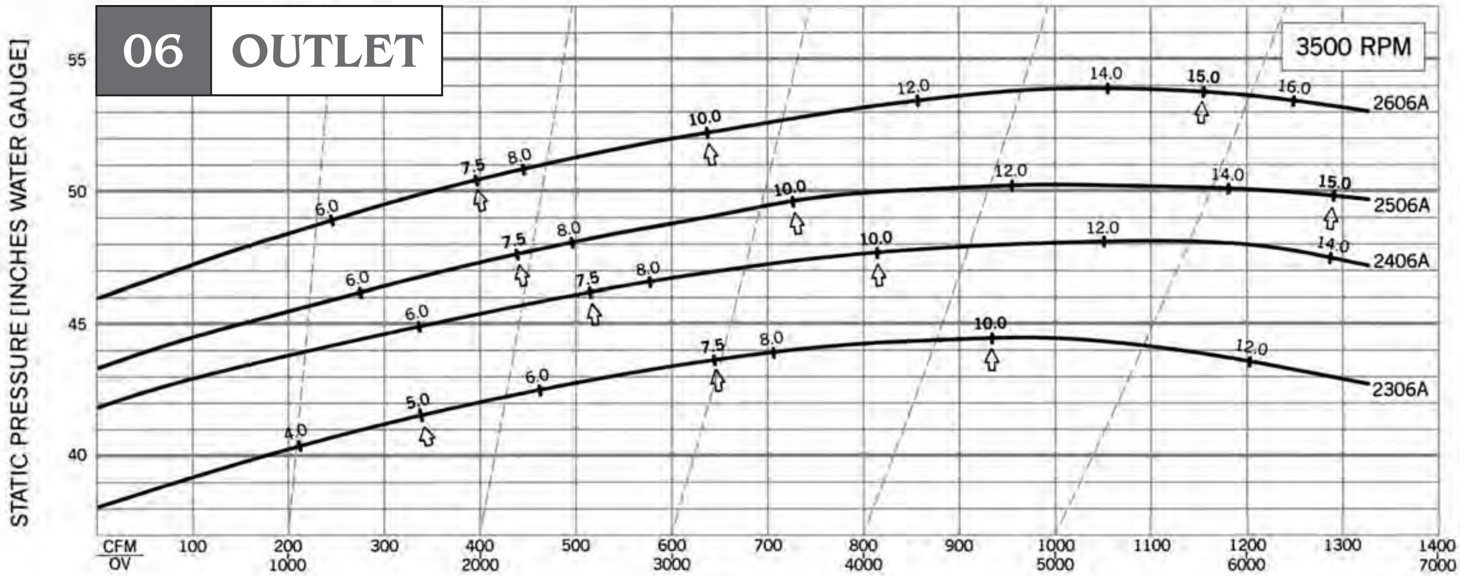
Note: The horsepower coverage of a given motor will increase 15% when a 1.15 service factor motor is utilized.

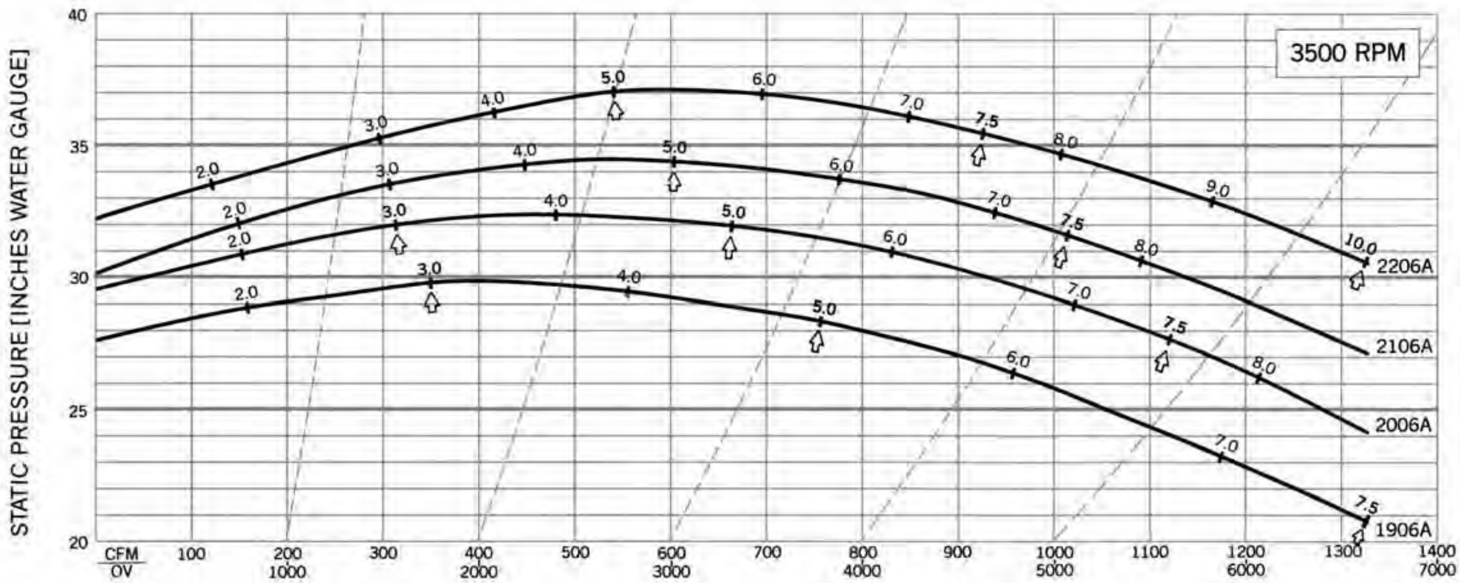


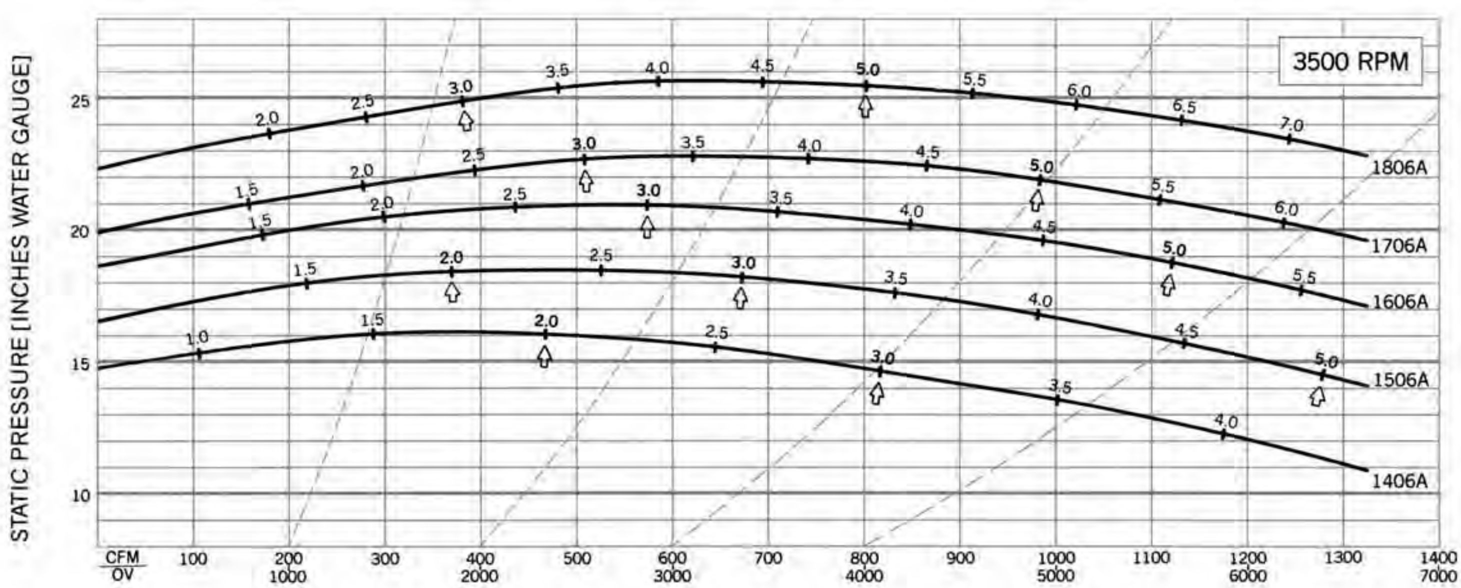


Performance shown is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include drive losses.
Performance ratings do not include the effects of appurtenances in airstream.

06 OUTLET

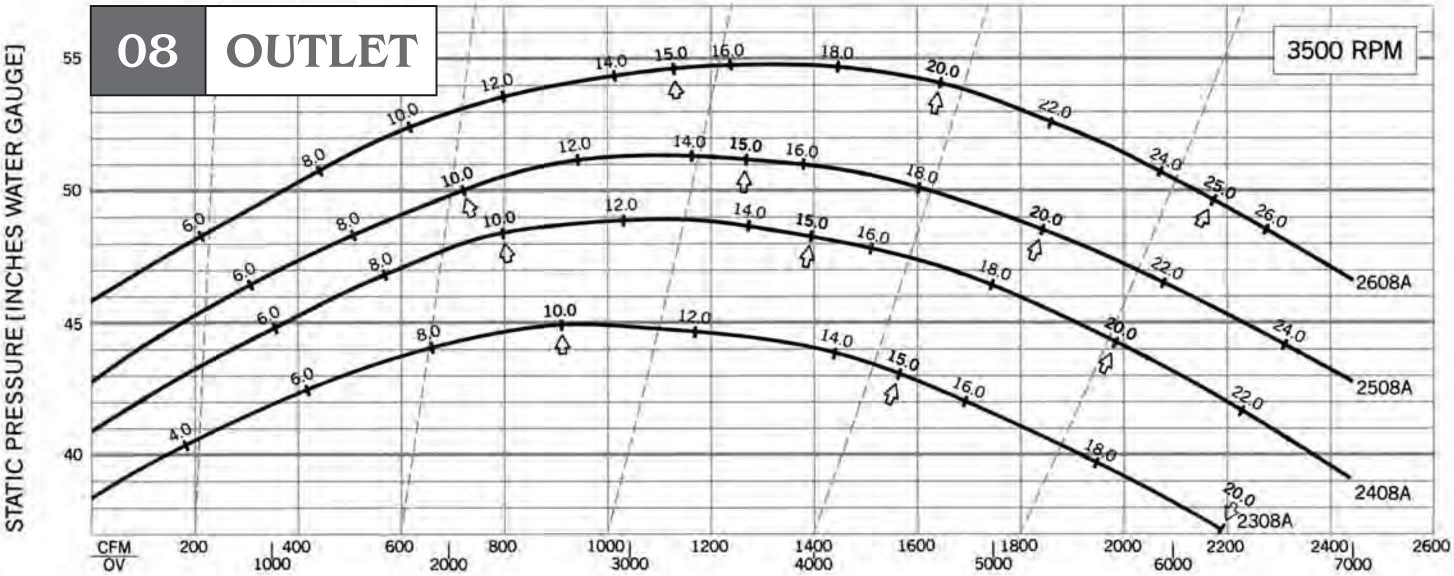


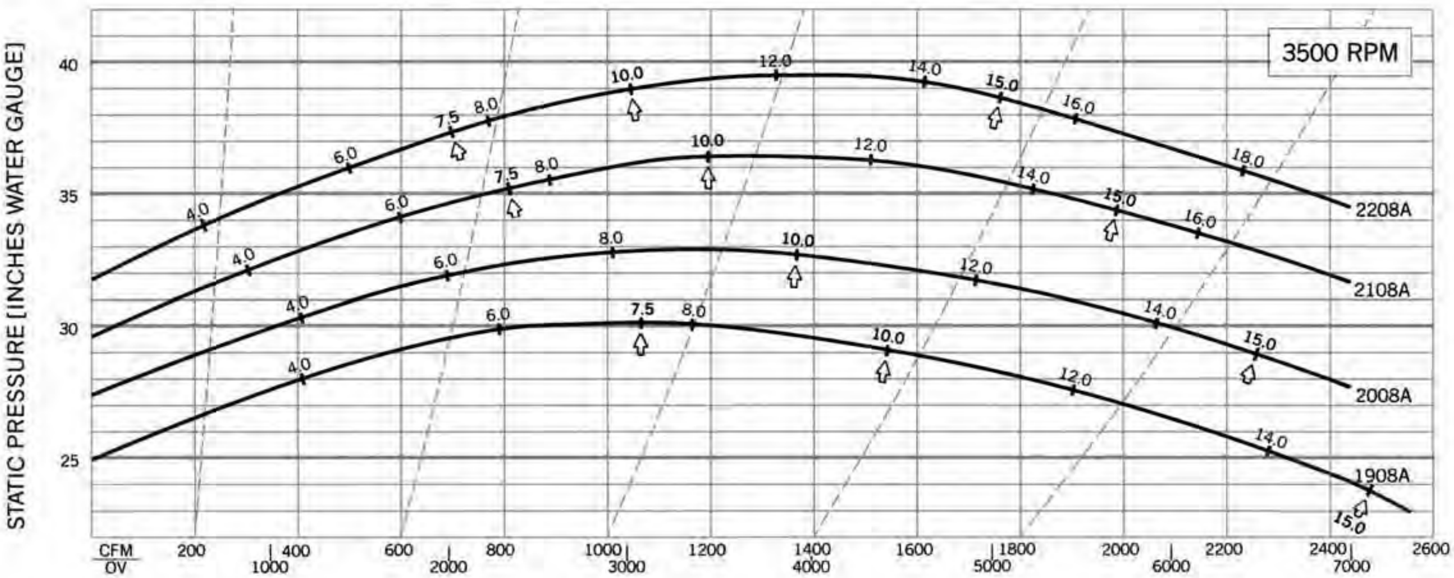


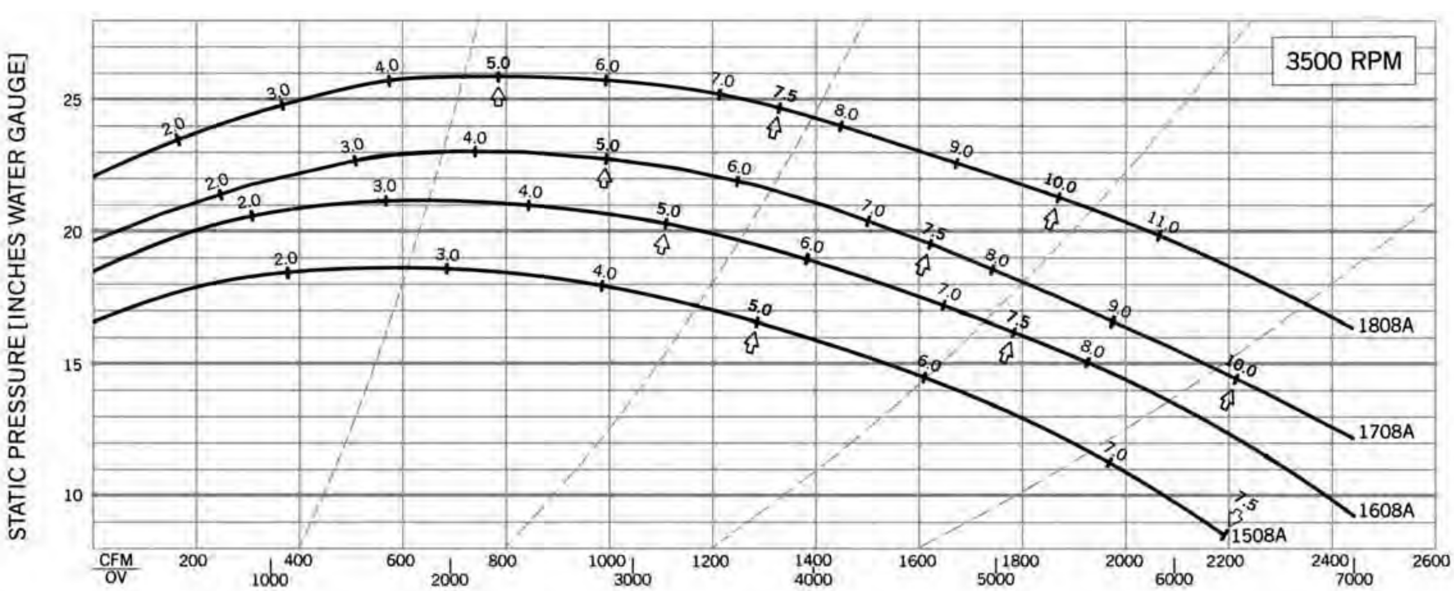


Performance shown is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include drive losses.
Performance ratings do not include the effects of appurtenances in airstream.

08 OUTLET







Performance shown is installation Type B: Free inlet, Ducted outlet. Power rating (BHP) does not include drive losses. Performance ratings do not include the effects of appurtenances in airstream.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.

Recommended SAFETY PRACTICES

for Users and Installers of Industrial and Commercial Fans AMCA Publication 410-96

FOREWORD

i. This publication has been prepared by the Air Movement Division of the Air Movement and Control Association International, Inc. (AMCA International). The information contained in this publication has been derived from many sources. The suggestions made necessarily should be general in their meaning and cannot be applied literally to all specific situations or conditions.

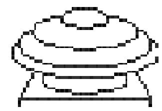
ii. ***The safe installation and operation of fans is the responsibility of the system designer, installer, maintainer, and user.*** From the initial system design through the life of the equipment, safety should be a foremost consideration. Some areas which require some special attention include system design, layout and construction, fan performance specification, foundation and installation details, storage procedures, start-up and commissioning procedures, operation, maintenance, and repair. Specific safety requirements are mandated by federal, state, and local codes. *Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans* is published by AMCA International for assistance. System designers, installers, maintainers, and users should consult and properly comply with all applicable codes and guidelines.

iii. The safety recommendations contained herein are intended to assist designers, installers, maintainers, or other users of air moving devices in the safe operation and use of the devices mentioned. These recommendations do not represent the only methods, procedures, or devices appropriate for the situations discussed. Caution should be used at all times when working in or around moving parts.

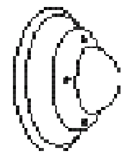
iv. AMCA International disclaims any and all warranties, expressed or implied, regarding the products sold by the manufacturer with which this booklet has been provided. Further, AMCA International recommends that competent personnel be consulted in deciding what is the preferred or recommended safety procedure in a particular instance where the guidelines contained in this booklet are unclear or in any way incomplete.

v. AMCA International has offered the information within this booklet to assist in the safe operation, maintenance, and use of the products sold by members of AMCA International. In so doing, AMCA International does not assume any legal duties of the designer or manufacturer to instruct or warn about their product. AMCA International expressly disclaims liability for any injury or damage arising out of the operation or use of the product or the guidelines contained herein.

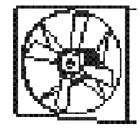
vi. These recommended safety practices were adopted by the AMCA International membership on April 28, 1996.



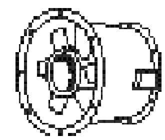
Power Roof Ventilator



Wall Exhauster

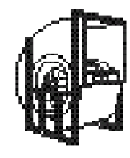


Propeller Fan

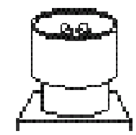


Axial Fan

1. INTRODUCTION



Centrifugal Fan



Upblast Roof Exhauster

1.1 Fans and other air moving devices are made in a wide variety of types, sizes, and arrangements. This publication addresses the proper use and installation of industrial and commercial fans. It is not intended to address residential and consumer fans.

1.2 Various "size" factors are important when assessing potential for injury; some factors are: diameter of impeller (wheel, rotor, propeller), rotational inertia, voltage, and current.

1.3 This guide is intended to assist in the safe installation of air moving equipment and to warn operating and maintenance personnel of the commonly recognized hazards associated with this equipment.

1.4 ***Handling and installation should always be performed only by experienced and trained personnel who are aware of the hazards associated with rotating equipment. Failure to comply with these practices may result in death or serious bodily injury.*** In addition to following the manufacturer's installation instructions, care should be taken to ensure compliance with specific safety requirements mandated by federal, state, and local codes. Industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be consulted and followed where applicable.

2. PERSONNEL SAFETY ACCESSORIES

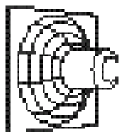
2.1 GENERAL

2.1.1 Protective devices are incorporated as standard construction on some types of fans but on many fans, these devices are offered as optional accessories. This is done because the need for the devices and the design required will frequently depend upon the type of system, fan location, and operating procedures being employed. Proper protective safety devices; company safety standards; specific safety requirements mandated by federal, state, and local codes; and industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be determined by the user, who should specify and obtain the appropriate devices from the fan manufacturer or others, and should not allow operation of the equipment without them. Examples of available devices include the following:

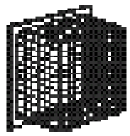
2.2 FAN GUARDS

2.2.1 All fans have moving parts which require guarding in the same way as other moving machinery. Fans located less than seven (7) feet above the floor require special consideration. Specific safety requirements should comply with mandated federal, state, and local codes; and industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be followed.

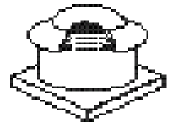
2.2.2 Roof-mounted fans and other fans which are not generally accessible may not require safety guards which might otherwise be appropriate. Where accessibility to these fans is occasional or infrequent, the expense of permanent guarding may be reduced through the use of lockout switches and suitable warnings. In such cases, maintenance personnel should engage the lockout switch before undertaking any maintenance or repairs. As is the case with other machinery involving moving parts, common sense and caution will preserve personal safety.



Industrial Type Guard For Propeller Fan



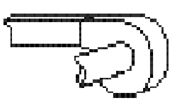
Maximum Safety Guard for Propeller Fan



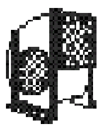
Screen on Roof Ventilator

2.3 INLET AND OUTLET GUARDS

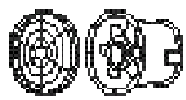
2.3.1 Axial and centrifugal fans are often connected directly to ductwork which will prevent contact with the internal moving parts; when an exposed inlet or outlet represents a hazard, a suitable guard should be installed.



Centrifugal Fan Protected by Ductwork



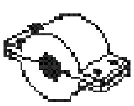
Inlet or Outlet Guard on Centrifugal Fan



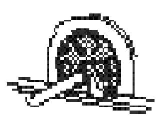
Guard for Axial Fan With Non-Ducted Inlet or Outleg

2.4 DRIVE GUARDS

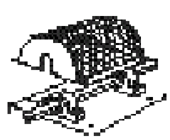
2.4.1 Fans may be driven directly from the motor shaft or through a belt drive. Where the bearing assembly, rotating shaft, sheaves, or belts are exposed, a suitable guard may need to be provided. Some example guards are shown below.



Drive Coupling Guard

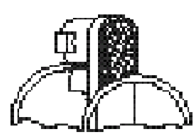


Heat Slinger Guard (Shaft and bearing guard omitted for clarity



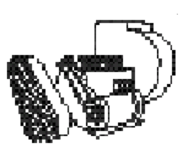
Shaft and Bearing Guard

2.4.2 Drive guards may be required for tubular centrifugal or axial fans to cover the exposed drive sheave and belts outside the fan housing.



Drive Guard - Axial Fan

2.4.3 A typical centrifugal fan drive guard may vary with the arrangement. Safety guards should be used when drive systems are accessible to personnel. In restricted areas, omission of the back cover may be acceptable.



Drive Guard - Centrifugal Fan

2.4.4 Dampers and their linkage may operate suddenly without warning at high speeds Dampers and their linkage contain pinch points which should be identified and guarded.

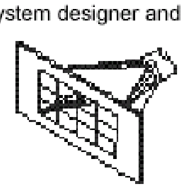
3. HIDDEN DANGERS

3.1 GENERAL

3.1.1 In addition to the obvious hazards associated with the moving parts of rotating machinery, fans present additional potential hazards that are not so obvious and should be considered by the system designer and user for safe operation.

3.2 SUCTION AND AIR PRESSURE

3.2.1 Fans operate by creating suction and air pressure which can be hazardous. Solid objects can be drawn into a fan's inlet and then become dangerous projectiles when they are exhausted through the fan's outlet. ***Solid objects can also cause fan failure or impeller failure due to imbalance or damage to the impeller blades.*** Personnel in close proximity to a fan inlet can be overcome by the suction, and drawn into the fan.



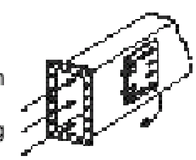
Special Purpose Intake Screen

3.2.2 Whenever there is a possibility that solid objects can be drawn into a remote intake, the intake should be guarded at all times. Before a guard is removed, the fan should be disconnected and the power supply locked out.

3.2.3 Where fans are installed over an occupied area, safety guards should be provided to prevent dropped objects from entering this area during installation and maintenance.

3.2.4 Access doors to a fan or duct system should never be opened while the fan is operating or coasting to a stop. On the downstream (or pressure) side of the system, releasing the door with the system in operation may result in an explosive opening. On the upstream (or suction) side, the inflow may be sufficient to draw in tools, clothing, and other materials. The power supply should always be locked out prior to accessing a fan or ductwork.

3.2.5 Fan design sometimes requires access doors to be supplied with internal components such as a plug to fill a hole in the fan casing. These doors can often be heavy and difficult to handle. Care should be exercised when opening, removing, and installing these components.



Bolted Access Door in Duct

3.3 WINDMILLING

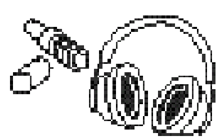
3.3.1 Even when the power supply is locked out, fans may cause injury or damage if the impeller is subject to "windmilling" which is the turning of the impeller and drive components due to a draft in the system. To guard against this hazard, the impeller should be secured to physically restrict rotational movement.

3.4 TEMPERATURE

3.4.1 Many fans, fan motors, and fan components run at temperatures that could burn someone who comes in contact with the hot areas, including discharged or leaking gases. If this potential hazard is present, steps should be taken so that personnel working near the fan are aware of the danger and can exercise caution.

3.5 FAN NOISE AND ENVIRONMENT

3.5.1 Some fans can generate sound that could be haz ardous to exposed personnel. Sound pressure can be measured in the field, but obtaining accurate data is difficult. The environment in which the fan operates can impact the ability to obtain accurate fan sound readings. Consult the manufacturer for fan sound data. It is the responsibility of the system designer, installer, user, and maintainer to comply with specific safety requirements mandated by federal, state, and local codes; and to follow industry safety standards and practices published by AMCA International and by other recognized agencies and associations, regarding personnel safety from exposure to fan noise associated with use and exposure to equipment.



Hearing Protection

3.6 STROBOSCOPIC EFFECT

3.6.1 The stroboscopic effect of certain lights in combination with certain fan speeds may cause a rotating assembly to appear stopped. In these cases, irregular markings can be placed on the moving parts to prevent this type of effect. Personnel should be warned that the fan may be in motion even if it appears not to be.

3.7 SPECIAL PRUPOSE FANS AND SYSTEMS

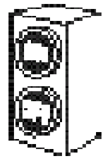
3.7.1 The hidden dangers associated with Special Purpose Fans used in special systems are covered in Section 6.

4. POWER ISOLATION

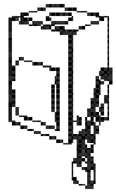
4.1 Every fan should be installed with a suitable device allowing it to be completely disconnected or isolated from the power supply.

4.2 Many fans are started by remote switches or push-buttons, by interlocks with other equipment, or by automatic controls. Before performing any maintenance, inspection, or other activity which will require removal of guards, ductwork, access doors, etc., or exposure of moving parts, the fan power supply should be locked out and the fan tagged out of service.

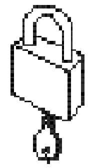
4.3 In some installations other equipment, such as gas burners, may be interlocked with the fan so that disconnecting the fan will automatically shut off the burner or other device. Maintenance on systems of this type should be performed only under the supervision of competent engineering personnel and in accordance with applicable codes and standards.



Remote Switch



Disconnect Switch



Lock Carried by Maintenance Personnel

4.4 In cases where the fan is power driven by a source other than an electric motor, appropriate provisions should be made for the isolation or disengagement of the power supply.

5. START-UP CHECK LIST

5.1 GENERAL

5.1.1 Before putting any fan into initial operation, the manufacturer's instructions should be followed. Transportation, handling, and installation can cause fasteners to loosen, and cause misalignment of fan components. Carefully follow this check list when commissioning equipment.
5.1.2 Lock out the primary and all secondary power sources.
5.1.3 A complete inspection should be made of all of the ductwork and the interior of the fan. Make certain there is no foreign material which can be drawn into or blown through the fan or ductwork. Appropriate protective measures and safety practices should be observed when entering or working within these areas. These measures might include the use of goggles, respirators, or other personal protective devices.
5.1.4 Make sure the foundation or mounting arrangement and the duct connections are adequately designed and installed per drawings and in accordance with recognized acceptable engineering practices and with the fan manufacturer's recommendations.
5.1.5 Check and tighten all bolts, fasteners, and set screws as necessary.
5.1.6 Check the fan assembly and bearings for proper grounding to prevent static electricity discharge.
5.1.7 Ensure power and drive components such as motor starter, variable frequency drive, or hydraulic power unit are properly sized, matched, and connected to the fan.
5.1.8 Check bearings for recommended lubricant and lubrication amount.
5.1.9 Spin the rotating assembly to determine whether it rotates freely, without hitting anything, and is not grossly out of balance.
5.1.10 Inspect impeller for proper rotation for the fan design.
5.1.11 Check alignment of drives and all other components.
5.1.12 Check the belt drive for proper sheave selection and installation and make sure the sheaves are not reversed (excessive speeds could develop).
5.1.13 Check for recommended belt tension.
5.1.14 Properly secure all safety guards.
5.1.15 Assure that all appropriate warnings have been put in place.
5.1.16 Secure all access doors to the fan and ductwork.
5.1.17 Momentarily energize the fan to check the direction of rotation. Listen as the fan coasts to a stop for any unusual noise, identify the source, and take corrective action as necessary.
5.1.18 Switch on the electrical supply and allow the fan to reach full speed. Check carefully for:

(1) Excessive vibration
(2) Unusual noise
(3) Proper belt alignment
(4) Proper lubrication
(5) Proper amperage, voltage, or power values.
(6) If any problem is indicated, **SWITCH OFF IMMEDIATELY.**
(7) Lock out the power supply. Secure the fan impeller if there is a potential for windmilling. Check carefully for the cause of the trouble, correct as necessary, and repeat check list procedure.

5.2 Even if the fan appears to be operating satisfactorily, shut down after a brief period, lock out the power supply, and recheck items 5.1.5 through 5.1.17 as the initial start-up may have loosened the bolts, fasteners, and set screws.
5.3 The fan may now be put into operation, but during the first eight hours of running, it should be closely observed and checked for excessive vibration and noise. At this time checks should also be made of motor input current and motor and bearing temperatures to ensure that they do not exceed manufacturer's recommendations.
5.4 After eight hours of operation, the fan should be shut down and the power locked out. Check list items 5.1.5 through 5.1.17 should be inspected and adjusted if necessary.
5.5 After twenty-four (24) hours of satisfactory operation, the fan should be shut down (locked out) and the drive belt tension should be readjusted to recommended tension.
5.6 After commissioning and start-up, the fan should be operated and maintained in accordance with the manufacturer's and component manufacturer's recommendations. Some basic guidelines for **WARNING SIGNS** and **ROUTINE MAINTENANCE** are included in Sections 7 and 8 of this publication. These sections are meant as a supplement to other publications and are not intended to replace the manufacturer's instructions.

6. SPECIAL PURPOSE FANS

6.1 Most fans are designed to handle clean air at standard temperatures between 32 F and 120 F. These fans should not be placed in systems or used for other than their design intended use. *Special Purpose Fans* are designed for use in systems that may include extreme temperatures, explosive, toxic, or special gases, material handling, corrosive environments, or other special hazards which should be carefully considered. Specific safety requirements should comply with mandated federal, state, and local codes; and industry safety standards and practices published by AMCA International and by other recognized agencies and associations should be followed.
6.2 Where the system will handle explosive or flammable material (i.e., dust, fumes, vapors or gases), fans of spark-resistant construction should be used.
6.3 Fans connected by ductwork or other piping may contain gases other than air which are hazardous. In these cases, procedures should be established to prevent exposure of personnel working on or near the fan, and by maintenance personnel who may need to enter the fan. Appropriate personal protective equipment as determined by the material safety data sheet, and system operators should be utilized. Appropriate environmental protective measures should also be taken.
6.4 Fan inlet boxes, housings, ductwork, and other system components which are large enough to permit entry should be considered confined spaces. System areas may also serve as low points where heavy gases, liquids, or other substances may accumulate and present explosive, fire, health, or suffocation hazards. Appropriate protective measures and safety practices should be observed when entering or working within these areas.
6.5 Material-handling fans are specially designed to allow the fan to handle a specific type of material without exces sive accumulation of material on the fan impeller. Fans handling corrosive gases or erosive material should be checked periodically. If loss of material is evident, the fan should be shut down, power supply locked out, and tagged out of service. The manufacturer or other qualified personnel should be consulted to determine if the fan is within safety limits for operation. To ensure satisfactory operation it is essential to observe the manufacturer's limitations concerning the type of material to be handled by the fan.
6.6 Fan ratings and maximum speed limits are typically based on the use of air at 70 F. At temperatures above the normal range (specified by the manufacturer), a reduction should be made in the maximum speed limit. Information on this reduction and on other precautions to be taken for high temperature applications should be obtained from the fan manufacturer. Personnel working near high temperature fans should be aware that coming in contact with the fan's housing, ductwork, or handled gases could result in serious burns. Where the danger of burns is not apparent, appropriate warnings should be posted. Appropriate protective apparel should be worn whenever working in close contact with heated housings or ductwork.
6.7 Corrosive contaminants can be formed when moisture combines with an active airborne chemical. Fans subjected to corrosive contaminants will corrode; however, suitable protective coatings or material, if used in

the fan construction, can delay corrosion. Protected fans should be regularly inspected to ensure that the protection remains effective. Personnel working in environments with airborne chemicals may require personal protective apparel equipment.
6.8 Where liquid can accumulate within the fan, provide for the installation of adequately sized drains.
6.9 In those applications where there is a potential for chemical build-up (such as grease, creosote, etc.), periodic cleaning and proper drainage are necessary to avoid a fire hazard.

7. WARNING SIGNS

7.1 GENERAL

7.1.1 A change in the operating characteristics of a fan may indicate the need for maintenance. Sudden changes may indicate severe problems or dangerous conditions developing. Investigate any changes in the operational characteristics or unusual symptoms of the fan. Refer to AMCA Publication 202, *Troubleshooting*, for a more detailed explanation of investigating procedures. Consult your manufacturer or other qualified consultant with questions concerning changes observed.

7.2 EXCESSIVE VIBRATION

7.2.1 Operational vibration levels are one of the best indicators of the condition of the blower. Careful observation and monitoring of vibration levels can detect a minor problem in the early stages of development when correction is less costly and easier. Recommended maximum vibration levels should be obtained from the equipment manufacturer.
7.2.2 If excessive vibration is observed, stop the fan and lock it out until the cause is corrected. Check for material build-up on the impeller. Generally this will show up as material flaking off the fan impeller and causing an imbalance which may lead to catastrophic failure of the fan or its components. Excessive vibration can also be caused by looseness in the drive train, loose fasteners, misalignment or impeller damage. Contact the fan manufacturer or other qualified consultant to determine the maximum vibration level if it is not included in maintenance instructions.

7.3 NOISE

7.3.1 Changes to the sound level may indicate maintenance is needed. Some unusual noises often heard include: bearing noise indicating the bearings need lubricant or replacement; scraping or ticking noise indicating the rotating parts are hitting the stationary parts; squealing indicating the belt drive needs tensioning; repeated changing pitch of the blower indicating operation of the blower at too low a flow. If any of these noises or any other unusual noises are detected, their cause should be determined and corrective action taken as necessary.

7.4 HIGH MOTOR TEMPERATURES

7.4.1 Check that cooling air to the motor has not been diverted or blocked by dirty guards or similar obstacles. Check the input amperage. An increase in amperage may indicate that some major change has occurred in the system.

7.5 HIGH BEARING TEMPERATURES

7.5.1 This condition is usually caused by improper lubrication; this can be either "over," "under," or "unsuitable" lubrication. In every case, if the cause of the trouble is not easily seen, experienced personnel should examine the equipment before it is put back in operation.

7.6 POOR PERFORMANCE

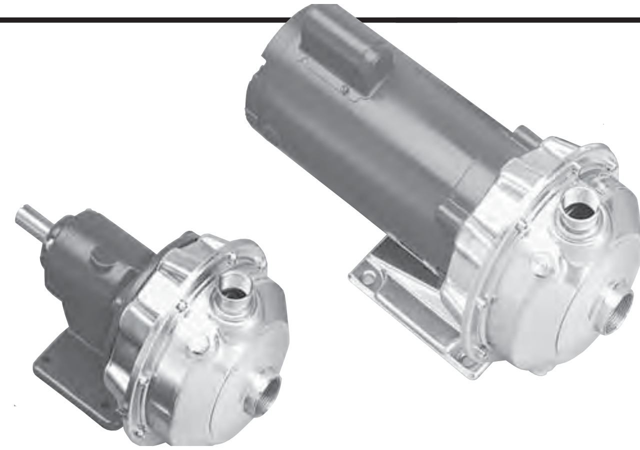
7.6.1 Too much flow or pressure or too little flow or pressure is often a symptom of a change in the operating system. A fan will typically operate at the same performance in a static system some typical causes include: operating of the fan backwards after maintenance procedures; filters dirty or not in place; change or blockage in the ductwork; change in speed of the fan (switching the sheaves); loss or failure of the impeller. All of these causes and many others will affect the flow and pressure produced by the fan.

8. ROUTINE MAINTENANCE

8.1 A preventive maintenance program is an important aspect of an effective safety program. Consult your manufacturer or other qualified consultant with questions concerning changes observed during periodic inspections and routine maintenance.
8.2 The fan manufacturer's operating and maintenance recommendations, as well as the components manufacturer's instructions (such as motor, bearing, drives, etc.) should be strictly followed.
8.3 *Maintenance should always be performed by experienced and trained personnel who are aware of the hazards associated with rotating equipment.* Do not attempt any maintenance on a fan unless the fan power supply has been locked out and tagged out and the impeller has been secured.
8.4 When performing maintenance functions which include disassembly of the fan, careful consideration should be given to the size, weight, center of gravity, and lifting means of the fan components. It should also be noted that the outboard bearing on some fans such as arrangements 1, 8, 9, and 10 is often cap-loaded. Removal of the securing means may result in a sudden change in impeller position.
8.5 Historical data is often the best indicator for determining the operational condition of the fan. Maintenance logs which include relubrication, vibration levels, temperature levels, power requirements, inspection, and other pertinent records should be maintained and consulted as necessary when assessing the condition of the fan.
8.6 Under normal circumstances, handling clean air, the system should require cleaning only once a year. However, the fan and system should be checked at regular intervals to detect any unusual accumulation.
8.7 The fan impeller should be specially checked for build-up of material or dirt which may cause an imbalance with resulting undue wear on bearings and belt drives. A regular maintenance program should be established as needed to prevent material build-up.
8.8 Periodic inspection of the rotating assembly should be made to detect any indication of weakening of the rotor because of corrosion, erosion, or metal fatigue. Where signs of deterioration are found, lock out and tag out the impeller until the unit has been inspected and approved by a qualified consultant.

Installation, Operation and Maintenance Instructions

Model NPE/ NPE-F



DESCRIPTION & SPECIFICATIONS:

The Models NPE (close-coupled) and NPE-F (frame-mounted) are end suction, single stage centrifugal pumps for general liquid transfer service, booster applications, etc. Liquid-end construction is all AISI Type 316 stainless steel, stamped and welded. Impellers are fully enclosed, non-trimable to intermediate diameters. Casings are fitted with a diffuser for efficiency and for negligible radial shaft loading.

Close-coupled units have NEMA 48J or 56J motors with C-face mounting and threaded shaft extension. Frame-mounted units can be coupled to motors through a spacer coupling, or belt driven.

1. Important:

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

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

CAUTION

Always disconnect electrical power when handling pump or controls.

1.3. Motors must be wired for proper voltage. Motor wiring diagram is on motor nameplate. Wire size must limit maximum voltage drop to 10% of nameplate voltage at motor terminals, or motor life and pump performance will be lowered.

1.4. Always use horsepower-rated switches, contactor and starters.

1.5. Motor Protection

1.5.1. Single-phase: Thermal protection for single-phase units is sometimes built in (check nameplate). If no built-in protection is provided, use a contactor with a proper overload. Fusing is permissible.

1.5.2. Three-phase: Provide three-leg protection with properly sized magnetic starter and thermal overloads.

1.6. Maximum Operating Limits:

Liquid Temperature:	212º F (100º C) with standard seal. 250º F (120º C) with optional high temp seal.
Pressure:	75 PSI.
Starts Per Hour:	20, evenly distributed.

1.7. Regular inspection and maintenance will increase service life. Base schedule on operating time. Refer to Section 8.

2. Installation:

2.1. General

2.1.1. Locate pump as near liquid source as possible (below level of liquid for automatic operation).

2.1.2. Protect from freezing or flooding.

2.1.3. Allow adequate space for servicing and ventilation.

2.1.4. All piping must be supported independently of the pump, and must "line-up" naturally.

CAUTION

Never draw piping into place by forcing the pump suction and discharge connections.

2.1.5. Avoid unnecessary fittings. Select sizes to keep friction losses to a minimum.

2.2. Close-Coupled Units:

2.2.1. Units may be installed horizontally, inclined or vertically.

CAUTION

Do not install with motor below pump. Any leakage or condensation will affect the motor.

2.2.2. Foundation must be flat and substantial to eliminate strain when tightening bolts. Use rubber mounts to minimize noise and vibration.

2.2.3. Tighten motor hold-down bolts before connecting piping to pump.

2.3. Frame-Mounted Units:

2.3.1. It is recommended that the bedplate be grouted to a foundation with solid footing. Refer to Fig.1.

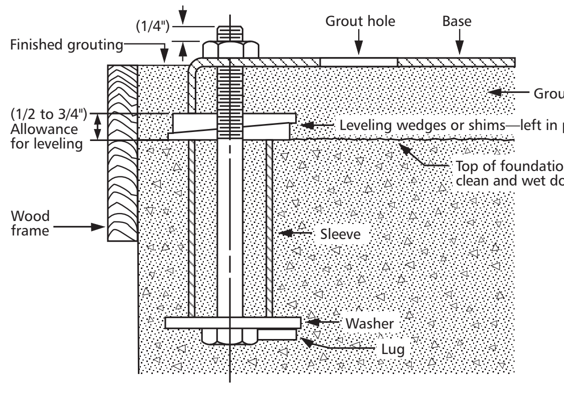


Figure 1

2.3.2. Place unit in position on wedges located at four points (two below approximate center of driver and two below approximate center of pump). Adjust wedges to level unit. Level or plumb suction and discharge flanges.

2.3.3. Make sure bedplate is not distorted and final coupling alignment can be made within the limits of movement of motor and by shimming, if necessary.

2.3.4. Tighten foundation bolts finger tight and build dam around foundation. Pour grout under bedplate making sure the areas under pump and motor feet are filled solid. Allow grout to harden 48 hours before fully tightening foundation bolts.

2.3.5. Tighten pump and motor hold-down bolts before connecting the piping to pump.

3. Suction Piping:

3.1. Low static suction lift and short, direct, suction piping is desired. For suction lift over 10 feet and liquid temperatures over 120 F, consult pump performance curve for Net Positive Suction Head Required.

3.2. Suction pipe must be at least as large as the suction connection of the pump. Smaller size will degrade performance.

3.3. If larger pipe is required, an eccentric pipe reducer (with straight side up) must be installed at the pump.

3.4. Installation with pump below source of supply:

3.4.1. Install full flow isolation valve in piping for inspection and maintenance.

CAUTION

Do not use suction isolation valve to throttle pump.

3.5. Installation with pump above source of supply:

3.5.1. Avoid air pockets. No part of piping should be higher than pump suction connection. Slope piping upward from liquid source.

3.5.2. All joints must be airtight.

3.5.3. Foot valve to be used only if necessary for priming, or to hold prime on intermittent service.

3.5.4. Suction strainer open area must be at least triple the pipe area.

3.6. Size of inlet from liquid source, and minimum submergence over inlet, must be sufficient to prevent air entering pump through vortexing. See Figs. 2-5

3.7. Use 3-4 wraps of Teflon tape to seal threaded connections.

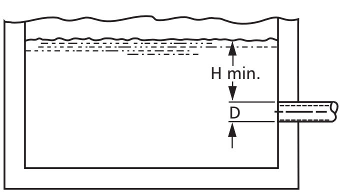


Figure 2

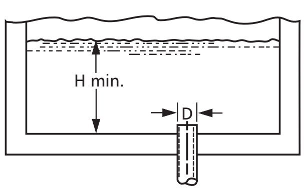


Figure 3

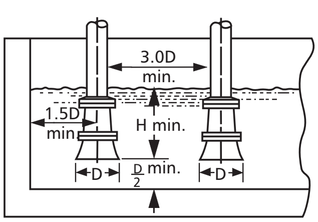


Figure 4

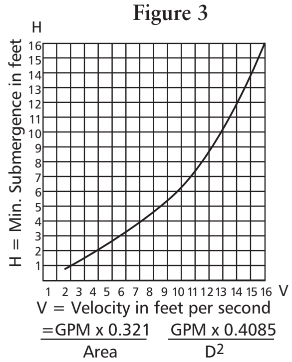


Figure 5

4. Discharge Piping:

4.1. Arrangement must include a check valve located between a gate valve and the pump. The gate valve is for regulation of capacity, or for inspection of the pump or check valve.

4.2. If an increaser is required, place between check valve and pump.

4.3. Use 3-4 wraps of Teflon tape to seal threaded connections.

5. Motor-To-Pump Shaft Alignment:

5.1. Close-Coupled Units:

5.1.1. No field alignment necessary.

5.2. Frame-Mounted Units:

5.2.1. Even though the pump-motor unit may have a factory alignment, this could be disturbed in transit and must be checked prior to running. See Fig. 6.

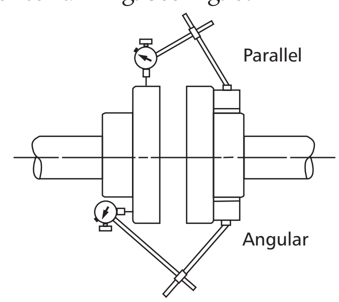


Figure 6

5.2.2. Tighten all hold-down bolts before checking the alignment.

5.2.3. If re-alignment is necessary, always move the motor. Shim as required.

5.2.4. Parallel misalignment - shafts with axis parallel but not concentric. Place dial indicator on one hub and rotate this hub 360 degrees while taking readings on the outside diameter of the other hub. Parallel alignment occurs when Total Indicator Reading is .005", or less.

5.2.5. Angular misalignment - shafts with axis concentric but not parallel. Place dial indicator on one hub and rotate this hub 360 degrees while taking readings on the face of the other hub. Angular alignment is achieved when Total Indicator Reading is .005", or less.

5.2.6. Final alignment is achieved when parallel and angular requirements are satisfied with motor hold-down bolts tight.

CAUTION

Always recheck both alignments after making any adjustment.

6. Rotation:

6.1. Correct rotation is right-hand (clockwise when viewed from the motor end). Switch power on and off quickly. Observe shaft rotation. To change rotation:

6.1.1. Single-phase motor: Non-reversible.

6.1.2. Three-phase motor: Interchange any two power supply leads.

7. Operation:

7.1. Before starting, pump must be primed (free of air and suction pipe full of liquid) and discharge valve partially open.

CAUTION

Pumped liquid provides lubrication. If pump is run dry,rotating parts will seize and mechanical seal will be damaged. Do not operate at or near zero flow. Energy imparted to the liquid is converted into heat. Liquid may flash to vapor. Rotating parts require liquid to prevent scoring or seizing.

7.2. Make complete check after unit is run under operating conditions and temperature has stabilized. Check for expansion of piping. On frame-mounted units coupling alignment may have changed due to the temperature differential between pump and motor. Recheck alignment.

8. Maintenance:

8.1. Close-Coupled Unit. Ball bearings are located in and are part of the motor. They are permanently lubricated. No greasing required.

8.2. Frame-Mounted Units:

8.2.1. Bearing frame should be regreased every 2,000 hours or 3 month interval, whichever occurs first. Use a #2 sodium or lithium based grease. Fill until grease comes out of relief fittings, or lip seals, then wipe off excess.

8.2.2. Follow motor and coupling manufacturers' lubrication instructions.

8.2.3. Alignment must be rechecked after any maintenance work involving any disturbance of the unit.

9. Disassembly:

Complete disassembly of the unit will be described. Proceed only as far as required to perform the maintenance work needed.

9.1. Turn off power.

9.2. Drain system. Flush if necessary.

9.3. Close-Coupled Units: Remove motor hold-down bolts.

Frame-Mounted Units: Remove coupling, spacer, coupling guard and frame hold-down bolts.

9.4. Disassembly of Liquid End:

9.4.1. Remove casing bolts (370).

9.4.2. Remove back pull-out assembly from casing (100).

9.4.3. Remove impeller locknut (304).

CAUTION

Do not insert screwdriver between impeller vanes to prevent rotation of close-coupled units. Remove cap at opposite end of motor. A screwdriver slot or a pair of flats will be exposed. Using them will prevent impeller damage.

9.4.4. Remove impeller (101) by turning counter-clockwise when looking at the front of the pump. Protect hand with rag or glove.

CAUTION

Failure to remove the impeller in a counter-clockwise direction may damage threading on the impeller, shaft or both.

9.4.5. With two pry bars 180 degrees apart and inserted between the seal housing (184) and the motor adapter (108), carefully separate the two parts. The mechanical seal rotary unit (383) should come off the shaft with the seal housing.

9.4.6. Push out the mechanical seal stationary seat from the motor side of the seal housing.

9.5. Disassembly of Bearing Frame:

9.5.1. Remove bearing cover (109).

9.5.2. Remove shaft assembly from frame (228).

9.5.3. Remove lip seals (138 & 139) from bearing frame and bearing cover if worn and are being replaced.

9.5.5. Use bearing puller or arbor press to remove ball bearings (112 & 168).

10. Reassembly:

10.1. All parts should be cleaned before assembly.

10.2. Refer to parts list to identify required replacement items. Specify pump index or catalog number when ordering parts.

10.3. Reassembly is the reverse of disassembly.

10.3.1. Impeller and impeller locknut assembled onto motor shaft with 10 ft-lbs of torque.

10.4. Observe the following when reassembling the bearing frame:

10.4.1. Replace lip seals if worn or damaged.

10.4.2. Replace ball bearings if loose, rough or noisy when rotated.

10.4.3. Check shaft for runout. Maximum permissible is .002" T.I.R.

10.5. Observe the following when reassembling the liquid-end:

10.5.1. All mechanical seal components must be in good condition or leakage may result. Replacement of complete seal assembly, whenever seal has been removed, is good standard practice.

It is permissible to use a light lubricant, such as glycerin, to facilitate assembly. Do not contaminate the mechanical seal faces with lubricant.

10.5.2. Inspect casing O-ring (513) and replace if damaged. This O-ring may be lubricated with petroleum jelly to ease assembly.

10.5.3. Inspect guidevane O-ring (349) and replace if worn.

CAUTION

Do not lubricate guidevane O-ring (349). Insure it is not pinched by the impeller on reassembly.

10.6. Check reassembled unit for binding. Correct as required.

10.7. Tighten casing bolts in a star pattern to prevent O-ring binding.

11. Trouble Shooting Chart:

MOTOR NOT RUNNING
(See causes 1 thru 6)

LITTLE OR NO LIQUID DELIVERED:
(See causes 7 thru 17)

POWER CONSUMPTION TOO HIGH:
(See causes 4, 17, 18, 19, 22)

EXCESSIVE NOISE AND VIBRATION:
(See causes 4, 6, 9, 13, 15, 16, 18, 20, 21, 22)

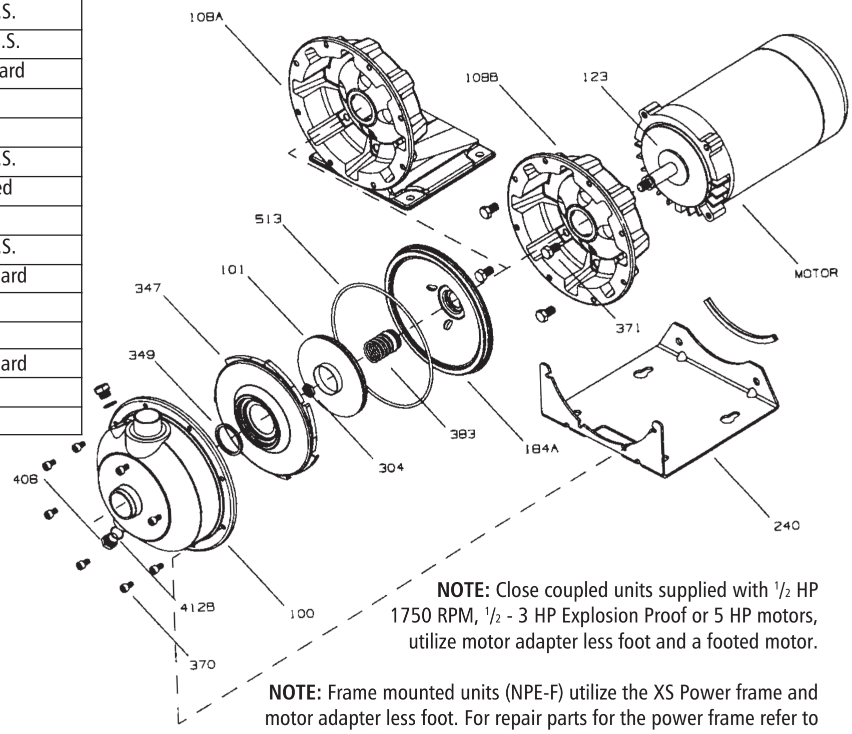
PROBABLE CAUSE:

1. Tripped thermal protector
2. Open circuit breaker
3. Blown fuse
4. Rotating parts binding
5. Motor wired improperly
6. Defective motor
7. Not primed
8. Discharge plugged or valve closed
9. Incorrect rotation
10. Foot valve too small, suction not submerged, inlet screen plugged.
11. Low voltage
12. Phase loss (3-phase only)
13. Air or gasses in liquid
14. System head too high
15. NPSHA too low:
    Suction lift too high or suction losses excessive. Check with vacuum gauge.
16. Impeller worn or plugged
17. Incorrect impeller diameter
18. Head too low causing excessive flow rate
19. Viscosity or specific gravity too high
20. Worn bearings
21. Pump or piping loose
22. Pump and motor misaligned

NPE Standard Repair Parts List

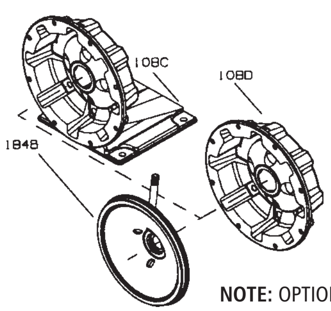
Item No.	Description	Materials of Construction
100	Casing	AISI 316L Stainless Steel
101	Impeller	
108A	Motor adapter with foot	
108B	Motor adapter less foot	
108C	Motor adapter with foot and Flush	
108D	Motor adapter less foot with Flush	
123	Deflector	BUNA-N
184A	Seal housing std.	AISI 316L S.S.
184B	Seal housing with seal flush	
240	Motor support	300 S.S.
	Rubber channel	Rubber
304	Impeller locknut	AISI 316 S.S.
347	Guidevane	AISI 316L S.S.
349	Seal-Ring, guidevane	Viton Standard
		EPR
		BUNA
370	Socket head screw, casing	AISI 410 S.S.
371	Bolts, motor	Steel/plated
383	Mechanical seal	
408	Drain and vent plug, casing	AISI 316 S.S.
412B	O-Ring, drain plugs	Viton, standard
		EPR
		BUNA
513	O-Ring, casing	Viton, standard
		EPR
		BUNA

Item 383 Mechanical Seal (⅝" seal)				
Rotary	Stationary	Elastomers	Metal Parts	Part No.
Carbon	Sil-Carbide	EPR	316SS	10K18
		Viton		10K55
Sil-Carbide		EPR		10K81
		Viton		10K62



NOTE: Close coupled units supplied with $^1/_2$ HP 1750 RPM, $^1/_2$ - 3 HP Explosion Proof or 5 HP motors, utilize motor adapter less foot and a footed motor.

NOTE: Frame mounted units (NPE-F) utilize the XS Power frame and motor adapter less foot. For repair parts for the power frame refer to the XS-Power frame repair parts page in the parts section of your catalog. To order the power frame complete order item 14L61



NOTE: OPTIONAL SEAL FLUSH COMPONENTS

GOULDS PUMPS LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by Goulds Pumps.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Goulds Pumps distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Goulds Pumps Customer Service Department.

The warranty excludes:

(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:

(1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Goulds Pumps and the dealer in purchases, consignments or contracts for sale of the subject pumps.
(2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
(3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

THIS WARRANTY EXTENDS TO THE DEALER ONLY.

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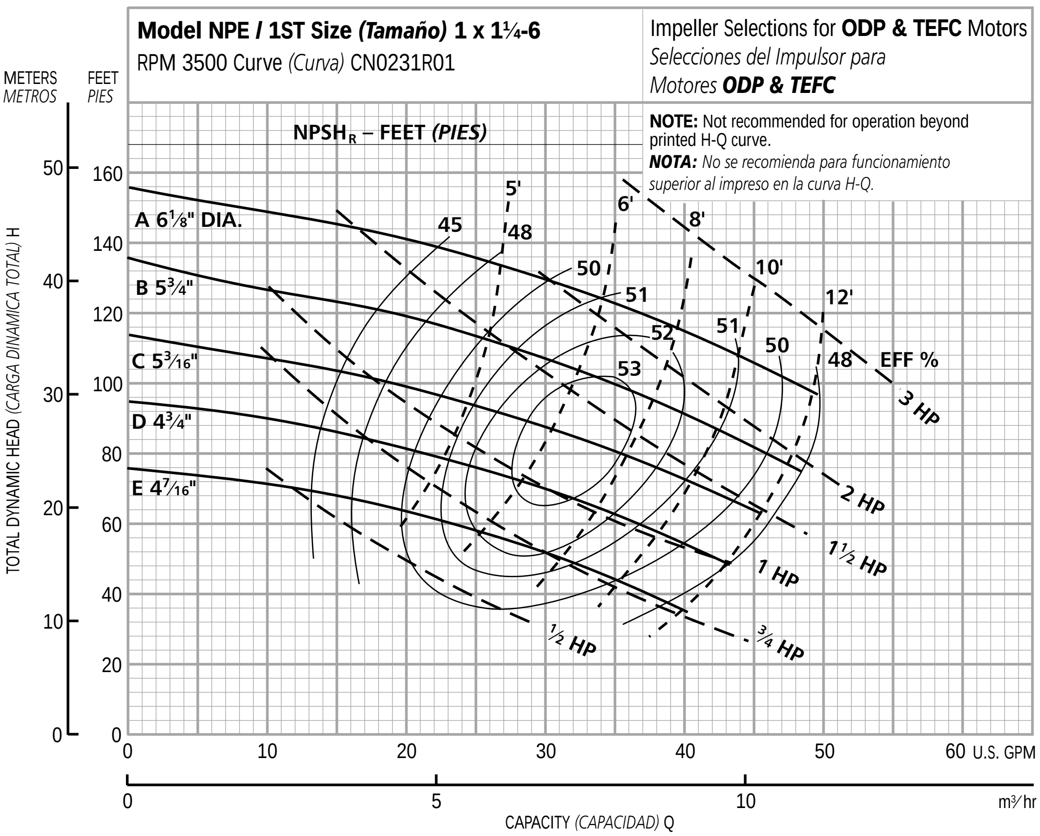
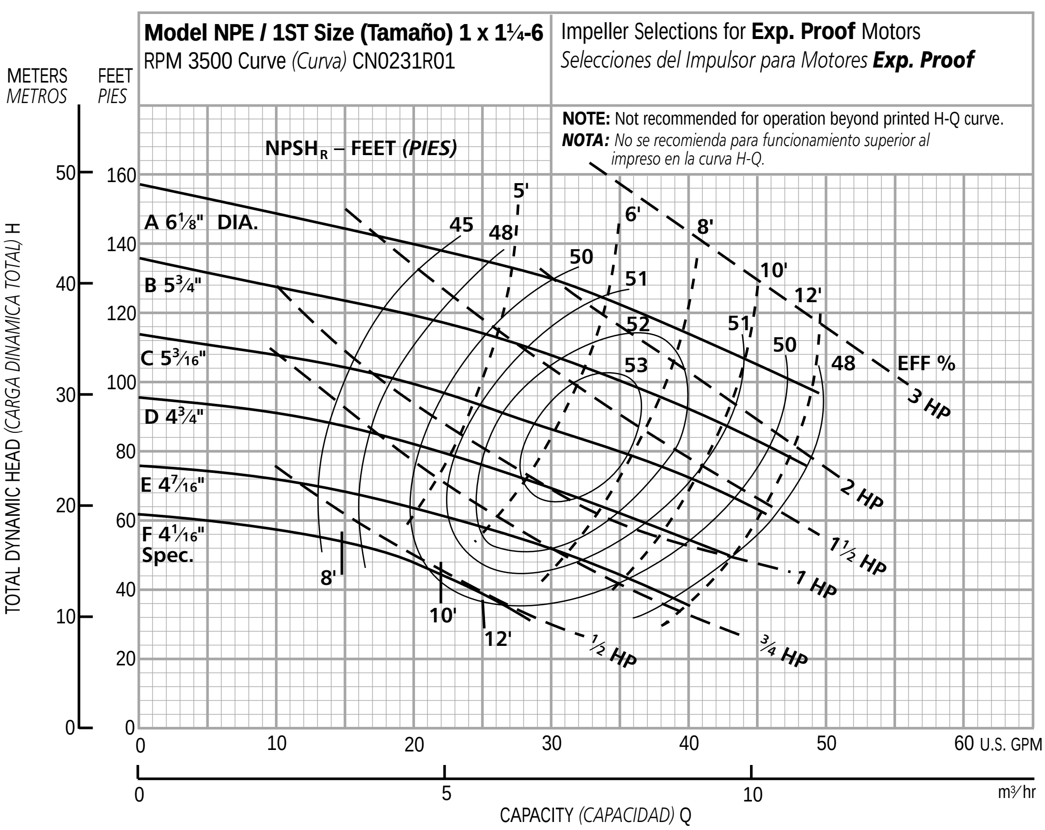
Goulds Pumps
ITT Industries



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
E	½	4⁷⁄₁₆"
D	¾	4¾
C	1	5³⁄₁₆
B	1½	5¾
A	2	6⅛

NOTE: Although not recommended, the pump may pass a ¹⁄₁₆" sphere.

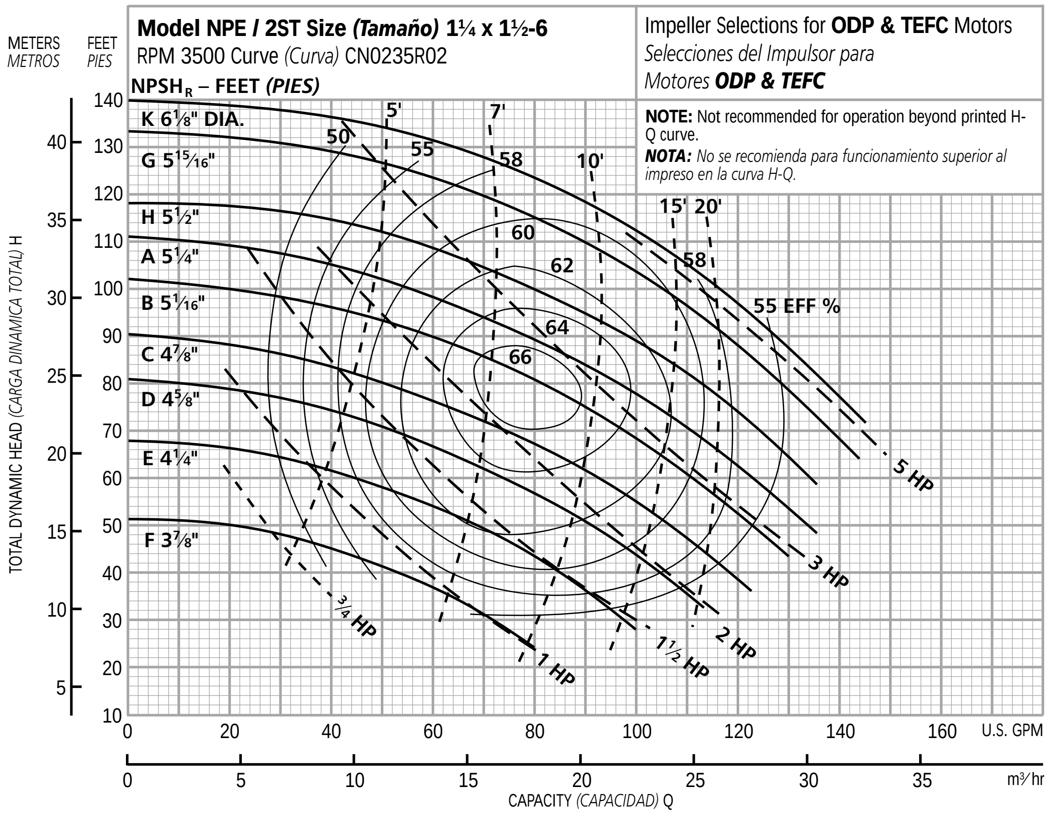
NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de ¹⁄₁₆".*



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
F	½	4¹⁄₁₆" spec.
E	¾	4⁷⁄₁₆
D	1	4¾
C	1½	5³⁄₁₆
B	2	5¾
A	3	6⅛

NOTE: Although not recommended, the pump may pass a ¹⁄₁₆" sphere.

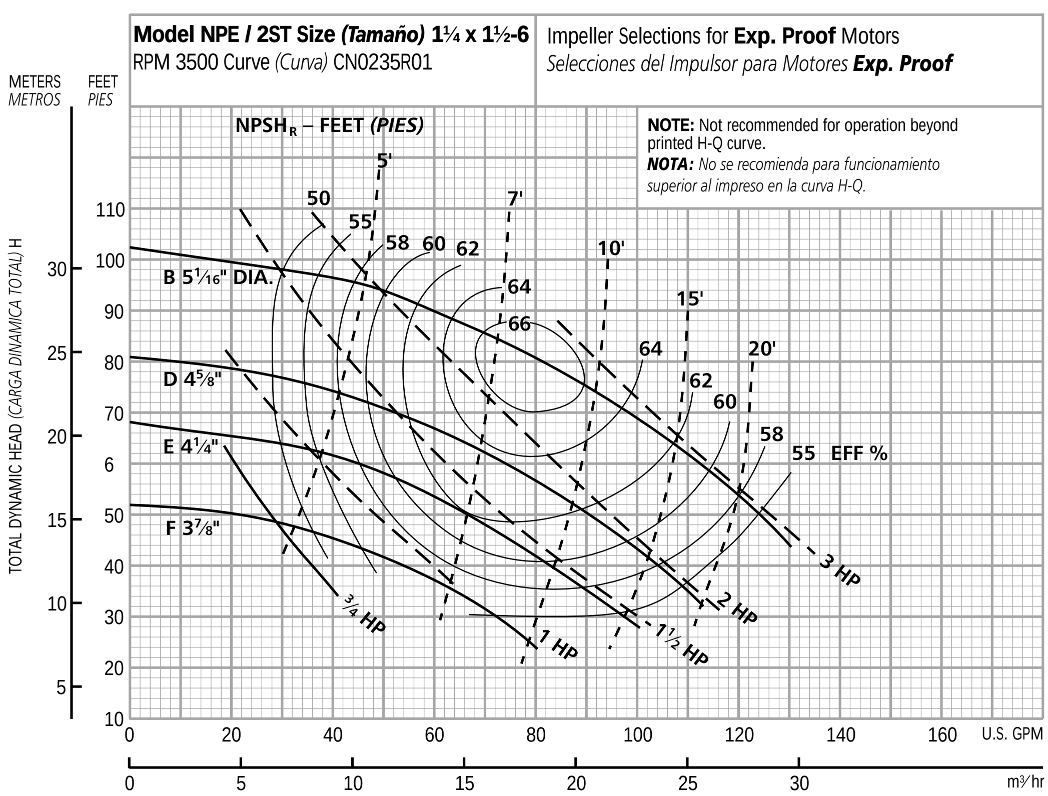
NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de ¹⁄₁₆".*



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
F	¾	3⅞"
E	1	4¼
D	1½	4⅝
C	2	4⅞
B	3	5 1/16
A	3	5¼
H	5	5½
G	5	5 15/16
K	5	6⅛

NOTE: Although not recommended, the pump may pass a 3/16" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de 3/16".*

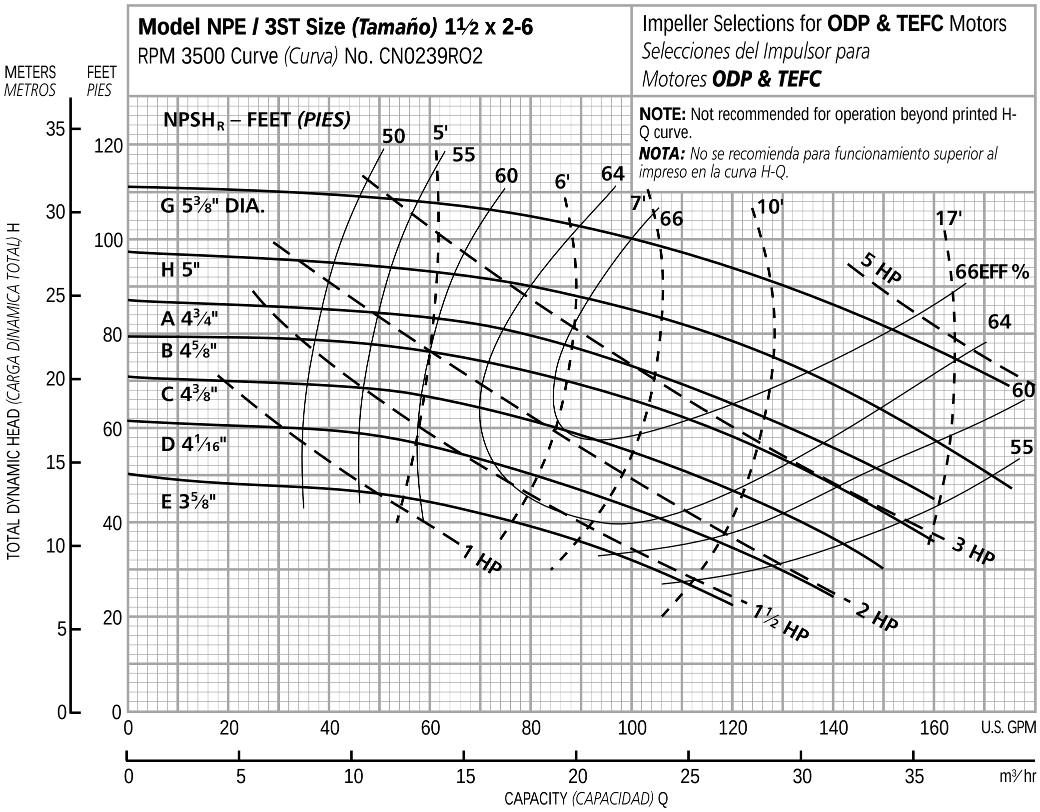


Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
F	1	3⅞"
E	1½	4¼
D	2	4⅝
B	3	5 1/16

NOTE: Although not recommended, the pump may pass a 3/16" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de 3/16".*

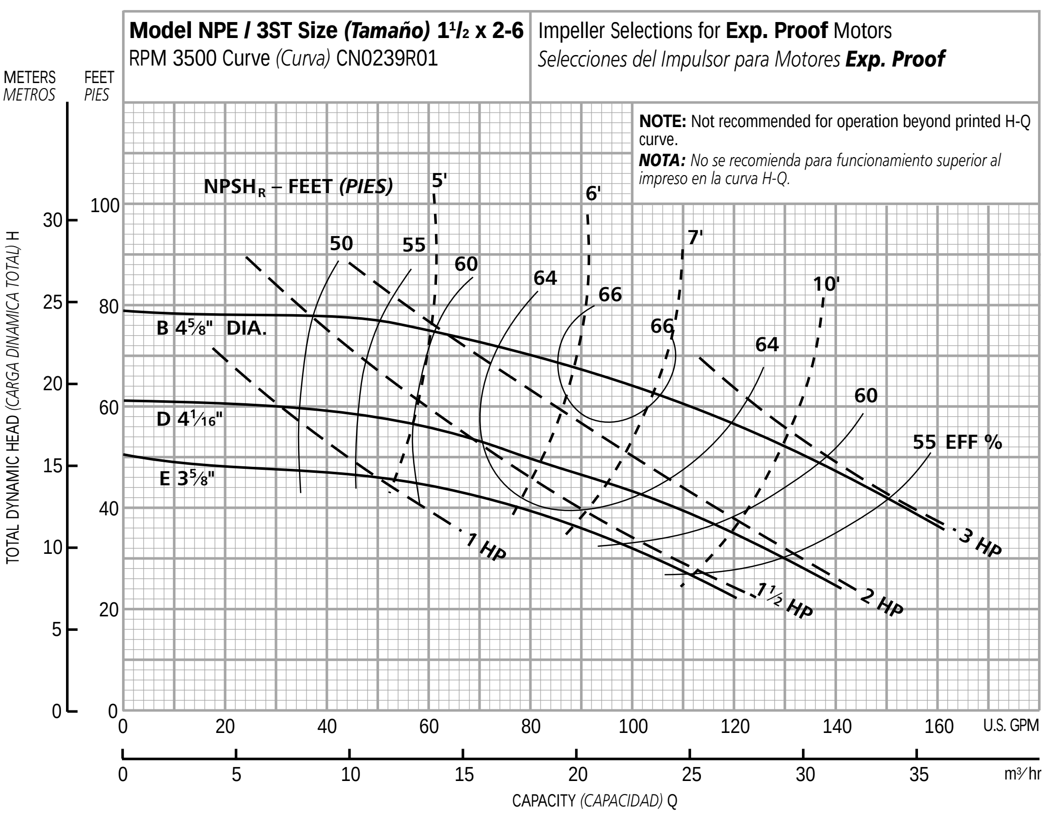
Performance Curves – 60 Hz, 3500 RPM
Curvas de Funcionamiento – 60 Hz, 3500 RPM



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
E	1	3⅝"
D	1½	4¹⁄₁₆
C	2	4⅜
B	3	4⅝
A	3	4¾
H	5	5
G	5	5⅜

NOTE: Although not recommended, the pump may pass a ¹¹⁄₃₂" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de ¹¹⁄₃₂".*



Ordering Code, *Código de Pedido*	Standard HP Rating, *Estándar HP Potencia*	Imp. Dia.
E	1½	3⅝"
D	2	4¹⁄₁₆
B	3	4⅝

NOTE: Although not recommended, the pump may pass a ¹¹⁄₃₂" sphere.

NOTA: *Si bien no se recomienda, la bomba puede pasar una esfera de ¹¹⁄₃₂".*

G&L Pumps

Repair Parts

MODEL

NPE/NPE-F

Goulds Pumps

ITT Industries

Effective February, 2003
RNPE

TABLE OF CONTENTS

NPE END SUCTION

NOTE:
For units built before September, 1997
The following upgrades are interchangeable.

(1) Item 349 Guidevane O-Ring was upgraded from O-Ring to Square Seal Ring.

(2) Pump Components have been upgraded from 304 SS to 316L SS

(3) Mechanical Seal upgrades as noted on page 1

(4) Pump Mounting location for motor adapter with foot to pump support are interchangeable.

NPE/NPE-F NUMBERING SYSTEM

1 ST 2 C 1 A 4 F

SEAL VENT/FLUSH OPTION

MECHANICAL SEAL and O-RING

4 = Pre-Engineered Standard

For Optional Mechanical Seal modify catalog order no. with Seal Code listed below.

21 Mechanical Seal (⅝" seal)						
Seal Code	Rotary	Stationary	Elastomers	Metal Parts	Part No.	Casing O-Ring
2	Carbon	Sil-Carbide	EPR	316 SS	10K18*	EPR
4			Viton		10K55***	Viton
5	Sil-Carbide		EPR		10K81	EPR
6			Viton		10K62**	Viton

Note: *Replaces obsolete 10K56 **Replaces obsolete 10K29 ***Replaces obsolete 10K46 and 10K24

Impeller Option Code . . . No Adder Required

For Optional Impeller Diameters modify catalog order no. with Impeller code listed below.

Select Optional Impeller Diameter from Pump Performance Curve.

Impeller Code	Pump Size		
	1 x 1¼-6	1¼ x 1½-6	1½ x 2-6
	Diameter	Diameter	Diameter
K		6⅛	
G		5¹⁵⁄₁₆	5⅜
H		5½	5
A	6⅛	5¼	4¾
B	5¾	5¹⁄₁₆	4⅝
C	5³⁄₁₆	4⅞	4⅜
D	4¾	4⅝	4¹⁄₁₆
E	4⁷⁄₁₆	4¼	3⅝
F	4¹⁄₁₆	3⅞	

Note: Not recommended for operation beyond printed H-Q curve.

For critical application conditions consult factory.

Note: Not all combinations of motor, impeller and seal options are available for every pump model. Please check with G&L on non-cataloged numbers.

DRIVER

1 = 1PH, ODP 4 = 1 PH, TEFC 7 = 3 PH, XP
2 = 3 PH, ODP 5 = 3 PH, TEFC 8 = 575 V, XP
3 = 575 V, ODP 6 = 575 V, TEFC 0 = 1 PH, XP

HP RATING

C = ½ HP F = 1½ HP J = 5 HP
D = ¾ HP G = 2 HP
E = 1 HP H = 3 HP

DRIVER: HERTZ/POLE/RPM

1 = 60 HZ, 2 pole, 3500 RPM
2 = 60 HZ, 4 pole, 1750 RPM
3 = 60 HZ, 6 pole, 1150 RPM
4 = 50 HZ, 2 pole, 2900 RPM
5 = 50 HZ, 4 pole, 1450 RPM

MATERIAL

ST = Stainless Steel

PUMP SIZE

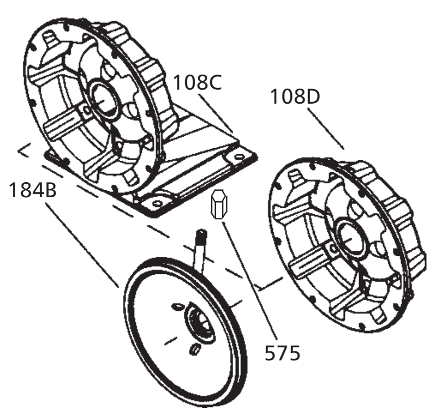
1 = 1 x 1¼ - 6 2 = 1¼ x 1½ - 6 3 = 1½ x 2 - 6

For Frame Mounted version, substitute the letters "FRM" in these positions.

NPE STANDARD REPAIR PARTS LIST

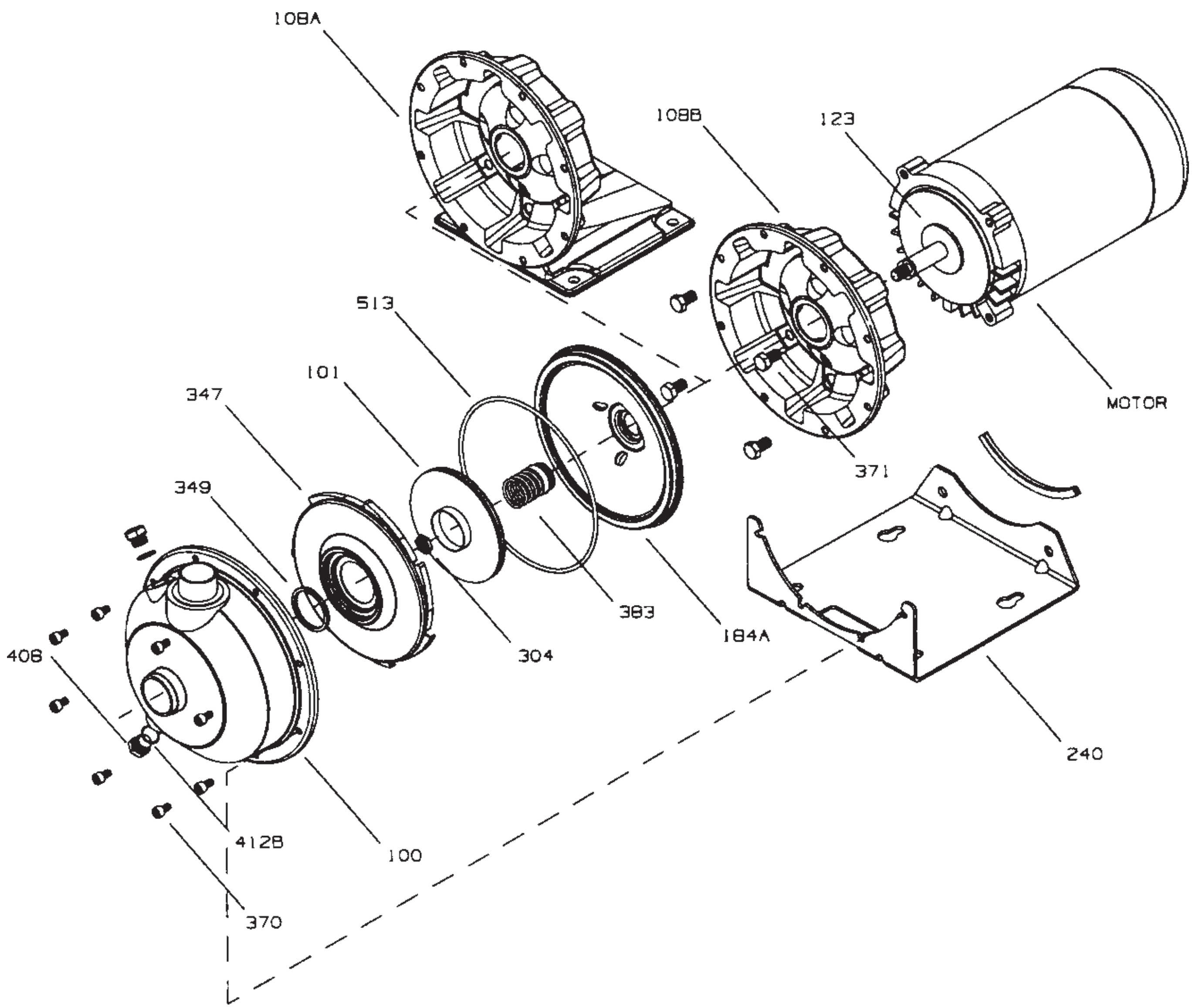
Item No.	Description	Materials of Construction	1ST 1 x 1¼	2ST 1¼ x 1½	3ST 1½ x 2	QTY.
100	Casing	AISI 316L SS	1L81	1L82	1L83	1
101	Impeller		See Impeller chart on page 4			1
108A	Motor adapter with foot		1L80			1
108B	Motor adapter less foot		1L87			
108C	Motor adapter with foot & flush		1L334			
108D	Motor adapter less foot with flush		1L335			
123	Deflector	BUNA-N	5K7			1
184A	Seal housing standard	AISI 316L SS	1L79			1
184B	Seal housing with seal flush		1L333			
240	Motor support	300 SS	4L320			1
	Rubber channel	Rubber	9K188			1
304	Impeller locknut	AISI 316 SS	13K286			1
347	Guidevane	AISI 316L SS	3L23	3L24	3L25	1
349	Seal ring, guidevane	Viton standard	5K269	5K270		1
		EPR	5K273	5K274		
		BUNA	5K271	5K272		
370	Socket head screw, casing	AISI 410 SS	13L65			8
371	Bolts, motor	Steel/plated	13K252			4
383	Mechanical seal		See Mechanical Seal Chart on Page 1			1
408	Drain and vent plug, casing	AISI 316 SS	6L3			2
412B	O-ring, drain plugs	Viton, standard	5L99			2
		EPR	5L80			
		BUNA	5L62			
513	O-ring, casing	Viton standard	5K206			1
		EPR	5K193			
		BUNA	5K4			
575	Pipe Cap	304 SS	6K150			1

NOTE:
OPTIONAL SEAL FLUSH COMPONENTS



NOTE:
Close coupled units supplied with ½ HP 1750 RPM, ½ - 3 HP Explosion Proof or 5 HP motors, utilize motor adapter less foot and a footed motor.

NOTE:
Frame mounted units (NPE-F) utilize the XS Power Frame and motor adapter less foot. For repair parts for the power frame refer to the XS-Power frame repair parts page in the parts section of your catalog. To order the power frame complete order item 14L61.



NPE STANDARD IMPELLERS

Impeller Code	Pump Size: 1 x $1\frac{1}{4}$-6		$1\frac{1}{4}$ x $1\frac{1}{2}$-6		$1\frac{1}{2}$ x 2-6	
	Diameter	Part No.	Diameter	Part No.	Diameter	Part No.
K			$6\frac{1}{8}$	2L885		
G			$5\frac{15}{16}$	2L700	$5\frac{3}{8}$	2L702
H			$5\frac{1}{2}$	2L699	5	2L701
A	$6\frac{1}{8}$	2L47	$5\frac{1}{4}$	2L48	$4\frac{3}{4}$	2L49
B	$5\frac{3}{4}$	2L44	$5\frac{1}{16}$	2L54	$4\frac{5}{8}$	2L58
C	$5\frac{3}{16}$	2L46	$4\frac{7}{8}$	2L53	$4\frac{3}{8}$	2L57
D	$4\frac{3}{4}$	2L42	$4\frac{5}{8}$	2L52	$4\frac{1}{16}$	2L56
E	$4\frac{7}{16}$	2L45	$4\frac{1}{4}$	2L51	$3\frac{5}{8}$	2L55
F	$4\frac{1}{16}$	2L59	$3\frac{7}{8}$	2L50		

NPE STANDARD IMPELLERS BY MOTOR SIZE AT 3500 RPM

For ODP/TEFC Units Built After September 1, 1997

HP	HP Code		1ST	2ST	3ST
			ODP/TEFC	ODP/TEFC	ODP/TEFC
$\frac{1}{2}$	C	Repair #	2L45		
		Dia.	$4\frac{7}{16}$		
		Imp. Code	E		
$\frac{3}{4}$	D	Repair #	2L42	2L50	
		Dia.	$4\frac{3}{4}$	$3\frac{7}{8}$	
		Imp. Code	D	F	
1	E	Repair #	2L46	2L51	2L55
		Dia.	$5\frac{3}{16}$	$4\frac{1}{4}$	$3\frac{5}{8}$
		Imp.Code	C	E	E
$1\frac{1}{2}$	F	Repair #	2L44	2L52	2L56
		Dia.	$5\frac{3}{4}$	$4\frac{5}{8}$	$4\frac{1}{16}$
		Imp. Code	B	D	D
2	G	Repair #	2L47	2L53	2L57
		Dia.	$6\frac{1}{8}$	$4\frac{7}{8}$	$4\frac{3}{8}$
		Imp. Code	A	C	C
3	H	Repair #	2L47	2L48	2L49
		Dia.	$6\frac{1}{8}$	$5\frac{1}{4}$	$4\frac{3}{4}$
		Imp. Code	A	A	A
5	J	Repair #		2L700 2L885	2L702
		Dia.		$5\frac{15}{16}$ $6\frac{1}{8}$	$5\frac{3}{8}$
		Imp. Code		G K	G

For Current Explosion Proof and All Units Built Before September 1, 1997

HP	HP Code		1ST		2ST		3ST	
			ODP	TEFC/EXP	ODP	TEFC/EXP	ODP	TEFC/EXP
$\frac{1}{2}$	C	Repair #	2L45	2L59				
		Dia.	$4\frac{7}{16}$	$4\frac{1}{16}$				
		Imp. Code	E	F				
$\frac{3}{4}$	D	Repair #	2L42	2L45	2L50			
		Dia.	$4\frac{3}{4}$	$4\frac{7}{16}$	$3\frac{7}{8}$			
		Imp. Code	D	E	F			
1	E	Repair #	2L46	2L42	2L51	2L50	2L55	
		Dia.	$5\frac{3}{16}$	$4\frac{3}{4}$	$4\frac{1}{4}$	$3\frac{7}{8}$	$3\frac{5}{8}$	
		Imp. Code	C	D	E	F	E	
$1\frac{1}{2}$	F	Repair #	2L44	2L46	2L52	2L51	2L56	2L55
		Dia.	$5\frac{3}{4}$	$5\frac{3}{16}$	$4\frac{5}{8}$	$4\frac{1}{4}$	$4\frac{1}{16}$	$3\frac{5}{8}$
		Imp. Code	B	C	D	E	D	E
2	G	Repair #	2L47	2L44	2L53	2L52	2L57	2L56
		Dia.	$6\frac{1}{8}$	$5\frac{3}{4}$	$4\frac{7}{8}$	$4\frac{5}{8}$	$4\frac{3}{8}$	$4\frac{1}{16}$
		Imp. Code	A	B	C	D	C	D
3	H	Repair #	2L47	2L47	2L48	2L54	2L49	2L58
		Dia.	$6\frac{1}{8}$	$6\frac{1}{8}$	$5\frac{1}{4}$	$5\frac{1}{16}$	$4\frac{3}{4}$	$4\frac{5}{8}$
		Imp. Code	A	A	A	B	A	B
5	J	Repair #			2L700 2L885		2L702	
		Dia.			$5\frac{15}{16}$ $6\frac{1}{8}$		$5\frac{3}{8}$	
		Imp. Code			G K		G	

Note:** Max. Explosion Proof rating is 2 HP.

NPE CLOSE-COUPLED MOTORS

MODEL NPE 3500 RPM

HP	Single-Phase, 60 Hz, 115/230 V**, 56J Frame								
	Open, Drip-Proof①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04853S	10.0/5.0	16	E04821	6.2/3.1	21	BBC04825	6.2/3.1	47
¾	E05853S	14.0/7.0	19	E05821	8.8/4.4	24	BBC05825	8.8/4.4	41
1	E06853S	16.0/8.0	22	E06821	11.6/5.8	26	BBC06825	11.6/5.8	49
1½	E07858S	21.4/10.7	31	E07821	16.2/8.1	35	BBC07825	16.2/8.1	56
2	E08854	26.8/13.4	36	E08821	20.8/10.4	39	BBC08825	20.8/10.4	60
3	E09854	14.0	40	E09821	11.89	44			
5	E10754	14.4	55						

Note:** 3 and 5 HP Single-Phase motors are 230 V only.

HP	Three-Phase, 60 Hz, 208-230/460 V, 56J Frame								
	Open, Drip-Proof①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04873	2.6/1.3	19	E04876	1.9/.95	18	BBC04875	1.9/.95	27
¾	E05873	3.4/1.7	19	E05876	2.3/1.15	21	BBC05875	2.3/1.15	30
1	E06873	4.2/2.1	22	E06876	3.2/1.6	21	BBC06875	3.2/1.6	30
1½	E07878	5.8/2.9	25	E07876	4.8/2.4	27	BBC07875	4.8/2.4	37
2	E08874	6.9/3.3	39	E08876	5.4/2.7	33	BBC08875	5.4/2.7	44
3	E09874	7.2/3.6	31	E09876	7.6/3.8	37			
5	E10774	7.2/14.4	50	E10876	6.2/12.4	48			

① For vertical mounting order motor canopy separately - 9K272 for ½, ¾ and 1 HP single phase or 9K273 for all other ODP motors.

MODEL NPE 1750 RPM

HP	Single-Phase, 60 HZ, 115/230 V, 56J Frame								
	Open, Drip-Proof①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04811	8.6/4.3	19	E04812	8.0/4.0	20	BBC04815	8.0/4.0	45

HP	Three-Phase, 60 HZ, 208-230/460 V, 56J Frame								
	Open, Drip-Proof①			Totally Enclosed, Fan Cooled			Explosion Proof		
	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)	Order No.	Max. Amps	Wt. (lbs.)
½	E04831	3.76/4.0/2.0	20	E04832	1.77/1.6/.8	20	BBC04835	1.77/1.6/.8	45

Note: Explosion Proof Motors are class 1 and 2, Group D

Magnehelic® Differential Pressure Gage

OPERATING INSTRUCTIONS

SPECIFICATIONS

Dimensions: 4-3/4″ dia. x 2-3/16″ deep.

Weight: 1 lb. 2 oz.

Finished: Baked dark gray enamel.

Connections: 1/8″ NPT high and low pressure taps, duplicated, one pair side and one pair back.

Accuracy: Plus or minus 2% of full scale, at 70°F. (Model 2000-0, 3%; 2000-00, 4%).

Pressure Rating: 15 PSI (0,35 bar)

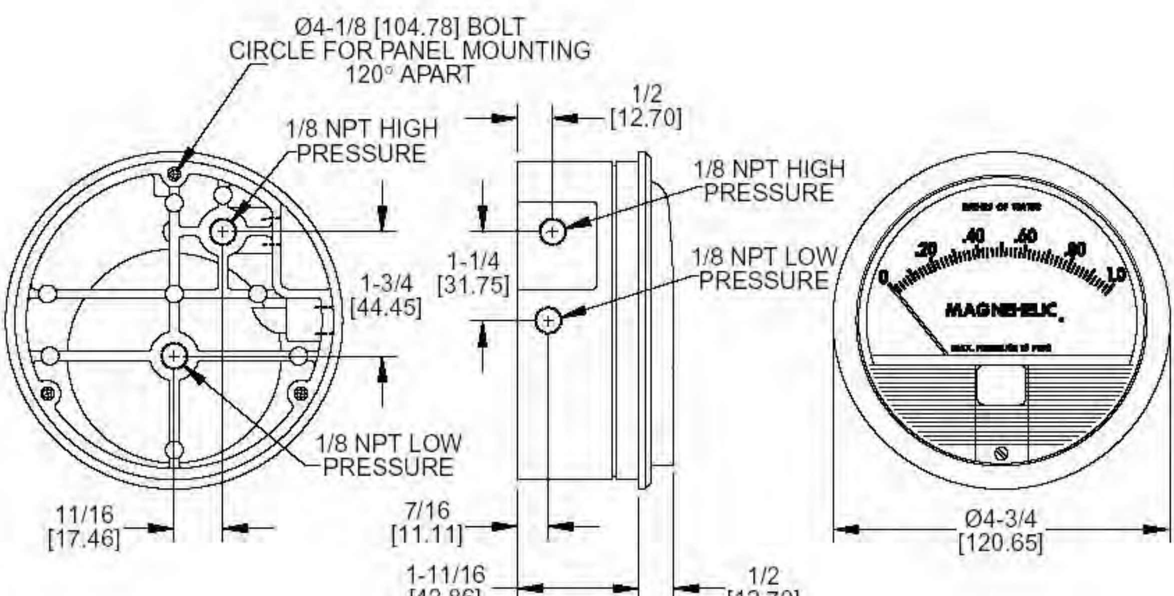
Ambient Temperature Range: 20° to 140°F (-7 to 60°C).

Standard gage accessories include two 1/8″ NPT plugs for duplicate pressure taps, two 1/8″ NPT pipe thread to rubber tubing adapters, and three flush mounting adapters with screws.

Caution: For use with air or compatible gases only.

For repeated over-ranging or high cycle rates, contact factory.

Not for use with Hydrogen gas. Dangerous reactions will occur.



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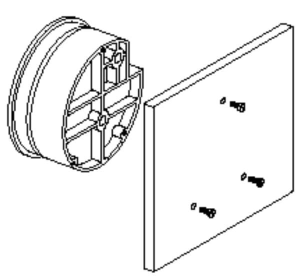
MAGNEHELIC® INSTALLATION

1. Select a location free from excessive vibration and where the ambient temperature will not exceed 140°F. Also, avoid direct sunlight which accelerates discoloration of the clear plastic cover. Sensing lines my be run any necessary distance. Long tubing lengths will not affect accuracy but will increase response time slightly. Do not restrict lines. If pulsating pressures or vibration cause excessive pointer oscillation, consult the factory for ways to provide additional damping.

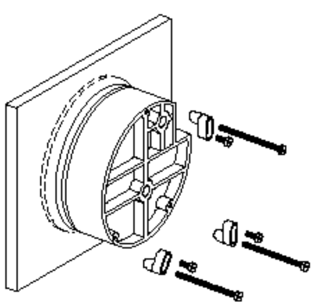
2. All standard Magnehelic gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions with only rezeroing. Low range Model 2000-00 and metric equivalents must be used in the vertical position only.

3. Surface Mounting



Locate mounting holes, 120° apart on a 4-1/8″ dia. circle. Use No. 6-32 machine screws of appropriate length.

4. Flush Mounting



Provide a 4-9/16″ dia. opening in panel. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adapters, firmly secured in place. To mount gage on 1-1/4″-2″ pipe, order optional A-610 pipe mounting kit.

5. To zero the gage after installation

Set the indicating pointer exactly on the zero mark, using the external zero adjust screw on the cover at the bottom. Note that the zero check or adjustment can only be made with the high and low pressure taps both open to atmosphere.

Operation

Positive Pressure: Connect tubing from source of pressure to either of the two high pressure ports. Plug the port not used. Vent one or both low pressure ports to atmosphere.

Negative Pressure: Connect tubing from source of vacuum or negative pressure to either of the two low pressure ports. Plug the port not used. Vent one or both high pressure ports to atmosphere.

Differential Pressure: Connect tubing from the greater of two pressure sources to either high pressure port and the lower to either low pressure port. Plug both unused ports.

When one side of the gage is vented in dirty, dusty atmosphere, we suggest an A-331 Filter Vent Plug be installed in the open port to keep inside of gage clean.

A. For portable use of temporary installation use 1/8″ pipe thread to rubber tubing adapter and connect to source of pressure with rubber or Tygon tubing.

B. For permanent installation, 1/4″ O.D., or larger, copper or aluminum tubing is recommended. See accessory bulletin S-101 for fittings.

Ordering Instructions:

When corresponding with the factory regarding Magnehelic® gage problems, be sure to include model number, pressure range, and any special options. Field repair is not recommended; contact the factory for repair service.

MAINTENANCE

Maintenance: No lubrication or periodic servicing is required. Keep case exterior and cover clean. Occasionally disconnect pressure lines to vent both sides of gage to atmosphere and re-zero. Optional vent valves, (bulletin S-101), should be used in permanent installations.

Calibration Check: Select a second gage or manometer of known accuracy and in an appropriate range. Using short lengths of rubber or vinyl tubing, connect the high pressure side of the Magnehelic gage and the test gage to two legs of a tee. Very slowly apply pressure through the third leg. Allow a few seconds for pressure to equalize, fluid to drain, etc., and compare readings. If accuracy unacceptable, gage may be returned to factory for recalibration. To calibrate in the field, use the following procedure.

Calibration:

1. With gage case, held firmly, loosen bezel, by turning counterclockwise. To avoid damage, a canvas strap wrench or similar tool should be used.
2. Lift out plastic cover and "O" ring.
3. Remove scale screws and scale assembly. Be careful not to damage pointer.
4. The calibration is changed by moving the clamp. Loosen the clamp screw(s) and move slightly toward the helix if gage is reading high, and away if reading low. Tighten clamp screw and install scale assembly.
5. Place cover and O-ring in position. Make sure the hex shaft on inside of cover is properly engaged in zero adjust screw.
6. Secure cover in place by screwing bezel down snug. Note that the area under the cover is pressurized in operation and therefore gage will leak if not properly tightened.
7. Zero gage and compare to test instrument. Make further adjustments as necessary.

Caution: If bezel binds when installing, lubricate threads sparingly with light oil or molybdenum disulphide compound.

Warning: Attempted field repair may void your warrenty. Recalibration or repair by the user is not recommended. For best results, return gage to the factory. Ship prepaid to:

Dwyer Instruments, Inc.

Attn: Repair Dept.

102 Indiana Highway 212

Michigan City, IN 46360

Trouble Shooting Tips:

•G*age won't indicate or is sluggish.*

1. Duplicate pressure port not plugged.
2. Diaphragm ruptured due to overpressure.
3. Fittings or sensing lines blocked, pinched, or leaking.
4. Cover loose or "O"ring damaged, missing.
5. Pressure sensor, (static tips, Pitot tube, etc.) improperly located.
6. Ambient temperature too low. For operation below 20°F, order gage with low temperature, (LT) option.

•Pointer stuck-gage can't be zeroed.

1. Scale touching pointer.
2. Spring/magnet assembly shifted and touching helix.
3. **Metallic particles clinging to magnet and interfering with helix movement.**
4. Cover zero adjust shaft broken or not properly engaged in adjusting screw.

We generally recommend that gages needing repair be returned to the factory. Parts used in various sub-assemblies vary from one range of gage to another, and use of incorrect components may cause improper operation. After receipt and inspection, we will be happy to quote repair costs before proceeding.

Consult factory for assistance on unusual applications or conditions.

Use with air or compatible gases only.

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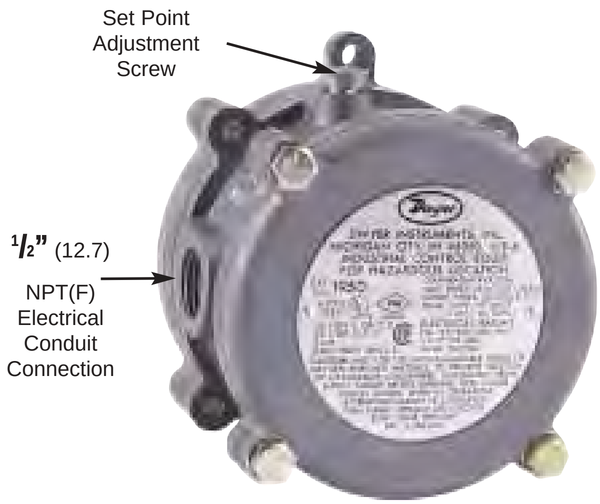
QED p/n EZ-LOWP - Dwyer p/n 1950-1

Kit Includes Pressure Switch, Fitting, Barb & Tubing

Series 1950 – Explosion-Proof Differential Pressure Switches

Specifications - Installation and Operating Instructions



Series 1950 Explosion-Proof Differential Pressure Switches combine the best features of the Dwyer Series 1900 Pressure Switch with an integral explosion-proof and weather-proof housing. Each unit is UL & CSA listed; FM approved for use in Class I, Groups C & D; Class II, Groups E, F, & G; and Class III atmospheres (NEMA 7 & 9). They are totally rain-tight for outdoor installations. Twelve models allow set-points from .03 to 20 inches w.c. and from .5 to 50 psi (3.4 to 345 kPa).

Easy access to the SPDT switch for electrical hook-up is provided by removing the top plate of the three-part aluminum housing. Adjustment to the set point of the switch can be made without disassembling the housing. The unit is very compact, about half the weight and bulk of equivalent conventional explosion-proof switches.

CAUTION

For use only with air or compatible gases. Use of the Model 1950 switch with explosive media connected to the Low pressure port (including differential pressure applications in such media) is not recommended. Switch contact arcing can cause an explosion inside the switch housing which, while contained, may render the switch inoperative. If switch is being used to sense a single positive pressure relative to atmosphere, run a line from the low pressure port to a non-hazardous area free of combustible gases. This may increase response time on -0 and -00 models.

NOTE: The last number-letter combination in the model number identifies the switch's electrical rating (number) and diaphragm material (letter). The 2F combination is standard as described in the physical data above. In case of special models, a number 1 rating is the same as 2; a number 3 or 4 rating is 10A 125, 250, 480 VAC; $^1/_8$ H.P. 125 VAC; $^1/_4$ H.P. 250 VAC; a number 5 or 6 rating is 1A 125 VAC. Letter B indicates a Buna-N diaphragm; N = Neoprene; S = Silicone; and V = Viton®.

UL and CSA Listed, FM Approved For

CL. I GR. C, D - CL. II GR. E, F, G - CL. III

Series 1950 Switches

Operating ranges and deadbands

To order specify Model Number	Operating Range: Inches, W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1950-02	0.03 to 0.10	0.025	0.05
1950-00	0.07 to 0.15	0.04	0.05
1950-0	0.15 to 0.5	0.10	0.15
1950-1	0.4 to 1.6	0.15	0.20
1950-5	1.4 to 5.5	0.3	0.4
1950-10	3.0 to 11.0	0.4	0.5
1950-20	4.0 to 20.0	0.4	0.6
Model Number	**Operating Range: PSI**	**Approximate Dead Band**	
		Min. Set Point	Max. Set Point
1950P-2	0.5 to 2.0	0.3 PSI	0.3 PSI
1950P-8	1.5 to 8.0	1.0 PSI	1.0 PSI
1950P-15	3.0 to 15.0	0.9 PSI	0.9 PSI
1950P-25	4.0 to 25.0	0.7 PSI	0.7 PSI
1950P-50	15.0 to 50	1.0 PSI	1.5 PSI

PHYSICAL DATA

Temperature Limits: -40° to 140°F (-40° to 60°C); 1950P-8, -15, -25, -50: 0° to 140°F (-17.8° to 60°C); 1950-02: - 30° to 130°F (-34.4° to 54.4°C).
Rated Pressure: 1950: 45 in. w.c. (0.1 bar); 1950P: 35 psi (2.4 bar); 1950P-50 only: 70 psi (4.8 bar).
Maximum Surge Pressure: 1950: 10 psi (0.7 bar); 1950P: 50 psi (3.4 bar); 1950P-50 only: 90 psi (6.2 bar).
Pressure Connections: $^1/_8$″ NPT(F).
Electrical Rating: 15A, 125, 250, 480 volts, 60 Hz. AC Resistive $^1/_8$ H.P. @ 125 volts, $^1/_4$ H.P. @ 250 volts, 60 Hz. AC.
Wiring Connections: 3-screw type; common, normally open and normally closed.
Conduit Connections: $^1/_2$″ NPT(F).
Set point adjustment: Screw type on top of housing, field adjustable.
Housing: Anodized cast aluminum.
Diaphragm: Molded fluorosilicone rubber, 02 model: silicone on Nylon.
Calibration Spring: Stainless Steel
Installation: Mount with diaphragm in vertical position.
Weight: 3 $^1/_4$ lbs (1.5 kg), 02 model; 4 lbs, 7 oz. (2 kg).

RESPONSE TIME: Because of restrictive effect of flame arrestors, switch response time may be as much as 10-25 seconds where applied pressures are near set point.

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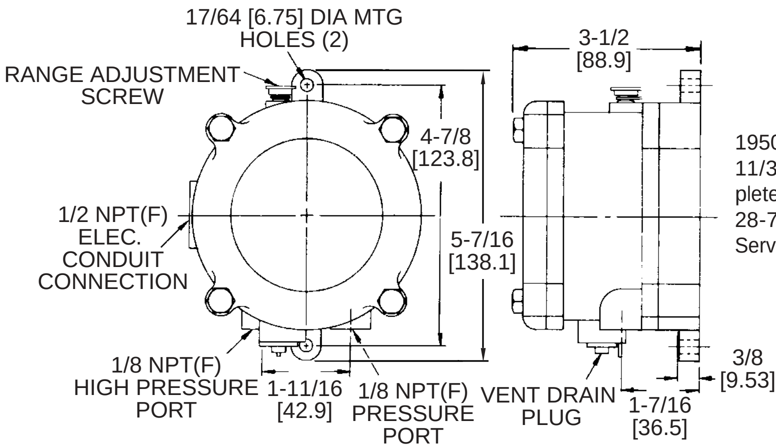
Series 1950 – Explosion-Proof Differential Pressure Switches

Specifications - Installation and Operating Instructions



1950-02: 7-3/4″ (196.9) dia. x 4-11/32″ (110.3) depth. For complete dimensions request drawing 28-700175-00 from our Customer Service Department

1950 Switch Outline Dimensions

INSTALLATION

1. Select a location free from excess vibration and corrosive atmospheres where temperatures will be within the limits noted under Physical Data on page 1. Switch may be installed outdoors or in areas where the hazard of explosion exists. See page 1 for specific types of hazardous service.

2. Mount standard switches with the diaphragm in a vertical plane and with switch lettering and Dwyer nameplate in an upright position. Some switches are position sensitive and may not reset properly unless they are mounted with the diaphragm vertical.

3. Connect switch to source of pressure, vacuum or differential pressure. Metal tubing with 1/4″ O.D. is recommended, but any tubing which will not restrict the air flow can be used. Connect to the two 1/8″ NPT(F) pressure ports as noted below:

A. Differential pressures - connect pipes or tubes from source of greater pressure to high pressure port marked HIGH PRESS, and from source of lower pressure to low pressure port marked LOW PRESS.

B. Pressure only (above atmospheric pressure) - connect tube from source of pressure to high pressure port. The low pressure port is left open to atmosphere.

C. Vacuum only (below atmospheric pressure) - connect tube from source of vacuum to low pressure port. The high pressure port is left open to atmosphere.

4. To make electrical connections, remove the three hex head screws from the cover and after loosening the fourth captive screw, swing the cover aside. Electrical connections to the standard single pole, double throw snap switch are provided by means of terminals marked “COM” (common), “NO” (norm open), “NC” (norm closed). The normally open contacts close and the normally closed contacts open when pressure increases beyond the set point. Switch loads for standard models should not exceed the maximum specified current rating of 15 amps resistive. Switch capabilities decrease with an increase in ambient temperature, load inductance, or cycling rate. Whenever an application involves one or more of these factors, the user may find it desirable to limit the switched current to 10 amps or less in the interest of prolonging switch life.

ADJUSTMENT: To Change the Set point

1. Remove the plastic cap and turn the slotted Adjust-ment Screw at the top of the housing clockwise to raise the set point pressure and counter-clockwise to lower the set point. After calibration, replace the plastic cap and re-check the set point.

2. The recommended procedure for calibrating or checking calibration is to use a “T” assembly with three rubber tubing leads, all as short as possible and the entire assembly offering minimum flow restriction. Run one lead to the pressure switch, another to a manometer of known accuracy and appropriate range, and apply pressure through the third tube. Make final approach to the set point very slowly. Note that manometer and pressure switch will have different response times due to different internal volumes, lengths of tubing, fluid drainage, etc. Be certain the switch is checked in the position it will assume in use, i.e. with diaphragm in a vertical plane and switch lettering and Dwyer nameplate in an upright position.

3. For highly critical applications check the set point adjustment and if necessary, reset it as noted in step A.

MAINTENANCE

The moving parts of these switches need no maintenance or lubrication. The only adjustment is that of the set point. Care should be taken to keep the switch reasonably clean. Periodically the vent drain plug should be rotated, then returned to its original position. This will dislodge deposits which could accumulate in applications where there is excessive condensation within the switch.

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Form 237
Sheet P/N 7801165
Rev. B

Warrick®
Series M Mechanical Tilt Float Switch
Installation and Operation Bulletin

Specifications

Cord	16 gauge, 2 or 3 conductor SJOW, Oil Resistant CPE
Contact Rating	13 amp @ 120/240 VAC, 1/2hp
Contact Design	SPST, Normally Open or Normally Closed, Common with N.O. & N.C. (Form C)
Temperature Rating	32°F to 140°F (0°C to 60°C)
Overall Weight	1.0 lbs. (not including weight)
Tether Method	Tie-wrap nylon, weight: 2.5 lbs.
Approvals	U.L. Recognized, CSA Certified

Installation

Tether Tie-Wrap (Fig 1)
Attach cord, using a tie-wrap, to a stationary structure. This is known as the tether point, it will determine the pumping range. The farther the float is placed from the tether point, the greater the pumping range. The minimum distance that the float should be placed from the tether point is 3 inches.

Tether-Weight (Fig 2)
Place tension-brand over the cord before installation. Place the weight at the desired position and secure with the tension-band. This position will determine the pumping range. The farther the float is placed from the tether point, the greater the pumping range. The minimum distance that the float should be placed from the tether point is 3 inches.

Notes:
1. To Prevent Motor Burnout - In a pumpdown application make sure the turn-off level is at least 2 inches above the intake of the submersible pump.

2. Securing Tether Points - Make sure levels are correct and that floats are free from any obstructions before securing tether points.

3. When using Tether Weight - Place the tension-band over the cord prior to installation.

Determine tether point using charts below as a reference

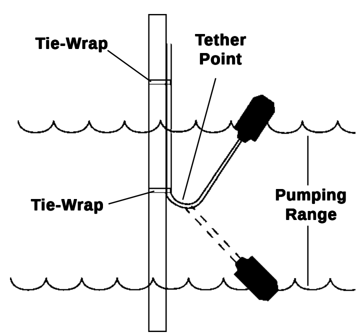


Figure 1

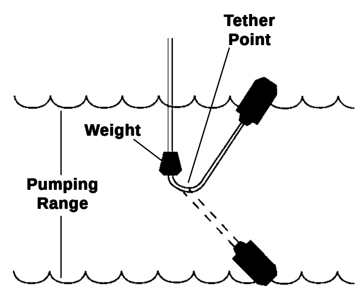
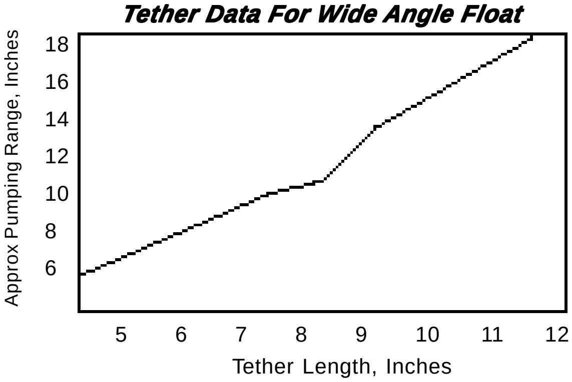
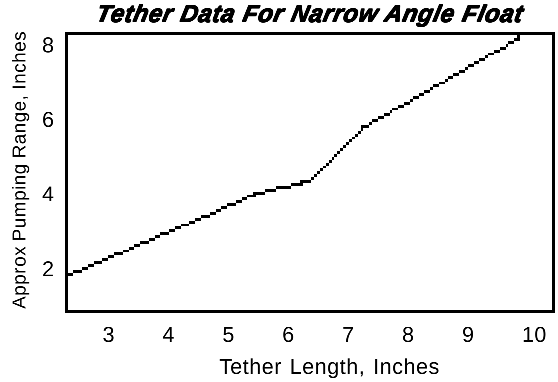


Figure 2

Tether Data For Wide Angle Float

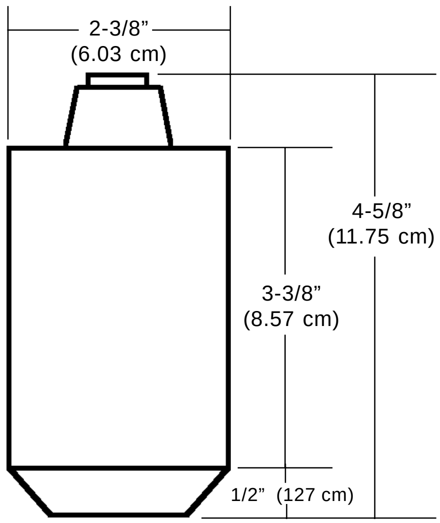


Tether Data For Narrow Angle Float

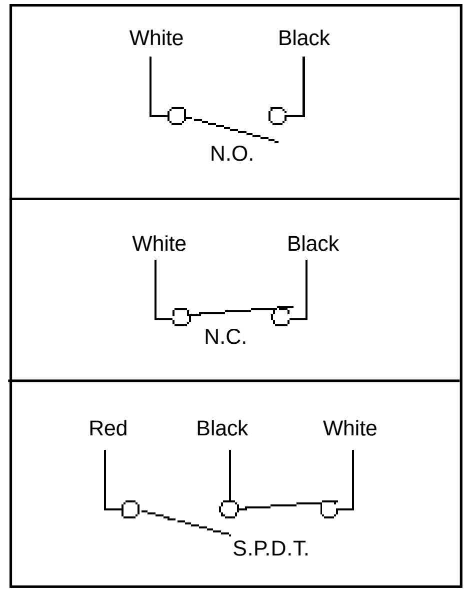


Notes:
1. Narrow angle pumping range is approximately 2 Ft. to 8 Ft.
2. Wide angle pumping range is approximately 5 Ft. to 18 Ft.

Dimensions



Contact Configurations



Important Points:

- Gems products must be maintained and installed in strict accordance with the National Electrical Code and the applicable Gems Product Instruction Bulletin that covers installation, operation and proper maintenance. Failure to observe this information may result in serious injury or damages.
- For hazardous area applications involving such things as, but not limited to, ignitable mixtures, combustible dust and flammable materials, use an appropriate explosionproof enclosure or intrinsically safe interface device.
- Please adhere to the pressure and temperature limitations shown throughout this catalog for our level and flow sensors. These limitations must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/temperatures and their frequencies.
- Selection of materials for compatibility with the media is critical to the life and operation of Gems products. Take care in the proper selection of materials of construction, testing is required.
- NSF-approved sensors are made of materials approved for potable water applica tions according to Standard 61.
- Stainless steel is generally regarded as safe by NSF and FDA.
- Life expectancy of switch contacts varies with application. Contact Gems if life cycle testing is required.
- Ambient temperature changes do affect switch set points, since the gravity of a liquid can vary with temperature.
- Our sensors have been designed to resist shock and vibration. However, shock and vibration should be minimized.
- Filter liquid media containing particulate and/or debris to ensure the proper operation of our products.
- Electrical entries and mounting points in an enclosed tank may require liquid/vapor sealing.
- Our sensors must not be field-repaired.
- Physical damage sustained by product may render it unserviceable.

Return Policy

Returns are accepted on stock items up to 30 days from date of order. You must contact our Returns Department for a Return Authorization (RA) number. Return the goods - freight prepaid - in the original container and include original packing slip. C. O. D. returns are not accepted. Gems reserves the right to apply restocking charges.

Tel: 860-793-4357
Fax: 860-793-4563

Gems Sensors Inc.
One Cowles Road
Plainville, CT 06062-1198
Tel: 860-793-4579
Fax: 860-793-4580

W.E. Anderson

FLOTECT® Vane Operated Flow Switch

INSTALLATION AND OPERATING INSTRUCTIONS

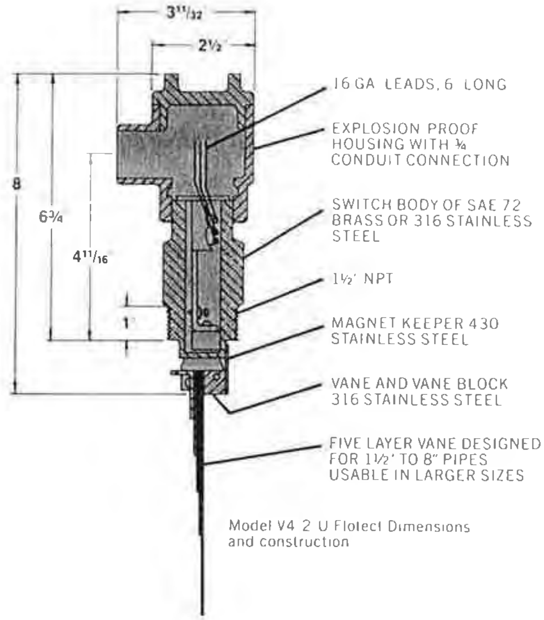
**Explosion-Proof; U.L. and C.S.A. listed – Class I, Groups C, D; Class II, Groups E, F, G.
CENELEC: EExd 11B T6.**

Dependable protection against flow variation or stopping in pipelines for fluids, gasses and flowing solids.

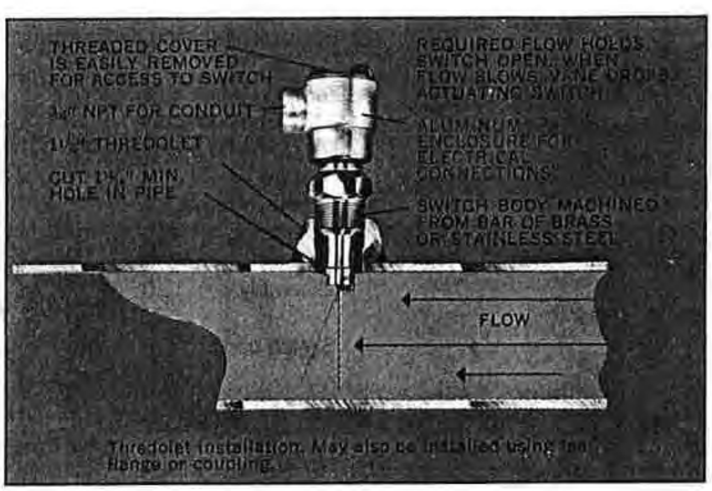
Supplied with custom or universal multi-layer vanes for field installation in pipes from 1½".

Compact and reliable, the Flotect V4 Flow switch operates automatically to protect equipment and pipeline systems against damage from reduction or loss of flow. Installed in thousands of pipelines and processing plants around the world, this unique magnetically actuated switching design gives superior performance. Universal multi-layer vane accommodates pipe sizes from 1½" up. Custom vanes are available with factory calibration. There are no bellows, springs, or seals to fail. Instead, the free-swinging vane attracts a magnet within the solid metal switch body above, actuating a snap switch by means of a simple lever arm.

Features include: Simplicity of design and a leak-proof switch body, machined from bar stock for pressures to 2000 psig, (138 bar), it eliminates the possibility of process fluid entering the switch compartment. The threaded conduit enclosure cover permits easy inspection or replacement of electrical assembly without shutting down the process, or removing electrical conduit. Power must be disconnected. The unit fits directly into pipeline with tee, thredolet or flange for easy installation. Pendulum-like vane action responds accurately to fluid flow rate. The custom vane or multi-layer vane is sensitive to low velocity flows, yet it is rugged enough to withstand high flow surges. If desired, a delay timer can be wired into the installation. All units are explosion-proof and listed with U.L. and C.S.A. for Class I, Groups C and D, Class II, Groups E, F, and G or are flame-proof to CENELEC EExd IIB T6.



Model V4 2 U Flotect Dimensions and construction



Thredolet installation. May also be installed using tee, flange or coupling.

APPLICATIONS

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

SPECIFICATIONS

Temperature limits:	Standard 275°F (135°C). High temperature option (not U.L., C.S.A. or CENELEC), 400°F (205°C) max.
Operating Pressure:	Brass 1000psig (69bar) 316S.S. 2000psig(138bar) Ratings to 5000psig(345bar) available (SPDT only).
Electrical Rating:	U.L. and CENELEC: 10A@125/250 Vac C.S.A.; 5A@125/250 Vac, 5A resistive 3A inductive@30Vdc Optional ratings (not UL, CSA or CENELEC); MV option; Gold contacts, 1.0A@125 Vac MT option: 400°F (205°C), 5A@125/250Vac
Wiring:	U.L./C.S.A. unit; 16 gauge copper wire, 6" long, mechanically and solder bonded to switch. CENELEC unit: Terminal board.
Switch body:	One piece milled and bored Brass or 316 SS. Other materials on request.
Vane:	316 SS 1⁹⁄₁₆" (40mm) wide. Std. trim includes 430 SS and silver solder. Other materials on request.
Piping Connection:	1½" NPT std for mounting in 1½" thredolet. For other mounting see back page. Thredolet fittings available.
Installation:	Within 5° of vertical for proper operation. Units for horizontal installation (vertical pipes) on request.
Weight:	4lb.-5oz. (1.96Kg)
Options:	All 316SS wetted parts. Teflon coated wetted parts. DPDT circuits. Cartridge heater to melt paraffin, etc. Time delay relay.

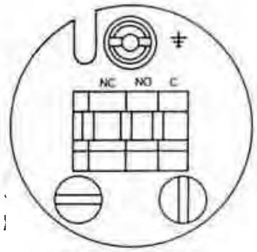
INSTALLATION

1. Remove packing material from switch body-cap and remove tape from magnet keeper. Adjust vane length if necessary on multi-layer vanes only. Install switch in thredolet previously welded to line. In some cases, it may be necessary to install the switch in a flange or tee. Note: extreme care must be excercised in welding the fitting to the line so that it is plumb and level.

2. The arrow on the side of the switch must point in the direction of flow.

3. **U.L. and C.S.A. units only:** Thread connecting wires through conduit and connect.
Black – Common
Blue – N.O.
Red – N.C.
Note: Double pole, double throw switches have dual black, blue and red leads. These are connected in the same manner as single pole, double throw switches, as described above.

CENELEC units only: Wire in accordance with local electrical codes. Cable should enter enclosure housing through an approved Ex cable gland (not supplied). Stripped and tinned leads are simply pushed into wire entry of terminal block. Depress spring release with small screwdriver when inserting or removing fine stranded leads. Be sure strands do not bridge across terminal spacing. Double pole, double throw switches have dual terminal blocks.



TERMINAL CONNECTIONS

Note: The switch is deactivated and contacts are in normal condition when there is no flow in the line.

4. Make sure conduit or cable are properly sealed. Electrical components must be kept free of moisture, including condensation, at all times. **CAUTION:** To prevent ignition of hazardous atmosphere, disconnect the device from the supply circuit before opening. Keep assembly tightly closed when in operation.

5. Inspect and clean wetted parts at regular intervals.

6 **CENELEC units only:** The "T" class is dependent upon the ambient temperature of the media. The approved ratings are: T6 at 75°C, T5 at 90°C; T4 at 125°C; T3 at 135°C.

7. Custom vane units have been calibrated at factory to meet requirements. Do not change.

ADJUSTMENT OF MULTI-LAYER VANE

Remove only those layers which are too long. Leave the smaller layers to reinforce the vane. The longest vane fits 6" (150mm) or larger pipe, the second longest vane fits 4" (100mm) pipe, etc. Actuation-Deactuation rates are shown in the charts on the next page.
To remove vane layers, proceed as follows:

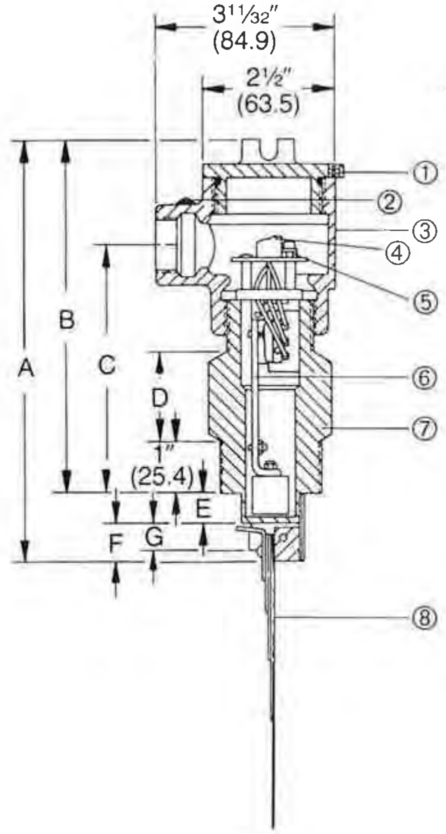
1. Remove the two screws and lockwashers holding the layers together. Do not lose these special corrosion resistant type 316 stainless steel screws and lockwashers.

2. Remove the unwanted layers.

3. Resecure the vane with the original two screws and lockwashers.

4. With a hammer, lightly peen the ends of the screws so that they can't back out.

5. If you lose the screws or lockwashers, don't replace with other parts which may corrode and break. That would void the warrantee and might cause severe damage to equipment located downstream of the switch.



CENELEC unit shown, for U.L./C.S.A. unit see first page.

DIM.	V4		V4-2	
	IN.	MM	IN.	MM
A	8 3/16	208	8	203
B	6	152	6¾	171
C	4 11/16	119	3 15/16	100
D	1	25.4	1¾	44
E	1 5/16	33	9/16	14
F	7/8	22	11/16	17
G	1 1/16	17	½	13

PARTS LIST

1. Cover lock. (CENELEC unit only).
2. External ground. (CENELEC unit only).
3. Enclosure housing and cover.
4. Terminal block. (CENELEC unit only, UL/CSA unit has 6" leads).
5. Internal ground.
* 6. Magnet arm and switch assembly.
7. Switch body.
* 8. Vane assembly.

*Approved replacement parts.

APPROXIMATE ACTUATION-DEACTUATION FLOW RATES FOR COLD WATER

UPPER FIGURES IN GPM. LOWER FIGURES IN M3/HR.

VANE LAYERS	1.5″ PIPE	2″ PIPE	3″ PIPE	4″ PIPE	6″ PIPE	8″ PIPE	10″ PIPE	12″ PIPE	14″ PIPE	16″ PIPE	18″ PIPE	20″ PIPE
1	7- 3 1.6-0.7	15- 8 3.4-1.8	45-22 10- 5	95-40 22- 9	210-120 48- 27	375-175 85- 40	600-300 136- 68	900-450 204-102	1200-600 273-136	1400-800 318-182	2000-1000 454- 227	2400-1200 545- 273
1&2		7- 4 1.6-0.9	23- 14 5.2-3.2	50- 35 11.4-7.9	130-90 30-20	230-150 52- 34	450-250 102- 57	650-350 148- 79	900-500 204-114	1200-650 273-148	1450-800 329-182	1800-1000 409- 227
1, 2&3			11- 7 2.5-1.6	27- 19 6.1-4.3	80-60 18-14	160-115 36- 26	300-180 68- 41	450-275 102- 62	600-350 136- 79	750-450 170-102	1000-600 227-136	1200-700 273-159
1, 2, 3&4				17- 12 3.9-2.7	60-45 14-10	120-90 27-20	230-150 52- 34	310-200 70- 45	430-280 98- 64	550-360 125- 82	700-450 159-102	850-550 193-125
1, 2, 3, 4&5					40- 30 9.1-6.8	80-65 18-15	135-100 31- 23	200-140 45- 32	290-200 66- 45	360-250 82- 57	460-325 104- 74	575-400 131- 91

Actuation rates are based on cold water at a specific gravity of 1.0. For fluids of different specific gravity, actuation rates may be approximated by dividing the rate shown by the square root of the specific gravity.

APPROXIMATE ACTUATION-DEACTUATION FLOW RATES FOR AIR

UPPER FIGURES IN SCFM. LOWER FIGURES IN NM3/S.

VANE LAYERS	1.5″ PIPE	2″ PIPE	3″ PIPE	4″ PIPE	6″ PIPE	8″ PIPE	10″ PIPE	12″ PIPE	14″ PIPE	16″ PIPE	18″ PIPE	20″ PIPE
1	32- 17 0.02-0.008	65- 32 0.03-0.02	210- 105 0.10-0.05	400- 200 0.19-0.09	950- 475 0.45-0.22	1550- 850 0.73-0.40	2400-1300 1.1- 0.6	3450-1900 1.6- 0.9	4700-2600 2.2- 1.2	6400-3500 3.0- 1.7	8000-4400 3.8- 2.1	10000-5500 4.7- 2.6
1&2		23- 13 0.01-0.006	120- 70 0.06-0.03	195- 140 0.09-0.07	550- 375 0.26-0.18	1100- 700 0.52-0.33	1850-1200 0.87- 0.57	2700-1750 1.3- 0.8	3400-2200 1.6- 1.0	4800-3100 2.3- 1.5	6000-3900 2.8- 1.8	7400-4800 3.5- 2.3
1, 2&3			60- 48 0.03-0.02	135- 100 0.06-0.05	375- 265 0.18-0.13	725- 500 0.34-0.24	1200- 850 0.57-0.40	1850-1300 0.87- 0.61	2600-1800 1.2- 0.8	3350-2350 1.6- 1.1	4300-3000 2.0- 1.4	5300-3700 2.5 1.7
1, 2, 3&4				65- 50 0.03-0.02	260- 200 0.12-0.09	500- 400 0.24-0.19	875- 700 0.41-0.33	1250-1000 0.59- 0.47	1900-1500 0.90- 0.71	2500-2000 1.2- 0.9	3100-2500 1.5- 1.2	3900-3100 1.8- 1.5
1, 2, 3, 4&5					130- 100 0.06-0.05	310- 250 0.15-0.12	650- 525 0.31-0.25	1000- 800 0.47-0.38	1600-1250 0.76- 0.59	2200-1750 1.04- 0.83	2800-2250 1.3- 1.1	3550-2850 1.7- 1.3

Values shown in both charts are nominal. If normal flows exceed actuation rates by less than 10%, custom vanes are recommended. Figures are based on standard vertical installation in a 1½″ thredolet in a horizontal run of pipe.

SERIES 636 FIXED RANGE PRESSURE TRANSMITTER

Specifications – Installation and Operating Instructions

$365

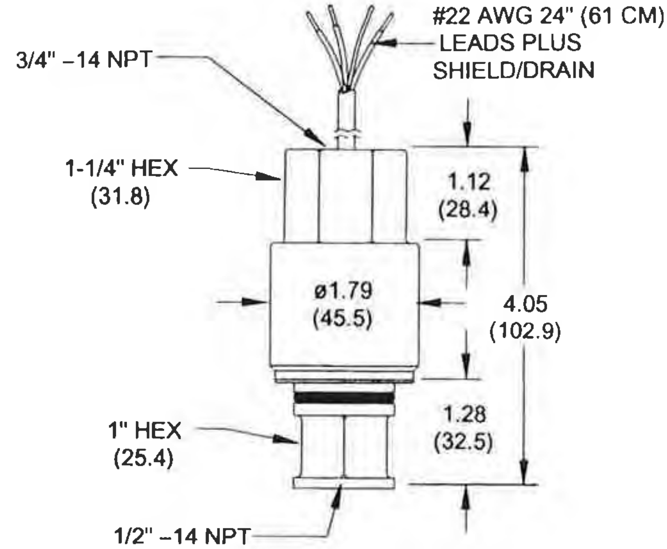


FIG. 1

The Series 636 Fixed Range Pressure Transmitter converts liquid, gas or vapor pressure into a standard 4-20 mA DC output signal. All 316 stainless steel construction makes it compatible with most corrosive media. This explosion-proof control is FM approved for use in hazardous locations and it meets NACE Standards for offshore applications. It is also weatherproof, capable of resisting a direct water spray. With these quality features and ±0.3% F.S. accuracy, the Series 636 Transmitter is an exceptional value.

The design is based on a sensitive piezoresistive sensing element consisting of four diffused strain gages. They form a bridge circuit which varies its resistance when stressed by the process pressure. Small size and light weight eliminate the need for complicated mounting hardware and mechanical supports. With simple in-line wiring, installation is quick and inexpensive. Slim profile enables mounting in spaces too tight for many other transmitters.

MODEL NUMBER	RANGE, PSIG	RANGE, BAR
636-0	0-15	0-1.03
636-1	0-30	0-2.06
636-2	0-100	0-6.89
636-3	0-300	0-20.67

SPECIFICATIONS

Service: Liquid, gas or vapor

Materials of Construction:
Process wetted parts: 316L stainless steel
Non-wetted parts: 316 stainless steel
Fluid fill: Dow Corning 200 silicone

Process Connection: 1/2" NPT female

Electrical Connection: 3/4" NPT female/cable

Weight: 13.2 ounces (374 grams)

Cable Length: 24 inches (61 cm), 22 AWG

Output: 4-20 mA DC, limited to 30 mA DC

Power Supply: 12-30 VDC with reverse polarity and surge protection

Offset: 4.0 mA, ±2% span

Span: 16.0 mA, ±1% span

Temperature Limits:
Electronics (ambient): –40 to 140°F (–40 to 60°C)
Process interface: –40 to 212°F (–40 to 100°C)
Storage: –40 to 212°F (–40 to 100°C)

Overrange Limit: 300% of full span pressure

Humidity Limits: 0-100% RH

Accuracy: ±0.30% of calibrated span including linearity hysteresis and repeatability (BFSL) at 25°C (77°F) and 12 VDC excitation

Stability: ±0.5% for six months

Temperature Effect (includes span and zero):
±2% per 50°F (28°C) from –20 to 180°F (–29 to 82°C)

Vibration Effect: ±0.1% for 3g to 200 Hz

Position Effect: 0.05%/90° tilt

Overrange Effect: ±0.15% F.S. per 300% of max. range

CLASSIFICATIONS

Explosion-Proof for Class I, Div. I, Groups B, C & D; Class II, Groups E, F & G; and Class III Hazardous locations. Indoor and outdoor NEMA Type 4 enclosure.

DWYER INSTRUMENTS, INC.
P. O. BOX 373 • MICHIGAN CITY, INDIANA 46360, U.S.A.
Telephone 219/879-8000
Fax 219/872-9057

INSTALLATION

Care should be taken during installation to prevent condensate accumulation in the conduit compartment or sediment accumulation in the diaphragm chamber. See Fig. 2 for suggested piping arrangements in several typical situations. Use pipe joint compound or Teflon® thread tape to assure a leak-proof process connection.

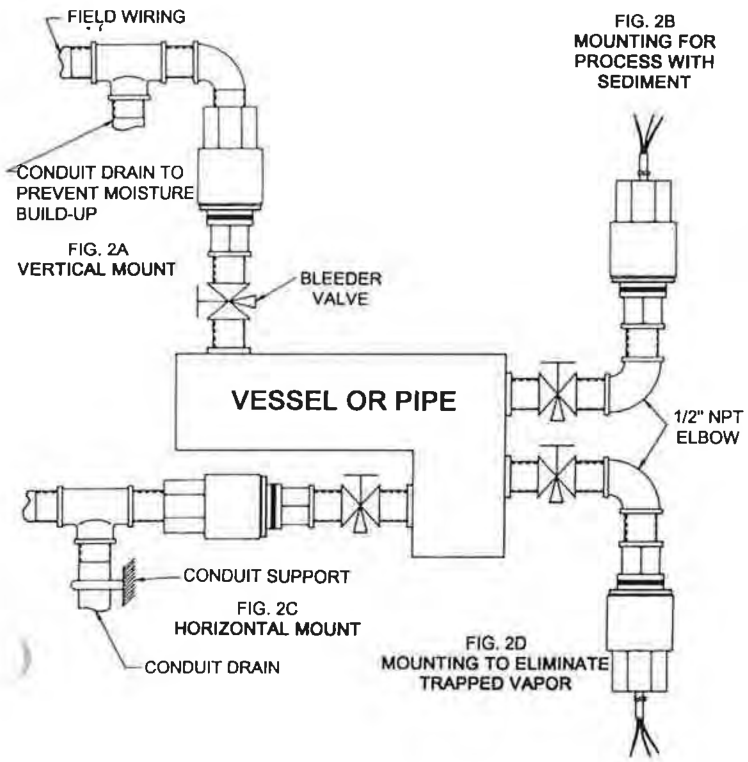


FIG. 2

ELECTRICAL CONNECTIONS

CAUTION: Do not exceed specified supply voltage rating. Permanent damage not covered by warranty will result. This unit is not designed for AC line voltage operation. Power must be off while wiring connections are being made.

An external power supply delivering 12-30 VDC with a minimum current capability of 40 mA DC (per transmitter) must be used to power the control loop. See Fig. 3.

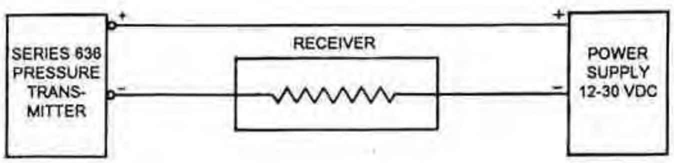


FIG. 3

The range of appropriate loop resistance, including the receiver load resistance for the DC power supply being used is limited to that expressed by the graph in Fig. 4.

To comply with good electrical practice, it is recommended that the transmitter be grounded. This can be accomplished through either the green wire or the transmitter case. To avoid a "ground loop" condition, DO NOT use both. The shield/drain wire is not connected to the case. This shield/drain is normally tied to ground at the receiver for optimal noise rejection.

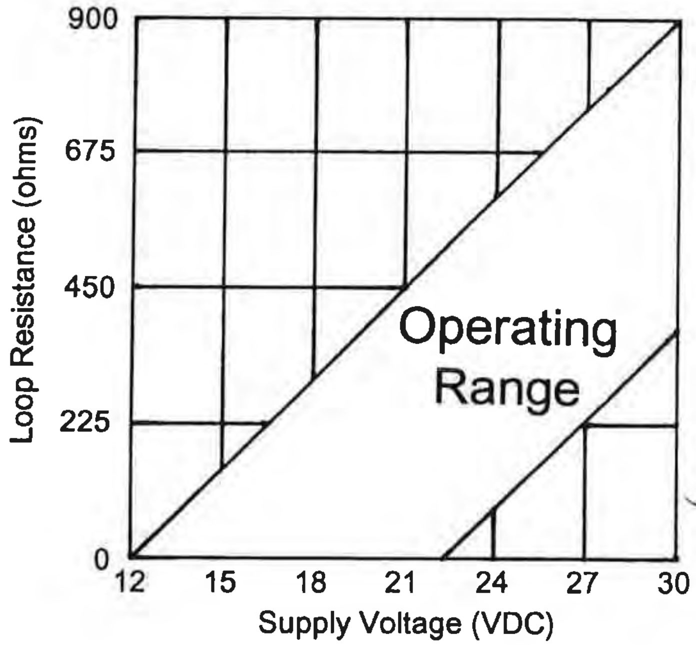


FIG. 4

MAINTENANCE

After final installation of the Series 636 Fixed Range Pressure Transmitter, no routine maintenance is necessary. These transmitters are not field serviceable and should be returned to the factory, freight prepaid, if repair is needed. Be sure to include a clear description of the problem plus any application information available.

Printed in U.S.A. 5/94

FR 01-440815-00

DWYER INSTRUMENTS, INC.
P.O. Box 373, Michigan City, Indiana 46360, U.S.A.
Phone: 219/879-8000 Fax: 219/872-9057

FLOTECT™ MODEL L-6 FLOAT SWITCH

Installation and Operating Instructions

Explosion-Proof; U.L. and C.S.A. Listed - Class I, Groups *A, B, C & D
Class II, Groups E, F & G
CENELEC: EExd IIC T6 (T amb=75ºC)
*(Group A, stainless steel body only)

PHYSICAL DATA

Temperature Limit: 220ºF (105ºC) maximum
Maximum Pressure: See chart below
Switches: One or two SPDT snap switches
Electrical Rating: U.L.: 5A @ 125/250 VAC.
C.S.A. and CENELEC: 5A @ 125/250 VAC, 5A resistive, 3A inductive @ 30 VDC.
Optional ratings: MV option—Gold contacts for dry circuits. Rated 0.1A @ 125 VAC MT option: 400ºF (205ºC) 5A @ 125/250 VAC (not listed).
Wiring Connections: 3-18" (460mm) wire leads, 18 ga.
CENELEC models only: push-in type terminal blocks
Black = common, blue = N.O., red = N.C.
Minimum Specific Gravity:
Polypropylene float - 0.9
Round SS float - 0.7
Cylindrical SS float - 0.5
Switch Body: Brass 3/4" NPT conduit connection.
For SS switch body, change model no. to L6EPS.
Piping/Mounting Connection: 1" NPT
Installation: Horizontal, index arrow pointing down.
Weight: 1 lb. (.5 KG); w/external chamber 1-3/4 lb. (.8 KG)

WETTED MATERIALS CHART

Model	Brass	Bronze	Ceramic	Polypropylene	301SS	303SS	304SS
B-S-3-A	X		X		X		X
B-S-3-B	X	X	X	X	X		
B-S-3-C	X		X		X		X
B-S-3-H	X	X	X		X		X
B-S-3-O	X		X	X	X		
S-S-3-A			X	X	X		X
S-S-3-C			X		X	X	X
S-S-3-L			X		X	X	X
S-S-3-O			X	X	X	X	
S-S-3-S			X	X	X	X	

MAXIMUM PRESSURE CHART

Model Number	Float	Pressure Rating PSIG (KG/CM²)
L6EPB-B-S-3-A	Cylindrical SS	200 (14)
L6EPB-B-S-3-B	Polypropylene	250 (18)
L6EPB-B-S-3-C	Round SS	350 (25)
L6EPB-B-S-3-H	Round SS	250 (18)
L6EPB-B-S-3-O	Polypropylene	1000 (70)
L6EPB-S-S-3-A	Cylindrical SS	200 (14)
L6EPB-S-S-3-C	Round SS	350 (25)
L6EPB-S-S-3-L	Round SS	350 (25)
L6EPB-S-S-3-O	Polypropylene	2000 (140)
L6EPB-S-S-3-S	Polypropylene	2000 (140)

INSTALLATION:

Unpack switch and remove any packing material found inside lower housing or float chamber.

Switch must be installed with body in a horizontal plane and arrow on side pointing down.

If switch has an external float chamber (tee), connect it to vertical sections of 1" NPT pipe installed outside vessel walls at appropriate levels. If unit has no external float chamber, it must be mounted in a 1" NPT half coupling welded to the vessel wall. The coupling must extend through the wall.

Inspect and clean wetted parts at regular intervals.

ELECTRICAL CONNECTIONS:

Connect wire leads in accordance with local electrical codes and switch action required. N.O. contacts will close and N.C. contacts will open when liquid level causes float to rise. They will return to "normal" condition on decreasing liquid level. Black = common, Blue = N.O. and Red = N.C.

For units supplied with both internal and external grounds, the ground screw inside the housing must be used to ground the control. The external ground screw is for supplementary bonding when allowed or required by local code. Some CSA listed models are furnished with a separate green ground wire. Such units must be equipped with a junction box, not supplied but available on special order.

CENELEC certified models include a junction box. Cable should enter enclosure through an approved EX cable gland, not supplied. Push stripped and tinned leads into appropriate openings in terminal block(s). To connect fine stranded leads or to remove any wire, depress spring release with small screwdriver first.

All wiring, conduit and enclosures must meet applicable codes for hazardous areas. Conduits and enclosures must be properly sealed. For outdoor or other locations where temperatures vary widely, precautions should be taken to prevent condensation inside switch or enclosure. Electrical components must be kept dry at all times. **CAUTION:** To prevent ignition of hazardous atmospheres, disconnect the device from the supply circuit before opening. Keep assembly tightly closed when in use.

Dimensions on reverse

W.E. ANDERSON DIV., DWYER INSTRUMENTS, INC.
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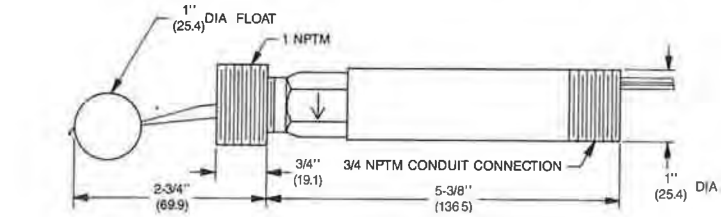
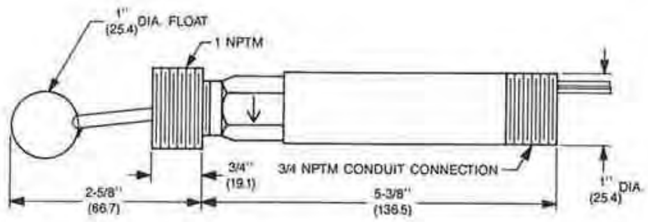
Telephone 219/879-8000
Fax 219/872-9057

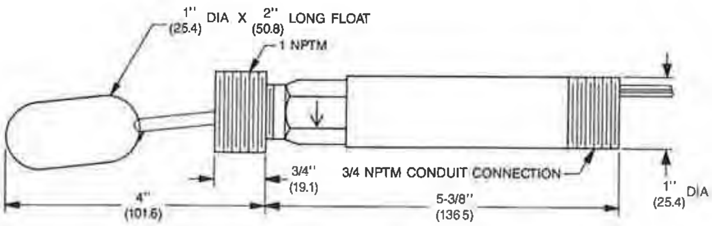
FLOTECT™ MODEL L-6 FLOAT SWITCH — DIMENSION DRAWINGS



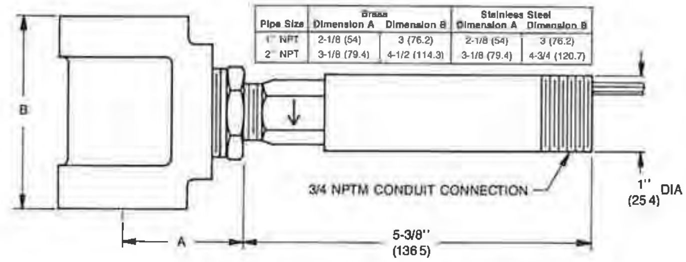
Polypropylene Float



Round Stainless Steel Float

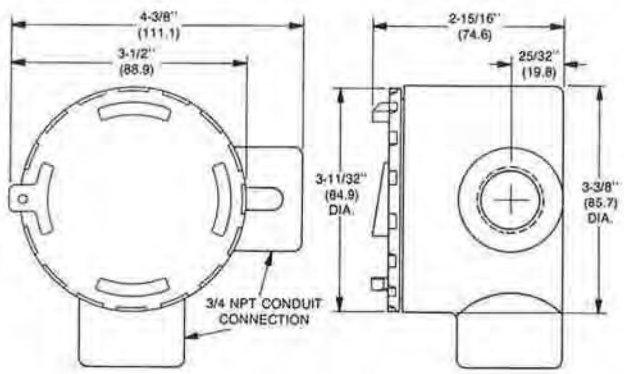


Cylindrical Stainless Steel Float



Pipe Size	Brass Dimension A	Brass Dimension B	Stainless Steel Dimension A	Stainless Steel Dimension B
1" NPT	2-1/8 (54)	3 (76.2)	2-1/8 (54)	3 (76.2)
2" NPT	3-1/8 (79.4)	4-1/2 (114.3)	3-1/8 (79.4)	4-3/4 (120.7)

With External Float Chamber (Tee)



CSA, CENELEC Conduit Enclosure

Limited Warranty: The Seller warrants all Dwyer instruments and equipment to be free from defects in workmanship or material under normal use and service for a period of one year from date of shipment. Liability under this warranty is limited to repair or replacement F.O.B. factory of any parts which prove to be defective within that time or repayment of the purchase price at the Seller's opinion provided the instruments have been returned, transportation prepaid, within one year from the date of purchase. All technical advice, recommendations and services are based on technical data and information which the Seller believes to be reliable and are intended for use by persons having skill and knowledge of the business, at their own discretion. In no case is Seller liable beyond replacement of equipment F.O.B. factory or the full purchase price. This warranty does not apply if the maximum ratings label is removed or if the instrument or equipment is abused, altered, used at ratings above the maximum specified, or otherwise misused in any way.

THIS EXPRESS LIMITED WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER REPRESENTATIONS MADE BY ADVERTISEMENTS OR BY AGENTS AND ALL OTHER WARRANTIES, BOTH EXPRESS AND IMPLIED. THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE FOR GOODS COVERED HEREUNDER.

Buyers Remedies: THE BUYER'S EXCLUSIVE AND SOLE REMEDY ON ACCOUNT OF OR IN RESPECT TO THE FURNISHING OF NONCONFORMING OR DEFECTIVE MATERIAL SHALL BE TO SECURE REPLACEMENT THEREOF AS AFORESAID. THE SELLER SHALL NOT IN ANY EVENT BE LIABLE FOR THE COST OF ANY LABOR EXPENDED ON ANY SUCH MATERIAL OR FOR ANY SPECIAL, DIRECT, INDIRECT OR CONSEQUENTIAL DAMAGES TO ANYONE BY REASON OF THE FACT THAT IT SHALL HAVE BEEN NON-CONFORMING OR DEFECTIVE.

W.E. Anderson

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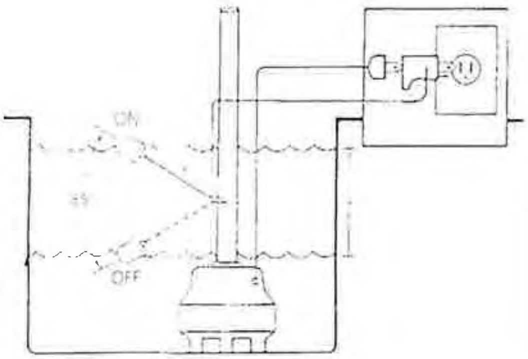
These instructions do not purport to cover all details or variation nor to provide for every contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Teel.

Teel® Mechanical Piggyback Sump Pump Floats

Description

This piggyback float with a wide-angle switch has been designed for use with residential sump pumps. The float is rated for 13 amps and 0.5 Hp at 120/240 VAC. The typical operating angle is 85°.

The inches of water pumped is determined by float tether length and location (see chart)



Tether length, inches (x)	Water pumped, inches (y)*
3	7
4	8
6	11
8	14
10	17
12	21

* Typical

Installation

1. Tether strap can be mounted on either pump or discharge pipe along with cord from float. See table for pumping differential. Be sure that float can move freely up and down without hanging up on pump, pipe, or sump. Before operating, inspect the tether strap to be sure that it is tightly secured and will not allow the float cord to slip in either direction. Failure to comply with this caution may result in excessive accumulation or an inadequate accumulation of water in the sump.
2. Insert the float's Series Tap Plug into 3-wire grounded-receptacle; then insert pump cord into back of Series Tap Plug.

Limited Warranty

Dayton One-Year Limited Warranty. *Teel® mechanical wide-angle sump pump piggyback floats, Models covered in this manual, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see PROMPT DISPOSITION below. This limited warranty gives purchasers specific legal rights which vary from jurisdiction to jurisdiction.*

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

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

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

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

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

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

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

Form 5S3764

Printed in U S A
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0696/082/VCPV?
20505

TEEL®

HAYWARD INDUSTRIAL PRODUCTS
INSTALLATION OPERATION & MAINTENANCE OF TRUE UNION BALL VALVES

SOCKET CONNECTION:

Socket end connections are manufactured to ASTM D2467-87A. Solvent cementing of socket end connections to pipe should be performed per ASTM specifications D2855-87. Cut pipe square. Chamfer and deburr pipe. Surfaces must be cleaned and free of dirt, moisture, oil and other foreign material. Remove assembly nuts and end connectors from valve body. Slide assembly nuts, with threads facing valve, onto pipe to which the end connector is to be cemented. Apply primer to inside socket surface of end connector. Never allow primer or cement to contact valve ball or end connector o-ring sealing surfaces, as leaking may result. Use a scrubbing motion. Repeat applications may be necessary to soften the surface of the socket. Next, liberally apply primer to the male end of the pipe to the length of the socket depth. Again apply to the socket, without delay apply cement to the pipe while the surface is still wet with primer. Next apply cement lightly, but uniformly to the inside of the socket. Apply a second coat of cement to the pipe, and assemble the end connector to the pipe, rotating the end connector 1/4 turn in one direction as it is slipped to full depth on to the pipe. The end connector should be held in position for approx. 30 seconds to allow the connection to "set". After assembly wipe off excess cement. Full set time is a minimum of 30 minutes at 60 to 100 F. Full cure time should be based on the chart below.

JOINT CURE SCHEDULE:

The cure schedules are suggested as guides. They are based on laboratory test data, and should not be taken to be the recommendations of all cement manufacturers. Individual manufacturer's recommendations for their particular cement should be followed.

Temperature Range During Cure Period(B) °F(°C)	Test Pressures for Pipe Sizes 1/2 to 1-1/4 In.		Test Pressures for Pipe Sizes 1-1/2 to 3 In.		Test Pressures for Pipe Sizes 4 to 5 In.		Test Pressures for Pipe Sizes 6 to 8 In.	
	Up to 180 PSI (1240 kPa)	Above 180 to 370 PSI (1240 to 2550 kPa)	Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI 1240) to 2170 kPa)	Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI (1240 to 2170 kPa)	Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI (1240 to 2170 kPa)
60 to 100 (15 to 40)	1 h	6 h	2 h	12 h	6 h	18 h	8 h	24 h
40 to 60 (5 to 15)	2 h	12 h	4 h	24 h	12 h	36 h	16 h	48 h
20 to 40 (-7 to 5)	6 h	36 h	12 h	72 h	36 h A	4 days A	3 days A	9 days A
10 to 20) (-15 to 7)	8 h	48 h	16 h	96 h	72 h A	8 days A	4 days A	12 days A
Colder than 10 (-15)	Extreme care should be exercised on all joints made where pipe, fittings or cement is below 10°F							

A: It is important to note that at temperatures colder than 20°F on sizes that exceed 3 in., test results indicate that many variables exist in the actual cure rate of the joint. The data expressed in these categories represent only estimated averages. In some cases, cure will be achieved in less time, but isolated test results indicate that even longer periods of cure may be required.
B: These cure schedules are based on laboratory test data obtained on Net Fit Joints (NET FIT=in a dry fit the pipe bottoms snugly in the fitting socket without meeting interference).

THREADED CONNECTION:

Threaded end connections are manufactured to ASTM specifications D2464-88. F437-88 and ANSI B2.1. Wrap threads of pipe with Teflon tape of 3 to 3-1/2 mil thickness. The tape should be wrapped in a clockwise direction starting at the first or second full thread. Overlap each wrap by, 1/2 the width of the tape. The wrap should be applied with sufficient tension to allow the threads of a single wrapped area to show through without cutting the tape. The wrap should continue for the full effective length of the thread. Pipe sizes 2" and greater will not benefit with more than a second wrap, due to the greater thread depth. To provide a leak proof joint, the pipe should be threaded into the end connection "hand tight". Using a strap wrench only. (Never use a stillson type wrench) tighten the joint an additional 1/2 to 1-1/2 turns past hand tight. Tightening beyond this point may induce excessive stress that could cause failure.

FLANGED CONNECTION:

Flange bolts should be tight enough to slightly compress the gasket and make a good seal, without distorting or putting excessive stress on the flanges. Suitable washers should be used between the bolt head and flange and the nut and flange. Bolts should be tightened in alternating sequence.

RECOMMENDED FLANGE BOLT TORQUE

FLANGE SIZE	BOLT DIA.	TORQUE FT. LBS.	FLANGE SIZE	BOLT DIA.	TORQUE FT. LBS.
1/2	1/2	10-15	2	5/8	15-25
3/4	1./2	10-15	2-1/2	5/8	20-25
1	1/2	10-15	3	5/8	20-25
1-1/4	1/2	10-15	4	5/8	20-25
1-1/2	1/2	10-15	6	3/4	30-40

NOTE: USE WELL LUBRICATED METAL BOLTS AND NUTS. USE SOFT RUBBER GASKETS.

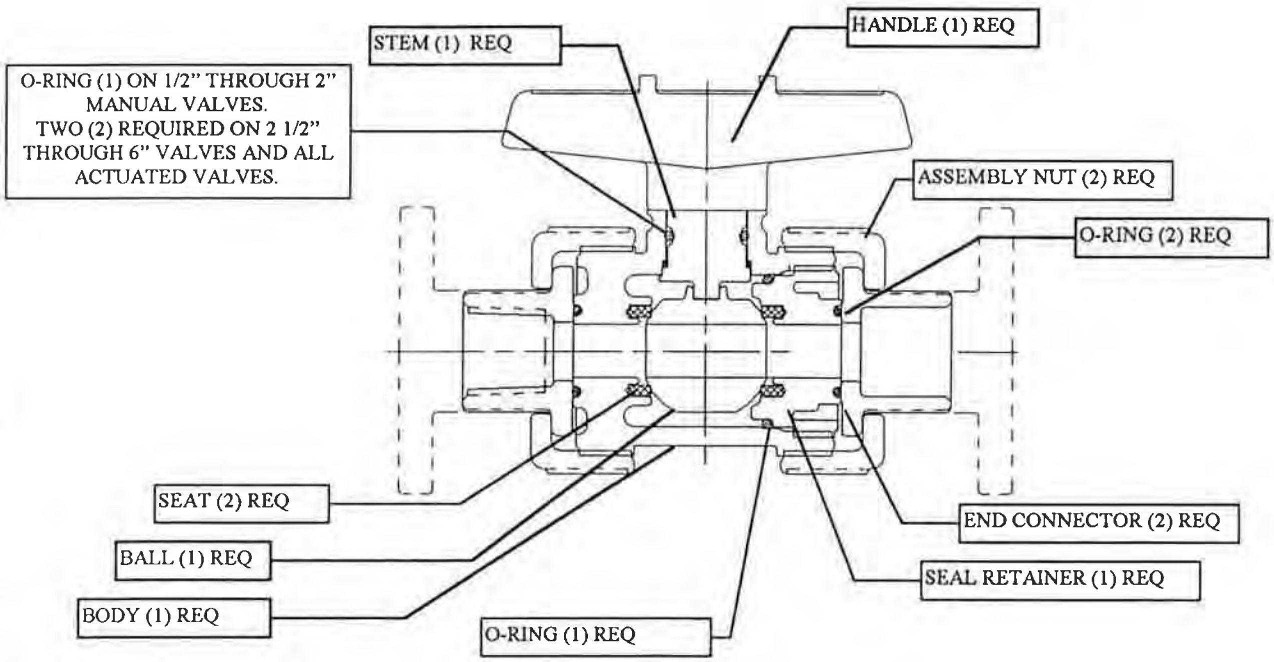
ADJUSTMENT:

EXTREME CAUTION MUST BE TAKEN WHEN WORKING ON THIS VALVE.
THE PIPING SYSTEM MUST BE DEPRESSURIZED AND DRAINED. PROPER CARE MUST BE TAKEN. CONSULT M.S.D.S. (MATERIAL SAFETY DATA SHEETS) INFORMATION REGARDING YOUR SPECIFIC APPLICATION.

Remove the assembly nut and end connector from the "adjust" end of the body, or the complete valve body from the piping system. The front face of the seal retainer indicates which direction of rotation tightens or loosens the seal retainer, with the word "tighten" and a directional arrow, and the word "loosen" and a directional arrow. Direction of rotation may vary depending on date of manufacture. The Assembly nut should be installed on the valve "hand tight". Using a strap wrench <u>only</u> the joint may be tightened 1/2 to 3/4 of a turn past hand tight.

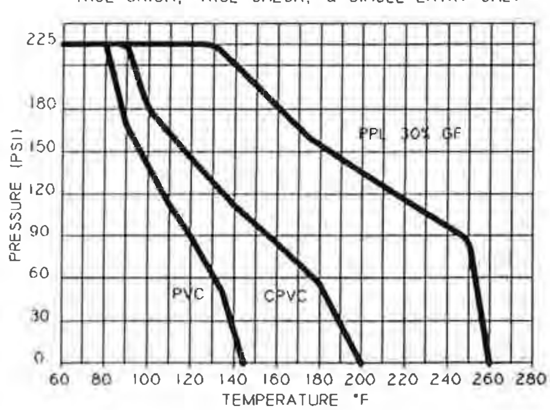
REPAIR:

Follow the adjustment sequence and information above, but rotating the seal retainer completely in the "loosen" direction and remove it from valve body. The o-rings and seals are now accessible for replacement using a "seal" repair kit. Carefully remove the o-rings from their respective locations taking care not to scratch their sealing surfaces. Use a non-petroleum base lubricant to lubricate the o-rings, and re-assemble the valve. See table below.



OPERATING PRESSURE
TEMPERATURE

TRUE UNION, TRUE CHECK, & SINGLE ENTRY ONLY



Recommended valve stem torque to rotate the ball 360° when valve is reassembled.

VALVE SIZE	TORQUE IN•LB
1/2"	30
3/4"	40
1"	50
1 1/4"	60
1 1/2"	60
2"	80
3" & 2 1/2"	140
4" & 6"	170

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

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

USE AND INSTALLATION OF PRESSURE GAUGES

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

3.3.4 Pressure Connection

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

3.3.4.2 Type of Connection. Taper pipe connections for pressures up through 20,000 psi (160,000 kPa) are usually 1/8-27, 1/4-18, or 1/2-14NPT American Standard external or internal taper pipe threads per ANSI/ASME B1.20.1, as required. Above this pressure, 1/4 high pressure tubing connections, or equal, may be used. Other appropriately sized connections, employing sealing means other than tapered threads, are acceptable.

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

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

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

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

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

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

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

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

4.2.5 When gauges are to be used in contact with media having known or uncertain corrosive effects or known to be radioactive, random or unique destructive phenomena can occur. In such cases the user should always furnish the supplier or manufacturer with information relative to the application and solicit his advice prior to installation of the gauge.
4.2.6 Fire and explosions within a pressure system can cause pressure element failure with very violent effects, even to the point of completely disintegrating or melting the pressure gauge. Violent effects are also produced when failure occurs due to:
(a) hydrogen embrittlement;
(b) contamination of a compressed gas;
(c) formation of acetylides;
(d) weakening of soft solder joints by steam or other heat sources;
(e) weakening of soft soldered or silver brazed joints caused by heat sources such as fires;
(f) corrosion;
(g) fatigue;
(h) mechanical shock;
(i) excessive vibration.
Failure in a compressed gas system can be expected to produce violent effects.

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

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

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

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

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

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

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

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

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

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

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

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

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

4.2.8 Pressure Connection. See recommendations in para. 3.3.4.

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

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

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

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

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

IMPORTANT - ***Read other side for additional instructions and warnings.***

(Excerpts from ASME B40 1-1991 continue on back)

can be selected.

4.3.4 In addition to the factors discussed above, the capability of a pressure element is influenced by the design, materials, and fabrication of the joints between its parts.
Common methods of joining are soft soldering, silver brazing, and welding. Joints can be affected by temperature, stress, and corrosive media. Where application questions arise, these factors should be considered and discussed by the user and manufacturer.

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

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

4.3.6.2 Cases, Liquid Filled. It has been general practice to use glycerine or silicone filling liquids. However, these fluids may not be suitable for all applications. They should be avoided where strong oxidizing agents including, but not limited to, oxygen, chlorine, nitric acid, and hydrogen peroxide are involved. In the presence of oxidizing agents, potential hazard can result from chemical reaction, ignition, or explosion. Completely fluorinated or chlorinated fluids or both, may be more suitable for such applications.
The user shall furnish detailed information relative to the application of gauges having liquid filled cases and solicit the advice of the gauge supplier prior to installation.
Consideration should also be given to the instantaneous hydraulic effect that may be created by one of the modes of failure outlined in para 4.2.7. The hydraulic effect due to pressure element failure could cause the window to be projected forward even when a case having a solid front is employed.

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

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

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

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

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

4.3.8.5 Oxygen Gauge. A gauge designed to indicate oxygen pressure. Cleanliness shall comply with Level IV (see Section 5). The dial shall be clearly marked with a universal symbol and/or USE NO OIL in red color (see para. 6.1.2.1).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

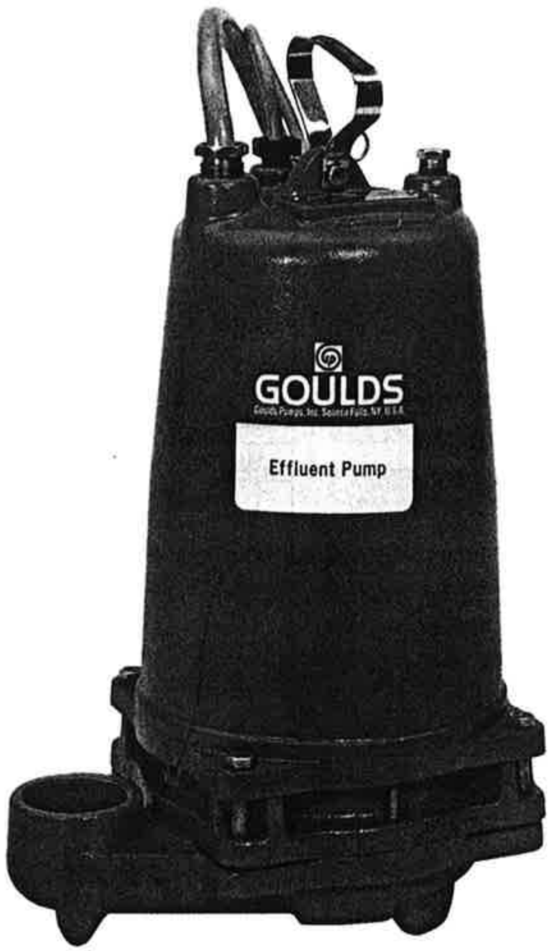
WARNING—Misuse of this product may cause explosion and personal injury. Do not use without first reading and understanding these instructions and the apparatus installation and operating instructions.

Important— Read other side for additional instructions and warnings.

GOULDS PUMPS, INC.
WATER TECHNOLOGIES GROUP
SENECA FALLS, NEW YORK 13148

Installation, Operation and Maintenance Instructions

Series 2ED



MODELS

2ED12B0FA	2ED11C0DA	2ED11C0HA	2ED11D1CA	2ED11E3BA	2ED11F4AA
2ED12B1FA	2ED11C1DA	2ED11C1HA	2ED11D3CA	2ED11E4BA	2ED11F1GA
2ED12B0EA	2ED11C3DA	2ED11C3HA	2ED11D4CA	2ED11F1AA	2ED11F3GA
2ED12B1EA	2ED11C4DA	2ED11C4HA	2ED11E1BA	2ED11F3AA	2ED11F4GA

Table of Contents

SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

This is a **SAFETY ALERT SYMBOL.** When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

DANGER Warns of hazards that **WILL** cause serious personal injury, death or major property damage.

WARNING Warns of hazards that **CAN** cause serious personal injury, death or major property damage.

CAUTION Warns of hazards that **CAN** cause personal injury or property damage.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

WARNING

Hazardous fluids can cause fire, burns or death.

UNIT NOT DESIGNED FOR USE WITH HAZARDOUS LIQUIDS OR FLAMMABLE GASES. THESE FLUIDS MAY BE PRESENT IN CONTAINMENT AREAS.

NOTICE: INSPECT UNIT FOR DAMAGE AND REPORT ALL DAMAGE TO THE CARRIER OR DEALER IMMEDIATELY.

Owner's Information

Model Number: ______________________

Serial Number: ______________________

Dealer: ______________________

Dealer's Phone No. ______________________

Date of Purchase: ____________ Installation: ____________

Current Readings at Startup:

Single Phase: ______________________

Three Phase – 1st Phase: ______________________

2nd Phase: ____________ 3rd Phase: ____________

DESCRIPTION AND SPECIFICATIONS

The Series 2ED embraces a line of residential 2" NPT discharge, ¾" (19 mm) solids handling, dual mechanical seal, submersible effluent pumps.

MODEL	HP	RPM	VOLTS	PHASE	AMPS	Wt.(lbs.)
2ED12B0FA	⅓	1725	115	1	9.4	56
2ED12B1FA	⅓	1725	230	1	4.7	56
2ED12B0EA	⅓	1725	115	1	9.4	56
2ED12B1EA	⅓	1725	230	1	4.7	56
2ED11C0DA	½	3450	115	1	13.0	60
2ED11C1DA	½	3450	230	1	6.5	60
2ED11C3DA	½	3450	208-230	3	3.4	60
2ED11C4DA	½	3450	460	3	1.7	60
2ED11C0HA	½	3450	115	1	13.0	60
2ED11C1HA	½	3450	230	1	6.5	60
2ED11C3HA	½	3450	208-230	3	3.3	60
2ED11C4HA	½	3450	460	3	1.7	60
2ED11D1CA	¾	3450	230	1	10.0	70
2ED11D3CA	¾	3450	208-230	3	5.4	70
2ED11D4CA	¾	3450	460	3	2.7	70
2ED11E1BA	1	3450	230	1	12.5	70
2ED11E3BA	1	3450	208-230	3	7.0	70
2ED11E4BA	1	3450	460	3	3.5	70
2ED11F1AA	1½	3450	230	1	15.0	80
2ED11F3AA	1½	3450	208-230	3	9.2	80
2ED11F4AA	1½	3450	460	3	4.6	80
2ED11F1GA	1½	3450	230	1	15.0	80
2ED11F3GA	1½	3450	208-230	3	9.2	80
2ED11F4GA	1½	3450	460	3	4.6	80

15.7

Optional Pump Styles

For optional lower mechanical seal, change 4th pump model number character from "1" to:
"3" = Tung Carb/Tung Carb, Buna – Lower seal only
"5" = Sil Carb/Sil Carb, Buna – Lower seal only

For optional length power, motor overheat and mechanical seal sensor cables, change the 9th pump model number character from "A" to "D" = 30', "F" = 50' and "J" = 100'.

The optional length CSA listed power, motor overheat and mechanical seal sensor cables are 20' and 50' for **ALL** models. Change the 9th pump model number character from "A" to "B" = 20' and "G" = 50'.

Add an optional 10th pump model number character for:
"B" – Bronze Impeller
"E" – Epoxy Paint
"F" – Bronze Impeller and Epoxy Paint

Add an optional 11th pump model number character "H" for three phase motor overheat sensor.

Lifting of Pump

⚠WARNING

Hazardous voltage can shock, burn or cause death.

DO NOT LIFT, CARRY OR HANG PUMP BY THE ELECTRICAL CABLES. DAMAGE TO THE ELECTRICAL CABLES CAN CAUSE SHOCK, BURNS OR DEATH.

Emerick Associates in Cohoes

- Lift the pump with an adequately sized chain or cable attached to the lifting handle (458). **DO NOT** damage electrical and sensor cables while raising and lowering unit.

Sliderail System

- The **OPTIONAL** Goulds Model A10-20 sliderail system is recommended for proper installation.

NOTICE: FOLLOW THE INSTALLATION AND OPERATION INSTRUCTIONS PROVIDED WITH THE SLIDERAIL SYSTEM.

- Installation of the sliderail system should locate the pump opposite the influent opening, preventing stagnate areas where solids can settle.
- The pit floor **MUST** be flat under the sliderail base and have sufficient loading capacity to support the entire weight of the assembly, including the sliderail base, sliderail guide, pump and all assorted piping.

Piping

- Discharge piping should be no smaller than 2" (51 mm) diameter and kept as short as possible, avoiding unnecessary fittings to minimize friction losses.
- Install an adequately sized check valve, suitable for handling ¾" (19 mm) solids, in the discharge pipe to prevent backflow. Follow the check valve manufacturer's installation instructions.
- Install an adequately sized gate valve **ABOVE** the check valve for pump, plumbing and check valve maintenance.
- To deter air locking, drill a 3⁄16" (4.8 mm) hole, 2" (50.8 mm) beyond the pump discharge connection.
- All piping must be adequately supported, so as not to impart any piping strain or loads on the pump.

Access Doors

- Access doors can be single or double leaf design. Doors should include a lifting handle and a lock provision for tamper resistant operation. Standard and heavy duty steel or aluminum doors are available.
- The pit access door must be of sufficient size to allow for inspection, maintenance and crane or hoist service.

Liquid Level Controls

- The recommended float operation sequence requires a three or four float system. In the three float system, the floats are designated SW-1 for the bottom float, SW-2 for the middle float and SW-3 for the top float. In a four float system the fourth float is designated SW-4.
  - Simplex Control – The rising liquid level raises float SW-2, turning on the pump. When the liquid level falls sufficiently, SW-1 will turn the pump off. If the influent is excessive, or if the pump fails to operate correctly, SW-3 will activate an alarm, which will remain on until manually reset.

- Duplex Control – The duplex control will alternate the two pumps, causing the lead pump to change at each system cycle. When equipped with three floats, the system will cycle the same as the simplex control, described above, except that the SW-1 will cause the lead pump to alternate.
- If the influent is excessive, or if the lead pump fails to operate correctly, the rising level will activate SW-3, turning on the lag pump and the alarm. As before the alarm must be manually reset.
- Four Float Control – The four float system operates the same as the duplex control system, except that float SW-3 will not turn on the alarm. In this system SW-4 turns on the alarm, which again must be manually reset.

- The **OPTIONAL** Goulds A2-3 mercury float switch has been designed to close on a 8" (20.3 cm) rise in liquid level from the bottom of the float bulb. A weight on the float's electrical cable, keeps the float suspended and allows the float to rise correctly. Floats may be suspended from their cables. See Figure 1.

NOTICE: POSITION THE FLOATS SO THAT THEY DO NOT SNAG OR TANGLE ON THE PUMP, DISCHARGE PIPING, OR OTHER EQUIPMENT.

- The lower most float turns the unit off and should be set as shown in the **"TYPICAL PLUMBING and INSTALLATION"** drawing provided in this manual.
- Increasing the distance between the SW-1 and SW-2 floats lengthens the running time. Six (6) minutes is the minimum recommended pump cycle time.

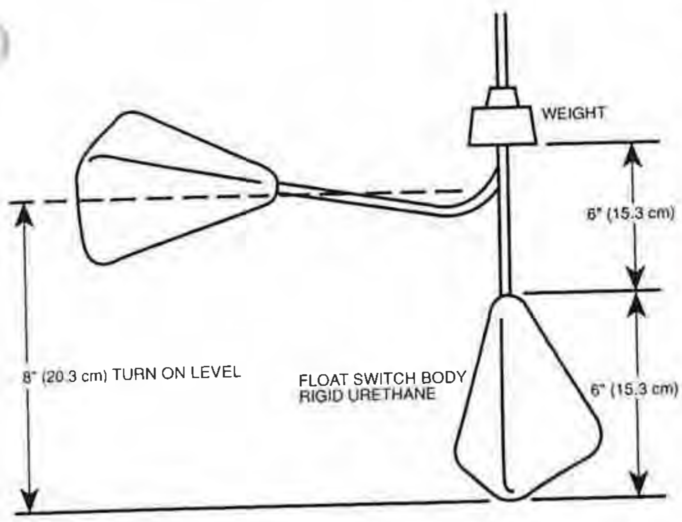


Figure 1

NOTICE: DURING PUMP OPERATION, INSURE THAT THE LIQUID LEVEL DOES NOT DROP BELOW THE PUMP MOTOR FOR EXTENDED PERIODS. THIS CAN CAUSE THE PUMP MOTOR TO OVERHEAT, CAUSING MOTOR DAMAGE AND VOIDING THE WARRANTY.

Sensors

- Seal Failure Sensor – All models of the 2ED are equipped with a moisture sensing probe that detects the presence of moisture in the seal chamber. The recommended sensor operating voltage is 24 volts or less, at 5 milliampere or less. If moisture is present, a serious problem may exist requiring immediate inspection of the pump mechanical seals.
- Motor Overheat Sensor – All single phase motors are equipped with a thermal protector, which when an over temperature, or over current exists, shuts down the pump motor. Three phase motors may be equipped with an **OPTIONAL** temperature sensing device, which when an over temperature exists, sends a signal to the pump control panel to shut down the pump motor and turn **ON** the indicator light.

Pump Motor Control Panels

- Control panels shall be in accordance with local and National Electrical Code requirements.
- It is recommended that control panels be equipped with a seal failure sensor circuit configured with a manual reset, an oil tight indicator light, and a seal failure sensor test circuit.
- Single phase panels shall be equipped with a Goulds' "SES" or "A" Series panel, or **AS A MINIMUM**, a control panel with a properly sized magnetic contactor and a disconnect switch.
- Three phase panels shall be equipped with a Goulds' "SES" or "A" Series panel, or **AS A MINIMUM** with a 3 pole circuit breaker, an across the line magnetic starter NEMA rated for the appropriate horsepower, ambient compensated Quick Trip Class 10 overload relays.
- On three phase units, equipped with the optional motor overheat sensor, the panel **MUST** be equipped with a motor overheat sensor circuit. It is recommended that this control circuit be configured with an auto reset motor overheat shut down circuit, oil tight indicator light and a motor overheat sensor test circuit.

Wiring and Grounding

- Use only stranded copper wire to motor and ground. The ground wire must be at least as large as the wires to the motor. Wires should be color coded for ease of maintenance.

⚠ Install, ground and wire according to local and National Electrical Code requirements.

⚠ Install an all leg disconnect switch near the pump.

⚠ Disconnect and lockout electrical power before installing or servicing pump.

⚠ Electrical supply **MUST** match pump's nameplate specifications. Incorrect voltage can cause fire, damage motor and voids warranty.

⚠ Motors are equipped with automatic thermal protectors which open the motor's electrical circuit when an overload exists. This can cause the pump to start unexpectedly and without warning.

⚠ Some models are equipped with a 3-prong grounded plug and **MUST** be used in a grounded 3-wire receptacle. **DO NOT** modify the plug or remove the ground prong.

- Where cables must be spliced or connected to the motor leads, splices **MUST** be water tight. Commercially available potting or heat shrink kits may be used, if allowed by local or federal regulations.

NOTICE: FOLLOW THE SPLICE KIT MANUFACTURER'S INSTRUCTIONS.

- Where wire splices are used, follow one of these procedures:
  - Butt join the wires using properly sized and correctly crimped Sta-Kon™, or equivalent, connectors. Insulate and water proof each joint using heat shrink tubing equipped with a self contained sealer. Apply heat evenly from a torch until adequately sealed.

OR

  - Use plastic insulators and a neoprene gasket sleeve set with properly sized and correctly crimped Sta-Kon™ connectors. Place a cap and gasket on each wire end, center insulator body over splice, insert the sleeve into the body as far as possible, hand tighten caps.
- In the case of multiple conductors, stagger the joints.

⚠WARNING Hazardous voltage	**FAILURE TO PERMANENTLY GROUND THE PUMP, MOTOR AND CONTROLS BEFORE CONNECTING TO ELECTRICAL POWER CAN CAUSE SHOCK, BURNS OR DEATH.**

Operation

- The 2ED mechanical seal chamber and motor is filled with a special insulating oil. No further lubrication is necessary or possible.
- If the unit has been stored for an extended period, check the oil level in the motor and seal chamber, to insure that they are full, using the following procedures:
  - Seal Chamber – With the pump secured on its side and the seal housing plug (358) up, remove the plug. The oil level should be no more than ½" (13 mm) below the inside of the housing. With the proper oil (218), fill as required. **DO NOT** over fill.
  - Motor Cover – With the pump in the upright position, remove the oil fill plug (358E), being careful that nothing enters the motor. The oil level should be above the top of the motor. With the correct oil fill as required. **DO NOT** over fill.
  - Cable Gland Assemblies – Re-torque both the power and sensor cable glands to values given in step 12 of **"POWER and SENSOR CABLE REPLACEMENT"**.
- Before lowering the pump(s) into the containment area, three phase units should be jogged to insure correct rotation. See the motor rotation arrow on the motor cover (341). Check both pumps in a duplex operation.

NOTICE: MOTOR STARTUP TORQUE, "KICKBACK", WILL CAUSE THE MOTOR TO TWIST IN THE DIRECTION OPPOSITE ROTATION. INSURE THAT THE PUMP ASSEMBLY IS ADEQUATELY RESTRAINED.

⚠ DANGER

Hazardous Machinery

DO NOT PLACE HANDS IN PUMP SUCTION WHILE CHECKING MOTOR ROTATION. TO DO SO WILL CAUSE SEVERE PERSONAL INJURY.

NOTICE: DO NOT SWITCH PRIMARY POWER LEADS COMING INTO A THREE PHASE DUPLEX CONTROL PANEL, THIS WILL REVERSE ROTATION OF BOTH PUMPS.

- If the three phase motor(s) rotation is backwards, reverse any two pump power cable leads at the pump control panel.
- Check the seal failure and motor overheat sensor circuits by depressing the appropriate sensor test button, when provided on the pump control panel. If the pilot light comes **ON** the circuit is operational, if the light does not come **ON**, repair as necessary.

⚠WARNING Hazardous machinery	**MOTOR OVERHEAT/OVER CURRENT SENSING DEVICES AUTOMATICALLY RESTART THE MOTOR UNEXPECTEDLY AND WITHOUT WARNING. THIS CAN CAUSE SEVERE PERSONAL INJURY.**

- After installing the pump into the containment area, with adequate submergence, open the discharge valve fully. Start the unit using manual controls. If flow is appreciably less than rated performance, pump may be air bound. To expel trapped air, jog the unit several times, using the manual controls.
- Have a qualified electrician take current measurements on the single or all three phases. Record these readings in the space provided in the **"OWNER'S INFORMATION"** section of this manual for future reference.
- Prior to beginning normal operations, again check the moisture sensor circuit by depressing the moisture sensor check button on the control panel.
- The unit is now ready for normal operation. Place the controls in the automatic position.

Maintenance

⚠WARNING
Hazardous voltage

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SHOCK, BURNS OR DEATH.

UNIT MUST BE FLUSHED AND DISINFECTED, INSIDE AND OUT, PRIOR TO SERVICING.

Periodic Maintenance

NOTICE: ROUTINE PERIODIC INSPECTIONS ARE REQUIRED AND SHOULD FOLLOW THE FREQUENCY AND MAINTENANCE SCHEDULE PROVIDED.

FREQUENCY — **REQUIRED MAINTENANCE**

MONTHLY

- Test moisture sensing circuit, using test button on pump control panel.
- Duplex Units – Check for even operating times. Uneven operation times indicate a defective unit, float switch or control.
- Unimpeded float operation.
- Check motor resistance to ground. See **"ENGINEERING DATA"** section for resistance readings and procedures.

EVERY TWO YEARS

- Remove and replace motor and seal chamber insulating oil. Inspect oil for contamination as follows:
  - Clear oil, no burnt odor – Oil, motor and seals are in satisfactory condition.
  - Dark oil, burnt odor – Pump motor has overheated. Check motor winding resistance to ground. Ohm readings of 1 megohm or higher is required. If lower readings are present, return the unit to an authorized service facility for service.
  - Milky, emulsified oil – Seals have failed. Unit must be returned to an authorized service facility for service.
- Dispose of the motor insulating oil properly.

FREQUENCY — **REQUIRED MAINTENANCE**

- Inspect power and sensor cables for damage or wear. Replace immediately if damage or wear is detected.
- Inspect impeller for damage or wear. Replace as required following the procedures provided in the **"LOWER MECHANICAL SEAL REPLACEMENT"** section of this manual.

EVERY FIVE YEARS

- Unit should undergo complete overhaul, including:
  a) Full disassembly, cleaning and inspection.
  b) Replacement of damaged or worn mechanical seals or impeller.
  c) Replacement of motor.
  d) Complete insulation tests to the resistance values provided in the **"ENGINEERING DATA"** section of this manual.

Disassembly

⚠WARNING
Hazardous voltage

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SHOCK, BURNS OR DEATH.

NOTICE: FOLLOW ALL SAFETY AND LIFTING INSTRUCTIONS PROVIDED IN THIS MANUAL.

- Following the slide rail instructions, remove the pumping unit from the sewage containment area.

UNIT MUST BE FLUSHED AND DISINFECTED, INSIDE AND OUT, PRIOR TO SERVICING.

LOWER MECHANICAL SEAL REPLACEMENT

1. Follow **ALL** instructions provided in the **"DISASSEMBLY"** section of this manual.
2. To gain access to the pump impeller and lower mechanical seal remove the four casing hex cap screws (372D). Remove casing (100) and casing gasket (351); discard the gasket.

FAILURE TO REMOVE DRAIN PLUG CAREFULLY CAN CAUSE HOT OIL TO ERUPT FROM OIL RESERVOIR CAUSING PERSONAL INJURY OR PROPERTY DAMAGE

3. Removal of the lower mechanical seal assembly (387) requires draining the special insulating oil from the seal housing (184). This is accomplished by removing the seal housing drain plug (358) and draining the oil into an adequately sized clean receptacle. See **"ENGINEERING DATA"** section for required volume.

NOTICE: THE MOTOR INSULATING OIL MUST BE INSPECTED FOLLOWING THE PROCEDURES PROVIDED IN THE **"TWO YEAR – PERIODIC MAINTENANCE"** SECTION.

4. To remove the impeller (101), it may be necessary to heat the impeller and impeller locknut (304), three phase motors only, with a torch. Use no more heat that is necessary, as excess heat will damage the mechanical seals. Secure the impeller from rotation, and remove the impeller lock nut, by turning the lock nut **COUNTERCLOCKWISE**. Remove the impeller from the motor shaft by holding the motor shaft with a screw driver and turning the impeller **COUNTERCLOCKWISE**.
5. Remove and discard the lower mechanical seal and lower stationary seat assembly. **DO NOT** damage the motor shaft or the stationary seat bore.
6. Inspect and wipe clean the stationary seat bore.
7. To install the new stationary seat into the seal housing, lubricate the stationary seat bore and motor shaft with clean motor insulating oil. Using Goulds mechanical seal installation tool (A02A013), slide the stationary seat fully and squarely into the seal housing.
8. With a clean, lint free cloth, wipe the stationary face clean of all lubricating oil or debris. **DO NOT** scratch or otherwise damage the seal face.
9. Lubricate the inside of the rotary elastomer with clean motor insulating oil. Using the Goulds installation tool, slide the seal rotary assembly onto the motor shaft and seat fully against the stationary seat. Remove the seal installation tool.

NOTICE: DISCARD THE SEAL SPRING RETAINER, IF PROVIDED.

10. Install the impeller onto the motor shaft by turning the impeller on **CLOCKWISE**, tighten securely. Treat the impeller with Loctite™ #271 and securely install. When provided, securely install the impeller locknut.
11. Fill the seal chamber with motor special insulating oil to within ½" (13 mm) of the seal chamber housing. Tape drain plug with Teflon™ tape and install plug securely.
12. Reassemble casing and new casing gasket to pump assembly by installing the four casing hex cap screws, torquing in sequence to 35 lbs ft (47 N m).

NOTICE: FOLLOW THE INSTRUCTIONS PROVIDED IN THE **"WIRING AND GROUNDING"** AND **"OPERATION"** SECTIONS OF THE MANUAL AFTER UNIT DISASSEMBLY, REASSEMBLY.

UPPER MECHANICAL SEAL REPLACEMENT

1. To gain access to the upper mechanical seal follow steps 1 through 6 in the **"LOWER MECHANICAL SEAL REPLACEMENT"** section of this manual.
2. Removal of the upper mechanical seal requires removal of the seal housing and draining the special insulating oil from the motor cover (341).

⚠ CAUTION Hazardous Pressure	**FAILURE TO REMOVE DRAIN PLUG CAREFULLY CAN CAUSE HOT OIL TO ERUPT FROM OIL RESERVOIR CAUSING PERSONAL INJURY OR PROPERTY DAMAGE.**

3. Remove the motor cover oil drain plug and drain the insulating oil into an adequately sized clean receptacle. See the **"ENGINEERING DATA"** section of this manual for volume. **DO NOT** allow the pump assembly to drag or rest on the motor shaft.

NOTICE: CAREFULLY FOLLOW THE INSTRUCTIONS PROVIDED IN THE **"TWO YEAR – PERIODIC MAINTENANCE"** SECTION OF THIS MANUAL, FOR THE OIL INSPECTION AND REQUIRED ACTIONS.

4. Remove the two phillips head screws (352). Remove the seal housing. Remove and discard the seal housing O-ring (412P). **DO NOT** damage the seal failure probe.
5. With a properly sized snap ring pliers, remove the seal retaining ring (361), **DO NOT** damage the motor shaft. Slide the upper mechanical seal rotary assembly (383) from the shaft and discard. Remove and discard the upper stationary seat, being careful not to damage the stationary seat bore in the seal housing.
6. Inspect and wipe the stationary seat bore clean.
7. To install a new upper stationary seat, lubricate the stationary seat bore and motor shaft with clean motor insulating oil. Using Goulds mechanical seal installation tool slide a new stationary seat fully and squarely into the seal housing bore.
8. With a clean, lint free cloth, wipe the stationary seat face clean of all lubricant or debris. **DO NOT** scratch or otherwise damage the seat face. Lightly lubricate the seat face with clean insulating oil.
9. Lubricate the inside of the rotary elastomer with clean motor insulating oil. Using the Goulds installation tool, slide the seal rotary assembly over motor shaft, and seat fully against the stationary seat. Install the seal spring retainer over the motor shaft and seat on the rotary half of the mechanical seal.
10. With properly sized retaining ring pliers, install a new retaining ring, compressing the seal spring and locking the upper mechanical seal in place. Wipe off excessive oil. **DO NOT** damage the motor shaft.

NOTICE: INSURE THAT THE UPPER MECHANICAL SEAL RETAINING RING IS SEATED FULLY INTO THE RETAINING RING GROOVE.

Install a new seal housing O-ring on the seal housing and then slide the seal housing over the motor shaft, seating it fully into the bearing housing (340). Secure the seal housing with the two phillips head screws, torquing each to 90 lbs in (10 N m).

12. To complete the pump assembly follow steps 7 through 11 in the **"LOWER MECHANICAL SEAL REPLACEMENT"** section of this manual.

13. Fill the motor cover, with special motor insulating oil, to a level above the top of the motor. **DO NOT** over fill.

14. Tape the motor cover oil drain plug with Teflon™ tape and install securely.

NOTICE: FOLLOW THE INSTRUCTIONS PROVIDED IN THE **"WIRING AND GROUNDING"** AND **"OPERATION"** SECTIONS OF THE MANUAL AFTER UNIT DISASSEMBLY, REASSEMBLY.

POWER AND SENSOR CABLE REPLACEMENT

1. To gain access to the motor cover screws follow steps 1 through 6 in the **"UPPER MECHANICAL SEAL REPLACEMENT"** section of this manual.

2. Remove the power cable strain relief (484B) and sensor cable strain relief (484) assemblies from the motor cover and slide up the cables.

3. Remove the two bearing housing socket head screws (371C). Carefully side the motor cover from the motor assembly. **DO NOT** damage the power and sensor cables.

4. Disconnect the power cable wires from the motor assembly (338). Disconnect the seal failure sensor wires from the seal failure probe (246) and ground. On three phase motors, when equipped with a motor overheat sensor, disconnect the motor overheat sensor wires from the sensor.

5. Remove cables from motor cover, inspect and replace as required, following the procedures provided.

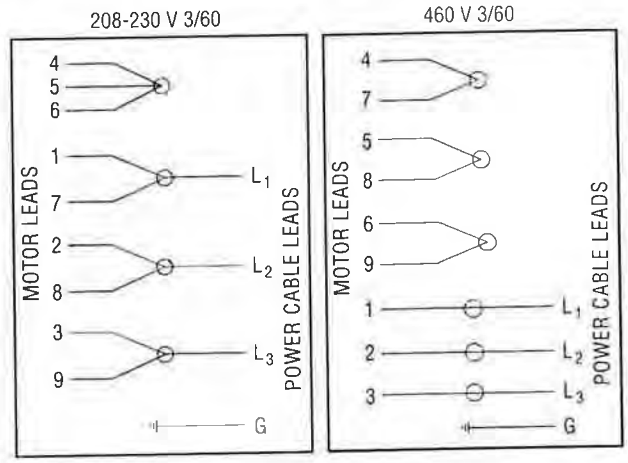
NOTICE: DISCARD BOTH STRAIN RELIEF ASSEMBLIES. THEY CAN NOT BE REUSED.

6. Install new motor and sensor cable strain relief assemblies onto cables, sliding the hex glands on first, then the washers and finally the packing. Insert the cables into their respective motor cover holes. Pull an appropriate amount of cable through the motor cover to allow for connecting the cable leads. **DO NOT** tighten the strain relief glands.

7. Connect the power cable leads to the motor assembly as follows:
   - Single Phase Motors – Connect the **BLACK** wire to motor terminal L_1. Connect the **WHITE** wire to motor terminal L_2. Connect the **GREEN** wire to the motor ground.
   - Three Phase Motors – See Figure 2.

⚠WARNING
Hazardous voltage

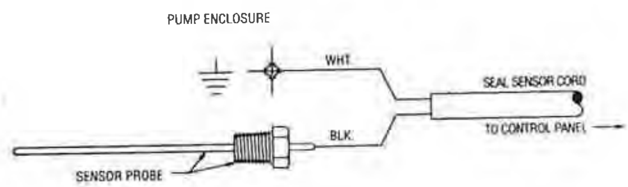
FAILURE TO CONNECT POWER AND SENSOR WIRES TO DESIGNATED WIRES CAN CAUSE SHOCK, BURNS OR DEATH.



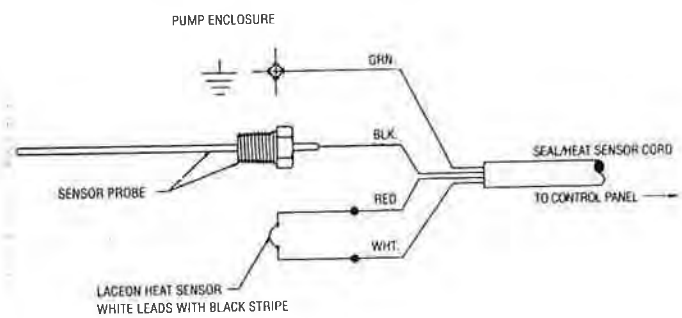
THREE PHASE MOTOR WIRING DIAGRAM

Figure 2

8. Attach the mechanical seal failure, and when equipped, motor overheat sensor cable leads as shown in Figure 3.



WIRING DIAGRAM FOR MECHANICAL SEAL SENSOR



WIRING DIAGRAM FOR MECHANICAL SEAL/HEAT SENSOR

Figure 3

9. Wire tie the power and sensor cables to the motor assembly.

10. Slide the motor cover onto the motor assembly, while carefully pulling the power and sensor cables out through their respective motor cover holes. **DO NOT** damage cables. Install the two seal housing socket head screws, torquing to 90 lbs in (10 N m).

11. Install the sensor cable strain relief assembly, torquing to 75 lbs in (8.5 N m) and then the power cable strain relief assembly torquing the nylon bushing to 75 lbs in (8.5 N m) and the steel bushing to 100 lbs in (11.3 N m).

12. Continue the assembly following steps 7 through 13 of the **"UPPER MECHANICAL SEAL REPLACEMENT"** section of this manual.

13. If the motor cover was replaced, it is necessary to transfer the Goulds nameplate. Using two stainless steel No. 2 round head metallic drive screws, install the Goulds nameplate.

NOTICE: FOLLOW THE INSTRUCTIONS PROVIDED IN THE **"WIRING AND GROUNDING"** AND **"OPERATION"** SECTIONS OF THE MANUAL AFTER UNIT DISASSEMBLY, REASSEMBLY.

START CAPACITOR REPLACEMENT

1. On single phase motors only, to gain access to the motor start capacitor (376), follow steps 1 through 5 in the **"POWER AND SENSOR CABLE REPLACEMENT"** section of this manual.

NOTICE: DISCARD BOTH STRAIN RELIEF ASSEMBLIES. THEY CAN NOT BE REUSED.

⚠WARNING Hazardous voltage	**FAILURE TO DRAIN CAPACITOR OF STORED ELECTRICAL CHARGE BEFORE SERVICE CAN CAUSE A SEVERE SHOCK.**

2. Remove the capacitor retaining screw and retaining bracket from the motor assembly. Remove the two wires from the capacitor. Discard the capacitor.

3. Connect the two motor wires to the new capacitor and reassemble with the retaining bracket and retaining screw, tightening securely.

4. Reassemble unit following steps 6 through 13 in the **"POWER AND SENSOR CABLE REPLACEMENT"** section of this manual.

NOTICE: FOLLOW THE INSTRUCTIONS PROVIDED IN THE **"WIRING AND GROUNDING"** AND **"OPERATION"** SECTIONS OF THE MANUAL AFTER UNIT DISASSEMBLY, REASSEMBLY.

MOTOR REPLACEMENT

1. To gain access to the motor assembly, follow steps 1 through 5 in the **"POWER AND SENSOR CABLE REPLACEMENT"** section of this manual.

NOTICE: DISCARD BOTH STRAIN RELIEF ASSEMBLIES. THEY CAN NOT BE REUSED.

2. Remove the four motor thru bolts and carefully pull motor assembly from bearing housing. Further motor service **MUST** be provided by a qualified motor repair facility.

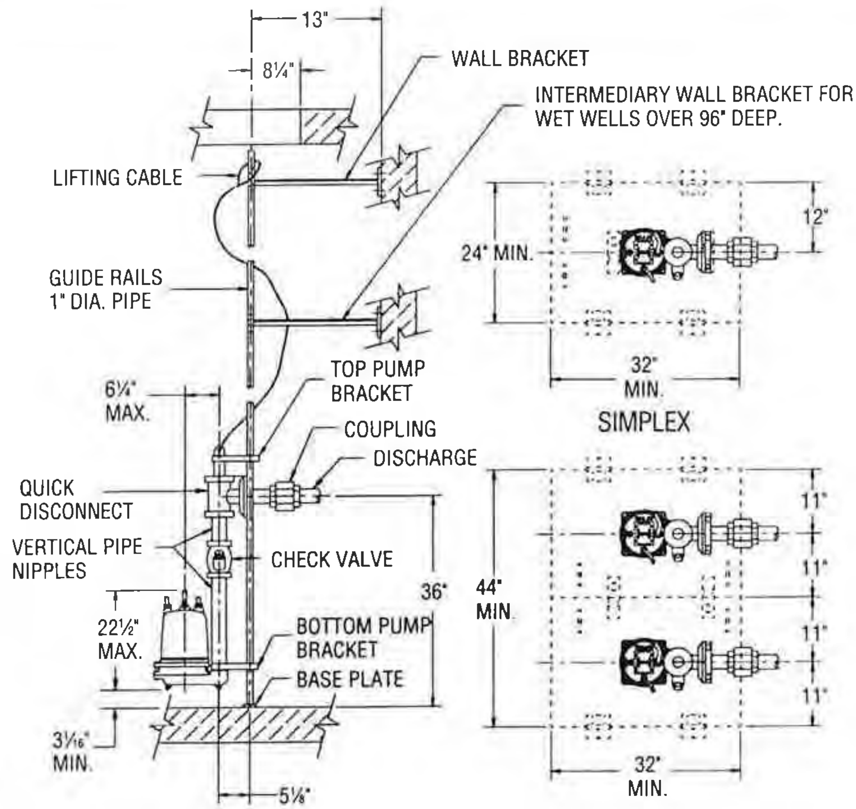
3. Insert the motor assembly into the bearing housing, visually aligning the motor thru bolts through the lower motor vent openings. A vent opening **MUST** be adjacent to the seal failure probe, for installation of probe wire.

4. Install the four motor thru bolts, torquing to 35 lbs in (4 N m).

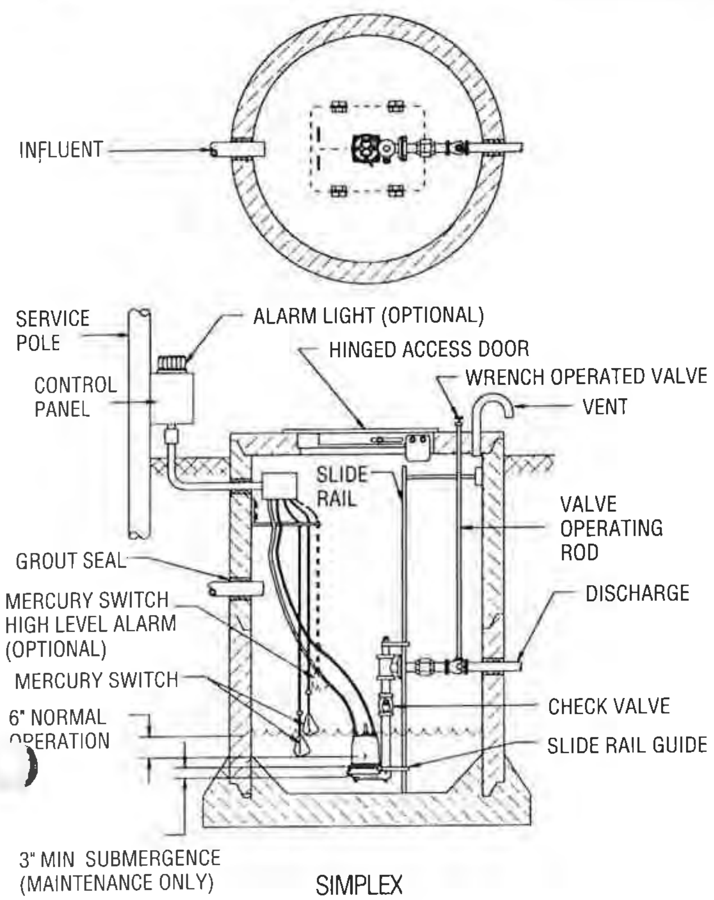
5. To complete the assembly follow steps 6 through 13 in the **"POWER AND SENSOR CABLE REPLACEMENT"** section of this manual.

NOTICE: FOLLOW THE INSTRUCTIONS PROVIDED IN THE **"WIRING AND GROUNDING"** AND **"OPERATION"** SECTIONS OF THE MANUAL AFTER UNIT DISASSEMBLY, REASSEMBLY.

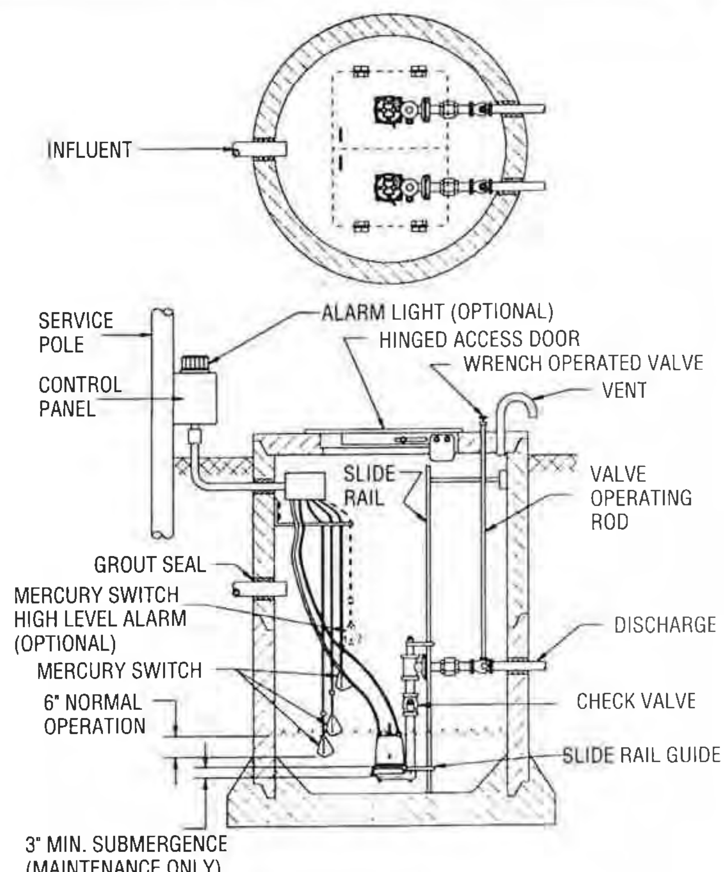
Typical 2" Slide Rail Installation



Typical Plumbing and Installation



SIMPLEX



DUPLEX

Engineering Data

Maximum Diameter Solids	¾ in	19 mm
Minimum Casing Thickness	5/16 in	8 mm
Casing Corrosion Allowance	⅛ in	3 mm
Maximum Working Pressure	55 psi	380 kPa
Maximum Pump Submergence – Below Top of Motor Dome	6 in	152 mm
Minimum Number of Evenly Distributed Starts per Hour	6	

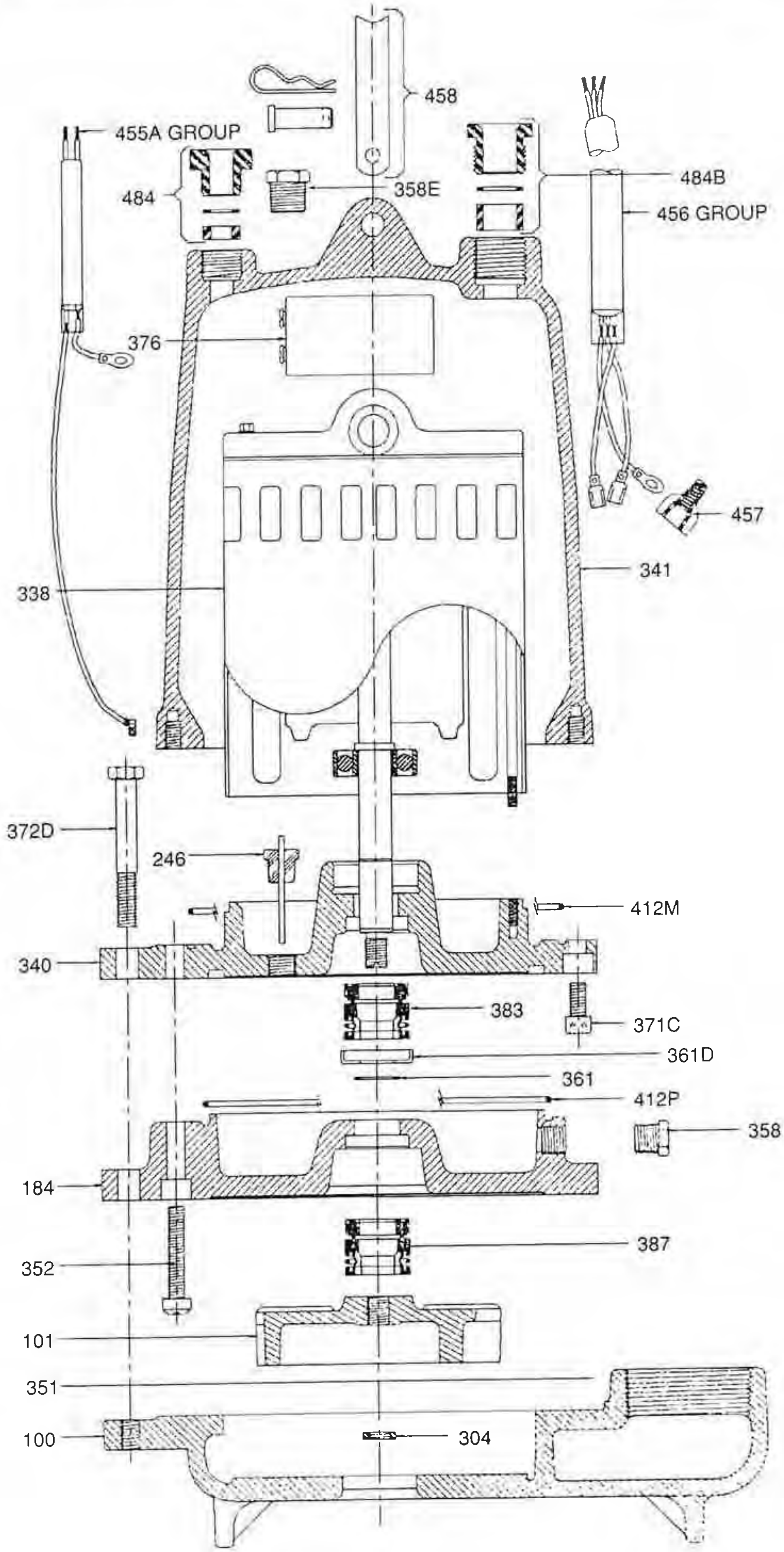
Maximum Operating Temperature		
Continuous Operation	40° C	104° F
Intermittent Operation	60° C	140° F
Seal Chamber Oil Capacity	10 oz	0.3 L
Motor Cover Oil Capacity		
All 3 Phase and 1 Phase ⅓ – ½ HP	3.5 qts	3.3 L
1 Phase ¾ – 1½ HP	4.5 qts	4.3 L

ELECTRICAL

HP	RPM	Voltage	Phase /Hz	Amps	KVA Code	Winding Resistance Line to Line (Ohms)	Power Cable AWG	Sensor Cables Seal	Sensor Cables Seal/Heat	Fuse/Circuit Breaker Amps
⅓	1725	115	1/60	9.4	M	1.92	16/3	16/2	18/4	15
⅓	1725	230	1/60	4.7	N	7.58	16/3	16/2	18/4	10
½	3450	115	1/60	13.0	M	1.00	16/3	16/2	18/4	20
½	3450	230	1/60	6.5	M	4.03	16/3	16/2	18/4	10
½	3450	208-230/460	3/60	3.4/1.7	R	5.81/23.24	14/4	16/2	18/4	10
¾	3450	230	1/60	10.0	J	2.99	14/3	16/2	18/4	15
¾	3450	208-230/460	3/60	5.4/2.7	L	4.04/16.15	14/4	16/2	18/4	10
1	3450	230	1/60	12.5	J	2.09	14/3	16/2	18/4	20
1	3450	208-230/460	3/60	7.0/3.5	L	4.04/16.15	14/4	16/2	18/4	10
1½	3450	230	1/60	15.0	H	1.61	14/3	16/2	18/4	20
1½	3450	208-230/460	3/60	9.2/4.6	K	2.87/11.46	14/4	16/2	18/4	15/10

Repair Motors

HP	Phase	Voltage	RPM	Order Number	Wt. (lbs.)
⅓	1	115	1725	119-49 #1	12.0
⅓	1	230	1725	119-49 #2	12.0
½	1	115	3450	119-49 #31	13.0
½	1	230	3450	119-49 #32	13.0
¾	1	230	3450	119-49 #33	15.0
1	1	230	3450	119-49 #34	17.0
1½	1	230	3450	119-49 #35	17.5
½	3	208-230/460	3450	119-49 #41	13.0
¾	3	208-230/460	3450	119-49 #42	15.0
1	3	208-230/460	3450	119-49 #43	17.0
1½	3	208-230/460	3450	119-49 #44	17.5


458
455A GROUP
484
358E
484B
456 GROUP
376
457
341
338
372D
246
412M
340
383
371C
361D
361
412P
358
184
387
352
101
351
100
304

Series 2ED: Repair Parts Table

Item No.	Part Name	Material	Qty.	Repair Parts Order Number: 1725 RPM	3450 RPM				Max. Wt. (lbs.)
				⅓ HP	½ HP	¾ HP	3 HP	1½ HP	
100	Casing – "F" model only (8th digit)	Cast Iron	1	1K171	N/A				13.0
	Casing (all others)			1K170					
101	Impeller – standard head Model number (8th digit) = diameter	Cast Iron	1	2K158 E or F = 5⅜"	2K220 D = 3 9/16"	2K219 C = 4 1/16"	2K218 B = 4 7/16"	2K217 A = 4 9/16"	2.0
	Impeller – standard head Model number (8th digit) = diameter	Bronze		2K271 E or F= 5⅜"	2K272 D = 3 9/16"	2K273 C = 4 1/16"	2K274 B = 4 7/16"	2K275 A = 4 9/16"	2.5
	Impeller – high head Model number (8th digit) = diameter	Cast Iron		N/A	2K225 H = 3⅞"	N/A	N/A	2K221 G = 5½"	3.5
	Impeller – high head Model number (8th digit) = diameter	Bronze		N/A	2K276 H = 3⅞"	N/A	N/A	2K277 G = 5½"	4.0
112A	Lower Ball Bearing	Steel	1	4K132					–
112B	Upper Ball Bearing	Steel	1	4K132					–
184	Seal Housing	Cast Iron	1	1K229					9.5
218	Insulating Oil (gallon)	Turbine Oil		4K245					7.5 lbs./gal.
	Gallons required 1 PH	Convis 150		1.0	1.0	1.2	1.2	1.2	
	3 PH			1.0	1.0	1.0	1.0	1.0	
246	Seal Sensor	Nylon/Brass	1	9K191					–
304	Impeller Locknut (3 PH only)	AISI 300 series SS	1	13K6					–
338	Motor		1	See Repair Motors chart					–
340	Bearing Housing	Cast Iron	1	1K228					10.0
341	Motor Cover 1 PH	Cast Iron	1	1K230	1K230	1K197	1K197	1K197	23.0
	3 PH			N/R	1K231				18.5
351	Casing Gasket	Composite	1	5K170					–
352	Phil. Head Screw – seal housing to motor cover	AISI 300 series SS	2	13K219					–
358	Plug – seal housing ¼" NPT	Steel	1	6K2					–
358E	Plug – motor cover ⅜" NPT	Steel	1	6K3					–
361	Retaining Ring	AISI 300 series SS	1	4K375					–
361D	Seal Retainer	AISI 300 series SS	1	4K379					–
371C	Skt. Hd. Screw – brg. housing to motor cover	AISI 300 series SS	2	13K210					–
372D	Hex Screw – seal housing to casing	AISI 300 series SS	4	13K222					–
376	Capacitor (1 PH only)		1	N/R	9K197	9K197	9K197	9K197	–
383	Mechanical Seal – upper	Carbon/Ceramic	1	10K10 (John Crane Type 6)					–
387	Mechanical Seal – lower (standard)	Carbon/Ceramic	1	10K10 (John Crane Type 6)					–
	Mechanical Seal – lower (optional)	Siliconized Carbon	1	10K29 (John Crane Type 21)					–
	Mechanical Seal – lower (optional)	Tungsten Carbide	1	10K30 (John Crane Type 21)					–
412M	O-Ring – motor cover	BUNA-N, AS 568A-166	1	4K252					–
412P	O-Ring – seal housing	BUNA-N, AS 568A-163	1	5K181					–
455A	Sensor cable		1	See chart below					–
456	Power cable		1	See chart below					–
457	Wire nut 3 PH, 200/230 V	Nylon Housing	4	9K145					–
	(power cable) 3 PH, 460 V		6	9K145					–
	Wire nut (seal/heat cable) Optional 3 PH only	Nylon Housing	2	9K223					–
458	Handle Assembly	AISI 300 series SS	1	4K243					–
484	Strain Relief Assembly (sensor cable)		1	5K113					–
484B	Strain Relief Assembly 1 PH		1	5K113	5K113	5K111	5K111	5K111	–
	(power cable) 3 PH		1	5K111					–
	Heat Sensor Kit (optional)		1	9K261					–
	Seal Installation Tool		1	A02A013					–
	Loctite #271		1	AL271121					–

2ED Power and Sensor Cables Description	Type and AWG Size	Standard length* 20'	Optional Lengths 30'	50'	100'	Wt. (lbs./5 ft.)
Power Cables						
1 PH: ⅓ and ½ HP, 115 V; standard with plug, optional with bare leads	SJTO – 16/3	9K165	9K214	9K215	N/A	0.5
*CSA listed models	SJTW – 16/3	9K195	N/A	9K245	N/A	0.5
1PH: ⅓ and ½ HP, 230 V; standard with plug, optional with bare leads	SJTO – 16/3	9K164	9K214	9K215	N/A	0.5
*CSA listed models	SJTW – 16/3	9K196	N/A	9K245	N/A	0.5
1 PH: ¾ – 1½ HP, 230 V with bare leads	STO – 14/3	9K163	9K216	9K161	9K217	0.9
*CSA listed models	STW – 14/3	9K180	N/A	9K244	N/A	0.9
3 PH: ½ – 1½ HP, 208–230/460 V with bare leads	STO – 14/4	9K153	9K218	9K154	9K219	1.1
*CSA listed models	STW – 14/4	9K181	N/A	9K243	N/A	1.1
Sensor Cables						
Mechanical seal sensor: standard for all models	SJTO – 16/2	9K189	9K220	9K221	9K222	0.5
*CSA listed models	SJTW – 16/2	9K190	N/A	9K236	N/A	0.5
Mechanical seal/heat sensor: optional for 3 PH models	SJTO – 18/4	9K237	9K238	9K239	9K240	0.5
*CSA listed models	SJTW – 18/4	9K241	N/A	9K242	N/A	0.5

*CSA models have 20 foot length cables as standard. Optional CSA cables available in 50 foot length only.

Trouble Shooting

⚠WARNING
Hazardous voltage

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY SERVICE CAN CAUSE SHOCK, BURNS OR DEATH.

SYMPTOM	PROBABLE CAUSE	RECOMMENDED ACTION
MOTOR NOT RUNNING	Motor thermal protector tripped.	Allow motor to cool. Insure minimum pump submergence. Clear debris from casing and impeller.
NOTE: If circuit breaker "OPENS" repeatedly, **DO NOT** reset. Call qualified electrician.	Open circuit breaker or blown fuse.	Determine cause, call a qualified electrician.
	Pump impeller binding or jammed.	Check motor amp draw. If two or more times higher than listed in the **"DESCRIPTION AND SPECIFICATIONS"** section, impeller is locked, motor bearings or shaft is damaged. Clear debris fromcasing and impeller, consult with dealer.
a) Manual operation	Power cable is damaged.	Resistance between power leads must read zero. Resistance between power leads and ground should read infinity. If any reading is incorrect, call a qualified electrician.
b) Automatic operation	Inadequate electrical connection in control panel.	Inspect control panel wiring. Call a qualified electrician
NOTE: Check the pump in manual mode first to confirm operation. If pump operates, the automatic controls are at fault. If pump does not operate, see above.	Defective liquid level switch.	With switch disconnected, check continuity while activating liquid level switch. Replace switch, as required.
	Insufficient liquid level to activate controls.	Allow liquid level to rise 3" to 4" (76 mm - 101 mm) above turn-on level.
	Liquid level cords tangled.	Untangle cords and insure free operation
PUMP WILL NOT TURN OFF	Liquid level cords tangled.	Untangle cords and insure free operation
	Pump is air locked.	Shut off pump for approximately one minute, then restart. Repeat until air lock clears. If air locking persists in a system with a check valve pipe, a 0.188" (5 mm) hole may be drilled in the discharge pipe approximately 2" (51 mm) beyond the discharge connection.
	Influent flow is matching pump's discharge capacity.	Larger pump may be required.
LITTLE OR NO LIQUID DELIVERED BY PUMP	Check valve installed backwards, plugged or stuck closed.	Check flow arrow on valve and check valve operation.
	Excessive system head.	Consult with dealer.
	Pump inlet plugged.	Inspect and clear as required.
	Improper voltage or wired incorrectly.	Check pump rotation, voltage and wiring. Consult with qualified electrician.
	Pump is air locked.	See recommended action, above.
	Impeller is worn or damaged.	Inspect impeller, replace as required.
	Liquid level controls defective or improperly positioned.	Inspect, readjust or replace as required.
PUMP CYCLES CONSTANTLY	Discharge check valve inoperative.	Inspect, repair or replace as required.
	Sewage containment area too small.	Consult with dealer.
	Liquid level controls defective or improperly positioned.	Inspect, readjust or replace as required.
	Influent excessive for this size pump.	Consult with dealer.

LIMITED WARRANTY

This warranty applies to all pumps and related accessories manufactured and/or supplied by Goulds Pumps, Inc., Water Technologies Group, Seneca Falls, New York 13148.

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

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

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

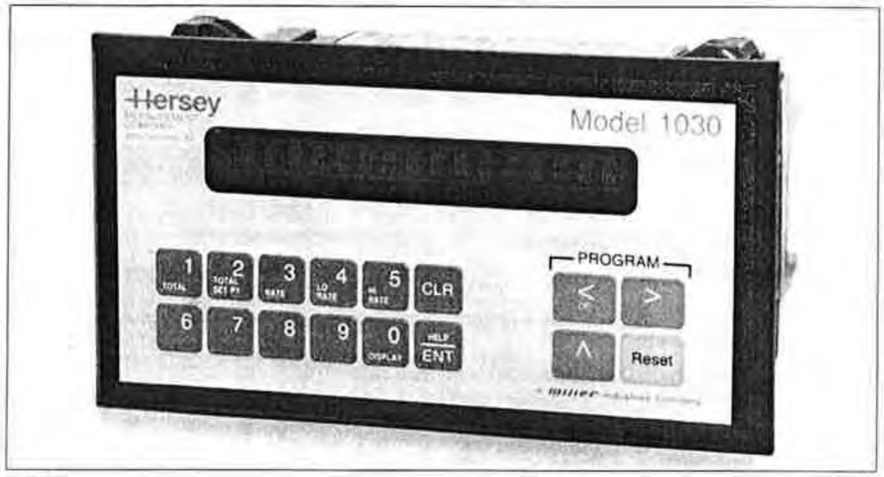
2ED.IOM (04/93)

Hersey MEASUREMENT COMPANY

M 516

Model 1030 Indicator - Totalizer

Table Of Contents



The Model 1030 is a microprocessor based indicator - totalizer. It gives you the ability to display important process parameters such as rate, total, and set points. It also supplies outputs for driving lights, alarms, chart recorders, and totalization for remote operations.

A special mode gives you the capability of simultaneously viewing two flow parameters such as rate and total. The 1030 also contains a set point lock out system to prevent unauthorized changes from the front panel.

The 1030 may be completely factory programmed for your application. It's easy to operate and to program when changes are required. Programming is accomplished through an easy to use menu system. There are built-in scrolling help messages that explain each program step. A 10 year memory backs up all program settings and parameters in case of a power failure.

Installation

Panel mounts: See dimensions for panel cut-out. Completely install the unit into the panel.
Wall mounts: Mount unit to wall. Wires should be 18 inches long inside the enclosure from the point of entry to the point of termination. This will provide ample length so the hinged door will swing freely and allow access to the terminals.

After installing unit, place the 3 adhesive cable clamps (enclosed) on the bottom rear of the unit near the wiring terminals as needed. Loop the 3 cable ties through the clamps and around the wires to transfer the strain from the terminal blocks to the clamps.

Wiring Notes

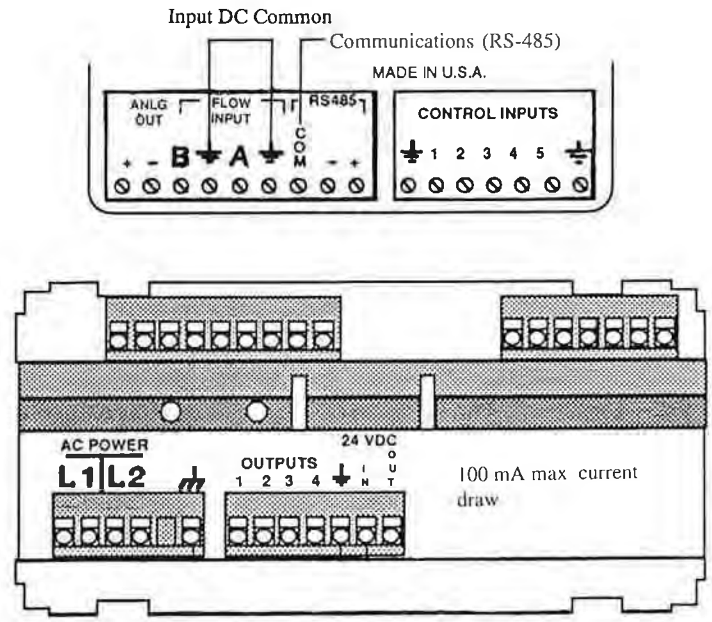
The following points should be kept in mind when wiring the unit:

- All connections should be made to the instrument with the power off.
- Improper wiring may cause damage to the instrument. Double check all connections before powering.
- Do not exceed the power ratings of the components. Observe the maximum current and voltage ratings as applicable. See Specifications section.
- An in-line fuse should be installed in the input power supply line. See the Applications Wiring section.
- Sensor, control, and ac power

lines should not be routed in the same conduit.

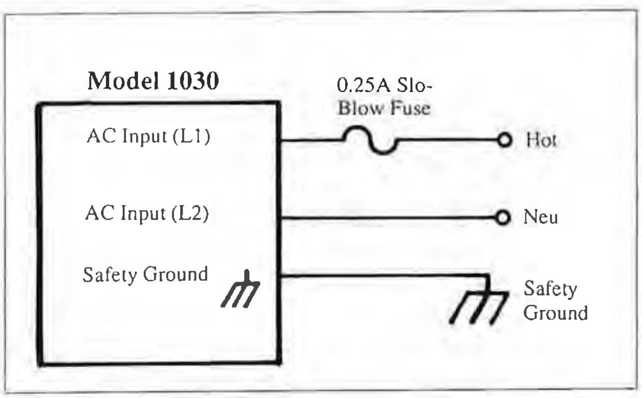
- The power connection terminals, L1 and L2, have two terminals each. The terminals for L1 are internally connected, as are the terminals for L2. This allows for easier "daisy chaining" of power when multiple units are used.
- When connecting inductive loads to the control outputs, diode protection should be provided.
- On Power Up, if the display reads "Run Installation," press the "Reset" key to clear. This is an indication that the unit has not been programmed. To program the unit, see page 6.

Wiring Control Inputs

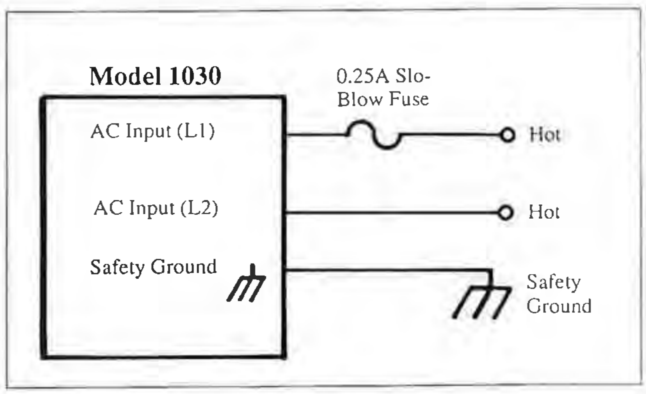


All grounds ⏚ (common) are connected internally.

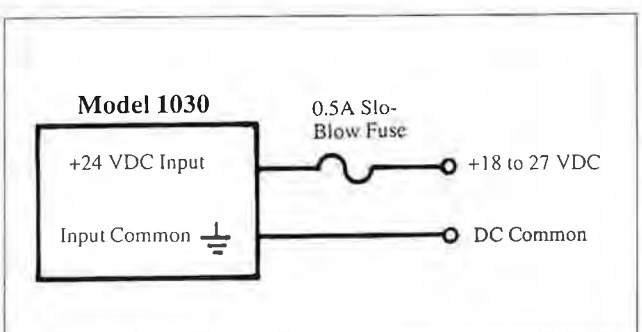
Applications Wiring



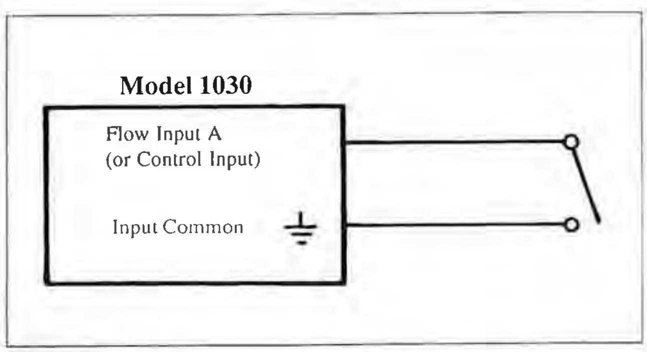
Powering the Model 1030 - 115 v ac version



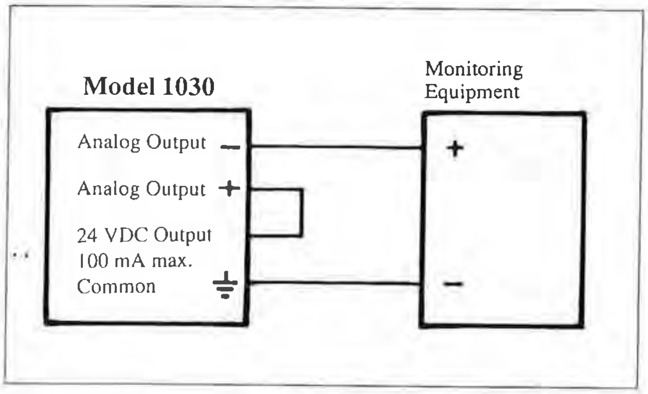
Powering the Model 1030 - 230 v ac version



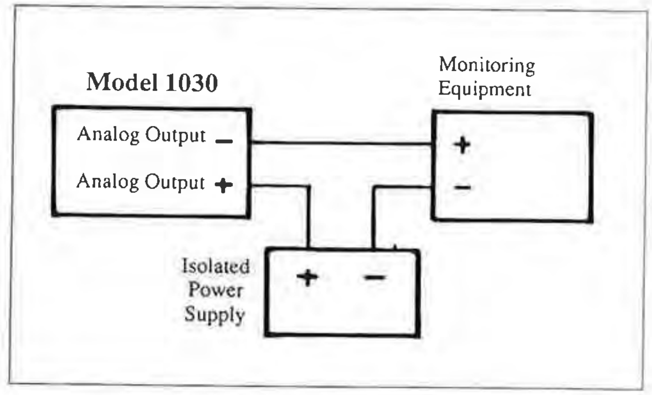
Powering the Model 1030 with dc supply



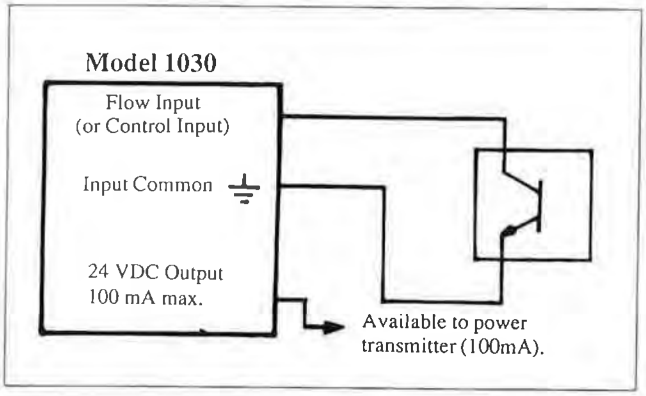
Flow input or control input using switch contact closure



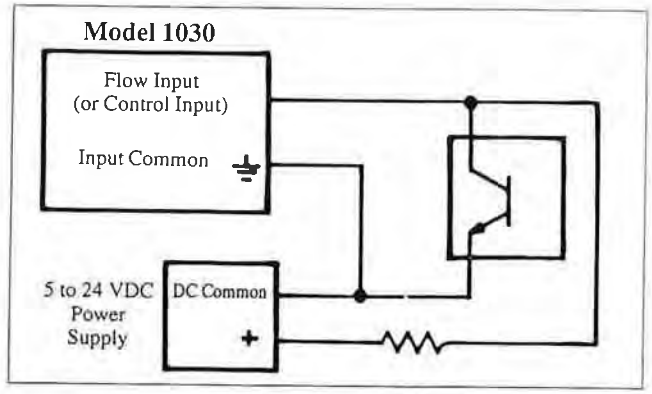
4-20 mA rate output (non-isolated)



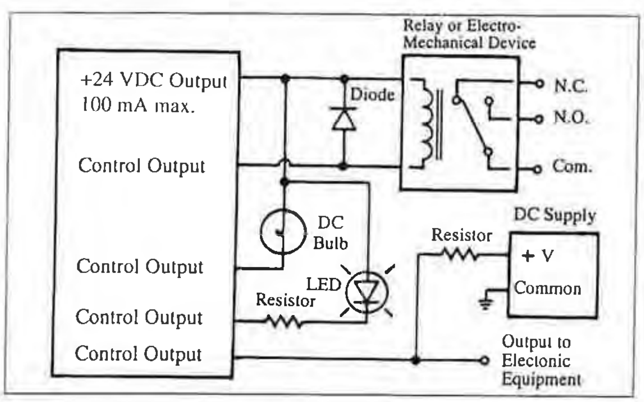
4-20 mA rate output (isolated)



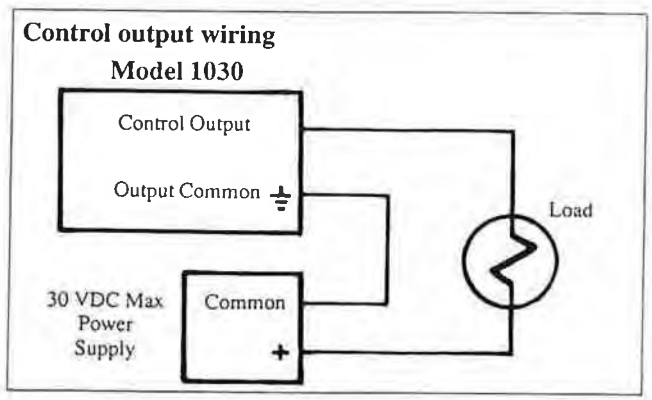
Flow input or control input utilizing open-collector npn transistor



Flow input or control input using open-collector npn transistor with pull-up resistor



Control output application examples

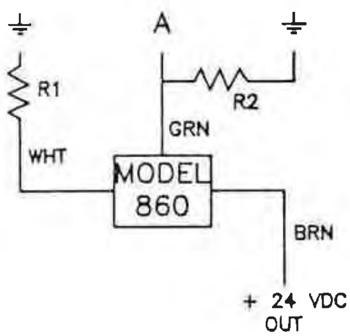


Wiring Hersey Transmitters to the Model 1030

Model 840 — Model 1030
black ____ Input A
brown ____ Input Common ⏚
white ____ No connection

Model 860 — Model 1030
green ____ Input A
white ____ Input Common ⏚
brown ____ +24 v output

Note: Place a 1200 to 1500 ohm resistor (3/4 watt or greater) in series with the white wire as R1. Place a 1500 ohm resistor between the green wire and ground as R2. In some cases, it may be necessary to substitute a resistor for R2 in the range of 1200 to 2000 ohms.



Model 1006 — Model 1030
1 ________ Input A
2 ________ +24 v output
3 ________ Input Common ⏚

Model 1050 — Model 1030
V in _____ + 24 v output
P out ____ Input A
Ground ___ Input Common

R-11 or R-12 with Reed Switch, R-15, R-39 — Model 1030
white _____ Input A
black _____ Input Common ⏚

R-11 or R-12 with micro-switch — Model 1030
blue ______ Input A
black _____ Input Common ⏚

R-22A Square Wave — Model 3030
black _____ Input A
white _____ Input Common ⏚
red _______ V out
(see note at R-38)

R-22A Form A — Model 3030
black ____ Input A
black ____ Input Common ⏚
green ____ No connection
(see note at R-38)

R-25 — Model 1030
T1 _______ Common ⏚
T2 _______ +24 v output
T3 _______ No connection
T4 _______ Input A

R-37A — Model 1030
red _______ +24 v output
black _____ Input Common ⏚
white _____ Input A

R-38 — Model 1030
black _____ Input Common ⏚
red _______ See note
white _____ Input A

Note: For proper hookup:

- Use a 15 v regulator (7815 or LM340T15 in a T0-220 package) to obtain power for R-38.
- Connect pin 1 (regulator input) of the regulator to the +24 v output of the Model 1030.
- Connect pin 2 (regulator ground) of the regulator to common on the Model 1030.
- Connect pin 3 (15 v output) of the regulator to the red wire of the R-38.
- Connect the black wire of the R-38 to the Input Common terminal of the Model 1030.

Mag Meter — Model 3030
P out
(0 to 10 K Hz.) ______ Input A
Ground ____________ DC Common ⏚

Operation

The indicator and the totalizer portions of the Model 1030 can be thought of as two separate instruments in a single case. They act mostly independent of each other and their functions are best understood with this in mind.

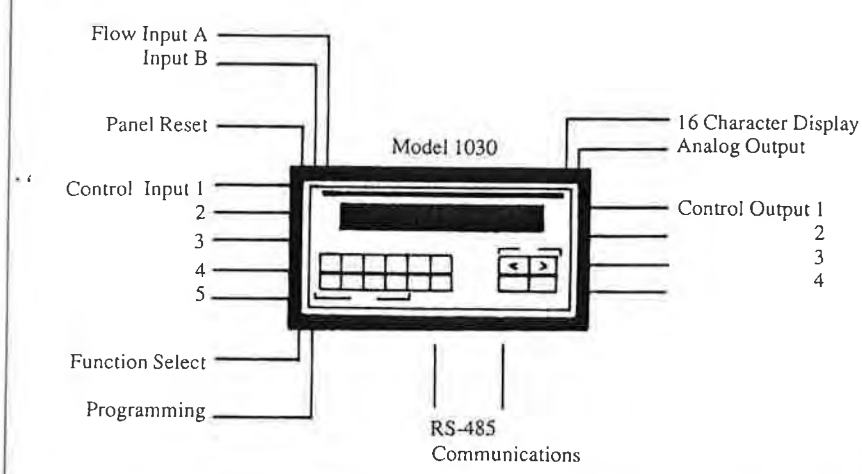
Indicator

The indicator provides 6 digit rate indication with three alphabetical characters for rate units such as gpm, lps, etc. A decimal point may be specified anywhere within the six digits. The indicator may provide a rate smoothing operation which averages pulsating flow rates. Smoothing provides "software dampening" of incoming flow signals.

There are two set points that may be used to signal the conditions of high and low flow rates. An open-collector transistor switches to ground upon set point activation. The set points may act in three modes. They may follow the flow rate, be latched , or activate for a specified amount of time (select from 0.1 to 999.9 seconds). When set up for latched or timed operation, the set points may be reset with front panel reset key or by wired control input.

The Model 1030 has a 4-20 mA current loop output. The current output follows the flow rate display. The output is calibrated through programming by a special menu. The active range of the current output is normally from zero to the full scale flow rate of the flow meter. However, the output range may be specified for any flow range — either within the meter's range, or greater than the meter's range. The range does not have to begin at a zero flow rate.

Input - Output Diagram



Front Panel Value Display

Key	Key Label	Description
1	Total	Totalizer
2	Total Set Pt.	Totalizer set point value
3	Rate	Flow rate value
4	Lo Rate	Rate low set point value
5	Hi Rate	Rate high set point value
0	Display	Dual display values

Hidden values

Keys	Function	Description
^ , then 1	K factor	Pulses input per unit volume value
^ , then 2	Calculated kmf hi	Portion greater than or equal to one
^ , then 3	Calculated kmf lo	(Portion less than one) Kmf hi and kmf lo values may be added to tell the operator the "unit volume per pulse input" or the reciprocal of the K factor.
^ , then 4	R factor	Rate multiplier
^ , then 5	Analog fraction	Percentage between 4-20 milliamps at which the analog output is operating
^ , then 0	Software version	Lets the customer and Hersey personnel know the version of software used

Totalizer
The Model 1030 has a ten digit totalizer. A decimal point may be specified within the ten digits. The totalizer may be reset from the front panel or by a wired control input.

The totalizer makes use of two control outputs. One output is a scaled pulse output that may be used for a remote totalizer or as input to another computer. The pulse width may be specified from three choices. A certain output frequency must not be exceeded for each choice. Naturally, a longer pulse width dictates a slower pulse rate output.

The second totalizer control output is for the totalizer set point. This output activates when the totalizer reaches a preset value. The output may be latched or timed and may be reset from the front panel or by a wired control input.

Front Panel Display
Flow parameter displays may be accessed by pressing a single key. When **Display** is pressed, two values are displayed simultaneously. An abbreviated label will accompany the value displayed. To see the full label, momentarily press the key labeled **DP** or **<** left arrow and the full labels will be shown for about a second. For dual display, you may choose from any values except the totalizer and the totalizer set point which require ten digits. In addition to rate, a decimal proportion of the analog output may be displayed.

To change the function, press and hold the **DP** key or < left arrow key until the left half of the display begins to flash. Then, press the ^ up arrow key until the desired parameter is displayed. Now, press the **>** right arrow key to select the right half of the display and press the ^ key until that desired parameter is displayed. Press the **Display** key to end the dual function display set up routine.

Note: It is recommended that when the totalizer is selected for dual display, it should be selected for the left side of the display. If the magnitude of the total becomes over 7 digits, the "T" header will not be displayed. It is possible that the display be completely full of numbers without spaces. If the totalizer reaches 10 digits and the right half display selection is showing 6 digits, it is recommended that the totalizer be reset before reaching 10 digits, or the right half display entity be restricted to 4 digits if display of both entities is desired.

There are other "hidden values" that may be displayed from the front panel that may be useful for some applications. The reason they are termed " hidden" is because they are not labeled. To see the hidden value, press the ^ key and immediately press the number key that corresponds to the parameter desired for viewing. See table on page 5.

Changing Set Point Values
Rate and totalizer set point may be easily changed from the front panel. First, press the function key desired as if to view the set point.

To change the value, press the **CLR** key, enter the new value using the number keys, then press **ENT**. If you change your mind before pressing the **ENT** key, just press the **CLR** key and the original value will be retained.

It is possible to selectively "lock out" the set point values so they cannot be changed from the front panel. This is done from within the program mode. See the programming section.

Front Panel Control - Reset Key
The **Reset** key may be used to unlatch the rate or totalizer set point outputs, or to reset the totalizer count. Any combination of these functions may be chosen from within the program mode. Standard factory setting is "None."

Flow inputs
There are two terminals for flow inputs (plus associated ground terminals):
Input A accepts electrical pulses from the flow meter or flow transmitter.
Input B is a flow inhibit input. When Input B is connected to ground, the Model 1030 will ignore any incoming pulses on Input A. When Input B is not used or connected to a logical positive voltage (see specifications), Input A is active as normal.

Wired Control Inputs
There are five wired control inputs that perform single or multiple functions similar to the Reset key. When switched to ground, the specific function is performed. Each control input has a specific function or functions which cannot be altered.

Input #	Function
1	Unlatch totalizer set point output
2	Reset totalizer count
3	Unlatch rate hi/lo set point outputs
4	Unlatch totalizer and rate hi/lo set point outputs
5	Reset totalizer count and unlatch totalizer and rate set point outputs

Control Outputs
Four control outputs are available. These are npn transistors that will switch a load to ground when activated. They may be used for electro-mechanical devices such as counters or relays, turning on lamps, or used to signal an automated processing device. The maximum current sinking capability is 150 milliamps and the maximum dc voltage is 30 volts.

Output #	Function
1	Scaled totalizer pulse output
2	Totalizer set point output
3	Rate low set point output
4	Rate high set point output

The totalizer set point output may be specified from within the program mode to have latched or timed (from 0.1 too 999.9 seconds) operation.

The rate set points have three modes of operation. One mode is for the set points to follow the flow rate. That is, the outputs activate and deactivate as the flow rate passes above and below the set values. The two rate set points may act independently by being latched or timed from 0.1 to 999.9 seconds.

In either case, latched or timed, an output that has been activated will remain activated as long as the responsible condition exists. When the condition ceases to exist, the output may either time out or be unlatched by a control input.

RS-485 Communications
The Model 1030 has an RS-485 communications link for two-way communication with other computers. This link may be used to make programming changes, set point changes, query flow data, and perform control functions. The Model 1030 may occupy a communication line with up to 100 units - each having a unique identification number (0 to 255). A single two wire line may be up to 4000 feet long without the use of signal repeaters. The communications link is specified as RS-485 multi-drop. Baud rates of 300, 600, 1200, 2400, 4800, 9600, and 19200 are possible. Parity may be specified as space, even, or odd. The protocol is Opto-22 compatible. For communication command specifics, please contact your Hersey representative.

Programming
See Programming Chart.

Programming the Model 1030 may be done from the front panel by two methods. The preferred method is using the menu that may be stepped through for making changes. The second method makes use of a rapid access technique that may be quicker for a simple change but requires the programming diagram to be in hand.

Enter the Programming Mode
Simultaneously press the < left arrow and the > right arrow keys. Notice that these keys have "Program" labeled immediately above them. A password may be requested if an operator has specified a password during a previous programming session. The Model 1030 comes from the factory with no password set. Setting of the password is explained on page 10. Enter the correct password and press the **ENT** key. If an incorrect password is entered the message "PW ERROR" will be flashed and the unit will again ask for a password. The user may try again if he desires. He may leave the password entry mode and return to the run mode by simultaneously pressing the < and > keys. If the password display is left idle, the unit will return to run mode automatically after 15 seconds.

Once the program mode is entered, "PROGRAM ?" will be displayed.

Rapid Access Programming Method
Program cells may be accessed directly from the "PROGRAM ?" screen by entering the row number and the column number from the Programming Chart on page 8. Other cells may be accessed by pressing < and > to get the "PROGRAM ?" display and entering another row and column number.

Sequential Menu Programming Method
Once the "PROGRAM ?" display is obtained, main menu items may be selected by pressing the ^ up arrow key. These menu items all contain the word "PROG". See Programming Chart on page 7. Once the main menu selection has been made, the > and < keys may be used to move to sub-menu items and to move back to the main menu. Then use the ^ key to select another main menu item.

Help Messages
When positioned at any sub-menu item, the **Help** key may be pressed and a helpful programming message will scroll across the display. After the message has completed, the display will return to the sub-menu item. If you do not want to read the entire message, pressing any key will end the message.

Returning to Run Mode
The operator may return to the running mode by simultaneously pressing the < and > keys to obtain the "PROGRAM ?" display. Then, press the **Reset** key to exit the programming mode.

Program Menu Descriptions

See Programming Chart, page 8.

PROG. CALIBRATION

K Factor
The K factor is the ratio of the number of input pulses from the flow meter or transmitter per unit of volume.

Example: 2.485 pulses per gallon

The value entered as the K factor affects both the totalizer and the rate meter calibrations. One way to increase resolution for the totalizer and rate meter is to change the K factor by a multiple of 10. Example: 0.2485. If this is done, the decimal point in both the totalizer menu and the rate meter menu should be moved one place to the left. See PROG. TOTALIZER and PROG. RATEMETER

Note: The totalizer scaled pulse output will also be 10 times greater.

Operation: Use the **CLR** key to enable a new entry. Use the **0 - 9**, **DP** (decimal point), and **ENT** keys to enter a new K factor.

Rate Multiplier
The rate multiplier is a factor used for scaling the pulse input rate into a time unit for flow rate indication such as "per minute" or "per day." To calculate the rate multiplier factor required for a unit, multiply the full scale flow rate by the K factor and divide by the full scale frequency.

Example: A given meter has a flow range of 0 - 10 gpm and a K factor of 570 pulses per gallon. First, calculate the frequency (pulses per second) of the flow input signal at the full scale flow rate.

FS Freq.:

$$\frac{10\text{ gal}}{1\text{ min.}} \times \frac{570\text{ pulses}}{1\text{ gal.}} \times \frac{1\text{ min.}}{60\text{ sec.}} = \frac{95\text{ pulses}}{1\text{ sec}}$$

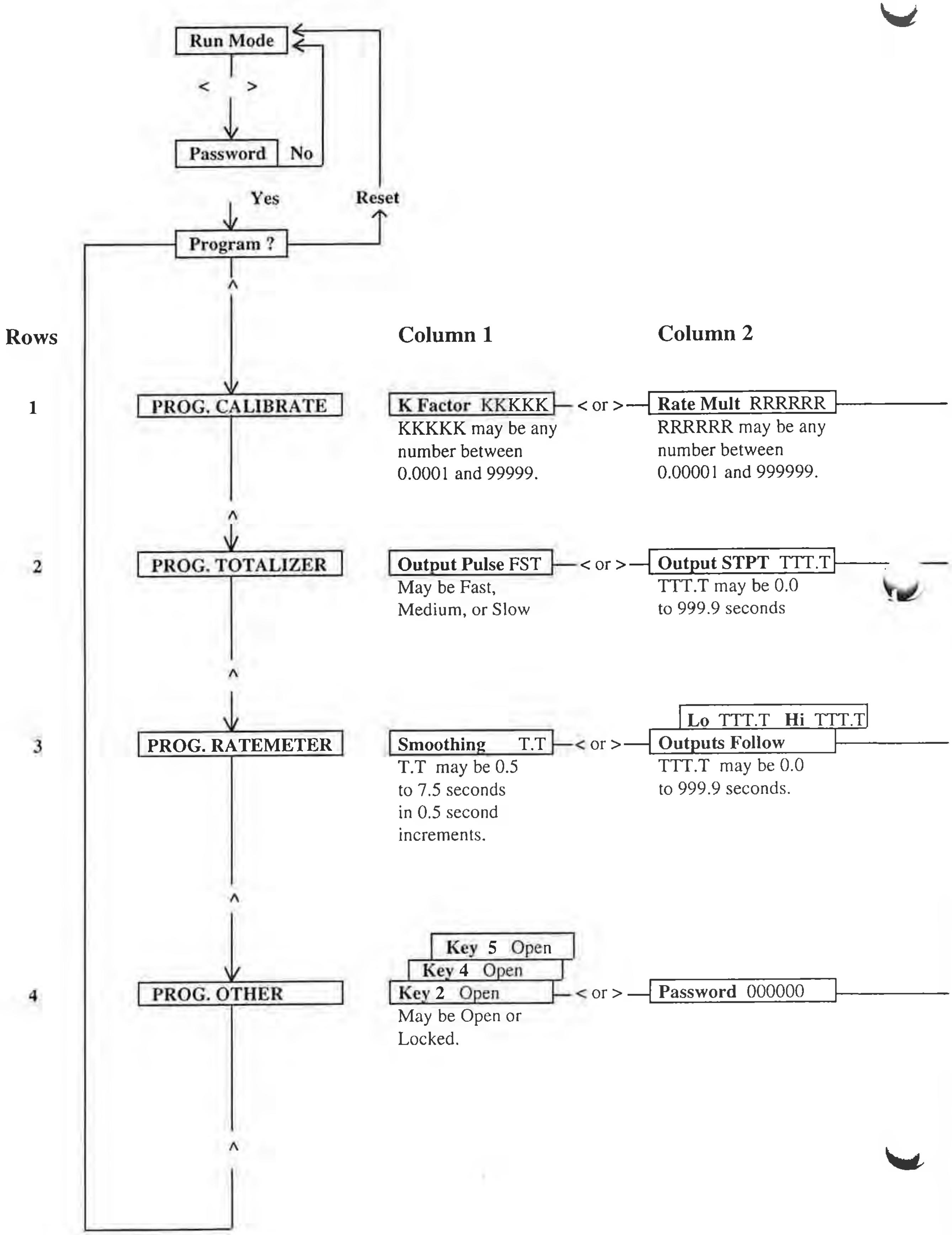
Next, multiply the full scale flow rate by the K factor and divide by the full frequency.

$$R_M = (\text{FS flow rate}) \times (\text{K factor}) / (\text{FSFreq.})$$
or
$$R_M = 10 \times 570 / 95 = 60$$

The readout will be in unitary gallons and unitary gpm. To obtain higher resolution for the rate meter, change R_M to 600 instead of 60. Change the rate meter decimal point to 00000.0 instead of 000000. Note that the high and low rate set point decimals will also shift a place to the left. These values may have to be re-entered. See PROG. RATEMETER.

Operation: Use the **CLR** key to enable a new entry. Use the **0 - 9**, **DP** (decimal point), and **ENT** keys to enter a new rate multiplier.

Programming Chart



Column 3	Column 4	Column 5	Column 6
20 mA Out Start ? **4 mA Out** Start ? <	> **20 mA Rate** RRRRRR **4 mA Rate** RRRRRR < RRRRRR may be any numbers less than or equal to 999999.	> **Diagnostics**	
Reset Unl. Out < May be None, Reset Count, Unlatch Output, or Reset and Unlatch	> **Dec. Pt.** 000000		
Reset Unl. Out < May be None or Unlatch Hi/Lo Alarms.	> **Dec. Pt.** 000000 <	> **Rate at Zero** TT < TT may be 1 to 15 seconds.	> **Rate Header** GPM G, P, and M may be any alphabetical character or a blank space.
Baud BBBBB PPPPP < Baud rate (BBBBB) may be 300, 600, 1200, 2400, 4800, or 9600. Parity (PPPPP) may be Space, Even, or Odd.	> **ID** III **Time** TTT < III may be 0 to 255. TTT may be 0, 10, 100, or 500.	> **Speed** 400 Hz max. Input pulse speed may be 40, 400, or 7500 Hz maximums.	

4 mA Out Start
This display is used when calibrating the analog output of the unit.

Operation: To calibrate the analog output, connect the analog output "+" terminal to +24 v dc out. Connect the analog output "-" terminal to ground through a current meter. Press the **CLR** key. Use the < and > keys to adjust the output current to 4 mA and then press the **ENT** key. Use the ^ key to select the 20 mA level and repeat the process.

4 mA Rate
This display is used to select the active range of the analog output. Enter the flow rate that is supposed to be represented by 4 milliamps normally, zero (0). Press the ^ key and enter the flow rate that is to be represented by 20 milliamps normally the rated full scale flow rate of the meter.

Operation: Use the ^ key to select the 4 or 20 mA rate. Use the **0 - 9** and **ENT** keys to enter a new rate.

Diagnostics
Two items may be tested when the diagnostics are run — the display and the computer itself. You may check for missing character segments in the display by pressing the ^ key. All "8"s and decimal points should be displayed. Press the ^ key again and all "*"s will be displayed. Again, you should check for missing segments. Pressing the ^ key again will start the computer's self-diagnostics test. Any errors will be flashed on the display.

Operation: Press the ^ key three times to cycle through the diagnostic tests.

PROG. TOTALIZER

Output Pulse
Fast - 125 microsecond pulse width, output 1500 pulses/second max.
Med. - 2 millisecond pulse width, output 200 pulses/second max.
Slow - 50 millisecond pulse width, 10 pulses/seconds max. frequency

Operation: Use the ^ key to select the function of the totalizer output.

Output Set Point
Decide the totalizer set point output. If 0.0 is entered, the output will be latched. If 0.1 to 999.9 is entered, the output will be timed. The output will remain on, if timed, for as long as the totalizer condition exists and for the time-out period. The time-out period may be preempted by unlatching the output.

Operation: Use the **CLR** key to enable entry of a new time-out. Use the **0 - 9** and **ENT** keys to enter the time-out value of the output.

Reset
The front panel reset key can be configured to perform multiple or no functions for the totalizer. These functions include reset totalizer count, unlatch totalizer set point output, reset totalizer count and unlatch totalizer set point output, and none.

Operation: Use the ^ key to select the totalizer function of the **Reset** key.

Decimal Point
The decimal point position of the totalizer may be selected using this display.
Example: Use the ^ key to select the decimal point location for the totalizer.

PROG. RATEMETER

Smoothing
A built-in dynamic averager performs software dampening. With this, a stable reading of flow rate may be obtained from a pulsating flow system. A smoothing factor of 0.5 to 7.5 may be set in 0.5 increments. By setting the smoothing factor at 0.5, no damping is performed. A smoothing factor of 7.5 provides a 7.5 second time delay for 100% display settling after a change in flow rate. Instantaneous rate readings are taken and averaged to produce a single reading to be displayed. With each rate update, the oldest reading will be incorporated into the average.

Operation: Use the ^ key to select a new rate smoothing time.

Outputs Follow
The high and low flow rate set points may operate three different ways. They may follow the flow rate, be latched, or be timed. If latched, set the time-out period for 0.0 seconds. If timed, set the time-out from 0.1 to 999.9 seconds. The output will persist until after the responsible conditions cease and the time-out period has expired or until the output is unlatched.

Operation: Use the ^ key to select whether the rate outputs follow the rate or are timed. If timed, use the < and > keys to select either the lo or hi rate output. Use the **CLR** key to enable a new entry. Use the **0 - 9** and **ENT** keys to enter a new output time. The output is latched if a time of 0.0 is entered.

Reset
The front panel reset key can perform either an unlatching of the rate set point outputs or no function at all.

Operation: Use the ^ key to select the rate meter function of the **Reset** key.

Decimal Point
The decimal point position of the rate meter may be selected using this display.

Operation: Use the ^ key to select

the decimal point location for the rate meter.

Rate at Zero
In absence of the flow pulse input, the rate at zero is the period that the rate meter will show the last legitimate flow reading before showing a zero flow rate. The period may be set from 1 to 15 seconds. An ideal application to use this function would be when flow pulse input rates are expected to be very slow. Example: A "rate at zero" set to "15" would be useful when the pulse input rate is expected to be as low as 1 pulse every 10 seconds. An expected low pulse rate of 1 pulse every 2 seconds may constitute a "rate at zero" setting of 3 to 5 seconds. For low pulse rates greater than 5 per seconds, a "rate at zero" settling of "1" is normal.

Operation: Use the **CLR** key to enable a new entry. Use the **0 - 9** keys and **ENT** to enter a new rate zero time.

Rate Header
Three alphabetical characters and a blank character may be used to label the flow rate display with engineering units.

Operation: Use the > and < keys to select which location to program. Use the ^ key to select the character for that location.

PROG. OTHER

Key 2 Open (Also, keys 4 and 5). The totalizer set point value, rate low set point value, and the rate high set point value may be designated as open or locked. Locking the value prevents the changing of the set point value from the front panel unless it is first reopened in the programming mode. This protects against unauthorized persons from having access change the set points in critical control applications.

Operation: Use the **2**, **4**, or **5** keys to select which set point mode to program. Use the ^ key to select whether or not the selected set point is locked.

Password
A password may be specified for the next entry into the programming mode. A password of zeros (000000) means that no password is required for program mode entry. Do not forget your password!

Operation: Use the **CLR** key to enable a new entry. Use the **0 - 9** and **ENT** keys to enter a new password.

Baud --- Parity
The baud rate and parity must be specified when using the RS-485 communications link. The baud rate should be chosen from 300, 600, 1200, 2400, 4800, 9600, 19200. The parity may be space(none), even, or odd.

Operation: Use the **CLR** key to enable entry. Use the **0 - 9** and **ENT** keys to enter the communication baud rate. Use the ^ key to select odd, even, or space parity.

ID --- Time
The Model 1030's identification number must be set whenever using the RS-485 communication link. This must be a number between 0 and 255. No two units on the same link may have the same ID. Also, the minimum communication response time for the unit must be specified. It may be selected from 0, 10, 100, or 500 milliseconds. A longer time is normally given for non-time-critical applications.

Operation: Use the **CLR** key to enable entry. Use the **0 - 9** and **ENT** keys to enter the unit identity number from 0 to 255. Each unit on the communication link must have a unique number. Use the ^ key to select the minimum communication response time.

Input Speed
The pulse frequency of the flow input must be specified. Three choices are available.
Fast (7500 Hz. max.) - is used for quick electronic pulses. Min. pulse width is 50 microseconds.
Medium (400 Hz. max.). Min. pulse width is 1.5 milliseconds.
Slow (40 Hz. max.) - is recommended for contact closure inputs. Min. pulse width is 10 milliseconds.

$$\text{FS Freq.} = \text{gpm} \times \frac{\text{pulses per gallon}}{60}$$

Operation: Use the ^ key to select the count input speed.

Specifications

Flow Inputs
Require npn current sinking or contact closure to ground.
Internal 5.8K ohm pull-up resistor to 5 v dc
- Voltage low: 0 - 2.2 v dc
- Voltage high: 2.8 - 24 v dc
- High Speed: 0 - 7500 Hz.: min. pulse width: 50 microseconds
- Med. Speed: 0 - 400 Hz.: min. pulse width: 1.5 milliseconds
- Low speed: 0 - 40 Hz.: min. pulse width: 10 milliseconds
- **Input A:** Flow input
- **Input B:** Flow input inhibit (flow input ignored when pulled low)

Front panel control: pushbutton control (may be locked out)
Reset*:
Rate meter: *unlatch rate hi/lo set point outputs*, or none;
Totalizer: reset totalizer count, *unlatch totalizer set point output*, reset totalizer count and unlatch totalizer set point output, or none
Note*: When more than one function is available, the function that is italicized is the program default. It is possible to change the function through the program menu.
Control inputs: contact closure or npn transistor pull down to ground

impedence: 5.8K ohm pull-up resistor to 5 v dc
low: 0 - 1.0 v dc; high: 3.5 - 24 v dc
response: min. low 30 millisec.: min. high 30 millisec.

Control Input 1: Unlatch totalizer set point output

Control Input 2: Reset totalizer count

Control Input 3: Unlatch rate hi/lo set point outputs

Control Input 4: Unlatch totalizer set point output and unlatch rate hi/lo set point outputs

Control Input 5: Reset totalizer count, unlatch totalizer set point output, and unlatch rate hi/lo set point outputs

Power supply: 115 v ac, 50/60 Hz., 0.2 A or 18 - 27 v dc 0.4 A max., 6 W max. (230 v ac or 18 - 27 v dc version available)

Power output: 24 v dc ±5% at 100 mA max for sensors and peripherals when unit is supplied with ac power input only

Rate meter
K factor: 0.0001 to 99999
Rate multiplier: 0.00001 to 999999
Accuracy: ±0.05%
Rate smoothing: designate 0.5 to 7.5 second dynamic averaging in 0.5 second increments
Rate update: 0.5 seconds

Current output: 4 - 20 mA: 100 ohm impedence: optically isolated
Load: 1000 ohms max. at 24 v dc
Compliance voltage: 12 - 27 v dc
Response time: 0.5 seconds (follows rate meter)
Accuracy: ±0.1% at 25° C; ±0.25% over temp. range

Resolution: 0.05% (11 bits)

Control outputs: npn trans. (150 mA max., 30 v dc max.)

Control output 1: scaled totalizer pulse output with designated pulse width
high speed: 1500 Hz. max.; 125 microsecond pulse width
med. speed: 200 Hz. max.; 2 millisecond pulse width
low speed: 10 Hz. max., 50 millisecond pulse width

Control output 2: totalizer set point output

Control output 3: low rate set point output

Control output 4: high rate set point output

Note: Rate hi/lo set point output operations may either: follow the flow; be latched; or be timed from 0.1 to 999.9 seconds. The totalizer set point output operation may be either: latched; or timed from 0.1 to 999.9 seconds

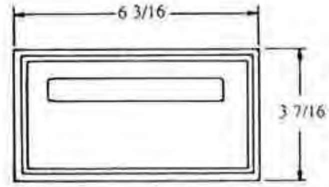
Communications
Type: RS-485 multidrop
Baud: 300, 600, 1200, 2400, 4800, 9600, 19200
Parity: space, even, or odd
Protocol: Opto-22 compatible

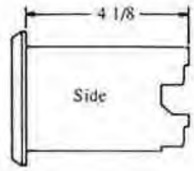
Wiring terminals: 14 awg max., detachable

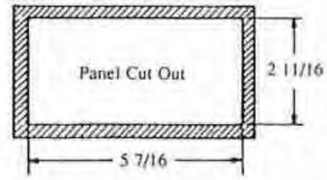
Environmental
Operating temperature: 32 to 131° F (0 to 55° C)
Storage temperature: -40 to 158° F (-40 to 70° C)
Humidity: 0 to 85% RH noncondensing
Panel mount version: key pad is NEMA 4X with gasket that will seal panel NEMA 4
Wall mount version: enclosure and front panel are NEMA 4X

Dimensions

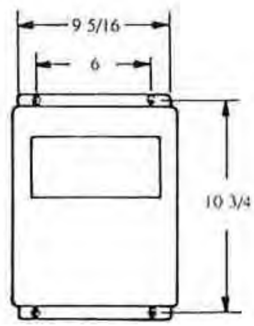
Panel mount

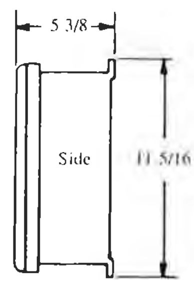






Wall mount





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Hersey liquid level, flow, and Btu measurement products are upgraded on a continual program of technical improvement. Hersey Measurement Company reserves the right to change specifications without notice.

Form M 516
BM#60500S027
1M-0596

M551

Models 840 and 860 sensors

Installation instructions

If the Model 840 Reed Switch or the 860 Infrared Transmitter is purchased with a meter, the resistors are installed at the factory. You do not need to follow any of the instructions on this sheet.

When the Models 840 and 860 are p separately from the meter, follov installation procedure below

Hersey
(800) 845-2102
TOTAL 1/2 OZ 4 GPM
(EACH PROD. WELL)

Installation

Loosen three screws (4), but do not completely. Grasp register box (5) and straight up. Pop out plug (10).

Insert sensor wire (12) through retaining nut (6). Then guide wire through hole in register box (5). Place strain relief (11) over wire as illustrated and then add bushing (9) and nut (8). Loosely tighten (6, 11, 9, and 8) at this time.

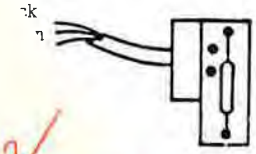
If you have a Model 860 Infrared Transmitter refer to *Figure 1* (3). On all meters except the 3/4″, the sensor will go in the second slot as illustrated. On the 3/4″, the sensor will go in the first slot. *Note:* On all registers the infrared sensor goes into the slot with the reflective silver bars. Refer to label in lid (7) for sensor placement.

If you have a Model 840 Reed Switch (2), it will go in the third or fifth slot depending on counts per gallon desired. Refer to label in lid for sensor placement.

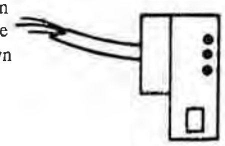
Push the sensor (2 or 3) wire side up until it bottoms out in the slot in the register (1).

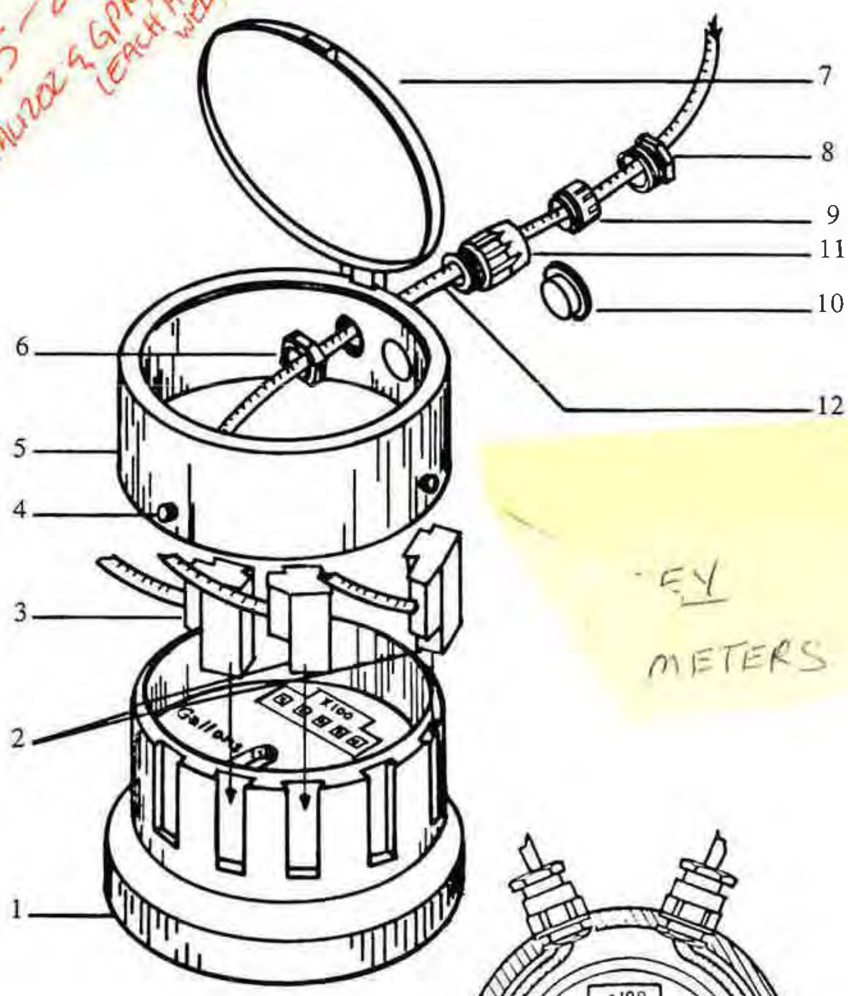
Route the sensor wire (12) around the register (1). See *Figure 2*. Push strain relief (11) through register box (5) and tighten retaining nut (6). Do not tighten (9 and 8) at this time. Place register box (5) on register (1) with lid (7) aligned with totalizer as indicated. Pull slack out of sensor cable through (8, 9, and 11). Put register box (5) on register (1) until it seats. Tighten three screws (4). Pull slack out of sensor cable (12) and tighten (8) securely.

Model 840 Reed Switch



Model 860 Infrared Transmitter





EY
METERS

Figure 1

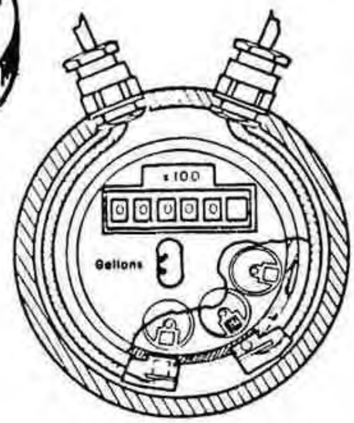


Figure 2

AALIANT
Fluid Measurement Solutions

Date: 4-28-03
Attn: Roger Gray
Company:
Re:

Fax to: 518-951 2300
From: Vickie Smith
Number of pages including cover: 7

☐ Urgent ☐ For your review ☐ Reply ASAP ☐ Please comment

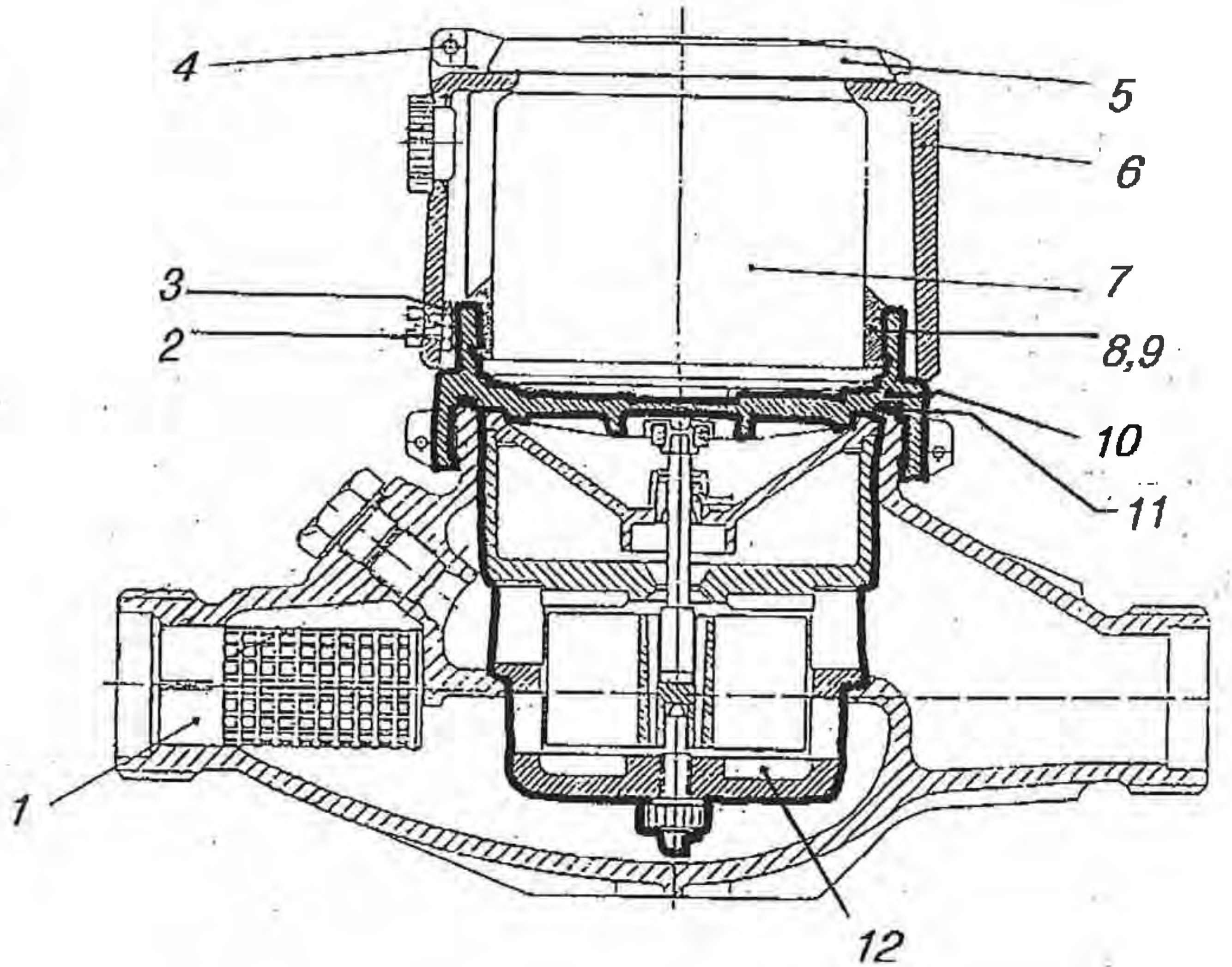
Parts list following for
3/4" & 1" Model 420 +
Model 433

ORDER PARTS
LAWRENCE ANGUS
716-877-7180
OR
315-445-5555

HERSEY FLOW METERS

...e call.

PO Box 4585 • 150 Venture Blvd. • Spartanburg, SC 29305
Phone: (864) 574-8960 • Fax: (864) 578-7308 • Customer Service: 1-800-778-9251



MODEL 420 COLD WATER (120°F) MTX METER

NIAGARA®

PARTS LIST FOR 3/4 INCH MODEL 420 COLD WATER MTX METER 60480P013

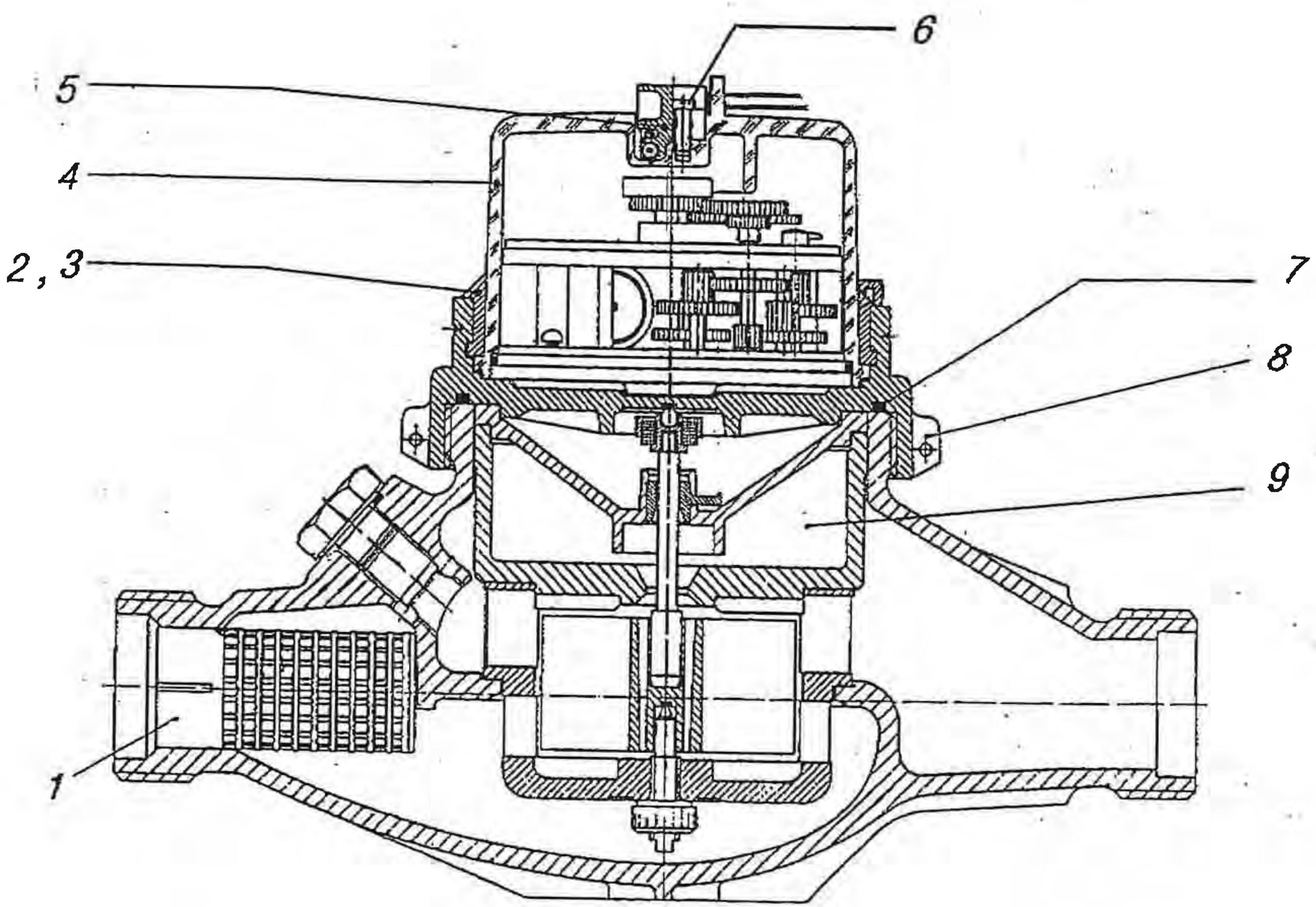
1. STRAINER	60480P206	$2.00
2. FILLISTER HEAD SCREW	60480P223	$1.00
SEALING SCREW	60480P316	$2.00
3. HEX NUT	60480P315	$0.50
4. SEALING PIN	60480P238	$1.00
5. PROTECTION LID	60480P264	$2.00
6. PROTECTION COVER	60480P265	$16.00
7. REGISTER	60480P112	$104.00 -
8. WORK CLAMP RING	60480P333	$10.00
9. SEALING SEGMENT	60480P334	$6.00
10. SCREWED HEAD	60480P308	$32.00
11. O-RING	60480P136	$5.00
12. MEASURING INSERT COMPLETE	60480P108	$48.00

2/20/03 JC

PARTS LIST FOR 1 INCH MODEL 420 COLD WATER MTX METER 60480P015

1.	STRAINER	60480P207	$2.00
2.	FILLISTER HEAD SCREW	60480P223	$1.00
	SEALING SCREW	60480P316	$2.00
3.	HEX NUT	60480P315	$0.50
4.	SEALING PIN	60480P238	$1.00
5.	PROTECTION LID	60480P264	$2.00
6.	PROTECTION COVER	60480P265	$16.00
7.	REGISTER	60480P113	$104.00
8.	WORK CLAMP RING	60480P333	$10.00
9.	SEALING SEGMENT	60480P334	$6.00
10.	SCREWED HEAD	60480P224	$35.00
11.	O-RING	60480P137	$5.00
12.	MEASURING INSERT COMPLETE	60480P109	$66.00

2/20/03 JC



MODEL 433 COLD WATER (120°F) MTX METER

NIAGARA®

PARTS LIST FOR 1 INCH MODEL 433 COLD WATER MTX METER 60480P038

1. STRAINER	60480P207	$2.00
2. WORK CLAMP RING	60480P333	$10.00
3. SEALING SEGMENT	60480P334	$6.00
4. REGISTER (1 PULSE=1 USG)	60480P121	$56.00
5. REED SWITCH	60480P257	$41.00
6. PHILLIPS HEAD SCREW	60480P572	$1.00
7. O-RING	60480P137	$5.00
8. SCREWED HEAD	60480P224	$35.00
9. MEASURING INSERT COMPLETE	60480P109	$66.00

2/20/03 JC

Hersey MEASUREMENT COMPANY

NIAGARA® LIQUID METERS

M 211

Series MTX

Models 123, 414, 420, and 433
Operating/Maintenance

Hersey - Tam
315-445-5555

Model 433

Measuring Chambers $57/1 inch

Shipped 5/24/00 $135/2 inch

ACI Controls
(716) 675-9450
877-7180
Lawrence Angus (Hersey?)

Jim McKena

X

(Flow Meter)
ACI Controls
(716) 675-9450
Lawrence Angus

$57/1 inch
$135/2 inch

Part # 60480P122 (Theresa)
Fax (315) 452-4608

Installation

In selecting a ... should consider ... nance, and insta...

The Niagara ... must be mount... the register on ...

In order to have accurate measurement, the meter must have a straight undisturbed pipe with length of 5 pipe diameters upstream and 3 pipe diameters downstream. If this is not possible, straightening vanes may have to be used.

The Series MTX must be placed in a pipeline free of scale, sediment, and debris. If there is excessive sediment in the pipeline, protect the meter by

... measuring elements.

Register Removal

Model 123

(See Illustration 1)

1. Remove sealing wire (1).
2. Tap out clamping pins (2) from the register cover with a rod.
3. Take off register cover (3) and register (4). The register cannot be disassembled further. It is

...aled and must be ...it if damaged.

...2)
...g wire (1).
...relief nut (2) and ...her and binding nut.
...ng screws (3) and lift off register cover (4).

4. Remove screw (5) and take off reed switch (6).
5. Remove sealing wire (7).
6. Lift sealing segment (8) out of ring. Turn working clamp ring (9) by 90 degrees to the left or the right and lift off.
7. The register (10) cannot be disassembled further. It is hermetically sealed and must be replaced as a unit if damaged.

Specifications

Pressure: 250 psi
Accuracy: ± 1%
Registration: US Gallons. Other units of measure available (consult factory).

Model 123 (cold) & 122 (hot)

Size		3/4"	1"	1 1/2"	2"
Flow Rate		1-20 gpm	2-50 gpm	3-85 gpm	4-130 gpm
Temperature	Cold	120 F	120 F	120 F	120 F
	Hot	250 F	250 F	250 F	250 F

Model 413

Size	3/4"	1"	1 1/2"	2"
Flow Rate	1-20 gpm	2-50 gpm	3-85 gpm	4-130 gpm
Temperature	250 F	250 F	250 F	250 F
Gallons per Contact	1	1	10	10

Model 420 (cold) & 421 (hot)

Size		3/4"	1"	1 1/2"	2"
Flow Rate		1-20 gpm	2-50 gpm	3-85 gpm	4-130 gpm
Temperature	Cold	120 F	120 F	120 F	120 F
	Hot	250 F	250 F	250 F	250 F
Gallons per contact with 840 Switch		10 or 100	10 or 100	10 or 100	10 or 100
Full Scale Freq. HZ with 860 Pulser	Cold	20.63	16.66	14.16	21.66
	Hot	38.57			
Pulses/Gallon	Cold	61.89	20	10	10
	Hot	115.71			

Model 433

Size	3/4"	1"	1 1/2"	2"
Flow Rate	1-20 gpm	2-50 gpm	3-85 gpm	4-130 gpm
Temperature	120 F	120 F	120 F	120 F
Gallons per contact	1	1	10	10

Wetted Material Of Construction

Body:	High Strength Brass (3/4" - 1 1/2") Epoxy Coated Cast Iron (2" only)
Measuring Element:	120 F - Polystyrene 250 F - Noryl
Impeller:	120 F - Polystyrene 250 F - Noryl
O Ring Seals:	EPDM

1030 Calibration Data Summary

Hersey Serial Number: 9705928

Program Settings

Setting	Value	Program Default Settings
PROG. CALIBRATE		
K-Factor:	1	(1.0000)
Rate Multiplier:	60	(1.00000)
4mA Output Start ?:	*Not applicable*	
^20 mA Output Start ?:	*Not applicable*	
Analog Output - Rate@4mA:	0	(0)
^Analog Output - Rate@20mA:	20	(7500)
Diagnostics:	*Not applicable*	
PROG. TOTALIZER		
Totalizer Output Pulse:	FST	(FST)
Totalizer Set Point Output Period:	0	(0.0)
Reset Key - Totalizer Function:	UNLATCH OUTPUT	(UNLATCH OUTPUT)
Totalizer Decimal Point:	0000000000.	(0000000000.)
PROG. RATEMETER		
Rate Smoothing Factor:	1.5	(0.5)
Rate Set Point Output Mode:	FOLLOW	(FOLLOW)
Reset Key - Rate Function:	UNLATCH HI/LO	(UNLATCH HI/LO)
Rate Decimal Point:	000000.	(000000.)
Rate-At-Zero Time:	15	(1)
Rate Display Header:	GPM	(GPM)
PROG. OTHER		
Totalizer Set Point - Key 2 Mode:	OPEN	(OPEN)
^Low Rate Set Point - Key 4 Mode:	OPEN	(OPEN)
^High Rate Set Point - Key 5 Mode:	OPEN	(OPEN)
Password:	0	(000000)
RS-485 Baud Rate:	1200	(1200)
^RS-485 Parity:	SPACE	(SPACE)
RS-485 Comm. ID#:	0	(0)
^RS-485 Response Time:	0	(0)
Input Speed:	40 HZ MAX	(400 HZ MAX)

Important:

'^' indicates second or sub-menu item.

Notes:

1030 Calibration Data Summary

Hersey Serial Number: 9705929

Program Settings

Setting	Value	Program Default Settings
PROG. CALIBRATE		
K-Factor:	1	(1.0000)
Rate Multiplier:	60	(1.00000)
4mA Output Start ?:	*Not applicable*	
^20 mA Output Start ?:	*Not applicable*	
Analog Output - Rate@4mA:	0	(0)
^Analog Output - Rate@20mA:	20	(7500)
Diagnostics:	*Not applicable*	
PROG. TOTALIZER		
Totalizer Output Pulse:	FST	(FST)
Totalizer Set Point Output Period:	0	(0.0)
Reset Key - Totalizer Function:	UNLATCH OUTPUT	(UNLATCH OUTPUT)
Totalizer Decimal Point:	0000000000.	(0000000000.)
PROG. RATEMETER		
Rate Smoothing Factor:	1.5	(0.5)
Rate Set Point Output Mode:	FOLLOW	(FOLLOW)
Reset Key - Rate Function:	UNLATCH HI/LO	(UNLATCH HI/LO)
Rate Decimal Point:	000000.	(000000.)
Rate-At-Zero Time:	15	(1)
Rate Display Header:	GPM	(GPM)
PROG. OTHER		
Totalizer Set Point - Key 2 Mode:	OPEN	(OPEN)
^Low Rate Set Point - Key 4 Mode:	OPEN	(OPEN)
^High Rate Set Point - Key 5 Mode:	OPEN	(OPEN)
Password:	0	(000000)
RS-485 Baud Rate:	1200	(1200)
^RS-485 Parity:	SPACE	(SPACE)
RS-485 Comm. ID#:	0	(0)
^RS-485 Response Time:	0	(0)
Input Speed:	40 HZ MAX	(400 HZ MAX)

Important:

'^' indicates second or sub-menu item.

Notes:

60500S029

TW-1

CALIBRATION REPORT

Model No: PX439-050GI
Serial No: 973608
Pressure Range: 0 to 50 PSIG
Excitation: 9-30 VDC
Output: 4-20 mA

Test Temperatures: Room = 25 C
Cold = 0 C
HOT = 50 C
PCU SERIAL# = 844

Test Pressure PSIG	BFSL Rm Temp Outputs	Run #1 Rm Temp Outputs	Run #1 Error %FSO	Run #2 Rm Temp Outputs	Run #2 Error %FSO	Run #3 Cd Temp Outputs	Run #3 Error %FSO	Run #4 Ht Temp Outputs	Run #4 Error %FSO
-0.0011	3.983	3.7049	0.014	3.9851	0.015	4.0073	0.006	3.9646	-0.005
9.9995	7.185	7.1850	-0.002	7.1853	0.000	7.2015	0.004	7.1939	0.002
20.0000	10.388	10.3854	-0.015	10.3859	-0.012	10.3820	-0.001	10.4271	0.010
29.9990	13.590	13.5873	-0.017	13.5882	-0.011	13.5680	-0.005	13.6618	0.018
40.0020	16.793	16.7928	-0.004	16.7928	-0.004	16.7591	-0.009	16.8991	0.026
50.0017	19.996	19.9997	0.025	19.9998	0.026	19.9580	-0.009	20.1389	0.036
39.9982	16.792	16.7926	0.003	16.7930	0.005	16.7745	-0.004	16.8997	0.027
29.9996	13.590	13.5883	-0.012	13.5892	-0.006	13.5798	-0.003	13.6627	0.018
20.0014	10.388	10.3860	-0.014	10.3864	-0.012	10.3817	-0.002	10.4264	0.010
10.0005	7.186	7.1848	-0.005	7.1847	-0.006	7.1946	0.002	7.1918	0.002
-0.0011	3.983	3.9852	0.016	3.9853	0.016	4.0078	0.006	3.9585	-0.006

Maximum Static Error: 0.026 %FSO

Maximum Non-Repeatability: 0.006 %FSO

Maximum Thermal Error @ Cold: -.009 %FSO/C

Maximum Thermal Error @ Hot: 0.036 %FSO/C

Electrical Termination: Red +Input
Black -Input (Gnd)

TW-2A

CALIBRATION REPORT

Model No: PX439-050GI
Serial No: 973609
Pressure Range: 0 to 50 PSIG
Excitation: 9-30 VDC
Output: 4-20 mA

Test Temperatures: Room = 25 C
Cold = 0 C
HOT = 50 C
PCU SERIAL# = 844

Test Pressure PSIG	BFSL Rm Temp Outputs	------Run #1------ Rm Temp Outputs	Error %FSO	------Run #2------ Rm Temp Outputs	Error %FSO	------Run #3------ Cd Temp Outputs	Error %FSO	------Run #4------ Ht Temp Outputs	Error %FSO
-0.0011	3.971	3.9731	0.014	3.9738	0.019	3.9596	-0.003	3.9640	-0.002
9.9995	7.173	7.1710	-0.010	7.1716	0.006	7.1432	-0.007	7.1934	0.005
20.0000	10.374	10.3705	-0.024	10.3709	-0.021	10.3286	-0.011	10.4277	0.013
29.9990	13.576	13.5718	-0.024	13.5726	-0.019	13.5139	-0.015	13.6613	0.021
40.0020	16.778	16.7772	-0.006	16.7774	-0.005	16.7050	-0.018	16.9029	0.031
50.0017	19.980	19.9846	0.031	19.9849	0.033	19.8976	-0.020	20.1423	0.041
39.9982	16.777	16.7781	0.007	16.7788	0.012	16.7074	-0.017	16.9014	0.031
29.9996	13.576	13.5740	-0.011	13.5741	0.011	13.5192	-0.014	13.6638	0.022
20.0014	10.375	10.3727	-0.013	10.3727	-0.013	10.3325	-0.011	10.4282	0.013
10.0005	7.173	7.1729	0.000	7.1726	-0.002	7.1469	-0.006	7.1950	0.006
-0.0011	3.971	3.9746	0.024	3.9746	0.024	3.9620	-0.002	3.9629	-0.002

Maximum Static Error: 0.033 %FSO

Maximum Thermal Error @ Cold: -.020 %FSO/C

Maximum Non-Repeatability: 0.005 %FSO

Maximum Thermal Error @ Hot: 0.041 %FSO/C

Electrical Termination: Red +Input
Black -Input (Gnd)

TW-3

CALIBRATION REPORT

Model No: PX439-050GI
Serial No: 973607
Pressure Range: 0 to 50 PSIG
Excitation: 9-30 VDC
Output: 4-20 mA

Test Temperatures: Room = 25 C
Cold = 0 C
HOT = 50 C
PCU SERIAL# = 844

Test Pressure PSIG	BFSL Rm Temp Outputs	Run #1 Rm Temp Outputs	Run #1 Error %FSO	Run #2 Rm Temp Outputs	Run #2 Error %FSO	Run #3 Cd Temp Outputs	Run #3 Error %FSO	Run #4 Ht Temp Outputs	Run #4 Error %FSO
-0.0011	3.984	3.9855	0.008	3.9858	0.010	4.0334	0.012	3.9643	-0.005
9.9995	7.181	7.1802	-0.003	7.1805	-0.002	7.2094	0.007	7.2027	0.005
20.0000	10.377	10.3744	-0.018	10.3751	-0.014	10.3815	0.001	10.4450	0.017
29.9990	13.573	13.5720	-0.009	13.5717	-0.011	13.5535	-0.005	13.6860	0.028
40.0020	16.771	16.7704	-0.002	16.7698	-0.006	16.7303	-0.010	16.9307	0.040
50.0017	19.967	19.9700	0.018	19.9691	0.013	19.9112	-0.014	20.1781	0.053
39.9982	16.770	16.7709	0.008	16.7706	0.007	16.7380	-0.008	16.9320	0.041
29.9996	13.574	13.5731	-0.003	13.5732	-0.003	13.5620	-0.003	13.6871	0.028
20.0014	10.378	10.3761	-0.010	10.3765	-0.008	10.3814	0.001	10.4445	0.017
10.0005	7.181	7.1810	-0.000	7.1808	-0.002	7.2074	0.007	7.2035	0.006
-0.0011	3.984	3.9863	0.013	3.9862	0.013	4.0348	0.013	3.9647	-0.005

Maximum Static Error: 0.018 %FSO

Maximum Thermal Error @ Cold: -.014 %FSO/C

Maximum Non-Repeatability: -.006 %FSO

Maximum Thermal Error @ Hot: 0.053 %FSO/C

Electrical Termination: Red +Input
Black -Input (Gnd)

LIMITED WARRANTY

This [illegible] to all water systems pumps and related [illegible] manufactured and/or supplied [illegible] Goulds Pumps.

Any part [illegible] to be defective within the warranty period [illegible] at no charge [illegible] or any subsequent owner during the [illegible]. The warranty period [illegible] for a period of twelve months from the date of [illegible] or eighteen [illegible] the date of manufacture, whichever period is shorter.

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

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

4SUB [illegible]

GARANTIE LIMITÉE

Cette garantie s'applique à tous les systèmes de pompe et [illegible] vendus par Goulds Pumps.

Pendant la durée de la garantie, toute pièce défectueuse sera [illegible] pour le premier acheteur et les acheteurs subséquents. La durée de la [illegible] mois à partir de la date d'installation ou de 18 mois à partir de la date de fabrication, selon la période la plus courte.

Le consommateur qui veut faire une réclamation doit communiquer avec le détaillant autorisé Goulds qui lui a vendu l'appareil et lui fournir tous les [illegible] nécessaires pour sa réclamation. Le détaillant est habilité à s'occuper [illegible] en passant par le service à la clientèle de Goulds ou par son réseau de [illegible].

Cette garantie ne couvre pas: a) les frais de port et de manutention [illegible] frais encourus par la livraison de l'appareil considéré défectueux au [illegible] inspection, b) les coûts de réinstallation de l'appareil réparé, c) les coûts de [illegible] de l'appareil de rechange, d) tout dommage y afférent et e) le remboursement [illegible] occasionnées par une interruption de service.

4SUB [illegible]

GARANTÍA LIMITADA

Esta garantía se aplica a todas las bombas de los sistemas de agua y de [illegible] afines, fabricados y/o suministrados por Goulds Pumps

Cualquier pieza o piezas encontradas defectuosas, dentro del período de la garantía, serán reemplazadas sin cargo al comprador o a cualquier propietario subsiguiente, durante el período de la garantía. El período de garantía es de doce (12) meses a partir de la fecha de instalación, o dieciocho (18) meses a partir de la fecha de fabricación, de los dos, el período que sea más corto.

Un consumidor que crea que existe una reclamación de garantía debe [illegible] con el agente autorizado de Goulds, a quien le compró el equipo originalmente, y debe proporcionar los detalles completos acerca de la reclamación. El agente está autorizado a ajustar las reclamaciones de garantía utilizando el Departamento de [illegible] del Cliente de Goulds y su organización de distribuidores.

Esta garantía excluye: a) la mano de obra, transporte y los costos relacionados incurridos por el consumidor para poner a disposición del agente para la inspección, el equipo que se alega es defectuoso, b) los costos de reinstalación del equipo reparado, c) los costos de reinstalación del equipo reemplazado, d) los daños [illegible] de cualquier clase que sean, y e) el reembolso por las pérdidas causadas por la [illegible] del servicio.

4SUB [illegible]

GOULDS PUMPS
WATER TECHNOLOGIES NORTH AMERICA
Seneca Falls, New York 13148

4" – 60 Hz Submersible Pump Installation and Operation Instructions

page 2

Directives d'installation et de fonctionnement des pompes submersibles 60 Hz de 4 po

page 17

Instalación de la bomba sumergible de 60 Hz y 4" e Instrucciones de Operación

página [illegible]

SUB PUMP

IM004R00

Table of Contents

Owner's Information

Model Number: ____________________

Serial Number: ____________________

Dealer: ____________________

Dealer Telephone #: ____________________

Date of Purchase: ____________________

Installation: ____________________

SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

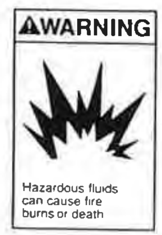
This is a **SAFETY ALERT SYMBOL.** When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

⚠ DANGER Warns of hazards that **WILL** cause serious personal injury, death or major property damage.

⚠ WARNING Warns of hazards that **CAN** cause serious personal injury, death or major property damage.

⚠ CAUTION **Warns of hazards that CAN** cause serious personal injury or **major property damage.**

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED



PUMPING HAZARDOUS LIQUIDS OR FLAMMABLE GASES CAN CAUSE FIRE, BURNS OR DEATH.

DESCRIPTION AND SPECIFICATIONS

Goulds 4" submersible centrifugal pumps are for use in 4" (102 mm), or larger, diameter wells. Assembled pump/motor units purchased from the factory are UL® and CSA listed. All Franklin Electric motors are UL® recognized and CSA listed.

NOTICE: INSPECT UNIT FOR DAMAGE AND REPORT ALL DAMAGE TO THE CARRIER OR DEALER IMMEDIATELY.

Install, ground and wire according to local and National Electrical Code requirements.

Install an all leg disconnect switch near the pump.

Disconnect and lockout electrical power before installing or servicing pump.

Electrical supply **MUST** match pump's nameplate specifications. Incorrect voltage can cause fire, damage to the motor and voids warranty.

Motors equipped with automatic thermal protection open the motor's electrical circuit when a thermal overload exists. This can cause the pump to start unexpectedly and without warning.

NOTICE: POWER CABLE SIZING MUST CONFORM TO LOCAL AND NATIONAL CODES AND STANDARDS.

- The use of wire size smaller than that provided in the National Electric Code could damage the motor and will void the warranty.
- Use only copper wire to motor and to ground. The ground wire must be at least as large as the wires to the motor. Wires should be color coded for ease of maintenance.

⚠WARNING Hazardous Voltage

FAILURE TO PERMANENTLY GROUND THE PUMP, MOTOR AND CONTROLS BEFORE CONNECTING TO ELECTRICAL POWER CAN CAUSE SHOCK, BURNS OR DEATH.

"WARNING" Reduced risk of electrical shock during operation of this pump requires the provisions of acceptable grounding.

This pump is provided with a means for grounding. To reduce the risk of electrical shock from contact with adjacent metal parts, bond supply box to the pump-motor grounding means and to all metal parts accessible at the well head, including metal discharge pipes, metal well casing, and the like, by means of:

1. an equipment-grounding conductor at least the size of the well-cable conductors or the equivalent, that runs down the well with the well cable and
2. a clamp, a weld or both if necessary, secured to the equipment-grounding lead, the equipment-grounding terminal, or the grounding conductor on the pump housing. The equipment-grounding lead, if one is provided, is the conductor that has an outer surface of insulation that is green with or without one or more yellow strips – UL 778

MOTOR CABLE INSTALLATIONS

1. Prepare the motor cable by stripping off ½" (13 mm) of the end of each conductor's insulation.

NOTICE: FOLLOW THE SPLICE KIT MANUFACTURER'S INSTRUCTIONS.

2. Where cables are spliced or connected to the motor leads, splices MUST be water tight. Commercially available potting or heat shrink kits may be used, if allowed by local or federal regulations.

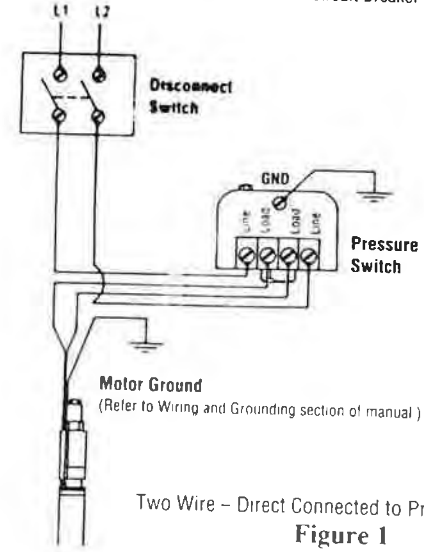
NOTICE: FOR MOTORS 5 HP AND LARGER, SPLICE CONNECTIONS MUST BE SOLDERED USING ONLY ROSIN CORE SOLDER.

3. To ensure proper sealing, immerse splice in a metal container filled with water for ten minutes, then take a resistance reading between the metal container and the cable conductor. Resistance should read 2 megohms or higher. Redo splice as required.
4. Complete the electrical connections to the pressure switch, contactor, control box or starter as indicated in Figure 1, 2, 3, or 4.
5. Affix motor information and submersible pump decals to the appropriate location.

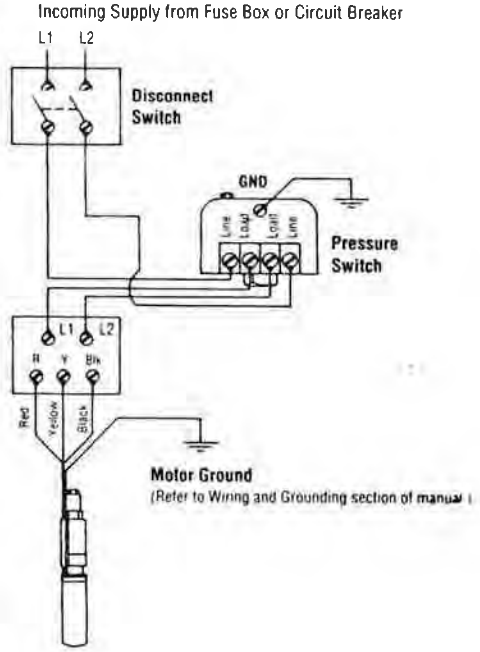
NOTICE: FOLLOW THE MOTOR CONTROL AND PRESSURE SWITCH MANUFACTURER'S INSTRUCTIONS CAREFULLY.

- Two wire motors do not require a control box. See Figure 1. Three wire, single phase motors require a control box. See Figure 2.
- Refer to "Technical Data" section of this manual for circuit breaker or fuse sizing.

SINGLE PHASE MOTORS

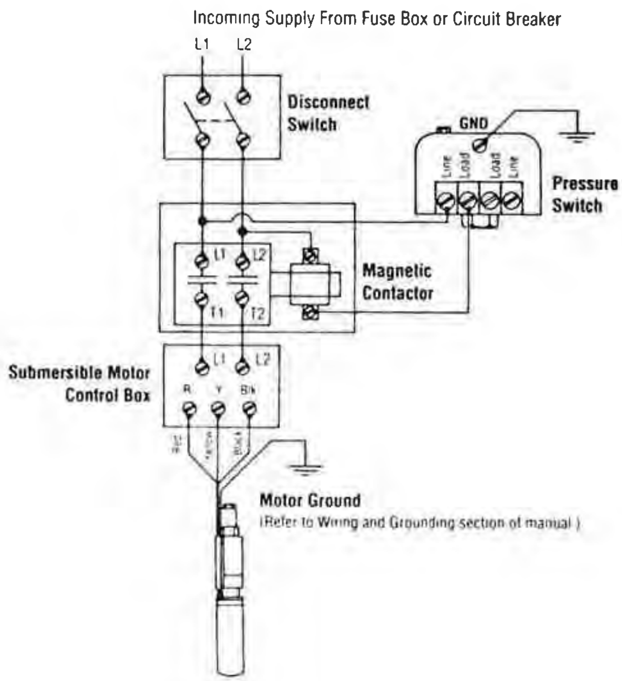


Two Wire – Direct Connected to Pressure Switch
Figure 1



Three Wire – Direct Connected to Pressure Switch

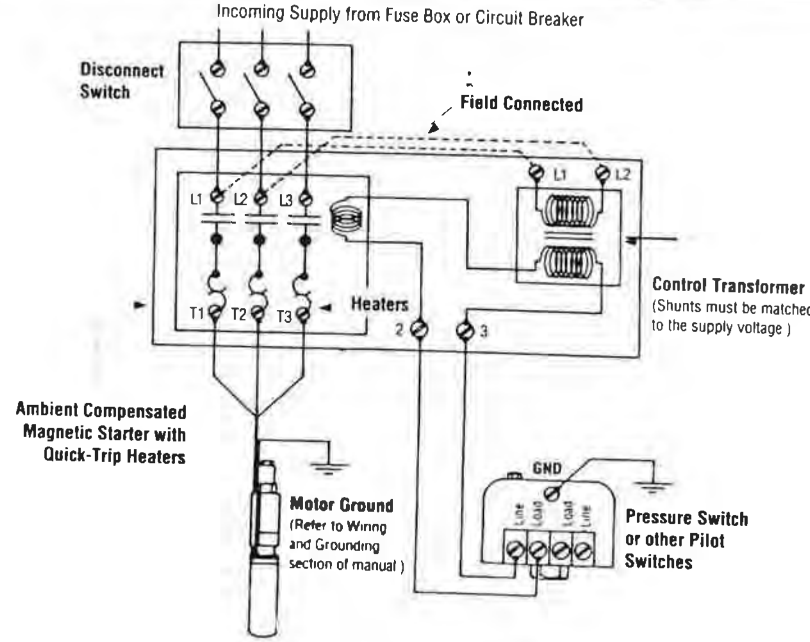
Figure 2



Three Wire – Connected through Magnetic Contactor

Figure 3

THREE PHASE MOTORS



Three Phase Connections

Figure 4

GENERATOR OPERATION

- For externally **regulated** generator kilovolt amperes (KVA) ratings see Table 1. Electrical voltage, **frequency**, phase and ampacity, **MUST** match that shown on the motor **nameplate**, or pump control box.

FAILURE TO USE A MANUAL OR AUTOMATIC TRANSFER SWITCH WHEN GENERATOR IS USED AS STANDBY OR BACKUP CAN CAUSE SHOCK, BURNS OR DEATH.

Table 1

Minimum Generator Rating	Pump Motor Horsepower							
	⅓	½	¾	1	1½	2	3	5
KVA	1.9	2.5	3.8	5.0	6.3	9.4	12.5	18.8
KW	1.5	2.0	3.0	4.0	5.0	7.5	10.0	15.0

NOTE: For best starting of two-wire motors, minimum generator ratings 50% higher than shown are recommended.

NOTICE: FOLLOW THE GENERATOR MANUFACTURER'S INSTRUCTIONS CAREFULLY

Pump Installation

NOTICE: PROTECT ALL PIPING, FITTINGS AND WATER SYSTEM COMPONENTS FROM FREEZING.

⚠WARNING

DO NOT LIFT, CARRY OR HANG PUMP BY THE ELECTRICAL CABLE. DAMAGE TO THE ELECTRICAL CABLE CAN CAUSE SHOCK, BURNS OR DEATH.

- Lower the pump into the well using the discharge pipe. **A safety** cable may be attached to the pump's discharge head lifting eye for **added security. DO NOT** use electrical cable to raise and lower unit. **DO NOT damage electrical** cables while raising and lowering unit.

Piping

- System piping **MUST** conform to all local and national **plumbing** codes and practices.
- To maximize the discharge flow, discharge piping should **be at least** 1" (25 mm) diameter. Keep the discharge pipe as short as **possible** and avoid unnecessary fittings.

NOTICE: MODELS GS AND SB ARE ASSEMBLED WITH **LEFT HAND THREADS**, HOLD THE PUMP WITH A WRENCH ON THE DISCHARGE HEAD WHILE INSTALLING THE **DISCHARGE** PIPE OR CONNECTOR.

- Ensure that the pump and motor are free to rotate by turning **the shaft** by hand.
- Connect drop pipe to pump and lower pump into well.
- Using waterproof plastic electrical tape, fasten the electrical **cable to the** drop pipe at approximately ten foot intervals.
- The pump **MUST** be submerged at all times for proper operation.
- Final setting must be within the pump's recommended operating range.

NOTICE: PROVIDE SUITABLE SAFEGUARDS TO PREVENT OVER PUMPING OF THE WELL. USE ONLY APPROVED DEVICES.

- Follow applicable local health codes for sealing the well and for providing an adequate power cable exit.

Tank Installation

⚠WARNING

FAILURE TO INSTALL A PROPERLY SIZED PRESSURE RELIEF VALVE CAN CAUSE PROPERTY DAMAGE, PERSONAL INJURY OR DEATH.

- If pump is to be operated with an open discharge, a discharge valve **MUST** be installed. Before startup, open this valve approximately ⅓ of the way, then start the pump. **SLOWLY** open the valve until the desired flow rate is achieved. Final setting **MUST** be within the pump's recommended operating range.

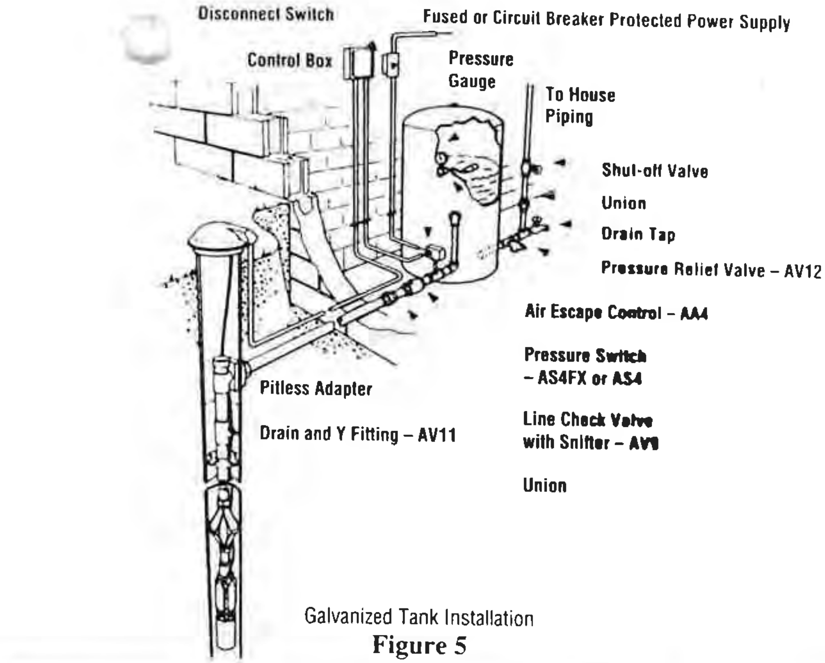
GALVANIZED TANKS

- An air charging system is required when using a Goulds' galvanized tank, or equivalent. The Goulds' **system** requires an AV11 – Drain and "Y" valve, an AA4 – Air Escape Control, and an AV9 – Line Check with a AA10 Snifter Valve.
- The distance **between the** AV9 and the AV11 determines the volume of the air charge to the tank. **When the** pump shuts off, the Snifter Valve on the AA4 will open to atmosphere. **The** AV11 will bleed the water between the AV9 and the AV11 **back to the well**. When the pump restarts, the air between the AV9 and AV11 **will be forced into** the tank. Excess tank air will automatically be bled to atmosphere **by the AA4**. See Table 2 for the required distance setting between the AV9 and **the AV11**, and Figure 5 for location and installation of required fittings and **system components**.

APPROXIMATE DRAIN FITTING SETTING

Tank Capacity	Distance Drain and "Y" Fitting BELOW the Line Check
42 gallon (9.5 m³/hr)	7 feet (2.1m)
82 gallon (18.6 m³/hr)	10 feet (3m)
120 gallon (27.3 m³/hr)	15 feet (4.6m)
220 gallon (50 m³/hr)	15 feet (4.6m)
315 gallon (71.5 m³/hr)	20 feet (6.1m)
525 gallon (119 m³/hr)	20 feet (6.1m)

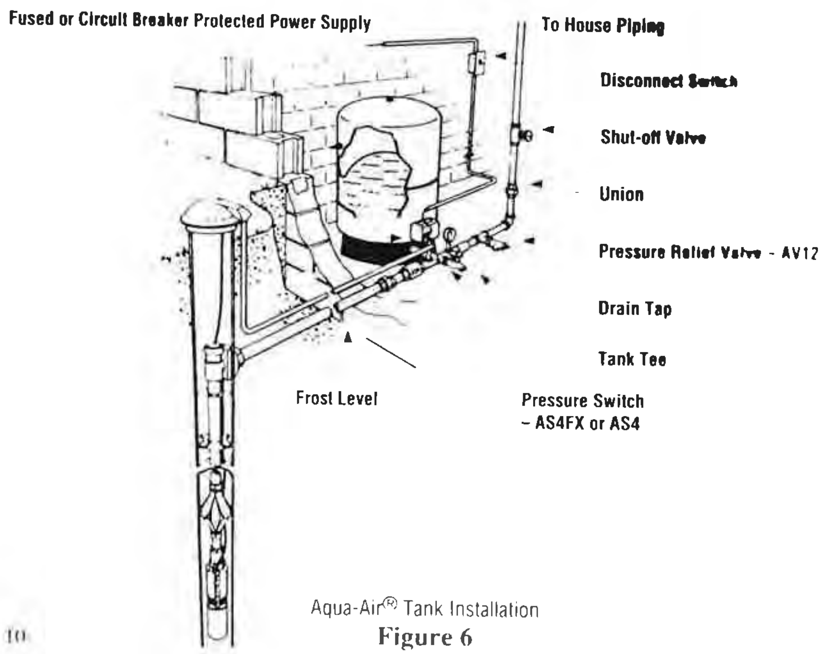
Table 2



Galvanized Tank Installation
Figure 5

AQUA-AIR® TANKS

NOTICE: TANK PRE-CHARGE PRESSURE CHANGES MUST BE MADE USING THE AIR VALVE ON TOP OF THE TANK.



Aqua-Air® Tank Installation
Figure 6

NOTICE: WITH NO WATER IN THE TANK, PRE-CHARGE MUST BE SET TO 2 PSIG (13.8 kPa) BELOW THE SYSTEM "CUT-IN" PRESSURE.

- See Figure 6 for location and installation of required fittings and system components.

Operation

⚠ WARNING **PUMP OPERATION IN LAKES, SWIMMING POOLS, OR OTHER OPEN BODIES OF WATER CAN CAUSE SHOCK, BURNS OR DEATH.**

Before operation, recheck the following items:
a) **ALL** electrical connections and grounds
b) Appropriate system shut-off valve settings
c) Appropriate pressure relief valve and check valve installations.

SINGLE PHASE MOTORS

1. Open one discharge line faucet and run the pump for one minute.
2. Close the faucet. The pump should stop when the system pressure reaches the pressure switch "cut-out" setting.
3. While observing the pressure gauge, open the faucet and note the gauge pressure reading when the pump starts.
4. Following the pressure switch manufacturer's instructions, adjust the pressure switch as required.

THREE PHASE MOTORS

⚠ WARNING **FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING SERVICE CAN CAUSE SHOCK, BURNS OR DEATH.**

NOTICE: **THREE PHASE INSTALLATIONS AND CURRENT UNBALANCE CHECKS SHOULD ONLY BE PERFORMED BY A QUALIFIED ELECTRICIAN.**

1. Check rotation
2. Check for current imbalance
3. Install "K" Type overload protection if using NEMA starters, or set adjustable overloads to match motor nameplate amps.

Current Reac[illegible] at Startup:

Phase 1: ______________________________

Phase 2: ______________________________

Phase 3: ______________________________

- The motor bearings are lubricated internally. No other motor or pump maintenance is required or possible.

Technical Data

MOTOR INSULATION RESISTANCE READINGS[1]

Normal Ohm/Megohm readings, ALL motors between all leads and ground

Condition of Motor and Leads	OHM Value	Megohm Value
New motor, without power cable	20,000,000 (or more)	20.0
Used motor, which can be reinstalled in well	10,000,000 (or more)	10.0
Motor in well – Readings are power cable plus motor		
New motor	2,000,000 (or more)	2.0
Motor in reasonably good condition	500,000 to 2,000,000	.5 – 2.0
Motor which may be damaged or have damaged power cable *Do not pull motor for these reasons*	20,000 to 500,000	.02 – 0.5
Motor definitely damaged or with damaged power cable *Pull motor and repair*	10,000 to 20,000	.01 – 0.02
Failed motor or power cable *Pull motor and repair*	Less than 10,000	0 – 0.01

[1] Courtesy of Franklin Electric Company

SINGLE PHASE – 60 HZ MOTOR SPECIFICATIONS

Type	Goulds Motor Model	Franklin Motor Model	HP	Volts	Hz	S.F.	Rated Input Amps[2]	Max S.F. Load Amps[2]	Line to Line[1] Resistance M = Main S = Start	Circuit Breaker/Fuse Amps Std	Circuit Breaker/Fuse Amps Delay	Control Box
4" Two Wire	S03932	2445020	1/3	115	60	1.75	8.0	9.2	1.4 – 1.8	25	10	N/R
	S03942	2445030	1/3	230	60	1.75	4.0	4.6	6.0 – 7.4	15	5	N/R
	S04932	2445040	1/2	115	60	1.60	10.0	12.0	1.0 – 1.3	30	15	N/R
	S04942	2445050	1/2	230	60	1.60	5.0	6.0	4.2 – 5.2	15	7	N/R
	S05942	2445070	3/4	230	60	1.50	7.2	8.4	3.0 – 3.6	25	10	N/R
	S06942	2445081	1	230	60	1.40	8.2	9.8	2.2 – 2.7	25	12	N/R
	S07942	2445091	1½	230	60	1.30	10.6	13.1	1.5 – 1.9	35	15	N/R
4" Three Wire	S03930	2145024	1/3	115	60	1.75	Y = 8.0 B = 8.0 R = 0.0	Y = 9.2 B = 9.2 R = 0.0	M = 1.4 – 1.8 S = 6.5 – 7.9	25	10	00033
	S03940	2145034	1/3	230	60	1.75	Y = 4.0 B = 4.0 R = 0.0	Y = 4.6 B = 4.6 R = 0.0	M = 6.0 – 7.4 S = 26.1 – 32.0	15	5	00034
	S04930	2145044	1/2	115	60	1.60	Y = 10.0 B = 10.0 R = 0.0	Y = 12.0 B = 12.0 R = 0.0	M = 1.0 – 1.3 S = 4.1 – 5.1	30	15	00043
	S04940	2145054	1/2	230	60	1.60	Y = 5.0 B = 5.0 R = 0.0	Y = 6.0 B = 6.0 R = 0.0	M = 4.2 – 5.2 S = 16.7 – 20.5	15	7	00044
	S05940	2145074	3/4	230	60	1.50	Y = 7.2 B = 7.2 R = 0.0	Y = 8.4 B = 8.4 R = 0.0	M = 3.0 – 3.6 S = 11.0 – 13.4	25	10	00054
	S06940	2145081	1	230	60	1.40	Y = 8.2 B = 8.2 R = 0.0	Y = 9.8 B = 9.8 R = 0.0	M = 2.2 – 2.7 S = 10.1 – 12.3	25	12	00064
4" Three Wire with RunCap	S07940	2243001	1½	230	60	1.30	Y = 10.0 B = 9.9 R = 1.3	Y = 11.6 B = 11.0 R = 1.3	M = 1.5 – 2.3 S = 6.2 – 12.0	30	15	00074
	S08940	2243011	2	230	60	1.25	Y = 10.0 B = 9.3 R = 2.6	Y = 13.2 B = 11.9 R = 2.6	M = 1.6 – 2.3 S = 5.2 – 7.15	30	15	00084
	S09940	2243027	3	230	60	1.15	Y = 14.0 B = 12.2 R = 4.7	Y = 17.0 B = 14.5 R = 4.5	M = 0.9 – 1.5 S = 3.0 – 4.9	45	20	00094
	S10940	2243037	5	230	60	1.15	Y = 23.0 B = 19.1 R = 8.0	Y = 27.5 B = 23.2 R = 7.8	M = 0.68 – 1.0 S = 2.1 – 2.8	70	30	00104

[1] M = Main Winding – Black to Yellow, S = Start Winding – Red to Yellow

[2] Yellow lead – line amps B = Black lead – main winding amps R = Red lead – start or auxiliary winding amps

Goulds Motor Model	Franklin Motor Model	HP	Volts	Hz	S.F.	Rated Input Amps	Max S.F. Load Amps	Line to Line Resistance	Circuit Breaker/ Fuse Amps Std	Circuit Breaker/ Fuse Amps Delay	Furnas® US/15 Starter	Furnas® US/15 Heater
S04978	2345014	½	200	60	1.6	2.8	3.7	6.64 – 7.3	10	5	BD	K32
S04970	2345114	½	230	60	1.6	2.3	2.9	9.5 – 10.4	8	4	BG	K29
S04975	2345213	½	460	60	1.6	1.2	1.6	38.4 – 41.6	4	2	BH	K21
S05978	2345024	¾	200	60	1.5	3.7	4.7	4.66 – 5.12	12	6	BD	K36
S05970	2345124	¾	230	60	1.5	3.3	4.1	7.24 – 7.84	11	5	BG	K33
S05975	2345223	¾	460	60	1.5	1.6	2.0	27.8 – 30.2	5	3	BH	K23
S06978	2345031	1	200	60	1.4	4.5	5.7	4.1 – 4.5	14	6	BD	K39
S06970	2345131	1	230	60	1.4	3.9	4.8	5.2 – 5.6	12	6	BG	K36
S06975	2345231	1	460	60	1.4	2.0	2.4	21.2 – 23.0	6	[illegible]	BH	K26
S07978	2345041	1½	200	60	1.3	6.1	7.3	2.4 – 3.4	20	[illegible]	BD	K43
S07970	2345141	1½	230	60	1.3	5.2	6.3	3.2 – 4.1	20	8	BG	K41
S07975	2345241	1½	460	60	1.3	2.6	3.1	11.3 – 15.0	15	4	BH	K29
S07979	2345341	1½	575	60	1.3	2.1	2.5	17.6 – 23.4	15	[illegible]	BI	K27
S08978	2343051	2	200	60	1.25	7.7	9.3	1.9 – 2.4	25	10	BD	K50
S08970	2343151	2	230	60	1.25	6.7	8.1	2.4 – 3.0	20	10	BG	K49
S08975	2343251	2	460	60	1.25	3.4	4.0	9.7 – 12.0	15	5	BH	K33
S08979	2343357	2	575	60	1.25	2.7	3.2	15.1 – 18.7	15	4	BE	K29
S09978	[illegible]	3	200	60	1.15	10.9	12.5	1.3 – 1.7	35	14	CD	K54
S09970	[illegible]	3	230	60	1.15	9.5	10.9	1.8 – 2.2	30	15	CG	K52
S09975	[illegible]	3	460	60	1.15	4.8	5.5	7.0 – 8.7	15	7	BH	K37
S09979	[illegible]	3	575	60	1.15	3.8	4.4	10.9 – 13.6	15	6	BI	K33
S10978	[illegible]	5	200	60	1.15	18.3	20.5	0.70 – 0.94	50	24	DD	K61
S10970	[illegible]	5	230	60	1.15	15.9	17.8	0.93 – 1.2	45	20	DG	K60
S10975	2343277	5	460	60	1.15	8.0	8.9	3.6 – 4.4	25	10	BH	K49
S10979	2343377	5	575	60	1.15	6.4	7.1	5.6 – 6.9	20	8	BI	K47
S119874	2343087	7½	200	60	1.15	26.5	30.5	0.46 – 0.57	80	35	[illegible]	K68
S119704	2343187	7½	230	60	1.15	23.0	26.4	0.61 – 0.75	70	30	[illegible]	K67
S119754	2343287	7½	460	60	1.15	11.5	13.2	2.4 – 3.4	35	15	[illegible]	[illegible]
S119794	2343387	7½	575	60	1.15	9.2	10.6	3.5 – 5.1	30	[illegible]	[illegible]	[illegible]

[illegible]

Troubleshooting

⚠WARNING

Hazardous voltage can shock, burn or cause death.

DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY SERVICE. FAILURE TO DO SO CAN CAUSE SHOCK, BURNS OR DEATH.

Symptom	Probable Cause	Recommended Action
PUMP MOTOR NOT RUNNING	1. Motor thermal protector tripped a. Incorrect control box b. Incorrect or faulty electrical connections c. Faulty thermal protector d. Low voltage e. Ambient temperature of control box/starter too high f. Pump bound by foreign matter g. Inadequate submergence	1. Allow motor to cool, thermal protector will automatically reset a – e. Have a qualified electrician inspect and repair, as required f. Pull pump, clean, adjust set depth as required g. Confirm adequate unit submergence in pumpage
	2. Open circuit breaker or blown fuse	2. Have a qualified electrician inspect and repair, as required
	3. Power source inadequate for load	3. Check supply or generator capacity
	4. Power cable insulation damage 5. Faulty power cable splice	4 – 5. Have a qualified electrician inspect and repair, as required
LITTLE OR NO LIQUID DELIVERED BY PUMP	1. Faulty or incorrectly installed check valve	1. Inspect check valve, repair as required
	2. Pump air bound	2. Successively start and stop pump until flow is delivered
	3. Lift too high for pump	3. Review unit performance, check with dealer
	4. Pump bound by foreign matter	4. Pull pump, clean, adjust set depth as required
	5. Pump not fully submerged	5. Check well recovery, lower pump if possible
	6. Well contains excessive amounts of air or gases	6. If successive starts and stops does not remedy, well contains excessive air or gases
	7. Excessive pump wear	7. Pull pump and repair as required
	8. Incorrect motor rotation – three phase only	8. Reverse any two motor electrical leads

ITT

Wastewater

Goulds Pumps
Wastewater Pumps
Dewatering, Effluent and Sewage

Installation, Operation and Maintainence Instructions

GOULDS PUMPS

Goulds Pumps is a brand of ITT Water Technology, Inc.
- a subsidiary of ITT Industries, Inc.

www.goulds.com

Engineered for life

Table of Contents

Owner's Information

Pump Model Number: 2ED51F1GA
Pump Serial Number: M0867019
Control Model Number: ______
Dealer: Pump Service and Supply of Troy, Inc.
Dealer Phone No. (518) 272-0388
Date of Purchase: 12\2008 Installation: ______

Current Readings at Startup:

1Ø	3Ø	L1-2	L2-3	L3-1
Amps: ______	Amps:	______	______	______
Volts: ______	Volts:	______	______	______

SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

This is a SAFETY ALERT SYMBOL. When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

DANGER Warns of hazards that WILL cause serious personal injury, death or major property damage.

WARNING Warns of hazards that CAN cause serious personal injury, death or major property damage.

CAUTION Warns of hazards that CAN cause personal injury or property damage.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

WARNING All electrical work must be performed by a qualified technician. Always follow the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial codes. Code questions should be directed to your local electrical inspector. Failure to follow electrical codes and OSHA safety standards may result in personal injury or equipment damage. Failure to follow manufacturer's installation instructions may result in electrical shock, fire hazard, personal injury or death, damaged equipment, provide unsatisfactory performance, and may void manufacturer's warranty.

WARNING Standard units are not designed for use in swimming pools, open bodies of water, hazardous liquids, or where flammable gases exist. These fluids and gases may be present in containment areas. Tank or wetwell must be vented per local codes.

Only pumps specifically Listed for Class 1, Division 1 are allowable in hazardous liquids and where flammable gases may exist. *See specific pump catalog bulletins or pump nameplate for all agency Listings.*

WARNING Disconnect and lockout electrical power before installing or servicing any electrical equipment. Many pumps are equipped with automatic thermal overload protection which may allow an overheated pump to restart unexpectedly.

CAUTION All three phase (3Ø) control panels for submersible pumps must provide Class 10, quick-trip, overload protection.

PRE-INSTALLATION CHECKS

Open all cartons and inspect for shipping damage. Report any damage to your supplier or shipping carrier immediately.

Important: Always verify that the pump nameplate Amps, Voltage, Phase and HP ratings match your control panel and power supply.

Many of our sewage pumps are oil-filled. If there are any signs of oil leakage or if the unit has been stored for an extended period check the oil level in the motor dome and the seal housing, if so equipped.

Check the motor cover oil level through the pipe plug on top of the unit. The motor chamber oil should just cover the motor. Do not overfill, leave room for expansion!

To check the seal housing oil level, where used, lay the unit on its side with the fill plug at 12 o'clock. Remove the plug. The oil should be within ½" (13mm) of the top. If low, refill with an ASTM 150 turbine oil. Replace the plug.

Oil is available in 5 gallon cans through our distributors. You can also source oil locally at motor repair shops. Typical oil brands are: Shell Turbo 32, Sunoco Sunvis 932, Texaco Regal R&O 32, Exxon Nuto 32 and Mobil DTE Light.

Check the strain relief nut on power cable strain assemblies. Power cables should be torqued to 75 in. lbs. for #16 cables and 80 in. lbs. for all other cable assemblies. Seal/heat sensor cables, where used, should be torqued to 75 in. lbs.

Warranty does not cover damage caused by connecting pumps and controls to an incorrect power source (voltage/phase supply).

Record the model numbers and serial numbers from the pumps and control panel on the front of this instruction manual for future reference. Give it to the owner or affix it to the control panel when finished with the installation.

LIFTING OF PUMP

WARNING

DO NOT LIFT, CARRY OR HANG PUMP BY THE ELECTRICAL CABLES. DAMAGE TO THE ELECTRICAL CABLES CAN CAUSE SHOCK, BURNS OR DEATH.

Lift the pump with an adequately sized chain or cable attached to the lifting eye bolt. DO NOT damage electrical and sensor cables while raising and lowering unit.

OPTIONAL GUIDE RAIL OR LIFT-OUT SYSTEM

In many effluent and sewage basins or lift stations it is advisable to install the pump on a guide rail system or on a lift-out adapter to facilitate installation and removal for inspection and/or service. Most codes do not allow personnel to enter a wetwell without the correct protective equipment and training. Guide rails are designed to allow easy removal of the pump without the need for entry into the wetwell or need to disturb piping. The guide rail or lift-out adapter should locate the pump opposite the influent opening preventing stagnate areas where solids can settle. The basin or pit must be capable of supporting the weight of the pump and guide rail. The pit floor must be flat.

NOTICE: FOLLOW THE INSTRUCTIONS THAT ARE PROVIDED WITH THE GUIDE RAIL ASSEMBLY.

PIPING

Discharge piping should be no smaller than the pump discharge diameter and kept as short as possible, avoiding unnecessary fittings to minimize friction losses.

Install an adequately sized check valve matched to the solids handling capability of the pump to prevent fluid backflow. Backflow can allow the pump to "turbine" backwards and may cause premature seal and/or bearing wear. If the pump is turning backwards when it is called on to start the increased torque may cause damage to the pump motor and/or motor shaft and some single-phase pumps may actually run backwards.

Install an adequately sized gate valve **AFTER** the check valve for pump, plumbing and check valve maintenance.

Important – Before pump installation. Drill a $^3/_{16}$" (4.8mm) relief hole in the discharge pipe. It should be located within the wetwell, 2" (51mm) above the pump discharge but below the check valve. The relief hole allows any air to escape from the casing. Allowing liquid into the casing will insure that the pump can start when the liquid level rises. Unless a relief hole is provided, a bottom intake pump could "air lock" and will not pump water even though the impeller turns.

All piping must be adequately supported, so as not to impart any piping strain or loads on the pump.

The pit access cover must be of sufficient size to allow for inspection, maintenance and crane or hoist service.

WIRING AND GROUNDING

Important notice: Read Safety Instructions before proceeding with any wiring.

⚠ Use only stranded copper wire to pump/motor and ground. The ground wire must be at least as large as the power supply wires. Wires should be color coded for ease of maintenance and troubleshooting.

⚠ Install wire and ground according to the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial codes.

⚠ Install an all leg disconnect switch where required by code.

⚠ Disconnect and lockout electrical power before performing any service or installation.

⚠ The electrical supply voltage and phase must match all equipment requirements. Incorrect voltage or phase can cause fire, motor and control damage, and voids the warranty.

⚠ All splices must be waterproof. If using splice kits follow manufacturer's instructions.

⚠ WARNING Select the correct type and NEMA grade junction box for the application and location. The junction box must insure dry, safe wiring connections.

⚠ WARNING Seal all controls from gases present which may damage electrical components.

⚠ WARNING Hazardous voltage **FAILURE TO PERMANENTLY GROUND THE PUMP, MOTOR AND CONTROLS BEFORE CONNECTING TO POWER CAN CAUSE SHOCK, BURNS OR DEATH.**

SELECTING AND WIRING PUMP CONTROL PANELS AND SWITCHES

FLOAT SWITCH TYPES

There are two basic float switch designs; single-action and wide-angle. Single-action switches operate over a range of 15° so they open and close quickly. Wide-angle floats operate over a 90° swing with the tether length between the float body and the pivot point controlling the On-Off range. The design determines how many floats are required with different systems or controls.

Floats may be normally open (NO) for pump down applications or to empty a tank. Normally closed (NC) switches are used to pump up or to fill a tank.

A single-action control switch may be used only with a control panel, never direct connected to a pump.

The wide-angle, pump down switches may be used as direct connected pump switches or as control switches.

SETTING THE FLOAT SWITCHES

There are no absolute rules for where to set the float switches, it varies from job to job.

Suggested Rules to Follow:
All floats should be set below the Inlet pipe!

Off Float: Best: set so the water level is always above the top of the pump (motor dome). **Next Best:** set so the water level is not more than 6" below the top of the pump.

On Float: set so the volume of water between the On and Off floats allows pumps of 1½ HP and under to operate for 1 minute minimum. Two (2) HP and larger pumps should run a minimum of 2 minutes. Basin literature states the gallons of storage per inch of basin height.

Lag/Alarm Float(s): should be staggered above the Off and On floats. Try to use most of the available storage provided by the basin, save some space for reserve storage capacity. *See Diagrams and Charts in Float Switch Chart Section.*

PANEL WIRING DIAGRAMS

Our control panels are shipped with instructions and wiring diagrams. Use those instructions in conjunction with this IOM. Electrical installation should be performed only by qualified technicians. Any problem or questions pertaining to another brand control must be referred to that control supplier or manufacturer. Our technical people have no technical schematics or trouble shooting information for other companies' controls.

ALARMS

We recommend the installation of an alarm on all Wastewater pump installations. Many standard control panels come equipped with alarm circuits. If a control panel is not used, a stand alone high liquid level alarm is available. The alarm alerts the owner of a high liquid level in the system so they can contact the appropriate service personnel to investigate the situation.

SINGLE PHASE PUMPS

Single phase (1Ø) pumps may be operated using a piggyback or hard wired float switch, a contactor, or a Simplex or Duplex control panel. *See Figures 1, 2 and 5.*

All ⅓ and ½ HP, 115 or 230 volt pumps, and some ¾ and 1 HP pumps, are supplied with plug style power cords. They may be plugged into piggyback float switches for simple installations. It is allowable to remove the plugs in order to hardwire or connect to a Simplex or Duplex controller. Removing the plug neither voids the warranty nor violates the agency Listings. *See Figure 5.*

PLUG-CONNECTED UNITS MUST BE CONNECTED TO A PROPERLY GROUNDED, GROUNDING TYPE RECEPTACLE.

ON NON-PLUG UNITS, DO NOT REMOVE CORD AND STRAIN RELIEF. DO NOT CONNECT CONDUIT TO PUMP.

Pumps with bare lead power cords can be hard-wired to a float switch, wired to a 1Ø contactor, a Simplex controller or a Duplex controller. Always verify that the float switch is rated for the maximum run amperage, maximum starting amperage, and the HP rating on the pump. Single-phase wastewater pumps contain on-winding overloads, unless noted on the pump nameplate. *See Figures 1 and 2.*

THREE PHASE PUMPS:

As a Minimum a 3Ø pump requires a 3 pole circuit breaker/fused circuit, an across the line magnetic starter rated for the pump HP, and ambient compensated Quick Trip Class 10 overloads.

SINGLE AND THREE PHASE CONTROL PANELS:

Control panels are available as Simplex (controls 1 pump) or Duplex (controls 2 pumps). Our standard SES Series Panels are available with many standard features and can be built with our most popular options. We also custom build panels which offer many more design options than the SES panels. Custom control panels are available in many different configurations. Custom panel quote requests may be forwarded to Customer Service through any authorized distributor.

Our "SES" Duplex panels feature a solid-state printed circuit board design with standard high level alarm circuits. Other standard features are: an auxiliary dry alarm contact for signaling a remote alarm and float switch position indicator lights. Our 3Ø panels have built-in, adjustable, Class 10 overloads. The adjustable overloads on all our 3Ø panels mean less labor for the installer and no need to order specific overloads. Most SES panels are in stock for immediate delivery.

On pumps equipped with seal fail and/or heat (high temperature) sensors it is recommended that you use our control panel with the appropriate options. The pump sensors do not function without a seal fail relay or terminal connection in the control panel and a warning device such as a bell, horn or light.

Seal Failure Circuit - Some dual seal pumps are equipped with a standard, built-in seal failure circuit, which may also be called a moisture detection circuit. This circuit must be connected to a control panel with an optional seal fail relay. The panel must be special ordered with the seal fail relay and alarm. There are also stand alone seal fail panels such as the A4-3 or A4-4 available as standard items. The pumps can be identified by an extra control cable exiting the motor cover. The cable contains two wires, a black wire, connects to panel "terminal" going to "probe"; and a white wire, connects to the panel "terminal" going to the relay ground. Do not connect to the panel ground screw. Follow the wiring instructions supplied with the panel.

Heat Sensor and Seal Failure Circuit - Some pumps are equipped with a seal fail and normally closed, on-winding high temperature thermostats (heat sensors). The pumps have a control cable with four (4) leads, black (probe) and green (relay ground) for the seal fail circuit and red and white for the high temperature circuit. Connect the high temperature (heat sensor) circuit to the panel terminal strip as indicated on the panel drawing using the red and white wires. The high temperature panel circuit is also an optional item which you must specifically order when you order your control panel. The high temperature circuit is different from the Class 10 overloads which are always required on three phase pumps. *Follow the wiring instructions supplied with the panel.*

INSTALLATION

Connect the pump(s) to the guide rail pump adapters or to the discharge piping. Slide rail bases should be anchored to the wetwell floor.

Complete all wiring per the control panel wiring diagrams and NEC, Canadian, state, provincial and/or local codes. This a good time to check for proper rotation of the motors/impellers.

DO NOT PLACE HANDS IN PUMP SUCTION WHILE CHECKING MOTOR ROTATION. TO DO SO WILL CAUSE SEVERE PERSONAL INJURY.

Always verify correct rotation. Correct rotation is indicated on the pump casing. Three phase motors are reversible. It is allowable to bump or jog the motor for a few seconds to check impeller rotation. It is easier to check rotation before installing the pump. Switch any two power leads to reverse rotation.

Lower the pump(s) into the wetwell.

Check to insure that the floats will operate freely and not contact the piping.

OPERATION

Once the piping connections are made and checked you can run the pumps.

Piggyback Switch Operation – Plug the piggyback switch into a dedicated grounded outlet and then plug the pump into the switch. Test the pump by filling the wetwell until the pump goes On. If the pumps run but fail to pump, they are probably air locked, drill the relief holes per the instructions in the Piping Section.

Check the operating range to insure a minimum one minute run time and that the pump goes Off in the correct position.

Control Panel Operation – Fill the wetwell with clear water.

Use the pump H-O-A (Hand-Off-Automatic) switches in Hand to test the pumps. If they operate well in Hand proceed to test Automatic operation. If the pumps run but fail to pump, they are probably air locked, drill the relief holes per the instructions in the Piping Section.

Place Control Panel switch(es) in Automatic position and thoroughly test the operation of the ON, OFF, and Alarm floats by filling the wetwell with clear water. **Important:** Failure to provide a Neutral from the power supply to a 1Ø, 230 volt Control Panel will not allow the panel control circuit to operate. The Neutral is necessary to complete the 115 volt control circuit.

Check voltage and amperage and record the data on the front of this manual for future reference. Compare the amperage readings to the pump nameplate maximum amperage. If higher than nameplate amperage investigate cause. Operating the pump off the curve, i.e. with too little head or with high or low voltage will increase amperage. The motor will operate properly with voltage not more than 10% above or below pump nameplate ratings. Performance within this range will not necessarily be the same as the published performance at the exact rated nameplate frequency and voltage. Correct the problem before proceeding. Three phase unbalance is also a possible cause. *See Three Phase Power Unbalance and follow the instructions.*

Reset the Alarm circuit, place pump switch(es) in the Automatic position and Control Switch in ON position. The system is now ready for automatic operation.

Explain the operation of the pumps, controls and alarms to the end user. Leave the paperwork with the owner or at the control panel if in a dry, secure location.

FLOAT SWITCH AND PANEL CHART

The purpose of this chart is to show the required switch quantities and the function of each switch in a typical wastewater system. The quantities required vary depending on the switch type, single-action or wide-angle. Switch quantities also vary by panel type: simplex with and without alarms, and duplex with alarms.

Duplex Panels using single-action switches:

Three Float Panel Wiring

SW1	Bottom	Pumps Off
SW2	Middle	1st Pump On
SW3	Top	2nd Pump & Alarm On

Four Float Panel Wiring ②

SW1	Bottom	Pumps Off
SW2	2nd	1st Pump On
SW3	3rd	2nd Pump On
SW4	Top	Alarm On

Duplex Panels using wide-angle switches:

Three Float Panel Wiring

SW1	Bottom	1st Pump On/Both Off
SW2	Top	2nd Pump & Alarm On

Four Float Panel Wiring

SW1	Bottom	1st Pump On/Both Off
SW2	Middle	2nd Pump On
SW3	Top	Alarm On

Simplex Panel using single-action switches:

Simplex Panel with Alarm ①

SW1	Bottom	Pump Off
SW2	Middle	Pump On
	SW3	Top Alarm On/Off

Simplex Panel with No Alarm

SW1	Bottom	Pump Off
SW2	Top	Pump On

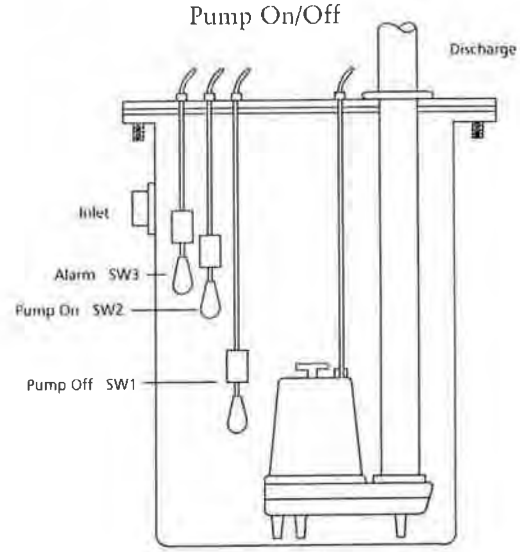
Simplex Panel using wide-angle switches:

Simplex Panel with Alarm

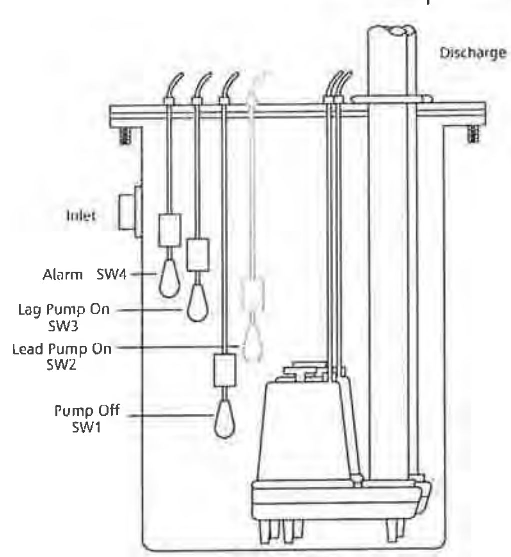
SW1	Bottom	Pump On/Off
SW2	Top	Alarm On/Off

Simplex Panel with No Alarm

SW1		Pump On/Off



Simplex ①



Duplex ②

THREE PHASE POWER UNBALANCE

A full three phase supply consisting of three individual transformers or one three phase transformer is recommended. “Open” delta or wye connections using only two transformers can be used, but are more likely to cause poor performance, overload tripping or early motor failure due to current unbalance.

Check the current in each of the three motor leads and calculate the current unbalance as explained below.

If the current unbalance is 2% or less, leave the leads as connected.

If the current unbalance is more than 2%, current readings should be checked on each leg using each of the three possible hook-ups. Roll the motor leads across the starter in the same direction to prevent motor reversal.

To calculate percent of current unbalance:

A. Add the three line amp values together.

B. Divide the sum by three, yielding average current.

C. Pick the amp value which is furthest from the average current (either high or low).

D. Determine the difference between this amp value (furthest from average) and the average.

E. Divide the difference by the average. Multiply the result by 100 to determine percent of unbalance.

Current unbalance should not exceed 5% at service factor load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg farthest from the average stays on the same power lead, most of the unbalance is coming from the power source.

Contact your local power company to resolve the imbalance.

	Hookup 1			Hookup 2			Hookup 3		
Starter Terminals	L1	L2	L3	L1	L2	L3	L1	L2	L3
	⊥	⊥	⊥	⊥	⊥	⊥	⊥	⊥	⊥
	T	T	T	T	T	T	T	T	T
Motor Leads	R	B	W	W	R	B	B	W	R
	T3	T1	T2	T2	T3	T1	T1	T2	T3

Example:

Hookup 1	Hookup 2	Hookup 3
T3-R = 51 amps	T2-W = 50 amps	T1-B = 50 amps
T1-B = 46 amps	T3-R = 48 amps	T2-W = 49 amps
T2-W = 53 amps	T1-B = 52 amps	T3-R = 51 amps
Total = 150 amps	Total = 150 amps	Total = 150 amps
÷ 3 = 50 amps	÷ 3 = 50 amps	÷ 3 = 50 amps
− 46 = 4 amps	− 48 = 2 amps	− 49 = 1 amps
4 ÷ 50 = .08 or 8%	2 ÷ 50 = .04 or 4%	1 ÷ 50 = .02 or 2%

INSULATION RESISTANCE READINGS

Normal Ohm and Megohm Values between all leads and ground

Condition of Motor and Leads	Ohm Value	Megohm Value
A new motor (without drop cable).	20,000,000 (or more)	20 (or more)
A used motor which can be reinstalled in well.	10,000,000 (or more)	10 (or more)
Motor in well. Readings are for drop cable plus motor.		
New motor.	2,000,000 (or more)	2 (or more)
Motor in good condition.	500,000 - 2,000,000	.5 - 2
Insulation damage, locate and repair.	Less than 500,000	Less than .5

Insulation resistance varies very little with rating. Motors of all HP, voltage and phase ratings have similar values of insulation resistance.

Insulation resistance values above are based on readings taken with a megohmmeter with a 500V DC output. Readings may vary using a lower voltage ohmmeter, consult factory if readings are in question.

Engineering data for specific models may be found in your catalog and on our website (address is on the cover).

Control panel wiring diagrams are shipped with the control panels. Please use the control panel drawings in conjunction with this instruction manual to complete the wiring.

PUMP OPERATION			
Minimum Submergence		**Maximum Fluid Temperature**	
Continuous Duty	Fully Submerged	Continuous Operation	104° F 40° C
Intermittent Duty	6" Below Top of Motor	Intermittent Operation	140° F 60° C

Pumpmaster and Pumpmaster Plus - Hard Wired

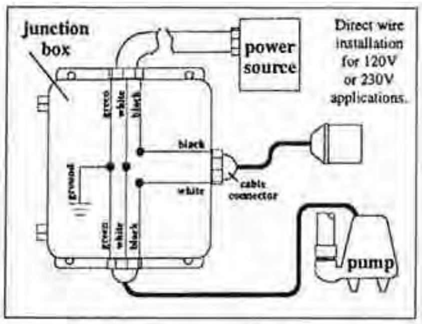


Figure 1

Single-Action Float Switch
"Typical" Installation

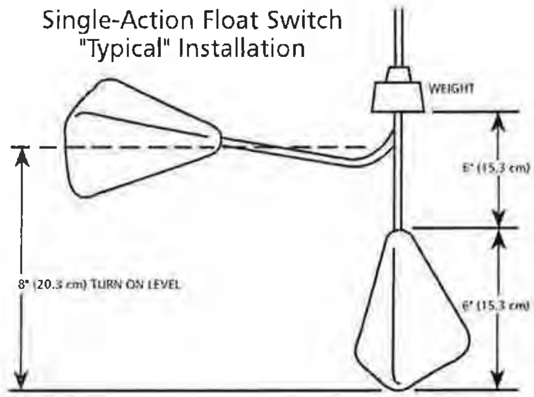


Figure 4

Double Float - Hard Wired

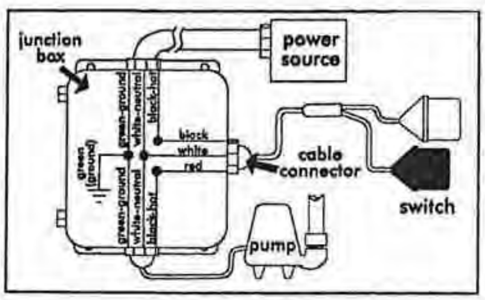


Figure 2

Wide-Angle Float Switch

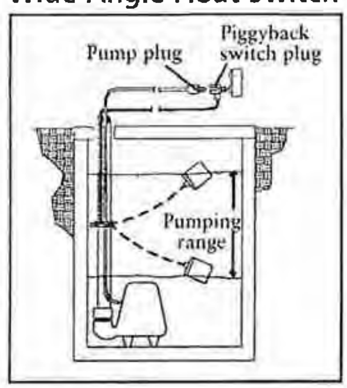


Figure 5

Determining Pumping Range

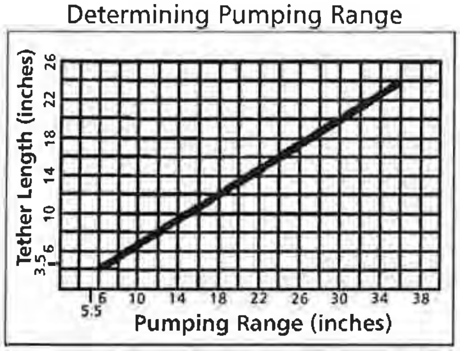


Figure 3

Three Phase Connection Diagram

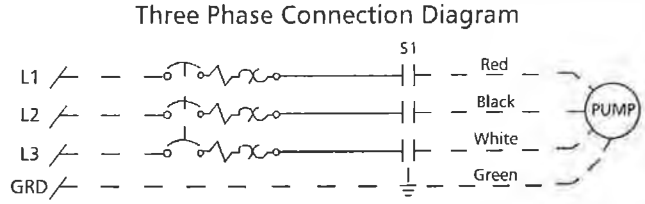
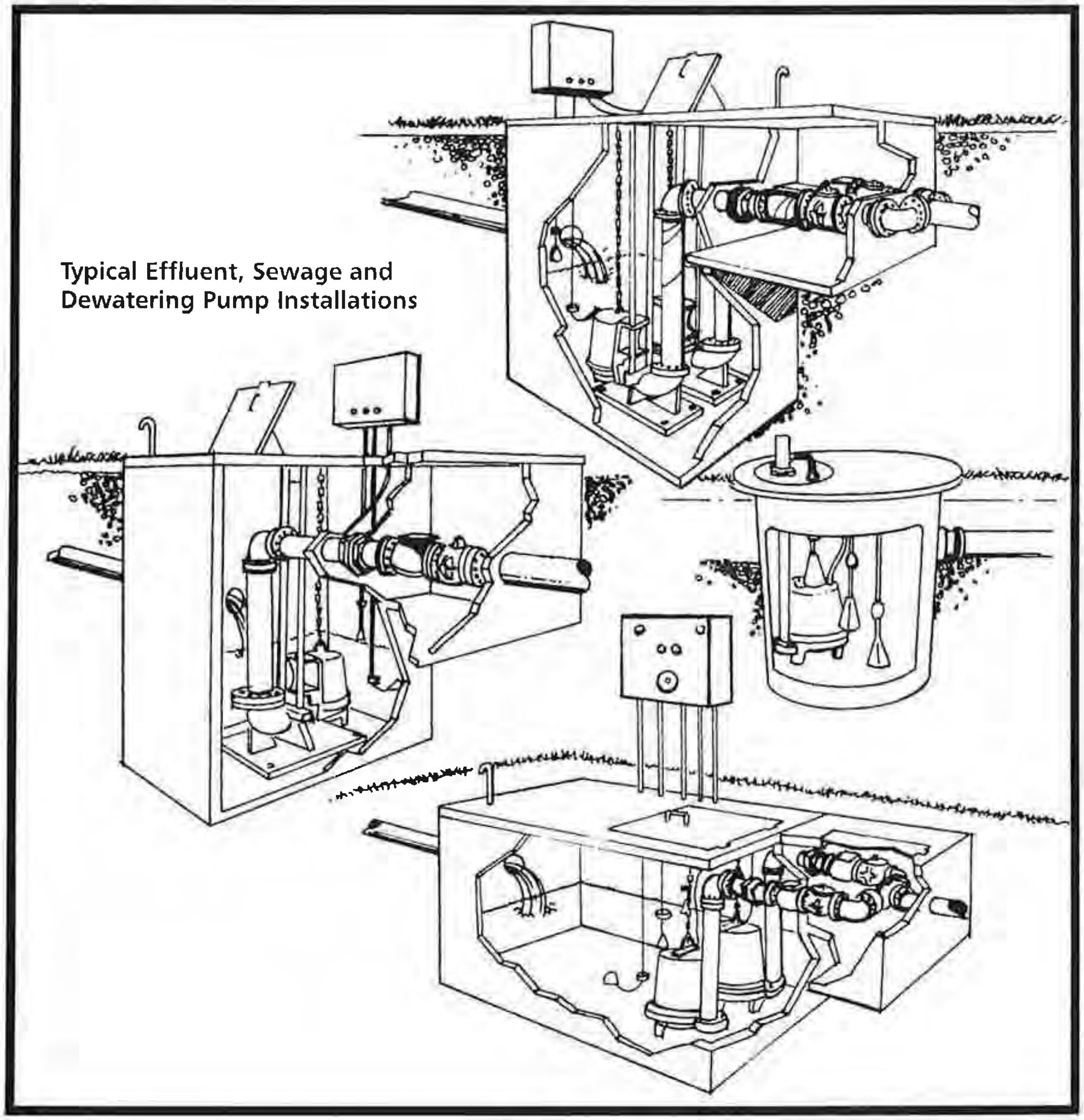


Figure 6

⚠WARNING Hazardous voltage

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY SERVICE CAN CAUSE SHOCK, BURNS OR DEATH.

SYMPTOM	PROBABLE CAUSE	RECOMMENDED ACTION
MOTOR NOT RUNNING	Motor thermal protector tripped.	Allow motor to cool. Insure minimum pump submergence. Clear debris from casing and impeller.
NOTE: If circuit breaker "OPENS" repeatedly, DO NOT reset. Call qualified electrician.	Open circuit breaker or blown fuse.	Determine cause, call a qualified electrician.
	Pump impeller binding or jammed.	Check motor amp draw. If two or more times higher than listed on pump nameplate, impeller is locked, motor bearings or shaft is damaged. Clear debris from casing and impeller, consult with dealer.
a) Manual operation	Power cable is damaged.	
	Inadequate electrical connection in control panel.	Resistance between power leads and ground should read infinity. If any reading is incorrect, call a qualified electrician.
b) Automatic operation	No neutral wire connected to control panel.	
	Inadequate electrical connection in control panel.	Inspect control panel wiring. Call a qualified electrician.
NOTE: Check the pump in manual mode first to confirm operation. If pump operates, the automatic control or wiring is at fault. If pump does not operate, see above.	Defective liquid level switch.	With switch disconnected, check continuity while activating liquid level switch. Replace switch, as required.
	Insufficient liquid level to activate controls.	Allow liquid level to rise 3" to 4" (76 mm - 101 mm) above turn-on level.
	Liquid level cords tangled.	Untangle cords and insure free operation.
PUMP WILL NOT TURN OFF	Liquid level cords tangled.	Untangle cords and insure free operation.
	Pump is air locked.	Shut off pump for approximately one minute, then restart. Repeat until air lock clears. If air locking persists in a system with a check valve, a 3/16" (4.8 mm) hole may be drilled in the discharge pipe approximately 2" (51 mm) above the discharge connection.
	Influent flow is matching pump's discharge capacity.	Larger pump may be required.
LITTLE OR NO LIQUID DELIVERED BY PUMP	Check valve installed backwards, plugged or stuck closed.	Check flow arrow on valve and check valve operation.
	Excessive system head.	Consult with dealer.
	Pump inlet plugged.	Inspect and clear as required.
	Improper voltage or wired incorrectly.	Check pump rotation, voltage and wiring. Consult with qualified electrician.
	Pump is air locked.	See recommended action, above.
	Impeller is worn or damaged.	Inspect impeller, replace as required.
	Liquid level controls defective or improperly positioned.	Inspect, readjust or replace as required.
PUMP CYCLES CONSTANTLY	Discharge check valve inoperative.	Inspect, repair or replace as required.
	Sewage containment area too small.	Consult with dealer.
	Liquid level controls defective or improperly positioned.	Inspect, readjust or replace as required.
	Influent excessive for this size pump.	Consult with dealer.



Typical Effluent, Sewage and Dewatering Pump Installations

ITT

Wastewater

GOULDS PUMPS LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by Goulds Pumps.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Goulds Pumps distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Goulds Pumps Customer Service Department.

The warranty excludes:

(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:

(1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Goulds Pumps and the dealer in purchases, consignments or contracts for sale of the subject pumps.
(2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
(3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

THIS WARRANTY EXTENDS TO THE DEALER ONLY.

GOULDS PUMPS

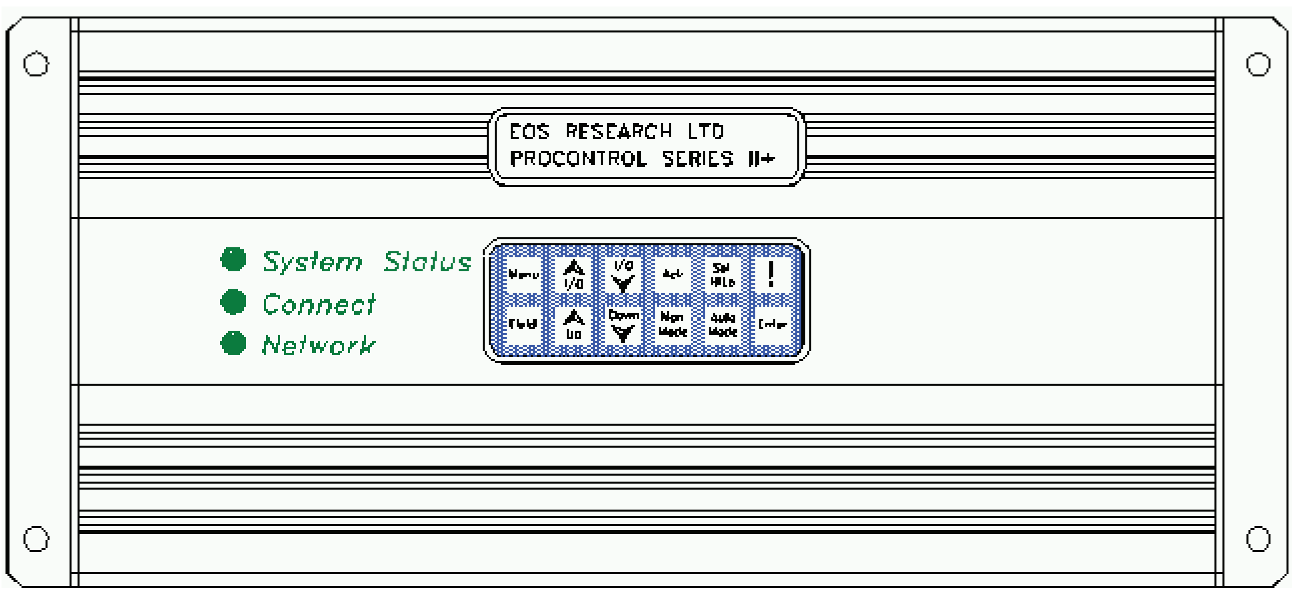
SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

IM107R03 March, 2006

Engineered for life

PROCONTROL

SERIES 2*plus* USER MANUAL



Version 2.X

LIMITED WARRANTY

EOS Research Ltd. (EOS) warrants its products to be free from defects in materials and workmanship for a period of one year from the date of purchase. Its obligation under this warranty is limited to repairing or replacing, at its sole option, any such defective products. This warranty includes parts and labor. This warranty does not apply to equipment which has been damaged by accident, negligence or misapplication or has been altered or modified in any way.

EXCEPT AS PROVIDED HEREIN, EOS RESEARCH LTD. MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MECHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Some states do not permit limitation or exclusion of implied warranties, therefore the aforesaid limitation(s) or exclusion(s) may not apply to the purchaser.

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

IMPORTANT SAFETY PRECAUTIONS

Any complex hardware or software may be difficult to document, explain or understand. It is important to consider the consequences or unexpected or abnormal behavior which may be caused by a defect or human failure to comprehend. In order to protect people and property from damage, a thorough safety analysis should always be performed. When the consequences of a failure are serious, it is essential to protect life and property against such a failure with redundant backup systems or safety devices. It is agreed between the purchaser and EOS Research Ltd. that protection against and the consequences of any such failure are entirely the purchaser's responsibility.

This device is not approved for use in life support or medical systems.

As installed, this product may be part of a system which is required to meet various electrical, fire, safety or other codes and regulations. Compliance with these codes is the purchaser's responsibility.

Specifications subject to change without notice.

EOS Research Ltd.
159 Walnut Street
Rochester, NH 03867
603.332.2099
Fax: 603.332.2727
procontrol@eosresearch.com

TABLE OF CONTENTS

Please see the ProView manual for operation of the remote access software which is supplied with the ProControl Series **2*plus***.

1.0 SYSTEM OVERVIEW

1.1 General

The *ProControl Series* **2*plus*** is a small but powerful microprocessor based control/ telemonitoring system. By combining a control panel and remote monitor in one unit, the Series **2*plus*** can act as a central supervisory and data management tool for any stand-alone operation. The *ProControl Series* **2*plus*** can perform multiple tasks:

- **Stand-Alone Control:** The *ProControl Series* **2*plus*** is a sophisticated programmable logic controller that will efficiently supervise and control your operation. It can interface with up to 70 electrical devices (float switches, pressure transducers, pH transmitters, flow meters, pumps, blowers, etc.), and execute numerous control functions simultaneously. Automatic shutdown routines can be programmed in to protect you operation during alarm conditions. It is extremely versatile in terms of the control algorithms it can execute.

- **Remote Control and Monitoring:** The *ProControl Series* **2*plus*** gives you a window into your operation from any remote location, using the easy-to-use Windows-based software supplied with the system. You communicate with the ProControl over a modem link, which allows you to view all of your system's operating conditions, while also providing the same access to control functions that you would have if you were at the site (e.g., turning pumps on and off, adjusting alarm setpoints, etc.). No other telemonitoring device gives you the ProControl's level of remote control capability.

- **Reporting:** The *ProControl Series* **2*plus*** will <u>keep you informed</u>. It will send you periodic fax status reports of your project operations on a schedule specified by you, and will alert you immediately either by fax or by numeric or alpha-numeric pager if an alarm condition warrants attention. No longer do you have to assume what's happening at your remote operation.....the ProControl will tell you exactly.

- **Datalogging:** The *ProControl Series* **2*plus*** is your information manager. It is a powerful datalogger that automatically records all operating conditions in its battery-backed memory. You can access your logged data remotely at any time, and download it to your office computer for further processing. The datalogging capability is an invaluable tool for reporting purposes, troubleshooting, and trend graphing.

One or more of these features can be used in your installation; they are standard in every ProControl unit.

1.2 Key Concepts

The following are the building blocks of any Series **2*plus*** monitoring and control system.

Inputs and Outputs (I/O's)

No system can be effective in the real world without communication and one of the principal ways the ProControl communicates is by responding to information collected by sensors and by issuing "commands" to other electronic or electrical devices. Sensor information constitutes an *Input* while a "command" to another device constitutes an *Output*. The Series **2*plus*** works with all of the more important types of I/O devices in general use. Appendix A demonstrates how a variety of I/O devices are connected to the ProControl.

Digital Inputs

These inputs are designed to detect the closure of switch contacts such as those found on float switches or overpressure sensors. They can respond to any normally open or normally closed dry contact. The Series **2*plus*** provides its own wetting (supply) voltage of 5 volts DC for each digital input circuit. The Series **2*plus*** can respond to changes in state as fast as 4 Hz or 3 Hz (cycles per second) depending on the model purchased. Digital inputs are "debounced" for 125 or 150 milliseconds, respectively. This means that a switch or other input that changes state (becomes open or closed) must stay in that state for 125 or 150 milliseconds before the Series **2*plus*** will respond to the change.

Eight high-speed digital inputs can also be used for traditional digital (pulse-output) flow meters. These inputs can detect signal changes at up to a 200/500 Hz rate. All high-speed digital inputs are "debounced" for 1250/500 microseconds. The faster rate applies only to those systems containing the 18.432 MHz processor.

Analog Inputs

These inputs are compatible with sensors which send out a 4 - 20 milliamp (mA) signal. Most analog sensors are available with this type of signal, examples being pressure transducers, pH transmitters, and many flow meters. These inputs allow the operator to read the actual "value" of a parameter, such as pressure, instead of an on/off signal.

Digital Outputs

Digital outputs turn things like pumps, solenoid valves, and alarm lights on and off. The Series **2*plus*** digital outputs are relay outputs designed to switch small loads directly, such as motor starters, lamps, and solenoid valves.

Analog Outputs

Analog outputs are typically used in process control schemes where a controlled piece of equipment can accept a signal which is variable over a range. This output is expressed as a percentage (0 - 100%) and is used to control pump speeds, chemical dosing rates, etc., instead of conventional on/off operation. The equipment that the ProControl sends the analog output to must accept a 4 - 20 mA signal. Often, an analog output is used in conjunction with an analog input such as a pH transmitter to form a control scheme known as *feedback control*. In essence, the input and output will work together to maintain a user set input level. This concept is described further in the next section under *Analog Output Processes*.

Tagnames

Each input and output is given a descriptive *Tagname* by the user that uniquely identifies it to the system operator. For instance, a digital input could be called "TANKHI", an analog input could be called "AIRFLO" and a digital output could be called "PUMP_1". This tagname is used by the local LCD display, the FAX report and by the ProView software. The analog inputs are also given a *Units Tagname* which identifies the unit of measure associated with the input sensor. Each tagname can be up to six characters long and each units tagname can be up to three characters long ("PSI", for instance). The tagnames can include the uppercase letters A-Z, the numbers 0-9, a blank space, and the underscore (_) character.

1.3 Control Basics

The status of all inputs or outputs can easily be monitored both locally and remotely. What gives the Series **2*plus*** its real power, however, is the ability to automatically initiate actions based on the status of the inputs and your pre-programmed instructions (this is often called *Process Control*). These actions can include switching certain outputs, faxing back a report, sending an alphanumeric or numeric page, shutting down the entire system or sounding the local alarm. Process control functions are programmed into your ProControl by EOS Research or one of our technology partners according to your specifications.

Active State

Central to the use of control on the Series $\mathbf{2}^{\mathit{plus}}$ is the concept of *Active State*. Each input on the ProControl receives certain signals from a sensor which constitute "normal" operation and other signals which constitute an exception to normal operation.

A digital input can monitor only two states, ON or OFF (alternatively, CLOSED or OPEN). The *Active State* would be the state in which the controller would respond to the digital input, and perform certain actions or generate an alarm. For example, if a high level float switch in a tank is tripped (turned ON) by rising fluid level, we can say that its *Active State* correlates to a situation in which the fluid level is high. The active state of the float switch could cause the Series $\mathbf{2}^{\mathit{plus}}$ to trigger an alarm, turn off a pump, or initiate some other action. The Series $\mathbf{2}^{\mathit{plus}}$ can be set up so that either ON or OFF is the active state.

An analog input sensor can take on many states (or values) between the minimum and maximum of its measurement range. The ProControl operator, however, can set two threshold values which divide the total input span into two functional regions. These threshold values are more commonly called the *Low Alarm Limit* and the *High Alarm Limit*, although on the Series $\mathbf{2}^{\mathit{plus}}$ these thresholds are somewhat more flexible in use than those names imply. An analog input which has transcended either its Low Alarm Limit or High Alarm Limit is said to be in its active state.

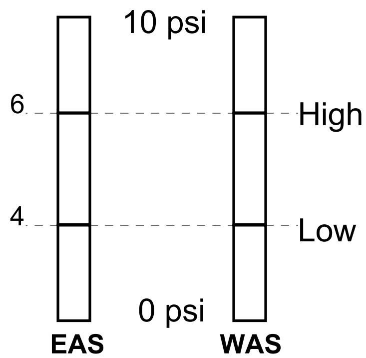


Figure 1. Active State

For instance, consider an analog input sensor which measures pressure from 0 to 10 PSI. The system operator could set the low limit to 4 PSI and the high limit to 6 PSI. In this case the *Active State* would usually be considered as the input state greater than 6 PSI or less than 4 PSI. This interpretation is called *Endpoint Active State* (EAS) on the Series $\mathbf{2}^{\mathit{plus}}$ because the endpoints of the range are the areas which need to trigger action or generate alarms. The opposite interpretation is also possible and is called *Window Active State* (WAS). Any input values between 4 PSI and 6 PSI would trigger action or generate alarms.

If the ProControl has *Alarms Set*, when any input enters its active state, a local beeper will sound on the ProControl. The word *Alarm* here applies only to the sounding of a local beeper and is not associated with any process control. The active state condition is indicated on the LCD display and can be acknowledged by the operator. The beeper is silenced when it has been acknowledged or after 30 seconds have elapsed. The beeper only operates when the system is operating in Manual mode.

Startup Sequence

The *Startup Sequence* is a series of control algorithms or steps which run in succession and which are designed to place the system in its normal operating mode. It can be as simple as turning all the outputs on simultaneously, or as complex as a multi-stage delay with many conditions. Up to 8 or 16 individual startup steps can be declared depending on the model of the controller. The ProControl can be configured to automatically run this sequence when the unit is powered up.

Process Tasks

A *Process Task* is an ongoing control algorithm which runs continuously. Think of each process task as an IF-THEN statement, in which an action is initiated if a certain condition or combination of conditions exists. Some examples are:

- IF Tank Level Sensor 2 is on, THEN turn Pump 2 off
- IF Air Flow Rate < 10 cfm AND Reactor Temperature > 250°, THEN open Bleed Valve 2

Up to 16 or 64 separate process tasks can be run simultaneously depending on the model of the controller. Process tasks can trigger FAX reports, pager alerts, and system shutdowns.

Shutdown Sequence

The *Shutdown Sequence* is a series of control steps which run in succession and which are designed to shut your system down in a manner which is best for the equipment or treatment processes involved. The shutdown sequence can be activated manually or automatically due to an alarm condition. Here is a typical shutdown sequence:

- Turn off Well Pumps 1 and 2
- Wait 5 minutes, then turn off Stripper Blower
- Open Bleed Valve 2
- When Oxidizer Temperature < 150°, turn off SVE Blower

Automatic Operation

The use of the startup sequence, process tasks, and the shutdown sequence constitutes *Automatic Operation* of your system with the ProControl Series **2*plus*** (otherwise known as *Auto Mode*). The Series **2*plus*** will be placed into auto mode (automatically) when your system has been started up using the programmed startup sequence. If one condition of the programmed startup sequence is not met during the startup process, your system will be completely shut down by the ProControl as a safety measure. Once the startup sequence has been successfully completed, the ProControl begins running the process tasks continuously. **PROCESS TASKS WILL RUN ONLY WHEN IN AUTO MODE**. Please note that the audible beeper will not sound even if the ProControl has *Alarms Set* when it is in Auto Mode, since the process tasks will control these situations as the user has specified.

Manual Operation

You can override the Series **2***plus* programmed control functions by operating in *Manual Mode*. In manual mode, your process will respond only to operator input from the keypad of the ProControl, or to commands issued from the ProView software. **PLEASE NOTE THAT PROCESS TASKS AND THEIR ERROR-CHECKING MECHANISMS DO NOT RUN DURING MANUAL MODE!** Manual mode is useful when you wish to troubleshoot your system, but none of the system safeguards built into auto mode are available. You can place your operation into auto mode any time by issuing the command from the keypad.

Analog Output Processes

In some cases, you may want to use an analog output to control equipment that maintains an analog input at a certain constant level. For example, you may wish to automatically maintain a pH of 8.5 in a reaction tank by varying the dosing rate of a chemical feed pump. The pH you wish to maintain (8.5) is called the *SetPoint* of the analog output process. An analog input to the ProControl (in this case, a pH transmitter) is said to provide *feedback* to the unit, and combined with an analog output, constitute *feedback control*.

PID Loops

A reliable type of feedback control can be obtained through a *PID Loop*. PID stands for *Proportional-Integral-Derivative*, and is a commonly-used process control technique. We'll skip the details of the mathematics involved, but suffice it to say that a PID loop is the favored control technique for most analog output processes. With only a *Proportional* term applied in the equation, the analog output is controlled based on an error signal generated from the difference between the SetPoint and the actual analog input. The PID loop can also improve its performance as it continues to run if an *Integral* term is used and can respond to quick changes in the controlling analog input if a *Derivative* term is used. EOS Research will configure your PID loops for you and can provide further information if necessary.

Proportional Outputs

In some cases, it may be desirable to base an analog output signal on an analog input value. In this situation, no specific SetPoint is used because there is a direct relationship between the output and input values. For example, if you wanted to base the output of a metering pump on some flow rate, you might use a proportional output to relate the amount of chemical metered to the flow rate.

2.0 ON-SITE OPERATION

2.1 LCD Display

If your unit did not come with an LCD display, the following sections *do not* apply.

The 2 line x 20 character LCD display is used to display and control system operations. The display is divided into separate areas or fields, as outlined below.

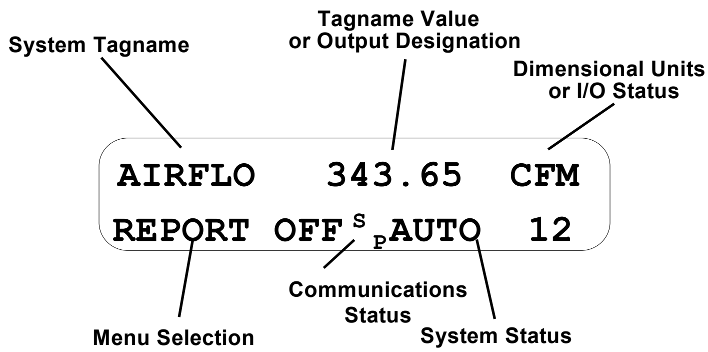


Figure 2. Display Fields

System Tagname This six-character field is used to identify the I/O point displayed. Descriptive names such as WELL1 or BLOWER are used.

Tagname Value For analog inputs, this field displays the value of the input, the high alarm limit, or the low alarm limit. For digital outputs, OUTPUT is displayed. For digital inputs, this field is unused. For analog outputs, this field displays the output percentage, the output level, or the associated input setpoint.

Dimensional Units or I/O Status For analog inputs, this three-character field displays the dimensional units associated with the input sensor, such as GPM or PSI. For digital inputs and outputs, this field displays either ON or OFF. For analog outputs, this field abbreviates percent with PCT. In the case of digital outputs, if the particular output displayed has been designated a lamp output (*see ProView manual*), and a lamp test is currently running, an asterisk (*) will appear before ON or OFF to indicate the lamp is illuminated despite the indicated output status (the output will return to this indicated status once the lamp test has been completed).

Menu Selection This field displays the current menu selection.

Communications Status This field displays one of five different descriptors which indicate any of several special functions of the ProControl. If no communications action is being taken, ">" will appear. Communications messages include: **SP** (Sending Page) - indicates that the unit is attempting to send either an alphanumeric or numeric page; **EF** (Encoding Fax) - indicates that the unit is presently encoding a facsimile report as a result of a request by either the operator or the unit itself; **SF** (Sending Fax) - indicates that the unit is attempting to send a fax report; and **DC** (Data Communications) - indicates that the unit is presently interfaced with ProView.

System Status This area displays the current system status: AUTO, MANUAL, START, or SHUTD and an associated process task number indicating the last successfully completed Auto process, current Startup process, or current Shutdown process.

2.2 Keypad

The Series $\mathbf{2}^{plus}$ keypad contains 12 buttons which are used along with the LCD Display to control the operations of the system.

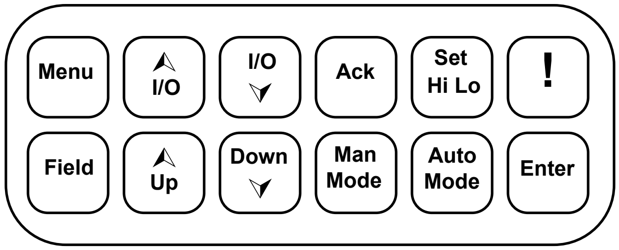
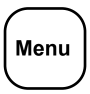
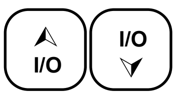


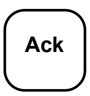
Figure 3. Series $\mathbf{2}^{plus}$ Keypad



This key is used to scroll through a series of options which are displayed on the LCD screen, and which allow the user to configure various aspects of system behavior.



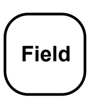
These keys are used to display information about particular I/O points on the LCD Screen. The keys allow the user to scroll through all of the system I/O points either forward or backward.



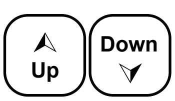
The Acknowledge key is used to silence the audible beeper or to acknowledge a memo sent from a remote ProView user.

The Set Hi Lo key allows the user to change the high and low alarm limits for analog inputs or to toggle the display in the I/O Summary.

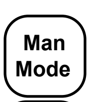
The Emergency Shutdown key is used to turn off all outputs and return the system to manual mode. The programmed shutdown sequence is not executed using this key.



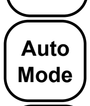
The Field key is used to select a character position to be edited. It is used in conjunction with any direct alphanumeric entry.



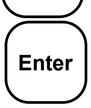
These keys are used to toggle system variables from one state to the next or to scroll through possible character entries when used in conjunction with the Field key.



This key is used to place the system in manual mode.



This key is used to place the system in auto mode.



The Enter key is used to initiate certain actions selected by other keys or to confirm alphanumeric editing done using other keys.

2.3 Password

When the system is first turned on the password screen is displayed and the user is prompted to enter the password to gain access to the system. "EOS" is the default password. The password on the Series **2**^{plus} was designed as a *low-level* security feature. It is not sufficient in and of itself to withstand a determined effort at system entry. The ProControl unit can be configured to bypass the password screen when the unit is powered up.

Up / Down

```
CUSTOMER ID TAGNAME
ENTER PASSWORD: BAA
```

Use the Up and Down keys to change the character displayed above the cursor.

Field

```
CUSTOMER ID TAGNAME
ENTER PASSWORD: BAA
```

The Field key is used to move the cursor to the next character to be edited.

Enter

```
CUSTOMER ID TAGNAME
ENTER PASSWORD: EOS
```

The enter key submits the password for approval.

If the password was entered correctly, the following screen will be displayed for about a second before the operations screen is displayed:

```
Password Accepted
VER 2.XXX   : 1
```

ROM Version #   User Setup Version #

Otherwise, the following message will be displayed for a second and the user will be returned to the password menu:

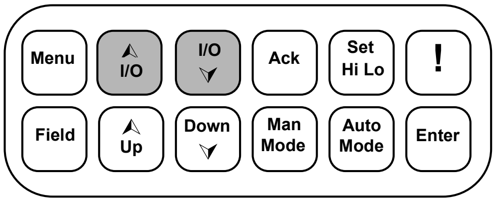
```
Incorrect Password
```

2.4 Operations Screen

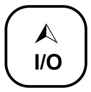
After the password has been entered correctly, the operations screen is displayed. The operations screen allows the user to set system parameters and to review the status of all system inputs and outputs.

```
WELL1              OFF
ALARMS SET >MANUAL
```

2.5 I/O Keys

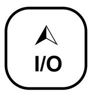


Pressing the I/O Up or I/O Down keys will scroll through the operational I/O points in the system. Data relevant to a particular I/O point will be displayed to right of the point's Tagname.



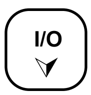

```
WELL2                ON
ALARMS  SET >MANUAL
```

Forward scroll through I/O points




```
WELL3               OFF
ALARMS  SET >MANUAL
```

Forward scroll through I/O points



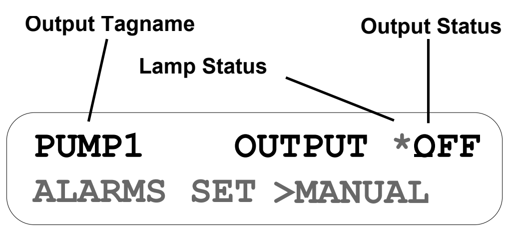

```
WELL2                ON
ALARMS  SET >MANUAL
```

Backward scroll through I/O points

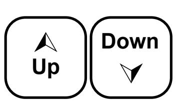
2.6 Digital Input Menu

A digital input displayed in the operations screen will be displayed as shown. When the input is in its Active State "ON" will be displayed in the Input Status area. Otherwise, "OFF" will be displayed.

2.7 Digital Output Menu

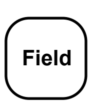


A digital output displayed in the operations screen will appear as shown. When the output has been turned on, "ON" will be displayed in the Output Status area. Otherwise, "OFF" will be displayed. The cursor is displayed under the first character in the status field to indicate that it can be changed. The Lamp Status character (*) will be shown for a lamp output if a *lamp test* is running regardless of the output's true state.




```
PUMP1     OUTPUT   ON
ALARMS  SET >MANUAL
```

Pressing the Up or Down key will toggle the digital output state and turn the corresponding relay OFF or ON.




```
PUMP1     OUTPUT   ON
ALARMS  SET >MANUAL
```

Pressing the Field key will move the cursor to the Menu selection field.

2.8 Analog Input Menu

Analog Tagname Analog Value Units

```
H2OFLO      54.6   GPM
ALARMS SET >MANUAL
```

An analog input displayed in the operations screen will be displayed as shown to the left. The value of the analog input will be shown along with the dimensional units. In the case of a pulse accumulator (totalizer only), you will see only TOT where units is normally displayed.

Set Hi Lo

```
H2OFLO      20.0   GPM
LOW ALARM  >MANUAL
```

Use the Set Hi Lo key to set the low alarm limit.

Set Hi Lo

```
H2OFLO      80.0   GPM
HIGH ALARM >MANUAL
```

Press the Set Hi Lo key again to set the high alarm limit.

Set Hi Lo

```
H2OFLO    120817   GAL
TOTAL FLOW >MANUAL
```

Press the Set Hi Lo key again to see the total flow on a flow type input, and once more to return.

Up Down

```
H2OFLO      30.0   GPM
LOW ALARM  >MANUAL
```

The Up and Down keys are used to change the value of the current character, as denoted by the cursor.

Field

```
H2OFLO      30.0   GPM
LOW ALARM  >MANUAL
```

The Field key is used to move to the next character to be edited.

Enter

```
H2OFLO      30.0   GPM
LOW ALARM  >MANUAL
```

To save the low alarm limit changes, press the enter key.

2.9 Analog Output Menu

Analog Tagname   Percentage

```
VRPUMP     25.0  PCT
ALARMS SET >MANUAL
```

An analog output displayed in the operations screen will be displayed as shown to the left. The percentage of full scale output will be displayed as well.

Set Hi Lo

```
VRPUMP     25.0  PCT
OUTPUT LVL >MANUAL
```

The Set Hi Lo key can be used to set the output percentage.

Set Hi Lo

```
WTRLVL     33.0  FT
SETPOINT   >MANUAL
```

Press the Set Hi Lo key again to declare the SetPoint of an associated analog input. The SetPoint is used only if a PID control loop is in use as an analog output process.

Pressing Set Hi Lo again returns to the original menu.

Up **Down**

```
VRPUMP     35.0  PCT
OUTPUT LVL >MANUAL
```

The Up and Down keys are used to change the value of the current character, as denoted by the cursor.

Field

```
VRPUMP     35.0  PCT
OUTPUT LVL >MANUAL
```

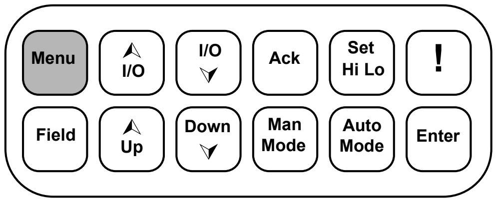
The Field key is used to move to the next character to be edited.

Enter

```
VRPUMP     35.0  PCT
OUTPUT LVL >MANUAL
```

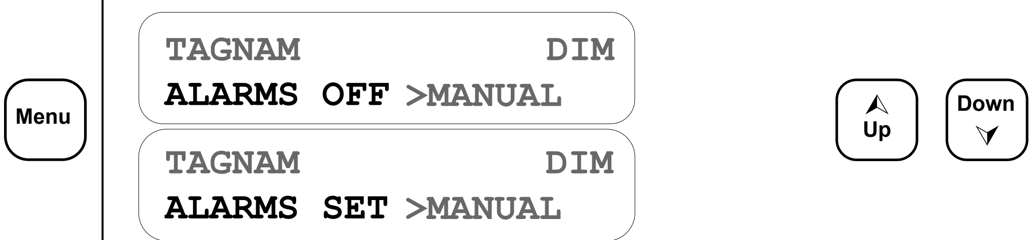
To save the output level changes, press the enter key.

2.10 Menu Key

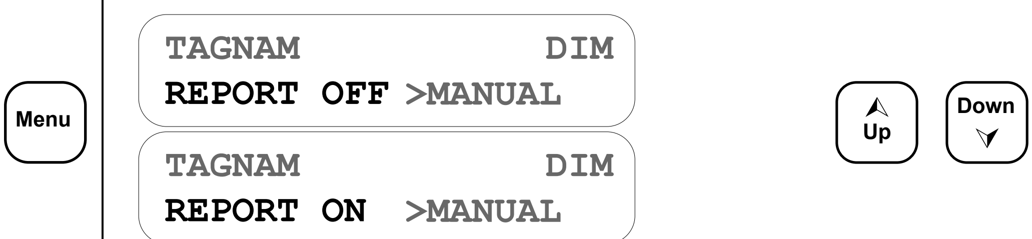


When pressed, the Menu key will scroll through a series of items which allow the user to configure various aspects of system behavior. A description of these items appear in a 10 character field at the bottom left of the display. Either the Up and Down keys or the Enter key is used to change the item.

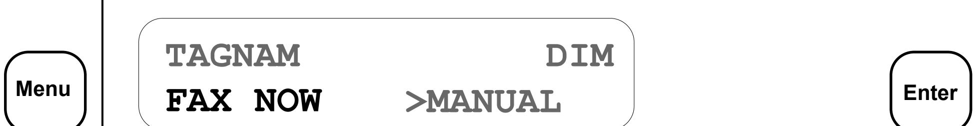
ALARMS Use the Up and Down keys to enable or disable Alarms.



REPORT Use the Up and Down keys to enable or disable the unit’s reporting capabilities (fax or page).



FAX NOW Use the Enter key to send a FAX report immediately.



STARTUP Use the Enter key to run the Startup Sequence.

SHUTDOWN Use the Enter key to run the Shutdown Sequence.

Menu

```
TAGNAM             DIM
SHUTDOWN    >MANUAL
```

Enter

LAST SHUTDOWN This display item shows what input or output caused the last shutdown.

Menu

```
TAGNAM             DIM
SDN TAGNAM  >MANUAL
```

LOG OFF Use the Enter key to Log Off the system and return to the password menu.

Menu

```
TAGNAM             DIM
LOGOFF      >MANUAL
```

Enter

LAST MEMO Use the Enter key to see the last memo sent from the remote ProView user. Up and Down are used to scroll through the message, and Ack is used to return to the ProControl menus. If you hit any other key you will see an informative message telling you which keys are valid. The message will be displayed for 3 seconds if no keys are pressed, but can be acknowledged before the 3-second period by pressing either the Ack or Enter keys.

Menu

```
TAGNAM             DIM
LAST MEMO   >MANUAL
```

Enter

```
HEY BULLWINKLE,
REMEMBER TO SHUT THE
```

Down

```
LIGHTS OFF!
PUSH <ACK> TO RETURN
```

Field

```
UP & DOWN TO SCROLL
OR <ACK>NOWLEDGE
```

Ack

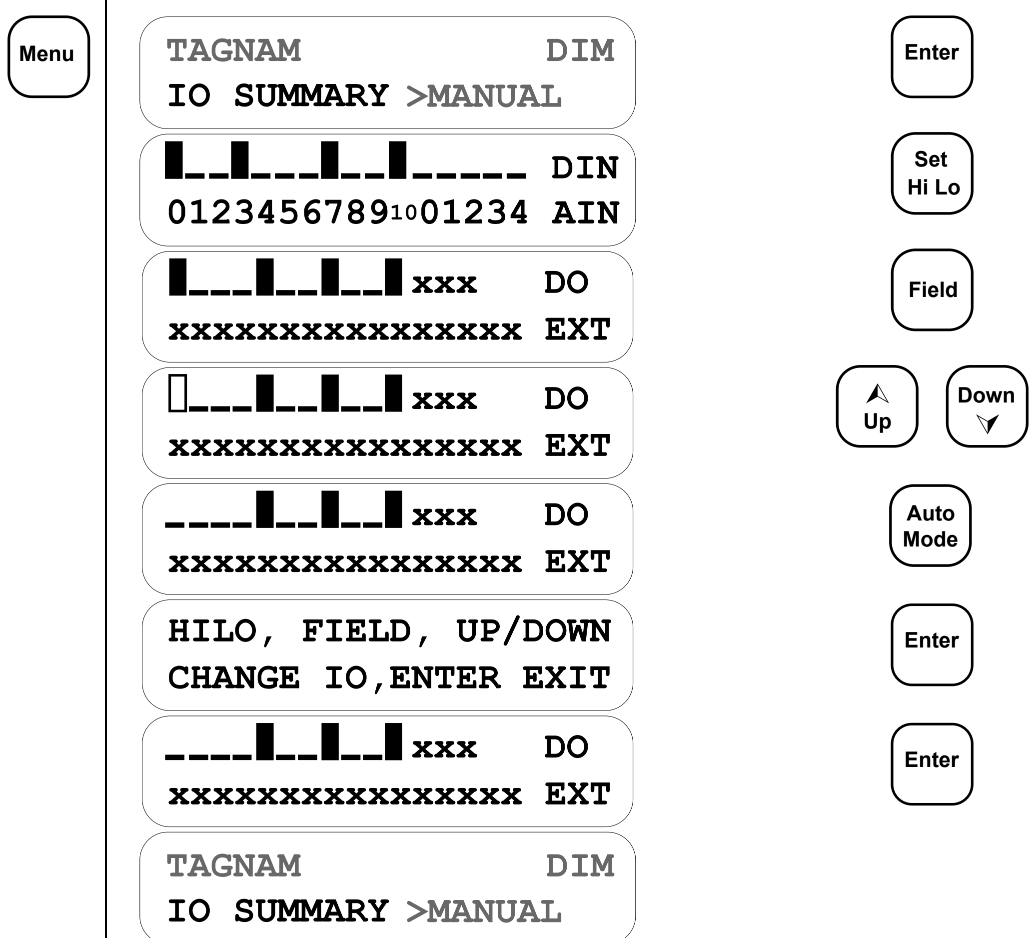
```
LIGHTS OFF!
PUSH <ACK> TO RETURN
```

Ack

```
TAGNAM             DIM
LAST MEMO   >MANUAL
```

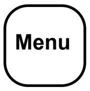
IO SUMMARY

Use the Enter key to enter the I/O summary. The analog input values 0-10 represent a percentage of full scale (i.e. 0 ≅ 4 mA, 5 ≅ 12 mA). Set HiLo is used to toggle between input/output summaries. An underscore represents an open input or an unswitched output. A block indicates a closed input or a switched output. An **x** or **X** is displayed when an output is not enabled and is unswitched or switched, respectively. An asterisk (*) will be displayed if an output is declared as a lamp and a lamp test is currently being performed. The Field key can be used to move the blinking cursor through the outputs. The Up/Down keys can be used to toggle the state of the output whose position is covered by the blinking cursor. The Enter key will return the ProControl back to its standard menus. If you press any other keys you will see an informative message telling you which keys are valid. The message will be displayed for 3 seconds if no keys are pressed, but can be interrupted before the 3-second period by pressing the Enter key.



MODES

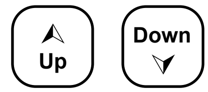
Use the Up and Down keys to toggle an Analog Output from Manual control to PID control or Proportional control, depending on which analog output process is being used. This selection will only appear if an analog output tagname is displayed and the analog output is part of an analog output process.




```
TAGNAM   100.0  PCT
MODE MAN   >MANUAL
```

```
TAGNAM    96.3  PCT
MODE PID   >MANUAL
```

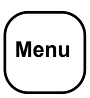
```
TAGNAM    25.0  PCT
MODE PRO   >MANUAL
```



GROUP

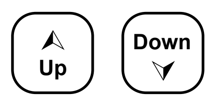
The ProControl allows outputs to be assigned to different *Groups* to allow greater process control flexibility. In some cases, you may wish to be able to specify alternate process tasks for a given output. For instance, you can have the operation of a pump be controlled by a series of level switches in a tank, or alternately, the pump can be run on a timed cycle. By selecting the appropriate process Group, you can change the control strategy for that piece of equipment. EOS Research will configure the groups for you according to your specifications

Use the Up and Down keys to select a Group for the displayed output. This menu item is displayed only for outputs that have been configured by EOS to have alternate process Groups.




```
TAGNAM   OUTPUT  DIM
GROUP 1    >MANUAL
```

```
TAGNAM   OUTPUT  DIM
GROUP 2    >MANUAL
```



2.11 LED Indicators

Your ProControl unit has three status LEDs to the left of the keypad, which are used to indicate the following:

System Status: Normally ON when unit is powered.
One blink - The system has internally reset.
Two blinks - An internal error has occurred.

Connect: ON if user is remotely or locally connected.
ON if system is faxing or paging.
Slow blink - last fax or page failed, press ACK to clear.
Fast blink - local connect cable inadvertantly left plugged in, press ACK to clear.

Network: Rapid blinking indicates an active network connection.

3.0 Reporting Features

3.1 Fax Report

The ProControl unit will keep you informed of your system's operations with facsimile status reports. With the supplied ProView software you can configure the unit to send fax reports to up to two different numbers. You can also have these reports sent on a daily basis, at regular intervals during the day, or when triggered by specific process tasks. You can send one at any time by using the *Fax Now* option either from the menu on the ProControl's display, or through the ProView software.

The fax report you receive will contain several fields, each denoted by a shadow box. The number of fields will depend on the configuration of your system. For instance, you would not see a field indicating *Analog Outputs* if your system does not contain any of these.

The fields as you will see them are shown below. All information enclosed in brackets is variable and depends on your particular system configuration.

To:

```
<FAX RECIPIENT>
```

will indicate the intended fax recipient's name.

From:

```
THE <SYSTEM NAME>        SYSTEM IN <SITE LOCATION>   AT <TIME> ON <DATE>
SETUP VERSION X       :  ROM VERSION 2.x          :  MODEL B1
```

will indicate the name and location of your system, the date and time at which the fax report was initiated, your current ProView setup version, and the current on-board software version 2.X.

System Status:

```
<MODE><PXX>  :   LAST SHUTDOWN AT <TIME> ON <DATE> BY <SHUTDOWN CAUSE>
                 FAX REPORT INITIATED BY <FAX CAUSE>
```

will indicate the current <MODE> of the controller and associated process. For example, if the controller is running the startup or shutdown sequence, you would see either START or SHUTD followed by the current algorithm. Similarly, in auto mode, you would see AUTO followed by the last successfully completed process task.

The LAST SHUTDOWN indicates when the system last initiated the shutdown sequence and what caused it to happen. For example, if the shutdown sequence were initiated by a key press, the cause you would see would be KEYPAD. Similarly, if the shutdown sequence were caused by a process task such as a high pressure sensor whose tagname was HIPRES, you would see HIPRES as the <SHUTDOWN CAUSE>. If multiple inputs or outputs caused the shutdown (i.e. a process task was dependent on more than one input being in the active state and/or multiple outputs being ON), the most recent one which changed will appear as the cause.

Similarly, the FAX REPORT INITIATED BY line will indicate the tagname of the I/O point which caused the fax to be sent, provided there was only one I/O point responsible. If multiple I/O points were responsible, the process itself will be indicated. Consider, for example, a process task where a shutdown was caused by HIPRES and BLOWER, and a fax was also generated. The <FAX CAUSE> would be PROCESS XX, where *XX* is the number from 1 - 64 of this process task. In the case where *Fax Now* was selected from the menu option on the LCD, the <FAX CAUSE> would be KEYPAD. The <FAX CAUSE> from a ProView generated *Fax Now* command would be REMOTE. This line will not appear on daily or interval scheduled fax reports.

Discrete Inputs:

```
<TAGNAME> is <STATE>   <TAGNAME> is <STATE> ...
```

will indicate the status of all of the digital inputs in four columns. Inputs which are in the active state will appear as `ON` and those which are in their normal state will appear as `OFF`.

Discrete Outputs:

```
<TAGNAME> is <STATE>   <TAGNAME> is <STATE> ...
```

will indicate the status of all of the digital outputs in four columns.

Analog Inputs:

```
<TAGNAME> is <VALUE> <DIM> LIMITS are L: <LO-LIM> <DIM> H: <HI-LIM> <DIM>
<TAGNAME> is <VALUE> <DIM> TOTAL FLOW is <FLOW>   <DIM>
<TAGNAME>                  TOTAL FLOW is <FLOW>   <DIM>
...
```

will indicate the current value, dimensional units, low alarm limit, and high alarm limit for all analog inputs which are not flow-type inputs. The precision of the values displayed can be selected through ProView. Any flow-type analog input which is responsible for maintaining a total flow will display that flow in place of the alarm limits. Any pulse-type digital input used for a digital flow meter will appear here since the information being obtained by that type of flow meter is analog in nature. In addition, pulse accumulators (volume totalizers) will appear here.

Analog Outputs:

```
<TAGNAME>   <PCT>  PCT  <MODE>      <TAGNAME>   <PCT>  PCT  <MODE>
...
```

will indicate the output percentage and mode of operation of all analog outputs. The precision is fixed to one decimal place and will range from 0.0 to 100.0, expressed as a percentage. The `<MODE>` of operation will be `PID` if the analog output is currently being used in a PID loop, or PRO if the analog output is currently being used in a Proportional scheme, otherwise it will be `MAN` indicating that the analog output is under manual control.

The next two pages contain examples of scheduled and alarm fax reports.

ProControl Series II+

EOS Research Ltd.

Fax Report

To:

BULLWINKLE J MOOSE

From:

THE NORTH WATER SUPPLY SYSTEM IN MAYBERRY USA @ 09:44:00 ON 12/10/1999
SETUP VERSION 1 : ROM VERSION 2.156 : MODEL B2

System Status:

AUTO P04 : NO PREVIOUS SHUTDOWN

Discrete Inputs:

WEL1LO is OFF	WEL2LO is OFF	TWR_HH is OFF	TNK_HH is OFF
RESET is OFF			

Discrete Outputs:

WLPMP1 is ON	WLPMP2 is ON	FINPMP is ON	CHLMET is ON
NAOMET is ON	PH_ALM is ON	CL_ALM is ON	TWRALM is OFF
WL1ALM is OFF	WL2ALM is OFF	TNKALM is OFF	

Analog Inputs:

TWRLVL is 59.2	FT	LIMITS are	L: 8.0	FT	H: 70.0	FT
TNKLVL is 0.00	FT	LIMITS are	L: 8.00	FT	H: 12.00	FT
FINFLO is 501.3	GPM	TOTAL FLOW is	14794	GAL		
FLOW_2 is 399.3	GPM	TOTAL FLOW is	12561	GAL		
FLOW_1 is 0.0	GPM	TOTAL FLOW is	0	GAL		
FIN_PH is 0.00	PH	LIMITS are	L: 6.00	PH	H: 8.00	PH
FIN_CL is 0.00	PPM	LIMITS are	L: 0.75	PPM	H: 2.00	PPM

Analog Outputs:

VSPMP1	86.8	PCT	PID	VSPMP2	100.0	PCT	PID
NAOHFD	100.0	PCT	PID	CHLRFD	20.0	PCT	PRO

ALARM Fax Report

EOS Research Ltd. ProControl Series II+

To:

```
BULLWINKLE J MOOSE
```

From:

```
THE NORTH WATER SUPPLY   SYSTEM IN MAYBERRY USA     @ 09:34:12 ON 12/10/1999
SETUP VERSION 1       : ROM VERSION 2.156   : MODEL B2
```

System Status:

```
AUTO  P04 :    NO PREVIOUS SHUTDOWN
               FAX REPORT INITIATED BY REMOTE
```

Discrete Inputs:

```
WEL1LO is OFF       WEL2LO is OFF       TWR_HH is OFF       TNK_HH is OFF
RESET  is OFF
```

Discrete Outputs:

```
WLPMP1 is ON        WLPMP2 is ON        FINPMP is ON        CHLMET is ON
NAOMET is ON        PH_ALM is ON        CL_ALM is ON        TWRALM is OFF
WL1ALM is OFF       WL2ALM is OFF       TNKALM is OFF
```

Analog Inputs:

```
TWRLVL is 59.1      FT   LIMITS are  L: 8.0       FT    H: 70.0      FT
TNKLVL is 0.00      FT   LIMITS are  L: 8.00      FT    H: 12.00     FT
FINFLO is 203.5     GPM  TOTAL FLOW is  11348     GAL
FLOW_2 is 399.6     GPM  TOTAL FLOW is  8671      GAL
FLOW_1 is 0.0       GPM  TOTAL FLOW is  0         GAL
FIN_PH is 0.00      PH   LIMITS are  L: 6.00      PH    H: 8.00      PH
FIN_CL is 0.00      PPM  LIMITS are  L: 0.75      PPM   H: 2.00      PPM
```

Analog Outputs:

```
VSPMP1    37.4 PCT  PID        VSPMP2  100.0 PCT  PID
NAOHFD   100.0 PCT  PID        CHLRFD   20.0 PCT  PRO
```

3.2 Page Alerts

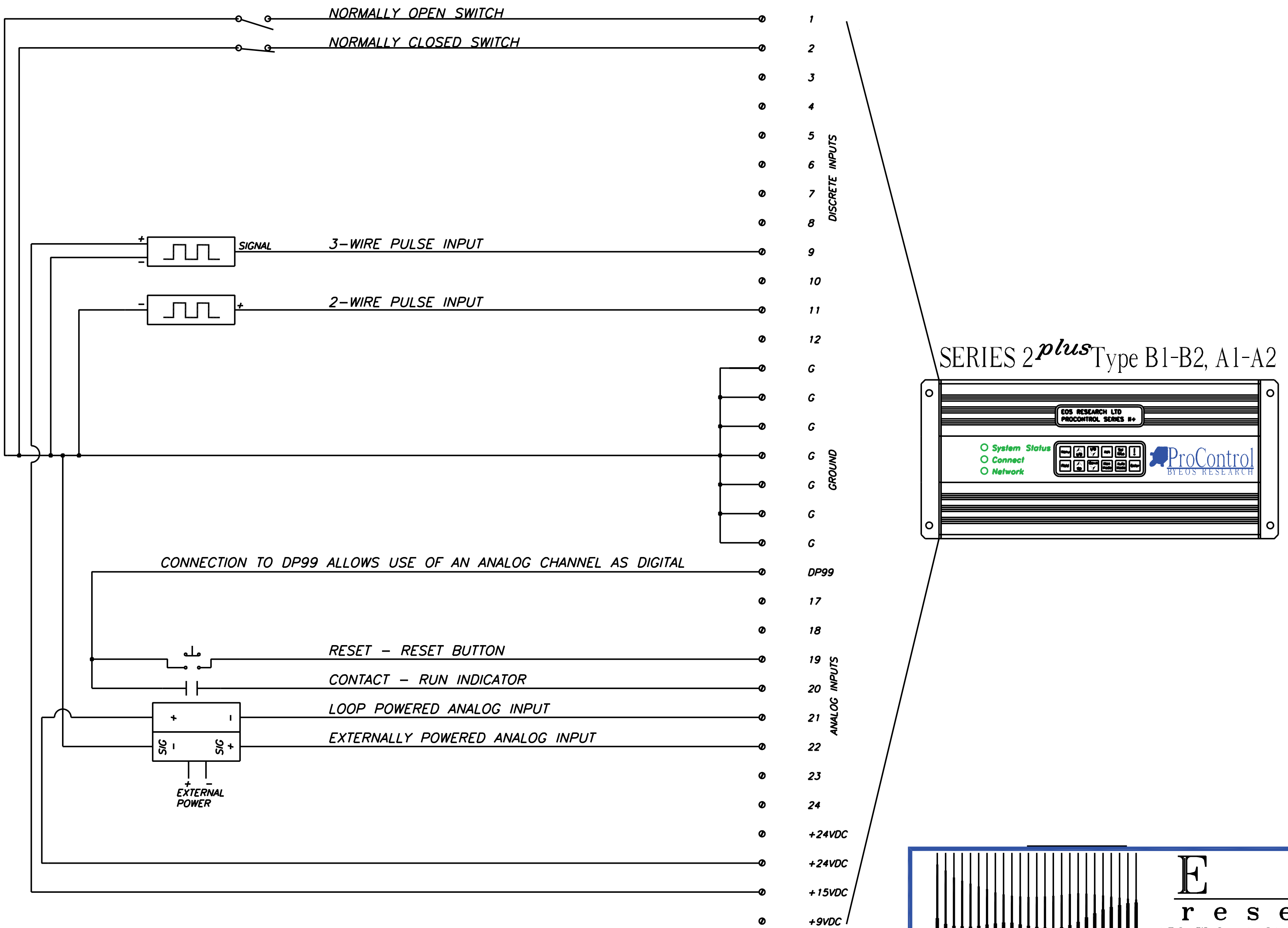
The ProControl unit can alert you to important conditions at your site via a page alert. Any system that is not in manual mode, that is, executing process tasks or the startup or shutdown sequences, can send a message up to eighty characters in length to an alphanumeric pager or up to nineteen digits in length to a numeric pager. If you are out of the office and away from a fax machine, you will still be alerted to any trouble at your site. With ProView you can select up to two pager numbers to be called. Each process task or startup/shutdown algorithm is capable of sending a message to either or both of these pagers. The pager messages are configured by EOS Research according to your specifications.

An example message for an alphanumeric pager would be:

```
ANYTOWN SITE
High water level EQ Tank
System shut down!
Call Fred to fix: 555-6789
```

APPENDIX A

EXAMPLE WIRING DIAGRAM



NOTES:
1. FOR ANALOG INPUTS, MAINTAIN VOLTAGE AND TOTAL LOOP RESISTANCE PER MFG. SPECIFICATIONS.
2. INPUT IMPEDANCE FOR SERIES 2Plus ANALOG INPUTS IS 135 OHMS.
3. ACTIVE DISCRETE INPUTS WILL SOURCE 1mA WHEN GROUNDED.
4. THE ProControl SOURCES 5VDC FOR DISCRETE INPUTS.
5. DISTRIBUTE ANALOG INSTRUMENTS EVENLY ACROSS +24VDC TERMINALS.

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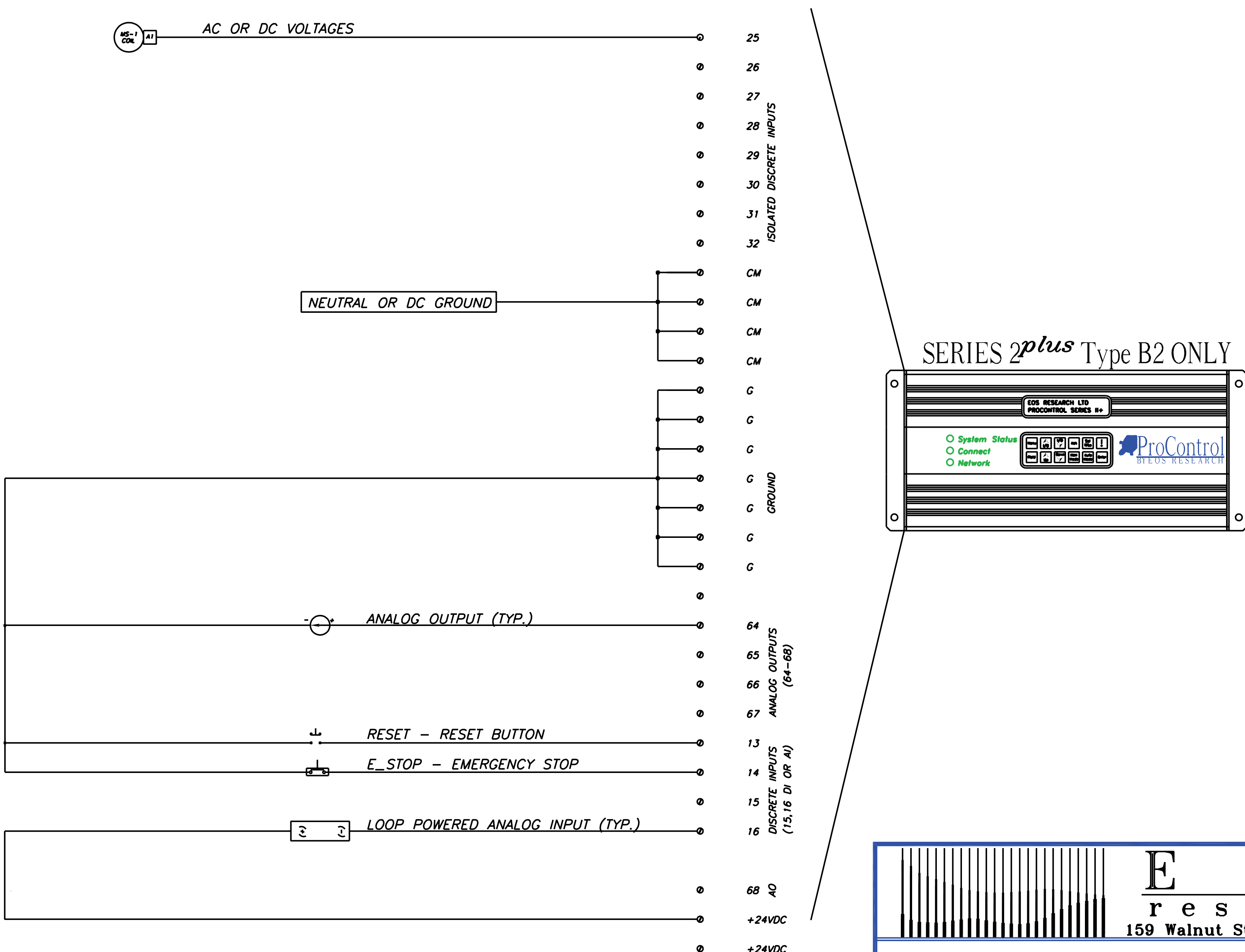
TYPICAL ProControl WIRING
DIGITAL & ANALOG INPUTS - BOTTOM LEFT SIDE

EXAMPLE WIRING DIAGRAM



NOTES:
1. FOR ANALOG INPUTS, MAINTAIN VOLTAGE AND TOTAL LOOP RESISTANCE PER MFG. SPECIFICATIONS.
2. INPUT IMPEDANCE FOR SERIES 2Plus ANALOG INPUTS IS 135 OHMS.
3. MAXIMUM ISOLATED DISCRETE INPUT VOLTAGE 120V. ALL INPUTS MUST BE SAME VOLTAGE AND SHARE THE SAME COMMON OR NEUTRAL!
4. CM REPRESENTS COMMON FOR INPUTS 25-32. (ie. 120VAC, CM=NEUTRAL/ 24VDC, CM=DC GROUND)

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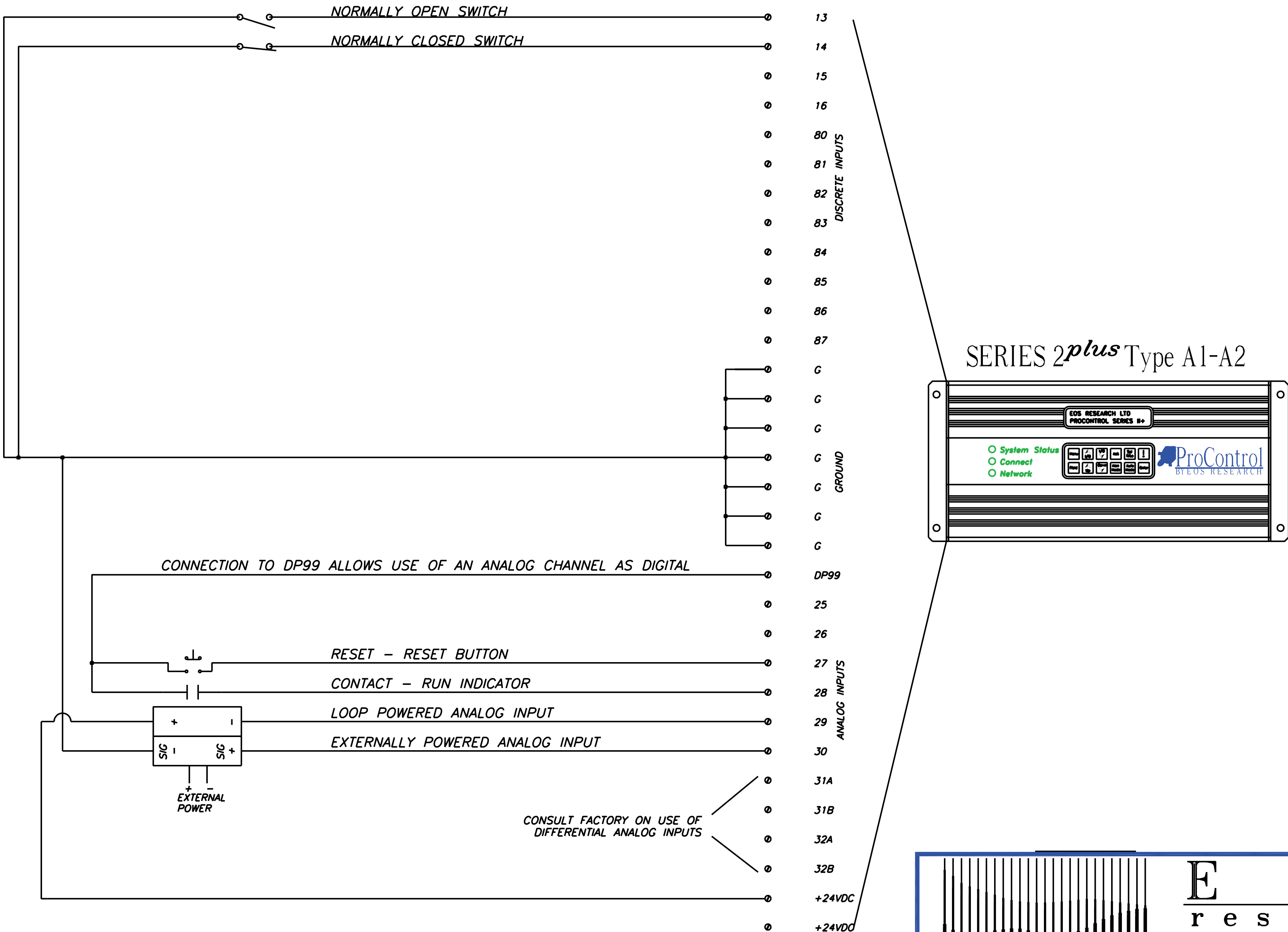
TYPICAL ProControl WIRING
DIGITAL INPUTS & ANALOG OUTPUTS
TYPE B2 - TOP LEFT SIDE

EXAMPLE WIRING DIAGRAM



NOTES:
1. FOR ANALOG INPUTS, MAINTAIN VOLTAGE AND TOTAL LOOP RESISTANCE PER MFG. SPECIFICATIONS.
2. INPUT IMPEDANCE FOR SERIES 2Plus ANALOG INPUTS IS 135 OHMS.
3. ACTIVE DISCRETE INPUTS WILL SOURCE 1mA WHEN GROUNDED.
4. THE ProControl SOURCES 5VDC FOR DISCRETE INPUTS.
5. DISTRIBUTE ANALOG INSTRUMENTS EVENLY ACROSS +24VDC TERMINALS.

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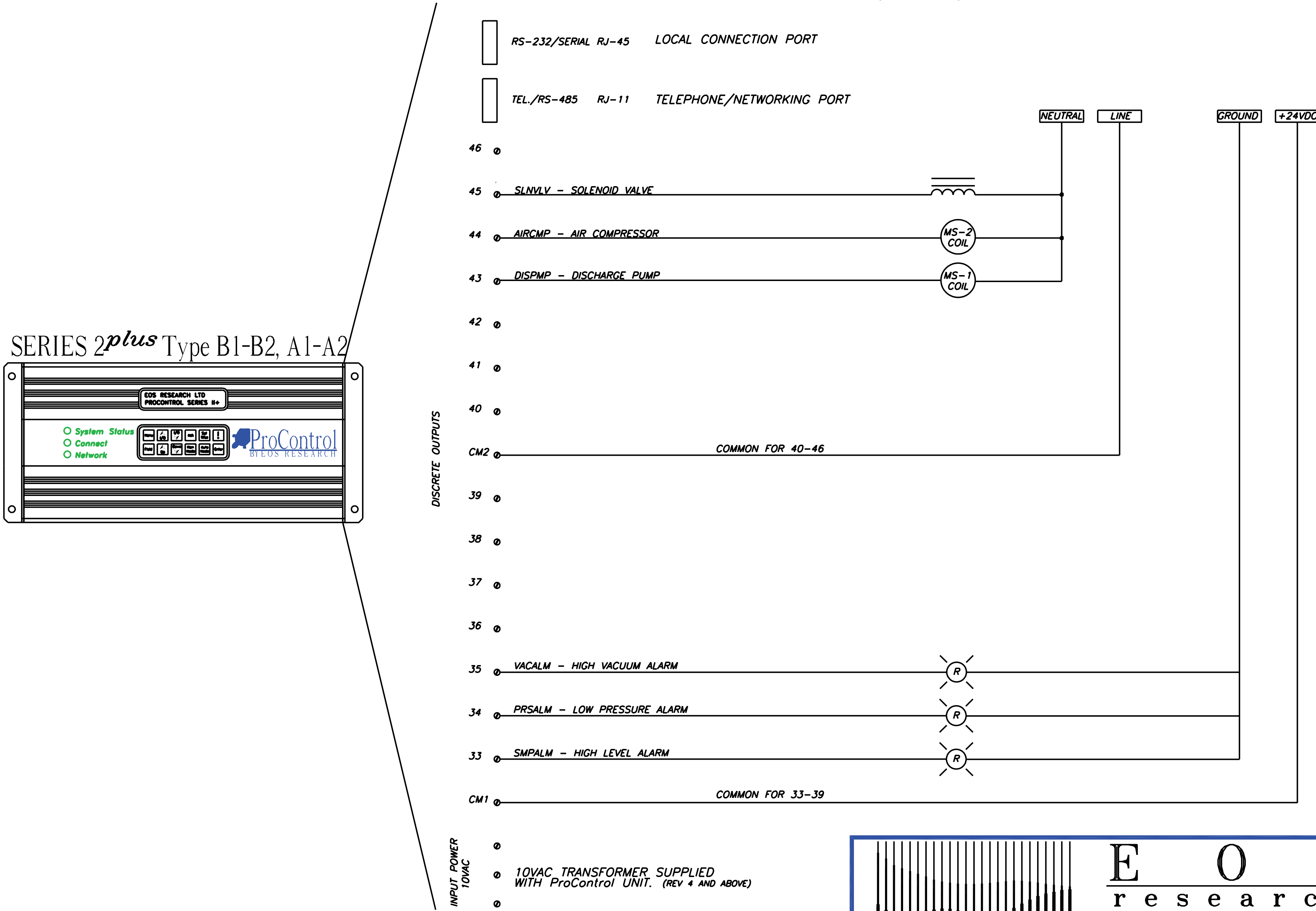
TYPICAL ProControl WIRING
DIGITAL & ANALOG INPUTS -
TYPE A - TOP LEFT SIDE

EXAMPLE WIRING DIAGRAM



NOTE: 20VAC-CT TRANSFORMER SUPPLIED PRIOR TO REV 4.
DO NOT USE 20VAC TRANSFORMER ON REV 4 AND ABOVE!!

NOTES:
1. OUTPUT RELAYS RATED AT 125VAC/0.5A, 24VDC/0.5A
UNITS SHIPPED AFTER 12/1/99 RATED AT 125VAC/1.0A, 24VDC/1.0A
2. CM1 IS SWITCHED TO 33-39 AND CM2 IS SWITCHED TO 40-46 WHEN OUTPUT IS ACTIVE.
3. DO NOT USE +24VDC FROM ProControl TO DRIVE OUTPUTS. FOR TRANSDUCER POWER ONLY.

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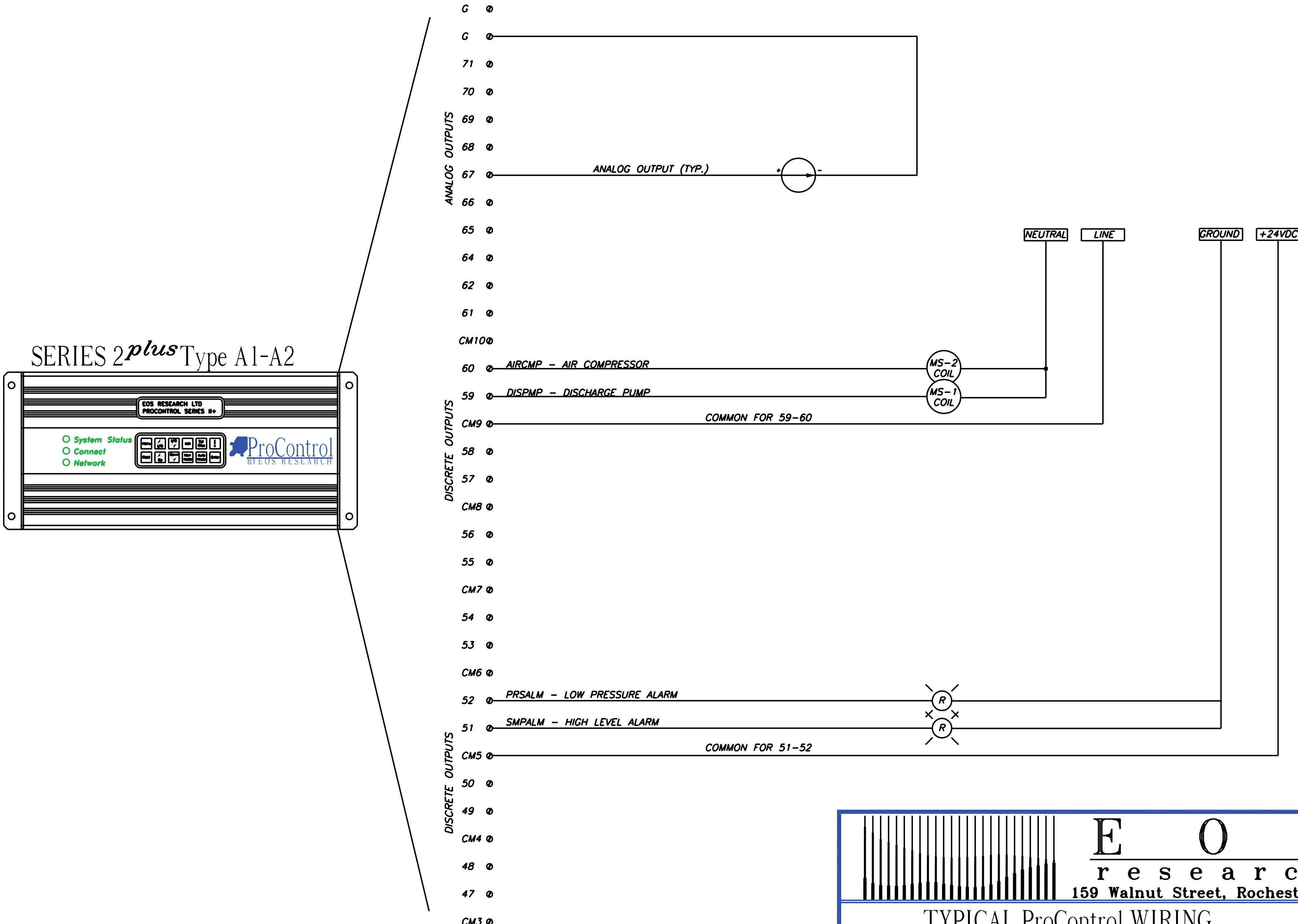
TYPICAL ProControl WIRING
DIGITAL OUTPUTS - RIGHT SIDE

EXAMPLE WIRING DIAGRAM



NOTES:
1. OUTPUT RELAYS ARE RATED AT 125VAC/0.5A, 24VDC/0.5A
2. CM3 IS SWITCHED TO 47–48, CM4 IS SWITCHED TO 49–50, ETC. WHEN OUTPUT IS ACTIVE.
3. DO NOT USE +24VDC FROM ProControl TO DRIVE OUTPUTS. FOR TRANSDUCER POWER ONLY.

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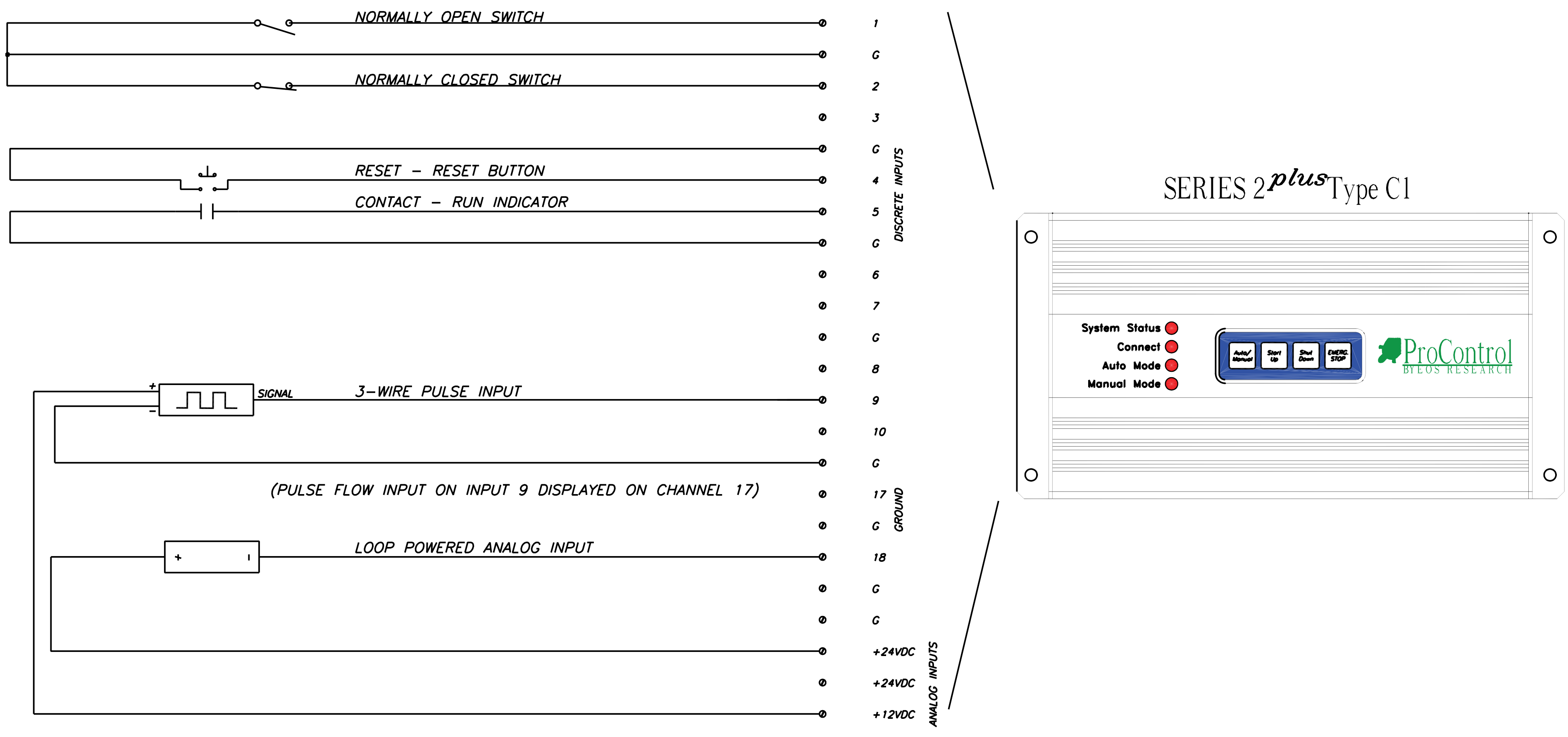
TYPICAL ProControl WIRING
DIGITAL & ANALOG OUTPUTS
TYPE A - TOP RIGHT SIDE

EXAMPLE WIRING DIAGRAM



NOTES:
1. FOR ANALOG INPUTS, MAINTAIN VOLTAGE AND TOTAL LOOP RESISTANCE PER MFG. SPECIFICATIONS.
2. INPUT IMPEDANCE FOR SERIES 2Plus ANALOG INPUTS IS 135 OHMS.
3. ACTIVE DISCRETE INPUTS WILL SOURCE 1mA WHEN GROUNDED.
4. THE ProControl SOURCES 5VDC FOR DISCRETE INPUTS.
5. DISTRIBUTE ANALOG INSTRUMENTS EVENLY ACROSS +24VDC TERMINALS.

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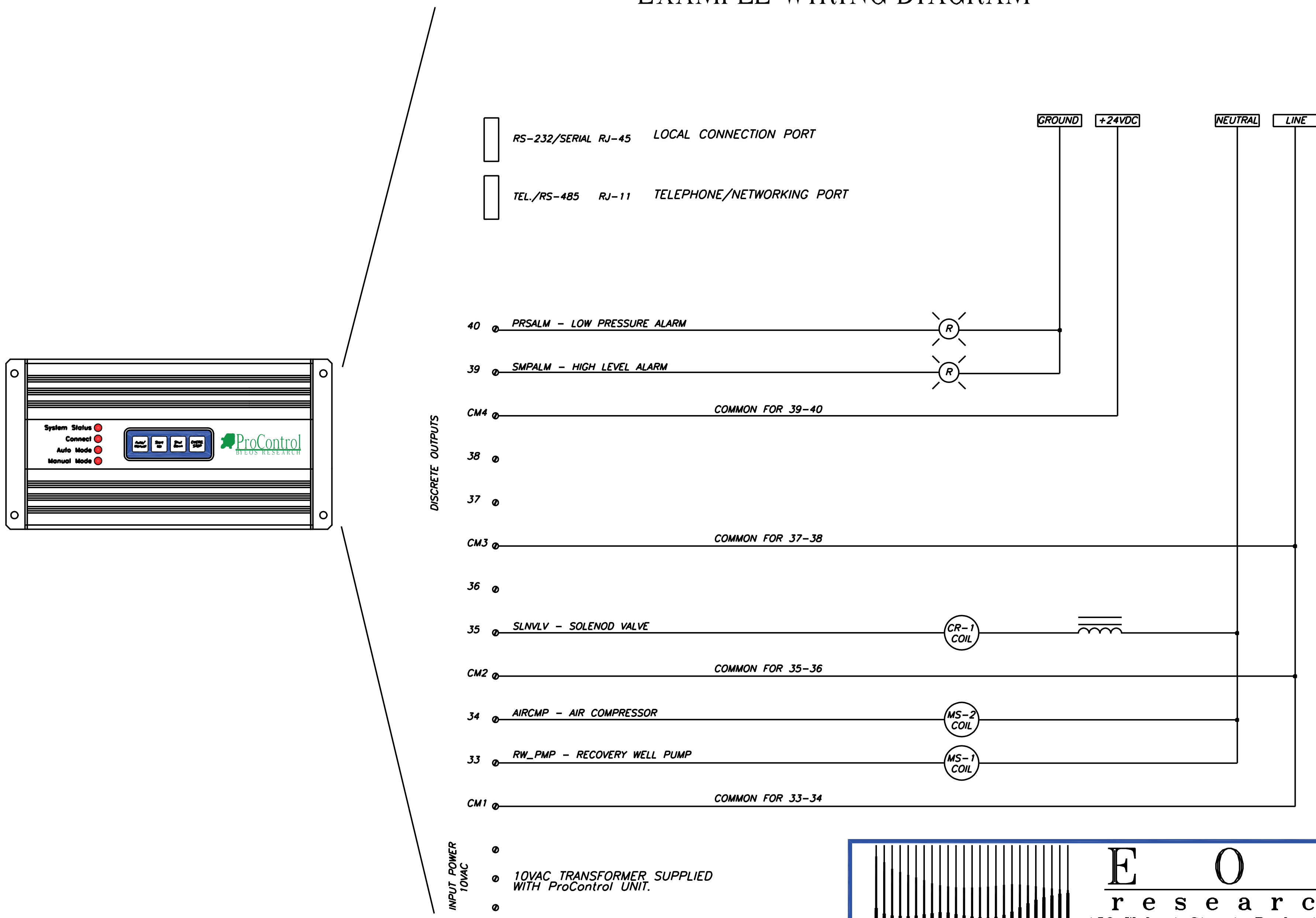
TYPICAL ProControl Type C1 WIRING
DIGITAL & ANALOG INPUTS - BOTTOM LEFT SIDE

REV 4.0 1/4/05

GENINC1.DWG

EXAMPLE WIRING DIAGRAM



NOTES:
1. OUTPUT RELAYS RATED AT 125VAC/1.0A, 24VDC/1.0A
2. CM1 IS SWITCHED TO 33-34 AND CM2 IS SWITCHED TO 35-36, CM3 IS SWITCHED TO 37-38, CM4 IS SWITCHED TO 39-40 WHEN OUTPUT IS ACTIVE.
3. DO <u>NOT</u> USE +24VDC FROM ProControl TO DRIVE OUTPUTS. FOR TRANSDUCER POWER ONLY.

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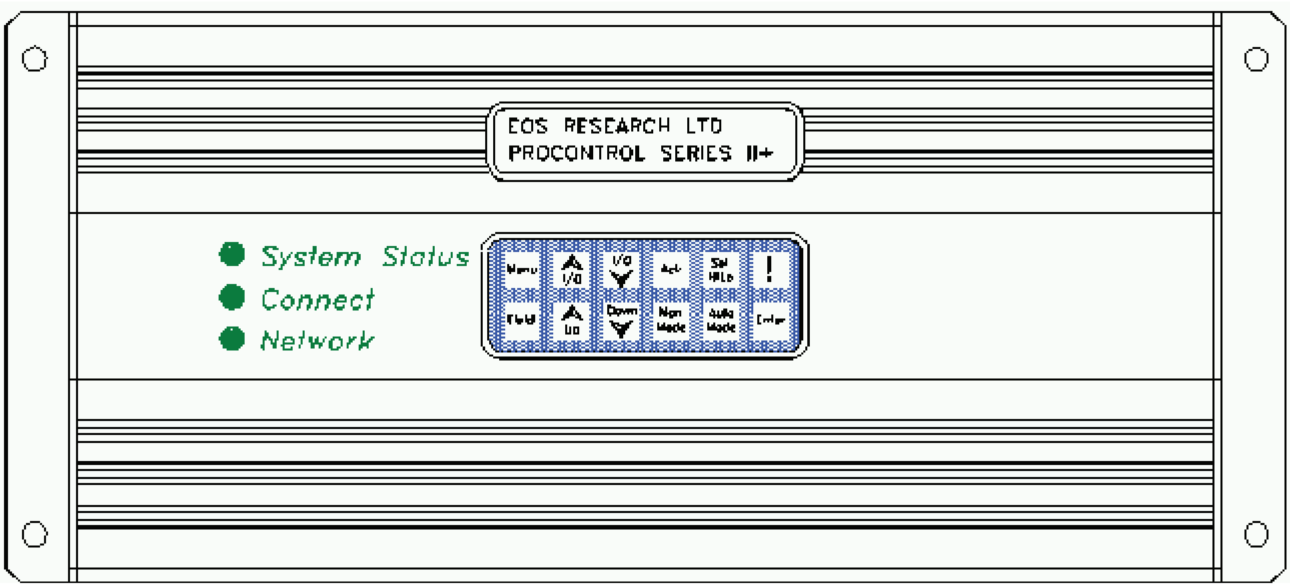
TYPICAL ProControl TYPE C WIRING
DIGITAL OUTPUTS - RIGHT SIDE

PROCONTROL SERIES 2^{plus}

Type A

Product Specification



The next generation **Type A** ProControl features a capacity of up to 78 industrially-hardened inputs and outputs in a small and easy-to-use package. The **Series** $\mathbf{2}^{plus}$ contains everything you need for the core of your control/telemetry system, including the ability to drive motor starters, solenoids and other devices directly from built-in relay outputs. The **Series** $\mathbf{2}^{plus}$ includes expanded datalogging and reporting capability, a built-in power supply for your instruments and transducers, as well as pluggable connectors for all I/O. The **Type A** features higher I/O counts, large datalog memory, greater process control capacity, and a vacuum fluorescent display.

	Model A1	**Model A2**
Inputs		
Discrete	Sixteen (16) protected discrete inputs. Support for 4 flowmeters or pulse accumulators with rates to 500Hz.	Twenty-Four (24) protected discrete inputs (Eight of these are status inputs). Support for 4 flowmeters or pulse accumulators with rates to 500Hz.
Analog	Sixteen (16) 4-20ma inputs with built-in 24Vdc supply. Inputs are surge and short-circuit protected and may also be used as discrete inputs	Sixteen (16) 4-20ma inputs with built-in 24Vdc supply. Inputs are surge and short-circuit protected and may also be used as discrete inputs
Outputs		
Discrete	Twenty-Two (22) relay outputs rated at 1/2A, 120VAC	Thirty (30) relay outputs rated at 1/2A, 120VAC
Analog		Eight (8) 4-20ma outputs. PID loop control.
Price	**$3,495**	**$3,995**

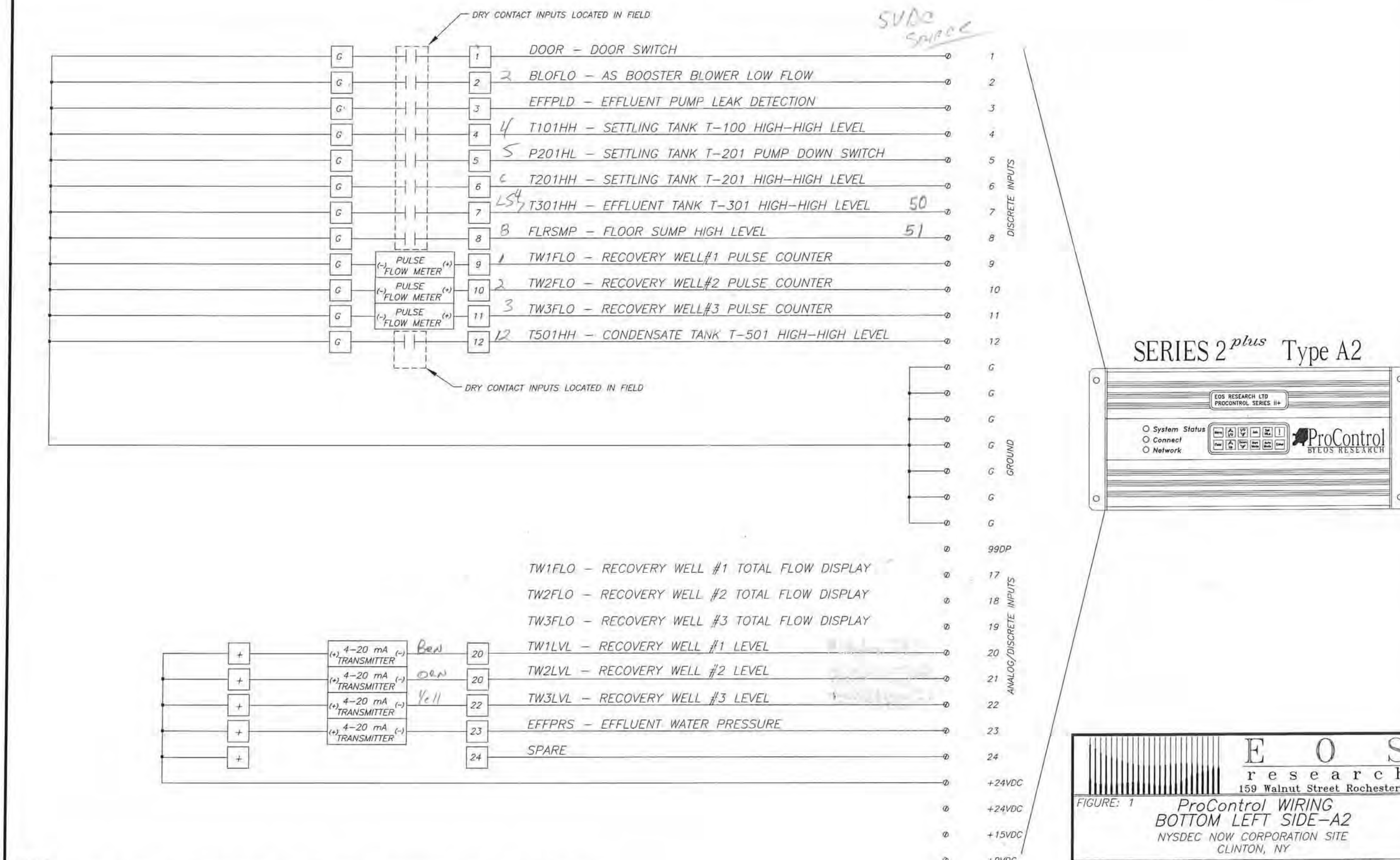


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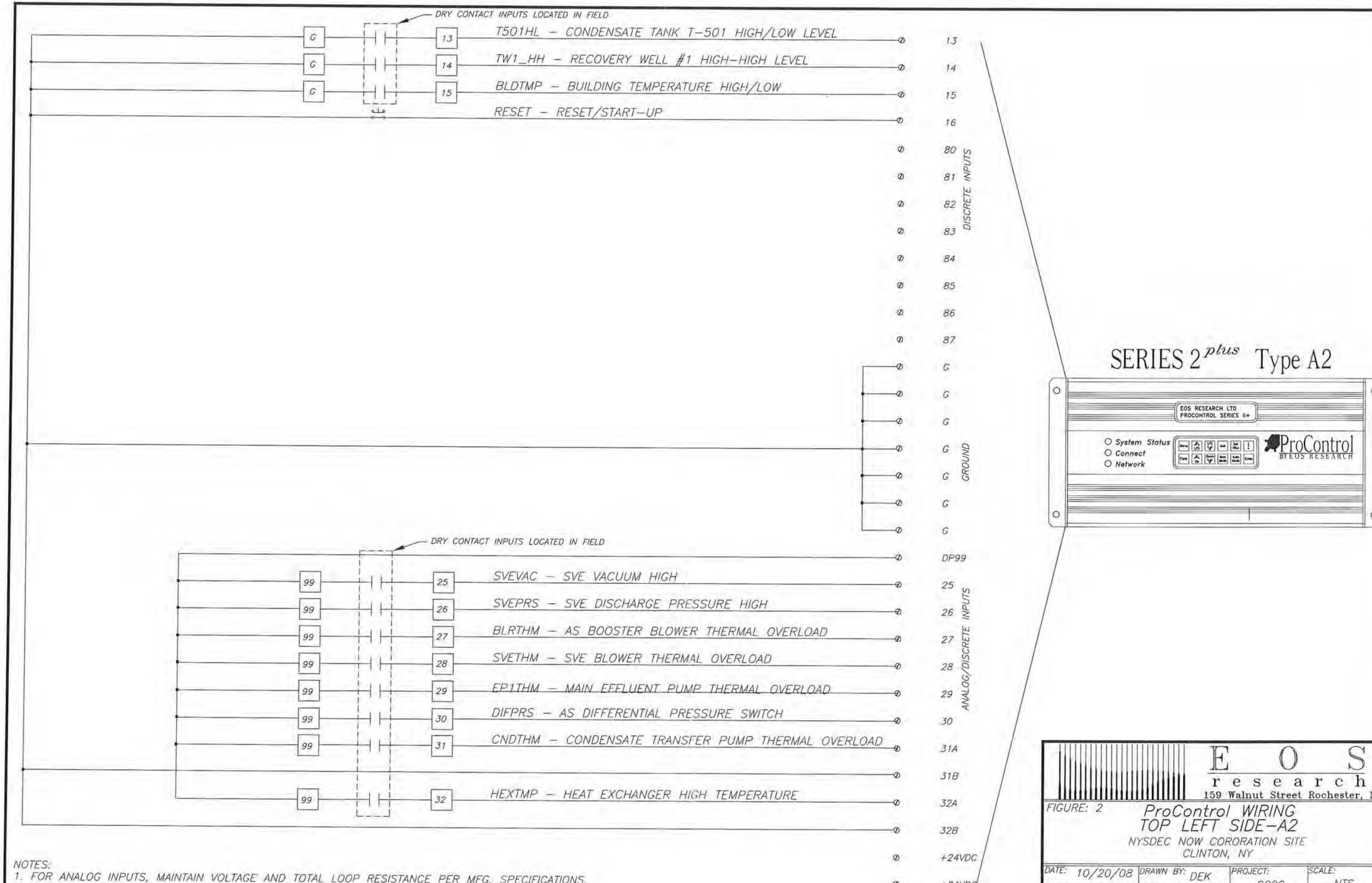
FIGURE: 1

ProControl WIRING
BOTTOM LEFT SIDE-A2
NYSDEC NOW CORPORATION SITE
CLINTON, NY

DATE: 10/20/08	DRAWN BY: DEK	PROJECT: 9290	SCALE: NTS
DATE:	REVISED BY:	PREPARED FOR: EARTHTECH	
DATE:	REVISED BY:		

NOTES:
1. FOR ANALOG INPUTS, MAINTAIN VOLTAGE AND TOTAL LOOP RESISTANCE PER MFG. SPECIFICATIONS.
2. INPUT IMPEDANCE FOR SERIES 2Plus ANALOG INPUTS IS 135 OHMS.
3. ACTIVE DISCRETE INPUTS WILL SOURCE 1mA WHEN GROUNDED.
4. THE ProControl SOURCES 5VDC FOR DISCRETE INPUTS.

BOTLTA2.DWG



NOTES:
1. FOR ANALOG INPUTS, MAINTAIN VOLTAGE AND TOTAL LOOP RESISTANCE PER MFG. SPECIFICATIONS.
2. INPUT IMPEDANCE FOR SERIES 2Plus ANALOG INPUTS IS 135 OHMS.
3. ACTIVE DISCRETE INPUTS WILL SOURCE 1mA WHEN GROUNDED.
4. THE ProControl SOURCES 5VDC FOR DISCRETE INPUTS.

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FIGURE: 2

ProControl WIRING
TOP LEFT SIDE–A2
NYSDEC NOW CORORATION SITE
CLINTON, NY

DATE: 10/20/08	DRAWN BY: DEK	PROJECT: 9290	SCALE: NTS
DATE:	REVISED BY:	PREPARED FOR: EARTHTECH	
DATE:	REVISED BY:		

TOPLTA2.DWG

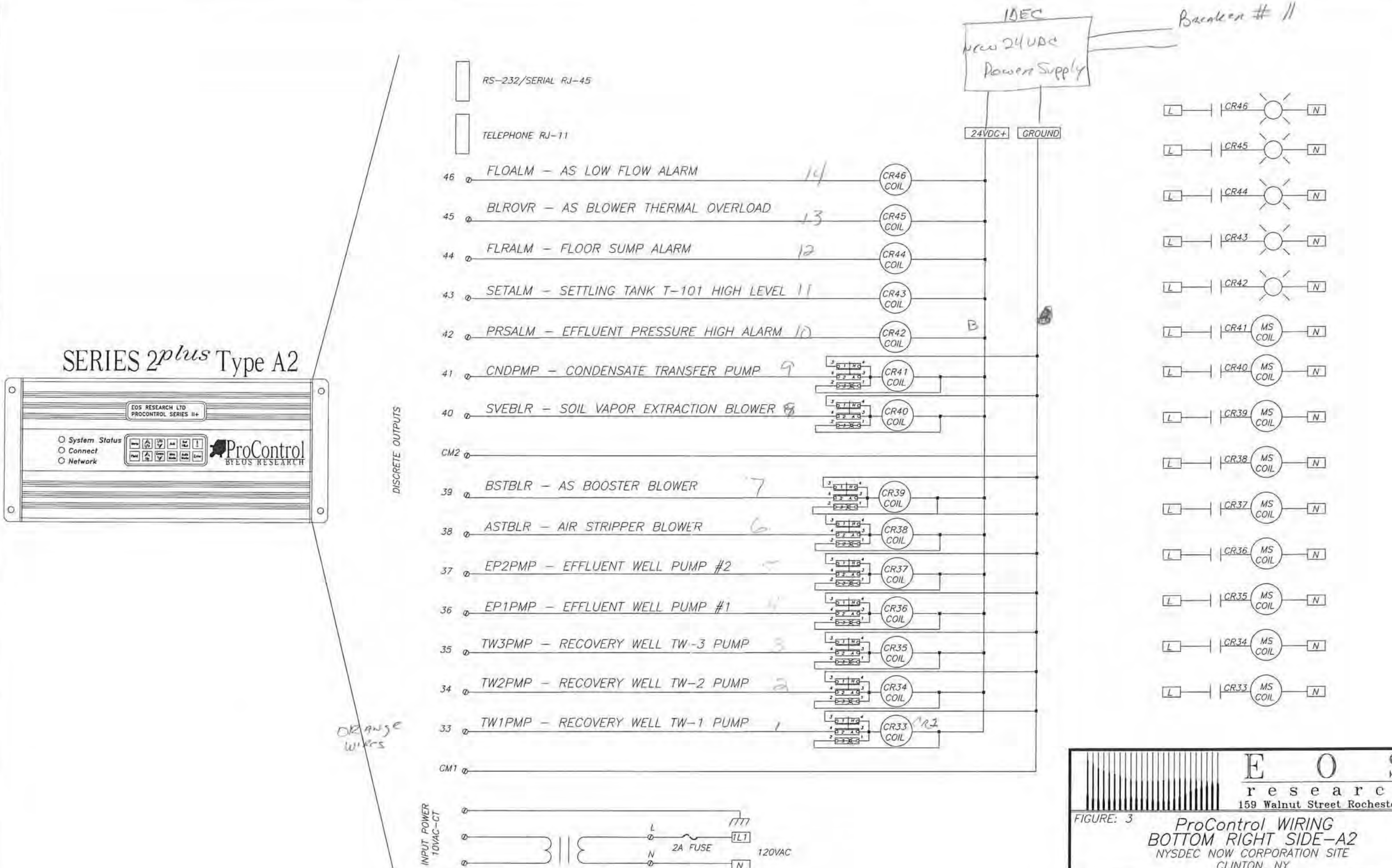

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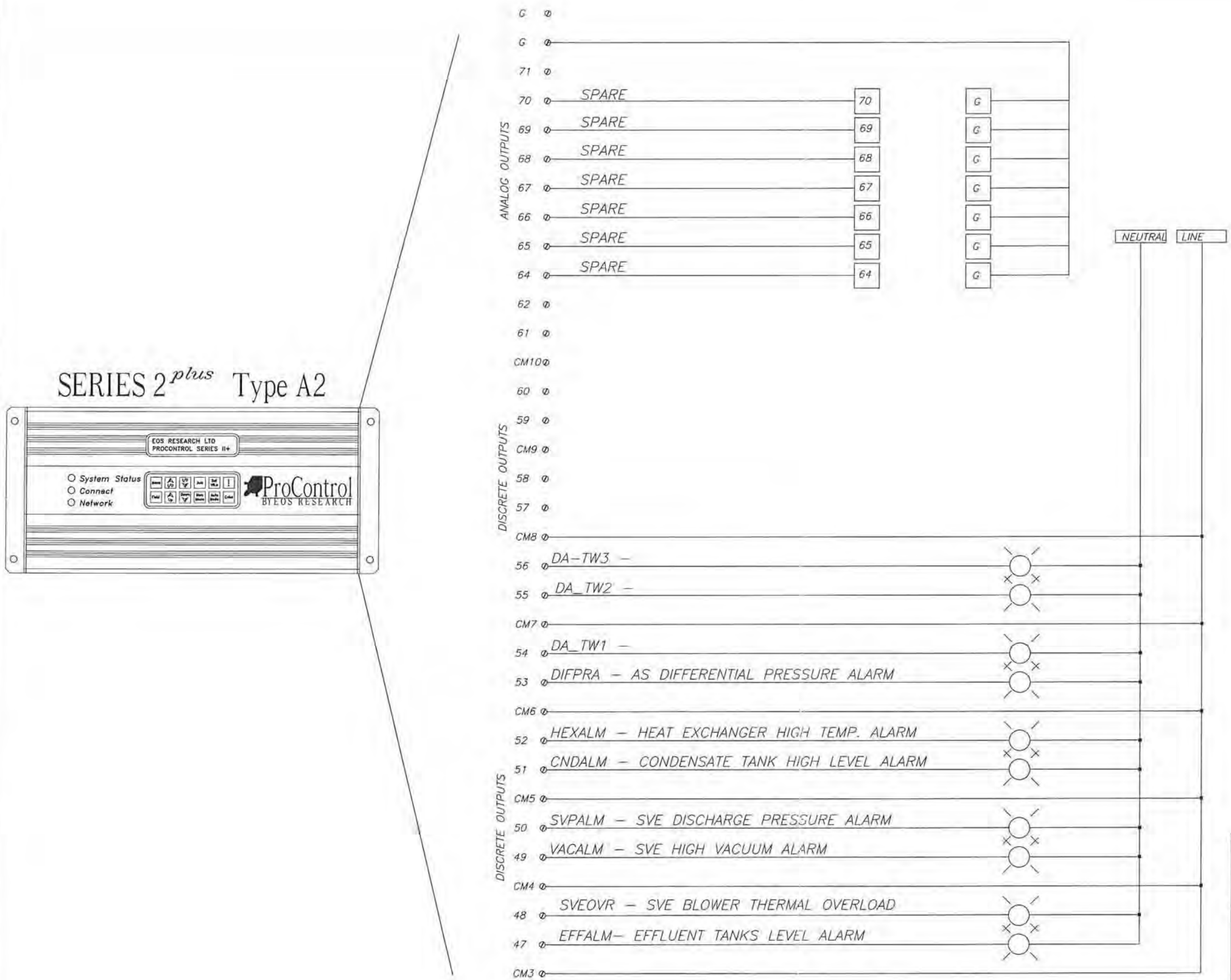
FIGURE: 3

ProControl WIRING
BOTTOM RIGHT SIDE–A2
NYSDEC NOW CORPORATION SITE
CLINTON, NY

DATE: 10/20/08	DRAWN BY: DEK	PROJECT: 9290	SCALE: NTS
DATE:	REVISED BY:	PREPARED FOR: EARTHTECH	
DATE:	REVISED BY:		

NOTES:
1. OUTPUT CHANNELS ARE RATED AT 125V/ 0.5A, 24VDC/0.5A
2. CM1 IS SWITCHED TO 33–39, CM2 IS SWITCHED TO 40–46. WHEN OUTPUT IS ACTIVE.

BOTRTA2.DWG



NOTES:
1. OUTPUT CHANNELS ARE RATED AT 125V/ 0.5A, 24VDC/0.5A
2. CM3 IS SWITCHED TO 47-48, CM4 IS SWITCHED TO 49-50, ETC. WHEN OUTPUT IS ACTIVE.

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FIGURE: 4

ProControl WIRING
TOP RIGHT SIDE-A2
NYSDEC NOW CORPORATION SITE
CLINTON, NY

DATE: 10/20/08	DRAWN BY: DEK	PROJECT: 9290	SCALE: NTS
DATE:	REVISED BY:	PREPARED FOR: EARTHTECH	
DATE:	REVISED BY:		

TOPRTA2.DWG

EOS RESEARCH LTD.
ProControl Series II+

ProView Configuration File Information

FAX Recipient:	STEVEN CHOIRIERE
Customer:	EARTH TECH
Site Location:	NOW CORPORATION
Setup:	2
Option:	A
Type:	122
Serial Number:	9290
Date:	10/20/2008
Time:	14:39:28
ProView:	Version 2.160

THE INPUTS INCLUDED IN THIS SYSTEM ARE:

#	TAGNAME	TAGNAME DESCRIPTION	SETUP*	RANGE
1	DOOR	Door Switch	D,NO,AL	
2	BLOFLO	Air Stripper/Booster Blower Low Flow	D,NO,AL	
3	EFFPLD	Effluent Pump Leak Detection	D,NO,AL	
4	T101HH	Settling Tank T-101 High-High Level	D,NO,AL	
5	P201HL	Settling Tank T-201 Pump Down Switch	D,NO,ST	
6	T201HH	Settling Tank T-201 High-High Level	D,NO,AL	
7	T301HH	Effluent Tank T-301 High-High Level	D,NO,AL	
8	FLRSMP	Floor Sump High Level	D,NO,AL	
12	T501HH	Condensate Tank T-501 High-High Level	D,NO,AL	
13	T501HL	Condensate Tank T-501 High/Low Level	D,NO,ST	
14	TW1_HH	Recovery Well #1 High-High Level	D,NO,AL	
15	BLDTMP	Building Temperature High/Low	D,NO,AL	
16	RESET	Reset Switch	D,NC,ST,SU	
17	TW1FLO	Recovery Well #1 Total Flow	P,EP,ST	0-1 UPP
18	TW2FLO	Recovery Well #2 Total Flow	P,EP,ST	0-1 UPP
19	TW3FLO	Recovery Well #3 Total Flow	P,EP,ST	0-1 UPP
20	TW1LVL	Recovery Well #1 Level	A,EP,ST	0-115.5 FT
21	TW2LVL	Recovery Well #2 Level	A,EP,ST	0-115.5 FT
22	TW3LVL	Recovery Well #3 Level	A,EP,ST	0-115.5 FT
23	EFFPRS	Effluent Water Pressure	A,EP,ST	0-100 PSI
25	SVEVAC	SVE Vacuum High	D,NO,AL	
26	SVEPRS	SVE Discharge Pressure High	D,NO,AL	
27	BLRTHM	Air Stripper/Booster Blowers Thermal Overload	D,NO,AL	
28	SVETHM	SVE Blower Thermal Overload	D,NO,AL	
29	EP1THM	Main Effluent Pump Thermal Overload	D,NO,AL	
30	DIFPRS	Air Stripper Differential Pressure Switch	D,NO,AL	
31	CNDTHM	Condensate Transfer Pump Thermal Overload	D,NO,AL	
32	HEXTMP	Heat Exchanger High Temperature	D,NO,AL	

*INPUT SETUP NOTES

D - This input is a (Discrete) or ON/OFF Input.
A - This input is a (Analog) or Variable Input.
C - This input is a Pulse Flowmeter Input.
P - This input is a Pulse Accumulator Input.
UPP - Units per Pulse. Number of units (i.e. Gallons) to record for each pulse
NO-This input is a (Normally Open) Discrete Input.
NC-This input is a (Normally Closed) Discrete Input.
EP-(Endpoint) This input is "Active" when its value is outside the low to high alarm levels.
WD-(Window) This input is "Active" when its value is between the low and high alarm levels.
ST-(Status) This input shows a green LED in ProView when it is in its Active State.
AL-(Alarm) This input shows a red alarm bell in ProView when it is in its Active State.
SU-(Startup) This is a menu function input. When activated it will run the startup routine.
SD-(Shutdown) This is a menu function input. When activated it will run an emergency shutdown.
MN-(Manual) This is a menu function input. When activated it place the unit in Manual Mode.
AU-(Auto) This is a menu function input. When activated it place the unit in Auto Mode.
SQ-(Square Root) This analog channel's reading is proportional to the square root of the input.
LT-(Lamp Test)This is a Lamp Test input. When activated it will turn on all Alarm Light outputs.

THE DISCRETE OUTPUTS INCLUDED IN THIS SYSTEM ARE:

	#	TAGNAME	TAGNAME DESCRIPTION	SETUP*
33	1	TW1PMP	Recovery Well TW-1 Pump	
	2	TW2PMP	Recovery Well TW-2A Pump	
	3	TW3PMP	Recovery Well TW-3 Pump	
	4	EP1PMP	Effluent Well Pump #1	
	5	EP2PMP	Effluent Well Pump #2	
	6	ASTBLR	Air Stripper Blower	
39	7	BSTBLR	Booster Blower	
	8	SVEBLR	Soil Vapor Extraction Blower	
	9	CNDPMP	Condensate Transfer Pump	
	10	PRSALM	Effluent Pressure High Alarm	LT,AI
	11	SETALM	Settling Tank T-101 High Level Alarm	LT,AI
	12	FLRALM	Floor Sump Alarm	LT,AI
	13	BLROVR	Air Stripper/Booster Blower Thermal Overload Al...	LT,AI
46	14	FLOALM	Air Stripper/Booster Blower Low Flow Alarm	LT,AI
47	15	EFFALM	Effluent Tanks T-201/T-301 High Level Alarm	LT,AI
	16	SVEOVR	SVE Blower Thermal Overload Alarm	LT,AI
	17	VACALM	SVE Vacuum High Alarm	LT,AI
	18	SVPALM	SVE Discharge Pressure High Alarm	LT,AI
	19	CNDALM	Condensate Tank High Level Alarm	LT,AI
	20	HEXALM	Heat Exchanger High Temperature Alarm	LT,AI
	21	DIFPRA	Air Stripper Differential Pressure Alarm	LT,AI
	23	DA_TW1		
	24	DA_TW2		
56	25	DA_TW3		

*OUTPUT SETUP NOTES

G1-(Group 1)- This output will not respond to processes 17-32.
G2-(Group 2)- This output will not respond to processes 01-16.
LT-(Lamp Test) - This output has been declared as an alarm light.
AI-(Alternate Image) - This output is displayed as an icon other than the default switch.

THE ANALOG OUTPUTS INCLUDED IN THIS SYSTEM ARE:

#	TAGNAME	TAGNAME DESCRIPTION	SETUP*	INPUT

*ANALOG OUTPUT SETUP NOTES

PID -This output is involved in a PID (Proportional,Integral,Derivative) control loop.
PRO -This output is involved in an open (Proportional) control loop.
FOR -The PID or PRO loop will run in the (Forward) direction.
REV -The PID or PRO loop will run in the (Reverse) direction.
INPUT-This Tagname will serve as the input to the control loop.

THE PROCESS CONTROL TASKS EXERCISED BY THIS SYSTEM ARE:

Process 01: If DOOR is ON
THEN Send Report[FAX #1;FAX #2;Page #1;Page #2],

Page Message: ' '

Process 02: If BLOFLO is ON
THEN Delay for 10 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
Initiate Shutdown, Switch FLOALM ON
Page Message: ' '

Process 03: If EFFPLD is ON
THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],

Page Message: ' '

Process 04: If T101HH is ON
THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
Initiate Shutdown, Switch SETALM ON
Page Message: ' '

Process 05: If T201HH is ON
THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
Initiate Shutdown, Switch EFFALM ON
Page Message: ' '

Process 06: If T301HH is ON
THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
Initiate Shutdown, Switch EFFALM ON
Page Message: ' '

Process 07: If P201HL is ON
THEN Switch EP1PMP ON

Process 08: If P201HL is OFF
THEN Switch EP1PMP OFF

Process 09: If FLRSMP is ON
THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
Initiate Shutdown, Switch FLRALM ON
Page Message: ' '

```
Process 10: If T501HH is ON
            THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
            Switch SVEBLR OFF AND CNDALM ON
            Page Message: '  '

Process 11: If T501HL is ON
            THEN Switch CNDPMP ON

Process 12: If T501HL is OFF
            THEN Switch CNDPMP OFF

Process 13: If TW1_HH is ON
            THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
            Switch TW1PMP OFF
            Page Message: '  '

Process 14: If BLDTMP is ON
            THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],

            Page Message: '  '

Process 15: If TW1_HH is OFF AND TW1LVL is High AND DA_TW1 is OFF
            THEN Delay for 5 Seconds, Switch TW1PMP ON

Process 16: If TW1LVL is Low
            THEN Switch TW1PMP OFF

Process 17: If TW2LVL is High AND DA_TW2 is OFF
            THEN Delay for 5 Seconds, Switch TW2PMP ON

Process 18: If TW2LVL is Low
            THEN Switch TW2PMP OFF

Process 19: If TW3LVL is High AND DA_TW3 is OFF
            THEN Delay for 5 Seconds, Switch TW3PMP ON

Process 20: If TW3LVL is Low
            THEN Switch TW3PMP OFF

Process 21: If EFFPRS is High
            THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
            Switch PRSALM ON
            Page Message: '  '

Process 22: If SVEVAC is ON
            THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
            Switch SVEBLR OFF AND VACALM ON
            Page Message: '  '

Process 23: If SVEPRS is ON
            THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
            Switch SVEBLR OFF AND SVPALM ON
            Page Message: '  '

Process 24: If BLRTHM is ON
            THEN Delay for 1 Second, Send Report[FAX #1;FAX #2;Page #1;Page #2],
            Initiate Shutdown, Switch BLROVR ON
            Page Message: '  '
```

Process 25: If SVETHM is ON
THEN Delay for 1 Second, Send Report[FAX #1;FAX #2;Page #1;Page #2],
Switch SVEBLR OFF AND SVEOVR ON
Page Message: ' '

Process 26: If EP1THM is ON
THEN Delay for 1 Second, Send Report[FAX #1;FAX #2;Page #1;Page #2],
Initiate Shutdown,
Page Message: ' '

Process 27: If DIFPRS is ON
THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
Initiate Shutdown, Switch DIFPRA ON
Page Message: ' '

Process 28: If CNDTHM is ON
THEN Delay for 1 Second, Send Report[FAX #1;FAX #2;Page #1;Page #2],
Switch SVEBLR OFF AND CNDPMP OFF
Page Message: ' '

Process 29: If HEXTMP is ON
THEN Delay for 5 Seconds, Send Report[FAX #1;FAX #2;Page #1;Page #2],
Switch SVEBLR OFF AND HEXALM ON
Page Message: ' '

Startup 01: Switch PRSALM OFF AND SETALM OFF AND FLRALM OFF AND BLROVR OFF AND FLOALM OFF AND EFFALM OFF AND SVEOVR OFF AND VACALM OFF AND SVPALM OFF AND CNDALM OFF AND HEXALM OFF AND DIFPRA OFF

Startup 02: Switch ASTBLR ON

Startup 03: Delay for 2 Seconds, Switch BSTBLR ON

Startup 04: Delay for 2 Seconds, Switch SVEBLR ON

Startup 05: Delay for 30 Seconds, Turn [illegible] mode

Shutdown 01: Switch TW1PMP OFF AND TW2PMP OFF AND TW3PMP OFF

Shutdown 02: Delay for 2 Seconds, Switch EP1PMP OFF AND EP2PMP OFF AND CNDPMP OFF

Shutdown 03: Delay for 2 Seconds, Switch SVEBLR OFF

Shutdown 04: Delay for 5 Minutes, Switch ASTBLR OFF AND BSTBLR OFF

Sensing the Environment™

KPSI® Transducers

measurement SPECIALTIES

MODEL	ACCURACY	DESCRIPTION	PHOTO	MINIMUM FULL SCALE	MAXIMUM FULL SCALE	OUTPUT
LEVEL TRANSDUCERS (SUBMERSIBLE)						
500 501	±0.05% TEB ±0.01 ft H_2O	1" Bore Diameter Microcomputer-based, digital output		10 feet	230 feet 50 feet	SDI-12
355 353 351	±0.05% TEB ±0.10% TEB ±0.01ft H2O	0.75" Bore Diameter Microcomputer-based, digital output		10 feet	230 feet 230 feet 69 feet	SDI-12
335 330 320	±0.05% FS ±0.10% FS ±0.25% FS	Small bore, analog output		5 feet	700 feet	4-20 mA, 0-5 VDC
735 730 720 710 700	±0.05% FS ±0.10% FS ±0.25% FS ±0.50% FS ±1.00% FS	General purpose, analog output		2.3 feet	700 feet	4-20 mA, 0-5 VDC
705	±0.25% FS	Non-fouling, 0.90" diaphragm, analog output		6 feet	115 feet	4-20 mA, 0-5 VDC
750	±0.25% FS	Non-fouling, 2.75" diaphragm, analog output		10 feet	115 feet	4-20 mA, 0-5 VDC
342	±0.10% FS ±0.25% TEB	ASIC-based, small bore, analog output		10 feet	230 feet	4-20 mA, 0-5 VDC
300DS	±0.50% FS	Deep water, small bore, analog output		700 feet	4614 feet	4-20 mA, 0-5 VDC
PRESSURE TRANSDUCERS (NON-SUBMERSIBLE)						
30 27 28	±0.10% FS ±0.25% FS ±0.50% FS	General purpose, analog output		1 psi	2000 psi	4-20 mA, 0-5 VDC

MODEL	ACCURACY	DESCRIPTION	PHOTO	MINIMUM FULL SCALE	MAXIMUM FULL SCALE	OUTPUT

ACCESSORIES

Lightning Protection		**Lifetime warranty** for damage due to lightning or voltage spikes Low peak clamping voltage Up to 20,000 Amperes Peak Surge Protection Automatically Resets
Aneroid Bellows		Maintenance free moisture protection for vented gage transducers Fluctuates with changes in atmospheric pressure maintaining a constant barometric reference
Vent Filter		Desiccant filled moisture protection 1 year warranty guarantees Low maintenance
Digital Displays		Many types to chose from Provides a visual readout of a single KPSI transducer having mA or VDC output

Installation Hardware:
Anti-Snag Cone, Cable Hanger, Mounting Clamp, Well Caps,
Junction Box, Identification Tags, Cable Splice Kit

Replaceable and Interchangeable Nose Caps:
Open-face Nose Cap, Ported Nose Cap
Piezometer Nose Cap, Male NPT Nose Cap

Options Include:
Reference Pressure Format
Transducer Output
Electrical Connection
Temperature Sense Output
Wetted Materials
Corrosion Protection
Expedite Shipment Service

For product photos and datasheets, visit our website at www.PressureSystems.com
Order online at: *LEVELandPRESSURE.com*

Measurement Specialties, Inc.
1000 Lucas Way
Hampton, VA 23666
(757) 865-1243; Fax (757) 865-8744
Toll Free: (800) 328-3665

KPSI Series 700 Submersible Level Transducer

Overview Specifications

Parameter	735(1)	730(1)	720	710	700	Units	Comments
LEVEL RANGES							
Full Scale Level Ranges (2)	5 thru 700 (1.5 thru 210)		2.3 thru 700 (0.70 thru 210)			ft pO (m pO)	for vented gage reference
	N/A	35 thru 700 (10 thru 210)	10 thru 700 (3 thru 210)			ft pO (m pO)	for sealed gage reference
	N/A	35 thru 700 (10 thru 210)				ft pO (m pO)	for absolute reference
Proof Pressure	1.5					x FS	
Burst Pressure	2.0					x FS	
STATIC PERFORMANCE							
Static Accuracy (3)	±0.05	±0.10	±0.25	±0.50	±1.00	% FSO	BFSL
Resolution	Infinitesimal						
ENVIRONMENTAL							
Wetted Materials	316 SS or Titanium; Delrin®; polyurethane or Viton®						Delrin® and Viton® are registered trademarks of DuPont.
Compensated Temp Range	0 to 50					ºC	
Thermal Error (4)	±0.05 (5)					%FSO/ºC	worst case over compensated temperature range
Operating Temp Range	-20 to 60 0 to 50					ºC ºC	when using polyurethane cable when using ETFE cable (11)
Protection Rating	IP 68, NEMA 6P						
ELECTRICAL							
Excitation	9 - 30 (12) 2.5 - 10					VDC	for mA, VDC
Input Current	20 3.5					mA max	for mA output for VDC output
Output (10)	4 - 20 0 - 5					mA VDC	options available (6)
Zero Offset	±0.20 (8) < 0.25					mA VDC	for mA output for VDC output
Output Impedance	See Loop Resistance diagram page 7 of datasheet 20					ohm	for mA output for VDC output
Insulation Resistance	100					mega ohm	at 50 VDC
Circuit Protection	Polarity, surge/shorted output						

PHYSICAL			
Approximate Weight	0.44 (198) 0.05 (79)	lbs (g) lbs/ft (g/m)	transducer cable
Cable Jacket Material Pull Strength Number of Conductors Conductor Size	 Polyurethane (std) ETFE (9) (opt) 200 (90) 4 22	 lbs (kg) AWG	Tefzel®, Teflon® and Kevlar® are registered trademarks of DuPont.
Cable Seal	Molded Polyurethane Viton® Gland		for polyurethane cable for ETFE cable
TEMPERATURE OUTPUT OPTION (NOT INTRINSIC SAFETY APPROVED)			
Temperature Range	-20 to 60	ºC	available for 4-20 mA output versions only
Output Signal	4-20	mA	
Temperature Measurement Accuracy	±4	ºC	
LIGHTNING PROTECTION (OPTIONAL) (13)			
Life Expectancy	> 1000 operations		
Peak Clamping Voltage	36 volts		
Response Time	< 10 nsecs		

1. For ranges > 230 ft (70 m) pO, output is 4-20 mA only.
2. Intermediate level ranges are available.
3. Static accuracy includes the combined errors due to nonlinearity, hysteresis and nonrepeatability on a Best Fit Straight Line (BFSL) basis, at 25ºC per ISA S51.1.
4. Thermal error is the maximum allowable deviation from the Best Fit Straight Line due to a change in temperature, per ISA S51.1.
5. For ranges < 12 ft (4 m) pO, maximum thermal error is ±0.1% FSO/ºC.
6. Custom VDC output levels can be provided up to 2.5 VDC less than the excitation supply voltage. Contact Customer Service for VDC output availability.
7. For ranges <= 5 ft (1 m) pO, zero offset is ±0.25 mA.
8. ETFE is a fluoropolymer (Teflon® derivative) material, Tefzel® or equivalent.
9. For range < 5 ft (1.5 m) pO, only 4-20 mA output is available.
10. -20ºC to 50ºC for level ranges <= 100 ft (70m) pO when using ETFE cable.
11. Intrinsic safety limits excitation to 28V.
12. The power supply needs to be limited to 150 mA to avoid lock up of the gas tube after a suppression event.

Specifications subject to change without notice.

KPSI 700 | 710 | 720 submersible level transducer

KPSI Level Transducers

FEATURES

- CUSTOM LEVEL RANGES UP TO 700FT (210M) H2O
- CUSTOM POLYURETHANE OR ETFE CABLE LENGTHS
- STATIC ACCURACY TO ± 0.25% FSO
- MULITPLE ANALOG OUTPUTS
- WELDED 316SS OR TITANIUM
- OPTIONAL LIFETIME LIGHTNING PROTECTION
- CUSTOM-BUILT IN TWO DAYS
- TWO YEAR WARRANTY
- MULTIPLE NOSE PIECE STYLES
- SHIPPED WITH LONG LIFE VENT FILTER

APPLICATIONS

- LIFT STATIONS
- PUMP CONTROL
- LEVEL CONTROL
- SURFACE WATER MONITORING
- LANDFILL LEACHATE
- WELL MONITORING
- GROUNDWATER MONITORING
- SLUG TESTS

KPSI 700 | 710 | 720 specifications information

FULL SCALE LEVEL RANGES

Intermediate Level Ranges Are Available.
Vented gage reference ....2.3 thru 700 ft (0.70 thru 210 m) H20
Sealed gage reference ....10 thru 700 ft (3 thru 210 m) H20
Absolute reference...........................35 thru 700 ft (10 thru 210 m) H20
Proof Pressure...1.5 X FS
Burst Pressure...2.0 X FS

STATIC PERFORMANCE

Combined Effects Of Non-Linearity, Hysteresis And Repeatability, Best Fit Straight Line Method.
Static Accuracy..•720:±0.25 %FSO
•710:±0.50 %FSO•700:±1.00 %FSO
Resolution..±0.0001%FS

ENVIRONMENTAL

Wetted Materials....316 SS or Titanium; Delrin®; polyurethane or Viton®
Delrin® and Viton® are registered trademarks of Dupont.
Compensated Temperature Range...0 To 50ºC
Maximum Allowable Deviation From The Best Fit Straight Line Due To A Change In Temperature
Thermal Error..±0.05%FSO/ºC worst case over compensated temperature range, for ranges < 12 ft (4 m) H2O, Maximum thermal error is ±0.1% FSO/ºC
Operating Temperature Range...-20 To 60ºC when attached to polyurethane cable
Protection Rating...IP 68, NEMA 6P

ELECTRICAL

Excitation.............................• 9-28V - VDC output (0-5V, 0-2.5V, 0-4V)
• 9-28V - mA output (4-20) • 15-28V - VDC output (0-10V)
• 10-28V - VDC output (1.5-7.5V)
Input Current.....20 mA max, for mA output; 3.5 mA max, for VDC output
Output....4–20 mA, 0-5 VDC, 0-2.5VDC, 0-4VDC, 0-10VDC, 1.5-7.5VDC
For ranges < 5 ft (1.5 M) H2O, only 4-20 mA output is available

Zero Offset......... ±0.25 mA for mA output, < 0.25 VDC for VDC output
Output Impedance ....See loop resistance diagram for mA output, 20 ohm for VDC output
Insulation Resistance.....................................100 mega ohm at 50 VDC
Circuit Protection..Polarity, surge/shorted output

CERTIFICATIONS

UL, CUL and FM – Intrinsically safety approved
CE compliant to EN 61326-1:2001 and EN 61326-2-3:2006

PHYSICAL

Approximate Weight...................................0.44 Lbs (198 g) transducer, 0.05 Lbs/ft (79 g/m) cable
Cable Jacket Material..Polyurethane (standard), Tefzel®, Teflon® and Kevlar® are registered trademarks of Dupont. ETFE (optional), ETFE is a fluoropolymer (Teflon® derivative) material, Tefzel® or equivalent
Cable Pull Strength...200 Lbs (90 kg)
Cable Number of Conductors...4
Cable Conductor size...22 AWG
Cable Seal.........................Molded Polyurethane for polyurethane cable
Viton® Gland for ETFE cable

TEMPERATURE OUTPUT OPTION

(not intrinsically safety approved)
Temperature Range......-20 To 60ºC, available for 4-20mA output versions only
Output Signal...4-20 mA
Temperature Measurement Accuracy..±4ºC

LIGHTNING PROTECTION

Power Supply Needs To Be Limited To 150 mA To Avoid Lock Up Of The Gas Tube After A Suppression Event
Life Expectancy..>1,000 Operations
Peak Clamping Voltage...36 Volts
Response Time...<10 nsecs

34 Research Drive, Hampton, VA 23666 USA, 757-865-1243, Toll Free 800-328-3665, Fax 757-865-8744
E-mail sales@PressureSystems.com • www.PressureSystems.com • online orders www.LevelandPressure.com • iso–9001:2008

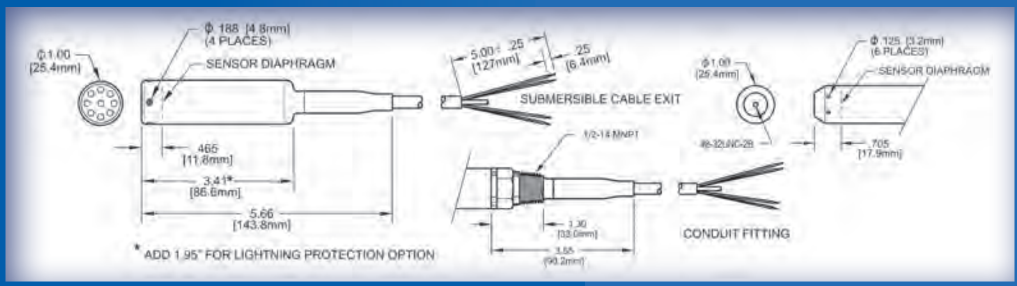
measurement SPECIALTIES

KPSI 700 | 710 | 720 technical data

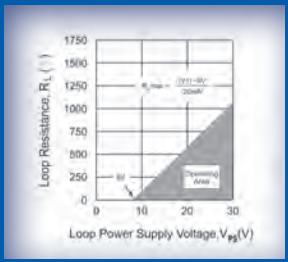
ELECTRICAL TERMINATION

22AWG CONDUCTORS IN A SHIELDED CABLE WITH VENT TUBE		
4-20 mA	RED BLACK	+ EXCITATION - EXCITATION
0-5 VDC	RED BLACK WHITE	+ EXCITATION - EXCITATION + SIGNAL
ALL	DRAIN WIRE	SHIELD

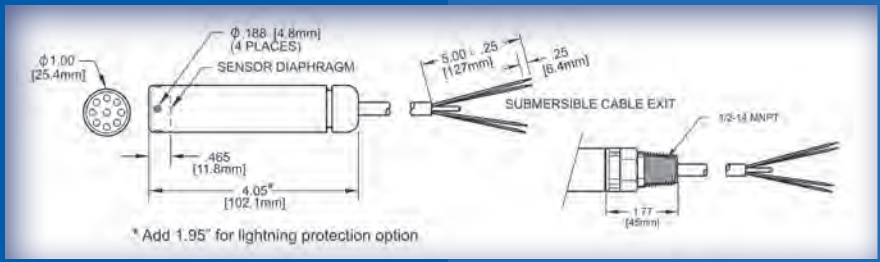
MOLDED CABLE SEAL CONFIGURATION FOR POLYURETHANE CABLE



LOOP RESISTANCE VS. POWER SUPPLY



GLAND CABLE SEAL CONFIGURATION FOR ETFE CABLE



KPSI 700 | 710 | 720 order information

RECYCLED PAPER

MODEL **700,** ±1.00% FSO Static Accuracy **710,** ±0.50% FSO Static Accuracy **720,** ±0.25% FSO Static Accuracy

MATERIAL **S,** Stainless Steel, **T,** Titanium

REFERENCE FORMAT **1,** Vented gage, **3,** Sealed gage, **4,** Absolute

OUTPUT **3,** 0-5 VDC, **F,** 0-2.5V **G,** 0-4V **H,** 0-10V **J,** 1.5-7.5V **4,** 4-20 mA **6,** 4-20 mA temp. measurement option

PRESSURE CONNECTION (NOSECAP FITTING) **A,** Open-face nosecap, **B,** Ported nose cap, **E,** Piezometer **2,** 1/4" - 18 NPT male fitting, **7,** 1/2"-14 NPT male fitting

ELECTRICAL CONNECTION **0,** Molded cable seal, **4,** 1/2"-14 NPT male conduit fitting with molded cable seal **A,** Gland cable seal **B,** 1/2"-14 NPT male conduit fitting with gland cable seal

LIGHTNING PROTECTION **A,** None **B,** Full Lightning Protection

LEVEL RANGE (at MAX output)1 ###.###

LEVEL RANGE (at MIN output)1 ###.###

MOISTURE PROTECTION **A,** None (sealed/absolute only) **B,** Vent Filter **C,** Aneroid Bellows

CABLE TYPE **1,** Polyurethane **2,** ETFE

CABLE LENGTH (in feet) ####

LABEL2 **A,** psi **B,** ft H2O **C,** m H2O

7 0

EXAMPLE 7 2 0 S 1 4 0 0 A 0 0 4 . 3 3 4 0 0 0 . 0 0 0 B 1 0 0 5 5 A

1. The part number requires two level range limits, corresponding to maximum and minimum outputs, to be specified in **pounds per square inch** (psi) to three decimal places. The lower level range is typically 000.000 unless otherwise required. For reverse output requirements, enter the lower range for the maximum output and the upper range for the minimum output. Use the following conversion factors:

ft H2O / 2.3073 = psi Examples: 10 ft H2O / 2.3073 = 4.334 psi (enter 004.334 in the part number)
m H2O / 0.703265 = psi 10m H2O / 0.703265 = 14.219 psi (enter 014.219 in the part number)

For sealed gage reference add local atmosphere when converting to psi. Contact PSI for assistance.
Example: 10 ft H2O / 2.3073 +14.7 = 19.034 psi (enter 019.034 in the part number)

2. Contact PSI if private labeling is required.

Warranty: The Series 700, 710 and 720 product is warranted against defects in material and workmanship for 2 years from date of shipment. Products not subjected to misuse will be repaired or replaced. THE FOREGOING IS IN LIEU OF ANY OTHER EXPRESSED OR IMPLIED WARRANTIES.We reserve the right to make changes to any product herein and assume no liability arising out of applications **OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED. PRODUCTS DESCRIBED IN THIS SPECIFICATION ARE NOT INTENDED FOR LIFE SUPPORT APPLICATIONS.**

NO. 0910

KPSI®

Level Transducers

KPSI® User's Manual

18th Edition

February 2010

Our Company

Pressure Systems is an ISO9001:2000 certified U.S. manufacturer of submersible and non-submersible (above ground) pressure transducers for environmental, industrial and municipal applications. Our KPSI™ Level and Pressure Transducers have been specified in thousands of projects throughout the United States, Canada and Europe by geologists, system integrators, national engineering firms and a variety of government agencies. Typical applications include, but are not limited to, pump control, tank level monitoring, sewage lift station operation, reservoirs, weirs, flumes, site remediation, watershed management, storm water/well monitoring, pump/pipeline pressures and compressor pressures.

Website and E-Mail

You may visit our website at www.PressureSystems.com to look at our latest new product releases, application notes, product certifications and specifications, as well as Intrinsic Safety control installation drawings. E-mail your questions and comments to us: sales@PressureSystems.com.

E-commerce

Orders may be placed on-line by visiting our e-commerce site *(www.LEVELandPRESSURE.com)* or by contacting the factory or local representative.

Applicable Products

This manual provides information applicable to the use of the following KPSI Level and Pressure Transducers:

Please note: Series 500 and Series 550 (waterMONITOR) have separate manuals.

Level Transducers (Submersible)
Series 700/710/720/730/735
Series 320/330/335/340
Series 300DS
Series 705
Series 750

Pressure Transducers (Non-submersible)
Series 27/28/30

Table of Contents

1.0 Product Description

General Characteristics

KPSI™ Level and Pressure Transducers use isolated-diaphragm sensors that are specifically designed for use with hostile fluids and gases. These sensors utilize a silicon pressure cell that has been fitted into a stainless steel or titanium package with an integral, compliant stainless steel or titanium barrier diaphragm. This sensor assembly is housed in a rugged 316 stainless steel or titanium case which provides for a variety of level ranges from 2.3 ft (0.75 m) H_2O through 4614 ft (1408 m) H_2O and pressure inputs from 0-1 (7 kPa) through 0-15000 psi (103 mPa). Our devices feature internal signal conditioning. Standard outputs are 4-20 mA and VDC.

All units containing active electronic components have surge and reverse polarity protection. For ease of use in the field, our transducers are permanently laser engraved with our logo and name, wiring information, part number (P/N), serial number (S/N), date of manufacture (DOM), range, excitation and output. Transducers are offered in diameters of 1.0 (25 mm) and 0.75 inches (19 mm).

Care and Handling

Our transducers are designed for rugged use. However, they need protection from over pressure and sharp impact. When lowering them into a liquid, penetrate the surface slowly and only to the depth necessary. Avoid dropping the unit from above the surface. Clean all transducers by rinsing them in a mild detergent. Direct probing of the diaphragm or attempts to remove protective screens will damage the sensor, voiding the warranty.

Calibration

All transducers are shipped with calibration information unique to each transducer. Make sure you keep each calibration report. However, should you misplace your calibration sheet, you can contact the factory and request a duplicate. All KPSI™ Transducer calibrations are traceable to the National Institute of Standards and Technology (NIST).

Approvals

Most of our products have UL and FM certification for intrinsic safety. Their respective installation control drawings can be downloaded from our website. Several of our product lines also carry ABS approval. Most products are CE compliant to EN 61326-1:2006 and EN 61326-2-3:2006. CE compliant units are labeled accordingly.

2.0 Product Accessories and Options

WARNING: POTENTIAL ELECTROSTATIC CHARGING HAZARD

In hazardous locations:

- **Avoid building up static charge on case of data protector and plastic accessories.**
- **Use damp rag to wipe data protector and plastic accessories to avoid static build up.**

Nose Caps

There are several different user-installable nose caps for the 700, 710, 720, 730, 735 submersible level transducers. The ported nose cap (Delrin) with #8-32UNC-2B threaded hole is best used where weights are required and for those installations where users may encounter sharp, protruding objects. The open-face nose cap which allows maximum contact with the liquid media is ideal for wastewater and "greasy" applications where clogging of the sensor is a concern. The piezometer nose cap allows the unit to be buried in saturated soil without damage to the sensor diaphragm. The 1/4" male NPT pressure nose cap is not only useful for calibration purposes but also allows the device to be used as a submersible or above ground pressure transducer.

WARNING: Caution must be exercised when inserting a screw into the nose cap as the maximum insertion length should not exceed 0.175".

810 SuperDry™ Vent Filter or 815 Aneroid Bellows

All submersible transducers with vented gauge format are supplied with a protective barrier that guards against moisture buildup in the cable vent tube. The 810 SuperDry™ vent filter is installed free of charge and is guaranteed to operate maintenance free for one year. We also offer the 815 Aneroid Bellows as a maintenance free option that can be used on submersibles with accuracies of: ±1%, ±0.5%, or ±0.25% FSO. These barriers ensure reliable operation and long life as they protect sensitive electronic components from mildew and prevent the formation of a liquid column in the vent tube. Any such liquid column directly affects calibration of the transducer.

Sacrificial Anodes

Our sacrificial anodes are made from a special zinc alloy formulated to guarantee continued effectiveness over long periods. Because the anodes are 95% galvanic, they will not corrode unless there is an electrolytic demand. The anode maintains a high driving potential throughout its 12 month life, is self-sluffing and always exposes new zinc for the best possible protection. For those applications where cable buoyancy is a problem, the sacrificial anode can be substituted for hanging weights.

Sacrificial Anodes provide cathodic protection against galvanic corrosion for our submersible pressure transducers. Galvanic corrosion occurs when dissimilar metals are placed in contact with an electrolyte. This condition causes a potential difference to exist between the two metals, causing electron flow between them. Corrosion of the less corrosion-resistant metal is increased and attack of the more resistant metal is decreased. The 820 Sacrificial Anode is clamped to the exterior of a one-inch bore submersible transducer. We also offer a 1" diameter pencil anode, the 825, that attaches to the nose cap of either a 3/4" or 1" bore submersible transducer.

Absolute/Sealed Gage Transducer

The sealed gage option for submersible transducers eliminates the need for a vent filter. The standard output of a sealed gauge transducer is 4 mA at 14.70 psia. Before ordering a sealed gauge transducer, the customer should determine the altitude (above sea level) of the installation and inform PSI's Customer Service of this value before order entry. During manufacture, the output of the transducer will be adjusted to compensate for the altitude difference, if applicable.

Polyurethane & ETFE Jacketed Cable

Most installations of our submersible level transducers connect our polyurethane or ETFE cable to a junction box. From this junction box (P/N 840), users typically run their own cable to the required instrumentation. Polyurethane-jacketed cable is used for most applications while ETFE material is recommended for more aggressive environments.

Specifications for our standard polyurethane and ETFE jacketed cable are as follows:

Specifications	Standard Submersible Cable	Standard Non-Submersible Cable
Weight	0.05 lbs/ft (0.07 kg/m)	0.025 lbs/ft (0.035 kg/m)
Min. OD	0.28" (7.10 mm)	0.189" (4.8 mm)
Max OD	0.31" (7.87 mm)	0.19" (4.9 mm)
Conductors	4 - 22 AWG	22 AWG
Insulation **Conductors** **Outer jacket**	PVC Polyurethane or ETFE	Color coded PVC
Shield	36 gauge spiral tinned copper wire foil shield with drain wire	Aluminum/polyester foil facing outward
Vent Tube	Polyethylene, .060" ID (1.52 mm)	Drain wire 7/32 tinned copper

- **Chemical resistance of polyurethane:** Potable Water, Wastewater, Borax, Butane, Animal Fat, Carbonic Acid, Citric Acid, Cod Liver Oil, Corn Oil, Glycerin, Glycol, Mineral Oils, Potassium Nitrate, Potassium Sulfate, Silicone Oils, Stoddard Solvent, Tannic Acid (10), Tartaric Acid, Turbine Oil.

- **Chemical resistance of ETFE:** Acetic Acid (Glacial), Acetic Anhydride, Acetone, Aluminum Chloride, Anti-Freeze, Bromine, Calcium Chloride, Calcium Hydroxide, Chlorine, Copper Chloride, Ferrous Chloride, Hydrochloric Acid, Ketones, Lacquer Thinners, Sulfuric Acid.

The vented cable termination end is specially prepared at the factory to eliminate the potential for moisture migration. Where the lead wires emerge from under the jacket, there's potting material and a shrink tube "boot", every effort should be made to leave this feature intact. Should the cable be longer than needed for the installation, it is recommended that the excess length be accommodated in a service loop and that the potted end of the cable **NOT** be shortened.

The cable attached to this instrument is specifically engineered for submersible applications. The polyurethane outer jacket provides long term reliability under most conditions. The cable should be handled carefully, however, as the jacket may be subject to cutting should it be "raked" over extremely sharp edges. To guard against water incursion should an inadvertent minor cut occur, we have incorporated an exclusive "water block" feature immediately beneath the jacket. The cable is fully shielded, with the shield connected to the metal housing at the transducer end and terminated in a drain wire at the termination or user end. The shield should always be terminated to a good earth ground, unless the transducer is installed in an area where galvanic corrosion is known to be a serious problem.

Lightning Protection

Lightning and surge protection for VDC, SDI-12 and 4-20 mA output are available. This is achieved through the use of 2 protectors, one is integral to the transducer housing and one is provided for the outside line located at the surface and grounded to a DIN-Rail. Please remember this option must be factory installed at the time of order entry or as a factory upgrade. **This option cannot be installed in the field.** Lightning protection is also available for unit only. Contact customer service for details.

Featuring quick response and low clamping voltages, these devices protect against fast rising voltage transients as well as severe current surges associated with lightning discharges up to 20,000 amperes. Following a surge, the protector automatically restores the line to normal operation and awaits the next surge without having to reset a breaker or replace a fuse. The power supply needs to be limited to 150 mA to avoid lock up of the gas tube after a suppression event. **Transducers installed with this option have a lifetime warranty *against damage due to voltage surge***.

Please note: When using the lightning protection option on 4-20 mA products, users should take into account the additional series resistance of this option when selecting the loop power supply. This option will increase total loop resistance by 88 Ohms.

½" Male NPT Conduit Fitting

Submersible level transducers can be attached to a rigid conduit and the cable run through the conduit. To achieve this, all of our submersible transducers can be fitted with an optional ½" NPT male conduit fitting (specify “Electrical Connection Option 4” when ordering) where the cable exits the transducer. This fitting can be mated to a standard rigid conduit.

Electrical Outputs

We offer the industry standard 0-5 VDC and 4-20 mA outputs. In addition we also offer a variety of voltage output ranges.

Reverse Signal Output

For some applications, it is important to know how far the water is from the top of the tank or the surface of the ground. If specified by the customer, our factory can set the transducer so that zero pressure reads full scale electrical output and maximum pressure reads zero electrical output.

Temperature Output

A temperature output option is available for most transducers having 4-20 mA pressure output. The temperature sensor requires an excitation of 9-28 VDC and is calibrated for a temperature range of -20 to 60ºC with an accuracy of ±4ºC.

Output Option 6 (4-20mA output for -20 to 60ºC) (mA Reading x 5) - 40 = Temperature ºC

Example:	Reading is 20mA	(20 x 5) - 40 = 60ºC
	Reading is 12mA	(12 x 5) - 40 = 20ºC
	Reading is 4mA	(4 x 5) - 40 = -20ºC

Cable Hanger

We can supply an optional cable hanger (P/N 12-90-0931) to help end users secure the cable. The cable hanger can be positioned anywhere on the cable by pushing the ends together. Once positioned, the cable hanger expands and provides a snug grip on the cable.

When mounting the transducer in a well casing, the cable hanger can be secured to a hook on the well plate or an eye bolt may be attached to the side of the well casing. The cable hanger loop is then secured to the eye bolt by using any number of types of fasteners. A similar technique can be used when working in stilling wells for surface water level measurement. In this case, the loop-end of the cable hanger can be attached directly to a screw or bolt bored into the still well shelf.

Submersible Cable Splicing Kit

Our field-installable cable splice kit (P/N 830) allows you to splice polyurethane and ETFE submersible cable. It is most commonly used for well applications where the more expensive ETFE cable is required for suspension in corrosive media where the liquid level is fairly shallow, but the well is hundreds of feet in depth. It is also used in emergency situations where cable must be spliced together to get an application up and running.

3.0 Installation & Maintenance Tips

WARNING: POTENTIAL ELECTROSTATIC CHARGING HAZARD

In hazardous locations:

- **Avoid building up static charge on case of data protector and plastic accessories.**
- **Use damp rag to wipe data protector and plastic accessories to avoid static build up.**

General Installation Procedures

The following is important installation and preventive maintenance information. Our Customer Service or Applications Engineering Support staff can provide additional instruction.

1. **Transducer Anchors:** Most users either suspend our submersible transducers in stilling wells or attach them to rigid conduit. This is done to prevent damage to the transducer from shock caused by water turbulence. It is not advisable to tie your transducer to a pump or to piping, as any problem with the transducer could require that the pump be pulled from the installation. This could prove to be *very expensive*. (Please refer to the Cable Anchoring Schemes drawing in **Appendix A**.)

   Some applications use our optional bracket (P/N 49-06-00PC) to clamp the transducer to a fixed object (i.e., wall, ladder, step) or require the unit to be suspended without any protective still well or attachment device. In all installations, care should be taken to ensure no damage occurs to the cable.

2. **Transducer Submersion:** Damage to submersible cable is one of the most frequent causes of transducer failure. Lower your transducer into the liquid slowly, making sure the cable does not drag over sharp edges and only to the depth necessary. Avoid dropping the unit from the surface. This does not apply to Series 27, 28, and 30 transducers.

3. **SuperDry™ Vent Filter (Desiccant) or Aneroid Bellows Installation** (For submersible transducers vented gage pressure format only) ***Always*** install a desiccant vent filter or aneroid bellows immediately after transducer installation**.** Failure to use one or the other could result in premature failure of the transducer; which would not be covered by warranty. If you use a desiccant filter, you should establish a regular maintenance schedule. You should change your vent filter when it is 75% spent (pink color). Replacement filters are available at a nominal cost from the factory. Do not remove the old vent filter until a new one is available. The most common failure mode of our transducers is moisture and corrosion damage due to lack of use or maintenance of the vent filter. This will allow air into the desiccant filter and allows the transducer to properly vent with changes in barometric pressure.

   To install/replace either the aneroid bellows or the vent filter, simply unplug the old unit from the vent tube and plug the 0.062" x 1" stainless steel connector tube (supplied with each filter or bellows) into the vent tube. (Installation and mounting instructions are supplied with each aneroid bellows and vent filter.) The diagram on page 16 shows typical vent filter and aneroid bellows hookups.

4. **Cable Protection** An inexpensive way to protect the cable from damage is to order the submersible pressure transducer with a ½" conduit attachment. Connect an inexpensive flexible 5/8" garden hose to the ½" conduit fitting with an equally inexpensive female PVC ½" NPT x 3/4" NHT swivel fitting, available at your local hardware store

5. **Bending of Cable** Our polyurethane and ETFE jacketed cables are quite flexible. Care needs to be taken to ensure that when bending the cable to suit your installation you do not crimp the vent tube inside the cable. Consequently, do not bend the cable more than a radius of 1 inch.

6. **Cable Compression** Many users require a compression fitting to secure our ETFE and polyurethane jacketed cable as it enters a junction box. Care needs to be taken that you do not over-tighten the fitting so as to damage the cable.

7. **4-20 mA Wiring** When connecting a 2-wire 4-20 mA transducer to a typical power supply and mA meter, verify that the meter has an input impedance of at least 10 Ohms. If you are unsure of the input impedance, then a 10 Ohm resistor may be placed in series with the meter and transducer. Connect the + (red) lead of the transducer to the + terminal of the power supply. If the 10 Ohm resistor is required, connect it to the - (black) lead of the transducer. Use a short length of 22 AWG or heavier wire to connect the + terminal of the meter to the resistor (if it is required) or the - (black) wire of the transducer. Connect the - terminal of the meter to the - terminal of the power supply with a length of 22 AWG or heavier wire. Connect the drain wire from the transducer to a good earth ground. (See **Appendix**, page **14** for wiring diagram.) Please refer to "**Maximum Cable Lengths and Minimum Supply Voltage**" in **Appendix C**, page **22** to verify minimum loop supply voltage requirements.

8. **VDC Wiring** To connect a 3 wire VDC output transducer to a typical power supply and the voltmeter, connect the - terminal of the power supply to the - input terminal of the meter with a length of 22 AWG or heavier wire. Connect the - excitation (black) lead of the transducer to the - input terminal of the meter. Connect the + input terminal of the meter to the signal lead (white) of the transducer. Connect the + terminal of the power supply to the + lead (red) of the transducer. Connect the drain wire to a good earth ground. (See **Appendix A**, **page 14**.)

9. **The Model 750** comes standard with a field removable diaphragm protector (one-inch or 25 mm standoff). The diaphragm protector can easily be taken off by removing six (6) fasteners located on the bottom of the unit.

10. **Sealed-Gage Transducer Configured For Altitude Above Sea Level** Since sealed-gauge transducers are normally calibrated at sea level, there may be considerable error induced when used at a higher elevation. If the transducer was calibrated without taking into consideration the difference in atmospheric pressure at sea level and the higher elevation, an offset error will occur. In order to eliminate error due to this difference, the customer must identify the elevation where the transducer will be installed. The nominal atmospheric pressure at the location is calculated and the transducer will be ranged accordingly. Not all KPSI Transducers are available in a sealed pressure format. Please refer to the appropriate datasheet for availability.

11. **Position Sensitivity** The transducer should be installed so that the diaphragm located behind the nose cap is oriented in a vertical position, otherwise the unit could exhibit an offset.

General Maintenance Tips for Submersible Transducers

1. **Desiccant Maintenance**

> **WARNING: POTENTIAL ELECTROSTATIC CHARGING HAZARD**
>
> **In hazardous locations:**
>
> - **Avoid building up static charge on case of data protector and plastic accessories.**
> - **Use damp rag to wipe data protector and plastic accessories to avoid static build up.**

If you use a desiccant vent filter, you should establish a regular maintenance schedule. You should change your vent filter when it is 75% spent (pink color). Replacement filters are available at a nominal cost from the factory. Do not remove the old vent filter until a new one is available. Remember that Pressure Systems' improved 810 SuperDry™ Vent Filter are designed to be effective for at least one year before requiring replacement.

2. **Clogged Nose Piece or Dirty Diaphragm**

Either of these conditions could result in erroneous readings from your transducer.

> **WARNING: NEVER attempt to clean your transducer's nose piece or diaphragm with any object. This will dent the sensor diaphragm and cause permanent damage to the transducer.**

Your transducer may be cleaned in accordance with the procedures listed in step 4, below.

3. **Cleaning your transducer**

Materials required:

- Plastic bowls 8-12 inches (200-300 mm) in diameter and 4-6 inches (100 - 150 mm) deep
- Supply of clean, lint-free cleaning rags
- 32 ounce bottle of "The Works-Tub and Shower Cleaner" (a mild detergent) manufactured by Lime-O-Sol Company in Ashley, IN 46705 and available locally through Wal-Mart, K-Mart, Target, and Ace Hardware stores at $2 to $4 per bottle

Preparation: Prior to cleaning your pressure transducer, ensure that all procedures have been followed in the proper cleaning of the cable and transducer to remove any hazardous materials. The vent filter (or bellows) must be properly attached. The cable should be coiled to ensure ease of handling and it must be protected against the possibility of accidental abrasion and/or penetration of the cable jacket by sharp objects. A lead length of 1 to 1 ½ feet (0.3 - 0.45 m) of cable from the transducer should be allowed to facilitate handling during cleaning. The protective covering (or similar protective device) that is shipped with each transducer should be attached to the transducer at all times. It should only be removed prior to installation or cleaning.

Your work surface needs to be clean and free of clutter and large enough to accommodate all materials required in addition to the transducer and cable. Fill one of the bowls with fresh water, one with a mild detergent mixed with water and the last with 16 ounces (0.45 kg) of "The Works".

Cleaning:

Step 1: Holding the cable 6 inches (150 mm) from the transducer, immerse the unit in the bowl containing the mild detergent and stir for 20-30 seconds. Remove and rinse in the bowl containing the fresh water, using the same stirring motion used in the mild detergent. Rinse and wipe dry.

Step 2: Holding the body of the transducer with one hand so that you are looking at the retaining screen protecting the sensor, carefully remove the sensor nose piece by simply unscrewing it from the transducer body. *Do not touch the sensor diaphragm with your finger or any other object. Also, do not try to dry the inside portion of the transducer, as you risk damaging the pressure sensor*.

Step 3: Place the transducer in a vertical position with the sensing end facing downward in the bowl containing "The Works" solution for approximately 15-20 seconds. Rinse in the bowl containing clean water and wipe dry the external casing only. Place the protective screen in the same solution for 15-20 seconds, rinse and wipe dry.

Step 4: Holding the transducer in a vertical position so that you can see the face of the sensor, screw the protective nose piece back into place.

4. **Cleaning the Lightning Protection Data Line Protector**

WARNING: POTENTIAL ELECTROSTATIC CHARGING HAZARD

In hazardous locations:

- **Avoid building up static charge on case of data protector and plastic accessories.**
- **Use damp rag to wipe data protector and plastic accessories to avoid static build up.**

4.0 Warranty and Product Return Procedure

Any transducer/transmitter that is less than 2 years old (see DOM) which does not meet the product's specifications and exhibits **no obvious physical damage to the housing, sensor, or cable (cuts),** will be replaced under warranty.

Units 2-3 years old: Units that fall within this age group and exhibit no obvious physical damage to the housing, sensor, or cable (cuts), may be replaced at a discounted list price.

Units greater than 3 years old: Units that fall within this age group are not replaced under warranty.

Merchandise Return Procedures

Contact the **Applications Support Group** or the **Customer Service Department** at Pressure Systems if your transducer is not operating properly. Our staff is available for troubleshooting at **(757) 865-1243** or toll free at **1-800-328-3665** during normal working hours, Eastern time. If your transducer or accessory needs to be returned to Pressure Systems, obtain a *Returned Merchandise Authorization* (RMA) from the Customer Service Department prior to shipment. Be prepared to supply the following information when requesting the RMA:

- Part number
- Serial number
- Complete description of problems/symptoms
- **Bill To** and **Ship To** address
- Purchase order number (not required for warranty repairs)
- Customer contact and telephone number

The above information, including the RMA number, must be on the customer's shipping documents that accompany the equipment to be repaired. Pressure Systems also requests that the outside of the shipping container be labeled with the RMA number to assist in tracking the repairs. All equipment should be sent to the following address:

ATTN: KPSI TRANSDUCER REPAIR DEPARTMENT (7-digit RMA number)
Pressure Systems, Inc.
34 Research Drive
Hampton, Virginia 23666

Prior to returning to Pressure Systems, the transducer and cable must be cleaned per instructions provided on the cleaning certificate supplied when the transducer was delivered. The certificate can also be found on Pressure Systems website:

www.PressureSystems.com/cleaning.html

The completed certificate must accompany the transducer when shipped to Pressure Systems. If the transducer has been used in media other than potable water, PSI customer service must be notified at the same time an RMA number is requested. PSI reserves the right to reject any shipment deemed to be unsanitary or environmentally unsafe to handle. If these guidelines are not met, the package will be sent back unopened and at the customer's expense. ***Please***

include the attached vent filter or aneroid bellow with each returned vented gage submersible transducer.

Pressure Systems will return warranty items prepaid via UPS GROUND. If the customer desires another method of return shipment, Pressure Systems will prepay and add the shipping charges to the repair bill.

Incoming freight charges are the customer's responsibility. The customer is also responsible for shipping charges to and from Pressure Systems for all equipment not under warranty.

Once the return is received, it typically takes 5-10 working days for the technician to make a fault determination.

A cable reconnect fee will be charged when the customer requests a different length of cable.

Restocking Policy

Pressure Systems does allow standard products to be returned for credit in the event it is no longer required, providing the products are in new and unused condition. A restocking fee will be assessed depending on the model type and variety.

A **25% restocking fee** applies to the following models, providing they are vented-gage reference format and [pressure ranges above 3 psig (20 kPa) and below 100 psig (690 kPa)].

27	320	700	710
28	342	705	720
Display Meters - all models			750

A **50% restocking fee** applies to the following models. This also applies to all other models with sealed-gage and absolute pressure formats as well as vented-gage reference formats with [pressure ranges below 3 psig (20 kPa) and above 100 psig (690 kPa)].

30	335
300DS	730
330	735

NOTE: Expedite premiums and shipping charges are non-refundable.

Please consult the individual manuals for the Series 500 and Series 550 (waterMONITOR) for the restocking policy.

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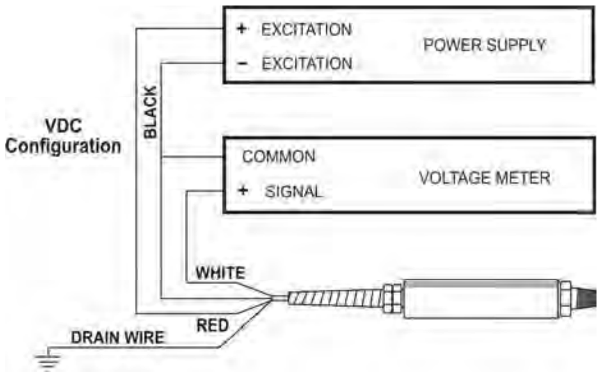
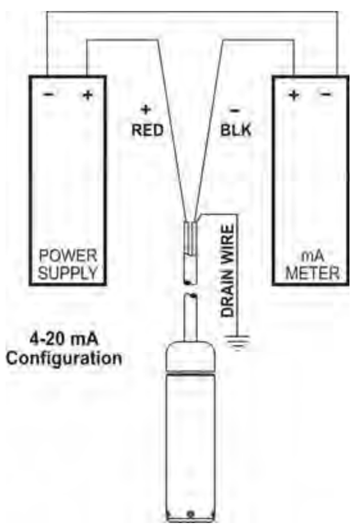
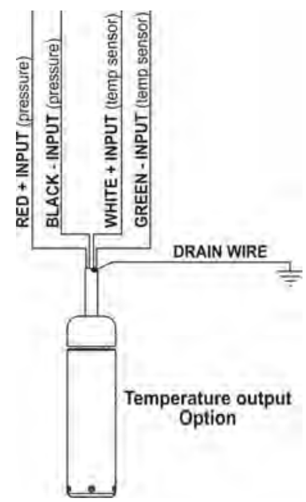
Appendix A

Drawings and Diagrams

Wiring Diagram VDC, mA, and Temp Output



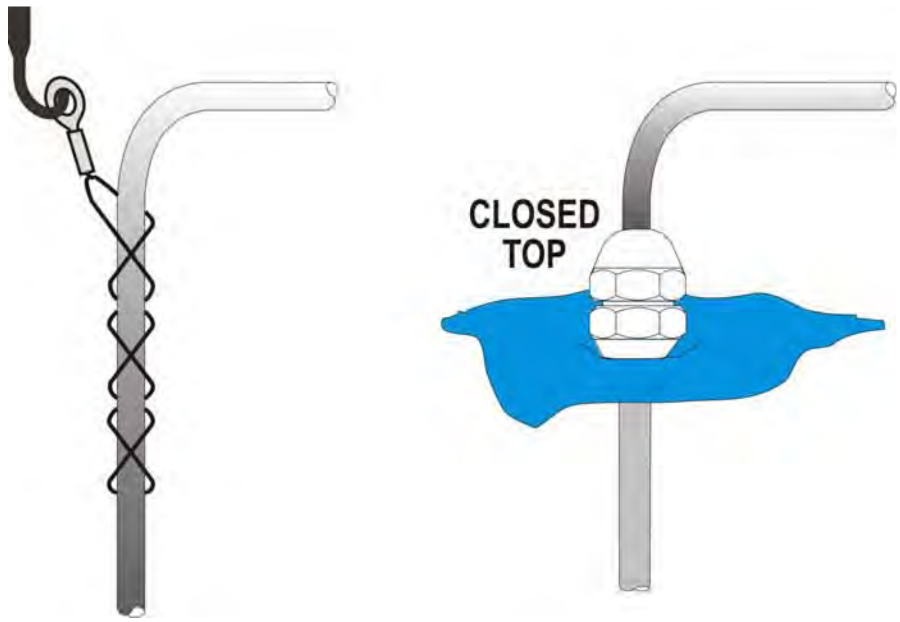




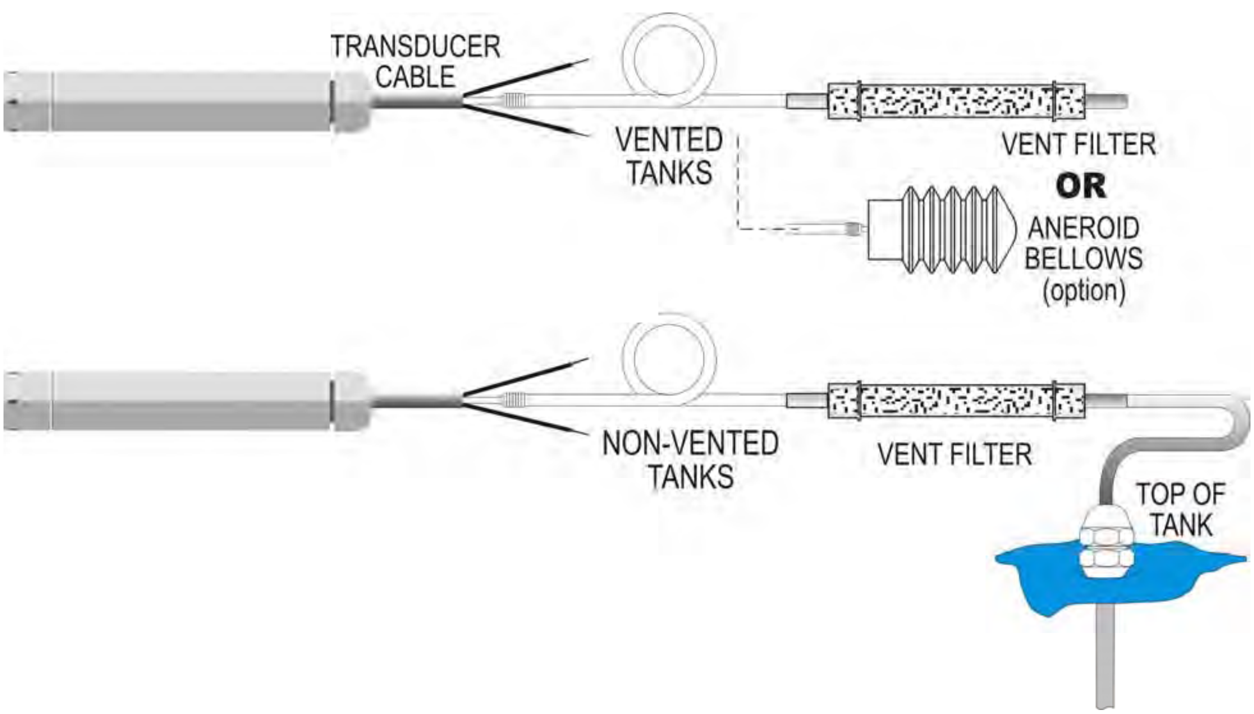
Notes:

1. These diagrams depict typical installations.
   Refer to your power supply and instrumentation
   Manufacturer for the specifics of your application.

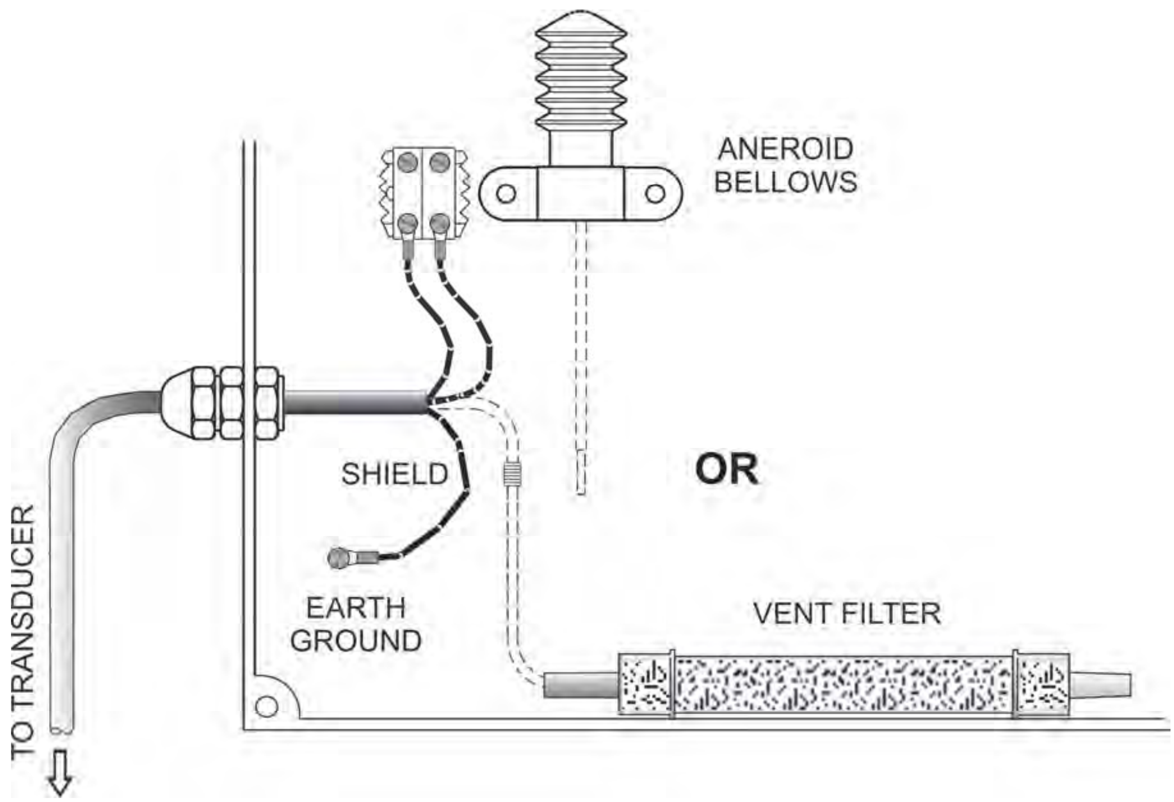
Cable Anchoring Schemes



Reference Connection Schemes



Submersible Cable Termination



Appendix B

1. **Question:** What installation ideas do you have to help me get rid of electrical noise interfering with the signal?

   Answer: An ounce of prevention goes a long way. Either try to eliminate the source of noise or move the transducer as far away from it as possible. We strongly encourage you to secure our cable shield to a good earth ground and that you use a 4-20 mA signal output. Armed with these precautions and the fact that many of our transducers are CE approved for electromagnetic interference, you should have few problems.

2. **Question:** The cable on the submersible transducer always seems to get cut and damaged. What am I doing wrong?

   Answer: This is the most common problem that our users encounter. Make sure that all of your colleagues and staff understand the importance of handling the cable with care. The cable should not be bent around rough or sharp edges. Always use a cable reel during transport. Where possible, suspend the unit in a perforated 2" (50 mm) PVC pipe and thread the cable through protective conduit to the nearest junction box.

3. **Question:** I have an application where the transducer is frequently damaged by voltage spikes. What can be done to prevent this?

   Answer: At a minimum, make sure the cable shield is connected to an earth ground as near as possible to the transducer. We can provide a surge protection kit for both our submersible and non-submersible transducers. See page 4. These kits will handle typical spikes that might come in through the power lines as well as surges that travel through the ground due to nearby lightning strikes

4. **Question:** How much impact shock can your submersible transducers withstand?

   Answer: Our transducers are not shock tested and the lower pressure ranges can be damaged if dropped from several feet onto an unforgiving surface like concrete. We recommend that the protective shipping foam remain in place until the unit is installed.

5. **Question:** What is the response time of your transducer?

   Answer: From initial power up, the transducer output will stabilize within a fraction of a second. The frequency response is rather low, probably less than 1 kHz, but it depends on the application, the media, plumbing, etc. Call our factory for application assistance if frequency response is critical in your application.

6. **Question:** How do I attach your vent filter or aneroid bellows to my cable vent tube?

Answer: The vent filter can be mounted anywhere convenient, preferably out of the weather. It can be mounted in any position and connects to the cable vent tube via the extension tube with metal connector tube provided. The aneroid bellows must be mounted in a way that its movement is not encumbered. It is provided with a mounting base.

7. **Question:** What is the best way to mark my cable?

Answer: Use white vinyl marking tape available from your local hardware or electronic stores. These same stores may also sell cable marking kits.

8. **Question:** Any ideas for preventing marine growth on your submersible transducers?

Answer: You might want to try waterproof grease. Remove the threaded nose cap to facilitate applying the grease**. Take care not to damage the diaphragm when applying the grease and not to trap air bubbles against the sensing diaphragm.**

9. **Question:** How many measurements can you make before the diaphragm on the sensor fails?

Answer: In normal operation - millions of cycles. We find that sensor failure is rarely due to diaphragm fatigue.

10. **Question:** What is the turnaround time on repairs?

Answer: Once we receive a unit into our facility it takes less than 10 working days to complete an evaluation.

11. **Question:** What is the longest length of cable you have attached to a submersible transducer?

Answer: Two thousand feet (610 meters).

12. **Question:** Why do you use 316 SS housings and sensors for your standard transducers?

Answer: It offers a good combination of corrosion resistance and reasonable cost. As an option, we do offer titanium for more aggressive environments.

13. **Question:** What wire gauge should I limit myself to when connecting to your 22 AWG wire?

Answer: Use 22 AWG or heavier.

14. **Question:** Does it make any difference if I mount the transducer in a vertical or horizontal position?

Answer: Yes. Our units will experience a certain amount of position sensitivity. You should mount it in a vertical position throughout the measurement cycle. If you lay the transducer down, the user must realize than an offset will occur.

15. Question: What happens when you freeze your transducer in a column of water?

Answer: We have frozen our transducers in a container of water in a home freezer, with no resulting damage. However, depending on the level range of the unit, over pressure of the unit is possible. In harsh environments where debris is common and ice shifts, you might expect damage to both the transducer and cable.

16. Question: Why would I choose a KPSI Transducer versus a competitor?

Answer: Reliable, long lasting products
Rapid delivery
Lightning protection lifetime warranty
Excellent pre & post sales/application support
No hassle service

Appendix C

Troubleshooting Techniques

Quick Check Procedure

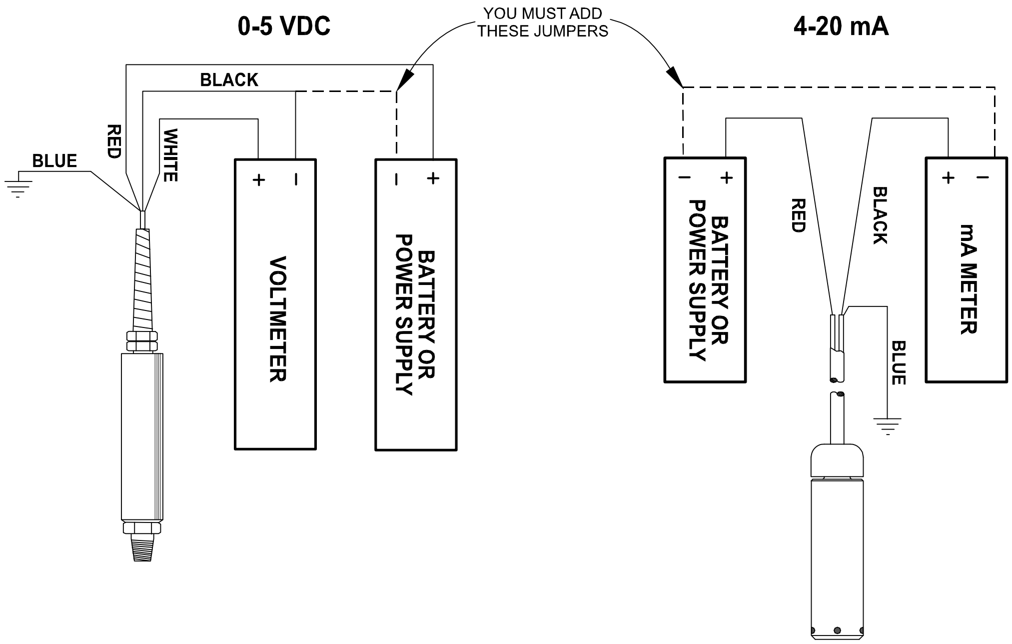
The following is a quick field checkout procedure for KPSI Level and Pressure Transducers. It will be referred to throughout the troubleshooting section.

Should a problem be encountered with a transducer or transmitter, it is sometimes helpful to test the transducer independently from the rest of the system, thereby establishing where to concentrate the troubleshooting effort.

On the next page is a simple hookup diagram for the most common types of electrical output, a 0-5 VDC transducer and a 4-20 mA transmitter. In either case, the "power supply" can be a common 12 volt lantern battery, or even a 9 volt transistor radio battery, although the lifetime of a 9 volt battery will be limited. The meter should be a digital type capable of reading at least 2 digits to the right of the decimal point. Use 22 gage or heavier hookup wire or clip leads for jumpers. If your unit has other than a 0-5 VDC or 4-20 mA output, please call Applications Support at **(800) 328-3665** for assistance.

Once your transducer is correctly configured per one of the diagrams below, orient the transducer in a vertical position with the pressure port down and then read the zero output on your meter. For a 0-5 VDC output, the zero should be between 0 and 0.10 volts, and for a 4-20 mA output, between 3.80 and 4.20 mA. For Series 300, the values do not change for VDC output but the values for mA are between 3.80 and 4.20 mA. If the output is outside of these limits, you may, at your option, choose to troubleshoot the transducer per the suggested measurements shown below. Otherwise, contact our Customer Service Department at **(800) 328-3665** for a Return Material Authorization number (RMA).

If the zero output is within these limits, the problem will more than likely be found elsewhere in your system.



When an error is observed at a customer's installation, it is important to determine if the fault lies in the transducer or the instrument reading the transducer signal, ie. digital panel meter, programmable logic controller, etc. . To do this, a second instrument should be used to confirm the observations. The second instrument may be a handheld DMM (Digital Multi-Meter) or a dedicated milliammeter capable of reading 4-20 mA of current to a resolution of at least 0.1 mA. The diagram above illustrates the attachment of the meter in series with the black (negative signal) wire of the transducer using a 9-28 VDC power supply for transducer excitation. Some suggested power supplies are:

- 1 - 12 VDC automotive battery.
- 2 - 6 VDC lantern batteries connected in series (for a total of 12 VDC).
- 2 - 9 VDC transistor batteries connected in series (for a total of 18 VDC).

Batteries are suggested to power the transducer during testing to eliminate the possibility that line noise is passing through an improperly filtered, grounded, or damaged power supply. All measurements should be recorded and sent to Pressure Systems along with the transducer to assist in the evaluation process.

Further Measurements:

0-5 VDC	Should read:	4-20 mA	Should read:
+Excitation (white) to Shield (drain)	> 2.5 Mohms	+Excitation (red) to Shield (drain)	> 2.5 Mohms
-Excitation (black) to Shield (drain)	> 2.5 Mohms	-Excitation (black) to Shield (drain)	> 2.5 Mohms
+Output (red) to Shield (drain)	> 2.5 Mohms	Shield (drain) to Housing	< 2 ohms
Shield (blue) to Housing	< 2 ohms		

Maximum Cable Lengths and Minimum Supply Voltage

The maximum length of cable to be used with our submersible transducers is largely dependent upon the type of electrical output of the transducer. For a 0-5 VDC output, a maximum cable length of 100 feet (30 m) is recommended. A voltage output is more susceptible to electrical interference than a 4-20 mA signal. A 4-20 mA signal can be transmitted much longer distances, depending upon such factors as temperature, wire size, length of the wire, power supply, and voltage requirements of any devices to be powered. At 25ºC the 22 AWG conducting copper wire used in our polyurethane jacketed cable has a resistance of 16.45 ohms per 1000 feet (304 m).

Using Ohms Law (E=IR) where E=voltage, I=current and R =resistance, one finds that a 20 mA signal requires .329 volts to drive it along 1000 feet (304 m) of 22 AWG copper wire (E=16.45 x .020). This drop is seen on both the supply and return wire for a total loop voltage drop of 0.658 volts

To find out how much voltage is required to drive our Series 700 submersible level transducer's 4-20 mA signal 10,000 feet, just add the minimum power requirement of the 700 (9 VDC) to the resistance offered by 10,000 feet (3048 m) of our polyurethane jacketed cable (10,000÷1000 x .658=6.58). The resulting power requirement is 15.58 VDC (9 + 6.58).

Connect the cable shield (drain wire) to a good earth ground. This will protect the transducer from relatively minor transient voltages. The only exception to this rule is if high rates of electrolytic corrosion have been previously experienced with grounded submersible devices. In this case it may be better to leave the shield disconnected.

Please note: When using products with the lightning protection option on 4-20 mA products, users should take into account the additional series resistance of this option when selecting the loop power supply. This option will increase total loop resistance by 88 Ohms.

Troubleshooting Techniques

1. Symptom: ***Transducer fails to give output of any kind.***

Procedure: Isolate the problem to either the transducer or the power supply/readout. See the Quick Check Procedures (above) for this check. If it can be determined that the transducer is no longer operable, remove it from service for further analysis. If the transducer output falls within the limits described above, the fault lies somewhere else in your system.

2. Symptom: ***Transducer has failed and has been removed for analysis.***

Procedure: Inspect the cable for physical damage. Cuts in the cable jacket can result in liquid incursion into the transducer housing, which can cause permanent damage. If operational, the cable can be repaired by using a splice kit (P/N 830) supplied by Pressure Systems.

Inspect the transducer housing. It should be intact and free of corrosion. If the outer surface of the transducer is pitted, this could be an indication of galvanic corrosion caused by stray ground currents. If this is the case, the transducer will probably require replacement. If the external case exhibits none of these characteristics, carefully unscrew the nosepiece and look into the pressure sensing end of the transducer. The concentric rings of the sensing diaphragm should be visible. If they are not, it could be that residue has accumulated on the diaphragm, preventing it from responding properly to pressure changes. The transducer can be cleaned by gently swishing the transducer back and forth in a bucket of warm, soapy water until the residue softens and washes off. (See **Cleaning Your Transducer**, page 8.) ***Under no circumstances should any object or tool be used to remove residue from the sensing diaphragm or else permanent damage will be done.*** If cleaning the diaphragm does not solve the problem, the transducer should be returned to the factory for repair or replacement.

3. Symptom: ***Transducer develops a negative offset and gets worse over time (actual level exceeds specified level).***

Procedure: This may be a sign that moisture has entered the reference (vent) tube in the cable and is inside the transducer housing. This is usually the result of not maintaining the desiccant vent filter or of operating the transducer without a desiccant filter or aneroid bellows. If caught early enough, the transducer can be saved by coiling the cable and transducer in a pan and baking it in an oven at 50°C (122°F) for a minimum of 2 hours. *Be careful that the oven temperature does not exceed 50ºC (122°F)* or both the transducer and the cable can be damaged. **Alternatively**, suspend <u>both</u> the cable and transducer in a vertical position (with vent tube down), overnight to allow water to drain from the transducer and vent tube.

4. Symptom: ***Transducer suddenly fails during or just after a nearby lightning event.***

Procedure: This failure is usually caused by overvoltage due to ground transients resulting from a direct or indirect lightning event. These transients can travel distances of a mile or more. The transducer may be returned to the factory for repair and optional retrofit of our ***lightning protection system.*** This system carries a lifetime warranty against transducer damage due to lightning.

5. Symptom: ***Transducer response to pressure/level input changes becomes sluggish.***

Procedure: This is usually a sign that the sensing end of the transducer has become fouled with residue. The transducer must be removed from service and the sensing diaphragm cleaned as described in Item 2, (warm, soapy water). If fouling persists, the transducer may be replaced with a Series 705 or Series 750 (non-fouling) transducer, which is specifically designed for trouble-free operation in a high residue environment.

6. Symptom: ***Output reading is within limits but "freezes" at one point.***

Procedure: In certain environments "crust" may form over the sensing diaphragm, preventing the sensor from identifying change in level. Removing the transducer from service and cleaning it (as described in Item 2) will generally solve the problem. To combat marine growth, you might try wrapping the transducer with copper wire similar to that found in wire scouring pads for cleaning dishes. Marine growth occurs on the copper and eventually erodes the copper and drops off or the copper is manually removed during routine maintenance. Alternatively, there are various companies that will impregnate/coat the 316 stainless steel with anti-fouling chemicals of coatings. Level transducers temporarily removed from the well or sump should not be stored dry, but should be stored in a bucket of fresh water in order to prevent "crust" formation.

7. Symptom: ***Readings increase very slowly over time***.

Procedure: Our cable is shipped coiled and consequently takes time to straighten when installed. Attaching a weight to the transducer (e.g., one of our sacrificial anodes) will help. To prevent cable stretch with lengths greater than 200 feet (60 m), secure the Kevlar fibers (just under the cable jacket) to your junction box or other secure object.

8. Symptom: ***No electrical output from your transducer.***

Procedure: Check all electrical connections to ensure they are correct and secure. Double check your power supply or use a battery (as described previously) to ensure the transducer is getting power. If all checks OK, the problem could be a circuit board or the sensor in your transducer. The unit must be returned to the factory for evaluation. The most probable cause of this type of failure is damage to the submersible cable jacket allowing water to leak down the cable and into the transducer housing or lightning damage.

9. Symptom: ***Formation of marine growth on a submersible transducer.***

Procedure: Certain transducer construction materials, for example, 316 stainless steel, attract marine life (snails) and algae. Clean the transducer diaphragm by soaking it in a bucket of warm water with a non-aggressive cleaning solution. You can also coat the transducer with marine grease. This may be the most effective and inexpensive way to protect your transducer.

10. Symptom: ***Submersible transducer exhibits corrosion or pitting on body or diaphragm***

Procedure: Dissimilar metals (for example, your transducer housing and your pump housing) in an electrolytic environment (fluid in your well) can lead to *galvanic corrosion* of the metal that is nearer the anodic end of the galvanic series. Likewise, a voltage potential between the ground wire of the transducer and the ground of other equipment in the well can lead to *galvanic corrosion*. Installation of a P/N 820 or 825 sacrificial anode will help protect your transducer from *galvanic corrosion*. Our sacrificial anodes are made of a zinc alloy that, being nearer the anodic end of the galvanic series than the 316 stainless steel or titanium housing of the transducer, will corrode before the transducer.

11. Symptom: ***The transducer is buried in dirt or silt and the readings seem to be erroneous.***

Procedure: Use of a piezometer nosepiece in this application would help. This nosepiece can be easily installed in the field and features a very fine screen to keep dirt from fouling the diaphragm, but allows the diaphragm to sense moisture levels.

12. Symptom: ***Transducer has an offset error.***

Procedure: Our submersible transducers perform best when the sensing end is pointing in a downward manner. Keep in mind that you can experience offset error due to the position sensitivity or orientation change of the sensor. Offset errors are more prominent in low pressure applications with the sensing end of the transducer lying flat or pointing upward.

13. Symptom: ***I am testing a Series 700 4-20mA sensor for use with our data logger. On page A-2 of the KPSI Level and Pressure Transducers User's Manual, I see the standard 4-20mA configuration. Does the recording channel of my data logger become the mA meter?***

Procedure: Most data loggers cannot measure current (mA) directly. When this is the case a load resistor must be used to convert the current (mA) output into an appropriate voltage. If the User's Manual for your particular instrument does not illustrate a preferred method for recording current (mA) data then you should attach your transducer signal wires to your data logger in the following manner.

Transducer red wire - Data Logger Excitation Terminal
(The minimum excitation for a Series 700 Transducer is 9VDC)
Transducer black wire – Data Logger signal input (+) terminal

Attach a Load resistor between the Data Logger signal input (+) terminal and the Data Logger signal input (-) terminal.

Attach a separate piece of wire between the Data Logger signal input (-) and analog ground.

In this configuration you will turn your data logger into a milliammeter. The size of your load resistor can be calculated in the following manner.

D/0.02=R

Where:

Data logger input range = D
Full scale output of transducer = 0.02 A (20 mA)
Load Resistor Value = R

Pick an appropriate standard value

250 Ohms results in 1 to 5 VDC at 4 and 20 mADC
125 Ohms results in 0.5 to 2.5 VDC (500 to 2500 mVDC) at 4 and 20 mADC

At this point the discussion needs to address IR loss (voltage drop) in series circuits. Note that Series 700 transducers need a minimum of 9 VDC to operate correctly. When the transducer is operating correctly it will output a current which, when driven through a resistor, will generate some amount of voltage drop. If the resistor value is 250 Ohms then the voltage measured across that resistor will be 0.004 A * 250 Ohms = 1.000 VDC and 0.020 A * 250 Ohms = 5 VDC. Notice that, if the available voltage from the data logger is12 VDC then 12 VDC - 5 VDC = 7 VDC which is less than the voltage required by the transducer to operate. If this scenario were to occur the transducer would actually stop functioning correctly when its output reached 12 mADC (50% of transducer full scale range). In this case the appropriate choice for a load resistor value is 125 Ohms.

14. Symptom: ***I have a Series 700 4-20mA transducer rated for 7.5 PSIG attached to a pressure source that is outputting 7.5 PSIG. With 20VDC being supplied I am getting 19.94 mA. I can't find the upper range allowance for the sensor, but this seems low to me. Does this mA reading fall into the acceptable range for the transducer with the settings I've specified?***

Procedure: When evaluating a transducer it is sometimes convenient to make some broad generalizations in order to rapidly determine the condition of the unit. In general, transducers that output a 4-20 mADC signal have a 16 mADC span (4 - 20 = 16). If the transducers accuracy is reported as being some percentage of its full-scale range then the following table could be used in conjunction with the instructional notations to determine whether a more detailed analysis of data quality is required.

Model	Accuracy	Accuracy in mADC
700	1.00%FS	±0.16 ma
710	0.50%FS	±0.08 ma
720	0.25%FS	±0.05 ma
730	0.10%FS	±0.016 ma
735	0.05%FS	±0.008 ma

In order to approximately determine how many milliamps a transducer should output at a given depth.

1. Determine the depth (in feet) at which the transducer is sited.
2. Divide the depth value (from step 1) by the transducer full-scale range (in feet). - Record the value.
3. Multiply the value calculated in step 2 by 16 (the transducer span in milliamps).
4. Add 4 to the product of step 3. This is the approximate value in milliamps that should be output by the transducer at its current depth.

In order to approximately determine the depth of a transducer (in feet) using a given value of milliamps.

1. Divide the full-scale range of the transducer (in feet) by 16. Record this value.
2. Subtract 4 from the milliamp output of the transducer. Record this value
3. Multiply the result of step one by the result of step 2. This is the approximate depth at which the transducer is sited.

If the resulting numbers are reasonably close to some verified value for current water depth, then the unit is functioning. In order to determine the quality of measurement, additional steps need to be performed.

Appendix D

Calibration Calculations

Pressure Systems ships a calibration sheet with every KPSI™ Transducer. This sheet lists the actual values that were output by the transducer, when it was being manufactured, at several different pressures. In addition, two coefficients are provided that can be used to calculate the actual depth from any given mA output value. These coefficients are derived from a Least Squares Best Fit Straight Line (BFSL) calibration using the data listed on the datasheet. Our accuracy specification is referenced to the line described by the BFSL coefficients and so the transducer may not output exactly 4 mADC at zero pressure and 20 mADC at full-scale. As an example here is an example of data for a typical transducer.

Calibration Report

Test Date: 02/28/08
Test Time: 13:02:57
Model No: 320T14B0A008.670000.000B10030B
Serial No: 0802048
Pressure Range: 0.00 to 8.67 PSIG
Excitation: 9-28 VDC
Output: 4-20 mA

Test Temps: ROOM = 25.3 DegC

PCU Serial No: TRF048

Target Test Pressure	BFSL Rm Temp Outputs	Run #1 Rm Temp Outputs	Run #1 Error %FSO	Run #2 Rm Temp Outputs	Run #2 Error %FSO
0.00	4.0017	3.9995	-0.0134	3.9981	-0.0222
1.73	7.2050	7.2003	-0.0295	7.2066	0.0098
3.47	10.4096	10.4111	0.0091	10.4144	0.0297
5.20	13.6133	13.6182	0.0305	13.6207	0.0461
6.94	16.8176	16.8158	-0.0114	16.8174	-0.0014
8.67	20.0219	20.0173	-0.0290	20.0190	-0.0184
6.94	16.8171	16.8162	-0.0057	16.8172	0.0006
5.20	13.6127	13.6176	0.0305	13.6175	0.0299
3.47	10.4083	10.4131	0.0298	10.4110	0.0167
1.73	7.2049	7.2067	0.0115	7.2059	0.0065
0.00	4.0020	4.0001	-0.0118	4.0000	-0.0124

Maximum Static Error: 0.0523 %FSO
Maximum Non-repeatability: -0.0393 %FSO

Electrical termination: RED: +SUPPLY
BLACK: -SUPPLY
BLUE: SHIELD

Slope1:	0.5411	PSIG/mA
Zero Offset1:	0.0000	PSIG
Slope2:	1.8479	mA/PSIG
Zero Offset2:	4.0017	mA
Conversion Factor:	1.0000	

Notes:

Calculations:

Method 1: Calculate pressure in desired units, using sensor's output as independent variable.
PSIG = 0.5411(mA - 4.0017) + 0.0000

Method 2: Calculate predicted sensor output in desired units using pressure as the independent variable.
mA = 1.8479(PSIG - 0.0000) + 4.0017

In this case, even though the offset or 0 PSIG output was 4.0017 mADC and the full-scale point was 20.0219 mADC the unit actually performed better than its specified accuracy of ±0.25% of full-scale range as indicated in the Error % FS column.

The calculation for pressure is illustrated below:

PSIG = (Span*Output (in mA)) + Offset

And, to convert to feet of water

Feet H_2O = PSIG * 2.3073

measurement
SPECIALTIES
34 Research Drive, Hampton, VA 23666 USA
757-865-1243, Toll Free 800-328-3665
Fax 757-865-8744
E-mail sales@PressureSystems.com
www.PressureSystems.com
online orders www.LevelandPressure.com

1000 Lucas Way
Hampton, VA 23666

Tel: 757-766-1500
Fax: 757-766-2644

Website: www.meas-spec.com

CERTIFICATIONS for KPSI® Transducers
FM
UL
CE

DATE	REV	ECO	REVISION	BY	CHK	EOR
7/28/06	V	N/A	SHT 1 ADDED "E" TO B=EXCITATION, SHT2 REVISED 1. P= ENTITY PARAMETERS & 2. STAHL APPARATUS	GKP	GWH	SMK
1/11/07	W	N/A	SHT2 REVISED 1. P= ENTITY PARAMETERS, ADDED "E" ENTITY PARAMETERS.	GKP	GWH	SMK
12/12/07	X	3901	SHT 1 ADDED VOLTAGE SUPPRESSION OPTIONS TO 300 SERIES TRANSDUCER, REVISED ALL P/Ns, SAME ON SHT. 3 FOR SERIES 169 & 173	GKP	GWH	SMK
2/25/09	Y	4015	RMV EXCITATION 1,2, ADD F,G,H,J. RMV PRESSURE CONN. 4,5,6,8,F,G. RMV ELEC. CONN. 3,K. RMV ENT PARAMETERSB=1,B=2. ADD B=F,G,H,J. DEL SHT 3 FROM DWG.	GKP		GWH
8/21/09	Z	4015	ADDED NOSE PIECE OPTIONS & REMOVED OPTION 2 (HIRSCHMANN)ELECTRIAL CONNECTION FROM SERIES 27, 28, & 30 , SHT 1 ONLY	GKP		GWH
10/7/09	AA	4015	CORRECTED ORDER OF ALL SERIES LETTER CONFIGURATIONS, SHT 1 ONLY. REVISED CLASS GROUPS ON SHT 3.	GKP		GWH
11/4/09	AB	4015	ADDED SHEET 4	GKP		GWH
9/20/10	AC	4210	REVISED BORDER FORMAT FROM ESTERLINE TO MEASUREMENT SPECIALTIES.	GKP		GWH
9/20/10	AD	4218	ADDED ELECTRICAL CONNECTION "0" TO SERIES 27,28 & 30, LT MODEL SERIES & REFORMATTED PAGE LAYOUT SHEETS 1, 2 & 3.	GKP		GWH
4/22/11	AE	4218	CLARIFIED ENTITY PARAMETERS, SHT 2 ONLY	GKP		GWH

The Transducers listed below are designed for installation in a Class I, Division 1, Groups A, B, C and D, Class II, Division 1, Groups E, F, and G, Class III, Division 1 hazardous location when connected to Associated Apparatus as described in note 1.

Series 27FABCDGEEEE, 28FABCDGEEEE, 30FABCDGEEEE
- A = pressure type: 1,3,4,6
- B = excitation/output 3,4,E,F,G,H,J,K,L,M
- C = pressure connection: 1,2,7
- D = electrical connection: 0,1,4
- EEEE = pressure range: 0-2000 PSI
- F = material: S,T
- G = voltage suppression: A,B,C

Series 700FABCDGEEEE, 705FABCDGEEEE, 710FABCDGEEEE, 720FABCDGEEEE, 730FABCDGEEEE, 735FABCDGEEEE, 750FABCDGEEEE
- A = pressure type: 1,3,4
- B = excitation/output: 3,4,E,F,G,H,J,K,L,M
- C = pressure connection: A,B,C,D,E,2,7
- D = electrical connection: 0,4,A,B
- EEEE = pressure range: 0-304 PSI
- F = material: S,T
- G = voltage suppression: A,B,C

Series 300FABCDGEEEE, 320FABCDGEEEE, 330FABCDGEEEE, 335FABCDGEEEE
- A = pressure type: 1,3,4
- B = excitation/output: 3,4,E,F,G,H,J,K,L,M
- C = pressure connection: B
- D = electrical connection: 0,A,B
- EEEE = pressure range: 0-304 PSI
- F = material: S,T
- G = voltage suppression: A,B,C

Series LTABCDEFGHIIIJK
- A = pressure connection: A,B
- B = excitation/output: 1,2,3,4,5,6,7,8,A,B,C,D,E,F,G
- C = cable type: A,B
- D = accuracy: A,B,C,D,E,F
- E = intrinsic safety approvals: A,B,C
- F = label: A,B,C
- G = material: S
- H = electrical connection: A
- III = pressure range: 0-50 psi
- J = units: P,F,M
- K = pressure type: G,S,A

Notes: (applies to all figures on sht 2)

1. Associated Apparatus shall provide intrinsically safe connections which meet the following parameters.

V_{max} ; For all barrier channels used.
I_{max} ; Combined current for all barrier channels used.
C_i ; For all barrier channels used.
L_i ; For all barrier channels used.
P_i ; Combined power for all barrier channels used.

Voc or $V_T \leq V_{max}$ $\quad C_a \geq C_i + C_{leads}$*
Isc or $I_T \leq I_{max}$ $\quad L_a \geq L_i + L_{leads}$*
Po or $P_T < P_i$

* Includes all cable connected to the barrier including the transducer cable.

Selected barriers must be third party approved as providing intrinsically safe circuits for the application, and have Voc or Vt not exceeding Vmax and Isc or It not exceeding Imax, and the Po of the barrier must be less than or equal to the Pmax of the intrinsically safe equipment, as shown in the Table of Entity parameters.

2. Control Room apparatus shall not generate in excess of 250V (U_{max}).

3. Installation should be in accordance with Article 504 in the *National Electrical Code,* ANSI/NFPA 70 and ISA RP-12.06.01

4. Float unused wires in cable. Insure that these wires are electrically isolated from other conductors.

WARNING!
AGENCY APPROVED DRAWING. REVISIONS MUST BE SUBMITTED FOR AGENCY APPROVAL.

DO NOT SCALE DRAWING UNLESS OTHERWISE NOTED	PART NUMBER		measurement SPECIALTIES	
ANGLES ±1° DIMENSIONS ARE IN DECIMALS .XX = ±.02 .XXX = ±.005	DRAWN: CHF	DATE: 4/24/00		
RUNOUT ±.015 CONCENTRICITY ±.005	CHECKED / APPROVED	DATE	PRODUCT TITLE: LIQUID LEVEL	
SURFACE FINISH IN MICROINCHES RMS 32 UNLESS SHOWN OTHERWISE	EOR: GWH / APPROVED: [signature]	DATE: 4/22/11	DRAWING TITLE: CERTIFICATION DRAWING, FM	
MATERIAL	SCALE: NTS / PROJECTION	DRAWING NUMBER: TA-6609	REVISION: AE	SHEET: 1/4

DATE	REV	ECO	REVISION	BY	CHK	EOR
7/28/06	V	N/A	SHT 1 ADDED "E" TO B=EXCITATION, SHT2 REVISED 1. P= ENTITY PARAMETERS & 2. STAHL APPARATUS	GKP	GWH	SMK
1/11/07	W	N/A	SHT2 REVISED 1. P= ENTITY PARAMETERS, ADDED "E" ENTITY PARAMETERS.	GKP	GWH	SMK
12/12/07	X	3901	SHT 1 ADDED VOLTAGE SUPPRESSION OPTIONS TO 300 SERIES TRANSDUCER, REVISED ALL P/Ns, SAME ON SHT. 3 FOR SERIES 169 & 173	GKP	GWH	SMK
2/25/09	Y	4015	RMV EXCITATION 1,2, ADD F,G,H,J. RMV PRESSURE CONN. 4,5,6,8,F,G. RMV ELEC. CONN. 3,K. RMV ENT PARAMETERSB=1,B=2, ADD B=F,G,H,J. DEL SHT 3 FROM DWG.	GKP		GWH
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4/22/11	AE	4218	CLARIFIED ENTITY PARAMETERS, SHT 2 ONLY	GKP		GWH

Class I, II, III, Div. 1 Groups A-G Hazardous Location ⟶ Entity Parameters
Figures 1-4

V_{max}= 28V
I_{max}= 110mA
C_i =0.064µF
L_i = 0
P_i = 1W

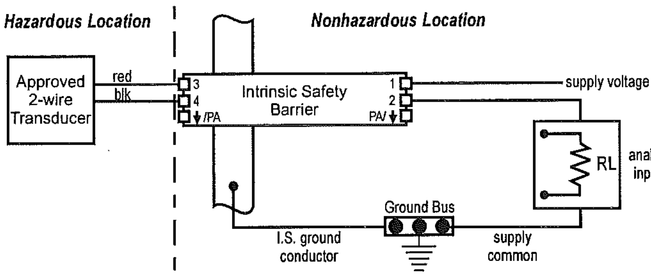


Figure 1. Return Lead Floating

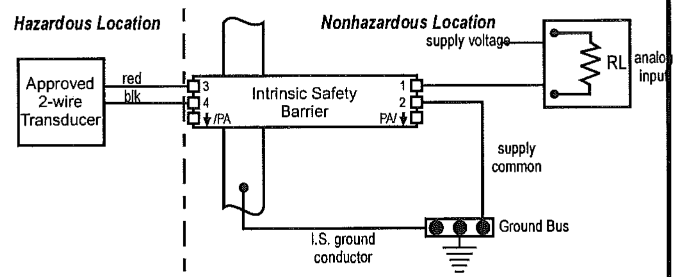


Figure 2. Return Lead Grounded

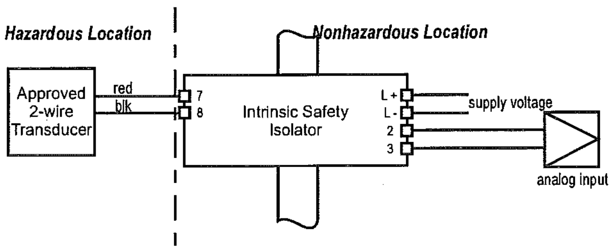


Figure 3. Field Circuit Isolated

Wiring diagram for 2-wire, 4-20mA output

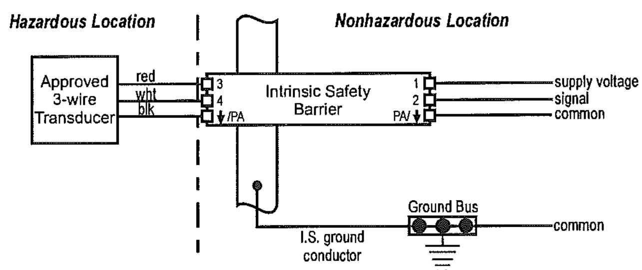


Figure 4. Wiring diagram for 3-wire, VDC output.

Class I, II, III, Div. 1 Groups C&D (only) Hazardous Location ⟶ Entity Parameters

V_{max}= 28V
I_{max}= 186mA
C_i =0.064µF
L_i = 0
P_i = 1.3 W

WIRING DIAGRAMS SAME AS FIGURES 1,2,3 & 4

AE

WARNING!
AGENCY APPROVED DRAWING. REVISIONS MUST BE SUBMITTED FOR AGENCY APPROVAL.

DO NOT SCALE DRAWING
UNLESS OTHERWISE NOTED
ANGLES ±
DIMENSIONS ARE IN DECIMALS .XX = ±.02 .XXX = ±.005
RUNOUT ±.015
CONCENTRICITY ±.005
SURFACE FINISH IN MICROINCHES RMS 32
UNLESS SHOWN OTHERWISE
MATERIAL

PART NUMBER

DRAWN	DATE
CHF	4/24/00

CHECKED	APPROVED	DATE

EOR	APPROVED	DATE
GWH	[signature]	4/22/11

measurement SPECIALTIES

PRODUCT TITLE
LIQUID LEVEL

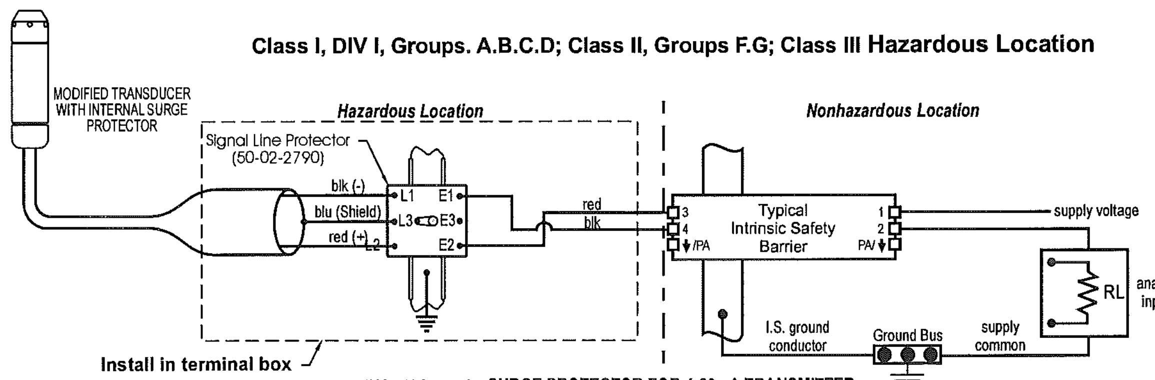
DRAWING TITLE
CERTIFICATION DRAWING, FM

SCALE	PROJECTION	DRAWING NUMBER	REVISION	SHEET
NTS		TA-6609	AE	2/4

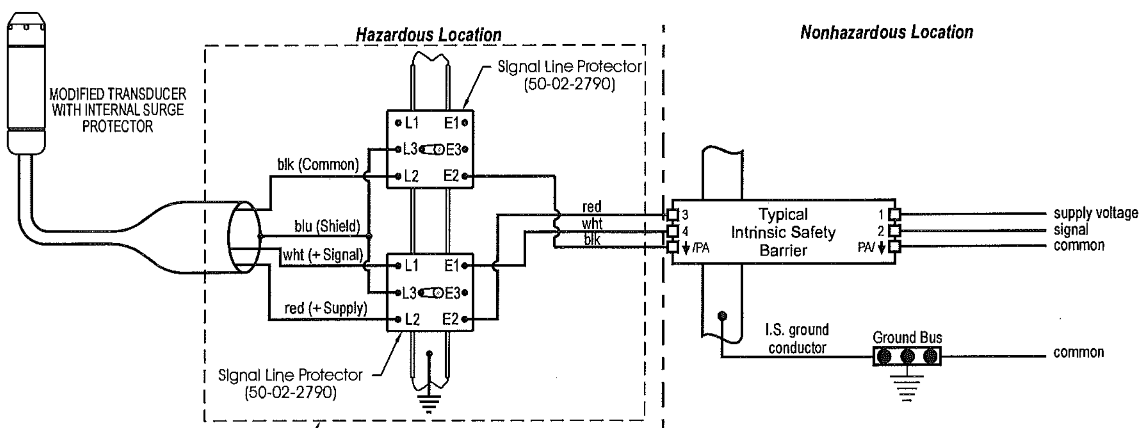
DATE	REV	ECO	REVISION	BY	CHK	EOR
7/28/06	V	N/A	SHT 1 ADDED "E" TO B=EXCITATION, SHT2 REVISED 1. P= ENTITY PARAMETERS & 2. STAHL APPARATUS	GKP	GWH	SMK
1/11/07	W	N/A	SHT2 REVISED 1. P= ENTITY PARAMETERS, ADDED "E" ENTITY PARAMETERS.	GKP	GWH	SMK
12/12/07	X	3901	SHT 1 ADDED VOLTAGE SUPPRESSION OPTIONS TO 300 SERIES TRANSDUCER, REVISED ALL P/Ns, SAME ON SHT. 3 FOR SERIES 169 & 173	GKP	GWH	SMK
2/25/09	Y	4015	RMV EXCITATION 1,2, ADD F,G,H,J. RMV PRESSURE CONN. 4,5,6,8,F,G. RMV ELEC. CONN. 3,K. RMV ENT PARAMETERSB=1,B=2, ADD B=F,G,H,J. DEL SHT 3 FROM DWG.	GKP		GWH
8/21/09	Z	4015	ADDED NOSE PIECE OPTIONS & REMOVED OPTION 2 (HIRSCHMANN)ELECTRIAL CONNECTION FROM SERIES 27, 28, & 30 , SHT 1 ONLY	GKP		GWH
10/7/09	AA	4015	CORRECTED ORDER OF ALL SERIES LETTER CONFIGURATIONS, SHT 1 ONLY, REVISED CLASS GROUPS ON SHT 3.	GKP		GWH
11/4/09	AB	4015	ADDED SHEET 4	GKP		GWH
9/20/10	AC	4210	REVISED BORDER FORMAT FROM ESTERLINE TO MEASUREMENT SPECIALTIES.	GKP		GWH
9/20/10	AD	4218	ADDED ELECTRICAL CONNECTION "0" TO SERIES 27,28 & 30, LT MODEL SERIES & REFORMATTED PAGE LAYOUT SHEETS 1, 2 & 3.	GKP		GWH
4/22/11	AE	4218	CLARIFIED ENTITY PARAMETERS, SHT 2 ONLY	GKP		GWH

Notes:
1. Install in terminal box.
2. Installation should be in accordance with Article 504 in the *National Electric Code,* ANSI/NFPA 70 and ISA RP12.06.01
3. The surge protector part #50-02-2790 is a passive device and as a result the device has no capacitance or inductance and it's Vmax and Imax would be identical to the connected transducer.
   However, when using the entity formula on page 2, note 1, the Ci value of the pressure transducer shall be used.
4. The surge protector part #50-02-2790 is used with all Series Transducers on sht. 1. **Not approved** for use in a class E environment.

Class I, DIV I, Groups. A.B.C.D; Class II, Groups F.G; Class III Hazardous Location



WIRING DIAGRAM for SURGE PROTECTOR FOR 4-20mA TRANSMITTER



WIRING DIAGRAM for SURGE PROTECTOR FOR 0-5VDC TRANSDUCER

WARNING!
AGENCY APPROVED DRAWING. REVISIONS MUST BE SUBMITTED FOR AGENCY APPROVAL.

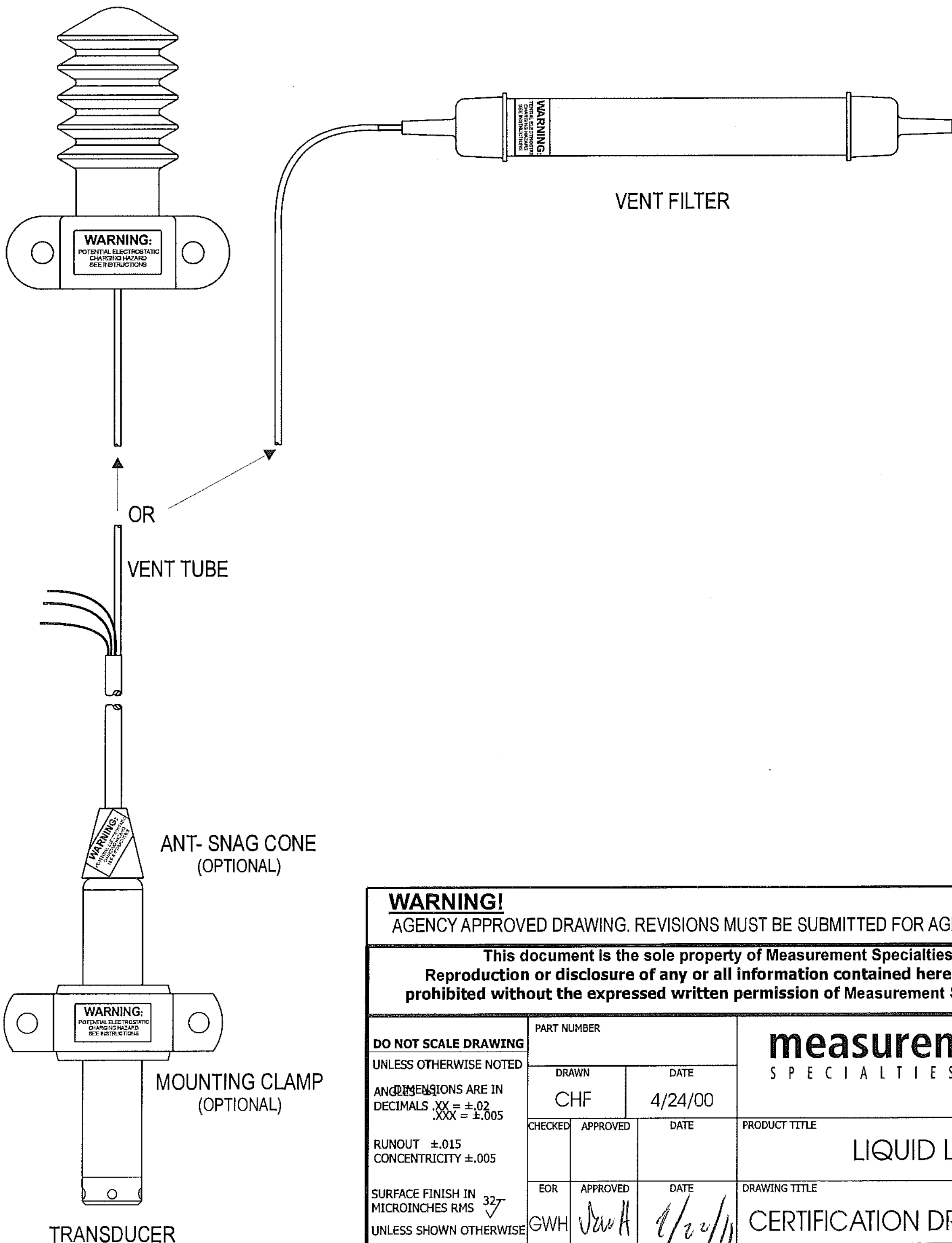
DO NOT SCALE DRAWING
UNLESS OTHERWISE NOTED
DIMENSIONS ARE IN DECIMALS .XX = ±.02 .XXX = ±.005
ANGLES ±1°
RUNOUT ±.015
CONCENTRICITY ±.005
SURFACE FINISH IN MICROINCHES RMS 32
UNLESS SHOWN OTHERWISE
MATERIAL

PART NUMBER			
DRAWN: CHF	DATE: 4/24/00		
CHECKED	APPROVED	DATE	PRODUCT TITLE: LIQUID LEVEL
EOR: GWH	APPROVED: WMH	DATE: 4/21/11	DRAWING TITLE: CERTIFICATION DRAWING, FM
SCALE: NTS	PROJECTION	DRAWING NUMBER: TA-6609	REVISION: AE / SHEET: 3/4

measurement SPECIALTIES

DATE	REV	ECO	REVISION	BY	CHK	EOR
7/28/06	V	N/A	SHT 1 ADDED "E" TO B=EXCITATION, SHT2 REVISED 1. P= ENTITY PARAMETERS & 2. STAHL APPARATUS	GKP	GWH	SMK
1/11/07	W	N/A	SHT2 REVISED 1. P= ENTITY PARAMETERS, ADDED "E" ENTITY PARAMETERS.	GKP	GWH	SMK
12/12/07	X	3901	SHT 1 ADDED VOLTAGE SUPPRESSION OPTIONS TO 300 SERIES TRANSDUCER, REVISED ALL P/Ns, SAME ON SHT. 3 FOR SERIES 169 & 173	GKP	GWH	SMK
2/25/09	Y	4015	RMV EXCITATION 1,2, ADD F,G,H,J. RMV PRESSURE CONN. 4,5,6,8,F,G. RMV ELEC. CONN. 3,K. RMV ENT PARAMETERSB=1,B=2, ADD B=F,G,H,J. DEL SHT 3 FROM DWG.	GKP		GWH
8/21/09	Z	4015	ADDED NOSE PIECE OPTIONS & REMOVED OPTION 2 (HIRSCHMANN)ELECTRIAL CONNECTION FROM SERIES 27, 28, & 30 , SHT 1 ONLY	GKP		GWH
10/7/09	AA	4015	CORRECTED ORDER OF ALL SERIES LETTER CONFIGURATIONS, SHT 1 ONLY, REVISED CLASS GROUPS ON SHT 3.	GKP		GWH
11/4/09	AB	4015	ADDED SHEET 4	GKP		GWH
9/20/10	AC	4210	REVISED BORDER FORMAT FROM ESTERLINE TO MEASUREMENT SPECIALTIES.	GKP		GWH
9/20/10	AD	4218	ADDED ELECTRICAL CONNECTION "0" TO SERIES 27,28 & 30, LT MODEL SERIES & REFORMATTED PAGE LAYOUT SHEETS 1, 2 & 3.	GKP		GWH
4/22/11	AE	4218	CLARIFIED ENTITY PARAMETERS, SHT 2 ONLY	GKP		GWH

TYPICAL MECHANICAL INSTALLATION



WARNING!
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DO NOT SCALE DRAWING
UNLESS OTHERWISE NOTED
DIMENSIONS ARE IN DECIMALS .XX = ±.02 .XXX = ±.005
ANGLES ±1
RUNOUT ±.015
CONCENTRICITY ±.005
SURFACE FINISH IN MICROINCHES RMS 32
UNLESS SHOWN OTHERWISE

PART NUMBER

DRAWN	DATE
CHF	4/24/00

CHECKED	APPROVED	DATE

EOR	APPROVED	DATE
GWH		4/22/11

measurement SPECIALTIES

PRODUCT TITLE: LIQUID LEVEL

DRAWING TITLE: CERTIFICATION DRAWING, FM

MATERIAL	SCALE	PROJECTION	DRAWING NUMBER	REVISION	SHEET
	NTS		TA-6609	AE	4/4

DATE	REV	ECO	REVISION	BY	CHK	EOR
7/28/06	V	N/A	SHT 1 ADDED "E" TO B=EXCITATION, SHT2 REVISED 1. P= ENTITY PARAMETERS & 2. STAHL APPARATUS	GKP	GWH	SMK
1/10/07	W	N/A	HT2 REVISED 1. P= ENTITY PARAMETERS	GKP	GWH	SMK
1/11/07	X	N/A	ADDED "E" ENTITY PARAMETERS ON SHT 2.	GKP	GWH	SMK
12/12/07	Y	3901	SHT 1 ADDED VOLTAGE SUPPRESSOR OPTIONS TO 300 SERIES TRANSDUCERS , REVISED ALL P/Ns, SAME ON SHT. 3 FOR SERIES 169 & 173, DELETED 500 SERIES, WAS 6 SHT. DWG.	GKP	GWH	SMK
2/24/09	Z	4015	RMV EXCITATION 1,2, ADD F,G,H,J. RMV PRESSURE CONN. 4,5,6,8,F,G. RMV ELEC. CONN. 3,K. RMV ENT PARAMETERSB=1,B=2, ADD B=F,G,H,J. DEL SHT 3 FROM DWG.	GKP		GWH
8/21/09	AA	4015	ADDED NOSE PIECE OPTIONS, REMOVED OPTION 2 (HIRSCHMANN)ELECTRIAL CONNECTION FROM SERIES 27, 28, & 30 , SHT 1 ONLY	GKP		GWH
10/7/09	AB	4015	CORRECTED ORDER OF ALL SERIES LETTER CONFIGURATIONS, SHT 1 ONLY, REVISED CLASS GROUPS ON SHT 3, GENERAL PRESENTATION REVISION SHTS. 1&2.	GKP		GWH
9/20/10	AC	4210	REVISED BORDER FORMAT FROM ESTERLINE TO MEASUREMENT SPECIALTIES.	GKP		GWH
9/20/10	AD	4218	ADDED ELECTRICAL CONNECTION "0" TO SERIES 27,28 & 30, LT MODEL SERIES SHT 1 ONLY AND ADDED SHEET 4	GKP		GWH
4/22/11	AE	4218	CLARIFIED ENTITY PARAMETERS, SHT 2 ONLY	GKP		GWH

The Transducers listed below are designed for installation in a Class I, Division 1, Groups A, B, C and D, Class II, Division 1, Groups E, F, and G, Class III, Division 1 hazardous location when connected to Associated Apparatus as described in note 1.

Series 27FABCDGEEEE, 28FABCDGEEEE, 30FABCDGEEEE
- A = pressure type: 1,3,4,6
- B = excitation/output 3,4,E,F,G,H,J,K,L,M
- C = pressure connection: 1,2,7
- D = electrical connection: 0,1,4
- EEEE = pressure range: 0-2000 PSI
- F = material: S,T
- G = voltage suppression: A,B,C

Series 700FABCDGEEEE, 705FABCDGEEEE, 710FABCDGEEEE, 720FABCDGEEEE, 730FABCDGEEEE, 735FABCDGEEEE, 750FABCDGEEEE
- A = pressure type: 1,3,4
- B = excitation/output: 3,4,E,F,G,H,J,K,L,M
- C = pressure connection: A,B,C,D,E,2,7
- D = electrical connection: 0,4,A,B
- EEEE = pressure range: 0-304 PSI
- F = material: S,T
- G = voltage suppression: A,B,C

Series 300FABCDGEEEE, 320FABCDGEEEE, 330FABCDGEEEE, 335FABCDGEEEE
- A = pressure type: 1,3,4
- B = excitation/output: 3,4,E,F,G,H,J,K,L,M
- C = pressure connection: B
- D = electrical connection: 0,A,B
- EEEE = pressure range: 0-304 PSI
- F = material: S,T
- G = voltage suppression: A,B,C

Series LTABCDEFGHIIIJK
- A = pressure connection: A,B
- B = excitation/output: 1,2,3,4,5,6,7,8,A,B,C,D,E,F,G
- C = cable type: A,B
- D = accuracy: A,B,C,D,E,F
- E = intrinsic safety approvals: A,B,C
- F = label: A,B,C
- G = material: S
- H = electrical connection: A
- III = pressure range: 0-50 psi
- J = units: P,F,M
- K = pressure type: G,S,A

Notes: (applies to all figures on sht 2)

1. Associated Apparatus shall provide intrinsically safe connections which meet the following parameters.

   V_{max} ; For all barrier channels used.
   I_{max} ; Combined current for all barrier channels used.
   C_i ; For all barrier channels used.
   L_i ; For all barrier channels used.
   P_i ; Combined power for all barrier channels used.

   Voc or $V_T \le V_{max}$ $\quad C_a \ge C_i + C_{leads}$*
   Isc or $I_T \le I_{max}$ $\quad L_a \ge L_i + L_{leads}$*
   Po or $P_T < P_i$

* Includes all cable connected to the barrier including the transducer cable.

Selected barriers must be third party approved as providing intrinsically safe circuits for the application, and have Voc or Vt not exceeding Vmax and Isc or It not exceeding Imax, and the Po of the barrier must be less than or equal to the Pmax of the intrinsically safe equipment, as shown in the Table of Entity parameters.

2. Control Room apparatus shall not generate in excess of 250V (U_{max}).

3. Installation should be in accordance with Article 504 in the *National Electrical Code,* ANSI/NFPA 70 and ISA RP-12.06.01

4. Float unused wires in cable. Insure that these wires are electrically isolated from other conductors.

WARNING!
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UNLESS OTHERWISE NOTED
DIMENSIONS ARE IN DECIMALS .XX = ±.02 .XXX = ±.005
ANGLES ±1°
RUNOUT ±.015
CONCENTRICITY ±.005
SURFACE FINISH IN MICROINCHES RMS 32 UNLESS SHOWN OTHERWISE
MATERIAL

PART NUMBER

DRAWN	DATE
CHF	4/24/00

CHECKED	APPROVED	DATE

EOR	APPROVED	DATE
GWH	[signature]	4/22/11

measurement SPECIALTIES

PRODUCT TITLE: LIQUID LEVEL

DRAWING TITLE: CERTIFICATION DRAWING, UL

SCALE	PROJECTION	DRAWING NUMBER	REVISION	SHEET
NTS		TA-6610	AE	1/4

DATE	REV	ECO	REVISION	BY	CHK	EOR
7/28/06	V	N/A	SHT 1 ADDED "E" TO B=EXCITATION, SHT2 REVISED 1. P= ENTITY PARAMETERS & 2. STAHL APPARATUS	GKP	GWH	SMK
1/10/07	W	N/A	HT2 REVISED 1. P= ENTITY PARAMETERS	GKP	GWH	SMK
1/11/07	X	N/A	ADDED "E" ENTITY PARAMETERS ON SHT 2.	GKP	GWH	SMK
12/12/07	Y	3901	SHT 1 ADDED VOLTAGE SUPPRESSOR OPTIONS TO 300 SERIES TRANSDUCERS , REVISED ALL P/Ns, SAME ON SHT. 3 FOR SERIES 169 & 173, DELETED 500 SERIES, WAS 6 SHT. DWG.	GKP	GWH	SMK
2/24/09	Z	4015	RMV EXCITATION 1,2, ADD F,G,H,J. RMV PRESSURE CONN. 4,5,6,8,F,G. RMV ELEC. CONN. 3,K. RMV ENT PARAMETERSB=1,B=2, ADD B=F,G,H,J. DEL SHT 3 FROM DWG.	GKP		GWH
8/21/09	AA	4015	ADDED NOSE PIECE OPTIONS, REMOVED OPTION 2 (HIRSCHMANN)ELECTRIAL CONNECTION FROM SERIES 27, 28, & 30 , SHT 1 ONLY	GKP		GWH
10/7/09	AB	4015	CORRECTED ORDER OF ALL SERIES LETTER CONFIGURATIONS, SHT 1 ONLY, REVISED CLASS GROUPS ON SHT 3, GENERAL PRESENTATION REVISION SHTS. 1&2.	GKP		GWH
9/20/10	AC	4210	REVISED BORDER FORMAT FROM ESTERLINE TO MEASUREMENT SPECIALTIES.	GKP		GWH
9/20/10	AD	4218	ADDED ELECTRICAL CONNECTION "0" TO SERIES 27,28 & 30, LT MODEL SERIES SHT 1 ONLY AND ADDED SHEET 4	GKP		GWH
4/22/11	AE	4218	CLARIFIED ENTITY PARAMETERS, SHT 2 ONLY	GKP		GWH

Class I, II, III, Div. 1 Groups A-G Hazardous Location → Entity Parameters

Figures 1-4

V_{max}= 28V
I_{max}= 110mA
C_i =0.064µF
L_i = 0
P_i = 1W

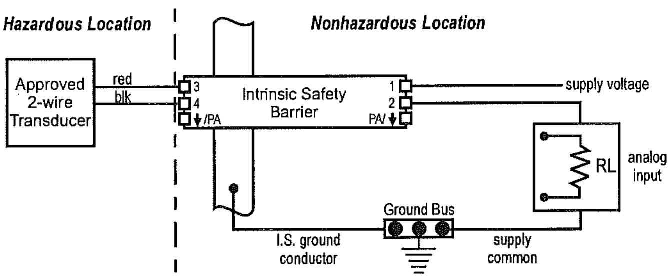

Figure 1. Return Lead Floating

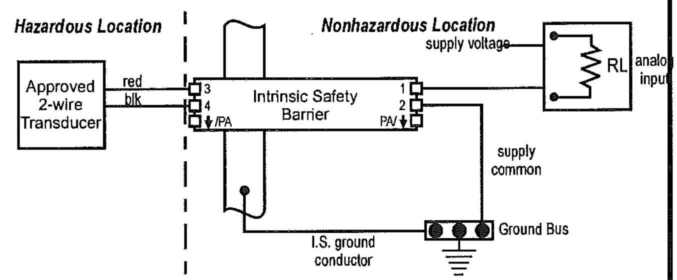

Figure 2. Return Lead Grounded

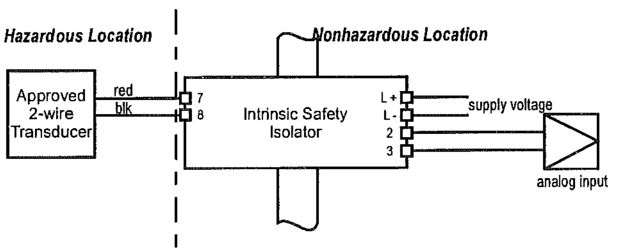

Figure 3. Field Circuit Isolated

Wiring diagram for 2-wire, 4-20mA output

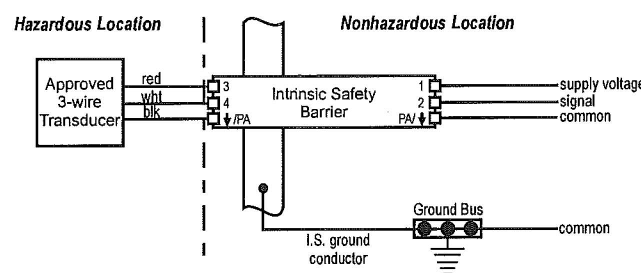

Figure 4. Wiring diagram for 3-wire, VDC output.

Class I, II, III, Div. 1 Groups C&D (only) Hazardous Location → Entity Parameters

V_{max}= 28V
I_{max}= 186mA
C_i =0.064µF
L_i = 0
P_i = 1.3 W

WIRING DIAGRAMS SAME AS FIGURES 1,2,3 & 4

AE

WARNING!
AGENCY APPROVED DRAWING. REVISIONS MUST BE SUBMITTED FOR AGENCY APPROVAL.

DO NOT SCALE DRAWING
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DIMENSIONS ARE IN ANGLES
DECIMALS .XX = ±.02
.XXX = ±.005
RUNOUT ±.015
CONCENTRICITY ±.005
SURFACE FINISH IN MICROINCHES RMS 32
UNLESS SHOWN OTHERWISE
MATERIAL

PART NUMBER

DRAWN	DATE
CHF	4/24/00

CHECKED	APPROVED	DATE

EOR	APPROVED	DATE
GWH	[signature]	4/21/11

measurement SPECIALTIES

PRODUCT TITLE: LIQUID LEVEL

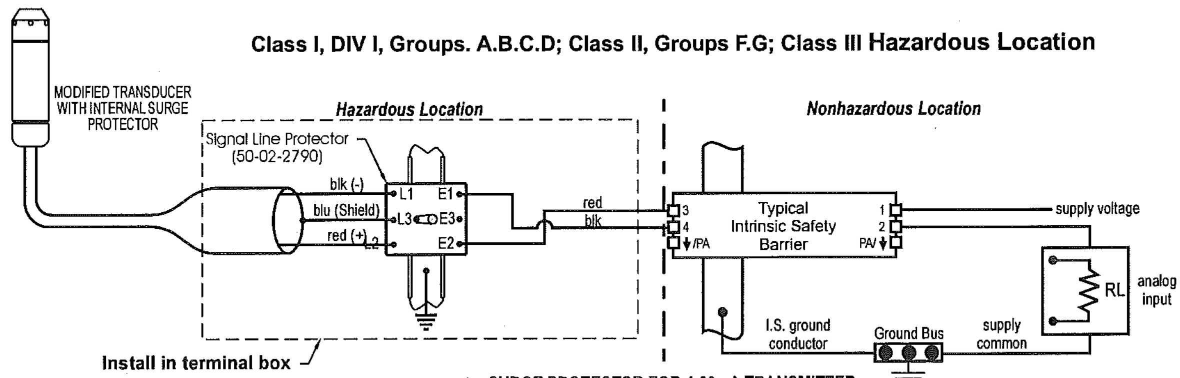
DRAWING TITLE: CERTIFICATION DRAWING, UL

SCALE	PROJECTION	DRAWING NUMBER	REVISION	SHEET
NTS		TA-6610	AE	2/4

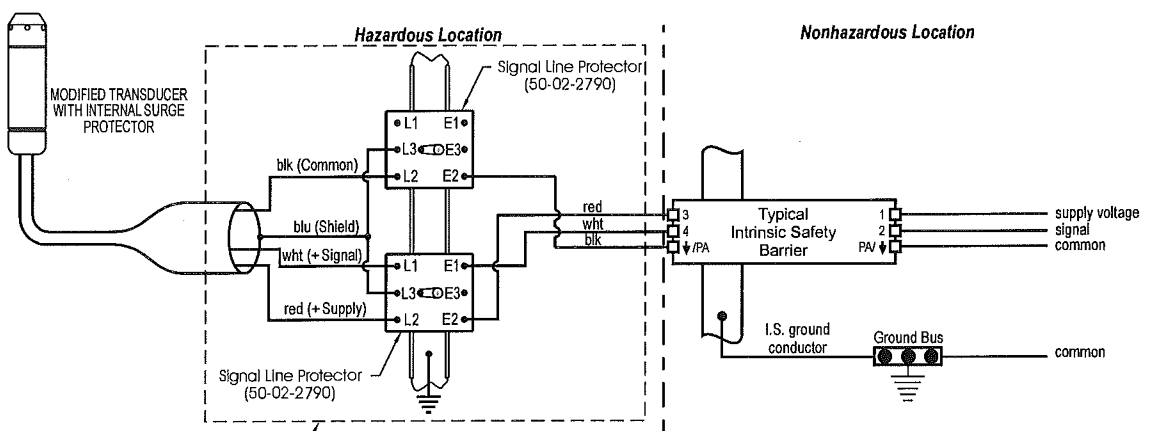
DATE	REV	ECO	REVISION	BY	CHK	EOR
7/28/06	V	N/A	SHT 1 ADDED "E" TO B=EXCITATION, SHT2 REVISED 1. P= ENTITY PARAMETERS & 2. STAHL APPARATUS	GKP	GWH	SMK
1/10/07	W	N/A	HT2 REVISED 1. P= ENTITY PARAMETERS	GKP	GWH	SMK
1/11/07	X	N/A	ADDED "E" ENTITY PARAMETERS ON SHT 2.	GKP	GWH	SMK
12/12/07	Y	3901	SHT 1 ADDED VOLTAGE SUPPRESSOR OPTIONS TO 300 SERIES TRANSDUCERS , REVISED ALL P/Ns, SAME ON SHT. 3 FOR SERIES 169 & 173, DELETED 500 SERIES, WAS 6 SHT. DWG.	GKP	GWH	SMK
2/24/09	Z	4015	RMV EXCITATION 1,2, ADD F,G,H,J. RMV PRESSURE CONN. 4,5,6,8,F,G. RMV ELEC. CONN. 3,K. RMV ENT PARAMETERSB=1,B=2, ADD B=F,G,H,J. DEL SHT 3 FROM DWG.	GKP		GWH
8/21/09	AA	4015	ADDED NOSE PIECE OPTIONS, REMOVED OPTION 2 (HIRSCHMANN)ELECTRIAL CONNECTION FROM SERIES 27, 28, & 30 , SHT 1 ONLY	GKP		GWH
10/7/09	AB	4015	CORRECTED ORDER OF ALL SERIES LETTER CONFIGURATIONS, SHT 1 ONLY, REVISED CLASS GROUPS ON SHT 3, GENERAL PRESENTATION REVISION SHTS. 1&2.	GKP		GWH
9/20/10	AC	4210	REVISED BORDER FORMAT FROM ESTERLINE TO MEASUREMENT SPECIALTIES.	GKP		GWH
9/20/10	AD	4218	ADDED ELECTRICAL CONNECTION "0" TO SERIES 27,28 & 30, LT MODEL SERIES SHT 1 ONLY AND ADDED SHEET 4	GKP		GWH
4/22/11	AE	4218	CLARIFIED ENTITY PARAMETERS, SHT 2 ONLY	GKP		GWH

Notes:
1. Install in terminal box.
2. Installation should be in accordance with Article 504 in the *National Electric Code,* ANSI/NFPA 70 and ISA RP12.06.01
3. The surge protector part #50-02-2790 is a passive device and as a result the device has no capacitance or inductance and it's Vmax and Imax would be identical to the connected transducer.
   However, when using the entity formula on page 2, note 1, the Ci value of the pressure transducer shall be used.
4. The surge protector part #50-02-2790 is used with all Series Transducers on sht. 1. **Not approved** for use in a class E environment.

Class I, DIV I, Groups. A.B.C.D; Class II, Groups F.G; Class III Hazardous Location



WIRING DIAGRAM for SURGE PROTECTOR FOR 4-20mA TRANSMITTER



WIRING DIAGRAM for SURGE PROTECTOR FOR 0-5VDC TRANSDUCER

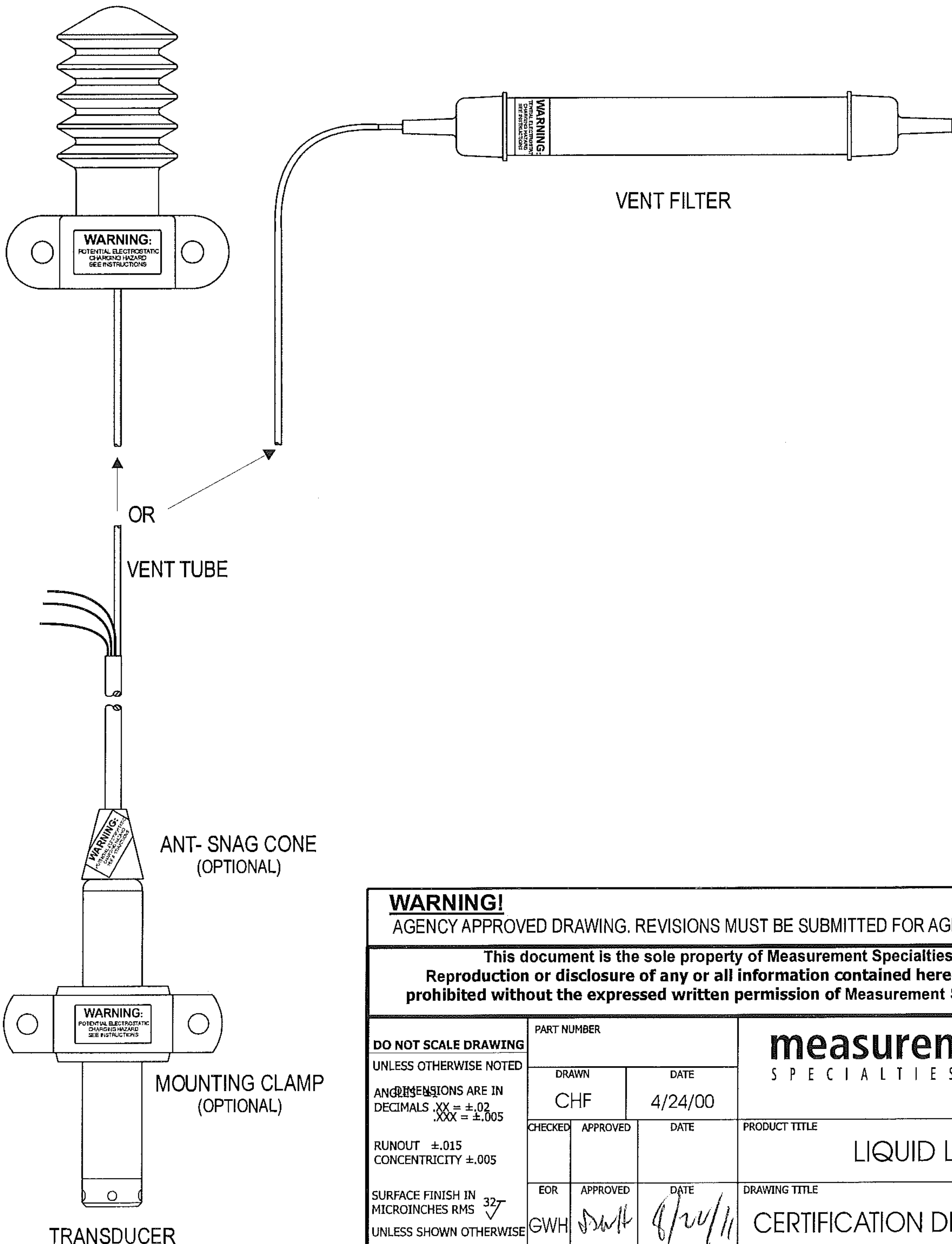
WARNING!
AGENCY APPROVED DRAWING. REVISIONS MUST BE SUBMITTED FOR AGENCY APPROVAL.

measurement SPECIALTIES

DO NOT SCALE DRAWING UNLESS OTHERWISE NOTED	PART NUMBER			
DIMENSIONS ARE IN DECIMALS .XX = ±.02 .XXX = ±.005 ANGLES ±1	DRAWN: CHF	DATE: 4/24/00		
RUNOUT ±.015 CONCENTRICITY ±.005	CHECKED	APPROVED	DATE	PRODUCT TITLE: LIQUID LEVEL
SURFACE FINISH IN MICROINCHES RMS 32 UNLESS SHOWN OTHERWISE	EOR: GWH	APPROVED: [signature]	DATE: 4/22/11	DRAWING TITLE: CERTIFICATION DRAWING, UL
MATERIAL	SCALE: NTS	PROJECTION	DRAWING NUMBER: TA-6610	REVISION: AE — SHEET: 3/4

DATE	REV	ECO	REVISION	BY	CHK	EOR
7/28/06	V	N/A	SHT 1 ADDED "E" TO B=EXCITATION, SHT2 REVISED 1. P= ENTITY PARAMETERS & 2. STAHL APPARATUS	GKP	GWH	SMK
1/10/07	W	N/A	HT2 REVISED 1. P= ENTITY PARAMETERS	GKP	GWH	SMK
1/11/07	X	N/A	ADDED "E" ENTITY PARAMETERS ON SHT 2.	GKP	GWH	SMK
12/12/07	Y	3901	SHT 1 ADDED VOLTAGE SUPPRESSOR OPTIONS TO 300 SERIES TRANSDUCERS , REVISED ALL P/Ns, SAME ON SHT. 3 FOR SERIES 169 & 173, DELETED 500 SERIES, WAS 6 SHT. DWG.	GKP	GWH	SMK
2/24/09	Z	4015	RMV EXCITATION 1,2, ADD F,G,H,J. RMV PRESSURE CONN. 4,5,6,8,F,G. RMV ELEC. CONN. 3,K. RMV ENT PARAMETERSB=1,B=2, ADD B=F,G,H,J. DEL SHT 3 FROM DWG.	GKP		GWH
8/21/09	AA	4015	ADDED NOSE PIECE OPTIONS, REMOVED OPTION 2 (HIRSCHMANN)ELECTRIAL CONNECTION FROM SERIES 27, 28, & 30 , SHT 1 ONLY	GKP		GWH
10/7/09	AB	4015	CORRECTED ORDER OF ALL SERIES LETTER CONFIGURATIONS, SHT 1 ONLY, REVISED CLASS GROUPS ON SHT 3, GENERAL PRESENTATION REVISION SHTS. 1&2.	GKP		GWH
9/20/10	AC	4210	REVISED BORDER FORMAT FROM ESTERLINE TO MEASUREMENT SPECIALTIES.	GKP		GWH
9/20/10	AD	4218	ADDED ELECTRICAL CONNECTION "0" TO SERIES 27,28 & 30, LT MODEL SERIES SHT 1 ONLY AND ADDED SHEET 4	GKP		GWH
4/22/11	AE	4218	CLARIFIED ENTITY PARAMETERS, SHT 2 ONLY	GKP		GWH

TYPICAL MECHANICAL INSTALLATION



WARNING!
AGENCY APPROVED DRAWING. REVISIONS MUST BE SUBMITTED FOR AGENCY APPROVAL.

DO NOT SCALE DRAWING
UNLESS OTHERWISE NOTED
DIMENSIONS ARE IN
DECIMALS .XX = ±.02
.XXX = ±.005
ANGLES ±1°
RUNOUT ±.015
CONCENTRICITY ±.005
SURFACE FINISH IN MICROINCHES RMS 32
UNLESS SHOWN OTHERWISE
MATERIAL

PART NUMBER	
DRAWN	CHF
DATE	4/24/00
CHECKED	
APPROVED	
DATE	
EOR	GWH
APPROVED	[signature]
DATE	4/22/11
PRODUCT TITLE	LIQUID LEVEL
DRAWING TITLE	CERTIFICATION DRAWING, UL
SCALE	NTS
PROJECTION	
DRAWING NUMBER	TA-6610
REVISION	AE
SHEET	4/4

measurement SPECIALTIES

measurement SPECIALTIES

CE Certificate of Compliance

July 7, 2011

We,

Measurement Specialties, Inc.

certify that the products listed below:

Series 27, 28, 30
Series 300DS, 320, 330, 335, 342
Series 500, 501
Series 700, 705, 710, 720, 730, 735, 750

complies with the specifications published in the following standard:

EN 61326-1:2006 & EN 61326-2-3:2006 Immunity & Emissions Standards

Including requirements of:

EN 61000-4-2	Electrostatic Discharge Immunity
EN 61000-4-3	Radiated Electromagnetic Field Immunity
EN 61000-4-4	Electrical Fast Transient/Burst Immunity
EN 61000-4-5	Surge Immunity
EN 61000-4-6	Conducted Radio-Frequency Immunity
EN 61000-4-8	Magnetic Field Immunity
CISPR11	Electromagnetic Disturbance Characteristics

Per the provisions of directive 89/336/EEC as amended by 92/31/EEC and 93/68/EEC.

97/23/EC Pressure Equipment Directive

Certified by:

Gregory L. Hall

Greg Hall
Senior Design Engineer
Email: greg.hall@meas-spec.com

Accessories and Options

KPSI™ Transducers

Pressure Systems, Inc. offers an extensive line of accessories and options to augment the functionality of our KPSI™ Level and Pressure Transducers. These enhancements can be specified with the instrument's order or, in many cases, can be retrofitted in the field. Our Accessories and Options include 1-4 day expedited shipping service, lifetime lightning protection, and a variety of pressure connections to suit almost any installation. Industry-leading performance and reliability, combined with short lead times, responsive, knowledgeable Customer Service personnel, and our ability to customize KPSI transducers to meet virtually any requirement give us our competitive advantage. For trouble-free, cost-effective level and pressure monitoring instrumentation, contact our Sales or Customer Service Team today.

Sensing the Environment™

34 Research Drive
Hampton, VA 23666
USA

www.PressureSystems.com

ISO-9001:2000 Certified

Order on-line!
www.LevelandPressure.com

Phone: 757-865-1243
Toll Free: 800-328-3665
Fax: 757-865-8744
E-mail: sales@PressureSystems.com

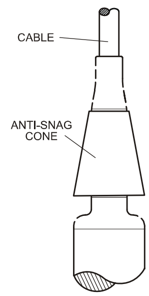
Table of Contents

INSTALLATION HARDWARE

Pressure Systems offers an extensive array of hardware to facilitate the installation of KPSI Transducers into almost any application. Contact our Technical Support staff for assistance in selecting the hardware that may best suit your application or if you have unique requirements that may require a custom solution.

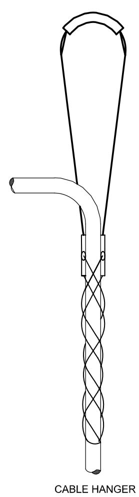
Anti-Snag Cone

Anti-Snag Cones are designed to fit over the cable end of either 1.0" or 0.75" diameter transducers to prevent the transducers from getting hung on obstacles when pulling the cable. The cones are constructed of PVC and come in separate sizes for the two diameters.



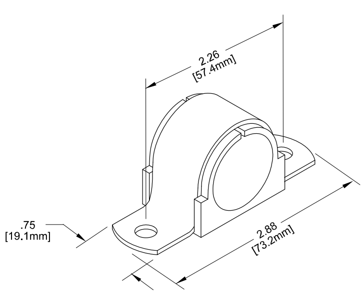
Cable Hanger

The *Cable Hanger* is used to suspend the transducers in the liquid media. The hanger slides onto the cable from the unterminated end and is easily positioned while pushing the ends of the hanger together. As the hanger expands from the weight of the transducer, it grips the cable by the sheath. The cable hanger is 6.0 in (15.3 cm) long and is constructed of 304 stainless steel. ***The cable hanger is not recommended for cable lengths in excess of 500 ft (150 m) as it does not take advantage of the Kevlar® strength members in the cable.***



Mounting Clamp

The *Mounting Clamp* is used to secure 1.0" diameter transducers to a bulkhead. The clamp is consists of a 304 stainless steel bracket with a thermoplastic insert that holds the transducer housing.

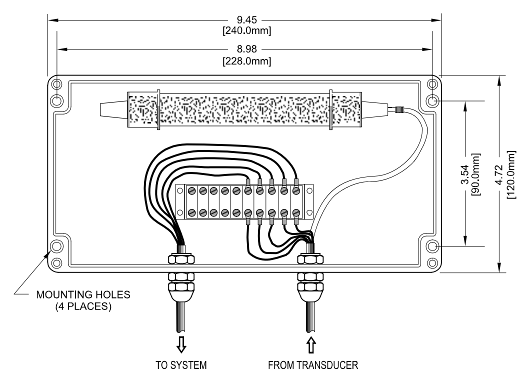


Well Caps

Locking *Well Caps* enable transducers to be suspended within the well while providing security. The vented orange PVC caps are 2" or 4" ID and come with a 304 stainless steel dock (ring and threaded quick-link) to support a cable hanger. The dual-hinge locking lid uses a Buna-N/Nitril o-ring for a watertight seal. The black triangle warning label on the lid can be marked for well identification.

Junction Box

The *Junction Box* provides a water-resistant enclosure for electrically connecting the transducer cable to the users system via a terminal strip. The enclosure also provides convenient location for terminating the vent tube on vented gage transducers. The enclosure can be ordered with either a vent filter or an aneroid bellows. The enclosure is constructed of polycarbonate with a clear top incorporating a neoprene seal. The junction box is rated IP66 and measures 9.45” L x 6.30” W x 4.72” H. Mounting screws are provided.



Identification Tags

Identification Tags are available to attach to the transducer cable to provide easy identification in the field. User-specified information is laser engraved onto the 1.0" square tag, which is constructed of 304 stainless steel.

Cable Splice Kit

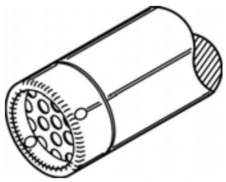
The *Cable Splice Kit* provides a waterproof connection to extend or repair Pressure Systems submersible cables. In many cases, the cable splice kit is a more economical alternative for repairing damaged cable. The kit includes all necessary items to electrically connect and insulate the conductors, couple the vent tubes, and seal the 316 stainless steel housing to either polyurethane and ETFE cable. Assembly instructions are also included.

Replaceable and Interchangeable Nose Caps

Submersible transducers having 1.0" diameter housings are shipped with replaceable nose caps of the requested variety at no additional cost when ordered. The nose caps screw on to the front of the transducer housing via a 7/8"-20 UNEF thread with an o-ring seal. Spare or alternative nose caps may be ordered separately.

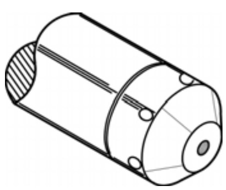
Open-face Nose Cap

The *Open-face Nose Cap* offers the best resistance to clogging. This single-piece nose cap provides maximum exposure of the sensing diaphragm to the liquid media through a protective perforated screen on the front. The open-face nose cap is constructed from molded Delrin®.



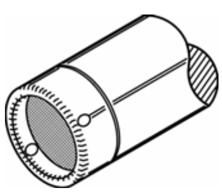
Ported Nose Cap

The *Ported Nose Cap* offers the best protection against damage to the sensing diaphragm. This single-piece nose cap allows the liquid media to enter through 6ea 1/8" holes around the outside and includes a #8-32 UNC-2B threaded hole on the front. The closed-face nose cap is constructed of molded Delrin®.



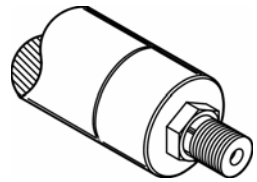
Piezometer Nose Cap

The *Piezometer Nose Cap* offers the best alternative for burying the transducer in the ground without risk to the sensing diaphragm. This two-piece nose cap allows the liquid media to enter through a permeable 40 micron centered stainless steel mesh filter at the front of the cap. The piezometer nose cap is constructed of Delrin®.



Male NPT Nose Cap

The *Male NPT Pressure Nose Cap* offers the best alternative for installing the transducer on a pipe. This single-piece nose cap incorporates a 1/4"-18 or a 1/2"-14 MNPT fitting on the front for connection. The male NPT nose cap is constructed of stainless steel or titanium, as required.

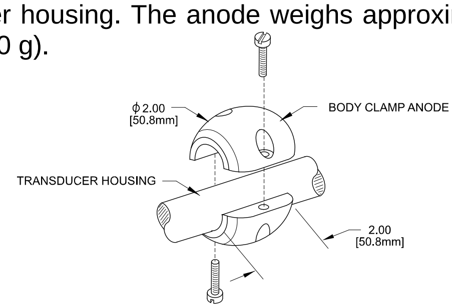


Corrosion Protection

KPSI Transducers are available with optional wetted materials to maintain compatibility with a variety of caustic liquid media. Stainless steel or titanium construction, Viton® seals, and polyurethane or ETFE cable permit the transducers to operate in most liquid environments. In the event galvanic corrosion is anticipated, PSI offers two self-sloughing sacrificial anodes that attach to 1.0" diameter transducers.

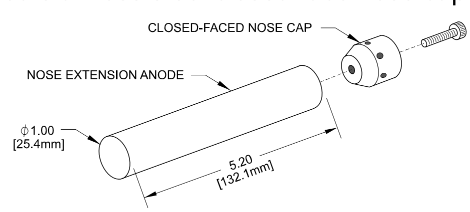
Body Clamp Anode

The *Body Clamp Anode* is a 2.2 in (5.6 cm) diameter zinc sphere of which the two halves bolt on to the transducer housing. The anode weighs approximately 13 oz (370 g).



Nose Extension Anode

The *Nose Extension Anode* is a 5.25 in (13.34 cm) long by 1.0" diameter zinc cylinder that attaches to a closed-face nose cap via an 8-32 threaded hole in the front of the nose cap. The anode weighs approximately 15 oz (417 g) and is shipped with an attached stainless steel closed-face nose cap.

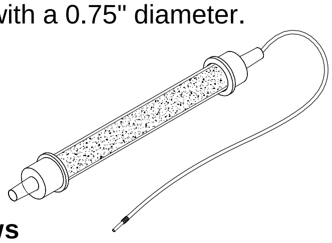


MOISTURE PROTECTION

Two solutions are offered to provide protection against moisture incursion on transducers with vented gage reference pressure format. The choice of which solution to utilize depends on the ability to provide periodic maintenance and the accuracy required for level measurement.

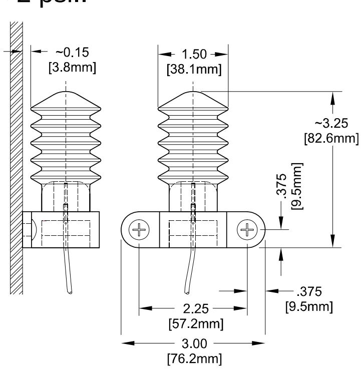
Vent Filter

Vent Filters provide the highest accuracy capability and utilize indicating desiccant to prevent moisture from entering the vent tube and damaging transducers with vented gage reference pressure format. The desiccant will turn from blue to pink when exposed to moisture indicating the need for maintenance. All vented gage transducers are shipped with our SuperDry™ Vent Filter. This latest vent filter design prevents moisture from entering the vent tube **for at least one year without maintenance**, at no additional cost. Spare filters may be ordered. The vent filters are 6.0 in (15.3 cm) long with a 0.75" diameter.



Aneroid Bellows

The *Aneroid Bellows* is a maintenance-free alternative to desiccant filters for moisture protection on vented gage transducers. Made of flexible neoprene material attached to a polycarbonate mounting bracket, the bellows fluctuates with changes in atmospheric pressure maintaining a constant barometric reference. Note that the use of the bellows results in a closed reference pressure system subject to zero shift errors induced by changing temperatures of up to 0.003 psi/ºC. The bellows is not recommended for use with accuracy requirements of ±0.25% FS or better, nor for ranges < 2 psi..



DIGITAL DISPLAYS

Pressure Systems offers two types of Display Meters to provide a visual readout of a single KPSI transducer having mA or VDC output. Both varieties utilize a red 0.54" LED display with 4 active characters to indicate a numeric range of -1999 to 9999. The units operate from VAC power and provide a 24 VDC supply for power to the transducer.

The Model 3019 Digital Readouts provide a sophisticated display of the transducer output with six 14-segment LED's for display of true alphanumeric characters; the last two used for process descriptors. These readouts offer programmable input configuration, isolated transducer power supply, selectable 2-point scaling or up to 17-point linearization, optional 4-20 mA retransmission, and two or four optional 10-amp SPDT alarm contacts for control. The 3019 has a NEMA 4X front panel with a polycarbonate bezel and a 1/8 DIN aluminum housing measuring 1.9375" H x 3.75 "W x 6.5" D.

The Model 3620 Pump Controllers provide a more rugged package specifically designed to operate external pumps via two 10-amp SPDT alarm contacts. The 3620 provides front panel scaling, operates from -20 to 70ºC, and uses 120 or 240 VAC. The NEMA 4X rated enclosure can be surface or panel mounted and measures 3.2" H x 5.5" W x 2.7" D.

Model 3019 Digital Readout	Model 3620 Pump Controller
6 digit 14 segment 0.54"red LED	4 digit7 segment 0.54" red LED
NEMA 4X front panel	NEMA 4X enclosure
Polycarbonate bezel, 1/8 DIN aluminum housing	Surface or panel mountable polycarbonate housing
Programmable mA or VDC input configuration	Fixed mA or VDC input configuration
Isolated 24 VDC@100 A power supply	Regulated 24 VDC@25A power supply
0 to 70ºC operation	-20 to 70ºC operation
20 bit A/D resolution	16 bit A/D resolution
90 to 140 VAC, 50/60 Hz power	Selectable 120/240 VAC, 50/60 Hz power
Plug-in terminal block electrical connections	Screw clamp terminal electrical connections
Selectable flashing display and/or horn alarm notification	Flashing display alarm notification
Optional 2ea or 4ea 10 amp, 250 VAC SPDT contacts	Standard 2 or optional 3ea 10 amp, 250 VAC SPDT contacts
Optional 4-20 mA retransmission	N/A

Expedite Shipment Service

Standard lead times for many of Pressure Systems' line of KPSI Level and Pressure Transducers are 5 working days. At a premium, PSI offers an *Expedite Shipment Service* in order to ship transducers within 1-4 working days. This service includes requirements for custom pressure ranges within the limits of the relevant transducer models as well as custom cable lengths. Expedite shipment service is available on most models. Consult our Customer Service staff for availability.

Reference Pressure Format

KPSI Transducers are available in three different *Reference Pressure Formats* to meet varying requirements. The format indicates whether the sensor is referenced to atmospheric pressure (vented gage), a hard vacuum (absolute), or a simulated atmospheric pressure (sealed gage).

Vented gage reference is usually used in lower full-scale range transducers where the sensor must track changes in atmosphere to maintain stated accuracy. Care must be taken to employ appropriate moisture protection to prevent humidity from entering the transducer via the vent tube.

Sealed gage and absolute reference is typically used when the full-scale range is above 700 ft (210 m) H_2O. Changes in atmospheric pressure have negligible impact on the accuracy of transducers at that range and moisture protection is not a concern since no vent tube is required. Sealed gage units are absolute units that are electrically adjusted to simulate reference to the atmospheric pressure at site of the installation. Base elevation with respect to sea level of the site must therefore be specified when ordering sealed gage transducers. Consult our Technical Support staff if you need assistance in choosing the reference pressure format.

Transducer Output

A variety of electrical *Transducer Output* signals are available to facilitate interfacing to almost any system. The most popular output signal is 4-20 mA, which is transmitted over two wires along with power for the transducer. Transducers with this output are typically referred to as transmitters and interface with almost any data logger or PLC

Amplified voltage output is also commonplace requiring three wires for power and output signal. Most common is 0-5 VDC, but the full-scale voltage output can be factory-adjusted to as much as 2.5 VDC less than the anticipated excitation voltage supply. Specify the voltage range required when ordering VDC output transducers.

Electrical Connection

Two basic *Electrical Connection* options are offered to facilitate submerged use in different environments.

The standard connection is a submersible cable exit using a factory molded polyurethane seal to the transducer housing. This provides the best water ingress protection. As an option, a compressed gland seal is offered to facilitate field attachment but requires considerable care in assembly to insure water-proof integrity.

An optional ½"-14 male NPT conduit fitting can also be specified for a more rugged and protected connection. This configuration also employs the standard molded cable seal or the optional gland cable seal.

Temperature Sense Output

As an option, a precision silicon temperature sensor can be installed within the transducer to provide a separate 4-20 mA temperature measurement output over the range of -20 to 60ºC. The accuracy of the temperature measurement is ±4ºC.

Wetted Materials

Optional *Wetted Materials* are offered for both the transducer and the cable to enable compatibility with a wide range of liquid media.

Transducer Housing Assemblies

The transducer assemblies are most commonly made from 316 stainless steel, which offers good compatibility for most water and hydrocarbon liquid applications. Alternatively, the transducer assembly can be made from titanium, which offers superior compatibility to salt water and chemical liquid applications.

Cable Seals

The molded cable seal is KPSI's standard offering and provides a very reliable injection molded polyurethane seal. The gland cable seal is primarily used for ETFE cable and incorporates a compressed Viton® gland.

Transducer Cable

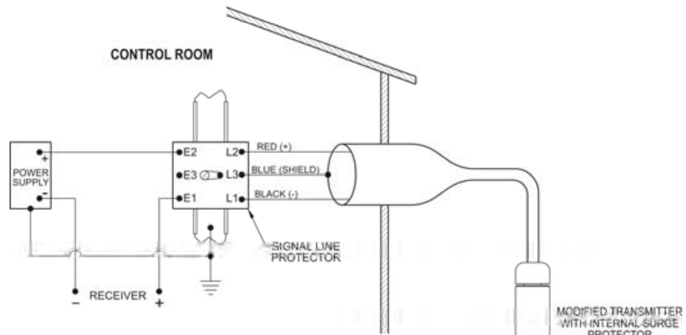
The jacket on our transducer cable is typically constructed from polyurethane, which provides excellent general-purpose use and reliability with good flexibility and economy. For liquid media such as hydrocarbons and other chemicals, ETFE can be specified providing excellent compatibility and maintaining all the features of the polyurethane though somewhat less flexible and more expensive.

Consult our Technical Support staff for the material best suited for the anticipated media.

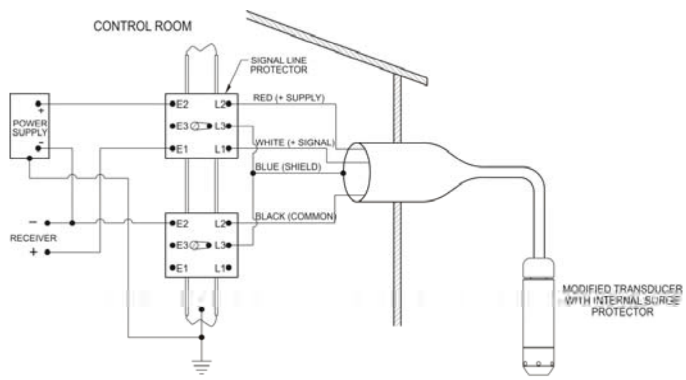
Lightning Protection)

Lightning Protection is designed to protect KPSI Level and Pressure Transducers from damaging surge voltage and current. The protection is offered for 2-wire 4-20 mA output as well as 3-wire VDC and digital output configurations. This circuit is capable of protecting against fast rising voltage transients as well as current surges associated with lightning discharges. The protectors are a multi-stage design, with a solid-state section that intercepts the leading edge of the surge within nanoseconds. The second stage of the design contains a gas discharge tube which crowbars up to 20,000 ampere currents to ground. The tube remains in the crowbar state until the surge has passed, then automatically resets the line to normal operation without the need to reset a circuit breaker. Each circuit consists of two parts. One is housed integral to the transducer via a factory-installed extension to the end of the housing while the other is installed by the user between the transducer wiring and the system. External line protection must be used at all times to ensure lifetime warranty coverage. The protectors are FM/UL/CUL Intrinsic Safety rated for use in hazardous environments when used with an appropriate Intrinsic Safety barrier. The transducer carries a **lifetime warranty for damage due to lightning or voltage spikes** when this 2-part option is properly installed. It is not warranted against continuous over voltage. This option is not available for the Series 300DS.

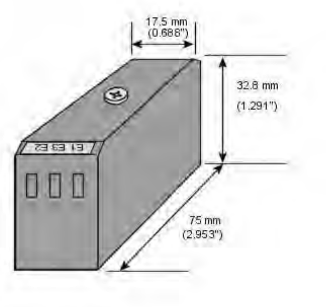
Note: For 4-20 mA output transducers the supply voltage must be at least 15 VDC when Lightning Protection is installed. Lightning Protection is available as an option on all new units.



CONNECTION DIAGRAM
KPSI SURGE PROTECTOR FOR 4-20mA TRANSMITTER



CONNECTION DIAGRAM
KPSI SURGE PROTECTOR FOR 0-5VDC TRANSDUCER



EXTERNAL LINE PROTECTOR

Installation Hardware

PN: 42-01-66181	Anti-Snag Cone for 1.0" diameter for use with molded cable seal
PN: 42-01-64134	Anti-Snag Cone for 1.0" diameter for use with gland cable seal
PN: 42-01-64136	Anti-Snag Cone for 0.75" diameter for use with gland cable seal
PN: 12-90-0931	Cable Hanger
PN: 49-06-00PC	Mounting Clamp
PN: 840	Junction Box with Vent Filter
PN: 845	Junction Box with Aneroid Bellows
PN: 36-05-1540T79	Identification Tags
PN: 830	Cable Splice Kit
PN: 861-2A	2" vented locking well cap with dock
PN: 861-2B	2" vented locking well cap
PN: 861-2C	2" well dock
PN: 861-4A	4" vented locking well cap with dock
PN: 861-4B	4" vented locking well cap
PN: 861-4C	4" well dock

Replaceable/Interchangeable Nose Caps

PN: 42-30-6659	Open-face Nose Cap
PN: 42-01-1314A	Closed-face Nose Cap
PN: 42-30-6676S	Piezometer Nose Cap
PN: 42-01-64154	Stainless Steel 1/4"-18 Male NPT Nose Cap
PN: 42-01-64154T	Titanium 1/4"-18 Male NPT Nose Cap
PN: 42-02-64180	Stainless Steel 1/2"- 14 Male NPT Nose Cap
PN: 42-02-64180T	Titanium 1/2"-14 Male NPT Nose Cap

Corrosion Protection

PN: 820	Body Clamp Anode
PN: 825	Nose Extension Anode

Moisture Protection

PN: 810	Vent Filter
PN: 815	Aneroid Bellows

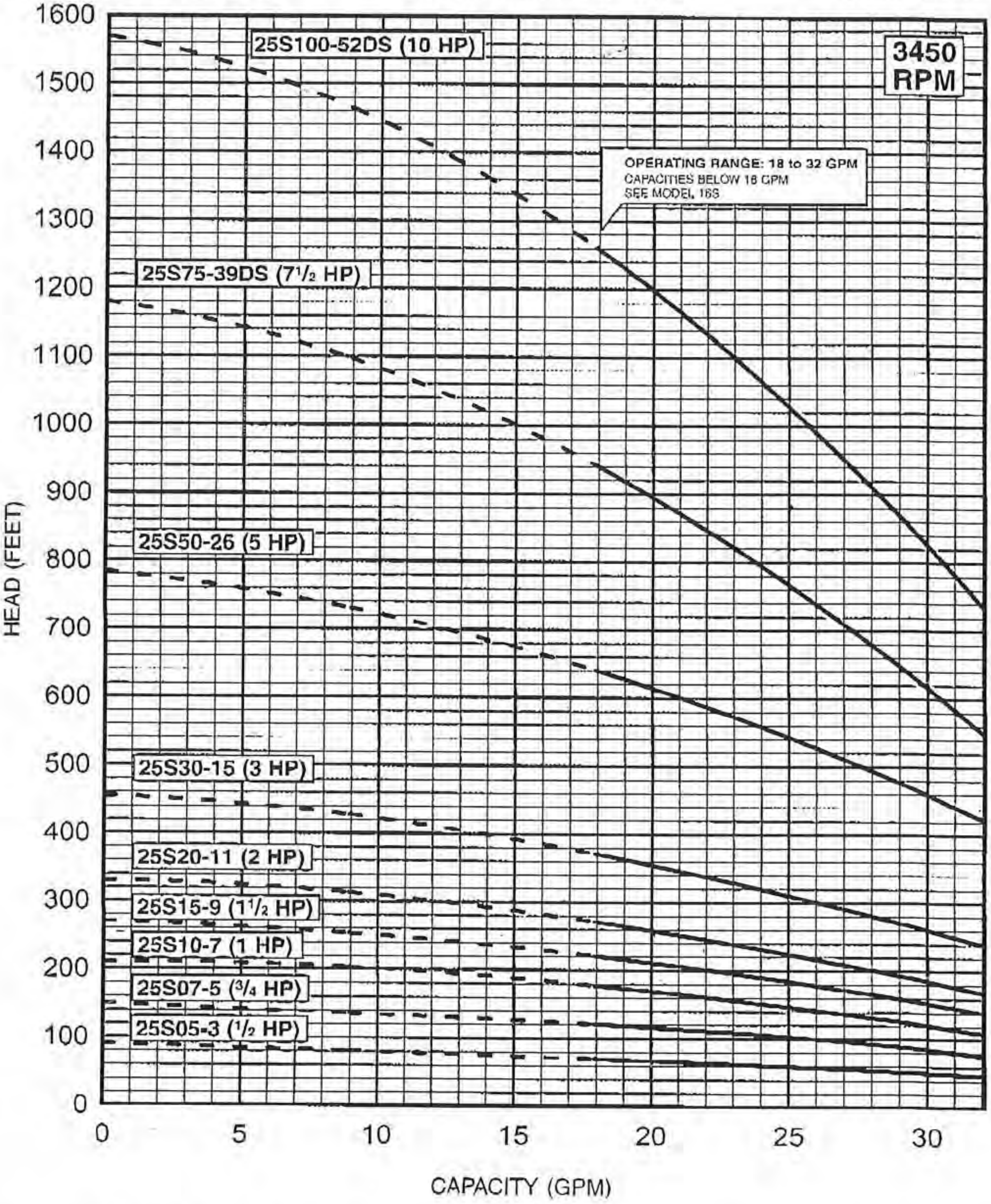
Digital Displays

PN: D3019-2-420	Digital Readout, two SPDT 10A control relays, 4-20 retransmission
PN: D3019-4	Digital Readout, four SPDT 10A control relays
PN: D3019-4-420	Digital Readout, four SPDT 10A control relays, 4-20 retransmission
PN: D3620	Digital Readout, NEMA 4X rated, two SPDT 10A control relays
PN: D3621	Digital Readout, NEMA 4X rated, three SPDT 10A control relays

Lightning Protection

PN: 809	External line protector

FLOW RANGE: 18 -32 GPM **OUTLET SIZE: 1½ " NPT** **NOMINAL DIA. 4"**



SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4" MOTOR STANDARD, .5 -5 HP/3450 RPM.
6" MOTOR STANDARD,7.5 -10HP/3450 RPM.

Performance conforms to ISO 9906. 1999 (E) Annex A
Minimum submergance is 2 feet.

4" SUPER STAINLESS
SUBMERSIBLE MOTORS

⅓ - 1.5 hp, 2 Wire: ⅓ - 3 hp 3 Wire, Single- & Three-Phase

Application Data:

These motors are built for dependable operation in 4" diameter or larger water wells. Continuous rating in 86 °F (30 °C) water.

For further information, refer to Franklin Electric's "Submersible Motors: Application, Installation, Maintenance Manual."

Special Features:

- No flow inducer sleeve required in water up to 86 °F (30 °C) for motors through 2 hp.
- Two-wire motors are split-phase designs with integral starting components and on-winding thermal overload protection, and do not require a control box. They feature Franklin's patented 2-wire BIAC starting switch which provides reverse impact torque to aid starting in adverse environments.
- Three-wire 60 Hz motors 1/3 - 1 hp use Franklin's exclusive 3-wire QD (Quick-Disconnect) Control Box with the patented QD Relay. This relay provides the ultimate in operational life.

Basic Features:

- Corrosion-Resistant All Stainless Steel Exterior Construction
- Stainless Steel Splined Shaft
- Hermetically-Sealed Windings
- Anti-Track Self-Healing Resin System
- Water Lubrication
- Filter Check Valve
- Kingsbury-Type Thrust Bearing
- Pressure Equalizing Diaphragm
- Built-In Lightning Arrestors (all single-phase; 200 and 230 Volt three-phase)
- Removable "Water-Bloc" lead installed In North American 60 Hz water well motors. Consult factory for additional leads.
- UL 778 Recognized (North American Voltages)
- CSA Certified
- ANSI/NSF 61 Certified
- NEMA Mounting Dimensions
- Rotation: single-phase - CCW; three-phase electrically reversible

WARNING: Serious or fatal electrical shock or fire hazard may result from failure to follow the instructions for proper installation and use which accompany this equipment. Do not use motor in swimming areas.

System Solutions

Franklin Electric

Availability

Single-Phase

2-Wire, Split-Phase, 60 Hz, 3450 rpm

HP	KW	VOLTS	"L" DIM	SHIPPING WEIGHT	
			INS	LBS	KGS
1/3	0.25	115 OR 230	8.78	16	7.2
1/2	0.37	115 OR 230	9.53	18	8.1
3/4	0.55	230	10.66	21	9.5
1	0.75	230	11.75	24	10.9
1.5	1.1	230	15.12	31	14.1

2-Wire, Split-Phase, 50 Hz, 2875 rpm

HP	KW	VOLTS	"L" DIM	SHIPPING WEIGHT	
			INS	LBS	KGS
1/2	0.37	220	9.53	18	8.1
3/4	0.55	220	10.66	21	9.5
1	0.75	220	11.75	24	10.9
1.5	1.1	220	15.12	31	14.1

3-Wire, Capacitor Start, 60 Hz, 3450 rpm ①

HP	KW	VOLTS	"L" DIM	SHIPPING WEIGHT	
			INS	LBS	KGS
1/3	0.25	115 OR 230	8.78	17	7.7
1/2	0.37	115 OR 230	9.53	19	8.6
3/4	0.55	230	10.66	21	9.5
1	0.75	230	11.75	24	10.9
1.5	1.1	230	13.62	28	12.7
2	1.5	230	15.12	33	15.0
3	2.2	230	19.06	41	18.6

3-Wire, Capacitor Start, 50 Hz, 2875 rpm ①

HP	KW	VOLTS	"L" DIM	SHIPPING WEIGHT	
			INS	LBS	KGS
1/3	0.25	220	8.78	17	7.7
1/2	0.37	220	9.53	19	8.6
3/4	0.55	220	10.66	21	9.5
1	0.75	220	11.75	24	10.9
1.5	1.1	220	13.62	28	12.7
2	1.5	220	15.12	33	15.0
3	2.2	220	19.06	41	18.6

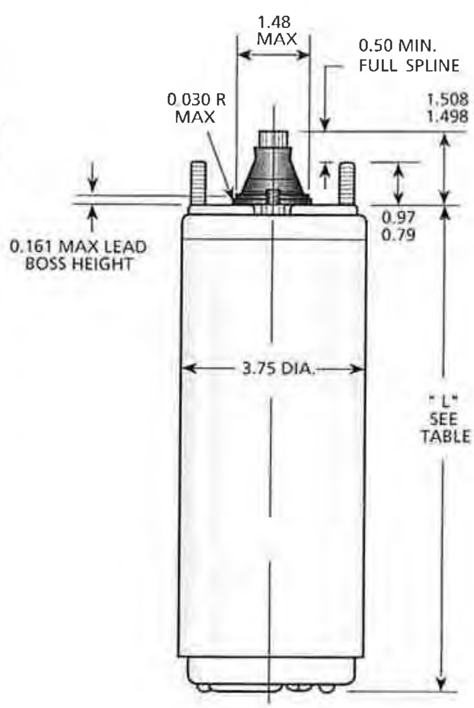
Three-Phase

200, 230, 380, 460, 575 Volt-60 Hz; 220, 380 Volt-50 Hz

Consult factory for dimensional and weight data.

Construction Materials

Components	Standard Water Well
Casting	304 SS Over Iron
Stator Shell	301 SS
Shaft Extension	17-4 SS
Fasteners	305 SS or 302 SS
Seal Cover	Acetal
Seal	Nitrile Rubber Lip
Diaphragm	Nitrile Rubber
Diaphragm Cover	301 SS
Slinger	Nitrile Rubber
Lead Wire (or Cable)	XLPE ②
Lead Potting	Epoxy
Lead Jam Nut	303 SS



① Franklin Electric control box required.

② Removable type installed in North American 60 Hz rated water well motors. Consult factory for additional leads.

Specifications subject to change without notice. Contact Franklin Electric if material types are required for bid specifications.

Franklin Electric

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Groundwater

home

Print this

4" Stainless Steel Submersibles

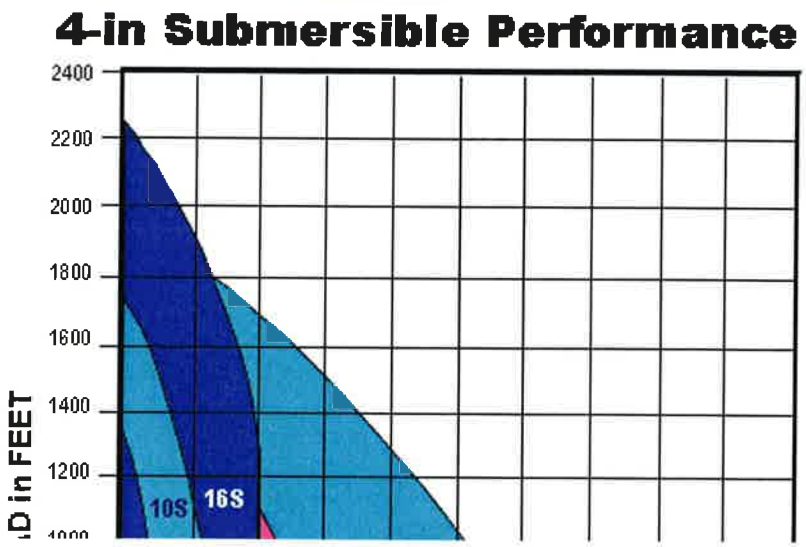
QUICK LINK

> Grundfos Submersible MS Motors

FEATURES

- All Stainless Steel construction for increased durability and reliability
- No lead-leaching components for maximum safety and health of end-users
- Built-in sand bearing minimizes sand damage experienced in most other submersible pumps and increases pump life, as well as offering protection against upthrust
- Built-in, jam-free check valves guarantee smooth running, fail safe operation
- User-friendly cable guard for the easiest installation among submersible pumps

PERFORMANCE



Performance chart is shown for reference only.
Download the submittal data sheet for exact performance.

APPLICATIONS

- Domestic Water Supply

Purchase One Today From An Authorized WaterPro Dealer !

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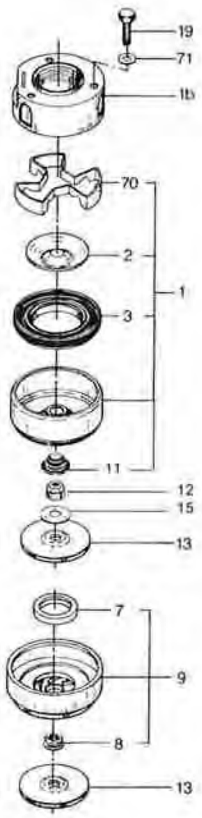
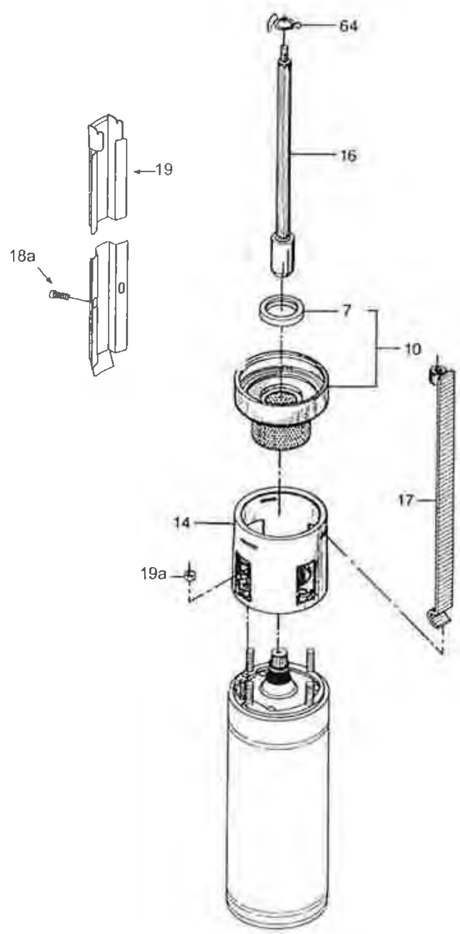
Kit Parts List

10S SPLINE SHAFT

GRUNDFOS
Leaders in Pump Technology



POS.	DESCRIPTION	QTY.	PART #	KIT
	INLET/DISCHARGE KIT			**INLET/DISCHARGE KIT**
1b	DISCHARGE PIECE 1 1/4"	1	095047	**FOR ANY NUMBER**
14	4" INLET	1	085020	**OF STAGE PUMPS**
10	LOWER INT W/SCREEN	1	085029	(Three strap)
1	UPPER CHAM W/ SAND BEARING	1	085053	**Part No.09002Z**
	BEARING KIT			
				BEARING KIT
8	INT BEARING	SEE KIT	080011	UP TO 9 STAGES **Pn. 08003Z**
7	SEAL RINGS	SEE KIT	095040	(HIGHER STAGES ORDER MULTIPLE KITS)
11	SAND BEARING	1	080099	
	IMPELLER KIT			
13	IMPELLER	SEE KIT	095048	**IMPELLER KIT**
19a	NUT KIT	1	UB9000	UP TO 9 STAGES **Pn. 09005Z**
19	BOLT FOR STRAP	3	ID3943	10 TO 18 STAGES **Pn. 09006Z**
71	WASHER	3	410026	19 TO 27STAGES **Pn.09007Z**
	CHAMBER KIT			
9	INT CHAMBERS	SEE KIT	095051	**CHAMBER KIT**
19a	NUT KIT	1	UB9000	UP TO 9 STAGES **Pn 08014Z**
19	BOLT FOR STRAP	3	ID3943	10 TO 18 STAGES **Pn.08015Z**
71	WASHER	3	410026	19 TO 27 STAGES **Pn. 08016Z**
10	LOWER INT W/SCREEN	1	085029	
	10S03-6 STRAP KIT			
17	STRAP	3	089206	**STRAP KIT**
19	BOLT FOR STRAP	3	ID3943	**Part No. 08052Z**
71	WASHER	3	410026	
18	CABLE GUARD	1	084606	
18a	SCREW FOR CABLE GUARD	2	ID7281	
	10S05-9 STRAP KIT			
17	STRAP	3	089209	**STRAP KIT**
19	BOLT FOR STRAP	3	ID3943	**Part No.08055Z**
71	WASHER	3	410026	
18	CABLE GUARD	1	084609	
18a	SCREW FOR CABLE GUARD	2	ID7281	
	10S07-12 STRAP KIT			
17	STRAP	3	089212	**STRAP KIT**
19	BOLT FOR STRAP	3	ID3943	**Part No. 08058Z**
71	WASHER	3	410026	
18	CABLE GUARD	1	084612	
18a	SCREW FOR CABLE GUARD	2	ID7821	



POS.	DESCRIPTION	QTY.	PART #	KIT
	10S10-15 STRAP KIT			
17	STRAP	3	089215	**STRAP KIT**
19	BOLT FOR STRAP	3	ID3943	**Part No. 08061Z**
71	WASHER	3	410026	
18	CABLE GUARD	1	084615	
18a	SCREW FOR CABLE GUARD	2	ID7821	
	10S10-21 STRAP KIT			
17	STRAP	3	089221	**STRAP KIT**
19	BOLT FOR STRAP	3	ID3943	**Part No.08064Z**
71	WASHER	3	410026	
18	CABLE GUARD	1	084621	
18a	SCREW FOR CABLE GUARD	2	ID7821	
	10S20-27 STRAP KIT			
17	STRAP	3	089227	**STRAP KIT**
19	BOLT FOR STRAP	3	ID3943	**Part No. 08068Z**
71	WASHER	3	410026	
18	CABLE GUARD	1	084627	
18a	SCREW FOR CABLE GUARD	2	ID7821	
	10S03-6 SHAFT KIT			
16	SHAFT	1	086206	**SHAFT KIT**
64	PRIMING PLATE	1	080051	**Part No.08023Z**
12	SAND NUT	1	080101	
15	UPTHRUST PLATE	1	080100	
	10S05-9 SHAFT KIT			
16	SHAFT	1	086209	**SHAFT KIT**
64	PRIMING PLATE	1	080051	**Part No. 08026Z**
12	SAND NUT	1	080101	
15	UPTHRUST PLATE	1	080100	
	10S07-12 SHAFT KIT			
16	SHAFT	1	086212	**SHAFT KIT**
64	PRIMING PLATE	1	080051	**Part No. 08029Z**
12	SAND NUT	1	080101	
15	UPTHRUST PLATE	1	080100	
	10S10-15 SHAFT KIT			
16	SHAFT	1	086215	**SHAFT KIT**
64	PRIMING PLATE	1	080051	**Part No. 08032Z**
12	SAND NUT	1	080101	
15	UPTHRUST PLATE	1	080100	
	10S15-21 SHAFT KIT			
16	SHAFT	1	086221	**SHAFT KIT**
64	PRIMING PLATE	1	080051	**Part No. 08035Z**
12	SAND NUT	1	080101	
15	UPTHRUST PLATE	1	080100	
	10S20-27 SHAFT KIT			
16	SHAFT	1	086227	**SHAFT KIT**
64	PRIMING PLATE	1	080051	**Part No.08039Z**
12	SAND NUT	1	080101	
15	UPTHRUST PLATE	1	080100	

Mitchell, Lindsay

From: Gray, Steve
Sent: Wednesday, November 09, 2011 4:39 PM
To: Choiniere, Stephen R.
Cc: Mitchell, Lindsay
Subject: FW: pressure sensor

Steve Gray
Senior Technician I
Environment
D 518-951-2382 C 518-424-3856
steve.gray@aecom.com

AECOM
40 British American Blvd.
Latham NY 12110
T 518-951-2200 F 518-951-2300
www.aecom.com

From: Terry Bohn [mailto:TBohn@aztechtech.com]
Sent: Wednesday, November 09, 2011 4:18 PM
To: Gray, Steve
Subject: pressure sensor

Hi Steve -

We ordered a KSMI sensor from Measurement Specialties on 2 Nov, 2010. My reference is SG-STAATS.

The part # was:

710 S 1 4 B 0 B 050.000 000.000 C 1 0125 A

Best regards -

T

Terrence Bohn
VP of Design
Aztech Technologies, Inc.
5 McCrea Hill Road
Ballston Spa, NY 12020
(518) 885-5383 x209 (office)
(518) 885-5385 (fax)
(518) 852-0666 (mobile)
tbohn@aztechtech.com

Earth Remediation Services
21 Business Park Drive
Branford, CT 06405
(203) 488-6713

3401 North Courtenay Parkway, Suite B
Merritt Island, FL 32953
(407)453-8685

LETTER OF TRANSMITTAL

October 30, 1997	ERS-239
ATTENTION: Ms. Heather Blakeley	
RE: Site No. 3-14-008	
NOW Corporation	
Dutchess County	
Contract No. D003682	

TO RUST Environment and Infrastructure
12 Metro Park Road
Albany, NY 12205

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6	10-30-97	013R2	Section 16100 Motor Control Panel Submittal
6	10-30-97	013R2	Schematic
6	10-30-97	013R2	Component Cut Sheets
6	10-30-97	013R2	Logic Listing

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REMARKS:

Please call with any questions.

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Programmable Logic Controller Inputs

DR-1	digital	Door Switch Overhead, SIGNAL ALARM, N/O	
DR-2	digital	Door Switch Entry, SIGNAL ALARM, N/O	
FE-1	digital	TW-1 totalizer/flow	
FE-2	digital	TW-2A totalizer/flow	
FE-3	digital	TW-3 totalizer/flow	
FS-1	digital	BL-101 Air Flow Sw. low flow shut down P-101,102,103 Signal Alarm n/o	
FS-2	digital	BL-102 Air Flow Sw. low flow shut down P-101,102,103 AND (BL-101 AFTER 10 SECONDS) Signal Alarm n/o	
LD-1	digital	P-201 Leakage Detector, SIGNAL ALARM	See these no outputs?
LD-2	digital	P-202 leakage detector, SIGNAL ALARM	
LS-1	digital	T-101 Hi level Switch shutdown P-101,102,103, Signal Alarm n/o	
LS-2	digital	P-201 Pump down switch n/o	
LS-3	digital	T-201 Hi hi Level Switch shutdown P-101,102,103, Signal Alarm n/o	
LS-4	digital	T-301 Hihi Level Switch shutdown P-101,102,103, Signal Alarm n/o	
LS-7	digital	Floor Sump Alarm, Shut down P-101,102,103 Signal Alarm n/o	
LS-8	digital	T-501 Pump P-501 Stop Switch n/o	
LS-9	digital	T-501 Pump P-501 Start Switch n/o, START BL-101, NO START IF BL-101 IN ALARM	
LS-10	digital	T-501 Hihi level Switch Shutdown BL-501, Signal Alarm n/o	
MS-1	digital	moisture switch TW-1 signal alarm n/o	
MS-2	digital	Floor Moisture Switch, Shutdown P-101, 102, 103, P-501, signal alarm n/o	
PB-1	digital	Reset push button	
PE-1	analog	TW-1 Water Level pressure transducer, operate P-101	4-20 mA
PE-2	analog	TW-2 Water Level pressure transducer, operate P-102	4-20 mA
PE-3	analog	TW-3 Water Level pressure transducer, operate P-103	4-20 mA
PE-4	analog	F-101 Pressure transducer, Hi pressure signal alarm	4-20 mA
PS-2	digital	BL-501 Hi Vacuum Switch Shut down BL-501, Signal Alarm n/o	
PS-3	digital	BL-501 Hi Pressure Switch Shutdown BL-501, Signal Alarm n/o	
T	digital	BL-101 Thermal Switch, Shutdown BL-101	SIGNAL ALARM n/o
T	digital	BL-102 Thermal Switch, Shutdown BL-102	SIGNAL ALARM n/o
T	digital	BL-501 Thermal Switch, Shutdown BL-501	SIGNAL ALARM n/o
T	digital	P-201 Thermal Switch, Shutdown P-201	SIGNAL ALARM n/o
T	digital	P-202 Thermal Switch, Shutdown P-202	SIGNAL ALARM n/o
T	digital	P-501 Thermal Switch, Shutdown P-501	SIGNAL ALARM n/o
TS-1	digital	HX-501 high temperature shutdown BL-501, signal alarm	n/o
TS-2	digital	building low or high temperature signal alarm	n/o

Programmable Logic Controller Outputs

CR-1	P-101	Recovery Well TW-1 Contactor Relay
CR-2	P-102	Recovery Well TW-2A Contactor Relay
CR-3	P-103	Recovery Well TW-3 Contactor Relay
CR-4	P-201	Effluent Well Pump Contactor Relay
CR-5	P-202	Effluent Well Pump Contactor Relay
CR-6	BL-101	Airstripper Blower Contactor Relay
CR-7	BL-102	Booster Blower Contactor Relay
CR-8	BL-501	Vapor extraction blower Contactor Relay
CR-9	P-501	Condensate Pump Contactor Relay
CR-10	PE-4	Alarm light relay
CR-11	LS-3/4	Alarm Light Relay
CR-12	LS-7	Alarm Light Relay
CR-13	BL-101	Thermal Alarm Light Relay
CR-14	BL-102	Thermal Alarm Light Relay
CR-15	FS-1	Alarm Light Relay
CR-16	FS-2	Alarm Light Relay
CR-17	LS-1	Alarm Light Relay
CR-18	BL-501	Thermal Alarm Relay
CR-19	PS-2	Alarm Light Relay
CR-20	PS-3	Alarm Light Relay
CR-21	LS-10	Alarm Light Relay
CR-22	TS-1	Alarm Light Relay

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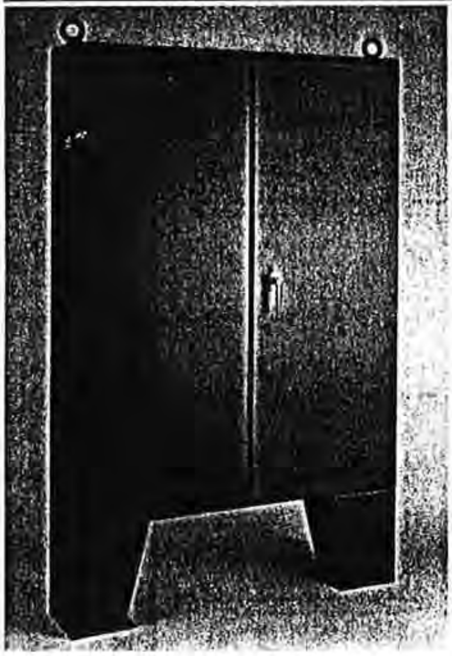
Two-Door Floor-Mount Type 12 Enclosures

Bulletin A12L



Application

Designed to house electrical and electronic controls, instruments, and components. Provide protection from dust, dirt, oil, and water.

Construction

- Seams continuously welded and ground smooth, no holes or knockouts
- Strong, rigid construction with body stiffeners
- Gasketed overlapping doors eliminate need for center post
- 3-point latching mechanism operated by oil-tight key-locking handle
- Latch rods have rollers for easier door closing
- Heavy gauge continuous hinges support each door
- Data pocket, provided on doors with 3-point latches, is high-impact thermoplastic
- 12-inch floor stands are welded to enclosure
- Heavy duty lifting eyes
- Panel supports
- Oil-resistant gasket attached with oil-resistant adhesive and held in place with steel retaining strips
- Collar studs for mounting optional panel

Finish

White inside with ANSI 61 gray outside finish over phosphatized surfaces. Optional panels are white.

Industry Standards

UL 508 Type 12
NEMA/EEMAC Type 12
JIC standard EGP-1-1967
CSA Type 12
IEC 529, IP65

Price List Page 4.06

Accessories

See General Accessories Index page 492.

Air Conditioners
Blower Package
Corrosion Inhibitors
Door Stop Kit
Drip Shield Kit
Electric Heaters
Electrical Interlocks
Enclosure Stabilizers
Fan Cooling Products
Folding Shelf
Heat Exchangers
Lighting Kit
Panel Support Kit
Panels (See table)
Touch-Up Paint
Window Kit
Wiring Duct

Air conditioners and heat exchangers for this enclosure can be found in Hoffman's Specifier's Guide for Climate Control Products.

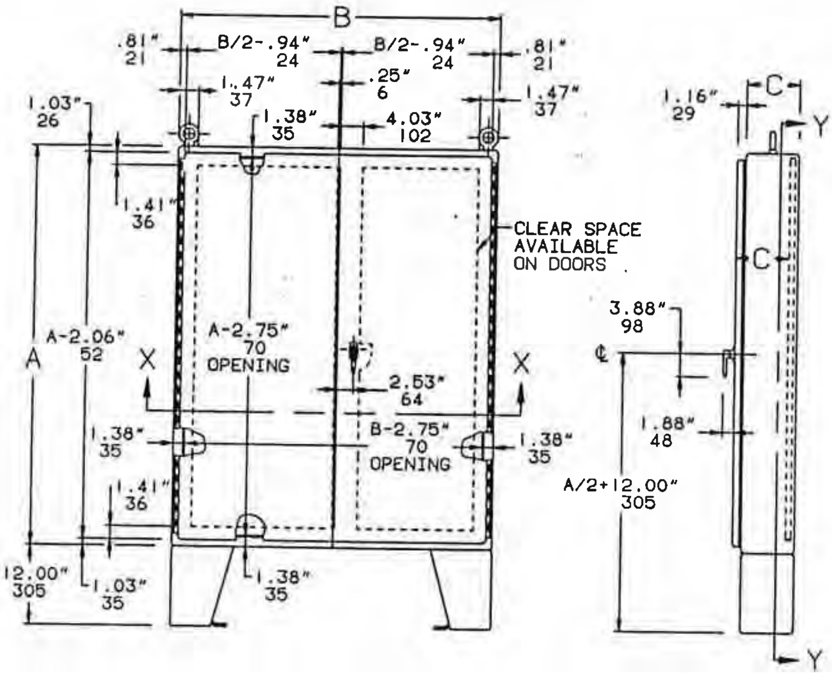
Cross Reference

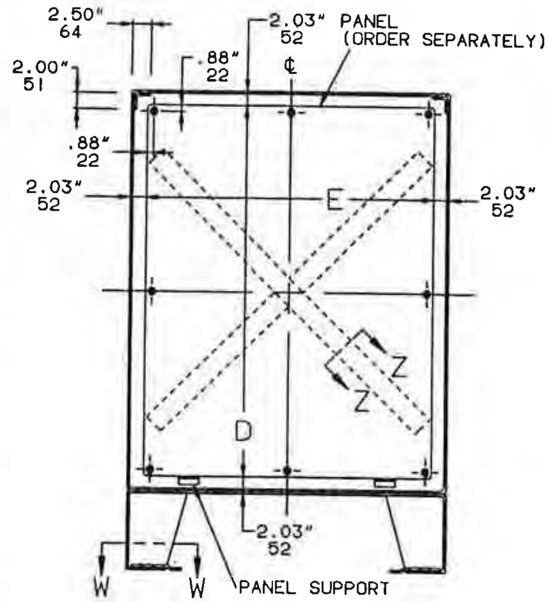
Stainless Steel Two-Door Floor-Mount Type 12 Enclosures (page 372)

Standard Sizes Two-Door Floor-Mount Type 12 Enclosures

Enclosure Catalog Number	Gauge	Enclosure Size A x B x C inch	(millimeter)	* Panel Catalog Number	Panel Gauge	Panel Size D x E inch	(mm)	Stiffener Door / Body
~~AA-544208LP~~	~~14~~	~~54.00x42.00x8.00~~	~~(1372x1067x203)~~	~~A-54P42~~	~~12~~	~~50.00x38.00~~	~~(1270x965)~~	~~0 0~~
~~A-604808LP~~	~~12~~	~~60.06x48.06x8.06~~	~~(1526x1221x205)~~	~~A-60P48~~	~~10~~	~~56.00x44.00~~	~~(1422x1118)~~	~~0 1 'X' form~~
A-604810LP	12	60.06x48.06x10.06	(1526x1221x256)	A-60P48	10	56.00x44.00	(1422x1118)	0 1 'X' form
~~A-606010LP~~	~~12~~	~~60.06x60.06x10.06~~	~~(1526x1526x256)~~	~~A-60P60~~	10	~~56.00x56.00~~	~~(1422x1422)~~	~~0 1 'X' form~~
~~A-726010ULP~~	~~12~~	~~72.06x60.06x10.06~~	~~(1830x1526x256)~~	~~A-72P60~~	~~10~~	~~68.00x56.00~~	~~(1727x1422)~~	~~0 1 'X' form~~
~~A-727210ULP~~	~~12~~	~~72.06x72.06x10.06~~	~~(1830x1830x256)~~	~~A-72P72~~	~~10~~	~~68.00x68.00~~	~~(1727x1727)~~	~~0 1 'X' form~~
A-604812LP	12	60.06x48.06x12.06	(1526x1221x306)	A-60P48	10	56.00x44.00	(1422x1118)	0 1 'X' form
A-606012LP	12	60.06x60.06x12.06	(1526x1526x306)	A-60P60	10	56.00x56.00	(1422x1422)	0 1 'X' form
A-726012ULP	12	72.06x60.06x12.06	(1830x1526x306)	A-72P60	10	68.00x56.00	(1727x1422)	0 1 'X' form
A-727212ULP	12	72.06x72.06x12.06	(1830x1830x306)	A-72P72	10	68.00x68.00	(1727x1727)	0 1 'X' form
A-604816LP	12	60.06x48.06x16.06	(1526x1221x408)	A-60P48	10	56.00x44.00	(1422x1118)	0 1 'X' form
A-606016LP	12	60.06x60.06x16.06	(1526x1526x408)	A-60P60	10	56.00x56.00	(1422x1422)	0 1 'X' form
A-726016ULP	12	72.06x60.06x16.06	(1830x1526x408)	A-72P60	10	68.00x56.00	(1727x1422)	0 1 'X' form
A-727216ULP	12	72.06x72.06x16.06	(1830x1830x408)	A-72P72	10	68.00x68.00	(1727x1727)	0 1 'X' form
A-604820LP	12	60.06x48.06x20.06	(1526x1221x510)	A-60P48	10	56.00x44.00	(1422x1118)	0 1 'X' form
A-726020ULP	12	72.06x60.06x20.06	(1830x1526x510)	A-72P60	10	68.00x56.00	(1727x1422)	0 1 'X' form
A-727220ULP	12	72.06x72.06x20.06	(1830x1830x510)	A-72P72	10	68.00x68.00	(1727x1727)	0 1 'X' form
A-604824LP	12	60.06x48.06x24.06	(1526x1221x611)	A-60P48	10	56.00x44.00	(1422x1118)	0 1 'X' form
A-606024LP	12	60.06x60.06x24.06	(1526x1526x611)	A-60P60	10	56.00x56.00	(1422x1422)	0 1 'X' form
A-726024ULP	12	72.06x60.06x24.06	(1830x1526x611)	A-72P60	10	68.00x56.00	(1727x1422)	0 1 'X' form
A-727224ULP	12	72.06x72.06x24.06	(1830x1830x611)	A-72P72	10	68.00x68.00	(1727x1727)	0 1 'X' form

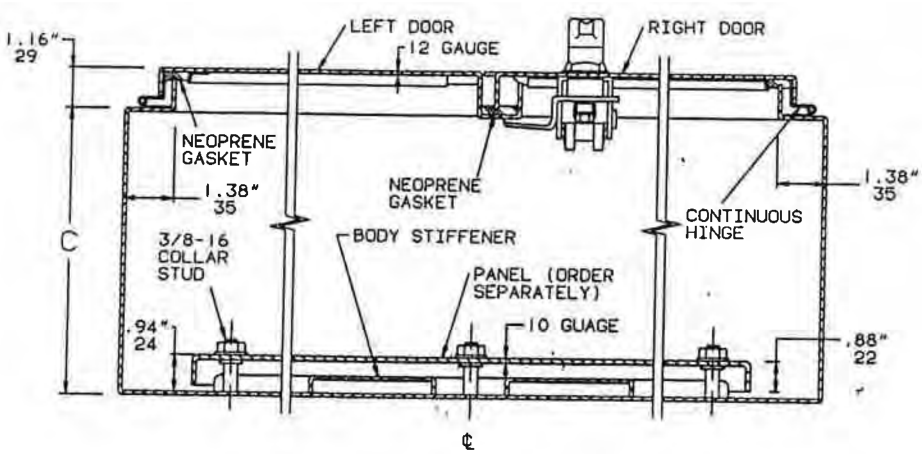
Millimeter dimensions ( ) are for reference only; do not convert metric dimensions to inch.
* Panels must be ordered separately.
† Rolled lip around door opening.





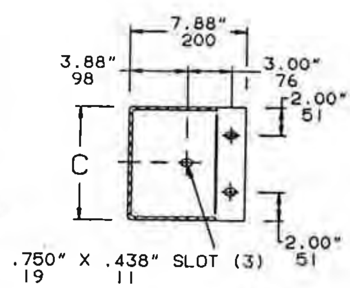
SECTION Y-Y

NOTE: 1. Panels are 10 gauge steel.
2. Right door has removable 12.00 x 12.00 (305 x 305) data pocket.

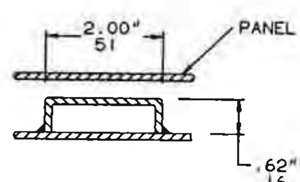


SECTION X-X

(LIFTING ANGLES NOT SHOWN)



SECTION W-W

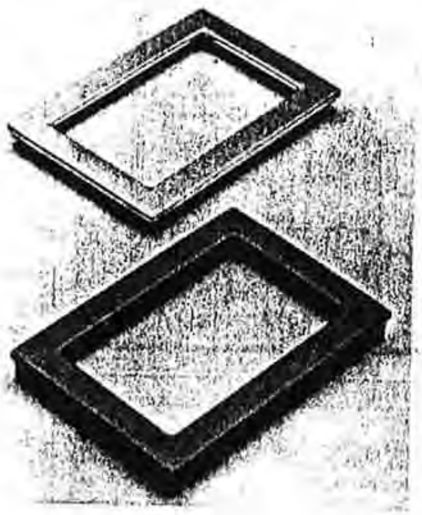


SECTION Z-Z

Inch
Millimeter

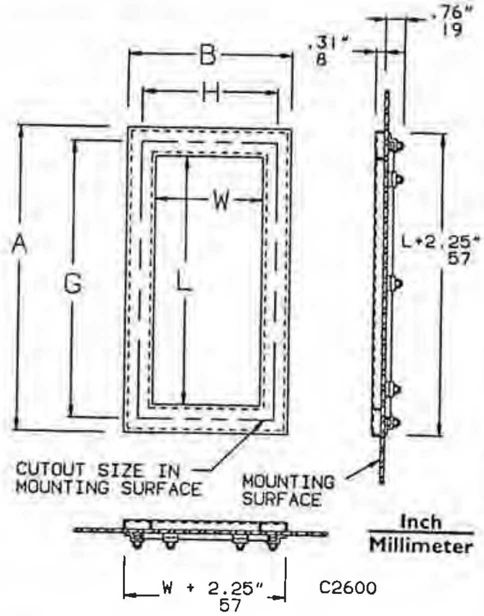
C2485

Data subject to change without notice. ☎ 612 421 2240 FAX 612 422 2178



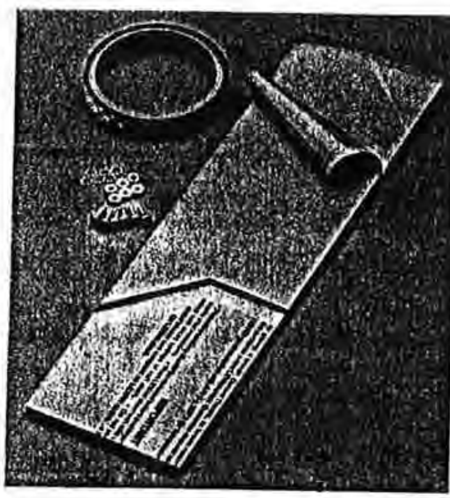
Steel and Stainless Steel Window Kits

Steel Window Kits are designed to be used indoors on Type 4 and 12 enclosures. Stainless Steel Window Kits are suitable for Type 4, 4X, 12, and 13 enclosures in indoor or outdoor applications where corrosion is a problem. These kits are easily installed by making a cutout in the enclosure and attaching the window and frame in place. Frames are made from heavy gauge steel and with an ANSI 61 gray polyester powder finish over phosphatized surfaces or heavy gauge Type 304 stainless steel with a brushed finish. The window is .25-inch (6 mm) acrylic for steel kits or .25-inch (6 mm) polycarbonate material for stainless steel kits. Oil-resistant gasketing ensures a water-tight seal around the perimeter of the window and frame. All mounting hardware is furnished. Custom sizes, materials, and finishes can be provided on special order. Consult factory for information.



Steel Window Kit Catalog Number	Stainless Steel Window Kit Catalog Number	Window Size LxW	Frame Size AxB	Required Cut-out Size GxH
A-PWK53NF	~~A-PWK53NFSS~~	5.00x3.00 (127x76)	7.50x5.50 (191x140)	6.69x4.69 (170x119)
~~A-PWK95NF~~	~~A-PWK95NFSS~~	~~9.00x5.50~~ (229x140)	~~11.50x8.00~~ (292x203)	~~10.69x7.19~~ (272x183)
A-PWK133NF	—	13.00x3.00 (330x76)	15.50x5.50 (394x140)	14.69x4.69 (373x119)
A-PWK138NF	A-PWK138NFSS	13.00x8.00 (330x203)	15.50x10.50 (394x267)	14.69x9.69 (373x246)
A-PWK175NF	—	17.00x5.50 (432x140)	19.50x8.00 (495x203)	18.69x7.19 (475x183)
A-PWK1711NF	A-PWK1711NFSS	17.00x11.00 (432x279)	19.50x13.50 (495x343)	18.69x12.69 (475x322)
A-PWK2315NF	A-PWK2315NFSS	23.00x15.00 (584x381)	25.50x17.50 (648x445)	24.69x16.69 (627x424)
A-PWK2919NF	A-PWK2919NFSS	29.00x19.00 (737x483)	31.50x21.50 (800x546)	30.69x20.69 (780x526)
A-PWK3523NF	—	35.00x23.00 (889x584)	37.50x25.50 (953x648)	36.69x24.69 (932x627)

When determining if a window kit will fit in a door or cover, be sure to allow for gaskets, gasket retainers, door stiffeners, data pockets, door handles, latch rods, and other parts attached to the door or cover.

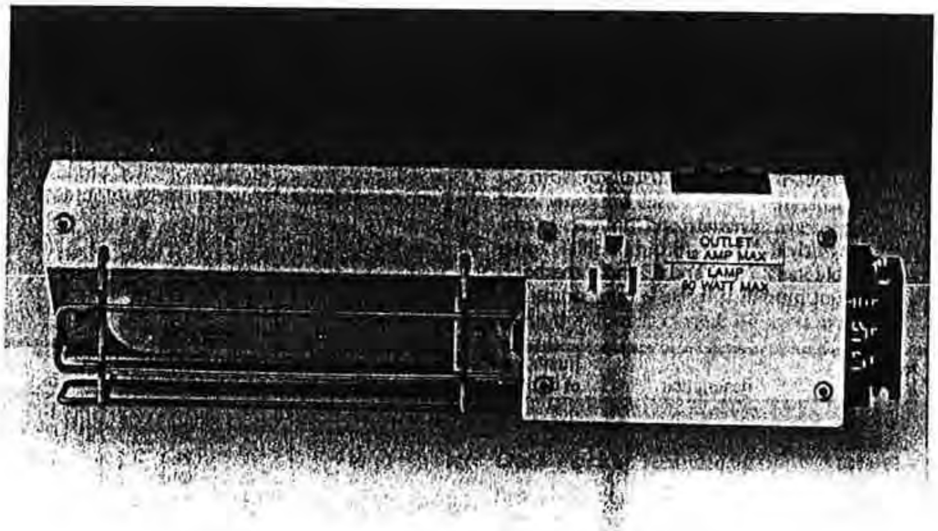


Frameless Window Kit

Designed for use on many Type 12 and 13 enclosures. These kits are for indoor use in a temperature range of 55° F to 125° F (13° C to 52° C). For more severe conditions use Steel or Stainless Steel Window Kits. The window is scratch-resistant .12-inch (3mm) GE Lexan Margard®. Special high-strength double-sided tape is supplied as well as screw fasteners. Windows can be cut to smaller sizes. Allow .50-inch (13 mm) overlap on each side of window for tape.

Catalog Number	Window Size	Maximum Cut-out Size
A-PWKE52	5.50x3.00 (140x76)	4.50x2.00 (114x51)
A-PWKE133	13.88x3.88 (353x99)	12.88x2.88 (327x73)
A-PWKE96	9.62x7.19 (244x183)	8.62x6.19 (219x157)

Millimeter dimensions ( ) are for reference only; do not convert metric dimensions to inch.



Incandescent Lighting Package

Designed to illuminate the interior of an electrical enclosure. Models are available with a door activated switch or a manually operated switch. A terminal block is provided for connection to the electrical supply circuit. A convenience outlet is also provided for ease of servicing components mounted within the enclosure. Lighting Package mounts at the top of the enclosure door opening and protrudes into the opening less than one inch (25mm). A removable wire guard protects the bulb from damage.

Construction

- 60 watt incandescent T-10 style bulb
- Terminal block has three 6-32 screw terminals with barriers labeled for power and ground connections
- Operates on 115 volts, 50/60 Hz
- 115 volt convenience outlet with ground, 12 amp maximum rating
- 20 gauge sheetmetal construction
- Stainless steel wire guard snaps in place for easy bulb replacement
- Includes two self-sealing installation screws

Industry Standards

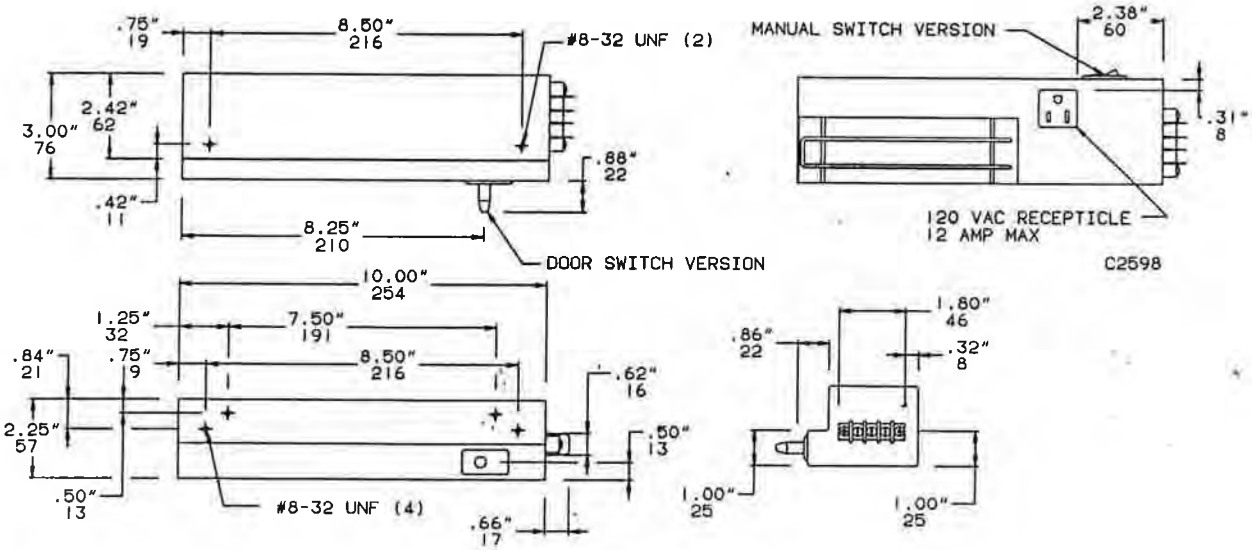
UL Component Recognized

Finish

Lighting Package is white. Wire guard is stainless steel.

Installation

Designed to be mounted in most Hoffman Type 4, 12, 13, 3, and 3R enclosures. Front mounting holes are used on most applications. Two .173-inch (4 mm) holes must be drilled in the enclosure. Lighting Package should be installed with two sealing screws which are included.



Catalog Number	Description	VAC	Hz	Amps
A-LTMB1	Manual Switch with Terminal Block	115	50/60	15
A-LTDB1	Door Switch with Terminal Block	115	50/60	15

MINIATURE AND MAG-GARD® CIRCUIT BREAKERS

THERMAL-MAGNETIC MINIATURE CIRCUIT BREAKERS

- Terminal lug wire size (1) #14-2 AWG Cu or Al wiring
- Reversible line and load lugs for flush or surface mount wiring
- 35mm DIN/EN 50022 mountable.
- One and two-pole models rated for 120/240VAC at 10,000 AIR
- Three-pole models rated 240VAC at 10,000 AIR
- All models are also 48VDC rated at 5,000 AIR
- UL Listed as HACR type (except 10 amp)
- See page 385 for handle lock off accessory

Amps	No. of Poles	Square D Model	Stock No.	List	Each	Shpg. Wt.
10	1	QOU110	5B966	$25.36	$15.22	0.3
10	2	QOU210	5B982	54.62	32.80	0.7
10	3	QOU310	5B996	179.39	107.65	1.1
15	1	QOU115	5B968	25.36	15.22	0.3
15	1	QOU115HM*	5B969	26.30	15.22	0.3
15	2	QOU215	5B984	54.62	32.80	1.5
15	3	QOU315	5B998	179.39	107.65	0.7
20	1	QOU120	5B970	25.36	15.22	1.1
20	1	QOU120HM*	5B971	25.36	15.22	0.4
20	2	QOU220	5B985	54.62	32.80	0.3
20	3	QOU320	5B999	179.39	107.65	0.7
25	1	QOU125	5B972	25.36	15.22	1.1
25	2	QOU225	5B986	54.62	32.80	0.4
25	3	QOU325	5U993	179.39	107.65	0.7
30	1	QOU130	5B973	25.36	15.22	1.1
30	2	QOU230	5B987	54.62	32.80	0.3
30	3	QOU330	5U994	179.39	107.65	0.7
35	1	QOU135	5B974	25.36	15.22	1.1
35	2	QOU235	5B988	54.62	32.80	0.4
35	3	QOU335	5U995	179.39	107.65	0.7
40	1	QOU140	5B975	25.36	15.22	1.0
40	2	QOU240	5B989	54.62	32.80	0.4
40	3	QOU340	5U996	179.39	$107.[illegible]	1.1
45	1	QOU145	5B976	25.36	15.[illegible]	[illegible]
45	2	QOU245	5B990	54.62	32.[illegible]	[illegible]
45	3	QOU345	5U997	179.39	107.[illegible]	[illegible]
50	1	QOU150	5B977	25.36	15.[illegible]	[illegible]
50	2	QOU250	5B991	54.62	32.[illegible]	[illegible]
50	3	QOU350	5U998	179.38	107.[illegible]	[illegible]
60	1	QOU160	5B978	[illegible]	[illegible]	[illegible]
60	2	QOU260	5B992	[illegible]	[illegible]	[illegible]
60	3	QOU360	5U999	[illegible]	[illegible]	[illegible]
70	1	QOU170	5B979	[illegible]	[illegible]	[illegible]
70	2	QOU270	5B993	[illegible]	[illegible]	[illegible]
70	3	QOU370	6B008	[illegible]	[illegible]	[illegible]
80	1	QOU180	5B980	[illegible]	[illegible]	[illegible]
80	2	QOU280	5B994	[illegible]	[illegible]	[illegible]
80	3	QOU380	6B009	[illegible]	[illegible]	[illegible]
90	1	QOU190	5B981	[illegible]	157.[illegible]	[illegible]
90	2	QOU290	5B995	[illegible]	68.[illegible]	[illegible]
90	3	QOU390	6B010	261.59	92.[illegible]	[illegible]
100	1	QOU1100	5B967	110.24	157.[illegible]	[illegible]
100	2	QOU2100	5B983	164.3[illegible]	68.[illegible]	[illegible]
100	3	QOU3100	5B997	261.59	92.[illegible]	[illegible]

(*) High Magnetic. Used for applications where high inrush currents may occur.

OPERATING MECHANISMS

Description	Square D Model	Stock No.	List	Each	Shpg. Wt.
3-Pole Finger Safe Cover	QOULFSCI	2DN76	$0.90	[illegible]	[illegible]
Jumper Bar Base, 100 Amp, 1P/L, 4 Pole Left Side Wiring	QOU14100BAL	2DN71	31.60	18.96	0.2
Jumper Bar Base, 100 Amp, 1P/L, 4 Pole Right Side Wiring	QOU14100BAR	2DN72	31.60	18.96	0.2
Jumper Bar Cover, 4 Pole	QOU14100C	2DN73	[illegible]	[illegible]	[illegible]
1-Pole Mounting Foot	QOUMF1	2DN36	[illegible]	[illegible]	[illegible]
2-Pole Mounting Foot	QOUMF2	2DN37	[illegible]	[illegible]	[illegible]

MAG-GARD® CIRCUIT BREAKERS WITH ADJUSTABLE INSTANTANEOUS TRIP

- 600VAC, 50/60 Hz
- Used in combination with motor starters with overload relays for protection of motor circuits against short circuits
- Magnetic trip only—provides no overcurrent protection
- Trip point adjustable from front
- Interrupt ratings are determined by testing in combination with motor starter and overload relays
- Trip setting tolerances are ±20% of nominal values

SUITABLE FOR MOTORS WITH LOCKED ROTOR CODES (Found on Motor Nameplate)

Horsepower	Motor Code
1/2 or LESS	A-L
3/4 to 1	A-K
2 to 3	A-J
5 to 25	A-H
30 to 125	A-G
150 or GREATER	A-F

SELECT AN ADJUSTABLE TRIP SETTING AT LEAST 7 TIMES BUT NOT GREATER THAN 13 TIMES THE MOTOR FULL LOAD (NAMEPLATE) AMPS.

Amps	No. of Poles	Adjustable Trip Range Amps	Square D Model	Stock No.	List	Each
3	3	9-28	FAL3600311M	5B851	$570.37	$342.25
7		18-70	FAL3600712M	5B852	570.37	342.25
15		50-180	FAL3601513M	5B854	570.37	342.25
30		50-180	FAL3603013M	5B857	570.37	342.25
50	3	75-260	FAL3605014M	5B860	921.47	553.00
		150-580	FAL3605016M	5B861	921.47	553.00
100	3	150-580	FAL3610016M	5B867	1066.39	640.00
		300-1100	FAL3610018M	5B868	1066.39	640.00
150	3	750-1500	KAL3615026M	5B889	856.01	514.00
250		625-1250	KAL3625025M	5B894	1637.95	983.00
		750-1500	KAL3625026M	5B895	1637.95	983.00
		875-1750	KAL3625029M	5B896	1637.95	983.00
		1000-2000	KAL3625030M	5B897	1637.95	983.00
		1125-2250	KAL3625031M	5B898	1637.95	983.00
		1250-2500	KAL3625032M	5B899	1637.95	983.00
400		1250-2500	LAL3640032M	5B919	2910.01	1747.00

CURRENT LIMITING MINIATURE CIRCUIT BREAKERS

MERLIN GERIN

No. of Poles	AC Magnetic Trip Setting (Amps) Low Trip	High Trip	Merlin Gerin Model
1	3.2	8	MG24116
	7.0	[illegible]	MG24426
	10.0	14.0	MG24500
2	3.2	8	MG24125
	7.0	[illegible]	MG24442
	10.0	[illegible]	MG24458
	[illegible]	[illegible]	MG24532
1	6.4	[illegible]	MG24111
	14.0	20.0	MG24426
	20.0	28.0	MG24501
2	6.4	[illegible]	MG24126
	14.0	[illegible]	MG24443
	20.0	[illegible]	MG24517
3	6.4	[illegible]	MG24141
	14.0	20.0	MG24460
	20.0	28.0	MG24533
4	6.4	9.6	MG24156
1	9.6	14	MG24112
	21.0	30.0	MG24427
	30.0	42.0	MG24502
2	9.6	14	MG24127
	21.0	30.0	MG24444
	30.0	42.0	MG24518
3	9.6	14	MG24142
	21.0	30.0	MG24461
	30.0	42.0	MG24534
1	12.8	19.2	MG24113
	28.0	40.0	MG24428
	40.0	56.0	MG24503
2	12.8	19.2	MG24128
	28.0	40.0	MG24445
	40.0	56.0	MG24519
3	12.8	19.2	MG24143
	28.0	40.0	MG24462

FRONT MOUNTING BRACKET ACCESSORIES

Merlin Gerin Model	Stock No.	List	Each

Front Mounting Brackets Allow Face Plate Mounting (Not UL/CSA Listed)

SEE REFERENCE GUIDES AND INDEXES

Class 720

Low Ampere QOU Series 3 Circuit Breaker

General Specifications Common to All Low Ampere QOU Circuit Breakers

- Terminal lug wire size 1 – #14 - #2 AWG Cu or Al
- Reversible line and load lugs for convenient flush or surface mount wiring
- DIN mount (symmetrical rail 35 x 7.5 DIN/EN 50022).
- UL listed as HACR type — Note: except 10A.
- Field installable quick connectors.
- Single handle with internal common trip
- UL listed 48Vdc (5,000 AIR)
- Bulk pack circuit breakers do not have mounting feet included.

Standard Lug Position

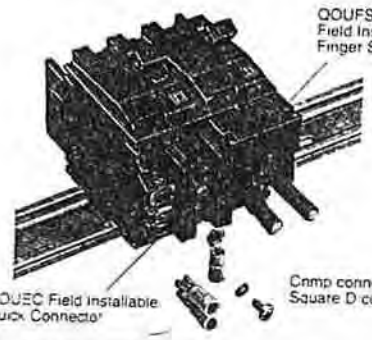
Field Reversed Lugs

QOU14100JBAF

4-pole Jumper Bar Assembly Base

Cover and Cover Screw

2 pole DIN Mounted QOU Circuit Breakers



QOUFSC1
Field Installable
Finger Safe Cover

QOUEC Field Installable
Quick Connector

Crimp connectors are not included with Square D connectors

High Ampere QOU Circuit Breakers

General Specifications Common to All High Ampere QOU Circuit Breakers

- Flush and suface mount.
- Internal common trip.
- Lugs supplied in standard position only.
- DIN mount (Symmetrical rail 35 x 7.5 DIN/EN 500022).
- Bulk pack circuit breakers do not have mounting feet included.
- Terminal lug wire size 1 – #4-#2/0 AWG Cu or Al
- UL listed 60Vdc per pole (5000 AIR) — Note: except switches

No. of Poles	Description	AIR Rating	Voltage Rating	Ampere Rating	Catalog Number	Unit Price	Order Qty.
One	Thermal-Magnetic Circuit Breaker	10,000 AIR	120/240 Vac	80	QOU180 QOU180B	$ 94.00 93.00	1 40
				90	QOU190 QOU190B	94.00 93.00	1 40
				100	QOU1100 QOU1100B	94.00 93.00	1 40
Two	Thermal-Magnetic Circuit Breaker	10,000 AIR	120/240 Vac	80	QOU280 QOU280B	131.00 130.00	1 40
				90	QOU290 QOU290B	131.00 130.00	1 40
				100	QOU2100 QOU2100B	131.00 130.00	1 40
	Non-Automatic Molded Case Switch	N/A	240 Vac		QOU2000 QOU2000B	131.00 130.00	1 40
	Thermal-Magnetic Circuit Breaker	10,000 AIR	240 Vac	125	QOU2125 QOU2125B	242.00 239.00	1 40
	Non-Automatic Molded Case Switch	N/A	240 Vac		QOU20001 QOU20001B	242.00 239.00	1 40
ee	Thermal-Magnetic Circuit Breaker	10,000 AIR	240 Vac	70	QOU370 QOU370B	193.00 190.00	1 40
				80	QOU380 QOU380B	222.00 219.00	1 40
				90	QOU390 QOU390B	222.00 219.00	1 40
				100	QOU3100 QOU3100B	222.00 219.00	1 40
	Non-Automatic Molded Case Switch	N/A	240 Vac		QOU3000 QOU3000B	222.00 219.00	1 40
				125	QOU30001 QOU30001B	381.00 379.00	1 40

Ordering Instructions for Bulk Packed QOU Circuit Breakers and Accessories

QOU Circuit Breakers and accessories must be ordered in multiples of the quantity listed. Units provided in standard quantity of one are individually packaged; standard quantities greater than one are bulk packed.

EXAMPLE:

Individual pack – small quantity order.

To order five QOU220 circuit breakers, order five of QOU220s at **$46.40** each. They will be single packed with the mounting feet included in each package.

Bulk pack – large quantity order.

If you want to order 440 QOU220s using bulk pack, order 440 QOU220Bs at **$44.60** each. They will be packed in 22 packages of 20. If the DIN mount is not needed but mounting feet are, order mounting feet separately. To do this, order 880 of a QOUMF2B at **$0.60** each. They will be packaged in eleven boxes each containing 80 QOUMF2s.

NOTE: You must order in multiples of the standard quantities listed, for example, 80 for the QOUMF2B.

Interrupting Ratings .... Page 5-4
Accessories .... Page 5-30, 5-36
Dimensions .... Pages 5-43

DE2		Discount Schedule

Class 8536

2-Pole Single Phase — 600 Volts AC Maximum — 50-60 Hertz
Thermal Units — Prices shown do not include thermal units. Devices require 1 thermal unit, standard trip thermal units are **$9.** each. See pages 23-18–23-39 for selection charts.

NEMA Size	Continuous Current Ratings	Motor Volts	Max HP	* Coil Voltage	Open Type		NEMA Type 1 General Purpose Enclosure		NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure		NEMA Type 4X Watertight, Dusttight, Corrosion-Resistant Glass-Polyester Enclosure	
					Type	Price	Type	Price	Type	Price	Type	Price
00	9	115 230	1/3 1	120 240	SAO11V02 SAO11V03	$ 162.	SAG11V02 SAG11V03	$ 176.	Use Size 0		Use Size 0	
0	18	115 230	1 2	120 240	SBO1V02 SBO1V03	183.	SBG1V02 SBG1V03	197.	SBW11V02 SBW11V03	$ 407.	SBW21V02 SBW21V03	$ 407.
1	27	115 230	2 3	120 240	SCO1V02 SCO1V03	213.	SCG1V02 SCG1V03	227.	SCW11V02 SCW11V03	443.	SCW21V02 SCW21V03	443.
1P	36	115 230	3 5	120 240	SCO2V02 SCO2V03	279.	SCG2V02 SCG2V03	293.	SCW12V02 SCW12V03	509.	SCW22V02 SCW22V03	509.
2	45	115 230	3 7 1/2	120 240	SDO6V02 SDO6V03	387.	SDG6V02 SDG6V03	449.	SDW16V02 SDW16V03	881.	SDW26V02 SDW26V03	881.

4-Pole, 2-Phase — 600 Volts AC Maximum — 50-60 Hertz
Thermal Units - Prices shown do not include thermal units. Devices require 2 thermal units, standard trip thermal units are **$9.** each. See pages 23-18–23-39 for selection charts.

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	Open Type		NEMA Type 1 General Purpose Enclosure		NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure		NEMA Type 4X Watertight, Dusttight, Corrosion-Resistant Glass-Polyester Enclosure	
					Type	Price	Type	Price	Type	Price	Type	Price
0	18	Separate Control† 200 230 460 575	 3 3 10 10	120 208 240 480 600	SBO3V02S SBO3V08 SBO3V03 SBO3V06 SBO3V07	264.	SBG3V02S SBG3V08 SBG3V03 SBG3V06 SBG3V07	284.	SBW13V02S SBW13V08 SBW13V03 SBW13V06 SBW13V07	518.	SBW23V02S SBW23V08 SBW23V03 SBW23V06 SBW23V07	518.
1	27	Separate Control† 200 230 460 575	 7 1/2 7 1/2 10 10	120 208 240 480 600	SCO4V02S SCO4V08 SCO4V03 SCO4V06 SCO4V07	300.	SCG4V02S SCG4V08 SCG4V03 SCG4V06 SCG4V07	320.	SCW14V02S SCW14V08 SCW14V03 SCW14V06 SCW14V07	548.	SCW24V02S SCW24V08 SCW24V03 SCW24V06 SCW24V07	548.
2	45	Separate Control† 200 230 460 575	 10 15 25 25	120 208 240 480 600	SDO2V02S SDO2V08 SDO2V03 SDO2V06 SDO2V07	540.	SDG2V02S SDG2V08 SDG2V03 SDG2V06 SDG2V07	602.	SDW12V02S SDW12V08 SDW12V03 SDW12V06 SDW12V07	1226.	SDW22V02S SDW22V08 SDW22V03 SDW22V06 SDW22V07	1226
3	90	Separate Control† 200 230 460 575	 15 30 50 50	120 208 240 480 600	SEO2V02S SEO2V08 SEO2V03 SEO2V06 SEO2V07	882.	SEG2V02S SEG2V08 SEG2V03 SEG2V06 SEG2V07	992.	SEW12V02S SEW12V08 SEW12V03 SEW12V06 SEW12V07	1772.	Consult Local Square D Field Office	
4	135	Separate Control† 200 230 460 575	 40 50 100 100	120 208 240 480 600	SFO2V02S SFO2V08 SFO2V03 SFO2V06 SFO2V07	2166.	SFG2V02S SFG2V08 SFG2V03 SFG2V06 SFG2V07	2408.	SFW12V02S SFW12V08 SFW12V03 SFW12V06 SFW12V07	3884.		

† 120 Volt Polyphase starters are wired for separate control.
* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes below and insert as shown in the How To Order block.

Coil Voltage Codes

Voltage 60 HZ	Voltage 50 HZ	Code	Price Adder
▲24	...	V01	N.C.
†120	110	V02	N.C.
208	...	V08	N.C.
240	220	V03	N.C
480	440	V06	N.C
600	550	V07	N.C
Specify	Specify	V99	$15.

▲ 24V coils are not available on Sizes 4-7. On sizes 00-3, where 24V coils are available, Form S (separate control) must be specified.
† 120 Volt Polyphase starters are wired for separate control.

How To Order:

To Order Specify:	Catalog Number			
• Class Number • Type Number • Coil Voltage Code • Form(s) see pg 12-161–12-169	Class	Type	Coil Voltage Code	Form(s)
	8536	SCG1	VO2	P1

CP1	

Discount Schedule

Class 8536

3-Pole Polyphase — 600 Volts AC Maximum — 50-60 Hertz
Thermal Units — Prices shown do not include thermal units. Devices require 3 thermal units (Sizes 00-6), standard trip thermal units are $9. each. See pages 23-18–23-39 for selection charts.

NEMA Size	Continuous Current Ratings	Motor Volts	Max. HP	* Coil Voltage	Open Type		NEMA Type 1 General Purpose Enclosure		NEMA Type 4 & 4X Watertight, Dusttight Brushed Stainless Steel Enclosure (Size 0-5)#		NEMA Type 4X Watertight, Dusttight, Corrosion-Resistant Glass-Polyester Enclosure	
					Type	Price	Type	Price	Type	Price	Type	Price
00	9	Separate Control† 200 230 460 575	 1½ 1½ 2 2	120 ~~208~~ ~~240~~ ~~480~~ 600	SAO12V02S ~~SAO12V08~~ ~~SAO12V03~~ ~~SAO12V06~~ ~~SAO12V07~~	$ 162.	SAG12V02S SAG12V08 SAG12V03 SAG12V06 SAG12V07	$ 176.	Use Size 0		Use Size 0	
0	18	Separate Control† 200 230 460 575	 3 3 5 5	120 208 240 480 600	SBO2V02S SBO2V08 SBO2V03 SBO2V06 SBO2V07	204.	SBG2V02S SBG2V08 SBG2V03 SBG2V06 SBG2V07	218.	SBW12V02S SBW12V08 SBW12V03 SBW12V06 SBW12V07	$ 428.	SBW22V02S SBW22V08 SBW22V03 SBW22V06 SBW22V07	$ 428.
1	27	Separate Control† 200 230 460 575	 7½ 7½ 10 10	120 ~~208~~ ~~240~~ ~~480~~ ~~600~~	SCO3V02S ~~SCO3V08~~ ~~SCO3V03~~ ~~SCO3V06~~ ~~SCO3V07~~	234.	SCG3V02S SCG3V08 SCG3V03 SCG3V06 SCG3V07	248.	SCW13V02S SCW13V08 SCW13V03 SCW13V06 SCW13V07	464.	SCW23V02S SCW23V08 SCW23V03 SCW23V06 SCW23V07	464.
2	45	Separate Control† 200 230 460 575	 10 15 25 25	120 208 240 480 600	SDO1V02S SDO1V08 SDO1V03 SDO1V06 SDO1V07	426.	SDG1V02S SDG1V08 SDG1V03 SDG1V06 SDG1V07	488.	SDW11V02S SDW11V08 SDW11V03 SDW11V06 SDW11V07	920.	SDW21V02S SDW21V08 SDW21V03 SDW21V06 SDW21V07	920.
3	90	Separate Control† 200 230 460 575	 25 30 50 50	120 208 240 480 600	SEO1V02S SEO1V08 SEO1V03 SEO1V06 SEO1V07	690.	SEG1V02S SEG1V08 SEG1V03 SEG1V06 SEG1V07	812.	SEW11V02S SEW11V08 SEW11V03 SEW11V06 SEW11V07	1424.	SEW21V02S SEW21V08 SEW21V03 SEW21V06 SEW21V07	1780.
4	135	Separate Control† 200 230 460 575	 40 50 100 100	120 208 240 480 600	SFO1V02S SFO1V08 SFO1V03 SFO1V06 SFO1V07	1578.	SFG1V02S SFG1V08 SFG1V03 SFG1V06 SFG1V07	1832.	SFW11V02S SFW11V08 SFW11V03 SFW11V06 SFW11V07	2876.	SFW21V02S SFW21V08 SFW21V03 SFW21V06 SFW21V07	3595.
5	270	Separate Control† 200 230 460 575	 75 100 200 200	120 208 240 480 600	SGO1V02S SGO1V08 SGO1V03 SGO1V06 SGO1V07	3855.	SGG1V02S SGG1V08 SGG1V03 SGG1V06 SGG1V07	4319.	SGW11V02S SGW11V08 SGW11V03 SGW11V06 SGW11V07	5639.	—	—
6	540	Separate Control† 200 230 460 575	 150 200 400 400	120 208 240 480 600	SHO2V02S SHO2V08 SHO2V03 SHO2V06 SHO2V07	9165.	SHG2V02S SHG2V08 SHG2V03 SHG2V06 SHG2V07	12167.	SHW2V02S SHW2V08 SHW2V03 SHW2V06 SHW2V07	15167.	—	—
7	810	Separate Control† 200 230 460 575	 — 300 600 600	120 208 240 480 600	SJO2V02S SJO2V08 SJO2V03 SJO2V06 SJO2V07	13167.	SJG2V02S SJG2V08 SJG2V03 SJG2V06 SJG2V07	16169.	SJW2V02S SJW2V08 SJW2V03 SJW2V06 SJW2V07	19169.	—	—

\# Size 6 and 7 are rated NEMA Type 4 only.
† 120 Volt Polyphase starters are wired for separate control.
* Coil voltage code must be specified to order this product. Refer to standard coil voltage codes listed in selection table above or additional standard voltage codes below and insert as shown in the HOW TO ORDER block.

Coil Voltage Codes

Voltage 60 HZ	Voltage 50 HZ	Code	Price Adder
▲24		V01	N.C.
†120	110	V02	N.C.
208		V08	N.C.
240	220	V03	N.C.
480	440	V06	N.C.
600	550	V07	N.C.
Specify	Specify	V99	$15.

▲ 24V coils are not available on Sizes 4-7. On sizes 00-3, where 24V coils are available, Form S (separate control) must be specified.
† 120 Volt Polyphase contactors are wired for separate control

How To Order:

To Order Specify:	Catalog Number			
• Class Number • Type Number • Coil Voltage Code • Form(s) see pg. 12-161–12-169	Class 8536	Type SBA2	Coil Voltage Code VO2	Form(s) P1S

NEW

New Solid State Overload Relay Available! Factory Modifications (Forms) Listed on Page 12-163.

Factory Modifications (Forms) .... Pages 12-161 – 12-169
Application Data .... Pages 12-27 – 12-30
Dimensions .... Pages 12-31 – 12-36
Separate Enclosures (Class 9991) .... Pages 12-153 – 12-160
Replacement Parts (Class 9998) .... Pages 23-2 – 23-6
Type S Accessories (Class 9999) .... Pages 23-10 – 23-15

Class 8502, 8536

NEMA Size	Load Volts	Maximum Horsepower Rating— Nonplugging and Nonjogging Duty: Single Phase	Maximum Horsepower Rating— Nonplugging and Nonjogging Duty: Poly-Phase	Maximum Horsepower Rating— Plugging and Jogging Duty †: Single Phase	Maximum Horsepower Rating— Plugging and Jogging Duty †: Poly-Phase	Continuous Current Rating, Amperes— 600 Volt Max.	Service-Limit Current Rating, Amperes ✱	Tungsten and Infrared Lamp Load, Amperes— 250 Volts Max. •	Resistance Heating Loads, KW — other than Infrared Lamp Loads ‡: Single Phase	Resistance Heating Loads, KW — other than Infrared Lamp Loads ‡: Poly-Phase	KVA Rating for Switching Transformer Primaries At 50 or 60 Cycles — Transformers Having Inrush Currents (Worst Case Peak) of Not More Than 20 Times Peak of Continuous Current Rating: Single Phase	(same): Poly-Phase	KVA Rating for Switching Transformer Primaries At 50 or 60 Cycles — Transformers Having Inrush Currents (Worst Case Peak) of Over 20 Through 40 Times Peak of Continuous Current Rating: Single Phase	(same): Poly-Phase	3 Phase Rating for Switching Capacitors •: KVAR
00	115	1/2	...	...	...	9	11	5	...	...	...	...	...	...	...
	200	...	1 1/2	...	...	9	11	5	...	...	...	...	...	...	...
	230	1	1 1/2	...	...	9	11	5	...	...	...	...	...	...	...
	380	...	1 1/2	...	...	9	11	...	...	...	...	...	...	...	...
	460	...	2	...	...	9	11	...	...	...	...	...	...	...	...
	575	...	2	...	...	9	11	...	...	...	...	...	...	...	...
0	115	1	...	1/2	...	18	21	10	...	...	0.6	...	0.3	...	...
	200	...	3	...	1 1/2	18	21	10	...	...	...	1.8	...	0.9	...
	230	2	3	1	1 1/2	18	21	10	...	...	1.2	2.1	0.6	1.0	...
	380	...	5	...	1 1/2	18	21	...	...	...	...	...	...	...	...
	460	...	5	...	2	18	21	...	...	...	2.4	4.2	1.2	2.1	...
	575	...	5	...	2	18	21	...	...	...	3.0	5.2	1.5	2.6	...
1	115	2	...	1	...	27	32	15	3	5	1.2	...	0.6	...	...
	200	...	7 1/2	...	3	27	32	15	...	9.1	...	3.6	...	1.8	...
	230	3	7 1/2	2	3	27	32	15	6	10	2.4	4.3	1.2	2.1	...
	380	...	10	...	5	27	32	...	...	16.5	...	...	...	...	...
	460	...	10	...	5	27	32	...	12	20	4.9	8.5	2.5	4.3	...
	575	...	10	...	5	27	32	...	15	25	6.2	11.0	3.1	5.3	...
1P	115	3	...	1 1/2	...	36	42	24	...	...	...	...	...	...	...
	230	5	...	3	...	36	42	24	...	...	...	...	...	...	...
2	115	3	...	2	...	45	52	30	5	8.5	2.1	...	1.0	...	...
	200	...	10	...	7 1/2	45	52	30	...	15.4	...	6.3	...	3.1	...
	230	7 1/2	15	5	10	45	52	30	10	17	4.1	7.2	2.1	3.6	8
	380	...	25	...	15	45	52	...	...	28	...	...	...	...	...
	460	...	25	...	15	45	52	...	20	34	8.3	14	4.2	7.2	16
	575	...	25	...	15	45	52	...	25	43	10.0	18	5.2	8.9	20
3	115	...	...	...	...	90	104	60	10	17	4.1	...	2.0	...	...
	200	...	25	...	15	90	104	60	...	31	...	12	...	6.1	...
	230	...	30	...	20	90	104	60	20	34	8.1	14	4.1	7.0	27
	380	...	50	...	30	90	104	...	...	56	...	...	...	...	...
	460	...	50	...	30	90	104	...	40	68	16	28	8.1	14	53
	575	...	50	...	30	90	104	...	50	86	20	35	10	18	67
4	200	...	40	...	25	135	156	120	...	45	...	20	...	10	...
	230	...	50	...	30	135	156	120	30	52	14	23	6.8	12	40
	380	...	75	...	50	135	156	...	...	86.7	...	...	...	...	...
	460	...	100	...	60	135	156	...	60	105	27	47	14	23	80
	575	...	100	...	60	135	156	...	75	130	34	59	17	29	100
5	200	...	75	...	60	270	311	240	...	91	...	41	...	20	...
	230	...	100	...	75	270	311	240	60	105	27	47	14	24	80
	380	...	150	...	125	270	311	...	...	173	...	...	...	...	...
	460	...	200	...	150	270	311	...	120	210	54	94	27	47	160
	575	...	200	...	150	270	311	...	150	260	68	117	34	59	200
6▲	200	...	150	...	125	540	621	480	...	182	...	81	...	47	...
	230	...	200	...	150	540	621	480	120	210	54	94	27	47	160
	380	...	300	...	250	540	621	...	...	342	...	...	...	...	...
	460	...	400	...	300	540	621	...	240	415	108	188	54	54	320
	575	...	400	...	300	540	621	...	300	515	135	234	68	117	400
7▲	230	...	300	...	...	810	932	...	180	315	...	...	...	...	240
	460	...	600	...	...	810	932	...	360	625	...	...	...	...	480
	575	...	600	...	...	810	932	...	450	775	...	...	...	...	600

Tables and footnotes are taken from NEMA Standards.

† Ratings shown are for applications requiring repeated interruptions of stalled motor current or repeated closing of high transient currents encountered in rapid motor reversal, involving more than five openings or closings per minute and more than ten in a ten-minute period, such as plug-stop, plug-reverse or jogging duty. Ratings apply to single speed and multi-speed controllers.

✱ Per NEMA Standards paragraph ICS 2-321.20, the service-limit current represents the maximum rms current, in amperes, which the controller may be expected to carry for protracted periods in normal service. At service-limit current ratings, temperature rises may exceed those obtained by testing the controller at its continuous current rating. The ultimate trip current of over-current (overload) relays or other motor protective devices shall not exceed the service-limit current ratings of the controller.

• FLUORESCENT LAMP LOADS — 300 VOLTS AND LESS — The characteristics of fluorescent lamps are such that it is not necessary to derate Class 8502 contactors below their normal continuous current rating. Class 8903 contactors may also be used with fluorescent lamp loads. For controlling tungsten and infrared lamp loads, and resistance heating loads, Class 8903 ac lighting contactors are recommended. These contactors are specifically designed for such loads and are applied at their full rating as listed in the Class 8903 Section.

‡ Ratings apply to contactors which are employed to switch the load at the utilization voltage of the heat producing element with a duty which requires continuous operation of not more than five openings per minute. Class 8903 Types L and S lighting contactors are rated for resistance heating loads.

• When discharged, a capacitor has essentially zero impedance. For repetitive switching by a contactor, sufficient impedance should be connected in series to limit inrush current to not more than 6 times the contactor rated continuous current. In many installations, the impedance of connecting conductors may be sufficient for this purpose. When switching to connect additional banks, the banks already on the line may be charged and can supply additional available short-circuit current which should be considered when selecting the impedance to limit the current.
The ratings for capacitor switching above assume the following maximum available fault currents:

NEMA Size 2-3: 5,000 A RMS Sym.
NEMA Size 4-5: 10,000 A RMS Sym.
NEMA Size 6: 18,000 A RMS Sym.
NEMA Size 7: 30,000 A RMS Sym.

If available fault current is greater than these values, connect sufficient impedance in series as noted in the previous paragraph.

▲ See page 12-30 regarding operation rates for NEMA Size 6 & 7

The motor ratings in the above table are NEMA standard ratings and apply only when the code letter of the motor is the same as or occurs earlier in the alphabet than is shown in the table below

Motors having code letters occurring later in the alphabet may require a larger controller. Consult local Square D field office.

Motor HP Rating	Maximum Allowable Motor Code Letter
1 1/2-2	L
3-5	K
7 1/2 & above	H

Reference No. 277AS
Bulletin No. 30072-013-09B
Raleigh, NC, U.S.A., February, 1994
Supersedes 30072-013-09A dated 9/93

2- and 3-Pole AC Magnetic Contactors and Starters Type SB, Series A or B
Class 8502 and 8536 – Size 0

INTRODUCTION

This instruction bulletin illustrates and describes Class 8502 and 8536 two- and three-pole magnetic contactors and starters. It also contains assembly, modification and parts ordering instructions. To identify parts, refer to Figure 1.

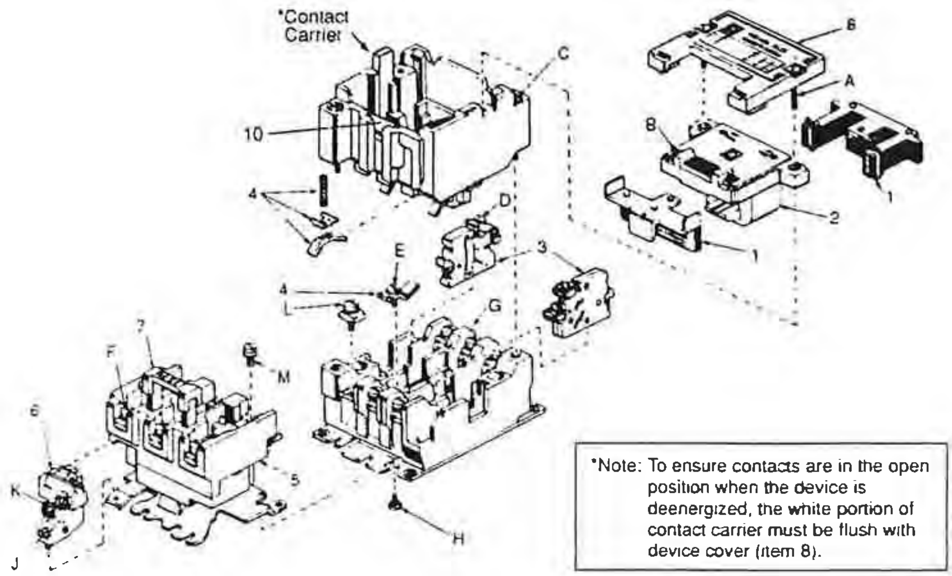


Figure 1 Contactor and Starter Assembly Drawing

⚠ DANGER

HAZARDOUS VOLTAGE.

Disconnect all power before working on equipment.

Electrical shock will cause severe injury or death.

SERIES

Series B applies only to the Type S Starter Form B (three ambient-compensated overloads). All parts of Form B Series A and B starters are interchangeable; only the overload relay block differs. If the overload relay block of a Form B Series A starter is replaced with the Series B block, the overload relay thermal units must be selected from the Series B thermal unit selection tables for proper motor protection.

AUXILIARY CONTACTS

All contactors are supplied with a normally-open holding circuit contact as standard. Additional normally-open or normally-closed auxiliary contacts can be installed in the field. Refer to Table 5 on page 4 for class and type. For application information, refer to Bulletin 9999-287 or the Square D Digest.

COVER MOUNTED CONTROL UNITS

NEMA Type 1 general purpose enclosures with slip-on or hinged covers are supplied with knockouts for field addition of the kits listed in Table 1 on page 2.

Table 1 Field Modification Kits, Class 9999

Kit	Slip-On Enclosure	Hinged Door Enclosure	Form (Factory Mod.)
Push button, Start-Stop	SA2	SA3	A
Push button, On-Off	SA10	SA3	A3
Selector switch, Hand-Off-Auto	SC2	SC8	C
Selector switch, On-Off	SC22	...	C6
Red pilot light	SP15R	SP28R [1]	P1

[1] For 120 V only. For other voltages, use Class 9001 Type KP units.

OVERLOAD RELAYS

A melting alloy overload relay is supplied as standard with provisions for three thermal units. The contact unit (item 6 of Figure 1 on page 1) of the melting alloy overload relay is available with a normally-open or normally-closed isolated alarm contact in addition to the standard normally-closed contact. The contact unit with alarm circuit contacts can be installed in the field (refer to Table 5 on page 4).

Non-temperature compensated bimetallic overload relays are available as an optional feature: Form B1 has provisions for two thermal units; Form B2 has provisions for three thermal units. Ambient-temperature compensated bimetallic overload relays (Form B) are also available as an optional feature, with provisions for three thermal units.

An SPDT contact is supplied as standard on all Type S bimetallic overload relays. The N.O. contact can be used in an alarm circuit and must be wired on the same polarity as the N.C. contact. Contacts are not replaceable. In order to directly replace any bimetallic overload relay, the appropriate part number listed on the parts list should be used.

These overload relays are not designed for field repair and should not be disassembled.

TERMINALS

Use **copper wire only** on device power and control terminals. Pressure wire power terminals are suitable for wire sizes #14-8 AWG, solid or stranded. Pressure wire control terminals are suitable for wire sizes #16-12 AWG, solid or stranded.

INSPECTING AND REPLACING CONTACTS

Contacts are not harmed by discoloration and slight pitting. **Do not file contacts**, as it wastes contact material. Replacement is necessary only when the contact has worn thin. Replacement contacts for starters or contactors are available as kits. Order from Table 5.

Replacement contacts and springs for the **power pole kits only** are contained in a Class 9998 Type SL22 kit. One kit is required for each N.O. or N.C. contact.

It is unnecessary to remove any wiring to inspect or replace the contacts. To inspect or replace contacts, loosen the two captive screws (item C in Figure 1) holding the contact actuator to the contact block. Lift the contact actuator to expose the contacts.

MANUAL OPERATION

⚠ WARNING

HAZARDOUS VOLTAGE.

Disconnect all power before manually operating equipment.

Manual operation with power on can cause contact arcing and unexpected energization of load, resulting in personal injury or equipment damage.

Manual operation of contactors and starters may be accomplished by pushing the contact carrier down with a screwdriver. A slot suitable for this use is provided in the coil cover.

COIL REPLACEMENT

To remove the coil, loosen the two captive cover screws (item A in Figure 1). Disconnect wires from the coil terminals and remove the cover. Remove and disassemble the magnet, coil and armature unit.

To replace the coil, first assemble the magnet, replacement coil and armature. Manually operate the contact carrier and insert the complete unit. Before installing the cover, manually operate the device as described in "Manual Operation" to ensure all parts are functioning properly. Follow recommended tightening torques (see Table 2) when reassembling device.

ASSEMBLY INSTRUCTIONS

Figure 1 on page 1 shows how contactors and starters are assembled. Factory recommended torques for mechanical, electrical and pressure wire connections are listed in Table 2 and the device instruction sheet. These torques must be followed to ensure proper device operation.

Table 2 Factory Recommended Tightening Torques

Item	Description	Tightening Torque (in-lb)
A	Cover screw (2 per cover)	18-21
B	Coil terminal pressure wire connector (2 per coil)	9-12
C	Power plant screw (2 per device)	18-21
D	Internal auxiliary contact pressure wire connector (2 per contact)	9-12
E	Stationary contact fastener (2 per pole)	6-9
F	Lug screw (2 per pole)	[1]
G	Auxiliary wire binding screw	18-21
H	Overload relay fastening screw (2 per overload block)	18-21
J	Overload switch module fastening screw (1 per module)	9-12
K	Switch module pressure wire connector (2 per module standard; 4 per module w/ alarm circuit contact)	9-12
L	Overload-to-contactor fasteners (1 per pole)	18-21 [2]
M	Overload thermal unit fastening screw (2 per pole)	18-21

[1] See instruction sheet.
[2] For contactor, see instruction sheet.

SHORT CIRCUIT PROTECTION

Provide branch-circuit overcurrent protection for starters, referring to instructions supplied with the thermal unit selection table. Provide branch-circuit overcurrent protection for contactors (Class 8502 or 8702) in accordance with the National Electrical Code. Do not exceed the maximum protective device ratings listed in Table 3.

Table 3 Maximum Ampere Ratings

Maximum Voltage (V)	Class K5, RK5 or RK1 Fuse (A)	Class J or T Fuse (A)	Inverse-Time Circuit Breaker (A)
600	20	30	20
250	25	30	35

DISTANT CONTROL

Series impedance and shunt capacitance of the control circuit must be considered to assure proper operation of contactors and starters when controlled from remote operator stations. Depending upon the voltage, wire size and number of control wires used, series impedance or shunt capacitance may limit the maximum distance of the wire run. If distances to start or stop stations are longer than those listed in Table 4, the wire-run configuration and materials must be analyzed. For further information, contact your local Square D field office for Product Data Bulletin M379.

Table 4 Maximum Control Distance

Coil Voltage (60 Hz)	Maximum Control Distance (feet) #14 AWG Copper Wire	#10 AWG Copper Wire
120	845	1500
240	595	395
480	145	95

ORDERING INSTRUCTIONS

Specify quantity, part number or class and type and description of part, giving complete nameplate data of the device. For example, one armature and magnet kit 31041-605-50 for a Class 8536 Type SBO2 Series A starter.

Table 5 Parts List

Item	Description	Part Number	Quantity				
			1-Pole	2-Pole	3-Pole	4-Pole	5-Pole
1	Armature and magnet kit	31041-605-50	1	1	1	1	1
2	Coil	See Table 6 below	1	1	1	1	1
3	Internal auxiliary contact	Class 9999:					
	Normally-open	Type SX11	[3]	[3]	1	1	1
	Normally-closed	Type SX12	...	...	...	...	...
4	Contact kit	Class 9998:					
		Type SL2	1	1	1	...	...
		Type SL12	...	...	...	1	...
		Type SL12 & SL22	...	...	...	...	1
5	Melting alloy overload relay assembly	Class 9065:					
	1 Element	Type SDO4	1	1	...	...	...
	2 or 3 Element	Type SDO5	...	...	1	1	1
[1] 5	Bimetallic overload relay						
	Non-compensated	Class 9065:					
	2 element (Form B1)	Type SDO5B1	...	...	...	...	...
	3 element (Form B2)	Type SDO6B2	...	...	...	...	...
	Compensated	Class 9065:					
	3 element (Form B)	Type SDO6B	...	...	...	...	...
6	Melting alloy overload contact unit	Class 9998 Type SO1	1	1	1	1	1
[1] 6	Melting alloy overload contact unit w/ alarm circuit						
	Normally-open alarm contact	Class 9999 Type SO4	...	...	...	...	...
	Normally-closed alarm contact	Class 9999 Type SO5	...	...	...	...	...
7	Reset bar	31034-042-01	1	1	1	1	1
8	Cover	31127-013-01	1	1	1	1	1
[1]	External auxiliary contact	Class 9999:					
	One normally-open	Type SX6	...	...	...	...	...
	One normally-closed	Type SX7	...	...	...	...	...
	One normally-open and one normally-closed	Type SX8	...	...	...	...	...
	One normally-open, overlapping	Type SX9	...	...	...	...	...
	One normally-closed, overlapping	Type SX10	...	...	...	...	...
[1]	Power pole kit	Class 9999:					
	One normally-open	Type SB6	...	...	...	1	...
	Two normally-open	Type SB9	...	...	...	...	1
[2] 10	Lever bearing	31041-032-01	1	1	1	1	1
A	Cover screw	21937-14341	2	2	2	2	2
B	Coil terminal pressure wire connector	31051-007-50	2	2	2	2	2
C	Power plant screw	21916-14501	2	2	2	2	2
F	Wire clamp and screw (Size 0 contactor)	30018-018-50	...	...	...	2	4
G	Auxiliary wire binding screw	21819-25081	2	2	2	2	2
L	Wire clamp and screw (Size 0 contactor)	30018-070-50	2	4	6	6	6
M	Overload thermal unit fastening screw	21920-16160	...	4	6	6	6

[1] Not shown.
[2] To ensure proper device operation: when installing the lever bearing onto the lever, the oval concavity on the inside surface of one leg of the bearing must mate with the corresponding oval convexity on the bottom of the lever.
[3] Furnished on 2-pole starters, however 1- and 2-pole contactors are furnished with a holding circuit contact rated the same as a power pole.

Table 6 Magnet Coil Part Numbers [1]

Coil Prefix	Hz	Coil Suffix													
		24 V	110 V	120 V	120/240 V	208 V	220 V	240 V	240/480 V	277 V	380 V	440 V	480 V	550 V	600 V
31041-400	60	20	Use 120 V	42	[2]	48	Use 240 V	51	[2]	52	56	Use 480 V	60	Use 600 V	62
	50	22	42	43	...	...	51	53	...	...	57	60	...	62	64

[1] Complete part number of coil consists of the prefix followed by the suffix (i.e.: for 120 V 60 Hz coil, select 31041-400-42). When ordering replacement coils, give part number, voltage and frequency of coil being replaced.
[2] Dual voltage coil. Order 120/240 V 60 Hz as 31041-402-02. Order 240/480 V 60 Hz as 31041-402-04.

PLEASE NOTE:

Electrical equipment should be serviced only by qualified electrical maintenance personnel, and this document should not be viewed as sufficient instruction for those who are not otherwise qualified to operate, service or maintain the equipment discussed. Although reasonable care has been taken to provide accurate and authoritative information in this document, no responsibility is assumed by Square D for any consequences arising out of the use of this material.

SQUARE D

NEMA Size 0 & 1 Starters
Class 8536, Type S
With Melting Alloy Overload Relay

Suitable For Use On A Circuit Capable of Delivering Not More Than 5000 rms Symmetrical Amperes 600 Volts Maximum

WARNING:

If burnout of an overload relay thermal unit occurs, the thermal unit must be replaced to provide continued protection against fire and shock hazard.

AVERTISSEMENT:

Si un élément thermique brûle, il doit être remplacé

CLASS 9999 ACCESSORIES	
N.O. Elec. Interlock	Type SX-6
N.C. Elec. Interlock	Type SX-7

Other Class 9999 Accessories may be installed on this product. Consult catalog for applicable Type numbers and description.

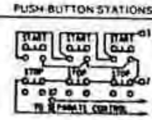
Additional Information in Service Bulletin 277AS Size 0 and 278AS Size 1.

CONTROL WIRING

Control circuit conductors must be protected against overcurrent in accordance with applicable electrical codes. This may require installation of protective devices not shown in control circuit diagrams. Fuse-holder Kits Class 9999 Types SF-4 and SFR-4 are available to allow compliance.

THREE-WIRE CONTROL (MOMENTARY CONTACT)

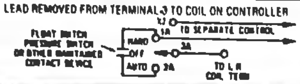
REMOTE
PUSH-BUTTON STATIONS



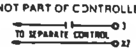
TWO-WIRE CONTROL (MAINTAINED CONTACT)

SELECTOR-SWITCH STATION

LEAD REMOVED FROM TERMINAL 3 TO COIL ON CONTROLLER



MAINTAINED CONTACT DEVICE
NOT PART OF CONTROLLER

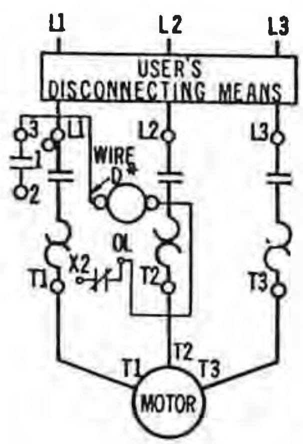


POWER WIRING

Power Lugs Suitable For Copper Conductors Only. Sized for 60°C Wire Ampacity Rated 60°C Minimum Or Sized for 75°C Wire Ampacity Rated 75°C Minimum

Lug Torque Requirements
Line and Load 20 in-lbs

THREE-PHASE, 3-WIRE SYSTEM



★ Wire D Omitted on Form CS

MO555M

OVERLOAD-RELAY THERMAL UNITS TABLE 15

For continuous-rated motors having service factors of 1.15 to 1.25, select thermal units directly from table using 100% of full-load current shown on motor nameplate. For continuous-rated motors having a service factor of 1.0, select thermal units from table using 90% of full-load current shown on motor nameplate.

Motor Full-Load Current (Amp.)	Thermal Unit No.	Maximum Fuse Rating (Amp.)	Motor Full-Load Current (Amp.)	Thermal Unit No.	Maximum Fuse Rating (Amp.)	
0.29-0.31	B0.44	0.6	4.73-5.21	B7.70	10	
0.32-0.36	B0.51	0.6	5.22-5.51	B8.20	10	
0.37-0.39	B0.57	0.8	5.52-6.17	B9.10	12	
0.40-0.46	B0.63	0.8	6.18-7.07	B10.2	12	
0.47-0.55	B0.71	1.0	7.08-8.05	B11.5	15	
0.56-0.61	B0.81	1.125	8.06-8.69	B12.8	17.5	
0.62-0.68	B0.92	1.25	8.70-9.32	B14	17.5	
0.69-0.75	B1.03	1.4	9.33-10.2	B15.5	20	
0.76-0.83	B1.16	1.6	10.3-11.3	B17.5	20	
0.84-0.93	B1.30	1.8			600V Max.	250V Max.
0.94-1.06	B1.45	2				
1.07-1.18	B1.67	2.25	11.4-12.0	B18.5	20	25
1.19-1.31	B1.88	2.5				
1.32-1.47	B2.10	2.8				
1.48-1.67	B2.40	3.2	Following Selections for Size 1 Only			
1.68-1.83	B2.65	3.5	11.4-12.7	B19.5	25	25
1.84-2.04	B3.00	4	12.7-13.7	B22	25	25
2.05-2.30	B3.30	4.5	13.8-15.2	B25	30	30
2.31-2.60	B3.70	5	15.3-17.2	B28.0	30	30
2.61-3.13	B4.15	5.6	17.3-18.9	B32	30	35
3.14-3.58	B4.85	7	19.0-21.4	B36	30	40
3.59-3.94	B5.50	8	21.5-23.7	B40	30	40
3.95-4.19	B6.25	8	23.8-26.0	B45	30	40
4.20-4.72	B6.90	8				

Trip current rating in a 40°C (104°F) ambient temperature is 1.25 times the minimum full-load current shown for the thermal unit selected. Instructions given above assume that the motor and the controller are located in approximately the same ambient temperature. For other conditions consult Square D.

SHORT-CIRCUIT PROTECTION. Branch-circuit protective device rating must comply with applicable electrical codes and the following additional limitations.

FUSES. Do not exceed the maximum fuse rating shown opposite the thermal unit selected. Fuses may need to be of the time delay type to permit motor starting. Class K5 or Class R fuses are recommended. Non-time delay fuses whose rating does not exceed 300 percent of motor full load current may also be used.

THERMAL-MAGNETIC (INVERSE TIME) CIRCUIT BREAKER. Maximum allowable circuit breaker rating is 225 percent of motor full load current. For full load currents below 6.67 amperes a 15 ampere circuit breaker may be used.

3 Position Selector Switch Units, Non-Illuminated

Accessories – Page 7-35
Legend Plates – Page 7-43
Dimensions – Page 7-45

800T-J2A

Standard Knob Operator
Catalog Number 800T-J2A

Knob Lever Operator
Catalog Number 800T-J17A

Metal Wing Lever Operator
Catalog Number 800T-[illegible]

Note: X=Closed/O=Open

Contact Type	Operator Position			Operator Type M=Maintained S=Spring Return	Standard Knob		Knob Lever		Metal Wing Lever	
					Catalog Number	Price	Catalog Number	Price	Catalog Number	Price
No Contacts	—	—	—	M M M	800T-J2	$22	800T-J17	$22	800T-JG11	[illegible]
				S→M M	800T-J4	34	800T-J18	34	800T-JG15	[illegible]
				M M←S	800T-J5	34	800T-J19	34	800T-JG16	[illegible]
				S→M←S	800T-J91	34	800T-J20	34	800T-JG141	[illegible]
1 N.O.- 1 N.C.	O X	O O	X O	~~M M M~~	~~800T-J2A~~	~~40~~	800T-J17A	40	800T-JG11A	[illegible]
				~~S→M M~~	~~800T-J4A~~	~~52~~	800T-J18A	52	800T-JG15A	[illegible]
				~~M M←S~~	~~800T-J5A~~	~~52~~	800T-J19A	52	800T-JG16A	[illegible]
				~~S→M←S~~	~~800T-J91A~~	~~52~~	800T-J20A	52	800T-JG141A	[illegible]
2 N.O.- 2 N.C.	O X O X	O O O O	X O X O	M M M	800T-J2B	58	800T-J17B	58	800T-JG11B	[illegible]
				S→M M	800T-J4B	70	800T-J18B	70	800T-JG15B	[illegible]
				M M←S	800T-J5B	70	800T-J19B	70	800T-JG16B	[illegible]
				S→M←S	800T-J91B	70	800T-J20B	70	800T-JG141B	[illegible]

3 Position Cylinder Lock Operator
Catalog Number 800T-J33A

Note: X=Closed/O=Open

Contact Type	Operator Position			Operator Type M=Maintained S=Spring Return	Cylinder Lock					
					Lock In Left		Lock In Center		Lock In All 0	
					Catalog Number	Price	Catalog Number	Price	Catalog Number	Price
No Contacts	—	—	—	M M M	800T-J41	$58	800T-J42	$58	800T-J44	[illegible]
				S→M M	—	—	800T-J50	70	—	
				M M←S	800T-J69	70	800T-J38	70	—	
				S→M←S	—	—	800T-J631	70	—	
1 N.O.- 1 N.C.	O X	O O	X O	M M M	800T-J41A	76	800T-J42A	76	800T-J44A	[illegible]
				S→M M	—	—	800T-J50A	88	800T-J5[illegible]A	[illegible]
				M M←S	800T-J69A	88	800T-J38A	88	800T-J7[illegible]A	[illegible]
				S→M←S	—	—	800T-J631A	88	—	

0 Key removable in Maintained positions only

7

Form I-UDA (Version B)
Obsoletes Form I-UDA (Version A)

REZNOR®

Installation / Operation

Applies to: **Model UDAP**

and Model UDAS

V3® Series Fan-Type Unit Heaters

⚠ WARNING:

FIRE OR EXPLOSION HAZARD

Failure to follow safety warnings exactly could result in serious injury, death, or property damage.

Be sure to read and understand the installation, operation, and service instructions in this manual.

Improper installation, adjustment, alteration, service, or maintenance can cause serious injury, death, or property damage.

— Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

— WHAT TO DO IF YOU SMELL GAS
- **Do not try to light any appliance.**
- **Do not touch any electrical switch; do not use any phone in your building.**
- **Leave the building immediately.**
- **Immediately call your gas supplier from a phone remote from the building. Follow the gas supplier's instructions.**
- **If you cannot reach your gas supplier, call the fire department.**

— Installation and service must be performed by a qualified installer, service agency, or the gas supplier.

Table of Contents

1.0 General

1.1 Hazard Labels and Notices

There are warning labels on the unit and throughout this manual. For your safety, read the definitions below and comply with all boxes labeled CAUTION, WARNING, and DANGER during installation, operation, maintenance, and service of this heater.

Definitions of Hazard Intensity Levels in this Manual

HAZARD INTENSITY LEVELS

1. **DANGER: Failure to comply will result in severe personal injury or death and/or property damage.**
2. **WARNING: Failure to comply could result in severe personal injury or death and/or property damage.**
3. **CAUTION: Failure to comply could result in minor personal injury and/or property damage.**

WARNING

Gas-fired appliances are not designed for use in hazardous atmospheres containing flammable vapors or combustible dust, in atmospheres containing chlorinated or halogenated hydrocarbons, or in applications with airborne silicone substances. See Hazard Levels, above.

WARNING

Should overheating occur, or the gas supply control system fail to shut off the flow of gas, shut off the manual gas valve to the utility heater before shutting off the electrical supply.

WARNING

Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and replace any gas control that has been under water.

1.2 General Installation Information

BOTH this manual and the correct venting manual are REQUIRED for installation of this heater.

1.2.1 Certification

UDAP and UDAS Models 30, 45, 60, 75, 100, and 125 are design certified by the Canadian Standards Association for use in residential, industrial, and commercial installations. Utility heaters certified for "residential use" are intended for heating of non-living spaces that are attached to, or part of a structure that contains space for family living quarters. They are not intended to be the primary source of heat in residential applications or to be used in sleeping quarters.

Models UDAP 150, 175, 200, 225, 250, 300, 350, and 400 and UDAS 150, 175, 200, 225, 250, 300, 350, and 400 are design certified by the Canadian Standards Association for use in industrial and commercial installations only.

All models and sizes are available for use with either natural or propane gas. The type of gas, the gas input rate, and the electrical supply requirement are shown on the heater rating plate. Check the rating plate to verify that the heater is appropriate for the installation site.

1.2.2 Venting Manual

Installation requires both this manual **AND** the venting manual.

Venting Manual by Model

Model	Venting Instruction Manual by Form No.	Look for Matching Label on Venting Manual and Heater
UDAP	**Form I-UD-V-PV**, Standard Power Vent Installation (Each heater has its own dedicated vent.)	Label with a **RED SQUARE**
UDAP-CV	**Form I-UD-V-CV**, Optional Common Vent Installation (Model UDAP heater must be equipped with Option AV6.)	Label with a **BLUE TRIANGLE**
Note: Model UDAP-CV is available in Sizes 30, 45, 60, 75, 100 only		
UDAS	**Form I-UD-V-SC**, Separated Combustion (Model UDAS requires field installation of either Option CC2, CC6, or CC14 Vent/Combustion Air Kit)	Label with a **GREEN CIRCLE**

Both this installation manual and the appropriate venting manual are shipped with the heater. Verify that the literature is correct for the heater being installed. If either manual is missing or incorrect, contact your distributor before beginning installation.

The instructions in this manual apply **only** to the models listed.

Installation should be done by a qualified agency in accordance with these instructions. The qualified service agency installing this heater is responsible for the installation.

1.0 General (cont'd)

1.3 Warranty

Refer to the limited warranty information on the Warranty Card in the "Literature Bag".

Warranty is void if ...

a. Wiring is not in accordance with the diagram furnished with the heater.
b. The unit is installed without proper clearance to combustible materials.
c. A fan model is connected to a duct system or if the air delivery system is modified.

1.4 Installation Codes

These units must be installed in accordance with local building codes. In the absence of local codes, in the United States, the unit must be installed in accordance with the National Fuel Gas Code, ANSI Z223.1. A Canadian installation must be in accordance with the CSA B149 Installation Codes. These codes are available from CSA Information Services, 1-800-463-6727. Local authorities having jurisdiction should be consulted before installation is made to verify local codes and installation procedure requirements.

Special Installations (Aircraft Hangars/ Repair Garages/ Parking Garages)

Installations in aircraft hangars should be in accordance with ANSI/NFPA No. 409 (latest edition), Standard for Aircraft Hangars; in public garages in accordance with ANSI/ NFPA No. 88A (latest edition), Standard for Parking Structures; and for repair garages in accordance with ANSI/NFPA No. 88B (latest edition), Standard for Repair Garages. In Canada, installations in aircraft hangars should be in accordance with the requirements of the enforcing authorities, and in public garages in accordance with CSA B149 codes.

California Warning Label

If the heater is being installed in the state of California, the installer **MUST** attach a warning label on the outside of the access door. The California Warning label is shipped in the literature bag along with this manual, the warranty form, and any other paperwork that applies.

If installation is in California, select a location on the heater access panel. Be sure the surface is clean and dry and adhere the label.

Massachusetts Requirement

If the heater is being installed in the Commonwealth of Massachusetts, these units must be installed by a licensed plumber or licensed gas fitter.

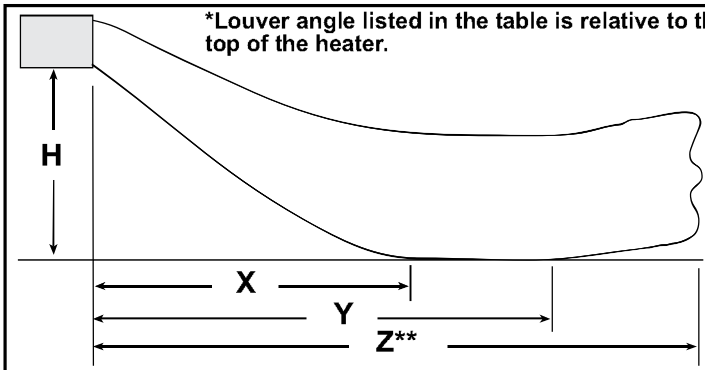
2.0 Unit Heater Location

Use the sound data in Technical Data table in the APPENDIX (page 38), clearances in Paragraph 4.1; the combustion air requirements in Paragraph 6.2; the throw tables, mounting height requirements, and location recommendations in Paragraphs 2.1 and 2.2; the weights in Paragraph 5.1; and the venting requirements in the Venting Manual to determine where to suspend the heater.

2.1 Heater Throw

FIGURE 1 - Throw for Fan Models UDAP and UDAS

***Louver angle listed in the table is relative to the top of the heater.**



H = Distance from bottom of heater to the floor
X = Distance from heater to start of floor coverage
Y = Distance to end of floor coverage
****Z = point when the air velocity drops below 50 ft (15.2M) per minute**

NOTE: Throws listed are with standard adjustable horizontal louvers at the angles listed (angle is relative to the top of the heater). Throw pattern changes with the addition of optional vertical louvers and/or downturn nozzles.

Dimensions X, Y, and Z (feet) Model UDAP and Model UDAS with Standard Horizontal Louvers at Mounting Heights of 5 - 18 ft

H	30				45				60				75				100				125			
	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*
5 ft	6	14	30	-21°	7	16	40	-20°	8	18	45	-16°	9	20	57	-14°	9	20	59	-18°	10	22	65	-14°
8 ft	7	13	26	-39°	9	16	37	-34°	10	18	42	-29°	12	22	54	-25°	11	21	56	-28°	12	23	63	-24°
10 ft	6	11	22	-52°	9	15	33	-43°	10	17	39	-37°	12	22	52	-32°	12	20	52	-36°	13	24	60	-30°
12 ft	-	-	-	-	8	12	27	-55°	10	16	34	-46°	12	21	48	-39°	11	19	47	-44°	14	23	57	-36°
14 ft	-	-	-	-	-	-	-	-	9	14	29	-56°	12	19	44	-46°	11	17	42	-51°	14	22	53	-43°
16 ft	-	-	-	-	-	-	-	-	-	-	-	-	11	17	38	-54°	10	14	34	-58°	13	20	47	-50°
18 ft	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	17	40	-57°

H	150				175				200				225				250				300				350				400			
	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*
8 ft	13	24	73	-26°	15	28	90	-22°	16	30	93	-20°	14	27	86	-24°	16	29	93	-21°	15	28	94	-24°	17	31	105	-20°	18	34	113	-17°
10 ft	14	24	69	-32°	17	29	87	-27°	17	31	91	-25°	15	27	82	-30°	17	30	90	-26°	16	28	89	-29°	18	32	103	-25°	20	35	110	-21°
12 ft	14	24	64	-39°	18	29	84	-32°	18	31	88	-30°	16	27	78	-35°	18	30	87	-31°	17	28	85	-34°	19	32	98	-30°	21	36	108	-25°
14 ft	14	22	59	-45°	18	28	79	-37°	19	30	84	-34°	16	26	73	-41°	18	30	83	-36°	17	27	80	-40°	20	32	95	-34°	23	35	105	-29°
16 ft	13	20	53	-51°	18	27	74	-42°	19	29	79	-39°	16	24	67	-47°	19	28	78	-41°	17	25	74	-45°	21	31	90	-38°	23	35	101	-33°
18 ft	11	17	44	-58°	17	26	68	-48°	19	28	74	-44°	14	22	60	-53°	18	27	72	-46°	16	24	66	-51°	20	30	85	-43°	23	35	97	-37°

Dimensions X, Y, and Z (meters) Model UDAP and Model UDAS with Standard Horizontal Louvers at Mounting Heights of 1.5 - 5.5M

H	30				45				60				75				100				125			
	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*
1.5 M	1.8	4.3	9.1	-21°	2.1	4.9	12.2	-20°	2.4	5.5	13.8	-16°	2.7	6.1	17.4	-14°	2.7	6.1	18.0	-18°	3.0	6.7	19.9	-14°
2.4 M	2.1	4.0	7.9	-39°	2.7	4.9	11.3	-34°	3.0	5.5	12.8	-29°	3.7	6.7	16.5	-25°	3.4	6.4	17.1	-28°	3.7	7.0	19.2	-24°
3.0 M	1.8	3.4	6.7	-52°	2.7	4.6	10.0	-43°	3.0	5.2	11.9	-37°	3.7	6.7	15.8	-32°	3.7	6.1	15.8	-36°	4.0	7.3	18.3	-30°
3.7 M	-	-	-	-	2.4	3.7	8.2	-55°	3.0	4.9	10.4	-46°	3.7	6.4	14.6	-39°	3.4	5.8	14.3	-44°	4.3	7.0	17.4	-36°
4.3 M	-	-	-	-	-	-	-	-	2.7	4.3	8.8	-56°	3.7	5.8	13.4	-46°	3.4	5.2	12.8	-51°	4.3	6.7	16.1	-43°
4.9 M	-	-	-	-	-	-	-	-	-	-	-	-	3.4	5.2	11.6	-54°	3.0	4.3	10.4	-58°	4.0	6.1	14.3	-50°
5.5 M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.4	5.2	12.2	-57°

H	150				175				200				225				250				300				350				400			
	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*	X	Y	Z	Louver Angle*
2.4 M	4.0	7.3	22.3	-26°	4.6	8.5	27.4	-22°	4.9	9.1	28.0	-20°	4.3	8.2	26.2	-24°	4.9	8.8	28.3	-21°	4.6	8.5	28.7	-24°	5.2	9.4	32.0	-20°	5.5	11.3	34.4	-17°
3.0 M	4.3	7.3	21.0	-32°	5.2	8.8	26.6	-27°	5.2	9.4	27.7	-25°	4.6	8.2	25.0	-30°	5.2	9.1	27.4	-26°	4.9	8.5	27.1	-29°	5.5	9.8	31.4	-25°	6.1	10.7	33.5	-21°
3.7 M	4.3	7.3	19.5	-39°	5.5	8.8	25.6	-32°	5.5	9.4	26.8	-30°	4.9	8.2	23.8	-35°	5.5	9.1	26.5	-31°	5.2	8.5	25.9	-34°	5.8	9.8	29.9	-30°	6.4	11.0	32.9	-25°
4.3 M	4.3	6.7	18.0	-45°	5.5	8.5	24.1	-37°	5.8	9.1	25.6	-34°	4.9	7.9	22.3	-41°	5.5	9.1	25.3	-36°	5.2	8.2	24.4	-40°	6.1	9.8	29.0	-34°	7.0	10.7	32.0	-29°
4.9 M	4.0	6.1	16.2	-51°	5.5	8.2	22.6	-42°	5.8	8.8	24.1	-39°	4.9	7.3	20.4	-47°	5.8	8.5	23.8	-41°	5.2	7.6	22.6	-45°	6.4	9.4	27.4	-38°	7.0	10.7	30.8	-33°
5.5 M	3.4	5.2	13.4	-58°	5.2	7.9	20.7	-48°	5.8	8.5	22.6	-44°	4.3	6.7	18.3	-53°	5.5	8.2	21.9	-46°	4.9	7.3	20.1	-51°	6.1	9.1	25.9	-43°	7.0	10.7	26.9	-37°

2.2 Location Recommendations

NOTE: Venting requirements may affect location. Consult the Venting Manual for this heater before making final determination.

Locate the heater so that it is a minimum of five feet (1.5M) above the floor and in compliance with the clearances in Paragraph 4.1.

WARNING

If touched, the vent pipe and internal heater surfaces that are accessible from outside the heater will cause burns. Suspend the heater a minimum of 5 feet (1.5M) above the floor.

For best results, the heater should be placed with certain rules in mind. In general, a unit should be located from 8 to 12 feet (2.4-3.7M) above the floor. Units should always be arranged to blow toward or along exposed wall surfaces, if possible. Where two or more units are installed in the same room, a general scheme of air circulation should be maintained for best results.

Suspended heaters are most effective when located as close to the working zone as possible, and this fact should be kept in mind when determining the mounting heights to be used. However, care should be exercised to avoid directing the discharged air directly on the room occupants.

Partitions, columns, counters, or other obstructions should be taken into consideration when locating the unit heater so that a minimum quantity of airflow will be deflected by such obstacles.

2.0 Unit Heater Location (cont'd)

2.2 Location Recommendations (cont'd)

When units are located in the center of the space to be heated, the air should be discharged toward the exposed walls. In large areas, units should be located to discharge air along exposed walls with extra units provided to discharge air in toward the center of the area.

At those points where infiltration of cold air is excessive, such as at entrance doors and shipping doors, it is desirable to locate the unit so that it will discharge directly toward the source of cold air from a distance of 15 to 20 feet (4.6-6.1M).

CAUTION: Do not locate the heater where it may be exposed to water spray, rain, or dripping water.

For a location where dirt, dust, or other airborne contaminants are present in the indoor environment, it is recommended to install a separated-combustion unit, Model UDAS, that uses outside air for combustion. Using a separated-combustion unit will reduce the build-up of contaminants on the burner. Any buildup on the burner will adversely affect the combustion process.

Hazards of Chlorine - applies to location of Model UDAS heater with regard to combustion air inlet

The presence of chlorine vapors in the combustion air of gas-fired heating equipment presents a potential corrosion hazard. Chlorine found usually in the form of freon or degreaser vapors, when exposed to flame will precipitate from the compound, and go into solution with any condensation that is present in the heat exchanger or associated parts. The result is hydrochloric acid which readily attacks all metals including 300 grade stainless steel. Care should be taken to separate these vapors from the combustion process. This may be done by wise location of the unit vent and combustion air terminals with regard to exhausters or prevailing wind directions. Chlorine is heavier than air. Keep these facts in mind when determining installation location of the heater in relation to building exhaust systems.

3.0 Uncrating and Preparation

3.1 Uncrating and Inspecting

This unit was test operated and inspected at the factory prior to crating and was in operating condition. If the heater has incurred any damage in shipment, document the damage with the transporting agency and contact an authorized Reznor® Distributor. If you are an authorized Distributor, follow the FOB freight policy procedures as published by Thomas & Betts for Reznor® products.

Check the rating plate for the gas specifications and electrical characteristics of the heater to be sure that they are compatible with the gas and electric supplies at the installation site.

3.2 Preparing for Installation

Read this booklet and become familiar with the installation requirements of your particular heater. If you do not have knowledge of local requirements, check with the local gas company or any other local agencies who might have requirements concerning this installation. Before beginning, make preparations for necessary supplies, tools, and manpower.

IMPORTANT: Shipping brackets are attached with cabinet screws. When removing shipping brackets, re-insert ALL screws into the cabinet.

3.2.1 Field-Installed Parts

Model UDAS - In the literature bag, find three cap screws, **P/N 203311**, and three sealing washers, **P/N 61658**. After attaching the hanging hardware (Paragraph 5.2), these screws and washers must be used to seal the unused holes in the top of the heater.

Models UDAP and UDAS - If the installation includes optional vertical louvers, downturn nozzle, ceiling mounting bracket, hanger kit, high altitude kit, multiple heater control, sensor for DDC control, and/or stepdown transformer, **install these options before the heater is suspended.** Complete instructions are in this form or in the option package; option packages are shipped separately.

Other shipped separate items could include a vent cap (Option CC1 for UDAP); a vent/combustion air kit (Option CC2 or CC6 for UDAS); a manual gas valve; a thermostat bracket kit; a thermostat; and/or a thermostat guard. Be sure all options ordered are at the installation site.

High Altitude Kit, Option DJ20 or DJ21

If the heater is being installed at an elevation above 2000 ft (610M), the input rate will have to be derated. This is done by adjusting the valve outlet pressure.

In addition, if the heater is being installed at an altitude above 6000 ft (1830M), the pressure switch will have to be changed. If ordered with the unit as Option DJ20 or DJ21, the pressure switch is shipped separately for field installation.

Gas valve adjustment for high altitude can only be done after heater is operating; see Paragraph 6.1.

Adjusting the valve outlet pressure is done after the heater is in operation; follow the instructions in Paragraph 6.1. Capacities and inputs for derated units are also listed in Paragraph 6.1.

If the pressure switch needs to be changed, do that before the heater is operated; follow the instructions in **FIGURE 2**.

FIGURE 2 - Installing High Altitude Pressure Switch required above 6000 ft (1830M) elevation

Pressure Switch

Model UDAP														
Size	**30**	**45**	**60**	**75**	**100**	**125**	**150**	**175**	**200**	**225**	**250**	**300**	**350**	**400**
High Altitude Switch P/N	197031		197032			197031			201160					
Negative Pressure OFF Setpoint "w.c.	0.35		0.45			0.35			1.05					
Label color	Purple		Pink			Purple			Brown					
Model UDAP-CV with Option AV6 for Common Venting														
Size	**30**	**45**	**60**	**75**	**100**									
High Altitude Switch P/N	197029	197032	196362		196388									
Negative Pressure OFF Setpoint "w.c.	0.60	0.45	0.55		0.50									
Label color	Lt Blue	Pink	White		Orange									
Model UDAS														
Size	**30**	**45**	**60**	**75**	**100**	**125**	**150**	**175**	**200**	**225**	**250**	**300**	**350**	**400**
High Altitude Switch P/N	197029				196388	197030	197031		201160					
Differential Pressure OFF Setpoint "w.c.	0.60				0.50	0.40	0.35		1.05					
Label color	Lt. Blue				Orange	Green	Purple		Brown					

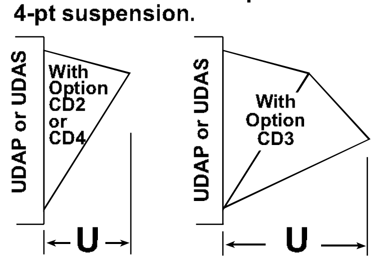
Instructions for Changing Pressure Switch

1. In the control compartment, locate the pressure switch.
2. Mark and disconnect the two wires attached to the pressure switch.
3. Disconnect the sensing tubes from the pressure switch.
4. Locate the two screws holding the switch mounting bracket. Remove the screws and the pressure switch. Save the screws.
5. Using the same screws, install the high altitude pressure switch. Attach the sensing tubes and wires.

Downturn Nozzle Kits, Option CD 2, 3, or 4

Follow the instructions with the kit to install. Additional length beyond the front of the unit is shown in **FIGURE 3.**

FIGURE 3 - With Optional Downturn Nozzle Dimension "U" -- Applies to both UDAP and UDAS



Size	Options CD2 and CD4		Option CD3	
	inches	mm	inches	mm
30, 45	7-1/8	181	12-3/8	314
60, 75	8-5/8	219	15	381
100, 125	12-5/8	321	21-7/8	556
150, 175, 200	11-1/2	292	19-7/8	505
225, 250	14-1/2	368	25-1/8	638
300, 350, 400	18-1/2	470	32	813

4.0 Clearances and Dimensions

4.1 Clearances

Units must be installed so that the clearances in the table are provided for combustion air space, inspection and service, and for proper spacing from combustible construction. Clearance to combustibles is defined as the minimum distance from the heater to a surface or object that is necessary to ensure that a surface temperature of 90°F (50°C) above the surrounding ambient temperature is not exceeded.

Clearances

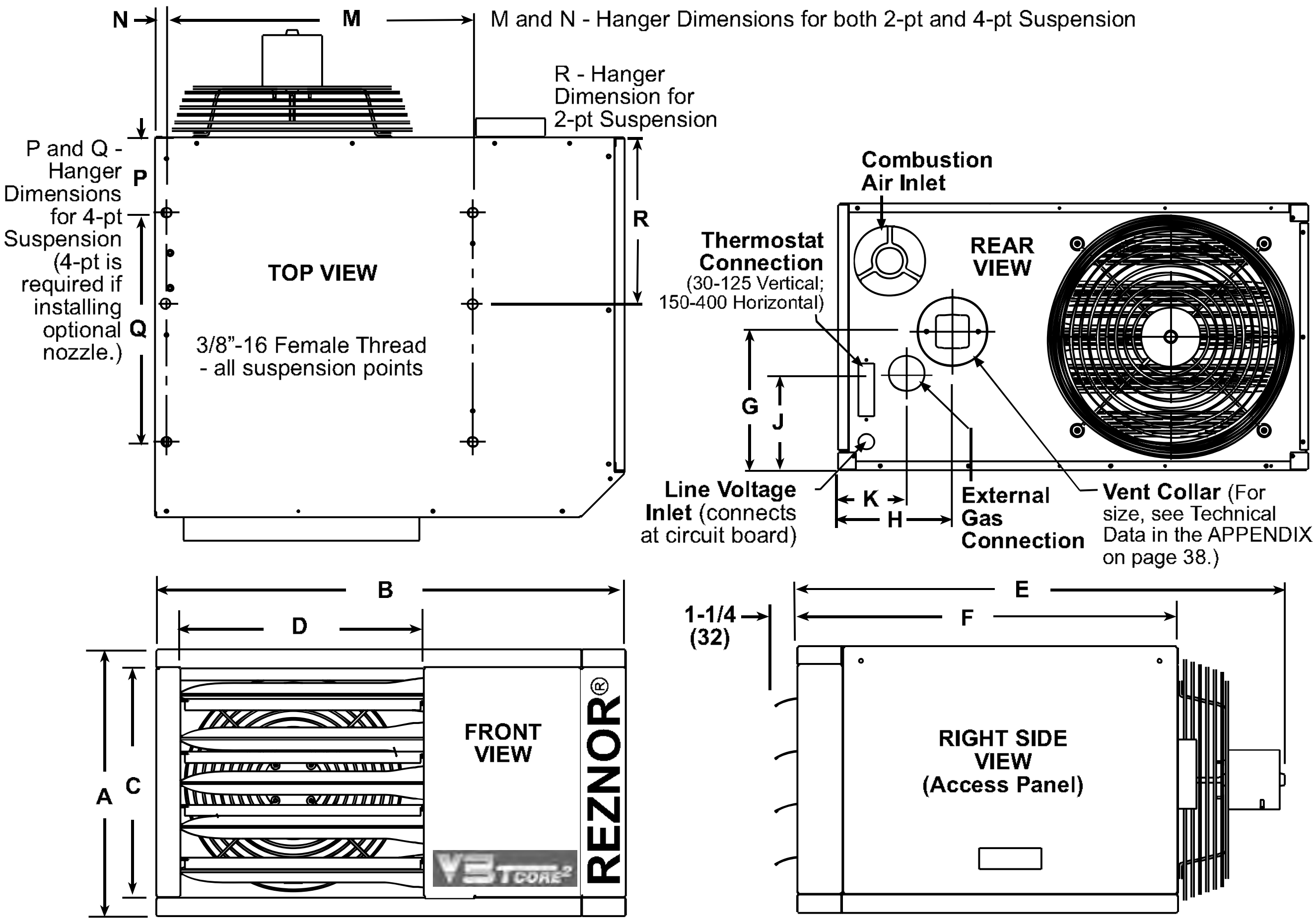
Size	Top		Flue Connector		Access Panel		Non-Access Side		Bottom*		Rear**	
	inches	mm	inches	mm	inches	mm	inches	mm	inches	mm	inches	mm
30 - 125	1	25	6	152	18	457	1	25	1	25	18	457
150 - 400	4	102	6	152	18	457	2	51	1	25	18	457

*Suspend the heater so that the bottom is a minimum of 5 feet (1.5M) above the floor.
** Measure rear clearance from the fan motor.

4.0 Clearances and Dimensions (cont'd)

4.2 Dimensions

FIGURE 4 - Model UDAP, Power Vented Fan Model



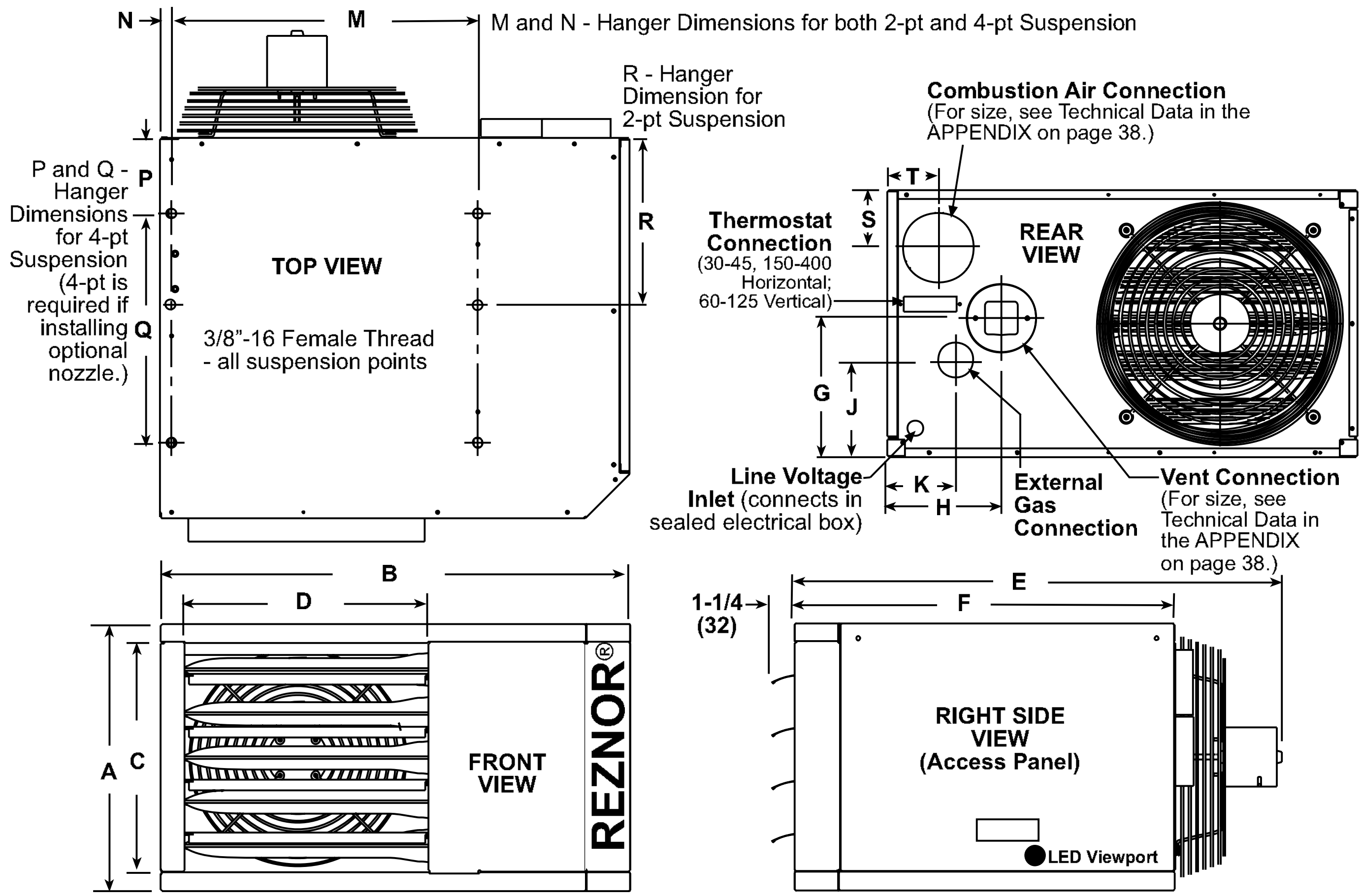
Model UDAP Dimensions (inches ± 1/16)

Size	A	B	C	D	E	F	G	H	J	K	M	N	P	Q	R
30, 45	12-1/8	26-5/8	10	13-13/16	26	21-9/16	5-3/16	6-1/2	2-11/16	3-7/8	17-3/8	11/16	4-5/16	13	9-9/16
60	15-1/8	26-5/8	13	13-13/16	27	21-9/16	7-7/8	6-1/2	5-1/2	3-7/8	17-3/8	11/16	4-5/16	13	10-1/2
75	15-1/8	26-5/8	13	13-13/16	27-5/8	21-9/16	7-7/8	6-1/2	5-1/2	3-7/8	17-3/8	11/16	4-5/16	13	10-1/2
100	23-1/8	26-5/8	21	13-13/16	28-5/8	21-9/16	14-1/2	6-1/2	8-3/4	3-7/8	17-3/8	11/16	4-5/16	13	10-1/2
125	23-1/8	26-5/8	21	13-13/16	29-3/8	21-9/16	14-1/2	6-1/2	8-3/4	3-7/8	17-3/8	11/16	4-5/16	13	10-1/2
150, 175, 200	20-1/8	38-3/16	16	23	42	35-3/8	8-1/2	8-1/4	5-7/16	6-1/2	25-11/16	1-3/8	8-3/16	22-3/16	16-3/8
225, 250	26-1/8	38-3/16	22	23	42	35-3/8	13-1/16	8-13/16	9	6-1/2	25-11/16	1-3/8	8-3/16	22-3/16	15-5/8
300, 350, 400	34-1/8	41	30	23	42	35-3/8	17-1/16	9	11-13/16	7-5/16	27-11/16	1-3/8	8-3/16	22-3/16	16-3/16

Model UDAP Dimensions (mm ± 2)

Size	A	B	C	D	E	F	G	H	J	K	M	N	P	Q	R
30, 45	308	676	254	351	660	548	132	165	68	98	441	17	110	330	243
60	384	676	330	351	686	548	200	165	140	98	441	17	110	330	267
75	384	676	330	351	702	548	200	165	140	98	441	17	110	330	267
100	587	676	533	351	727	548	368	165	222	98	441	17	110	330	267
125	587	676	533	351	746	548	368	165	222	98	441	17	110	330	267
150, 175, 200	511	970	406	584	1067	899	216	210	138	165	652	35	208	564	416
225, 250	664	970	559	584	1067	899	332	224	229	165	652	35	208	564	397
300, 350, 400	867	1041	762	584	1067	899	433	229	300	186	703	35	208	564	411

FIGURE 5 - Model UDAS, Separated Combustion Fan Model



Model UDAS Dimensions (inches ± 1/16)

Size	A	B	C	D	E	F	G	H	J	K	M	N	P	Q	R	S	T
30, 45	12-1/8	26-5/8	10	13-13/16	26	21-9/16	5-3/16	6-1/2	2-11/16	3-7/8	17-3/8	11/16	4-5/16	13	9-9/16	2-15/16	2-15/16
60	15-1/8	26-5/8	13	13-13/16	27	21-9/16	7-7/8	6-1/2	5-1/2	3-7/8	17-3/8	11/16	4-5/16	13	10-1/2	3-1/4	2-15/16
75	15-1/8	26-5/8	13	13-13/16	27-5/8	21-9/16	7-7/8	6-1/2	5-1/2	3-7/8	17-3/8	11/16	4-5/16	13	10-1/2	3-1/4	2-15/16
100	23-1/8	26-5/8	21	13-13/16	28-5/8	21-9/16	14-1/2	6-1/2	8-3/4	3-7/8	17-3/8	11/16	4-5/16	13	10-1/2	4-5/8	2-15/16
125	23-1/8	26-5/8	21	13-13/16	29-3/8	21-9/16	14-1/2	6-1/2	8-3/4	3-7/8	17-3/8	11/16	4-5/16	13	10-1/2	4-5/8	2-15/16
150, 175, 200	20-1/8	38-3/16	16	23	42	35-3/8	8-1/2	8-1/4	5-7/16	6-1/2	25-11/16	1-3/8	8-3/16	22-3/16	16-3/8	4-1/8	8-5/16
225, 250	26-1/8	38-3/16	22	23	42	35-3/8	13-1/16	8-13/16	9	6-1/2	25-11/16	1-3/8	8-3/16	22-3/16	15-5/8	5-9/16	8-5/16
300, 350, 400	34-1/8	41	30	23	42	35-3/8	17-1/16	9	11-13/16	7-5/16	27-11/16	1-3/8	8-3/16	22-3/16	16-3/16	9-1/16	8-9/16

Model UDAS Dimensions (mm ± 2)

Size	A	B	C	D	E	F	G	H	J	K	M	N	P	Q	R	S	T
30, 45	308	676	254	351	660	548	132	165	68	98	441	17	110	330	243	75	75
60	384	676	330	351	686	548	200	165	140	98	441	17	110	330	267	89	75
75	384	676	330	351	702	548	200	165	140	98	441	17	110	330	267	89	75
100	587	676	533	351	727	548	368	165	222	98	441	17	110	330	267	117	75
125	587	676	533	351	746	548	368	165	222	98	441	17	110	330	267	117	75
150, 175, 200	511	970	406	584	1067	899	216	210	138	165	652	35	208	564	416	105	211
225, 250	664	970	559	584	1067	899	332	224	229	165	652	35	208	564	397	141	211
300, 350, 400	867	1041	762	584	1067	899	433	229	300	186	703	35	208	564	411	230	217

5.0 Hanging the Heater

5.1 Weights

Before suspending the heater, check the supporting structure to be used to verify that it has sufficient load-carrying capacity to support the weight of the unit.

Model UDAP

Size	30	45	60	75	100	125	150	175, 200	225	250	300	350	400
lbs	54	59	67	72	96	101	172	187	203	215	269	294	306
kg	24	27	30	33	44	46	78	85	92	98	122	133	139

Model UDAS

Size	30	45	60	75	100	125	150	175, 200	225	250	300	350	400
lbs	55	60	68	73	97	102	173	188	204	216	270	295	307
kg	25	27	31	33	44	46	78	85	93	98	122	134	138

WARNINGS

Check the supporting structure to be used to verify that it has sufficient load carrying capacity to support the weight of the unit. Suspend the heater only from the threaded nut retainers or with a manufacturer provided kit. Do NOT suspend from the heater cabinet.

5.2 Lifting and Suspending

When the heater is lifted for suspension, support the bottom of the heater with plywood or other appropriately placed material. If the bottom is not supported, damage could occur. Before hanging, verify that any screws used for holding shipping brackets were re-installed in the cabinet.

Model UDAS - Whether using the suspension points or a hanger kit, when installing a Model UDAS, any **unused suspension points on the control side of the heater MUST be plugged**. Plug these holes with the 1/2" long cap screws and flat washers shipped in the bag with the heater. (See **FIGURE 6**.)

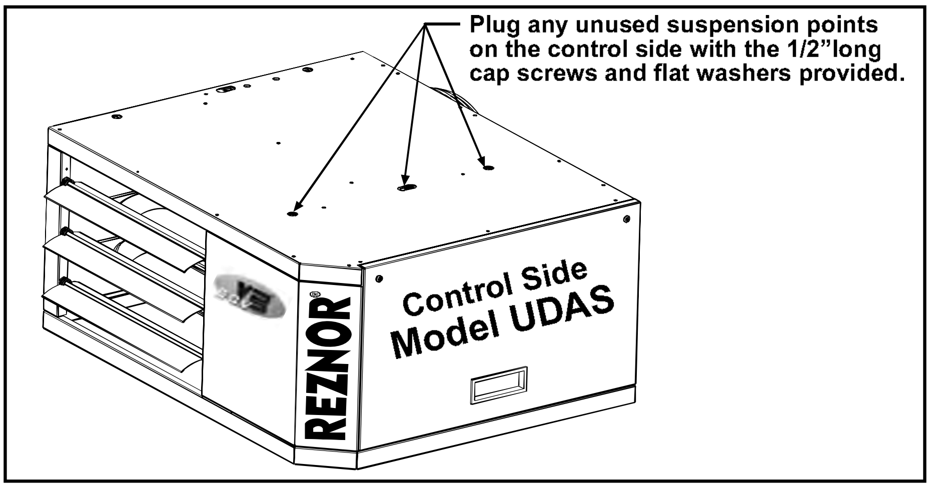


FIGURE 6 - Model UDAS - Plug the unused suspension points on the control side of the heater with the three 1/2" long screws, P/N 203311, and the three sealing washers, P/N 61658. Find the screws and washers in the literature bag shipped inside the heater.

WARNING

Unit must be level for proper operation. Do not place or add additional weight to the suspended heater. Hazard Levels, page 2.

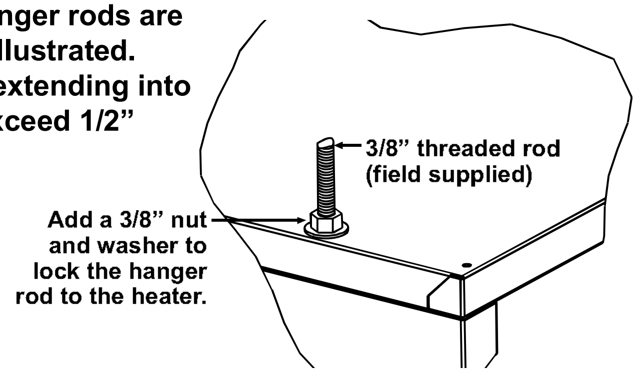
5.2.1 Two-Point or Four-Point Suspension

The heater is equipped for either two-point or four-point suspension. A 3/8"-16 threaded nut retainer is located at each suspension point. **NOTE:** Four-point suspension is **required** when installing an optional downturn nozzle. See Dimensions in Paragraph 4.2 and the illustration in **FIGURE 7A**.

FIGURE 7A - Suspending the Heater with Rods from the Threaded Nut Retainers (either two or four point suspension)

Be sure the threaded hanger rods are locked to the heater as illustrated. Length of threaded rod extending into the heater MUST NOT exceed 1/2" (13mm).

Recommended maximum hanger rod length is 6 feet (1.8M).

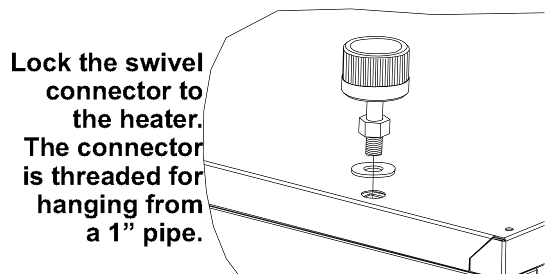


5.2.2 Hanger Kits, Option CK8, CK10, and CK22

If ordered with swivel connectors for 1" pipe, Option CK8 or CK10, attach the swivels at the threaded nut retainers. Suspend with 1" pipe. (See **FIGURE 7B**.)

FIGURE 7B - Swivel Connectors to Suspend the Heater from 1" Pipe, Option CK8 (2-pt) or CK10 (4-pt)

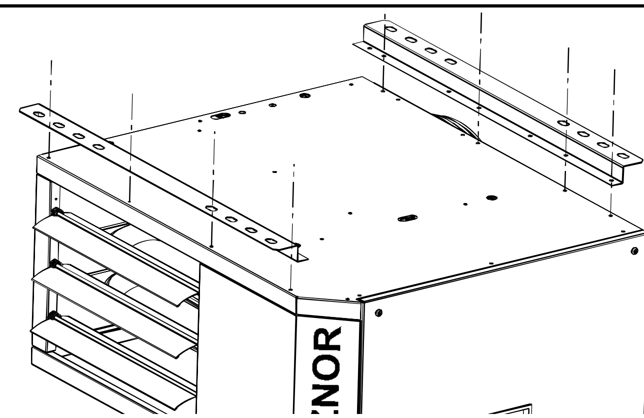
Be sure the threaded swivel connectors are locked to the heater as illustrated.



If ordered with a ceiling suspension kit, Option CK22, follow the illustrated instructions in the kit. (See **FIGURE 8**.)

FIGURE 8 - Suspending the Heater using Option CK22, Ceiling Suspension Kit (no hanger rods)

Available for Sizes 30-125. Allows the heater to be installed one inch from the ceiling.



6.0 Mechanical

6.1 Gas Piping and Pressures

6.1.1 Gas Supply and Connections

WARNING

This appliance is equipped for a maximum gas supply pressure of 1/2 psi, 3.5 kPa, or 14 inches water column. Supply pressure greater than 1/2 psi requires installation of an additional lockup-type service regulator external to the unit.

WARNING: PRESSURE TESTING SUPPLY PIPING

Test Pressures Above 1/2 PSI: Disconnect the heater and manual valve from the gas supply line which is to be tested. Cap or plug the supply line.

Test Pressures Below 1/2 PSI: Before testing, close the manual valve on the heater.

6.0 Mechanical (cont'd)

6.1 Gas Piping and Pressures (cont'd)

6.1.1 Gas Supply and Connections (cont'd)

Sizing Gas Supply Line

Capacity of Piping

Cubic Feet per Hour based on 0.3" w.c. Pressure Drop

Specific Gravity for Natural Gas -- 0.6 (Natural Gas -- 1000 BTU/Cubic Ft)

Specific Gravity for Propane Gas -- 1.6 (Propane Gas -- 2550 BTU/Cubic Ft)

Length of Pipe	Diameter of Pipe											
	1/2"		3/4"		1"		1-1/4"		1-1/2"		2"	
	Natural	Propane	Natural	Propane	Natural	Propane	Natural	Propane	Natural	Propane	Natural	Propane
20'	92	56	190	116	350	214	730	445	1100	671	2100	1281
30'	73	45	152	93	285	174	590	360	890	543	1650	1007
40'	63	38	130	79	245	149	500	305	760	464	1450	885
50'	56	34	115	70	215	131	440	268	670	409	1270	775
60'	50	31	105	64	195	119	400	244	610	372	1105	674
70'	46	28	96	59	180	110	370	226	560	342	1050	641
80'	43	26	90	55	170	104	350	214	530	323	990	604
90'	40	24	84	51	160	98	320	195	490	299	930	567
100'	38	23	79	48	150	92	305	186	460	281	870	531
125'	34	21	72	44	130	79	275	168	410	250	780	476
150'	31	19	64	39	120	73	250	153	380	232	710	433
175'	28	17	59	36	110	67	225	137	350	214	650	397
200'	26	16	55	34	100	61	210	128	320	195	610	372

Note: When sizing supply lines, consider possibilities of future expansion and increased requirements.

Refer to National Fuel Gas Code for additional information on line sizing.

All piping must be in accordance with requirements outlined in the National Fuel Gas Code ANSI/Z223.1a (latest edition) or CSA-B149.1 and B149.2 (See Paragraph 2). Gas supply piping installation should conform with good practice and with local codes. Support gas piping with pipe hangers, metal strapping, or other suitable material; do not rely on the heater to support the gas pipe.

The heater is orificed for operation with natural gas having a heating value of 1000 (± 50) BTU per cubic ft or propane gas with a heating value of 2500 (± 100) BTU per cubic ft. If the gas at the installation does not meet these specifications, consult the factory for proper orificing.

Pipe joint compounds (pipe dope) shall be resistant to the action of liquefied petroleum gas or any other chemical constituents of the gas being supplied.

Install a ground joint union and manual shutoff valve upstream of the unit control system, as shown in **FIGURE 9**. Installation of a trap with a minimum 3” (76mm) drip leg is required.

The unit is equipped with a nipple that extends outside the cabinet. The gas connection is either 1/2” or 3/4”.

Leak-test all connections by brushing on a leak-detecting solution.

WARNING

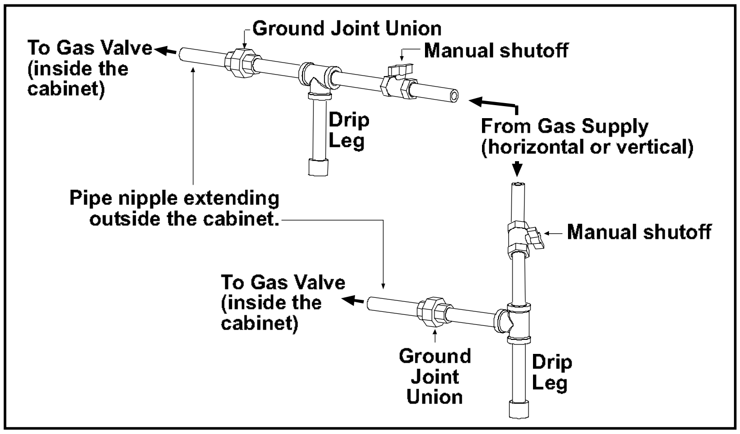
All components of a gas supply system must be leak tested prior to placing equipment in service. NEVER TEST FOR LEAKS WITH AN OPEN FLAME. Failure to comply could result in personal injury, property damage or death.

Gas Connection Size

Gas Connection (inches)		
Size	**Natural**	**Propane**
30, 45, 60, 75, 100, 125, 150, 175, 200	**1/2**	**1/2**
225, 250, 300, 350, 400	**3/4**	**3/4**

FIGURE 9 - Gas connection is at the pipe nipple that extends outside the cabinet.

Illustration shows both a vertical and horizontal gas supply; requirements are the same.



6.1.2 Valve Outlet or Orifice Pressure Setting

Measuring valve outlet gas pressure cannot be done until the heater is in operation. It is included in the steps of the “Check-Test-Start” procedure in Paragraph 9. The following warnings and instructions apply.

NOTE: Gas Conversion Kits are available for changing from propane gas to natural gas or natural gas to propane gas. A factory-authorized conversion kit MUST be used.

WARNING

Valve outlet gas pressure must never exceed 3.5” w.c. for natural gas and 10” w.c. for propane gas.

For Natural Gas: When the heater leaves the factory, the combination gas valve is set so that the valve outlet gas pressure for a single-stage valve or high fire of a two-stage valve is regulated to 3.5” w.c. Low fire on a two-stage valve is set to 1.8” w.c. Inlet supply pressure to the valve for natural gas must be a minimum of 5” w.c. or as noted on the rating plate and a maximum of 14” w.c.

For Propane Gas: When the heater leaves the factory, the combination gas valve is set so that the valve outlet gas pressure for a single-stage valve or high fire of a two-stage valve is regulated to 10” w.c. Low fire on a two-stage valve is set to 5.0” w.c. Inlet supply pressure to the valve for propane gas must be a minimum of 11” w.c. and a maximum of 14” w.c.

Before attempting to measure or adjust valve outlet gas pressure, the inlet supply pressure *must* be within the specified range both when the heater is in operation and on standby. Incorrect inlet pressure could cause excessive valve outlet gas pressure immediately or at some future time. If natural gas supply pressure is too high, install a regulator in the supply line before it reaches the heater. If natural gas supply pressure is too low, contact your gas supplier.

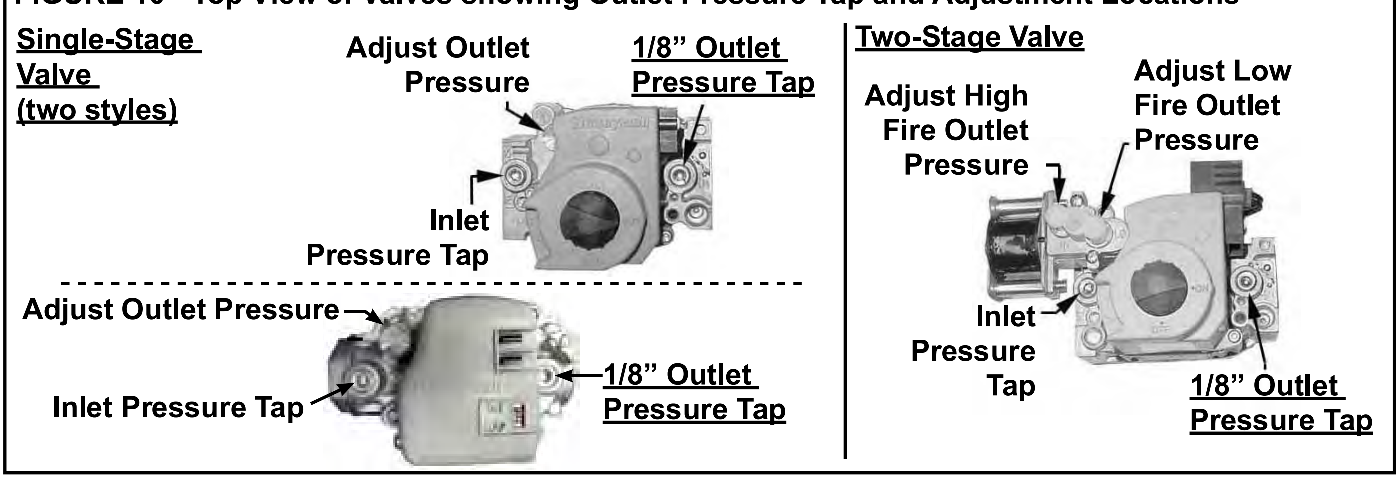
Check Valve Outlet Pressure (can only be done after heater is operating)

Instructions

NOTE: If operating at high altitude, outlet pressure requires adjustment. Follow instructions on page 14.

1) Locate the 1/8” output pressure tap on the valve (See **FIGURE 10**). With the manual valve turned off to prevent flow to the gas valve, connect a manometer to the 1/8” pipe outlet pressure tap in the valve. NOTE: A manometer (fluid-filled gauge)

FIGURE 10 - Top View of Valves showing Outlet Pressure Tap and Adjustment Locations



6.0 Mechanical (cont'd)

6.1 Gas Piping and Pressures (cont'd)

6.1.2 Valve Outlet or Orifice Pressure Setting (cont'd)

is recommended rather than a spring type gauge due to the difficulty of maintaining calibration of a spring type gauge.

2) Open the manual valve and operate the heater. (NOTE: On Model UDAS, depress and hold the door safety switch.) Measure the outlet pressure of the gas valve. To measure low-stage pressure on a unit equipped with a two-stage valve, disconnect the wire from the "HI" terminal on the valve. (Be sure to reconnect the wire.)

Normally when operating at sea level, adjustments should not be necessary to the factory setting. (For high altitude settings, see next paragraph.)

If adjustment is necessary, remove the cap from the adjustment screw(s). Set pressure to correct settings by turning the regulator screw IN (clockwise) to increase pressure. Turn regulator screw OUT (counterclockwise) to decrease pressure.

CAUTION: DO NOT bottom out the gas valve regulator adjusting screw. This can result in unregulated manifold pressure causing excess overfire and heat exchanger failure.

6.1.3 Derate by Valve Outlet Pressure Adjustment for <u>High Altitude</u> Operation

This adjustment can only be done after the heater is in operation. High altitude adjustment is included in the startup Steps.

NOTE: If elevation is above 6000 ft (1830M), a high altitude pressure switch is required; see Paragraph 3.2.1.

Instructions for High Altitude Derate

1. Determine the required valve outlet pressure for the elevation where the heater will be operating. If unsure of the elevation, contact the local gas supplier.

Valve Outlet Pressure Settings by Elevation

Manifold Pressure Settings by Altitude for the UNITED STATES					
Altitude		Natural Gas (inches w.c.)		Propane Gas (inches w.c.)	
Feet	Meters	Single-Stage and Two-Stage High Fire	Two-Stage Low Fire	Single-Stage and Two-Stage High Fire	Two-Stage Low Fire
0-2000	0-610	3.5	1.8	10.0	5.0
2001-3000	611-915	3.1	1.6	8.8	4.4
3001-4000	916-1220	3.0	1.5	8.5	4.2
4001-5000	1221-1525	2.8	1.5	8.1	4.1
5001-6000	1526-1830	2.7	1.4	7.7	3.9
6001-7000	1831-2135	2.6	1.3	7.4	3.7
7001-8000	2136-2440	2.5	1.3	7.1	3.5
8001-9000	2441-2745	2.4	1.2	6.7	3.4
9001-10000	2746-3045	2.3	1.2	6.7	3.4

Manifold Pressure Settings by Altitude for CANADA					
Altitude		Natural Gas (inches w.c.)		Propane Gas (inches w.c.)	
Feet	Meters	Single-Stage and Two-Stage High Fire	Two-Stage Low Fire	Single-Stage and Two-Stage High Fire	Two-Stage Low Fire
0-2000	0-610	3.5	1.8	10.0	5.0
2001-4500	611-1373	2.8	1.5	8.1	4.1

2. Locate the 1/8" output pressure tap on the valve (See **FIGURE 10**, page 13). Turn the knob or switch on the top of the valve to "OFF". Connect a manometer to the 1/8" pipe outlet pressure tap in the valve. Use a water column manometer that is readable to the nearest tenth of an inch.

3. **<u>Single-Stage and Two-Stage High Fire</u>** - Turn the knob or switch on the top of the valve to "ON". Remove the cap from the pressure adjusting screw and adjust the gas train pressure to the pressure selected from the table above. Adjust pressure by turning the regulator screw IN (clockwise) to increase pressure or OUT (counterclockwise) to decrease pressure.

<u>Two-Stage Low Fire</u> - Disconnect the wire from the "HI" terminal on the gas valve and check the low fire pressure. Turn the regulator screw to adjust the low fire outlet pressure to the "Low Fire" pressure selected from the table. Re-connect the wire to the gas valve.

4. Turn up the thermostat. (**NOTE**: On Model UDAS, depress and hold the door safety switch.) Cycle the burner once or twice to properly seat the adjustment spring in the valve.

Re-check the pressure(s). When the outlet pressure is right for the installation, remove the manometer and replace the cap.

Check for leak at the pressure tap fitting.

5. With the heater operating determine that the inlet pressure to the heater for natural gas is between 5 and 13.5 inches w.c. and for propane between 10 and 13.5 inches w.c. Take this reading as close as possible to the heater (Heaters are equipped with gas valves that have an inlet pressure tap.) If the inlet pressure is not within the specified range, the inlet pressure must be corrected and Steps 3 and 4 repeated.
6. Find the High Altitude Adjustment label in the plastic bag that contained these instructions. Using a permanent marker, fill-in the appropriate information from the tables below. Select a location for the label on the outside of the heater access panel so that it will be conspicuous to anyone operating or servicing the unit. Be sure the surface is clean and dry and adhere the label.

High Altitude Capacity Changes

The input and/or the capacity of the heater changes with the derate. The tables below list inputs and capacities at altitudes from sea level to 10,000 ft (3045M).

BTUH Inputs and Capacities by Altitude in the UNITED STATES for Model UDAP and Model UDAS

ALTITUDE		Normal Input	Thermal Output Capacity	Minimum Input	Normal Input	Thermal Output Capacity	Minimum Input	Normal Input	Thermal Output Capacity	Minimum Input	Normal Input	Thermal Output Capacity	Minimum Input
Feet	**Meters**		**Size 30**			**Size 45**			**Size 60**			**Size 75**	
0-2000	0-610	30000	24600	30000	45000	37350	45000	60000	49800	42000	75000	62250	52500
2001-3000	611-915	28200	23124	28200	42300	35109	42300	56400	46812	39480	70500	58515	49350
3001-4000	916-1220	27600	22632	27600	41400	34362	41400	55200	45816	38640	69000	57270	48300
4001-5000	1221-1525	27000	22140	27000	40500	33615	40500	54000	44820	37800	67500	56025	47250
5001-6000	1526-1830	26400	21648	26400	39600	32868	39600	52800	43824	36960	66000	54780	46200
6001-7000	1831-2135	25800	21156	25800	38700	32121	38700	51600	42828	36120	64500	53535	45150
7001-8000	2136-2440	25200	20664	25200	37800	31374	37800	50400	41832	35280	63000	52290	44100
8001-9000	2441-2745	24600	20172	24600	36900	30627	36900	49200	40836	34440	61500	51045	43050
9001-10000	2746-3045	24000	19680	24000	36000	29880	36000	48000	39840	33600	60000	49800	42000
Feet	**Meters**		**Size 100**			**Size 125**			**Size 150**			**Size 175**	
0-2000	0-610	105000	88200	73500	120000	100800	84000	150000	124500	105000	175000	145250	122500
2001-3000	611-915	98700	82908	69090	112800	94752	78960	141000	117030	98700	164500	136535	115150
3001-4000	916-1220	96600	81144	67620	110400	92736	77280	138000	114540	96600	161000	133630	112700
4001-5000	1221-1525	94500	79380	66150	108000	90720	75600	135000	112050	94500	157500	130725	110250
5001-6000	1526-1830	92400	77616	64680	105600	88704	73920	132000	109560	92400	154000	127820	107800
6001-7000	1831-2135	90300	75852	63210	103200	86688	72240	129000	107070	90300	150500	124915	105350
7001-8000	2136-2440	88200	74088	61740	100800	84672	70560	126000	104580	88200	147000	122010	102900
8001-9000	2441-2745	86100	72324	60270	98400	82656	68880	123000	102090	86100	143500	119105	100450
9001-10000	2746-3045	84000	70560	58800	96000	80640	67200	120000	99600	84000	140000	116200	98000
Feet	**Meters**		**Size 200**			**Size 225**			**Size 250**			**Size 300**	
0-2000	0-610	200000	166000	140000	225000	186750	157500	250000	207500	175000	300000	249000	210000
2001-3000	611-915	188000	156040	131600	211500	175545	148050	235000	195050	164500	282000	234060	197400
3001-4000	916-1220	184000	152720	128800	207000	171810	144900	230000	190900	161000	276000	229080	193200
4001-5000	1221-1525	180000	149400	126000	202500	168075	141750	225000	186750	157500	270000	224100	189000
5001-6000	1526-1830	176000	146080	123200	198000	164340	138600	220000	182600	154000	264000	219120	184800
6001-7000	1831-2135	172000	142760	120400	193500	160605	135450	215000	178450	150500	258000	214140	180600
7001-8000	2136-2440	168000	139440	117600	189000	156870	132300	210000	174300	147000	252000	209160	176400
8001-9000	2441-2745	164000	136120	114800	184500	153135	129150	205000	170150	143500	246000	204180	172200
9001-10000	2746-3045	160000	132800	112000	180000	149400	126000	200000	166000	140000	240000	199200	168000
Feet	**Meters**		**Size 350**			**Size 400**							
0-2000	0-610	350000	290500	245000	400000	332000	280000						
2001-3000	611-915	329000	273070	230300	376000	312080	263200						
3001-4000	916-1220	322000	267260	225400	368000	305440	257600						
4001-5000	1221-1525	315000	261450	220500	360000	298800	252000						
5001-6000	1526-1830	308000	255640	215600	352000	292160	246400						
6001-7000	1831-2135	301000	249830	210700	344000	285520	240800						
7001-8000	2136-2440	294000	244020	205800	336000	278880	235200						
8001-9000	2441-2745	287000	238210	200900	328000	272240	229600						
9001-10000	2746-3045	280000	232400	196000	320000	265600	224000						

BTUH Inputs and Capacities by Altitude in CANADA for Models UDAP and UDAS

ALTITUDE		Normal Input	Thermal Output Capacity	Minimum Input	Normal Input	Thermal Output Capacity	Minimum Input	Normal Input	Thermal Output Capacity	Minimum Input	Normal Input	Thermal Output Capacity	Minimum Input
Feet	**Meters**		**Size 30**			**Size 45**			**Size 60**			**Size 75**	
0-2000	0-610	30000	24600	30000	45000	37350	45000	60000	49800	42000	75000	62250	52500
2001-4500	611-1373	27000	22140	27000	40500	33615	40500	54000	44820	37800	67500	56025	47250
Feet	**Meters**		**Size 100**			**Size 125**			**Size 150**			**Size 175**	
0-2000	0-610	105000	88200	73500	120000	100800	84000	150000	124500	105000	175000	145250	122500
2001-4500	611-1373	94500	79380	66150	108000	90720	75600	135000	113400	94500	157500	132300	110250
Feet	**Meters**		**Size 200**			**Size 225**			**Size 250**			**Size 300**	
0-2000	0-610	200000	166000	140000	225000	186750	157500	250000	207500	175000	300000	249000	210000
2001-4500	611-1373	180000	151200	126000	202500	170100	141750	225000	189000	157500	270000	226800	189000
Feet	**Meters**		**Size 350**			**Size 400**							
0-2000	0-610	350000	290500	245000	400000	332000	280000						
2001-4500	611-1373	315000	264600	220500	360000	302400	252000						

6.0 Mechanical (cont'd)

(Note: For Model UDAS, see Venting Manual for combustion air requirements.)

6.2 Combustion Air - Models UDAP and UDAP-CV

This heater must be supplied with the air that enters into the combustion process and is then vented to the outdoors. Sufficient air must enter the equipment location to replace that exhausted through the heater vent system. In the past, the infiltration of outside air assumed in heat loss calculations (one air change per hour) was assumed to be sufficient. However, current construction methods using more insulation, vapor barriers, tighter fitting and gasketed doors and windows, weather-stripping, and/or mechanical exhaust fans may now require the introduction of outside air through wall openings or ducts.

The requirements for combustion and ventilation air depend upon whether the unit is located in a confined or unconfined space. An "unconfined space" is defined as a space whose volume is not less than 50 cubic feet per 1000 BTUH of the installed appliance. **Under ALL conditions,** enough air must be provided to ensure there will not be a negative pressure condition within the equipment room or space.

WARNING

Model UDAP and UDAP-CV power-vented unit heaters are designed to take combustion air from the space in which the unit is installed and are not designed for connection to outside combustion air intake ducts. Connecting outside air ducts voids the warranty and could cause hazardous operation. See Hazard Levels, page 2.

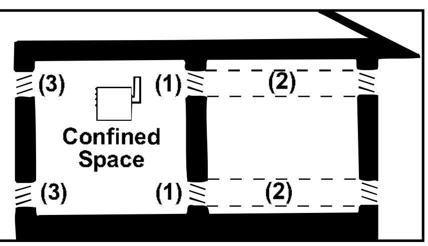
Combustion Air Requirements for a Heater Located in a Confined Space - applies to Model UDAP and Model UDAP-CV

Do not install a unit in a confined space without providing wall openings leading to and from the space. Provide openings near the floor and ceiling for ventilation and air for combustion as shown in **FIGURE 11**, depending on the combustion air source as noted in Items 1, 2, and 3 below.

Add total BTUH of all appliances in the confined space and divide by figures below for square inch free area size of each (top and bottom) opening.

FIGURE 11 - Definition of Confined Space and Required Openings for Combustion Air

Confined Space:
A space whose volume is less than 50 cubic feet per 1000 BTUH of the installed appliance input rating



1. **Air from inside the building** -- openings 1 square inch free area per 1000 BTUH. Never less than 100 square inches of free area for each opening. See (1) in **FIGURE 11**.
2. **Air from outside through duct** -- openings 1 square inch free area per 2000 BTUH. See (2) in **FIGURE 11**.
3. **Air direct from outside** -- openings 1 square inch free area per 4000 BTUH. See (3) in **FIGURE 11**.

NOTE: For further details on supplying combustion air to a confined space, see the National Fuel Gas Code ANSI Z223.1a (latest edition).

7.0 Electrical Supply and Wiring

CAUTION: Route wires so that they do not contact the flue wrapper or venter housing.

7.1 General

All electrical wiring and connections, including electrical grounding MUST be made in accordance with the National Electric Code ANSI/NFPA No. 70 (latest edition) or, in Canada, with CSA Standard C22.1. In addition, the installer should be aware of any local ordinances or gas company requirements that might apply.

CAUTION: If any of the original wire as supplied with the appliance must be replaced, it must be replaced with wiring material having a temperature rating of at least 105°C, except for limit control, flame rollout, and sensor lead wires which must be 150°C. See Hazard Levels, page 2.

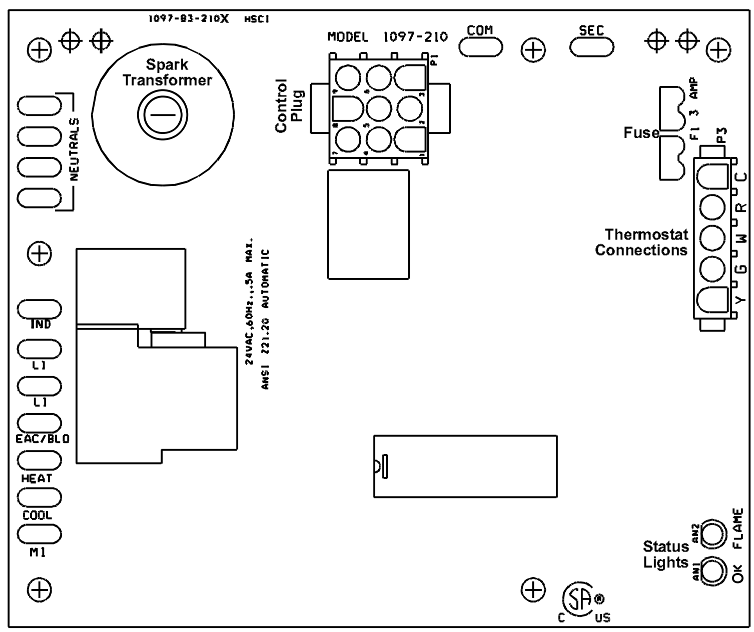
7.2 Supply Wiring

Check the rating plate on the heater for the supply voltage and current requirements. A dedicated line voltage supply with disconnect switch should be run directly from the main electrical panel to the heater. All external wiring must be within approved conduit and have a minimum temperature rise rating of 60°C. Conduit must be run so as not to interfere with the heater access panel. If the installation requires a stepdown transformer (Option CG), follow the instructions shipped with the option package for attaching the transformer to the heater.

The electrical supply enters at the rear of the heater (See **FIGURE 13**). Model UDAS includes a built-in disconnect switch (20A @ 115V; 10A @ 230V Rating). Model UDAS supply wiring connects to leads located inside a sealed electrical box. To maintain the sealing feature of the electrical box, always replace the cover plate. Model UDAP supply wiring connects directly to leads on the integrated circuit board.

The circuit board (See **FIGURE 12**) is located inside on the bottom of the control compartment. The circuit board is polarity sensitive. It is advisable to check the electrical supply to be certain that the black wire is the "hot" wire and that the white wire is the neutral wire. The supply connection made to "L1" on the circuit board must be the "hot" wire.

FIGURE 12 - Supply Wiring Connections at the Circuit Board (DSI Integrated Control Module)



Supply Wiring Connections

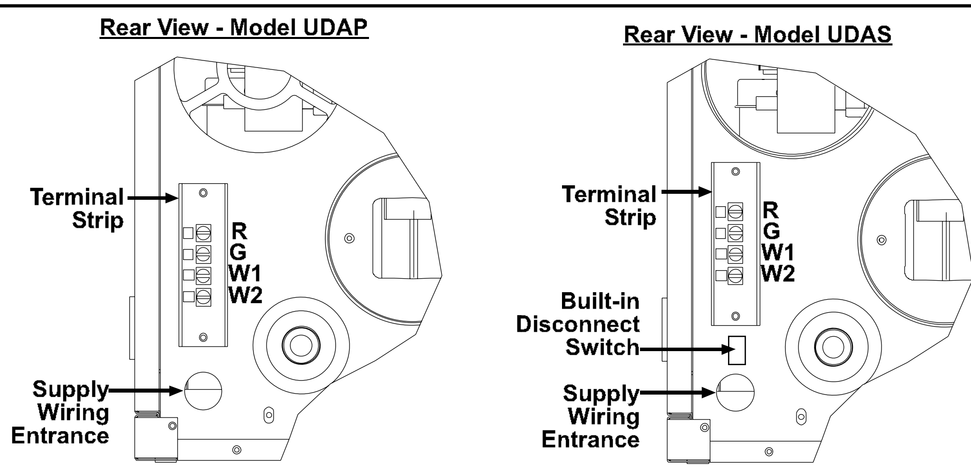
NOTE: Circuit board is polarity sensitive; "hot" wire MUST BE connected to Terminal L1.

7.3 24V Control Wiring Connections

For all models, the terminal strip for 24 volt thermostat connections is located on the outside of the cabinet at the back of the heater (See **FIGURE 13**). Wires from the terminal strip are factory wired to the circuit board.

FIGURE 13 - Terminal Strip for 24-volt wiring is on the outside rear of the heater.

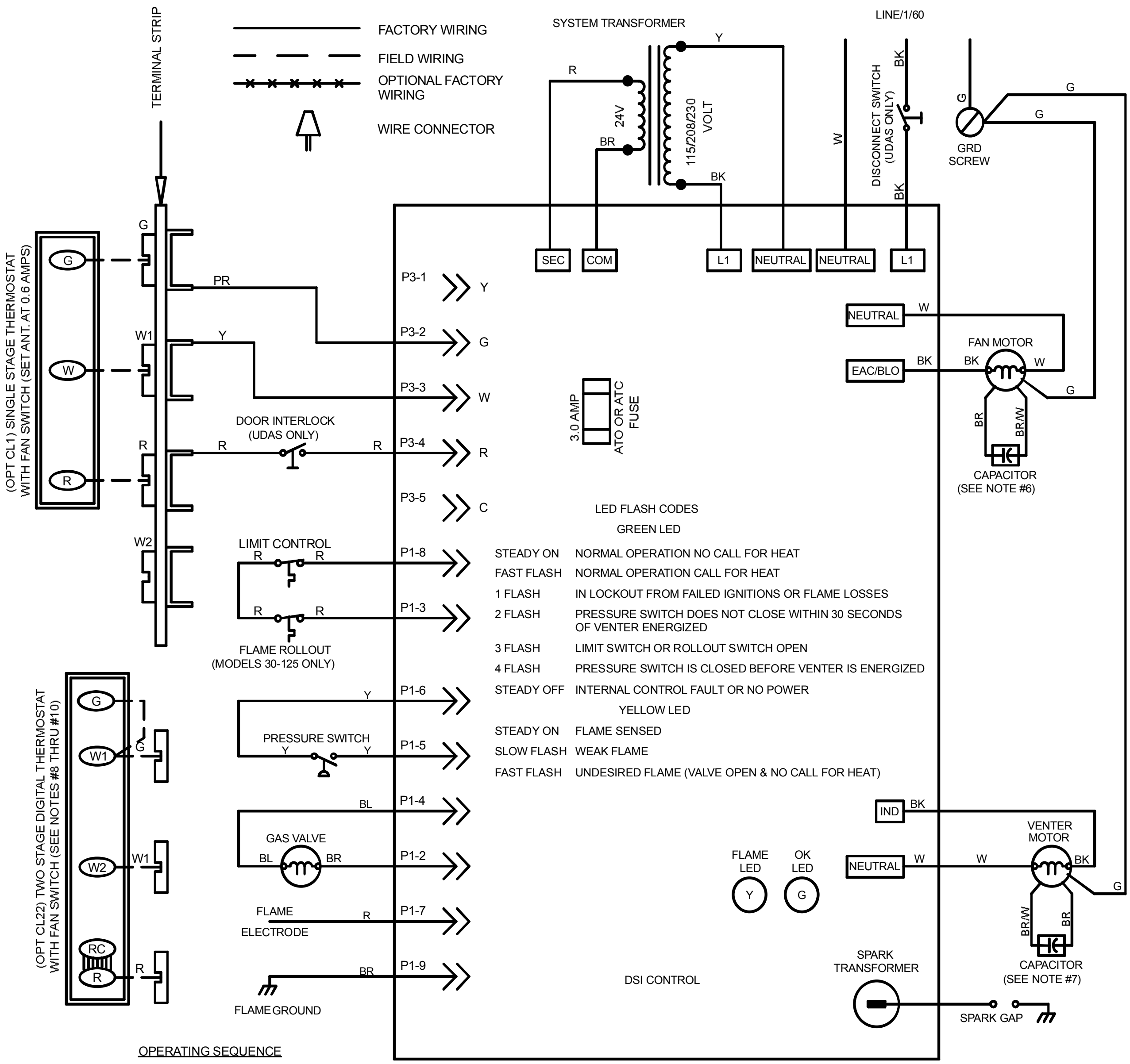
NOTE: The size of heater illustrated has a vertical terminal strip. Some sizes have a horizontal terminal strip.



7.0 Electrical Supply and Wiring (cont'd)

7.4 Wiring Diagrams

FIGURE 14A - Typical Wiring Diagram for Model UDAP or Model UDAS, Single Stage



OPERATING SEQUENCE

1. SET THERMOSTAT AT LOWEST SETTING, (FAN SWITCH AT "AUTO" POSITION.
2. TURN ON MANUAL GAS VALVE.
3. TURN ON POWER TO UNIT.
4. SET THERMOSTAT AT DESIRED SETTING.
5. THERMOSTAT CALLS FOR HEAT, ENERGIZING THE VENTER MOTOR.
6. VENTER PRESSURE SWITCH CLOSES, FIRING UNIT AT FULL RATE.
7. BURNER FLAME IS SENSED, AND IN 30 SECONDS THE FAN MOTOR IS ENERGIZED.
8. IF THE FLAME IS EXTINGUISHED DURING MAIN BURNER OPERATION, THE INTEGRATED CONTROL SYSTEM CLOSES THE MAIN VALVE AND MUST BE RESET BY INTERRUPTING POWER TO THE CONTROL CIRCUIT (SEE LIGHTING INSTRUCTIONS).
9. SET FAN SWITCH AT "ON" POSITION FOR CONTINUOUS FAN OPERATION.

NOTES

1. THE FOLLOWING CONTROLS ARE FIELD INSTALLED OPTIONS: THERMOSTAT
2. DOTTED WIRING INSTALLED BY OTHERS.
3. CAUTION: IF ANY OF THE ORIGINAL WIRING AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH WIRING MATERIAL HAVING A TEMPERATURE RATING OF AT LEAST 105° C. EXCEPT FOR SENSOR LEAD WIRE, FLAME ROLLOUT AND LIMIT WIRING WHICH MUST BE 150° C.
4. USE 18 GA. WIRE FOR ALL WIRING ON THE UNIT.
5. LINE AND FAN MOTOR BRANCH WIRE SIZES SHOULD BE OF A SIZE TO PREVENT VOLTAGE DROPS BEYOND 5% OF SUPPLY LINE VOLTAGE.
6. CAPACITOR IS REMOTE MOUNTED AND INCLUDED ONLY ON 115V MODELS 150-400 AND 208/230V MODELS 100-400.
7. CAPACITOR IS REMOTE MOUNTED AND INCLUDED ONLY ON MODELS 150 - 400.
8. VERIFY JUMPER ON CL22 THERMOSTAT TERMINALS R TO RC.
9. FAN SWITCH OR LOW STAGE OF CL22 THERMOSTAT ENERGIZES THE BLOWER MOTOR.
10. HIGH STAGE OF CL22 THERMOSTAT INITIATES A CALL FOR HEAT.

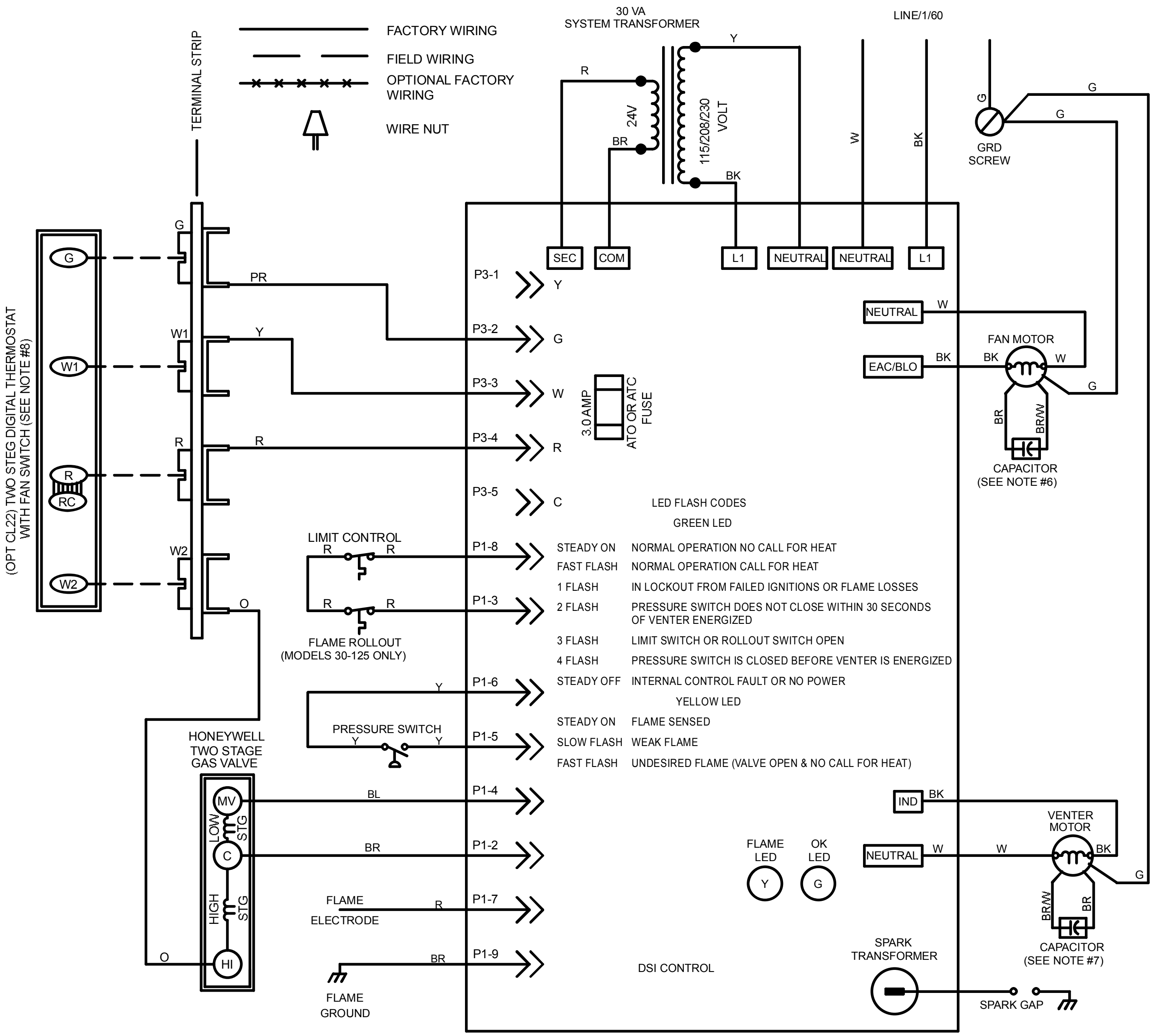
FIELD CONTROL WIRING

TOTAL WIRE LENGTH	DISTANCE FROM UNIT TO CONTROL	MIN. RECOMMENDED WIRE GUAGE
150'	75'	#18 GA. WIRE
250'	125'	#16 GA. WIRE
350'	175'	#14 GA. WIRE

WIRING CODE
BLACK - BK
BROWN - BR
RED - R
ORANGE - O
YELLOW - Y
GREEN - G
BLUE - BL
PURPLE - PR
WHITE - W

UDAP & UDAS SERIES
WD# 185139 REV #4
AG1-CL1 or CL22

FIGURE 14B - Typical Wiring Diagram for Model UDAP or Model UDAS, Two Stage Gas Valve or Recirculation



OPERATING SEQUENCE

1. SET THERMOSTAT AT LOWEST SETTING, FAN SWITCH AT "AUTO" POSITION.
2. TURN ON MANUAL GAS VALVE.
3. TURN ON POWER TO UNIT.
4. SET THERMOSTAT AT DESIRED SETTING.
5. LOW STAGE OF THERMOSTAT CALLS FOR HEAT, ENERGIZING THE VENTER MOTOR.
6. VENTER PRESSURE SWITCH CLOSES, FIRING UNIT AT LOW RATE.
7. BURNER FLAME IS SENSED, AND IN 30 SECONDS THE FAN MOTOR IS ENERGIZED.
8. HIGH STAGE OF THERMOSTAT CALLS FOR HEAT, FIRING UNIT AT FULL RATE.
9. SET FAN SWITCH AT "ON" POSITION FOR CONTINUOUS FAN OPERATION.
10. IF THE FLAME IS EXTINGUISHED DURING MAIN BURNER OPERATION, THE INTEGRATED CONTROL SYSTEM CLOSES THE MAIN VALVE AND MUST BE RESET BY INTERRUPTING POWER TO THE CONTROL CIRCUIT (SEE LIGHTING INSTRUCTIONS).

FIELD CONTROL WIRING

TOTAL WIRE LENGTH	DISTANCE FROM UNIT TO CONTROL	MIN. RECOMMENDED WIRE GUAGE
150'	75'	#18 GA. WIRE
250'	125'	#16 GA. WIRE
350'	175'	#14 GA. WIRE

WIRING CODE
BLACK - BK
BROWN - BR
RED - R
ORANGE - O
YELLOW - Y
GREEN - G
BLUE - BL
PURPLE - PR
WHITE - W

NOTES

1. THE FOLLOWING CONTROLS ARE FIELD INSTALLED OPTIONS: THERMOSTAT
2. DOTTED WIRING INSTALLED BY OTHERS.
3. CAUTION: IF ANY OF THE ORIGINAL WIRING AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH WIRING MATERIAL HAVING A TEMPERATURE RATING OF AT LEAST 105° C. EXCEPT FOR SENSOR LEAD WIRE, FLAME ROLLOUT AND LIMIT WIRING WHICH MUST BE 150° C.
4. USE 18 GA. WIRE FOR ALL WIRING ON THE UNIT.
5. LINE AND FAN MOTOR BRANCH WIRE SIZES SHOULD BE OF A SIZE TO PREVENT VOLTAGE DROPS BEYOND 5% OF SUPPLY LINE VOLTAGE.
6. CAPACITOR IS REMOTE MOUNTED AND INCLUDED ONLY ON 115V MODELS 150-400 AND 208/230V MODELS 100-400.
7. CAPACITOR IS REMOTE MOUNTED AND INCLUDED ONLY ON MODELS 150 - 400.
8. VERIFY JUMPER ON THERMOSTAT TERMINALS R TO RC.

UDAP & UDAS SERIES
AG2-CL22
WD# 185244 REV #2

7.0 Electrical Supply and Wiring (cont'd)

7.5 Electrical Operating Components

7.5.1 Combustion Air Proving (Pressure) Switch

The combustion air proving switch is a pressure sensitive switch that monitors air pressure to ensure that proper combustion airflow is available. On Model UDAP, the switch is a single pole/normally open device which closes when a negative pressure is sensed in the venter housing. On Model UDAS, the switch senses the differential pressure between the negative pressure in the venter housing and the pressure in the cabinet. (For switch location, see **FIGURE 18**, page 30.)

On startup when the heater is cold, the sensing pressure is at the most negative level, and as the heater and flue system warm up, the sensing pressure becomes less negative. After the system has reached equilibrium (about 20 minutes), the sensing pressure levels off.

If a restriction or excessive flue length or turns cause the sensing pressure to be outside the switch setpoint, the pressure switch will function to shutoff the main burner. The main burner will remain off until the system has cooled and/or the flue system resistance is reduced.

The Tables on the left below list the approximate water column negative pressure readings and switch setpoints for sea level operating conditions for Model UDAP and Model UDAP-CV heaters. The Table on the right lists the approximate water column differential pressure readings and switch setpoints for sea level operating conditions for Model UDAS heaters.

DANGER

Safe operation of this unit requires proper venting flow. NEVER bypass combustion air proving switch or attempt to operate the unit without the venter running and the proper flow in the vent system. Hazardous conditions could result. See Hazard Intensity Levels, page 2.

Pressure Switch Settings

Model UDAP	Startup Cold	Equilibrium Hot	Setpoint OFF	Setpoint ON	Label Color	Switch P/N
	Negative Pressure (" w.c.)					
30	1.0	0.8	0.4	0.6	Green	197030
45	1.0	0.8	0.4	0.6	Green	197030
60	1.0	0.8	0.5	0.7	Orange	196388
75	1.0	0.9	0.5	0.7	Orange	196388
100	0.9	0.7	0.5	0.7	Orange	196388
125	0.8	0.6	0.4	0.6	Green	197030
150, 175	0.8	0.7	0.4	0.6	Green	197030
200, 225	2.2	1.5	1.1	1.3	Blue	201158
250, 300	2.3	1.6	1.1	1.3	Blue	201158
350, 400	2.6	1.8	1.1	1.6	Red	201159

Model UDAS	Startup Cold	Equilibrium Hot	Setpoint OFF	Setpoint ON	Label Color	Switch P/N
	Differential Pressure (" w.c.)					
30	1.0	0.8	0.65	0.8	Yellow	197028
45	1.1	0.8	0.65	0.8	Yellow	197028
60	1.1	0.9	0.65	0.8	Yellow	197028
75	1.1	0.9	0.65	0.8	Yellow	197028
100	0.9	0.7	0.55	0.7	White	196362
125	0.8	0.6	0.45	0.6	Pink	197032
150, 175	0.8	0.6	0.40	0.6	Green	197030
200, 225	2.2	1.5	1.10	1.3	Blue	201158
250, 300	2.3	1.6	1.10	1.3	Blue	201158
350, 400	2.6	1.8	1.10	1.6	Blue	201158

Model UDAP-CV with Opt AV6	Startup Cold	Equilibrium Hot	Setpoint OFF	Setpoint ON	Label Color	Switch P/N
	Negative Pressure (" w.c.)					
30	1.1	0.8	0.65	0.8	Yellow	197028
45	1.1	0.8	0.50	0.7	Orange	196388
60	0.9	0.8	0.60	0.8	Lt Blue	197029
75	1.0	0.8	0.60	0.8	Lt Blue	197029
100	0.9	0.7	0.55	0.7	White	196362

7.5.2 Limit Control

All units are equipped with a temperature activated auto reset limit control. The control is factory set and is non-adjustable. If the setpoint is reached, the limit control will interrupt the electric supply to the gas valve. This safety device provides protection in the case of motor failure or lack of airflow due to a restriction at the inlet or outlet. (For location, see **FIGURE 18**, page 30.)

CAUTION: The auto reset limit control will continue to shut down the heater until the cause is corrected. Never bypass the limit control; hazardous conditions could result. See Hazard Intensity Levels, page 2.

Sizes 30-125 are equipped with a temperature activated manually reset flame rollout switch. The flame rollout switch is located at the top of the burner assembly. It is factory set and is non-adjustable. If the setpoint is reached, the flame rollout acts to interrupt the electric supply to the gas valve. If the flame rollout switch activates, identify and correct the cause before resetting the switch. Refer to the Maintenance Section, Paragraph 10.2.10, for information on probable causes and instructions on resetting the flame rollout switch. (For location, see **FIGURE 18**, page 30.)

DANGER

If the manual reset flame rollout switch activates, identify and correct the cause before resetting the switch. Never bypass the flame rollout switch; hazardous conditions could result. See Hazard Intensity Levels, page 2.

7.5.3 Door Switch - Model UDAS only

All sizes of Model UDAS heaters are equipped with a door switch which prevents the heater from operating when the service door panel is open. The service panel of a Model UDAS is equipped with a pliable gasket material that fully seals the door to provide added protection from building air entering the combustion zone of the heater. (For switch location, see **FIGURE 18**, page 30.)

7.5.4 Gas Valve

The main operating gas valve is powered by the 24-volt control circuit through the thermostat and safety controls. The main control valve is of the diaphragm type providing regulated gas flow preset at the factory. (For location, see **FIGURE 18**, page 30.)

WARNING

The operating valve is the prime safety shutoff. All gas supply lines must be free of dirt or scale before connecting the unit to ensure positive closure. See Hazard Levels, page 2.

7.5.5 Fan Motor

The fan motor is equipped with thermal overload protection of the automatic reset type. Should the motor refuse to run, it may be because of improper current characteristics. Make certain that the correct voltage is available at the motor.

NOTE: If the unit is equipped with an optional totally enclosed motor or optional voltage, the horsepower may be larger than the standard motor. Refer to the motor nameplate to verify horsepower.

7.5.6 Venter Motor

The venter motor is assembled to the venter wheel and operates to provide combustion airflow. Operation is controlled by the ignition control module (circuit board); refer to ignition system in Paragraph 8.3.

8.0 Controls and Operation

8.1 Thermostat

Use either an optional thermostat available with the heater or a field-supplied 24-volt thermostat. Install according to the thermostat manufacturer's instructions, paying particular attention to the requirements regarding the location of the thermostat.

Make sure that if there is a heat anticipator setting on the thermostat, it is set at 0.6 amps (or in accordance with the amperage value noted on the heater wiring diagram).

Make thermostat connections at the terminal strip on the back of the heater. The strip has four terminals, R, G, W1, and W2; refer to the wiring diagram.

IMPORTANT: All units MUST be operated by a 24-volt thermostat. Never use a line voltage disconnect switch as a means of operating the heater. Operating Model Sizes 30-125 by means other than a 24-volt thermostat may result in the flame rollout switch tripping.

Unit Mounted Thermostat, Option CM3 - If the heater was ordered with Option CM3, a kit for mounting the thermostat on the rear of the heater is shipped separately. Follow the instructions in the option package to attach the bracket.

Select a snap-action thermostat when using the unit mounted thermostat bracket. Do not use a mercury switch thermostat because the vibration may cause excessive unit cycling. Be careful with the thermostat leads; shorting the thermostat wires to a metal surface will cause the transformer to fail.

8.0 Controls and Operation (cont'd)

8.1 Thermostat (cont'd)

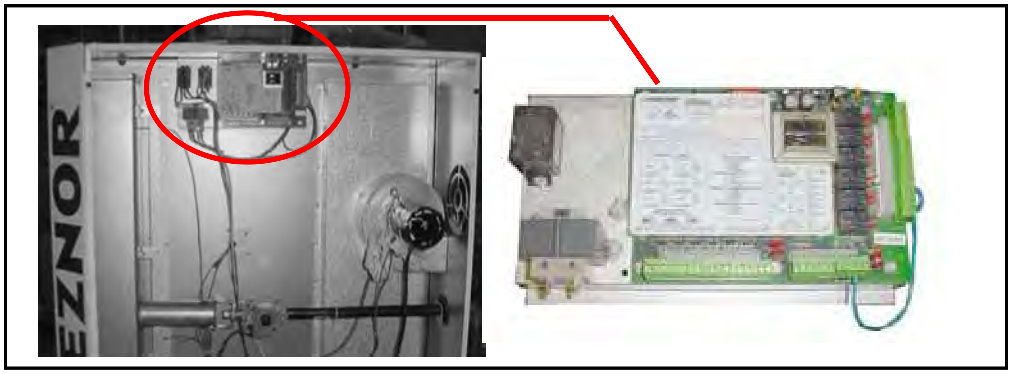
Multiple Heater Control, Option CL31 and Option CL32 - If the heater was ordered with a multiple heater control option, one thermostat can be used to control up to six heaters. The option includes a 40VA transformer that replaces the standard transformer in the "controlling" unit and a relay assembly that attaches to the additional unit. Option CL31 provides for control of two heaters. If control of additional heaters is desired (up to six total), Option CL32 which is the relay assembly only must be added to each additional heater.

The option packages are shipped separately and include complete instructions on installation and wiring.

8.2 DDC Controls, Options D10 and D14

If the heater was ordered with Option D10 or D14, it is equipped with a Novar Minio control module. The Novar control with its accompanying relays and power transformer are mounted in the control compartment of the unit. See **FIGURE 15A.** This control offers a wide variety of input and output points that can be configured to meet a wide range of building management applications. User-selectable input types are Thermistor, 4-20 milliamp, 1-5 volts, or digital.

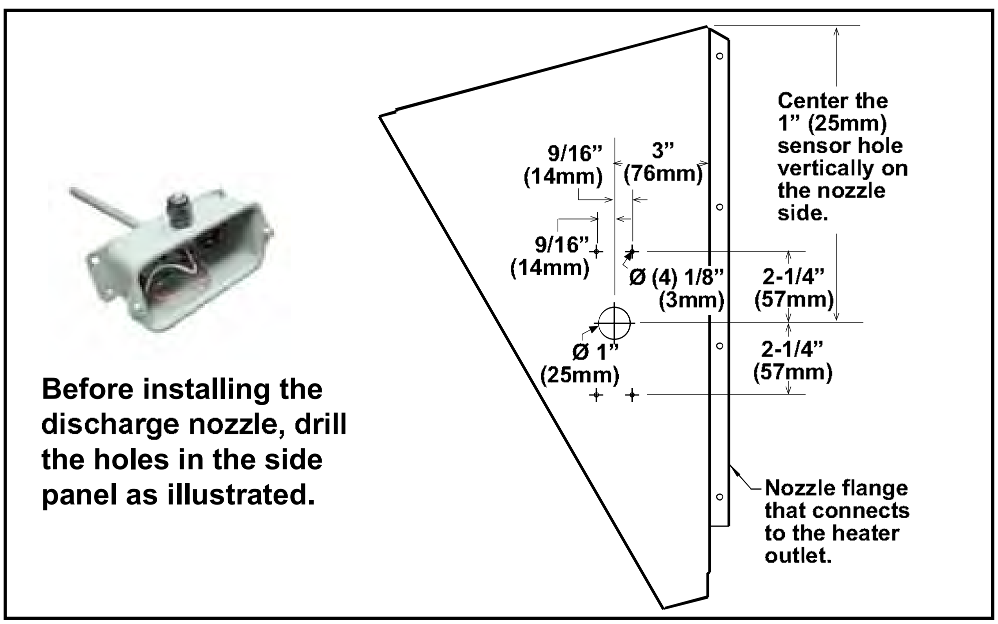
FIGURE 15A - DDC Control with Transformer and Relays is Mounted on a Specially Designed Bracket in the Control Compartment



Control **Option D10** includes the controller and the sensor to be field mounted at the heater discharge. **Option D14** requires a field-supplied sensor that is compatible with the control. For regulatory compliance specifications, and safety precautions, review the control manufacturer's installation instructions in the owner's envelope.

The recommended location for mounting the sensor is on the side of a field-installed optional downturn nozzle. See **FIGURE 15B** for an illustration of the sensor included with Option D10 and dimensions for mounting it on the nozzle side.

FIGURE 15B - Recommended Location for Mounting the Sensor is on the Side Panel of a Discharge Nozzle (Option CD 2, 3, or 4)



Mount the sensor on the nozzle side.

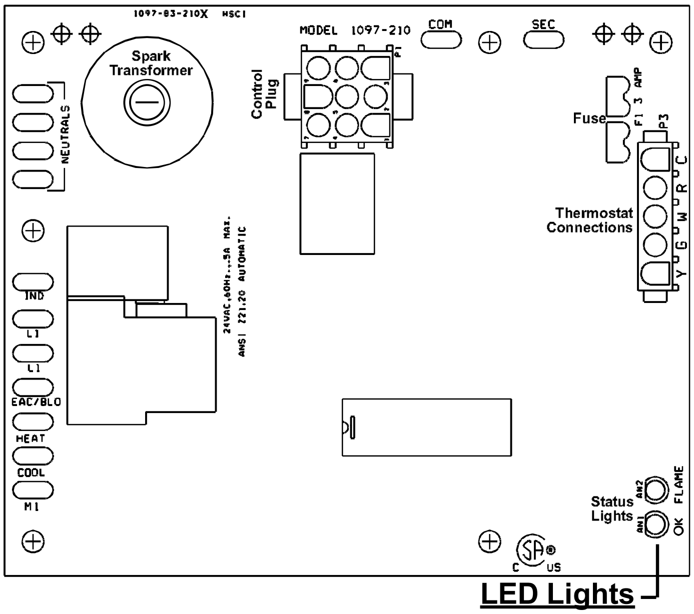
Drill a 7/8" hole in the cabinet top above the controller and install the bushing supplied with the unit for running the sensor wire. Wire the sensor to the controller as illustrated on the wiring diagram on the heater. Sensor wire is field-supplied.

8.3 Ignition System

This heater is equipped with a direct spark integrated control module (circuit board). The module monitors the safety devices and controls the operation of the fan and venter motors and the gas valve between heat cycles.

FIGURE 16 – DSI Integrated Control Module (circuit board)

LED lights are visible through a viewport on Model UDAS. Remove door panel to view LED lights on Model UDAP.



Control Status - Green LED Codes

Steady ON	Normal Operation, No call for heat
Fast Flash	Normal Operation, Call for heat
1 Flash	System Lockout, Failed to detect or sustain flame
2 Flashes	Pressure Switch Did Not Close within 30 Seconds of Venter motor
3 Flashes	High Limit or Flame Rollout Switch Open
4 Flashes	Pressure switch is closed before venter motor is energized
Steady OFF	Blown Fuse, No Power, or Defective Board

Flame Status - Yellow LED Codes

Steady ON	Flame is sensed
Slow Flash	Weak flame (current below 1.0 microamps ±50%)
Fast Flash	Undesired Flame (valve open and no call for heat)

Normal Heat Cycle Operating Sequence

LED lights are visible through viewport on Model UDAS. Remove door panel to view LED lights on Model UDAP.

1) Call for Heat - The thermostat calls for heat by energizing the "W" terminal. The control checks to see that the limit switch is closed and the pressure switch is open. If the limit switch is open, the control responds as defined in the "Abnormal Heat Cycle, Limit Switch Operation". If the pressure switch is closed, the control will do four flashes on the green LED and wait indefinitely for the pressure switch to open. If the pressure switch is open, the control proceeds to prepurge.

2) Prepurge - The control energizes the venter motor and waits for the pressure switch to close. If the pressure switch does not close within 30 seconds of the venter motor energizing, the control will do two flashes on the green LED. The control will leave the venter motor energized indefinitely as long as the call for heat remains and the pressure switch is open.

When the pressure switch is proven closed, the control begins the prepurge time. If flame is present any time while in prepurge, the prepurge time is restarted. If flame is present long enough to cause lockout, the control responds as defined in "Fault Modes, Undesired Flame".

The control runs the venter motor for a 20 second prepurge time, then proceeds to the ignition trial period.

3) Ignition Trial Period - The control energizes the spark and main gas valve. The venter remains energized. If flame is sensed during the first 16 seconds, the spark is de-energized and the control proceeds to heat fan/blower on delay. If flame has not been sensed during the first 16 seconds, the control de-energizes the spark output and keeps the gas valve energized for an additional one second flame proving period. If flame is not present after the flame proving period, the control de-energizes the gas valve and proceeds with ignition re-tries as specified in "Abnormal Heat Cycle, Ignition Retry". If flame is present, the control proceeds to the fan/blower on delay.

4) Fan/Blower On Delay - The control waits for 30 seconds from the time the gas valve opened and then energizes the fan/blower motor. The gas valve and venter motor remain energized. The control proceeds to steady heat mode.

5) Steady Heat - Control inputs are continuously monitored to ensure limit and pressure switches are closed, flame is established, and the thermostat call for heat remains. When the thermostat call for heat is removed, the control de-energizes the gas valve and begins post-purge and fan/blower off delay timing.

8.0 Controls and Operation (cont'd)

8.3 Ignition System (cont'd)

Normal Heat Cycle Operating Sequence (cont'd)

6) Post Purge - The venter motor output remains on for a 45-second post-purge period after the thermostat is satisfied.

7) Fan/Blower Off Delay - The fan/blower motor is de-energized after a fan/blower off delay (120 seconds). Timing begins when the thermostat is satisfied.

Abnormal Heat Cycle Functions

Interrupted Thermostat Call for Heat - If the thermostat demand for heat is removed before the flame is recognized, the control will run the venter motor for the post purge period and de-energize all outputs.

If the thermostat demand for heat is removed after successful ignition, the control will de-energize the gas valve, run the venter motor through post purge, and run the fan/blower motor on heat speed for the selected delay off time.

Ignition Retry - If flame is not established on the first trial for ignition period, the control de-energizes the gas valve and the venter motor remains energized for an inter-purge period of 10 seconds. The spark and gas valve are then re-energized, and the control initiates another trial for ignition.

If flame is not established on the second trial for ignition, the control de-energizes the gas valve, energizes the fan/blower motor on heat speed, and venter motor remains energized. The fan/blower motor is shut off after 120 seconds. When the fan/blower motor de-energizes, the spark and gas valve are re-energized and the control initiates another trial for ignition. (This fan delay is self-healing feature for an open auxiliary limit switch).

If flame is not established on the third trial for ignition period, the control de-energizes the gas valve, and the venter motor remains energized for an inter-purge period of 10 seconds. The control then re-energizes the gas valve and spark and initiates another trial for ignition.

If flame is not established on the fourth trial for ignition (initial try plus 3 re-tries), the control de-energizes the gas valve and goes into lockout. The control goes to one flash on the green LED to indicate ignition failure lockout.

Limit Switch Operation - The limit switch is ignored unless a call for heat is present (W energized). If the limit switch is open and a call for heat is present, the control de-energizes the gas valve and turns the fan/blower motor on heat speed and runs the venter motor. The control will be in soft lockout and flashing fault code "3" before returning to normal operation.

When the switch re-closes or the call for heat is lost, the control runs the venter motor through post purge and runs the blower/fan motor through the selected fan off delay.

Pressure Switch - If the pressure switch opens before the trial for ignition period, the venter motor will run through the pressure switch recognition delay (2 seconds), the gas valve will be de-energized, and the venter motor will run through the postpurge time. The control will re-start the heat cycle at the pressure switch proving state if the call for heat still exists.

Pressure switch opening for less than 2 seconds during the trial for ignition period shall not interrupt the heat cycle. (Gas valve will de-energize while the pressure switch is open.)

If the pressure switch opens after a successful ignition, the control will de-energize the gas valve. If flame is lost before the end of the 2 second pressure switch recognition delay, the control will respond to the loss of flame. If the pressure switch remains open for 2 seconds and the flame remains, the control de-energizes the gas valve, the venter motor runs through post-purge, and the fan/blower motor runs on heat speed through the selected fan off delay. When the fan off delay is over, the fan/blower motor is de-energized, and a heat cycle is begun if the call for heat still exists.

When the thermostat calls for continuous fan (G) without a call for heat, the fan motor is energized after a .25 second delay. NOTE: This brief on delay is to allow the "G" terminal to energize slightly before "Y" and an external changeover relay to switch from "G" to "W" without causing momentary glitches in the fan/blower output. The fan remains energized as long as the call for fan remains without a call for heat.

If a call for heat (W) occurs during continuous fan, the fan/blower will de-energize.

A call for fan is ignored while in lockout.

Continuous Fan Operation

Undesired Flame - If flame is sensed longer than 20 seconds while the gas valve is de-energized, the control shall energize the venter motor and fan/blower motor on heat speed. When flame is no longer sensed, the venter motor will run through postpurge, and the fan/blower motor will run through the selected heat fan off delay time. The control will do a soft lockout, but will still respond to open limit and flame. The FLAME (yellow) LED shall flash rapidly when lockout is due to undesired flame.

Fault Modes

Gas Valve Relay Fault - If the control senses the gas valve as energized for more than one second when the control is not attempting to energize the gas valve, or the gas valve is sensed as not energized when it is supposed to be energized, then the control will lockout with green LED off. The control assumes either the contacts of the relay driving the gas valve have welded shut, or the sensing circuit has failed. The venter motor is forced off to open the pressure switch to stop gas flow unless flame is present.

If the gas valve was sensed as closed when it should be open, and has not de-energized after the venter motor was shutoff for 15 seconds, then the venter motor is re-energized to vent the unburned gas.

Soft Lockout - The control shall not initiate a call for heat or call for continuous fan while in lockout. The control will still respond to an open limit and undesired flame. Lockout shall automatically reset after one hour. Lockout may be manually reset by removing power from the control for more than one second or removing the thermostat call for heat for more than one and less than 20 seconds.

Hard Lockout - If the control detects a fault on the control board, the status LED will be de-energized, and the control will lockout as long as the fault remains. A hard lockout will automatically reset if the hardware fault clears.

Lockout

Power Interruption - During a momentary power interruption or at voltage levels below the minimum operating voltage (line voltage or low voltage) the system will self-recover without lockout when voltage returns to the operating range.

Power interruptions of less than 80mS shall not cause the control to change operating states. Power interruptions greater than 80mS may cause the control to interrupt the current operating cycle and re-start.

9.0 Commissioning and Startup

9.1 Check the installation prior to startup:

☐ Check to be sure that all screws used to hold shipping brackets were re-installed in the heater cabinet.

☐ Check suspension. Unit must be secure and level.

☐ Check clearances from combustibles. Requirements are in Paragraph 4.1.

☐ Check vent system to be sure that it is installed according to the instructions in the appropriate Vent Installation Manual as listed in Paragraph 2.2.

☐ Check piping for leaks and proper gas line pressure. Bleed gas lines of trapped air. See Paragraph 6.1.

☐ Check electrical wiring. Be sure all wire gauges are as recommended. A service disconnect switch should be used. Verify that fusing or circuit breakers are adequate for the load use.

☐ Check polarity. Verify that line voltage exists between the black "L1" and earth ground.

☐ If installed in California, verify that California Warning Label is displayed.

9.2 Heater Startup:

WARNINGS

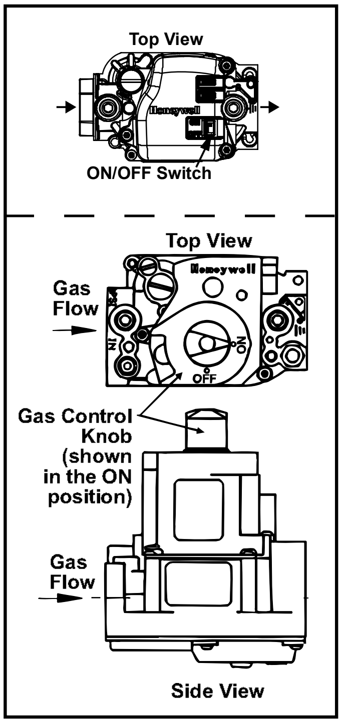
For your safety, read before operating. If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury, or loss of life.

- **This appliance does not have a pilot. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.**
- **Before operating, smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.**

WHAT TO DO IF YOU SMELL GAS
- **Do not try to light any appliance.**
- **Do not touch any electrical switch; do not use any phone in your building.**
- **Leave the building immediately.**
- **Immediately call your gas supplier from a phone remote from the building. Follow the gas supplier's instructions.**
- **If you cannot reach your gas supplier, call your fire department.**

- **Use only your hand to turn the gas control ON/OFF knob on the gas valve. Never use tools. If the valve ON/OFF knob will not turn by hand, do not try to repair it. Call a qualified service technician. Force or attempted repair may result in a fire or explosion.**
- **Should overheating occur, or the gas supply control system fail to shut off the flow of gas, turn off the manual gas valve to the appliance before shutting off the electrical supply.**
- **Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.**

FIGURE 17 - Gas Valve



Operating Sequence

1. Set thermostat at lowest setting.
2. Turn off all electric power to the appliance.
3. This appliance is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand. Open the access door and locate the gas control (ON/OFF) knob or switch on the gas valve. (See **FIGURE 17**.)
4. Turn the gas control switch to "OFF" or the knob clockwise to "OFF".
5. Wait five (5) minutes to clear out any gas. Then smell for gas, including near the floor. **If you smell gas, STOP!** and follow the steps in the **WARNINGS** printed above or on the Operating Label on the heater. If you do not smell gas, proceed to the next step.
6. Turn the gas control switch to "ON" or the knob counterclockwise to "ON".
7. Close the access door.
8. Turn on the electric power to the heater.
9. Set the thermostat to the desired setting.

NOTE: If the appliance does not operate, follow the instructions "To Turn Off Gas to Appliance" printed below (and on the Operating Label on the heater) and call your service technician.

10. Thermostat calls for heat, energizing the venter motor.
11. Venter pressure switch closes, firing the unit.
12. Burner flame is sensed and in 30 seconds after the gas valve is energized, the fan motor is energized.
13. If the flame is extinguished during the main burner operation, the integrated control system closes the main valve and must be reset by interrupting power to the control circuit. (See lighting instructions on the heater.).

TO TURN OFF GAS TO THE APPLIANCE

1) Set thermostat to lowest setting
2) If service is to be performed, turn off all electric power to the appliance.
3) Open the access door.
4) Turn the gas control switch to "OFF" or turn knob clockwise to "OFF" (Do not force).
5) Close the access door.

9.3 Check installation after startup:

☐ Vent System Testing Procedure

The steps below shall be followed with each heater or utility heater connected to the venting system placed in operation while any other appliance(s) connected to the venting system(s) is not in operation.

1. Seal unused openings(s) in the venting system.
2. Inspect the venting system for proper size and horizontal pitch as required in the National Flue Gas Code, ANSI Z223.1/NFPA 54, or the Natural Gas and Propane Installation Code, CSA B149.1, and the venting manual instructions. Verify that there is no blockage or restriction, leakage, corrosion, and/or other deficiencies that could cause an unsafe condition.
3. In so far as is practical, close all doors, windows, other open spaces within the building, and all doors between the space in which the appliance(s) connected to the venting system is located. Turn on clothes dryers and any exhaust fans (such as range hoods and bathroom exhausts) so they operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.
4. Following the lighting instructions, place the utility heater being inspected in operation. Adjust the thermostat so that the utility heater will operate continuously.
5. After it has been determined that each utility heater connected to the venting system properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers, and any other gas-burning appliance to their previous condition of use.
6. If improper venting is observed during any of the above tests, the venting system must be corrected.

9.0 Commissioning and Startup (cont'd)

9.3 Check installation after startup (cont'd)

- ☐ With the unit in operation, measure valve outlet gas pressure. If operated at high altitude, adjust outlet gas pressure for altitude.
  See information and instructions in Paragraph 6.1.
- ☐ Turn the unit off and on, pausing two minutes between each cycle. Observe for smooth ignition.
- ☐ Place the "Literature Bag" containing the Limited Warranty, this booklet, the venting manual, and any control or optional information in an accessible location near the heater.

DANGER

The gas burner in this gas-fired equipment is designed and equipped to provide safe controlled complete combustion. However, if the installation does not permit the burner to receive the proper supply of combustion air, complete combustion may not occur. The result is incomplete combustion which produces carbon monoxide, a poisonous gas that can cause death. Safe operation of indirect-fired gas burning equipment requires a properly operating vent system that vents all flue products to the outside atmosphere. FAILURE TO PROVIDE PROPER VENTING WILL RESULT IN A HEALTH HAZARD WHICH COULD CAUSE SERIOUS PERSONAL INJURY OR DEATH.

Always comply with the combustion air requirements in the installation codes and in Paragraph 6.2. Combustion air at the burner should be regulated only by manufacturer-provided equipment. NEVER RESTRICT OR OTHERWISE ALTER THE SUPPLY OF COMBUSTION AIR TO ANY HEATER. Model UDAP units installed in a confined space must be supplied with air for combustion as required by Code and in Paragraph 6.2 of this heater installation manual. MAINTAIN THE VENT OR VENT/ COMBUSTION AIR SYSTEM IN STRUCTURALLY SOUND AND PROPER OPERATING CONDITION.

10.0 Maintenance and Service

WARNING

If you turn off the power supply, turn off the gas. See Hazard Levels, page 2.

The material contained in the MAINTENANCE AND SERVICE Section of this manual is designed to aid a qualified service person in maintaining and servicing this equipment. This heater will operate with a minimum of maintenance. To ensure long life and satisfactory performance, a heater that is operated under normal conditions should be inspected and cleaned at the start of each heating season. If the heater is operating in an area where an unusual amount of dust or soot or other impurities are present in the air, more frequent maintenance is recommended.

When any service is completed, be careful to reassemble correctly to ensure that no unsafe conditions are created. When re-lighting, always follow the lighting instructions on the heater.

This heater is equipped with a TCORE^{2}® burner.

Inspect the burner/control compartment annually to determine if cleaning is necessary.

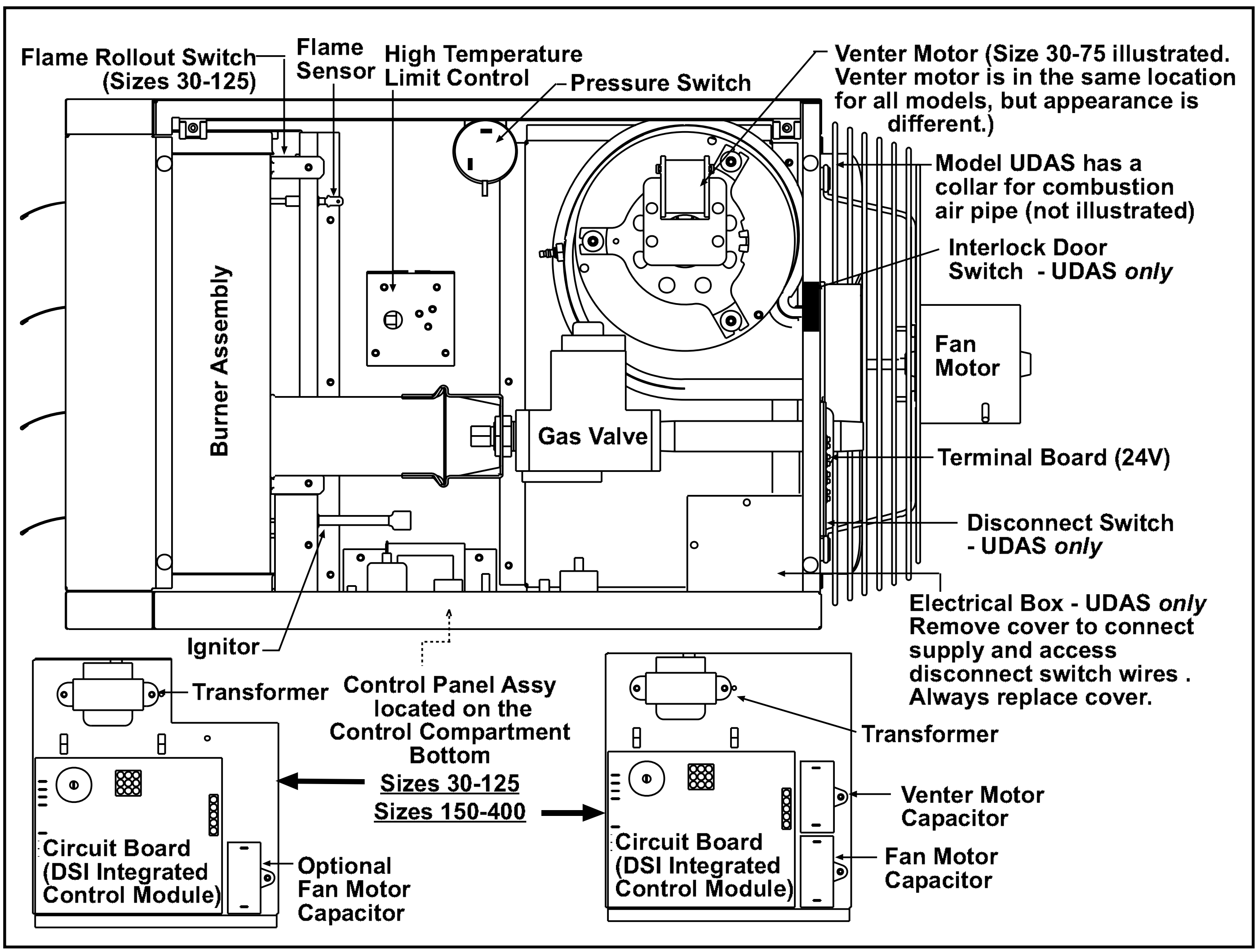
10.1 Maintenance Schedule

Maintenance Schedule - The following procedures should be carried out at least annually (See **FIGURE 18** and Paragraphs 10.2.1 - 10.2.14.):

- **Clean all dirt, lint, and grease from the combustion air opening (UDAP) and venter assembly.**
- **Clean all dirt, lint, and grease from the fan blade, fan guard, and motor.**
- **Check the heat exchanger both internally and externally.**
- **Check the burner for scale, dust, or lint accumulation. Clean if needed.**
- **Check gas valve to ensure that gas flow is being shutoff completely.**
- **Check the vent or vent/combustion air system for soundness. Clean openings. Replace any parts that do not appear sound.**
- **Check the wiring for any damaged wire. Replace damaged wiring. (See Paragraph 7 for replacement wiring requirements.)**

NOTE: If replacement parts are required, use only factory-authorized parts.

FIGURE 18 - Location of Controls



10.2 Maintenance Procedures

10.2.1 Heat Exchanger Maintenance

This heater has a TCORE^{2}® heat exchanger.

Remove any external dirt or dust accumulation. Visually check the heat exchanger for cracks and holes. If a crack or hole is observed, replace the heat exchanger.

NOTE: Inspection of the lower portion of the heat exchanger is done with the burner removed. See the Burner Service section below for information on inspecting the lower portion of the heat exchanger.

10.2.2 Burner Maintenance

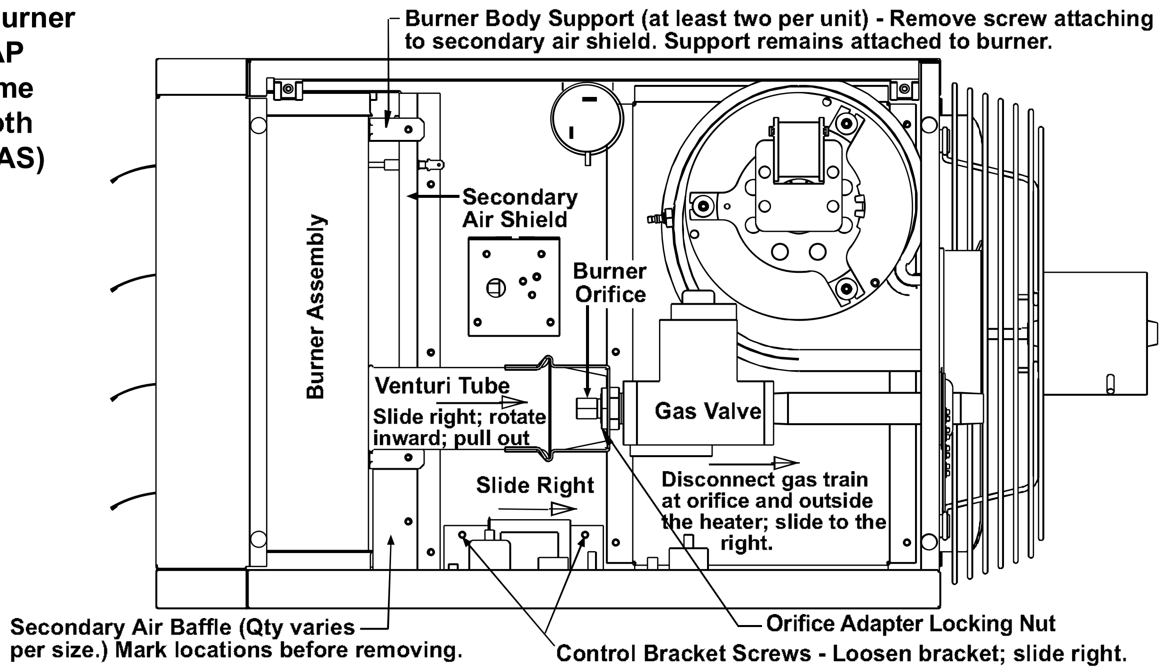
If there is an accumulation of dirt, dust, and/or lint, clean the compartment and follow the instructions below to remove and clean the burner.

CAUTION: Use of eye protection is recommended.

Burner Removal Instructions (Refer to FIGURE 19.)

1. Outside the cabinet, shut the gas supply off at the manual valve ahead of the union.
2. Turn off electric supply.
3. Disconnect the gas supply at the union outside of the cabinet.
4. Remove the access panel.
5. **Disconnect and Move the Gas Train** - At the gas valve, mark and disconnect the wires. Carefully remove the burner orifice and orifice adapter locking nut. Slide the orifice adapter out through the bracket on the burner pushing the gas train to the right. This will move the gas train out of the way.
6. **Move the Control Assembly** - Remove the two screws holding the control assembly bracket. Being careful not to disconnect any wires, slide the control assembly to the right.
7. **Remove Secondary Air Baffles (Sizes 60-400 only)** - Vertical along the right side of the burner, locate the flat plate(s) identified as the secondary air baffle(s). The quantity of baffles could be one to four depending on heater size. Each baffle is held in place by one screw. **For re-assembly, on the secondary air shield, mark the location (top and bottom) of each baffle.** Remove all baffles.
8. **Remove Burner Assembly**
   a) Locate the burner body supports. Depending on the size, the burner will have two or more supports. At each support, remove the one screw that attaches it to the secondary air shield
   b) Holding the venturi tube, slide the entire burner assembly slightly to the right to disengage the burner from the supports on the left. Then rotate the open end of the venturi tube inward toward the heater. Carefully pull the burner assembly out of the cabinet.

FIGURE 19 - Burner Removal (UDAP illustrated; same process for both UDAP and UDAS)



Inspect and Clean the Burner

With the burner assembly removed, shine a flashlight on the burner ribbons. Look for carbon buildup, scale, dust, lint, and/or anything that might restrict flow through the spaces between the burner ribbons. Holding the burner assembly so that any foreign material will fall away from the burner, use a stiff bristle brush to loosen and remove any foreign material(s). If the burner is excessively dirty, remove one of the burner end caps. Remove the four screws that hold the end cap to the burner housing. Lightly tap the end cap to remove it.

Clean all foreign material from the burner and venturi. After the burner is thoroughly clean, replace the end cap making certain that it is tight against the burner housing. **NOTE:** If any of the burner components are damaged or deteriorated, replace the burner assembly.

Inspect the Lower Portion of the Heat Exchanger (with burner assembly removed)

At the burner flame entrance of each tube, shine a bright light into each heat exchanger section. With the light shining into the heat exchanger, observe the outside for visible light. Repeat this procedure with each heat exchanger section. If any light is observed, replace the heat exchanger.

Re-Install the Burner

Instructions to Re-Install the Burner (Refer to FIGURE 19)

1. **Attach the Burner Assembly -** Holding the venturi tube, slide the entire burner assembly into position. Align the supports on the left side with the slots in the burner shield; sliding the supports into the slots. On the right, re-attach each burner body support to the secondary air shield.
2. **Attach the Secondary Air Baffles (Sizes 60-400 only)** - Re-attach the secondary air baffles as marked. Baffles may be different sizes and each **must** be attached in the correct location.
3. **Attach the Control Assembly** - Carefully slide the control assembly into position. Re-attach with the same screws. Check to be sure all wire connections are secure.
4. **Attach the Gas Train** - Slide the gas train so that the orifice adapter is through the bracket. Fasten the gas train to the bracket with the locking nut. Install the gas orifice. Re-connect the wires to the gas valve.
5. Close the access panel.
6. Reconnect the gas supply at the union outside of the cabinet. Leak test the connection with leak detecting solution.
7. Turn on the electric and the gas. Check for proper operation.

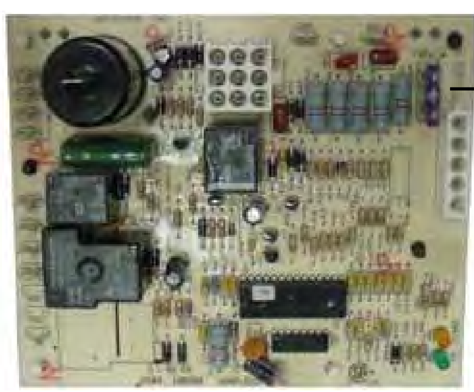
10.2.3 Burner Orifice

Burner orifice usually only needs to be replaced when installing a gas conversion kit. If ordering a replacement orifice only, give BTUH content and specific gravity of gas, as well as the model and serial number of the unit. When removing or replacing the burner orifice, be careful not to damage the venturi tube and/or the bracket.

10.2.4 Ignition System

DSI Integrated Control Module (circuit board) - See **FIGURE 20.** The module monitors the operation of the heater including ignition. The only replaceable component is the 3 amp Type ATC or ATO fuse. If the fuse is blown, the problem is most likely an external overload. Correct the problem and replace the fuse.

FIGURE 20 - DSI Integrated Control Module (Circuit Board)



Only replaceable part is a Type ATC or ATO 3 amp fuse (Color Code Violet), P/N 201685

10.0 Maintenance and Service (cont'd)

10.2 Maintenance Procedures (cont'd)

10.2.4 Ignition System (cont'd)

Do not attempt to disassemble the control module. However, each heating season check the lead wires for insulation deterioration and good connections.

Proper operation of the direct spark ignition system requires a minimum flame signal of 1.0 microamps as measured by a microampmeter.

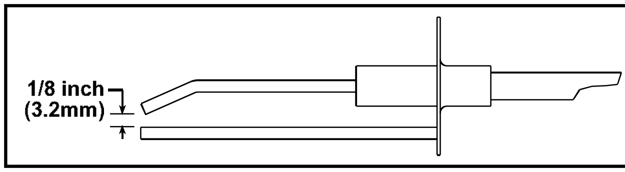
For further information and check out procedure on the direct spark ignition system, refer to Paragraph 8.3 and the Troubleshooting Flow Chart in Paragraph 10.3.

Ignitor

Ignitor - Refer to **FIGURE 18** and locate the ignitor. Disconnect the wire; remove the screw and the ignitor. Clean the ignitor assembly with an emery cloth.

Spark gap must be maintained to 1/8". See **FIGURE 21.**

FIGURE 21 - Ignitor showing required Spark Gap measurement



CAUTION: Due to high voltage on the spark wire and electrode, do not touch when energized. See Hazard Levels, page 2.

Flame Sensor

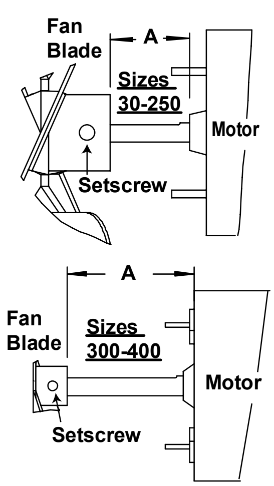
Flame Sensor - Refer to **FIGURE 18** and locate the flame sensor. Disconnect the wire; remove the screw and the flame sensor. Clean with an emery cloth.

10.2.5 Fan Motor, Fan Blades, and Guard

Remove dirt and grease from the motor, the fan guard, and blades. Use care when cleaning the fan blades to prevent causing misalignment or imbalance. Check that the hub of the fan blades is secure to the shaft.

Follow these instructions for replacement of the fan guard, fan motor and/or fan blades.

FIGURE 22 - Fan Blade Position on the Shaft by Unit Size and Type of Fan Guard



UDAP/UDAS Size	A = Fan Spacing				Setscrew Torque (in/lbs ±10)
	Standard Wire Fan Guard with .5" (13mm) Spacing		Option AZ8 Wire Fan Guard with .334" (8.5mm) Spacing		
30	1"	25 mm	1"	25 mm	80
45	9/16"	14 mm	1-1/16"	27 mm	
45-LN	3/4"	19 mm	N/A		
60	1-1/2"	38 mm	1-3/4"	44 mm	
75	2-1/8"	54 mm	1-1/2"	38 mm	
100	2-3/8"	60 mm	2-3/8"	60 mm	120
125	2-5/16"	59 mm	2-1/8"	54 mm	
150	2-3/8"	60 mm	N/A		130
175	2-1/8"	54 mm			
200	1-5/8"	41 mm			
225/250/300	2"	51 mm			
350	1-7/8"	48 mm			
400	1-3/8"	35 mm			

1. If the heater is installed, turn off the gas and disconnect the electric power.
2. Open the access door and disconnect the fan motor wires, capacitor wires at the capacitor, and ground screw.
3. Remove the assembled parts (the fan guard, the motor and the fan blade).
4. Disassemble and replace whatever parts are needed and reassemble using whatever part(s) are being replaced and the original parts.

   Be sure the fan blade is in the proper position on the shaft; refer to the illustration and table in **FIGURE 22.**

   Position the assembly on the heater. Attach the fan guard.

   Rotate the fan blade to check for adequate clearance. If adjustment is required, loosen the mounting screws, re-position the fan guard, and tighten the screws. Rotate the fan blade and re-check for adequate clearance. Repeat this procedure until the assembly is positioned properly.

5. Reconnect the fan motor wires according to the wiring diagram and close the access panel.
6. Restore power to the heater and turn on the gas. Light, following the instructions on the lighting instruction plate. Check for proper operation.

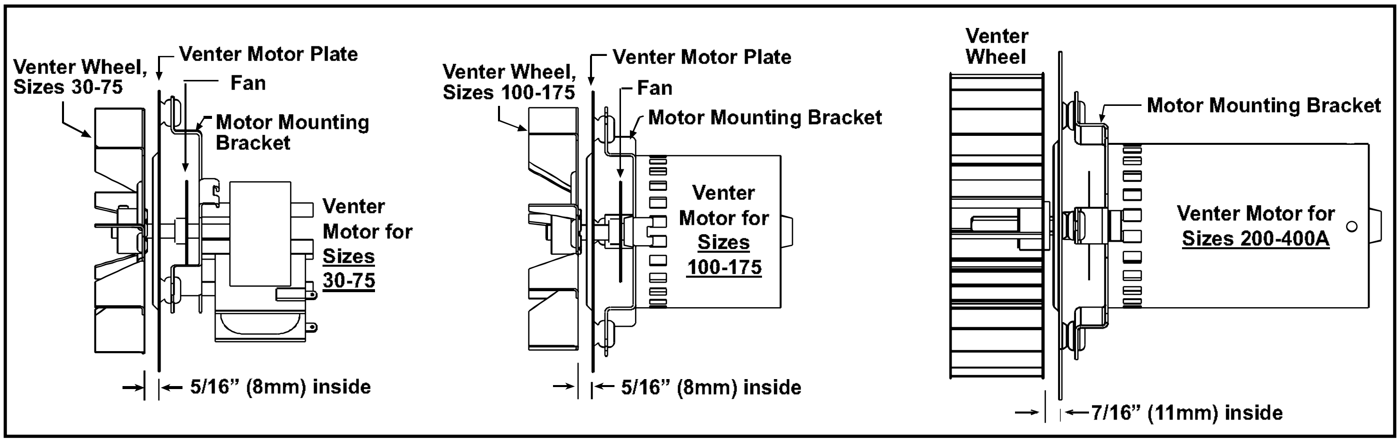
10.2.6 Venter Motor and Wheel

Replacement Instructions

Remove dirt and grease from the motor casing, the venter housing, and the venter wheel. Venter motor bearings are permanently lubricated. Follow these instructions for replacement of the venter motor and wheel assembly. Keep all hardware removed to be used in re-assembling and installing the replacement parts.

1. Turn off the gas and disconnect the electric power.
2. Open the burner/control compartment access panel.
3. Disconnect the three venter motor wires at the DSI control, capacitor wires at the capacitor (if applicable), and ground screw (located on the control panel).
4. Sizes 30 and 45 - Disconnect the gas train and move it out of the way. Disconnect the gas supply at the union outside of the cabinet. At the gas valve, mark and disconnect the wires. Carefully remove the burner orifice and orifice adapter locking nut. Slide the orifice adapter out through the bracket on the burner pushing the gas train to the right. This will move the gas train out of the way.
5. Holding the venter motor, remove the three or four screws that attach the venter motor mounting plate to the venter housing. Remove the motor and wheel assembly from the heater.
6. Re-assemble with the replacement venter motor and wheel assembly. See **FIGURE 23**.

FIGURE 23 - Venter Wheel Position on Shaft



7. Follow the wiring diagram to connect the venter wires.
8. Sizes 30 and 45 - Reconnect the gas supply at the union outside of the cabinet. Leak test the connection with leak detecting solution.
9. Replace the access panel. Restore power to the heater and turn on the gas. Light, following the instructions on the lighting instruction plate. Check for proper operation.

10.2.7 Operating Gas Valve

Carefully remove external dirt accumulation and check wiring connections.

WARNING

The operating valve is the prime safety shutoff. All gas supply lines must be free of dirt or scale before connecting to the unit to ensure positive closure. See Hazard Levels, page 2.

The combination gas valve must be checked annually to ensure that the valve is shutting off gas flow completely.

<u>**Instructions**</u>:

1) Locate the 1/8" NPT pressure tap on the combination valve. (See **FIGURE 24**, page 34.

10.0 Maintenance and Service (cont'd)

10.2 Maintenance Procedures (cont'd)

10.2.7 Operating Gas Valve (cont'd)

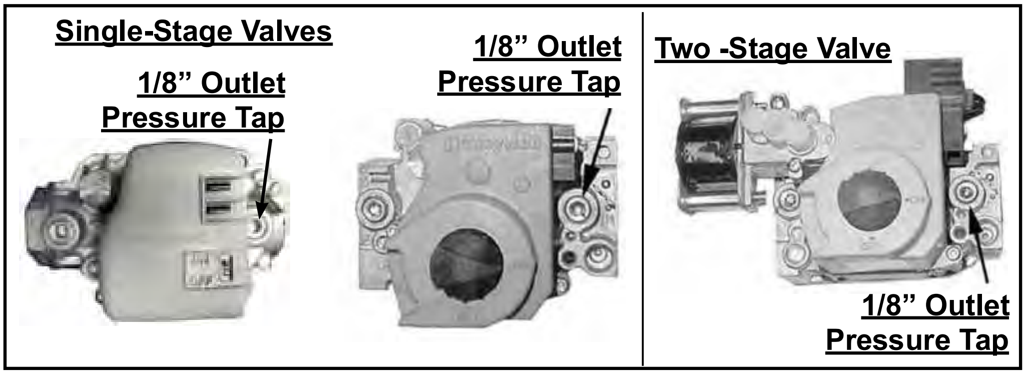


FIGURE 24 - Pressure Tap for Checking Gas Flow Shutoff

NOTE: Operational pressure settings and instructions for checking pressure settings are in Paragraph 6.1.

2) With the manual valve turned off to prevent flow to the gas valve, connect a manometer to the 1/8" outlet pressure tap in the valve. NOTE: A manometer (fluid-filled gauge) is recommended.
3) Turn the manual valve to the ON position and the heater OFF. Use your finger to fully block the main burner orifice for several seconds. Observe the manometer with the orifice blocked, and if any pressure is indicated, the gas valve is leaking. **A leaking gas valve must be replaced before the heater is put back in operation.**

10.2.8 Combustion Air Pressure Switch

See **FIGURE 18**, page 30, for location. (NOTE: Depending on date of manufacture and size, pressure switch may not be in the location indicated. Check the control bracket on the bottom of the compartment or further down on the compartment wall.) If it is determined that the pressure switch needs replacing, use only the factory-authorized replacement part that is designed for the model and size of heater being serviced.

NOTE: A unit operating above 6000 ft (1830M) elevation requires a high altitude pressure switch. See Paragraph 3.2.

10.2.9 Limit Control

If it is determined that the limit control needs replacing, use only a factory-authorized replacement part that is designed for the size of heater.

For approximate limit location, see **FIGURE 18**, page 30.

10.2.10 Flame Rollout Switch - Sizes 30-125 only

For location, see FIGURE 18, page 30.

The cause of a flame rollout switch activating must be determined. Activation of the manually reset flame rollout switch could be caused by one or more of the following:

- Restricted or plugged heat exchanger
- Too much building exhaust
- Manifold gas pressure too high
- Restricted combustion air inlet or exhaust outlet in combination with a defective pressure switch
- Electrical power interruption during operation
- Unit being operated with a line voltage disconnect (a 24-volt thermostat is required)

If a flame rollout switch trips, inspect the burner/control compartment for signs of excessive heat and burned wiring.

If the compartment appears normal, reset by depressing the red button on the switch. 15 to 20 minutes are required for the switch to cool sufficiently for resetting. A distinct click will be felt when the switch resets. Operate the furnace. If the flame rollout switch trips again, determine and correct the cause before resetting the switch.

If there is damage to the control compartment, repairs must be made before resetting the switch.

If it is determined that the flame rollout switch needs replacing, use only the factory-authorized replacement part that is designed for that size of heater.

The disconnect switch is located in the sealed electrical box inside the control compartment with the toggle on the rear of the heater.

10.2.11. Door Switch - UDAS only

If it is determined that the door switch needs replacing, use only a factory-authorized replacement part that is designed for the heater.

For approximate switch location, see **FIGURE 18**, page 30.

10.2.12 Transformer

See **FIGURE 18**, page 30, for location. Use a voltmeter to verify that there are 24 volts output from the transformer. If the transformer is not functioning, it must be replaced. Use a replacement transformer identical to the factory-installed model.

10.2.13 Disconnect Switch - UDAS only

If it is determined that the disconnect switch needs replacing, use only the factory-authorized replacement part that is designed for the heater. Always replace electrical box cover.

10.2.14 Vent or Vent/ Combustion Air System

Check the complete system at least once a year. Inspection should include all joints, seams, concentric adapter box (UDAS), inlet air guard or inlet air cap (UDAS), and the vent terminal cap. Clean openings. Replace any defective parts.

10.3 Troubleshooting

Check the Lights on the DSI Integrated Control Module (Circuit Board)

IMPORTANT: When using a multimeter to troubleshoot the 24 volt circuit, place the meter's test leads into the 5 or 9 pin connectors located on the ignition control. Do not remove connectors or terminals from the electrical components. Doing so can result in misinterpreted readings due to the ignition control board's fault mode monitoring circuits.

The integrated circuit board monitors the operation of the heater and includes two LED signal lights that indicate normal operation and various abnormal conditions. If the heater fails to operate properly, check this signal to determine the cause and/or to eliminate certain causes. LED is visible through viewport on Model UDAS. Remove access panel on Model UDAP. See operating sequence in Paragraph 9.

Do not attempt to repair the DSI integrated control module (circuit board); the only field replaceable component is the fuse.

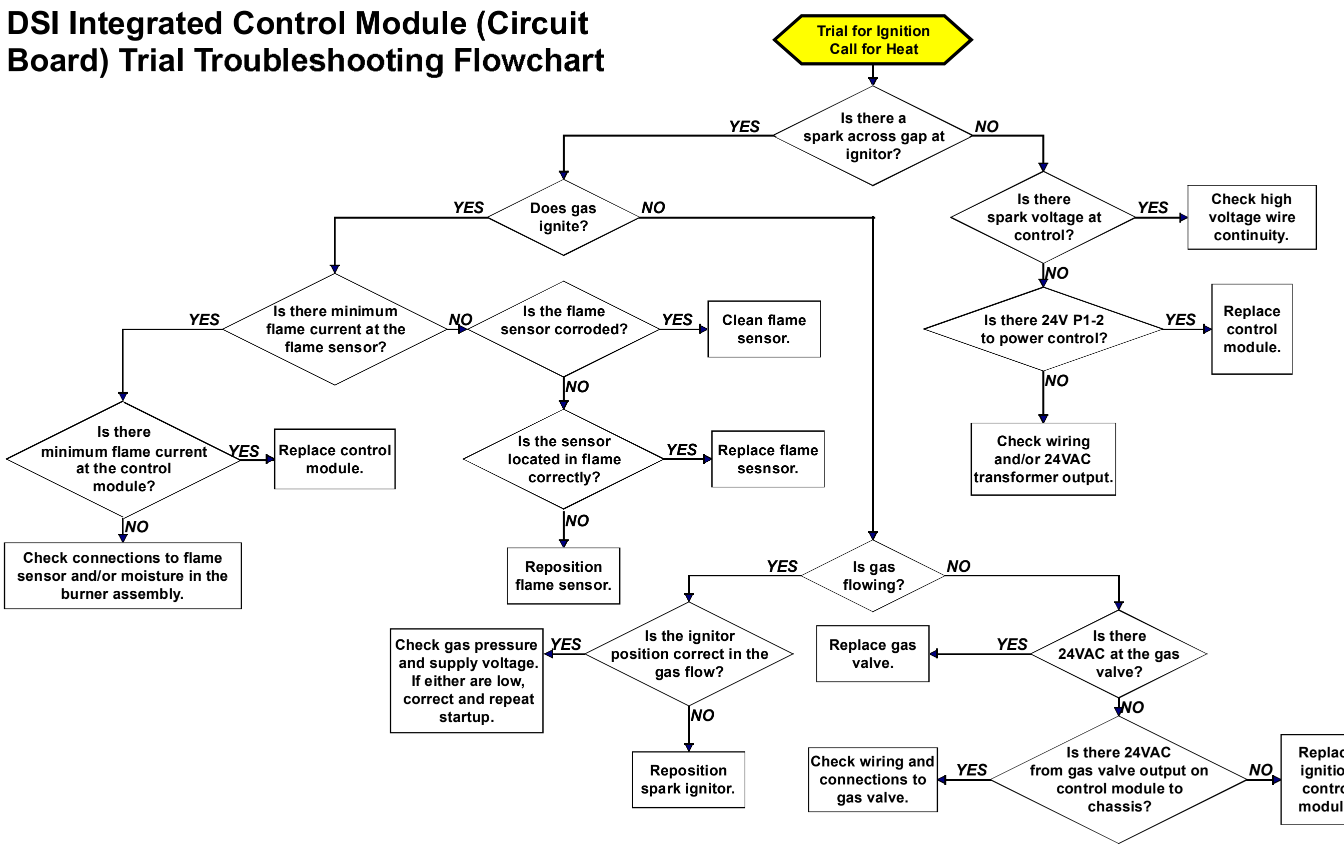
Control Status - Green LED Codes

Steady ON Normal Operation, No call for heat
Fast Flash . Normal Operation, Call for heat
1 Flash ...... System Lockout, Failed to detect or sustain flame
2 Flashes .. Pressure Switch Did Not Close within 30 Seconds of Venter Motor
3 Flashes .. High Limit or Flame Rollout Switch Open
4 Flashes ....Pressure Switch is Closed Before Venter Motor is Energized
Steady OFF Blown fuse, No Power, or Defective Board

Flame Status - Yellow LED Codes

Steady ON ..Flame is sensed
Slow Flash ..Weak flame (current below 1.0 microamps ± 50%)
Fast Flash ...Undesired Flame (valve open and no call for heat)

DSI Integrated Control Module (Circuit Board) Trial Troubleshooting Flowchart



10.3 Troubleshooting (cont'd)

General Troubleshooting

PROBLEM	PROBABLE CAUSE	REMEDY
Venter motor will not start	**1.** No power to unit.	**1.** Turn on power, check supply fuses or circuit breaker.
	2. No 24 volt power to integrated circuit board.	**2.** Turn up thermostat; check control transformer output.
	3. Integrated circuit board fuse blown.	**3.** Correct cause. Replace fuse (type ATC or ATO, 32VDC, 3A).
	4. No power to venter motor.	**4.** Tighten connections at circuit board and/or motor terminals.
	5. Integrated circuit board defective.	**5.** Replace integrated circuit board.
	6. Defective venter motor.	**6.** Replace venter motor. See Paragraph 29.
Burner will not light	**1.** Manual valve not open.	**1.** Open manual valve.
	2. Air in the gas line.	**2.** Bleed gas line (initial startup only).
	3. Gas pressure too high or too low.	**3.** Supply pressure should be 5" - 14" w.c. for natural gas or 11" - 14" w.c. for propane.
	4. No Spark: a) Loose wire connections b) Transformer failure.: c) Incorrect spark gap. d) Spark cable shorted to ground. e) Spark electrode shorted to ground. f) Burner not grounded. g) Circuit board not grounded. h) Unit not properly grounded. i) Integrated circuit board fuse blown. j) Faulty integrated circuit board.	**4.** a) Be certain all wire connections are solid. b) Be sure 24 volts is available. c) Maintain spark gap at 1/8". d) Replace worn or grounded spark cable. e) Replace if ceramic spark electrode is cracked or grounded. f) Make certain integrated circuit board is grounded (Terminal P1-9). g) Make certain integrated circuit board is grounded to furnace chassis. h) Make certain unit is properly field grounded to earth ground and properly phased (L1 to hot lead L2 to neutral). i) Correct cause. Replace fuse (type ATC or ATO, 32VDC, 3A). j) If 24 volt is available to the integrated circuit board and all other causes have been eliminated, replace board.
	5. Lockout device interrupting control circuit by above causes.	**5.** Reset lockout by interrupting control at the thermostat or main power.
	6. Combustion air proving switch not closing.	**6.** a) Make sure unit is **properly vented.** b) Remove obstructions from vent. c) Replace faulty tubing to pressure switch.
	7. Faulty combustion air proving switch.	**7.** Replace combustion air proving switch.
	8. Main valve not operating. a) Defective valve. b) Loose wire connections	**8.** a) If 24 volt is measured at the valve connections and valve remains closed, replace valve. b) Check and tighten all wiring connections.
	9. Integrated circuit board does not power main valve. a) Loose wire connections. b) Flame sensor grounded. c) Incorrect gas pressure. d) Cracked ceramic at sensor.	**9.** a) Check and tighten all wiring connections. b) Be certain flame sensor lead is not grounded or insulation or ceramic is not cracked. Replace as required. c) Supply pressure should be 5" - 14" w.c. for natural gas or 11" - 14" w.c. for propane. d) Replace sensor.
Burner cycle on and off	**1.** Gas pressure too high or too low.	**1.** Supply pressure should be 5" - 14" w.c. for natural gas or 11" - 14" w.c. for propane.
	2. Burner not grounded	**2.** Make certain integrated circuit board is grounded (Terminal P1-9).
	3. Circuit board not grounded.	**3.** Make certain integrated circuit board is grounded to furnace chassis.
	4. Faulty integrated circuit board	**4.** If 24 volt is available to the integrated circuit board and all other causes have been eliminated, replace board.
	5. Combustion air proving switch not closing.	**5.** a) Make sure unit is properly vented. b) Remove obstructions from vent. c) Replace faulty tubing to pressure switch.
	6. Faulty combustion air proving switch.	**6.** Replace combustion air proving switch.
	7. Flame sensor grounded.	**7.** Be certain flame sensor lead is not grounded or insulation or ceramic is not cracked. Replace as required.
	8. Cracked ceramic at sensor.	**8.** Replace sensor.
	9. Incorrect polarity.	**9.** Reverse line volt leads to integrated circuit board.
	10. Pin terminal loose on 9 pin plug.	**10.** Replace wire harness.

No heat (Heater Operating)	**1.** Incorrect valve outlet pressure or orifice.	**1.** Check valve outlet pressure. See Rating plate for manifold pressure.
	2. Cycling on limit control.	**2.** Check air throughput.
	3. Improper thermostat location or adjustment.	**3.** See thermostat manufacturer's instructions.
Fan or venter motor will not run	**1.** Circuit open.	**1.** Check wiring and connections.
	2. Defective integrated circuit board.	**2.** Replace board.
	3. Defective motor or starter.	**3.** Replace motor or starter.
Fan or venter motor turns on and off while burner is operating	**1.** Motor overload device cycling on and off.	**1.** Check motor load against motor rating plate. Replace motor if needed.
Fan or venter motor cuts out on overload	**1.** Low or high voltage supply.	**1.** Correct electric supply.
	2. Defective motor.	**2.** Replace motor.
	3. Poor airflow.	**3.** Clean motor, fan, fan guard, filter, and coils

APPENDIX

TECHNICAL DATA - Sizes 30 - 125 (Data applies to both Models UDAP and UDAS unless noted otherwise.)

Size		**30**	**45**	**60**	**75**	**100**	**125**
Input Heating Capacity	BTUH	30,000	45,000	60,000	75,000	105,000	120,000
	kw	8.8	13.2	17.6	22.0	30.8	35.2
Thermal Efficiency (%)		82	83	83	83	83	83
Output Heating Capacity [A]	BTUH	24,600	37,350	49,800	62,250	87,150	99,600
	kw	7.2	11.0	14.6	18.3	25.6	29.2
Gas Connection (inches) [B]	Natural	1/2	1/2	1/2	1/2	1/2	1/2
	Propane	1/2	1/2	1/2	1/2	1/2	1/2
Vent Connection [C] (inches diameter)		4	4	4	4	4	4
Combustion Air Inlet [C] (inches diameter) - **UDAS only**		4	4	4	4	4	4
Control Amps (24 volt)		1.0	1.0	1.0	1.0	1.0	1.0
Full Load Amps (115 volt)		1.9	2.4	2.4	3.3	3.9	5.1
Maximum Over Current Protection [D E]	Standard 115V	15	15	15	15	15	15
	Optional 208V or 230V	15	15	15	15	15	15
Normal Power Consumption (watts)		109	155	155	217	276	354
Discharge Air Temperature Rise (°F)		50	55	60	60	60	60
Air Volume	CFM	456	629	769	961	1345	1537
	M^3/minute	12.9	17.8	21.8	27.5	36.7	45.9
Discharge Air Opening Area	ft^2	1.0	1.0	1.2	1.2	2.0	2.0
	M^2	0.1	0.1	0.1	0.1	0.2	0.2
Output Velocity	FPM	475	656	616	770	668	763
	M/minute	145	200	188	238	196	245
Fan Motor HP [E]	Standard Open	0.0	0.0	0.0	0.1	1/30	1/20
	Optional Enclosed	N.A.	N.A.	N.A.	N.A.	1/4	1/4
Fan Motor RPM		1550	1550	1550	1550	1050	1050
Fan Diameter (inches)		10	10	12	12	16	16
Sound Level	dba @ 15 ft	40	40	40	49	54	55

TECHNICAL DATA - Sizes 150 - 400 (Data applies to both Models UDAP and UDAS unless noted otherwise.)

Size		**150**	**175**	**200**	**225**	**250**	**300**	**350**	**400**
Input Heating Capacity	BTUH	150,000	175,000	200,000	225,000	250,000	300,000	350,000	400,000
	kw	43.9	51.2	58.6	65.9	73.2	87.8	102.5	117.1
Thermal Efficiency (%)		83	83	83	83	83	83	83	83
Output Heating Capacity [A]	BTUH	124,500	145,250	166,000	186,750	207,500	249,000	290,500	332,000
	kw	36.4	42.5	48.6	54.7	60.8	72.9	85.1	97.2
Gas Connection (inches) [B]	Natural	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4
	Propane	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4
Vent Connection [C] (inches diameter)		5	5	5	5	5	6	6	6
Combustion Air Inlet [C] (inches diameter) - **UDAS only**		6	6	6	6	6	6	6	6
Control Amps (24 volt)		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Full Load Amps (115 volt)		3.8	3.8	4.6	7.5	7.5	10.7	10.7	10.7
Maximum Over Current Protection [D E]	Standard 115V	15	15	15	15	15	20	20	20
	Optional 208V or 230V	15	15	15	15	15	15	15	15
Normal Power Consumption (watts)		392	392	491	747	747	1086	1086	1086
Discharge Air Temperature Rise (°F)		60	60	60	60	60	60	60	60
Air Volume	CFM	1921	2242	2562	2882	3202	3843	4483	5123
	M^3/minute	54.4	63.5	72.5	81.6	90.7	108.8	126.9	145.1
Discharge Air Opening Area	ft^2	2.6	2.6	2.6	3.5	3.5	4.8	4.8	4.8
	M^2	0.2	0.2	0.2	0.3	0.3	0.5	0.5	0.5
Output Velocity	FPM	752	877	1003	820	911	802	936	1069
	M/minute	229	267	306	250	278	244	285	326
Fan Motor HP [E]	Standard Open	1/6	1/6	1/6	1/4	1/4	1/2	1/2	1/2
	Optional Enclosed	1/4	1/4	1/4	1/4	1/4	1/2	1/2	1/2
Fan Motor RPM		1050	1050	1050	1050	1050	1050	1050	1050
Fan Diameter (inches)		18	18	18	20	20	24	24	24
Sound Level	dba @ 15 ft	51	52	53	56	56	59	61	62

[A] CSA ratings for altitudes to 2000 ft.
[B] Size shown is for gas connection to a single-stage gas valve, not supply line size.
[C] Smaller and/or larger vent and combustion air pipe diameters may be permissible. For Model UDAS refer to the Venting Installation Manual for Separated Combustion Units. For Model UDAP refer to the Venting Installation Manual for Power Vented units. For a Model UDAP with Option AV6, refer to the Venting Installation Manual for Common Venting.
[D] MOCP = 2.25 x (largest motor FLA) + smallest motor FLA. Answer is rounded to the next lower standard circuit breaker size.
[E] Except where indicated, information in this table is based on a heater equipped with a standard 115 volt open fan motor.

INDEX

INSTALLATION RECORD - to be completed by the installer:

Installer:

Name ____

Company ____

Address ____

____

____

Phone ______________________________

Distributor (company from which the unit was purchased):

Company ____

Contact ____

Address ____

____

____

Phone ______________________________

Model ______________ Serial No.__________________________Date of Installation __________

SPECIFIC INSTALLATION NOTES: (i.e. Location, Amps, Gas Pressure, Temperature, Voltage, Adjustments, Warranty, etc.)

____

____

____

____

____

BUILDING OWNER OR MAINTENANCE PERSONNEL:

For service or repair

- Contact the installer listed above.
- If you need additional assistance, contact the Reznor® Distributor listed above.
- For more information, contact your Reznor® Representative by calling 1-800-695-1901.

Thomas & Betts Corporation
150 McKinley Avenue
Mercer, PA 16137

www.RezSpec.com
(800) 695-1901

02/13 (Serial No. Date Code BMB) Form I-UDA (Version B.4)

Thomas&Betts

JOB RECORD
JOB WO 84487
INSTALLATION DATE 2/24/2014
CONTRACTOR PORCO ENERGY CORP
REZNOR® DISTRIBUTOR

Form W (Version H)
Obsoletes W (Version G)

WARRANTY

Applies to: **Reznor® Products**

REZNOR® PRODUCT LIMITED WARRANTY

Thomas & Betts Corporation warrants to the original owner-user that this Reznor product will be free from defects in material and workmanship. This warranty is limited to twelve (12) months from the date of original installation, whether or not actual use begins on that date, or eighteen (18) months from date of shipment by Thomas & Betts Corporation, whichever occurs first.

EXTENDED WARRANTY

(Limited to the following Models, Components, and Applications. See Application NOTE below.)

Model ZQYRA — Extended one (1)-year, non-prorated warranty on all parts.

Models F and B — Extended nine (9)-year, non-prorated warranty on the heat exchanger, burners, draft hood, and flue baffle assembly. Extended four (4)-year, non-prorated warranty on all electrical and mechanical operating components (with the exception of blower belts on Model B).

Models UDAP, UDAS, UDBP, UDBS, and UEAS — Extended nine (9)-year, non-prorated warranty on the heat exchanger, burner, and flue collection box assembly. Extended four (4)-year, non-prorated warranty on all electrical and mechanical operating components (with the exception of blower belts on Models UDBP and UDBS).

Model CAUA — Extended nine (9)-year, non-prorated warranty on the heat exchanger and burners. Extended four (4)-year, non-prorated warranty on all electrical and mechanical operating components (with the exception of blower belts).

Model VR — Extended nine (9)-year, non-prorated warranty on all tubes. Extended four (4)-year, non-prorated warranty on the burner and all electrical and mechanical operating components.

Model OH — Extended four (4)-year, non-prorated warranty on the heat exchanger and combustion chamber.

Models AEB and PCD — Extended four (4)-year, non-prorated warranty on standard stainless steel primary and secondary heat exchangers.

Application NOTE: Extended warranty on electrical and mechanical operating components does not apply to any Reznor® HVAC equipment installed in highly humid environments such as greenhouses.

OPTIONAL PURCHASED EXTENDED WARRANTY

(Purchased with and limited to the following Models and Components.)

Model ZQYRA — **Option XW9** - Extended three (3) years for a total five-year, non-prorated warranty on all parts. — **Option XW10** - Extended eight (8) years for a total ten-year, non-prorated warranty on all parts.

Models SDH, PDH, RDH, SHH with AC2, RDCB, RDDB, RDCC, RDDC, RPB, RPBL, SCE, SSCBL — **Option XW2** - Extended four (4) years for a total five-year, non-prorated warranty on the heat exchanger. — **Option XW3** - Extended nine (9) years for a total ten-year, non-prorated warranty on the heat exchanger.

Models RCB, RDB, RDCB, RDDB, RECB, REDB, RCC, RDC, RDCC, RDDC, RECC, REDC, MASA — **Option XW1** - Extended four (4) years for a total five-year, non-prorated warranty on compressors.

Models PEH, REH, RECB, REDB, RECC, REDC — **Option XW4** - Extended four (4) years for a total five-year, non-prorated warranty on electric furnace.

LIMITATIONS AND EXCLUSIONS

Thomas & Betts Corporation's obligations under this warranty and the sole remedy for its breach are limited to repair, at its manufacturing facility, of any part or parts of its Reznor products which prove to be defective; or, in its sole discretion, replacement of such products. All returns of defective parts or products must include the product model number and serial number, and must be made through an authorized Reznor distributor or arranged through Reznor Customer Service. Authorized returns must be shipped prepaid. Repaired or replacement parts will be shipped by Thomas & Betts, F.O.B. shipping point.

1. The warranty provided herein does not cover charges for labor or other costs incurred in the troubleshooting, repair, removal, installation, service or handling of parts or complete products.
   EXCEPTION: **Model WS** — If heat exchanger leaks or other failure occurs within the warranty period, Thomas & Betts will pay up to $50 for qualified contractor to make necessary repairs. If the heat exchanger cannot be repaired, Thomas & Betts will exchange the defective unit for a new hydronic heater.
2. All claims under the warranty provided herein must be made within ninety (90) days from the date of discovery of the defect. Failure to notify Thomas & Betts of a warranted defect within ninety (90) days of its discovery voids Thomas & Betts's obligation hereunder.
3. The warranty provided herein shall be void and of no effect in the event that (a) the product has been operated outside its designed output capacity (heating, cooling, airflow); (b) the product has been subjected to misuse, neglect, accident, improper or inadequate maintenance, corrosive environments, environments containing airborne contaminants (silicone, aluminum oxide, etc.), or excessive thermal shock; (c) unauthorized modifications are made to the product; (d) the product is not installed or operated in compliance with the manufacturer's printed instructions; (e) the product is not installed and operated in compliance with applicable building, mechanical, plumbing and electrical codes; or (f) the serial number of the product has been altered, defaced, or removed.
4. The warranty provided herein is for repair or replacement only. Thomas & Betts Corporation shall not be liable for any loss, cost, damage, or expense of any kind arising out of a breach of the warranty. Further, Thomas & Betts Corporation shall not be liable for any incidental, consequential, exemplary, special, or punitive damages, nor for any loss of revenue, profit or use, arising out of a breach of this warranty or in connection with the sale, maintenance, use, operation, or repair of any Reznor product. In no event will Thomas & Betts be liable for any amount greater than the purchase price of a defective product. The disclaimers of liability included in this paragraph 4 shall remain in effect and shall continue to be enforceable in the event that any remedy herein shall fail of its essential purpose.
5. THIS WARRANTY IS THE SOLE AND EXCLUSIVE WARRANTY FOR REZNOR PRODUCTS, AND IS IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES. THOMAS & BETTS CORPORATION SPECIFICALLY DISCLAIMS ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. No person or entity is authorized to bind Thomas & Betts Corporation to any other warranty, obligation, or liability for any Reznor product. Installation, operation, or use of the Reznor product for which this warranty is issued shall constitute acceptance of the terms hereof.

Thomas&Betts

REZNOR®

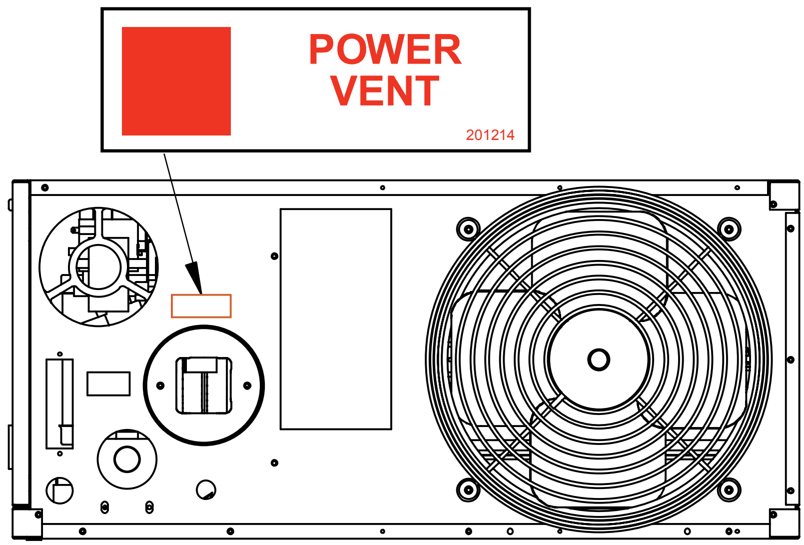
APPLIES TO:

Venting Requirements for Indoor, Power Vent Model UDAP and Model UDBP

General

This manual applies only to venting instructions and must be used with the installation manual. Both manuals are shipped with the heater. If either manual is missing, contact your distributor before beginning installation. The instructions in this manual apply to fan type Model UDAP and blower type Model UDBP.

Verify that the label near the vent outlet on the heater matches the label illustrated below. (Label P/N is 201214; color is red.)



Rear View - Model UDAP

WARNING

Installation should be done by a qualified agency in accordance with these instructions. The qualified service agency installing this heater is responsible for the installation.

WARNING

Each heater requires its own individual vent pipe run and vent cap. Manifolding of vent runs can cause recirculation of combustion products into the building. Failure to comply could result in severe personal injury or death and/or property damage.

CAUTION: Model UDAP and UDBP unit heaters should not be used in an application where the heated space temperature is below 50°F (10°C). Operating under low ambient conditions may cause condensate to form in the heat exchanger.

Table of Contents

1.0 Venting Requirements

Model UDAP and UDBP heaters are certified as Category III heaters.

Venting must be in accordance with local codes and the National Fuel Gas Code Z223.1 or CAN/CSA B149.1 and B149.2, Installation Code for Gas Burning Appliances and Equipment. Local requirements supersede national requirements.

These power-vented unit heaters are designed to operate safely and efficiently with either a horizontal or vertical vent. Comply with the specific requirements and instructions.

When an existing appliance is removed or replaced in a venting system, verify that the venting system is properly sized to vent the new appliance. An improperly sized venting system may result in the formation of condensate, leakage, and/or spillage.

Do not vent into an existing gravity vent or chimney.

Installation should be done by a qualified agency in accordance with these instructions. The qualified service agency installing this system is responsible for the installation.

Requirements and instructions vary depending on whether the installation is residential or commercial/industrial. Select and follow the venting instructions that apply to the installation only. All sizes of Model UDAP and Model UDBP unit heaters are certified for commercial/industrial installation. Model UDAP Sizes 30, 45, 60, 75, 100, and 125 are also certified for residential installation. Utility heaters certified for "residential use" are intended for heating of non-living spaces that are attached to, or part of, a structure that contains space for family living quarters. They are not intended to be the primary source of heat in residential applications or to be used in sleeping quarters.

Is the Installation Residential or Commercial/Industrial?

Select and follow the venting instructions that apply. **Do not mix** any instructions or requirements.

- **Paragraph 2.0, <u>Residential Installation Venting Requirements and Instructions</u> (begins on page 3)**
- **Paragraph 3.0, <u>Commercial/Industrial Installation Venting Requirements and Instructions</u> (begins on page 6)**

Residential Installation
Only Model UDAP 30, 45, 60, 75, 100, 125

2.0 Venting Requirements and Instructions - Residential Installation

A Category III vent as defined by the National Fuel Gas Code Z223.1 or CAN/CSA B149.1 and B149.2 is required for a residential installation of a Model UDAP. Some venting requirements will vary, however, depending on whether the vent is horizontal or vertical.

Read and follow all of the requirements and instructions in Paragraphs 2.1 through 2.7.

2.1 Type of Vent Pipe Required for Vent Run

Type of Pipe for Standard Horizontal Vent (Category III)

- Vent pipe approved to UL Std 1738 for Category III appliance.

Type of Pipe for Standard Vertical Vent (Category III)

- Vent pipe approved to UL Std 1738 for Category III appliance.

2.2 Vent Pipe Diameter and Vent Length

Vent pipe diameters and maximum vent lengths are shown in **TABLE 1**. Minimum vent length is 3 feet (1M). Add all straight sections and equivalent lengths for elbows. The total must not exceed the Maximum Vent Length listed. Use only one diameter of vent pipe on an installation.

TABLE 1 - Vent Pipe Diameter and Maximum Vent Length for a Heater with either a Horizontal or Vertical Vent

UDAP Size	Vent Pipe Diameter		Maximum Vent Length		Equivalent Straight Length for 90° Elbow		Equivalent Straight Length for 45° Elbow		Field-supplied taper type reducer required at the venter outlet
	inches	mm	feet	M	feet	M	feet	M	
30	3	76	20	6.1	3	0.9	1.5	0.5	4” to 3” (102mm to 76mm)
	4	102	10	3.0	2	0.6	1	0.3	None
45	3	76	20	6.1	3	0.9	1.5	0.5	4” to 3” (102mm to 76mm)
	4	102	10	3.0	2	0.6	1	0.3	None
60	3	76	30	9.1	4	1.2	2	0.6	4” to 3” (102mm to 76mm)
	4	102	15	4.6	2	0.6	1	0.3	None
75	4	102	30	9.1	4	1.2	2	0.6	None
100	4	102	40	12.2	5	1.5	2.5	0.8	None
125	4	102	40	12.2	5	1.5	2.5	0.8	None

2.3 Venter (Flue) Outlet Diameter

Depending on the size of vent pipe (either 3 or 4 inch) as determined in Paragraph 2.2, attach a 4” appliance adapter from Category III pipe manufacturer directly to the collar, then use a reducer if using 3” pipe.

TABLE 2 - Venter Outlet Diameter	UDAP	30		45		60		75		100		125	
	Outlet Diameter	inches	mm	inches	mm	inches	mm	inches	mm	inches	mm	inches	mm
		4	102	4	102	4	102	4	102	4	102	4	102

2.4 Vent System Sealing

Follow the Category III pipe manufacturer’s instructions for joining pipe sections. When attaching Category III pipe to the venter outlet or the vent cap, make secure, sealed joints following a procedure that best suits the style of Category III pipe being used.

2.0 Venting Requirements and Instructions - Residential Installation (cont'd)

2.5 Vent System Support

Support horizontal runs every six feet (1.8M). Support vertical runs of Category III vent pipe in accordance with the requirements of the pipe manufacturer.
Do not rely on the heater for support of either horizontal or vertical pipes. Use non-combustible supports on vent pipe.

2.6 Condensation

On units with long vent runs (over 50% of maximum vent length allowed) or installed in low ambient conditions (below 50°F), it is recommended that vent pipes be fitted with a tee, a drip leg, and a clean out cap to prevent any moisture in the vent pipe from entering the unit. The drip leg should be inspected and cleaned out periodically during the heating season.

Any length of single-wall vent pipe exposed to cold air or run through an unheated area or an area with an ambient temperature of 50°F or less, **must be insulated along its entire length** with a minimum of 1/2" foil-faced fiberglass, 1-1/2# density insulation.

On horizontal vent runs, the flue pipe **must be pitched down toward the terminal end** 1/4" per foot for condensate drainage. Slope applies to the entire length of the horizontal vent run. Failure to pitch the vent run properly may damage the heater due to condensate running back into the unit.

CAUTION: Exceeding the specified vent pipe diameter and length may result in condensate forming in the vent pipe.

2.7 Vent Terminal (Type of Pipe and Vent Cap)

The vent terminal pipe must be UL Std1738 approved Category III vent pipe. Terminate the vent with a Reznor® Option CC1 vent cap. A different style vent cap could cause nuisance problems or unsafe conditions. The vent cap must be the same size as the vent pipe.

See **TABLE 3** and **FIGURE 1** for requirements of a horizontal vent terminal. See **FIGURE 2,** for requirements of vertical vent termination.

TABLE 3 - Horizontal Vent Terminal Clearances

A Reznor® Option CC1 vent cap is required. Maintain a clearance of 6 to 12 inches (152-305mm) from the wall to the vent terminal cap for stability under wind conditions.

Products of combustion can cause discoloration of some building finishes and deterioration of masonry materials. Applying a clear silicone sealant that is normally used to protect concrete driveways can protect masonry materials. If discoloration is an esthetic problem, relocate the vent or install a vertical vent.

Structure	Minimum Clearances for Vent Termination Location (all directions unless specified)
Forced air inlet within 10 ft (3.1M)	3 ft (0.9M) above
Combustion air inlet of another appliance	6 ft (1.8M)
Door, window, or gravity air inlet (any building opening)	4 ft (1.2M) horizontally
	4 ft (1.2M) below
	1 ft (305mm) above
Electric meter, gas meter*, gas regulator*,	U.S. - 4 ft (1.2M) horizontally
Gas regulator *	U.S. - 3 ft (0.9M)
Adjoining building or parapet	6 ft (1.8M)
Adjacent public walkways	7 ft (2.1M) above
Grade (ground level)	1 ft (305mm) above**

*Do not terminate the vent directly above a gas meter or service regulator.
** Consider local snow depth conditions. The vent must be at least 6" (152mm) higher than anticipated snow depth.

Residential Installation
Only Model UDAP Sizes 30, 45, 60, 75, 100, 125

FIGURE 1 - Horizontal Vent Terminal - Residential Installation
(**NOTE**: Read all measurements; drawing is not proportional.)

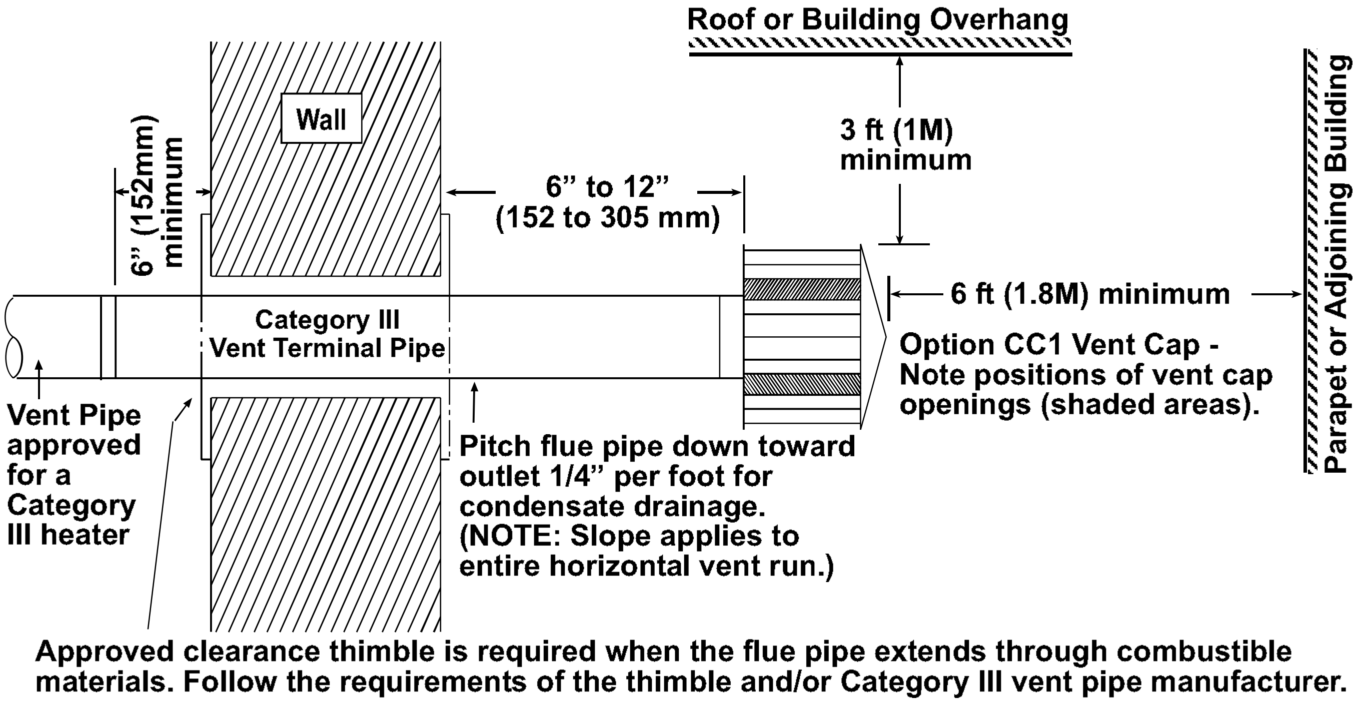
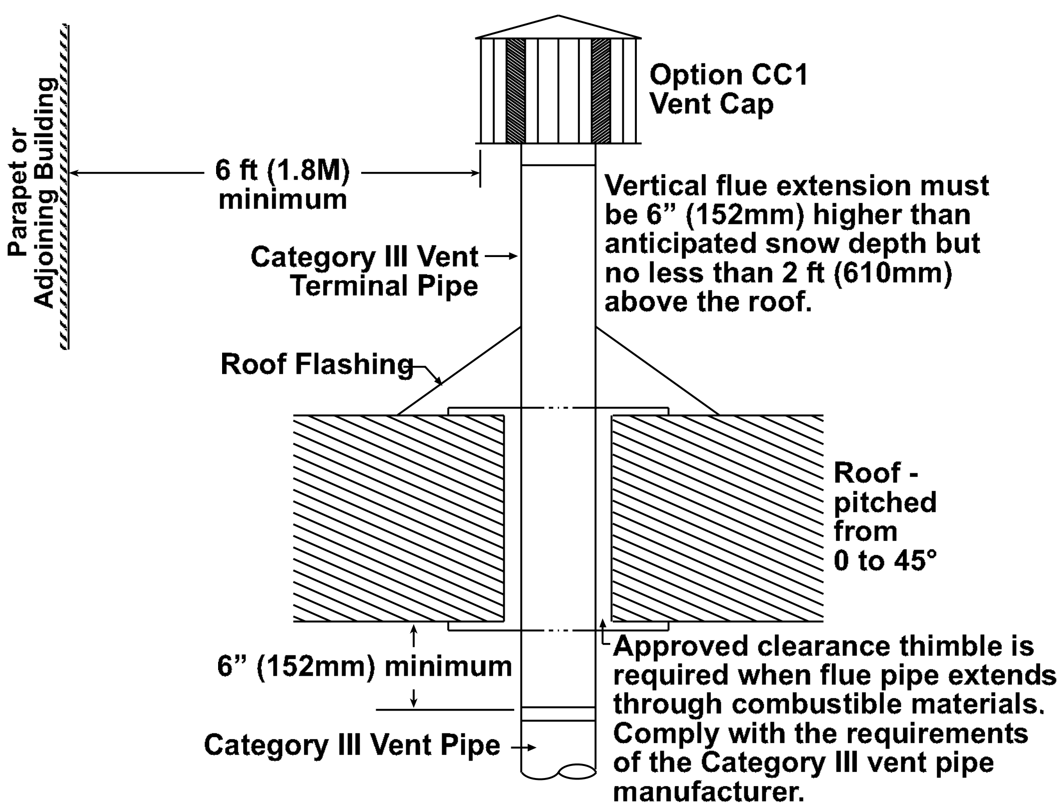


FIGURE 2 - Vertical Vent Terminal - Residential Installation
(**NOTE**: Read all measurements; drawing is not proportional.)



Commercial/Industrial Installation
Models UDAP and UDBP - ALL Sizes

3.0 Venting Requirements and Instructions - Commercial/ Industrial Installation

3.1 Type of Vent Pipe Required for Vent Run

A commercial/industrial installation may have either a horizontal or a vertical vent run using one of the types of vent pipe listed.

Horizontal Vent Run	Vent pipe approved to UL Std 1738 for a Category III appliance, OR Appropriately sealed 26-gauge or heavier galvanized steel or equivalent single-wall pipe
Vertical Vent Run	Vent pipe approved to UL Std 1738 for a Category III appliance, OR Appropriately sealed 26-gauge or heavier galvanized steel or equivalent single-wall pipe, OR If at least 75% of the equivalent length of the vent run is vertical - Double-wall (Type B) vent pipe

3.2 Vent Pipe Diameter and Length

Vent pipe diameters and maximum vent lengths in **TABLE 4** apply to both **Horizontal** and **Vertical** vents. Add **all** straight sections and equivalent lengths for elbows. The total combined length must not exceed the **Maximum Vent Length**. Minimum vent length is 3 feet (1M). Use only one diameter of vent pipe on an installation.

TABLE 4 - Vent Pipe Diameter and Length for Horizontal and Vertical Vents

UDAP and UDBP	Vent Pipe Diameter		Maximum Vent Length		Equivalent Straight Length for 90° Elbow		Equivalent Straight Length for 45° Elbow		Field-supplied taper type connection required at the venter outlet
	inches	mm	feet	M	feet	M	feet	M	
30	3	76	20	6.1	3	0.9	1.5	0.5	4” to 3” (102mm to 76mm) reducer
	4	102	10	3	2	0.6	1	0.3	None
45	3	76	20	6.1	3	0.9	1.5	0.5	4” to 3” (102mm to 76mm) reducer
	4	102	10	3	2	0.6	1	0.3	None
60	3	76	30	9.1	4	1.2	2	0.6	4” to 3” (102mm to 76mm) reducer
	4	102	15	4.6	2	0.6	1	0.3	None
75	4	102	30	9.1	4	1.2	2	0.6	None
100	4	102	40	12.2	5	1.5	2.5	0.8	None
125	4	102	40	12.2	5	1.5	2.5	0.8	None
150	5	127	35	10.7	5	1.5	2.5	0.8	None
175	5	127	35	10.7	5	1.5	2.5	0.8	None
200	5	127	50	15.2	5	1.5	2.5	0.8	None
225	5	127	50	15.2	5	1.5	2.5	0.8	None
250	5	127	50	15.2	5	1.5	2.5	0.8	None
300	6	152	50	15.2	5	1.5	2.5	0.8	None
350	6	152	50	15.2	7	2.1	3.5	1.1	None
	7	178	50	15.2	4.5	1.4	2.25	0.7	6” to 7” (152 to 178mm) enlarger
400	6	152	50	15.2	8	2.4	4	1.2	None
	7	178	50	15.2	5	1.5	2.5	0.8	6” to 7” (152 to 178mm) enlarger

3.3 Venter (Flue) Outlet

Venter Outlet Attachment Requirements:

Depending on the size of vent pipe as determined in Paragraph 3.2, attach either the vent pipe directly to the collar or a taper-type connector. For Category III, attach a 4" appliance adapter from Category III pipe manufacturer directly to the collar, then use a reducer if using 3" pipe.

TABLE 5 - Venter Outlet Size	UDAP or UDBP		30	45	60	75	100	125	150	175	200	225	250	300	350	400
	Outlet Diameter	inches	4	4	4	4	4	4	5	5	5	5	5	6	6	6
		mm	102	102	102	102	102	102	127	127	127	127	127	152	152	152

NOTE: If attaching double-wall pipe to the heater, follow instructions in Addendum, Section A, pages 10-11.

3.4 Vent System Sealing

Vent system joints depend on the type of pipe being used (See "Type of Vent Pipe", Paragraph 3.1, page 6).

- When using Category III vent pipe, follow the pipe manufacturer's instructions for joining pipe sections. When attaching Category III pipe to the venter outlet or the vent cap, make secure, sealed joints following a procedure that best suits the style of Category III pipe being used.
- If using single wall, 26-gauge or heavier galvanized pipe, secure slip-fit connections using sheetmetal screws or rivets. Seal all joints and seams of single-wall vent pipe inside the building with aluminum tape or silicone sealant.
- If using double-wall (Type B) vent pipe, follow the pipe manufacturer's instructions for joining pipe sections.

  For joining double-wall pipe to heater collar, single-wall pipe, and vent cap, follow the illustrated instructions in Addendum Section A, pages 10-11.

3.5 Vent System Support

Support horizontal runs every six feet (1.8M).

Support vertical runs of Type "B" double-wall or Category III vent pipe in accordance with the requirements of the pipe manufacturer.

Support vertical single-wall pipe in accordance with accepted industry practice.

Do not rely on the heater for support of either horizontal or vertical pipes. Use non-combustible supports on vent pipe.

3.6 Condensation

CAUTION: Exceeding the specified vent pipe diameter and length may result in condensate forming in the vent pipe.

On units with long vent runs (over 50% of maximum vent length allowed) or installed in low ambient conditions (below 50°F), it is recommended that vent pipes be fitted with a tee, a drip leg, and a cleanout cap to prevent any moisture in the vent pipe from entering the unit. The drip leg should be inspected and cleaned out periodically during the heating season.

On all Model Sizes, any length of single-wall vent pipe exposed to cold air or run through an unheated area or an area with an ambient temperature of 50°F or less **must be insulated along its entire length** with a minimum of 1/2" foil-faced fiber-glass, 1-1/2# density insulation.

On horizontal vent runs, the flue pipe **must be pitched down toward the terminal end** 1/4" per foot for condensate drainage. Slope applies to entire length of horizontal vent run. Failure to pitch vent run properly may damage the heater due to condensate running back into the unit.

3.7 Vent Terminal

The vent terminal pipe must be double-wall (Type B). Terminate the vent with a Reznor® Option CC1 vent cap. A different style vent cap could cause nuisance problems or unsafe conditions. The vent cap must be the same size as the vent pipe.

See **TABLE 6** and **FIGURE 3** for requirements of a horizontal vent terminal. See **FIGURE 4** for requirements of a vertical vent termination.

Commercial/Industrial Installation
Models UDAP and UDBP - ALL Sizes

3. Venting Requirements and Instructions - Commercial/Industrial Installation - applies to ALL Sizes of Models UDAP and UDBP (cont'd)

3.7 Vent Terminal (cont'd)

TABLE 6 - Horizontal Vent Terminal Clearances

A Reznor® Option CC1 vent cap is required. Maintain a clearance of 6 to 12 inches (152-305mm) from the wall to the vent terminal cap for stability under wind conditions.

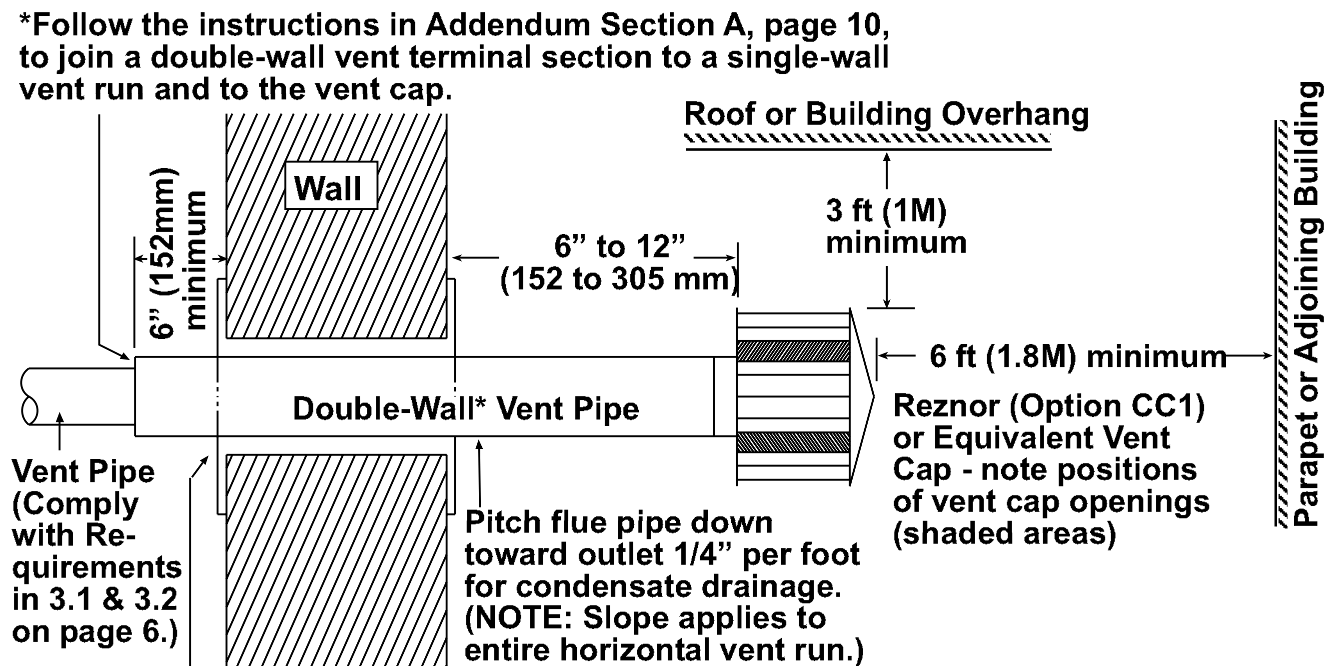
Products of combustion can cause discoloration of some building finishes and deterioration of masonry materials. Applying a clear silicone sealant that is normally used to protect concrete driveways can protect masonry materials. If discoloration is an esthetic problem, relocate the vent or install a vertical vent.

Structure	Minimum Clearances for Vent Termination Location (all directions unless specified)
Forced air inlet within 10 ft (3.1M)	3 ft (0.9M) above
Combustion air inlet of another appliance	6 ft (1.8M)
Door, window, or gravity air inlet (any building opening)	4 ft (1.2M) horizontally
	4 ft (1.2M) below
	1 ft (305mm) above
Electric meter, gas meter*, gas regulator*,	U.S. - 4 ft (1.2M) horizontally
Gas regulator *	U.S. - 3 ft (0.9M)
Adjoining building or parapet	6 ft (1.8M)
Adjacent public walkways	7 ft (2.1M) above
Grade (ground level)	1 ft (305mm) above**

*Do not terminate the vent directly above a gas meter or service regulator.

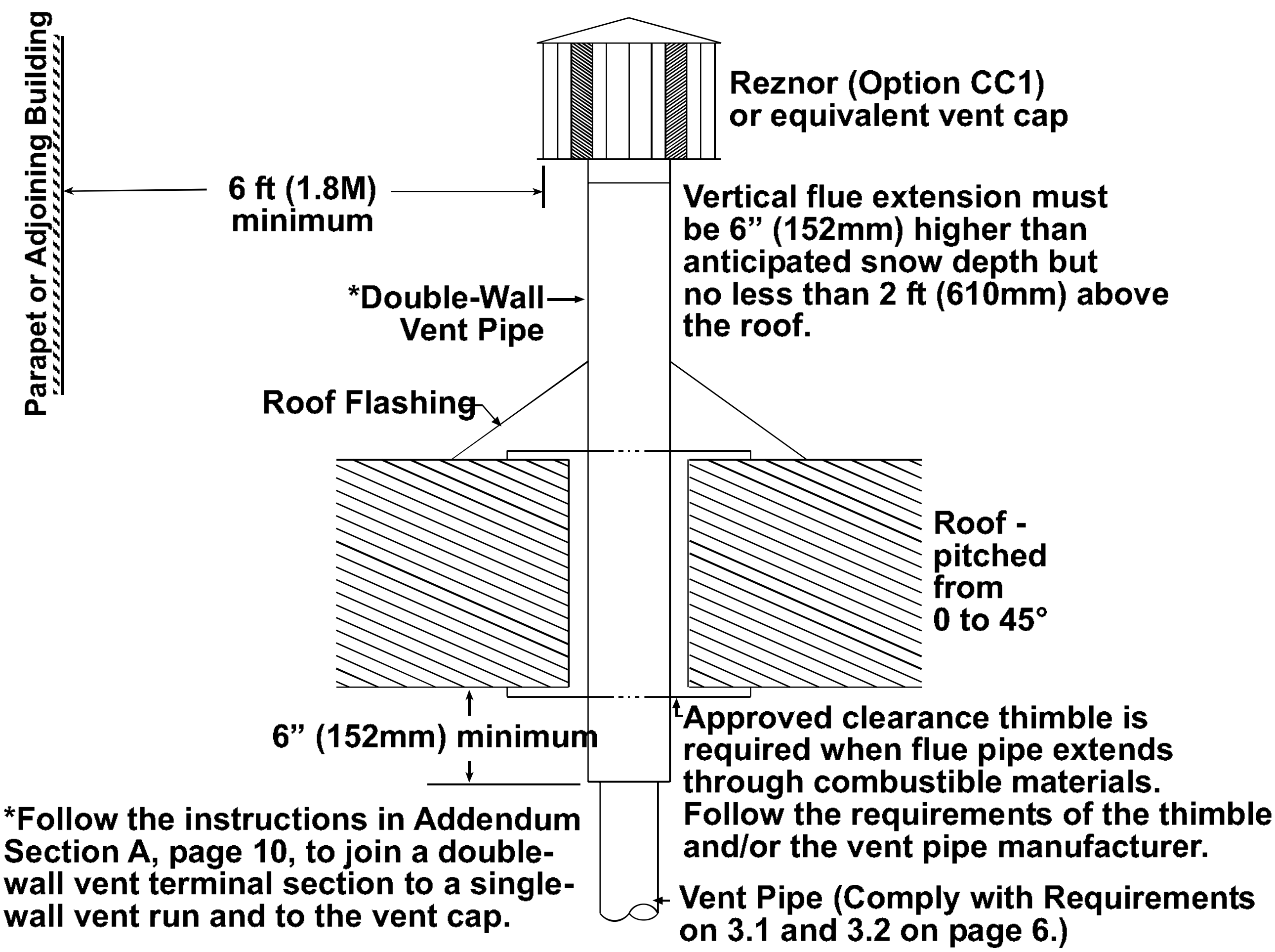
** Consider local snow depth conditions. The vent must be at least 6" (152mm) higher than anticipated snow depth.

FIGURE 3 - Horizontal Vent Terminal - Commercial/Industrial Installation
(**NOTE:** Read all measurements; drawing is not proportional.)



Approved clearance thimble is required when flue pipe extends through combustible materials. Follow the requirements of the thimble and/or the vent pipe manufacturer.

FIGURE 4 - Vertical Vent Terminal - Commercial/Industrial
(**NOTE**: Read all measurements; drawing is not proportional.)



ADDENDUM

Section A -

Instructions for Attaching Double-Wall Vent Pipe (Type-B)

FIGURE 5 - Attaching Double-Wall (Type B) Pipe to Single-Wall Pipe

Figure 5 - STEP 1

On the single-wall pipe, where illustrated, place a continual 1/4 inch bead of silicone sealant around the circumference. Do STEP 2 immediately following STEP 1.

Single-Wall Vent Pipe

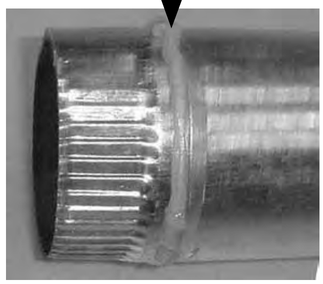
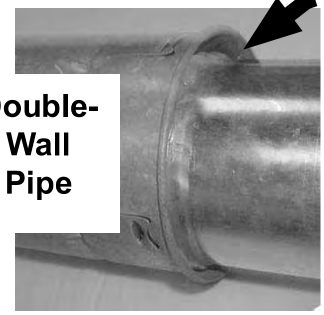


Figure 5 - STEP 2

Insert the single-wall pipe into the inner pipe of the double-wall pipe until the bead of sealant contacts the inner pipe creating a sealed joint.



Single-Wall Vent Pipe with Sealant

Figure 5 - STEP 3

Spaced equally around the double-wall pipe, drill three small holes below the sealant ring. Insert 3/4 inch long sheetmetal screws to secure the joint. Do not over tighten screws.

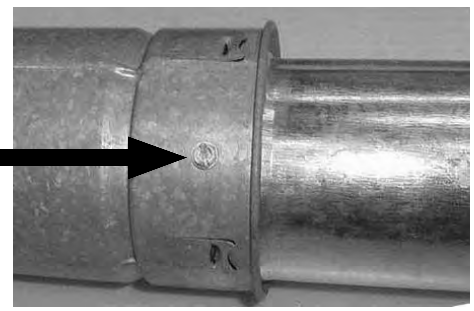


FIGURE 6 - Attaching Double-Wall (Type B) Pipe to a Vent Cap

Figure 6 - STEP 1

Place a continual 3/8" bead of silicone sealant around the circumference of the vent cap collar. This will prevent any water inside the vent cap from running down the double-wall pipe. Do STEP 2 immediately following STEP 1.

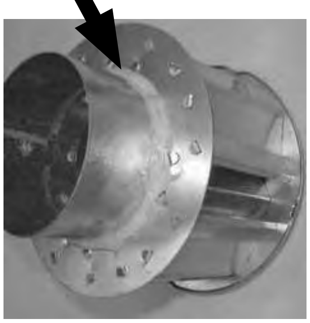


Figure 6 - STEP 2

Insert the collar on the vent cap inside the inner wall of the double-wall pipe. Insert as far as possible. Add additional silicone sealant to fully close any gaps between the vent cap and the double wall pipe. This is necessary to prevent water from entering the double wall pipe.

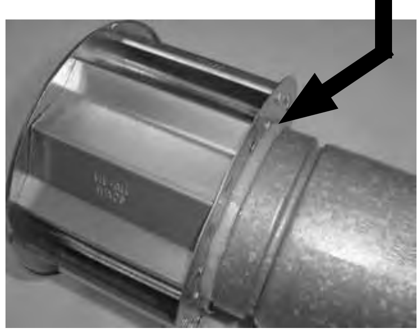


Figure 6 - STEP 3

Secure the vent cap to the double wall pipe by drilling and inserting a 3/4" long sheetmetal screw into the vent cap collar. Do not over tighten screw.

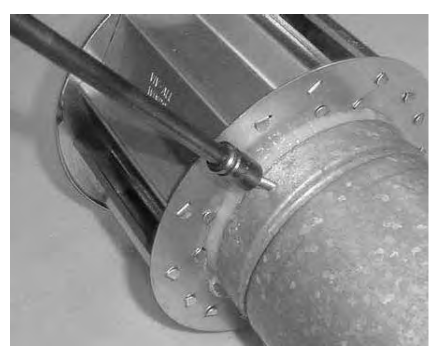


FIGURE 7 - Attaching Double-Wall (Type-B) Vent Pipe to the Heater

Figure 7 - STEP 1

Place a continual 1/4" bead of silicone sealant around the circumference of the venter outlet collar.
Do STEP 2 immediately after STEP 1.

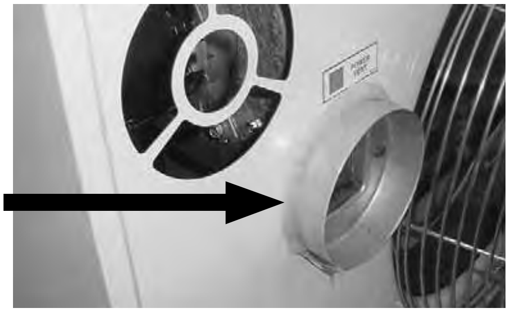
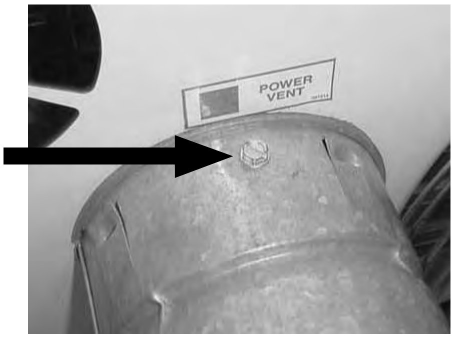


Figure 7 - STEP 2

Slide the double-wall pipe over the collar so that the collar is inside the inner pipe. Push the double-wall pipe tight to the heater cabinet. To secure the connection, spaced equal distance around the pipe, drill and insert three 3/4" long sheetmetal screws through the pipe and into the collar. Do not over tighten the screws.

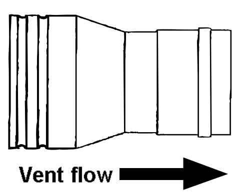


ADDENDUM

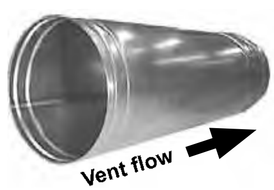
Section B - Instructions for Installing Flex-L brand Category III Vent Pipe on a Reznor® Model UDAP or UDBP Power-Vented Heater

SUPPLIER NOTE: The adapters for Flex-L vent pipe illustrated in FIGURE 8 are not available from Reznor® or Thomas & Betts; the adapters are available from a Flex-L brand vent pipe distributor. These instructions are designed to assist the contractor who has selected to use Flex-L brand Category III vent pipe to install a Reznor® power vented heater with a 4" (102mm) venter outlet.

FIGURE 8 - Flex-L brand Vent Pipe Adapters



4" to 3" (102 to 76mm) diameter, 6-3/4" long Adapter Reducer, Flex-L #SRARZA43, specially designed for attaching Flex-L brand Category III vent pipe to a Reznor® Model UDAP or UDBP 30, 45, and 60 for 3" (76mm) diameter vent pipe.



4" (102mm) diameter, 12" long Adapter Pipe, Flex-L® #SRARZA4, specially designed for attaching Flex-L brand Category III vent pipe to a Reznor® Model UDAP or UDBP 30, 45, 60, 75, 100, and 125 for 4" (102mm) diameter vent pipe.

1. **Attach the Adapter Pipe or Reducer to the Venter Collar**
   a) On the end of the adapter or reducer that attaches to the venter collar (the end of the adapter with the double emboss without the locking ring hole), run a continuous bead of high temperature silicone around the inside of the pipe. See **FIGURE 9**.

FIGURE 9 - Attach to Venter Outlet

Slide the adapter pipe or reducer over the venter outlet. Secure with a sheetmetal screw.

Run a continuous bead of high temperature silicone around the inside of the pipe.

ADDENDUM, Section B (cont'd)

Instructions for Installing Flex-L brand Category III Vent Pipe (cont'd)

b) Push the adapter pipe or reducer over the flue collar.

c) On the top of the overlap, drill a 1/8" hole and insert a sheetmetal screw to secure the connection.

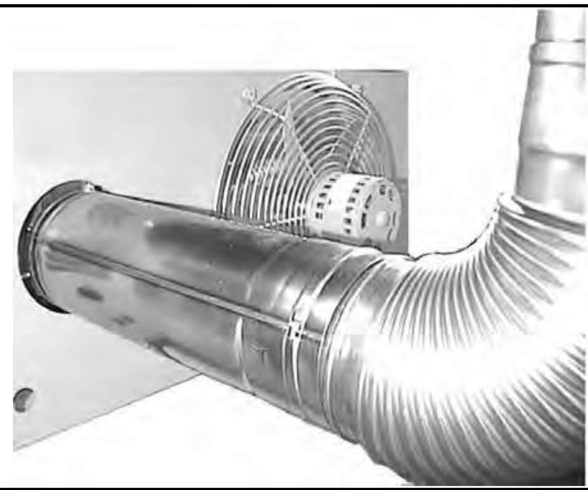
2. Run the Vent Pipe

a) Refer to either the residential or commercial/industrial venting instructions in this manual for vent length requirements.

b) If using a 4" to 3" (102 to 76mm) reducer - Following the vent pipe manufacturer's instructions, attach a straight piece of 3" diameter horizontal pipe or an elbow in any direction above horizontal.

FIGURE 10 - Extend vent in any direction above horizontal

Flex-L brand elbow attached to the 12" (305mm) adapter pipe



If using a 4" (102mm) diameter, 12" (305mm) long adapter pipe - Following the vent pipe manufacturer's instructions, attach one of the following:

- an elbow in any direction above horizontal, or
- a straight horizontal pipe

c) Follow the pipe manufacturer's instructions to connect the vent pipe sections and install the vent pipe run. The length of vent must not exceed the maximum allowed for the heater being installed.

d) Extend the vent pipe through the wall or roof to the outdoors. An approved clearance thimble is required when flue pipe extends through combustible materials. Follow the requirements of the pipe and thimble manufacturer. Be sure to comply with local and national codes when selecting the vent terminal location. The vent pipe installer is responsible for following the manufacturer's instructions and complying with all applicable codes.

3. Attach the Vent Cap (FIGURE 11)

FIGURE 11 - Attach Vent Cap

a) Use a Reznor® Option CC1 vent cap.

b) Slide the vent cap collar into the vent pipe.

c) Around the end of the vent pipe, drill three evenly spaced 1/8" holes through the vent pipe and vent cap. Insert sheetmetal screws to secure the vent cap to the vent pipe.

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11/13 (Serial No. Date Code BMk) Form I-UD-V-PV (Version D)

FORM 270-D

WARRICK CONTROLS

Installation

INSTALLATION OF WARRICK SERIES 27 — INTRINSICALLY SAFE SENSING CIRCUIT

This bulletin should be used by experienced personnel as a guide to the installation of the Series 27. Selection or installation of equipment should always be accomplished by competent technical assistance. We encourage you to contact Warrick or its local representative if further information is required.

IMPORTANT: BEFORE PROCEEDING TO INSTALL AND WIRE THE CONTROL, READ AND THOROUGHLY UNDERSTAND THESE INSTRUCTIONS.

When installed according to these instructions, this device provides an intrinsically safe output for interface into Class I and II, Division I, Groups A, B, C, D, E, F, and G Hazardous locations. Electrical equipment connected to associated apparatus should not exceed maximum voltage marked on product.

LOCATION: The control must be situated in a non-hazardous area where an explosive atmosphere will not exist at any time unless it is mounted in a suitable U.L. approved explosion-proof enclosure with suitable U.L. approved explosion-proof seals.

WIRING:

1. Intrinsically safe wiring must be kept separate from non-intrinsically safe wiring.
2. Intrinsically safe and non-intrinsically safe wiring may occupy the same enclosure or raceway if they are at least 2 inches (50mm) apart and separately tied down. Inside panels, field wiring terminals for intrinsically safe circuits must be separated by at least 2 inches (50mm) from non-intrinsically safe terminals.
3. Wire the control device(s) to the Series 27 relay as shown in the specific application wiring diagram on reverse side. A separate rigid metallic conduit should be used to enclose the conductors of the intrinsically safe control circuit.
4. An approved seal should be used at the point where the intrinsically safe control circuit wiring enters the hazardous area.

For intrinsically safe output wiring use #14 or #16 AWG type MTW or THHN wire. By using these wire types in conjunction with the following distance recommendations, you will not exceed the maximum capacitance for field wiring.

Use the following chart as a guide for maximum wire runs for differential level service (3 wire) field wiring.

Model	Max. Sensitivity (K OHMS)	Distance (Ft.)
27XXDO	3	4,000
27XXEO	10	900
27XXHO	24	800
27XXGO	100	75

GROUNDING: Both mounting tabs of the Series 27 provide an electrical connection for earth grounding between the control's internal solid state circuitry and the enclosure chassis. To insure proper grounding, use only metal screws and lock washers when mounting this control.

One of the two ground terminals provided on the intrinsically safe output terminal strip must be connected as reference to the same conductive media presented to terminals "H" and "L" (see applicable wiring diagram on reverse side).

Terminal G1 on the supply line/load side terminal strip is a redundant system ground terminal and should be connected to the earth ground buss of the control's AC supply line feeder.

NOTE:

1. Intrinsically safe terminals can be connected to any non-energy generating or storing switch device such as a pushbutton, limit or float type switch or any Warrick electrode and fitting assembly.
2. To prevent electrical shock from supply line/load side powered connections, the Series 27 should be mounted in a tool accessible enclosure of proper NEMA rated integrity.
3. For additional guidance on "Hazardous Location Installations" and "Intrinsically Safe Devices", consult ANSI/ISA standard RP 12-6 or NEC articles 500 through 516.

MODEL NUMBER DESIGNATION:

SERIES 27 X X X X

- **Enclosure:** 0 – open (no enclosure); 1 – NEMA 1 Enclosure
- **Sensitivity** (ohms): D-3,000; E-10,000; H-24,000; G-100,000
- **Primary AC Supply:** 1 - 120 VAC; 2 - 240 VAC (50/60 Hz)
- **Mode of Operation:** A - Direct; B - Inverse
- **Control Series**

SPECIFICATIONS

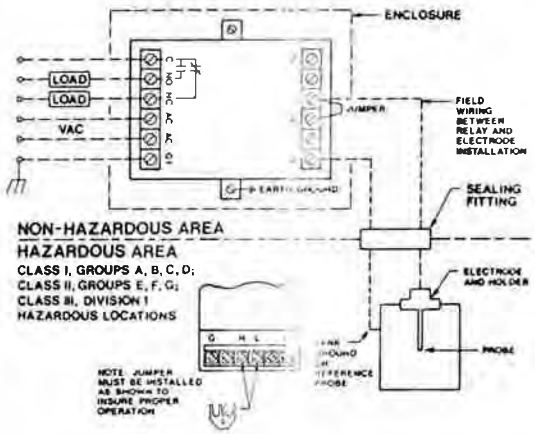
CONTACT DESIGN: SPDT (1 form C), one normally open (N O) and one normally closed (N.C.)
CONTACT RATING: 8 Amps - 250 VAC, 8 Amps - 30 VDC Resistive.
CONTACT LIFE: Electrical @ rated load = 100,000 cycles minimum. Mechanical = 10,000,000 cycles
ELECTRONICS MODULE: Solid state components epoxy encapsulated in a black nylon shell.
SENSITIVITY RANGE: 0-100,000 Ohms maximum specific resistance.
TEMPERATURE RANGE: (minus) -40 deg F. to (plus) + 150 deg F
PRIMARY AC SUPPLY LINE: A) Voltage — (120, and 240 VAC) (plus) + 10%, (minus) — 10%. B) Frequency — 50/60 Hertz C) Power — (Relay energized) 1.7 VA.
SECONDARY CIRCUIT: Nominal 11 Volts, AC, RMS, Current: 2.3 Milliampere, RMS.
TERMINALS: Size 6 pan head screws with captivated wire clamping plate

WARRICK CONTROLS

INSTALLATION OF WARRICK SERIES 27 — INTRINSICALLY SAFE SENSING CIRCUIT

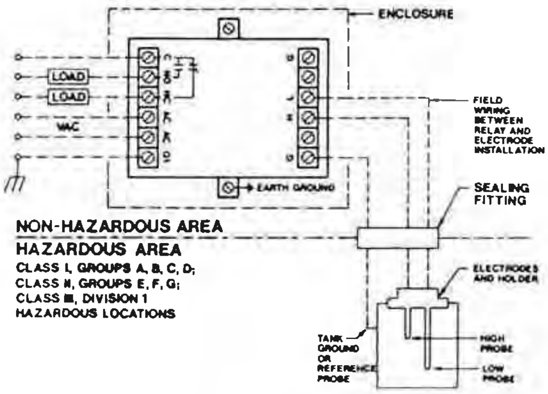
SINGLE LEVEL SERVICE — CONDUCTANCE ACTUATED:

Connect terminals AC & G1 to appropriate VAC supply line.
Install metallic jumper between terminals H-L.
Connect terminal L to the electrode.
Terminal G must be grounded to the tank if metallic. When the tank is non-metallic, terminal G must be connected to an additional electrode of length equal to the longest electrode.
NOTE: Jumper must be installed as shown to insure proper operation. Wire contacts (C-NO) normally open and (C-NC) normally closed into load circuit as required.



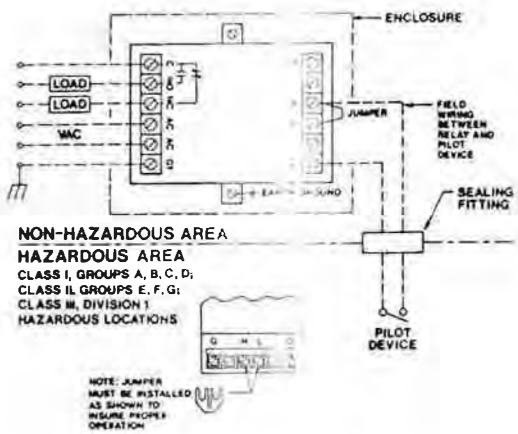
DIFFERENTIAL LEVEL SERVICE — CONDUCTANCE ACTUATED:

Connect terminals AC & G1 to appropriate VAC supply line.
Connect terminal H to high electrode and terminal L to low electrode.
Terminal G must be grounded to the tank if metallic. When the tank is non-metallic, terminal G must be connected on an additional electrode of length equal to the longest electrode.
Wire contacts (C-NO) normally open and (C-NC) normally closed into load circuit as required.



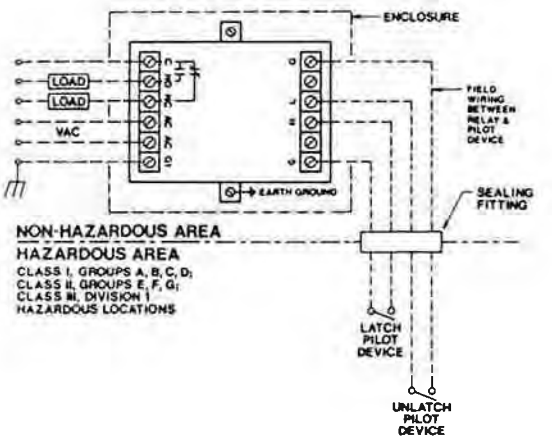
SINGLE INPUT (NON-LATCHING) — PILOT CONTACT ACTUATED:

Connect terminals AC & G1 to appropriate VAC supply line.
Install metallic jumper between terminals H-L.
Wire contacts (C-NO) normally open and (C-NC) normally closed into load circuits as required.
Connect the pilot contact to terminals G-L.
NOTE: Jumper must be installed as shown to insure proper operation.



DUAL INPUT (LATCHING) — PILOT CONTACT ACTUATED:

Connect terminals AC & G1 to appropriate VAC supply line.
Wire contacts (C-NO) normally open and (C-NC) normally closed into load circuits as required.
Connect the latch pilot contact to terminals G-H and the unlatch pilot contact to terminals G-L.



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When mounting an auxiliary contact unit on a starter or contactor, position the operating lever (item 2 in Figure 2, part no. 31033-013-01) so it engages the movable-contact carrier of the starter. If necessary, remove the operating lever and rotate it 180° for proper engagement of the contact carrier. This allows installation of any single-circuit auxiliary contact in any one of the four available positions.

Note: Use the same mounting bracket when mounting two single-circuit auxiliary contacts on the same side (shown on the right side of Figure 1). Remove one auxiliary contact from its mounting bracket and install it on the mounting bracket of the other auxiliary contact.

When adding an external auxiliary contact to a Size 00-2 starter or contactor, use two screws to secure the mounting bracket of the auxiliary contact to the baseplate of the contactor, as shown in Figure 1. When adding an external auxiliary contact to a Size 3-7 starter or contactor, remove the auxiliary contact from its mounting bracket and mount it directly to the contactor baseplate, exactly as it attaches to its own mounting bracket.

When adding four auxiliary contacts to a Size 0 or 1 contactor or starter with mechanical interlock, one contact return spring must be removed. See "Size 0 & 1 Mechanically-Interlocked Devices" on page 3.

Auxiliary Contact Kits

Auxiliary contact kits are available for mounting auxiliary contacts to Size 00-7 contactors or starters in the field (refer to Table 2).

Table 2 Auxiliary Contact Kits

NEMA Size	Type	Auxiliary Contact Kit	Class 9999	
			Field Convertible	Non-Convertible
		External		
00-7	SA-SJ	1 N.O. Contact	SX6	SX13
		1 N.C. Contact	SX7	SX14
		1 N.O. /1 N.C. Isolated Contact	SX8	SX15
		1 N.O. Overlapping Contact [1]	SX9	SX16
		1 N.C. Overlapping Contact [1]	SX10	SX17
		Internal		
00-2	SA-SD	1 N.O. Contact	...	SX11
		1 N.C. Contact	...	SX12

[1] Type SX9 and SX10 or SX16 and SX17 contacts must be used together and mounted on the same side of the contactor. They are suitable for applications where it is necessary for a normally-open auxiliary contact to overlap a normally-closed auxiliary contact.

Contact Conversion

Contacts may be converted from N.O. (normally-open) to N.C. (normally-closed) or vice-versa without any additional parts. Contact status on devices with date codes JN and later can be viewed through the transparent auxiliary contact housing. (Devices with date codes HN and earlier are black. On these devices, a small window indicates whether an auxiliary contact is N.O. or N.C.) Figure 2 below shows a N.O. and N.C. auxiliary contact with the cover removed. To change from N.O. to N.C. or vice-versa:

1. Remove rotary cam (item 1), rotate it 180° and replace. Return spring to original position. Be sure spring is located over guide on rotary cam.
2. Remove the operating lever (item 2) with a screwdriver. Rotate the lever 180° so it will engage the contact carrier of the starter or contactor.

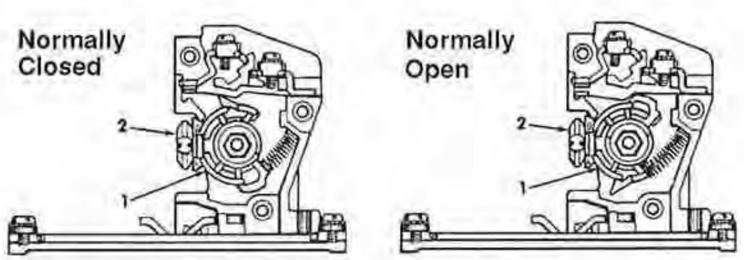


Figure 2 Determining Contact Status

Tandem Mounting

On horizontally-mounted reversing or multispeed devices, the contactors may be too close to mount two single-circuit auxiliary contacts on each side of a contactor. To mount three or four auxiliary contacts on a 3-pole device, use the arrangement shown in Figure 3.

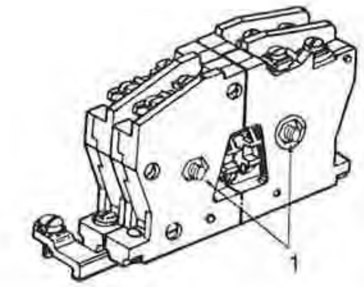


Figure 3 Tandem Mounting

> **⚠ WARNING**
>
> **SWITCH MALFUNCTION.**
>
> **Do not mount an SX10 or SX17 contact in tandem with any Type SX contact.**
>
> Failure to observe this precaution can cause a switch malfunction, resulting in equipment damage, severe personal injury or death.

Note: use a common mounting bracket for the two inside auxiliary contacts that engage the contact carrier of the starter. Each outside auxiliary contact is held to the side auxiliary contact by a #6-32 x 1" inch screw with a #6 star lock washer and #6-32 hex nut (item 1 in Figure 3 – not included with individual auxiliary contact kits). The operating levers of the two outside auxiliary contacts engage the operating levers of the two inside auxiliary contacts.

Auxiliary contacts must be mounted in tandem when a fourth auxiliary contact is used on a Size 3 or 4 non-reversing device, or when more than two additional contacts are needed on reversing or multispeed devices. Mount the two auxiliary contacts in tandem, then mount the inside auxiliary contact next to the contactor, directly on the baseplate of the contactor.

Size 0 & 1 Mechanically-Interlocked Devices

When adding four auxiliary contacts to a Size 0 or 1 contactor or starter with a mechanical interlock, one contactor return spring must be removed. To remove the contactor return spring (refer to Figure 4):

1. Loosen the cover screws (item D) and remove the cover.
2. Remove the coil and magnet assembly
3. Remove the screw (item 4), retainer plate (item 5) and return springs (item 6).
4. Discard one return spring.
5. Replace one return spring, the spring retainer plate and screw.
6. Replace coil, magnet assembly and cover. Tighten screws on cover.

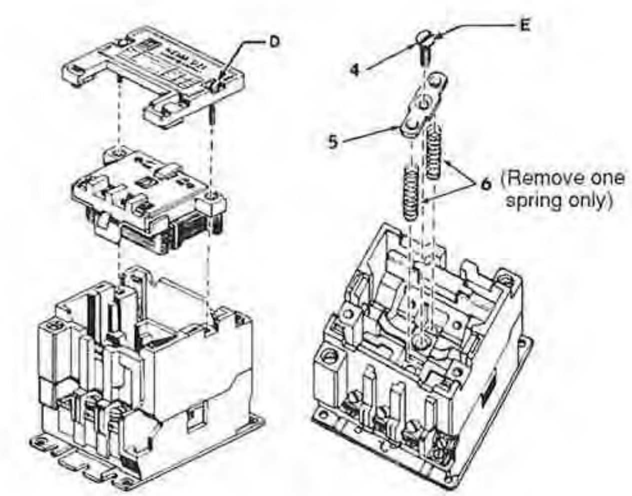


Figure 4 Removing Contactor Return Spring

Internal Auxiliary Contacts

Internal auxiliary contacts (Figure 5) are normally used on Size 00, 0, 1 and 2 for the holding-circuit contact (upper left) and for electrically-interlocking reversing or multispeed devices (lower right). INTERNAL AUXILIARY CONTACTS **CANNOT** BE CONVERTED FROM N.O. TO N.C. OR VICE VERSA AS IN THE CASE OF THE EXTERNAL AUXILIARY CONTACTS.

For a replacement N.O. contact, order Class 9999 Type SX11. For a N.C. contact, order Class 9999 Type SX12.

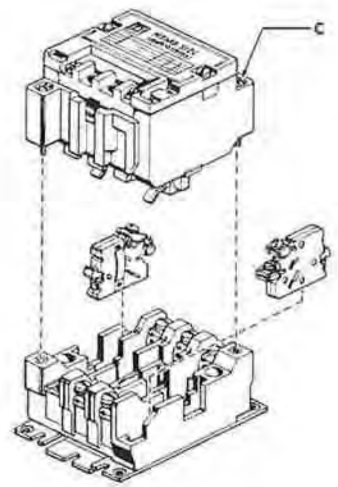


Figure 5 Internal Auxiliary Contacts

Factory Recommended Tightening Torques

Table 3 lists the recommended tightening torques for the screws shown in Figures 1, 4 and 5.

Table 3 Tightening Torques

Item	Tightening Torque (lb-in)
A	17 to 21
B	13 to 16
C	17 to 21
D	17 to 21
E	24 to 28

PLEASE NOTE:

Electrical equipment should be serviced only by qualified electrical maintenance personnel, and this document should not be viewed as sufficient instruction for those who are not otherwise qualified to operate, service or maintain the equipment discussed. Although reasonable care has been taken to provide accurate and authoritative information in this document, no responsibility is assumed by Square D for any consequences arising out of the use of this material.

SQUARE D
Instruction Bulletin

Reference No. 287AS
Bulletin No. 30072-013-21
Raleigh NC, USA, July, 1994
Supersedes 9999-287 dated 3/87

Class 9999 Type SX, Series B Auxiliary Contact Kit

For NEMA Size 00-7 Type SA, SB, SC, SD, SE, SF, SG, SH and SJ Series A and B Starters and Contactors

INTRODUCTION

Refer to Table 1 when adding auxiliary contacts to Type S starters and contactors.

Table 1 Adding Auxiliary Contacts

Type S Contactor/Starter Size	Poles	Maximum No. of Auxiliary Contacts
00	2, 3	• 4 single-circuit auxiliary contacts (internal/external) • With timer attachment: 2 auxiliary contacts (internal/external)
0, 1, 2	1, 2, 3	• 4 single-circuit external auxiliary contacts
	3	• With timer attachment: 3 auxiliary contacts
	4, 5	• 2 single-circuit auxiliary contacts
3, 4	2, 3, 4, 5	• 4 single-circuit external auxiliary contacts • 1 single-circuit N.O. external auxiliary contact used as holding-circuit contact • Fourth auxiliary contact must be tandem-mounted to one of the other auxiliary contacts • With timer attachment: 2 external auxiliary contacts
5, 6, 7	2, 3	• 1 single-circuit N.O. external auxiliary contact used as holding-circuit contact • 2 external auxiliary contacts used in DC coil control circuit • 4 single-circuit auxiliary contacts can be added (tandem mounted) • With timer attachment: 3 external auxiliary contacts

INSTALLATION

⚠ DANGER

HAZARDOUS VOLTAGE

Disconnect all power before working on equipment.

Electrical shock will cause severe personal injury or death.

A mounting bracket is supplied with all Class 9999 Type SX external auxiliary contact kits. Figure 1 shows one single-circuit auxiliary contact unit on the left and two single-circuit auxiliary contact units on the right. A Class 9999 Type SX8, 1 N.O./1 N.C. auxiliary contact kit consists of two single-circuit auxiliary contact units on a common mounting bracket.

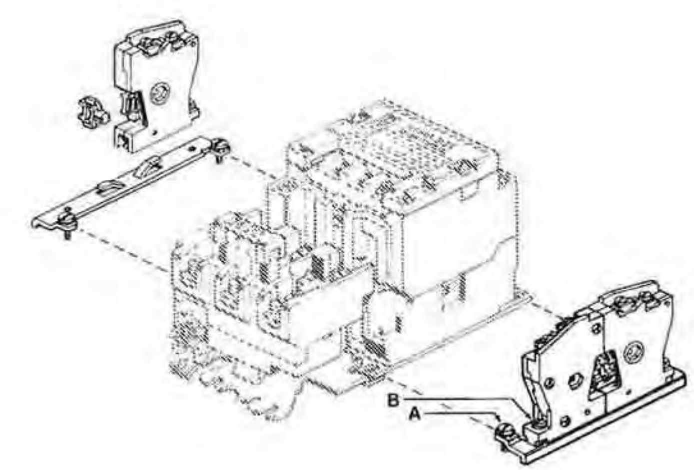


Figure 1 Installing External Auxiliary Contacts

Table 1 Field Modification Kits, Class 9999

Kit	Slip-On Enclosure	Hinged Door Enclosure	Form (Factory Mod.)
Push button, Start-Stop	SA2	SA3	A
Push button, On-Off	SA10	SA3	A3
Selector switch, Hand-Off-Auto	SC2	SC8	C
Selector switch, On-Off	SC22	....	C6
Red pilot light	SP15R	SP28R [1]	P1

[1] For 120 V only. For other voltages, use Class 9001 Type KP units.

OVERLOAD RELAYS

A melting alloy overload relay is supplied as standard with provisions for three thermal units. The contact unit (item 6 of Figure 1 on page 1) of the melting alloy overload relay is available with a normally-open or normally-closed isolated alarm contact in addition to the standard normally-closed contact. The contact unit with alarm circuit contacts can be installed in the field (refer to Table 5 on page 4).

Non-temperature compensated bimetallic overload relays are available as an optional feature: Form B1 has provisions for two thermal units; Form B2 has provisions for three thermal units. Ambient-temperature compensated bimetallic overload relays (Form B) are also available as an optional feature, with provisions for three thermal units.

An SPDT contact is supplied as standard on all Type S bimetallic overload relays. The N.O. contact can be used in an alarm circuit and must be wired on the same polarity as the N.C. contact. Contacts are not replaceable. In order to directly replace any bimetallic overload relay, the appropriate part number listed on the parts list should be used.

These overload relays are not designed for field repair and should not be disassembled.

TERMINALS

Use copper wire only on device power and control terminals. Pressure wire power terminals are suitable for wire sizes #14-8 AWG, solid or stranded. Pressure wire control terminals are suitable for wire sizes #16-12 AWG, solid or stranded.

INSPECTING AND REPLACING CONTACTS

Contacts are not harmed by discoloration and slight pitting. **Do not file contacts**, as it wastes contact material. Replacement is necessary only when the contact has worn thin. Replacement contacts for starters or contactors are available as kits. Order from Table 5.

Replacement contacts and springs for the **power pole kits only** are contained in a Class 9998 Type SL22 kit. One kit is required for each N.O. or N.C. contact.

It is unnecessary to remove any wiring to inspect or replace the contacts. To inspect or replace contacts, loosen the two captive screws (item C in Figure 1) holding the contact actuator to the contact block. Lift the contact actuator to expose the contacts.

MANUAL OPERATION

⚠ WARNING

HAZARDOUS VOLTAGE.

Disconnect all power before manually operating equipment.

Manual operation with power on can cause contact arcing and unexpected energization of load, resulting in personal injury or equipment damage.

Manual operation of contactors and starters may be accomplished by pushing the contact carrier down with a screwdriver. A slot suitable for this use is provided in the coil cover.

COIL REPLACEMENT

To remove the coil, loosen the two captive cover screws (item A in Figure 1). Disconnect wires from the coil terminals and remove the cover. Remove and disassemble the magnet, coil and armature unit.

To replace the coil, first assemble the magnet, replacement coil and armature. Manually operate the contact carrier and insert the complete unit. Before installing the cover, manually

operate the device as described in "Manual Operation" to ensure all parts are functioning properly. Follow recommended tightening torques (see Table 2) when reassembling device.

ASSEMBLY INSTRUCTIONS

Figure 1 on page 1 shows how contactors and starters are assembled. Factory recommended torques for mechanical, electrical and pressure wire connections are listed in Table 2 and the device instruction sheet. These torques must be followed to ensure proper device operation.

Table 2 Factory Recommended Tightening Torques

Item	Description	Tightening Torque (in-lb)
A	Cover screw (2 per cover)	18-21
B	Coil terminal pressure wire connector (2 per coil)	9-12
C	Power plant screw (2 per device)	18-21
D	Internal auxiliary contact pressure wire connector (2 per contact)	9-12
E	Stationary contact fastener (2 per pole)	6-9
F	Lug screw (2 per pole)	[1]
G	Auxiliary wire binding screw	18-21
H	Overload relay fastening screw (2 per overload block)	18-21
J	Overload switch module fastening screw (1 per module)	9-12
K	Switch module pressure wire connector (2 per module standard; 4 per module w/ alarm circuit contact)	9-12
L	Overload-to-contactor fasteners (1 per pole)	18-21 [2]
M	Overload thermal unit fastening screw (2 per pole)	18-21

[1] See instruction sheet.
[2] For contactor, see instruction sheet.

SHORT CIRCUIT PROTECTION

Provide branch-circuit overcurrent protection for starters, referring to instructions supplied with the thermal unit selection table. Provide branch-circuit overcurrent protection for contactors (Class 8502 or 8702) in accordance with the National Electrical Code. Do not exceed the maximum protective device ratings listed in Table 3.

Table 3 Maximum Ampere Ratings

Maximum Voltage (V)	Class K5, RK5 or RK1 Fuse (A)	Class J or T Fuse (A)	Inverse-Time Circuit Breaker (A)
600	20	30	20
250	25	30	35

DISTANT CONTROL

Series impedance and shunt capacitance of the control circuit must be considered to assure proper operation of contactors and starters when controlled from remote operator stations. Depending upon the voltage, wire size and number of control wires used, series impedance or shunt capacitance may limit the maximum distance of the wire run. If distances to start or stop stations are longer than those listed in Table 4, the wire-run configuration and materials must be analyzed. For further information, contact your local Square D field office for Product Data Bulletin M379.

Table 4 Maximum Control Distance

Coil Voltage (60 Hz)	Maximum Control Distance (feet) #14 AWG Copper Wire	#10 AWG Copper Wire
120	845	1500
240	595	395
480	145	95

ORDERING INSTRUCTIONS

Specify quantity, part number or class and type and description of part, giving complete nameplate data of the device. For example, one armature and magnet kit 31041-605-50 for a Class 8536 Type SBO2 Series A starter.

Table 5 Parts List

Item	Description	Part Number	Quantity 1-Pole	2-Pole	3-Pole	4-Pole	5-Pole
1	Armature and magnet kit	31041-605-50	1	1	1	1	1
2	Coil	See Table 6 below	1	1	1	1	1
3	Internal auxiliary contact Normally-open Normally-closed	Class 9999: Type SX11 Type SX12	 [3] ...	 [3] ...	 1 ...	 1 ...	 1 ...
4	Contact kit	Class 9998: Type SL2 Type SL12 Type SL12 & SL22	 1	 1	 1	 ... 1 ...	 1
5	Melting alloy overload relay assembly 1 Element 2 or 3 Element	Class 9065: Type SDO4 Type SDO5	 1 ...	 1 ...	 ... 1	 ... 1	 ... 1
[1] 5	Bimetallic overload relay Non-compensated 2 element (Form B1) 3 element (Form B2) Compensated 3 element (Form B)	Class 9065: Type SDO5B1 Type SDO6B2 Class 9065: Type SDO6B					 ... ...
6	Melting alloy overload contact unit	Class 9998 Type SO1	1	1	1	1	1
[1] 6	Melting alloy overload contact unit w/ alarm circuit Normally-open alarm contact Normally-closed alarm contact	 Class 9999 Type SO4 Class 9999 Type SO5					 ... ...
7	Reset bar	31034-042-01	1	1	1	1	1
8	Cover	31127-013-01	1	1	1	1	1
[1]	External auxiliary contact One normally-open One normally-closed One normally-open and one normally-closed One normally-open, overlapping One normally-closed, overlapping	Class 9999: Type SX6 Type SX7 Type SX8 Type SX9 Type SX10					 ... ...
[1]	Power pole kit One normally-open Two normally-open	Class 9999: Type SB6 Type SB9				 1 ...	 ... 1
[2] 10	Lever bearing	31041-032-01	1	1	1	1	1
A	Cover screw	21937-14341	2	2	2	2	2
B	Coil terminal pressure wire connector	31051-007-50	2	2	2	2	2
C	Power plant screw	21916-14501	2	2	2	2	2
F	Wire clamp and screw (Size 0 contactor)	30018-018-50	...	...	...	2	4
G	Auxiliary wire binding screw	21819-25081	2	2	2	2	2
L	Wire clamp and screw (Size 0 contactor)	30018-070-50	2	4	6	6	6
M	Overload thermal unit fastening screw	21920-16160	...	4	6	6	6

[1] Not shown.
[2] To ensure proper device operation: when installing the lever bearing onto the lever, the oval concavity on the inside surface of one leg of the bearing must mate with the corresponding oval convexity on the bottom of the lever.
[3] Furnished on 2-pole starters, however 1- and 2-pole contactors are furnished with a holding circuit contact rated the same as a power pole.

Table 6 Magnet Coil Part Numbers [1]

Coil Prefix	Hz	Coil Suffix 24 V	110 V	120 V	120/240 V	208 V	220 V	240 V	240/480 V	277 V	380 V	440 V	480 V	550 V	600 V
31041-400	60	20	Use 120 V	42	[2]	48	Use 240 V	51	[2]	52	56	Use 480 V	60	Use 600 V	62
	50	22	42	43	...	...	51	53	...	...	57	60	...	62	64

[1] Complete part number of coil consists of the prefix followed by the suffix (i.e.: for 120 V 60 Hz coil, select 31041-400-42). When ordering replacement coils, give part number, voltage and frequency of coil being replaced.
[2] Dual voltage coil. Order 120/240 V 60 Hz as 31041-402-02. Order 240/480 V 60 Hz as 31041-402-04.

PLEASE NOTE:

Electrical equipment should be serviced only by qualified electrical maintenance personnel, and this document should not be viewed as sufficient instruction for those who are not otherwise qualified to operate, service or maintain the equipment discussed. Although reasonable care has been taken to provide accurate and authoritative information in this document, no responsibility is assumed by Square D for any consequences arising out of the use of this material.

Osterhaudt Elec. (Ralph) 914-229-5652

SQUARE D
Instruction Bulletin

Reference No. 277AS
Bulletin No. 30072-013-09B
Raleigh, NC, U.S.A., February, 1994
Supersedes 30072-013-09A dated 9/93

2- and 3-Pole AC Magnetic Contactors and Starters
Type SB, Series A or B
Class 8502 and 8536 – Size 0

INTRODUCTION

This instruction bulletin illustrates and describes Class 8502 and 8536 two- and three-pole magnetic contactors and starters. It also contains assembly, modification and parts ordering instructions. To identify parts, refer to Figure 1.

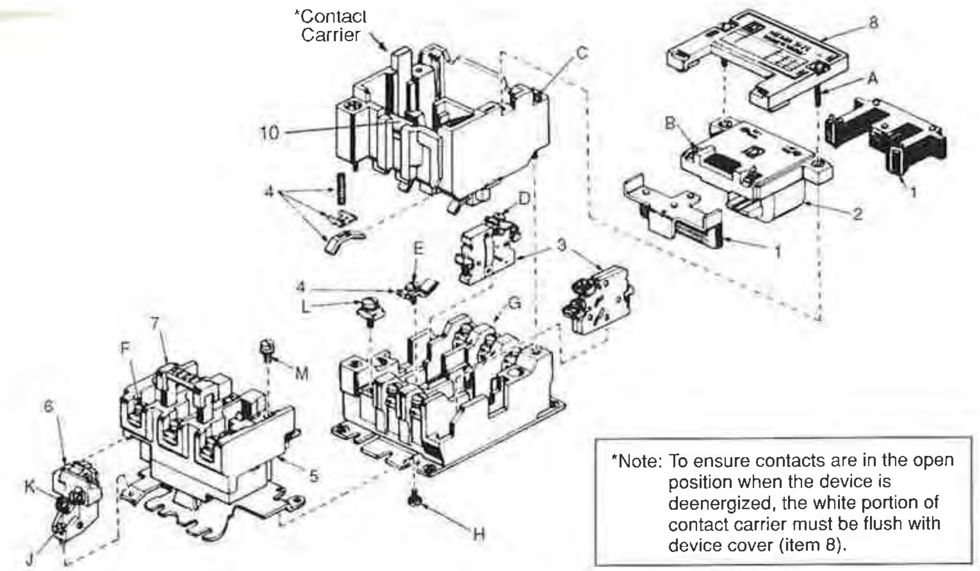


Figure 1 Contactor and Starter Assembly Drawing

⚠ DANGER

HAZARDOUS VOLTAGE.

Disconnect all power before working on equipment.

Electrical shock will cause severe injury or death.

SERIES

Series B applies only to the Type S Starter Form B (three ambient-compensated overloads). All parts of Form B Series A and B starters are interchangeable; only the overload relay block differs. If the overload relay block of a Form B Series A starter is replaced with the Series B block, the overload relay thermal units must be selected from the Series B thermal unit selection tables for proper motor protection.

AUXILIARY CONTACTS

All contactors are supplied with a normally-open holding circuit contact as standard. Additional normally-open or normally-closed auxiliary contacts can be installed in the field. Refer to Table 5 on page 4 for class and type. For application information, refer to Bulletin 9999-287 or the Square D Digest.

COVER MOUNTED CONTROL UNITS

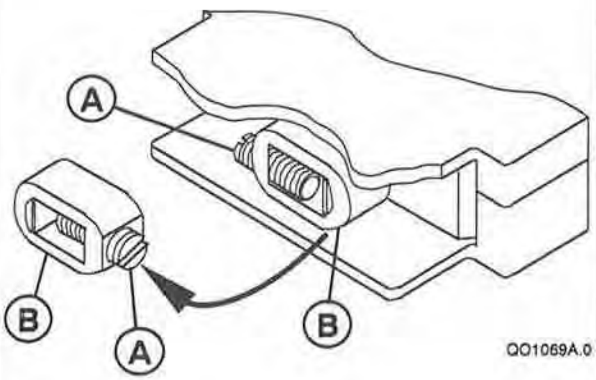
NEMA Type 1 general purpose enclosures with slip-on or hinged covers are supplied with knockouts for field addition of the kits listed in Table 1 on page 2.

INSTALLATION INFORMATION
FOR
SERIES 3 QOU CIRCUIT BREAKERS AND QYU SUPPLEMENTARY PROTECTORS

CIRCUIT BREAKER INSTALLATION

WARNING: Hazardous voltages can cause severe personal injury or death and/or property damage. Disconnect all power to electrical equipment before installing or removing circuit breaker.

Circuit breaker lugs can be rotated to allow access to wire binding screw (A) from top or bottom of circuit breaker. To rotate lug, remove wire binding screw (A) and rotate lug body (B) to desired position. Reinstall wire binding screw (A).



QO1069A.0

Mounting Feet

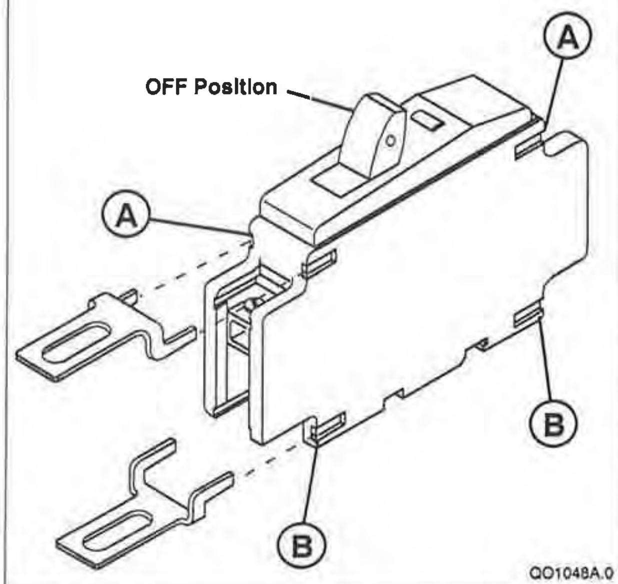
NOTE: Mounting feet are provided with individually packed circuit breakers. If circuit breaker was purchased in a bulk pack, mounting feet must be ordered separately.

Install mounting feet on each end of circuit breaker.

A. For flush mounting, install mounting feet at location (A).

B. For surface mounting, install mounting feet at location (B).

Use screws through mounting feet to fasten circuit breaker inside enclosure.



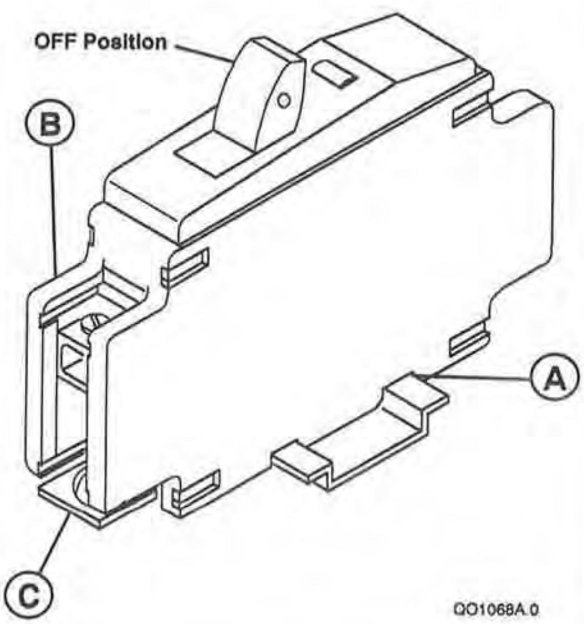
QO1048A.0

DIN Rail Mounting

Mount DIN rail in enclosure.

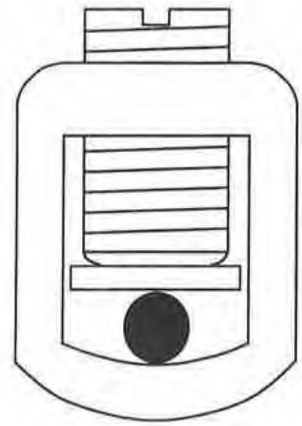
Slide circuit breaker notch (A) onto DIN rail lip. Push down end (B) to snap circuit breaker onto DIN rail.

Pull tab (C) to release circuit breaker for repositioning or removal.



Connecting Wires

See circuit breaker label for wire size and torque



CIRCUIT BREAKER REMOVAL

WARNING: Hazardous voltages can cause severe personal injury or death and/or property damage. Disconnect all power to electrical equipment before installing or removing circuit breaker.

Remove circuit breaker in reverse order of installation.

INSTALLATION AND OPERATING INSTRUCTIONS

GENERAL

The type 2820 is a conductance actuated control for detecting moisture in the oil chamber of a submersible pump motor. It is used as a warning device to indicate a seal leakage and to signal the need for preventative maintenance.

INSTALLATION

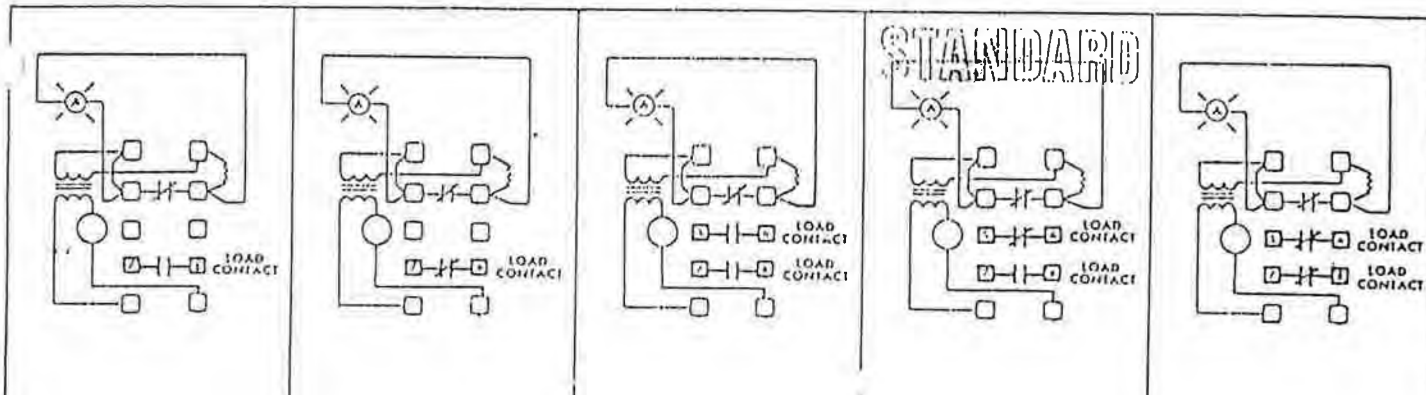
Mount control box vertically on wall or other solid structure and accomplish all indicated wiring. Terminals on the control are numbered and are in the same relative position as shown on the wiring diagram. Terminal pair 1-2 must be continuously energized from an A.C. supply line of electrical characteristics shown on the data plate. Contacts 5-6 and/or 7-8 are available for load duty, and if required, must be wired in series with the load device or devices, and that series branch circuit connected across a power source compatible with the load. Terminal 10 must be connected to the moisture sensing probe in the motor marked W1 via the cable provided with the motor. Terminal 9 must be connected to the motor chassis ground via cable provided with the motor.

OPERATION

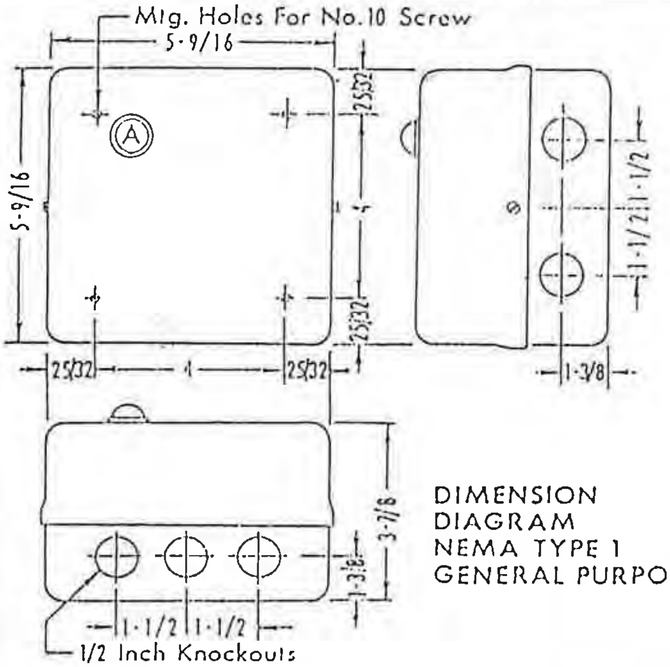
Normally the oil surrounding the probes is nonconductive, and the control and seal leakage indicator light will be deenergized. An influx of moisture past the outer seal and into the oil reservoir will cause a change in conductivity. This condition will cause the relay to energize, the seal leakage light to energize indicating a seal leakage. Load contacts 5-6 and/or 7-8 will also change from their normally open or normally closed position when the control energizes.

WARRICK CONTROLS, INC.
4237 NORMANDY COURT
ROYAL OAK, MI 48073
PH: 313/545-2512

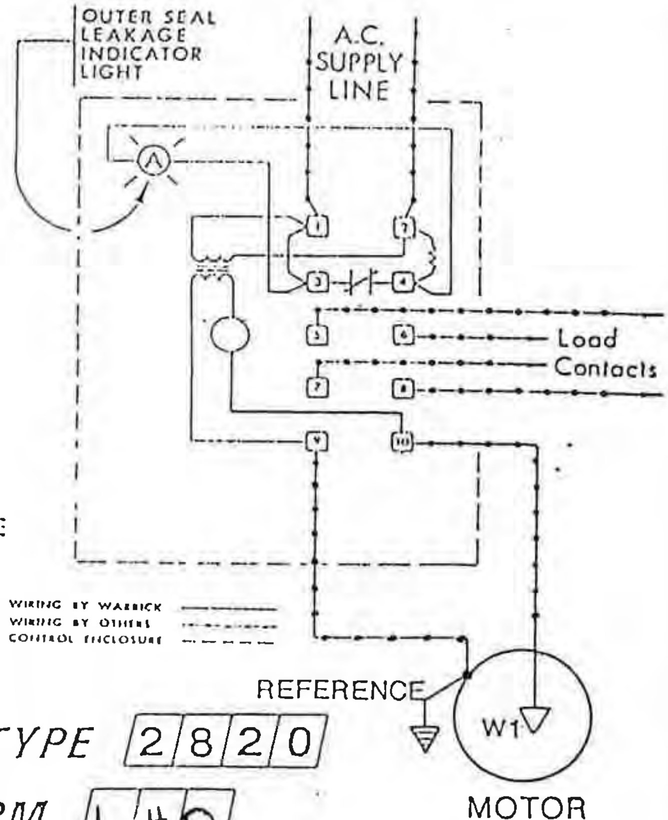
SA 2020



D CONTACT CONFIGURATION | E CONTACT CONFIGURATION | G CONTACT CONFIGURATION | H CONTACT CONFIGURATION | J CONTACT CONFIGURATION



DIMENSION DIAGRAM
NEMA TYPE 1
GENERAL PURPOSE



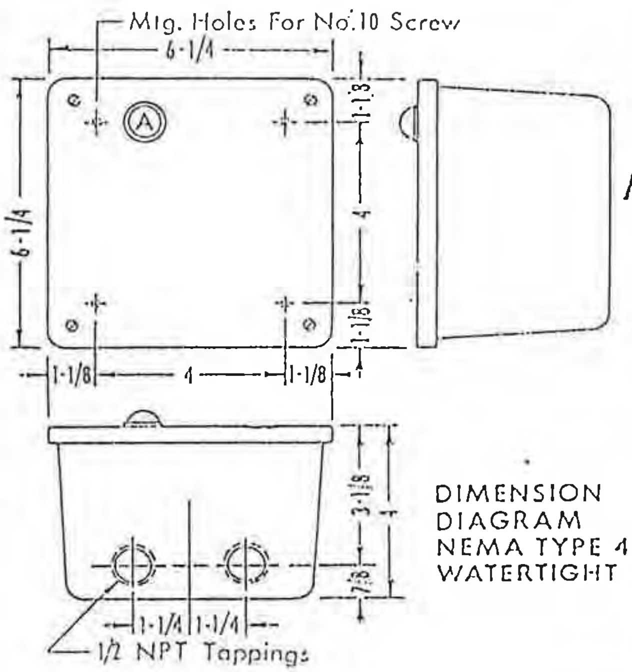
TYPE 2820

FORM 1 H 0

ENCLOSURE TYPE
1 - Nema 1 or 4 - Nema 4

CONTACT CONFIGURATION
D, E, G, H or J from diagrams at top

SUPPLY LINE VOLTAGE
1 - 115VAC
2 - 230VAC
4 - 460VAC
5 - 575VAC



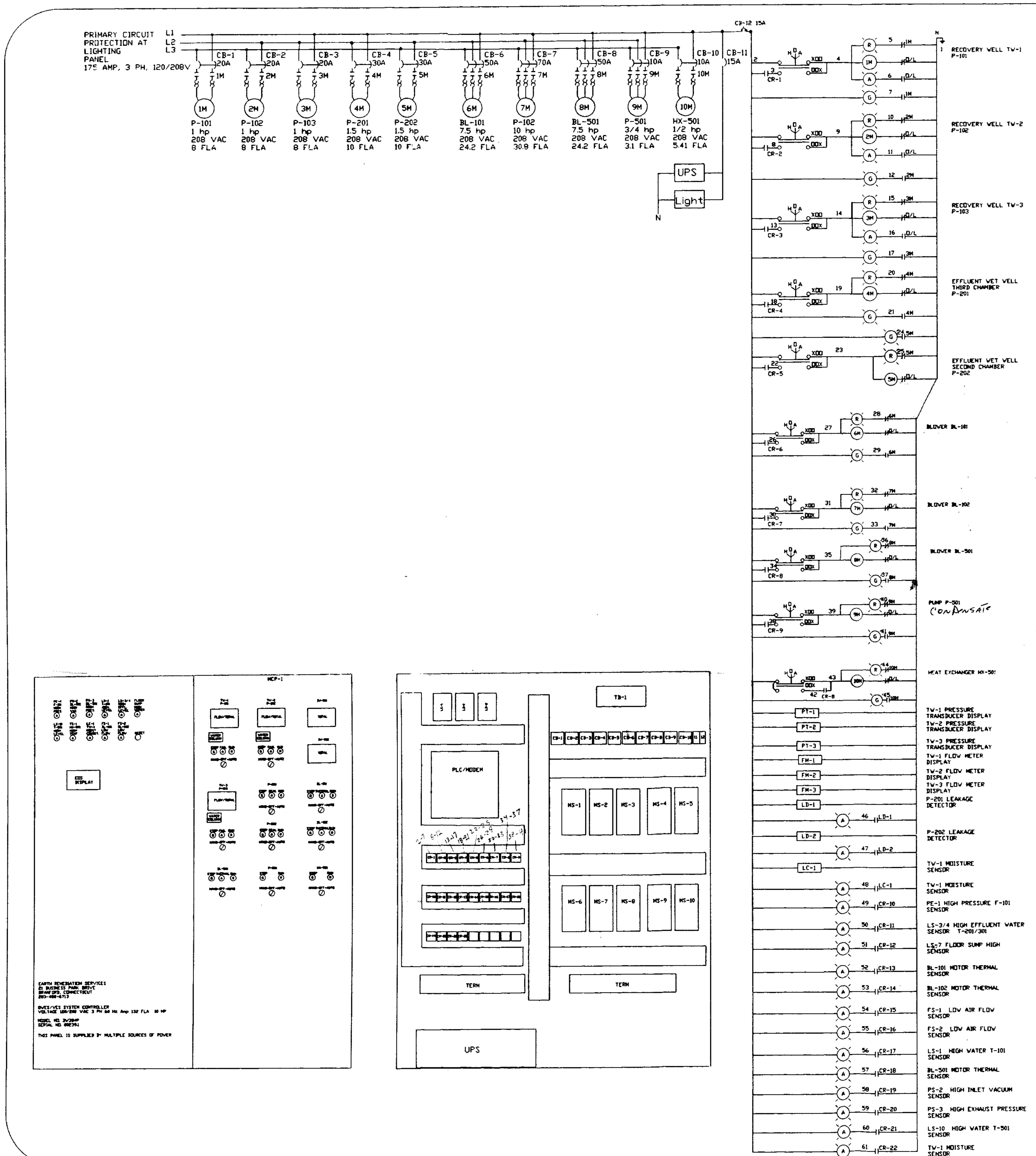
DIMENSION DIAGRAM
NEMA TYPE 4
WATERTIGHT

DATE: 11-5-91	DRWN BY: FB
SHEET NO: 1	CHKD BY: BE

WARRICK CONTROLS, INC.
4237 Normandy Court (Zip 48073)
P.O. Box 460
Royal Oak, Michigan 48068-0460

TITLE: MODEL 2820 SUBMERSIBLE MOTOR MOISTURE DETECTION CONTROL

DRWG NO: SA 2020



MCP-1 Component Listing

QTY	KEY	DESCRIPTION
1	Enclosure	A-604810LP
1	Panel	C-60P48
2	TB-1	Bussman 16021-3
3	CB-1,2,3	S/D QOU220
2	CB-4,5	S/D QOU230
2	CB-6,8	S/D QOU350
1	CB-7	S/D QOU370
1	CB-9	S/D QOU310
1	CB-10	S/D QOU210
2	CB-11,12	S/D QOU115
22	CR-1-27	OMRON M-K Series
6	MS-1,2,3,4,5,10	S/D 8536SBO1V02
2	MS-6,8	S/D 8536SCO3V02S
2	MS-7,9	S/D 8536SDO1V02S
1	MS-9	S/D 8536SAO12V02S
3	TW-1,2,3	Redlion IMP20162
3	FM-1,2,3	Hersey Model 1030P/115
2	LD-1,2	Warrick Type 28201H1
1	LC-1	Warrick Series 27AEIO
10	Ind Red	A/B 800T-Q10R
10	Ind Green	A/B 800T-Q10G
19	Ind Amb	A/B 800T-Q10A
1	PB	A/B 800T-A6A
10	H-O-A	A/B 800T-J2A
112	TERM	S/D 9080GM6
1	LIGHT	Hoffman A-LTMB1
1	WINDOW	Hoffman A-PWK53NF
1	PLC w/Modem	PROCONTROL SER. 2 TYPE A
1	UPS	APC BACKUPS 200
30	DUCT	T&B NA150X300WH6

General Notes

1. CONNECTIONS TO EOS PROCONTROL PER THE ATTACHED INPUT/OUTPUT SHEET.

No.	Revision/Issue	Date
1	CHANGE TO 120/208	10/97

an Earth Engineers, Inc. Company

HEYNEN ENGINEERS

21 BUSINESS PARK DR.
BRANFORD, CT 06405
203-481-6286(TEL)
203-488-3628(FAX)
203-439-0063
FAX 439-1036

3401 NO COURTENAY PKWY
MERRITT ISLAND, FL 32953
407-453-8685(TEL)
407-453-8305(FAX)
321-453-8685
FAX 321-453-8305

Project Name and Address

NOW Corporation
1182 Route 9G
Clinton, NY

Title

Motor Control Panel
GW & VES System

Project: 239	Drawing No.
Date: 9/97	
Scale: N/A	
Drawn By: JJB	Reviewed: LLB
File: MCP-1.239	Approved: PMH

WARNING: IT IS A VIOLATION OF THE NEW YORK STATE EDUCATION LAW FOR ANY PERSON, UNLESS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER AN ITEM OF THESE PLANS IN ANY WAY. IF ALTERATIONS TO THESE PLANS ARE REQUIRED, THE ALTERATIONS SHALL BE MADE IN ACCORDANCE WITH ARTICLE 145 - SUBSECTION 7209 OF THE NEW YORK STATE EDUCATION LAW.

NAMES		DATE
DRAWN:	DAM	11/8/95
DESIGN:	HAB	11/8/95
CHECKED:		
PE:	AWT	12/6/96
APP'D:		
APP'D:		
APP'D:		

GROUNDWATER/SVE TREATMENT ENCLOSURE LAYOUT

NOW CORPORATION SITE
SITE ID No. 3-14-008
WORK ASSIGNMENT No. D002520-34

RUST ENVIRONMENT & INFRASTRUCTURE

34288.300
DATE: DEC 96
34288-17
11 of 14
34288-17.dgn
4/15/97

NO.	REVISION	MADE	CHK	DATE	NO.	REVISIONS	MADE	CHK	DATE

Appendix C

Pre-Remedial Residential Water Conditions

Key to Residence IDs (Only Properties Referenced in SMP)

[Refer to Table 1 – NOW Corporation Site Residential Well Analytical Results Summary]

Residence ID	Current Property Reference
G	House #1
F	House #2
B	House #3
I	House #4

TABLE 1
NOW CORPORATION SITE
RESIDENTIAL WELL ANALYTICAL RESULTS SUMMARY

		COMPOUNDS DETECTED (ug/L)										
		1,1-DCA	1,1-DCE	1,1,1-TCA	TRANS-1,2 DCE	CIS-1,2 DCE	TCE	VINYL CHLORIDE	ACETONE	CARBON TETRACHLORIDE	TOTAL (1,2-DCE)	TOTAL VOC'S
(1) NYSDEC CLASS GA WATER QUALITY STANDARD/GUIDELINES		5	5	5	5	5	5	2	50 (G)	5	5	
RESIDENCE	SAMPLE DATE											
G	4-19-89	10	1	21	ND	1	66	ND	ND	ND	ND	99.0
G	8-21-89	290	56	420	8	ND	330	ND	ND	ND	ND	1104.0
G	2-21-90	NA	NA	NA	NA	NA	35	NA	ND	ND	ND	35.0
G	3-21-90	NA	NA	NA	NA	NA	86	NA	ND	ND	ND	86.0
G	8-9-90	79	12	63	ND	2	200	ND	ND	ND	ND	375.6
G	5-28-91	11	ND	27	ND	38	75	ND	ND	ND	ND	151.0
G	7-15-91	110	7	250	11	ND	550	ND	ND	ND	ND	928.0
G	10-28-91	310	8	700	13	ND	460	3	ND	ND	ND	1,514.0
G	1-3-92	20	3	27	4	ND	27	ND	ND	ND	ND	81.0
G	4-13-92	22	ND	32	ND	ND	150	ND	ND	ND	ND	204.0
G	7-16-92	73	4.9	140	3.3	ND	230	ND	ND	ND	ND	451.2
G	10-19-92	ND	220	600	NA	ND	780	NA	NA	ND	ND	1,600.0
G	1-7-93	130	7.2	380	NA	3.4	370	NA	NA	ND	ND	890.6
G	4-8-93	4	ND	6.1	NA	ND	28	NA	NA	ND	ND	38.1
G	8-3-93	59	ND	120	NA	6.9	400	NA	NA	ND	ND	585.9
G	11-8-93	350	16	640	NA	6.9	540	NA	NA	61	4.9	1,836.8
G	2-17-94	130	6.7	230	NA	7.1	320	NA	NA	NA	ND	693.8
G	6-21-94	71	ND	140	NA	ND	270	NA	NA	NA	ND	481.0
I	2-16-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
I	4-19-89	ND	ND	ND	ND	ND	ND	ND	94	ND	ND	94.0
I	6-25-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
I	2-21-90	NA	NA	NA	NA	NA	ND	NA	ND	ND	ND	0
I	3-21-90	NA	NA	NA	NA	NA	ND	NA	ND	ND	ND	0
I	5-16-90	NA	NA	NA	NA	NA	ND	NA	ND	ND	ND	0
I	11-19-90	ND	ND	ND	ND	NA	ND	NA	NA	ND	ND	0
I	3-1-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
I	4-3-91	ND	ND	ND	ND	NA	ND	NA	NA	ND	ND	0
I	4-28-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
H	2-16-89	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	0
H	9-14-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
H	7-7-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
F	9-13-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
F	10-23-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
F	3-15-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
F	4-28-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
F	11-4-93	ND	ND	1.6	ND	ND	2	ND	ND	ND	ND	3.6
J	2-16-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
J	9-13-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
J	4-27-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
E	9-13-89	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
E	4-29-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
NOW WELL	4-6-89	1600	95	2600	160	ND	960	2	ND	ND	ND	5617.0
NOW WELL	4-28-93	ND	ND	ND	ND	ND	0.8	ND	ND	ND	ND	0.8
K	4-29-93	ND	ND	4	ND	ND	9	ND	ND	ND	ND	13.0
K	7-7-93	1	ND	4	ND	2	8	ND	ND	ND	ND	15.0
K	4-22-94	ND	ND	4	ND	0.9	6	ND	ND	ND	ND	10.9
K	6-21-94	2.3	ND	5.5	ND	ND	11	ND	ND	ND	ND	18.8
B	4-28-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
B	11-4-93	1.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.7
D	4-28-93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0
9G GARDEN CTR	10-1-92	72	21	62	ND	2	20	ND	ND	ND	ND	177.0
9G GARDEN CTR	4-29-93	ND	5	53	ND	1	28	ND	ND	ND	ND	87.0
M	4-29-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
N	4-29-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
L	7-7-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
C	7-7-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0
A	11-4-93	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND	0

(1) NYSDEC WATER QUALITY STANDARDS AND GUIDANCE VALUES (11/91)

(G) GUIDANCE VALUE

SEE FIGURE 4.1 FOR SAMPLE LOCATIONS

ND NOT DETECTED

NA NOT ANALYZED

NOTE DATA NOT VALIDATED

Appendix D

House #4 – Routine Operations of Soil Vapor Mitigation System

June 11, 2009

Current occupant of
House #4

RE: Routine Operations of Soil Vapor Mitigation System
Introductory Letter for 2009 – 2011 Inspection & Maintenance
House #4 ; System ID: 314008-NOW-001
Site Name: NOW Corporation; Site Code: 314008

Dear Property Owner:

This letter is being sent to provide you with important information regarding the ventilation system that the New York State Department of Environmental Conservation (NYSDEC) is responsible for maintaining at the property referenced above. The NYSDEC is maintaining the system as part of the ongoing remediation of the NOW Corporation site.

HDR, Inc. has been retained by the NYSDEC to conduct routine inspection and maintenance (I&M) activities at hundreds of ventilation systems across the state, including the system installed on your property. HDR is an engineering and consulting firm with offices located across the country, ten in New York alone. Contact information is provided below.

HDR, Inc.
Attn: Michael P. Musso, P.E.
One Blue Hill Plaza
Pearl River, NY 10965
Phone: 845-735-8300
Email: michael.musso@hdrinc.com

In order to familiarize our technical staff with the operational details of your system and make sure it is performing as expected, an inspection of the system will be performed by HDR (or one of our subcontractors) sometime between September 2009 and April 2010. HDR will attempt to coordinate **interior access** for the upcoming inspection for purposes of observing the system fan and other equipment that may be contained within the building's basement or attic. Interior inspections are anticipated to be brief (15 – 30 minutes). You will be receiving another letter providing the anticipated inspection date approximately two weeks prior to the inspection. In addition, HDR will attempt to contact you by telephone a few days prior to the scheduled inspection for confirmation.

In the meantime, please contact the NYSDEC at the toll-free number 1-888-459-8667 if any of the following situations arise:

- If the exhaust fan is not operating or is making excessive, unusual noise;
- If the liquid levels in any U-tube are even (no difference in levels);
- If any new construction or structural changes occur that affect the footprint of the building or the basement or crawl space including penetrations through the slab;
- If there is standing water or flooding observed in the basement;
- If any new combustion appliance or exhaust system is installed; or
- If the property is sold.

If you are not a resident or occupant of the building, please pass along this information to your tenant(s). Thank you again for your cooperation.

Respectfully submitted on behalf of NYSDEC,

Henningson, Durham & Richardson
Architecture and Engineering, P.C.
In association with HDR Engineering, Inc.

Michael P. Musso, P.E.

Michael P. Musso, P.E.
Project Manager

October 19, 2009

Current occupant of
House #4

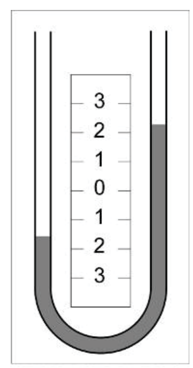
RE: Routine Operations of Soil Vapor Mitigation System
Annual Inspection Notification
House #4 ; System ID#: 314008-NOW-001
Site Name: NOW Corporation; Site Code: 314008

Dear Property Owner:

This letter is being sent to provide you with important information regarding the ventilation system that the New York State Department of Environmental Conservation (DEC) installed, or is responsible for maintaining, at the property referenced above. The DEC is maintaining the system as part of the ongoing remediation of the NOW Corporation site. If you have any questions regarding the information contained in this letter, please call Mr. Eric Hausamann at the DEC's toll-free number: 888-459-8667.

The ventilation system installed on your property draws air from beneath the building and vents it to the outdoor air above the roofline to prevent subslab vapors from potentially entering your building (see the attached schematic diagram at the end of this letter). The primary system components include:

- An electrically-powered exhaust fan mounted on the outside of your home/building. The exhaust fan should operate on a continuous basis.
- Vacuum gauges ("U-tubes") attached at one or more suction points (pipe entering the basement floor). The levels of the liquid in the U-tube(s) should be uneven as shown to the right.
- Labels identifying the system and providing contact information.



UNEVEN LEVELS INDICATE SYSTEM IS OPERATING

While the system is designed to operate continuously, there may be instances when the system needs to be repaired or modified. In any of the following situations, please contact the DEC at the toll-free number listed above and on the system label:

- If the exhaust fan is not operating or is making excessive, unusual noise;
- If the liquid levels in any U-tube are even (no difference in levels);
- If any new construction or structural changes occur that affect the footprint of the building or the basement or crawl space including penetrations through the slab;
- If there is standing water or flooding observed in the basement;
- If any new combustion appliance or exhaust system is installed; or
- If the property is sold.

HDR has been retained by the DEC to conduct inspection and maintenance activities associated with your ventilation system. A periodic inspection of the ventilation system installed on your property is required and will be performed by HDR or one of our subcontractors. Please be advised that HDR has scheduled an interior and exterior inspection of the soil vapor mitigation system on **November 18th, 2009**. HDR will attempt to contact you by telephone a few days prior to the scheduled inspection as a reminder. My contact information is provided below.

HDR, Inc.
Attn: Michael P. Musso, P.E.
One Blue Hill Plaza
Pearl River, NY 10965
Phone: 845-735-8300
Email: michael.musso@hdrinc.com

HDR will attempt to coordinate **<u>interior access</u>** for the inspection, for purposes of observing the system fan and other equipment that may be contained within the building's basement or attic. Interior inspections are anticipated to be brief (15 – 30 minutes).

If you are not a resident or occupant of the building, please pass along this information to your tenant(s) or kindly let me know who we should contact. Thank you again for your cooperation.

Respectfully submitted on behalf of the DEC,

Henningson, Durham & Richardson
Architecture and Engineering, P.C.
In association with HDR Engineering, Inc.

Michael P. Musso, P.E.

Michael P. Musso, P.E.
Project Manager

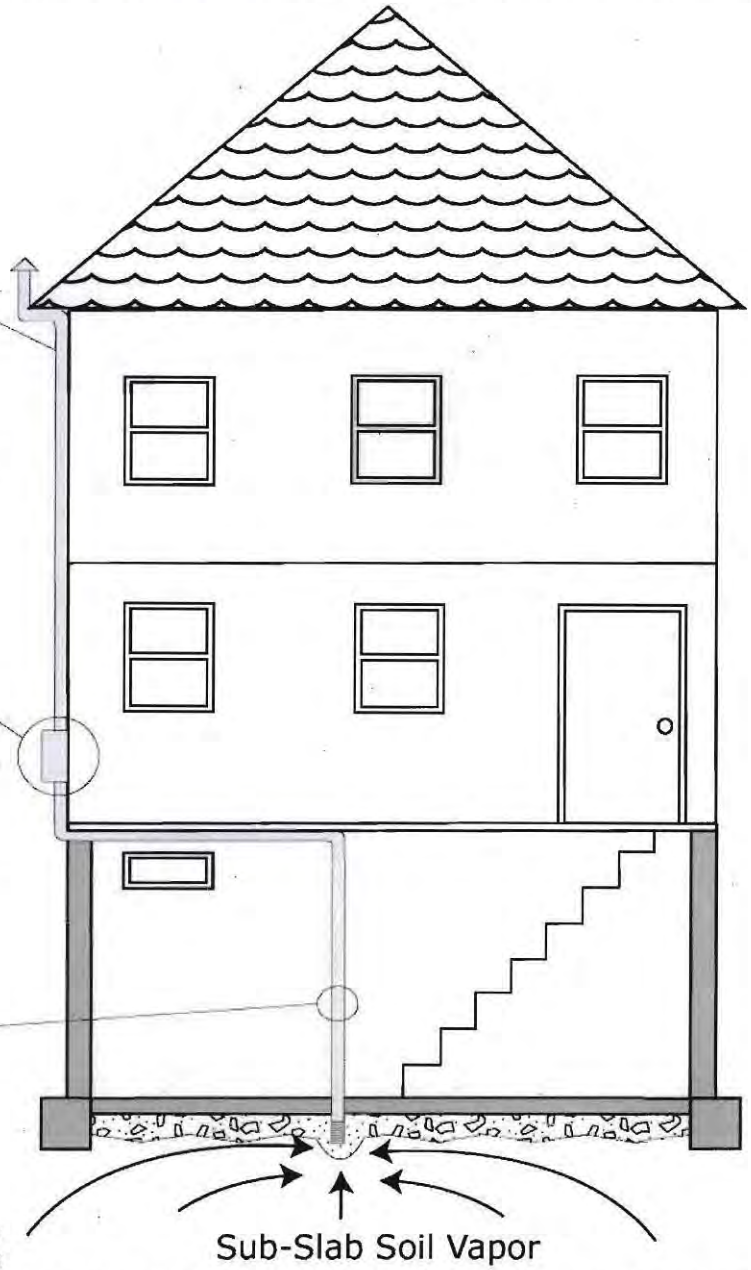
Sub-Slab Depressurization System

(commonly called a radon mitigation system)

The vent pipe is routed **up** the side of the structure to a location above the roof line.

A fan is used to draw soil vapor from beneath the slab.

A liquid gauge, or manometer is used to verify that the system is operating properly



A sub-slab depressurization system vents contaminated soil vapor before it enters a structure. The fan draws vapor from beneath the building outside to the roof line where it is released to the outside air.

Export Data

Import Sys Data

Periodic Operations Visit Form

☐ Check box if new sys info

System ID: **314008-NOW-001**

Date of Visit: **Nov 18, 2009**

Owner Name:	Current occupant of House #4	Date Installed:	Nov 11, 2008
System Address:		Telephone:	
City:	Zip:	Alt. Telephone:	
Performed By:	Paul Lenarczyk	Site No:	314008
Company:	Yu & Associates	Site Name:	NOW Corporation

EXTERIOR

Fan Operation Confirmation

	Fan #1	Fan #2	Fan #3
Fan Model No(s).	RP145		
Is Fan Operating (arrival)?	(•) Yes ( ) No	( ) Yes ( ) No	( ) Yes ( ) No
Confirmation Method	Sound		
Is Fan Operating (departure)?	(•) Yes ( ) No	( ) Yes ( ) No	( ) Yes ( ) No

Requested to inspect interior system components? ( ) Yes ( ) No

If yes, when and by whom? ____________ Date: ____________

INTERIOR

Structural Review	Yes	No	Notes
Change in building footprint since last inspection?	( )	(•)	
Basement occupied (>4 hrs per day)?	( )	(•)	
Heating/ventilation system modifications?	( )	(•)	
Crawlspace inspected?	( )	(•)	
Large cracks in floor or near sumps?	( )	(•)	
Wall penetrations or cracks noted?	( )	(•)	
Piping, Slab & Wall			
Are system suction points sealed?	(•)	( )	
Is piping system in need of repair?	( )	(•)	
Miscellaneous			
Are manometer levels equal?	( )	(•)	2.1
Are system labels accurate and applied correctly?	(•)	( )	

Maintenance completed (check all that apply): ☐ Replace fan ☐ Seal pipe ☐ Electrical ☒ Other

Describe repairs made and any proposed actions requiring a subsequent visit (if necessary):

Secured metal clamps above and under the fan. No further action required.

Print Form

Submit by Email

September 13, 2010

Current occupant of
House #4

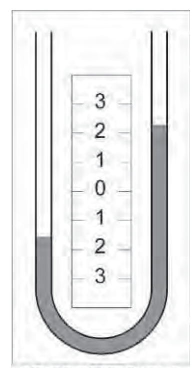
RE: Routine Operations of Soil Vapor Mitigation System
Annual Letter
House #4 ; System ID: 314008-NOW-001
Site Name: NOW Corporation Site Code: 314008

Dear Property Owner:

This letter is being sent to provide you with information regarding the ventilation system that the New York State Department of Environmental Conservation (DEC) installed, or is responsible for maintaining, at the property referenced above. The DEC is maintaining the system as part of the ongoing remediation of the NOW Corporation site. If you have any questions regarding the information contained in this letter, please refer to the Vapor Intrusion Mitigation System Owner's Manual (Manual) that was left at the address during the last system inspection visit, or call Mr. Eric Hausamann at the DEC's toll-free number: 888-459-8667.

The ventilation system installed on your property draws air from beneath the building and vents it to the outdoor air above the roofline to prevent subslab vapors from potentially entering your building (see the attached schematic diagram at the end of this letter). The primary system components include:

- An electrically-powered exhaust fan mounted on the outside of your home/building. The exhaust fan should operate on a continuous basis.
- Vacuum gauges ("U-tubes") attached at one or more suction points (pipe entering the basement floor). The levels of the liquid in the U-tube(s) should be uneven as shown to the right.
- Labels identifying the system and providing contact information.



UNEVEN LEVELS INDICATE SYSTEM IS OPERATING

While the system is designed to operate continuously, it is important that it be inspected periodically by the building owner or occupant. There may be instances when the system needs to be repaired or modified. If the exhaust fan is not operating, the occupant should refer to the Manual for tips to troubleshoot the issue. In any of the following situations, please contact the DEC at the toll-free number listed above and on the system label:

- If the exhaust fan is not operating or is making excessive, unusual noise;
- If the liquid levels in any U-tube are even (no difference in levels);
- If any new construction or structural changes occur that affect the footprint of the building or the basement or crawl space including penetrations through the slab;
- If there is standing water or flooding observed in the basement;
- If any new combustion appliance or exhaust system is installed; or

- If the property is sold.

HDR has been retained by the DEC to coordinate maintenance activities associated with ventilation systems like the one at your property. You are responsible for periodically checking to see that the system is operating and informing the DEC or HDR if it is not running properly. In the mean time, should you have any questions about the system or the information included in the Manual, please feel free to contact me. My contact information is provided below.

HDR, Inc.
Attn: Michael P. Musso, P.E.
One Blue Hill Plaza
Pearl River, NY 10965
Phone: 845-735-8300
Email: michael.musso@hdrinc.com

If you are not a resident or occupant of the building, please pass along this information to your tenant(s) or kindly let me know who we should contact. Thank you again for your cooperation.

Respectfully submitted on behalf of the DEC,

Henningson, Durham & Richardson
Architecture and Engineering, P.C.
In association with HDR Engineering, Inc.

Michael P. Musso, P.E.

Michael P. Musso, P.E.
Project Manager

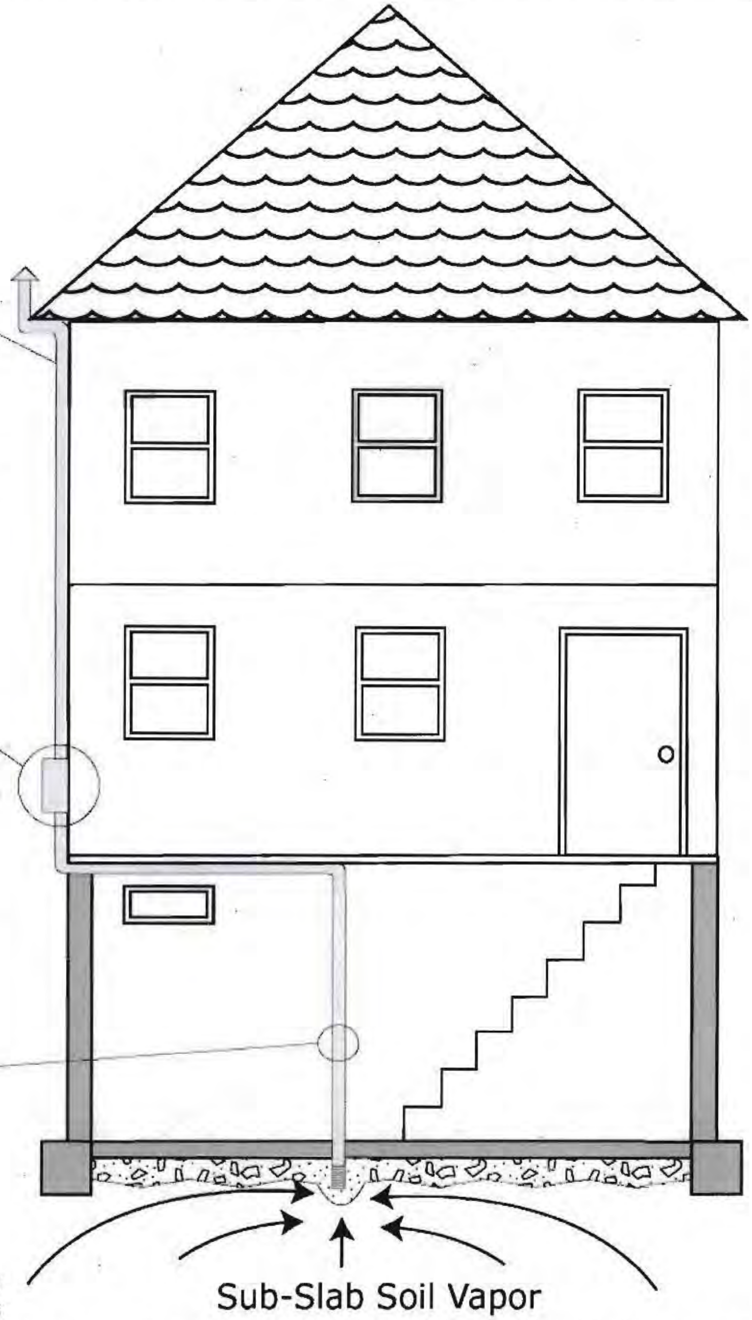
Sub-Slab Depressurization System

(commonly called a radon mitigation system)

The vent pipe is routed up the side of the structure to a location above the roof line.

A fan is used to draw soil vapor from beneath the slab.

A liquid gauge, or manometer is used to verify that the system is operating properly



A sub-slab depressurization system vents contaminated soil vapor before it enters a structure. The fan draws vapor from beneath the building outside to the roof line where it is released to the outside air.

Appendix E

Soil Boring Logs and Monitoring Well Construction Diagrams

RUST E&I Albany, NY (518) 458-1313	**Test Boring Log**	Boring No. TW-2

PROJECT: NOW Corp.					Sheet 1 of 1
CLIENT: NYSSP					Job No. 34288.000
DRILLING CONTRACTOR: American Auger					Meas. Pt. Elev.
PURPOSE:					Ground Elev.
DRILLING METHOD: Air hammer		SAMPLE	CORE	CASING	Datum
DRILL RIG TYPE: I-R TZW	TYPE		12.25" to 15"	8" to 15'	Date Started: 12/14
GROUNDWATER DEPTH:	DIAM.				Date Finished:
MEAS. PT.:	WEIGHT				Driller: Rocky Boyce
DATE OF MEAS.:	FALL				Inspector: Rothset

Depth (Feet)	Sample Number	Blow Count	~~Unified Classification~~	GRAPHIC LOG	GEOLOGIC DESCRIPTION	REMARKS
0			←12.25"→ ←8"→		Brown silty clay loam w/ occ. gravel, Till.	Consistent w/ other Borings,
4'						
8'						
12'	Grout					
8'		9'			Shale, gray to blackish gray appears phyllite (shiny luster	
12'						
16'		15'				
20						

RUST E&I Albany, NY (518) 458-1313	Test Boring Log			Boring No. TW-3
PROJECT: NOW Corp				Sheet 1 of 1
CLIENT: NYS DEC				Job No. 34288.000
DRILLING CONTRACTOR: American Auger				Meas. Pt. Elev.
PURPOSE:				Ground Elev.
DRILLING METHOD: Air Hammer		SAMPLE	CORE	CASING	Datum
DRILL RIG TYPE:	TYPE		12.25"+11'	8" to 11'	Date Started: 12/14
GROUNDWATER DEPTH:	DIAM.			13' total	Date Finished: 12/
MEAS. PT.:	WEIGHT		2.' stickup on casing		Driller: Rocky Bayne
DATE OF MEAS.:	FALL				Inspector: R. Hiser

Depth (Feet)	Sample Number	Blow Count	~~Unified Classification~~	GRAPHIC LOG	GEOLOGIC DESCRIPTION	REMARKS
0					-Brown silty clay loam w/ gravel, shale pieces. Till	As in other Boring
2						
4						
6	Grout.					
8					-Shale, gray w/ fine parting	
~~5~~ 10						
10						

RUST E&I

RUST E&I Albany, NY (518) 458-1313	**Test Boring Log**	Boring No. IW-1
PROJECT: Now Corp		Sheet 1 of 1
CLIENT: NYSDEC		Job No. 34288,000
DRILLING CONTRACTOR: American Auger		Meas. Pt. Elev.
PURPOSE:		Ground Elev.

		SAMPLE	CORE	CASING	
DRILLING METHOD: Air Hammer					Datum
DRILL RIG TYPE: IR T2W	TYPE		12.25"	8" to 19'4"	Date Started: 12/13
GROUNDWATER DEPTH:	DIAM.				Date Finished: 12/13
MEAS. PT.:	WEIGHT		2' 6" stickup		Driller: Rocky Bove
DATE OF MEAS.:	FALL				Inspector: Rich Hirst

Depth (Feet)	Sample Number	Blow Count	~~Unified Classification~~	GRAPHIC LOG	GEOLOGIC DESCRIPTION	REMARKS
0			12.25"		Brown silty clay loam w/ gravel, Till	Till overburden
5			8"			
10	Grout					
15					- shale, grey to blackish grey.	-
20						
25						
40						

Not to scale

RUST E&I Albany, NY (518) 458-1313	Test Boring Log				Boring No. IW-2
PROJECT: NOW Corp.					Sheet 1 of 1
CLIENT: NYSDEC					Job No. 34286.000
DRILLING CONTRACTOR: America Auger					Meas. Pt. Elev.
PURPOSE:					Ground Elev.
DRILLING METHOD: Air Hammer		SAMPLE	CORE	CASING	Datum
DRILL RIG TYPE: I-R T2W	TYPE		12.25"	8" to 23.4'	Date Started:
GROUNDWATER DEPTH:	DIAM.				Date Finished:
MEAS. PT.:	WEIGHT				Driller:
DATE OF MEAS.:	FALL				Inspector:

Depth (Feet)	Sample Number	Blow Count	Unified Classification	GRAPHIC LOG	GEOLOGIC DESCRIPTION	REMARKS
0			12.25		Brown, silty clay loam w/ gravel, Till	
5			8"			
10						
15	grout					
20		18'4"			Shale, black to grayish black	
25		23.4'				
10						

RUST E&I Albany, NY (518) 458-1313	Test Boring Log			Boring No. OW-6
PROJECT: Now Corp				Sheet 1 of 1
CLIENT: NY~~S~~ DEC				Job No. 34288.000
DRILLING CONTRACTOR: American Auger				Meas. Pt. Elev.
PURPOSE:				Ground Elev.
DRILLING METHOD: Air Rotary	SAMPLE	CORE	CASING	Datum
DRILL RIG TYPE: I-R T2W / TYPE		9 7/8"	8" to 9'4"	Date Started: 12/18
GROUNDWATER DEPTH: ~2' / DIAM.				Date Finished:
MEAS. PT.: / WEIGHT		2.2' stickup		Driller: Zachy Boyce
DATE OF MEAS.: / FALL				Inspector: Zach Hisert

Depth (Feet)	Sample Number	Blow Count	~~Unified Classification~~	GRAPHIC LOG	GEOLOGIC DESCRIPTION	REMARKS
0	grout		9 7/8"		Brown, silty clay loam w/ gravel till.	Till overburden,
4'			8"		Gray to black gray shale.	water throughout section, coming from above
9'4"						
0						
40'						

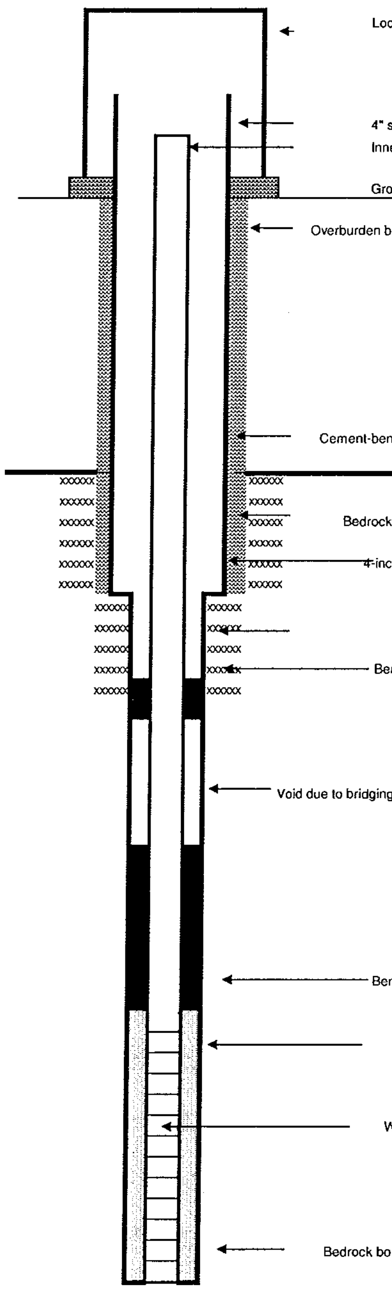
Not to Scale

Attachment 4
Well Construction Diagram
NOW Corporation
Staatsburg, NY

EarthTech
A Tyco International Ltd. Company

Bedrock Well Diagram | **Well No. MW-12S/D**

Project: **NYSDEC IIWA - NOW Corporation**	Location: **Staatsburg, NY**	Page 1 of 1		
Earth Tech Project No.:	Subcontractor: **Earth Tech**	Water Levels		
Surface Elevation: 285 Ft	Driller: **Aztech**	Date	Time	Depth
Top of PVC Casing Elevation: 287.5 Ft	Well Permit No.: NA Earth Tech Rep.: Dino Zack			
Datum: NGVD 1988	Date of Completion: May 8, 2008			



Locking protective stickup with concrete pad 2.85 ft

4" steel overburden casing stickup 2.1 ft
Inner PVC 2" casing stickup (deep) 2.55 ft

Ground Surface 285 ft

Overburden borehole diameter 6.75 inches (ID)

Cement-bentonite grout from 0.0 ft to 15.0 ft

Top of Bedrock 10.2 ft bgs

Bedrock socket diameter 5.8 inches

4-inch ID steel casing 2.1 ft to 15.0 ft

Open hole from 15.0 ft to 17.0 ft

Bentonite seal from 17.0 ft to 18.0 ft

Void due to bridging of bentonite 17.0 ft to 41.0 ft

Bentonite seal from -41.0 ft to -49.0 ft

Filter pack from -49.0 ft to -60.0 ft

Sand Size Morie "0" grade

Well screen from -50.0 ft to -60.0 ft

Diameter 2 inches
Slot size 010
Type PVC

Bedrock borehole diameter 3.75 inches

Bottom of Borehole at -60.0 ft

(NOT TO SCALE)

Appendix F

Sample Checklists and Forms

Monitoring Well Purging / Sampling Form

Project Name and Number: ______________________

Monitoring Well Number: ____________ Date: ____________

Samplers: ______________________

Sample Number: ____________ QA/QC Collected? ____________

Purging / Sampling Method: ______________________

1. L = Well Depth: ________ feet
2. D = Riser Diameter (I.D.): ________ feet
3. W = Depth to Water: ________ feet
4. C = Column of Water in Well: ________ feet
5. V = Volume of Water in Well = $C(3.14159)(0.5D)^2(7.48)$ ________ gal
6. 3(V) = Target Purge Volume ________ gal

D (inches)	D (feet)
1-inch	0.08
2-inch	0.17
3-inch	0.25
4-inch	0.33
6-inch	0.50

Conversion factors to determine V given C

D (inches)	1-inch	2-inch	3-inch	4-inch	6-inch
V (gal / ft)	0.041	0.163	0.37	0.65	1.5

Water Quality Readings Collected Using ______________________

Parameter	**Units**	**Readings**						
Time	24 hr							
Water Level (0.33)	feet							
Volume Purged	gal							
Flow Rate	mL/min							
Turbidity (+/- 10%)	NTU							
Dissolved Oxygen (+/- 10%)	%							
Dissolved Oxygen (+/- 10%)	mg/L							
Eh / ORP (+/- 10)	MeV							
Specific Conductivity (+/- 3%)	mS/cm^c							
Conductivity (+/- 3%)	mS/cm							
pH (+/- 0.1)	pH unit							
Temp (+/- 0.5)	C°							
Color	Visual							
Odor	Olfactory							

Comments:

Monitoring Well Purging/Sampling Form (Low-Flow Sampling)

Project Name and Number: ______________________________

Monitoring Well Number: ____________ Date: ______________________

Samplers: ______________________________

Sample Number: ____________ QA/QC Collected? ______________________

Purging / Sampling Method: ______________________________

1. L = Total Well Depth: ________ feet
2. D = Riser Diameter (I.D.): ________ feet
3. W = Static Depth to Water (TOC): ________ feet
4. C = Column of Water in Casing: ________ feet
5. V = Volume of Water in Well = $C(3.14159)(0.5D)^2(7.48)$ ________ gal
6. D2 = Pump Setting Depth (ft): ________ feet
7. C2 = Column of water in Pump/Tubing (ft): ________ feet
8. Tubing Volume = C2(0.005737088) ________ gal

D (inches)	D (feet)
1-inch	0.08
2-inch	0.17
3-inch	0.25
4-inch	0.33
6-inch	0.50

Conversion factors to determine V given C

D (inches)	1-inch	2-inch	3-inch	4-inch	6-inch
V (gal / ft)	0.041	0.163	0.37	0.65	1.5

Water Quality Readings Collected Using ______________________________

Parameter	**Units**				**Readings**			
Time	24 hr							
Water Level (0.33)	feet							
Volume Purged	gal							
Flow Rate	mL / min							
Turbidity (+/- 10%)	NTU							
Dissolved Oxygen (+/- 10%)	%							
Dissolved Oxygen (+/- 10%)	mg/L							
Eh / ORP (+/- 10)	MeV							
Specific Conductivity	mS/cm^c							
Conductivity (+/- 3%)	mS/cm							
pH (+/- 0.1)	pH unit							
Temp (+/- 0.5)	C							
Color	Visual							
Odor	Olfactory							

Comments:

* Three consecutive readings within range indicates stabilization of that parameter.

Operation, Maintenance & Monitoring Checklist

Groundwater Treatment System
NYSDEC SSP/NOW Corporation Site
Town of Clinton, New York

This summary inspection checklist is to be completed during each site inspection. Note all items which require repair or maintenance. Use the last page to note any additional comments or usual events.

General:

Service by: ____________________ Weather/Temperature: ____________________

Date: ______________ Arrival Time: ______________ Departure Time: ______________

Reason for Service ____

Inspection Items:			OK:	Comments:
Site Appearance/Condition			___	____________________
Building Exterior				
Entry Door			___	____________________
Overhead Door			___	____________________
Propane Tank		___%	___	____________________
Building Interior				
Indication of Spills or Leaks			___	____________________
Building Heater			___	____________________
Phone System			___	____________________
Exhaust Fan			___	____________________
Fire Extinguisher			___	____________________
Floor Sump Pump			___	____________________
Groundwater Treatment System				
Air Stripper	(T-101)		___	____________________
Settling Tank	(T-201)		___	____________________
Sand Filter	(F-101)		___	____________________

Groundwater Treatment System (continued)

Main Effluent Pump	(P-201)	____	____
Mid-Tank Pump	(P-202)	____	____
Stripper Blower	(BL-101)	____	____
Indication of Alarm		____	____

Groundwater Treatment Wells

TW-1 Pump	(P-101)	____	____
TW-1 Transducer	(PE-1)	____	____
TW-1 Flow Meter	(FE-1)	____	____
TW-2A Pump	(P-102)	____	____
TW-2A Transducer	(PE-2)	____	____
TW-2A Flow Meter (FE-2)		____	____
TW-3 Pump	(P-103)	____	____
TW-3 Transducer	(PE-3)	____	____
TW-3 Flow Meter	(FE-3)	____	____

Effluent Discharge

Distribution Pit	(T-301)	____	____
Meter Pit	(T-301)	____	____
Infiltration Well 1	(IW-1)	____	____
Infiltration Well 2	(IW-2)	____	____
Outfall		____	____

Vapor Extraction System

Knock-out Pot	(T-501)	____	____
Air Filter	(F-501)	____	____
Vapor Blower	(BL-501)	____	____
Heat Exchanger	(H-501)	____	____
Condensate Pump	(P-501)	____	____

Instrumentation/Readings:

TW-1

Pumping Rate	(FE-1)	______ GPM
Water Level Above Transducer	(PE-1)	____________ feet
Flow Meter Reading	(FE-1)	____________ gallons
Pump Pressure		______ psi

TW-2A

Pumping Rate	(FE-2)	______ GPM
Water Level Above Transducer	(PE-2)	____________ feet
Flow Meter Reading	(FE-2)	____________ gallons
Pump Pressure		______ psi

TW-3

Pumping Rate	(FE-3)	______ GPM
Water Level Above Transducer	(PE-3)	____________ feet
Flow Meter Reading	(FE-3)	____________ gallons
Pump Pressure		______ psi

Air Stripper

Stripper Blower Pressure	______ inches H_2O
Air Temperature in Stripper	______ °F
Pressure Gauge - Left Leg	______ inches H_2O
Pressure Gauge - Right Leg	______ inches H_2O
Pressure/Vacuum on the Stripper	______ inches H_2O

Sand Filter

Influent Pressure	______ psi
Effluent Pressure	______ psi
Differential Pressure Across Filter	______ *psi*

Effluent Flow

Total System Meter Reading	(FE-4)	____________	gallons
IW-1 Flow Meter Reading		____________	gallons
IW-2 Flow Meter Reading		____________	gallons

Vapor Extraction System

Vapor Blower Vacuum	______	inches Hg
Vacuum before Filter with Dilution Air	______	inches Hg
Vacuum on Knock-out Pot	______	inches Hg
Blower Inlet Temperature	______	°F
Blower Outlet Temperature	______	°F
Pressure After Blower	______	psi
Heat Exchanger Outlet Temperature	______	°F

Water Levels

Well ID	Water Level	Well ID	Water Level
MW-1	________ ft b.m.p.	MW-7S	________ ft b.m.p.
MW-2	________ ft b.m.p.	MW-7D	________ ft b.m.p.
MW-3	________ ft b.m.p.	OW-1	________ ft b.m.p.
MW-3S	________ ft b.m.p.	OW-2	________ ft b.m.p.
MW-4	________ ft b.m.p.	OW-6	________ ft b.m.p.
MW-4D	________ ft b.m.p.	IW-1	________ ft b.m.p.
MW-5	________ ft b.m.p.	IW-2	________ ft b.m.p.
MW-6S	________ ft b.m.p.		
MW-6D	________ ft b.m.p.		

Additional Wells (optional)

MW-8	________ ft b.m.p.	TW-2A	________ ft b.m.p.
MW-9	________ ft b.m.p.	OW-3	________ ft b.m.p.
MW-10	________ ft b.m.p.	OW-4	________ ft b.m.p.
MW-11	________ ft b.m.p.	OW-5	________ ft b.m.p.
MW-10	________ ft b.m.p.		

Influent/Effluent Sampling

On a monthly basis, samples of the system influent and effluent must be collected and submitted for the following analyses:

- VOAs by EPA 8260
- Metals (Al, As, Ba, Cr, Cu, Fe, Mn, Hg, Ni, Zn)
- TDS
- TSS
- O&G
- Cyanide

pH measurements must be made in the field:

Influent pH ________

Effluent pH ________

Notes/Explanations

(Please include any additional information on those items which require attention as indicated above.)

Periodic Operations Visit Form

☐ Check box if new sys info

System ID: ______ Date of Visit: ______

Owner Name: ______ Date Installed: ______

System Address: ______ Telephone: ______

City: ______ Zip: ______ Alt. Telephone: ______

Performed By: ______ Site No: ______

Company: ______ Site Name: ______

EXTERIOR

Fan Operation Confirmation

	Fan #1	Fan #2	Fan #3
Fan Model No(s).	______	______	______
Is Fan Operating (arrival)?	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No
Confirmation Method			
Is Fan Operating (departure)?	○ Yes ○ No	○ Yes ○ No	○ Yes ○ No

Requested to inspect interior system components? ○ Yes ○ No

If yes, when and by whom? ______ Date: ______

INTERIOR

Structural Review			Notes
Change in building footprint since last inspection?	○ Yes	○ No	______
Basement occupied (>4 hrs per day)?	○ Yes	○ No	______
Heating/ventilation system modifications?	○ Yes	○ No	______
Crawlspace inspected?	○ Yes	○ No	______
Large cracks in floor or near sumps?	○ Yes	○ No	______
Wall penetrations or cracks noted?	○ Yes	○ No	______
Piping, Slab & Wall			
Are system suction points sealed?	○ Yes	○ No	______
Is piping system in need of repair?	○ Yes	○ No	______
Miscellaneous			
Are manometer levels equal?	○ Yes	○ No	______
Are system labels accurate and applied correctly?	○ Yes	○ No	______

Maintenance completed (check all that apply): ☐ Replace fan ☐ Seal pipe ☐ Electrical ☐ Other

Describe repairs made and any proposed actions requiring a subsequent visit (if necessary):

Annual Site-Wide Inspection Checklist

Purpose of the Checklist

The site inspection checklist provides a useful method for collecting important information during the annual Site-Wide Inspection. The checklist serves as a reminder of what information should be gathered and provides the means of checking off information obtained and reviewed, or information not available or applicable. The checklist is divided into sections as follows:

I. Site Information
II. Interviews
III. On-site Documents & Records Verified
IV. O&M Costs
V. Access and Institutional Controls
VI. General Site Conditions
VII. Groundwater/Surface Water Remedies
VIII. Other Remedies
IX. Overall Observations

Some data and information identified in the checklist may or may not be available at the site depending on how the site is managed. Sampling results, costs, and maintenance reports may be kept on-site or may be kept in the offices of the contractor or at State offices. In cases where the information is not kept at the site, the item should not be checked as "not applicable," but rather it should be obtained from the office or agency where it is maintained. If this is known in advance, it may be possible to obtain the information before the site inspection.

The checklist may be completed and attached to the annual Site-Wide Inspection report to document site status. Please note that the checklist is not meant to be completely definitive or restrictive; additional information may be supplemented if the reviewer deems necessary. Also note that actual site conditions should be documented with photographs whenever possible.

Using the Checklist for Types of Remedies

The checklist has sections designed to capture information concerning the main types of remedies for hazardous waste sites. These are groundwater and surface water remedies (Section VII of the checklist). The primary elements and appurtenances for these remedies are listed in sections which can be checked off as the facility is inspected. The opportunity is also provided to note site conditions, write comments on the facilities, and attach any additional pertinent information. If a site includes remedies beyond these, such as soil vapor extraction or soil landfarming, the information should be gathered in a similar manner and attached to the checklist.

Considering Operation and Maintenance Costs

Unexpectedly widely varying or unexpectedly high O&M costs may be early indicators of remedy problems. For this reason, it is important to obtain a record of the original O&M cost estimate and of annual O&M costs during the years for which costs incurred are available. Section IV of the checklist provides a place for documenting annual costs and for commenting on unanticipated or unusually high O&M costs. A more detailed categorization of costs may be attached to the checklist if available. Examples of categories of O&M costs are listed below.

<u>Operating Labor</u> - This includes all wages, salaries, training, overhead, and fringe benefits associated with the labor needed for operation of the facilities and equipment associated with the remedial actions.

<u>Maintenance Equipment and Materials</u> - This includes the costs for equipment, parts, and other materials required to perform routine maintenance of facilities and equipment associated with a remedial action.

<u>Maintenance Labor</u> - This includes the costs for labor required to perform routine maintenance of facilities and for equipment associated with a remedial action.

<u>Auxiliary Materials and Energy</u> - This includes items such as chemicals and utilities which can include electricity, telephone, natural gas, water, and fuel. Auxiliary materials include other expendable materials such as chemicals used during plant operations.

<u>Purchased Services</u> - This includes items such as sampling costs, laboratory fees, and other professional services for which the need can be predicted.

<u>Administrative Costs</u> - This includes all costs associated with administration of O&M not included under other categories, such as labor overhead.

Insurance, Taxes and Licenses - This includes items such as liability and sudden and accidental insurance, real estate taxes on purchased land or right-of-way, licensing fees for certain technologies, and permit renewal and reporting costs.

Other Costs - This includes all other items which do not fit into any of the above categories.

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Annual Site-Wide Inspection Checklist

"N/A" refers to "not applicable."

I. SITE INFORMATION	
Site name:	**Date of inspection:**
Location and Region:	**Site ID:**
Agency, office, or company leading the annual review:	**Weather/temperature:**
Remedy Includes: (Check all that apply) ☐ Monitored natural attenuation ☐ Access controls ☐ Institutional controls ☐ Groundwater containment ☐ Groundwater pump and treatment ☐ Surface water collection and treatment ☐ Other____________________	
Attachments: ☐ Inspection team roster attached ☐ Site map attached	
II. INTERVIEWS (Check all that apply)	
1. **O&M site manager** ________ Name ________ Title ________ Date Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ________ Problems, suggestions; ☐ Report attached ____________________	
2. **O&M staff** ________ Name ________ Title ________ Date Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ________ Problems, suggestions; ☐ Report attached ____________________	

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

Agency ______________________________
Contact ______________________________ ____________________ _________ _____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

4. **Other interviews** (optional) ☐ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
   - ☐ O&M manual ☐ Readily available ☐ Up to date ☐ N/A
   - ☐ As-built drawings ☐ Readily available ☐ Up to date ☐ N/A
   - ☐ Maintenance logs ☐ Readily available ☐ Up to date ☐ N/A

   Remarks____
   ____

2. **Site-Specific Health and Safety Plan** ☐ Readily available ☐ Up to date ☐ N/A
   - ☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☐ N/A

   Remarks____
   ____

3. **O&M and OSHA Training Records** ☐ Readily available ☐ Up to date ☐ N/A

   Remarks____
   ____

4. **Permits and Service Agreements**
   - ☐ Air discharge permit ☐ Readily available ☐ Up to date ☐ N/A
   - ☐ Effluent discharge ☐ Readily available ☐ Up to date ☐ N/A
   - ☐ Waste disposal, POTW ☐ Readily available ☐ Up to date ☐ N/A
   - ☐ Other permits______________________ ☐ Readily available ☐ Up to date ☐ N/A

   Remarks____
   ____

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☐ N/A

   Remarks____
   ____

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ☐ N/A

   Remarks____
   ____

7. **Groundwater Monitoring Records** ☐ Readily available ☐ Up to date ☐ N/A

   Remarks____
   ____

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ☐ N/A

   Remarks____
   ____

9. **Discharge Compliance Records**
   - ☐ Air ☐ Readily available ☐ Up to date ☐ N/A
   - ☐ Water (effluent) ☐ Readily available ☐ Up to date ☐ N/A

   Remarks____
   ____

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☐ N/A

    Remarks____
    ____

IV. O&M COSTS

1. **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☐ Contractor for Federal Facility
☐ Other____
____

2. **O&M Cost Records**
☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From__________ (Date)	To__________ (Date)	__________________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________________ (Total cost)	☐ Breakdown attached
From__________ (Date)	To__________ (Date)	__________________ (Total cost)	☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: ____
____
____
____
____
____

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A
Remarks____
____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks____
____

C. Institutional Controls (ICs)

1. **Implementation and enforcement**
Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) ______________________
Frequency ______________________
Responsible party/agency ______________________
Contact ______________ ______________ ________ ________
Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☐ No ☐ N/A
Other problems or suggestions: ☐ Report attached

____
____
____
____

2. **Adequacy** ☐ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks______________________
____
____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☐ No vandalism evident
Remarks______________________
____

2. **Land use changes on site** ☐ N/A
Remarks______________________
____

3. **Land use changes off site** ☐ N/A
Remarks______________________
____

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☐ Roads adequate ☐ N/A
Remarks______________________
____

B. Other Site Conditions
Remarks ____
VII. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable ☐ N/A
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Pumps, Wellhead Plumbing, and Electrical** ☐ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A Remarks____
2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks____
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks____
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☐ N/A
1. **Collection Structures, Pumps, and Electrical** ☐ Good condition ☐ Needs Maintenance Remarks____
2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances** ☐ Good condition ☐ Needs Maintenance Remarks____
3. **Spare Parts and Equipment** ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided Remarks____

C. Treatment System ☐ Applicable ☐ N/A	
1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation ☐ Air stripping ☐ Carbon adsorbers ☐ Filters_______________ ☐ Additive (*e.g.*, chelation agent, flocculent)_______________ ☐ Others_______________ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually_______________ ☐ Quantity of surface water treated annually_______________ Remarks_______________
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks_______________
3.	**Tanks, Vaults, Storage Vessels** ☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks_______________
4.	**Discharge Structure and Appurtenances** ☐ N/A ☐ Good condition ☐ Needs Maintenance Remarks_______________
5.	**Treatment Building(s)** ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks_______________
6.	**Monitoring Wells** (pump and treatment remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks_______________
D. Monitoring Data	
1.	Monitoring Data ☐ Is routinely submitted on time ☐ Is of acceptable quality
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

E. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A

Remarks____
____

VIII. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

IX. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

____
____
____
____
____
____
____
____
____
____

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

____
____
____
____
____
____
____
____
____

C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. ____ ____ ____ ____ ____ ____ ____ ____ ____
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. ____ ____ ____ ____ ____ ____ ____ ____ ____

Appendix G

Effluent Limitations and Monitoring Requirements

Now

DHWR Site No.: 3-14-008

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS - SURFACE WATER DISCHARGES

During the period beginning with the start of treatment plant operations (STPO)

and lasting until STPO + 5 years

the discharges from the treatment facility to Crum Elbow Creek shall be limited and monitored by the operator as specified below:

Outfall Number & Effluent Parameter	Discharge Limitations Daily Avg.	Daily Max.	Units	Minimum Monitoring Requirements Measurement Frequency	Sample Type
001 - Groundwater remediation system and soil vapor extraction system discharge					
Flow	NA	Monitor	gpd	Continuous	Meter
pH(Range)	NA	6.5 to 8.5	SU	(1)	Grab
Oil and Grease	NA	15	mg/l	(1)	Grab
Solids, Total Dissolved	NA	1,000	mg/l	(1)	Grab
Solids, Total Suspended	NA	50	mg/l	(1)	Grab
Aluminum, Total	NA	Monitor	µg/l	(1)	Grab
Arsenic, Total	NA	100	µg/l	(1)	Grab
Barium, Total	NA	Monitor	µg/l	(1)	Grab
Benzene	71-43-2	1.4	µg/l	(1)	Grab
Chlorobenzene	108-90-7	10	µg/l	(1)	Grab
Chloroethane	75-00-3	10	µg/l	(1)	Grab
Chromium, Total	NA	400	µg/l	(1)	Grab
Copper, Total	NA	24	µg/l	(1)	Grab
Cyanide, Total	NA	10	µg/l	(1)	Grab
1,1-Dichloroethane	75-34-3	10	µg/l	(1)	Grab
1,2-Dichloroethane	107-06-2	1.6	µg/l	(1)	Grab
cis-1,2-Dichloroethylene	156-59-2	5	µg/l	(1)	Grab
trans-1,2-Dichloroethylene	156-60-5	5	µg/l	(1)	Grab
1,1-Dichloroethylene	75-35-4	0.5	µg/l	(1)	Grab
Ethylbenzene	100-41-4	10	µg/l	(1)	Grab
Iron, Total	NA	600	µg/l	(1)	Grab
Manganese, Total	NA	Monitor	µg/l	(1)	Grab
Mercury, Total	NA	0.8	µg/l	(1)	Grab
Nickel, Total	NA	200	µg/l	(1)	Grab
Tetrachloroethylene	127-18-4	1.4	µg/l	(1)	Grab
Toluene	108-88-3	10	µg/l	(1)	Grab
1,1,1-Trichloroethane	71-55-6	10	µg/l	(1)	Grab
1,1,2-Trichloroethane	79-00-5	1.2	µg/l	(1)	Grab
Trichloroethylene	79-01-6	6	µg/l	(1)	Grab
Vinyl chloride	75-01-4	0.6	µg/l	(1)	Grab
Xylenes, 1,2- and 1,4-, sum	95-47-6	10	µg/l	(1)	Grab
Xylenes, 1,3-	108-38-2	5	µg/l	(1)	Grab
Zinc, Total	NA	150	µg/l	(1)	Grab

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS - GROUNDWATER DISCHARGES

During the period beginning with the start of treatment plant operations (STPO)

and lasting until STPO + 5 years

the discharges from the treatment facility to groundwater shall be limited and monitored by the operator as specified below:

Outfall Number & Effluent Parameter	CAS No.	Discharge Limitations Daily Max.	Units	Minimum Monitoring Requirements: Measurement Frequency	Minimum Monitoring Requirements: Sample Type
001 - Groundwater remediation system and soil vapor extraction system discharge					
Flow	NA	Monitor	gpd	Continuous	Meter
pH(Range)	NA	6.5 to 8.5	SU	(1)	Grab
Oil and Grease	NA	15	mg/l	(1)	Grab
Solids, Total Dissolved	NA	1,000	mg/l	(1)	Grab
Solids, Total Suspended	NA	50	mg/l	(1)	Grab
Aluminum, Total	NA	2000	µg/l	(1)	Grab
Arsenic, Total	NA	50	µg/l	(1)	Grab
B[illegible]n, Total	NA	2,000	µg/l	(1)	Grab
B[illegible]ene	71-43-2	0.80	µg/l	(1)	Grab
Chlorobenzene	108-90-7	5	µg/l	(1)	Grab
Chloroethane	75-00-3	5	µg/l	(1)	Grab
Chromium, Total	NA	100	µg/l	(1)	Grab
Copper, Total	NA	1,000	µg/l	(1)	Grab
Cyanide, Total	NA	400	µg/l	(1)	Grab
1,1-Dichloroethane	75-34-3	5	µg/l	(1)	Grab
1,2-Dichloroethane	107-06-2	5	µg/l	(1)	Grab
cis-1,2-Dichloroethylene	156-59-2	5	µg/l	(1)	Grab
trans-1,2-Dichloroethylene	156-60-5	5	µg/l	(1)	Grab
1,1-Dichloroethylene	75-35-4	5	µg/l	(1)	Grab
Ethylbenzene	100-41-4	5	µg/l	(1)	Grab
Iron, Total[2]	NA	600	µg/l	(1)	Grab
Manganese, Total[2]	NA	600	µg/l	(1)	Grab
Mercury, Total	NA	4	µg/l	(1)	Grab
Nickel, Total	NA	2,000	µg/l	(1)	Grab
Tetrachloroethylene	127-18-4	5	µg/l	(1)	Grab
Toluene	108-88-3	5	µg/l	(1)	Grab
1,1,1-Trichloroethane	71-55-6	5	µg/l	(1)	Grab
1,1,2-Trichloroethane	79-00-5	5	µg/l	(1)	Grab
Trichloroethylene	79-01-6	5	µg/l	(1)	Grab
Vinyl chloride	75-01-4	2	µg/l	(1)	Grab
Xylenes, 1,2- and 1,4-, sum	95-47-6	10	µg/l	(1)	Grab
1,[illegible]lene	108-38-2	5	µg/l	(1)	Grab
Z[illegible]otal	NA	5,000	µg/l	(1)	Grab

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Special Conditions:

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

(2) The combined concentration of iron, total and manganese, total shall not exceed 1000 μg/l.

(3) The discharge rate may not exceed the effective treatment system or ground adsorptive capacity. All monitoring data, engineering submissions and modification requests must be submitted to the following DHWR contact person: ______________________.

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

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

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

Discharge may not occur unless the ground is capable of accepting the treated effluent. The discharged water may not be ponded on top of saturated or frozen ground or permitted to flow across the ground surface. Also, a minimum separation distance of 100 feet must be maintained between the discharge location and any surface waters (including wetlands).

(8) Surface water discharges: Samples and measurements, to comply with the monitoring requirements specified above, shall be taken from the discharge equalization and settling tank effluent prior to discharge to Crum Elbow Creek.

(9) Groundwater discharges: Samples and measurements, to comply with the monitoring requirements specified above, must be taken from the discharge equalization and settling tank effluent prior to discharge to groundwater.

Appendix G
Effluent Limitations
NOW Corporation Site
Town of Clinton, New York

Analytes/ Parameters	Effluent Limitations	(units)
Quantity treated, per day	Monitor	gallons
pH	6.5 to 8.5	standard units
Oil and Grease	15	mg/L
Total Cyanide	10	µg/L
TDS	1000	mg/L
TSS	50	mg/L
Aluminum, Total	Monitor	µg/L
Arsenic, Total	100	µg/L
Barium, Total	Monitor	µg/L
Chromium	400	µg/L
Copper	24	µg/L
Iron	600	µg/L
Mercury	0.8	µg/L
Manganese	Monitor	µg/L
Nickel	200	µg/L
Zinc	150	µg/L
1,1,1-Trichloroethane	10	µg/L
1,1,2-Trichloroethane	1.2	µg/L
1,1-Dichloroethane	10	µg/L
1,1-Dichloroethene	0.5	µg/L
1,2-Dichloroethane	1.6	µg/L
Benzene	1.4	µg/L
Chlorobenzene	10	µg/L
Chloroethane	10	µg/L
cis -1,2-Dichloroethene	5	µg/L
Ethylbenzene	10	µg/L
o-Xylene	5	µg/L
m,p-Xylene	10	µg/L
Tetrachloroethene	1.4	µg/L
Toluene	10	µg/L
trans -1,2-Dichloroethene	5	µg/L
Trichloroethene	6	µg/L
Vinyl Chloride	0.6	µg/L

Notes:
TDS - Total Dissolved Solids
TSS - Total Suspended Solids
mg/L - Milligrams per Liter
µg/L - Micrograms per Liter