

SITE MANAGEMENT PLAN

Site Name:

**Former Corporate Research Center
Bradley Hill Office Park
Blauvelt, New York
NYSDEC Site No. 3-44-021**

Prepared for:

XEROX[®]

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1.0 SITE BACKGROUND

1.1 General

This Site Management Plan (SMP) is designed to identify the ongoing remedial requirements for the former Xerox CRC (Centralized Refurbishing Center) facility located at the intersection of Route 303 and Bradley Hill Road in Blauvelt, New York. Xerox is seeking approval from the New York State Department of Environmental Conservation (NYSDEC) for a site reclassification from a class 2 to class 4. This request is being made based on the successful implementation and operation of all the requirements of the corrective measures selected by NYSDEC in a Record of Decision (ROD) dated March 1993. In addition to the specific requirements outlined in the ROD, Xerox also supplemented these measures with several other enhancements conducted with NYSDEC approval. As a result of the extensive remedial effort completed at the site, significant improvements have been realized in soil, soil gas and groundwater quality at the site.

This SMP summarizes current and former remedial activities conducted on the site and provides a description of the ongoing continued remedial efforts that are required for the site. This SMP has been prepared by Bergmann Associates (Bergmann), on behalf of Xerox, for this site identified as Site No. 3-44-021.

The media contaminated at the Blauvelt site included on-site soils, on-site soil gas, on-site groundwater, and off-site groundwater. After establishing groundwater migration control measures, on-site soils, which were acting as a continuing source of contamination recharge to groundwater, became the primary focus of remedial efforts. Aggressive source area removal (greater than 50,000 lbs of contaminants were recovered) was completed using Xerox's patented 2-PHASE[®] Extraction technology. The source area removal efforts were terminated in October 2002 when mass recovery had dropped to negligible amounts. This Site Management Plan identifies the remaining remedial measures currently being implemented / operated at the site.

There were two reported overflows from the waste solvent storage tank during the facility's operation as a CRC (1977 and 1979). Environmental assessment of the site began in 1980 subsequent to the removal of two underground solvent storage tanks. These investigations determined that groundwater at the site had been impacted and resulted in the development of additional programs to evaluate the subsurface conditions. A Remedial Investigation (RI) and Feasibility Study (FS) were subsequently completed through Consent Orders with NYSDEC to define the extent of the contamination and to identify the best alternative to mitigate the impacts to the affected media at the site.

The following contaminants have been identified at the Blauvelt site:

- Tetrachloroethene
- Trichloroethene
- 1,1,1-Trichloroethane
- Cis-1,2-Dichloroethene

- Vinyl Chloride
- Mineral Spirits

1.2 Site Location and Description

The former CRC is 15.28 acres in size and is located at 614 Route 303 in the Town of Blauvelt, Rockland County, New York. The location of this site is shown on Figure 1. The building was previously used by Xerox as a refurbishing and distribution center. Since 1980, Xerox used the facility mainly as a distribution facility. From the mid 1980's through the mid 1990's, Xerox subleased a portion of the building (the CRC area and the adjacent warehouse comprising the old building portion of the site) to Materials Research Inc (MRI). Xerox vacated the building in 2002 subleasing the entire facility to Advanced Distribution Systems (ADS). Since that time, ADS has operated within the building, using the structure as a warehouse and shipping site.

The Xerox Blauvelt site is located on Bradley Hill Road near the intersection of Route 303 and Bradley Hill Road in the Town of Blauvelt, Rockland County, New York. The Xerox facility (now Advanced Distribution Systems) is located between the west side of Route 303 and an active CSX freight rail line. A small unnamed tributary that discharges into the Hackensack River, runs along the western perimeter of the Xerox facility to the north into a light industrial park. The site is located in a valley that slopes downward to the north.

Beginning in 1970, operations at the site included the refurbishing of electrostatic copiers and copier parts using chlorinated solvent blends. Two underground storage tanks located at the north end of the property stored both virgin and spent solvents used in the refurbishing process. In addition to the underground storage tanks, other areas investigated included former paint booths, a former solvent storage room and the CRC area. Operations that resulted in the contamination at the site are no longer present.

The immediate area surrounding the facility is a mixture of light industrial and commercial locations. The former CRC "old building" structure consists of a single story slab-on-grade, approximately 166,200 square feet, steel frame structure with aluminum siding expansions. In 1982, the main facility structure was expanded by 97,344 square feet ("new building"). Utility services (water, heat and electric) have been maintained for operation within the building.

1.3 Remedial Operations Milestones

The following are several remediation related milestones that have occurred, are currently in progress, or are targeted for completion in the near future.

- On-site edge of property containment wells were installed in October 1986 as part of an Interim Remedial Measure (IRM). The first iteration of the Groundwater Treatment Plant (GTP) was constructed in December 1987. Official full time start up of the GTP and recovery wells was in November 1989. The on-site edge of property wells operated until 1993.

- Wells to support the 2-PHASE[®] Extraction process were installed in 1990. Full time operation of this system began in 1991. Upgrades to increase extraction in the source area (additional wells) were performed in 1993, 1994 and 1998. This remedial component was shutdown in 2002 following the removal of more than 50,000 pounds of volatile organic compounds (VOCs).
- Off-site edge of plume recovery well installation began in December 1992. Groundwater recovery began in February 1993 and operated until 2001.
- An off-site intermediate plume zone recovery well was installed in 1993 and operated from 1995 through 1996.
- Five recovery wells (including R-3) were installed in November 1995 to aide in source area dewatering and migration control. These wells were phased off line through the years with only R-3 remaining active at approximately 100 GPM.
- The GTP has remained mostly operational since 1989 until current. The system has been transformed during the years to increase efficiency, increase capacity, continually meet discharge requirements, reduce routine operations and maintenance and to allow for the treatment of recovered groundwater. Currently only R-3 remains on line as the only recovery well.
- In 2006 a Soil Vapor Intrusion system was installed to mitigate potential sub slab soil vapors in a portion of the CRC. Pending NYSDEC and NYSDOH approval, it is proposed to expand this system to encompass areas of the warehouse where sub slab vapor have been delineated to be above NYSDOH guidance values.

1.4 Applicable Standards, Criteria & Guidance

The media contaminated at the Blauvelt site include on-site soils, on-site soil gas, on-site groundwater and off-site groundwater. The site compounds of concern primarily include tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, 1,1-dichloroethene and 1,2-dichloroethene. With respect to soils, residual levels of chlorinated solvents and mineral spirits remain in source areas. On average, VOC soil concentrations have been reduced by **90%** in the source areas as a result of the aggressive remedial approach employed.

In order to identify potential exposure pathways, applicable standards, criteria and guidance (SCGs) controls had to be identified. For this review, SCGs were categorized as compound specific, location specific and action specific. The following SCG categories have been identified as applicable to the former CRC facility:

Design Standards

Former, current and proposed remedial systems were or will be designed to comply with local and NYS codes and standards including but not limited to the NYS mechanical and plumbing codes.

Soil SCGs

- NYSDEC Division of Hazardous Waste Remediation Technical and Administrative Guidance Memorandum (TAGM) 4046 (HWR-94-4046), "Determination of Soil Cleanup Objectives and Cleanup Levels", Revised January 24, 1994.
- NYCRR Part 371, Identification and Listing of Hazardous Wastes.
- NYSDEC Division of Hazardous Substance Regulation Technical and Administrative Guidance Memorandum (TAGM) 3028, "Contained in Criteria for Environmental Media," dated November 1992.

Groundwater SCGs

- NYCRR Part 700-705, Water Quality Regulations for Surface Water and Groundwater.
- NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1, "Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations", Reissued June 1998, April 2000 Addendum.

Indoor Air SCGs

- The NYSDOH "Study of Volatile Organic Chemicals in Air of Fuel Oil Heated Homes" (http://www.health.state.ny.us/nysdoh/indoor/fuel_oil.htm), February, 2005. This document references petroleum-based aromatic VOCs along with select chlorinated VOCs.
- Final "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" (http://www.health.state.ny.us/environmental/investigations/soil_gas/svi_guidance/), October, 2006. This document includes decision matrices for actions to be taken for both petroleum-based aromatic VOCs along with chlorinated VOCs.
- NYSDOH Division of Environmental Health Assessment, Bureau of Toxic Substance Assessment "Indoor Air Sampling & Analysis Guidance".

Waste SCGs

- NYCRR Part 371, Listing of Hazardous Waste.
- NYSDEC Division of Hazardous Substance Regulation TAGM 3028, "Contained in Criteria for Environmental Media," dated November 1992.

Risk Assessment

Xerox conducted an assessment of risks to human health resulting from the remaining residual levels of contamination at the Xerox Blauvelt site. This risk assessment was completed by Haley & Aldrich of New York on behalf of Xerox and is included as Attachment 1.

2.0 REMEDIAL SYSTEMS OPERATION

2.1 Recovery Well RW-3

The primary means of remediation being conducted at the site is plume migration control through groundwater recovery from source area well RW-3. Groundwater is being recovered at approximately 100 GPM and conveyed to the GTP located inside the former CRC via an underground discharge line originating at the well head and terminating at the primary holding tank for the GTP. Exposed sections of conveyance line are heat traced and insulated. Attachment 2 includes the well installation details for this unit.

The recovery well contains a Grundfos submersible pump that can be operated in an automatic mode using level sensing devices or in a manual mode where a fixed discharge rate is set to maximize groundwater recovery while not decreasing available groundwater to the point where the pump may cavitate.

2.2 Groundwater Treatment Plant (GTP)

The GTP is used in conjunction with RW-3 to treat influent groundwater prior to discharge into an unnamed tributary that discharges into the Hackensack River. Initial operation of the GTP began in 1989 and currently consists of the following major components:

- Primary Holding Tank
- Variable Speed Drive Transfer Pump P1
- Primary Air Stripper Tower Above Ground Storage Tank 1 (AST)
- Variable Speed Drive Transfer Pump P2
- Secondary Shallow Tray Air Stripper AST2
- Effluent Flow Meter
- Day Automation Control and Remote Data Collection System

P1 and P2 operate on an automated basis to transfer groundwater from the holding to the two air strippers that are piped in series. As treated groundwater leaves AST2, the effluent flow meter totalizes the number of gallons being discharged. The air discharges from AST1 and AST2 are combined into one discharge point that extends through the roof of the former CRC and ultimately to atmosphere.

The Day Automation Control and Remote Data Collection System were added to the GTP in 1994 to provide better system control and remote system evaluation. Utility services are maintained to the GTP including space heating, potable water, electricity and telephone. The loading dock on the west side of the building is used to accept deliveries of equipment and supplies used in the operations and maintenance of the GTP.

Attachment 3 provides specifications of the major equipment that remains in service at the site.

2.3 Discharge Sampling and Analysis Requirements

Influent and treated groundwater samples are collected on a monthly basis. The following samples are collected for laboratory analysis:

- Primary Influent – untreated groundwater conveyed from the recovery well(s) to the GTP.
- Secondary Influent – partially treated groundwater after it passes through AST1.
- Effluent – treated groundwater after it passes through AST1 and AST2.

The Primary Influent samples provide VOC concentrations used for treatment efficiency and mass removal calculations. The Secondary Influent samples provide VOC concentrations used for treatment efficiency calculations. The Effluent samples provide compliance data for VOCs and treatment efficiency calculations.

During routine operations with the GTP operating, the onsite O&M contractor collects the three samples from pre-designated sample port locations that are installed in process piping. 40 ml volatile organic analysis (VOA) vials are carefully filled and capped void of headspace. The samples are then placed into a cooler with ice packs (blue ice) and secured for overnight shipping via Fed Ex to Columbia Analytical Services (CAS) in Rochester, New York. Samples are shipped under Chain of Custody control.

Analysis

CAS is a NYSDOH-certified analytical laboratory. All three samples are analyzed for VOCs via U.S. EPA Method 601/602. In addition, the pH of the Effluent sample is measured. Results are provided by CAS typically within 2-3 weeks for evaluation and reporting.

2.4 Operation and Maintenance Requirements

The objectives of the current O&M Program are the following:

- Minimize further migration of contaminated groundwater from on-site source areas to down-gradient and off-site areas.
- Promote extraction of VOCs from the groundwater associated with the site.
- Treat recovered groundwater to remove VOCs.

Some of the routine procedures to be followed for the maintenance and servicing of the GTP are provided in Attachment 4.

- Filter Bag Change-Out Procedure.
- Flooded Air Stripper Fan Draining Procedure.
- Air Stripper Tower Cleaning Procedure.

Attachment 5 provides an example of log sheets that are used to record operational parameters and document system downtime.

The on-site O&M contractor visits the site at least once per week. Primary tasks include:

- Inspect the GTP and active groundwater recovery wells for proper operation and evidence of leaks.
- Maintain security of the remedial systems.
- Record operational parameters of the GTP and active recovery wells.
- Verify feed rate of water conditioning chemical added to the treatment process for prevention of water scale.
- Perform GTP discharge sampling (monthly).
- Communicate with Xerox and managing environmental consulting firm regarding the O&M of the GTP.
- Respond to system shutdowns (as needed).
- Maintain proper operation per manufacturer's specifications, transfer pump operation, transfer pump discharge pressure, bag filter pressures, AST extraction pump operation, blower operation and blower pressure. All other mechanical and electrical components will be kept in working order.
- Inspect the treated groundwater discharge to the outfall for rate of flow and visual characteristics.

The GTP system will be monitored via the remote data collection system on a frequent basis for by Xerox's environmental consultant. System parameters, similar to the readings the O&M Contractor records, are documented and used for monthly performance reporting. In addition, this system is used to determine alarm conditions and system shutdown rationale. The alarms scenarios that are monitored by the remote device and include:

- Pump P1 Operation.
- Pump P2 Operation.
- System Enable.
- Filter Emergency Change out.
- AST #1 Blower Operation.
- AST #1 High Level.

System operating parameters that are monitored on a routine basis include:

- Inlet Pressure to Filters: This gauge measures the pressure from the groundwater recovery pumps prior to the filter bank.
- Outlet Pressure from Filters: This gauge measures the downstream pressure and is used in determining differential pressure across the filter bank. The differential pressure is used to determine fouling and filter replacement.
- Holding Tank Liquid Level Transmitter: The signal from device provides input for the liquid level within the holding tank. The level set point will be maintained by modulating the variable speed drive on the primary air stripper feed pump (P-1).
- Pump (P-1) Discharge Pressure: This gauge measures the pressure in the primary air stripper feed line.
- Pump (P-2) Discharge Pressure: This gauge measures the pressure in the secondary air stripper feed line.
- Air Stripper Tank Liquid Level Transmitter: The signal from device provides input for the liquid level within the air stripper tank. The level set point will be maintained by modulating the variable speed drive on the secondary air stripper feed pump (P-2).
- Air Stripper Blower Pressure Transmitter: The signal from this device measures the discharge pressure on the blower on the primary air stripper to provide blower operational status and determine the level of fouling of the stripper packing.
- Final Effluent Flow Rate: This will indicate the liquid flow rate discharging from the GTP from Flow Meter FM-5.
- Final Effluent Total Flow: This will indicate total liquid flow discharged from the GTP from Flow Meter FM-5.

Attachment 4 provides routine O&M Procedures. Attachment 5 provides an example of the Inspection Log and Shutdown Form currently used.

2.5 Criteria to Discontinue Active Pumping

Environmental investigations began at this site in 1980 subsequent to the removal of the two underground solvent storage tanks. These investigations determined that groundwater at the site was impacted by chlorinated solvents previously stored in these tanks and resulted in the development of additional programs to evaluate the subsurface conditions. A Remedial Investigation (RI) and Feasibility Study (FS) were subsequently completed through Consent Orders with the NYSDEC to define the nature and extent of the contamination and to identify the best alternative to mitigate the impacts to the affected media at the site.

Based on the results of the RI/FS, a ROD was issued in March 1993 selecting 2-PHASE® Extraction for contaminants in soil and groundwater in the source area. Conventional pumping systems were also employed north of the source area for migration control. A significant volume of contaminant mass has been removed from the site (over 50,000 lbs of VOCs) and as a result, groundwater concentrations of VOCs have been substantially reduced.

However, the current remedial program is approaching its practical and technically feasible limits for attaining further site environmental improvement, as evidenced by asymptotic mass removal conditions and subsequent limited improvement to groundwater quality over the past 4+ years. Life to date, remedial program spending is over \$10 M. Given the diminishing impact of on-site conditions and the impressive remedial benefits that have been achieved to date, a review of the remedial program strategy and current site conditions versus risk assessment based criteria was deemed to be appropriate at this time.

In order to terminate the active groundwater recovery and treatment systems at the site, Xerox will need to demonstrate that the residual levels of VOCs in site groundwater do not rebound after termination of operation to pose a significant threat to human health or the environment. A specific site rebound monitoring plan will be submitted to the NYSDEC for approval that specifies the additional rebound monitoring program sampling requirements. Once approved by the NYSDEC, the rebound event will be conducted until such time that it can be demonstrated that rebound concentrations have reached asymptotic conditions and do not pose a threat to human health and the environment, or until it is decided to restart the groundwater recovery and treatment systems.

The following milestones shall be established to allow for the discontinuance of active pumping:

- Petition for rebound event (based on diminished mass removal, asymptotic groundwater and GTP influent concentrations).
- Conduct rebound event, Static Water Levels (SWLs) and sampling per NYSDEC approved plan.
- Evaluate groundwater migration impact potential.
- Evaluate migration potential impact to surrounding environmental and human receptors
- Report results to the NYSDEC.
- Restart groundwater pumping or petition for extended shutdown.
- Receive agency approval for extended shutdown.

2.6 Previous Remedial Systems Operated

2.6.1 Off-Site Intermediate Zone Recovery

Xerox installed and operated an off-site groundwater recovery component that addressed intermediate plume recovery well in 1993 as part of the remedial program. Xerox subsequently received approval from the NYSDEC to cease operation of this recovery well after it was operated from 1995 through 1996. Figure 2 shows the location of the off-site well.

2.6.2 Edge of Property Pumping

As an IRM, Xerox implemented edge of property groundwater recovery with a series of ten well installations in October 1989. These ten conventional pumping wells were located at the Xerox property boundary just south of Bradley Hill Road and were operated to prevent migration of contaminated groundwater from the source areas to off-site properties. Figures 3 and 4 illustrate the location of these wells.

2.6.3 Edge of Plume Pumping

Off-site IRMs also consisted of two edge of plume migration control recovery wells that were engaged in 1993 as part of this remedial program. Groundwater from these recovery wells was passed through activated carbon units prior to discharge to the adjacent stream. Xerox received approval from NYSDEC to cease operation of these two wells 2001. The units were shutdown during the first quarter of 2002. Figure 2 shows the location of the off-site wells.

2.6.4 2-PHASE[®] Extraction Source Area Removal

In 1990, Xerox pilot tested 2-PHASE[®] Extraction (allowed for the simultaneous recovery of both groundwater and soil vapor from a single extraction well) in the source area. The demonstrated performance and the knowledge gained from this and other evaluations eventually led to the development of the patented 2-PHASE[®] Extraction technology and its subsequent selection in the ROD for full-scale implementation at the Blauvelt site.

The installed remedial system consisted of two 2-PHASE[®] Extraction systems that operated in conjunction with a vapor carbon treatment system at the GTP. Expansion of the 2-PHASE[®] Extraction network occurred in 1994 (on-site saturated zone) and again in 1998 (swale/road area). A low permeability surface membrane was also installed over the former tank storage source area in 1993. Installation of additional source area 2-PHASE[®] Extraction wells occurred in 1994. Installation of 16 piezometers to be used as additional 2-PHASE[®] Extraction wells occurred in 1995. Approximately 35 2-PHASE[®] Extraction wells were installed and operated throughout the operational timeframe of the system.

The primary function of the 2-PHASE[®] Extraction system was to recover contaminants from the source areas. Effluent generated from the various collection processes were treated by several systems. The vapor effluent stream from this system was treated by three Granular Activated Carbon (GAC) canisters in series. The vapor discharge from this system was treated in

compliance with the guidelines received from the NYSDEC in correspondence dated 23 May 1991 and amendments dated 20 March 1992. The recovered groundwater from source area wells and 2-PHASE[®] Extraction systems was pumped to the GTP for treatment prior to discharge. Groundwater from the intermediate plume groundwater recovery wells was also pumped to the GTP.

Recovered groundwater enters the plant into an oil/water separator tank. The groundwater is then pumped through a packed column air stripper as a primary treatment. The discharge of the air stripper process exhaust is permitted by NYSDEC #BVT01. The treated water from the primary air stripper is then pumped through the shallow tray air stripper as a secondary treatment/polish before it is discharged to the stream located just outside (west of) the building. Treatment levels are maintained in accordance with SPDES discharge criteria that had formerly governed the effluent discharges and reporting at the site. All spent carbon from the remedial processes (off-site groundwater treatment, on-site GTP treatment and 2-PHASE[®] vapor treatment) was regenerated at a licensed regeneration facility. Licensed waste haulers were contracted by Xerox to transport the spent carbon from the Blauvelt site to the regeneration facility. The spent carbon was manifested as a hazardous waste.

2.6.5 Liquid Boot[®] Liner

During the 2-PHASE[®] Extraction IRM application in the solvent tanks source area, it was evident that some of the remedial benefits of the 2-PHASE[®] Extraction application were being lost due to short circuiting within the desired extraction zone. To address the issue of subsurface vacuum loss, the site was cleared, graded and an impermeable membrane was installed to prevent the “venting” concerns. In 1993, a Liquid Boot[®] membrane was installed within the limits of the on-site well field as a vapor barrier to prevent vacuum being short circuited to atmosphere. Currently this black monolithic membrane still exists below grade level.

2.6.6 Source Area Dewatering Wells

During 1995, five 8-inch diameter bedrock-pumping wells were installed in the source area to dewater the overburden soils and increase the effectiveness of the source area 2-PHASE[®] Extraction wells. Once the benefits of the 2-PHASE[®] Extraction application on the overburden source soils of the site decreased significantly, Xerox pursued enhanced dewatering as a mechanism to depress the groundwater to expose formerly saturated source area soils to the 2-PHASE[®] remedial benefits. Multiple wells were installed in anticipation of site dewatering requirements. Due to the large amounts of water that was generated by the dewatering effort, modifications to the GTP had to be made to handle the additional flows. With the enhanced dewatering, all of the formerly saturated smear zone could be addressed without fear of drawing contamination from the source soil contamination into the water-bearing zone at the site. Significant improvements to both mass recovery and soil and groundwater quality were realized as a result of the combined dewatering / 2-PHASE[®] extraction efforts. One well (RW-3) is responsible for the vast majority of the groundwater recovery from the source area. This well has been in continuous operation after the 2-PHASE[®] benefits declined, as a source area migration control measure.

3.0 EXISTING SAMPLING & ANALYSIS PLAN

3.1 Well Sampling and Frequency

NYSDEC approved a revised Sampling and Analysis Plan (SAP) for the site in 2004. The current SAP is included as Table 1. This includes wells located upgradient, within the source area and in near and far downgradient areas as well as wells in the overburden, shallow bedrock and deep bedrock zones across the on-site and off-site portions of the plume. The semi annual sampling frequency was determined based on the extensive groundwater database for this site (>20 years) and stable nature of the plume as demonstrated through the extensive groundwater analytical data base for the site and previous rebound test events.

TABLE 1
XEROX CORPORATION - BLAUVELT SITE
CURRENT GROUNDWATER SAMPLING & ANALYSIS PLAN

Well	Location	Monitoring Interval		Sampling Frequency--VOCs
U-6D	Upgradient--background	Shallow Bedrock		SA
OW-1	Source	Shallow Bedrock		SA
OW-2	Source	Shallow Bedrock		SA
MW-12	Source	Overburden		SA
MW-13	Source	Overburden		SA
PW-2	Source	Overburden		SA
W-2	Source	Overburden		SA
RI-6	Source2	Shallow Bedrock		SA
OS-2R	Downgradient--near	Shallow Bedrock		SA
OS-5R	Downgradient--mid	Shallow Bedrock		SA
OS-5D	Downgradient--mid	Deep Bedrock		SA
OS-6	Downgradient--mid	Overburden		SA
OS-6R	Downgradient--mid	Shallow Bedrock		SA
OS-7R	Downgradient--mid	Shallow Bedrock		SA
OS-7D	Downgradient--mid	Deep Bedrock		SA
OS-9	Downgradient--far	Overburden		SA
OS-9R	Downgradient--far	Shallow Bedrock		SA
OS-11R	Downgradient--far	Shallow Bedrock		SA

TABLE 1 - continued

XEROX CORPORATION - BLAUVELT SITE

CURRENT GROUNDWATER SAMPLING & ANALYSIS PLAN

Well	Location	Monitoring Interval		Sampling Frequency--VOCs
OS-11D	Downgradient--far	Deep Bedrock		SA
OS-12R	Downgradient--far	Shallow Bedrock		SA
OS-15R	Downgradient--far	Shallow Bedrock		SA
OS-15D	Downgradient--far	Deep Bedrock		SA

SA Semi Annual sampling - proposed as January and July

A Annual sampling - currently January

Notes:

1. Groundwater samples will be obtained by low-flow collection techniques, per EPA-approved procedures.

The well network is depicted on Figure 2 and is included in this report. During each sampling event, elevations for top of well casing, total well depth and depth to water measurements are recorded for each monitoring well by qualified CAS field staff.

3.2 Sampling Protocol

The Groundwater Sampling Procedure is provided in Attachment 6. For quality control and quality assurance purposes, one duplicate groundwater sample, one field blank – rinse water sample and one trip blank sample are collected during the groundwater sampling events.

3.3 Laboratory Analysis

Samples are collected from monitoring wells by CAS under Chain of Custody Protocol. All samples are analyzed for VOCs via U.S. EPA Method 8021B. Reporting is provided using a standard deliverable package

3.4 Monitoring Well Abandonment Protocol

Subject to approval from the NYSDEC, monitoring wells may periodically be abandoned. The process for monitoring well abandonment consists of cutting off or removing well risers and casings below grade and injecting a cement-bentonite grout mixture into the well bore using tremie rods and a drill rig pump. The grout will consist of approximately 5 pounds of powdered bentonite per sack of Portland cement and will be allowed to set for 48 hours. The uppermost five feet of the borehole at land surface will be filled with a material appropriate to the intended use of the land.

The materials will be physically similar to the natural soils. No material will be used that will limit the use of the property in any way. The surface of the borehole will be restored to the condition of the area surrounding the borehole. All solid waste materials generated during the decommissioning process will be disposed of properly. Documentation of well abandonment activities will be included in site semi annual reports.

4.0 MONITORED NATURAL ATTENUATION / DILUTION / DISPERSION / DIFFUSION PROCESSES

Xerox desires to achieve remedial objectives that are protective of human health and the environment at the Blauvelt site. IRMs have been operated at the site since 1988 to achieve source area reduction and plume migration control. Since the issuance of the ROD in 1993, these systems have been expanded and enhanced to achieve remarkable improvements to soil, soil gas and groundwater quality at the site. Over time, the installed remedy to satisfy the ROD requirements has reached its practical limit of success relative to contaminant mass removal. Data collected to date indicates that the current rate of mass removal will likely continue without promoting a further significant reduction in source area groundwater concentrations. Furthermore, off-site groundwater concentrations have similarly shown significant improvement in groundwater quality. Any future improvement in quality is more likely attributable to natural attenuation processes than continued source area remediation efforts. Operation of pumping well R-3 as an on-site migration control should continue until it is demonstrated that the concentration of source area VOCs has stabilized.

Preliminary assessment indicates that natural attenuation processes are acting to further reduce VOC concentrations and reduce the overall size of the plume in the bedrock groundwater system. Accordingly, natural attenuation and dilution/dispersion/diffusion processes should be considered as an intrinsic component to the overall site remedy and future remedial efforts.

5.0 VAPOR INTRUSION ABATEMENT

Soil Vapor Intrusion (SVI) has become an important element to environmental site response and management within the regulatory community. SVI refers to the process by which volatile organic compounds migrate from a subsurface source into indoor air through cracks in floor slabs, openings around where pipes go through the foundation, etc. This initiative by the regulatory community has resulted in the development of draft guidance for evaluating and mitigating soil vapor intrusion that is orders of magnitude more stringent than the criteria used for assessment of vapor intrusion impacts when the ROD was issued for the Blauvelt site. As a result, Xerox implemented a comprehensive soil vapor sampling, testing and abatement program under regulatory oversight (NYSDEC and NYSDOH) to assess and mitigate potential soil vapor intrusion concerns.

Soil vapor samples were collected from six off-site locations across Bradley Hill Road from the former Xerox Blauvelt CRC site in late 2005 and in May 2006. The results of this program demonstrated that significant reductions of VOCs in soil gas had occurred in the off-site area since the previous study was conducted in 1991. The off-site vapor sampling performed to date did not exhibit concentrations above current draft guidance criteria and no further action is

warranted at this time. If a significant change in use over the current site configuration is considered in the future, Xerox will review any proposed redevelopment with the interested party and the Department. Xerox will work with the NYSDOH and the Department to evaluate specific activities relative to the area immediately north of Bradley Hill Road in the vicinity of the access road leading to the subject parking lot.

Soil vapor samples were also collected from areas beneath the floor slab at 27 locations inside of the building in former CRC room and adjacent main warehouse area. The results of this effort identified that VOCs in sub-slab soil vapor were mostly concentrated in the CRC room where copiers were refurbished near two former spray booths. Despite an average 99% improvement in soil vapor quality from the 1991 sampling event, the 2005 and 2006 sampling events identified areas that exceeded the new draft vapor intrusion abatement guidance criteria.

An active Sub-Slab Depressurization (SSD) has been installed in the CRC room in response to the sampling described above and a vacuum envelope has been confirmed to encompass this portion of the building (see Figures 5 and 6). The installed SSD system consists of two high suction blowers that are piped through the roof of the facility. A total of four vacuum points are connected to each high suction blower. Visible expansion joints and/or cracks in the floor slab were sealed with a gun-grade urethane caulk sealant to maintain the integrity of the floor slab and to improve operational performance of the system.

A vacuum monitoring network was also installed throughout the target area and in adjacent locations outside of the CRC room to validate performance of the active mitigation system. The data indicates that the design criteria of 0.002 inches water column was exceeded within the CRC room and that the vacuum influence extends into the warehouse area and adjacent room to the east. Routine monitoring of the operational equipment relative to this system, including the planned expansion program into the warehouse area adjacent to the former CRC location will be performed on a monthly basis to confirm proper operation as part of routine site O&M activities. The planned expansion of the SSD System, referred to as the Phase II System Expansion, is currently scheduled for late December 2006 or early January 2007 (See Figure 5). Attachment 7 provides related cut sheets for the SSD system components.

For the first year of operation of the SSD system, sub slab vacuum readings will be collected on a quarterly basis to demonstrate that the desired vacuum influence is being achieved in the targeted mitigation areas. After demonstrating compliance with the sub slab vacuum reading performance objective for a period of 1 year, the sub slab vacuum readings will then be collected on an annual basis to demonstrate continued compliance with this abatement objective. The results from the sub slab vacuum readings will be included in the semi-annual reports generated for the site. Xerox also agrees to evaluate post-installation conditions after a 6 month period, and annually thereafter for a three year period to assess the sub-slab soil vapor conditions relative to Matrix No. 2 of the Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York dated October 2006. Xerox will conduct this activity by selecting a representative number of locations across the impacted area.

In the event that it is desired to discontinue operation of all or part of the SSD system, soil vapor data will need to demonstrate that the area being abated by the portion(s) of the SSD system targeted to be shut down no longer have soil vapor concentrations that exceed the guidance criteria. Termination of the operation of any section or portion of the SSD system will only be done with NYSDEC approval.

6.0 SITE REPORTING REQUIREMENTS

6.1 Content

Site reporting requirements relate to the sampling and analysis of groundwater monitoring wells, performance monitoring of the GTP, and evaluation of related site operational data.

This evaluation will require monitoring and testing as part of the O&M program as described above. The following items need to be evaluated or demonstrated:

1. Discussion of operational performance and major O&M activities as they pertain to the groundwater treatment plant.
2. An assessment of analytical results obtained from the groundwater monitoring performed under the site SAP. SVI systems maintain negative pressure under the impacted area building slab. Monthly vacuum measurements will be recorded.
3. Monthly laboratory analysis the influent and effluent groundwater samples of the GTP.
4. Discussion of operational performance and major O&M activities as they pertain to operation of the VI abatement system.

6.2 Frequency

Semi-annual reports will be submitted to NYSDEC regarding remedial system efficiency, uptime and effectiveness. Analytical results generated from items listed in 5.1 will be included in these semi annual progress reports.

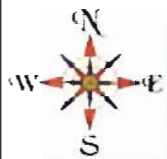
6.3 Distribution

Semi-annual reports will be distributed to the following:

- NYSDEC
- NYSDOH
- Rockland County Department of Health

Emergency Telephone Numbers

Elliott Duffney, Program Manager, Xerox Corporation	585-422-5825
Gary Flisnik, Site Operations Coordinator, Bergmann Associates	585-232-5135



JM



FORMER XEROX FACILITY
610 Bradley Hill Road, Blauvelt, NY

Aerial Photograph

Google Earth Copyright 2006

Date

April-06

Figure

1

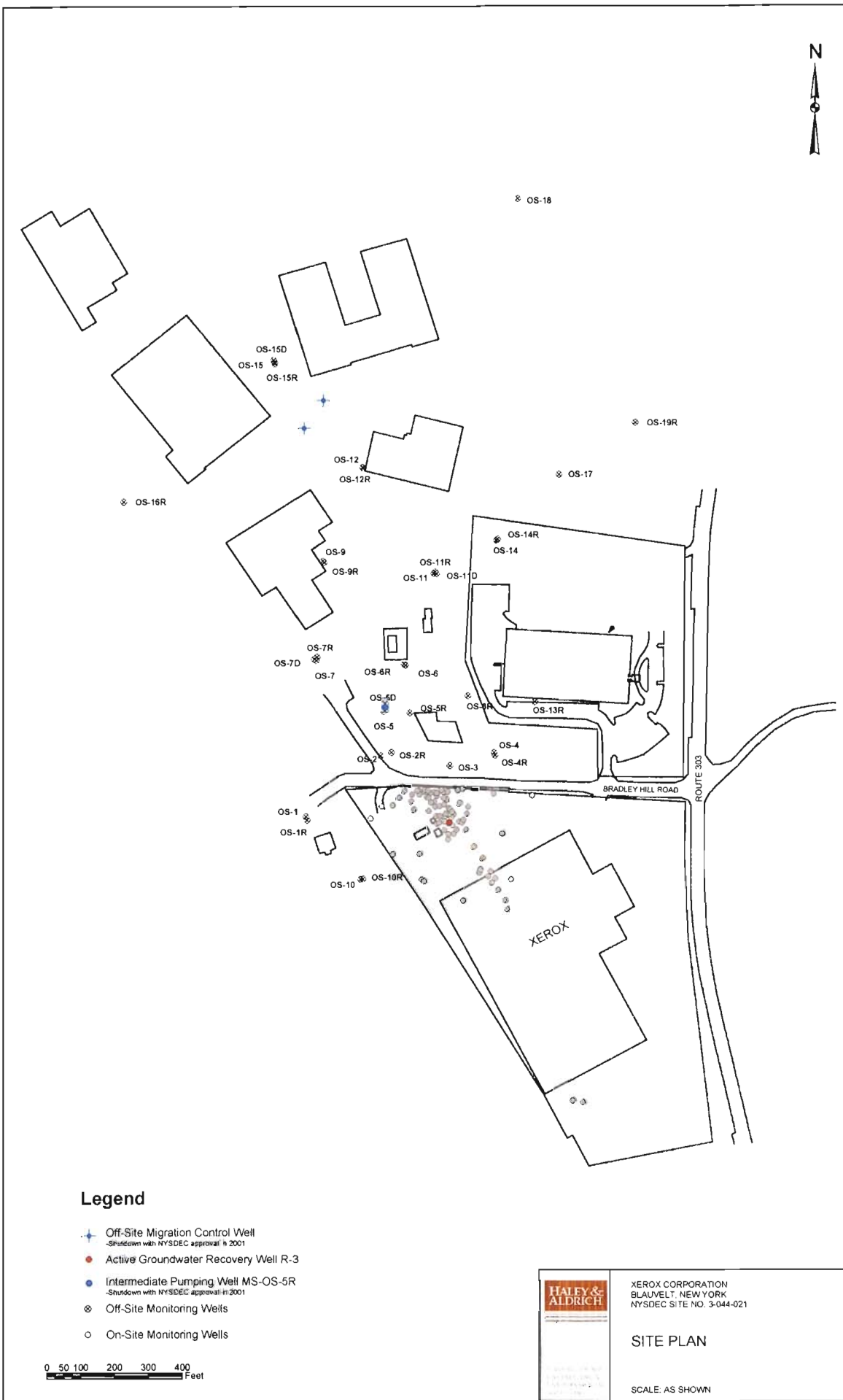
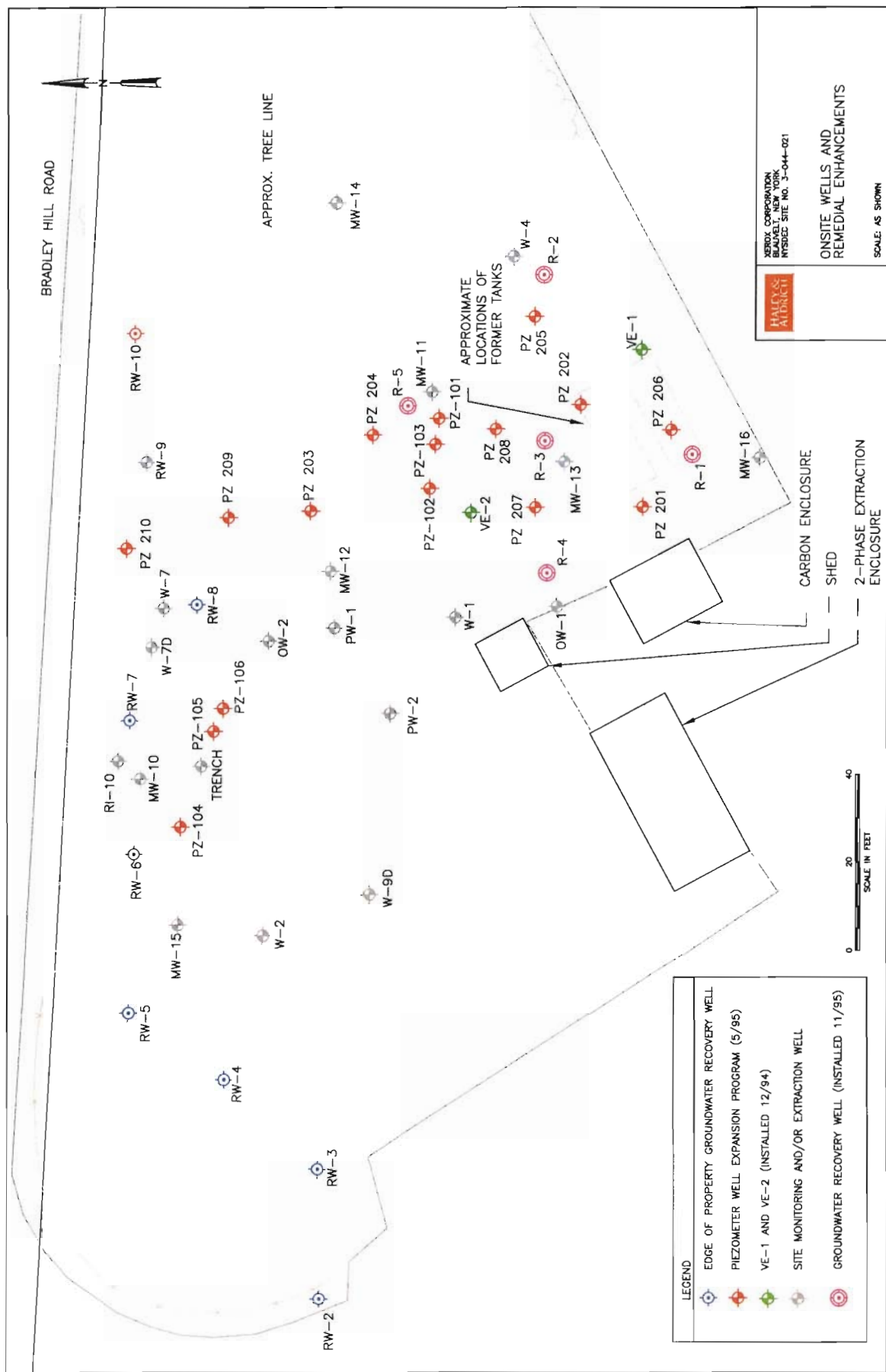


FIGURE 2



70302\111\CLOSURE\HYW01B.DWG

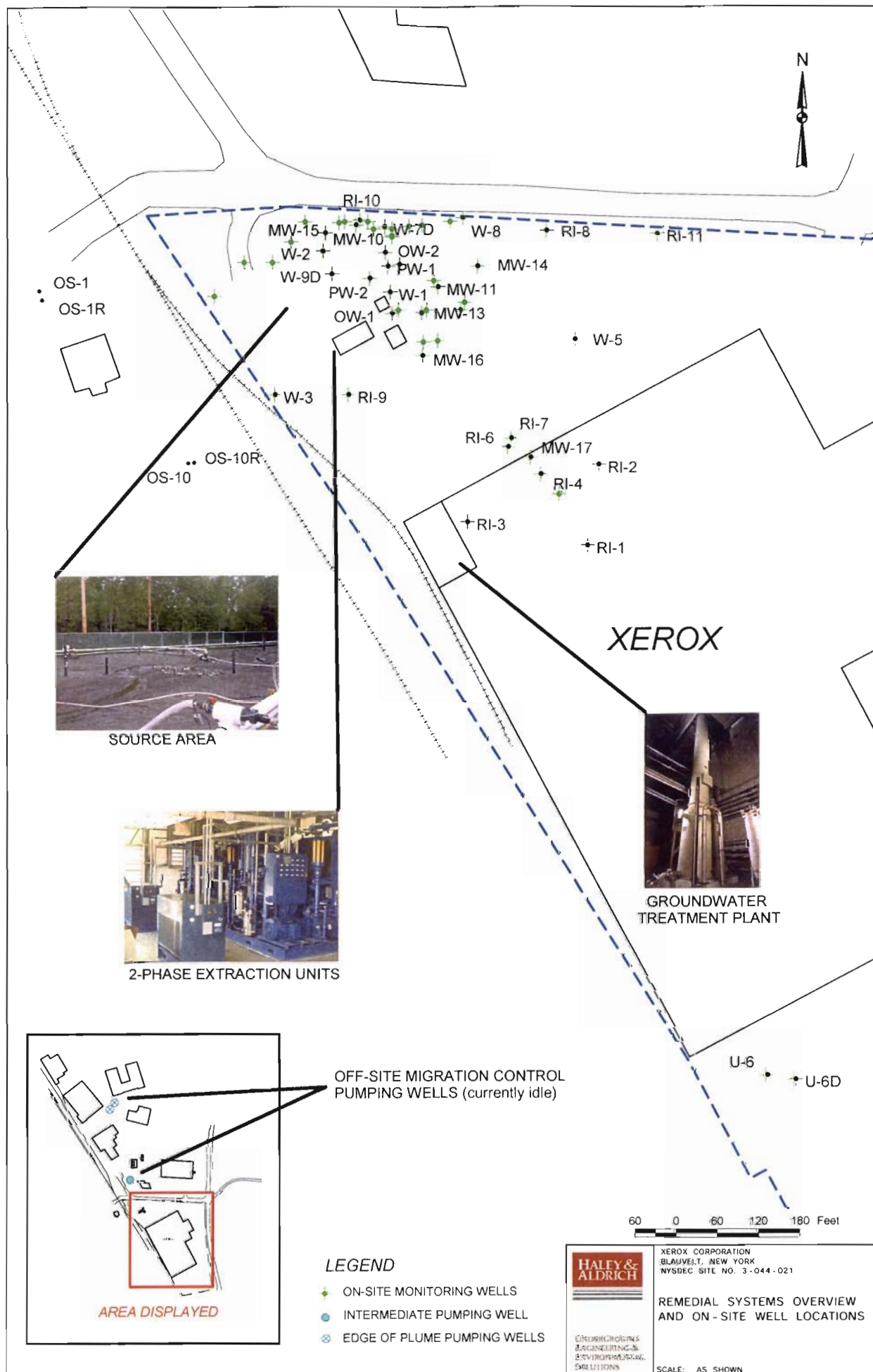
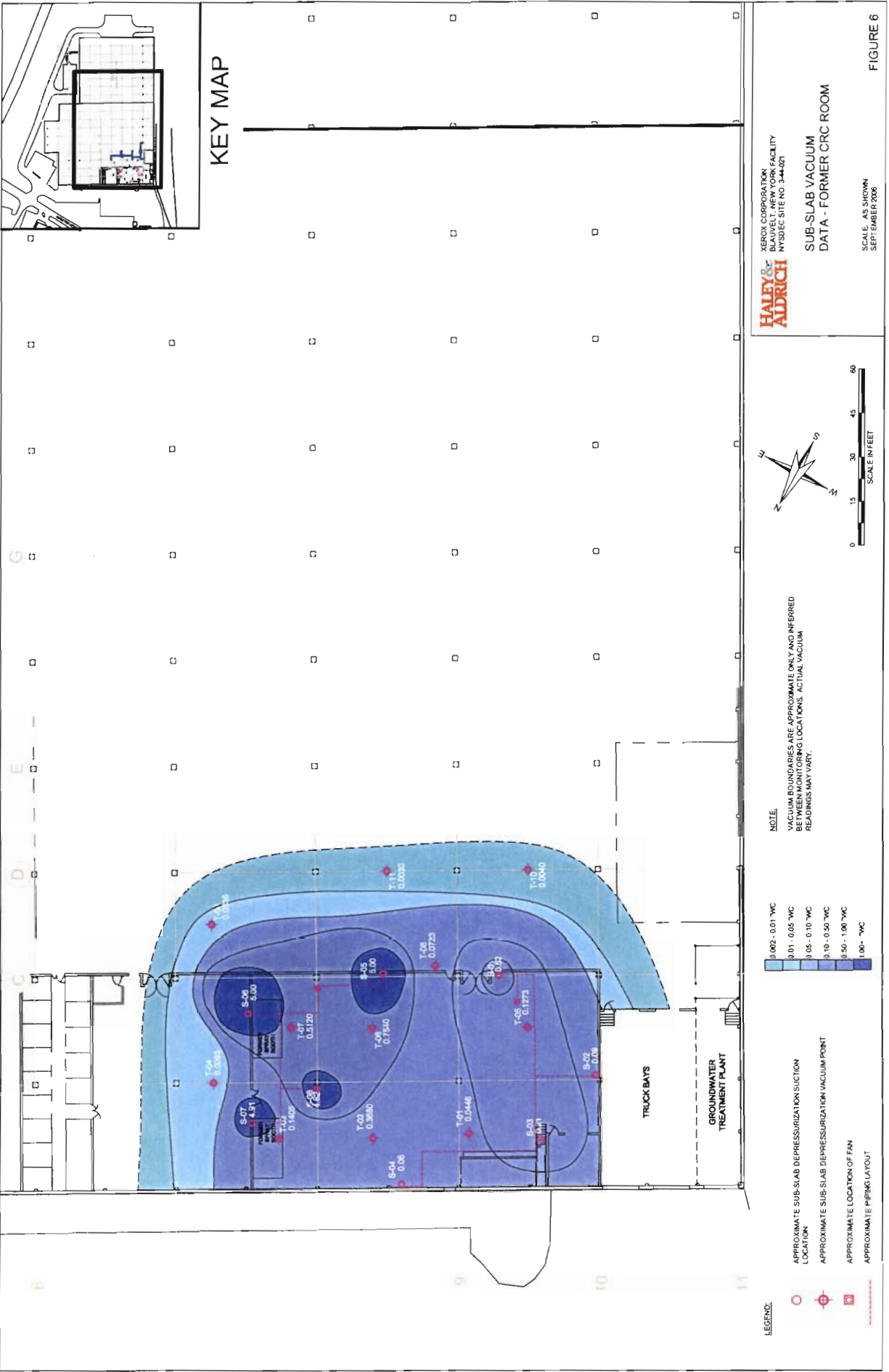


FIGURE 4



SOIL VAPOR INTRUSION PATHWAY ANALYSIS

XEROX CORPORATION FORMER CENTRALIZED REFURBISHING CENTER (CRC) FACILITY BLAUVELT, NEW YORK

BACKGROUND

From January 2005 through March 2006, Xerox Corporation (Xerox) conducted multiple Soil Vapor Intrusion sampling events for volatile organic compounds (VOCs) at the Former Xerox Centralized Refurbishing Center (CRC) facility located in Blauvelt, New York. The purpose of the sampling and analysis was to delineate the extent that soil gas beneath the facility exceeds the New York State Department of Health (NYSDOH) draft guidance criteria that would require abatement. VOCs were detected in the soil vapor samples during the events. The primary VOCs of concern (compounds attributable to Xerox activities and compounds that NYSDOH has proposed abatement levels for are tetrachloroethene (PCE) and trichloroethene (TCE).

To further evaluate the data, a focused human health risk assessment has been performed in accordance with guidance provided by current USEPA Risk Assessment Guidance Series (RAGs) procedures. Procedures were employed to estimate the potential impact of the VOCs detected in the subsurface soil vapor to current and future on-site workers at the facility. This analysis is intended to guide the development of an appropriate remedy to mitigate potential exposure of the facility workers to these current and future site conditions.

INTRODUCTION

In accordance with USEPA guidance, this focused human health risk assessment utilized the following/ five (5) step process; Hazard Identification, Toxicity Assessment, Dose Response Assessment, Exposure Pathway Analysis, and Risk Characterization. Hazard identification and toxicity assessment include the selection of the compounds of concern (COC) from the list of materials identified as present in the subsurface by laboratory analysis. This process includes the elimination of materials and chemicals that are not known to exhibit toxic effects and/or the dose response assessment determines the potential toxic effects of the identified COC on current and future potential receptors are negligible. Exposure assessment procedures include the development of a site conceptual model to determine the likely route of exposure that receptors could be exposed to the COC and conservatively calculates the dose of the COC the receptors may receive.

The risk characterization combines the findings of the dose response assessment of the identified COCs and the exposure assessment pathway analysis to determine the risk of adverse health effects for the current and future potential receptors as compared with USEPA acceptable risk thresholds. If USEPA risk thresholds are exceeded, Risk Based Remediation Goals are developed to determine the level of COCs that could be present in the source area soils where the USEPA risk thresholds would not be exceeded. The following sections describe the evaluation of human health risk to the current and future workers at the Xerox Corporation Blauvelt, New York facility based on the site conditions indicated by the sub slab soil vapor sampling events conducted from January 2005 through March 2006.

HAZARD IDENTIFICATION

Hazard identification involves the selection of the COC detected in the media sampled, and the hazards associated with potential exposure to these materials. COC are defined as those compounds that are potentially site-related and whose data are of sufficient quality for use in a quantitative assessment of human health risk. Compounds determined to be laboratory contaminants or do not exceed background levels were not considered further in the characterization of risk of adverse health effects.

For the medium affected at the facility (subsurface beneath the facility floor slab), the recent sampling and analysis data was used to establish the current and potential future indoor air conditions, and a list of COC for evaluation in the characterization of health risk was developed.

The following sections discuss the data selected for use in the evaluation, and the identification of the COC used in the evaluation of potential current and future impacts to human health and the environment.

Soil Vapor Sampling and Analysis Data

Soil vapor data for this evaluation was collected from the sub-slab soil vapor sampling program conducted at the facility from January 2005 through March 2006. Three separate sub-slab soil vapor sampling events were conducted over the period. Each VOC detected above laboratory reporting limits were considered for potential adverse health effects to current and future facility workers from exposure to these compounds. A laboratory reports presenting a summary of the soil vapor data used in this assessment is provided as Attachment A to this report.

Identification of Compounds of Concern (COC)

The soil vapor data was reviewed to identify the COC that could impact in the indoor air of the facility. The COC detected at the highest concentrations included tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, and 1,2-dichloroethene (cis). The detection of these compounds in the soil vapor is consistent with the documented release of chlorinated hydrocarbons at the facility. These compounds are not known to be naturally occurring, thus, the anticipated background level was assumed to be non-detect. Therefore, each compound was selected as a COC and considered further in the evaluation of health risk.

DOSE-RESPONSE ASSESSMENT

The dose-response assessment evaluates the potential non-carcinogenic (threshold) and carcinogenic (non-threshold) effects of the identified COC, and describes the effects observed in humans as indicated by studies using laboratory animals following the inhalation, ingestion, or dermal application of a specific dose of a COC. The dose-response assessment is used in conjunction with information from the exposure assessment to estimate the cumulative human health risk posed by the COC present in the media.

Non-Carcinogenic

The non-carcinogenic toxicity values used in the risk calculations for chronic exposure periods (exposures lasting seven years or more) are termed the chronic reference dose (RfD) for oral and dermal exposures, and the chronic reference concentration (RfC) for inhalation exposure scenarios. RfD and RfC values are published by the USEPA, and provide an estimate of the daily dose of the compound an individual may receive without an appreciable risk of adverse health effects appearing during their lifetime including organ damage or reproductive effects. Chronic exposures were evaluated for a current and potential future facility worker.

The COC that exhibit potential non-carcinogenic effects include 1,1,1-trichloroethane, cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene.

Carcinogenicity

The toxicity value used to estimate the risk of cancer from exposure to chemicals that are known to induce carcinogenic effects is termed a Cancer Slope Factor (CSF) for oral/dermal or the Unit Risk (UR) and inhalation exposures. Unlike the RfD or RfC value, the CSF/UR is based on the assumption that there is no threshold dose for adverse health effects but that carcinogenicity is a function of the frequency of exposure.

The CSF/UR values are generally derived from data obtained through test animal exposure studies and/or human epidemiological studies from exposed populations. By estimating the upper 95% confidence limit of the slope of the dose-response curve extrapolated to low doses, the CSF is considered a measure of the cancer causing potential of a substance as a result of exposure to a chemical at any time throughout a lifetime (70 years).

Lifetime exposures for cancer effects were evaluated for compounds considered as a Class A (carcinogen), Class B (probable carcinogen), and Class C (possible carcinogen) carcinogens as defined by the USEPA weight-of-evidence classification.

The COC that are currently identified as Class A or Class B probable carcinogens include trichloroethene, and tetrachloroethene.

TOXICITY ASSESSMENT

Sources of Toxicity Values

The non-cancer and cancer toxicity values were obtained from the USEPA Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or obtained from the Superfund Health Risk Technical Support Center. The non-carcinogenic and carcinogenic toxicity values and associated sources are presented in Table 1.

TABLE 1
Carcinogenic and Non-Carcinogenic Toxicity Values

Compound of Concern	Carcinogenic Risk Values URi/CSFi (inhalation)	Non-Carcinogenic Risk Values Reference Dose /Concentration (RfD/RfC)	Source
Tetrachloroethene	5.9E-03/2.07E-02	1.0E-02/6.0E-01	IRIS/NCEA
1,1,1-Trichloroethane	NA	6.9E-01/2.2E+00	IRIS
Trichloroethene	5.7E-06/2.0E-02	1.14E-02/4.0E-02	NCEA
Cis-1,2-Dichloroethene	NA	1.0E-02	HEAST

NCEA – National Center for Environment Assessment

IRIS – Integrated Risk Information System

HEAST- Health Effects Assessment Summary Tables

RfC – Units of mg/M³

RfD – Units of mg/kg body weight-day

CSFi – Units of mg/kg body weight-day

NA- Not Applicable

Attachment C provides the currently available toxicity value sources for each COC available at <http://risk.lsd.ornl.gov/cgi-bin/tox/TOX>.

EXPOSURE ASSESSMENT

To characterize the risk of adverse health effects from contact with the COCs, an exposure assessment was performed to identify potential receptors and to estimate the exposure point concentration (EPC). Consistent with USEPA guidance, the exposure assessment considers both current and reasonably foreseeable future facility activities and uses. Current exposure estimates assess whether significant health risks are present based upon existing property conditions, and foreseeable future exposure estimates are used to provide an understanding of potential exposures and potential health risks associated with likely future facility uses.

In order to evaluate human health risk, potential exposure pathways are identified and EPC are estimated to estimate the maximum chemical intake. An exposure pathway is a term that includes a source or release from a source, an exposure point, and a route of exposure (e.g., oral, dermal, or inhalation) to the COC. The results of the exposure assessment are integrated with the toxicity information obtained in the dose-response assessment to assess the health risk for the current and future facility users. Since each of the COC are volatile at standard temperature and pressure, the exposure pathway that exhibits the maximum chemical intake potential was assumed to be through inhalation of impacted indoor air above the source area soils with the highest concentration of COC detected during the sub-slab soil vapor sampling program.

The soil vapor concentration for each COC detected during the sampling program was used to estimate the potential maximum ambient air impact to the facility indoor air above the source area soils. The estimated maximum indoor air concentration was calculated using site

information and chemical-specific characteristics in accordance with applicable USEPA guidance to determine the potential EPC under current and foreseeable facility use scenarios.

This procedure utilized soil vapor to indoor air volatilization models provided by the USEPA Office of Solid Waste and Emergency Response (OSWER), Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), November 2002, EPA530-D-02-004. Available at <http://www.epa.gov/correctiveaction/eis/vapor/complete.pdf>

Specific parameters used including the identification of human receptors, the estimation of exposure point concentrations, and chemical intake parameters are integral parts of the exposure assessment.

Exposure Scenario

Current and Foreseeable Future Use

The area evaluated comprised the Former CRC area where degreasing operations had occurred within the facility. This area of the property is covered with approximately 12 inches of concrete flooring serving as a cap and barrier to subsurface vapor intrusion. This area was previously subjected to treatment using a 2-PHASE® extraction system. Based on the results of the soil sampling programs conducted during the facility remedial investigation, soils containing site-related COC were assumed to be located from 2-10 feet below ground surface below the facility.

The human receptors associated with current and foreseeable future site conditions include facility workers and/or personnel assigned to this area of the facility.

The assumed route of exposure for these potential receptors included inhalation of contaminated soil vapor released from the subsurface soils through evaporation/volatilization into the indoor air through cracks within the building foundation.

Based on the EPA guidance and assumptions for dilution of the soil vapor within the building air space and the effects of ambient air introduced to the facility, an attenuation factor of 0.01 was assumed for the soil vapor intrusion and used in the calculation of the EPC.

Frequency and Duration of Exposure Assumptions

Facility Workers/Users

Under current and foreseeable future facility operation, it is assumed that the facility worker would be exposed to impacted ambient air 8 hours per day, 250 day per year, for 25 years. These values are default assumptions for a commercial worker scenario provide by current USEPA guidance, "Standard Default Exposure Factors" OSWER Directive 9285.6, 1991.

Exposure Assumptions for Inhalation

For inhalation, receptor-specific inhalation rates and ambient air concentrations are used in the dose calculations. The inhalation assumptions used in the calculation of human health risk are summarized below:

Facility Workers/Users

For current and foreseeable future facility uses, a respiration rate corresponding to an activity level of moderate exertion (2.5 m³/hour) was assumed for the facility worker. This is equivalent to a daily inhalation rate of 20 m³ /day and is consistent with the USEPA guidance referenced above.

Body Weight

For the exposure scenarios, receptor-specific body weights were used in the estimation of average daily doses. For the site worker, and the potential future site user, a default adult body weight of 70 kg was assumed.

Estimation of Exposure Point Concentrations (EPC)

Exposure points are locations where potential receptors may be exposed to a COC. Depending on the exposure pathway, the exposure point may consist of an area or zone of potential exposure, or a single exposure point. Exposure point concentrations represent the COC concentrations in media that the receptor may absorb/adsorb or ingest at the exposure point. Estimation of exposure point concentrations uses the analytical data from the environmental media collected at the Site to calculate the potential maximum concentration of the COC at the receptor exposure point.

The EPC of the COC in indoor air in the facility were determined using the results of the sub-slab sampling events conducted from January 2005 through March 2006 at the former Xerox Blauvelt facility. The reported values provided for each sub-slab sample collected and analyzed by Columbia Analytical Services was used to calculate the EPC.

Table 2 presents a summary of the soil vapor data used in the calculation.

Estimation of Average Daily Doses

Estimation of average daily dose or exposure involves assessing the amount of material in contact with the receptor and the amount of absorption by the body. This assessment is achieved through the calculation of an average daily dose (ADD) for each COC and for each route of exposure. For this scenario, the amount of absorbed dose was assumed to be equivalent to the amount of COC inhaled over the exposure period. Several exposure factors (i.e., intake rate, frequency of exposure, duration of exposure) are included in the calculation of the ADD. The general average daily dose (ADD) equation is as follows:

$$\text{ADD} = \frac{\text{Total Amount of COC Absorbed}}{(\text{Body Weight}) * (\text{Averaging Period})}$$

For evaluation of non-carcinogenic effects, the averaging period is the period of time of the total absorption of COCs. For this scenario, the averaging time was 25 years or equivalent to the assumed maximum career period of a facility worker.

For evaluation of potential carcinogenic effects, the averaging time is equivalent to the lifetime of the receptor and is termed as the Lifetime Average Daily Dose (LADD). For this evaluation, a lifetime of a typical facility worker was assumed to be 70 years.

The ADD and LADD values are then compared with appropriate toxicity values discussed in the Dose-Response Assessment to provide a numerical estimate of the non-carcinogenic and carcinogenic levels of risk due to exposure to the COC under the exposure scenario.

Table 3 presents the ADD and LADD for the COC under the Industrial Worker Exposure Scenario for the Former Xerox CRC facility in Blauvelt, New York.

HUMAN HEALTH RISK CHARACTERIZATION

Human health risk characterization involves integrating the results of the hazard identification, dose-response assessment, and exposure assessment to quantify the potential risk to human health posed by potential exposures to the COC. To estimate non-carcinogenic risk, the Hazard Index (HI) for each compound is calculated by dividing the ADD determined in the exposure assessment by the appropriate Reference Concentration (RfC), given in the dose-response assessment. The Hazard Index for each route of exposure is summed for the route of exposure in the exposure scenario. This sum is the Total Site Hazard Index for the receptor and is compared with the EPA Acceptable Total Site Risk Limit of 1.0.

Carcinogenic risk is estimated as the incremental probability of an individual developing cancer over a lifetime (70 years) as a result of exposure to the potential carcinogen. The excess lifetime cancer risk (ELCR) for each compound is calculated by multiplying the lifetime average daily dose (LADD) estimated in the exposure assessment by the Cancer Slope Factor (CSF) given in the dose-response assessment. The ELCR for each compound is summed to calculate the Total Excess Lifetime Cancer Risk for the exposure scenario. The Total Site ELCR is compared with the USEPA Total Site Acceptable ELCR range of 1×10^{-4} to 10^{-6} (1 in 10,000 to 1 in 1,000,000 population).

Current and Foreseeable Future Human Health Site Risk

For the site worker/user, the current cumulative Hazard Index for inhalation of COC impacted indoor air within the facility is **0.659**. This value is below the USEPA acceptable risk limit of 1.0. Since current non-carcinogenic health risk is currently below the risk limit of 1.0 and the EPC of the site COCs is anticipated to decrease with time, the health risk for foreseeable future site use is anticipated to be less and thus below the acceptable risk limit as well.

Estimated Excess Lifetime Cancer Risk for the current facility worker from the inhalation of COC impacted indoor air is estimated to be **5.8E-05** which is within the USEPA acceptable risk limit range of $1.0 \text{ E-}04$ to $1.0\text{E-}06$.

CONCLUSION

The results of the focused human health risk assessment at the Former Xerox CRC facility located in Blauvelt, New York indicates that the current and foreseeable future risk of adverse health effects from exposure to the current conditions identified in the subsurface is within acceptable USEPA thresholds. Using the attenuation factors developed by the USEPA Office of Solid Waste and Emergency Response (OSWER), the estimated indoor air concentrations of the COCs are less than 1% of the Permissible Exposure Limits promulgated by the Occupational Safety and Health Administration (OSHA) General Industry Air Contaminants Standard under 29 Code of Federal Regulations (CFR) Part 1910.1000.

However, the maximum soil vapor concentrations detected during the January 2005 to March 2006 soil vapor sampling events exceed the New York State Department of Health (NYSDOH) draft soil vapor screening criteria published in Guidance for Evaluating Soil Vapor Intrusion in the State of New York." Available at http://www.health.state.ny.us/nysdoh/gas/svi_guidance/index.htm.

Since the COC levels detected exceed these criteria, a vapor intrusion abatement system will be installed and operated beneath the concrete floor slab for areas of the facility where concentrations of PCE and TCE exceeded the draft NYSDOH screening criteria.

ATTACHMENT A

SOIL VAPOR SAMPLE ANALYSIS DATA

TABLE 2
SUMMARY OF LABORATORY ANALYTICAL DATA - SOIL VAPOR SAMPLING EVENTS
XEROX BLAUVELT, NEW YORK FACILITY

Sample ID	Sampling Date	Trichloroethene $\mu\text{g}/\text{m}^3$	Tetrachloroethene $\mu\text{g}/\text{m}^3$	1,1,1-Trichloroethane $\mu\text{g}/\text{m}^3$	Cis 1,2-Dichloroethene $\mu\text{g}/\text{m}^3$
Sub Slab Soil Vapor Sampling - Insider Former CRC Area					
SV-1	1/6/2005	4,300	13,000	600	1.6
SV-2	1/7/2005	1,200	4,300	440	1.6
SV-3	1/8/2005	5,400	48,000	1,100	160
SV-4	1/9/2005	12,000	49,000	2,500	470
SV-5	1/10/2005	830	4,500	320	1.6
SV-6	1/11/2005	3	29	3	1.6
SV-7	1/24/2006	13	1,100	250	1.6
SV-8	1/25/2006	13	4,000	110	1.6
SV-9	1/26/2006	21,000	61,000	2,800	1.6
SV-10	1/27/2006	1,200	10,000	770	1.6
SV-11	1/28/2006	18,000	47,000	2,400	1.6
SV-12	1/29/2006	11,000	32,000	1,600	1.6
SV-13	1/30/2006	97	660	34	1.6
SV-14	1/31/2006	1,700	16,000	610	1.6
AVG		5,483	20,756	967	46
ST DEV		7,143	21,854	970	129
n		14	14	14	14
$t_{\alpha/2}$		2.16	2.16	2.16	2.16
Confidence		4123.55	12616.02	559.88	74.49
Upper Confidence Limit		9,606	33,372	1,527	121
Max Value		21,000	61,000	2,800	470
OSHA	PEL	537,000	678,000	1,911,000	794,000

TABLE 3
INDUSTRIAL WORKER EXPOSURE:
INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS
XEROX BLAUVELT, NEW YORK FACILITY

$$\text{Intake (mg/kg-day)} = \frac{\text{CA} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

	Trichloroethene	Tetrachloroethene	1,1,1-Trichloroethane	Cis 1,2-Dichloroethene
CA (mg/m ³)	0.096	0.334	0.015	0.001
IR (m ³ /hour)	0.8	0.8	0.8	0.8
ET (hours/day)	8	8	8	8
EF (days/year)	250	250	250	250
ED (years)	25	25	25	25
BW (kg)	70	70	70	70
AT (years)	25	25	25	25
AT (days) NC	9125	9125	9125	9125
AT (days) CA	25550	25550	NA	NA
CDI NC (mg/kg-day)	0.00602	0.02090	0.00096	0.00008
CDI CA (mg/kg-day)	0.00215	0.00746		

Note: CA = Contaminant Concentration in Air

IR = Inhalation Rate

ET = Exposure Time

EF = Exposure Frequency

ED = Exposure Duration

BW = Body Weight

AT = Average Time (period over which exposure is averaged)

CDI = Chronic Daily Intake

NC = Non-carcinogenic

CA = Carcinogenic

ATTACHMENT B

CURRENT RAIS DATABASE
TOXICOLOGICAL PROFILE REFERENCES

H&A OF NEW YORK
CONSULTING GEOTECHNICAL ENGINEERS
GEOLOGISTS AND HYDROGEOLOGISTS

BEDROCK RECOVERY WELL REPORT

PROJECT: VACUUM ENHANCED PUMPING WELL INSTALLATIONS
LOCATION: BLAUVELT, NEW YORK
CLIENT: XEROX CORPORATION
CONTRACTOR: NOTHNAGLE DRILLING
DRILLER: N. SHORT RIG TYPE:
INSTALLATION DATE: 8-9 NOVEMBER 1995

FILE NO.: 70302-079
WELL NO.: R-3
LOCATION: See Plan
SHEET: 1 OF 1
INSPECTOR: J. Marschner

Survey

Datum NGVD

Ground

Elevation: N/A

S
U
M
M
A
R
I
Z
E
D
S
T
O
O
I
L
S
C
A
O
L
N
E
D
I
T
I
O
N
S

-OVERBURDEN
DEPOSITS-
(Not sampled)

-CEMENT
BENTONITE
GROUT-

23.3

24.3

-BRUNSWICK
SHALE/SANDSTONE
FORMATION-

Stickup above ground
surface of protective casing.

1.9 ft.

Depth/Stickup above/below ground
surface of well casing.

Thickness of Surface Seal

24.3 ft.

Type of Surface Seal

[indicated all seals showing depth,
thickness and type]

Portland Cement
2% Calcium Chloride
4% Bentonite

Type of Protective Casing

Steel

Inside Diameter of Protective Casing

10.0 in.

Depth of Bottom of Protective Casing

24.3 ft.

Inside Diameter of Well Casing

8.0 in.

Type of Backfill Around Casing

Portland Cement
2% Calcium Chloride
4% Bentonite

Diameter of Borehole

10 1/4 in.

Depth of Top of Bedrock

23.3 ft.

Depth of Bottom of Casing

24.3 ft.

Diameter of Open Rock Hole

7 7/8 in.

Depth of Bottom of Open Rock Hole

41.4 ft.

Remarks:

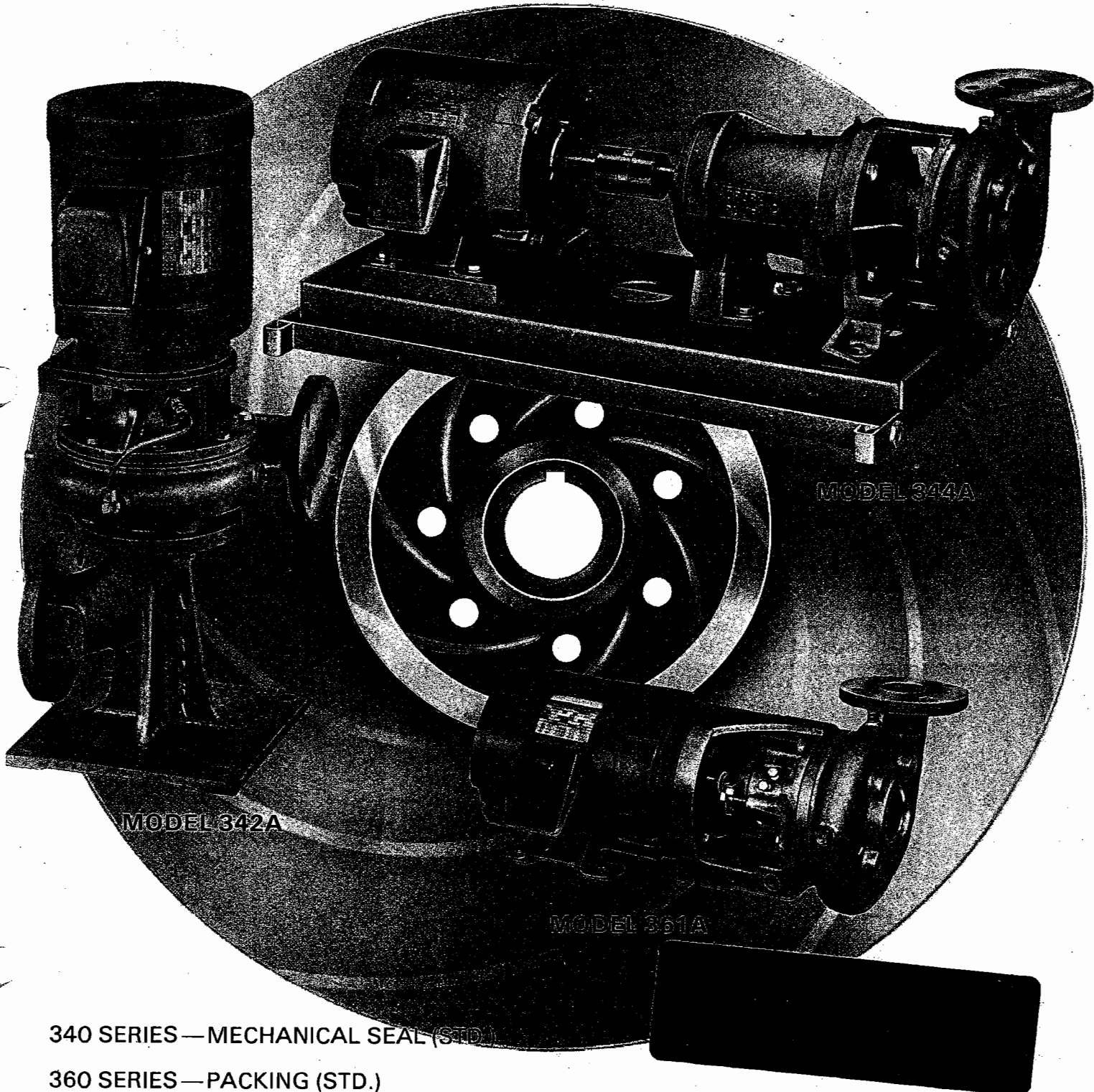
A UNIT OF GENERAL SIGNAL

GS

AURORA PUMP

BULLETIN 340/360E
340-360 SERIES
SINGLE STAGE
END SUCTION
PUMPS

CAPACITIES TO 4500 G.P.M.
HEADS TO 360 FEET
TEMPERATURES TO 300° F.

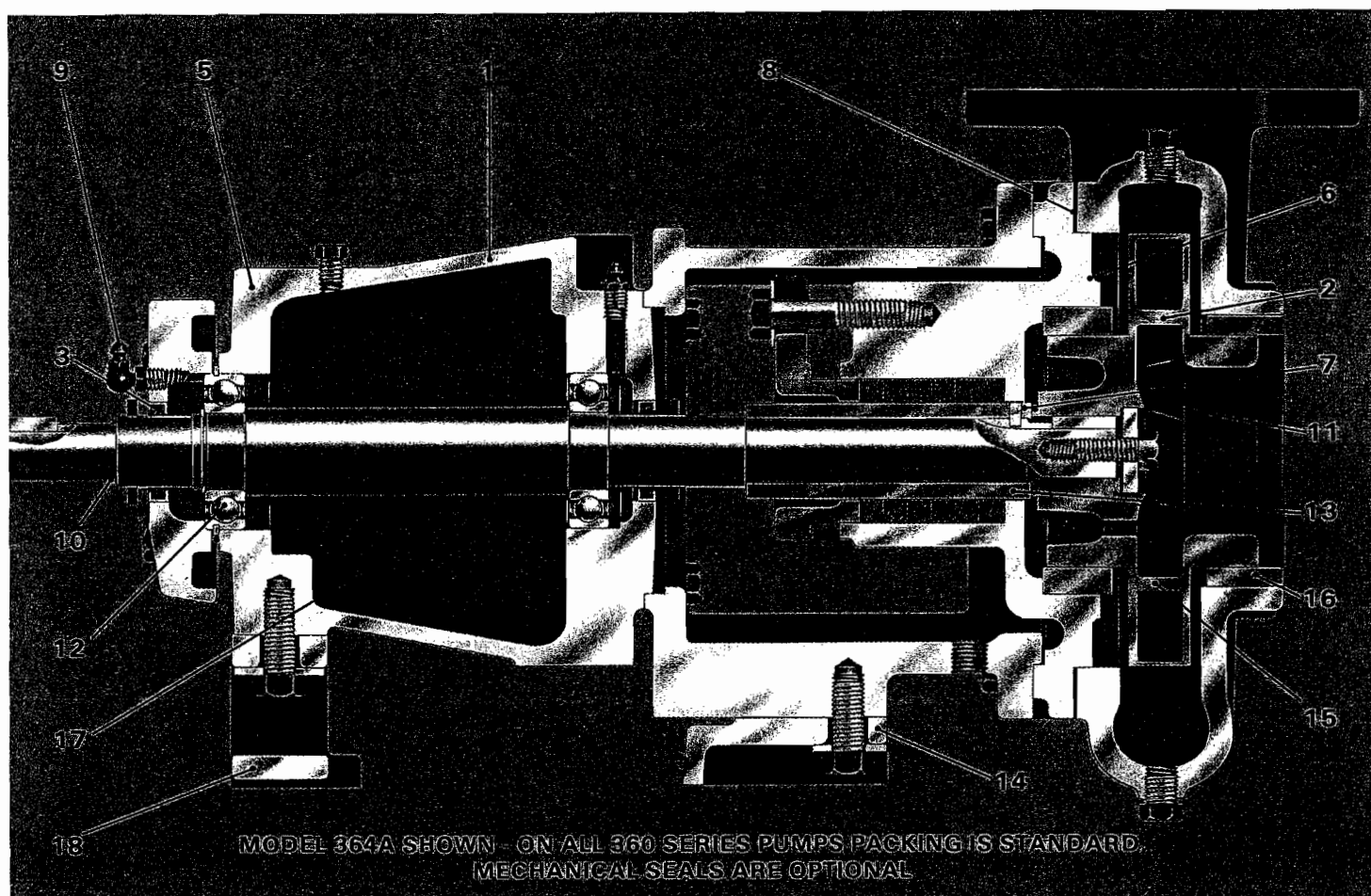


340 SERIES — MECHANICAL SEAL (STD.)

360 SERIES — PACKING (STD.)

INTRODUCTION

AURORA 340/360 SERIES PUMPS



Today's problem of liquid handling is much more involved than it was five years ago. The variety of liquids being handled has increased along with temperatures and pressures. The costs of engineering and construction have risen considerably. The need for economy and interchangeability

in design has become more important. The variety of today's installations demands quiet, smooth-running, long life pumps. The reliability of pump performance has become an essential. The 340/360 series is a modern design based on Aurora Pump's 70+ years experience with the de-

sign, sales and manufacture of centrifugal pumps. Significantly, pump Models 341A and 342A offer as standard HI-NEMA Type JM stock motors and Models 361A and 362A offer HI-NEMA Type JP stock motors. Aurora Pump also offers the power frame mounted Model 344A and 364A.

QUICK REFERENCE 340/360 SERIES FEATURE SELECTOR

NOTE

Front case wearing rings are standard on all models and size pumps. Rear case wearing rings are standard only on 2" discharge and larger model 360 series pumps.

Front impeller wearing rings are optional on all models and size pumps. Rear impeller wearing rings are optional only on 2" discharge and larger model 340 and 360 series pumps.

STANDARD - 340 & 360

Dynamically balanced enclosed impeller
Casing wearing ring(s) (see note)
Discharge position No. 1
Regreaseable bearings (344A, 364A)
Std. JM motor (Model 341A, 342A)
Std. JP motor (Model 361A, 362A)
V.I.P. performance test
Carbon steel shaft
Hydrostatic test
"O" Ring sealed shaft
Back pull-out casing
Coupling guard (344A, 364A)

STANDARD - 360 ONLY

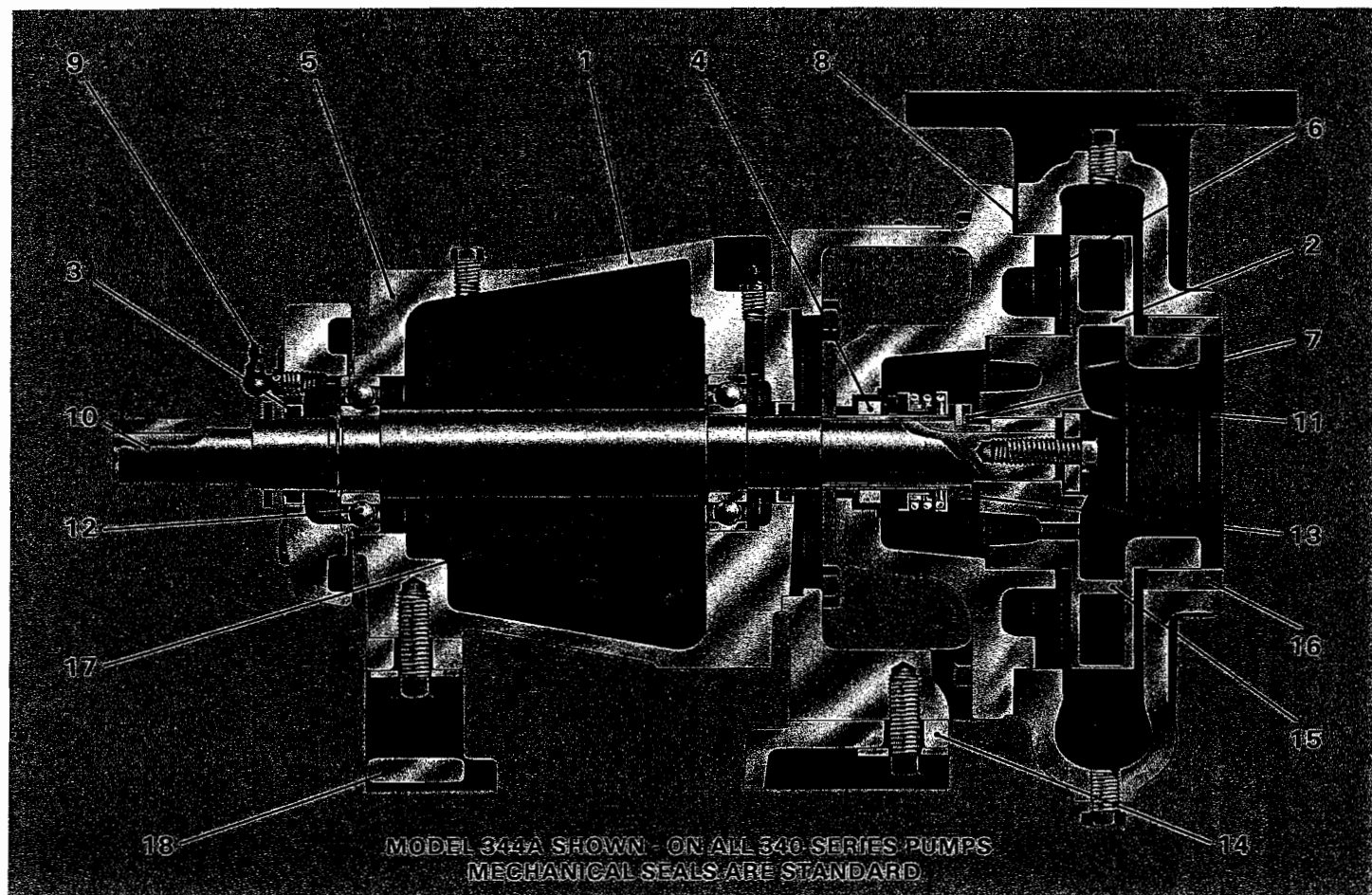
Interchangeable stuffing box
Graphite impregnated T.F.E. packing
316 Stainless steel shaft sleeve (all iron & stainless steel pumps)

OPTIONAL - 340 & 360

316 Stainless steel shaft sleeve (standard on all iron pumps)
Stainless steel shaft
Impeller wearing rings
Oil lubricated ball bearings (344A, 364A)
Discharge position No. 2, 3 & 4
Fab. st. drip rim bases (344A, 364A)
Formed steel bases (344A, 364A)
High temp. mech. seal
Variety of alternative constructions

OPTIONAL - 360 ONLY

All iron, all bronze or S.S. construction
316 S.S. or hardened shaft sleeve
Various mechanical seal types
Water jacketed stuffing box
Semi-open impellers (Model 364A)
Double row thrust bearings (364A)
Packing with lantern ring



1 COMPUTER MACHINED major components with 360 degree registered fits to assure concentricity of all pump parts.

2 VACUUM CAST IMPELLER Quality controlled manufacturing process assures consistently high pumping performance.

3 OIL SEALS and non-sparking Neoprene rotating slingers protect both bearings during pump operation and pump washdown.

4 MECHANICAL SEAL has carbon against Ni-Resist face for optimum hot water performance. Long life is also assured with 303 stainless steel metal parts and "Buna-N" elastomers.

5 POWER FRAME provides maximum interchangeability for flexible coupled applications.

6 V.I.P. FACTORY TEST guarantees performance at your specified operating conditions.

7 BRONZE SHAFT SLEEVE prevents shaft wear, is slip fit over the shaft, keylocked, and extends the full length of seal box. Sleeve is "O" ring sealed.

8 BACK PULL-OUT design simplifies disassembly. The suction and discharge piping is not disturbed at disassembly.

9 LUBRICATION FITTINGS are conveniently located for quick accessibility and provides positive bearing lubrication. Oil lubrication optionally available.

10 CARBON STEEL SHAFT designed for minimum deflection, not to exceed .002" at the sealing faces at maximum load.

11 DYNAMICALLY BALANCED IMPELLER is keyed to the shaft extension and secured by a capscrew and washer.

12 BEARINGS selected for 3 year minimum life at maximum load. Average bearing life 5 x minimum. Grease lube standard.

13 SHAFT SLEEVE and hex head impeller screw are "O" ring sealed to eliminate corrosion of the shaft by the pumped liquid. This eliminates the requirement for high cost, special stainless steel or alloy shafts.

14 CLOSE COUPLED MOTORS in smaller frame sizes are supported off of the motor bracket for maximum rigidity.

15 ENCLOSED IMPELLER design provides highest efficiency.

16 CASE WEARING RING prevents wear on casing and is easily and inexpensively replaced. Impeller rings are available (See note on Page 2).

17 LARGE CAPACITY OIL RESERVOIR is provided on power frame Model 344A and 364A pumps for optional oil lube.

18 REAR SUPPORT FOOT provides support and simplifies coupling alignment. All supports are slotted to simplify back pull-out of power frame.

OPTIONAL EQUIPMENT

Standard 340 and 360 series pumps are designed to meet the requirements of most applications. However, to meet special services, a number of optional features have been made available. For services not handled by the features listed, refer to the factory.

IMPELLER WEARING RINGS — Replaceable wearing rings protect the impeller from wear.

ALTERNATE DISCHARGE POSITIONS — Refer to dimension tables page 8 for details.

SHAFTS — Stainless steel shafts are available for special applications.

FAB. STEEL DRIP RIM BASES — Are available for Model 344A & 364A. Drip pocket extends under pump casing drain openings. Close coupled pumps have cast iron bases which allow back pull out of pump.

340 SERIES RANGE CHARTS

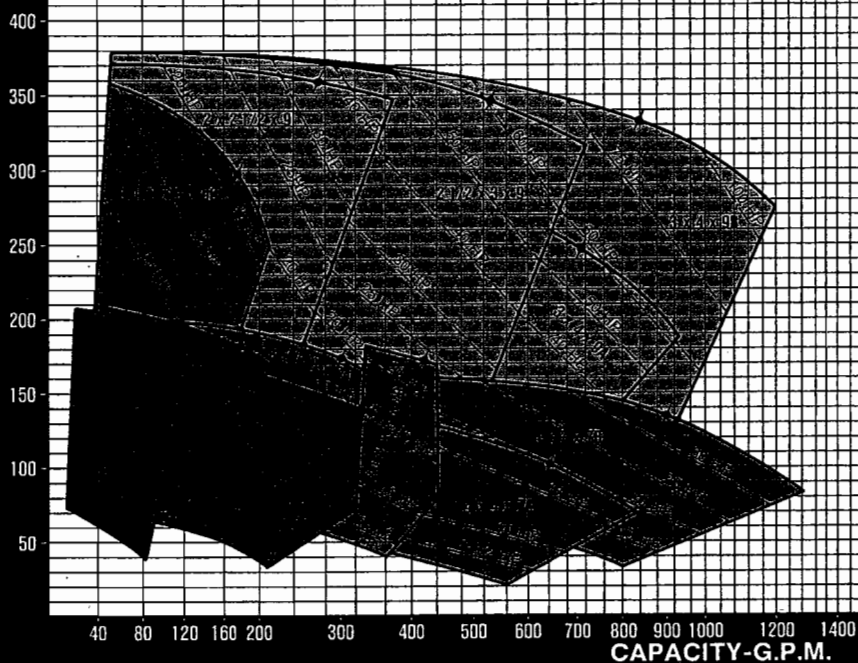
3500 R.P.M.
Enclosed Impeller

INDIVIDUAL PERFORMANCE CURVES SHOULD BE CHECKED FOR FINAL SELECTION. FOR SELECTIONS NOT SHOWN ON THIS CHART PLEASE REFER TO THE FACTORY.

POWER FRAME NO. 1
POWER FRAME NO. 2
POWER FRAME NO. 3

	CLOSE	OPEN DRIP PROOF	60
MAXIMUM	COUPLED	TE & EX PR	50
HORSEPOWER	FRAME MOUNTED		100

TOTAL DYNAMIC HEAD-FEET



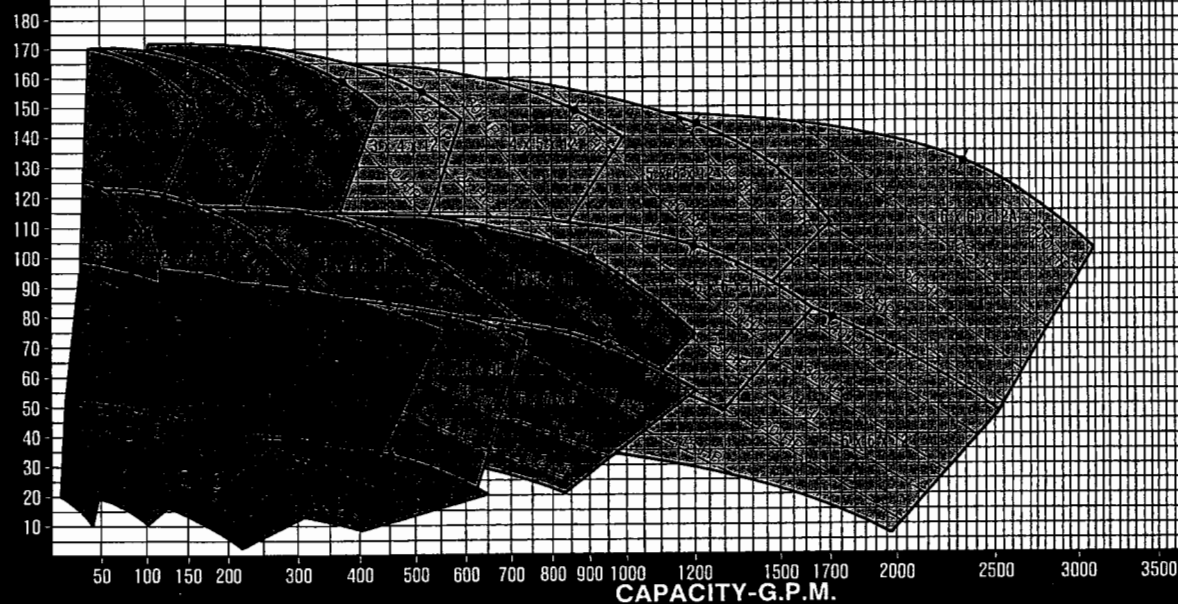
1750 R.P.M.
Enclosed Impeller

INDIVIDUAL PERFORMANCE CURVES SHOULD BE CHECKED FOR FINAL SELECTION. FOR SELECTIONS NOT SHOWN ON THIS CHART PLEASE REFER TO THE FACTORY.

POWER FRAME NO. 1
POWER FRAME NO. 2
POWER FRAME NO. 3

	CLOSE	OPEN DRIP PROOF	50
MAXIMUM	COUPLED	TE & EX PR	50
HORSEPOWER	FRAME MOUNTED		100

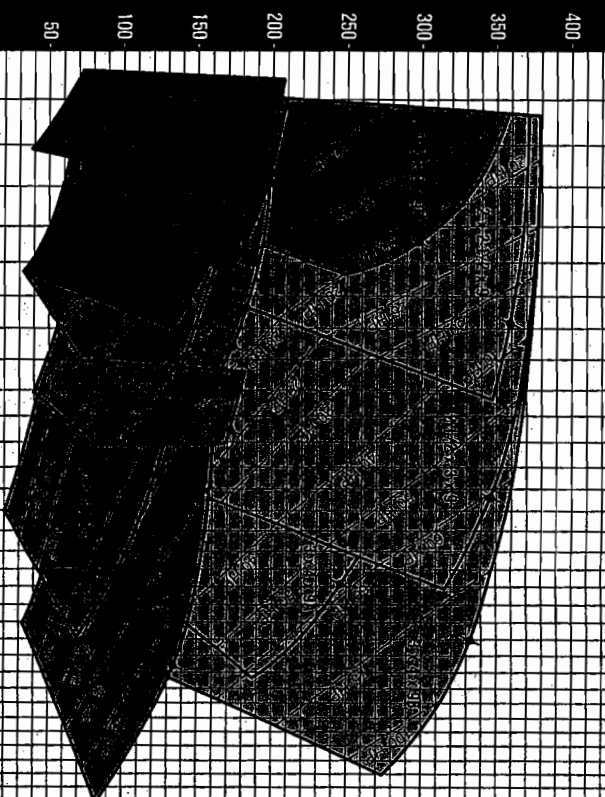
TOTAL DYNAMIC HEAD-FEET



- ① 1-1/4 x 1-1/2 x 98
- ② 1-1/2 x 2 x 98
- ③ 2 x 2-1/2 x 9
- ④ 1-1/4 x 1-1/2 x 7
- ⑤ 1-1/2 x 2 x 7
- ⑥ 2 x 2-1/2 x 7A
- ⑦ 2 x 2-1/2 x 7B
- ⑧ 2-1/2 x 3 x 7B
- ⑨ 1-1/2 x 2 x 11

360 SERIES
RANGE CHARTS

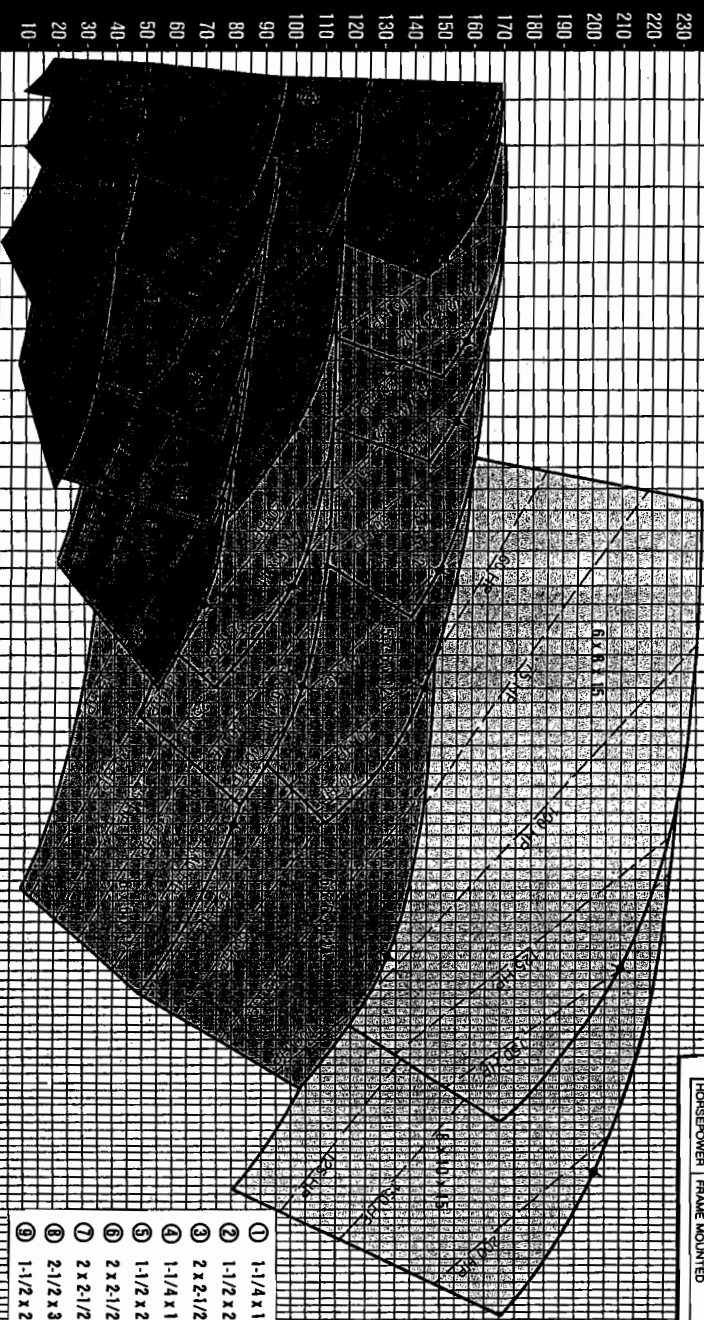
3500 R.P.M.
Enclosed Impeller



INDIVIDUAL PERFORMANCE CURVES SHOULD BE CHECKED FOR FINAL SELECTION. FOR SELECTIONS NOT SHOWN ON THIS CHART PLEASE REFER TO THE FACTORY.			
POWER FRAME NO. 1		OPEN DRAIN PROOF 80	
POWER FRAME NO. 2		COUPLED 1E & EX PM 50	
POWER FRAME NO. 3		FRAME MOUNTED 100	
MAXIMUM HORSEPOWER			

40 80 120 160 200 300 400 500 600 700 800 900 1000 1200 1400
CAPACITY-G.P.M.

1750 R.P.M.
Enclosed Impeller

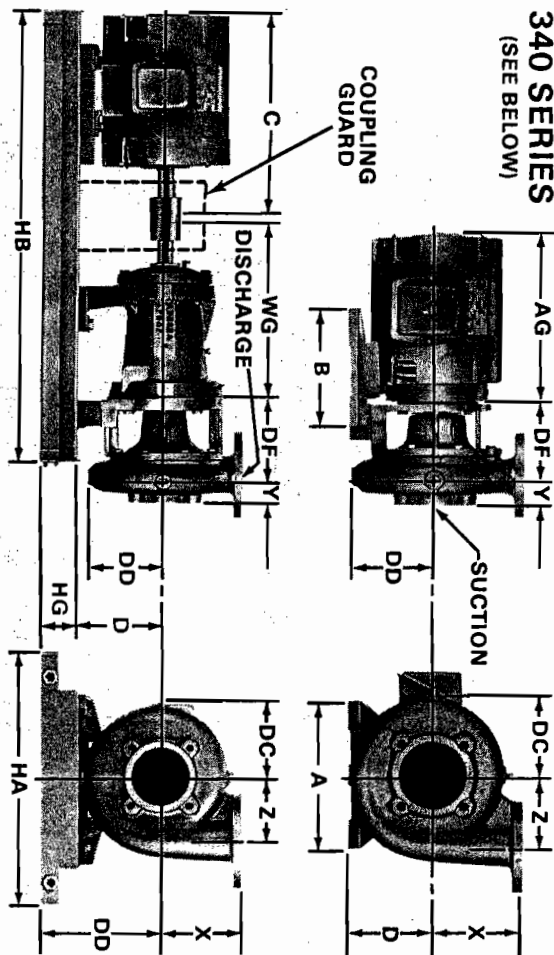


INDIVIDUAL PERFORMANCE CURVES SHOULD BE CHECKED FOR FINAL SELECTION. FOR SELECTIONS NOT SHOWN ON THIS CHART PLEASE REFER TO THE FACTORY.			
POWER FRAME NO. 1		OPEN DRAIN PROOF 50	
POWER FRAME NO. 2		COUPLED 1E & EX PM 50	
POWER FRAME NO. 3		FRAME MOUNTED 100	
MAXIMUM HORSEPOWER			

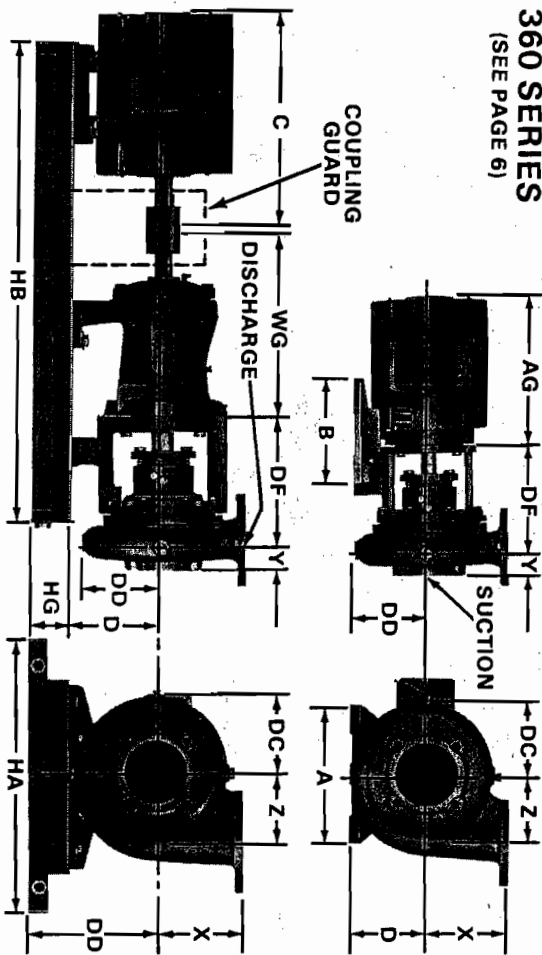
50 100 150 200 300 400 500 600 700 800 900 1000 1200 1500 1700 2000 2500 3000 3500 4000 4500
CAPACITY-G.P.M.

DIMENSIONS

340 SERIES
(SEE BELOW)

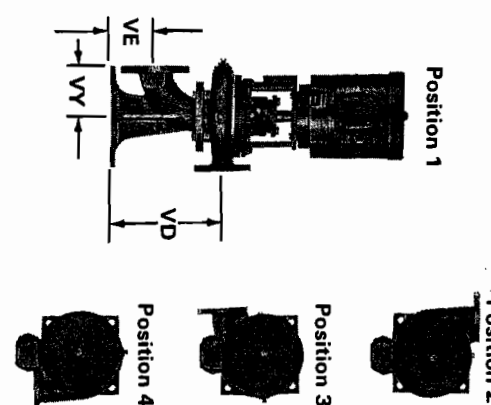
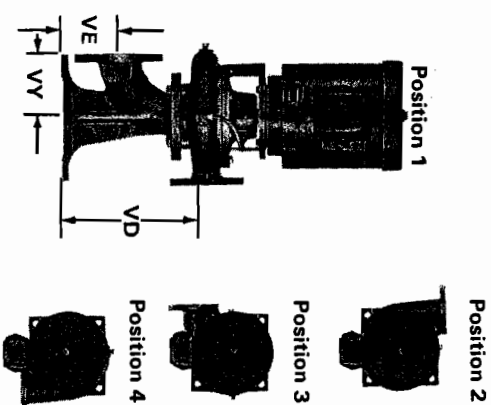


360 SERIES
(SEE PAGE 6)



PUMP MODEL	BASE NUMBER	WGT. LBS.	HP	HG	POWER FRAME WEIGHT IN POUNDS	CASE BORE	WGT.
340A	4	49	30.5/4	3	7	5-1/4	6-1/4
	5	59	32.5/4	3	9	6-1/4	7
	7	82	20.5/4	3	11	7	7
	8	96	20.5/4	3	12	7	7
	10	104	26.5/4	4	10.5/16	18.5/16	15.1/16

PUMP MODEL	BASE NUMBER	WGT. LBS.	HP	HG	POWER FRAME WEIGHT IN POUNDS	CASE BORE	WGT.
340A	4	49	30.5/4	3	7	5-1/4	6-1/4
	5	59	32.5/4	3	9	6-1/4	7
	7	82	20.5/4	3	11	7	7
	8	96	20.5/4	3	12	7	7
	10	104	26.5/4	4	10.5/16	18.5/16	15.1/16



360 SERIES

ENGINEERING
DETAILS

LIMITATIONS
340 & 360 SERIES—H.P.

LIMITATIONS	340 SERIES	360 SERIES	340 SERIES	360 SERIES
1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45
46	47	48	49	50
51	52	53	54	55
56	57	58	59	60
61	62	63	64	65
66	67	68	69	70
71	72	73	74	75
76	77	78	79	80
81	82	83	84	85
86	87	88	89	90
91	92	93	94	95
96	97	98	99	100

340 SERIES

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45
46	47	48	49	50
51	52	53	54	55
56	57	58	59	60
61	62	63	64	65
66	67	68	69	70
71	72	73	74	75
76	77	78	79	80
81	82	83	84	85
86	87	88	89	90
91	92	93	94	95
96	97	98	99	100

360 SERIES

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45
46	47	48	49	50
51	52	53	54	55
56	57	58	59	60
61	62	63	64	65
66	67	68	69	70
71	72	73	74	75
76	77	78	79	80
81	82	83	84	85
86	87	88	89	90
91	92	93	94	95
96	97	98	99	100

DESIGN DETAILS

AREA	DESCRIPTION	POWER SERIES			
		1	2	3	21
SHAFT	ROTATION—TROMBOLVER END	GW	GW	GW	GW
	DIAMETER IMPELLER	7/8	1-1/4	1-1/2	1-5/8-12
SHAFT	DIAMETER AT SHAFT SLEEVE	1	1-3/8	1-1/2	2-1/4
	DIAMETER BEARING BEARINGS	1-3/8	1-5/8	2-3/8	3-1/4
SHAFT	DIAMETER COUPLING END	7/8	1-1/4	1-1/2	2-3/8
	COUPLING KEY SQUARE	3/4	1/2	1/2	5/8
SHAFT	MAX DEFLECTION AT SEAL AGE	.002	.002	.002	.002
	BEARING HOUSING RADIAL	206K	306K	310K	313
SHAFT	BEARING HOUSING THUS	206KG	306KG	310KG	313G
	BEARING CENTERS	5-11/16	7-11/16	7-11/16	9-5/8
SHAFT	BEARING TYPE	BALL	BALL	BALL	BALL
	MINIMUM BEARING LIFE UNDER MAXIMUM LOAD	3YRS.	3YRS.	3YRS.	3YRS.
SHAFT	PACKING SIZE 340 SERIES	3/8	3/8	3/8	7/16
	OUTSIDE DIAMETER OF SLEEVE 360 SERIES	1-1/2	1-7/8	1-7/8	2-1/2
SHAFT	OUTSIDE DIAMETER OF SLEEVE 340 SERIES	1-1/8	1-1/2	1-1/2	NA

MATERIAL OF CONSTRUCTION

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45
46	47	48	49	50
51	52	53	54	55
56	57	58	59	60
61	62	63	64	65
66	67	68	69	70
71	72	73	74	75
76	77	78	79	80
81	82	83	84	85
86	87	88	89	90
91	92	93	94	95
96	97	98	99	100

Advantages of the joint NEMA-Hydraulic Institute standard motor to the close coupled pump users are:

1. Increased availability of motors. Less danger of downtime.
2. Better control of tolerances and quieter, more uniform performance.
3. Assured control of shaft deflection and longer mechanical seal life.
4. Adequate bearing size for longer bearing life.

Detailed dimensions can be obtained from Aurora Pump, your motor supplier, NEMA, or the Hydraulic Institute.

These motors are now available at no added cost. Specify: all close coupled pumps to use joint NEMA-Hydraulic Institute design type JM (340 Series) or JP (360 Series) pump approved motors.

VERTICAL PUMPS

Aurora quality is also available in a space saving vertical package. Valuable floor space is saved by specifying vertical Aurora pumps with all the advantages of the HI-NEMA standard motor. Aurora Models 342A & 362A conserve on floor space — actually using less than 1/2 of the space normally required with horizontal pumps. Vertical design makes installation easy, too. Choose from the four discharge positions — lay out piping the way you need it.

Model 342A and Model 362A pumps are illustrated on page 8.

SPECIAL FEATURES

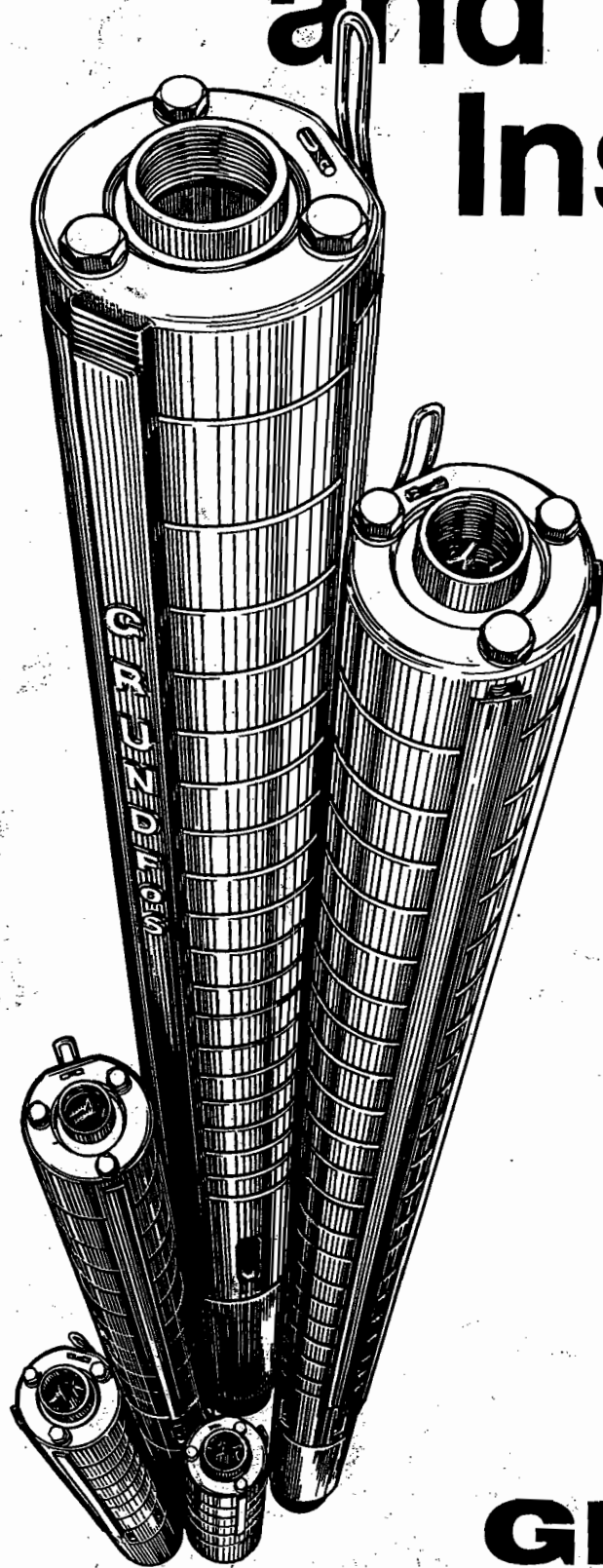
Aurora 340 & 360 Series pumps are each available in 33 horizontal and 31 vertical sizes, offering a size and model precisely fitted to a wide range of head and capacity requirements. For maximum interchangeability of parts all sizes are grouped into 3 power series. Pump size nomenclatures are as follows.
Example: 2 x 2-1/2 x 12
2 — Diameter of discharge
2-1/2 — Diameter of suction
12 — Maximum (nominal) impeller diameter.

POWER SERIES

MODEL 342A		MODEL 362A		MODEL 382A		MODEL 402A		MODEL 422A		MODEL 442A		MODEL 462A		MODEL 482A		MODEL 502A		MODEL 522A		MODEL 542A		MODEL 562A		MODEL 582A		MODEL 602A		MODEL 622A		MODEL 642A		MODEL 662A		MODEL 682A		MODEL 702A		MODEL 722A		MODEL 742A		MODEL 762A		MODEL 782A		MODEL 802A		MODEL 822A		MODEL 842A		MODEL 862A		MODEL 882A		MODEL 902A		MODEL 922A		MODEL 942A		MODEL 962A		MODEL 982A		MODEL 1002A		MODEL 1022A		MODEL 1042A		MODEL 1062A		MODEL 1082A		MODEL 1102A		MODEL 1122A		MODEL 1142A		MODEL 1162A		MODEL 1182A		MODEL 1202A		MODEL 1222A		MODEL 1242A		MODEL 1262A		MODEL 1282A		MODEL 1302A		MODEL 1322A		MODEL 1342A		MODEL 1362A		MODEL 1382A		MODEL 1402A		MODEL 1422A		MODEL 1442A		MODEL 1462A		MODEL 1482A		MODEL 1502A		MODEL 1522A		MODEL 1542A		MODEL 1562A		MODEL 1582A		MODEL 1602A		MODEL 1622A		MODEL 1642A		MODEL 1662A		MODEL 1682A		MODEL 1702A		MODEL 1722A		MODEL 1742A		MODEL 1762A		MODEL 1782A		MODEL 1802A		MODEL 1822A		MODEL 1842A		MODEL 1862A		MODEL 1882A		MODEL 1902A		MODEL 1922A		MODEL 1942A		MODEL 1962A		MODEL 1982A		MODEL 2002A		MODEL 2022A		MODEL 2042A		MODEL 2062A		MODEL 2082A		MODEL 2102A		MODEL 2122A		MODEL 2142A		MODEL 2162A		MODEL 2182A		MODEL 2202A		MODEL 2222A		MODEL 2242A		MODEL 2262A		MODEL 2282A		MODEL 2302A		MODEL 2322A		MODEL 2342A		MODEL 2362A		MODEL 2382A		MODEL 2402A		MODEL 2422A		MODEL 2442A		MODEL 2462A		MODEL 2482A		MODEL 2502A		MODEL 2522A		MODEL 2542A		MODEL 2562A		MODEL 2582A		MODEL 2602A		MODEL 2622A		MODEL 2642A		MODEL 2662A		MODEL 2682A		MODEL 2702A		MODEL 2722A		MODEL 2742A		MODEL 2762A		MODEL 2782A		MODEL 2802A		MODEL 2822A		MODEL 2842A		MODEL 2862A		MODEL 2882A		MODEL 2902A		MODEL 2922A		MODEL 2942A		MODEL 2962A		MODEL 2982A		MODEL 3002A		MODEL 3022A		MODEL 3042A		MODEL 3062A		MODEL 3082A		MODEL 3102A		MODEL 3122A		MODEL 3142A		MODEL 3162A		MODEL 3182A		MODEL 3202A		MODEL 3222A		MODEL 3242A		MODEL 3262A		MODEL 3282A		MODEL 3302A		MODEL 3322A		MODEL 3342A		MODEL 3362A		MODEL 3382A		MODEL 3402A		MODEL 3422A		MODEL 3442A		MODEL 3462A		MODEL 3482A		MODEL 3502A		MODEL 3522A		MODEL 3542A		MODEL 3562A		MODEL 3582A		MODEL 3602A		MODEL 3622A		MODEL 3642A		MODEL 3662A		MODEL 3682A		MODEL 3702A		MODEL 3722A		MODEL 3742A		MODEL 3762A		MODEL 3782A		MODEL 3802A		MODEL 3822A		MODEL 3842A		MODEL 3862A		MODEL 3882A		MODEL 3902A		MODEL 3922A		MODEL 3942A		MODEL 3962A		MODEL 3982A		MODEL 4002A		MODEL 4022A		MODEL 4042A		MODEL 4062A		MODEL 4082A		MODEL 4102A		MODEL 4122A		MODEL 4142A		MODEL 4162A		MODEL 4182A		MODEL 4202A		MODEL 4222A		MODEL 4242A		MODEL 4262A		MODEL 4282A		MODEL 4302A		MODEL 4322A		MODEL 4342A		MODEL 4362A		MODEL 4382A		MODEL 4402A		MODEL 4422A		MODEL 4442A		MODEL 4462A		MODEL 4482A		MODEL 4502A		MODEL 4522A		MODEL 4542A		MODEL 4562A		MODEL 4582A		MODEL 4602A		MODEL 4622A		MODEL 4642A		MODEL 4662A		MODEL 4682A		MODEL 4702A		MODEL 4722A		MODEL 4742A		MODEL 4762A		MODEL 4782A		MODEL 4802A		MODEL 4822A		MODEL 4842A		MODEL 4862A		MODEL 4882A		MODEL 4902A		MODEL 4922A		MODEL 4942A		MODEL 4962A		MODEL 4982A		MODEL 5002A		MODEL 5022A		MODEL 5042A		MODEL 5062A		MODEL 5082A		MODEL 5102A		MODEL 5122A		MODEL 5142A		MODEL 5162A		MODEL 5182A		MODEL 5202A		MODEL 5222A		MODEL 5242A		MODEL 5262A		MODEL 5282A		MODEL 5302A		MODEL 5322A		MODEL 5342A		MODEL 5362A		MODEL 5382A		MODEL 5402A		MODEL 5422A		MODEL 5442A		MODEL 5462A		MODEL 5482A		MODEL 5502A		MODEL 5522A		MODEL 5542A		MODEL 5562A		MODEL 5582A		MODEL 5602A		MODEL 5622A		MODEL 5642A		MODEL 5662A		MODEL 5682A		MODEL 5702A		MODEL 5722A		MODEL 5742A		MODEL 5762A		MODEL 5782A		MODEL 5802A		MODEL 5822A		MODEL 5842A		MODEL 5862A		MODEL 5882A		MODEL 5902A		MODEL 5922A		MODEL 5942A		MODEL 5962A		MODEL 5982A		MODEL 6002A		MODEL 6022A		MODEL 6042A		MODEL 6062A		MODEL 6082A		MODEL 6102A		MODEL 6122A		MODEL 6142A		MODEL 6162A		MODEL 6182A		MODEL 6202A		MODEL 6222A		MODEL 6242A		MODEL 6262A		MODEL 6282A		MODEL 6302A		MODEL 6322A		MODEL 6342A		MODEL 6362A		MODEL 6382A		MODEL 6402A		MODEL 6422A		MODEL 6442A		MODEL 6462A		MODEL 6482A		MODEL 6502A		MODEL 6522A		MODEL 6542A		MODEL 6562A		MODEL 6582A		MODEL 6602A		MODEL 6622A		MODEL 6642A		MODEL 6662A		MODEL 6682A		MODEL 6702A		MODEL 6722A		MODEL 6742A		MODEL 6762A		MODEL 6782A		MODEL 6802A		MODEL 6822A		MODEL 6842A		MODEL 6862A		MODEL 6882A		MODEL 6902A		MODEL 6922A		MODEL 6942A		MODEL 6962A		MODEL 6982A		MODEL 7002A		MODEL 7022A		MODEL 7042A		MODEL 7062A		MODEL 7082A		MODEL 7102A		MODEL 7122A		MODEL 7142A		MODEL 7162A		MODEL 7182A		MODEL 7202A		MODEL 7222A		MODEL 7242A		MODEL 7262A		MODEL 7282A		MODEL 7302A		MODEL 7322A		MODEL 7342A		MODEL 7362A		MODEL 7382A		MODEL 7402A		MODEL 7422A		MODEL 7442A		MODEL 7462A		MODEL 7482A		MODEL 7502A		MODEL 7522A		MODEL 7542A		MODEL 7562A		MODEL 7582A		MODEL 7602A		MODEL 7622A		MODEL 7642A		MODEL 7662A		MODEL 7682A		MODEL 7702A		MODEL 7722A		MODEL 7742A		MODEL 7762A		MODEL 7782A		MODEL 7802A		MODEL 7822A		MODEL 7842A		MODEL 7862A		MODEL 7882A		MODEL 7902A		MODEL 7922A		MODEL 7942A		MODEL 7962A		MODEL 7982A		MODEL 8002A		MODEL 8022A		MODEL 8042A		MODEL 8062A		MODEL 8082A		MODEL 8102A		MODEL 8122A		MODEL 8142A		MODEL 8162A		MODEL 8182A		MODEL 8202A		MODEL 8222A		MODEL 8242A		MODEL 8262A		MODEL 8282A		MODEL 8302A		MODEL 8322A		MODEL 8342A		MODEL 8362A		MODEL 8382A		MODEL 8402A		MODEL 8422A		MODEL 8442A		MODEL 8462A		MODEL 8482A		MODEL 8502A		MODEL 8522A		MODEL 8542A		MODEL 8562A		MODEL 8582A		MODEL 8602A		MODEL 8622A		MODEL 8642A		MODEL 8662A		MODEL 8682A		MODEL 8702A		MODEL 8722A		MODEL 8742A		MODEL 8762A		MODEL 8782A		MODEL 8802A		MODEL 8822A		MODEL 8842A		MODEL 8862A		MODEL 8882A		MODEL 8902A		MODEL 8922A		MODEL 8942A		MODEL 8962A		MODEL 8982A		MODEL 9002A		MODEL 9022A		MODEL 9042A		MODEL 9062A		MODEL 9082A		MODEL 9102A		MODEL 9122A		MODEL 9142A		MODEL 9162A		MODEL 9182A		MODEL 9202A		MODEL 9222A		MODEL 9242A		MODEL 9262A		MODEL 9282A		MODEL 9302A		MODEL 9322A		MODEL 9342A		MODEL 9362A		MODEL 9382A		MODEL 9402A		MODEL 9422A		MODEL 9442A		MODEL 9462A		MODEL 9482A		MODEL 9502A		MODEL 9522A		MODEL 9542A		MODEL 9562A		MODEL 9582A		MODEL 9602A		MODEL 9622A		MODEL 9642A		MODEL 9662A		MODEL 9682A		MODEL 9702A		MODEL 9722A		MODEL 9742A		MODEL 9762A		MODEL 9782A		MODEL 9802A		MODEL 9822A		MODEL 9842A		MODEL 9862A		MODEL 9882A		MODEL 9902A		MODEL 9922A		MODEL 9942A		MODEL 9962A		MODEL 9982A		MODEL 10002A		MODEL 10022A		MODEL 10042A		MODEL 10062A		MODEL 10082A		MODEL 10102A		MODEL 10122A		MODEL 10142A		MODEL 10162A		MODEL 10182A		MODEL 10202A		MODEL 10222A		MODEL 10242A		MODEL 10262A		MODEL 10282A		MODEL 10302A		MODEL 10322A		MODEL 10342A		MODEL 10362A		MODEL 10382A		MODEL 10402A		MODEL 10422A		MODEL 10442A		MODEL 10462A		MODEL 10482A		MODEL 10502A		MODEL 10522A		MODEL 10542A		MODEL 10562A		MODEL 10582A		MODEL 10602A		MODEL 10622A		MODEL 10642A		MODEL 10662A		MODEL 10682A		MODEL 10702A		MODEL 10722A		MODEL 10742A		MODEL 10762A		MODEL 10782A		MODEL 10802A		MODEL 10822A		MODEL 10842A		MODEL 10862A		MODEL 10882A		MODEL 10902A		MODEL 10922A		MODEL 10942A		MODEL 10962A		MODEL 10982A		MODEL 11002A		MODEL 11022A		MODEL 11042A		MODEL 11062A		MODEL 11082A		MODEL 11102A		MODEL 11122A		MODEL 11142A		MODEL 11162A		MODEL 11182A		MODEL 11202A		MODEL 11222A		MODEL 11242A		MODEL 11262A		MODEL 11282A		MODEL 11302A		MODEL 11322A		MODEL 11342A		MODEL 11362A		MODEL 11382A		MODEL 11402A		MODEL 11422A		MODEL 11442A		MODEL 11462A		MODEL 11482A		MODEL 11502A		MODEL 11522A		MODEL 11542A		MODEL 11562A		MODEL 11582A		MODEL 11602A		MODEL 11622A		MODEL 11642A		MODEL 11662A		MODEL 11682A		MODEL 11702A		MODEL 11722A		MODEL 11742A		MODEL 11762A		MODEL 11782A		MODEL 11802A		MODEL 11822A		MODEL 11842A		MODEL 11862A		MODEL 11882A		MODEL 11902A		MODEL 11922A		MODEL 11942A		MODEL 11962A		MODEL 11982A		MODEL 12002A		MODEL 12022A		MODEL 12042A		MODEL 12062A		MODEL 12082A		MODEL 12102A		MODEL 12122A		MODEL 12142A		MODEL 12162A		MODEL 12182A		MODEL 12202A		MODEL 12222A		MODEL 12242A		MODEL 12262A		MODEL 12282A		MODEL 12302A		MODEL 12322A		MODEL 12342A		MODEL 12362A		MODEL 12382A		MODEL 12402A		MODEL 12422A		MODEL 12442A		MODEL 12462A		MODEL 12482A		MODEL 12502A		MODEL 12522A		MODEL 12542A		MODEL 12562A		MODEL 12582A		MODEL 12602A		MODEL 12622A		MODEL 12642A		MODEL 12662A		MODEL 12682A		MODEL 12702A		MODEL 12722A		MODEL 12742A		MODEL 12762A		MODEL 12782A		MODEL 12802A		MODEL 12822A		MODEL 12842A		MODEL 12862A		MODEL 12882A		MODEL 12902A		MODEL 12922A		MODEL 12942A		MODEL 12962A		MODEL 12982A		MODEL 13002A		MODEL 13022A		MODEL 13042A		MODEL 13062A		MODEL 13082A		MODEL 13102A		MODEL 13122A		MODEL 13142A		MODEL 13162A		MODEL 13182A		MODEL 13202A		MODEL 13222A		MODEL 13242A		MODEL 13262A		MODEL 13282A		MODEL 13302A		MODEL 13322A		MODEL 13342A		MODEL 13362A		MODEL 13382A		MODEL 13402A		MODEL 13422A		MODEL 13442A		MODEL 13462A		MODEL 13482A		MODEL 13502A		MODEL 13522A		MODEL 13542A		MODEL 13562A		MODEL 13582A		MODEL 13602A		MODEL 13622A		MODEL 13642A		MODEL 13662A		MODEL 13682A		MODEL 13702A		MODEL 13722A		MODEL 13742A		MODEL 13762A		MODEL 13782A		MODEL 13802A		MODEL 13822A		MODEL 13842A		MODEL 13862A		MODEL 13882A		MODEL 13902A		MODEL 13922A		MODEL 13942A		MODEL 13962A		MODEL 13982A		MODEL 14002A		MODEL 14022A		MODEL 14042A		MODEL 14062A		MODEL 14082A		MODEL 14102A		MODEL 14122A		MODEL 14142A		MODEL 14162A		MODEL 14182A		MODEL 14202A		MODEL 14222A		MODEL 14242A		MODEL 14262A		MODEL 14282A		MODEL 14302A		MODEL 14322A		MODEL 14342A		MODEL 14362A		MODEL 14382A		MODEL 14402A		MODEL 14422A		MODEL 14442A		MODEL 14462A		MODEL 14482A		MODEL 14502A		MODEL 14522A		MODEL 14542A		MODEL 14562A		MODEL 14582A		MODEL 14602A		MODEL 14622A		MODEL 14642A		MODEL 14662A		MODEL 14682A		MODEL 14702A		MODEL 14722A		MODEL 14742A		MODEL 14762A		MODEL 14782A		MODEL 14802A		MODEL 14822A		MODEL 14842A		MODEL 14862A		MODEL 14882A		MODEL 14902A		MODEL 14922A		MODEL 14942A		MODEL 14962A		MODEL 14982A		MODEL 15002A		MODEL 15022A		MODEL 15042A		MODEL 15062A		MODEL 15082A		MODEL 15102A		MODEL 15122A		MODEL 15142A		MODEL 15162A		MODEL 15182A		MODEL 15202A		MODEL 15222A		MODEL 15242A		MODEL 15262A		MODEL 15282A		MODEL 15302A		MODEL 15322A		MODEL 15342A		MODEL 15362A		MODEL 15382A		MODEL 15402A		MODEL 15422A		MODEL 15442A		MODEL 15462A		MODEL 15482A		MODEL 15502A		MODEL 15522A		MODEL 15542A		MODEL 15562A		MODEL 15582A		MODEL 15602A		MODEL 15622A		MODEL 15642A		MODEL 15662A		MODEL 15682A		MODEL 15702A		MODEL 15722A		MODEL 15742A		MODEL 15762A		MODEL 15782A		MODEL 15802A		MODEL 15822A		MODEL 15842A		MODEL 15862A		MODEL 15882A		MODEL 15902A		MODEL 15922A		MODEL 15942A		MODEL 15962A		MODEL 15982A		MODEL 16002A		MODEL 16022A		MODEL 16042A		MODEL 16062A		MODEL 16082A		MODEL 16102A		MODEL 16122A		MODEL 16142A		MODEL 16162A		MODEL 16182A		MODEL 16202A		MODEL 16222A		MODEL 16242A		MODEL 16262A		MODEL 16282A		MODEL 16302A		MODEL 16322A		MODEL 16342A		MODEL 16362A		MODEL 16382A		MODEL 16402A		MODEL 16422A		MODEL 16442A	

Installation and Operating Instructions

*4-Inch Single Phase
Stainless Steel
Submersible Pumps*



1. Pre-Installation
2. Splicing the Motor Cable
3. Installation
4. Electrical
5. Start Up

GRUNDFOS®



Installation and Operating Instructions

4-INCH SINGLE PHASE STAINLESS STEEL SUBMERSIBLE PUMPS

1. Pre-Installation

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the GRUNDFOS submersible makes it resistant to abrasion; however, no pump made of any material can forever withstand the destructive wear that occurs when constantly pumping sandy water.

If this pump is used to replace an oil-filled submersible or oil lubricated line-shaft turbine in an existing well, the well must be blown or bailed clear of oil.

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

Submersible well pumps are designed for pumping clear, cold water, free of air or gases. Decreased pump performance and life expectancy can occur if the water is not clear, cold or contains air or gases. Water temperature should not exceed 102°F.

A check should be made to ensure that the installation depth of the pump will always be at least three feet below the maximum drawdown level of the well.

The bottom of the motor should never be installed lower than the top of the well screen or within five feet of the well bottom.

Ensure that the requirement for minimum flow past the motor (Table A) is met.

2. Splicing the Motor Cable

If the splice is carefully made, it will be as efficient as any other portion of the cable, and will be completely watertight.

There are a number of cable splicing kits available today – epoxy filled, rubber-sealed and so on. Many perform well if the manufacturer's directions are followed carefully. If one of these kits is not used, we recommend the following method for splicing the motor cable to the drop cable:

Examine the motor cable and the drop cable carefully for damage. Cut the motor leads off in a staggered manner. Cut the ends of the drop cable so that the ends match up with the motor leads. Be sure to match the colors. Strip back and trim off one-half inch of insulation from each lead, making sure to scrape the wire bare to obtain a good connection. Be careful not to damage the copper conductor when stripping off the insulation. Insert a properly sized Sta-Kon-type connector on each pair of leads, again making sure that colors are matched. Using Sta-Kon crimping pliers, indent the lugs. Be sure to squeeze down hard on the pliers, particularly when using large cable. Form a piece of electrical insulation putty tightly around each Sta-Kon. The putty should overlap on the insulation of the wire. Use a good quality tape such as #33 Scotch Waterproof or Plymouth Rubber Company Slipknot Grey. Wrap each wire and joint tightly for a distance of about 2½ inches on each side of the joint. Make a minimum of four passes over each joint and overlap each pass approximately one inch to assure a completely watertight seal.

After splicing the motor cable, replace the cable guard by inserting into the slots at the discharge end of the pump. Resecure the tabs at the bottom end of the cable guard. **NOTE: For proper installation the cable guard must be pushed to the TOP end of the mounting slots before securing bottom tabs.**

3. Installation

A back-up wrench should be used when the riser pipe is attached to the pump. The pump should only be gripped by the flats on the top of the discharge chamber. Under no circumstances grip the body of the pump, cable guard or motor.

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

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

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

Do not use the power cable to support the weight of the pump.

To protect against surface water entering the well and contaminating the water source, the well should be finished off above grade, utilizing a locally-approved well seal or pitless adapter unit.

We recommend that steel riser pipes always be used with the larger submersibles. A pipe thread compound should be used on all joints. Make sure that the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

It is recommended that plastic-type riser pipe be used only with the smaller domestic submersibles. The manufacturer or representative should be contacted to insure the pipe type and physical characteristics are suitable for this use. Use the correct joint compound recommended by the specific pipe manufacturer. Besides making sure that joints are securely fastened, we recommend the use of a torque arrestor when using plastic pipe.

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

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping and possible cable damage. Nylon cable clips or waterproof tape may be used. The cable splice should be protected by securing it with clips or tape just above each joint.

IMPORTANT: Plastic pipe tends to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave three to four inches of slack between clips or taped points. This tendency for plastic pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it. The discharge chamber of GRUNDFOS 4-inch submersibles is designed to accommodate this cable. (See figures 1A, 1B, and 2).



FIG. 1A

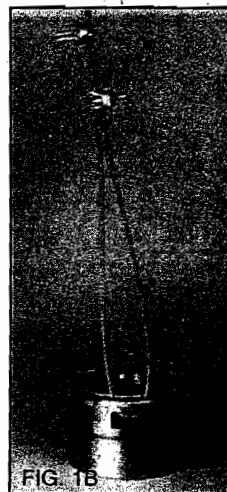


FIG. 1B

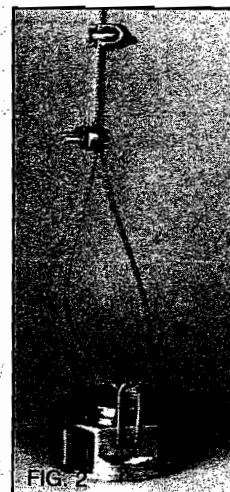


FIG. 2

CHECK VALVES: A check valve should always be installed at the surface of the well. In addition, for installations deeper than 200 feet, check valves should be installed at no more than 200 foot intervals.

4. Electrical

WARNING: A faulty motor or wiring can be a serious electrical shock hazard if it or surrounding water are accessible to human contact. To avoid this danger, connect the motor frame to the power supply grounding terminal with copper conductor no smaller than the circuit conductors unless the motor and surrounding water are inaccessible, as in a drilled well. In all installations connect above-ground metal plumbing to the power supply ground per National Electrical Code Article 250-80 to prevent electrical shock hazard.

Verification of the electrical supply should be made to insure the voltage, phase and frequency match that of the motor. Motor electrical data can be found in Table B.

If voltage variations are larger than $\pm 10\%$, do not operate the pump.

Single phase motor control boxes should be connected as shown on the wiring diagram mounted on the inside cover of the control box supplied with the motor.

The type of wire used between the pump and control boxes should be approved for submersible pump application. The conductor insulation should be type RW, RUW, TW or equivalent.

A high voltage surge arrestor should be used to protect the motor against lightning and switching surges. Lightning voltage surges in power lines are caused when lightning strikes somewhere in the area. Switching surges are caused by the opening and closing of switches on the main high-voltage distribution power lines.

The correct voltage-rated arrestor should be installed on the supply (line) side of the control box or starter (see figure 3). The arrestor must be grounded in accordance with the National Electrical Code and local governing regulations.

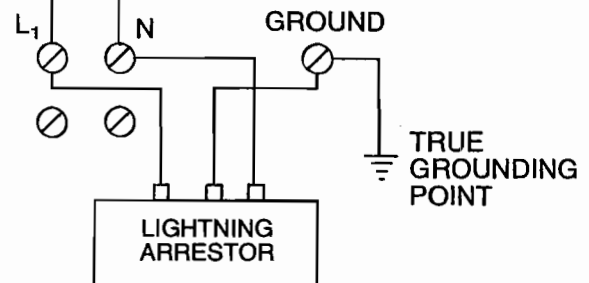
PUMPS SHOULD NEVER BE STARTED UNLESS THE PUMP IS TOTALLY SUBMERGED. SEVERE DAMAGE MAY BE CAUSED TO THE PUMP AND MOTOR IF THEY ARE RUN DRY.

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

True grounding points are considered to be: a grounding rod driven into the water strata; steel well casing submerged into the water lower than the pump setting level; and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are

used, a properly sized bare copper wire should be connected to a stud on the motor and run to the control panel. Do not ground to a gas supply line. Connect the grounding wire to the ground point first, and then to the terminal in the control box.

SINGLE PHASE POWER SUPPLY



SINGLE PHASE HOOK-UP

FIGURE 3

5. Start Up

- Attach a temporary horizontal length of pipe to the riser pipe.
- Install a gate valve and another short length of pipe to the temporary pipe.
- Adjust the gate valve one-third of the way open.
- Verify that the electrical connections are in accordance with the wiring diagram.
- After proper rotation has been checked, start the pump and let it operate until the water runs clear of sand, silt and other impurities.
- Slowly open the valve in small increments as the water clears until the valve is all the way open. The pump should not be stopped until the water runs clear.
- If the water is clean and clear when the pump is first started, the valve should still be slowly opened until it is all the way open.

Table A — Min. Water Flow Requirements for 4-Inch Submersible Pump Motors

Motor Diameter	Casing or Sleeve I.D. in Inches	Min. GPM Flow Passing the Motor
4-Inch	4	1.2
	5	7
	6	13
	7	21
	8	30

NOTES:

- For Franklin Motors Only: A flow inducer or sleeve must be used if the water enters the well above the motor or if there is insufficient water flow past the motor.
- For Franklin Motors Only: The minimum water velocity over 4" motors is 0.25 feet per second.

Table B — GRUNDFOS Electrical Data: 4-Inch, 2-Wire and 3-Wire, 60 Hertz Submersible Pump Motors

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)	
4-Inch, Two-Wire											
1/3	230	1	1.75	3.0	4.4	15	5	S	25.5	6.8-8.2	
1/2	230	1	1.60	4.3	5.9	15	7	R	34.5	5.2-6.3	
3/4	230	1	1.50	6.6	8.0	20	9	N	40.5	3.2-3.8	
1	230	1	1.40	8.0	9.6	25	12	M	47.4	2.5-3.1	
1 1/2	230	1	1.30	10.6	13.1	35	15	L	60.8	1.9-2.3	
4-Inch, Three-Wire										BY	RY
1/3	230	1	1.75	3.0	4.4	15	5	L	14.0	6.8-8.3	17.3-21.1
1/2	230	1	1.60	4.3	5.9	15	7	L	20.0	4.7-5.7	15.8-19.6
3/4	230	1	1.50	6.6	8.0	20	9	L	30.8	3.2-3.9	14.0-17.2
1	230	1	1.40	8.0	9.6	25	12	K	36.3	2.6-3.1	10.3-12.5
1 1/2	230	1	1.30	9.7	11.5	30	15	H	44.0	1.9-2.3	7.8-9.6

Table C**Franklin Electrical Data: 4-Inch, 60 Hz Submersible Pump Motors**

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)
4-Inch, Two Wire										
1/3	115	1	1.75	7.0	8.9	25	10	S	48.4	1.5-1.9
	230	1	1.75	3.5	4.4	15	5	S	24.2	6.0-7.4
1/2	115	1	1.60	9.6	11.9	30	15	R	62.4	1.0-1.3
	230	1	1.60	4.8	5.9	15	7	R	31.2	4.2-5.2
3/4	230	1	1.50	6.4	8.0	20	9	N	40.2	2.7-3.4
1	230	1	1.40	8.2	9.6	25	12	M	46.0	2.2-2.8
1 1/2	230	1	1.30	10.6	13.1	35	15	L	56.8	1.5-1.9

Rated HP	Volts	PH	Service Factor	Rated HP Amps	Service Factor Amps	Circuit Breaker or Standard Fuse	Dual Element Fuse	KVA Code	Locked Rotor Amps	Winding Resistance (Ohms)	
										BY	RY

4-Inch, Three Wire

1/3	115	1	1.75	7.0	8.9	20	8	N	32.8	1.5-1.9	5.7-7.1
	230	1	1.75	3.5	4.4	15	5	N	16.4	6.0-7.4	23.4-28.6
1/2	115	1	1.60	9.6	11.9	30	15	M	46.0	1.0-1.3	3.8-4.7
	230	1	1.60	4.8	5.9	15	7	M	23.1	4.2-5.2	15.5-19.6
3/4	230	1	1.50	6.4	8.0	20	9	M	33.1	2.7-3.4	11.0-13.6
1	230	1	1.40	8.0	9.6	25	12	L	42.0	2.2-2.8	9.5-11.7
1 1/2	230	1	1.30	10.0	11.5	30	15	J	52.8	1.5-1.9	6.2-8.5
2	230	1	1.25	10.0	13.1	35	15	G	51.0	1.6-2.3	5.2-7.1
3	230	1	1.15	14.0	16.5	45	20	F	71.0	0.9-1.5	3.0-4.9
5	230	1	1.15	23.0	27.5	80	30	F	118.0	0.7-1.0	2.1-2.8

LIMITED WARRANTY

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

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

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction. GRUNDFOS PUMPS CORPORATION, 2555 Clovis Avenue, Clovis California 93612, telephone number (209) 292-8000.

GRUNDFOS®

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 Support Centers: Allentown, PA • Atlanta, GA • Mississauga, Ontario, Canada

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GS
A UNIT OF GENERAL SIGNAL

AURORA PUMP

INSTRUCTION MANUAL

REPAIR

MODELS 341A, 342A, 344A

6

NOTE

This repair manual is applicable to pump Models 341A, 342A, 344A. All photos illustrate Model 344A.

SERVICE

Your Aurora pump requires no maintenance other than periodic inspection, occasional cleaning and lubrication of bearings. The intent of inspection is to prevent breakdown, thus obtaining optimum service life. The liquid end of the pump is lubricated by the fluid being pumped and therefore does not require periodic lubrication. The motor, however may require lubrication, in which case, the motor manufacturer's recommendation should be followed.

LUBRICATION OF IMPELLER SHAFT BEARINGS

The MODEL 344 pump is available with two options for lubricating the shaft bearings. They are:

1. Regreasable (standard)
2. Oil Lubrication

Regreasable bearings will require periodic lubrication and can be accomplished by using the zerk or lubrication fittings in the cartridge cap and power frame. Lubricate the bearings at regular intervals using a grease of high quality. Lithium, lithium soda or calcium base grease is recommended as lubricants for pumps operating in both wet and dry locations. Mixing of different brands of grease should be avoided due to possible chemical reactions between the brands which could damage the bearings. Accordingly, avoid grease of vegetable or animal base which can develop acids, as well as grease containing rosin, graphite, talc and other impurities. Under no circumstances should used grease be reused.

Over lubrication should be avoided as it may result in overheating and possible bearing failure. Under normal application, adequate lubrication is assured if the amount of grease is maintained at 1/3 to 1/2 the capacity of the bearing and adjacent space surrounding it.

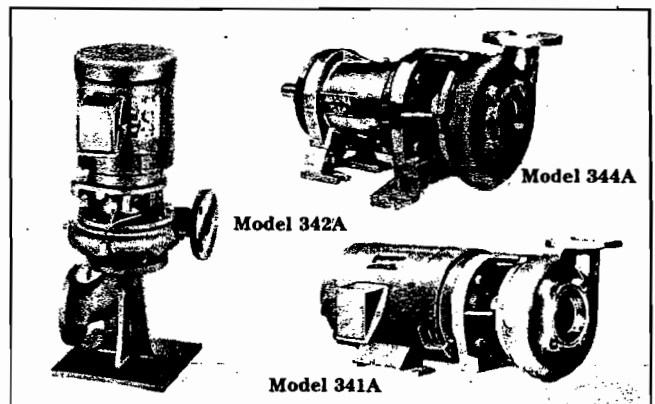
In dry locations, each bearing will need lubrication at least every 600 hours of running time or every 6 to 12 months, whichever is more frequent. In wet locations the bearings should be lubricated at least after every 300 hours of running time or every 4 to 6 months, whichever is more frequent. A unit is considered to be installed in a wet location if the pump and motor are exposed to dripping water, to the weather, or to heavy condensation such as is found in unheated and poorly ventilated underground locations.

Oil lubricated bearings are optional on MODEL 344 pumps. A fixed oil level is maintained with the power frame by an oiler which allows visual indications of reserve oil.

At initial installation and before starting a unit that has been shut down for repairs or for any extended length of time, run enough 10W-30 weight motor oil through the oiler to maintain a constant oil level to insure that the bearing will never be without an oil supply. Oil will have to be added at intervals to maintain a constant level in the oiler. This interval can only be determined by experience.

Under working conditions, oil will breakdown and need to be replaced at regular intervals. The length of these intervals will depend on many factors. Under normal operation, in clean and dry locations, the oil should be changed about once a year. However, when the pump is exposed to dirt contamination, high temperatures (200° F. or above) or a wet location, the oil may have to be changed every 2 to 3 months.

At times it may be necessary to clean the bearings due to accumulated dirt or deteriorated lubricants. This can be accomplished by flushing the bearing with a light oil heated to 180 to 200°F. While rotating it on a spindle, wipe the bearing housing with a clean rag soaked in a cleaning solvent and flush all surfaces.



A. Assembled Units.

Dry bearing thoroughly before relubricating. Compressed air can be used to speed drying, but care should be taken not to let bearings rotate while being dried.

CAUTION

Use normal fire caution procedures when using any petroleum cleaner.

REPAIRS

The pump may be disassembled using the illustrations and text provided. Although complete disassembly is covered, it will seldom be necessary to completely disassemble your Aurora pump.

The illustrations accompanying the disassembly instructions show the pump at various stages of disassembly. The illustrations are intended to aid in the correct identification of the parts mentioned in the text.

Inspect removed parts at disassembly to determine their reusability. Cracked castings should never be reused. Gaskets should be replaced at reassembly simply as a matter of economy; they are much less expensive to replace routinely than to replace as the need occurs. In general it is economical to return to the manufacturer for repair only the motor and motor controller.

DISASSEMBLY

Disassemble only what is needed to make repairs or accomplish inspection. (See Figure 2 for Model 341A, Figure 3 for Model 342A and Figure 3 for Model 344A.)

1. Break electrical connections to prevent drive unit from being energized during disassembly.

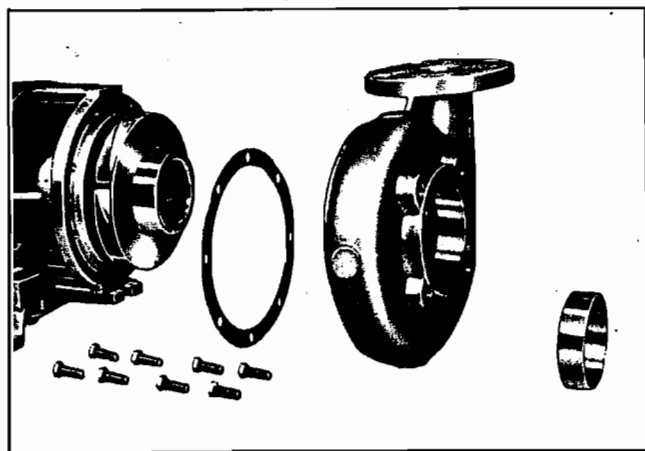
2. Unscrew the two drain plugs (4) from the casing (6). On Model 342A pumps, remove plugs (74 and 75) to drain pump. Also unscrew the two plugs (4) from casing (6).

3. Remove all relief, cooling, flushing or drain lines from pump, including compression connections (1 and 2) and tubing (3). Break suction and discharge connections unless it is intended to remove the power frame or motor assembly and leave casing (6) in the line. On Model 342A pumps, break discharge connections only, unless it is desired to remove base (73). Remove capscrews (39) and lift pump assembly from base (73). Remove gasket (72).

4. On Model 344A pumps, remove the flexible coupling from between the pump and motor. Next unscrew the bolts that hold support(s) (41 & 64) to the base and slide the pump out to be worked on.

5. Remove capscrews (5) and pull casing (6) from bracket (35). Remove gasket (8).

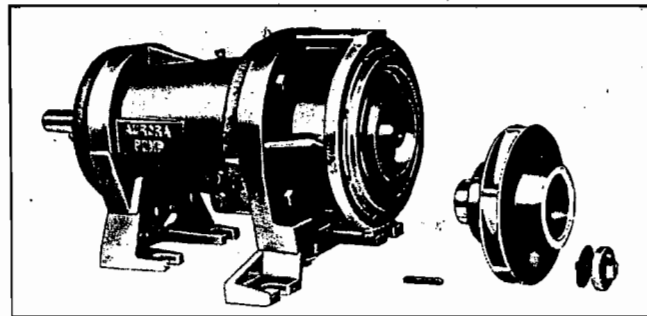
6. Unscrew impeller screw (9) and remove washer (9A), taking care not to damage gasket (9B).



B. Casing, Gasket, and Wearing Ring Removed.

7. Slide impeller (11) and impeller key (12) from the shaft, again taking care not to damage gasket (10) located behind impeller. Remove gasket (10).

8. Wearing ring(s) (7 & 16) are pressed into their housings with an interference fit and must be removed with a puller. New ring(s) should be used for reassembly since it is likely that during removal this fit will be lost.



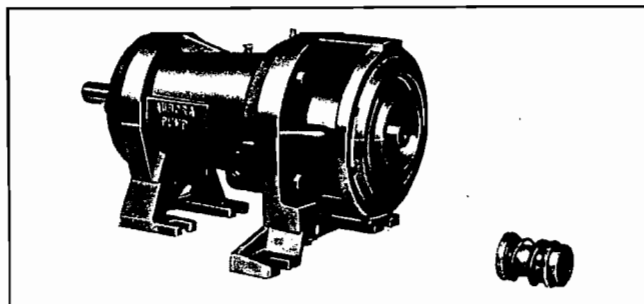
C. Impeller and Key Removed.

9. Impeller wearing rings (optional - 14 and 15) are pressed on and must be cut off if replacement is necessary. If they are turned off in a lathe, take care not to cut into the impeller.

10. Slide sleeve (25) with rotating parts of mechanical seal (27) from the shaft. The sleeve should be carefully cleaned to remove any residue that may be remaining in the seal area. The rubber in seal (27) may have become partially adhered to the sleeve. The sleeve must also be checked for abrasion or corrosion that can occur when fluid residue penetrates between the seal (27) and sleeve (25). The sleeve under the seal may be polished lightly to a 32 RMS finish before reassembly. Do not reuse a pitted sleeve. Pin (61) may be removed if necessary.

CAUTION

The mechanical seal is a precision product and must be treated as such. During removal great care must be taken to avoid dropping any part of the seal. Take particular care not to scratch the lapped faces on the washer or the sealing seat. Do not put a seal back into service until the sealing faces of the washer and seat have been lapped or replaced. (SEE FIGURE 1.)



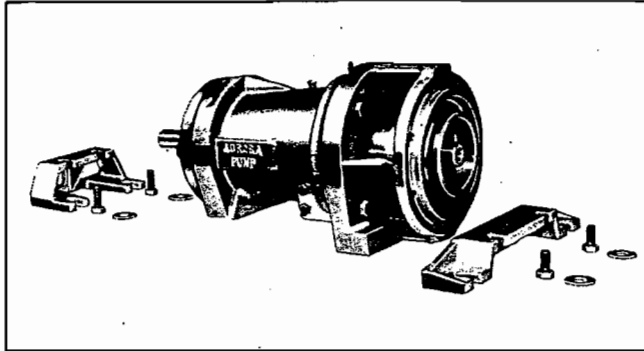
D. Mechanical Seal Removed.

11. On Model 344A pumps, remove capscrews (39 and 62) and washers (40 and 63) to take off support feet (41 and 64). On Model 341A frame size 143 thru 184-JM only. Unscrew capscrews (39) washers (40) and remove support (41) from bracket (35).

12. Unscrew capscrews (32) to remove bracket (35) from frame (57) or motor on Models 341A and 342A.

MODELS 341A-342A-344A

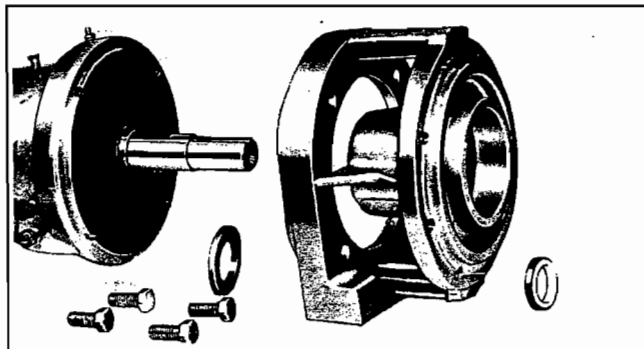
13. The seal flexible cup and stationary seat should be pressed out of the bracket (35) and the cavity cleaned of all residue. Make sure that the 1/32 inch radius in the seal seat cavity is not damaged during disassembly since a sharp edge can easily cut the flexible cup during reassembly.



E. Support Feet Removed.

14. On Model 344A pumps, remove key (42) from the shaft and remove slingers (47) and (47A).

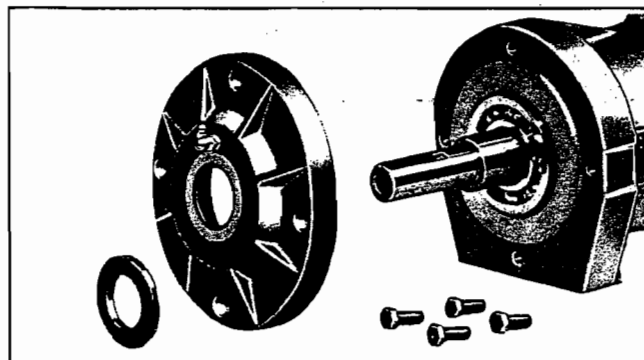
15. Unscrew capscrews (48) and remove bearing cap (49). Remove o-ring (oil lubed only) (50) and retainer ring (52).



F. Bracket and Slinger Seal Flexible Cup and Stationary Seat Removed.

16. Slide out shaft (55) and bearings (53 and 54). Since bearings (53 and 54) are press fitted on the shaft, they will have to be pulled or pressed off the shaft. Remove grease seals (51) from frame (57), and bearing cap (49).

17. Remove nameplate (34) and screws (33) only if replacement is needed.



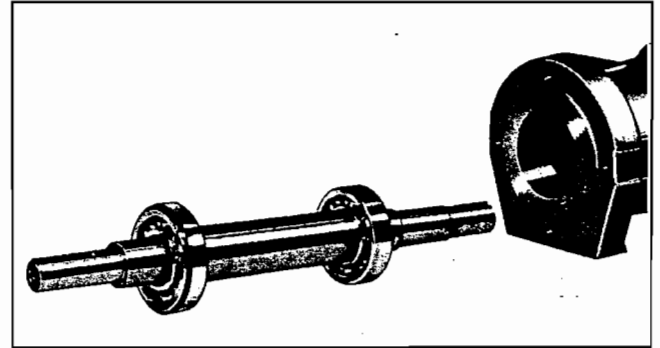
G. Bearing Cap and Slinger Removed.

REASSEMBLY

Reassembly will generally be in reverse order of disassembly. If disassembly was not complete, use only those steps related to your particular repair program.

1. Press grease seals (51) into frame (57) (344A).

2. Press bearings (53 and 54) onto shaft (55). Snap retainer ring (52) into place. (344A)



H. Shaft Assembly Removed.

3. Slide shaft (55) and bearings (53 and 54) into frame (57) and place o-ring (oil lubed only) (50) in place. (344A)

4. Fasten bearing cap (49) in position with capscrews (48). Insert grease seals (51) and position slingers (47) and (47A) on the shaft. (344A)

5. The mechanical seal (27) (see Figure 1) cannot be installed as an assembly. It is necessary to have the seal seat properly in place before the balance of parts can be added.

Thoroughly inspect the seal cavity in seal bracket, checking for burrs or nicks which could damage flexible cup of mechanical seal. Apply a film of liquid dishwashing detergent (do not use oil or grease) to the flexible cup and seal seat. Insert seat in cup and install in seal bracket, taking care to seat it evenly and squarely.

NOTE

If it is not possible to insert seat with fingers, place the cardboard protecting ring furnished with seal over lapped face of seat and press into place with a piece of tubing having end cut square. Tubing should be slightly larger than the diameter of the shaft. Remove cardboard after seat is firmly seated.

6. On Model 344A pumps, mount bracket (35) by screwing capscrews (32) evenly into frame (57) to assure proper alignment. Turn all capscrews in an even amount. Fasten the bracket and frame to supports (41 and 64) by placing washers (40 and 63) over capscrews (39 and 62) and screwing them into position.

On Model 341A and 342A pumps position bracket (35) on the motor and secure with capscrews (32). Tighten screws evenly to assure proper alignment.

Secure support (41) to bracket (35) with capscrews (39) and washers (40). Frame sizes 143 thru 184-JM Model 341A only.

7. If nameplate (34) was removed, install and attach with screws (33).

8. Wipe the sealing faces of the seat and seal washer clean. Replace pin (61) in sleeve if it was removed during disassembly. Apply a film of liquid dishwashing detergent to the washer and bellows of the seal and slide the remaining seal parts onto the sleeve making sure the washer is seated against the seal seat. Check the proper sequence of assembly as indicated in figure 1. The shaft sleeve with the seal rotating assembly on it may now be replaced onto the motor shaft. Spring tension will probably prevent the sleeve from remaining in position axially until the impeller is locked against it.

9. Press wearing ring(s) (7 & 16) in casing (6) and bracket (35). Rings should not be hammered into place. Use a press, or clamp the parts in a bench vise, using wooden blocks to protect the rings. It may be necessary to pin or dowel the rings after assembly if the insert or casing has had rings replaced before, since each reassembly can stretch or tear metal and thereby loosen the fits. If the facilities are available, it is good practice to take a very light finish cut or to ream the inside diameter of the casing rings after pressing to restore roundness. When rings are pressed, they may get squeezed out of shape.

10. Coat the mating surfaces of impeller wear ring(s) (optional - 14 and 15) and impeller (11) with Loctite sealant grade 271. Replace wear rings, using the same care as for the case wear ring(s). If the rings are to be trued on a lathe, do not clamp the impeller so tightly that it is permanently distorted.

11. Carefully replace gasket (10) on motor end of impeller. Assemble key (12) and impeller (11) to motor

shaft. Secure impeller with gasket (9B), washer (9A), and impeller screw (9).

12. Install the two pipe plugs (4) in the pump casing. Position the gasket (8) and casing (6) against the motor bracket and secure with screws (5). On Model 342A pumps position gasket (72) and set pump assembly in place. Tighten pump to base (73) with capscrews (39).

13. Replace all relief, cooling, flushings, or drain lines from the pump including compression connections (1 and 2) and tubing (3). Replace all grease fittings pipe plugs, tube vents and oiler assembly for oil lubricated units. Connect discharge piping and suction piping, if required. Make sure to install gaskets on the flanged connections. On Model 342A pumps replace plugs (74) and (75) in base elbow (73).

14. Read carefully the section of the manual titled INSTALLATION, especially those paragraphs referring to pump and coupling alignment.

15. Connect electricity to the motor.

STARTING PUMP AFTER REASSEMBLY

Do not start pump until all air and vapor has been bled and until making sure that there is liquid in the pump to provide the necessary lubrication. Without the fluid around it, the seal may be ruined in a few seconds of operation. It is possible that the mechanical seal may drip during the first few minutes to one hour of operation.

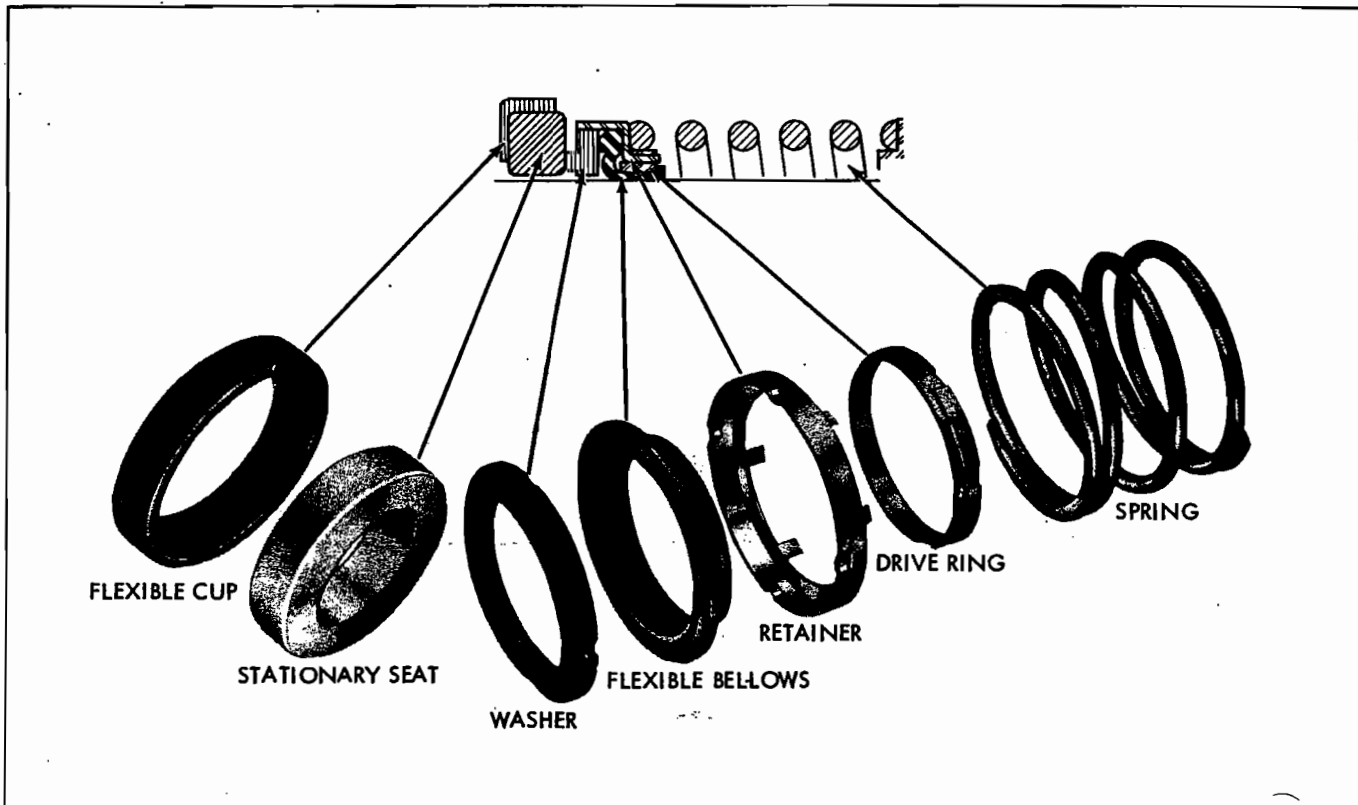


Figure 1. Mechanical Seal

MODELS 341A-342A-344A

MODEL 341A LIST OF PARTS

1. Elbow	9A. Washer	27. Seal
2. Connector	9B. Gasket	32. Capscrew
3. Tubing	10. Gasket	33. Screw
4. Plug, Pipe	11. Impeller	34. Nameplate
5. Capscrew	12. Impeller Key	35. Bracket
6. Casing	14. Wear Ring	39. Capscrew
7. Wear Ring	15. Wear Ring	40. Washer
8. Gasket	16. Wear Ring	41. Support
9. Impeller Screw	25. Sleeve	61. Pin

MODEL 342A LIST OF PARTS

1. Elbow	9B. Gasket	33. Screw
2. Connector	10. Gasket	34. Nameplate
3. Tubing	11. Impeller	35. Bracket
4. Plug, Pipe	12. Impeller Key	39. Capscrew
5. Capscrew	14. Wear Ring	61. Pin
6. Casing	15. Wear Ring	72. Gasket
7. Wear Ring	16. Wear Ring	73. Base
8. Gasket	25. Sleeve	74. Plug, Pipe
9. Impeller Screw	27. Seal	75. Plug, Pipe
9A. Washer	32. Capscrew	

MODEL 344A LIST OF PARTS

1. Elbow	16. Wear Ring	49. Bearing Cap
2. Connector	25. Sleeve	50. O-Ring
3. Tubing	27. Seal	51. Seal
4. Plug, Pipe	32. Capscrew	51A. Seal
5. Capscrew	33. Screw	52. Retaining Ring
6. Casing	34. Nameplate	53. Bearing
7. Wear Ring	35. Bracket	54. Bearing
8. Gasket	39. Capscrew	55. Shaft
9. Impeller Screw	40. Washer	56. Plug, Pipe
9A. Washer	41. Support	57. Frame
9B. Gasket	42. Key	58. Grease Fitting
10. Gasket	43. Grease Fitting	59. Plug, Pipe
11. Impeller	44. Tube, Vent	60. Oiler Assembly
12. Impeller Key	46. Plug, Pipe	61. Pin
14. Wear Ring	47. Slinger	62. Capscrew
15. Wear Ring	47A. Slinger	63. Washer
	48. Capscrew	64. Support

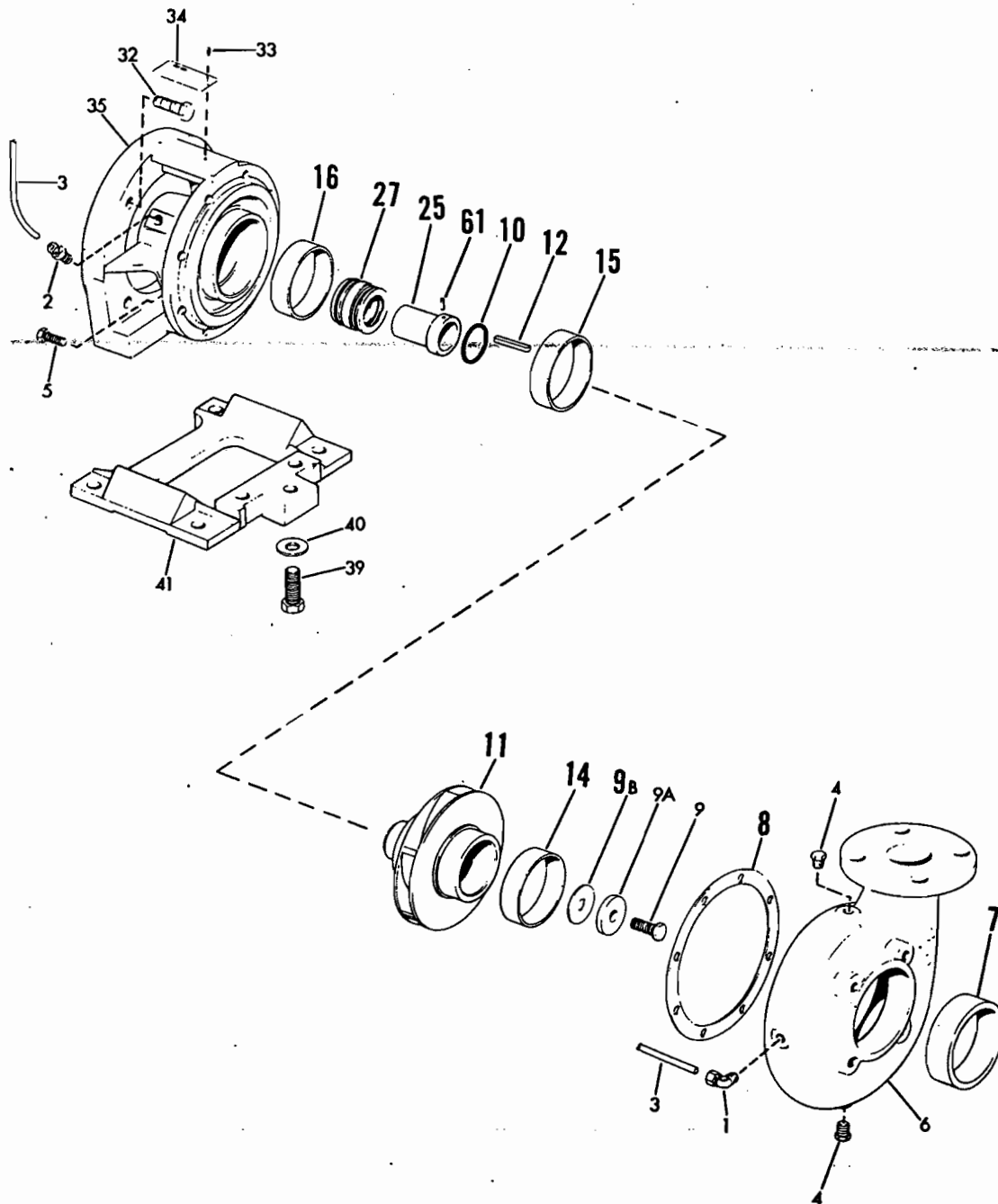
NOTES:

1. STANDARD FITTED CONSTRUCTION WILL BE FURNISHED AS STANDARD UNLESS SPECIFIED.
2. REFER TO FACTORY FOR SPECIAL ALLOYS.
3. AURORA PUMP RESERVES THE RIGHT TO SUBSTITUTE MATERIALS WITHOUT NOTICE
4. PIECE NUMBERS 14 AND 15 ARE NOT FURNISHED AS STANDARD, WHEN FURNISHED IMPELLER MUST BE MODIFIED.
5. PIECE NUMBERS 39, 40, 41 USED ONLY WITH MOTOR FRAMES 143 THRU 184-JM ON MODEL 341A PUMPS.

NOTE

WHEN ORDERING SPARE PARTS ALWAYS INCLUDE THE PUMP
TYPE, SIZE, SERIAL NUMBER, AND THE PIECE NUMBER FROM
THE EXPLODED VIEW IN THIS MANUAL.

ORDER ALL PARTS FROM YOUR LOCAL AUTHORIZED DISTRIBUTOR, FACTORY
BRANCH SALES OFFICE OR THE FACTORY AT NORTH AURORA, ILLINOIS.



**BOLD FACE NUMBERS INDICATE
RECOMMENDED SPARE PARTS.**

Figure 2. Model 341A Exploded View

MODEL 342A

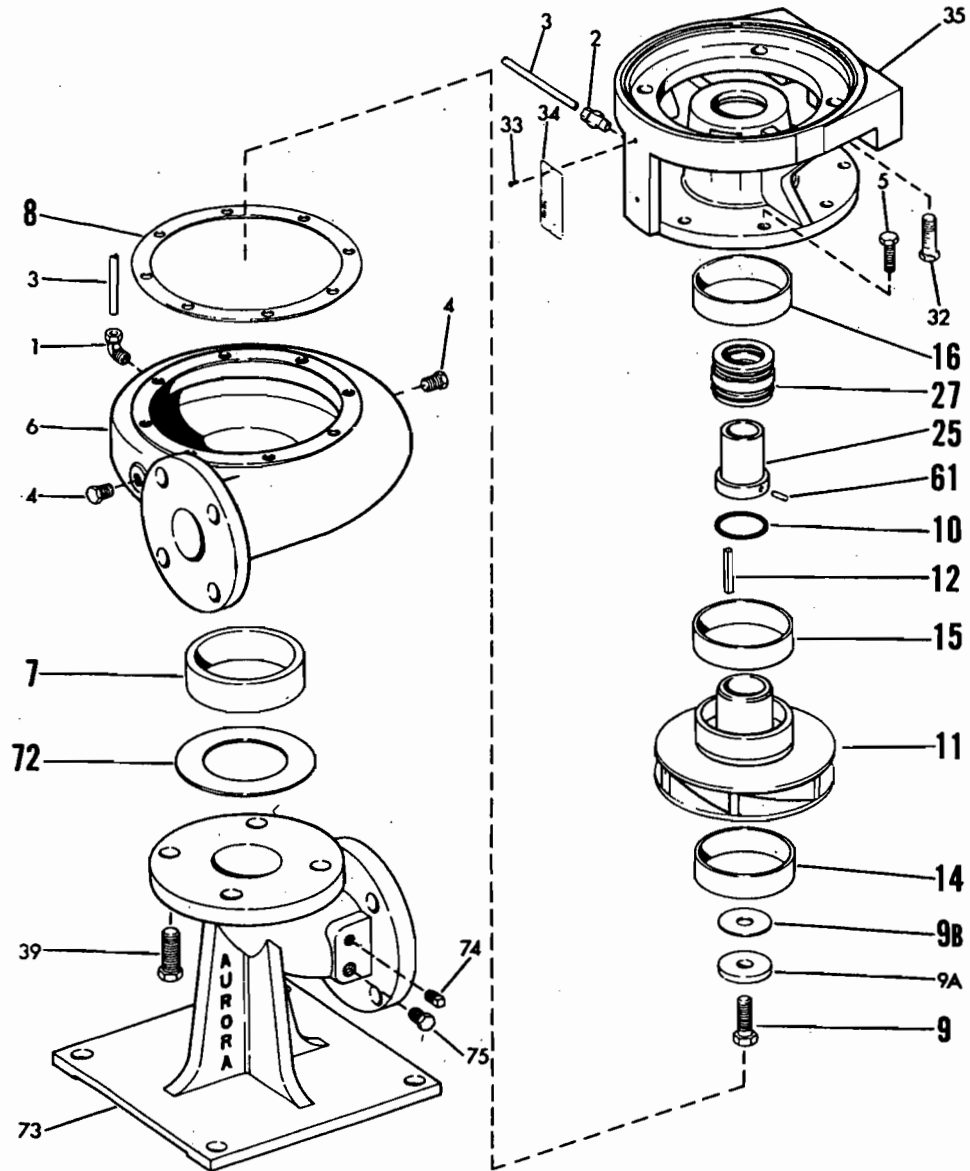


Figure 3. Model 342A Exploded View

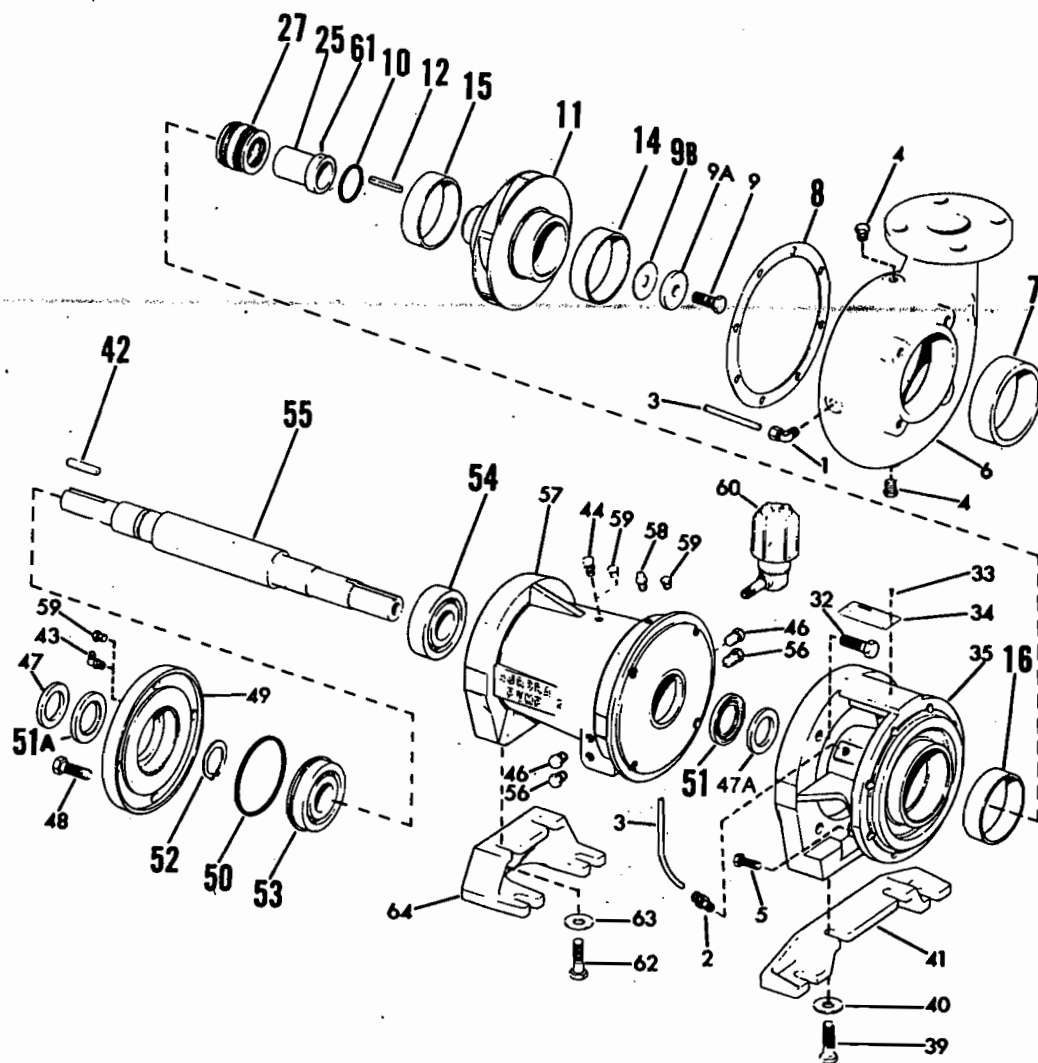
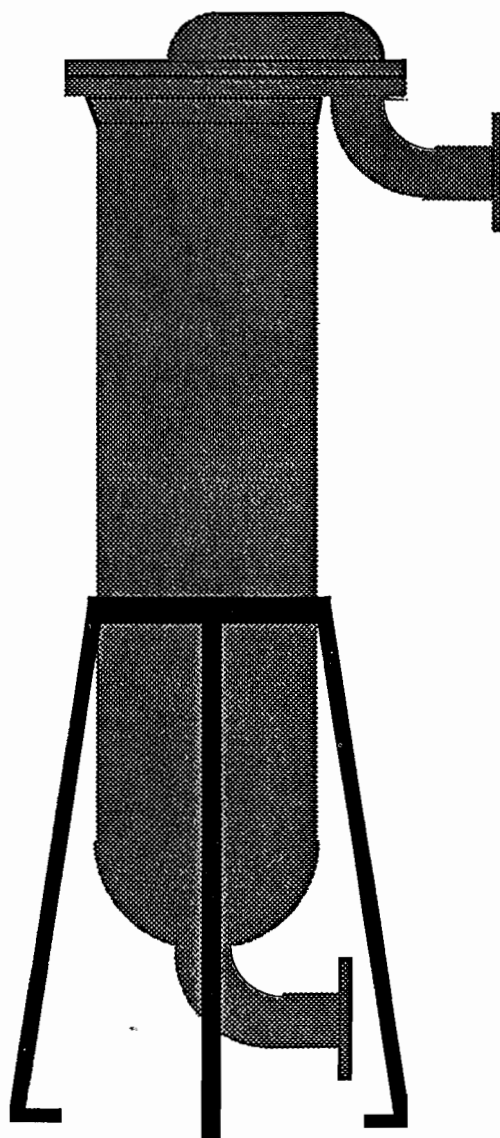


Figure 4. Model 344A Exploded View

3M Brand Filter Housings

Installation, Operation and Maintenance Instructions



3M Filtration Products

3M Center Bldg. 76-1W-04
St. Paul, MN 55144-1000
800-648-3550

Contents

This vessel was specially designed and manufactured by R-P Products, a division of Ronningen-Petter, for use with 3M manufactured filter bags and cartridges. This vessel is distributed exclusively by authorized 3M Filtration Products distributors. 3M vessels are available in 304 and 316 stainless steel and in carbon steel.

This manual was designed to assist you in proper use of the vessel and 3M Brand filters.

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Cartridge Filtration	13
Vessel Maintenance	18
Troubleshooting	19
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Parts & Service	22
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Customer Record Sheet	24

Important Safety Information



WARNING

FAILURE TO PROPERLY USE THE VESSEL MAY RESULT IN SERIOUS PHYSICAL INJURY OR PROPERTY DAMAGE. BEFORE REMOVING FILTER ELEMENT, ALWAYS RELIEVE PRESSURE. FULLY SECURE ALL CONNECTIONS BEFORE REPRESSURING VESSEL. THIS VESSEL IS DESIGNED FOR MAXIMUM PRESSURE OF 150 PSIG. A SUITABLE RELIEF DEVICE MUST BE USED IF PRESSURE COULD EXCEED 150 PSIG.

Filter vessels are designed to safely handle liquids under pressure with safety in mind. There are a few areas of safety that you should be familiar with. Please read and understand these instructions prior to use.

Elevated pressures

Each vessel has a metal plate that is welded to the vessel that contains the manufacturer's name, the vessel's ID, the pressure rating, and the stamp identifying the level of inspection. **CHECK TO SEE THAT YOUR SYSTEM LIMITS DO NOT EXCEED THE WORKING PRESSURE ALLOWED FOR THE VESSEL. MAXIMUM PRESSURE IS 150 PSIG @ 220F.**

It is important to know that to retain the ASME certification, no modification is allowed to the vessel. Welding something to it or otherwise changing the vessel cancels the ASME certification and could be dangerous.

Fluid must be compatible with materials of construction from a standpoint of pressure, temperature and chemical compatibility. This includes metals & elastomers.

Always check to see that the liquids are compatible with both the metal type of the vessel and the gaskets used. Different liquids require carbon steel, 304 stainless steel, 316 stainless steel, or plastic to insure proper performance. Gaskets are even more important since they prevent leakage. Check with a liquid compatibility guide when ordering hardware or ask your local dealer.

Toxic, corrosive, hazardous liquids

CAUTION:

Use proper cleaning techniques if the vessel must be properly cleaned if it is to be used for more than one application. Some materials may leave a residue that may be hard to detect and could contaminate later filter batches. Vessel is not designed for lethal service.

Elevated Temperatures

Check to see that the vessel pressure rating is greater than the possible system limits that you may have so that when you have a clogged filter, you do not exceed the rating of the vessel. Maximum pressure is 150 psig at 220F. Hot liquids can cause burns. Wear protective clothing to prevent contact with hot liquids or surfaces.

Back injury lifting out filters

Use caution when removing the filters. Filter, with dirt and liquid, can be heavy. Always try to evacuate the liquid before removing the filter. If possible, install a platform next to the vessel such that the person changing filters does not have to lift the filter over head to remove the entire filter. The use of compressed gas or air can speed the process of evacuating the liquid.

Important Safety Information

Eye protection, gloves, respirators, splash protection

Always wear protective clothing and safety glasses when changing filters. Accidents can happen when a liquid gets splashed or sprayed. If the liquid contains dangerous solvents or particulates, we suggest you use an approved respirator as well as splash protection.

Fumes, gases

If the liquid emits highly dangerous fumes or gases, we suggest you use of a fume hood over the filter vessel as well as respirators.

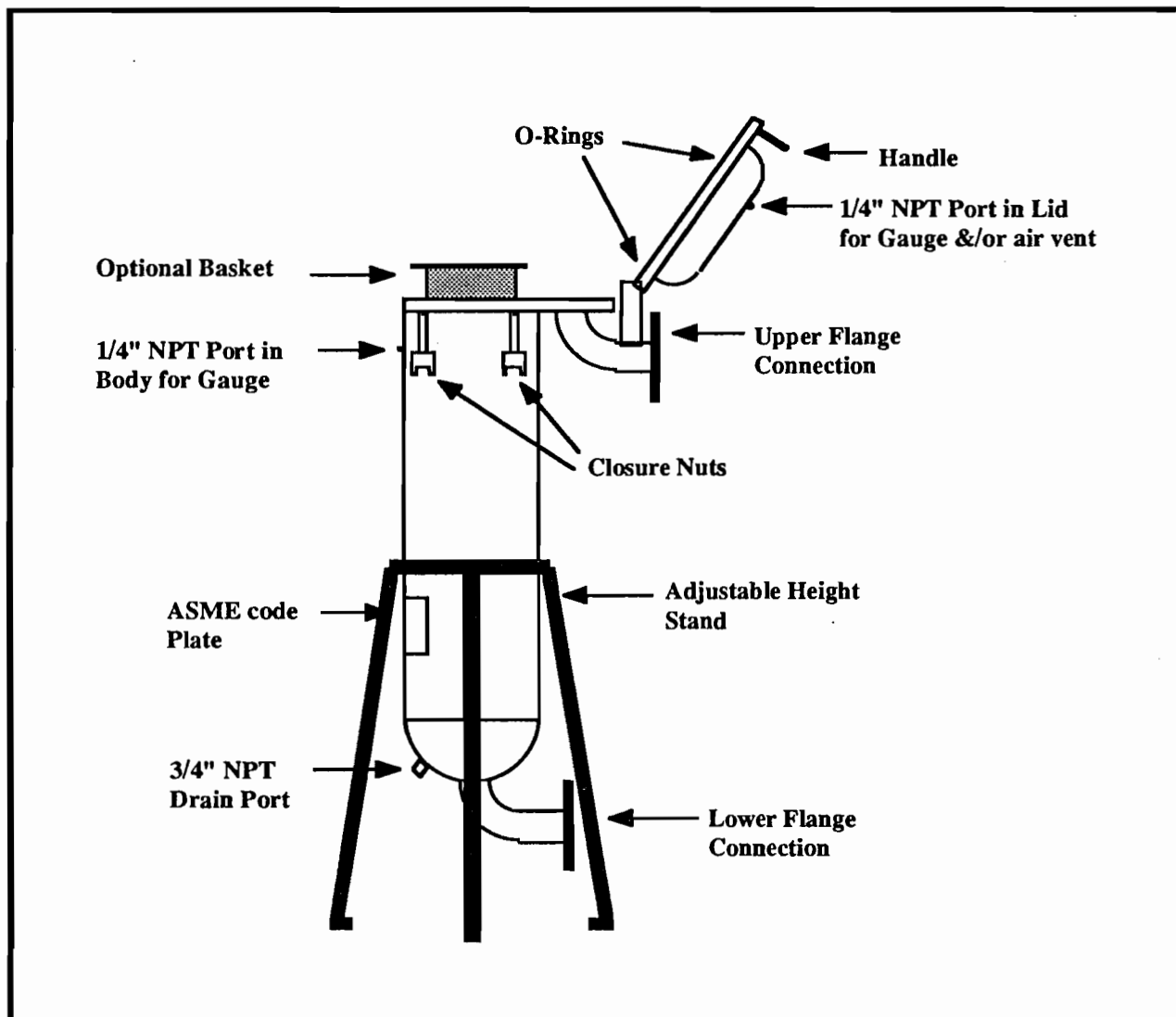
Proper disposal of spent filters

 WARNING
FILTERS USED WITH HAZARDOUS LIQUIDS MAY RETAIN THE SAME HAZARDOUS PROPERTIES AS THE LIQUID FILTERED. ALWAYS WEAR APPROPRIATE RESPIRATORY EQUIPMENT AND PROTECTIVE CLOTHING WHEN HANDLING FILTERS USED WITH HAZARDOUS LIQUIDS. DISPOSE OF IN ACCORDANCE WITH FEDERAL, STATE, AND LOCAL LAWS AND REGULATIONS.

Flammable materials, static electricity, grounding of equipment

 WARNING
REMOVAL OF PACKAGING USED WITH FILTERS MAY PRODUCE STATIC ELECTRICAL CHARGE OR SPARKS, RISKING COMBUSTION OF FLAMMABLE OR EXPLOSIVE MATERIALS, LIQUIDS, OR GASSES. TO AVOID RISK OF SERIOUS PHYSICAL INJURY, NEVER OPEN FILTER PACKAGE IN OR AROUND AREAS CONTAINING POTENTIALLY FLAMMABLE OR EXPLOSIVE MATERIALS, LIQUIDS, OR GASSES.

Component Identification



Before you install the housing...

In many new installations weld slag, welding rod scrap and other debris may accumulate in piping, tanks, etc. A new system should be flushed prior to installation of the filter housing. 3M Brand stainless steel filter housings are washed with hot water and soap followed by a water rinse prior to shipment. Carbon steel housings are coated inside with (Mobil Arma 247) rust inhibitor. If necessary, the rust inhibitor can be removed before use by applying paint remover solvent and flushing with hot soapy water.

Where to install the housing relative to other piping

Install filter as close to the final process as possible. This will reduce the time that agglomerates can form. Prior to installation be certain to determine whether there may be possible back flow in the system when it is turned off. This can lead to filter failure. If back flow is possible, install check valves to protect the filters.

Space requirements - access for filter servicing

Install filter vessel in an area that allows access for changing out used filters. Allow enough room for opening the lid. Allow at least 34 inches of room above the vessel for removing the filter and/or basket, as well as allowing for storage of filters. Allow space around the vessel to swing an 18" wrench when tightening bolts. Installing a platform along the side of the vessel for removing filters is recommended. Allow room for positioning gauges so that they can be easily read.

For use of this vessel with 3M Brand filter bags, refer to page 7, "Bag Filtration."

For use with 3M Brand Series 700 filter cartridges, begin at page 13, "Cartridge Filtration."

Bag Filtration

Two important features in bag installation:

- 1. Must use basket to support bag.**
- 2. Flow is from top to bottom.**

Installation Instructions

Locate the unit and anchor the feet. Support inlet and outlet piping so that a rigid close relation to the housing inlet and outlet is maintained.

Tightening of the lid requires considerable force. Make sure that vessel and pipes are well supported to prevent torque on piping.

Flow direction

Check to see that the proper flow direction is installed. For bags, the flow direction is top to bottom. Make sure that a shut off valve is installed before and after the filter to allow for filter changing.

Flow control

Make sure that a shut off valve is installed before and after the filter to allow for filter changing. If backflow is possible when the system is shut off, a check valve should be installed. Filters are not self-controlling with regard to flow rate. Excessive flow will seriously reduce the useful life of the filter. Your system should include means to control the flow. Check with your distributor or 3M for recommended flow rates.

Operation

Servicing the Filter

Liquid drain and blowdown

You must provide for draining the housing prior to servicing the filter. A 3/4" NPT drain coupling near the bottom of the housing is included with the vessel for this purpose. In many cases, it is useful to use compressed gas or air to push residual liquid out the drain. The gas or air can be admitted through the 1/4" NPT port in the lid or through a fitting in the pipe attached to the upper flange connection. If possible, reduce air pressure on this line to less than 40 psi or open valve slowly when forcing out fluid. **ALWAYS OPEN DRAIN BEFORE OPENING GAS OR AIR LINE.**

Caution: Fabric bags must be in complete contact with the metal basket in order to withstand the hydraulic forces generated during filtration. The housing must be free of liquid when the bag is installed.

Failure to drain the housing before installation of new filter bags will result in floating bags and possible bag rupture during filtration.

We suggest using a baseball bat or a 2 inch PVC pipe with an end cap to make sure the bag is installed all the way to the bottom of the basket. Bags should be slightly longer than the basket to prevent breakage. For additional bag installation instructions, see page 10.

Bag Filtration

Suggested torque on lid bolts

To ensure a proper seal on the filter, we recommend 30 to 50 ft.-lbs. torque on the lid bolts.

Pressure gauges

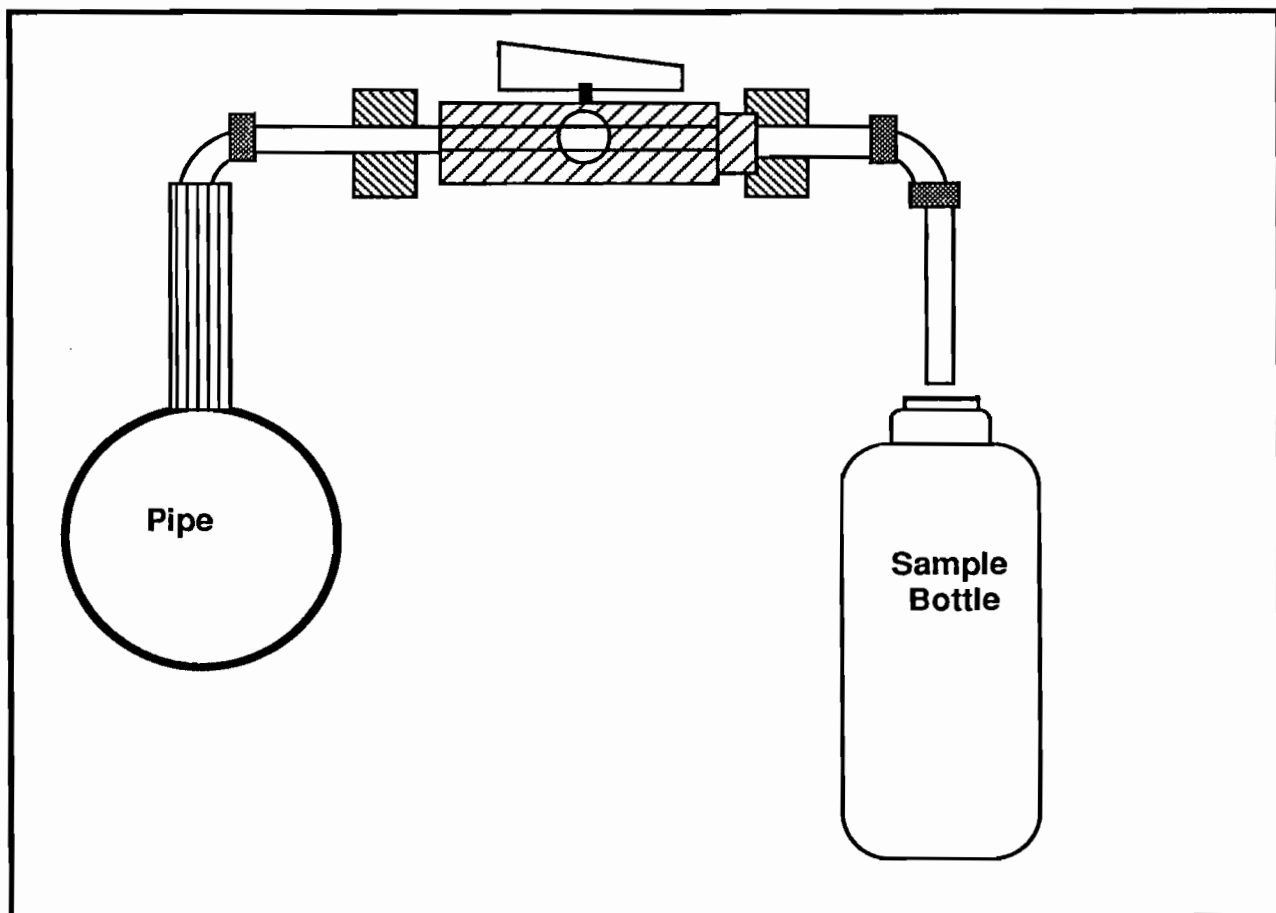
Pressure gauges should be installed either in the ports on the vessel or just before and just after the vessel such that the operator can monitor the life of the filter and change filters after reaching a differential pressure of 35 psid.

Air venting

Before returning the filter to operation, vent any trapped air out of the vessel using the vent port on top of the vessel. This is accomplished by opening a valve slightly and allowing a small amount of material to vent out until all the air has escaped. We recommend using flexible piping on this vent to allow the air and liquid to safely escape to a drain or container and not spray into the air.

Sample ports

It is always good practice to install a sample port before and after the filter for testing purposes. These ports should be installed in such a manner that they do not collect dirt. A suggested direction for a sample port is to have the valve pointing upward to prevent dirt buildup and a output pipe turned downward for safe easy sample collecting.



Bag Filtration

Angle mounting for vessel access

Sometimes it is easier to remove filters if the vessel is placed at an angle. If this is required, contact your 3M authorized dealer. Angle mounting usually requires a different placement of the drain plug and includes spacers inside to support the filters. Remember, modification of the vessel in any way invalidates ASME certification.

Duplex installation, bypass lines

For continuous operation, we recommend the use of duplex filters. This allows continuous filtering while one of the filters is being changed. A second filter vessel connected with valves allows quick changes to the backup filter and time for the initial filter to be changed without shutting down the operation. If continuous flow is required and duplex filtration is not present, install a bypass line to allow for filter changes.

Flowrate

Proper flow rates for filtration is a function of viscosity and filter material. Consult with your 3M sales representative for the recommended flow rates for the filter media or contact 3M Technical Service at 800-648-3550.

When to service the filter

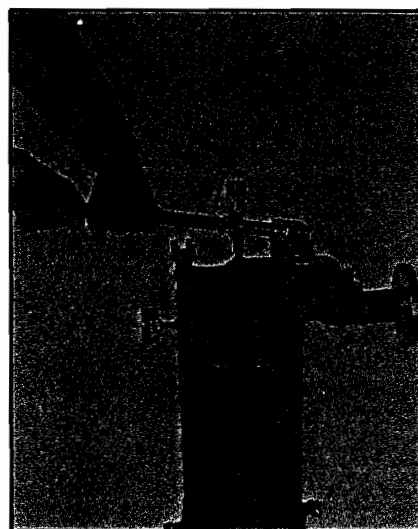
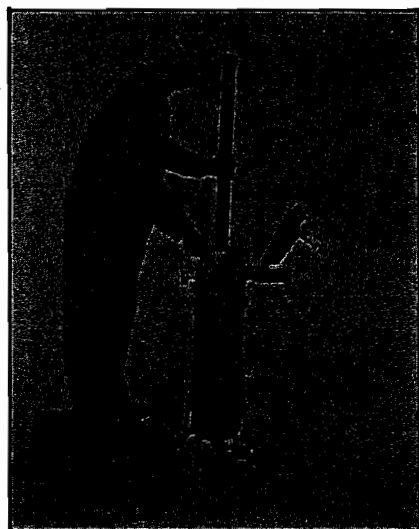
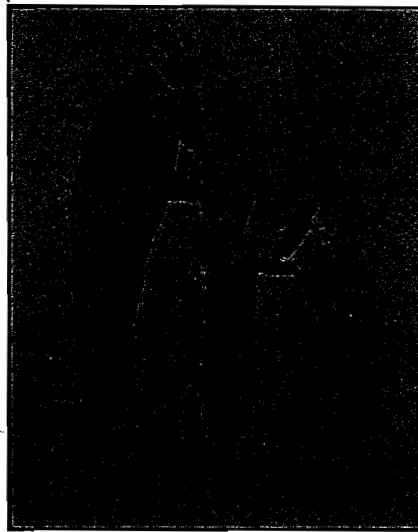
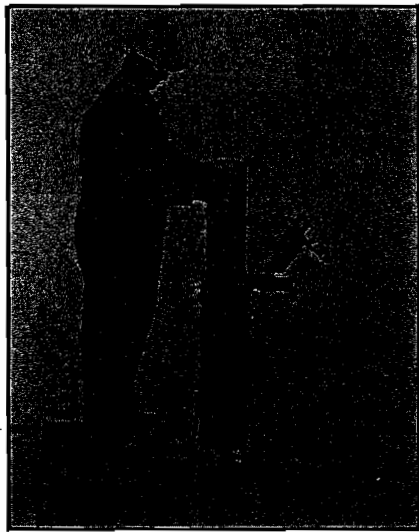
Bag filters are to be changed at or before the recommended maximum pressure differential. This means the difference in pressure between gauges placed in the gauge ports of the vessel or placed just before and just after the filter. For 3M bag filters, we recommend changing filters at 35 psid.

Maintain records - filter ID tag

We recommend that the bag ID tag be removed from the filter prior to installation to record in your maintenance records the date and time of filter installation, when it was removed and any other information you may require -- e.g., lot number, gallons, etc.

Bag Filtration

How to Install a Bag Filter



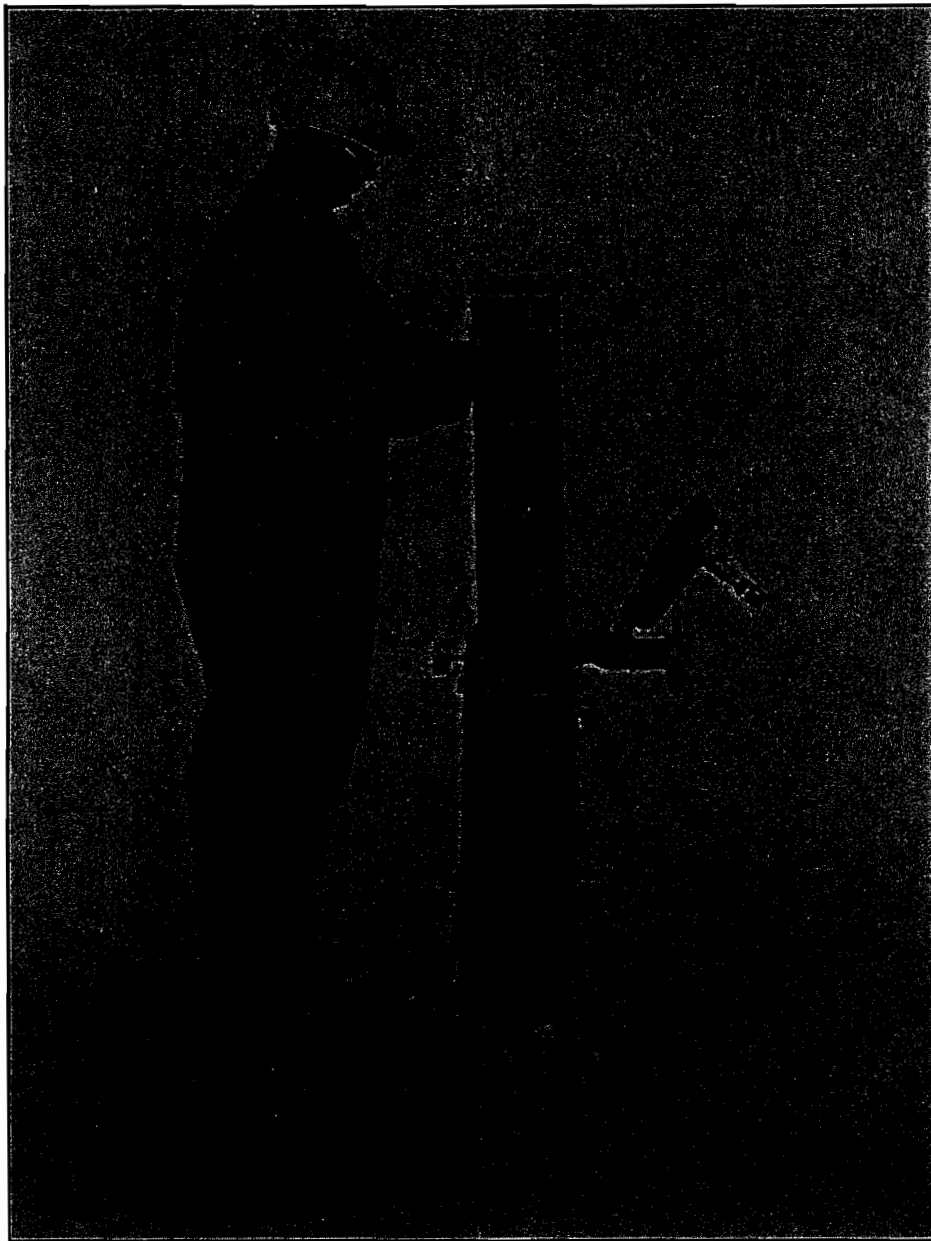
Instructions

1. Place basket in vessel.
2. Remove any ID tags from the bag and enter information in maintenance records.
3. Fold bag slightly length wise and slide into basket until top ring sits on top of basket ring.
4. Use a baseball bat, or 2 inch PVC pipe with an end cap to push bottom of bag to the bottom of the basket.
Caution: Be careful when using hands to locate filter. Jewelry such as rings can cut the filter. Do not use smaller pipe or broom handle which could put a hole in the filter.
5. Check bag top to make sure fabric is not gathered on the top rim and is pushed down in bag.
6. Close cover and tighten bolts to a recommended torque of 30 to 50 ft.-lbs.
7. Open upstream valve before downstream valve to prevent backflow.
8. Bleed air from vessel.
9. Apply system pressure slowly and evenly. If possible, do not apply full pressure all at one time.

For bag removal, see instructions on page 12.

Bag Filtration

Proper positioning of elevated platform makes filter replacement easier and safer.

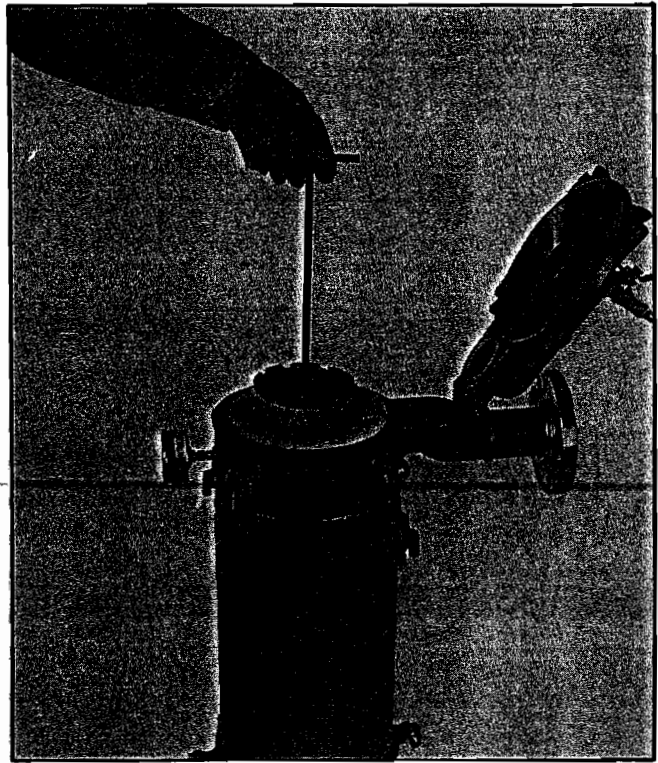


Platform assists lifting and prevents slipping on wet surfaces.

Bag Filtration

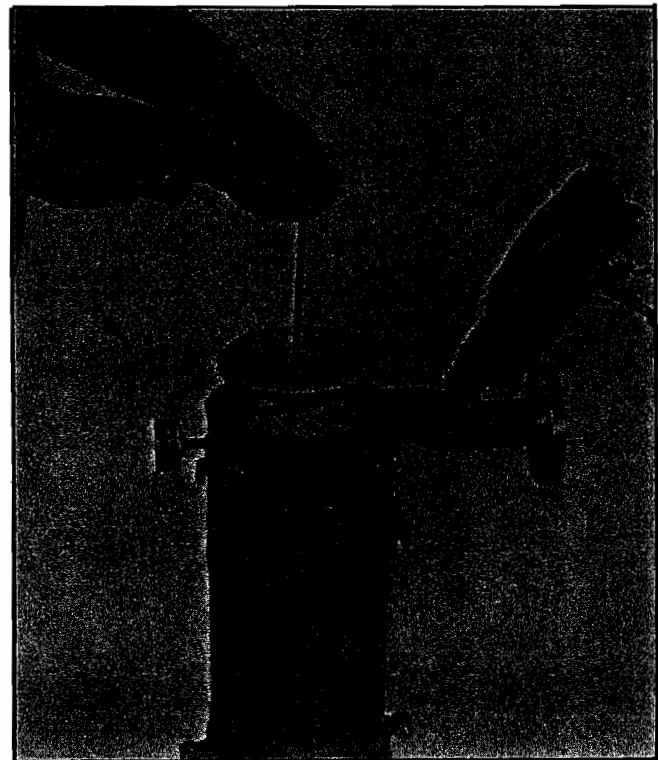
Optional Bag Removal Tool for 3M Series 500 Bags

The tool shown to the right, was designed to assist in removing the 3M Brand Series 500 bags from the filter housing. It is especially useful when filtering hazardous liquids.



Removal of the bag and basket with the optional tool as seen to the right, is very easy.

For bag removal without the optional tool, the following suggestions will assist you in easy removal. Make sure the liquid has been removed from the bag before lifting. Remove the basket and bag together from the housing. Tip upside down and slide the bag out.



Cartridge Filtration

Three important features in cartridge installation:

- 1. Gasket must be used on top of cartridge.**
- 2. Flow is from bottom to top.**
- 3. Basket is not used.**

Installation Instructions

Locate the unit and anchor the feet. Support inlet and outlet piping so that a rigid close relation to the housing inlet and outlet is maintained.

Tightening of lid requires considerable force. Make sure that vessel and pipes are well supported to prevent torque on piping.

Flow direction

Check to see that the proper flow direction is installed. **For cartridges, the flow direction is bottom to top.** The inlet pipe must be connected to the bottom of the vessel. This is the opposite of bag filtration. **Make sure that a shut off valve is installed before and after the filter to allow for filter changing.**

Flow control

Make sure that a shut off valve is installed before and after the filter to allow for filter changing. If backflow is possible when the system is shut off, a check valve should be installed. Filters are not self-controlling with regard to flow rate. Excessive flow will seriously reduce the useful life of the filter. Your system should include means to control the flow. Check with your distributor or 3M for recommended flow rates.

Operation

Servicing the Filter

Liquid drain and blowdown

You must provide for draining the housing prior to servicing the filter. A 3/4" NPT drain coupling near the bottom of the housing is provided for this purpose. In many cases it is useful to use compressed gas or air to push residual liquid out the drain. The gas or air can be admitted through the 1/4" NPT port in the lid or through a fitting in the pipe attached to the upper flange connection. If possible reduce air pressure on this line to less than 40 psi or open valve slowly when forcing out fluid. **ALWAYS OPEN DRAIN BEFORE OPENING GAS OR AIR LINE.**

Suggested torque on lid bolts

To ensure a proper seal on the filter, we recommend 30 to 50 ft.-lbs. torque on the lid bolts.

Pressure gauges

Pressure gauges should be installed either in the ports on the vessel or just before and just after the vessel such that the operator can monitor the life of the filter and change filters after reaching a differential pressure of 35 psid.

Flowrate

Proper flow rates for filtration is a function of viscosity and filter material. Consult with your 3M sales representative for the recommended flowrates for the filter media or call 3M Technical Service at 800-648-3550.

Cartridge Filtration

When to service the filter

Cartridge filters should be changed at or before the recommended maximum pressure differential. This means the difference in pressure between gauges placed in the gauge ports of the vessel, or those placed just before and just after the filter. For 3M cartridge filters we recommend changing filters at 35 psid.

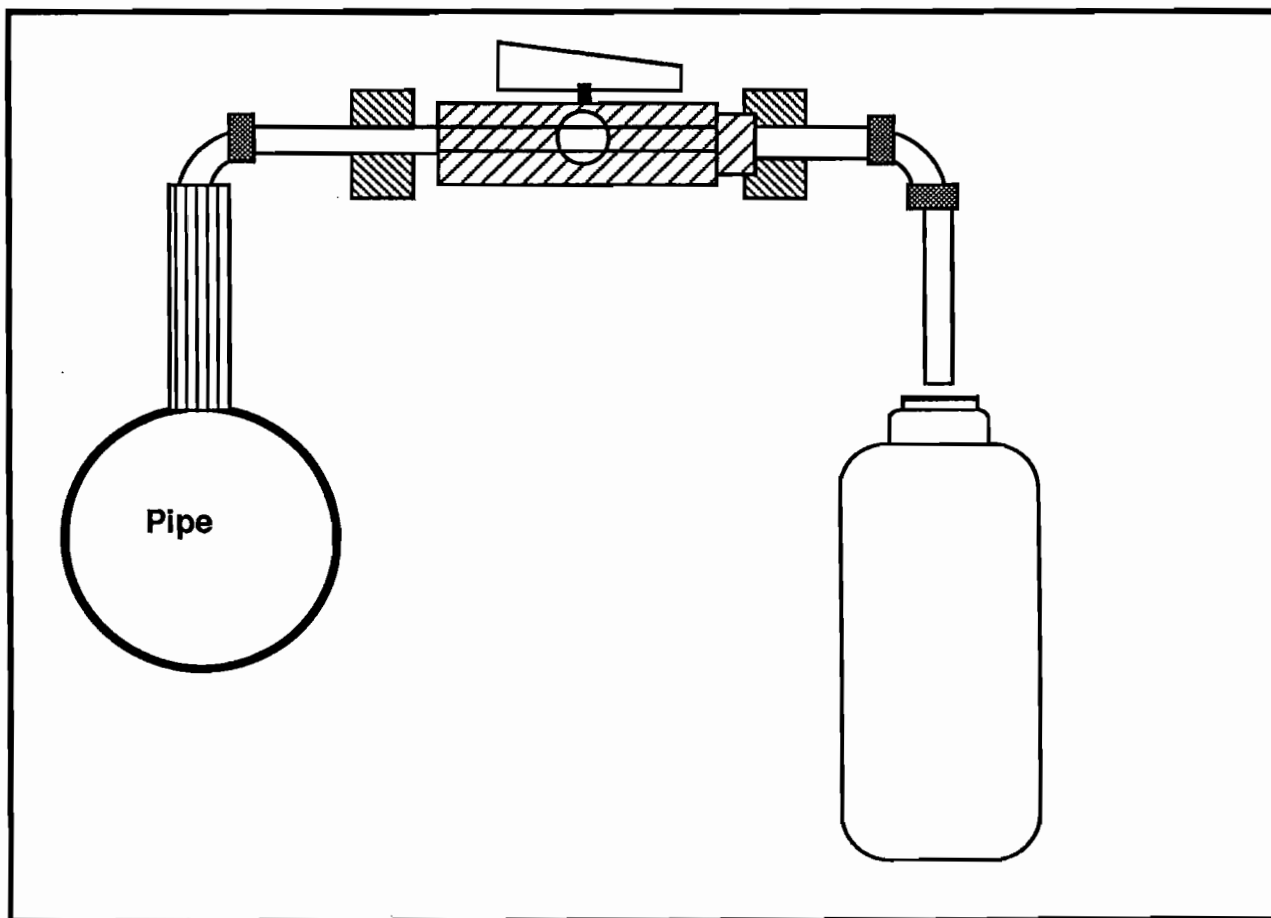
Air venting

Before returning the filter to operation, vent any trapped air out of the vessel using the vent port on top of the vessel.

This is accomplished by opening a valve slightly and allowing a small amount of material to vent out until all the air has escaped. We recommend using flexible piping on this vent to allow the air and liquid to safely escape to a drain or container and not spray into the air.

Sample ports

It is always good practice to install a sample port before and after the filter for testing purposes. These ports should be installed in such a manner that they do not collect dirt. A suggested direction for a sample port is to install it so that the valve is pointing upward to prevent dirt buildup and a output pipe is turned downward for safe easy sample collecting.



Cartridge Filtration

Angle mounting for access

Sometimes it is easier to remove filters if the vessel is placed at an angle. If this is required, contact your 3M authorized dealer. Angle mounting usually requires a different placement of the drain plug and includes spacers inside to support the filters.

Duplex installations, bypass lines

For continuous operation, we recommend the use of duplex filters. This allows continuous filtering during changeout of another filter. A second filter vessel connected with valves allows you to quickly change to the backup filter allowing time for the initial filter to be changed without shutting down the operation. If continuous flow is required and duplex filtration is not present, install a bypass line to allow for filter changes.

Maintain records -

Filter ID tag, when it was installed, when it was removed.

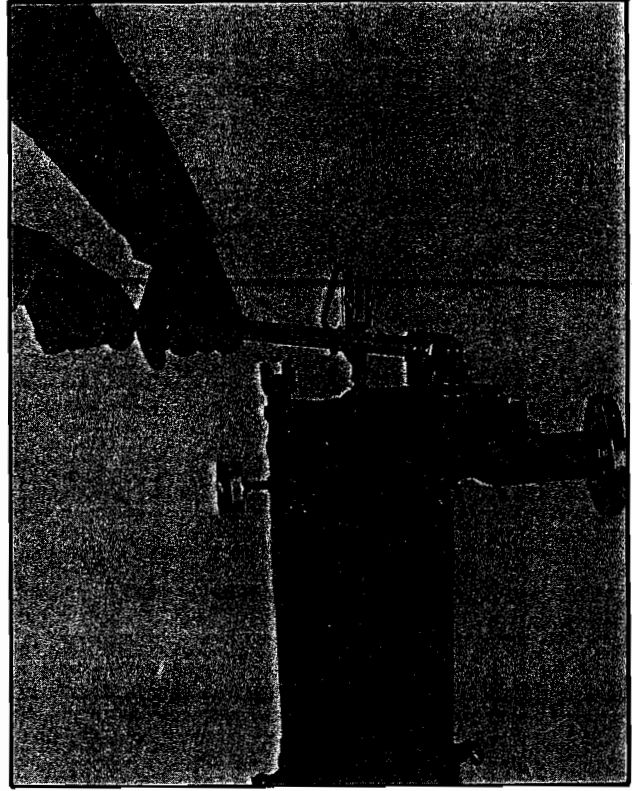
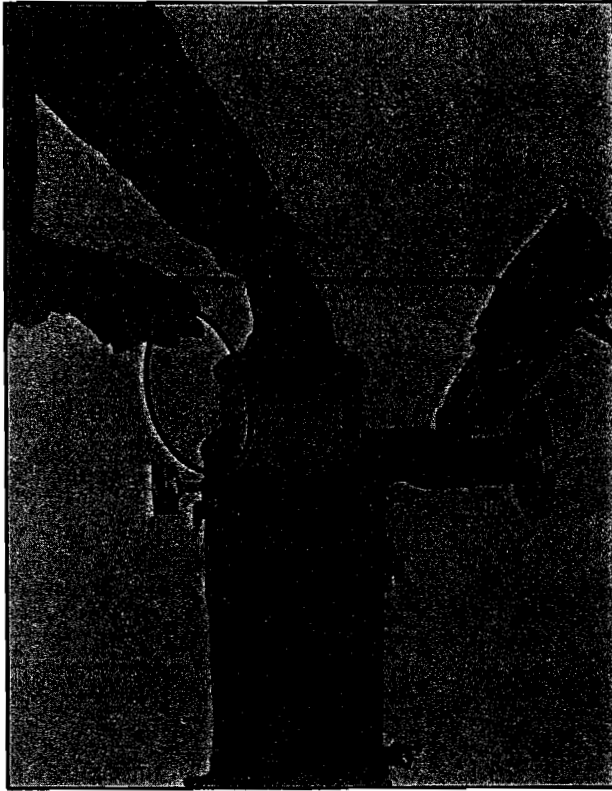
We recommend that the cartridge ID tag be removed from the filter prior to installation to record in your maintenance records the date and time the filter was installed, when it was removed, and any other information you may require -- e.g., lot number, gallons, etc.

O-rings are shipped separately!!!

O-rings to be installed on top of the 3M cartridge are shipped separately and are reusable. Make sure that it is installed on top of the cartridge or you will not get the proper seal required for quality filtration. When changing filters, carefully remove the O-ring and place it on top of the new cartridge. Do not set it down in a place that may contaminate the O-ring and the liquid.

Cartridge Filtration

How to Install a 3M Series 700 Cartridge Filter



Instructions

1. Remove basket from vessel if installed.
2. Insert cartridge in vessel as shown above.
3. Place O-ring on cartridge. See illustration on page 17.
4. Close lid and tighten bolts to a recommended torque of 30 to 50 ft.-lbs.
5. Open upstream valve before opening downstream valve to prevent backflow.
6. Vent air from vessel.
7. Apply system pressure slowly and evenly. If possible, do not apply full pressure all at one time.

Cartridge Filtration

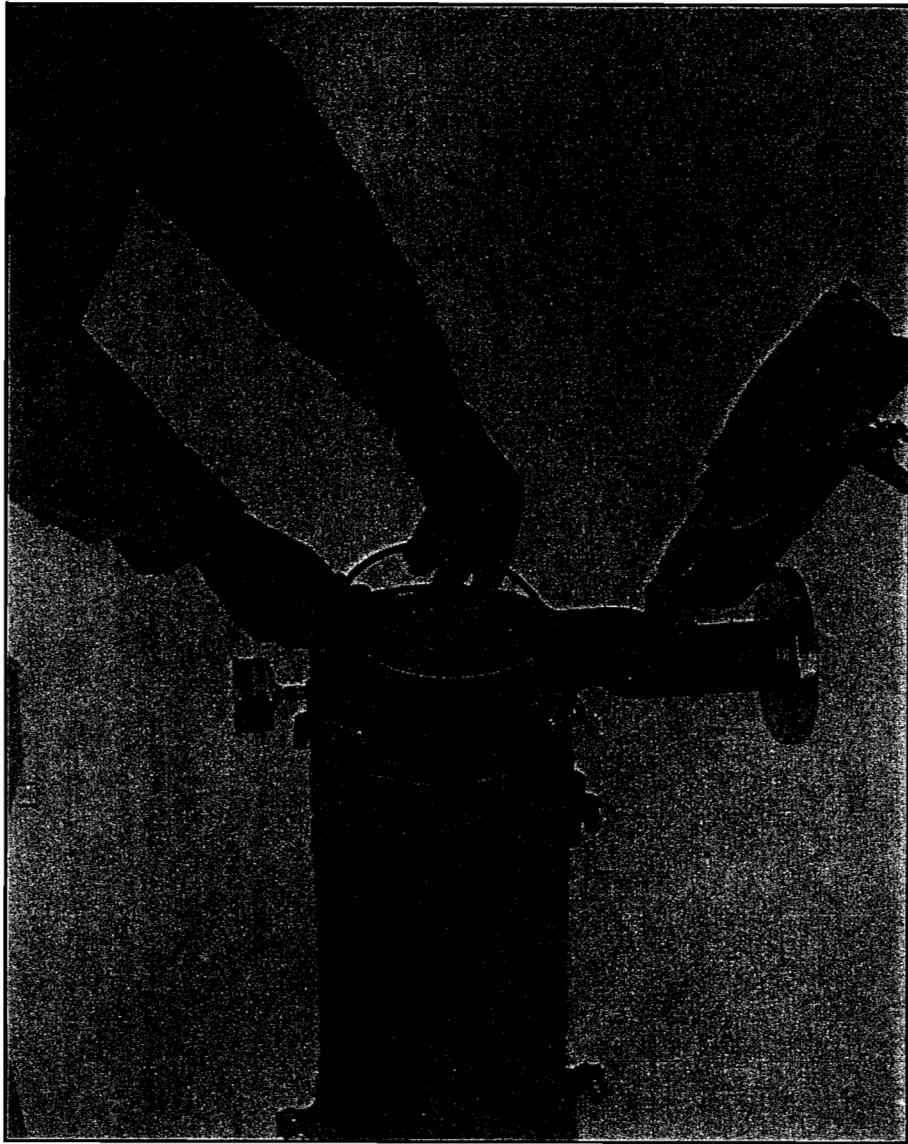


Illustration of installation of re-usable O-ring for 3M Brand Series 700 cartridges.

Vessel Maintenance

As with all equipment some minor maintenance is required to ensure giving you a long and productive vessel life. We suggest:

Grease the bolts

To make it easier to open and close the lid, grease the bolts with a grease that will not contaminate the filtered liquid. A very small amount is all that is needed. If contamination is critical, do not grease.

Make sure gauges are working

Periodically check to see if the gauges return to zero when you change filters and read the same (or close to the same if the viscosity is 1 cps) when new filter is installed.

Check condition of O-rings

O-rings require checking. Check for cleanliness, abrasion or distortion of O-rings. Good O-rings are required for sealing the vessel.

Troubleshooting

Filter not removing particles

If filters do not seem to be removing the proper size particles, check to see if the lid bolts were properly tightened.

For bags, check to see if the bag is properly positioned in the basket with the ring sitting evenly on the lid. When the bag is removed, the area around the top ring of the bag should be clean indicating a good seal.

For cartridges, check to see if the O-ring was installed on top of the cartridge.

If you need further assistance, contact your local salesperson for proper filter sizing.

Bags breakage

Bag breakage is characteristic of improper bag position caused either by the bag not being installed all the way to the bottom of the basket, back flow causing the bag to float up off the bottom of the basket, or bag installation without fluid removal from the vessel. Check that these causes do not exist. Do not exceed recommended maximum working temperatures or flow rates.

Insufficient flow through the housing

Check that both the input and output shut off valves are fully open. Check viscosity of fluid. High viscosity can restrict flow. Check gauge pressures -- the filter may be dirty. If pressure is not at endpoint, check pump capability.

Abnormally high pressure differential across housing

High viscosity can cause an abnormally high initial differential pressure. If sized properly, this pressure will decrease after a short period of time due to elimination of trapped air and wetting of filter material. Some fluids may require pre-heating the filter before restarting the process as the viscosity of the fluid may be too high at lower temperatures. Too tight of filter grade may cause high pressure with some liquids. Check flow rate recommendations for the filter being used. Make sure gauges are accurate and in proper working operation.

Abnormally short filter life

This corresponds to the preceding paragraph for abnormally high pressure. If the filter life is too short, we suggest putting multiple filters in parallel. A rule of thumb: if you get 1 day of useful filter life from a filter, adding a second filter in parallel will allow you to get 3 days with the two filters running at the same time. The reduced flow rate will allow better capacity in both filters. Sometimes, shortened filtered life is caused by gel-like particles blinding off the pores of the filter. Check flow rate recommendations for the filter being used. Make sure gauges are accurate and in proper working operation. Check for changes in raw materials or process changes.

Leaking housing - lid won't seal

1. Check to see if the proper torque was used on bolts on the lid (30 to 50 ft.-lbs.).
2. Check to see if the bag or cartridge was installed properly.
3. Check the O-rings on top of the vessel or deterioration for dirt. Check the bolts for worn or dirty threads.
4. Check to see if the proper filters were used in the vessel.
5. Check for distorted bolts or a warped lid caused by excessive pressure.

Difficulty getting bags out of housing

Suggestions for easy bag removal:

1. Make sure all the liquid has been removed before opening the vessel.
2. Remove basket and bag together from the housing. Tip upside down and slide bag out.
3. Make sure that bags are removed at 35 psid. Higher pressures do not add significantly to filter life and may push the filter media into the holes of the basket.

Troubleshooting

Difficulty getting Series 500 bags into housing

To install a Series 500 bag in the basket, place basket in the vessel, fold the bag slightly length wise and slide it into the basket. The last inch or two will be more difficult to slide in the basket. We suggest either using something such as a baseball bat or a 2 inch PVC pipe with a end cap to push the bag bottom to the bottom of the basket. If you use your fist, be careful that you do not have a sharp ring that may cut the filter.

Check to see that the bag material is not gapped at the top ring and is pushed into the basket.

Degradation, collapse or failure of integrity of filter

If filter is showing signs of improper wear, the following items should be checked:

1. Fluid compatibility with filter fibers. Soak test of fibers will show problem.
2. Excessive pressure before changing filters.
3. Large sharp particles swirling around inside of filter.
4. Plumbing hooked up backwards.
5. Excessive temperature for filter. Check filter specifications.
6. Lack of proper basket support. Check installation techniques.
7. Check for system backflow.

If assistance is needed, call your local 3M authorized dealer or 3M Technical Service at 800-648-3550.

Specifications

Weight

Dry weight = 68 lbs.(150kg)

Wet weight = 130 lbs (286kg) (approximate)

Internal Volume

1 cubic foot (0.028 m³)

7.6 gal. (28.7 liters)

Maximum Working Pressure

150 psig (10.2 bar) @ 220F (104C)

Temperature Limits

Carbon steel = -20F to 400F (-29C to 204C)

Stainless steel = -20F to 220F (@ 150 psi) (-29C to 104C)

Recommended Flowrates

Vessel only (no filter installed) 150 gpm (568 lpm)

Check with the recommended flowrates of the filters being used.

Pipe & Flange Sizes

2" threaded (NPTE, 2" flanged (ANSI B16.5, RF, Class 150 or DIN 16)

Maximum differential pressure on basket

150 psig (10.2 bar)

Basket weight empty

5.5 lbs. (12.1 kg)

Suggested torque on lid bolts

30 - 50 foot/lbs. (40 - 68 joules)

Parts & Service

Air vent valve

RP part # P-12352-SS6 2 way 1/4" connection.

Basket

RP part # S-43516-SS6

Drain valve

RP part # S-30115-SS6 3/4" with threaded nipple.

Gauges

RP part # P-20275-SS6 0-200 psi stainless steel, liquid filled, back connected
2 1/2" dial, for stainless steel vessel.

RP part # P-20282-BRZ 0-200 psi bronze, liquid filled, back connected
2 1/2" dial, for carbon steel vessel.

Lid bolts and castle nuts

RP part # S-30130-SS4 Includes (1) each of rod ends, nuts, eyebolt pin and (2) retainer-rings.

O-rings

1 Large and 1 Small required in lid

Type	Large #	Small #
Buna-N	RP part # P-43517-BUN	RP part # RP-10747-BUN
EPT-Nordel	RP part # P-43517-EPT	RP part # RP-10747-EPT
White Neoprene	RP part # P-43517-FGL	RP part # RP-10747-FGL
Silicone	RP part # P-43517-SIL	RP part # RP-10747-SIL
Teflon	RP part # P-43517-TEV	RP part # RP-10747-TEV
Fluoroelastomer (Fluorel™, Viton™)	RP part # P-43517-VIT	RP part # RP-10747-VIT

Stand

RP part # BS-30694-CST Leg assembly complete.

Parts should be purchased through your local authorized 3M distributor.

Warranty

WARRANTY: 3M and the manufacturer warrant that all 3M Brand Vessels shall be free of defects in materials and manufacture for a period of twelve (12) months from date of shipment from manufacturer's factory, provided that Vessels are used under the conditions and for the purposes indicated in written Operating Instructions. Prior to returning any Vessels under this warranty, user MUST contact R-P Products at (616) 273-1512 for return authorization.

EXCLUSIONS TO WARRANTY: THIS WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHER WARRANTY OF QUALITY, EXCEPT OF TITLE AND AGAINST PATENT INFRINGEMENT.

LIMITATION OF LIABILITY: Except as provided above, 3M and manufacturer shall not be liable or responsible for any loss or damage, whether direct, indirect, incidental, special or consequential, arising out of the sale, use or misuse of 3M Filtration products, or the user's inability to use such products. THE REMEDIES SET FORTH HEREIN ARE EXCLUSIVE.

Serial Number_____

Date of Manufacture_____

Model Number_____

Inspected By_____

Distributed by:



OPERATING INSTRUCTIONS & PARTS MANUAL

BELT DRIVE BLOWERS

MODELS 4C129, 4C130 AND 4C131

FORM 5S1575

06820

0692/192/2M

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

Description

Dayton high pressure belt drive blowers are used when air is laden with dust or where dust-collection bags are necessary. Blower comes complete with weather proof drive cover, self-cleaning radial blade wheel, 16 Ga. steel housing and self-aligning ball bearing pillow blocks. Applications include: handling long stringy material, paper trim, fibrous material such as textile scrap, wool and ensilage. **Blower is not suitable for coarse material, heavy or abrasive dust.**

Blower is assembled for bottom horizontal discharge and clockwise rotation as viewed from drive side, but can be changed in the field to any one of the 15 other standard discharge positions (see Figure 3). Maximum operating temperature is 180°F (82.2°C). Finished in baked-on enamel.

Unpacking

After unpacking the blower, inspect carefully for any damage that may have occurred during transit. Rotate wheel by hand to be sure it turns freely.

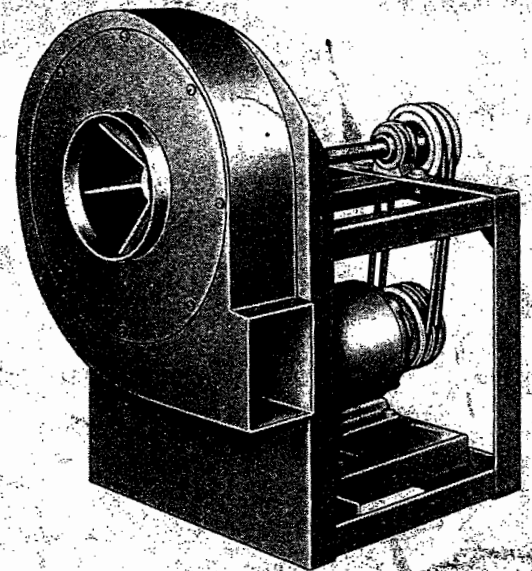


Figure 1

Dimensions

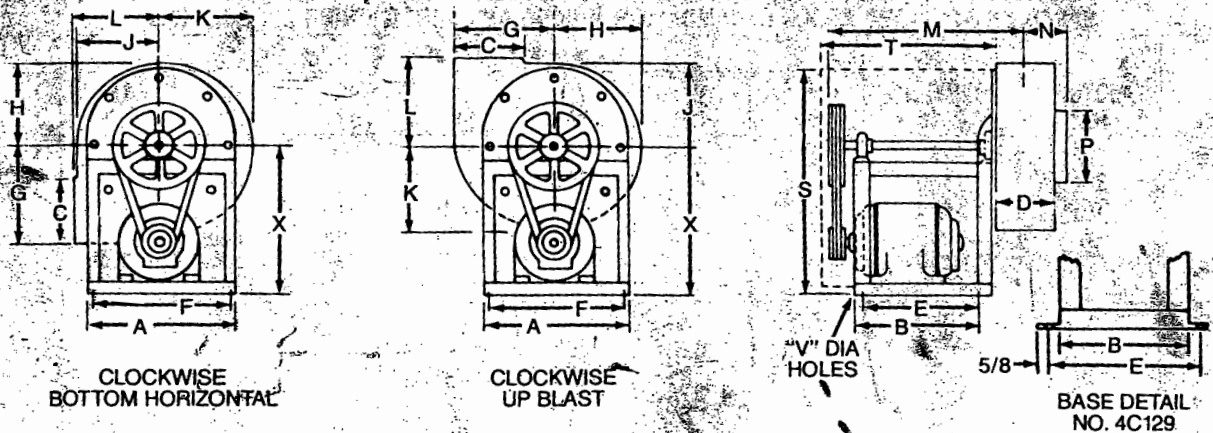


Figure 2

MODEL	WHEEL DIA.	WHEEL WIDTH	SHAFT DIA.	DIMENSIONS IN INCHES																	
				A	B	C	D	E	F	G	H	J	K	L	M	N	P	S	T	V	X
4C129	10 ⁹ / ₁₆ "	3"	3/4"	12 ⁷ / ₈	13	4	3 ¹ / ₂	14 ¹ / ₄	10 ³ / ₄	8 ⁵ / ₈	7 ¹ / ₄	6 ¹ / ₂	8	7 ⁵ / ₈	17 ³ / ₄	2 ¹ / ₈	6	20 ⁹ / ₁₆	17	7 ¹ / ₁₆	1 ¹ / ₂
4C130	12 ¹ / ₂ "	3	1	16 ¹ / ₈	15	5	4	13 ¹ / ₂	14 ³ / ₄	10	8 ³ / ₄	7 ¹ / ₂	9	9 ⁵ / ₈	20 ¹ / ₂	3 ¹ / ₈	7	25 ¹ / ₄	20	9 ¹ / ₁₆	1 ⁷ / ₈
4C131	13 ¹ / ₂ "	4 ¹ / ₂	1	17 ¹ / ₈	15	7 ¹ / ₈	5 ¹ / ₄	13 ¹ / ₂	16	11 ¹ / ₂	10 ³ / ₄	9 ⁵ / ₈	11 ¹ / ₂	11	21	4	8	25 ³ / ₈	20 ³ / ₄	1 ¹ / ₂	1

Specifications

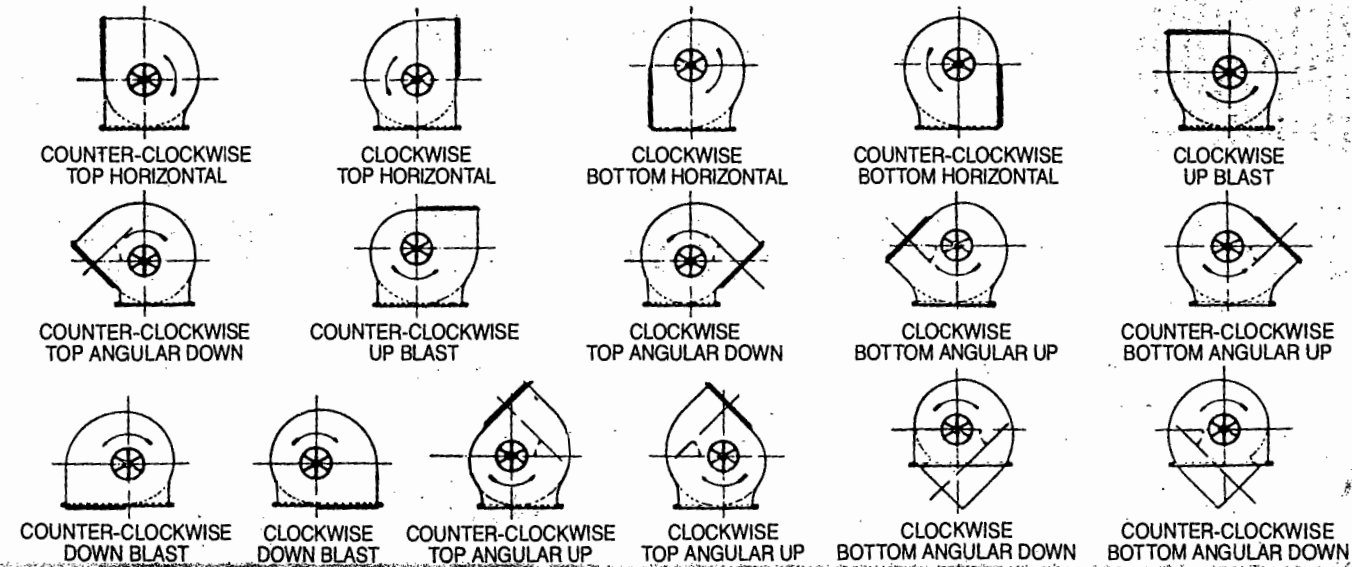


Figure 3 — Standard Discharge Positions

Drive Data

MODEL	MOTOR HP	BLOWER RPM	MOTOR SHEAVE BELT PITCH DIA.	BELT	BLOWER SHEAVE BELT PITCH DIA.	GROOVES	MODEL	MOTOR HP	BLOWER RPM	MOTOR SHEAVE BELT PITCH DIA.	BELT	BLOWER SHEAVE BELT PITCH DIA.	GROOVES
4C129	1/2	3250	2.4-3.4	4L270	2.6	1	4C130 (cont.)	2	3500	3.4-4.4	4L340	3.5	2
	3/4	3500	2.4-3.4	4L280	2.6	1		2	3680	4.0-5.0	4L350	3.5	2
	3/4	3750	2.4-3.4	4L280	2.6	1		3	3950	4.0-5.0	4L350	3.5	2
	1	4000	2.4-3.4	4L280	2.6	1	4C131	1	2500	2.6-3.6	4L330	3.5	2
	1	4250	2.4-3.4	4L280	2.6	1		1 1/2	2670	2.6-3.6	4L330	3.5	2
	1 1/2	4625	3.4-4.4	4L280	2.4	2		2	2920	3.4-4.4	4L340	3.5	2
4C130	1	2810	2.6-3.6	4L340	3.5	2		2	3080	3.4-4.4	4L340	3.5	2
	1 1/2	3065	3.4-4.4	4L340	3.5	2		3	3340	3.4-4.4	4L340	3.5	2
	1 1/2	3250	3.4-4.4	4L340	3.5	2		3	3500	4.0-5.0	4L340	3.5	2
								5	3920	4.0-5.0	4L330	4.2	2

Performance

BASED ON STANDARD CODES OF (AMCA) AIR MOVING AND CONDITIONING ASSOCIATION										
MODEL	MOTOR H.P.	BLOWER RPM	CFM AIR DELIVERY AT RPM SHOWN							
			5" SP	6" SP	7" SP	8" SP	9" SP	10" SP	11" SP	12" SP
4C129	1/2	3250	390	235	—	—	—	—	—	—
	3/4	3500	505	410	300	—	—	—	—	—
	3/4	3750	610	535	445	325	—	—	—	—
	1	4000	685	625	545	455	350	175	—	—
	1	4250	†	†	†	570	490	395	250	—
	1 1/2	4625	†	†	†	†	†	560	460	350
4C130	1	2810	575	430	—	—	—	—	—	—
	1 1/2	3065	740	620	495	230	—	—	—	—
	1 1/2	3250	†	725	630	500	—	—	—	—
	2	3500	†	870	790	700	590	400	—	—
	2	3680	†	†	†	805	720	610	440	—
	3	3950	†	†	†	995	930	850	760	635
4C131	1	2500	840	540	—	—	—	—	—	—
	1 1/2	2670	1100	920	620	—	—	—	—	—
	2	2920	1300	1150	970	750	—	—	—	—
	2	3080	†	1300	1150	990	750	—	—	—
	3	3340	1630	1500	1380	1240	1085	900	600	—
	3	3500	†	†	†	1400	1260	1120	940	670
	5	3920	†	†	†	1900	1800	1700	1590	1480

† Motor overload will result if blower is operated at static pressures below performance shown.

LIMITED WARRANTY

DAYTON ONE-YEAR LIMITED WARRANTY. Belt drive blowers, Models 4C129, 4C130 & 4C131, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use for one year after date of purchase. Any part which is determined by Dayton to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be, as the exclusive remedy, repaired or replaced at Dayton's option. For limited warranty claim procedures, see **PROMPT DISPOSITION** below. This limited warranty gives purchasers specific legal rights which vary from state to state.

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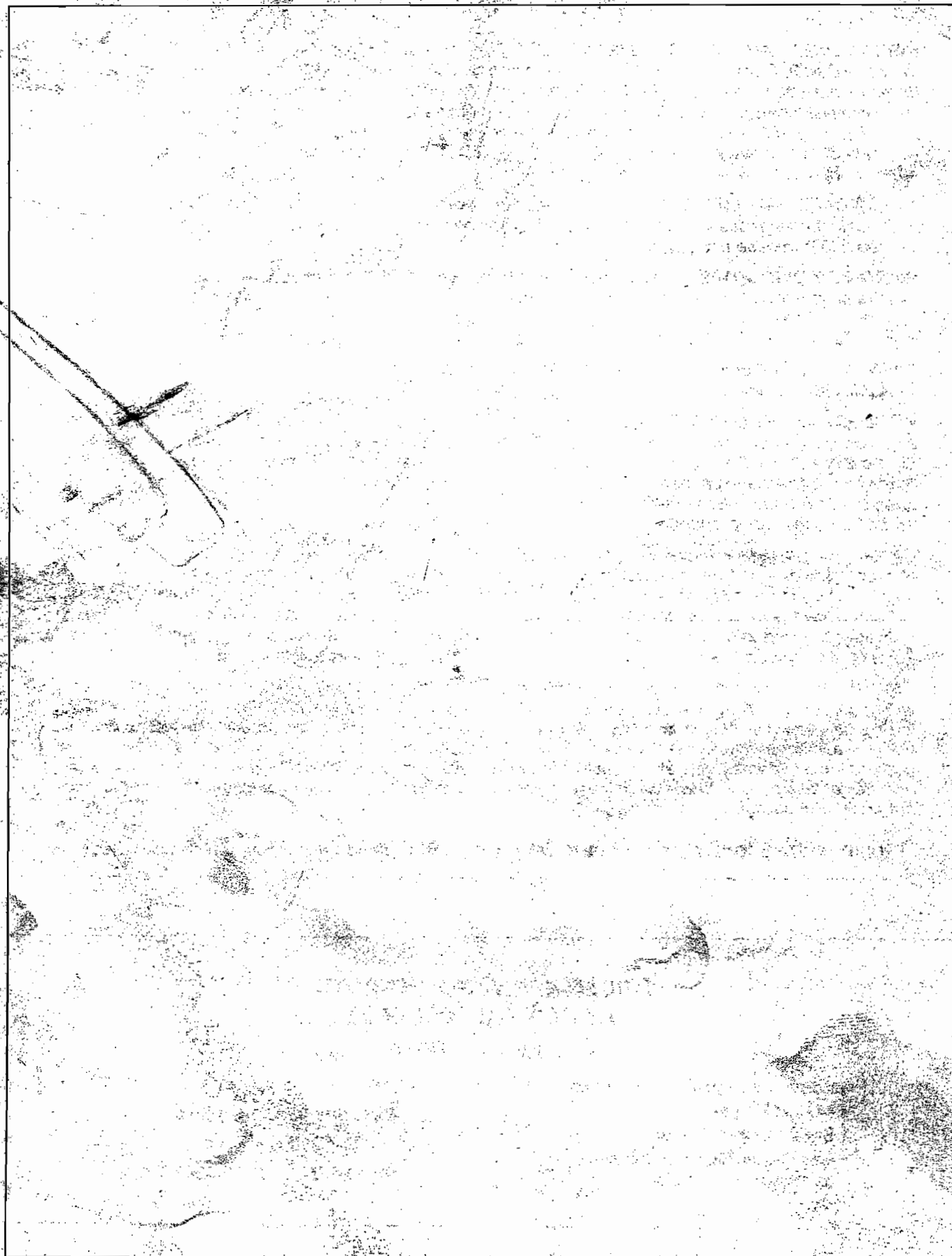
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Notes

ACS 500

Programming Manual Including Application Macros

ACS 500 Adjustable Frequency
AC Drives 1 to 400 HP, Series B

ACS 500-05C
EFFECTIVE 9/1/94
SUPERCEDES 6/1/94

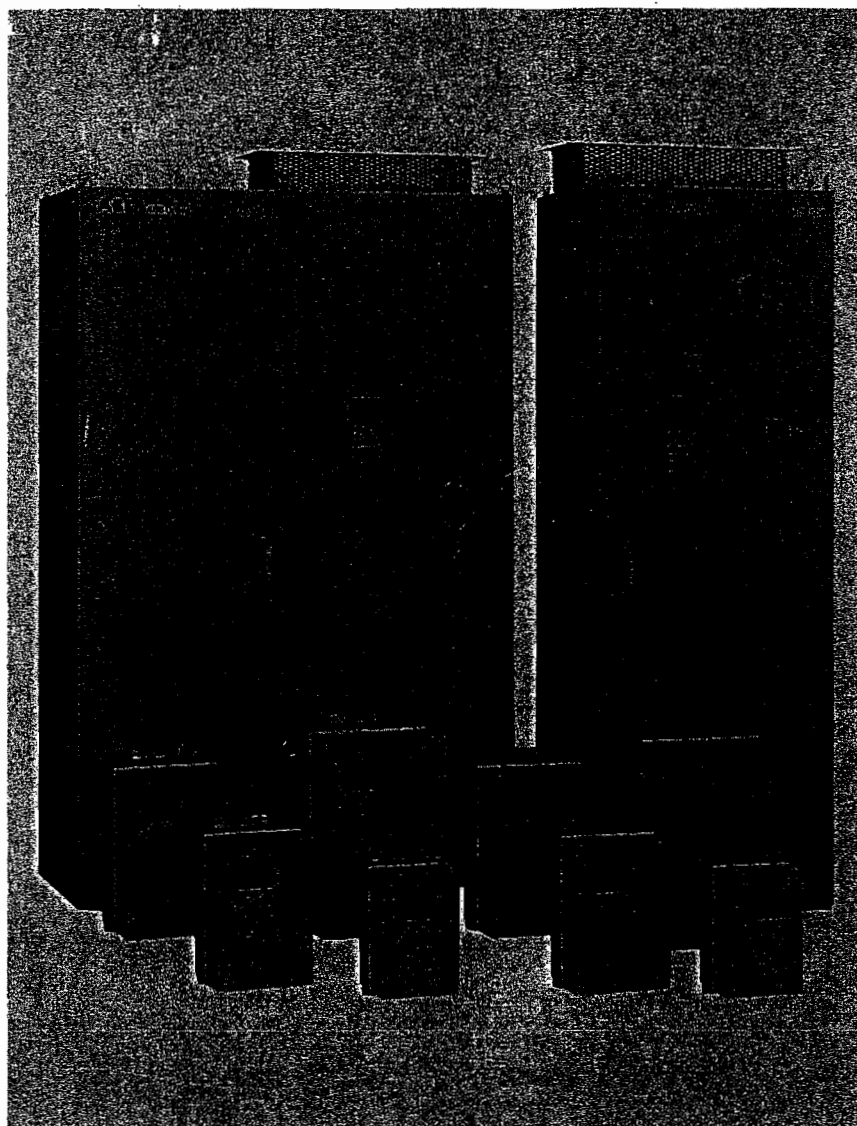


ABB Drives



**ACS 500 Adjustable Frequency
AC Drives 1 to 400 HP**

**Programming Manual
Including Application Macros**

ACS 500-05C

EFFECTIVE: 1994-09-01
SUPERCEDES: 1994-06-01



Safety Instructions

General Safety Instructions

Warnings in this manual appear in either of two ways:

- *Dangerous voltage warnings*, preceded by a Dangerous Voltage symbol, indicate the presence of voltages which may cause death or serious injury. These warnings describe procedures to avoid death or serious injury.
- *General warnings*, preceded by a General Warning symbol, indicate situations or conditions which may cause death or serious injury. These warnings describe procedures to avoid death or serious injury.

CAUTIONS inform you of situations or conditions which will damage machinery or cause additional motor-operation down-time if you do not take suggested steps to correct or address such situations or conditions.

Note: Notes provide you with additional and useful information. Although less urgent than cautions and warnings, notes are important and should not be ignored.

Warning Symbols

For your own safety please pay special attention to instructions containing these symbols:



This warning symbol indicates the presence of dangerous voltage. This symbol informs you of high voltage conditions, situations, and locations that may cause death or serious injury if you do not follow precautions and proper steps.



This warning symbol indicates a general warning.



This warning symbol indicates an electrostatic discharge hazard.

**Warnings, Cautions,
and Notes**



WARNING! Your drive contains dangerous voltages when connected to the line power. Always check that the ACS 500 is safe, after disconnecting the power, by measuring the DC bus voltage and line input voltage. Failure to check voltages could cause death or serious injury. Only a qualified electrician should carry out the electrical installation.

Note that the Motor Control Card of the ACS 500 is at DC bus voltage potential.

The DC bus capacitors contain dangerous DC voltage levels ($1.35 \times V_{IN}$). After disconnecting the supply, wait at least five minutes after the display readout on the control panel has disappeared before taking any measurements.

Dangerous external control voltages may be present on the relay outputs of the Control Interface Card and Option Cards.



CAUTION: Electrostatic Discharge (ESD) can damage electronic circuits. Do not handle any components without following the proper ESD precautions.

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Chapter 1 – Introduction

This chapter describes the purpose and contents of this manual, describes the intended audience, explains conventions used in this manual, and lists related publications.

How To Use This Manual

The purpose of this manual is to provide you with the information necessary to select, modify, and apply Application macros to the operation of your ACS 500 drive.

ACS 500 user documentation also includes either the *ACS 501 Installation & Start-up Manual* or the *ACS 502 Installation & Start-up Manual*, which is included with the drive.

Chapter 1 – Introduction, the chapter you are reading now, introduces you to the *ACS 500 Adjustable Frequency AC Drives Programming Manual Including Application Macros* and conventions used throughout the manual.

Chapter 2 – Overview of ACS 500 Programming provides an overview of Application macros and describes how to use the menu system of parameters to select and modify the macros.

Chapter 3 – Start-up Data lists and explains the Start-up Data parameters. This chapter also describes how to set the Start-up Data parameters.

Chapter 4 – Control Operation describes operating data parameters, keypad references, drive-mounted and external controls, setting parameters for your specific drive application, and protecting your drive parameters from unauthorized changes.

Chapter 5 – Standard Application Macro Programs defines Application macros in terms of parameter settings. This chapter also describes the operation and application suitability of six standard Application macros and the User macro.

Chapter 6 – Parameters lists the ACS 500 parameters and explains the functions of each parameter.

Appendix A – Complete Parameter Settings lists, in a table form, all parameter settings for the ACS 500.

Appendix B – Programming Digital Inputs DI1 – DI6 lists, in table form, parameter values and digital I/O configurations.

Index helps you locate the page numbers of topics contained in this manual.

Intended Audience

The audience for this manual has:

- Knowledge of standard electrical wiring practices, electronic components, and electrical schematic symbols.
- Minimal knowledge of ABB product names and terminology.
- No experience or training in installing, operating, or servicing the ACS 500.

Conventions Used In This Manual

The following are illustrations and examples of Control Panel keys and Control Panel display formats.

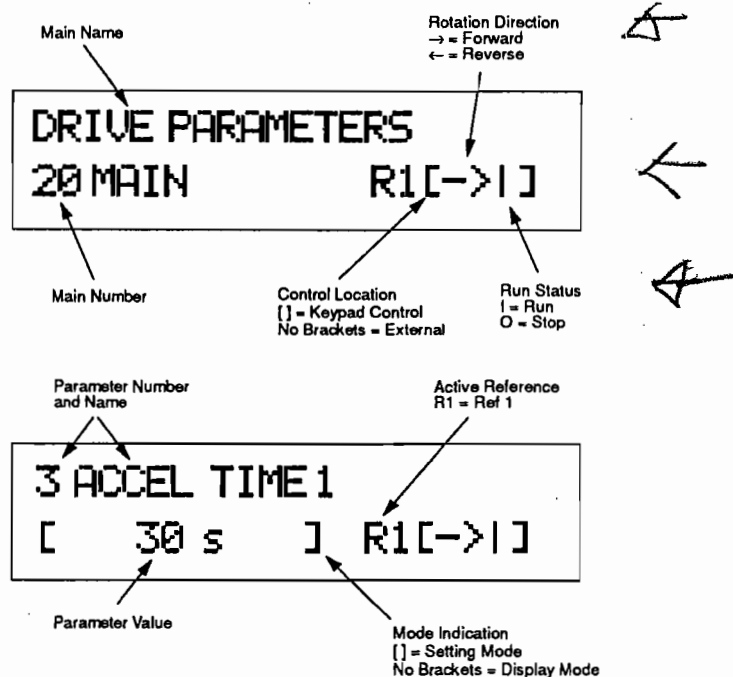
Control Panel Display

The Control Panel display is an LCD readout of drive functions, drive parameter selections, and other drive information. Letters or numbers appear in the display according to which Control Panel keys you press.

The operation information, parameters and fault indications are displayed in nine languages: English, German, Italian, Spanish, Dutch, French, Danish, Finnish, and Swedish. The language selection is made in Start-up Data Parameter A (Language).

Figure 1-1 shows control panel display indications.

Figure 1-1 Control Panel Displays



Control Panel Keys

Control Panel keys are flat, labeled, pushbutton keys that allow you to monitor drive functions, select drive parameters, and change drive macros and settings.

Table 1-1 illustrates each Control Panel Key as it appears on the Control Panel Keypad. Table 1-1 also shows how the keys are represented in this manual's text and describes the function of each key.

Table 1-1 Control Panel Keys

Control Panel Key	Text Reference	Function
	[*]	Selects the Setting mode and saves the selected parameter value.
	[Right Arrow]	Steps between levels. Selects between Operating Data, Main, Group, and Parameter levels.
	[Left Arrow]	and In Setting Mode, returns to the Display mode without changing the Parameter value.
	[Up Arrow]	Steps through choices within a level. In Display mode, selects the next/previous Main, Group, or Parameter.
	[Down Arrow]	and In Setting mode, increases/decreases parameter value.
	[Fwd/Rev]	Changes the rotation direction in Keypad control (refer to parameter 10.1.3).
	[Start/Stop]	Starts and stops the motor in Keypad control. Resets faults, warnings, and supervision indications.

Related Publications

For related information, refer to the *Installation & Start-up Manual*.

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Chapter 2 – Overview of ACS 500 Programming

This chapter defines Application macros in terms of parameter settings and describes how to use the menu system of parameters to select and modify the macros.

Overview of Application Macros

Application Macros Defined

Application macros are pre-programmed parameter sets. You'll use them to start the ACS 500 quickly and easily.

Application macros minimize the number of different parameters to be set during start-up. All parameters have factory-set default values. The Factory macro program is the factory-set default macro.

While starting up the ACS 500, you can specify a macro as the base setting for a drive. You can select any one of the following macros from Start-up Data Parameter B (Applications):

- Factory
- Hand/Auto Ctrl
- PI-Control
- Opt. Pack
- Seq Ctrl
- Pump and Fan

In addition to these application macros, there is a User macro. The User macro allows the user to save the existing parameter settings for recall at a later time.

Macro programs do not usually set all parameter values exactly as needed for a special application. Check frequency limits and acceleration/deceleration times and modify as required for your application.

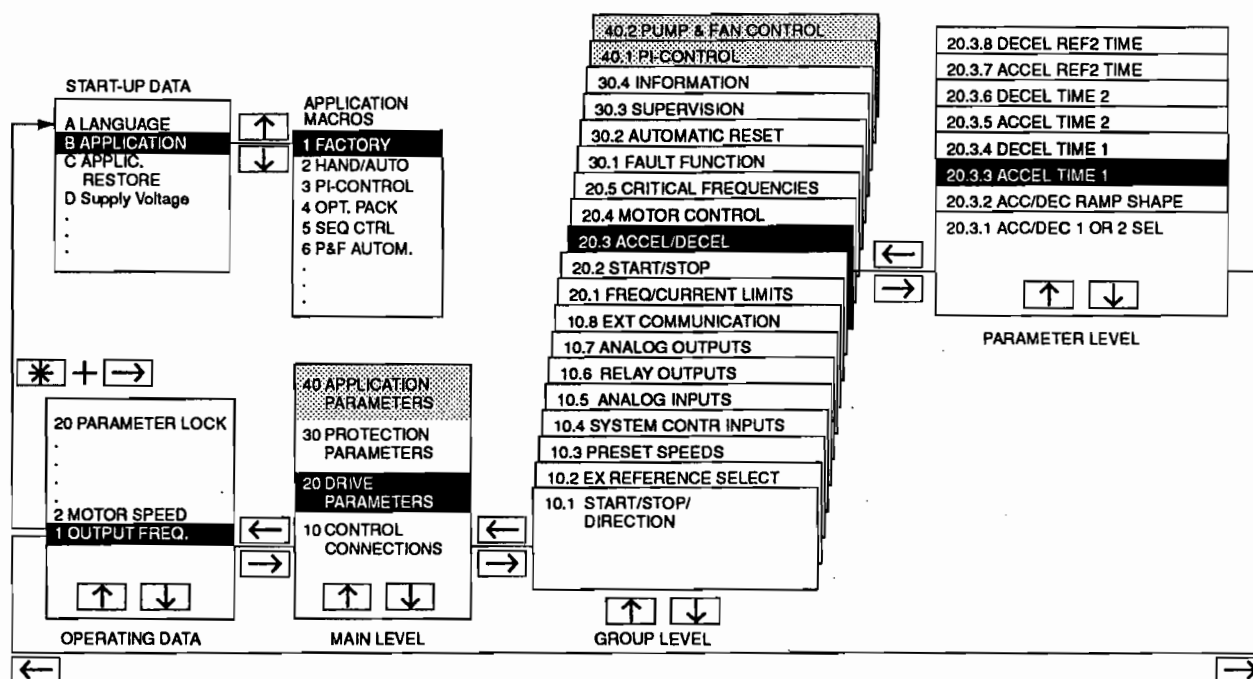
You may need to modify digital and analog inputs and/or outputs. The Parameter Settings tables in *Chapter 5 – Standard Application Macro Programs* indicate parameters you may have to modify. These parameters are indicated in the tables with an arrow (→) symbol.

Menu System of Parameters

The parameters in the ACS 500 are organized via a system of menus. There are four levels of information, plus a start-up data menu. The four levels are: Operating Data, Main Level, Group Level, and Parameter Level. Each is described in this chapter.

Figure 2-1 shows how to select Start-up Data parameters, Operating Data parameters, Application macros, Main, Group, and Parameter levels using the Control Panel keypad.

Figure 2-1 Parameter Selection



Start-up Data Parameters

The Start-up Data menu contains some basic settings needed to match the ACS 500 with your motor and to set the Control Panel display language. This menu also contains a list of pre-programmed Application macros. The Start-up Data menu is the first menu you modify to start-up your drive.

Using the Start-up Data Menu

The Start-up Data Menu provides access to parameters that should be set at start-up, and should not need to be changed. These parameters are Language, Application Macro, and Motor Information. Refer to *Chapter 3 – Start-up Data* for descriptions of each parameter.

To enter the Start-up Data menu:

1. Choose Operating Data Parameter 1 (Output Frequency).
2. Press and hold [*], then press [Right Arrow].

To change a parameter:

1. Use the [Up Arrow] or [Down Arrow] to select a value.
2. Press [*] to confirm the value and step to the next parameter.
3. Repeat Steps 1 and 2 for Parameters A through K.

To exit the Start-up Data menu, press [*] to confirm the value for the last parameter, Parameter K. The program returns automatically to Operating Data Parameter 1 (Output Frequency).

Operating Data Parameters

The Operating Data menu contains 20 data values, status information, and three selection functions. There are eight additional Operating Data parameters that display when certain applications are selected. The selection functions are:

- Control Location Selection,
- External Reference Input Selection, and
- Parameter Lock locking/unlocking function.

Refer to *Chapter 4 – Control Operation* for a detailed discussion of the Operating Data parameters.

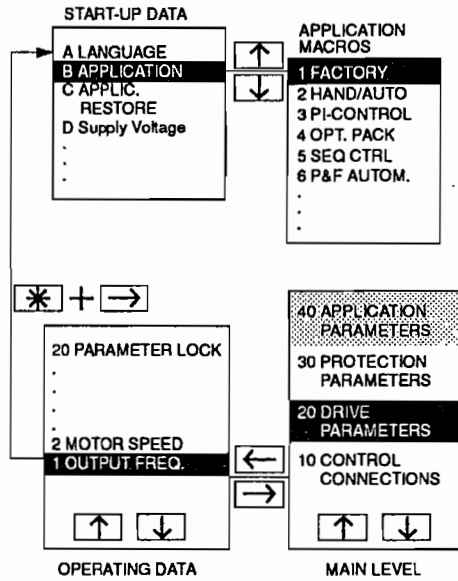
Menu Navigation

The [Right Arrow] and [Left Arrow] keys are used to move between the different levels (Operating Data, Main Level, Group Level, and Parameter Level).

The [Up Arrow] and [Down Arrow] keys are used to step through the choices within a level.

Main Level The Main Level organizes the parameters into four main functional areas. The ACS 500 has four Mains. Each Main allows you to access Groups within the Main. One of the Mains, *Application Parameters*, is only accessible when you select an Application macro that requires additional set-up parameters. Figure 2-2 shows how to select the Main level using the Control Panel Keypad.

Figure 2-2 Main Level Selection



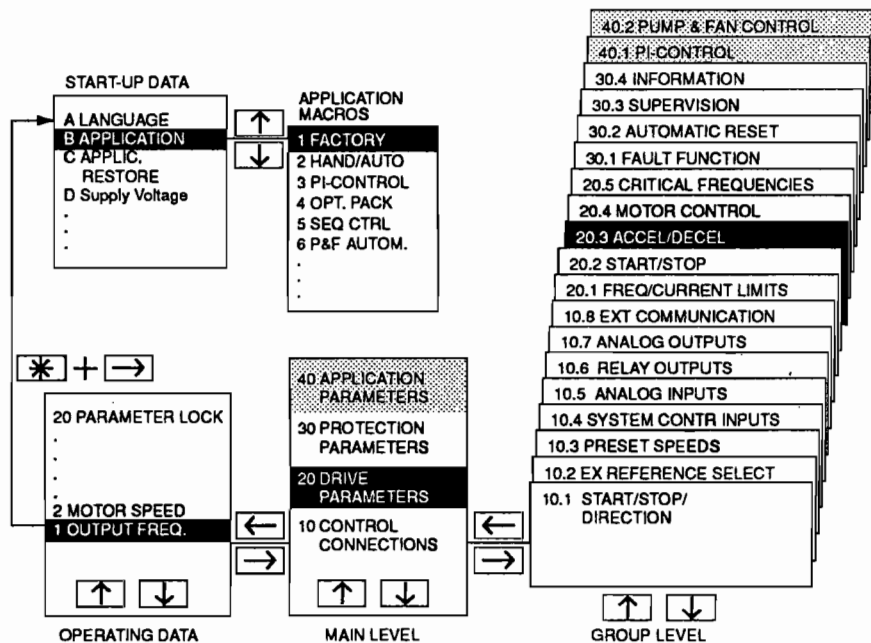
Group Level The Group Level groups the parameters by their functionality. Each Main provides access to several Groups. For example:

- CONTROL CONNECTIONS/10 MAIN contains Groups 10.1 – 10.8.
- DRIVE PARAMETERS/20 MAIN contains Groups 20.1 – 20.5.
- PROTECTION PARAMETER/30 MAIN contains Groups 30.1 – 30.4.
- APPLIC. PARAMETERS/40 MAIN contains Groups 40.1 – 40.2.

The groups in Main 40 can only be accessed if the appropriate macro has been selected.

Figure 2-3 shows how to select the group level using the Control Panel Keypad.

Figure 2-3 Group Level Selection



Parameter Level

The Parameter Level is the programming level where the parameters are viewed and can be modified. Each Group contains several Parameters. Parameters allow you to change certain specifications or values to meet the needs of your particular application.

To change a Parameter value:

1. Use the arrow keys to select the parameter you would like to change.
2. Press [*] to enter the Setting mode. This places square brackets around the value displayed in the lower left of the Display.
3. Press [Up Arrow] or [Down Arrow] to change the Parameter value.
4. Press [*] to save the selected value and exit Setting mode, or [Right Arrow] or [Left Arrow] to cancel and return to previous value.

Note: Start-up Data and Operating Data are not Main or Group levels, but define certain Parameters. Procedures for changing Start-up Data Parameters A – K are not the same as those described above. Refer to Chapter 3 – Start-up Data for Start-up Data details.

Figure 2-4 shows how to select a Parameter using the Control Panel Keypad.

Figure 2-4 Parameter Level Selection

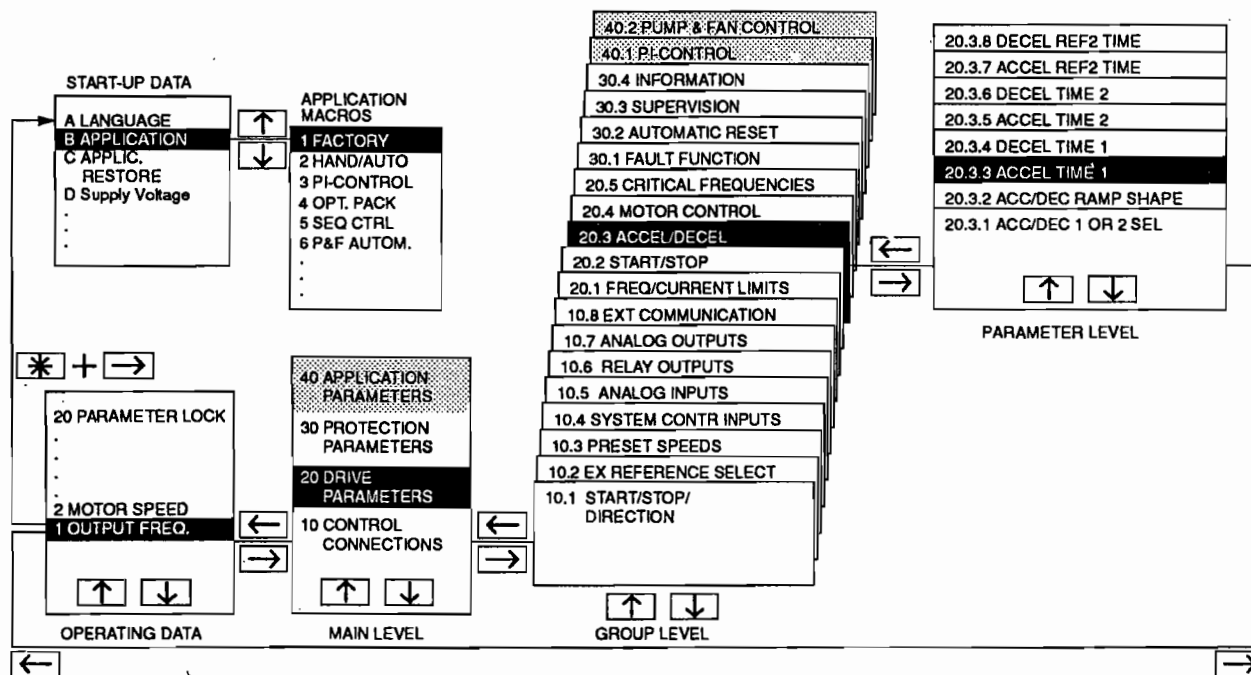
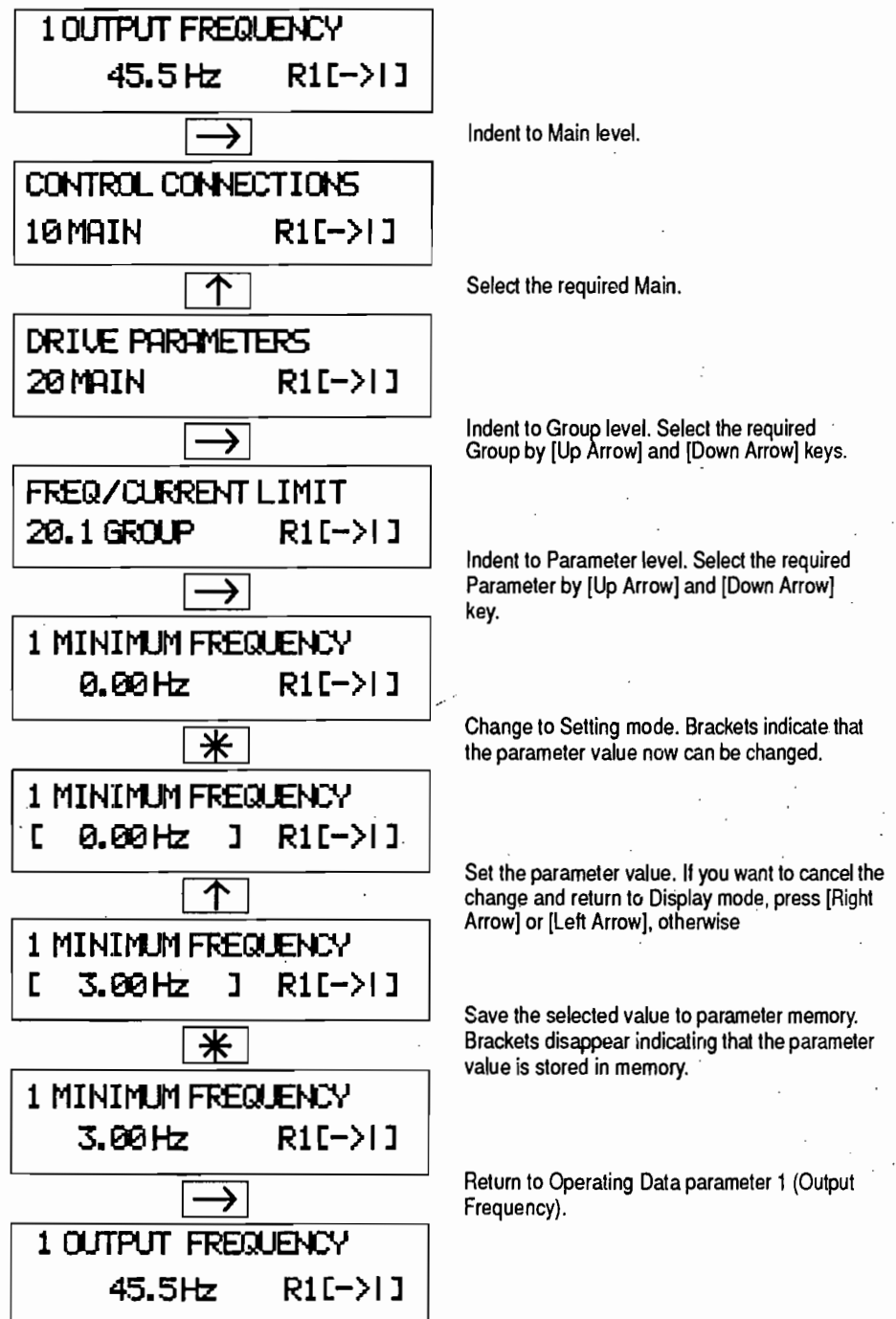


Figure 2-5 shows how to set Parameter 20.1.1 (Minimum Frequency) to 3 Hz starting from Operating Data Parameter 1 (Output Frequency).

Note: To accelerate the change of parameter value, press and hold the [Up Arrow] or [Down Arrow] button.

Figure 2-5 Parameter Settings



Application Macros

Table 2-1 is an example of Factory macro parameters that you are most likely to modify if you are using the ACS 500 Factory macro to control your motor. The Factory macro default settings appear in the Default column.

Table 2-1 Factory Macro Parameters

Main	Group	Parameter	Default
OPERATING DATA	OPERATING DATA	9 CONTROL LOCATION	KEYPAD R1
		12 EXT REF 1 OR 2	REF 1
		20 PARAMETER LOCK	OPEN xxx
START-UP DATA	START-UP DATA	A LANGUAGE	ENGLISH
		B APPLICATIONS	FACTORY
		C APPLIC. RESTORE	NO
		D SUPPLY VOLTAGE	480
		E USER DISPLAY SCALE	0
		F MOTOR CURRENT -FLA	(Current Rating)
		G MOTOR POWER	(Power Rating)
		H MOTOR POWER FACTOR	0.83
10 CONTROL CONNECTIONS	10.1 START/STOP/DIRECTION	10.1.3 LOC/EXT DIRECTION	FORWARD
	10.3 PRESET SPEEDS	10.3.2 PRESET SPEED 1	5 Hz
		10.3.3 PRESET SPEED 2	10 Hz
		10.3.4 PRESET SPEED 3	15 Hz
	10.5 ANALOG INPUTS	10.5.1 MINIMUM AI1	0 V/0 mA
		10.5.2 MAXIMUM AI1	10 V/20 mA
	10.7 ANALOG OUTPUTS	10.7.3 MINIMUM AO1	0 mA
		10.7.8 MINIMUM AO2	0 mA
20 DRIVE PARAMETERS	20.1 FREQ / CURRENT LIMITS	20.1.1 MINIMUM FREQUENCY	0 Hz
		20.1.2 MAXIMUM FREQUENCY	60 Hz
		20.1.4 CURRENT LIMIT	(1.5 x I _N) A
	20.3 ACCEL/ DECEL	20.3.3 ACCEL TIME 1	3s
		20.3.4 DECEL TIME 1	3s

Refer to *Chapter 5 – Standard Application Macro Programs* for a detailed discussion of the Application macros.

Chapter 3 – Start-up Data

This chapter lists and explains the Start-up Data parameters and describes how to set these parameters. The Start-up Data parameters are a special set of parameters that allow you to set-up the drive and motor information.

Start-up Data parameters should only need to be set during start-up and should not need to be changed.

Start-up Data Parameters

Overview To access the Start-up Data parameters, you must be at Operating Data Parameter 1 (Output Frequency). Press and Hold the [*] key while pressing the [Right Arrow] key. This will bring you to Start-up Data Parameter A (Language).

The [Up Arrow] and [Down Arrow] keys are used to change the value or selection for the Start-up Data parameters. When a parameter is set to the value or selection you want, press the [*] key to enter that value as the acceptable value and move to the next parameter.

To complete the Start-up Data parameters and return to the Operating Data parameters, continue to enter the information by pressing [*] for each Start-up Data parameter.

The Range/Unit column in Table 3-1 shows parameter values. The text following the table explains parameter values in detail.

Table 3-1 Start-up Data Parameters

Parameter	Range/Unit	Description
A LANGUAGE	Available languages	Language selection.
B APPLICATIONS	Application macros	Application macro selection.
C APPLIC. RESTORE	No, Yes	Restores parameters to original values.
D SUPPLY VOLTAGE	Supply voltage selections	Sets the supply voltage.
E USER DISPLAY SCALE	0 – 10000	Scaling factor for speed.
F MOTOR CURRENT -FLA	0 A – 1000 A	Matches the ACS 500 to the rated motor current.
G MOTOR POWER hp (kW)	0.7 hp – 1340 hp (0.5 kW – 1000 kW)	Matches the motor rated power.
H MOTOR POWER FACTOR	0.1 – 1.0	Matches the motor power factor.
I MOTOR BASE FREQ.	30 Hz – 500 Hz	Sets the motor frequency.
J MOTOR BASE R.P.M.	200 rpm – sync. speed	Sets the nameplate speed.
K MOTOR NOM. VOLTAGE	110 V – 575 V	Sets the motor nameplate voltage.

Parameter Selection

The following is a list of the Start-up Data parameters with a description of each parameter.

A LANGUAGE

The ACS 500 displays all information in the language you select. The available languages are: English, German, Italian, Spanish, Dutch, French, Danish, Finnish, and Swedish.

B APPLICATIONS

This parameter is used to select the Application macro which will configure the ACS 500 for a particular application. Refer to *Chapter 6 – Parameters* for a list of available Application macros.

C APPLIC. RESTORE

This parameter restores all parameters of the current application to the original parameter values for that macro.

D SUPPLY VOLTAGE

This parameter is used to set the supply voltage to the ACS 500. The choices are 208, 220, 230, and 240 VAC for 230-volt units; 440, 460, 480, and 500 VAC for 480-volt units; 380, 400, and 415 VAC for 380-volt units; or 525, 550, 575, and 600 VAC for 600-volt units.

E USER DISPLAY SCALE

This parameter is used to set the scaling factor for Operating Data Parameter 2 (Speed). When set to 0, the speed display will show RPM. When set to 100, the speed display will show %. When set to any other value from 0 – 10000, the display will show this value (minus slip unless slip compensation is ON) when the output frequency is at the frequency set by Start-up Data Parameter I (Motor Base Frequency).

**F MOTOR CURRENT
-FLA**

This parameter matches the ACS 500 to the rated motor current, adjustable between 0 and 1000 amps. The drive uses this parameter for motor overload protection and current (amperage) information displays.

If the accuracy of the current display (parameter O.3) is off by more than 10% due to long motor cables (ACS 501 units only), a software calculation can be installed by pressing and holding the [left arrow] until an exclamation point appears on the display. This will calculate the current based on the motor power and power factor. These parameters must be entered correctly for the calculation to be accurate.

G MOTOR POWER

This parameter matches the motor rated power, adjustable between 0.7 hp and 1340 hp. The drive uses this parameter for motor overload and kWh information displays. The left key switches the display between hp and kWh. To change the display, press and hold the left key for two seconds.

**H MOTOR POWER
FACTOR**

This parameter matches the motor power factor (at rated speed and load on sinusoidal power), adjustable between 0.10 and 1.0. The drive uses this parameter for motor torque and power information displays.

**I MOTOR BASE
FREQUENCY**

This parameter is used to set the designed frequency of the motor, adjustable from 30 Hz to 500 Hz in 10 Hz increments. Changing this value will automatically set the Field Weakening Point (FWP) to the same value.

J MOTOR BASE R.P.M.

This parameter is used to set the nameplate speed of the motor and is adjustable from 200 to the maximum 2 pole motor speed based on Start-up Data Parameter I (Motor Base Frequency).

**K MOTOR NOM.
VOLTAGE**

This parameter is used to set the motor nameplate voltage. The default is 460 V for 480-volt units, 380 V for 380-volt units, and 230 V for 230-volt units. Changing this parameter automatically changes the Maximum Output Voltage.

Note: If the motor rated voltage is lower than the supply voltage, make sure that the motor insulation is rated for the DC bus voltage level which is $V_{IN} \times 110\% \times 1.35 \times 1.3$ minimum (input voltage $\times \pm 10\%$ tolerance $\times$ peak of rectified wave $\times$ overvoltage limit).

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Chapter 4 – Control Operation

This chapter describes the Operating Data parameters and how to monitor and select them. It explains Keypad control and External control, and describes the Keypad Reference 1, Keypad PI, and External Reference 1 and 2 parameters.

Operating Data Parameters

The Operating Data Parameter monitored values are updated five times a second.

Parameters 1 – 8 monitor drive functions and do not affect drive performance.

Overview

To monitor drive and motor activity, select Operating Data Parameters 1 – 8. These parameters display information about the ACS 500 and motor activity only. You cannot change the values of these parameters. Refer to *Motor Control Values* in this chapter for more information on the monitoring functions of Operating Data Parameters 1 – 8.

The Operating Data parameters begin with Parameter 1 (Output Frequency). Press [Up Arrow] or [Down Arrow] to move to the next Operating Data Parameter.

Figure 4-1 Operating Data Parameter 1

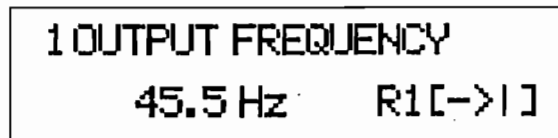
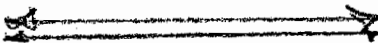
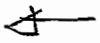


Table 4-1 lists the Operating Data Parameters, selected or monitored values, and functions.

Table 4-1 Operating Data Parameters

Parameter	Range/Unit	Description
1 OUTPUT FREQUENCY	Hz	Frequency to motor.
2 SPEED	rpm/%/no units	Calculated speed, either motor RPM, %, or a scaled speed display. Displayed value is based on frequency minus slip.
3 MOTOR CURRENT		Motor current, (10% accuracy).
4 % RATED TORQUE		Calculated motor torque. 100 is the motor nominal torque rating, (15% accuracy).
5 % RATED POWER		Calculated motor power. 100 is the motor nominal power rating, (15% accuracy).
6 DC BUS VOLTAGE		Intermediate circuit DC voltage displayed in VDC and % of full voltage.
7 OUTPUT VOLTAGE		Calculated motor voltage, (5% accuracy).
8 DRIVE TEMPERATURE		Temperature of the heatsink.
9 CONTROL LOCATION		Control location selection (R1 = Referenced, PI = Closed loop controller).
10 KEYPAD REF 1		Frequency reference from Control Panel.
11 KEYPAD PI (REF 2)		Frequency reference (controller reference for PI) from Control Panel.
12 EXT REF 1 OR 2		External control place selection.
13 EXTERNAL REF 1		External frequency reference.
14 EXTERNAL REF 2		External controller reference.
15 RUN TIME		Elapsed time meter.
16 KILOWATT HOURS		kWh meter.
17 LAST-RECD FAULT		The latest fault and warning indication.
18 SECOND-RECD FAULT	-	The previous fault and warning indication.
19 FIRST-RECD FAULT	-	The oldest fault and warning indication.
20 PARAMETER LOCK	OPEN xxx/LOCKED xxx OPEN/LOCKED	Parameter software lock (xxx = 358 to unlock). Lock from Digital Inputs.

Right & Left Arrows are used
to move Between Group Levels

  = 1-40 C

Up & Down Arrows are used to
step through Choices within Levels

Such as Group 10 = 10.1 - 10.8

Parameter	Range/Unit	Description
21 APPL BLOCK OUTPUT *	Hz	PI-Controller output signal.
22 ACTUAL VALUE 1 *	%	Feedback signal for the PI-Controller.
23 ACTUAL VALUE 2 *	%	Feedback signal for the PI-Controller.
24 LAG MOTORS RUNNING **	0 – 3	Number of lag motors running in Pump and Fan Control.
25	%	PI-Controller output signal.
26	%	Difference between reference and actual signal.
27	Engineering Units	Actual (feedback) signal 1.
28	Engineering Units	Actual (feedback) signal 2.

For External Control

control macro or P&F Autom. macro is selected.
Autom. macro is selected.

You may change the values of some of the parameters to fit the needs of your application. For example, to control the ACS 500 from a control device other than the ACS 500 Control Panel keypad, follow these steps:

1. Press [left Arrow] or [Right Arrow] until the LCD Display displays any one of the Operating Data Parameters listed in Table 4-1.
2. Press [Up Arrow] or [Down Arrow] until 9 CONTROL LOCATION displays. KEYPAD R1 displays on the second line of the LCD Display.
3. Press [*] to enter the Parameter Setting mode. This displays square brackets [] around the KEYPAD R1 display.
4. Press [Up Arrow] or [Down Arrow] to change the KEYPAD R1 display to EXTERNAL.
5. Press [*] to save the selection and exit Setting mode.

This procedure allows you to operate the ACS 500 from a control device other than the ACS 500 Control Panel keypad.

The following procedures describe the Operating Data parameters, how to change values, and how to advance through the parameters.

1 OUTPUT FREQUENCY

This parameter displays the ACS 500 frequency (Hz) to the motor. Press [Up Arrow] to move to the next parameter.

2 SPEED

This parameter displays a calculated speed based on load and slip compensation. With no slip compensation, motor speed decreases as load increases. As default, the speed is displayed in motor RPM. The scaling of this display is set by Start-up Data Parameter E (User Display Scale). The speed display can be scaled to show % or any other scaled value up to 10,000. This will allow the ACS 500 to display the process speed, i.e., cans per minute. Press [Up Arrow] to move to the next parameter.

3 MOTOR CURRENT

This parameter displays motor current. Long motor cables can cause an inaccurate current display. Press [Up Arrow] to move to the next parameter.

4 CALCULATED TORQUE	This parameter displays motor torque in percent of motor rating, as calculated by the drive. Press [Up Arrow] to move to the next parameter.
5 CALCULATED POWER	This parameter displays motor power in percent of motor rating, as calculated by the drive. Press [Up Arrow] to move to the next parameter.
6 DC BUS VOLTAGE	This parameter displays DC bus voltage, as measured in the drive. The voltage is displayed in volts DC and in % ($100\% = 1.35 \times V_N$). Press [Up Arrow] to move to the next parameter.
7 OUTPUT VOLTAGE	This parameter displays motor voltage as calculated by the drive. Press [Up Arrow] to move to the next parameter.
8 DRIVE TEMPERATURE	This parameter displays the temperature of the drive heatsink in degrees Fahrenheit and degrees centigrade. Press [Up Arrow] to move to the next parameter.
9 CONTROL LOCATION	This parameter allows you to select the location of the drive controls for start/stop, speed reference, and rotation direction commands. Press [*] to enter Setting mode. Press [Up Arrow] or [Down Arrow] to change the control location. Select: • KEYPAD R1 to operate the drive from the Control Panel keypad. • EXTERNAL to operate the drive from an external control device connected to Terminal Block X50. • KEYPAD PI to use the Control Panel keypad to change the reference for a PI -Controller if using PI control. Press [*] to save the setting. Press [Up Arrow] to move to the next parameter.
10 KEYPAD REF 1	This parameter displays the ACS 500 reference frequency (Hz) used when in Keypad R1. Press [*] to enter Setting mode. Press [Up Arrow] or [Down Arrow] to change the value of the reference frequency. This parameter can be set while viewing any of the first eight Operating Data parameters. Press [*] to save the setting. Press [Up Arrow] to move to the next parameter.
11 KEYPAD PI (REF 2)	This parameter displays the ACS 500 keypad reference used when in Keypad PI. Press [*] to enter Setting mode. Press [Up Arrow] or [Down Arrow] to change the value of the reference. Press [*] to save the setting. Press [Up Arrow] to move to the next parameter.
12 EXT REF 1 OR 2	This parameter allows you to select between two external control locations. Use this parameter when Parameter 10.2.1 (Ext 1/Ext 2 Select) is set to KEYPAD, otherwise the external control location is selected by a digital input. Press [*] to enter Setting mode. Press [Up Arrow] or [Down Arrow] to change the external control location. Press [*] to save the setting. Press [Up Arrow] to move to the next parameter.
13 EXTERNAL REF 1	This parameter is the external frequency reference (Hz) from control location R1. The signal source selection is made with Parameter 10.2.2 (External Ref1 Sel). Press [Up Arrow] to move to the next parameter.

14 EXTERNAL REF 2

This parameter is the external frequency reference from control location R2, displayed in percent. The signal source selection is made with Parameter 10.2.5 (External Ref2 Sel). Press [Up Arrow] to move to the next parameter.

15 RUN TIME

This parameter is an elapsed-time indicator. It counts time that a drive has an Enable signal and a Start command, and is not in a faulted state. Counted time cannot be reset. Press [Up Arrow] to move to the next parameter.

16 KILOWATT HOURS

This parameter counts kilowatt hours of drive operation. Press [Up Arrow] to move to the next parameter.

17 LAST-RECD FAULT

This parameter displays the name of the most recent fault/warning message. Refer to *Chapter 5 – Fault Tracing* in the *Installation & Start-up Manual* for information on resetting faults. Press [Up Arrow] to move to the next parameter.

This parameter displays the name of the second most recent fault/warning message. Refer to *Chapter 5 – Fault Tracing* in the *Installation & Start-up Manual* for information on resetting faults. Press [Up Arrow] to move to the next parameter.

This parameter displays the name of the third most recent fault/warning message. Refer to *Chapter 5 – Fault Tracing* in the *Installation & Start-up Manual* for information on resetting faults. Press [Up Arrow] to move to the next parameter.

20 PARAMETER LOCK

This parameter indicates if the parameters are locked or open. If LOCKED or OPEN are followed by xxx, then the parameter lock is from the Keypad, otherwise the parameter lock is from a digital input. The parameter lock allows you to lock all the ACS 500 parameters, protecting the parameters from unauthorized changes through parameter Setting mode. Parameter 10.4.3 (Param. Lock Sel) allows you to select the Parameter Lock control location. You may view locked parameters at any time.

When Parameter Lock is from the Keypad:

To lock: Press [*] to enter Setting mode. Press [Up Arrow] or [Down Arrow] to change from OPEN xxx to LOCKED xxx. Press [*] to save the setting. Press [Up Arrow] to move to the next parameter. To unlock the parameters:

1. Return to Operating Data Parameter 20 (Parameter Lock). The LCD Display shows LOCKED xxx.
2. Press [*] to enter Setting mode.
3. Press and hold [Up Arrow] to change LOCKED xxx to LOCKED 358.
4. Press [*] to open the Parameter Lock. The LCD Display shows OPEN xxx.

21 APPL BLOCK OUTPUT

This parameter is the PI-Controller output signal. Refer to Figure 4-3 in the *External Control* section of this chapter. Press [Up Arrow] to move to the next parameter.

ACTUAL VALUE 1

This parameter is a feedback signal to the PI-Controller, displayed in percent. Press [Up Arrow] to move to the next parameter.

23 ACTUAL VALUE 2	This parameter is a feedback signal to the PI-Controller, displayed in percent. Press [Up Arrow] to move to the next parameter.
24 LAG MOTRS RUNNING	Number of lag motors running in Pump and Fan control.
25 CONTROLLER OUTPUT	Output value of the PI-Controller. Value is in percent of the regulation range.
ACT VALUE 1 (PFC)	Unscaled actual feedback signal number one. Displayed in the units set by Parameter 40.2.30 (Display Unit).
ACT VALUE 2 (PFC)	Unscaled actual feedback signal number two. Displayed in the units set by Parameter 40.2.31 (Displ Unit Scale).

Motor Control Values

During motor operation, or when troubleshooting, you may need to check the vital statistics of the motor and drive. Operating Data Parameters 1 – 8 allow you to view motor and drive activity.

When controlling the drive from the keypad, you may adjust motor speed while displaying Operating Data Parameters 1 – 8. To do this while viewing these parameters:

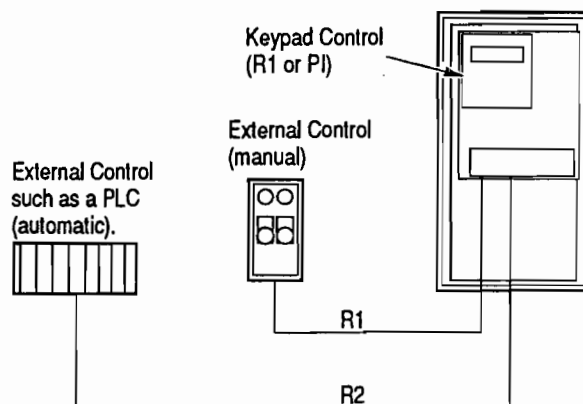
1. Press [*] to enter the Setting mode.
2. Press [Up Arrow] to increase motor speed or [Down Arrow] to decrease motor speed.

When viewing Operating Data Parameters 1 (Output Frequency) and 2 (Speed), the LCD display changes to show Operating Data Parameter 10 (Keypad Ref 1) while pressing the [Up Arrow] or [Down Arrow].

Keypad Control vs. External Control

The ACS 500 can be controlled from two external control locations or from the Control Panel keypad. Figure 4-2 shows all control locations.

Figure 4-2 Control Locations



Select Operating Data Parameter 9 (Control Location), then select KEYPAD R1 for keypad control or EXTERNAL for external control. The valid control location is indicated on the display. Square brackets around the Direction and Run indicators on the LCD Display mean Keypad control. No square brackets means External control. R1 on the LCD means Ref 1 and R2 means Ref 2.

Keypad Control

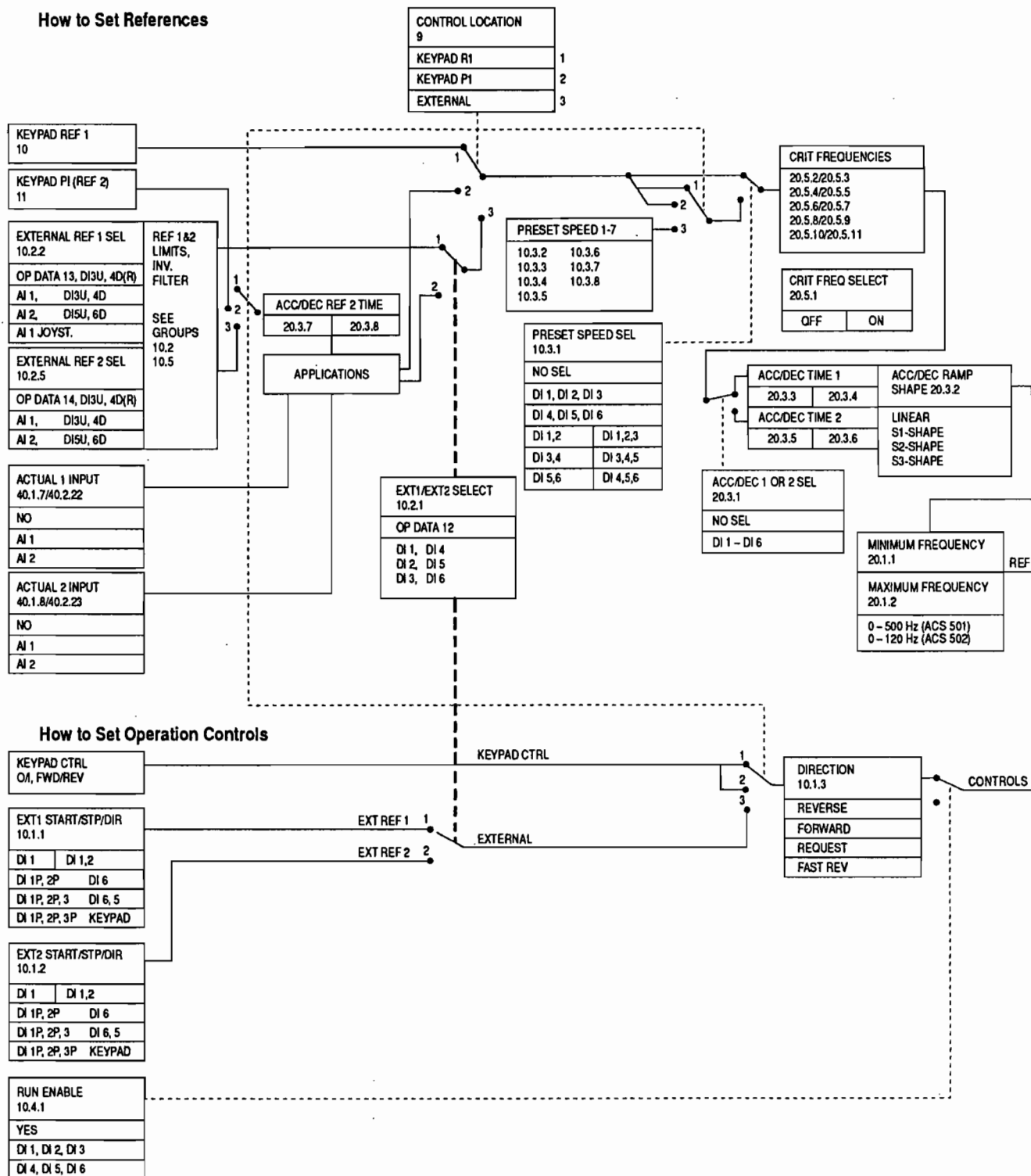
When you select KEYPAD R1 or KEYPAD PI from Operating Data Parameter 9, Keypad commands operate the ACS 500.

External Control

External control locations Ref 1 and Ref 2 are selected with digital inputs 1 – 6 or Operating Data Parameter 12 (Ext Ref 1 or 2), depending on the setting of Parameter 10.2.1 (Ext 1/Ext 2 Select).

Figure 4-3 shows a signal flow diagram indicating the control signal selections.

Figure 4-3 Control Signal Selection



Keypad Reference 1 and Keypad PI

Keypad Reference 1

Operating Data Parameter 10 (Keypad Ref 1) is a direct frequency reference. To set the frequency reference, select Parameter 10 (Keypad Ref 1), press [*], then press [Up Arrow] or [Down Arrow] keys to increase or decrease the keypad reference.

When in Keypad control using Reference 1, you can change the Keypad Reference value while monitoring any of the measured values 1 – 8. For example, you can monitor Operating Data Parameter 7 (Output Voltage) while changing the frequency. To do this, select the measured value you prefer, press [*], then press [Up Arrow] or [Down Arrow] to increase or decrease the reference frequency. If Operating Data Parameters 1 (Output Frequency) or 2 (Speed) are selected, the display will switch to show Parameter 10 (Keypad Ref 1) while changing the reference and will automatically change back when the arrow key is released.

If the ACS 500 is running with an External Reference and the control location is changed to Keypad R1, it is possible to let the Keypad Ref 1 assume the current value of the External Reference.

Example: The ACS 500 is receiving frequency reference from a transducer via Terminal Block X50. You want to temporarily override the external frequency reference.

1. Set Operating Data Parameter 9 (Control Location) to KEYPAD R1.
2. Press and hold down [Start/Stop] and press [*].

Note: If external Start/Stop function is set to Keypad, the ACS 500 will stop, but will read the reference.

The ACS 500 puts the value of External Reference into Operating Data Parameter 10 (Keypad Ref 1) which will make a smooth transition from External to Keypad possible. You may now control the drive manually by Keypad Ref 1.

If you enter Display mode by pressing [*] after setting Operating Data Parameter 9 (Control Location) to KEYPAD R1, the value of Operating Data Parameter 10 (Keypad Ref 1) will be the set minimum frequency.

Keypad PI (Ref 2)

Keypad PI goes through an application block, where it can be manipulated when the PI-Controller is selected. Keypad PI can be used as controller reference or it can be given its own acceleration/deceleration ramps. Refer to Parameters 20.3.7 (Accel Ref 2 Time) and 20.3.8 (Decel Ref 2 Time).

External Reference 1 and 2

External Reference 1 This is the external frequency reference from control location R1. The signal source selection is made with Parameter 10.2.2 (External Ref 1 Sel).

External Reference 2 This is the external reference from control location R2. The signal source selection is made with Parameter 10.2.5 (External Ref 2 Sel). External Reference 2 goes through an application block, where it can be manipulated as Keypad Reference 2.

Password Protection (Parameter Lock)

Parameter Lock prevents unauthorized persons from altering the parameters. If Parameter Lock is active through Operating Data Parameter 23 (Parameter Lock) or Parameter 10.4.3 (Param. Lock Sel) (Keypad, DI1 – DI6), it is not possible to select the Setting mode to change any ACS 500 parameters, but all parameters may be accessed and viewed.

The ACS 500 Parameter Lock can be controlled with Keypad (Operating Data Parameter 23 (Parameter Lock)) or a digital input. The control location is selected with Parameter 10.4.3 (Param. Lock Sel) (Keypad, DI1 – DI6). To activate the Parameter Lock, set Operating Data Parameter 23 (Parameter Lock) to LOCKED xxx (if the control location is the Keypad) or activate the selected digital input (if the control location is a DI setting).

The Parameter Lock control location is indicated in Operating Data Parameter 23 (Parameter Lock). Characters xxx after the parameter value (OPEN xxx, LOCKED xxx) indicate that the current control location is Keypad.

To open the Parameter Lock, you must enter the correct combination. The combination for all ACS 500 units is 358. When viewing Parameter Lock, enter setting mode and set the 358 code. Press [*] to open the Parameter Lock.

Chapter 5 – Standard Application Macro Programs

This chapter describes the operation and application suitability of six standard Application macros and the User macro.

The chapter begins with Table 5-1 which lists the macros, suitable applications for each, what each macro controls, and how to access each macro to modify its parameters.

The remainder of this chapter contains the following information for each macro:

- Operation
- Input and Output Signals
- External Connections
- Parameter Settings

User Macro

The User macro allows the current parameter settings to be stored in memory.

To store your customized parameters:

1. Access the Start-up Data menu.
2. Change Parameter B (Application) to USER save.
3. Press [*] to save.
4. Press [*] for each of the remaining Start-up Data Parameters to get back to the Operating Data.

The current settings are now stored in the User macro. Changes can be made to the programming without losing the parameters saved to the User Macro.

To recall the last saved parameters or User macro:

1. Access the Start-up Data menu.
2. Change Parameter B (Application) to USER load.
3. Press [*] to load.
4. Press [*] for each of the remaining Start-up Data Parameters to get back to the Operating Data.

Macro Applications and Access

Table 5-1 Macro Applications and Access

Macro	Suitable Applications	Controls	Select
Factory	Conveyors and other constant torque industrial applications. Vibration endurance test benches needing variable speeds of vibrating motors. Testing of rotating machines. Drives to be run long periods with constant speed different from the nominal speed of the drive. All applications needing traditional external controls.	Keypad, External	FACTORY
Hand/Auto	Processes requiring motor speed control both automatically with PLC or other process automation and manually with a remote control panel. Active control location selection with digital input. Speed controls having one or two external control locations with reference setting and START/STOP control. Active reference selection with digital input.	Ext1, Ext2	HAND/AUTO
PI-Control	Intended for use with different closed loop control systems such as pressure control, level control, and flow control. For example: • Booster pumps of municipal water supply systems. • Automatic level control of water reservoirs. • Booster pumps of district heating systems. • Speed control of different types of material handling systems where material flow has to be regulated (use linear V/Hz-curve.)	Process	PI-CONTROL
Option Pack	Fans and pumps when factory supplied option pack on ACS 501 units, or when Hand/Off/Auto or Bypass are supplied on ACS 502 units.	Enclosure Mounted Operator Devices, External Signals	OPT. PACK
Sequential Control	Processes requiring motor speed control in addition to the adjustable speed with 1 to 7 preset speeds and/or with two different acceleration/deceleration times automatically with PLC or other process automation or using manual speed selection switches.	Regulated Constant Speed	SEQ CTRL
Pump and Fan	Closed loop control systems utilizing pumps or fans such as constant pressure control, level control, or flow control. • Booster pumps of municipal water supply systems. • Automatic level control of water reservoirs. • Pumps and fans of waste water treatment plants. • Cooling tower fan drives. • Combustion air and exhaust gas fans of power plants.	Process	P & F AUTOM.
Speed Control	Closed loop speed control for more precise control of motor speed. Requires SNAT 7610 BAC option card. For a complete description and parameter listing, see the Users Manual for the SNAT 7610 BAC option board.		SPEED CTRL

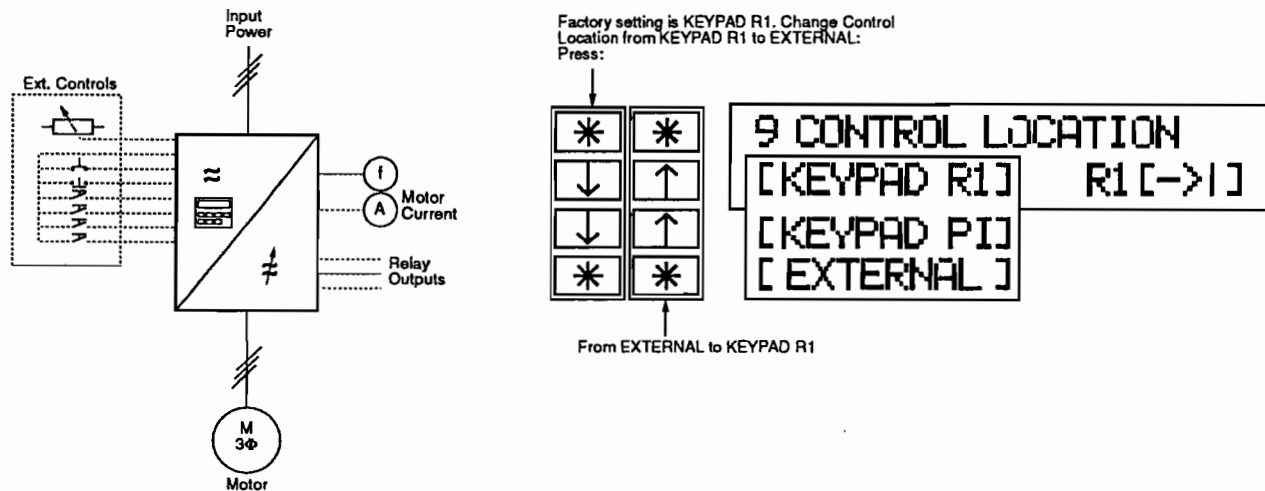
Refer to Appendix A – Complete Parameter Settings for the alternative settings for all parameters.

Application 1 – Factory Macro

All drive commands, reference settings, and parameter settings can be undertaken from the local keypad or through the screw terminals (external). Select the control device with Parameter 9 (Control Location). Two analog and three relay output contact signals are available on Terminal Block X50.

Operation Diagram

Figure 5-1 Operation Diagram



Input and Output Signals

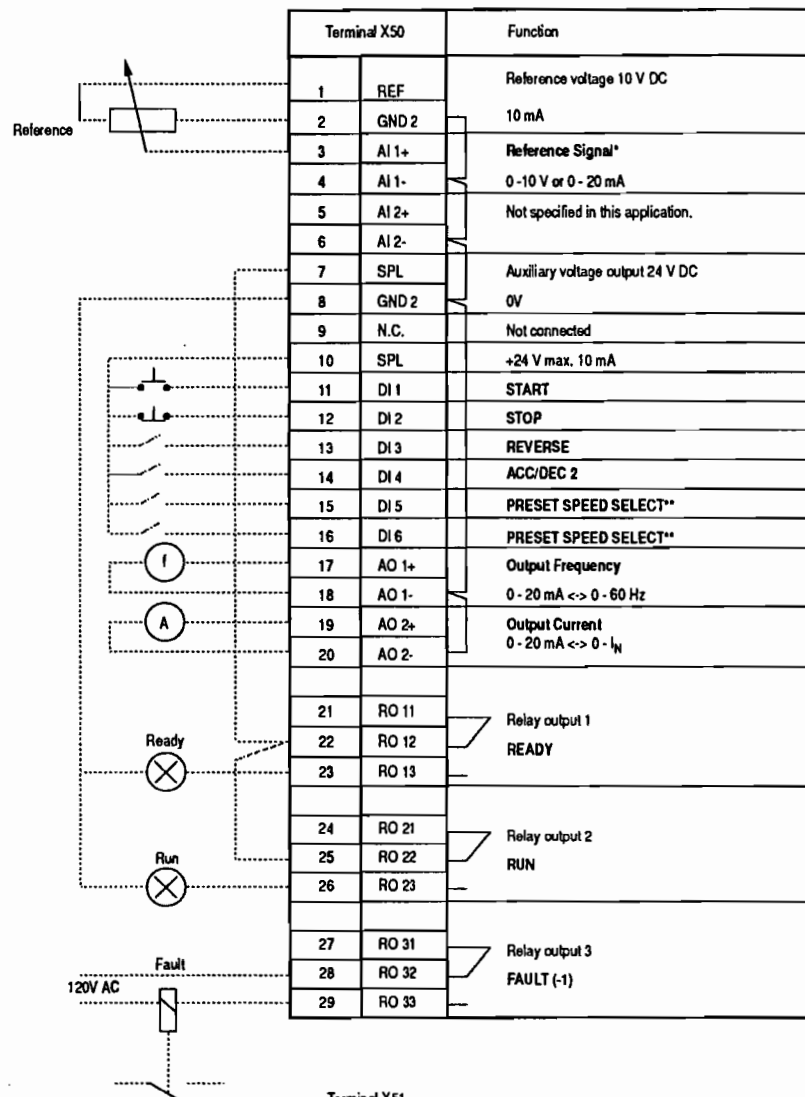
Table 5-2 Input and Output Signals

Input Signals	Output Signals
Start, Stop, Direction, ACC/DEC 1/2, and two Preset Speeds. One Analog Reference input.	Analog Output AO1: Output Frequency Analog Output AO2: Output Current Relay Output RO1: READY Relay Output RO2: RUN Relay Output RO3: FAULT (-1)

Factory Macro External Connections

Connection Example

Figure 5-2 Factory Macro Connection Example



* Select voltage or current reference with plugs S1 and S2 on the customer interface board (beside the screw terminals 1-6 of X50).

** Operation:

D15	D16	Output
0	0	set freq. through AI1
1	0	Preset Speed 1
0	1	Preset Speed 2
1	1	Preset Speed 3

0 = Open
1 = Closed

Factory Macro Parameter Settings

START-UP DATA

A LANGUAGE	→ ENGLISH
B APPLICATIONS	→ FACTORY
C APPLIC. RESTORE	→ NO
D SUPPLY VOLTAGE	→ 480/230/380
E USER DISPLAY SCALE	→ 0
F MOTOR CURRENT -FLA	→ I_{N} of drive
G MOTOR POWER (kW)	→ P_N of drive
H MOTOR POWER FACTOR	→ 0.83
I MOTOR BASE FREQ.	→ 60
J MOTOR BASE R.P.M.	→ 1728
K MOTOR NOM. VOLTAGE	→ 460/230/380

OPERATING DATA

1 OUTPUT	
2 SPEED	
3 MOTOR CURRENT	
4 % RATED TORQUE	
5 % RATED POWER	
6 DC BUS VOLTAGE	
7 OUTPUT VOLTAGE	
8 DRIVE TEMPERATURE	
9 CONTROL LOCATION	→ KEYPAD R1
10 KEYPAD REF 1	
11 KEYPAD PI (REF 2)	
12 EXT REF 1 OR 2	REF 1
13 EXTERNAL REF 1	
14 EXTERNAL REF 2	
15 RUN TIME	
16 KILOWATT HOURS	
17 LAST-RECD FAULT	
18 SECOND-RECD FAULT	
19 FIRST-RECD FAULT	
20 PARAMETER LOCK	OPEN

10 CONTROL CONNECTIONS

10.1 START/STOP/DIRECTION	
10.1.1 EXT 1 STRT/STP/DIR	DI1P2P3
10.1.2 EXT 2 STRT/STP/DIR	NOT SEL
10.1.3 LOC/EXT DIRECTION	→ FORWARD
10.2 EX REFERENCE SELECT	
10.2.1 EXT 1/EXT 2 SELECT	OP DATA 12
10.2.2 EXTERNAL REF1 SEL	AI1
10.2.3 EXT REF1 MINIMUM	0 Hz
10.2.4 EXT REF1 MAXIMUM	60 Hz
10.2.7 EXTERNAL REF2 SEL	OP DATA 14
10.2.8 EXT REF2 MINIMUM	0 Hz
10.2.9 EXT REF2 MAXIMUM	60 Hz
10.3 PRESET SPEEDS	
10.3.1 PRESET SPEED SEL	DI5,6
10.3.2 PRESET SPEED 1	→ 5 Hz
10.3.3 PRESET SPEED 2	→ 10 Hz
10.3.4 PRESET SPEED 3	→ 15 Hz
10.4 SYSTEM CONTR INPUTS	
10.4.1 RUN ENABLE	YES
10.4.2 FAULT RESET SELECT	NOT SEL
10.4.3 PARAM. LOCK SEL	OP DATA 20
10.4.4 EXTERNAL FAULT	NOT SEL

10.5 ANALOG INPUTS

10.5.1 MINIMUM AI1	→ 0 V/0 mA
10.5.2 MAXIMUM AI1	→ 10 V/20 mA
10.5.3 RC FILTER ON AI1	0.1s
10.5.4 INVERT AI1	NO
10.5.5 MINIMUM AI2	0 V/0 mA
10.5.6 MAXIMUM AI2	10 V/20 mA
10.5.7 RC FILTER ON AI2	0.1s
10.5.8 INVERT AI2	NO

10.6 RELAY OUTPUTS

10.6.1 RELAY RO1 OUTPUT	READY
10.6.2 RELAY RO2 OUTPUT	RUN
10.6.3 RELAY RO3 OUTPUT	FAULT (-1)

10.7 ANALOG OUTPUTS

10.7.1 ANALOG OUTPUT 1	OUT FREQ
10.7.2 SCALE AO1	100%
10.7.3 MINIMUM AO1	→ 0 mA
10.7.4 RC FILTER ON AO1	2s
10.7.5 INVERT AO1	NO
10.7.6 ANALOG OUTPUT 2	OUT CURR
10.7.7 SCALE AO2	100%
10.7.8 MINIMUM AO2	→ 0 mA
10.7.9 RC FILTER ON AO2	2s
10.7.10 INVERT AO2	NO

20 DRIVE PARAMETERS

20.1 FREQ/CURRENT LIMITS

20.1.1 MINIMUM FREQUENCY	→ 0 Hz
20.1.2 MAXIMUM FREQUENCY	→ 60 Hz
20.1.3 FREQUENCY RANGE	0 – 120 Hz
20.1.4 CURRENT LIMIT	→ $1.5 \times I_N$

20.2 START/STOP

20.2.1 START FUNCTION	RAMP
20.2.2 TORQUE BOOST CURR	$1.5 \times I_N$
20.2.3 STOP FUNCTION	COAST
20.2.4 BRAKE CHOPPER	NO
20.2.5 DC HOLD	OFF
20.2.6 DC HOLD VOLTAGE	$0.01 \times V_N$
20.2.7 DC BRAKE VOLTAGE	$0.01 \times V_N$
20.2.8 DC BRAKE TIME	0s

20.3 ACCEL/DECEL

20.3.1 ACC/DEC 1 OR 2 SEL	DI4
20.3.2 ACC/DEC RAMP SHAPE	LINEAR
20.3.3 ACCEL TIME 1	→ 3s
20.3.4 DECEL TIME 1	→ 3s
20.3.5 ACCEL TIME 2	60s
20.3.6 DECEL TIME 2	60s

20.4 MOTOR CONTROL

20.4.1 SWITCHING FREQ	3 kHz
20.4.2 MAX OUTPUT VOLTAGE	460 V
20.4.3 V/Hz RATIO	LINEAR
20.4.4 FIELD WEAK POINT	60 Hz
20.4.5 IR COMPENSATION	NO
20.4.6 IR COMP VOLTAGE	$0.01 \times V_N$
20.4.7 IR COMP RANGE	0 Hz
20.4.8 SLIP COMPENSATION	OFF
20.4.9 NOMINAL SLIP	4%
20.4.10 VOLTAGE LIMIT	ON

20.5 CRIT FREQUENCIES

20.5.1 CRIT FREQ SELECT	OFF
20.5.2 CRIT FREQ 1 LOW	0 Hz
20.5.3 CRIT FREQ 1 HIGH	0 Hz
20.5.4 CRIT FREQ 2 LOW	0 Hz
20.5.5 CRIT FREQ 2 HIGH	0 Hz
20.5.6 CRIT FREQ 3 LOW	0 Hz
20.5.7 CRIT FREQ 3 HIGH	0 Hz
20.5.8 CRIT FREQ 4 LOW	0 Hz
20.5.9 CRIT FREQ 4 HIGH	0 Hz
20.5.10 CRIT FREQ 5 LOW	0 Hz
20.5.11 CRIT FREQ 5 HIGH	0 Hz

30 PROTECTION/INFORMAT

30.1 FAULT FUNCTION

30.1.1 SERIAL FAULT FUNC	STOP
30.1.2 AI <MIN FUNCTION	NO
30.1.3 MOT TEMP FLT FUNC	→ FAULT
30.1.4 MOTOR THERM TIME	700s
30.1.5 MOTOR LOAD CURVE	100%
30.1.6 ZERO SPEED LOAD	40%
30.1.7 BREAK POINT	60 Hz
30.1.8 STALL FUNCTION	WARNING
30.1.9 STALL CURRENT	$1.2 \times I_N$
30.1.10 STALL TIME/FREQ	20s/25 Hz
30.1.11 UNDERLOAD FUNC	NO
30.1.12 UNDERLOAD TIME	600s
30.1.13 UNDERLOAD CURVE	1

30.2 AUTOMATIC RESET

30.2.1 NUMBER OF RESETS	2
30.2.2 TIME WINDOW	30s
30.2.3 TIME BETW. RES ATT	0
30.2.4 OVERVOLTAGE	NO
30.2.5 UNDERVOLTAGE	YES
30.2.6 OVERCURRENT	NO
30.2.7 AI SIGNAL <MIN	NO

30.3 SUPERVISION

30.3.1 OUTPUT FREQ 1 FUNC	NO
30.3.2 OUTPUT FREQ 1 LIM	0
30.3.3 OUTPUT FREQ 2 FUNC	NO
30.3.4 OUTPUT FREQ 2 LIM	0
30.3.5 CURRENT FUNCTION	NO
30.3.6 CURRENT LIMIT	$0 \times I_N$
30.3.7 REF1 FUNCTION	NO
30.3.8 REF1 LIMIT	0 Hz
30.3.9 REF2 FUNCTION	NO
30.3.10 REF2 LIMIT	0%
30.3.11 SUPERVIS MESSAGES	ON

30.4 INFORMATION

30.4.11 CRI PROG VERSION	(version)
30.4.2 MC PROG VERSION	(version)
30.4.3 TEST DATE	(date)

→ = Typical parameter values to check during start-up. If needed, change values to meet the needs of your application. Complete parameter list provided in Appendix A.

Application 2 – Hand/Auto Control

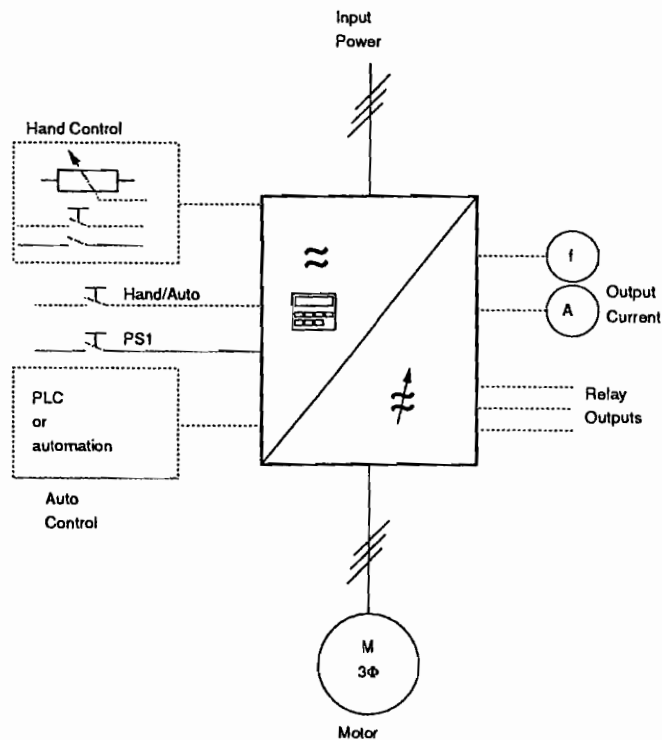
START/STOP and REVERSE commands and reference settings can be issued selectively from two different external control places, Ext1 and Ext2.

Control location selection is through digital input. Control is also possible with KEYPAD. One preset speed is available.

Two analog and three relay output contact signals are available on Terminal Block X50.

Operation Diagram

Figure 5-3 Operation Diagram



Input and Output Signals

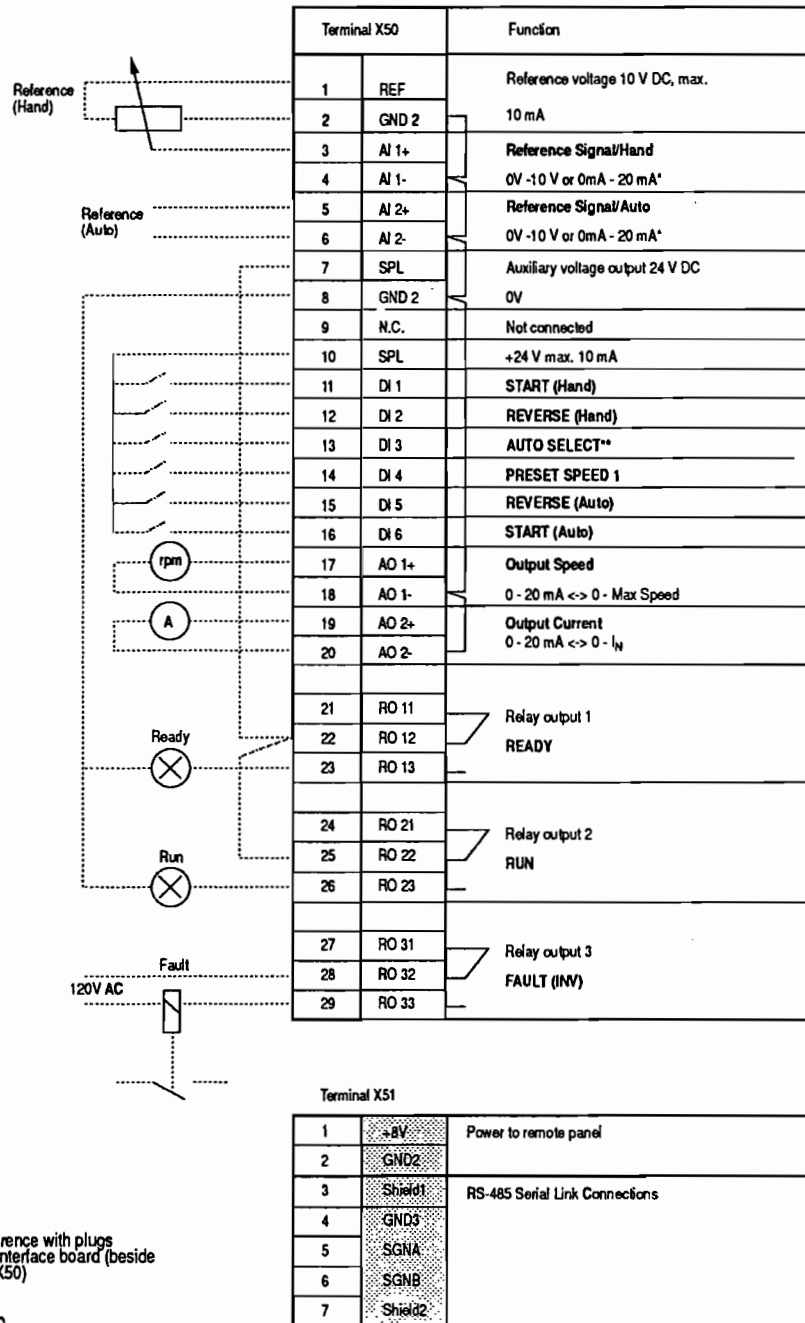
Table 5-3 Input and Output Signals

Input Signals	Output Signals
Two analog reference inputs, START/STOP and REVERSE-switch input for each control location. Control switch inputs for selection of the location and one preset speed.	Analog Output AO1: Output Frequency Analog Output AO2: Output Current Relay Output RO1: READY Relay Output RO2: RUN Relay Output RO3: FAULT (1)

Hand/Auto External Connections

Connection Example

Figure 5-4 Connection Example



Hand/Auto Parameter Settings

START-UP DATA

A LANGUAGE	→ ENGLISH
B APPLICATIONS	→ HAND/AUTO CTRL
C APPLIC. RESTORE	→ NO
D SUPPLY VOLTAGE	→ 480/230/380
E USER DISPLAY SCALE	→ 0
F MOTOR CURRENT -FLA	→ I_N of drive
G MOTOR POWER (KW)	→ P_N of drive
H MOTOR POWER FACTOR	→ 0.83
I MOTOR BASE FREQ.	→ 60
J MOTOR BASE R.P.M.	→ 1728
K MOTOR NOM. VOLTAGE	→ 460/230/380

OPERATING DATA

1 OUTPUT	
2 SPEED	
3 MOTOR CURRENT	
4 % RATED TORQUE	
5 % RATED POWER	
6 DC BUS VOLTAGE	
7 OUTPUT VOLTAGE	
8 DRIVE TEMPERATURE	
9 CONTROL LOCATION	→ EXTERNAL
10 KEYPAD REF 1	
11 KEYPAD PI (REF 2)	
12 EXT REF 1 OR 2	REF 1
13 EXTERNAL REF 1	
14 EXTERNAL REF 2	
15 RUN TIME	
16 KILOWATT HOURS	
17 LAST-RECD FAULT	
18 SECOND-RECD FAULT	
19 FIRST-RECD FAULT	
20 PARAMETER LOCK	OPEN

10 CONTROL CONNECTIONS

10.1 START/STOP/DIRECTION	
10.1.1 EXT 1 STRT/STP/DIR	DI1,2
10.1.2 EXT 2 STRT/STP/DIR	DI6,5
10.1.3 LOC/EXT DIRECTION	→ REQUEST

10.2 EX REFERENCE SELECT

10.2.1 EXT 1/EXT 2 SELECT	DI3
10.2.2 EXTERNAL REF1 SEL	AI1
10.2.3 EXT REF1 MINIMUM	0 Hz
10.2.4 EXT REF1 MAXIMUM	60 Hz
10.2.7 EXTERNAL REF2 SEL	AI2
10.2.8 EXT REF2 MINIMUM	0 Hz
10.2.9 EXT REF2 MAXIMUM	60 Hz

10.3 PRESET SPEEDS

10.3.1 PRESET SPEED SEL	DI4
10.3.2 PRESET SPEED 1	→ 5 Hz

10.4 SYSTEM CONTR INPUTS

10.4.1 RUN ENABLE	YES
10.4.2 FAULT RESET SELECT	NOT SEL
10.4.3 PARAM. LOCK SEL	OP DATA 20
10.4.4 EXTERNAL FAULT	NOT SEL

10.5 ANALOG INPUTS

10.5.1 MINIMUM AI1	→ 0 V/0 mA
10.5.2 MAXIMUM AI1	→ 10 V/20 mA
10.5.3 RC FILTER ON AI1	0.1s
10.5.4 INVERT AI1	NO
10.5.5 MINIMUM AI2	0 V/0 mA
10.5.6 MAXIMUM AI2	10 V/20 mA
10.5.7 RC FILTER ON AI2	0.1s
10.5.8 INVERT AI2	NO

10.6 RELAY OUTPUTS

10.6.1 RELAY RO1 OUTPUT	READY
10.6.2 RELAY RO2 OUTPUT	RUN
10.6.3 RELAY RO3 OUTPUT	FAULT (-1)

10.7 ANALOG OUTPUTS

10.7.1 ANALOG OUTPUT 1	MOT SPEED
10.7.2 SCALE AO1	100%
10.7.3 MINIMUM AO1	→ 0 mA
10.7.4 RC FILTER ON AO1	2s
10.7.5 INVERT AO1	NO
10.7.6 ANALOG OUTPUT 2	OUT CURR
10.7.7 SCALE AO2	100%
10.7.8 MINIMUM AO2	→ 0 mA
10.7.9 RC FILTER ON AO2	2s
10.7.10 INVERT AO2	NO

20 DRIVE PARAMETERS

20.1 FREQ/CURRENT LIMITS

20.1.1 MINIMUM FREQUENCY	→ 0 Hz
20.1.2 MAXIMUM FREQUENCY	→ 60 Hz
20.1.3 FREQUENCY RANGE	0 – 120 Hz
20.1.4 CURRENT LIMIT	→ $1.5 \times I_N$

20.2 START/STOP

20.2.1 START FUNCTION	RAMP
20.2.2 TORQUE BOOST CURR	$1.5 \times I_N$
20.2.3 STOP FUNCTION	COAST
20.2.4 BRAKE CHOPPER	NO
20.2.5 DC HOLD	OFF
20.2.6 DC HOLD VOLTAGE	$0.01 \times V_N$
20.2.7 DC BRAKE VOLTAGE	$0.01 \times V_N$
20.2.8 DC BRAKE TIME	0s

20.3 ACCEL/DECCEL

20.3.1 ACC/DEC 1 OR 2 SEL	NOT SEL
20.3.2 ACC/OEC RAMP SHAPE	LINEAR
20.3.3 ACCEL TIME 1	→ 3s
20.3.4 DECEL TIME 1	→ 3s
20.3.7 ACCEL REF2 TIME	→ 0.1s
20.3.8 DECEL REF2 TIME	→ 0.1s

20.4 MOTOR CONTROL

20.4.1 SWITCHING FREQ	3 kHz
20.4.2 MAX OUTPUT VOLTAGE	460 V
20.4.3 V/Hz RATIO	LINEAR
20.4.4 FIELD WEAK POINT	60 Hz
20.4.5 IR COMPENSATION	NO
20.4.6 IR COMP VOLTAGE	$0.01 \times V_N$
20.4.7 IR COMP RANGE	0 Hz
20.4.8 SLIP COMPENSATION	OFF
20.4.9 NOMINAL SLIP	4%
20.4.10 VOLTAGE LIMIT	ON

20.5 CRIT FREQUENCIES

20.5.1 CRIT FREQ SELECT	OFF
20.5.2 CRIT FREQ 1 LOW	0 Hz
20.5.3 CRIT FREQ 1 HIGH	0 Hz
20.5.4 CRIT FREQ 2 LOW	0 Hz
20.5.5 CRIT FREQ 2 HIGH	0 Hz
20.5.6 CRIT FREQ 3 LOW	0 Hz
20.5.7 CRIT FREQ 3 HIGH	0 Hz
20.5.8 CRIT FREQ 4 LOW	0 Hz
20.5.9 CRIT FREQ 4 HIGH	0 Hz
20.5.10 CRIT FREQ 5 LOW	0 Hz
20.5.11 CRIT FREQ 5 HIGH	0 Hz

30 PROTECTION/INFORMAT

30.1 FAULT FUNCTION

30.1.1 SERIAL FAULT FUNC	STOP
30.1.2 AI <MIN FUNCTION	NO
30.1.3 MOT TEMP FLT FUNC	→ FAULT
30.1.4 MOTOR THERM TIME	700s
30.1.5 MOTOR LOAD CURVE	100%
30.1.6 ZERO SPEED LOAD	40%
30.1.7 BREAK POINT	60 Hz
30.1.8 STALL FUNCTION	WARNING
30.1.9 STALL CURRENT	$1.2 \times I_N$
30.1.10 STALL TIME/FREQ	20s/25 Hz
30.1.11 UNDERLOAD FUNC	NO
30.1.12 UNDERLOAD TIME	600s
30.1.13 UNDERLOAD CURVE	1

30.2 AUTOMATIC RESET

30.2.1 NUMBER OF RESETS	2
30.2.2 TIME WINDOW	30s
30.2.3 TIME BETW. RES ATT	0
30.2.4 OVERVOLTAGE	NO
30.2.5 UNDERVOLTAGE	YES
30.2.6 OVERCURRENT	NO
30.2.7 AI SIGNAL <MIN	NO

30.3 SUPERVISION

30.3.1 OUTPUT FREQ 1 FUNC	NO
30.3.2 OUTPUT FREQ 1 LIM	0
30.3.3 OUTPUT FREQ 2 FUNC	NO
30.3.4 OUTPUT FREQ 2 LIM	0
30.3.5 CURRENT FUNCTION	NO
30.3.6 CURRENT LIMIT	$0 \times I_N$
30.3.7 REF1 FUNCTION	NO
30.3.8 REF1 LIMIT	0 Hz
30.3.9 REF2 FUNCTION	NO
30.3.10 REF2 LIMIT	0%
30.3.11 SUPERVIS MESSAGES	ON

30.4 INFORMATION

30.4.11 CRI PROG VERSION	(version)
30.4.2 MC PROG VERSION	(version)
30.4.3 TEST DATE	(date)

→ = Typical parameter values to check during start-up. If needed, change values to meet the needs of your application. Complete parameter list provided in Appendix A.

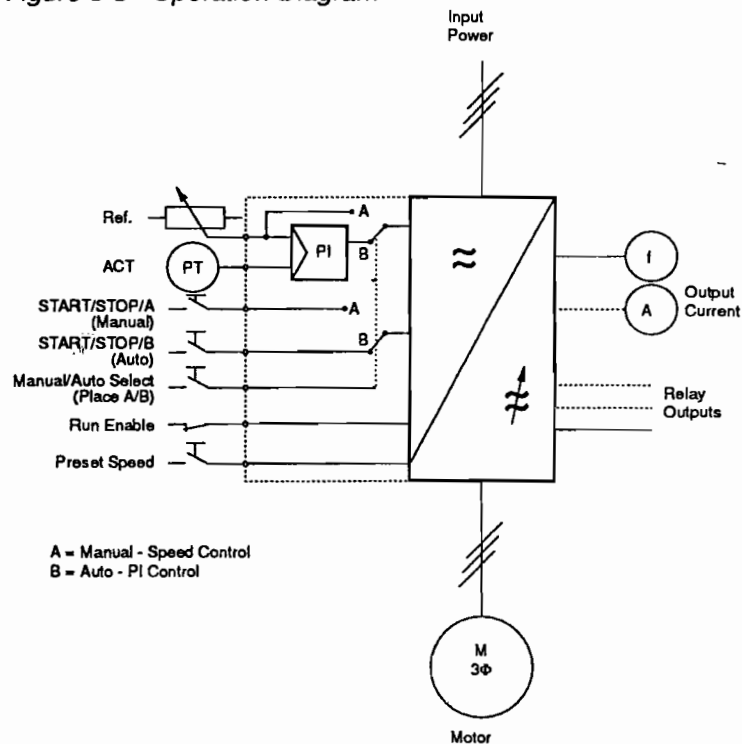
Application 3 – PI Control

Start/Stop from two different places, Control Location selection, Run Enable selection, one Preset Speed selection, Reference setting and actual value feedback through screw terminal inputs. Reference setting also possible internally with the keypad.

Place A is intended for direct speed setting with a reference signal and Place B is intended for closed-loop speed control using the same reference as Place A. Preset speed overrides external analog settings.

Operation Diagram

Figure 5-5 Operation Diagram



Input and Output Signals

Table 5-4 Input and Output Signals

Input Signals	Output Signals
Reference Value 0 – V DC Actual Value 4 – 20 mA	Analog Output AO1: Output Frequency Analog Output AO2: Output Current Relay Output RO1: READY Relay Output RO2: RUN Relay Output RO3: FAULT (-1)

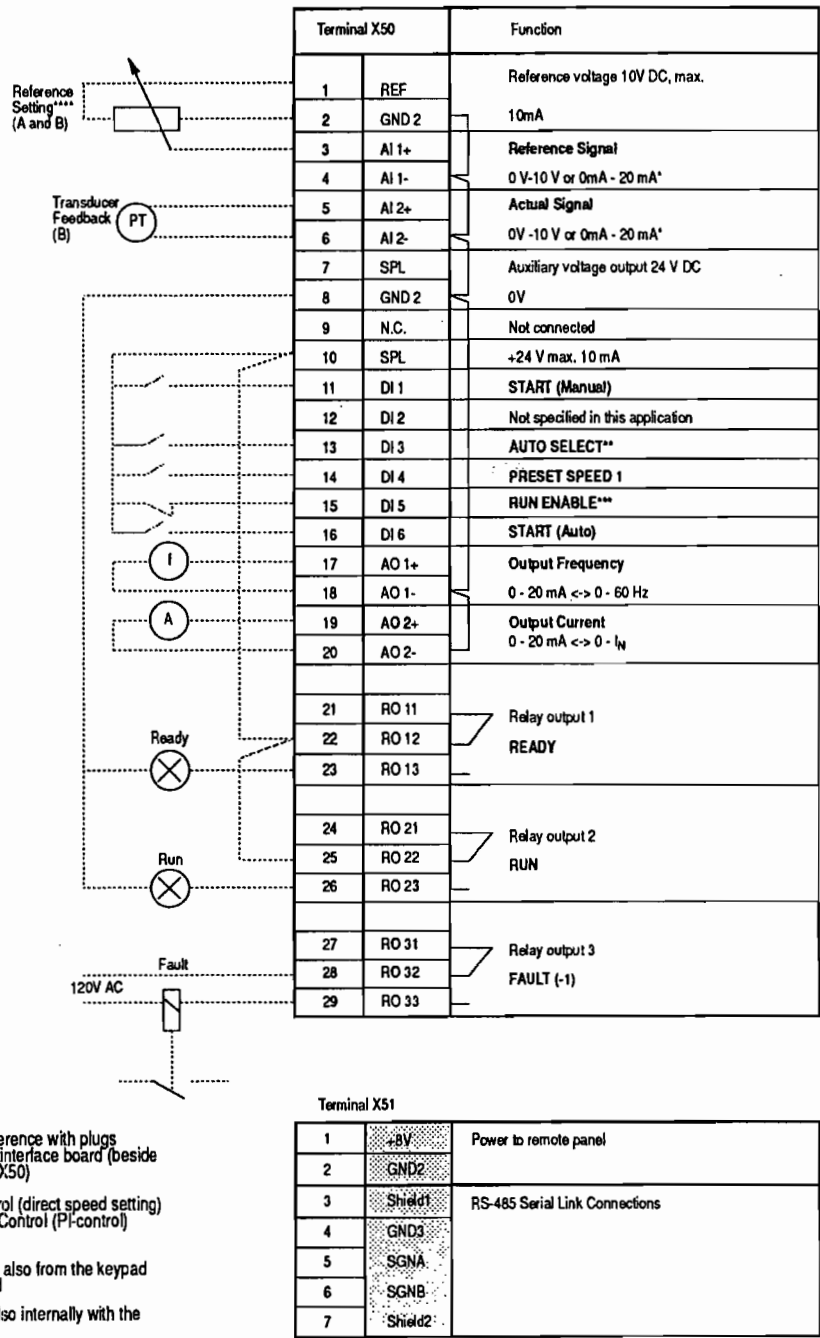
PI Control External Connections

Connection Example

Process Control = Auto

Direct Speed Control = Manual

Figure 5-6 Connection Example



PI Control Parameter Settings

START-UP DATA

A LANGUAGE	→ ENGLISH
B APPLICATIONS	→ PI-CONTROL
C APPLIC. RESTORE	→ NO
D SUPPLY VOLTAGE	→ 480/230/380
E USER DISPLAY SCALE	→ 0
F MOTOR CURRENT -FLA	→ I _N of drive
G MOTOR POWER (kW)	→ P _N of drive
H MOTOR POWER FACTOR	→ 0.83
I MOTOR BASE FREQ.	→ 60
J MOTOR BASE R.P.M.	→ 1728
K MOTOR NOM. VOLTAGE	→ 480/230/380

OPERATING DATA

1 OUTPUT	
2 SPEED	
3 MOTOR CURRENT	
4 % RATED TORQUE	
5 % RATED POWER	
6 DC BUS VOLTAGE	
7 OUTPUT VOLTAGE	
8 DRIVE TEMPERATURE	
9 CONTROL LOCATION	→ EXTERNAL
10 KEYPAD REF 1	
11 KEYPAD PI (REF 2)	
12 EXT REF 1 OR 2	REF 1
13 EXTERNAL REF 1	
14 EXTERNAL REF 2	
15 RUN TIME	
16 KILOWATT HOURS	
17 LAST-RECD FAULT	
18 SECOND-RECD FAULT	
19 FIRST-RECD FAULT	
20 PARAMETER LOCK	OPEN
21 APPL BLOCK OUTPUT	
22 ACTUAL VALUE 1	
23 ACTUAL VALUE 2	

10 CONTROL CONNECTIONS

10.1 START/STOP/DIRECTION	
10.1.1 EXT 1 STRT/STP/DIR	DI1
10.1.2 EXT 2 STRT/STP/DIR	DI6
10.2 EX REFERENCE SELECT	
10.2.1 EXT 1/EXT 2 SELECT	DI3
10.2.2 EXTERNAL REF1 SEL	AI1
10.2.3 EXT REF1 MINIMUM	0 Hz
10.2.4 EXT REF1 MAXIMUM	60 Hz
10.2.7 EXTERNAL REF2 SEL	AI1
10.3 PRESET SPEEDS	
10.3.1 PRESET SPEED SEL	DI4
10.3.2 PRESET SPEED 1	→ 5 Hz
10.4 SYSTEM CONTR INPUTS	
10.4.1 RUN ENABLE	DI5
10.4.2 FAULT RESET SELECT	NOT SEL
10.4.3 PARAM. LOCK SEL	OP DATA 20
10.4.4 EXTERNAL FAULT	NOT SEL

10.5 ANALOG INPUTS

10.5.1 MINIMUM AI1	→ 0 V/0 mA
10.5.2 MAXIMUM AI1	→ 10 V/20 mA
10.5.3 RC FILTER ON AI1	0.1s
10.5.4 INVERT AI1	NO
10.5.5 MINIMUM AI2	→ 0 V/0 mA
10.5.6 MAXIMUM AI2	→ 10 V/20 mA
10.5.7 RC FILTER ON AI2	0.1s
10.5.8 INVERT AI2	NO

10.6 RELAY OUTPUTS

10.6.1 RELAY RO1 OUTPUT	READY
10.6.2 RELAY RO2 OUTPUT	RUN
10.6.3 RELAY RO3 OUTPUT	FAULT (-1)

10.7 ANALOG OUTPUTS

10.7.1 ANALOG OUTPUT 1	OUT FREQ
10.7.2 SCALE AO1	100%
10.7.3 MINIMUM AO1	→ 0 mA
10.7.4 RC FILTER ON AO1	2s
10.7.5 INVERT AO1	NO
10.7.6 ANALOG OUTPUT 2	OUT CURR
10.7.7 SCALE AO2	100%
10.7.8 MINIMUM AO2	→ 0 mA
10.7.9 RC FILTER ON AO2	2s
10.7.10 INVERT AO2	NO

20 DRIVE PARAMETERS**20.1 FREQ/CURRENT LIMITS**

20.1.1 MINIMUM FREQUENCY	→ 0 Hz
20.1.2 MAXIMUM FREQUENCY	→ 60 Hz
20.1.3 FREQUENCY RANGE	0 – 120 Hz
20.1.4 CURRENT LIMIT	→ 1.5 x I _N

20.2 START/STOP

20.2.1 START FUNCTION	RAMP
20.2.2 TORQUE BOOST CURR	1.5 x I _N
20.2.3 STOP FUNCTION	COAST
20.2.4 BRAKE CHOPPER	NO
20.2.5 DC HOLD	OFF
20.2.6 DC HOLD VOLTAGE	0.01 x V _N
20.2.7 DC BRAKE VOLTAGE	0.01 x V _N
20.2.8 DC BRAKE TIME	0s

20.3 ACCEL/DECCEL

20.3.1 ACC/DEC 1 OR 2 SEL	NOT SEL
20.3.2 ACC/DEC RAMP SHAPE	LINEAR
20.3.3 ACCEL TIME 1	→ 1s
20.3.4 DECEL TIME 1	→ 1s
20.3.7 ACCEL REF2 TIME	→ 0.1s
20.3.8 DECEL REF2 TIME	→ 0.1s

20.4 MOTOR CONTROL

20.4.1 SWITCHING FREQ	3 kHz
20.4.2 MAX OUTPUT VOLTAGE	460 V
20.4.3 V/Hz RATIO	LINEAR
20.4.4 FIELD WEAK POINT	60 Hz
20.4.5 IR COMPENSATION	NO
20.4.6 IR COMP VOLTAGE	0.01 x V _N
20.4.7 IR COMP RANGE	0 Hz
20.4.8 SLIP COMPENSATION	OFF
20.4.9 NOMINAL SLIP	4%
20.4.10 VOLTAGE LIMIT	ON

20.5 CRIT FREQUENCIES*

20.5.1 CRIT FREQ SELECT	OFF
20.5.2 CRIT FREQ 1 LOW	0 Hz
20.5.3 CRIT FREQ 1 HIGH	0 Hz
20.5.4 CRIT FREQ 2 LOW	0 Hz
20.5.5 CRIT FREQ 2 HIGH	0 Hz
20.5.6 CRIT FREQ 3 LOW	0 Hz
20.5.7 CRIT FREQ 3 HIGH	0 Hz
20.5.8 CRIT FREQ 4 LOW	0 Hz
20.5.9 CRIT FREQ 4 HIGH	0 Hz
20.5.10 CRIT FREQ 5 LOW	0 Hz
20.5.11 CRIT FREQ 5 HIGH	0 Hz

30 PROTECTION/INFORMAT**30.1 FAULT FUNCTION**

30.1.1 SERIAL FAULT FUNC	STOP
30.1.2 AI <MIN FUNCTION	FAULT
30.1.3 MOT TEMP FLT FUNC	→ FAULT
30.1.4 MOTOR THERM TIME	700s
30.1.5 MOTOR LOAD CURVE	100%
30.1.6 ZERO SPEED LOAD	40%
30.1.7 BREAK POINT	60 Hz
30.1.8 STALL FUNCTION	WARNING
30.1.9 STALL CURRENT	1.2 x I _N
30.1.10 STALL TIME/FREQ	20s/25 Hz
30.1.11 UNDERLOAD FUNC	NO
30.1.12 UNDERLOAD TIME	600s
30.1.13 UNDERLOAD CURVE	1

30.2 AUTOMATIC RESET

30.2.1 NUMBER OF RESETS	2
30.2.2 TIME WINDOW	30s
30.2.3 TIME BETW. RES ATT	0
30.2.4 OVERVOLTAGE	NO
30.2.5 UNDERVOLTAGE	YES
30.2.6 OVERCURRENT	NO
30.2.7 AI SIGNAL <MIN	→ NO

30.3 SUPERVISION

30.3.1 OUTPUT FREQ 1 FUNC	NO
30.3.2 OUTPUT FREQ 1 LIM	0
30.3.3 OUTPUT FREQ 2 FUNC	NO
30.3.4 OUTPUT FREQ 2 LIM	0
30.3.5 CURRENT FUNCTION	NO
30.3.6 CURRENT LIMIT	0 x I _N
30.3.7 REF1 FUNCTION	NO
30.3.8 REF1 LIMIT	0 Hz
30.3.9 REF2 FUNCTION	NO
30.3.10 REF2 LIMIT	0%
30.3.11 SUPERVIS MESSAGES	ON

30.4 INFORMATION

30.4.11 CRI PROG VERSION	(version)
30.4.2 MC PROG VERSION	(version)
30.4.3 TEST DATE	(date)

40 APPLICATION PARAMETERS**40.1 PI-CONTROL**

40.1.1 PI-CONT GAIN	100%
40.1.2 PI-CONT I-TIME	60s
40.1.3 PI-CONT MIN LIMIT	25 Hz
40.1.4 PI-CONT MAX LIMIT	60 Hz
40.1.5 ERROR VALUE INVERT	NO
40.1.6 ACTUAL VALUE SEL	ACT 1
40.1.7 ACTUAL 1 INPUT	AI2
40.1.8 ACTUAL 2 INPUT	NO
40.1.9 ACT 1 MIN SCALE	0
40.1.10 ACT 1 MAX SCALE	100
40.1.11 ACT 2 MIN SCALE	0
40.1.12 ACT 2 MAX SCALE	0

→ = Typical parameter values to check during start-up. If needed, change values to meet needs of your application. Complete parameter list in Appendix A.

* - See Critical Frequencies in Chapter 6.

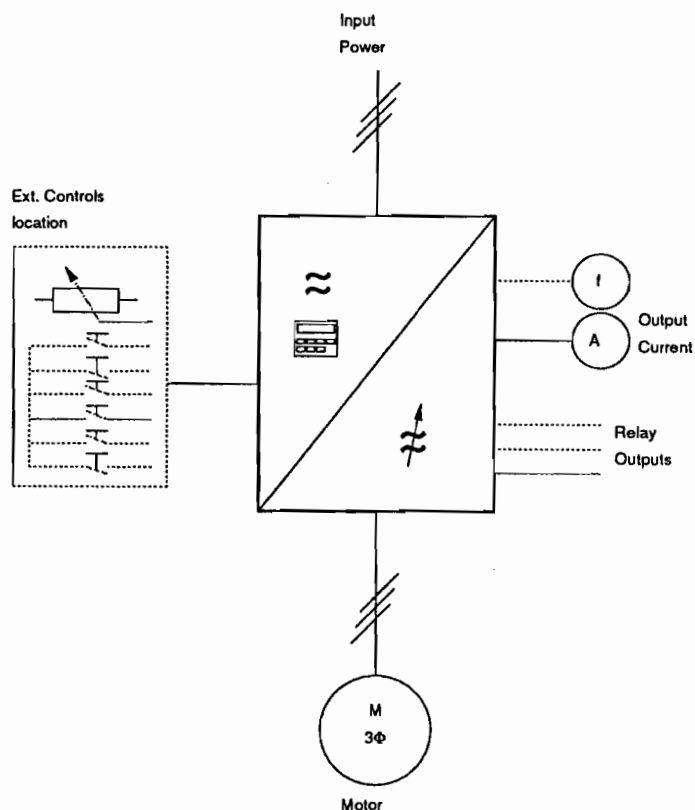
Application 4 – Opt. Pack

This macro configures the terminals on X50 to interface with the Option Pack on the ACS 500, and with the extended terminal board supplied with the ACS 502 with Bypass or Hand/Off/Auto options. Refer to the appropriate option manual (ACS501-08 or ACS502-04) supplied with the drive for complete connection details.

Two analog and three relay contact output signals available through Terminal Block X50.

Operation Diagram

Figure 5-7 Operation Diagram



Input and Output Signals

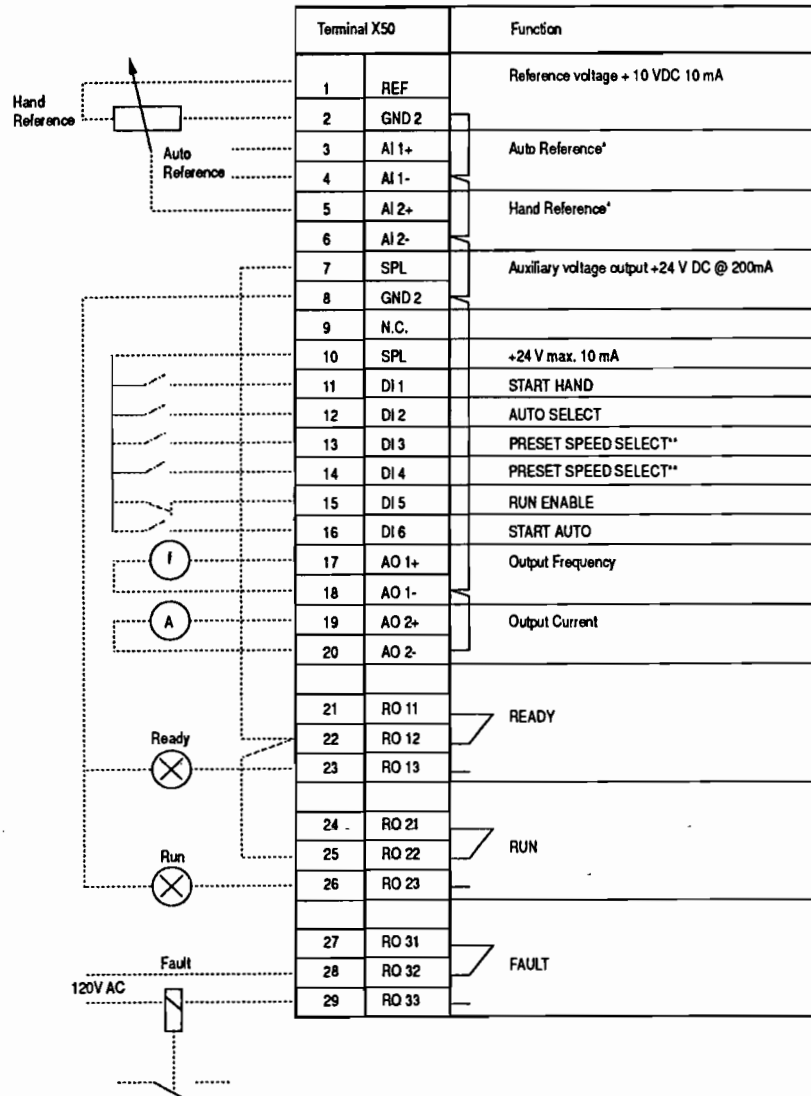
Table 5-5 Input and Output Signals

Input Signals	Output Signals
Two Analog Reference inputs. Six Digital Inputs: Start Hand, Start Auto, Preset Speed (2), Auto Select, and Run Enable.	Analog Output AO1: Output Frequency Analog Output AO2: Output Current Relay Output RO1: READY Relay Output RO2: RUN Relay Output RO3: FAULT

Opt. Pack External Connections

Connection Example

Figure 5-8 Connection Example



* Select voltage or current reference with plugs S1 and S2 on the customer interface board (beside the screw terminals 1-6 of X50).

** Operation:

D15	D16	Output
0	0	set freq. through AI1
1	0	Preset Speed 1
0	1	Preset Speed 2
1	1	Preset Speed 3

0 = Open
1 = Closed

Terminal X51

Terminal X51	Function
1	+8V
2	GND2
3	Shield1
4	GND3
5	SGNA
6	SGNB
7	Shield2

Opt. Pack Parameter Settings

START-UP DATA

A LANGUAGE	→ ENGLISH
B APPLICATIONS	→ OPT. PACK
C APPLIC. RESTORE	→ NO
D SUPPLY VOLTAGE	→ 480/230/380
E USER DISPLAY SCALE	→ 0
F MOTOR CURRENT -FLA	→ I_N of drive
G MOTOR POWER (KW)	→ P_N of drive
H MOTOR POWER FACTOR	→ 0.83
I MOTOR BASE FREQ.	→ 60
J MOTOR BASE R.P.M.	→ 1728
K MOTOR NOM. VOLTAGE	→ 460/230/380

OPERATING DATA

1 OUTPUT	
2 SPEED	
3 MOTOR CURRENT	
4 % RATED TORQUE	
5 % RATED POWER	
6 DC BUS VOLTAGE	
7 OUTPUT VOLTAGE	
8 DRIVE TEMPERATURE	
9 CONTROL LOCATION	→ EXTERNAL
10 KEYPAD REF 1	
11 KEYPAD P1 (REF 2)	
12 EXT REF 1 OR 2	REF 1
13 EXTERNAL REF 1	
14 EXTERNAL REF 2	
15 RUN TIME	
16 KILOWATT HOURS	
17 LAST-RECD FAULT	
18 SECOND-RECD FAULT	
19 FIRST-RECD FAULT	
20 PARAMETER LOCK	OPEN

10 CONTROL CONNECTIONS

10.1 START/STOP/DIRECTION	
10.1.1 EXT 1 STRT/STP/DIR	DI1
10.1.2 EXT 2 STRT/STP/DIR	DI6
10.2 EX REFERENCE SELECT	
10.2.1 EXT 1/EXT 2 SELECT	DI2
10.2.2 EXTERNAL REF1 SEL	AI2
10.2.3 EXT REF1 MINIMUM	0 Hz
10.2.4 EXT REF1 MAXIMUM	60 Hz
10.2.7 EXTERNAL REF2 SEL	AI1
10.2.8 EXT REF2 MINIMUM	0 Hz
10.2.9 EXT REF2 MAXIMUM	60 Hz
10.3 PRESET SPEEDS	
10.3.1 PRESET SPEED SEL	DI3,4
10.3.2 PRESET SPEED 1	→ 5 Hz
10.3.3 PRESET SPEED 2	→ 10 Hz
10.3.4 PRESET SPEED 3	→ 15 Hz
10.4 SYSTEM CONTR INPUTS	
10.4.1 RUN ENABLE	DI5
10.4.2 FAULT RESET SELECT	NOT SEL
10.4.3 PARAM. LOCK SEL	OP DATA 20
10.4.4 EXTERNAL FAULT	NOT SEL

10.5 ANALOG INPUTS

10.5.1 MINIMUM AI1	→ 0 V/0 mA
10.5.2 MAXIMUM AI1	→ 10 V/20 mA
10.5.3 RC FILTER ON AI1	0.1s
10.5.4 INVERT AI1	NO
10.5.5 MINIMUM AI2	0 V/0 mA
10.5.6 MAXIMUM AI2	10 V/20 mA
10.5.7 RC FILTER ON AI2	0.1s
10.5.8 INVERT AI2	NO

10.6 RELAY OUTPUTS

10.6.1 RELAY RO1 OUTPUT	READY
10.6.2 RELAY RO2 OUTPUT	RUN
10.6.3 RELAY RO3 OUTPUT	FAULT

10.7 ANALOG OUTPUTS

10.7.1 ANALOG OUTPUT 1	OUT FREQ
10.7.2 SCALE AO1	100%
10.7.3 MINIMUM AO1	→ 0 mA
10.7.4 RC FILTER ON AO1	2s
10.7.5 INVERT AO1	NO
10.7.6 ANALOG OUTPUT 2	OUT CURR
10.7.7 SCALE AO2	100%
10.7.8 MINIMUM AO2	→ 0 mA
10.7.9 RC FILTER ON AO2	2s
10.7.10 INVERT AO2	NO

20 DRIVE PARAMETERS**20.1 FREQ/CURRENT LIMITS**

20.1.1 MINIMUM FREQUENCY	→ 0 Hz
20.1.2 MAXIMUM FREQUENCY	→ 60 Hz
20.1.3 FREQUENCY RANGE	0 – 120 Hz
20.1.4 CURRENT LIMIT	→ $1.5 \times I_N$

20.2 START/STOP

20.2.1 START FUNCTION	FLYING
20.2.2 TORQUE BOOST CURR	$1.5 \times I_N$
20.2.3 STOP FUNCTION	COAST
20.2.4 BRAKE CHOPPER	NO
20.2.5 DC HOLD	OFF
20.2.6 DC HOLD VOLTAGE	$0.01 \times V_N$
20.2.7 DC BRAKE VOLTAGE	$0.01 \times V_N$
20.2.8 DC BRAKE TIME	0s

20.3 ACCEL/DECEL

20.3.1 ACC/DEC 1 OR 2 SEL	NOT SEL
20.3.2 ACC/DEC RAMP SHAPE	LINEAR
20.3.3 ACCEL TIME 1	→ 30s
20.3.4 DECEL TIME 1	→ 30s
20.3.5 ACCEL TIME 2	60s
20.3.6 DECEL TIME 2	60s
20.3.7 ACCEL REF2 TIME	0.1s
20.3.8 DECEL REF2 TIME	0.1s

20.4 MOTOR CONTROL

20.4.1 SWITCHING FREQ	3 kHz
20.4.2 MAX OUTPUT VOLTAGE	460 V
20.4.3 V/Hz RATIO	→ SQUARED
20.4.4 FIELD WEAK POINT	60 Hz
20.4.5 IR COMPENSATION	NO
20.4.6 IR COMP VOLTAGE	$0.01 \times V_N$
20.4.7 IR COMP RANGE	0 Hz
20.4.8 SLIP COMPENSATION	OFF
20.4.9 NOMINAL SLIP	4%
20.4.10 VOLTAGE LIMIT	ON

20.5 CRIT FREQUENCIES

20.5.1 CRIT FREQ SELECT	OFF
20.5.2 CRIT FREQ 1 LOW	0 Hz
20.5.3 CRIT FREQ 1 HIGH	0 Hz
20.5.4 CRIT FREQ 2 LOW	0 Hz
20.5.5 CRIT FREQ 2 HIGH	0 Hz
20.5.6 CRIT FREQ 3 LOW	0 Hz
20.5.7 CRIT FREQ 3 HIGH	0 Hz
20.5.8 CRIT FREQ 4 LOW	0 Hz
20.5.9 CRIT FREQ 4 HIGH	0 Hz
20.5.10 CRIT FREQ 5 LOW	0 Hz
20.5.11 CRIT FREQ 5 HIGH	0 Hz

30 PROTECTION/INFORMAT**30.1 FAULT FUNCTION**

30.1.1 SERIAL FAULT FUNC	STOP
30.1.2 AI <MIN FUNCTION	NO
30.1.3 MOT TEMP FLT FUNC	→ FAULT
30.1.4 MOTOR THERM TIME	700s
30.1.5 MOTOR LOAD CURVE	100%
30.1.6 ZERO SPEED LOAD	40%
30.1.7 BREAK POINT	60 Hz
30.1.8 STALL FUNCTION	WARNING
30.1.9 STALL CURRENT	$1.5 \times I_N$
30.1.10 STALL TIME/FREQ	20s/25 Hz
30.1.11 UNDERLOAD FUNC	NO
30.1.12 UNDERLOAD TIME	600s
30.1.13 UNDERLOAD CURVE	1

30.2 AUTOMATIC RESET

30.2.1 NUMBER OF RESETS	5
30.2.2 TIME WINDOW	30s
30.2.3 TIME BETW. RES ATT	0
30.2.4 OVERVOLTAGE	→ NO
30.2.5 UNDERVOLTAGE	YES
30.2.6 OVERCURRENT	→ NO
30.2.7 AI SIGNAL <MIN	NO

30.3 SUPERVISION

30.3.1 OUTPUT FREQ 1 FUNC	→ NO
30.3.2 OUTPUT FREQ 1 LIM	→ 0
30.3.3 OUTPUT FREQ 2 FUNC	NO
30.3.4 OUTPUT FREQ 2 LIM	0
30.3.5 CURRENT FUNCTION	NO
30.3.6 CURRENT LIMIT	$0 \times I_N$
30.3.7 REF1 FUNCTION	NO
30.3.8 REF1 LIMIT	0 Hz
30.3.9 REF2 FUNCTION	NO
30.3.10 REF2 LIMIT	0%
30.3.11 SUPERVIS MESSAGES	ON

30.4 INFORMATION

30.4.11 CRI PROG VERSION	(version)
30.4.2 MC PROG VERSION	(version)
30.4.3 TEST DATE	(date)

→ = Typical parameter values to check during start-up. If needed, change values to meet the needs of your application. Complete parameter list provided in Appendix A.

**Application 5 –
Seq Ctrl**

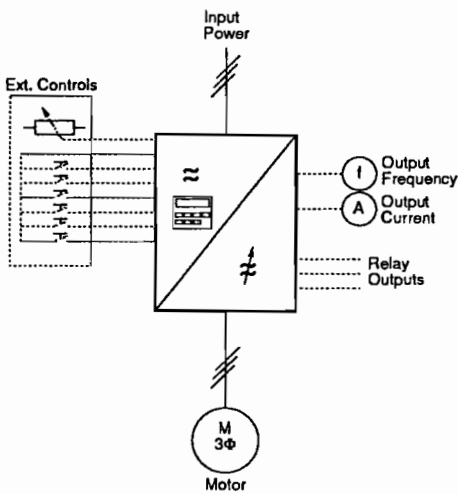
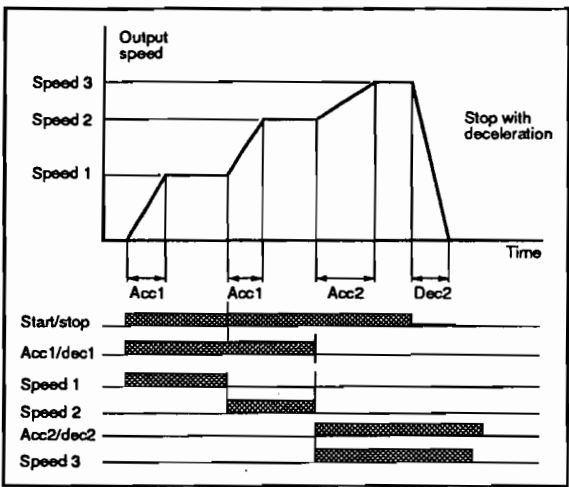
Start/Stop, Direction, Selection of 7 preset speeds, and Acc/Dec 1 or 2 selection commands and analog reference setting through screw terminals.

Control location selection and local control possible with the Keypad.

Two analog and three relay contact output signals available through Terminal Block X50.

Operation Diagram

Figure 5-9 Operation Diagram



**Input and Output
Signals**

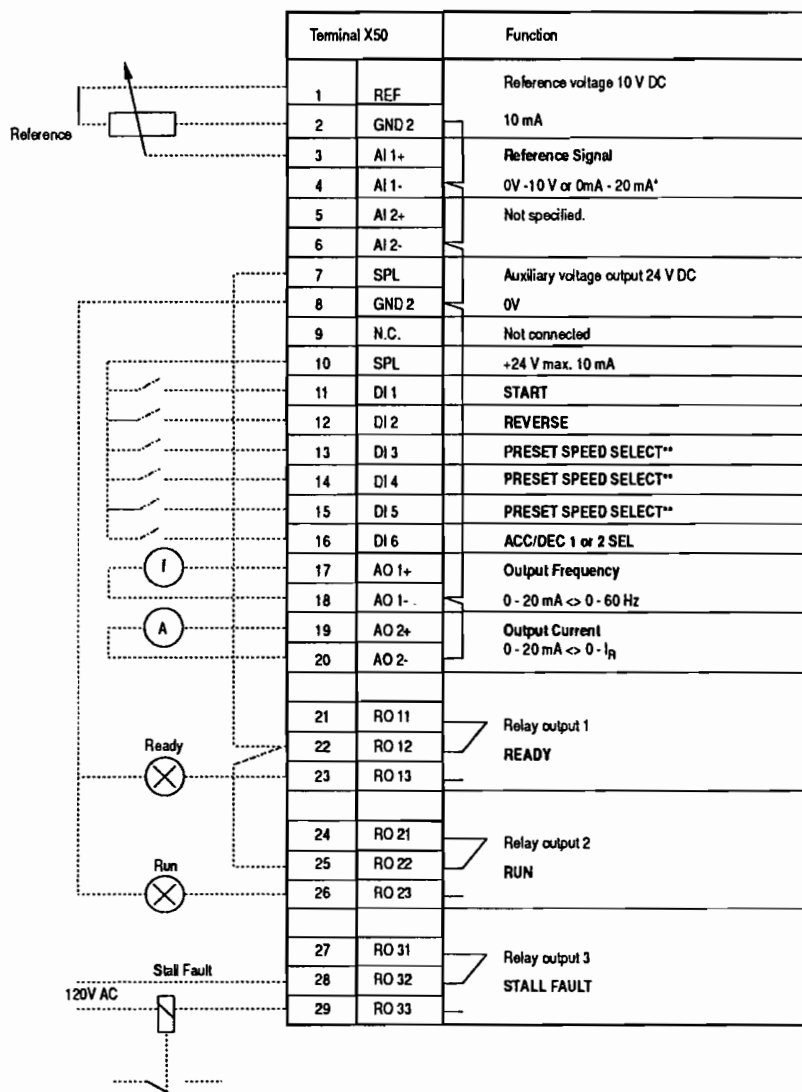
Table 5-6 Input and Output Signals

Input Signals	Output Signals
One Analog Reference input, Start/Stop switch, Direction switch, three switches for Preset Speed selection, and one input for selection of Acc/Dec 1 or Acc/Dec 2 time.	Analog Output AO1: Output Frequency Analog Output AO2: Output Current Relay Output RO1: READY Relay Output RO2: RUN Relay Output RO3: STALL FAULT

Seq Ctrl External Connections

Connection Example

Figure 5-10 Connection Example



* Select voltage or current reference with plugs S1 and S2 on the customer interface board (beside the screw terminals 1-6 of X50).

** Operation:

	D13	D14	D14	Output
	0	0	0	set freq. through AI1
	1	0	0	Preset Speed 1
	0	1	0	Preset Speed 2
	1	1	0	Preset Speed 3
	0	0	1	Preset Speed 4
	1	0	1	Preset Speed 5
	0	1	1	Preset Speed 6
	1	1	1	Preset Speed 7

0 = Open
1 = Closed

Terminal X51

1	+8V	Power to remote panel
2	GND2	
3	Shield1	RS-485 Serial Link Connections
4	GND3	
5	SGNA	
6	SGNB	
7	Shield2	

Seq Ctrl Parameter Settings

START-UP DATA

A LANGUAGE	→ ENGLISH
B APPLICATIONS	→ SEQ CTRL
C APPLIC. RESTORE	→ NO
D SUPPLY VOLTAGE	→ 480/230/380
E USER DISPLAY SCALE	→ 0
F MOTOR CURRENT -FLA	→ I_N of drive
G MOTOR POWER (KW)	→ P_N of drive
H MOTOR POWER FACTOR	→ 0.83
I MOTOR BASE FREQ.	→ 60
J MOTOR BASE R.P.M.	→ 1728
K MOTOR NOM. VOLTAGE	→ 460/230/380

OPERATING DATA

1 OUTPUT	
2 SPEED	
3 MOTOR CURRENT	
4 % RATED TORQUE	
5 % RATED POWER	
6 DC BUS VOLTAGE	
7 OUTPUT VOLTAGE	
8 DRIVE TEMPERATURE	
9 CONTROL LOCATION	→ EXTERNAL
10 KEYPAD REF 1	
11 KEYPAD PI (REF 2)	
12 EXT REF 1 OR 2	REF 1
13 EXTERNAL REF 1	
14 EXTERNAL REF 2	
15 RUN TIME	
16 KILOWATT HOURS	
17 LAST-RECD FAULT	
18 SECOND-RECD FAULT	
19 FIRST-RECD FAULT	
20 PARAMETER LOCK	OPEN

10 CONTROL CONNECTIONS

10.1 START/STOP/DIRECTION	
10.1.1 EXT 1 STRT/STP/DIR	DI1,2
10.1.2 EXT 2 STRT/STP/DIR	NOT SEL
10.1.3 LOC/EXT DIRECTION	→ REQUEST
10.2 EX REFERENCE SELECT	
10.2.1 EXT 1/EXT 2 SELECT	OP DATA 12
10.2.2 EXTERNAL REF1 SEL	AI1
10.2.3 EXT REF1 MINIMUM	0 Hz
10.2.4 EXT REF1 MAXIMUM	60 Hz
10.2.7 EXTERNAL REF2 SEL	OP DATA 14
10.2.8 EXT REF2 MINIMUM	0 Hz
10.2.9 EXT REF2 MAXIMUM	60 Hz
10.3 PRESET SPEEDS	
10.3.1 PRESET SPEED SEL	DI3,4,5
10.3.2 PRESET SPEED 1	→ 5 Hz
10.3.3 PRESET SPEED 2	→ 25 Hz
10.3.4 PRESET SPEED 3	→ 50 Hz
10.3.4 PRESET SPEED 4	→ 20 Hz
10.3.4 PRESET SPEED 5	→ 25 Hz
10.3.4 PRESET SPEED 6	→ 40 Hz
10.3.4 PRESET SPEED 7	→ 50 Hz
10.4 SYSTEM CONTR INPUTS	
10.4.1 RUN ENABLE	YES
10.4.2 FAULT RESET SELECT	NOT SEL
10.4.3 PARAM. LOCK SEL	OP DATA 20
10.4.4 EXTERNAL FAULT	NOT SEL

10.5 ANALOG INPUTS

10.5.1 MINIMUM AI1	→ 0 V/0 mA
10.5.2 MAXIMUM AI1	→ 10 V/20 mA
10.5.3 RC FILTER ON AI1	0.1s
10.5.4 INVERT AI1	NO
10.5.5 MINIMUM AI2	0 V/0 mA
10.5.6 MAXIMUM AI2	10 V/20 mA
10.5.7 RC FILTER ON AI2	0.1s
10.5.8 INVERT AI2	NO

10.6 RELAY OUTPUTS

10.6.1 RELAY RO1 OUTPUT	READY
10.6.2 RELAY RO2 OUTPUT	RUN
10.6.3 RELAY RO3 OUTPUT	STALL FAULT

10.7 ANALOG OUTPUTS

10.7.1 ANALOG OUTPUT 1	OUT FREQ
10.7.2 SCALE AO1	100%
10.7.3 MINIMUM AO1	→ 0 mA
10.7.4 RC FILTER ON AO1	2s
10.7.5 INVERT AO1	NO
10.7.6 ANALOG OUTPUT 2	OUT CURR
10.7.7 SCALE AO2	100%
10.7.8 MINIMUM AO2	→ 0 mA
10.7.9 RC FILTER ON AO2	2s
10.7.10 INVERT AO2	NO

20 DRIVE PARAMETERS

20.1 FREQ/CURRENT LIMITS

20.1.1 MINIMUM FREQUENCY	→ 0 Hz
20.1.2 MAXIMUM FREQUENCY	→ 60 Hz
20.1.3 FREQUENCY RANGE	0 – 120 Hz
20.1.4 CURRENT LIMIT	→ $1.5 \times I_N$

20.2 START/STOP

20.2.1 START FUNCTION	RAMP
20.2.2 TORQUE BOOST CURR	$1.5 \times I_N$
20.2.3 STOP FUNCTION	RAMP
20.2.4 BRAKE CHOPPER	NO
20.2.5 DC HOLD	ON
20.2.6 DC HOLD VOLTAGE	$0.01 \times V_N$
20.2.7 DC BRAKE VOLTAGE	$0.01 \times V_N$
20.2.8 DC BRAKE TIME	2s

20.3 ACCEL/DECCEL

20.3.1 ACC/DEC 1 OR 2 SEL	DI6
20.3.2 ACC/DEC RAMP SHAPE	LINEAR
20.3.3 ACCEL TIME 1	→ 3s
20.3.4 DECEL TIME 1	→ 3s
20.3.5 ACCEL TIME 2	10s
20.3.6 DECEL TIME 2	10s

20.4 MOTOR CONTROL

20.4.1 SWITCHING FREQ	3 kHz
20.4.2 MAX OUTPUT VOLTAGE	460 V
20.4.3 V/Hz RATIO	LINEAR
20.4.4 FIELD WEAK POINT	60 Hz
20.4.5 IR COMPENSATION	NO
20.4.6 IR COMP VOLTAGE	$0.01 \times V_N$
20.4.7 IR COMP RANGE	0 Hz
20.4.8 SLIP COMPENSATION	OFF
20.4.9 NOMINAL SLIP	4%
20.4.10 VOLTAGE LIMIT	ON

20.5 CRIT FREQUENCIES

20.5.1 CRIT FREQ SELECT	OFF
20.5.2 CRIT FREQ 1 LOW	0 Hz
20.5.3 CRIT FREQ 1 HIGH	0 Hz
20.5.4 CRIT FREQ 2 LOW	0 Hz
20.5.5 CRIT FREQ 2 HIGH	0 Hz
20.5.6 CRIT FREQ 3 LOW	0 Hz
20.5.7 CRIT FREQ 3 HIGH	0 Hz
20.5.8 CRIT FREQ 4 LOW	0 Hz
20.5.9 CRIT FREQ 4 HIGH	0 Hz
20.5.10 CRIT FREQ 5 LOW	0 Hz
20.5.11 CRIT FREQ 5 HIGH	0 Hz

30 PROTECTION/INFORMAT

30.1 FAULT FUNCTION

30.1.1 SERIAL FAULT FUNC	STOP
30.1.2 AI <MIN FUNCTION	NO
30.1.3 MOT TEMP FLT FUNC	→ FAULT
30.1.4 MOTOR THERM TIME	700s
30.1.5 MOTOR LOAD CURVE	100%
30.1.6 ZERO SPEED LOAD	40%
30.1.7 BREAK POINT	60 Hz
30.1.8 STALL FUNCTION	WARNING
30.1.9 STALL CURRENT	$1.2 \times I_N$
30.1.10 STALL TIME/FREQ	20s/25 Hz
30.1.11 UNDERLOAD FUNC	NO
30.1.12 UNDERLOAD TIME	600s
30.1.13 UNDERLOAD CURVE	1

30.2 AUTOMATIC RESET

30.2.1 NUMBER OF RESETS	2
30.2.2 TIME WINDOW	30s
30.2.3 TIME BETW. RES ATT	0
30.2.4 OVERVOLTAGE	NO
30.2.5 UNDERVOLTAGE	YES
30.2.6 OVERCURRENT	NO
30.2.7 AI SIGNAL <MIN	NO

30.3 SUPERVISION

30.3.1 OUTPUT FREQ 1 FUNC	NO
30.3.2 OUTPUT FREQ 1 LIM	0
30.3.3 OUTPUT FREQ 2 FUNC	NO
30.3.4 OUTPUT FREQ 2 LIM	0
30.3.5 CURRENT FUNCTION	NO
30.3.6 CURRENT LIMIT	$0 \times I_N$
30.3.7 REF1 FUNCTION	NO
30.3.8 REF1 LIMIT	0 Hz
30.3.9 REF2 FUNCTION	NO
30.3.10 REF2 LIMIT	0%
30.3.11 SUPERVIS MESSAGES	ON

30.4 INFORMATION

30.4.11 CRI PROG VERSION	(version)
30.4.2 MC PROG VERSION	(version)
30.4.3 TEST DATE	(date)

→ = Typical parameter values to check during start-up. If needed, change values to meet needs of your application. Complete parameter list in Appendix A.

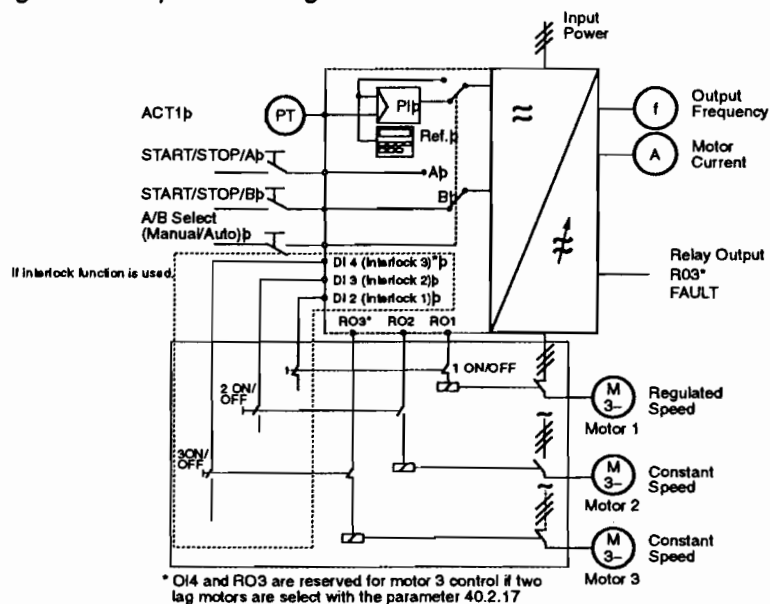
Application 6 – Pump and Fan

The main application areas of Pump and Fan Control (PFC) are pumping and ventilation systems where speed regulation of a drive motor and automatic start/stop of a maximum of three constant speed motors are beneficial. PFC can easily be connected to a custom made automatic motor alternation system for controlled changing of drive motors. In this way, all the motors run equal duty times. This Application macro allows you to choose between manual and automatic control. A reference (setpoint) value can be given either internally through a LCD panel or externally through screw terminals. A maximum of two actual values can be connected through the screw terminals. Actual values can perform different mathematical operations (addition, subtraction, multiplication, minimum, maximum, and square root) to get a correct final actual value for the PI-controller.

The PI-controller can also be bypassed and actual value used as the speed reference.

Operation Diagram

Figure 5-11 Operation Diagram



Input and Output Signals

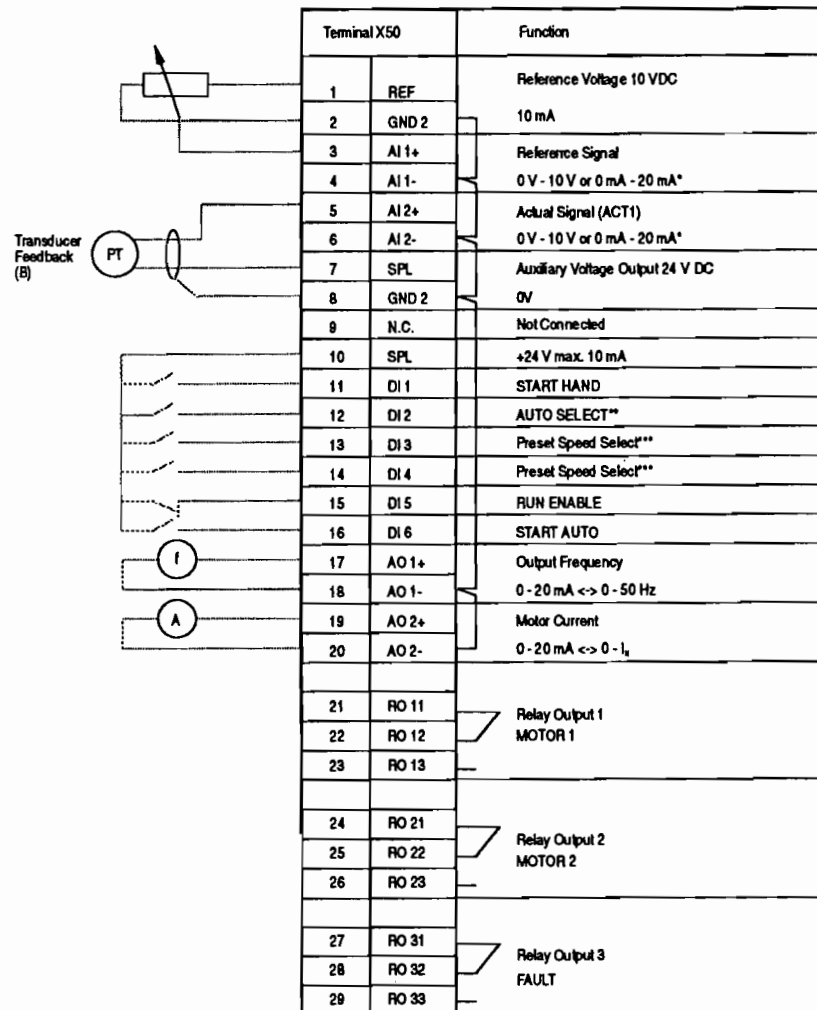
Table 5-7 Input and Output Signals

Input Signals	Output Signals
Actual value 4 – 20 mA	Analog Output AO1: Output Frequency Analog Output AO2: Motor Current Relay Output RO1: First Motor Control Relay Output RO2: Second Motor Control Relay Output RO3: FAULT

Pump and Fan External Connections

Connection Example

Figure 5-12 Connection Example



* Select voltage or current reference with plugs S1 and S2 on the customer interface board (beside the screw terminals 1-6 of X50).

** Open switch = Manual (direct speed setting)
Closed switch (+24V) = Automatic (PFC)

*** Operation:

	D13	D14	Output
0 = Open	0	0	set freq. through AI1
1 = Closed	1	0	Preset Speed 1
	0	1	Preset Speed 2
	1	1	Preset Speed 3

Terminal X51

Terminal	Terminal X51	Function
1	+5V	Power to Remote Panel
2	GND2	
3	Shield1	RS485 Serial Link Connections
4	GND3	
5	SDMA	
6	SDNB	
7	Shield2	

Pump and Fan Parameter Settings

START-UP DATA

A LANGUAGE	→ ENGLISH
B APPLICATIONS	→ P&F AUTOM.
C APPLIC. RESTORE	→ NO
D SUPPLY VOLTAGE	→ 480/230/380
E USER DISPLAY SCALE	→ 0
F MOTOR CURRENT -FLA	→ I _N of drive
G MOTOR POWER (KW)	→ P _N of drive
H MOTOR POWER FACTOR	→ 0.83
I MOTOR BASE FREQ.	→ 60
J MOTOR BASE R.P.M.	→ 1728
K MOTOR NOM. VOLTAGE	→ 460/230/380

OPERATING DATA

1 OUTPUT	
2 SPEED	
3 MOTOR CURRENT	
4 % RATED TORQUE	
5 % RATED POWER	
6 DC BUS VOLTAGE	
7 OUTPUT VOLTAGE	
8 DRIVE TEMPERATURE	
9 CONTROL LOCATION	EXTERNAL
10 KEYPAD REF 1	
11 KEYPAD PI (REF 2)	
12 EXT REF 1 OR 2	REF 1
13 EXTERNAL REF 1	
14 EXTERNAL REF 2	
15 RUN TIME	
16 KILOWATT HOURS	
17 LAST-RECD FAULT	
18 SECOND-RECD FAULT	
19 FIRST-RECD FAULT	
20 PARAMETER LOCK	→ OPEN
21 APPL BLOCK OUTPUT	
22 ACTUAL VALUE 1	
23 ACTUAL VALUE 2	
24 AUX MOTRS RUNNING	
25 CONTROLLER OUTPUT	
26 CONTROL ERROR	
27 ACT VALUE 1 (PFC)	
28 ACT VALUE 2 (PFC)	

10 CONTROL CONNECTIONS

10.1 START/STOP/DIRECTION	
10.1.1 EXT 1 STRT/STP/DIR	→ DI1
10.1.2 EXT 2 STRT/STP/DIR	→ DI6
10.1.3 LOC/EXT DIRECTION	→ FORWARD
10.2 EX REFERENCE SELECT	
10.2.1 EXT 1/EXT 2 SELECT	→ DI2
10.2.2 EXTERNAL REF1 SEL	→ OP DATA 13
10.2.3 EXT REF1 MINIMUM	0 Hz
10.2.4 EXT REF1 MAXIMUM	60 Hz
10.2.7 EXTERNAL REF2 SEL	→ OP DATA 14
10.3 PRESET SPEEDS	
10.3.1 PRESET SPEED SEL	DI3,4
10.3.2 PRESET SPEED 1	→ 5 Hz
10.3.3 PRESET SPEED 2	→ 10 Hz
10.3.4 PRESET SPEED 3	→ 15 Hz
10.4 SYSTEM CONTR INPUTS	
10.4.1 RUN ENABLE	DI5
10.4.2 FAULT RESET SELECT	→ ON STOP
10.4.3 PARAM. LOCK SEL	→ KEYPAD
10.4.4 EXTERNAL FAULT	NOT SEL

10.5 ANALOG INPUTS

10.5.1 MINIMUM AI1	→ 0 V/0 mA
10.5.2 MAXIMUM AI1	→ 10 V/20 mA
10.5.3 RC FILTER ON AI1	0.1s
10.5.4 INVERT AI1	NO
10.5.5 MINIMUM AI2	→ 2 V/4 mA
10.5.6 MAXIMUM AI2	10 V/20 mA

10.5.7 RC FILTER ON AI2	0.1s
10.5.8 INVERT AI2	NO
10.6 RELAY OUTPUTS	
10.6.1 RELAY RO1 OUTPUT	PFC AUTOM
10.6.2 RELAY RO2 OUTPUT	PFC AUTOM
10.6.3 RELAY RO3 OUTPUT	FAULT

10.7 ANALOG OUTPUTS

10.7.1 ANALOG OUTPUT 1	OUT FREQ
10.7.2 SCALE AO1	100%
10.7.3 MINIMUM AO1	→ 0 mA
10.7.4 RC FILTER ON AO1	2s
10.7.5 INVERT AO1	NO
10.7.6 ANALOG OUTPUT 2	OUT CURR
10.7.7 SCALE AO2	100%
10.7.8 MINIMUM AO2	→ 0 mA
10.7.9 RC FILTER ON AO2	2s
10.7.10 INVERT AO2	NO

20 DRIVE PARAMETERS

20.1 FREQ/CURRENT LIMITS

20.1.1 MINIMUM FREQUENCY	→ 25 Hz
20.1.2 MAXIMUM FREQUENCY	→ 60 Hz
20.1.3 FREQUENCY RANGE	120 Hz
20.1.4 CURRENT LIMIT	→ 1.5 x I _N

20.2 START/STOP

20.2.1 START FUNCTION	RAMP
20.2.2 TORQUE BOOST CURR	1.5 x I _N
20.2.3 STOP FUNCTION	COAST
20.2.4 BRAKE CHOPPER	NO
20.2.5 DC HOLD	OFF
20.2.6 DC HOLD VOLTAGE	0.01 x V _N
20.2.7 DC BRAKE VOLTAGE	0.01 x V _N
20.2.8 DC BRAKE TIME	0s

20.3 ACCEL/DECCEL

20.3.1 ACC/DEC 1 OR 2 SEL	NOT SEL
20.3.2 ACC/DEC RAMP SHAPE	UNEAR
20.3.3 ACCEL TIME 1	→ 1s
20.3.4 DECEL TIME 1	→ 1s
20.3.5 ACCEL TIME 2	60s
20.3.6 DECEL TIME 2	60s
20.3.7 ACCEL REF2 TIME	0.1s
20.3.8 DECEL REF2 TIME	0.1s

20.4 MOTOR CONTROL

20.4.1 SWITCHING FREQ	3 kHz
20.4.2 MAX OUTPUT VOLTAGE	100% x V _N
20.4.3 V/Hz RATIO	→ LINEAR
20.4.4 FIELD WEAK POINT	60 Hz
20.4.5 IR COMPENSATION	NO
20.4.6 IR COMP VOLTAGE	0.01 x V _N
20.4.7 IR COMP RANGE	0 Hz
20.4.8 SLIP COMPENSATION	OFF
20.4.9 NOMINAL SLIP	4%
20.4.10 VOLTAGE LIMIT	ON

20.5 CRIT FREQUENCIES*

20.5.1 CRIT FREQ SELECT	OFF
20.5.2 CRIT FREQ 1 LOW	0 Hz
20.5.3 CRIT FREQ 1 HIGH	0 Hz
20.5.4 CRIT FREQ 2 LOW	0 Hz
20.5.5 CRIT FREQ 2 HIGH	0 Hz
20.5.6 CRIT FREQ 3 LOW	0 Hz
20.5.7 CRIT FREQ 3 HIGH	0 Hz
20.5.8 CRIT FREQ 4 LOW	0 Hz
20.5.9 CRIT FREQ 4 HIGH	0 Hz
20.5.10 CRIT FREQ 5 LOW	0 Hz
20.5.11 CRIT FREQ 5 HIGH	0 Hz

30 PROTECTION/INFORMAT

30.1 FAULT FUNCTION	
30.1.1 SERIAL FAULT FUNC	STOP
30.1.2 AI <MIN FUNCTION	FAULT
30.1.3 MOT TEMP FLT FUNC	→ FAULT
30.1.4 MOTOR THERM TIME	700s
30.1.5 MOTOR LOAD CURVE	100%
30.1.6 ZERO SPEED LOAD	40%

30.1.7 BREAK POINT	60 Hz
30.1.8 STALL FUNCTION	FAULT
30.1.9 STALL CURRENT	.75 x I _N
30.1.10 STALL TIME/FREQ	20s/25 Hz
30.1.11 UNDERLOAD FUNC	NO
30.1.12 UNDERLOAD TIME	600s
30.1.13 UNDERLOAD CURVE	1

30.2 AUTOMATIC RESET

30.2.1 NUMBER OF RESETS	2
30.2.2 TIME WINDOW	30s
30.2.3 TIME BETW. RES ATT	0
30.2.4 OVERVOLTAGE	YES
30.2.5 UNDERVOLTAGE	YES
30.2.6 OVERCURRENT	YES
30.2.7 AI SIGNAL <MIN	→ NO

30.3 SUPERVISION

30.3.1 OUTPUT FREQ 1 FUNC	NO
30.3.2 OUTPUT FREQ 1 LIM	0
30.3.3 OUTPUT FREQ 2 FUNC	NO
30.3.4 OUTPUT FREQ 2 LIM	0
30.3.5 CURRENT FUNCTION	NO
30.3.6 CURRENT LIMIT	0 x I _N
30.3.7 REF1 FUNCTION	NO
30.3.8 REF1 LIMIT	0 Hz
30.3.9 REF2 FUNCTION	NO
30.3.10 REF2 LIMIT	0%
30.3.11 SUPERVIS MESSAGES	OFF

30.4 INFORMATION

30.4.11 CRI PROG VERSION	(version)
30.4.2 MC PROG VERSION	(version)
30.4.3 TEST DATE	(date)

40 APPLICATION PARAMETERS

40.2 P&F AUTOM	
40.2.1 PI-CONT GAIN	→ 250.0%
40.2.2 PI-CONT I-TIME	→ 3s
40.2.3 REFERENCE STEP 1	→ 0%
40.2.4 REFERENCE STEP 2	→ 0%
40.2.5 REFERENCE STEP 3	→ 0%
40.2.6 SLEEP DELAY	→ 60s
40.2.7 SLEEP LEVEL	→ 24.00 Hz
40.2.8 WAKE UP LEVEL	→ 35.0%
40.2.9 START FREQ 1	→ 57.00 Hz
40.2.10 START FREQ 2	→ 57.00 Hz
40.2.11 START FREQ 3	→ 57.00 Hz
40.2.12 LOW FREQ 1	→ 27.00 Hz
40.2.13 LOW FREQ 2	→ 27.00 Hz
40.2.14 LOW FREQ 3	→ 27.00 Hz
40.2.15 AUX MOT START DLY	→ 5s
40.2.16 AUX MOT STOP DLY	→ 3s
40.2.17 NBR OF AUX MOTORS	→ 1
40.2.18 AUTOCHANGE INTERV	→ 72 h 00 min
40.2.19 AUTOCHANGE LEVEL	→ 45.0%
40.2.20 INTERLOCKS	→ OFF
40.2.21 ERROR VALUE INV	→ NO
40.2.22 ACTUAL 1 INPUT	AI2
40.2.23 ACTUAL 2 INPUT	NO
40.2.24 ACTUAL VALUE SEL	→ ACT 1
40.2.25 ACT 1 MIN SCALE	→ 0%
40.2.26 ACT 1 MAX SCALE	→ +100%
40.2.27 ACT 2 MIN SCALE	→ 0%
40.2.28 ACT 2 MAX SCALE	→ 0%
40.2.29 REGUL BYPASS	→ NO
40.2.30 DISPLAY UNIT	→ psi
40.2.31 DISPL UNIT SCALE	→ 1000
40.2.32 NBR OF DECIMALS	→ 2

→ = Typical parameter values to check during start-up. If needed, change values to meet the needs of your application. Complete parameter list provided in Appendix A.

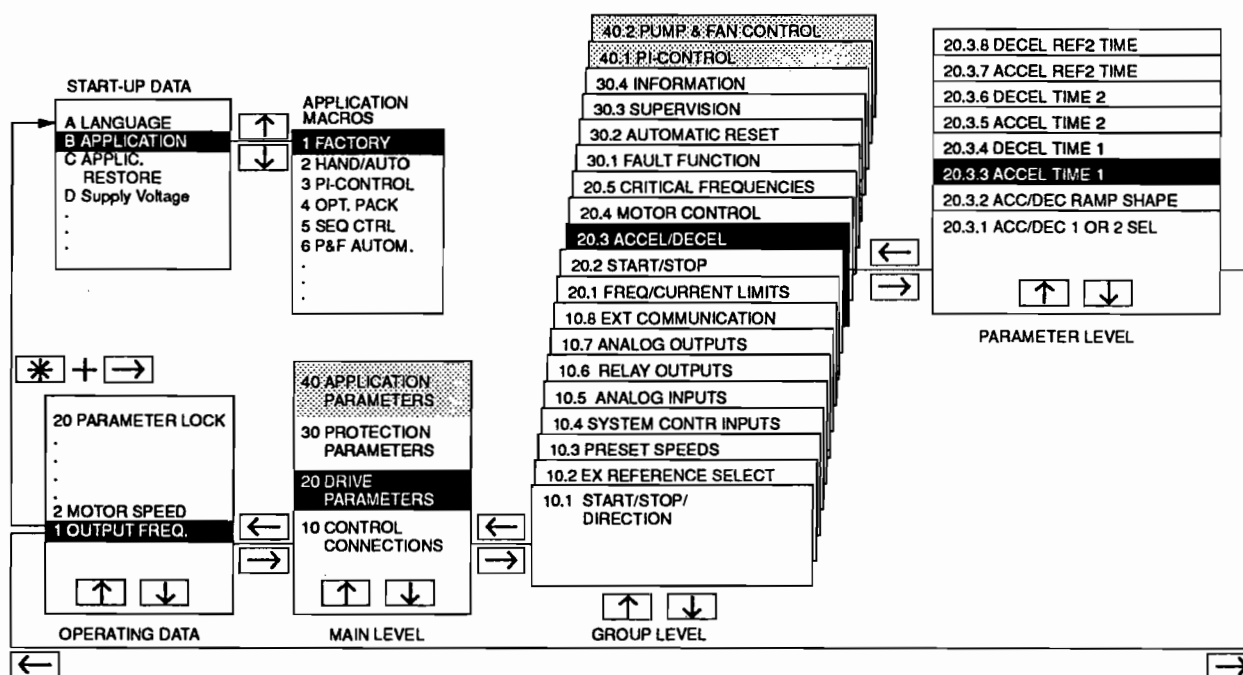
* - See Critical Frequencies in Chapter 6.

Chapter 6 – Parameters

ACS 500 Parameter Menus

This chapter explains the function of each parameter in the ACS 500, and the valid selections for each parameter. Figure 6-1 shows the process of accessing the ACS 500 Parameter Menus.

Figure 6-1 Parameter Menu Selection



ACS 500 Parameters

The ACS 500 parameters are divided according to function into four Mains and 19 Groups. Operating Data parameters and Start-up Data parameters are not accessed through Mains or Groups. Refer to *Chapter 3 – Start-up Data* and *Chapter 4 – Control Operations* in this manual for more information on Operating Data parameters.

Main 10 Control Connections

Group 10.1 Start/Stop/Direction

These parameter values can only be altered with the ACS 500 stopped. The Range/Unit column in Table 6-1 shows parameter values. The text following the table explains parameter values in detail.

Table 6-1 Group 10.1

Parameter	Range/Unit	Description
1 EXT 1 STRT/STP/DIR	Not Sel/Digital Inputs	External control reference R1 start/ stop and direction input.
2 EXT 2 STRT/STP/DIR	Not Sel/Digital Inputs	External control reference R2 Start/ stop and direction input.
3 DIRECTION	Reverse/Forward/ Request/Fast Rev	Rotation direction lock.

1 EXT 1 STRT/STP/DIR

This parameter selects the Digital Inputs used for Start/Stop and Reverse commands.

NOT SEL

No Digital Input selected.

DI1

Two-wire start/stop.

0 V DC = Stop and 24 V DC = Start. Rotation direction is fixed.

DI1,2

Two-wire start/stop and direction.

Start/Stop is connected to DI1 and Reverse to DI2. 0 V DC on DI2 = Forward and 24 V DC = Reverse.

DI1P,2P

Three-wire start/stop.

Start/Stop commands are from momentary push-buttons. The stop push-button is normally closed, and connected to DI2. The start push-button is normally open, and connected to DI1. Multiple start push-buttons are connected in parallel, and stop push-buttons in series.

DI1P,2P,3

Three-wire start/stop and direction.

Refer to DI1P,2P. Reverse is connected to DI3. 0 V DC = Forward, 24 V DC = Reverse.

DI1P,2P,3P

Start forward, start reverse, and stop.

Start and direction commands are given simultaneously with two separate momentary push-buttons. The stop push-button is normally closed, and connected to DI3. The start forward push-button is normally open, and connected to DI1. The start reverse push-button is normally open, and connected to DI2. Multiple start push-buttons are connected in parallel, and stop push-buttons in series.

DI6

Two-wire start/stop.

0 V DC = Stop and 24 V DC = Start. Rotation direction is fixed.

DI6,5

Two-wire start/stop and direction.

Start/Stop is connected to DI6 and Reverse is connected to DI5. 0 V DC on DI5 = Forward.

KEYPAD

Start/Stop command and Direction command are from the Keypad for Ext 1.

2 EXT 2 STRT/STP/DIR

This parameter selects the Digital Inputs used for Start/Stop and Reverse commands. The choices are the same as Parameter 10.1.1 (Ext 1 Strt/Stp/Dir).

3 DIRECTION

This parameter allows you to fix rotation direction to FORWARD or REVERSE. If you select REQUEST, the rotation direction is selected by Digital Inputs as defined in Parameters 10.1.1 (Ext 1 Strt/Stp/Dir) and 10.1.2 (Ext 2 Strt/Stp/Dir) or by keypad push-button. If FAST REV is selected, and Parameter 20.2.3 (Stop Function) is set to COAST, the modulator starts to operate in a reverse direction immediately when REVERSE is requested. This procedure results in fast reversing.

**Group 10.2 Ext
Reference Select**

These parameter values can be altered with the ACS 500 running, except those marked with (O). The Range/Unit column in Table 6-2 shows parameter values. The text following the table explains parameter values in detail.

Table 6-2 Group 10.2

Parameter	Range/Unit	Description
1 EXT 1/EXT 2 SELECT (O)	OP DATA 12/ DI1–DI6/	External control location selection input.
2 EXTERNAL REF1 SEL (O)	OP DATA 13/Analog and Digital Inputs	External reference 1 input.
3 EXT REF1 MINIMUM	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	External reference 1 minimum value.
4 EXT REF1 MAXIMUM	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	External reference 1 maximum value.
5 EXT REF1 OFFSET	-30 - 30 Hz	Offset for scaling external reference 1
6 EXT REF1 GAIN	-100 - 100%	Gain for scaling external reference 1
7 EXTERNAL REF2 SEL (O)	OP DATA 14/Analog and Digital Inputs	External reference 2 input.
8 EXT REF2 MINIMUM	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	External reference 2 minimum value.
9 EXT REF2 MAXIMUM	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	External reference 2 maximum value.
10 EXT REF2 OFFSET	-30 - 30 Hz	Offset for scaling external reference 2
11 EXT REF2 GAIN	-100 - 100%	Gain for scaling external reference 2

Parameters 10.2.8 - 10.2.11 are not available in PI, PFC, or Speed Control.

1 EXT 1/EXT 2 SELECT

This parameter defines how to select the external control location (Ext Ref 1/ Ext Ref 2). If you choose OP DATA 12, the selection is made with Operating Data Parameter 12 (Ext Ref 1 or 2). If you choose a Digital Input (DI1 – DI6), 0 V DC = Ext Ref 1 and 24 V DC = Ext Ref 2.

2 EXTERNAL REF1 SEL

This parameter selects the signal source of External Reference 1.

OP DATA 13

Reference is given from the Keypad, Operating Data Parameter 13.

AI1

Reference from analog input 1.

AI2

Reference from analog input 2.

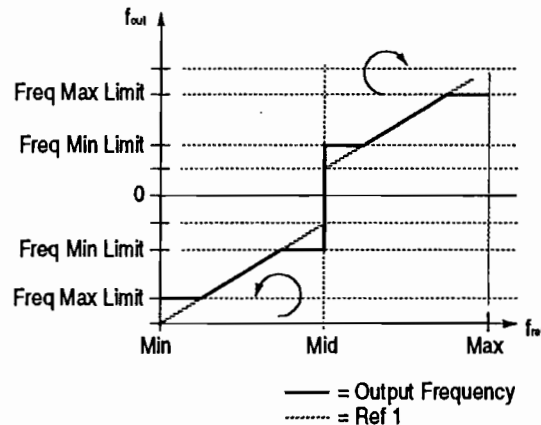
A11/JOYST

Reference from analog input 1 configured for a joystick. Analog input minimum signal is full speed reverse, and analog input maximum signal is full speed forward. The mid point between minimum and maximum is zero speed.

CAUTION: Minimum reference for joystick must be 0.3 V/0.6 mA or greater. If a 0 – 10 V or 0 – 20 mA signal is used, the drive will run at fmax to Reverse if the control signal is lost. Set Parameter 10.5.1 (Minimum A11) to 2 V/4 mA or to a value 0.3 V/0.6 mA or greater, and Parameter 30.1.2 (AI < Min Function) to Fault, and the drive will stop in case of lost control signal.

Figure 6-2 shows Joystick control.

Figure 6-2 Joystick Control

**DI3U,4D(R)**

Speed reference via digital inputs as Floating Point Control, or Motor Operated Potentiometer Control. DI3 increases speed, and DI4 decreases speed. (R) indicates that the reference will reset to minimum frequency when stop command is given. The rate of change of the reference signal is controlled by parameter 20.3.5, ACCEL TIME 2.

DI3U,4D

Same as above except speed reference does not reset to zero on stop command.

DI5U,6D

Same as above.

3 EXT REF1 MINIMUM 0 Hz – 500 Hz (ACS 501)

0 Hz – 120 Hz (ACS 502)

This parameter sets the frequency corresponding to the minimum reference. When Parameter 20.1.1 (Minimum Frequency) is changed, this parameter is automatically set to the same value.

4 EXT REF1 MAXIMUM 0 Hz – 500 Hz (ACS 501)

0 Hz – 120 Hz (ACS 502)

This parameter sets the frequency corresponding to the maximum reference. When Parameter 20.1.2 (Maximum Frequency) is changed, this parameter is automatically set to the same value.

5 EXT REF1 OFFSET

This parameter with the **EXT REF1 GAIN** are used for scaling the incoming serial reference. The **EXT REF1 OFFSET** is added to the received serial reference.

6 EXT REF1 GAIN

This parameter with the **EXT REF1 OFFSET** are used for scaling the incoming serial reference. The **EXT REF1 GAIN** specifies what percentage of the received serial reference is added to the received serial reference.

The External Reference Offset and Gain are used to scale also the reference sources AI1, AI2, and AI1/JOYST.

Example: The reference is 20 Hz, EXT REF1 OFFSET is 5Hz, and EXT REF1 GAIN is 10%. The drive reference is now $20\text{Hz} + 5\text{Hz} + 0.1 * 20\text{Hz} = 27\text{Hz}$.

7 EXTERNAL REF2 SEL

OP DATA 14

This parameter selects the signal source for External Reference 2.

Reference is given from the Keypad, Operating Data Parameter 14.

AI1

Reference from analog input 1.

AI2

Reference from analog input 2

DI3U,4D(R)

Speed reference via digital inputs as Floating Point Control, or Motor Operated Potentiometer Control. DI3 increases speed, and DI4 decreases speed. (R) indicates that the reference will reset to zero when stop command is given.

DI3U,4D

Same as above except speed reference does not reset to zero on stop command.

DI5U,6D

Same as above.

8EXT REF2 MINIMUM

0 Hz – 500 Hz (ACS 501)

0 Hz – 120 Hz (ACS 502)

This parameter sets the frequency corresponding to the minimum reference. When Parameter 20.1.1 (Minimum Frequency) is changed, this parameter is automatically set to the same value.

9EXT REF2 MAXIMUM 0 Hz – 500 Hz (ACS 501)

0 Hz – 120 Hz (ACS 502)

This parameter sets the frequency corresponding to the maximum reference. When Parameter 20.1.2 (Maximum Frequency) is changed, this parameter is automatically set to the same value.

10EXT REF2 OFFSET Same as parameter 10.2.5.

11EXT REF2 GAIN Same as parameter 10.2.6.

Group 10.3 Preset Speeds

These parameter values can be altered with the ACS 500 running, except those marked with (O). The Range/Unit column in Table 6-3 shows parameter values. The text following the table explains parameter values in detail.

Table 6-3 Group 10.3

Parameter	Range/Unit	Description
1 PRESET SPEED SEL (O)	Digital Inputs	Preset speed selection.
2 PRESET SPEED 1	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Override frequency 1.
3 PRESET SPEED 2	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Override frequency 2.
4 PRESET SPEED 3	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Override frequency 3.
5 PRESET SPEED 4	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Override frequency 4.
6 PRESET SPEED 5	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Override frequency 5.
7 PRESET SPEED 6	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Override frequency 6.
8 PRESET SPEED 7	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Override frequency 7/Fault Frequency (Refer to Parameters 30.1.1 and 30.1.2).

This Group has seven programmable preset speeds, ranging from 0.0 Hz to 500 Hz (ACS 501) or 0.0 Hz to 120 Hz (ACS 502), with a 0.01 Hz step.

When in External Control mode, preset speeds override any other reference. Preset speeds are activated with Digital Input(s) selected through Parameter 10.3.1 (Preset Speed Sel).

Note: Parameter 10.3.8 (Preset Speed 7) is a fault frequency, which may be activated in case of a serial communication fault or a loss of analog input fault. Refer to Parameter 30.1.1 (Serial Fault Func) and 30.1.2 (AI < Min Func) when in external mode.

1 PRESET SPEED SEL This parameter defines which Digital Inputs are used to select Preset Speeds.
NOT SEL
DI1 – DI6

Preset speed number 1 selected by the Digital Input. 24 V DC = Preset Speed activated.

DI1,2

Three Preset Speeds (1 – 3) are selected with two Digital Inputs.

Table 6-4 Digital Inputs DI1,2

DI1	DI2	Function
0	0	No Preset Speed.
1	0	Preset Speed 1.
0	1	Preset Speed 2.
1	1	Preset Speed 3.

DI3,4

Three Preset Speeds (1 – 3) are selected with two Digital Inputs as in DI1,2.

DI5,6

Three Preset Speeds (1 – 3) are selected with two Digital Inputs as in DI1,2.

DI1,2,3

Seven Preset Speeds (1 – 7) are selected with three Digital Inputs.

Table 6-5 Digital Inputs DI1,2,3

DI1	DI2	DI3	Function
0	0	0	No Preset Speed.
1	0	0	Preset Speed 1.
0	1	0	Preset Speed 2.
1	1	0	Preset Speed 3.
0	0	1	Preset Speed 4.
1	0	1	Preset Speed 5.
0	1	1	Preset Speed 6.
1	1	1	Preset Speed 7.

DI3,4,5

Refer to DI1,2,3.

DI4,5,6

Refer to DI1,2,3.

**Group 10.4 System
Contr Inputs**

These parameter values can only be altered with the ACS 500 stopped. The Range/Unit column in Table 6-6 shows parameter values. The text following the table explains parameter values in detail.

Table 6-6 Group 10.4

Parameter	Range/Unit	Description
1 RUN ENABLE	Yes/DI1–DI6	Run enable input.
2 FAULT RESET SELECT	Not Sel/DI1–DI6/ On Stop	Fault/Warning/Supervision reset input.
3 PARAM LOCK SEL	Op Data 20/ DI1–DI6	Parameter lock input.
4 EXTERNAL FAULT	Not Sel/DI1–DI6	External fault input.

1 RUN ENABLE

This parameter selects the source of the Run Enable signal.

YES

Run Enable signal active. Drive is ready to start without an external Run Enable signal.

DI1 – DI6

To activate the Run Enable signal, the selected Digital Input must be connected to +24 V DC. If the Digital Input goes to 0 V DC, the drive will coast to stop.

**2 FAULT RESET
SELECT****NOT SEL/DI1 – DI6/ON STOP**

If you select NOT SEL, fault reset is done from the Keypad. If a digital input is selected, fault reset is done from an external switch or from the keypad. Reset is activated by opening a normally closed contact (negative edge on digital input). If ON STOP is selected, a fault is reset by giving a stop command from the active STOP signal, or from the Keypad.

3 PARAM. LOCK SEL

This parameter selects the control location for Parameter Lock.

If you select OP DATA 20, Parameter Lock is controlled with Operating Data Parameter 20 (Parameter Lock). If you select a Digital Input (1 – 6), 0 V DC equals Open and 24 V DC equals Locked.

4 EXTERNAL FAULT**NOT SEL****DI1 – DI6**

Input for external fault device such as a motor overload relay or fire alarm. The device should have a normally closed contact. The digital input must be connected to +24 VDC. If the digital input goes to 0 VDC, the drive will coast to stop and a fault message will display.

Group 10.5 Analog Inputs

These parameter values can be altered with the ACS 500 running. The Range/Unit column in Table 6-7 shows parameter values. The text following the table explains parameter values in detail.

Table 6-7 Group 10.5

Parameter	Range/Unit	Description
1 MINIMUM AI1	V/mA	Minimum value of AI1. Value to correspond to minimum reference.
2 MAXIMUM AI1	V/mA	Maximum value of AI1. Value to correspond to maximum reference.
3 RC FILTER ON AI1	0.01 – 10s	Filter time constant for AI1.
4 INVERT AI1	No/Yes	Analog Input signal 1 inversion.
5 MINIMUM AI2	V/mA	Minimum value of AI2. Value to correspond to minimum reference.
6 MAXIMUM AI2	V/mA	Maximum value of AI2. Value to correspond to maximum reference.
7 RC FILTER ON AI2	0.01 – 10s	Filter time constant for AI2.
8 INVERT AI2	No/Yes	Analog Input signal 2 inversion.

1 MINIMUM AI1 0V/0mA; 2V/4mA; READ INPUT

This parameter sets the minimum value of the signal to be applied to AI1. This value will then correspond to zero speed. Typical minimum values are 0 V/0 mA or 2 V/4 mA.

When input minimum is not 0 or 2 V for a voltage signal, or 0 or 4 mA for a current signal, the drive can read the minimum from this third display by applying the minimum signal to the analog input, and pressing [*]. This value then becomes the minimum. The range is 0 – 10 V, and 0 – 20 mA.

The ACS 500 has a “living zero” function which allows the protection and supervision circuits to detect a loss of signal. For this feature to be functional, the minimum input signal must be greater than 0.3 V/0.6 mA. When the minimum is set less than this level, the “/” between the volts and milliamps will disappear, indicating the “living zero” is not active even if it has been programmed.

2 MAXIMUM AI1 10V/20mA; READ INPUT

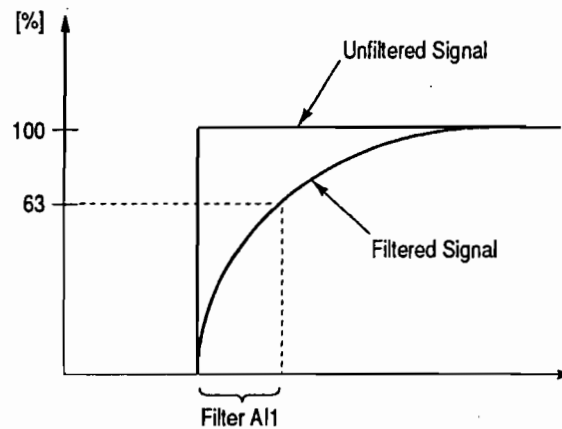
When the maximum reference is less than 10 V or 20 mA, this parameter will set what the maximum reference is, so the drive will run at full speed when this reference is applied. By going into this parameter and applying the maximum reference, pressing [*] will store the applied reference, and the ACS 500 will consider this value to be maximum.

3 RC FILTER ON AI1 Filter time constant for Analog Input 1.

As the Analog Input value changes, 63 percent of the change takes place within the time period given by this parameter. If you select the minimum value 0.01s, the signal is not filtered.

Figure 6-3 shows filter time constant.

Figure 6-3 Filter Time Constant

**4 INVERT AI1** NO/YES

If this parameter is set to YES, maximum reference gives minimum frequency and minimum reference gives maximum frequency.

5 MINIMUM AI2 Refer to Parameter 10.5.1.**6 MAXIMUM AI2** Refer to Parameter 10.5.2.**7 RC FILTER ON AI2** Refer to Parameter 10.5.3.**8 INVERT AI2** Refer to Parameter 10.5.4.

Group 10.6
Relay Outputs

These parameter values can only be altered when the ACS 500 is not running. The text following Table 6-8 explains parameter values in detail.

Table 6-8 Group 10.6

Parameter	Range/Unit	Description
1 RELAY RO1 OUTPUT	Refer to the text below for the available selections.	Relay Output 1 content.
2 RELAY RO2 OUTPUT		Relay Output 2 content.
3 RELAY RO3 OUTPUT		Relay Output 3 content.

1 RELAY RO1 OUTPUT

This parameter allows you to select which information is indicated with Relay Output 1.

READY

The ACS 500 is ready to function. The relay is energized unless no run enable is present or a fault exists.

RUN

The drive has been started, has an enable signal, and is not in a fault trip.

FAULT

Any fault occurs. Refer to *Chapter 5 – Fault Tracing in the Installation & Start-up Manual* for more details.

FAULT (-1)

Relay energizes when power is applied, and de-energizes upon a fault trip.

FAULT(RST)

The ACS 500 is in a fault condition, but will reset after the programmed autoreset delay.

STALL FLT

Stall protection has tripped.

MOT OT FLT

Motor overload (I^2t) protection has tripped.

OT FAULT

The ACS 500 overheat protection has tripped. The tripping level is 158°F (70°C) for ACS 501 and 185°F (85°C) for ACS 502.

FAULT/WARN

Any fault or warning has occurred.

WARNING

Any warning has occurred.

OT WARNING

The heatsink temperature has exceeded the warning level 149°F (65°C).

REVERSED

Reverse is selected.

EXT. CTRL

External control selected.

REF 2 SEL

Reference 2 selected.

PRESET SPD

A Preset Speed (1 – 7) selected.

DC BUS LIM

Voltage regulator is activated.

FREQ1 LIM

Output frequency has exceeded the Supervision Limit 1. Refer to Parameter 30.3.1 (Output Freq 1 Func).

FREQ2 LIM

Output frequency has exceeded the Supervision Limit 2. Refer to Parameter 30.3.4 (Output Freq 2 Lim).

CURRENT LIMIT

Motor current has exceeded the set Current Supervision Limit. Refer to Parameter 30.3.6 (Current Limit).

REF 1 LIMIT

Reference 1 has exceeded the set Supervision Limit. Refer to Parameter 30.3.8 (Ref 1 Limit).

REF 2 LIMIT

Reference 2 has exceeded the set Supervision Limit. Refer to Parameter 30.3.10 (Ref 2 Limit).

AT SPEED

The output frequency is equal to the set frequency (+/- .25 Hz of set frequency).

HIGH TEMP

High heatsink temperature indication with hysteresis. Relay activates at 60°C (140°F), and opens at 40°C (104°F).

P&F AUTOM

When Pump and Fan macro is selected, some relays are automatically reserved for the lag pumps. When a relay is reserved for Pump and Fan sequencing, P&F AUTOM will appear in this parameter.

2 RELAY RO2 OUTPUT

Refer to Parameter 10.6.1 (Relay RO1 Output).

3 RELAY RO3 OUTPUT

Refer to Parameter 10.6.1 (Relay RO1 Output).

Group 10.7 Analog Outputs

These parameter values can be altered with the ACS 500 running, except those marked with (O). The Range/Unit column in Table 6-9 shows parameter values. The text following the table explains parameter values in detail.

Table 6-9 Group 10.7

Parameter	Range/Unit	Description
1 ANALOG OUTPUT 1 (O)	Refer to the text below for the available selections.	Analog Output 1 content.
2 SCALE AO1	10 – 1000%	Analog Output signal 1 scaling factor.
3 MINIMUM AO1	0 mA/4 mA	Analog Output signal 1 minimum.
4 RC FILTER ON AO1	0.01 – 10s	Filter time constant for AO1.
5 INVERT AO1	NO/YES	Analog Output signal 1 inversion.
6 ANALOG OUTPUT 2 (O)	Refer to the text below for the available selections.	Analog Output 2 content.
7 SCALE AO2	10 – 1000%	Analog Output signal 2 scaling factor.
8 MINIMUM AO2	0 mA/4 mA	Analog Output signal 2 minimum.
9 RC FILTER ON AO2	0.01 – 10s	Filter time constant for AO2.
10 INVERT AO2	NO/YES	Analog Output signal 2 inversion.

1 ANALOG OUTPUT 1

This Parameter allows you to select which output signal is connected to Analog Output 1 (current signal). The following list shows the full scale reading with Parameters 10.7.2 (Scale AO1) and 10.7.7 (Scale AO2) set to 100%.

NOT USED**OUT FREQ**

Output frequency. 20 mA = 60 Hz.

MOT SPEED

Motor speed. 20 mA = motor speed at 60 Hz.

OUT CURR

Output current. 20 mA = motor nominal current.

MOT TORQ

Motor torque. 20 mA = 100% of motor nominal rating.

MOT POWER

Motor power. 20 mA = 100% of motor nominal rating.

V/DC BUS

DC bus voltage. 20 mA = 100% of Nominal DC Bus Voltage ($V_N \times 1.35$).

MOTOR VOLT

Motor voltage. 20 mA = Supply Voltage.

REFERENCE

Active reference that the ACS 500 is currently following. 20 mA = 100% of the active reference.

The following can only be seen when the Pump & Fan macro is selected.

ERROR VAL

Scaled difference of ACT and REF values.

PICON OUTP

PI regulator output.

ACTUAL 1

Unscaled actual value 1.

ACTUAL 2

Unscaled actual value 2.

PICON REF

Reference of PI-Controller.

2 SCALE AO1	This parameter is the scaling factor for the Analog Output 1 signal. If you select 100%, the nominal value of the output signal corresponds to 20 mA. If the maximum is less than full scale, increase the value of this parameter.
3 MINIMUM AO1	The minimum value of the Analog Output signal can be set to either 0 mA or 4 mA.
4 RC FILTER ON AO1	Filter time constant for Analog Output 1. As Analog Output value changes, 63 percent of the change takes place within the time period given by this parameter. If you select the minimum value 0.01s, the signal is not filtered. (See Figure 6-3 for Parameter 10.7.4).
5 INVERT AO1	If you select YES, the Analog Output 1 signal is inverted.
6 ANALOG OUTPUT 2	Refer to Parameter 10.7.1.
7 SCALE AO2	Refer to Parameter 10.7.2.
8 MINIMUM AO2	Refer to Parameter 10.7.3.
9 RC FILTER ON AO2	Refer to Parameter 10.7.4.
10 INVERT AO2	Refer to Parameter 10.7.5.

**Group 10.8 Ext
Communication**

For external communication parameter settings, refer to the *Remote Panel Manual* (SAGS700PAN-04) or the *DMT 500 PC Manual* (DMT500PC-US-04) for information on the GS protocol parameters, or the *ACS 500 Modbus Manual* (ACS500MODBUS-US-04) for information on the Modbus protocol parameters.

**Main 20
Drive Parameters****Group 20.1
Freq/Current Limits**

These parameter values can be altered with the ACS 500 running, except those marked with (O). The Range/Unit column in Table 6-10 shows parameter values. The text following the table explains parameter values in detail.

Table 6-10 Group 20.1

Parameter	Range/Unit	Description
1 MINIMUM FREQUENCY	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Operating range minimum frequency.
2 MAXIMUM FREQUENCY	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Operating range maximum frequency.
3 FREQUENCY RANGE (O)	0 – 500 Hz or 0 – 120 Hz	Frequency Range. (ACS 501 only)
4 CURRENT LIMIT	0.5 – 2.0 times ACS 500 current (I_N)	Output current limit.

1 MINIMUM FREQUENCY Represents the minimum output frequency.

2 MAXIMUM FREQUENCY Represents the maximum output frequency.

3 FREQUENCY RANGE To use the ACS 501 for frequencies higher than 120 Hz, you must first change this parameter.

This parameter sets the range for all frequency parameters.

0 – 120 Hz

Default frequency range. Output frequency display to 0.01 Hz.

0 – 500 Hz

Extended frequency range. Available for ACS 501 only. Output frequency display to 0.1 Hz.

CAUTION: Special application considerations must be taken into account for high frequency operation.

4 CURRENT LIMIT

This setting is the output current limit the ACS 500 will supply to the motor. If the rated current of the motor is lower than the rated current of the ACS 500, set the current limit in accordance with the motor rating in standard applications.

Note: Current limitation time is not supervised. Too long a period of overcurrent may cause the ACS 500 to shut down due to overtemperature.

**Group 20.2
Start/Stop**

These parameter values can only be altered with the ACS 500 stopped, except those marked with (I). The Range/Unit column in Table 6-11 shows parameter values. The text following the table explains parameters values in detail.

Table 6-11 Group 20.2

Parameter	Range/Unit	Description
1 START FUNCTION	RAMP/FLYING/ TORQ BOOST/ FLYING+TQB	Conditions during motor acceleration.
2 TORQUE BOOST CURR	0.5 – 2.0 times drive output current	Torque Boost current level selection.
3 STOP FUNCTION (I)	COAST/RAMP/ DC BRAKE	Conditions during motor deceleration.
4 BRAKE CHOPPER (I)	NO/YES	Dynamic Braking Device activation.
5 DC HOLD	OFF/ON	Enable DC Hold.
6 DC HOLD VOLTAGE	0.01 – 0.1 times drive output voltage	Voltage set for DC Hold.
7 DC BRAKE VOLTAGE	0.01 – 0.1 times drive output voltage	Voltage set for DC injection braking.
8 DC BRAKE TIME	0 – 250s	Duration of DC injection braking.

1 START FUNCTION RAMP

Ramp acceleration as set in Group 20.3.

FLYING

Use this setting to start the motor if it is already rotating, such as in a fan drive. The drive will start smoothly at the current frequency instead of starting at 0 Hz.

Note: Flying Start searches for the running speed by applying a small voltage to the load at the maximum frequency and decreasing the output frequency until the load speed is found. If the motor is not coupled to a load or the load has low inertia, the shaft speed can follow this search program.

TORQ BOOST

Automatic start current boost, which may be necessary in applications requiring high starting torque. Automatic torque boost is active only from 0 Hz to 20 Hz or until the reference speed is reached. Torque boost is not activated if the output frequency falls below 20 Hz while running.

Refer to IR Compensation in Group 20.4 for added torque at low speeds while running.

FLYING + TQB

Both Flying Start and Torque Boost functions are active.

2 TORQUE BOOST CUR

Sets the current that will be allowed when Torque Boost start is selected. Keep the boost current as low as possible for the application. Setting is in actual amps, 0.5 – 2.0 x I_N , 1% step.

3 STOP FUNCTION

COAST

The ACS 500 AC drive stops supplying voltage immediately after stop command is received and the motor coasts to a stop.

RAMP

Ramp deceleration as set in Group 20.3.

DC BRAKE

DC injection braking stops the motor by applying DC to the stator windings. By using DC braking, the motor can be stopped in the shortest possible time, outside of using a dynamic braking device.

Note: If the Run Enable input is deactivated, the ACS 500 will stop by coasting, regardless of the Stop Function setting.

4 BRAKE CHOPPER

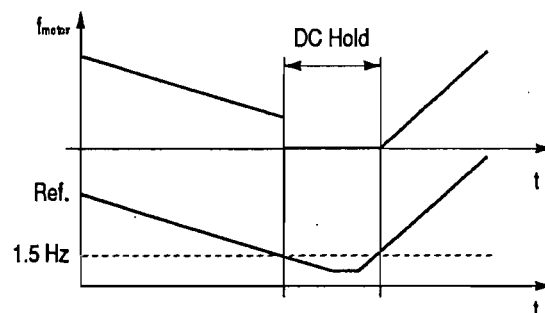
If a dynamic braking device is used, the Decel Limit level (voltage regulator upper limit) can be increased by selecting YES for this parameter. Decel Limit level is raised to within five percent of the Overvoltage Trip point, essentially eliminating the Decel Limit.

5 DC HOLD

If this parameter is set to YES, the DC Hold feature is enabled.

Figure 6-4 shows DC Hold.

Figure 6-4 DC Hold



When both reference and output frequencies drop below 1.5 Hz, the drive will stop generating sinusoidal current and inject DC into the motor. The voltage value is the voltage set in the DC Hold Voltage. When the reference frequency goes above 1.5 Hz, the DC will be removed and normal drive function resumes.

DC Hold has no effect if the Start signal is deactivated.

Note: Injecting DC voltage into the motor causes the motor to heat up. In applications where long DC Hold times are required, externally ventilated motors should be used. In a long DC Hold period, the DC Hold cannot keep the motor shaft from rotating if a constant load is applied to the motor.

6 DC HOLD VOLTAGE

Sets the voltage level applied to the motor when DC Hold is activated. Range is from 0.01 to 0.1 times the nominal voltage.

7 DC-BRAKE VOLTAGE

When the stop function is set to DC BRAKE, this parameter sets the voltage injected into the motor. The factory setting is suitable for a nominal size motor. If braking is too sudden, decrease this value. If braking is not sufficient, increase this value.

8 DC-BRAKE TIME

When the stop function is set to DC BRAKE, this parameter sets the DC injection time in seconds. If the braking time is too short, the drive stops by coasting after the DC-Brake Time has elapsed.

**Group 20.3
Accel/Decel**

These parameter values can be altered with the ACS 500 running, except those marked with (O). The Range/Unit column in Table 6-12 shows parameter values. The text following the table explains parameter values in detail.

Table 6-12 Group 20.3

Parameter	Range/Unit	Description
1 ACC/DEC 1OR2 SEL (O)	Not Sel/ DI1–DI6	Acceleration/Deceleration ramp selection.
2 ACC/DEC RAMP SHAPE	Linear/S1 – S3	Accel./Decel. ramp shape selection.
3 ACCEL TIME 1	0.1 – 1800s	Time for output frequency min. to max. acceleration ramp 1.
4 DECEL TIME 1	0.1 – 1800s	Time for output frequency max. to min. deceleration ramp 1.
5 ACCEL TIME 2	0.1 – 1800s	Time for output frequency min. to max. acceleration ramp 2.
6 DECEL TIME 2	0.1 – 1800s	Time for output frequency max. to min. deceleration ramp 2.
7 ACCEL REF2 TIME	0.1 – 1800s	Ref2 acceleration ramp time for 0 – 100%.
8 DECEL REF2 TIME	0.1 – 1800s	Ref2 deceleration ramp time for 100 – 0%.

1 ACC/DEC 1OR2 SEL

This parameter defines which Digital Input (1 – 6) is used to select the Acceleration/Deceleration Ramp used. 0 V DC equals Acc/Dec Time 1, 24 V DC equals Acc/Dec Time 2.

**2 ACC/DEC
RAMP SHAPE**

This parameter allows you to select the shape of the acceleration/deceleration ramp. The available options are:

LINEAR

Suitable for drives requiring steady acceleration/deceleration and/or slow ramps.

S1 SHAPE

Suitable for ramp times less than one second.

S2 SHAPE

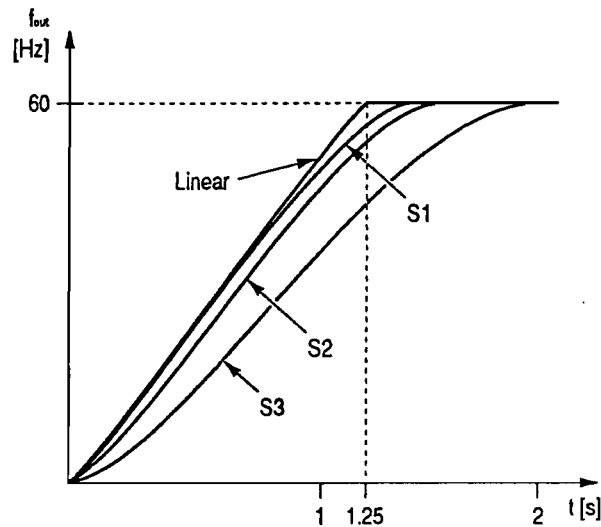
Suitable for ramp times less than 1.5 seconds.

S3 SHAPE

Suitable for ramp times up to 15 seconds.

Figure 6-5 shows acceleration and deceleration ramp shapes.

Figure 6-5 Acceleration and Deceleration Ramp Shapes

**3 ACCEL TIME 1**

The time required for the output frequency to change from minimum to maximum frequency. Regardless of the settings, the maximum acceleration/deceleration is 120 Hz/0.1s and the minimum is 120 Hz/1800s. The time required for the acceleration from zero to minimum frequency depends on the Accel Time (acceleration equals $f_{\max} - f_{\min} / \text{acceleration time}$).

Note: The ACS 500 incorporates a bus controller that prevents overcurrent and overvoltage trips caused by too quick acceleration and deceleration settings for a given system (by increasing the acceleration/deceleration).

If a small number is entered for acceleration time in a system with high inertia, the acceleration time will be limited by Parameter 20.1.4 (Current Limit). Conversely, if a small number is entered for deceleration time in such a system, the deceleration time will be limited by the DC bus regulator. In some cases, the motor will take a long time to come to a stop. If a short deceleration time is critical to your application, we suggest you add a dynamic braking device to your system.

The maximum/minimum recommended acceleration/deceleration for the nominal size motor is 40 Hz in one second. If the motor rating is less than the maximum power of the ACS 500, smaller settings can be used.

If the reference signal changes at a rate slower than the acceleration or deceleration time, the output frequency change will follow the reference signal. If the reference signal changes faster than the acceleration or deceleration time, the output frequency change will be limited by the parameters.

4 DECEL TIME 1

The time required for output frequency to change from maximum to minimum. Refer to Parameter 20.3.3.

5 ACCEL TIME 2

Refer to Parameter 20.3.3.

6 DECEL TIME 2 Refer to Parameter 20.3.4.

7 ACCEL REF2 TIME Corresponds to the time required for the reference to change from 0 to 100 percent and vice versa, if the PI-Controller is not used.

8 DECEL REF2 TIME Refer to Parameter 20.3.7.

**Group 20.4
Motor Control**

These parameter values can only be altered with the ACS 500 stopped, except those marked with (I). The Range/Unit column in Table 6-13 shows parameter values. The text following the table explains parameter values in detail.

Table 6-13 Group 20.4

Parameter	Range/Unit	Description
1 SWITCHING FREQ	1.0 – 12.0 kHz (ACS 501) 1.0 – 5.0 kHz (600 V - ACS 501) 3.0 kHz (ACS 502)	Carrier frequency selection.
2 MAX OUT VOLTAGE	0.15 – 1.05 times drive output voltage	Maximum motor voltage selection.
3 V/Hz RATIO	LINEAR/SQUARED/AUTOMATIC	Voltage to frequency relationship in region below Field Weakening Point.
4 FIELD WEAK POINT	30 – 500 Hz	Threshold for nominal voltage.
5 IR COMPENSATION	NO/MANUAL/AUTOMATIC	Low speed torque boost function.
6 IR COMP VOLTAGE	0.01 – 0.15 times drive output voltage	Voltage level in manual IR Compensation.
7 IR COMP RANGE	0 Hz – FWP	Zero point in manual IR Compensation.
8 SLIP COMPENSATION (I)	OFF/ON	Automatic slip reduction.
9 NOMINAL SLIP (I)	0.1 – 10%	Nominal slip of the motor.
10 VOLTAGE LIMIT (I)	OFF/ON	Over-/Undervoltage Controller.

1 SWITCHING FREQ

Motor noise can be minimized by adjusting the switching frequency to a value that does not create resonances in the motor and load. The optimum switching frequency is the lowest frequency where the noise is acceptable.

As the switching frequency goes up, the inverter efficiency goes down, so it is best to use as low a switching frequency as possible relative to acceptable noise levels for the particular application.

Note: Consult factory for derating information for increased switching frequency above 3 kHz.

2 MAX OUTPUT VOLTAGE

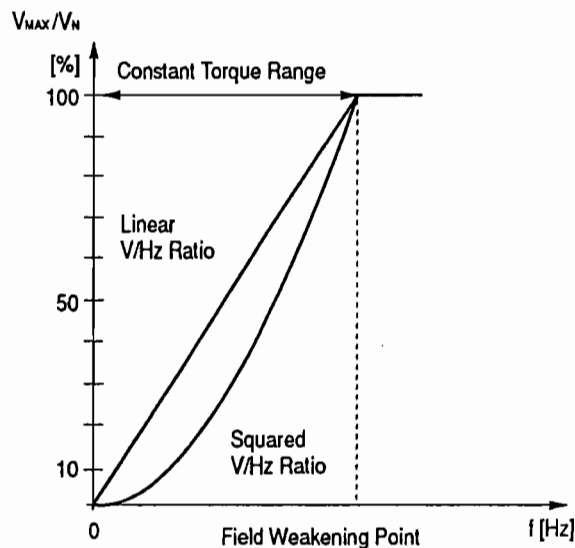
Maximum voltage that the drive will output at and above the Field Weakening point. This parameter is automatically set to the same value as Start-up Data Parameter K (Motor Nom. Voltage) when that parameter is changed. Set in actual volts, step equals 1% of V_N . Range is $0.15 - 1.05 \times V_N$.

3 V/Hz RATIO**LINEAR**

The voltage of the motor changes linearly with frequency in the constant torque area. Linear V/Hz ratio is normally used in Torque control mode, or where the torque characteristics of the load is constant with speed.

Figure 6-6 shows V/Hz ratios.

Figure 6-6 V/Hz Ratios

**SQUARED**

A squared V/Hz ratio undermagnetizes the motor, reducing noise and motor losses. Squared V/Hz ratio is normally used in applications where the load torque characteristic is proportional to the square of the speed, such as centrifugal pumps, fans and compressor drives.

AUTOMATIC

The motor voltage is automatically controlled to minimize the motor losses and noise. This setting is suitable for a motor which has a slowly changing load torque and which operates mainly below nominal load. This feature should not be used with undersized motors (motor hp below drive rated hp).

Note: If Parameter 20.4.3 (V/Hz Ratio) is set to SQUARED or AUTOMATIC, Parameter 20.4.5 (IR Compensation) must be set to NO.

4 FIELD WEAK POINT

The Field Weakening Point is the frequency where the output voltage reaches the maximum output voltage. Above this frequency, the voltage remains at the maximum motor voltage value.

Figure 6-7 shows various field weakening points.

Figure 6-7 Field Weakening Points

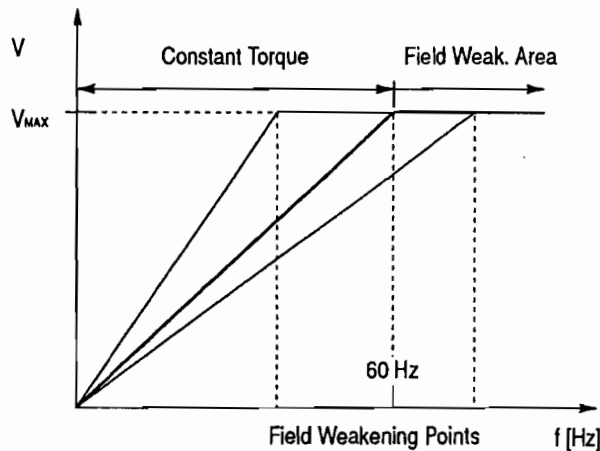
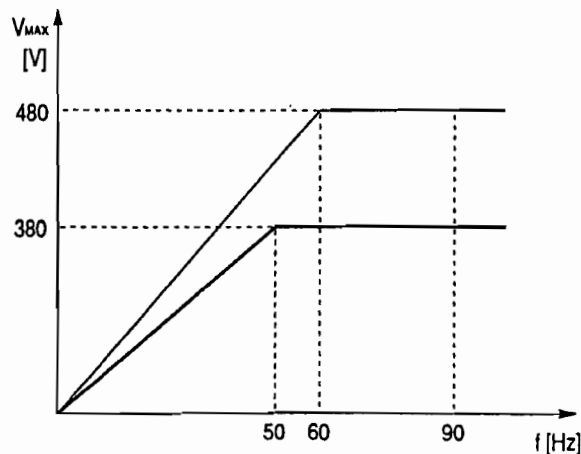


Figure 6-8 shows Parameters 20.4.2 and 20.4.4 adjusted to run a motor not of rated voltage.

Figure 6-8 Motor Not of Rated Voltage



5 IR COMPENSATION

This parameter allows extra torque at speeds between 0.1 Hz and the set field weakening point. This parameter differs from the Torq Boost option of the Start Function in that it is always valid in the above mentioned speed range.

When using IR Compensation, always set Parameter 20.4.3 (V/Hz Ratio) to **LINEAR**.

NO

No compensation wanted.

MANUAL

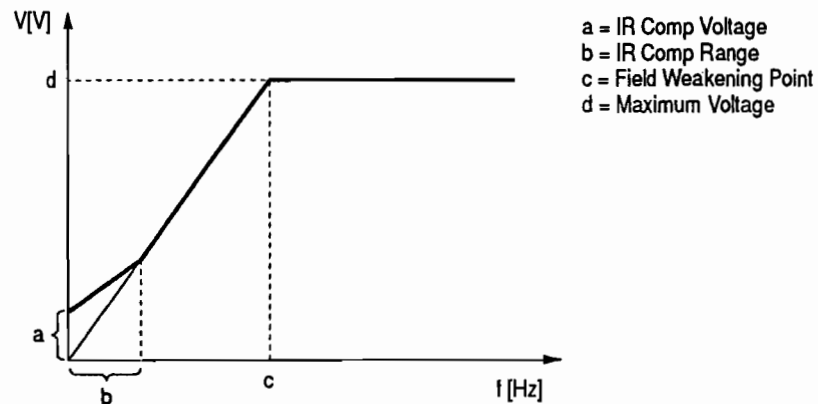
The user sets the compensation voltage and range (Parameters 20.4.6 and 20.4.7).

AUTOMATIC

The IR-Compensation voltage is automatically controlled as a function of effective motor current. This setting is suitable when the need for IR Compensation changes or manual optimization of the compensation voltage is difficult.

Figure 6-9 shows IR-Compensation applying extra voltage to a motor.

Figure 6-9 IR Compensation



Changing the motor base frequency automatically changes this value if it is set higher than the motor base frequency.

6 IR-COMP VOLTAGE

This parameter sets the compensation voltage level in Manual IR Compensation. Keep the boost voltage as low as possible for the application, as the motor will overheat rapidly or an overcurrent fault may occur if a high level of compensation is applied.

Small motors can take higher compensation than larger motors because the winding resistance is higher in small motors. If the motor must drive a load with a high starting torque, use Torq Boost to start. If the load torque is high below the set field weakening point, and you run continuously below the field weakening point, use just enough IR-Compensation to drive the load. If you have trouble with the motor overheating, use a lower speed motor, and run at a higher frequency. Set in actual volts, step equals 1% of V_N , $0.01 - 0.15 \times V_N$, voltage level at 0.1 Hz.

7 IR-COMP RANGE

This parameter defines the frequency at which the Manual IR Compensation reduces to zero. The compensation voltage reduces linearly when the frequency increases.

If Start-Up Data Parameter I (Motor Base Frequency) or Parameter 20.4.4 (Field Weak Point) is changed to a value lower than Parameter 20.4.7 (IR Comp Range), that value will automatically be copied to Parameter 20.4.7 (IR-Comp Range).

8 SLIP COMPENSATION

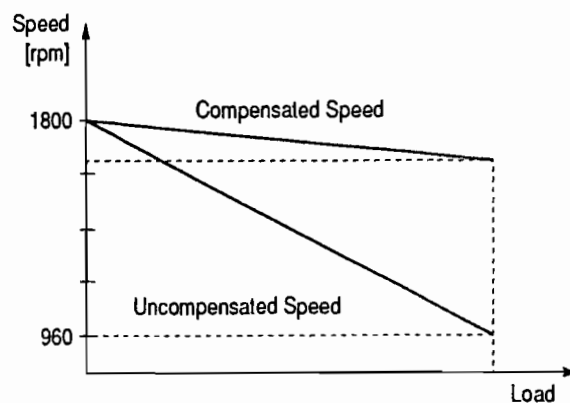
A squirrel-cage motor will slip when loaded. The ACS 500 can compensate for this slip by increasing the frequency as the current increases. With this parameter ON, the slip will be reduced down to approximately 10 percent of the original value.

You must set this function to OFF when using synchronous motors.

This parameter is automatically set to a value based on Start-Up Data Parameters I (Motor Base Freq.) and J (Motor Base R.P.M.). You can adjust the slip compensation after start-up.

Figure 6-10 shows how slip compensation reduces slip in a 4-pole motor under load.

Figure 6-10 Slip Reduction



9 NOMINAL SLIP

For the precise operation of the Slip Compensation function, the ACS 500 must know the nominal slip of the motor. Set the nominal slip as a percentage of the nominal motor speed with a range of 0.1 – 10.0%, 0.1% step.

$$\text{Slip} = \left(1 - \frac{\text{nameplate speed}}{\text{synchronous speed}} \right) \times 100$$

10 VOLTAGE LIMIT

This parameter allows you to deactivate the Over and Undervoltage Controllers.

The overvoltage controller will increase the output frequency if the DC bus voltage exceeds the high DC bus voltage limit level, typically from an overhauling load, to prevent an overvoltage trip.

The undervoltage controller will decrease the output frequency if the DC bus voltage drops below the low DC bus voltage limit, caused by a loss of input power. By decreasing the output frequency, the inertia of the load will cause regeneration back into the drive, keeping the DC bus charged, and preventing an undervoltage trip. This will increase power loss ride through on systems with a high inertia, such as a centrifuge or fan.

Group 20.5 Crit Frequencies

These parameter values can be altered with the ACS 500 running. The Range/Unit column in Table 6-14 shows parameter values. The text following the table explains parameter values in detail.

Table 6-14 Group 20.5

Parameter	Range/Unit	Description
1 CRIT FREQ SELECT	OFF/ON	Critical frequency jump over logic.
2 CRIT FREQ 1 LOW	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Critical frequency 1 start.
3 CRIT FREQ 1 HIGH	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Critical frequency 1 end.
4 CRIT FREQ 2 LOW	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Critical frequency 2 start.
5 CRIT FREQ 2 HIGH	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Critical frequency 2 end.
6 CRIT FREQ 3 LOW	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Critical frequency 3 start.
7 CRIT FREQ 3 HIGH	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Critical frequency 3 end.
8 CRIT FREQ 4 LOW	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Critical frequency 4 start.
9 CRIT FREQ 4 HIGH	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Critical frequency 4 end.
10 CRIT FREQ 5 LOW	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Critical frequency 5 start.
11 CRIT FREQ 5 HIGH	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Critical frequency 5 end.

Note: Using the critical frequency lockout function in a closed loop application (such as PI Control or Pump & Fan Control) will cause the system to oscillate if the output frequency required is within the critical frequency band.

In some mechanical systems, certain frequency ranges can cause resonance problems. With this Group, it is possible to set up to five different frequency ranges that the ACS 500 will skip over. For example, it is not necessary that Parameter 20.5.4 (Crit Freq 2 Low) be greater than Parameter 20.5.3 (Crit Freq 1 High), just as long as the Low parameter of any one set is lower than the High parameter of the same set. Sets may overlap, but the skip will be from the lower Low value to the higher High value.

To activate the Critical Frequency settings, select Parameter 20.5.1 (Crit Freq Select) YES.

Note: Set unused Critical Frequencies to 0 Hz.

Example: Fan system with bad vibration from 18 Hz to 23 Hz and from 46 Hz to 52 Hz. Running speed set to 60 Hz with reference. Set the parameters as follows:

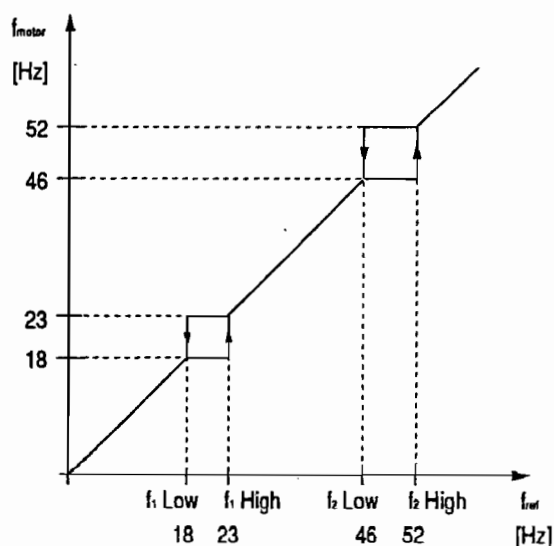
- 2 CRIT FREQ 1 LOW 18 Hz
- 3 CRIT FREQ 1 HIGH 23 Hz
- 4 CRIT FREQ 2 LOW 46 Hz
- 5 CRIT FREQ 2 HIGH 52 Hz

If, due to bearing wear, another resonance occurs at 34 – 36 Hz, the critical frequency table can be added to as follows:

- 6 CRIT FREQ 3 LOW 34 Hz
- 7 CRIT FREQ 3 HIGH 36 Hz

Figure 6-11 shows the critical frequencies settings for fan vibration ranges 18 – 23 Hz and 46 – 52 Hz.

Figure 6-11 Critical Frequency Settings



Main 30 Protection Parameters

Group 30.1 Fault Function

These parameter values can be altered with the ACS 500 running. The Range/Unit column in Table 6-15 shows parameter values. The text following the table explains parameter values in detail.

Table 6-15 Group 30.1

Parameter	Range/Unit	Description
1 SERIAL FAULT FUNC	STOP/ PRE SPEED7	Operation in case of Serial Communication fault.
2 AI < MIN FUNCTION	NO/WARNING/ FAULT/ PRE SPEED7/ LAST SPEED	Operation in case of AI <Minimum fault.
3 MOT TEMP FLT FUNC	NO/WARNING/ FAULT	Operation in case of motor overtemp.
4 MOTOR THERM TIME	20 – 10000s	Time for 63% temperature rise.
5 MOTOR LOAD CURVE	50 – 150%	Motor current maximum limit.
6 ZERO SPEED LOAD	40% - MOTOR LOAD CURVE	Motor load curve point at zero speed.
7 BREAK POINT	1 Hz – 500 Hz	Break point of motor load curve.
8 STALL FUNCTION	NO/WARNING/ FAULT	Operation in case of motor stall.
9 STALL CURRENT	0 – 1.5 times drive current rating.	Current limit for Stall protection logic.
10 STALL TIME/FREQ	10s/15Hz or 20s/ 25Hz or 30s/35Hz	Time/Freq limit for Stall protection logic.
11 UNDERLOAD FUNC	NO/WARNING/ FAULT	Operation in case of Underload fault.
12 UNDERLOAD TIME	0 – 600s	Time limit for Underload logic.
13 UNDERLOAD CURVE	1 – 5	Torque limit for Underload logic.

1 SERIAL FAULT FUNC

This parameter allows you to select the preferred operation in case of a malfunction in serial communication between Control Interface and Motor Control Cards.

STOP

The ACS 500 stops according to the setting of Parameter 20.2.3 (Stop Function).

PRE SPEED7

The ACS 500 drives the motor at a preset speed selected with Parameter 10.3.8 (Preset Speed 7) when in external mode.

Note: If the selected control location is Keypad, the ACS 500 stops in case of serial communication fault.

2 AI < MIN FUNCTION

This parameter allows you to select the preferred operation in case Analog Input (1 or 2) (whichever is being used at that time) signal drops below the minimum setting, provided the minimum is set at 0.3 V/0.6 mA or above ("living zero").

NO

No activity wanted.

WARNING

Warning indication on display.

FAULT

Fault indication on display and the drive stops according to the setting of Parameter 20.2.3 (Stop Function).

PRE SPEED7

Fault indication on display and the output frequency goes to the value set by Parameter 10.3.8 (Preset Speed 7).

LAST SPEED

Fault indication on display and the output frequency goes to the last speed (average over the last 10 seconds).

3 MOT TEMP FLT FUNC

This parameter defines the operation of the motor thermal protection function.

NO

No activity wanted.

WARNING

Warning indication is displayed when the motor temperature reaches the warning level (95 percent of the nominal value).

FAULT

Displays a warning indication at warning level. Displays a fault indication and stops the ACS 500 when the motor temperature reaches 100 percent level.

The motor connected to the ACS 500 can be protected from overheating by motor thermal protection. The ACS 500 calculates the temperature rise of the motor using the following assumptions:

- The ambient temperature is 104°F (40°C).
- The motor is at ambient when power is applied to the ACS 500.
- When stopped, the motor cooling time is four times the cooling time when running.

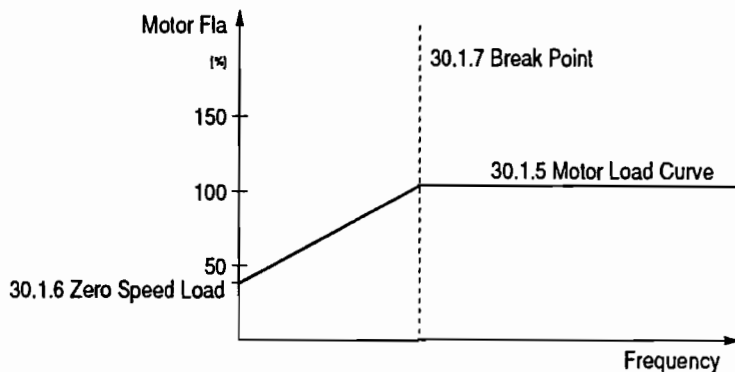
Motor heating is calculated assuming a load curve. The load curve is defined by the Motor Load Curve, Zero Speed Load, and Break Point parameters. If Motor Load Curve is set to 100%, the Motor Thermal Protection allows the motor to be loaded to 100% of the current set by Start-up Data Parameter F (Motor Current -FLA). The load curve level should be adjusted if the ambient temperature differs from the nominal value.

The motor will heat above nominal temperature if it operates in the region above the curve, and cool if operated below the curve. The rate of heating and cooling is set by Motor Therm Time. Motor Therm Time is the time period within which the motor temperature reaches 63 percent of the final temperature rise. As a rule of thumb, Motor Thermal Time equals 35 times t_6 (t_6 in seconds is the safe operating time at locked rotor current given by the motor manufacturer).

Because of the simple thermal model used for calculating temperature rise, this technique of thermal protection may cause undesirable trips if the motor is run continuously at low frequencies. If your application requires continuous running at frequencies lower than 25 Hz, you may need to provide external cooling.

CAUTION: Motor thermal protection will not protect the motor if the cooling efficiency of the motor is reduced due to dust and dirt.

Figure 6-12 Motor Load Curve



4 MOTOR THERM TIME

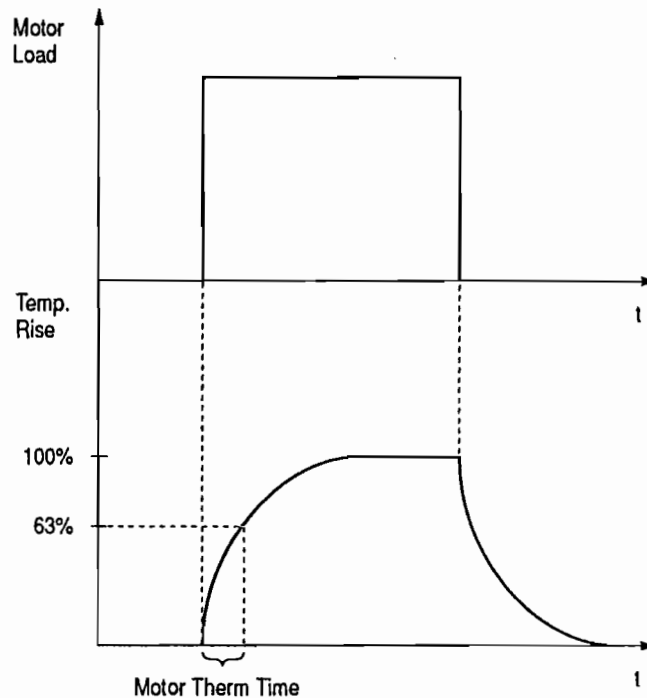
The time period within which the motor temperature reaches 63 percent of the final temperature rise. As a rule of thumb, Motor Thermal Time equals 35 times t_6 (t_6 in seconds is the time that the motor can safely operate at six times its rated current, given by the motor manufacturer). Table 6-16 shows some motor thermal times measured by ABB. The default value is set to 700s, which is the value for a Class 20 trip curve. This has been tested and is UL Listed as motor overload protection. The time for a Class 10 trip curve is 350s and for a Class 30 trip curve is 1050s.

Table 6-16 Motor Thermal Times

P_N [HP]	Number of Poles		
	2	4	6
	t [s]	t [s]	t [s]
3	660	1020	1440
5	780	1140	1740
7.5	900	1260	1760
10	970	1380	1860
15	1140	1560	2040
20	1200	1740	2340
25	1260	1860	2340
30	1380	2040	2760
40	1680	2220	2940
50	1860	2460	3180
60	2040	2640	3420
75	2220	2820	3660
100	2400	3120	3960
125	2640	3300	4320
150	2820	3600	4680
200	3120	3960	5100
250	3420	4320	5700
300	3780	4740	6420
350	3780	4740	6420
400	3780	4740	6420

Figure 6-13 shows motor thermal time.

Figure 6-13 Motor Thermal Time



5 MOTOR LOAD CURVE

The Motor Load Curve sets the maximum allowable operating load of the motor. The load is adjustable from 50% to 150%. Refer to Figure 6-12 for an example of motor load curve.

When set to 100%, the maximum allowable load is equal to the value of Start-up Data Parameter F (Motor Current -FLA).

6 ZERO SPEED LOAD

This parameter defines the maximum allowable current at zero speed to define the Motor Load Curve. Refer to Figure 6-12 for an illustration of the Motor Load Curve.

The current is adjustable from 40% to the Motor Load Curve set by Parameter 30.1.5 (Motor Load Curve).

7 BREAK POINT

This parameter defines the point at which the motor load curve begins to decrease from the maximum value set by Parameter 30.1.5 (Motor Load Curve) to the Zero Speed Load (Parameter 30.1.6). The value is adjustable from 1 Hz to 500 Hz. Refer to Figure 6-12 for an example of motor load curve.

8 STALL FUNCTION

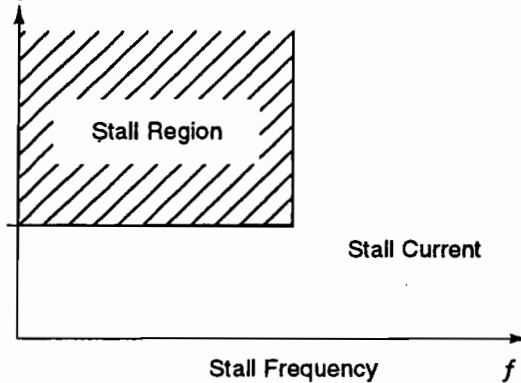
This parameter defines the operation (NO/WARNING/FAULT) of the Stall Protection. The protection is activated if:

- The motor current exceeds the limit set in Parameter 30.1.9 (Stall Current),
- The output frequency is below the level set in Parameter 30.1.10 (Stall Time/Freq), and

- This condition has lasted longer than the period set in Parameter 30.1.10 (Stall Time/Freq).

Figure 6-14 shows stall protection.

Figure 6-14 Stall Protection



9 STALL CURRENT

This parameter sets the current level that must be exceeded for the stall protection to activate. Setting in actual amps, step is 1% of I_N , 0 – 1.5 x I_N .

10 STALL TIME/FREQ

10s/15Hz

20s/25Hz

30s/35Hz

This parameter sets the time and frequency values for the stall function.

11 UNDERLOAD FUNC

Removal of motor load may indicate a process malfunction. The protection is activated if:

- The motor torque drops below the load curve selected in Parameter 30.1.13 (Underload Curve),
- This condition has lasted longer than the time set in Parameter 30.1.12 (Underload Time), and
- Output frequency is more than 5 Hz.

Select NO/WARNING/FAULT according to the activity you prefer.

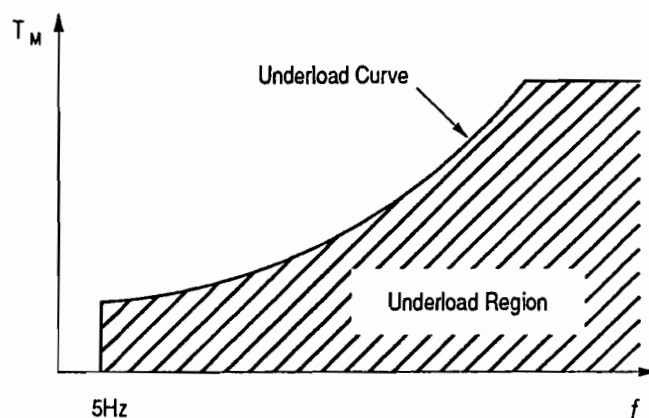
12 UNDERLOAD TIME

0 – 600s, 1s step.

Time limit for underload logic.

Figure 6-15 shows underload protection.

Figure 6-15 Underload Protection



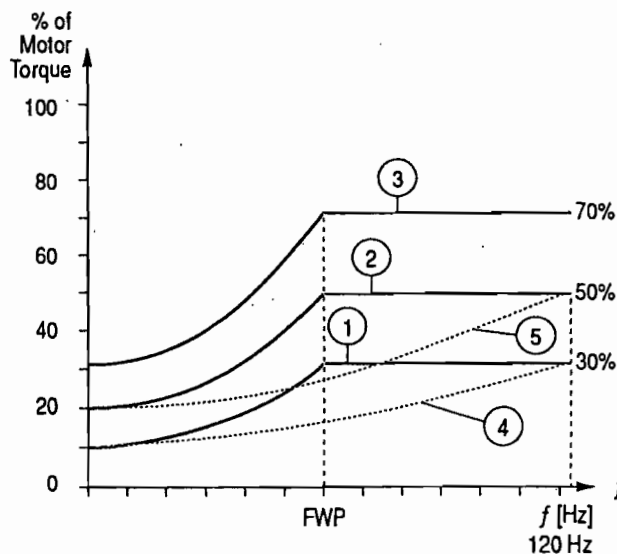
13 UNDERLOAD CURVE

This parameter provides you with five selectable curves.

Torque limit for underload logic.

Figure 6-16 shows five available Underload Curve types. If the load drops below the set curve for a longer time than the time set by Parameter 30.1.12, the underload protection will activate. Curves 1 – 3 reach maximum at the Field Weakening Point set by Parameter 20.4.4 (Field Weak Point).

Figure 6-16 Underload Curve Types



Group 30.2 Automatic Reset

These parameter values can be altered with the ACS 500 running. The Range/Unit column in Table 6-17 shows parameter values. The text following the table explains parameter values in detail.

Table 6-17 Group 30.2

Parameter	Range/Unit	Description
1 NUMBER OF RESETS	0 – 5	Number of faults limit for Autoreset logic.
2 TIME WINDOW	1s – 180s	Time limit for Autoreset logic.
3 TIME BETW. RESET ATTEMPTS	0s– 120s	Time delay between reset attempts.
4 OVERVOLTAGE	NO/YES	Enable automatic fault reset.
5 UNDERVOLTAGE	NO/YES	Enable automatic fault reset when bus voltage returns to normal.
6 OVERCURRENT	NO/YES	Enable automatic fault reset.
7 AI SIGNAL < MIN	NO/YES	Enable automatic fault reset when AI is greater than 0.25V.

1 NUMBER OF RESETS

Sets the number of resets the ACS 500 will attempt before staying shut down and indicating a fault.

2 TIME WINDOW

The maximum number of faults per time period to keep the Automatic Fault Reset System active is given with Parameters 30.2.1 (Number of Resets) and 30.2.2 (Time Window).

If more faults occur or a fault persists longer than Trial Time, the drive stops.

The Automatic Fault Reset System resets the faults selected with Parameters 30.2.4 (Overvoltage), 30.2.5 (Undervoltage), 30.2.6 (Overcurrent), and 30.2.7 (AI Signal < Min).

3 TIME BETW. RESET ATTEMPTS

0 – 120s

This parameter sets the time that the ACS 500 will wait after a fault occurs before attempting to reset. If set to zero, the ACS 500 will reset immediately making the fault transparent to the user. If set to a value greater than zero, the drive will wait before resetting and will count down the time until reset on the digital display. For AI Signal < Min Fault, the ACS 500 will start immediately when the signal returns.

4 OVERVOLTAGE

If you select YES, the ACS 500 resumes operation when the DC bus voltage returns to normal level.

5 UNDERVOLTAGE

If you select YES, the ACS 500 resumes operation when the DC bus voltage returns to normal level. If the number of reset attempts is set to 0 and this parameter is set to YES, the drive will always reset in an undervoltage condition. If the number of reset attempts is greater than 0, the drive counts the number of undervoltage faults.

6 OVERCURRENT

If you select YES, the fault resets automatically and the ACS 500 resumes normal operation.

7 AI SIGNAL < MIN

If you select YES, the drive resets when the analog input signal returns to a level above the minimum.

**Group 30.3
Supervision**

These parameter values can be altered with the ACS 500 running. The Range/Unit column in Table 6-18 shows parameter values. The text following the table explains parameter values in detail.

Table 6-18 Group 30.3

Parameter	Range/Unit	Description
1 OUTPUT FREQ 1 FUNC	NO/LOW LIMIT/ HIGH LIMIT	Output Frequency 1 supervision.
2 OUTPUT FREQ 1 LIM	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Output Frequency 1 supervision limit.
3 OUTPUT FREQ 2 FUNC	NO/LOW LIMIT/ HIGH LIMIT	Output Frequency 2 supervision.
4 OUTPUT FREQ 2 LIM	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Output Frequency 2 supervision limit.
5 CURRENT FUNCTION	NO/LOW LIMIT/ HIGH LIMIT	Motor Current supervision.
6 CURRENT LIMIT	0 – 2 times drive output current	Motor Current supervision limit.
7 REF1 FUNCTION	NO/LOW LIMIT/ HIGH LIMIT	Reference 1 supervision.
8 REF1 LIMIT	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Reference 1 supervision limit.
9 REF2 FUNCTION	NO/LOW LIMIT/ HIGH LIMIT	Reference 2 supervision.
10 REF2 LIMIT	0 – 100%	Reference 2 supervision limit.
11 SUPERVIS MESSAGES	ON/OFF	Turn off display of supervision messages.

Figure 6-17 shows an example of a supervision indication.

Figure 6-17 Supervision Indication

```

*** SUPERVISION ***
2 ACT FREQ 1      R1[->1]

```

1 OUTPUT FREQ 1 FUNC	This parameter allows you to activate an output frequency supervision function. Relay outputs such as Parameters 10.6.1 (Relay RO1 Output), 10.6.2 (Relay RO2 Output), and 10.6.3 (Relay RO3 Output) and displays are used to indicate that the output frequency drops below (LOW LIMIT) or exceeds (HIGH LIMIT) the supervision limit.
	NO
	Supervision not used.
	LOW LIMIT
	Supervision will activate if value is below the limit set.
	HIGH LIMIT
	Supervision will activate if value is above the limit set.
2 OUTPUT FREQ 1 LIMIT	Output frequency supervision limit adjustable from 0 – 500 Hz (ACS 501) or 0 – 120 Hz (ACS 502), 0.1 Hz step.
3 OUTPUT FREQ 2 FUNC	Refer to Parameter 30.3.1.
4 OUTPUT FREQ 2 LIMIT	A second output frequency supervision limit adjustable from 0 – 500 Hz (ACS 501) or 0 – 120 Hz (ACS 502), 0.1 Hz step.
5 CURRENT FUNCTION	Motor Current supervision. Operates the same as Parameter 30.3.1.
6 CURRENT LIMIT	Motor current supervision limit. Setting in actual amps, step is 1% of I_R , adjustable from 0 – $2.0 \times I_R$.
7 REF1 FUNCTION	Reference 1 supervision. Operates the same as Parameter 30.3.1.
8 REF1 LIMIT	Reference 1 supervision limit adjustable from 0 – 120 Hz, 0.1 Hz step.
9 REF2 FUNCTION	Reference 2 supervision. Operates the same as Parameter 30.3.1.
10 REF2 LIMIT	Reference 2 supervision limit adjustable from 0 – 120 Hz, 0.1 Hz step.
11 SUPERVIS MESSAGES	This parameter controls the display of supervision messages. If set to OFF, the supervision messages will not display on the digital display.

**Group 30.4
Information**

You cannot alter these parameter values. The Range/Unit column in Table 6-19 shows parameter values. The text following the table explains parameter values in detail.

Table 6-19 Group 30.4

Parameter	Range/Unit	Description
1 CRI PROG VERSION	CRU _{xy}	Control Interface Card program version.
2 MC PROG VERSION	MCR _{xy} /CNT _{xy}	Motor Control Card program version.
3 TEST DATE	YY.MM.DD	Test date (year,month,day).

1 CRI PROG VERSION

This parameter displays the Control Interface Card version installed in your ACS 500.

2 MC PROG VERSION

This parameter displays the Motor Control Card version installed in your ACS 500.

3 TEST DATE

This parameter displays the test date of the ACS 500.

**Group 30.5
I/O Status**

You cannot alter these parameter values. The Range/Unit column in Table 6-20 shows parameter values. The text following the table explains parameter values in detail. The parameters in this group show the status of the I/O.

Table 6-20 Group 30.5

Parameter	Range/Unit	Description
1 DI1-6 STATUS	000000	Indication of the status of the six digital inputs. 0=Open; 1=Closed
2 AI1 V/mA	0.00/ 0.00	Signal at Analog Input 1 in volts and milliamps
3 AI2 V/mA	0.00/ 0.00	Signal at Analog Input 2 in volts and milliamps
4 RO1-3 STATUS	000	Indication of the status of the three relay outputs. 0=Open; 1=Closed
5 AO1 mA/%	0.00/ 0%	Signal at Analog Output 1 in milliamps and percent.
6 AO2 mA/%	0.00/ 0%	Signal at Analog Output 2 in milliamps and percent.

Main 40 Application Parameters

Group 40.1 PI-Controller

These parameters can only be seen when you select the PI-Control macro.

These parameter values can be altered with the ACS 500 running, except those marked with (O). The Range/Unit column in Table 6-20 shows parameter values. The text following the table explains parameter values in detail.

Table 6-20 Group 40.1

Parameter	Range/Unit	Description
1 PI-CONT GAIN	3 – 800%	PI-Controller Gain selection.
2 PI-CONT I-TIME	0.02 – 320.00s	PI-Controller I-time selection.
3 PI-CONT MIN LIMIT	0 – 120 Hz	PI-Controller output freq. minimum limit.
4 PI-CONT MAX LIMIT	0 – 120 Hz	PI-Controller output freq. maximum limit.
5 ERROR VALUE INVERT	NO/YES	PI-Controller error value inversion.
6 ACTUAL VALUE SEL (O)	ACT1/ACT1 - ACT2/ ACT+ACT2/ ACT1*ACT2	PI-Controller output signal selection.
7 ACTUAL 1 INPUT (O)	AI1/AI2	Actual 1 signal input selection.
8 ACTUAL 2 INPUT (O)	AI1/AI2	Actual 2 signal input selection.
9 ACT 1 MIN SCALE	-1600.0 – +1600.0%	Minimum scaling factor of the Actual 1.
10 ACT 1 MAX SCALE	-1600.0 – +1600.0%	Maximum scaling factor of the Actual 1.
11 ACT 2 MIN SCALE	-1600.0 – +1600.0%	Minimum scaling factor of the Actual 2.
12 ACT 2 MAX SCALE	-1600.0 – +1600.0%	Maximum scaling factor of the Actual 2.

The PI Controller allows the ACS 500 to take a reference signal (setpoint) and an actual signal (feedback), and automatically adjust the output frequency of the drive to match the actual signal to the reference.

1 PI-CONT GAIN

This parameter defines the gain of the PI-Controller included in the Application macros of the ACS 500. Setting range is 3 – 800%. If you select 100%, a 10% change in error value causes controller output to change by 1.5 Hz.

If the parameter value is set to 3.0%, the PI-Controller operates as an I-Controller.

Table 6-21 lists a few examples of gain settings, and the resulting output frequency change to a 10% change in error and a 50% change in error.

Table 6-21 Gain Settings

PI-Cont Gain	Output Frequency Change for a 10% Change in Error	Output Frequency Change for a 50% Change in Error
50%	0.75 Hz	3.75 Hz
100%	1.5 Hz	7.5 Hz
300%	4.5 Hz	22.5 Hz

2 PI-CONT I-TIME

If the parameter value is set to 320.00s, the PI-Controller operates as a P-Controller. Time range is 0.02s – 320.00s, 0.01s step.

3 PI-CONT MIN LIMIT

The minimum value of the PI-Controller frequency output. The limit cannot be set less than 20.1.1 (Minimum Frequency). Range is 0 – 120 Hz, 0.01 Hz step.

4 PI-CONT MAX LIMIT

The maximum value of the PI-Controller frequency output. The limit cannot be set greater than 20.1.2 (Maximum Frequency). Range is 0 – 120 Hz, 0.01 Hz Step.

**5 ERROR VALUE
INVERT**

This parameter allows you to invert the Error Value (and thus the operation of the PI-Controller). Normally, a decrease in Actual Signal (Feedback) causes an increase in drive speed. If a decrease in Actual should cause a decrease in speed, set Error Value Invert to YES.

6 ACTUAL VALUE

The Actual Value for the PI Controller can be a single signal, or two signals combined by subtraction, addition or multiplication. The choices are as follows.

ACT1

ACT1-ACT2

ACT1+ACT2

ACT1*ACT2

7 ACTUAL 1 INPUT

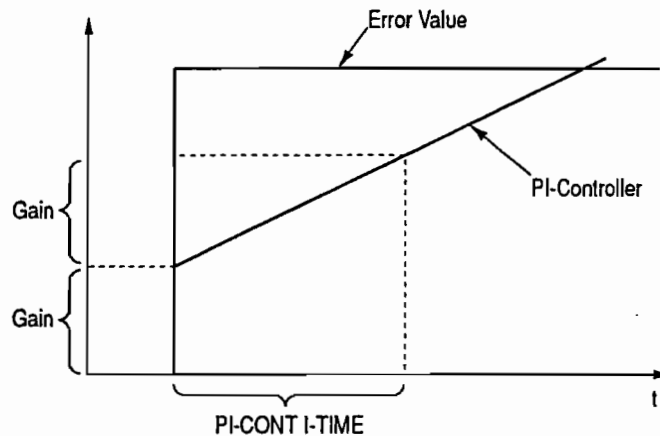
AI1 OR AI2

8 ACTUAL 2 INPUT

AI1 OR AI2

Figure 6-18 shows PI-Controller Gain, I-Time, and Error Value.

Figure 6-18 PI-Controller Gain, I-Time, and Error Value



9 ACT 1 MIN SCALE

Minimum scaling factor of the Actual Value 1. Setting range is -1600 to +1600%.

0%

The minimum Actual Value corresponds to the minimum scaled Actual Value.

100%

The maximum Actual Value corresponds to the minimum scaled Actual Value.

10 ACT 1 MAX SCALE

Maximum scaling factor of the Actual Value 1. Setting range is -1600 to +1600%.

0%

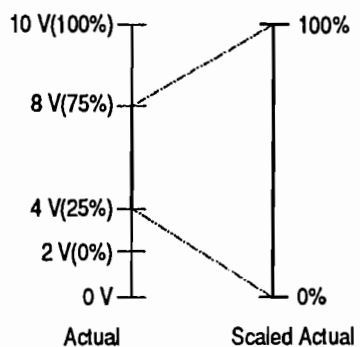
The minimum Actual Value corresponds to the maximum scaled Actual Value.

100%

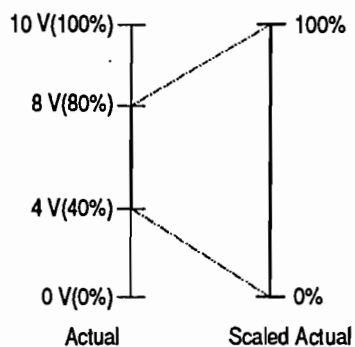
The maximum Actual Value corresponds to the maximum scaled Actual Value.

Figure 6-19 show three examples of actual value scaling.

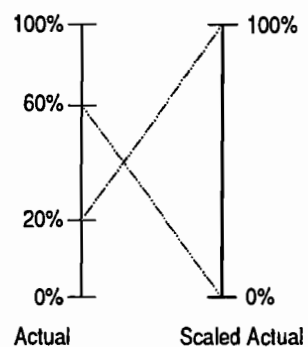
Figure 6-19 Actual Value Scaling



Minimum AI 2V/4mA
Act 1 Max Scale 75%
Act 1 Min Scale 25%



Minimum AI 0V/0mA
Act 1 Max Scale 80%
Act 1 Min Scale 40%



Act 1 Max Scale = 20%
Act 1 Min Scale = 60%

- 11 ACT 2 MIN SCALE Refer to Parameter 40.1.9.
12 ACT 2 MAX SCALE Refer to Parameter 40.1.10.

Group 40.2 Pump & Fan Control

These parameters can only be seen when you select the P&F Autom. macro.

These parameter values can be altered with the ACS 500 running, except those marked with (O). The Range/Unit column in Table 6-22 shows parameter values.

Table 6-22 Group 40.2

Parameter	Range/Unit	Description
1 PI-CONT GAIN	3% – 800%	PI-Controller Gain selection.
2 PI-CONT I-TIME	0, 1s – 320s	PI-Controller I-time selection.
3 REFERENCE STEP 1	0% – 100%	Reference increase 1.
4 REFERENCE STEP 2	0% – 100%	Reference increase 2.
5 REFERENCE STEP 3	0% – 100%	Reference increase 3.
6 SLEEP DELAY	0s – 3600s	Time delay for sleep function.
7 SLEEP LEVEL	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Level for activation of sleep function.
8 WAKE UP LEVEL	0% – 100%	Level for deactivation of sleep function.
9 START FREQ 1	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Start frequency for first lag motor.
10 START FREQ 2	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Start frequency for second lag motor.
11 START FREQ 3	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Start frequency for third lag motor.
12 LOW FREQ 1	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Output frequency after first lag motor starts.
13 LOW FREQ 2	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Output frequency after second lag motor starts.
14 LOW FREQ 3	0 – 500 Hz (ACS 501) 0 – 120 Hz (ACS 502)	Output frequency after third lag motor starts.
15 LAG MOT START DLY	0s – 3600s	Lag motor start delay.
16 LAG MOT STOP DLY	0s – 3600s	Lag motor stop delay.
17 NBR OF LAG MOTORS	0 – 3	Number of lag motors.
18 ALTERNATION INTERV.	0h – 168h	Lag motor alternation interval.
19 ALTERNATION LEVEL	0% – 100%	Low level threshold for alternation.
20 INTERLOCKS	OFF/ON	Lag motor interlocks.

Parameter	Range/Unit	Description
21 ERROR VALUE INVERT	NO/YES	PI-Controller error value inversion.
22 ACTUAL 1 INPUT (O)	NO/AI1/AI2	Actual 1 signal input selection.
23 ACTUAL 2 INPUT (O)	NO/AI1/AI2	Actual 2 signal input selection.
24 ACTUAL VALUE SEL (O)	ACT1/ACT1 - ACT2/ ACT+ACT2/ ACT1*ACT2/ min(A1,A2)/ max(A1,A2)/sqrt(ACT1)/ sqA1+sqA2	PI-Controller output signal selection.
25 ACT 1 MIN SCALE	-1600.0 – +1600.0%	Minimum scaling factor of the Actual 1.
26 ACT 1 MAX SCALE	-1600.0 – +1600.0%	Maximum scaling factor of the Actual 1.
27 ACT 2 MIN SCALE	-1600.0 – +1600.0%	Minimum scaling factor of the Actual 2.
28 ACT 2 MAX SCALE	-1600.0 – +1600.0%	Maximum scaling factor of the Actual 2.
29 REGUL. BYPASS	OFF/ON	Bypass PI Regulator.
30 DISPLAY UNIT	NO UNIT; bar; %; m/s; C; F; diff temp; kPa; 1/min; m ³ /min; gpm; psi; dpsi; cFm; ft; in.; inHg	Units of ACT1 and ACT2 on the display.
31 DISPL UNIT SCALE	0 – 50000	Scaling factor for display.
32 NBR OF DECIMALS	0 – 5	Number of decimal digits.

The Pump and Fan Control (PFC) is a special type of PI-Control that will allow the ACS 500 to sequence on additional or lag motors when the demand exceeds the capabilities of one motor. As in the PI-Control macro, the ACS 500 is given two signals: a setpoint (or reference) and a feedback (or actual). The output frequency of the ACS 500 will adjust automatically to maintain the feedback at the same value as the setpoint. If the feedback and setpoint are not equal, the output frequency will increase or decrease.

An additional feature of the PFC is that if the output frequency reaches a high limit without making the feedback equal to the setpoint, a second motor will be started and the output frequency of the drive will decrease. Up to three lag motors can be connected.

An example of Pump and Fan Control use is provided after the following description of the parameters.

1 PI-CONT GAIN

This parameter defines the gain of the PI-Controller included in the Application macros of the ACS 500. Setting range is 3 – 800%. If you select 100%, a 10% change in error value causes controller output to change by 1.5 Hz.

If the parameter value is set to 3.0%, the PI-Controller operates as an I-Controller.

Table 6-23 lists a few examples of gain settings, and the resulting output frequency change to a 10% change in error and a 50% change in error.

Table 6-23 Gain Settings

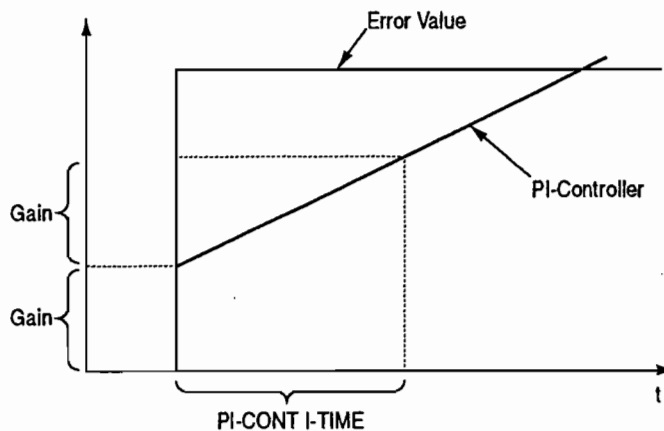
PI-Cont Gain	Output Frequency Change for a 10% Change in Error	Output Frequency Change for a 50% Change in Error
50%	0.75 Hz	3.75 Hz
100%	1.5 Hz	7.5 Hz
300%	4.5 Hz	22.5 Hz

2 PI-CONT I-TIME

If the parameter value is set to 320.00s, the PI-Controller operates as a P-Controller. Time range is 0.02s – 320.00s, 0.01s step.

Figure 6-20 shows PI-Controller Gain, I-Time, and Error Value.

Figure 6-20 PI-Controller Gain, I-Time, and Error Value

**3 REFERENCE STEP 1**

0 – 100%

Value that the setpoint (reference) is increased when the first lag motor is started.

4 REFERENCE STEP 2 0 – 100%

Value that the setpoint (reference) is increased when the second lag motor is started.

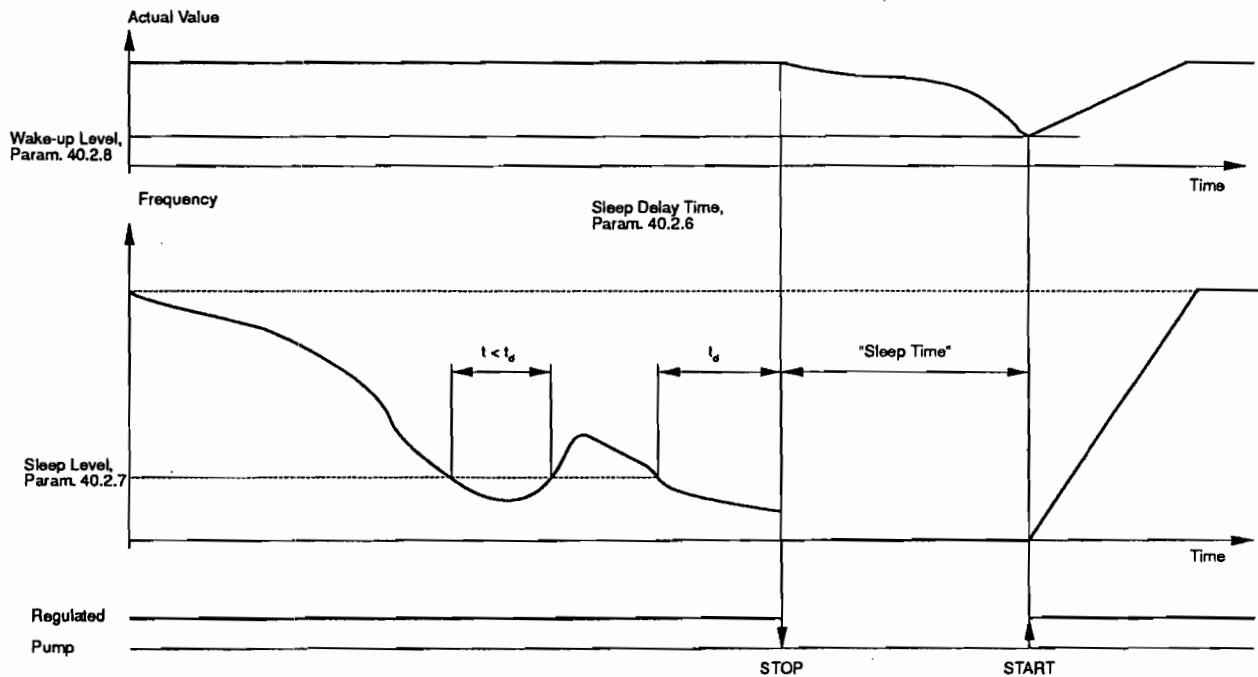
5 REFERENCE STEP 3 0 – 100%

Value that the setpoint (reference) is increased when the third lag motor is started.

Sleep Function

Sleep function is a special energy savings facility. This function can be used in pumping stations, for example, to minimize energy consumption by stopping the regulated pump automatically if demand stays very low longer than the preset time. Usually water consumption at night is almost zero and the regulated pump runs at the set minimum speed, which normally means that flow through the pump is zero. The sleep level (Parameter 40.2.7) and sleep delay (Parameter 40.2.8) parameters define when PFC stops the regulated pump. The wake-up level (Parameter 40.2.8) defines the start level which the actual signal has to reach to restart the regulated pump. Figure 6-21 shows an example of a sleep function.

Figure 6-21 Sleep Function Example

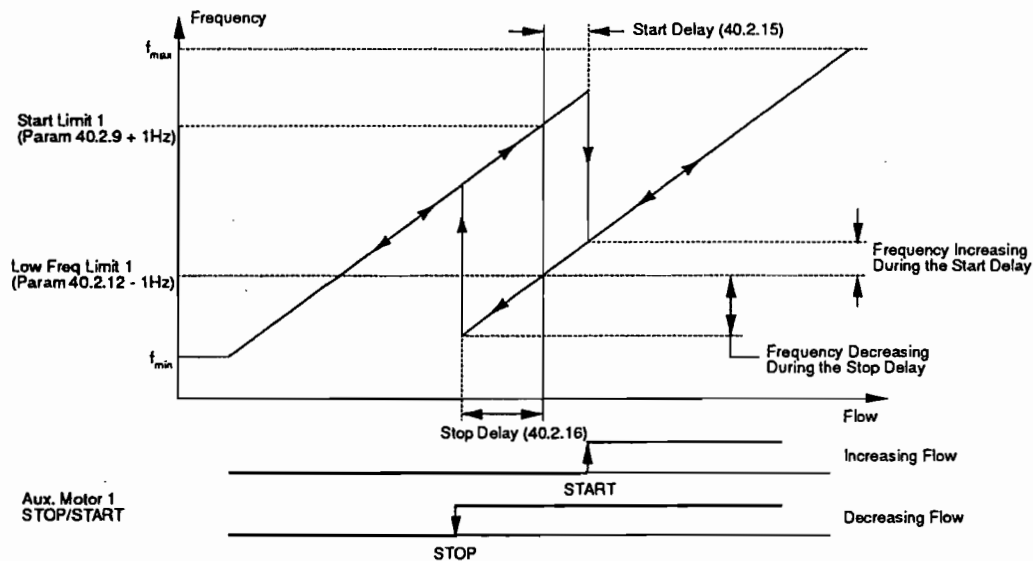


6 SLEEP DELAY 0 – 3600s

If the output frequency remains below the set sleep level longer than the Sleep Delay, the ACS 500 is stopped automatically. If Sleep Delay is set to 0, the sleep function is disabled.

- 7 SLEEP LEVEL** 0 – 500 Hz (ACS 501)
 0 – 120 Hz (ACS 502)
 Level to start sleep delay counter.
- 8 WAKE UP LEVEL** 0 – 100%
 Level in % of the set reference range. This parameter determines the level of the actual value at which the ACS 500 will restart.
- 9 START FREQ 1** 0 – 500 Hz (ACS 501)
 0 – 120 Hz (ACS 502)
 Output frequency at which the first lag motor will start. The start frequency has a fixed 1 Hz hysteresis.

Figure 6-22 Pump Automation Example



- 10 START FREQ 2** Same functionality as Parameter 40.2.9 (Start Freq 1) except for second lag motor.
- 11 START FREQ 2** Same functionality as Parameter 40.2.9 (Start Freq 1) except for third lag motor.
- 12 LOW FREQ 1** 0 – 500 Hz (ACS 501)
 0 – 120 Hz (ACS 502)
 Output frequency that the ACS 500 will go to after the first lag motor is started. If the output frequency goes below this limit by 1 Hz, the lag motor will stop.

- 13 LOW FREQ 2** **0 – 500 Hz (ACS 501)**
0 – 120 Hz (ACS 502)
- Output frequency that the ACS 500 will go to after the second lag motor is started. If the output frequency goes below this limit by 1 Hz, the lag motor will stop.
- 14 LOW FREQ 3** **0 – 500 Hz (ACS 501)**
0 – 120 Hz (ACS 502)
- Output frequency that the ACS 500 will go to after the third lag motor is started. If the output frequency goes below this limit by 1 Hz, the lag motor will stop.
- 15 LAG MOT START DLY** **0 – 3600s**
- Start delay for lag motors to prevent the lag motor from starting due to a momentary crossing of the start limit. The frequency must remain above the start limit for the period of time set by this parameter before the lag motor will start.
- 16 LAG MOT STOP DLY** **0 – 3600s**
- Stop delay for lag motors to prevent the lag motor from stopping due to a momentary crossing of the stop limit. The frequency must remain below the stop limit for the period of time set by this parameter before the lag motor will stop.
- 17 NBR OF LAG MOTORS** **0 – 3**
- Number of lag motors in the system. Requires I/O Extension Board to use third motor.
- 18 ALTERNATION INTERV.** **0 min – 168 hrs**
- Time interval for changing the sequencing order of the motors. Alternation only occurs when the actual signal goes below the level set by Parameter 40.2.19 (Alternation Level). Setting the value to 00h 00min disables the alternation function. This must be done with the drive stopped. The interval time only counts the time that the ACS 500 is commanded to run.
- 19 ALTERNATION LEVEL** **0 – 100%**
- Actual value level below which the alternation takes place. When the time set by Parameter 40.2.18 (Alternation Interv.) is exceeded and the level goes below the level set by this parameter, the order of the lag motors will change.
- With this parameter set to 0, automatic alternation only takes place when the ACS 500 is stopped (normal or “sleep”).
- The alternation level is in relation to the set maximum frequency and to the capacity of the system such that, if a value of the parameter is 45% and the system has only two motors, the automatic exchange takes place at the frequency of $0.45/50 \times f_{max}$.
- If there are more motors connected, the percentage value corresponding to the set maximum frequency is:

1+1 motors	50.0%
1+2 motors	33.3%
1+3 motors	25.0%

For example: if the values of the parameters are:

Nbr of lag motors (40.2.17) = 2

Alternation level (40.2.19) = 25%

Max frequency (20.1.2) = 51 Hz

the alternation takes place at 38.3 Hz (25%/33.3% x 51 Hz) if the following conditions are true:

- Alternation interval time has elapsed,
- Actual value is below the set alternation level,
- Minimum one lag motor is not running, and
- The ACS 500 is not running at a preset speed (DI/param., Group 10.3).

When all the conditions are valid, PFC stops all motors, changes the order of the motors, and starts the motors using the new start order. The starting order cannot be changed externally.

The start order and the elapsed run time remain in the ACS 500 memory during a power interruption.

Note: If only the regulated pump is used, cancel the alternation operation by setting Parameter 40.2.18 (Alternation Interv.) to 00 h 00 min. This releases relay outputs RO1 to RO4 for other use.

20 INTERLOCKS ON/OFF

Digital inputs can be used as interlocks for the connected motors. A contact from the disconnect at each motor is brought to a digital input. If a motor is taken out of service, the ACS 500 will skip that motor when it is needed and select the next available pump. If this parameter is set to ON, DI2 DI3, and DI4 are reserved for the interlocks. The I/O extension board must be ordered to use this function. If this function is set to OFF, the digital inputs are available for other functions.

If an interlocking function is in use and one of the interlocking signals disappears while the motors are running, the ACS 500 will stop and a corresponding output relay (RO1 to RO4) will release and stop the respective motor. If other motors are available, PFC connects one of those instead and starts the ACS 500 again.

21 ERROR VALUE INV. NO/YES

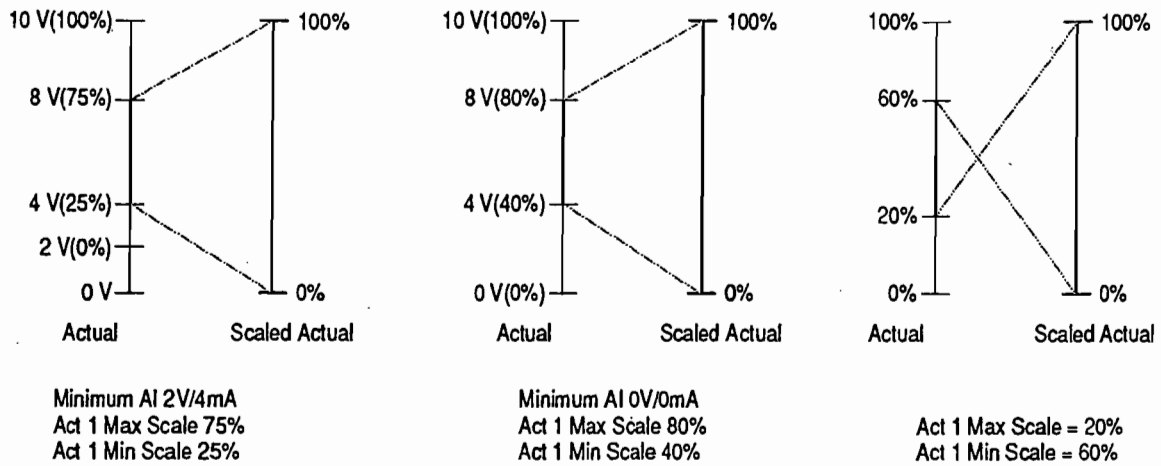
This parameter allows you to invert the Error Value (and thus the operation of the PI-Controller). Normally, a decrease in Actual Signal (Feedback) causes an increase in drive speed. If a decrease in Actual should cause a decrease in speed, set Error Value Invert to YES.

22 ACTUAL 1 INPUT AI1 OR AI2

23 ACTUAL 2 INPUT	AI1 OR AI2
24 ACTUAL VALUE SEL	The Actual Value for the PI Controller can be a single signal, or two signals combined by subtraction, addition or multiplication. The choices are as follows. ACT1 ACT1-ACT2 ACT1+ACT2 ACT1*ACT2 min(A1,A2) Actual value is ACT1 or ACT2, whichever is lower. max(A1,A2) Actual value is ACT1 or ACT2, whichever is higher. sqrt(ACT1) Square root of ACT1. sqA1+sqA2 Square root of ACT1 + square root of ACT2.
25 ACT 1 MIN SCALE	Minimum scaling factor of the Actual Value 1. Setting range is -1600 to +1600%. 0% The minimum Actual Value corresponds to the minimum scaled Actual Value. 100% The maximum Actual Value corresponds to the minimum scaled Actual Value.
26 ACT 1 MAX SCALE	Maximum scaling factor of the Actual Value 1. Setting range is -1600 to +1600%. 0% The minimum Actual Value corresponds to the maximum scaled Actual Value. 100% The maximum Actual Value corresponds to the maximum scaled Actual Value.

Figure 6-23 show three examples of actual value scaling.

Figure 6-23 Actual Value Scaling



27 ACT 2 MIN SCALE

Refer to Parameter 40.2.25.

28 ACT 2 MAX SCALE

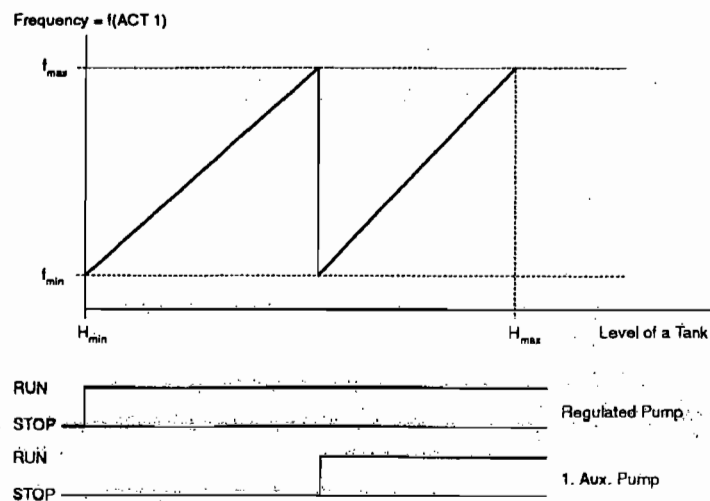
Refer to Parameter 40.2.26.

29 BYPASS CONTROL

NO/YES

The PI regulator of the PFC can be bypassed if the value of Parameter 40.2.29 is set to YES. When the regulator is bypassed, the actual value signal replaces the output of the PI regulator as a final speed reference. The automatic start and stop of constant speed motors is referred to the actual value signal instead of the output of the PI regulator. Refer to Figure 6-24 for an example of the PI regulator bypass function. This function is useful in flow control of precipitation tanks.

Figure 6-24 PI Regulator Bypass Function



30 DISPLAY UNIT	NO UNIT; bar; %; m/s; °C; °F; diff temp; kPa; 1/min; m ³ /min; gpm; psi; dpsi; cFm; ft; in.; inHg
	Unit of ACT1 and ACT2 indicated on the display.
31 DISPL UNIT SCALE	0 – 50000
	Scaling factor for display unit.
32 NBR OF DECIMALS	0 – 5
	Number of decimal places in the displayed actual values.
<i>Sample PFC Application</i>	One example of automatic Pump and Fan Control application is fresh water constant pressure control with two pumps.
	In this example a pump station has two pumps used to maintain constant pressure at different flow situations. One of the pumps is speed regulated with an ACS 500 and the other is a constant speed pump ON/OFF controlled with the PFC macro.
	<i>Note: The other pump could also be controlled by an ACS 500.</i>
	When water consumption is less than the nominal output of the pump, PFC controls the speed of the regulated pump downwards so that production of the pump equals the demand. If water consumption increases, the PFC regulator speed of the pump increases equally until the start limit of the constant speed pump is reached (start limit = set value of Parameter 40.2.9 (Start Freq 1) + 1 Hz). Start occurs after the set start delay (set value of Parameter 40.2.15) if demand remains above the start limit for longer than the start delay. When the constant speed pump starts, the speed of the regulated pump will automatically regulate to the set low frequency 1 value (Parameter 40.2.12).
	If the demand increases further, the speed of the regulated pump regulates upwards, maintaining equal pressure in the system.
	If demand decreases, the speed of the regulated pump first regulates downwards until the stop limit (stop limit = set value of Parameter 40.2.12 (Low Freq 1) - 1 Hz) of the constant speed pump is reached. The constant speed pump is stopped after the set stop delay (Parameter 40.2.16) if demand remains below the stop limit for longer than the stop delay. When the constant speed pump stops, the speed of the regulated pump will increase to meet the demand. Refer to Figure 6-22 for an example of pump automation.
	If a start limit of an auxiliary pump has been set higher than the maximum frequency of the ACS 500, the lag pump starts at the defined start limit because the output of the PI regulator has not been limited by the maximum frequency of the ACS 500.
	If a stop limit is set lower than the minimum frequency of the ACS 500, a lag pump will stop at the defined stop limit because the output of the PI regulator has not been limited by the minimum frequency of the ACS 500.
	As long as the output of the regulator remains above the maximum frequency or below the minimum frequency, the regulated pump runs at the corresponding frequency limit.

Appendix A – Complete Parameter Settings

The tables in this appendix list all the parameters and alternative settings for the ACS 500. Use these tables as reference guides when you are customizing macros for your ACS 500 application. A signal flow diagram is included at the end of this appendix.

Table A-1 Parameter Settings

Parameter	Alternative Settings	Custom Setting
START-UP DATA		
A LANGUAGE	ENGLISH; GERMAN; ITALIAN; SPANISH; DUTCH; FRENCH; DANISH; FINNISH; SWEDISH	
B APPLICATIONS	FACTORY; HAND/AUTO; PI-CONTROL; OPT. PACK; SEQ CTRL; P&F AUTOM; USER load; USER save	
C APPLIC. RESTORE	NO; YES	
D SUPPLY VOLTAGE	208/220/230/240; 380/400/415; 440/460/480/500	
E USER DISPLAY SCALE	0 – 10000	
F MOTOR CURRENT -FLA	0 A – 1000 A (printed on the motor nameplate)	
G MOTOR POWER hp (kW)	0.7 hp – 1340 hp (0.5 kW – 1000 kW) (printed on the motor nameplate)	
H MOTOR POWER FACTOR	0.1 – 1.0 (printed on the motor nameplate)	
I MOTOR BASE FREQ.	30 Hz – 500 Hz (printed on the motor nameplate)	
J MOTOR BASE R.P.M.	200 RPM – SYNC. SPEED (printed on the motor nameplate)	
K MOTOR NOM. VOLTAGE	110 V – 575 V (printed on the motor nameplate)	

Parameter	Alternative Settings	Custom Setting
OPERATING DATA		
1 OUTPUT FREQUENCY	Hz	
2 SPEED	RPM; %; USER SCALING	
3 MOTOR CURRENT	A	
4 % RATED TORQUE	%	
5 % RATED POWER	%	
6 DC BUS VOLTAGE	V; % OF RATED NOMINAL	
7 OUTPUT VOLTAGE	V	
8 DRIVE TEMPERATURE	degrees C and F	
9 CONTROL LOCATION	KEYPAD R1; KEYPAD PI; EXTERNAL	
10 KEYPAD REF 1	Hz	
11 KEYPAD PI (REF 2)	%	
12 EXT REF 1 OR 2	REF1/REF2	
13 EXTERNAL REF 1	Hz	
14 EXTERNAL REF 2	%	
15 RUN TIME	h/min	
16 KILOWATT HOURS	kWh	
17 LAST-RECD FAULT	FAULT; WARNING	
18 SECOND-RECD FAULT	FAULT; WARNING	
19 FIRST-RECD FAULT	FAULT; WARNING	
20 PARAMETER LOCK	OPEN xxx; LOCKED xxx; OPEN; LOCKED	
21 APPL BLOCK OUTPUT	%	
22 ACTUAL VALUE 1	%	
23 ACTUAL VALUE 2	%	
24 AUX MOTORS RUNNING	0 – 3	
25 CONTROLLER OUTPUT	%	
26 CONTROL ERROR	%	
27 ACT VALUE 1 (PFC)	Engineering Units	
28 ACT VALUE 2 (PFC)	Engineering Units	

Parameter	Alternative Settings	Custom Setting
10 CONTROL CONNECTIONS		
10.1 START/STOP/DIRECTION		
10.1.1 EXT 1 STRT/STP/DIR	NOT SEL; DI1; DI1,2; DI1P,2P; DI 1P, 2P, 3; DI1P,2P,3P; DI6; DI6,5; KEYPAD	
10.1.2 EXT 2 STRT/STP/DIR	NOT SEL; DI6; DI6,5; DI1; DI1,2; DI1P,2P; DI 1P, 2P, 3; DI1P,2P,3P; KEYPAD	
10.1.3 LOC/EXT DIRECTION	REVERSE; FORWARD; REQUEST; FAST REV	
10.2 EX REFERENCE SELECT		
10.2.1 EXT 1/EXT 2 SELECT	OP DATA 12; DI1; DI2; DI3; DI4; DI5; DI6	
10.2.2 EXTERNAL REF1 SEL	OP DATA 13; AI1; AI2; AI1/JOYST; DI3U,4D; DI3U,4D(R); DI5U,6D	
10.2.3 EXT REF1 MINIMUM	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.2.4 EXT REF1 MAXIMUM	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.2.5 EXT REF1 OFFSET	-30 Hz – 30 Hz	
10.2.6 EXT REF1 GAIN	-100% – 100 %	
10.2.7 EXTERNAL REF2 SEL	OP DATA 14; AI1; AI2; DI3U,4D; DI3U,4D(R); DI5U,6D	
10.2.8 EXT REF2 MINIMUM	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.2.9 EXT REF2 MAXIMUM	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.2.10 EXT REF2 OFFSET	-30 Hz – 30 Hz	
10.2.11 EXT REF2 GAIN	-100% – 100 %	
10.3 PRESET SPEEDS		
10.3.1 PRESET SPEED SEL	NOT SEL; DI1 – DI6; DI1,2; DI3,4; DI5, 6; DI1,2,3; DI3,4,5; DI4,5,6	
10.3.2 PRESET SPEED 1	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.3.3 PRESET SPEED 2	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.3.4 PRESET SPEED 3	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.3.5 PRESET SPEED 4	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.3.6 PRESET SPEED 5	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.3.7 PRESET SPEED 6	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.3.8 PRESET SPEED 7	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
10.4 SYSTEM CONTR INPUTS		
10.4.1 RUN ENABLE	YES; DI1; DI2; DI3; DI4; DI5; DI6	

Parameter	Alternative Settings	Custom Setting
10.4.2 FAULT RESET SELECT	NOT SEL; DI1; DI2; DI3; DI4; DI5; DI6; ON STOP	
10.4.3 PARAM. LOCK SEL	OP DATA 20; DI1; DI2; DI3; DI4; DI5; DI6	
10.4.4 EXTERNAL FAULT	NOT SEL; DI1; DI2; DI3; DI4; DI5; DI6	
10.5 ANALOG INPUTS		
10.5.1 MINIMUM AI1	0 V/0 mA; 2 V/4 mA; READ INPUT	
10.5.2 MAXIMUM AI1	10 V/20 mA; READ INPUT	
10.5.3 RC FILTER ON AI1	0.1s – 10s	
10.5.4 INVERT AI1	NO; YES	
10.5.5 MINIMUM AI2	0 V/0 mA; 2 V/4 mA; READ INPUT	
10.5.6 MAXIMUM AI2	10 V/20 mA; READ INPUT	
10.5.7 RC FILTER ON AI2	0.1s – 10s	
10.5.8 INVERT AI2	NO; YES	
10.6 RELAY OUTPUTS		
10.6.1 RELAY RO1 OUTPUT	NOT USED; READY; RUN; FAULT; FAULT(-1); FAULT(RST) STALL FLT; MOT OT FLT; OT FAULT; FAULT/WARN; WARNING OT WARNING; REVERSED; EXT. CTRL; REF 2 SEL; PRESET SPD; DC BUS LIM; FREQ 1 LIM; FREQ 2 LIM; CURR LIMIT; REF 1 LIMIT; REF 2 LIMIT; AT SPEED; HIGH TEMP; (P&F AUTOM)	
10.6.2 RELAY RO2 OUTPUT		
10.6.3 RELAY RO3 OUTPUT		
10.7 ANALOG OUTPUTS		
10.7.1 ANALOG OUTPUT 1	NOT USED; OUT FREQ; MOT SPEED; OUT CURR; MOT TORQ; MOT POWER; V/DC BUS; MOTOR VOLT; REFERENCE; ERROR VAL; PICON OUTP; ACTUAL 1; ACTUAL 2; PICON REF	
10.7.2 SCALE AO1	10% – 1000%	
10.7.3 MINIMUM AO1	0 mA; 4mA	
10.7.4 RC FILTER ON AO1	0.01s – 10s	
10.7.5 INVERT AO1	NO; YES	
10.7.6 ANALOG OUTPUT 2	NOT USED; OUT FREQ; MOT SPEED; OUT CURR; MOT TORQ; MOT POWER; V/DC BUS; MOTOR VOLT; REFERENCE; ERROR VAL; PICON OUTP; ACTUAL 1; ACTUAL 2; PICON REF	
10.7.7 SCALE AO2	10% – 1000%	
10.7.8 MINIMUM AO2	0 mA; 4 mA	
10.7.9 RC FILTER ON AO2	0.01s – 10s	
10.7.10 INVERT AO2	NO; YES	

Parameter	Alternative Settings	Custom Setting
10.8 EXT COMMUNICATION		
10.8.1 DRIVE ID-NUMBER	1 - 247	
10.8.2 PROTOCOL	MODBUS; GS-BUS	
10.8.3 BIT RATE SELECT	0:1200; 1:2400; 3:4800; 4:9600	
10.8.4 PARITY	0:NONE; 1:FAULT; 2:FAULT+STOP	
10.8.5 COMMS FAULT FUNCT	0:NONE; 1:FAULT; 2:FAULT+STOP	
10.8.6 BAD MESSAGES COUNTER	0 - 65535	
10.8.7 GOOD MESSAGES COUNTER	0 - 65535	
20 DRIVE PARAMETERS		
20.1 FREQ/CURRENT LIMITS		
20.1.1 MINIMUM FREQUENCY	0 Hz - MAX. FREQ.	
20.1.2 MAXIMUM FREQUENCY	0 Hz - 500 Hz (ACS 501); 0 Hz - 120 Hz (ACS 502)	
20.1.3 FREQUENCY RANGE	0 Hz - 120 Hz; 0 Hz - 500 Hz (ACS 501 only)	
20.1.4 CURRENT LIMIT	0.5 - 2.0 x I_N (ACS 500)	
20.2 START/STOP		
20.2.1 START FUNCTION	RAMP; FLYING; TORQ BOOST; FLYING+TQB	
20.2.2 TORQUE BOOST CURR	0.5 - 2.0 x I_N (ACS 500)	
20.2.3 STOP FUNCTION	COAST; RAMP; DC BRAKE	
20.2.4 BRAKE CHOPPER	NO; YES	
20.2.5 DC HOLD	OFF; ON	
20.2.6 DC HOLD VOLTAGE	0.01 - 0.1 x V_N	
20.2.7 DC BRAKE VOLTAGE	0.01 - 0.1 x V_N	
20.2.8 DC BRAKE TIME	0s - 250s	
20.3 ACCEL/DECEL		
20.3.1 ACC/DEC 1 OR 2 SEL	NOT SEL; DI1; DI2; DI3; DI4; DI5; DI6	
20.3.2 ACC/DEC RAMP SHAPE	LINEAR; S1; S2; S3	
20.3.3 ACCEL TIME 1	0.1s - 1800s	

Appendix A – Complete Parameter Settings

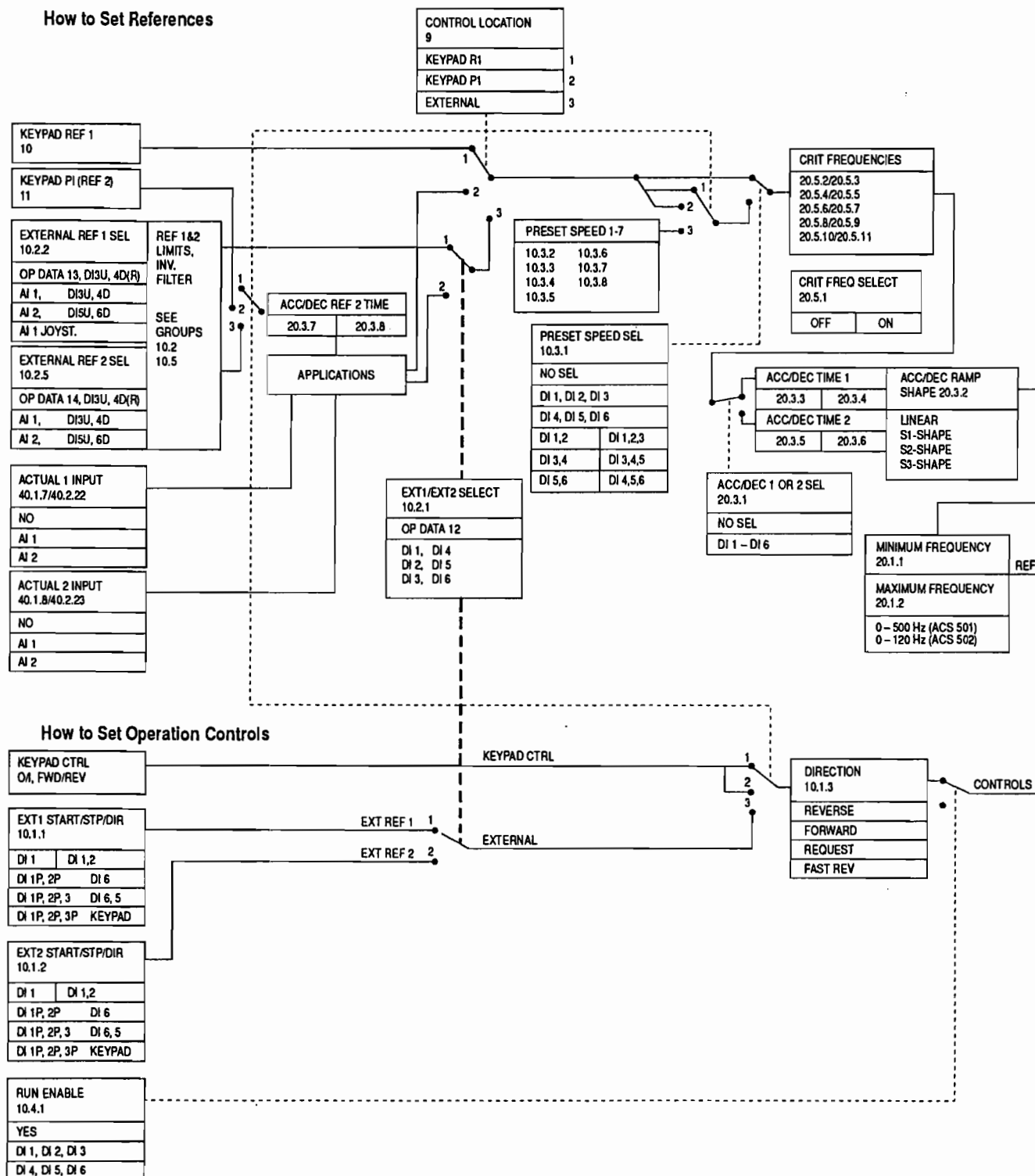
Parameter	Alternative Settings	Custom Setting
20.3.4 DECEL TIME 1	0.1s – 1800s	
20.3.5 ACCEL TIME 2	0.1s – 1800s	
20.3.6 DECEL TIME 2	0.1s – 1800s	
20.3.7 ACCEL REF2 TIME	0.1s – 1800s	
20.3.8 DECEL REF2 TIME	0.1s – 1800s	
20.4 MOTOR CONTROL		
20.4.1 SWITCHING FREQ	1.0 kHz – 12.0 kHz (ACS 501); 3.0 kHz (ACS 502)	
20.4.2 MAX OUTPUT VOLTAGE	0.15 – 1.05 x V_N	
20.4.3 V/Hz RATIO	LINEAR; SQUARED; AUTOMATIC	
20.4.4 FIELD WEAK POINT	30 Hz – 500 Hz	
20.4.5 IR COMPENSATION	NO; MANUAL; AUTOMATIC	
20.4.6 IR COMP VOLTAGE	0.01 – 0.15 x V_N	
20.4.7 IR COMP RANGE	0 Hz – FWP	
20.4.8 SLIP COMPENSATION	OFF; ON	
20.4.9 NOMINAL SLIP	0.1% – 10%	
20.4.10 VOLTAGE LIMIT	OFF; ON	
20.5 CRITICAL FREQUENCIES		
20.5.1 CRIT FREQ SELECT	OFF; ON	
20.5.2 CRIT FREQ 1 LOW	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
20.5.3 CRIT FREQ 1 HIGH	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
20.5.4 CRIT FREQ 2 LOW	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
20.5.5 CRIT FREQ 2 HIGH	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
20.5.6 CRIT FREQ 3 LOW	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
20.5.7 CRIT FREQ 3 HIGH	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
20.5.8 CRIT FREQ 4 LOW	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
20.5.9 CRIT FREQ 4 HIGH	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
20.5.10 CRIT FREQ 5 LOW	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
20.5.11 CRIT FREQ 5 HIGH	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	

Parameter	Alternative Settings	Custom Setting
30 PROTECTION/INFORMAT		
30.1 FAULT FUNCTION		
30.1.1 SERIAL FAULT FUNC	STOP; PRE SPEED7	
30.1.2 AI <MIN FUNCTION	NO; WARNING; FAULT; PRE SPEED7; LAST SPEED	
30.1.3 MOT TEMP FLT FUNC	NO; WARNING; FAULT	
30.1.4 MOTOR THERM TIME	300s – 10000s	
30.1.5 MOTOR LOAD CURVE	50% – 150%	
30.1.6 ZERO SPEED LOAD	40% – MOTOR LOAD CURVE	
30.1.7 BREAK POINT	1 Hz – 500 Hz	
30.1.8 STALL FUNCTION	NO; WARNING; FAULT	
30.1.9 STALL CURRENT	0 – 1.5 x I_N	
30.1.10 STALL TIME/FREQ	10s/15 Hz; 20s/25 Hz; 30s/35 Hz	
30.1.11 UNDERLOAD FUNC	NO; WARNING FAULT	
30.1.12 UNDERLOAD TIME	0 – 600s	
30.1.13 UNDERLOAD CURVE	1 – 5	
30.2 AUTOMATIC RESET		
30.2.1 NUMBER OF RESETS	0 – 5	
30.2.2 TIME WINDOW	1s – 180s	
30.2.3 TIME BETW. RESET ATTEMPTS	0s – 120s	
30.2.4 OVERVOLTAGE	NO; YES	
30.2.5 UNDERVOLTAGE	NO; YES	
30.2.6 OVERCURRENT	NO; YES	
30.2.7 AI SIGNAL <MIN	NO; YES	

Parameter	Alternative Settings	Custom Setting
30.3 SUPERVISION		
30.3.1 OUTPUT FREQ 1 FUNC	NO; LOW LIMIT; HIGH LIMIT	
30.3.2 OUTPUT FREQ 1 LIM	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
30.3.3 OUTPUT FREQ 2 FUNC	NO; LOW LIMIT; HIGH LIMIT	
30.3.4 OUTPUT FREQ 2 LIM	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
30.3.5 CURRENT FUNCTION	NO; LOW LIMIT; HIGH LIMIT	
30.3.6 CURRENT LIMIT	0 – 2 x I _N (ACS 500)	
30.3.7 REF1 FUNCTION	NO; LOW LIMIT; HIGH LIMIT	
30.3.8 REF1 LIMIT	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
30.3.9 REF2 FUNCTION	NO; LOW LIMIT; HIGH LIMIT	
30.3.10 REF2 LIMIT	0% – 100%	
30.3.11 SUPERVIS MESSAGES	OFF; ON	
30.4 INFORMATION		
30.4.11 CRI PROG VERSION	(Version in Drive)	
30.4.2 MC PROG VERSION	(Version in Drive)	
30.4.3 TEST DATE	(Date Tested)	
40 APPLICATION PARAMETERS	(CAN BE SEEN ONLY WITH APPLICATION MACROS)	
40.1 PI-CONTROL	(CAN BE SEEN ONLY WITH PI-CONTROL MACRO)	
40.1.1 PI-CONT GAIN	3% – 800%	
40.1.2 PI-CONT I-TIME	0.02s – 320s	
40.1.3 PI-CONT MIN LIMIT	0 Hz – PI-CONT MAX LIMIT	
40.1.4 PI-CONT MAX LIMIT	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
40.1.5 ERROR VALUE INVERT	NO; YES	
40.1.6 ACTUAL VALUE SEL	ACT1; ACT1-ACT2; ACT1+ACT2; ACT1*ACT2	
40.1.7 ACTUAL 1 INPUT	AI1; AI2	
40.1.8 ACTUAL 2 INPUT	AI1; AI2	
40.1.9 ACT 1 MIN SCALE	-1600.0% – 1600.0%	
40.1.10 ACT 1 MAX SCALE	-1600.0% – 1600.0%	
40.1.11 ACT 2 MIN SCALE	-1600.0% – 1600.0%	
40.1.12 ACT 2 MAX SCALE	-1600.0% – 1600.0%	

Parameter	Alternative Settings	Custom Setting
40.2 PUMP & FAN CONTROL	(CAN BE SEEN ONLY WITH P&F AUTOM MACRO)	
40.2.1 PI-CONT GAIN	3% – 800%	
40.2.2 PI-CONT I-TIME	0.1s – 320s	
40.2.3 REFERENCE STEP 1	0% – 100%	
40.2.4 REFERENCE STEP 2	0% – 100%	
40.2.5 REFERENCE STEP 3	0% – 100%	
40.2.6 SLEEP DELAY	0s – 3600s	
40.2.7 SLEEP LEVEL	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
40.2.8 WAKE UP LEVEL	0% – 100%	
40.2.9 START FREQ 1	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
40.2.10 START FREQ 2	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
40.2.11 START FREQ 3	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
40.2.12 LOW FREQ 1	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
40.2.13 LOW FREQ 2	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
40.2.14 LOW FREQ 3	0 Hz – 500 Hz (ACS 501); 0 Hz – 120 Hz (ACS 502)	
40.2.15 LAG MOT START DLY	0s – 3600s	
40.2.16 LAG MOT STOP DLY	0s – 3600s	
40.2.17 NBR OF LAG MOTORS	0 – 3	
40.2.18 ALTERNATION INTERV	0h – 168h	
40.2.19 ALTERNATION LEVEL	0% – 100%	
40.2.20 INTERLOCKS	OFF; ON	
40.2.21 ERROR VALUE INV	NO; YES	
40.2.22 ACTUAL 1 INPUT	NO; AI1; AI2	
40.2.23 ACTUAL 2 INPUT	NO; AI1; AI2	
40.2.24 ACTUAL VALUE SEL	ACT1; ACT1-ACT2; ACT1+ACT2; ACT1*ACT2; min(A1,A2); max(A1,A2); sqrt(ACT1); sqA1+sqA2	
40.2.25 ACT 1 MIN SCALE	-1600.0% – 1600.0%	
40.2.26 ACT 1 MAX SCALE	-1600.0% – 1600.0%	
40.2.27 ACT 2 MIN SCALE	-1600.0% – 1600.0%	
40.2.28 ACT 2 MAX SCALE	-1600.0% – 1600.0%	
40.2.29 REGUL BYPASS	OFF; ON	
40.2.30 DISPLAY UNIT	NO UNIT; bar; %; m/s; C; Pa; 1/min; m ³ /min; gpm;psi	
40.2.31 DISPL UNIT SCALE	0 – 50000	
40.2.32 NBR OF DECIMALS	0 – 5	

Figure A-1 Signal Diagram



Appendix B – Programming Digital Inputs

Table B-1 shows the available digital inputs and how these digital inputs can be applied to different tasks.

Table B-1 Digital Inputs

Name/Task of Parameter	Parameter Value	Digital I/O Configuration								
10.1.1 EXT 1 STRT/STOP/DIR RUN/STOP 0 = Stop, 1 = Run RUN/STOP, REVERSE 0 = Forward, 1 = Reverse RUN FWD -pulse, STOP-pulse RUN-pulse, STOP-pulse, REVERSE 0 = Forward, 1 = Reverse RUN FWD-pulse, RUN REV-pulse, STOP-pulse	DI1; DI6 DI1,2; DI6,5 DI1P,2P DI1P,2P,3 DI1P,2P,3P	DI1 DI1 DI1 DI1 DI1	 DI2 DI2 DI2 DI2	 DI3 DI3 DI3	 	 	DI6 DI6 	 	 	
10.1.2 EXT 2 STRT/STOP/DIR RUN/STOP 0 = Stop, 1 = Run RUN/STOP, REVERSE 0 = Forward, 1 = Reverse RUN FWD -pulse, STOP-pulse RUN-pulse, STOP-pulse, REVERSE 0 = Forward, 1 = Reverse RUN FWD-pulse, RUN REV-pulse, STOP-pulse	DI1; DI6 DI1,2; DI6,5 DI1P,2P DI1P,2P,3 DI1P,2P,3P	DI1 DI1 DI1 DI1 DI1	 DI2 DI2 DI2 DI2	 DI3 DI3 DI3	 	 	DI6 DI6 	 	 	
10.2.1 EXT 1/EXT 2 SELECT 0 = EXT 1 (R1), 1 = EXT 2 (R2)	DIx	DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8	DI9
10.2.2 EXTERNAL REF 1 SEL DI3, DI5 = Increase reference DI4, DI6 = Decrease reference	DI3U,4D (R)** D3U,4D D5U,6D			DI3 DI3	DI4 DI4	 DI5	 DI6	 	 	
10.2.5 EXTERNAL REF 2 SEL DI3, DI5 = Increase reference DI4, DI6 = Decrease reference	DI3U,4D (R)** DI3U,4D DI5U,6D			DI3 DI3	DI4 DI4	 DI5	 DI6	 	 	

Name/Task of Parameter	Parameter Value	Digital I/O Configuration								
10.3 PRESET SPEED SEL		DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8	DI9
Single speed:	DIx*	DI1	DI2							
Three speeds:	DI1,2			DI3	DI4	DI5	DI6			
0 0 No Preset Speed	DI3,4									
1 0 Preset Speed 1	DI5,6					DI5	DI6			
0 1 Preset Speed 2										
1 1 Preset Speed 3										
Seven speeds:	DI1,2,3	DI1	DI2	DI3						
0 0 0 No Preset Speed	DI3,4,5			DI3	DI4	DI5	DI6			
1 0 0 Preset Speed 1	DI4,5,6				DI4	DI5				
0 1 0 Preset Speed 2										
1 1 0 Preset Speed 3										
0 0 1 Preset Speed 4										
1 0 1 Preset Speed 5										
0 1 1 Preset Speed 6										
1 1 1 Preset Speed 7										
10.4.1 RUN ENABLE	DIx*	DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8	DI9
0 = Disabled, 1 = Run enabled										
10.4.2 FAULT RESET SEL	DIx	DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8	DI9
10.4.3 PARAM LOCK SEL	DIx	DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8	DI9
20.3.1 ACC/DEC 1 OR 2 SEL	DIx	DI1	DI2	DI3	DI4	DI5	DI6	DI7	DI8	DI9

* DIx = Any free DI input.

** This selection resets reference value to 0 V if supply voltage is interrupted.

Input function:

0 = open input.

1 = +24 V applied to the input.

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Project Name: Xerox Corporation
Blauvelt Site Telecommunications

EUA Day Contract No. 94-17

Date: May 3, 1996

*Microprocessor Control System
Operation and Maintenance Manual*



XEROX CORPORATION
BLAUVELT SITE TELECOMMUNICATIONS
SEQUENCE OF OPERATION

General Information:

Alarm Points

The following alarms will call out to H & A's office:

Alarm	Description	Controller
Alarm	VES1 Comm Fault	VES1
VES1 VacuumPump	VES1Pump run indication	VES1
TransferAlarm	High Pressure Alarm	VES1
VES2 VacuumPump	VES2 Pump run indication	VES2
Alarm	VES2 Comm Fault	VES2
PumpP1Alarm	Pump P1 run indication	GTP
PumpP2Alarm	Pump P2 run indication	GTP
SystemEnable	Sump Pump Failure	GTP
EmergencyAlarm	Both filters Dirty	GTP
Alarm	GTP Comm Fault	GTP
pHAlarm	pH Comm Fault	pH
FaceDisplayAlarm	Face Display Comm Fault	FaceDisplay

Systems

The systems and sub-systems that shall be monitored are intended to operate as close to 100% as possible. The DDC system shall be configured as a monitoring and data logging tool with some control functions to enable immediate notification and response to problems and provide the ability to perform trouble shooting and make software changes to the system remotely. All points on the Data Point List shall be logged and downloaded to an existing computer at H&A of New York. The system set up shall include installation of any communications interface software on an existing computer at the office of H&A of New York located in Rochester, New York. Data shall be automatically formatted and presented in prefabricated spreadsheet reports using Lotus 123 Ver. 24.



Data Logging

Data logging shall be divided into two discreet types: digital events and analog trends.

The digital events shall consist of a log containing the point description, date and time at each status change or event as shown below:

<u>POINT DESCRIPTION</u>	<u>DATE</u>	<u>TIME</u>
VES-1 HIGH WATER ALARM	3/1/94	22:38:16
VES-1 TRANSFER PUMP-1 ON	3/1/94	22:45:54
VES-1 TRANSFER PUMP-2 ON	3/1/94	22:47:32
VES-1 TRANSFER PUMP-1 OFF	3/1/94	22:48:40
VES-1 TRANSFER PUMP-2 OFF	3/1/94	22:50:15

Individual run times of VES-1 and VES-2, transfer pump on the VES's (four total), pumps P-1 and P-2, GTP filters (time between lead/lag switch over) and the air stripper fan in the GTP shall be calculated by totaling the time from the event logs. Run time shall be totaled for summary reports in daily, weekly, monthly and yearly formats. Summary reports for the event logs shall also be generated showing the total number of events in daily, weekly, monthly and yearly formats.

The analog trend logs shall poll all analog points at least once every six minutes. The Detailed Trend Report shall include all data points with the date, time (for each data point) and average the data on an hourly basis. The Daily Summary Report format shall import the hourly averages from the Detailed Trend Report (i.e. 24 data point entries). The Monthly Summary Report format shall import the average daily data point entries from the Daily Summary Report and provide up to 31 data point entries (based on the number of days in the month).



Event Logging

The following events will be listed in the event log:

Alarm	Controller	Alarm	Controller
AirStripHiAlm	GTP	EmergencyAlarm	GTP
AirStripLoAlm	GTP	PumpP1Alarm	GTP
FilterReset	GTP	PumpP2Alarm	GTP
HoldingHiAlm	GTP	CondHiAlm	VES1
HoldingLoAlm	GTP	HiOilAlm	VES1
SumpPumpAlm	GTP	HiVaporPressAlm	VES1
LagChange	GTP	HiWaterAlm	VES1
LagRun	GTP	LoOilAlm	VES1
LeadChange	GTP	MotorOL	VES1
LeadRun	GTP	VacuumPump	VES1
PumpP1Start	GTP	TransferAlarm	VES1
PumpP2Start	GTP	CondHiAlm	VES2
SystemEnable	GTP	HiOilAlm	VES2
ValveCV4	GTP	HiVaporPressAlm	VES2
ValveCV5	GTP	HiWaterAlm	VES2
BlowerAlarm	GTP	LoOilAlm	VES2
CarbonAlarm	GTP	MotorOL	VES2
PumpP1DeadHead	GTP	VacuumPump	VES2
PumpP2DeadHead	GTP	PhPumpSS	pH

Control Sequences:

All analog points shall be monitored for signal out of limits and alarm all such occurrences in the Daily Event Log.

In the event of a plant shut down an alarm shall be sent to the remote host computer.

Transfer Pump

1.) The transfer pump discharge pressure shall be monitored and an alarm shall be sent in the event the pressure exceeds the setpoint of 35 psig (adj.).



GTP Filters

- 1.) The GTP filter differential pressure shall be monitored and automatically switch the influent flow from the lead filter bank to the lag filter bank when the differential pressure is greater than 15 psig setpoint (adj).
- 2.) An alarm shall be sent when the lead filter bank requires change out.
- 3.) When the lag filter differential pressure is greater than setpoint the influent flow shall be automatically switched over to the lead filter bank.
- 4.) An alarm shall be sent when the lag filter bank requires change out. Four annunciator lights shall indicate which filter bank is in use (green) and which filter requires change-out (red), located on the face of the control panel. The annunciator lights shall be labeled accordingly.
- 5.) The panel shall also have reset buttons to be utilized after filter change-out as been performed.
- 6.) The operating filter shall be held open for a minimum time period required for the switch over valve to operate. Valves shall be slow acting to minimize water hammer conditions.
- 7.) If the differential pressure exceeds setpoint immediately after switch over, an EMERGENCY alarm shall be sent when both the lead and lag filter banks require change out. The lead and lag filters shall operate in parallel and all four lights shall be enunciated.
- 8.) If the differential pressure of the filter bank, which is on-line, has a downward trend with respect to flow, an alarm shall be sent indicating that the above condition exists (pressure drop decreasing on Filter Bank #1). This alarm shall be used to notify the operator of a possible break in one of the bags or an improperly installed bag. The filters shall switch over as in the above sequence.

Holding Tank

- 1.) The holding tank level shall be monitored and the control valve on the discharge pump P-1 shall modulate to maintain a level setpoint at the mid-point of the tank.
- 2.) The high water alarm shall shut down the entire GTP, VES and all ground water recovery wells and an alarm shall be sent to the remote host computer.
- 3.) The low water alarm shall shut down the pumps and an alarm shall be sent to the remote host computer. The pumps shall automatically restart when the level reaches operating level and is rising.



Discharge Pumps P-1 and P-2

- 1.) The discharge pressure shall be monitored to confirm operational status, provide trend information and shut the pumps off in the event that the influent flow has diminished or stopped altogether and the pump is "dead headed".
- 2.) The pressure setpoint for this condition shall be determined in the field by shutting the valve on the discharge side of each pump and reading the pressure. The pressure reading shall be the setpoint.
- 3.) The pumps shall restart when the level in their respective tank reaches operating level and is rising.

Air Stripper

- 1.) The discharge pressure of the blower shall be monitored to confirm operational status and provide trend information. An alarm shall be sent if the pressure exceeds 5" water column (adj).
- 2.) The air stripper tank shall be monitored from the existing level probe and the existing control valve on the discharge pump P-2 shall modulate to maintain a level setpoint at the mid-point of the tank.
- 3.) The high water alarm shall shut down the entire GTP, VES and all ground water recovery wells and an alarm shall be sent to the remote host computer.
- 4.) The low water alarm shall shut down the pumps and an alarm shall be sent to the remote host computer. The pumps shall automatically restart when the level reaches operating level and is rising.
- 5.) The differential pressure across a calibrated orifice plate in the pipe line to the air stripper tower shall be monitored. The three-way mixing valve, located after the air stripper, shall modulate to maintain flow rates to the air stripper less than or equal to the setpoint of 100 GPM (adj).

Carbon Vessels

- 1.) The Pre-Carbon, Mid-Carbon and Post-Carbon pressure shall be monitored.
- 2.) If the pressure drops across either the lead or lag carbon vessels is greater than 5 psig (adj) an alarm shall be sent to the remote host computer indicating a high pressure condition (lead or lag).

Sump Pump

- 1.) The existing sump pump in the GTP shall be monitored for operation in excess of 60 seconds, with the use of an existing time delay relay.
- 2.) The GTP, VES and the ground water recovery wells shall shut down and an alarm shall be sent to the remote host computer if the sump pump relay is made.



No.	Cont. Type	Cont. Name	Cont. Assoc.	Panel No.	PL No.	PL Type	Point Description	Actual Software Assignment	Term. Conn.	Conn. Type	Detail	Rev. Date
1	SCX-920	GTP	Infinity1	1	1	V	Filter Differential Pressure	FilterDP	100	101		
2	SCX-920	GTP	Infinity1	1	2	V	Holding Tank Level	HoldingLevel	102	103		
3	SCX-920	GTP	Infinity1	1	3	V	Pump P-1 Discharge Pressure	PumpP1DisPres	104	105		
4	SCX-920	GTP	Infinity1	1	4	V	Blower Discharge Pressure	A_SBlowerDP	106	107		
5	SCX-920	GTP	Infinity1	1	5	V	Air Stripper Tank Level	AirStripLevel	108	109		
6	SCX-920	GTP	Infinity1	1	6	V	Pump P-2 Discharge Pressure	PumpP2DisPres	110	111		
7	SCX-920	GTP	Infinity1	1	7	V	Air Stripper Flow (DP)	AirStripFlow	112	113		
8	SCX-920	GTP	Infinity1	1	8	V	Treatment P1t Discharge Flow Meter (FM-5)	FM5Flow	114	115		
9	SCX-920	GTP	Infinity1	1	9	V	Pump P-1 Discharge Flow Meter (FM-4)	FM4Flow	116	117		
10	SCX-920	GTP	Infinity1	1	10	V	Pre-Carbon Pressure	PreCarbPres	118	119		
11	SCX-920	GTP	Infinity1	1	11	V	Post Carbon Pressure	PostCarbPres	120	121		
12	SCX-920	GTP	Infinity1	1	12	V	Intermediate Carbon Pressure	InterCarbPres	122	123		
13	SCX-920	GTP	Infinity1	1	13	D	Sump Pump Alarm	SumpPumpAlm	124	125		
14	SCX-920	GTP	Infinity1	1	14		Spare		126	127		
15	SCX-920	GTP	Infinity1	1	15	V	pH A	pH A	128	129		
16	SCX-920	GTP	Infinity1	1	16	V	pH B	pH B	130	131		
17	EMX-160	GTP	Infinity1	1	1	D	Holding Tank High Level Alarm	HoldingHiAlm	132	133		
18	EMX-160	GTP	Infinity1	1	2	D	Holding Tank Low Level Alarm	HoldingLoAlm	134	135		
19	EMX-160	GTP	Infinity1	1	3		Spare		136	137		
20	EMX-160	GTP	Infinity1	1	4		Spare		138	139		
21	EMX-160	GTP	Infinity1	1	5		Spare		140	141		
22	EMX-160	GTP	Infinity1	1	6	D	Filter Change-Out Reset	FilterReset	142	143		
23	EMX-160	GTP	Infinity1	1	7		Spare		144	145		
24	EMX-160	GTP	Infinity1	1	8		Spare		146	147		
25	SCX-920	GTP	Infinity1	1	1	PAO	Control Valve CV-1	ValveCV1	P1			
26	SCX-920	GTP	Infinity1	1	2	PAO	Control Valve CV-2	ValveCV2	P2			
27	SCX-920	GTP	Infinity1	1	3	PAO	Control Valve CV-3	ValveCV3	P3			
28	SCX-920	GTP	Infinity1	1	4	EDO	Pump P-1 Start/Stop	PumpP1Start	200	201		
29	SCX-920	GTP	Infinity1	1	5	EDO	Pump P-2 Start/Stop	PumpP2Start	202	203		
30	SCX-920	GTP	Infinity1	1	6	EDO	CV-4 - Lead Filter Switchover	ValveCV4	204	205		
31	SCX-920	GTP	Infinity1	1	7	EDO	CV-5 - Lag Filter Switchover	ValveCV5	206	207		
32	SCX-920	GTP	Infinity1	1	8	EDO	System Shutdown Contact	SystemEnable	208	209		
33	EMX-155-1	GTP	Infinity1	1	1	EDO	Lag Filter Bank Operation	LagRun				
34	EMX-155-1	GTP	Infinity1	1	2	EDO	Lag Filter Bank Change Out	LagChange				
35	EMX-155-2	GTP	Infinity1	1	1	EDO	Lead Filter Bank Operation	LeadRun				
36	EMX-155-2	GTP	Infinity1	1	2	EDO	Lead Filter Bank Change Out	LeadChange				



PL No.	Conn. Type	Conn. Name	Conn. Assoc.	Panel No.	PL No.	PL Type	Point Description	Actual Software Assignment	Term. Conn.	Conn. Type	Detail	Rev. Date
37	TCX-851	pH	Infinity1	1	1	D	GTP Panel Reset Relay in Auto	GTPStartAuto				
38	TCX-851	pH	Infinity1	1	2	D	GTP Panel Phase Monitor	GTPPowerMonitor				
39	TCX-851	pH	Infinity1	1	3		Spare					
40	TCX-851	pH	Infinity1	1	4		Spare					
41	TCX-851	pH	Infinity1	1	1		pH Pump Start/Stop	pHPumpSS				
42	TCX-851	pH	Infinity1	1	2		Start GTP Reset	GTPStart				
43	TCX-851	pH	Infinity1	1	3		Spare					
44	TCX-851	pH	Infinity1	1	4		Spare					
45	EMX-150-1	pH	Infinity1	1	1	AO	pH Pump Stroke	pHStroke				
46	EMX-150-1	pH	Infinity1	1	2		Spare					



No.	Cont. Type	Cont. Name	Cont. Assoc.	Panel No.	Pt. No.	Pt. Type	Point Description	Actual Software Assignment	Term. Conn.	Conn. Type	Detail	Rev. Date
47	LCX-810	VES1	Infinity1	2	1	T	Ambient Temperature	Ambient	300			
48	LCX-810	VES1	Infinity1	2	2	T	VES Enclosure Temperature	VESTemp	302			
49	LCX-810	VES1	Infinity1	2	3	V	Transfer Pump Discharge Pressure	TransferPress	304			
50	LCX-810	VES1	Infinity1	2	4	V	Inlet Vacuum	InletVacuum	306			
51	LCX-810	VES1	Infinity1	2	5	T	Vacuum Pump Discharge Temperature	VacuumDis	308			
52	LCX-810	VES1	Infinity1	2	6	T	Vapor Discharge Temperature	VaporDis	310			
53	LCX-810	VES1	Infinity1	2	7	T	Chiller Outlet Temperature	ChillerOut	312			
54	LCX-810	VES1	Infinity1	2	8	D	Vacuum Pump Run Time Indicator	VacuumPump	314			
55	EMX-160	VES1	Infinity1	2	1	D	High Water Level Alarm - Inlet Separator	HiWaterAlm	316			
56	EMX-160	VES1	Infinity1	2	2	D	High Oil Level Alarm	HiOilAlm	318			
57	EMX-160	VES1	Infinity1	2	3	D	Low Oil Level Alarm	LoOilAlm	320			
58	EMX-160	VES1	Infinity1	2	4	D	Transfer Pump Run Time Indicator	TransferPump1	322			
59	EMX-160	VES1	Infinity1	2	5	D	Transfer Pump Run Time Indicator	TransferPump2	324			
60	EMX-160	VES1	Infinity1	2	6	D	Condensate High Level Alarm	CondHiAlm	326			
61	EMX-160	VES1	Infinity1	2	7	D	High Vapor Back Pressure Alarm	HiVaporPressAlm	328			
62	EMX-160	VES1	Infinity1	2	8	D	Motor Overloads	MotorOL	330			
63	LCX-810	VES1	Infinity1	2	1		Spare		400			
64	LCX-810	VES1	Infinity1	2	2		Spare		402			
65	LCX-810	VES1	Infinity1	2	3		Spare		404			
66	LCX-810	VES1	Infinity1	2	4		Spare		406			
67	LCX-810	VES1	Infinity1	2	5		Spare		408			
68	LCX-810	VES1	Infinity1	2	6		Spare		410			
69	LCX-810	VES1	Infinity1	2	7		Spare		412			
70	LCX-810	VES1	Infinity1	2	8		Spare		414			



Termination Schedules for Xerox Corp. Blauvelt Site Telecommunications

No.	Cont. Type	Cont. Name	Cont. Assoc.	Panel No.	Pt. No.	Pt. Type	Point Description	Actual Software Assignment	Term. Conn.	Conn. Type	Detail	Rev. Date
71	LCX-810	VES2	Infinity1	2	1	V	Fence Line Flow Meter FM-2	FM2Flow	500			
72	LCX-810	VES2	Infinity1	2	2		Spare		502			
73	LCX-810	VES2	Infinity1	2	3	V	Carbon Enclosure Vapor Flow Meter	VaporFlow	504			
74	LCX-810	VES2	Infinity1	2	4	V	Inlet Vacuum	InletVacuum	506			
75	LCX-810	VES2	Infinity1	2	5	T	Vacuum Pump Discharge Temperature	VacuumDis	508			
76	LCX-810	VES2	Infinity1	2	6	T	Vapor Discharge Temperature	VaporDis	510			
77	LCX-810	VES2	Infinity1	2	7	T	Chiller Outlet Temperature	ChillerOut	512			
78	LCX-810	VES2	Infinity1	2	8	D	Vacuum Pump Run Time Indicator	VacuumPump	514			
79	EMX-160-1	VES2	Infinity1	2	1	D	High Water Level Alarm - Inlet Separator	HiWaterAlm	516			
80	EMX-160-1	VES2	Infinity1	2	2	D	High Oil Level Alarm	HiOilAlm	518			
81	EMX-160-1	VES2	Infinity1	2	3	D	Low Oil Level Alarm	LoOilAlm	520			
82	EMX-160-1	VES2	Infinity1	2	4	D	Transfer Pump Run Time Indicator	TransferPump1	522			
83	EMX-160-1	VES2	Infinity1	2	5	D	Transfer Pump Run Time Indicator	TransferPump2	524			
84	EMX-160-1	VES2	Infinity1	2	6	D	Condensate High Level Alarm	CondHiAlm	526			
85	EMX-160-1	VES2	Infinity1	2	7	D	High Vapor Back Pressure Alarm	HiVaporPressAlm	528			
86	EMX-160-1	VES2	Infinity1	2	8	D	Motor Overloads	MotorOL	530			
87	EMX-160-2	VES2	Infinity1	2	1	D	VES1 Panel Reset Relay in Auto	VES1StartAuto				
88	EMX-160-2	VES2	Infinity1	2	2	D	VES2 Panel Reset Relay in Auto	VES2StartAuto				
89	EMX-160-2	VES2	Infinity1	2	3	D	VES Panel Phase Monitor	VESPowerMonitor				
90	EMX-160-2	VES2	Infinity1	2	4		Spare					
91	EMX-160-2	VES2	Infinity1	2	5		Spare					
92	EMX-160-2	VES2	Infinity1	2	6		Spare					
93	EMX-160-2	VES2	Infinity1	2	7		Spare					
94	EMX-160-2	VES2	Infinity1	2	8		Spare					
87	LCX-810	VES2	Infinity1	2	1	EDO	VES1 Start	VES1Start	600			
88	LCX-810	VES2	Infinity1	2	2	EDO	VES2 Start	VES2Start	602			
89	LCX-810	VES2	Infinity1	2	3	EDO	VES1 Alarm Reset	VES1AlarmReset	604			
90	LCX-810	VES2	Infinity1	2	4	EDO	VES2 Alarm Reset	VES2AlarmReset	606			
91	LCX-810	VES2	Infinity1	2	5		Spare		608			
92	LCX-810	VES2	Infinity1	2	6		Spare		610			
93	LCX-810	VES2	Infinity1	2	7		Spare		612			
94	LCX-810	VES2	Infinity1	2	8		Spare		614			



Control Valve Schedule

Project Name: Xerox Corporation - Blauvelt Site Telecommunications		Valve Outlet	Total
Project No: 94-17		Pressure: 5.00	Valves: 3

Item No.	Valve Description	Qty	Location	Flow G.P.M.	Flow #/HR	Valve Cv	Design Cv	Valve Press. Drop	Valve Size	Valve Part No.	Valve Fail Pos.	Spring Range	Valve Manufacturer	Valve Type	Revision Date
1	Control Valve CV-3	1	GTP	100.00	0.00	120.00	57.74	0.69	3"	592-6730	3-Way	5-10#	LG Powers	3-Way	
2	Control Valve CV-4	1	GTP	100.00	0.00	165.00	57.74	0.37	3"	3-815-11-21-36-TT	N.O.	40#	Jamesbury	Butterfly	
3	Control Valve CV-5	1	GTP	100.00	0.00	165.00	57.74	0.37	3"	3-815-11-21-36-TT	N.C.	40#	Jamesbury	Butterfly	

Note: CV-4 must be specified as a N.O. valve and CV-5 must be specified as a N.C. valve

Note: The actuator part no. for each of the butterfly valves is an SP36SR40.

Note: The linkage part no. for each of the butterfly valves is an LK732.



Features

Supports Modular Expansion To 64 Infinet Controllers

Optional Modem For Dial In/Dial Out Communications

Dumb Terminal User Interface With Full Screen Editor

Full Plain English Programming Language

Custom Menus, Reports And Alarm Messages

Data Logging And Trending

The Andover Controls Infinity CMX 220 is the focal point for small to medium size networks of intelligent controllers. While other Andover panels are providing stand alone direct digital control of all the building's environmental systems (heating, ventilating, air conditioning, and lighting), and access control, the Infinity CMX 220 provides a cost effective means for network communications and information management.

The Infinity CMX 220 acts as the system coordinator for all distributed controllers, providing integrated global control, history logging, local and remote alarming, and a fully menu-driven user interface. Each CMX 220 contains a communication port to the Infinet, a high speed token-passing bus that provides transparent data transfer between all controllers and an RS232 communications port for a modem, dumb terminal or printer.

The CMX 220 is available in three models with maximum network sizes of 4, 16 or 64 controllers. The CMX 220 supports the full family of Infinet controllers including the SCX 900, LCX 800, LCX 810 and TCX 850. In addition, the Infinet can also support ACX 700 access controllers, and DCX 250 display controllers.

The CMX 220 comes standard with a metal baseplate and cover, suitable for panel mounting. An optional enclosure (shown) is available for wall mounting.

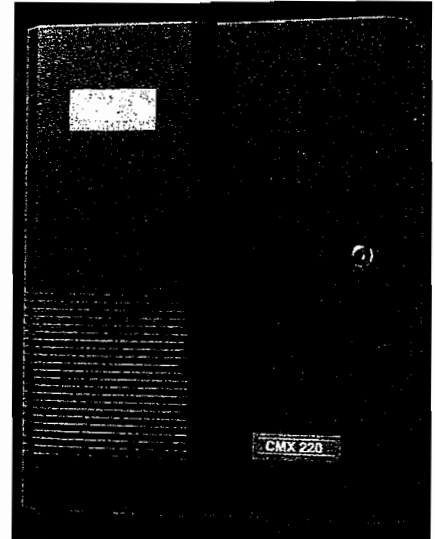
Auto-Baud Modem

The Auto Dial/Auto Answer modem allows the Infinity CMX 220 to receive or initiate exchanges of information across voice grade telephone lines with speeds up to 2400 baud.

Programming

Programs are entered into a CMX 220 using a dumb terminal, LSX 280 laptop service tool or the SX 8000 workstation. The program is created using the standard Andover Controls Plain English™ programming language. Once completed, the program is stored in, and executed by, the CMX 220. The full screen editor for the dumb terminal includes built-in menus, command windows and a programmable status bar.

Andover Controls Infinity CMX 220 Communications Module



Software Capabilities

The dynamic memory of the CMX 220 can be allocated for any combination of Plain English programs, scheduling, alarming, reporting and data logging. In addition to basic algebraic expressions, mathematical capabilities include logarithms, exponentials and trigonometric functions. Library functions include PID, auto-tuning PID, curve fit, and psychrometric equations. User configurable functions aid in minimizing programming time for repetitive applications.

Command Line Support

For users requiring interface to third party monitoring software, the CMX 220 features optional command line support. This capability provides for direct and efficient communications through the RS232C port or modem of the CMX 220.



Specifications

Memory Size:	512K RAM, 1MB EPROM, 2K EEPROM
Power:	24VAC $\pm$ 20%, 60/50 HZ
Power Consumption:	20 VA
Operating Environment:	32 to 120° F, 10 to 95% RH
Battery Backup:	Replaceable, non-rechargeable, Lithium Battery (DOT certified). Provides 7 years typical accumulated power failure backup of RAM memory and real-time clock.
Overload Protection:	Fused with 3 Amp 3AG fuse. Power transformer thermally fused and MOV protected.
Real-Time Clock:	Synchronized to 60 (50) Hz line frequency with battery-backed real-time clock.
Communication Interface:	1 RS232 port for a user, terminal, printer or optional modem.
Communication Speed:	1 Inifet expandable from 4 to 64 nodes 300 to 19.2K Baud selectable for Inifet and user terminal, 2400 baud for modem
Bus Length:	4,000 ft. standard for Inifet, InfiLink amplification module allows extension to longer distances
Bus Media:	Inifet - twisted, shielded pair low capacitance cable
Size:	19"H x 15"W x 4 3/4"D (with enclosure) 11 13/16"H x 8 9/16"W x 3 3/16"D (without enclosure)
Weight:	21 lbs. (with enclosure), 5 lbs. (without enclosure)
Agency Approvals:	UL 916, FCC

Connections:

Power:	3 position barrier strip
Inifet:	Removable terminal strip
User Terminal, Printer:	Male RS232C 25 pin D connector
Modem:	RJ11

Models:

CMX220	Supports 4 nodes of Inifet controllers
CMX221	Supports 16 nodes of Inifet controllers
CMX222	Supports 64 nodes of Inifet controllers
CMX230	Supports 4 nodes of Inifet controllers with Command Line support
CMX231	Supports 16 nodes of Inifet controllers with Command Line support
CMX232	Supports 64 nodes of Inifet controllers with Command Line support

CMX 220

INIFET

SCX 900

LCX 810

LCX 800

JCX 850

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Features

High Resolution Touch Screen Display

User Defineable Graphics, Text and Controls

Library of Knobs, Dials, Gauges and Buttons

Real-Time Information

Change Setpoints, Schedules and Alarm Limits

Fully Programmable in Andover Controls Plain English™

Ideal for Conference Rooms, Lobbies and Large Equipment Rooms

The Andover Controls Infinity DCX 250 touch screen display controller sets a new standard for ease of use in man-machine interfaces. Based on the flexibility and power of Infinity's Plain English programming language, users can view and create custom graphics depicting mechanical systems such as air handlers, VAV boxes or chillers; control panels consisting of dials, knobs, gauges, buttons and switches; and menus for direct selection of the desired information. Altogether, these capabilities give users an incredibly easy but powerful means to monitor equipment operation and to adjust system parameters.

The DCX 250 eliminates the need for keyboards, mice and typing skills. Simply, touch the screen to select a display, change a setpoint or modify equipment status. The DCX 250 can be mounted and installed anywhere in your facility. With its flush mounted design, it is ideal for conference rooms, lobbies, nurse's stations or virtually any location where building personnel or occupants need quick and direct access to the building automation system.

Communications

The DCX 250 display controller can be located anywhere on the 2 wire Infinet field bus. Up to 32 DCX 250's can be configured for each Infinet as priority controllers. Each DCX 250 has complete access to any information in the system including EnergyNet and Infinet controllers.

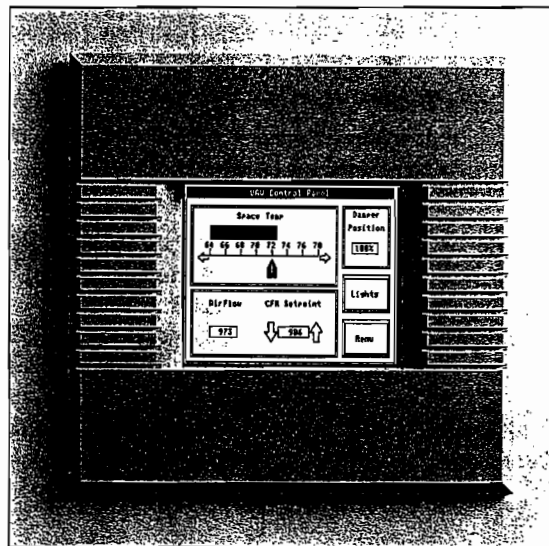
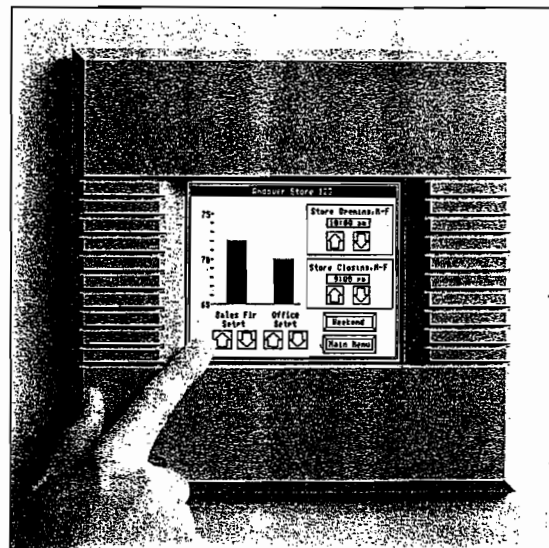
Programming

The DCX 250 can be configured from a dumb terminal connected to a CX 9000 or CMX 220, the LSX 280 laptop service tool, or a SX 8000 workstation. All programming is performed in Andover Controls Plain English™ and is stored locally in the DCX 250. Power failures are not a problem, since all programs are stored in battery-backed RAM with up to 7 years of continuous protection.

Software Capabilities

As part of Andover Controls Plain English™, you can easily generate sophisticated graphics and control panels. The Plain English language allows one to draw lines, circles, rectangles and text, locating them anywhere on the DCX 250's generous 24 line by 40 character display. In addition, the DCX 250 includes a built-in library of operator controls including knobs, dials, gauges and buttons making it possible for users to operate and

Andover Controls Infinity DCX 250 Display Controller

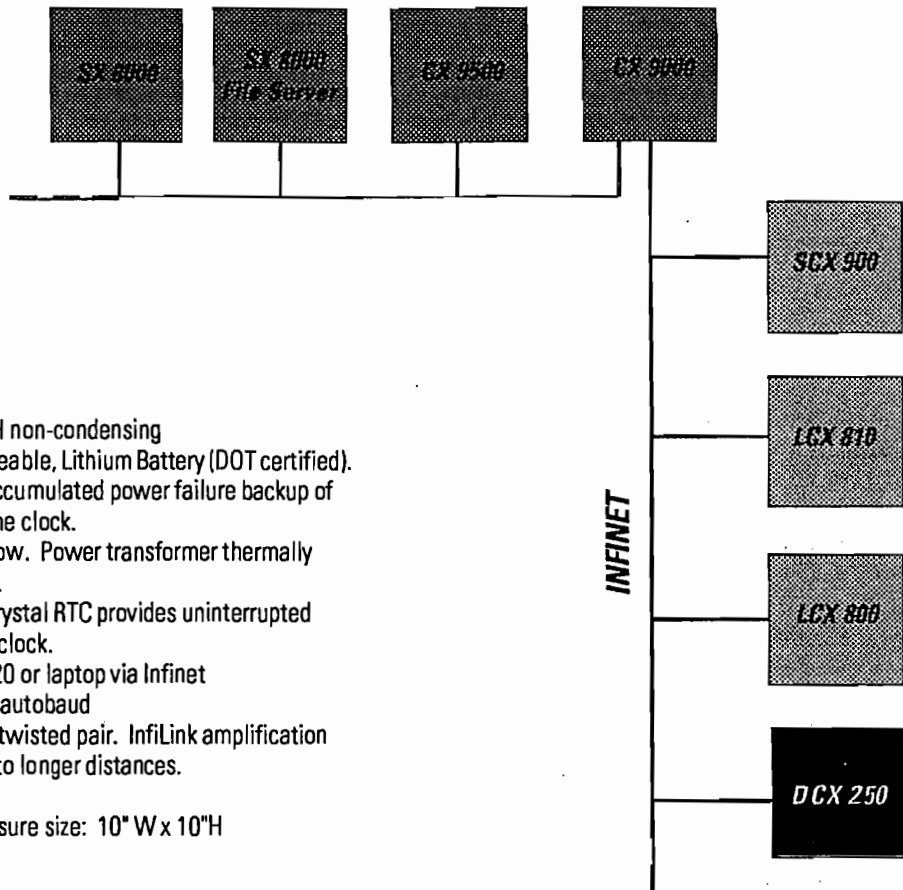


understand the system without lengthy training or computer backgrounds. Real-time data is placed anywhere on the screen, including setpoints and other parameters that building occupants may need to modify on a routine basis.

Optional Mounting in CX 9000 Network Master

The DCX 250 is also available as a built-in option for the CX 9000 Network Master controller. The front door of the CX 9000 has a cutout, allowing direct access to the DCX 250's touch screen display. This option provides users with a convenient user interface in central plants and other large equipment areas.

ENERGYNET



Specifications

Memory:	64K RAM, 128K EPROM
Power:	24VAC $\pm$ 20%, 50/60 Hz
Power Consumption:	18 VA
Operating Environment:	40 to 104°F, 30 to 85% RH non-condensing
Battery Backup:	Replaceable, non-rechargeable, Lithium Battery (DOT certified). Provides 7 years typical accumulated power failure backup of RAM memory and real-time clock.
Overload Protection:	Fused with 3 amp slow blow. Power transformer thermally fused and MOV protected.
Real-Time Clock:	Under battery backup, a crystal RTC provides uninterrupted operation of the DCX 250 clock.
Communications:	Through CX 9000, CMX 220 or laptop via Infinet
Communication Speed:	300, 1200, 9600, or 19.2K autobaud
Bus Length:	4,000 feet using shielded twisted pair. InfiLink amplification module allows extension to longer distances.
Dimensions:	8" W x 8"H x 3.75"D
Weight:	9.5 lbs
Agency Approvals:	UL 916, FCC

Touch Screen Display:

Colors:	White background with blue figures and text, or vice versa (programmable)
Resolution:	320 x 200
Backlight Life:	Minimum of 10,000 hours of continuous operation - (software can automatically turn off the backlight when the display is not in use)
Touchscreen:	64 key matrix, .562 x .475 inch resolution
Feedback:	Audio beep

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#DS-DCX-2.94



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Features

**Cost Effective I/O
Enlargement**

**Transparent Point
Expansion**

**Convenient
Installation**

The Andover Controls Infinity family of expansion modules provides for a convenient, and cost effective means to add input and output points to Infinet controllers.

Expansion modules can be used with the SCX 900, LCX 810, TCX 850, TCX 851 and TCX 853 controllers. Up to two modules can be powered directly from the Infinet controller. Additional modules can be added by providing power from an external 24 VDC supply.

EMX 150

The EMX 150 contains two analog outputs configurable for either 0 - 20 VDC or 0 - 20 mA operation. Each output contains an override switch and potentiometer for local control.

EMX 151

The EMX 151 contains 2 high-resolution, 12-bit analog outputs configurable for either 0-10 VDC or 0-20 mA operation. No override switches are provided.

EMX 155

The EMX 155 provides two form C relay outputs rated for 24 VAC/VDC operation. Each relay can be used for on/off control of motors and lighting, or can be used for pulse width modulation control, with .1 second resolution. Each output contains an override switch for manual operation, with software feedback of the switch position.

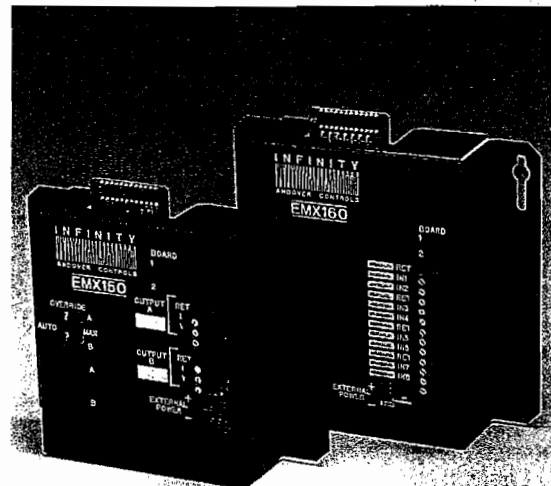
EMX 156

The EMX 156 provides 2 digital outputs rated for 120/240 VAC operation. Each output is a field replaceable, solid state device that can be used for control of motors and lighting, or can be used for pulse width modulation control, with .1 second resolution. Each output has 4000V isolation, and has a maximum surge current of 80 amps. Each output contains an override switch for manual operation, with software feedback of the switch position.

Andover Controls

EMX 150, EMX 151, EMX 155, EMX 156, EMX 160

Infinity Expansion Modules



EMX 160

The EMX 160 contains 8 digital inputs designed for dry contact signals. In addition, each input can be configured to accept pulses up to 140 per second.

Programming

All expansion module points are treated in the same manner as the built-in I/O of each Infinet controller. Once expansion points are assigned in the Plain English programming language, they are automatically added to operator input and output summaries, and can be used unrestricted in programs, reports and alarms.

Installation

All expansion modules are designed to be plugged into the expansion port found at the bottom of each Infinet controller. Modules can be stacked in descending order. The expansion module enclosure is intended for panel mounting, using two sheet metal screws.

Specifications

General Specifications

Power : Up to two of the modules listed can be powered directly from the Infinet controller. Additional modules can be powered with an external 24 VDC power supply.

EMX Modules per Infinet Controller: Consult the Infinity Expansion Module Configuration Guide for restrictions on the use of expansion modules.

Operating Environment: 32 to 120°F (0 to 49°C), 10 to 95% RH
Communications: Via the expansion serial port of the local Infinet controller.

External Power Connector: 2-position connector
I/O Connectors: Removable two-piece terminal blocks. (EMX 156 has screw terminals).

EMX 150

Points: 2 analog outputs
Range: 0-20 mA or 0-20 VDC for each output
Impedance: 0-20 mA into maximum 750 ohms
0-20 VDC into minimum 4,000 ohms
Resolution: .1 mA or .1 VDC
Overrides: 2-position plus potentiometer, no software feedback
Power Consumption: 55 mA
Dimensions: 6.13"W x 4.88"H x 1.52"D
(15.57cm x 12.40cm x 3.86cm)

EMX 151

Points: 2 high-resolution analog outputs
Range: 0-20 mA (sourcing) or 0-10 VDC
Impedance: 0-20 mA into maximum 1000 ohms
0-10 VDC into minimum 4000 ohms
Resolution: 4.88 mA or 2.44 mV
Accuracy: $\pm 0.1\%$ of span
Power Consumption: 70mA
Dimensions: 6.13"W x 4.88"H x 1.52"D
(15.57cm x 12.40cm x 3.86cm)

EMX 155

Points: 2 digital outputs
Type: Form C relay
Contact Rating: 5A, 24 VAC / VDC
Resolution: .1 second
Overrides: Hand-Off-Auto switch with software feedback
Power Consumption: 46 mA
Dimensions: 6.13"W x 4.42"H x 1.82"D
(15.57cm x 11.23cm x 3.86cm)

EMX 156

Points: 2 high voltage digital outputs
Type: Form A solid state device, field replaceable
Contact Rating: 3A, 120/240 VAC @ 25°C, 2A, 120/240 VAC @ 50°C (DC loads not permitted).

Minimum Load: 12 VAC, 20 mA
Single Cycle Surge Current: 80A
Contact Isolation: 4,000 V RMS
Allowable Power Factor: EMX 156 provides switching for inductive loads with .4 to 1.0 power factor.
Resolution: .1 second
Overrides: Hand-Off-Auto switch with software feedback
Power Consumption: 32 mA

Dimensions: 6.13"W x 4.42"H x 1.52"D
(15.57cm x 11.23cm x 3.86cm)

EMX 160

Points: 8 digital inputs. Any or all points can be assigned as counter inputs. All inputs must be dry contacts.

Maximum Counter Frequency: 140 Hz, 50% duty cycling, 3.57 ms minimum pulse width
Reference Voltage: 5 VDC into 24K ohms
Input Protection: 24 VAC / VDC indefinitely on any single channel, 1500 volt transients

Power Consumption: 12 mA
Dimensions: 6.13"W x 5.72"H x 1.52"D
(15.57cm x 14.53cm x 3.86cm)

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DS-EMX150-5.95



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Features

Stand Alone Direct Digital Controller

User-Programmable

Transparent Data Transfer Including Peer-to-Peer Communications

Battery Backup For 7 Years Accumulated Power Failure

Battery Backed Real-Time Clock

Universal Inputs

Form C Outputs

PID and On/Off Control Algorithms

Detachable Input/Output Connectors

Full Function Manual Overrides

Built-In Service Port Using Andover Lap-Top Software

Optional Local Display/Keypad

Expandable I/O

The Infinity LCX 810 is an intelligent stand alone microprocessor based controller that is used for cost-effective Direct Digital Control of packaged HVAC units, Heat Pumps and Fan Coil Units. Infinet communication protocol provides the Infinity LCX 810 with the ability to communicate with an Infinity CX 9000 or CMX 220 controller, as well as the Infinity TCX 850, LCX 800, SCX 900 and other LCX 810s. Up to 254 Infinity LCX 810s can be networked with the Infinity CX 9000.

The LCX 810 comes standard in a molded plastic enclosure suitable for panel mounting (shown). An optional metal enclosure is available for wall mounting.

Inputs

The Infinity LCX 810 is capable of sensing eight inputs. Each input can accept a digital (on/off), counter (up to 5 Hz), voltage (0-10VDC), or temperature signal.

Outputs

The Infinity LCX 810 has eight Form C relay outputs rated at 5 Amp 24VAC/DC which provide On/Off or pulse width modulation switching for control of Fans, Heating, Cooling, and Economizers. Each output has a built-in switch for manual override.

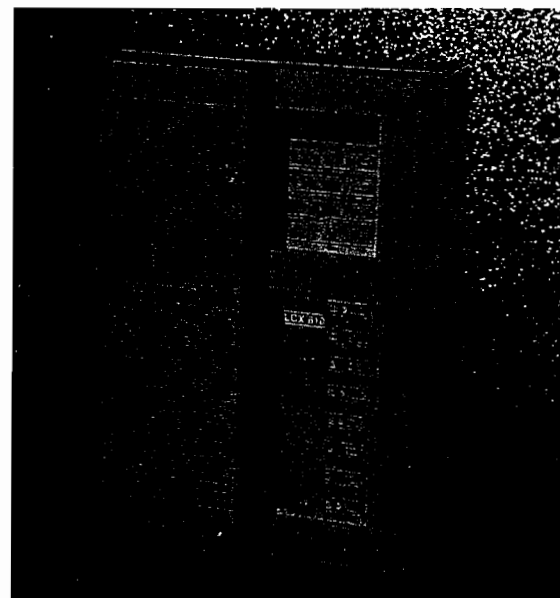
I/O Expansion

The LCX 810 contains the I/O expansion port for the addition of low-cost I/O modules directly on the bottom of the controller. The family of modules includes the EMX 140 (2 pneumatic outputs), the EMX 150 (2 analog outputs), and the EMX 160 (8 digital inputs).

Communications

Communication to Infinity LCX 810 is handled via the Infinet bus, a twisted pair, half duplex RS-485 interface. Communication is accomplished with a token passing protocol which provides full transparent data transfer between all the Infinity controllers on the network.

Andover Controls Infinity LCX 810 Local Control Unit



Programming

Every LCX 810 can be configured to meet the exact control requirements of your application, using the powerful Plain English™ programming language. Programs are entered into individual Infinity LCX 810s using an Infinity CX 9000 or CMX 220 controller, the LSX 280 Lap Top Service Tool, or an SX 8000 workstation. A simple command opens communications to a particular LCX 810. The program is then created using Plain English™. Once completed, the program is stored in, and executed by, the LCX 810.

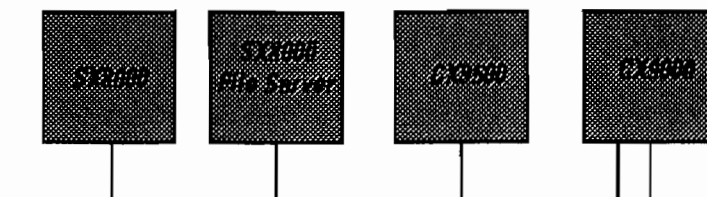
Software Capabilities

The dynamic memory of the LCX 810 can be allocated for any combination of Plain English control programs, scheduling, alarming and data logging. In addition to basic algebraic expressions, mathematical capabilities include logarithms, exponentials and trigonometric functions. Library functions include PID, auto-tuning PID, optimum start and curve fit.

Local Display With Keypad

An optional 2 x 16 character liquid crystal display allows point values to be viewed and setpoints to be changed in the controller.

ENERGYNET



Specifications

Memory:	128K EPROM, 32K RAM, 128 EEPROM
Power:	24 VAC $\pm 20\%$, 50/60 Hz
Power Consumption:	18 VA
Operating Environment:	-10 to 140°F, 10 to 95% RH non-condensing 32 to 104°F with display option
Battery Backup:	Replaceable, non-rechargeable, Lithium Battery (DOT certified). Provides 7 years typical accumulated power failure backup of RAM memory and real-time clock.
Overload Protection:	Fused with 2 Amp pico fuse. Power transformer thermally fused and MOV protected.
On-board real-time clock:	Under battery backup, a crystal real-time clock provides uninterrupted operation of the LCX 810's clock.
Communications:	Through Infinity CX 9000, CMX 220, or Lap-Top via Infinet
Communications Speed:	300, 1200, 9600, or 19,200 autobaud
Bus Length:	4,000 ft. using shielded twisted pair, InfiLink amplification module allows extension to longer distances and is required after every group of 32 units in the network.
Dimensions:	11 13/16"H x 8 9/16" W x 33/16"D (Without enclosure) 19"H x 15"W x 4 3/4"D (With enclosure)
Weight:	5.0 lbs. (Without enclosure) 19.0 lbs. (With enclosure)
Agency Approvals:	UL, FCC

Inputs/Outputs

Inputs:	8 Universal inputs (Counter 0-5Hz at 50% duty cycle. Temperature -30 to +230, Digital On/Off, Voltage 0-10 VDC)
Input Voltage Range:	0-10 Volts.DC
Input Impedance:	30K Ohm to 10V or 10 MEG Ω
Input Protection:	24 VAC or 24 VDC indefinitely on any single channel, ± 1500 volt transients
Input Resolution:	2.5 mV
Input Accuracy:	± 5 mV ($\pm .46^\circ\text{F}$ over range of -10 to +150°F)
Outputs:	8 single-pole double-throw (SPDT) Form C relays
Output Rating:	5A 24VAC, ± 1500 volt transients
Output Resolution:	.1 seconds for pulse width modulation
Overrides:	Each output is equipped with an HOA switch for manual control of the output.
Expansion Bus:	Interfaces to optional I/O Expansion Modules

Connections

Power:	Three-position barrier strip
Outputs:	Removable two-piece terminal strip
Inputs:	Removable two-piece terminal strip
Communication Bus:	Removable two-piece terminal strip

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DS-LCX810-2.94



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Features

Stand-alone Direct Digital Controller

User Programmable

Transparent Data Transfer Including Peer-to-Peer Communications

Battery Back-Up For 7 Years Accumulated Power Failure

Battery Backed Real-Time Clock

Universal Inputs

Universal Outputs

Detachable Input/Output Connectors

Full Function Manual Overrides

Optional Local Display/Keypad

Built-In Service Port For Infinity Lap-Top Service Tool

PID and On/Off Control Algorithms

Expandable I/O

The Infinity SCX 920 is an intelligent, stand-alone, microprocessor based system controller that is used for cost effective Direct Digital Control of chillers, cooling towers, boilers, air handling units, perimeter radiation, lighting, etc. Infinet communication protocol provides the Infinity SCX 920 with the ability to communicate with an Infinity CX 9200 or CMX 220 controller, as well as the Infinity TCX 850, LCX 800, LCX 810 and other SCX 920s. Up to 254 Infinity SCX 920s can be networked with the Infinity CX 9200.

The SCX 920 comes standard in a molded plastic enclosure suitable for panel mounting (shown). An optional metal enclosure is available for wall mounting.

Inputs

The Infinity SCX 920 is capable of sensing sixteen inputs. Each input can accept a Digital (on/off), Counter (up to 5 Hz), Voltage (0-10VDC), or Temperature signal.

Outputs

The Infinity SCX 920 has 8 Universal outputs providing pulse, variable voltage (0 - 20VDC), variable current, (0 - 20mA) or on/off control of motors and lighting with Form C relays. In addition, 2 Form C relays can be combined in software to provide 1 Tri-State output, for bi-directional control of motors and actuators..

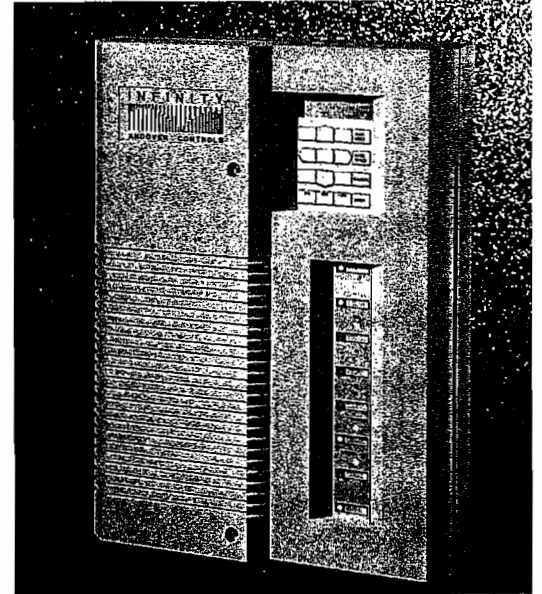
I/O Expansion

The SCX 920 contains the I/O expansion port for the addition of low-cost I/O modules directly on the bottom of the controller. The family of modules includes the EMX 140 (2 pneumatic outputs), the EMX 150 (2 analog outputs), and the EMX 160 (8 digital inputs).

Communications

Communication to Infinity SCX 920s is handled via the Infinet bus, a twisted pair, half duplex RS-485 interface. Communication is accomplished with a token passing protocol which provides full transparent data transfer between all the Infinity controllers on the network.

Andover Controls Infinity SCX 920 System Control Unit



Programming

Every SCX 920 can be configured to meet the exact control requirements of your application, using the powerful Plain English™ programming language. Programs are entered into individual Infinity SCX 920s using an Infinity CX 9000 or 9200 or CMX 220 or 240 controller, the LSX 280 Lap-Top service tool, or a SX 8000 workstation. A simple command opens communications to a particular SCX 920. The program is then created using Plain English™. Once completed, the program is stored in, and executed by, the SCX 920.

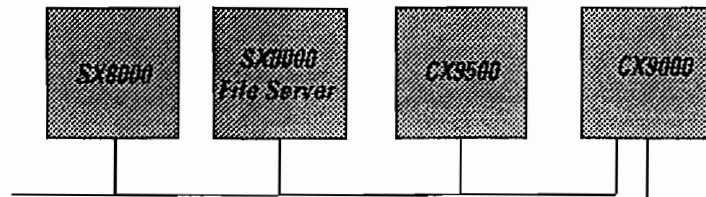
Local Display With Keypad

An optional 2 x 16 character liquid crystal display allows point values to be viewed and setpoints to be changed in the controller.

Software Capabilities

The dynamic memory of the SCX 920 can be allotted for any combination of Plain English control programs, scheduling, alarming and data logging. In addition to basic algebraic expressions, mathematical capabilities include logarithms, exponentials and trigonometric functions. Library functions include PID, auto-tuning PID, optimum start and curve fit.

ENERGYNET



Specifications

Memory:	128K EPROM, 32K RAM, 128 EEPROM (64K RAM on SCX 920)
Power:	24 / 115 / 230 VAC 50/60 Hz $\pm$ 20% field selectable
Power Consumption:	32 VA
Operating Environment:	32 to 120°F, 10 to 95% RH (non-condensing) 32 to 104°F w/display option
Battery Back-up:	Replaceable, non-rechargeable, Lithium Battery (DOT certified). Provides 7 years typical accumulated power failure backup of RAM memory and real-time clock
Overload Protection:	Fused with 3 Amp 3AG fuse. Power transformer thermally fused and MOV protected
Real-time Clock:	Under battery backup, a crystal RTC provides uninterrupted operation of the SCX 920 clock.
Communications:	Through Infinet field bus to CX 9200, CX 9000 or CMX 240 Network Controller
Communications Speed:	300, 1200, 9600, or 19,200 autobaud
Bus Length:	4,000 ft. using shielded twisted pair, InfiLink amplification module allows extension to longer distances and is required after every group of 32 units on the network.
Dimensions / Weight	14 11/16"H x 10 11/16"W x 3 3/16"D / 7.0 lbs. (No enclosure) 19"H x 15"W x 4 3/4"D / 21 lbs. (with enclosure)
Agency Approvals:	UL 916, FCC, CSA

Inputs/Outputs

Inputs:	16 Universal: Digital (on/off), Counter (up to 5 Hz at 50% duty cycle), Voltage (0-10 VDC), or Temperature (-30 to +230°F)
Input Voltage Range:	0-10 volts DC
Input Impedance:	30K Ohm to 10V, or 10 Meg.
Input Protection:	Each input can withstand continuous shorting to 120 VAC/DC or up to $\pm$ 1500 volt transients
Input Resolution:	2.5mV
Input Accuracy:	$\pm$ 5mV ($\pm$ 46°F over range -10 to 150°F)
Outputs:	8 Universal software-configurable outputs. Each output configurable as Form C relay, 0-20 ma, 0-20V or Tri-State. (Tri-State outputs use 2 Form C relays.)
Output Rating:	5A 24VAC (Form C/Tri-State), 0-20 mA into maximum 750 ohms, 0-20 VDC into minimum 4000 ohms. Transient protection: $\pm$ 1500 volts.
Output Resolution:	0.1 sec. for Form C/Tri-State, 0.1mA for 0-20mA output, and 0.1 volt for 0-20 volt output
Overrides:	Each output is equipped with an HOA switch for manual control of the Form C or Tri-State relay, and for universal, an override potentiometer for manual control of the 0-20mA, and 0-20 VDC output signals.
Expansion Bus:	Interfaces to optional I/O expansion modules

Connections

Power:	Three-position barrier strip.
Outputs:	Removable two-piece terminal strip
Inputs:	Removable two-piece terminal strip
Communication Bus:	Removable two-piece terminal strip

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DS-SCX920-4.94



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DESCRIPTION

The BEO-2000 is a compact, double pole relay board. Each 24 VDC relay is provided with a status LED and a SPDT contact rated for 10 amps at 120 VAC. The BEO-2000 may control any electrical start/stop point such as pumps, fans, or lights. The BEO-2000 will also switch motor loads up to 1/3 horse power.

FEATURES

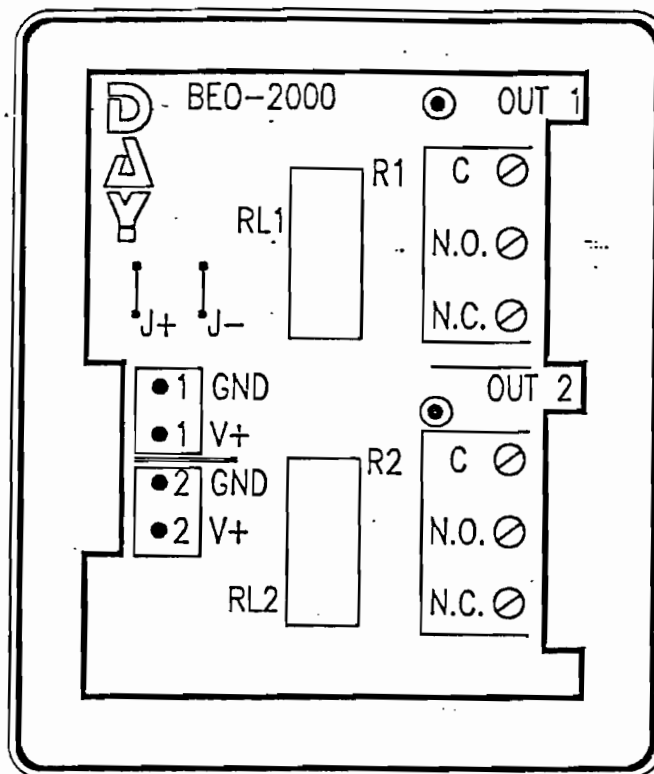
- * On board coil suppression
- * Quick disconnect screw terminations on the input
- * Captive wire-clamping plated screws on the outputs
- * LED indication of relay status
- * Snap Track or James L. Day Co. Channel Track mounting
- * Compact relay package

OPERATION

See wiring diagrams

SPECIFICATIONS

* Operating Conditions	-45 C to +75 C 95% RH non-condensing maximum
* Input signal	24 VDC at 45 mA
* Contact rating	Resistive 10 A at 120 VAC 10 A at 277 VAC 10 A at 24 VAC
	Motor (inductive) 1/3 HP at 120 VAC
* Mounting	Snap Track Channel Track
* Size	3.25" x 2.5" x 1.25"



RELAY

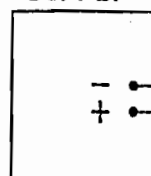
MODEL BEO-2000

WIRING DIAGRAMS:

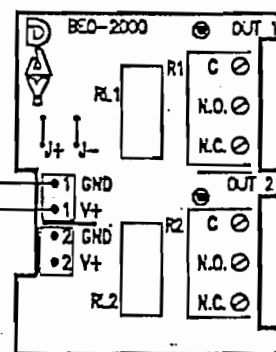
WARNING!!!

Check jumpers for
proper application.

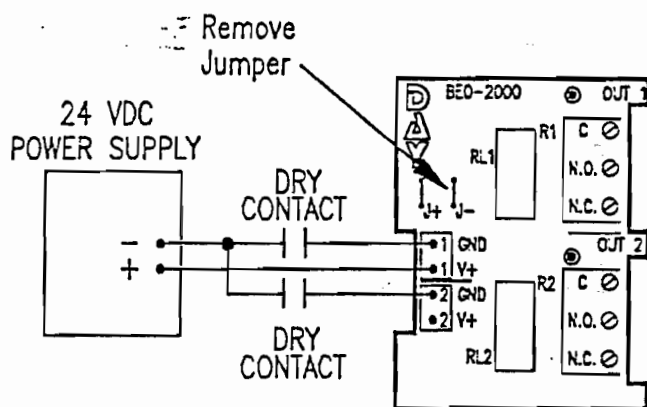
24 VDC
POWER
SUPPLY



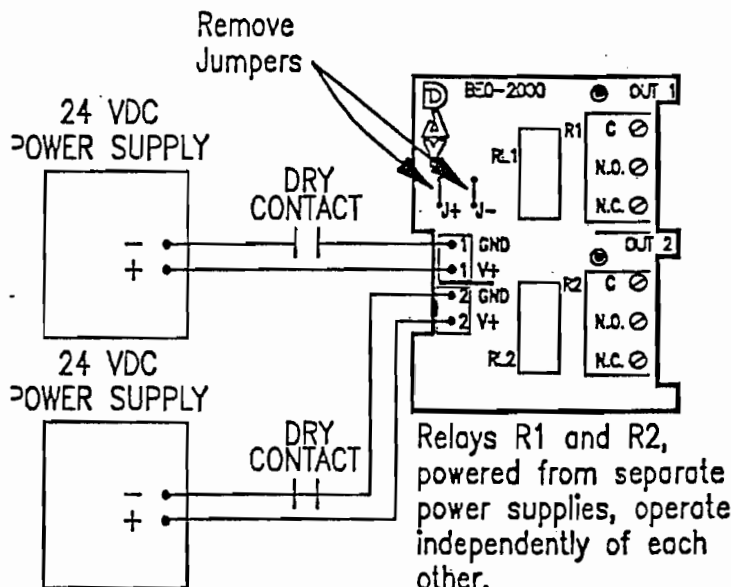
DRY
CONTACT



Relays R1 and R2
operate simultaneously.



Relays R1 and R2, powered from the same
power supply, operate indepently of each other.



Relays R1 and R2,
powered from separate
power supplies, operate
independently of each other.

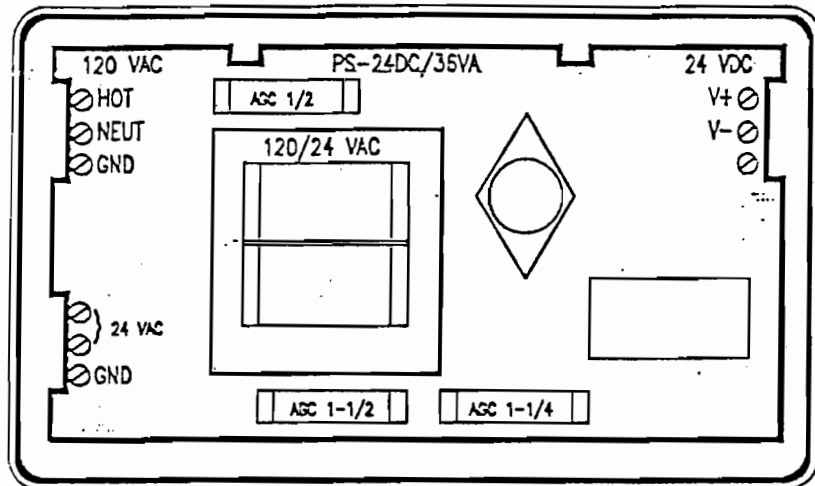
ORDERING INFORMATION

BEO2X

- 1 - Single Pole Double Throw
- 2 - Double Pole Double Throw

DESCRIPTION

The PS-24VDC/36VA is a compact dual-output power supply. It converts 120 VAC to 24 VAC and regulated 24 VDC. The primary and secondary sides of the transformer, as well as the 24 VDC output, are fuse protected. The supply is suited to power energy management transducer/control boards at the point of control interface.



FEATURES

- * Power disconnect
- * Overload protection
- * Captive wire-clamping plated screw terminals
- * 24 VAC and Regulated 24 VDC outputs

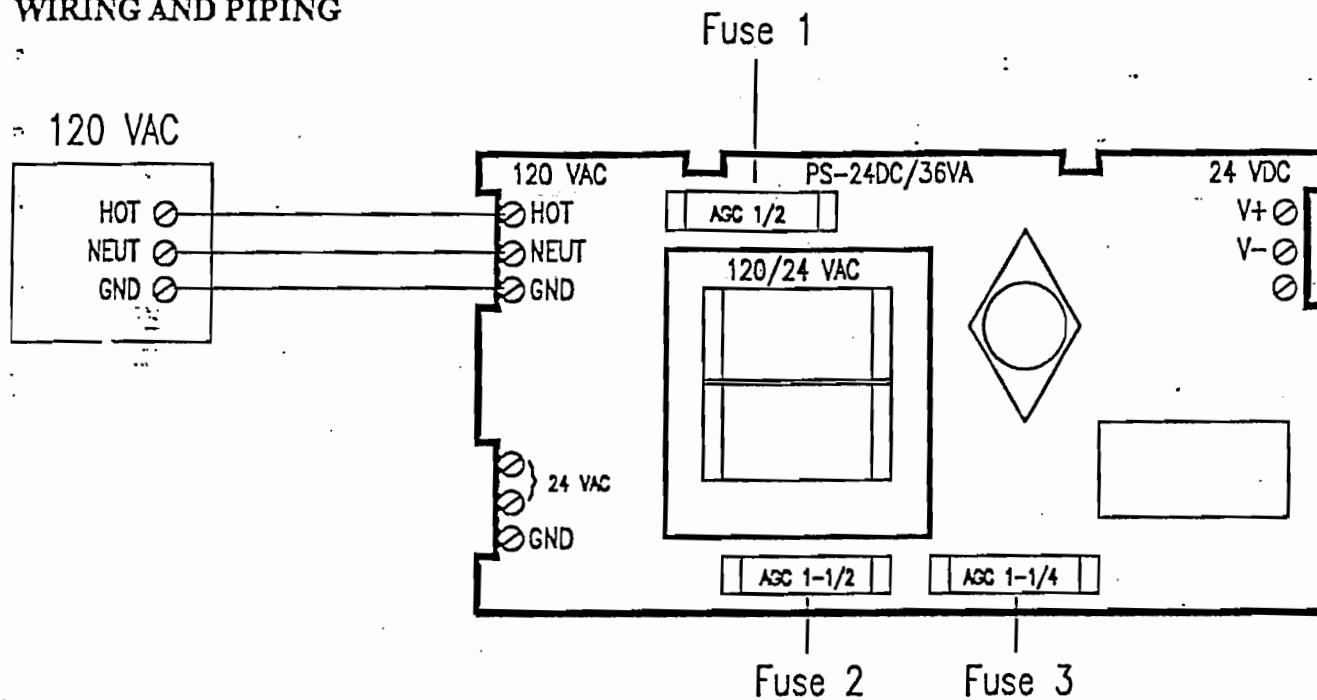
SPECIFICATIONS

- * Input Signal
 - 120 VAC
- * Output
 - 24 VAC at 1.25 amp
 - 24 VDC at 1 amp
 - total current not to exceed 1.3 amp
- * Operating Conditions
 - 0 to 55 deg. C
 - 95% RH non-condensing maximum
- * Mounting
 - Snap Track
 - James L. Day Co. Channel Track
- * Size
 - 3.25" x 7.0" x 1.75"

POWER SUPPLY

MODEL: PS-24VDC / 36VA

WIRING AND PIPING



ORDERING INFORMATION

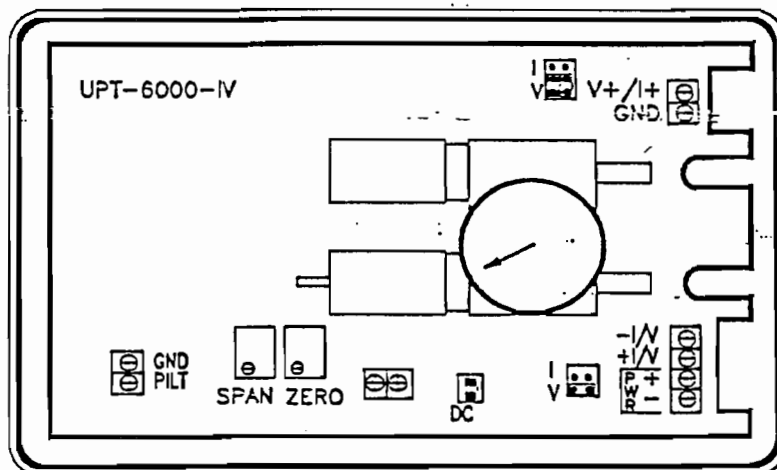
PS24

DESCRIPTION

The UPT-6000-IV is an electronic to pneumatic transducer that converts a 4-20 mA or 0-10 V DC signal to a 0-20 PSIG pressure output. The UPT-5000-IV is compatible with most building automation systems.

FEATURES

- * AC or DC power
- * Selectable voltage or current signal
- * Adjustable zero and span
- * Pressure feedback voltage or optional sourcing current
- * No constant air bleed
- * Optional positive positioning
- * Optional pressure gauge
- * Quick disconnect screw terminals
- * J.L. Day channel track or snap track mounting
- * Can be mounted in any position



OPERATION

The UPT-6000-IV provides a 0-20 PSIG output directly proportional to the input signal. It compares the input signal to the branch line pressure signal and maintains the pressure setting regardless of air line leaks in the branch line. The UPT-6000-IV may be field adjusted where an output pressure other than 0-20 PSIG is desired. This feature is convenient when an input signal other than the standard is used.

SPECIFICATIONS

* Supply voltage	24 VAC or regulated DC
* Supply current (current mode)	90 mA standby, 110 mA transition
* Supply current (voltage mode)	51 mA standby, 72 mA transition
* Output	0-20 PSIG (adjustable)
* Minimum branch volume	2.3 cubic inches
* Input signal	4-20 mA or 0-10 V DC
* Feedback signal	1-5 VDC
	4-20 mA DC sourcing (optional)
* Maximum main air pressure	25 PSIG

TRANSDUCER

MODEL UPT-6000 IV

SPECIFICATIONS CONT.

* Air capacity	250 SCIM at 20 PSIG
* Air consumption	none in steady state
* Linearity	1% of span @ 25 C
* Hysteresis	1% of span @ 25 C
* Resolution	.5% of span @ 25 C
* Operating temperature	0 to 50 C
* Humidity	5% to 95% RH noncondensing
* Temperature drift	.04% / F
- * Supply voltage must be isolated from the signal voltage when 4-20 mA mode is used with current sinking controllers.

INSTALLATION AND WIRING

Mount the UPT-6000-IV in a NEMA 1 enclosure in a clean, dry environment. Check AC/DC jumper for proper power voltage position (see diagram). Check I/V jumper for proper control signal position (see diagram). Make all connections in accordance with job wiring diagrams and in compliance with local and national electrical codes. Wiring terminations should be made with power removed. 18 gauge shielded wire is recommended.

FIELD CALIBRATION

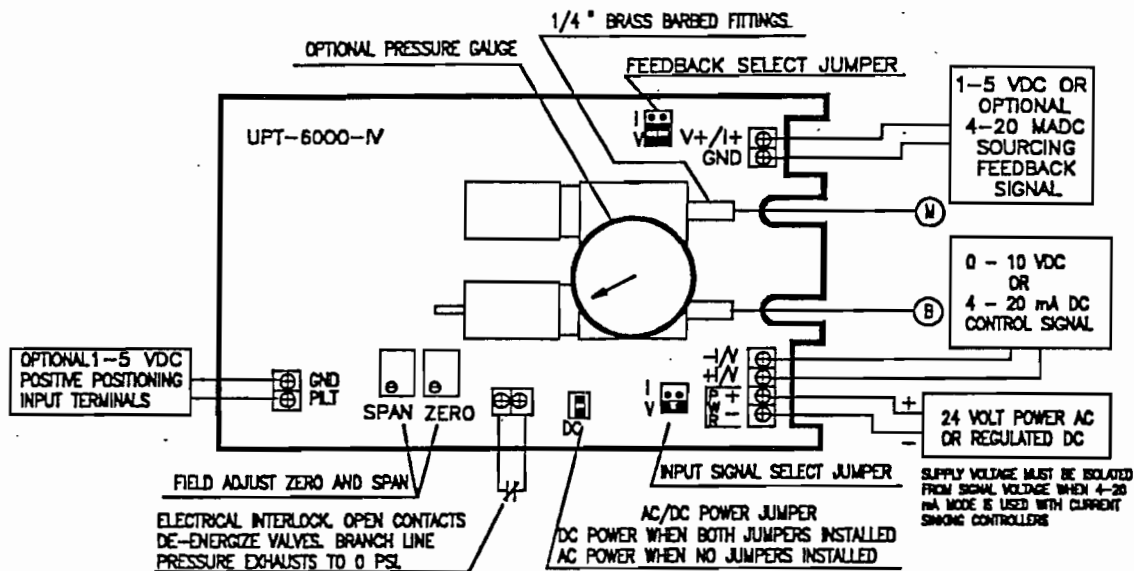
The UPT-6000-IV is factory calibrated for an output span of 0-20 PSIG. If a tighter span is required perform the following procedure:

- 1) Set the input signal to 0VDC or 4 mA DC.
- 2) Adjust the ZERO potentiometer for the desired low end pressure.
- 3) Set the input signal to 10 VDC or 20 mA DC.
- 4) Adjust the SPAN potentiometer for the desired high end pressure.
- 5) Repeat steps 1-4 as necessary.

NOTE: DO NOT ADJUST ANY POTENTIOMETERS OTHER THAN THE ZERO AND SPAN. DOING SO WILL VOID THE WARRANTY.

TRANSDUCER

MODEL UPT-6000 IV



ORDERING INFORMATION

UPT6XXXXX

G - For Gauge (Blank for no gauge)
 B - Branch
 P - Pilot
 D - No Feedback
 V - Voltage Feedback
 I - Current Feedback
 D - DC pwr
 A - AC pwr
 V - Voltage
 I - Current

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36

GENERAL SERVICE 3 Way Solenoid Valves

Forged Brass, Steel or Stainless Steel Body
1/8", 1/4", 3/8" and 1/2" N.P.T.

General Description

These rugged forged brass, steel and stainless steel body valves are especially suited for heavy duty industrial applications.

Important: No minimum operating pressure required.

Applications

These valves may be used on:

- air vices
- compressors
- large control valves as "pilots"
- machine tools
- turbines

Specifications

Operation: Three types available:

- (a) Normally Closed (suffix "F")
- (b) Normally Open (suffix "G")
- (c) Universal (suffix "U")

Valve Parts in Contact with Fluid:

Body — Forged Brass, Steel or 304 Stainless Steel, as listed.

Disc — 303 s.s. (metal seated); Nylon (resilient seated).

Core Tube — 305 s.s.

Core and Plugnut — 430F s.s.

Springs — 302 s.s., 17-7PH or Inconel.

Shading Coil — Copper for forged brass and steel valves; Silver for stainless steel valves.

Seats — Buna "N," Phosphor Bronze (brass body), or 303 s.s. (steel and stainless steel bodies), as listed.

Gaskets — Buna "N" for forged brass and steel valves; Teflon* for stainless steel valves; Ethylene Propylene for steam valves.

Solenoid Enclosures: Two types available:

(a) **Type 1** — General Purpose.

(b) **Types 4 and 7 (C and D)** — Combination Watertight and Explosion-Proof. Also meets Types 3 and 9 (E, F and G). Refer to Engineering Section for definitions and details. Consult your local ASCO office for Types 3S and 4X.

Electrical: Standard Voltages:

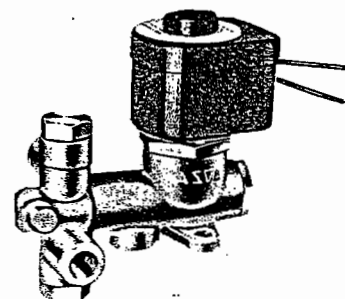
24, 120, 240, 480 volts, AC, 60 Hz (or 110, 220 volts, AC, 50 Hz).

6, 12, 24, 120, 240 volts, DC.

Other voltages available when required.

Note: 125 volt AC, and 250 volts, DC, are battery voltages applied in power plants. Special valves in both AC and DC construction are available for power plant applications, to act as pilots for control valves. Consult your local ASCO sales office for details.

*DuPont Co. trademark.



Coils: Continuous Duty Molded Class F or H, as listed.

Temperature:

Fluid: To 405°F., as listed.

Ambient: Nominal Range, 32°F. to 77°F. (104°F. occasionally — refer to Engineering Section.)

Installation:

Dimensions: Refer to Dimensions Table for envelope size and mounting.

Attitude: Valves must be mounted with solenoid vertical and upright.

Approvals: CSA certified. Refer to Engineering Section for details.

SPECIFICATIONS

Pipe Size (ins.)	Orifice Size (ins.)	Cv Flow Factor	Maximum Operating Pressure Differential (psi)						Maximum Fluid Temp. °F.		Type 1 General Purpose Solenoid Enclosure		Types 4 and 7 (C and D) Watertight and Explosion-Proof Solenoid Enclosure		Watt Rating/ Class of Coil Insulation	
			Normally Closed ① or Normally Open ②				Universal ③									
			Air-Inert Gas, Water, Light Oil		Steam		Air-Inert Gas, Water, Light Oil									
			AC	DC ④	AC	DC	AC	DC ④	AC	OC	Catalog Number	Constr. Ref. No.	Catalog Number	AC	DC	
Forged Brass Body, Metal Seats and Discs for General Service																
1/8	1/8	.13	550	250	—	—	300	125	200	180	8300D55	1	8302D24	20/F	33/H	
	3/16	.35	250	125	—	—	150	60	200	180	8300D3	1	8302D1	20/F	33/H	
1/4	3/16	.35	250	125	—	—	150	60	200	180	8300D58	1	8302D25	20/F	33/H	
	1/4	.45	190	75	—	—	90	25	200	180	8300A81	1	8302A81	20/F	33/H	
	1/4	.45	250	—	—	—	120	—	200	—	8300D61	1	8302D26 ⑥	28/H	—	
3/8	1/4	.45	190	75	—	—	90	25	200	180	8300A82	1	8302A82	20/F	33/H	
	1/4	.45	250	—	—	—	120	—	200	—	8300D9	1	8302D4 ⑥	28/H	—	
	5/16	.75	120	40	—	—	60	20	200	180	8300D64	2	8302D27	20/F	33/H	
	3/8	1.0	75	30	—	—	35	15	200	180	8300D72	2	8302D31	20/F	33/H	
1/2	3/16	.75	120	40	—	—	60	20	200	180	8300D68	2	8302D29	20/F	33/H	
	3/8	1.0	75	30	—	—	35	15	200	180	8300D76	2	8302D33	20/F	33/H	
Forged Brass Body, Buna "N" Seats and Nylon Discs for General Service																
1/4	3/16	.25	250	125	—	—	150	60	180	180	8300D58R	1	8302D25R	20/F	33/H	
	1/4	.39	150	75	—	—	75	25	180	180	8300A81R	1	8302A81R	20/F	33/H	
3/8	1/4	.39	150	75	—	—	75	25	180	180	8300A82R	1	8302A82R	20/F	33/H	
	5/16	.53	120	40	—	—	60	20	180	180	8300D64R	2	8302D27R	20/F	33/H	
1/2	3/16	.53	120	40	—	—	60	20	180	180	8300D68R	2	8302D29R	20/F	33/H	
Forged Brass Body, Metal Seats and Discs for Steam Service																
1/4	1/4	.45	—	—	110	—	55	—	344	—	8315D2	1	8315D22	15.4/H	—	
	1/4	.45	—	—	225	150	110	75	405	360	831532	4	831538 ⑦	28.2/H	21.4/H	
3/8	1/4	.45	—	—	110	—	55	—	344	—	8315D3	1	8315D23	15.4/H	—	
	1/4	.45	—	—	225	150	110	75	405	360	831533	4	831539 ⑦	28.2/H	21.4/H	
	5/16	.75	—	—	105	75	50	40	341	320	831534	5	831540 ⑧	28.2/H	21.4/H	
	3/8	1.0	—	—	75	45	40	20	320	300	831536	5	831542 ⑧	28.2/H	21.4/H	
1/2	5/16	.75	—	—	105	75	50	40	341	320	831535	5	831541 ⑧	28.2/H	21.4/H	
	3/8	1.0	—	—	75	45	40	20	320	300	831537	5	831543 ⑧	28.2/H	21.4/H	

SPECIFICATIONS (continued)

Pipe Size (ins.)	Orifice Size (ins.)	Cv Flow Factor	Maximum Operating Pressure Differential (psi)						Maximum Fluid Temp. °F.		Type 1 General Purpose Solenoid Enclosure		Types 4 and 7 (C and D) Watertight and Explosion-Proof Solenoid Enclosure	Watt Rating/ Class of Coil Insulation	
			Normally Closed① or Normally Open②				Universal③								
			Air-Inert Gas, Water, Light Oil		Steam		Air-Inert Gas, Water, Light Oil		AC	DC	Catalog Number	Constr. Ref. No.	Catalog Number	AC	DC
			AC	DC④	AC	DC	AC	DC④							
Steel Body, Metal Seats and Discs for Corrosive Service															
3/8	1/16	.35	250	100	—	—	125	50	200	180	8300B32	3	8302B8	20/F	33/H
	1/4	.45	150	50	—	—	75	25	200	180	8300A83	3	8302A83	20/F	33/H
	1/4	.45	175	—	—	—	85	—	200	—	8300B41	3	8302B46④	28/H	—
	5/16	.75	120	40	—	—	60	20	200	180	8300B89	3	8302B38	20/F	33/H
	3/8	1.0	75	30	—	—	35	15	200	180	8300B97	3	8302B42	20/F	33/H
1/2	5/16	.75	120	40	—	—	60	20	200	180	8300B203	3	8302B203	20/F	33/H
	3/8	1.0	75	30	—	—	35	15	200	180	8300B204	3	8302B204	20/F	33/H
Stainless Steel Body, Metal Seats and Discs for Corrosive Service															
1/2	5/16	.75	120	40	—	—	60	20	200	180	8300B403	3	8302B403	20/F	33/H
	3/8	1.0	75	30	—	—	35	15	200	180	8300B404	3	8302B404	20/F	33/H

Notes: ① For normally closed operation, use catalog number suffix "F".

② For normally open operation, use catalog number suffix "G".

③ For universal operation, use catalog number suffix "U".

④ For higher DC rating valves, refer to Bulletin 8321.

⑤ Suitable for Types 4 and 7 (C and D) only and has a temperature range code T2B. Refer to Engineering Section for details.

⑥ Suitable for Types 4 and 7 (C and D) only and has a temperature range code T2C. Refer to Engineering Section for details.

OPTIONAL FEATURES

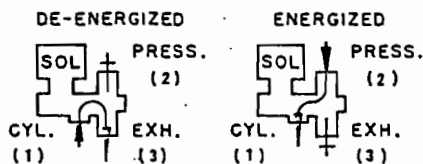
Many optional electrical and construction features are available, refer to Optional Feature Section.

ELECTRICAL INFORMATION

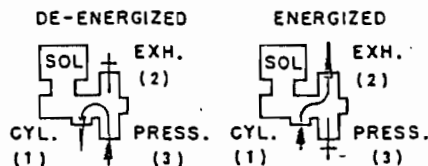
Standard Coil and Class of Insulation	Watt Rating and Power Consumption				Spare Coil Part No.	
	DC Watts	AC				
		Watts	VA Holding	VA Inrush		
					AC	DC
F	—	20	41.5	195	99-257	—
H	33	28.2	59	329	204-806	222-184
H	21.4	28	57	250	222-345	208-492
H	—	15.4	27	145	222-345	—

FLOW DIAGRAMS

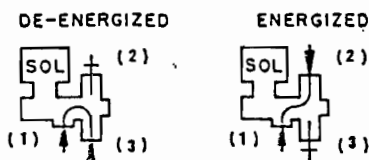
NORMALLY CLOSED (Suffix "F")



NORMALLY OPEN (Suffix "G")



UNIVERSAL (Suffix "U")

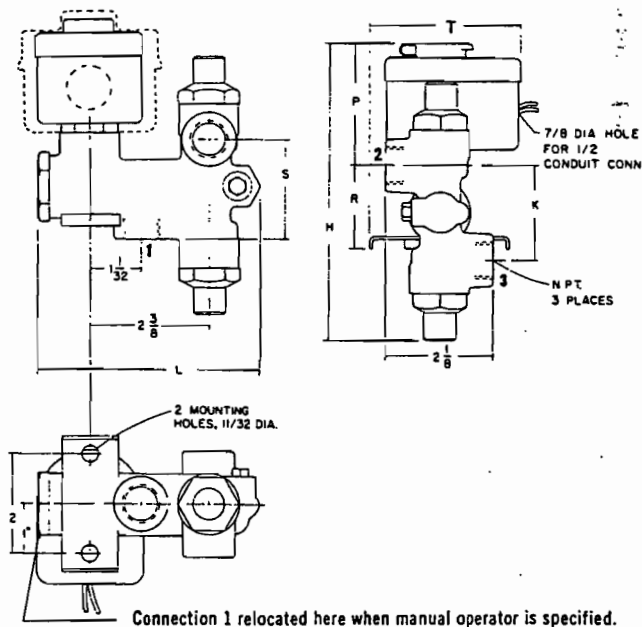


ORDERING INFORMATION

IMPORTANT: We must have CATALOG NUMBER, VOLTAGE and HERTZ, operating pressure and fluid handled. Use strainers with solenoid valves.

DIMENSIONS (in inches)

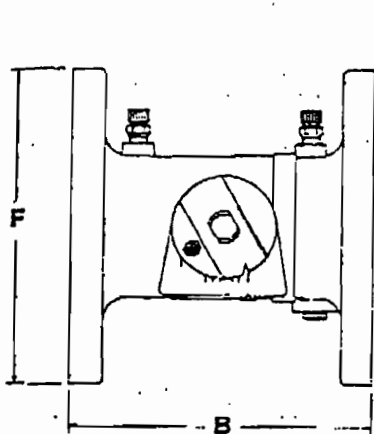
(Watertight and Explosion-Proof Solenoid Enclosure shown dotted-in. Details available on request.)



Constr. Ref.	H	K	L	P	R	S	T
1	4 ³ / ₃₂	1 ⁷ / ₁₆	4 ¹ / ₂	2 ⁹ / ₁₆	1 ³ / ₈	1 ¹³ / ₃₂	2 ¹¹ / ₃₂
2	5 ¹ / ₃₂	1 ⁷ / ₈		2 ⁷ / ₁₆	1 ⁴³ / ₆₄	2	
3	6 ³ / ₁₆	1 ⁷ / ₁₆	4 ⁵ / ₈	3 ³ / ₄	1 ¹¹ / ₃₂	1 ¹⁹ / ₃₂	3 ³ / ₁₆
4	7 ³ / ₁₆	1 ⁷ / ₈	5 ¹ / ₁₆	3 ³ / ₄	1 ¹¹ / ₃₂	1 ¹⁹ / ₃₂	3 ³ / ₁₆
5	7 ³ / ₁₆	1 ⁷ / ₈	5 ¹ / ₁₆	3 ³ / ₄	1 ¹¹ / ₃₂	1 ¹⁹ / ₃₂	3 ³ / ₁₆

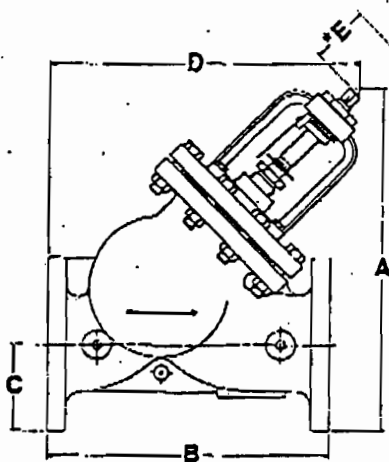
Circuit Setter Calibrated Balance Valves

*DISTANCE REQUIRED
TO DISASSEMBLE
(VALVE CLOSED)

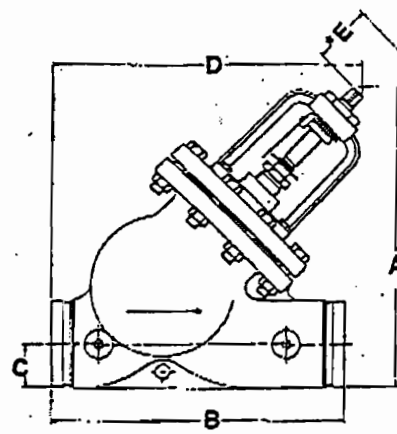


SIZES 2½"-3"

FLANGED MODELS



SIZES 4"-8"



GROOVED MODELS

SIZES 4"-8"

DIMENSIONS AND WEIGHTS

DIMENSIONS IN INCHES												
MODEL NO.	PIPE SIZE	CONNS.	A		B	C	D		E	F	MAX. WIDTH OF VALVE	WEIGHT IN LBS.
			OPEN	CLOSED			OPEN	CLOSED				
CB-2½F	2½	FLGD.	—	—	6¾	—	—	—	—	7	—	23
CB-3F	3	FLGD.	—	—	8¾	—	—	—	—	7½	—	29
CB-4F	4	FLGD.	18¾	17¾	14½	4½	17½	16	7¾	—	9	100
CB-4G		GRVD.	16¾	15¾	15½	2½	17½	16	—	—	76	
CB-5F	5	FLGD.	20¾	19¾	16	5	18¾	17½	8¾	—	10	120
CB-5G		GRVD.	18¾	16¾	17½	2¾	18¾	17¾	—	—	92	
CB-6F	6	FLGD.	22¾	21¾	18	5½	20¾	19	9¾	—	11	197
CB-6G		GRVD.	20¾	19¾	19	3¾	20¾	19½	—	—	171	
CB-8F	8	FLGD.	26¾	24¾	21½	6¾	23¾	22½	12¾	—	14¼	327
CB-8G		GRVD.	23¾	22¾	22½	4¾	23¾	22	—	—	281	

SCHEDULE

MODEL NO.	TAGGING INFORMATION	QUANTITY
CB-2½F		
CB-3F		
CB-4F		
CB-4G		
CB-5F		
CB-5G		
CB-6F		
CB-6G		
CB-8F		
CB-8G		

For further information, contact ITT Bell & Gossett, 8200 N. Austin Avenue, Morton Grove, IL 60053,
Phone: (708) 966-3700 — Telex 4949943 — Facsimile (708) 966-9052.

ITT Bell & Gossett
ITT Fluid Technology Corporation



Tech Specs

Crosstalk Mark 4 Version 2.1

Crosstalk[®] Mark 4 is the most versatile PC communications software you can buy. It's the ideal cornerstone of your corporate asynchronous communications strategy. Plus, it's a perfect complement to easy, economical Crosstalk Communicator.



April 30, 1991
Crosstalk Mk.4, Version 2.0



You can choose from 30 different terminal emulations, 11 different file-transfer protocols, and most intelligent modems. And, you can access leading network asynchronous communications servers (ACSs).

When you need customized capabilities, you can create them with CASL[™], the powerful Crosstalk Application Script

Language that comes with Crosstalk Mark 4. CASL helps you create custom interfaces and write scripts that automate almost any communications task.

It's no wonder that Crosstalk Mark 4 won an Editors' Choice award from *PC Magazine* and a Best Buy award from *PC World*, and that it's the only PC communications program to earn a 4-Star rating from *Software Digest*.

Point-and-shoot interface

Crosstalk Mark 4 features a point-and-shoot Dialing Directory interface that's easy to learn and efficient to use. Crosstalk Mark 4 shares this intuitive interface with economical Crosstalk Communicator and with Crosstalk's remote computing software, Remote².

More ways to connect

Crosstalk Mark 4 expands your terminal emulation options to 30 with IBM[®] FTERM emulation, which provides asynchronous 3270 support via IBM 3708, 7171, 9370, and 3174 protocol converters. Also, Crosstalk Mark 4 supports the IBM 3270 adapter as well as the DCA[®] IRMA[™] 3270 adapter.

LAT (Local Area Transport) support allows communications with a DEC host directly via an Ethernet connection.

You can conduct multiple, concurrent communications sessions, in the foreground or background.

Network-based PCs can access leading network asynchronous communications servers via NETBIOS, NASI, or Interrupt 14 (INT14) to share network modems.

File-transfer options

Crosstalk Mark 4 supports 11 file-transfer protocols: Crosstalk and DART[™] from Crosstalk, plus IBM IND\$FILE (Send/Receive), Kermit[™], XMODEM, YMODEM (including YMODEM-G), ZMODEM, and others.

You can use Crosstalk Mark 4's DART protocol to speed up file transfer. It uses "file skipping" to send only those files from a directory that are not already on the receiving computer. If a transmission is interrupted, DART also knows to resend only the part of a file not successfully transmitted the first time.

For on-line help, just ask

Context-sensitive help is always available. There's even help for CASL.

Streamlining communications with CASL

As your communications activities expand, so does the need to do them efficiently. Crosstalk Mark 4 helps here, too.

Now it's easier to create and use custom menus on line, and you can use the new script utility menu to call up built-in scripts or those you have created for yourself.

Also, you can use CASL to automate routine tasks and unattended operations, develop custom interfaces, and customize the program to your needs.

With CASL, you can write scripts for tasks as simple as logging on to services or as complex as managing multiple communications sessions. And you can create an easy-to-use menu that cuts down on training time and expense.

You can do all this because CASL is no ordinary scripter. It's a complete programming language with power like that of C or Pascal. It contains over 380 commands for handling variables, loops, procedures, file access, and floating point math, plus other tools to help you use your on-line sessions more efficiently.

Another valuable tool is Crosstalk Mark 4's LEARN mode. It records system prompts and your responses, and saves them as scripts that you can recall later to automate repetitive tasks. LEARN is part of the script library, which also includes logon scripts for many popular information services as well as a variety of useful utilities.

Moving up from Crosstalk XVI

If you've been using Crosstalk XVI, you'll find moving up to Crosstalk Mark 4 is easy. When you're getting started, you can continue using the Crosstalk XVI interface that you're already familiar with. And, Crosstalk Mark 4 automatically converts your Crosstalk XVI scripts.

Easy to update

As advanced as it is, Crosstalk Mark 4 also is designed to grow. Its modular design allows quick and easy updating. As new terminal emulations and file-transfer protocols become available, you can simply "snap" them in. It's like having software expansion slots.

Concurrent user licensing

If your organization has LAN users requiring asynchronous communications, you may find Crosstalk Mark 4 LAN Pack an attractive alternative to single-user licensing. This product allows up to 4 network users to access Crosstalk Mark 4 concurrently. With LAN Pack, you can run Crosstalk on a network server or copy the product onto as many network nodes as you like; LAN Pack keeps up with how many people are using Crosstalk at a particular moment. You can increase the number of concurrent users by purchasing additional LAN Packs.

Other Crosstalk Mark 4 version 2.1 features

- Multiple sessions, in windows or with a full screen for each session
- Unattended call-in access with password protection for file transfer, e-mail, and disk access
- Virtualized port parameters for easy modification of port and modem configuration
- Internal editor for creating scripts or writing notes
- Review buffer with cut and paste to editor
- Data capture to disk or printer
- Extremely high-speed data-transfer rates with hardwire connection or through high-speed modems

- Queue dialing allows marking Dialing Directory entries which are dialed sequentially until a connection is established
- International character support through NRC (National Replacement Character) support
- Credit card dialing
- Access to disk directories and file manipulation from within the program
- Easy selection of communications parameters
- Pacing of data-transfer speeds to avoid overrun of E-mail and bulletin board hosts
- Single-key entry of pre-stored codes and passwords
- User-programmable function and keypad keys
- Easy configuration of entries for popular information services, such as CompuServe® and Dow Jones News/Retrieval®
- Filter modules for case conversion or display/removal of control characters
- Compatibility with Microsoft® Windows™ and DESQview™
- 16550 UART support

Operating system

PC DOS or MS-DOS®, version 2.0 or newer (background mode not available under DOS 4.x or 5.x)

Environments

Windows, DESQview, other windowing programs

RAM requirements

320 KB

Speed

300 to 115,200 bps

Communications devices supported

Most popular modems, including Hayes®, Intel®, U.S. Robotics®, and other auto-dial modems; DCA IRMA and IBM 3270 adapters; network modem pools (also X.PC protocol); DEC LAT

Asynchronous communications servers

IBM ACS, IBM LANACS, Novell® ACS, Telebit® ACS

Terminal emulations supported

ADDStm Viewpoint™
ANSI Color Graphics
AT&T® 510 and 513
Data General® Dasher™ 200 Series
Datapoint® 3501
DEC® VT-52, VT100, VT102, VT220, VT320
FITTERM
Hazeltine® Esprit™ III
IBM 3101 (page and character modes), 327x (IRMA or IBM adapter)
Lear Siegler® ADM™
Prestel®
TeleVideo® 912, 920, 925, 950 series (including block mode)
TYMNET78™ (for async to 3270 communication)
Generic TTY terminal
WYSE 50, 50+, 60
Hewlett-Packard 2392a, 2394a, 2623a, 2624a

File-transfer protocols

Crosstalk, DART, FAST, XMODEM (CRC and CHECKSUM methods), YMODEM (including YMODEM-G), ZMODEM, Kermit (including Super Kermit), CompuServe B™, CompuServe B Plus™, and INDSFILE

Programming language

Nearly 400 commands, statements, and functions; floating point math; string and numeric operators; full control of screen windows, colors; includes WHILE, WEND, IF...THEN, REPEAT...UNTIL, CASE, TRACK, and WATCH

Simultaneous sessions

Up to 15, depending on available memory, in windows or with full-page per session

™ European version only

General Product Information

800-348-3221

Technical Assistance

404-442-3210

1000 Alderman Drive
Alpharetta, Georgia 30202-4199
404-442-4000
Fax: 404-442-4361

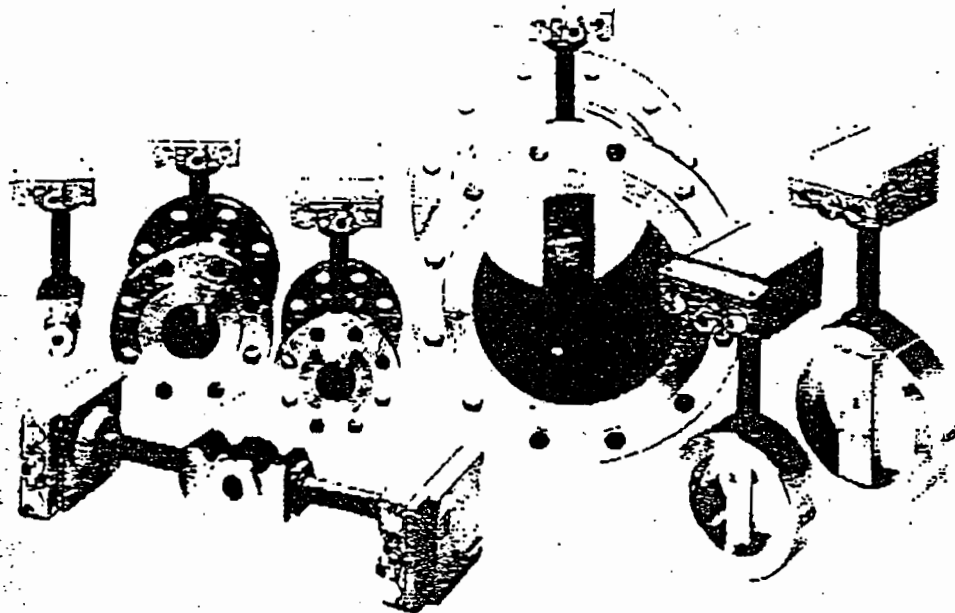
Air Center Blandonnet
1214 Vernier
Geneva, Switzerland
41-22-3412650
Fax: 41-22-3410682

152 Beach Road
#12-08 The Gateway East
Singapore 0718
65-291-7988
Fax: 65-291-9281

2946 8/93

Vortex Flow Measurement *swingwirl II*

For measuring gas, steam and liquids



Measuring Principle

The operating principle is based on the Karman Vortex Street. When a fluid flows past a delta-shaped bluff body, vortices are alternately formed on the sides of that body and are detached or shed by the flow. The frequency of vortex shedding (with a Reynolds number above 20,000) is proportional to the mean flow velocity and therefore the volumetric flow.

Alternating pressure changes caused by the vortices are transmitted via lateral port holes in the bluff body. The DSC (Differential Switched Capacitor) sensor detects these pressure pulses and converts them into an electrical signal. The sensor is located within the bluff body, well protected from water hammer, temperature or pressure shocks.

The preamplifier processes the sinusoidal sensor signal into flow proportional square wave pulses. The same sensor and

preamplifier are used for all nominal diameters and for all media. The sensor signal is galvanically isolated from the preamplifier output signal.

Applications

- Chemical
 - In-line / continuous metering.
 - High temperature chemical flow monitoring.
 - Off gas measurement.
- Power Plants
 - Steam distribution.
 - Fuel usage.
 - Cooling water metering.
- Food and Dairy Production
 - CIP fluid flow monitoring.
 - High pressure steam distribution..
 - CO₂ flow metering.
- General Industrial Manufacturing
 - Plant air distribution.
 - Steam flow usage.
 - Interdepartmental billing.

Endress+Hauser

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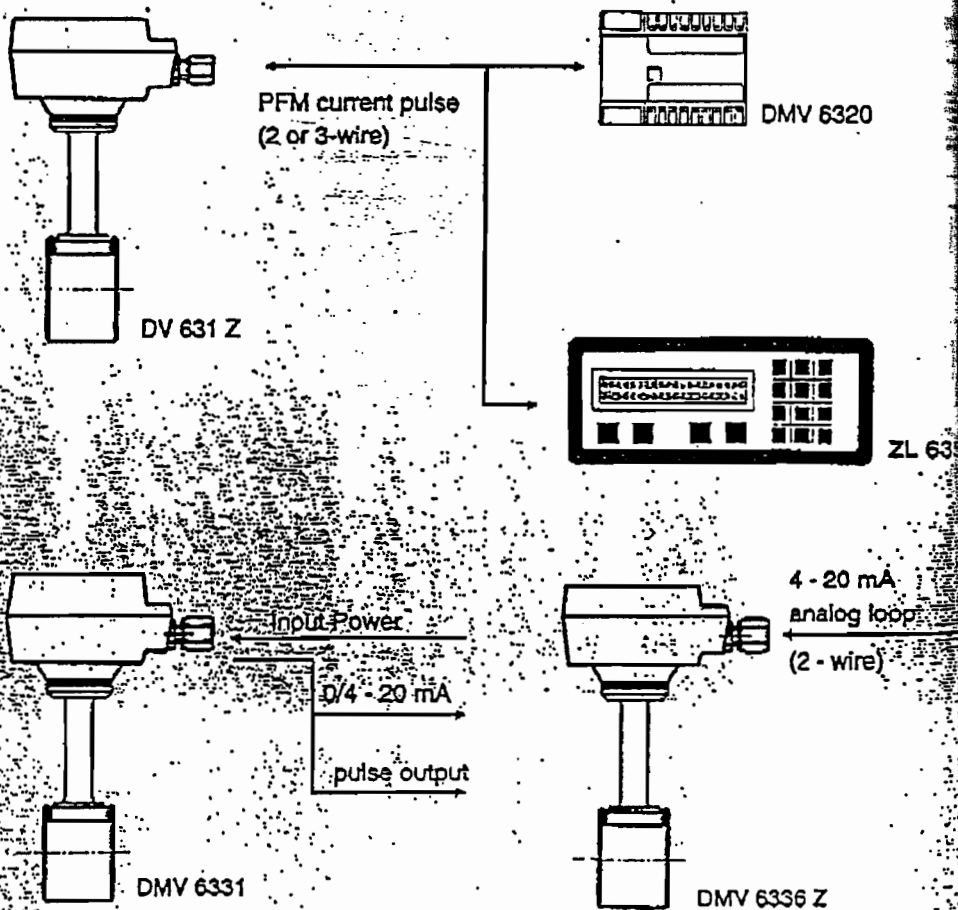
Measuring System

The measuring system can be configured according to the application and process requirements (Figure 1):

- Steam, gas and liquid
 - Sensor DV 631Z with the ZL 6351 flow computer (single channel).
- Liquids
 - Sensor DV 631Z with the separate DMV 6320 transmitter.
 - Sensor and transmitter in a compact version DMV 6331 (with integral power supply).
 - Sensor DMV 6336Z as a 2-wire, 4 to 20 mA transmitter.

Features

- FM approved Class I, Div 1, Groups through G.
- Full range of sizes from 1/2" to 12", available in wafer (1/2" to 6") and flanged (1/2" to 12") process connections.
- Handles fluid temperature ranges from -330°F to +750°F.
- Maintenance free design, no moving parts.
- High accuracy of $\pm 1.0\%$ of actual rate for gas or steam, $\pm 0.75\%$ for liquids.
- Repeatability typically better than 0.2% of rate.
- Wide turndown ratio, typically:
 - 24 : 1 for steam or gas
 - 50 : 1 for liquids
- Universal sensor and electronics for all sizes and applications; reduces spare parts requirements.
- Low in-line pressure loss.
- Optional flow computer for mass, thermal, or standardized volumetric flow.



Measuring System
Figure 1

Theory of Operation

The DSC Sensor

The DSC (Differential Switched Capacitor) sensor detects the vortices shed by the bluff body. Electrodes inside the sensor detect capacitance changes resulting from minute deflections of the sensor's outer shell which are caused by the vortex shedding action. The unique sensor design enables the Swingwirl II Vortex Flowmeter to measure a wider range of flow rates than ever before possible with other vortex type sensors. The sensor can handle fluid temperatures ranging from + 750°F superheated steam down to - 330°F cryogenic liquids, and it can not be damaged by thermal shock.

Engineered using computer aided design techniques, the sensor can ignore pipe vibration which is a major source of measurement error for most other vortex flowmeters. Plus, this rugged sensor has over-speed protection to 2 times the maximum specified flow rate.

Spare parts requirements have been drastically reduced; all size flowmeters use the same sensor, a one-piece machined part with no weld seams to break or fatigue (Figure 2). If a sensor ever needs to be replaced, it can be done without removing the flowmeter from the process piping. The

electronics are universal for all sizes and all applications. There is no need to order different electronics for liquids, gas or steam measurement. The DSC sensor has proven its ruggedness in thousands of applications.

Swingwirl II Vortex Operation

The Swingwirl II Flowmeter measures flow rate using the vortex shedding principle. As fluid flows past a bluff body, vortices are produced on alternate sides of the bluff body (Figure 3). The frequency at which these vortices are produced (or shed) is directly proportional to the flow rate and is independent of the fluid density, viscosity, pressure or temperature

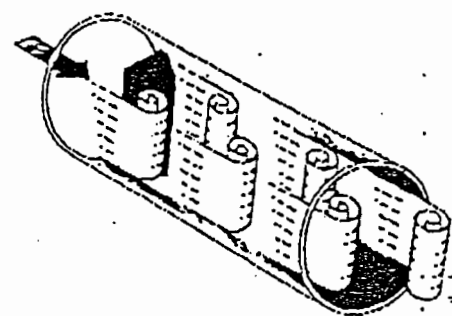


Figure 3

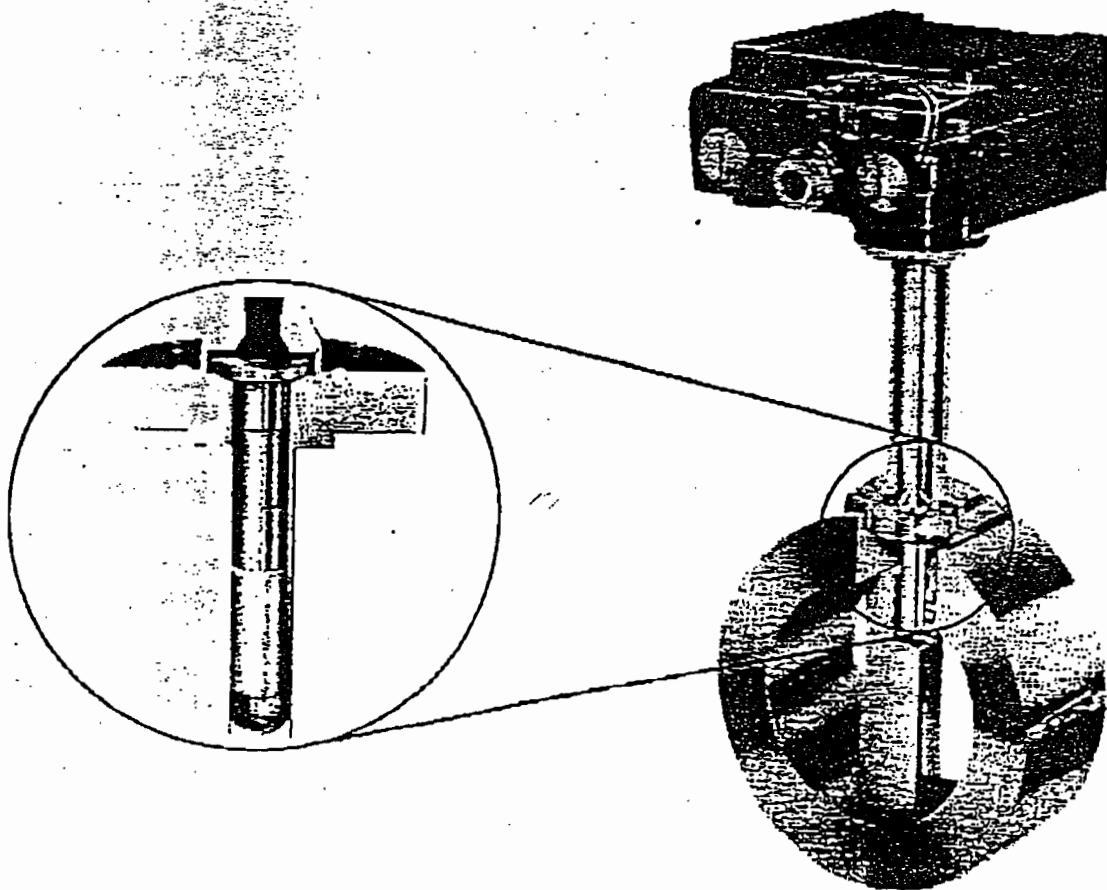


Figure 2

Complete Measuring System

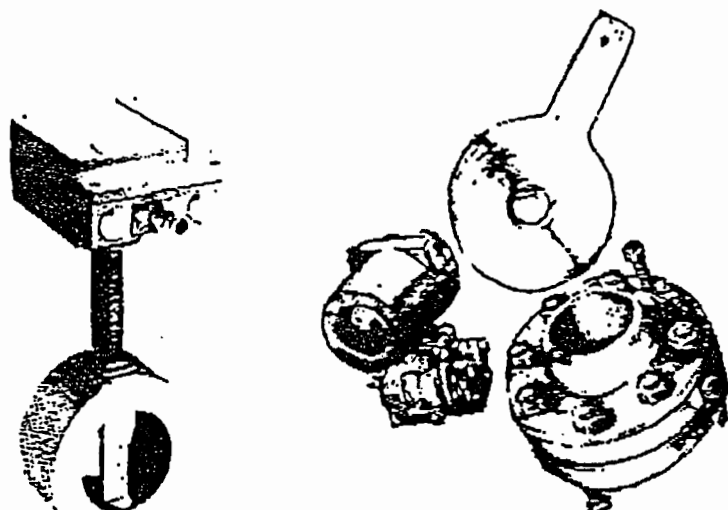


Figure 4

Four Systems to Suit Your Steam, Gas and Liquid Flowmeter Applications

The Swingwirl II Flowmeter is an extremely flexible flowmetering system which can be tailored to your specific needs and offers four basic systems from which to choose.

DMV 6336 Z Loop-Powered System

The lowest priced flowmeter system with convenient 2-wire operation provides a 4 to 20 mA flow rate output signal on the same wires that power the unit from a user-supplied 24 VDC power supply. The full scale flow rate is easily rescaled via BCD switches as your measurement requirements change. The ideal choice for simple volumetric flow rate measurement (refer to Figure 4).

DMV 6331 Self-Contained, Dual Output System

A compact system that provides two outputs; a 4 to 20 mA volumetric flow rate signal, plus a 24 VDC or open collector pulse signal for totalized flow. The system operates on 115 VAC (or optional 230 VAC) and has separate terminals for the output signals. The full scale flow rate and pulse weight are easily rescaled via BCD switches — no field calibration equipment is needed. This unit is an ideal choice for simple volumetric flow rate and totalized flow measurement.

DMV 6320 Remote Transmitter

When the flow sensor will be located in an inaccessible area, this system enables you to mount the transmitter up to 3000 feet away. The DV 631 Z sensor is powered by

The Preferred Alternative to Orifice Plates

The Swingwirl II Flowmeter is the ideal replacement for orifice plate systems to measure the flow of steam, gas and liquids in closed pipes. Its wide turndown of 24:1 for steam and 50:1 for water far surpass the typical 3:1 turndown of an orifice plate, enabling the user to measure accurately over a much wider range of flow rates.

The Swingwirl II meter does not suffer the large accuracy degradation experienced when an orifice plate's sharp edge wears down over time. Your pumps will have less of a burden as well, since the pressure loss is much lower. The installed cost is lower because there is no need for orifice flanges, separate transmitter mounting, pressure lines, purge lines, valves or square root extractors. Compare the components required for measurement as shown in Figure 4.

the transmitter; an additional power source is not required. Sensor and transmitter are connected using inexpensive 2-wire instrument cable. The PTM (Pulse Frequency Modulated) transmission signal is highly immune to noise.

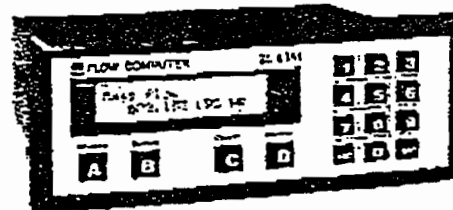
The DMV 6320 standard transmitter (Figure 5) provides the same two volumetric flow rate and totalized flow output signals as the DMV 6331. Full scale flow rate and pulse weight are easily rescaled via BCD switches located in the transmitter. Field calibration equipment is not required.

ZL 6351 Flow Computer

The ZL 6351 Flow Computer is a reliable, economical system for the measurement of mass, heat, or standard volumetric flow (Figure 6). This microprocessor-based flow computer calculates the flow rates using inputs from pressure and/or temperature sensors to compensate the volumetric flow rate measured by the DV 631 Z sensor.



DMV 6320 Transmitter
Figure 5



ZL 6351 Flow Computer
Figure 6

Measuring Ranges and Size Selection

Flowmeter Size Selection

Tables for saturated steam and the diagram showing measuring ranges for superheated steam, gas and liquids are shown on pages 6 and 7. Swingwirl II vortex flowmeters measure the volumetric flow (ACFM) at operating conditions (i.e., the actual volume which is dependent on pressure and temperature). Since gas quantities are usually stated at standard conditions (14.7 PSIA at 60°F) and steam quantities in pounds, the volumetric flow limits at operating conditions are found by using the formulas and table values below.

Flow Limits (Wafer, 1/2" to 6"; Flanged, 8" to 12")

The maximum flow velocity for steam and gases = 246 fps (75 m/s), 1/2" = 151 fps (46 m/s). For liquids, 30 fps (9 m/s).

The minimum flow velocity, q_{min} , is dependent on three criteria:

1. Sensitivity (start of measurement depends on the liquid density)

$$1" \text{ to } 12": \quad q_{min} \text{ (fps)} = \frac{20}{\sqrt{\rho}}$$

$$1/2" \text{ (liquids):} \quad q_{min} \text{ (fps)} = \frac{40}{\sqrt{\rho}}$$

$$\text{(gas/steam):} \quad q_{min} \text{ (fps)} = \frac{50}{\sqrt{\rho}}$$

2. Linearity from $Re > 3800$
3. Minimum vortex frequency of 1 Hz.

Criteria #1 should be followed for all applications, #2 for liquids, and #3 for larger diameters.

Flow Limits (Flanged 1/2" to 6")

Minimum flow velocity:

$$q_{min} \text{ (ACFM)} \geq \frac{ID^2 \times 1.61}{\sqrt{\rho}}$$

$$q_{min} \text{ (GPM)} \geq \frac{ID^2 \times 12}{\sqrt{\rho}}$$

Maximum flow velocity:

$$\text{for } 0.06 \leq \rho \leq 0.75 \text{ lb/ft}^3$$

$$q_{max} \text{ (ACFM)} \leq ID^2 \times 80.65$$

$$\text{for } \rho > 0.75 \text{ lb/ft}^3$$

$$q_{max} \text{ (ACFM)} \leq \frac{ID^2 \times 70.7}{\sqrt{\rho}}$$

$$q_{max} \text{ (GPM)} \leq \frac{ID^2 \times 529.4}{\sqrt{\rho}}$$

Where ρ = density (lb/ft³) and meter ID value as listed below:

Size	I.D.	Size	I.D.
1/2"	0.547"	3"	2.902"
1"	0.957"	4"	3.819"
1-1/2"	1.50"	6"	5.760"
2"	1.937"		

Table 1
Pressure (PSIG)

Dia. (in.)	10	20	30	40	50	60	80	100	150	200	250	300	350	400	500	600	700	800	900
0.5	10	12	15	18	21	24	30	36	45	54	63	72	81	90	108	126	144	162	180
1	30	36	45	54	63	72	81	90	108	126	144	162	180	207	243	288	333	378	423
1.5	72	84	108	126	151	176	207	243	300	360	423	486	549	630	756	882	1008	1134	1260
2	119	139	176	207	243	288	333	378	450	540	630	720	810	900	1080	1260	1440	1620	1800
3	281	333	423	504	594	684	774	864	1035	1224	1413	1602	1791	2070	2430	2880	3330	3780	4230
4	460	540	684	810	954	1098	1242	1386	1662	1938	2214	2490	2766	3150	3780	4410	5040	5670	6300
6	1020	1224	1512	1800	2098	2396	2694	2992	3582	4272	4962	5652	6342	7230	8520	9810	11100	12390	13680
8	1790	2098	2694	3150	3606	4062	4518	4974	5940	7020	8100	9180	10260	11700	13860	16020	18180	20340	22500
10	2760	3330	4230	5040	5940	6840	7740	8640	10350	12240	14130	16020	17910	20700	24300	28800	33300	37800	42300
12	3670	4410	5540	6540	7540	8540	9540	10540	12600	14700	16800	18900	21000	24300	28800	33300	37800	42300	46800
Temp.	°F	228	229	274	287	296	307	323	338	368	386	406	422	436	448	470	486	506	524
Density	lb/ft ³	0.081	0.083	0.108	0.128	0.150	0.171	0.214	0.257	0.353	0.408	0.574	0.678	0.787	0.884	1.11	1.20	1.26	1.29

Saturated Steam Flow

Minimum and maximum flow rates by meter size are shown in Table 1.

Example: What is the measuring range for 150 PSIG saturated steam in a 4" line?

1. From Table 1, scan across the 4" row and read the measuring range under the 150 PSIG column (1100 to 28,500 lb/hr).
2. The saturation temperature is 366°F and the density is 0.363 lb/ft³ (last two lines of Table 1).

Table 2
Density

PSIG	Temperature (degrees F)					
	300	400	500	600	700	750
10	0.056	0.049	0.044	0.039	0.035	0.034
20	0.073	0.069	0.061	0.055	0.050	0.048
30	0.102	0.099	0.079	0.071	0.065	0.062
40	0.125	0.109	0.097	0.087	0.080	0.076
50	0.149	0.129	0.115	0.103	0.094	0.090
60		0.150	0.133	0.120	0.108	0.105
80		0.182	0.169	0.152	0.139	0.133
100		0.234	0.206	0.185	0.162	0.161
150		0.344	0.300	0.257	0.243	0.233
200		0.458	0.396	0.351	0.318	0.305
250			0.495	0.437	0.395	0.379
300			0.597	0.523	0.471	0.451
350			0.703	0.612	0.550	0.525
400			0.814	0.703	0.630	0.602
500			1.046	0.890	0.790	0.754
600			1.300	1.086	0.965	0.910
700				1.293	1.126	1.079
800				1.512	1.302	1.233
900				1.745	1.485	1.401

Superheated Steam Flow

1. Read the density from Table 2 based on operating temperature and pressure (interpolation may be required).
2. If flow rate is known only in lb/hr, convert to volumetric flow rate using the formula below.

$$q = \frac{m}{(60)(\rho)} \quad \text{Where:}$$

q = volumetric flow rate in ACFM

m = mass flow rate in lb/hr

ρ = density in lb/ft³

3. Refer to the Measuring Range for Steam and Gas (Figure 7) to determine minimum / maximum flow rates by meter size.

Example: Determine the proper line size and measuring range for superheated steam at 500°F and 200 PSIG, flowing at 20,000 lb/hr.

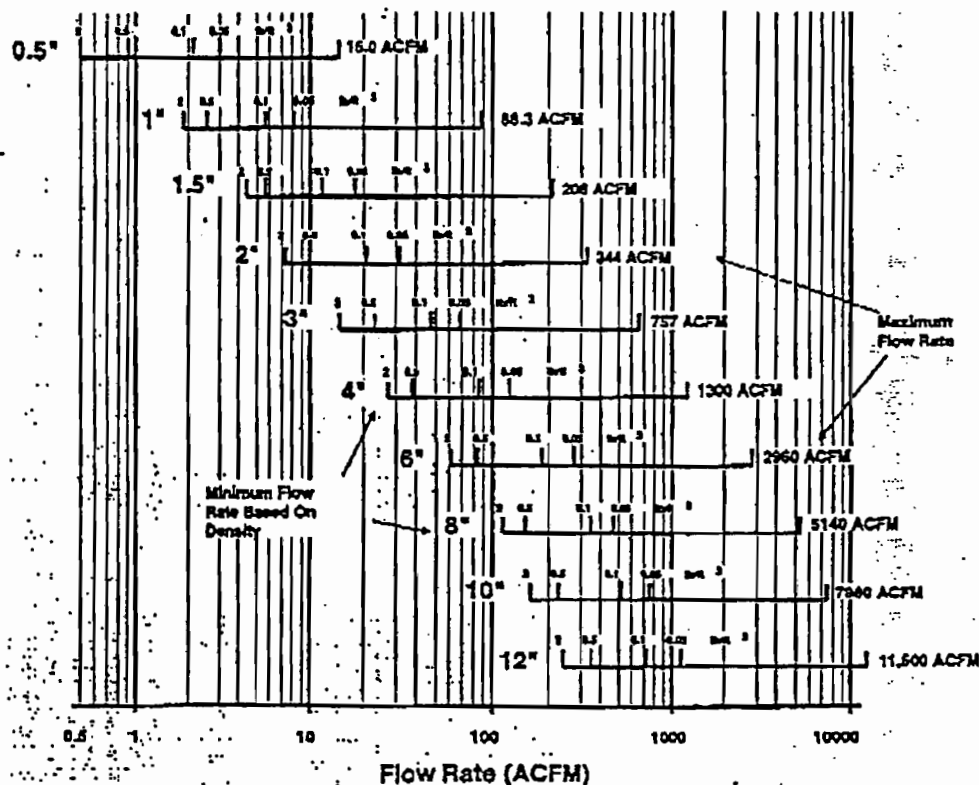
1. From Table 2, the steam density is 0.396 lb/ft³.

$$2. \quad q = \frac{20,000}{(60)(0.396)} = 847 \text{ ACFM}$$

3. From Figure 7, a 4" meter would be a good choice, offering a 17.5:1 turndown.

The measuring range for a steam density of 0.396 lb/ft³ is 48 to 1300 ACFM (1150 to 31,000 lb/hr).

Measuring Range for Steam and Gas



NOTE: For extremely dense gases, the maximum flow may be less than shown. Gases with extremely low densities (eg. hydrogen, helium) may not be measurable.
Figure 7

Gas Flow

1. If the flow rate is only known in SCFM, convert to ACFM using the following formula.

$$q_A = \frac{(q_S)(T)}{(35.4)(P)} \quad \text{Where:}$$

q_A = Actual volumetric flow in ACFM
 q_S = Volumetric flow rate at standard conditions (60°F, 14.7 PSIA)

T = Actual process temperature in °R (°F + 460)

2. Determine the actual gas density. Standard densities of some common gases are shown in Table 3. Calculate actual density as:

$$\rho_A = \frac{(\rho_S)(P)(35.4)}{(T)} \quad \text{Where:}$$

ρ_A = Actual density in lb/ft³

ρ_S = Density at standard conditions (60°F, 14.7 PSIA) in lb/ft³

P = Actual process pressure in PSIA

T = Actual process temperature in °R (°F + 460)

3. If the density is unknown, it can be determined from the molecular weight or

specific gravity of the gas as:

$$\rho_S = \frac{M}{361} = \frac{G}{13.1} \quad \text{Where:}$$

ρ_S = Density at standard conditions (60°F, 14.7 PSIA) in lb/ft³

M = Molecular weight of the gas

G = Specific gravity of the gas.

4. Refer to Figure 7 for minimum/maximum flow rates by meter size.

Example: Determine the proper line size and measuring range for air at 70°F and 100 PSIG, flowing at 5000 SCFM.

1. Converting from SCFM to ACFM

$$Q_s = \frac{(5000)(70+460)}{(35.4)(100+14.7)} = 653 \text{ ACFM}$$

2. Actual gas density:

$$\rho_A = \frac{(0.0761)(100+14.7)(35.4)}{(70+460)} = 0.583 \text{ lb/ft}^3$$

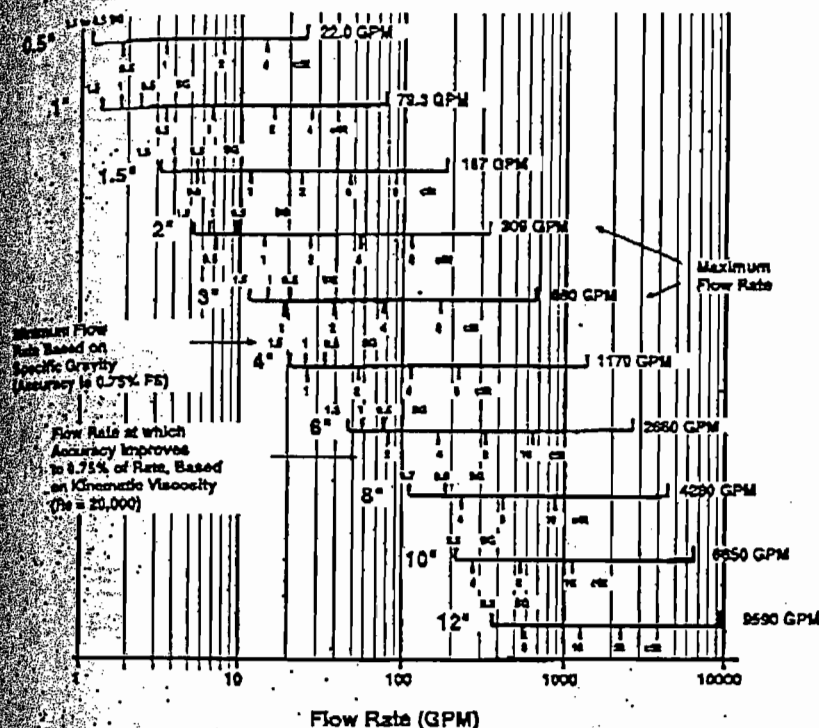
3. From Figure 7, a 4" meter would be a good choice, offering a 16:1 turndown. The measuring range for a gas density of 0.583 lb/ft³ is 40 to 1300 ACFM.

NOTES: Minimum flow rates for sizes 8" to 12" are based on the 1/2 minimum vortex shedding frequency criteria.

Minimum flow rates for viscous liquids (≥ 2 cSt) may be higher than shown due to the criteria that $Re \geq 3800$.

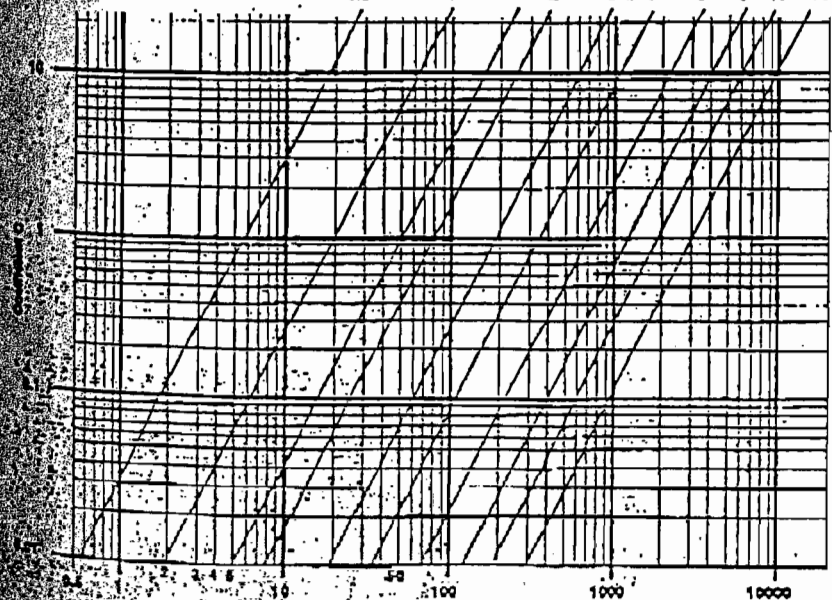
Figure 8

Measuring Range for Liquids (S.G. = 1.0, Viscosity = 1 cSt)



Pressure Loss for Steam, Gas and Liquids

Meter Diameter 0.5" 1" 1.5" 2" 3" 4" 5" 6" 8" 10" 12"



(ACFM for Steam and Gas, GPM for Liquids)

Table 3

Gas	Standard Density*	Gas	Standard Density*
Air (dry)	0.0761	Nitrogen	0.0779
Ammonia	0.0448	Hydrogen	0.0053
Argon	0.1031	Hydrogen Sulfide	0.0998
Benzene	0.2094	Isobutane	0.1528
Bromine	0.1628	Isopentane	0.1977
Carbon Dioxide	0.1475	Methane	0.0422
Carbon Monoxide	0.1158	Methyl Fluoride	0.0823
Chlorine	0.0736	Nitrous Oxide	0.0631
Chloroform	0.0108	Oxygen	0.0779
Ethane	0.0790	Propane	0.0411
Ethylene	0.0757	Refrigerant	0.1169
ETFE Ester	0.1949	Steam	0.1169
Helium	0.0108		
N-Heptane	0.2534		

* Standard conditions are 60 degrees F, 14.7 PSIA.

Liquid Flow

Minimum and maximum flow rates for liquids are shown in Figure 8.

Example: Determine the proper line size and measuring range for a liquid with a Specific Gravity (S.G.) of 1.2 and a Kinematic Viscosity of 2 Centistokes (cSt), flowing at 800 gallons per minute (GPM).

From Figure 8, a 4" meter would be a good choice with 800 GPM offering a 31:1 turndown. Maximum flow rate is 1170 GPM. Minimum flow rate at 1.2 S.G. is 26 GPM. Measurement accuracy: 0.75% of rate at 51 to 1170 GPM, 1% of full scale at 26 to 51 GPM.

Pressure Loss

Pressure loss is extremely low for the Swingwirl II Flowmeter. To determine the pressure loss:

1. Use Figure 9 to find a coefficient value (C) based on flow rate and meter diameter. For steam and gas, read the flow on the horizontal axis in units of ACFM. For liquids, read the flow rate in units of "GPM".

2. Calculate the pressure loss as:

A. Steam and gas, $\Delta p = (C)(\rho)$

B. Liquids, $\Delta p = (C)(SG)$

Where:

Δp = pressure loss in PSI

C = Coefficient from Figure 4

ρ = Density in lb/ft³

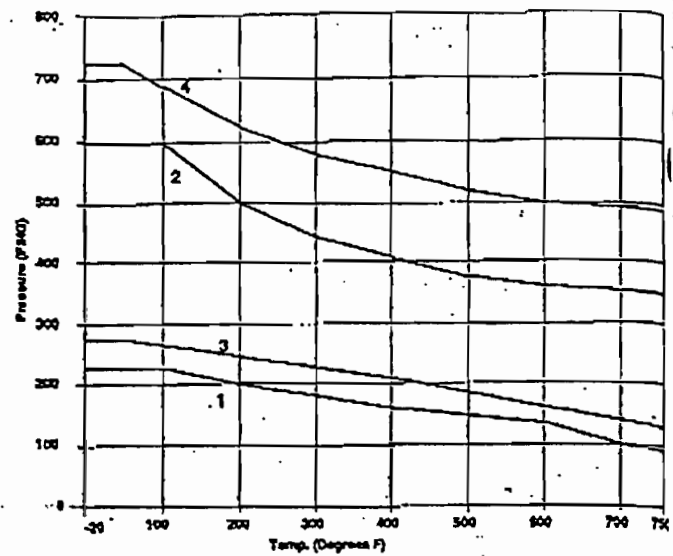
SG = Specific Gravity

Example: Determine the pressure loss for a liquid with a Specific Gravity of 0.9 flowing through a 6" meter at 600 GPM.

1. From Figure 9, the Coefficient (C) for 600 GPM flow through a 6" meter is 0.7.

2. $\Delta p = (0.7)(0.9) = 0.63$ PSI

Pressure/Temperature Limitations
 Certain application limits for the flanged and wafer designed sensors are dependent on pressure and temperature. Figure 10 illustrates the working ranges for the flanged sensors. Ranges for wafer sensors are in accordance with B16.5 for A105 Carbon Steel.



- Line 1 150# flanged style, 8, 10 and 12"
 Line 2 300# flanged style, 8, 10, and 12"
 Line 3 150# flanged style, 1/2" to 6"
 Line 4 300# flanged style, 1/2" to 6"
 Figure 10

Installation Guidelines

Location and Orientation

Installation location and orientation of the Swingwirl II sensor must be considered for proper operation of the measurement system. The recommended inlet and outlet section distance is a multiple of the pipe nominal diameter as shown in Figure 11. Valves and other restrictions should be downstream from the sensor whenever possible. If there is not enough distance between the sensor and an upstream device, a flow straightener may be installed between the device and the flow sensor. The flow straightener can reduce the inlet section length.

Example: A control valve requires 50 X D. Installing a flow straightener reduces the recommended distance to 25 X D. The minimum straight inlet including the flow straightener must be 12 X D.

NOTE: ID of process pipe and measuring sensor should be equal. Wafer 1" to 6" and flanged 1/2" to 12" are Schedule 40, standard. Wafer 1/2" is Schedule 80, standard.

Inlet distance for other standard devices are as follows:

1. Ball valve, fully open, requires 23 X D.
2. Expansion section requires 18 X D (same pipe size as the installed sensor).
3. Shut-off valve, fully open, requires 14 X D.
4. Inlet distances listed are for maximum performance. Distance may be shortened, please consult factory.

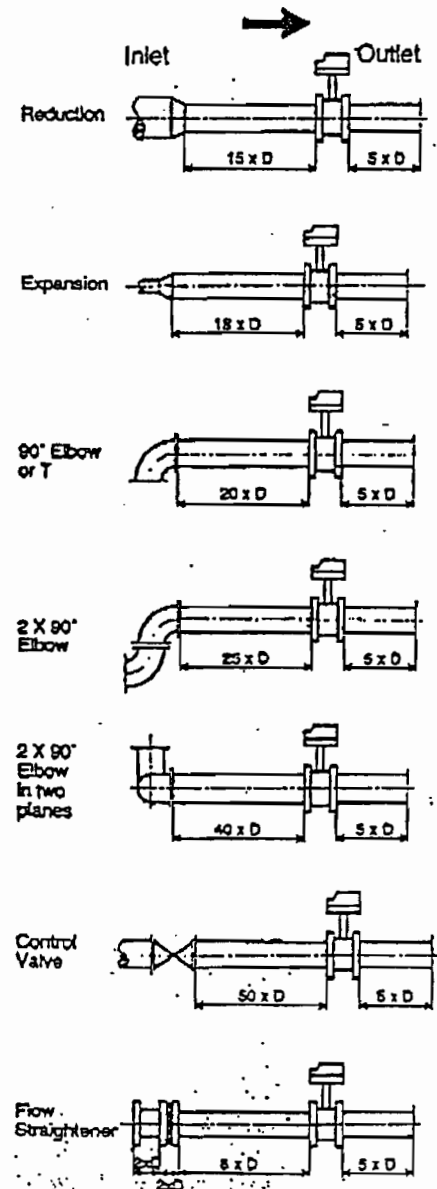
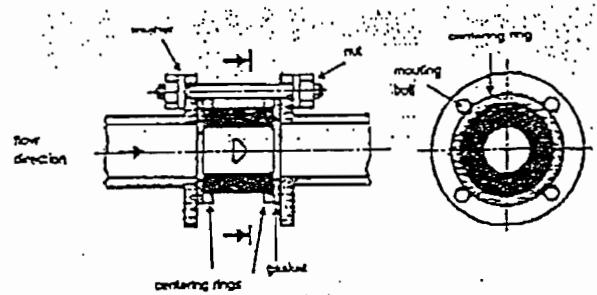


Figure 11

Wafer designed sensors (1/2" to 6") include a mounting kit which consists of two centering rings, two gaskets and mounting hardware (Figure 12). Long sections of pipe with a tendency to vibrate should be rigidly supported upstream and downstream of the vortex sensor.



Mounting Hardware Kit for 1/2" to 6" Wafer Sensors
Figure 12

Mounting Orientation

Recommended mounting orientation of the vortex sensor is shown in Figure 13. In liquid applications, vertical installation with the liquid flowing upwards is recommended to ensure a full pipe (#3, Figure 13).

For high temperature applications, the sensor electronics housing should project horizontally, laterally or downwards to prevent heat build-up inside the electronics (#2, #3 and #4, Figure 13). For cryogenic liquids, sensor orientation should be per #1, Figure 13.

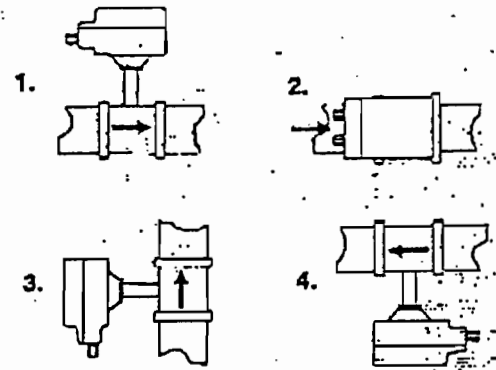


Figure 13

Pressure / Temperature Sensors

Whenever a ZL 6351 Flow Computer is specified, a user-supplied pressure and temperature sensor for input signals is mounted in the outlet section from the sensor according to Figure 14.

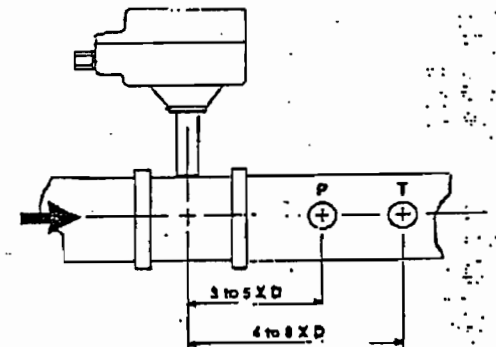


Figure 14

Steam Applications

In steam applications where the pipe and meter body must be insulated, maintain a 2" clearance between the electronics housing and the insulation to prevent over heating of the electronics (Figure 15). When mounting the sensor in a horizontal pipe, the electronics should face downwards (refer to figure 13, #4).

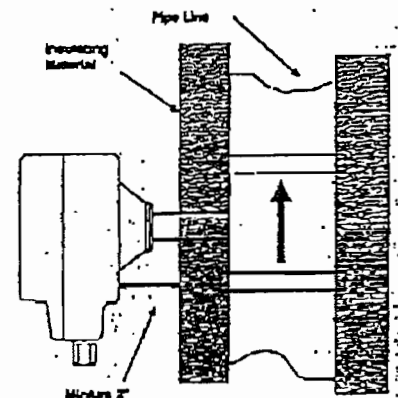


Figure 15

Sensor Technical Data

General Sensor Specifications

Accuracy:	Reynolds Number $\geq 20,000$: $\pm 1\%$ of rate for steam and gas. $\pm 0.75\%$ of rate for liquids. Reynolds Number between 3800 and 20,000: $\pm 1\%$ of full scale for steam and gas. $\pm 0.75\%$ of full scale for liquids
Repeatability:	$\pm 0.2\%$ of rate.
Voltage Fluctuation:	$\pm 0.05\%$ full scale, 10% fluctuation.
Sensor Gasket:	Graphite, standard. Kalrez, optional.
Process Fluids:	Liquids, steam (including saturated and superheated) and gas
Process Pressure Limits:	In accordance with ANSI standard B16.5. 740 PSIG maximum pressure for FM approved wafer meters. See graph (Figure 10 page 8) for flanged meters.
Process Temp. Limits:	-330°F to $+750^{\circ}\text{F}$, (-5°F to $+465^{\circ}\text{F}$ with Kalrez sensor gasket). Maximum liquid temperature for the DMV 6331 is $+570^{\circ}\text{F}$.
Wetted Parts:	Sensor 316 L. Wafer body (1/2" to 6") or flanged body (8" to 12") 316L stainless steel. Flanged body (1/2" to 6") A351 CF 8C cast stainless steel.
Dimensions:	1/2" to 1" wafer and flanged, Figure 16; 1-1/2" to 6" wafer and flanged, Figure 17; 8" to 12" flanged, Figure 18.
Mounting:	1/2" to 6" wafer design, fits between 150#, 300# or 600# ANSI flanges and includes mounting kit. Kit includes centering rings, nuts, bolts, washers (4140 carbon steel, zinc plated) and Victopac 69 (non-asbestos) gaskets. 1/2" to 12" flanged design, mates to 150# or 300# ANSI flanges. Process connection type must be specified when ordered.
System Approvals:	DV 631 Z, DMV 6336 Z: FM approved Intrinsically Safe, Class I, II and III; Division 1; Groups A through G. Dust Ignition-proof, Class I and II; Division 1; Groups E through G; Outdoor locations (NFMA 4). Non-Incendive, Class I; Division 2, Groups A through D.

ATTENTION: Transmitters specified with the DV 631 Z sensor (DMV 6320 or ZL 6351) must be mounted in a safe area. Only the sensor is approved for hazardous locations.

DV 631 Z Remote Powered Sensor

Ambient Temp. Limits:	-13°F to $+140^{\circ}\text{F}$
Power Input:	From DMV 6320 transmitter or ZL 6351 flow computer. 12.5 to 36 VDC.
Electronics Housing:	Epoxy coated die-cast aluminum.
Housing Protection:	NEMA 4.
Power Consumption:	0.5 Watt.
Electrical Connection:	2-conductor instrument cable, 3000 feet maximum.

DMV 6336 Z Loop-Powered Sensor

Specifications same as DV 631 Z, except:

Power Consumption:	< 0.5 Watt (< 1.0 Watt with optional analog display).
Flow Rate Output:	4 to 20 mA into 600 Ohms maximum load at 24 VDC supply voltage. Scaling locally via BCD switches.
Response Time:	2.5 seconds.

DMV 6331 Self-Contained Sensor

Specifications same as DV 631 Z, except:

Power Input: 115 VAC, + 10%, - 15%, 50/60 Hz, standard.
Optional 220 VAC.

Power Consumption: 2.5 VA

Process Temp. Limit: + 570°F maximum.

Ambient Temp. Limits: + 14°F to + 122°F.

Flow Rate Output: 4 to 20 mA (0 to 20) into 800 Ohms maximum load, isolated.

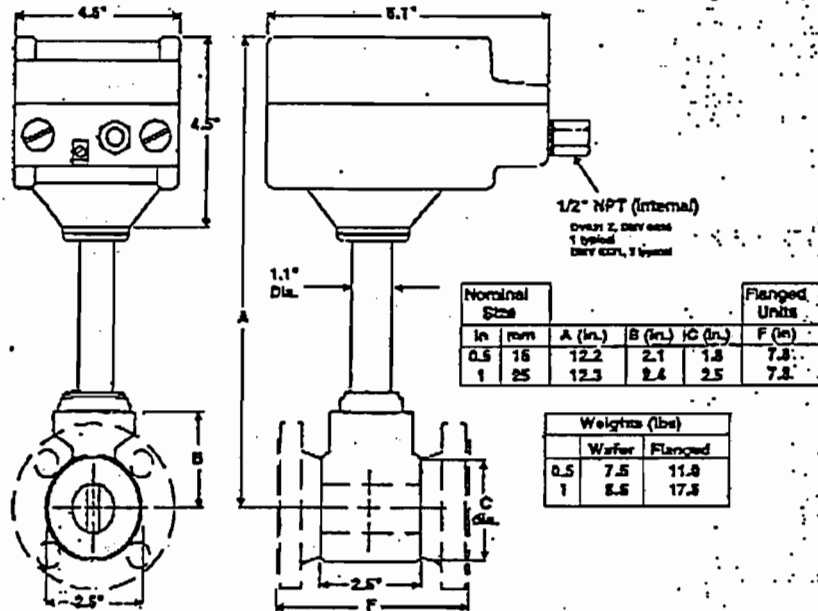
Totalized Flow Output: Scaled pulse, 24 V peak, 150 Ohms minimum load, 25 ms pulse duration, $f_{max} \leq 2$ Hz, isolated.

OR

Open collector, 50 mA maximum load, $f_{max} \leq 20$ Hz, isolated.

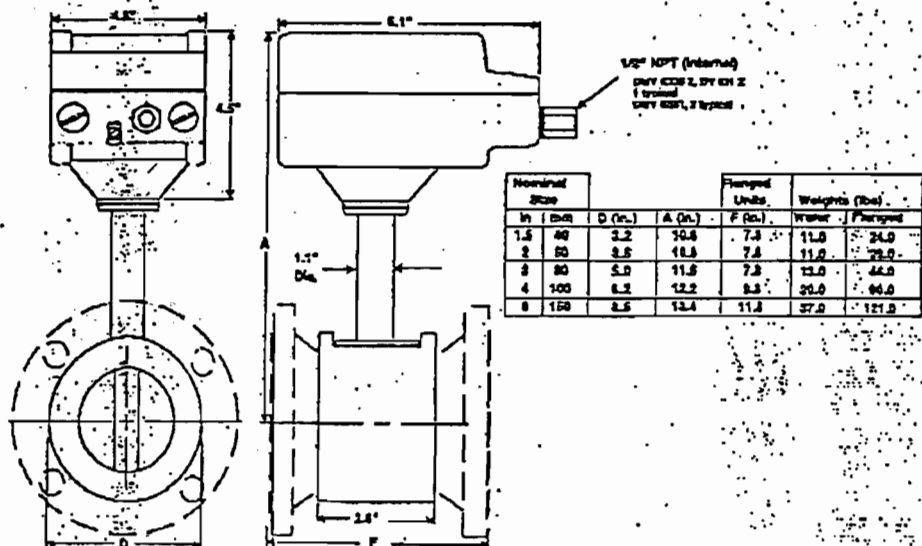
DMV 6336 Z, DMV 6331,
DV 631 Z Sensor Dimensions
1/2" and 1" Nominal
Sizes.

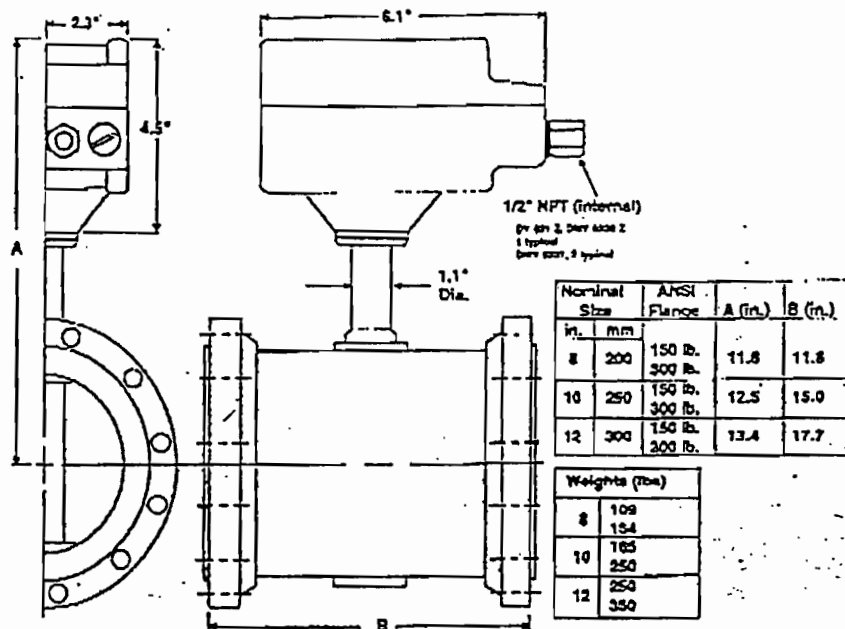
Figure 16



DMV 6336 Z, DMV 6331,
DV 631 Z Sensor Dimensions
1-1/2" to 6" Nominal
Sizes.

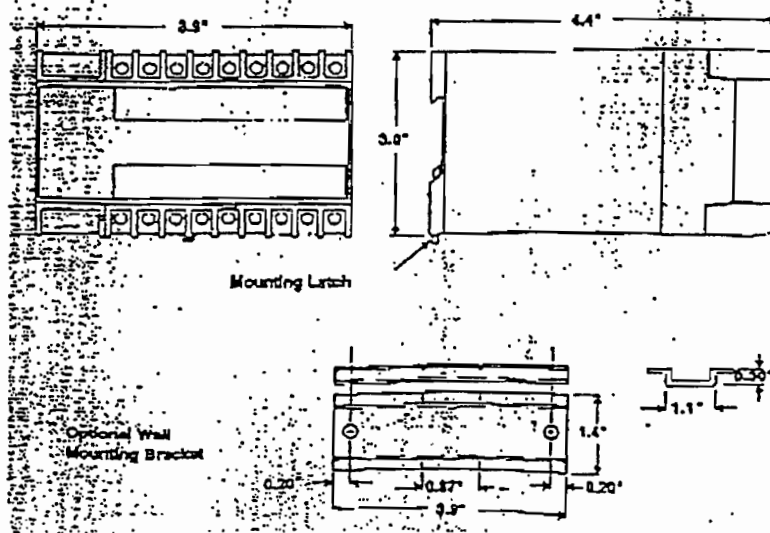
Figure 17



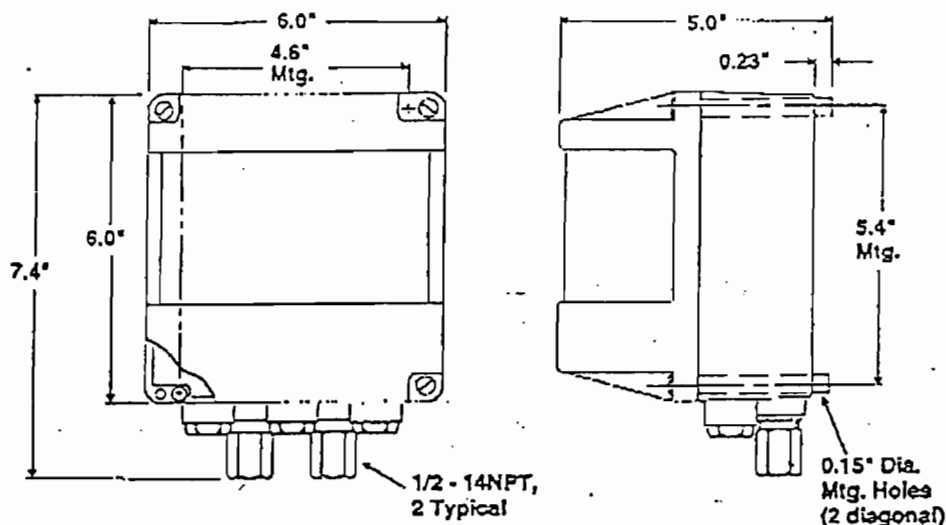


Transmitter Technical Data

DMV 6320 Transmitter (Remote, control room mounting)	
Housing:	ABS plastic.
Protection Rating:	NEMA 1
Power Input:	115 VAC +15%, - 10%, 50/60 Hz $\pm$ 5%, standard. 230 VAC optional.
Power Consumption:	2.5 VA
Output Scaling:	Locally via BCD switches.
Response Time:	2.5 seconds.
Flow Rate Output:	4 to 20 mA (0 to 20) into 800 Ohms maximum load, isolated.
Totalized Flow Output:	Scaled pulse, 24 V peak, 180 Ohms minimum load, 25 ms pulse duration, $f_{max} \leq 2$ Hz, isolated. OR Open collector, 50 mA maximum load, $f_{max} \leq 20$ Hz, isolated.
Ambient Temp. Limits:	+ 14°F to + 122°F.
Dimensions:	Refer to Figure 19.
Mounting:	Rail-mounted, standard. Wall mounting bracket, optional. Wall-mount NEMA 4X plastic enclosure, optional (refer to Figure 20 for wall mount unit).



Wiring



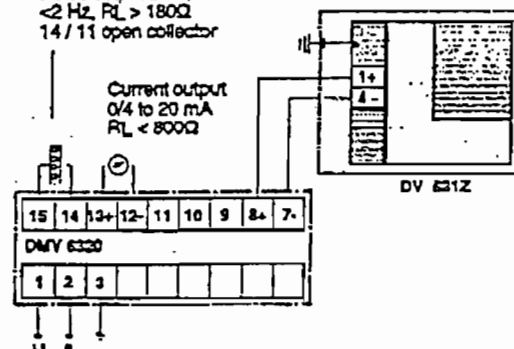
Optional Wall Mount Enclosure
Figure 20

DV 631 Z

Basic version (20 mA current pulse, 2-wire), for connection to either a DMV 6320 transmitter or ZL 6351 Flow Computer (Figure 21).
Pulse width 260 μ s, $\pm$ 20%
Maximum output frequency, 3000 Hz.

Pulse output 24 V, 25 ms.
< 2 Hz, $R_L > 180\Omega$
14 / 11 open collector

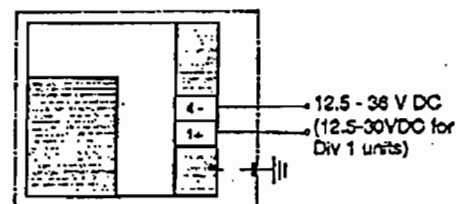
Current output
0/4 to 20 mA
 $R_L < 800\Omega$



DV 631 Z
Figure 21

DMV 6336 Z

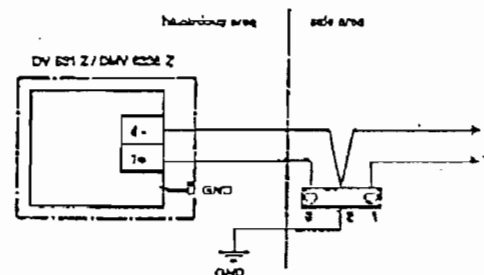
Loop powered 2-wire transmitter (4 to 20 mA) with preamplifier (same as the DV 631 Z) and current output board (Figure 22).



DMV 6336 Z
Figure 22

DV 631 Z / DMV 6336 Z (FM Div 1 installations)

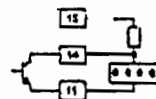
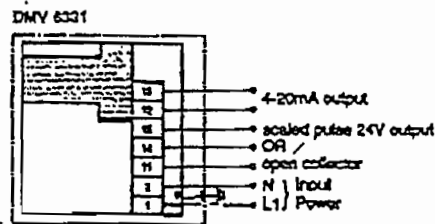
For applications in FM Class I, Division 1 areas, the DV 631 Z and DMV 6336 Z must be used in conjunction with an approved zener barrier (e.g. Stahl 8901/31-280/110/00). $V_{max} = 30$ VDC, $I_{max} = 245$ mA, $C_i = 0$ and $L_i = 0$ (0.25 mH if equipped with optional analog meter). Refer to Figure 23.



DV 631 Z / DMV 6336 Z
Figure 23

DMV 6331 (Compact Transmitter)
The DMV 6331 remote transmitter is wired according to Figure 24. The DMV 6331 is not available in an FM approved version.

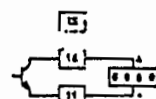
The various wiring connections for pulse, open collector, current and electronic counter are shown in Figure 24.



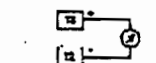
Electronic counter without integral power supply.



Pulse output, electro-mechanical counter
 $f \leq 2 \text{ Hz}$, $R \geq 180\Omega$



Open collector electronic counter with integral supply
 $f \leq 20 \text{ Hz}$, $I_{max} = 50 \text{ mA}$



Current output
 $0/4 \text{ to } 20 \text{ mA}$, $R_L < 800\Omega$

DMV 6331
Figure 24

Local Display

An analog display allows an immediate on-site indication of flow (Figure 27). The display is connected into the 4 to 20 mA circuit of the DMV 6336 Z using a connector to the upper PC board. A viewing window is provided in the electronics housing cover.

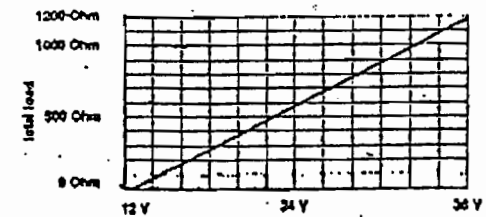
"Applicator" Software for Optimum Sizing

Application software for sizing and range selections is available. The Applicator program simplifies the following calculations:

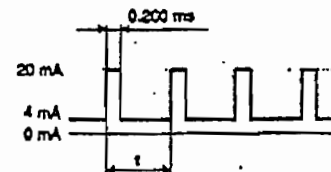
- Converting actual volume to standard volume for gas.
- Converting to mass flow with steam, allowing for temperature and/or pressure.
- Determining minimum and maximum flow limits.
- Calculating pressure loss at the measuring point.
- Simultaneous display of other nominal diameters, etc.

Load Diagram (DV 631 Z / DMV 6336 Z)
Figure 25 illustrates maximum load according to input voltage. Shielded cable for the power supply is recommended.

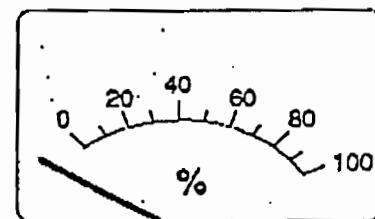
A pulse wave diagram for the DV 631 Z is shown in Figure 26.



Load Diagram
Figure 25



DV 631 Z Pulse Wave
Figure 26



Analog Display
Figure 27

The Applicator runs on all PC's (IBM AT/XT or compatibles). Please contact Endress + Hauser for a free copy or for sizing assistance.

Accessories

Ordering Code, Swingwirl II

Swingwirl II

									0	0	2

DV631 Z (requires DMV 6320 transmitter or ZL 6351 flow computer).	S10
DMV 6331 self-contained, dual output (not FM Approved).	S31
DMV 6332 Z Two-wire loop powered system.	S36

Nominal Size	
1/2"	015
1.0"	025
1.5"	040
2.0"	050
3.0"	080
4.0"	100
6.0"	150
8.0"	200
10.0"	250
12.0"	300

Process Connection Class	
Wafer, 150 / 300 / 600 lb ANSI, Sch. 40, 1/2" to 6"	6
Flange, 150 lb ANSI, Sch. 40, 8" to 12"	7
Flange, 300, lb ANSI, Sch. 40, 8" to 12"	8
Flange, 150 lb ANSI, Sch. 40, 1/2" to 6"	T
Flange, 300 lb ANSI, Sch. 40, 1/2" to 6"	U
Flange, 150 lb ANSI, Sch 80, 1/2" to 6"	V
Flange, 300 lb ANSI, Sch 80, 1/2" to 6"	W

Electrical Classification	
General purpose, safe area only, DMV 6331.	0
FM Approved I.S. Class I, II and III; Div. 1; Grp A to G (DV 631 Z and DMV 6336 Z).	3

Power Supply	
220 VAC, 50/60 Hz (DMV 6331 only).	0
115 VAC, 50/60 Hz (DMV 6331 only).	2
External power supply for DMV 6336 Z, 12.5 to 36 VDC (FM, 12.5 to 30 VDC).	6
Power supply with DV 631 Z, 12.5 to 36 VDC (FM, 12.5 to 30 VDC).	8

Signal Outputs	
Current output, 4 to 20 mA / pulse output, DMV 6331 only.	1
Current output, 4 to 20 mA, no display, with DMV 6336 Z only.	2
Current output, 4 to 20 mA with analog display, DMV 6336 Z only.	3
Pulse frequency output for connecting to transmitter, 2-wire / unscaled, DV 631 Z only.	5

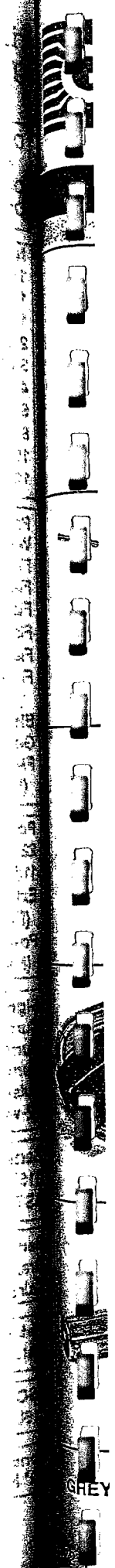
Sensor Body Materials	
316L Stainless Steel, wafer 1/2" to 6", flanged 8" to 12"	0
ASTM A 351 Grade CF8C Stainless Steel (flanged 1/2" to 6")	A

Sensor Gasket	
Graphite	0
Kalrez	3

Meter Body Certification	
Meter body without material certificate	0

bSC Sensor Material	
316L Stainless Steel	0

Conduit Connection	
1/2" NPT cable only	2

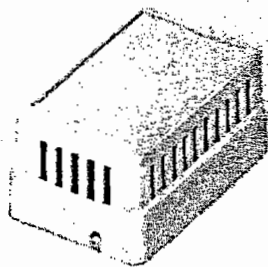




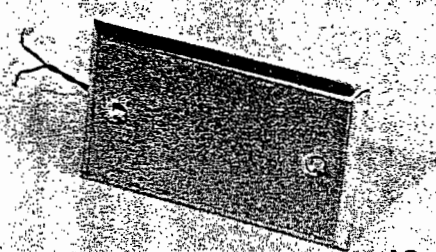
GREYSTONE
ENERGY SYSTEMS INC

TEMPERATURE SENSORS

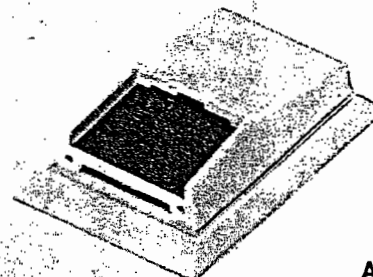
Model TE-200



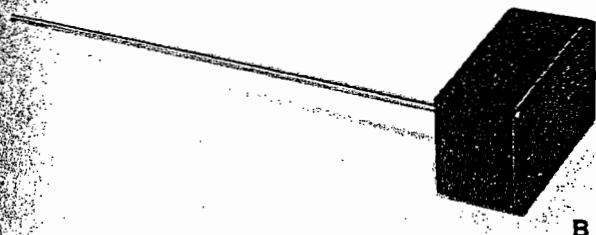
A



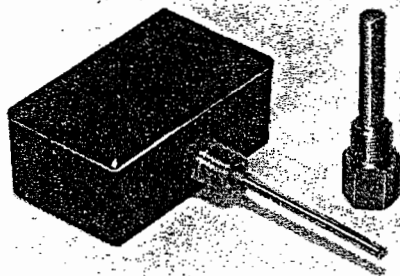
AS



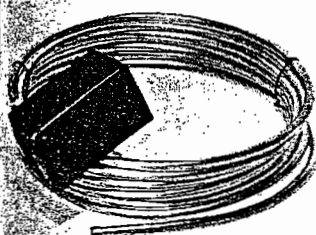
AE



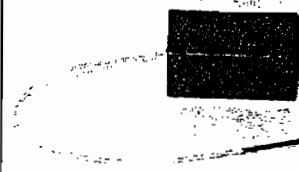
B



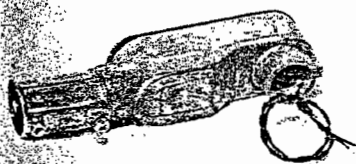
C



D



E



F



G

FEATURES:

- The TE-200 Temperature Sensors offer a choice of precision platinum resistance temperature detectors (RTD's), integrated circuits or thermistors which can be interfaced with a computerized monitoring or control system.
- Sensors are available in different housing for space, surface, duct, immersion, duct averaging, strap-on probe and outside air applications.

ENCLOSURE:

- A) Space - The Plastic Surface Mount Zone Temperature Sensor provides precision remote space temperature sensing.
- AS) Surface - The Stainless Steel Surface Mount Zone Temperature Sensor provides precision remote space temperature sensing.
- AE) Executive Space - The Executive Decorator Zone Temperature Sensor provides precision remote space temperature sensing.
- B) Duct - The sensor is encapsulated in a 1/4 inch OD aluminum, stainless steel, or copper probe. The probe can be inserted directly into the duct and mounting holes are provided to rigidly support to the assembly.
- C) Immersion - The sensor is encapsulated in a 1/4 inch OD probe with a spring-loaded fitting that can be screwed directly into any thermowell providing assured contact with the bottom of the thermowell and a rigid support to the assembly.
- D) Duct Averaging - The probe is a bendable copper or aluminum 1/4 inch OD. The probe incorporates numerous sensors encapsulated at equal distances across the length of the probe. The complete assembly acts as a single sensor and any temperature change is averaged across the sensors. The probe can be easily bent to fit any size duct.
- E) Strap-on - The remote probe can be strapped on a pipe or any other application in which high temperature are encountered.
- F) Outside Air - The sensor is encapsulated in a 1/4 inch probe. The probe protrudes from a weather proof enclosure with a suitable sun shield to be mounted outside.
- G) Glass - The sensor is encapsulated in an aluminum wafer which can be mounted directly to the surface of a window for sensing the glass surface temperature.

TEMPERATURE SENSORS

Model TE-200

SPECIFICATIONS: SENSORS

1) PT100-100 ohm Platinum, $\pm 0.12\Omega$, DIN 43760, 0.00385 ohms/ohm/$^{\circ}\text{C}$, thin film, 2 wire 2) PT100-100 ohm Platinum, $\pm 0.12\Omega$, DIN 43760, 0.00385 ohms/ohm/$^{\circ}\text{C}$, thin film, 3 wire 3) PT100-100 ohm Platinum, $\pm 0.12\Omega$, DIN 43760, 0.00385 ohms/ohm/$^{\circ}\text{C}$, wire wound-ceramic, 2 wire 4) PT100-100 ohm Platinum, $\pm 0.12\Omega$, DIN 43760, 0.00385 ohms/ohm/$^{\circ}\text{C}$, wire wound-ceramic, 3 wire 5) 1,801 ohm Thermistor, $\pm 0.2^{\circ}\text{C}$ 6) 3,000 ohm Thermistor, $\pm 0.2^{\circ}\text{C}$	7) 10,000 ohm Thermistor, $\pm 0.2^{\circ}\text{C}$ 8) 3,000 ohm Thermistor, $\pm 0.2^{\circ}\text{C}$ Alerton 9) 100,000 ohm Thermistor, $\pm 0.2^{\circ}\text{C}$ 10) 1,000 ohm Balco, $\pm 0.5^{\circ}\text{C}$ 11) Integrated Circuit, 1.0uA/$^{\circ}\text{C}$ 12) 1,000 ohm Platinum, $\pm 0.12\Omega$, DIN 43760, 0.0385 ohms/ohm/$^{\circ}\text{C}$, thin film, 2 wire 13) 1,000 ohm Platinum, $\pm 0.24\Omega$, DIN 43760, 0.0385 ohms/ohm/$^{\circ}\text{C}$, thin film, 2 wire

PRODUCT ORDERING INFORMATION

Greystone Temperature Sensors are available in a variety of housings with a number of alternations for sensors, probe lengths, and probe material.

To facilitate your ordering, the following check list permits you to select the optimum configuration to match your particular requirements.

ENCLOSURE

☐	A) Space
☐	AE) Executive
☐	AS) Surface
☐	B) Duct
☐	C) Immersion
☐	D) Duct Average
☐	E) Strap-on
☐	F) OSA
☐	G) Glass
☐	H) Custom

SENSOR

☐	1) PT-100, 2 Wire
☐	2) PT-100, 3 Wire
☐	3) PT-100-W, 2 Wire
☐	4) PT-100-W, 3 Wire
☐	5) 1,801 ohm Thermistor
☐	6) 3,000 ohm Thermistor
☐	7) 10,000 ohm Thermistor
☐	8) 3K Alerton
☐	9) 100,000 ohm Thermistor
☐	10) 1,000 ohm Balco
☐	11) Integrated Circuit
☐	12) 1,000 ohm Platinum, 2 wire
☐	13) 1,000 ohm Platinum, 2 wire

PROBE LENGTH

☐	A) 50 mm (2 inches)
☐	B) 100 mm (4 inches)
☐	C) 150 mm (6 inches)
☐	D) 200 mm (8 inches)
☐	E) 300 mm (12 inches)
☐	F) 450 mm (18 inches)
☐	G) 1,800 mm (6 feet)
☐	H) 3,600 mm (12 feet)
☐	I) 6,100 mm (20 feet)
☐	J) 7,300 mm (24 feet)

PROBE MATERIAL

☐	1) Aluminum
☐	2) Stainless Steel
☐	3) Copper
☐	4) Custom

FITTING

☐	A) Brass 1/2" NPT
☐	B) Thermowell
☐	C) Custom

NOTE: SENSOR TYPES 1 AND 2 MAXIMUM ALLOWABLE CURRENT IS 3 mA
 SENSOR TYPES 3 AND 4 MAXIMUM ALLOWABLE CURRENT IS 12 mA
 SENSOR TYPES 12 AND 13 MAXIMUM ALLOWABLE CURRENT IS 1 mA

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*Modems That Work
Just As Hard
For Business
As You Do*

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Affordable*

*Data
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Portables
PCMCIA*

File Edit Connection Settings SCOPE Special Help

Customer Number: 44592-00

Ship To: **DEVELOPMENT CO.**
Ship Via: **101**
Freight: **101**
FOB: **101**
Terms: **101**

Print Order Rch: **101**
Back Orders (Y/N): **101**
Statements (Y/N/S): **101**
Customer Status: **101**
Customer Class: **101**
Tax Exempt No: **101**
Required #9: **101**
Special Pricing: **101**
Priority Code: **101**
Fax Number: **101**
Tax Authorities: **101**

City/State: **101**
Zip Code: **101**
Country: **101**
Phone No.: **101**
Phone No. 2: **101**
Contact: **101**
SIC Code: **101**
Order Freq: **101**
Sales ID: **101**
Price Group: **101**
Region: **101**
Billing Cn: **101**
Bill to: **101**

General: 23

Navigation icons: [Back] [Forward] [Home] [Stop] [Print] [Find] [Help] [Close] [Cancel] [OK] [Apply] [Reset] [Default] [Previous] [Next] [First] [Last] [Refresh] [Zoom In] [Zoom Out] [Full Screen] [Exit]



101-101
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101-101

Whether you spend your time in the office every day or travel frequently, reliable modem communications for business is crucial. Only OPTIMA modems can assure you of Hayes™ reliability and quality for your data or data + FAX communications needs.

• **Versatile** You can choose from data or data + FAX. Externals, internals, even portable OPTIMAs for your PC, laptop, or Mac™. Speeds from 14,400 bps to 2400 bps for data and FAX transmissions. Asynchronous, synchronous, and Hayes AutoSync for virtually any communications application. You can communicate immediately with corporate E-mail systems or mainframes, online services, BBSs, other computers, and Group 3 FAX modems or FAX machines using the free Smartcom™ data and FAX software included with OPTIMA modems.

• **Dependable** As modem prices continue to drop, it's important that reliability doesn't. Hayes modems feature our patented Escape Sequence With Guard Time to allow your OPTIMA modem to reliably escape from the on-line mode to the command mode without being accidentally triggered by transmitted data. And, the Hayes Standard AT Command Set supported by these modems enables you to communicate with no problems using the huge installed base of communications software. Error-control eliminates file transfer problems and data compression gives you the highest throughput possible. Best of all, you don't have to do anything to take advantage of OPTIMA's capabilities since Automatic Feature Negotiation selects the best features for maximum communications performance. And it's all backed by our famous Technical Support team, plus our guarantee that your OPTIMA modem will perform the way the manual says it will, backed by the Hayes return or refund policy.

• **Affordable** Legendary Hayes quality and reliability have never been so affordable! OPTIMA data modems offer all the latest features for any business environment. Choose a data + FAX model and you add Group 3 FAX for only a few dollars more. Low operating costs for OPTIMAs are another big plus. Their high-speed, data compression combination means lower connect times and lower long distance bills.

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OPTIMA™ 144
OPTIMA™ 96 + FAX96
OPTIMA™ 96
OPTIMA™ 24 + FAX96
OPTIMA™ 24

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OPTIMA™ 144B + FAX144
OPTIMA™ 96B + FAX96
OPTIMA™ 24B + FAX96

Portable Modems

OPTIMA™ 144 + FAX144 Pocket Edition™
OPTIMA™ 24 + FAX96 for PCMCIA

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OPTIMA™ 144 + FAX144 Pocket Edition™ for the Mac
OPTIMA™ 144 + FAX144/Macintosh™ Edition
OPTIMA™ 96 + FAX96/Macintosh™ Edition
OPTIMA™ 96/Macintosh™ Edition
OPTIMA™ 24 + FAX96/Macintosh™ Edition
OPTIMA™ 24/Macintosh™ Edition



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Use OPTIMA modems for these
high-performance benefits:

Automatic Feature Negotiation

Don't have to know anything about the modem or FAX machine
you're calling. OPTIMA products automatically handle all the speed
(300 to 300 bps), error-control, and data compression decisions for you.

Error-Control

No data loss thanks to CCITT V.42 international error-control standard, and no
compatibility problems with earlier, MNP 2-5 protocols.

Data Compression

No worry, you'll get the highest data throughput
possible. V.42bis data compression provides speeds
up to 57,600 bps over dial-up phone lines.

High-Speed FAX

Send and receive features bring high-speed FAX
capability right to your computer (data + FAX modems).

Hayes Standard AT Command Set

Full support for this industry standard for operation
on the large installed worldwide base of
communications software.

Patented Escape Sequence With Guard Time

Allows the modem to reliably escape from the on-line
mode to the command mode without being
accidentally triggered by transmitted data. U.S. Patent
granted to Hayes in 1985 and subsequent patents
have been granted in Canada, Great Britain, France,
Germany, Italy, Hong Kong, and Singapore.

Asynchronous

Most popular data format for communications
between personal computers, online services,
bulletin boards.

Synchronous

data format primarily used for communications
between mini and mainframe computers.

Hayes AutoSync

Uses the system's asynchronous communications port and AutoSync software
for asynchronous communications, eliminating the additional expense of a
synchronous adapter card for SDLC or HDLC.

ESP Communications Accelerator

OPTIMA 96B + FAX96 and OPTIMA 144B + FAX144 features include Hayes ESP
Communications Accelerator with its on-board dedicated communications
processor to ensure data integrity and increase data throughput in
multi-tasking or network environments.

Limited Performance Warranty

Guarantees that your OPTIMA modem will perform the way the manual says
it will. Backed by the Hayes return or refund policy.

Software For Easy Communications

*Nobody knows more about modems and
software than Hayes*

Smartcom™ for Windows™

Fast, powerful Windows communications software
for everyone. Unique, powerful Smartcom
Communications Editor, peruse buffer,
Smart Buttons, SCOPE scripting language,
and LAN support for sharing modems
on asynchronous communications servers.



Smartcom Exec™

Powerful communications features to meet the
everyday needs of the business user. Full featured
text editor, peruse buffer, handy Phone Book entries
automate communications, SCOPE scripting
language, and LAN
support for sharing
modems on
asynchronous
communications
servers.

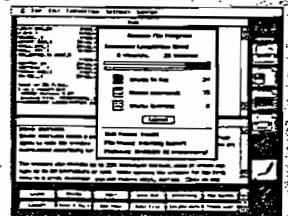


Smartcom EZ™

Introductory PC communications software that's
based on award winning Smartcom Exec. Stores
phone numbers and communications instructions in
Phone Book and uses Keyboard Macros for fast
implementation of frequently typed commands
(I.D. number, password, etc.).

Smartcom™ for the Mac™

Introductory Mac communications software that's
modeled after award winning Smartcom II™ for the
Macintosh™. Stores phone numbers and communica-
tions settings for
repetitive use,
saves I.D. number,
password, etc. as
Buttons, peruse
buffer, and
Graphics Canvas.



PC Sources

PC Week

Windows User

*"The modem delivered excellent performance
in every case, with rapid, stable data
transfers and connections."*

*"For high-speed communications, a trusted
brand name, and excellent support,
the OPTIMA 96 is a very tough
combination to top."*

*"OPTIMA 96 made interactive work on
CompuServe a pleasure and made
taking control of a remote PC much
more like being there."*

*"...OPTIMA 144 + FAX144 delivers good
value...immunity to noise and consistent data
throughput under adverse line conditions
place it securely in the upper echelon
of fax-modem hardware."*

FAX Software for Windows™

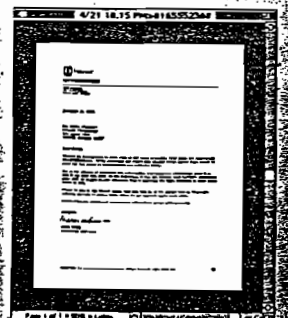
Uses the popular Windows interface to make sending and receiving FAXes fast
and simple. Stores FAX numbers, view, print, save or delete FAXes, and broadcast.

Smartcom™ FAX

Packed with features for your PC to get FAXes moving
in a hurry. Terminate and Stay Resident software with
"hot key" access, send, receive, view, print, save
or delete FAXes, broadcast, and FAX Phone Book.

Smartcom™ FAX for the Macintosh

High-powered FAX software for your Mac. Send and
receive FAXes, text rotation, font substitution and
direct ATM support, FAX Phone Book, and broadcast.



	External PC	Internal PC	External Mac	V.32bis 14,400 bps	V.32 9600 bps	V.22bis 2400 bps	V.22/12A 1200 bps	103/300 bps	V.42 Error-Control	V.42bis Data Compression	MNP 2-5	Data Throughput	V.17 FAX	V.29 FAX	V.27ter FAX	Smartcom for Windows	Windows/FAX software	Smartcom Exec	Smartcom EZ	Smartcom FAX software	Smartcom for the Mac	Smartcom FAX for the Macintosh
OPTIMA 24	•	•	•	•	•	•	•	•	•	•	•	9600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 24/Mac	•	•	•	•	•	•	•	•	•	•	•	9600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 24 + FAX96	•	•	•	•	•	•	•	•	•	•	•	9600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 24B + FAX96	•	•	•	•	•	•	•	•	•	•	•	9600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 24 + FAX96/ Mac	•	•	•	•	•	•	•	•	•	•	•	9600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 24 + FAX96 for PCMCIA	•	•	•	•	•	•	•	•	•	•	•	9600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 96	•	•	•	•	•	•	•	•	•	•	•	38,400 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 96/ Mac	•	•	•	•	•	•	•	•	•	•	•	38,400 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 96 + FAX96	•	•	•	•	•	•	•	•	•	•	•	38,400 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 96B* + FAX96	•	•	•	•	•	•	•	•	•	•	•	38,400 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 96 + FAX96/Mac	•	•	•	•	•	•	•	•	•	•	•	38,400 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 144	•	•	•	•	•	•	•	•	•	•	•	57,600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 144 + FAX144	•	•	•	•	•	•	•	•	•	•	•	57,600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 144B* + FAX144	•	•	•	•	•	•	•	•	•	•	•	57,600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 144 + FAX144/Mac	•	•	•	•	•	•	•	•	•	•	•	57,600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA 144 + FAX144 Pocket Edition	•	•	•	•	•	•	•	•	•	•	•	57,600 bps	•	•	•	•	•	•	•	•	•	•
OPTIMA144 + FAX144 Pocket Edition/Mac	•	•	•	•	•	•	•	•	•	•	•	57,600 bps	•	•	•	•	•	•	•	•	•	•

* Includes ESP Communications Accelerator
with on-board, dedicated co-processor



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Hayes products have the computer
world talking. More than ever.*



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 Hayes Microcomputer Products (France) SARL, Immeuble Les Maradas, 1, bd de l'Oise 95030 Cergy Cedex France Phone: 33 1 34 22 30 15 FAX: 33 1 30 73 44 00
 Hayes Microcomputer Products, Inc., 39/F, Unit B, Manulife Tower, 169 Electric Road, North Point, Hong Kong Phone: 852-887-1037 FAX: 852-887-7548 BBS: 852-887-7590
 Hayes Technical Service Station, 40 Xue Yuan Road, Beijing, P.R. China, Postal Code 100083 Phone: 86-1-2031692 FAX: 86-1-2031691
 Hayes Microcomputer Products, Inc., Hayes ISDN Technologies, 501 Second Street, Suite 300, San Francisco, California 94107 Phone: (415) 974-5544 FAX: (415) 543-5810

U.S. Patent 4,549,302 Canada Patents 1,186,080 and 1,186,081

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JOHNSON
NTROLS

Johnson Controls, Inc.
 Products Division

Michigan Street
 224
 WI 53201

Series M-8100 Control Cabinets

The control cabinets are general purpose utility enclosures designed for use in grouping and mounting various components of wire or electronic control systems. The cabinets are easily adapted to other related devices and are available in various sizes.

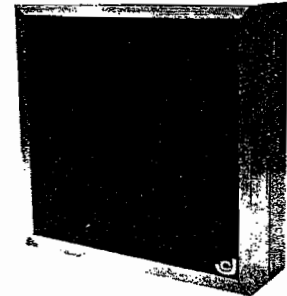
The cabinet frame is made of 6061-T6 extruded alloy with fluted faces. All corners are securely joined and supported by an internal angle bracket. An internal hinge around the door provides an overlap seal with the frame. The face panel and back panel are easily removed from the cabinet to allow mounting equipment. The face and equipment mounting back panel are made of aluminum bonded on both sides of a plywood core. A hole or knockout punch can

be used on the face panel permitting equipment such as meters, gages and switches to be door mounted for continuous viewing and access.

A drill or hole saw can easily be used to provide holes in top and bottom of cabinet.

An attractive beige, baked-on, paint finish is applied to both sides of the face panel.

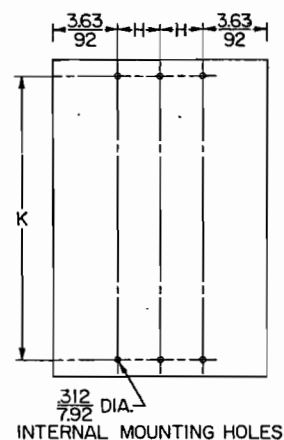
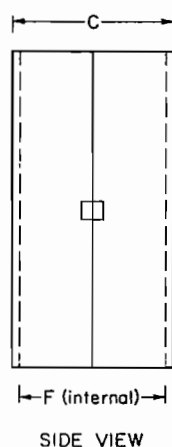
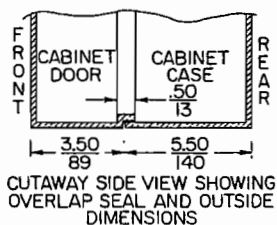
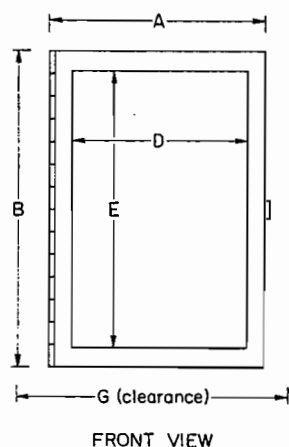
A non-removable piano type hinge runs the entire length of the cabinet to support the door. Cabinets may be mounted to open from either the right or left. Standard on all cabinets is a key locking latch which can be used to assure that authorized personnel only have access to the internal equipment.



M-8100 Control Cabinet.

The M-8100 model is listed by Underwriter's Laboratories and is used for line voltage systems or any other application requiring a rated cabinet. The face and back panels are held in place with continuous, solid retaining bars.

Control Cabinet Dimensions $\frac{\text{in}}{\text{mm}}$



Code Number	Cabinet			Face and Back Panel (Usable)		Internal Depth F	Clearance Width G	Holes H	Holes K
	Width A	Height B	Depth C	Area in ² cm ²	Width D				
M-8100-11	12	18	9	150	9.75	15.75	8.13	2.38	16.06
	305	457	229	968	248	400	207	60	408
M-8100-12	18	24	9	340	15.75	21.75	8.13	5.38	22.06
	457	610	229	2194	400	552	207	137	560
M-8100-13	24	24	9	470	21.75	21.75	8.13	8.38	22.06
	610	610	229	3032	552	552	207	213	560
M-8100-14	24	36	9	730	21.75	33.75	8.13	8.38	34.06
	610	914	229	4710	552	857	207	213	865
M-8100-15	24	30	9	600	21.75	27.75	8.13	8.38	28.06
	610	762	229	3871	552	705	207	213	713
M-8100-17	36	48	9	1540	33.75	45.75	8.13	14.38	46.06
	914	1219	229	9936	857	1162	207	365	1170
M-8100-18	30	42	9	1100	27.75	39.25	8.13	11.38	40.06
	762	1067	229	7097	705	997	207	289	1018

NOTES: (1) All dimensions in inches except as noted.

(2) Std. face and back panel thickness = .28 in. (7.1 mm). Formica face panel thickness = .34 in. (8.7 mm).

(3) When using a sub-panel, subtract 2 in. (51 mm) from dimension "E"; subtract .75 in. (19 mm) from dimension "F"; dimension "D" remains unchanged.

Performance specifications appearing herein are nominal and are subject to accepted manufacturing tolerances and application variables.

U.L. Guide No. CXGZ
File E40499

TRANSFORMER / MANUAL RESET

Y66 SERIES / 694 SERIES

DESCRIPTION

These transformers are NEC Class 2 type, approved by Underwriters' Laboratories, Inc. They provide rated secondary output at rated load for proper operation of system components.

FEATURES

- Choice of primary voltages to meet power requirements.
- A manual resettable "current limiting" circuit breaker.
- Color coded leads for simplicity and standardization.

APPLICATION

These transformers are for use on residential and industrial applications and are particularly suited for combination heating and cooling installations. Transformers are available for 120, 208/240, and 277/480 volt primary requirements.

CAUTION: Do not use with any load that exceeds the rating stamped on the transformer. Overloading the transformer will open the circuit permanently.

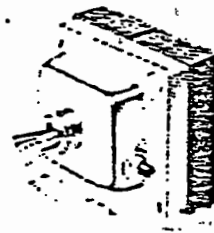


Fig. 1 • Type Y66SUD Transformer

SPECIFICATIONS

75VA., NEC Class 2, Non-Energy Limiting

Shipping Weight	Individual	3.8 lb. (1.7 kg)
	Overpack of	
	10 units	40 lb. (18.1 kg)

ORDERING INFORMATION

Product Number	Primary		Secondary		Mounting
	Voltage	Electrical Connection	Voltage	Electrical Connection	
Y66AUD-1	120	8" B, W Lead Wires (1)	25	8" Br., O Lead Wires (1)	Foot
Y66FUD-1	277/480	8" B, R, Y Lead Wires (1)	25	8" Br., O Lead Wires (1)	Foot
Y66SUD-1	208/240	8" B, R, Y Lead Wires (1)	25	8" Br., O Lead Wires (1)	Foot

Lead wire color code: B-black, W-white, R-red, Y-yellow, Br-brown, O-orange.
(1) With 1/2" Male Conduit Connector.

694-M1 / 694-M2 MULTI-TAP WITH CIRCUIT BREAKER

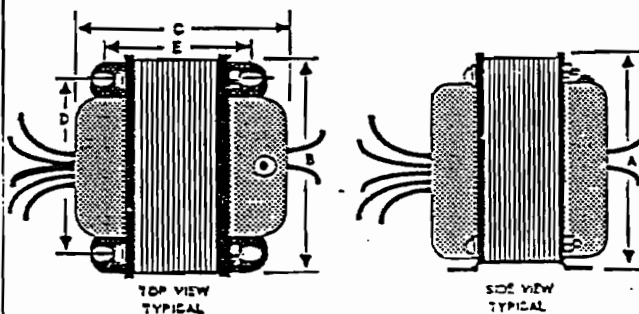
DESCRIPTION

These Multi-tap Stepdown Voltage Transformers, with manual resettable current limiting circuit breaker, are for use in temperature control systems. UL recognized, they are designed to provide 24 volts AC control voltage from 120 thru 480 volts AC primary supply.

MOUNTING

These Foot-mounted Transformers are designed for NEMA 1 locations. They should be installed in compliance with all national and local electrical codes.

DIMENSIONS - 694-M1 / 694-M2 TRANSFORMER



DIMENSIONS - INCHES

MODEL	A	B	C	D	E
694-M1	3.13	2.53	3.56	2.0	2.25
694-M2	3.75	3.13	3.56	2.5	2.25

SPECIFICATIONS / ORDERING INFORMATION

MODEL	VA RATING	PRIMARY WIRES	SECONDARY WIRES
694-M1	75VA	COM H1 120VAC H2 208VAC H3 240VAC H4 480VAC H5	24VAC X1
694-M2	100VA		24VAC X2



PILOT LIGHTS

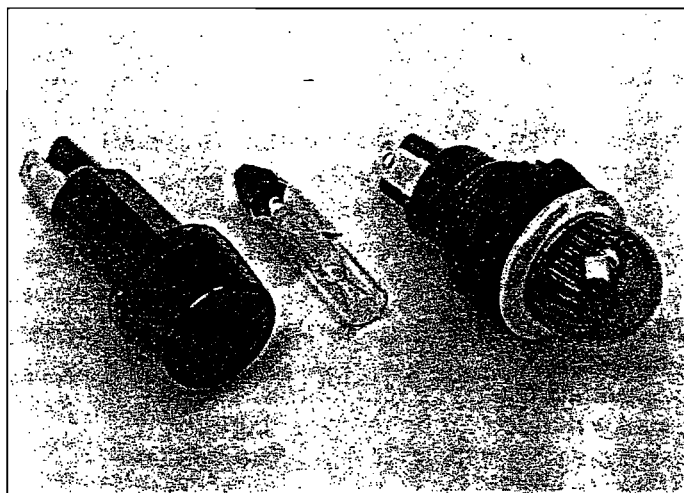
L4000 SERIES

DESCRIPTION

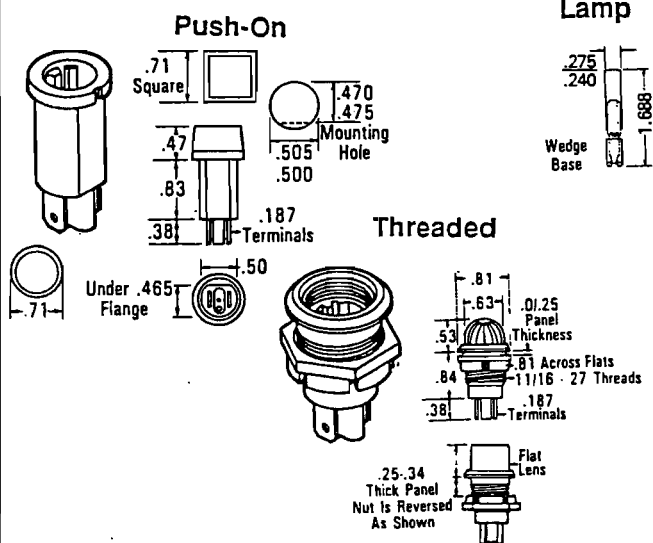
The L4000 / PSBS Series Threaded or Push-on Pilot Lights (with associated colored lenses) provide instantaneous status of mechanical equipment such as fans, pumps, or compressors.

FEATURES

- Non-corrosive black polyester body
- Nickel plated brass terminals for positive contact
- Sturdy polycarbonate lenses
- Threaded model provides economical installation with nylon hex nut
- Push-on model provides quick installation with push-on speednut



DIMENSIONS



SPECIFICATIONS

Threaded	Requires .81" dia.hole. Supplied with nylon hex nut for mounting. Bezel made of polished stainless steel
Push-On	Requires .50" dia. hole. Supplied with push-on speed nut
Threaded and Push-On	Lamps are Type 2; lenses are polycarbonate; bodies are black polyester; terminals are nickel plated brass

ORDERING INFORMATION

SOCKETS AND LENSES

MODEL	DESCRIPTION	MODEL	DESCRIPTION	LAMPS		
L4017	Lamp Socket 11/16" dia. threaded	L4032	Lamp socket 1/2" dia. Push-on	Model	Volts	Amps
L4018	Round lens, red	L4033	Round lens, red	12PSB5	Lamp, 12VAC or DC	.17
L4019	Round lens, clear	L4034	Round lens, clear	24PSB5	Lamp, 24VAC or DC	.073
L4020	Round lens, amber	L4035	Round lens, amber	120PSB5	Lamp, 120VAC or DC	.025
L4021	Round lens, white	L4036	Round lens, white			
L4022	Round lens, green	L4037	Round lens, green			
L4023	Round lens, blue	L4038	Round lens, blue			
L4024	Round lens, yellow	L4039	Round lens, yellow			
L4025	Flat lens, red	L4040	Square lens, red			
L4026	Flat lens, clear	L4041	Square lens, clear			
L4027	Flat lens, amber	L4042	Square lens, amber			
L4028	Flat lens, white	L4043	Square lens, white			
L4029	Flat lens, green	L4044	Square lens, green			
L4030	Flat lens, blue	L4045	Square lens, blue			
L4031	Flat lens, yellow	L4046	Square lens, yellow			



PUSH-BUTTON SWITCH

AOW110

DESCRIPTION

Push-button switches are manual devices that can be used to open or close electrical circuits.

FEATURES

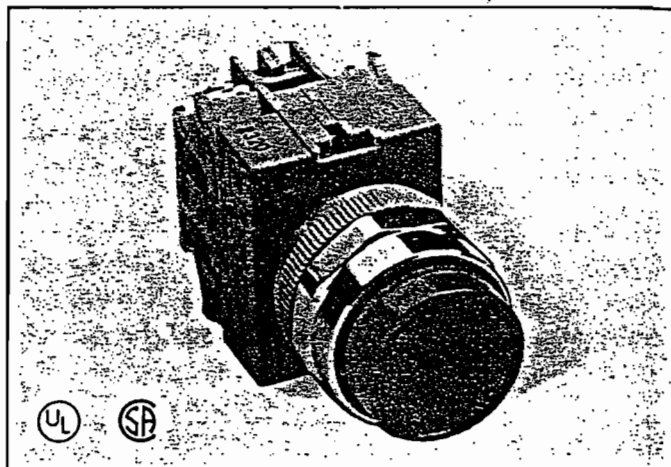
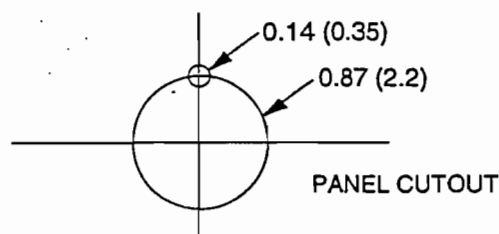
- *Flush, extended or mushroom style available*
- *Various contact arrangements available*

SPECIFICATIONS

Mechanical life	5,000,000 operations
Electrical life	500,000 operations
UL listed	File #E70646
CSA certified	File #LR48366

INSTALLATION

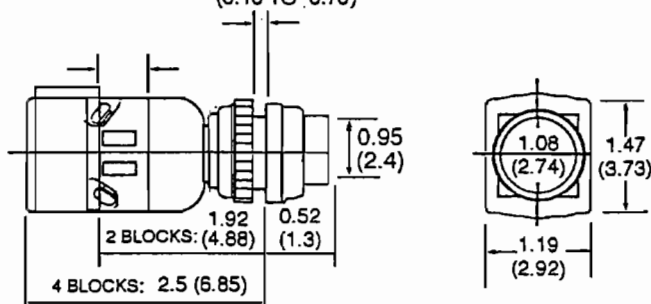
in
(cm)



DIMENSIONS

in
(cm)

PANEL THICKNESS
0.046 TO 0.28
(0.10 TO 0.70)



ORDERING INFORMATION

MODEL
AOW110

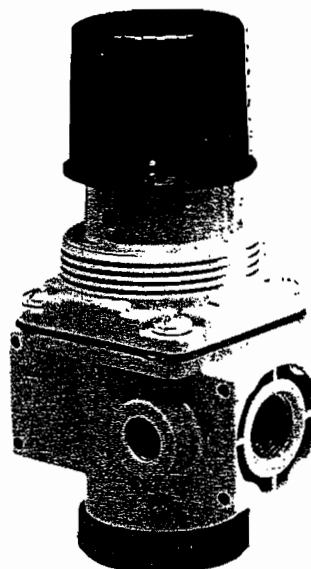
NWAL-(212)

DESCRIPTION

Alternating push-button switch with 1 N.O. contact, and red, black, and green push-buttons included
Legend plate "Off-On"

Call Kele & Associates for push-buttons with other contact arrangements or legend plates.



KMC**KREUTER
MANUFACTURING
COMPANY****DATA
SHEET**Pressure Regulators
Standard And
MiniatureMADE
IN USAHAO-1001
HAO-1002
HAO-1111
HAO-1112
HAO-1113
HAO-1114**DESCRIPTION****MINIATURE PRESSURE REGULATORS**

The "HAO" series Miniature Pressure Regulators feature a compact design and lightweight construction and are especially suitable for applications where space is limited or panel mounting is desired.

The nonrising adjustment knob with "snap-action" locking maintains pressure setting. Gauge ports are full flow and either can be used as an additional regulated outlet port.

These devices are typically used to regulate branch air pressures in pneumatic control applications.

STANDARD PRESSURE REGULATORS

The "HAO" series Standard Pressure Regulators provide accurate and fast response to flow demands and line pressure changes. The nonrising adjustment knob incorporates an integral locking device for maintaining pressure setting. Gauge ports are full flow and either can be used as an additional regulated outlet port.

Typical applications include regulation of main air pressures, day/night setback, and summer/winter change-over in pneumatic control installations.

SPECIFICATIONS

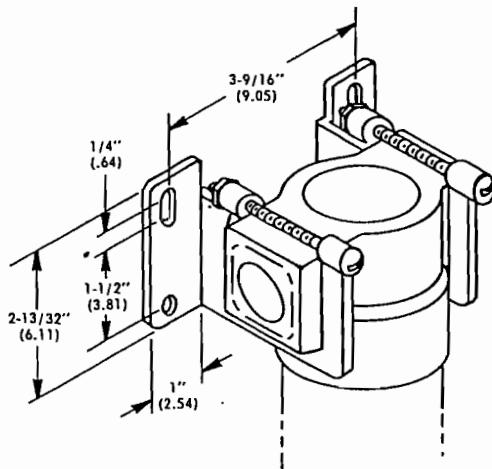
MODEL	HAO-1001	HAO-1002	HAO-1111	HAO-1113	HAO-1112	HAO-1114
MAIN PORT SIZE	1/8" FPT	1/4" FPT	1/4" FPT	3/8" FPT	1/4" FPT	3/8" FPT
RATED FLOW	10 SCFM	15 SCFM	80 SCFM			
GAUGE PORTS (TWO) FULL FLOW	1/8" FPT		1/8" FPT			
MAXIMUM INLET PRESSURE	400 PSIG		300 PSIG			
OUTLET PRESSURE RANGE	2 to 50 PSIG		5-150 PSIG		5-60 PSIG	
OPERATING TEMPERATURE RANGE*	0 to 150 Degrees F		0 to 175 Degrees F			
REGULATOR TYPE	Relieving Diaphragm		Relieving Diaphragm			
FLUID	Compressed Air Only		Compressed Air Only			
MATERIALS OF CONSTRUCTION	Zinc Body Brass Valve Buna-N Elastomers Plastic Bonnet		Zinc Body Brass Valve Nitrile Elastomers Zinc Bonnet			
AVAILABLE ACCESSORIES	HAO-1003 Panel Mounting Nut HAO-1004 Wall Mounting Bracket (with Nut)		HAO-1115 Wall Mounting Bracket			

ORDERING INFORMATION

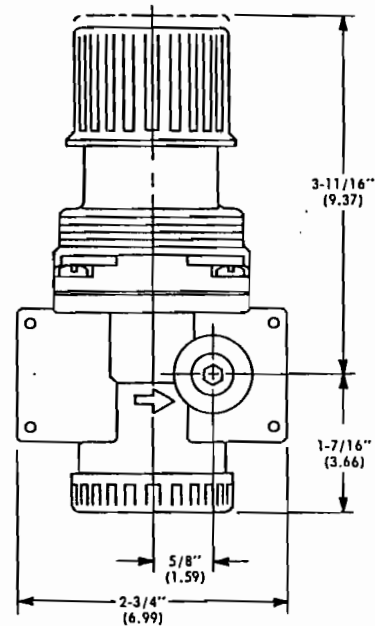
SPECIFY: Model Number

ORDER FROM:
Local KMC Dealer or
Kreuter Manufacturing Co.

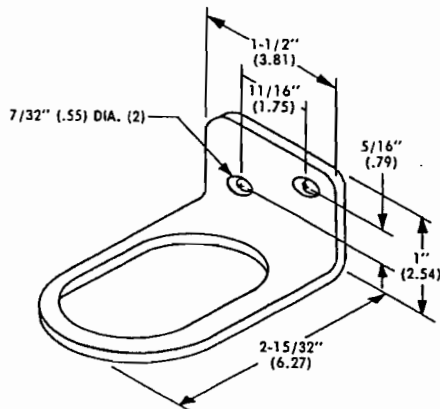
DIMENSIONS



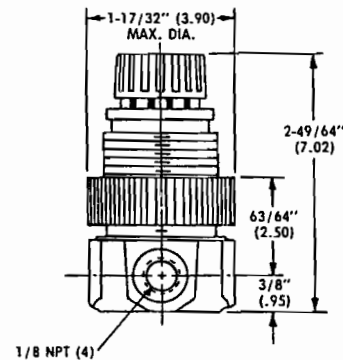
HAO-1115



HAO-1011
HAO-1012
HAO-1013
HAO-1014



HAO-1004



HAO-1001
HAO-1002

INSTALLATION - CALIBRATION

The regulators are not position sensitive and can be installed at any angle. Air line piping should be the same size as the regulator ports. A filter should be installed upstream of the regulator. Air flow must be in the direction of the arrow on the regulator body. Connect piping using pipe thread sealant on male threads only. Plug unused gauge ports.

Before applying system air pressure, turn regulator adjustment knob counterclockwise until all load is removed from the regulator spring. Apply system pressure, and turn regulator adjustment knob clockwise until the desired outlet pressure is reached. When making a change in pressure setting, always approach the desired pressure from a lower pressure. When changing from higher to lower setting, first reduce to pressure lower than desired and then adjust upwards. Push adjustment knob downward to lock setting. Pull knob up to release.

CAUTION

Do not use these regulators on any fluid other than compressed air, on other than industrial applications, or where pressures or temperatures can exceed the maximum rated operating specifications. If outlet pressures in excess of the regulator setting can damage or cause malfunction of downstream equipment, install a properly sized pressure relief device downstream of the regulator.

2-1/2" - 60" SERIES 815 ANSI CLASS 150 WAFER-SPHERE® BUTTERFLY VALVES

Neles-Jamesbury's series 815 ANSI Class 150 high-performance Wafer-Sphere butterfly valves provide long-lasting tight shutoff capability, excellent flow characteristics, and a long service life. They are available in 2-1/2"-30" (65-750 mm) sizes in a wafer-style body design (815W), and 2-1/2"-60" (65-1500 mm) in a single-flange lugged design (815L).

The series 815 Wafer-Sphere butterfly valve is available in a wide variety of materials in both standard and Fire-Tite® construction. Valves in all the materials listed in this bulletin (except ductile iron) meet NACE MR-01-75 requirements. Optionally available are valves specifically prepared for chlorine, oxygen, high-vacuum, or abrasive service, as well as a cryogenic series.

FEATURES

FIELD PROVEN SINGLE PIECE FLEXIBLE TFE SEAT DESIGN

- No additional o-rings or metal parts required to maintain tightness
- Tight shut-off in either direction
- Lip-seal design compensates for temperature and pressure changes
- Longer service life with less maintenance

OFFSET SHAFT AND ECCENTRIC DISC

- No seat/disc contact in the open or intermediate position
- Eliminates wear points at top and bottom of seats
- Reduces torque requirements, allowing for smaller operators

FIRE-TESTED VERSION AVAILABLE

- Fire-Tite Wafer-Sphere valves have been tested to API 607 and BS 6755 part 2

POSITIVE SHAFT RETENTION

- Valves are equipped with a retaining ring at the top of the shaft to prevent movement of the top portion of the shaft past the compression ring if for any reason the shaft should break within the valve

EASY SEAT MAINTENANCE

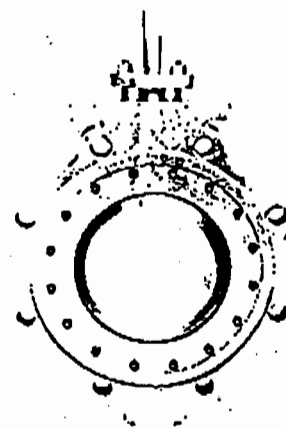
- Simply remove body insert and replace seat—disassembly of disc and shaft is not required

EXCELLENT FOR BOTH ON-OFF AND CONTROL APPLICATIONS

- Superior control characteristics
- Inherent flow characteristic is modified equal percentage



3"-12" TYPE 815W



3"-12" TYPE 815L

- Wide rangeability
- Tight shut-off even in control applications

SINGLE SOURCE RESPONSIBILITY

- Purchase valves, actuators, and accessories, completely mounted from one source
- Available with electric, manual gear, and pneumatic double acting or spring return actuators and a variety of accessories including limit switches, solenoids, and positioners
- Experienced Neles-Jamesbury Service Centers insure quality maintenance

AVAILABLE IN A WIDE CHOICE OF MATERIALS FOR A BROAD RANGE OF APPLICATIONS

- Standard body materials include ductile iron, carbon steel, stainless steel Alloy 20, and Monel.® Other materials, such as Avesta® 254SMO are available on application.

Please refer to the bulletins listed below for information on other Neles-Jamesbury high-performance butterfly valves.

ANSI class 300 Wafer-Sphere®	WI02-3
ANSI class 150 metal seated Neldisc®	WI20-1
ANSI class 300 metal seated Neldisc®	WI21-1
Wafer-Sphere Valves for Steam Service	WI50-1
Wafer-Sphere Valves for Chlorine Service	WI50-2
Wafer-Sphere Valves for Oxygen Service	WI50-3
Wafer-Sphere Valves for Vacuum Service	WI50-4*
Cryogenic Wafer-Sphere Valves	WI30-1

* Standard valves are rated to 20 microns. Refer to the bulletin for higher vacuums.

Seat ratings shown in the chart at right are based on differential pressure with the disc in the fully closed position and refer to seats only. Maximum body working pressures and test pressures of different materials are shown in the Valve Body Ratings tables at center right.

These ratings are a conservative guide for general service. Previous experience in a process or new developments may permit applications at ratings above those shown. Please consult Notes-Jamesbury's home office for specific recommendations.

VALVE BODY RATINGS

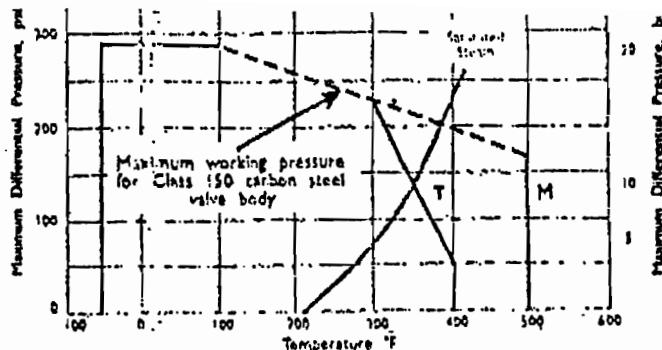
The tables below are maximum working pressure ratings of the valve body only. The seat ratings (above right) determine the practical pressure limitations according to actual service conditions. Test pressures are for hydrostatic test with disc open.

Valve Body Ratings — psi					
Temp. °F	Carbon Steel*	Ductile Iron	316 Stainless Steel*	Alloy 20*	Monel*
-20 to 100	285 psi	250 psi	275 psi	230 psi	230 psi
200	260	235	240	215	200
300	230	215	215	200	190
400	200	200	195	—	185
500	170	170	170	—	170
Test Pressure	450	375	425	350	350

* Corresponds to ratings of ANSI B16.34-1968 for material grades shown in bills of material on pages 5 and 6.

FLOW DATA

The tables at right provide flow coefficients for Series 815W and 815L valves covered in this bulletin. The C_v values represent the flow of water at +60°F through the valve in U.S. gallons per minute at a pressure drop of 1 psi. See Bulletin T150-1 for more information.



T-TFE M-FILLED TFE SEAT

NOTE: 14"-60" valves equipped with 316 stainless or Alloy 20 shaft are rated for maximum differential pressure of 150 psi.

Valve Body Ratings — bar					
Temp. °C	Carbon Steel*	Ductile Iron	316 Stainless Steel*	Alloy 20*	Monel*
29 to 38	19.6 bar	17.3 bar	19.0 bar	15.8 bar	15.8 bar
50	19.2	16.9	18.4	15.6	15.2
100	17.7	16.0	16.2	14.6	13.6
150	15.8	14.8	14.8	13.8	13.1
200	14.0	13.8	13.7	—	12.8
250	12.1	11.7	12.1	—	11.7
300	10.2	—	10.2	—	—
Test Pressure	31.0	25.9	29.3	24.1	24.1

Valve Size	C_v
	815W and 815L
2-1/2"	78
3"	165
4"	400
5"	510
6"	1,050
8"	2,200
10"	3,300
12"	5,100
14"	5,800
16"	8,000

Valve Size	C_v
	815W and 815L
18"	10,500
20"	14,000
24"	21,600
30"	34,000
36"	55,500
42"	82,650
48"	108,300
54"	133,500
60"	159,000

STANDARDS AND SPECIFICATIONS

Wafer-Sphere valves are available conforming to the latest issue of the following industry and agency standards and specifications. Please note: Inquiries and orders must reference the need for conformance to specific standard(s) and specifications(s).

ANSI B16.34	Valves—Flanged, Threaded, and Welding End.	API 598	Valve Inspection and Test.
ANSI B16.5	Steel Pipe Flanges and Flanged Fittings.	API 600	Steel Gate Valves (Wall thickness Requirement)
ANSI B31.1	Power Piping	API 607	Fire Test for Soft-Seated Ball Valves (Div. of Refining).
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping	API RP6F	Fire Test for Soft-Seated Ball Valves (Div. of Production).
ANSI B31.4	Liquid Transportation Systems for Hydrocarbons (Liquid Petroleum Gas), Anhydrous Ammonia, and Alcohols	API 609	Butterfly Valves—Lug-Type and Wafer-Type.
ANSI B31.8	Gas Transmission and Distribution Piping Systems	NACE Standard	Sulfide Stress Cracking Resistant Metallic Material for Oilfield Equipment.
ANSI B16.104	Control Valve Seat Leakage	MR-01-75	
MSS SP-25	Standard Marking System for Valves	ASME	Nuclear Stamp (Class II and III)
MSS SP-55	Quality Standard for Steel Castings—Visual Method	USCG	Affidavit Manufacturer (ISA)
MSS SP-68	High Pressure Offset Seat Butterfly Valves		
BS 6755-Part 2	Specification for Fire-Type Testing Requirements Appendix A		

ANSI-American National Standards Institute

API-American Petroleum Institute

ASME-American Society of Mechanical Engineers

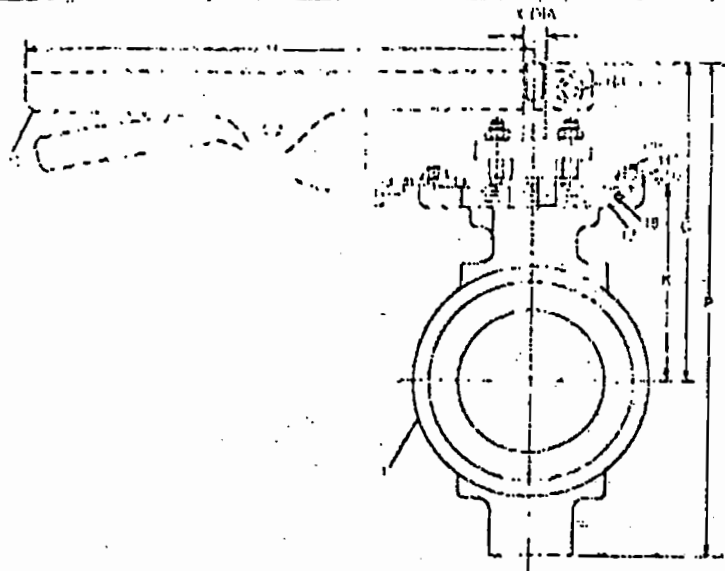
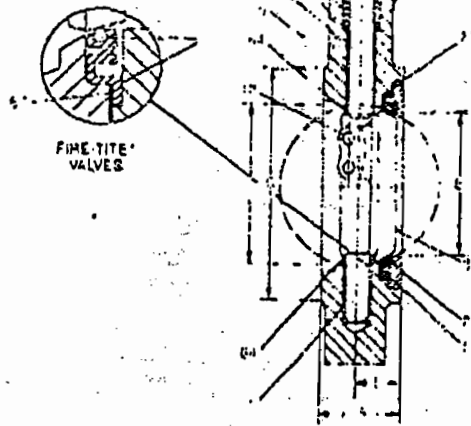
BS-British Standards Institute

MSS-Manufacturers Standardization Society

NACE-National Association of Corrosion Engineers

USCG-United States Coast Guard

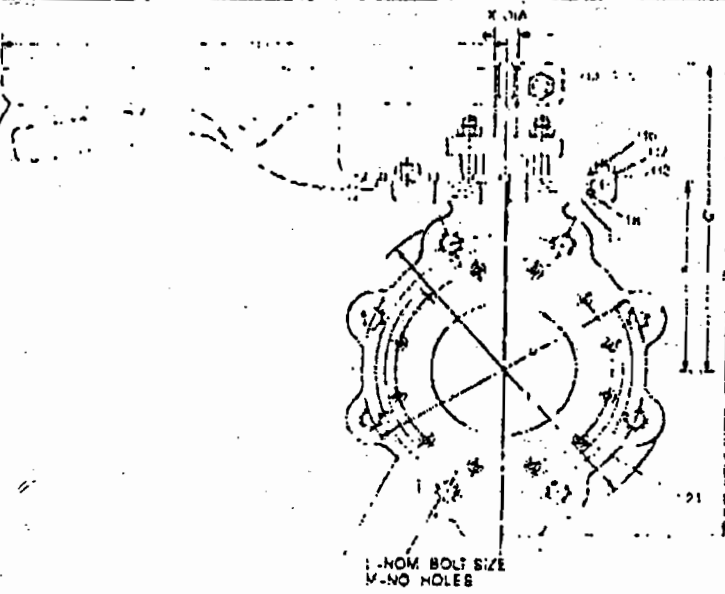
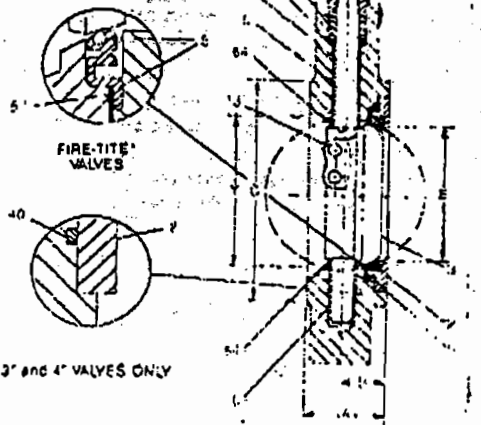
**2-1/2"-12" TYPE 815W
(Model C) VALVES
ANSI CLASS 150
WAFER DESIGN**



APPROXIMATE DIMENSIONS — inches (mm)													Approx. Weight** — lb (kg)
VALVE SIZE	A	B	C	E	G	H	K	P	S Blade	X	Y ¹		
2-1/2"	1.94 (49)	1.06 (27)	4.49 (119)	2.31 (59)	7.63 (194)	11.00 (279)	4.38 (111)	10.81 (275)	.44 (11)	.63 (16)	1.88 (48)	11 (3)	
3"	1.94 (49)	1.06 (27)	5.19 (132)	2.88 (73)	8.00 (203)	11.00 (279)	4.75 (121)	12.44 (316)	.44 (11)	.63 (16)	2.90 (74)	13 (6)	
4"	2.12 (54)	1.19 (30)	6.19 (157)	3.75 (95)	8.50 (216)	11.00 (279)	5.25 (133)	13.44 (341)	.44 (11)	.63 (16)	3.83 (97)	18 (8)	
5"	2.5 (64)	1.19 (30)	7.31 (186)	4.38 (112)	9.34 (237)	11.00 (279)	5.31 (135)	14.25 (362)	.44 (11)	.63 (16)	4.38 (111)	27 (13)	
6"	2.35 (57)	1.31 (33)	8.30 (211)	5.59 (142)	9.25 (235)	11.00 (279)	6.00 (153)	15.13 (384)	.53 (13)	.75 (19)	5.76 (146)	28 (13)	
8"	2.50 (64)	1.41 (36)	10.61 (270)	7.41 (188)	10.63 (270)	22.00 (559)	7.38 (187)	18.25 (464)	.63 (16)	.88 (22)	7.63 (194)	45 (20)	
10"	2.81 (71)	1.63 (41)	12.75 (324)	9.28 (236)	12.81 (325)	22.00 (559)	9.13 (232)	22.06 (560)	.81 (21)	1.13 (29)	9.56 (243)	78 (35)	
12"	3.19 (81)	1.88 (48)	15.00 (381)	11.09 (282)	14.13 (359)	22.00 (559)	10.25 (260)	24.88 (632)	.94 (24)	1.38 (35)	11.37 (289)	112 (51)	

¹Conforms to API 609 and MSS SP 68 requirements for minimum clearances of pipe inside diameters for Schedule 80 pipe. **Weights do not include handles. See page 8 for handle weights.

**2-1/2"-12" TYPE 815L
(Model C) VALVES
ANSI CLASS 150
SINGLE-FLANGE
LUGGED DESIGN**



VALVE SIZE	APPROXIMATE DIMENSION — Inches (mm)															Approx. Weight** — lb (kg)
	A	B	C	D	E	F	G	H	K	L	M	P	S Blade	X	Y*	
2-1/2"	1.94 (49)	1.06 (27)	4.13 (105)	5.50 (140)	3.31 (84)	7.00 (178)	7.81 (199)	11 (279)	4.38 (111)	5.8-11	4	10.81 (275)	.44 (11)	.63 (16)	1.38 (48)	13 (7)
3"	1.94 (49)	1.06 (27)	5.19 (132)	6.00 (152)	3.88 (98)	7.50 (191)	8.00 (203)	11.00 (279)	4.75 (121)	5.8-11	4	12.44 (316)	.44 (11)	.63 (16)	2.90 (74)	17 (8)
4"	2.12 (54)	1.19 (30)	6.19 (157)	7.50 (191)	3.75 (95)	9.00 (229)	8.50 (216)	11.00 (279)	5.25 (133)	5.8-11	8	13.44 (341)	.44 (11)	.63 (16)	3.83 (97)	26 (12)
5"	2.5 (64)	1.19 (30)	7.31 (186)	8.50 (216)	4.38 (112)	10.38 (264)	9.56 (243)	11.00 (279)	5.31 (135)	5.8-11	8	14.25 (362)	.44 (11)	.63 (16)	4.38 (111)	40 (18)
6"	2.35 (57)	1.31 (33)	8.30 (211)	9.50 (241)	5.59 (142)	11.00 (279)	9.25 (235)	11.00 (279)	6.00 (153)	5.8-11	8	15.13 (384)	.53 (13)	.75 (19)	5.76 (146)	43 (20)
8"	2.50 (64)	1.41 (36)	10.61 (270)	11.75 (298)	7.41 (188)	13.50 (343)	10.63 (270)	22.00 (559)	7.38 (187)	5.8-11	8	18.25 (464)	.63 (16)	.88 (22)	7.63 (194)	69 (31)
10"	2.81 (71)	1.63 (41)	12.75 (324)	14.25 (363)	9.28 (236)	16.75 (425)	12.81 (325)	22.00 (559)	9.13 (232)	7.6-9	12	22.06 (560)	.81 (21)	1.13 (29)	9.56 (243)	93 (42)
12"	3.19 (81)	1.88 (48)	15.00 (381)	17.00 (432)	11.09 (282)	19.00 (483)	14.13 (359)	22.00 (559)	10.25 (260)	7.6-9	12	24.88 (632)	.94 (24)	1.38 (35)	11.37 (289)	140 (64)

¹Conforms to API 609 and MSS SP 68 requirements for minimum clearances of pipe inside diameters for Schedule 80 pipe. **Weights do not include handles. See page 8 for handle weights.

Part No.	Part Name	Type 815W-3500 815L-3500 Alloy 20 Body and Disc	Type 815W-3635 815L-3635 Stainless Body Alloy 20 Disc	Type 815W-7100 815L-7100 Monel® Body and Disc
1	Body	Alloy 20 stainless steel ASTM A351-Type CN7M	316 stainless steel ASTM A351-Type CF8M	Monel ASTM A743 Grade M35
2	Insert	Alloy 20	316 stainless steel	Monel
3	Disc	Alloy 20		Monel
4	Shaft	Alloy 20		Monel
5	Seat	TFE, filled TFE, or TFE/316 stainless steel (Fire-Tite® valves) ¹		
6	Shaft Bearing	Alloy 20 backed TFE		Monel backed TFE
7	Spacer	Alloy 20		Monel
8	Shaft Seal	TFE or graphite		
9	Compression Ring	316 stainless steel		Monel ²
10	Compression Plate	316 stainless steel ³	316 stainless steel ^{3, 4}	Monel ²
11	Pressure Plug (14")	Alloy 20	316 stainless steel	Monel
13	Disc Pin	Alloy 20		Monel
14	Stud	Stainless steel		Monel
15	Nut	Stainless steel		Monel
16	Lock Washer (14"-16" only)	Carbon steel		Monel
17	Name Plate		Stainless steel	
18	Drive Screw		Stainless steel	
21	Cap Screw (815L only)	Stainless steel		Monel
24	Handle Assembly (2-1/2"-12" only)		(see below)	
26	Indicator Plate (30"-60" only)		Stainless steel	
27	Drive Screw (30"-60" only)		Stainless steel	
29	Indicator Pointer (14"-60" only)		Carbon steel	
40	Body Seal (2-1/2"-4" 815L)		TFE	
41	Top Bearing Spacer (except 12")		TFE	
42	Plug Seal (14")		TFE	
43	Bottom Bearing Spacer (14"-60" only)		TFE	
47	Retaining Ring (2-1/2"-12")		Inconel	
53	Cover Plate (16"-60")	Alloy 20	316 Stainless steel	Monel
54	Gasket (16"-60")		TFE	
55	Cap Screw (16"-60")	Stainless steel		Monel
56	Lock Washer (16"-60")	Stainless steel		Monel
64	Thrust Bearing	Alloy 20		Monel
67	Body Seal (2-1/2"-12" Fire-Tite® only)		Graphite	
77	Insert Spring (2-1/2"-12" 815W only)		Inconel	

¹ VALVES IN OTHER MATERIALS THAN SHOWN AVAILABLE ON APPLICATION.

² Other materials available for special applications.

See "How to order" section on page 7.

³ Monel available on application

⁴ Carbon steel with 2-1/2"-12" 815W valves.

⁵ Compression ring and compression plate are one piece and Monel on 14"-24" Model B valves.

⁶ Compression ring and compression plate are one piece and 304 stainless steel on 14"-24" Model B valves.

HANDLE COMPONENTS (2-1/2"-12" valves only)			
Part No.	Part Name	Material	
		2-1/2"-6"	8"-12"
H1	Handle Subassembly	Stainless steel	Malleable iron
H2	Ratchet	Stainless steel	Carbon steel
H3	Cap Screw	Stainless steel	Carbon steel
H4	Lock Washer	—	Carbon steel
H5	Hex Nut	—	Carbon steel
H6	Cap Screw	Stainless steel	Carbon steel
H7	Lock Washer	Stainless steel	Carbon steel

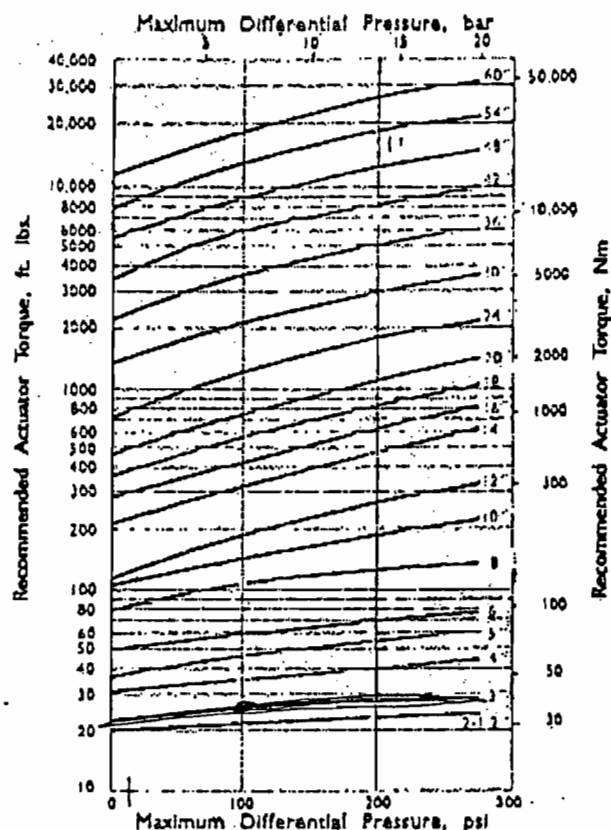
Inconel and Monel are registered trademarks of Inco.

VALVE TORQUE DATA

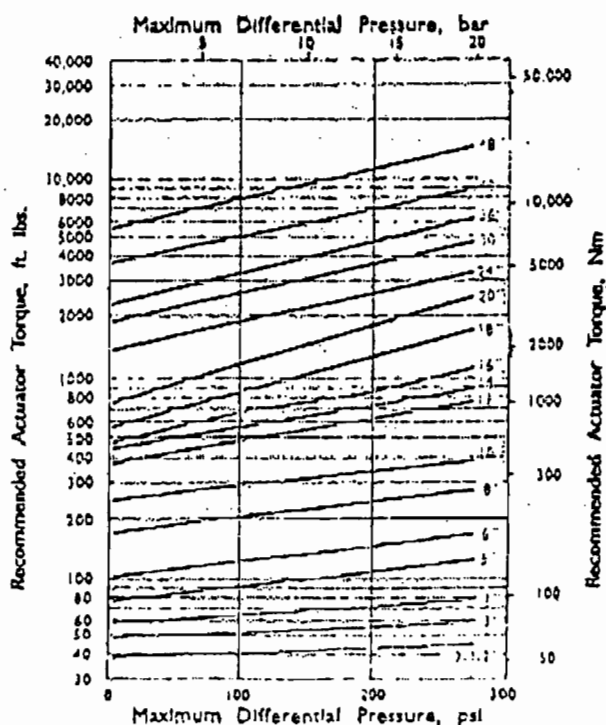
These torque charts are to be used as a guide for actuator selection. An actuator should be selected that provides the same or greater torque output than that shown in the charts below. Refer to bulletins on Neles-Jamesbury pneumatic and

electric actuators for torque output valves and actuator selection tables. If in doubt, select the next larger actuator.

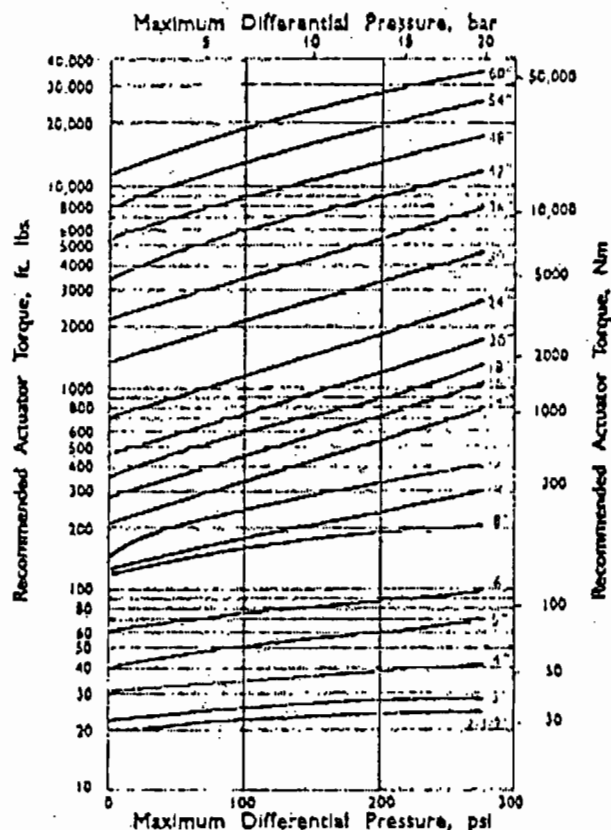
STANDARD TYPE 815W AND 815L VALVES with TFE (T) or Filled TFE (M) seat SHAFT DOWNSTREAM



FIRE-TITE® F815W and F815L VALVES with TFE/316 stainless steel seat SHAFT DOWNSTREAM OR UPSTREAM



STANDARD TYPE 815W and 815L VALVES with TFE (T) or Filled TFE (M) seat SHAFT UPSTREAM



ACTUATOR SELECTION

Specifications of Neles-Jamesbury actuators to operate Wafer-Sphere valves are contained in the following bulletins:

ACTUATOR	BULLETIN
Manual Gear Actuators	A100-1
SP Rack and Pinion Actuators	A101-1
Piston Actuators	A102-1
Double-Acting Rack and Pinion Piston Actuators (for larger valves)	A103-1
Spring-Return Rack and Pinion Piston Actuators (for larger valves)	A104-1
Double-Acting Vane Actuators	A105-1
Spring-Return Vane Actuators	A106-1
Spring-Diaphragm Actuators	A110-1
Electric Actuators	A120-2
Enhanced Electric Actuators	A121-1

RECOMMENDED FASTENERS

For recommendations on machine bolts and stud-bolts and their lengths for installing Type 815-W and 815L valves described in this bulletin in pipe lines, refer to Bulletin T104-1.

NELES-JAMESBURY

SPECIFICATIONS

TYPE SP AND SP-SR PNEUMATIC/HYDRAULIC RACK AND PINION ACTUATORS

Neles-Jamesbury's SP and SP-SR rack and pinion actuators are designed to offer long lasting trouble free operation as an economical means of automatic control of quarter turn valves.

Type SP double-acting actuators produce output torques ranging from 7 to 250 ft.lbs. (10-340 Nm) for operating 1/4" through 6" ball valves and 3" through 10" butterfly valves.

Type SP-SR spring-return actuators produce torques ranging from 10 to 92 ft.lbs. (14-125 Nm) for operating 1/4" through 4" ball valves and 3" through 8" butterfly valves.

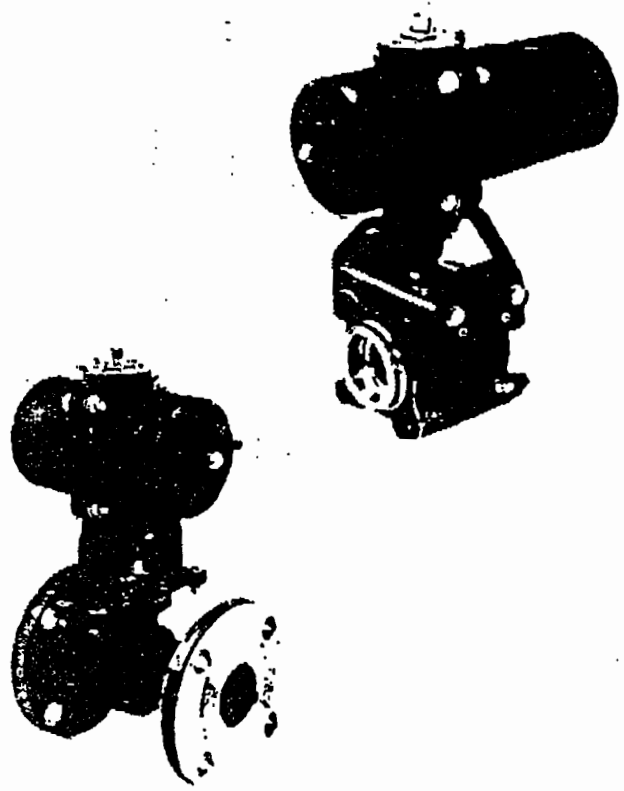
FEATURES

- Outstanding corrosion resistance.
- Compact size and light weight.
- Stainless steel rack and pinion with lifetime guarantee.*
- Advanced single rack and pinion system driven by a one-piece shuttling piston provides smooth operation and superior cycle life.
- Adjustable travel stops for both open and closed positions.
- Spring-return units are completely field reversible.
- NAMUR and NPT solenoid connections.
- Easily fitted with a wide variety of accessories and control devices.

Type SP and SP-SR actuators have a stainless steel rack and pinion system consisting of two drive elements: a shuttling piston with rack, and a one-piece pinion/drive shaft. Together they offer smooth, low backlash operation with a minimum number of parts. The single piston is exceptionally stable and provides reduced stresses compared to other popular designs, thereby avoiding scuffing and galling.

Of major importance are the thermoplastic precision molded housings. The material's low coefficient of friction reduces bearing and seal wear to give superior cycle life. The thermoplastic housing in combination with stainless steel fasteners give the actuators excellent corrosion resistance.

* If at any time during the useful life of the actuator the rack or pinion fails, the actuator will be replaced at Neles-Jamesbury's expense. Neles-Jamesbury's liability is limited to the value of the actuator.



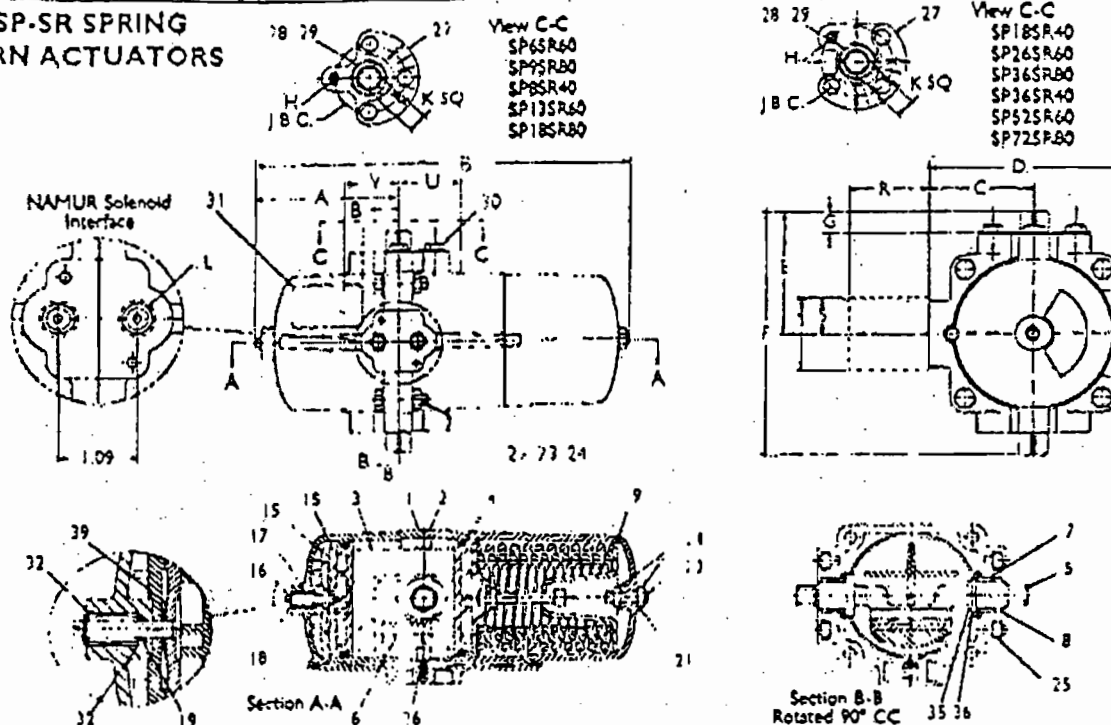
Type SP-SR spring-return units feature springs preloaded in a self-contained cartridge for safer handling and easy maintenance. Fail-open or fail-close operation can be quickly changed in the field by simply inverting the actuator - top and bottom mounting pads are identical. These SP-SR actuators are available in three series, the SR40 for 40 psi minimum supply pressure, the SR60 for 60 psi minimum supply pressure and the SR80 for minimum supplies of 80 psi.

Type SP and Type SP-SR actuators come with a NAMUR solenoid interface for direct mounting of solenoid valves or standard NPT piping connections.

A wide choice of optional accessories and control devices that include limit switches, position indicators, two-stage flow controllers, programmable cycling controllers and positioners is available to satisfy virtually all automatic valve requirements.

DIMENSIONS

TYPE SP-SR SPRING RETURN ACTUATORS



Approximate Dimensions, inches (mm)

Actuator	A	B	C	D	E	F	G	H	J	K	L	Weight lbs (kg)
SP6SR60	3.50 (89)	9.31 (236)	2.31 (59)	4.06 (103)	2.94 (75)	5.81 (148)	0.63 (16)	1/4-20	2.00 (51)	0.56 (13)	1/8-NPT	4.3 (2.0)
SP9SR60	3.50 (89)	9.31 (236)	2.31 (59)	4.06 (103)	2.94 (75)	5.81 (148)	0.63 (16)	1/4-20	2.00 (51)	0.56 (13)	1/8-NPT	4.9 (2.2)
SP8SR40	3.88 (99)	10.31 (262)	2.63 (67)	4.69 (119)	3.25 (83)	6.44 (164)	0.63 (16)	1/4-20	2.00 (51)	0.56 (13)	1/4-NPT	6.2 (2.8)
SPI3SR60	3.88 (99)	10.31 (262)	2.63 (67)	4.69 (119)	3.25 (83)	6.44 (164)	0.63 (16)	1/4-20	2.00 (51)	0.56 (13)	1/4-NPT	6.8 (3.1)
SPI8SR80	3.88 (99)	10.31 (262)	2.63 (67)	4.69 (119)	3.25 (83)	6.44 (164)	0.63 (16)	1/4-20	2.00 (51)	0.56 (13)	1/4-NPT	7.6 (3.4)
SPI8SR40	4.81 (122)	13.69 (348)	3.06 (78)	5.88 (149)	4.56 (116)	9.13 (232)	1.00 (25)	3/8-16	3.00 (76)	0.75 (19)	1/4-NPT	13.0 (5.9)
SP26SR60	4.81 (122)	13.69 (348)	3.06 (78)	5.88 (149)	4.56 (116)	9.13 (232)	1.00 (25)	3/8-16	3.00 (76)	0.75 (19)	1/4-NPT	15.0 (6.8)
SP36SR80	4.81 (122)	13.69 (348)	3.06 (78)	5.88 (149)	4.56 (116)	9.13 (232)	1.00 (25)	3/8-16	3.00 (76)	0.75 (19)	1/4-NPT	17.6 (8.0)
SP36SR40	5.44 (138)	16.50 (419)	3.69 (94)	7.06 (179)	5.13 (130)	10.25 (260)	1.00 (25)	3/8-16	3.00 (76)	0.75 (19)	1/4-NPT	26.3 (12.0)
SP52SR60	5.44 (138)	16.50 (419)	3.69 (94)	7.06 (179)	5.13 (130)	10.25 (260)	1.00 (25)	3/8-16	3.00 (76)	0.75 (19)	1/4-NPT	29.0 (13.2)
SP72SR60	5.44 (138)	16.50 (419)	3.69 (94)	7.06 (179)	5.13 (130)	10.25 (260)	1.00 (25)	3/8-16	3.00 (76)	0.75 (19)	1/4-NPT	33.6 (15.2)

Approximate Solenoid Dimensions, inches (mm)

	R	S	T	U	V
NJ-3W-N7	3.22 (82)	.938 (24)	1.91 (49)	1.69 (43)	5.38 (137)

PARTS AND BILL OF MATERIALS FOR TYPE SP-SR SPRING-RETURN ACTUATORS

Part No.	Part Name	Material	Quantity			
			SP4SR60 SP9SR80	SP8SR40 SP13SR60 SP18SR80	SP18SR40 SP26SR60 SP36SR80	SP36SR40 SP52SR60 SP72SR80
1	Housing DA	Thermoplastic polyphenylene oxide	1	1	1	1
2	Housing SR	Thermoplastic polyphenylene oxide	1	1	1	1
3	Piston ¹	Thermoplastic polyphenylene oxide	1	1	1	1
4	Piston Seal	Buna-N	2	2	2	2
5	Pinion Shaft	Stainless steel	1	1	1	1
6	Rack ¹	Stainless steel	1	1	1	1
7	Shaft Bearing	Nylon	2	2	2	2
8	Shaft O-Ring	Buna-N	2	2	2	2
9*	Spring Cartridge Assembly	Carbon Steel	See* Note Below			
15	Stop Plate ²	Thermoplastic polycarbonate	2	2	2	2
16	Stop Plate Shaft ²	Stainless steel	1	1	1	1
17	Stop Plate Spring	Stainless steel	1	1	1	1
18	Stop Plate Retaining Ring	Stainless steel	1	1	1	1
19	Stop Plate Shaft O-Ring	Stainless steel/Buna-N	1	1	1	1
20	Set Screw	Stainless steel	1	1	1	1
21	Set Screw Seal	Buna-N	1	1	1	1
22	Body Bolts	Stainless steel	4	4	4	4
23	Flat Washers	Stainless steel	8	8	8	8
24	Hex Nuts	Stainless steel	4	4	4	6
25	Heavy Hex Nuts	Stainless steel	4	4	NA	NA
26	Housing Seal	Buna-N/Polyethylene	1	1	1†	1†
27	Indicator Plate	Stainless steel	1	1	1	1
28	Indicator Pointer	Carbon steel	1	1	1	1
29	Indicator Retaining Ring	Stainless steel	1	1	1	1
30	Indicator Plate Bolts	Carbon Steel	3	3	3	3
31	Nameplate	Mylar™	1	1	1	1
32	Flat Washers	Stainless steel	2	2	2	2
35	Retaining Ring	Stainless steel	1	NA	NA	NA
36	Thrust Washer	Stainless steel	1	NA	NA	NA
39	Conical Spring	Stainless steel	1	1	1	1

* This is a permanent assembly that should not be disassembled in the field. If repair is necessary, unit must be returned to the factory.

Note 1: The rack is permanently attached to the piston. Disassembly is not recommended.

Note 2: The shaft is permanently attached to the stop plate. Disassembly is not recommended.

† Housing seal is polyethylene for SP18SR40 through SP72SR80

ACTUATOR SELECTION

To select the proper actuator for a particular valve and service, first determine the maximum operating torque that will be required for the valve from the applicable valve torque table in the appropriate valve bulletin. Then refer to the appropriate mode of operation of the actuator in the torque output tables and select the actuator that will, at the available air supply pressure, provide a torque output no less than the required operating torque for the valve. In the event confirmation by Neles-Jamesbury is desired of the selection of an actuator for a given valve under specific service conditions, include full details on trim and seat materials, and on fluid characteristics.

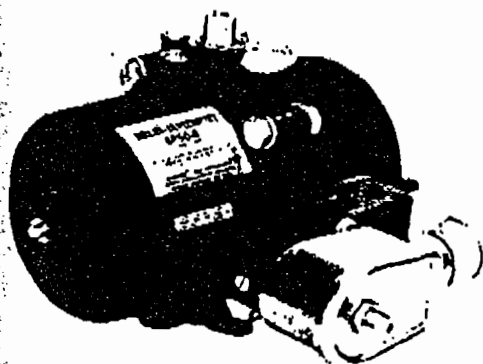
OUTPUT TORQUE OF DOUBLE-ACTING ACTUATORS, FT.LBS. (NM)

Actuator	Supply Pressure, psi (bar)							
	30 (2.1)	40 (2.8)	50 (3.3)	60 (4.1)	70 (4.8)	80 (5.5)	90 (6.2)	100 (6.9)
SP25	7 (9)	10 (14)	12 (16)	15 (20)	17 (23)	20 (27)	22 (30)	25 (34)
SP50	15 (20)	20 (27)	25 (34)	30 (41)	35 (47)	40 (54)	45 (61)	50 (68)
SP100	30 (41)	40 (54)	50 (68)	60 (81)	70 (95)	80 (108)	90 (122)	100 (136)
SP200	60 (81)	80 (108)	100 (136)	120 (163)	140 (190)	160 (217)	180 (244)	200 (271)

OUTPUT TORQUE OF SPRING-RETURN ACTUATORS, FT. LBS. (NM)

Actuator	Supply Pressure, psi (bar)									
	40(2.8)		50(3.5)		60(4.1)		70(4.8)		80(5.5)	
	Spring to open	Spring to close	Spring to open	Spring to close	Spring to open	Spring to close	Spring to open	Spring to close	Spring to open	Spring to close
SPSR60	—	—	—	—	8(11)	6(8)	11(15)	6(8)	—	—
SPSR80	—	—	—	—	—	—	—	—	9(12)	9(12)
SPSR40	10(14)	8(11)	15(20)	8(11)	—	—	—	—	—	—
SP3SR60	—	—	—	—	14(19)	13(18)	19(26)	13(18)	—	—
SP3SR80	—	—	—	—	—	—	—	—	18(24)	18(24)
SP3SR40	16(24)	16(24)	28(38)	16(24)	—	—	—	—	23(31)	18(24)
SP2SR60	—	—	—	—	27(37)	26(35)	32(43)	26(35)	—	—
SP2SR80	—	—	—	—	—	—	—	—	36(49)	36(49)
SP2SR40	32(49)	32(49)	56(76)	32(49)	—	—	—	—	46(62)	36(49)
SP2SR60	—	—	—	—	56(76)	52(70)	76(103)	52(70)	—	—
SP2SR80	—	—	—	—	—	—	—	—	72(98)	72(98)
SP2SR40	—	—	—	—	—	—	—	—	92(125)	72(98)

SOLENOIDS



The Neles-Jamesbury direct mount solenoid valves offer a few features not found on other solenoids. Available as a 3-way version that is rated both NEMA IV & VII and a 4-way that is either NEMA IV or NEMA IV & VII. The 4-way is standard with manual override. Although the 3-way does not have the override, the 4-way can be converted to a three way by simply turning the NAMUR Interface plate 180 degrees and remounting the solenoid. The solenoids have the following specifications:

3-WAY NEMA IV & VII	4-WAY NEMA IV	4-WAY NEMA IV & VII
#NJ-3W-N7	#NJ-4W-N4	#NJ-4W-N7
Net Cv .095	.35	.35
Throat Cv .17	.35	.35
Pressure 125 psi	15-150 psi	15-150 psi
Connections 1/4 NPT	1/4 NPT	1/4 NPT
Voltage 120 VAC/60Hz	120 VAC/60Hz	120 VAC/60Hz
Coil Class B	Class B	Class B

Power consumption 10 Watts.
Max. ambient temperature 113°F (45°C).

ACTUATOR ORIENTATION

While Type SP and SP-SR actuators may be mounted on Neles-Jamesbury valves in any of four directions, standard orientation of these actuators when furnished on valves is with the axis of the actuator parallel to the pipeline unless otherwise specified.

ACTUATOR ACCESSORIES AND CONTROLS

Information on available limit switches is contained in Bulletin A161-2. Other actuator accessories including two-stage (dribble) shutoff, filter regulators, lock-up valves, etc. are covered in Bulletin A165-1.

Whenever periodic cycling of a valve is required for draining, blowdown, flushing, or sampling of a system, a Neles-Jamesbury Type PPV programmable valve controller permits accomplishing the function automatically. Mounted directly to the valve actuator's solenoid pilot valve or wall mounted and wired to the solenoid valve, the unit provides appropriately timed flow of current for required valve operation. Easily set miniature switches allow setting time intervals for cycling the valve from one minute to sixty-three hours, and setting valve-open times from ten seconds to sixty-three minutes. Refer to Bulletin A135-1 for complete information.

ORDERING NELES-JAMESBURY TYPE SP AND SP-SR ACTUATORS

To order an actuator mounted and tested on a valve, the actuator designation should be given after the designation for the valve. For Type SP-SR spring-return actuators, mode of spring operation should be stated. Examples: 2" Fig. 21-2236TT-0 with Type SP25 actuator, or 1-1/2" Fig. 5150-11-3600TT with Type SP9SR80 actuator, spring-to-close.

To order an actuator for installation on a valve already in service, the order should specify the type and size of valve on which the actuator will be mounted in order that correct linkage and mounting kits will be supplied. Contact your Neles-Jamesbury representative or distributor for further information.

INTERNATIONAL MANUFACTURING and SALES LOCATIONS

UNITED STATES	CANADA	MEXICO	BRAZIL	FINLAND	ENGLAND	FRANCE	PEOPLE'S REPUBLIC OF CHINA
Cam Falls, New York Worcester, Massachusetts	Ottawa, Ontario	San Juan del Rio Queretaro Mexico	Sao Jose dos Campos	Helsinki	Basingstoke Hampshire	Wittenheim	Shanghai

Our products are available through Neles-Jamesbury sales offices in Australia, Austria, Belgium, Germany, Italy, Japan, The Netherlands, Norway, Portugal, Saudi Arabia, Singapore, South Korea, Spain, Sweden, Switzerland, United Arab Emirates, Venezuela as well as through a world-wide network of representatives.

NELES-JAMESBURY

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VF 591 WM Flowrite Water Mix Valve

Description

The Flowrite Water Mix Valves proportionally mix hot and cold water to satisfy the demands of the controlling instrument. Air operated, they are used in a variety of mixing applications.

- The Water Mix Valve has many fine features, including:
- A completely enclosed actuator housing which protects the diaphragm, spring and ball bearing spring startpoint adjustment
- A plated ball bearing spring start point adjustment which resists corrosion
- Valve plug stems of highly polished corrosion-resistant alloy to decrease friction and increase speed of response
- Removable composition discs for the 1/2" through 2" valves
- Guided valve plugs to insure perfect seating
- Teflon composition stem packing. This packing eliminates water leakage around the stem and insures a minimum amount of stem friction

Application

These valves are recommended for mixing two different temperature water supplies. They are also recommended for by-pass service in recirculating systems with the valve installed in the return line. This valve should be used as a mixing valve with two inlets and one outlet. It should not be used as a diverting valve.

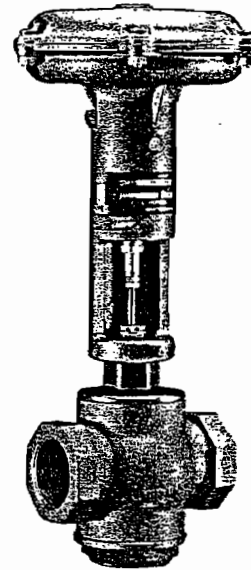
Specifications

Valve Body

Line Size	1/2 to 6"
Capacity	See Section H, Table 3.
Body Style	
1/2 to 2"	Screwed
2-1/2 to 6"	Flanged
Action	Water mixing
Stem Travel	Table 2
Stem Diameter	
1/2 to 2"	1/4" (6.4mm)
2-1/2 to 6"	3/8" (9.5mm)
Valve Body Rating	
1/2 to 2"	ANSI Class 250
2-1/2 to 6"	ANSI Class 125
	See Section H, Table 1.

Material

Body	
1/2 to 2"	Bronze
2-1/2 to 6"	Cast iron
Body Trim	Bronze
Shut-off Disc	1/2 to 2" EPT, soft
Throttling Plug	2-1/2 to 6" Bronze
Packing	EP V-ring



591-6600

Actuator Diaphragm	
8" actuator	Neoprene
12" actuator	Buna-N/Nylon
Stem	Stainless steel
Actuator	
Nominal Spring Range, Adjustable Start Point	
Span	5 psig (34 kPa)
Factory Setting	5-10 psig (34-69 kPa)
Effective Diaphragm Area	
8" actuator	28 in ² (180 cm ²)
12" actuator	74 in ² (477 cm ²)
Maximum Diaphragm	
Pressure	35 psig (241 kPa)
Air Connection	1/8" NPT
Operating	
Controlled Medium	Water, glycol solution
Maximum Medium Temperature	
1/2 to 2"	250°F (12°C)
2-1/2 to 6"	350°F (177°C)
Max. Inlet Pressure	See Section H, Table 1.
Maximum Differential	
Pressure for Modulating	
Service	30 psi (207 kPa)
Close-Off Ratings	Table 3.
Flow Characteristics	Linear
Ambient Operating Temperature	
8" actuator	35 to 180°F (2 to 82°C)
12" actuator	35 to 160°F (2 to 71°C)
Dimensions	Table 2
Shipping Weight	Table 1

Note: For temperatures between 300°F and 350°F, use Teflon V-ring packing.

Accessories

Factory Mounted Positioning Relay	See Note.
Field Mounted Positioning Relay	147-2000
Positioning Relay Field Mounting Kit	
8" Actuator – Models 3 & 4	147-333
12" Actuator	147-311
Stem Position Indicator	
for 1/4" stem threads only	672-137
12" Actuator	672-456

For repack kits, repair kits, parts and diaphragms: see Section F of this catalog, sales support documents 152-032 or 152-035, or consult your local Landis & Gyr Powers representative.

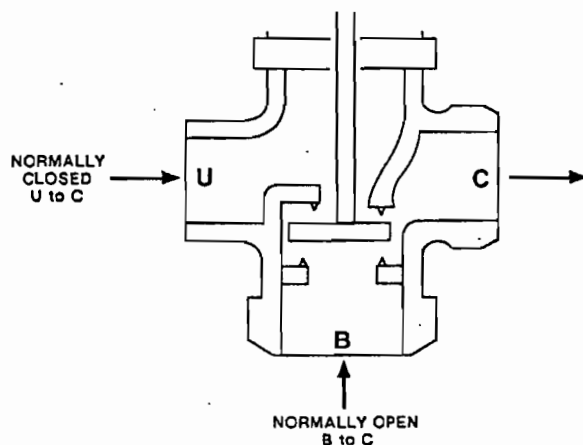


Table 1. Product Numbers

Product Number	Valve Size (in.)	C _v		Top Dia. (in.)	Body Material	Con-nections	Valve Plugs	Wt. (lb.)
		Flow B to C U port closed	Flow U to C B port closed					
591-6600	1/2	2.2	3.5	8	Bronze	Screwed Ends	EPT Discs	13
591-6610	3/4	6.0	6.0					14
591-6620	1	8.9	11.2					15
591-6630	1-1/4	15.8	16.7					17
591-6640	1-1/2	17.9	23.7					19
591-6650	2	30.2	38.1					24
591-6720	2-1/2	82	77	8	Cast Iron	Flanged Ends	Bronze Trim	63
591-8028	2-1/2	82	77	12				88
591-6730	3	120	92	8				80
591-8029	3	120	92	12				105
591-6740	4	190	160	8				121
591-8030	4	190	160	12				146
591-8031	5	270	252	12	Semi-Steel			194
591-8032	6	340	275	12				222

For control valve selection and sizing, refer to pages H-1 through H-11 of this catalog.

Note: To order Flowrite Valve with factory mounted positioning relay, use 592-XXXX instead of 591-XXXX.

Table 2. Dimensions (in inches).

		Valve Size	A	B	C	D	Stem Travel
FOR 8" TOP		1/2	8-3/4	13-9/16	1-3/4	2-7/8	1/8
		3/4	8-3/4	14-3/8	2-1/8	3-3/8	3/16
		1	8-3/4	14-7/16	2-7/16	3-7/8	1/4
		1-1/4	8-3/4	14-3/4	2-5/8	4-5/8	5/16
		1-1/2	8-3/4	15	2-7/8	5-3/16	5/16
		2	8-3/4	15-3/8	3-5/16	6-1/4	5/16
		2-1/2	8-3/4	16-1/4	7-1/4	8-1/2	5/8
		3	8-3/4	16-5/8	7-1/2	9-1/2	3/4
FOR 12" TOP		4	8-3/4	17-3/8	9-3/16	11-1/2	1
		2-1/2	13-1/2	24-1/2	7-1/4	8-1/2	5/8
		3	13-1/2	24-7/8	7-1/2	9-1/2	3/4
		4	13-1/2	25-5/8	9-3/16	11-1/2	1
		5	13-1/2	28	10	15	1-1/4
		6	13-1/2	28-7/16	10	15	1-3/8

**HIGHEST
ACCURACY**

Model C-204

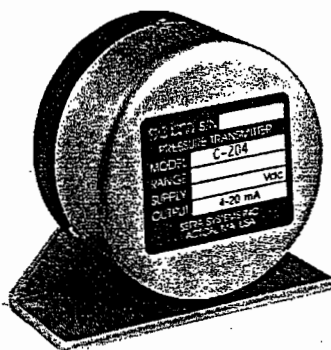
PRESSURE TRANSMITTERS

Gage Pressures: 0-25 psig to 0-10,000 psig
Absolute Pressures: 0-25 psia to 0-5,000 psia
Vacuum: 0 to 14.7 psi(v)
Corrosive Liquids or Gases

SETRA SYSTEMS, INC. HIGH ACCURACY PRESSURE TRANSMITTERS

Features

- Instant warm-up
- 4 to 20mA output
- 0.02% Repeatability
- 0.05% Hysteresis
- 0.1% Non-linearity
- 0.004%/°F Thermal effects
- 0.01% Output noise
- Solid one-piece stainless steel sensor



Description

The Model C-204 pressure transmitter is a complete pressure transmitter system for accurate pressure measurement of gaseous or liquid media compatible with type 17-4PH stainless steel. The high level output signal, combined with excellent stability, make this unit ideally suitable for industrial, laboratory, and aerospace applications requiring the highest accuracy. This unit is carefully compensated for both zero and sensitivity shifts due to environmental temperature variations. It is recommended for applications requiring highest accuracy. The unique Setra electronic circuitry is combined with a rugged capacitance-type sensor in this transmitter.

Full Scale Ranges

Standard Pressure Ranges (psi)	Proof Pressure (psi)	Burst Pressure Rating (psi)	Approximate Natural Frequency (KHz)
0-25	50	150	2.0
0-50	75	200	2.5
0-100	150	500	3.5
0-250	375	1000	5.0
0-500	750	1500	8.0
0-1000	1250	3000	11.0
0-3000	3750	4500	15.0
0-5000	6000	7500	25.0
0-10000	11000	12500	30.0
0-14.7 psi vac	50	150	2.0

Gage Pressure: Pressure measured relative to ambient atmospheric pressure. Referred to as pounds per square inch (gage) or psig.

Absolute pressure: Pressure measured relative to high vacuum. Referred to as pounds per square inch (absolute) or psia.

Vacuum: Vacuum measured relative to ambient atmospheric pressure. Referred to as pounds per square inch (vacuum) or psiv.

Proof pressure: The maximum pressure that may be applied without changing performance beyond specifications. ($\leq 0.5\%$ FS zero shift.)

Applications

- For highest accuracy, where extremely low hysteresis, high linearity, low power consumption and fast warm-up are essential.
- For connection directly into most A/D converters.
- Replacing low output strain gage type transducers and associated signal conditioning, getting higher accuracy at much lower cost.

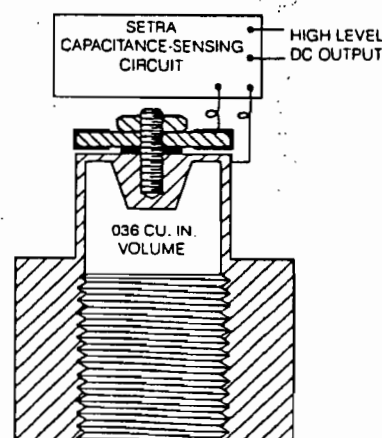
Construction

Setra's patented* variable capacitance sensor approaches the ultimate in design simplicity. It features a one-piece 17-4 PH stainless steel pressure cavity and an insulated electrode plate which is fastened to the center of the diaphragm of the sensor, forming a variable capacitance. As the pressure increases the capacitance will decrease. This capacitance is detected and converted to a linear 4-20mA electric signal by Setra's unique electronic circuit.

On absolute pressure units, the reference side of the diaphragm is electron beam weld sealed under high vacuum.

This sensor has extremely low hysteresis and is very stable under transient temperature or temperature gradient conditions.

*US Patent 3,859,575



**HIGH
ACCURACY**

Model C-204 Specifications

Pressure Ranges and Media

Gage Pressure	0 to 25, 50, 100, 250, 500, 1000, 3000, 5000, 10,000 psig.
Absolute Pressure	0 to 25, 50, 100, 250, 500, 1000, 3000, 5000 psia.
Vacuum Pressure	0 to 14.7 psi vacuum.
Pressure Media	Gases or liquids compatible with 17-4 PH stainless steel.

Accuracy Data

Accuracy*	$< \pm 0.11\%$ FS at constant temperature.
Non-linearity	$< \pm 0.1\%$ FS output (best straight line).
Hysteresis	$< 0.05\%$ FS (infinite resolution). ($< \pm 0.1\%$ for 10,000 psig only)
Non-repeatability	$< 0.02\%$ FS
Thermal Effects	30°F to 150°F
Thermal Zero Shift	$< \pm 0.4\%$ FS/100°F
Thermal Coef. Sensitivity	$< \pm 0.3\%$ FS/100°F
Acceleration Response	< 0.05 psi/g typical, pressure port axis only.
Volume Increase due to FS Pressure	5×10^{-5} cu. in.
Warm-up Shift (typical)	$< \pm 0.5\%$ FS total; $< \pm 0.1\%$ FS residual shift after 5 minutes.
Zero Pressure Output	4 mA (adjustment range ± 0.2 mA)
Full Scale Output	20 mA (adjustment range ± 1 mA)

*Accuracy as RSS non-linearity, hysteresis, and non-repeatability.

Electrical Data

True 2-wire, 4 to 20 milliamperes, constant current (a 16 mA span); delivers rated current into any external load between 0 and 1000 ohms**. Designed to meet ISA-S50.1 (1975) standard. "Compatibility of analog signals for electronic industrial process instruments", type and class 2U within the following parameters:

- Minimum supply voltage (volts) = $17 + 0.02 \times$
(Resistance of receiver plus line
[plus intrinsic safety resistor if used]).
- Maximum supply voltage (volts) = $42 + 0.004 \times$
(Resistance of receiver plus line
[plus intrinsic safety resistor if used]).

Variations in power supply voltage cause less than 0.003mA change in the transmitter's current output, per volt change in the power supply.

Ripple and Noise Content < 10 microamperes RMS
(0 Hz to 10 KHz).

Setting Time < 100 milliseconds.

**Calibrated at the factory using a 250 ohm load.

Electrical Isolation

The electrical circuit includes a 0.1 microfarad 50 VDC capacitor from circuit to case. The resistance between both electrical leads tied together and case ground exceeds 50 megohms at 50 VDC.

Options

- Special Pressure Range (Consult factory for availability and quantity pricing).
- 316 stainless steel sensor available for ranges 25 through 3000 psig and 14.7 psiv (Hysteresis $\pm 0.1\%$ FS).
- 0 to 5 VDC output transducer available as Model 204.

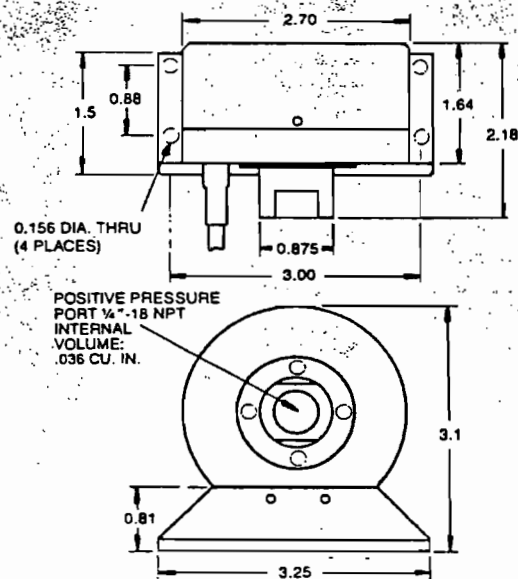
Ordering Information

Order as Model C-204 pressure transmitter. Specify pressure range, noting gage pressure, absolute pressure, or vacuum, and desired options.

Environmental and Dimensional Data

Temperature	0°F to 175°F operating -65°F to 250°F storage
Vibration	2 g's from 5 Hz to 500 Hz
Acceleration	10 g's maximum
Shock	50 g's operating
Positive Pressure Fitting	1/4"-18 NPT internal
Electrical Connection	2-foot multiconductor cable
Weight (approx.)	10 ounces

Outline Drawing



Specifications subject to change without notice.

SETRA SYSTEMS, INC. HIGH OUTPUT PRESSURE TRANSDUCERS

Model 228 HIGH LINE, LOW DIFFERENTIAL PRESSURE

Ranges ± 0.5 to ± 25 psid
Corrosive Liquids or Gases Both Sides
Features Fast Response for Test Applications

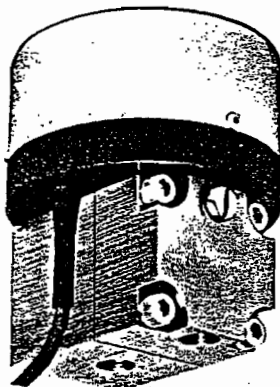
Features

- Fast response
- Corrosive gases and liquids both sides
- Low range differential pressures, to ± 0.5 psi F.S.
- Low line pressure effect.
- Overpressure (differential) will not damage unit.
- High level (standardized) output signal 5 volts F.S.

Description

The Model 228 pressure transducer is a high output, low differential pressure range, transducer designed for wet-to-wet pressure measurement tests of liquids or gases. It contains a fast-response Setra capacitance-type sensor and the high output, high linearity Setra electronic circuitry to provide a complete transducer system. Optional circuitry enables remote adjustment of zero, span, and calibration signal.

The 228 features very fast response to changes in differential pressure, as different from the slower response type transducers and transmitters used in many control applications.



Applications

Typical test applications include:

- Those test applications requiring fast response to pressure changes, (wet/wet usage response on order of 40 milliseconds),
- Flow measurement of various gases or liquids,
- Liquid level measurement of pressurized vessels,
- Determination of pressure drop across filters,
- Many other test applications for high line, low differential pressure of liquid or gaseous media.

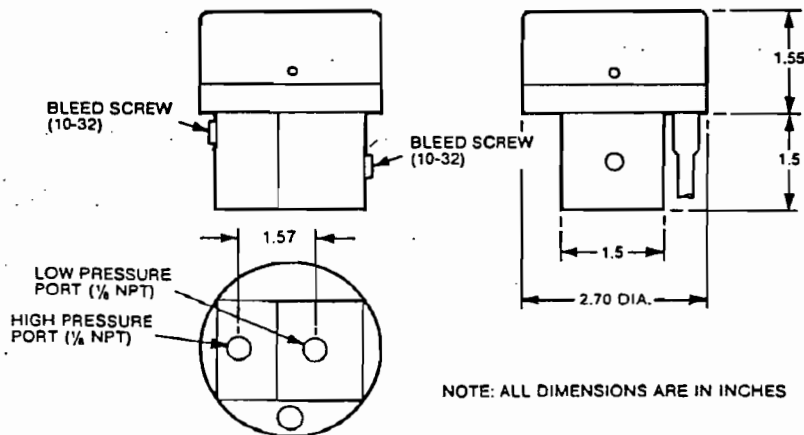
Construction

A unique isolation system transmits the motion of the differential pressure sensing diaphragm from the high line pressure environment (e.g. corrosive liquids) to the round dry (air) enclosure where it moves one of a pair of capacitance plates proportionally to the diaphragm movement. This system responds to pressure changes approximately 20 times faster than the more conventional fluid-filled construction.

The variation of capacitance is converted to a voltage proportional to the differential pressure by the capacitance-sensing and signal conditioning circuit located in the round enclosure. The electronic circuit linearizes output vs. pressure, standardizes the output (zero and gain) and compensates thermal effects of the sensor.

All parts exposed to pressure media are stainless steel and elastomer seals. Stainless steel screens are located in both pressure ports. Since there is no through-flow, these screens seldom need replacement.

Outline Drawing



Setra
systems
INC.

Model 228 Specifications

Pressure Data

Pressure Ranges	Unidirectional 0 to 1, 2, 5, 10, 50 psid	Bidirectional 0 to ± 0.5 , ± 1 , ± 2.5 , ± 5 , ± 25 psid
Maximum Working Pressure	2000 psig	
Maximum Overload (either side)	2000 psig, slight zero shift can be calibrated out.*	
Pressure Media	Gases or liquids compatible with (300 series and 17-4 PH) stainless steels, Buna N "O" ring and bleed screw seals.	
Maximum Test Pressure	3000 psig	

Accuracy Data

Non-linearity and Hysteresis	$\leq \pm 0.25\%$ FS (best straight line).
Line Pressure Effect	Zero shift approximately $\pm 0.004\%$ FS/psig line pressure.
Resolution	Infinite, limited only by output noise level (0.02% FS).
Thermal Effects	Operating temperature 0°F to 175°F.
Thermal Zero Shift	$\leq \pm 0.03\%$ FS/°F, 30°F to 150°F
Thermal Coefficient of Sensitivity	$\leq \pm 0.02\%$ FS/°F, 30°F to 150°F
Static Acceleration Effect	2% FS/g (most sensitive axis).
Natural Frequency	>500 Hz. (gaseous media)
Response Time	Very fast, 30 to 50 milliseconds (pressure measurand water)

Electrical Data

Full Scale Output**	Unidirectional units: 0 to 5 VDC Bidirectional units: 0 to ± 2.5 VDC
Output Impedance	<10 ohms.
Zero Pressure Output	Internally adjustable to 0 mv. Factory set within ± 100 mv (Pressure Ports Down).
Excitation Power	Nominal 24 VDC, 8 milliamperes (0.25 watt), 22 to 30 VDC. Reversed excitation protected. Internal regulation minimizes effect of excitation variation, with $\leq \pm 0.2\%$ FS output change. Will operate on 28 VDC aircraft power per MIL-STD-704A and not be damaged by emergency power conditions.
Electrical Circuit Isolation	Four-terminal equivalent circuit. The insulation resistance between all signal leads tied together and case ground is 100 megohms minimum at 25 VDC.
Output Noise	<100 microvolts RMS (0 Hz to 10 KHz).

Environmental and Dimensional Data

Temperature	0 to 175°F operating -65°F to 250°F storage***	Pressure fittings	1/8"-27 NPT internal
Vibration	2 g's from 5Hz to 500Hz	Electrical conn.	2 foot multiconductor cable
Acceleration	10 g's maximum	Weight (approx.)	2 pounds
Shock	50 g's operating		

*The output zero will shift slightly when high differential overpressure is applied. The shift may be as much as $\pm 10\%$ FS depending on the pressure range. Other parameters (sensitivity, linearity, etc.) will not shift. If the overpressure is nominally only in one direction, the user may apply this overpressure to preset the sensor. Subsequent overload of less magnitude will not cause additional shift. Unit is pre-zeroed at factory after application of positive 500 psid.

**Calibrated into a 50K ohm load; operable into load impedances of 5000 ohms or greater. Specify choice of bidirectional or unidirectional output when ordering. Has internal adjustment for sensitivity.

***Storage at temperature extremes may cause zero shift, correctable with internal zero adjustment.

Electronic Circuit Information

Four-terminal equivalent circuit. For best performance, either negative excitation or negative output should be connected to case. Unit calibrated at the factory with negative excitation connected to case.

Electronic circuit options:

- Remote calibration signal (output voltage shifts a pre-determined percentage of full scale when a pair of specially provided wires are connected). Specify either as a fixed percent full scale or adjustable.
- Remote zero adjustment.
- Remote sensitivity adjustment.
- ± 24 VDC or ± 15 VDC ground referenced excitation.
(Allows ground referenced output).
- 24 VDC excitation. 3-terminal equivalent circuit, output 1 to 5 VDC.
- 12 VDC (Automotive) excitation, 2 VDC output.
- Excitation and output compatible with 10 volt strain gage-type signal conditioners.
- Intrinsic safety feature. (Class 1, Div. 1, Groups C, D).
- Also available as Model C-228 Pressure Transmitter, 2-wire, 4 to 20 milliamperes.

Ordering Information

Order as Model 228 pressure transducer.

Specify: Differential pressure range
Line pressure
Electrical output
Desired options.

Specifications subject to change without notice.

Setra
systems
INC.

45 Nagog Park, Acton, Massachusetts 01720 / Telephone: (617) 263-1400

Setra Systems, Inc. PRESSURE TRANSDUCERS AND TRANSMITTERS

Model 280E/C280E

Gage Pressure: 0-15 psig to 0-10,000 psig
Compound Pressures: -14.7 to 35, 50, 100 psig
Absolute Pressures: 0-25 psia to 0-5000 psia
Corrosive Liquids or Gases

Features

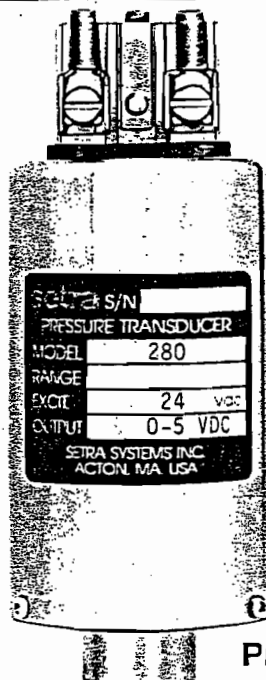
- 0.11% full scale accuracy
- High level output:
0-5 VDC or 4-20 mA
- Temperature compensated for low thermal error
- One-piece stainless steel sensor
- Small size and light weight

Applications

- General Purpose
- Hydraulics and Pneumatics
- Process Control
- P/I Process Signals
- Level Measurement

Operation

Setra Model 280E pressure transducers and C-280E pressure transmitters are intended for low to high pressure measurements of gases or liquids in applications requiring rugged packaging, high performance and affordability. Model 280E transducers provide a 0-5 VDC output and Model C280E is a true 2-wire, 4-20 mA output transmitter. The 17-4 PH stainless steel capacitance sensing element coupled with an IC-based



circuit assures excellent accuracy and long term stability. Low hysteresis and low temperature coefficients are also inherent in this construction.

Setra's patented variable capacitance sensor approaches the ultimate in design simplicity. A capacitor is formed between the sensor body and an insulated electrode plate. An increase in pressure causes a slight rounding of the diaphragm which decreases the capacitance.

The capacitance is detected and converted to a highly accurate DC electric signal by Setra's unique custom Integrated Circuit utilizing a patented charge-balance principle.

Pressure Ranges

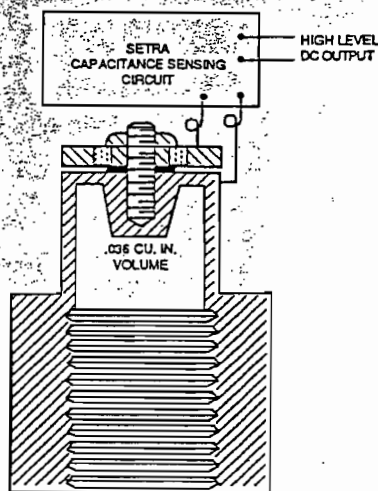
Gage Pressure psig	Absolute Pressure psia	Proof Pressure psi	Burst Pressure psi
0-15		25	75
0-25	0-25	50	150
0-50	0-50	75	200
0-100	0-100	150	500
0-250	0-250	375	1000
0-500	0-500	750	1500
0-1000	0-1000	1250	3000
0-3000	0-3000	3750	4500
0-5000	0-5000	6000	7500
0-10000		11000	12500
-14.7 to 35		75	200
-14.7 to 50		150	500
-14.7 to 100		150	500
3-15 (P/I) (C280E only)		25	75

Gage pressure: Pressure measured relative to ambient atmospheric pressure. Referred to as pounds per square inch (gage).

Absolute pressure: Pressure measured relative to high vacuum. Referred to as pounds per square inch (absolute) or psia.

Proof pressure: The maximum pressure that may be applied without changing performance beyond specifications ($\pm 0.5\%$ FS zero shift).

Burst pressure: The maximum pressure that may be applied to the positive pressure port without rupturing the sensing element.



U.S. Patent Nos. 3646538; 3859575; 3975719; 4093915; RE30603
Canada Patented (Brevete) 1974, 1975, 1976, 1979, 1980 and 1982
Mexico Patendo No. 141235

Model 280E/C280E Specifications

Accuracy Data

Accuracy ¹	< ± 0.11% FS at constant temperature	
Non-linearity	< ± 0.1% FS (best straight line)	
Hysteresis ²	< 0.05% FS (infinite resolution)	
Non-repeatability	< 0.02% FS	
Thermal Effects	30°F to 150°F range	
	(3-15PSI and 15 psig)	
Zero Shift (%FS/°F)	< ± 0.015	< ± 0.02
Span Shift (%FS/°F)	< ± 0.015	< ± 0.02

Environmental and Dimensional Data

Temperature	0°F to 175°F operating ⁴ -65°F to 250°F storage
Case	Stainless Steel with O-Ring seal
Vibration	2 g from 5 Hz to 500 Hz
Weight	5 ounces
Acceleration	10g maximum ⁵
Shock	50g operating
Pressure Cavity Volume	0.04 in. ³
Pressure Fitting	1/4"-18 NPT internal
Volume increase	5 x 10 ⁻⁵ in. ³ (at FS pressure)

Electrical Data

VOLTAGE OUTPUT (MODEL 280E)

Circuit	3-wire (common ground)
Excitation	Nominal 24 VDC, typically 15 to 32 VDC unregulated
Power Consumption	< 0.25 watts (approx. 10mA @ 24 VDC)
Full Scale Output ³	0-5 VDC, internally adjustable. Factory set to within ± 50 mV.
Zero Pressure Output	Internally adjustable to 0 mV. Factory set to within ± 50 mV.
Output Impedance	< 100 Ohms
Output Noise	< 100 microvolts RMS (0 Hz to 10K Hz)
Warm-up Shift (typical)	< ± 0.5% FS total; < ± 0.1% FS Residual shift after 5 minutes
Electrical Connection	One inch edge card with spade lugs and dust boot.

Notes:

- Accuracy as RSS of Non-linearity, Hysteresis and Non-repeatability.
- Units calibrated at nominal 70°F. Maximum thermal error is computed from this datum.
- Calibrated into a 50k ohm load; operable into a 5000 ohm load or greater.
- Operating temperature limits of the electronics only. Process fluid temperatures may be considerably higher or lower.
- Shift in output reading of < 0.05 FS/g typical, pressure port axis only.
- < 0.1% FS for 10,000 psi unit only.
- Lower excitation voltage available on request.

Specifications subject to change without notice.

CURRENT OUTPUT (MODEL C-280E)

Circuit	2-wire
Output	4-20 milliamperes
External Load	0 to 800 ohms
(Calibrated at factory using a 250 ohm load at 24 VDC.)	

Minimum supply voltage (VDC) = 18 + 0.02 x (Resistance of receiver plus line)

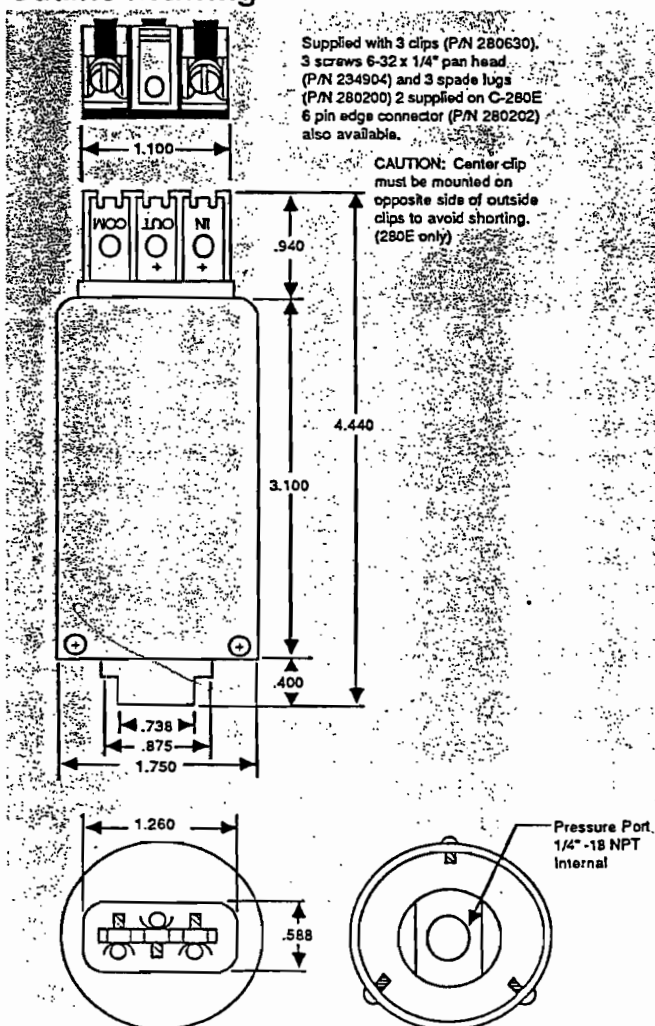
Maximum supply voltage (VDC) = 32 + 0.004 x (Resistance of receiver plus line)

Variations in the power supply cause less than 0.02 mA change in the transmitter's current output per volt change in the power supply.

Reverse excitation will not damage circuit

Electrical Connection One inch edge card with spade lugs and dust boot.

Outline Drawing



Note: All dimensions are shown in inches

Ordering Information

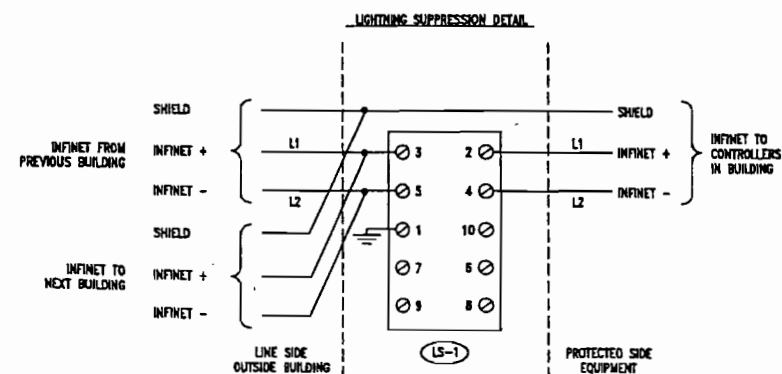
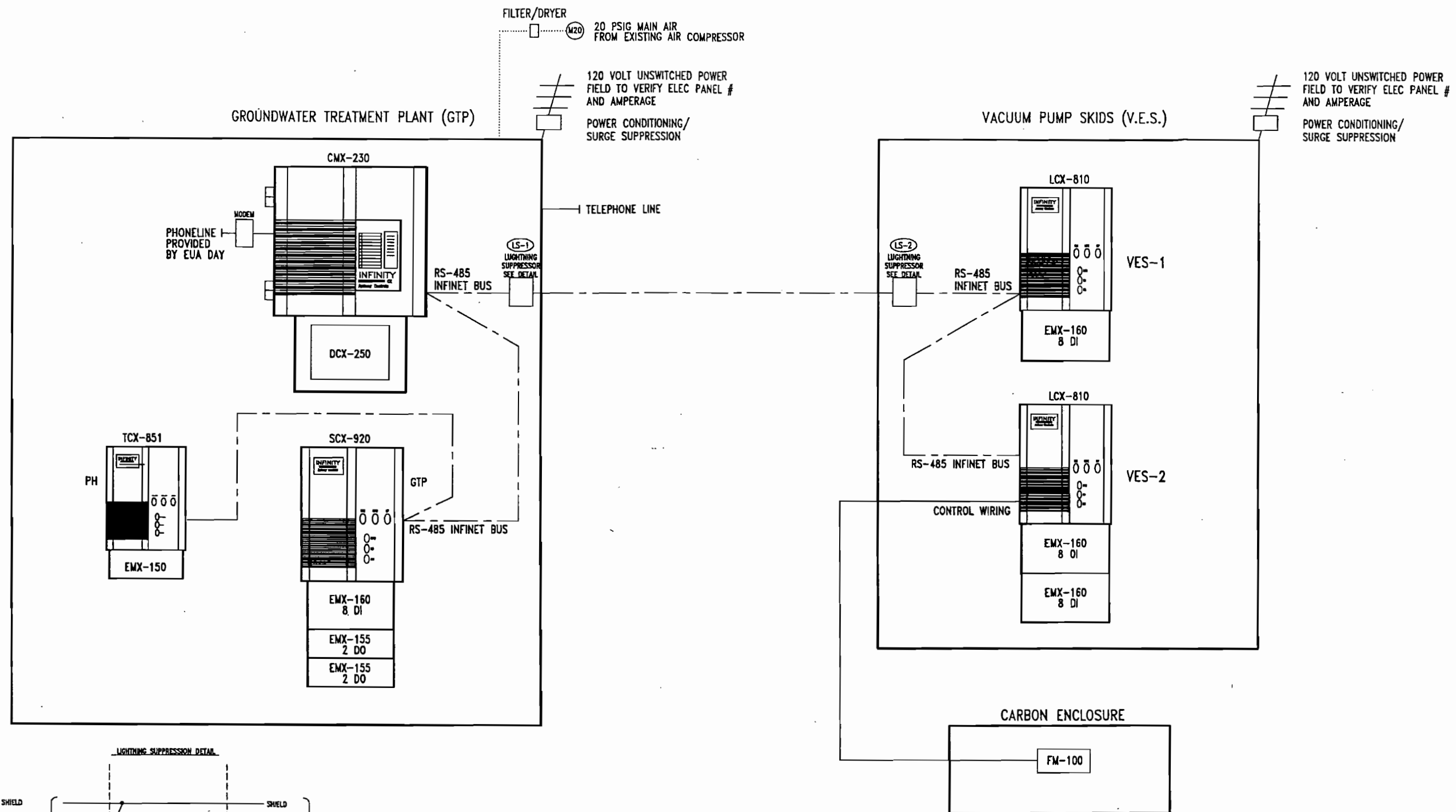
Order as Model 280E Pressure Transducer or C280E Pressure Transmitter.
Specify pressure range, noting gage, absolute or compound pressure.

XEROX CORPORATION
BLAUVELT SITE TELECOMMUNICATIONS

MICROPROCESSOR DATA ACQUISITION AND CONTROL SYSTEM INDEX

DRAWING NUMBER	DRAWING TITLE	EUA DAY CONTRACT NO.
94-17-00	MICROPROCESSOR DATA ACQUISITION AND CONTROL SYSTEM INDEX	94-17
94-17-01	MICROPROCESSOR DATA ACQUISITION AND CONTROL SYSTEM RISER	94-17
94-17-02	GROUNDWATER TREATMENT PLANT FIELD CONTROL DETAILS	94-17
94-17-03	PANEL #1 GROUNDWATER TREATMENT PLANT WIRING AND PIPING CONTROL DETAILS	94-17
94-17-04	V.E.S. 1 AND 2 FIELD CONTROL DETAILS	94-17
94-17-05	PANEL #2 V.E.S. 1 AND 2 WIRING CONTROL DETAILS	94-17

NOTES	7							 EUA Day 7931 RAE BOULEVARD VICTOR, NEW YORK 14564 PHONE: (716)924-4630 FAX: (716)924-4698	PROJECT	XEROX CORPORATION		
	6								DESCRIPTION	BLAUVELT SITE TELECOMMUNICATIONS		
	5									MICROPROCESSOR CONTROL SYSTEM		
	4									DRAWING INDEX		
	3								SCALE	NTS	DRAWING NO.	94-17-00
	2								DATE	04/05/94	DRAWN BY	SGE
	1	041394	CHANGES PER ENG REVIEW	DLB	SGE	DLB			ENG BY	SGE	APP BY	DLB
	NO.	DATE	REVISION RECORD		APPD	DRN	CKD					



EQUIPMENT LIST

DEVICE TAG	QUANTITY	PART NUMBER	MANUFACTURER	DEVICE DESCRIPTION
LS-1	02	013LC	IMCO	LOW-LOSS LIGHTNING SUPPRESSION MODULE

7					
6					
5					
4					
3					
2	041196	AS/BUILT RECORD REVISIONS	JBV	JNS	JBV
1	041394	CHANGES PER ENG REVIEW	DLB	SGE	DLB
NO.	DATE	REVISION RECORD	APPD	DRN	CKD

Eastern Utilities
EUA Day

7931 RAE BLVD. VICTOR, NEW YORK 14564
 PHONE: (716)924-4630 FAX: (716)924-4698

PROJECT	XEROX CORPORATION BLAUVELT SITE TELECOMMUNICATIONS			
DESCRIPTION	MICROPROCESSOR CONTROL SYSTEM RISER DIAGRAM			
SCALE	NTS	DRAWING NO.	94-17-01	
DATE	04/04/94	DRAWN BY	SGE	
ENG BY	SGE	APP BY	DLB	PROJECT MGR. MRF



Operation & Maintenance Manual

Carbonair Model STAT-180

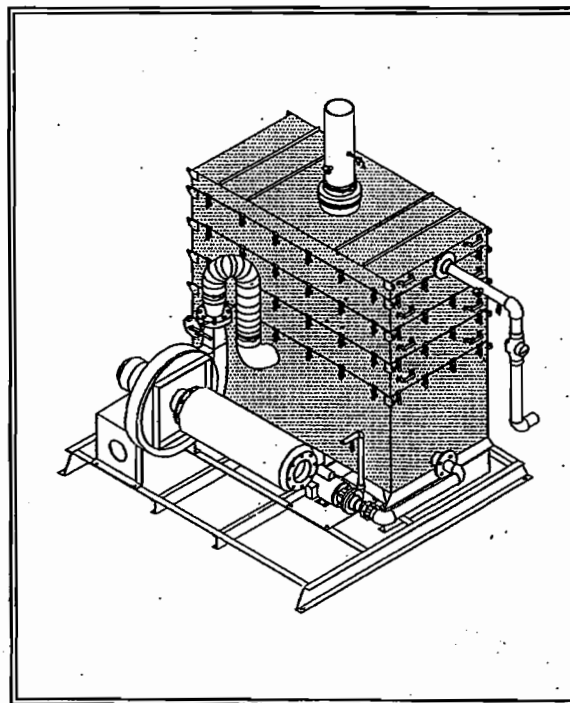
Low Profile Air Stripper

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	Fact Sheet #1-3	Attached

- Always wear gloves, eye protection & protective clothing when working with the equipment.
- Be sure the STAT is properly vented and the duct hose between blower and STAT is fastened securely.
- The introduction of free-product into the STAT-180 is not recommended because it will adversely affect any nonmetallic materials and system performance.
- Take time to record your specific operating parameters on page 16.

Figure No.1
Typical STAT Unit



1.0 SAFETY PRECAUTIONS

Failure to observe these precautions could result in serious bodily injury and/or property damage.

- Be sure to read and understand this O & M manual before beginning operation. If you have any questions, please call Carbonair Environmental Systems Inc. at (800) 526-4999.
- Be sure all electrical disconnects are "OFF" and locked out before servicing.

2.0 EQUIPMENT DESCRIPTION

The STAT-180 is a low profile stainless steel air stripper with a modular design capable of accommodating from 1 to 6 aeration trays. The design allows the trays to be easily removed, cleaned and replaced with minimal downtime. The following table summarizes the specifications for the typical STAT-180 low profile air stripper.

Table No.1
STAT-180 Specifications

#	Design Parameter	Specification
1	Tray Length	72 inches
2	Tray Width	36 inches
3	Height/Stage	10 inches
4	Overall Sump Height	24 inches
5	Demister Height	8½ inches
6	Maximum Height	92½ inches (6 trays)
7	Water Flow	10 - 200 gpm
8	Water Inlet	4 inch
9	Water Outlet	6 inch-Gravity Drain 3 inch-Pump Down
10	Air Flow	650 & 700 cfm
11	Air Inlet	8 inch
12	Air Outlet	12 inch

Be sure to refer to Section 12 at the end of this manual for specific operating parameters and dimensions.

The STAT-180 is equipped with the following standard system components:

- ✓ Pump-Down Collection Sump
 - Level Control Kit
 - Low, High, High-High Level Switches
- ✓ Gravity Drain Sump
 - Sight Glass
 - High Level Switch
- ✓ Aeration Trays
- ✓ Demister
- ✓ Blower

The STAT-180 can also be configured with the following optional components:

- ✓ Air Temperature Kit
- ✓ Air Flow Kit
- ✓ Water Flow Meter Kit
- ✓ Water Temperature Kit
- ✓ Sample Tap Kit
- ✓ Pump-Down Kit
- ✓ Blower Muffler Kit

3.0 PROCESS DESCRIPTION

Carbonair's STAT-180 air stripper is a sieve tray aeration unit and does not contain packing media.

In this technology the water and air are contacted in step-wise fashion through multiple trays. The water enters near the top and flows horizontally across each tray and through a downcomer to the tray below. A pressure blower provides air for the aerating process. The air enters the bottom of the unit and is forced through openings in the trays, bubbling through the water to form "a surface of foam" which provides extreme turbulence and excellent volatilization. The overall effect is a multiple counter-current contact of water and air, with each tray having a cross-flow of water opposing a vertical flow of air.

4.0 INSTALLATION

Be sure to carefully read all of the instructions before beginning the installation of the STAT-180 low profile air stripper.

4.1 Inspection

Upon receipt of the STAT unit, and before the unit is removed from the truck, be sure to inspect the system for damage to the shell, all the fittings, the inlet/outlet ports and the equipment. Structural damage to these items could compromise the integrity of the system.

DO NOT operate the unit if it has been damaged since this could result in damage to other equipment or personal injury. If the STAT-180 low profile air stripper sustains damage during transit, notify the carrier and call Carbonair immediately at (800) 526-4999.

4.2 Loading & Unloading Unit

The STAT-180 should be unloaded and placed by an appropriately sized crane, forklift, or pallet jack operated by an experienced operator. A STAT unit with one tray weighs approximately 1,500 pounds and a STAT unit with 6 trays weighs approximately 2,500 lbs - excluding external piping (*refer to Section 12.0 at the end of this manual*).

The STAT-180 must be placed on a level concrete pad designed to handle the full operating load of the unit (*refer to Section 12.0 at the end of this manual*). The STAT base should be bolted to the concrete pad prior to initiating operation.

Be sure to follow proper safety procedures when loading & unloading the STAT unit.

4.3 Connections

Assemble and mount all of the external piping, valves, and instrumentation after the STAT is in place. Make sure that the piping is adequately supported so that excessive load or torque is not placed on the unit fittings.

4.31 Mechanical Connections

1. Locate and anchor the STAT unit in an area which allows access to all sides of the unit. Shim as needed to make sure STAT unit is level.
2. Attach exhaust stack (or off gas downcomer if required). Avoid unnecessary restrictions in off-gas ducting. Ducting should be sized for minimal friction loss according to the STAT design air flow rate. When in doubt, ducting should match the size of the STAT air discharge.

3. Connect the influent water piping to the influent flange or coupling. We recommend installing a sampling tap (sample tap kit, part No. 128320) in the influent piping and discharge piping. All interconnecting piping should be self-supporting.

4. Install the drain piping and pump-down kit if supplied.

For gravity drainage, connect the effluent water discharge piping to the discharge flange or coupling. Discharge piping should be the same diameter as the effluent flange or coupling on the STAT unit, or larger (see Table No. 2)

Table No. 2
Minimum Pipe Size for Gravity Drain

DRAIN DIAMETER (INCHES)	SLOPE PER FOOT		
	1/8 INCH	1/4 INCH	1/2 INCH
2	16 gpm	21 gpm	26 gpm
2½	18 gpm	24 gpm	31 gpm
3	36 gpm	42 gpm	50 gpm
4	180 gpm	216 gpm	250 gpm
5	390 gpm	480 gpm	575 gpm
6	700 gpm	840 gpm	1,000 gpm

▣ IMPORTANT: *STAT gravity discharge lines require a vacuum relief system. This will prevent any type of vacuum on the float valve on the interior of the STAT. Do not attempt to pump out a STAT sump intended for gravity drain. A simple vacuum relief system is a tee inserted in the discharge piping with a vertical pipe open to the atmosphere. The tee should be installed as close as possible to the STAT discharge connection.*

5. If no skid base is provided, locate and anchor the blower anywhere near the STAT air inlet tube, as long as the supplied flex ducting will reach from the blower discharge to the STAT inlet tube without kinking. Mount the blower off the floor, if possible. Secure ends of the flex ducting with hose clamps.

4.32 Electrical Connections

Make the following electrical connections, observing codes or restrictions (such as explosion-proof wiring) at your installation site:

1. Connect sump high level switch to control panel (if not already wired). The sump high level switch is located near the top of the sump sidewall. The switch is normally open until sump flooding occurs.
2. Connect blower low pressure switch to controls (if not already wired). The blower low pressure switch is located either on the blower outlet pipe or in the control panel. The blower low pressure switch has the following three options:
 - ✓ Common
 - ✓ Normally Open
 - ✓ Normally Closed

See Operation for switch set-up.

3. For pump-down systems, a level control kit is provided in the sump sidewall (see options, page 14). This control must also be wired (if not wired already) in order to control the discharge pump. The switch options are:
 - ✓ Top (Red) System Shutdown
 - ✓ Middle (White) Pump On
 - ✓ Bottom (Black) Pump Off

All level switches are normally open when the sump is empty.

5.0 START-UP

Upon completion of the system installation, checkout and start-up of the unit can be initiated.

Before starting the unit, check the following:

1. Verify that the blower low pressure switch is calibrated before start-up.

If blower low pressure switch does not

operate as described, see the manufacturer's data sheet supplied to adjust the set point of the switch.

2. Jog the blower motor and verify proper rotation direction.
3. If a transfer pump is supplied, jog the transfer pump motor and verify proper rotation direction.

After the unit is checked-out, start-up can be initiated to verify system operations prior to full scale operation. Whenever possible, it is advisable to use clean, fresh water for system start-up. This will eliminate possible exposure to potentially hazardous contaminants if mechanical adjustments are required.

1. Verify that all the valves are positioned properly.
2. Start the STAT blower.

It is important to start the blower first to ensure that the contaminated water is treated immediately upon entering the STAT unit.

Because the STAT-180 uses a centrifugal type blower, it is important to start the blower under **LOAD** to minimize the motor in-rush current and reduce the subsequent rise in the motor winding temperature. To accomplish this, Carbonair has incorporated a flow restricting valve into the design which is preset to provide system back pressure to the blower during start-up.

The flow restricting valve is actuated by excessive air flow on start up of the blower. The valve throttles the flow to maintain the airflow below the recommended maximum of the unit. The valve then fully opens when it senses a sufficient amount of water in the STAT unit to create the desired back pressure and design flow rate. This reduces the start-up load on the blower motor and helps to extend the operating life of the unit.

3. Start the flow of clean water to the unit.

Stripping starts immediately as the downcomer blocking valve forces air into the processing area of each tray, preventing air from passing upward through the downcomer.

After flow is initiated, water enters the top demisting section and flows into the top tray. The water flows over the weir and gravity-flows across each successive tray in a serpentine pattern.

If the STAT unit is not equipped with a transfer pump, the water accumulates in the sump section and then gravity-drains to the discharge point through the mechanical float valve. The mechanical float valve prevents pressurized air to escape through the effluent flange.

If the STAT unit is set up for pump-out operation, a mechanical float valve is not used.

4. Immediately start the transfer pump to remove the treated water from the STAT sump (if supplied).
5. Check the system for leaks.
6. Check system pressures and equipment temperatures. Verify that the operating parameters are within equipment design specifications.
7. Measure the water and air flows to the unit.
8. Check the pressure drop across the trays and compare with the pressure drop chart in Section 10. Verify that the pressure drop is within system design guidelines.
9. Adjust air flows as necessary to optimize blower and system performance.

Air Flow Adjustment and Measurement

You must have a means of measuring air flow to correctly operate your STAT unit. Carbonair can provide you with an air flow kit (Part No. KI 132008) composed of a flow element, a

magnehelic gauge and tubing that when installed, provide a means of measuring the air flow through the system.

This STAT unit is designed to operate at the air flow rate specified in section 12.0 of this manual. **The blower air flow rate is not preset at the factory.** Varying field conditions and the sensitivity of the blower damper require that the damper be set in the field. Improper adjustment of the valve can lead to excessive water carry over in the exhaust stream as well as a lowered stripping efficiency.

To adjust the STAT operating air flow rate, first turn on the STAT blower and begin to introduce water into the system at the design flow rate. (Note: You must have a means of measuring the water flow rate (flow meter) on the influent line, down stream of any pumps). Once the system is accepting water at the operating flow rate note the measured air flow rate using the air flow kit. If the measured air flow rate is above or below the design air flow rate listed in Section 12.0, you must adjust the damper on the outlet of the centrifugal blower. Moving the damper towards the shut-off position will *decrease* the air flow through the unit. Moving the damper towards the open position will *increase* the air flow through the STAT.

Note: You must periodically check and adjust the air flow during the operation of the system. Conditions may change (like increase or decrease in water flow rates, addition of down stream air treatment technologies or fouling of the air stripper) that will increase or decrease back pressure in the blower and cause the air flow rate to deviate from the design flow rate.

6.0 OPERATION

When STAT is operating within its parameters, a base line pressure drop should be established. This can be monitored during operation for maintenance purposes. Your STAT system should be supplied with the proper blower for overcoming the total pressure drop through the system. If adding gas phase carbon adsorption to the off-gas of a STAT unit previously operated with atmosphere discharge, contact

Carbonair to determine if the current blower/ducting configuration will be adequate.

Once the system has been tested with fresh water, proceed with treating contaminated water.

7.0 TROUBLE SHOOTING

There are a few situations that may arise while operating the STAT-180 which can adversely effect the performance of the unit and/or result in abnormally high maintenance costs. If these situations cannot be resolved using the following trouble shooting guide, contact Carbonair at (800) 526-4999 for additional help.

1. Situation:

Excessive condensate or foam is noted leaving the exhaust of the STAT.

Probable Cause:

There are two main items that can cause water carry over into the exhaust:

- a. Air flow rate that is in excess of the rated air flow of unit.
- b. Surfactants in the water such as soaps, detergents and other organic compounds may cause a stable bubble froth to form and accumulate in the stripper.

Solution:

- a. Measure the air/water flows and compare with the design water and air flow rate of the system. If air flow is excessive, the flow should be adjusted to design conditions.
- b. It may be necessary to add a defoaming agent to influent water of the STAT. This agent will prevent stable bubble formation and allow the STAT to operate properly. Additional information is found in Fact Sheet #8. Contact Carbonair at (800) 526-4999 for information on defoaming agents.

2. Situation:

The pressure drop across the trays is higher at initial start-up than it should be according to the pressure drop chart in Section 10.

Probable Cause:

If this occurs, the flow of air through the tray holes is restricted. The most common causes for this pressure drop build up are:

- a. Sediment/solids in the water stream have clogged the holes in the aeration trays.

At initial start-up, sometimes there can be an excessive amount of solids introduced into the system from the well(s). Eventually, these solids are removed from the well(s) and cleaner ground water is produced.

- b. The flow of air through the STAT unit is greater than the system design specifications.
- c. The flow of water through the STAT unit is greater than the system design specifications.

Solution:

- a. Measure the air/water flows and check the pressure drop curve to determine the design pressure drop and compare with the actual pressure drop.
- b. If the flows are in excess of design specifications, adjust flows accordingly.
- c. If process flow adjustments have no effect, clean out the STAT unit and develop the well(s) further before introducing flow to the STAT unit.

3. Situation:

Deteriorating treatment performance.

Probable Cause:

Treatment performance can deteriorate for a number of reasons including:

- a. Inadequate air/water ratio resulting in poor volatilization of organic components.

- b. Influent contaminant concentrations higher than initial design parameters.
- c. Influent contaminant components different than initial design parameters.

Solutions:

- a. Verify that the system flows are within the design specifications.
- b. Verify that the air/water ratio is within design specifications.
- c. Clean the STAT trays.
- d. Conduct influent analyses to verify initial design parameters - components and concentrations.
- e. Call Carbonair for assistance if operating parameters have changed - system modifications may be necessary.

4. Situation:

The STAT sump high level alarm frequently trips due to high sump level conditions.

Probable Cause:

If the sump high level alarm trips, it means that the water is not being removed as quickly as it is accumulating in the sump. This could occur for the following reasons:

- a. The transfer pump has failed.
- b. The influent flow rate exceeds the effluent drainage or pumping capacity.
- c. The drain piping is not sufficiently sloped to adequately drain the sump.
- d. The effluent piping is plugged.

Solutions:

- a. Verify that the transfer pump is operating properly.
- b. Measure the influent flow rate and check the effluent drainage design to determine if the influent flow rate exceeds the effluent drainage system capacity.

- c. If the flow rate is within design specifications, clean the effluent piping to clear any blockages.

8.0 MAINTENANCE

There are several maintenance tasks which must be performed periodically to ensure continued, trouble free operation. These tasks are discussed in subsequent sections.

8.1 Disassembly

Read all installation instructions before beginning disassembly. Contact Carbonair for replacement parts.

1. Prior to disassembly of unit, turn off influent pump and allow blower to operate for a few minutes,

This will allow contaminated water within aeration plates to be treated as the unit drains.

2. When effluent flow has completely stopped, turn off blower and turn main power disconnects to the off position and lock them out.

Be sure that STAT is completely drained by removing plug at the bottom of sump.

3. Disconnect and remove air discharge stack or ducting from unit.

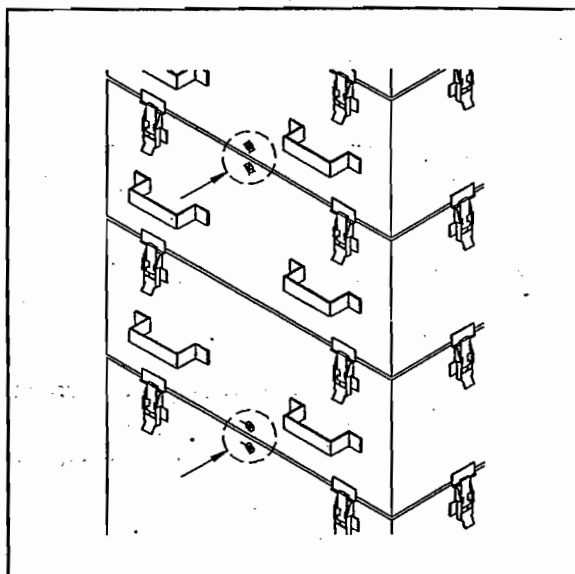
This procedure may not be necessary if space permits removal of the demister section with stack attached.

4. Disconnect the influent piping. Make sure loose influent piping is adequately supported.
5. Starting with the demister section, unfasten the lever-lock clips and lift off the demister section.

6. Before and during disassembly, it is important to note the placement of the aeration trays. Taking time to familiarize yourself with the STAT unit will make reassembly faster and easier.

Alignment of buttons on trays, sump and demister should be noted. Proper assembly of STAT requires alignment of buttons as shown in Figure No. 2.

Figure No. 2
Proper Alignment of STAT Buttons



7. The unit must always be disassembled piece by piece from the top down. It is recommended that removed pieces be set on wooden supports, such as a pallet, to avoid damage to the gasket sealing surfaces.
8. Each section must be raised a few inches prior to moving the piece horizontally.
9. Paying special attention to the placement of each aeration tray, remove each tray until only the sump section remains. Again, make note of proper alignment of buttons.
10. Once all aeration trays are removed, check the integrity of the gasket material.

11. When cleaning the demister section and aeration trays, be careful not to damage the gaskets. The mist eliminator pad may have to be cleaned with water pressure or cleaning solvent. If this is unsuccessful, the pad must be replaced.

12. The sump section should be cleaned in the same manner. Check the float valve gravity flow system in the sump section (if supplied) for plugging and material deterioration.

Check each tray downcomer valve for scale and bacteria build-up. Clean if necessary.

13. Prior to reassembly, make sure the areas that mate with the gasket material are clean and free of foreign matter.
14. While the unit is drained, remove the level float assembly from the sight glass (if pump out) and check for contaminant build-up and scaling. Completely clean the assembly to ensure proper operation.

The float assembly should be checked periodically even while the system is operating by viewing the floats through the sight glass. Do not remove the float assembly if the system is under pressure or the water level is above the sump.

8.2 Reassembly

1. To reassemble the unit, follow the disassembly instructions in reverse order. A light coating of silicone grease on the gasket surface before reassembly will act as an inert gasket sealant and lubricant. DO NOT use any other material for gasket sealant, as it may affect the operation of the STAT unit. If silicone grease or replacement gasket material is not available, contact Carbonair for supplies. Keep in mind that each piece **MUST** be put back in the same position and orientation as before disassembly. Improper assembly could cause malfunction or damage to the STAT unit. Refer to Figure No. 2 for button alignment.

2. Connect all inlet and outlet piping, discharge stacks, etc., prior to restarting unit.
3. Whenever possible, use clean, fresh water for system testing after reassembly. Start the blower first. Once blower is operating, start influent pump(s) or water flow.
4. After starting the influent pump(s), check for leaks throughout the system.

Refer to Operation of STAT, page 5.

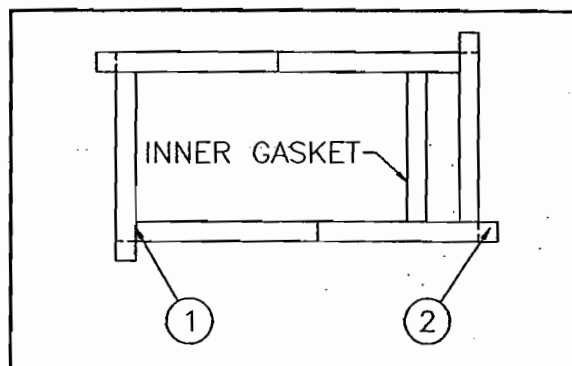
8.3 Gasket Replacement

1. Disassemble STAT, placing the trays gasket side up on clean surface. Observe corner pattern of gasket seal (Figure No. 2).
2. Using sharp putty knife, remove old gasket and as much adhesive as possible.
3. Tip trays upside down and remove silicone grease with putty knife, then mineral spirits. Repeat process on demister.
4. Remove remaining gasket fragments, adhesive residue, and leftover silicone grease with mineral spirits. Change cloths frequently. This should leave the surfaces clean. In some cases, however, patches of residue still remain on the flange. You must then "scuff" the flange surface as explained in step 5.
5. Prepare flange for new adhesive by "scuffing" the flange surface with a belt sander (40-50 grit belt). Run sander along lengths of flange. Use only light pressure as only a slightly roughened surface is all that is required.
6. Wash the flange area with denatured alcohol. This should remove all traces of mineral spirits or oil and leave the surface clean, dry and dust-free, as required.
7. Cut one set of gaskets (two ends, two sides and one inner piece) $\frac{1}{2}$ " longer than tray dimensions and square at the ends

(see Fig. No. 3). Position gasket strips on a flat surface, smooth sides down, porous sides up.

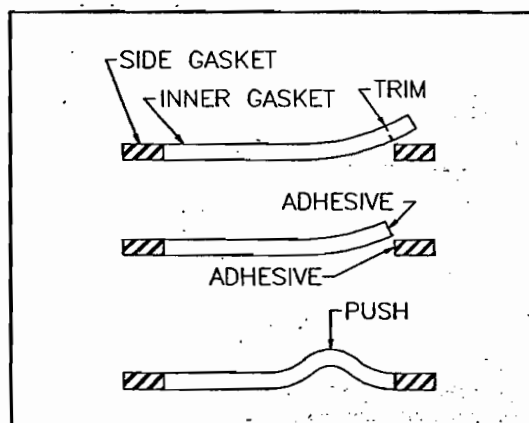
8. Apply a thin, uniform bead ($\frac{1}{4}$ " wide) of silicone adhesive (RHINO HYDE 100% Silicone RTV) to tray's flange surface.

Figure No. 3
Gasket Strips



9. Carefully position gasket onto flange (adhesive sides together), as shown in Figure No. 3. Do not pull or stretch gaskets. Trim overlaps as shown in Figure No. 4.

Figure No. 4
Installing Inner Gasket

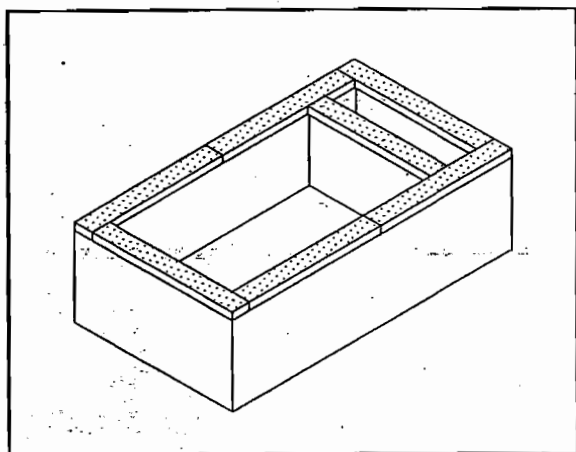


10. Position inner gasket strip with one end abutting side gasket; the other end overlapping opposite side gasket (Figure No. 4). Install abutting end by applying silicone adhesive on adjoining edges as shown in Figure No. 3. Press in place.

11. Trim overlapping end of inner gasket as shown in Figure No. 4, and apply adhesive to adjoining edges. Abut joining surfaces and press in place. The gasket material is extremely stretchy and may ripple somewhat, but small ripples can easily be pressed flat.

Figure No. 5 shows how the gasket should look when it is properly installed.

Figure No. 5
Trimmed Gasket on Flange



12. Allow 30 minutes to start adhesive set-up, then apply very thin layer of silicone (Dow Corning #111) to smooth side of gasket to strengthen seal between gasket and tray above.
13. STAT may be reassembled, but allow 24 hours to cure adhesive before system is started. (See Reassembly.)

8.4 Acid Cleaning

The need for cleaning a STAT unit is determined by an increase in pneumatic pressure drop and a decrease in air flow rate. The decrease in air flow rate will result in deterioration of stripping efficiency. This can be caused by the holes in the tray becoming clogged with bacterial or/and inorganic materials. These materials, e.g. calcium, magnesium, iron, and manganese, can be easily removed from the STAT unit with an acid solution.

Refer to the attached fact sheet for additional information on inorganic fouling in air strippers.

8.41 Equipment Set-up

Acid cleaning of a STAT unit involves a closed-loop recirculation of an acid solution between the STAT unit and a holding tank. From past experience, a 3% hydrochloric solution (10 gallons of muriatic acid solution in 100 gallons of clean water) has been found to be effective in cleaning STAT units. The pH of the cleaning solution should be below 1.0. A 50% sodium hydroxide (NaOH) solution is recommended for neutralizing the spent acid solution after the cleaning is accomplished. Table No. 3 shows the recommended minimum volumes of holding tanks and the volumes of acid solutions required for cleaning each STAT model.

Table No. 3
Minimum Holding Tank & Acid Volumes

Volume	Gallons
Holding Tank	400
Cleaning Solution	200
Muriatic Acid	20
50% Caustic Soda	12

Also given, are the minimum required amounts of muriatic acid and sodium hydroxide solutions. Please notice that the cleaning solution is recommended to fill only 50% of a holding tank. Its purpose is to reduce the chance of splashing the acid solution out of the holding tank.

If the discharge of total suspended solids (TSS) is regulated, a bag filter will be needed for removing the re-precipitated inorganic substances from the cleaning solution after being neutralized. A pore size of less than 1 micron is recommended for the bag filter.

8.42 Safety Precautions for Acid Wash

Check the acid and alkali compatibility of all the materials, such as pump, holding tank, pipes, valves, and flow meter. All the materials constructed in STAT units are acid resistant.

WARNING: *Always wear appropriate protective clothing when performing an acid wash, including: goggles, rubber gloves, coveralls, boots, etc.*

When working with acid, be sure to:

1. Follow all safety procedures when handling acid and alkali solutions.
2. Use a proper chemical handpump when transferring the acid and alkali solutions.
3. Install an easily accessible eye wash and shower at the site.
4. Prepare lime stone, soda ash, lime, or sodium bicarbonate for neutralizing the acid solution in case of spill.

8.43 Procedure

After the piping has been set up and the required materials have been prepared, the following procedure is recommended:

1. Fill 50% of holding tank with clean water.
2. Add a muriatic solution into the holding tank to make approximately a 3% acid solution (10 gallons of muriatic acid per 100 gallons of water).

WARNING: ***NEVER ADD WATER TO ACID.** Excessive heat is generated immediately upon contact creating a very dangerous situation. **ONLY ADD ACID TO WATER !!** Adding acid to water allows the heat of solution to be dissipated more effectively, safely and less violently.*

3. Start to recirculate the cleaning solution. A low recirculation flow rate is recommended in order to prevent the STAT unit from a flooding condition. A maximum recirculation flow rate of 40 gpm is recommended for the STAT-180. Past experience has shown that recirculation for about 2 hours will be sufficient for the acid cleaning. After 2 hours of recirculation, the pneumatic pressure drop across the STAT unit should significantly decrease.
4. Neutralize the spent cleaning solution by gradually adding, while recirculating, a 50% caustic soda solution into the holding tank to a pH of around 7.0. Be slow in adding the caustic soda solution since even a small excessive amount can abruptly increase the pH. Then you must add the acid solution to neutralize the cleaning solution. After neutralization, you should see the dissolved solids precipitate in the holding tank if the scale has been removed from the STAT unit.
5. Discharge the neutralized cleaning solution from the holding tank. The bag filter will be needed if the TSS removal is required by the regulation.

WARNING: *Before discharging the neutralized spent acid, be sure to check discharge permits requirements and/or other local regulations.*
6. Rinse the STAT unit by adding clean water into the holding tank with approximately the same volume as the cleaning solution. Recirculate the water for about 15 minutes. Discharge the rinsing water after neutralization. The STAT unit will be ready for a normal operation.
7. Do not forget to rinse all the equipment and clothing with clean water after using.

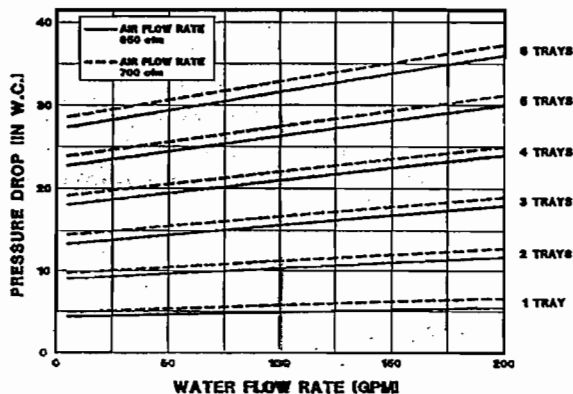
9.0 SPARE PARTS

When ordering spare parts, refer to the drawings at the end of this manual. Be sure to provide the unit model number and the complete description of the part.

10.0 PRESSURE DROP CHART

The following pressure drop chart shows the estimated pressure drop in inches of water at different liquid flow rates through the STAT-180 with 1,2,3,4,5, and 6 aeration tray configurations. These curves apply to STAT units with clean aeration trays.

Figure No. 6
Pressure Drops through a Clean STAT-180
at Different Water Flow Rates



11.0 DRAWINGS

Assembly drawings have been included on pages 12 and 14 to simplify the part identification and ordering process. A parts list is included along with the corresponding order number.

Figure No. 7
STAT-180 Low Profile Air Stripper - Exploded Assembly Drawing No.1

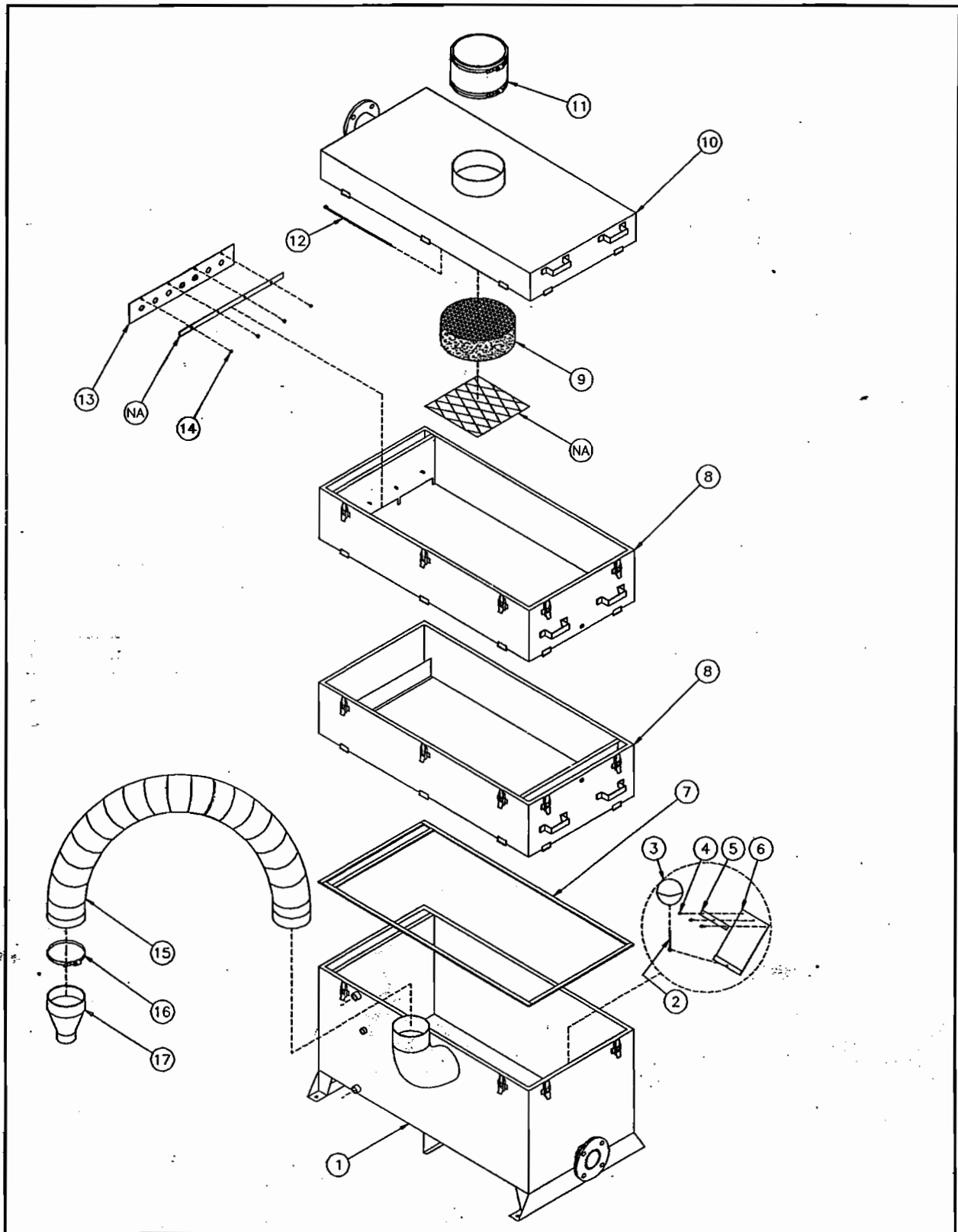


Table No. 4
STAT-180 Low Profile Air Stripper - Parts List & Order Numbers

[illegible]

Figure No. 8
STAT-180 Low Profile Air Stripper - Assembly Drawing No. 2

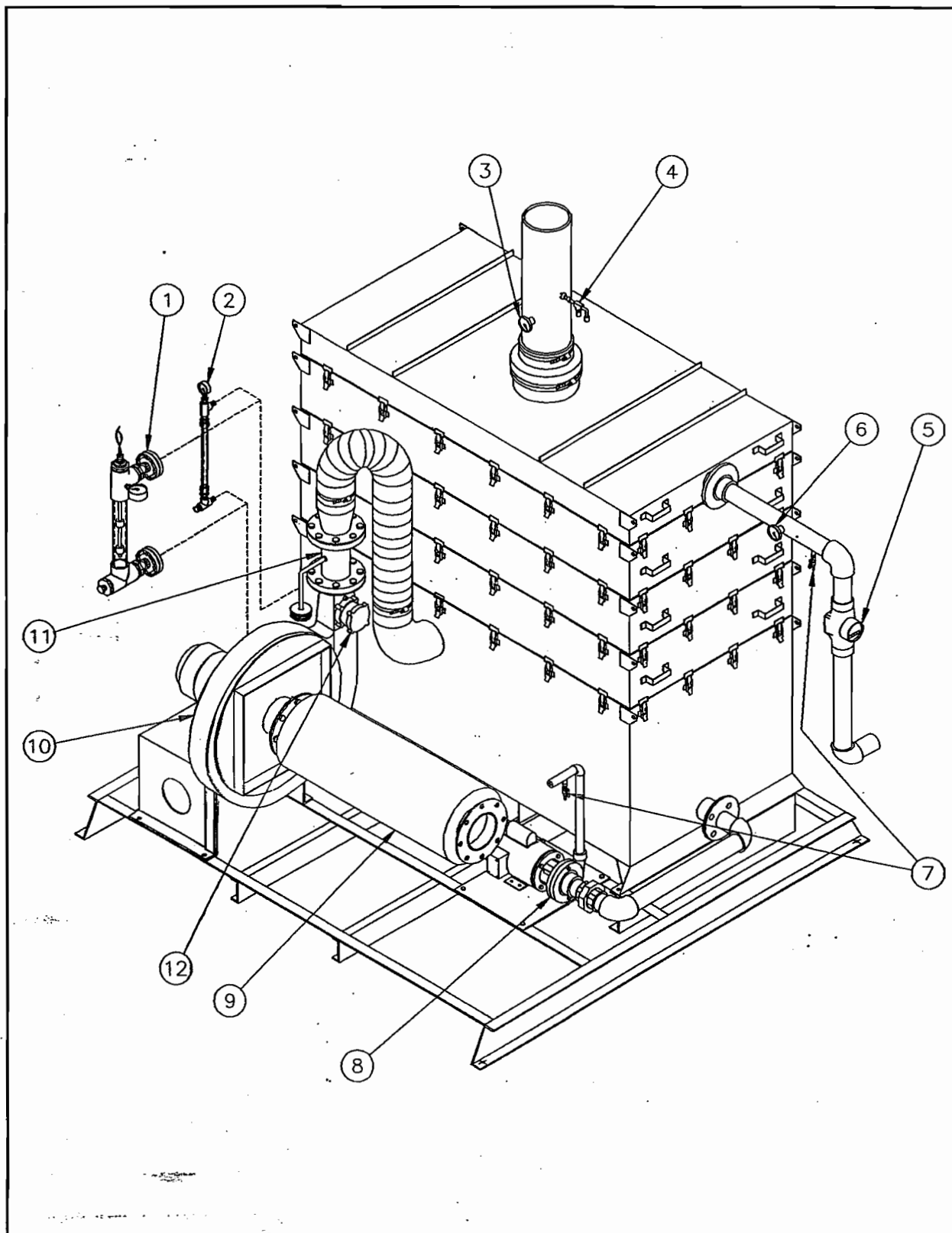


Table No. 5
STAT-180 Low Profile Air Stripper - Parts List & Order Numbers

[illegible]

12.0 SPECIFIC OPERATING PARAMETERS

Job 17505 shipped 3/97

Recommended Air Stripper

STAT 180

Serial Number

2169

Cross-Sectional Dimensions

Number of Plates

5 Tray

Design Liquid Flow Rate

150 GPM

Critical Compound

CIS, 1-2

Average Concentration

25 ppb

Effluent Concentration Requirement

< 1 ppb

Air Flow Rate

650 cfm

Air-to-Water Ratio

32:1

Control Panel Yes ☒ NO ☐

Rating: NEMA 4 Relay Logic

Water Discharge

Gravity

Pump Out ☒

Air Discharge

Atmosphere

Post Treatment

Blower Motor

HP

10

Phase

3

Volts

230-460

Rating

TEFC

Level Switch(es)

Standard

Explosion-Proof

Pressure Switch

Standard

Explosion-Proof

Mounting: Blower

Panel

OPTIONAL FEATURES INCLUDED:

Air Temperature Kit ☐

Sample Tap Kit ☐

Air Flow Kit ☐

Pump-Down Kit ☐

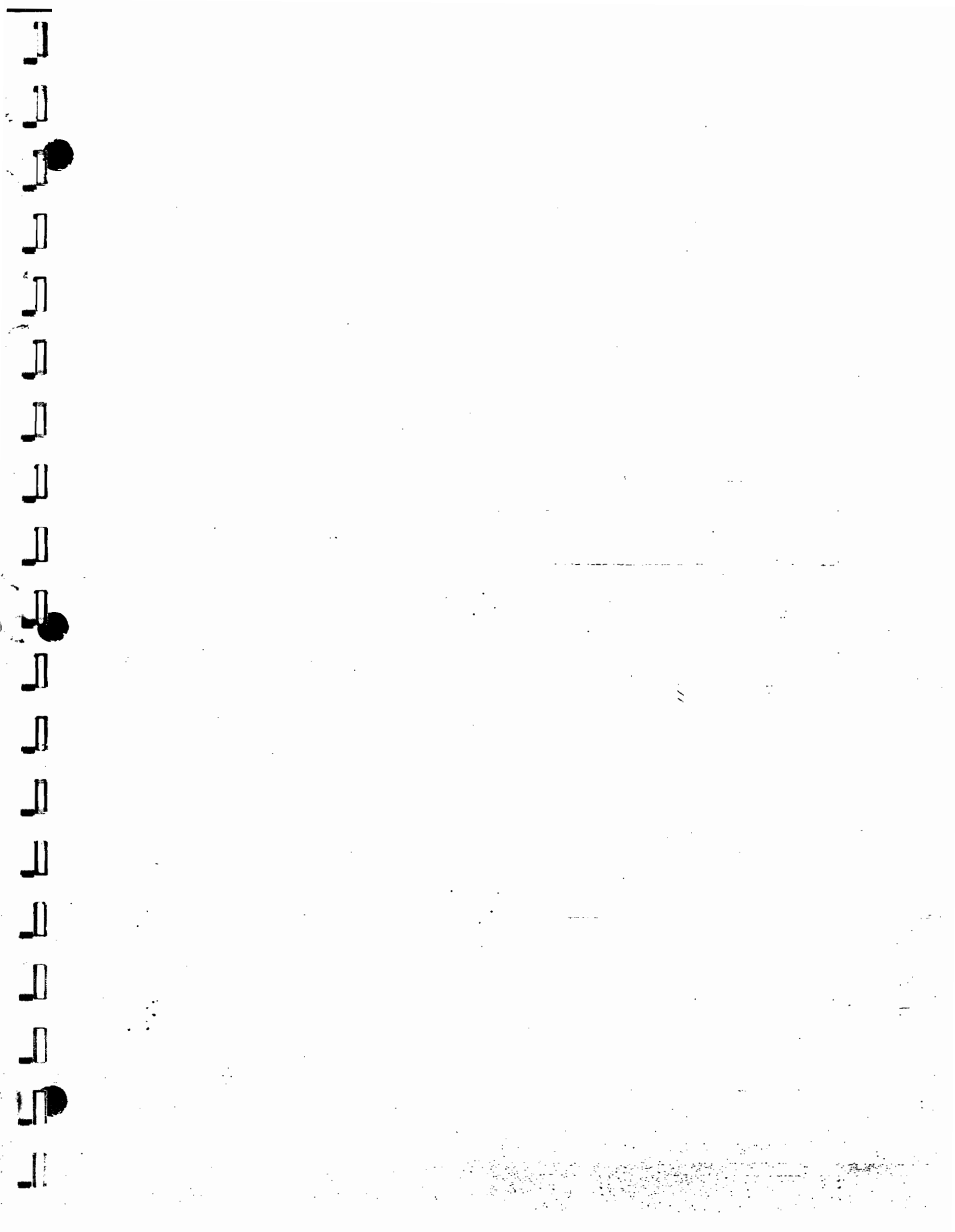
Water Flow Meter Kit ☐

Blower Kit ☐

Water Temperature Kit ☐

NOTES:

Panel mounted on skid & prewired to components





Carbonair Environmental Systems
8640 Monticello Lane
Maple Grove, MN 55369
612-425-2992 800-526-4999
Fax: 612-425-6882

10/16/96
13:40:39

-----STAT 180-----
VERSION 2.5
WATER FLOW RATE: 150.0 gpm
AIR FLOW RATE: 650.0 cfm
WATER TEMPERATURE: 55.0 F
AIR-TO-WATER RATIO: 32:1

Influent Conc. for TETRACHLOROETHENE 5.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	66.81315	1.6593	0.1044	0.0060
2	88.61766	0.5691	0.1385	0.0080
3	96.05299	0.1974	0.1501	0.0086
4	98.62614	0.0687	0.1541	0.0089
5	99.52116	0.0239	0.1555	0.0090
6	99.83303	0.0083	0.1560	0.0090

Influent Conc. for CIS-1,2-DICHLOROETHENE 25.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	52.89711	11.7757	0.4133	0.0238
2	75.97931	6.0052	0.5936	0.0342
3	87.29201	3.1770	0.6820	0.0393
4	93.15133	1.7122	0.7277	0.0419
5	96.27301	0.9317	0.7521	0.0433
6	97.96119	0.5097	0.7653	0.0441

Influent Conc. for TOTAL VOCs 30.0 ppb

NO OF TRAY	REMOVAL EFF %	EFF CONC ppb	OFF-GAS CONC ug/l	AIR EMISSION lb/d
1	55.21645	13.4351	0.5177	0.0298
2	78.08570	6.5743	0.7321	0.0422
3	88.75217	3.3743	0.8321	0.0479
4	94.06380	1.7809	0.8818	0.0508
5	96.81437	0.9557	0.9076	0.0523
6	98.27316	0.5181	0.9213	0.0531

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FACT SHEET #2

Sieve Tray Air Strippers: Performance & Selection Criteria

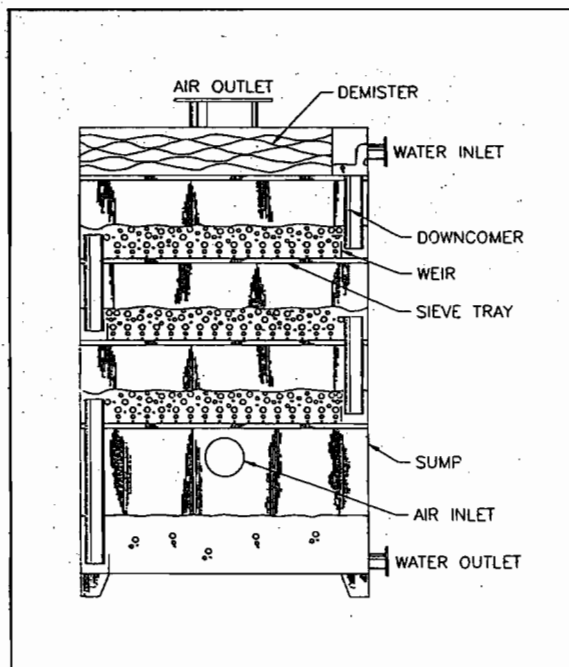
For decades, sieve tray columns have been used for distillation in chemical process industries. The same design principle has been recently utilized by several environmental remediation manufacturers to develop sieve tray air strippers. A sieve tray air stripper offers a much lower height than a conventional packed column. The low profile configuration yields numerous advantages such as unit compactness, inconspicuous appearance, rapid installation, easy mobilization and easy maintenance. The demand for sieve tray air strippers for environmental remediation has, therefore, increased dramatically in past few years. The purpose of this article is to present an overview of sieve tray air strippers with respect to structure and performance, as well as criteria for choosing between sieve tray and packed column air strippers.

STRUCTURE

In sieve tray air strippers, water and air are contacted in a step-wise fashion in multiple chambers as shown in Figure No.1. The water enters at the top and flows across each chamber or tray. The air flows upwards through perforated holes into a layer of water on each tray, forming numerous small bubbles or froth. The frothing provides an excellent condition for the volatilization of organic contaminants. Since the water flows horizontally across each tray, the required removal efficiency can be achieved by increasing the length or width of the trays, instead of the height of the air strippers, to maintain the low

profile configuration. The total height of a sieve tray air stripper is typically less than 10 feet.

Figure No. 1
Sectional View of Sieve Tray Air Stripper



As shown in Figure 1, the unit comprises a stack series of intermediate stripping chambers "trays," a top chamber "demister," and a bottom chamber "sump." The trays are typically rectangular due to the ease of fabrication although other configurations may be used. Fabrication is preferably of stainless steel or plastic for durability and chemical compatibility.

Water is conveyed into the tray below through a "downcomer," which may consist of a single conduit or a series of pipes. The stripping area is provided along the trays between the inlet and outlet downcomers. The top portion of the downcomer above the trays, is designed to maintain the height of the water in the processing area. The sump functions to collect treated water and includes an air inlet, to which a source of pressurized air, e.g., a blower, is connected. The top chamber contains an air outlet and a demister, which can be made of fiberglass, plastic or metal mesh. The purpose of the demister is to capture the entrained water from the exhausted air stream "off-gas."

PERFORMANCE

Hydraulically and pneumatically, there are minimum and maximum water flow rates, as well as minimum and maximum air flow rates, which can be applied to each sieve tray air stripper. When the water flow rate is excessively high, water will not flow easily through the downcomers. This causes a hydraulic upset known as "downcomer flooding." Under a downcomer flooding condition, the water is unable to flow downward through the unit. The water eventually overflows through the demister and exits through the air outlet.

When the water flow rate is relatively low, the water will partially flow through the downcomers, allowing a portion of air to bypass through the downcomers instead of flowing upwards through the holes on the trays. The bypassing of the air will result in the loss of pneumatic pressure within the trays, which will allow the water to drip through the perforated holes, a phenomenon known as "weeping." With excessive weeping, the water level on each tray will not be fully developed to the height of the weir. Weeping is undesirable in sieve tray air strippers because it will cause water to exit the unit faster and therefore reduce the time of contact between water and air. Weeping can also occur when the air flow rate is too low to provide a sufficient pneumatic

pressure to retain the water on the trays. When the air flow rate is excessively high, the air will disperse most of the contaminated water into droplets, which will overload the demister and exit the unit through the air outlet. This phenomenon is called "entrainment flooding." Consequently, a sieve tray air stripper is designed to operate at a constant air flow rate or a narrow range of air flow rates in order to avoid weeping and flooding conditions.

Figure No. 2
Removal Performance
of a Sieve Tray Air Stripper

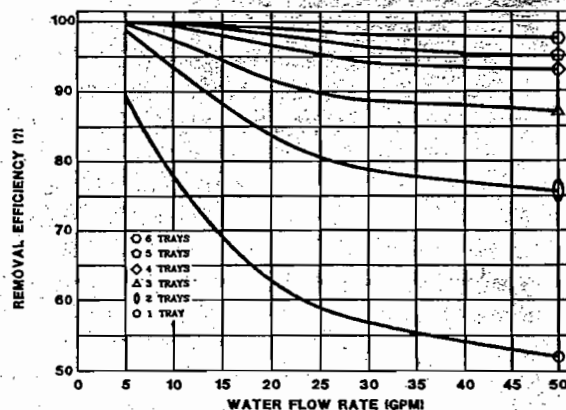


Figure No. 2 shows the removal performance for a sieve tray air stripper designed for a maximum operating flow rate of 50 gpm. With the same number of trays, the removal efficiency decreases as the water flow rate increases. This is due to the fact that the air-to-water ratio, to which the removal efficiency is directly proportional, decreases when the water flow rate increases while the air flow rate is maintained constant. It can also be seen from Figure No. 2 that the removal efficiency decreases more slowly at a water flow rate above 20 gpm. As the water flow rate increases, the froth height or liquid hold-up on the trays will also increase, extending the contact time between the water and the air. The influence of the liquid hold-up on the

removal efficiency is more pronounced at a higher flow rate. Beyond 500 gpm, the liquid hold-up will excessively increase until a flooding condition occurs.

A computer model can be developed to predict the performance of a sieve tray air stripper for different water flow rates, temperatures, types and concentrations of contaminants. By knowing the water flow rate, temperature, influent concentration of each contaminant and discharge criteria, the optimum size and number of trays can be determined.

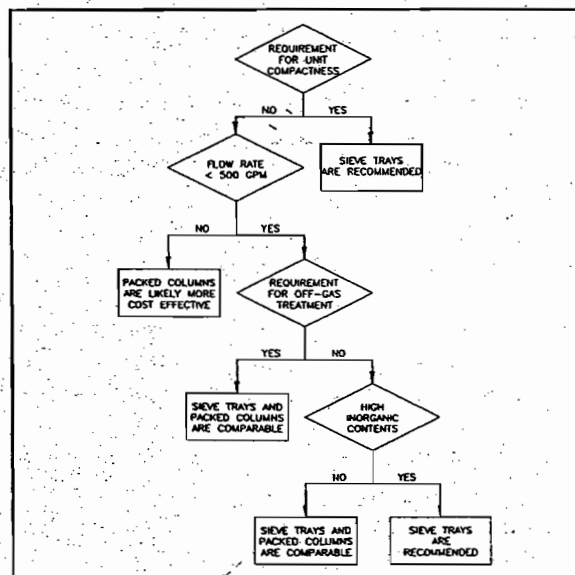
CRITERIA FOR SELECTION

Low profile air strippers can be classified into two major types: sieve tray and diffused chamber. A diffused chamber air stripper consists of a series of chambers. Air is introduced at the bottom of each chamber through diffusers which may be constructed of perforated multiple tubes, orifice plates, or porous media. Each chamber requires a separate air stream in a diffused air stripper, whereas only one air stream is forced through all the stacked trays in a sieve tray air stripper. The air consumption for the former is therefore typically much higher than that for the latter. Diffused chamber air strippers are, however, less complex in design and less expensive. The mass transfer efficiencies of diffused chamber air strippers will depend upon the types of diffusers used. Very fine-bubble diffusers are expensive and tend to foul easily. With poorly-designed inexpensive diffusers, more chambers and a higher air flow rate will be required, resulting in much higher capital and operating costs than those for a sieve tray air stripper. A diffused chamber air stripper is normally comparable to a sieve tray air stripper when a low removal efficiency and no off-gas treatment are required.

To choose between sieve tray and packed column air strippers, the following criteria should be considered: requirement for unit compactness, flow rate, requirement for off-gas

treatment, inorganic contents in the water stream, capital and operational costs. Figure 3 shows an algorithm recommended for choosing between sieve tray and packed column air strippers. A sieve tray air stripper is recommended for an application requiring unit compactness, inconspicuous appearance, or a mobile trailer system. When unit compactness is not required, sieve tray air strippers are normally recommended when flow rates are below 500 gpm. For a flow rate greater than 500 gpm, a large sieve tray air stripper or several units operating in parallel will be required, resulting in high capital and operating costs. It is typically less expensive to fabricate a large packed column air stripper than large or multiple sieve tray air strippers. For 500 gpm and 99% removal of benzene, for instance, a packed column air stripper system will cost approximately \$40,000 whereas a sieve tray air stripper system will cost over \$100,000.

Figure No. 3
Criteria for Choosing between
Sieve Tray and Packed Column Air Stripper



As shown in Figure 3, sieve tray air strippers are recommended when the flow rate is lower than 500 gpm, the treatment of off-gas is not regulated, and when the contaminated water

contains high inorganics, such as iron and hardness. Lower fouling potential is experienced in sieve tray air strippers than in conventional packed tower air strippers since they contain no packing media and provide an extremely turbulent flow condition. It is also much easier to disassemble, clean, and reassemble a sieve tray air stripper than a packed column air stripper.

When the flow rate is lower than 500 gpm and off-gas treatment is required, packed columns and sieve tray air strippers are comparable. The analysis of capital and operating costs should be performed to select the most cost effective treatment system. When carbon adsorption is the best technology for treating the off-gas, the capital costs will include the air strippers and vapor phase carbon adsorbers while the operating costs will include the carbon replacement and power consumption.

The carbon usage rate mainly depends upon the air flow rate used for the air stripper. For the same water flow rate and contaminant level, the carbon usage rate will decrease when a lower air flow rate is used. The lower air flow rate yields more concentrated off-gas which can be more efficiently treated by vapor phase carbon. The air flow rate for a packed column air stripper can be decreased by increasing the packing height; however, the increased height will add to capital cost. A cost analysis will determine the most cost effective system.

In regard to the power consumption, a sieve tray air stripper normally requires a higher horsepower blower than a packed column air stripper. In a sieve tray air stripper, the air must be forced through multiple trays, each with typically 2 to 6 inches of water layer. A pressure drop of up to 40 inches W.C. can be seen in a sieve tray air stripper, whereas a pressure drop under 10 inches W.C. is typical in a packed column air stripper. At 300 cfm, for instance, a 5-hp blower will be required for a sieve tray air stripper while a 2-hp blower will be required for a packed column air stripper for the same removal efficiency.

CONCLUSIONS

Because of their low profile configurations, the demand for sieve tray air strippers for environmental remediation has dramatically increased. Sieve tray air strippers are very attractive for the applications where unit compactness, a water flow rate of below 500 gpm, and no off-gas treatment are required. A sieve tray air stripper should also be considered when the contaminated water is expected to cause a serious fouling problem for a packed column air stripper.



FACT SHEET #8

Air Stripping: Factors Adversely Affecting the Performance

The following factors can adversely affect the air stripper performance and should be taken into consideration when an air stripper is being designed or is not meeting the design performance.

FOULING

Fouling in an air stripper can be caused by high concentrations of dissolved salts and/or high biological activity in the process water. The fouling can adversely affect the air stripper performance by causing a rise in the pneumatic pressure drop and, in turn, a reduction in the air flow rate. It is recommended that the interior of an air stripper be cleaned when the pressure drop across the unit is increased by 30%. Cleaning with a 5-10% acid solution has been found to be an effective solution. Acid cleaning will take a much longer period of time or may not be possible when a packed tower air stripper has been left severely fouled. In that case, replacement with new packing media may be necessary.

FREE PHASE PRODUCTS

Free phase products are defined as organic contaminants which are present in water in an insoluble phase. Free phase products can be classified into two groups: LNAPLs (light non-aqueous phase liquids) such as oil and grease, and DNAPLs (dense non-aqueous phase liquids) such as chlorinated solvents, creosote, coal tar,

and PCBs.

Air stripping is effective in removing volatile contaminants only when they are in a soluble phase. Contaminants in an insoluble free phase will stay in globules, only the surface of which has the ability to become solubilized and then transfer from the liquid phase into the vapor phase. Large diameter globules may not become completely solubilized and stripped before leaving the air stripper.

HIGH CONCENTRATIONS

Most air stripping models are developed based on a linear air/water equilibrium equation, called Henry's law. Henry's law is strictly valid when a contaminant is present at a low concentration, normally below 30% of its solubility. When the concentration is approaching the solubility limit, its vapor pressure no longer increases linearly with the concentration, but rather becomes flattened out, resulting in a drop in strippability. Furthermore, free phase products are also likely to be present in water when the concentrations are relatively high. An air stripper should be sized with a larger safety factor when a high concentration situation is encountered.

CO-SOLVENCY

Some organic compounds, such as alcohols and ketones, have much higher capabilities of solubilizing organic contaminants than water. Examples of alcohols are ethanol, methanol and propanol and examples of ketones are acetone, methyl ethyl ketone and methyl isobutyl ketone. When these compounds are present in the process water, they will behave as co-solvents, causing an increase in solubility and a reduction in strippability of a target compound. The effect of co-solvency becomes critical when a co-solvent concentration exceeds 10% of the target compound solubility. In that case, Henry's law constants should be modified to account for the effect of co-solvency in the model calculations.

SURFACTANTS

Surfactants are compounds which can change, normally lower, the interfacial tension between water and an adjacent non-aqueous phase. Surfactants found in contaminated water may be derived from household or industrial uses (such as soaps, detergents, dispersants, and emulsifiers) or from natural decomposition of animal proteins (such as fatty acids).

Surfactants can adversely affect the air stripper performance by increasing the solubility and reducing the strippability of the target contaminants. Surfactants can also reduce the interfacial tension between water and packing media in packed towers. The decreased surface tension causes the water to move faster through an air stripper and consequently reduces the contact time for air stripping. Surfactants can also produce long lasting foams on packing media. This will greatly reduce mass transfer because some of the air stream will be trapped inside the bubbles, resulting in additional resistance to mass transfer.

In a low profile air stripper, surfactants may cause the froth level on each tray to be high enough to contact the contaminated water on the tray above. Upon contact, the water on the tray above can bypass the treatment process by dripping through the perforated holes.

In a severe case, surfactants can produce an excessive amount of foam which will be blown out through the off-gas stack. This phenomenon is called flooding. In cases where flooding caused by a surfactant inhibits the operation, an anti-foaming agent can be added to the water prior to the air stripper to prevent excessive foaming. There are several types of commercial anti-foaming agents; however, silicone types are most commonly used for aqueous systems. A dosage of less than 50 ppm has been found to be effective in preventing excessive foaming, in most cases. Some of the silicone-type anti-foaming agents have been approved for direct addition to foods for human consumption and involve no hazard to the public health.

When an antifoaming agent is being used for a sieve tray air stripper, it should be realized that the antifoaming agent will also suppress frothing and reduce the mass transfer efficiency. The optimum dosage of an antifoaming agent is the dosage that is just high enough to prevent the air stripper from flooding and must be determined by field experiments because a high dosage of an antifoaming agent will significantly reduce the removal efficiency.

FREEZING

Freezing can cause a problem for an air stripper by partially or completely plugging the interior of the air strippers distributors, mist eliminators, packing media, packing supporters, and/or ducting. Normally freezing will not occur when an air stripper is continuously operated at an air-to-water ratio of less than 200:1. For most groundwater remediation, changes in water temperature due to heat transfer to the air in the air stripper is typically less than 5°F. This is due to the fact that the heat capacity and density of water is much higher than that of air, and therefore a relatively high air-to-water ratio will be required to cool the water below the freezing point.

Freezing is possible when an air stripper is operated at a very high air-to-water ratio. High air-to-water ratios are required for the removal of difficult to strip compounds such as ammonia and ketones. Freezing can also occur where an air stripper is to be operated intermittently and the water remaining within the air stripper is allowed to freeze during the non-operating period.

When an air stripper is operated at a high air-to-water ratio, it is recommended that the air stream be heated to avoid freezing. Heating of the water stream is not recommended because the power consumption required for heating the air stream is usually lower than that required for heating the water stream. Heating of the water stream will increase the temperature gradient between the water and air streams, causing a higher heat loss due to evaporation. Heating of the air stream can be also used to melt the ice within the air stripper when an air stripper has frozen.





FACT SHEET #3

Inorganic Fouling in Air Strippers: Mechanisms & Prevention

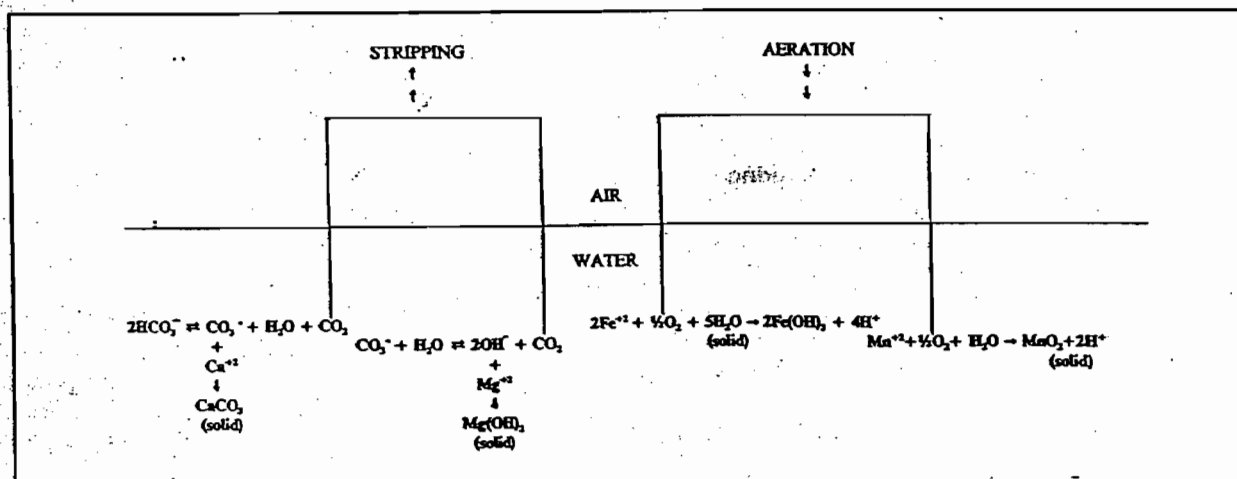
CAUSE

Fouling in air strippers is typically caused by precipitation of inorganic material such as hardness (mainly calcium and magnesium), iron and manganese. The hardness of groundwater varies considerably from place to place. Groundwater is commonly classified in terms of the degree of hardness, as follows: soft (0-75 ppm), moderately hard (75-150 ppm), hard (150-300 ppm) and very hard (greater than 300 ppm). The occurrence of iron in groundwater at concentrations of 1-10 ppm is common; however, higher concentrations of up to 50 ppm have been found in some cases. Manganese is often present with iron in groundwater at concentrations of 0.1-1 ppm. Since the concentration of iron is always much higher than the concentration of manganese, fouling in

air strippers is caused more by the precipitation of iron than manganese.

In the air stripping process, carbon dioxide, together with, volatile organic chemicals (VOCs); will be removed from water, causing an increase in pH. As the pH increases, the form of alkalinity will change from bicarbonate to carbonate, and from carbonate to hydroxide. If the water contains an appreciable amount of calcium and magnesium, calcium will precipitate in a carbonate form, and magnesium will precipitate in a hydroxide form. Iron and manganese will precipitate due to the aeration in the forms of iron hydroxide and manganese oxide. Figure No. 1 below illustrates the chemical reactions involved in inorganic fouling during the air stripping process.

Figure No. 1
Chemical Reactions Involved in Inorganic Fouling in Air Strippers



There are three common approaches for the prevention of inorganic fouling in air strippers: 1) enhancing the precipitation rate entering an air stripper, 2) supersaturating the precipitation by adding acid to maintain low pH, and 3) supersaturating the water and providing a nucleation site.

[illegible]

One of the advantages of using sequestering agents is that no sludge will be produced due to the inorganic precipitation, and the capital cost can be significantly reduced because there is no need for a settling tank and media filters. However, using an acid as a sequestering agent for water with high concentrations of hardness and iron, may require an excessive amount of acid. Also, the use of a strong acid for a sequestering agent requires the transportation, storage, and handling of a hazardous material. Also, air strippers, which are constructed of stainless steel or aluminum, may not be compatible with the long-term exposure to an

[illegible]

The general guidelines for preventing inorganic fouling in air strippers are as follows:

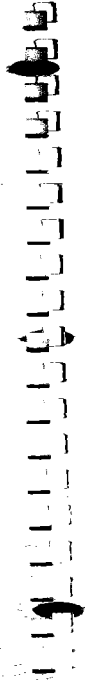
Air strippers are expected to operate for a long period of time (over a year). No preventative measures are necessary; however, an annual inspection of the interior of the air strippers is recommended. An acid cleaning may be necessary when appreciable inorganic build-up is found.

Air strippers are expected to operate for at least half a year. No preventative measures are necessary. Periodic cleanings are more economical than the continuous addition of preventative chemicals. It is recommended that the

interior of the air strippers be inspected every six months. An acid cleaning is recommended when appreciable inorganic build-up is found.

Hardness > 300 ppm and/or Dissolved Iron > 5 ppm

Air strippers are expected to operate for less than half a year and may foul very rapidly. A sequestering agent, preferably polyphosphate, is recommended. An acid should only be used under the following conditions: 1) the use of polyphosphates is not allowed by regulation, 2) the air stripper is constructed of materials compatible with acid and 3) hardness is below 500 ppm and/or iron is below 10 ppm. When the use of a sequestering agent, either polyphosphate or acid, is not practical, the removal of hardness and iron by chemical precipitation and filtering is recommended prior to air stripping.





The
New York Blower
Company®

7660 QUINCY STREET — WILLOWBROOK, ILLINOIS 60521-5596

**INSTALLATION
MAINTENANCE,
OPERATING
INSTRUCTIONS**

IM-140

PRESSURE BLOWERS

CAUTION

THIS MACHINE HAS MOVING PARTS THAT CAN CAUSE SERIOUS BODILY INJURY. BEFORE OPERATING OR PERFORMING MAINTENANCE, THE FOLLOWING PRECAUTIONS MUST BE TAKEN.

- 1. MAKE SURE ALL MOVING PARTS ARE SHIELDED FROM PERSONNEL AND FALLING OBJECTS.**
- 2. READ THE INSTALLATION AND MAINTENANCE INSTRUCTIONS, AS WELL AS THE RECOMMENDED SAFETY PRACTICES MANUAL FURNISHED WITH THIS UNIT.**
- 3. DO NOT OPERATE AT SPEEDS OR TEMPERATURES HIGHER THAN PUBLISHED FOR THE SPECIFIC OPERATING CONDITIONS FOR WHICH THE MACHINE WAS PURCHASED.**

A FAILURE TO TAKE THESE PRECAUTIONS COULD RESULT IN SERIOUS BODILY INJURY AND PROPERTY DAMAGE.

98-0250

A WORD ABOUT SAFETY

The above **CAUTION** decal appears on all **nyb** fans. Air moving equipment involves electrical wiring, moving parts, 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 The New York Blower Company, 7660 Quincy Street, Willowbrook, IL 60521-5596.

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.

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.

ACCESS DOORS

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

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.

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 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 dampers 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 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 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.

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.

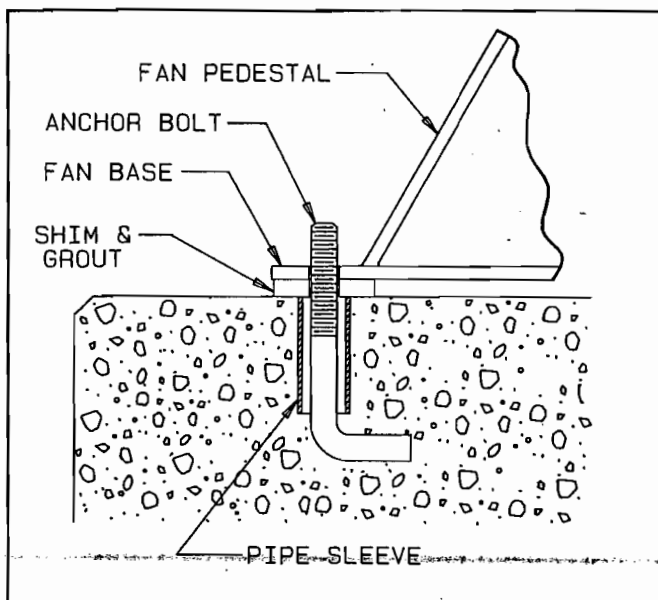


Figure 1
V-BELT DRIVE

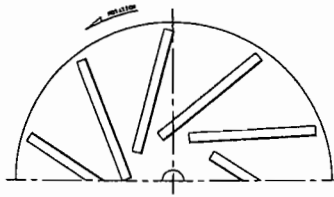
Installation

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 crocus 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 faces 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.

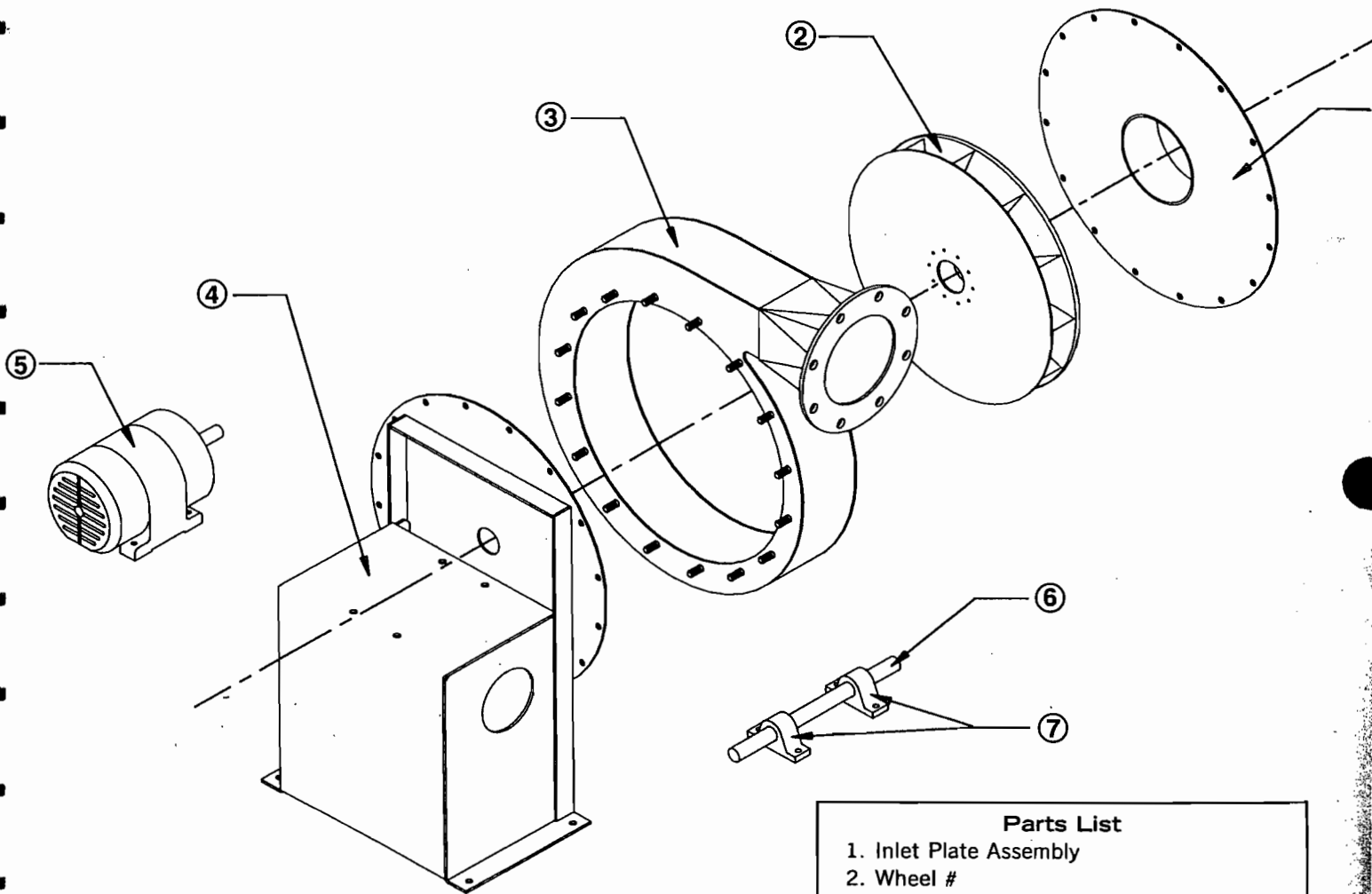
Belt Tensioning

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 startup, but slipping should stop as soon as the fan reaches full speed. For more precise tensioning methods, consult the drive manufacturer's literature.

SPECIFY ROTATION AS VIEWED FROM DRIVE SIDE



ARROW INDICATES COUNTERCLOCKWISE ROTATION



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.

When ordering replacement parts supply **nyb** shop number from nameplate and complete description of parts required.

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 crocus 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 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.

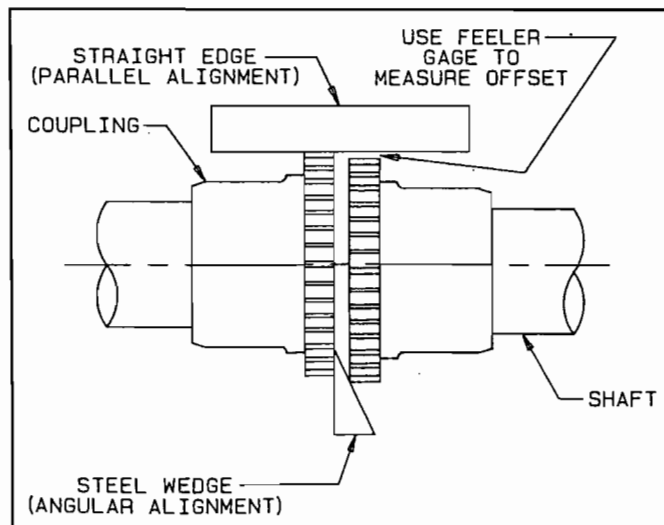


Figure 2

START-UP

Safe operation and maintenance includes the selection and use of appropriate safety accessories for the specific application. This is the responsibility of the system designer. The designer requires consideration of equipment location and accessibility as well as adjacent components. All safety devices 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** manual, which is available from your **nyb** field sales representative.

Procedure

1. If the drive components are not supplied by **nyb**, consult 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. Look 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. **Wheel bushing bolts should be torqued to 9 lb.-ft.** Tighten hub setscrews with the wheel or so that the setscrew is positioned underneath the wheel.
5. Install all remaining safety devices and guards. Verify the supply voltage is correct and wire the motor to the starter to check for proper wheel rotation.
6. Use extreme caution when testing the fan with ductwork disconnected. Apply power and check for unusual noise 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 attained without motor overload unless the fan is fully installed. Check for correct fan speed and complete the installation. Ductwork and guards must be installed for safety.
7. Setscrews should be rechecked after a few minutes, hours and two weeks of operation (see Tables 1 & 2 for correct tightening torques).

WHEEL SETSCREW TORQUES

Setscrew Size Diameter (in.)	Carbon Steel Setscrew Torque	
	lb.-in.	lb.-ft.
1/2"	600	50

Table 1

* Stainless Steel setscrews are not hardened and should be tightened to more than 1/2 the values shown.

BEARING SETSCREW TORQUE, lb.-in.

Setscrew Diameter	Manufacturer			
	Link-Belt	Sealmaster	SKF	McGill
1/4"	90	65	50	85
5/16"	185	125	165	165

Table 2

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.

NOTE: Shut the fan down immediately if there is any sudden increase in fan vibration.

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 overlubricate (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 destroy them.

WHEEL-INLET CLEARANCE

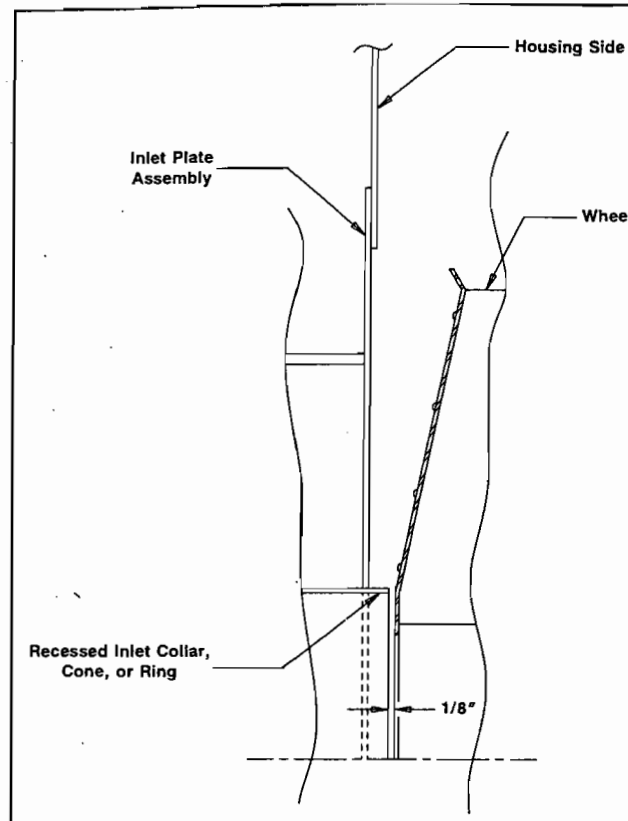


Figure 3

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 setscrew torque before startup (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, as grease may bleed from the bearing seals. This is normal; 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 good quality lithium-based grease conforming to NLGI Grade 2 consistency. Examples are:

Mobil	—	Mobilith 22
Texaco	—	Premium RB
Standard Oil	—	Amolith #2
Gulf Oil	—	Gulf Crown #2
Shell	—	Alvania #2

Do not use "high temperature" greases, as many are not formulated for the high speeds associated 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. Do not overlubricate.

Split pillowblock bearings (Link-Belt P-LB6800 & P-LB6900, SKF SAF 22500) 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.

BEARING LUBRICATION INTERVAL

		[Months]							
Shaft	RPM	1-500	501-1000	1001-1500	1501-2000	2001-2500	2501-3000	3001-3500	3501-4000
1-7/16	6	6	5-6	4-6	4-6	3-5	2-4	2-4	1
1-11/16	6	6	4-6	4-6	2-4	2-4	2	1-2	1-2

All Sealmaster & McGill;
Most Link-Belt and SKF.



Link-Belt 22400 Series,
SKF SYR Series, and
Dodge S-2000 Series.

NOTE:

- These are general recommendations only; specific manufacturer's recommendations may vary slightly.
- Assumes clean environment, 0°F. to 120°F.
 - Consult The New York Blower Company for operation below 0°F. ambient.
 - Ambients greater than 120°F. may shorten bearing life.
 - Under extremely dirty conditions, lubricate more frequently.

COMMON FAN PROBLEMS

Excessive Vibration

A common complaint regarding industrial fans is "excessive vibration." **nyb** is careful to ensure that each fan is precisely balanced prior to shipment; however, there are many other causes of fan vibration including:

- Loose mounting bolts, setscrews, bearings or couplings.
- Misalignment or excessive wear of bearings.
- Misaligned or unbalanced motor.
- Bent shaft due to mishandling or material impact.
- Accumulation of foreign material on the wheel.
- Excessive wear or erosion of the wheel.
- Excessive system pressure or restriction of airflow due to closed dampers.
- Inadequate structural support, mounting procedures or materials.
- Externally transmitted vibration.

Inadequate Performance

- Incorrect testing procedures or calculations.
- Fan running too slowly.
- Fan wheel rotating in wrong direction.
- Wheel not properly centered relative to inlet.
- Poor system design, closed dampers, air leaks, clogged filters or coils.
- Obstructions or sharp elbows near inlets.
- Sharp deflection of airstream at fan outlet.

Excessive Noise

- Fan operating near "stall" due to incorrect system design or installation.
- Vibration originating elsewhere in the system.
- System resonance or pulsation.
- Improper location or orientation of fan intake and discharge.
- Inadequate or faulty design of supporting structures.
- Nearby sound reflecting surfaces.
- Loose accessories or components.
- Loose drive belts.
- Worn bearings.

Premature Component Failure

- Prolonged or major vibration.
- Inadequate or improper maintenance.
- Abrasive or corrosive elements in the airstream or surrounding environment.
- Misalignment or physical damage to rotating components or bearings.
- Bearing failure from incorrect or contaminated lubricant or grounding through the bearings while arc welding.
- Excessive fan speed.
- Extreme ambient or airstream temperatures.
- Improper belt tension.
- Improper tightening of wheel bushing bolts.

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 mounting position and bearing size or bore. Most of this information is on the metal nameplate attached to the fan base.

Example: Part required: Wheel
Shop/control number: B-10106-100
Fan description: Size 2206A10 Pressure Blower
Rotation: Clockwise
Arrangement: 4

Suggested spare parts include:

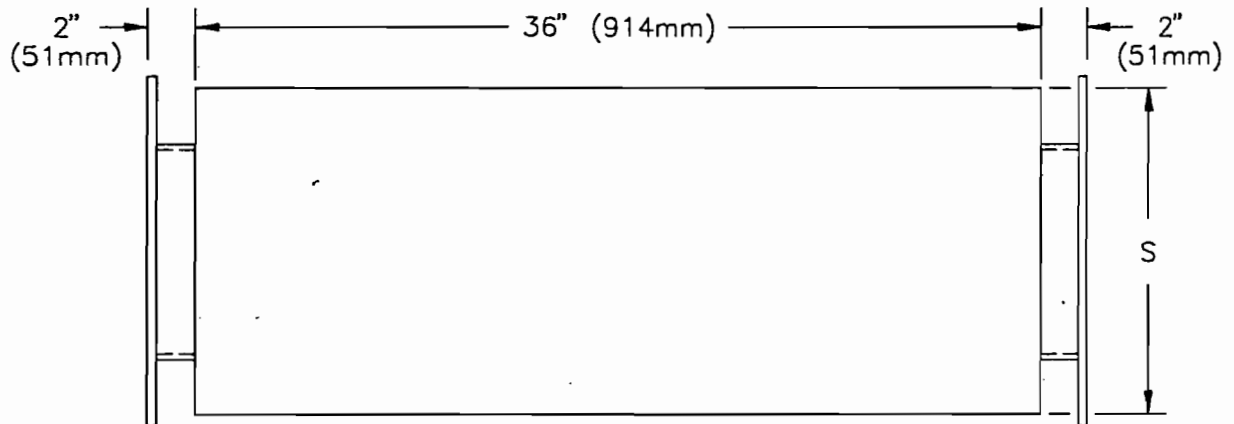
Wheel	Component parts: Damper
Shaft*	Motor
Bearings*	Coupling*
Shaft Seal*	Sheaves*
	V-Belts*

* Arrangements 1/8 only.

CARBONAIR ENVIORNMENTAL

PURCHASE ORDER: 11808

TAG:



FAN SILENCERS ARE OF HEAVY WELDED STEEL CONSTRUCTION FILLED WITH HIGH DENSITY ACOUSTICAL ABSORPTION MATERIAL.

ITEM	DIMENSIONS	
	in	mm
S (DIA.)	14	356

MAXIMUM TEMPERATURE: 800°F (427°C)

TOLERANCE: $\pm 1/8"$ ($\pm 3\text{mm}$)

ITEM	DIMENSIONS	
	in	mm
I.D.	8	203
O.D.	13 1/2	343
B.C.	11 3/4	298
NO. HOLES	8	-
HOLE DIA.	7/8	22

nyb The
New York Blower
Company

7660 Quincy Street, Willowbrook, IL 60521

**PRESSURE BLOWER
SILENCER SIZE 8**

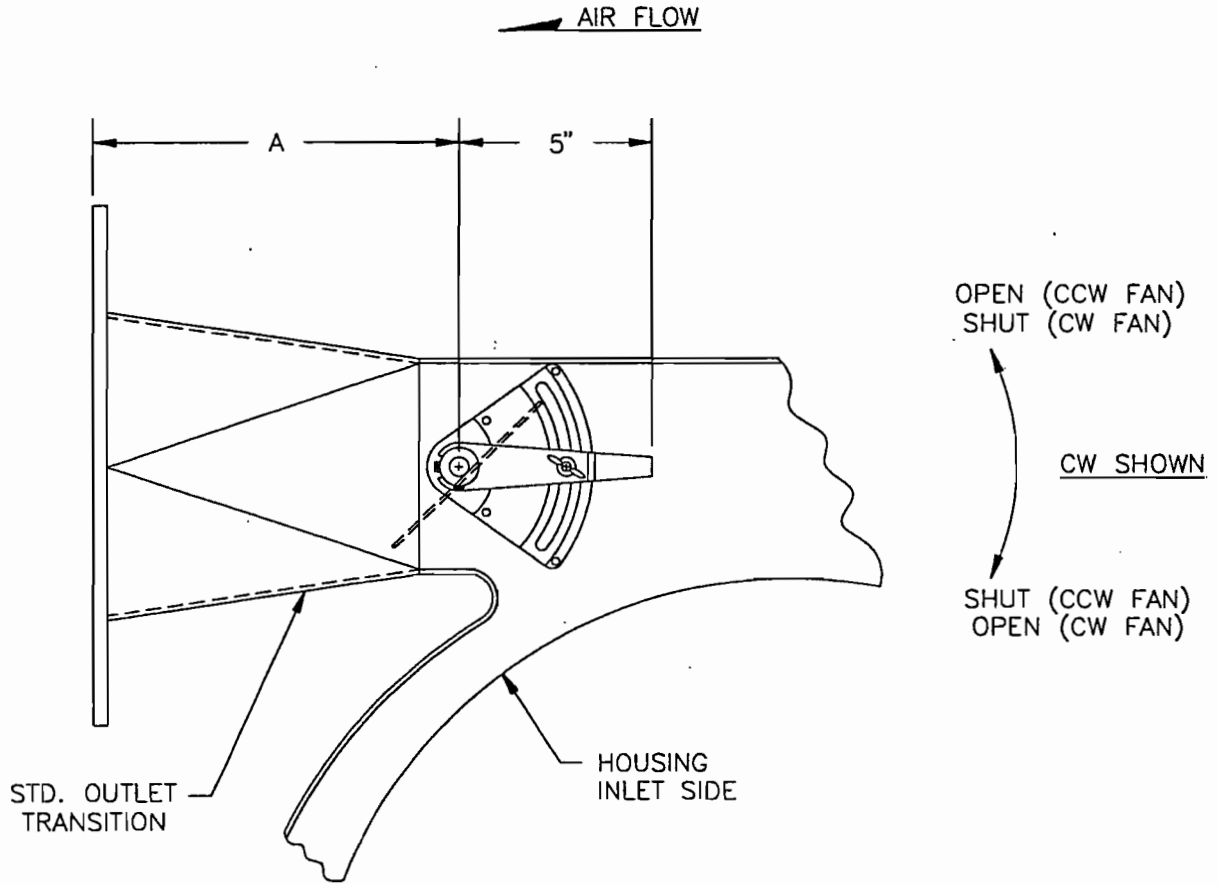
Date 02-24-97 Certified KJW

Drawing No. P02796-101-3 Rev.

CARBONAIR ENVIRONMENTAL

PURCHASE ORDER: 11808

TAG:



ITEM	DIMENSIONS	
	in	mm
WHEEL DIA.	23	-
OUTLET DIA.	6	-
A	9 5/8	244

TOLERANCE: $\pm 1/8"$ ($\pm 3\text{mm}$)

nyb The
New York Blower
Company

7660 Quincy Street, Willowbrook, IL 60521

PRESSURE BLOWER
INTEGRAL OUTLET DAMPER

Date 02-24-97 Certified KJW

Drawing No. P02796-100-4 Rev. _____

CARBONAIR ENVIORNMENTAL

PURCHASE ORDER : 11808

TAG :

FAN INFORMATION

QUANTITY : 1
FAN TYPE : Pressure Blower - AL
FAN SIZE : 2306A
FAN CLASS : NONE
ROTATION : CW
DISCHARGE : UB
ARRANGEMENT : 4
INLET TYPE : FLANGED

MOTOR INFORMATION

ENCLOSURE : TEFC
HORSEPOWER : 10
RPM : 3500
ELECT. DATA : 3-60-230/460
FRAME SIZE : 215T
MOTOR BY : NYB
MOUNT BY : NYB

FAN PERFORMANCE DATA

MAX SAFE SPEED : 3800 RPM at 70 Deg.

CERTIFIED DRAWING PACKET*

FAN CERTIFIED DRAWING..... Dwg# P02796-100-2
SILENCER..... Dwg# P02796-101-3
INTEGRAL OUTLET DAMPER..... Dwg# P02796-100-4

ADDITIONAL NOTES

MOTOR DATA SHEETS (TO FOLLOW)

ADDITIONAL INFORMATION

NUMBER OF DRAWING SETS : 3
ESTIMATED SHIPPING WT. : 585 lbs.
(includes fan, motor, & pertinent accessory weights)

* DRAWINGS ARE FOR CONSTRUCTION PURPOSES

nyb The
New York Blower
Company

7660 Quincy Street, Willowbrook, IL 60521

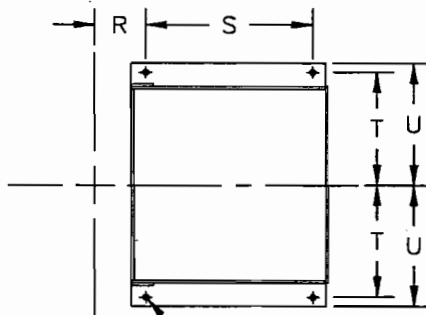
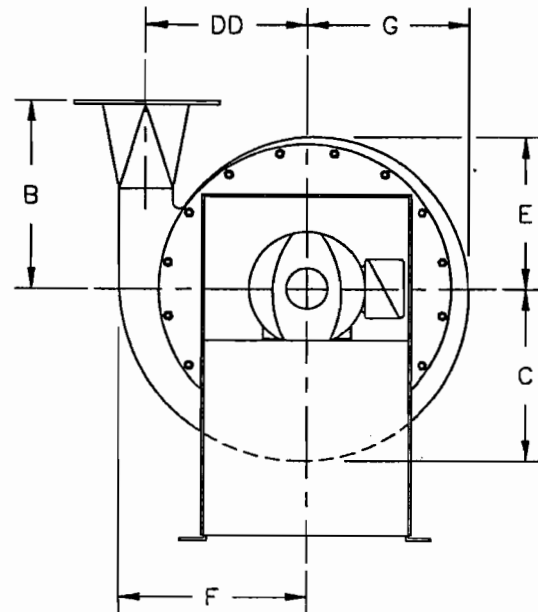
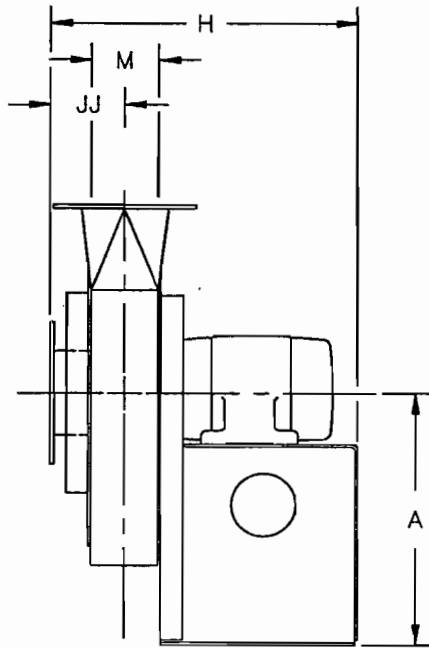
Pressure Blower - AL
SIZE 2306A

Date 02/24/97 Certified KJW
Drawing No. P02796-100-1 Rev.

CARBONAIR ENVIRONMENTAL

PURCHASE ORDER: 11808

TAG:



9/16" (14mm) DIA. HOLES

PRESSURE BLOWERS ARE ROTATABLE IN THE FIELD BY 22 1/2° INCREMENTS.

MAXIMUM TEMPERATURE: 180°F (82°C)

FURNISHED WITH FLANGED INLET AND OUTLET WHICH FITS ANSI 150 PIPE FLANGES.

ITEM	DIMENSIONS	
	in	mm
A	24 3/4	629
B	19	483
C	19 1/2	495
E	17 1/8	435
F	20 5/8	524
G	18 1/4	464
H	26 1/2	673
M	5	127
R	3 7/8	98
S	14 1/8	359
T	10 7/8	276
U	11 3/4	298
DD	17 5/8	448
JJ	7	178

FLANGED OUTLET	DIMENSIONS	
	in	mm
I.D.	6	152
B.C.	9 1/2	241
O.D.	11	279
NO. HOLES	8	-
DIA. HOLES	7/8	22

FLANGED INLET	DIMENSIONS	
	in	mm
I.D.	8	203
B.C.	11 3/4	298
O.D.	13 1/2	343
NO. HOLES	8	-
DIA. HOLES	7/8	22

TOLERANCE: $\pm 1/8"$ ($\pm 3\text{mm}$)

nyb The New York Blower Company

7660 Quincy Street, Willowbrook, IL 60521

**PRESSURE BLOWER
SIZE 2306 CW UB**

Date 02-24-97 Certified KJW

Drawing No. P02796-100-2 Rev. _____

SIEMENS

Installation • Operation • Maintenance

Instructions

**Induction Motors
143-449 Frame**

SIEMENS

INDUSTRIAL MOTOR DIVISION

INTRODUCTION

THIS EQUIPMENT CONTAINS HAZARDOUS VOLTAGES, ROTATING PARTS AND HOT SURFACES. SEVERE PERSONAL INJURY OR PROPERTY DAMAGE CAN RESULT IF SAFETY INSTRUCTIONS ARE NOT FOLLOWED. ONLY QUALIFIED PERSONNEL SHOULD WORK ON OR AROUND THIS EQUIPMENT AFTER BECOMING THOROUGHLY FAMILIAR WITH ALL WARNINGS, SAFETY NOTICES, AND MAINTENANCE PROCEDURES CONTAINED HEREIN. THE SUCCESSFUL AND SAFE OPERATION OF THIS EQUIPMENT IS DEPENDENT UPON PROPER HANDLING, INSTALLATION, OPERATION AND MAINTENANCE.

QUALIFIED PERSON

For the purpose of this manual and product labels, a qualified person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he has the following qualifications:

- a) Is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.
- b) Is trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
- c) Is trained in rendering first aid.



DANGER

For the purpose of this manual and product labels, **DANGER** indicates death, severe personal injury or substantial property damage will result if proper precautions are not taken.



WARNING

For the purpose of this manual and product labels, **WARNING** indicates death, severe personal injury or substantial property damage can result if proper precautions are not taken.



CAUTION

For the purpose of this manual and product labels, **CAUTION** indicates minor personal injury or property damage can result if proper precautions are not taken.

OPERATION

Repeated trial starts can overheat the motor and may result in motor burnout (particularly for across the line starting). If repeated trial starts are made, allow sufficient time between trials to permit heat to dissipate from windings and rotor to prevent overheating. Starting currents are several times running currents, and heating varies as the square of the current.

After installation is completed, but before motor is put in regular service, make an initial start as follows:

1. Check motor starting and control device connections against wiring diagrams.
2. Check voltage, phase, and frequency of line circuit (power supply) against motor nameplate.
3. If possible, remove external load (disconnect drive) and turn shaft by hand to ensure free rotation. This may have been done during installation procedure; if so, and conditions have not changed since, this check may not be necessary.
 - a. If drive is disconnected, run motor at no load long enough to be certain that no unusual conditions develop. Listen and feel for excessive noise, vibration, clicking, or pounding. If present, stop motor immediately. Investigate the cause and correct before putting motor in service.
 - b. If drive is not disconnected, interrupt the starting cycle after motor has accelerated to low speed. Carefully observe for unusual conditions as motor coasts to a stop.
4. When checks are satisfactory, operate at minimum load and look for unusual condition. Increase load slowly to maximum. Check unit for satisfactory operation.

**CAUTION**

Guard against overloading. Overloading causes overheating and overheating means shortened insulation life. A motor subjected to a 10°C temperature rise above the maximum limit for the insulation may cause the insulation life to be reduced by 50%. To avoid overloading, be sure motor current does not exceed nameplate current when nameplate voltage is applied.

Electric motors operating under normal conditions become quite warm. Although some places may feel hot to the touch, the unit may be operational within limits. Use a thermocouple to measure winding temperature when there is any concern.

The total temperature, not the temperature rise, is the measure of safe operation. Investigate the operating conditions if the total temperature measured by a thermocouple placed on the winding exceeds:

230°F (110°C) for class "B" insulation

275°F (135°C) for class "F" insulation

302°F (150°C) for class "H" insulation

BEARING LUBRICATION**CAUTION**

Do not lubricate motor while in operation, since excess grease will be forced through the bearings and into the motor before it will force its way out of the drain plug. Excess grease accumulation on windings reduces insulation life.

Bearing life is assured by maintaining proper alignment, proper belt or chain tension, and good lubrication at all times.

Prior to shipment, motor bearings are lubricated with the proper amount and grade to provide six months of satisfactory service under normal operation and conditions.

For best results, grease should be compounded from a polyurea base and a good grade of petroleum oil. It should be of No. 2 consistency and stabilized against oxidation. Operating temperature range should be from -15°F to $+250^{\circ}\text{F}$ for class B insulation, and to $+300^{\circ}\text{F}$ for class F and H. Most leading oil companies have special bearing greases that are satisfactory.

Relubricate bearings every six months (more often if conditions require), as follows:

1. Stop the motor. Lock out the switch.
2. Thoroughly clean off pipe plugs and remove from housings.
3. Remove hardened grease from drains with stiff wire or rod.
4. Add grease to inlet with hand gun until small amount of new grease is forced out of drain.
5. Remove excess grease from ports, replace inlet plugs, and run motor $\frac{1}{2}$ hour before replacing drain plug.
6. Put motor back in operation.

INSULATION RESISTANCE

Check insulation resistance periodically. Any approved method of measuring insulation resistance may be used, provided the voltage across the insulation is at a safe value for the type and condition of the insulation. A hand cranked megger of not over 500 volts is the most convenient and safest method. Standards of the Institute of Electrical and Electronics Engineers, Inc. (IEEE) recommend that the insulation resistance of stator windings at 75°C , measured at 500 volts DC, after one minute should not be less than:

$$\frac{\text{Rated Voltage of Machine} + 1000}{1000} = \text{Insulation Resistance In Megohms}$$

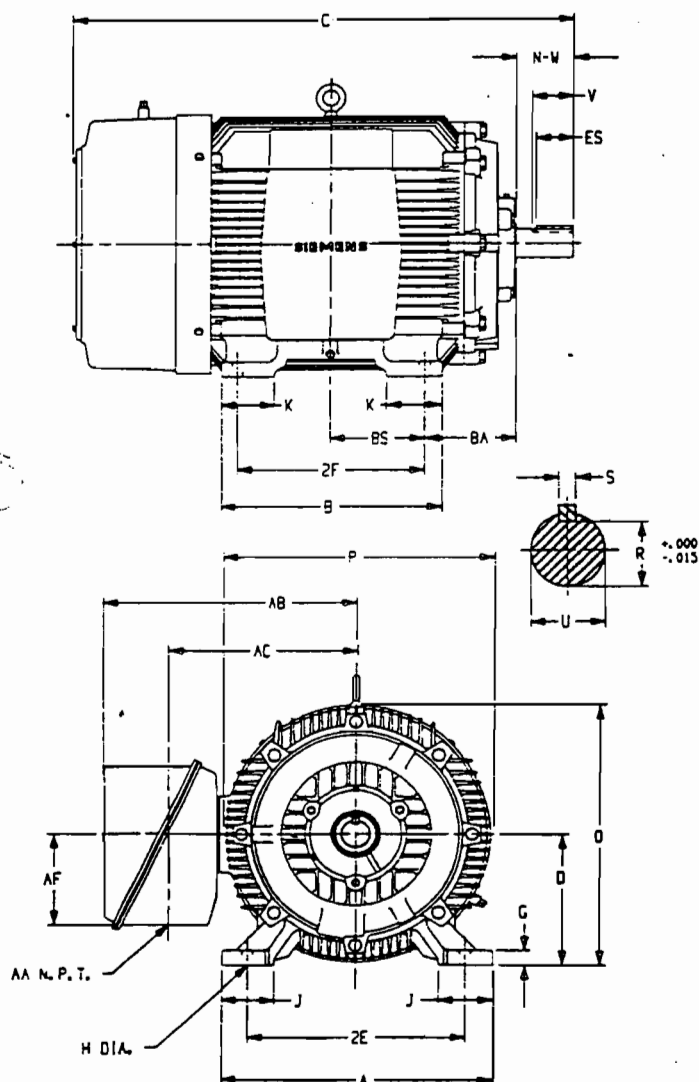
This formula is satisfactory for most checks. For more information, see IEEE Standard No. 43, "Recommended Practice for Insulation Resistance Testing of AC Rotating Machinery".

NEMA Frames Application Manual

Motors & Drives Division

Type RGZ
Totally Enclosed Fan Cooled
Frames 213T-256T

Standard Dimensions - In Inches



FRAME	213T	215T	254T	256T
A	10.08	10.08	11.81	11.81
B	7.01	8.50	10.08	11.81
C	17.52	19.02	22.28	24.02
D	5.25	5.25	6.25	6.25
2E	8.50	8.50	10.00	10.00
2F	5.50	7.00	8.25	10.00
G	0.67	0.67	0.79	0.79
H	0.41	0.41	0.53	0.53
J	1.97	1.97	2.36	2.36
K	1.97	1.97	2.48	2.48
N-W	3.38	3.38	4.00	4.00
O	13.39	13.39	15.63	15.63
U	1.375	1.375	1.625	1.625
V	3.12	3.12	3.75	3.75
ES	2.41	2.41	2.91	2.91
BA	3.50	3.50	4.25	4.25
BS	2.75	3.50	4.12	5.00
AA (NPT)	1.00	1.00	1.25	1.25
AB	9.02	9.02	9.92	9.92
AC	6.97	6.97	7.87	7.87
AF	2.93	2.93	2.94	2.94
R	1.201	1.201	1.416	1.416
S	3.12	3.12	3.75	3.75
Approx. Ship. Wt. (Lbs.)	130	162	250	295

Footnotes:

- (D) Frames 143T-326T +.000-.032
Frames 364T-449T +.000-.062
- (S) .188 to .750 +.002-.000
Over .750 to 1.500 +.003-.000
- (U) .750 to 1.500 +.000-.0005
Larger than 1.500 +.000-.001
- (V) Shaft length available for coupling, pinion or pulley hub.

CERTIFIED PRINT							
CUSTOMER CARBONAIR ENVIRONMENTAL							
P.O. # 11808				S.O. INYS FILE # P02796-100			
H.P.	R.P.M.	FRAME	TYPE	VOLTS	PH	HZ	
10	3600	215T	RGZ	230	3	60	
				TEFC	460		
BY:				DATE:			

NOT FOR CONSTRUCTION, INSTALLATION OR APPLICATION PURPOSES, UNLESS CERTIFIED

NEMA Frames Application Manual

Motors & Drives Division

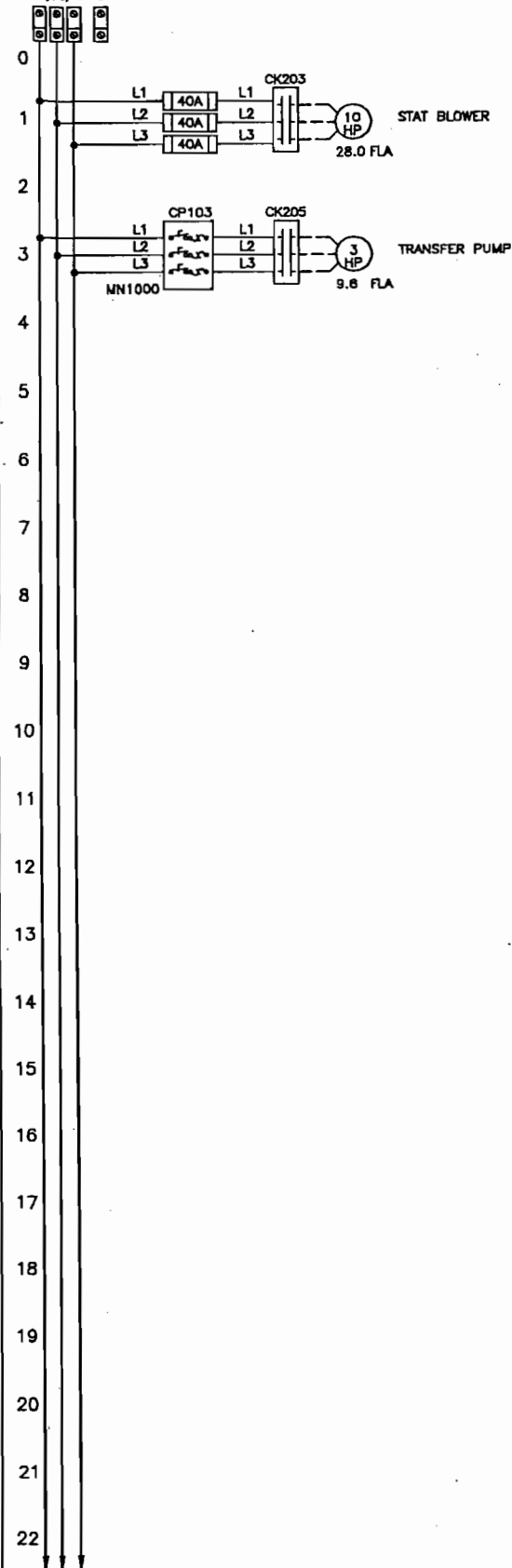
Premium Efficiency Totally Enclosed Fan Cooled (TEFC) Types RGZESD, RGZZESD Performance Data, 460 V, 60 Hz

hp	full load rpm	frame	amps			kVA/ hp code	nominal efficiency			power factor			torque			LR stall time		winding connection
			no load	full load	locked rotor		full load	3/4 load	1/2 load	full load	3/4 load	1/2 load	full load [lb-ft]	locked rotor	break- down	hot [sec]	cold [sec]	
1.0	1720	143T	0.95	1.5	15.0	N	84.0%	83.5%	81.0%	74.3%	65.1%	59.1%	3.1	290%	320%	14	30	wye
1.0	1125	145T	1.4	1.8	15.0	N	81.5%	81.7%	79.5%	63.8%	62.8%	53.8%	4.7	230%	290%	19	40	wye
1.5	3455	143T	0.90	2.0	20.0	M	84.0%	83.5%	81.5%	83.6%	79.4%	70.4%	2.3	230%	300%	13	28	wye
1.5	1720	145T	1.4	2.2	20.0	M	85.5%	85.5%	83.5%	74.6%	69.6%	58.6%	4.6	290%	320%	13	29	wye
1.5	1155	182T	1.5	2.4	20.0	M	86.5%	86.3%	84.5%	67.6%	61.7%	54.2%	6.8	190%	290%	22	33	wye
2.0	3455	145T	1.1	2.5	25.0	L	85.5%	85.7%	85.0%	87.6%	81.4%	68.4%	3.0	230%	300%	15	33	wye
2.0	1720	145T	1.8	2.9	25.0	L	86.5%	86.3%	84.0%	74.6%	66.6%	57.1%	6.1	280%	310%	12	25	wye
2.0	1160	184T	1.9	3.2	25.0	L	87.5%	87.8%	86.3%	66.9%	59.7%	51.2%	9.1	190%	290%	21	32	wye
3.0	3495	182T	1.4	3.7	32.0	K	87.5%	86.3%	82.3%	86.7%	82.9%	77.4%	4.5	200%	290%	15	34	wye
3.0	1735	182T	1.6	3.8	32.0	K	89.5%	89.2%	87.5%	82.6%	76.6%	68.1%	9.1	220%	280%	16	35	wye
3.0	1160	213T	2.2	4.3	32.0	K	89.5%	89.7%	88.5%	73.0%	66.6%	56.1%	14	190%	290%	17	35	wye
5.0	3470	184T	1.6	5.8	46.0	J	88.5%	89.1%	86.9%	91.2%	88.2%	82.8%	7.6	190%	280%	12	26	wye
5.0	1725	184T	2.7	6.4	46.0	J	89.5%	90.3%	89.2%	81.7%	77.6%	70.7%	15	220%	280%	17	36	wye
5.0	1160	215T	3.5	7.1	46.0	J	89.5%	89.8%	88.5%	73.6%	69.1%	56.6%	23	190%	250%	14	29	wye
7.5	3505	213T	2.3	8.7	63.5	H	89.5%	88.5%	85.0%	90.1%	87.4%	81.9%	11	190%	270%	11	25	wye
7.5	1740	213T	4.0	9.4	63.5	H	90.2%	90.6%	88.5%	82.8%	78.0%	70.2%	23	210%	270%	14	29	wye
7.5	1170	254T	4.7	9.6	63.5	H	91.0%	91.0%	90.0%	80.4%	74.1%	62.1%	34	180%	250%	18	35	wye
10.0	3505	215T	3.3	12	81.0	H	90.2%	90.0%	86.8%	90.2%	86.0%	80.5%	15	185%	260%	14	29	wye
10.0	1740	215T	4.6	12	81.0	H	91.0%	92.4%	90.0%	83.6%	79.0%	71.3%	30	210%	270%	15	30	wye
10.0	1170	256T	6.0	12	81.0	H	91.7%	92.2%	91.5%	83.0%	78.0%	67.5%	45	180%	250%	18	35	wye

MAIN INCOMING POWER

DISCONNECT TO BE
PROVIDED BY OTHERS

230 VAC, 3 ϕ , 60 HZ
L1, L2, L3, G



REVISIONS

REV	ECO	DESCRIPTION	DATE	DRN
		RELEASED FOR SUBMITTAL	2/19/97	MTO
A		AS BUILT	03/27/97	GGR

LEGEND

- ▲ TERMINAL IN PANEL
- (P) LOCATED IN PANEL
- (F) FIELD MOUNTED DEVICE
- (PD) LOCATED ON PANEL DOOR
- (CK) MOTOR CONTACTOR
- (CR) CONTROL RELAY
- (G) GREEN PILOT LIGHT
- (R) RED PILOT LIGHT
- (W) WHITE PILOT LIGHT
- (Y) YELLOW PILOT LIGHT
- ⏏ FLOAT SWITCH CLOSING ON RISING LEVEL
- ⏏ FLOAT SWITCH OPENING ON RISING LEVEL
- ⏏ PRESSURE SWITCH CLOSING ON RISING PRESSURE
- ⏏ PRESSURE SWITCH OPENING ON RISING PRESSURE
- ⏏ TEMPERATURE SWITCH OPENING ON RISING TEMPERATURE
- || NORMALLY OPEN CONTACT
- ⏏ NORMALLY CLOSED CONTACT
- FIELD WIRING
- ⏏ NORMALLY OPEN PUSHBUTTON MOMENTARY
- ⏏ THREE POSITION H.O.A. SELECTOR SWITCH ILLUMINATED
- ⏏ SELECTOR SWITCH ADDITIONAL CONTACTS MAY BE ADDED
- CP101 MOTOR CIRCUIT PROTECTOR (PROVIDES MAGNETIC TRIPS AND OVERLOAD PROTECTION)
- ⏏ MOTOR CIRCUIT PROTECTOR AUXILIARY CONTACTS (N.O. CONTACTS/CLOSED WHEN START BUTTON DEPRESSED)

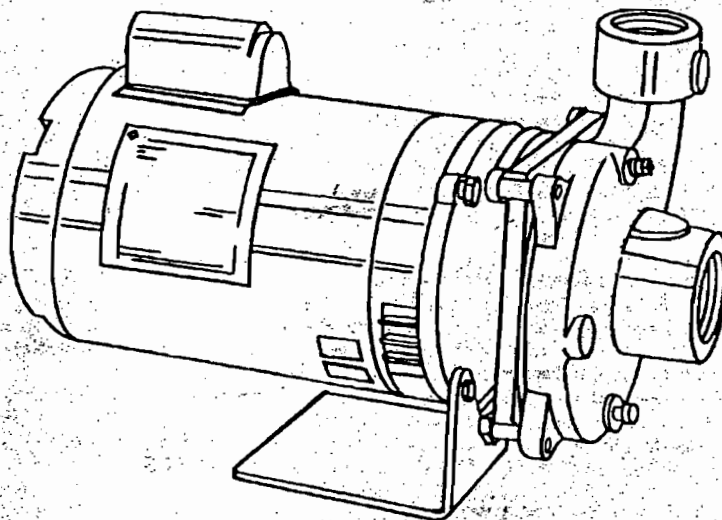
NOTE:

1. DRAWING NOT TO SCALE
2. NORMAL STATE, DEVICE ENERGIZED

APPROVAL	DATE	 CARBONAIR WATER AND AIR DECONTAMINATION MINNEAPOLIS, MINNESOTA ©1996
DWT M.T.O.	2/19/97	
DNSCALE 1	LYSCALE .5	
PROJECT NO.	107505	
TITLE SCHEMATIC, CONTROL PANEL HALEY & ALDRICH		SIZE D
DWG. NO. 153303		REV A
SCALE 1=1		EQUIP. NO.
SHEET 1 OF 1		

INSTALLATION, OPERATING AND MAINTENANCE INSTRUCTIONS

CENTRIFUGAL PUMPS



WARNING: Do not work on this pump until you are sure the pump and associated piping are totally depressurized, and if pumping hot liquids that the temperature is safe to handle.

Be sure that electricity to the motor is shut off and locked out, or if the motor is to be tested while running that it is conducted by a qualified person and safe electrical procedures are followed.

To insure safety and a successful repair, if there is anything about the pump and motor you do not completely understand contact your distributor or the factory for instructions.

SAFETY FIRST!

PLEASE READ THIS BEFORE INSTALLING OR OPERATING PUMP.

GENERAL

1. Most accidents can be avoided by using **COMMON SENSE**.
2. Read the operation and maintenance instruction manual supplied with the pump.
3. Do not wear loose clothing that may become entangled in the impeller or other moving parts.
4. This pump is designed to handle materials which could cause illness or disease through direct exposure. Wear adequate protective clothing when working on the pump or piping.

PUMPS

5. Pump builds up heat and pressure during operation-allow time for pump to cool before handling or servicing.
6. Only qualified personnel should install, operate and repair pump.
7. Keep clear of suction and discharge openings. **DO NOT** insert fingers in pump with power connected.
8. Do not pump hazardous materials (flammable, caustic, etc.).
9. Do not block or restrict discharge hose-be careful of discharge hose whipping under pressure.
10. Make sure lifting handles are securely fastened each time before lifting.
11. Do not lift pump by the power cord.
12. Do not exceed manufacturers recommendation for maximum performance, as this could cause the motor to overheat.
13. Secure the pump in its operating position so it can not tip over, fall or slide.
14. Keep hands and feet away from impeller when power is connected.
15. Submersible Non-Clog Pumps are not approved for use in swimming pools, recreational water installations, decorative fountains or any installation where human contact with the pumped fluid is common.
16. Do not operate pump without guards or safety devices in place.
17. For hazardous locations, use pumps that are listed and classified for such locations.
18. When towing pump behind a vehicle; make sure hitch is properly attached, always attach safety chains.
19. Always replace safety devices that have been removed during service or repair.

ELECTRICAL

20. To reduce risk of electrical shock, pump must be properly grounded in accordance with the National Electric Code and all applicable state and local codes and ordinances.
21. To reduce risk of electrical shock, disconnect the pump from the power source before handling or servicing.
22. Any wiring of pumps should be performed by a qualified electrician.
23. Never operate a pump with a power cord that has frayed or brittle insulation.
24. Never allow cords or plugs to lay in water.
25. Never handle connected power cords with wet hands.
26. Never operate a pump with a plug-in type power cord without a ground fault circuit interrupter.

GAS/DIESEL ENGINE POWER PUMPS ONLY

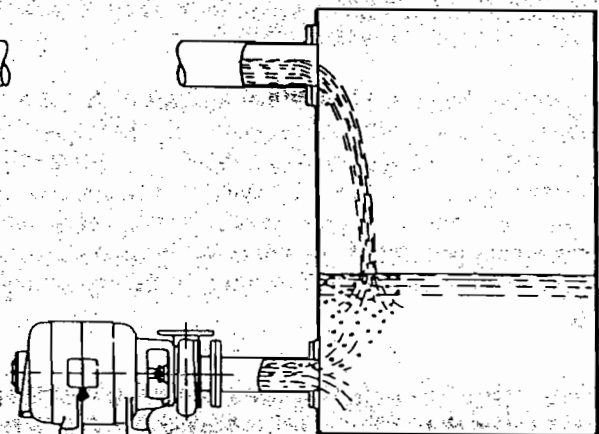
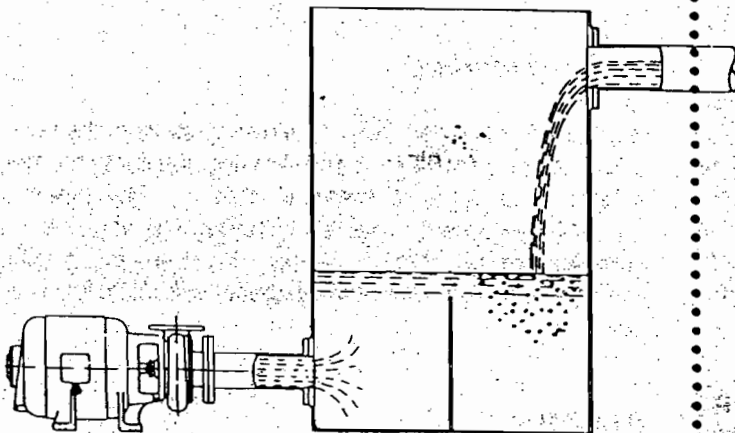
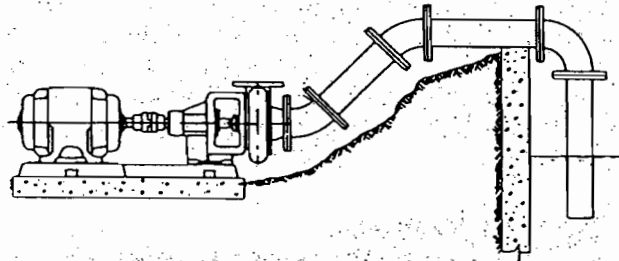
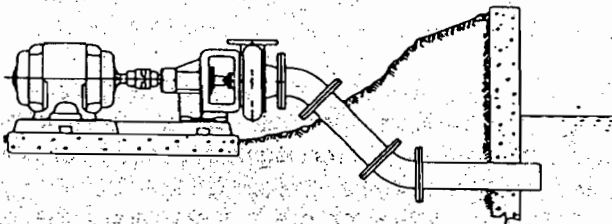
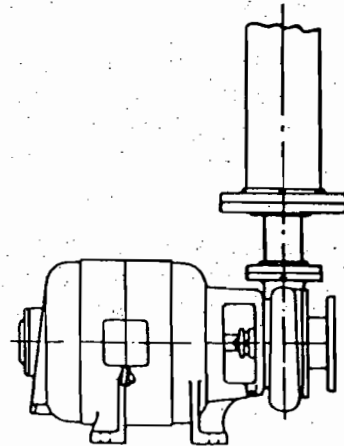
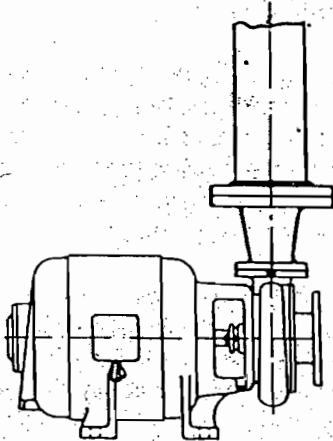
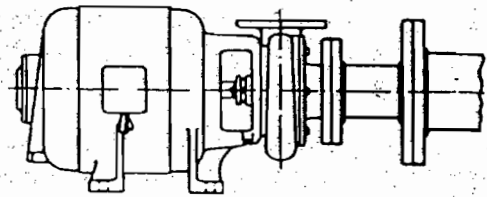
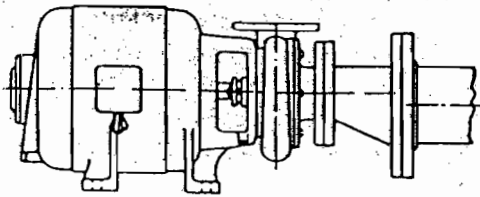
27. Never operate in a enclosed building or area where exhaust gases can accumulate.
28. Do not breath exhaust fumes when working in the area of the engine. (Exhaust gases are odorless and deadly poison.)
29. Never operate near a building where exhaust gases can seep inside.
30. Never operate in a pit or sump without making provisions for adequate ventilation.
31. Allow exhaust system to cool before touching.
32. Never add fuel to the tank while the engine is running. Stop engine and allow to cool.
33. Do not smoke while refueling the engine.
34. Do not refuel near open flame.

IMPORTANT! Weinman®Pumps is not responsible for losses, injury, or death resulting from a failure to observe these safety precautions, misuse or abuse of pumps or equipment.

PIPING

RIGHT

WRONG



that the discharge line has been completely filled, it is then unnecessary to close the gate valve in starting.

SEASONAL SERVICE

To Take Out of Service:

1. Drain the liquid from the pump to prevent freezing and damage to the pump body. It is recommended that a good rust inhibitor be put into the liquid end to prevent excessive corrosion. Keep the motor dry and covered.
2. To drain, remove the drain plug which is located below the suction inlet of the pump. Drain the suction pipe to a point below the frost line. All other pipes, which may be exposed to freezing temperatures, should also be drained.
3. Remove the priming plug. This will help the pump body to drain by permitting air to enter the case.

To Place Pump Back Into Service:

1. Replace all drain plugs previously removed, using pipe joint compound on all male threads.
2. If the suction line has been removed, be certain that it is re-connected.
3. Check to be certain that the pump shaft turns freely.
4. Prime and start.

DO NOT START THE PUMP UNTIL IT IS FILLED WITH WATER.

STUFFING BOX - MECHANICAL SEAL:

With the exercise of a few precautions a mechanical seal will furnish very satisfactory operation in pumps. Precautions which should be observed are:

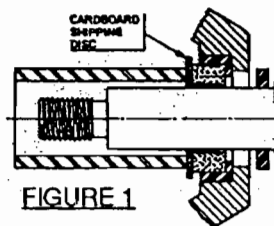
1. Do not run the pump dry. The flat faces of the seal are lubricated by the liquid being pumped.
2. Vent the seal housing if it is the high point in the pump.
3. Purge the system thoroughly to remove welding slag, scale, or dirt which may injure the seal prematurely due to the abrasive condition of liquid.

INSTALLING A NEW MECHANICAL SEAL

CAUTION: This seal is a precision product and should be handled accordingly. Be especially careful not to scratch or chip the lapped sealing faces of the washer and floating seat. If reinstalling a used seal, both sealing faces should be relapped.

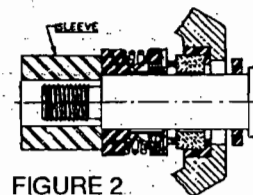
INSTALLING STATIONARY ELEMENT

The seat must be seated securely in the seat ring with the lapped face out. The *unlapped* face is marked and correctly assembled when shipped. Oil the seat ring with *light oil* and seat it firmly and squarely. If this cannot be done with the fingers, use a sleeve as shown in Fig. 1, inserting the cardboard shipping disc between the sleeve and the lapped face to prevent scratching sealing face.



INSTALLING ROTATING ELEMENT

Oil shaft with *light oil*. Shaft should be clean and polished smooth. Slide seal body on shaft (washer end first) and seat firmly. A sleeve as shown in Fig. 2 will facilitate this operation and prevent the rubber driving ring from pulling out of place as the seal body is slid along the shaft. Assembly of impeller automatically sets seal in proper position.



Make sure at all times, and particularly before final assembly, that both sealing faces are absolutely clean. Sealing faces should be oiled with clean, light oil.

NOTE: DO NOT USE PETROLEUM BASED PRODUCTS TO LUBRICATE EPT OR EPDM ELASTOMERS - USE ONLY WATER BASED LUBRICANT.

INNOVATIVE FUSION, INC.
60 GREAT HILL ROAD
NAUGATUCK, CT 06770

PHONE: (203) 729-3873 / FAX: (203) 729-0541

INSTALLATION
AND
MAINTENANCE
OF
MULTI-LEVEL
FLOAT TYPE
LIQUID LEVEL SWITCHES

CONFIGURATION

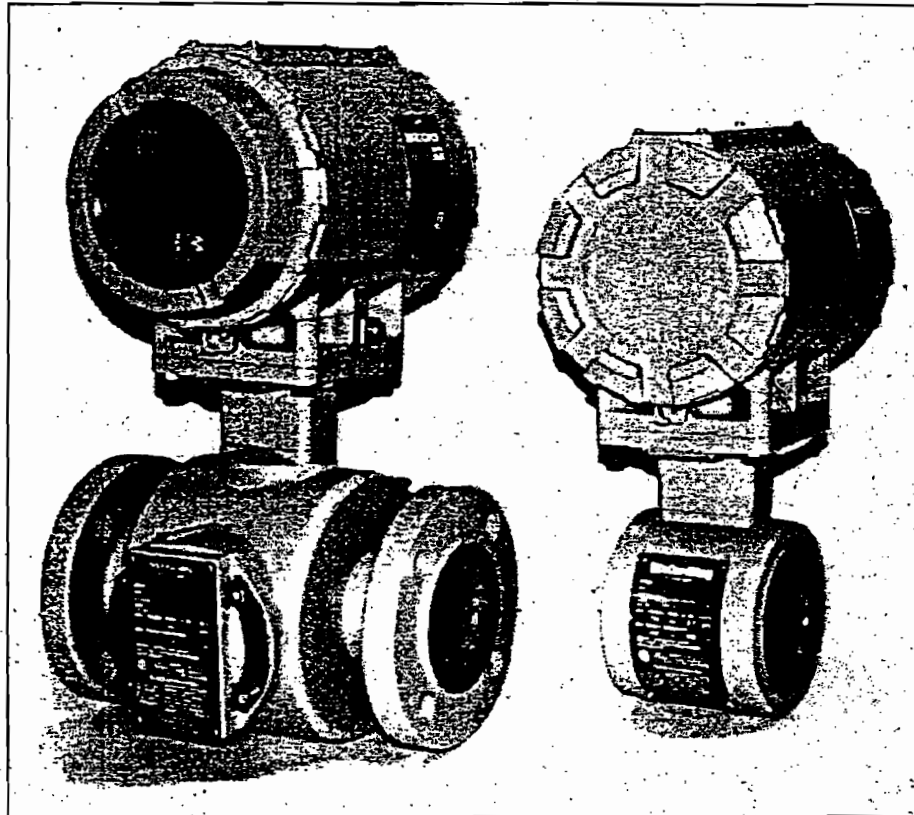
- Stem: 316 Stainless Steel welded assembly
- Grip Rings: 316 Stainless Steel
- Float: 316 Stainless Steel with ceramic magnet
- Reed Switch: 50 Watt
- Wire: 18 gage PVC jacket
- Level Locations: Per customer drawing
- Switch Configuration: Normally open (factory set)

<u>CURRENT AND VOLTAGE RATING</u>		
<u>WATTS</u>	<u>VOLTAGE</u>	<u>CURRENT AMPS</u> <u>(RESISTIVE)</u>
50	220 AC	.2
	110 AC	.4
	120 DC	.33
	24 DC	.6

Level Assembly Wiring	
<u>Wire Color</u>	<u>Switch Location</u>
Black	Low Level
White	High Level
Red	High-High Level

X-3520
September, 1996
Issue 2

Brooks Magmeters with Model 3520 Smart Touch Integral Transmitter



Brooks Instrument

FISHER-ROSEMOUNT™ Managing The Process Better.

Brooks Magmeters with Model 3520 Smart Touch Integral Transmitter

NOTICE

Read this manual before working with the product. For personal and system safety, and for optimum product performance, make sure you thoroughly understand the contents before installing, using, or maintaining this product.

⚠ CAUTION

The products described in this document are NOT designed for nuclear-qualified applications.

Using non-nuclear qualified products in applications that require nuclear-qualified hardware or products may cause inaccurate readings.

For information on Brooks nuclear-qualified products, contact your local Sales Representative.

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Introduction

MANUAL SCOPE

This manual provides instructions for installing, operating, and troubleshooting Brooks magmeters with Smart Touch integral transmitter.

Section 2 Installation

provides step by step instructions for installing and starting-up the Brooks magmeters with Smart Touch integral transmitter

Section 3 Local Operator Interface

introduces the local operator interface (LOI) and its function in configuring the Smart Touch transmitter.

Section 4 Transmitter Functions

guides you through the software configuration functions for the Smart Touch. Basic configuration covers the functions that are necessary to get the system up and running as well as special configuration.

Section 5 Troubleshooting

includes troubleshooting tables, software test procedures, and hardware procedures for diagnosing and repairing problems with the Smart Touch.

Section 6 Specifications and Reference Data

provides functional, performance, and physical specifications for the Smart Touch. It also includes ordering information, approvals and a configuration data sheet.

Appendix A Hart Communicator

is a detailed summary of the operational features of the HART Communicator. It includes a menu tree, Fast Key Sequence table, and other instructions.

Appendix B Operation Planning

provides guidance for system planning when using a magnetic flowmeter system.

Appendix C Transmitter Output Instability

describes the problems of signal noise and the signal processing system of the Brooks Smart Touch transmitter.

Installation

INTRODUCTION

This section covers the installation procedures for the magmeters with Smart Touch integral transmitter.

⚠ WARNING

These installation and servicing instructions are for use by qualified personnel only. Failure to follow safe installation guidelines can cause death or serious injury. Do not perform any service other than that contained in this manual, unless qualified.

⚠ WARNING

Explosions can cause death or serious injury. Verify that the operating environment of the flowtube and transmitter is consistent with the appropriate agency approval. Failure to comply could result in an electrical spark or an explosion.

⚠ CAUTION

The flowtube liner is vulnerable to handling damage. Never place anything through the flowtube for the purpose of lifting or gaining leverage. Liner damage can render the flowtube useless.

PRE-INSTALLATION

Before installing the magmeter, there are several pre-installation steps that make the installation process easier. They include identifying the options and configurations that apply to your application, setting the hardware switches if necessary, and consideration of mechanical, electrical, and environmental requirements.

Identify Options and Configurations

The standard application of the Smart Touch includes a 4–20 mA output and control of the flowtube coils. Other applications may require one or more of the following configurations or options:

- Multidrop Communications
- Auxiliary Output
- Pulse Output

Additional options may also apply. Be sure to identify the options and configurations that apply to your situation, and keep a list of them nearby for consideration during the installation and configuration procedures.

Changing Hardware Switch Settings

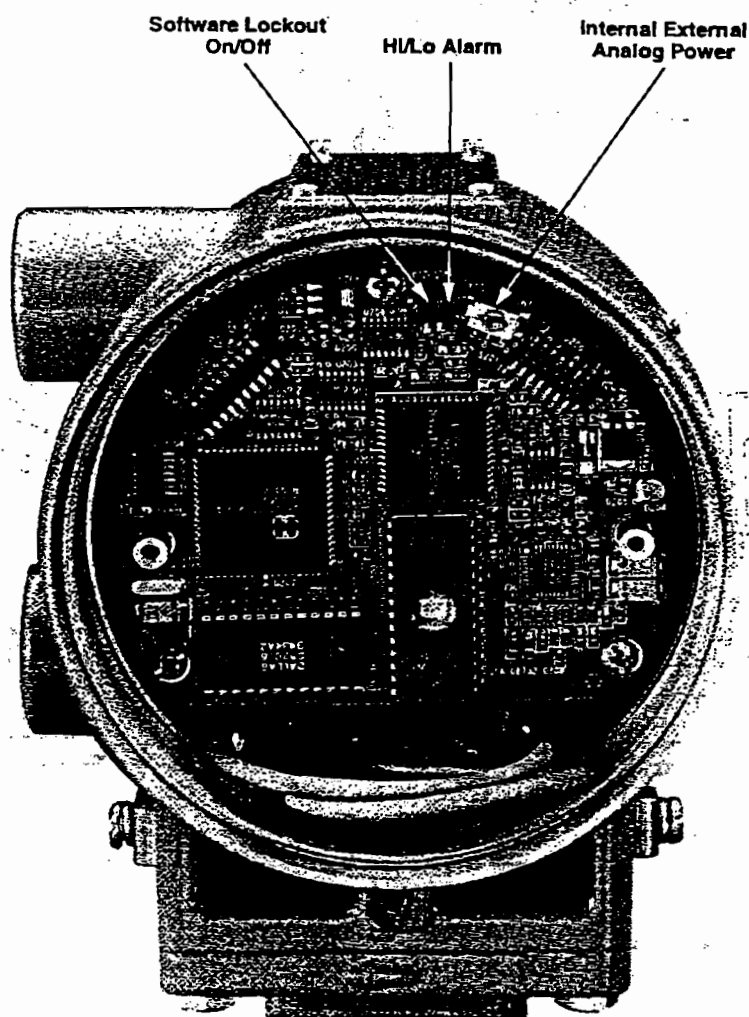
In most cases, it is not necessary to change the setting of the hardware switches. If you need to change the switch settings, complete the steps outlined below:

NOTE

The hardware switches are located under the cover opposite the terminal block. Because changing their settings requires opening the electronics housing, make every attempt possible to carry out these procedures away from the plant environment to protect the electronics.

1. Remove power to the transmitter.
2. Unscrew and remove the electronics cover.
3. Identify the location of each switch (see Figure 2-1).
4. Change the setting of the desired switches with a small screwdriver.
5. Reinstall and tighten the electronics cover.

FIGURE 2-1. Smart Touch Electronics Board and Hardware Switches.



Electrical Considerations

Before making any electrical connections to the Smart Touch, consider the following standards and be sure to have proper power supply, conduit, and other accessories.

Conduit Connections

The Smart Touch has $\frac{3}{4}$ -inch NPT conduit connections. If one of these ports is not used, it must be sealed with a conduit seal. In some cases, conduits may also require drainage if moisture could build up in the line.

Transmitter Input Power

The Smart Touch is designed to be powered by voltages ranging from 90 to 250 V ac (50 to 60 Hz). Units powered with an ac power supply should be connected to standard ac connections for 115 V ac or 230 V ac.

Environmental Considerations

To ensure maximum transmitter life, avoid excessive heat and vibration. Typical problem areas include high-vibration lines with integrally mounted transmitters, warm-climate installations in direct sunlight, and outdoor installations in cold climates.

Because the Smart Touch requires external power, access to a suitable power source must be ensured.

⚠ CAUTION

Overheating will damage the flowtube and integral transmitter. Do not encapsulate the flowtube or integral transmitter with heating elements.

Do not encapsulate the flowtube with heating elements.

Flowtube Mounting

Physical mounting of a flowtube is similar to installing a typical section of pipe. Only conventional tools, equipment, and accessories (such as bolts, gaskets, and grounding hardware) are required.

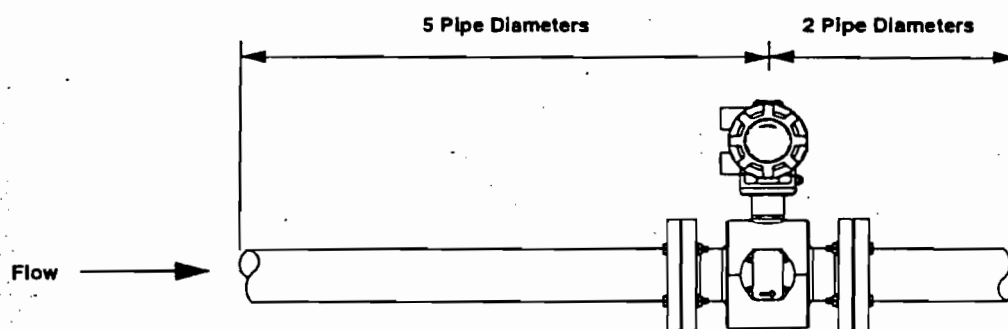
Calibration

Brooks magnetic flowmeter systems are wet-calibrated at the factory and need no further calibration during installation.

**Upstream/
Downstream
Piping**

To ensure specific accuracy over widely varying process conditions, install the flowtube with a minimum of five straight pipe diameters upstream and two pipe diameters downstream from the electrode plane, as shown in Figure 2-4. This flowtube placement is usually adequate to allow for disturbances created by elbows, valves, and reducers.

FIGURE 2-4. Upstream and Downstream Straight Pipe Diameter.



The electrodes in the 7400 Wafer-Mag and MagLite are properly oriented when the top of the flowtube is either vertical or horizontal, as shown in Figure 2-7. Avoid any mounting orientation that positions the top of the flowtube at 45° from the vertical or horizontal position.

FIGURE 2-7.
7400 Wafer-Mag and
MagLite Mounting
Position.

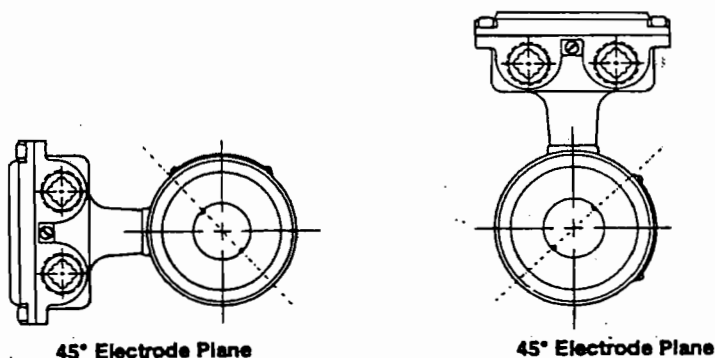
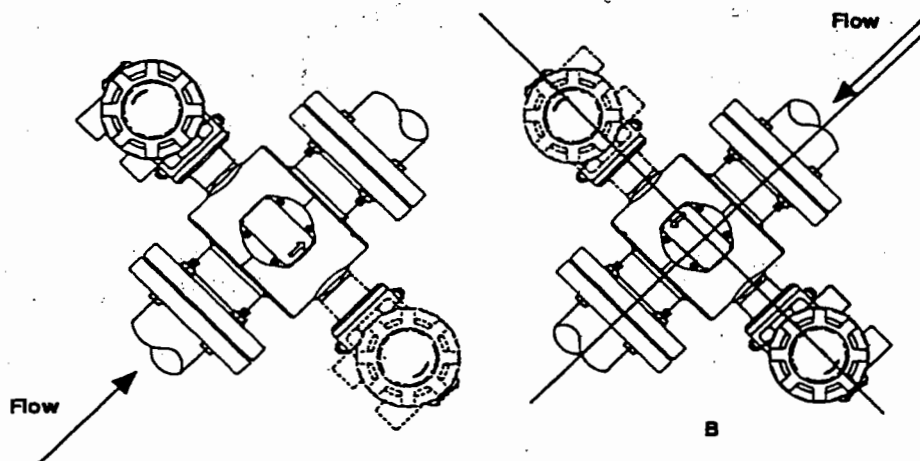


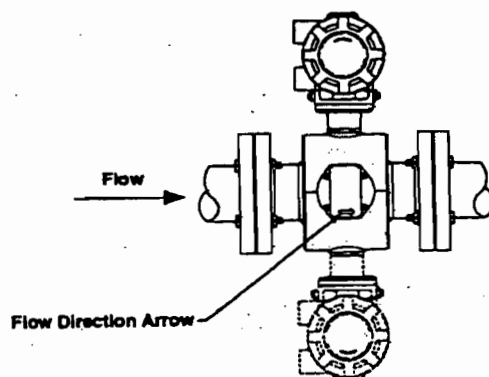
FIGURE 2-8.
Incline or



Flow Direction

The flowtube should be mounted so that the FORWARD end of the flow arrow, shown on the flowtube identification tag, points in the direction of flow through the tube (see Figure 2-9).

FIGURE 2-9. Flow Direction.



The electrodes in the 7400 Wafer-Mag and MagLite are properly oriented when the top of the flowtube is either vertical or horizontal, as shown in Figure 2-7. Avoid any mounting orientation that positions the top of the flowtube at 45° from the vertical or horizontal position.

FIGURE 2-7.
7400 Wafer-Mag and
MagLite Mounting
Position.

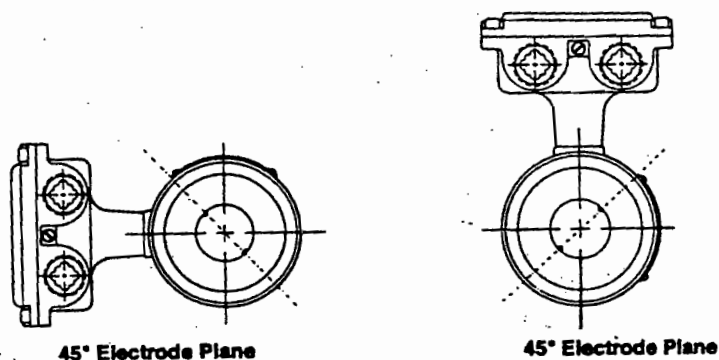
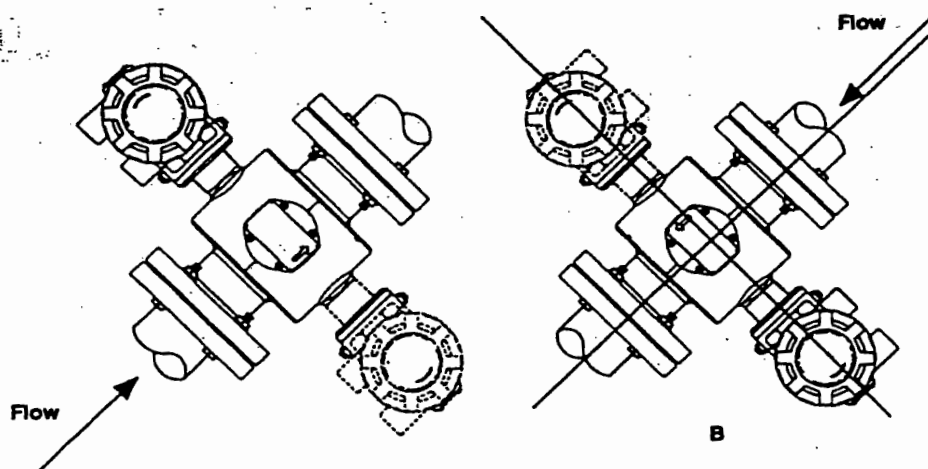


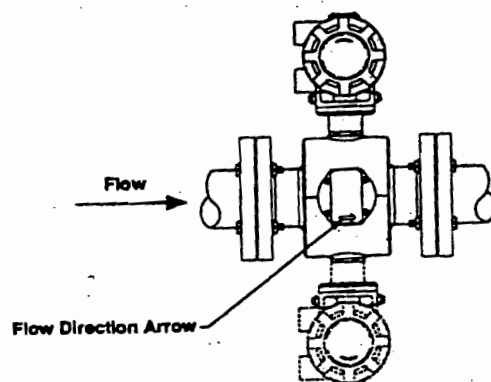
FIGURE 2-8.
Incline or



Flow Direction

The flowtube should be mounted so that the FORWARD end of the flow arrow, shown on the flowtube identification tag, points in the direction of flow through the tube (see Figure 2-9).

FIGURE 2-9. Flow Direction.



Flange Bolts

Mag 5000

Flowtube sizes and torque values for Class 150 and Class 300 flanges are listed in Table 2-1. Tighten flange bolts in the incremental sequence shown in Figure 2-11.

Always check for leaks after tightening flange bolts. All flowtubes require a second torquing 24 hours after initial flange bolt tightening.

CAUTION

Correct flange bolt tightening is crucial for proper flowtube operation and life. All bolts must be tightened in the proper sequence to the specified torque limits. Failure to observe these instructions could result in severe damage to the flowtube lining and possible flowtube replacement.

FIGURE 2-11. Mag 5000 Flange Bolt Torquing Sequence.

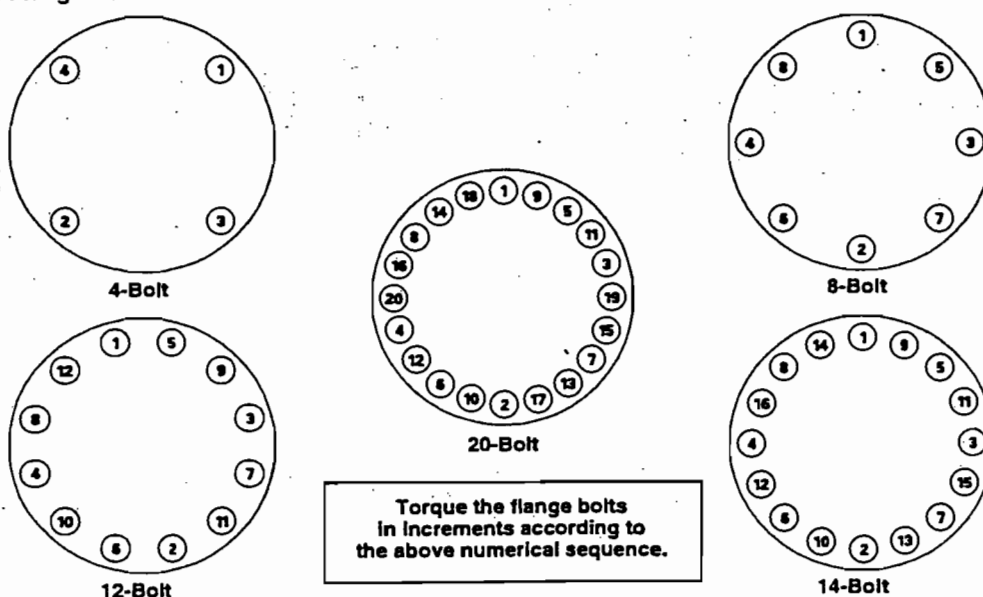


TABLE 2-1. Mag 5000 Flange Bolt Torque Specifications.

Nominal Flowtube Size (inches)	Bolt Torque Specifications in Foot-Pounds	
	Class 150 Flange	Class 300 Flange
½	10	10
1	10	10
1½	17	22
2	25	17
3	45	35
4	35	50
6	60	65
8	80	60
10	70	65
12	80	80
14	100	—
16	90	—
18	125	—
20	125	—
24	150	—
30	150	—
36	200	—

Grounding

Grounding the flowtube is one of the most important details of flowtube installation. Proper grounding ensures that only the voltage induced in the flowtube's magnetic field is measured.

Mag 5000

Use Table 2-3 to determine which grounding option figure to use for proper installation.

NOTE

Consult factory for installations requiring cathodic protection or situations where high currents or high potential exist in the process.

TABLE 2-3. Mag 5000
Grounding Installation.

Type of Pipe	Grounding Options			
	No Grounding Options	Grounding Rings	Grounding Electrodes	Lining Protectors
Conductive Unlined Pipe	See Figure 2-13	Not Required	Not Required	See Figure 2-14
Conductive Lined Pipe	Insufficient Grounding	See Figure 2-15	See Figure 2-13	See Figure 2-14
Non-conductive Pipe	Insufficient Grounding	See Figure 2-17	See Figure 2-18	See Figure 2-16

FIGURE 2-13. Mag 5000 Grounding for
Conductive Unlined Pipe and
Grounding for Conductive Lined Pipe
with Grounding Electrodes.

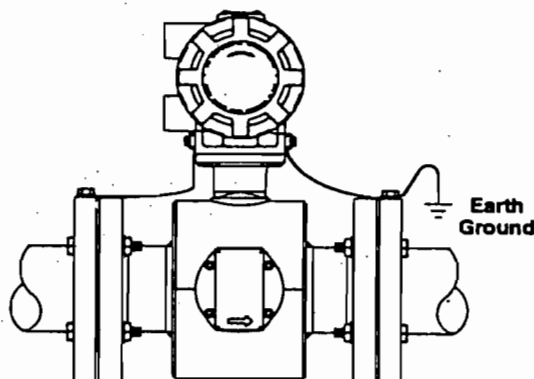


FIGURE 2-14. Mag 5000 Grounding for
Conductive Unlined Pipe with Lining
Protectors and Grounding for Conductive
Lined Pipe with Lining Protectors.

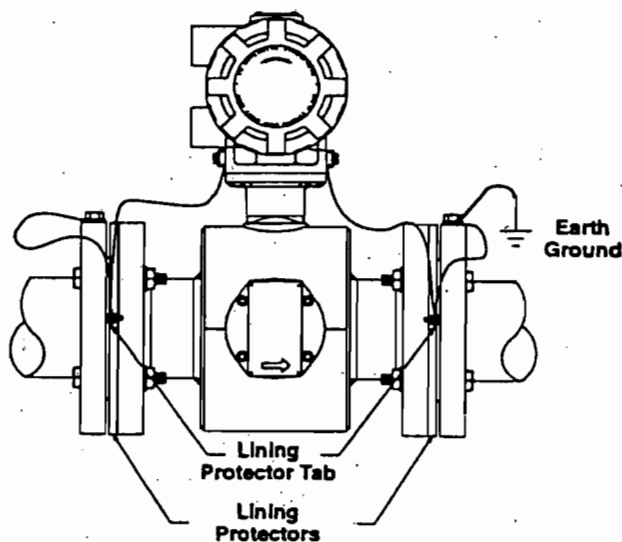
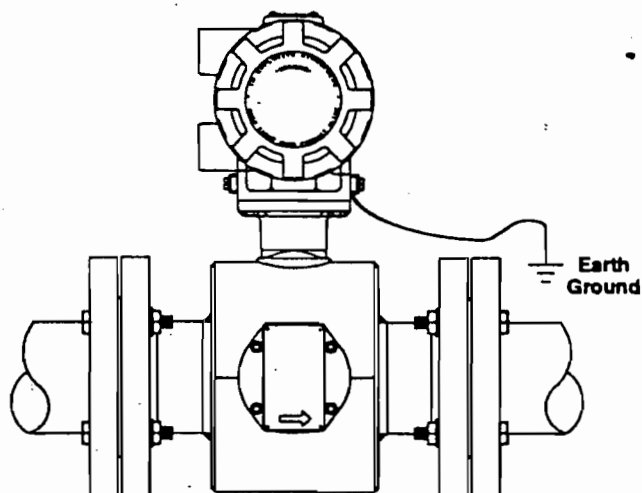


FIGURE 2-18. 7400 Wafer-Mag and MagLite Grounding for Non-conductive Pipe with Grounding Electrodes.



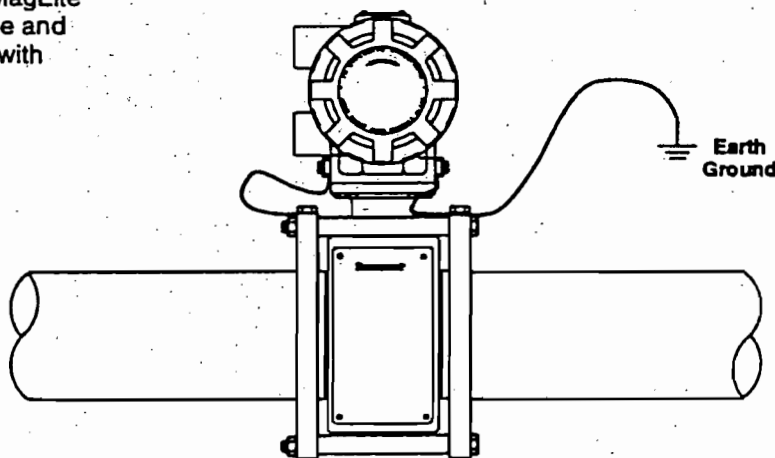
7400 Wafer-Mag and MagLite

Use Table 2-4 to help determine the grounding option required for proper operation.

TABLE 2-4.
7400 Wafer-Mag and
MagLite Grounding
Installation.

Type of Pipe	Grounding Options		
	No Grounding Options	Grounding Rings	Grounding Electrodes
Conductive Unlined Pipe	See Figure 2-19	Not Required	Not Required
Conductive Lined Pipe	Insufficient Grounding	See Figure 2-20	See Figure 2-19
Non-conductive Pipe	Insufficient Grounding	See Figure 2-18	See Figure 2-18

FIGURE 2-19. 7400 Wafer-Mag and MagLite Grounding for Conductive Unlined Pipe and Grounding for Conductive Lined Pipe with Grounding Electrodes.



Install Conduit

Transmitter junction boxes have 3/4-inch NPT conduit connections.

1. Connect the 3/4-inch NPT conduit to the transmitter in accordance with local or plant electrical codes.
2. Seal unused ports to prevent moisture or other contamination from entering the junction box.

CAUTION

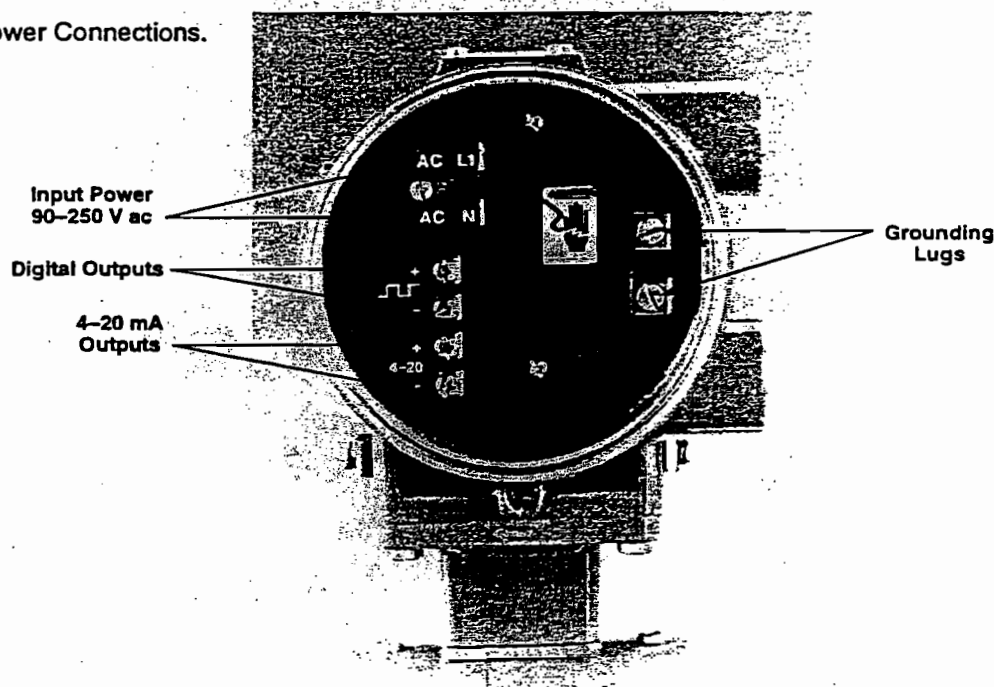
Do not overtighten metal plugs used to seal wiring compartment ports; overtightening can damage the housing.

Power Connections

To connect power to the transmitter, complete the following steps:

1. Ensure that the power source and connecting cable meet the requirements outlined in **Transmitter Input Power** on page 2-5.
2. Turn off the power source.
3. Open the power terminal cover.
4. Run the power cable through the conduit to the transmitter.
5. Loosen the terminal cable guard for terminals L1 and N.
6. Connect the power cable leads as follows:
 - Connect ac Ground to a grounding lug.
 - Connect ac Neutral to terminal N.
 - Connect ac Line to terminal L1.

FIGURE 2-23. Power Connections.



Connect Pulse Output Power Source

The Pulse Output function provides an isolated switch-closure frequency output signal that is proportional to the flow through the flowtube. The signal is normally used in conjunction with an external totalizer or control system. The following requirements apply:

Supply Voltage: Up to 24 V ac or dc.
Load Resistance: 100 to 100 k ohms (typical 1 k).
Pulse Duration: 0.5 to 100 msec (adjustable).
Maximum Power: 5.75 watts.
Switch Closure: Bi-directional MOFSET.

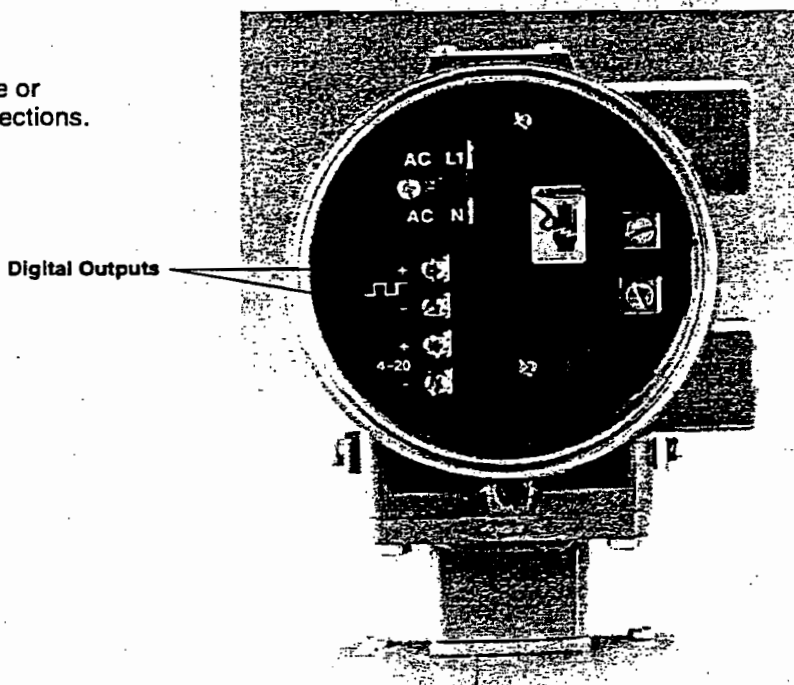
If your application uses the pulse output option, complete the following steps to connect the power source to the transmitter:

1. Ensure that the power source and connecting cable meet the requirements outlined above.
2. Turn off the transmitter and pulse output-power sources.
3. Run the power cable into the transmitter and connect according to power connections section.
4. Connect the two wires that convey switch closure information to the positive and negative digital output terminals.

NOTE

If dc power is used, it is preferred to connect - dc to terminal - and + dc to terminal +.

FIGURE 2-25. Pulse or Digital Output Connections.



Installation Check and Guide

Use this guide to check new installations of Brooks Magnetic Flowmeter Systems that appear to malfunction. For detailed troubleshooting instructions, see **Section 5: Troubleshooting**.

Before You Begin

Be sure that power to your system is off before beginning these checks.

Transmitter

1. Check for correct flowtube calibration number entered in the software. (The calibration number is listed on the flowtube nameplate.)
2. Check for correct flowtube line size entered in the software. (The line size value is listed on the flowtube nameplate.)
3. Check that the analog range of the transmitter matches the analog range in the control system.
4. Check that the forced analog output of the transmitter produces the correct output at the control system.

Flowtube

1. For horizontal flow installations, ensure that the electrodes are in a plane such that they remain covered by process fluid.
2. For vertical or inclined installations, ensure that process fluid is flowing up into the flowtube to keep the electrodes covered by process fluid.
3. Ensure that the grounding straps on the flowtube are connected to grounding rings, lining protectors, or the adjacent pipe flanges. Improper grounding will cause erratic operation of the system.

Process Fluid

1. Process fluid conductivity should be 5 μ mhos per centimeter, minimum.
2. Process fluid must be free of air and gasses.
3. Flowtube should be full of process fluid.

PROCESS LEAK PROTECTION (MAG 5000 ONLY)

The Mag 5000 Flowtube housing is fabricated from carbon steel to perform two separate functions in the flowtube design. First, it provides shielding for the flowtube magnetics so that external disturbances cannot interfere with the magnetic field and thus affect the flow measurement.

Second, it provides the physical protection to the coils and other internal components from contamination and physical damage that might occur in the industrial environment. The housing is completely welded, and the joints contain no gaskets; the totally leak-free enclosure protects the internal components, even in the most demanding installations.

Local Operator Interface

THE LOCAL OPERATOR INTERFACE (LOI)

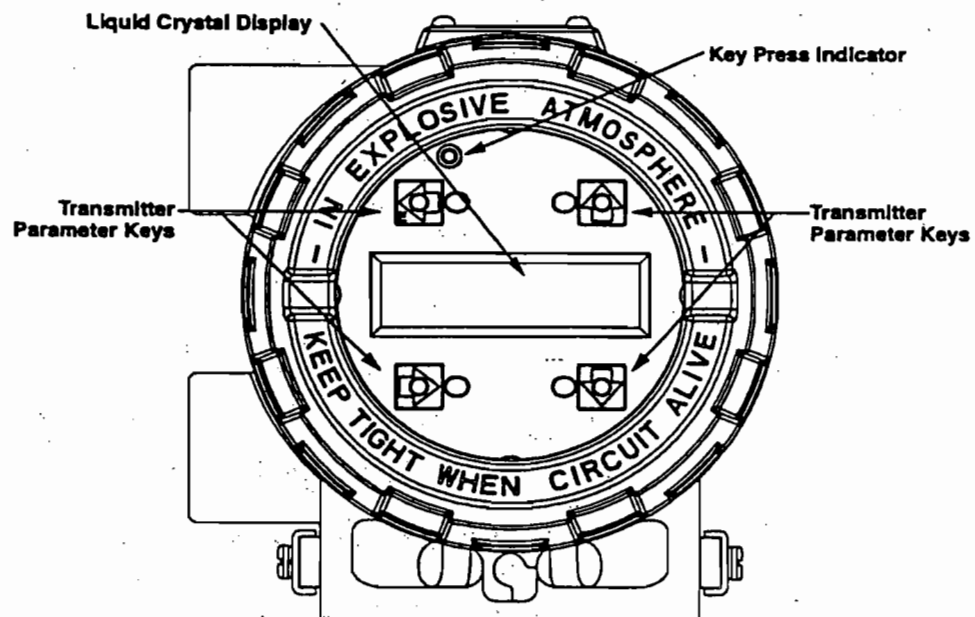
The LOI option is an operator communications center for the Smart Touch. Through the LOI, the operator can access any transmitter function for changing configuration parameter settings, checking totaled values, or other functions.

LOI Features

The LOI option contains a two-line, 16 character liquid crystal display (LCD) that is backlit and visible from any angle. This display uses optical switches that reliably detect the touch of a finger on the LOI glass. Because the switches are completely enclosed, they will not be affected by the process environment.

A red light emitting diode (LED) on the display illuminates whenever an optical switch is activated providing positive operator feedback and guarding against accidental transmitter. Table 3-2 lists and details the functions of the LOI keys.

FIGURE 3-1. Smart Touch Local Operator Interface.



Data Entry

The LOI keypad has no numerical keys. Enter numerical data using the following procedure:

1. Access the appropriate function.
2. Use → to highlight the digit you want to enter or change.
3. Use ↑ or ↓ to change the highlighted value. For numerical data, ↑ or ↓ toggles through the digits 0-9, decimal point, dash, and blank. For alphabetical data, it toggles through the letters of the alphabet A-Z, digits 0-9, and the symbols &, +, -, *, /, \$, @, %, and the blank space. (↑ or ↓ is also used to toggle through predetermined choices that do not require data entry.)
4. Use → to highlight and change other digits you want to change.
5. Press E← when the desired choice is displayed on the screen.

LOI EXAMPLES

Use the *Transmitter Parameter* keys shown in Figure 3-1 to change the parameters. The parameters are set in one of two ways: Table Value and Select Value.

Table Values

Parameters that are available from a predefined list, such as units.

Select Values

Parameters that consist of a user-created number or character string, such as a calibration number. Values are entered one character at a time using the data entry keys.

Table Value Example

Setting the TUBE SIZE:

1. Access the tube size through basic setup.
2. Press ↑ or ↓ to increment the tube size to the next value.
3. When you reach the desired size, press E←.
4. Set the loop to manual if necessary, and press E← again.

After a moment, the LCD will display the new tube size and the maximum flow rate.

Select Value Example

Changing the UPPER RANGE VALUE (URV):

1. Access the URV through basic setup.
2. Press → to position the cursor.
3. Press ↑ or ↓ to set the number.
4. Repeat steps 2 and 3 until the desired number is displayed.
5. Press E←.

DAVID COLE

WALLACE NEWTON

LOI SCREEN FLOW

hxt 269

912 489-0269

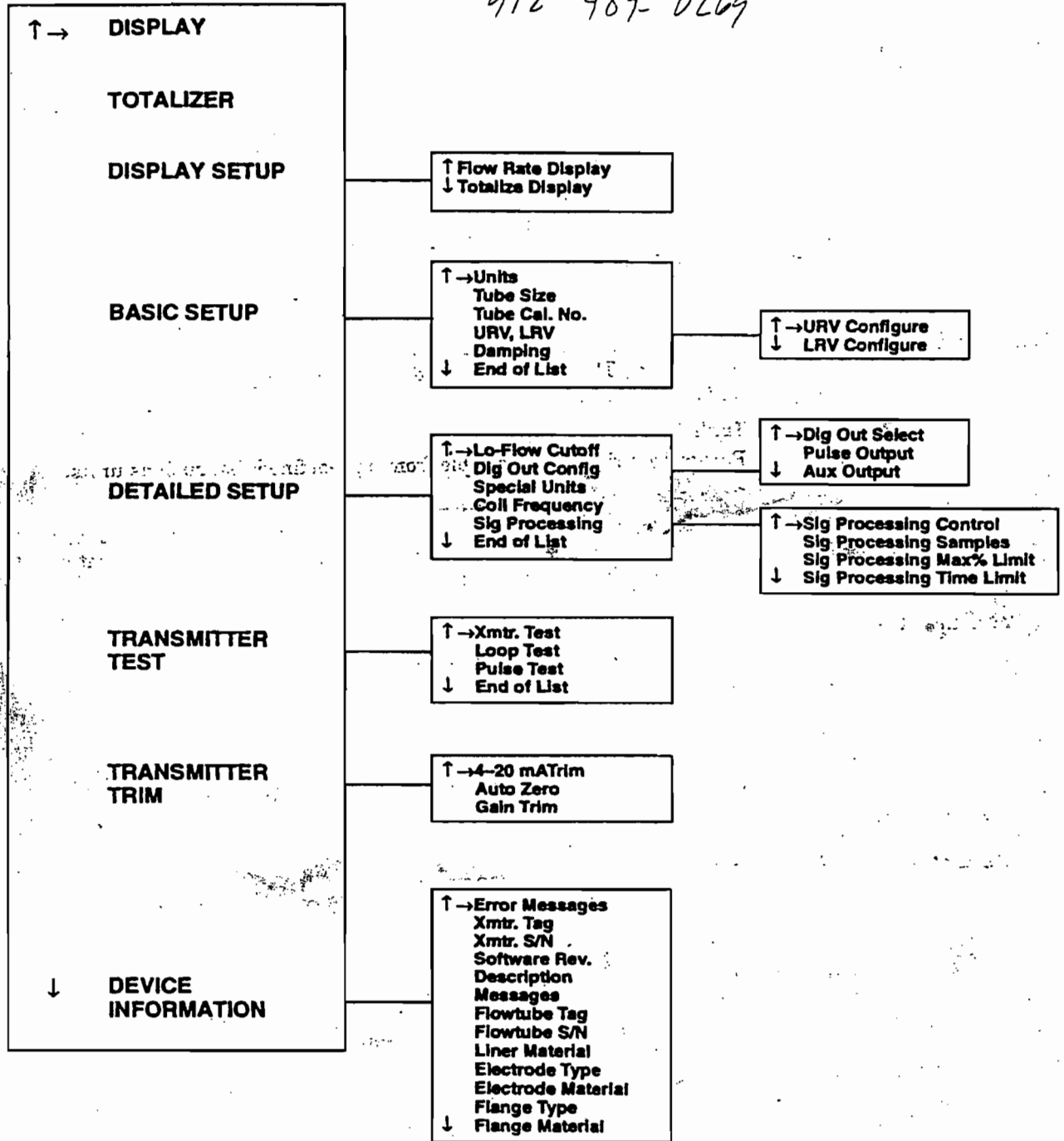


TABLE 3-2. LOI Display and Functions.

LOI Display	Transmitter Function
Display Setup	Flow Rate Display User-selected settings for transmitter flow indication: Flow-% Span, Flow-Totalize, %Span-Totalize. Totalize Display User-selected settings for transmitter totalizer indication: Forward-Reverse, Net-Gross.
Basic Setup	Units: Specifies the desired units: Gal/Min, Lit/Min, IG/Min, CuM/Hr, Ft/Sec, M/Sec, Special. Tube Size Specifies the flowtube size (0.15 through 60 inches) and identifies the corresponding maximum flow. Tube Cal No. Identifies the flowtube calibration number. URV, LRV Sets the desired 20 mA (Upper Range Value) and 4 mA (Lower Range Value) points. Flowtube size must be set first. Damping Sets response time, in seconds, to a step change in flow.
Detailed Set-up	Lo-Flow Cutoff Determines the flow rate at which the transmitter indicates an output of zero flow and 4 mA. Dig Out Config Selects pulse or auxiliary outputs, set pulse scaling and width, and select an auxiliary output (zero or reverse flow). Special Units Specifies input base unit, conversion, and time base for special units. Coil Frequency Specifies coil drive frequency of 6 or 30 Hz. Sig Processing Specifies signal processing status (on/off) and sets signal processing parameters.
Transmitter Test	XMTR Test Performs a test of the transmitter electronics. Loop Test Drives the transmitter analog output to a user-specified value. Pulse Test Drives the transmitter digital output to a user-specified value.
Transmitter Trim	4-20 mA Trim Adjusts the 4-20 mA Output. Auto Zero Performs flowtube zero for 30 Hz operation. Gain Trim Performs a calibration of the transmitter.
Device Information	Permits viewing and changing useful information about the transmitter and flowtube.

DIAGNOSTIC MESSAGES

The following error messages appear on the LOI screen when a diagnostic error is detected. To correct the problem, complete the steps as indicated. If the problem persists, contact your sales or service representative.

TABLE 3-3. LOI Error Messages.

Symptom	Potential Cause	Corrective Action
"Empty Pipe" displayed	Empty pipe. Electrode failure. Conductivity less than 5 mmho per cm.	None. Message will clear when pipe is full. Perform flowtube tests C and D on page 5-5. Increase conductivity to ≥ 5 mmho per cm.
"Coil Open ckt." displayed. Flowtube will not Autozero ("Autozero Failure" can be cleared by cycling power).	Damaged Coils. Electronics failure. Flow is not set to zero.	Check flowtube coils. Perform flowtube test A- Flowtube Coil on page 5-5. Replace Smart Touch electronics. Force flow to zero, re-perform autozero.
LOI is blank.	Smart Touch is ranged improperly. No power to transmitter. LOI failure. Electronics failure.	Correct ranging with HART-based Communicator. Connect power. Replace LOI. Replace electronics. See Replacing the Electronics Module on page 5-6.
LOI blinks, scrolls, or displays scrambled letters.	Unit experienced large transient.	Recycle power. If problem persists replace electronics.
LOI does not respond to key press.	LOI failure. Electronics failure. LOI glass is dirty.	Replace LOI. Use the HART Communicator in the interim. Replace the electronics. See Replacing the Electronics Module on page 5-6. Clean the LOI glass.

Transmitter Functions

INTRODUCTION

The Smart Touch features a full range of software functions for configuration of output from the transmitter. Software functions are accessed through the LOI (see Section 3), a HART-based communicator (see Appendix A), or a control system. Configuration variables may be changed at any time, and specific instructions are provided through on-screen instructions.

Set-up Parameters	Page
Basic Configuration	4-4
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Digital Output Configuration	4-8
Totalizer Configuration	4-11
Noise Reduction	4-12
Calibration	4-13
Transmitter Information Configuration	4-14
Multidrop Communications	4-17

Be sure to observe the following warnings and cautions before carrying out any software functions or changing configuration parameters.

⚠ WARNING

Explosions can result in death or serious injury. Do not make connections to the HART Communicator's serial port or NiCad recharger jack in an explosive atmosphere.

⚠ WARNING

Explosions can result in death or serious injury. Before connecting the HART Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or nonincendive field wiring practices.

REVIEW VARIABLES

Review

HART Fast Keys	1, 5

Before operating the Smart Touch in an actual installation, review all of the factory set configuration data to ensure that they reflect the current application.

Review the flowmeter configuration parameters set at the factory to ensure accuracy and compatibility with your particular application of the flowmeter.

NOTE

If you are using the LOI to review variables, each variable must be accessed as if you were going to change its setting. The value displayed on the LOI screen is the configured value of the variable.

If you need to make any changes to flowmeter configuration data, see **Basic Configuration** on page 4-4 for additional information.

CHECK OUTPUT VARIABLES

Process Variables

HART Fast Keys	1, 1
LOI	Display Setup

The next step of start-up and commissioning is to check the transmitter output. Smart Touch digital outputs include: flow rate (PV), pulse output, measure gross total, measure net total, and measure reverse total. The settings should be reviewed to ensure that the flowmeter is operating properly.

The process variables for the Smart Touch provide the flowmeter output. They measure flow in several ways that reflect your needs and the configuration of your flowmeter.

When commissioning a flowmeter, review each process variable, its function, and output. If you suspect a problem with the digital outputs, you may need to reconfigure the transmitter or check the troubleshooting table in Section 5: Troubleshooting.

PV—The Process Variable is the actual configured flow rate in the line. On the bench, the PV value should be zero. Check the units on the PV to make sure they are configured correctly. If the units format is not correct, see **Units** on page 4-4.

Puls Out—Pulse Output provides the actual pulse reading from the meter if your transmitter is configured for pulse output.

Measure gross totl—Measure Gross Total provides a reading of the total forward flow since the totalizer was last reset. The totalizer value should be zero during commissioning on the bench, and the units should reflect the volume units of the flow rate.

If the totalizer value is not zero, it may need to be reset (see **Totalize Display** on page 4-11).

Measure net totl—Measure Net Total provides a reading of the net totalized flow in the forward direction. The net totalize value can be reset using **READ/RESET**.

Measure reverse totl—Measure Reverse Total provides a reading of the total flow of process fluid in the reverse direction.

BASIC CONFIGURATION

Units

HART Fast Keys	1, 4, 1, 2
LOI	Basic Setup

The Basic Configuration functions of the Smart Touch must be set for all applications of the transmitter in a magnetic flowmeter system. If your application requires the advanced functionality features of the Smart Touch, see **Special Units Configuration** on page 4-5.

The units variable specifies the format in which the flow rate will be displayed. Units should be selected to meet your particular metering needs. The choices are shown below:

Choices

- Gal/Min
- Liters/Min
- ImpGal/Min
- CuMeter/Min
- FVSec
- Meters/Sec
- Special

The maximum flow rate information is not updated as the available units appear, but only after the data are entered. The maximum flow rate on the second line of the display is for informational purposes, and cannot be changed directly by the user.

If the transmitter is totalizing, the numerator of the unit of measure is used by the transmitter as the volumetric unit for totalization and pulse output scaling. For example, if gal/min is selected, the Smart Touch totalizes and provides a pulse output in gallons.

Tube Size

HART Fast Keys	1, 3, 4
LOI	Basic Setup

The tube size (or line size) must be set to match the actual flowtube connected to the transmitter. The size is set at the factory before the flowtube is shipped. If a value is entered from a control system or HART Communicator that does not match one of these figures, the value will be rounded to match the nearest choice.

The tube size choices available are as follows:

0.15, 0.30, 0.50, 1, 1.5, 2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 30, 36, 42, 48, 54, 60 (inches).

NOTE

The second line on the LOI screen, **MAX FLOW**, is strictly for informational purposes and indicates the maximum flow rate for a given line size.

Tube Cal. Number

HART Fast Keys	1, 3, 5
LOI	Basic Setup

The tube calibration number is a 16-digit number used to identify flowtubes calibrated at the Brooks factory. It provides detailed calibration information to the Smart Touch.

This number is set at the factory before the flowmeter is shipped.

Upper Range Value

HART Fast Keys	1, 4, 4, 2, 1
LOI	Basic Setup

The upper range value (URV) is preset to 30 ft/s at the factory. The units that appear will be the same as those selected under the units parameter.

The URV (20 mA point) can be set for any forward or reverse flow rate. Flow in the forward direction is represented by positive values and flow in the reverse direction is represented by negative values. The URV can be any value from -30 ft/s to +30 ft/s, as long as it is at least 1 ft/s from the Lower Range Value (LRV) (4 mA point). The URV can also be set to a value less than the LRV, which would cause the transmitter analog output to operate in reverse, with the electrical current increasing for lower (or more negative) flow rates.

SPECIAL UNITS CONFIGURATION

The Smart Touch provides a selection of standard units configurations that meet the needs of most applications (see Units on page 4-4). If, however, your application has special needs and the standard configurations do not apply, the Smart Touch provides the flexibility to configure the transmitter in a custom-designed units format.

NOTE

For flowtubes larger than 36 inches (900 mm), line size must be selected prior to configuration of special units. If special units are configured first, the communication interface may not display the correct flow rate.

To configure a special unit, set values for each function listed below.

Volume Unit

HART Fast Keys	1, 4, 1, 2, 2, 1
LOI	Detailed Setup

Special volume units enables you to display the volume unit format to which you have converted the base volume units. For example, if the special units are abc/min, the special volume variable is abc. The volume units variable is also used in totalizing the special units flow.

Base Volume Unit

HART Fast Keys	1, 4, 1, 2, 2, 2
LOI	Detailed Setup

Base volume unit is the unit from which the conversion is being made. Set this variable to the appropriate option.

Conversion Number

HART Fast Keys	1, 4, 1, 2, 2, 3
LOI	Detailed Setup

The special units conversion number is used to convert base units to special units. For a straight conversion of volume units from one to another, the conversion number is the number of base units in the new unit.

For example, if you are converting from gallons to barrels and there are 31 gallons in a barrel, the conversion factor is 31.

Base Time Unit

HART Fast Keys	1, 4, 1, 2, 2, 4
LOI	Detailed Setup

Base time unit provides the time unit from which to calculate the special units. For example, if your special units is a volume per minute, select minutes.

Flow Rate Unit

HART Fast Keys	1, 4, 1, 2, 2, 5
LOI	Detailed Setup

Flow rate units is a format variable that provides a record of the units to which you are converting. The HART Communicator and Smart Touch will display a special units designator as the units format for your primary variable. The actual special units setting you define will not appear. There are four characters available to store the new units designation.

Example

Suppose you work for a brewery, and want the Smart Touch to display flow in barrels per hour. One barrel of beer is equal to 31.0 gallons.

Set the Volume Unit to BARL.
Set the Base Volume Unit to Gallons.
Set the Input Conversion Number to 31.
Set the Time Base to Hour.
Set the Rate Unit to BR/H.

ANALOG OUTPUT CONFIGURATION

Upper Range Value (URV)

HART Fast Keys	1, 3, 2
LOI	Basic Setup

The standard 4–20 mA analog output can be configured to meet the special requirements of your application. In the standard configuration, a 4 mA output (LRV) corresponds to 0.0 ft/s in the line, while a 20 mA output (URV) corresponds to a maximum flow of 30 ft/s. The 4 and 20 mA output points can be changed to any value between –30 ft/s and 30 ft/s, but the minimum allowable range between them is 1 ft/s.

Reset the Upper Range Value (URV) to change the size of the range (or span) between the URV and LRV. Under normal circumstances, the URV should be set to a value near the maximum expected flow rate and must be between –30 ft/s to 30 ft/s.

NOTE

The minimum span between the analog output range (URV) and analog output zero (LRV) is 1 ft/s.

Lower Range Value (LRV)

HART Fast Keys	1, 3, 3
LOI	Basic Setup

Reset the Lower Range Value (LRV) to change the size of the range (or span) between the URV and LRV. Under normal circumstances, the LRV should be set to a value near the minimum expected flow rate to maximize resolution. LRV must be between –30 ft/s to 30 ft/s.

NOTE

The LRV can be set to a value greater than the URV, which will cause the analog output to operate in reverse. In this mode, the analog output will increase with lower (more negative) flow rates.

Example

If the URV is greater than the LRV, the analog output becomes 3.9 mA when the flow rate falls below the selected 4 mA point.

If the URV is less than the LRV, the analog output becomes 3.9 mA when the flow rate rises above the selected 4 mA point.

The minimum allowable span between the URV and LRV is 1 ft/s. You can not set the LRV at less than 1 ft/s of the 20 mA point. For example, if the URV is set to 15.67 ft/s and if the desired URV is greater than the LRV, then the highest allowable LRV would be 14.67 ft/s. If the desired URV is less than the LRV, then the lowest allowable analog zero setting would be 16.67 ft/s.

4–20 mA Output Trim

HART Fast Keys	1, 2, 1, 3
LOI	Transmitter Trim

For maximum accuracy, the analog output should be calibrated and, if necessary, trimmed for your system loop. The Output Trim procedure alters the conversion of the digital signal into an analog 4–20 mA output.

Use the following steps to complete the Output Trim function.

1. Set the loop to manual, if necessary.
2. Connect a precision ammeter to the 4–20 mA loop.
3. Initiate the Output Trim function with the LOI or HART Communicator.
4. Enter the 4 mA meter value when prompted to do so.
5. Enter the 20 mA meter value when prompted to do so.
6. Return the loop to automatic control, if necessary.

The 4–20 mA trim is now completed. You may repeat the 4–20 mA trim to check the results, or use the analog output test.

Analog Output Test

HART Fast Keys	1, 4, 4, 2, 3
LOI	Transmitter Test

The analog output test allows you to drive the transmitter output to a desired electric current output on the 4–20 mA terminals. This capability allows you to check the entire current loop prior to start-up. The test will terminate after five minutes if the transmitter is not returned to normal operation manually.

DIGITAL OUTPUT

Pulse Output Scaling

HART Fast Keys	1, 4, 3, 3, 1
LOI	Detailed Setup

The Smart Touch includes a pulse output option or auxiliary output option for its digital terminals.

The pulse output option equates one transistor switch closure pulse to a selectable number of volume units. The volume unit used for scaling pulse output is taken from the numerator of the configured flow units. For example, if gal/min had been chosen when selecting the flow rate unit, the volume unit displayed would be gallons.

NOTE

The scaled pulse output is designed to operate between 0 and 1000 Hz. The electronics will not accept a conversion factor that would result in a pulse frequency outside that range. The minimum conversion factor value is found by dividing the upper range value (in units of volume per second) by 1000 Hz.

When selecting pulse output scaling, remember that the maximum pulse rate is 1000 Hz. With the 110 percent overrange capability, the absolute limit is 1100 Hz. For example, if you want the Smart Touch to pulse every time 0.01 gallons pass through the flowtube, and the flow rate is 1000 gal/min, you will exceed the 1000 Hz full-scale limit:

$$\frac{1000 \text{ gal/min}}{60 \text{ sec/min} \times 0.01 \text{ gal/pulse}} = 1666.65 \text{ Hz}$$

The best choice for this parameter depends upon the required resolution, the number of digits in the totalizer, the extent of range required, and the maximum counter input frequency.

NOTE

When totalizing on the LOI, the maximum total value is 1,000,000,000.

Aux. Output Control

HART Fast Keys	1, 4, 4, 4
LOI	Detailed Setup

In lieu of the pulse output on the digital terminals, an auxiliary output is available to indicate a reverse flow or zero flow condition. The two terminals are actually a transistor switch closure, which must be externally powered.

Reverse Flow Enable

This choice activates the switch closure with a reverse flow. A forward flow is defined by the flow direction arrow on the flowtube. This also enables the totalizer to count in the reverse direction.

Zero Flow

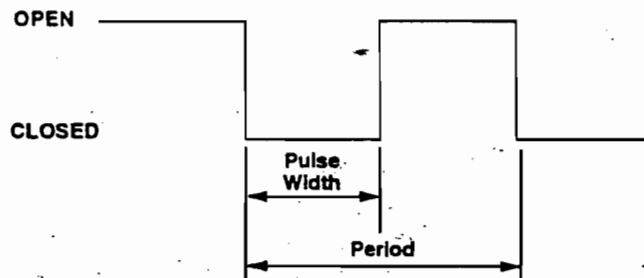
This choice activates the switch closure whenever the flow rate drops below the low flow cutoff.

Pulse Width

HART Fast Keys	1, 4, 3, 3, 2
LOI	Detailed Setup

The width, or duration, of the frequency output pulse can be adjusted to match the requirements of different counters or controllers (See Figure 4-1). The pulse width adjusts the time that the switch is closed.

FIGURE 4-1. Pulse Output.



Example

For example, if pulse width is set to 100 ms, the maximum output is 5 Hz; for a pulse width of 0.5 ms, the maximum output would be 1000 Hz. (At the maximum frequency output there is a 50 percent duty cycle.)

PULSE WIDTH	MINIMUM PERIOD (50% duty cycle)	MAXIMUM FREQUENCY
100 ms	200 ms	$\frac{1 \text{ Cycle}}{200 \text{ ms}} = 5 \text{ Hz}$
0.5 ms	1.0 ms	$\frac{1 \text{ Cycle}}{1.0 \text{ ms}} = 1000 \text{ Hz}$

To achieve the greatest maximum frequency output, set the pulse width to the lowest value that is consistent with the requirements of the pulse output power source, pulse driven external totalizer, or other peripheral equipment.

Example

The maximum flow rate is 1,000 gpm. Set the pulse output scaling such that the transmitter outputs 1000 Hz at 1,000 gpm.

$$\begin{aligned} \text{Pulse Scaling} &= \frac{\text{Flow Rate (gpm)}}{(60 \text{ s/min})(\text{Frequency})} \\ &= \frac{1,000 \text{ gpm}}{(60 \text{ s/min})(1000 \text{ Hz})} \end{aligned}$$

$$\text{Pulse Scaling} = .0167 \text{ gal/pulse}$$

$$1 \text{ Pulse} = 0.0167 \text{ gallon}$$

Example

The external counter is ranged for 350 gpm. You want to set 1 pulse for every gallon of flow. What is the maximum frequency output? (Assume the pulse width = 0.5 ms.)

$$\begin{aligned}\text{Frequency} &= \frac{\text{Flow Rate (gpm)}}{(60 \text{ s/min})(\text{Pulse Scaling gal/pulse})} \\ &= \frac{350 \text{ gpm}}{(60 \text{ s/min})(1 \text{ gal/pulse})} \\ &= 5.833 \text{ Hz}\end{aligned}$$

Example

Set the pulse output scaling to get the most accurate reading from the totalizer (highest resolution). The 20 mA point = 3,000 gpm. (Hint: Range 1000 Hz to full scale analog reading.)

$$\begin{aligned}\text{Pulse Scaling} &= \frac{\text{Flow Rate (gpm)}}{(60 \text{ s/min})(\text{Frequency})} \\ &= \frac{3000 \text{ gpm}}{(60 \text{ s/min})(1000 \text{ Hz})} \\ &= 0.05 \text{ gal/pulse}\end{aligned}$$

$$1 \text{ Pulse} = 0.05 \text{ gallon}$$

Coil Frequency

HART Fast Keys	1, 4, 1, 4, 3, 1
LOI	Detailed Setup

The coil frequency allows pulse-rate selection of the flowtube coils.

6 Hz

The standard coil pulse mode is 6 Hz, which is sufficient for nearly all applications.

30 Hz

If the process fluid causes a noisy or unstable output, increase the coil pulse mode to 30 Hz. If the 30 Hz mode is selected, perform the Auto Zero function as shown below.

Auto Zero

HART Fast Keys	1, 2, 1, 2
LOI	Transmitter Trim

The Auto Zero function initializes the transmitter for use with the 30 Hz coil drive mode only. Run this function only with the transmitter and flowtube installed in the process. The flowtube must be filled with process fluid at zero flow. Before running the auto zero function, be sure the coil drive mode is set to 30 Hz.

Set the loop to manual if necessary and begin the auto zero procedure. The transmitter completes the procedure automatically in about two minutes. A symbol appears in the lower right-hand corner of the display to indicate that the procedure is running.

TOTALIZER CONFIGURATION

Totalize Display

HART Fast Keys	1, 4, 3, 2
LOI	Detailed Setup

The totalizer tracks total flow in the process line. You can reset the totalizer to start counting from zero, as well as configure it to present the data specific to your application.

The totalize display allows you to choose the desired format for indicating the totalized values. You may choose either forward-reverse or net-gross for displaying totalized values.

Forward-Reverse

The forward-reverse function shows both the forward and reverse totalized values, updating continuously. You must choose *reverse flow enable* to allow totalizing in the reverse direction.

The forward-reverse values cannot be reset by using the totalizer reset button. These values can only be reset indirectly by doing one of the following:

- Change the pulse scaling.
- Change the tube size.
- Change the units.
- Power down a transmitter that is not equipped with the non-volatile totalizer option.

Net-Gross

Net-gross shows both net and gross total values, updating continuously. The net value can be reset by the operator. The gross value cannot be reset by using the → button. To reset it indirectly, do one of the following:

- Change the pulse scaling.
- Change the tube size.
- Change the units.
- Power down a transmitter that is not equipped with the non-volatile totalizer option.

To prevent an operator from accidentally resetting the gross value, the *Software Protect* jumper on the electronics board should be in the ON position. This action does not block the functions of the E ← and → buttons for starting and stopping or reading and resetting the totals.

Example

If you had a batch-type process, you would use the net value to measure each batch and then have the operator reset it. In addition, the gross value would keep track of a period of production (e.g., eight hour shift, day, week, month). The gross value could be reset by cycling power to the unit (if not equipped with a backed totalizer battery) or changing one of the parameters described above.

Noise Reduction

Lo-Flow Cutoff

HART Fast Keys	1, 4, 1, 3, 3
LOI	Detailed Setup

Signal Processing

HART Fast Keys	1, 4, 2, 5
LOI	Detailed Setup

Signal Processing Control

HART Fast Keys	1, 4, 2, 5, 1
LOI	Detailed Setup

Number of Samples

HART Fast Keys	1, 4, 2, 5, 2
LOI	Detailed Setup

Maximum Percent Limit

HART Fast Keys	1, 4, 2, 5, 3
LOI	Detailed Setup

Time Limit

HART Fast Keys	1, 4, 2, 5, 4
LOI	Detailed Setup

Lo-flow cutoff allows you to specify the flow rate, between 0.04 and 1.0 foot per second, below which the outputs are driven to zero. The units format for low flow cutoff cannot be changed. It is always displayed as feet per second regardless of the format selected. The low cutoff value applies to both forward and reverse flows.

Signal processing is a software algorithm that examines the quality of the electrode signal against user-specified tolerances. If spurious noise spikes are detected, they are automatically rejected.

There are three parameters associated with this function:

- Number of samples (0 to 125)
- Maximum percent limit (0 to 100 percent of running average)
- Time limit (0 to 256 seconds)

On/Off

When ON is selected, the Smart Touch output is derived using a running average of the individual flow inputs. This average is updated at the rate of 12 samples per second regardless of the selected coil drive mode. The three parameters that make up signal processing (number of samples, maximum percent limit, and time limit) are described individually below.

0 to 125 Samples

The number of samples function sets the number of previous inputs used to calculate the average value. Because the output stage of the Smart Touch circuit is updated twelve times each second, regardless of 6 or 30 Hz coil drive mode, the factory preset value of 90 samples equates to 7.5 seconds. For example, if you select a sample number of 120, the response time of the system will be 10 seconds (120 samples / 12 samples per second). A suggested nominal number of 90 samples is a good starting point for most applicable process fluids.

0 to 100 Percent

The maximum percent limit is a tolerance band set up on either side of the running average. The percentage value refers to deviation from the running average. For example, if the running average is 100 gal/min, and a 2 percent maximum limit is selected, then the acceptable range is from 98 to 102 gal/min.

Values within the limit are accepted while values outside the limit are analyzed to determine if they are a noise spike or an actual flow change.

0 to 256 Seconds

This parameter forces the output and running average values to the new value of an actual flow rate change that is outside the percent limit boundaries. It thereby limits response time to flow changes to the time limit value rather than the length of the running average.

For example, if the number of samples selected is 120, then the response time of the system is 10 seconds. In some cases this may be unacceptable. By setting the time limit, you can force the Smart Touch to clear the value of the running average and re-establish the output and average at the new flow rate once the time limit has elapsed. This parameter limits the response time added to the loop. A suggested time limit value of 2 seconds is a good starting point for most applicable process fluids. The selected signal processing configuration may be turned ON or OFF to suit your needs.

CALIBRATION

Damping

HART Fast Keys	1, 2, 3
LOI	Basic Setup

Gain Trim

HART Fast Keys	1, 4, 1, 4
LOI	Transmitter Trim

The Smart Touch offers the calibration functions described below.

Damping allows selection of a response time, in seconds, to a step change in flow rate. It is most often used to smooth fluctuations in output.

You will need a Brooks Model 7798 Calibration Standard to complete a gain trim.

Gain trim is the function by which the factory calibrates the transmitter. This procedure is rarely needed by customers. It is only necessary if you believe the Smart Touch is no longer accurate. It must be performed only with the coil drive mode set to 6 Hz and with a nominal flowtube calibration number stored in the memory.

CAUTION

Attempting an electronics trim without a Model 7798 may result in an inaccurate transmitter, or a "DIGITAL TRIM FAILURE" message may appear. If this message occurs, no values were changed in the transmitter. Simply power down the Smart Touch to clear the message. If the trim was completed or no error message appears, correction requires a Model 7798.

To simulate a nominal flowtube with the Model 7798, you must change the following parameters in the Smart Touch:

- Tube Calibration Number—1000015010000000
- Units—ft/s
- Upper Range Value—20 mA = 30.00 ft/s
- Lower Range Value—4 mA = 0 ft/s
- Coil Frequency—6 Hz

The instructions for changing these parameters are located in the parameter descriptions in this section.

Set the loop to manual, if necessary, before you begin. Complete the following steps:

1. Power down the transmitter.
2. Connect the transmitter to a Model 7798 Flowtube Simulator.
3. Power up the transmitter with the Model 7798 connected and read the flow rate. The electronics need about a 30-minute warm-up time to stabilize.
4. The flow rate reading after warm-up should be between 29.97 and 30.03 ft/s.
5. If the reading is within the range, return the transmitter to the original configuration parameters.
6. If the reading is not within this range, initiate an electronics trim with the LOI or HART Communicator. The gain trim takes about 6 minutes to complete. No transmitter adjustments are required.

TRANSMITTER INFORMATION CONFIGURATION

Transmitter Tag

HART Fast Keys	1, 4, 5, 1
LOI	Device Information

This function allows you to view and change identification data and other information about the transmitter and flowtube. This information does not affect the performance or operation of the transmitter; it is strictly for information purposes (exceptions are noted below).

Transmitter tag is the quickest and shortest way of identifying and distinguishing between transmitters. Transmitters can be tagged according to the requirements of your application. The tag may be up to eight characters long and is user-defined.

Software Revision Number

HART Fast Keys	1, 4, 5, 9, 3
LOI	Device Information

The Smart Touch microcontroller will automatically read the software revision and display it under this heading. The software revision number is not user-changeable.

Descriptor

HART Fast Keys	1, 4, 5, 2
LOI	Device Information

Descriptor is a longer user-defined variable to assist with more specific identification of the particular transmitter. It is usually used in multi-transmitter environments and provides 16 characters.

Message

HART Fast Keys	1, 4, 5, 3
LOI	Device Information

The message variable provides an even longer user-defined variable for identification and other purposes. It provides 32 characters of information and is stored with the other configuration data.

Date

HART Fast Keys	1, 4, 5, 4
LOI	Device Information

Date is a user-defined variable that provides a place to save the date of the last revision of configuration information.

Flowtube Tag

HART Fast Keys	1, 4, 5, 8
LOI	Device Information

Flowtube tag is the quickest and shortest way of identifying and distinguishing between Flowtubes. Flowtubes can be tagged according to the requirements of your application. The tag may be up to eight characters long and is user-defined.

Flowtube Serial Number

HART Fast Keys	1, 4, 1, 3, 5
LOI	Device Information

The flowtube serial number is stored in the transmitter configuration for future reference. The number provides easy identification if the flowtube needs servicing or for other purposes.

Liner Material

HART Fast Keys	1, 4, 5, 7, 5
LOI	Device Information

Liner Material enables you to select the liner material for the attached flowtube. This variable needs to be changed only if you have replaced your flowtube.

- PTFE Teflon
- ETFE Tefzel
- Polyurethane
- Natural Rubber
- Neoprene
- Ryton
- Other

Electrode Type

HART Fast Keys	1, 4, 5, 7, 3
LOI	Device Information

Electrode Type enables you to select the electrode type for your magnetic transmitter system. This variable needs to be changed only if you have replaced electrodes in the hardware.

- Standard
- Std and Ground
- Bullet
- Other

Electrode Material

HART Fast Keys	1, 4, 5, 7, 4
LOI	Device Information

Electrode Type enables you to select the electrode material for your magnetic transmitter system. This variable needs to be changed only if you have replaced electrodes in the hardware.

- 316L SST
- Hast-C 276
- Tantalum
- Pt-Ir
- Titanium
- Ryton
- Alloy 20
- Other

Flange Type

HART Fast Keys	1, 4, 5, 7, 1
LOI	Device Information

Flange Type enables you to specify the type of flange on the transmitter for later reference. This variable is preset at the factory but can be changed if necessary.

- ANSI 150
- ANSI 300
- ANSI 600
- ANSI 900
- PN 10
- PN 16
- PN 25
- PN 40
- PN 64
- Flangeless
- Other

Flange Material

HART Fast Keys	1, 4, 5, 7, 2
LOI	Device Information

Flange Material is a factory-set configuration variable that reflects the construction of your flowtube.

- Carbon steel
- 304 SST
- 316L SST
- Flangeless
- Other

For flowtubes without flanges, this screen can be ignored or used to indicate the adjacent pipe flange material.

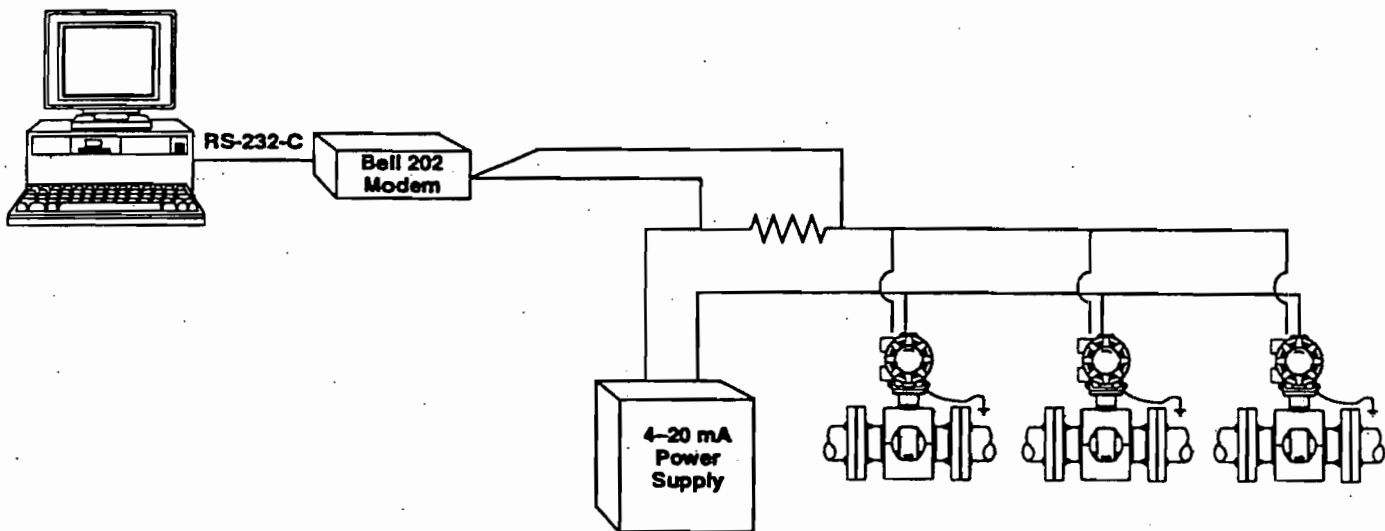
MULTIDROP COMMUNICATIONS

Multidrop configuration refers to the connection of several transmitters to a single communications transmission line. Communication between the HART Communicator and the transmitters takes place digitally with the analog output of the transmitters deactivated. Using the HART communications protocol, up to 15 transmitters can be connected on a single twisted pair of wires or over leased phone lines.

The use of a multidrop installation requires consideration of the update rate necessary from each transmitter, the combination of transmitter models, and the length of the transmission line. Multidrop installations are not recommended where intrinsic safety is a requirement. Communication with the transmitters can be accomplished with commercially available Bell 202 modems and a host implementing the HART protocol. Each transmitter is identified by a unique address (1-15) and responds to the commands defined in the HART protocol.

Figure 4-2 shows a typical multidrop network. This figure is not intended as an installation diagram. Contact Brooks product support with specific requirements for multidrop applications.

FIGURE 4-2. Typical Multidrop Network.



The HART Communicator can test, configure, and format a multidropped Smart Touch in the same way as it can a Smart Touch in a standard point-to-point installation.

NOTE

The Smart Touch is set to poll address zero at the factory, allowing it to operate in the standard point-to-point manner with a 4-20 mA output signal. To activate multidrop communication, the transmitter poll address must be changed to a number between 1 and 15. This change deactivates the 4-20 mA analog output, sending it to 4 mA. It also disables the failure mode alarm signal.

Auto Poll

HART Fast Keys	OFF LINE FCN

When the HART Communicator is powered up and auto polling is on, it automatically polls the transmitter addresses to which it is connected. If the address is 0, the HART Communicator enters its normal on-line mode. If it detects an address other than 0, the communicator finds each device in the loop and lists them by poll address and tag number. Use the action keys to scroll through the list and select the transmitter with which you need to communicate.

If a single connected device has an address other than zero and auto polling is off, the device will not be found.

Poll Address

HART Fast Keys	1, 4, 4, 3, 1

Poll Address enables you to set the poll address for a multi-dropped meter. The poll address is used to identify each meter on the multi-drop line. Follow the on-screen instructions to set the address at a number from 1 to 15. To set or change the flowmeter address, establish communication with the selected Smart Touch in the loop.

Troubleshooting

BASIC TROUBLESHOOTING

Problems in the magnetic flowmeter system are usually indicated by incorrect output readings from the system, error messages, or failed tests. Consider all sources when identifying a problem in your system.

TABLE 5-1. Basic Troubleshooting—Smart Touch.

Symptom	Potential Cause	Corrective Action
Output at 0 mA.	No power to transmitter. Analog output improperly configured. Electronics failure.	Check power source and connections to the transmitter. Check the analog power switch. See Hardware Switches on page 2-2 for proper settings. Replace the electronics boards.
Output at 4 mA.	Transmitter in multidrop mode. Low Flow Cutoff set too high. Flow is in reverse direction. Shorted coil. Empty pipe. Electronics failure.	Configure Poll Address to 0 to take transmitter out of multidrop mode. Configure low-flow cutoff to a lower setting or increase flow to a value above the low-flow cutoff. Enable Reverse Flow function. Coil check. Perform flowtube Test A and B on page 5-5. Fill pipe. Replace the electronics boards.
Output at 21.6 mA.	Transmitter not ranged properly.	Reset the transmitter range values. See Lower Range Value (LRV) and Upper Range Value (URV) on page 4-6. Check tube size setting in transmitter and make sure it matches your actual tube size. See Units on page 4-4.
Output at alarm level.	Electronics failure.	Cycle power. If alarm is still present, replace the electronics boards.
Pulse output at zero, regardless of flow.	No power to transmitter. Wiring error. Reverse flow. Pulse width too wide or too narrow. Electronics failure.	Check power source and connection to the transmitter. Check pulse output wiring at digital output terminals. Refer to wiring diagram for pulse output. Enable Reverse Flow function. Reset pulse width. See Pulse Width on page 4-9. Replace the electronics boards.
Communication problems with the HART Communicator.	4–20 mA output configuration. Communication interface wiring problems. Low batteries in the HART Communicator. Old revision of software in the HART Communicator.	Check analog power switch (internal/external). HART Communicator requires a 4–20 mA output to function. Incorrect load resistance (250 V minimum). Check appropriate wiring diagram in Appendix A. Replace the batteries in the HART Communicator. See the communicator manual for instructions. Consult your local sales office about updating to the latest revision of software.
Error Messages on LOI or HART Communicator	Many possible causes depending upon the message.	See the Error Messages Table for the LOI (Section 3) or the Diagnostic Messages for the HART Communicator (Appendix A).

ADVANCED TROUBLESHOOTING

If your system is experiencing problems and the basic troubleshooting steps do not address your problem, use the following advanced troubleshooting procedures or call your service representative. The procedure for advanced troubleshooting is as follows:

1. Consider symptoms in the basic troubleshooting table.
2. Consider symptoms in the advanced troubleshooting table.
3. Run the software tests, if possible.
4. Perform the flowtube tests to see if flowtube must be removed from the process line.
5. If the problem persists, contact your sales or service representative.

Process Noise

In some circumstances, process conditions themselves can cause the meter output to be unstable. The basic procedure for addressing a noisy process situation is outlined below. Complete them in order. When the output attains the desired stability, no further steps are required.

Noisy Conditions Basic Procedure

1. Change coil drive to 30 Hz.
2. Increase the damping.
3. Activate signal processing.

TABLE 5-2. Advanced Troubleshooting—Smart Touch.

Accuracy		
Symptom	Potential Cause	Corrective Action
Reading doesn't appear to be within rated accuracy.	Transmitter, control system, or other receiving device not configured properly.	Check all configuration variables for the transmitter, flowtube, communicator, and/or control system. See Process Variables on page 4-3.
		Check these other transmitter settings: • Flowtube calibration number • Units • Line size
		Perform a loop test to check the integrity of the circuit. See Loop Test on page 5-4.
	Electrode Coating.	Use replaceable electrodes in Mag 5000 Downsize flowtube to increase flow rate above 3 ft/s. Periodically clean flowtube.
	Air in line.	Move the flowtube to another location in the process line to ensure that it is full under all conditions.
	Flow rate is below 1 ft/s (specification issue).	See accuracy specification for specific transmitter and flowtube.
	Auto zero was not performed when the coil drive frequency was changed from 6 Hz to 30 Hz.	Perform the auto zero function. See Auto Zero on page 4-10.
	Flowtube failure—Shorted electrode.	Perform flowtube Tests C and D on page 5-5.
	Flowtube failure—Shorted or open coil.	Perform flowtube Tests A and B on page 5-5.
	Transmitter failure.	Replace the electronics boards.

TABLE 5-2. Advanced Troubleshooting-Smart Touch.

Symptom	Potential Cause	Corrective Action
Noisy Process.	Chemical additives upstream of magnetic flowmeter.	Complete the Noisy Process Basic procedure (page 5-2). Move injection point downstream of magnetic flowmeter, or move magnetic flowmeter.
	Sludge flows-Mining/Coal/Sand/Slurries (other slurries with hard particles).	Decrease flow rate below 10 ft/s.
	Styrofoam or other insulating particles in process.	Complete the Noisy Process Basic procedure (page 5-2). Consult factory.
	Electrode coating.	Use replaceable electrodes in Mag 5000. Use a smaller flowtube to increase flow rate above 3 ft/s. Periodically clean flowtube.
	Air in line.	Move the flowtube to another location in the process line to ensure that it is full under all conditions.
Meter output is unstable.	Electrode incompatibility.	Check for chemical compatibility with electrode material.
	Improper grounding.	Check ground wiring. See Grounding on page 2-15 for wiring and grounding procedures.
	High local magnetic or electric fields.	Move magnetic flowmeter (20-25 ft. away is usually acceptable).
	Control loop improperly tuned.	Check control loop tuning.
	Sticky valve (look for periodic oscillation of meter output).	Correct valve sticking.
	Flowtube failure.	Perform Flowtube Tests A, B, C, and D on page 5-5.
	Analog output loop problem.	Check that the 4-20 mA loop matches the digital value. Perform analog output test.

SOFTWARE TESTING

Loop Test

HART Fast Keys	1, 2, 2
LOI	Transmitter Test

The analog output test drives the transmitter output to a desired electrical current output on the 4–20 mA terminals. This capability allows you to check the entire current loop prior to start-up. On the LOI the test quits after five minutes if the transmitter is not returned to normal operation manually.

Pulse Test

HART Fast Keys	1, 4, 3, 3, 3
LOI	Transmitter Test

The pulse output test allows you to drive the frequency output at digital output terminals to a desired value. This capability allows you to check auxiliary equipment prior to start-up. On the LOI the test quits after five minutes if the transmitter is not manually returned to normal operation.

Transmitter Test

HART Fast Keys	1, 2, 1, 1, 2

The transmitter test initiates a series of diagnostic tests that are not performed continuously during normal operation. It performs the following tests:

- Display Test
- RAM Test
- PROM Test

During the entire transmitter test, all outputs are driven to full-scale: 20 mA and 1,000 Hz. The test requires about 10 seconds to complete.

Flowtube Troubleshooting Procedures

The following tests can check Mag 5000 or 7400 Wafer-Mag and MagLite flowtubes in line and full of process material. The tests allow you to determine whether or not the flowtube needs to be removed from the process. The transmitter must be removed to conduct these tests. Use the following procedure to remove the transmitter:

Transmitter Removal Procedure

1. Remove power to the transmitter.
2. Remove the electronics compartment cover.
3. Carefully unhook the wires at the base of the electronics stack.
4. Remove the four bolts that attach the flowtube to the transmitter.
5. Carefully remove the housing, ensuring not to snag any wires.
6. Leave the wiring harness connected to the flowtube terminal block.

Transmitter Assembly Procedure

1. Carefully attach the electronics stack to the housing.
2. Secure the four bolts that attach the flowtube to the transmitter.
3. Carefully hook up the wires at the base of the electronic stack.
4. Attach the electronics compartment cover.
5. Restore power to the transmitter.

TABLE 5-3. Magnetic Flowmeter Troubleshooting Chart.

Test A—Flowtube Coil		
Step 1	Step 2	Step 3
Remove transmitter. Take all readings across flowtube terminals.	➤ Measure the resistance across wires 1 and 2 going to the flowtube, using the lowest ohms scale. The reading should be between 2 and 18 V.	➤ A reading outside this range indicates that the coils or cables are open or shorted.
Test B— Coil Shield to Coil		
Step 1	Step 2	Step 3
Remove transmitter. Take all readings across flowtube terminals.	➤ Measure the resistance from the coil shield (ground) to wires 1 and 2 using the highest ohms scale. Both readings should be overrange.	➤ Any reading on the scale indicates that the coils are shorted to the housing.
Test C— Electrode Shield Resistance		
Step 1	Step 2	Step 3
Remove transmitter. Take all readings across flowtube terminals. Test with process in the flowtube (either in flowing or non-flowing condition.)	➤ Measure the resistance from wire 17 to 18 and 17 to 19. This reading will change as you hold the leads on the wires, so use the initial reading. These readings should both be close to each other.	➤ A reading less than 100 kV indicates a possible shorted electrode. A high reading indicates a possible coated electrode, nonconductive process, or electrode not in contact with the process. A stable reading indicates a shorted electrode.
Test D— Positive to Negative Electrode		
Step 1	Step 2	Step 3
Remove transmitter. Take all readings across flowtube terminals. Test with process in the flowtube (either in flowing or non-flowing condition.)	➤ Measure the resistance between wires 18 and 19. This reading should be in the range between 100 kV and 600 kV.	➤ An overrange reading indicates a coated electrode, nonconductive process, or electrode not in contact with the process.

SOFTWARE

Specifications and Reference Data

SPECIFICATIONS

FUNCTIONAL SPECIFICATIONS

Flowtube Compatibility

Compatible with Brooks Mag 5000 or 7400 Wafer-Mag and MagLite Flowtubes.

Flow Rate Range

Capable of processing signals from fluids that are traveling between 0.04 and 30 ft/s (0.01 to 10 m/s) for both forward and reverse flow in all flowtube sizes. Full scale continuously adjustable between -30 and 30 ft/s (-10 to +10 m/s).

Fluid Conductivity

Fluid must have conductivity of at least 5 microsiemen/cm.

Power Supply

90-250 Vac, 50-60 Hz or 15-50 Vdc.

Power Consumption

10 watts maximum.

Ambient Temperature Limits

Operating

-40 to 165 °F (-40 to 74 °C).

Storage

-40 to 185 °F (-40 to 85 °C).

Output Signals

4-20 mA, switch-selectable as internally or externally powered; 0 to 1000 ohm load.

On the digital output terminals, a scalable frequency output is available, 0 to 1000 Hz; transistor switch closure up to 5.75 W, externally powered, 5 to 24 V ac or dc.

HART Communications, digital flow signal, superimposed on 4-20 mA signal, available for control system interface. 250 ohms required for HART Communications.

Analog Output Adjustment

Engineering units, lower and upper range values are user-selected. Output automatically scaled to provide 4 mA at selected lower range value, 20 mA at the selected upper range value. Full scale continuously adjustable between -30 and +30 ft/s (-10 to +10 m/s), 1 ft/s (0.3 m/s) minimum span. 4 mA also continuously adjustable.

Scalable Frequency Adjustment

Pulse Value

Value of one pulse can be set to equal desired volume in selected engineering units.

Pulse Width

Adjustable from 0.5 to 100 ms. Local Operator Interface option automatically calculates and displays maximum allowable output frequency.

Software Lockout

Security switch on electronics can be set for deactivation of all LOI and HART-based communicator functions that affect the transmitter input/output.

Auxiliary Output Function

In lieu of a scalable frequency output, an auxiliary output is available using the digital output terminals. Transistor switch closure up to 5.75 W, externally powered, 5 to 24 V ac or dc, to indicate either:

Reverse Flow

Activates switch closure output when reverse flow is detected. The reverse flow rate is displayed.

Zero Flow

Activates switch closure output when flow goes to 0 ft/s.

Output Testing

Current Source

Transmitter can be commanded to supply a specified current between 3.75 and 23.25 mA.

Frequency Source

Transmitter can be commanded to supply a specified frequency between 1 and 1000 Hz.

Turn-on Time

30 minutes to rated accuracy from power up; 5 seconds from power interruption.

Start-up Time

0.2 seconds from zero flow.

Low-Flow Cutoff

Adjustable between 0.04 and 1 ft/s (0.01 and 0.3 m/s). Below selected value, output is driven to the zero flow rate signal level.

Humidity Limits

0–100% RH to 150 °F (65 °C).

Overrange Capability

Signal output continues to 110% of upper range value setting, then remains constant. Out of range message displayed on LOI and the HART Communicator.

Damping

Adjustable between 0.2 and 256 seconds.

Flowtube Compensation

Brooks flowtubes are flow-calibrated and assigned a calibration factor at the factory. The calibration factor is entered into the transmitter, enabling interchangeability of flowtubes without calculations or a compromise in accuracy.

**Performance
Specifications**

Standard Hazardous Locations Certifications

Factory Mutual (FM) Approval

Approved for Class I, Division 2, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III hazardous locations. NEMA 4X.

Canadian Standards Association (CSA) Approval

Approved for Class I Division 2, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III hazardous locations, CSA enclosure 4.

Optional Hazardous Locations Certifications

FM Approval (E5)

Approved for Class I, Division 1, Groups C and D.

(System specifications are given using the frequency output and with the unit at reference conditions.)

Accuracy

System accuracy is $\pm 0.5\%$ of rate from 1 to 30 ft/s (0.3 to 10 m/s); below 1.0 ft/s (0.3 m/s), the system has an accuracy of ± 0.005 ft/s (0.0015 m/s). Analog output has the same accuracy as frequency output plus an additional 0.05% of span.

Repeatability

$\pm 0.1\%$ of reading.

Response Time

0.2 seconds maximum response to step change in input.

Stability

$\pm 0.1\%$ of rate over six months.

Ambient Temperature Effect

$\pm 0.25\%$ change over operating temperature range.

Electromagnetic Compatibility

Designed to the increased requirements from the NAMUR Recommendations: May 1993, Part 1. Electromagnetic compatibility (EMC) for process and laboratory apparatus.

Vibration Effect

Meets IEC 770 Pipeline Installation Conditions.

Physical Specifications

Electrical Connections

¾-14 NPT connections provided on the transmitter housing. PG13.5 and CM20 adapters are available. Screw terminals provided for all connections. Power wiring connected to transmitter only. Integrally mounted transmitters are factory wired to the flowtube.

Mounting

Transmitter is mounted integrally with the flowtube.

Materials of Construction

Housing

Low copper aluminum, NEMA 4X and IEC 529 IP66.

Paint

Polyurethane.

Cover Gasket

Rubber.

Weight

Approximately 7 pounds (3.2 kg). Add 1 pound (0.5 kg) for the M4 option.

TRADEMARKS

Brooks is a trademark of Brooks Instrument Division, Emerson Electric Co.

HART is a trademark of HART Communication Foundation

Neoprene is a trademark of E.I. DuPont de Nemours Co.

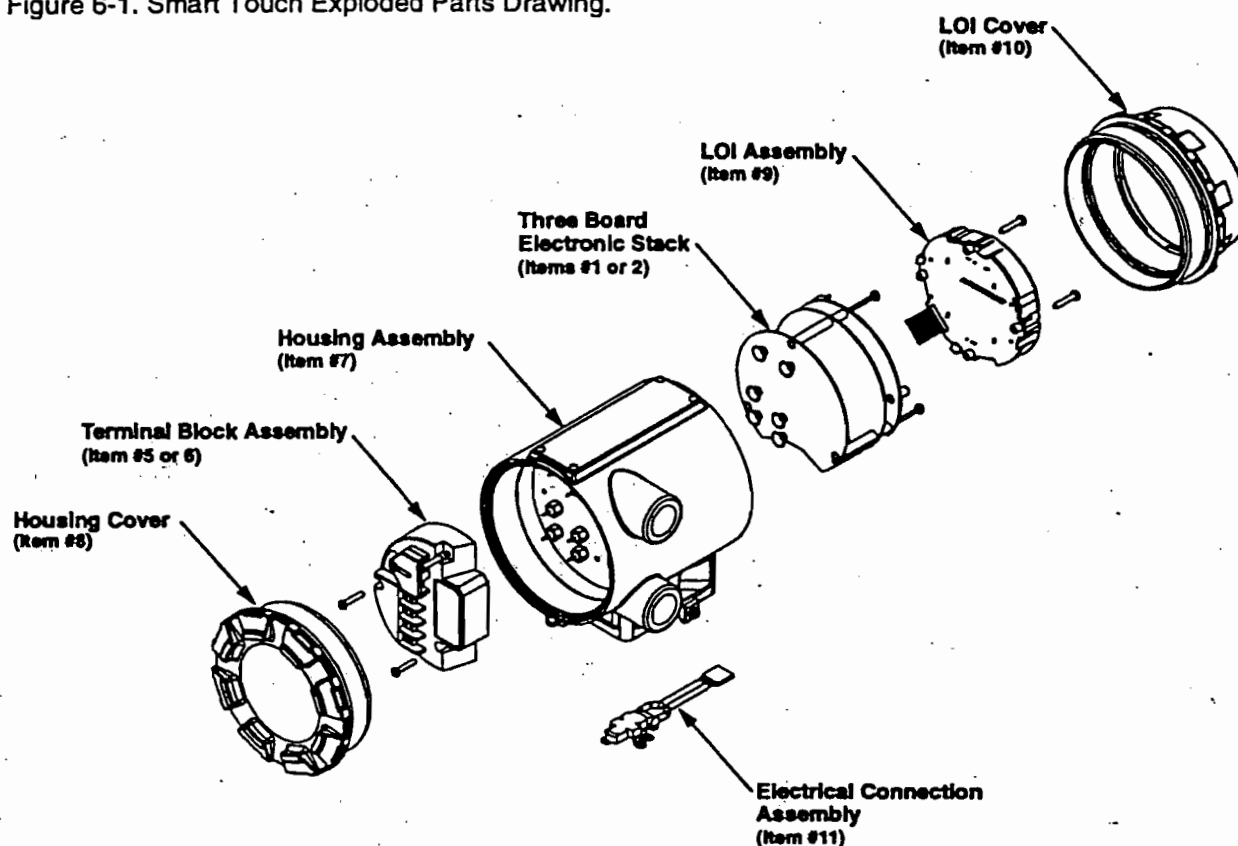
Teflon is a trademark of E.I. DuPont de Nemours Co.

Tefzel is a trademark of E.I. DuPont de Nemours Co.

ORDERING INFORMATION

Code	Description
352	Base Model Number
Code	Local Operator Interface
3	None, No local operator interface (LOI)
4	None, Factory configured to customer specifications
5	Local operator interface package (includes display)
6	Local operator interface package (Factory configured to customer specification)
Code	Revision Level
C	Level C
Code	Mounting
3	For integral mounting to flow element
Code	Hazardous Location Operation
B	FM/CSA Class 1, Division 2, all groups, NEMA 4X
C	FM Class I, Division 1, Group C & D. Available with Model 7400 flow elements only.
Code	Electrical transient protection
1	Without electrical transient protection
4	With electrical transient protection
Code	Totalizer (Display total with LOI or HART Communicator)
A	Standard totalizer
B	Non-volatile totalizer (to retain total on loss of power)
Code	Line Powers
1	90 to 250 Vac
3	15-50 Vdc
Code	Conduit Connectors
1	3/4 NPT, No adaptors
Code	Accuracy
1	+/- 0.50% of rate accuracy (standard)
2	+/- 0.25% of rate accuracy. Available only with Mag 5000.
Code	Internal Use
A	Always

Figure 6-1. Smart Touch Exploded Parts Drawing.



Smart Touch Spare Parts

Part Description	Item Number	Part Number
Smart Touch Electronics, 90–250 V ac (includes mounting hardware)	1	08732-0001-0001
Smart Touch Electronics with Non-volatile Totalizer, 90–250 V ac (includes mounting hardware)	2	08732-0001-0003
Standard Terminal Block Assembly (includes mounting hardware)	5	08732-0002-0001
Transient Protection Terminal Block Assembly (includes mounting hardware)	6	08732-0002-0002
Integral Mount Housing Assembly (does not include terminal block assembly)	7	08732-0004-0001
Standard Housing Cover (without glass for LOI)	8	08732-0005-0001
Local Operator Interface (LOI) Assembly (does not include LOI cover)	9	08732-0006-0002
LOI Cover	10	08732-0007-0002
Electrical Connection Assembly	11	08732-0133-0001

NOTE 1

When removing or replacing the transmitter housing, refer to **Transmitter Removal Procedure** on page 5-5.

NOTE 2

Housing covers (Item 8) used at both ends of transmitters for transmitters without LOI.

HART Communicator

INTRODUCTION

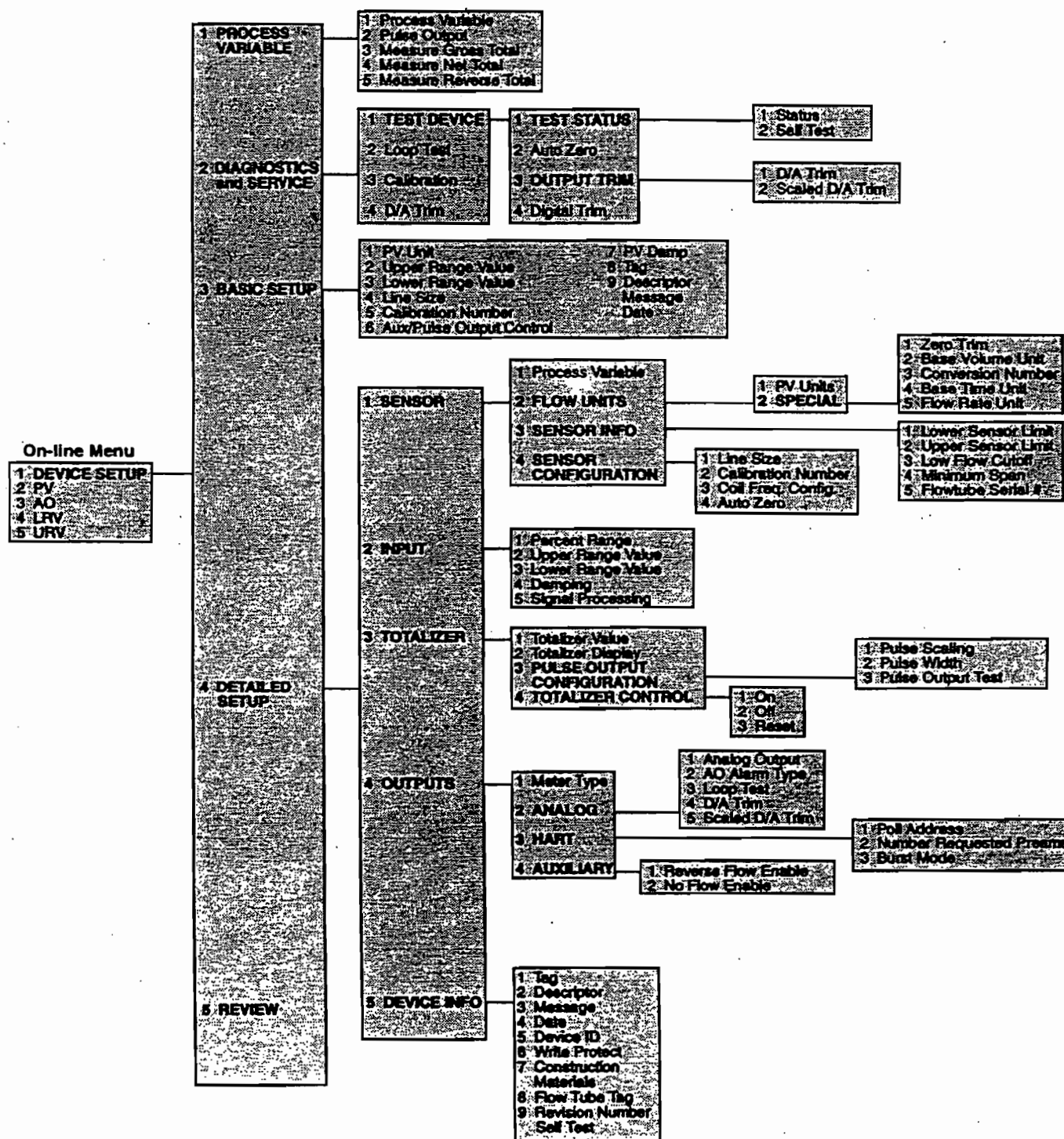
This appendix provides basic communicator information.

Included in this appendix are a menu tree, a table of fast key sequences, and information on using the HART communicator.

For more complete information on the HART Communicator, refer to the HART Communicator Product Manual 00809-0100-4275.

This brief appendix will familiarize you with the HART Communicator but is not meant to replace the HART Communicator product manual.

FIGURE A-1. HART Communicator Menu Tree for Smart Touch.



NOTE

The Review menu lists all of the information stored in the Smart Touch. This includes device information, measuring element, signal condition, output condition, and software revision.

TABLE A-1. HART Fast Key Sequences for the Smart Touch.

Function	HART Fast Key
AO Alarm Type	1, 4, 4, 2, 2
Analog Output	1, 4, 4, 2, 1
Analog Output Range (URV)	1, 3, 2
Analog Output Zero (LRV)	1, 3, 3
Analog Output Test	1, 4, 4, 2, 3
Auto Zero	1, 2, 1, 2
Auxiliary Output Control	1, 4, 4, 4
Base Time Unit	1, 4, 1, 2, 2, 4
Base Volume Unit	1, 4, 1, 2, 2, 2
Burst Mode	1, 4, 4, 3, 3
Calibration	1, 2, 3
Calibration Number	1, 3, 5
Coil Frequency	1, 4, 1, 4, 3, 1
Conversion Number	1, 4, 1, 2, 2, 3
Damping	1, 3, 7
D/A Trim	1, 2, 4
Date	1, 4, 5, 4
Descriptor	1, 4, 5, 2
Device ID	1, 4, 5, 5
Digital Trim	1, 2, 1, 4
Electrode Material	1, 4, 5, 7, 4
Electrode Type	1, 4, 5, 7, 3
Flange Material	1, 4, 5, 7, 2
Flange Type	1, 4, 5, 7, 1
Flow Rate Unit	1, 4, 1, 2, 2, 5
Flowtube Serial Number	1, 4, 1, 3, 5
Flow Units	1, 4, 1, 2
Line Size	1, 3, 4
Liner Material	1, 4, 5, 7, 5
Loop Test	1, 2, 2
Low Flow Cutoff	1, 4, 1, 3, 3
Lower Range Value	1, 3, 3
Measure Gross Total	1, 1, 3
Measure Net Total	1, 1, 4

Function	HART Fast Key
Measure Reverse Total	1, 1, 5
Message	1, 4, 5, 3
Meter Type	1, 4, 4, 1
Number Requested Preams	1, 4, 4, 3, 2
Poll Address	1, 4, 4, 3, 1
Process Variables-PV	1, 1
Pulse Output	1, 1, 2
Pulse Output Loop Test	1, 4, 3, 3, 3
Pulse Scaling	1, 4, 3, 3, 1
Pulse Width	1, 4, 3, 3, 2
PV Percent Range	1, 4, 2, 1
PV Unit	1, 3, 1
Review	1, 5
Revision Number	1, 4, 5, 9
Scaled D/A Trim	1, 4, 4, 2, 5
Self Test	1, 2, 1, 1, 2
Sensor-PV	1, 4, 1, 1
Sensor Configuration	1, 4, 1, 4
Sensor Information	1, 4, 1, 3
Signal Processing	1, 4, 2, 5
Signal Processing-Percent Rate	1, 4, 2, 5, 3
Signal Processing-Samples	1, 4, 2, 5, 2
Signal Processing-Status	1, 4, 2, 5, 1
Signal Processing-Time Limit	1, 4, 2, 5, 4
Special Units	1, 4, 1, 2, 2
Tag Number	1, 4, 5, 1
Totalize Control	1, 4, 3, 4
Totalize Display	1, 4, 3, 2
Totalize Value	1, 4, 3, 1
Upper Range Value	1, 3, 3
Volume Unit	1, 4, 1, 2, 2, 1
Write Protect	1, 4, 5, 6

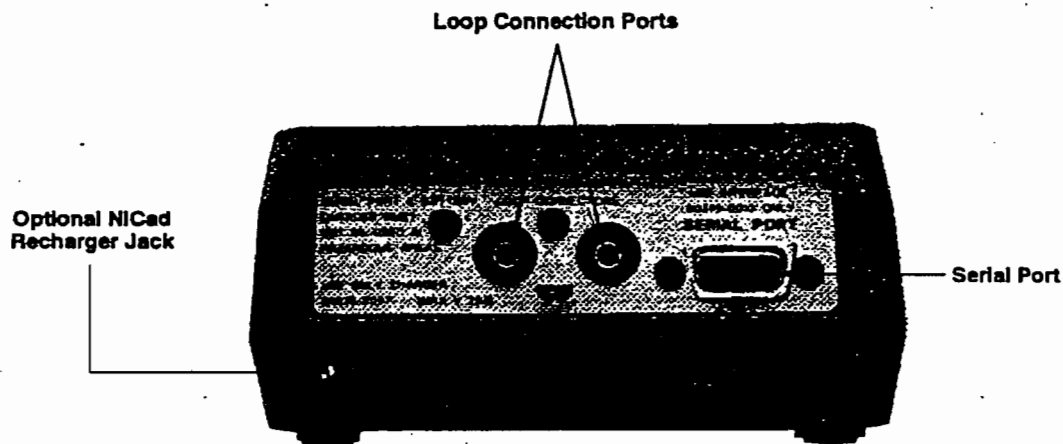
CONNECTIONS AND HARDWARE

The HART Communicator exchanges information with the transmitter from the control room, the instrument site, or any wiring termination point in the loop. The HART Communicator should be connected in parallel with the transmitter. Use the loop connection ports on the rear panel of the HART Communicator (see Figure A-2). The connections are non-polarized.

⚠ WARNING

Explosions can result in death or serious injury. Do not make connections to the serial port or NiCad recharger jack in an explosive atmosphere.

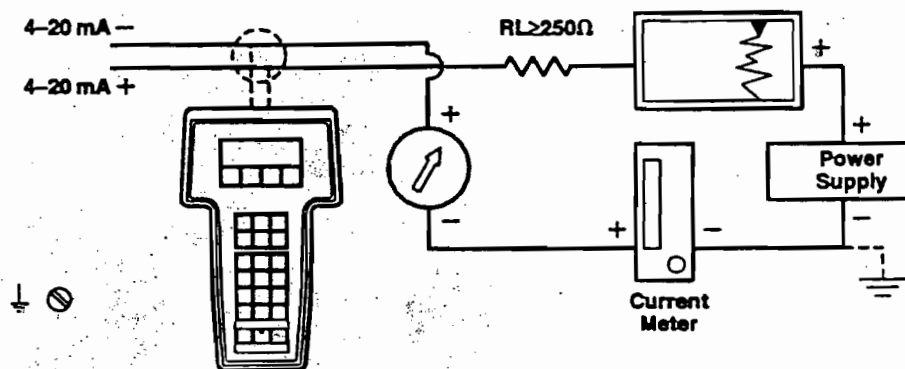
FIGURE A-2.
Rear



⚠ WARNING

Explosions can result in death or serious injury. Before connecting the HART Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or nonincendive field wiring practices.

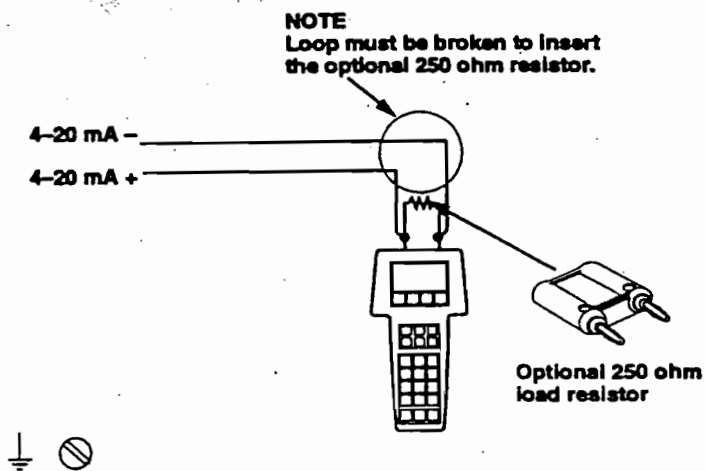
FIGURE A-3. Connecting the HART Communicator to a Transmitter Loop.



NOTE

The HART Communicator needs a minimum of 250 ohms resistance in the loop to function properly. The HART Communicator does not measure loop current directly.

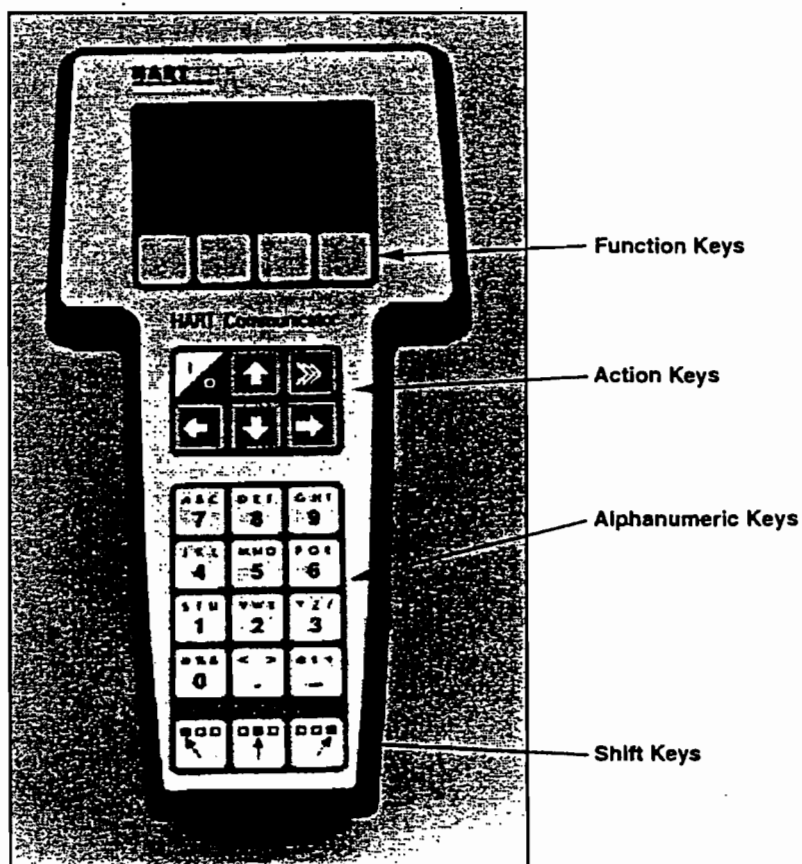
FIGURE A-4. Connecting the HART Communicator with the Optional Load Resistor.



BASIC FEATURES

The basic features of the HART Communicator include Action Keys, Function Keys, and Alphanumeric and Shift Keys.

FIGURE A-5. The HART Communicator.



Action Keys

The Action Keys

As shown in Figure A-5, the action keys are the six blue, white, and black keys located above the alphanumeric keys. The function of each key is described as follows:

ON/OFF Key

Use this key to power the HART Communicator. When the communicator is turned on, it searches for a transmitter on the 4–20 mA loop. If a device is not found, the communicator displays the message, “No Device Found. Press OK.”

If a HART-compatible device is found, the communicator displays the Online Menu with device ID and tag.

Directional Keys

Use these keys to move the cursor up, down, left, or right. The right arrow key also selects menu options, and the left arrow key returns to the previous menu.

HOT Key

Use this key to quickly access important, user-defined options when connected to a HART-compatible device. Pressing the Hot Key turns the HART Communicator on and displays the Hot Key Menu. See Customizing the Hot Key Menu in the HART Communicator manual for more information.

Function Keys



Use the four software-defined function keys, located below the LCD, to perform software functions. On any given menu, the label appearing above a function key indicates the function of that key for the current menu. As you move among menus, different function key labels appear over the four keys. For example, in menus providing access to on-line help, the **HELP** label may appear above the F1 key. In menus providing access to the Home Menu, the **HOME** label may appear above the F3 key. Simply press the key to activate the function. See your HART Communicator manual for details on specific Function Key definitions.

Alphanumeric and Shift Keys

FIGURE A-6. HART Communicator Alphanumeric and Shift Keys.

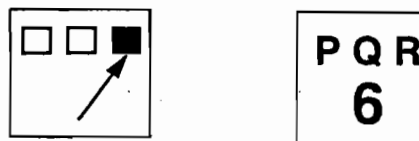
ABC	DEF	GHI
7	8	9
JKL	MNO	PQR
4	5	6
STU	VWX	YZ/
1	2	3
#%&	<->	*:+
0	.	-
←	→	↩

Data Entry

Some menus require data entry. Use the Alphanumeric and Shift keys to enter all alphanumeric information into the HART Communicator. If you press an Alphanumeric key alone from within an edit menu, the bold character in the center of the key appears. These large characters include the numbers zero through nine, the decimal point (.), and the dash symbol (—).

To enter an alphabetic character, first press the Shift key that corresponds to the position of the letter you want on the alphanumeric key. Then press the alphanumeric key. For example, to enter the letter R, first press the right Shift key, then the “6” key (see Figure A-7). Do not press these keys simultaneously, but one after the other.

FIGURE A-7. Data Entry Key Sequence.



HART Fast Key Feature

The HART Fast Key feature provides quick on-line access to transmitter variables and functions. Instead of stepping your way through the menu structure using the Action Keys, you can press a HART Fast Key Sequence to move from the Online Menu to the desired variable or function. On-screen instructions guide you through the rest of the screens.

HART Fast Key Example

The HART Fast Key sequences are made up of the series of numbers corresponding to the individual options in each step of the menu structure. For example, from the Online Menu you can change the Date. Following the menu structure, press 1 to reach **Device Setup**, press 4 for **Detailed Setup**, press 5 for **Device Info**, press 5 for **Date**. The corresponding HART Fast Key sequence is 1,4,5,5.

HART Fast Keys are operational only from the Online Menu. If you use them consistently, you will need to return to the Online Menu by pressing HOME (F3) when it is available. If you do not start at the Online Menu, the HART Fast Keys will not function properly.

Use Table A-1, an alphabetical listing of every on-line function, to find the corresponding HART Fast Keys. These codes are applicable only to the transmitter and the HART Communicator.

MENUS AND FUNCTIONS

The HART Communicator is a menu driven system. Each screen provides a menu of options that can be selected as outlined above, or provides direction for input of data, warnings, messages, or other instructions.

Main Menu

When the HART Communicator is turned on, one of two menus will appear. If the HART Communicator is connected to an operating loop, the communicator will find the device and display the Online Menu (see below). If it is not connected to a loop, the communicator will indicate that no device was found. When you press OK (F4), it will display the Main Menu.

The Main Menu provides the following options:

- *Offline*—The Offline option provides access to offline configuration data and simulation functions.
- *Online*—The Online option checks for a device and if it finds one, brings up the Online Menu.
- *Transfer*—The Transfer option provides access to options for transferring data either from the HART Communicator (Memory) to the transmitter (Device) or vice versa. Transfer is used to move off-line data from the HART Communicator to the flowmeter, or to retrieve data from a flowmeter for off-line revision.

NOTE

Online communication with the flowmeter automatically loads the current flowmeter data to the HART Communicator. Changes in on-line data are made active by pressing SEND (F2). The transfer function is used only for off-line data retrieval and sending.

- *Frequency Device*—The Frequency Device option displays the frequency output and corresponding pressure output of current-to-pressure transmitters.
- *Utility*—The Utility option provides access to the contrast control for the HART Communicator LCD screen and to the autopoll setting used in multidrop applications.

Once you have selected a Main Menu option, the HART Communicator provides the information you need to complete the operation. If further details are required, consult the HART Communicator manual.

Online Menu

The Online Menu can be selected from the Main Menu as outlined above, or it may appear automatically if the HART Communicator is connected to an active loop and can detect an operating flowmeter.

NOTE

The Main Menu can be accessed from the Online Menu. Press the left arrow action key to deactivate the on-line communication with the flowmeter and to activate the Main Menu options.

When configuration variables are reset in the on-line mode, the new settings are not activated until the data are sent to the flowmeter. Press SEND (F2) when it is activated to update the process variables of the flowmeter.

On-line mode is used for direct evaluation of a particular meter, re-configuration, changing parameters, maintenance, and other functions.

Diagnostic Messages

The following is a list of messages used by the HART Communicator (HC) and their corresponding descriptions.

Variable parameters within the text of a message are indicated with *<variable parameter>*.

Reference to the name of another message is identified by *[another message]*.

TABLE A-2. Diagnostic Messages.

Message	Description
Add item for ALL device types or only for this ONE device type.	Asks the user whether the hot key item being added should be added for all device types or only for the type of device that is connected.
Command Not Implemented	The connected device does not support this function.
Communication Error	Either a device sends back a response indicating that the message it received was unintelligible, or the HC cannot understand the response from the device.
Configuration memory not compatible with connected device	The configuration stored in memory is incompatible with the device to which a transfer has been requested.
Device Busy	The connected device is busy performing another task.
Device Disconnected	Device fails to respond to a command.
Device write protected	Device is in write-protect mode. Data can not be written.
Device write protected. Do you still want to shut off?	Device is in write-protect mode. Press YES to turn the HC off and lose the unsent data.
Display value of variable on hotkey menu?	Asks whether the value of the variable should be displayed adjacent to its label on the hotkey menu if the item being added to the hotkey menu is a variable.
Download data from configuration memory to device	Prompts user to press SEND softkey to initiate a memory to device transfer.
Exceed field width	Indicates that the field width for the current arithmetic variable exceeds the device- specified description edit format.
Exceed precision	Indicates that the precision for the current arithmetic variable exceeds the device- specified description edit format.
Ignore next 50 occurrences of status?	Asked after displaying device status. Softkey answer determines whether next 50 occurrences of device status will be ignored or displayed.
Illegal character	An invalid character for the variable type was entered.
Illegal date	The day portion of the date is invalid.
Illegal month	The month portion of the date is invalid.
Illegal year	The year portion of the date is invalid.
Incomplete exponent	The exponent of a scientific notation floating point variable is incomplete.
Incomplete field	The value entered is not complete for the variable type.
Looking for a device	Polling for multidropped devices at addresses 1–15.

Message	Description
Mark as read only variable on hotkey menu?	Asks whether the user should be allowed to edit the variable from the hotkey menu if the item being added to the hotkey menu is a variable.
No device configuration in configuration memory	There is no configuration saved in memory available to re-configure off-line or transfer to a device.
No Device Found	Poll of address zero fails to find a device, or poll of all addresses fails to find a device if auto-poll is enabled.
No hotkey menu available for this device.	There is no menu named "hotkey" defined in the device description for this device.
No offline devices available.	There are no device descriptions available to be used to configure a device offline.
No simulation devices available.	There are no device descriptions available to simulate a device.
No UPLOAD_VARIABLES in ddl for this device	There is no menu named "upload_variables" defined in the device description for this device. This menu is required for offline configuration.
No Valid Items	The selected menu or edit display contains no valid items.
OFF KEY DISABLED	Appears when the user attempts to turn the HC off before sending modified data or before completing a method.
Online device disconnected with unsent data. RETRY or OK to lose data.	There is unsent data for a previously connected device. Press RETRY to send data, or press OK to disconnect and lose unsent data.
Out of memory for hotkey configuration. Delete unnecessary items.	There is no more memory available to store additional hot key items. Unnecessary items should be deleted to make space available.
Overwrite existing configuration memory	Requests permission to overwrite existing configuration either by a device-to-memory transfer or by an offline configuration. User answers using the softkeys.
Press OK...	Press the OK softkey. This message usually appears after an error message from the application or as a result of HART communications.
Restore device value?	The edited value that was sent to a device was not properly implemented. Restoring the device value returns the variable to its original value.
Save data from device to configuration memory	Prompts user to press SAVE softkey to initiate a device-to-memory transfer.
Saving data to configuration memory.	Data is being transferred from a device to configuration memory.
Sending data to device.	Data is being transferred from configuration memory to a device.
There are write only variables which have not been edited. Please edit them.	There are write-only variables which have not been set by the user. These variables should be set or invalid values may be sent to the device.

Message	Description
There is unsent data. Send it before shutting off?	Press YES to send unsent data and turn the HC off. Press NO to turn the HC off and lose the unsent data.
Too few data bytes received	Command returns fewer data bytes than expected as determined by the device description.
Transmitter Fault	Device returns a command response indicating a fault with the connected device.
Units for <variable label> has changed. Unit must be sent before editing, or invalid data will be sent.	The engineering units for this variable have been edited. Send engineering units to the device before editing this variable.
Unsent data to online device. SEND or LOSE data.	There is unsent data for a previously connected device which must be sent or thrown away before connecting to another device.
Use up/down arrows to change contrast. Press DONE when done.	Gives direction to change the contrast of the HC display.
Value out of range	The user-entered value is either not within the range for the given type and size of variable or not within the min/max specified by the device.
<message> occurred reading/writing <variable label>	Either a read/write command indicates too few data bytes received, transmitter fault, invalid response code, invalid response command, invalid reply data field, or failed pre- or post-read method; or a response code of any class other than SUCCESS is returned reading a particular variable.
<variable label> has an unknown value. Unit must be sent before editing, or invalid data will be sent.	A variable related to this variable has been edited. Send related variable to the device before editing this variable.

Operation Planning

INTRODUCTION

Operation planning is necessary for successful installation. Process fluid conductivity should be 5 microsiemens/cm (5 micromhos/cm) or greater. All options available to the magmeter with Smart Touch integral transmitter should be carefully reviewed before selection.

Flowtube site and process fluid characteristics are also important considerations. Proper flowtube orientation, sizing, and bypass piping minimize the effects of corrosive, fatty, or abrasive process fluids. Careful installation reduces start-up delays, facilitates maintenance, and ensures optimum performance.

Flowtube Site Selection

Site planning reduces process down-time, prevents connection problems, and simplifies maintenance. The allowable distance between flowtube and transmitter is the length of the cable run, not the distance between their physical locations.

⚠ WARNING

Explosions can cause death or serious injury. Verify that the operating environment of the flowtube is consistent with the appropriate hazardous locations certifications.

Line Power Access

Requirements for a satisfactory flowtube site depend on the exact installation configuration. Consider the following when planning a site:

A magmeter with Smart Touch integral transmitter requires a supply of ac power only at the transmitter, and not at the flowtube. Check the power service requirements on the transmitter identification tag.

Bypass Piping

Bypass piping may be desirable to allow isolating the flowtube for servicing, cleaning, and replacement. Two configurations are shown in Figures B-1 and B-2.

Figure B-2 illustrates a conventional bypass useful for flowtube isolation.

Figure B-1 illustrates bypass piping with a cleanout tee. A cleanout tee is recommended when measuring greasy or insulating process fluids that may coat the flowtube wall.

FIGURE B-1. Bypass Piping with Cleanout Tee.

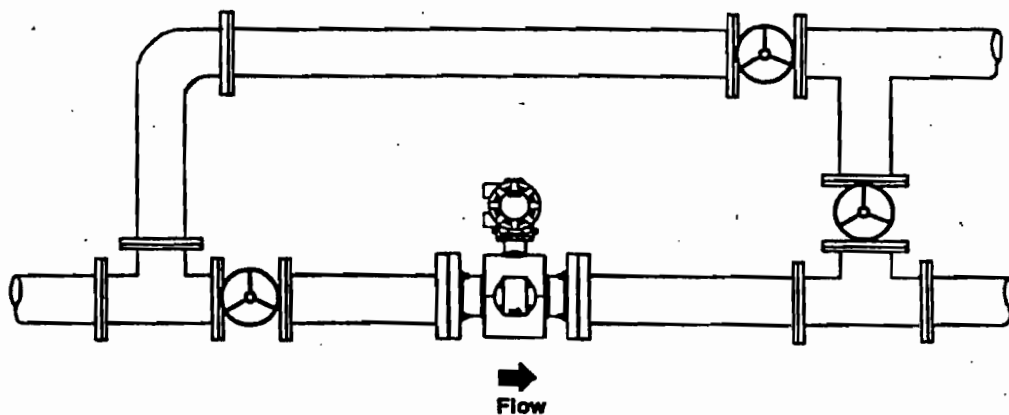
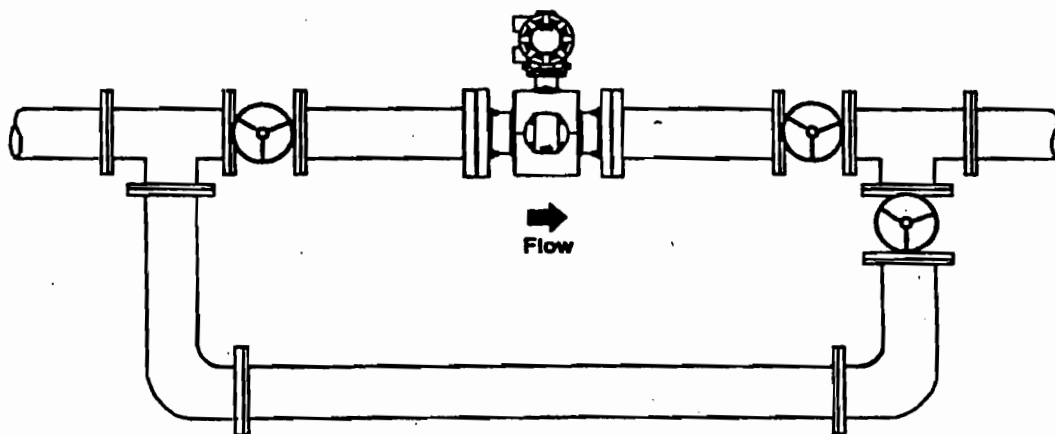


FIGURE B-2.
Typical Bypass
Piping



Process Conditions

Process conditions and loop elements must be considered during site selection to ensure an accurate, noise-free output signal. Avoid placement near pumps (especially positive displacement pumps) or flow variations may appear in the output signal. Also, keep slurries as homogeneous as possible to prevent damage to the flowtube electrodes and liner. Homogeneity can often be achieved by locating the flowtube five straight pipe diameters downstream of loop pumps, with additives upstream of the pumps. Finally, design the process loop conditions to ensure that the flowtube always remains full, with no entrapped air.

Adequate Space

Allow space for the flowtube, bypass piping, and equipment maneuverability during installation and removal. Note that integrally mounted transmitters require more space at the flowtube site.

Earth Ground

Specification accuracy and safety considerations require flowtube grounding.

Low-Noise Environment

Although a pulsed dc coil design reduces flowtube susceptibility to extraneous noise, some environments are more suitable than others. Avoid a close proximity to devices that may produce high intensity electromagnetic and electrostatic fields. Such devices include electric welding equipment, large electric motors and transformers, motor devices or controls, and communication transmitters.

Conductivity

Process fluid conductivity should be 5 microsiemens/cm (5 micromhos/cm) or greater. For low conductivity fluids, 5–20 micromhos/cm, cable length should be less than 25 feet and unshielded cable ends should be maintained.

Flowtube Orientation**Upstream Piping Length**

Magnetic flowmeters are less sensitive to liquid velocity profile variation than most other flowmeters. However, to ensure specification accuracy over widely varying process conditions, install the flowtube with a minimum of five straight pipe diameters upstream and two straight pipe diameters downstream from the electrode plane. This will allow disturbances to settle out prior to measurement. This procedure is usually adequate to allow for disturbances created by elbows, valves, and reducers.

Vertical Installation

Vertical installation allows upward process fluid flow and is generally preferred. Upward flow keeps the cross-sectional area full, regardless of flow rate. Orientation of the electrode plane is unimportant in vertical installations.

NOTE

Avoid downward vertical flows where back pressure is inadequate to ensure that the flowtube remains full.

Horizontal Installation

Horizontal installation should be restricted to low piping sections that are normally full. Orient the electrode plane to within 45 degrees of horizontal in horizontal installations. A deviation of more than 45 degrees of horizontal would place an electrode at or near the top of the flowtube—making it more susceptible to insulation by air or entrapped gas at the top of the flowtube.

Magnetic Flowmeter Sizing

The flowtube size is a very important consideration because it affects flow velocity. It is often necessary to select a magmeter that is larger or smaller than the adjacent piping to ensure the fluid velocity is in the range of 1 to 30 ft/s (0.3 to 9.1 m/s). Table B-1 shows guidelines for sizing normal velocities for magmeters in different types of applications (operation outside these guidelines may also give acceptable performance).

TABLE B-1. Sizing Guidelines.

Application	Velocity Range (ft/s)	Velocity Range (m/s)
Normal Service	2-20	0.6-6.1
Abrasive Slurries	3-10	0.9-3.1
Non-Abrasive Slurries	5-15	1.5-4.6

To convert flow rate to velocity, use the appropriate factor listed in Table B-2 and the following equation:

$$\text{Velocity} = \frac{\text{Flow Rate}}{\text{Factor}}$$

Example: English Units

Magmeter Size: 4 inch (factor from Table 2 = 39.679)
Normal Flow Rate: 300 gpm

$$\text{Velocity} = \frac{300 \text{ (gpm)}}{39.679}$$

$$\text{Velocity} = 7.56 \text{ ft/s}$$

Example: SI Units

Magmeter Size: 100 mm (factor from Table 2 = 150.22)
Normal Flow Rate: 80 L/min

$$\text{Velocity} = \frac{80 \text{ (L/min)}}{150.22}$$

$$\text{Velocity} = 0.53 \text{ m/s}$$

TABLE B-2. Line Size vs. Conversion Factor.

Nominal Line Size Inches (mm)	Gallons Per Minute Factor	Liters Per Minute Factor
½ (15)	0.947	3.586
1 (25)	2.693	10.199
1½ (40)	6.345	24.024
2 (50)	10.459	39.598
3 (80)	23.042	87.237
4 (100)	39.679	150.22
6 (150)	90.048	340.92
8 (200)	155.94	590.39
10 (250)	245.78	930.52
12 (300)	352.51	1,344.6
14 (350)	421.70	1,596.6
16 (400)	550.80	2,085.3
18 (450)	697.19	2,689.6
20 (500)	866.51	3,280.6
24 (600)	1,253.2	4,744.6

FIGURE B-3. Fluid Velocity vs. Rate Curves.

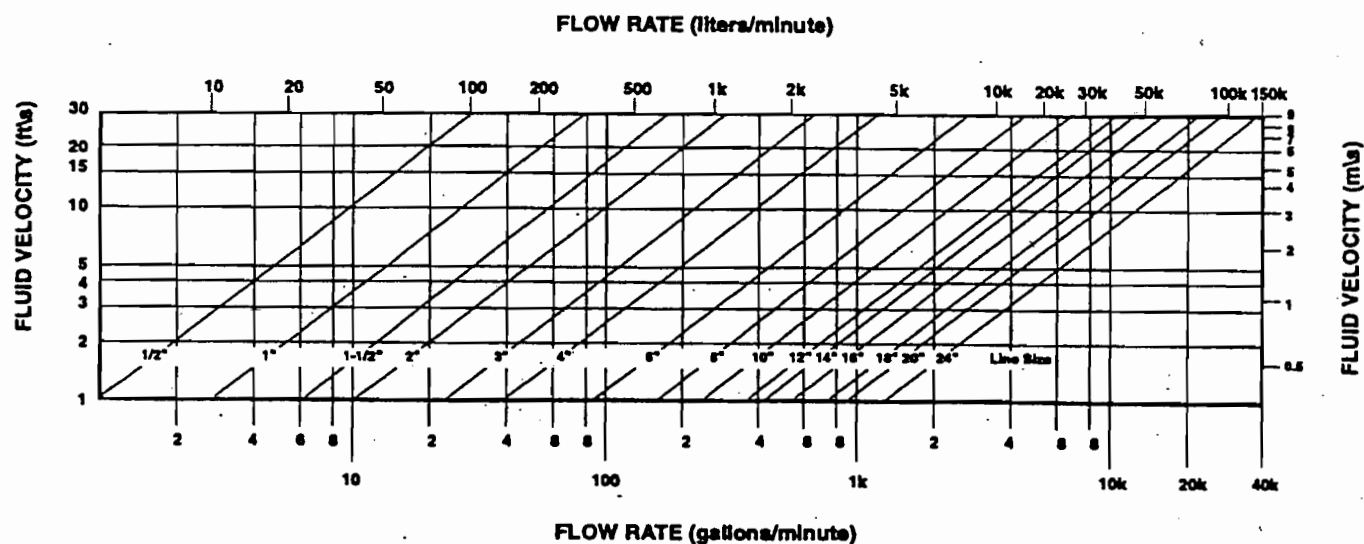


TABLE B-3. Line Size vs. Fluid Velocity/Rate.

Nominal Line Size in Inches (mm)	Minimum/Maximum Flow Rate					
	Gallons per Minute			Liters per Minute		
	at 0.04 ft/s (Low-flow Cutoff)	at 1 ft/s (Min. Range Setting)	at 30 ft/s (Max Range Setting)	at 0.012 m/s (Low-flow Cutoff)	at 0.3 m/s (Min. Range Setting)	at 9.1 m/s (Max Range Setting)
0.15 (4)	0.002	0.055	1.65	0.008	0.209	6.27
0.30 (8)	0.009	0.220	6.60	0.033	0.834	25.02
1/2 (15)	0.038	0.947	28.412	0.144	3.568	107.55
1 (25)	0.108	2.694	80.813	0.408	10.199	305.91
1 1/2 (40)	0.254	6.345	190.36	0.962	24.024	720.36
2 (50)	0.418	10.459	313.77	1.582	39.598	1,187.7
3 (80)	0.922	23.042	691.26	3.490	87.237	2,616.7
4 (100)	1.588	36.679	1,190.4	6.010	150.22	4,506.0
6 (150)	3.600	90.048	2,701.4	13.620	340.92	10,226
8 (200)	6.240	155.94	4,677.8	23.620	590.39	17,707
10 (250)	9.840	245.78	7,373.4	37.240	930.52	27,911
12 (300)	14.200	352.51	10,575	53.400	1,344.6	40,031
14 (350)	16.800	421.70	12,651	62.800	1,596.6	47,890
16 (400)	22.000	550.80	16,524	82.000	2,085.3	62,551
18 (450)	27.800	697.19	20,916	104.00	2,689.6	79,192
20 (500)	34.600	866.51	25,995	129.20	3,280.6	98,412
24 (600)	50.200	1,253.2	37,596	186.80	4,744.6	142,338
30 (750)	80.200	2,006.0	60,180	303.60	7,595.0	227,840
36 (900)	117.40	2,935.0	88,050	444.40	11,112	333,360

Transmitter Output Instability

PROCEDURES

If the output of your Smart Touch is unstable, first check the wiring and grounding associated with the magnetic flowmeter system (see the **Installation Check and Guide** on page 2-24). Ensure that the following conditions are met:

- Ground straps are attached to the adjacent flange or ground ring?
- Grounding rings, lining protectors, or grounding electrodes are being used in lined or nonconductive piping?
- Both of the shields on the electrode and coil cable attached at both ends?

The causes of unstable transmitter output can usually be traced to extraneous voltages on the measuring electrodes. This "process noise" can arise from several causes including electrochemical reactions between the fluid and the electrode, chemical reactions in the process itself, free ion activity in the fluid, or some other disturbance of the fluid/electrode capacitive layer. In such noisy applications, an analysis of the frequency spectrum reveals process noise that typically becomes significant below 15 Hz.

In some cases, the effects of process noise may be sharply reduced by elevating the coil drive frequency above the 15 Hz region. The Smart Touch coil drive mode is selectable between the standard 6 Hz and the noise-reducing 30 Hz. See **Coil Frequency** on page 4-10 for instructions on how to change the coil drive mode to 30 Hz.

Auto Zero

To ensure optimum accuracy when using 30 Hz coil drive mode, there is an auto zero function that must be initiated during start-up. The auto zero operation is also discussed in the start-up and configuration sections. When using 30 Hz coil drive mode it is important to zero the system for the specific application and installation.

The auto zero procedure should be performed only under the following conditions:

1. With the transmitter and flowtube installed in their final positions. This procedure is not applicable on the bench.
2. With the transmitter in 30 Hz coil drive mode. Never attempt this procedure with the transmitter in 6 Hz coil drive mode.
3. With the flowtube full of process fluid at zero flow.

These conditions should cause an output equivalent to zero flow.

Signal Processing

If the 30 Hz coil drive mode has been set, and the output is still unstable, the damping and signal processing function should be used. It is important to set the coil drive mode to 30 Hz first, so the loop response time is not increased.

The Smart Touch provides for a very easy and straightforward start-up, and also incorporates the capability to deal with difficult applications that have previously manifested themselves in a noisy output signal. In addition to selecting a higher coil drive frequency (30 Hz vs. 6 Hz) to isolate the flow signal from the process noise, the Smart Touch microprocessor can actually scrutinize each input based on three user-defined parameters to reject the noise specific to the application.

This software technique, known as signal processing, "qualifies" individual flow signals based on historic flow information and three user-definable parameters, plus an on/off control. These parameters are:

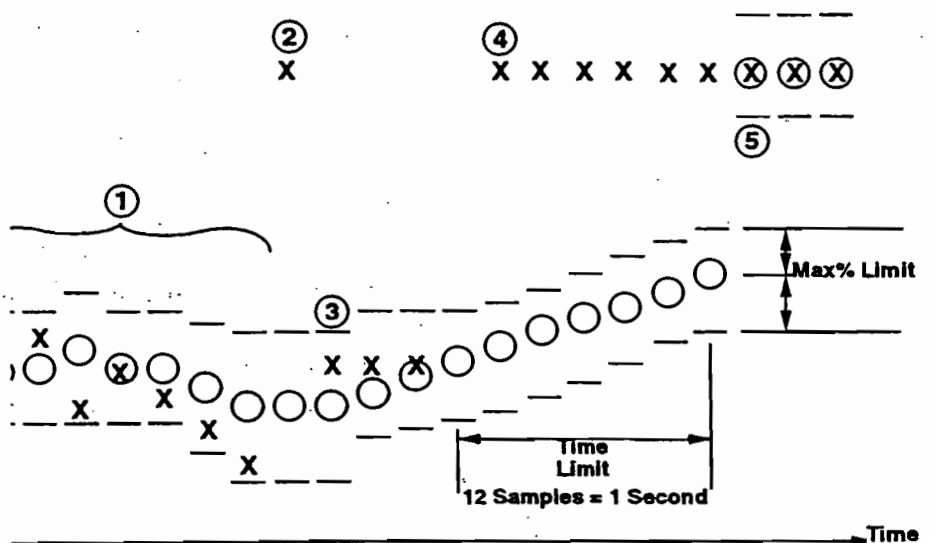
1. Number of samples: the number of samples or discrete input values included in the running average.

Adjustable between 0 and 125 samples, it is this number of previous inputs that are averaged together to arrive at the average value. Because the output stage of the Smart Touch circuit is updated twelve times each second, regardless of coil drive mode, twelve samples equals one second (i.e., 0 to 120 samples = 0 to 10 seconds). Factory Preset Value = 90 samples (7.5 seconds).

2. Maximum Percent Limit: The tolerance band set up on either side of the running average, referring to percent deviation from the average. Values within the limit are accepted while values outside the limit are scrutinized to determine if they are a noise spike or an actual flow change. Factory Preset Value = 2 percent.
3. Time Limit: Forces the output and running average values to the new value of an actual flow rate change that is outside the percent limit boundaries, thereby limiting response time to real flow changes to the time limit value rather than the length of the running average. Factory Preset Value = 2 seconds.

How does it really work?

The best way to explain this is with the help of an example, plotting flow rate versus time.



x: Input flow signal from flowtube.

o: Average flow signals and transmitter output, determined by the "number of samples" parameter.

Tolerance band, determined by the "percent limit" parameter.

—Upper value = average flow + [(percent limit/100) average flow]

—Lower value = average flow - [(percent limit/100) average flow]

- ①. This scenario is that of a typical non-noisy flow. The input flow signal is within the percent limit tolerance band, therefore qualifying itself as a good input. In this case the new input is added directly into the running average and is passed on as a part of the average value to the output.
- ②. This signal is outside the tolerance band and therefore is held in memory until the next input can be evaluated. The running average is provided as the output.
- ③. The previous signal currently held in memory is simply rejected as a noise spike since the next flow input signal is back within the tolerance band. This results in complete rejection of noise spikes rather than allowing them to be "averaged" with the good signals as occurs in the typical analog damping circuits.
- ④. As in Number 2 above, the input is outside the tolerance band. This first signal is held in memory and compared to the next signal. The next signal is also outside the tolerance band (in the same direction), so the stored value is added to the running average as the next input and the running average begins to slowly approach the new input level.
- ⑤. To avoid waiting for the slowly incrementing average value to catch up to the new level input, a shortcut is provided. This is the "time limit" parameter. The user can set this parameter to eliminate the slow ramping of the output toward the new input level.

When should signal processing be used?

The Smart Touch offers three separate functions that can be used in series for improving a noisy output. The first step is to toggle the coil drive to the 30 Hz mode and initialize with an auto zero. If the output is still noisy at this stage, signal processing should be actuated and, if necessary, tuned to match the specific application. Finally, if the signal is still too unstable, the traditional damping function can be used.

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**OPERATIONS, MAINTENANCE, AND MONITORING PLAN
XEROX CORPORATION
NYSDEC SITE CODE: 3-44-021
BLAUVELT, NEW YORK**

Original July 1997 – Haley & Aldrich of New York
Revised March 2006 – Bergmann Associates

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I. SITE MAINTENANCE

1-01 Description of Operation and Maintenance Activities

The following is an explanation of system operating parameters that are to be monitored and recorded during routine checks on GTP system. The description below is presented according to each subsystem, followed by the subsystem component monitored. Each description includes the monitoring point and what the reading is intended to monitor.

There is a direct digital data acquisition and control system under contract which was completed in 1994 to allow remote monitoring of the primary operating parameters. The intent of this system is to reduce the operations over sight and manual data collection and provide a tool to interrogate the system remotely.

A. Groundwater Treatment Plant (GTP)

Inlet Pressure to Filters: This gauge measures the pressure from the groundwater recovery pumps prior to the filter bank.

Outlet Pressure from Filters: This gauge measures the downstream pressure and is used in determining differential pressure across the filter bank. The differential pressure is used to determine fouling and filter replacement.

Holding Tank Liquid Level Transmitter: The signal from device provides input for the liquid level within the holding tank. The level set point will be maintained by modulating the variable speed drive on the primary air stripper feed pump (P-1).

Pump (P-1) Discharge Pressure: This gauge measures the pressure in the primary air stripper feed line.

Pump (P-2) Discharge Pressure: This gauge measures the pressure in the secondary air stripper feed line.

Air Stripper Tank Liquid Level Transmitter: The signal from device provides input for the liquid level within the air stripper tank. The level setpoint will be maintained by modulating the variable speed drive on the secondary air stripper feed pump (P-2).

Air Stripper Blower Pressure Transmitter: The signal from this device measures the discharge pressure on the blower on the primary air stripper to provide blower operational status and determine the level of fouling of the stripper packing.

Final Effluent Flow Rate: This will indicate the liquid flow rate discharging from the GTP from Flow Meter FM-5.

Final Effluent Total Flow: This will indicate total liquid flow discharged from the GTP from Flow Meter FM-5.

Recovery Well R-3

Pressure at Wellhead: This gauge measures the discharge pressure from the submersible groundwater recovery pumps.

B. Preventative and Special Maintenance

The following is the recommended Preventative and Special Maintenance activities suggested for maximum system up-time and reliability. The preventative services include any expected or upcoming maintenance activities. The special services include any unexpected maintenance and will include troubleshooting, materials procurement, and communication with engineer and owner.

Particle Filter Housing

Particle filters have been installed on the 2-Phase Extraction System. These filters are primarily in place to prevent excess particulate loadings on the treatment system.

Filter loadings will be identified through observed pressure drop between the inlet and outlet pressure indicators. Change-out is required when pressure differentials exceed 25-30 psi. The desired filter housing should be isolated while the other unit is brought on-line. This can be accomplished through resetting the ball valves which control flow into the filter housings without system shutdown.

A vent installed on the filter housing should be opened prior removing the top cover to release any pressure that may exist inside the housing. When this has been completed, the top can be removed and the change out accomplished. The spent filters will be placed in a labeled, 55-gallon container for disposal.

Personal protective equipment will primarily include safety glasses and rubber gloves for this activity.

Capacitance Probe

The capacitance probe is located in the clear level glass and contains four (4) electronic level switch points that are adjustable. If the transfer pump does not activate at the desired set point, the probe may need to be cleaned.

This may be accomplished by completely draining the probe housing and flushing with potable water. If a more thorough cleaning is necessary, the level glass can be removed and a solution of muriatic acid and water can be used to remove accumulations on the probe and/or level glass. Clean level probe column, flush with water and verify pump response to set points: lead pump on, lag pump on, pumps off, and unit shutdown.

The system must also be shutdown for this activity and caution should be given whenever working with any acids. Personal protective equipment should include safety glasses and rubber gloves.

Transfer Pump

Clean suction strainer, replace filter bag(s) as needed

(average one filter change per week)

Check pump flow rate and record.

Visually inspect pump for leaks and any unusual noises

1-02 Inspection and Maintenance

Systems are checked weekly by operations personnel in addition to the continuous monitoring of key parameters by supervisory control and data acquisition system installed at the site.

1-03 Disposal of Used Material and Waste

All wastes generated are properly containerized, labeled, manifested, hauled away and disposed of by a licensed waste disposal contractor.

II. PERSONNEL

2-02 Manpower Requirements

The project is managed by Xerox in-house personnel with support from operations contractor(s) for on going operations and maintenance. Professional support is provided by the site environmental consultant-Haley & Aldrich.

2-03 Responsibilities and Duties

Xerox has ultimate responsibility for all activities at the site. Capital installation or improvements are designed and implemented by the site environmental consultant. The operations contractor(s) are responsible for maintaining the remedial systems functionality and responding to alarm conditions as reported through the remote data acquisition system.

2-04 Qualifications

All capital installation and improvement project designs are prepared under the direct supervision of a New York State registered Professional Engineer. All project personnel are trained in accordance with OSHA Regulations 1910.120.

2-05 Training (Including Health & Safety)

As required, all project personnel are trained in accordance with OSHA Regulations 1910.120.

2-06 Material Safety Data Sheets

MSDS sheet are on file at the Xerox facility for all products and compounds used at the site.

III. RECORDS

3-01 Operating/Inspection

Operations log sheets are filled out by the operations contractor during every site visit. These log sheets are entered into a relational database and used to document any operational changes to the remedial systems.

3-02 Monitoring (Environmental and Hydro-geological)

Sampling and analysis of site monitoring wells and water levels are stored in a relational database to provide easy access to these data for trending and evaluation.

3-03 Maintenance

Maintenance is performed on a regular basis to remedial components as they fail or show signs of failure. Xerox keeps a significant spare parts inventory to replace components that may fail.

3-04 Maintenance Costs

Maintenance costs for the site have typically run between \$200K to \$250K per year depending on the system component reliability and other factors beyond control such as power failures, etc.

IV. EMERGENCY RESPONSE

4-01 Emergency Contingency Plan

If the Remedial Design fails to achieve its objectives or otherwise fails to protect human health or the environment, a contingency plan will be developed and implemented. Specific elements of the remedial design which provide contingencies are as follows:

A. Air Stripper Discharge

Air emissions from the air strippers in the GTP are governed by an air discharge permit from the NYSDEC Emission point #BVT01. Monthly sampling of the water influent and effluent from the air strippers allows actual emissions to be calculated by performing a mass balance.

B. Water Emissions

1. Water Discharge from the GTP

Water discharged from the Groundwater Treatment Plant (GTP) was formerly governed under the SPDES Discharge Permit #NY0215147. Treatment consists of two air strippers piped in series. Monthly samples are performed to insure compliance with the discharge permit requirements. If the contaminants are detected in the effluent from the secondary air stripper, modifications will be made as soon as possible to maintain compliance with the effluent limits.

The Data Acquisition system will monitor the GTP for process parameters and provide automatic shut down in the event of an alarm. If an element of the treatment system fails such as a pipe break in the GTP the sump pump in the plant provides input to the data acquisition system and automatically shuts the entire system down if the sump pump runs for more than 60 seconds. Failures of the process pumps and or air stripper(s) also have the ability to shut the system down. The data acquisition system automatically dials out designated telephone numbers in the event of an alarm. The system also down-loads data collected over time. Manual shut down is also available at the control panel of each respective piece of equipment.

C. Site Emergency

In the event of a site emergency, procedures outlined in the site specific health and safety plan will be implemented.

4-02 Emergency Spill Response

In the event of a pipe break in the GTP, the sump collects the spill and pumps back to the holding tank in the room. The system is automatically shut down and an alarm is sent to project personnel to notify them of the alarm condition.

4-03 Fire/Explosion

In the event of a Fire or Explosion procedures outlined in the site health and safety plan will be implemented.

4-04 Personal Injury

In the event of any Personal Injury procedures outlined in the site health and safety plan will be implemented.

4-05 Toxic Exposures

In the event of any Toxic Exposures procedures outlined in the site health and safety plan will be implemented.

4-06 Public Notification

Xerox will endeavor to provide any and all public notification as required under the Consent Order governing the site remedial activities.

4-07 Emergency Telephone Numbers

Elliott Duffney, Program Manager, Xerox Corporation 585-422-5825
Gary Flisnik, Site Operations Coordinator, Bergmann Associates 585-232-5135

XEROX CORPORATION - BLAUVELT GROUNDWATER TREATMENT PLANT OPERATIONS LOG SHEET

PAGE 1 OF 1

DATE:

TIME:

BY:

DESCRIPTION	ID#	RANGE	NORMAL	DATA	DATA	DATA
GROUNDWATER TREATMENT PLANT						
INLET PRESSURE TO FILTERS	PI-360	0-20 PSIG	10 PSIG			
OUTLET PRESSURE FROM FILTERS	PI-361	0-20 PSIG	10 PSIG			
HOLDING TANK LIQUID LEVEL	LG-360	INCHES	READ			
PUMP (P-1) OUTLET PRESSURE (AIR STRIPPER FEED)	PI-362	50-75 PSIG	60 PSIG			
FLOW CONTROL VALVE POSITION & AUTO/MAN STATUS	*	% OPEN	READ			
FLOW CONTROL VALVE AVERAGE FLOW RATE	*	0-100 GPM	60 GPM			
PUMP (P-2) OUTLET PRESSURE (CARBON FEED)	PI-363	25-50 PSIG	35 PSIG			
AIR STRIPPER TANK LIQUID LEVEL	LG-361	INCHES	READ			
AIR STRIPPER BLOWER PRESSURE	PI-160	0-5" W.C.	5" W.C.			
LEVEL CONTROL VALVE POSITION	*	% OPEN	READ			
LEVEL CONTROL VALVE AVERAGE LEVEL	*	0-100"	70"			
INLET PRESSURE TO CARBON SYSTEM	PI-364	15-30 PSIG	20 PSIG			
OUTLET PRESSURE OF LEFT CARBON	PI-365	15-30 PSIG	20 PSIG			
PRESSURE OF MID-CARBON SYSTEM	PI-366	15-30 PSIG	20 PSIG			
OUTLET PRESSURE OF RIGHT CARBON	PI-367	15-30 PSIG	20 PSIG			
OUTLET PRESSURE FROM CARBON SYSTEM	PI-368	15-30 PSIG	20 PSIG			
FINAL EFFLUENT FLOW RATE	FM-5	GPM	READ			
FINAL EFFLUENT TOTAL FLOW	FM-5	GALLONS	READ			
NALCO Product Level		Inches				

REMARKS:

XEROX CORPORATION
BLAUVELT, NEW YORK
ENVIRONMENTAL REMEDIATION SYSTEMS
OPERATIONS SHUTDOWN INCIDENT REPORT

DATE

TIME

BY

SYSTEM NAME:

ESTIMATED TIME OF SHUTDOWN:

HOUR METER (IF APPLICABLE):

REASON FOR SHUTDOWN:

ACTION TAKEN:

START-UP TIME:

START-UP DATE:

COMMENTS/SUGGESTIONS:

H&A OF NEW YORK NOTIFICATION:

YES

☐

NO

☐

(716-232-7386)

MONTH

[illegible]

[illegible]

Groundwater Sampling Procedures for Monitoring Wells

1.0 Introduction

This protocol describes the procedures to be used to collect groundwater samples. A low-flow submersible pump or dedicated bailer will be used to purge the wells prior to sampling. After purging is completed, a bailer will be used to collect the sample. During precipitation events, groundwater sampling will be discontinued until precipitation ceases.

2.0 Materials

The following materials, as required, shall be available during groundwater sampling:

- Photoionization detector (PID)
- Appropriate health and safety equipment, as specified in the Health and Safety Plan
- Bailers (Teflon or stainless steel)
- Decontaminated submersible pump and controller, tubing, etc., as necessary for purging and sampling (e.g., Grundfos™ variable rate pump)
- Decontamination sleeve for pump
- 120/240 volt, 3500 watt generator for operation of pump, if required
- Gasoline and container (for the generator), if required
- Polypropylene rope
- Buckets to measure purge water
- Water level well probe
- 6 foot rule with gradation in hundredths of a foot
- Conductivity meter

- pH meter
- Dissolved oxygen meter
- Appropriate water sample containers
- Appropriate blanks (trip blank supplied by the laboratory)
- Appropriate transport containers (coolers with ice) and appropriate labeling, packing, and shipping materials
- Groundwater sampling logs
- Chain-of-custody forms
- Indelible ink pens
- Site map with well locations and groundwater contour maps
- Keys to wells

3.0 Procedures

1. Identify site and well sampled on sampling log sheets along with date, arrival time, and weather conditions. Identify the personnel and equipment utilized and other pertinent data requested on the logs provided at the end of this procedure. Calibrate field instruments in accordance with the manufacturer's instruction manual and record this calibration in the field notebook.
2. Label all sample containers with indelible ink.
3. Don safety equipment, as required in the Health and Safety Plan. Don a new pair of disposable gloves. Disposable gloves will be used for the entire sampling event and are well-specific.
4. Remove lock from well and if rusted or broken, replaced with a new brass keyed-alike lock.
5. Obtain a water level depth and bottom of well depth using an electric well probe and record on sampling log sheet using indelible ink. Clean the well probe after each use with a soapy (Alconox) water wash and a distilled/deionized water rinse.

(Note: water levels may be measured at all wells prior to initiating any sampling activities.)

6. Calculate the number of gallons of water in the well. Record the well volume on the groundwater sampling field log using indelible ink.
7. Calculate the length of the tubing needed to extend the submersible pump to the required depth (usually the bottom of the well), leaving enough length at the top of the tubing to reach the purge water container on a hose connection which extends to a holding vessel.
8. Place one end of the tubing and the clamp over the pump discharge fitting and tighten the clamp.
9. Lower the pump and the power cord into the well. If the well opening is sharp, precautions should be taken so as not to cut the tubing or power cord on the edge of the well opening. Lower the pump until it is about 1 foot off the bottom of the well. Secure the power cord and the tubing to the side of the well.
10. Position the generator so that the exhaust from the engine is downwind of the working area.
11. Plug the pump controller source into the 20 amp, 240 volt outlet on the generator. Move the pump switch to the middle position and dial the flow rate to approximately 2.5 gallons per minute (gpm).
12. Start the generator by turning the fuel level to the "on" position and if the generator is cold, pull out the choke. (Check the oil level in the generator prior to starting. If the level is low, fill with 4-cycle oil [see operator's manual for proper SAE rating for ambient air temperature]).
13. When the generator is running smoothly, push the choke in, and turn the generator power switch "on." The economy switch must be in the "off" position.
14. Put the pump switch to the run position (middle) and adjust the pump to produce a smooth flow of discharge water from the well. The optimum maximum operating flow rate for the Grundfos™ pump is about 4.5 gpm.
15. Care should be taken to never allow the submersible pump to pump air or pull in silt and sand.
16. Remove the required purge volume of water from the well (measure purge water volume in measuring buckets). The required purge volume shall be 3 well

volumes, unless the well runs dry, in which case the water that comes into the well will be sampled. When pumping wells which are known to pump dry, the pumping rate will be decreased to minimize volatilization of the groundwater in the well prior to sampling. Measure and record the initial temperature, specific conductance, and pH of the purge water and periodically make additional measurements during well evacuation. Evacuation should continue until these parameters have stabilized to within $\pm 10\%$ over at least 2 successive well volumes removed or until at least 3 well volumes have been purged.

17. After purging, the pump will be removed from the well and the sample will be taken directly from a bailer.
18. Secure with packing material and maintain at approximately 4°C on wet ice in an insulated transport container provided by the laboratory.
19. After all sampling containers have been filled, remove an additional volume of groundwater. Check the calibration of the pH meter and then measure and record on the field log physical appearance, pH, temperature, conductivity, dissolved oxygen, and turbidity. Obtain and record duplicate measurements every 20 samples. Record measurements using an indelible ink pen.
20. Replace the well cap and lock well.
21. Record the time sampling procedures were completed on the field logs.
22. Place all disposable materials (PPE, tubing, etc.) in appropriate containers. Go to next well and repeat the above steps until all wells are sampled.
23. Complete the procedures for packing, shipping, and handling with associated chain-of-custody.

The Eagle has landed...

Performance Figures - AMG Eagle, Radon Extract Fan

CFM at STATIC PRESSURE in. w.g.																		
Model	Volts	Watts	Max. Amps	0"	0.5"	0.75"	1.0"	1.25"	1.5"	1.75"	2.0"	2.25"	2.5"	2.75"	3.0"	3.25"	3.5"	3.985"
AMG Eagle	115V 60Hz	160	1.37	134	114	109	104	99	91	83	76	69	61	52	41	30	18	0

Weight: 12lb 1oz Fan Speed: 3150 rpm

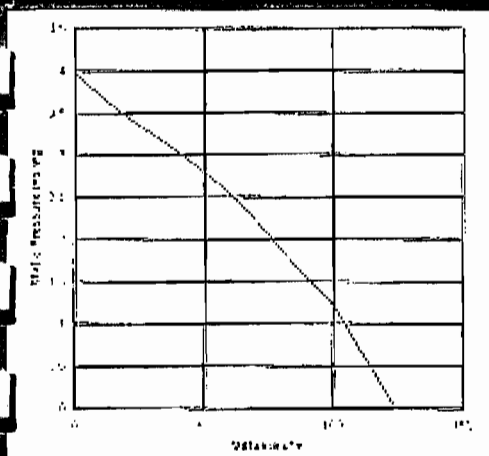
Performance shown is for installation type D - Ducted inlet, Ducted outlet.

Speed (rpm) shown is nominal. Performance is based on actual speed of test.

Performance ratings do not include the effects of appurtenances in the airstream.

The performance figures shown have been corrected to standard air density.

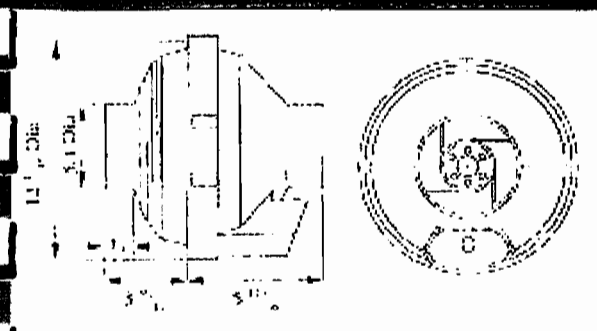
Performance Graph



Vent-Axia Ltd certifies that the AMG Eagle shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and comply with the requirements of the AMCA Certified Ratings Program.

Manufactured by:
Vent-Axia Ltd
Blackbrook Road, Narrow Boat Way,
Dudley, West Midlands DY2 0NB
United Kingdom

Dimensions



Prices

No. of Fans	
1 to 3	- \$157.95
4 to 7	- \$155.95
8 to 19	- \$153.95
20+	- \$149.95

Solely distributed throughout the USA and Canada by:

Festa Radon Technologies Co

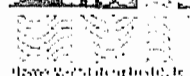
634 North Avenue, Pittsburgh, PA15209

Toll Free 1(800) 806-7866

Fax 1(412) 931-0754

TESTED/CERTIFIED

2100



HVI Certified Performance Rating

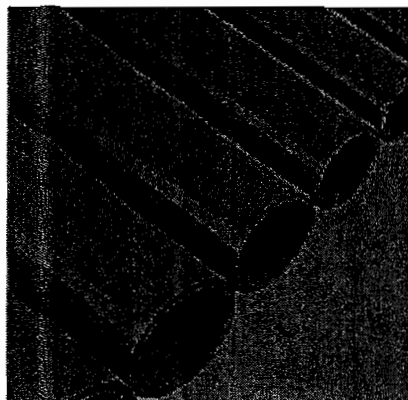
120 CFM @ 0.2 in. w.g.

91 CFM @ 1.5 in. w.g.

41 CFM @ 3.0 in. w.g.

United States Plastic Corporation ®

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PVC Pipe

This is schedule 40 and schedule 80 pvc pipe. Schedule 40 is available in gray and white, and is for socket fittings only. It is NSF listed, but can't be threaded. Schedule 80 is available in gray and is for socket or threaded fittings. It can be threaded and is NSF listed. Both have a wide variety of uses in the chemical field and resistance, also in industrial plants, just to name a couple. For UV resistance of PVC pipe and fittings, paint with a white water based latex paint. Under chemical, the service temp is 33-140° F. Pipe is not recommended for use with compressed air or gases. PVC material is Type 1 according to the American Society for Testing Material D-1784. For industrial plants, the PSI is based on water at 73° F. Derate 50% at 110° F and 78% at 140° F. Pipe is round and smooth on the inside and out, resistant to cracking, and made from premium virgin Goodrich gray PVC resin. Is superior to regular commercial grade used for regular plumbing. Round and smooth inside and out. Resistant to cracking. This pipe is manufactured by harvel plastics and is superior in quality to commercial grades of PVC pipe used for regular plumbing. Sch. 40 socket fitting ASTM D-2466; Sch. 80 socket fitting ASTM D-2467; Sch 80 threaded fittings ASTM D-2464. Pipe-ASTM D-1785. PSI is based on water at 73°F. Derate 50% at 110°F and 78% at 140°F. Schedule 40 is for socket fittings only; threading is not a recommended practice. Schedule 80 pipe can be threaded. NSF listed. **Standard lengths: 20', we will sell in 5', 10' and 20' sections only. 10' is too long to ship UPS. Please note how you would like this cut. Pipe must be smaller then 8 feet to ship UPS. If you do not want the pipe cut we must ship via Motor Freight.**

Other Information

Catalog Page Number: P-114
 Manufacturer: Harvel Plastics
 Spec Sheet for OD, ID, Wall, and
 Max. Pressure

Page Tools

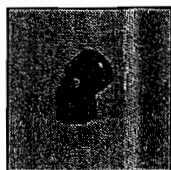
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This product is available in following variations:

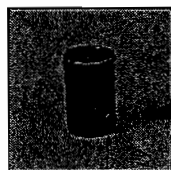
Item No.	Description	In Stock	Sold By	List Price
26301	3/8" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$1.00
26321	3/8" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	On Order 	Foot	\$0.89
26302	1/2" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$0.52
26502	1/2" White PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$0.46
26322	1/2" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$0.64
26303	3/4" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$0.68
26503	3/4" White PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$0.68
26323	3/4" Gray PVC Schedule 80 Pipe	Yes	Foot	\$0.87

	Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;			
26304	1" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$1.00
26504	1" White PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$1.00
26324	1" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$1.27
26305	1 1/4" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$1.35
26505	1 1/4" White PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$1.35
26325	1 1/4" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$1.76
26306	1 1/2" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$1.57
26506	1 1/2" White PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	On Order 	Foot	\$1.57
26326	1 1/2" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$2.10
26307	2" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$2.12
26507	2" White PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$2.12
26327	2" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$2.87
26308	2 1/2" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$3.40
26508	2 1/2" White PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$3.40
26328	2 1/2" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	On Order 	Foot	\$4.47
26309	3" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$4.31
26509	3" White PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	On Order 	Foot	\$4.31
26329	3" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$5.88
26310	4" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$6.18
26510	4" White PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$6.18
26330	4" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$8.60
26311	6" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$10.87
26511	6" White PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$10.87
26331	6" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$16.20
26300	1/4" Gray PVC Schedule 40 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$0.76

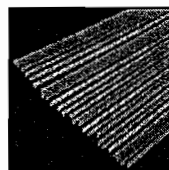
26320	1/4" Gray PVC Schedule 80 Pipe Qty 100: 5% off; Qty 200: 10% off; Qty 600: 15% off;	Yes	Foot	\$0.66



45° Elbow PVC
Threaded Pipe Fittings



Coupling PVC Socket
Fitting



PVC-1 Welding Rod

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40								80							
Pipe Size	O.D.	Ave. I.D.	Min. Wall Thick.	Approx. Wt. Per 100 ft.	Max. Press. Plain Ends	Work Press. Gray	White	Pipe Size	O.D.	Ave. I.D.	Min. Wall Thick.	Approx. Wt. Per 100 ft.	Work Press. Plain Ends	Max. Press. Thrd. Ends	Gray
1/4"	.540	.354	.088	7.88	780	26300	-	1/4"	.540	.302	.119	9.4	1130	550	26320
3/8"	.675	.483	.091	10.53	620	26301	-	3/8"	.675	.423	.126	13.0	920	450	26321
1/2"	.840	.608	.109	15.63	600	26302	26502	1/2"	.840	.546	.147	19.2	850	420	26322
3/4"	1.050	.810	.113	20.78	480	26303	26503	3/4"	1.050	.742	.154	25.9	690	340	26323
1"	1.315	1.033	.133	30.85	450	26304	26504	1"	1.315	.957	.179	38.2	630	320	26324
1-1/4"	1.660	1.364	.140	41.76	370	26305	26505	1-1/4"	1.660	1.278	.191	52.7	520	260	26325
1-1/2"	1.900	1.592	.145	49.94	330	26306	26506	1-1/2"	1.900	1.500	.220	63.9	470	240	26326
2"	2.375	2.049	.154	67.92	280	26307	26507	2"	2.375	1.939	.218	88.3	400	210	26327
2-1/2"	2.875	2.445	.203	105.46	300	26308	26508	2-1/2"	2.875	2.323	.276	134.6	420	200	26328
3"	3.500	3.042	.216	137.91	260	26309	26509	3"	3.500	2.900	.300	180.4	370	190	26329
4"	4.500	3.998	.237	194.58	220	26310	26510	4"	4.500	3.826	.337	263.4	320	160	26330
6"	6.625	6.031	.280	338.88	180	26311	26511	6"	6.625	5.761	.432	502.6	280	140	26331

*Spec Sheet for OD, ID, Wall & max pressure from
United States Plastic Corp. PVE pipe
www.usplastic.com

MATERIAL SAFETY DATA SHEET

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3/17/2004

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

24-Hour Emergency Phone Number: 989-636-4400

Product Name: **GREAT STUFF* Gaps and Cracks**

Collective ID: 19

Material Type: Flammable - OCF

Revised: 02/16/04 (sec. 2 & 15)

The Dow Chemical Company, Midland, MI 48674

Customer Service: 800-366-4740

2. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL	CAS#	CONCENTRATION
Polymethylene polyphenyl isocyanate containing 4,4'-Methylene bisphenyl isocyanate CAS# 000101-68-8 (Approximately 40-50% MDI)	009016-87-9	5-10, 10-30%
Liquified Petroleum Mixture Containing Isobutane (CAS# 75-28-5) Propane (CAS# 74-98-6) Dimethyl Ether (CAS# 115-10-6)		10-30%
Prepolymers of MDI and Polyether Polyol	mixture	40-70, 60-100%

3. HAZARDS IDENTIFICATION

DANGER!

Extremely Flammable.

Sprayed or heated material harmful if inhaled. May cause allergic skin reaction. May cause allergic respiratory reaction and lung injury. Avoid temperatures above 105F (41C). Toxic flammable gases and heat are released under decomposition conditions. Toxic fumes may be released in fire situations. Reacts slowly with water releasing, carbon dioxide, which can cause pressure buildup and rupture of closed containers. Elevated temperatures accelerate this process.

POTENTIAL HEALTH EFFECTS (See Section 11 for toxicological data.)

EYE: May cause moderate eye irritation. May cause very slight transient (temporary) corneal injury.

SKIN: Prolonged or repeated exposure may cause slight skin irritation. May cause allergic skin reaction in susceptible individuals. Animal studies have shown that skin contact with isocyanates may play a role in respiratory sensitization. May stain skin. A single prolonged exposure is not likely to result in the material being absorbed in harmful amounts.

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GREAT STUFF Gaps and Cracks

INGESTION: Single dose oral toxicity is considered to be low. No hazards anticipated from swallowing small amounts incidental to normal handling operations.

INHALATION: At room temperature, PMDI vapors are minimal due to low vapor pressure. However, certain operations may generate vapor or aerosol concentrations sufficient to cause irritation or other adverse effects. Excessive exposure may cause irritation to upper respiratory tract and lungs, and pulmonary edema (fluid in the lungs). May cause respiratory sensitization in susceptible individuals. MDI concentrations below the exposure guidelines may cause allergic respiratory reactions in individuals already sensitized. Symptoms may include coughing, difficult breathing and a feeling of tightness in the chest. Effects may be delayed. Decreased lung function has been associated with overexposure to isocyanates.

In confined or poorly ventilated areas, propane and isobutane vapors can readily accumulate and can cause unconsciousness and death due to displacement of oxygen (simple asphyxia). Excessive exposure may increase sensitivity to epinephrine and increase myocardial irritability (irregular heartbeats). Signs and symptoms of excessive exposure may be central nervous system effects. At air concentrations < 1000 ppm, propane exerts very little physiological action; at 100,000 ppm and above it may produce dizziness or other central nervous system effects. Signs and symptoms of central nervous system depression, in order of increasing exposure, are headache, dizziness, drowsiness, and unconsciousness, even death.

A single prolonged (hours) excessive inhalation exposure to dimethyl ether may cause serious adverse effects, even death. Excessive exposure may cause irritation to upper respiratory tract (nose and throat). Signs and symptoms of excessive exposure may be anesthetic or narcotic effects. In animals,

4. FIRST-AID MEASURES

EYE: Irrigate with flowing water immediately and continuously for 15 minutes. Consult medical personnel.

SKIN: Remove material from skin immediately by washing with soap and plenty of water, (warm water is preferable if readily available). Remove contaminated clothing and shoes while washing. Seek medical attention if irritation persists. An MDI skin decontamination study demonstrated that cleaning very soon after exposure is important, and that a polyglycol-based skin cleanser or corn oil may be more effective than soap and water.

INGESTION: If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.

NOTE TO PHYSICIAN: No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient. May cause respiratory sensitization or asthma-like symptoms. Bronchodilators, expectorants, and antitussives may be of help. Respiratory symptoms, including pulmonary edema, may be delayed. Persons receiving significant exposure should be observed for 24-48 hours for signs of respiratory distress.

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5. FIRE-FIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINT: -156F, -104C

METHOD USED: Estimated

AUTOIGNITION TEMPERATURE: NA

FLAMMABILITY LIMITS

LFL: NA

UFL: NA

HAZARDOUS COMBUSTION PRODUCTS: During a fire, smoke may contain the original material in addition to unidentified toxic and/or irritating compounds. Hazardous combustion products may include but are not limited to: nitrogen oxides, isocyanates, hydrogen cyanide, carbon monoxide, and carbon dioxide.

OTHER FLAMMABILITY INFORMATION: Product reacts with water. Reaction may produce heat and/or gases. Reaction may be violent. Container may rupture from gas generation in a fire situation. Violent steam generation or eruption may occur upon application of direct water stream to hot liquids. Dense smoke is produced when product burns. Spills of these organic liquids on hot fibrous insulations may lead to lowering of the autoignition temperatures possibly resulting in spontaneous combustion.

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, foam, water fog or fine spray. Alcohol resistant foams (ATC type) are preferred if available. General purpose synthetic foams (including AFFF) or protein foams may function, but much less effectively. Do not use direct water stream. May spread fire.

FIRE FIGHTING INSTRUCTIONS: Keep people away. Isolate fire area and deny unnecessary entry. Stay upwind. Keep out of low areas where gases (fumes) can accumulate. Water is not recommended but may be applied in very large quantities as a fine spray when other extinguishing agents are not available.

Contain fire water run-off if possible. Do not use direct water stream. May spread fire. Fight fire from protected location or safe distance. Consider use of unmanned hose holder or monitor nozzles. Use water spray to cool fire exposed containers and fire affected zone until fire is out. Immediately withdraw all personnel from area in case of rising sound from venting safety device or discoloration of the container. Move container from fire area if this is possible without hazard.

PROTECTIVE EQUIPMENT FOR FIRE FIGHTERS: Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, pants, boots, and gloves). Avoid contact with this material during fire fighting operations. If contact is likely, change to full chemical resistant clothing with SCBA. This will not provide sufficient fire protection; consider fighting fire from a remote location. For protective equipment in post-fire or non-fire clean-up situations, refer

6. ACCIDENTAL RELEASE MEASURES

PROTECT PEOPLE: Avoid any contact. Barricade area. Clear non-emergency personnel from area. Keep upwind of spill. Ventilate area of leak or spill. The area must be evacuated and reentered by persons equipped for decontamination. Use appropriate safety equipment. Ventilate area of leak or spill. If available, use foam to suppress vapors. For additional information, refer to "Exposure Controls/Personal Protection", MSDS Section 8. See Section 10, Stability and Reactivity.

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PROTECT THE ENVIRONMENT: Contain liquid to prevent contamination of soil, surface water or ground water. Keep out of ditches, sewers, and water supplies. Should the product enter sewers or drains, it should be pumped into a covered, vented container; the cover should be placed loosely on the container but not made pressure tight. Move to a well-ventilated area. Emergency services may need to be called to assist in the cleanup operation.

CLEAN-UP: Supplies of suitable decontaminant should always be kept available.

Absorb with material such as: sawdust, vermiculite, dirt, sand, clay, cob grit, Milsorb. Avoid materials such as cement powder. Collect material in suitable and properly labeled OPEN containers. Do not place in sealed container. Prolonged contact with water results in a chemical reaction which may result in rupture of the container. Place in: polylined fiber pacs, plastic drums, or properly labeled metal containers. Remove to a well ventilated area. Clean up floor areas. Attempt to neutralize by suitable decontaminant solution: Formulation 1: sodium carbonate 5-10%; liquid detergent 0.2-2%; water to make up to 100%. OR Formulation 2: Concentrated ammonia solution 3-8%; liquid detergent 0.2-2%; water to make up to 100%. If ammonia is used, use good ventilation to prevent vapor exposure. If you have any questions on how to neutralize call The Dow Chemical Company. Please refer to Disposal Information, MSDS Section 13. See Section 7 and 15 for more specific information.

7. HANDLING AND STORAGE

HANDLING: Avoid contact of this product with water at all times during handling and storage. Use only with adequate ventilation. Keep equipment clean. Use disposable containers and tools where possible. Do not eat, drink, or smoke in working area. Refer to Exposure Controls/Personal Protection, Section 8, of the MSDS.

STORAGE: Store in a dry place. Store between 32°F-90°F (0°-32°C). Keep containers tightly closed when not in use. Protect containers from physical abuse. Avoid direct sunlight. DO NOT incinerate aerosol can.

8. EXPOSURE CONTROL/PERSONAL PROTECTION

ENGINEERING CONTROLS: Use only with adequate ventilation. Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines. Exhaust systems should be designed to move the air away from the source of vapor/aerosol generation and the people working at this point. Odor is inadequate warning of excessive exposure.

PERSONAL PROTECTIVE EQUIPMENT

EYE/FACE PROTECTION: Use chemical goggles.

SKIN PROTECTION Use protective clothing impervious to this material. Selection of specific items such as faceshield, gloves, boots, apron, or full-body suit will depend on operation. Remove contaminated clothing immediately, wash skin area with soap and water (warm water if available) and launder clothing before reuse. Items which cannot be decontaminated, such as shoes, belts and watchbands, should be removed and destroyed.

RESPIRATORY PROTECTION: Atmospheric levels should be maintained below the exposure guideline. When atmospheric levels may exceed the exposure guideline, use an approved air-purifying respirator equipped with an organic

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vapor sorbent and a particle filter. For situations where the atmospheric levels may exceed the level for which an air-purifying respirator is effective, use a positive-pressure air-supplying respirator (airline or self-contained breathing apparatus). For emergency response or for situations where the atmospheric level is unknown, use an approved positive-pressure self-contained breathing apparatus.

EXPOSURE GUIDELINES(S):

Methylene bisphenyl isocyanate (MDI): ACGIH TLV is 0.005 ppm TWA and OSHA PEL is 0.02 ppm Ceiling.

Isobutane: ACGIH TLV and OSHA PEL are 800 ppm.

Propane: ACGIH TLV is 2500 ppm TWA and OSHA PEL is 1000 ppm.

Dimethyl Ether: ACGIH TLV is 1000 ppm TWA.

PELs are in accord with those recommended by OSHA, as in the 1989 revision of

9. PHYSICAL AND CHEMICAL PROPERTIES

Flash Point : -156°F (-104°C) (estimated)

Vapor Pres. (21°C/70°F) : 4210 mm HG

Specific Gravity : 1.1

VOC Content (g/L) : 158.1 grams/Litre

10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable under recommended storage conditions.

See Section 7, Storage.

CONDITIONS TO AVOID: Avoid temperatures above 105F, 41C. Avoid temperatures below 75F, 24C. Can react with itself at temperatures above 320F, 160C. Product can decompose at elevated temperatures. Generation of gas during decomposition can cause pressure in closed systems. Pressure build-up can be rapid. Avoid moisture. Material reacts slowly with water, releasing carbon dioxide, which can cause pressure buildup and rupture of closed containers. Elevated temperatures accelerate this reaction.

INCOMPATIBILITY WITH OTHER MATERIALS: Avoid contact with acids, water, alcohols, amines, ammonia, bases, moist air, and strong oxidizers. Avoid contact with metals such as aluminum, brass, copper, galvanized metals, tin, zinc. Avoid contact with moist organic absorbents. Reaction with water will generate carbon dioxide and heat. Generation of gas can cause pressure buildup in closed systems. Avoid unintended contact with polyols. The reaction of polyols and isocyanates generate heat. Diisocyanates react with many materials and the rate of reaction increases with temperature as well as increased contact, these reactions can become violent. Contact is increased by stirring or if the other material mixes with the diisocyanate. Diisocyanates are not soluble in water and are denser than water and sink to the bottom, but react slowly at the interface. The reaction forms carbon dioxide gas and a layer of solid polyurea. See Hazardous Polymerization Section.

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HAZARDOUS DECOMPOSITION PRODUCTS: Hazardous decomposition products depend upon temperature, air supply and the presence of other materials. Gases are released during decomposition.

HAZARDOUS POLYMERIZATION: Can occur. Polymerization can be catalyzed by: strong bases and water. Can react with itself at temperatures above 320F (160C).

11. TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION (See Section 3 for Potential Health Effects)

ACUTE:

SKIN: The LD50 for skin absorption in rabbits is > 2000 mg/kg.

INGESTION: The oral LD50 for rats is > 10,000 mg/kg.

MUTAGENICITY (EFFECTS ON GENETIC MATERIAL): Mutagenicity data on MDI are inconclusive. MDI was weakly positive in some in-vitro (test tube) studies; other in-vitro studies were negative. A mutagenicity study in animals was

DIMETHYL ETHER (115-10-6)

MUTAGENICITY

In vitro mutagenicity studies were positive. Animal mutagenicity studies were negative in some cases and positive in other cases.

12. ECOLOGICAL INFORMATION

ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE

MOVEMENT & PARTITIONING: Based on information for MDI and polymeric MDI. In the aquatic or terrestrial environment, movement is expected to be limited by its reactivity with water forming predominantly insoluble polyureas.

DEGRADATION & PERSISTENCE: Based on information for MDI and polymeric MDI. In the aquatic and terrestrial environment, material reacts with water forming predominantly insoluble polyureas which appear to be stable. In the atmospheric environment, material is expected to have a short tropospheric half-life, based on calculations and by analogy with related diisocyanates.

ECOTOXICITY: Based on information for MDI and polymeric MDI. The measured ecotoxicity is that of the hydrolyzed product, generally under conditions maximizing production of soluble species. Material is practically non-toxic to aquatic organisms on an acute basis (LC50/EC50 > 100 mg/L in most sensitive species). The LC50 in earthworm *Eisenia foetida* is > 1000 mg/kg.

13. DISPOSAL CONSIDERATIONS

DISPOSAL CONSIDERATIONS (See Section 15 for Regulatory Information)

DISPOSAL: DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. All disposal methods must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. THE DOW CHEMICAL COMPANY HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING

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PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION 2 (Composition/Information On Ingredients).

FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: recycler, reclaimer, incinerator or other thermal destruction device.

For additional information, refer to:

- Handling & Storage Information, MSDS Section 7. - Stability & Reactivity Information, MSDS Section 10.
- Regulatory Information, MSDS Section 15.

As a service to its customers, Dow can provide names of information resources to help identify waste management companies and other facilities which recycle, reprocess or manage chemicals or plastics, and that manage used drums. Telephone Dow's Customer Information Center at 800-258-2436 or 989-832-1556 for further details.

14. TRANSPORT INFORMATION

Consumer Commodity ORM-D

15. REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, expressed or implied is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations. See other sections for health and safety information.

U.S. REGULATIONS

SARA 313 INFORMATION: This product contains the following subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372:

CHEMICAL NAME	CAS NUMBER
METHYLENE BIS(PHENYLISOCYANATE) (MDI)	000101-68-8
POLYMERIC DIPHENYLMETHANE DIISOCYANATE	009016-87-9

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

PMDI/MDI

An immediate health hazard
A delayed health hazard

ISOBUTANE/PROPANE: A fire hazard

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GREAT STUFF Gaps and Cracks

TOXIC SUBSTANCES CONTROL ACT (TSCA):

All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

STATE RIGHT-TO-KNOW: The following product components are cited on certain state lists as mentioned. Non-listed components may be shown in the composition section of the MSDS.

CHEMICAL NAME	CAS NUMBER	LIST
Isobutane	75-28-5	MA. NJ, PA
Propane	74-98-6	MA. NJ, PA15.

REGULATORY INFORMATION

MA=Massachusetts Right to Know Substance List
NJ2=New Jersey Environmental Hazardous Substance
NJ3=New Jersey Workplace Hazardous Substance
PA1=Pennsylvania Hazardous Substance
PA3=Pennsylvania Environmental Hazardous Substance

OSHA HAZARD COMMUNICATION STANDARD: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND): To the best of our knowledge, this product contains the following chemical subject to reporting under CERCLA.

Propane 100 lbs
Isobutane 100 lbs

CANADIAN REGULATIONS

WHMIS INFORMATION: The Canadian Workplace Hazardous Materials Information System (WHMIS) Classification for this product is:
D3 combustible liquid.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA):

All substances in this product are listed on the Canadian Domestic Substances List (DSL) or are not required to be listed.

16. OTHER INFORMATION

HMIS - H - F - R - PPE
2 - 4 - 1 - B

This product is a polyurethane blend in the form of a solution in liquid containing by weight 50% or more polymer.

(TM), *, OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

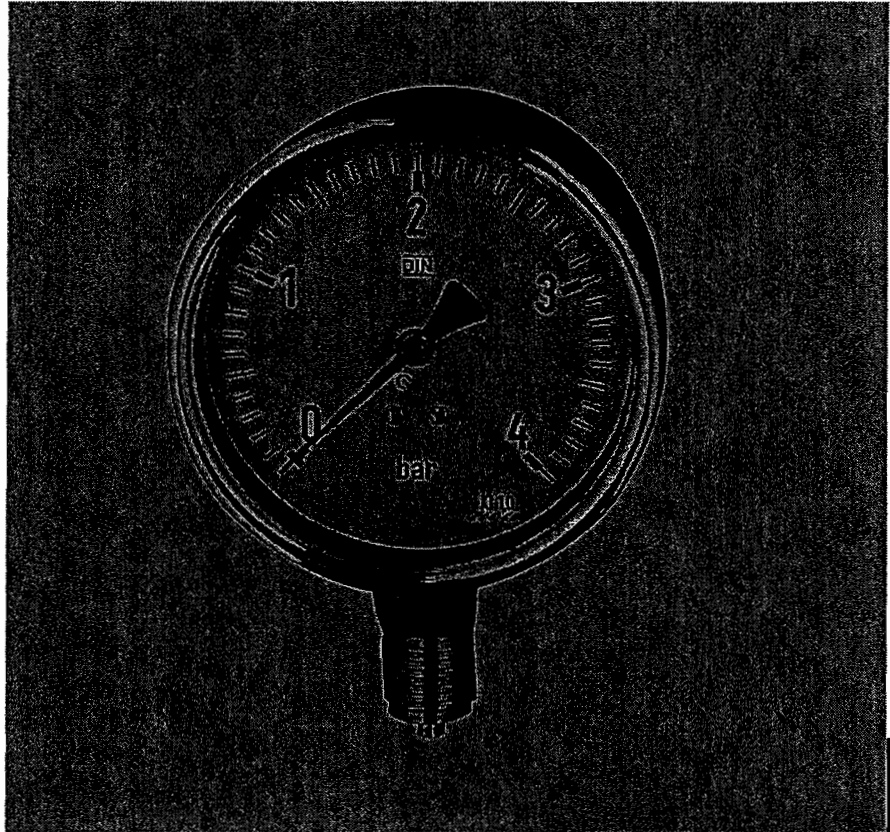


Features

- Economical Brass Construction
- Highly Reliable
- Rugged Design
- $\pm 1.0\%$ Accuracy
- Pulsation and Vibration Damping Through Optional Glycerin Filling

The DRF22 pressure gauge series is a versatile bourdon tube based device with brass movement. Stainless steel and brass construction offers a good combination of corrosion resistance and value.

To make installation a snap, the DRF22 is offered with or without panel mounting bezel, and either bottom or rear ports. An optional glycerin filled housing makes the unit suitable for deployment with media prone to pulsation and vibration. With ranges reaching from $-30''$ Hg to 10,000 PSIG, the DRF22 is the right fit for most pressure sensing applications.



Specifications

Ranges: -14.7 to 10,000 PSIG
(see table)

Over Pressure Protection
Momentary: 1.15 to 1.3 x
range max.

Sensing Element: bourdon tube

Accuracy: $\pm 1.0\%$ of full scale

Operating Temperature
Medium: freezing to 180°F
Ambient: freezing to 140°F

Fittings: $\frac{1}{2}''$ NPT

Materials of Construction

Wetted Parts

Element

< 1000 PSIG: Copper
1000 PSIG & Up: Stainless Steel
Fitting: CuZn Alloy

KOBOLD DRF22 Pressure Gauge

Exterior

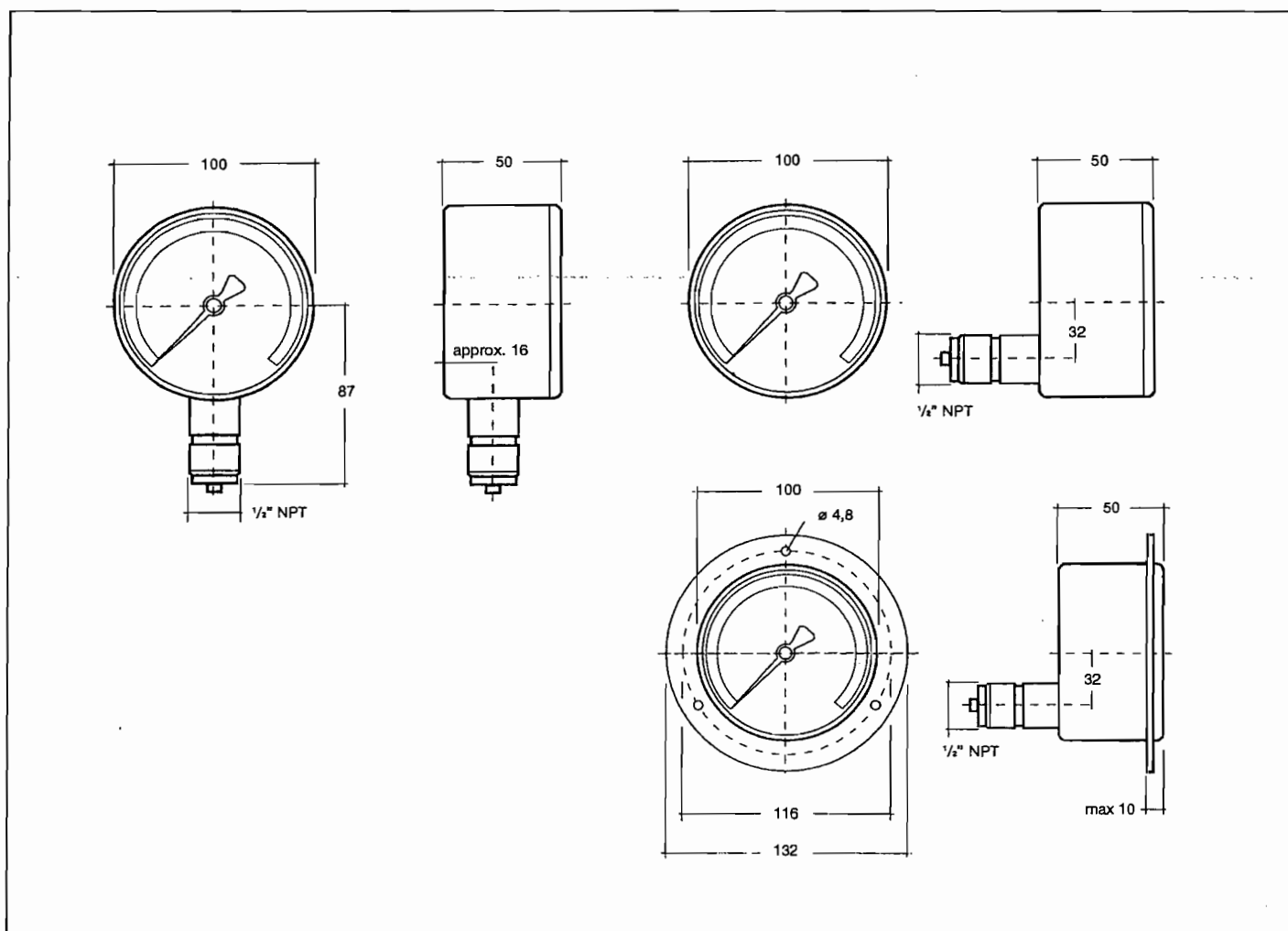
Movement: Brass
Housing: 304 SS or aluminum
Bezel: 304 SS
Pointer: Black aluminum
Indicator Dial: White aluminum
Window: Safety glass

Options: Glycerin damped
indicator assembly

DRF22 Ordering Information				
DRF22	= Copper Element High Pressure Bourdon Tube Pressure Gauge			
-1	= 100 mm (4 inch) Dial Face, Bottom Process Connection			
-2	= 100 mm (4 inch) Dial Face, Rear Process Connection			
-3	= 100 mm (4 inch) Dial face, Rear Process Connection with Panel Mountable Bezel			
Range	= Pressure Range Abbreviation		Available Measuring Ranges	
H00	= -30" to 0" Hg		210	= 100 PSIG
115	= 15 PSIG		260	= 600 PSIG
130	= 30 PSIG		310	= 1000 PSIG
160	= 60 PSIG		320	= 2000 PSIG
			350	= 5000 PSIG
			410	= 10000 PSIG
F	= Optional glycerin damped indicator assembly (NOTE: DRF22-3xxxF comes with aluminum housing)			
DRF22 -1 320 F	Sample DRF22 Specification			

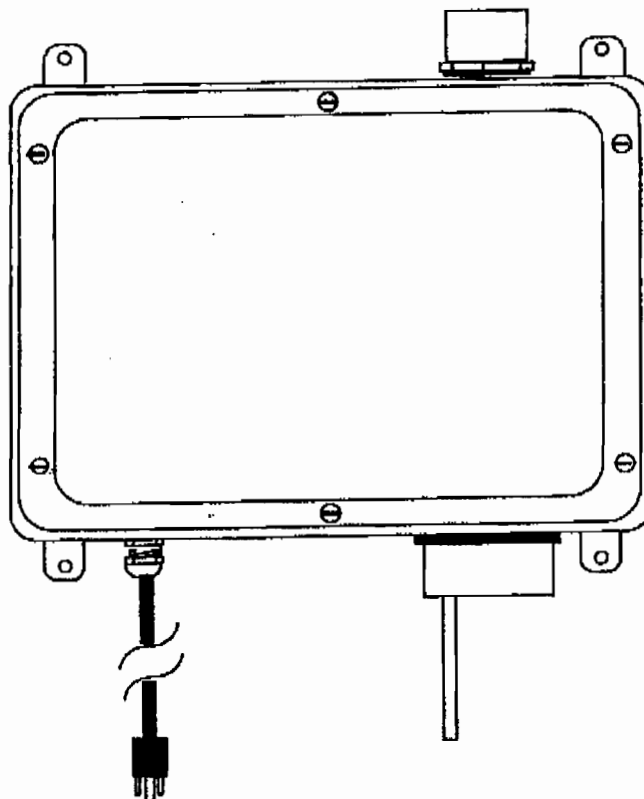
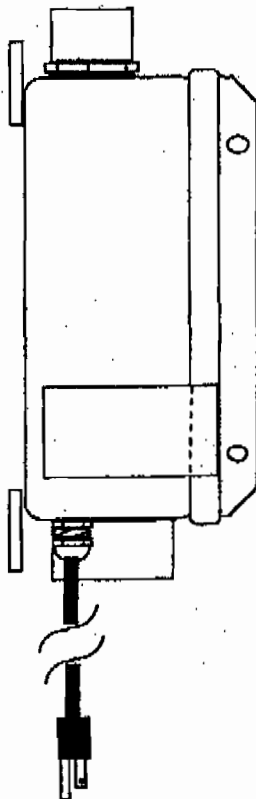
P1

Dimensions (mm)



HS SERIES INSTALLATION INSTRUCTIONS

BY



RadonAway, Inc. Ward Hill, MA.

P/N IN007 Rev E



RadonAway Ward Hill, MA.

HS Series Fan Installation Instructions

Please Read and Save These Instructions.

DO NOT CONNECT POWER SUPPLY UNTIL FAN IS COMPLETELY INSTALLED. MAKE SURE ELECTRICAL SERVICE TO FAN IS LOCKED IN "OFF" POSITION. DISCONNECT POWER BEFORE SERVICING FAN.

1. **WARNING!** Do not use fan in hazardous environments where fan electrical system could provide ignition to combustible or flammable materials.
2. **WARNING!** Do not use fan to pump explosive or corrosive gases.
3. **WARNING!** Check voltage at the fan to insure it corresponds with nameplate.
4. **WARNING!** Normal operation of this device may affect the combustion airflow needed for safe operation of fuel burning equipment. Check for possible backdraft conditions on all combustion devices after installation.
5. **NOTICE!** There are no user serviceable parts located inside the fan unit. **Do NOT attempt to open.** Return unit to the factory for service.
6. All wiring must be in accordance with local and national electrical codes.
7. **WARNING!** In the event that the fan is immersed in water, return unit to factory for service before operating.
8. **WARNING!** Do not twist or torque fan inlet or outlet piping as Leakage may result.

INSTALLATION INSTRUCTIONS (Rev D)
for DynaVac High Suction Series

HS2000	p/n 23004-1
HS3000	p/n 23004-2
HS5000	p/n 23004-3

1.0 SYSTEM DESIGN CONSIDERATIONS

1.1 INTRODUCTION

The DynaVac is intended for use by trained, professional Radon mitigators. The purpose of this instruction is to provide additional guidance for the most effective use of the DynaVac. This instruction should be considered as a supplement to EPA standard practices, state and local building codes and state regulations. In the event of a conflict, those codes, practices and regulations take precedence over this instruction.

1.2 ENVIRONMENTALS

The DynaVac is designed to perform year-round in all but the harshest climates without additional concern for temperature or weather. For installations in an area of severe cold weather, please contact RadonAway for assistance. When not in operation, the DynaVac should be stored in an area where the temperature is never less than 32 degrees F. or more than 100 degrees F. The DynaVac is thermally protected such that it will shut off when the internal temperature is above 104 degrees F. Thus if the DynaVac is idle in an area where the ambient temperature exceeds this shut off, it will not restart until the internal temperature falls below 104 degrees F.

1.3 ACOUSTICS

The DynaVac, when installed properly, operates with little or no noticeable noise to the building occupants. There are, however, some considerations to be taken into account in the system design and installation. When installing the DynaVac above sleeping areas, select a location for mounting which is as far away as possible from those areas. Avoid mounting near doors, fold-down stairs or other uninsulated structures which may transmit sound. Insure a solid mounting for the DynaVac to avoid structure-borne vibration or noise.

The velocity of the outgoing air must also be considered in the overall system design. With small diameter piping, the "rushing" sound of the outlet air can be disturbing. The system design should incorporate a means to slow and quiet the outlet air. The use of the RadonAway Exhaust Muffler, p/n 24001, is strongly recommended.

1.4 GROUND WATER

Under no circumstances should water be allowed to be drawn into the inlet of the DynaVac as this may result in damage to the unit. The DynaVac should be mounted at least 5 feet above the slab penetration to minimize the risk of filling the DynaVac with water in installations with occasional high water tables.

In the event that a temporary high water table results in water at or above slab level, water will be drawn into the riser pipes thus blocking air flow to the DynaVac. The lack of cooling air will result in the DynaVac cycling on and off as the internal temperature rises above the thermal cutoff and falls upon shutoff. Should this condition arise, it is recommended that the DynaVac be disconnected until the water recedes allowing for return to normal operation.

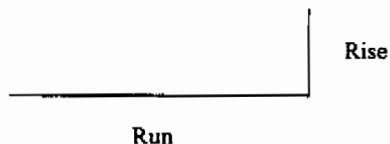
1.5 CONDENSATION & DRAINAGE

(WARNING!: Failure to provide adequate drainage for condensation can result in system failure and damage the DynaVac).

Condensation is formed in the piping of a mitigation system when the air in the piping is chilled below its dew point. This can occur at points where the system piping goes through unheated space such as an attic, garage or outside. The system design must provide a means for water to drain back to a slab hole to remove the condensation.

The use of small diameter piping in a system increases the speed at which the air moves. The speed of the air can pull water uphill and at sufficient velocity it can actually move water vertically up the side walls of the pipe. This has the potential of creating a problem in the negative pressure (inlet) side piping. For DynaVac inlet piping, the following table provides the minimum recommended pipe diameters as well as minimum pitch under several system condition. Use this chart to size piping for a system.

Pipe Diam.	Minimum Rise per Foot of Run*		
	@ 25 CFM	@ 50 CFM	@ 100 CFM
4"	1/32 "	3/32 "	3/8 "
3"	1/8 "	3/8 "	1 1/2 "



*Typical operational flow rates:

HS3000, or HS5000
HS2000

20 - 40 CFM
50 - 90 CFM

All exhaust piping should be 2" PVC.

1.6 "SYSTEM ON" INDICATOR

A properly designed system should incorporate a "System On" Indicator for affirmation of system operation. A Magnehelic pressure gauge is recommended for this purpose. The indicator should be mounted at least 5 feet above the slab penetration to minimize the risk of filling the gauge with water in installations with occasional high water tables.

1.7 SLAB COVERAGE

The DynaVac can provide coverage of well over 1000 sq. ft. per slab penetration. This will, of course, depend on the sub-slab aggregate in any particular installation and the diagnostic results. In general, sand and gravel are much looser aggregates than dirt and clay. Additional suction points can be added as required. It is recommended that a small pit (2 to 10 gallons in size) be created below the slab at each suction hole.

1.8 ELECTRICAL WIRING

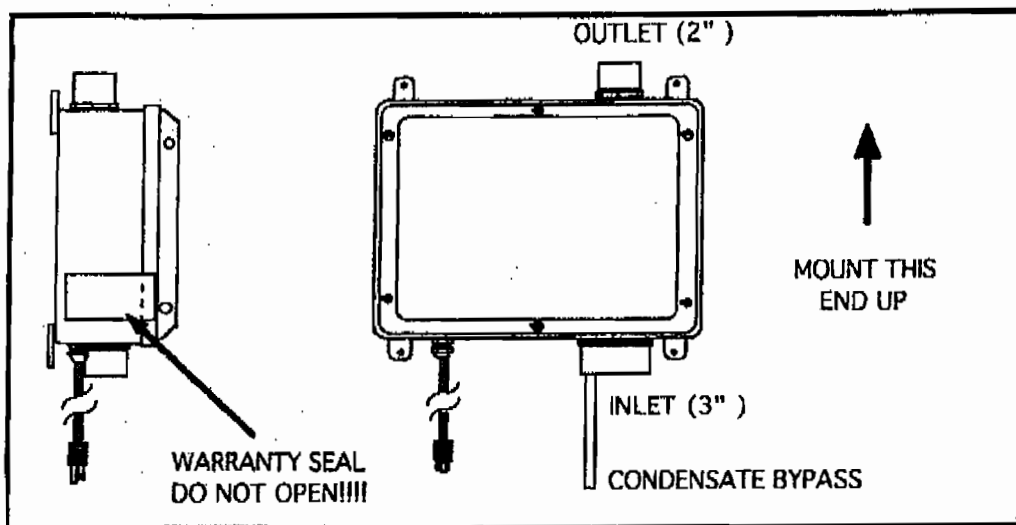
The DynaVac plugs into a standard 120V outlet. All wiring must be performed in accordance with the National Electrical Code and state and local building codes.

1.8a ELECTRICAL BOX (optional)

The optional Electrical Box (p/n 20003) provides a weathertight box with switch for outdoor hardwire connection. All wiring must be performed in accordance with the National Electrical Code and state and local building codes. All electrical work should be performed by a qualified electrician. Outdoor installations require the use of a U.L. listed watertight conduit.

1.9 SPEED CONTROLS

Electronic speed controls can **NOT** be used on HS series units.



2.0 INSTALLATION

2.1 MOUNTING

Mount the DynaVac to the wall studs, or similar structure, in the selected location with (4) 1/4" x 1 1/2" lag screws (not provided). Insure the DynaVac is both plumb and level.

2.2 DUCTING CONNECTIONS

Make final ducting connection to DynaVac with flexible couplings. Insure all connections are tight. Do not twist or torque inlet and outlet piping on DynaVac or leaks may result.

2.3 VENT MUFFLER INSTALLATION

Install the muffler assembly in the selected location in the outlet ducting. Solvent weld all connections. The muffler is normally installed above the roofline at the end of the vent pipe.

2.5 OPERATION CHECKS

___ Make final operation checks by verifying all connections are tight and leak-free.

___ Insure the DynaVac and all ducting is secure and vibration-free.

___ Verify system vacuum pressure with Magnehelic. Insure vacuum pressure is less than the maximum recommended as shown below:

DynaVac	HS2000	14" WC
DynaVac	HS3000	21" WC
DynaVac	HS5000	40" WC

(Above are based on sea-level operation, at higher altitudes reduce above by about 4% per 1000 Feet.)

If these are exceeded, increase number of suction points.

___ Verify Radon levels by testing to EPA protocol.

Addendum

PRODUCT SPECIFICATIONS

Model	Maximum Static Suction	Typical CFM vs Static Suction WC (Recommended Operating Range)						Power* Watts @ 115 VAC
		0"	10"	15"	20"	25"	35"	
HS2000	18"	110	72	40	-	-	-	150-270
HS3000	27"	40	33	30	23	18	-	105-195
HS5000	50"	53	47	42	38	34	24	180-320

*Power consumption varies with actual load conditions

Inlet: 3.0" PVC

Outlet: 2.0" PVC

Mounting: Brackets for vertical mount

Weight: Approximately 18 lbs.

Size: Approximately 15"W x 13"H x 8"D

Minimum recommended inlet ducting (greater diameter may always be used):

HS3000, HS5000 --- 2.0" PVC Pipe

HS2000 --- Main feeder line of 3.0" or greater PVC Pipe

Branch lines (if 3 or more) may be 2.0" PVC Pipe

Outlet ducting: 2.0" PVC

Storage temperature range: 32 - 100 degrees F.

Thermally protected

Locked rotor protection

Internal Condensate Bypass

IMPORTANT INSTRUCTIONS TO INSTALLER

Inspect the HS Series Fan for shipping damage within 15 days of receipt. Notify RadonAway of any damages immediately. Radonaway is not responsible for damages incurred during shipping. However, for your benefit, Radonaway does insure shipments.

There are no user serviceable parts inside the fan. Do not attempt to open. Return unit to factory for service.

Install the HS Series Fan in accordance with all EPA standard practices, and state and local building codes and state regulations.

WARRANTY

Subject to any applicable consumer protection legislation, RadonAway warrants that the HS Series Fan (the "Fan") will be free from defects in materials and workmanship for a period of one (1) year from the date of manufacture (the "Warranty Term"). Outside the Continental United States and Canada the Warranty Term is one (1) year from the date of manufacture.

RadonAway will replace any Fan which fails due to defects in materials or workmanship. The Fan must be returned (at owner's cost) to the RadonAway factory. Proof of purchase must be supplied upon request for service under this Warranty.

This Warranty is contingent on installation of the Fan in accordance with the instructions provided. This Warranty does not apply where any repairs or alterations have been made or attempted by others, or if the unit has been abused or misused. Warranty does not include damage in shipment unless the damage is due to the negligence of RadonAway.

RadonAway is not responsible for installation, removal or delivery costs associated with this Warranty.

EXCEPT AS STATED ABOVE, THE HS SERIES FANS ARE PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

IN NO EVENT SHALL RADONAWAY BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING OUT OF, OR RELATING TO, THE FAN OR THE PERFORMANCE THEREOF. RADONAWAY'S AGGREGATE LIABILITY HEREUNDER SHALL NOT IN ANY EVENT EXCEED THE AMOUNT OF THE PURCHASE PRICE OF SAID PRODUCT. THE SOLE AND EXCLUSIVE REMEDY UNDER THIS WARRANTY SHALL BE THE REPAIR OR REPLACEMENT OF THE PRODUCT, TO THE EXTENT THE SAME DOES NOT MEET WITH RADONAWAY'S WARRANTY AS PROVIDED ABOVE.

For service under this Warranty, contact RadonAway for a Return Material Authorization (RMA) number and shipping information. No returns can be accepted without an RMA. If factory return is required, the customer assumes all shipping cost to and from factory.

RadonAway
3 Saber Way
Ward Hill, MA 01835
TEL. (978) 521-3703
FAX (978) 521-3964

Record the following information for your records:

Serial No. _____
Purchase Date _____

BULLETIN NO. A-27B

Magnehelic® Differential Pressure Gage OPERATING INSTRUCTIONS



SPECIFICATIONS

Dimensions: 4-3/4" dia. x 2-3/16" deep.

Weight: 1 lb. 2 oz. (510 g)

Finished: Baked dark gray enamel.

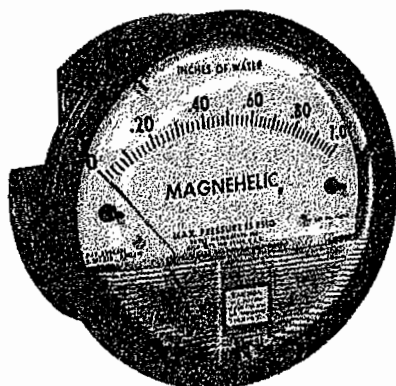
Connections: 1/8" female NPT high and low pressure taps, duplicated, one pair side and one pair back.

Accuracy: Plus or minus 2% of full scale, at 70°F (21.1°C). (Model 2000-0, 3%; 2000-00, 4%).

Pressure Rating: 15 PSI (1.03 bar)

Ambient Temperature Range: 20° to 140°F (-7 to 60°C).

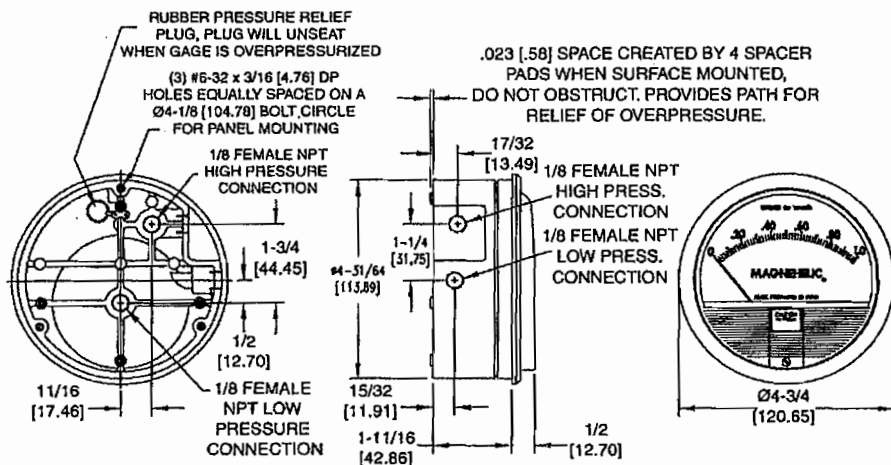
Standard gage accessories include two
1/8" male NPT plugs for duplicate pressure taps, two 1/8" male NPT pipe thread to rubber tubing adapters, and three flush mounting adapters with screws.



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.



DWYER INSTRUMENTS, INC.

P.O. BOX 375 • MICHIGAN CITY, INDIANA 46361-0375

Phone 219/672-8000 • Fax 219/672-8057 • e-mail: info@dwyerinst.com

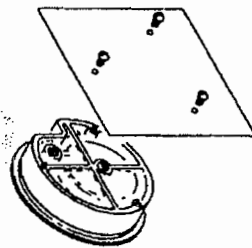
U.S. By Fax: 888/891-4068

Overpressure Protection: Standard Magnehelic gages are rated for a maximum pressure of 15 PSIG and should not be used where that limit could be exceeded. Newer models employ a rubber plug on the rear which functions as a relief valve by unseating and venting the gage interior when overpressure reaches approximately 25 PSIG. To provide a free path for pressure relief, there are four spacer pads which maintain .040" clearance when gage is surface mounted. Do not obstruct the gap created by these pads.

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 may 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.

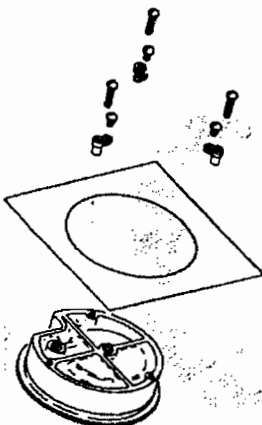
2. All standard Magnehelic gages are calibrated with the diaphragm vertical and should be used in that position for maximum accuracy. If gages are to be used in other than vertical position, this should be specified on the order. Many higher range gages will perform within tolerance in other positions 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 1/2" dia. opening in panel. Insert gage and secure in place with No. 6-32 machine screws of appropriate length, with adaptors, Part No. 360c, 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 gage is vented in a dirty, dusty atmosphere, we suggest an A-331 Filter Plug be installed in the open port to keep inside of gage clean.

a. For portable use or 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.

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, P/N 1, held firmly, loosen bezel, P/N 4 by turning counter-clockwise. 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, P/N 70-b. 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, P/N 230-b.

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 warranty. 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.
55 Ward St.
Waukegan, IN 46573

Trouble Shooting Tips:

• *Gage 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 sensors, (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 P/N 230-b 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 or failure. Gages repaired at the factory are carefully calibrated and tested to assure "like-new" operation. After receipt and inspection, we will be happy to quote repair costs before proceeding.

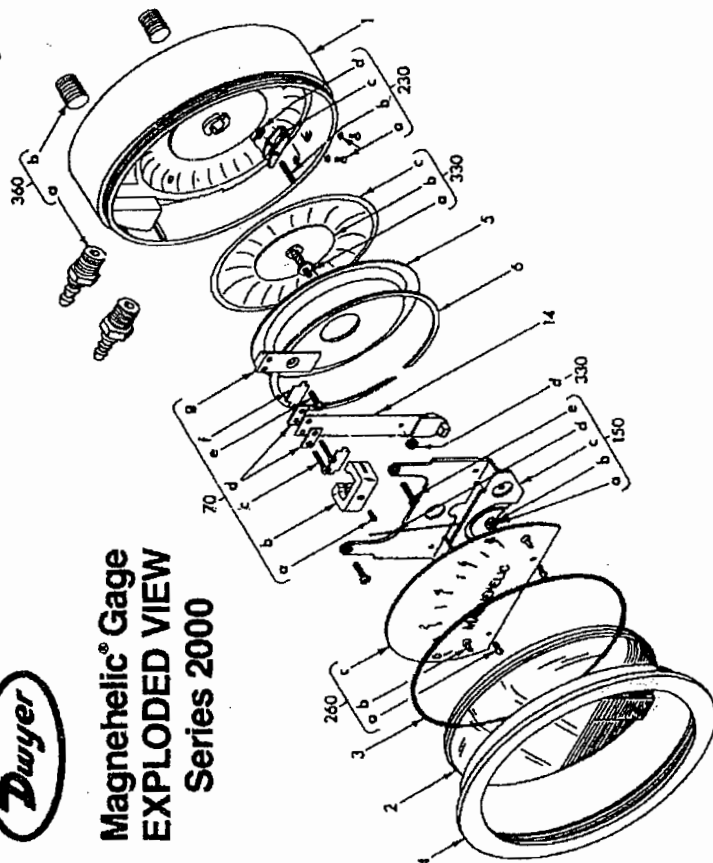
Consult factory for assistance on unusual applications or conditions.

Use with air or compatible gases only.

DWYER INSTRUMENTS, INC.
P.O. Box 1373 • MICHIGAN CITY, INDIANA 46360 U.S.A.
Telephone 219/873-8000
Fax 219/873-9957



Magnehelic® Gage EXPLODED VIEW Series 2000



1. Case
2. Cover with zero adjust assy.
3. "O" ring seal
4. Bezel
5. Diaphragm sealing plate
6. Retaining ring
70. Range Spring assembly
 - a. Clamp set screw
 - b. Clamp
 - c. Mounting screws (2 req'd)
 - d. Clamping shoe (2 req'd)
 - e. Clamping plate screw
 - f. Spacer (2 req'd)
 - g. Clamp plate
 - h. Clamp plate
14. Range Spring with magnet
150. Wishesbone Assembly—consists of:
 - a. Front jewel
 - b. Locking nut
 - c. Wishesbone
 - d. Pointer
 - e. Mounting screws (2 req'd)
 - f. Helix assembly (not shown)
 - g. Pivots (2 req'd) (not shown)
 - h. Rear jewel (not shown)
230. Zero adjust assembly—consists of:
 - a. Foot screws with washers (2 req'd)
 - b. Adjust screw
 - c. Foot
 - d. Finger
260. Scale Assembly—consists of:
 - a. Mounting screws (2 req'd)
 - b. Bumper pointer stop (2 req'd)
 - c. Scale
330. Diaphragm Assembly—consists of:
 - a. Linkage assy., complete (Arbor press needed to install)
 - b. Front plate
 - c. Diaphragm
 - d. Rear plate (not shown)
 - e. Plate washer (not shown)
360. Mounting Hardware Kit
 - a. Adapter—pipe plug w/ NPT to rubber tubing—(2 req'd)
 - b. Pipe plug w/ NPT—(2 req'd)
 - c. Mounting lug (3 req'd)
 - d. Long screw (3 req'd)
 - e. Short screw (3 req'd)

Ordering Instructions:

When corresponding with the factory regarding Magnehelic® gage problems, refer to the call-out numbers in this view. Be sure to include model number, pressure range, and any special options. Field repair is not recommended; contact the factory for repair service information.

BULLETIN NO. A-27 OPERATING INSTRUCTIONS and PARTS LIST Magnehelic® Differential Pressure Gage

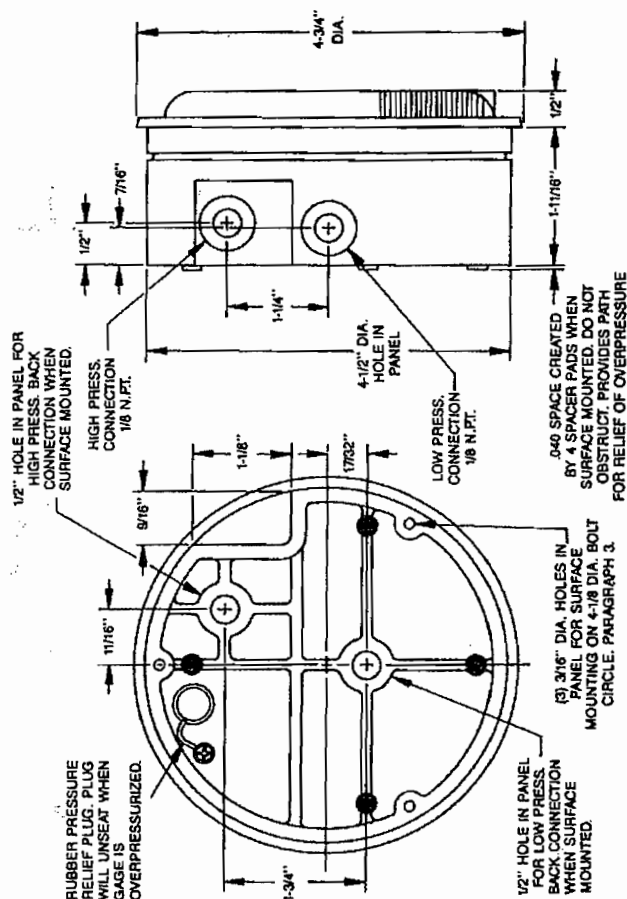
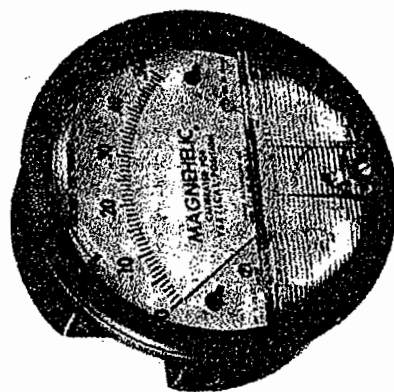


SPECIFICATIONS

Dimensions: 4-3/4" dia. X 2-3/16" deep.
Weight: 1 lb. 2 oz.
Finish: Baked dark gray enamel.
Connections: 1/8 N.P.T. 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.
Ambient Temperature Range: 20° to 140°F.
Standard gage accessories include two 1/8" N.P.T. plugs for duplicate pressure taps, two 1/8" 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.

Hydrogen Gas Precautionary Note: The rectangular rate earth magnet used in the standard gage may not be suitable for use with hydrogen gas since a toxic and explosive gas may form. For hydrogen service, consult the factory for an alternate gage construction.



DWYER INSTRUMENTS, INC.
P.O. BOX 373 • MICHIGAN CITY, INDIANA 46360 U.S.A.

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