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NAVAL FACILITIES ENGINEERING COMMAND, ATLANTIC
REMEDIAL ACTION CONTRACT (RAC)
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CONTRACT TASK ORDER NO. 0096

Draft Final Operation, Maintenance & Monitoring Plan for Groundwater Treatment Plant GM-38 Area Groundwater Remediation Naval Weapons Industrial Reserve Plant Bethpage, New York

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Prepared for:

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List of Acronyms and Abbreviations

CAA	Clean Air Act
CDL	Commercial Driver's License
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CMCS	Computer Monitoring and Control System
COC	Chain of Custody
DQOs	Data Quality Objectives
ECL	Environmental Conservation Law
EHS	Environmental Health and Safety
EPP	Employee Participation Program
GOCO	Government Owned Contractor-Operated
GPM	Gallons per minute
GWTP	Groundwater Treatment Plan
HMI	Human-Machine Interface
HP	Horsepower
IRP	Installation Restoration Program
kW	Kilowatts
LO/TO	Lock-out and Tag-out
MCC	Motor Control Center
NAAQS	National Ambient Air Quality Standards
NAVFAC	Naval Facilities Engineering Command
NCPD	Nassau County Police Department
NGC	Northrop Grumman Corporation
NWIRP	Naval Weapons Industrial Reserve Plant
NYCRR	New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
OM&M	Operation, Maintenance & Monitoring
OSHA	Occupational Safety and Health Administration
PCE	Perchloroethene
PESM	Project Environmental and Safety Manager
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RODs	Records of Decision
RPM	Revolutions per minute
SCFM	Standard cubic feet per minute
SHSO	Site Health and Safety Officer
SHSP	Site-specific Health and Safety Plan
SOP	Standard Operating Procedure
SPDES	State Pollution Discharge Elimination System
SVOCs	Semivolatile organic compounds
TtEC	Tetra Tech EC, Inc.
TCE	Trichloroethene
USEPA	United States Environmental Protection Agency
VOCs	Volatile organic compounds
VSD	Variable speed drives
ZIP	Zero Incident Performance

1.0 INTRODUCTION

Tetra Tech EC, Inc. (TtEC) has prepared this Operation, Maintenance & Monitoring Plan (OM&M Plan) for the GM-38 Area Groundwater Treatment Plant (GWTP) at the Naval Weapons Industrial Reserve Plant (NWIRP) in Bethpage, New York, for the United States Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC), Atlantic, under Remedial Action Contract No. N62472-99-D-0032 Contract Task Order No. 0096. This GWTP has been designed by TtEC, with support from various subcontractors for the remediation of the GM-38 Area groundwater "hot spot" containing chlorinated volatile organic compounds (VOCs) that lies hydraulically downgradient of the NWIRP Site in Bethpage, New York (Site; Figure 1-1). The equipment needed for the GWTP has been provided by various subcontractors (TIGG Corporation, BISCO Environmental, Product Recovery Management, Siemens Water Technologies, Inc., and others). Construction of the GWTP has been performed under TtEC's supervision by various subcontractors including Merrick Utility Associates, WHM Plumbing and Heating Contractors, and JVR Electric, Inc. The GWTP operations will be conducted in the groundwater treatment building located within the utility easement on property owned by the Town of Oyster Bay in the GM-38 Area (see Figure 1-2). The groundwater that is extracted from recovery wells RW-1 and RW-3 will be treated in the GWTP to meet the effluent limitations and monitoring requirements contained in the State Pollutant Discharge Elimination System (SPDES) Permit Equivalent dated June 6, 2008, issued by the New York State Department of Environmental Conservation (NYSDEC) before being returned to the aquifer via re-injection into injection well IW-1 and discharge into Nassau County Recharge Basin # 495.

The "hot spot" cleanup remedy for the GM-38 Area groundwater was originally set forth in Records of Decision (RODs) for Operable Unit 2 (OU 2) Groundwater for the Northrop Grumman Corporation (NGC) and NWIRP Sites (New York State Registry Site Numbers 1-30-003A & 1-30-003B, respectively) issued by NYSDEC Division of Environmental Remediation in March 2001 and for the NWIRP Bethpage Site by NAVFAC in April 2003 (Revision 1). The selected remedy was chosen in accordance with the New York State Environmental Conservation Law (ECL) and the Navy's Installation Restoration Program (IRP). It is also consistent with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, 42 U.S.C. §§ 9601-9675.

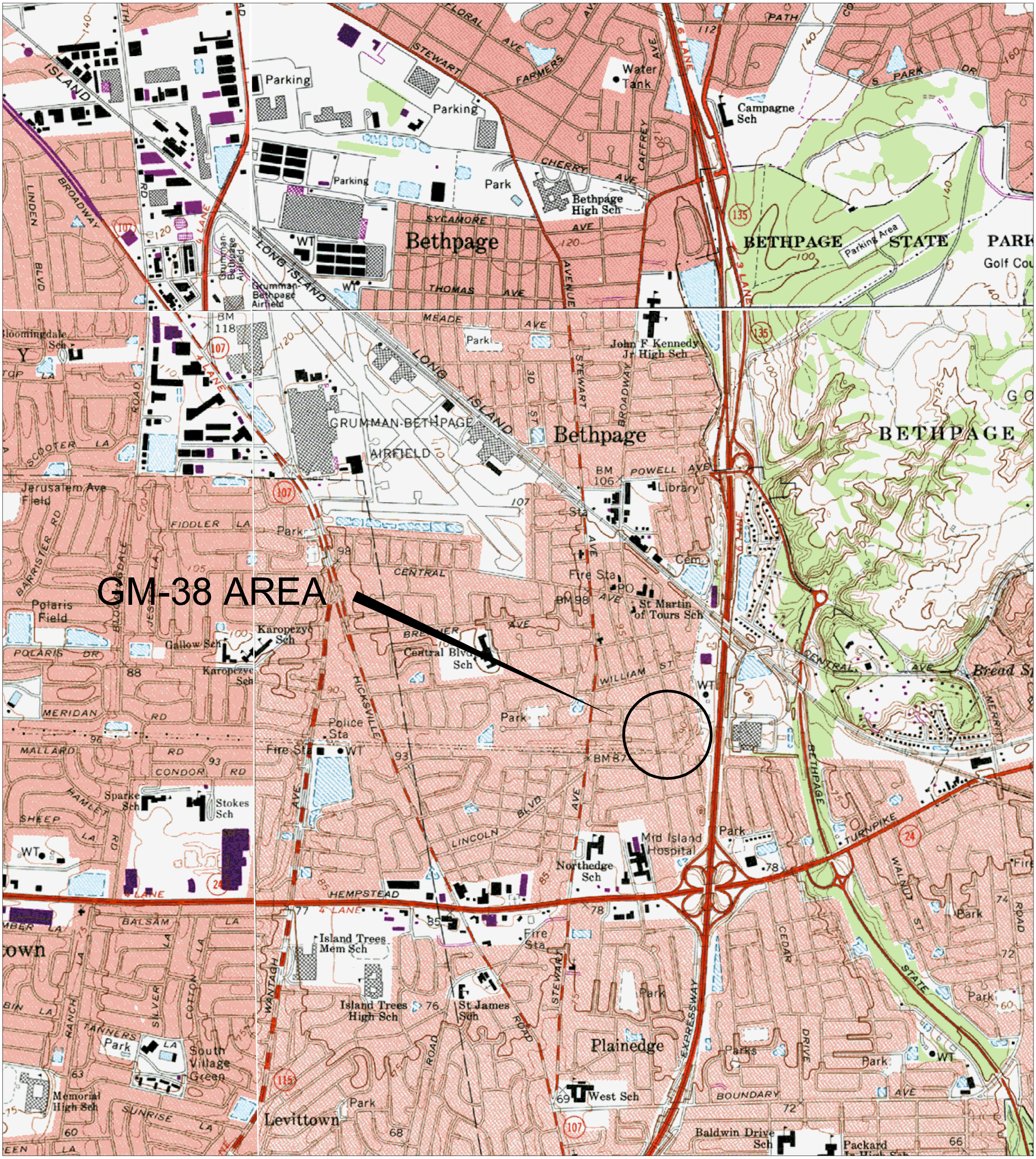
1.1 Purpose

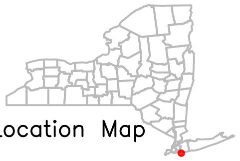
This OM&M Plan was written to provide a generalized set of instructions of the methods and procedures required to maintain and operate the GWTP at the site. This Plan includes information pertaining to the operation and maintenance of the facility, site security, regulatory requirements for plant operation, management of plant records, qualifications of plant personnel, sampling and analysis requirements, health and safety procedures, and waste handling procedures.

This Plan is supplemented by equipment manufacturer O&M manuals for each equipment component. As the project progresses, additional equipment manufacturer O&M information may be added, as it is obtained. This Plan is to be treated as a living document that will require periodic updating as information and operational experience is obtained.

1.2 Organization of the OM&M Plan

The purpose of this OM&M Plan is to facilitate the understanding of key operations and maintenance features of this facility. The following gives a brief overview of the remaining sections of this OM&M Plan.





Quadrangle Location Map

0 2000 4000 Feet

N

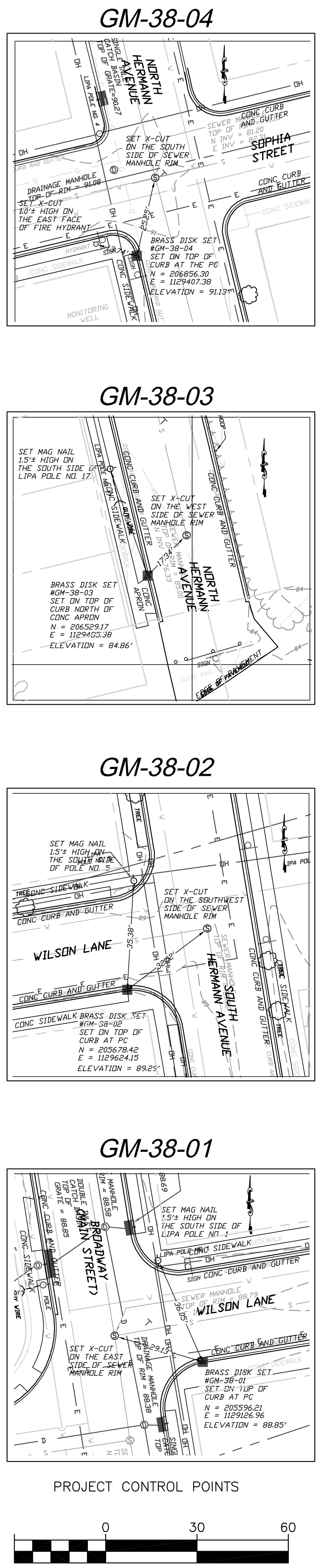
Source: U.S.G.S. Topographic Maps (7.5 Minute) Amityville, Freeport, Hicksville, Huntington, NY Quadrangles

U.S. Navy RAC
Engineering Field Activity, Northeast

GM-38 Area (Offsite)
NWIRP Bethpage
Bethpage, NY

Figure 1—1
Site Location Map

TETRA TECH ENGINEERING CORPORATION PC

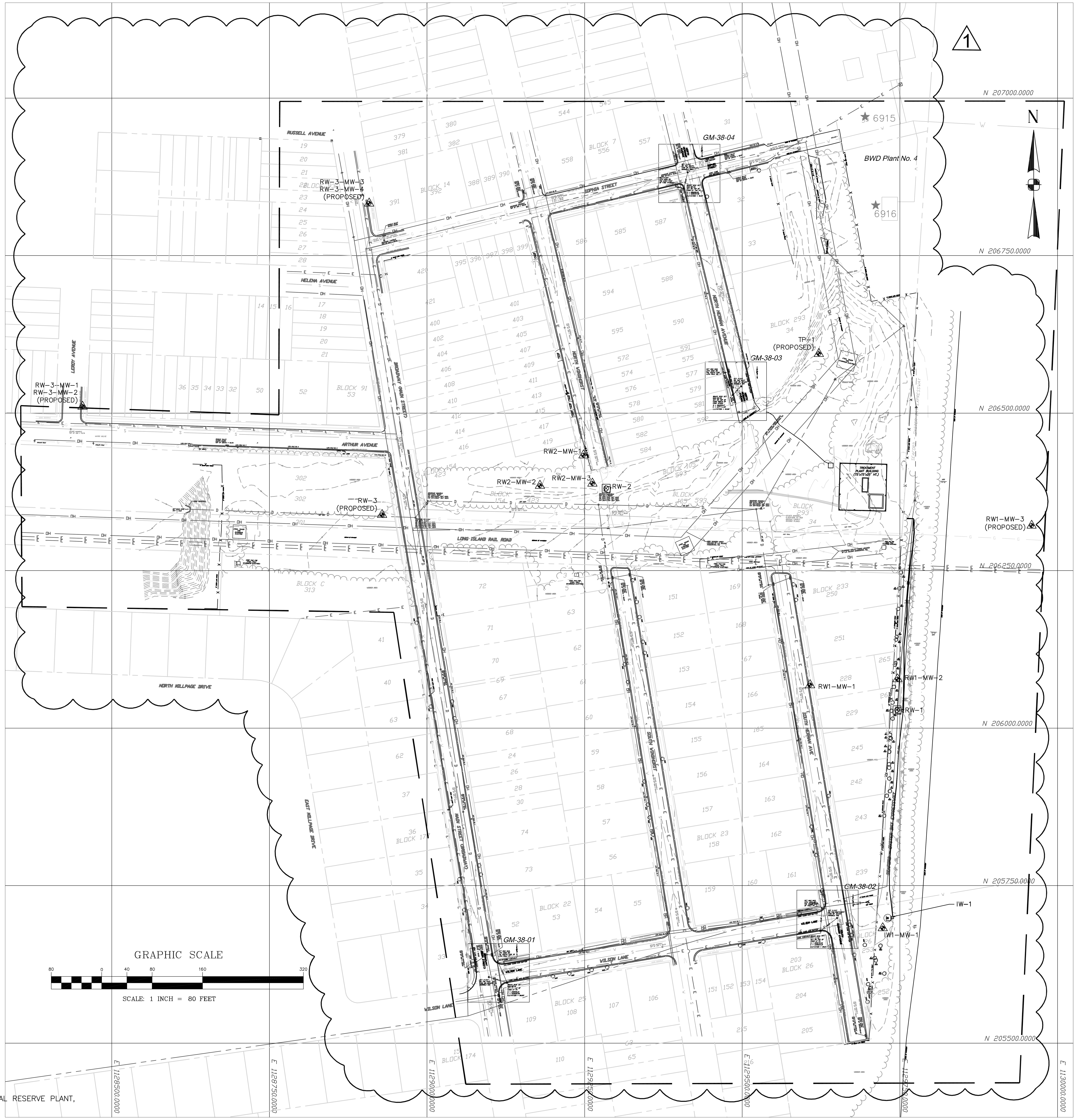


PROJECT CONTROL POINTS

1 INCH= 30 FEET

REFERENCE:

L. K. McLEAN ASSOCIATES, P.C.
437 SO. COUNTRY ROAD, BROOKHAVEN, NY
TOPOGRAPHIC SURVEY, NAVAL WEAPONS INDUSTRIAL RESERVE PLANT,
GM-38 AREA, FILE # 04033.000
FEB AND MAR 2009.



NOTES:

1. SANITARY SEWER MANHOLE LOCATIONS AND RIM ELEVATIONS ARE AS PER L.K. McLEAN ASSOCIATES FIELD DATA EXCEPT WHERE OTHERWISE NOTED. ALL SEWER PIPE INVERTS (WHERE SHOWN) ARE AS PER NASSAU COUNTY SANITARY SEWER RECORD PLANS.
2. THE LOCATION OF OVERHEAD AND UNDERGROUND ELECTRIC LINES SHOWN ON THIS MAP ARE AS PER UTILITY MAPS PROVIDED BY LIPA UNLESS OTHERWISE NOTED.
3. THE LOCATION OF GAS MAINS SHOWN ON THIS MAP ARE AS PER UTILITY MAPS PROVIDED BY KEYSPAN.
4. THE LOCATION OF WATER MAINS SHOWN ON THIS MAP ARE AS PER UTILITY MAPS PROVIDED BY THE BETHPAGE WATER DISTRICT.
5. STORM SEWER DRAINAGE MANHOLE LOCATIONS, AND CATCH BASIN LOCATIONS AND RIM ELEVATIONS ARE AS PER L.K. McLEAN ASSOCIATES FIELD DATA EXCEPT WHERE OTHERWISE NOTED.
6. THE LOCATION OF THE DRAINAGE (STORM SEWER) PIPES ON SOPHIA STREET HAVE NOT BEEN ESTABLISHED. THERE IS NO DATA ON RECORD AT THE TOWN OF OYSTER BAY DEPARTMENT OF PUBLIC WORKS.
7. MEASUREMENTS ARE IN ACCORDANCE WITH U.S. STANDARDS.
8. COORDINATES AND BEARINGS SHOWN ARE IN LONG ISLAND ZONE OF THE NEW YORK STATE PLANE COORDINATE SYSTEM NAD 1983. ELEVATIONS REFER TO NAVD 1929.
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LIST OF UTILITIES:

NEW YORK CITY ONE-CALL CENTER
(800) 272-4480

BETHPAGE WATER DISTRICT
25 ADAMS AVE.
BETHPAGE, NY 11714
(516) 931-0093

CABLEVISION
(516) 393-3295

COUNTY OF NASSAU
DEPARTMENT OF PUBLIC WORKS
[SANITARY SEWER]
1550 FRANKLIN AVENUE
MINEOLA, NY 11501-4822
(516) 571-7319, 20

KEYSPAN ENERGY [GAS]
175 EAST OLD COUNTRY ROAD
HICKSVILLE, NY 11801
(800) 272-4480
(631) 567-7800 (LOCATIONS SERVICE)

LONG ISLAND POWER AUTHORITY (LIPA)
[ELECTRIC]
175 EAST OLD COUNTRY ROAD
HICKSVILLE, NY 11801
(800) 272-4480
(631) 567-7800 (LOCATIONS SERVICE)

MCI
(800) 840-0338

TOWN OF OYSTER BAY
DEPARTMENT OF PUBLIC WORKS
[STREETS AND STORM SEWER]
SYOSSET, NY 11791-5699
(516) 677-5935

VERIZON
(718) 471-4206

LEGEND:

= EXISTING GRADE-MAJOR CONTOUR
= EXISTING GRADE-MINOR CONTOUR
= PROPOSED GRADE
= TAX LOT LINE
= OVERHEAD ELECTRIC WIRES
= UNDERGROUND ELECTRIC WIRES
= WATER MAIN
= GAS MAIN
= DRAINAGE LINES (STORM SEWER)
= SANITARY SEWER MAIN
= WOODED AREA
= CHAIN-LINK OR BOARD FENCE
= DIRT TRAIL
= LIMITS OF CLEARING
= SILT FENCE
= NEW UNDERGROUND ELECTRIC WIRES
= NEW WATER LINE
= NEW SANITARY SEWER MAIN
= HDPE PIPE AND ELECTRICAL CONDUIT
242 = TAX LOT NUMBER
= WATER VALVE
GV = GAS VALVE
RW1-MW-1 = MONITORING WELL
RW-1 = RECOVERY WELL
IW-1 = INJECTION WELL
PB = PULL BOX
= LEAK DETECTION ACCESS PORT
= EXISTING DECIDUOUS TREE
= EXISTING CONIFEROUS TREE
= WHITE PINE TREE LOCATION
= SIGN
= MANHOLE
= GRAVEL ACCESS ROAD AND PARKING LOT
6916 = PUBLIC WATER SUPPLY WELL

THIS DRAWING PRODUCED ON AUTOCAD
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REV	DESCRIPTION	PREP BY	DATE	APPRVD
0	FINAL DESIGN	DL	05/05/06	CYC
1	ADDED REVISED TOPO, ADDED BUILDING AND ADDITIONAL WELLS	DLB	05/15/09	???

TETRA TECH ENGINEERING CORPORATION PC

DSGN: DR: CHK:
SUPV: CH ENG:
SUBMITTED BY: (FIRM MEMBER) (TITLE) (DATE)
NORTHDIV DM: HD:
HD:
FPE: DIR:
OFFICER IN CHARGE
APPROVED DATE

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
ENGINEERING FIELD ACTIVITY - NORTHEAST
LESTER PENNSYLVANIA
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK
GM-38 AREA
GROUNDWATER TREATMENT PLANT
GM-38 AREA AND VICINITY
APPROVED DATE EFANE FOR COMMANDER, NAVFAC

SEAL AREA

SAT TO DATE
CODE I.D. NO. 80091
SCALE : AS SHOWN
SPEC. NO.
CONSTRN. CONTR. NO. N62472-99-D-0032
NAVFAC DRAWING NO.
SHEET OF
SIZE: D
DIS. SH. NO. 1-2

- ***Section 2.0, Regulatory Compliance,*** outlines local, state and federal codes and regulations pertaining to the operation and maintenance of the GWTP. The SPDES effluent limitations and monitoring requirements for the discharge of treated groundwater and the air permit emissions criteria and monitoring requirements for the discharge of treated off-gas and other operational requirements are contained in this section.
- ***Section 3.0, Records Management,*** describes record keeping forms and procedures for recording data from the operation and maintenance of the GWTP. Samples of the required record keeping forms are contained in Appendix A, ***Report Forms***.
- ***Section 4.0, Sampling and Analysis Plan Description,*** outlines the schedule and procedures for sampling and analyzing the various influent, intermediate, and effluent process streams associated with the operation of the GWTP. Adherence to the quality standards and schedules for sampling and analysis described in this section are critical to the compliant, safe and efficient operation of the GWTP.
- ***Section 5.0, Health and Safety,*** contains safety standards and procedures for all aspects of GWTP operation and maintenance. This section along with the Site-Specific Health and Safety Plan must be consulted prior to the execution of any tasks performed by Operators and subcontractors to ensure they are performed in compliance with applicable safety procedures.
- ***Section 6.0, Process Description and Operation,*** describes the functions and relationships of the major pieces of equipment in the thirteen process loops of the GWTP. The Computer Monitoring and Control System (CMCS) programming is developed from these descriptions to ensure the process equipment functions properly with respect to the rest of the system. Manual and remote electronic controls and equipment interlocks are detailed in this section. Set points and ranges of operational parameters for normal function of the groundwater treatment process are found in this section.
- ***Section 7.0, Operations,*** contains procedures for the daily operation of process equipment. Start-up and shut-down procedures and equipment specifications for the major process equipment are included in this section.
- ***Section 8.0, System Troubleshooting,*** highlights procedures for diagnosing and solving problems with the major pieces of equipment in the GWTP. Additional troubleshooting information is also found in Appendix D, ***Manufacturer's Operation and Maintenance Manuals***.
- ***Section 9.0, Equipment Maintenance,*** includes a matrix (under preparation) outlining the schedule and procedures for performing preventive maintenance on system equipment. This section also describes maintenance record keeping procedures and instructions for housekeeping and the general upkeep of the GWTP.
- ***Section 10.0, Waste Transportation and Disposal,*** describes the requirements for on-site storage, marking, transportation, and disposal of all liquid and solid waste generated at the GWTP. This section includes the requirements for selecting and approving subcontractors to handle and dispose of the waste generated at the facility, as well as record keeping requirements for waste generation and disposal.

1.3 Using the OM&M Plan

The purpose of this OM&M Plan is to facilitate the understanding of key operations and maintenance features of the GWTP. A cursory review of this Plan by a new Operator will not qualify him/her to operate and maintain the Facility. Side-by-side training with an experienced Operator, a comprehensive review of this OM&M Plan, and the appropriate State of New York Operator Certification are recommended to qualify a new Operator.

This OM&M Plan should be updated periodically to remain current. The Plan should be revised when new and improved techniques are devised for operating and maintaining the GWTP.

1.4 Site Location

NWIRP Bethpage is located in east central Nassau County, Long Island, New York, approximately 30 miles east of New York City. The Navy's property totaled approximately 109.5 acres and was formerly a Government Owned Contractor-Operated (GOCO) facility that was operated by the NGC until September 1998. NWIRP Bethpage is bordered on the north, west, and south by property owned, or formerly owned, by NGC that covered approximately 605 acres, and, on the east, by a residential neighborhood.

The GM-38 Area (see Figure 1-1) refers to a cluster of monitoring wells that were installed in the 1990s by NGC and that first identified an isolated groundwater contaminant plume in this area. The GM-38 Area is approximately 8,500 feet south southeast and hydraulically downgradient of NWIRP Bethpage. The GWTP is located within a utility easement that is located east of Broadway Avenue, west of the Seaford Oyster Bay Expressway (Route 135), and between the north and south dead ends of Windhorst and Herman Avenues (see Figure 1-2).

1.5 Site Background

NWIRP Bethpage is currently listed by NYSDEC as an “inactive hazardous waste site” (#1-30-003B), as is NGC (#1-30-003A) and the Hooker/RUCO site (#1-30-004) located less than 1/2 mile west of NWIRP Bethpage.

NWIRP Bethpage was established in 1933. Since inception, the primary mission of the facility has been the research, prototyping, testing, design engineering, fabrication, and primary assembly of military aircraft. The facilities at NWIRP Bethpage include four plants (Nos. 3, 5, and 20, used for assembly and prototype testing; and No. 10, which contains a group of quality control laboratories), two warehouse complexes, a salvage storage area, water recharge basins, an industrial wastewater treatment plant, and several smaller support buildings.

Historical operations that resulted in hazardous material generation at the facility included metal finishing processes, maintenance operations, painting of aircraft and components, and other activities that involve aircraft manufacturing. Wastes generated by plant operations were disposed directly into either drainage sumps, dry wells, and/or on the ground surface, resulting in the disposal of a number of hazardous wastes, including the volatile organic compounds (VOCs) perchloroethene (PCE) and trichloroethene (TCE), the semivolatile organic compounds (SVOCs) polychlorinated biphenyls (PCBs), and the inorganic analytes, chromium and cadmium at the site. Some of these contaminants have migrated from the points of disposal to surrounding areas, including the soils of these sites and the groundwater beneath and downgradient of the NWIRP Bethpage property.

Chlorinated VOCs were identified in the GM-38 Area in moderately deep (220 to 470 feet below ground surface [bgs]) groundwater at concentrations greater than 500 micrograms per liter (µg/L). The contaminated groundwater in the area represents a relatively large mass of chlorinated VOCs that would remain for extended periods and could adversely affect public water supplies in the area, as well as other downgradient water supplies. Two public water supply systems are present in the general area and extract groundwater at depths ranging from 540 to 740 feet bgs. Navy and contractor funded systems are in place at the public water supply wells to remove VOCs from the water prior to distribution.

1.6 Project Overview and Objectives

As stated in the Navy's Record of Decision (ROD), the purpose of the groundwater treatment system is to "Eliminate, to the extent practical, site-related contaminants from the affected public water supplies and to prevent, to the extent practical, the future contamination of public water supplies through the implementation of the offsite groundwater remediation." The treatment system has been designed for a 5 to 10 year operational life. It is not intended to remediate groundwater contamination in the local aquifer to non-detectable levels. Rather, the intent of the system is to remove mass, reduce elevated VOC levels to levels similar to those in the surrounding aquifer, and in doing so will minimize the impacts on water supply wells and currently unaffected portions of the aquifer.

Groundwater in the GM-38 Area will be monitored by a group of 14 existing and proposed monitoring wells. There are three monitoring wells near recovery well RW-1 that are screened between 395 and 435 ft bgs. RW-1 MW-1 is located approximately 140 ft northwest of RW-1 and RW-1 MW-2 is located approximately 50 ft north of RW-1. RW-1 MW-3 is proposed to be located approximately 400 ft northeast of RW-1, on the eastern side of Seaford Oyster Bay Expressway. There are three monitoring wells near recovery well RW-2 that are screened between 470 and 510 ft bgs. RW-2 MW-1 is located approximately 60 ft northwest of RW-2, RW-2 MW-2 is located approximately 20 ft west of RW-2, and RW-2 MW-3 is located approximately 100 ft west of RW-2.

There are four proposed monitoring wells near recovery well RW-3. Two of these four wells (RW-3 MW-1 and RW-3 MW-3) are proposed to be screened between 320 and 340 ft bgs. The other two wells (RW-3 MW-2 and RW-3 MW-4) are proposed to be screened between 475 and 495 ft bgs. RW-3 MW-1 and RW-3 MW-2 are proposed to be located approximately 500 ft west of cluster GM-38, at the intersection of Arthur Avenue and Leroy Avenue. RW-3 MW-3 and RW-3 MW-4 are proposed to be located approximately 400 ft north of the intersection of Arthur Avenue and Broadway, on Broadway between Helena Avenue and Russell Avenue.

There is one monitoring well near injection well IW-1. IW-1 MW-1 is screened between 130 and 150 ft bgs and is located approximately 20 ft south of IW-1. There are two monitoring wells GM-38D and GM-38D2 that are located approximately 320 ft west of RW-2, at the corner of Arthur Avenue and Broadway. GM-38D is screened between 320 and 340 ft bgs and GM-38D2 is screened between 475 and 495 ft bgs. Monitoring well TP-1 is proposed to be screened between 450 and 470 ft bgs and is proposed to be located approximately 350 ft north of the GWTP building, alongside the GWTP access road. All of these monitoring wells will serve to monitor hydraulic containment and capture of the groundwater "hot spot" by the recovery wells and some of these monitoring wells will also serve to monitor water quality. This groundwater monitoring and sampling and the exit strategy are discussed further in Section 4.

1.7 General Description of GM-38 Area GWTP

The GWTP will be housed in a 75 ft long x 75 ft wide x 25 ft tall metal building located within a utility easement that is located east of Broadway Avenue, west of the Seaford Oyster Bay Expressway (Route 135), and between the north and south dead ends of Windhorst and Herman Avenues. The groundwater extraction system consists of two recovery wells that are approximately 500 ft deep. The treatment system consists of flow equalization, air stripping and off-gas treatment, bag filtration, liquid-phase granular activated carbon, and pH adjustment. The treated effluent will be returned to the aquifer via re-injection into an injection well that is approximately 230 ft deep and via discharge into a recharge basin.

The layout plan for the GWTP is shown on Figure 1-3. The groundwater influent pipes from the recovery wells enter the GWTP building through the floor in the southwest corner. The equalization tank is also located in the southwest corner of the building. The air stripper is located in the southeast corner of the building. The air stripper tower is 42 ft tall and extends through the roof of the GWTP building. The two bag filters are located west of the air stripper tower and the three liquid-phase granular activated carbon tanks are located in the center of the GWTP building. The building sump is also located in the center, east of the liquid-phase granular activated carbon tanks. The sodium hydroxide tank is located just north of the equalization tank and the treated groundwater effluent discharge pipe is located in the southwest corner. The off-gas treatment system including the two vapor-phase granular activated carbon vessels and one vessel containing zeolite molecular sieves impregnated with potassium permanganate and the exhaust stack are located in the northeast corner. The north side of the building is equipped with a 12 ft wide x 12 ft high overhead door. There is another 3 ft wide x 7 ft tall door on the south side of the building. The office and control room are located in the northwest corner of the building. A 500 KVA electrical transformer is also located outside the northwest corner of the building. A potable water supply with double backflow preventers enters the GWTP along the west side, south of the office and control room.

1.7.1 Groundwater Treatment System Overview

A Process Flow Diagram is presented on Figure 1-4, and illustrates the design flow rates through the groundwater treatment process. This drawing also includes the GWTP mass balance. The treatment process consists of flow equalization, air stripping and off-gas treatment, bag filtration, liquid-phase granular activated carbon, and pH adjustment. Contaminated groundwater will be pumped from the two recovery wells RW-1 and RW-3, and be collected in equalization tank T-1. From T-1, which also receives any water that is collected in the building sump, the groundwater will be the pumped to the air stripper AS-1. In the packed column air stripper, the bulk of the VOCs will be removed from the groundwater by a countercurrent flow of air from blower B-1 and be transferred to the vapor phase. From the air stripper sump, the groundwater containing residual VOCs will be pumped to two bag filters F-1A and F-1B, operating in parallel, for removal of particulates. Any dissolved solids that may have precipitated during air stripping will be removed by the bag filters. A small portion of the feed stream to the bag filters will also be recirculated and combined with the liquid feed to the air stripper from the equalization tank.

From the bag filters, the groundwater will be passed through three liquid-phase granular activated carbon polishing adsorbers, LGAC-1, LGAC-2, and LGAC-3, operating in parallel. In these tanks, any residual VOCs that are still present in the groundwater will be removed. The pH of the treated effluent from the liquid-phase granular activated carbon tanks will be adjusted by the addition of sodium hydroxide solution from tank T-2 before it leaves the GWTP. The treated effluent will be tested to meet the SPDES effluent limitations and monitoring requirements, before being re-injected into injection well IW-1 and discharged into the stormwater manhole that will convey it to Nassau County Recharge Basin # 495. From AS-1, the off-gas will be heated in air stream heater H-1 to prevent any condensation. The VOCs in the heated off-gas will be removed via passage through two vapor-phase granular activated carbon adsorbers VGAC-1 and VGAC-2, operating in series, followed by a vessel VGAC-3 containing Hydrosil HS-600 media (zeolite molecular sieves impregnated with potassium permanganate). In order to help overcome the pressure drop in the off-gas stream, booster blower B-2 will be placed between VGAC-2 and VGAC-3. All of the VOCs in the off-gas, except for vinyl chloride will be removed in the vapor-phase granular activated carbon adsorbers. Vinyl chloride will be oxidized by the potassium permanganate into potassium chloride and carbon dioxide. The potassium chloride will remain in the pore structure of the zeolite substrate. The treated off-gas will be discharged out of the stack.


PLAN VIEW
SCALE: 1/4"=1'-0"
BOLLARD (TYP.)
TRANSFORMER PAD
500 KVA ELECTRICAL TRANSFORMER
75'-0"
25'-0"
3'-0"
6'-6"
OVERHEAD STEEL DOOR (12' W x 12' HT)
FLOOR (EL. 87'-0")
MOTOR CONTROL CENTER MCC-1
FCP
SCP
LADDER
OFFICE/CONTROL ROOM (EL. 87'-4")
10'-0"
8'-0"
LP-1
PLC
RAMP
STEEL DOOR (4'-0"W X 8'-0"H)
DESK
WINDOW
CLOSET
LAVATORY
SHOWER
BENCH
V-1 (MTD ON ROOF)
BLOWER B-2
8'ø GAC VESSEL #3
8'ø GAC VESSEL #2
8'ø GAC VESSEL #1
6" HOSE TYP.
BUILDING SUMP (8'x21'x8'HT)
BUILDING SUMP PUMPS (P-5A/5B)
APPROXIMATE LOCATION OF AIR STREAM HEATER H-1 (EL. 97'-0")
TOP OF GRADE BEAM (EL. 87'-6")
BLOWER B-1
TOP OF WALL (EL. 87'-6")
TOP OF WALL (EL. 86'-9")
SANITARY SEWER CLEAN-OUT
DOUBLE BACKFLOW PREVENTORS
POTABLE WATER SUPPLY PIPE
SAMPLE PREPARATION SINK
MOP SINK
EYE WASH & SHOWER STATION
SODIUM HYDROXIDE FEED (CFS-1)
(T-2)
P-6A
P-6B
V-2 (MTD ON ROOF)
PARTICULATE FILTERS
F-1A
F-1B
EQUALIZATION TANK T-1
PUMP P-3A PUMP P-3B
PUMP P-4A PUMP P-4B
AIR STRIPPER AS-1
AIR STRIPPER SUMP PUMP (P-7)
AIR STRIPPER SUMP (20'x20'x13'-9"HT)
INFLUENT FROM WELL RW-3
INFLUENT FROM WELL RW-2
TO FUTURE DISCHARGE POINT
INFLUENT FROM WELL RW-1
EFFLUENT TO INJECTION WELLS IW-1 TO IW-4
11'-0"
A A-2
B A-2
C A-3
D A-3
N
SCALE: 1/4" = 1'-0"
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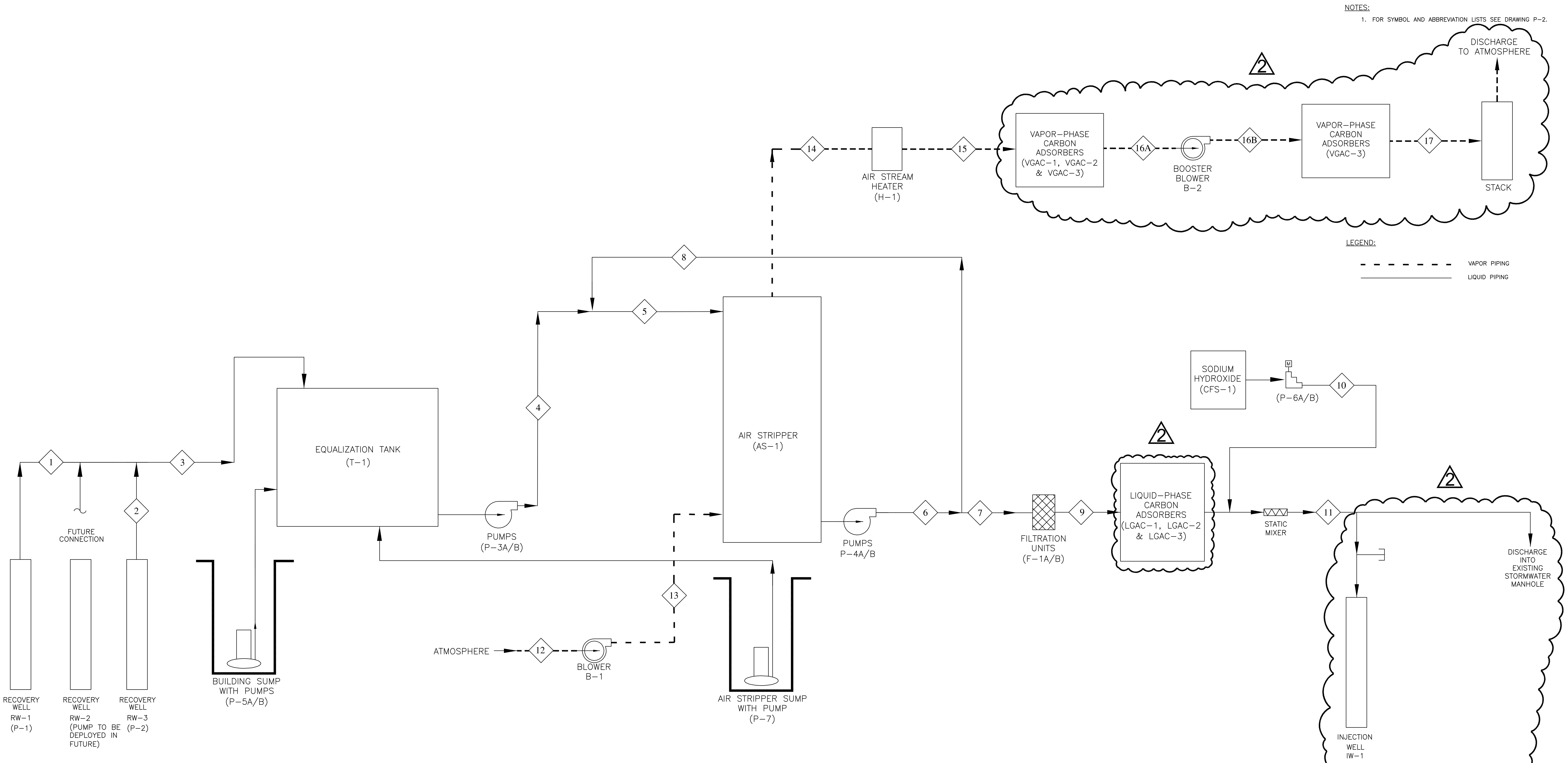
TETRA TECH ENGINEERING CORPORATION PC
REV | DESCRIPTION | PREP BY | DATE | APPRVD
0 | FINAL DESIGN | DL | 05/05/06 | BKB
1 | REPLACED FUTURE RECOVERY WELL WITH RW-3, RELOCATED RW-2 AND ADDED LADDER | DLB | 03/31/08 | BKB
2 | ADDED REVISED BUILDING LAYOUT | DLB | 05/15/09 | BKB
DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
ENGINEERING FIELD ACTIVITY - NORTHEAST
LESTER PENNSYLVANIA
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK
GM-38 AREA
GROUNDWATER TREATMENT PLANT
LAYOUT PLAN
SEAL AREA
SAT TO
DATE 05/05/06
CODE I.D. NO. 80091
SCALE : AS SHOWN
SPEC. NO.
CONSTR. CONTR. NO. N62472-99-D-0032
NAVFAC DRAWING NO.
SHEET OF
SIZE: D
DIS. SH. NO. 1-3



STREAM NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
COMPOSITION (UG/L, UNLESS OTHERWISE NOTED)																
BENZENE	4	4	4	4	3	-	-	-	-		-					
TOLUENE	15	15	15	15	12	-	-	-	-		-					
XYLENES, TOTAL	16	16	16	16	12	-	-	-	-		-					
1,2-DICHLOROETHANE	3	3	3	3	2.8						2.7 E-07					
cis 1,2-DICHLOROETHENE	1100	1100	1100	1100	1008	0.10	0.10	0.10	0.10		1.0 E-04					
VINYL CHLORIDE	300	300	300	300	275	0.03	0.03	0.03	0.03		2.7 E-05					
TETRACHLOROETHENE (PCE)	900	900	900	900	825	0.08	0.08	0.08	0.08		8.2 E-05					
TRICHLOROETHENE (TCE)	3400	3400	3400	3400	3117	3.12	3.12	3.12	3.12		3.1 E-03					
WATER FLOW RATE (GPM)	800	300	1100	1100	1200	1200	1100	100	1100	1.1 gpd	1100					
TEMPERATURE (°F)	55	55	55	55	55	55	55	55	55	60	55					
PRESSURE (PSIG)												-0.27	1.50	1.36	1.18	0.53
DENSITY (lb/ft^3)										95.5		0.077	0.085	0.084	0.082	0.079
MASS FLOW RATE (lb/hr)	400364	150136	550500	550500	600545	600545	550500	50,045	550500	0.59	550500	36,960	40,800	40,320	39,360	37,920
RELATIVE HUMIDITY (%)												50	50	100	50	50
STATIC PRESSURE (PSIA)												0.214	0.214	0.214	0.275	0.275
pH (S.U.)	5.5	5.5	5.5	5.5	5.5	6.0	6.0	6.0	6.0	14	7.0					
VAPOR FLOW RATE (CFM)												8000	8000	8000	8000	8000
TOTAL VAPOR VOC (PPMV)												-	-	25.5	25.5	1.2
TOTAL VAPOR VOC (LBS/HR)												-	-	3.18	3.18	0.15

REV	DESCRIPTION	PREP BY	DATE	APPRVD
0	FINAL DESIGN	DL	05/05/06	BKB
1	ADDED RECOVERY WELL RW-3 CHANGED RW-2 TO FUTURE CONNECTION	DLB	03/31/08	BKB
2	REVISED BASED ON VENDOR SUBMITTALS, DRAWING UPDATES FOR CONSTRUCTION	DLB	02/24/09	BKB

TETRA TECH ENGINEERING CORPORATION PC
DSGN: DR: CHK:
SUPV: CH ENG:
SUBMITTED BY: (FIRM MEMBER) (TITLE) (DATE)
NORTHDIV DM: HD:
HD:
FPE: DIR:
OFFICER IN CHARGE
APPROVED DATE

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
ENGINEERING FIELD ACTIVITY - NORTHEAST
LESTER PENNSYLVANIA
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK
GM-38 AREA
GROUNDWATER TREATMENT PLANT
PROCESS FLOW DIAGRAM - GROUNDWATER AND OFF-GAS TREATMENT
APPROVED DATE EFANE FOR COMMANDER, NAVFAC

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1.7.1.1 Design Flow and Influent Concentration

The groundwater treatment system has been designed to process an average flow of 1,100 gallons per minute (gpm) consisting of 800 gpm from recovery well RW-1 and 300 gpm from recovery well RW-3. The average composition of VOCs in the influent groundwater consists of 3,400 µg/l of trichloroethene, 900 µg/l of tetrachloroethene, 300 µg/l of vinyl chloride, 1,100 µg/l of cis-1,2-dichloroethene, and smaller concentrations of 1,2-dichloroethane, benzene, toluene, and total xylenes. The vapor treatment system has been designed to process an average flow of 8,000 standard cubic feet per minute (scfm).

1.7.1.2 Groundwater Extraction

The groundwater extraction system consists of two recovery wells RW-1 and RW-3, which are 10-inch in diameter and approximately 500 ft deep. A third recovery well RW-2 may be deployed in the future. These wells are equipped with Grundfos submersible electric pumps. Pump P-1 in RW-1 is Model 1100S600-2-2, rated for 60 horsepower (HP), 480 volts, 3-phase and pump P-2 in RW-3 is Model 385S150-2, rated for 15 HP, 480 volts, 3-phase. These pumps are equipped with variable speed drives (VSDs) and will pump the groundwater through double-walled transfer pipe into the equalization tank T-1. The water level in both wells will be monitored and transmitted to the programmable logic controller (PLC) and will be used to start and stop pumps P-1 and P-2. The double-walled pipes are equipped with leak detection ports. The flow rates of the groundwater pumped from recovery wells RW-1 and RW-3 is separately recorded by two magnetic flow meters manufactured by Siemens. These flow measurements will also be totalized and transmitted to the PLC.

The equalization tank T-1 manufactured by Highland Tank is 12 ft diameter x 20 ft high and has a capacity of 16,920 gallons. It is equipped with a ProQuip Model 3ZES25B agitator (M-1) powered by a 3 HP motor and uses a single 50 inch diameter 3-blade high efficiency impeller that operates at 72 revolutions per minute (rpm). The agitator serves to keep any solids that may be present in the groundwater in suspension and prevents them from settling to the bottom of the tank. The equalization tank is also equipped with a 20 ft ladder that has a safety cage and a safety rail at the top of the tank all round the entire circumference. An Occupational Safety and Health Administration (OSHA) compliant adjustable self closing swing gate has also been installed at the top of the ladder. The water level in the equalization tank will be monitored and transmitted to the programmable logic controller (PLC) and will be used to start and stop the air stripper feed pumps P-3A and P-3B. Pumps P-3A and P-3B are Model 18BF3P2L0, 3656 Series M&L Gould centrifugal pumps, rated for 25 HP, 460 volts, 3 phase. One of these pumps will operate at any given time and the other will serve as a spare. Both pumps are equipped with VSDs. The flow rate of the groundwater pumped from the equalization tank to the air stripper will be recorded by a magnetic flow meter manufactured by Siemens. This flow measurement will also be totalized and transmitted to the PLC. The pH in the equalization tank will also be monitored and recorded.

1.7.1.3 Air Stripping and Off-Gas Treatment

The air stripper AS-1 is a 5000 series structural aluminum tower provided by the Navy that is 10 ft diameter x 47 ft tall. The air stripper is fitted with a 316 stainless steel exhaust header that is 5ft tall. This packed tower column is equipped with a 25 ft high packing material consisting of 3.5 inch diameter polypropylene Jaeger Tripack. Groundwater from pump P-3A or P-3B will enter the air stripper distribution port and be sprayed over the column of Jaeger Tripack at a flow rate of approximately 1,200 gpm. This includes approximately 1,100 gpm of raw groundwater and 100 gpm of recirculation water. An induced draft countercurrent flow of air from blower B-1 will enter the air stripper below the base of the packing material at a rate of 8,000 scfm and move up through the packing. The large surface area of the packing material allows for a mass transfer of the VOCs from the groundwater into the air stream. A demister pad at the top of the air stripper prevents the release of water droplets into the off-gas which is exhausted from the top of the air stripper tower. The treated groundwater containing residual VOCs that passes through the packed column is collected in a sump at the bottom of the air stripper and pumped out. The water level in the air stripper sump will be monitored and transmitted to the programmable logic controller (PLC) and will be used to start and stop the liquid-phase carbon feed pumps P-4A and P-4B. Pumps P-4A and P-4B are Model 18BF2R2H0, 3656 Series M&L Gould centrifugal pumps, rated for 40 HP, 460 volts, 3 phase. One of these pumps will operate at any given time and the other will serve as a spare. Both pumps are equipped with VSDs. A portion of the water from the air stripper sump that is pumped via P-4A or P-4B will be recirculated and combined with the raw groundwater feed to the air stripper distribution port. The flow rate in the recirculation loop will be measured and recorded by a magnetic flow meter manufactured by Endress Hauser. This flow measurement will also be totalized and transmitted to the PLC. The air stripper is mounted inside a 20 ft x 20 ft square containment sump that is 13 ft 9 inches deep. The air stripper containment sump has been designed to provide secondary containment and is equipped with a submersible pump P-7 that can transfer any water that leaks into the sump to the equalization tank. Pump P-7 is a Gould Model WE0511H submersible pump which is rated for ½ HP, 120 volts, single phase.

Blower B-1 is a Twin City Fan Model 300W BCN equipped with a backward curved high pressure fan with a totally enclosed fan cooled motor that is rated for 100 HP, 3,600 rpm, 460 volts, 3–phase. The blower is also equipped with an inlet silencer. The blower motor is equipped with a VSD. The VSD can be controlled by the Operator from the motor control center (MCC) or remotely via the PLC. The blower discharge pressure is monitored by high and low pressure switches manufactured by Ashcroft and the flow rate is monitored by a mass flow meter manufactured by FCI. This flow measurement will also be totalized and transmitted to the PLC. The differential pressure across the air stripper will also be monitored continuously by a Dwyer differential pressure switch and this measurement will also be transmitted to the PLC. From AS-1, the off-gas will be heated in air stream heater H-1 to prevent any condensation. Air stream heater H-1 is 12 inch x 36 inch rectangular x 46 inch long duct insulated with 2-inch ceramic fiber and equipped with a Chromalox heating element Model ADH-162T which is rated for 162 kilowatts (kW), 480 volts, 3-phase. H-1 will heat the off-gas to a temperature of 110 ^{o}F. The temperature of the off-gas leaving H-1 will be monitored and be used to control the heater and also be transmitted to the PLC.

The VOCs in the heated off-gas will first be removed via passage through two vapor-phase granular activated carbon adsorbers VGAC-1 and VGAC-2, operating in series. VGAC-1 and VGAC-2 are Model RB20 vessels supplied by Siemens that are 21 ft long x 8 ft 6 inches wide x 9 ft 4 inches high, each containing 20,000 lbs of Westates™ brand VoCarb® 48C granular activated carbon. Each RB20 vessel is rated for a maximum flow rate of 12,000 scfm. All of the VOCs in the off-gas, except for vinyl chloride will be removed in VGAC-1 and VGAC-2. In order to help overcome the pressure drop in the off-gas stream, booster blower B-2 has been placed between VGAC-2 and a third RB20 vessel designated as VGAC-3. Booster blower B-2 is a Twin City Fan Model 300 BCN equipped with a backward curved high pressure fan with a totally enclosed fan cooled motor that is rated for 100 HP, 3,505 rpm, 460 volts, 3–phase. The blower motor is equipped with a VSD. The VSD can be controlled by the Operator from the MCC or remotely via the PLC. The blower discharge pressure is monitored by high and low pressure switches manufactured by Ashcroft and the flow rate is monitored by a mass flow meter manufactured by FCI. This flow measurement will also be totalized and transmitted to the PLC. The discharge from booster blower B-2 will be directed to vessel VGAC-3 containing 40,000 lbs of Hydrosil HS-600 media (zeolite molecular sieves impregnated with 6 percent by weight potassium permanganate). Vinyl chloride will be oxidized by the potassium permanganate into potassium chloride and carbon dioxide. The potassium chloride will remain in the pore structure of the zeolite substrate. The treated off-gas will be discharged out of the stack.

1.7.1.4 Bag Filtration

The water from the air stripper sump will be pumped to the two multi-bag filter vessels F-1A and F-1B, operating in parallel by feed pump P-4A or P-4B in order to remove any particulates in the water. F-1A and F-1B are Krystal Klear Model LR12308FAC15 manufactured by Pentair Industrial containing 12 baskets each. The filter bags that are placed in each of the 12 baskets are rated for 25 microns. The maximum hydraulic capacity of each multi-bag filter vessel is 2,100 gpm. The differential pressure across both of the multi-bag filter vessels will also be continuously monitored using a differential pressure switch manufactured by Midwest. When a high differential pressure is indicated, the Operator will be notified by an alarm and the GWTP will have to be shut down in order to replace the spent bag filters with clean bag filters. From the bag filter vessels F-1A and F-1B, the water containing residual VOCs will be transferred to the liquid-phase granular activated carbon unit.

1.7.1.5 Liquid-Phase Granular Activated Carbon Polishing

Liquid-phase granular activated carbon polishing will be performed in three vessels, LGAC-1, LGAC-2, and LGAC-3, operating in parallel. Here the residual VOCs will be completely removed from the water. Each of the three vessels are TIGG Model C-500 steel vessels rated for a flow of 500 gpm and contain 8,000 lbs of TIGG 5D 1240 activated carbon. The differential pressure across all three of the LGAC vessels will also be continuously monitored using a differential pressure switch manufactured by Midwest. When a high differential pressure is indicated, the Operator will be notified by an alarm and the carbon vessels will have to be backwashed. The treated water from the liquid-phase granular activated carbon unit will then go through the pH adjustment step before leaving the GWTP. There is also a provision to recycle the treated water back to the equalization tank T-1.

1.7.1.6 pH Adjustment

The pH of the treated effluent from the liquid-phase granular activated carbon tanks will be adjusted by the addition of sodium hydroxide (caustic soda) solution from tank T-2 before it leaves the GWTP. Tank T-2 consists of a 55-gallon drum containing sodium hydroxide solution that is equipped with a Morse Model 711-55-115 band heater rated for 750 watts and 115 volts with an adjustable thermostat. The caustic feed pumps P-6A and P-6B are LMI Milton Roy Model C731-318SI electronic metering pumps rated for 120 volts, 8 gph at 60 psig and equipped with a 4-function valve. One of these pumps will operate at any given time and the other will serve as a spare. Pump P-6A or P-6B will inject sodium hydroxide solution into the treated effluent line just ahead of in-line static mixer M-2 which is Chemineer-Kenics Model 10 KME-PVC-4 and rated for 1,100 gpm. A Lutz-JESCO America Model PDS0080-1-1 pulsation damper will be utilized to help dampen the pulsations from pumps P-6A and P-6B and avoid damaging water hammer. The level of the sodium hydroxide solution in T-2 will be monitored and transmitted to the PLC. The pH of the effluent will be monitored downstream of M-2 and controlled by adjusting the stroke of pump P-6A or P-6B.

1.7.1.7 Treated Groundwater Discharge and Re-injection

The treated groundwater discharge and re-injection system consists of the stormwater manhole (within the utility easement east of Broadway Avenue) leading to Nassau County Recharge Basin # 495 and injection well IW-1. The flow rates of the treated groundwater pumped to the stormwater manhole and to IW-1 will be recorded by magnetic flow meters manufactured by Siemens. These flow measurements will also be totalized and transmitted to the PLC. It is anticipated that approximately 800 gpm will be discharged into the stormwater manhole and approximately 300 gpm will be re-injected into IW-1. Injection well IW-1 is a 12-inch diameter well that is approximately 230 ft deep. The water level in IW-1 will be monitored continuously and the signal will be transmitted to the PLC. It should be noted that the treated effluent will be tested to meet the SPDES effluent limitations and monitoring requirements, before being re-injected into injection well IW-1 and discharged into the stormwater manhole.

1.7.1.8 Instrumentation Description

The components of the groundwater treatment system will be monitored by appropriate instrumentation. Each of the three groundwater treatment units – the air stripper, 2 bag filters, and the LGAC package units will be equipped with local pressure indicators and/or differential pressure transmitters. The differential pressure transmitters will include a high pressure cutoff switch and communicate with the plant control system. The pumps, the blowers, the VGAC adsorbers, and the Hydrosil HS-600 unit will be monitored by local pressure indicators and pressure switches.

Additional instrumentation will provide real time monitoring of pH in the equalization tank and the treated effluent discharge line. These data will be transmitted to the control system.

Magnetic flow meters will be used on the influent, effluent, and recirculation lines. Indicating flow totalizers will track current and cumulative flow at the influent, effluent, and recirculation lines.

The water treatment system effluent will be monitored for pH, chlorinated VOCs and mercury as identified in the SPDES effluent limitations and monitoring requirements. This monitoring will be accomplished through the monitoring of real-time data for pH and flow, as well as collection of effluent water grab samples on a weekly basis for the first 24 consecutive weeks. Following this initial 24 week period, the minimum sample collection frequency will be monthly. The samples will be analyzed by an analytical laboratory for 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, vinyl chloride, and mercury.

1.7.1.9 Computer Monitoring and Control System Description

The GWTP will be controlled by a PLC-based digital and analog control system, as described above. Monitoring instrumentation, such as pH, pressure, level, and flow transmitters, differential pressure transmitters, and pump signals will communicate with a PLC. In turn, the information in the PLC is made available to the Operator via a human-machine interface (HMI) program. By using this program, the status of the GWTP can be displayed in real time in an easily understood series of graphical and tabular screens to the Plant Operator.

The HMI also has the capability of accepting Operator commands, such as starting or stopping a pump, by simple mouse clicks or touch screen points. These commands are communicated back to the PLC, which then issues the appropriate commands to the plant equipment.

Process set points, such as maximum flow rates, high or low tank levels, or acceptable pressure ranges, will be defined in the programming. This ensures that the plant will operate within normal parameters. If any of the monitored parameters moves out of the normal operating limits, the Plant Operator will be immediately notified, and corrective actions can be taken.

Logging and trending capabilities are available in the HMI. This information can be used to optimize the operation of the facility and is often used in documenting operation for regulatory purposes.

The control system will be on uninterruptible power supplies. Should a loss of power occur, the control system will be operational long enough to assist in a sequential and controlled shutdown of the plant.

1.8 Site Security

The GWTP building and the equipment inside are surrounded by a fence with locked gates to protect it from burglary and vandalism and to protect the public and property from the equipment's operations. The GWTP is also equipped with a Honeywell Model VISTA-128FBP-24 commercial fire and partitioned burglary alarm control panel. In the event of a break-in, this alarm will activate the Auto Dialer and notify the security agency. The security agency will notify the Nassau County Police Department (NCPD) and the on-call Operator. After the Operator has inspected the GWTP property and determined the extent of the damage (if any), he will notify NCPD and the TtEC Project Manager. In the event of a fire at the GWTP, the local emergency services (including fire and police departments) will be automatically notified. The Operator will quickly initiate any necessary repairs to the GWTP and proceed to clean up any graffiti on the GWTP property caused by vandalism. All of these activities will be performed soon after seeking the necessary authorization from the TtEC Project Manager. Emergency telephone numbers are listed in Table 1-1.

1.9 Staffing and Training

1.9.1 Staffing

The GWTP has been designed to be operated on a long-term basis as an unmanned operation equipped with an Auto Dialer. It is anticipated that the Operator will remotely monitor the GWTP operation at least once or twice a day. In the event of an alarm condition or plant shutdown, the Auto Dialer will dial an on-call Operator. The GWTP will be staffed by experienced Operators from ECOR Solutions Inc. (under subcontract to TtEC) and will follow the requirements of 6 New York Codes, Rules and Regulations (NYCRR) Part 650.

During the first month of operation, there will be at least one Operator on duty at the GWTP, one shift per day, 5 days per week. For the next 5 months, the Operator will be present at the GWTP up to three days per week. After the first six months the operation will be unmanned with an on-call Operator. Emergency or back-up personnel will be available as required to support repair or complex maintenance activities. If necessary, technical support and alternate Operators will be provided by specialty subcontractors for operational or equipment problems of a technical nature and additional operations support. For example, a local I&C/electrical subcontractor may be retained to troubleshoot and repair the PLC quickly, in the event problems are experienced.

Monitoring of the GWTP required by NYSDEC and the Navy for compliance with the ROD will be carried out under the direction of registered Professional Engineers.

A contracted maintenance crew or authorized equipment service representatives will perform repairs of mechanical/electrical equipment which are in excess of the Operator's capabilities.

Table 1-1 Emergency Telephone Numbers

GM-38 Area Groundwater Remediation Emergency Telephone Numbers		
Contact	**Firm or Agency**	**Telephone Number**
Police	Nassau County Police Department	911 516-573-6800
Fire	Bethpage Fire Department	911 516-931-2660
Hospital	New Island Hospital 4295 Hempstead Turnpike Bethpage, New York 11714	516-579-6000
Ambulance		911
Non-emergency Medical Clinic – approved by WorkCare	Island Occupational Medical 4 Dorothy Gate Massapequa, New York	516-795-5544
PM - Stavros Patselas TtEC 1st Contact	TtEC	Office - 215-702-4099 Cell - 267-688-9967
Joe Gray TtEC 2nd Contact	TtEC	Cell - 267-688-9966
Primary Operator - Fred Mattison	ECOR Solutions, Inc.	Office - 610-840-9200 Cell - 484-432-1188
PESM - Grey Coppi	TtEC	Office - 973-630-8101 Cell - 215-327-0751
Navy RPM- Lora Fly	MIDLANT	757-444-0781
Navy PWD FEAD New London-Insp.- Greg Pearman Project Manager - Chris Shukis	NAVY NAVY	Office - 860-694-4556 Cell - 860-235-2040 Cell - 860-235-2041
WorkCare	Anaheim, California	800-455-6155
Poison Control Center		800-222-1222
National Response Center		800-424-8802

1.9.2 Training

The Operator will be required to participate in a field training program given by TtEC and/or selected equipment manufacturer representatives. The training will address equipment operation, maintenance, equipment, safety requirements and troubleshooting and other subjects required to properly operate the GWTP including regular communication with the Site management.

The Operator will also comply with the requirements of 6 NYCRR Part 650.

1.10 Supporting Documentation

The following supporting documents and manual have been used as technical references for this Operations and Maintenance Manual. A copy of these documents can be found in the control room.

1. *Final Design for GM-38 Area Groundwater Remediation, NWIRP Bethpage, NY, May 8, 2006*, by TtEC

2. *Record of Decision NWIRP Bethpage, NY, Operable Unit 2 Groundwater, NYS Registry 1-3-003B,* April 2003 (Revision 1), by EFANE
3. *Record of Decision, Operable Unit 2 Groundwater, Northup Grumman and NWIRP Sites, Nassau County, Site Numbers 1-30-003A & B,* March 2001, by NYSDEC
4. *O&M Manuals, Appendix D* (Manufacturers' Operation & Maintenance Manuals)
5. *Final Site-specific Health and Safety Plan for Construction Tasks, GM-38 Area Groundwater Remediation, May 8, 2006,* by TtEC
6. *Final Waste Management Plan for Construction Tasks, GM-38 Area Groundwater Remediation, May 8, 2006,* by TtEC

2.0 REGULATORY COMPLIANCE

This section of the Operation and Maintenance Manual identifies the Federal, State and local regulations that are applicable to the operation of the GWTP. The applicable regulations have been summarized relative to the following activities:

- Discharge and Re-injection of Treated Groundwater
- Discharge of Treated Off-gas
- Waste Storage, Transportation and Disposal (spent air stripper packing, spent liquid-phase granular activated carbon, spent vapor-phase granular activated carbon, spent bag filters, personal protective equipment [PPE])

The specific regulations are identified below. The agency names, addresses and telephone numbers are provided for reference.

2.1 Discharge and Re-injection of Treated Groundwater

Effective July 1, 2001, the United States Congress passed the Federal Water Pollution Control Act Amendments (Also known as the Clean Water Act, 33 USC 1251 et seq.). Federal water quality regulations are found in Title 40 of the Code of Federal Regulations. This law (originally passed in 1972) authorized the federal government through United States Environmental Protection Agency (USEPA) to assume the dominant role in directing and defining a national program for water pollution control. The law also authorized USEPA to delegate certain responsibilities to any state that could demonstrate the necessary levels of expertise and authority to administer the program. The State of New York obtained USEPA delegation and approval for the control of wastewater and stormwater discharges.

The New York State Pollutant Discharge Elimination System (SPDES) permit program is authorized by the Environmental Conservation Law (ECL – Chapter 43-B of the Consolidated Laws of the State of New York) Article 3 (Department of Environmental Conservation; General Functions, Powers, Duties and Jurisdiction), Title 3; Article 15 (Water Resources); Article 17 (Water Pollution Control), Titles 3, 5, 7, 8; Article 21 (Pollution Control Compacts); Article 70 (Uniform Procedures), Title 1; Article 71 (Enforcement), Title 19. The regulations in 6 NYCRR Part 750 describe the procedures and substantive rules concerning the SPDES program as set forth in the statutory authorities noted above. The New York SPDES program is broader in scope than that required by the federal program in that it controls point source discharges to groundwaters as well as surface waters.

In New York, SPDES permits are issued by the NYSDEC's Division of Water, Bureau of Water Permits, with federal oversight from the USEPA. The permit program is administered by NYSDEC, with the Office of the Attorney General providing legal resources for NYSDEC in enforcement activities. NYSDEC is responsible for the issuance, reissuance, modification, and enforcement of all SPDES permits issued for discharges into the waters of New York (except discharges occurring on Native American lands which are regulated directly by USEPA). New York regulates discharges to both groundwater and surface water; USEPA only requires regulation of surface water discharges. No person or entity may legally discharge to waters of the state without a permit issued under this authority.

2.1.1 SDPES Effluent Limitations and Monitoring Requirements

The treated groundwater discharge and re-injection system consists of the stormwater manhole (within the utility easement east of Broadway Avenue) leading to Nassau County Recharge Basin # 495 and injection well IW-1. It is anticipated that approximately 800 gpm will be discharged into the stormwater manhole and approximately 300 gpm will be re-injected into IW-1. Injection well IW-1 is a 12-inch diameter well that is approximately 230 ft deep. The treated effluent will be tested to meet the SPDES effluent limitations and monitoring requirements, before being re-injected into injection well IW-1 and discharged into the stormwater manhole.

Physical Location

Injection well IW-1 is located approximately 650 ft south of the GWTP along the right of way just west of the Seaford Oyster Bay Expressway (Route 135). Nassau County Recharge Basin # 495 is located on the south side of Arthur Avenue in Bethpage, New York. The stormwater manhole is located in the utility easement, just east of Broadway Avenue.

Monitoring of Compliance with SPDES Effluent Limitations

Within the GWTP there are sampling ports located on the effluent water discharge lines going to the stormwater manhole and injection well IW-1. Samples from these locations will be collected for the various parameters identified in the SPDES permit equivalent at the frequency described below in Table 2-1.

The effluent limitations and monitoring requirements for the GWTP during the period beginning April 1, 2009 and lasting until April 1, 2014 are shown in Table 2-1.

Table 2-1
SDPES Effluent Limitations and Monitoring Requirements

Outfall and Parameters	Limitations		Units	Minimum Monitoring Requirements	
	Daily Average	Daily Maximum		Measurement Frequency	Sample Type
Treated Groundwater Remediation Discharge from Recovery wells 1, 2, and 3					
Flow	Monitor	1100	GPM	Continuous	Recorder
pH (range)	5.5 – 8.5		SU	Weekly	Grab
1,1-Dichloroethane	NA	5	µg/l	Monthly[1]	Grab
1,2-Dichloroethane	NA	0.6	µg/l	Monthly[1]	Grab
1,1-Dichloroethene	NA	5	µg/l	Monthly[1]	Grab
cis 1,2-Dichloroethene	NA	5	µg/l	Monthly[1]	Grab
Trans 1,2-Dichloroethene	NA	5	µg/l	Monthly[1]	Grab
Tetrachloroethene	NA	5	µg/l	Monthly[1]	Grab
1,1,1-Trichloroethane	NA	5	µg/l	Monthly[1]	Grab
Trichloroethene	NA	5	µg/l	Monthly[1]	Grab

Outfall and Parameters	Limitations		Units	Minimum Monitoring Requirements	
	Daily Average	Daily Maximum		Measurement Frequency	Sample Type
Vinyl chloride	NA	2	µg/l	Monthly[1]	Grab
Mercury	NA	0.25	µg/l	Monthly[1]	Grab

Footnotes:

(1) The minimum measurement frequency shall be monthly following a period of 24 consecutive weekly sampling events showing no exceedances of the stated discharge limitations

Additional Conditions:

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

Steven Scharf
Division of Environmental Remediation
NYSDEC, 625 Broadway
Albany, NY 12233-7015
Phone: (518) 402-9620

With a copy sent to:

Regional Water Engineer
NYSDEC – Region 1
Building 40, SUNY Campus
Stony Brook, NY 11790-2356
Phone: (631) 444-0354

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

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

(4) Any use of corrosion/scale inhibitors, biocidal-type compounds, or other water treatment chemicals used in the treatment process must be approved by the department prior to use.

(5) This discharge and administration of this discharge must comply with the substantive requirements of 6 NYCRR Part 750.

In addition, the Nassau County Department of Public Works Water/Wastewater Engineering Unit must be notified prior to discharge and copies of monthly Discharge Monitoring Reports should be forwarded to them. Further, during significant rainfall events, the discharge would have to be suspended if the system cannot accept the flow. Also, as an additional condition, Nassau County will require that TtEC will provide the equipment and resources necessary to clear and scarify the basin floor in the area surrounding the outfall in order to achieve sufficient infiltration for the proposed discharge rate. Injection well IW-1 and the Nassau County Recharge Basin # 495 are shown on Figure 2-1.

2.2 Discharge of Treated Off-Gas

The Clean Air Act (CAA) is a comprehensive federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes USEPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants. Section 112 of the Clean Air Act addresses emissions of hazardous air pollutants. After the issuance of the CAA, New York State enacted amendments to Environmental Conservation Law Articles 19 (Air Pollution Control) and 70 (Uniform Procedures), and DEC amended regulations 6NYCRR Parts 200 (General Provisions), 201 (Permits and Certificates), 621 (Uniform Procedures) and 231 (New Source Review in Non-Attainment Areas and Ozone Transport Regions).

With this demonstration of authority, DEC received delegation of the Title V operating permit program from the USEPA. Chapter III of the New York Code of Regulations and Rules, Subpart 201-5 regulates State Facility Permits. In New York, air permits are issued by the New York Department of Environmental Conservation (NYSDEC) Division of Environmental Permits, with federal oversight from the USEPA. NYSDEC is responsible for the issuance, reissuance, modification, and enforcement of all air permits issued for discharges into the air of New York. Air emissions from the Bethpage GM-038 water treatment facility are subject to this subpart.

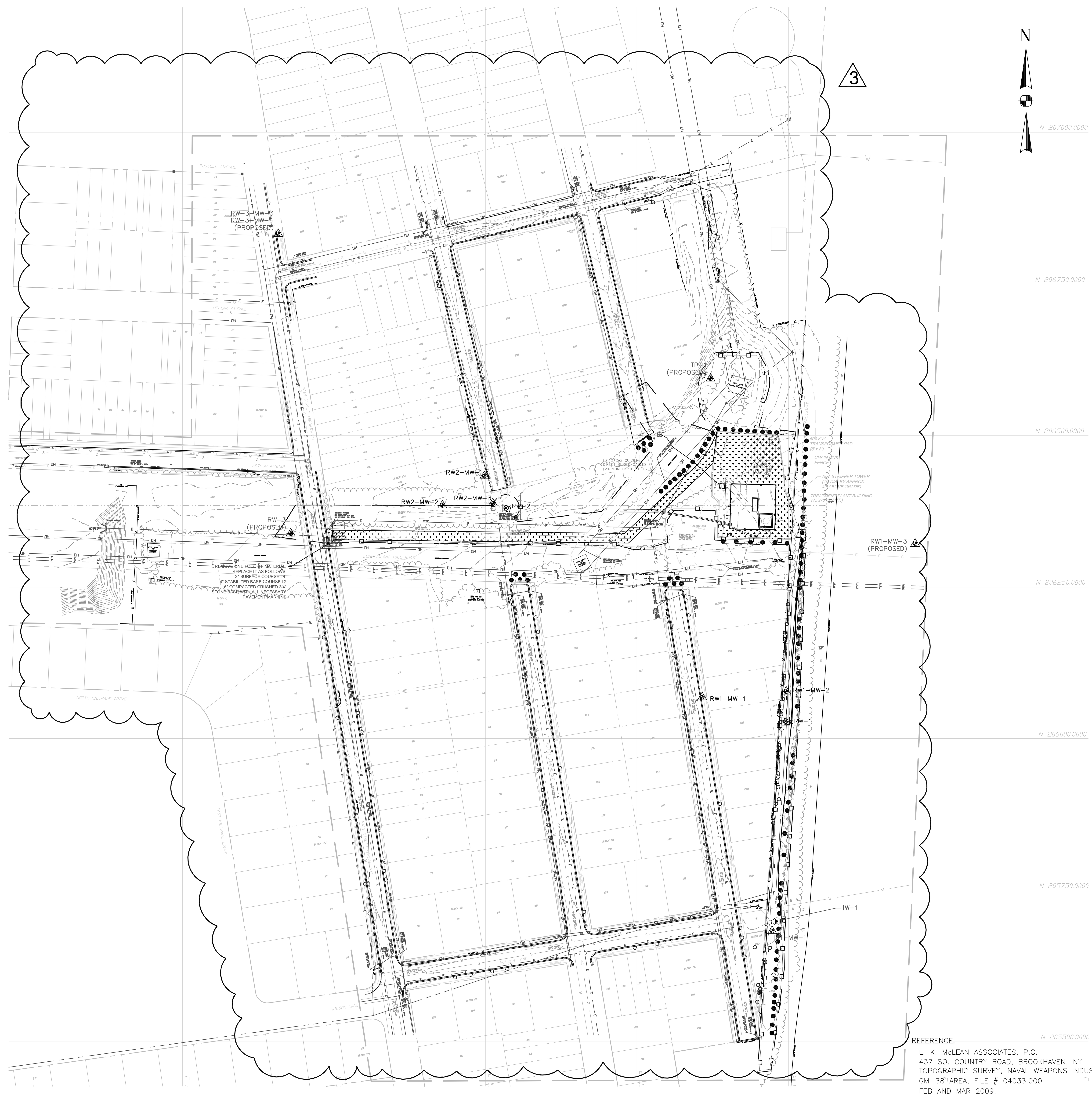
2.2.1 Air Emissions Criteria and Monitoring Requirements

The allowable air emissions from the stack of the vapor-phase granular activated carbon adsorption unit are identified below. Monthly grab samples will be collected from the vapor phase treatment system influent, effluent and two intermediate locations as shown in Section 4.3. The samples will be analyzed for VOCs to monitor compliance with air effluent limits shown in Table 2-2:

Table 2-2
Air Effluent Limitations

Contaminant	Discharge Limit (lb/hr)	Discharge Limit (lbs/year)
Trichloroethylene	0.09	99
Vinyl Chloride	0.01	3.7
1,2-Dichloroethylene	0.03	7.3
1,2-Dichloroethane	BRT	BRT
Toluene	BRT	BRT
Xylene	BRT	BRT
1,1,2-Trichloroethane	BRT	BRT

BRT = Below Reporting Thresholds



SEEDING NOTES:

THIS PRACTICE APPLIES TO ALL DISTURBED AREAS VOID OF VEGETATION EXCEPT WHERE SPECIFIC SEEDING/PLANTING RECOMMENDATIONS EXIST IN OTHER STANDARDS AND SPECIFICATIONS FOR SPECIFIC USES SUCH AS RECREATION.

1. SURFACE AND SUBSURFACE WATER CONTROL PRACTICES MAY BE REQUIRED.
2. PLANNED USE OF THE AREA MUST BE CONSIDERED WHEN SELECTING AN APPROPRIATE SEED MIX.
3. SITE PREPARATION WILL INCLUDE:

A. SEEDBED PREPARATION – SCARIFY IF COMPACTED. REMOVE DEBRIS AND OBSTACLES SUCH AS ROCKS AND STUMPS.

B. SOIL AMENDMENTS

1) LIME TO pH OF 6.0.
2) FERTILIZE WITH 600 LBS. OF 5–10–10 OR EQUIVALENT PER ACRE (14 LBS./1000 SQ. FT.).

C. SEED MIXTURES

1) TEMPORARY SEEDINGS

A. RYEGRASS (ANNUAL OR PERENNIAL) @ 30 LBS. PER ACRE (0.7 LBS./1000 SQ. FT.)
B. CERTIFIED 'AROOSTOOK' WINTER RYE (CEREAL RYE) @ 100 LBS. PER ACRE (2.5 LBS./1000 SQ. FT.).

USE WINTER RYE IF SEEDING IN OCTOBER/NOVEMBER.

2) PERMANENT SEEDINGS

A. ROUGH OR OCCASIONALLY MOWED AREAS:

	LBS/ACRE	LBS/1000 SQ. FT.
EMPIRE BIRDSFOOT TREFOIL[2] OR	8	0.20
COMMON WHITE CLOVER[2]	8	0.20
PLUS		
TALL FESCUE	20	0.45
PLUS		
RED TOP OR	2	0.05
RYEGRASS (PERENNIAL)	5	0.10

[2] ADD INOCULANT IMMEDIATELY PRIOR TO SEEDING.

B. FREQUENTLY MOWED AREAS: REFER TO STANDARD AND SPECIFICATION FOR RECREATION AREA IMPROVEMENT ON PAGE 3.5 OF THE NEW YORK GUIDELINES FOR URBAN EROSION AND SEDIMENT CONTROL DATED APRIL 1997.

D. TIME OF SEEDING

THE OPTIMUM TIME FOR PERMANENT SEEDINGS WITH LEGUMES (BIRDSFOOT TREFOIL OR CLOVER) IS EARLY SPRING.

PERMANENT SEEDINGS MAY BE MADE ANY TIME OF YEAR IF PROPERLY MULCHED AND ADEQUATE MOISTURE IS PROVIDED. MID SUMMER IS NOT A GOOD TIME TO SEED, BUT THESE SEEDINGS, IF CONSTRUCTION IS COMPLETE, WILL FACILITATE COVERING THE LAND. PORTIONS MAY FAIL AND MAY NEED RESEEDING THE FOLLOWING YEAR.

TEMPORARY SEEDINGS SHOULD BE MADE WITHIN 24 HOURS OF CONSTRUCTION OF DISTURBANCE. IF NOT, THE SOIL MUST BE SCARIFIED PRIOR TO SEEDING.

E. METHOD OF SEEDING

BROADCASTING, DRILLING WITH CULTIPACK TYPE SEEDER OR HYDROSEEDING ARE ACCEPTABLE. GOOD SOIL TO SEED CONTACT IS THE KEY TO SUCCESSFUL SEEDINGS.

F. MULCHING AND MULCH ANCHORING

MULCHING IS ESSENTIAL TO OBTAIN A UNIFORM STAND OF PLANTS. SEE STANDARD AND SPECIFICATIONS FOR MULCHING ON PAGE 3.31 OF THE NEW YORK GUIDELINES FOR URBAN EROSION AND SEDIMENT CONTROL DATED APRIL 1997.

G. IRRIGATION

WATERING MAY BE ESSENTIAL TO ESTABLISH A NEW SEEDING. WEATHER CONDITIONS AND THE INTENDED USE OF THE AREA WILL DICTATE WHEN TO WATER. IRRIGATION IS A SPECIALIZED PRACTICE AND CARE NEEDS TO BE TAKEN NOT TO EXCEED THE APPLICATION RATE/INFILTRATION RATE OF ANY GIVEN SOIL.

NOTE:

1. A MAXIMUM OF 100 PINUS STROBUS (WHITE PINE) SHALL BE PLANTED AT THE APPROXIMATE LOCATIONS SHOWN ON THIS CONTRACT DRAWING. THESE EASTERN WHITE PINE TREES ARE SELECTED DUE TO THEIR RAPID GROWTH AND ABILITY TO PROVIDE A VISUAL AND NOISE BARRIER WHEN FULLY GROWN. THE TREES WILL BE 10'–12' IN HEIGHT WITH 3" MINIMUM AVERAGE DIAMETER AND SPACED APPROXIMATELY 10 FEET ON CENTER. THE WHITE PINE TREES PARALLELING THE SEAFORD OYSTER BAY EXPRESSWAY WILL BE SPREAD AROUND EXISTING TREES AND PREVIOUSLY PLANTED WHITE PINE TREES. PEAT MOSS AND FERTILIZERS CONSISTING OF NITRATE OF SODA AND HOLLY TONE ACID WILL BE USED DURING PLANTING.
2. THE CONTRACTOR IS RESPONSIBLE FOR THE PLANTINGS FOR A PERIOD OF AT LEAST ONE YEAR AFTER THE INSTALLATION AND MUST REPLACE ANY DEAD OR DAMAGED PLANTINGS IN A TIMELY FASHION. AFTER THIS MAINTENANCE PERIOD, THE NAVY SHOULD ASSUME THIS RESPONSIBILITY UNTIL THE SYSTEM IS DECOMMISSIONED.
3. UP TO AN ADDITIONAL 20 TREES SHALL BE PLANTED WITHIN PROJECT AREA. THE LOCATION OF THESE TREES SHALL BE DETERMINED IN THE FIELD.

LEGEND:

= EXISTING GRADE–MAJOR CONTOUR
= EXISTING GRADE–MINOR CONTOUR
= PROPOSED GRADE
= TAX LOT LINE
= OVERHEAD ELECTRIC WIRES
= UNDERGROUND ELECTRIC WIRES
= WATER MAIN
= GAS MAIN
= DRAINAGE LINES (STORM SEWER)
= SANITARY SEWER MAIN
= WOODED AREA
= CHAIN–LINK OR BOARD FENCE
= DIRT TRAIL
= LIMITS OF CLEARING
= SILT FENCE
NE = NEW UNDERGROUND ELECTRIC WIRES
NW = NEW WATER LINE
NS = NEW SANITARY SEWER MAIN
= HDPE PIPE AND ELECTRICAL CONDUIT
242 = TAX LOT NUMBER
= WATER VALVE
GV = GAS VALVE
RW1–MW–1 = MONITORING WELL
RW–1 = RECOVERY WELL
IW–1 = INJECTION WELL
PB = PULL BOX
= LEAK DETECTION ACCESS PORT

= EXISTING DECIDUOUS TREE
= EXISTING CONIFEROUS TREE
= WHITE PINE TREE LOCATION
= SIGN
= MANHOLE
= GRAVEL ACCESS ROAD AND PARKING LOT
6916 = PUBLIC WATER SUPPLY WELL

REFERENCE:

L. K. McLEAN ASSOCIATES, P.C.
437 SO. COUNTRY ROAD, BROOKHAVEN, NY
TOPOGRAPHIC SURVEY, NAVAL WEAPONS INDUSTRIAL RESERVE PLANT, GM–38 AREA, FILE # 04033.000
FEB AND MAR 2009.

GRAPHIC SCALE

80 0 40 80 160 320

SCALE: 1 INCH = 80 FEET

THIS DRAWING PRODUCED ON AUTOCAD
DO NOT REVISE MANUALLY

TETRA TECH ENGINEERING CORPORATION PC

DSGN: DR: CHK:
SUPV: CH ENG:
SUBMITTED BY: (FIRM MEMBER) (TITLE) (DATE)
NORTHDIV DM: HD:
FPE: HD: DIR:
OFFICER IN CHARGE
APPROVED DATE

REV	DESCRIPTION	PREP BY	DATE	APPRVD
0	FINAL DESIGN	DL	05/05/06	CYC
1	RELOCATED ACCESS ROAD AND ASSOCIATED RESTORATION FEATURES. ADD RW-3.	DLB	03/31/08	CYC
2	REVISE LIMITS OF CLEARING	DLB	04/23/08	CYC
3	ADDED REVISED TOPO, ADDED BUILDING AND ADDITIONAL WELLS	DLB	05/15/09	???

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
ENGINEERING FIELD ACTIVITY – NORTHEAST
LESTER PENNSYLVANIA
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK
GM–38 AREA
GROUNDWATER TREATMENT PLANT
LOCATION OF TREATED GROUNDWATER DISCHARGE AND RE–INJECTION WELL
APPROVED DATE EFANE FOR COMMANDER, NAVFAC

SEAL AREA

SAT TO DATE
CODE I.D. NO. 80091
SCALE : AS SHOWN
SPEC. NO.
CONSTRN. CONTR. NO. N62472–99–D–0032
NAVFAC DRAWING NO.
SHEET OF
SIZE: D
DIS. SH. NO. 2–1

Agency Contacts Information:

- SPDES and Air Emissions Requirements

New York Department of Environmental Conservation
Mr. Steven Scharf, P.E.
Division of Environmental Remediation
Remedial Action, Bureau A
625 Broadway
Albany, NY 12233-7015
(518) 402-9620

2.3 Waste Storage, Transportation and Disposal

Wastes generated due to GWTP operations will be handled in accordance with the Final Waste Management Plan for Construction Tasks (TtEC, May 8, 2006). Storage of waste on-site will consist of spent air stripper packing materials, spent liquid-phase granular activated carbon, spent vapor-phase granular activated carbon, spent bag filters and used personal protective equipment (PPE). These waste streams will be appropriately characterized (profiled) prior to disposal, as described in Sections 4 and 10. It is anticipated that the wastes generated will be non-hazardous. The wastes will be manifested as either non-hazardous or hazardous waste depending on the waste profile, for offsite transportation and appropriate disposal. It is planned that non-hazardous wastes will be transported via trucks and disposed of at a NYSDEC approved RCRA Subtitle D solid waste landfill. Wastes will be shipped using a Bill of Lading or non-hazardous waste manifest.

When necessary, carbon change-out can be conducted using either dry carbon delivered in 1,100-pound super sacks or by means of carbon/water slurry delivered in a 20,000-pound load by a tractor trailer unit. The layout of the carbon vessels has been designed so that a tractor trailer unit can approach to within 20 feet or less of each carbon vessel. Using the carbon slurry method, pressurized air will be used to push the spent carbon out of the vessel and into a waiting empty tractor trailer unit for off-site regeneration or disposal. New or regenerated carbon from a second tractor trailer can then immediately be transferred into the empty carbon vessel.

Agency Contacts Information:

- 49 CFR 100-180 - Transportation

U.S.Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Central Region Office
2300 East Devon Avenue, Suite 478
Des Plaines, IL 60018
(847) 294-8580

or

U.S.Department of Transportation
Pipeline and Hazardous Materials Safety Administration
East Building, 2nd floor
1200 New Jersey Avenue, SE
Washington, D.C. 20590
(202) 366-0656

or

DOT Hazardous Materials Information Center: (800) 467-4922

3.0 RECORDS MANAGEMENT

3.1 Introduction

A comprehensive Records Management Program is essential to the efficient operation of the GWTP. Information relative to: facility usage, equipment preventative maintenance, sampling analysis and monitoring, process control monitoring, chemical usage, personnel management, etc. must be collected by the Plant Operator and reported upon request to meet regulatory and client requirements. This Section briefly summarizes the recommended records management program for the NWIRP Bethpage Groundwater Treatment Plant.

In accordance with the requirements of the client contract, a bound operation and maintenance log and an electronic log is to be maintained by the Operator on-site, to include all collected records and events as described in this Section.

3.2 Process Control Recording

Process control recording is to be completed by the Operator on a daily/weekly/monthly basis. It is divided into two categories: 1) process monitoring via the CMCS and 2) equipment operation monitoring via manual/visual inspections.

3.2.1 Process Monitoring

Process control data will be transmitted from the instrumentation to the CMCS system. The Operator will download selected process control data into a daily/weekly/monthly report. Information that is not directly available from the CMCS will be manually recorded by the Operator. Tables 3-1 and 3-2, CMCS Monitoring, include a listing of systems that are to be monitored by the CMCS.

The process monitoring reports will include at a minimum the following information:

- Total daily flow and average daily flow rate of groundwater pumped to the GWTP from recovery wells RW-1 and RW-3 (from CMCS);
- Concentrations of VOCs, mercury, and pH of groundwater pumped to the GWTP in accordance with the established sampling frequency (pH from CMCS, VOCs and mercury from laboratory analysis);
- Total daily flow and average daily flow rate of groundwater pumped to the air stripper AS-1 (from CMCS);
- Total daily flow and average daily flow rate of air from blower B-1 to the air stripper AS-1 (from CMCS);

- Concentrations of VOCs in off-gas entering the vapor phase carbon adsorbers in accordance with the established sampling frequency (from laboratory analysis);
- Total daily flow and average daily flow rate of off-gas from booster blower B-2 to the exhaust stack (from CMCS);
- Concentrations of VOCs in treated off-gas leaving the exhaust stack in accordance with the established sampling frequency (from laboratory analysis);
- Identification of mode of operation of liquid phase carbon adsorbers (series/parallel) (from Operator records);
- Identification of the liquid phase carbon adsorbers that were switched from secondary to primary, if applicable (from Operator records);
- Identification of any liquid phase carbon adsorbers that were backwashed, if applicable (from Operator records);
- Total daily volume of backwash water pumped through the liquid phase carbon adsorbers, if applicable (from Operator records);
- Identification of the carbon adsorbers that were charged with fresh carbon, if any (from Operator records);
- Identification of the multi-bag filter vessels in which spent bag filters were replaced (from Operator records);
- Concentrations of VOCs, mercury, and pH of treated effluent pumped to the recharge basin and the injection well IW-1 in accordance with the established sampling frequency (pH from CMCS, VOCs and mercury from laboratory analysis);
- Total daily flow and average daily flow rate of treated effluent pumped to the recharge basin and the injection well IW-1 (from CMCS);
- Daily/weekly recording of maintenance and repairs made to equipment, as applicable (from Operator records); and
- Daily/weekly recording of instrument alarms and process control system upsets (from CMCS).

This information will be made available through summarized spreadsheets via the CMCS software program. Based on experience gained in operating the GWTP, following the start-up and prove-out periods as discussed in Section 4.3.1, TtEC may reduce the frequency of sampling and analyses for the influent wastewater.

During 2009, the operation of the various subsystems of the GWTP will be monitored and the data collected will be utilized to conduct value engineering studies in order to determine how the GWTP process can be optimized and/or modified to improve the efficiency and reduce operating costs. Depending on the results of these studies, the operation of the GWTP may be modified for 2010 and later years.

Table 3-1 CMCS Monitoring - Digital Signals

INSTRUMENT TAG	DESCRIPTION
Digital Input	
MI-P1	Recovery Well RW-1 Pump P-1 Run Indication
MI-P2	Recovery Well RW-3 Pump P-2 Run Indication
MI-P3A	Air Stripper AS-1 Feed Pump P-3A Run Indication
MI-P3B	Air Stripper AS-1 Feed Pump P-3B Run Indication
MI-P4A	Liquid Carbon Feed Pump P-4A Run Indication
MI-P4B	Liquid Carbon Feed Pump P-4B Run Indication
MI-P5A	Building Sump Pump P-5A Run Indication
MI-P5B	Building Sump Pump P-5B Run Indication
MI-M1	Equalization Tank Agitator M-1 Run Indication
MI-B1	Air Stripper AS-1 Blower B-1 Run Indication
MI-B2	Booster Blower B-2 Run Indication
PSH-101	Effluent Water Discharge High Pressure Switch
PSL-102	Blower B-1 Discharge Low Pressure Switch
PSH-102	Blower B-1 Discharge High Pressure Switch
PSL-103	Booster Blower B-2 Discharge Low Pressure Switch
PSH-103	Booster Blower B-2 Discharge High Pressure Switch
PDSH-117	Bag Filters High Differential Pressure Switch
PDSH-118	Liquid Carbon Tanks High Differential Pressure Switch
LSH-101	Air Stripper Containment Sump High Level Switch
LSL-102	Sodium Hydroxide Tank T-2 Low Level Switch
TSH-103	Vapor Phase Carbon Off-gas Inlet Temperature Switch
TAH-103	Heater H-1 High Temperature Alarm
CR-277	24 Volts D.C. Power Failure
Fire AL	Fire Alarm
Digital Output	
MC-P1	Recovery Well RW-1 Pump P-1 Control
MC-P2	Recovery Well RW-3 Pump P-2 Control
MC-P3A	Air Stripper AS-1 Feed Pump P-3A Control
MC-P3B	Air Stripper AS-1 Feed Pump P-3B Control
MC-P4A	Liquid Carbon Feed Pump P-4A Control
MC-P4B	Liquid Carbon Feed Pump P-4B Control
MC-P5A	Building Sump Pump P-5A Control
MC-P5B	Building Sump Pump P-5B Control
MC-M1	Equalization Tank T-1 Agitator M-1 Control
MC-B1	Air Stripper AS-1 Blower B-1 Control
MC-B2	Booster Blower B-2 Control
SHDN-H1	Heater H-1 Shutdown Signal
Auto Dialer-1	Recovery Well RW-1 Pump P-1 Shutdown Signal
Auto Dialer-2	Recovery Well RW-3 Pump P-2 Shutdown Signal
Auto Dialer-3	Air Stripper AS-1 Blower B-1 Shutdown Signal
Auto Dialer-4	Building Sump High-High Level
Auto Dialer-5	Fire Alarm
Auto Dialer-6	Effluent Water Discharge High pH

INSTRUMENT TAG	DESCRIPTION
Auto Dialer-7	Effluent Water Discharge Low pH
Auto Dialer-8	High water level in Air Stripper Containment Sump or High differential pressure across the Bag Filters or High differential pressure across the LGAC vessels

Table 3-2 CMCS Monitoring - Analog Signals

INSTRUMENT TAG	DESCRIPTION
Analog Input	
LT-101	Recovery Well RW-1 Level Transmitter
LT-102	Recovery Well RW-3 Level Transmitter
LIT-103	Equalization Tank T-1 Level Indicator Transmitter
LIT-104	Building Sump Level Indicator Transmitter
LIT-105	Air Stripper AS-1 Inner Sump Level Indicator Transmitter
LT-106	Injection Well IW-1 Level Transmitter
FQIT-101	Recovery Well RW-1 Flow Indicator Transmitter
FQIT-102	Recovery Well RW-3 Flow Indicator Transmitter
FQIT-103	Air Stripper AS-1 Inlet Flow Indicator Transmitter
FQIT-105	Blower B-1 Discharge Flow Indicator Transmitter
FQIT-106	Air Stripper AS-1 Recycle to T-1 Flow Indicator Transmitter
FQIT-108	Effluent Water Discharge to Bypass Flow Indicator Transmitter
FQIT-109	Effluent Water Discharge to IW-1 Flow Indicator Transmitter
FQIT-B2	Booster Blower B-2 Discharge Flow Indicator Transmitter
AIT-101	Influent Water pH Indicator Transmitter
AIT-102	Effluent Water pH Indicator Transmitter
SI-P1	Recovery Well RW-1 Pump P-1 Speed Indication
SI-P2	Recovery Well RW-3 Pump P-2 Speed Indication
SI-P3A	Air Stripper AS-1 Feed Pump P-3A Speed Indication
SI-P3B	Air Stripper AS-1 Feed Pump P-3B Speed Indication
INSTRUMENT TAG	**DESCRIPTION**
Analog Input	
SI-P4A	Liquid Carbon Feed Pump P-4A Speed Indication
SI-P4B	Liquid Carbon Feed Pump P-4B Speed Indication
SI-B1	Air Stripper AS-1 Blower B-1 Speed Indication
SI-B2	Booster Blower B-2 Speed Indication
DPIT-101	Air Stripper AS-1 Differential Pressure Indicator Transmitter
RT-101	Rainfall Gauge Signal Transmitter
TIC-104	Heater H-1 Off-gas Temperature
Analog Output	
SC-P1	Recovery Well RW-1 Pump P-1 Speed Control
SC-P2	Recovery Well RW-3 Pump P-2 Speed Control
SC-P3A	Air Stripper AS-1 Feed Pump P-3A Speed Control
SC-P3B	Air Stripper AS-1 Feed Pump P-3B Speed Control

SC-P4A	Liquid Carbon Feed Pump P-4A Speed Control
SC-P4B	Liquid Carbon Feed Pump P-4B Speed Control
SC-B1	Air Stripper AS-1 Blower B-1 Speed Control
SC-B2	Booster Blower B-2 Speed Control

3.2.2 Equipment Operation Monitoring

Reports will be generated to document regular equipment inspections and operational parameters. The following information will be documented on the "***Daily Inspection Form***" located in ***Appendix A, Report Forms***:

- Visual inspection of all piping, fixtures, pumps and tanks to check for leaks or visible signs of wear;
- Visual inspection of water flow throughout system via designated sight tubes within the system; and
- Visual inspection of security, heating and ventilation and fire protection systems.

Specific preventative maintenance on the equipment is described in ***Section 9.0, Equipment Maintenance*** of the Manual. Maintenance performed for each piece of equipment is to be recorded using the "***Equipment Maintenance Form***", located in ***Appendix A, Report Forms***.

3.3 Laboratory Data

Laboratory results from the GWTP process and waste sampling will be summarized in the quarterly status and monitoring reports to be prepared by TtEC.

3.4 Inventory Monitoring and Recording

It is recommended that the Operator monitor and record all equipment used during regular treatment system operations at least on a weekly basis and make an inventory. This includes process equipment, as well as, building maintenance supplies/equipment. This information is to be included in the Equipment Maintenance Form, found in ***Appendix A, Report Forms***. Reference is also made to the ***"Tools and Equipment List"*** found in ***Appendix B, Tools and Equipment***, and the ***"Spare Parts Inventory"*** located in ***Appendix C, Spare Parts***.

3.5 Personnel Management

On-site personnel management is an important part of the efficient operation and maintenance of the GWTP. Location of on-site personnel is essential in order to meet site health and safety protocol.

Personnel management includes records of time on-site for the Operator, as well as, visitors and security personnel. Operators are to prepare daily logs for inclusion in weekly employer timesheets.

4.0 SAMPLING AND ANALYSIS PROGRAM DESCRIPTION

4.1 Purpose

The purpose of this sampling and analysis program section is to describe data acquisition procedures, numbers and types of samples, methods of analysis, and quality control measures associated with data collection and analysis for the GWTP. The detailed definition of quality assurance (QA) and quality control (QC) for all sampling related project activities to be implemented at the Site is covered in a separate document, the Uniform Federal Policy SAP/Quality Assurance Project Plan (UFP SAP/QAPP), which ensures the integrity of the work to be performed at the Site and ensures that the data collected will be of the appropriate type and quality needed for their intended use. This SAP is intended to be a procedural guide for all TtEC team personnel and subcontractors involved in sampling and analysis and data acquisition while implementing remedial actions for the GM-38 Area Groundwater. Collection of process aqueous samples is described in Standard Operating Procedure 001 (SOP001) and collection of process vapor samples is described in SOP002 in the SAP and these SOPs are also included in Appendix A of this OM&M Plan.

4.2 Sampling and Analysis Data Objectives

This section gives an overview of sampling and analysis activities and their data objectives. Sampling and analysis activities for the GWTP consist of: 1) process monitoring and sampling; and, 2) monitoring and characterization of the effluent streams (treated water pumped to the injection well IW-1 and the storm water manhole, and spent media [air stripper packing material, bag filters] for waste disposal) from the GWTP.

4.2.1 Generalized Scope of Work

Process and groundwater monitoring and sampling and effluent stream characterization activities for this project will include the following:

- Sampling and monitoring of influent, effluent, and intermediate process streams within the GWTP for the purpose of evaluating the operation and performance of the process equipment used for air stripping, bag filtration, liquid-phase and vapor-phase granular activated carbon adsorption, and backwashing during routine operations.
- Sampling and monitoring of the GWTP performance during the start-up period in 2009 in order to ensure that the system is operating properly and that effluent streams meet all regulatory and disposal facility requirements.
- Sampling and monitoring of the GWTP during the prove-out period in 2009 in order to ensure that the system is operating in accordance with the design specifications and meets all regulatory and disposal facility requirements.
- Sampling and monitoring of the groundwater to determine the effectiveness of the remediation activities and monitor the hydraulic containment and capture of the groundwater "hot spot" by the recovery wells.

Other activities include sampling and analysis for health and safety related monitoring of the indoor air within the GWTP building as well as sampling and analysis for waste characterization purposes. Sampling and analysis for monitoring of the indoor air is discussed in detail in the Site Safety and Health Plan (SSHP).

4.2.2 Data Quality Objectives

Data Quality Objectives (DQOs) are requirements needed to support decisions relative to the various site activities. Sampling procedures and analytical data collected must be of a quality that supports the decision making process and ensures that project objectives are achieved. The sampling and analysis program will ensure that data meet the requirements for precision, accuracy, representativeness, comparability, completeness, and sensitivity defined in the SAP. Project Quality Objectives and Systematic Planning Process Statements are stated in SAP Worksheet #11. Measurement Performance Criteria for the various matrices and analyses are stated in SAP Worksheet #12. The Reference Limits and Evaluation Table for the various matrices and analyses are provided in SAP Worksheet #15.

Samples will be analyzed in strict accordance with the analytical test methods and procedures utilizing approved USEPA and NYSDEC Analytical Services Protocol methods. Analytical methods will provide results with detection limits sufficiently below designated action levels, and the methods will be accurate enough to quantify contamination at concentrations below action levels. Sample collection will utilize approved techniques that will ensure that the sample is representative of current environmental and operational conditions. QA/QC samples will be collected and analyzed for the purpose of assessing the quality of the sampling effort and of the analytical data. A description and frequency of QA/QC samples to be collected is specified in Section 4.3.2.

Laboratories providing chemical measurements for the purposes of determining the effectiveness of the remediation must be certified by the State of New York's Environmental Laboratory Approval Program (ELAP) for aqueous and vapor media and the appropriate analytes and methods, and all laboratory methods must meet the reporting limit requirements acceptable to both the USEPA and NYSDEC. TtEC plans to send samples for a particular analytical parameter only to those laboratories that have been certified by the State of New York for that parameter. To the extent possible, TtEC plans to utilize local certified laboratories with the samples being delivered to the certified laboratory by a local courier service instead of shipping samples via an overnight delivery service to laboratories that are further away. Only if required during the project (e.g., the chosen laboratory loses its certification for the parameter, etc.) will additional laboratories be utilized for analysis of a particular parameter. The primary subcontract laboratories are Test America, Pittsburgh (through contract with Southern University and A & M College-CEES) and,Air Toxics, Ltd.

A Project Manager and QA Manager will be assigned by each laboratory to the project, and they will provide technical guidance to the project team, oversee laboratory requirements (including QA/QC requirements) for the project, review laboratory data for compliance with approved planning documents, maintain laboratory documentation, and coordinate corrective action procedures as necessary. The TtEC QA/QC Manager, in concert with the TtEC Database Management Specialist, will coordinate with the laboratories on the number and type of analytical samples necessary. The subcontractor laboratory(ies) will be responsible for the delivery of sample bottles (pre-preserved as necessary) to the Site, and subsequent pick-up/shipment and analysis of collected samples. Data packages will be submitted by the subcontractor laboratories directly to the TtEC Team.

4.3 Sampling Program Procedures and Requirements

This section discusses and summarizes the sampling and monitoring activities described in the Scope of Work and summarized in Section 4.2.1, and identifies chemical and physical sampling requirements for this program.

4.3.1 Sampling and Monitoring Programs

Several sampling and monitoring programs will be conducted as part of the GWTP operations. These include:

1) sampling and monitoring of influent, effluent, and intermediate process streams for routine operations;
2) sampling and monitoring of influent, effluent, and intermediate process streams during the start-up period;
3) sampling and monitoring of influent, effluent, and intermediate process streams during the prove-out period; and,
4) sampling and monitoring of groundwater.

These sampling and monitoring programs are described below. Specific sampling protocols are identified below. QA/QC samples will be collected as identified in Section 4.3.2. All procedures for decontamination of equipment, identification, labeling, chain-of-custody, packing, and transportation will be followed as identified in Section 4.3.3 and 4.3.4.

4.3.1.1 Sampling and Monitoring for Routine Operations

In order to keep the plant running as designed, the GWTP Operator will have to communicate regularly with the GWTP Plant Manager and the GWTP Design Engineer. The communication with the GWTP Plant Manager and/or the GWTP Design Engineer is necessary so that if changed groundwater quality or other such conditions are encountered, plant flow rates and set points can be adjusted as required (if necessary).

Routine operations will commence at the end of the prove-out period (i.e., after the end of the first six months of operations). During routine operations, the following process streams will be sampled and/or monitored (see Table 4-1). It should be noted that most of this sampling and monitoring is for the purpose of tracking and documenting the performance of plant operations and not for regulatory compliance reporting purposes. Only the process effluent streams will be sampled for regulatory compliance purposes for the parameters identified by NYSDEC, and the disposal facilities at the designated frequency. Based on experience gained in operating the GWTP, following the start-up and prove-out periods as discussed below, TtEC may reduce the frequency of sampling and analyses for the influent process water and some of the intermediate process streams. **All analytical parameters for regulatory compliance (including pH for effluent water to the stormwater manhole and the injection well IW-1) will be collected monthly (samples for pH will be collected weekly) and analyzed at a laboratory certified by the State of New York for these parameters.** Samples for regulatory compliance will be grab samples collected to assure that the sample is maintained at $4^{o}C$ during the collection period.

Table 4-1 Sampling and Monitoring for Routine Operations

Process Stream	Sampling/Monitoring Location	Analytical Parameters	Required for Regulatory Compliance
Influent from RW-1	Sample port (BV-103)	Chlorinated VOCs, mercury and pH	No
Influent from RW-3	Sample port (BV-104)	Chlorinated VOCs, mercury and pH	No

Process Stream	Sampling/Monitoring Location	Analytical Parameters	Required for Regulatory Compliance
Air Stripper Effluent	Sample port (BV-115)	Chlorinated VOCs, mercury, TSS and pH	No
Bag Filter Effluent	Sample port (BV-124)	Chlorinated VOCs, mercury, TSS and pH	No
Treated Effluent to stormwater manhole and injection well IW-1	Sample port (BV-127)	Chlorinated VOCs, mercury, and pH	Yes
LGAC-1 outlet (for series flow)	Sample port (BV-145)	Chlorinated VOCs, mercury, and pH	No
LGAC-2 outlet (for series flow)	Sample port (BV-149)	Chlorinated VOCs, mercury, and pH	No
LGAC-3 outlet (for series flow)	Sample port (BV-153)	Chlorinated VOCs, mercury, and pH	No
Off-gas VGAC-1 Inlet	Sample port (BV-132)	Chlorinated VOCs	No
Off-gas between VGAC-1 and VGAC-2	Sample port (BV-134)	Chlorinated VOCs	No
Off-gas between VGAC-2 and VGAC-3	Sample port (BV-136)	Chlorinated VOCs	No
Off-gas between VGAC-3 and Exhaust Stack	Sample port (BV-139)	Chlorinated VOCs	Yes
Spent air stripper packing /filter / adsorber media	Composite sample	TCLP VOCs and TCLP metals	Yes

Sampling Locations and Methods and SOP Requirements are identified in SAP Worksheet #18. Analytical SOP Requirements are detailed in SAP Worksheet #19. Field Quality Control Samples are summarized in SAP Worksheet #20. Project Sampling SOPs are referenced in SAP Worksheet #21. Analytical SOPs are referenced in SAP Worksheet #23. Collection of process aqueous samples is described in SOP001 and collection of process vapor samples is described in SOP002 in the SAP and these SOPs are also included in Appendix A of this OM&M Plan.

4.3.1.2 Sampling and Monitoring GWTP Performance during Start-up Period

Sampling and monitoring of the GWTP performance will be implemented during the start-up period in 2009 in order to ensure that the system is operating properly and that effluent streams meet all regulatory, and disposal facility requirements. The start-up period is defined as the first 30 days of operations. In order to keep the plant running as designed, the GWTP Operator will have to communicate regularly with the GWTP Plant Manager and the GWTP Design Engineer. The communication with the GWTP Plant Manager and/or the GWTP Design Engineer is necessary so that if changed groundwater quality or other such conditions are encountered, plant flow rates and set points can be adjusted as required (if necessary).

During the start-up period, the following process streams will be sampled and/or monitored (see Table 4-2). The purpose of this sampling and monitoring is for tracking and documenting GWTP operations performance as well as for regulatory compliance. **During the system start-up period, all samples will be collected on a weekly basis.** Only the process effluent streams will be sampled for regulatory compliance purposes for the parameters identified by NYSDEC, and the disposal facilities at the designated frequency. All analytical parameters for regulatory compliance (including pH for effluent water to the stormwater manhole and the injection well IW-1) will be collected weekly and analyzed at a laboratory certified by the State of New York for these parameters. Samples for regulatory compliance will be grab samples collected to assure that the sample is maintained at 4^{o}C during the collection period.

Table 4-2 Sampling and Monitoring during the Start-up Period

Process Stream	Sampling/Monitoring Location	Analytical Parameters	Required for Regulatory Compliance
Influent from RW-1	Sample port (BV-103)	Chlorinated VOCs, mercury and pH	No
Influent from RW-3	Sample port (BV-104)	Chlorinated VOCs, mercury and pH	No
Air Stripper Effluent	Sample port (BV-115)	Chlorinated VOCs, mercury, TSS and pH	No
Bag Filter Effluent	Sample port (BV-124)	Chlorinated VOCs, mercury, TSS and pH	No
Treated Effluent to stormwater manhole and injection well IW-1	Sample port (BV-127)	Chlorinated VOCs, mercury, and pH	Yes
LGAC-1 outlet (for series flow)	Sample port (BV-145)	Chlorinated VOCs, mercury, and pH	No
LGAC-2 outlet (for series flow)	Sample port (BV-149)	Chlorinated VOCs, mercury, and pH	No
LGAC-3 outlet (for series flow)	Sample port (BV-153)	Chlorinated VOCs, mercury, and pH	No
Off-gas VGAC-1 Inlet	Sample port (BV-132)	Chlorinated VOCs	No
Off-gas between VGAC-1 and VGAC-2	Sample port (BV-134)	Chlorinated VOCs	No
Off-gas between VGAC-2 and VGAC-3	Sample port (BV-136)	Chlorinated VOCs	No
Off-gas between VGAC-3 and Exhaust Stack	Sample port (BV-139)	Chlorinated VOCs	Yes
Spent air stripper packing /filter / adsorber media	Composite sample	TCLP VOCs and TCLP metals	Yes

Sampling Locations and Methods and SOP Requirements are identified in SAP Worksheet #18. Analytical SOP Requirements are detailed in SAP Worksheet #19. Field Quality Control Samples are summarized in SAP Worksheet #20. Project Sampling SOPs are referenced in SAP Worksheet #21. Analytical SOPs are referenced in SAP Worksheet #23. Collection of process aqueous samples is described in SOP001 and collection of process vapor samples is described in SOP002 in the SAP and these SOPs are also included in Appendix A of this OM&M Plan.

4.3.1.3 Sampling and Monitoring GWTP Performance during Prove-Out Period

Sampling and monitoring of the GWTP performance will be implemented during the prove-out period in 2009 in order to ensure that the GWTP is operating in accordance with the design specifications and that effluent streams meet all regulatory, and disposal facility requirements. The prove-out period is defined as the second through the sixth months of operations. In order to keep the plant running as designed, the GWTP Operator will have to communicate regularly with the GWTP Plant Manager and the GWTP Design Engineer. The communication with the GWTP Plant Manager and/or the GWTP Design Engineer is necessary so that if changed groundwater quality or other such conditions are encountered, plant flow rates and set points can be adjusted as required (if necessary).

During the prove-out period, the following process streams will be sampled and/or monitored (see Table 4-3). The purpose of this sampling and monitoring is for ensuring that the GWTP is operating in accordance with the design specifications and that effluent streams meet all regulatory, and disposal facility requirements. **During the system prove-out period, all samples will be collected on a weekly basis.** Based on the data that is collected during the start-up and prove-out periods, TtEC may decide to reduce the frequency of sampling and analyses for the influent process water and some of the intermediate process streams. Only the process effluent streams will be sampled for regulatory compliance purposes for the parameters identified by NYSDEC, and the disposal facilities at the designated frequency. All analytical parameters for regulatory compliance (including pH for effluent water to the stormwater manhole and the injection well IW-1) will be collected weekly and analyzed at a laboratory certified by the State of New York for these parameters. Samples for regulatory compliance will be grab samples collected to assure that the sample is maintained at 4^{o}C during the collection period.

Table 4-3 Sampling and Monitoring during the Prove-out Period

Process Stream	**Sampling/Monitoring Location**	**Analytical Parameters**	**Required for Regulatory Compliance**
Influent from RW-1	Sample port (BV-103)	Chlorinated VOCs, mercury and pH	No
Influent from RW-3	Sample port (BV-104)	Chlorinated VOCs, mercury and pH	No
Air Stripper Effluent	Sample port (BV-115)	Chlorinated VOCs, mercury, TSS and pH	No
Bag Filter Effluent	Sample port (BV-124)	Chlorinated VOCs, mercury, TSS and pH	No
Treated Effluent to stormwater manhole and injection well IW-1	Sample port (BV-127)	Chlorinated VOCs, mercury, and pH	Yes
LGAC-1 outlet (for series flow)	Sample port (BV-145)	Chlorinated VOCs, mercury, and pH	No
LGAC-2 outlet (for series flow)	Sample port (BV-149)	Chlorinated VOCs, mercury, and pH	No
LGAC-3 outlet (for series flow)	Sample port (BV-153)	Chlorinated VOCs, mercury, and pH	No
Off-gas VGAC-1 Inlet	Sample port (BV-132)	Chlorinated VOCs	No
Off-gas between VGAC-1 and VGAC-2	Sample port (BV-134)	Chlorinated VOCs	No
Process Stream	**Sampling/Monitoring Location**	**Analytical Parameters**	**Required for Regulatory Compliance**
Off-gas between VGAC-2 and VGAC-3	Sample port (BV-136)	Chlorinated VOCs	No

Off-gas between VGAC-3 and Exhaust Stack	Sample port (BV-139)	Chlorinated VOCs	Yes
Spent air stripper packing /filter / adsorber media	Composite sample	TCLP VOCs and TCLP metals	Yes

Sampling Locations and Methods and SOP Requirements are identified in SAP Worksheet #18. Analytical SOP Requirements are detailed in SAP Worksheet #19. Field Quality Control Samples are summarized in SAP Worksheet #20. Project Sampling SOPs are referenced in SAP Worksheet #21. Analytical SOPs are referenced in SAP Worksheet #23. Collection of process aqueous samples is described in SOP001 and collection of process vapor samples is described in SOP002 in the SAP and these SOPs are also included in Appendix A of this OM&M Plan.

4.3.1.4 Sampling and Monitoring of Groundwater in GM-38 Area

Sampling and monitoring of the groundwater from the 14 existing and proposed monitoring wells will be performed throughout the period of operation of the GWTP and for two years beyond the shut-down of GWTP operations to determine the effectiveness of the remediation activities and monitor the hydraulic containment and capture of the groundwater "hot spot" by the recovery wells. The depths of the screened intervals and location of these wells were described in Section 1.6. **Water level measurements will be performed in all 14 monitoring wells on a quarterly basis. In addition, samples for water quality monitoring will be collected from nine of the 14 wells on a quarterly basis for the first two years from the start of GWTP operations, on a semi-annual basis for years three and four, and then on an annual basis from the fifth year onwards.** It is not necessary to collect samples from all 14 wells because some of them are in close proximity and are therefore expected to have the same water quality. The final determination to take the GWTP off-line will be made by the Navy in consultation with NYSDEC. When concentrations of chlorinated VOCs in the GM-38 Area groundwater "hot spot" are equal to those concentrations in the surrounding aquifer, TtEC will make the recommendation to the Navy that operations at the GWTP be terminated. **With consent from the Navy and NYSDEC, sampling and monitoring of the groundwater quality for the same parameters will continue for two years (on a quarterly basis) beyond the shut-down of the GWTP** operations. Please refer to Section 4.5 for a further discussion of the exit strategy. Table 4-4 presents the list of wells that will be sampled for water quality monitoring.

Table 4-4 Sampling and Monitoring of Groundwater Monitoring Wells

Sampling/Monitoring Location	Analytical Parameters	Required for Regulatory Compliance
RW-1 MW-1	Target Compound List (TCL) VOCs, mercury, TSS, and pH	No
RW-1 MW-3	TCL VOCs, mercury, TSS, and pH	No
RW-2 MW-1	TCL VOCs, mercury, TSS, and pH	No
RW-3 MW-1	TCL VOCs, mercury, TSS, and pH	No
RW-3 MW-2	TCL VOCs, mercury, TSS, and pH	No
RW-3 MW-3	TCL VOCs, mercury, TSS, and pH	No
RW-3 MW-4	TCL VOCs, mercury, TSS, and pH	No
GM-38D	TCL VOCs, mercury, TSS, and pH	No
GM-38D2	TCL VOCs, mercury, TSS, and pH	No

Sampling Locations and Methods and SOP Requirements are identified in SAP Worksheet #18. Analytical SOP Requirements are detailed in SAP Worksheet #19. Field Quality Control Samples are summarized in SAP Worksheet #20. Project Sampling SOPs are referenced in SAP Worksheet #21. Analytical SOPs are referenced in SAP Worksheet #23. Sampling of monitoring wells is described in the SAP.

4.3.2 Quality Control Sample Requirements

QC samples are analyzed for the purpose of assessing the quality of the sampling effort and of the analytical data. QC samples include field QC samples and laboratory QC samples. Field QC samples are described in the SAP and include environmental field duplicate samples, trip blanks, equipment rinsate blanks, and cooler temperature blanks. Laboratory QC samples include method blanks, matrix spike/matrix spike duplicates, surrogate compounds, internal standards, laboratory control samples, and laboratory duplicate samples. The general information and guidance regarding the different types of field QC samples is provided below. Similar information for laboratory QC samples including their definitions and frequency of collection is provided in the SAP. Field QC samples and their acceptance criteria are summarized in SAP Worksheet #20. A summary of QC procedures, frequencies, criteria, and corrective actions for the laboratory QC samples, as determined by the applicable guidelines is provided in SAP Worksheet #28.

4.3.2.1 Environmental Field Duplicate Samples

Field duplicates are used to monitor the precision of the field sampling procedures and the variability of sample data. Aqueous field duplicates are field split samples collected by mixing enough process water volume for two samples. Field duplicates will typically be collected and analyzed at a frequency of 1 for every 20 samples (approximately 5 percent); exceptions to this rate are noted on SAP Worksheet #20.

Field duplicates will only be collected for the Effluent Water that is analyzed for regulatory purposes. Field duplicates will be analyzed for the same parameters, as applicable, as the original samples.

4.3.2.2 Trip Blanks

A trip blank serves to detect possible cross-contamination of samples resulting from handling, storage and shipment procedures. Trip blanks consist of volatile organic analysis (VOA) vials filled with deionized (DI) water prior to initiation of daily field activities and preserved accordingly, which accompany the day's environmental samples through collection and shipment to the laboratory. In addition, trip blanks are stored by the laboratory under the same conditions as the environmental samples. A trip blank must accompany each cooler containing aqueous samples for VOC analysis, and will be analyzed identically to the associated environmental samples. All aqueous VOC samples will be consolidated in one cooler for daily shipment, as possible, to minimize the number of trip blanks required.

4.3.2.3 Equipment Rinsate Blanks

Equipment rinsate blanks are used to monitor cleanliness of the sampling equipment and the effectiveness of the decontamination procedures. Dedicated sampling equipment will be used during the project to the extent possible, reducing the need and frequency of equipment rinsate blanks. As required, equipment rinsate blanks will be collected once per week (assuming 5-day work week) and sent to the off-site laboratory for analysis of the same parameters (chemical only) as the original samples.

4.3.2.4 Cooler Temperature Blanks

Temperature blanks are used to monitor the receipt temperature of the samples upon arrival at the analytical laboratory. Temperature blanks will consist of an unpreserved 40-milliliter glass or plastic vial filled with tap water. A temperature blank must be included in each sample container sent to an analytical laboratory. However, New York regulations include provisions for omitting sample receipt temperature at the laboratory if the samples are received on ice.

4.3.3 Equipment Decontamination Procedures

For this sampling and analysis program, both disposable and non-disposable sampling equipment may be used. All non-disposable sampling equipment will be decontaminated prior to collecting each sample. The following sequence will be used:

- Remove all visible contaminants using laboratory detergent and potable water.
- Rinse with potable water.
- Rinse with deionized water.
- Rinse organic sampling equipment with methanol. For inorganic sampling equipment, rinse with 9.9% nitric acid in water. Then rinse with deionized water again.

Decontamination fluids generated will be collected and stored on site for later disposal as specified in the Final Waste Management Plan for Construction Tasks (TtEC, May 8, 2006).

4.3.4 Sample Identification, Documentation, Chain of Custody, Packaging, and Shipping

Identification, documentation and strict custody of samples are important for ensuring the integrity of the environmental samples and maintaining data quality. The subsections below and SAP Worksheets #26 and #27 address sample identification, packaging, shipping, and documentation.

4.3.4.1 Sample Identification and Labeling

Samples collected from the GWTP will be uniquely identified. Each sample will be denoted with an identification code as to the process stream (i.e., the location of sampling and type of material being sampled). These codes are outlined in the table below. The date of the sampling (e.g., "011609") will then be added to the identification to segregate different process sampling events. If required, further differentiation may be added (such as "01" and "02" if sampled twice during the same day).

Process Stream / Monitoring Well	Location/Material Code
Influent from RW-1	RW1
Influent from RW-3	RW3
Air Stripper Effluent	ASE
Bag Filter Effluent	BFE
Treated Effluent to stormwater manhole and injection well IW-1	TE
LGAC-1 outlet (for series flow)	LC1
LGAC-2 outlet (for series flow)	LC2
LGAC-3 outlet (for series flow)	LC3
Off-gas VGAC-1 Inlet	VC11
Off-gas between VGAC-1 and VGAC-2	VC12
Off-gas between VGAC-2 and VGAC-3	VC23
Off-gas between VGAC-3 and Exhaust Stack	ES
Monitoring Well	Use well ID

For example, the bag filter effluent sample collected on July 14, 2009 would be denoted as "BFE-071409." If two samples of the treated effluent water were obtained on August 17, 2009, then the first sample would be "TE-081709-01" and the second would be "TE-081709-02."

Sample labels will be completed by field personnel. Labels will include the project identification, sample identification, date and time of sampling, sampler, analyses to be performed on the specific sample bottle, type of sample (grab or composite) and preservative (if applicable). Each sample label will be filled out completely with indelible ink.

4.3.4.2 Sample Documentation

The sampling team or any individual performing a particular field investigation activity will be required to maintain a field logbook. Each logbook will be controlled and assigned a unique sequential identification by the Field Team Lead (e.g., the second logbook devoted to the GWTP sampling activities may be designated "GWTP Sampling Logbook No. 2"). In addition, a list of field logbooks will be maintained by the Field Team Lead, and will include the name of the logbook, purpose, person to whom assigned (i.e., name of task lead), date assigned, and date returned to the Field Team Lead.

The field logbook will be a bound weatherproof notebook, and entries to the logbook must be filled out legibly in black waterproof ink. Pertinent information to be recorded in field logbooks includes all information that is necessary to reconstruct the sampling operations. Documentation of sample activities in the field logbook will be completed immediately after sampling at the location of sample collection. Logbook entries will contain all sample information, including sample number, collection time, location, descriptions, field measurements, and other site- or sample-specific observations. Any additional information, such as generated instrument output, will be attached into the field logbook with clear tape in the order of generation or will be filed in a specific folder for inclusion with project files.

Logbook pages (for both the master site logbook and the field logbooks) will have the name of the Site and a description of the location/activity discussed, as well as the calendar date, written on the top of each page. Logbook pages will be consecutively numbered, and upon entry of data, the logbook pages require the date and the signature of the responsible project team member at the bottom of each page. Corrections to the logbooks will consist of a single strike line through the incorrect entry, the new accurate information, the initials of the corrector, and the date of amendment. Any blank spaces/pages in the logbooks will be crossed out with a single strike mark and signed by the person making the notation.

4.3.4.3 Sample Chain of Custody

Sample custody must be strictly maintained and carefully documented each time the sample material is collected, transported, received, prepared, and analyzed. Custody procedures are necessary to ensure the integrity of the samples, and samples collected during the field investigation must be traceable from the time the samples are collected until they are disposed of and/or stored, and their derived data are used in the final report.

A sample is considered under custody if it is/was:

- In a sampler's possession;
- In a sampler's view after being in his/her possession;
- In a sampler's possession and locked up in a secured container; or
- In a designated secure area.

Personnel collecting samples are responsible for the care and integrity of those samples until they are properly transferred or dispatched. Therefore, the number of people handling a sample will be kept to a minimum.

Chain of Custody (COC) records will be completed by the sampler and shall accompany the samples at all times. The following information shall be indicated on the COC record:

- Project identification;
- Signature of samplers;
- Sample identification, sample matrix, date and time of collection, grab or composite sample designation, number of containers corresponding to that sample identification, analyses required, remarks or sample location (if applicable), and preservation method(s);
- Signature of the individual relinquishing the samples; and
- Name of the individual(s) receiving the samples and air bill number, if applicable.

The COC preparer will then check the sample label and COC record for accuracy and completeness.

4.3.4.4 *Sample Tracking*

When transferring custody of samples, individuals relinquishing custody and individuals receiving custody will sign, date, and record the time on the COC. When samples are being shipped to the laboratory via courier, the COC record will be signed as "receiver" by the courier when he/she accepts possession of the samples, and a signed copy will be retained by the TtEC Team. For samples transported by an overnight shipping company (e.g.,Federal Express), the shipping company will be indicated as receiving custody. Upon receipt of shipment at the laboratory, a designated sample custodian will accept custody of the samples and verify that information on the sample labels matches the COC record. Pertinent information on shipment, air bill number, pickup, courier, date, and time will be recorded on the COC. It is then the laboratory's responsibility to maintain logbooks and custody records throughout sample preparation and analysis.

4.3.4.5 *Sample Packaging and Shipping*

Samples for off-site laboratory analysis will be shipped via Federal Express or by courier for overnight delivery in waterproof coolers using the procedures outlined below. The samples taken for this project shall be considered low-level or environmental samples for packaging and shipping purposes. Prior to packing and shipping, as applicable, samples will be stored on ice. The sample packing procedures are as follows:

- After filling out the pertinent information on the sample label, if necessary cover the label with clear tape.
- Place about 3 inches of inert cushioning material, such as bubble wrap, in the bottom of the cooler.
- Place containers upright in the cooler in such a way that they will not touch during shipment.
- Put in additional inert packing material to partially cover the sample containers (more than halfway).
- Place ice, when necessary, sealed in plastic bags, around and on top of the containers. As applicable to specific analyses (outlined in Worksheet #19 of the SAP), the temperature of the samples shall be maintained at or below 4 °C during shipment to the laboratory. The addition of ice will not be necessary for those parameters that do not require cooling as a preservation technique
- Fill cooler with cushioning material.
- Tape the drain on the cooler shut.

If the samples are sent directly via courier service from the Site to a local laboratory certified by the State of New York, the COC record will not be placed inside the cooler. The sample cooler(s) will be secured, with signed and dated custody seals affixed over the lid opening in at least two locations, and the cooler wrapped with strapping tape (without obscuring the custody seals). Orientation "this end up" arrows will be drawn or attached on two sides of the cooler. The COC record will be signed by the receiver (e.g., the courier, the laboratory sample custodian) when he/she accepts possession of the samples, and a signed copy will be retained by the TtEC Team.

For samples being shipped by an overnight delivery service to a laboratory certified by the State ofNew York, the COC record will be placed in a waterproof plastic bag and taped with masking tape to the inside lid of the cooler. The cooler lid will be secured with strapping/shipping tape (wrap the cooler completely with tape at a minimum of two locations), and a completed shipping label will be attached to the top of the cooler. Orientation "this end up" arrows will be drawn or attached on two sides of the cooler. Two signed and dated custody seals will be placed on opposite corners of the cooler so that the cooler cannot be opened without breaking the seals.

4.4 Laboratory Analytical Procedures and Requirements

4.4.1 Analytical Procedures

As stated previously, samples will be analyzed in strict accordance with the analytical test methods and procedures utilizing approved USEPA and NYSDEC Analytical Services Protocol methods. The anticipated number of samples, analytical methods, and number of QC samples are identified in Section 4.3.1 and the SAP Worksheets identified above.

Analytical methods selected for the Site will provide results with detection limits sufficiently below designated action levels, and the methods will be accurate enough to quantify contamination at concentrations below action levels.

4.4.2 Laboratory Reporting Requirements

Laboratory reports will include a full data package in order to support QA/QC review. Reporting requirements will include, but are not limited to the following:

- The name, address, and phone number of the analytical laboratory.
- Signature of an authorized laboratory individual, indicating the acceptability of the data.
- A copy of signed chain of custody forms, indicating the condition of samples at the time of receipt by the laboratory.
- Sample results reported in units of g or mg per liter or kg. Results will be reported on a dry weight basis and will include correction for dilution/concentration factors.
- Sample results will include a summary of pertinent chain of custody and tracking information (i.e., dates of preparation and analysis, analytical instrumentation, calibration information, associated QC samples, etc.). Other raw data including chromatograms must be on file at the laboratory and available for review upon request.
- Quality control results reported are to include spiking concentrations and acceptable limits. QC results that exceeded criteria and corrective actions should be discussed by the laboratory.

4.4.3 Data Review

All data will be reviewed by laboratory QC personnel prior to submittal to TtEC. In addition, the TtEC chemistry staff will perform a review of QA/QC data for all sample analysis results. After these reviews, the data will be provided to the TtEC personnel who are responsible for monitoring the performance of the GWTP operation. They will utilize the analytical results to verify that the plant is operating in the normal expected range of operation for each variable reported.

The review will include the following:

- Review of chain-of-custody and sample receipt documents to verify sample identities.
- Review of sample log-in documents to verify any potential problems with sample custody, integrity, preservation, labeling, etc.
- Review of field blank data to ascertain any problems with container or preservative contamination, or field contamination.

- Review of method blank data to determine the presence and approximate concentration of sources of contamination in the analytical process.
- Review of matrix spike data as a measure of matrix effects and analytical precision.
- Review of field and laboratory duplicate data as a measure of sampling technique applicability, homogeneity, and analytical precision.
- Review of standard reference material or laboratory control sample data as a measure of analytical accuracy. Data will be compared to the certified acceptable ranges of analytical values.
- Review of sample dates, extraction/digestion dates, and analysis dates to determine whether maximum holding times were met or exceeded.

Where appropriate, data qualifiers will be incorporated into certain data summary tables generated for this project. A brief summary of the data QA/QC review will be included in the final report.

4.5 Exit Strategy

As stated in the Navy's ROD, the purpose of the groundwater treatment system is to "Eliminate, to the extent practical, site-related contaminants from the affected public water supplies and to prevent, to the extent practical, the future contamination of public water supplies through the implementation of the offsite groundwater remediation." The treatment system has been designed for a 5 to 10 year operational life. It is not intended to remediate groundwater contamination in the local aquifer to non-detectable levels. Rather, the intent of the system is to remove mass, reduce elevated VOC levels to levels similar to those in the surrounding aquifer, and in doing so will minimize the impacts on water supply wells and currently unaffected portions of the aquifer. The final determination to take the GWTP off-line will be made by the Navy in consultation with NYSDEC. When concentrations of chlorinated VOCs in the GM-38 Area groundwater "hot spot" are equal to those concentrations in the surrounding aquifer, TtEC will make the recommendation to the Navy that operations at the GWTP be terminated. With consent from the Navy and NYSDEC, sampling and monitoring of the groundwater quality for the same parameters will continue for two years (on a quarterly basis) beyond the shut-down of the GWTP operations. If the results of this monitoring continue to show that concentrations of chlorinated VOCs in the GM-38 Area groundwater "hot spot" are equal to the background concentrations in the surrounding aquifer, TtEC will make the recommendation to the Navy that the GWTP building and all associated equipment and wells be decommissioned and dismantled. The final determination to decommission and dismantle the GWTP and associated wells will be made by the Navy in consultation with NYSDEC.

5.0 HEALTH AND SAFETY

5.1 Introduction

All activities performed at the GWTP are governed by the Site-Specific Health and Safety Plan for Construction Tasks (SHSP). The SHSP presents procedures to be followed by TtEC and its subcontractors (including ECOR Solutions Inc.) and all other on-site personnel in order to avoid and, if necessary, protect against health and/or safety hazards. The SHSP is designed to protect on-site personnel and area residents from physical, chemical, and all other hazards posed by construction, operation, maintenance, and monitoring activities conducted at the Site. The SHSP takes into account the hazards inherent to the planned activities. In addition, Section 12.0 of the SHSP includes the Emergency Response and Contingency Plan. The SHSP will comply with applicable parts of Occupational Safety and Health Administration (OSHA) Regulations, primarily 29 CFR Parts 1910 and 1926, and TtEC's Environmental Health and Safety (EHS) Program. Many programs from the EHS Program are referenced in the SHSP and are included in the appendices. Modifications to the SHSP may be made with the approval of the Project Environmental and Safety Manager (PESM) for this project using the Change Request Form found in Appendix A of the SHSP.

5.2 Summary of Major Risks

- Work near power transmission lines.
- Heavy equipment hazards.
- Slips, Trips, and Falls.
- Exposure to chlorinated VOCs and other VOCs (including vinyl chloride and benzene).
- Rotating machinery
- Electrical hazards
- Pressurized air and process water pipelines and process equipment
- Handling of chemicals (see Appendix A for sodium hydroxide MSDS)
- Handling of motor oils and greases for pump motors and mixers (see Appendix A for MSDS)

5.3 Zero Incident Performance

Zero Incident Performance (ZIP) describes TtEC's approach and expectations for both safety and project execution. TtEC will achieve this level of performance excellence through teamwork and partnering with our client and our Subcontractors, and through the participation of every person on this project.

We (TtEC and our client) believe that:

- All incidents are preventable through proper planning, tasking, and execution of plans as written.
- Any goal besides *Zero Incident Performance* is unacceptable and sends the message that incidents cannot be prevented and that losses are tolerated. Incidents are defined as OSHA recordables, property damage cases, fires, explosions, spills or releases to the environment and safety-related work stoppages. In addition, an incident includes an event which could have resulted in one of these outcomes had the circumstances been different ("near miss").
- Active participation by all personnel is required to achieve *Zero Incident Performance*. This includes TtEC, the client, and all Subcontractor personnel.
- Each person on this project is individually responsible and accountable for their safety performance.
- If any incident does occur, it must be reported and investigated to identify root causes, take corrective actions, and communicate the lessons learned.

All TtEC and subcontractor personnel will sign a *ZIP* pledge poster affirming their belief in and commitment to *ZIP*. The *ZIP* Banner will be posted conspicuously at the project site and the hours worked without a loss time incident will also be posted. The TtEC SHSO will continually evaluate planning and project execution to ensure that *ZIP* is embedded in the work process. In addition, awareness programs are utilized to assist in implementation of TtEC's *ZIP* initiative.

A subcontractor, after award of a contract, shall be required to attend a pre-construction Health and Safety Orientation meeting. This meeting will involve the subcontractor's key personnel, and will cover such items as *ZIP* expectations and the Employee Participation Program (EPP).

5.4 Activity Hazard Analyses

The Activity Hazard Analysis (AHA) is a systematic way of identifying the potential health and safety hazards associated with major phases of work on the project and the methods to avoid, control and mitigate those hazards. The AHAs follow the guidance of the TtEC Corporate Program EHS 3-5. AHAs are developed for all activities and will be used to train workers in proper safety procedures during phase preparatory meetings.

AHAs for 2009 and subsequent years' site activities are included in Appendix C of the SHSP. AHAs that are applicable to activities at the GWTP and adjacent areas include:

- General Site Hazards (chemical, biological, and physical hazards)
- Mobilization, Site Preparation and Demobilization
- Treatment Plant Building Construction
- Treatment Building Systems Installation
- Extraction System Construction
- Groundwater Injection System Installation
- Groundwater Treatment System Installation
- Site Restoration
- Treatment Plant Startup and Shakedown (includes chemical handling)
- New Groundwater Monitoring Wells Installation
- Off-site Waste Transportation and Disposal
- Sampling (Monitoring Wells and Process Streams)

5.5 Personal Protective Equipment

The personal protective equipment specified in Table 6-1 of the SHSP represents the initial level of PPE selection for each activity required by 29 CFR 1910.132. Specific information on the selection rationale for each activity can be found in the Activity Hazard Analyses. Personal protective equipment selection shall be made by the Site Health and Safety Officer (SHSO) and approved by the PESM. Additional tasks not included in Table 6-1 of the SHSP shall be reviewed by the SHSO and PESM.

Due to the nature of the activities it is not anticipated that upgrading to Level C or B will be required during the site activities. Level D or modified Level D is anticipated for all site work but the SHSO has the responsibility for monitoring site and work conditions and deciding the appropriate level of protection based on indications of potential exposure.

6.0 PROCESS DESCRIPTION AND OPERATION

The process descriptions for the NWIRP Bethpage GWTP, provide the written narrative which explains the individual system loops and their inter-relationship. They were used to program the CMCS by describing the setpoints and relationships between the process equipment and the instrumentation used for monitoring the water treatment process. The process loops are shown in Table 6-1 and the functional descriptions are provided in the following sections.

Table 6-1 Treatment Process Loops

SYSTEM No.	TITLE
1	Groundwater Recovery Wells
2	Equalization Tank
3	Air Stripper
4	Bag Filtration
5	Liquid-Phase Granular Activated Carbon
6	Chemical Feed System
7	Injection Well and Stormwater Manhole
8	Air Stripper Blower
9	Air Stream Heater
10	Vapor-Phase Granular Activated Carbon
11	Booster Blower
12	Rainfall Sensor
13	GWTP Sump

6.1 Process Loop # 1 – Groundwater Recovery Wells

This process loop corresponds to P&IDs P-3 and P-4. The major equipment for this process loop is listed in Section 6.1.1, the instrumentation and controls and the functional description are included in Section 6.1.2 and the process interlocks are listed in Section 6.1.3.

6.1.1 Major Equipment

Tag Number	Description
RW-1	Recovery Well RW-1
RW-3	Recovery Well RW-3
P-1	Recovery Well RW-1 Pump
P-2	Recovery Well RW-3 Pump
GV-101	Gate Valve on RW-1 Influent Line to Equalization Tank T-1
GV-102	Gate Valve on RW-3 Influent Line to Equalization Tank T-1
BV-101	Isolation Valve Pressure Gauge on RW-1 Influent Line
BV-102	Isolation Valve Pressure Gauge on RW-3 Influent Line
BV-103	Isolation Valve Sample Port on RW-1 Influent Line
BV-104	Isolation Valve Sample Port on RW-3 Influent Line

6.1.2 System Functional Description

The groundwater extraction system consists of two recovery wells RW-1 and RW-3. Each recovery well will be equipped with a submersible pump (P-1 in RW-1 and P-2 in RW-3) that has a variable speed drive (VSD) and will pump the groundwater to equalization tank T-1. The groundwater level in RW-1 will be monitored by level transmitter LT-101 and the groundwater level in RW-3 will be monitored by level transmitter LT-102. Level measurement signals will be indicated and transmitted to the PLC and displayed and recorded on the HMI screens. Based on pre-selected high and low level set points, the PLC will send signals to corresponding switches to start and stop the submersible well pumps, and the corresponding high and low level alarms will be displayed on the HMI screens. Each of the two well pumps will also be equipped with a speed indicator controller and a motor run indicator. The PLC will also send start-stop and speed control signals to the VSD and the corresponding speed and run indications will be displayed on the HMI screens. Speed indicator controllers SIC-P1 and SIC-P2 will control pumps P-1 and P-2 respectively to maintain the Operator selected speed.

Each of the two pumps will be equipped with Hand-Off-Auto selector switches, HOA-P1 and HOA-P2. In the Hand position, the pumps will be kept running and the normal start-stop interlocks will be by-passed. In the Off position, the pumps will be de-energized. In the Auto position, the pumps will be started automatically on high groundwater level LSH-101 (RW-1) and LSH-102 (RW-3), respectively and stopped automatically on low groundwater level LSL-101 (RW-1) and LSL-102 (RW-3), respectively. A low-low groundwater level in RW-1 will shut down pump P-1 and a corresponding low-low groundwater level in RW-3 will shut down pump P-2. These low-low levels will also generate alarm signals on the control panel. A high-high water level in the equalization tank T-1 or a low pH in the treated effluent discharge or a high pH in the treated effluent discharge or a fire alarm signal or a high rainfall signal will also shut down pumps P-1 and P-2.

The influent groundwater flow rate from RW-1 to the equalization tank T-1 will be measured by the magnetic flow meter FE-101, transmitted by FQIT-101 and the total flow from RW-1 will be recorded. Similarly, the influent groundwater flow rate from RW-3 to the equalization tank T-1 will be measured by the magnetic flow meter FE-102, transmitted by FQIT-102 and the total flow from RW-3 will be recorded. These flow rates will also be indicated and transmitted to the PLC and displayed and recorded on the HMI screens.

Instrumentation and controls associated with the Groundwater Recovery Wells Process Loop are summarized in the following table:

Control	Setpoint	Function
Level Transmitter LT-101		Transmits water level in Recovery Well RW-1
Level Indicator LI-101		Indicates water level in Recovery Well RW-1
Level Switch LSL-101		Indicates low level in Recovery Well RW-1
Level Switch LSLL-101		Indicates low-low level in Recovery Well RW-1
Level Alarm LALL-101		Alarms low-low level in Recovery Well RW-1
Level Switch LSH-101		Indicates high level in Recovery Well RW-1
Hand Switch HOA-P1	• HAND • OFF • AUTO	• Manual operation Pump P-1 running, normal start-stop interlocks bypassed • Pump P-1 de-energized • Pump P-1 starts automatically on high level LSH-101 and stops automatically on low level LSL-101
Run Indicator MI-P1		Indicates Pump P-1 is running
Speed Indicator Controller SIC-P1		Indicates and controls speed of Pump P-1
Level Transmitter LT-102		Transmits water level in Recovery Well RW-3
Level Indicator LI-102		Indicates water level in Recovery Well RW-3
Level Switch LSL-102		Indicates low level in Recovery Well RW-3
Level Switch LSLL-102		Indicates low-low level in Recovery Well RW-3

Control	Setpoint	Function
Level Alarm LALL-102		Alarms low-low level in Recovery Well RW-3
Level Switch LSH-102		Indicates high level in Recovery Well RW-3
Hand Switch HOA-P2	• HAND • OFF • AUTO	• Manual operation Pump P-2 running, normal start-stop interlocks bypassed • Pump P-2 de-energized • Pump P-2 starts automatically on high level LSH-102 and stops automatically on low level LSL-102
Run Indicator MI-P2		Indicates Pump P-2 is running
Speed Indicator Controller SIC-P2		Indicates and controls speed of Pump P-2
Pressure Indicator PI-101	0-60 psig	Indicates pressure in RW-1 Influent Line to Equalization Tank T-1
Flow Element-FE-101	0-1200 gpm	Measures groundwater flow rate from RW-1 to Equalization Tank T-1
Flow Quantity Indicator Transmitter FQIT-101	0-1200 gpm	Indicates and transmits total groundwater flow rate from RW-1 to Equalization Tank T-1
Pressure Indicator PI-102	0-60 psig	Indicates pressure in RW-3 Influent Line to Equalization Tank T-1
Flow Element-FE-102	0-500 gpm	Measures groundwater flow rate from RW-3 to Equalization Tank T-1
Flow Quantity Indicator Transmitter FQIT-102	0-500 gpm	Indicates and transmits total groundwater flow rate from RW-3 to Equalization Tank T-1

6.1.3 Interlock Summary

Signal	Interlock	Result
Low-low groundwater water level in RW-1	I-101	De-energizes Pump P-1
Low-low groundwater water level in RW-3	I-102	De-energizes Pump P-2
High-high groundwater level in Equalization Tank T-1		De-energizes Pumps P-1 and P-2
Fire alarm signal		De-energizes Pumps P-1 and P-2
Treated effluent discharge low pH (ASL-102)		De-energizes Pumps P-1 and P-2
Treated effluent discharge high pH (ASH-102)		De-energizes Pumps P-1 and P-2
Rainfall Sensor RT-101 heavy rainfall		De-energizes Pumps P-1 and P-2

6.2 Process Loop #2 – Equalization Tank

This process loop corresponds to P&ID P-4. The major equipment for this process loop is listed in Section 6.2.1, the instrumentation and controls and the functional description are included in Section 6.2.2 and the process interlocks are listed in Section 6.2.3.

6.2.1 Major Equipment

Tag Number	Description
T-1	Equalization Tank
M-1	Equalization Tank Mixer/Agitator
P-3A	Air Stripper Feed Pump
P-3B	Air Stripper Feed Pump
GV-103	Gate Valve Equalization Tank Outlet
GV-104	Gate Valve Equalization Tank Drain
GV-105	Gate Valve Pump P-3A Inlet
GV-106	Gate Valve Pump P-3B Inlet
GV-107	Gate Valve Pump P-3A Outlet
GV-108	Gate Valve Pump P-3B Outlet
BV-105	Isolation Valve Pressure Gauge Pump P-3A Inlet
BV-106	Isolation Valve Pressure Gauge Pump P-3B Inlet
BV-107	Isolation Valve Pressure Gauge Pump P-3A Outlet
BV-108	Isolation Valve Pressure Gauge Pump P-3B Outlet
CV-101	Check Valve Pump P-3A Outlet
CV-102	Check Valve Pump P-3B Outlet
PRV-101	Pressure Relief Valve Pump P-3A Outlet
PRV-102	Pressure Relief Valve Pump P-3B Outlet

6.2.2 System Functional Description

Equalization tank T-1 will receive groundwater from recovery wells RW-1 and RW-3. It will also receive recycled treated water from the air stripper clear well sump and the effluent from the liquid phase granulated activated carbon adsorbers. Water from the GWTP sump and the air stripper containment sump will also be pumped to tank T-1. Water from all of these streams will be mixed by mixer/agitator M-1 so that any solid particles that may be present will remain in suspension and be prevented from settling to the bottom of tank T-1. From the equalization tank, the water will be pumped to the air stripper by the air stripper feed pumps P-3A and P-3B. Only one of these two pumps will be operating at any given time, the second one will serve as a spare. Mixer M-1 will be equipped with a Hand-Off-Auto selector switch, HOA-M1. In the Hand position, the mixer will be kept running and the normal start-stop interlocks will be by-passed. In the Off position, the mixer will be de-energized. In the Auto position, the mixer will be started automatically. The mixer will shut down automatically on any one of the following conditions: A low-low water level in the equalization tank T-1 or a low pH in the treated effluent discharge or a high pH in the treated effluent discharge or a fire alarm signal or a high rainfall signal. Mixer M-1 will also be equipped with a motor run indicator. The PLC will also send start-stop signals to the mixer motor and the corresponding run indication will be displayed on the HMI screen.

The pH of the water in the equalization tank T-1 will be measured by AE-101 and transmitted by AIT-101. The pH signals including high and low pH alarms will be indicated and displayed on the PLC/HMI screen. The water level in tank T-1 will be measured by LE-103 and transmitted by LIT-103. Tank T-1 will also be equipped with a hard wired high-high limit switch LSHH-103 which will alarm at the HMI and shut down well pumps P-1 and P-2. The water flow rate from equalization tank T-1 to the air stripper AS-1 will be measured by the magnetic flow meter FE-103, transmitted by FQIT-103 and the total flow from T-1 to AS-1 will be recorded. Flow indicator controller FIC-103 will control the flow of the water to the air stripper at the Operator selected flow rate.

Each of the two air stripper feed pumps P-3A and P-3B will be equipped with a VSD, a speed indicator controller and a motor run indicator. The two pumps will be equipped with Hand-Off-Auto selector switches, HOA-P3A and HOA-P3B. In the Hand position, the pumps will be kept running and the normal start-stop interlocks will be by-passed. In the Off position, the pumps will be de-energized. In the Auto position, the pumps will be started automatically on high water level LSH-103 and stopped automatically on low water level LSL-103. The PLC will also send start-stop and speed control signals to the VSD and the corresponding speed and run indications will be displayed on the HMI screens. Speed indicator controllers SIC-P3A and SIC-P3B will control the speed of pumps P-3A and P-3B, respectively to maintain the Operator selected flow rate based on signals from FIC-103.

A low-low water level or a high-high water level in T-1 will generate alarm signals on the control panel. A high-high water level in the air stripper sump or a low pH in the treated effluent discharge or a high pH in the treated effluent discharge or blower B-1 shutdown or booster blower B-2 shut down or a fire alarm signal or a high rainfall signal will also shut down pumps P-3A and P-3B.

Instrumentation and controls associated with the Equalization Tank Process Loop are summarized in the following table:

Control	Setpoint	Function
Level Switch LSHH-101		Indicates high-high level in Equalization Tank T-1
pH Element AE-101	0-14 pH	Measures pH of water in Equalization Tank
pH Indicator Transmitter AIT-101	7 pH	Indicates and transmits pH of water in Equalization Tank
pH Alarm AAL-101	5.5 pH	Alarms low pH of water in Equalization Tank
pH Alarm AAH-101	8.5 pH	Alarms high pH of water in Equalization Tank
Level Element LE-103		Measures water level in Equalization Tank
Level Indicator Transmitter LIT-103		Indicates and transmits water level in Equalization Tank
Level Indicator Controller LIC-103		Indicates and controls water level in Equalization Tank
Level Switch LSL-103		Indicates low level in Equalization Tank
Level Switch LSLL-103		Indicates low-low level in Equalization Tank
Level Alarm LALL-103		Alarms low-low level in Equalization Tank
Level Switch LSH-103		Indicates high level in Equalization Tank
Level Switch LSHH-103		Indicates high-high level in Equalization Tank
Level Alarm LAHH-103		Alarms high-high level in Equalization Tank
Hand Switch HOA-M1	• HAND • OFF • AUTO	• Manual operation Mixer/Agitator M-1 running, normal start-stop interlocks bypassed • Mixer/Agitator M-1 de-energized • Mixer/Agitator M-1 starts automatically above low-low level LSLL-103 and stops automatically on low-low level LSLL-103
Run Indicator MI-M1		Indicates Mixer/Agitator M-1 is running
Pressure Indicator PI-105A	0-60 psig	Indicates pressure in Pump P-3A inlet
Pressure Indicator PI-105B	0-60 psig	Indicates pressure in Pump P-3A outlet
Pressure Indicator PI-106A	0-60 psig	Indicates pressure in Pump P-3B inlet
Pressure Indicator PI-106B	0-60 psig	Indicates pressure in Pump P-3B outlet

Control	Setpoint	Function
Hand Switch HOA-P3A	• HAND • OFF • AUTO	• Manual operation Pump P-3A running, normal start-stop interlocks bypassed • Pump P-3A de-energized • Pump P-3A starts automatically on high level LSH-103 and stops automatically on low level LSL-103
Run Indicator MI-P3A		Indicates Pump P-3A is running
Speed Indicator Controller SIC-P3A		Indicates and controls speed of Pump P-3A based on FIC-103
Hand Switch HOA-P3B	• HAND • OFF • AUTO	• Manual operation Pump P-3B running, normal start-stop interlocks bypassed • Pump P-3B de-energized • Pump P-3B starts automatically on high level LSH-103 and stops automatically on low level LSL-103
Run Indicator MI-P3B		Indicates Pump P-3B is running
Speed Indicator Controller SIC-P3B		Indicates and controls speed of Pump P-3B based on FIC-103
Flow Element FE-103	0-1500 gpm	Measures flow rate of groundwater from Equalization Tank T-1 to Air Stripper AS-1
Flow Quantity Indicator Transmitter FQIT-103	0-1500 gpm	Indicates and transmits total groundwater flow rate from Equalization Tank T-1 to Air Stripper AS-1
Flow Indicator Controller FIC-103		Indicates and controls groundwater flow rate from Equalization Tank T-1 to Air Stripper AS-1

6.2.3 Interlock Summary

Signal	Interlock	Result
Low-low water level in Equalization Tank T-1		De-energizes Mixer/Agitator M-1
Fire alarm signal		De-energizes Mixer/Agitator M-1, Pumps P-3A and P-3B
Treated effluent discharge low pH (ASL-102)		De-energizes Mixer/Agitator M-1, Pumps P-3A and P-3B
Treated effluent discharge high pH (ASH-102)		De-energizes Mixer/Agitator M-1, Pumps P-3A and P-3B
Rainfall Sensor RT-101 heavy rainfall		De-energizes Mixer/Agitator M-1, Pumps P-3A and P-3B
High-high groundwater level in Air Stripper Sump (LSHH-105)		De-energizes Pumps P-3A and P-3B
Blower B-1 Shutdown		De-energizes Pumps P-3A and P-3B
Blower B-2 Shutdown		De-energizes Pumps P-3A and P-3B

6.3 Process Loop #3 – Air Stripper

This process loop corresponds to P&ID P-5. The major equipment for this process loop is listed in Section 6.3.1, the instrumentation and controls and the functional description are included in Section 6.3.2 and the process interlocks are listed in Section 6.3.3.

6.3.1 Major Equipment

Tag Number	Description
AS-1	Air Stripper
P-4A	Liquid-phase Carbon Feed Pump
P-4B	Liquid-phase Carbon Feed Pump
P-7	Air Stripper Containment Sump Pump
GV-109	Gate Valve Pump P-4A Inlet
GV-110	Gate Valve Pump P-4B Inlet
GV-111	Gate Valve Pump P-4A Outlet
GV-112	Gate Valve Pump P-4B Outlet
GV-113	Gate Valve Recycle Line to Equalization Tank T-1
GV-114	Gate Valve Recycle Line from Air Stripper Feed
BV-111	Isolation Valve Pressure Gauge Pump P-4A Inlet
BV-112	Isolation Valve Pressure Gauge Pump P-4B Inlet
BV-113	Isolation Valve Pressure Gauge Pump P-4A Outlet
BV-114	Isolation Valve Pressure Gauge Pump P-4B Outlet
BV-115	Isolation Valve Sample Port on Feed Line to Bag Filters
CV-105	Check Valve Pump P-4A Outlet
CV-106	Check Valve Pump P-4B Outlet
CV-107	Check Valve Recycle Line to Equalization Tank T-1 from Feed Line to Bag Filters
PRV-105	Pressure Relief Valve Pump P-4A Outlet
PRV-106	Pressure Relief Valve Pump P-4B Outlet

6.3.2 System Functional Description

In the air stripper AS-1, an induced draft counter-current flow of air from blower B-1 will result in a mass transfer of VOCs that are present in the groundwater to the off-gas. The groundwater will pass through the packing material and be collected in the air stripper sump. The water level in the air stripper sump will be measured by LE-105 and transmitted by LIT-105. From the air stripper sump, liquid carbon feed pumps P-4A and P-4B will pump the treated water to the bag filters F-1A and F-1B. Only one of these two pumps will be operating at any given time, the second one will serve as a spare. Level indicator controller LIC-105 will control the water level in the air stripper sump at the Operator selected value. A portion of the treated water that is pumped to the bag filters from the air stripper sump will be re-circulated back to the equalization tank T-1. The flow rate of the water in the re-circulation line will be measured by the magnetic flow meter FE-106, transmitted by FQIT-106 and the total flow from AS-1 to T-1 will be recorded.

Each of the two liquid carbon feed pumps P-4A and P-4B will be equipped with a VSD, a speed indicator controller and a motor run indicator. The two pumps will be equipped with Hand-Off-Auto selector switches, HOA-P4A and HOA-P4B. In the Hand position, the pumps will be kept running and the normal start-stop interlocks will be by-passed. In the Off position, the pumps will be de-energized. In the Auto position, the pumps will be started automatically on high water level LSH-105 and stopped automatically on low water level LSL-105. The PLC will also send start-stop and speed control signals to the VSD and the corresponding speed and run indications will be displayed on the HMI screens. Speed indicator controllers SIC-P4A and SIC-P4B will control the speed of pumps P-4A and P-4B, respectively to maintain the Operator selected water level in the air stripper sump based on signals from LIC-105.

A low-low water level or a high-high water level in the air stripper sump will generate alarm signals on the control panel. A high-high water level in injection well IW-1 or a low pH in the treated effluent discharge or a high pH in the treated effluent discharge or blower B-1 shutdown or booster blower B-2 shut down or a fire alarm signal or a high rainfall signal will also shut down pumps P-4A and P-4B. The air stripper containment sump is equipped with pump P-7 which will be operated by a local tear drop float switch. The air stripper containment sump is also equipped with a level switch LSH-101. When a pre-determined high water level is reached, an alarm signal will be sent to the Operator.

Instrumentation and controls associated with the Air Stripper Process Loop are summarized in the following table:

Control	Setpoint	Function
LSH-101		Indicates high water level in air stripper containment sump
LAH-101		Alarms high level in air stripper containment sump
Level Element LE-105		Measures water level in Air Stripper Sump
Level Indicator Transmitter LIT-105		Indicates and transmits water level in Air Stripper Sump
Level Indicator Controller LIC-105		Indicates and controls water level in Air Stripper Sump
Level Switch LSL-105		Indicates low level in Air Stripper Sump
Level Switch LSLL-105		Indicates low-low level in Air Stripper Sump
Level Alarm LALL-105		Alarms low-low level in Air Stripper Sump
Level Switch LSH-105		Indicates high level in Air Stripper Sump
Level Switch LSHH-105		Indicates high-high level in Air Stripper Sump
Level Alarm LAHH-105		Alarms high-high level in Air Stripper Sump
Pressure Indicator PI-113A	0-60 psig	Indicates pressure in Pump P-4A inlet
Pressure Indicator PI-113B	0-60 psig	Indicates pressure in Pump P-4A outlet
Pressure Indicator PI-114A	0-60 psig	Indicates pressure in Pump P-4B inlet
Pressure Indicator PI-114B	0-60 psig	Indicates pressure in Pump P-4B outlet
Hand Switch HOA-P4A	• HAND • OFF • AUTO	• Manual operation Pump P-4A running, normal start-stop interlocks bypassed • Pump P-4A de-energized • Pump P-4A starts automatically on high level LSH-105 and stops automatically on low level LSL-105
Run Indicator MI-P4A		Indicates Pump P-4A is running
Speed Indicator Controller SIC-P4A		Indicates and controls speed of Pump P-4A based on LIC-105

Control	Setpoint	Function
Hand Switch HOA-P4B	• HAND • OFF • AUTO	• Manual operation Pump P-4B running, normal start-stop interlocks bypassed • Pump P-4B de-energized • Pump P-4B starts automatically on high level LSH-105 and stops automatically on low level LSL-105
Run Indicator MI-P4B		Indicates Pump P-4B is running
Speed Indicator Controller SIC-P4B		Indicates and controls speed of Pump P-4B based on LIC-105
Flow Element FE-106	0-150 gpm	Measures flow rate of groundwater in Recycle Line from Air Stripper AS-1 to Equalization Tank T-1
Flow Quantity Indicator Transmitter FQIT-106	0-150 gpm	Indicates and transmits total groundwater flow rate in Recycle Line from Air Stripper AS-1 to Equalization Tank T-1

6.3.3 Interlock Summary

Signal	Interlock	Result
High-high water level in Injection Well IW-1		De-energizes Pumps P-4A and P-4B
Fire alarm signal		De-energizes Pumps P-4A and P-4B
Treated effluent discharge low pH (ASL-102)		De-energizes Pumps P-4A and P-4B
Treated effluent discharge high pH (ASH-102)		De-energizes Pumps P-4A and P-4B
Rainfall Sensor RT-101 heavy rainfall		De-energizes Pumps P-4A and P-4B
Blower B-1 Shutdown		De-energizes Pumps P-4A and P-4B
Blower B-2 Shutdown		De-energizes Pumps P-4A and P-4B

6.4 Process Loop #4 – Bag Filtration

This process loop corresponds to P&ID P-6. The major equipment for this process loop is listed in Section 6.4.1, the instrumentation and controls and the functional description are included in Section 6.4.2 and the process interlocks are listed in Section 6.4.3.

6.4.1 Major Equipment

Tag Number	Description
F-1A	Bag Filter F-1A
F-1B	Bag Filter F-1B
BFV-103	Butterfly Valve Bag Filter F-1A Inlet
BFV-104	Butterfly Valve Bag Filter F-1B Inlet
BFV-105	Butterfly Valve Bag Filter F-1A Outlet
BFV-106	Butterfly Valve Bag Filter F-1B Outlet
BV-118	Isolation Valve Pressure Gauge Bag Filters Inlet

Tag Number	Description
BV-119	Isolation Valve Bag Filter F-1A Vent
BV-120	Isolation Valve Bag Filter F-1B Vent
BV-121	Isolation Valve Bag Filter F-1A Drain
BV-122	Isolation Valve Bag Filter F-1B Drain
BV-123	Isolation Valve Pressure Gauge Bag Filters Outlet
BV-124	Isolation Valve Sample Port on Feed Line to Liquid-phase Granular Activated Carbon Adsorbers
GV-115	Gate Valve on Feed Line to Liquid-phase Granular Activated Carbon Adsorbers

6.4.2 System Functional Description

Treated water from the air stripper sump will be pumped to the Multi-Bag Filter Vessels F-1A and F-1B which will be operated in parallel to remove fine suspended solid particles. Each multi-bag filter vessel will be equipped with manually operated butterfly valves on the inlet and outlet. The inlet and outlet pressures to and from both multi-bag filter vessels will be measured by pressure gauges. The differential pressure across both multi-bag filter vessels will also be measured and monitored continuously by differential pressure switch DPSH-117. When a pre-selected high differential pressure is reached an alarm signal will be sent to the PLC and displayed on the HMI screen.

Instrumentation and controls associated with the Bag Filtration Process Loop are summarized in the following table:

Control	Setpoint	Function
Differential Pressure Switch DPSH-117	10 psig	Indicates and transmits differential pressure across Bag Filters F-1A and F-1B
Differential Pressure Alarm DPAH-117	10 psig	Alarms high differential pressure across Bag Filters F-1A and F-1B
Pressure Indicator PI-117	0-60 psig	Indicates pressure on inlet to Bag Filters F-1A and F-1B
Pressure Indicator PI-118	0-60 psig	Indicates pressure on outlet from Bag Filters F-1A and F-1B

6.4.3 Interlock Summary

There are no interlocks for this process loop.

6.5 Process Loop #5 – Liquid-Phase Granular Activated Carbon

This process loop corresponds to P&ID P-6. The major equipment for this process loop is listed in Section 6.5.1, the instrumentation and controls and the functional description are included in Section 6.5.2 and the process interlocks are listed in Section 6.5.3.

6.5.1 Major Equipment

Tag Number	Description
LGAC-1	Liquid-phase Granular Activated Carbon Adsorber 1
LGAC-2	Liquid-phase Granular Activated Carbon Adsorber 2
LGAC-3	Liquid-phase Granular Activated Carbon Adsorber 3
V-1	Butterfly Valve Backwash Effluent LGAC-1
V-2	Butterfly Valve Backwash Effluent LGAC-2
V-3	Butterfly Valve Backwash Effluent LGAC-3
V-4	Butterfly Valve Backwash Influent LGAC-1
V-5	Butterfly Valve Backwash Influent LGAC-2
V-6	Butterfly Valve Backwash Influent LGAC-3
V-7	Butterfly Valve Treated Water Influent LGAC-1
V-8	Butterfly Valve Treated Water Influent LGAC-2
V-9	Butterfly Valve Treated Water Influent LGAC-3
V-10	Butterfly Valve Cross Over LGAC-1
V-11	Butterfly Valve Cross Over LGAC-2
V-12	Butterfly Valve Cross Over LGAC-3
V-13	Butterfly Valve Series Flow Isolation LGAC-1
V-14	Butterfly Valve Series Flow Isolation LGAC-2
V-15	Butterfly Valve Series Flow Isolation LGAC-3
V-16	Butterfly Valve Treated Water Efffluent LGAC-1
V-17	Butterfly Valve Treated Water Efffluent LGAC-2
V-18	Butterfly Valve Treated Water Efffluent LGAC-3
BV-125	Isolation Valve Pressure Gauge Liquid-phase Granular Activated Carbon Adsorbers Inlet
BV-126	Isolation Valve Pressure Gauge Liquid-phase Granular Activated Carbon Adsorbers Outlet
BV-142	Pipe Rack High Point Vent
BV-143	Pipe Rack Low Point Drain
BV-144	Isolation Valve Pressure Gauge LGAC-1 Outlet
BV-145	Isolation Valve Sample Port LGAC-1 Outlet
BV-146	Isolation Valve Pressure Gauge LGAC-1 Inlet
BV-147	Isolation Valve Sample Port LGAC-1 Inlet
BV-148	Isolation Valve Pressure Gauge LGAC-2 Outlet

Tag Number	Description
BV-149	Isolation Valve Sample Port LGAC-2 Outlet
BV-150	Isolation Valve Pressure Gauge LGAC-2 Inlet
BV-151	Isolation Valve Sample Port LGAC-2 Inlet
BV-152	Isolation Valve Pressure Gauge LGAC-3 Outlet
BV-153	Isolation Valve Sample Port LGAC-3 Outlet
BV-154	Isolation Valve Pressure Gauge LGAC-3 Inlet
BV-155	Isolation Valve Sample Port LGAC-3 Inlet
BV-156	Vent Valve LGAC-1
BV-157	Vent Valve LGAC-2
BV-158	Vent Valve LGAC-3
	Pressure Relief Rupture Disk LGAC-1
	Pressure Relief Rupture Disk LGAC-2
	Pressure Relief Rupture Disk LGAC-3
	Carbon Discharge Valve LGAC-1
	Carbon Discharge Valve LGAC-2
	Carbon Discharge Valve LGAC-3
CV-108	Check Valve on Recycle Line to Equalization Tank T-1 from Liquid-phase Granular Activated Carbon Adsorbers
GV-119	Gate Valve on Recycle Line to Equalization Tank T-1 from Liquid-phase Granular Activated Carbon Adsorbers

6.5.2 System Functional Description

From the multi-bag filters the treated water will be processed through the liquid-phase granular activated carbon unit. This unit consists of three vessels LGAC-1, LGAC-2, and LGAC-3 which are expected to be operated in parallel. However, this unit will also be equipped with a custom-designed piping rack such that any two vessels can also be operated in series or parallel while the third vessel is being backwashed. There are 18 manually operated butterfly valves (V-1 through V-18) on this piping rack. Table 2.1 in the manufacturer's O&M manual provided by TIGG Corporation shows the open/close positions of these butterfly valves for various series/parallel operating configurations. The inlet and outlet pressures to and from all three liquid-phase granular activated carbon vessels will be measured by pressure gauges. The differential pressure across all three liquid-phase granular activated carbon vessels will also be measured and monitored continuously by differential pressure switch DPSH-118. When a pre-selected high differential pressure is reached an alarm signal will be sent to the PLC and displayed on the HMI screen.

When any two carbon adsorbers are to be operated in series, one vessel will serve as the primary adsorber and the other one as the secondary or polishing adsorber. Each primary adsorber and each secondary adsorber will be equipped with inlet and outlet pressure gauges. When a high differential pressure alarm DPAH-118 is activated due to accumulation of fines, the Operator will have to manually backwash the carbon adsorbers following the steps described in the manufacturer's O&M manual supplied by TIGG Corporation. During the backwash cycle, municipal water from a hose connection will be used to backwash each carbon adsorber one by one, remove any accumulated fine solid particles, and send the fine solid particles to the GWTP sump. From the GWTP sump, this water will be pumped by any one of the GWTP sump pumps P-5A or P-5B to the equalization tank T-1. The second pump will serve as a spare. It is anticipated that initially, each carbon adsorber may be backwashed once weekly. Later, backwashing will be performed on an as-needed basis based on high differential pressure. The duration for backwashing any given carbon adsorber will be based on the total suspended solids concentration in the backwash outlet stream going to the GWTP sump.

Series operation allows the Operator to monitor for breakthrough of contaminants at the midpoint between the primary and secondary adsorbers. When breakthrough of the primary adsorber is detected, a change-out of the carbon in the primary adsorber will be initiated. Contaminants (VOCs) that break through the primary adsorber will be captured on the secondary adsorber instead of being discharged to the aquifer. The position of the valves on the two carbon adsorbers will then be changed such that secondary adsorber will become the primary adsorber and the adsorber with the newly replaced activated carbon will become the secondary adsorber. Other configurations are also possible as shown in Table 2.1 of the TIGG Corporation O&M manual.

Some or all of the treated effluent water from the carbon adsorbers can be re-circulated back to the equalization tank T-1. Under normal operating conditions the treated effluent water from the carbon adsorbers will undergo pH adjustment before being discharged to the injection wells or the stormwater manhole.

Instrumentation and controls associated with the Liquid-phase Granular Activated Carbon Process Loop are summarized in the following table:

Control	Setpoint	Function
Differential Pressure Switch DPSH-118	15 psig	Indicates and transmits differential pressure across Liquid-phase Granular Activated Carbon Adsorbers LGAC-1, LGAC-2, and LGAC-3
Differential Pressure Alarm DPAH-118	15 psig	Alarms high differential pressure across Liquid-phase Granular Activated Carbon Adsorbers LGAC-1, LGAC-2, and LGAC-3
Pressure Indicator PI-119	0-60 psig	Indicates pressure on inlet to Liquid-phase Granular Activated Carbon Adsorbers LGAC-1, LGAC-2, and LGAC-3
Pressure Indicator PI-120	0-60 psig	Indicates pressure on outlet from Liquid-phase Granular Activated Carbon Adsorbers LGAC-1, LGAC-2, and LGAC-3

6.5.3 Interlock Summary

There are no interlocks for this process loop.

6.6 Process Loop #6 –Chemical Feed System

This process loop corresponds to P&ID P-6. The major equipment for this process loop is listed in Section 6.6.1, the instrumentation and controls and the functional description are included in Section 6.6.2 and the process interlocks are listed in Section 6.6.3.

6.6.1 Major Equipment

Tag Number	Description
T-2	Sodium Hydroxide Tank
P-6A	Caustic Feed Pump
P-6B	Caustic Feed Pump

Tag Number	Description
M-2	In-line Static Mixer
GV-116	Gate Valve on inlet to In-line Static Mixer
PRV-103	Pressure Relief Valve Pump P-6A Outlet
PRV-104	Pressure Relief Valve Pump P-6B Outlet
	Air Release Valve
BV-127	Isolation Valve Sample Port on treated effluent line
BV-140	Isolation Valve High Pressure Switch PSH-101

6.6.2 System Functional Description

The chemical feed system consists of the sodium hydroxide tank T-2, two metering pumps P-6A and P-6B, and in-line static mixer M-2. The pH of the treated effluent water from the carbon adsorbers will be adjusted based on pH measurements made by AE-102 and controlled by pH controller AIC-102 downstream of mixer M-2. These measurements will be transmitted to the PLC and displayed on the HMI screen. Based on the current pH reading, AIC-102 will send a signal to the caustic feed pumps P-6A and P-6B in order to adjust the pump stroke and control the amount of sodium hydroxide addition. Only one of these two pumps will be operating at any given time, the second one will serve as a spare. Low level switch LSL-102 will monitor the level of sodium hydroxide in tank T-2 and it will send an alarm signal to the PLC/HMI. A low pH in the treated effluent discharge (ASL-102) or a high pH in the treated effluent discharge (ASH-102) will result in alarm signals being sent to the PLC and shut down of the GWTP. High pressure switch PSH-101 will continuously monitor the pressure in the treated effluent water discharge line. If there is a blockage or back pressure generated in the stormwater manhole or in injection well IW-1, it will generate a high pressure alarm condition that will be transmitted to the PLC and shut down the GWTP.

Instrumentation and controls associated with the Chemical Feed System Process Loop are summarized in the following table:

Control	Setpoint	Function
Level Switch LSL-102		Indicates low level in Sodium Hydroxide Tank
Level Alarm LAL-102		Alarms low level in Sodium Hydroxide Tank
Pressure Indicator PI-107		Indicates pressure in Pumps P-6A and P-6B discharge line
pH Element AE-102	0-14 pH	Measures pH of water in Treated Effluent Line
pH Indicator Controller AIC-102		Indicates and controls pH of water in Treated Effluent Line
Low pH Switch ASL-102	5.5 pH	Indicates low pH of water in Treated Effluent Line
Low pH Alarm AAL-102	5.5 pH	Alarms low pH of water in Treated Effluent Line
High pH Switch ASH-102	8.5 pH	Indicates high pH of water in Treated Effluent Line
High pH Alarm AAH-102	8.5 pH	Alarms high pH of water in Treated Effluent Line

Control	Setpoint	Function
High Pressure Switch PSH-101	20 psig	Indicates high pressure in Treated Effluent Line
High Pressure Alarm PAH-101	20 psig	Alarms high pressure in Treated Effluent Line

6.6.3 Interlock Summary

Signal	Interlock	Result
Treated effluent discharge low pH (ASL-102)		Plant shut-down
Treated effluent discharge high pH (ASH-102)		Plant shut-down
High Pressure in Treated Effluent Line (PSH-101)		Plant shut-down

6.7 Process Loop #7 – Injection Well and Stormwater Manhole

This process loop corresponds to P&ID P-6. The major equipment for this process loop is listed in Section 6.7.1, the instrumentation and controls and the functional description are included in Section 6.7.2 and the process interlocks are listed in Section 6.7.3.

6.7.1 Major Equipment

Tag Number	Description
IW-1	Injection Well
	Stormwater Manhole
GV-117	Gate Valve Treated Effluent Line to Injection well IW-1
GV-118	Gate Valve Treated Effluent Line to Stormwater Manhole
GV-120	Gate Valve inside Injection well IW-1 Vault
CV-109	Check Valve inside Injection well IW-1 Vault

6.7.2 System Functional Description

The treated groundwater discharge and re-injection system consists of the stormwater manhole (within the utility easement east of Broadway Avenue) leading to Nassau County Recharge Basin # 495 and injection well IW-1. It is anticipated that approximately 800 gpm will be discharged into the stormwater manhole and approximately 300 gpm will be re-injected into IW-1. The flow rate of the treated effluent water pumped to the stormwater manhole will be measured by the magnetic flow meter FE-108, transmitted by FQIT-108 and the total flow to Nassau County Recharge Basin # 495 will be recorded. Similarly, the flow rate of the treated effluent water pumped to injection well IW-1 will be measured by the magnetic flow meter FE-109, transmitted by FQIT-109 and the total flow to IW-1 will be recorded. The water level in injection well IW-1 will be measured by LE-106 and transmitted by LT-106 to the PLC and displayed on the HMI screen. A high-high water level in IW-1 will result in an alarm signal being sent to the PLC and shut down of the liquid carbon feed pumps P-4A and P-4B.

Instrumentation and controls associated with the Injection Well and Stormwater Manhole Process Loop are summarized in the following table:

Control	Setpoint	Function
Flow Element-FE-108	0-1500 gpm	Measures treated effluent flow rate to stormwater manhole
Flow Quantity Indicator Transmitter FQIT-108	0-1500 gpm	Indicates and transmits total treated effluent flow rate to stormwater manhole
Flow Element-FE-109	0-1500 gpm	Measures treated effluent flow rate to Injection well IW-1
Flow Quantity Indicator Transmitter FQIT-109	0-1500 gpm	Indicates and transmits total treated effluent flow rate to Injection Well IW-1
Level Element LE-106		Measures groundwater level in Injection Well IW-1
Level Transmitter LIT-106		Transmits groundwater level in Injection Well IW-1
Level Switch LSH-106		Indicates high groundwater level in Injection Well IW-1
Level Switch LSHH-106		Indicates high-high groundwater level in Injection Well IW-1
Level Switch LAHH-106		Alarms high-high groundwater level in Injection Well IW-1

6.7.3 Interlock Summary

Signal	Interlock	Result
High-high water level in Injection Well IW-1		De-energizes Pumps P-4A and P-4B

6.8 Process Loop #8 – Air Stripper Blower

This process loop corresponds to P&ID P-5. The major equipment for this process loop is listed in Section 6.8.1, the instrumentation and controls and the functional description are included in Section 6.8.2 and the process interlocks are listed in Section 6.8.3.

6.8.1 Major Equipment

Tag Number	Description
B-1	Air Stripper Blower
	Air Stripper Blower Inlet Filter
	Air Stripper Blower Inlet Silencer
BFV-101	Butterfly Valve Blower B-1 Inlet from Equalization Tank
BFV-102	Butterfly Valve Blower B-1 Outlet
BV-116	Isolation Valve Pressure Gauge on Blower B-1 Inlet
BV-117	Isolation Valve Pressure Gauge on Blower B-1 Outlet

6.8.2 System Functional Description

Air stripper blower B-1 will take in air from outside the GWTP building through an inlet filter and silencer and will blow it into the bottom of air stripper AS-1 below the packing material. Blower B-1 will be equipped with a VSD, a speed indicator controller SIC-B1 and a motor run indicator MI-B1. The pressure in the blower discharge line will be measured by PE-102 and monitored continuously by low pressure switch PSL-102 and high pressure switch PSH-102. If the discharge pressure falls below or rises above pre-selected levels blower B-1 will be shut down. In addition the differential pressure across the air stripper will be indicated and transmitted continuously by differential pressure indicator transmitter DPIT-101. A high differential pressure across the air stripper (DPSH-101) will also shut down blower B-1. The air flow from blower B-1 to air stripper AS-1 will be measured by mass flow meter FE-105, transmitted by FQIT-105 and the total flow to AS-1 will be recorded. These measurements will be transmitted to the PLC and displayed on the HMI screen.

Blower B-1 will be equipped with a Hand-Off-Auto selector switch, HOA-B1. In the Hand position, the blower will be kept running and the normal start-stop interlocks will be by-passed. In the Off position, the blower will be de-energized. In the Auto position, the blower will be started automatically. The blower will shut down automatically on any one of the following conditions: A high-high water level in the air stripper sump or a high differential pressure across the air stripper or a shut down of booster blower B-2 or a low pH in the treated effluent discharge or a high pH in the treated effluent discharge or a fire alarm signal or a high rainfall signal. The PLC will also send start-stop and speed control signals to the blower motor and the corresponding run indication will be displayed on the HMI screen. SIC-B1 will control the speed of the blower to maintain the Operator selected speed.

Instrumentation and controls associated with the Air Stripper Blower Process Loop are summarized in the following table:

Control	Setpoint	Function
Pressure Indicator PI-111	0-60 i.w.	Indicates pressure in Blower B-1 suction line
Pressure Indicator PI-112	0-60 i.w.	Indicates pressure in Blower B-1 discharge line
Pressure Element PE-102	0-60 i.w.	Measures pressure in Blower B-1 discharge line
Pressure Switch PSL-102	35 i.w.	Indicates low pressure in Blower B-1 discharge line
Pressure Switch PSH-102	50 i.w.	Indicates high pressure in Blower B-1 discharge line
Hand Switch HOA-B1	• HAND • OFF • AUTO	• Manual operation Blower B-1 running, normal start-stop interlocks bypassed • Blower B-1 de-energized • Blower B-1 starts automatically and stops automatically on high pressure PSH-102
Run Indicator MI-B1		Indicates Blower B-1 is running
Speed Indicator Controller SIC-B1		Indicates and controls speed of Blower B-1 based on operator setting
Flow Element-FE-105	0-12,000 cfm	Measures air flow rate to Air Stripper AS-1
Flow Quantity Indicator Transmitter FQIT-105	0-12,000 cfm	Indicates and transmits total air flow rate to Air Stripper AS-1
Temperature Indicator TI-101		Measures air temperature in Blower B-1 discharge
Pressure Element PE-101A		Measures pressure in inlet to Air Stripper AS-1
Pressure Element PE-101B		Measures pressure in outlet from Air Stripper AS-1
Differential Pressure Indicator Transmitter DPIT-101	0-10 i.w.	Indicates and transmits differential pressure across Air Stripper AS-1

Control	Setpoint	Function
Differential Pressure Switch DPSH-101		Indicates high differential pressure across Air Stripper AS-1

6.8.3 Interlock Summary

Signal	Interlock	Result
High-high water level in Air Stripper Sump (LSHH-105)		De-energizes Blower B-1
High pressure in Blower B-1 discharge (PSH-102)		De-energizes Blower B-1
High differential pressure across Air Stripper AS-1 (DPSH-101)		De-energizes Blower B-1
Treated effluent discharge low pH (ASL-102)		De-energizes Blower B-1
Treated effluent discharge high pH (ASH-102)		De-energizes Blower B-1
Blower B-2 Shutdown		De-energizes Blower B-1
Fire alarm signal		De-energizes Blower B-1
Rainfall Sensor RT-101 heavy rainfall		De-energizes Blower B-1

6.9 Process Loop #9 – Air Stream Heater

This process loop corresponds to P&ID P7. The major equipment for this process loop is listed in Section 6.9.1, the instrumentation and controls and the functional description are included in Section 6.9.2 and the process interlocks are listed in Section 6.9.3.

6.9.1 Major Equipment

Tag Number	Description
H-1	Air Stream Heater
BV-128	Isolation Valve Pressure Gauge Heater Inlet
BV-129	Isolation Valve Temperature Indicator Heater Inlet
BV-130	Isolation Valve Temperature Element Heater Outlet
BV-131	Isolation Valve High Temperature Switch Heater Outlet

6.9.2 System Functional Description

From air stripper AS-1, the off-gas will be heated in air stream heater H-1 to prevent any condensation. Heater H-1 will have a local control panel and will heat the off-gas to a temperature of 110 ^{o}F. The temperature of the off-gas entering H-1 will be indicated by temperature indicator TI-102. The temperature of the off-gas leaving H-1 will be measured by TE-104 and controlled by TIC-104. In addition, the temperature of the off-gas leaving the heater will be monitored continuously by high temperature switch TSH-103. If the temperature of the off-gas leaving the heater falls below or rises above pre-selected temperatures, alarm signals will be generated and be transmitted to the PLC and displayed on the HMI screen. The pressure of the off-gas entering heater H-1 will be indicated on a pressure gauge. Heater H-1 will be shut down if any of the following conditions are encountered: High temperature leaving heater H-1 or blower B-1 shut down or booster blower B-2 shut down or fire alarm signal.

Instrumentation and controls associated with the Air Stream Heater Process Loop are summarized in the following table:

Control	Setpoint	Function
Pressure Indicator PI-121	0-60 i.w.	Indicates off-gas pressure in Heater H-1 inlet line
Temperature Indicator TI-102	0-200 ^{o}F	Measures off-gas temperature in Heater H-1 inlet line
Temperature Element TE-104		Measures off-gas temperature in Heater H-1 outlet line
Temperature Indicator Controller TIC-104		Indicates and controls off-gas temperature in Heater H-1 outlet line
Temperature Alarm TAL-104		Alarms low off-gas temperature in Heater H-1 outlet line
Temperature Alarm TAH-104		Alarms high off-gas temperature in Heater H-1 outlet line
Temperature Switch TSH-103	140^{o}F	Indicates high off-gas temperature in Heater H-1 outlet line

6.9.3 Interlock Summary

Signal	Interlock	Result
High off-gas temperature in Heater H-1 outlet line		De-energizes Heater H-1
Blower B-1 Shutdown		De-energizes Heater H-1
Blower B-2 Shutdown		De-energizes Heater H-1
Fire alarm signal		De-energizes Heater H-1

6.10 Process Loop #10 – Vapor-Phase Granular Activated Carbon

This process loop corresponds to P&ID P-7. The major equipment for this process loop is listed in Section 6.10.1, the instrumentation and controls and the functional description are included in Section 6.10.2 and the process interlocks are listed in Section 6.10.3.

6.10.1 Major Equipment

Tag Number	Description
VGAC-1	Vapor-phase Granular Activated Carbon Adsorber 1
VGAC-2	Vapor-phase Granular Activated Carbon Adsorber 2
VGAC-3	Vapor-phase Granular Activated Carbon Adsorber 3
BV-132	Isolation Valve Sample Port Inlet to VGAC-1
BV-133	Isolation Valve Pressure Gauge Inlet to VGAC-1
BV-134	Isolation Valve Sample Port between VGAC-1 and VGAC-2
BV-135	Isolation Valve Pressure Gauge between VGAC-1 and VGAC-2
BV-136	Isolation Valve Sample Port between VGAC-2 and VGAC-3

Tag Number	Description
BV-137	Isolation Valve Pressure Gauge between Booster Blower B-2 and VGAC-3
BV-138	Isolation Valve Pressure Gauge between VGAC-3 and Exhaust Stack
BV-139	Isolation Valve Sample Port between VGAC-3 and Exhaust Stack
BV-141	Isolation Valve Pressure Gauge between VGAC-2 and Booster Blower B-2

6.10.2 System Functional Description

The heated off-gas will enter the vapor-phase granular activated carbon unit in order to remove the VOCs including vinyl chloride before being discharged into the atmosphere via the exhaust stack. This unit consists of three vessels VGAC-1, VGAC-2, and VGAC-3 which will be operated in series. All of the VOCs except for vinyl chloride will be removed in vessels VGAC-1 and VGAC-2 which will contain vapor-phase granular activated carbon. Vinyl chloride will be removed in vessel VGAC-3 which will contain Hydrosil HS-600 media (zeolite molecular sieves impregnated with 6 percent by weight potassium permanganate). Vinyl chloride will be oxidized by the potassium permanganate into potassium chloride and carbon dioxide. The potassium chloride will remain in the pore structure of the zeolite substrate. The treated off-gas will be discharged out of the stack. The pressure of the off-gas entering and leaving each of the three vessels will be measured by pressure gauges. The temperature of the off-gas entering vessel VGAC-3 will be indicated by temperature indicator TI-103. The flow rate of the off-gas entering vessel VGAC-3 will be measured by mass flow meter FE-B2, transmitted by FQIT-B2 and the total flow to VGAC-3 will be recorded. These measurements will be transmitted to the PLC and displayed on the HMI screen.

Instrumentation and controls associated with the Vapor-phase Granular Activated Carbon Process Loop are summarized in the following table:

Control	Setpoint	Function
Pressure Indicator PI-122A	0-60 i.w.	Indicates off-gas pressure in VGAC-1 inlet line
Pressure Indicator PI-122B	0-60 i.w.	Indicates off-gas pressure between VGAC-1 and VGAC-2
Pressure Indicator PI-122C	0-60 i.w.	Indicates off-gas pressure between VGAC-2 and Booster Blower B-2
Pressure Indicator PI-122D	0-60 i.w.	Indicates off-gas pressure between Booster Blower B-2 and VGAC-3
Pressure Indicator PI-123	0-30 i.w.	Indicates off-gas pressure between VGAC-3 and Exhaust Stack
Temperature Indicator TI-103	0-200 ^{o}F	Indicates off-gas temperature between Booster Blower B-2 and VGAC-3
Flow Element FE-B2	0-12,000 cfm	Measures off-gas flow rate to VGAC-3
Flow Quantity Indicator Transmitter FQIT-B2	0-12,000 cfm	Indicates and transmits total off-gas flow rate to VGAC-3

6.10.3 Interlock Summary

There are no interlocks for this process loop.

6.11 Process Loop #11 – Booster Blower

This process loop corresponds to P&ID P-7. The major equipment for this process loop is listed in Section 6.11.1, the instrumentation and controls and the functional description are included in Section 6.11.2 and the process interlocks are listed in Section 6.11.3.

6.11.1 Major Equipment

Tag Number	Description
B-2	Booster Blower
BFV-107	Butterfly Valve Blower B-2 Inlet
BFV-108	Butterfly Valve Blower B-2 Outlet

6.11.2 System Functional Description

In order to help overcome the pressure drop in the off-gas stream, booster blower B-2 will be placed between vessels VGAC-2 and VGAC-3. Blower B-2 will be equipped with a VSD, a speed indicator controller SIC-B2 and a motor run indicator MI-B2. The pressure in the blower discharge line will be measured by PE-103 and monitored continuously by low pressure switch PSL-103 and high pressure switch PSH-103. If the discharge pressure falls below or rises above pre-selected levels blower B-2 will be shut down. These measurements will be transmitted to the PLC and displayed on the HMI screen.

Blower B-2 will be equipped with a Hand-Off-Auto selector switch, HOA-B2. In the Hand position, the blower will be kept running and the normal start-stop interlocks will be by-passed. In the Off position, the blower will be de-energized. In the Auto position, the blower will be started automatically. The blower will shut down automatically on any one of the following conditions: A high discharge pressure or a low discharge pressure or a shut down of blower B-1 or a fire alarm signal. The PLC will also send start-stop and speed control signals to the blower motor and the corresponding run indication will be displayed on the HMI screen. SIC-B2 will control the speed of the blower to maintain the Operator selected speed.

Instrumentation and controls associated with the Booster Blower Process Loop are summarized in the following table:

Control	Setpoint	Function
Pressure Element PE-103	0-60 i.w.	Measures pressure in Booster Blower B-2 discharge line
Pressure Switch PSL-103	25 i.w.	Indicates low pressure in Booster Blower B-2 discharge line
Pressure Switch PSH-103	45 i.w.	Indicates high pressure in Booster Blower B-2 discharge line
Hand Switch HOA-B2	• HAND • OFF • AUTO	• Manual operation Booster Blower B-2 running, normal start-stop interlocks bypassed • Booster Blower B-2 de-energized • Booster Blower B-2 starts automatically and stops automatically on high pressure PSH-103
Run Indicator MI-B2		Indicates Booster Blower B-2 is running

Control	Setpoint	Function
Speed Indicator Controller SIC-B2		Indicates and controls speed of Booster Blower B-2 based on operator setting

6.11.3 Interlock Summary

Signal	Interlock	Result
High pressure in Blower B-2 discharge (PSH-103)		De-energizes Booster Blower B-2
Low pressure in Blower B-2 discharge (PSL-103)		De-energizes Booster Blower B-2
Blower B-1 Shutdown		De-energizes Booster Blower B-2
Fire alarm signal		De-energizes Booster Blower B-2

6.12 Process Loop #12 – Rainfall Sensor

This process loop corresponds to P&ID P-6. The major equipment for this process loop is listed in Section 6.12.1, the instrumentation and controls and the functional description are included in Section 6.12.2 and the process interlocks are listed in Section 6.12.3.

6.12.1 Major Equipment

Tag Number	Description
RT-101	Rainfall Sensor

6.12.2 System Functional Description

Rainfall sensor RT-101 will monitor the rainfall. If the rainfall is higher than a pre-selected value chosen by the Nassau County Department of Public Works Water/Wastewater Engineering Unit, RT-101 will send an alarm signal to the PLC, be displayed on the HMI screen and the GWTP will be shut down.

Instrumentation and controls associated with the Rainfall Sensor Process Loop are summarized in the following table:

Control	Setpoint	Function
Rainfall Switch QSH-101		Indicates high rainfall
Rainfall Alarm QAH-101		Alarms high rainfall

6.12.3 Interlock Summary

There are no interlocks for this process loop.

6.13 Process Loop #13 – GWTP Sump

This process loop corresponds to P&ID P-4. The major equipment for this process loop is listed in Section 6.13.1, the instrumentation and controls and the functional description are included in Section 6.13.2 and the process interlocks are listed in Section 6.13.3.

6.13.1 Major Equipment

Tag Number	Description
P-5A	Building Sump Pump
P-5B	Building Sump Pump
CV-103	Check Valve Pump P-5A discharge
CV-104	Check Valve Pump P-5B discharge
BV-109	Isolation Valve Pump P-5A
BV-110	Isolation Valve Pump P-5B

6.13.2 System Functional Description

Any process water that is spilled in the GWTP building will be collected in the GWTP Sump. From the GWTP Sump, pumps P-5A and P-5B will pump this collected water to the equalization tank T-1. At any given time, one pump will be in operation and the second one will serve as a spare. The water level in the GWTP sump will be measured by LE-104 and transmitted by LT-104. Level measurement signals will be indicated and transmitted to the PLC and displayed and recorded on the HMI screens. Based on pre-selected high and low level set points, the PLC will send signals to corresponding switches to start and stop the GWTP sump pumps P-5A and P-5B, and the corresponding high and low level alarms will be displayed on the HMI screens. Each of the two GWTP sump pumps will also be equipped with a motor run indicator (MI-P5A and MI-P5B). The PLC will also send start-stop and speed control signals to the pump motors and the corresponding run indications will be displayed on the HMI screens. The two pumps will be equipped with Hand-Off-Auto selector switches, HOA-P5A and HOA-P5B. In the Hand position, the pumps will be kept running and the normal start-stop interlocks will be by-passed. In the Off position, the pumps will be de-energized. In the Auto position, the pumps will be started automatically on high water level LSH-104 and stopped automatically on low water level LSL-104.

A low-low water level or a high-high water level in the GWTP sump will generate alarm signals on the control panel. A high-high level in the GWTP sump will shut down the GWTP. A high-high water level in the equalization tank T-1 or a fire alarm signal will also shut down pumps P-5A and P-5B.

Instrumentation and controls associated with the GWTP Sump Process Loop are summarized in the following table:

Control	Setpoint	Function
Level Element LE-104		Measures water level in GWTP Sump
Level Transmitter LT-104		Transmits water level in GWTP Sump
Level Switch LSL-104		Indicates low level in GWTP Sump
Level Switch LSLL-104		Indicates low-low level in GWTP Sump
Level Alarm LALL-104		Alarms low-low level in GWTP Sump
Level Switch LSH-104		Indicates high level in GWTP Sump
Level Switch LSHH-104		Indicates high-high level in GWTP Sump
Level Alarm LAHH-104		Alarms high-high level in GWTP Sump
Hand Switch HOA-P5A	• HAND • OFF • AUTO	• Manual operation Pump P-5A running, normal start-stop interlocks bypassed • Pump P-5A de-energized • Pump P-5A starts automatically on high level LSH-104 and stops automatically on low level LSL-104
Run Indicator MI-P5A		Indicates Pump P-5A is running

Control	Setpoint	Function
Hand Switch HOA-P5B	• HAND • OFF • AUTO	• Manual operation Pump P-5B running, normal start-stop interlocks bypassed • Pump P-5B de-energized • Pump P-5B starts automatically on high level LSH-104 and stops automatically on low level LSL-104
Run Indicator MI-P5B		Indicates Pump P-5B is running

6.13.3 Interlock Summary

Signal	Interlock	Result
High-high water level in Equalization Tank T-1 (LSHH-103)		De-energize Pumps P-5A and P-5B
Fire alarm signal		De-energize Pumps P-5A and P-5B
High-high level in GWTP sump		De-energize Pumps P-5A and P-5B and plant shut down

7.0 OPERATIONS

7.1 Introduction

The Operations Section of this Plan has been divided into seven primary subsections: Groundwater Extraction and Flow Equalization, Air Stripping and Off-gas Treatment, Bag Filtration, Liquid-phase Granular Activated Carbon Polishing, pH Adjustment, Treated Groundwater Discharge and Re-injection, and GWTP Sump. The major equipment for each subsystem is defined with respect to its applicable operating parameters and specifications. All issues pertaining to safety within any subsystem are addressed in ***Section 5.0, Health and Safety.***

Appendix D, Manufacturers' O&M Manuals, contains copies of the O&M information for the major equipment components.

Set points for all equipment can be found in Section 6. Although set points have the potential for change over time, the Start-Up and Shut-down procedures will act as a good base and reference.

The ***Master Equipment List, located in Appendix D***, is a summary of all pertinent information relative to the treatment/process equipment. The Operator is also directed to the on-site computer copy of this list for information on all GWTP equipment.

7.2 Groundwater Extraction and Flow Equalization

7.2.1 Equipment Specifications

Refer to Manufacturer's O&M Manual (Appendix D) for further information.

Recovery Well Pumps

Tag No: P-1
Name: Recovery Well Pump, RW-1
Type: Submersible Centrifugal

Rating: 800 GPM, 111 ft TDH
Manufacturer: Grundfos
Model: 1100S600-2-2
Serial No: C19BH00B2-P20837003
Motor
Manufacturer: Franklin Electric
Rating: 60 HP, 460V 60Hz 3Phase, Inverter Drive
Model: 2766194020

Tag No: P-2
Name: Recovery Well Pump, RW-3
Type: Submersible Centrifugal
Rating: 300 GPM, 100 ft TDH
Manufacturer: Grundfos
Model: 385S150-2
Serial: B16B70002-P20837003
Motor
Manufacturer: Franklin Electric
Rating: 15 HP, 460V 60Hz 3Phase, Inverter Drive
Model: 2366139020

Equalization Tank

Tag No.: T-1
Name: Equalization Tank
Type: Vertical, Cylindrical, Closed-top, Vented
Rating: 16,900 Gallons, 12 ft DIA 20 ft H
Manufacturer: Highland Tank

Equalization Tank Mixer

Tag No: M-1
Name: Equalization Tank Mixer
Type: Turbine, Top Center Mount
Rating: 72 RPM
Model: 3ZES25B
Serial: 19022
Motor
Manufacturer: Marathon Electric
Rating: 3HP, 460V 60Hz 3Phase, TEFC
Model: 182TTFC4026BD

Air Stripper Feed Pumps

Tag No: P-3A, P-3B
Name: Air Stripper Feed Pumps
Type: Horizontal Centrifugal
Rating: 1375 GPM, 60 ft TDH
Manufacturer: Goulds
Model: 3656
Serial: 18BF3P2L0

Motor
Manufacturer: Baldor Electric
Rating: 25 HP, 460V 60Hz 3Phase, Inverter Duty, TEFC
Model:
Serial: 40H026X115G2

7.2.2 Operation and Controls

The groundwater extraction system consists of two recovery wells RW-1 and RW-3, which are 10-inch in diameter and approximately 500 ft deep. A third recovery well RW-2 may be deployed in the future. These wells are equipped with Grundfos submersible electric pumps (P-1 in RW-1 and P-2 in RW-3). Pumps P-1 and P-2 are equipped with VSDs and will pump the groundwater through double-walled transfer pipes into the equalization tank T-1. The double-walled pipes are equipped with leak detection ports. The pumps will be equipped with HOA switches which will allow them to be operated in manual or automatic modes. The groundwater level in RW-1 will be monitored by level transmitter LT-101 and the groundwater level in RW-3 will be monitored by level transmitter LT-102. Based on pre-selected high level and low level set points, the PLC will send signals to corresponding switches to start and stop pumps P-1 and P-2, and the corresponding high and low level alarms will be displayed on the HMI screens. Pumps P-1 and P-2 will also be equipped with speed indicator controllers and motor run indicators. Speed indicator controllers SIC-P1 and SIC-P2 will control the speeds of pumps P-1 and P-2, respectively, based on signals received from the PLC to maintain the Operator selected speed and the corresponding speed and run indications will be displayed on the HMI screens. The influent groundwater flow rates from recovery wells RW-1 and RW-3 to the equalization tank T-1 will be measured by the magnetic flow meters FE-101 and FE-102, respectively. These flow rates will also be indicated, totalized and transmitted to the PLC by FQIT-101 and FQIT-102, respectively, and displayed and recorded on the HMI screens.

Equalization tank T-1 will receive groundwater from recovery wells RW-1 and RW-3. It will also receive re-circulated treated water from the air stripper sump and the effluent from the liquid phase granulated activated carbon adsorbers. Water from the GWTP sump and the air stripper containment sump will also be pumped to tank T-1. Water from all of these streams will be mixed by mixer/agitator M-1 so that any solid particles that may be present will remain in suspension and be prevented from settling to the bottom of tank T-1. Mixer M-1 will be equipped with a HOA switch and a motor run indicator. The PLC will also send start-stop signals to the mixer motor and the corresponding run indication will be displayed on the HMI screen. The water level in tank T-1 will be measured by LE-103 and the pH of the water in the equalization tank T-1 will be measured by AE-101.

From the equalization tank, the groundwater will be pumped to the air stripper by the air stripper feed pumps P-3A and P-3B. One of these pumps will operate at any given time and the other will serve as a spare. The flow rate of the groundwater pumped from the equalization tank to the air stripper will be measured by the magnetic flow meter FE-103. This flow rate will also be indicated, totalized and transmitted to the PLC by FQIT-103 and displayed and recorded on the HMI screens. Flow indicator controller FIC-103 will control the flow rate of the groundwater to the air stripper at the Operator selected flow rate. Both pumps P-3A and P-3B are equipped with VSDs, speed indicator controllers and motor run indicators. The pumps will be equipped with HOA switches which will allow them to be operated in manual or automatic modes. Based on pre-selected high level and low level set points for Tank T-1, the PLC will send signals to corresponding switches to start and stop pumps P-3A and P-3B, and the corresponding high and low level alarms will be displayed on the HMI screens. Speed indicator controllers SIC-P3A and SIC-P3B will control the speed of pumps P-3A and P-3B, respectively, to maintain the Operator selected flow rate based on signals from FIC-103 and the corresponding speed and run indications will be displayed on the HMI screens.

7.3 Air Stripping and Off-Gas Treatment

7.3.1 Equipment Specifications

Refer to *Manufacturer's O&M Manual (Appendix D)* for further information.

Air Stripper

Tag No.: AS-1
Name: Air Stripper
Type: Packed Tower Column 10 ft DIA 47 ft H
Material: 5000 Series structural aluminum
Rating: 1,375 GPM
Manufacturer: Remedial Systems Inc.
Packing Details: 3.5" Jaeger Tripack 25 ft H

Air Stripper Blower

Tag No: B-1
Name: Air Stripper Blower
Type: Radial Blade Fan
Rating: 9,860 CFM, 46" SP
Manufacturer: Twin City Fan & Blower
Model: 300W-BCN
Serial: 08-252433-1-1
Motor
Manufacturer: TECO Westinghouse
Rating: 100 HP, 460V 60Hz 3Phase, Inverter Duty, TEFC
Model: EP1002
Serial: AEHH8N-02-01000YH

Booster Blower

Tag No: B-2
Name: Booster Blower
Type: Radial Blade Fan
Rating: 9,860 CFM, 37" SP
Manufacturer: Twin City Fan & Blower
Model: 300-BCN
Serial: 08-259816-1-1
Motor
Manufacturer: TECO Westinghouse
Rating: 100HP, 460V 60Hz 3PH, Inverter Duty, TEFC
Model: N1002
Serial: AEEANE-02-01000YH

Air Stream Heater

Tag no.: H-1
Name: Air Stripper Exhaust Heater

Type: Inline, In-duct Electric Heater
Rating: 162 kW, 480V 3PH
Manufacturer: Chromalox
Model: ADH-162T

Vapor-phase Granular Activated Carbon Adsorbers

Tag No.: VGAC-1, VGAC-2, VGAC-3
Name: Vapor Phase Granular Activated Carbon Adsorber
Type: Flat Box Carbon Adsorption Vessels
Rating: 12,000 CFM
Operating Conditions: 28” WC max pressure, 14” WC max Vacuum
Manufacturer: Siemens
Model: RB20
Carbon Details: Westates VoCarb 48C (VGAC-1, VGAC-2), Hydrosil Potassium Permanganate (VGAC-3)

Liquid Carbon Feed Pumps

Tag No: P-4A, P-4B
Name: Liquid Carbon Feed Pumps
Type: Horizontal Centrifugal
Rating: 1375 GPM, 75 ft TDH
Manufacturer: Goulds
Model: 3656
Serial: 18BF2R2H0
Motor
Manufacturer: Baldor Electric
Rating: 40 HP, 460V 60Hz 3Phase, Inverter Duty, TEFC
Model: JPM2539T
Serial: 40H026W969

Air Stripper Containment Sump Pump

Tag No: P-7
Name: Air Stripper Containment Sump Pump
Type: Submersible Centrifugal
Rating: 10 GPM, 40 ft TDH
Manufacturer: Goulds
Model: WE0511H
Serial: K0873971
Motor
Rating: 1/2 HP, 120V 60Hz Single Phase

7.3.2 Operation and Control

The air stripper AS-1 was provided by the Navy and is a packed tower column equipped with a 25 ft high packing material consisting of 3.5 inch diameter polypropylene Jaeger Tripack. Groundwater from pump P-3A or P-3B will enter the air stripper distribution port and be sprayed over the column of Jaeger Tripack at a flow rate of approximately 1,200 gpm. This includes approximately 1,100 gpm of raw groundwater and 100 gpm of recirculation water. An induced draft countercurrent flow of air from air stripper blower B-1 will enter AS-1 below the base of the packing material at a rate of 8,000 scfm and move up through the packing. The large surface area of the packing material allows for a mass transfer of the VOCs from the groundwater into the air stream. A demister pad at the top of the air stripper will prevent the release of water droplets into the off-gas which is exhausted from the top of the air stripper tower. The treated groundwater containing residual VOCs will pass through the packing material and be collected in the air stripper sump. The water level in the air stripper sump will be measured by LE-105, indicated and transmitted by LIT-105 to the PLC and be used to start and stop the liquid-phase carbon feed pumps P-4A and P-4B. From the air stripper sump, liquid carbon feed pumps P-4A and P-4B will pump the treated water to the bag filters F-1A and F-1B. Only one of these two pumps will be operating at any given time, the second one will serve as a spare. Level indicator controller LIC-105 will control the water level in the air stripper sump at the Operator selected value. A portion of the treated water that is pumped to the bag filters from the air stripper sump will be re-circulated back to the equalization tank T-1. The flow rate of the water in the re-circulation line will be measured by the magnetic flow meter FE-106. This flow rate will also be indicated, totalized and transmitted to the PLC by FQIT-106 and displayed and recorded on the HMI screens.

Each of the two liquid carbon feed pumps P-4A and P-4B will be equipped with a VSD, a speed indicator controller and a motor run indicator. The PLC will also send start-stop and speed control signals to the VSD and the corresponding speed and run indications will be displayed on the HMI screens. Speed indicator controllers SIC-P4A and SIC-P4B will control the speed of pumps P-4A and P-4B, respectively to maintain the Operator selected water level in the air stripper sump based on signals from LIC-105. The pumps will be equipped with HOA switches which will allow them to be operated in manual or automatic modes. The air stripper is mounted inside a containment sump that has been designed to provide secondary containment and is equipped with a submersible pump P-7 that can transfer any water that leaks into the sump to the equalization tank.

Air stripper blower B-1 will take in air from outside the GWTP building through an inlet filter and silencer and will blow it into the bottom of air stripper AS-1 below the packing material. Blower B-1 will be equipped with a VSD, a speed indicator controller SIC-B1 and a motor run indicator MI-B1. The PLC will also send start-stop and speed control signals to the blower motor and the corresponding run indication will be displayed on the HMI screen. SIC-B1 will control the speed of the blower to maintain the Operator selected speed. Blower B-1 will also be equipped with a HOA switch which will allow it to be operated in manual or automatic modes. The pressure in the blower discharge line will be measured by PE-102 and monitored continuously by low pressure switch PSL-102 and high pressure switch PSH-102. In addition the differential pressure across the air stripper will be indicated and transmitted continuously by differential pressure indicator transmitter DPIT-101. If the discharge pressure falls below or rises above pre-selected levels blower B-1 will be shut down. The air flow from blower B-1 to air stripper AS-1 will be measured by mass flow meter FE-105. This flow rate will also be indicated, totalized and transmitted to the PLC by FQIT-105 and displayed and recorded on the HMI screens.

From air stripper AS-1, the off-gas will be heated in air stream heater H-1 to prevent any condensation. Heater H-1 will have a local control panel and will heat the off-gas to a temperature of 110 ^{o}F. The temperature of the off-gas entering H-1 will be indicated by temperature indicator TI-102. The temperature of the off-gas leaving H-1 will be measured by TE-104 and controlled by TIC-104. In addition, the temperature of the off-gas leaving the heater will be monitored continuously by high temperature switch TSH-103. If the temperature of the off-gas leaving the heater falls below or rises above pre-selected temperatures, alarm signals will be generated and be transmitted to the PLC and displayed on the HMI screen. The pressure of the off-gas entering heater H-1 will be indicated on pressure gauge PI-121.

The heated off-gas will enter the vapor-phase granular activated carbon unit in order to remove the VOCs including vinyl chloride before being discharged into the atmosphere via the exhaust stack. This unit consists of three vessels VGAC-1, VGAC-2, and VGAC-3 which will be operated in series. All of the VOCs except for vinyl chloride will be removed in vessels VGAC-1 and VGAC-2 which will contain vapor-phase granular activated carbon. Vinyl chloride will be removed in vessel VGAC-3 which will contain Hydrosil HS-600 media (zeolite molecular sieves impregnated with 6 percent by weight potassium permanganate). Vinyl chloride will be oxidized by the potassium permanganate into potassium chloride and carbon dioxide. The potassium chloride will remain in the pore structure of the zeolite substrate. The treated off-gas will be discharged out of the stack. The pressure of the off-gas entering and leaving each of the three vessels will be measured by pressure gauges. The temperature of the off-gas entering vessel VGAC-3 will be indicated by temperature indicator TI-103. The flow rate of the off-gas entering vessel VGAC-3 will be measured by mass flow meter FE-B2. This flow rate will also be indicated, totalized and transmitted to the PLC by FQIT-B2 and displayed and recorded on the HMI screens.

In order to help overcome the pressure drop in the off-gas stream, booster blower B-2 will be placed between vessels VGAC-2 and VGAC-3. Blower B-2 will be equipped with a VSD, a speed indicator controller SIC-B2 and a motor run indicator MI-B2. The PLC will also send start-stop and speed control signals to the blower motor and the corresponding run indication will be displayed on the HMI screen. SIC-B2 will control the speed of the blower to maintain the Operator selected speed. Booster blower B-2 will also be equipped with a HOA switch which will allow it to be operated in manual or automatic modes. The pressure in the blower discharge line will be measured by PE-103 and monitored continuously by low pressure switch PSL-103 and high pressure switch PSH-103. If the discharge pressure falls below or rises above pre-selected levels blower B-2 will be shut down. These measurements will be transmitted to the PLC and displayed on the HMI screen.

7.4 Bag Filtration

7.4.1 Equipment Specifications

Refer to *Manufacturer's O&M Manual (Appendix D)* for further information.

Bag Filters

Tag No.: F-1A, F-1B
Name: Bag Filter Vessels
Type: Multi-Bag Filtration Housings
Rating: 1,600 GPM, 12 Baskets, 25 Micron Bags
Operating Conditions: 150 PSIG max, 300 ^{o}F max
Manufacturer: Pentair Industries
Model: LR123010FAC15

7.4.2 Operation and Control

Treated water from the air stripper sump will be pumped to the two multi-bag filter vessels F-1A and F-1B, operating in parallel by feed pump P-4A or P-4B in order to remove fine suspended solid particles in the water. The filter bags that are placed in each of the 12 baskets in F-1A and F-1B are rated for 25 microns. Each multi-bag filter vessel will be equipped with manually operated butterfly valves on the inlet and outlet. The inlet and outlet pressures to and from both multi-bag filter vessels will be measured by pressure gauges. The differential pressure across both multi-bag filter vessels will also be measured and monitored continuously by differential pressure switch DPSH-117. When a pre-selected high differential pressure is reached an alarm signal will be sent to the PLC and displayed on the HMI screen. The GWTP will have to be shut down in order to replace the spent bag filters with clean bag filters. From the bag filter vessels F-1A and F-1B, the water containing residual VOCs will be transferred to the liquid-phase granular activated carbon unit.

7.5 Liquid-Phase Granular Activated Carbon Polishing

7.5.1 Equipment Specifications

Refer to *Manufacturer's O&M Manual (Appendix D)* for further information.

Liquid-phase Granular Activated Carbon Adsorbers

Tag No.: LGAC-1, LGAC-2, LGAC-3
Name: Liquid Phase Granular Activated Carbon Adsorbers
Type: Cylindrical, Straight Side Carbon Adsorption Vessels
Configuration: Piped Manifold, System Parallel and Independent Backwash
Rating: 1100 GPM (System in Parallel)
Operating Conditions: 100 PSIG max, 75 Deg F max
Manufacturer: TIGG Corporation
Carbon Details: TIGG 5D 1240

7.5.2 Operation and Control

From the multi-bag filters the treated water will be processed through the liquid-phase granular activated carbon unit. This unit consists of three vessels LGAC-1, LGAC-2, and LGAC-3 which are expected to be operated in parallel. However, this unit will also be equipped with a custom-designed piping rack such that any two vessels can also be operated in series while the third vessel is being backwashed. There are 18 manually operated butterfly valves (V-1 through V-18) on this piping rack. Table 2.1 in the manufacturer's O&M manual provided by TIGG Corporation shows the open/close positions of these butterfly valves for various series/parallel operating configurations. The inlet and outlet pressures to and from all three liquid-phase granular activated carbon vessels will be measured by pressure gauges PI-119 and PI-120, respectively. The differential pressure across all three liquid-phase granular activated carbon vessels will also be measured and monitored continuously by differential pressure switch DPSH-118. When a pre-selected high differential pressure is reached an alarm signal will be sent to the PLC and displayed on the HMI screen.

When any two carbon adsorbers are to be operated in series, one vessel will serve as the primary adsorber and the other one as the secondary or polishing adsorber. Each primary adsorber and each secondary adsorber will be equipped with inlet and outlet pressure gauges. When a high differential pressure alarm DPAH-118 is activated due to accumulation of fines, the Operator will have to manually backwash the carbon adsorbers following the steps described in the manufacturer's O&M manual supplied by TIGG Corporation. During the backwash cycle, municipal water from a hose connection will be used to backwash each carbon adsorber one by one, remove any accumulated fine solid particles, and send the fine solid particles to the GWTP sump. From the GWTP sump, this water will be pumped by any one of the GWTP sump pumps P-5A or P-5B to the equalization tank T-1. The second pump will serve as a spare. It is anticipated that initially, each carbon adsorber may be backwashed once weekly. Later, backwashing will be performed on an as-needed basis based on high differential pressure. The duration for backwashing any given carbon adsorber will be based on the total suspended solids concentration in the backwash outlet stream going to the GWTP sump.

Series operation allows the Operator to monitor for breakthrough of contaminants at the midpoint between the primary and secondary adsorbers by sampling as described in Section 4.3. When breakthrough of the primary adsorber is detected, a change-out of the carbon in the primary adsorber will be initiated. Spent carbon will be replaced with virgin or regenerated carbon. Contaminants (VOCs) that break through the primary adsorber will be captured on the secondary adsorber instead of being discharged to the aquifer. The position of the valves on the two carbon adsorbers will then be changed such that secondary adsorber will become the primary adsorber and the adsorber with the newly replaced activated carbon will become the secondary adsorber. Other configurations are also possible as shown in Table 2.1 of the TIGG Corporation O&M manual.

Some or all of the treated effluent water from the carbon adsorbers can be re-circulated back to the equalization tank T-1. Under normal operating conditions the treated effluent water from the carbon adsorbers will undergo pH adjustment before being discharged to the injection wells or the stormwater manhole.

7.6 pH Adjustment

7.6.1 Equipment Specifications

Refer to *Manufacturer's O&M Manual (Appendix D)* for further information.

Sodium Hydroxide Tank

Tag No.: T-2
Name: Sodium Hydroxide Tank
Type: 55-gallon drum

Caustic Feed Pumps

Tag No: P-6A, P-6B
Name: Caustic Feed Pumps
Type: Metering Pump
Rating: 8 GPH
Manufacturer: LMI Milton Roy
Model: C731-318SI

Sodium Hydroxide Mixer

Tag No.: M-2
Name: Static Mixer
Type: Inline, with integral injection port
Rating: 1,100 GPM
Details: Flanged, Stainless Steel Baffles, 10" PVC
Manufacturer: Chemineer-Kenics
Model: 10 KME-PVC-4

7.6.2 Operation and Control

The pH of the treated effluent from the liquid-phase granular activated carbon tanks will be adjusted by the addition of sodium hydroxide (caustic soda) solution from tank T-2 before it leaves the GWTP. The chemical feed system consists of the sodium hydroxide tank T-2, two metering pumps P-6A and P-6B, and in-line static mixer M-2. The pH of the treated effluent water from the carbon adsorbers will be adjusted based on pH measurements made by pH probe AE-102 and controlled by pH controller AIC-102 downstream of mixer M-2. These measurements will be transmitted to the PLC and displayed on the HMI screen. Based on the current pH of the treated effluent, AIC-102 will send a signal to the caustic feed pumps P-6A and P-6B in order to adjust the pump stroke and control the amount of sodium hydroxide addition. Only one of these two pumps will be operating at any given time, the second one will serve as a spare. The discharge line from these two pumps will be equipped with a pulsation damper to help dampen the pulsations and avoid damaging water hammer Low level switch LSL-102 will monitor the level of sodium hydroxide in tank T-2 and it will send an alarm signal to the PLC/HMI. A low pH in the treated effluent discharge (ASL-102) or a high pH in the treated effluent discharge (ASH-102) will result in alarm signals being sent to the PLC and shut down of the GWTP. High pressure switch PSH-101 will continuously monitor the pressure in the treated effluent water discharge line.

7.7 Treated Groundwater Discharge and Re-injection

7.7.1 Equipment Specifications

There is no major equipment like pumps in the treated groundwater discharge and re-injection system.

7.7.2 Operation and Control

The treated groundwater discharge and re-injection system consists of the stormwater manhole (within the utility easement east of Broadway Avenue) leading to Nassau County Recharge Basin # 495 and injection well IW-1. It is anticipated that approximately 800 gpm will be discharged into the stormwater manhole and approximately 300 gpm will be re-injected into IW-1. Injection well IW-1 is a 12-inch diameter well that is approximately 230 ft deep. The flow rate of the treated effluent water pumped to the stormwater manhole will be measured by the magnetic flow meter FE-108. Similarly, the flow rate of the treated effluent water pumped to injection well IW-1 will be measured by the magnetic flow meter FE-109. These flow rates will also be indicated, totalized and transmitted to the PLC by FQIT-108 and FQIT-109, respectively, and displayed and recorded on the HMI screens. The water level in injection well IW-1 will be measured by LE-106 and transmitted by LT-106 to the PLC and displayed on the HMI screen. A high-high water level in IW-1 will result in an alarm signal being sent to the PLC and shut down of the liquid carbon feed pumps P-4A and P-4B. It should be noted that the treated effluent will be tested to meet the SPDES effluent limitations and monitoring requirements described in Sections 2.1 and 4.3, before being re-injected into injection well IW-1 and discharged into the stormwater manhole.

7.8 GWTP Sump

7.8.1 Equipment Specifications

Refer to *Manufacturer's O&M Manual (Appendix D)* for further information.

GWTP Sump Pumps

Tag No: P-5A, P-5B
Name: GWTP Sump Pumps
Type: Submersible Centrifugal
Rating: 50 GPM, 35 ft TDH
Manufacturer: Gould
Model: WE0734H
Serial: K0874140

Motor
Rating: 3/4 HP, 460V 60Hz 3Phase

7.8.2 Operation and Control

Any process water that is spilled in the GWTP building will be collected in the GWTP Sump. From the GWTP Sump, pumps P-5A and P-5B will pump this collected water to the equalization tank T-1. At any given time, one pump will be in operation and the second one will serve as a spare. The water level in the GWTP sump will be measured by LE-104 and transmitted by level transmitter LT-104. Level measurement signals will be indicated and transmitted to the PLC and displayed and recorded on the HMI screens. Based on pre-selected high and low level set points, the PLC will send signals to corresponding switches to start and stop the GWTP sump pumps P-5A and P-5B, and the corresponding high and low level alarms will be displayed on the HMI screens. Each of the two GWTP sump pumps will also be equipped with a motor run indicator (MI-P5A and MI-P5B). The PLC will also send start-stop and speed control signals to the pump motors and the corresponding run indications will be displayed on the HMI screens. The two pumps will be equipped with HOA selector switches, which will allow them to be operated in manual or automatic modes.

7.9 Start-up and Shut-down Procedures

1. Normal Start-up

    a. Verify that all process vessels contain the various packing, adsorption, and filter media.
    b. Check valve positions to make sure the necessary valves are set in proper positions:
        i. Recovery Well Pumps and Equalization Tank valves open. Close gate valve GV-104 and open GV-101, GV-102, and GV-103.
        ii. Air Stripper Feed Pumps valves open. If P-3A will be running and P-3B will serve as a spare, close GV-106 and GV-108 and open GV-105 and GV-107. However, if P-3B will be running and P-3A will serve as a spare, close GV-105 and GV-107 and open GV-106 and GV-108.
        iii. Liquid-phase Carbon Feed Pumps valves open. If P-4A will be running and P-4B will serve as a spare, close GV-110 and GV-112 and open GV-109 and GV-111. However, if P-4B will be running and P-4A will serve as a spare, close GV-109 and GV-111 and open GV-110 and GV-112.
        iv. Air-stripper re-circulation line valves open. Close GV-114 and open GV-113.
        v. Bag Filter valves open. Parallel operation of F-1A and F-1B. Open BFV-103, BFV-104, BFV-105, and BFV-106.
        vi. Liquid-phase GAC Adsorber valves open. Close GV-119 and open GV-115 and GV-116. Refer to Table 2.1 in TIGG Corporation O&M Manual and open/close valves V-1 through V-18 based on the desired series/parallel operating configuration.
        vii. Stormwater manhole and re-injection well valves open. Open GV-117, GV-118 and GV-120.
        viii. Air stripper blower and booster blower valves open. Open BFV-101, BFV-102, BFV-107, and BFV-108.
        ix. Verify that all ball valves connected to pressure gauges are open and that all ball valves connected to sample ports are closed throughout the GWTP.
    c. Verify that set points for pH, temperature, pressure, flow, level, and rainfall instruments are set at the desired values on the HMI screens of the CMCS.
    d. Verify MCC/VSD HOA switches for blowers are in ‘Auto’ position. Start blower B-1 first and blower B-2 next.

e. Verify MCC/VSD HOA switches for all pumps and mixers are in 'Auto' position. If pumps P-3A, P-4A, P-5A, and P-6A will be running, verify that the switches for these pumps are in 'Auto' position. If pumps P-3B, P-4B, P-5B, and P-6B will serve as spares, verify that the switches for these pumps are in 'Off" position. Pumps P-1, P-2, P-3A, P-4A, P-5A, P-6A, and P-7 will start automatically when desired setpoint levels are reached in the recovery wells, equalization tank, air stripper sump, GWTP sump, and air stripper containment sump.

2. Normal Shut-down

a. Place pumps P-1 and P-2 in 'Off' position at CMCS.
b. After pumps P-3A and P-4A stop running due to low levels in the equalization tank and air stripper sump, respectively, place pump P-6A and blowers B-1 and B-2 in 'Off' position at CMCS.
c. Optional – Shut off pumps and blowers at MCC/VSD (Building Sump remains in "Auto" position).
d. Optional – Shut off valves at tanks.
e. Optional – Shut off valves at pump and blower discharges.

3. Emergency Shutdown

a. Activate Emergency Shutdown Button on CMCS.
b. Alternate Method: Shutdown switches at MCC/VSD panels.

8.0 SYSTEM TROUBLESHOOTING

If any portion of the GWTP is not operating properly, the Operator will be required to take steps to restore the particular part of the GWTP to its proper state of operation. This Section summarizes general actions which can be taken to troubleshoot potential problems. Troubleshooting activities must be performed in compliance with the safety guidelines in ***Section 5.0, Health and Safety***, and applicable federal, state, and local safety regulations.

For the Operator to troubleshoot the proper operation of the GWTP, recognition of the safety hazards and the ability to follow safe procedures, along with the knowledge of how the equipment is supposed to function and the physical and chemical processes involved are required. The following tables provide a brief description of information that can help in troubleshooting. The areas of operation for which troubleshooting guidelines are provided in this section include:

Table 8-1: Centrifugal Pump Troubleshooting
Table 8-2: Tank Level Troubleshooting
Table 8-3: Groundwater pH Troubleshooting
Table 8-4: Air Stripper Troubleshooting
Table 8-5: Bag Filter Troubleshooting
Table 8-6: Liquid-Phase Carbon Adsorber Troubleshooting
Table 8-7 Vapor-Phase Carbon Adsorber Troubleshooting
Table 8-8 Blower Troubleshooting

More specific equipment troubleshooting information is provided in the Manufacturer's Operations and Maintenance Manuals located in Appendix D. In conjunction, this information will assist the Operator in locating and eliminating sources of dysfunction in the equipment or process operation.

Should the Operator require additional assistance in troubleshooting, TtEC will be ressponsible for providing the additional expertise in the resolution of technical issues relating to operation and maintenance.

Table 8-1 Centrifugal Pump Troubleshooting

Problem	Potential Cause	Corrective Action
Pump does not operate	Switch in “Off” Position	Change switch to “Hand” or “Auto” position
	Alarm condition	Check control panel for alarms which may shut down pump.
	Circuit overload	Check circuit breaker at MCC. Reset if necessary. Determine cause of overload.
	Thermal overload	Check thermal overload protection relay at MCC and reset if necessary. Determine cause of overload.
Pump has no or low flow	Valves closed upstream or downstream	Shut off pump. Check manual valves upstream and downstream of pump, ensure they are in the “Open” position, and restart pump.
	Leak in pipe	Shut off pump; repair or replace line.
	Flow control setting too low	Check VSD operation.
Pump has high flow	Flow control setting too high	Check VSD operation.

Table 8-2 Tank Level Troubleshooting

Problem	Potential Cause	Corrective Action
Level too high or too low	Malfunctioning pump operation	Refer to Table 8-1.
	Malfunctioning level element, transmitter, or controller	Check, readjust, or replace if necessary.

Table 8-3 Groundwater pH Troubleshooting

Problem	Potential Cause	Corrective Action
pH too high or too low	pH probe out of calibration	Recalibrate pH probe
	pH probe fouled	Manually check pH of sample to determine if reading is accurate. If not, remove and clean pH probe according to manufacturer’s recommendations.
	pH probe failure	If cleaning does not alleviate improper readings, replace probe with spare and monitor.
	Groundwater entering plant has pH either too low or too high	Determine the cause of groundwater entering the plant that is outside of proper pH range.
	Groundwater entering plant has pH	Determine the cause within the

Problem	Potential Cause	Corrective Action
	within the correct range but pH of groundwater leaving the plant is out of range	plant that is resulting in groundwater pH that is outside of proper range. Check sodium hydroxide solution in Tank T-2 and operation of pumps P-6A and P-6B.

Table 8-4 Air Stripper Troubleshooting

Problem	Potential Cause	Corrective Action
Low mass transfer of VOCs	System not operating within design criteria	Check flow rates of air and groundwater. Check air: water ratio. Reset flow rates to desired values.
	Improper or insufficient air to liquid contact	Check the liquid flow distributor to ensure that groundwater is not short circuiting or channeling through the packing material. Adjust or replace as necessary.
High differential pressure	Fouled packing material	If possible, circulate cleaning solution to remove the fouling agent. If cleaning does not resolve the problem, physically replace the fouled packing with new packing.
	Solids precipitate on packing material	If possible, circulate acid solution to dissolve the precipitated solids. If this does not solve the problem, physically replace packing containing precipitated solids with new packing material. Consider adjusting pH of groundwater in equalization tank.
Groundwater droplets carry over into off-gas leaving the air stripper	Torn or damaged demister pad	Check demister pad to see if it in proper position and whether there is any tear or damage. Replace demister pad if necessary.
Groundwater level in air stripper sump too high	Level probe out of calibration	Recalibrate level probe. Check sump level set points and adjust if necessary.
	Level probe failure	If calibration does not correct the problem, replace probe with spare and monitor.

Table 8-5 Bag Filter Troubleshooting

Problem	Potential Cause	Corrective Action
High inlet pressure	Bags plugged	Check differential pressure. Check filter bags and replace if necessary.
	Valves closed upstream or downstream	Check valves upstream and downstream of filters and ensure they are in the “Open” position.

Table 8-6 Liquid-Phase Carbon Adsorber Troubleshooting

Problem	Potential Cause	Corrective Action
High inlet pressure	Valves closed upstream or downstream	Check valves upstream and downstream of vessels, and ensure they are in the "Open" position.
	Solids buildup in vessels	Backwash vessels according to manufacturer's recommendations (see Appendix D).
		Check operation of bag filters to determine if carryover of particulates is occurring. Consider changing the micron rating of the bag filters, if necessary.

Table 8-7 Vapor-Phase Carbon Adsorber Troubleshooting

Problem	Potential Cause	Corrective Action
High pressure drop or low air flow across system	Buildup of salts in carbon bed	Check position of inlet damper. Clean or replace carbon.
	Foreign object blocking flow path	Remove object.
	Carbon bed has become wet	Blow dry air through bed.
VOCs present in outlet from unit	Carbon capacity been exceeded	Replace carbon.
	Channeling of flow through bed	Level and redistribute carbon.

Table 8-8 Blower Troubleshooting

Problem	Potential Cause	Corrective Action
Blower does not operate	Switch in "Off" Position	Change switch to "Hand" or "Auto" position
	Alarm condition	Check control panel for alarms which may shut down blower.
	Circuit overload	Check circuit breaker at MCC. Reset if necessary. Determine cause of overload.
	Thermal overload	Check thermal overload protection relay at MCC and reset if necessary. Determine cause of overload.
Blower has no or low flow	Valves closed upstream or downstream	Shut off blower. Check manual valves upstream and downstream of blower, ensure they are in the "Open" position, and restart blower.
	Leak in air duct	Shut off blower; repair or replace air duct.
	Flow control setting too low	Check VSD operation.
Blower has high flow	Flow control setting too high	Check VSD operation.

9.0 EQUIPMENT MAINTENANCE

First and foremost, it is imperative that all operations and maintenance tasks be performed with strict adherence to the SHSP. Lock-out and tag-out (LO/TO) safety procedures must be followed during all equipment maintenance in accordance with requirements specified in the SHSP.

The key to good maintenance is regular and systematic inspection of all equipment. Inspection frequency and preventative maintenance is determined by the process application and local conditions such as temperature, dust and operation runtime. The ***Daily Inspection Form, Appendix A, Report Forms*** is provided as the documentation format for the Operator's use during daily shift inspections.

A sound program carried out by qualified individuals will greatly increase equipment reliability and productivity. The manufacturers' instruction manuals, referenced in ***Appendix D, Manufacturers' O&M Manuals*** and located on-site, must be carefully studied by the Operator before any attempt is made to service a particular piece of equipment.

Master Equipment List, Appendix D, has been created to act as a quick reference for the Operator to all necessary maintenance information. The list is an electronic spreadsheet defining all major equipment, instruments and valves with respect to part number, equipment description, vendor name and contact telephone number.

9.1 Alarm Responses

The CMCS system as described in ***Section 6.0, Process Description and Operation*** interfaces directly with the process equipment and identifies emergency/alarm conditions in the GWTP. In the event of an alarm condition a visible alarm signal will display on the CMCS system. In the event of an alarm condition that remains unacknowledged after a set amount of time, an Auto Dialer system will initiate a series of phone calls to alert alternate personnel of alarm conditions so that corrective action may be taken.

9.2 Maintenance Procedures and Recording

A total maintenance program has been developed for the process equipment which combines corrective and preventative maintenance. The preventative maintenance and frequency information for each piece of equipment is included in **Appendix D, Manufacturers' O&M Manuals.** Recording of performed maintenance tasks is to be documented on the ***Equipment Maintenance Form, Appendix A, Report Forms*** for each piece of equipment.

It is important to note that all operations and maintenance tasks be performed with strict adherence to the SHSP.

9.2.1 Tools, Equipment, and Supplies

To maintain and repair equipment, the proper tools must be readily available on-site. A complete list of available site tools is included as ***Appendix B, Tools and Equipment List.***

Spare parts, lubricants and other supplies necessary for routine equipment repairs and maintenance are to be stocked in the GWTP. A spare parts inventory list is included as ***Appendix C, Spare Parts Inventory.*** Manufacturers' recommended parts constitute most of the list.

Seasonal building and grounds-keeping equipment, such as snow shovels, are to be stored on-site and maintained when not in use.

9.2.2 Housekeeping

The plant should be kept in a neat and orderly appearance to provide a safe and pleasant working environment. To maintain a clean and safe workplace, the Operator should create a housekeeping plan and schedule. The housekeeping tasks should include both interior and exterior work. Regular yard pickup and inside sweeping, weekly mopping, along with seasonal snow removal will be performed by plant staff.

9.2.3 Lubrication

Proper lubrication of motors and bearings will insure longer equipment run time and efficient operation. Recommended lubrication intervals and types of oils and greases as supplied by the vendor are to be followed. The schedules will be adjusted to conform to heavier usage of the equipment.

LO/TO safety procedures will be followed during all equipment maintenance in accordance with requirements specified in ***Section 5.0, Health and Safety***. Some of the motors and fan bearings, however, must be greased while in motion. Safety procedures applicable to this energized maintenance are to be followed.

Under or over lubrication of bearings can be harmful to their life expectancy. Excessive grease will cause the bearings to slide rather than rotate, increasing friction and causing heat buildup. The following general instructions are recommended:

1. Assure that the grease gun tip is clean.
2. Clean the grease fitting with a clean rag. If a plug is to be removed, clean the area round the plug before removal of plug and inserting grease fitting.
3. Remove any relief plug or vent before pumping in grease.
4. Pump the proper amount of grease indicated by information found in the manufacturer’s instructions. This information is included (along with frequency of greasing) in the manufacturer’s operation and maintenance manuals referenced in ***Appendix D, Manufacturers’ O&M Manuals.***
5. Wipe off all excessive grease around unit.
6. Clean vent before replacing vent plug to allow for expansion of grease and to allow excess grease to work out of the bearing.
7. Note in the maintenance records the date, Operator or service personnel and what was done to the equipment.

9.2.4 Storage of Lubricants

An area in the GWTP has been designated as a storage area for maintenance lubricants. This area will be configured to prevent any fire or safety hazard and will be posted with “NO SMOKING” signs. Stored lubricants will be tightly sealed to prevent contamination by dust and dirt, and decomposition of the lubricant.

9.2.5 Equipment Rotation

Equipment with multiple pumps arrangement is automatically run in an alternating fashion so that all pumps maintain approximate equal hours of operation. The CMCS shall monitor and record equipment runtimes to verify that rotation of pumps is operating appropriately.

9.2.6 Electrical

CAUTION: Maintenance work performed on exposed live electrical conductors and connections will be done by a licensed electrician using the N.F.P.A. 70 E standard. Routine service to the equipment beyond the Operator's experience, will be performed by 40 Hour trained OSHA field technicians.

9.2.7 Computer Monitoring and Control System (CMCS)

Advantech will provide all initial service needed for the CMCS. An operation and maintenance manual prepared by Advantech is located on-site for general OM&M by the Operator. Following the prove-out period a local I&C/electrical service firm, knowledgeable about PLCs, may be retained to provide ongoing troubleshooting and service on an ongoing basis.

9.3 Maintenance Schedule Matrix

A total maintenance program has been developed for the process equipment which combines corrective and preventative maintenance. The preventative maintenance and frequency information for each piece of equipment (Tag No.) has been summarized in a Preventative Maintenance Matrix***, Appendix E, Preventative Maintenance Matrix***. Recording of performed maintenance tasks is to be documented on the ***Equipment Maintenance Form, Appendix A, Report Forms*** for each piece of equipment.

It is important to note that all operations and maintenance tasks be performed with strict adherence to Section 5.0, Health and Safety.

9.4 Special Maintenance Procedures

9.4.1 Contaminated Groundwater or Chemical Spill - Operational Response

Should a large spill of groundwater occur, the Operator shall immediately shutdown the GWTP and verify that the groundwater is properly draining to the GWTP building sump and that the sump pumps are operating as planned. The Operator should then rectify the cause of the spill and resume plant operation when it is safe to do so. Normal treatment plant operations do not require the use of process chemicals other than sodium hydroxide solution. In the unlikely event of a chemical spill (e.g. cleaning chemicals) the spill should be isolated using absorbent materials or booms. The Operator should consult Health and Safety personnel and review the MSDS to determine further action. If it is determined safe to do and will not adversely affect the GWTP processes, the chemical spill may be allowed to drain to the building sump. Dilution water from potable water service may be required. This will help prevent the spilled chemical from moving through the GWTP as a slug and keep unnecessary overloading of the treatment system. If the chemical cannot enter the system, then the chemical shall be properly cleaned up, drummed, and disposed of off-site. Refer to ***Section 5.0, Health and Safety*** for all safety issues pertaining to chemical spills.

9.4.2 Liquid-Phase Granular Activated Carbon Change-out

Prior to the process of carbon change-out, proper procedures must be followed and a review of effluent analytical data must be performed to make a proper decision on when to replace the carbon in the adsorber vessels. Refer to ***Section 4*** of this OM&M Plan for a narrative on the sampling procedures required for this evaluation and the TIGG Corporation O&M Manual in ***Appendix D*** for the carbon replacement procedures.

9.4.3 Vapor-Phase Granular Activated Carbon Change-out

Prior to the process of carbon and Hydrosil HS-600 change-out, proper procedures must be followed and a review of effluent analytical data must be performed to make a proper decision on when to replace the carbon/Hydrosil HS-600 in the adsorber vessels. Refer to ***Section 4*** of this OM&M Plan for a narrative on the sampling procedures required for this evaluation and the Siemens Water Technologies Corporation O&M Manual in ***Appendix D*** for the carbon replacement procedures.

10.0 WASTE TRANSPORTATION AND DISPOSAL

10.1 Background

The GM-38 Area groundwater remediation will result in the generation of waste materials at the NWIRP Bethpage, NY GWTP. This section describes the process and methods that will be used to address the safe and compliant handling and transport of generated project wastes from the GWTP. The facility will operate 24 hours per day, 7 days per week. Maintenance activities will be performed on an as-needed basis. Wastes at the GWTP will consist of spent air stripper packing material, spent granular activated carbon, spent bag filters and used personal protective equipment (PPE). It is anticipated that the stored wastes will be non-hazardous and therefore will not require storage and will not require manifests for off-site transportation. The wastes will be manifested as either non-hazardous or hazardous waste depending on the waste profile, for offsite transportation and appropriate disposal. The procedures outlined in the Final Waste Management Plan for Construction Tasks (Tetra Tech EC May 8, 2006) will be followed.

10.2 Waste Disposal Criteria and Methods

Before wastes are transported from the GWTP, they will be sampled and analyzed as described in Section 4 of this document and the associated SAP Worksheets. This sampling and analysis will comply with the regulatory requirements identified in Section 2 of this document as well as the requirements of the disposal facilities.

10.3 Waste Disposal Facilities

10.3.1 Disposal Facility for Hazardous Wastes

It is anticipated that hazardous wastes from the GWTP will be transported via trucks and disposed of at a NYSDEC approved RCRA Subtitle C hazardous waste landfill. A particular waste disposal facility has not been identified at present.

10.3.2 Disposal Facility for Non-Hazardous Wastes

It is anticipated that non-hazardous wastes from the GWTP will be transported via trucks and disposed of at a NYSDEC approved RCRA Subtitle D solid waste landfill. A particular waste disposal facility has not been identified at present.

10.4 Waste Transportation Contractor Requirements

All Waste Transportation Contractors (transporters) must use the disposal facilities identified above, or perhaps others, that have been approved in advance by Tetra Tech, the Navy, USEPA and NYSDEC.

10.4.1 Qualifications

All waste transporters will be prequalified according to Tetra Tech's regulatory compliance screening process prior to being awarded a transportation subcontract to work on the project. All drivers will have a current commercial driver's license (CDL) with HAZMAT endorsement as required.

10.4.2 Trucking Equipment

Transport vehicles brought to the GWTP will be in good operating condition and substantially free of mud or other contamination. Owners and operators of transport vehicles will be responsible for maintaining their equipment in a safe operating condition suitable for transport over public roads in accordance with applicable motor carrier safety requirements.

Transport vehicles will meet the required specifications for hauling hazardous and non-hazardous solid wastes. These specifications include use of covers and tight dump bodies to prevent leakage and display of the appropriate USDOT-required placards.

10.5 Waste Quantity Determination

Estimated quantities of wastes likely to be produced will be developed after gaining some operating experience over the first several months of operation in 2009 and 2010.

10.6 Shipping Documentation

Tracking and documentation of waste transport is required by the federal and state solid waste, hazardous waste, and USDOT transportation and hazardous materials regulations. For hazardous wastes, a Uniform Hazardous Waste Manifest and a weight ticket are required. For non-hazardous wastes, a Bill of Lading or a non-hazardous waste manifest is required.

10.7 Safety

10.7.1 Facility Safety

Facility personnel and transporters will receive training in the project-specific SHSP at the GWTP facility. The SHSP includes requirements for traffic control, loading/unloading operations, and site rules to follow when driving within the facility.

10.7.2 Public Road Transport Safety

Transporters of hazardous and solid waste materials will comply with applicable federal and state regulations for transportation of wastes over public roadways. These regulations include:

USDOT Hazardous Materials Requirements (49 CFR 171-397);

NYSDOT Height/Weight Restrictions (17 NYCRR Part 820);
NY State Transportation Law (TRA Section 140)

10.7.3 Landfill Facilities Safety

Transporters will adhere to the landfill-specific rules for access and unloading of wastes. When trucks enter the landfill facilities, drivers will be informed about and will abide by site-specific traffic control procedures for each landfill. Before exiting the facility, trucks will be visually inspected and decontaminated as needed to remove any residue on the exterior of the truck. The receiving landfill will coordinate and manage incoming truck traffic such that delays and traffic impacts are minimized. GWTP operations personnel will coordinate delivery of waste with offsite landfills in advance of shipments so that they are informed about the composition, delivery method, and schedule for the waste. Waste profiles and supporting documentation (e.g., sample results) will be prepared, signed by the NWIRP Bethpage representative, and forwarded to the landfills in advance of shipment as required.

10.8 Spill Response and Contingency Plan

10.8.1 Spill Procedures

The primary obligation for reporting and cleaning up a hazardous materials spill that occurs during transportation lies with the owner and operator of the truck from which the material has been released. TtEC will require that transporters of hazardous materials be familiar with the contents of the spill response and contingency plan, comply with all current rules governing the transportation, and have an emergency spill response plan in effect as part of their contract. Drivers will be trained in transportation spill response and be equipped with spill response equipment appropriate for responding to spills of hazardous and non-hazardous wastes. Such response equipment will include a shovel, bags, booms, cones, or other means to demarcate the spill area. Training will also address the general spill response objectives and procedures, which include:

Safeguard life and property
Notify the proper authorities
Begin containment and cleanup
Follow-up with reporting.

10.8.2 Notification

Transporters will immediately report spills of hazardous substances in accordance with the NYSDEC spill reporting requirements. Additionally, any transportation incident involving hazardous materials will be reported to the USDOT as required by the regulations. All spills on site and during transportation must also be reported to the Navy/Navy's Representative.

Samples of the Uniform Hazardous Waste Manifest Form, the Bill of Lading, a Non-Hazardous Waste Label, and a Hazardous Waste Label are shown in Figures 10-1 through 10-4 respectively.

Figure 10-1 Uniform Hazardous Waste Manifest Form

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	**4. Manifest Tracking Number**

5. Generator's Name and Mailing Address

Generator's Site Address (if different than mailing address)

Generator's Phone:

6. Transporter 1 Company Name — U.S. EPA ID Number

7. Transporter 2 Company Name — U.S. EPA ID Number

8. Designated Facility Name and Site Address — U.S. EPA ID Number

Facility's Phone:

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
	1.					
	2.					
	3.					
	4.					

14. Special Handling Instructions and Additional Information

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name — Signature — Month Day Year

GENERATOR

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit: ______

Transporter signature (for exports only): Date leaving U.S.:

INT'L

17. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name — Signature — Month Day Year

Transporter 2 Printed/Typed Name — Signature — Month Day Year

TRANSPORTER

18. Discrepancy

18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

18b. Alternate Facility (or Generator) — U.S. EPA ID Number

Facility's Phone:

18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)

1.	2.	3.	4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a

Printed/Typed Name — Signature — Month Day Year

DESIGNATED FACILITY

VOID

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Figure 10-2 Straight Bill of Lading Form

STRAIGHT BILL OF LADING – SHORT FORM – Original – Not Negotiable

Shipper's No. ____________

(Carrier) ____________ SCAC. ____________ Carrier's No. ____________

RECEIVED, subject to individually determined rates or contracts that have been agreed upon in writing between the carrier and shipper, if applicable, otherwise to the rates, classifications and rules that have been established by the carrier and are available to the shipper, on request; and all applicable state and federal regulations;

at ____________, date ____________ from ____________

the Property described below, in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated below which said company (the word company being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to delivery at said destination, if on its route, or otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of said Property over all or any portion of said route to destination and as to each party at any time interested in all or any of said Property that every service to be performed hereunder shall be subject to all the conditions not prohibited by law, whether printed or written, herein contained, including the conditions on the back hereof, which are hereby agreed to by the shipper and accepted for himself and his assigns.

TO:	FROM:
Consignee	Shipper
Street	Street
Destination Zip	Origin Zip
Route	
Telephone ( ) / Fax ( )	Telephone ( ) / Fax ( )
E-mail	E-mail
Delivering Carrier	Trailer Initial/Number

No. of Packages	Type of Packages	Type of Food Brand Name/Specific Variety	Lot, Code or Identifier No.	*Weight (Subject to correction)	Class or Rate

Remit C.O.D. to:
Address:
City: State: Zip:

COD AMT: $

Subject to Section 7 of conditions, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:
The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.

(Signature of consignor)

C. O. D. FEE:
Prepaid ☐
Collect ☐ $

Note. – where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property. The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding ____________ per ____________

NOTE: Liability Limitation for loss or damage in this shipment may be applicable. See 49 U.S.C. 14706(c)(1)(A) and (B).

Charges Advanced $ ____________

FREIGHT CHARGES
☐ Prepaid ☐ Collect

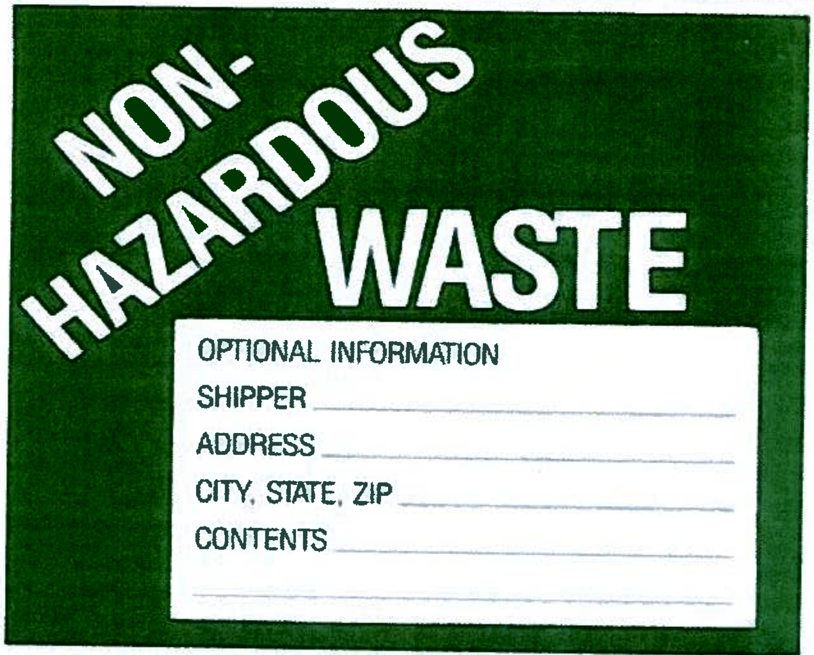
Shipper | Carrier

Per Date | Per Date

Consignee ____________ Date received ____________

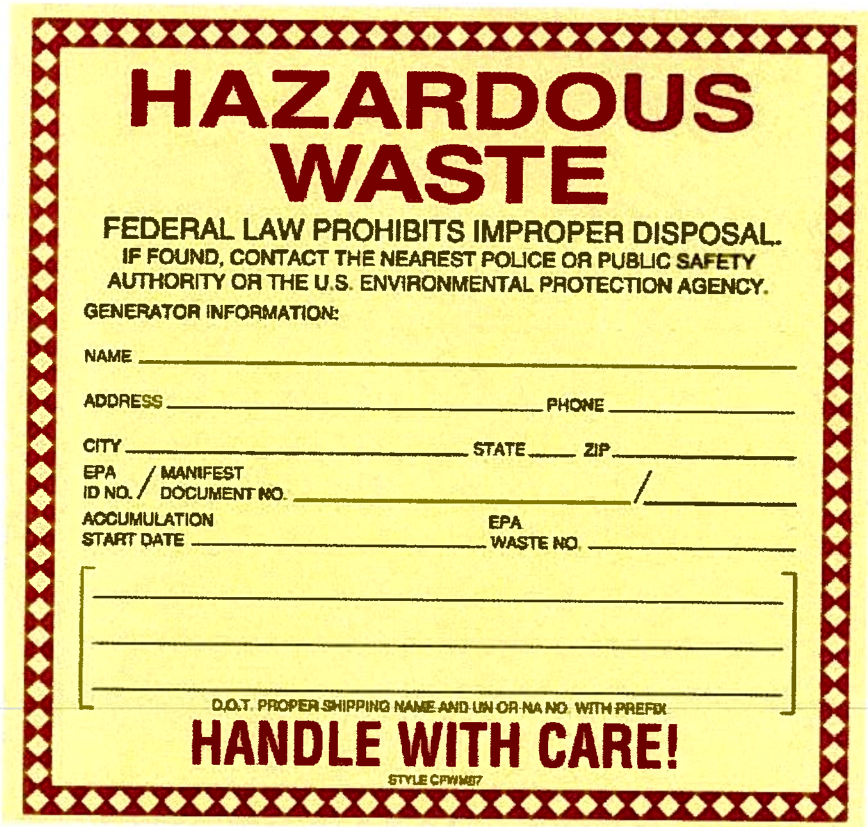
51-BLC-O3 9080

Figure 10-3 Non-Hazardous Waste Label



NON-HAZARDOUS WASTE

Figure 10-4 Hazardous Waste Label



HAZARDOUS
WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.
IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

GENERATOR INFORMATION:

NAME ______

ADDRESS ______ PHONE ______

CITY ______ STATE ______ ZIP ______

EPA ID NO. / MANIFEST DOCUMENT NO. ______ / ______

ACCUMULATION START DATE ______ EPA WASTE NO. ______

D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX

HANDLE WITH CARE!

STYLE CPWM87

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND, ATLANTIC
REMEDIAL ACTION CONTRACT (RAC)
CONTRACT NO. N62472-99-D-0032
CONTRACT TASK ORDER NO. 0096

Draft Final Operation, Maintenance & Monitoring Plan for Groundwater Treatment Plant GM-38 Area Groundwater Remediation Naval Weapons Industrial Reserve Plant Bethpage, New York

VOLUME II

APPENDICES A THROUGH E

Prepared for:

Department of the Navy
Naval Facilities Engineering Command, Mid-Atlantic
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Prepared by:

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APPENDIX A
Report Forms

Daily Inspection Form
Equipment Maintenance Form
Collection of Process Aqueous Samples SOP 001
Collection of Process Vapor Samples SOP 002
GWTP Record Drawings (to be submitted as Final)
MSDS
Warranties

A-1
Daily Inspection Form

GM-38 Area Groundwater Remediation
Groundwater Treatment Plant
NWIRP Bethpage, NY

DAILY INSPECTION FORM

Inspector's Name: ________________________ **Date:** ______________

Time Began: ________ **Time Finished:** ________

EQUIPMENT DESCRIPTION	**VISUAL INSPECTION** (Circle one)	**SYSTEM PARAMETERS** (Circle one or Fill in the blank)	**COMMENTS**
Recovery Well RW-1	Yes No	Water Level (LT-101): ________ feet	
Recovery Well RW-3	Yes No	Water Level (LT-102): ________ feet	
Pump P-1 in RW-1	Yes No	Pump Power: Hand / Off / Auto Pump: On / Off PI-101 psig ________ VSD _______%	
Pump P-2 in RW-3	Yes No	Pump Power: Hand / Off / Auto Pump: On / Off PI-102 psig ________ VSD _______%	
RW-1 Influent Flow Meter FQIT-101	Yes No	Flow Rate: ________ gpm Flow Total: ___________ gallons	
RW-3 Influent Flow Meter FQIT-102	Yes No	Flow Rate: ________ gpm Flow Total: ___________ gallons	
Equalization Tank	Yes No	Tank Level (LE-103): ________ feet pH (AE-101): ________	
Mixer M-1	Yes No	Mixer Power: Hand / Off / Auto Mixer: On / Off	
Air Stripper Feed Pumps P-3A Standby (Yes / No) P-3B Standby (Yes / No)	Yes No	Pump Power: Hand / Off / Auto Pump: On / Off PI-105B psig ________ VSD _______% Pump Power: Hand / Off / Auto Pump: On / Off PI-106B psig ________ VSD _______%	
Air Stripper Feed Flow Meter FQIT-103	Yes No	Flow Rate: ________ gpm Flow Total: ___________ gallons	
Blower B-1	Yes No	Blower Power: Hand / Off / Auto Blower: On / Off PE-102 i.w. ________ VSD _______%	
Blower B-1 Discharge Flow Meter FQIT-105	Yes No	Flow Rate: ________ cfm Flow Total: ___________ cubic feet	
Air Stripper AS-1	Yes No	Differential Pressure DPSH-101: ________ i.w.	
Air Stripper Sump	Yes No	Sump Level (LE-105): ________ feet	
Liquid Carbon Feed Pumps P-4A Standby (Yes / No) P-4B Standby (Yes / No)	Yes No	Pump Power: Hand / Off / Auto Pump: On / Off PI-113B psig ________ VSD _______% Pump Power: Hand / Off / Auto Pump: On / Off PI-114B psig ________ VSD _______%	
Air Stripper Recirculation Line Flow Meter FQIT-106	Yes No	Flow Rate: ________ gpm Flow Total: ___________ gallons	

GM-38 Area Groundwater Remediation
Groundwater Treatment Plant
NWIRP Bethpage, NY

DAILY INSPECTION FORM

EQUIPMENT DESCRIPTION	VISUAL INSPECTION (Circle one)	SYSTEM PARAMETERS (Circle one or Fill in the blank)	COMMENTS
Bag Filters Vessel F-1A Vessel F-1B	Yes No	Overall Differential Pressure DPSH-117: ________ psig. Flow Through / Change-out During Shift? Yes / No Yes / No Yes / No Yes / No	
Liquid-phase Granulated Activated Carbon Vessel LGAC-1 Vessel LGAC-2 Vessel LGAC-3	Yes No	Overall Differential Pressure DPSH-118: ________ psig. Flow Through / Change-out During Shift? Yes / No Yes / No (series/parallel) Yes / No Yes / No (series/parallel) Yes / No Yes / No (series/parallel)	
Caustic Feed Pumps P-6A Standby (Yes / No) P-6B Standby (Yes / No)	Yes No	 Pump: On / Off Pump: On / Off	
Treated Effluent pH	Yes No	pH (AE-102): ________	
Stormwater Manhole Flow Meter FQIT-108	Yes No	Flow Rate: ________ gpm Flow Total: ___________ gallons	
Injection Well IW-1 Flow Meter FQIT-109	Yes No	Flow Rate: ________ gpm Flow Total: ___________ gallons	
Air Stream Heater H-1	Yes No	Temperature (TE-104) : ________ ^{o}F	
Vapor-phase Granulated Activated Carbon Vessel VGAC-1 Vessel VGAC-2 Vessel VGAC-3	Yes No	 Inlet pressure / Change-out During Shift? (PI-122A) ____ i.w. Yes / No (PI-122B) ____ i.w. Yes / No (PI-122D) ____ i.w. Yes / No	
Blower B-2	Yes No	Blower Power: Hand / Off / Auto Blower: On / Off PE-103 i.w. ________ VSD _______%	
Blower B-2 Discharge Flow Meter FQIT-B2	Yes No	Flow Rate: ________ cfm Flow Total: ___________ cubic feet	
GWTP Sump Pumps P-5A Standby (Yes / No) P-5B Standby (Yes / No)	Yes No	 Pump Power: Hand / Off / Auto Pump: On / Off Pump Power: Hand / Off / Auto Pump: On / Off	
GWTP Sump	Yes No	Sump Level (LE-104): ________ feet	
Air Stripper Containment Sump Pump P-7	Yes No	Pump: On / Off	

A-2
Equipment Maintenance Form

GM-38 Area Groundwater Remediation
Groundwater Treatment Plant
NWIRP Bethpage, NY

EQUIPMENT MAINTENANCE FORM

EQUIPMENT IDENTIFICATION	DATE	MAINTENANCE ACTIVITY PERFORMED	COMMENTS

A-3

Collection of Process Aqueous Samples SOP 001

Sampling of Process Aqueous Samples (SOP 001)

Process water samples will be collected from various sampling ports within the GWTP building according to the following procedure:

1. Be aware that the nominal process water flow rate through the GWTP is 1100 gallons per minute and that the process water pipelines are under pressure (up to 60 psig). Be aware that the process water contains chlorinated VOCs and follow the proper health and safety guidelines as identified in the SHSP.

2. Partially open the ball valve at the sample port for a few seconds and collect the process water in a 5-gallon bucket in order to flush out any dead zones. Close the ball valve at the sample port and empty the water in the bucket into the GWTP sump.

3. Partially open the ball valve at the sample port for a few seconds once more and collect the process water in a dedicated clean glass beaker. Close the ball valve at the sample port and quickly transfer an appropriate volume of the sample from the beaker into the proper sample vials and bottles**. If possible, avoid use of the dedicated clean glass beaker and collect process water samples directly from the sample port into the sample containers.**

4. Samples for VOCs must be collected first. The sample vials and bottles should be preserved and filled according to the procedures specified below and in the QAPP.

5. Fill all sample vials and bottles by allowing the water to flow gently down the inside of the vial or bottle with minimal turbulence. Cap each vial or bottle as it is filled.

6. Preserve and label the samples, and record them on the Chain of Custody form and in the field logbook. Place the sample vials and bottles immediately into a cooler for shipment and maintain at 4^oC.

7. The filling and preservation procedures will be:

    - VOCs - Determine the amount of 1:1 HCl preservative required to adjust the pH of the sample to less than 2 in an extra 40 ml glass vial. Add this volume to the empty 40 ml vials prior to sampling. Fill each container with sample to just overflowing so that no air bubbles are entrapped inside. If effervescence occurs, submit the sample without preservative and note on the chain of custody form.

    - Other Parameters - Fill each container and preserve immediately as required. To test for pH, pour a minimal portion of sample onto broad range pH paper to verify that the appropriate pH level has been obtained.

A-4
Collection of Process Vapor Samples SOP 002

Sampling of Process Vapor Samples (SOP 002)

Process vapor samples will be collected from the four sampling ports in the VGAC unit within the GWTP building according to the following procedure:

1. This procedure involves the collection of a 30-minute integrated sample using 6-liter Summa canisters supplied by the laboratory. Be aware that the nominal process vapor flow rate through the GWTP is 8,000 cubic feet per minute and that the process vapor pipelines are under pressure (up to 50 inches of water or 94 mm of Hg). Be aware that the process vapor contains chlorinated VOCs and follow the proper health and safety guidelines as identified in the SHSP. Be aware that the Summa canisters and associated hardware are expensive containers that need to be handled with special care.

2. Verify the initial vacuum of the canister as received from the laboratory utilizing the following steps. Confirm that the valve on the canister is closed. Remove the brass cap from the canister and attach the critical orifice flow controller to the canister. Attach the brass cap to the other end of the flow controller. After ensuring that the ¼ inch Swagelok fittings are tight using a 9/16 inch wrench and that you have a closed leak-free train, quickly open and close the canister valve. Read the vacuum on the built-in gauge on the flow controller. The initial vacuum should be greater than 25 in of Hg. If this is not the case, do not use that canister for sampling and call the laboratory to arrange for a replacement. Record the gauge reading in the "initial vacuum" column on the Chain of Custody form.

3. Connect a purge line to the sample port making sure that the other end is vented outside the GWTP building. Partially open the ball valve at the sample port for a few seconds and allow the line to purge in order to flush out any dead zones. Close the ball valve at the sample port. Disconnect the purge line. UNDER NO CIRCUMSTANCES SHOULD THE VAPORS FROM THE SAMPLE PORT BE VENTED INSIDE THE GWTP. Some the chlorinated VOCs can be immediately dangerous to life and health.

4. Remove the brass cap from the flow controller and connect the sample train to the sample port. After ensuring that the ¼ inch Swagelok fittings are tight using a 9/16 inch wrench and that you have a closed leak-free train and that the canister and flow controller are properly supported, quickly open the canister valve (1/2 turn) and the ball valve on the sample port. Record sample start time.

5. Monitor the integrated sampling process periodically. After 30 minutes, record the "final vacuum" on the Chain of Custody form by reading the vacuum on the built-in gauge on the flow controller. Close the canister valve and the ball valve on the sample port. Record sample finish time.

6. Detach the sampling train from the sample port. Detach the flow controller from the canister and replace the brass cap on the canister. Fill out the canister sample tag and log

book making sure that the information matches that recorded on the Chain of Custody form. DO NOT attach any labels to the surface of the canister or write on the canister.

7. Return the canisters and the flow controllers to the laboratory in the boxes and packaging provided. Place the chain of custody form (after retaining the appropriate copies) in the box with the canister. Tape the box shut and place custody seals at each opening.

A-5
GWTP Record Drawings (To be submitted as Final)

A-6
MSDS

SAFETY DATA SHEET

CAUSTIC SODA LIQUID (ALL GRADES)

MSDS No.: M32415 **Rev. Date:** 05/29/2009 **Rev. Num.:** 08

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Company Identification:	Occidental Chemical Corporation 5005 LBJ Freeway P.O. Box 809050 Dallas, Tx 75380-9050
24 Hour Emergency Telephone Number:	1-800-733-3665 or 1-972-404-3228 (U.S.); 32.3.575.55.55 (Europe); 1800-033-111 (Australia)
To Request an MSDS:	MSDS@oxy.com or 1-972-404-3245
Customer Service:	1-800-752-5151 or 1-972-404-3700
Trade Name:	Caustic Soda Diaphragm Grade 10%, 15%, 18%, 20%, 25%, 30%, 35%, 40%, 50%, Caustic Soda Rayon Grade 18%, 20%, 25%, 30%, 50%, 50% Caustic Soda Rayon Grade OS, Caustic Soda Membrane 6%, 18%, 20%, 25%, 30%, 48%, 50%, 50% Caustic Soda Membrane OS, 50% Caustic Soda Diaphragm OS, Caustic Soda Low Salt 50%, 25% Caustic Soda Purified, 50% Caustic Soda Purified, 50% Caustic Soda Purified OS, Caustic Soda Liquid 70/30, Membrane Blended, 50% Caustic Soda Membrane (Northeast), 50% Caustic Soda Diaphragm (West Coast), 50% Blended Rayon Grade Blended, Membrane Cell Liquor
Synonyms:	Sodium hydroxide solution, Liquid Caustic, Lye Solution, Caustic, Lye, Soda Lye
Product Use:	Metal finishing, Cleaner, Process chemical, Petroleum industry

2. HAZARDS IDENTIFICATION

****

EMERGENCY OVERVIEW:

Color:	Colorless to slightly colored
Physical State:	Liquid
Odor:	Odorless
Signal Word:	Danger

MAJOR HEALTH HAZARDS: CORROSIVE. CAUSES BURNS TO THE RESPIRATORY TRACT, SKIN, EYES AND GASTROINTESTINAL TRACT. CAUSES PERMANENT EYE DAMAGE.
PHYSICAL HAZARDS: CORROSIVE. Mixing with water, acid or incompatible materials may cause splattering and release of heat.
ECOLOGICAL HAZARDS: Keep out of water supplies and sewers. This material is alkaline and may raise the pH of surface waters. This material has exhibited moderate toxicity to aquatic organisms.
PRECAUTIONARY STATEMENTS: Avoid breathing vapors or mist. Avoid contact with skin, eyes and clothing. Keep container tightly closed. Wash thoroughly after handling. Use only with adequate ventilation.
****

POTENTIAL HEALTH EFFECTS:

Inhalation: May cause irritation (possibly severe), chemical burns, and pulmonary edema.

Skin contact: May cause irritation (possibly severe) and chemical burns.

Eye contact: May cause irritation (possibly severe), chemical burns, eye damage, and blindness.

Ingestion: May cause irritation (possibly severe), chemical burns, nausea, and vomiting.

Target Organs Effected: Respiratory System, Skin, Eye

Medical Conditions Aggravated by Exposure: Asthma, Respiratory disorders

See Section 11: TOXICOLOGICAL INFORMATION

3. COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous Component	Concentration (by weight %)	CAS - No.
Water	48.5 - 94.5	7732-18-5
Sodium hydroxide	5.5 - 51.5	1310-73-2
Sodium chloride (NaCl)	1 - 5	7647-14-5

4. FIRST AID MEASURES

Inhalation: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. If respiration or pulse has stopped, have a trained person administer basic life support (Cardio-Pulmonary Resuscitation/Automatic External Defibrillator) and CALL FOR EMERGENCY SERVICES IMMEDIATELY.

Skin Contact: Immediately flush contaminated areas with water. Remove contaminated clothing, jewelry, and shoes immediately. Wash contaminated areas with soap and water. Thoroughly clean and dry contaminated clothing before reuse. Discard contaminated leather goods. GET MEDICAL ATTENTION IMMEDIATELY.

4. FIRST AID MEASURES

Eye Contact: Immediately flush eyes with a directed stream of water for at least 15 minutes, forcibly holding eyelids apart to ensure complete irrigation of all eye and lid tissues. Washing eyes within several seconds is essential to achieve maximum effectiveness. GET MEDICAL ATTENTION IMMEDIATELY.

Ingestion: Never give anything by mouth to an unconscious or convulsive person. If swallowed, do not induce vomiting. Give large amounts of water. If vomiting occurs spontaneously, keep airway clear. Give more water when vomiting stops. GET MEDICAL ATTENTION IMMEDIATELY.

Notes to Physician: The absence of visible signs or symptoms of burns does NOT reliably exclude the presence of actual tissue damage. Probable mucosal damage may contraindicate the use of gastric lavage.

5. FIRE-FIGHTING MEASURES

Fire Hazard: Negligible fire hazard.

Extinguishing Media: Use media appropriate for surrounding fire

Fire Fighting: Move container from fire area if it can be done without risk. Cool containers with water. Avoid contact with skin.

Sensitivity to Mechanical Impact: Not sensitive.

Sensitivity to Static Discharge: Not sensitive.

Flash point: Not flammable

6. ACCIDENTAL RELEASE MEASURES

Occupational Release:
Wear appropriate personal protective equipment recommended in Section 8 of the MSDS. Completely contain spilled material with dikes, sandbags, etc. Shovel dry material into suitable container. Liquid material may be removed with a vacuum truck. Remaining material may be diluted with water and neutralized with dilute acid, then absorbed and collected. Flush spill area with water, if appropriate. Keep product and flush water out of water supplies and sewers. This material is alkaline and may raise the pH of surface waters with low buffering capacity. Releases should be reported, if required, to appropriate agencies.

7. HANDLING AND STORAGE

Storage Conditions: Store and handle in accordance with all current regulations and standards. Keep container tightly closed and properly labeled. Do not store in aluminum container or use aluminum fittings or transfer lines, as flammable hydrogen gas may be generated. Keep separated from incompatible substances.

7. HANDLING AND STORAGE

Handling Procedures: Avoid breathing vapor or mist. Do not get in eyes, on skin, or on clothing. Wash thoroughly after handling. When mixing, slowly add to water to minimize heat generation and spattering.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

OSHA Regulatory Exposure limit(s):

Hazardous Component	CAS - No.	OSHA Final PEL TWA	OSHA Final PEL STEL	OSHA Final PEL Ceiling
Sodium hydroxide	1310-73-2	2 mg/m^3	-----	-----

Non-Regulatory Exposure Limit(s):

The Non-Regulatory OSHA limits shown in the table are the Vacated 1989 PEL's (vacated by 58 FR 35338, June 30, 1993).

Hazardous Component	CAS - No.	ACGIH TWA	ACGIH STEL	ACGIH Ceiling	OSHA TWA (Vacated)	OSHA STEL (Vacated)	OSHA Ceiling (Vacated)
Sodium hydroxide	1310-73-2	-----	-----	2 mg/m^3	-----	-----	2 mg/m^3

ENGINEERING CONTROLS: Provide local exhaust ventilation where dust or mist may be generated. Ensure compliance with applicable exposure limits.

PERSONAL PROTECTIVE EQUIPMENT:

Eye Protection: Wear chemical safety goggles with a faceshield to protect against eye and skin contact when appropriate. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

Skin and Body Protection: Wear chemical resistant clothing and rubber boots when potential for contact with the material exists. Contaminated clothing should be removed, then discarded or laundered.

Hand Protection: Wear appropriate chemical resistant gloves

Protective Material Types: Natural rubber, Neoprene, Nitrile

Hazardous Component	Immediately Dangerous to Life/ Health (IDLH)
Sodium hydroxide	10 mg/m^3 IDLH

Respiratory Protection: A NIOSH approved respirator with N95 (dust, fume, mist) cartridges may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits, or when symptoms have been observed that are indicative of overexposure. If eye irritation occurs, a full face style mask should be used. A respiratory protection program that meets 29 CFR 1910.134 must be followed whenever workplace conditions warrant use of a respirator.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Liquid
Appearance:	Clear to opaque
Color:	Colorless to slightly colored
Odor:	Odorless
Boiling Point/Range:	230 – 291 F (110 – 144 C)

9. PHYSICAL AND CHEMICAL PROPERTIES

Freezing Point/Range: -26 to 59 F (-32 to 15 C)
Vapor Pressure: 13 - 135 mmHg @ 60 C
Vapor Density (air=1): No data available
Specific Gravity (water=1): 1.11 – 1.53 @ 15.6 C
Water Solubility: 100%
pH: 14.0 (7.5% solution)
Volatility: No data available
Evaporation Rate (ether=1): No data available
Partition Coefficient (n-octanol/water): No data available

10. STABILITY AND REACTIVITY

Reactivity/ Stability: Stable at normal temperatures and pressures.

Conditions to Avoid: Mixing with water, acid or incompatible materials may cause splattering and release of large amounts of heat. Will react with some metals forming flammable hydrogen gas. Carbon monoxide gas may form upon contact with reducing sugars, food and beverage products in enclosed spaces.

Incompatibilities/ Materials to Avoid: Acids, Halogenated compounds, Prolonged contact with aluminum, brass, bronze, copper, lead, tin, zinc or other alkali sensitive metals or alloys

Hazardous Decomposition Products: Toxic fumes of sodium oxide

Hazardous Polymerization: Will not occur

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA:

Hazardous Component	LD50 Oral	LC50 Inhalation	LD50 Dermal
Sodium hydroxide	Not listed	Not listed	1350 mg/kg (Rabbit)
Sodium chloride (NaCl)	3 g/kg (Rat)	42 g/m^3 (1 hr-Rat)	10 g/kg (Rabbit)

TOXICITY:
The severity of the tissue damage is a function of its concentration, the length of tissue contact time, and local tissue conditions. After exposure there may be a time delay before irritation and other effects occur. This material is a strong irritant and is corrosive to the skin, eyes, and mucous membranes. This material may cause severe burns and permanent damage to any tissue with which it comes into contact. Inhalation will cause severe irritation, possible burns with pulmonary edema, which may lead to pneumonitis. Skin contact with this material may cause severe irritation and corrosion of tissue. Repeated exposure may cause dermatitis. Eye contact can cause severe irritation, corrosion with possible corneal damage and blindness. Ingestion may cause irritation, corrosion/ulceration, nausea, and vomiting.

CARCINOGENICITY: This product is not classified as a carcinogen by NTP, IARC or OSHA.

12. ECOLOGICAL INFORMATION

AQUATIC TOXICITY: This material has exhibited moderate toxicity to aquatic organisms. Data provided are for sodium hydroxide.

Freshwater Fish Data:
LC50 brook trout: 25 ppm/24 hr
LC50 king salmon: 48 ppm
Invertebrate Toxicity Data:
EC50 daphnia magna: 100 ppm
EC50 shrimp: 33 – 100 ppm/48 hr
EC50 cockle: 330 – 1000 ppm/48 hr

BIODEGRADATION: This material is inorganic and not subject to biodegradation.

PERSISTENCE: This material is alkaline and may raise the pH of surface waters with low buffering capacity. This material is believed to exist in the disassociated state in the environment.

BIOCONCENTRATION: This material is not expected to bioconcentrate in organisms.

ADDITIONAL ECOLOGICAL INFORMATION: This material has exhibited slight toxicity to terrestrial organisms.

13. DISPOSAL CONSIDERATIONS

Reuse or reprocess, if possible. Dispose in accordance with all applicable regulations. May be subject to disposal regulations: U.S. EPA 40 CFR 261. Hazardous Waste Number(s): D002

14. TRANSPORT INFORMATION

U.S.DOT 49 CFR 172.101:

PROPER SHIPPING NAME:	Sodium Hydroxide Solution
DOT UN NUMBER:	UN1824
HAZARD CLASS/ DIVISION:	8
PACKING GROUP:	II
LABELING REQUIREMENTS:	8
DOT RQ (lbs):	RQ 1000 lbs. (Sodium Hydroxide)

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:

SHIPPING NAME:	Sodium hydroxide solution
UN NUMBER:	UN1824
CLASS:	8
PACKING/RISK GROUP:	II

15. REGULATORY INFORMATION

U.S. REGULATIONS

OSHA REGULATORY STATUS:
This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200) (US).

CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4):
If a release is reportable under CERCLA section 103, notify the state emergency response commission and local emergency planning committee. In addition, notify the National Response Center at (800) 424-8802 or (202) 426-2675.

Hazardous Component	CERCLA Reportable Quantities:
Sodium hydroxide	1000 lb (final RQ)

EPCRA EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.30): No components are listed.

EPCRA SECTIONS 311/312 HAZARD CATEGORIES (40 CFR 370.21):
Acute Health Hazard

EPCRA SECTION 313 (40 CFR 372.65): No components are listed.

OSHA PROCESS SAFETY (29 CFR 1910.119): Not regulated

NATIONAL INVENTORY STATUS

U.S. INVENTORY STATUS (TSCA): All components are listed or exempt

TSCA 12(b): This product is not subject to export notification

CANADIAN DOMESTIC SUBSTANCE LIST (DSL/NDSL): All components are listed.

STATE REGULATIONS

California Proposition 65: This product is not listed, but it may contain contaminants known to the State of California to cause cancer or reproductive toxicity as listed under Proposition 65 State Drinking Water and Toxic Enforcement Act. For additional information, contact OxyChem Customer Service.

Hazardous Component	Sodium hydroxide
California Proposition 65 Cancer WARNING:	Not Listed
California Proposition 65 CRT List - Male reproductive toxin:	Not Listed
California Proposition 65 CRT List - Female reproductive toxin:	Not Listed
Massachusetts Right to Know Hazardous Substance List	Listed
New Jersey Right to Know Hazardous Substance List	Listed
New Jersey Special Health Hazards Substance List	Listed
Pennsylvania Right to Know Hazardous Substance List	Listed
Pennsylvania Right to Know Environmental Hazard List	Listed
Rhode Island Right to Know Hazardous Substance List	Listed

CANADIAN REGULATIONS:
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

	WHMIS Classification:	E

16. OTHER INFORMATION

Prepared by: OxyChem Corporate HESS - Health Risk Management

HMIS: (SCALE 0-4) (Rated using National Paint & Coatings Association HMIS: Rating Instructions, 2nd Edition)

Health:	3	**Flammability:**	0	**Reactivity:**	1

NFPA 704 - Hazard Identification Ratings (SCALE 0-4)

Health:	3	**Flammability:**	0	**Reactivity:**	1

Reason for Revision:
1. Removed Chronic Toxicity: SEE SECTION 11

IMPORTANT:
The information presented herein, while not guaranteed, was prepared by technical personnel and is true and accurate to the best of our knowledge. NO WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTY OR GUARANTY OF ANY OTHER KIND, EXPRESS OR IMPLIED, IS MADE REGARDING PERFORMANCE, SAFETY, SUITABILITY, STABILITY OR OTHERWISE. This information is not intended to be all-inclusive as to the manner and conditions of use, handling, storage, disposal and other factors that may involve other or additional legal, environmental, safety or performance considerations, and OxyChem assumes no liability whatsoever for the use of or reliance upon this information. While our technical personnel will be happy to respond to questions, safe handling and use of the product remains the responsibility of the customer. No suggestions for use are intended as, and nothing herein shall be construed as, a recommendation to infringe any existing patents or to violate any Federal, State, local or foreign laws.

Standard 29 CFR 1910.1200 requires that information be provided to employees regarding the hazards of chemicals by means of a hazard communication program including labeling, material safety data sheets, training and access to written records. We request that you, and it is your legal duty to, make all information in this Material Safety Data Sheet available to your employees.

A-7
Warranties

Ceco Building Systems

Precoated SIGNATURE® 200 Panel
LIMITED WARRANTY

Ceco Building Systems (hereinafter referred to as "Manufacturer") warrants the panels, effective from the date of shipment, will perform in accordance to the following Signature® 200 Warranty:

PERFORMANCE SUMMARY

A. FILM INTEGRITY: The paint film WILL NOT crack, check, or peel for a period of twenty-five (25) years for Wall and Roof panels, except; Crimson Red, in which case the period is twenty (20) years. Cracking is defined as breaks in the flat coating as opposed to breaks in the film caused by metal forming, which is not warranted hereunder.

B. CHALK AND FADE: The paint film WILL NOT;

(1) For a period of twenty-five (25) years, chalk in excess of a numerical rating of 8 for vertical panel applications or 7 for non-vertical panel applications, when measured in accordance with the standard procedures as defined by the "Standard Methods of Evaluating Degree of Chalking of Exterior Paints", ASTM D4214, except; Crimson Red, in which case the period is five (5) years, Polar White, in which case this warranty for chalk does not apply, or

(2) For a period of twenty-five (25) years, fade or change in color in excess of 5 color difference units for vertical panel applications or 6 color difference units for non-vertical panel applications, measured in accordance with ASTM D2244 on the exposed painted surfaces which have been cleaned of external deposits and chalk and the corresponding values measured on the original (unexposed) painted surfaces, except; Crimson Red, in which case the period is five (5) years. It is understood that fading or color changes may not be uniform if the surfaces are not equally exposed to the sun and elements.

TERMS AND CONDITIONS

1. This warranty covers the material exposed to normal atmospheric conditions (which term excludes exposure to salt spray or corrosive or aggressive atmospheres such as, but not limited to, those contaminated with chemical fumes) in the continental United States, Alaska or Canada, unless Manufacturer agrees otherwise in writing. This warranty shall not apply where material failure is the result of fire, other accident or casualty, vandalism, salt spray, atomic radiation, harmful fumes or foreign substances in the atmosphere, acts of God, or other such occurrences beyond Manufacturer's control.
2. This warranty will not extend to or cover damages to the material due to improper packaging, shipping or processing as specified in the National Coil Coaters Association Technical Bulletin No. IV- (7), improper handling (whether pre-erection or during erection), improper storage, improper erection, or improper installation (which includes failure to permit drainage of standing water.)
3. Microscopic crazing of the film on formed radii is considered normal and is not to be construed as film cracking.
4. This warranty does not apply in the event of deterioration to the panels caused directly or indirectly by panel contact with inferior fasteners. Selection of suitable long-lasting fasteners to be used with Manufacturer's extended life panels rests solely with the Purchaser.
5. The improper use of Manufacturer's seaming equipment or use of seaming equipment obtained from a party other than the Manufacturer may result in this and all warranties being void.
6. This warranty will not extend to or cover:
   a) Damage to the coating occasioned by moisture or other contamination detrimental to the coating because of improper storage of the coated Metal prior to installation.
   b) Water damage to any materials after they leave the possession of the Manufacturer.
   c) Damage to the prepainted metal caused by shipping, handling, and/or installation, storing, erecting and/or handling of the panels on the job site and/or any act or acts of negligence of the customer or any third party after the panels leave the possession of the Manufacturer.
   d) Damage to the coated Metal as a result of standing water in non-vertical application.
   e) Damage to the prepainted metal caused by cascading water.
   f) Damage to the coated Metal caused by contact with, or water run-off from, lead, copper, graphite or other dissimilar material. This includes, but is not limited to, A/C condensation and treated wood.
   g) Damage to the coated Metal caused by contact with corrosive substances, or allowing panel cut edges to be in continual contact with water, damp insulation, soil or vegetation i.e. setting wall panels directly on the concrete sheeting notch or base trim.
   h) This warranty does not apply to products, materials, accessories, parts, or attachments which are not produced by the Manufacturer. In addition, all items not specifically listed as included are hereby excluded from this warranty.
7. Customer shall exercise diligence in inspection of materials as received from Manufacturer prior to use so as to mitigate expense involved to Manufacturer under this warranty.
8. This warranty does not apply to the interior or reverse side finish nor does it extend to pre-painted materials used in interior (not atmospherically exposed) applications.
9. This warranty applies only to the paint film on the material and does not cover in any way any other aspect of the material.
10. If the panel finish fails to perform as indicated under the terms of Performance outlined above, Manufacturer shall have no liability with respect thereto except, at its sole option to repaint, replace, or restore the failed material, which shall be the purchaser's sole and exclusive remedy. When Manufacturer chooses to replace the defective coated Metal, its sole obligation is for the replacement of the material only. Manufacturer shall not be liable for any expenses connected with labor for the replacement of the defective material or any consequential damages. Repainting shall not necessarily be with Signature® 200. In no event, however, shall Manufacturer's responsibility extend to any consequential damages, or for any special, indirect, or consequential loss of profits or any other incidental, general, special, or compensatory damages to anyone because such panels may have been nonconforming. In all cases Manufacturer reserves the right to approve and negotiate the contract for such repainting or restoring. The warranty on any repainted, replaced or restored coated material supplied hereunder shall be for the unexpired portion of the warranty period applicable to the original coated material.

Precoated SIGNATURE® 200 Panel
LIMITED WARRANTY

TERMS AND CONDITIONS (CONT.)

11. Claims must be reported in writing to Manufacturer within thirty (30) days after discovery of nonconformance. Adequate identification of the material involved in the claim, including date of installation, Manufacturer order number, Manufacturer invoice number, and date of shipment must be established by Buyer. A copy of this document must be presented to Manufacturer at time of claim. All notices given under or pursuant to this Agreement shall be in writing and sent by registered mail, postage prepaid, return receipt requested to:

NCI Building Systems, L.P.
P.O. Box 602055
Houston, TX 77269-2055
Attn: Claims Department

12. No terms or conditions other than those stated herein and no agreement or understanding, oral or written in any way purporting to modify this warranty shall be binding on Manufacturer unless made in writing and signed by the President of Manufacturer.
13. This warranty shall extend to the original Building Owner and is non-assignable and/or non-transferable. Should the Owner become insolvent, bankrupt, make an assignment for the benefit of its creditors, or for any reason discontinue its normal or regular business practices, this warranty shall forthwith become null and void and of no legal effect.
14. Any party seeking to enforce claims under this Warranty hereby acknowledges and agrees that (i) all matters relating to the validity, performance, interpretation, and/or enforcement of this Warranty shall be governed by and construed in accordance with the laws of the State of Texas, (ii) any and all claims, actions, proceedings or causes of action relating to the validity, performance, interpretation, and/or enforcement hereof must be submitted to a court of competent jurisdiction in Houston, Harris County, Texas, (iii) this Warranty is capable of being performed in Harris County, Texas, (iv) it irrevocably submits itself to the jurisdiction of the state and federal courts in Harris County, Texas, (v) service of process may be made upon it in any legal proceeding in connection with this Warranty or any other agreement as provided by Texas law, (vi) it irrevocably waives, to the fullest extent permitted by law, any objection that it may now or hereafter have to the laying of venue of any litigation arising out of or in connection with this Warranty or any other agreement or transaction brought in any such court, (vii) it irrevocably waives any claims that litigation brought in any such court has been brought in an inconvenient forum, and (viii) it irrevocably consents to the service of process out of any of the aforementioned courts by the mailing of copies thereof by Certified Mail, Return Receipt Requested, postage prepaid, and its address set forth herein. The scope of each of the foregoing waivers is intended to be all encompassing. Each party acknowledges that this waiver is a material inducement to the agreement of each party hereto to enter into a business relationship, and that each has already relied on this waiver in entering into this Warranty. Each party warrants and represents that it has reviewed these waivers with its legal counsel, and that it knowingly and voluntarily agrees to each such waiver following consultation therewith.
15. **FORCE MAJEURE. UNDER NO CIRCUMSTANCES SHALL MANUFACTURER BE LIABLE IN ANY WAY TO THE BUILDING OWNER OR ANY OTHER PARTY FOR DELAYS, FAILURE IN PERFORMANCE, OR LOSS OR DAMAGE DUE TO *FORCE MAJEURE* CONDITIONS INCLUDING, WITHOUT LIMITATION: FIRE; LIGHTNING; STRIKE; EMBARGO; EXPLOSION; POWER SURGE OR FAILURE; ACTS OF GOD; WAR; LABOR OR EMPLOYMENT DISPUTES; CIVIL DISTURBANCES; ACTS OF CIVIL OR MILITARY AUTHORITY; INABILITY TO SECURE MATERIALS, FUEL, PRODUCTS OR TRANSPORTATION FACILITIES; ACTS OR OMISSIONS OF SUPPLIERS, OR ANY OTHER CAUSES BEYOND ITS REASONABLE CONTROL, WHETHER OR NOT SIMILAR TO THE FOREGOING.**
16. Notwithstanding the foregoing, the warranty coverage provided above by Manufacturer shall be expressly limited to and shall include only such warranty coverage on coatings applied to Manufacturer's panel materials by the original supplier(s) thereof. Any and all such warranty coverage available from Manufacturer shall apply only to the same extent that such warranty coverage is available from the original supplier thereof. To the extent that warranty coverage from such supplier(s) is unavailable for any reason whatsoever, Manufacturer shall not have any further liability to purchaser or any other party.

DISCLAIMER-EXCEPT AS EXPRESSLY STATED HEREIN, THE ABOVE WARRANTY PROVISIONS DO NOT COVER COATINGS, PRODUCTS, ACCESSORIES, PARTS OR ATTACHMENTS THAT ARE NOT PRODUCED BY MANUFACTURER. EXCEPT AS OTHERWISE EXPRESSLY STATED, THERE IS NO WARRANTY, REPRESENTATION OR CONDITION OF ANY KIND AND ANY WARRANTY, EXPRESS OR IMPLIED, IS HEREBY EXCLUDED AND DISCLAIMED INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE. NOTWITHSTANDING ANYTHING ELSE CONTAINED HEREIN TO THE CONTRARY, IT IS EXPRESSLY UNDERSTOOD AND AGREED THAT MANUFACTURER'S LIABILITY AND PURCHASER'S SOLE REMEDY, WHETHER IN CONTRACT, UNDER ANY WARRANTY, IN TORT (INCLUDING NEGLIGENCE), IN STRICT LIABLITY OR OTHERWISE SHALL NOT EXCEED THE COST OF THE AMOUNT OF THE MATERIALS, EXPRESSLY EXCLUDING LABOR COSTS AND EXPENSES, COSTS OF RENTING REPLACEMENTS AND ANY OTHER ADDITIONAL EXPENSES. UNDER NO CIRCUMSTANCES SHALL MANUFACTURER BE LIABLE FOR ANY SPECIAL, INCIDENTAL, LIQUIDATED OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO, PERSONAL INJURY, PROPERTY DAMAGE, DAMAGE TO OR LOSS OF EQUIPMENT, LOST PROFITS OR REVENUE, LABOR COSTS AND EXPENSES, COSTS OF RENTING REPLACEMENTS AND OTHER ADDITIONAL EXPENSES, EVEN IF MANUFACTURER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. MANUFACTURER WILL NOT BE LIABLE FOR ANY DAMAGES, LOSSES OR EXPENSES AS A RESULT OF PURCHASER'S (OR ANY OTHER PARTY'S) NEGLIGENCE, WHETHER DEEMED ACTIVE OR PASSIVE AND WHETHER OR NOT ANY SUCH NEGLIGENCE IS THE SOLE OR PARTIAL CAUSE OF ANY SUCH DAMAGE, LOSS OR EXPENSE. IN ADDITION, UNDER NO CIRCUMSTANCES SHALL MANUFACTURER BE LIABLE FOR ANY DAMAGES, LOSSES OR EXPENSES WHATSOEVER AS A RESULT OF ANY OTHER PARTY'S MATERIALS OR PRODUCTS WHICH CAUSE OR ALLEGEDLY CAUSE, IN WHOLE OR IN PART, DAMAGE, LOSS OR DETERIORATION TO THE MANUFACTURER'S WALL AND/OR ROOF PANELS.

United States Department of Navy - Bethpage, NY
Project Name

12-B-10433
Manufacturer's Job #

MAP - Polar White
Color(s)

Authorized Representative

4/21/09
Date

Ceco Building Systems

BARE GALVALUME®

20 YEAR LIMITED WARRANTY

Ceco Building Systems (hereinafter referred to as "Manufacturer") warrants the panels will perform in accordance to the following Bare GALVALUME® Warranty:

Manufacturer's hot dipped aluminum-zinc alloy coated GALVALUME® sheet steel sold for use as unpainted steel building roofing and siding panels, if erected within the United States WILL NOT rupture, fail structurally, or perforate within a period of 20 years from date of shipment due to exposure to normal atmospheric corrosion.

THIS WARRANTY DOES NOT APPLY to sheets exposed at any time to corrosive or aggressive atmospheric conditions, including but not limited to:

1. Areas subject to saltwater marine atmospheres or to constant spraying of either salt or fresh water.
2. Areas subject to fallout or exposure to corrosive chemicals, fumes, ash, cement dust, or animal waste.
3. Areas subject to water run-off from lead or copper flashings or areas in metallic contact with lead or copper.
4. Conditions/circumstances where corrosive fumes or condensates are generated or released inside the building.

This warranty DOES NOT APPLY in the event of:

A. Degree of bending less than 2T for sheet gauges up to 0.030 in. and degree of bending less than 4T for sheet gauges 0.031 in. and thicker.
B. Slopes of roof or sections of the roof flatter than ¼:12.
C. Mechanical, chemical or other damage sustained during shipment, storage, forming, fabrication, during or after erection.
D. Forming which incorporates severe reverse bending or which subjects coating to alternate compression and tension.
E. Failure to provide free drainage of water, including internal condensation, from overlaps and all other surfaces of the sheets or panels.
F. Failure to remove debris from overlaps and all other surfaces of the sheets or panels.
G. Damage caused to the metallic coating by improper scouring or cleaning procedures.
H. Deterioration of the panels caused by contact with green, wet, or pressure-treated lumber or wet storage stain caused by water damage or condensation.
I. Presence of damp insulation, soil, vegetation or other corrosive materials in contact with or close proximity to the panel.
J. This warranty does not apply in the event of deterioration to the panels caused directly or indirectly by the panel contact with fasteners. Selection of suitable long lasting fasteners to be used with GALVALUME® roofing and siding panels rests solely with the buyer.
K. Damage to the GALVALUME® coating caused by cascading water.
L. Damage caused by cutting panels with an abrasive blade saw or other means which damages the GALVALUME® coating.
M. Damages to the coated Metal caused by contact with, or water run-off from, lead, copper graphite or dissimilar material. This includes A/C condensation.

This warranty shall be subject to the stipulations, limitations, and conditions hereinafter set forth:

1. Manufacturer's liability for breach of this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, rupturing, perforating, or structurally failing panels.
2. Manufacturer shall not in any event be liable for the cost of labor expended by others on any nonconforming, rupturing, perforating or structurally failing sheet or for any special, indirect, or consequential loss of profits or any other incidental, general, special or compensatory damages to anyone by reason of the fact that such panels shall have been nonconforming, rupturing, perforating, or structurally failing.
3. This warranty will not extend to or cover damages to the material due to shipping, improper handling (whether pre-erection or during erection), improper storage, improper erection, or improper installation (which includes failure to permit drainage of standing water.)
4. Claims must be reported in writing to Manufacturer within thirty (30) days after discovery of nonconformance, rupture, perforation, or structural failing and Manufacturer shall be given a reasonable opportunity (which shall not be less than thirty days from the date of receipt of notification) to inspect the panels claimed to be non conforming, rupturing, perforating, or structurally failing. Adequate identification of the material involved in the claim, including date of installation, Manufacturer's order number invoice number and date of shipment must be established by Buyer. A copy of this document must be presented to Manufacturer at time of claim.
5. The improper use of Manufacturer's seaming equipment or use of seaming equipment obtained from a party other than the Manufacturer may result in this and all warranties being void.
6. Buyer shall exercise diligence in inspection of sheets as received from Manufacturer so as to mitigate any expenses to Manufacturer under this warranty.
7. This warranty shall extend to the original Building Owner and is non-assignable and/or nontransferable. Should the Owner become insolvent, bankrupt, make an assignment for the benefit of its creditors, or for any other reason discontinue its normal or regular business practice, this warranty shall forthwith become null and void and of no legal effect.
8. Manufacturer reserves the right to terminate this warranty at any time (except as to orders already accepted) upon the giving of written notice thereof.

BARE GALVALUME®
20 YEAR LIMITED WARRANTY

9. Panel repaired or sheet product furnished under this warranty shall not extend the original warranty time period hereunder.
10. Any party seeking to enforce claims under this Warranty hereby acknowledges and agrees that (i) all matters relating to the validity, performance, interpretation, and/or enforcement of this Warranty shall be governed by and construed in accordance with the laws of the State of Texas, (ii) any and all claims, actions, proceedings or causes of action relating to the validity, performance, interpretation, and/or enforcement hereof must be submitted to a court of competent jurisdiction in Houston, Harris County, Texas, (iii) this Warranty is capable of being performed in Harris County, Texas, (iv) it irrevocably submits itself to the jurisdiction of the state and federal courts in Harris County, Texas, (v) service of process may be made upon it in any legal proceeding in connection with this Warranty or any other agreement as provided by Texas law, (vi) it irrevocably waives, to the fullest extent permitted by law, any objection that it may now or hereafter have to the laying of venue of any litigation arising out of or in connection with this Warranty or any other agreement or transaction brought in any such court, (vii) it irrevocably waives any claims that litigation brought in any such court has been brought in an inconvenient forum, and (viii) it irrevocably consents to the service of process out of any of the aforementioned courts by the mailing of copies thereof by Certified Mail, Return Receipt Requested, postage prepaid, and its address set forth herein. The scope of each of the foregoing waivers is intended to be all encompassing. Each party acknowledges that this waiver is a material inducement to the agreement of each party hereto to enter into a business relationship, and that each has already relied on this waiver in entering into this Warranty. Each party warrants and represents that it has reviewed these waivers with its legal counsel, and that it knowingly and voluntarily agrees to each such waiver following consultation therewith.
11. This warranty is the full and complete agreement of the parties and shall not be modified, altered or extended except in writing and signed by an authorized agent of the Manufacturer and the Buyer.
12. **FORCE MAJEURE. UNDER NO CIRCUMSTANCES SHALL MANUFACTURER BE LIABLE IN ANY WAY TO THE BUILDING OWNER OR ANY OTHER PARTY FOR DELAYS, FAILURE IN PERFORMANCE, OR LOSS OR DAMAGE DUE TO *FORCE MAJEURE* CONDITIONS INCLUDING, WITHOUT LIMITATION: FIRE; LIGHTNING; STRIKE; EMBARGO; EXPLOSION; POWER SURGE OR FAILURE; ACTS OF GOD; WAR; LABOR OR EMPLOYMENT DISPUTES; CIVIL DISTURBANCES; ACTS OF CIVIL OR MILITARY AUTHORITY; INABILITY TO SECURE MATERIALS, FUEL, PRODUCTS OR TRANSPORTATION FACILITIES; ACTS OR OMISSIONS OF SUPPLIERS, OR ANY OTHER CAUSES BEYOND ITS REASONABLE CONTROL, WHETHER OR NOT SIMILAR TO THE FOREGOING.**
13. Notwithstanding the foregoing, the warranty coverage provided above by the Manufacturer shall be expressly limited to and shall include only such warranty coverage on coatings applied to Manufacturer's panel materials by the original supplier(s) thereof. Any and all such warranty coverage available from Manufacturer shall apply only to the same extent that such warranty coverage is available from the original supplier thereof. To the extent that warranty coverage from such supplier(s) is unavailable for any reason whatsoever, Manufacturer shall not have any further liability to purchaser or any other party.
14. All notices given under or pursuant to this Agreement shall be in writing and sent by registered mail, postage prepaid, return receipt requested, to:

NCI Building Systems, L.P.
P.O. Box 602055
Houston, TX 77269-2055
Attn: Claims Department

DISCLAIMER-EXCEPT AS EXPRESSLY STATED HEREIN, THE ABOVE WARRANTY PROVISIONS DO NOT COVER COATINGS, PRODUCTS, ACCESSORIES, PARTS OR ATTACHMENTS THAT ARE NOT PRODUCED BY MANUFACTURER. EXCEPT AS OTHERWISE EXPRESSLY STATED, THERE IS NO WARRANTY, REPRESENTATION OR CONDITION OF ANY KIND AND ANY WARRANTY, EXPRESS OR IMPLIED, IS HEREBY EXCLUDED AND DISCLAIMED INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE. NOTWITHSTANDING ANYTHING ELSE CONTAINED HEREIN TO THE CONTRARY, IT IS EXPRESSLY UNDERSTOOD AND AGREED THAT MANUFACTURER'S LIABILITY AND PURCHASER'S SOLE REMEDY, WHETHER IN CONTRACT, UNDER ANY WARRANTY, IN TORT (INCLUDING NEGLIGENCE), IN STRICT LIABLITY OR OTHERWISE SHALL NOT EXCEED THE COST OF THE AMOUNT OF THE MATERIALS, EXPRESSLY EXCLUDING LABOR COSTS AND EXPENSES, COSTS OF RENTING REPLACEMENTS AND ANY OTHER ADDITIONAL EXPENSES. UNDER NO CIRCUMSTANCES SHALL MANUFACTURER BE LIABLE FOR ANY SPECIAL, INCIDENTAL, LIQUIDATED OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO, PERSONAL INJURY, PROPERTY DAMAGE, DAMAGE TO OR LOSS OF EQUIPMENT, LOST PROFITS OR REVENUE, LABOR COSTS AND EXPENSES, COSTS OF RENTING REPLACEMENTS AND OTHER ADDITIONAL EXPENSES, EVEN IF MANUFACTURER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. MANUFACTURER WILL NOT BE LIABLE FOR ANY DAMAGES, LOSSES OR EXPENSES AS A RESULT OF PURCHASER'S (OR ANY OTHER PARTY'S) NEGLIGENCE, WHETHER DEEMED ACTIVE OR PASSIVE AND WHETHER OR NOT ANY SUCH NEGLIGENCE IS THE SOLE OR PARTIAL CAUSE OF ANY SUCH DAMAGE, LOSS OR EXPENSE. IN ADDITION, UNDER NO CIRCUMSTANCES SHALL MANUFACTURER BE LIABLE FOR ANY DAMAGES, LOSSES OR EXPENSES WHATSOEVER AS A RESULT OF ANY OTHER PARTY'S MATERIALS OR PRODUCTS WHICH CAUSE OR ALLEGEDLY CAUSE, IN WHOLE OR IN PART, DAMAGE, LOSS OR DETERIORATION TO THE MANUFACTURER'S WALL AND/OR ROOF PANELS.

United States Department of Navy - Bethpage, NY
Project Name

Authorized Representative

12-B-10433
Manufacturer's Job #

4/21/09
Date

Ceco Building Systems

PRODUCT WARRANTY

CECO BUILDING SYSTEMS (SELLER) WARRANTS TO THE ORIGINAL PURCHASER (BUYER) AND TO THE ORIGINAL BUILDING OWNER ONLY AS SHOWN BELOW, ITS PRODUCTS AS LISTED BELOW, AND SUBJECT TO THE LIMITATIONS, TERMS, CONDITIONS AND EXCLUSIONS SET FORTH HEREIN:

FABRICATED STEEL COMPONENTS ARE WARRANTED ONLY AGAINST FAILURE DUE TO DEFECTIVE MATERIAL OR WORKMANSHIP FOR A PERIOD OF ONE YEAR EFFECTIVE FROM DATE OF SHIPMENT.

WARRANTY DISCLAIMER

I. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES (SAVE AND EXCEPT ANY WRITTEN WARRANTIES ISSUED BY SELLER AND SIGNED BY AN OFFICER OF SELLER FOR A SPECIFIC ROOF SYSTEM), WHETHER EXPRESS, IMPLIED OR STATUTORY, AND ALL OTHER LIABILITIES (CONTRACT, TORT OR OTHERWISE, INCLUDING NEGLIGENCE) AND SELLER MAKES NO WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR ANY PARTICULAR PURPOSE. THIS WARRANTY WILL AUTOMATICALLY TERMINATE AND BECOME VOID UPON THE SALE, TRANSFER OR CONVEYANCE (EXCEPT TO SECURE DEBT) OF THE PRODUCTS OR BUILDING OR PROPERTY ON WHICH THE PRODUCTS ARE ERECTED.

IN CONSIDERATION OF THE SALE OF THE PRODUCTS AND THIS WARRANTY, SELLER SHALL NOT BE RESPONSIBLE OR LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL OR SPECIAL DAMAGES, EXPENSES, LOSS TO THE BUILDING OR LOSS OF THE USE THEREOF, EITHER IN CONTRACT, NEGLIGENCE OR TORT, ARISING OUT OF ANY FAILURE OF THE PRODUCTS, BREACH OF WARRANTY OR FOR OTHER CAUSE.

SELLER DOES NOT MAKE ANY WARRANTY OR ASSUME ANY OBLIGATION WITH RESPECT TO THE VALIDITY OF ANY PATENTS, DESIGNS, COPYRIGHTS OR TRADEMARKS WHICH MAY COVER SUCH PRODUCTS. THE CONDITIONING OF LIABILITY, RIGHTS, OBLIGATIONS AND REMEDIES OF THE PARTIES RELATING TO CLAIMS ARISING FROM DEFECTIVE PRODUCTS SHALL BE GOVERNED EXCLUSIVELY BY THE TERMS HEREOF.

II. A. THIS WARRANTY IS SUBJECT TO THE FOLLOWING CONDITIONS, TERMS, LIMITATIONS AND EXCLUSIONS.

B. ACTIVATION. IN ORDER TO SEGREGATE AND MAINTAIN FOR THE EXTENDED PERIOD OF TIME COVERED BY THIS WARRANTY, THE RECORDS AND LOT SAMPLES NECESSARY TO ENABLE SELLER TO TRACE THE VARIOUS COMPONENTS MANUFACTURED FOR ANY DEFECTS ALLEGED, SELLER REQUIRES THAT BUYER, WITHIN 90 DAYS FROM THE EFFECTIVE DATE OF THIS WARRANTY, MUST INDICATE THE DESIRE TO BE COVERED HEREUNDER, AND ACTIVATE IT BY A DATED EXECUTION IN THE SPACE PROVIDED HEREIN AND BY MAILING SUCH EXECUTED COPY TO SELLER VIA REGISTERED OR CERTIFIED MAIL, RETURN RECEIPT REQUESTED. IT IS A CONDITION PRECEDENT TO THE FILING OF A CLAIM UNDER THIS WARRANTY THAT BUYER PROVE COMPLIANCE WITH THIS REQUIREMENT.

C. THIS WARRANTY IS LIMITED TO THE ORIGINAL OWNER OF THE BUILDING (BUYER), IS SPECIFICALLY NON-ASSIGNABLE, NON-TRANSFERABLE AND IS EFFECTIVE ONLY IF ACTIVATED BY STRICT COMPLIANCE WITH THE PROVISIONS OF PARAGRAPH II B ABOVE (ACTIVATION).

D. BUYER SHALL EXERCISE DILIGENCE IN INSPECTION OF MATERIALS AS RECEIVED FROM SELLER PRIOR TO UTILIZATION SO AS TO MITIGATE EXPENSE INVOLVED IN REPAIRING, REPAINTING, OR REPLACING NONCONFORMING PRODUCTS.

1. THIS WARRANTY APPLIES ONLY TO THE ABOVE-DESCRIBED PRODUCTS OF SELLER AND DOES NOT COVER ACCESSORIES, FIXTURES, INSULATION, GOODS OR MATERIALS NOT MANUFACTURED BUT SOLD BY SELLER. THIS WARRANTY SHALL BE VALID AND APPLY TO SELLERS PRODUCTS ONLY IF THE PRODUCTS ARE ERECTED AND INSTALLED STRICTLY IN ACCORDANCE WITH SELLER'S ENGINEERING PLANS AND SPECIFICATIONS, SELLER'S PROJECT SPECIFIC ERECTION DETAILS, SELLER'S STANDARD ERECTION INSTRUCTIONS AND DETAILS CURRENT AT THE TIME OF PRODUCT SHIPMENT TO JOBSITE BY SELLER AND ALL APPLICABLE ERECTION STANDARDS AND PROCEDURES REGULARLY PUBLISHED BY THE METAL BUILDING MANUFACTURE'S ASSOCIATION. ANY MODIFICATION OF, DEVIATION OR VARIATION FROM THE SPECIFIED MATERIALS, PRODUCTS OR SPECIFIED ERECTION PROCEDURES WITHOUT THE PRIOR WRITTEN CONSENT OF AN OFFICER OF SELLER, WILL VOID THIS WARRANTY.
2. THIS WARRANTY IS APPLICABLE ONLY TO PRODUCT DAMAGE OR FAILURE CAUSED BY "NORMAL ATMOSPHERIC EXPOSURE" WHICH SHALL NOT BE CONSTRUED TO INCLUDE THE FOLLOWING CONDITIONS WHICH ARE SPECIFICALLY EXCLUDED FROM THIS WARRANTY:
   a. DETERIORATION CAUSED BY MARINE (SALT WATER) ATMOSPHERES OR BY CONSTANT EXPOSURE TO EITHER SALT OR FRESH WATER.
   b. CORROSION CAUSED BY HEAVY FALLOUT OR EXPOSURE TO CORROSIVE CHEMICALS, ASH, OR FUMES FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, PAPER PLANTS, FERTILIZERS, ANIMAL WASTE, OR ANY SIMILAR FOREIGN CHEMICAL SUBSTANCES.
   c. DETERIORATION CAUSED BY CORROSIVE FUMES OR CONDENSATES OF HARMFUL SUBSTANCES GENERATED OR RELEASED INSIDE THE BUILDING.

d. DAMAGE DUE TO CONTACT WITH GREEN OR WET LUMBER.

e. IF THE PRODUCTS ARE ERECTED IN AN AREA WHICH IS ORIGINALLY A "NORMAL ATMOSPHERIC EXPOSURE" BUT THE ENVIRONMENT SUBSEQUENTLY CHANGES TO THE ONE THAT IS NOT A "NORMAL" ATMOSPHERE (E.G. THE CONSTRUCTION OF A CHEMICAL PLANT NEARBY) THIS WARRANTY WILL THEN BE VOID.

3. THIS WARRANTY IS LIMITED TO PRODUCTS OF SELLER WHICH ARE SOLD AND ERECTED WITHIN THE CONTINENTAL UNITED STATES OF AMERICA, ALASKA, HAWAII AND CANADA.

4. THIS WARRANTY SHALL NOT APPLY TO ANY STRUCTURAL OR PANEL FAILURE ATTRIBUTABLE TO ENGINEERING DESIGN CAUSED BY INCORRECT, INADEQUATE, OR ERRONEOUS DESIGN INFORMATION TRANSMITTED TO SELLER, BY OR THROUGH THE OWNER, CONTRACTOR OR THEIR RESPECTIVE DESIGN REPRESENTATIVE.

5. THIS WARRANTY SPECIFICALLY EXCLUDES THE FOLLOWING:

   a. DAMAGES CAUSED BY WORKERS OR OTHER TRAFFIC ON THE ROOF.
   b. DAMAGES CAUSED BY ACT OF GOD - INCLUDING, BUT NOT LIMITED TO, LIGHTNING, STRONG GALE, HURRICANE, TORNADO, EARTHQUAKE, FIRE OR FLOOD.
   c. DAMAGES CAUSED BY ANY OTHER CAUSE BEYOND THE CONTROL OF SELLER, INCLUDING, BUT NOT LIMITED TO, THE FOLLOWING EXAMPLES:
      i. IF AFTER ERECTION, THERE ARE ALTERATIONS, SUCH AS, BUT NOT LIMITED TO, STRUCTURES, FIXTURES OR UTILITIES BEING PLACED UPON OR ATTACHED TO THE STRUCTURE OR OVERLOADING BRIDGE CRANES.
      ii. IF THERE IS ANY FAILURE BY THE BUYER TO USE REASONABLE CARE IN MAINTENANCE.
      iii. IF BUYER FAILS TO COMPLY WITH EVERY TERM AND/OR CONDITION STATED IN THIS WARRANTY.
      iv. FOUNDATION MOVEMENT.
   d. DAMAGE TO THE PRIMER PAINT COATING ON THE PRIMARY OR SECONDARY FRAMING MEMBERS.

6. CLAIMS FOR ANY DEFECTS OR BREACH OF THIS WARRANTY MUST BE SUBMITTED BY THE OWNER, OR OWNER'S REPRESENTATIVE, BY WRITTEN NOTICE WITHIN THE WARRANTY PERIOD AND WITHIN THIRTY (30) DAYS OF THE OCCURRENCE OF A FAILURE OR BREACH OF WARRANTY SO THAT SELLER HAS REASONABLE OPPORTUNITY TO INSPECT THE PRODUCTS. OWNER WILL EXERCISE REASONABLE DILIGENCE IN INSPECTION AND MAINTENANCE OF THE PRODUCTS IN ORDER TO MITIGATE EXPENSE INVOLVED IN REPAIRING, REPLACING OR REPAINTING THE PRODUCTS.

7. SELLER'S RESPONSIBILITY AND LIABILITY PURSUANT TO THIS WARRANTY IS EXPRESSLY LIMITED TO THE REPLACEMENT, REPAIR OR REPAINTING OF THE DEFECTIVE MATERIALS AND IN NO EVENT WILL SUCH LIABILITY EXCEED AN AMOUNT EQUAL TO TWENTY (20) CENTS PER SQUARE FOOT OF BUILDING AREA, AND ANY EXPENSE OF LABOR, INSTALLATION, OR REMOVAL WILL NOT BE INCLUDED IN THIS WARRANTY.

8. THIS WARRANTY WILL NOT BE EFFECTIVE AND BINDING ON SELLER UNTIL (1) PAYMENT IN FULL FOR THE PRODUCT HAS BEEN RECEIVED BY SELLER, (2) THE WARRANTY HAS BEEN SIGNED BY AN OFFICER OF SELLER AND (3) THIS WARRANTY HAS BEEN ACTIVATED IN ACCORDANCE WITH THE PROVISIONS OF PARAGRAPH II B.

9. THIS WARRANTY MAY NOT BE MODIFIED, AMENDED OR SUPPLEMENTED EXCEPT BY WRITTEN AGREEMENT SIGNED BY AN AUTHORIZED CORPORATE OFFICER OF SELLER.

JOB NUMBER: 12-B-10433 EFFECTIVE DATE: 11-24-08
BUILDING LOCATION:

CUSTOMER: RBR Construction, Inc. CUSTOMER PHONE NO.: 631-385-7500
CUSTOMER ADDRESS: 179 New York Ave.
Huntington, NY 11743

CUSTOMER'S SIGNATURE: ____________ DATE: 5-5-09

ORIGINAL OWNER: United States Department of Navy
BUILDING ADDRESS 100 Broadway
Bethpage, NY 11714

OWNER'S SIGNATURE: ____________ DATE: ____________

CECO BUILDING SYSTEMS

SIGNED: ____________

TITLE: Vice President, Mr. Tim Schrock DATE: 4/21/09

APPENDIX B

Tools and Equipment

Tools and Equipment List

SUBMITTED BY: F&M MAFCO, INC.
9149 DRY FORK ROAD
HARRISON, OH 45030

AN OHIO CORPORATION

PRICE FORM
EXHIBIT-B
TOOL LIST

QUOTED BY: CASEY MCKENNA, INSIDE SALES

EXHIBIT B: PRICE FORM	TABLE 1				PRICE
Description	Quantity	Manufacturer	Manufacturer Model #	W.W. Grainger Model No	QUOTED
Master hand tool set, 453 piece, to include wrenches, sockets, scredrivers, pliers etc	1	PROTO	99720	6C365	$5,572.88
5-Drawer tool roller cabinet, steel RED, 26" W x 18" D X 41" Ht	1	PROTO ~~Waterloo~~	442742-4RD WI-500	3W032	$493.58
10-Drawer tool chest, steel, RED, 26" W x 12"D x 19" Ht	1	PROTO ~~Waterloo~~	442719-10RD-D WI-1000	2W026	$484.48
Pipe Wrench, 36" aluminum	1	Rigid	836/31110	6A654	$150.56
Strap Wrench 18"	1	Rigid	5/31360	4CW49	$56.60
Chain Wrench 17-1/2"	1	Rigid	C-18/31320	4CW48	$80.34
Prybar 36" goose-neck bar	1	MAYHEW	41004 ~~117-1000~~	5ML13	$9.35
Multi-meter, volt-ohmn-amp- digital display	1	Fluke	75-3	4KD97	DISCONTINUED
Ammeter clamp on digital display	1	Fluke	32	1W550	DISCONTINUED
Current calibrator, 4-20mA, digital display	1	Extech	412355	3ZH90	DISCONTINUED
Step-Ladder, 8 ft type IA, Fiberglass	1	GREENBULL ~~Werner~~	202208 ~~6208~~	3W142	$109.10
Drum hand truck, for Poly drums, steel RED, Solid wheels, strapping to secure drums	1	WESCO ~~Dayton~~	240077	~~4ZX22~~	$306.00
Standard hand truck, convertible to horizontal or vertical, steel, RED, semi pneumatic wheels, 500 LBS, Load Capacity	1	WESCO ~~Dayton~~	210324	2W065	$154.67
Universal drum plug wrench	1	Wesco Ind		5A500	$27.06
Shelving system sets, bolt-less, steel, particle board decking (not included in set) 8' W x 2'D x 7'Ht, 3 shelves and 4 posts included	3	Tennsco		7B853	NO QUOTE
Additional shelves for shelving system sets, 2 per system	6	Tennsco		4TW17	NO QUOTE
Portable Yoke Vise	1	Rigid	40130	1VUV5	$408.43
Bench Vise 5"	1	~~Westward~~	WILTON 00191	3FDH4	$112.72
Workbench Industrial	1	EDSAL		M5331	NO QUOTE
Drill/Driver 18VDC	1	Dewalt		DC720KA	$217.85
Drill/Bit Set	1	Dewalt		DW2583	$71.20

SUBMITTED BY: F&M MAFCO, INC.
9149 DRY FORK ROAD
HARRISON, OH 45030

AN OHIO CORPORATION

PRICE FORM
EXHIBIT-B
TOOL LIST

QUOTED BY: CASEY MCKENNA, INSIDE SALES

EXHIBIT B: PRICE FORM	TABLE 1				PRICE
Description	Quantity	Manufacturer	Manufacturer Model #	W.W. Grainger Model No	QUOTED
Storage cabinet, stee., locking double doors, 36"W x 18"D x 78"Ht, GRAY, pre-assembled	1	Tennsco	7818	4W274	NO QUOTE
Office desk, steel, double-pedestal, GRAY, 60" L x 30" W x 29-1/2 Ht	3	Anderson hickey	PF4160-4P01/L11	3W818	NO QUOTE
Chair Plastic contour seat & back BLACK, tubular steel legs	4	KI		3W034	NO QUOTE
Acid/Corrosive storage, cabinet steel, 30 Gallon Capacity, 1 Shelf, 43" W x 18"D x 44" Ht	1	Eagle	CRA-32	4T026	$806.69
Extra Shelves for acid/corrosive cabinet 40"W x 14 3/4"D x 1" Ht	2	Eagle	CRA-1914	5T423	$49.97
Trash Container, 32 Gallon GRAY plastic	2	Rubbermaid	2632	2W276	$27.88
Push-Broom medium bristle, 36" W chemically resistant block and bristles	1	Weiler	42195	3U768	$23.44 EACH 5 WEEK LEAD TIME
Handle for Push Broom, Hardwood Handle, Chemically resistant threaded tip 60"L	1	Weiler	44301	3H389	$3.50
Floor Squeengee Neoprene 24"W	1	WEILER	45507 ~~0270NSP~~	3A332	$18.20
Handle for Floor Squeengee, hardwood handle, tapered end, 60"L	1	Weiler	44020	3A326	$3.55
Emergency Burn Kit	1	GEC ~~North~~	3030 1/18/2000	3T958	$35.96
Chemical Spill Kit with 95 Gallon over pack drum	1	NEW PIG	KIT302 ~~C-SHFL81~~	5F835	$1,100.75
Pneumatic hose, 3/8" x 50' L with 1/4" NPT Threaded ends, YELLOW	2	THAMAN ~~Speedaire~~	385014	4XR50	$29.28
Telephone-Digital Duplex Speakerphone and all digital answering system W/Remote Retrieval	1	Panasonic	Kxtmc98b	N/A	NO QUOTE

APPENDIX C
Spare Parts and Materials

Spare Parts and Materials List

GM-38, GWTP
Bethpage, NY.

SPARE PARTS LIST

Equipment Name	Model	Part- Description	Part Number
Air Stripper Exhaust Heater	ADH-162	No recommended spare parts	
Backflow Preventer	826-YD	No recommended spare parts	
Blowers: B-1 & B-2	EP1002 + N1002	Grease	ESSO Polyrex EM
LGAC		Rupture Disk	A6003591-1
Particulate Filtration Unit	LR123010FAC15	Buna Lid 0-ring (2 pcs.)	36LB
		Filter Bags (24 pcs x 26 wks= 624	#KE25K2S
Equalization Tank Mixer	3ZES25B	Grease	Lithium Base NLG1-#2
		Gear box oil	Mobil oil SHC-634
LMI Metering Pump	DP5000-1-B-1-3	Liquifram kit	RPM-312/318
		pH electrode w/pre-amp (EQ tank)	Signet 2714-2717
		pH electrode w/pre-amp (Static mi	Signet 3-2760-1 / 3-2774
Submersible Pump -60 hp	Franklin Elect/ Grunfos	No recommended spare parts	
Submersible pump - 15 hp	Franklin Elect/ Grunfos	No recommended spare parts	
Pump 3A	Gould Pump	No recommended spare parts	
3B	Gould Pump	No recommended spare parts	
4A	Gould Pump	No recommended spare parts	
4B	Gould Pump	No recommended spare parts	
Pump-Sumps (Bldg) 5A	Gould Pump	No recommended spare parts	
5B	Gould Pump	No recommended spare parts	
Pump- Sump (Air Strip) 7	Gould Pump	No recommended spare parts	
Air Filter (Intake)	Northeast Controls inc- FSH-20-12	Filter Pads- 12 pcs 20"x 25"x4"	

APPENDIX D

Manufacturer’s Operation and Maintenance Manuals

D-1

Recovery Well Pumps P-1 and P-2

6", 8", & 10"
Stainless Steel Submersible Pumps

(USA) Installation and operating instructions

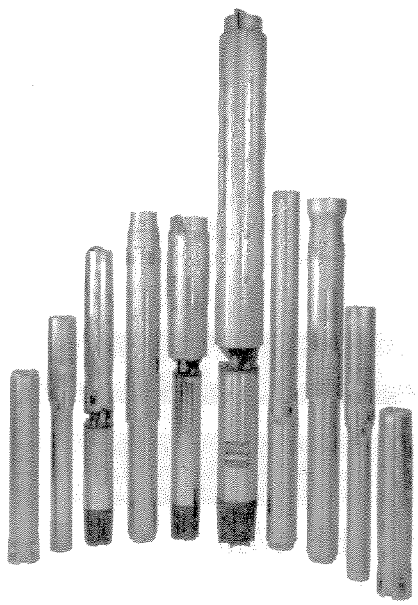


TABLE OF CONTENTS

Please leave these instructions with the pump for future reference.

SAFETY WARNING

Grundfos Stainless Steel Submersible Pumps

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

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

Shipment Inspection

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

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

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

You will find a loose data plate with an adhesive backing with the pump. The nameplate should be completed in pen and attached to the control box.

Pre-Installation Checklist

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

A. Condition of the Well

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. The stainless steel construction of the Grundfos submersible make 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 draw-down level at the pump's maximum capacity. Pump selection and setting depth should be based on this data.

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

B. Condition of the Water

Submersible pumps are designed for pumping clear and cold water that is free of air and gases. Decreased pump performance and life expectancy can occur if the water is not cold and clear or contains air and gasses.

Maximum water temperature should not exceed 102°F. Special consideration must be given to the pump and motor if it is to be used to pump water above 102°F.

The Grundfos stainless steel submersible is highly resistant to the normal corrosive environment found in some water wells. If water well tests determine the water has an excessive or unusual corrosive quality, or exceeds 102°F, contact your Grundfos representative for information concerning specially designed pumps for these applications.

C. Installation Depth

A check should be made to ensure that the installation depth of the pump will always be at least (5) five to (10) ten feet below the maximum draw-down level of the well. For flow rates exceeding 100 gpm, refer to performance curves for recommended minimum submergence.

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.

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

D. Electrical Supply

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

Wire Cable Type

The wire cable used between the pump and control box or panel should be approved for submersible pump applications. The conductor may be solid or stranded. The cable may consist of individually insulated conductors twisted together, insulated conductors molded side by side in one flat cable or insulated conductors with a round overall jacket.

The conductor insulation should be type RW, RUW, TW, TWU or equivalent and must be suitable for use with submersible pumps. An equivalent Canadian Standards Association certified wire may also be used. See Table D for recommended sizes of cable lengths.

Splicing the Motor Cable

A good cable splice is critical to proper operation of the submersible pump and must be done with extreme care.

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

Grundfos recommends using a heat shrink splice kit. The splice should be made in accordance with the kit manufacture's instructions. Typically a heat shrink splice can be made as follows:

1. Examine the motor cable and the drop cable carefully for damage.

2. 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 (See Figure 4-A). On single-phase motors, be sure to match the colors.

3. Strip back and trim off 1/2 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.

4. Slide the heat shrink tubing on to each lead. Insert a properly sized "Sta-kon" type connector on each lead, making sure that lead colors are matched. Using a "Sta-kon" crimping pliers, indent the lugs (Figure 4-B). Be sure to squeeze hard on the pliers, particularly when using large cable.

5. Center the heat shrink tubing over the connector. Using a propane torch, lighter, or electric heat gun, uniformly heat the tubing starting first in the center working towards the ends (Figure 4-C).

6. Continue to apply the heat to the tubing using care not to let the flame directly contact the tubing. When the tubing shrinks and the sealant flows from the ends of the tubing, the splice is complete (Figure 4-D).

FIGURE 4-A

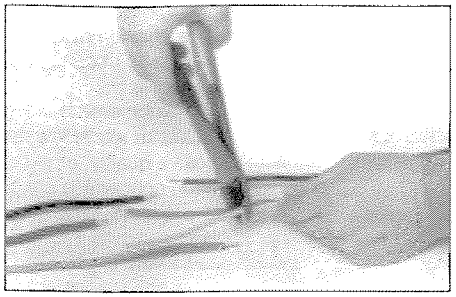


FIGURE 4-B

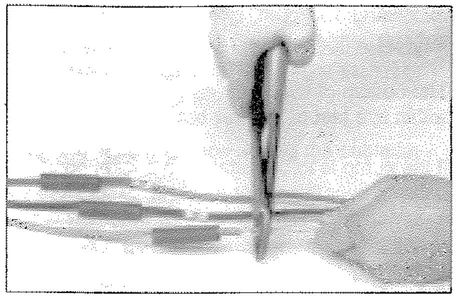


FIGURE 4-C

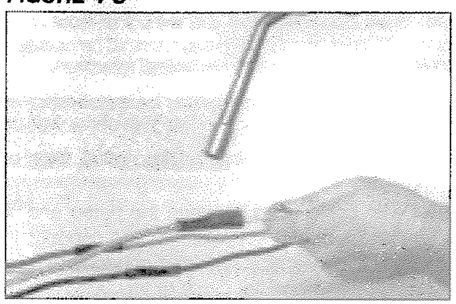
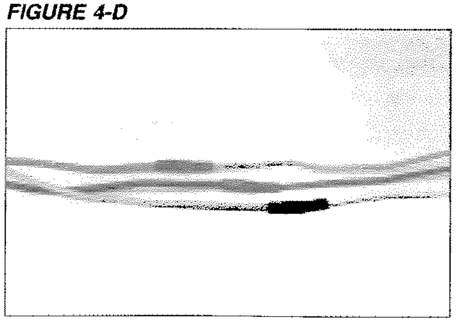
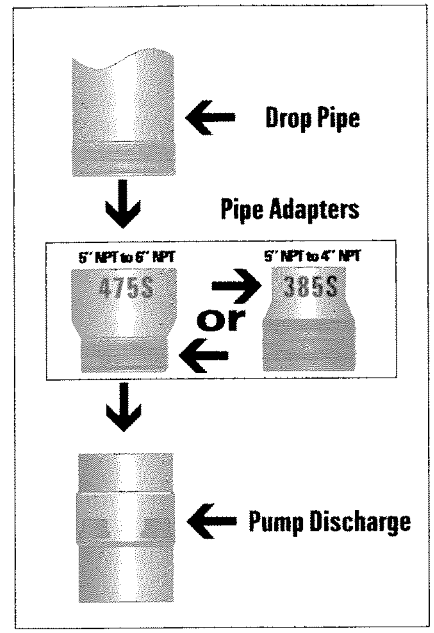


FIGURE 4-D



Installation

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



If An Adapter Needs To Be Installed:

It is recommended to first install the drop pipe to the pipe adapter. Then install the drop pipe with the adapter to the pump discharge.

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

If Steel Riser Pipe Is Used:

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

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

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

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

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping or 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 and below the splice.

If Plastic or Flexible Riser Pipe Is Used:

It is recommended that plastic type riser pipe be used only with the smaller domestic submersibles. The pipe 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 pipe manufacturer. In addition to making sure that joints are securely fastened, the use of a torque arrester is recommended when using plastic pipe.

Installation

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

The drop cable should be secured to the riser pipe at frequent intervals 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 and flexible pipe tend to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe. Leave 3 to 4 inches of slack between clips or taped points to allow for this stretching. This tendency for plastic and flexible pipe to stretch will also affect the calculation of the pump setting depth. As a general rule, you can estimate that plastic pipe will stretch to approximately 2% of its length. For example, if you installed 200 feet of plastic riser pipe, the pump may actually be down 204 feet. If the depth setting is critical, check with the manufacturer of the pipe to determine who to compensate for pipe stretch.

When plastic riser pipe is used, it is recommended that a safety cable be attached to the pump to lower and raise it.

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.

Protect the well from contamination:
To protect against surface water entering the well and contaminating the water source, the well should be finished off above grade, and a locally approved well seal or pitless adapter unit utilized.

Electrical

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

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

Verification of the electrical supply should be made to ensure the voltage, phase and frequency match that of the motor. Motor voltage, phase, frequency and full-load current information can be found on the nameplate attached to the motor. Motor electrical data can be found in Table E.

If voltage variations are larger than ± 10%, do not operate the pump.

Direct on-line starting is used due to the extremely fast run-up time of the motor (0.1 second maximum), and the low moment of inertia of the pump and motor. Direct on-line starting current (locked rotor amp) is between 4 and 6.5 times the full-load current. If direct on-line starting is not acceptable and reduced starting current is required, an auto-transformer or resistant starters should be used for 5 to 30 HP motors (depending on cable length). For motors over 30 HP, use auto-transformer starters.

Engine-Driven Generators

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

If power is going to be supplied through transformers, Table C outlines the minimum KVA rating and capacity required for satisfactory pump operation.

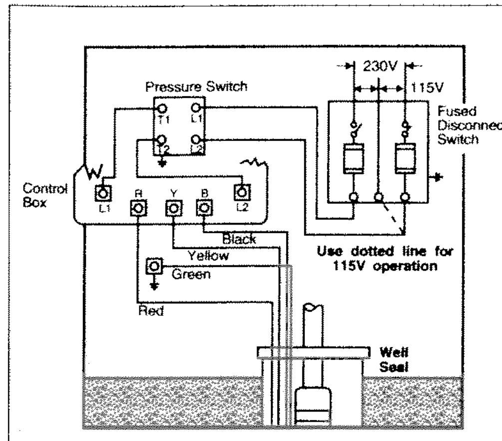
Control Box/Panel Wiring

1. Single-Phase Motors:
Single-phase motors must be connected as indicated in the motor control box. A typical single-phase wiring diagram using a Grundfos control box is shown (Figure 6-A).

2. Three-Phase Motors:
Three-phase motors must be used with the proper size and type of motor starter to ensure the motor is protected against damage from low voltage, phase failure, current unbalance and overload current. A properly sized starter with ambient-compensated extra quick-trip overloads must be used to give the best possible motor winding protection. ***Each of the three motor legs must be protected with overloads.*** The thermal overloads must trip in less than 10 seconds at locked rotor (starting) current. For starter and overload protection guide, see Table H. A three-phase motor wiring diagram is illustrated below (See Figure 6-B).

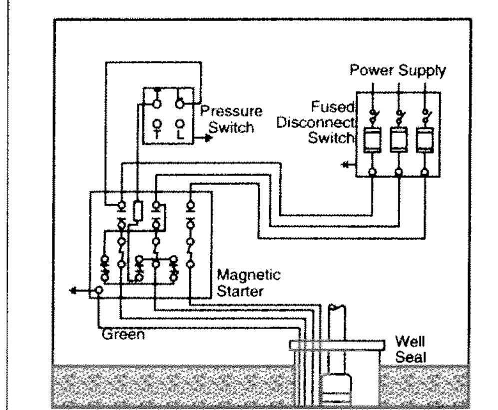
Pumps should NEVER be started to check rotation unless the pump is totally submerged. Severe damage may be caused to the pump and motor if they are run dry.

FIGURE 6-A



Single-Phase Wiring Diagram for GRUNDFOS Control Boxes

FIGURE 6-B



Three-Phase Wiring Diagram for GRUNDFOS and FRANKLIN Motors

Electrical

High Voltage Surge Arresters

A high voltage surge arrester 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 surge arrester should be installed on the supply (line) side of the control box (Figure 6-C and 6-D). The arrester must be grounded in accordance with the National Electrical Code and local codes and regulations

FIGURE 6-C

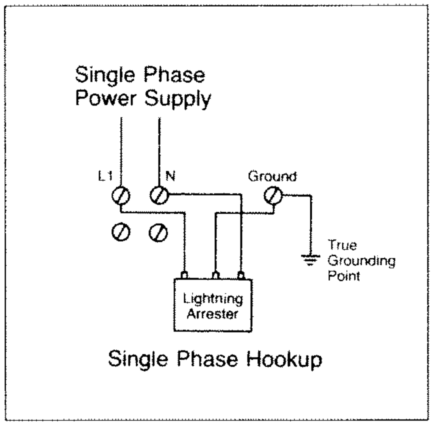
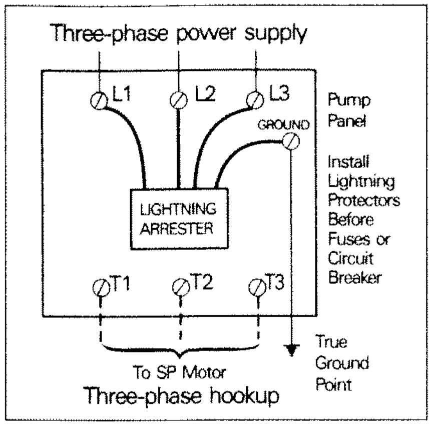


FIGURE 6-D



The warranty on all three-phase submersible motors is VOID if:

1. **The motor is operated with single-phase power through a phase converter.**
2. **Three-leg ambient compensated extra quick-trip overload protectors are not used.**
3. **Three-phase current unbalance is not checked and recorded. (See START-UP Section 7 for instructions.)**
4. **High voltage surge arresters are not installed.**

Control Box/Panel Grounding

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

True grounding points are considered to be: a grounding rod driven into the water strata, steel well casing submerged into the water lower than the pump setting level, and steel discharge pipes without insulating couplings. If plastic discharge pipe and well casing are used or if a grounding wire is required by local codes, 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 or panel.

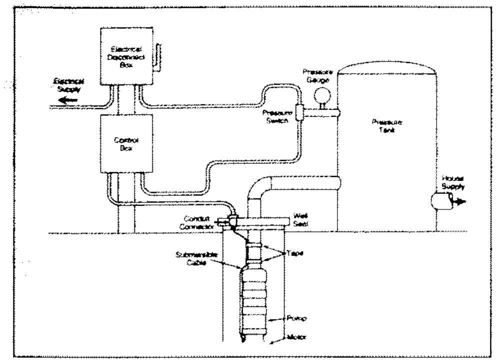
Operating Procedures

Wiring Checks and Installation

Before making the final surface wiring connection of the drop cable to the control box or panel, it is a good practice to check the insulation resistance to ensure that the cable and splice are good. Measurements for a new installation must be at least 2,000,000 ohm. Do not start the pump if the measurement is less than this.

If it is higher than 2,000,000 ohm, the drop cable should then be run through the well seal by means of a conduit connector in such a way as to eliminate any possibility of foreign matter entering the well casing. Conduit should always be used from the pump to the control box or panel to protect the drop cable (See Figure 6-E). Finish wiring and verify that all electrical connections are made in accordance with the wiring diagram. Check to ensure the control box or panel and high voltage surge arrester have been grounded.

FIGURE 6-E



Start-Up

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

A. Attach a temporary horizontal length of pipe with installed gate valve to the riser pipe.
B. Adjust the gate valve one-third of the way open.
C. On three-phase units, check direction of rotation and current unbalance according to the instructions below. For single-phase units proceed directly to "Developing the Well."
D. Under no circumstances should the pump be operated for any prolonged period of time with the discharge valve closed. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed at the well head to prevent the pump from running against a closed valve.

Three-Phase Motors

1. Check the direction of rotation

Three-phase motors can run in either direction depending on how they are connected to the power supply. When the three cable leads are first connected to the power supply, there is a 50% chance that the motor will run in the proper direction. To make sure the motor is running in the proper direction, carefully follow the procedures below:

A. Start the pump and check the water quantity and pressure developed.
B. Stop the pump and interchange any two leads.
C. Start the pump and again check the water quantity and pressure.
D. Compare the results observed. The wire connection which gave the highest pressure and largest water quantity is the correct connection.

2. Check for current unbalance

Current unbalance causes the motor to have reduced starting torque, overload tripping, excessive vibration and poor performance which can result in early motor failure. It is very important that current unbalance be checked in all three-phase systems. **Current unbalance between the legs should not exceed 5% under normal operating conditions.**

The supply power service should be verified to see if it is a two or three transformer system. If two transformers are present, the system is an "open" delta or wye. If three transformers are present, the system is true three-phase.

Make sure the transformer ratings in kilovolt amps (KVA) is sufficient for the motor load. See Table C.

The percentage of current unbalance can be calculated by using the following formulas and procedures:

$$\text{Average current} = \frac{\text{Total of current values measured on each leg}}{3}$$

$$\text{\% Current unbalance} = \frac{\text{Greatest amp difference from the average}}{\text{average current}} \quad \text{X } 100$$

To determine the percentage of current unbalance:

A. Measure and record current readings in amps for each leg (hookup 1). Disconnect power.
B. Shift or roll the motor leads from left to right so the drop cable lead that was on terminal 1 is now on 2, lead on 2 is now on 3, and lead on 3 is now on 1 (hookup 2). Rolling the motor leads in this manner will not reverse the motor rotation. Start the pump, measure and record current reading on each leg. Disconnect power.
C. Again shift drop cable leads from left to right so the lead on terminal 1 goes to 2, 2 to 3 and 3 to 1 (hookup 3). Start pump, measure and record current reading on each leg. Disconnect power.
D. Add the values for each hookup.
E. Divide the total by 3 to obtain the average.
F. Compare each single leg reading from the average to obtain the greatest amp difference from the average.
G. Divide this difference by the average to obtain the percentage of unbalance.

Use the wiring hookup which provides the lowest percentage of unbalance. (See Table F for a specific example of correcting for three-phase power unbalance.)

Developing the Well

After proper rotation and current unbalance have 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 dseired flow rate is reached. Do not operate the pump beyond its maximum flow rating. **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 the desired flow rate is reached.** As the valve is being opened, the drawdown should be checked to ensure the pump is always submerged. **The dynamic water level should always be more than 3 feet above the inlet strainer of the pump.**

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

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

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

Operation

1. The pump and system should be periodically checked for water quantity, pressure, drawdown, periods of cycling and operation of controls.

2. If the pump fails to operate, or there is a loss of performance, refer to Troubleshooting, Section 8.

Troubleshooting

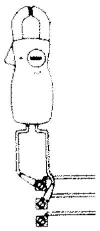
The majority of problems that develop with submersible pumps are electrical, and most of these problems can be corrected without pulling the pump from the well. The following chart covers most of the submersible service work. As with any troubleshooting procedure, start with the simplest solution first;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

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

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

Preliminary Tests

SUPPLY VOLTAGE



How to Measure

By means of a voltmeter, which has been set to the proper scale, measure the voltage at the control box or starter.

On single-phase units, measure between line and neutral.

On three-phase units, measure between the legs (phases).

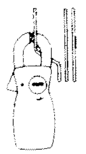
What it Means

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

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

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

CURRENT MEASUREMENT



How to Measure

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

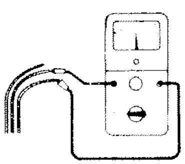
Current should be measured when the pump is operating at a constant discharge pressure with the motor fully loaded.

What it Means

If the amp draw exceeds the listed service factor amps (SFA) or if the current unbalance is greater than 5% between each leg on three-phase units, check for the following:

1. Burnt contacts on motor starter.
2. Loose terminals in starter or control box or possible cable defect. Check winding and insulation resistances.
3. Supply voltage too high or low.
4. Motor windings are shorted.
5. Pump is damaged, causing a motor overload.

WINDING RESISTANCE



How to Measure

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

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

Motor resistance values can be found in Electrical Data, Table E. Cable resistance values are in Table G.

What it Means

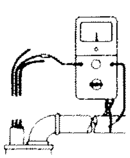
If all the ohm values are normal, and the cable colors correct, the windings are not damaged.

If any one ohm value is less than normal, the motor may be shorted.

If any one ohm value is greater than normal, there is a poor cable connection or joint. The windings or cable may also be open.

If some of the ohm values are greater than normal and some less, the drop cable leads are mixed. To verify lead colors, see resistance values in Electrical Data, Table E.

INSULATION RESISTANCE



How to Measure

Turn off power and disconnect the drop cable leads in the control box or starter. Using an ohm or mega ohmmeter, set the scale selector to Rx 100K and zero-adjust the meter.

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

What it Means

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

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

A. Pump Does Not Run

POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
1. No power at pump panel.	Check for voltage at panel.	If no voltage at panel, check feeder panel for tripped circuits.
2. Fuses are blown or circuit breakers are tripped.	Remove fuses and check for continuity with ohmmeter.	Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation and motor must be checked.
3. Motor starter overloads are burnt or have tripped out (three-phase only).	Check for voltage on line or load side of starter.	Replace burnt heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
4. Starter does not energize (three-phase only).	Energize control circuit and check for voltage at the holding coil.	If no voltage, check control circuit. If voltage, check holding coil for shorts. Replace bad coil.
5. Defective controls.	Check all safety and pressure switches for operation. Inspect contacts in control devices.	Replace worn or defective parts.
6. Motor and/or cable are defective.	Turn off power. Disconnect motor leads from control box. Measure the lead-to-lead resistances with the ohmmeter (Rx1). Measure lead-to-ground values with ohmmeter (Rx100K). Record measured values.	If open motor winding or ground is found, remove pump and recheck values at the surface. Repair or replace motor or cable.
7. Defective capacitor (single-phase only).	Turn off the power, then discharge capacitor. Check with an ohmmeter (Rx100K). When meter is connected, the needle should jump forward and slowly drift back.	If there is no needle movement, replace the capacitor.

B. Pump Runs But Does Not Deliver Water

POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
1. Groundwater level in well is too low or well is collapsed.	Check well draw-down. Water level should be at least 3 ft. above pump inlet during operation.	If not, lower pump if possible, or throttle discharge valve and install water level control.
2. Integral pump check valve is blocked.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shut-off. After taking reading, open valve to its previous position. Convert PSI to feet. (For water: PSI x 2.31 ft/PSI = ____ ft.), and add this to the total vertical distance from the pressure gauge to the water level in the well while the pump is running. Refer to the specific pump curve for the shut-off head for that pump model. If the measured head is close to the curve, pump is probably OK.	If not close to the pump curve, remove pump and inspect discharge section. Remove blockage, repair valve and valve seat if necessary. Check for other damage. Rinse out pump and re-install.
3. Inlet strainer is clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and re-install.
4. Pump is damaged.	Same as B.2 above.	If damaged, repair as necessary. Rinse out pump and re-install.

C. Pump Runs But at Reduced Capacity

POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
1. Wrong rotation (three-phase only).	Check for proper electrical connection in control panel.	Correct wiring and change leads as required.
2. Draw-down is larger than anticipated.	Check draw-down during pump operation.	Lower pump if possible. If not, throttle discharge valve and install water level control.
3. Discharge piping or valve leaking.	Examine system for leaks.	Repair leaks.
4. Pump strainer or check valve are clogged.	Same as B.2 above.	If not close to the pump curve, remove pump and inspect. Clean strainer, inspect integral check valve for blockage, rinse out pump and re-install.
5. Pump worn.	Same as B.2 above.	If not close to pump curve, remove pump and inspect.

D. Pump Cycles Too Much

POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
1. Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts.	Re-adjust switch or replace if defective.
2. Level control is not properly set or is defective.	Check setting and operation.	Re-adjust setting (refer to manufacturer data.) Replace if defective.
3. Insufficient air charging or leaking tank or piping.	Pump air into tank or diaphram chamber. Check diaphram for leak. Check tank and piping for leaks with soap and water solution. Check air to water volume.	Repair or replace damaged component.
4. Plugged snifter valve or bleed orifice.	Examine valve and orifice for dirt or corrosion.	Clean and/or replace if defective.
5. Tank is too small.	Check tank size. Tank volume should be approximately 10 gallons for each gpm or pump capacity.	If tank is too small, replace with proper size tank.

E. Fuses Blow or Circuit Breakers Trip

POSSIBLE CAUSES	HOW TO CHECK	HOW TO CORRECT
1. High or low voltage.	Check voltage at pump panel. If not within ± 10%, check wire size and length of run to pump panel.	If wire size is correct, contact power company. If not, correct and/or replace as necessary.
2. Three-phase current unbalance.	Check current draw on each lead. Unbalance must be within ± 5%.	If current unbalance is not within ± 5%, contact power company.
3. Control box wiring and components (single-phase only).	Check that control box parts match the parts list. Check to see that wiring matches wiring diagram. Check for loose or broken wires or terminals.	Correct as required.
4. Defective capacitor (single-phase only).	Turn off power and discharge capacitor. Check using an ohmmeter (Rx100K). When the meter is connected, the needle should jump forward and slowly drift back.	If no meter movement, replace the capacitor.
5. Starting relay (Franklin single-phase motors only).	Check resistance of relay coil with an ohmmeter (Rx1000K). Check contacts for wear.	Replace defective relay.

Table A

Minimum Water Flow Requirements for Submersible Pump Motors

MOTOR DIAMETER	CASING OR SLEEVE I.D. IN INCHES	MIN. FLOW PAST THE MOTOR (GPM)
4"	4	1.2
	5	7
	6	13
	7	21
	8	30
6"	6	10
	7	28
	8	45
	10	85
	12	140
	14	198
	16	275
8"	8	10
	10	55
	12	110
	14	180
	16	255
10"	10	30
	12	85
	14	145
	16	220
	18	305

NOTES:

1. A flow inducer or sleeve must be used if the water enters the well above the motor or if there is unsufficient water flow past the motor.
2. The minimum recommended water velocity over 4" motors is 0.25 feet per second.
3. The minimum recommended water velocity over 6, 8, and 10" motors is 0.5 feet per second.

Table B

Guide for Engine-Driven Generators in Submersible Pump Applications

	MINIMUM KILOWATT RATING OF GENERATOR FOR THREE-WIRE SUBMERSIBLE PUMP MOTORS	
MOTOR HP SINGLE OR THREE PHASE UNITS	EXTERNALLY REGULATED GENERATOR	INTERNALLY REGULATED GENERATOR
0.33 HP	1.5 KW	1.2 KW
0.50	2.0	1.5
0.75	3.0	2.0
1.0	4.0	2.5
1.5	5.0	3.0
2.0	7.5	4.0
3.0	10.0	5.0
5.0	15.0	7.5
7.5	20.0	10.0
10.0	30.0	15.0
15.0	40.0	20.0
20.0	60.0	25.0
25.0	75.0	30.0
30.0	100.0	40.0
40.0	100.0	50.0
50.0	150.0	60.0
60.0	175.0	75.0
75.0	250.0	100.0
100.0	300.0	150.0
125.0	375.0	175.0
150.0	450.0	200.0
200.0	600.0	275.0

NOTES:

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

Table C

Transformer Capacity Required for Three-Phase Submersible Pump Motors

		MINIMUM KVA RATING FOR EACH TRANSFORMER	
THREE-PHASE MOTOR HP	MINIMUM TOTAL KVA REQUIRED*	2 TRANSFORMERS OPEN DELTA OR WYE	3 TRANSFORMERS DELTA OR WYE
1.5	3	2	1
2	4	2	1-1/2
3	5	3	2
5	7-1/2	5	3
7.5	10	7-1/2	5
10	15	10	5
15	20	15	7-1/2
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40
125	150	85	50
150	175	100	60
200	230	130	75

* Pump motor KVA requirements only, and does not include allowances for other loads.

Table D

Submersible Pump Cable Selection Chart (60 Hz)

The following tables list the recommended copper cable sizes and various cable lengths for submersible pump motors.

These tables comply with the 1978 edition of the National Electric Table 310-16, Column 2 for 75°C wire. The ampacity (current carrying properties of a conductor) have been divided by 1.25 per the N.E.C., Article 430-22, for motor branch circuits based on motor amps at rated horsepower.

To assure adequate starting torque, the maximum cable lengths are calculated to maintain 95% of the service entrance voltage at the motor when the motor is running at maximum nameplate amps. Cable sizes larger than specified may always be used and will reduce power usage.

The use of cables smaller than the recommended sizes will void the warranty. Smaller cable sizes will cause reduced starting torque and poor motor operation.

Single-Phase Motor Maximum Cable Length

(Motor to service entrance) (2)

VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
115	1/3	130	210	340	540	840	1300	1960	2910					
	1/2	100	160	250	390	620	960	1460	2160					
230	1/3	550	880	1390	2190	3400	5250	7960						
	1/2	400	650	1020	1610	2510	3880	5880						
	3/4	300	480	760	1200	1870	2890	4370	6470					
	1	250	400	630	990	1540	2380	3610	5360	6520				
	1-1/2	190	310	480	770	1200	1870	2850	4280	5240				
	2	150	250	390	620	970	1530	2360	3620	4480				
	3	120	190	300	470	750	1190	1850	2890	3610				
	5			180	280	450	710	1110	1740	2170				
	7-1/2				200	310	490	750	1140	1410				
	10					250	390	600	930	1160				

CAUTION: Use of wire size smaller than listed will void warranty.

FOOTNOTES:

1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.
2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length of assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length.
3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

Three-Phase Motor Maximum Cable Length
(Motor to service entrance) (2)

VOLTS	HP	14	12	10	8	6	4	2	0	00	000	0000	250	300
208	1-1/2	310	500	790	1260									
	2	240	390	610	970	1520								
	3	180	290	470	740	1160	1810							
	5		170	280	440	690	1080	1660						
	7-1/2			200	310	490	770	1180	1770					
	10				230	370	570	880	1330	1640				
	15					250	390	600	910	1110	1340			
	20						300	460	700	860	1050	1270		
	25							370	570	700	840	1030	1170	
	30							310	470	580	700	850	970	1110
230	1-1/2	360	580	920	1450									
	2	280	450	700	1110	1740								
	3	210	340	540	860	1340	2080							
	5		200	320	510	800	1240	1900						
	7-1/2			230	360	570	890	1350	2030					
	10				270	420	660	1010	1520	1870				
	15					290	450	690	1040	1280	1540			
	20						350	530	810	990	1200	1450		
	25						280	430	650	800	970	1170	1340	
	30							350	540	660	800	970	1110	1270
460	1-1/2	1700												
	2	1300	2070											
	3	1000	1600	2520										
	5	590	950	1500	2360									
	7-1/2	420	680	1070	1690	2640								
	10	310	500	790	1250	1960	3050							
	15			540	850	1340	2090	3200						
	20			410	650	1030	1610	2470	3730					
	25				530	830	1300	1990	3010	3700				
	30				430	680	1070	1640	2490	3060	3700			
	40						790	1210	1830	2250	2710	3290		
	50						640	980	1480	1810	2190	2650	3010	
	60							830	1250	1540	1850	2240	2540	2890
	75								1030	1260	1520	1850	2100	2400
	100									940	1130	1380	1560	1790
	125											1080	1220	1390
	150												1050	1190
	200												1080	1300
	250													1080
575	1-1/2	2620												
	2	2030												
	3	1580	2530											
	5	920	1480	2330										
	7-1/2	660	1060	1680	2650									
	10	490	780	1240	1950									
	15		530	850	1340	2090								
	20			650	1030	1610	2520							
	25			520	830	1300	2030	3110						
	30				680	1070	1670	2560	3880					
	40					790	1240	1900	2860	3510				
	50						1000	1540	2310	2840	3420			
	60						850	1300	1960	2400	2890	3500		
	75							1060	1600	1970	2380	2890	3290	
	100								1190	1460	1770	2150	2440	2790

CAUTION: Use of wire size smaller than listed will void warranty. FOOTNOTES: 1. If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size. 2. The portion of the total cable which is between the service entrance and a 3Ø motor starter should not exceed 25% of the total maximum length of assure reliable starter operation. Single-phase control boxes may be connected at any point of the total cable length. 3. Cables #14 to #0000 are AWG sizes, and 250 to 300 are MCM sizes.

Electrical Data
Submersible Pump Motors - 60Hz

GRUNDFOS MOTORS

4-Inch, Single Phase, 2-Wire Motors (control box not required)

HP	PH	VOLT	S.F.	CIR. BRKR OR FUSES STD.	DELAY	AMPERAGE START	MAX.	FULL LOAD EFF. (%)	PWR FACT.	MAX. THRUST (LBS)	NAMEPLATE NO.	GRUNDFOS PRODUCT NO.
1/3	1	230	1.75	15	5	25.7	4.6	59	77	750	79952101	791595016
1/2	1	230	1.60	15	7	34.5	6.0	62	76	750	79952102	791595026
3/4	1	230	1.50	20	9	40.5	8.4	62	75	750	79952103	791595036
1	1	230	1.40	25	12	48.4	9.8	63	82	750	79952104	791595046
1-1/2	1	230	1.30	35	15	62.0	13.1	64	85	750	79952105	791595056

4-Inch, Single Phase, 3-Wire Motors

HP	PH	VOLT	S.F.	CIR. BRKR OR FUSES STD.	DELAY	AMPERAGE START	MAX.	FULL LOAD EFF. (%)	PWR FACT.	MAX. THRUST (LBS)	NAMEPLATE NO.	GRUNDFOS PRODUCT NO.
1/3	1	230	1.75	15	5	14.0	4.6	59	77	750	79453101	791545016
1/2	1	230	1.60	15	7	21.5	6.0	62	76	750	79453102	791545026
3/4	1	230	1.50	20	9	31.4	8.4	62	75	750	79453103	791545036
1	1	230	1.40	25	12	37.0	9.8	63	82	750	79453104	791545046
1-1/2	1	230	1.30	35	15	45.9	11.6	69	89	750	79453105	791545056

4-Inch, Three Phase, 3-Wire Motors

HP	PH	VOLT	S.F.	CIR. BRKR OR FUSES STD.	DELAY	AMPERAGE START	MAX.	FULL LOAD EFF. (%)	PWR FACT.	MAX. THRUST (LBS)	NAMEPLATE NO.	GRUNDFOS PRODUCT NO.
1-1/2	3	230	1.30	15	8	40.3	7.3	75	72	750	79302005	791530056
		460	1.30	10	4	20.1	3.7	75	72	750	79362005	791536056
		575	1.30	10	4	16.1	2.9	75	72	750	79392005	791539056
2	3	230	1.25	20	10	48	8.7	76	75	750	79302006	791530066
		460	1.25	10	5	24	4.4	76	75	750	79362006	791536066
		575	1.25	10	4	19.2	3.5	76	75	750	79392006	791539066
3	3	230	1.15	30	15	56	12.2	77	75	1000	79304507	96405801
		460	1.15	15	7	28	6.1	77	75	1000	79354507	96405810
		575	1.15	15	6	22	4.8	77	75	1000	79394507	96405815
5	3	230	1.15	40	25	108	19.8	80	82	1000	79304509	96405802
		460	1.15	20	12	54	9.9	80	82	1000	79354509	96405811
		575	1.15	15	9	54	7.9	80	82	1000	79394509	96405816
7-1/2	3	230	1.15	60	30	130	25.0	81	82	1000	79305511	96405805
		460	1.15	35	15	67	13.2	81	82	1000	79355511	96405814
		575	1.15	30	15	67	10.6	81	82	1000	79395511	96405819

6-Inch, Three Phase, 3-Wire Motors

HP	PH	VOLT	S.F.	CIR. BRKR OR FUSES STD.	DELAY	AMPERAGE START	MAX.	FULL LOAD EFF. (%)	PWR FACT.	MAX. THRUST (LBS)	NAMEPLATE NO.	GRUNDFOS PRODUCT NO.
7-1/2	3	230	1.15	60	35	119	26.4	80.5	76	1000	78305511	96405781
		460	1.15	30	15	59	13.2	80.5	76	1000	78355511	96405794
10	3	230	1.15	80	45	156	34.0	82.5	79	1000	78305512	96405782
		460	1.15	40	20	78	17.0	82	79	1000	78355512	96405795
15	3	230	1.15	150	80	343	66.0	84	81	4400	78305516	96405784
		460	1.15	60	30	115	24.5	82.5	82	440	78355514	96405796
20	3	230	1.15	150	80	343	66.0	84	81	4400	78305516	96405784
		460	1.15	80	40	172	33.0	84	82	4400	78355516	96405797
25	3	460	1.15	100	50	217	41.0	84.5	80	4400	78355517	96405798
30	3	460	1.15	110	60	237	46.5	85	83	4400	78355518	96405799
40	3	460	1.15	150	80	320	64.0	85	82	4400	78355520	96405800

HITACHI MOTORS

6 Inch (Three Wire) Motors

60 HZ

HP	PH	Volts	Service Factor	Circuit Breaker or Standard Fuse	Dual Element Fuse	AMPERAGE Full Load	AMPERAGE Locked Rotor	AMPERAGE S.F. Amps	FULL LOAD Eff.	FULL LOAD Power Factor	Line-to-Line Resistance (Ohms) Blk-Yel / Delta	Line-to-Line Resistance (Ohms) Red-Yel	KVA Code ***	Three-Phase Overload Protection Starter Size	Three-Phase Overload Protection Fuses Amb. Comp	Maximum Thrust (lbs.)	GRUNDFOS PART NO.
5	1	230	1.15	80	35	23.8	124	27.1	74.8	91.2	0.51	2.2	G	-	-	1500	82.4119H
	3	230	1.15	45	20	14.8	110	16.4	76.8	82.5	0.81		K	1	K58	1500	82.9915H3
	3	460	1.15	25	10	7.4	55	8.2	76.8	82.5	3.05		K	1	K43	1500	82.9915H6
7-1/2	1	230	1.15	125	45	35.2	167	40.9	72.9	94.9	0.40	1.40	F	-	-	1500	82.4121H
	3	230	1.15	70	30	21.8	144	24.4	78.5	81.8	0.65		J	1	K64	1500	82.9116H3
	3	460	1.15	35	15	10.9	72	12.2	78.5	81.8	2.43		J	1	K54	1500	82.9916H65
10	1	230	1.15	175	60	48.0	202	54.0	73.6	93.2	0.32	1.05	#	-	-	3500	82.4123H
	3	230	1.15	80	40	28.2	208	32.0	79.3	82.8	0.45		K	1.75	K66	3500	82.9117H3
	3	460	1.15	40	20	14.3	104	16.0	79.3	82.8	1.62		K	1	K58	3500	82.9117H6
15	1	230	1.15	250	100	70.8	275	84.9	73.7	93.2	0.23	0.68	D	-	-	3500	82.9118H3
	3	230	1.15	125	60	41.4	320	46.2	81.7	83.2	0.31		K	2	K74	3500	82.9118H3
	3	460	1.15	60	30	20.7	160	23.1	81.7	83.2	1.07		K	1.75	K63	3500	82.9118H6
20	3	230	1.15	175	70	53.0	392	63.0	83.2	84.9	0.26		K	2.5	K77	3500	82.9119H3
	3	460	1.15	90	35	26.5	196	30.0	83.2	84.9	0.86		K	2	K67	3500	82.9119H6
25	3	230	1.15	200	90	67.2	530	75.4	83.0	83.9	0.21		K	3	K83	3500	82.9120H3
	3	460	1.15	100	45	33.6	265	37.7	83.0	83.9	0.67		K	2	K72	3500	82.9120H6
30	3	230	1.15	250	110	80.8	610	90.6	82.5	84.3	0.16		K	3	K86	3500	82.9121H3
	3	460	1.15	125	50	40.4	305	45.3	82.5	84.3	0.55		K	2.5	K74	3500	82.9121H6
40	3	460	1.15	150	70	51.7	340	58.8	84.0	86.3	0.46		H	3	K76	5000	82.3228H
50	3	460	1.15	200	90	69.7	465	78.6	82.5	81.4	0.39		J	5	K83	5000	82.3229H
60	3	460	1.15	225	100	80.8	465	92.8	82.4	84.4	0.39		G	3.5	K86	5000	82.3230H

8 Inch Motors

40	3	460	1.15	150	70	54.3	380	60.9	83.9	82.1	0.37	J	3	K76	10,000	82,3270H
50	3	460	1.15	200	90	64.9	435	73.6	84.1	85.7	0.33	H	3	K78	10,000	82,3271H
60	3	460	1.15	225	100	77.8	510	88.5	84.7	85.3	0.28	H	3.5	K86	10,000	82,3272H
75	3	460	1.15	350	150	96.7	650	110	84.9	85.9	0.22	H	3.5	K88	10,000	82,3274H
100	3	460	1.15	400	175	127	795	145	85.2	86.6	0.16	H	4	K89	10,000	82,3275H
125	3	460	1.15	500	225	172.0	980	192	84.2	80.9	0.14	G	4.5	K28	10,000	82,36H042
150	3	460	1.15	600	250	187.0	1060	216	85.6	87.9	0.13	G	4.5	K29	10,000	82.36H043

10 Inch Motors

200	3	460	1.15	800	350	233.0	1260	270	87.2	92.2	0.09	F	5	K33	10,000	82,36H064
250	3	460	1.15	900	450	294.0	1500	344	86.5	92.1	0.08	E	6	K27	10,000	82,36H066

FRANKLIN MOTORS

(refer to the Franklin Submersible Motors Application Maintenance Manual)

Table F

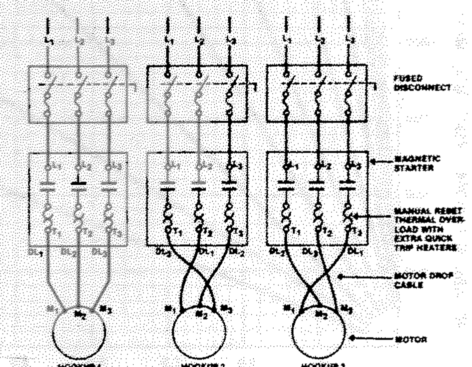
Example: Correcting for Three-Phase Power Unbalance

Example: Check for current unbalance for a 230 volt, 3 phase, 60 Hz submersible pump motor, 18.6 full load amps.

Solution: Steps 1 to 3 measure and record amps on each motor drop lead for Hookups 1, 2 and 3.

	Step 1 (Hookup 1)	Step 2 (Hookup 2)	Step 3 (Hookup 3)
(T_1)	DI_1 = 25.5 amps	DL_3 = 25 amps	DL_2 = 25.0 amps
(T_2)	DL_2 = 23.0 amps	DL_1 = 24 amps	DL_3 = 24.5 amps
(T_3)	DL_3 = 26.5 amps	DL_2 = 26 amps	DL_1 = 25.5 amps
Step 4	Total = 75 amps	Total = 75 amps	Total = 75 amps
Step 5	Average Current =	$\frac{\text{total current}}{\text{3 readings}}$ =	$\frac{75}{3}$ = 25 amps
Step 6	Greatest amp difference from the average:		(Hookup 1) = 25-23 = 2 (Hookup 2) = 26-25 = 1 (Hookup 3) = 25.5-25 = .5
Step 7	% Unbalance		(HOOKUP 1) = 2/25 X 100 = 8 (HOOKUP 2) = 1/25 X 100 = 4 (HOOKUP 3) = .5/25 X 100 = 2

As can be seen, Hookup 3 should be used since it shows the least amount of current unbalance. Therefore, the motor will operate at maximum efficiency and reliability.



By comparing the current values recorded on each leg, you will note the highest value was always on the same leg, L_3. This indicates the unbalance is in the power source. If the high current values were on a different leg each time the leads were changed, the unbalance would be caused by the motor or a poor connection.

If the current is greater than 5%, contact your power company for help.

*For a detailed explanation of three-phase balance procedures, see Three-Phase Motor, section 2, page 6.

Table G

Total Resistance of Drop Cable (OHMS)

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

To determine the resistance:

1. Disconnect the drop cable leads from the control box or panel.

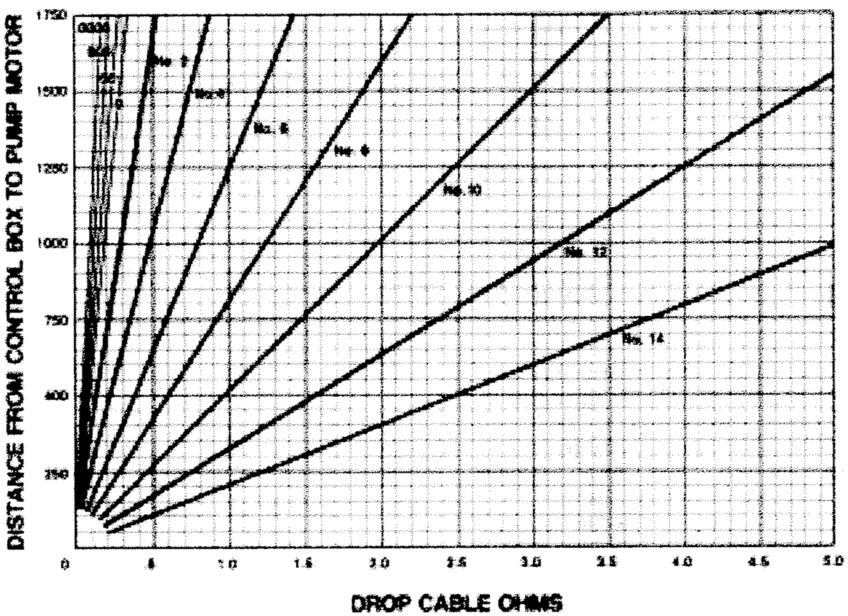
2. Record the size and length of drop cable.

3. Determine the cable resistance from the table.

4. Add drop cable resistance to motor resistance. Motor resistances can be found in the Electrical Data Chart, Table E.

5. Measure the resistance between each drop cable lead using an ohmmeter. Meter should be set on Rx1 and zero-balanced for this measurement.

6. The measured values should be approximately equal to the calculated values.



LIMITED WARRANTY

Products manufactured by GRUNDFOS are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 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. EXCEPT AS EXPRESSLY HERIN PROVIDED THE GOODS ARE SOLD "AS IS", THE ENTIRE RISK AS TO QUALITY AND FITNESS FOR A PARTICULAR PURPOSE, AND PERFORMANCE OF THE GOODS IS WITH THE BUYER, AND SHOULD THE GOODS PROVE DEFECTIVE FOLLOWING THIER PURCHASE, THE BUYER AND NOT THE MANUFACTURER, DISTRIBUTOR, OR RETAILER ASSUMES THE ENTIRE RISK OF ALL NECESSARY SERVICING AND REPAIR.

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 or require you to pay certain expenses as set forth above. 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.

The telephone number of our service and repair facilities central directory, from which you can obtain the locations of our service and repair facility is, 1-800-333-1366

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Boulevard TLC #15
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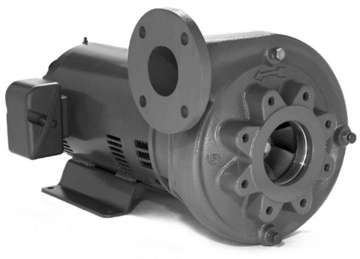
PRINTED IN THE U.S.A.	

D-2
Air Stripper Feed Pumps P-3A and B
Liquid Carbon Feed Pumps P-4A and B

GOULDS PUMPS

Installation, Operation and Maintenance Instructions



Owner's Information

Please fill in information and give this booklet to homeowner. Warranty information is on page 14.

Model Number: ______________________

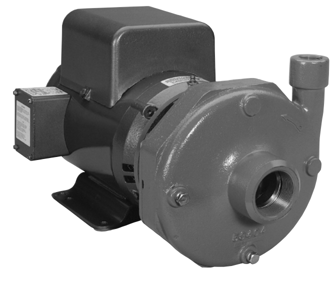
Serial Number: ______________________

Dealer: ______________________

Dealer's Phone No. ______________________

Date of Purchase: ____________ Installation Date: ____________

Model 3656/3756



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Goulds Pumps

ITT Industries

IM010R07

SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN THE MANUAL AND ON THE PUMP.

This is a **SAFETY ALERT SYMBOL.** When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

DANGER Warns of hazards that **WILL** cause serious personal injury, death or major property damage.

WARNING Warns of hazards that **CAN** cause serious personal injury, death or major property damage.

CAUTION Warns of hazards that **CAN** cause personal injury or property damage.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT. THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

NOTICE: INSPECT UNIT FOR DAMAGE AND REPORT ALL DAMAGE TO CARRIER IMMEDIATELY.

WARNING

Hazardous fluids can cause fire, burns or death.

UNIT NOT DESIGNED FOR USE WITH HAZARDOUS LIQUIDS OR FLAMMABLE GASES.

DESCRIPTION and SPECIFICATIONS

The series 3656/3756 are single stage, end suction, centrifugal pumps for general liquid transfer, booster applications, irrigation and general service pumping. Pumps are available in three different materials of construction: all iron, bronze-fitted and all bronze ("S" group only).

Pump impellers are fully enclosed, key driven and held in position by an impeller bolt and washer. Casings are full volute in design with replaceable wear rings.

Dependant on the pump size, the suction and discharge connections will be threaded or flanged. Shafts are protected with stainless steel shaft sleeves.

Close-coupled units have NEMA standard JM or JP motors with C-face mounting and key driven shaft extension. SAE drive units bolt directly to the engine flywheel housing for SAE sizes 1, 2, 3, 4 or 5. Optional elastomer element couplings are available for 6½, 7½, 8, 10, 11½ and 14 inch flywheels. Frame mounted units can be coupled to motors through a spacer coupling, or belt driven.

Engineering Data

Maximum Liquid Temperature:
- 212º F (100º C) – standard seal or packing
- 250º F (120º C) – Optional high temp. seal

Maximum Working Pressure (Fluid temperature dependant):
- – NPT connections, 200 PSI (1379 kPa)
- – 125# ANSI flanged connections, 200 PSI (1379 kPa)

Maximum Suction Pressure: 100 PSI (689.5 kPa)

Starts per Hour: 20, evenly distributed

Group	Size	Suction	Discharge
S	1½ x 2-6 (H)	2" NPT	1½" NPT
	1 x 2-7	2" NPT	1" NPT
	2½ x 3-7	3" NPT	2½" NPT
	3 x 4-7	4" Flange	3" Flange
	1 x 2-8	2" NPT	1" NPT
	1½ x 2-8	2" NPT	1½" NPT
LH	2 x 2-5	2" NPT	2" NPT
	2½ x 2½-5	2½" NPT	2½" NPT
	3 x 3-5	3" NPT	3" NPT
	4 x 4-5	4" Flange	4" Flange
	5 x 5-6	5" Flange	5" Flange
M	2½ x 3-8	3" NPT	2½" NPT
	3 x 4-8	4" Flange	3" Flange
	4 x 5-8	5" Flange	4" Flange
	1½ x 2-10	2" NPT	1½" NPT
	2½ x 3-10	3" Flange	2½" Flange
	3 x 4-10	4" Flange	3" Flange
	4 x 6-10	6" Flange	4" Flange
	2½ x 3-13	3" Flange	2½" Flange
	3 x 4-13	4" Flange	3" Flange
	4 x 6-13	6" Flange	4" Flange
L	6 x 8-13	8" Flange	6" Flange
	8 x 10-13	10" Flange	8" Flange
	4 x 6-16	6" Flange	4" Flange

Installation

LOCATION

- Locate the pump as near liquid source as practical; below level of liquid for automatic repriming capability.
- Allow adequate space for servicing and ventilation. Protect the unit from weather and water damage due to rain, flooding or freezing temperatures.
- Protect the pump and piping from freezing temperatures.
- Allow adequate space around the unit for service and ventilation.

CLOSE-COUPLED UNITS

- Units may be installed horizontally, inclined or vertically with the motor above the pump.
- The motor feet **MUST** be bolted to a substantial surface (horizontal or vertical) that is capable of complete and rigid support for the pump and motor. For L-Group pumps, the motor adapter feet must also be bolted to the supportive surface.
- For vertical operation, the motor should be fitted with a drip cover or otherwise protected against liquid entering the motor (rain, spray, condensation, etc.)

NOTICE: DO NOT INSTALL WITH MOTOR BELOW PUMP. ANY LEAKAGE OR CONDENSATION WILL AFFECT THE MOTOR.

FRAME-MOUNTED UNITS

- A flat substantial foundation surface **MUST** be provided to avoid distortion and/or strain when tightening the foundation bolts. A rubber mounting is acceptable to reduce noise or excessive vibration.
- Tighten motor hold-down bolts **BEFORE** connecting piping to pump.

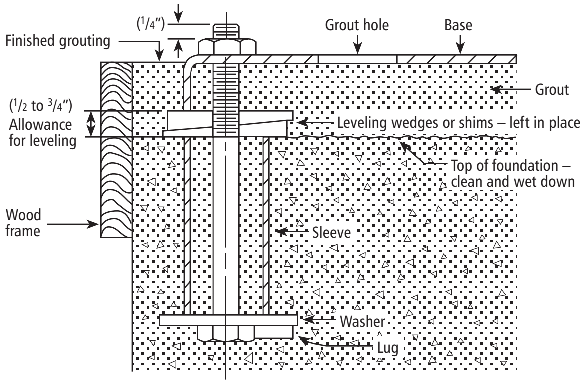


Figure 1

- It is recommended that the baseplate be grouted to a foundation with solid footing. Refer to Figure 1.
- Place unit in position on wedges located at four points, two below approximate center of driver and two below approximate center of pump. Adjust wedges to level unit. Level or plumb suction and discharge connections.
- Make sure bedplate is not distorted and final coupling alignment can be made within the limits of movement of motor and by shimming, if necessary.
- Tighten foundation bolts finger tight and build dam around foundation. Pour grout under bedplate making sure the areas under the pump and motor feet are filled solid. Allow grout to harden 48 hours before fully tightening foundation bolts.
- Tighten pump and motor hold-down bolts before aligning shaft or connecting the piping to pump.
- Allow grout to harden for 48 hours before tightening 4 foundation bolts.

SAE – Engine Driven Pumps

The SAE engine drive bearing frame is designed to bolt directly to the flywheel housing for engines with an SAE no. 1, 2, 3, 4 or 5 mount. The pump shaft extension is sized for use with couplings bolted directly to the flywheel. Goulds Pumps optional couplings are sized for 6½", 7½", 8", 10", and 14" flywheels. Although other flywheel mount couplings may be used, it is recommended that the Goulds Pumps coupling be used to ensure long and trouble-free operation from your Goulds Pump.

REQUIREMENTS FOR PROPER OPERATION

Pump End:
When delivering the required capacity (GPM) to the system piping, the pump must add the amount of Head required by the system at the capacity. The operating head-capacity point should be as close as possible to the highest efficiency line shown on the performance curve, and must be below the head-capacity line labeled "maximum" RPM. The maximum operaton RPM for the pump is determined by bearing life, or in some cases, by the pressure limits of the pump. Suction and discharge openings are NPT tapped for standard pipe, or faced and drilled per ANSI B16.1, class 125 for standard flanges as indicated. Maximum working pressure for class 30 cast iron, per ANSI B16.1, is 175 PSI.

Internal combustion engines are variable speed and variable power machines. The power output depends on the engine speed (RPM) and will be reduced when operating altitude, and/or the air temperature increases. When driving the pump at the RPM required to deliver water into the system piping, the engine must operate within the Engine Manufacturers minimum and maximum RPM limits. The power output to supply the pump power demand must not exceed the continuous power rating of the engine, after derating for all power consuming engine accessories, and adjustmaner for installation site altitude and air temperature.

DRIVE-TRAIN SIZING (BHP)

The BHP Equation is: (Flow x TDH) / 3960 x Eff.)
Note: For internal combustion units the BHP calculation must be de-rated for the following conditions:

- 20% for continuous duty
- 5% for right-angle drive
- 3% for each 1,000 feet above sea level
- 1% for each 10º F above 60º F.

DRIVE-TRAIN SIZING (TORQUE)

Other than sizing an engine for BHP, torque calculations also are required for proper sizing. Typically the horsepower and torque rating do not follow the same relationship throughout the usable range of a diesel engine (Figure 2). The equation for torque (lbs/ft) is (5250 x BHP) / RPM.

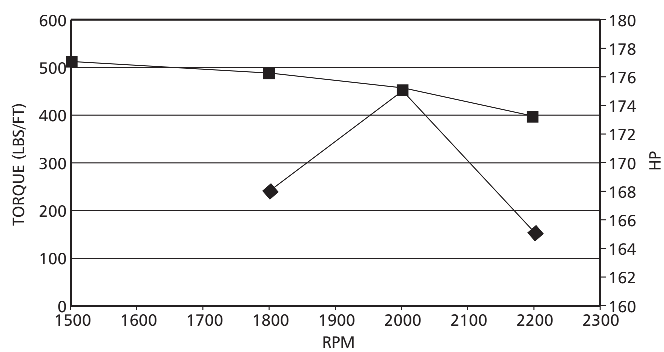


Figure 2: HP (◆) vs. Torque (■)

VERIFY MATCH OF PUMP END TO ENGINE

SAE Bracket Size:
Engine drive pumps are available to fit engines having a standard SAE 5 through SAE 1 flywheel housing.

For a new engine, the engine supplier can provide the SAE housing number.

For an existing engine, the flywheel housing bore and bolt circle can be measured and compared against the standard SAE housing dimensions listed in Table 1, to identify the housing SAE number.

- Measure the flywheel housing bore (A), and the bolt circle (B), as accurately as possible with a tape measure (to the nearest 1/32 inch).
- Count the number of threaded holes in the flywheel housing (C). Test the threaded holes with a bolt, to determine the thread series.
- Compare the measured dimensions (A), (B), and (C) against Table 1, to determine the SAE number of the flywheel housing, to be sure it matches the SAE number of your pump.

Flywheel Housing Dimensions		SAE Flywheel Housing Size				
		1	2	3	4	5
A		20⅛	17⅝	16⅛	14¼	12⅜
B		20⅞	18⅜	16⅞	15	13⅛
C	No.	12	12	12	12	8
	Size	7/16-14	⅜-16	⅜-16	⅜-16	⅜-16

Table 1

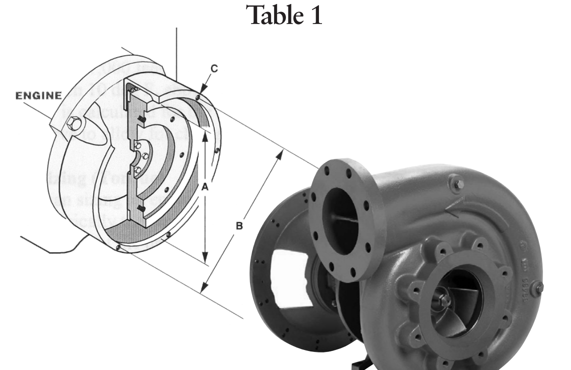


Figure 3

INSTALLATION

- The pump may be installed horizontally, with the discharge rotated to any position allowed by the casing bolt pattern (13). It is recommended that the discharge be located horizontally, above the suction.
- The casing must be supported on all pumps by a rigid support which is anchored to the unit base or foundation.
- For M-Group pumps it is recommended that this support is bolted to the motor adapter ring using 2 or more of the casing bolts (13). It is likely that longer bolts will be required for the additional support thickness. Use SAE grade 5 bolts, torqued as indicated in this manual.
- For L-Group pumps it is recommended that the pump is supported beneath the two feet cast into the motor adapter (3). These feet must be bolted to the support.

PUMP TO ENGINE ASSEMBLY (SPLINE COUPLING)

Preparation for Assembly of Pump on Engine

- Clean face and register fit of flywheel housing and flywheel as necessary to remove all grease, dirt, or rust (and all traces of rust preventative) which would interfere with installation of pump and/or prevent correct alignment. If flywheel is fitted with a pilot bearing for a transmission shaft, remove and discard. The pilot bearing is not required for installation of the pump end, and could interfere with the pump shaft.
- Examine shaft spline closely. Use a file, if necessary, to remove any burrs that would prevent coupling from sliding freely onto the shaft.
- Lubricate pump shaft spline sparingly with light grease. Don't lubricate straight keyed shaft.
- Slide the coupling onto shaft until it is stopped against the shaft (refer to page 5 for straight shaft installation).
- Measure the distance from the engine side of the flywheel coupling adapter ring to the mounting face of the pump bracket. Refer to Figure 4 below, **Dimension "A"**.
- Next, measure depth from face of flywheel housing on engine, to face on flywheel against which coupling will be bolted. Refer to Figure 4 below, **Dimension "B"**.
- Pump measurement must be less than engine measurement or axial interference will result in thrust force on engine crank shaft bearings. Simply stated, **Dimension "A" must be less than Dimension "B"**.

FLYWHEEL COUPLING

- The flywheel coupling transmits power from the engine flywheel to the pump shaft. The maximum power that a coupling can safely handle is shown by a rating number, "R", which is listed in the coupling dimensions tables.
- When selecting a flywheel coupling for a pump and engine, first determine the power rating that the pump will demand. On the pump performance curve, find the RPM and BHP values required to produce the spplication head-capacity point.
- Divide the BHP by the RPM, then multiply the result times 100. The result will be the demand number for the pump. For example, a 20BFSAE1AO can deliver 800 GPM at 270 feet Total Head when running at 1800 RPM. The power required by the pump will be 75 BHP. The demand number will be: (75 / 1800) x 100 = 4.16
- Next, select a coupling that can safely transmit the power, and which will fit the flywheel dimensions. For a coupling to be suitable, it must have an "R" rating number GREATER THAN the pump demand number. In the above example, the minimum coupling "R" number whould be 5.
- Torsional compatibility of the engine, pump, and coupling is the responsibility of the assembler. Goulds Pumps will supply data for the pump and coupling for use by the assembler for a torsional analysis.

NOTE: If the flywheel is fitted with a pilot bearing pressed into a bore at the center, remove it to avoid interference with the pump shaft.

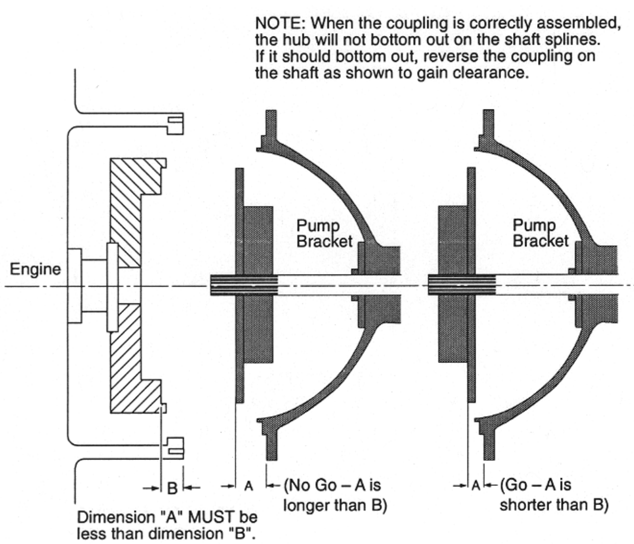


Figure 4

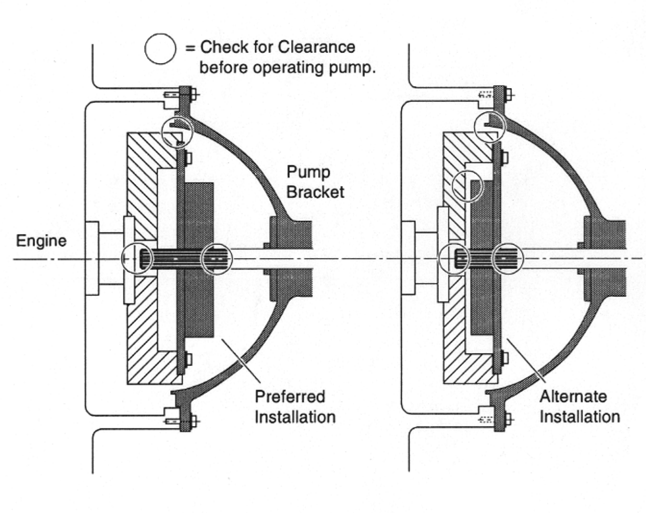


Figure 5

FLYWHEEL FOR INDUSTRIAL TYPE OVERCENTER CLUTCHES

- Figure 6 shows the hollowed-out appearance of the flywheels made for use with overcenter type clutch power take-off assemblies.
- These flywheels will have a recessed bore machined into the face, and a set of tapped holes, which will be used to attach the coupling to the flywheel. Dimensions are governed by an SAE standard and are listed in Tables 1A and 1B, Figure 3. The “clutch size” shown in the table is the nominal clutch facing diameter for Drive Ring Type Overcenter Clutches.

OTHER FLYWHEELS

- Some engines are fitted with flywheels especially machined for coupling to other kinds of machinery (electrical generators, torque converters, etc.), and require nonstandard flywheel couplings. These may be purchased from third party vendors or suppliers.

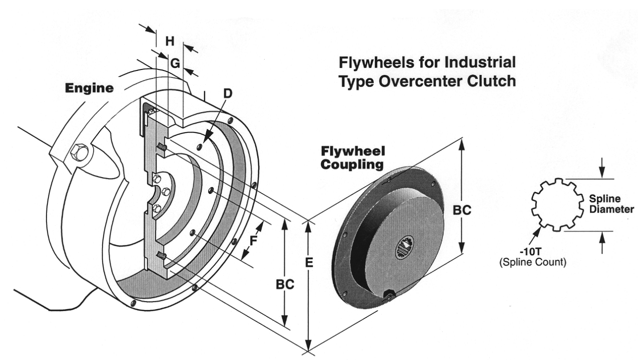


Figure 6

**Table IA –
Wide RPM Range, Elastomer Mounted Hub – Spline Shaft**

Clutch Size	D Qty.	D Size (UNC)	E	BC	F	G	H	R*	Catalog Number	Shaft Spline Dia.
	Flywheel Dimensions							Flywheel Coupling (Spline)		
6½"	6	5/16-18	8½ OD	7.88	3.94	1.19	1.69	7	A00569C 1	1½" 10T
7½"	8	5/16-18	9½" OD	8.75	3.69	1.19	1.69	7	A00569C 2	1½" 10T
8"	6	3/8-16	10⅜" OD	9.62	4.81	2.44	2.94	7	A00569C 3	1½" 10T
10"	8	3/8-16	12⅜" OD	11.62	4.47	2.13	2.75	7	A00569C 4	1½" 10T
10"	8	3/8-16	12⅜" OD	11.62	4.47	2.13	2.75	9	A00569C 6	1½" 10T
11½"	8	3/8-16	13⅞" OD	13.12	5.06	1.56	2.69	7	A00569C 5	1½" 10T
11½"	8	3/8-16	13⅞" OD	13.12	5.06	1.56	2.69	9	A00569C 7	1½" 10T
14"	8	½-13	18⅜" OD	17.25	6.63	1.00	2.13	9	A00569C 8	1½" 10T

* R = Coupling Rating Max.
Coupling Rating = (Rated horsepower x 100) / Rated RPM

**Table IB –
Wide RPM Range, Elastomer Mounted Hub – Straight Shaft**

Clutch Size	D Qty.	D Size (UNC)	E	BC	F	G	H	R*	Catalog Number	Shaft Spline Dia.
	Flywheel Dimensions							Flywheel Coupling		
6½"	6	5/16-18	8½ OD	7.88	3.94	1.19	1.69	2.28	CD616	1.625-1.624Ø ⅜ x 3/16 Keyway
								3.51	CD625	
7½"	8	5/16-18	9½" OD	8.75	3.69	1.19	1.69	2.28	CD716	
								3.51	CD725	
8"	6	3/8-16	10⅜" OD	9.62	4.81	2.44	2.94	2.28	CD816	
								3.51	CD825	
10"	8	3/8-16	12⅜" OD	11.62	4.47	2.13	2.75	2.28	CD1016	
								3.51	CD1025	
								5.71	CD1030	
								8.57	CD1050	
								11.23	CD1080	
11½"	8	3/8-16	13⅞" OD	13.12	5.06	1.56	2.69	2.28	CD1116	
								3.51	CD1125	
								5.71	CD1130	
								8.57	CD1150	
								11.23	CD1180	
								12.62	CD1190	
								16.85	CD11110H	
14"	8	3/8-16	18⅜" OD	17.25	6.63	1.00	2.13	2.28	CD1416	
								3.51	CD1425	
								5.71	CD1430	
								8.57	CD1450	
								11.23	CD1480	
								12.62	CD1490	
								16.85	CD14110H	

Dimensions in inches
* R = Coupling Rating Max.
Coupling Rating = (Rated horsepower x 100) / Rated RPM

- For Goulds Pumps straight shaft keyed couplings – Ensure that the coupling hub set screw is backed out enough to ensure clearance for the shaft key during assembly.
- Mount the coupling assembly to the engine flywheel using the bolts provided torqued as follows in a crossing sequence:
  6½" or 7½" Flywheel – 11 lbs.-ft. (15 N·m)
  8", 10" or 11½" Flywheel – 20 lbs.-ft. (27 N·m)
  14" Flywheel – 50 lbs.-ft. (68 N·m)
  (For other couplings follow manufacturers recommended installation procedure.)
- Place the pump shaft key into the pump shaft (122) and align the shaft to the coupling. Slide the pump into the coupling until the engine adapter ring (340) contacts the engine flywheel housing.

INSTALLATION OF COUPLING ON FLYWHEEL

Flywheel Coupling Overcenter Type:

- These couplings are aligned concentrically with the flywheel by register fit on the flywheel.
- Be sure to remove all preservatives from the engine’s flywheel.
- Fit the coupling into the flywheel. Align the bolt holes and engage coupling with register fit on flywheel. Tap coupling with a soft heavy hammer, if necessary, to be sure that it is seated flat against flywheel. Secure coupling tightly to flywheel with capscrews and lockwasher.

INSTALLATION OF PUMP ON ENGINE

- Lift pump with suitable lifting apparatus and align pump shaft with coupling. End of pump shaft has a pilot diameter which epermits wasy engagement of pump shaft into coupling.

- Reach into pump suction opening and rotate impeller slightly until the shaft will engage the coupling. Verify that there is no gap between bracket and flywheel housing faces. Rotate pump as necessary to align bracket holes with engine. Install capscrews and bolt pump end securely to engine.

NOTE: If any interference, or incompatibility of parts is detected during installation, DO NOT proceed with assembly. Direct the problem to your nearest Goulds Pumps distributor.

- Mount the pump to the engine using the bolts and lockwashers provided, torqued as follows in a crossing sequence:

  SAE #2, #3, #4, #5 – 20 lbs.-ft. (27 N·m)
  SAE #1 – 50 lbs.-ft. (68 N·m)

- Install coupling guards (501N).
- Bolt motor adapter (3) to the rigid support described above.

Coupling Alignment

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SEVERE PERSONAL INJURY.

FRAME-MOUNTED UNITS ONLY

- Alignment **MUST** be checked prior to running. See Figure 7.

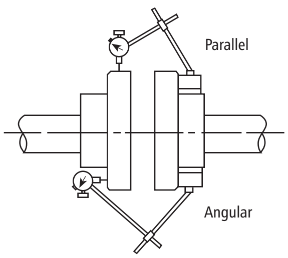


Figure 7

- Tighten all hold-down bolts before checking alignment.
- If realignment is necessary, always move the motor. Shim as required.
- Parallel misalignment, shafts with axis parallel but not concentric. Place dial indicator on one hub and rotate this hub 360° while taking readings on the outside diameter of the other hub. Parallel alignment is achieved when reading is 0.010" (0.254 mm) TIR, or less.
- Angular misalignment, shaft with axis concentric but not parallel. Place dial indicator on one hub and rotate this hub 360° while taking readings on the face of the other hub. Angular alignment is achieved when reading is 0.020" (0.508 mm) TIR, or less.
- Final alignment is achieved when parallel and angular requirements are satisfied with motor hold-down bolts tight.

NOTICE: ALWAYS RECHECK BOTH ALIGNMENTS AFTER MAKING ANY MECHANICAL ADJUSTMENTS.

Piping

- Piping should be no smaller than pump's discharge and suction connections and kept as short as possible, avoiding unnecessary fittings to minimize friction losses. See Table 1.
- All piping **MUST** be independently supported and **MUST NOT** place any piping loads on the pump

NOTICE: DO NOT FORCE PIPING INTO PLACE AT PUMP SUCTION AND DISCHARGE CONNECTIONS.

- All pipe joints **MUST** be airtight.

PIPING – SUCTION

- For suction lifts over 10 ft. (3 m) and liquid temperatures over 120° F (49° C), consult pump performance curve for net positive suction head required ($NPSH_R$).
- If a pipe size larger than pump suction is required, an eccentric pipe reducer, with the straight side up, **MUST** be installed at the pump suction.
- If pump is installed below the liquid source, install a gate valve in the suction for pump inspection and maintenance.

NOTICE: DO NOT USE THE GATE VALVE TO THROTTLE PUMP. THIS MAY CAUSE LOSS OF PRIME, EXCESSIVE TEMPERATURES AND DAMAGE TO PUMP, VOIDING WARRANTY.

- If the pump is installed above the liquid source, the following **MUST** be provided:
  - To avoid air pockets, no part of the piping should be above the pump suction connection.
  - Slope the piping upward from liquid source.
  - Use a foot valve or check valve **ONLY** if necessary for priming or to hold prime during intermittent duty.
  - The suction strainer or suction bell **MUST** be at least 3 times the suction pipe diameter area.
  - Insure that the size and minimum submergence over suction inlet is sufficient to prevent air from entering pump through a suction vortex. See Figures 8 through 11.

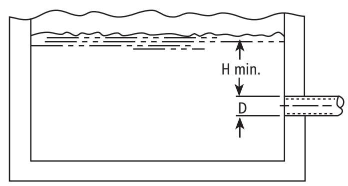


Figure 8

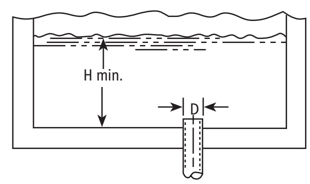


Figure 9

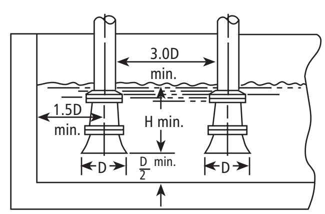


Figure 10

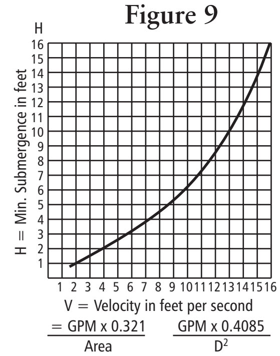


Figure 11

PIPING – DISCHARGE

- Install a check valve suitable to handle the flow, liquids and to prevent backflow. After the check valve, install an appropriately sized gate valve to be used to regulate the pump capacity, pump inspection and for maintenance.
- When required, pipe increaser should be installed between the check valve and the pump discharge.

Wiring and Grounding

Install, ground and wire according to local and National Electrical Code Requirements.

Install an all leg electrical power disconnect switch near the pump.

Disconnect and lockout electrical power before installing or servicing the pump.

Electrical supply **MUST** match pump's nameplate specifications. Incorrect voltage can cause fire, damage motor and void the warranty.

Motors without built-in protection **MUST** be provided with contactors and thermal overloads for single phase motors, or starters with heaters for three phase motors. See motor nameplate.

- Use only copper wire to motor and ground. The ground wire **MUST** be at least as large as the wire to the motor. Wires should be color coded for ease of maintenance.
- Follow motor manufacturer's wiring diagram on the motor nameplate or terminal cover carefully.

WARNING Hazardous voltage

FAILURE TO PERMANENTLY GROUND THE PUMP, MOTOR AND CONTROLS BEFORE CONNECTING TO ELECTRICAL POWER CAN CAUSE SHOCK, BURNS OR DEATH.

Rotation

NOTICE: INCORRECT ROTATION MAY CAUSE DAMAGE TO THE PUMP AND VOIDS THE WARRANTY.

- Correct rotation is right-hand, **CLOCKWISE** when viewed from the motor end. For frame mounted units, switch power on and off quickly to observe rotation. On close coupled units, remove motor end plug or cover to observe rotation.
- To reverse three phase motor rotation, interchange any two power supply leads.

Operation

DO NOT OPERATE FRAME MOUNTED OR SAE UNITS WITHOUT SAFETY GUARDS IN PLACE OR SEVERE PERSONAL INJURY MAY RESULT.

SPLASHING OR IMMERSING OPEN DRIP PROOF MOTORS IN FLUID CAN CAUSE FIRE, SHOCK, BURNS OR DEATH.

OPERATION AT OR NEAR ZERO FLOW CAN CAUSE EXTREME HEAT, PERSONAL INJURY OR PROPERTY DAMAGE.

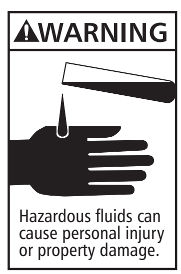
NOTICE: NO NOT RUN PUMP DRY OR SEAL DAMAGE WILL RESULT.

- After stabilizing the system at normal operating conditions, check the piping. If necessary, adjust the pipe supports.
- On frame-mounted units, coupling alignment may have changed due to the temperature differential between pump and motor. Recheck alignment following procedures and hazard warnings in **"COUPLING ALIGNMENT"** section of this manual.

Maintenance

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SHOCK, BURNS OR DEATH.

FAILURE TO RELIEVE SYSTEM PRESSURE AND DRAIN SYSTEM BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE PROPERTY DAMAGE, PERSONAL INJURY OR DEATH.



IF PIPING HAZARDOUS OR TOXIC FLUIDS, SYSTEM MUST BE FLUSHED PRIOR TO PERFORMING SERVICE.

CLOSE-COUPLED UNITS

- Bearings are located in and are part of the motor. For lubrication information, refer to motor manufacturer's instructions.

FRAME-MOUNTED UNITS

- Model 3756 S-group has greased for life bearings. No regreasing is possible or necessary.
- Model 3756 M or L-group bearing frame and SAE drive bearing frame should be regreased every 2,000 hours or at a three month interval, whichever occurs first. Use a #2 sodium or lithium based grease. Fill until grease comes out of relief fittings, or lip seals, then wipe off excess.
- Follow motor or engine and coupling manufacturer's lubrication instructions.
- Recheck alignment.

SEASONAL SERVICE

- To **REMOVE** pump from service, remove drain plug and drain all unprotected piping.
- To **RETURN** pump to service, replace drain plug using Teflon™ tape or equivalent on male threads.
- Reconnect suction line if removed, examine union and repair if necessary.
- Refer to **OPERATION** section of manual.

Disassembly

- Follow **ALL** warnings and instructions in the **"MAINTENANCE"** section of this manual.
- Close-coupled units: Remove motor hold-down bolts.
- Frame-mounted units: Remove coupling guard, spacer, coupling and frame hold-down bolts.

LIQUID END

1. Remove casing bolts (13).
2. Remove back pull-out assembly from casing (1).
3. Remove casing wear ring (4) if excessively worn.

NOTICE: DO NOT INSERT SCREWDRIVER BETWEEN IMPELLER VANES TO PREVENT ROTATION.

4. On close-coupled units, remove motor end plug or cover to expose screwdriver slot or flats on end of motor shaft.
5. While restraining shaft with an appropriate tool (close-coupled units) or with a strap wrench (frame-mounted units) remove impeller bolt (6). Impeller bolt may need to be heated with torch to remove. Discard.

NOTICE: EXERCISE CAUTION WHEN HANDLING HOT IMPELLER BOLT.

NOTICE: FOR SAE DRIVE UNITS, REMOVE IMPELLER NUT SET SCREW (22A) PRIOR TO REMOVING IMPELLER NUT (22). IMPELLER SET SCREW AND IMPELLER NUT MAY NEED TO BE HEATED TO BE REMOVED.

6. Remove impeller washer (7).
7. Insert two pry bars, 180° apart, between impeller (2) and seal housing (3). **CAREFULLY** pry off impeller.
8. Remove impeller key (8).
9. Remove seal housing bolts (14) and seal housing (3) pulling with it the mechanical seal assembly. Discard seal assembly and seal housing o-ring (9). For packed box pumps see **"PACKED BOX INSTRUCTIONS"**.
10. Remove adapter (108).
11. Inspect shaft sleeve (11). If badly scored, remove by heating with torch. Discard.
12. Push out the mechanical seal stationary seat from the seal housing. Discard.
13. On units equipped, remove seal housing wear ring (5) if excessively worn.

DISASSEMBLY OF BEARING FRAME OR SAE BEARING FRAME

1. Remove deflector (123) from shaft.
2. Remove bearing cover (134).
3. Remove shaft assembly from frame.
4. Remove lip seals (138, 139) from bearing frame (228) and bearing cover (134) if worn. Discard.
5. Remove retaining ring (361).
6. Use bearing puller or arbor press to remove ball bearings (112, 168).

Reassembly

- All parts should be cleaned before assembly.

NOTICE: O-RING SHOULD BE REPLACED AFTER ANY DISASSEMBLY OF UNIT.

BEARING FRAME

1. Replace lip seals if removed.
2. Replace ball bearings if loose, rough or noisy when rotated.
3. Check shaft (122) for runout. Maximum permissible is 0.002" (0.05 mm) TIR.
4. Refer to the **"MAINTENANCE"** section of this manual for M-group bearing frame regreasing instructions.

LIQUID END

1. Inspect shaft removing any debris or burrs.
2. Treat shaft with LOCQUIC® Primer "T", or equivalent, following manufacturer's instructions carefully.
3. When replacing shaft sleeve, spray new shaft sleeve's bore with LOCQUIC® Primer "T", or equivalent. Let parts dry and then apply LOCTITE® #262 on the same surfaces. Slide new sleeve over shaft with a twisting motion, wipe off excess. Let cure according to instructions.

NOTICE: MECHANICAL SEAL MUST BE REPLACED WHENEVER SEAL HAS BEEN REMOVED. FOLLOW SEAL MANUFACTURER'S INSTRUCTIONS CAREFULLY. FOR PACKED BOX PUMPS SEE **"PACKED BOX INSTRUCTIONS"**.

4. Replace seal housing wear ring, if removed.
5. For mechanical seal pumps, stationary seal seat may be dipped in water to ease installation. Place stationary seal seat squarely into seal housing bore. Cover the polished face of the seat with a thin piece of cardboard or paper towel. Press seat firmly into bore using a round piece of plastic or wood that disperses the force over the entire seal face. **NOTE:** If mechanical seal is supplied with a spring retainer, remove and discard the retainer.
6. Place adapter, concave face pointing up, over motor shaft and lower it onto the motor.
7. Replace seal housing o-ring. This o-ring may be lubricated with water or glycerin to ease in installation. Install seal housing on adapter. Exercise care in that the motor shaft does not dislodge or damage seal seat.
8. Fully and squarely install the rotary assembly of seal against the stationary seat.

NOTICE: REPLACE IMPELLER BOLT AND WASHER WHENEVER IMPELLER IS REMOVED.

9. Install impeller key in shaft keyway. Mount impeller on shaft and push until it bottoms. Hold in place. For SAE units, apply LOCTITE 271 to the impeller bore, keyway and shaft. Mount impeller on shaft and push until it bottoms. Hold in place.
10. Install new impeller washer. Impeller washer not used for SAE units..

11. Apply LOCTITE® #271 or equivalent, to new impeller bolt threads and tighten to:

3/8"-16 bolts	20 lbs.-ft. (27 N·m)
1/2"-13 bolts	38 lbs.-ft. (51 N·m)

Impeller bolt not used for SAE units.

12. For SAE units apply LOCTITE® #271 to the external threads of the shaft and internal threads of the impeller nut (22). Tighten impeller nut to the following:

1/2"-Impeller Nut (SAE M-Group)	80 lbs.-ft. (107 N·m)
3/4"-Impeller Nut (SAE L-Group)	100 lbs.-ft. (134 N·m)

13. For SAE units, after impeller nut (22) has been installed, apply LOCTITE® #271 to set screw (22A). Install impeller set screw into face of impeller nut (22) and tighten hand-tight.
14. Replace casing wear ring, if removed.
15. Replace casing bolts and tighten, in a crossing sequence, to torque values indicated below:

3/8"-16 bolts (bronze casing)	25 lbs.-ft. (34 N·m)
1/2"-16 bolts (cast iron casing)	37 lbs.-ft. (50 N·m)
1/2"-13 bolts (cast iron casing)	90 lbs.-ft. (122 N·m)
3/4"-10 bolts (cast iron casing)	175 lbs.-ft. (237 N·m)

16. Check reassembled unit for binding by rotating shaft with appropriate tool from motor end.
17. If rubbing exists, loosen casing bolts and proceed with tightening sequence again.
18. Replace motor hold-down bolts and motor end plug or cover on close-coupled units.
19. Replace coupling, spacer, coupling guard and frame hold-down bolts on frame-mounted units.

NOTICE: ALWAYS RECHECK BOTH ALIGNMENTS AFTER MAKING ANY ADJUSTMENTS.

20. Refer to the **"COUPLING ALIGNMENT"** section of this manual to realign shaft.
21. Assembly is complete.

Packed Box

1. Make sure stuffing box is free of foreign materials and clean before beginning packing of packed box. Refer to Sectional Assembly in the repair parts section.
2. Take special care during installation of packing rings because they are die-formed. To install, twist the ring sideways just enough to fit it around the shaft sleeve. **DO NOT ATTEMPT TO PULL RINGS STRAIGHT OUT**. See Figure 12.

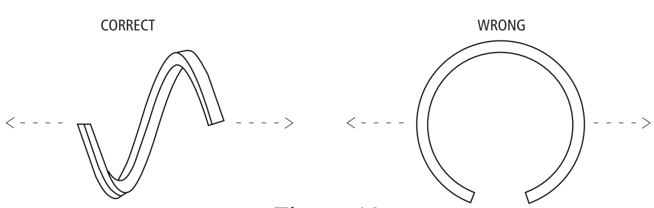
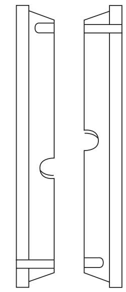


Figure 12

3. Install the two piece Teflon lantern ring supplied as shown in figure 13. Note: two pieces make one ring. Notches on ring must face each other, but alignment is not necessary.



Teflon Lantern Ring
Figure 13

4. Install the packing rings and lantern ring in the following sequence to pack the packed box. Install two rings of packing, then the lantern ring, followed by the final three rings of packing. Install each ring separately and firmly seat. The use of a wooden split bushing is recommended to accomplish this. See Figure 14. Use gland to jack the bushing and ring into the box. Stagger joints in each ring 90°. Make sure the flush tap in the packed box lines up with the center of the lantern ring. Any extra rings are spares.

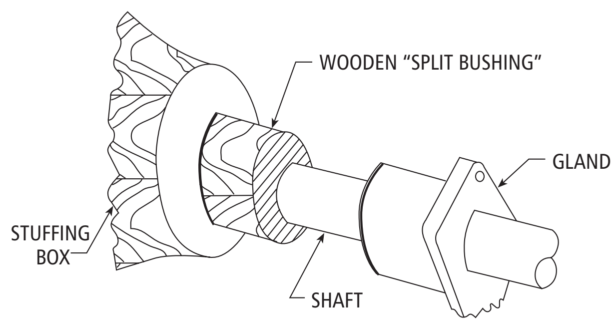


Figure 14

5. Tighten gland nuts evenly, but not tight. When the pump is started, slowly tighten the gland nuts until the leak rate is between 40 and 60 drops per minute. A grease lubricant can be used when the pumpage contains abrasive particles or for a suction lift condition.

REMOVAL OF PACKED BOX

- Follow these steps to remove the packing from the packed box.

1. Remove gland assembly.
2. With a "packing hook" remove packing.
3. Insert a wire hook into the ring on the outer edge to remove the lantern ring.
4. Clean the packed box.

PRIME SAFE ARRANGEMENT (Optional – M & L Group Only)

- The Prime Safe arrangement can be provided with grease or an oiler feed lubrication.

1. The grease gland (24) will have the letters "G" and "O" stamped on the outside diameter and have two 1/8" NPT connections for mounting a grease feeder or oiler.

2. For grease feed applications, the grease gland is assembled with the “G” stamp in the 12 o' clock position. The grease feeder (23) will mount in the grease gland at a 30 degree angle from the horizontal. This is done to gain access to the grease fitting located on the grease feeder. The lip seal (26) mounted in the grease gland will be assembled as shown in Figure 15.
3. For oiler feed applications, the grease gland is assembled with the “O” stamp in the 12 o' clock position. The two ⅛" NPT connections on the grease gland will be located on the horizontal, which is to ensure proper function of the oiler. The lip seal (26) is to be mounted in the reverse or opposite direction as shown in Figure 10.
4. The mounting of a grease feeder or oiler may require additional pipe extensions and/or fittings that will be provided from the factory as needed.
5. The grease feeder (23) will come with three springs (blue, red and silver). The use of the different springs will be varied depending on the operating temperature and the lubricant (grease) to be used.

	Grease Feeder Spring Size		
Operating Temperature	No. 1 Grease	No. 2 Grease	No. 3 Grease
-10ºF (-23ºC) to 40ºF (4ºC)	SILVER	RED	—
-40ºF (-40ºC) to 110ºF (43ºC)	SILVER	SILVER	RED
-110ºF (-79ºC) to 200ºF (93ºC)	BLUE	SILVER	SILVER

Use SAE 30W oil for oiler application.

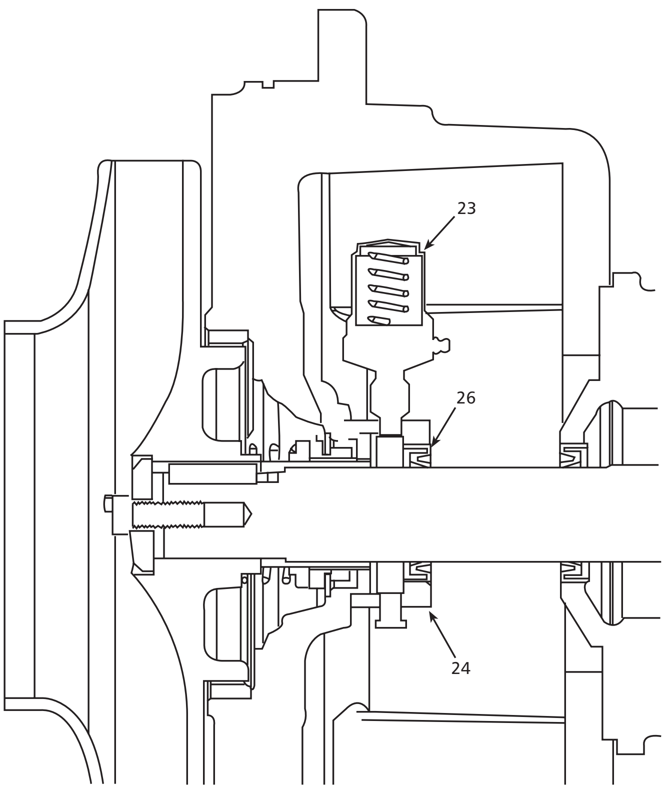


Figure 15

Troubleshooting Guide

DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE. FAILURE TO DO SO CAN CAUSE A SHOCK, BURN OR DEATH.

SYMPTOM

MOTOR NOT RUNNING
See Probable Cause – 1 through 5

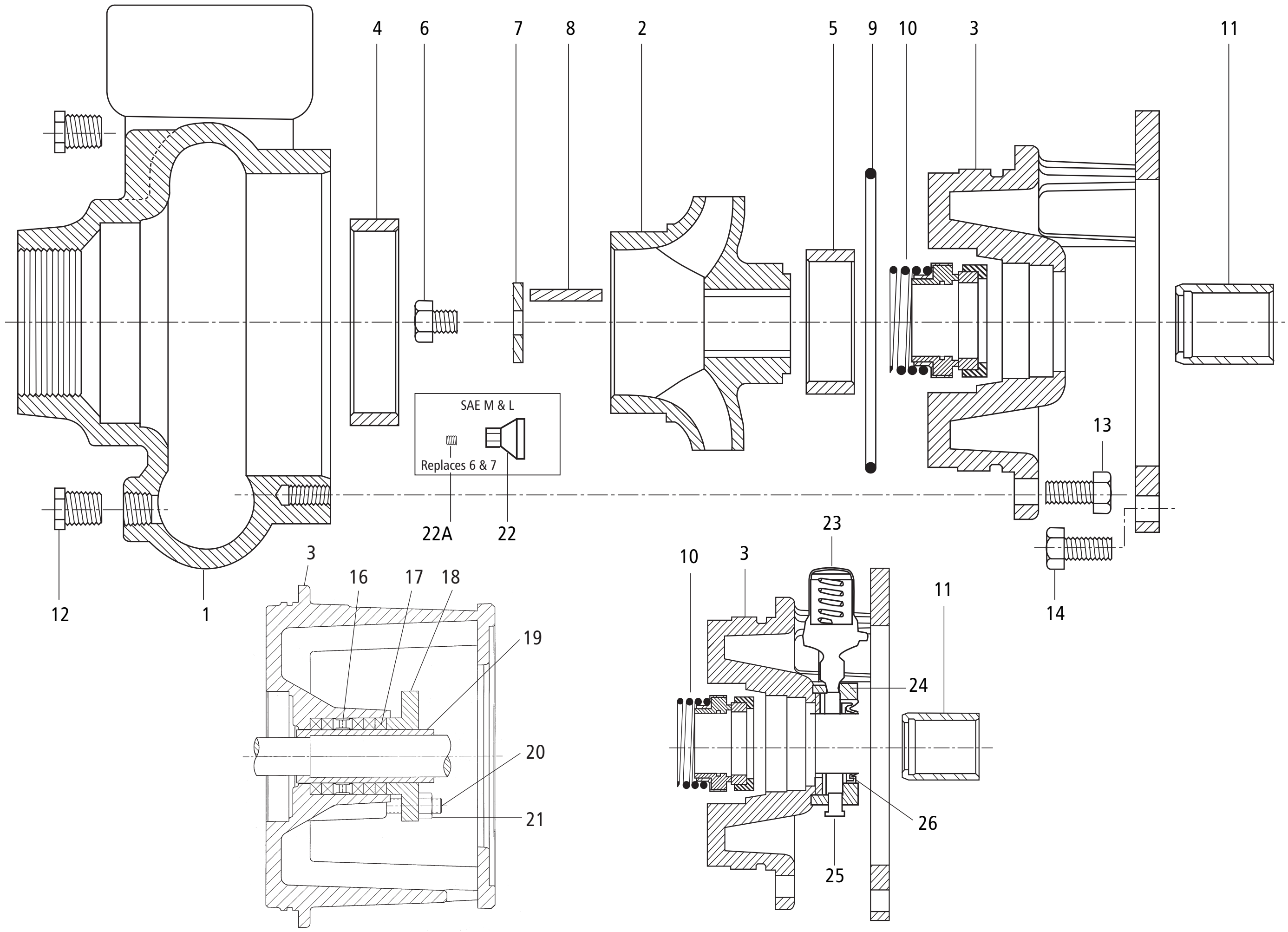
LITTLE OR NO LIQUID DELIVERED
See Probable Cause – 6 through 13

EXCESSIVE POWER CONSUMPTION
See Probable Cause – 3, 13, 14, 15

EXCESSIVE NOISE and VIBRATION
See Probable Cause – 3, 6, 7, 10, 12, 14, 16, 17

PROBABLE CAUSE

1. Motor thermal protector tripped
2. Open circuit breaker or blown fuse
3. Impeller binding
4. Motor improperly wired
5. Defective motor
6. Pump is not primed, air or gases in pumpage
7. Discharge, suction plugged or valve closed
8. Incorrect rotation (3 phase only)
9. Low voltage or phase loss
10. Impeller worn or plugged
11. System head too high
12. $NPSH_A$ too low – Excessive Suction lift or losses
13. Incorrect impeller diameter
14. Discharge head too low – excessive flow rate
15. Fluid viscosity, specific gravity too high
16. Worn bearing
17. Pump, motor or piping loose



Packed Box Arrangement

Prime Safe Arrangement (optional – M & L group only)

LIQUID END COMPONENTS

Item No.	Description	Material
1	Casing	Cast iron or Sil-brass*
2	Impeller	
3	Adapter	
4	Wear ring (casing)	Cast iron or bronze*
5**	Wear ring (seal housing)	
6	Impeller bolt	AISI Type 300 stainless steel
7	Impeller washer	
8	Impeller key	Steel
9	Seal housing o-ring (optional materials)	BUNA-N/EPR/Viton
10	Mechanical seal	Consult factory
11	Shaft sleeve	AISI Type 300 stainless steel
12	Drain plug – ¼ or ⅜ NPT	Zinc plated steel
13	Hex head cap screw (casing to adapter)	
14	Hex head cap screw (adapter to motor/frame)	
15	Hex head cap screw (Adapter to seal housing)	
16	Lantern ring	Teflon™
17	Packing, 5 rings	Teflon™ impregnated
18	Gland	AISI 300SS
19	Shaft sleeve	AISI Type 300 stainless steel
20	Gland stud	
21	Gland nut	
22	Impeller nut (SAE only)	304 SS
22A	Set screw, impeller nut (SAE only)	
23	Grease feeder (oiler optional)	Polycarbonate

LIQUID END COMPONENTS

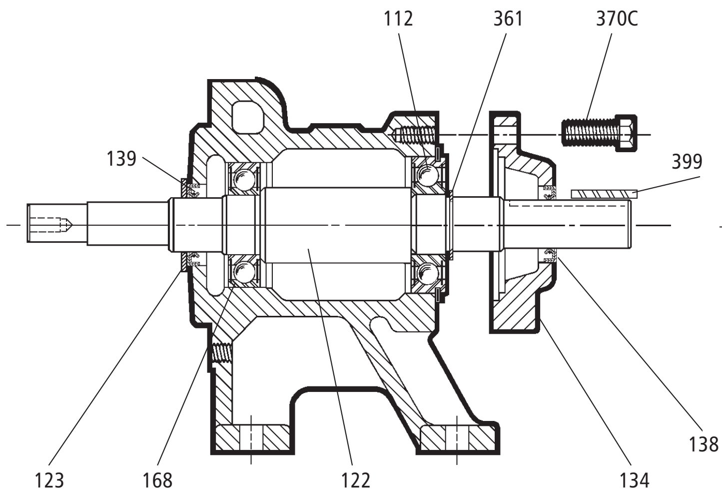
Item No.	Description	Material
24	Grease gland	Aluminum
25	Pipe plug	Zinc plated steel
26	Lip seal	Buna

* Lead free

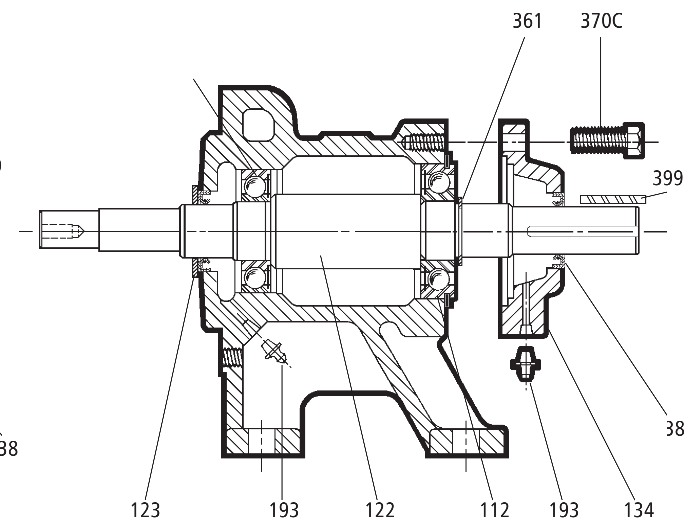
** Item #5 supplied on S-group model 2½ x 3-7 (7½, 10 and 15 HP) and M-group (except 3 x 4-10).

POWER END COMPONENTS (shown on next page)

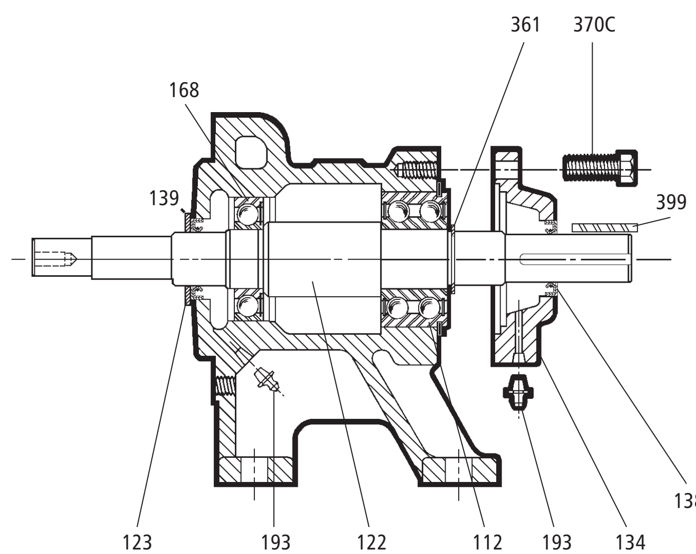
Item No.	Description	Material
112	Ball bearing (outboard)	Steel
122	Pump shaft	
122A	Pump shaft (SAE)	AISI 4140 steel
123	V-ring, deflector	BUNA-N
134	Bearing cover	Cast iron
138	Lip seal (outboard)	BUNA-N
139	Lip seal (inboard)	
168	Ball bearing (inboard)	Steel
193	Grease fitting (M & L group)	
327C	Screw (cover to adapter) (SAE only)	Zinc plated steel
340	Adapter/engine (SAE only)	Cast iron
361	Retaining ring	Steel
370C	Hex head cap screw (frame to cover)	Zinc plated steel
371C	Hex head cap screw (adapter to frame) (SAE only) *NOT SHOWN*	Steel
399	Key, coupling	
501N	Cover/adapter (SAE only)	Galvanized steel



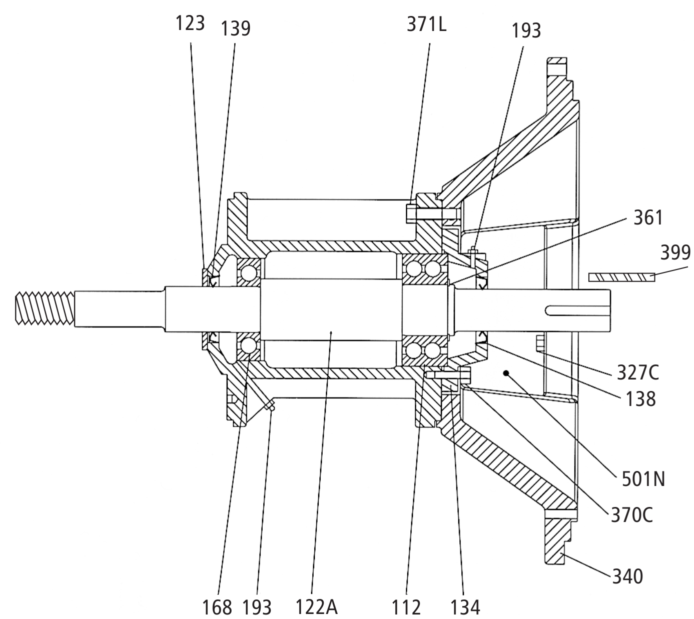
S-Group Power Frame



M-Group Power Frame



L-Group Power Frame



SAE Power Frame

Notes

GOULDS PUMPS LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by Goulds Pumps.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Goulds Pumps distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Goulds Pumps Customer Service Department.

The warranty excludes:

(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:

(1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Goulds Pumps and the dealer in purchases, consignments or contracts for sale of the subject pumps.
(2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
(3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

THIS WARRANTY EXTENDS TO THE DEALER ONLY.

Goulds Pumps is a brand of ITT Water Technology, Inc. – a subsidiary of ITT Industries, Inc.

www.goulds.com

Goulds Pumps

ITT Industries

GOULDS PUMPS

Instrucciones de operación, instalación y mantenimiento

Modelo 3656/3756

Información del propietario

Por favor anote los siguientes datos y entregue el manual al dueño de casa. Encontrará información sobre garantía en la página 28.

Número de modelo: ______________________

Número de serie: ______________________

Comercio donde se adquirió: ______________________

Teléfono del comercio: ______________________

Fecha de compra: __________ Fecha de instalación: __________

Índice

Goulds Pumps

ITT Industries

INSTRUCCIONES DE SEGURIDAD

PARA EVITAR LESIONES PERSONALES GRAVES O FATALES Y SERIOS DAÑOS MATERIALES, LEA Y SIGA TODAS LAS INSTRUCCIONES DE SEGURIDAD EN EL MANUAL Y EN LA BOMBA.

Este es un **SÍMBOLO DE ALERTA** relacionado con la seguridad. Cuando encuentre este símbolo en la bomba o en el manual, busque una de las siguientes palabras de advertencia y esté alerta a las potenciales lesiones personales o daños materiales.

PELIGRO Advierte sobre peligros que **CAUSARÁN** lesiones personales graves, muerte o daños materiales mayores.

ADVERTENCIA Advierte sobre peligros que **PUEDEN** causar lesiones personales graves, muerte o daños materiales mayores.

PRECAUCIÓN Advierte sobre peligros que **PUEDEN** causar lesiones personales o daños materiales.

ATENCIÓN: INDICA QUE A CONTINUACIÓN ENCONTRARÁ INSTRUCCIONES ESPECIALES MUY IMPORTANTES, LAS CUALES DEBE OBSERVAR.

ESTE MANUAL HA SIDO CREADO COMO UNA GUÍA PARA LA INSTALACIÓN Y OPERACIÓN DE LA UNIDAD. REPASE EN DETALLE TODAS LAS INSTRUCCIONES Y ADVERTENCIAS ANTES DE REALIZAR CUALQUIER TRABAJO EN ESTA BOMBA.

CONSERVE TODAS LAS CALCOMANÍAS DE SEGURIDAD.

ATENCIÓN: INSPECCIONE LA UNIDAD E INFORME INMEDIATAMENTE AL TRANSPORTISTA DE CUALQUIER DAÑO QUE ENCUENTRE.

ADVERTENCIA

Los fluidos peligrosos pueden originar fuego, quemaduras o causar la muerte.

ESTA UNIDAD NO HA SIDO DISEÑADA PARA OPERAR CON LÍQUIDOS PELIGROSOS O GASES INFLAMABLES.

DESCRIPCIÓN Y ESPECIFICACIONES

Las bombas de la serie 3656/3756 son bombas centrífugas de una etapa con succión en el extremo, para la transferencia general de líquidos, aplicaciones de refuerzo, riego y servicios generales de bombeo. Están disponibles en tres materiales distintos: todo hierro, con accesorios de bronce o todo bronce (grupo "S" únicamente).

Los impulsores de la bomba están completamente encerrados, son accionados por chaveta y se mantienen en posición con un perno y una arandela. Las carcasas tienen diseño de voluta completa con anillos de desgaste reemplazables.

Dependiendo del tamaño de la bomba, las conexiones de succión y descarga son roscadas o con bridas. Los ejes están protegidos por camisas de acero inoxidable.

Las unidades de acoplamiento corto tienen motores NEMA JM o JP estándar con montaje en cara C y extensión del eje accionado por chaveta. Las unidades con accionamiento SAE se sujetan con pernos directamente a la cubierta del volante del motor en los modelos de tamaño SAE 1, 2, 3, 4 y 5. Para los volantes de 6½, 7½, 8, 10, 11½ y 14 pulgadas, hay disponibles elementos elastómeros para acoplamiento. Las unidades para montaje en bastidor se pueden acoplar a motores a través de un acoplamiento espaciador, o pueden ser accionadas por correa.

Datos de ingeniería

Temperatura máxima del líquido:
212ºF (100ºC) - sello o empaque estándar
250ºF (120ºC) - sello de alta temperatura opcional
Presión máxima de trabajo (dependiendo de la temperatura del fluido):
- conexiones NPT, 200 PSI (1379 kPa)
- conexiones con brida ANSI de 125 lbs., 200 PSI (1379 kPa)

Presión máxima de succión: 100 PSI (689.5 kPa)
Arranques por hora: 20, distribuidos uniformemente

Grupo	Tamaño	Succión	Descarga
S	1½ x 2-6 (H)	2" NPT	1½" NPT
	1 x 2-7	2" NPT	1" NPT
	2½ x 3-7	3" NPT	2½" NPT
	3 x 4-7	4" Brida	3" Brida
	1 x 2-8	2" NPT	1" NPT
	1½ x 2-8	2" NPT	1½" NPT
LH	2 x 2-5	2" NPT	2" NPT
	2½ x 2½-5	2½" NPT	2½" NPT
	3 x 3-5	3" NPT	3" NPT
	4 x 4-5	4" Brida	4" Brida
	5 x 5-6	5" Brida	5" Brida
M	2½ x 3-8	3" NPT	2½" NPT
	3 x 4-8	4" Brida	3" Brida
	4 x 5-8	5" Brida	4" Brida
	1½ x 2-10	2" NPT	1½" NPT
	2½ x 3-10	3" Brida	2½" Brida
	3 x 4-10	4" Brida	3" Brida
	4 x 6-10	6" Brida	4" Brida
	2½ x 3-13	3" Brida	2½" Brida
	3 x 4-13	4" Brida	3" Brida
	4 x 6-13	6" Brida	4" Brida
L	6 x 8-13	8" Brida	6" Brida
	8 x 10-13	10" Brida	8" Brida
	4 x 6-16	6" Brida	4" Brida

Instalación

UBICACIÓN

- Ubique la bomba tan cerca de la fuente de líquido como resulte práctico y por debajo del nivel del líquido para permitir el cebado automático.
- Deje suficiente espacio para ventilación y tareas de mantenimiento. Proteja la unidad de las inclemencias del tiempo y daños causados por lluvias, inundaciones o temperaturas bajo cero.
- Proteja la bomba y las cañerías de temperaturas bajo cero.
- Deje suficiente espacio alrededor de la unidad para ventilación y tareas de mantenimiento.

BOMBAS DE ACOPLAMIENTO CORTO

- Estas unidades se pueden instalar en forma horizontal, inclinada o vertical con el motor sobre la bomba.
- Los pies del motor **DEBEN** abulonarse a una superficie resistente (horizontal o vertical) que sea capaz de brindar un soporte completo y rígido para la bomba y el motor. Para las bombas del grupo L, los pies del adaptador del motor también deben estar abulonados a la superficie de apoyo.
- Para la operación vertical, el motor debe equiparse con una cubierta antigoteo o protegerse de alguna otra manera para evitar que entre líquido (lluvia, rociado, condensación, etc.).

ATENCIÓN: NO INSTALE EL MOTOR POR DEBAJO DE LA BOMBA. CUALQUIER PÉRDIDA O CONDENSACIÓN AFECTARÁ AL MOTOR.

BOMBAS DE MONTAJE EN BASTIDOR

- Se **DEBE** proveer una superficie de base substancial para evitar la distorsión o la tensión al ajustar los bulones de la base de montaje. Se puede utilizar un montaje de caucho para reducir el ruido y la vibración excesiva.
- Ajuste los pernos de sujeción del motor **ANTES** de conectar la tubería a la bomba.

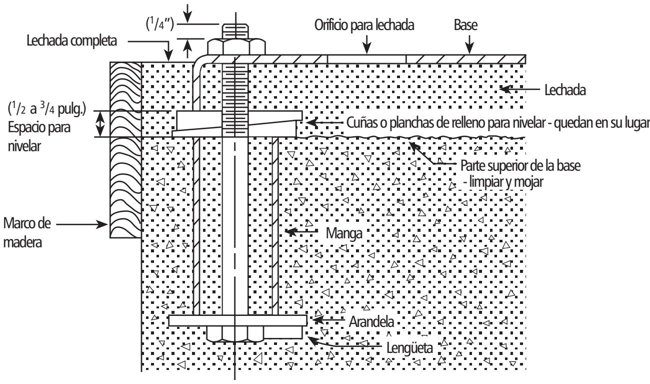


Figura 1

- Se recomienda enlechar la placa de base a un cimiento con zapata sólida. Consulte la figura 1.
- Coloque la unidad en posición sobre cuñas ubicadas en las cuatro puntas, dos debajo del centro aproximado del motor accionador y dos debajo del centro aproximado de la bomba. Ajuste las cuñas para nivelar la unidad. Nivele o verifique con plomada las conexiones de succión y descarga.
- Asegúrese de que la placa de base no está distorsionada y que la alineación final del acoplamiento se puede efectuar dentro de los límites de movimiento del motor, con la ayuda de cuñas si fuera necesario.
- Ajuste los pernos de la base con la mano y construya una presa alrededor de la base. Vierta la lechada debajo de la placa de base asegurándose de llenar completamente las áreas debajo de los pies del motor y de la bomba. Deje endurecer la lechada por 48 horas antes de ajustar completamente los pernos de la base.
- Ajuste los bulones de sujeción de la bomba y el motor antes de alinear el eje o conectar la cañería a la bomba.
- Deje endurecer la lechada por 48 horas antes de ajustar los 4 pernos de la base.

Bombas accionadas por motor SAE

La caja de cojinetes del motor de accionamiento SAE está diseñada para sujetarla directamente a la cubierta del motor para los montajes SAE tamaño 1, 2, 3, 4 y 5. La extensión del eje de la bomba es del tamaño apropiado para acoplamientos abulonados directamente al volante. Goulds Pumps ofrece acoplamientos opcionales para los volantes de 6½, 7½, 8, 10 y 14 pulgadas. Si bien se pueden utilizar otros acoplamientos de montaje en el volante, recomendamos el uso de los acoplamientos de Goulds Pumps para asegurar la operación prolongada y sin inconvenientes de la bomba.

REQUISITOS PARA UNA CORRECTA OPERACIÓN

Extremo de la bomba
Cuando se libere la capacidad requerida (GPM) a la tubería del sistema, la bomba deberá añadir la cantidad de Altura requerida por el sistema a tal capacidad. El punto de capacidad de altura de operación debe encontrarse lo más cerca posible a la mayor línea de rendimiento que se muestra en la curva de desempeño, y debe encontrarse por debajo de la línea de capacidad de altura indicada como "máxima" RPM. La máxima velocidad de operación RPM para la bomba se encuentra determinada por la antigüedad del cojinete o, en ciertos casos, por los límites de presión de la bomba. Las aberturas de succión y descarga tienen roscas NPT para tuberías estándar, o recubiertas y taladradas según norma ANSI B16.1, clase 125 para bridas estándar de acuerdo con lo indicado. La presión máxima de trabajo para el hierro fundido clase 30, según la norma ANSI B16.1, es 175 PSI.

Los motores de combustión interna son de velocidad variable y de potencia variable. La salida de potencia depende de la velocidad del motor (RPM) y se reducirá si la altura de operación y/o la temperatura del aire aumentan. Cuando se acciona la bomba a las RPM requeridas para distribuir el agua en la tubería del sistema, el motor debe operar dentro de los límites mínimos y máximos de RPM establecidos por el fabricante del motor. Luego de la reducción de la potencia nominal de todos los accesorios del motor que consumen energía y el ajuste de la altitud y la temperatura aérea del sitio de instalación, la salida de potencia que suministra la potencia demandada por la bomba no debe exceder la potencia nominal continua del motor.

DIMENSIONAMIENTO DEL ELEMENTO MOTRIZ (BHP)

La ecuación para obtener el BHP es: (Flujo x TDH) / 3960 x Rendimiento).
Nota: Para las unidades de combustión interna el cálculo del BHP debe tomar en cuenta las siguientes condiciones:

- 20% por servicio continuo
- 5% por accionamiento mediante caja de engranaje de angulo recto
- 3% por cada 1.000 pies sobre el nivel del mar
- 1% por cada 10º F sobre 60º F.

DIMENSIONAMIENTO DEL ELEMENTO MOTRIZ (TORQUE)

Además del dimensionamiento de un motor por BHP, también se requieren cálculos de torque para un dimensionamiento correcto. Generalmente, la potencia y el torque nominal no mantienen la misma relación durante el rango utilizable de un motor diesel (Figura 2). La ecuación para obtener el torque (libras/pies) es (5250 x BHP) / RPM.

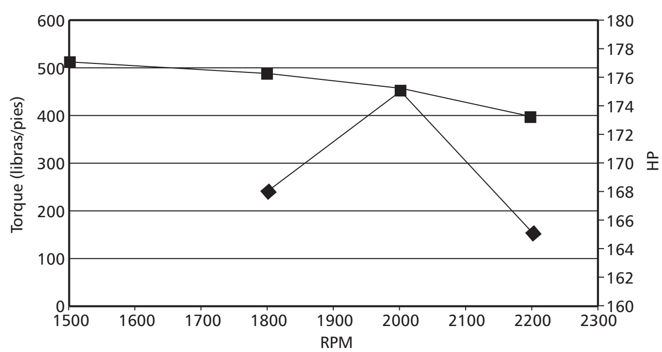


Figura 2: HP (◆) vs. Torque (■)

VERIFIQUE LA COINCIDENCIA DEL EXTREMO DE LA BOMBA Y EL MOTOR

Tamaño de la abrazadera SAE
A las bombas accionadas por motor se les pueden colocar motores que poseen desde una cubierta del volante estándar SAE 5 hasta una SAE 1.

En el caso de un motor nuevo, el proveedor del motor puede suministrar el número de cubierta SAE.

En el caso de un motor existente, puede medir el orificio de la cubierta del volante y la circunferencia de los agujeros de los pernos y luego compararlos con las dimensiones estándar de cubierta SAE detalladas en la Tabla 1, para identificar el número de cubierta SAE.

Mida el orificio de la cubierta del volante (A) y la circunferencia de los agujeros de los pernos (B), con la mayor precisión posible, con una cinta métrica (a la medida más cercana a 1/32 pulgada).

- Cuente la cantidad de orificios roscados en la cubierta del volante (C). Pruebe los orificios roscados con un perno, para determinar la serie de rosca.
- Compare las dimensiones tomadas (A), (B), (C) con la Tabla 1 para determinar el número SAE de la cubierta del volante, para asegurarse de que coincida con el número SAE de su bomba.

Dimensiones de la cubierta del volante		Tamaño de la cubierta del volante SAE				
		1	2	3	4	5
A		20⅛	17⅝	16⅛	14¼	12⅜
B		20⅞	18⅜	16⅞	15	13⅛
C	Nº	12	12	12	12	8
	Tamaño	7/16-14	3/8-16	3/8-16	3/8-16	3/8-16

Tabla 1

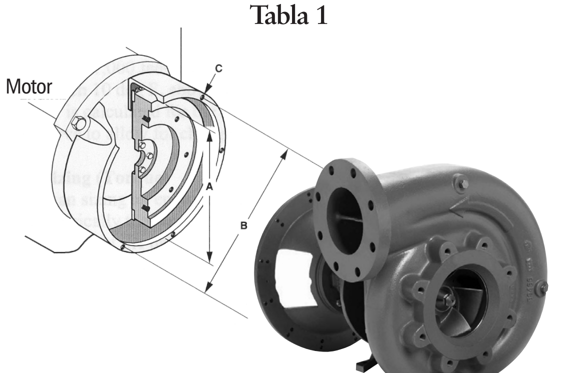


Figura 3

INSTALACIÓN

- La bomba se puede instalar en posición horizontal, con la descarga girada hacia cualquier posición permitida por el patrón de los pernos de la carcasa (13). Se recomienda que la descarga se encuentre en posición horizontal, por encima de la succión.
- En todas las bombas la carcasa debe estar sostenida por un soporte rígido sujeto al cimiento o base de la unidad.
- Para las bombas del grupo M, se recomienda que dicho soporte se sujete con 2 o más pernos de la carcasa (13) al anillo adaptador del motor. Probablemente se requieran pernos más largos para el grosor adicional del soporte. Utilice pernos SAE grado 5, torsionados según se indica en este manual.
- Para las bombas del grupo L, se recomienda que la bomba se apoye debajo de los dos pies fundidos en el adaptador del motor (3). Dichos pies deben sujetarse con pernos al soporte.

MONTAJE DE LA BOMBA SOBRE EL MOTOR (ACOPLAMIENTO RANURADO)

Preparación para el montaje de la bomba sobre el motor

- Limpie la superficie de la cubierta del volante y el volante según sea necesario para quitar toda la grasa, suciedad o polvo (y todos los rastros de antioxidante), que interferirían en la instalación de la bomba y/o impedirían la correcta alineación. Si el volante incluye un cojinete piloto para eje de transmisión, quítelo y deséchelo. No se necesita el cojinete piloto para la instalación del extremo de la bomba, y puede interferir con el eje de la bomba.
- Examine detenidamente la ranura del eje. Utilice una lima, si es necesario, para quitar toda la rebaba que impediría el libre desplazamiento del acoplamiento sobre el eje.
- Lubrique moderadamente la ranura del eje de la bomba con grasa liviana. No lubrique el eje recto con chaveta.
- Deslice el acoplamiento sobre el eje hasta que se detenga contra el eje (remítase a la página 5 para la instalación del eje recto).
- Mida la distancia existente desde el lado del motor del anillo adaptador de acoplamiento del volante hasta la superficie de montaje de la abrazadera de la bomba. Remítase a la Figura 4 debajo, **Dimensión "A"**.
- Luego, mida la profundidad existente desde la superficie de la cubierta del volante sobre el motor hasta la superficie del volante contra la cual se colocará con pernos el acoplamiento. Remítase a la Figura 4 debajo, **Dimensión "B"**.
- La medición de la bomba debe ser inferior a la medición del motor porque sino la interferencia axial producirá una fuerza de empuje sobre los cojinetes de cigüeñal del motor. Dicho de manera simple, la Dimensión "A" debe ser inferior a la **Dimensión "B"**.

ACOPLAMIENTO DEL VOLANTE

- El acoplamiento del volante transmite la potencia desde el volante del motor hasta el eje de la bomba. El máximo de potencia que un acoplamiento puede manejar sin peligros se demuestra en un número nominal, "R", que se detalla en las tablas de dimensiones de acoplamiento.
- Al escoger un acoplamiento del volante para una bomba y un motor, primero determine la potencia nominal que la

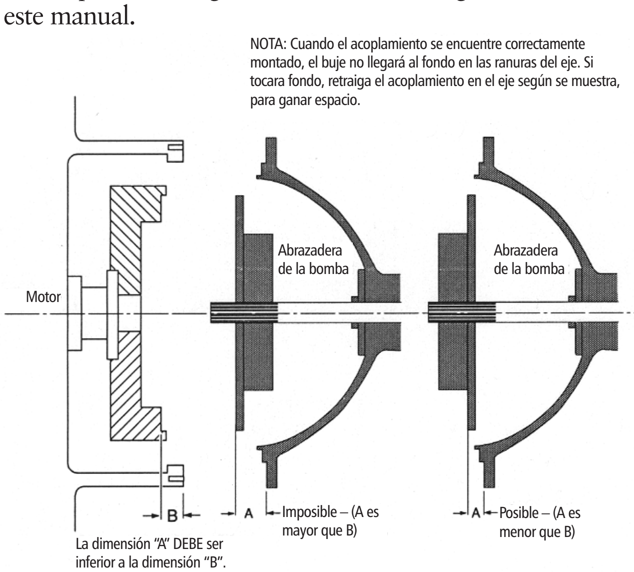


Figura 4

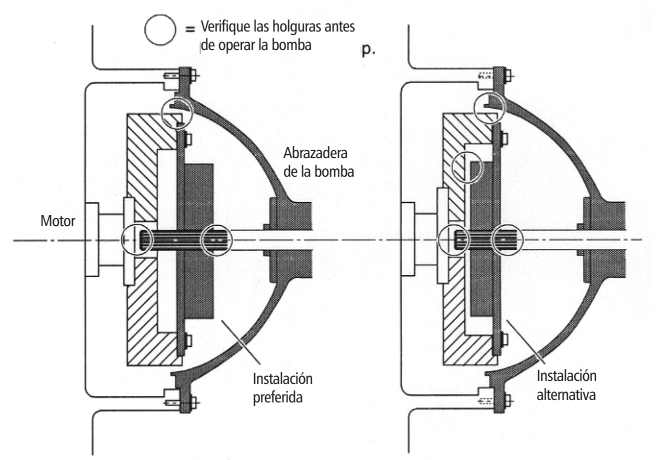


Figura 5

bomba demandará. En la curva de desempeño de la bomba, obtenga los valores de RPM y BHP necesarios para producir el punto de aplicación de la capacidad de altura.

- Divida el BHP por EL RPM, luego multiplique el resultado por 100. El resultado será el número de demanda de la bomba. Por ejemplo, una 20BFSAE1AO puede liberar 800 GPM a 270 pies de Altura total mientras funciona a 1800 RPM. La potencia requerida por la bomba será de 75 BHP. El número de demanda será: (75 / 1800) x 100 = 4.16
- Luego, seleccione un acoplamiento que pueda transmitir sin peligros la potencia y que se adecuará a las dimensiones del volante. Para que un acoplamiento resulte adecuado debe poseer un número nominal "R" MAYOR QUE el número de demanda de la bomba. En el ejemplo anterior, el mínimo número "R" de acoplamiento sería 5.
- La compatibilidad de torsión del motor, la bomba y el acoplamiento es responsabilidad de quien realiza el montaje. Goulds Pumps suministrará los datos necesarios sobre la bomba y el acoplamiento para ser utilizados por quien realiza el montaje en una análisis torsional.

NOTA: Si el volante se coloca con un cojinete piloto presionado en un orificio en el centro, quítelo para evitar la interferencia con el eje de la bomba.

VOLANTE PARA EMBRAGUES DE SOBRECENTRO DE TIPO INDUSTRIAL

- La Figura 6 muestra la apariencia ahuecada de los volantes fabricados para ser utilizados en montajes de despegue propulsados con embragues de sobrecentro.
- Dichos volantes poseerán un orificio empotrado mecanizado en la superficie, y un conjunto de agujeros de colada, que serán utilizados para conectar el acoplamiento al volante. Las dimensiones se encuentran determinadas por el estándar SAE y se detallan en las Tabla 1A y 1B, Figura 3. El "tamaño del embrague" que se muestra en la tabla es el diámetro nominal del recubrimiento del embrague para Embragues de sobrecentro con anillo de accionamiento.

OTROS VOLANTES

- Ciertos motores están equipados con volantes especialmente mecanizados para acoplarse a otros tipos de maquinaria (generadores eléctricos, convertidores de torque, etc.) y necesitan de acoplamientos de volante que no sean estándar. Estos pueden adquirirse por medio de vendedores o proveedores.

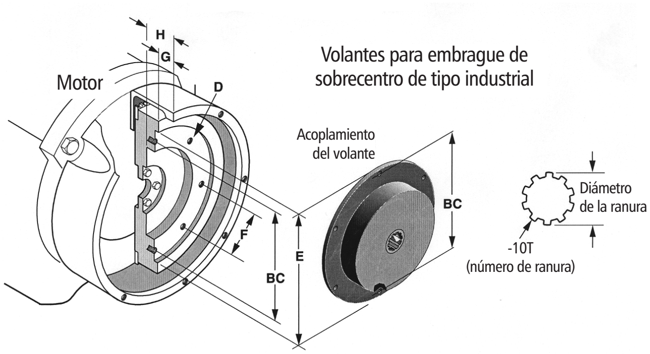


Figura 6

**Tabla IA –
Rango amplio de RPM, Buje montado elastomérico –
Eje ranurado**

Tamaño del embrague	Dimensiones del volante: D Cant.	D Tamaño (UNC)	E	BC	F	G	H	Acoplamiento del volante (Ranurado): R*	Nº del Catálago	diám. de la ranura del eje
6½"	6	5/16-18	8½ OD	7.88	3.94	1.19	1.69	7	A00569C 1	1½" 10T
7½"	8	5/16-18	9½" OD	8.75	3.69	1.19	1.69	7	A00569C 2	1½" 10T
8"	6	⅜-16	10⅜" OD	9.62	4.81	2.44	2.94	7	A00569C 3	1½" 10T
10"	8	⅜-16	12⅜" OD	11.62	4.47	2.13	2.75	7	A00569C 4	1½" 10T
10"	8	⅜-16	12⅜" OD	11.62	4.47	2.13	2.75	9	A00569C 6	1½" 10T
11½"	8	⅜-16	13⅞" OD	13.12	5.06	1.56	2.69	7	A00569C 5	1½" 10T
11½"	8	⅜-16	13⅞" OD	13.12	5.06	1.56	2.69	9	A00569C 7	1½" 10T
14"	8	½-13	18⅜" OD	17.25	6.63	1.00	2.13	9	A00569C 8	1½" 10T

OD = Diámetro exterior
*R = Máxima potencia nominal del acoplamiento
Potencia nominal del acoplamiento = (Potencia Nominal x 100) / RPM nominal

**Table IB –
Rango amplio de RPM, Buje montado elastomérico –
Eje recto**

Tamaño del embrague	Dimensiones del volante: D Cant.	D Tamaño (UNC)	E	BC	F	G	H	Acoplamiento del volante (Ranurado): R*	Nº del Catálago	diám. de la ranura del eje
6½"	6	5/16-18	8½ OD	7.88	3.94	1.19	1.69	2.28	CD616	1.625-1.624 Ø Ranura de ⅜ x 3/16
								3.51	CD625	
7½"	8	5/16-18	9½" OD	8.75	3.69	1.19	1.69	2.28	CD716	
								3.51	CD725	
8"	6	⅜-16	10⅜" OD	9.62	4.81	2.44	2.94	2.28	CD816	
								3.51	CD825	
10"	8	⅜-16	12⅜" OD	11.62	4.47	2.13	2.75	2.28	CD1016	
								3.51	CD1025	
								5.71	CD1030	
								8.57	CD1050	
								11.23	CD1080	
11½"	8	⅜-16	13⅞" OD	13.12	5.06	1.56	2.69	2.28	CD1116	
								3.51	CD1125	
								5.71	CD1130	
								8.57	CD1150	
								11.23	CD1180	
								12.62	CD1190	
								16.85	CD11110H	
14"	8	⅜-16	18⅜" OD	17.25	6.63	1.00	2.13	2.28	CD1416	
								3.51	CD1425	
								5.71	CD1430	
								8.57	CD1450	
								11.23	CD1480	
								12.62	CD1490	
								16.85	CD14110H	

OD = Diámetro exterior
Dimensiones en pulgadas
*R = Máxima potencia nominal del acoplamiento
Potencia nominal del acoplamiento = (Potencia Nominal x 100) / RPM nominal

- Para los acoplamientos Goulds Pumps con chaveta de eje recto – Asegúrese de que el tornillo de fijación del rodete de acoplamiento se encuentre lo suficientemente retraído como para asegurar espacio para la chaveta del eje durante el montaje.

- Monte el ensamblaje de acoplamiento en el volante del motor utilizando los pernos suministrados, ajustándolos en zigzag de la siguiente manera:

  Volante de 6½ ó 7½ " – 11 libras-pie (15 N·m)
  Volante de 8, 10 o 11½ ” – 20 libras-pie (27 N·m)
  Volante de 14” - 50 libras-pie (68 N·m)
  (Para otros acoplamientos, respete el procedimiento de instalación recomendado por sus fabricantes.)
- Coloque la chaveta del eje de la bomba en el eje (122) y alinee el eje con el acoplamiento. Deslice la bomba dentro del acoplamiento hasta que el anillo adaptador del motor (340) esté en contacto con la cubierta del volante del motor.

INSTALACIÓN DEL ACOPLAMIENTO EN EL VOLANTE

Acoplamiento del volante de sobrecentro:

- Estos acoplamientos se encuentran alineados en forma concéntrica con el volante mediante el montaje de registro del volante.
- Asegúrese de quitar todos los protectores del volante del motor.
- Coloque el acoplamiento dentro del volante. Alinee los agujeros de los pernos y conecte el acoplamiento con el montaje de registro en el volante. Golpee ligeramente el acoplamiento con un martillo pesado dúctil, si es necesario, para asegurarse que se encuentra aplastado contra el volante. Asegure fuertemente el acoplamiento al volante con tornillos tipo “capscrew” y arandela de presión.

INSTALACIÓN DE LA BOMBA EN EL MOTOR

- Eleve la bomba utilizando un aparato de elevación adecuado y alinee el eje de la bomba con el acoplamiento. El extremo del eje de la bomba posee un diámetro piloto que facilita el encaje del eje de la bomba en el acoplamiento.
- A traves de la abertura de succión de la bomba, gire el impulsor ligeramente hasta que el eje se conecte con el acoplamiento. Verifique que no existan espacios entre las superficies de la abrazadera y la cubierta del volante. Gire la bomba lo necesario para alinear los agujeros de la abrazadera con el motor. Instale los tornillos tipo “capscrew” y sujete con pernos el extremo de la bomba al motor.

NOTA: Si se detectara alguna interferencia o incompatibilidad de las partes durante la instalación, NO prosiga con el montaje. Notifique el problema al distribuidor de Goulds Pumps más cercano.

- Monte la bomba en el motor utilizando los pernos y arandelas de seguridad provistos y ajústelos en zigzag como sigue:

  SAE No. 2, 3, 4, 5 – 20 libras-pie (27 N . m)
  SAE No. 1 - 50 libras-pie (68 N . m)
- Instale los protectores de acoplamiento (501N).
- Sujete con pernos el adaptador del motor (3) al soporte rígido descripto anteriormente.

Alineación del acoplamiento

EL NO DESCONECTAR Y BLOQUEAR LA ALIMENTACIÓN ELÉCTRICA ANTES DE INTENTAR TAREAS DE MANTENIMIENTO PUEDE CAUSAR LESIONES PERSONALES GRAVES.

BOMBAS DE MONTAJE EN BASTIDOR ÚNICAMENTE

- Se **DEBE** verificar la alineación antes de operar la bomba. Observe la figura 7.

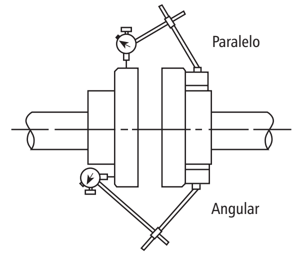


Figura 7

- Ajuste todos los bulones de sujeción antes de verificar la alineación.
- Si fuera necesario realinear, mueva siempre el motor. Coloque planchas de relleno según sea necesario.
- Desalineación paralela, ejes con línea de centro paralela pero no concéntrica. Coloque el indicador de dial en un rodete y haga girar el rodete 360° mientras registra las lecturas en el diámetro exterior del otro rodete. La alineación paralela se logra cuando la lectura es 0.010 pulg. (0.254 mm) TIR o menos.
- Desalineación angular, ejes con línea de centro concéntrica pero no paralela. Coloque el indicador de dial en un rodete y haga girar el rodete 360º mientras registra las lecturas en la cara del otro rodete. La alineación angular se alcanza cuando la lectura es 0.020 pulg. (0.508 mm) TIR o menos.
- La alineación final se alcanza cuando se satisfacen los requisitos paralelos y angulares con los bulones de sujeción del motor completamente ajustados.

ATENCIÓN: SIEMPRE VUELVA A VERIFICAR AMBAS ALINEACIONES LUEGO DE EFECTUAR CUALQUIER AJUSTE MECÁNICO.

Tuberías

- La tubería no debe ser menor que las conexiones de succión y descarga de la bomba, y debe ser lo más corta posible. Evite conexiones innecesarias para minimizar las pérdidas por fricción. Observe la tabla 1.
- Toda la tubería **DEBE** estar soportada en forma independiente y **NO DEBE** existir ninguna carga de la tubería sobre la bomba.

ATENCIÓN: NO FUERCE LA TUBERÍA EN LAS CONEXIONES DE SUCCIÓN O DESCARGA.

- Todas las juntas de la tubería **DEBEN** ser herméticas.

TUBERÍA – SUCCIÓN

- Para elevaciones de succión de más de 10 pies (3 m) y líquidos con temperaturas de más de 120º F (49° C), consulte la curva de desempeño de la bomba para la carga de succión positiva neta requerida ($NPSH_R$).
- Si es necesario utilizar un tamaño de tubería mayor que el tamaño de la succión de la bomba, se DEBE instalar un reductor de caño excéntrico (con el lado recto hacia arriba) en la succión de la bomba.
- Si la bomba se instala por debajo de la fuente de líquido, instale una válvula de aislamiento total de flujo en la succión de la bomba para tareas de inspección y mantenimiento.

ATENCIÓN: NO USE LA VÁLVULA DE AISLAMIENTO DE SUCCIÓN PARA AHOGAR LA BOMBA. DE HACERLO, PODRÍA OCASIONAR LA PÉRDIDA DE CEBADO, TEMPERATURAS EXCESIVAS O DAÑOS A LA BOMBA, Y ADEMÁS ANULARÁ LA GARANTÍA.

• Si la bomba se instala por encima de la fuente de líquido, se **DEBEN** seguir los siguientes pasos:
  • Para evitar baches de aire, ninguna sección de la tubería debe estar más elevada que la conexión de succión de la bomba.
  • Incline la tubería hacia arriba desde la fuente de líquido.
  • Utilice una válvula de pie o una válvula de retención **SÓLO** si fuera necesario para cebar la bomba o mantener el cebado durante el servicio intermitente.
  • El colador o campana de succión **DEBE** ser al menos 3 veces más grande que el diámetro de la tubería de succión.
  • Asegúrese de que el tamaño de la succión de entrada y la inmersión mínima de la succión de entrada sean suficientes para que no se produzca la entrada de aire a la bomba a causa de un vortice de succión. Consulte las figuras 8 a 11.

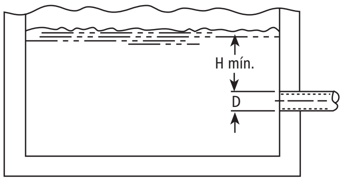


Figura 8

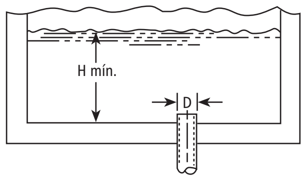


Figura 9

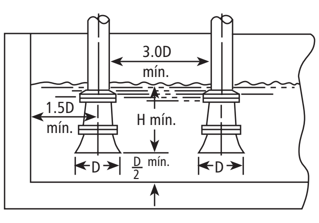


Figura 10

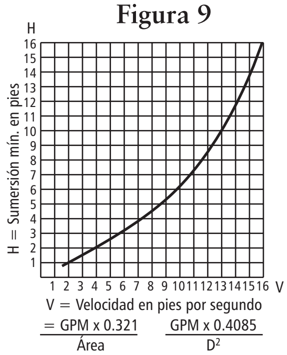


Figura 11

TUBERÍA – DESCARGA

• Instale una válvula de retención capaz de manejar el flujo, los líquidos y evitar el retroflujo. Después de la válvula de retención, instale una válvula de compuerta del tamaño apropiado para regular la capacidad de la bomba y realizar inspecciones y tareas de mantenimiento.

• Cuando sea necesario, se debe instalar un aumentador del caño entre la válvula de retención y la descarga de la bomba.

Cableado y puesta a tierra

Instale el cableado y la puesta a tierra de acuerdo con los requisitos locales y al Código Eléctrico Nacional Requisitos.

Instale un interruptor de desconexión de todos los circuitos de alimentación eléctrica cerca de la bomba.

Desconecte y bloquee el suministro eléctrico antes de instalar la bomba o realizar tareas de mantenimiento.

El suministro eléctrico **DEBE** ser el que se especifica en la placa nominal de la bomba. Un voltaje incorrecto puede provocar un incendio, dañar el motor y anular la garantía.

Los motores sin protección incorporada **DEBEN** equiparse con contactores y protectores contra sobrecarga térmica si son monofásicos, o con arrancadores con calentadores si son trifásicos. Consulte la placa nominal del motor.

• Use únicamente cable de cobre para la conexión al motor y a tierra. El cable a tierra **DEBE** ser por lo menos del mismo tamaño que el cable al motor. Los cables deben estar codificados con colores para facilitar el mantenimiento.

• Siga cuidadosamente el diagrama de cableado indicado por el fabricante del motor en la placa nominal o en la tapa de la terminal.

ADVERTENCIA Tensión Peligrosa

SI LA BOMBA, EL MOTOR O LOS CONTROLES NO SE CONECTAN A TIERRA EN FORMA PERMANENTE ANTES DE CONECTAR LA ALIMENTACIÓN ELÉCTRICA, SE PUEDEN PRODUCIR DESCARGAS ELÉCTRICAS, QUEMADURAS Y HASTA LA MUERTE.

Rotación

ATENCIÓN: LA ROTACIÓN INCORRECTA PUEDE DAÑAR LA BOMBA Y ANULA LA GARANTÍA.

• La rotación correcta es hacia la derecha, en el **SENTIDO DE LAS AGUJAS DEL RELOJ** cuando se mira desde el extremo del motor. En las unidades montadas en bastidor, encienda y apague la bomba rápidamente para observar la rotación. En las unidades de acoplamiento corto, retire el motor y el tapón o la cubierta para observar la rotación.

• Para invertir la rotación de un motor trifásico, intercambie dos conductores eléctricos cualesquiera.

Operación

NO HAGA FUNCIONAR LAS UNIDADES SAE O LAS UNIDADES MONTADAS EN BASTIDOR SIN LAS PROTECCIONES DE SEGURIDAD CORRESPONDIENTES. DE HACERLO, PODRÍA SUFRIR GRAVES LESIONES PERSONALES.

SALPICAR O SUMERGIR EN FLUIDOS UN MOTOR ABIERTO A PRUEBA DE FILTRACIONES PUEDE PROVOCAR UN INCENDIO, UNA DESCARGA ELÉCTRICA, QUEMADURAS, O INCLUSO LA MUERTE.

EL FUNCIONAMIENTO SIN FLUJO O CON FLUJO MÍNIMO PUEDE CAUSAR TEMPERATURAS EXCESIVAS, LESIONES PERSONALES O DAÑOS MATERIALES.

ATENCIÓN: NO HAGA FUNCIONAR LA BOMBA EN SECO. DE HACERLO, SE DAÑARÁ EL SELLO.

• Luego de estabilizar el sistema en las condiciones normales de operación, verifique la tubería. Si fuera necesario, ajuste los soportes de la tubería.

• En las unidades de montaje en bastidor, la alineación del acoplamiento puede haber variado debido a las diferencias de temperatura entre la bomba y el motor. Vuelva a verificar la alineación siguiendo los procedimientos y advertencias de la sección **"ALINEACIÓN DEL ACOPLAMIENTO"** de este manual.

Mantenimiento

EL NO DESCONECTAR Y BLOQUEAR LA ALIMENTACIÓN ELÉCTRICA ANTES DE INTENTAR TAREAS DE MANTENIMIENTO PUEDE CAUSAR DESCARGAS ELÉCTRICAS, QUEMADURAS E INCLUSO LA MUERTE.

SI NO SE LIBERA LA PRESIÓN Y SE DRENA EL SISTEMA ANTES DE INTENTAR TAREAS DE MANTENIMIENTO, SE PUEDEN PRODUCIR DAÑOS MATERIALES Y LESIONES PERSONALES, INCLUYENDO LA MUERTE.

SI SE BOMBEAN FLUIDOS TÓXICOS O PELIGROSOS, EL SISTEMA DEBE LAVARSE COMPLETAMENTE CON UNA DESCARGA DE AGUA ANTES DE REALIZAR TAREAS DE MANTENIMIENTO.

BOMBAS DE ACOPLAMIENTO CORTO

- Los cojinetes están ubicados en el motor y forman parte del mismo. Para obtener información sobre lubricación, consulte las instrucciones del fabricante del motor.

BOMBAS DE MONTAJE EN BASTIDOR

- El modelo 3756 del grupo S cuenta con cojinetes engrasados de por vida. No es posible lubricarlos, y tampoco es necesario.
- La caja de cojinetes del modelo 3756 de los grupos M y L y de accionamiento SAE debe ser lubricada cada 2000 horas o cada 3 meses, lo que se presente primero. Use grasa con base de litio o sodio No. 2. Llene hasta que la grasa salga por los accesorios de alivio o los sellos, luego limpie la grasa excesiva.
- Siga las instrucciones de lubricación del fabricante del motor y el acoplamiento.
- Verifique nuevamente la alineación.

SERVICIO REGULAR

- Para **RETIRAR** la bomba del servicio, saque el tapón de drenaje y drene toda la tubería no protegida.
- Para **VOLVER A PONER** la bomba en servicio, vuelva a colocar el tapón de drenaje utilizando cinta de Teflon™ o equivalente en las roscas macho.
- Reconecte la línea de succión si ha sido desconectada, inspeccione la unión y repare si fuera necesario.
- Consulte la sección **"OPERACIÓN"** del manual.

Desarmado

- Observe TODAS las instrucciones y advertencias de la sección **"MANTENIMIENTO"** de este manual.
- Unidades de acoplamiento corto: Retire los bulones de sujeción del motor.
- Unidades montadas en bastidor: Retire los bulones de sujeción del protector de acoplamiento, espaciador, acoplamiento y bastidor.

EXTREMO DEL LÍQUIDO

1. Retire los pernos de la carcasa (13).
2. Retire de la carcasa el conjunto posterior retractable (1).
3. Retire el anillo de desgaste de la carcasa (4) si se encuentra muy gastado.

ATENCIÓN: NO INSERTE UN DESTORNILLADOR ENTRE LAS ALETAS DEL IMPULSOR PARA EVITAR LA ROTACIÓN.

4. En las unidades de acoplamiento corto, retire el tapón o cubierta del extremo del motor para dejar a la vista las partes planas o ranuras para el destornillador en el extremo del eje del motor.
5. Mientras inmoviliza el eje con una herramienta apropiada (unidades de acoplamiento corto) o con una llave de lengüeta (unidades de montaje en bastidor), retire el perno del impulsor (6). Puede ser necesario tener que calentar el perno del impulsor con una antorcha para poder retirarlo. Deséchelo.

ATENCIÓN: TENGA CUIDADO AL MANIPULAR EL PERNO CALIENTE DEL IMPULSOR.

AVISO: PARA UNIDADES DE IMPULSIÓN SAE, QUITE EL TORNILLO DE FIJACIÓN DE LA TUERCA DEL IMPULSOR (22A) ANTES DE CALENTAR CON EL SOPLETE.

6. Retire la arandela del impulsor (7).
7. Inserte dos barras de palanca a 180° de distancia entre sí, entre el impulsor (2) y el compartimiento del sello (3). **CON SUMO CUIDADO**, haga palanca y retire el impulsor.
8. Retire la chaveta del impulsor (8).
9. Retire los tornillos del compartimiento de sellos (14) y el compartimiento (3), sacando con él el conjunto del sello mecánico. Deseche el conjunto del sello y el anillo en O del compartimiento del sello (9). Para las bombas con caja prensaestopas, consulte las **"INSTRUCCIONES PARA CAJA PRENSAESTOPAS"**.
10. Retire el adaptador (108).
11. Inspeccione la camisa del eje (11). Si tiene muchas muescas, retírela calentándola con una antorcha. Deséchela.

ATENCIÓN: TENGA CUIDADO AL MANIPULAR LA CAMISA DEL EJE CALIENTE.

12. Empuje y saque del compartimiento de sellos el asiento del sello mecánico estacionario. Deséchelo.
13. En las unidades equipadas con anillo de desgaste (5) en el compartimiento de sellos, retírelo si se encuentra muy gastado.

DESMONTAJE DE LA CAJA DE COJINETES O CAJA DE COJINETES SAE

1. Retire el deflector (123) del eje.
2. Retire la cubierta de cojinetes (134).
3. Retire del bastidor el conjunto del eje.
4. Retire los sellos de reborde (138, 139) de la caja de cojinetes (228) y la cubierta de cojinetes (134) si se encuentran gastados. Deséchelos.
5. Retire el anillo de retención (361).
6. Use un extractor de cojinetes o una prensa de eje para retirar los cojinetes de bola (112, 168).

Reensamblaje

- Antes de volver a armar la bomba se deben limpiar todas las piezas.

ATENCIÓN: EL ANILLO EN O SE DEBE REEMPLAZAR CADA VEZ QUE SE DESARMA LA UNIDAD.

CAJA DE COJINETES

1. Reemplace los sellos de reborde si han sido retirados.
2. Reemplace los cojinetes de bola si están sueltos o hacen ruido al rotar.
3. Controle el descentramiento del eje (122). El valor máximo permitido es 0.002 pulgadas (0.05 mm) TIR.
4. Consulte la sección **"MANTENIMIENTO"** de este manual para las instrucciones de lubricación de la caja de cojinetes en las bombas del grupo M.

EXTREMO DEL LÍQUIDO

1. Inspeccione el eje y limpie toda basura o rebaba.
2. Aplique LOCQUIC® Primer "T" o equivalente al eje, siguiendo cuidadosamente las instrucciones del fabricante.
3. Al colocar la nueva camisa del eje, rocíe el diámetro interior de la camisa con LOCQUIC® Primer "T" o equivalente. Deje secar las piezas y aplique LOCTITE® #262 a las mismas superficies. Deslice la nueva camisa sobre el eje con un movimiento de torsión y limpie el excedente. Deje curar de acuerdo con las instrucciones.

ATENCIÓN: EL SELLO MECÁNICO DEBE SER REEMPLAZADO CADA VEZ QUE SE RETIRA EL SELLO. SIGA ATENTAMENTE LAS INSTRUCCIONES DEL FABRICANTE DEL SELLO. PARA BOMBAS CON CAJA PRENSAESTOPAS, CONSULTE LAS **"INSTRUCCIONES PARA CAJA PRENSAESTOPAS"**.

4. Reemplace el anillo de desgaste del compartimiento de sellos si es que ha sido retirado.
5. En el caso de bombas de sello mecánico, el asiento del sello estacionario puede sumergirse en agua para facilitar la instalación. Coloque el asiento del sello estacionario encuadrado en el agujero de la caja del sello. Cubra la cara pulida del asiento con una sección delgada de cartón o toalla de papel. Oprima firmemente el asiento en el agujero usando una sección de plástico o madera que disperse la fuerza sobre la cara completa del sello. NOTA: Si el sello mecánico está equipado con un retén a resorte, retire y descarte el retén.
6. Coloque el adaptador, con la cara cóncava hacia arriba, sobre el eje del motor y hágalo descender hasta el motor.
7. Reemplace el anillo en O del compartimiento de sellos. Este anillo en O puede ser lubricado con agua o glicerina para facilitar la instalación. Instale el compartimiento del sello sobre el adaptador. Tenga cuidado para que el eje del motor no dañe o desaloje el asiento del sello.
8. Instale de frente y completamente el conjunto rotativo del sello contra el asiento estacionario.

AVISO: REEMPLACE EL PERNO Y LA ARANDELA DEL IMPULSOR CADA VEZ QUE SE RETIRE ESTE ÚLTIMO.

9. Instale la chaveta del impulsor en la ranura de posicionamiento. Monte el impulsor sobre el eje y empújelo hasta que llegue al fondo. Sosténgalo en su lugar. Para las unidades del SAE, aplique el loctite 271 al alesaje, a la chavetera y al eje del impulsor. Monte el impulsor en el eje y empújelo hasta que llegue al fondo. Sostenga en lugar.
10. Instale una nueva arandela del impulsor. Para unidades SAE, aplique Loctite 271 al diámetro interior, chavetero y eje del impulsor. Después de haber ajustado la tuerca del impulsor SAE, aplique 271 al tornillo de fijación y apriete con la mano hacia la cara del perno del impulsor.
11. Aplique LOCTITE® #271 o su equivalente a las roscas del perno nuevo del impulsor y apriete a:

Pernos de ⅜ pulg.-16	20 lbs.-pie (27 N·m)
Pernos de ½ pulg.-13	38 lbs.-pie (51 N·m)

Perno del impeledor no usado para las unidades del SAE.

12. Para las unidades SAE aplique el loctite 271 a los hilos de rosca externos del eje y a los hilos de rosca internos de la tuerca del impulsor (22). Apriete la tuerca del impulsor al siguiente:

½ pulg. – Tuerca del impulsor (SAE grupo M)	80 lbs.-pie (107 N·m)
¾ pulg. – Tuerca del impulsor (SAE Grupo L)	100 lbs.-pie (134 N·m)

13. Para las unidades SAE, después de que la tuerca del impulsor (22) esté instalada, aplique el loctite 271 al tornillo de presión (2À). Instale el tornillo de presión del impulsor en la cara de la tuerca del impulsor (22) y apriete con la mano.
14. Reemplace el anillo de desgaste de la carcasa si es que ha sido retirado.
15. Coloque y ajuste los pernos de la carcasa en una secuencia de zigzag hasta los valores indicados a continuación:
   ⅜"-16 pernos (carcasa de bronce) 25 lbs.-pie (34 N · m)
   ⅜"-16 pernos (carcasa de hierro fundido) 37 lbs.-pie (50 N · m)
   ½"-13 pernos (carcasa de hierro fundido) 90 lbs.-pie (122 N · m)
   ¾"-10 pernos (carcasa de hierro fundido) 175 lbs.-pie (237 N · m)
16. Verifique que la unidad reensamblada no experimente agarrotamiento. Haga rotar el eje con la herramienta apropiada desde el extremo del motor.
17. Si hubiera rozamiento, afloje los pernos de la carcasa y realice la secuencia de ajuste otra vez.
18. Vuelva a colocar los pernos de sujeción del motor y el tapón o la cubierta del extremo del motor en las unidades de acoplamiento corto.
19. Vuelva a colocar los pernos de sujeción del acoplamiento, el espaciador, el protector de acoplamiento y el bastidor en las unidades montadas en bastidor.

ATENCIÓN: SIEMPRE VUELVA A VERIFICAR AMBAS ALINEACIONES LUEGO DE EFECTUAR ALGÚN AJUSTE.

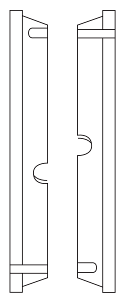
20. Para realinear el eje, consulte la sección **"ALINEACIÓN DEL ACOPLAMIENTO"** en este manual.
21. El reensamblaje está ahora completo.

Instrucciones para la caja prensaestopas

1. Asegúrese de que la caja prensaestopas esté limpia y libre de materias extrañas antes de comenzar la empaquetadura. Consulte el título Ensamblaje por Secciones en la sección de repuestos.
2. Sea especialmente cuidadoso durante la instalación de los anillos de empaque porque están formados con matriz. Para instalarlos, retuerza el anillo hacia el costado lo suficiente como para poder colocarlo alrededor de la camisa del eje. **NO INTENTE RETIRAR LOS ANILLOS HALANDO EN DIRECCION OPUESTO**. Observe la figura 12.

Figura 12

3. Instale el aro de linterna de Teflon de dos piezas provisto según se muestra en la figura 13. Nota: dos piezas conforman un aro. Las muescas del anillo deben enfrentarse, pero el alineamiento no es necesario.



Aro de linterna de Teflon
Figura 13

4. Para empacar la caja prensaestopas, instale los anillos de empaque y el aro de linterna en la secuencia siguiente. Instale dos anillos de empaquetadura, luego el aro de linterna, y luego los tres anillos de empaquetadura restantes. Instale cada anillo por separado y asiéntelo firmemente. Se recomienda el uso de un manguito dividido de madera para esta operación. Vea la figura 14. Use el casquillo para mover el manguito y el anillo dentro de la caja. Alterne las juntas en cada aro 90º. Asegúrese de que la toma embutida en la caja prensaestopas se alinea con el centro del aro de linterna. Los anillos extra son de repuesto.

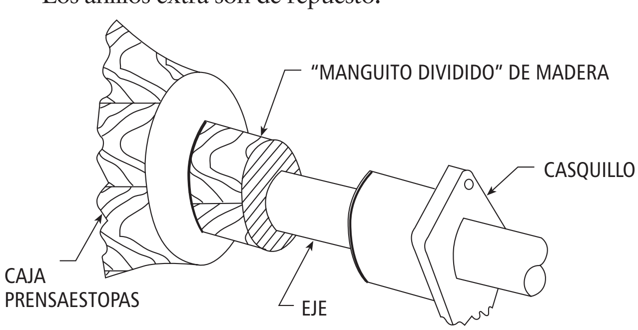


Figura 14

5. Ajuste las tuercas del casquillo en forma pareja pero sin ajustar mucho. Cuando se arranca la bomba, lentamente ajuste las tuercas del casquillo hasta que la pérdida llegue a entre 40 y 60 gotas por minuto. Se puede utilizar un lubricante a base de grasa cuando el líquido bombeado contiene partículas abrasivas o para condiciones de succión negativa.

PARA RETIRAR LA CAJA PRENSAESTOPAS

- Para retirar las empaquetaduras de la caja prensaestopas siga estos pasos.

1. Retire el conjunto del casquillo.
2. Retire la empaquetadura con un "gancho de empaque".
3. Inserte un gancho de alambre en el anillo en el borde exterior para retirar el aro de linterna.
4. Limpie la caja prensaestopas.

DISPOSITIVO DE CEBADO SEGURO (Opcional – Grupo M y L únicamente)

- El dispositivo se puede suplir con un alimentador de grasa o aceite lubricante.

1. El casquillo para grasa (24) tendrá las letras "G" y "O" estampadas en el diámetro exterior y dos conexiones NPT de ⅛ pulg. para montar una grasera o aceitador.
2. Para las aplicaciones de alimentación de grasa, el casquillo para grasa se instala con la marca "G" en la posición de las 12:00. El alimentador de grasa (23) se montará en el casquillo para grasa en un ángulo de 30 grados con respecto a la horizontal. Esto se hace para ganar acceso a la grasera situada en el alimentador de grasa. El sello de reborde (26) montado en el casquillo para grasa se instalara en la forma mostrada en la Figura 10.
3. Para las aplicaciones de alimentación con aceitador, el casquillo para grasa se instala con la marca "O" en la posición de las 12:00. Las dos conexiones NPT de ⅛ pulg. sobre el casquillo para grasa estarán situadas sobre la horizontal, lo cual asegurará el funcionamiento apropiado del aceitador. El sello de reborde (26) debe montarse en la dirección inversa u opuesta, tal como se muestra en la Figura 15.
4. El montaje del alimentador de grasa o aceitador podría requerir extensiones de tubos y/o accesorios adicionales que serán suministrados por la fábrica según sea necesario.
5. El alimentador de grasa (23) incluirá tres resortes (azul, rojo y plateado). El uso de resortes diferentes variará dependiendo de la temperatura de operación y del lubricante (grasa) a utilizarse.

	Tamaño del resorte del alimentador de grasa		
Temperatura de operación	Grasa Nº 1	Grasa Nº 2	Grasa Nº 3
-10ºF (-23ºC) a 40ºF (4ºC)	PLATEADO	ROJO	—
-40ºF (-40ºC) a 110ºF (43ºC)	PLATEADO	PLATEADO	ROJO
-110ºF (-79ºC) a 200ºF (93ºC)	AZUL	PLATEADO	PLATEADO

Utilice aceite SAE 30W para la aplicación del engrasador.

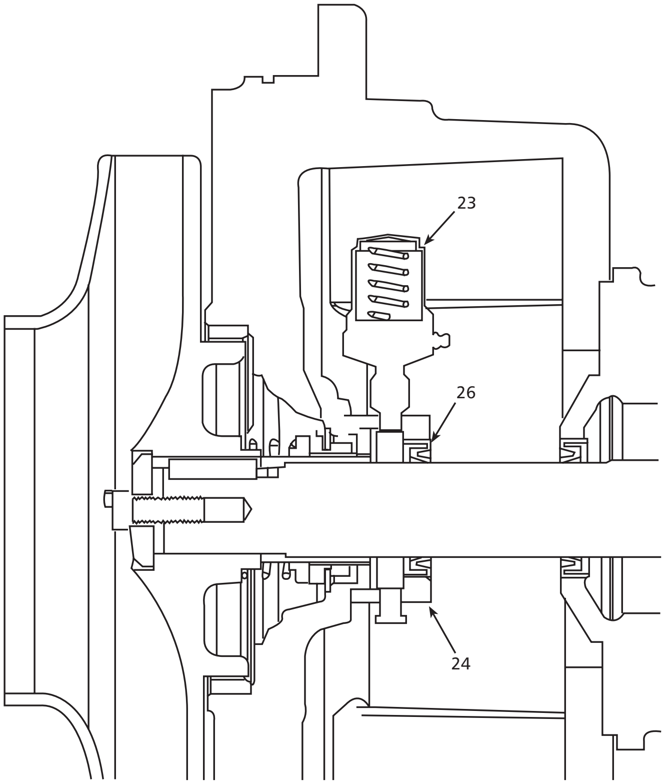


Figura 15

Guía de resolución de problemas

DESCONECTE Y BLOQUEE LA ALIMENTACIÓN ELÉCTRICA ANTES DE INTENTAR TAREAS DE MANTENIMIENTO. EL NO HACERLO PUEDE OCASIONAR DESCARGAS ELÉCTRICAS, QUEMADURAS O INCLUSO LA MUERTE.

SÍNTOMA

EL MOTOR NO FUNCIONA
Vea las causas probables N° 1 a 5

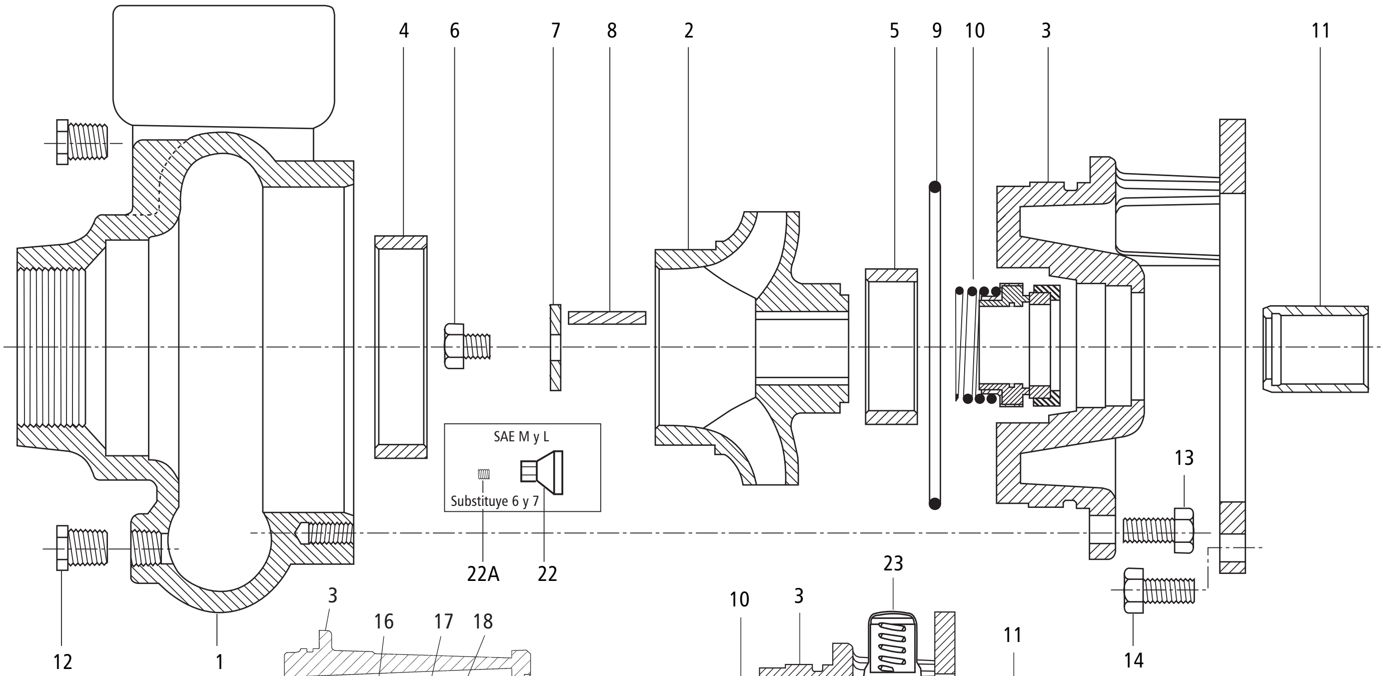
SE ENTREGA POCO O NADA DE LÍQUIDO
Vea las causas probables N° 6 a 13

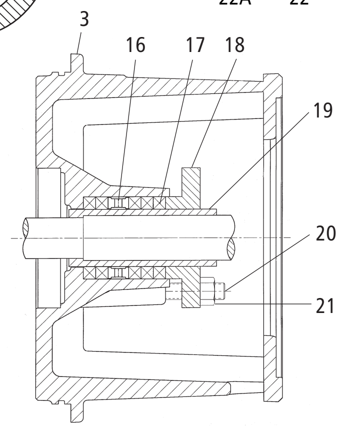
CONSUMO EXCESIVO DE ELECTRICIDAD
Vea las causas probables N° 3, 13, 14 y 15

RUIDO O VIBRACIÓN EXCESIVOS
Vea las causas probables N° 3, 6, 7 10, 12, 14, 16 y 17

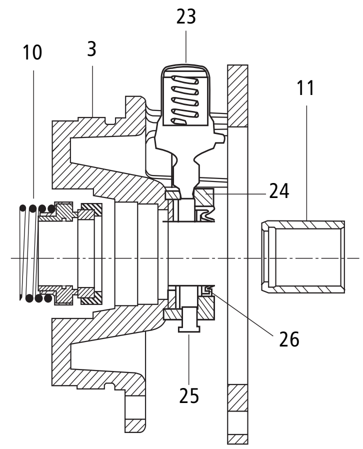
CAUSA PROBABLE

1. Se disparó el protector térmico del motor
2. Interruptor de circuito abierto o fusible quemado
3. Agarrotamiento del impulsor
4. El cableado del motor es incorrecto
5. El motor es defectuoso
6. La bomba no está cebada, hay aire o gases en el bombeo
7. Descarga o succión bloqueadas o válvula cerrada
8. Rotación incorrecta (motor trifásico solamente)
9. Bajo voltaje o pérdida de fase
10. Impulsor gastado o tapado
11. Altura del sistema muy alta
12. NPSHA muy baja – Elevación excesiva de succión o pérdidas
13. Diámetro incorrecto del impulsor
14. Altura de descarga muy baja — velocidad excesiva del flujo
15. Viscosidad o gravedad específica del fluido muy altas
16. Cojinete gastado
17. Bomba, motor o tubería flojos





Conjunto de la caja prensaestopas



Disposición de cebado seguro (opcional – grupo M y L únicamente)

COMPONENTES DEL EXTREMO DEL LÍQUIDO

No. Ítem	Descripción	Material
1	Carcasa	Hierro fundido o silicio-latón*
2	Impulsor	
3	Adaptador	
4	Anillo de desgaste (carcasa)	Hierro fundido o bronce*
5**	Anillo de desgaste (compartimiento de sellos)	
6	Perno del impulsor	Acero inoxidable tipo AISI 300
7	Arandela del impulsor	
8	Chaveta del impulsor	
9	Anillo en O de la caja del sello (materiales opcionales)	BUNA-N/EPR/Viton
10	Sello mecánico	Consulte la tabla
11	Camisa del eje	Acero inoxidable tipo AISI 300
12	Tapón de drenaje – ¼ ó ⅜ NPT	Acero zincado
13	Tornillo de cabeza hexagonal (de la carcasa al adaptador)	Acero zincado
14	Tornillo de cabeza hexagonal (del adaptador al motor/bastidor)	
15	Tornillo de cabeza hexagonal (del adaptador al compartimiento de sellos)	
16	Aro de linterna	Teflon™
17	Empaque, 5 anillos	Impregnado de Teflon
18	Casquillo	Acero inoxidable AISI 316
19	Camisa del eje	Acero inoxidable tipo AISI 300
20	Perno del casquillo	
21	Tuerca del casquillo	
22	Tuerca del impulsor (SAE únicamente) 304 SS	Acero inoxidable 304
22A	Tornillo de fijación, tuerca del impulsor (SAE únicamente)	
23	Engrasador (aceitador opcional)	Policarbonato

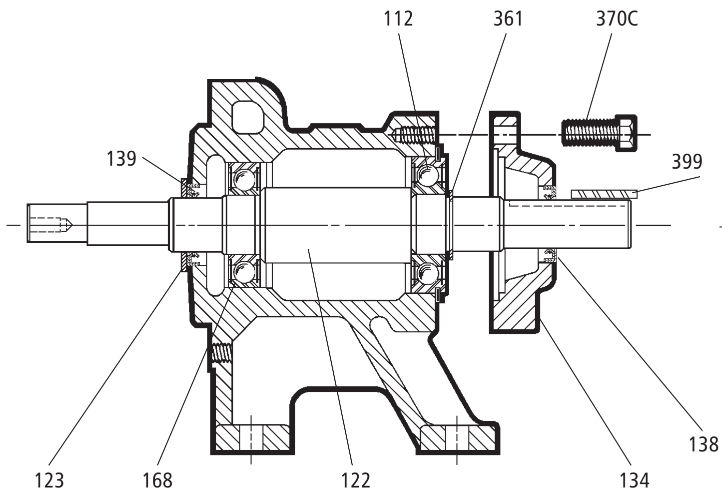
COMPONENTES DEL EXTREMO DEL LÍQUIDO

No. Ítem	Descripción	Material
24	Casquillo para grasa	Aluminum
25	Tapón de tubería	Acero zincado
26	Sello del reborde	Buna

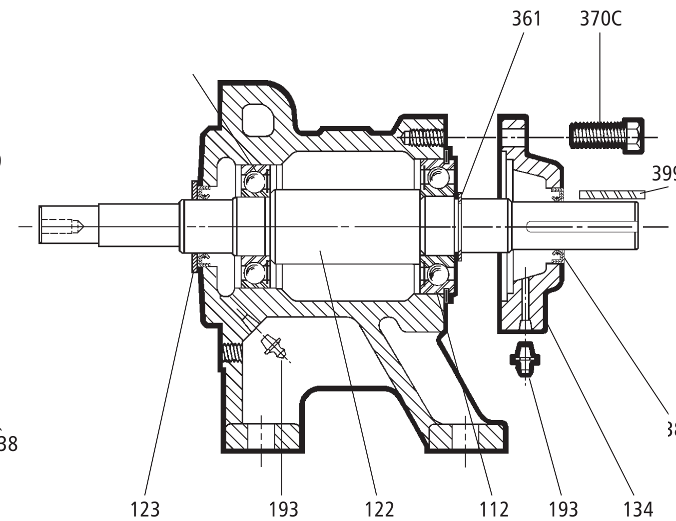
* Sin plomo
** El ítem No. 5 se provee con los modelos 2½ x 3-7 (7½ , 10 y 15 HP) del grupo S y con el grupo M (excepto 3 x 4-10).

COMPONENTES DEL EXTREMO DE POTENCIA (ilustrados en la página siguiente)

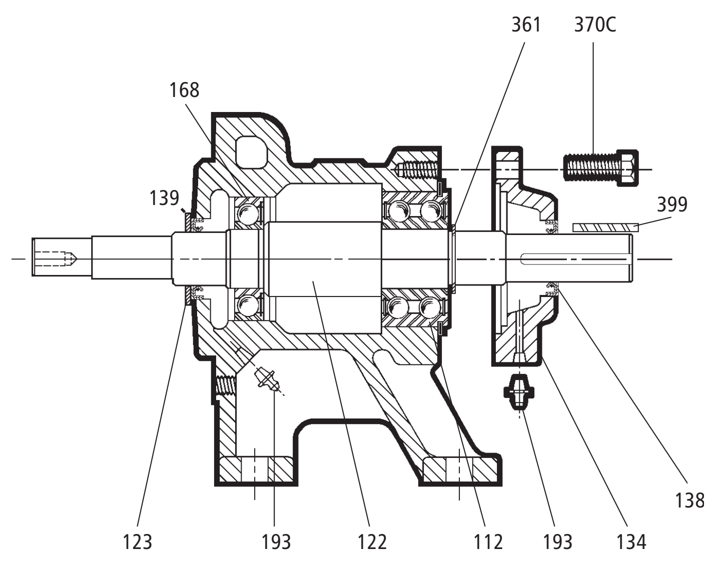
No. Ítem	Descripción	Material
112	Cojinete de bolas (exterior)	Acero
122	Eje de la bomba	
122A	Eje de la bomba (SAE)	Acero AISI 4140
123	Anillo en V (Deflector)	BUNA-N
134	Cubierta del cojinete	Hierro fundido
138	Sello de reborde (exterior)	BUNA-N
139	Sello de reborde (interior)	
168	Cojinete de bolas (interior)	Acero
193	Grasera (grupo M y L)	
327C	Tornillo (cubierta a adaptador) (SAE únicamente)	Acero zincado
340	Adaptador/motor (SAE únicamente)	Hierro fundido
361	Anillo de retención	Acero
370C	Tornillo de cabeza hexagonal (del marco a la cubierta)	Acero zincado
371C	Tornillo de cabeza hexagonal (del adaptador al marco) (SAE únicamente) *NO SE MUESTRA*	Acero
399	Chaveta, acoplamiento	
501N	Cubierta/adaptador (SAE únicamente)	Acero galvanizado



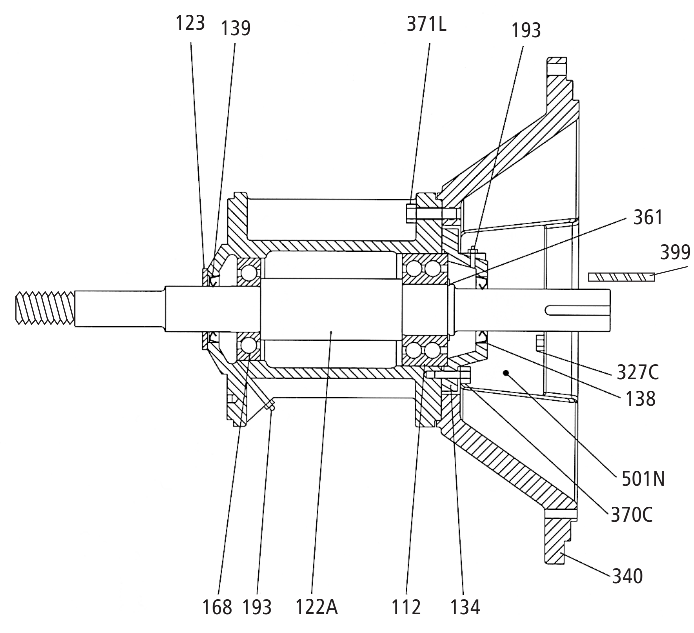
Cuadro de fuerza, Grupo S



Cuadro de fuerza, Grupo M



Cuadro de fuerza, Grupo L



Cuadro de fuerza, SAE

GOULDS PUMPS

GARANTÍA LIMITADA DE GOULDS PUMPS

Esta garantía es aplicable a todas las bombas para sistemas de agua fabricadas por Goulds Pumps.

Toda parte o partes que resulten defectuosas dentro del período de garantía serán reemplazadas, sin cargo para el comerciante, durante dicho período de garantía. Tal período de garantía se extiende por doce (12) meses a partir de la fecha de instalación, o dieciocho (18) meses a partir de la fecha de fabricación, cualquiera que se cumpla primero.

Todo comerciante que considere que existe lugar a un reclamo de garantía deberá ponerse en contacto con el distribuidor autorizado de Goulds Pumps del cual adquiriera la bomba, y ofrecer información detallada con respecto al reclamo El distribuidor está autorizado a liquidar todos los reclamos por garantía a través del Departamento de Servicios a Clientes de Goulds Pumps.

La presente garantía excluye:

(a) La mano de obra, el transporte y los costos relacionados en los que incurra el comerciante;
(b) los costos de reinstalación del equipo reparado;
(c) los costos de reinstalación del equipo reemplazado;
(d) daños emergentes de cualquier naturaleza; y
(e) el reembolso de cualquier pérdida causada por la interrupción del servicio

A los fines de esta garantía, los términos "Distribuidor", "Comerciante" y "Cliente" se definen como sigue:

(1) "Distribuidor" es aquel individuo, sociedad, corporación, asociación u otra entidad jurídica que opera entre Goulds y el comerciante para la compra, consignación o contratos de venta de las bombas en cuestión.
(2) "Comerciante" es todo individuo, sociedad, corporación, asociación u otra entidad jurídica que realiza negocios de venta o alquiler-venta (leasing) de bombas a clientes.
(3) "Cliente" es toda entidad que compra o que adquiere bajo la modalidad de leasing las bombas en cuestión de un comerciante. El término "cliente" puede significar un individuo, sociedad, corporación, sociedad de responsabilidad limitada, asociación o cualquier otra entidad jurídica con actividades en cualquier tipo de negocios.

LA PRESENTE GARANTÍA SE EXTIENDE AL COMERCIANTE <u>ÚNICAMENTE</u>.

www.goulds.com

Goulds Pumps

ITT Industries

GOULDS PUMPS

Directives d'installation, d'utilisation et d'entretien

Informations pour le propriétaire

Noter les informations pertinentes ci-dessous et remettre le livret à la ou au propriétaire. La garantie est présentée en page 44.

Numéro de modèle : ____________________

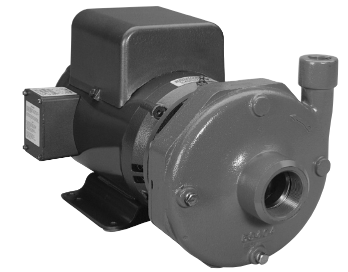
Numéro de série : ____________________

Détaillant : ____________________

N° de téléphone du détaillant : ____________________

Date d'achat : __________ Date d'installation : __________

Modèles 3656 et 3756



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Goulds Pumps

ITT Industries

CONSIGNES DE SÉCURITÉ

AFIN DE PRÉVENIR LES BLESSURES GRAVES OU MORTELLES ET LES DOMMAGES MATÉRIELS IMPORTANTS, LIRE ET SUIVRE TOUTES LES CONSIGNES DE SÉCURITÉ FIGURANT DANS LE PRÉSENT MANUEL ET SUR LA POMPE.

Le symbole ci-contre est un **SYMBOLE DE SÉCURITÉ** employé pour signaler les mots-indicateurs dont on trouvera la description ci-dessous. Sa présence sert à attirer l'attention afin d'éviter les blessures et les dommages matériels.

DANGER Prévient des risques qui **VONT** causer des blessures graves, la mort ou des dommages matériels importants.

AVERTISSEMENT Prévient des risques qui **PEUVENT** causer des blessures graves, la mort ou des dommages matériels importants.

ATTENTION Prévient des risques qui **PEUVENT** causer des blessures ou des dommages matériels.

AVIS : SERT À ÉNONCER LES DIRECTIVES SPÉCIALES DE GRANDE IMPORTANCE QUE L'ON DOIT SUIVRE.

LE PRÉSENT MANUEL A POUR BUT DE FACILITER L'INSTALLATION ET L'UTILISATION DE LA POMPE. LIRE SOIGNEUSEMENT CHAQUE DIRECTIVE ET AVERTISSEMENT AVANT D'EFFECTUER TOUT TRAVAIL SUR LA POMPE.

N'ENLEVER AUCUNE DÉCALCOMANIE DE SÉCURITÉ.

AVIS : INSPECTER L'APPAREIL ET SIGNALER IMMÉDIATEMENT TOUT DOMMAGE AU TRANSPORTEUR OU AU DÉTAILLANT.

AVERTISSEMENT

Les fluides dangereux peuvent causer un incendie, des brûlures ou la mort.

APPAREIL NON CONÇU POUR LES LIQUIDES DANGEREUX NI POUR LES GAZ INFLAMMABLES.

DESCRIPTION et CARACTÉRISTIQUES

Les pompes de séries 3656 et 3756 sont des pompes centrifuges à un étage, à aspiration en bout, servant au transfert de liquides et au pompage de nature générale, ainsi qu'à l'augmentation de pression et à l'irrigation. Elles sont offertes en trois versions : tout fonte, avec composants en bronze ou tout bronze (groupe S seulement).

Les pompes sont munies d'une roue fermée, clavetée sur l'arbre et retenue par une rondelle et une vis. Le corps de pompe est du type à volute, à bagues d'usure remplaçables.

Selon les dimensions de la pompe, les raccords d'aspiration et de refoulement sont filetés ou à brides. Des chemises d'arbre en inox protègent l'arbre.

Les groupes monobloc (pompes sur moteur) sont dotés de moteurs JM ou JP conformes aux normes NEMA, d'un adaptateur en C et d'un arbre-rallonge claveté. Les paliers SAE sont vissés au carter de volant du moteur thermique par l'intermédiaire d'un support SAE de format nº 1, 2, 3, 4 ou 5. Des accouplements en élastomère sont offerts en option pour les diamètres de volant de 6½ po, 7½ po, 8 po, 10 po, 11½ po et 14 po. Les pompes montées sur palier peuvent être entraînées par accouplement ou par courroie.

Données techniques

Température maximale du liquide :
- 100 °C (212 °F), avec garniture mécanique ou d'étanchéité standard ;
- 120 °C (250 °F), avec garniture mécanique pour hautes températures, en option.

Pression de service maximale (selon la température du liquide) :
- 1,379 MPa (200 lbf/po²), avec raccords NPT ;
- 1,379 MPa (200 lbf/po²), avec raccords à bride ANSI 125.

Pression d'aspiration maximale : 689,5 kPa (100 lbf/po²)

Démarrages par heure : 20, répartis uniformément

Groupe	Dimensions	Aspiration	Refoulement
S	1½ x 2-6 (H)	2 po, NPT	1½ po, NPT
	1 x 2-7	2 po, NPT	1 po, NPT
	2½ x 3-7	3 po, NPT	2½ po, NPT
	3 x 4-7	4 po, à bride	3 po, à bride
	1 x 2-8	2 po, NPT	1 po, NPT
	1½ x 2-8	2 po, NPT	1½ po, NPT
LH	2 x 2-5	2 po, NPT	2 po, NPT
	2½ x 2½-5	2½ po, NPT	2½ po, NPT
	3 x 3-5	3 po, NPT	3 po, NPT
	4 x 4-5	4 po, à bride	4 po, à bride
	5 x 5-6	5 po, à bride	5 po, à bride
M	2½ x 3-8	3 po, NPT	2½ po, NPT
	3 x 4-8	4 po, à bride	3 po, à bride
	4 x 5-8	5 po, à bride	4 po, à bride
	1½ x 2-10	2 po, NPT	1½ po, NPT
	2½ x 3-10	3 po, à bride	2½ po, à bride
	3 x 4-10	4 po, à bride	3 po, à bride
	4 x 6-10	6 po, à bride	4 po, à bride
	2½ x 3-13	3 po, à bride	2½ po, à bride
	3 x 4-13	4 po, à bride	3 po, à bride
	4 x 6-13	6 po, à bride	4 po, à bride
L	6 x 8-13	8 po, à bride	6 po, à bride
	8 x 10-13	10 po, à bride	8 po, à bride
	4 x 6-16	6 po, à bride	4 po, à bride

Installation

EMPLACEMENT

- Placer la pompe aussi près de la source de liquide que possible, plus bas que celle-ci pour assurer l'amorçage automatique.
- Le dégagement autour du groupe de pompage doit être suffisant pour faciliter l'entretien et l'aération.
- Protéger l'appareil contre les intempéries, les inondations et le gel.
- Protéger la tuyauterie contre le gel.

GROUPES MONOBLOC (POMPES SUR MOTEUR)

- Le groupe monobloc peut être installé à l'horizontale, à la verticale ou sur une surface inclinée, le moteur plus haut que la pompe.

- Les pattes de fixation du moteur **DOIVENT** être ancrées à une surface solide et rigide pouvant supporter tout le poids du groupe monobloc. Dans le cas du groupe L, les pattes de l'adaptateur de moteur doivent aussi être ancrées à cette surface.
- S'il s'agit d'une installation verticale, protéger le moteur contre les intempéries, les éclaboussures, la condensation, etc.

AVIS: NE PAS PLACER LE MOTEUR PLUS BAS QUE LA POMPE AFIN DE LE PROTÉGER CONTRE LES FUITES ET L'EAU DE CONDENSATION.

POMPES SUR PALIER

- On **DOIT** fixer le groupe de pompage à une surface plane et solide pour prévenir toute déformation ou contrainte due au serrage des boulons d'ancrage. Le montage sur support en caoutchouc est permis pour réduire les vibrations et le bruit excessifs.
- Serrer les boulons de fixation du moteur **AVANT** de raccorder la tuyauterie à la pompe.

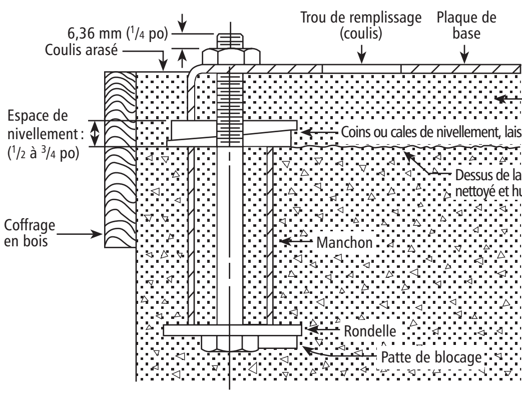


Figure 1

- Il est recommandé de remplir de coulis le vide entre la plaque de base et le massif de béton. Le massif doit reposer sur une semelle de fondations solide. (Voir la figure 1.)
- Placer des coins de nivellement sous le groupe de pompage : en deux endroits distincts sous le centre approximatif du moteur et en deux autres sous celui de la pompe. Régler la hauteur des coins pour que les raccords d'aspiration et de refoulement soient de niveau (employer un fil à plomb ou un niveau).
- S'assurer que la plaque de base n'est pas déformée et que l'alignement final de l'accouplement est possible dans les limites de déplacement du moteur ou en calant celui-ci au besoin.
- Serrer les boulons d'ancrage à la main et construire un coffrage autour de la plaque de base. Remplir entièrement le coffrage et le dessous de la plaque de coulis : s'assurer qu'il n'y a aucun creux sous les pattes de fixation de la pompe et du moteur.
- Laisser le coulis durcir pendant 48 heures avant de visser les boulons d'ancrage à fond.
- Serrer les boulons de fixation de la pompe et du moteur avant d'aligner les arbres ou de raccorder la tuyauterie à la pompe.

Pompes sur palier SAE (moteur thermique)

- Le palier SAE est fixé au carter de volant du moteur thermique par le biais d'un support SAE de format nº 1, 2, 3, 4 ou 5. L'arbre-rallonge de la pompe est conçu pour être accouplé directement au volant. Goulds offre des accouplements en option pour les diamètres de volant de 6½ po, 7½ po, 8 po, 10 po, 11½ po et 14 po. Bien que l'on puisse employer d'autres accouplements, il est recommandé d'utiliser les accouplements Goulds, conçus pour assurer un fonctionnement fiable et de longue durée.

EXIGENCES VISANT LE BON FONCTIONNEMENT

Pompe

Outre le débit requis (en gal US/min) fourni par la pompe, la hauteur manométrique totale à pareil débit doit être prise en compte. Le point de fonctionnement débit-hauteur manométrique totale devrait être aussi près que possible du point de rendement le plus haut de la courbe de performances, mais doit être sous la vitesse de rotation «maximale» (en r/min), déterminée selon la durée de vie des roulements et, parfois, la limite de pression de la pompe.

Les orifices d'aspiration et de refoulement sont soit taraudés (NPT) pour les tuyaux ordinaires, soit à bride standard à trous de vis ANSI B16.1, classe 125. Suivant la norme ANSI B16.1, la pression de service maximale pour la fonte de classe 30 est de 175 lbf/po².

Les moteurs à combustion interne ont une vitesse et une puissance utile variables. La puissance est fonction de la vitesse et diminue quand il y a hausse de la température de l'air ou de l'altitude d'utilisation du moteur. Lorsqu'il entraîne la pompe à la vitesse requise pour fournir l'eau au système, le moteur doit tourner dans les limites de vitesse minimale et maximale stipulées par le constructeur du moteur. La puissance nécessaire à la pompe ne doit pas dépasser la puissance continue nominale du moteur, une fois incluse toute réduction de puissance due aux accessoires de moteur et à la hausse de la température de l'air ou de l'altitude de service du moteur.

P_e DU GROUPE MOTOPROPULSEUR

On choisit le groupe motopropulseur à combustion interne selon la P_e, la puissance effective (au frein), égale au débit multiplié par la hauteur manométrique totale, divisés par 3960 fois le rendement ([gal US/min x h_{mt}] ÷ [3960 x rend.]).

Nota: on doit cependant réduire la P_e comme suit :
- 20% pour le service continu;
- 5% pour la transmission à angle droit;
- 3% aux 1000 pi au-dessus du niveau de la mer;
- 1% aux 10°F passé 60°F.

COUPLE DU GROUPE MOTOPROPULSEUR

Il faut aussi tenir compte du couple pour choisir le groupe motopropulseur. En général, la relation entre la P_e et le couple varie dans la plage utile d'un diesel (v. fig. 2). Le couple (en lbf·pi) égale 5250 fois la puissance effective, divisée par la vitesse de rotation ([5250 x P_e] ÷ r/min).

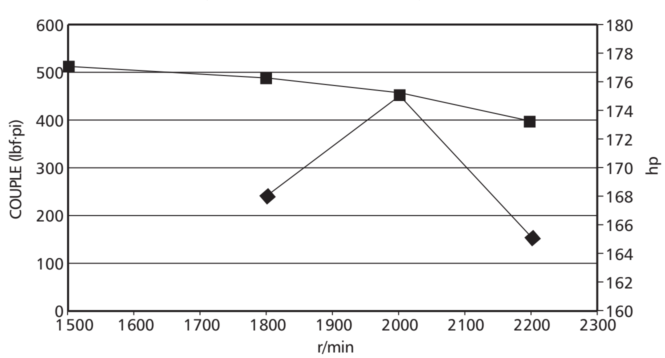


Figure 2 — Courbes puissance (◆)-couple (■)

VÉRIFICATION DE LA CORRESPONDANCE POMPE-MOTEUR

Format de la ferrure SAE

Les pompes pour moteurs à combustion sont prévues pour les carters de volant (moteur) de formats SAE 1 à 5.

S'il s'agit d'un nouveau moteur, on peut s'adresser au fournisseur pour savoir le format SAE du carter de volant.

Si le moteur est déjà en place, on peut en mesurer comme suit le diamètre d'alésage du carter de volant et le diamètre du cercle de vissage et les comparer avec ceux de la table 1 pour trouver le format SAE :

- Prendre au 1/32 po le plus proche la mesure diamétrale de l'alésage (A) et du cercle (B) avec un ruban à mesurer (v. fig. 3).
- Compter le nombre de trous taraudés sur le carter de volant (C). Utiliser des vis de séries de filetages différentes pour déterminer la série des trous.
- Comparer les données de A, B et C avec celles de la table 1 pour connaître le format SAE du carter de volant et s'assurer qu'il convient à la pompe.

Dimensions du carter de volant (en po)		Format SAE du carter de volant				
		1	2	3	4	5
A		20⅛	17⅝	16⅛	14¼	12⅜
B		20⅞	18⅜	16⅞	15	13⅛
C	Nombre	12	12	12	12	8
	Cotation	7/16 — 14	3/8 — 16	3/8 — 16	3/8 — 16	3/8 — 16

Table 1

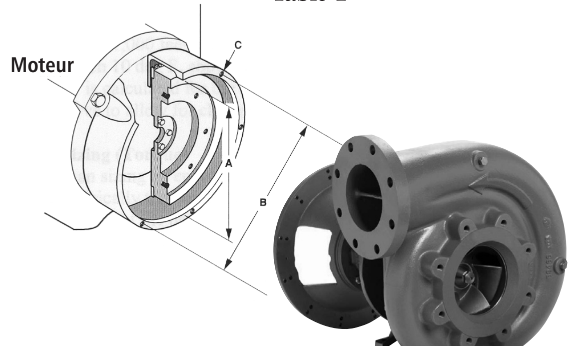


Figure 3

INSTALLATION

- S'il s'agit d'une installation horizontale, on peut placer l'orifice de refoulement dans n'importe laquelle des positions permises par l'emplacement des vis de fixation (13) du corps de pompe. Il est toutefois recommandé de mettre l'orifice de refoulement à l'horizontale et plus haut que l'orifice d'aspiration.
- Chaque corps de pompe doit être soutenu par un support rigide assujetti à la plaque de base ou au massif de béton.
- Dans le cas du groupe M, fixer le support rigide à l'anneau-adaptateur du moteur avec au moins deux (2) des vis de fixation (13) du corps de pompe. L'épaisseur accrue du support pourrait requérir des vis plus longues. Employer des vis SAE 5, serrées au couple indiqué ci-après.
- Pour le groupe L, supporter la pompe à l'aide des deux pattes moulées de l'adaptateur de moteur (3). Les pattes doivent être vissées au support.

ACCOUPLEMENT CANNELÉ

Préparatifs

- Au besoin, nettoyer les faces d'emboîtement et de fixation du carter de volant et du volant pour les débarrasser de la graisse, des saletés, de la rouille et des résidus d'antirouille, pouvant nuire à la pose et à l'alignement de la pompe. Si le volant est muni d'un roulement-guide pour arbre de transmission, enlever et jeter le roulement, non requis pour l'installation de la pompe et pouvant gêner l'introduction de l'arbre de pompe.
- Examiner les cannelures de l'arbre de près. Au besoin, en limer les bavures pour faciliter le glissement de l'arbre dans le moyeu de l'accouplement.
- Avec modération, appliquer de la graisse sur les cannelures de l'arbre. Ne pas en mettre sur les arbres clavetés.
- Enfiler l'accouplement sur l'arbre et le pousser à fond (v. en page suivante pour les arbres clavetés).
- Mesurer l'écart A entre la face de fixation de l'accouplement et la face de fixation de la ferrure de pompe (v. **A**, fig. 4).
- Mesurer l'écart B entre la face du volant servant à fixer l'accouplement et la face du carter de volant utilisée pour fixer la ferrure de pompe (v. **B**, fig. 4).

NOTA : l'écart A (côté moteur de la pompe) doit être moindre que l'écart B (côté pompe du moteur), sinon le vilebrequin du moteur subira une poussée axiale nuisible. Donc, **A doit être plus petit que B**.

ACCOUPLEMENT DE VOLANT

- L'accouplement de volant transmet l'énergie du moteur à l'arbre de pompe. La limite de puissance maximale que peut supporter sans risque l'accouplement est exprimée par un chiffre dans la colonne R des tables 1A et 1B.

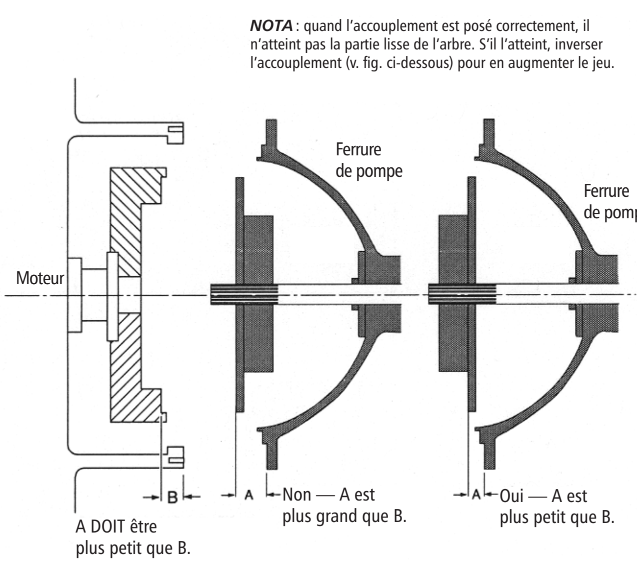


Figure 4

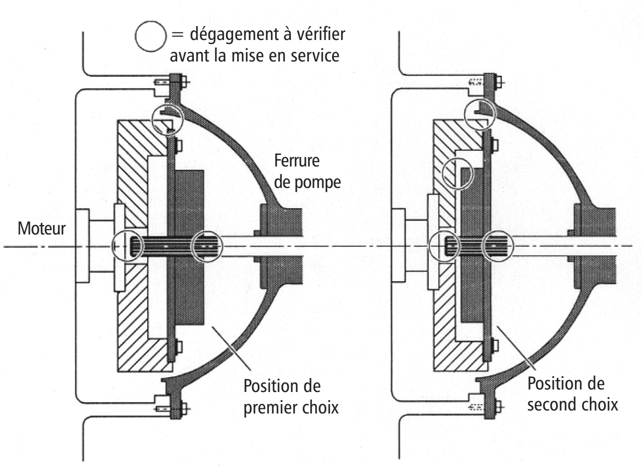


Figure 5

- Pour choisir l'accouplement de volant, déterminer d'abord la puissance nominale requise par la pompe en repérant, sur sa courbe de performances, le point de rencontre des valeurs r/min et P_e nécessaires pour obtenir le point débit-hauteur manométrique totale approprié.
- Diviser ensuite P_e par r/min, puis multiplier le quotient par 100. Le résultat constituera la limite de puissance pour la pompe. Par exemple, pour une 20BFSAE1AO fournissant 800 gal US/min à une h_{mt} de 270 pi, à 1800 r/min, la P_e serait de 75 hp, et la limite de puissance pour la pompe, de 4,16 ([75 ÷ 1800] x 100).
- Choisir l'accouplement convenant au volant (limite de puissance et dimensions). En pareil cas, l'accouplement doit avoir une limite de puissance (R) SUPÉRIEURE à celle qui a été calculée pour la pompe. Dans l'exemple ci-dessus, la limite de puissance R pour l'accouplement serait au moins de 5.
- L'ajusteur-monteur est responsable de l'analyse de compatibilité du moteur, de la pompe et de l'accouplement quant à leur rigidité en torsion. Goulds Pumps fournira à l'ajusteur-monteur les données pour la pompe et l'accouplement.

NOTA : si le moyeu du volant est muni d'un roulement-guide, enlever le roulement pour ne pas qu'il gêne l'insertion de l'arbre de pompe.

VOLANT POUR EMBRAYAGES CONCENTRIQUES INDUSTRIELS

- La fig. 6 montre le volant évidé conçu pour les embrayages concentriques des prises de force.
- On y notera aussi la partie alésée renfoncée du volant, dotée de trous taraudés servant à fixer l'accouplement. Les dimensions sont conformes aux normes SAE et figurent dans les tables 1A et 1B. Le diamètre d'embrayage mentionné est le diamètre nominal de la garniture du disque d'embrayage concentrique de type couronne.

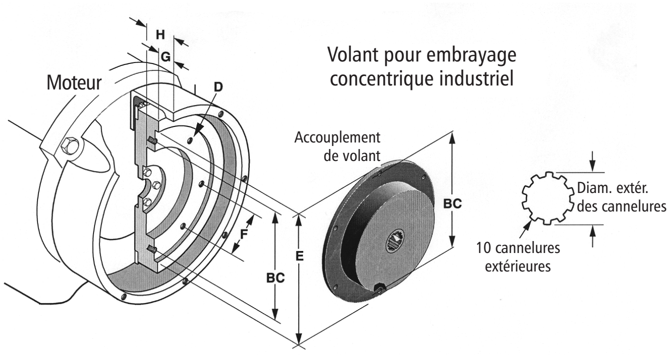


Figure 6

Table 1A — Accouplement cannelé à moyeu en élastomère pour plage r/min étendue

Diam. d'embr. (po)	Dimensions du volant (en pouces)							Accoupl. cannelé (po)		
	D		E							
	Nbre	Filet. UNC	(diam. extér.)	BC	F	G	H	R*	Numéro d'article	Diam. extér., cannel.
6½	6	5/16 — 18	8½	7,88	3,94	1,19	1,69	7	A00569C 1	1½
7½	8	5/16 — 18	9½	8,75	3,69	1,19	1,69	7	A00569C 2	1½
8	6	3/8 — 16	10⅜	9,62	4,81	2,44	2,94	7	A00569C 3	1½
10	8	3/8 — 16	12⅜	11,62	4,47	2,13	2,75	7	A00569C 4	1½
10	8	3/8 — 16	12⅜	11,62	4,47	2,13	2,75	9	A00569C 6	1½
11½	8	3/8 — 16	13⅞	13,12	5,06	1,56	2,69	7	A00569C 5	1½
11½	8	3/8 — 16	13⅞	13,12	5,06	1,56	2,69	9	A00569C 7	1½
14	8	½ — 13	18⅜	17,25	6,63	1,00	2,13	9	A00569C 8	1½

* R = limite de puissance maximale pour l'accouplement = (hp nomin. x 100) ÷ r/min nomin.

Table 1B — Accouplement claveté à moyeu en élastomère pour plage r/min étendue

Diam. d'embr. (po)	Dimensions du volant (en pouces)							Accoupl. claveté (po)		
	D		E							
	Nbre	Filet. UNC	(diam. extér.)	BC	F	G	H	R*	Numéro d'article	Diam. de l'arbre
6½	6	5/16 — 18	8½	7,88	3,94	1,19	1,69	2,28	CD616	1,625 à 1,624 Rainure de clavette : 3/8 x 3/16
								3,51	CD625	
7½	8	5/16 — 18	9½	8,75	3,69	1,19	1,69	2,28	CD716	
								3,51	CD725	
8	6	3/8 — 16	10⅜	9,62	4,81	2,44	2,94	2,28	CD816	
								3,51	CD825	
10	8	3/8 — 16	12⅜	11,62	4,47	2,13	2,75	2,28	CD1016	
								3,51	CD1025	
								5,71	CD1030	
								8,57	CD1050	
								11,23	CD1080	
11½	8	3/8 — 16	13⅞	13,12	5,06	1,56	2,69	2,28	CD1116	
								3,51	CD1125	
								5,71	CD1130	
								8,57	CD1150	
								11,23	CD1180	
								12,62	CD1190	
								16,85	CD11110H	
14	8	3/8 — 16	18⅜	17,25	6,63	1,00	2,13	2,28	CD1416	
								3,51	CD1425	
								5,71	CD1430	
								8,57	CD1450	
								11,23	CD1480	
								12,62	CD1490	
								16,85	CD14110H	

* R = limite de puissance max. pour l'accouplement = (hp nomin. x 100) ÷ r/min nomin.

AUTRES TYPES DE VOLANTS

- Le volant de certains moteurs est usiné spécialement pour diverses machines (génératrices, convertisseurs de couple, etc.) et nécessite donc un accouplement de volant spécial, que l'on obtiendra d'un vendeur ou d'un fournisseur indépendants.
- S'il s'agit d'un accouplement claveté Goulds Pumps, s'assurer que la vis de pression du moyeu de l'accouplement est suffisamment dévissée pour permettre l'insertion de la clavette cours du montage.
- Fixer l'accouplement au volant du moteur avec les vis fournies, serrées en croix au couple approprié ci-après : 15 N·m (11 lbf·pi) pour les volants de 6½ po et de 7½ po, 27 N·m (20 lbf·pi) pour les volants de 8 po, de 10 po et de 11½ po et 68 N·m (50 lbf·pi) pour ceux de 14 po. (Pour tout autre accouplement, suivre les directives d'installation recommandées par le fabricant.)
- Placer la clavette dans la rainure de l'arbre de pompe (122) et aligner l'arbre sur l'accouplement. Introduire l'arbre de pompe dans l'accouplement jusqu'à ce que la ferrure ou l'adaptateur de pompe (340) touche le carter de volant.

FIXATION DE L'ACCOUPLEMENT AU VOLANT

Accouplement de volant du type concentrique

- Ce type d'accouplement est concentrique par rapport au volant et est aligné sur celui-ci par emboîtement.
- S'assurer d'enlever tout enduit protecteur du volant du moteur.

• Emboîter l'accouplement dans le volant en prenant soin d'aligner les trous de vis. Au besoin, frapper l'accouplement avec une massette à panne douce pour s'assurer qu'il est bien appuyé contre le volant. Fixer l'accouplement solidement en place avec des vis d'assemblage et des rondelles-freins à ressort.

FIXATION DE LA POMPE AU MOTEUR

• Lever la pompe avec un appareil approprié et aligner l'arbre de pompe sur le moyeu d'accouplement. Le bout de l'arbre est biseauté pour en faciliter l'introduction dans l'accouplement.

• Par l'orifice d'aspiration de la pompe, faire tourner la roue légèrement jusqu'à ce que l'arbre pénètre dans le moyeu d'accouplement. S'assurer qu'il n'y aucun espace entre la face de fixation de la ferrure de pompe et celle du carter de volant. Au besoin, faire tourner le corps de pompe pour aligner les trous de vis de la ferrure sur ceux du carter. Avec des vis d'assemblage, fixer la pompe solidement au carter.

NOTA : si l'on découvre des pièces incompatibles, impossibles à poser, etc. au cours de l'installation, NE PAS poursuivre le travail. S'en référer au distributeur Goulds Pumps.

• Assujettir la pompe au moteur avec les rondelles-freins et les vis fournies, serrées en croix au couple approprié ci-dessous :
  indices SAE n^{os} 2, 3, 4, et 5 – 27 N·m (20 lbf·pi) ;
  indice SAE n^{o} 1 – 68 N·m (50 lbf·pi).

• Poser le carter d'accouplement (501N).

• Visser l'adaptateur de moteur (3) au support rigide précité.

Alignement de l'accouplement

OMETTRE LE VERROUILLAGE DU CIRCUIT D'ALIMENTATION ÉLECTRIQUE EN POSITION OUVERTE (HORS CIRCUIT) AVANT D'EFFECTUER TOUT TRAVAIL D'ENTRETIEN SUR LA POMPE PEUT CAUSER DES BLESSURES GRAVES.

POMPES SUR PALIER SEULEMENT

• On **DOIT** vérifier l'alignement avant la mise en service de la pompe (fig. 7).

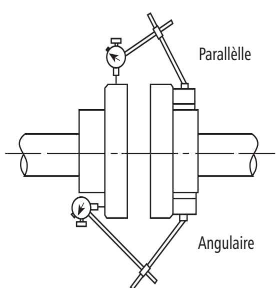


Figure 7

• Serrer tous les boulons de fixation avant de vérifier l'alignement.

• Lorsqu'un alignement est nécessaire, on doit toujours déplacer uniquement le moteur. Employer des cales au besoin.

• Désalignement parallèle (arbres parallèles mais non concentriques) – Fixer au moyeu d'un demi-accouplement un comparateur à cadran, dont on déplace le curseur de 360° le long de la jante de l'autre demi-accouplement tout en notant l'écart indiqué par l'aiguille. L'alignement est correct si le faux-rond total est de 0,254 mm (0,010 po) ou moins.

• Désalignement angulaire (arbres concentriques mais non parallèles) – Fixer au moyeu d'un demi-accouplement un comparateur à cadran et déplacer le curseur de celui-ci de 360° le long du plateau de l'autre demi-accouplement tout en notant l'écart indiqué par l'aiguille. L'alignement est correct si le faux-rond total est de 0,508 mm (0,020 po) ou moins.

• L'alignement final est correct quand il est conforme aux exigences sur l'alignement parallèle et angulaire après le serrage à fond des boulons de fixation du moteur.

AVIS : IL FAUT TOUJOURS VÉRIFIER LES DEUX TYPES D'ALIGNEMENT APRÈS CHAQUE RÉGLAGE MÉCANIQUE.

Tuyauterie

• Afin de réduire les pertes de charge (par frottement) au minimum, maintenir la tuyauterie aussi courte que possible, ne pas employer un calibre de tuyau inférieur à celui des raccords d'aspiration et de refoulement de la pompe ni utiliser d'accessoires ou de raccords de tuyauterie superflus.

• La tuyauterie **DOIT** posséder ses propres supports et N'appliquer **AUCUNE** contrainte sur la pompe.

AVIS : LA TUYAUTERIE NE DOIT APPLIQUER AUCUNE CONTRAINTE SUR LES RACCORDS D'ASPIRATION ET DE REFOULEMENT DE LA POMPE.

• Chaque joint **DOIT** être étanche.

ASPIRATION

• Si la hauteur d'aspiration dépasse 3 m (10 pi), et la température du liquide, 49°C (120°F), consulter la courbe de performances de la pompe pour obtenir la hauteur nette d'aspiration requise (NPSHR).

• Lorsqu'il faut un tuyau d'aspiration plus gros que l'orifice d'aspiration de la pompe, on **DOIT** poser un raccord réducteur excentré (la partie droite en haut) près de l'orifice.

• Si la pompe est plus basse que la source de liquide, poser un robinet-vanne sur le tuyau d'aspiration pour pouvoir effectuer l'inspection et l'entretien de la pompe.

AVIS : NE PAS EMPLOYER LE ROBINET-VANNE POUR RÉDUIRE L'ÉCOULEMENT DU LIQUIDE VERS LA POMPE, CAR CELA POURRAIT DÉSAMORCER CELLE-CI, EN CAUSER LA SURCHAUFFE ET L'ENDOMMAGER, ANNULANT AINSI LA GARANTIE.

• Lorsque la pompe est plus haute que la source de liquide, on **DOIT** suivre les directives suivantes :
  • Prévenir les poches d'air en ne posant aucun élément de la tuyauterie d'aspiration plus haut que le raccord d'aspiration de la pompe.
  • Incliner la tuyauterie vers le haut à partir de la source de liquide.
  • Employer un clapet de pied **SEULEMENT** s'il est nécessaire pour amorcer la pompe ou la maintenir amorcée au cours des interruptions de service.
  • La section de passage de la crépine ou de la tulipe d'aspiration doit être au moins le triple de celle du tuyau d'aspiration.
  • S'assurer que le diamètre (*d*) et la hauteur d'immersion (*h*) de l'orifice d'entrée du tuyau d'aspiration sont suffisants pour empêcher l'aspiration d'air par vortex (fig. 8 à 11).

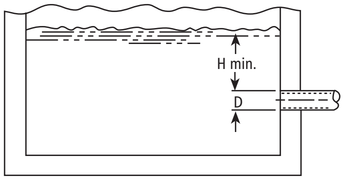


Figure 8

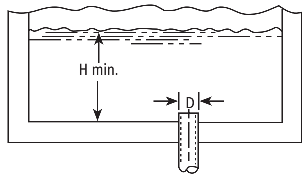


Figure 9

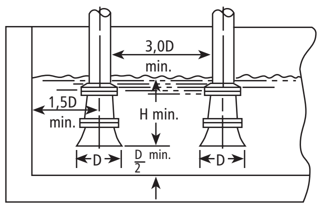


Figure 10

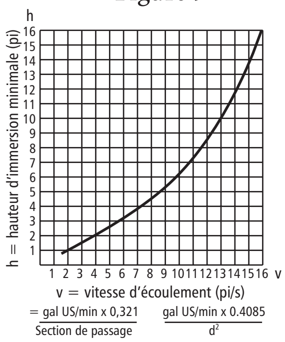


Figure 11

REFOULEMENT

- Poser un clapet de non-retour convenant au débit et aux liquides pompés. En aval du clapet, installer un robinet-vanne de section de passage appropriée pour la régularisation du débit ainsi que l'inspection et l'entretien de la pompe.
- Lorsqu'un raccord agrandisseur est nécessaire, le poser entre le clapet de non-retour et l'orifice de refoulement de la pompe.

Câblage et mise à la terre

Installer la pompe, la mettre à la terre et la brancher suivant les prescriptions du code provincial ou national de l'électricité pertinent et les règlements locaux.

Poser un sectionneur tout conducteur près de la pompe.

Verrouiller le circuit d'alimentation électrique de la pompe en position ouverte (hors circuit) avant de procéder à l'installation ou à l'entretien de la pompe.

L'alimentation électrique **DOIT** être conforme aux spécifications de la plaque signalétique. Une tension inappropriée peut causer un incendie ou des dommages au moteur et annule la garantie.

Les moteurs monophasés non protégés **DOIVENT** être munis de contacteurs et de protections contre les surcharges thermiques, et les moteurs triphasés, de démarreurs à protection contre la surcharge. Consulter la plaque signalétique du moteur.

- N'utiliser que du fil de cuivre pour la mise à la terre et l'alimentation du moteur. Le calibre du fil de terre **DOIT** être au moins égal à celui des fils d'alimentation, et les fils devraient tous être chromocodés pour faciliter l'entretien.
- Suivre soigneusement le schéma de câblage sur la plaque signalétique ou le cache-bornes du moteur.

OMETTRE LA MISE À LA TERRE PERMANENTE DE LA POMPE, DU MOTEUR ET DES COMMANDES AVANT LE BRANCHEMENT À LA SOURCE DE COURANT PEUT CAUSER UN CHOC ÉLECTRIQUE, DES BRÛLURES OU LA MORT.

Sens de rotation

AVIS : LA ROTATION DANS LE MAUVAIS SENS PEUT ENDOMMAGER LA POMPE ET ANNULE LA GARANTIE.

- La rotation appropriée est EN SENS HORAIRE (vers la droite), vue de l'extrémité du moteur. S'il s'agit d'une pompe sur palier, la mettre en marche, puis l'arrêter rapidement tout en vérifiant son sens de rotation. Dans le cas des pompes sur moteur, enlever l'obturateur ou le couvercle d'extrémité du moteur et vérifier le sens de rotation.
- Pour inverser la rotation des moteurs triphasés, en intervertir deux des conducteurs.

Utilisation

NE PAS FAIRE FONCTIONNER LES POMPES SUR PALIER (ORDINAIRE OU SAE) SANS CARTER D'ACCOUPLEMENT, CAR CELA POURRAIT CAUSER DES BLESSURES GRAVES.

ÉCLABOUSSER OU PLONGER UN MOTEUR ABRITÉ DANS UN LIQUIDE PEUT CAUSER UN INCENDIE, UN CHOC ÉLECTRIQUE, DES BRÛLURES OU LA MORT.

NE PAS FAIRE FONCTIONNER LA POMPE SI SON DÉBIT EST NUL OU PRESQUE, SINON IL POURRAIT EN RÉSULTER UN ÉCHAUFFEMENT EXCESSIF, DES BLESSURES OU DES DOMMAGES MATÉRIELS.

AVIS : NE PAS FAIRE FONCTIONNER LA POMPE À SEC POUR NE PAS ENDOMMAGER LA GARNITURE MÉCANIQUE.

- Faire fonctionner la pompe dans des conditions de service normales, attendre que le système se stabilise, puis vérifier la tuyauterie et en régler la position des supports au besoin.
- La différence de température entre la pompe sur palier et le moteur peut provoquer le désalignement de l'accouplement. Par conséquent, vérifier l'alignement de nouveau en respectant les directives et les avertissements de la section «**Alignement de l'accouplement**» ci-dessus.

Entretien

OMETTRE LE VERROUILLAGE DU CIRCUIT D'ALIMENTATION ÉLECTRIQUE EN POSITION OUVERTE (HORS CIRCUIT) AVANT D'EFFECTUER TOUT TRAVAIL D'ENTRETIEN SUR LA POMPE PEUT CAUSER UN CHOC ÉLECTRIQUE, DES BRÛLURES OU LA MORT.

OMETTRE DE RÉDUIRE LA PRESSION DU SYSTÈME OU DE VIDANGER CELUI-CI AVANT DE PROCÉDER À L'ENTRETIEN PEUT CAUSER DES DOMMAGES MATÉRIELS ET DES BLESSURES, VOIRE LA MORT.

LORSQUE LES LIQUIDES POMPÉS SONT DANGEREUX OU TOXIQUES, ON DOIT RINCER LE SYSTÈME AVANT D'EN EFFECTUER L'ENTRETIEN.

GROUPES MONOBLOC

- Les roulements sont situés à l'intérieur du moteur. Suivre les directives du fabricant du moteur pour leur graissage.

POMPES SUR PALIER

- Les roulements de palier du modèle 3756, groupe S, sont graissés à vie. Il est donc impossible et inutile de les graisser.
- Les roulements de palier SAE et de palier modèle 3756, groupes M et L, devraient être graissés à la fin de la période suivante arrivant la première : 2 000 heures de fonctionnement ou trois mois de temps écoulé. Employer une graisse au lithium ou au sodium nº 2. Injecter la graisse dans le roulement jusqu'à ce qu'elle sorte par les garnitures ou les joints à lèvre(s), puis essuyer le surplus.
- Suivre les directives du fabricant du moteur et de l'accouplement pour le graissage.
- Vérifier l'alignement de nouveau.

ENTRETIEN SAISONNIER

- Avant la **MISE HORS SERVICE** de la pompe, enlever le bouchon de vidange et vidanger tous les tuyaux non protégés du gel.
- Avant la **REMISE EN SERVICE** de la pompe, garnir les filets du bouchon de vidange de ruban de Téflon^MC ou l'équivalent et reposer le bouchon.
- Si le tuyau d'aspiration a été séparé de la pompe, en examiner le raccord union, le réparer au besoin, puis raccorder le tuyau.
- Consulter la section «Utilisation» ci-dessus.

Démontage

- Suivre **CHAQUE** avertissement et directive de la section «**Entretien**» ci-dessus.
- Groupes monobloc : enlever les boulons de fixation du moteur.
- Pompes sur palier : déposer le carter d'accouplement, la pièce d'écartement de l'accouplement, l'accouplement et les boulons de fixation du palier.

POMPE

1. Enlever les vis (13) du corps de pompe.
2. Écarter l'ensemble d'entraînement d'avec le corps de pompe (1).
3. Retirer la bague d'usure (4) du corps de pompe si elle est trop usée.

AVIS : NE PAS INSÉRER DE TOURNEVIS ENTRE LES AUBES DE LA ROUE POUR EMPÊCHER CELLE-CI DE TOURNER.

4. Dans le cas des groupes monobloc (pompes sur moteur), enlever l'obturateur ou le couvercle d'extrémité du moteur pour accéder à la fente ou aux méplats de blocage du bout d'arbre.
5. Bloquer l'arbre de la pompe sur moteur avec l'outil approprié et celui de la pompe sur palier avec un serre-tubes à sangle, puis enlever et jeter la vis (6) de la roue : on devra peut-être chauffer la vis au chalumeau d'abord.

AVIS : MANIPULER LA VIS DE LA ROUE AVEC PRÉCAUTION QUAND ELLE EST CHAUDE.

AVIS : POUR LES POMPES SUR PALIER SAE, ENLEVER LA VIS D'ARRÊT (22A), PUIS L'ÉCROU DE ROUE (22). ON DEVRA PEUT- ÊTRE CHAUFFER LA VIS ET L'ÉCROU D'ABORD.

6. Ôter la rondelle de roue (7).
7. Enlever la roue (2) **DÉLICATEMENT** au moyen de deux leviers placés entre celle-ci et le logement de garniture mécanique (3), dans un angle de 180°.
8. Ôter la clavette (8).
9. Déposer les vis (14) du logement de garniture mécanique (3), puis tirer le logement pour l'enlever avec la garniture. Jeter cette dernière ainsi que le joint torique (9) du logement. Pour les directives portant sur le presse-garniture, voir la section «**Presse-garniture**».
10. Enlever l'adaptateur (108).
11. Inspecter la chemise d'arbre (11). Si elle trop rayée, la chauffer au chalumeau, l'enlever et la jeter.
12. Pousser l'élément fixe de la garniture mécanique hors du logement et le jeter.
13. Dans le cas des logements de garniture munis d'une bague d'usure (5), enlever la bague si elle est trop usée.

DÉMONTAGE DU PALIER (ORDINAIRE OU SAE)

1. Ôter le déflecteur (123) de l'arbre.
2. Enlever le couvercle de palier (134).
3. Sortir l'ensemble arbre du palier.
4. Si les joints à lèvre(s) 138 et 139 sont usés, les enlever du couvercle de palier (134) et du corps de palier (228) et les jeter.
5. Déposer la bague de retenue (361).
6. Avec un arrache-roulement ou une presse à mandriner, ôter les roulements (112 et 168).

Remontage

- Chaque pièce devrait être nettoyée avant le remontage.

AVIS : ON DEVRAIT REMPLACER LE JOINT TORIQUE CHAQUE FOIS QUE LA POMPE EST DÉMONTÉE.

PALIER

1. Remplacer les joints à lèvre(s) s'ils ont été enlevés.
2. Remplacer les roulements à billes s'ils ont du jeu, s'ils ne tournent pas rond ou s'ils sont bruyants.
3. Vérifier si l'arbre (122) comporte un faux-rond : le faux-rond maximal admissible est de 0,05 mm (0,002 po).
4. Voir les directives de graissage des pompes du groupe M dans la section «**Entretien**».

POMPE

1. Inspecter l’arbre et en enlever les aspérités et les résidus.
2. Appliquer de l’apprêt Primer T de LOCQUIC$^{\text{MD}}$ ou l’équivalent sur l’arbre : suivre les directives du fabricant avec soin.
3. Lorsque l’on pose une chemise d’arbre neuve, en enduire la paroi intérieure d’apprêt Primer T de LOCQUIC$^{\text{MD}}$ ou l’équivalent. Laisser l’apprêt sécher, puis le recouvrir de LOCTITE$^{\text{MD}}$ nº 262. Poser ensuite la chemise sur l’arbre dans un mouvement de rotation, puis essuyer l’arbre. Laisser le produit durcir suivant les directives pertinentes.

AVIS : LA GARNITURE MÉCANIQUE DOIT ÊTRE REMPLACÉE CHAQUE FOIS QU’ON L’ENLÈVE. SUIVRE LES DIRECTIVES DU FABRICANT DE LA GARNITURE AVEC SOIN. POUR LES PRESSE-GARNITURE, VOIR LA SECTION «**Presse-garniture**».

4. Si l’on a retiré la bague d’usure du logement de garniture mécanique, la remplacer.
5. On peut tremper l’élément fixe de la garniture mécanique dans l’eau pour en faciliter la pose. L’aligner ensuite avec soin sur son logement. En recouvrir la surface polie avec un morceau de carton mince ou d’essuie-tout. Pousser l’élément jusqu’au fond avec un morceau de plastique ou de bois rond pour répartir uniformément la force appliquée. *NOTA* : si la garniture mécanique est munie d’un anneau élastique, enlever et jeter celui-ci.
6. Poser l’adaptateur sur le moteur, la face plate de l’adaptateur contre le moteur.
7. Mettre le joint torique sur le logement de garniture. On peut glycériner ou tremper le joint dans l’eau pour en faciliter la pose. Poser le logement de garniture sur l’adaptateur. Prendre garde que l’arbre ne déloge l’élément fixe de la garniture ni n’en endommage le siège.
8. Poser l’élément mobile de la garniture sur l’arbre en l’alignant avec soin et en le poussant à fond contre l’élément fixe.

AVIS : REMPLACER LA VIS ET LA RONDELLE DE ROUE CHAQUE FOIS QUE L’ON DÉPOSE LA ROUE.

9. Insérer la clavette de la roue dans sa rainure, poser la roue sur l’arbre, la pousser à fond et la maintenir en place. Dans le cas des pompes sur palier SAE, enduire d’abord de Loctite 271 la rainure de clavetage, la paroi intérieure alésée de la roue et la surface correspondante de l’arbre, puis poser la roue sur l’arbre, la pousser à fond et la maintenir en place.
10. Poser une rondelle de roue neuve. Il n’y a pas de rondelle de roue dans les pompes sur palier SAE.
11. Enduire de Loctite 271 (ou l’équivalent) les filets de la vis de roue neuve, puis poser la vis et la serrer au couple approprié ci-dessous :
    vis ⅜ - 16 — 27 N·m (20 lbf·pi) ;
    vis ½ - 13 — 51 N·m (38 lbf·pi) ;
    (aucune vis de roue dans les pompes sur palier SAE).
12. S’il s’agit d’une pompe sur palier SAE, enduire de Loctite 271 les filets du bout d’arbre et ceux de l’écrou de roue (22), poser l’écrou et le serrer au couple approprié suivant :
    écrou de ½ po (SAE, groupe M) — 107 N·m (80 lbf·pi) ;
    écrou de ¾ po (SAE, groupe L) — 134 N·m (100 lbf·pi).
13. Une fois l’écrou de roue (pompe sur palier SAE) en place, mettre du Loctite 271 sur la vis d’arrêt (22A), poser la vis sur l’écrou et la serrer à la main.
14. Si l’on a retiré la bague d’usure du corps de pompe, la remplacer.
15. Poser les vis du corps de pompe et les serrer en croix au couple approprié ci-dessous :
    vis ⅜ - 16 (corps en bronze) – 34 N·m (25 lbf·pi) ;
    vis ⅜ - 16 (corps en fonte) – 50 N·m (37 lbf·pi) ;
    vis ½ - 13 (corps en fonte) – 122 N·m (90 lbf·pi) ;
    vis ¾ - 10 po (corps en fonte) – 237 N·m (175 lbf·pi).
16. Une fois la pompe remontée, faire tourner l’arbre par l’extrémité du moteur avec l’outil approprié pour vérifier s’il y a grippage.
17. En cas de grippage ou de frottement, desserrer les vis du corps de pompe, puis les serrer de nouveau.
18. Dans le cas des groupes monobloc, reposer les boulons de fixation, puis l’obturateur ou le couvercle d’extrémité du moteur.
19. S’il s’agit d’une pompe sur palier, reposer l’accouplement, la pièce d’écartement, le carter d’accouplement et les boulons de fixation du palier.

AVIS : IL FAUT TOUJOURS VÉRIFIER LES DEUX TYPES D’ALIGNEMENT APRÈS CHAQUE RÉGLAGE MÉCANIQUE.

20. Voir la section «**Alignement de l’accouplement**» pour aligner celui-ci de nouveau.
21. Le remontage est maintenant terminé.

Presse-garniture

1. S’assurer que le presse-garniture est propre et exempt de corps étrangers avant d’y placer la garniture. Voir le presse-garniture illustré dans la section «Pièces de rechange – séries 3656 et 3756».
2. Poser les anneaux de garniture avec précaution parce qu’ils sont matricés. Mettre chaque anneau en place en en écartant les extrémités par torsion juste assez pour y introduire la chemise d’arbre. **NE PAS ESSAYER D’ÉCARTER LES EXTRÉMITÉS EN LIGNE DROITE**. Voir la figure 12.

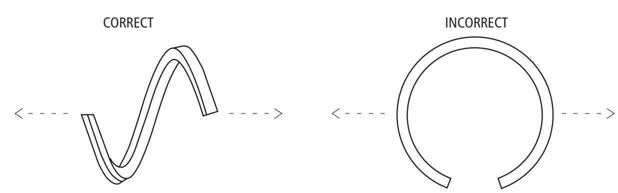
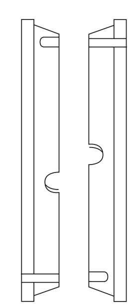


Figure 12

3. Placer les deux pièces en Téflon (fournies) de la lanterne d’arrosage comme le montre la figure 13. Les encoches doivent être l’une en face de l’autre, sans être obligatoirement alignées.



Lanterne d'arrosage en Téflon (2 pièces)
Figure 13

4. On pose les éléments de garniture dans l'ordre suivant : deux anneaux de garniture, deux pièces de lanterne d'arrosage, trois anneaux de garniture. Placer le joint de chaque anneau à 90° par rapport à celui de l'anneau précédent. Introduire et pousser chaque élément séparément et à fond. Pour ce faire, il est recommandé d'employer une douille de bois en deux pièces (fig. 14), enfoncée à l'aide du fouloir. S'assurer que la lanterne d'arrosage est bien en face de l'orifice d'admission du liquide de rinçage. Les anneaux de garniture supplémentaires servent de rechanges.

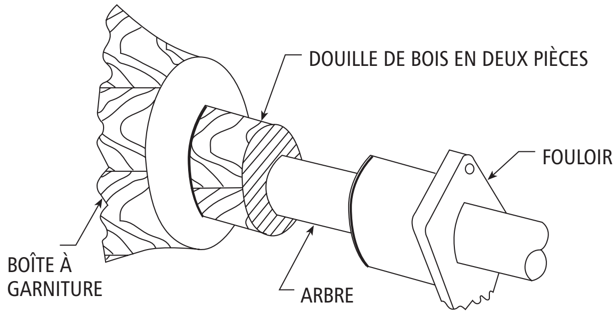


Figure 14

5. Poser les écrous sur les goujons du fouloir et les serrer légèrement et uniformément. Après la mise en marche de la pompe, les serrer davantage et lentement jusqu'à ce que le débit de suintement soit de 40-60 gouttes par minute. On peut utiliser une graisse lubrifiante quand le liquide pompé contient des particules abrasives ou que la pression à l'entrée de la pompe est inférieure à la pression atmosphérique.

ENLÈVEMENT DE LA GARNITURE

• Suivre les étapes ci-dessous pour retirer la garniture du presse-garniture.

1. Enlever le fouloir.
2. Extraire la garniture avec un «crochet à garniture».
3. Introduire un crochet en métal dans un des orifices du pourtour des pièces de lanterne d'arrosage, puis retirer ces dernières.
4. Nettoyer le presse-garniture.

GRAISSEUR PRIME SAFE
(en option — groupes M et L seulement)

• Le graisseur Prime Safe peut être fourni avec un lubrificateur à graisse ou à huile.

1. La boîte de lubrification (24) est marquée de la lettre G ou O et possède deux orifices de ⅛ po, NPT, pour la pose du lubrificateur.
2. Si l'on choisit le lubrificateur à graisse (23), la boîte de lubrification portera la lettre G, placée en haut, et le lubrificateur sera monté dans un angle de 30° par rapport à l'horizontale pour permettre l'accès à son téton de graissage. Le joint à lèvre(s) 26 sera posé sur la boîte de lubrification comme le montre la figure 10.
3. Dans le cas du lubrificateur à huile, la boîte de lubrification portera la lettre O, placée en haut, et les deux orifices de ⅛ po, NPT, seront montés à l'horizontale pour assurer une bonne lubrification. Le joint à lèvre(s) 26 sera toutefois posé sur la boîte de lubrification en sens inverse par rapport à celui de la figure 15.
4. La pose du lubrificateur peut nécessiter l'emploi de tubes et de raccords, qui seront fournis par l'usine selon le cas.
5. Le lubrificateur à graisse (23) vient avec trois ressorts (argent, rouge et bleu). Le choix du ressort est fonction de la température de service et de la graisse utilisée :

	Ressort de lubrificateur à graisse		
Température de service	Graisse nº 1	Graisse nº 2	Graisse nº 3
– 23 ºC (– 10 ºF) à 4 ºC (40 ºF)	ARGENT	ROUGE	
– 40 ºC (– 40 ºF) à 43 ºC (110 ºF)	ARGENT	ARGENT	ROUGE
– 79 ºC (– 110 ºF) à 93 ºC (200 ºF)	BLEU	ARGENT	ARGENT

Employer de l'huile SAE 30W pour le lubrificateur à huile.

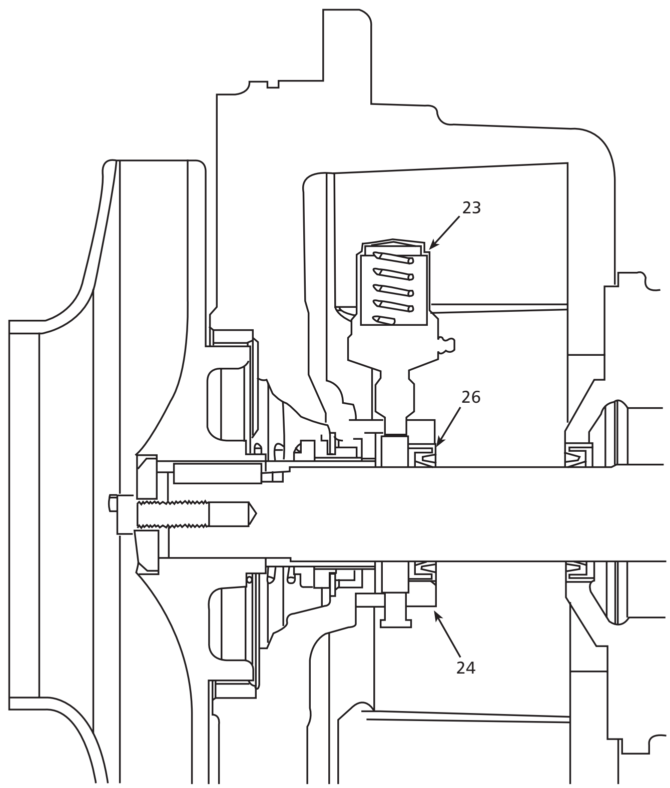


Figure 15

Diagnostic des anomalies

VERROUILLER LE CIRCUIT D'ALIMENTATION ÉLECTRIQUE EN POSITION OUVERTE (HORS CIRCUIT) AVANT D'EFFECTUER TOUT TRAVAIL D'ENTRETIEN SUR LA POMPE. OMETTRE CE POINT PEUT CAUSER UN CHOC ÉLECTRIQUE, DES BRÛLURES OU LA MORT.

ANOMALIE

LE MOTEUR NE FONCTIONNE PAS.
(V. causes probables 1 à 5.)

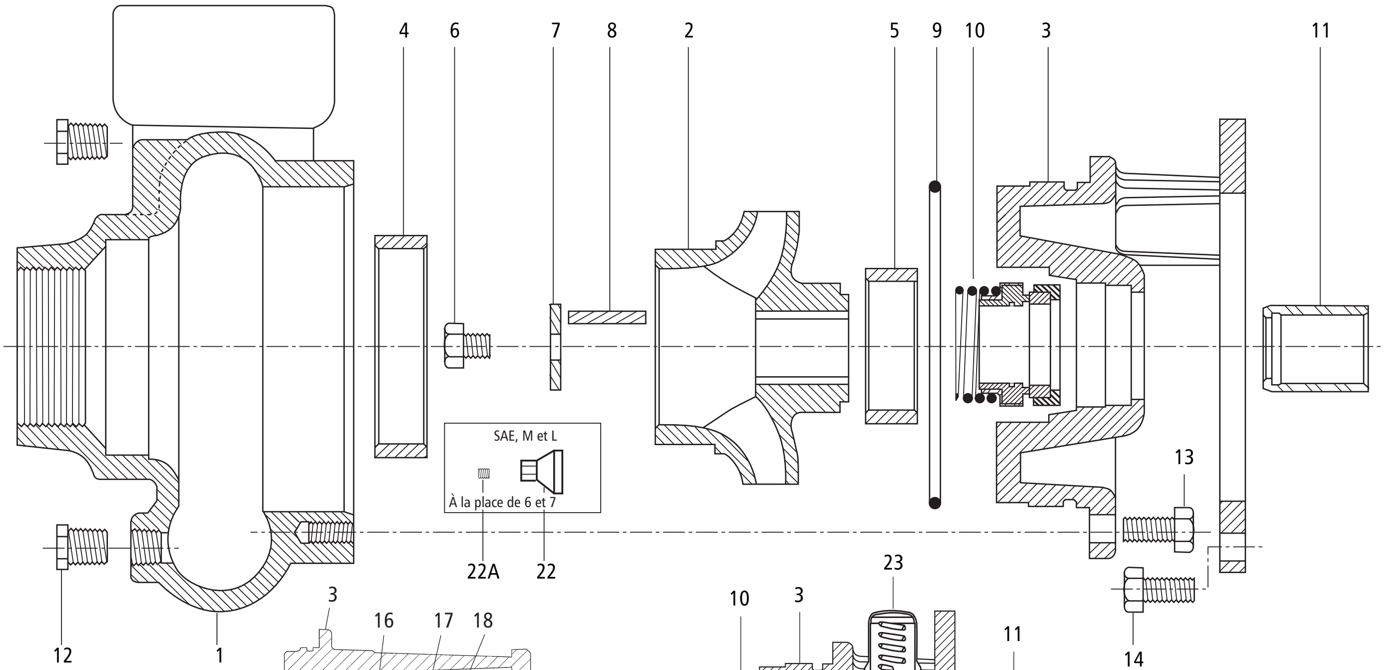
LE DÉBIT DE REFOULEMENT EST FAIBLE OU NUL.
(V. causes probables 6 à 13.)

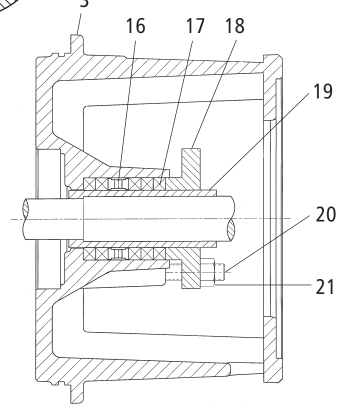
LA POMPE CONSOMME TROP D'ÉNERGIE.
(V. causes probables 3, 13, 14 et 15.)

LA VIBRATION ET LE BRUIT SONT EXCESSIFS.
(V. causes probables 3, 6, 7, 10, 12, 14, 16, et 17.)

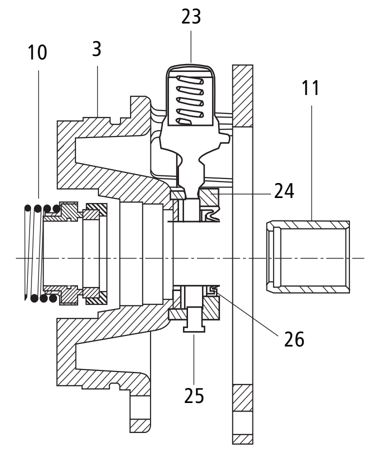
CAUSES PROBABLES

1. Protecteur thermique du moteur déclenché
2. Disjoncteur ouvert ou fusible sauté
3. Roue grippée
4. Câblage incorrect
5. Moteur défectueux
6. Pompe non amorcée, air ou gaz présent dans le liquide pompé
7. Tuyau d'aspiration ou de refoulement obstrué ou robinet(s) fermé(s)
8. Mauvais sens de rotation (moteurs triphasés seulement)
9. Basse tension électrique ou perte de phase
10. Roue usée ou engorgée
11. Hauteur de charge trop élevée du système
12. Hauteur nette d'aspiration disponible (NPSHA) : hauteur ou perte d'aspiration excessives
13. Diamètre de roue inapproprié
14. Hauteur de refoulement trop faible – débit excessif
15. Viscosité ou densité trop élevée du liquide
16. Roulement usé
17. Pompe, moteur ou tuyauterie mal assujettis





Composants du presse-garniture



Graisseur Prime Safe (en option — M et L seulement)

COMPOSANTS DE LA POMPE

Nº d'article	Description	Matériau
1	Corps de pompe	Fonte ou laiton au silicium*
2	Roue	
3	Adaptateur	
4	Bague d'usure (corps de pompe)	Fonte ou bronze*
5**	Bague d'usure (logement de garniture méc.)	
6	Vis (roue)	Inox AISI, type 300
7	Rondelle (roue)	
8	Clavette de roue	Acier
9	Joint torique (logem. de garn. méc.. — matér. opt.)	Buna-N, E-P①, Viton
10	Garniture mécanique	(communiquer avec l'usine)
11	Chemise d'arbre	Inox AISI, type 300
12	Bouchon de vidange, $^1/_4$ et $^3/_8$ po NPT	Acier zingué
13	Vis à tête hex. (adaptateur-corps de pompe)	
14	Vis à tête hex. (adapt.-moteur, adapt.-palier)	
15	Vis à tête hex. (adaptateur-logem. de garn.)	
16	Lanterne d'arrosage	Téflon[MC]
17	Anneaux de garniture (cinq)	Téflon[MC] imprégné
18	Fouloir	Inox AISI 300
19	Chemise d'arbre	Inox AISI, type 300
20	Goujon de fouloir	
21	Écrou de fouloir	
22	Écrou de roue (SAE seulement)	Inox 304
22A	Vis d'arrêt de l'écrou de roue (SAE seulement)	
23	Lubrificateur à graisse (lubrific. à huile en option)	Polycarbonate

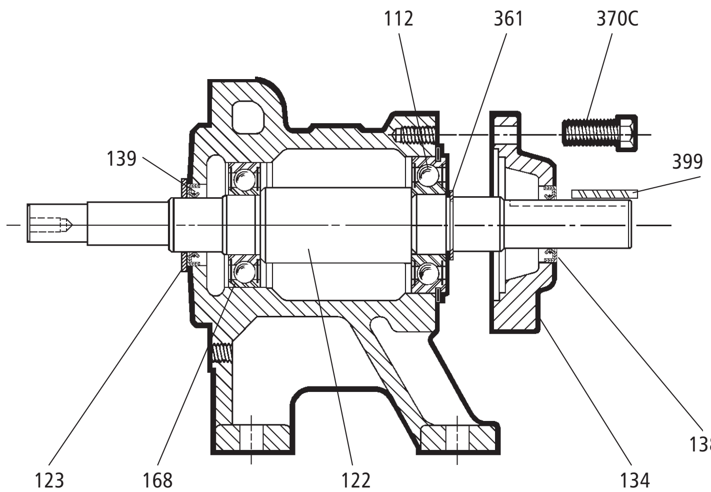
COMPOSANTS DE LA POMPE *(suite)*

Nº d'article	Description	Matériau
24	Boîte de lubrification	Aluminium
25	Bouchon de tuyau	Acier zingué
26	Joint à lèvre(s)	Buna

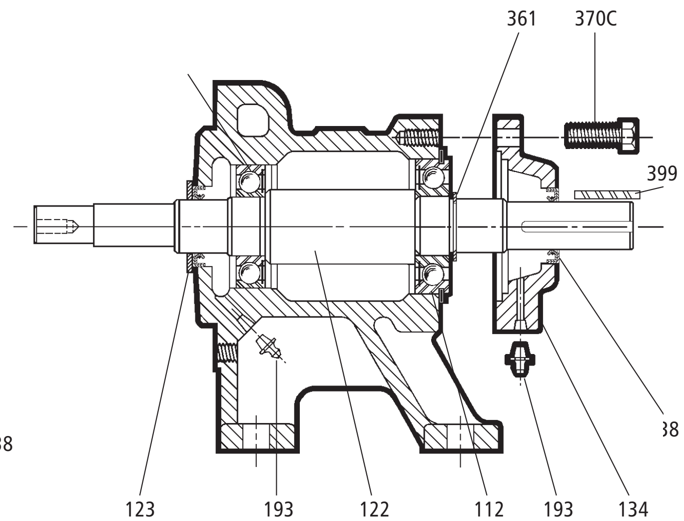
* Sans plomb ; ① E-P = éthylène-propylène.
** L'article 5 est fourni pour le groupe S, dimensions 2½x3-7 (7½, 10 et 15 hp), et le groupe M (sauf les dimensions 3x4-10).

COMPOSANTS DES PALIERS (v. page suivante)

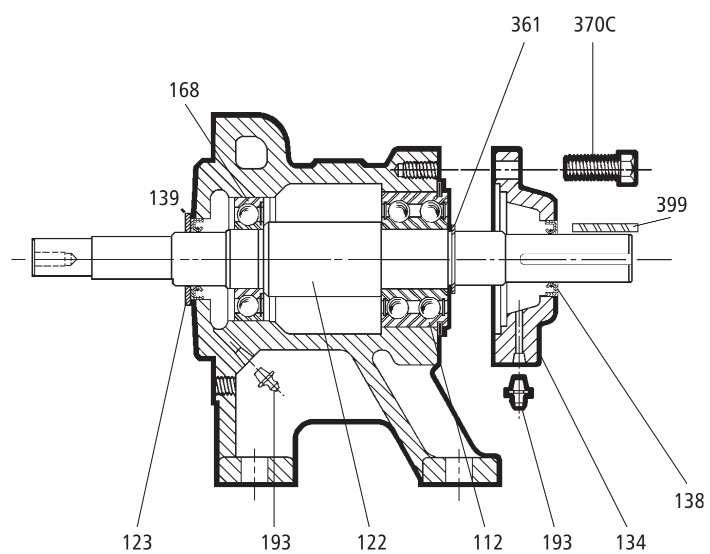
Nº d'article	Description	Matériau
112	Roulement à billes externe	Acier
122	Arbre de pompe	
122A	Arbre de pompe (SAE)	Acier AISI 4140
123	Déflecteur annulaire en V	Buna-N
134	Couvercle de palier	Fonte
138	Joint à lèvre(s) externe	Buna-N
139	Joint à lèvre(s) interne	
168	Roulement à billes interne	Acier
193	Graisseur (groupes M et L)	
327C	Vis (couvercle de l'adaptateur) – SAE seulement	Acier zingué
340	Adaptateur de moteur thermique SAE	Fonte
361	Bague de retenue	Acier
370C	Vis à tête hex. (couvercle-palier)	Acier zingué
371C	Vis à tête hex. (adaptateur-palier) – SAE seulement – (non montrée)	Acier
399	Clavette (accouplement)	
501N	Couvercle de l'adaptateur – SAE seulement	Acier galvanisé



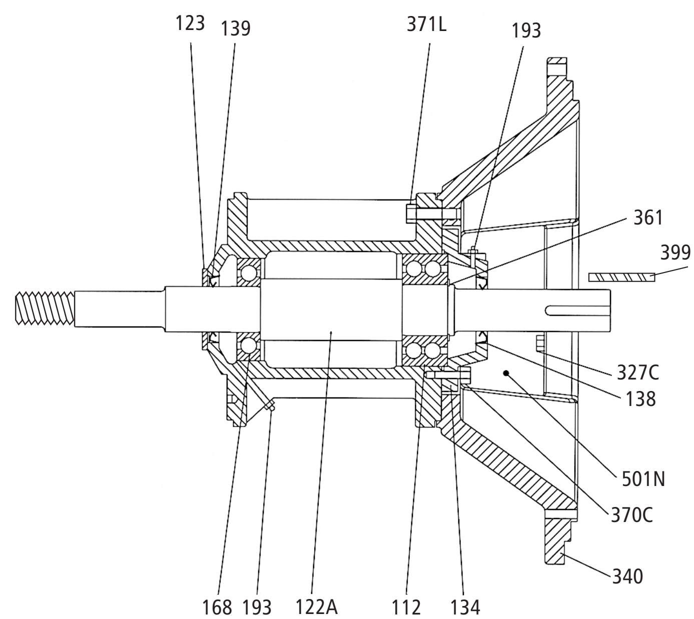
Palier du groupe S



Palier du groupe M



Palier du groupe L



Palier SAE

Notes

Declaration of Conformity

We at,
Goulds Pumps/ITT Industries
1 Goulds Drive
Auburn, NY 13021
Declare that the following products: NPE, MCS, MCC, 3656, 3656 SP, GB, SSV, SVI, NPO, Prime Line SP, HB, HMS, LC, NPV, LB, LBS
Comply with Machine Directive 98/37/EC. This equipment is intended to be incorporated with machinery covered by this directive, but must not be put into service until the machinery into which it is to be incorporated has been declared in conformity with the actual provisions of the directive.

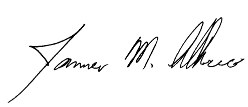
Declaración de Conformidad

Nosotros en
Goulds Pumps/ITT Industries
1 Goulds Drive
Auburn, NY 13021
Declaramos que los siguientes productos: NPE, MCS, MCC, 3656, 3656 SP, GB, SSV, SVI, NPO, Prime Line SP, HB, HMS, LC, NPV, LB, LBS
cumplen con las Directivas para Maquinarias 98/37/EC. Este equipo ha sido diseñado para ser incorporado a la maquinaria cubierta por esta directiva pero no debe ponerse en funcionamiento hasta que se declare que la maquinaria en la que será incorporado cumple con las disposiciones reales de la directiva.

Déclaration de conformité

Nous, à
Goulds Pumps, ITT Industries
1 Goulds Drive
Auburn, NY, U.S.A. 13021,
déclarons que les produits NPE, MCS, MCC, 3656, 3656 SP, GB, SSV, SVI, NPO, Prime Line SP, HB, HMS, LC, NPV, LB et LBS
sont conformes à la directive 98/37/CE (législation relative aux machines). Ils sont destinés à être intégrés dans la machinerie faisant l'objet de ladite directive, mais ne doivent pas être mis en service tant que la machinerie en question ne sera pas déclarée conforme aux stipulations de la directive.

Le directeur des produits,



James M. Allocco

Product Manager

GOULDS PUMPS

GARANTIE LIMITÉE DE GOULDS PUMPS

La présente garantie s'applique à chaque pompe de système d'alimentation en eau fabriquée par Goulds Pumps.

Toute pièce se révélant défectueuse sera remplacée sans frais pour le détaillant durant la période de garantie suivante expirant la première : douze (12) mois à compter de la date d'installation ou dix-huit (18) mois à partir de la date de fabrication.

Le détaillant qui, aux termes de la présente garantie, désire effectuer une demande de règlement doit s'adresser au distributeur Goulds Pumps agréé chez lequel la pompe a été achetée et fournir tous les détails à l'appui de sa demande. Le distributeur est autorisé à régler toute demande par le biais du service à la clientèle de Goulds Pumps.

La garantie ne couvre pas :

a) les frais de main-d'œuvre ou de transport ni les frais connexes encourus par le détaillant ;
b) les frais de réinstallation du matériel réparé ;
c) les frais de réinstallation du matériel de remplacement ;
d) les dommages indirects de quelque nature que ce soit ;
e) ni les pertes découlant de la panne.

Aux fins de la garantie, les termes ci-dessous sont définis comme suit :

1) « Distributeur » signifie une personne, une société de personnes, une société de capitaux, une association ou autre entité juridique servant d'intermédiaire entre Goulds Pumps et le détaillant pour les achats, les consignations ou les contrats de vente des pompes en question.
2) « Détaillant » veut dire une personne, une société de personnes, une société de capitaux, une association ou autre entité juridique dont les activités commerciales sont la vente ou la location de pompes à des clients.
3) « Client » désigne une entité qui achète ou loue les pompes en question chez un détaillant. Le « client » peut être une personne, une société de personnes, une société de capitaux, une société à responsabilité limitée, une association ou autre entité juridique se livrant à quelque activité que ce soit.

LA PRÉSENTE GARANTIE SE RAPPORTE AU DÉTAILLANT SEULEMENT.

www.goulds.com

Goulds Pumps
ITT Industries

BALDOR • RELIANCE

Integral Horsepower AC Induction Motors

Installation & Operating Manual

Table of Contents

Section 1
General Information

Overview This manual contains general procedures that apply to Baldor Motor products. Be sure to read and understand the Safety Notice statements in this manual. For your protection, do not install, operate or attempt to perform maintenance procedures until you understand the Warning and Caution statements. A Warning statement indicates a possible unsafe condition that can cause harm to personnel. A Caution statement indicates a condition that can cause damage to equipment.

Important: **This instruction manual is not intended to include a comprehensive listing of all details for all procedures required for installation, operation and maintenance. This manual describes general guidelines that apply to most of the motor products shipped by Baldor. If you have a question about a procedure or are uncertain about any detail, Do Not Proceed. Please contact your Baldor distributor for more information or clarification.**

Before you install, operate or perform maintenance, become familiar with the following:

- NEMA Publication MG-2, Safety Standard for Construction and guide for Selection, Installation and Use of Electric Motors and Generators.
- The National Electrical Code
- Local codes and Practices

Limited Warranty

www.baldor.com/support/warranty_standard.asp

Safety Notice: This equipment contains high voltage! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation and maintenance of electrical equipment.

Be sure that you are completely familiar with NEMA publication MG-2, safety standards for construction and guide for selection, installation and use of electric motors and generators, the National Electrical Code and local codes and practices. Unsafe installation or use can cause conditions that lead to serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

WARNING: **Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.**

WARNING: **Disconnect all electrical power from the motor windings and accessory devices before disassembly of the motor. Electrical shock can cause serious or fatal injury.**

WARNING: **Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury. National Electrical Code and Local codes must be carefully followed.**

WARNING: **Avoid extended exposure to machinery with high noise levels. Be sure to wear ear protective devices to reduce harmful effects to your hearing.**

WARNING: **Surface temperatures of motor enclosures may reach temperatures which can cause discomfort or injury to personnel accidentally coming into contact with hot surfaces. When installing, protection should be provided by the user to protect against accidental contact with hot surfaces. Failure to observe this precaution could result in bodily injury.**

WARNING: **This equipment may be connected to other machinery that has rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to install operate or maintain this equipment.**

WARNING: **Do not by-pass or disable protective devices or safety guards. Safety features are designed to prevent damage to personnel or equipment. These devices can only provide protection if they remain operative.**

WARNING: **Avoid the use of automatic reset devices if the automatic restarting of equipment can be hazardous to personnel or equipment.**

WARNING: **Be sure the load is properly coupled to the motor shaft before applying power. The shaft key must be fully captive by the load device. Improper coupling can cause harm to personnel or equipment if the load decouples from the shaft during operation.**

WARNING: **Use proper care and procedures that are safe during handling, lifting, installing, operating and maintaining operations. Improper methods may cause muscle strain or other harm.**

WARNING: **Thermostat contacts automatically reset when the motor has slightly cooled down. To prevent injury or damage, the control circuit should be designed so that automatic starting of the motor is not possible when the thermostat resets.**

Safety Notice Continued

WARNING: **UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.**

WARNING: **Pacemaker danger – Magnetic and electromagnetic fields in the vicinity of current carrying carrying conductors and permanent magnet motors can result result in a serious health hazard to persons with cardiac pacemakers, metal implants, and hearing aids. To avoid risk, stay way from the area surrounding a permanent magnet motor.**

WARNING: **Before performing any motor maintenance procedure, be sure that the equipment connected to the motor shaft cannot cause shaft rotation. If the load can cause shaft rotation, disconnect the load from the motor shaft before maintenance is performed. Unexpected mechanical rotation of the motor parts can cause injury or motor damage.**

WARNING: **Use only UL/CSA listed explosion proof motors in the presence of flammable or combustible vapors or dust.**

WARNING: **Motors that are to be used in flammable and/or explosive atmospheres must display the UL label on the nameplate along with CSA listed logo. Specific service conditions for these motors are defined in NFPA 70 (NEC) Article 500.**

WARNING: **Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.**

Caution: **To prevent premature equipment failure or damage, only qualified maintenance personnel should perform maintenance.**

Caution: **Do not over–lubricate motor as this may cause premature bearing failure.**

Caution: **Do not over tension belts. Excess tension may damage the motor or driven equipment.**

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

Caution: **If eye bolts are used for lifting a motor, be sure they are securely tightened. The lifting direction should not exceed a 20° angle from the shank of the eye bolt or lifting lug. Excessive lifting angles can cause damage.**

Caution: **To prevent equipment damage, be sure that the electrical service is not capable of delivering more than the maximum motor rated amps listed on the rating plate.**

Caution: **If a HI POT test (High Potential Insulation test) must be performed, follow the precautions and procedure in NEMA MG1 and MG2 standards to avoid equipment damage.**

If you have any questions or are uncertain about any statement or procedure, or if you require additional information please contact your Baldor distributor or an Authorized Baldor Service Center.

Receiving

Each Baldor Electric Motor is thoroughly tested at the factory and carefully packaged for shipment. When you receive your motor, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your motor.
2. Verify that the part number of the motor you received is the same as the part number listed on your purchase order.

Handling

The motor should be lifted using the lifting lugs or eye bolts provided.

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.**

1. Use the lugs or eye bolts provided to lift the motor. Never attempt to lift the motor and additional equipment connected to the motor by this method. The lugs or eye bolts provided are designed to lift only the motor. Never lift the motor by the motor shaft or the hood of a WPII motor.
2. To avoid condensation inside the motor, do not unpack until the motor has reached room temperature. (Room temperature is the temperature of the room in which it will be installed).
   The packing provides insulation from temperature changes during transportation.
3. When lifting a WPII (Weather Proof Type 2) motor, do not lift the motor by inserting lifting lugs into holes on top of the cooling hood. These lugs are to be used for hood removal only.
   A spreader bar should be used to lift the motor by the cast lifting lugs located on the motor frame.

4. If the motor must be mounted to a plate with the driven equipment such as pump, compressor etc., it may not be possible to lift the motor alone. For this case, the assembly should be lifted by a sling around the mounting base. The entire assembly can be lifted as an assembly for installation.

   Do not lift the assembly using the motor lugs or eye bolts provided. Lugs or eye bolts are designed to lift motor only. If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting. If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting.

Storage

Storage requirements for motors and generators that will not be placed in service for at least six months from date of shipment.

Improper motor storage will result in seriously reduced reliability and failure. An electric motor that does not experience regular usage while being exposed to normally humid atmospheric conditions is likely to develop rust in the bearings or rust particles from surrounding surfaces may contaminate the bearings. The electrical insulation may absorb an excessive amount of moisture leading to the motor winding failure.

A wooden crate “shell” should be constructed to secure the motor during storage. This is similar to an export box but the sides & top must be secured to the wooden base with lag bolts (not nailed as export boxes are) to allow opening and reclosing many times without damage to the “shell”.

Minimum resistance of motor winding insulation is 5 Meg ohms or the calculated minimum, which ever is greater. Minimum resistance is calculated as follows: **Rm = kV + 1**

where: (Rm is minimum resistance to ground in Meg−Ohms and
kV is rated nameplate voltage defined as Kilo−Volts.)

Example: For a 480VAC rated motor Rm =1.48 meg−ohms (use 5 MΩ).
For a 4160VAC rated motor Rm = 5.16 meg−ohms.

Preparation for Storage

1. Some motors have a shipping brace attached to the shaft to prevent damage during transportation. The shipping brace, if provided, must be removed and stored for future use. The brace must be reinstalled to hold the shaft firmly in place against the bearing before the motor is moved.
2. Store in a clean, dry, protected warehouse where control is maintained as follows:
   a. Shock or vibration must not exceed 2 mils maximum at 60 hertz, to prevent the bearings from brinelling. If shock or vibration exceeds this limit vibration isolation pads must be used.
   b. Storage temperatures of 10°C (50°F) to 49°C (120°F) must be maintained.
   c. Relative humidity must not exceed 60%.
   d. Motor space heaters (when present) are to be connected and energized whenever there is a possibility that the storage ambient conditions will reach the dew point. Space heaters are optional.

   Note: Remove motor from containers when heaters are energized, reprotect if necessary.
3. Measure and record the resistance of the winding insulation (dielectric withstand) every 30 days of storage.
   a. If motor insulation resistance decreases below the minimum resistance, contact your Baldor District office.
   b. Place new desiccant inside the vapor bag and re−seal by taping it closed.
   c. If a zipper−closing type bag is used instead of the heat−sealed type bag, zip the bag closed instead of taping it. Be sure to place new desiccant inside bag after each monthly inspection.
   d. Place the shell over the motor and secure with lag bolts.
4. Where motors are mounted to machinery, the mounting must be such that the drains and breathers are fully operable and are at the lowest point of the motor. Vertical motors must be stored in the vertical position. Storage environment must be maintained as stated in step 2.

5. Motors with anti−friction bearings are to be greased at the time of going into extended storage with periodic service as follows:
   a. Motors marked “Do Not Lubricate” on the nameplate do not need to be greased before or during storage.
   b. Ball and roller bearing (anti−friction) motor shafts are to be rotated manually every 3 months and greased every 6 months in accordance with the Maintenance section of this manual.
   c. Sleeve bearing (oil lube) motors are drained of oil prior to shipment.
      The oil reservoirs must be refilled to the indicated level with the specified lubricant, (see Maintenance). The shaft should be rotated monthly by hand at least 10 to 15 revolutions to distribute oil to bearing surfaces.
   d. “Provisions for oil mist lubrication” – These motors are packed with grease. Storage procedures are the same as paragraph 5b.
   e. “Oil Mist Lubricated” – These bearings are protected for temporary storage by a corrosion inhibitor. If stored for greater than 3 months or outdoor storage is anticipated, connected to the oil mist system while in storage. If this is not possible, add the amount of grease indicated under “Standard Condition” in Section 3, then rotate the shaft 15 times by hand.
6. All breather drains are to be fully operable while in storage (drain plugs removed). The motors must be stored so that the drain is at the lowest point. All breathers and automatic “T” drains must be operable to allow breathing and draining at points other than through the bearings around the shaft. Vertical motors should be stored in a safe stable vertical position.
7. Coat all external machined surfaces with a rust preventing material.
   An acceptable product for this purpose is Exxon Rust Ban # 392.

Non−Regreaseable Motors

Non−regreasable motors with “Do Not Lubricate” on the nameplate should have the motor shaft rotated 15 times to redistribute the grease within the bearing every 3 months or more often.

All Other Motor Types

Before storage, the following procedure must be performed.

1. Remove the grease drain plug, if supplied, (opposite the grease fitting) on the bottom of each bracket prior to lubricating the motor.
2. The motor with regreasable bearing must be greased as instructed in Section 3 of this manual.
3. Replace the grease drain plug after greasing.
4. The motor shaft must be rotated a minimum of 15 times after greasing.
5. Motor Shafts are to be rotated at least 15 revolutions manually every 3 months and additional grease added every nine months (see Section 3) to each bearing.
6. Bearings are to be greased at the time of removal from storage.

Removal From Storage

1. Remove all packing material.
2. Measure and record the electrical resistance of the winding insulation resistance meter at the time of removal from storage. The insulation resistance must not be less than 50% from the initial reading recorded when the motor was placed into storage. A decrease in resistance indicates moisture in the windings and necessitates electrical or mechanical drying before the motor can be placed into service. If resistance is low, contact your Baldor District office.
3. Regrease the bearings as instructed in Section 3 of this manual.
4. Reinstall the original shipping brace if motor is to be moved. This will hold the shaft firmly against the bearing and prevent damage during movement.

Section 2
Installation & Operation

Overview Installation should conform to the National Electrical Code as well as local codes and practices. When other devices are coupled to the motor shaft, be sure to install protective devices to prevent future accidents. Some protective devices include, coupling, belt guard, chain guard, shaft covers etc. These protect against accidental contact with moving parts. Machinery that is accessible to personnel should provide further protection in the form of guard rails, screening, warning signs etc.

Location It is important that motors be installed in locations that are compatible with motor enclosure and ambient conditions. Improper selection of the motor enclosure and ambient conditions can lead to reduced operating life of the motor.

Proper ventilation for the motor must be provided. Obstructed airflow can lead to reduction of motor life.

1. **Open Drip−Proof/WPI** motors are intended for use indoors where atmosphere is relatively clean, dry, well ventilated and non−corrosive.
2. **Totally Enclosed and WPII** motors may be installed where dirt, moisture or dust are present and in outdoor locations.

Severe Duty, IEEE 841 and Washdown Duty enclosed motors are designed for installations with high corrosion or excessive moisture conditions. These motors should not be placed into an environment where there is the presence of flammable or combustible vapors, dust or any combustible material, unless specifically designed for this type of service.

Hazardous Locations are those where there is a risk of ignition or explosion due to the presence of combustible gases, vapors, dust, fibers, or flyings. Facilities requiring special equipment for hazardous locations are typically classified in accordance with local requirements. In the US market, guidance is provided by the National Electric Code.

Caution: Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load (gears, pumps, compressors, or other driven equipment) from the motor shaft before lifting the motor.

Mounting The motor must be securely installed to a rigid foundation or mounting surface to minimize vibration and maintain alignment between the motor and shaft load. Failure to provide a proper mounting surface may cause vibration, misalignment and bearing damage.

Foundation caps and sole plates are designed to act as spacers for the equipment they support. If these devices are used, be sure that they are evenly supported by the foundation or mounting surface.

After installation is complete and accurate alignment of the motor and load is accomplished, the base should be grouted to the foundation to maintain this alignment.

The standard motor base is designed for horizontal or vertical mounting. Adjustable or sliding rails are designed for horizontal mounting only. Consult your Baldor distributor or authorized Baldor Service Center for further information.

Alignment Accurate alignment of the motor with the driven equipment is extremely important. The pulley, sprocket, or gear used in the drive should be located on the shaft as close to the shaft shoulder as possible.
It is recommended to heat the pulley, sprocket, or gear before installing on the motor shaft.
Forcibly driving a unit on the motor shaft will damage the bearings.

1. **Direct Coupling**
   For direct drive, use flexible couplings if possible. Consult the drive or equipment manufacturer for more information. Mechanical vibration and roughness during operation may indicate poor alignment. Use dial indicators to check alignment. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.
2. **End-Play Adjustment**
   The axial position of the motor frame with respect to its load is also extremely important. The motor bearings are not designed for excessive external axial thrust loads. Improper adjustment will cause failure.
3. **Pulley Ratio**
   The pulley ratio should not exceed 8:1.

Caution: Do not over tension belts. Excess tension may damage the motor or driven equipment.

4. **Belt Drive**
   Align sheaves carefully to minimize belt wear and axial bearing loads (see End-Play Adjustment). Belt tension should be sufficient to prevent belt slippage at rated speed and load. However, belt slippage may occur during starting.
5. Sleeve bearing motors are only suitable for coupled loads.

Doweling & Bolting After proper alignment is verified, dowel pins should be inserted through the motor feet into the foundation. This will maintain the correct motor position should motor removal be required. (Baldor motors are designed for doweling.)

1. Drill dowel holes in diagonally opposite motor feet in the locations provided.
2. Drill corresponding holes in the foundation.
3. Ream all holes.
4. Install proper fitting dowels.
5. Mounting bolts must be carefully tightened to prevent changes in alignment. Use a flat washer and lock washer under each nut or bolt head to hold the motor feet secure. Flanged nuts or bolts may be used as an alternative to washers.

WARNING: Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.

Guarding

Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions. This is particularly important where the parts have surface irregularities such as keys, key ways or set screws. Some satisfactory methods of guarding are:

1. Covering the machine and associated rotating parts with structural or decorative parts of the driven equipment.
2. Providing covers for the rotating parts. Covers should be sufficiently rigid to maintain adequate guarding during normal service.

Power Connection Motor and control wiring, overload protection, disconnects, accessories and grounding should conform to the National Electrical Code and local codes and practices. Flying leads must be insulated with two full wraps of electrical grade insulating tape or heat shrink tubing.

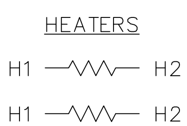
Conduit Box For ease of making connections, an oversize conduit box is provided.
The box can be rotated 360° in 90° increments.
Auxiliary conduit boxes are provided on some motors for accessories such as space heaters, RTD's etc.

AC Power Connect the motor leads as shown on the connection diagram located on the name plate or inside the cover on the conduit box. Be sure the following guidelines are met:

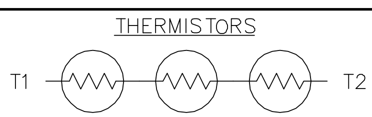
1. AC power is within ±10% of rated voltage with rated frequency. (See motor name plate for ratings).
   OR
2. AC power is within ±5% of rated frequency with rated voltage.
   OR
3. A combined variation in voltage and frequency of ±10% (sum of absolute values) of rated values, provided the frequency variation does not exceed ±5% of rated frequency.

Performance within these voltage and frequency variations are shown in Figure 2-2.

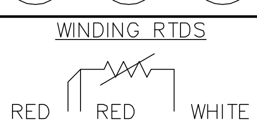
Figure 2-1 Accessory Connections



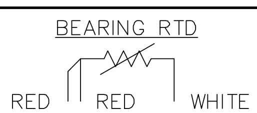
One heater is installed in each end of motor.
Leads for each heater are labeled H1 & H2.
(Like numbers should be tied together).



Three thermistors are installed in windings and tied in series.
Leads are labeled T1 & T2.

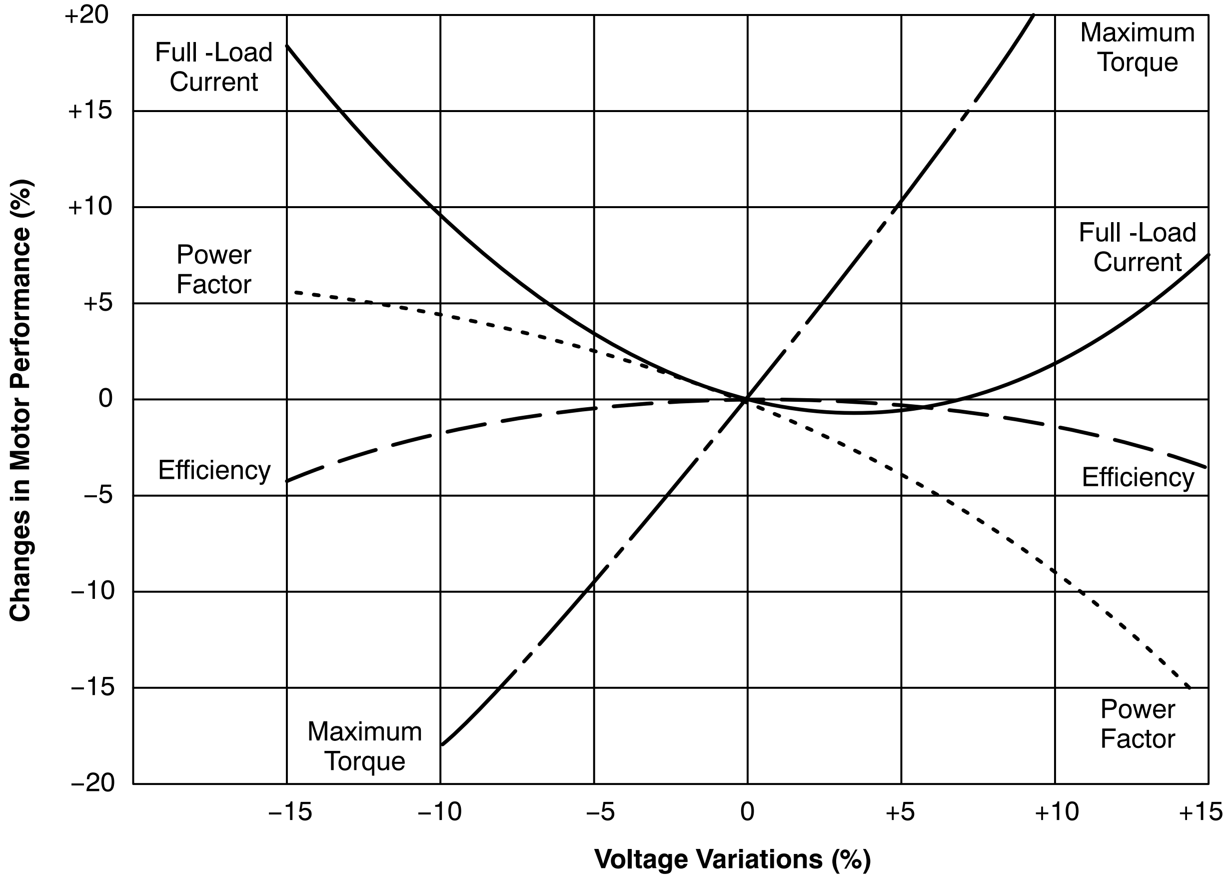


Winding RTDs are installed in windings (2) per phase.
Each set of leads is labeled W1, W2, W3, W4, W5, & W6.



* One bearing RTD is installed in Drive endplate (PUEP), leads are labeled RTDDE.
* One bearing RTD is installed in Opposite Drive endplate (FREP), leads are labeled RTDODE.
* Note RTD may have 2-Red/1-White leads; or 2-White/1-Red Lead.

Figure 2-2 Typical Motor Performance VS Voltage Variations



Rotation All three phase motors are reversible. To reverse the direction of rotation, disconnect and lock out power and interchange any two of the three line leads for three phase motors. For single phase motors, check the connection diagram to determine if the motor is reversible and follow the connection instructions for lead numbers to be interchanged. Not all single phase motors are reversible.

Adjustable Frequency Power Inverters used to supply adjustable frequency power to induction motors produce wave forms with lower order harmonics with voltage spikes superimposed. Turn−to−turn, phase−to−phase, and ground insulation of stator windings are subject to the resulting dielectric stresses. Suitable precautions should be taken in the design of these drive systems to minimize the magnitude of these voltage spikes. Consult the drive instructions for maximum acceptable motor lead lengths, and proper grounding.

First Time Start Up Be sure that all power to motor and accessories is off. Be sure the motor shaft is disconnected from the load and will not cause mechanical rotation of the motor shaft.

1. Make sure that the mechanical installation is secure. All bolts and nuts are tightened etc.
2. If motor has been in storage or idle for some time, check winding insulation integrity.
3. Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity.
4. Be sure all shipping materials and braces (if used) are removed from motor shaft.
5. Manually rotate the motor shaft to ensure that it rotates freely.
6. Replace all panels and covers that were removed during installation.
7. Momentarily apply power and check the direction of rotation of the motor shaft.
8. If motor rotation is wrong, be sure power is off and change the motor lead connections. Verify rotation direction before you continue.
9. Start the motor and ensure operation is smooth without excessive vibration or noise. If so, run the motor for 1 hour with no load connected.
10. After 1 hour of operation, disconnect power and connect the load to the motor shaft. Verify all coupling guards and protective devices are installed. Ensure motor is properly ventilated.

Coupled Start Up This procedure assumes a coupled start up. Also, that the first time start up procedure was successful.

1. Check the coupling and ensure that all guards and protective devices are installed.
2. Check that the coupling is properly aligned and not binding.
3. The first coupled start up should be with no load. Apply power and verify that the load is not transmitting excessive vibration back to the motor though the coupling or the foundation. Vibration should be at an acceptable level.
4. Run for approximately 1 hour with the driven equipment in an unloaded condition.

The equipment can now be loaded and operated within specified limits. Do not exceed the name plate ratings for amperes for steady continuous loads.

Jogging and Repeated Starts Repeated starts and/or jogs of induction motors generally reduce the life of the motor winding insulation. A much greater amount of heat is produced by each acceleration or jog than by the same motor under full load. If it is necessary to repeatedly start or jog the motor, it is advisable to check the application with your local Baldor distributor or Baldor Service Center.

Heating - Duty rating and maximum ambient temperature are stated on the motor name plate. Do not exceed these values. If there is any question regarding safe operation, contact your local Baldor District Office or Baldor Service Center.

Section 3
Maintenance & Troubleshooting

WARNING: UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.

General Inspection Inspect the motor at regular intervals, approximately every 500 hours of operation or every 3 months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
3. Check all electrical connectors to be sure that they are tight.

Relubrication & Bearings Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program.

Type of Grease A high grade ball or roller bearing grease should be used. Recommended grease for standard service conditions is **Polyrex EM (Exxon Mobil)**. Do not mix greases unless compatibility has been checked and verified.

Equivalent and compatible greases include:
Texaco Polystar, Rykon Premium #2, Pennzoil Pen 2 Lube and Chevron SRI.

Relubrication Intervals Recommended relubrication intervals are shown in Table 3-1. It is important to realize that the recommended intervals of Table 3-1 are based on average use.

Refer to additional information contained in Tables 3-2, 3-3 and 3-4.

Table 3-1 Relubrication Intervals *

NEMA / (IEC) Frame Size	Rated Speed - RPM					
	10000	6000	3600	1800	1200	900
Up to 210 incl. (132)	**	2700 Hrs.	5500 Hrs.	12000 Hrs.	18000 Hrs.	22000 Hrs.
Over 210 to 280 incl. (180)		**	3600 Hrs.	9500 Hrs.	15000 Hrs.	18000 Hrs.
Over 280 to 360 incl. (225)		**	* 2200 Hrs.	7400 Hrs.	12000 Hrs.	15000 Hrs.
Over 360 to 5800 incl. (300)		**	*2200 Hrs.	3500 Hrs.	7400 Hrs.	10500 Hrs.

* Relubrication intervals are for ball bearings.
For vertically mounted motors and roller bearings, divide the relubrication interval by 2.

** For motors operating at speeds greater than 3600 RPM, contact Baldor for relubrication recommendations.

Table 3-2 Service Conditions

Severity of Service	Hours per day of Operation	Ambient Temperature Maximum	Atmospheric Contamination
Standard	8	40° C	Clean, Little Corrosion
Severe	16 Plus	50° C	Moderate dirt, Corrosion
Extreme	16 Plus	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion, Heavy Shock or Vibration
Low Temperature		<−29° C **	

* Special high temperature grease is recommended (Dow Corning DC44). Note that Dow Corning DC44 grease does not mix with other grease types. Thoroughly clean bearing & cavity before adding grease.

** Special low temperature grease is recommended (Aeroshell 7).

Table 3-3 Relubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Some motor designs use different bearings on each motor end. This is normally indicated on the motor nameplate. In this case, the larger bearing is installed on the motor Drive endplate. For best relubrication results, only use the appropriate amount of grease for each bearing size (not the same for both).

Table 3-4 Bearings Sizes and Types

Frame Size NEMA (IEC)	Bearing Description (These are the "Large" bearings (Shaft End) in each frame size)			
	Bearing	Weight of Grease to add * oz (Grams)	Volume of grease to be added	
			in^3	teaspoon
56 to 140 (90)	6203	0.08 (2.4)	0.15	0.5
140 (90)	6205	0.15 (3.9)	0.2	0.8
180 (100−112)	6206	0.19 (5.0)	0.3	1.0
210 (132)	6307	0.30 (8.4)	0.6	2.0
250 (160)	6309	0.47 (12.5)	0.7	2.5
280 (180)	6311	0.61 (17)	1.2	3.9
320 (200)	6312	0.76 (20.1)	1.2	4.0
360 (225)	6313	0.81 (23)	1.5	5.2
400 (250)	6316	1.25 (33)	2.0	6.6
440 (280)	6319	2.12 (60)	4.1	13.4
5000 to 5800 (315−450)	6328	4.70 (130)	9.2	30.0
5000 to 5800 (315−450)	NU328	4.70 (130)	9.2	30.0
360 to 449 (225−280)	NU319	2.12 (60)	4.1	13.4
AC Induction Servo				
76 Frame 180 (112)	6207	0.22 (6.1)	0.44	1.4
77 Frame 210 (132)	6210	0.32 (9.0)	0.64	2.1
80 Frame 250(160)	6213	0.49 (14.0)	0.99	3.3

* Weight in grams = .005 DB of grease to be added

Note: Not all bearing sizes are listed. For intermediate bearing sizes, use the grease volume for the next larger size bearing.

Caution: To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact your Baldor distributor or an authorized Baldor Service Center for additional information.

Relubrication Procedure Be sure that the grease you are adding to the motor is compatible with the grease already in the motor. Consult your Baldor distributor or an authorized service center if a grease other than the recommended type is to be used.

Caution: Do not over-lubricate motor as this may cause premature bearing failure.

With Grease Outlet Plug

1. With the motor stopped, clean all grease fittings with a clean cloth.
2. Remove grease outlet plug.

Caution: Over-lubricating can cause excessive bearing temperatures, premature lubrication breakdown and bearing failure.

3. Add the recommended amount of grease.
4. Operate the motor for 15 minutes with grease plug removed.
   This allows excess grease to purge.
5. Re-install grease outlet plug.

Without Grease Provisions

Note: Only a Baldor authorized and UL or CSA certified service center can disassemble a UL/CSA listed explosion proof motor to maintain it's UL/CSA listing.

1. Disassemble the motor.
2. Add recommended amount of grease to bearing and bearing cavity. (Bearing should be about 1/3 full of grease and outboard bearing cavity should be about 1/2 full of grease.)
3. Assemble the motor.

Sample Relubrication Determination

Assume - NEMA 286T (IEC 180), 1750 RPM motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 3-1 list 9500 hours for standard conditions.
2. Table 3-2 classifies severity of service as "Severe".
3. Table 3-4 shows that 1.2 in^3 or 3.9 teaspoon of grease is to be added.

Note: Smaller bearings in size category may require reduced amounts of grease.

Table 3-5 Troubleshooting Chart

Symptom	Possible Causes	Possible Solutions
Motor will not start	Usually caused by line trouble, such as, single phasing at the starter.	Check source of power. Check overloads, fuses, controls, etc.
Excessive humming	High Voltage.	Check input line connections.
	Eccentric air gap.	Have motor serviced at local Baldor service center.
Motor Over Heating	Overload. Compare actual amps (measured) with nameplate rating.	Locate and remove source of excessive friction in motor or load. Reduce load or replace with motor of greater capacity.
	Single Phasing.	Check current at all phases (should be approximately equal) to isolate and correct the problem.
	Improper ventilation.	Check external cooling fan to be sure air is moving properly across cooling fins. Excessive dirt build-up on motor. Clean motor.
	Unbalanced voltage.	Check voltage at all phases (should be approximately equal) to isolate and correct the problem.
	Rotor rubbing on stator.	Check air gap clearance and bearings.
		Tighten “Thru Bolts”.
	Over voltage or under voltage.	Check input voltage at each phase to motor.
	Open stator winding.	Check stator resistance at all three phases for balance.
	Grounded winding.	Perform dielectric test and repair as required.
	Improper connections.	Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity. Refer to motor lead connection diagram.
Bearing Over Heating	Misalignment.	Check and align motor and driven equipment.
	Excessive belt tension.	Reduce belt tension to proper point for load.
	Excessive end thrust.	Reduce the end thrust from driven machine.
	Excessive grease in bearing.	Remove grease until cavity is approximately $^3/_4$ filled.
	Insufficient grease in bearing.	Add grease until cavity is approximately $^3/_4$ filled.
	Dirt in bearing.	Clean bearing cavity and bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.
Vibration	Misalignment.	Check and align motor and driven equipment.
	Rubbing between rotating parts and stationary parts.	Isolate and eliminate cause of rubbing.
	Rotor out of balance.	Have rotor balance checked are repaired at your Baldor Service Center.
	Resonance.	Tune system or contact your Baldor Service Center for assistance.
Noise	Foreign material in air gap or ventilation openings.	Remove rotor and foreign material. Reinstall rotor. Check insulation integrity. Clean ventilation openings.
Growling or whining	Bad bearing.	Replace bearing. Clean all grease from cavity and new bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.

Suggested bearing and winding RTD setting guidelines

Most large frame AC Baldor motors with a 1.15 service factor are designed to operate below a Class B (80°C) temperature rise at rated load and are built with a Class H winding insulation system. Based on this low temperature rise, RTD (Resistance Temperature Detectors) settings for Class B rise should be used as a starting point. Some motors with 1.0 service factor have Class F temperature rise.

The following tables show the suggested alarm and trip settings for RTDs. Proper bearing and winding RTD alarm and trip settings should be selected based on these tables unless otherwise specified for specific applications.

If the driven load is found to operate well below the initial temperature settings under normal conditions, the alarm and trip settings may be reduced so that an abnormal machine load will be identified.

The temperature limits are based on the installation of the winding RTDs imbedded in the winding as specified by NEMA. Bearing RTDs should be installed so they are in contact with the outer race on ball or roller bearings or in direct contact with the sleeve bearing shell.

Winding RTDs – Temperature Limit In °C (40°C Maximum Ambient)

Motor Load	Class B Temp Rise ≤ 80°C (Typical Design)		Class F Temp Rise ≤ 105°C		Class H Temp Rise ≤ 125°C	
	Alarm	Trip	Alarm	Trip	Alarm	Trip
≤ Rated Load	130	140	155	165	175	185
Rated Load to 1.15 S.F.	140	150	160	165	180	185

Note: • Winding RTDs are factory production installed, not from Mod–Express.
• When Class H temperatures are used, consider bearing temperatures and relubrication requirements.

Bearing RTDs – Temperature Limit In °C (40°C Maximum Ambient)

Bearing Type Oil or Grease	Anti–Friction		Sleeve	
	Alarm	Trip	Alarm	Trip
Standard*	95	100	85	95
High Temperature**	110	115	105	110

Note: * Bearing temperature limits are for standard design motors operating at Class B temperature rise.
** High temperature lubricants include some special synthetic oils and greases.

Greases that may be substituted that are compatible with Polyrex EM (but considered as "standard" lubricants) include the following:

- Texaco Polystar
- Mobilith SHC–100
- Darmex 707
- Rykon Premium #2
- Pennzoil Pennzlube EM–2
- Darmex 711
- Chevron SRI #2
- Chevron Black Pearl
- Petro–Canada Peerless LLG

See the motor nameplate for replacement grease or oil recommendation.
Contact Baldor application engineering for special lubricants or further clarifications.

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Table of Contents

Owner's Information

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Pump Serial Number: ____________________

Control Model Number: ____________________

Dealer: ____________________

Dealer Phone No. ____________________

Date of Purchase: __________ Installation: __________

Current Readings at Startup:

1Ø	3Ø	L1-2	L2-3	L3-1
Amps: ______	Amps:	______	______	______
Volts: ______	Volts:	______	______	______

SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

This is a **SAFETY ALERT SYMBOL.** When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

DANGER Warns of hazards that **WILL** cause serious personal injury, death or major property damage.

WARNING Warns of hazards that **CAN** cause serious personal injury, death or major property damage.

CAUTION Warns of hazards that **CAN** cause personal injury or property damage.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

WARNING All electrical work must be performed by a qualified technician. Always follow the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial codes. Code questions should be directed to your local electrical inspector. Failure to follow electrical codes and OSHA safety standards may result in personal injury or equipment damage. Failure to follow manufacturer's installation instructions may result in electrical shock, fire hazard, personal injury or death, damaged equipment, provide unsatisfactory performance, and may void manufacturer's warranty.

WARNING Standard units are not designed for use in swimming pools, open bodies of water, hazardous liquids, or where flammable gases exist. These fluids and gases may be present in containment areas. Tank or wetwell must be vented per local codes.

Only pumps specifically Listed for Class 1, Division 1 are allowable in hazardous liquids and where flammable gases may exist. *See specific pump catalog bulletins or pump nameplate for all agency Listings*.

WARNING Disconnect and lockout electrical power before installing or servicing any electrical equipment. Many pumps are equipped with automatic thermal overload protection which may allow an overheated pump to restart unexpectedly.

CAUTION All three phase (3Ø) control panels for submersible pumps must provide Class 10, quick-trip, overload protection.

PRE-INSTALLATION CHECKS

Open all cartons and inspect for shipping damage. Report any damage to your supplier or shipping carrier immediately.

Important: Always verify that the pump nameplate Amps, Voltage, Phase and HP ratings match your control panel and power supply.

Many of our sewage pumps are oil-filled. If there are any signs of oil leakage or if the unit has been stored for an extended period check the oil level in the motor dome and the seal housing, if so equipped.

Check the motor cover oil level through the pipe plug on top of the unit. The motor chamber oil should just cover the motor. Do not overfill, leave room for expansion!

To check the seal housing oil level, where used, lay the unit on its side with the fill plug at 12 o'clock. Remove the plug. The oil should be within ½" (13mm) of the top. If low, refill with an ASTM 150 turbine oil. Replace the plug.

Oil is available in 5 gallon cans through our distributors. You can also source oil locally at motor repair shops. Typical oil brands are: Shell Turbo 32, Sunoco Sunvis 932, Texaco Regal R&O 32, Exxon Nuto 32 and Mobil DTE Light.

Check the strain relief nut on power cable strain assemblies. Power cables should be torqued to 75 in. lbs. for #16 cables and 80 in. lbs. for all other cable assemblies. Seal/heat sensor cables, where used, should be torqued to 75 in. lbs.

Warranty does not cover damage caused by connecting pumps and controls to an incorrect power source (voltage/phase supply).

Record the model numbers and serial numbers from the pumps and control panel on the front of this instruction manual for future reference. Give it to the owner or affix it to the control panel when finished with the installation.

LIFTING OF PUMP

DO NOT LIFT, CARRY OR HANG PUMP BY THE ELECTRICAL CABLES. DAMAGE TO THE ELECTRICAL CABLES CAN CAUSE SHOCK, BURNS OR DEATH.

Lift the pump with an adequately sized chain or cable attached to the lifting eye bolt. **DO NOT** damage electrical and sensor cables while raising and lowering unit.

OPTIONAL GUIDE RAIL OR LIFT-OUT SYSTEM

In many effluent and sewage basins or lift stations it is advisable to install the pump on a guide rail system or on a lift-out adapter to facilitate installation and removal for inspection and/or service. Most codes do not allow personnel to enter a wetwell without the correct protective equipment and training. Guide rails are designed to allow easy removal of the pump without the need for entry into the wetwell or need to disturb piping. The guide rail or lift-out adapter should locate the pump opposite the influent opening preventing stagnate areas where solids can settle. The basin or pit must be capable of supporting the weight of the pump and guide rail. The pit floor must be flat.

NOTICE: FOLLOW THE INSTRUCTIONS THAT ARE PROVIDED WITH THE GUIDE RAIL ASSEMBLY.

PIPING

Discharge piping should be no smaller than the pump discharge diameter and kept as short as possible, avoiding unnecessary fittings to minimize friction losses.

Install an adequately sized check valve matched to the solids handling capability of the pump to prevent fluid backflow. Backflow can allow the pump to "turbine" backwards and may cause premature seal and/or bearing wear. If the pump is turning backwards when it is called on to start the increased torque may cause damage to the pump motor and/or motor shaft and some single-phase pumps may actually run backwards.

Install an adequately sized gate valve **AFTER** the check valve for pump, plumbing and check valve maintenance.

Important – Before pump installation. Drill a $^3/_{16}$" (4.8mm) relief hole in the discharge pipe. It should be located within the wetwell, 2" (51mm) above the pump discharge but below the check valve. The relief hole allows any air to escape from the casing. Allowing liquid into the casing will insure that the pump can start when the liquid level rises. Unless a relief hole is provided, a bottom intake pump could "air lock" and will not pump water even though the impeller turns.

All piping must be adequately supported, so as not to impart any piping strain or loads on the pump.

The pit access cover must be of sufficient size to allow for inspection, maintenance and crane or hoist service.

WIRING AND GROUNDING

Important notice: Read Safety Instructions before proceeding with any wiring.

⚠ Use only stranded copper wire to pump/motor and ground. The ground wire must be at least as large as the power supply wires. Wires should be color coded for ease of maintenance and troubleshooting.

⚠ Install wire and ground according to the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial codes.

⚠ Install an all leg disconnect switch where required by code.

⚠ Disconnect and lockout electrical power before performing any service or installation.

⚠ The electrical supply voltage and phase must match all equipment requirements. Incorrect voltage or phase can cause fire, motor and control damage, and voids the warranty.

⚠ All splices must be waterproof. If using splice kits follow manufacturer's instructions.

⚠ WARNING Select the correct type and NEMA grade junction box for the application and location. The junction box must insure dry, safe wiring connections.

⚠ WARNING Seal all controls from gases present which may damage electrical components.

⚠ **WARNING** Hazardous voltage **FAILURE TO PERMANENTLY GROUND THE PUMP, MOTOR AND CONTROLS BEFORE CONNECTING TO POWER CAN CAUSE SHOCK, BURNS OR DEATH.**

SELECTING AND WIRING PUMP CONTROL PANELS AND SWITCHES

FLOAT SWITCH TYPES

There are two basic float switch designs; single-action and wide-angle. Single-action switches operate over a range of 15° so they open and close quickly. Wide-angle floats operate over a 90° swing with the tether length between the float body and the pivot point controlling the On-Off range. The design determines how many floats are required with different systems or controls.

Floats may be normally open (NO) for pump down applications or to empty a tank. Normally closed (NC) switches are used to pump up or to fill a tank.

A single-action control switch may be used only with a control panel, never direct connected to a pump.

The wide-angle, pump down switches may be used as direct connected pump switches or as control switches.

SETTING THE FLOAT SWITCHES

There are no absolute rules for where to set the float switches, it varies from job to job.

Suggested Rules to Follow:
All floats should be set below the Inlet pipe!

Off Float: Best: set so the water level is always above the top of the pump (motor dome). **Next Best:** set so the water level is not more than 6" below the top of the pump.

On Float: set so the volume of water between the On and Off floats allows pumps of 1½ HP and under to operate for 1 minute minimum. Two (2) HP and larger pumps should run a minimum of 2 minutes. Basin literature states the gallons of storage per inch of basin height.

Lag/Alarm Float(s): should be staggered above the Off and On floats. Try to use most of the available storage provided by the basin, save some space for reserve storage capacity. *See Diagrams and Charts in Float Switch Chart Section.*

PANEL WIRING DIAGRAMS

Our control panels are shipped with instructions and wiring diagrams. Use those instructions in conjunction with this IOM. Electrical installation should be performed only by qualified technicians. Any problem or questions pertaining to another brand control must be referred to that control supplier or manufacturer. Our technical people have no technical schematics or trouble shooting information for other companies' controls.

ALARMS

We recommend the installation of an alarm on all Wastewater pump installations. Many standard control panels come equipped with alarm circuits. If a control panel is not used, a stand alone high liquid level alarm is available. The alarm alerts the owner of a high liquid level in the system so they can contact the appropriate service personnel to investigate the situation.

SINGLE PHASE PUMPS
Single phase (1Ø) pumps may be operated using a piggy-back or hard wired float switch, a contactor, or a Simplex or Duplex control panel. *See Figures 1, 2 and 5.*

All 1/3 and 1/2 HP, 115 or 230 volt pumps, and some 3/4 and 1 HP pumps, are supplied with plug style power cords. They may be plugged into piggyback float switches for simple installations. It is allowable to remove the plugs in order to hardwire or connect to a Simplex or Duplex controller. Removing the plug neither voids the warranty nor violates the agency Listings. *See Figure 5.*

PLUG-CONNECTED UNITS MUST BE CONNECTED TO A PROPERLY GROUNDED, GROUNDING TYPE RECEPTACLE.

ON NON-PLUG UNITS, DO NOT REMOVE CORD AND STRAIN RELIEF. DO NOT CONNECT CONDUIT TO PUMP.

Pumps with bare lead power cords can be hard-wired to a float switch, wired to a 1Ø contactor, a Simplex controller or a Duplex controller. Always verify that the float switch is rated for the maximum run amperage, maximum starting amperage, and the HP rating on the pump. Single-phase wastewater pumps contain on-winding overloads, unless noted on the pump nameplate. *See Figures 1 and 2.*

THREE PHASE PUMPS:
As a Minimum a 3Ø pump requires a 3 pole circuit breaker/fused circuit, an across the line magnetic starter rated for the pump HP, and ambient compensated Quick Trip Class 10 overloads.

SINGLE AND THREE PHASE CONTROL PANELS:
Control panels are available as Simplex (controls 1 pump) or Duplex (controls 2 pumps). Our standard SES Series Panels are available with many standard features and can be built with our most popular options. We also custom build panels which offer many more design options than the SES panels. Custom control panels are available in many different configurations. Custom panel quote requests may be forwarded to Customer Service through any authorized distributor.

Our "SES" Duplex panels feature a solid-state printed circuit board design with standard high level alarm circuits. Other standard features are: an auxiliary dry alarm contact for signaling a remote alarm and float switch position indicator lights. Our 3Ø panels have built-in, adjustable, Class 10 overloads. The adjustable overloads on all our 3Ø panels mean less labor for the installer and no need to order specific overloads. Most SES panels are in stock for immediate delivery.

On pumps equipped with seal fail and/or heat (high temperature) sensors it is recommended that you use our control panel with the appropriate options. The pump sensors do not function without a seal fail relay or terminal connection in the control panel and a warning device such as a bell, horn or light.

Seal Failure Circuit - Some dual seal pumps are equipped with a standard, built-in seal failure circuit, which may also be called a moisture detection circuit. This circuit must be connected to a control panel with an optional seal fail relay. The panel must be special ordered with the seal fail relay and alarm. There are also stand alone seal fail panels such as the A4-3 or A4-4 available as standard items. The pumps can be identified by an extra control cable exiting the motor cover. The cable contains two wires, a black wire, connects to panel "terminal" going to "probe"; and a white wire, connects to the panel "terminal" going to the relay ground. Do not connect to the panel ground screw. Follow the wiring instructions supplied with the panel.

Heat Sensor and Seal Failure Circuit - Some pumps are equipped with a seal fail and normally closed, on-winding high temperature thermostats (heat sensors). The pumps have a control cable with four (4) leads, black (probe) and green (relay ground) for the seal fail circuit and red and white for the high temperature circuit. Connect the high temperature (heat sensor) circuit to the panel terminal strip as indicated on the panel drawing using the red and white wires. The high temperature panel circuit is also an optional item which you must specifically order when you order your control panel. The high temperature circuit is different from the Class 10 overloads which are always required on three phase pumps. *Follow the wiring instructions supplied with the panel.*

INSTALLATION

Connect the pump(s) to the guide rail pump adapters or to the discharge piping. Slide rail bases should be anchored to the wetwell floor.

Complete all wiring per the control panel wiring diagrams and NEC, Canadian, state, provincial and/or local codes. This a good time to check for proper rotation of the motors/impellers.

⚠ DANGER

Hazardous Machinery

DO NOT PLACE HANDS IN PUMP SUCTION WHILE CHECKING MOTOR ROTATION. TO DO SO WILL CAUSE SEVERE PERSONAL INJURY.

Always verify correct rotation. Correct rotation is indicated on the pump casing. Three phase motors are reversible. It is allowable to bump or jog the motor for a few seconds to check impeller rotation. It is easier to check rotation before installing the pump. Switch any two power leads to reverse rotation.

Lower the pump(s) into the wetwell.

Check to insure that the floats will operate freely and not contact the piping.

OPERATION

Once the piping connections are made and checked you can run the pumps.

Piggyback Switch Operation – Plug the piggyback switch into a dedicated grounded outlet and then plug the pump into the switch. Test the pump by filling the wetwell until the pump goes On. If the pumps run but fail to pump, they are probably air locked, drill the relief holes per the instructions in the Piping Section.

Check the operating range to insure a minimum one minute run time and that the pump goes Off in the correct position.

Control Panel Operation – Fill the wetwell with clear water.

Use the pump H-O-A (Hand-Off-Automatic) switches in Hand to test the pumps. If they operate well in Hand proceed to test Automatic operation. If the pumps run but fail to pump, they are probably air locked, drill the relief holes per the instructions in the Piping Section.

Place Control Panel switch(es) in Automatic position and thoroughly test the operation of the ON, OFF, and Alarm floats by filling the wetwell with clear water. **Important:** Failure to provide a Neutral from the power supply to a 1Ø, 230 volt Control Panel will not allow the panel control circuit to operate. The Neutral is necessary to complete the 115 volt control circuit.

Check voltage and amperage and record the data on the front of this manual for future reference. Compare the amperage readings to the pump nameplate maximum amperage. If higher than nameplate amperage investigate cause. Operating the pump off the curve, i.e. with too little head or with high or low voltage will increase amperage. The motor will operate properly with voltage not more than 10% above or below pump nameplate ratings. Performance within this range will not necessarily be the same as the published performance at the exact rated nameplate frequency and voltage. Correct the problem before proceeding. Three phase unbalance is also a possible cause. *See Three Phase Power Unbalance and follow the instructions*.

Reset the Alarm circuit, place pump switch(es) in the Automatic position and Control Switch in ON position. The system is now ready for automatic operation.

Explain the operation of the pumps, controls and alarms to the end user. Leave the paperwork with the owner or at the control panel if in a dry, secure location.

FLOAT SWITCH AND PANEL CHART

The purpose of this chart is to show the required switch quantities and the function of each switch in a typical wastewater system. The quantities required vary depending on the switch type, single-action or wide-angle. Switch quantities also vary by panel type: simplex with and without alarms, and duplex with alarms.

Duplex Panels using single-action switches:

Three Float Panel Wiring

SW1	Bottom	Pumps Off
SW2	Middle	1st Pump On
SW3	Top	2nd Pump & Alarm On

Four Float Panel Wiring ②

SW1	Bottom	Pumps Off
SW2	2nd	1st Pump On
SW3	3rd	2nd Pump On
SW4	Top	Alarm On

Duplex Panels using wide-angle switches:

Three Float Panel Wiring

SW1	Bottom	1st Pump On/Both Off
SW2	Top	2nd Pump & Alarm On

Four Float Panel Wiring

SW1	Bottom	1st Pump On/Both Off
SW2	Middle	2nd Pump On
SW3	Top	Alarm On

Simplex Panel using single-action switches:

Simplex Panel with Alarm ①

SW1	Bottom	Pump Off
SW2	Middle	Pump On
	SW3	Top Alarm On/Off

Simplex Panel with No Alarm

SW1	Bottom	Pump Off
SW2	Top	Pump On

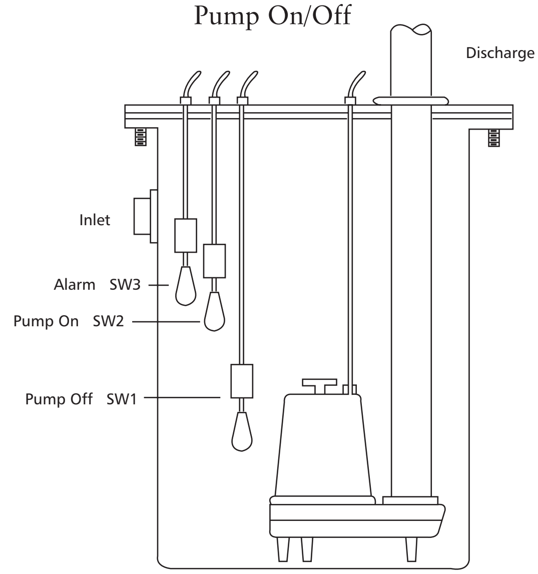
Simplex Panel using wide-angle switches:

Simplex Panel with Alarm

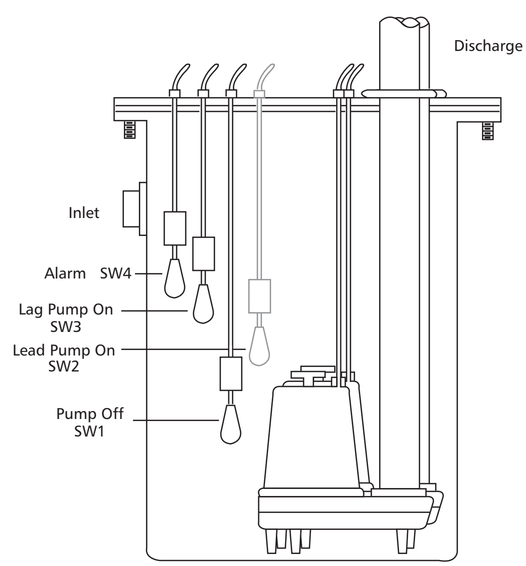
SW1	Bottom	Pump On/Off
SW2	Top	Alarm On/Off

Simplex Panel with No Alarm

SW1		Pump On/Off



Simplex ①



Duplex ②

THREE PHASE POWER UNBALANCE

A full three phase supply consisting of three individual transformers or one three phase transformer is recommended. "Open" delta or wye connections using only two transformers can be used, but are more likely to cause poor performance, overload tripping or early motor failure due to current unbalance.

Check the current in each of the three motor leads and calculate the current unbalance as explained below.

If the current unbalance is 2% or less, leave the leads as connected.

If the current unbalance is more than 2%, current readings should be checked on each leg using each of the three possible hook-ups. Roll the motor leads across the starter in the same direction to prevent motor reversal.

To calculate percent of current unbalance:

A. Add the three line amp values together.

B. Divide the sum by three, yielding average current.

C. Pick the amp value which is furthest from the average current (either high or low).

D. Determine the difference between this amp value (furthest from average) and the average.

E. Divide the difference by the average. Multiply the result by 100 to determine percent of unbalance.

Current unbalance should not exceed 5% at service factor load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg farthest from the average stays on the same power lead, most of the unbalance is coming from the power source.

Contact your local power company to resolve the imbalance.

	Hookup 1			Hookup 2			Hookup 3		
Starter Terminals	L1	L2	L3	L1	L2	L3	L1	L2	L3
	⊥ ⊤	⊥ ⊤	⊥ ⊤	⊥ ⊤	⊥ ⊤	⊥ ⊤	⊥ ⊤	⊥ ⊤	⊥ ⊤
Motor Leads	R	B	W	W	R	B	B	W	R
	T3	T1	T2	T2	T3	T1	T1	T2	T3

Example:

Hookup 1	Hookup 2	Hookup 3
T3-R = 51 amps	T2-W = 50 amps	T1-B = 50 amps
T1-B = 46 amps	T3-R = 48 amps	T2-W = 49 amps
T2-W = 53 amps	T1-B = 52 amps	T3-R = 51 amps
Total = 150 amps	Total = 150 amps	Total = 150 amps
÷ 3 = 50 amps	÷ 3 = 50 amps	÷ 3 = 50 amps
− 46 = 4 amps	− 48 = 2 amps	− 49 = 1 amps
4 ÷ 50 = .08 or 8%	2 ÷ 50 = .04 or 4%	1 ÷ 50 = .02 or 2%

INSULATION RESISTANCE READINGS

Normal Ohm and Megohm Values between all leads and ground

Condition of Motor and Leads	Ohm Value	Megohm Value
A new motor (without drop cable).	20,000,000 (or more)	20 (or more)
A used motor which can be reinstalled in well.	10,000,000 (or more)	10 (or more)
Motor in well. Readings are for drop cable plus motor.		
New motor.	2,000,000 (or more)	2 (or more)
Motor in good condition.	500,000 - 2,000,000	.5 - 2
Insulation damage, locate and repair.	Less than 500,000	Less than .5

Insulation resistance varies very little with rating. Motors of all HP, voltage and phase ratings have similar values of insulation resistance.

Insulation resistance values above are based on readings taken with a megohmmeter with a 500V DC output. Readings may vary using a lower voltage ohmmeter, consult factory if readings are in question.

Engineering data for specific models may be found in your catalog and on our website (address is on the cover).

Control panel wiring diagrams are shipped with the control panels. Please use the control panel drawings in conjunction with this instruction manual to complete the wiring.

PUMP OPERATION

Minimum Submergence	
Continuous Duty	Fully Submerged
Intermittent Duty	6" Below Top of Motor

Maximum Fluid Temperature	
Continuous Operation	104º F 40º C
Intermittent Operation	140º F 60º C

Pumpmaster and Pumpmaster Plus - Hard Wired

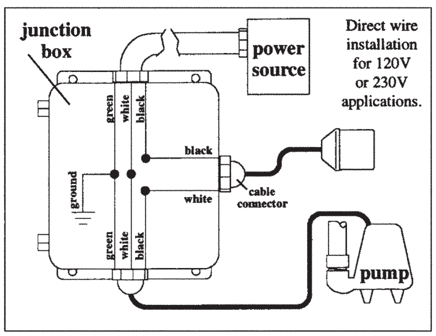


Figure 1

Single-Action Float Switch "Typical" Installation

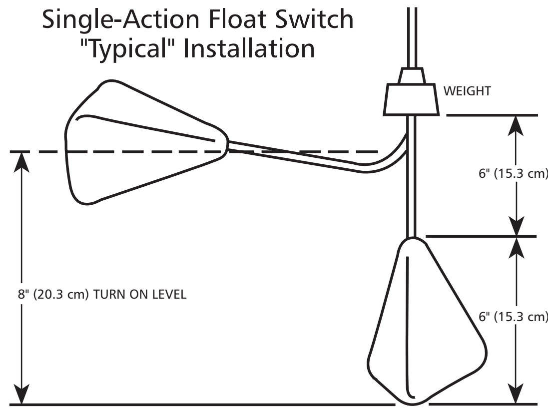


Figure 4

Double Float - Hard Wired

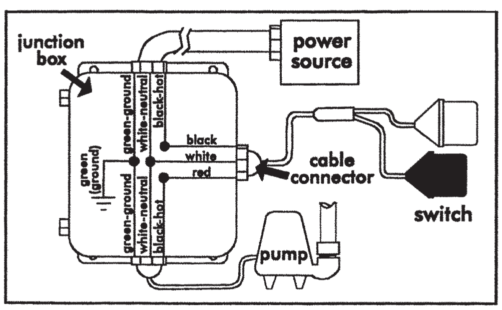


Figure 2

Wide-Angle Float Switch

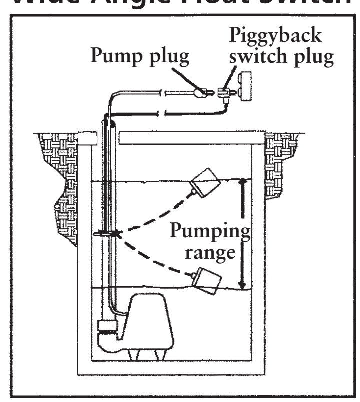


Figure 5

Determining Pumping Range

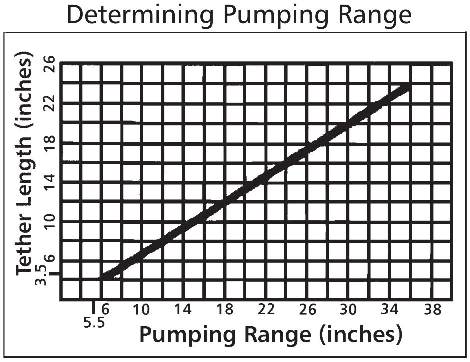


Figure 3

Three Phase Connection Diagram

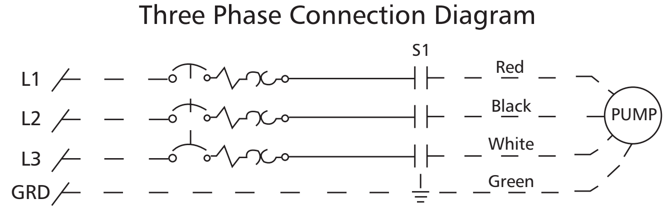
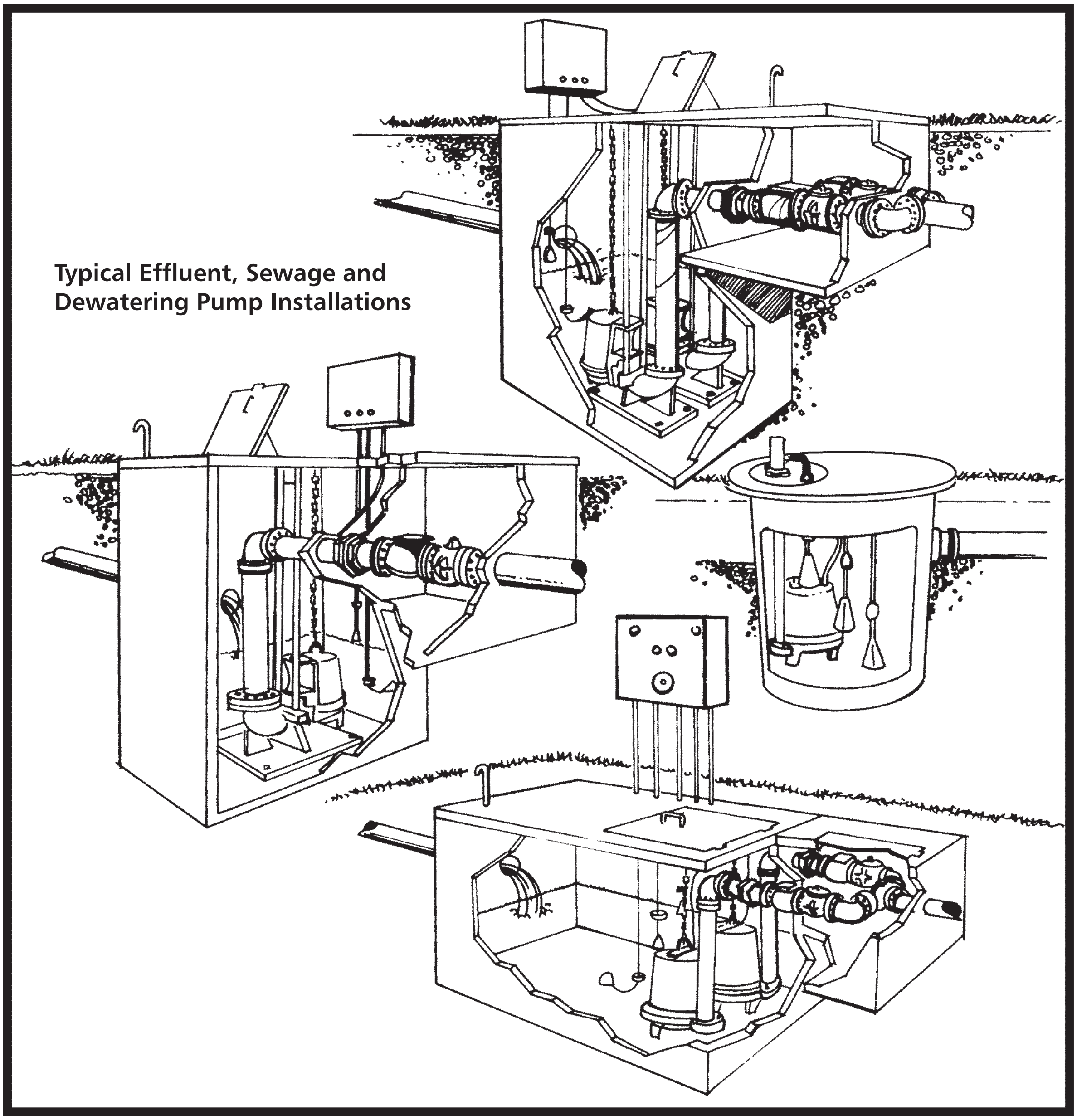


Figure 6

⚠WARNING Hazardous voltage

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY SERVICE CAN CAUSE SHOCK, BURNS OR DEATH.

SYMPTOM	PROBABLE CAUSE	RECOMMENDED ACTION
MOTOR NOT RUNNING	Motor thermal protector tripped.	Allow motor to cool. Insure minimum pump submergence. Clear debris from casing and impeller.
NOTE: If circuit breaker "OPENS" repeatedly, **DO NOT** reset. Call qualified electrician.	Open circuit breaker or blown fuse.	Determine cause, call a qualified electrician.
	Pump impeller binding or jammed.	Check motor amp draw. If two or more times higher than listed on pump nameplate, impeller is locked, motor bearings or shaft is damaged. Clear debris from casing and impeller, consult with dealer.
a) Manual operation	Power cable is damaged.	Resistance between power leads and ground should read infinity. If any reading is incorrect, call a qualified electrician.
	Inadequate electrical connection in control panel.	
b) Automatic operation	No neutral wire connected to control panel.	
	Inadequate electrical connection in control panel.	Inspect control panel wiring. Call a qualified electrician.
NOTE: Check the pump in manual mode first to confirm operation. If pump operates, the automatic control or wiring is at fault. If pump does not operate, see above.	Defective liquid level switch.	With switch disconnected, check continuity while activating liquid level switch. Replace switch, as required.
	Insufficient liquid level to activate controls.	Allow liquid level to rise 3" to 4" (76 mm - 101 mm) above turn-on level.
	Liquid level cords tangled.	Untangle cords and insure free operation.
PUMP WILL NOT TURN OFF	Liquid level cords tangled.	Untangle cords and insure free operation.
	Pump is air locked.	Shut off pump for approximately one minute, then restart. Repeat until air lock clears. If air locking persists in a system with a check valve, a 3/16" (4.8 mm) hole may be drilled in the discharge pipe approximately 2" (51 mm) above the discharge connection.
	Influent flow is matching pump's discharge capacity.	Larger pump may be required.
LITTLE OR NO LIQUID DELIVERED BY PUMP	Check valve installed backwards, plugged or stuck closed.	Check flow arrow on valve and check valve operation.
	Excessive system head.	Consult with dealer.
	Pump inlet plugged.	Inspect and clear as required.
	Improper voltage or wired incorrectly.	Check pump rotation, voltage and wiring. Consult with qualified electrician.
	Pump is air locked.	See recommended action, above.
	Impeller is worn or damaged.	Inspect impeller, replace as required.
	Liquid level controls defective or improperly positioned.	Inspect, readjust or replace as required.
PUMP CYCLES CONSTANTLY	Discharge check valve inoperative.	Inspect, repair or replace as required.
	Sewage containment area too small.	Consult with dealer.
	Liquid level controls defective or improperly positioned.	Inspect, readjust or replace as required.
	Influent excessive for this size pump.	Consult with dealer.



Typical Effluent, Sewage and Dewatering Pump Installations

ITT

Wastewater

GOULDS PUMPS LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by Goulds Pumps.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Goulds Pumps distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Goulds Pumps Customer Service Department.

The warranty excludes:

(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:

(1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Goulds Pumps and the dealer in purchases, consignments or contracts for sale of the subject pumps.
(2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
(3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

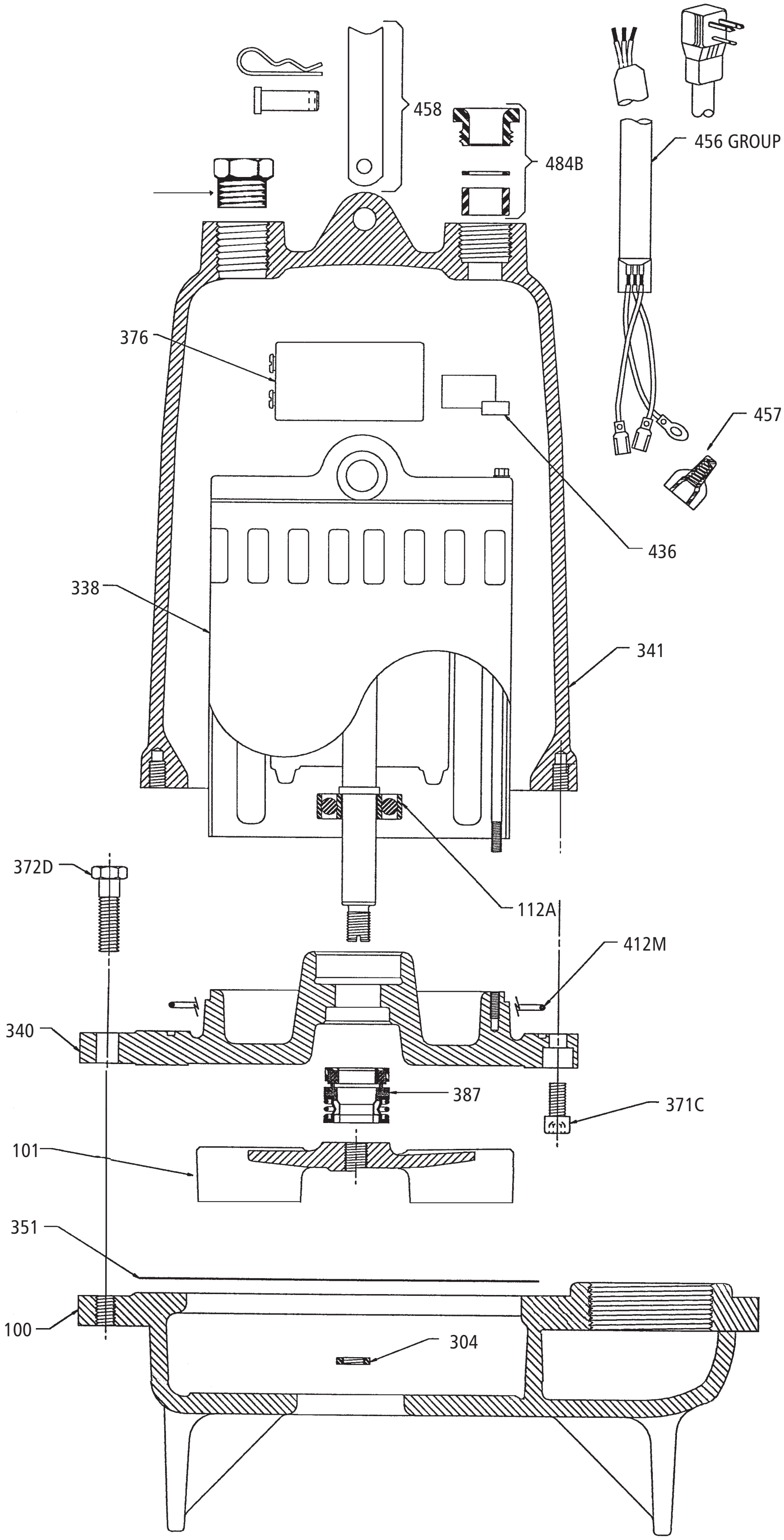
THIS WARRANTY EXTENDS TO THE DEALER ONLY.

GOULDS PUMPS

IM107R03 March, 2006

Engineered for life

MODEL 3885 – WE SERIES



CAPACITOR DATA		
"K" no.	MFD	VAC
9K197	161/193	110
9K351	30	370
9K352	200/240	220

MODEL 3885 – WE SERIES

Item No.	Part Description		Material	Qty. Reqd.	Repair Parts Order Number						Max. Wt. (lbs.)
					1725 RPM	3450 RPM					
					⅓ HP	½ HP	¾ HP	1 HP	1½ HP	2 HP	
100	Casing – ⅓ HP "L" Model Only 59115		Cast Iron	1	1K171	N/A					13.0
	Casing – All Others (M, H, HH) 59114				N/A	1K170					
101	Impeller		Cast Iron	1	2K158	2K220	2K219	2K218	2K217	2K840	2.0
	Impeller		Bronze		2K271	2K272	2K273	2K274	2K275	2K841	2½
	Impeller – High Head "HH"		Cast Iron		N/A	2K225	N/A	N/A	2K221	N/A	3½
	Impeller – High Head "HH"		Bronze		N/A	2K276	N/A	N/A	2K277	N/A	4.0
112A	Lower Ball Bearing		Steel	1	4K132					4K384	–
112B	Upper Ball Bearing		Steel	1	4K132						–
218	Insulating Turbine Oil		ASTM150		4K432 (1 gallon ⅓-1½ HP, .88 gallons 2 HP)						7½ lbs./gal.
304	Impeller Locknut - All		AISI 300 SS	1	13K286						–
338	Motor	1 Phase, 115V	Motor with Stainless Steel Shaft	1	118-121R	118-1222R	N/A	N/A	N/A	N/A	13.0 to 24.0
		1 Phase, 208V			118-1215R	118-1236R	118-1236R	118-1238R	118-1238R	N/A	
		1 Phase, 230V			118-122R	118-1223R	118-1232R	118-1233R	118-1234R	120-845R	
		3 Phase, 200 V			N/A	118-1333R	118-1334R	118-1335R	118-1336R	120-8425R	
		3 Phase, 230/460 V			N/A	118-1321R	118-1322R	118-1323R	118-1324R	120-8425R	
		3 Phase, 575 V			N/A	118-1328R	118-1330R	118-1330R	118-1331R	120-8435R	
340	Seal / Bearing Housing		Cast Iron	1	1K167					1K332	10.0
341	Motor Cover	1 Phase	Cast Iron	1	1K207				1K208		23.0
		3 Phase			N/A	1K208					
351	Casing Gasket - All Except "HH"		Composite	1	5K170						–
	Shim Set - "HH" Models Only		Plastic	1	5K169						–
358E	Plug – Motor Cover ⅜" NPT		AISI 300 SS	1	6K169						–
371C	Skt. Hd. Screw – Housing to Motor Cover		AISI 300 SS	4	13K271						–
372D	Hex Cap Screw – Housing to Casing		AISI 300 SS	4	13K186						–
376	Capacitor (1 Phase Only)	Start	Varies	1	9K197					9K352	–
		Run			N/A					9K351	
387	Mechanical Seal – Standard		Silicon Carbide	1	10K120					10K119	–
	Mechanical Seal – Optional		Tungsten Carbide	1	10K122					10K123	–
412M	O-ring – Motor Cover		BUNA-N, AS 568A-166	1	4K252						–
436	Motor Start Switch (1 Phase Only)			1	629002-2					9K356	
457	Wire Nut (Power Cable)	1 Phase	Special Nylon Housing	2	N/A					9K145	–
		3 Phase		up to 6	N/A	9K145					–
458	Handle Assembly		AISI 300 SS	1	4K243						–
484B	Strain Relief Assembly (Power Cable)	1 Phase	Varies	1	5K113				5K111		–
		3 Phase		1	N/A	5K111					–
	Loctite #271 - Impeller / Nut			1	AL27121						–

Item No. 456, Power Cables	Type and AWG Size	Standard length	Optional Lengths			Wt. (lbs./5 ft.)
		20'	30'	50'	100'	
1 PH: ⅓ HP, 115 V; standard with plug, optional length cords have bare leads.	SJTOW – 16/3	9K165	9K214	9K215	N/A	0.5
1 PH: ½ HP, 115 V; standard with plug, optional length cords have bare leads.	STOW – 14/3	9K385 - SJTOW	9K216*	9K161*	9K217*	0.9
1 PH: ⅓ & ½ HP, 208 & 230 V; standard with plug, opt. length cords have bare leads.	SJTOW – 16/3	9K164	9K214	9K215	N/A	0.5
1 PH: ¾ & 1 HP, 208 & 230 V; standard with plug, opt. length cords have bare leads.	STOW – 14/3	9K444 - SJTOW	9K216*	9K161*	9K217*	0.9
1 PH: 1½ HP, 208 & 230 V with bare leads.	STOW – 14/3	9K163	9K216*	9K161*	9K217*	0.9
1 PH: 2 HP, 230 V with bare leads.	STOW – 14/3	9K266	9K267	9K268	9K269	0.9
3 PH: ½ – 2 HP, 200–230/460/575 V with bare leads.	STOW – 14/4	9K153	9K218	9K154	9K219	1.1

* Requires 5K111 Strain Relief Assembly and 1K208 Motor Cover.
"P" option –9K445 1PH, 208/230 V, 14/3 SJTOW Cord with Plug, 30 ft.

ITT

Wastewater

CentriPro

Slide Rail Systems - Series A10

Installation, Operation and Maintenance Instructions

CentriPro®

CentriPro is a brand of ITT Corporation.

www.centripro.com

Engineered for life

Table of Contents

Owner's Information

Pump Model Number: ______________________

Pump Serial Number: ______________________

Control Model Number: ______________________

Dealer: ______________________

Dealer Phone No. ______________________

Date of Purchase: ____________ Installation: __________

SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON PUMP.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE SLIDE RAIL.

This is a SAFETY ALERT SYMBOL. When you see this symbol on the pump or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage.

⚠ DANGER Warns of hazards that WILL cause serious personal injury, death or major property damage.

⚠ WARNING Warns of hazards that CAN cause serious personal injury, death or major property damage.

⚠ CAUTION Warns of hazards that CAN cause personal injury or property damage.

NOTICE: INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

⚠ WARNING

Hazardous fluids can cause fire, burns or death.

HAZARDOUS LIQUIDS OR FLAMMABLE GASES CAN CAUSE FIRE, BURNS OR DEATH.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS UNIT.

MAINTAIN ALL SAFETY DECALS.

NOTICE: INSPECT UNIT FOR DAMAGE AND REPORT ALL DAMAGE TO THE CARRIER OR DEALER IMMEDIATELY.

DESCRIPTIONS AND SPECIFICATIONS

Goulds Pumps A10 slide rail systems provide easy wet well pump removal, utilize a self-cleaning quick disconnect and guide assembly, and eliminate the need to enter the wet well.

Model	Slide Rail Discharge	Pump Discharge
A10-12	1¼" NPTM	1¼" F
A10-2015	1½" NPTM	1½" F
A10-20	2" NPTM	2" F
A10-30 and	4" 125#	3" ANSI Flange
A10-40	ANSI Flange	4" ANSI Flange
A10-60	6" 125# ANSI Flange	4" ANSI Flange

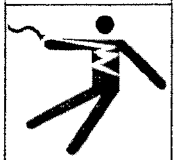
PIPING

System piping MUST conform to all local and national plumbing codes and practices.

To maximize the discharge flow, discharge piping should be at least as large as the pump discharge. Keep the discharge pipe as short as possible and avoid unnecessary fittings.

SLIDE RAIL INSTALLATION

⚠ WARNING



Hazardous voltage can shock, burn or cause death.

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SHOCK, BURNS OR DEATH.

⚠ WARNING

Wire rope WILL FAIL if worn-out, overloaded, misused, damaged, improperly maintained or abused.
Wire rope failure may cause serious injury or death!

Protect yourself and others:

- ALWAYS INSPECT wire rope for, WEAR, DAMAGE or ABUSE BEFORE USE.
- NEVER USE wire rope that is WORN-OUT, DAMAGED or ABUSED.
- NEVER OVERLOAD a wire rope.
- INFORM YOURSELF: Read and understand manufacturer's literature or "Wire Rope and Wire Rope Sling Safety Bulletin*."
- REFER TO APPLICABLE CODES, STANDARDS and REGULATIONS for INSPECTION REQUIREMENTS and REMOVAL CRITERIA.*

* For additional information or the BULLETIN, ask your employer or wire rope supplier.

 Form No. 193

NOTICE: ALL DIMENSIONS ARE IN INCHES. DO NOT USE DIMENSIONAL DATA FOR CONSTRUCTION PURPOSES.

Installation of the slide rail system should locate the pump opposite the influent opening, preventing stagnate areas where solids can settle.

NOTICE: GUIDE RAILS MUST BE PLUMB TO FACILITATE PUMP(S) INSTALLATION OR REMOVAL.

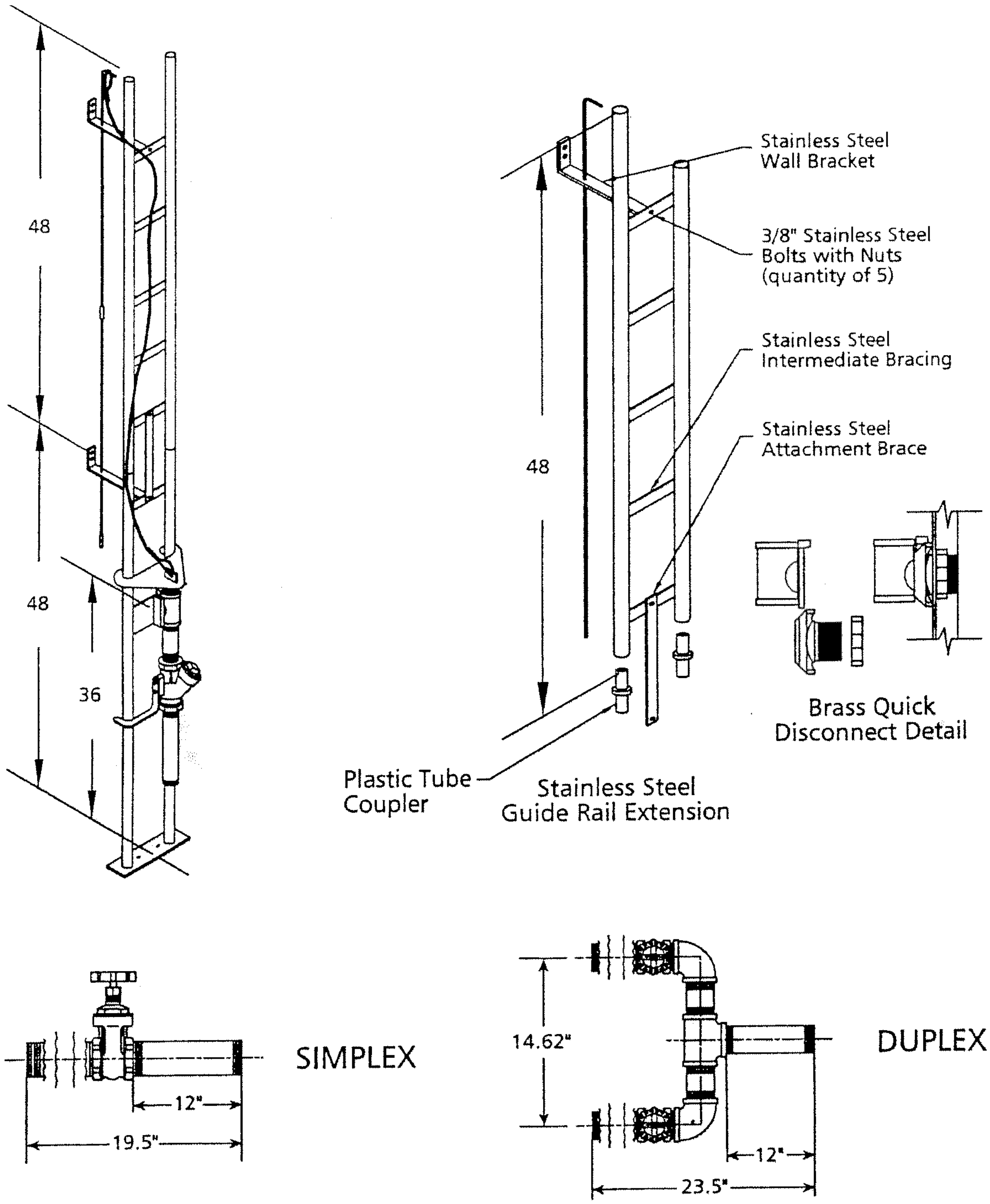
The containment area floor MUST be flat under the slide rail base and have sufficient loading capacity to support the entire weight of the assembly, including the slide rail base, slide rail guide, pump and all assorted piping.

Prior to anchoring the slide rail base to the containment area floor, ensure adequate clearance for pump(s) installation or removal AND for access doors.

NOTICE: MATERIAL SELECTION FOR CONTAINMENT AREA EQUIPMENT MUST BE COMPATIBLE WITH ANTICIPATED FLUIDS AND SERVICE.

Slide Rail Systems – A10-12, A10-20, A10-2015

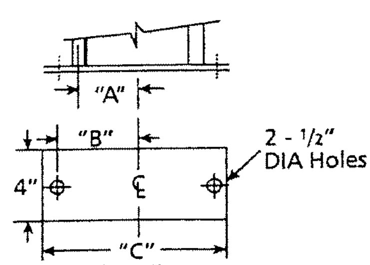
Typical hardware specifications, piping arrangements and basin attachment dimensions are provided in Figure 1 and Table 1.



A10-12, A10-20, A10-2015
Figure 1

Table 1: Guide Rail Base Dimensions

SIZE	A"	B"	C"
A10-12	3	4½	10
A10-20	3¾	5½	12
A10-2015	3¾	5½	12



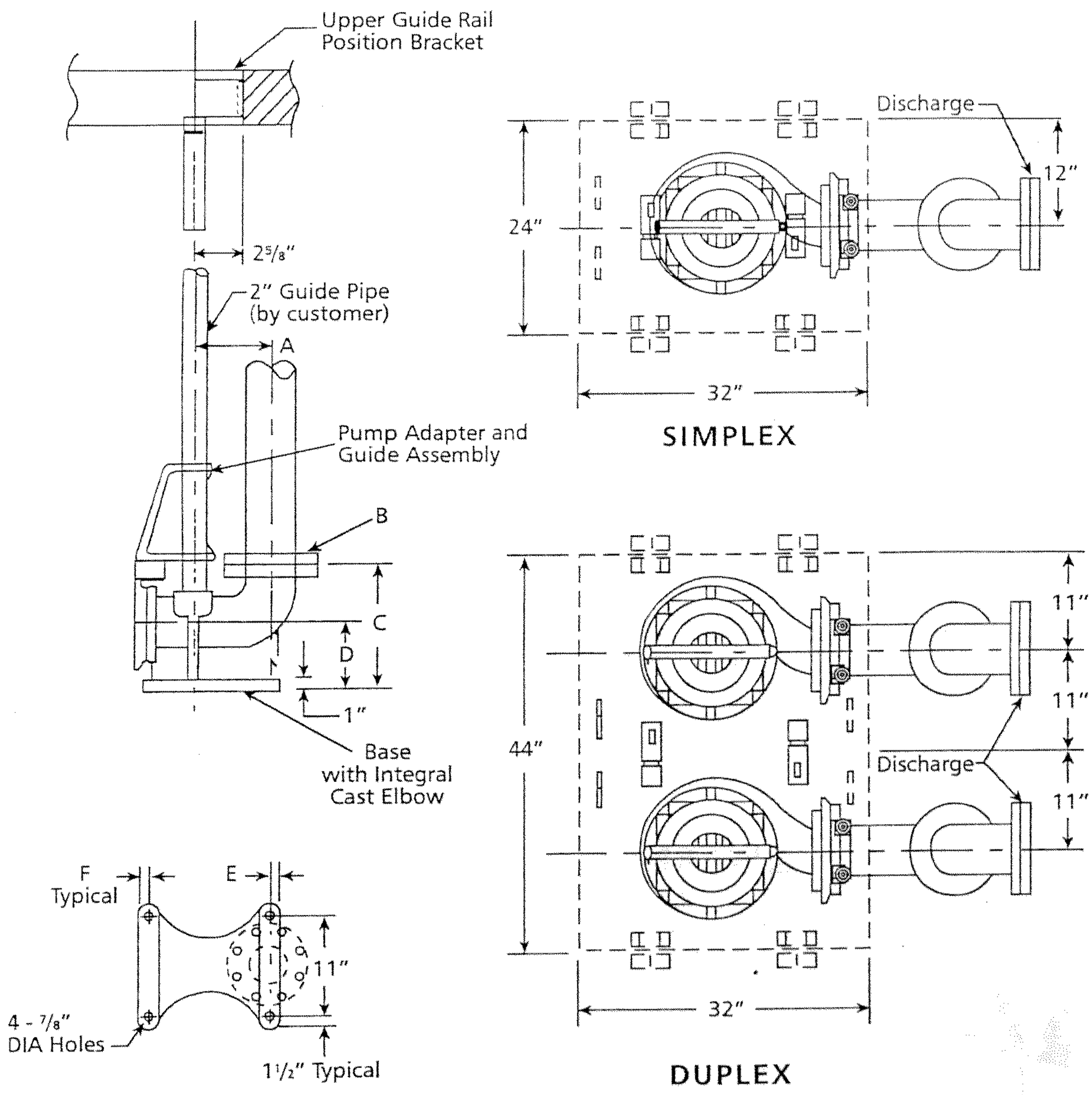
Guide Rail Base

Slide Rail Systems – A10-30 and A10-40

The A10-30 system is designed for pumps with a 3", 125# ANSI flanged discharge. The A10-40 system is designed for pumps with a 4", 125# ANSI flanged discharge. Both 3" and 4" flanged pumps bolt directly to their respective slide rail cast iron pump adapters. The adapter, which slides up and down on the rails, mates with the slide rail base and the integrally cast elbow to provide a 4", 125# ANSI flanged discharge connection. See Figure 2 and Table 2 for the typical hardware specifications, piping arrangements and basin attachment dimensions.

Slide Rail Systems – A10-60

The A10-60 system is designed for pumps with a 4", 125# ANSI flanged discharge. The pump bolts directly to the slide rail cast iron pump adapter, mating with the slide rail base and integrally cast elbow to provide a 6", 125# ANSI flanged discharge connection. See Figure 2 and Table 2 for the typical hardware specifications, piping arrangements and basin attachment dimensions.

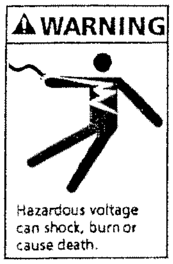


A10-30, A10-40 and A10-60
Figure 2

Table 2

SIZE	A"	B	C"	D"	E"	F"
A10-30	7 1/4	4" ANSI 125# Flange	12	7	13	1
A10-40	7 5/18	4" ANSI 125# Flange	12	7	13	1
A10-60	8 5/16	6" ANSI 125# Flange	17	10	15	2

OPERATION



DO NOT LIFT, CARRY OR HANG PUMP BY THE ELECTRICAL CABLE. DAMAGE TO THE ELECTRICAL CABLE CAN CAUSE SHOCK, BURNS OR DEATH.

Raise and lower the pump in the containment area using the lifting cable attached to the system's quick disconnect for the A10-12, A10-2015 or A10-20, and to the pump's lifting eye/strap for the A10-30, A10-40 and A10-60. DO NOT use electrical cable and DO NOT damage the electrical cables while raising and lowering unit. A10-40 and A10-60 units can be used in conjunction with a lifting bail (part # ABAIL2).

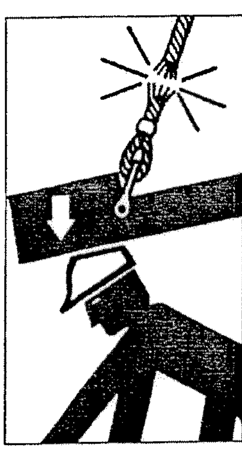
To ensure full prime, lower the pump(s) on the slide rails until fully submerged. Do not engage pump discharge to the rail discharge connection. Jog the pump motor, one to two seconds, to purge air from pump casing. Lower the pump and engage with base.

While the slide rail system mating surfaces are self cleaning and contain no sealing devices, a check for leaks at the initial installation and after each pump removal or installation is recommended.

While manually controlling the pump and the containment area inflow, using each pump independently, pump down the containment area.

Observe the pump, piping and slide rail base discharge connections for leaks.

If leaks are present, reset the pump and slide rail mating surfaces and recheck. If this fails to stop the leak, the pump should be removed and the necessary adjustments made to correct the leak. Leakage will cause longer operation time, higher costs and may lead to premature failure of slide rail base discharge connection.



⚠WARNING

Wire rope WILL FAIL if worn-out, overloaded, misused, damaged, improperly maintained or abused.
Wire rope failure may cause serious injury or death!

Protect yourself and others:

- ALWAYS INSPECT wire rope for, WEAR, DAMAGE or ABUSE BEFORE USE.
- NEVER USE wire rope that is WORN-OUT, DAMAGED or ABUSED.
- NEVER OVERLOAD a wire rope.
- INFORM YOURSELF: Read and understand manufacturer's literature or "Wire Rope and Wire Rope Sling Safety Bulletin".*
- REFER TO APPLICABLE CODES, STANDARDS and REGULATIONS for INSPECTION REQUIREMENTS and REMOVAL CRITERIA.*

* For additional information or the BULLETIN, ask your employer or wire rope supplier.

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WORKING LOAD LIMIT

Cable A10-12, A10-20 and A10-2015

The working load limit is based on a load being uniformly applied in a straight line pull.

3/16" 7x19 304SS Air Craft Cable WLL = 740 lbs.

Do not exceed safe working load limits.

WARNINGS

Inspection

Wire ropes, cables and attachments must all be inspected regularly for visible damage or distortion, elongation, corrosion, cracks, nicks or abrasion which may cause failure or reduce the original strength or ability of the products to perform safely. User must determine whether future use of the wire rope or cable would constitute a safety hazard to life or property.

Safety

Refer to WARNING and CAUTION labels prior to use.

Keep out from under any raised loads and keep out of the line of force of any load.

Do not use wire ropes or cables for any purpose other than which it was intended.

AVOID SHOCK LOADS

Warnings

Failure to use wire ropes or cables properly may cause loads to slip or fall.

Failure to read, understand and follow these instructions may cause death or serious injury.

Do not exceed safe working load limits.

ITT

Wastewater

CENTRIPRO LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by CentriPro.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized CentriPro distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the CentriPro Customer Service Department.

The warranty excludes:

(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:

(1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between CentriPro and the dealer in purchases, consignments or contracts for sale of the subject pumps.
(2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
(3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

THIS WARRANTY EXTENDS TO THE DEALER ONLY.

CentriPro®

IM042R02 January, 2008

Engineered for life

D-4

Caustic Feed Pumps P-6A and B

Instruction Manual

Electronic Metering Pumps

Carefully read and understand all precautions before installing or servicing any metering pump.

CAUTION

For file reference, please record the following data:

Model No: ____________________

Serial No: ____________________

Installation Date: ____________________

Installation Location: ____________________

When ordering replacement parts for your LMI Metering Pump or Accessory, please include complete Model Number and Serial Number of your unit.

LMI MILTON ROY
201 Ivyland Road
Ivyland, PA 18974
TEL: (215) 293-0401
FAX: (215) 293-0445
www.lmipumps.com

Replaces same of Rev. N 8/00
1615.O 11/06

Contents

1.0 Introduction

LMI is the world's most versatile manufacturer of economical and efficient metering pumps. This manual addresses the installation, maintenance and troubleshooting procedures for manually and externally controlled pumps. LMI has a worldwide network of stocking representatives and authorized repair centers to give you prompt and efficient service.

Please review this manual carefully. Pay particular attention to warnings and precautions. Always follow good safety procedures, including the use of proper clothing, eye and face protection.

This manual is for Series A, B, C, E, J5, and P pumps.

1.1 Spare Parts

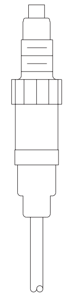
LMI recommends replacing the elastomeric components of the pump on an annual basis. RPM Pro Pacs™ and spare part kits are available from your local LMI Master Stocking Distributor.

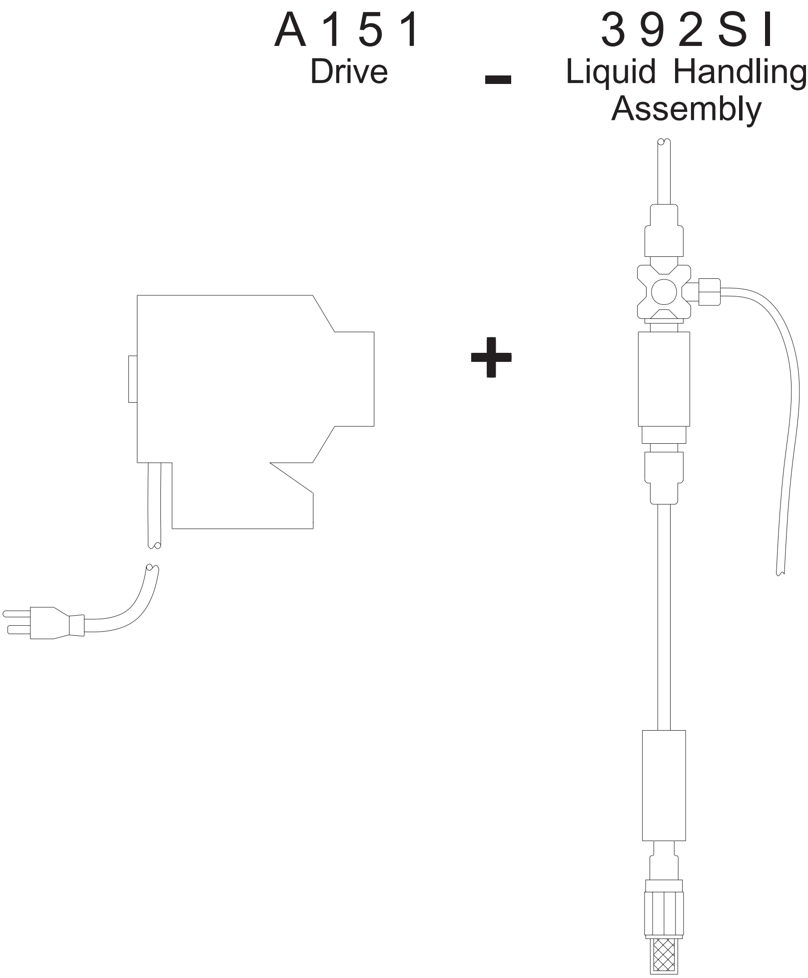
Example:

Your pump consists of two main components:

1. The **Drive Assembly**; and

2. The **Liquid Handling Assembly**.

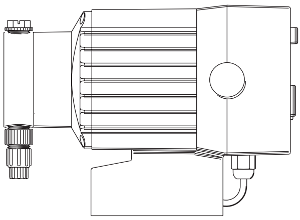




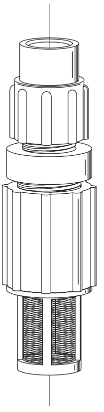
2.0 Unpacking Check List

Your carton will contain many or all of the following items. Please notify the carrier immediately if there are any signs of damage to the pump or its parts.

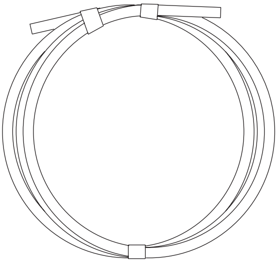
Please refer to the enclosed Instruction Supplement for an illustration and electrical diagram of your complete pump.



Metering Pump

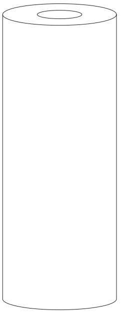


Foot Valve

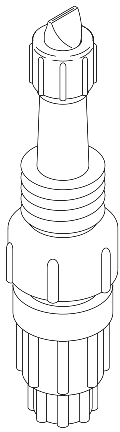


Tubing

Depending on the model, your carton may contain 0, 1, 2 or 3 rolls of tubing. Your carton may contain a roll of clear vinyl tubing; this is for connection to the SUCTION SIDE OF THE PUMP HEAD ONLY.

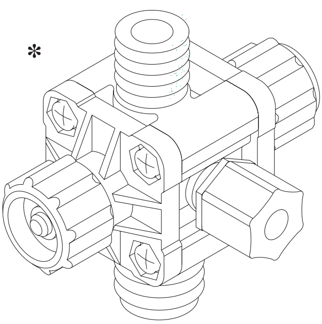


Ceramic Foot Valve Weight



Injection Check
Valve

Instruction Supplement



MULTI-FUNCTION Valve and Tubing

* Your carton may or may not contain a 3-FV, 4-FV, or bleed 4-FV accessory.

3.0 Pre-Installation Instructions

The following precautions should be taken when working with LMI metering pumps. Please read this section carefully prior to installation.

Precautions

Protective Clothing

ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or near your metering pump. Additional precautions should be taken depending on the solution being pumped. Refer to MSDS precautions from your solution supplier.

Water Pre-Prime

All LMI pumps are pre-primed with water when shipped from the factory. If your solution is not compatible with water, disassemble the Pump Head Assembly. Thoroughly dry the pump head, valves, seal rings, balls and Liquifram™ (diaphragm). Reassemble head assembly tightening screws in a crisscross pattern. Refill the pump head with the solution to be pumped before priming the pump. (This will aid in priming.)

Solution Compatibility

Determine if the materials of construction included in the liquid handling portion of your pump are adequate for the solution (chemical) to be pumped. LMI pumps are tested by NSF for use on muriatic acid and sodium hypochlorite. Always refer to the solution supplier and the **LMI Chemical Resistance Chart** for compatibility of your specific LMI metering pump. Contact your local LMI distributor for further information.

CAUTION

Tubing Connections

Inlet and outlet tubing or pipe sizes must not be reduced. Make certain that all tubing is SECURELY ATTACHED to fittings prior to start-up (see Section 4.3, Tubing Connections). ALWAYS use LMI supplied tubing with your pump, as the tubing is specifically designed for use with the pump fittings. It is recommended that all tubing be shielded to prevent possible injury in case of rupture or accidental damage. If tubing is exposed to sunlight, black UV resistant tubing should be installed. Check tubing frequently for cracks and replace as necessary.

CAUTION

Fittings And Machine Threads

All fittings should be hand-tightened. An additional 1/8 - 1/4 turn after the fitting contacts the seal ring may be necessary to provide a leak-proof seal. Excessive overtightening or use of a pipe wrench can cause damage to the fittings, seals, or pump head.

All LMI pumps have straight screw machine threads on the head and fittings and are sealed by the seal rings or O-rings. **DO NOT use Teflon® tape or pipe dope to seal threads. Teflon® Tape may only be used on the 1/2" NPT thread side of the Injection Check Valve as well as stainless steel liquid end connections.**

CAUTION

Plumbing

Always adhere to your local plumbing codes and requirements. Be sure installation does not constitute a cross connection. Check local plumbing codes for guidelines. LMI is not responsible for improper installations.

CAUTION

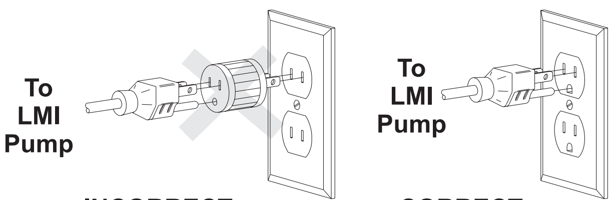
Back Pressure/Anti-Syphon Valve

If you are pumping downhill or into low or no system pressure, a back pressure/anti-syphon device such as LMI's Four Function Valve should be installed to prevent overpumping or syphoning. Contact your LMI distributor for furthur information.

Electrical Connections

WARNING

To reduce the risk of electrical shock, install only on a circuit protected by a ground-fault circuit-interrupter (GFCI). The metering pump must be plugged into a grounded outlet with ratings conforming to the data on the pump control panel. The pump must be connected to a good ground. **DO NOT USE ADAPTERS!** All wiring must conform to local electrical codes.



INCORRECT CORRECT

4.0 Installation

4.1 Pump Location and Installation

Locate pump in an area convenient to solution tank and electrical supply.

The pump should be accessible for routine maintenance, and should not be subjected to ambient temperatures above 122°F (50°C). If the pump will be exposed to direct sunlight, LMI black, UV resistant tubing should be installed.

4.2 Pump Mounting

The pump can be mounted in one of two ways:

A. **FLOODED SUCTION** (ideal installation); or

B. **SUCTION LIFT -** when suction lift is less than 5 feet (1.5 m) for solutions having a specific gravity of water. For denser solutions, consult distributor.

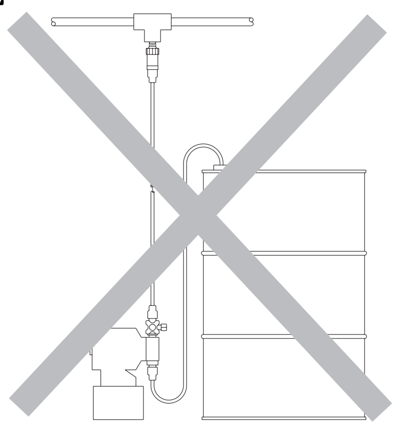
Your LMI metering pump must be mounted so that the suction and discharge valves are vertical. **NEVER position pump head and fittings horizontally.**

4.2.1 Flooded Suction

The pump is mounted at the base of the storage tank. This installation is the most trouble-free , and is recommended for very low outputs, solutions that gasify, and high-viscosity solutions. Since the suction tubing is filled with solution, priming is accomplished quickly and the chance of losing prime is reduced.

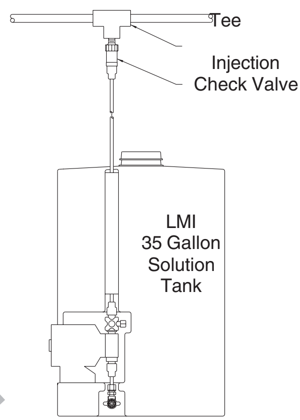
When pumping downhill or into low or no pressure system, a back pressure/anti-syphon device should be installed to prevent overpumping or syphoning.

Although popular for all solutions, LMI recommends flooded suction installations for all high-viscosity fluid applications.

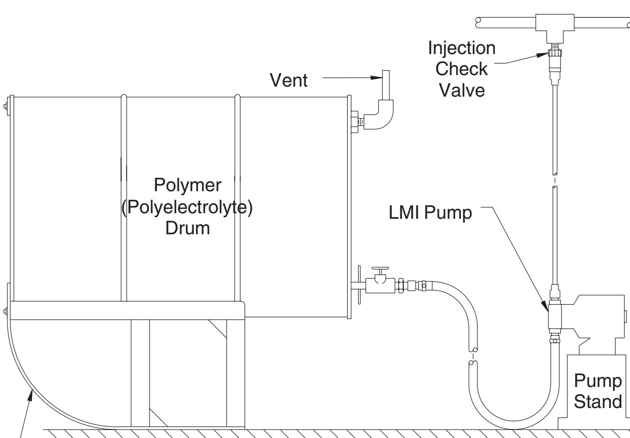


INCORRECT

Avoid this type of false flooded suction.



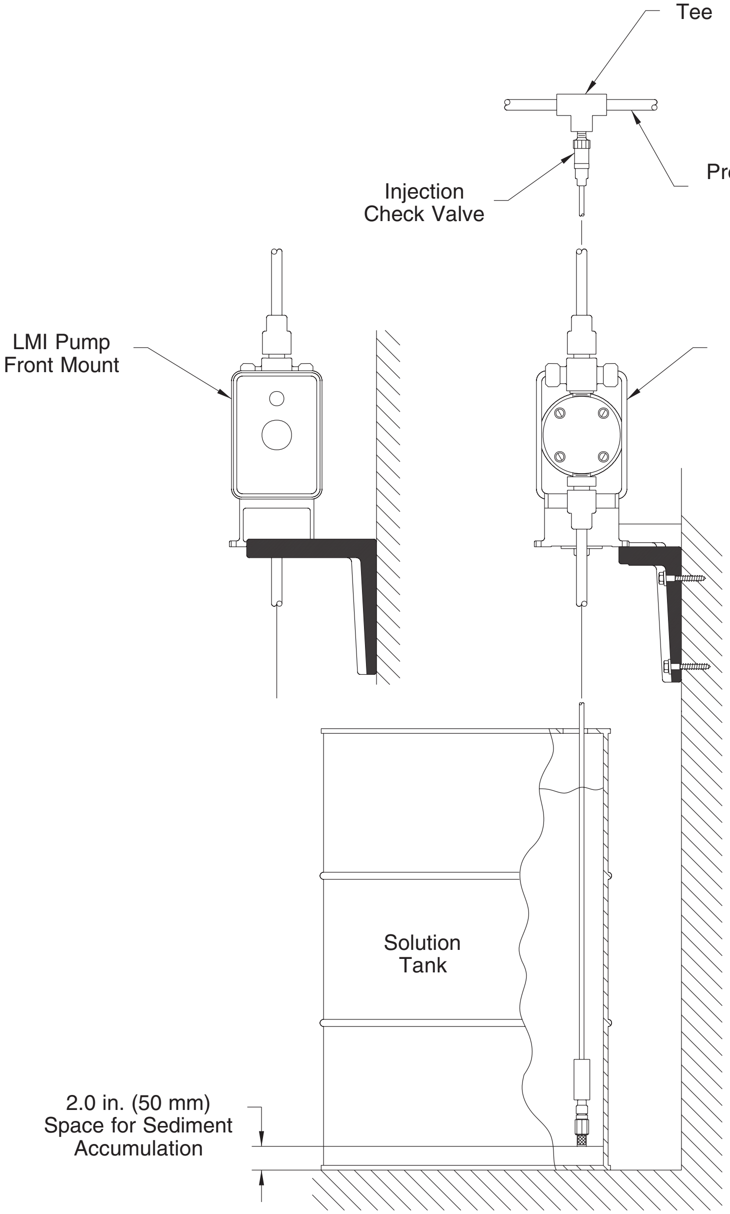
CORRECT



CORRECT

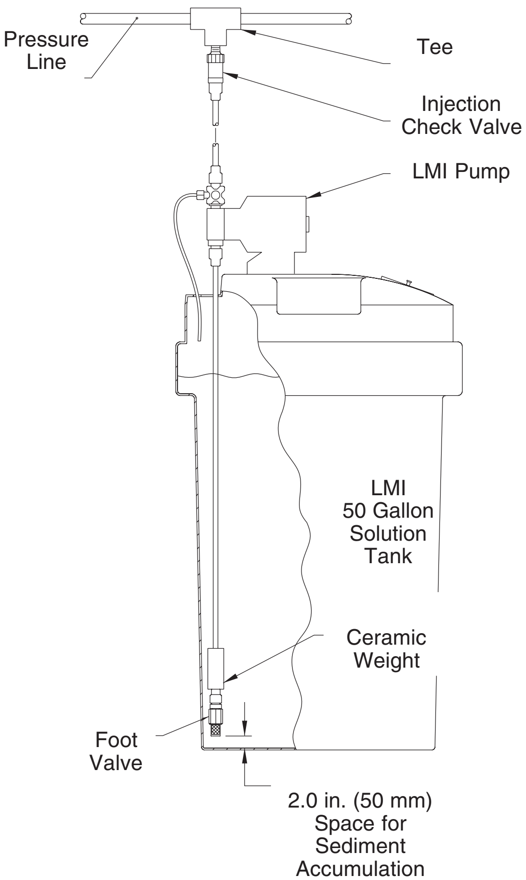
4.2.2 Suction Lift - Wall Bracket Mount

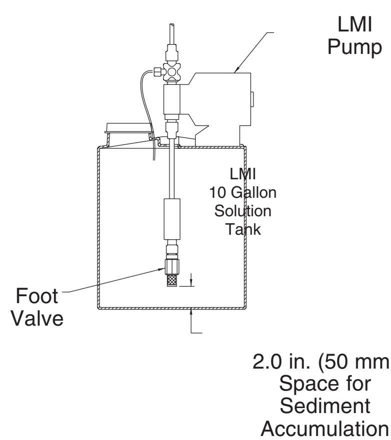
The pump may be mounted using an LMI Wall Mount Bracket Assembly (part no. 34643) directly above the solution tank. A pump mounted in this manner allows for easy changing of solution tanks or drums.



4.2.3 Suction Lift - Tank Mount

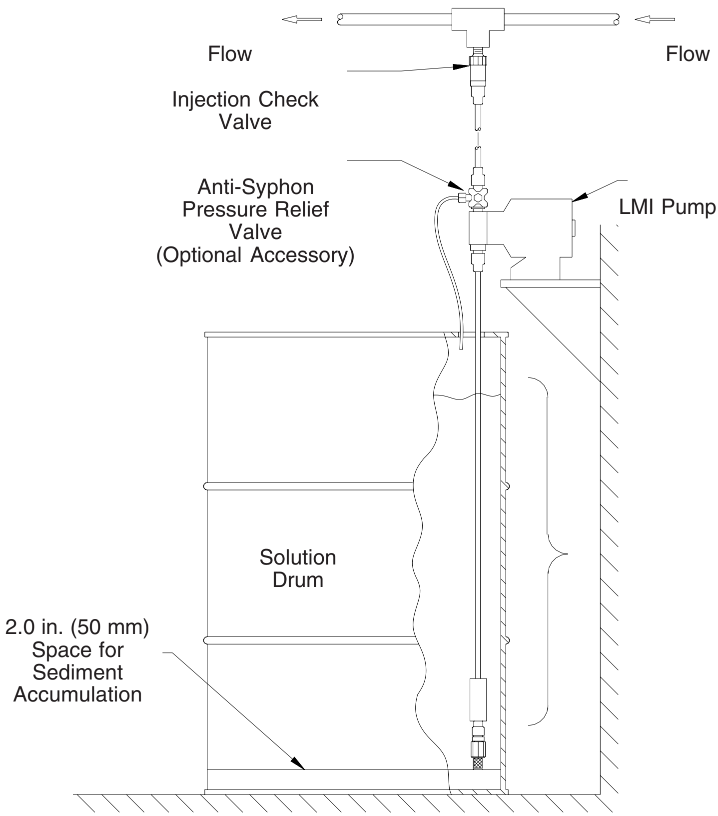
The pump may be mounted on a molded tank provided there is a recess to keep the pump stationary. LMI 10-gallon tank (part no. 27421), 35-gallon tank (part no. 27400), and 50-gallon tank (part no. 26350) have molded recesses for pump mounting.





4.2.4 Suction Lift - Shelf Mount

The pump may be mounted on a shelf (customer supplied) maintaining a suction lift of less than 5 ft (1.5 m). An LMI mounting kit (part number 10461) is available for securing the pump to a shelf.



4.3 Tubing Connections

A. Use only LMI tubing.

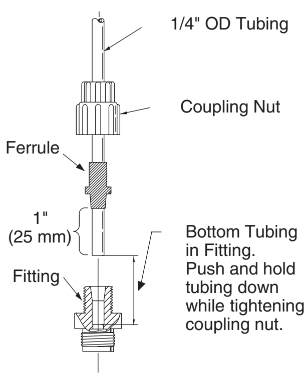
B. ***DO NOT USE CLEAR VINYL TUBING ON THE DISCHARGE SIDE OF THE PUMP***. The pressure created by the pump can rupture vinyl tubing.

C. Before installation, all tubing must be cut with a clean square end.

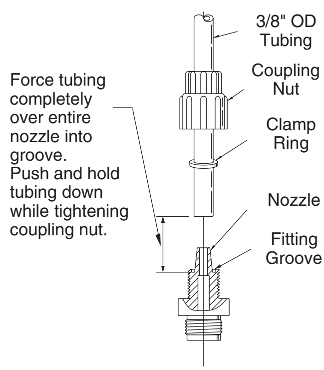
D. Valve and head connections from the factory are capped or plugged to retain pre-prime water. Remove and discard these caps or plugs before connecting tubing.

DO NOT USE PLIERS OR PIPE WRENCH ON COUPLING NUTS OR FITTINGS.

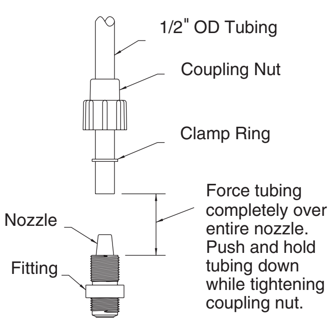
Tubing Connection
1/4" O.D. (.250") Tubing



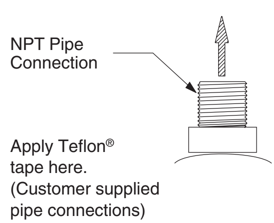
Tubing Connection
3/8" O.D. (.375") Tubing



Tubing Connection
1/2" O.D. (.5") Tubing



Pipe Thread Connection
1/4" or 1/2" NPT



4.4 Multi-Function Valves

Your pump may be equipped with one of the following multi-function valves: 3-FV, 4-FV, Bleed 4-FV, or standard discharge valve. If your pump is not equipped with a multi-function valve and you feel it is needed in your application, it can be purchased as an accessory. Contact your local LMI stocking distributor.

4.4.1 Three Function Valve (3-FV)

1. **Pressure Relief**

   If the discharge line is over pressurized, the valve opens sending solution back to the supply tank.

2. **Line Depressurization**

   Opening the relief knob provides line drain back to the supply tank.

3. **Priming Aid**

   Opening the relief knob assists in priming the pump by venting the discharge line to the atmosphere.

4.4.2 Four Function Valve (4-FV)

1. **Pressure Relief**

   If the discharge line is over pressurized, the valve opens sending solution back to the supply tank.

2. **Line Depressurization**

   Opening the relief knob provides line drain back to the supply tank.

3. **Anti-Syphon**

   Prevents syphoning when pumping solution downhill or into a vacuum.

4. **Back Pressure**

   Supplies approximately 25 psi back pressure to prevent overpumping when little or no system back pressure is present.

4.4.3 Bleed Four Function Valve (Bleed 4-FV)

1. **Line Depressurization**

   Opening the relief port provides line drain back to the supply tank.

2. **Anti-Syphon**

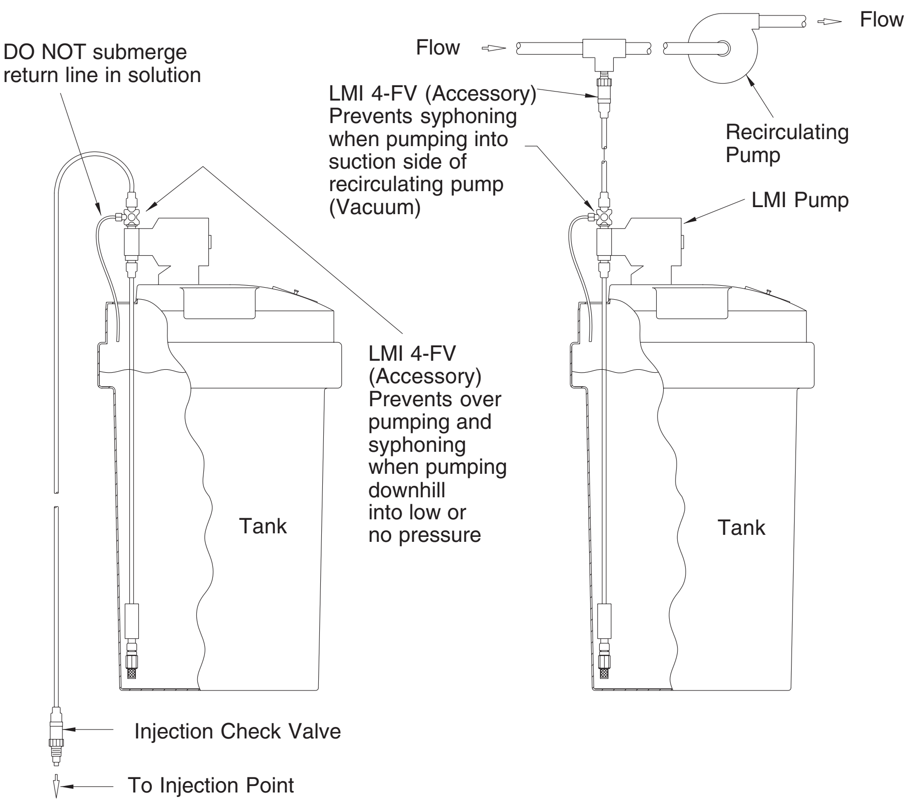
   Prevents syphoning when pumping solution downhill or into a vacuum.

3. **Back Pressure**

   Supplies approximately 25 psi back pressure to prevent overpumping when little or no system back pressure is present.

4. **Bleed Function**

   Manually adjusted valve provides continuous bleed of entrapped vapors from Sodium Hypochlorite or Hydrogen Peroxide.



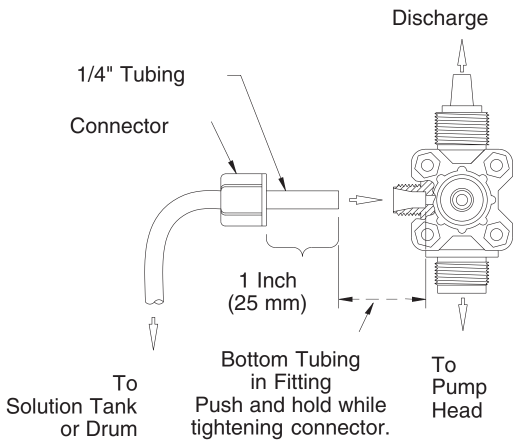
Typical 4-FV Installation

4.5 Multi-Function Valve Installation

To install the multi-function valve, remove the yellow screw cap on the top of the pump head and screw in the valve so that it contacts the seal ring. An additional 1/8 - 1/4 turn may be necessary to prevent leakage.

1/4" O.D. tubing connects to the side of the valve and acts as a return line to the solution tank. To ensure priming, this tubing must **NOT** be submerged in the solution.

This return line tubing must be secured to ensure pumped solution will safely return to supply tank.



Multi-Function Valve Tubing Connection

4.6 Foot Valve/Suction Tubing Installation

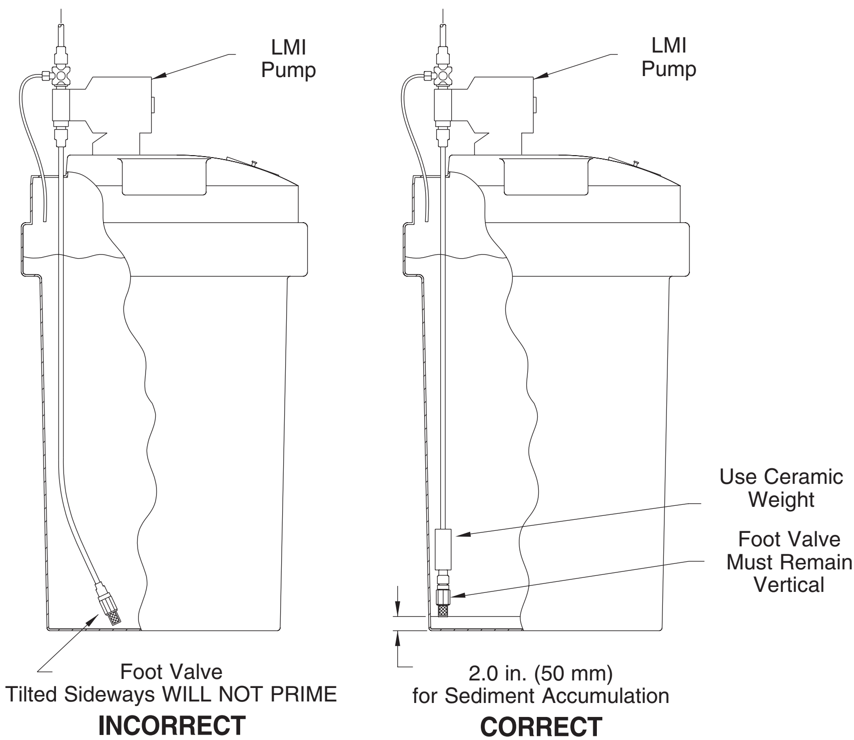
The Foot Valve acts as a check valve to keep the pump primed in suction lift applications.

The foot valve is designed to be submersed in the solution tank or drum and must sit in a vertical position at the bottom. Position approximately 2 inches (50 mm) off the bottom if the tank or drum contains sediment.

Note Pump models equipped with high-viscosity liquid ends are not equipped with foot valves. Flooded suction is recommended. A 1/2" NPT connector is included for flooded suction installations.

The ceramic weight, when installed, positions the foot valve in a vertical position.

1. Attach the foot valve to one end of the suction tubing (see Tubing Connections, Section 4.3).
2. Slide the ceramic weight over the tubing end until it contacts the top of the foot valve coupling nut.
3. Place foot valve and tubing into the solution tank. Check that the foot valve is vertical and approximately 2 inches (50 mm) from the bottom of the tank or drum (see illustration). Connect the other end of the tubing to the suction side of the pump head (bottom side) (see Tubing Connections, Section 4.3).



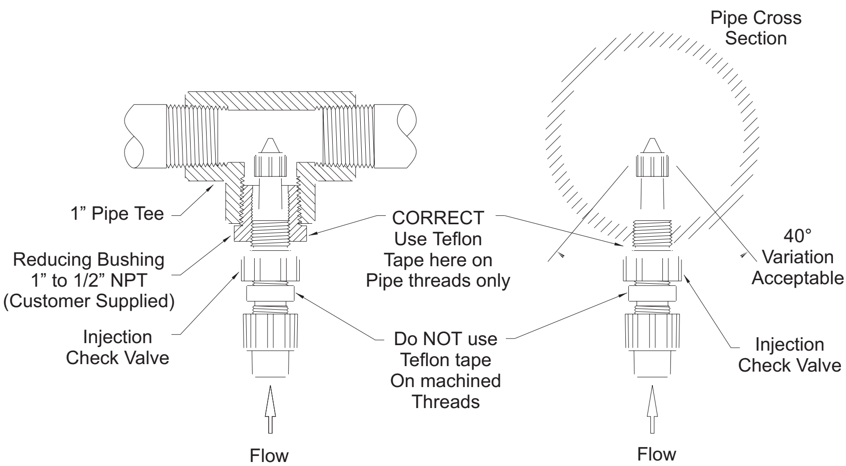
Proper Foot Valve Position

4.7 Injection Check Valve and Discharge Tubing Installation

The Injection Check Valve prevents backflow from a treated line. Connect the Injection Check Valve to your "DISCHARGE" (outlet) line. Any size NPTF fitting or pipe tee with a reducing bushing to 1/2" NPTF will accept the injection check valve. Use Teflon® tape or pipe dope to seal the pipe threads ***only***.

When installing the Injection Check Valve, be sure to position it so that the valve enters the bottom of your pipe in a vertical position. Variations left and right within 80° are acceptable (see illustration below).

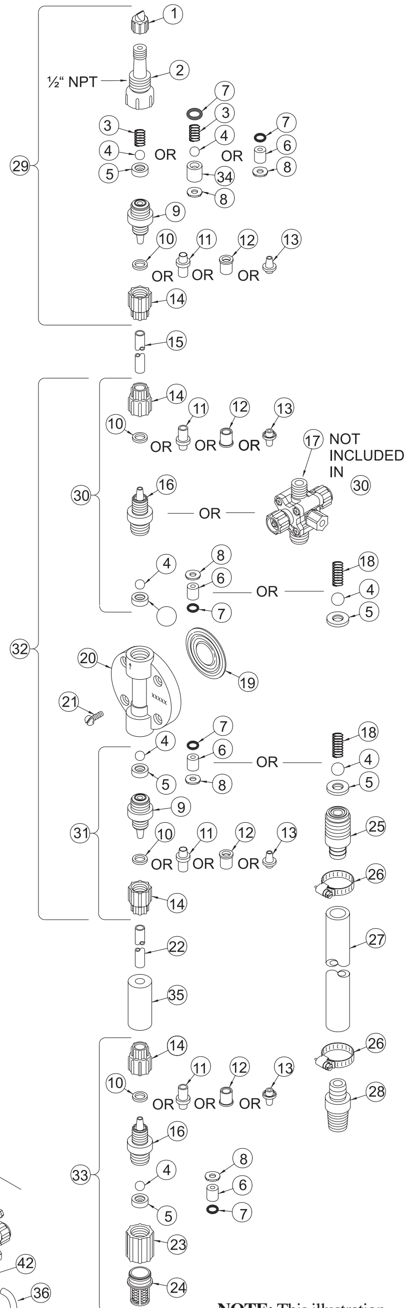
After cutting an appropriate length of tubing, connect tubing to the injection check valve then back to the discharge side of the pump head valve or discharge fitting (top side), making sure it does not crimp or come into contact with hot or sharp surfaces (see Tubing Connections, Section 4.3).

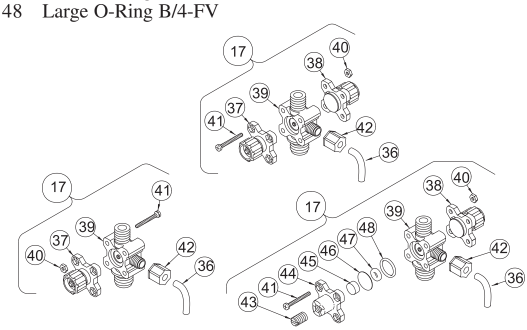


Typical Injection Check Valve Installations

5.0 Liquid End Parts List

1 Flapper valve
2 Injection check valve body
3 Injection check valve spring
4 Check valve ball
5 Seal ring
6 Cartridge valve
7 Cartridge valve o-ring
8 Cartridge valve washer
9 Valve seat
10 Clamp ring
11 Ferrule
12 Clamp sleeve
13 Tubing adapter
14 Coupling nut
15 Discharge tubing
16 Valve housing
17 Multi-function valve
18 High-viscosity spring
19 Liquifram
20 Pump head
21 Pump head screw
22 Suction tubing
23 Foot valve seat
24 Foot valve screen
25 High-viscosity valve seat
26 H.V. tubing clamp
27 H.V. suction tubing
28 H.V. Tubing x 1/2 NPT connector
29 Injection check valve assembly
30 Discharge valve assembly
31 Suction valve assembly
32 Pump head assembly
33 Foot valve assembly
34 Injection Seat PTFE
35 Ceramic Weight
36 Return Line
37 Cap ASM (Black Knob)
38 Cap ASM (Yellow Knob)
39 Multi-Function Valve Body
40 Nut Multi-Function Valve
41 Screw Multi-Function Valve
42 Return Line Coupling Nut
43 Adjustment Screw B/4-FV
44 Cap B/4-FV
45 Plug B/4-FV
46 Gasket B/4-FV
47 Small O-Ring B/4-FV
48 Large O-Ring B/4-FV





NOTE: This illustration is a visual representation of all LE components. Liquid ends will not include all parts shown.

6.0 Start-up and Adjustment

a.) The pump is normally self-priming if suction lift is 5 ft (1.5m) or less and the steps below are followed.

b.) Pumps are shipped from the factory with water in the pump head to aid in priming.

6.1 Output Adjustment Controls

Manual series pump controls are not equipped with pressure control.

1. Pressure Control Adjustment (if equipped): Pressure control provides the adjustment of the pump's pressure capability and power consumption, reducing heat, pipe shock and pulsation while increasing pump life. See Section 7.0 after priming for proper adjustment settings.

2. Speed Adjustment (Upper Knob) (if equipped): Speed control provides adjustment of the percent of maximum strokes per minute. Turning this knob clockwise increases stroke frequency (speed).

3. Stroke Adjustment (Lower Knob): Stroke control provides adjustment of the percent maximum of solution discharged during each pump actuation. Turning this knob clockwise ↻ increases solution displacement.

A7 and P7 Only*: When operating the pump in external mode, the speed control knob should be turned fully counter-clockwise ↺.*

A34 and A37 Only: *Pump comes equipped with a range selector switch which provides high or low speed adjustment. The high setting provides speed adjustments between 8 and 100 strokes per minute. The low setting provides accurate speed adjustments between 1 and 12.5 strokes per minute for applications requiring infrequent stroking.*

6.2 Start-Up/Priming for Pump Supplied with Multi-Function Valve

CAUTION

Read this entire section completely before proceeding.

When all precautionary steps have been taken, the pump is mounted, and the tubing is securely attached, you may now start priming the pump.

1. Plug in or switch the pump on.

2. While the pump is running, set the speed knob at 80% and the stroke knob at 100%.

Note

If the pump is equipped with pressure control, turn fully clockwise. ↻

3. 1/4 turn open the relief side (black knob) of the multi-function valve.

3A. **(Bleed 4FV only)** With screwdriver rotate bleed adjustment screw counter-clockwise ↺. 2 full turns. When solution begins to flow through translucent bleed return tubing, the pump is primed. Stop pump.

4. The suction tubing should begin to fill with solution from the tank.

5. A small amount of solution will begin to discharge out the return line of the multi-function valve. Once this happens, 1/4 turn or release the knob and **SHUT THE PUMP OFF**. (If pump is not equipped with an on/off switch, disconnect the power cord.)

6. The pump is now primed.

6A. **(Bleed 4FV only)**

- **a.** Start pump and let pump inject solution into the discharge line.
- **b.** Close the bleed adjustment screw by rotating it clockwise ↻ with a screwdriver.
- **c.** Now adjust the pump stroke length and/or speed (frequency) to a range approximately 25% higher than you would normally want for the process.
- **d.** Slowly rotate bleed adjustment screw counter-clockwise ↺. until just a small amount of solution begins to trickle

down inside the bleed return tubing. A small amount of solution pumped back to the tank with each stroke of the pump will allow gas and air to escape without air or gas locking in the pump head.

7. Proceed to output adjustment, Section 6.4.

If the pump does not self-prime, remove the multi-function valve on the discharge side of the pump head. Remove the check valve and pour water or solution into the port until the head is filled. Replace valve, then follow start up/priming steps.

6.3 Start-Up/Priming without Multi-Function Valve

Read this entire section completely before proceeding.

When all precautionary steps have been taken, the pump is mounted, and the tubing is securely attached, you may now prime the pump.

1. Plug in or switch on the pump.

2. While the pump is running, set the speed knob at 80% and the stroke knob at 100%.

If the pump is equipped with pressure control, turn fully clockwise ↻.

3. The suction tubing should begin to fill with solution from the tank.

4. Once the solution begins to exit the pump head on the discharge side, **SHUT THE PUMP OFF**. (If pump is not equipped with an on/off switch, disconnect the power cord).

5. The pump is now primed.

6. Proceed to output adjustment, Section 6.4.

If the pump does not self-prime, remove the fitting on the discharge side of the pump head. Remove the ball and pour water or solution into the port until the head is filled. Replace valve, then follow start up/priming steps.

6.4 Output Adjustment

Once the pump has been primed, an appropriate output adjustment **MUST** be made. Pump output should be calculated and adjustments made accordingly.

6.5 Total Pump Output

Calculate the total output of the pump as follows:

PUMP OUTPUT = MAX PUMP OUTPUT x % SPEED x % STROKE

Example: A151-392SI

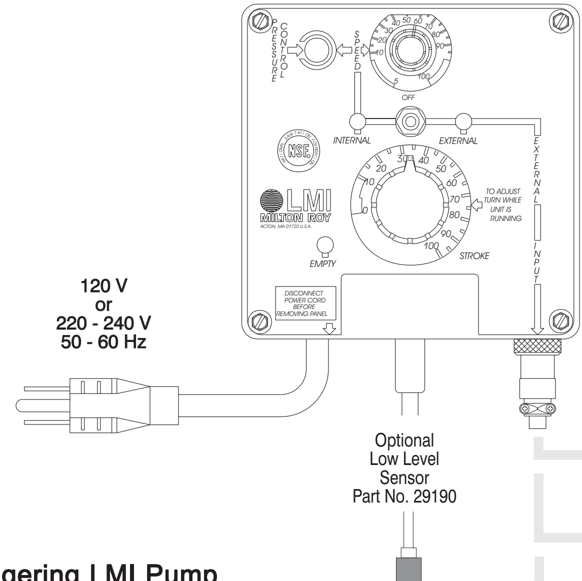
Use MAX Output (from dataplate on bottom center of pump control panel) = 24 GPD (24 gallons per day).

If the pump is set at 60% speed and 70% stroke length, the approximate pump output is:

24.0 x 0.60 x 0.70 = 10.08 GPD (gallons per day). Divide by 24 (hours in one day) to calculate in gallons per hour.

If pump is not equipped with speed adjustment, calculate by ***Max Pump Output x % Stroke*** *only.*

7.0 Methods of Externally Triggering



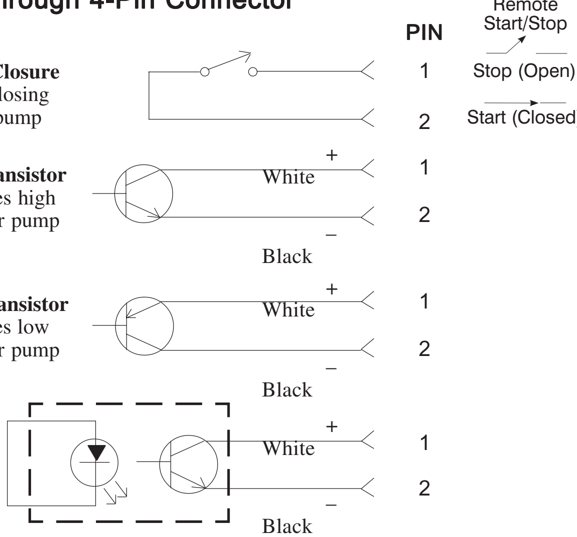
Method of Triggering LMI Pump Through 4-Pin Connector

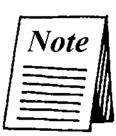
1. **Switch Closure**
   Switch closing triggers pump

2. **NPN Transistor**
   Base goes high to trigger pump

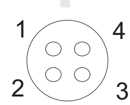
3. **PNP Transistor**
   Base goes low to trigger pump

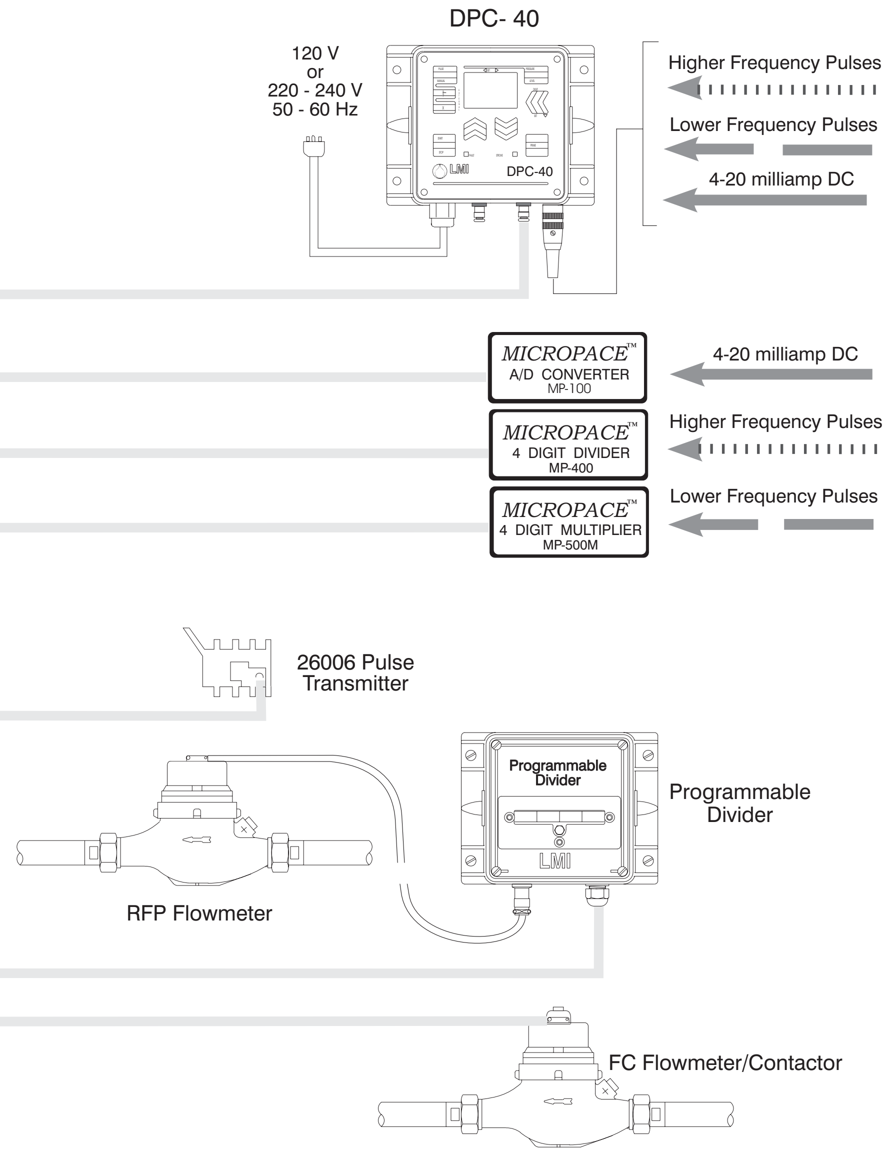
4. **Opto Isolator**





Switch or transistors must be capable of switching 15V DC at 2 milliamperes. Minimum time in low impedance state (ON) is 50 milliseconds. Minimum time in high impedance state (OFF) is 100 milliseconds.




DPC- 40
120 V
or
220 - 240 V
50 - 60 Hz
DPC-40
LMI
Higher Frequency Pulses
Lower Frequency Pulses
4-20 milliamp DC
MICROPACE™
A/D CONVERTER
MP-100
4-20 milliamp DC
MICROPACE™
4 DIGIT DIVIDER
MP-400
Higher Frequency Pulses
MICROPACE™
4 DIGIT MULTIPLIER
MP-500M
Lower Frequency Pulses
26006 Pulse
Transmitter
Programmable
Divider
LMI
Programmable
Divider
RFP Flowmeter
FC Flowmeter/Contactor

8.0 Calibration

Once installation is complete and the approximate output has been determined, the pump should be calibrated to adjust speed and stroke for your actual desired output. (Calibration cylinders may be purchased from your local LMI distributor, ref. publication 1798.)

1. Be sure the pump is primed, and discharge tubing and Injection Check Valve are installed as they would be in normal service (i.e., including factors such as injection pressure, fluid viscosity, and suction lift).

2. Place the Foot Valve in a graduated container with a volume of 1000 ml or more.

3. Plug in and switch pump to Internal Mode. Pump until all the air is exhausted from the suction line and head.

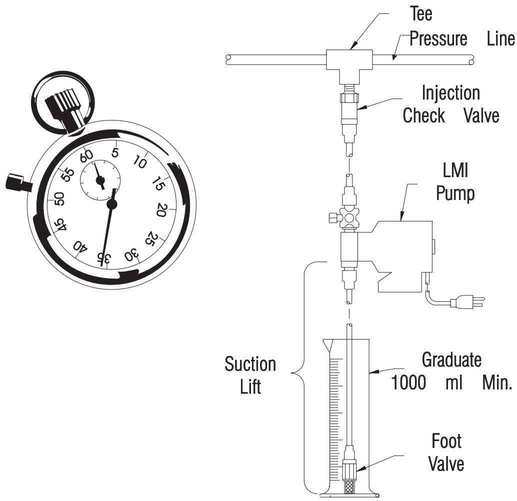
4. Turn the pump off. Refill graduated container to a level starting point.

If pump is equipped with pressure control, see Section 8.1 before proceeding.

5. Using a stopwatch or timer, turn the pump on for a measured amount of time (50 pump strokes minimum). The longer the time period, the more confident you can be of the results. Be sure to count the number of strokes during the calibration period when making comparisons.

6. Turn the pump off. Note the time elapsed in relation to volume displaced in the graduate. Now, calculate the output in the time unit you choose (minutes, hours, days, etc.).

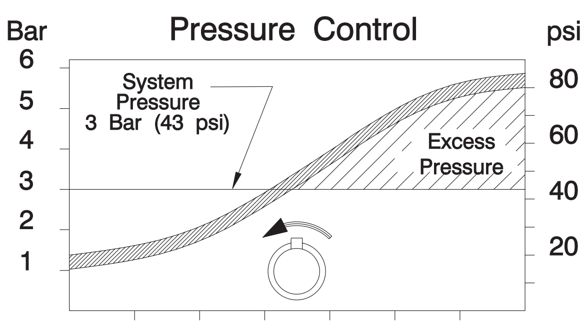
7. If the output is too low or too great, adjust speed and or stroke, estimating required correction and repeat steps 1-7.



8.1 Pressure Control

Adjust Pressure Control: While unit is running, turn Pressure Control Potentiometer slowly counter-clockwise ↺ until unit just begins to stall. From this stall point, now turn Pressure Control Potentiometer clockwise ↻ halfway between the stall point and maximum setting. This is the optimum pressure control setting for your application.

Increase setting if back pressure is increased. Adjusting pressure control decreases pressure rating of pump.



Adjust pressure control to reduce heat, shock, and pulsations; and to prolong pump life.

8.2 Calibration Procedure - On-Site Volumetric Calibration in External Mode

1. Since pump output is governed by an external device such as Flowmeter-Pulser, Liquitron™ Controller, or 4-20 mA DC signal from an instrument with an LMI Analog-to-Digital Converter, **only the output per stroke may be calibrated**.

2. With pump primed and discharge tubing connected to the injection point as it would be in normal service, place Foot Valve Assembly in a graduated container with a volume of 1000 ml or more.

3. Switch pump to **Internal** mode with Speed Knob set at 100 until air is exhausted from suction line and pump head.

4. **Adjust Pressure Control (if desired)** - See Section 8.1.

5. Switch pump **OFF** and note solution level in graduated container. Refill graduate to a starting point.

6. Switch pump **ON** and **count the number of strokes** for exactly one minute, then switch pump **OFF**.

7. Note volume pumped during the calibration period of one minute. Divide into this the number of strokes to determine the volume of solution pumped per stroke.

   Example: 500 ml in 100 strokes = 5.0 ml per stroke.

Multiply this by your expected stroke rate per minute, per hour or per day and compare with desired output requirements.

8. Adjust Stroke Length Knob (lower knob) to your best estimate of required correction and repeat calibration procedure.

9.0 Spare Parts Replacement Routine Maintenance

9.1 Depressurizing the Discharge Line (For Pumps Equipped with a 3-FV or a 4-FV only)

CAUTION

ALWAYS wear protective clothing, face shield, safety glasses and gloves when performing any maintenance or replacement on your pump.

CAUTION

Read steps 1 and 2 below before proceeding.

1. Be sure the Injection Check Valve is properly installed and is operating. If a shut off valve has been installed downstream of the Injection Valve, it should be closed.

CAUTION

Be sure your relief tubing is connected to your multi-function valve and runs back to your solution drum or tank.

2. 1/4 turn the black knob on the valve. The discharge line is now depressurized. Keep valve open until solution drains back down the discharge tubing into solution drum or tank. Then 1/4 turn knob to normal position.

9.2 Liquifram™ (Diaphragm) Replacement

CAUTION

ALWAYS wear protective clothing, face shield, safety glasses and gloves when working near or performing any maintenance or replacement on your pump. See MSDS information from solution supplier for additional precautions.

LMI metering pumps are designed for trouble-free operation, yet routine maintenance of elastomeric parts is essential for optimum performance. This involves replacing the Liquifram™, cartridge valves or seal rings/valve balls, multi-function valve cap assemblies and the injection check valve spring. LMI recommends replacing these parts at least once a year; however, frequency will depend on your particular application.

When replacing the Liquifram™ and the cartridge valves or seal rings/valve balls, the injection check valve spring should also be replaced (see next Section 9.3). A Spare Parts Kit (SP-#) or RPM Pro Pac™ kit containing these parts may be obtained from your local distributor.

Replacing the Liquifram™:

1. Carefully depressurize, drain, and disconnect the discharge line (see Section 8.1 in this manual). Place the Foot Valve into a container of water or other neutralizing solution. Turn the pump on to flush the head assembly. Once the pump head has been flushed, lift the Foot Valve out of the solution and continue to pump air into the pump head until the pump head is purged of water or neutralizing solution.

If the liquid cannot be pumped due to Liquifram™ rupture using protective clothing, gloves and face shield, carefully disconnect the suction and discharge tubing. Remove the four screws to the head and immerse the head in water or other neutralizing solution.

2. Start the pump. While running, set the stroke knob to zero and turn the pump off.

See Section 10.0 for proper zero

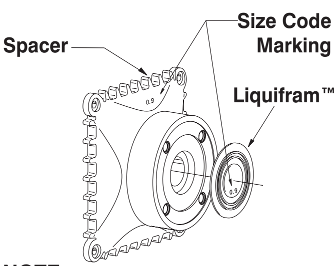
.

3. With the unit off, unscrew the Liquifram™ by carefully grasping the outer edge and turning it counter-clockwise ↶. Discard old Liquifram™. Remove the Liquifram™ disk if so equipped (located behind the Liquifram™) and check that the size code matches the size code on the replacement Liquifram™ (see illustration).

4. Reinstall the disk so the alignment pin on the disk (if present) seats in the recessed hole in the EPU.

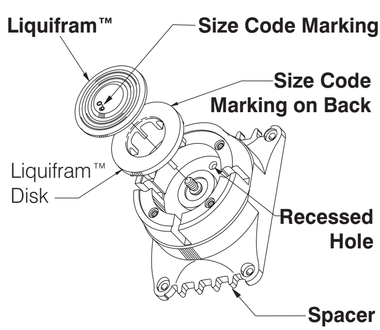
Be careful not to scratch the Teflon® face of the new Liquifram™.

For Series B, C, & E



NOTE:
Size code markings for pumps supplied with 6.0 Liquiframs™ (diaphragms) should be referenced to the 6.0 Black Adapter, not the 3.0 Spacer

For Series A, J, & P



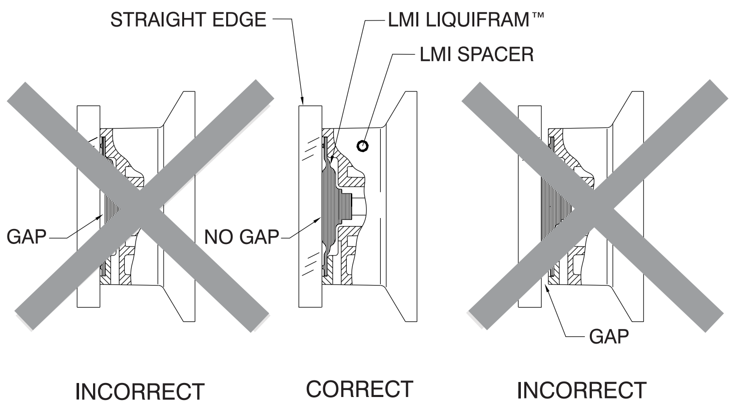
5. Start the pump and turn the stroke knob to the setting indicated on the following Stroke Setting Chart which matches the pump series number located on the pump dataplate. With the pump stroking (running), screw on the new Liquifram™ clockwise ↷ until the center begins to buckle inwards. Stop the pump.

Liquifram™ Stroke Setting Chart

Pump Series	Stroke Knob Setting
All A, B, J, P, Z Series C10, C11, C12, C70, C71, C72, C76, C90, C91, C92, E70, E71, E72	90%
All L Series	85%
C78	50%
C13, C14, C73, C74, C77, C93, C94, E73, E74	70%
All M Series	100% *

* Liquifram™ on M Series pumps only, must be bottomed completely (turned all the way in). ***Do Not Use Straight Edge***.

6. Grasp the outer edge of the Liquifram™ and adjust by screwing it in or out so that the center of the Liquifram™ is flush with the outside of the spacer edge (see illustration below).



(Liquifram™ is flush with spacer and straight edge.)

7. Once the Liquifram™ is properly positioned, remount the pump head to the spacer using the four (4) screws. Tighten in a criss-cross pattern. After one week of operation, recheck the screws and tighten if necessary.

9.3 Cartridge Valves, Seal Rings/Valve Balls and Injection Check Valve Spring Replacement

CAUTION

ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or performing any maintenance or replacement on your pump. See MSDS information from solution supplier for additional precautions.

1. Refer to the LMI Metering Pump Price List for the proper Spare Parts Kit or RPM Pro Pac™ kit number or contact your local LMI stocking distributor.

2. Carefully depressurize and disconnect the discharge line (see Section 9.1 in this manual). Place the Foot Valve into a container of water or other neutralizing solution. Turn the pump on to flush the head assembly. Once the pump has been flushed, lift the Foot Valve out and continue to pump to let air into the pump head until pump is purged of water or neutralizing solution.

Once the pump has been flushed, lift the Foot Valve out and continue to let air into the pump head until pump is purged of water or neutralizing solution.

If the liquid cannot be pumped due to Liquifram™ rupture, with protective clothing, gloves and face shield, carefully disconnect the tubing and four screws to remove the head. Immerse the head in water or other neutralizing solution.

Spare part replacement kits include specific instructions for valve replacement. Please follow the instructions included with the replacement kit.

CAUTION

***IMPORTANT**: Before disassembling the check valves, note the orientation of the valve.*

3. Carefully disconnect one tubing connection and fitting at a time, then remove and replace the worn valve.

If necessary, carefully loosen stuck valves by prying side to side using a small screwdriver through the center hole of the valve.

4. Install new check valves in each location.

IMPORTANT: *Note correct orientation of each check valve.*

5. Install the new spring in the Injection Check Valve.

CAUTION

Depressurize and drain pipeline (or isolate I.C.V. point using valves) so that I.C.V. can safely be disassembled.

10.0 Checking Pump for Proper Zero Position (Stroke Knob)

1. With pump running, turn stroke knob counter-clockwise toward zero or end of black or red band on dial.

2. LISTEN to the clicking as the pump is running. The pump should operate quietly at the zero position (no clicking).

3. If the pump continues to click at zero or stops clicking before zero is reached, the pump zero must be reset (see Section 10.1 or 10.2).

10.1 Type I - Push on Knob
Re-Zeroing and Stroke Knob Disassembly and Assembly

1. Remove stroke knob from the pump by grasping the knob firmly and pulling it toward you.

2. Pry off the yellow cap.

3. Place the knob on a flat surface.

4. Using needle-nose pliers, squeeze the inner section together while lifting the outer section up.

5. Push the inner section back onto the “D” shaped stroke shaft.

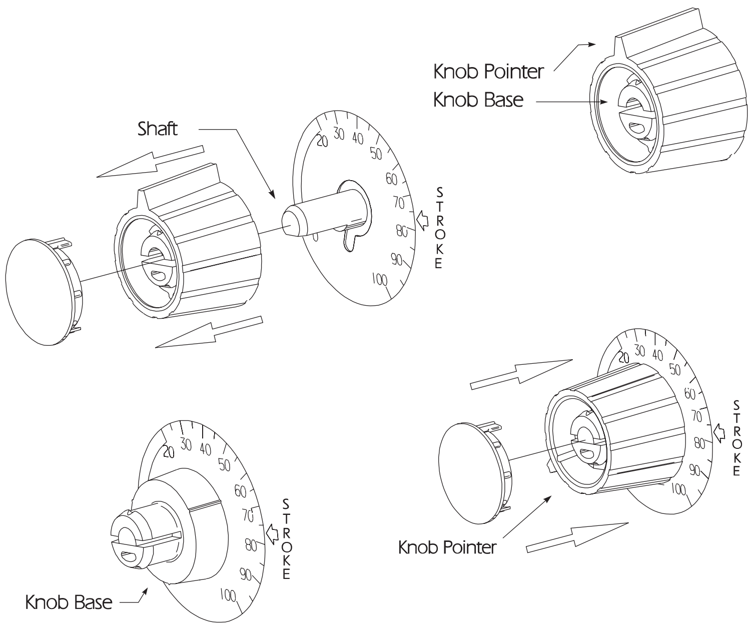
6. With the pump running, zero the pump by turning the inner section of the knob counter-clockwise until the pump stops clicking.

7. Position the outer section of the knob so that the pointer aligns with zero on the nameplate or end of the black or red band.

8. Push down on the outer section (a snap sound indicates parts are locked together).

9. Replace the yellow cap over the outer section of the knob, aligning the tabs on the cap with the slots inside the knob.

Stroke Knob Assembly (Type I)



10.2 Type II Collet Knob

Re-Zeroing and Stroke Knob Disassembly and Assembly

1. Remove Yellow Cap.

2. Hold knob with soft jaw pliers.

3. Disconnect knob by loosening 5/16" (8 mm) collet nut. There is no need to remove nut.

4. Remove knob by pulling towards you.

5. With pump running, zero the pump using a screw driver to turn the stroke shaft counter-clockwise until the pump just stops clicking.

6. Pump is now zeroed.

7. Position knob at zero, or the end of the low range band, and tighten 5/16" (8 mm) collet nut.

8. Replace yellow cap.

11.0 Troubleshooting

PROBLEM	POSSIBLE CAUSE
Pump Will Not Prime	1. Pump not turned on or plugged in.
	2. Output dials not set properly.
	3. Foot Valve not in vertical position on bottom of tank.
	4. Pump suction lift too high.
	5. Suction tubing is curved or coiled in tank.
	6. Fittings are over tightened.
	7. Air trap in suction valve tubing.
	8. Too much pressure at discharge. (Pumps without multi-function valve.)
Pump Loses Prime	1. Solution container ran dry.
	2. Foot Valve is not in a vertical position on the bottom of the tank.
	3. Pump suction lift is too high.
	4. Suction tubing is curved or coiled in tank.
	5. Fittings are over tightened.
	6. Air trap in suction valve tubing.
	7. Air leak on suction side.

	SOLUTION
	1. Turn on pump/plug in pump.
	2. Always prime pump with speed at 80% and stroke at 100%.
	3. Foot Valve must be vertical (see Foot Valve Installation, Section 4.6).
	4. Maximum suction lift is 5 ft (1.5 m). Pumps with High Viscosity Liquid Handling Assemblies require flooded suction.
	5. Suction tubing must be vertical. Use LMI tubing straightener supplied with pump (see Section 4.6).
	6. Do not overtighten fittings. This causes seal rings to distort and not seat properly which causes pump to leak back or lose prime.
	7. Suction tubing should be as vertical as possible. AVOID FALSE FLOODED SUCTION! (see Section 4.2.1).
	8. Shut off valves in pressurized line. Disconnect tubing at injection check valve (see Priming Section 6.0). When pump is primed, reconnect discharge tubing.
	1. Refill container with solution and reprime (see Section 6.0).
	2. Foot Valve must be vertical (see Foot Valve Installation, Section 4.6).
	3. Maximum suction lift is 5 ft (1.5 m). Pumps with High Viscosity Liquid Handling Assemblies require flooded suction.
	4. Suction tubing must be vertical. Use LMI tubing straightener supplied with pump (see Section 4.6).
	5. DO NOT OVERTIGHTEN FITTINGS. This causes seal rings to distort and not seat properly which caused pump to leak back or lose prime.
	6. Suction tubing should be as vertical as possible. AVOID FALSE FLOODED SUCTION! (see Section 4.2.1).
	7. Check for pinholes, cracks. Replace if necessary.

Troubleshooting (continued)

PROBLEM	POSSIBLE CAUSE
Leakage at tubing	1. Worn tubing ends.
	2. Loose or cracked fitting.
	3. Worn seal rings.
	4. Solution attacking Liquid Handling Assembly material.
Low Output or Failure to Pump Against Pressure	1. Pump's maximum pressure rating is exceeded by injection pressure.
	2. Worn Seal Rings.
	3. Ruptured Liquifram™.
	4. Incorrect stroke length.
	5. Tubing run on discharge may be too long.
	6. Clogged Foot Valve strainer.
Failure to Run	1. Pump not turned on or plugged in.
	2. EPU failure.
	3. Pulser failure.
Excessive Pump Output	1. Syphoning. (Pumping downhill without a multi-function valve).
	2. Little or no pressure at injection point.
	3. Excessive strokes per minute.

SOLUTION
1. Cut about 1 in (25 mm) off tubing and then replace as before.
2. Replace fitting if cracked. Carefully hand tighten fittings. *DO NOT USE PIPE WRENCH.* Once fitting comes into contact with seal ring, tighten an additional 1/8 or 1/4 turn.
3. Replace balls and seal rings (see Section 8.3) Spare Parts (SP-#).
4. Consult your local distributor for alternate materials.
1. Injection pressure cannot exceed pump's maximum pressure. See pump data plate.
2. Worn seal rings or cartridge valves may need replacement (see Section 9.3). Spare Parts (SP- #), or RPM Pro Pac™ kit.
3. Replace Liquifram™ (see Section 9.2).
4. Check zero on pump/Re-zero pump (see Section 10.0).
5. Longer tubing runs may create frictional losses sufficient to reduce pump's pressure rating. Consult factory for more information.
6. Remove Foot Valve strainer when pumping slurries or when solution particles cause strainer to clog.
1. Turn on or plug in pump.
2. Disassemble pump and measure the resistance of the EPU across the EPU wires. Resistance reading should be in accordance to the EPU Resistance Chart (see Section 12.0). Also, check EPU leads to ground. Consult supplier or factory.
3. The pulser should be replaced if EPU checks out OK. Consult supplier or factory.
1. Move injection point to a pressurized location or install an LMI 4-FV (see Section 4.4).
2. If pressure at injection point is less than 25 psi (1.7 Bar), an LMI 4-FV should be installed (see Section 4.4).
3. Replace pulser or resistor. Consult factory.

12.0 EPU Resistance Chart

Pump Series	Voltage	Coil Resistance (Ohms) @ 20° C (68° F)*
A14, A15, A16, A34 A74, A75, A76 A94, A95, A96 J02, J03, J04, J05, J06 J13, J15, J16 PW4, PW5, PW6 P04, P05, P06 P08, P14, P15 P16, P18, P74 P75, P76, P78	115 VAC 230 VAC	76 - 87 307 - 353
(see Note 1) A17, A37, A77, A97, A18, A78 P02,P03 P12,P13	115 VAC 230 VAC	152 - 176 583 - 671
(see Note 2) A17, A37, A77, A97, A18, A78 P02, P03 P12, P13	115 VAC 230 VAC	76- 87 291- 335
J54D, J55D, J56D	12 VDC	1.1 - 1.3
D10, D11, D12, D13, D14 D70, D71, D72, D73, D74	115 VAC 230 VAC	25.7- 29.6 97 - 112
E70, E71, E72, E73, E74	115 VAC 230 VAC	22.8 - 26.2 91 - 105
B11, B12, B13, B14 B71, B72, B73, B74	115 VAC 230 VAC	43 - 49 167 - 193
C10, C11, C12, C13, C14 C70, C71, C72, C73, C74	115 VAC 230 VAC	22.8 - 26.2 91 - 105
C76, C77, C78	115 VAC 230 VAC	14.4 - 16.6 57.7 - 66.3

* Let pump cool down completely before checking resistance. EPU checked within 10 hours of operation can increase coil resistance reading as much as 20%.

NOTES:

1. Pumps with serial numbers **LOWER** than: **960113429**
2. Pumps with serial numbers **HIGHER** than: **960113429**

LMI
MILTON ROY

201 Ivyland Road
Ivyland, PA 18974
TEL: (215) 293-0401
FAX: (215) 293-0445
http://www.lmipumps.com

D-5
Air Stripper Blower B-1
Booster Blower B-2

Twin City Fan & Blower

ENGINEERING SUPPLEMENT

ES-52

Issue Date: 1-1-94
Rev. Date: 2-1-06

INSTALLATION, OPERATION & MAINTENANCE MANUAL

Centrifugal Fans

Contents

Introduction

The purpose of this manual is to provide instructions that complement good general practices when installing or operating fans manufactured by Twin City Fan & Blower. It is the responsibility of the purchaser to provide qualified personnel experienced in the installation, operation, and maintenance of air moving equipment.

Instructions given in the body of this manual are general in nature and apply to a variety of models manufactured by Twin City Fan & Blower. Most units can be installed and maintained with the instructions given.

Special applications may require additional information. These instructions are supplied in the form of attached appendices. Use the instructions in the appendix if the directions in this manual differ from instructions in the appendix.

As always, follow good safety practices when installing, maintaining and operating your air moving equipment. A variety of safety devices are available. It is the user's responsibility to determine adequate safety measures and to obtain the required safety equipment.

Shipping and Receiving

All Twin City Fan & Blower products are carefully constructed and inspected before shipment to insure the highest standards of quality and performance.

Compare all components with the bill of lading or packing list to verify that the proper unit was received.

Check each unit for any damage that may have occurred in transit. Any damage should be reported immediately to the carrier and the necessary damage report filed.

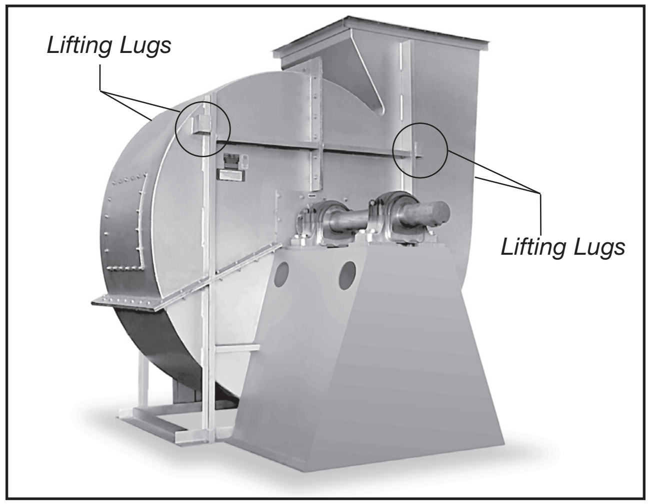
Handling

Handling of all air moving equipment should be conducted by trained personnel and be consistent with safe handling practices. Verify the lift capacity and operating condition of handling equipment. Maintain handling equipment to avoid serious personal injury.

Units shipped completely assembled may be lifted with slings and spreader bars. Use well-padded chains, cables or nylon straps. On most units, lifting lugs are provided for attaching chains (see Figure 1). Lift the fan in a fashion that protects the fan and fan coating from damage. Never lift a fan by the inlet or discharge flange, shafting or drives, wheel or impeller, motor or motor base, or in any other manner that may bend or distort parts.

Partial or disassembled units require special handling. All parts should be handled in a fashion which protects the coatings and parts from damage. Components should be handled such that forces are not concentrated and bending or distortion cannot occur.

Figure 1. Lifting Lug Locations

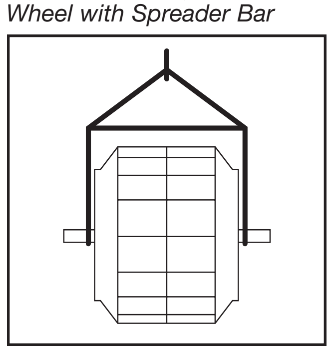


Housing should be lifted using straps and spreaders. Do not distort housing or side plates when lifting.

Bearing pedestals should be lifted using straps or padded chains. Under no circumstances should an attached or separated bearing pedestal be lifted by the shaft, bearings, drives, motor or wheel.

The shaft and wheel assembly may be lifted using a hoist and a spreader with a sling around the shaft at points nearest the wheel (see Figure 2). Take care not to scratch the shaft where the wheel or bearings will be mounted. Never lift or support the assembly by the wheel. Always support the assembly by the shaft when lifting or storing. Do

Figure 2. Moving Shaft and Wheel with Spreader Bar



not support the shaft or the wheel on housing sides. Use only the key provided with the shaft and wheel.

Wheels shipped separately can be lifted by slings running through the blades and around the hub. Never lift the wheel by blades or flanges. Always transport wheels by lifting. Do not roll the wheel as this can damage coatings and change the balance of the wheel.

Bent shafting is a source of vibration and bearing failure, so handle the shaft with care. Any scratches on the shaft may be removed with fine emery cloth or a stone.

Short Term Storage

If fan installation is to be delayed, store the unit in a protected area. Protect the fan and motor bearings from moisture and vibration (or shock loading).

Long Term Storage

Prior to Storage – Fan bearings (and motor bearings per the motor manufacturer's specifications) are to be greased at the time of going into extended storage. On belt drive units the belt tension should be reduced to less than half the specified value for the fan's design to prevent a sag/set from forming in the shafts and belts. If the unit was supplied with a motor, the motor windings should be measured at this time and recorded for comparison prior to placing in service. If the fan housing was supplied with a drain connection, this plug should be removed to prevent any moisture from accumulating in this portion of the unit during storage.

Storage Procedure – Fans should be stored indoors whenever possible where control over temperature, shock and dust is reasonably maintained. If units are to be stored outside in the elements, they should be covered with a water-resistant material. The bearings should be shielded individually from water and dirt; however, do not tightly seal to avoid trapping condensation. Stored equipment should be stored on a clean, dry floor or blocked up off the ground on blocks to prevent unit from setting in any water or directly on the ground. If shock or vibration will be present during storage, the unit may need to be placed on some type of vibration dampening material to aid in preventing brinelling of the bearing surfaces.

Periodic Check – On a monthly interval, the equipment should be checked to ensure that it has remained in an acceptable stored condition. The fan (and motor if supplied) should be rotated several times by hand while adding enough grease to replenish the bearing surfaces with fresh grease and to maintain a full bearing cavity. Grease used must be compatible with that already supplied in the motor and fan bearings. The fan impeller should be left at approximately 180 degrees from that of the previous month to prevent the shaft and impeller from taking a set in one position. Storage records should be maintained which indicate the above requirements have been followed. Consult the motor manufacturer for proper storage, space heater connection and lubrication if the unit was supplied with one.

Start-Up – When the unit is removed from storage, all bearing grease should be purged and replenished with fresh grease as per the lubrication decal. The motor should be measured to verify that the resistance is still at a satisfactory level compared to the value recorded prior to storage.

Foundations and Supporting Structures

Floor mounted fans should be installed on a flat, level, rigid concrete foundation with a mass at least three to five times that of the assembly supported as a guide, depending on the size and speed of the fan. Foundation shall be suitable for static and dynamic loads and foundation frequencies be separated at least 20% from the rotational speed/speed ranges. The plan area should be no more than twice that required by the equipment. Foundations with larger areas should have correspondingly larger mass. Anchor bolts should be "L" or "T" shaped with sufficient length for nuts, washers, shims, and threads for draw-down. Each bolt should be placed in a sleeve or pipe with a diameter larger than the bolt to allow for adjustment.

If the fans are mounted on a sub-structure, an inertia base with spring isolator system should be considered.

Fans mounted to or within a structure should be placed as close as possible to a rigid member such as a wall or column. The structure must be designed for rotating equipment; static design for strength is not sufficient to insure proper operation. Supports for suspended fans must be cross-braced to prevent side sway. Structural resonance should be at least 20% from fan operating speed. Vibration isolators should be used where applicable.

Any ducting should have independent support; do not use the fan to support ducting. Isolating the fan from ductwork with flex connections eliminates transmission of vibration. Fans handling hot gases require expansion joints at both the inlet and discharge to prevent excessive loads caused by thermal growth.

Fan Installation – Factory Assembled Units

Follow proper handling instructions given earlier.

1. Move the fan to the final mounting position.
2. Remove skid, crates, and packing materials carefully.
3. If supplied, place vibration pads or isolation base on mounting bolts. Line up holes in fan base with bolts.
4. Place fan on mounting structure. Carefully level unit using shims as required at all mounting hole locations. Bolt down the unit.
5. Any grout may now be used. Bolt the fan in position before applying grout. Do not depend upon grout to support rotating equipment.
6. Continue with Operations Checklist.

Additional instructions may be given for some fan models, components and accessories in the appendix.

Fan Installation – Disassembled Units

A unit is considered "disassembled" if any component required for proper operation is shipped or supplied separately or in pieces. Reference earlier instructions concerning proper handling of fan components.

Instructions for Mounting and Assembly of Unit:

1. Move lower housing/framework to mounting location.
2. If vibration pads or bases are used, place on bolts first. Place lower housing assembly onto bolts.
3. Level and shim if required. Bolt into place.
4. If separated pedestal or bearing pedestal:
   a. Bring bearing pedestal to desired location.
   b. Place any vibration base or pads into place. Set bearing pedestal on bolts.
   c. Never distort bearing pedestal by forcing it to align with a non-level surface. Shim beneath the pedestal as required.

d. Check bearing centerline height. Change centerline height to match centerline height of housing. High temperature units may require the housing centerline to be lower when cold so that it will be centered when hot.

e. Measure from housing to bearing pedestal to bring bearing pedestal into square with housing (a large square may also suffice).

f. Bolt into position.

5. Shaft and wheel assembly preparation:

a. Clean protective coating off shaft with solvent. Do not touch clean areas of shaft with hands. Perspiration can cause rust or pitting over time.

b. Remove keys from shaft.

c. Clean inside of wheel bore with solvent. Make sure setscrews will not interfere when inserting shaft into wheel bore.

6. Arrangement 1, 9 or 10: Drive Component Assembly (See Figure 3):

a. Insert shaft into wheel from back side of wheel.

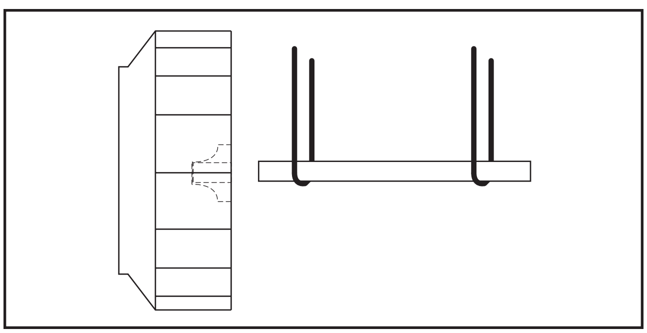
b. When shaft is flush with wheel hub, put key into keyway and tighten wheel setscrews.

c. Insert shaft through opening in drive side. (If split housed unit, lower into position.)

d. Install bearings onto shaft. Do not tighten bearing setscrews at this time. The bearing housing should be perpendicular and the bearing base parallel to the axis of the shaft to prevent loads caused by misalignment.

e. Mount assembly, bolt bearings to drive stand. Shaft must be parallel with side of bearing pedestal. After aligning and bolting bearings to pedestal, tighten bearing setscrews. Continue with step 8.

Figure 3. Drive Component Assembly



7. Arrangement 3 (Split-housed) units (See Figure 4):

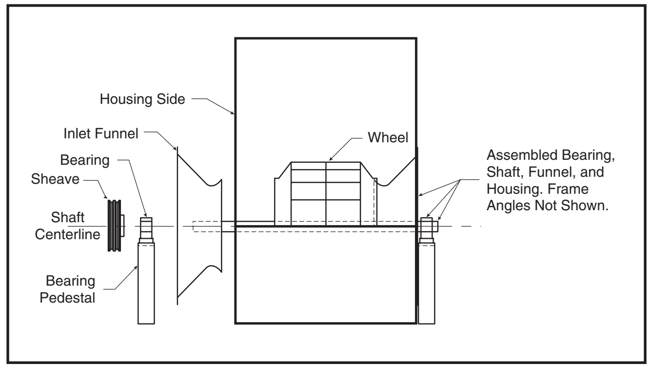
a. Parts on DWDI units are assembled in the following order as viewed from opposite drive side: Bearing bar assembly and opposite bearing, funnel, (housing side), wheel, (housing side), funnel, drive side bearing bar assembly, drive bearing and sheaves. Mount bearing bar assembly to housing. Center wheel in funnels.

b. Parts on SWSI units are assembled in the following order as viewed from opposite drive side: Bearing bar assembly and opposite bearing, funnel, (housing side), wheel, (housing side), drive side bearing bar assembly, drive bearing and sheaves. Mount bearing bar assembly to housing. (See Figure 6 for wheel-funnel overlap.)

c. Assemble parts in above order on shaft.

d. Move assembly into position. Lightly bolt bearings into place.

Figure 4. Split-housed Drive Component Assembly



e. Shaft should be parallel with discharge of housing. Move bearings to accommodate.

f. Level shaft; shim bearings if required. Tighten bearing setscrews.

8. Install motor on base. Carefully align shafts for drive installation.

9. Mount drives as follows:

a. Slip (do not pound) proper sheave onto corresponding shaft. CAUTION: PLACING FAN SHEAVE ON MOTOR CAN OVERSPEED WHEEL AND CAUSE STRUCTURAL FAILURE.

b. Align sheaves with a straightedge extended along the perimeters of both sheaves, just making contact in two places on outside perimeters of both sheaves (see Figure 5).

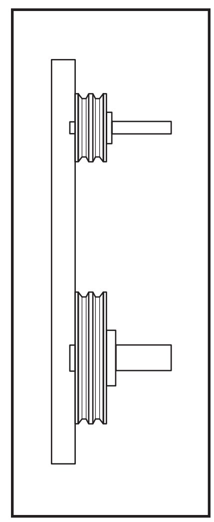
c. Tighten down sheave bolts.

d. Install a matched set of belts. Slide the motor to obtain slack and tighten belts. Using a pry will damage belts.

e. Tighten belts to proper belt tension. Ideal tension is just enough tension so that belts do not slip under peak load. Recheck sheave alignment.

f. After initial installation of belts, recheck belt tension again after a few days to adjust belt tension. (New belts require a break-in period of operation.)

Figure 5. Sheave Alignment



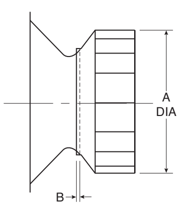
10. Install any safety devices or accessories supplied. (Accessories commonly used are inlet vanes, shaft seals and shaft coolers, plugs, dampers, and inlet or discharge screens. Refer to appropriate documents in appendix.)

11. Grout may now be applied. Grout is used to distribute loads and should not be used as the sole support of any rotating equipment.

12. When connecting the fan to the system, it is recommended that the inlet and discharge be isolated from the system with flex connections (where practical) to block transmitted vibration. All duct connections to the fan should be independently supported. Do not use fan to support duct.

Figure 6. Wheel-Funnel Overlap

HIB, RTF, HRT, BC, BCS, TSL, BAF, BAE, EPF & EPQ



HIB, RTF, HRT* Wheel Placement

Size	A	B	B* 19	B* 23	Size	A	B	B* 19	B* 23
180	20.50	0.31	—	—	400	45.25	0.69	1.03	0.97
200	22.50	0.34	—	—	450	50.00	0.75	1.13	1.06
220	25.00	0.38	—	—	490	55.13	0.81	1.25	1.13
240	27.50	0.44	—	—	540	61.00	0.91	1.38	1.25
270	30.38	0.47	0.50	0.50	600	67.50	1.00	1.31	1.31
300	33.50	0.50	0.69	0.69	660	74.25	1.13	1.56	1.44
330	37.00	0.56	0.69	0.69	730	82.00	1.22	1.75	1.63
360	41.00	0.63	0.81	0.81	800	90.75	1.34	1.06	1.31

*Use second 'B' columns for HRT-19 and HRT-23 dimensions

BC, BCS, TSL & BAF SWSI Wheel Placement

Size	122	135	150	165	182	200	222	245	270	300	330
A	12.25	13.50	15.00	16.50	18.25	20.00	22.25	24.50	27.00	30.00	33.00
B	0.32	0.34	0.38	0.44	0.56	0.63	0.69	0.75	0.88	0.97	1.06

Size	365	402	445	490	542	600	660	730	807	890
A	36.50	40.25	44.50	49.00	54.25	60.00	66.00	73.00	80.75	89.00
B	0.94	1.03	1.13	1.25	1.38	1.56	1.69	1.88	2.09	2.28

EPF, EPQ Wheel Placement

Size	122	150	165
A	13.00	14.13	16.16
B	0.25	0.25	0.25

BAE Wheel Placement

Size	122	135	150	165
A	12.25	13.50	15.00	16.50
B	0.31	0.34	0.38	0.44

EPF, EPQ & BAE SWSI Wheel Placement

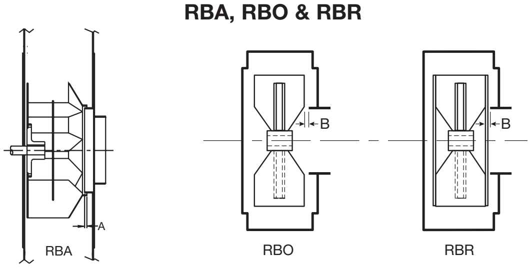
Size	182	200	222	245	270	300	330	365	402	445	490
A	19.00	20.82	23.16	25.51	28.11	31.23	34.36	38.00	41.90	46.33	51.01
B	0.38	0.41	0.46	0.50	0.55	0.62	0.68	0.75	0.83	0.91	1.01

Size	542	600	660	730	807
A	56.48	62.47	68.71	76.00	84.07
B	1.11	1.23	1.36	1.50	1.66

APF & APQ Wheel Placement

Size	121	141	161	181	201	221	251	281	321	351	391	441	491	551	631	711	791
A	13.00	14.13	16.16	18.44	19.94	22.78	25.06	28.25	31.81	35.81	39.81	44.56	50.06	55.75	63.69	71.69	79.63
B	0.25	0.25	0.25	0.31	0.31	0.31	0.50	0.50	0.56	0.63	0.63	0.75	0.78	0.81	1.03	1.28	1.38

RBA, RBO & RBR



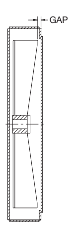
RBA Wheel Placement

Size	907	909	911	913	915	917	919	921	923	926	929	933	937	941	945	949	954	960
A	0.25	0.38	0.47	0.53	0.59	0.69	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

RBO, RBR Wheel Placement

Size	913	915	917	919	921	923	926	929	933	937	941	945	949	954	960
B	0.53	0.53	0.59	0.69	0.78	0.88	0.97	1.03	1.22	1.38	1.56	1.69	1.81	1.88	2.16

Note: On sizes 905-911 wheel is to be centered in housing.

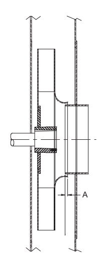


MBW, MBO & MBR

MBW, MBO, MBR Wheel Placement

Size	196	224	252	280	308	336	365	421	477	533	589
MBW	0.50	0.44	0.38	0.25	0.38	0.44	0.56	0.63	0.75	0.75	0.88
MBO	0.50	0.44	0.38	0.25	0.38	0.44	0.56	0.63	0.75	0.75	0.88
MBR	0.25	0.25	0.25	0.25	0.25	0.38	0.50	0.69	0.81	0.94	1.00

Note: On sizes 421-589 wheel is to be centered in housing.

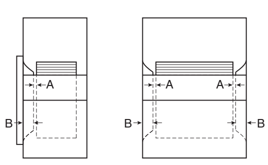


BCN

BCN Wheel Placement

Size	270	300	330	365	402	445	490	542	600	660	730
A	0.09	0.09	0.13	0.13	0.13	0.16	0.16	0.19	0.22	0.22	0.25

FC



FC Wheel Placement

Size	A	B	Size	A	B
10.5	0.47	0.69	30	0.75	4.38
12	0.25	1.88	33	0.81	5.00
15	0.44	2.19	36	0.75	5.00
18	0.50	2.25	39	1.06	6.38
21	0.69	2.88	42	1.69	7.50
24	0.81	3.00	48	1.50	7.13
27	0.69	3.13	54	1.00	10.50

Fan Operation - Safety

For general safety practices for air moving equipment, see AMCA Bulletin 410.

Twin City Fan & Blower has many safety accessories available. These safety devices include (but are not limited to) belt guards, shaft guards, inlet and discharge screens. The use, abuse, or non-use of safety devices is the responsibility of the purchaser.

Facility-related safety conditions include fan accessibility and location. How easily can non-service personnel access the unit? Is the fan in a hazardous duty environment? Was the unit ordered for this duty? Other concerns must also be addressed. All fans should be powered through switches which are easily accessible to service personnel from the fan. Every switch should have the ability to be "locked-off" by the service person and the key to be retained by this person to prevent accidental power of the fan while service is in process.

Operation Check List

Verify that proper safety precautions have been followed:
- ☐ Electrical power must be locked off.

Check fan mechanism components:
- ☐ System connections are properly made and tightened.
- ☐ Bearings are properly lubricated.
- ☐ Wheel, drives and fan surfaces are clean and free of debris.
- ☐ Rotate the impeller by hand to verify it has not shifted in transit.
- ☐ Check fan/wheel overlap. See Figure 6.
- ☐ Drives on correct shafts (not reversed).
- ☐ Check position of guards to prevent rubbing.

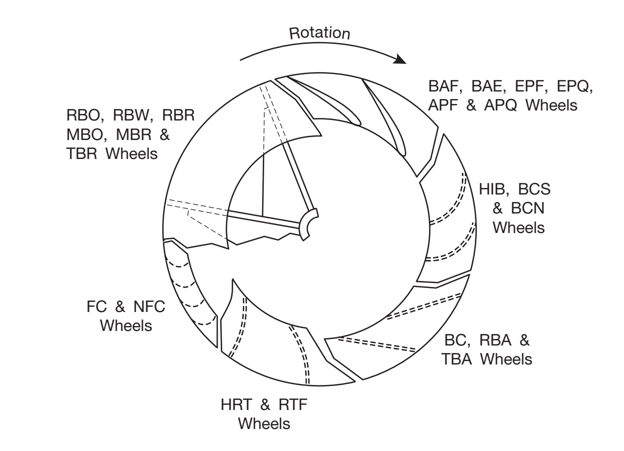
Check fan electrical components:
- ☐ Motor is wired for proper supply voltage.
- ☐ Motor was properly sized for power and rotational inertia of rotating assembly.
- ☐ Motor is properly grounded.
- ☐ All leads are properly insulated.

Trial "bump":
- ☐ Turn on power just long enough to start assembly rotating.
- ☐ Check rotation for agreement with rotation arrow. Does the assembly make any unusual noise? (See Figure 7.)
- ☐ Check drive alignment and tension. Does this meet with drive manufacturer's recommendations?
- ☐ Correct any problems which may have been found. (Follow safety guidelines - shut power off.) Perform checklist again until unit is operating properly.
- ☐ Run unit up to speed.

Verify fastener tightness. These may have loosened during shipment or installation.
- ☐ Setscrews attaching wheel hub to shaft.
- ☐ Setscrews in drive sheaves or coupling.
- ☐ Nuts on inlet funnel.
- ☐ Nuts and bolts holding motor.
- ☐ Nuts holding housing frame to base and base to ground.
- ☐ Nuts on accessories including shaft seal, access doors and pie-splits.
- ☐ Bolts in taper-lock bushings.
- ☐ Grease line connections.

After one week of operation, check all nuts, bolts and setscrews and tighten if necessary.

Figure 7. Proper Wheel Rotation



Maintenance of Fans

This section contains general maintenance instructions for your Twin City Fan & Blower unit. For specific information about maintenance of components, particularly for special application fans, see the attached documents.

General Motor Maintenance

The three basic rules of motor maintenance are keep the motor clean, dry and properly lubricated.

Keeping motors and windings clean is important because dirt and dust serve as thermal insulators. Heat normally dissipated by the motor is trapped causing overheating and/or premature failure. Blow dust and dirt out of windings and off the motor periodically. Use low pressure (50 psig) airstream so that winding damage does not occur. Keep the area surrounding the motor open so the air can circulate through the motor cooling fan. Follow normal maintenance schedule given to the right.

Motors should be kept dry to avoid electrical short circuits. Motors kept in storage for long periods of time can have moisture condense on the windings. Be certain the motor is dry before using.

Some smaller motors are lubricated for life. Motor bearing lubrication, if required, must follow a rigorous schedule. Motors less than 10 hp running about eight hours a day in a clean environment should be lubricated once every five years; motors 15 to 50 hp, every 3 years; and motors 50 to 150 hp, yearly. For motors in a dusty or dirty environment or running 24 hours a day, divide the service interval by 2. If the environment is very dirty or high temperatures exist, divide the service interval by 4. Lubrication requirements are normally attached to the motor. Do not overlubricate.

Drive Maintenance

V-belt drives need periodic inspection and occasional belt replacement. When inspecting drives, look for dirt buildup, burrs or obstructions which can cause premature belt or drive replacement. If burrs are found, use fine emery cloth or a stone to remove the burr. Be careful that dust does not enter the bearings.

Check the sheaves for wear. Excessive slippage of belts on sheaves can cause wear and vibration. Replace worn sheaves with new ones. Carefully align sheaves to avoid premature sheave failure.

Observe belts for wear. If fraying or other wear is observed to be mostly on one side of the belts, the drives may be misaligned. Reinstall the drives according to instructions given for Fan Installation – Disassembled Units. Never use belt dressing on any belts.

Figure 8. Safety & Lubrication Instructions for Fans with Ball Bearings

WARNING

1. This equipment must not be operated without proper guarding of all moving parts. While performing maintenance be sure remote power switches are locked off. See AMCA Publication 410 for recommended safety practices.
2. Before starting: Check all setscrews for tightness, and rotate wheel by hand to make sure it has not moved in transit.

Relubrication Schedule (Months)*
Ball Bearing Pillow Blocks

Speed (RPM)	500	1000	1500	2000	2500	3000	3500	4000	4500
Shaft DIA									
½" thru 1¹¹⁄₁₆"	6	6	5	3	3	2	2	2	1
1¹⁵⁄₁₆" thru 2⁷⁄₁₆"	6	5	4	2	2	1	1	1	1
2¹¹⁄₁₆" thru 2¹⁵⁄₁₆"	5	4	3	2	1	1	1		
3⁷⁄₁₆" thru 3¹⁵⁄₁₆"	4	3	2	1	1	1			

* Suggested initial greasing interval: Relubricate while running, if safety permits, until some purging occurs at seals. Adjust lubrication frequency depending on condition of purged grease. Hours of operation, temperature, and surrounding conditions will affect the relubrication frequency required.

1. Lubricate with a high quality NLGI No. 2 or No. 3 multipurpose ball bearing grease having rust inhibitors and antioxidant additives. Some greases having these properties are:

   Shell - Alvania No. 2   Mobil - Mobilith AW2/Mobilith SHC100
   Gulf - Gulfcrown No. 2   American - Rykon Premium 2
2. Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Figure 9. Safety & Lubrication Instructions for Fans with Unit Roller Bearings

WARNING

1. This equipment must not be operated without proper guarding of all moving parts. While performing maintenance be sure remote power switches are locked off. See AMCA Publication 410 for recommended safety practices.
2. Before starting: Check all setscrews for tightness, and rotate wheel by hand to make sure it has not moved in transit.

Relubrication Schedule (Months)*
Spherical Roller Bearing - Solid Pillow Blocks

Speed (RPM)	500	1000	1500	2000	2500	3000	3500	4000	4500
Shaft DIA									
1³⁄₁₆" thru 1⁷⁄₁₆"	6	4	4	2	1	1	1	1	½
1¹¹⁄₁₆" thru 2³⁄₁₆"	4	2	1½	1	½	½	½	½	½
2⁷⁄₁₆" thru 3⁷⁄₁₆"	3	1½	1	½	½	¼	¼		
3¹⁵⁄₁₆" thru 4¹⁵⁄₁₆"	2½	1	½	¼					

*Suggested initial greasing interval: Relubricate while running, if safety permits, until some purging occurs at seals. Adjust lubrication frequency depending on condition of purged grease. Hours of operation, temperature, and surrounding conditions will affect the relubrication frequency required.

1. Lubricate with a multipurpose roller bearing NLGI No. 2 having rust inhibitors and antioxidant additives, and a minimum oil viscosity of 500 SSU at 100ºF. Some greases having these properties are:

   Shell - Alvania No. 2   Mobil - Mobilith AW2/Mobilith SHC100
   Texaco - Premium RB2   American - Rykon Premium 2
2. Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Figure 10. Safety & Lubrication Instructions for Fans with Split Roller Bearings

WARNING

1. This equipment must not be operated without proper guarding of all moving parts. While performing maintenance be sure remote power switches are locked off. See AMCA Publication 410 for recommended safety practices.
2. Before starting: Check all setscrews for tightness, and rotate wheel by hand to make sure it has not moved in transit.

Relubrication Schedule (Months)* Spherical Roller Bearing - Split Pillow Blocks										Grease to be added at each interval
Speed (RPM)	**500**	**750**	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	
Shaft DIA										
$1\frac{7}{16}$" thru $1\frac{15}{16}$"	6	4½	4	4	3½	2½	2½	1	1	0.50 oz.
$2\frac{3}{16}$" thru $2\frac{11}{16}$"	5	4½	4	2½	2½	1½	½	¼	¼	0.75 oz.
$2\frac{15}{16}$" thru $3\frac{15}{16}$"	4½	4	3½	2½	1½	1	½			2.00 oz.
$4\frac{7}{16}$" thru $4\frac{15}{16}$"	4	4	2½	1	½					4.00 oz.
$5\frac{7}{16}$" thru $5\frac{15}{16}$"	4	2½	1½	1						7.00 oz.

*Suggested initial greasing interval - remove bearing cap and observe condition of used grease after lubricating. Adjust lubrication frequency as needed. Hours of operation, temperature, and surrounding conditions will affect the relubrication frequency required. Clean and repack bearings annually. Remove old grease, pack bearing full and fill housing reservoirs on both sides of bearing to bottom of shaft.

1. Lubricate with a multipurpose roller bearing NLGI No. 2 having rust inhibitors and antioxidant additives, and a minimum oil viscosity of 500 SSU at 100ºF. Some greases having these properties are:

   Shell - Alvania No. 2 Mobil - Mobilith AW2/Mobilith SHC100
   Texaco - Premium RB2 American - Rykon Premium 2

2. Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Static Oil Lubrication

1. Use only highest quality mineral oil with a minimum viscosity of 100 SSU at the oil's operating temperature. The oil's operating temperature is approximately 10º greater than the bearing's housing. SAE values having this viscosity at the following operating temperature are:

   150º - SAE 20 160º - SAE 30 180º - SAE 40

2. Static oil level should be at the center of the lower-most roller (Do not overfill.)
3. Complete lubrication change should be made annually.

When replacing belts, replace the entire set. After initial replacement and tensioning, recheck belt tension after a few days to adjust belt tension again. (New belts require a break-in period of operation.)

Bearing Maintenance

For instructions covering special lubrication intervals, bearing assembly or disassembly, or installation details, see attached documents. Any bearing which is disassembled should be kept separate from other bearing parts as components may not be interchangeable. Maintain cleanliness of components and bearings to prevent bearing contamination.

Bearing failure can occur from many causes. See Troubleshooting section for details.

Note: All speeds shown do not apply to all shaft sizes in that group. Consult the factory if in doubt of maximum speed for a particular bearing.

Lubrication

Proper lubrication of bearings helps assure maximum bearing life. All fans are equipped with decals indicating relubrication intervals for normal operating conditions. However, every installation is different and the frequency of lubrication should be established accordingly.

Experience has shown that airborne moisture and heavy dust will dramatically reduce the life of the bearing lubricant. If any of these adverse conditions exist, it is recommended that bearings be regreased after several days of operation. Lubrication intervals can then be adjusted based on the condition of the purged grease.

Figure 8 illustrates the decal for ball bearings, Figure 9 the decal for solid pillow block spherical roller bearings, and Figure 10 shows the decal for split pillow block spherical roller bearings. Observation of the condition of the grease expelled from the bearings at the time of relubrication is the best guide as to whether regreasing intervals and the amount of grease added should be altered. This observation is particularly important when bearings operate continuously over 160°F.

Greases are made with different bases. There are synthetic base greases, lithium base, sodium base, etc. Avoid mixing greases with different bases. They could be incompatible and result in rapid deterioration or breakdown of the grease.

All bearings are filled with grease before leaving the factory. When the fans are started, the bearings may discharge excess grease through the seals for a short period of time. Do not replace the initial discharge because leakage will cease when the excess grease has worked out. Sometimes the bearing has a tendency to run hotter during this period and one should not get alarmed unless it lasts over 48 hours or gets above 220ºF. When relubricating, use a sufficient amount of grease to purge the seals. Rotate bearings during relubrication where good safety practice permits.

For bearings with oil lubrication, sight gauges are installed so that a proper level can be reviewed and maintained. Sight gauges should be read with bearings not rotating.

Wheel and Shaft Maintenance

Periodically inspect the shaft and wheel for dirt buildup, corrosion, and signs of excess stress or fatigue. Clean the components and, when appropriate, apply new coatings. (Any addition of coatings or weld can create an imbalance.) Check the balance of the assembly.

Structural Maintenance

All structural components or devices used to support or attach the fan to a structure should be checked at regular intervals. Vibration isolators, bolts, foundations, etc., are subject to failure from corrosion, erosion, and other causes. Improper mounting can lead to poor operation characteristics or fan fatigue and failure.

Check metallic components for corrosion, cracks, or other signs of stress. Concrete should be checked to ensure the structural integrity of the foundation.

Troubleshooting Guidelines

Use current safety practices when investigating fan or system performance problems. General safe practices and performance troubleshooting guidelines can be found in AMCA Publications 410 and 202, respectively. Fan application and field measurement procedures can be found in AMCA Publications 201 and 203.

Troubleshooting Performance Problems

The lists below indicate possible areas to check when air or sound values do not match expectations. Most fan problems can be pinpointed to one of these common causes.

Air Capacity Problems:

1. Resistance of system not at design rating. If resistance is lower than expected, both airflow and horsepower may be up. If resistance is higher than anticipated, air volume will be down.
2. Fan speed is not at design speed.
3. Air density not at design values. Also check air performance measurement techniques/procedures.
4. Devices for air modulation are closed or plugged. Also check filters.
5. Wheel mounted improperly or is rotating in reverse.
6. Parts of system or fan have been damaged or need cleaning.

Noise Problems:

1. Air performance is incorrect and fan is not at design point of operation. Fan forced to operate in an unstable flow region.
2. Bearing failure. Check bearings (lubrication).
3. Supply voltage high or inconsistent supply frequency. Adjustable frequency controllers can generate motor noise.
4. Objects which are installed in a high velocity airstream can generate noise. This includes flow sensors, turning vanes, etc.
5. Poor fan inlet conditions.
6. Acoustics or sound measurement procedure incorrect.

Vibration Problems:

1. Misalignment of drive components.
2. Poor foundations or mounting structure (resonances).
3. Foreign material attached to rotating components.
4. Damaged rotating components (bearings, shaft, fan, wheel, sheaves).
5. Broken, loose or missing setscrews.
6. Loose bolts.
7. Vibration transmitted by another source.
8. Water accumulating in airfoil blades.
9. Fan is operating in stall or unstable flow region.

NOTE: All fans manufactured by Twin City Fan & Blower are factory balanced prior to shipment. Handling and movement of the fan during shipment may cause the rotating assembly to shift. Balance should be checked once the fan is installed. If a final trim balance is required, it is the end user's responsibility to bring the fan back to factory specifications. Final trim balancing is not the responsibility of Twin City Fan & Blower.

Motor Problems:

1. Incorrect wiring.
2. Speed of fan too high.
3. Parts improperly installed - binding.
4. Bearings improperly lubricated.
5. WR^2 capability of motor too low for application.
6. Protection devices may be improperly sized.

Drive Problems:

1. Belts improperly tensioned.
2. Drive alignment is poor.

Bearing Problems:

Generally speaking, Twin City Fan & Blower uses three types of bearings:
1. Ball bearing with set screw lock.
2. Spherical roller bearings with set screw lock.
3. Spherical roller bearings with adapter lock/taper lock feature to attach them to the shaft.

Ball bearings – These are self-aligning bearings and should present no alignment problems with one exception: i.e., on Sealmaster bearings there is a pin beneath the grease fitting which prevents the bearings outer race from rotating. Should this pin jam, the bearing loses its alignment feature.

Common failure causes are (1) set screws loosening and shaft turning within the bearing, and (2) crowned bearing supports. Loosen one bolt and measure the clearance between the pillow block and the support. Add shim to compensate.

Spherical Roller Bearings with Set Screw Lock – The self-aligning characteristic of these bearings are inherent in the spherical roller design. The closer that these bearings are to perfect alignment, the cooler they will operate.

Common failure causes are the same as with ball bearings, mainly set screws loosening and crowned bearing supports.

Spherical Roller Bearings with Adapter Lock – Again, the self-aligning feature is inherent in the spherical design. Good alignment results in a cooler operating bearing. The faster the bearing operates the more critical this becomes.

A common cause of failure is improper installation practice. Removing too much clearance from the bearing can result in preloading the bearing, resulting in premature failure; and removing not enough can result in the shaft rotating within the bearing. Properly tightened, this method of attaching a bearing to a shaft is second only to a press fit. Crowned bearing supports can also preload these bearings and should be checked by loosening one side of the bearing and checking for clearance.

Lubrication – The major cause of bearing failure is contamination of grease, insufficient grease, or incompatibility of grease. If a fan is to be stored for any length of time at the job site, the bearings immediately should be filled with grease while rotating the shaft and then the bearings should be regreased and rotated monthly. This will prevent moisture, which condenses within the bearing, from corroding the raceways. Most greases used on fan pillow blocks are lithium base. Use the greases shown on the bearing decal. Do not mix the bases without completely purging out the initial grease.

Initially, follow the lubrication instruction on the side of the fan. The frequency of lubrication should be adjusted depending on the condition of the old grease being purged. This is the responsibility of the user. If the grease is dirty, the lubrication frequency should be more often.

a. Noise – If a bearing is increasing in noise intensity and/or vibration, it will probably result in failure.

b. Temperature – If a bearing temperature begins to gradually rise, it will generally result in failure. A bearing can operate up to 200 degrees and operate satisfactorily if the temperature remains constant and the bearing receives adequate lubrication. Remember that a roller bearing under the same load and speed will be somewhat more noisy and run warmer than a ball bearing. This is normal.

Rough handling and/or dropping a fan can result in brinelling the bearing. This appears as a clicking noise at first, then gradually worsens until failure.

When replacing a bearing, always align the bearings first, then bolt the pillow blocks to their support, rotate the shaft, fasten the bearings to it. If the bearing is fastened to the shaft first, tightening the pillow block bolts may bind the shaft and preload the bearings.

Limitation of Warranties and Claims

Seller warrants to the original purchaser that the goods sold hereunder shall be free from defects in workmanship and material under normal use and service (except in those cases where the materials are supplied by the buyer) for a period of one year from the date of original installation or eighteen (18) months from the date of shipment, whichever occurs first. The liability of seller under this warranty is limited to replacing, repairing, or issuing credit (at cost, F.O.B. factory and at seller's discretion) for any part or parts which are returned by buyer during such period provided that:

a. seller is notified in writing within ten (10) days following discovery of such defects by buyer, or within ten (10) days after such defects should reasonably have been discovered, whichever is less;

b. the defective unit is returned to seller, transportation charges prepaid by buyer.

c. payment in full has been received by seller or said products; and

d. seller's examination of such unit shall disclose to its satisfaction that such defects have not been caused by misuse, neglect, improper installation, repair, alteration, act of God, or accident.

e. seller cannot guarantee sound pressure levels or dBA.

No warranty made hereunder shall extend to any seller product whose serial number is altered, effaced or removed. Seller makes no warranty, express or implied, with respect to motors, switches, controls, or other components of seller's product, where such components are warranted separately by their respective manufacturers. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHETHER STATUTORY OR OTHERWISE, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. In no event shall seller be liable to buyer for indirect, incidental collateral, or consequential damages of any kind. (BUYER'S FAILURE TO PAY THE FULL AMOUNT DUE WITHIN SIXTY (60) DAYS OF DATE OF INVOICE SHALL OPERATE TO RELEASE SELLER FROM ANY AND ALL LIABILITY OR OBLIGATION ARISING PURSUANT TO ANY WARRANTY, EXPRESS OR IMPLIED, WHETHER STATUTORY OR OTHERWISE, INCLUDING ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, MADE IN CONNECTION WITH ANY CONTRACT FORMED HEREUNDER. BUYER AGREES THAT SUCH FAILURE TO PAY SHALL CONSTITUTE A VOLUNTARY WAIVER OF ANY AND ALL SUCH WARRANTIES ARISING PURSUANT TO SUCH CONTACT.)

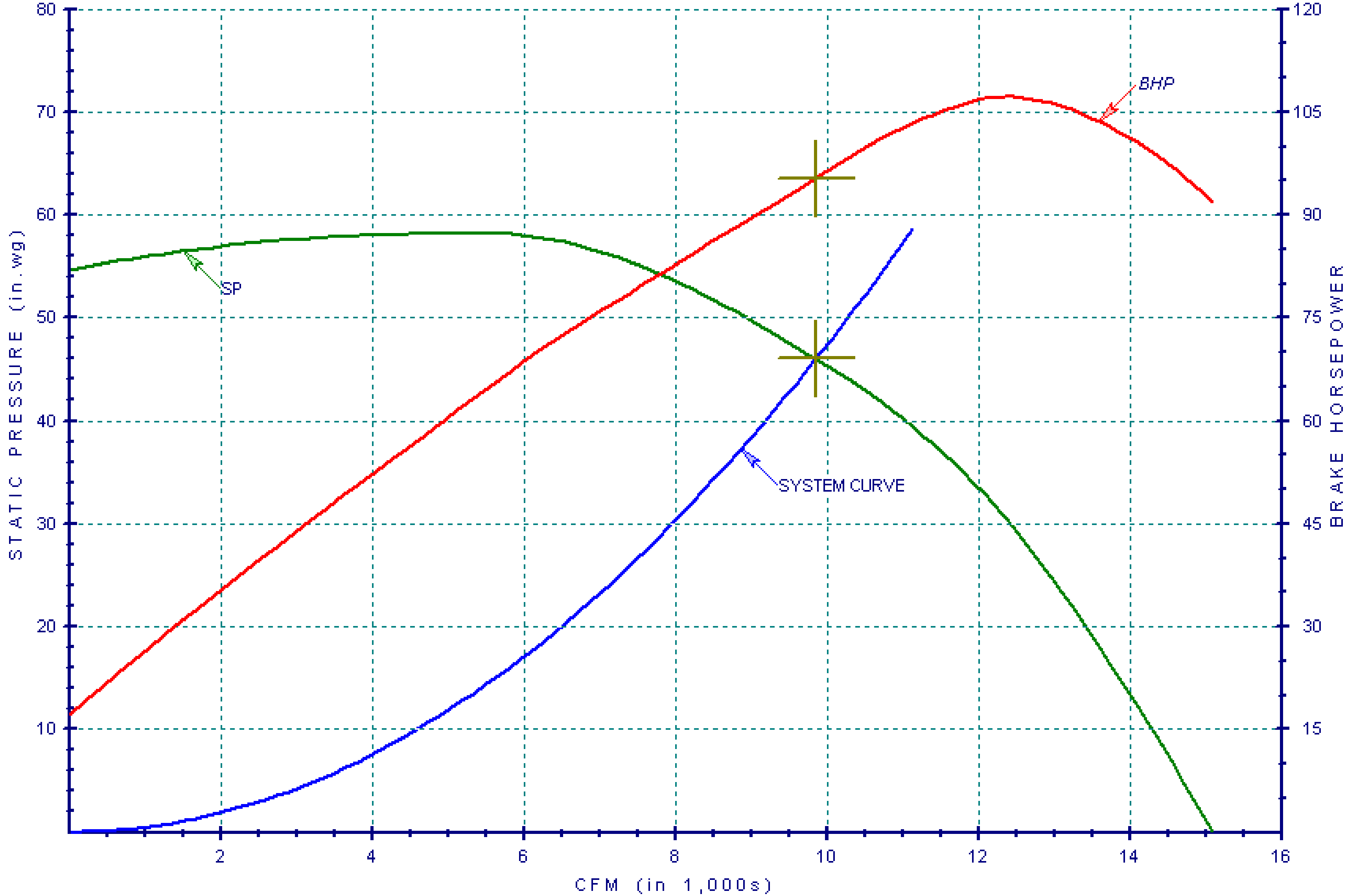
Twin City Fan & Blower
A Twin City Fan Company
5959 Trenton Lane · Minneapolis, MN 55442-3237
Phone (763) 551-7600 · Fax (763) 551-7601 · www.tcf.com

20MPP02/06

110

Customer: Tetra Tech	Fan Tag:
Job ID: s/n 08-252433-1-1	Model: 300W BCN
Represented By: Twin City Fan Companies, Ltd. (763) 551-7600	

TWIN CITY FAN AND BLOWER PERFORMANCE CURVE



CFM:	9,860
SP:	46 in.wg
RPM:	3451
BHP:	95.36
Outlet Velocity:	8,574
Density:	0.075

Corrected for:
Mild steel wheel
Compressibility
Evase

Inlet Sound Power

Octave	Level
1	113
2	112
3	108
4	105
5	105
6	101
7	99
8	97

in db re 10^{-12} watts

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#460

Twin City Fan & Blower
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Phone (763) 551-7600 · Fax (763) 551-7601 · www.tcf.com
ISO 9001 CERTIFIED

Customer: Tetra Tech
Job Name:
Job ID: s/n 08-252433-1-1

November 03, 2008

Fan Description

Tag	N/A
Type	BCN
Size	300W
Width	SWSI
Class	H
Wheel diameter (in.)	30
Percentage width	100%
Percentage diameter	100%

Fan Performance

CFM	9,860
Operating SP (in.wg)	46
Standard SP (in.wg)	46
RPM	3451
Tip Speed (fpm)	27,104
Oper. BHP	95.36
Standard BHP	95.36
Outlet area (sq. ft)	1.15
Outlet Velocity (fpm)	8,574
Temperature (°F)	70
Altitude (ft)	0
Density (lb/ft³)	0.075
Max RPM for Class	2800
Static Efficiency	74.76
Mechanical Efficiency	82.21

Modifiers

Mild steel wheel, Compressibility, Evase

Sound

Sound Power Levels in dB re. 10-12 Watts:

Octave Bands	1	2	3	4	5	6	7	8	LwA
Level at Inlet	113	112	108	105	105	101	99	97	110

Estimated sound pressure level in dBA (re: 0.0002 microbar) based on a single* ducted installation:

Distance in ft	1	3	5
dBA at Inlet	110	100	96

*To estimate dBA level for ducted inlet and ducted outlet (into and out of the room) type installation, deduct 20 from the LWA value shown.

Using a directivity factor of 1.

Estimated Sound Pressure based on free field, spherical (Q = 1) radiation at the stated distance.

Definitions:

LwA The overall (single value) fan sound power level, 'A' weighted.

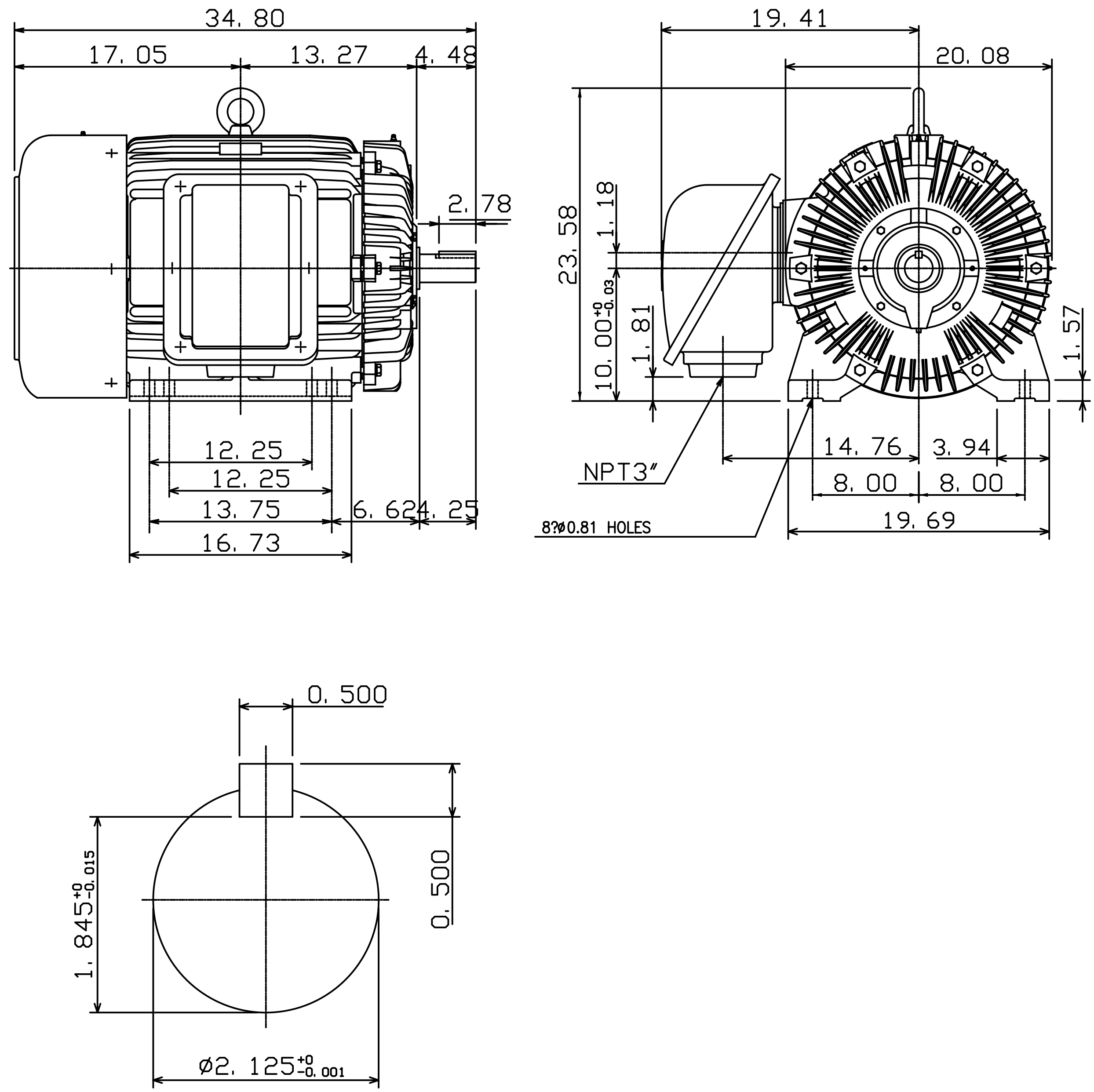
dBA The environment for each fan installation influences its measured sound value, therefore dBA levels cannot be guaranteed. Consult AMCA Publication 303 for further details.
A fan's dBA is influenced by nearby reflective surfaces.

DATE Sept. 8, 2005	OUTLINE DIMENSIONS	MOTOR TYPE: AEHH8N
CAT. #: EP1002	3-PHASE INDUCTION MOTOR	FRAME NO. 405TS

Pole	HP	kW	Hz	VOLT	Syn. Speed r/min(rpm)
2	100	75	60	230/460	3600

Ins	Rating	Dimension in	Approx Weight	Bearings
F	CONT.	inches	1179 lbs.	DE: 6313C3 NDE: 6313C3

Totally Enclosed Fan Cooled Type. Squirrel-cage Rotor.



DWN.	K. L. KUO	01·11·05	TECO Westinghouse	DWG NO.
CHKD.	C. H. KAO	01·28·05		31057H372190
APPD.	M. C. TSAI	01·28·05		

TECO Westinghouse

ISSUED	PERFORMANCE DATA	ENCLOSURE
June 27, 2005	3-PHASE INDUCTION MOTOR	TEFC
TYPE		CATALOG#
AEHH8N		EP1002

NAMEPLATE INFORMATION

OUTPUT HP	OUTPUT KW	POLE	FRAME SIZE	VOLTAGE	HZ	RATED AMBIENT	INS. CLASS	NEMA DESIGN	TIME RATING	SERVICE FACTOR
100	**74.6**	**2**	**405TS**	**230/460**	**60**	**40°C**	**F**	**B**	**CONT.**	**1.15**

TYPICAL PERFORMANCE

FULL LOAD RPM	EFFICIENCY FULL LOAD MIN. %	EFFICIENCY FULL LOAD NOM. %	EFFICIENCY 3/4 LOAD %	EFFICIENCY 1/2 LOAD %	POWER FACTOR F. L. %	POWER FACTOR 3/4 LOAD %	POWER FACTOR 1/2 LOAD %	MAXIMUM POWER FACTOR CORRECTION
3560	**94.5**	**95.4**	**95.8**	**95.4**	**92**	**91.5**	**88.5**	**16 KVAR**

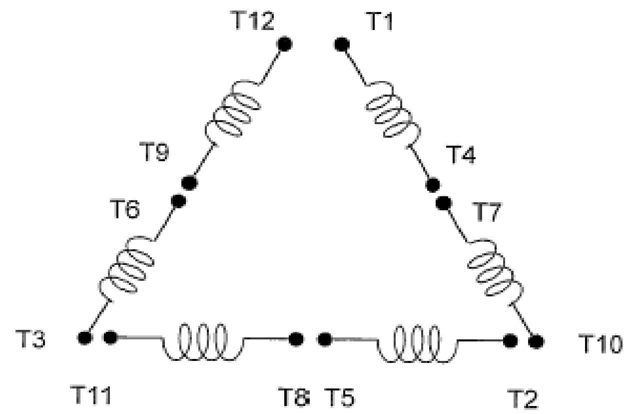
CURRENTS									NEMA KVA CODE LETTER
NO LOAD			FULL LOAD			LOCKED ROTOR			
AT 208 VOLT	AT 230 VOLT	AT 460 VOLT	AT 208 VOLT	AT 230 VOLT	AT 460 VOLT	AT 208 VOLT	AT 230 VOLT	AT 460 VOLT	
43.30	**39.20**	**19.60**	**236.60**	**214.00**	**107.00**	**1603.00**	**1450.00**	**725.00**	**G**

TORQUE				INERTIA			ACCEL TIME	
FULL LOAD lb-ft	LOCKED ROTOR %FLT	PULL UP %FLT	BREAK DOWN %FLT	ROTOR WR^2 lb-ft^2	NEMA LOAD WK^2 lb-ft^2	MAX ALLOWABLE WK^2 lb-ft^2	NEMA LOAD WK^2 Sec	MAX ALLOWABLE WK^2 Sec
147.5	**140**	**125**	**270**	**10.773**	**92**	**213**	**4.06**	**8.84**

SAFE STALL TIME IN SECONDS		ALLOWABLE STARTS PER HOUR		SOUND PRESSURE LEVEL @ 3 FT dB(A)
COLD	HOT	COLD	HOT	
17	**12**	**2**	**1**	**85**

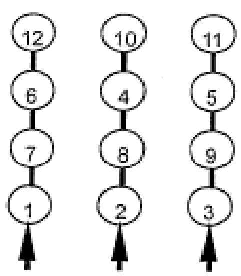
APPROVED:	M. PRATER	DRAWING NO.	31057EP1002	REVISION	0

DATE: June 22, 2005	CONNECTION DIAGRAM	CATALOG NO.: EP1002

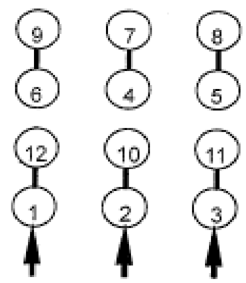


SCHEMATIC - Δ / Y CONNECTION

ACROSS THE LINE CONNECTION

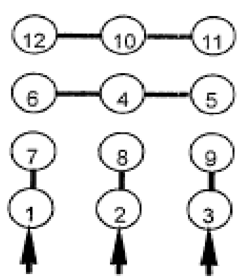


LINE
230 VOLT CONNECTION



LINE
460 VOLT CONNECTION

WYE START-DELTA RUN CONNECTION



LINE
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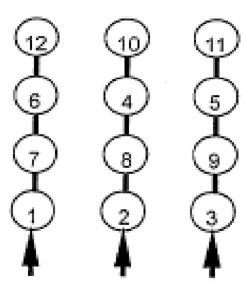

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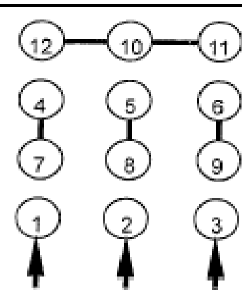
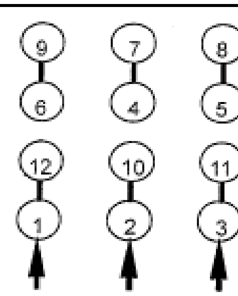
230 VOLT RUN



LINE
460 VOLT START



LINE
460 VOLT RUN

TECO Westinghouse

DWG NO.
DAC-1565-4

OPERATION
&
MAINTENANCE
MANUAL
FOR
THREE PHASE
INDUCTION
MOTORS

TECO-Westinghouse Motor Company
5100 North IH-35
Round Rock, Tx. 78681

INDEX PAGE

1. INTRODUCTION

This and the following instruction address the more common situations encountered in motor installation, operation and maintenance. For the TWMC motor warranty to be and to remain in effect, the motor must be installed and operated in strict accordance with the outline drawing, motor nameplates and these instructions and must not be altered or modified in any unauthorized manner.

During the installation and operation of motors in heavy industrial applications there is a danger of live electrical parts and rotating parts. Therefore to prevent injury and/or damage the basic planning work for installation, transportation, assembly, operation, etc... needs to be done and checked by authorized and competent personnel only.

Since these instructions cannot cover every eventuality of installation, operation and maintenance, the following points should be considered and checked.

- The technical data and information on permissible use such as assembly, connection, ambient and operating conditions given in the related catalogue, operating instructions, nameplates and other production documentation.
- The general erection and safety regulations.
- The local and plant-specific specifications and requirements.
- The proper use of transport, lifting devices and tools.
- The use of personal protective equipment.

Following indications should be observed when reading these instructions.

Safety instructions are marked as follows:

Warning of electric hazards for personnel.

Warning of dangers for personnel.

ATTENTION!
Warning of damage for the motor or installation.

2. ACCEPTING, INSPECTION, STORAGE, TRANSPORTATION

Inspection upon receipt

Check to following points upon receipt:

- Are the nameplate ratings identical with what you ordered?
- Are dimensions and color in compliance with your specifications?
- Are the nameplate ratings for space heater, thermal protector, temperature detector, etc. identical with what you ordered?
- Is there any damage?
- Are all accessories and accompanying instruction manuals in good order?
- Please ensure that the arrow head indicator really indicates direction of rotation.
- If there are any specific requirements, please ensure they are in conformity with your specifications.

2.1 Storage

When motors are not in operation, the following precautionary measures should be undertaken to assure best performance.

2.2 Place

(a) High and dry, well ventilated without direct sun, dust or corrosive gas.
(b) Not located near to a boiler or freezer.
(c) Entirely free form vibration and easy for movements.
(d) Motors should be put on pallets to prevent moisture.

2.3 Moisture prevention

Since moisture can be very detrimental to electrical components, the motor temperature should be maintained about 3ºC above the dew point temperature by providing either external or internal heat. If the motor is equipped with space heaters, they should be energized at the voltage shown by the space heater nameplate attached to the motor. Incandescent light bulbs can be placed within the motor to provide heat. However, if used, they must not be allowed to come in contact with any parts of the motor because of the concentrated hot spot that could result.

2.4

Even during storage, the insulation resistance should be kept above the specified values.

(a) For measurement of insulation resistance and acceptable standard values, please refer to measures stated in 3.1.2 “Measurement of insulation resistance”.
(b) Insulation resistance test should be performed once every three months.

2.5

If the motor is not in operation for a long period (one week and above) after installation or has been in operation but stopped for a period of time, the following precautions must be taken.

(a) Protect the motor as measures stated in 2.2.3.
(b) Insulation resistance test should be performed as stated in 2.2.4.

2.6 Bearing protection

(a) If the motor has been provided with a shaft shipping brace to prevent shaft movement during transit, it must be removed before operating the motor. It is very important that this brace be re-installed exactly as it was originally, before the motor is moved form storage or any time when the motor is being transported. This prevents axial rotor movement that might damage the bearings.
(b) Motors equipped with sleeve bearings are shipped from the factory with the bearing oil reservoirs drained. In storage, the oil reservoirs should be properly filled to the center of the oil level gauge with a good grade of rust inhibiting oil. To keep the bearing journals well oiled and to prevent rusting, the motor shaft should be rotated several revolutions about every month ensuring the shaft does not come to rest in its original position. While the shaft is rotating, it should be pushed to both extremes of the endplay.
(c) Motors with anti-friction bearings are properly lubricated with the correct grade of grease at the factory and no further greasing is required in storage. The shaft should be rotated several revolutions about every month to maintain proper distribution of the grease within the bearings.
(d) Tilt-pad bearings are a type of sleeve bearing used in special design applications. Due to the nature of this bearing, a loose oil ring for delivering lubricant cannot be provided. Therefore, during the storage internal, oil must be periodically manually introduced into the pads and housing to prevent the occurrence of oxidation of the precision machined components.
    (1) Remove the pipe plug from the bearing cap located above the tilt-bearing shell.
    (2) Pour in approximately one cup of oil every month and rotate the shaft a few revolutions about every two (2) weeks.
    (3) For long periods of storage, the oil that accumulates in the housing should be removed.

ATTENTION!
Care should be taken to keep parts such as fitting surfaces, key, shaft extension and axial central hole from any collision with foreign matter. Grease should also be generously applied to prevent rusting.

2.7 Transportation

To keep the rotating parts of motors from moving, thus preventing damage and scratching during transportation, they should be held securely with a locking device. Remove all transit clamps before operating the motor. It is very important that this device be reinstalled exactly as it was originally, before the motor is moved from storage or any time when the motor is being transported. The vertical mounting type motors should be transported in the vertical position.

⚠ Do not use the hoisting hook/eyebolts to lift more that the motor itself. They are designed to support the motor only. Make sure the hoisting hook is correctly attached to the eyebolt(s)/lug(s) are fully screwed in before hoisting. Also note such parts as fan cover, ventilation box, bracket, slip-ring, etc. may have their own hoisting lugs which can only carry their own weight. Nothing extra should be attached while hoisting.
Do not twist the steel wires and make sure the eyebolts have been firmly screwed and the sling angle is correct.

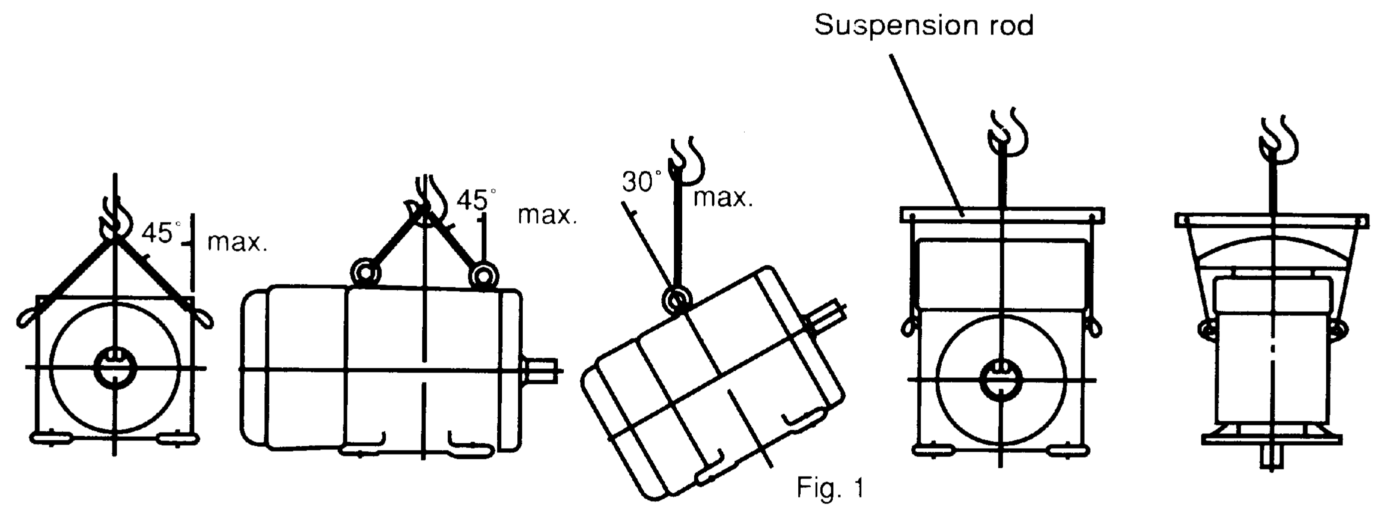


Fig. 1

3 INSTALLATION

Site and environment for motor installation
3.1.1
Standard environment and site conditions for the installation of motors are usually set as follows:
- (a) Ambient temperature: -10~40ºC
- (b) Humidity: Relative humidity below 90%RH for totally enclosed types, and below 80%RH for semi-enclosed types.
- (c) Elevation: below 1000 meters or 3300 feet.
- (d) Harmful gases, liquids, dusts, high moisture should be absent.
- (e) Foundations should be strong and free of vibration.

If there are any special environmental conditions, please inform TWMC prior o ordering.

3.1.2 Ventilation and space
- (a) Installation area should be well ventilated.
- (b) The installation space should be large enough to facilitate heat dissipation and maintenance.

3.2 Foundation
3.2.1
Use rigid and solid sole plate or common bed as foundation.
For best motor performance, it is advisable to use a sole plate or common bed, particularly when using a shaft coupling.

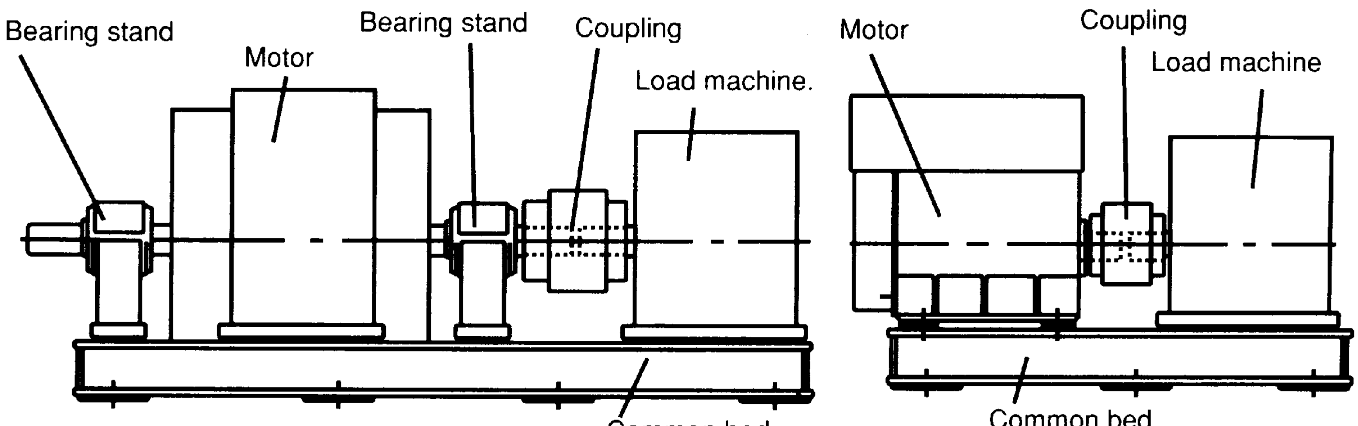


Fig. 2

3.2.2 Installation

(a) Select an appropriate foundation surface for the sole plate or common bed, which will be, considered the ultimate level.
(b) Align the position of the common bed with reference to that level.
(c) Align the level accuracy at least at four points such as bearing mounting, shaft extension etc. The accuracy should be within 0.04mm or .0015 inches
(d) Sole plate or common bed should be embedded in concrete foundation as illustrated in Fig. 3. Stiff pads should also be installed beneath the wedges, which are welded together at various spots about 400-500mm (15.75-19.70 inches) apart etc., to enable the foundation to carry evenly the weight of the whole motor.
(e) The base should be sturdy and rigid to keep it flat and level.
(f) Make sure the mortar and concrete are completely dry, and the precision of the level is acceptable, and then set the motor on the mounting foundation.
(g) Accurately install shaft couplings, belt sheaves etc., then weld the wedges solid to prevent untoward change in position.

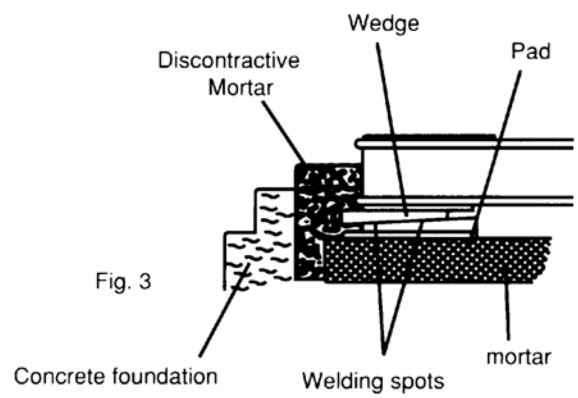


Fig. 3

3.2.3 The foundation of vertical induction motors: (Also the foundation of pump)

(a) Foundation of motor/pump must be rigid and secure to provide adequate support. There must be no vibration, twisting, misalignment etc. due to inadequate foundations.
(b) A massive concrete foundation is preferred in order to minimize vibration. Rigidity and stability are enhanced by prop plate and foundation bolt. As shown in Fig. 4.

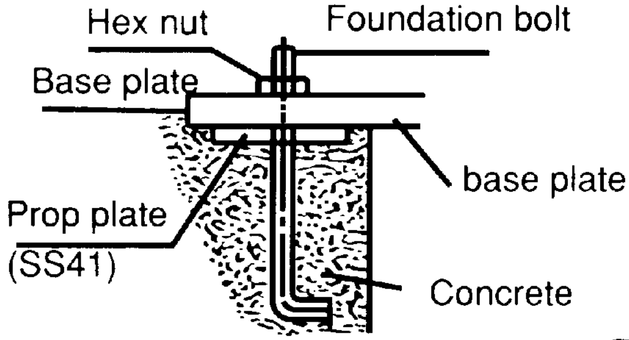


Fig. 4

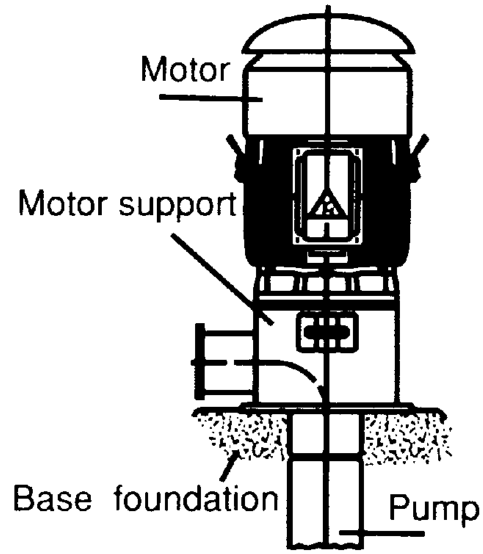


Fig. 5

3.2.4 Installation of vertical motors:

(a) All mounting surfaces must be clean and level.
(b) Foundation must be leveled at least at 4 points and guaranteed to be below 0.04mm (.0015 in.) flat and level.
(c) Make sure the mortar and concrete are completely dry, and the precision of the level is acceptable, and then set the motor on the mounting foundation.
(d) Accurately install shaft couplings.

3.3 Installation of shaft coupling

ATTENTION!
Motors must always be accurately aligned, and this applies especially where they are directly coupled.
Incorrect alignment can lead to bearing failure, vibration and even shaft fracture. As soon as bearing failure or vibration is detected, the alignment should be checked.

3.3.1
Field application of a coupling to the motor shaft should follow the procedures recommended by the coupling manufacturer. The motor shaft extension must not be subjected to either extreme heat or cold during coupling installation.

ATTENTION!
Basically, the coupling should be heated and pushed onto the shaft extension with slight axial force. Do not hammer coupling to prevent bearing damage.

3.3.2
Although the sleeve bearings are equipped with thrust faces, these are intended only to provide momentary axial restraint of rotor movement either during start-up or when operating the motor disconnected from the driven equipment. They must not be operated under a constant thrust load unless they were originally designed for this condition.

Motors with either sleeve or anti-friction bearings are suitable for connection to the driven load through a flexible coupling. Coupling solidly to the load is not acceptable. With sleeve bearings, the flexible coupling should be of the limited end float type to prevent the possibility of any end thrust from load being transmitted to the motor bearings, which could cause bearing damage. The recommended limits of end float are as follows:

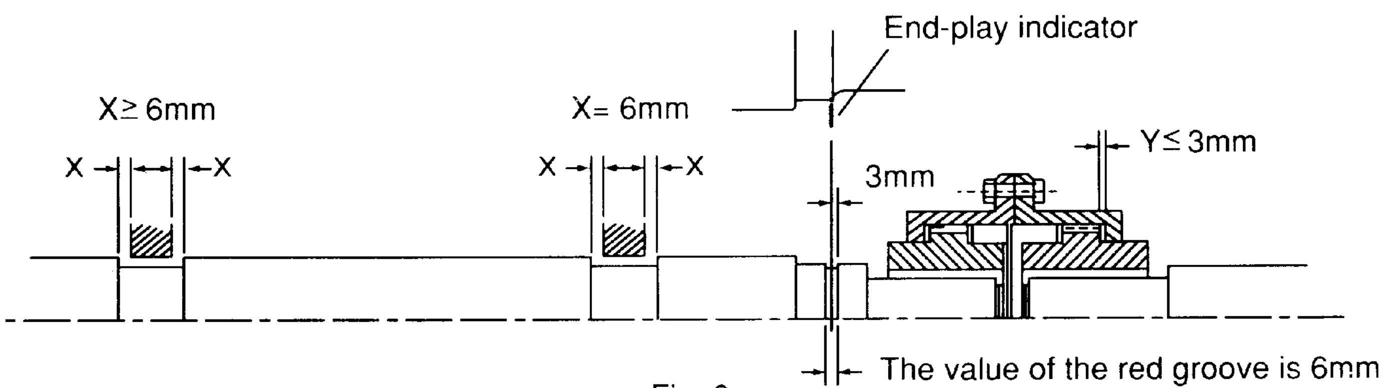


Fig. 6

(a) When the motor is in operation after installation, be sure that the end-play indicator is within the 6mm (.236 in.) of the groove on the shaft or aligned to the shaft shoulder immediately outboard of the drive-end bearing to assure there is low friction between shaft and bearing.
(b) Unless otherwise specified, the designed end-play value X of the groove for TWMC motors in general is within 6mm (.236 in.) as illustrated in Fig. 6. In essence, the endplay indicator is adjusted to point at the center of the groove or the drive-end shaft shoulder; thus X equals to 6±1mm or so, and the endplay value (Y) of the couplings should equal or be smaller than 3mm (.118 in.).
(c) If the desired value Y is grater than 3mmm (.118 in.) caused for instance by a thrust load and/or load machine with large end-play, please inform TWMC prior to entering an order.

3.3.3
In aligning the motor (and rotor) axially with the driven equipment, consideration should be given not only to the endplay indicator position but also to axial shaft expansion and increase in shaft centerline height due to thermal effects. In general, the axial shaft growth for motors can be disregarded since neither bearing is fixed and any shaft growth due to temperature increase will produce an elongation away from the coupling.

Shaft height growth (change in shaft centerline elevation) for TEFC machines can be calculated as follows:

$$\Delta=(0.0005") \times (\text{motor foot to shaft £ dimension})$$

For non-TEFC machines, divide the number by 2.

3.3.4
It is desirable, in normal operation that the motor operates on its magnetic center, so that no axial force is exerted on the coupling.

The motor shaft and the driven shaft should be aligned within the following tolerances in both angular and parallel alignment:

Unit: mm

TIR	Range of rotating speed	Solid coupling	Flexible coupling
C	2500 rpm and above	0.03	0.03
	Below 2500 rpm	0.04	0.05
A	2500 rpm and above	0.03	0.03
	Below 2500 rpm	0.03	0.04

Angular misalignment is the amount by which the centerlines of driver and driven shafts are skewed. It can be measured using a dial indicator set up as shown in Fig. 7. The couplings are rotated together through 360 degrees so that the indicator does not measure runout of the coupling hub face. The shafts should be forced against either the in or out extreme of their end float while being rotated.

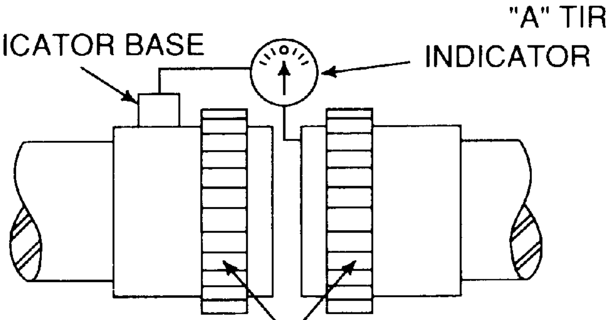


Fig. 7
TIR=Total indicator reading (by dial indicator)

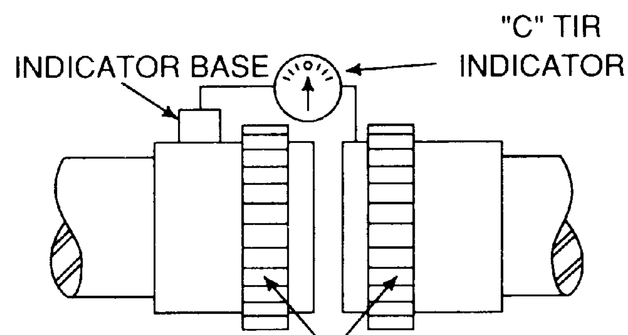


Fig. 8

Parallel misalignment is the amount by which the centerlines of the driver and driven shafts are out of parallel. It can be measured using a dial indicator set up as shown in Fig. 8. Again, the couplings are rotated together through 360 degrees so that the indicator does not measure runout of the coupling hub outside diameter.

3.3.5
After the motor has been properly aligned with the driven equipment and the hold-down bolts have been installed and tightened, for motors with fabricated frames, at least two dowel pins should be installed in two diagonally opposite motor feet.

3.3.6 Installation of shaft coupling: (Vertical hollow shaft motor only)
Bolted Coupling as shown in Fig. 9
(a) Bearings are provided to absorb some upward shaft thrust when the coupling is fitted.
(b) The coupling is fastened with bolts.
(c) This coupling type is not auto-release type.

Note: Standard high thrust motors can absorb momentary up-thrust load up to 30% of the standard down thrust load. If the up-thrust is long in duration (over 10 Seconds) and/or exceeds 30% of the standard high thrust rating, special design arrangements are required and standard motor is not suitable.

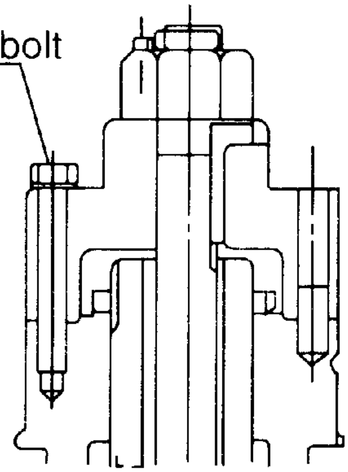


Fig. 9

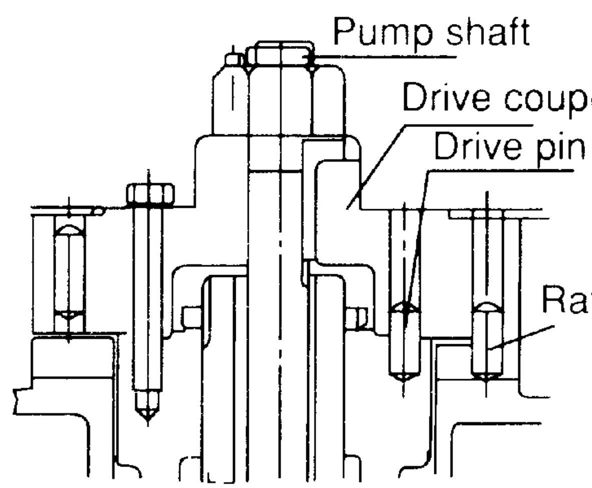


Fig. 10

3.3.7 Non-reverse ratchet/coupling, as Fig. 10 (If necessary)
The non-reverse coupling is also a bolted type and,

(a) It prevents the pump and motor from rotating in the reverse direction.
(b) It also prevents damage form over speeding and damage to pump shaft and bearings.
(c) The ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed.
(d) When power is removed, speed decreases, and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.
(e) When installing the non-reverse coupling, do not use lubricant. Lubricant will interfere with proper operation. The top half of the coupling should seat solidly on the lower half and the pins should touch the bottom of the pockets between the teeth in the plate.
(f) As with the bolted coupling, the up-thrust capabilities are 30% of the standard high thrust rating for down thrust.

ATTENTION!
Do not apply non-reverse ratchets on applications in which the pump reversal time from shutdown (the instant the stop button is pressed) to zero speed is less than one second.

3.4 Installation for belt drive
In general, power transmission though direct flexible coupling is appropriate for large motors. Such motors are not suitable for belt, chain or gear connection unless specially designed for such service. However, for small and medium motors of which outputs within the ranges shown on table below, it is acceptable to use belt transmission as indicated. Beyond these ranges, do not apply belt sheaves unless specially designed.

3.4.1
The diameter ratio between conveyance sheaves should not be greater than 5 to 1 for flat belts, and 8 to 1 for V-belts. It is also advisable to limit the belt velocity to under 35m/sec (115 ft/sec) to limit belt abrasion and vibration. The smaller the outer diameter of the V-belt sheave, the greater the shaft bending stress will be. If the bending stress is in excess of the shaft fatigue stress, the shaft may break. Therefore, please inform TWMC when you have decided the size of the sheaves and the length of the belts upon ordering.

ATTENTION!
Place the sheave and belt as close as possible to the motor body (it is advisable to make x as shown in Fig. 11 equal to 0) to reduce the bending moment and improve shaft life.

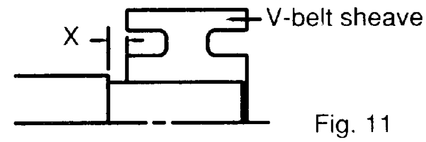


Fig. 11

3.4.2 Table of belt-sheave application for general electric motors

Output (KW/HP)			V-Belt Sheave							
			Conventional V-Belts				Narrow V-Belts			
4P	6P	8P	V-Belt Type	Number Of Belts	Min. PCD (mm)	Max Width (mm)	V-Belt Type	Number Of Belts	Min. PCD (mm)	Max Width (mm)
11/15	-	-	B	4	160	82	3V	4	125	48
-	11/15	-	B	5	170	101	3V	5	140	59
-	-	11/15	B	5	190	101	3V	6	160	69
15/20	-	-	B	5	170	101	3V	6	125	69
-	15/20	-	B	5	224	101	3V	6	160	69
-	-	15/20	C	4	224	111	5V	3	180	60
18.5/25	-	-	B	5	200	101	3V	6	140	69
-	18.5/25	-	C	4	224	111	5V	3	180	60
-	-	18.5/25	C	5	224	136	5V	4	180	78
22/30	-	-	B	5	224	101	5V	6	160	69
-	22/30	-	C	5	224	136	3V	4	180	78
-	-	22/30	C	5	250	136	5V	4	200	78
30/40	-	-	C	5	224	136	5V	4	180	78
-	30/40	-	C	5	265	136	5V	4	224	78
-	-	30/40	C	6	265	162	5V	5	224	95
37/50	-	-	C	6	224	162	5V	4	200	78
-	37/50	-	C	6	265	162	5V	4	224	78
-	-	37/50	C	7	280	187	5V	5	250	95
45/60	-	-	C	6	265	162	5V	4	224	78
-	45/60	-	C	7	280	187	5V	5	224	95
-	-	45/60	C	7	315	187	5V	6	250	113
55/75	-	-	C	7	265	187	5V	5	224	95
-	55/75	-	C	8	300	213	5V	6	250	113
-	-	55/75	D	5	355	196	5V	6	280	113
75/100	-	-	C	8	315	213	5V	6	250	113
-	75/100	-	D	6	355	233	5V	6	315	113
-	-	75/100	D	6	400	233	5V	6	355	113
-	90/120	-	D	6	400	233	5V	6	355	113
-	-	90/120	D	6	425	233	8V	4	355	124
-	110/150	-	D	7	400	270	8V	4	355	124
-	132/175	110/150	D	7	450	270	8V	4	400	124
-	160/200	132/175	D	9	450	344	8V	4	450	124

3.5 Conveyance with chain or gear

3.5.1
Make sure the loading capacity of shaft and bearings is appropriate for the size and installation position (overhung) of chain and gear. If necessary, please contact us to ensure the shaft and bearings will meet your requirements.

3.5.2
Pay close attention to ensure the parallelism of shafts.

3.5.3
The teeth of couplings should be correctly and precisely matched; the force conveyance centers should lie on the same line.

3.5.4
There should be no skip, jumping, vibration or unusual noises.

ATTENTION!
Do not hammer the conveyance devices such as couplings, belt sheaves, chain wheels, gears etc. onto the shaft. Those shaft fitments should be fitted and removed only by means of suitable devices. Heat shrinking may be a better alternative to avoid damaging bearings and components.

The exposed rotating parts should be covered to prevent accidents.

3.6 Electrical connections
All interconnecting wiring for controls and grounding should be in strict accordance with local requirements such as the USA National Electrical Code and UK IEE wiring regulations. Wiring of motor and control, overload protection and grounding should follow the instructions of connection diagrams attached to the motor.

3.6.1 Power
The rated conditions of operation for the motor are as shown on the nameplate. Within the limits, given below, of voltage and frequency variation from the nameplate values, the motor will continue to operate but with performance characteristics that may differ from those at rated conditions:

±10% of rated voltage
±5% of rated frequency
±10% combined voltage and frequency variation so long as frequency variation is no more than ±5% of rated.

Operating the motor at voltages and frequencies outside of the above limits can result in both unsatisfactory motor performance and damage to or failure of the motor.

3.6.2
The main lead box furnished with the motor has been sized to provide adequate space for the make-up of the connections between the motor lead cables and the incoming power cables.

The bolted joints between the motor lead and the power cables must be made and insulated in a workman-like manner following the best trade practices.

3.6.3
Either fabricated motors or fan cooled cast frame, motors are all provided with grounding pads or bolts.

The motor must be grounded by proper connection to the electrical system ground.

3.6.4
The rotation direction of the motor will be as shown by either a nameplate on the motor or the outline drawing. The required phase rotation of the incoming power for this motor rotation may also be stated. If either is unknown, the correct sequence can be determined in the following manner: While the motor is uncoupled from the load, start the motor and observe the direction of rotation. Allow the motor to achieve full speed before disconnecting it from the power source. Refer to the operation section of these instructions for information concerning initial start-up. If resulting rotation is incorrect, it can be reversed by interchanging any two (2) incoming cables.

3.6.5 Auxiliary devices
Auxiliary devices such as resistance temperature detectors, thermocouples, thermoguards, etc., will generally terminate on terminal blocks located in the auxiliary terminal box on the motor. Other devices may terminate in their own enclosures elsewhere on the motor. Such information can be obtained by referring to the outline drawing. Information regarding terminal designation and the connection of auxiliary devices can be obtained from auxiliary drawings or attached nameplates.
If the motor is provided with internal space heaters, the incoming voltage supplied to them must be exactly as shown by either a nameplate on the motor or the outline drawing for proper heater operation.

Caution must be exercised anytime contact is made with the incoming space heater circuit as space heater voltage is often automatically applied when the motor is shutdown.

4. OPERATION

4.1 Examination before start

4.1.1
When motors are installed in good manner, ensure the wiring is according to the diagram. Also, the following points should be noted:

(a) Make sure all wiring is correct.
(b) Ensure the sizes of cable wires are appropriate and all connections are well made for the currents they will carry.
(c) Ensure all connections are properly insulated for the voltage and temperature they will experience.
(d) Ensure the capacity of fuses, switches, magnetic switches and thermo relays etc. are appropriate and the contactors are in good condition.
(e) Make sure the frame and terminal box are grounded.
(f) Make sure that the starting method is correct.
(g) Make sure switches and starters are set at their right positions.
(h) Motor heaters must be switched off when the motor is running.

4.1.2 Measurement of insulation resistance

During and immediately after measuring, the terminals must not be touched as they may carry residual dangerous voltages. Furthermore, if power cables are connected, make sure that the power supplies are clearly disconnected and there are no moving parts.

(a) For rated voltage below 1000V, measured with a 500VDC megger.
(b) For rated voltage above 1000V, measured with a 1000VDC megger.
(c) In accordance with IEEE 43, clause 9.3, the following formula should be applied:

$$R \geq \left(\frac{\text{Rated voltage (v)}}{1000} + 1 \right) \times 10(M\Omega)$$

(d) On a new winding, where the contaminant causing low insulation resistance is generally moisture, drying the winding through the proper application of heat will normally increase the insulation resistance to an acceptable level. The following are several accepted methods for applying heat to the winding:
   (1) If the motor is equipped with space heaters, they can be energized to heat the winding.
   (2) Direct current (as from a welder) can be passed through the winding. The total current should not exceed approximately 50% of rated full load current. If the motor has only three leads, two must be connected together to form one circuit through the winding. In this case, one phase will carry the fully applied current and each of the others, one-half each. If the motor has six leads (3 mains and 3 neutrals), the three phases should be connected into one series circuit.

Ensure there is adequate guarding so live parts cannot be touched.

   (3) Heated air can either blown directly into the motor or into a temporary enclosure surrounding the motor. The source of heated air should preferably be electrical as opposed to fueled (such as kerosene) where a malfunction of the fuel burner could result in carbon entering the motor.

ATTENTION!
Caution must be exercised, when heating the motor with any source of heat other than self contained space heaters, to raise the winding temperature at a gradual rate to allow any entrapped moisture to vaporize and escape without rupturing the insulation. The entire heating cycle should extend over 15-20 hours.

Insulation resistance measurements can be made while the winding is being heated. However, they must be corrected to 40ºC for evaluation since the actual insulation resistance will decrease with increasing temperature. As an approximation for a new winding, the insulation resistance will approximately halve for each 10ºC increase in insulation temperature above the dew point temperature.

(e) Should the resistance fail to attain the specified value even after drying, careful examination should be undertaken to eliminate all other possible causes, if any.

4.1.3 Power Source

(a) Ensure the capacity of the power source is sufficient.
(b) Ensure the supply voltage and frequency ratings are identical to those on the nameplate.
(c) Voltage variation should be confined to within ±10% of the rated value and the phase to phase voltages should be balanced.

4.1.4 Bearing lubrication

(a) For sleeve bearing motors, the oil reservoir must be filled with oil to the correct level. On self-lubricated bearings, the standstill oil level will be at the center of the oil gauge. The proper oil is a rust and oxidation inhibited, turbine grade oil. Refer to the lubrication nameplate for the recommended viscosity.

(b) Motors, which are supplied with provision for flood lubrication, have an inlet orifice to meter the oil flow to the bearing. Refer to the outline drawing for these values. If the supply pressure does not match that stated on the outline, the orifice size must be adjusted to produce the specified flow rate. The drain adapter (also provided) has a weir plate fixed to the inside of the pipe to permit the establishment of the proper oil level. This weir plate must be located at the bottom of the pipe and must be parallel to the plane of the motor feet. To ensure optimum flow, the drain line should be vented to the atmosphere.

Oil inlet temperature:	Normal below 50ºC
	Alarm 60ºC
	Trip 65ºC

(c) If the motor is in storage for over three (3) months, refilling of some new oil should be undertaken before operation to prevent bearing damage due to dry friction. The oil level should be kept at the center of the oil gauge. If necessary, drain some oil after refilling.

(d) Motors that have been designed with anti-friction bearings for use with an oil mist lubrication system have been packed at the factory with a small amount of grease for short test runs. Continuous running should not be considered unless the oil mist system is installed and operating.

(e) Grease lubricant type

(1) The bearings have been well greased at the factory before delivery. However, regreasing is required if a significant period has elapsed between manufacture and use or in storage

(2) All motors with ZZ bearings will have SHELL Alvania R3 (*Lithium base grease*). All motors with open bearings will have Polyrex EM (polyurea base grease).

4.1.5 Cooling water for the cooler on water-cooled motors

Make sure the quality, volume and inlet temperature of cooling water for the motors are normal before the machine is in operation.

Water: General tower water or industrial water.

Volume: Please see outline drawing

Inlet temperature:	Normal below 30ºC
	Alarm 35ºC
	Trip 40ºC

ATTENTION!
Make sure all locks, which fasten the movable parts of the motors during transportation, are dismantled and the shaft can rotate freely.

ATTENTION!
Ensure there is no foreign matter or tools inside the motors before starting motors.

4.1.6
Make sure the transmission system, including belts, screws, bolts, nuts and set pins are in good condition.

⚠ **The keys fitted to the shaft extensions are held by plastic tape only to prevent them from falling out during transportation or handling. The shaft key shall be removed to avoid flying out, when the motor is operated prior to the couplings etc. being fitted to the shaft extension.**

4.1.7
Make sure the items above are examined. Test the motor running with or without load. Record and check according to "Maintenance" at 15-minute intervals during the first three hours of operation. Then regular examinations should take place at longer intervals. If all goes well the motor can be classified as "in good order".

4.2 Starting operation

4.2.1 Starting load
Initially run the motor unloaded prior to coupling to other machines. Unless otherwise specified, a motor usually starts with light load, which is then gradually increased, proportional to the square of the speed and at last reaches 100% load at full load speed.

4.2.2 Starting
Too frequent starts can be harmful to the motors. The following restrictions should be observed:
- (a) Motor can be restarted should the initial start fail. Two starts are generally permissible when the motor is cold.
- (b) Motor can be started only once when it is at normal running temperature.
- (c) Should additional starts be necessary beyond the conditions stated above, the following restrictions should be noted:
  - (1) Let the motor cool down for 60 minutes before restarting, fully loaded.
  - (2) Let the motor cool down for 30 minutes before restarting, unloaded.
  - (3) Two inching starts can be regarded as one normal start.

ATTENTION!
If the motor rotor fails to start turning within one or two seconds, shut off the power supply immediately.
Investigate thoroughly and take corrective action before attempting a restart.

Possible reasons for not starting are:
(1) Too low a voltage at the motor terminals.
(2) The load is too much for the rotor to accelerate.
(3) The load is frozen up mechanically.
(4) All electrical connections have not been made.
(5) Single-phase power has been applied.
(6) Any combination of the above.

4.2.3 Rotating direction

(a) Most TWMC motors are bi-directional. However, when some special types, such as high speed 2-Pole, certain large capacity motors, those with a non-reversing ratchet etc., should rotate in one direction, please ensure the rotation is in conformity with the directional arrow-mark shown on the attached nameplate.

(b) To reverse a bi-directional motor, cut the power and wait until the motor stops. Then interchange any two of the three phases.

4.2.4 Power source, Voltage, Current

(a) Ensure the voltage and frequency of the power source are identical to the ratings shown on the nameplate.

(b) Voltage variation should be confined to within ±10% of the rating and the three phase voltages should be in full balance

(c) Ensure the motor phase currents, when without load, are within ±5% of the average values.

4.2.5

Frequency variation should be confined to within ±5% of the rating. The aggregate variation of voltage and frequency should be confined to within ±10% of the absolute value of the ratings.

Starting time and unusual noises

> **ATTENTION!**
> **Starting time is longer for the motors with large inertia. However, if starting time is longer than usual or if there is difficulty in starting, or there is abnormal noise, do not run the motor and refer to TWMC Service representative.**

4.2.6 Sleeve bearing oil rings (sleeve bearing types only)

As the oil ring is used to carry lubricant to sleeve bearings, frequently check to ensure the oil ring is in motion.

4.2.7 Bearing temperature rise

Following the initial start-up, the bearing temperatures should be closely monitored. The rate of rise in bearing temperature is more indicative of impending trouble than is the actual temperature.

> **ATTENTION!**
> **If the rate of rise in temperature is excessive or if the motor exhibits excessive vibration or noise, it should be shut down immediately and a thorough investigation made as to the cause before it is operated again.**

If the bearing temperature rise and motor operation appear to be normal, operation should continue until the bearing temperature stabilizes.

Recommended limits on bearing temperature are as follows:

Sleeve Bearings	**Total measured temperature**
● By permanently installed detector	90ºC
● By temporary detector on top of the bearing sleeve near the oil ring	85ºC

Anti-Friction Bearings	Total measured temperature
● By permanently installed detector	100ºC
● By temporary detector measuring the outside of the bearing housing	95ºC

ATTENTION! (For sleeve bearing)

(1) It must be noted that when operating flood lubricated sleeve bearings without outside lubrication supplied, the bearing temperature must not be allowed to exceed 85ºC total temperature

(2) Under normal condition, for the self-lube bearing, the rate of temperature rise should be from 11 to 14ºC for the first ten (10) minutes after starting up and approximately 22ºC at thirty (30) minutes. The rate of bearing temperature rise is a function of the natural ventilation and operating conditions.

(3) When the rate of bearing temperature rise is less than 1ºC per half-hour, the bearing temperature is considered to be stabilized.

(4) If the total bearing temperature exceeds 95ºC, the motor should be shut down immediately.

Noise and Vibration

ATTENTION!
Any abnormal noise or vibration should be immediately investigated and corrected. Increased vibration can be indicative of a change in balance due to mechanical failure of a rotor part, a stator winding problem or a change in motor alignment.

5. MAINTENANCE

5.1 Major points in regular inspections and maintenance.

For safety, maintenance and repairs must only be carried out by properly trained personnel.

Some testing, such as insulation resistance, usually requires the motor to be stopped and isolated from power supplie(s).

Routine inspection and maintenance are usually performed by looking, listening, smelling and simple meters.

High temperature may arise under operating conditions on the motor surfaces, so that touching should be prevented or avoided. Keep away from moving and live parts. Unless deemed necessary, do not remove guards whilst assessing the motor.

Timely replacement of worn parts can assure longevity and prevent breakdown.

Routine inspection and regular inspection and maintenance are important in preventing breakdown and lengthening service life.

Owing to the varied time and circumstances, motors are used, it is difficult to set the items and periods for regular inspection and maintenance. However, as a guide it is recommended to be performed periodically according to factory maintenance program. Generally, the inspection scope determined by the following factors:

(a) Ambient temperature.
(b) Starting and stopping frequency.
(c) Troublesome parts usually affecting motor functions.
(d) Easily abraded parts.
(e) The important position of motor in the operational system of a factory should be duly recognized. Therefore, its health and wellbeing should be fully protected especially when it is operating in severe conditions.

5.2 Motor windings:

(a) Measurement of insulation resistance and standards to determine quality of insulation resistance, please refer to measures stated in 3.1.2 "Measurement of insulation resistance".
(b) Inspection of coil-ends:
    (1) Grease and dust accumulated on coils may cause insulation deterioration and poor cooling effect.
    (2) Moisture must not accumulate. Keep coils warm when motor is not in use if moisture can be seen.
    (3) Discoloring. This is mainly caused by overheating.
(c) Ensure no untoward change of wedges from original position.
(d) Ensure the binding at the coil end is in its normal position.

5.3 Clean the interior of the motor:

(a) After a motor is in operation for some time, accumulation of dust, carbon powder and grease etc., on the inside is unavoidable, and may cause damage. Regular cleaning and examination is necessary to assure top performance.
(b) Points to note during cleaning:
    (1) If using compressed air or blower:
        (a) Compressed air should be free of moisture.
        (b) Maintain air pressure at 4 kg/cm², since high pressure can cause damage to coils.
    (2) Vacuum
        Vacuum cleaning can be used, both before and after other methods of cleaning, to remove loose dirt and debris. It is a very effective way to remove loose surface contamination from the winding without scattering. Vacuum cleaning tools should be non-metallic to avoid any damage to thee winding insulation
    (3) Wiping
        Surface contamination on the winding can be removed by wiping using a soft, lint-free wiping material. If the contamination is oily, the wiping material can be moistened (not dripping wet) with a safety type petroleum solvent. In hazardous locations, a solvent such as inhibited methyl chloroform may be used, but must be used sparingly and immediately removed. While this solvent is non-flammable under ordinary conditions, it is toxic and proper health and safety precautions should be followed while using it.

ATTENTION!
Solvents of nay type should never be used on windings provided with abrasion protection. Abrasion protection is a gray, rubber-like coating applied to the winding end-turns.

⚠ **Adequate ventilation must always be provided in any area where solvents are being used to avoid the danger of fire, explosion or health hazards. In confined areas (such as pits) each operator should be provided with an airline respirator, a hose mask or a self-contained breathing apparatus. Operators should wear goggles, aprons and suitable gloves. Solvents and their vapors should never be exposed to open flames or sparks and should always be stored in approved safety containers.**

(4) Keep core ducts completely clean. The difference in temperature rise could be around 10°C before and after cleaning

5.4 Clean the exterior of the motor:

(a) On open ventilated motors, screens and louvers over the inlet air openings should not be allowed to accumulate any build-up of dirt, lint, etc. that could restrict free air movement.

ATTENTION!
Screens and louvers should never be cleaned or disturbed while the motor is in operation because any dislodged dirt or debris can be drawn directly into the motor.

(b) If the motor is equipped with air filters, they should be replaced (disposable type) or cleaned and reconditioned (permanent type) at a frequency that is dictated by conditions. It is better to replace or recondition filters too often than not often enough.
(c) Totally enclosed air to air cooled and totally enclosed fan cooled motors require special cleaning considerations. The external fan must be cleaned thoroughly since any dirt build-up not removed can lead to unbalance and vibration. All of the tubes of the air-to-air heat exchanger should be cleaned using a suitable tube brush having synthetic fiber bristles (not wire of any type).

5.5 Maintenance of anti-friction bearings

5.5.1 Frequency of re-lubrication:

The life of grease varies greatly as a result of types of model, revolution speed, temperature, operational conditions etc. It is, therefore, impossible to be precise about replenishment intervals. However, for normal direct coupling transmission, the periods shown as Table 1 may be used as a guide.

Remarks:

(a) The periods shown in Table 1 should be halved where bearings are used for belt drive and/or in dirty or high ambient temperature or high humidity environments.
(b) Please refer to the lubrication nameplate, if attached to the motor.
(c) For bearing numbers outside the range of Table 1, please contact TWMC

(d) If the periods referred to in Table 1 for drive-end bearing and opposite drive-end are different, for the convenience of maintenance operation, please take the shorter one the required grease replenishment period of these bearings.

5.5.1 Kinds of grease:

All motors with ZZ bearings will have SHELL Alvania R3 (lithium base grease). All motors with open bearings will have Polyrex EM (polyurea base grease).
Certain T-frame models will utilize special grease and will be noted on the lubrication nameplate. Please us identical grease or its equivalents when maintaining lubrication schedule.

ATTENTION!
Do not mix different kinds of grease.
Mixing grease with different type of thickeners may destroy its composition and physical properties. Even if the thickeners are of the same type, possible differences in the additive may cause detrimental effects.

5.5.2 Grease quantity

The amount of grease per replenishment depends on the type, size and construction of the bearings. The maximum amount of one replenishment for each bearing is shown in Table 2.

5.5.3 Re-greasing

If re-lubrication is to be performed when the motor is running, stay clear of rotating parts.

It is advisable to re-grease when the motor is running to allow the new grease to be evenly distributed inside the bearing.
Before re-greasing, the inlet fitting should be thoroughly cleaned to prevent any accumulated dirt from being carried into the bearing with the new grease. The outlet of grease drainage should be opened to allow the proper venting of old grease.

Use a grease gun to pump grease through grease nipple into the bearings. After re-greasing, operate the motor for 10-30 minutes to allow any excess grease to vent out.

TABLE 1.

Bearing Number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM	3000 RPM	3600 RPM
62XX 63XX 72XX 73XX	6210	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.
	12	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.
	13	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	1000 Hrs.	1000 Hrs.
	14	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	1000 Hrs.	1000 Hrs.
	15	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	720 Hrs.	720 Hrs.
	16	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	720 Hrs.	720 Hrs.
	17	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.		
	18	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.		
	20	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.		
	22	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	1500 Hrs.	1500 Hrs.		
	24	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	1500 Hrs.	1500 Hrs.		
	26	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.		
	28	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.		
	30	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	500 Hrs.	500 Hrs.		
	32	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	1500 Hrs.	1500 Hrs.	500 Hrs.	500 Hrs.		
	34	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	1500 Hrs.	1500 Hrs.				
	36	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.				
	38	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.				

Bearing Number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
NU2XX NU3XX	NU214	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.
	15	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.
	16	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.
	17	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	1500 Hrs.	1500 Hrs.
	18	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	1500 Hrs.	1500 Hrs.
	20	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	1000 Hrs.	1000 Hrs.
	22	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.
	24	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.
	26	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	500 Hrs.	500 Hrs.
	28	3000 Hrs.	3000 Hrs.	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	500 Hrs.	500 Hrs.
	30	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.	500 Hrs.	500 Hrs.
	32	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.		
	34	3000 Hrs.	3000 Hrs.	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.		
	36	2000 Hrs.	2000 Hrs.	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.		
	38	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.	1000 Hrs.	1000 Hrs.		
	40	2000 Hrs.	2000 Hrs.	1000 Hrs.	1000 Hrs.				
	44	1000 Hrs.	1000 Hrs.	1000 Hrs.	1000 Hrs.				
	48	1000 Hrs.	1000 Hrs.	1000 Hrs.	1000 Hrs.				

Bearing Number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
222XX 223XX	22220	1000 Hrs.	1000 Hrs.	1000 Hrs.	1000 Hrs.	500 Hrs.	500 Hrs.	300 Hrs.	300 Hrs.
	22	1000 Hrs.	1000 Hrs.	1000 Hrs.	1000 Hrs.	500 Hrs.	500 Hrs.		
	24	1000 Hrs.	1000 Hrs.	1000 Hrs.	1000 Hrs.	500 Hrs.	500 Hrs.		
	26	1000 Hrs.	1000 Hrs.	1000 Hrs.	1000 Hrs.	500 Hrs.	500 Hrs.		
	28	1000 Hrs.	1000 Hrs.	500 Hrs.	500 Hrs.	300 Hrs.	300 Hrs.		
	30	1000 Hrs.	1000 Hrs.	500 Hrs.	500 Hrs.	300 Hrs.	300 Hrs.		
	32	1000 Hrs.	1000 Hrs.	500 Hrs.	500 Hrs.	300 Hrs.	300 Hrs.		
	34	500 Hrs.	500 Hrs.	500 Hrs.	500 Hrs.				
	36	500 Hrs.	500 Hrs.	500 Hrs.	500 Hrs.				
	38	500 Hrs.	500 Hrs.	300 Hrs.	300 Hrs.				
	40	500 Hrs.	500 Hrs.	300 Hrs.	300 Hrs.				
	44	300 Hrs.	300 Hrs.						
	48	300 Hrs.	300 Hrs.						

TABLE 2.

Bearing No.		Amount of replenishment
62XX 72XX NU2XX 2222XX	6210	30 g
	6212	40
	6213	50
	6214	50
	6215	60
	6216	60
	6217	80
	6218	80
	6220	100
	6222	120
	6224	120
	6226	140
	6228	160
	6230	180
	6232	200
	6234	250
	6236	300
	6238	350
	6240	400
	6244	450
	6248	500

Bearing No.		Amount of replenishment
63XX 73XX NU223XX 223XX	6310	40 g
	6312	60
	6313	80
	6314	80
	6315	100
	6316	100
	6317	120
	6318	120
	6320	160
	6322	220
	6324	270
	6326	300
	6328	400
	6330	450
	6332	500
	6334	600
	6336	700
	6338	800
	6340	900
	6344	900
	6348	900

*Fill new grease until it overflows and the old grease is entirely replaced.

5.5.4 Oil re-lubrication (For oil lubrication types only)

Maintain proper lubrication by checking the oil level periodically and adding oil when necessary. Because of the initial clearing action of the bearing and the expansion of the oil as it comes up to operating temperature, the oil level will be higher after the motor has been in operation for a while than it is with the motor at standstill.
Overfilling should be avoided not only because of the possibility that expansion may force the oil over the oil sleeve and on to the rotor, but also because too high an operating oil level prevents the bearing form clearing itself of excess oil. The resultant churning can cause extra loss, high temperatures, and oxidized oil. If, during operation, the oil level goes above the maximum shown on the sight gauge, drain enough oil to bring the level back within the recommended operating range. **Do not permit the operating level to fall below the minimum shown on the gauge.**

ATTENTION!
Should it ever become necessary to add excessive amount of make-up oil, investigate immediately for oil leaks.

Change the oil at regular intervals. The time between oil changes depends upon the severity of operating conditions and, hence, must be determined by the motor user. Two or three changes a year is typical, but special conditions, such as high ambient temperature, may require more frequent changes. Avoid operating the motor with oxidized oil.
Use only good grade, oxidation-corrosion-inhibited turbine oils produced by reputable oil companies.

The viscosity of the oil to be used depends upon the type and size of the bearings, its load and speed, the ambient temperature, and the amount and temperature of the cooling water (if used)). The lubrication nameplate or instructions with each motor specifies the viscosity range of oil suitable for average conditions. The usual oil viscosity range of oil suitable for average conditions. The usual oil viscosity recommendations are summarized in Table 3. Operation in ambient temperatures that are near or below freezing may require preheating the oil or the use of special oil. Whenever the motor is disassembled for general cleaning and reconditioning, the bearing housing may be washed out with a suitable cleaning solvent. Be sure that the oil-metering hole is clear, and then dry the housing thoroughly before re-assembly, and ensure all traces of cleaning solvent have been removed.

TABLE 3 Oil Viscosity**

Bearing function and location	Bearing Type	Oil Viscosity - SSU	
		@ 100°F	@ 200°F
Thrust Bearing	72XX, 73XX Angular contact ball And/or (62XX, 63XX)	150	45
	Spherical roller	300	53
	Plate (Kingsbury Type)	300	53

**Remark: When a lubrication nameplate attached to the motor, use lubrication oil it stipulates.

5.5.5 Cleaning and installation of bearings

(a) Apply the proper amount of grease to the disassembled parts of the bearing after they have been thoroughly cleaned with high quality cleaning oil. Then protect them from contamination before and during assembly.

(b) Bearing installation

ATTENTION!
Before installing the bearings, make sure that the shaft mounted parts inside the bearings are in place before installation.

Since the bearing is a high precision component, it is important to avoid ingression of dust and foreign matter, and hammering during cleaning and installation. Use extreme care and insure clean conditions during installation and assembly.

ATTENTION!
The best way for bearing installation is heat shrinking. Knocking and hammering during installation should be avoided absolutely.

The bearing should be heated in a bath of clean oil at a temperature of approximately 80°C. After warming, slide the bearings in place quickly and nimbly so that it has not shrunk before being fully in position.
Grease the bearing after the temperature returns to normal, and then reassemble the motor.

5.6 Maintenance of sleeve bearings

5.6.1 Daily inspections

(a) Ensure the volume and quality of lubrication oil are in compliance with specifications.

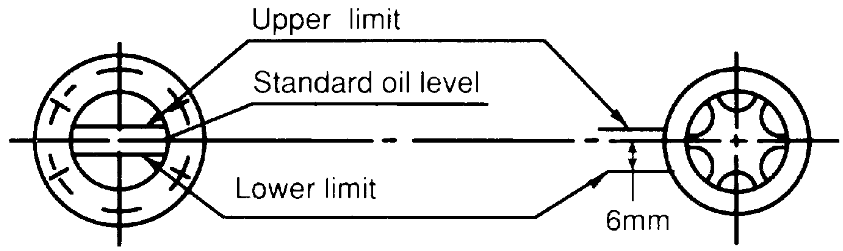


Fig. 12

(b) Ensure there is motion of the oil ring and it is not clamped.
(c) The indicator of the shaft endplay should be restricted within the specified range of the red groove of the shaft or the ±3mm (.118 in.) range of the drive-end shaft shoulder, or the bearing may be damaged.

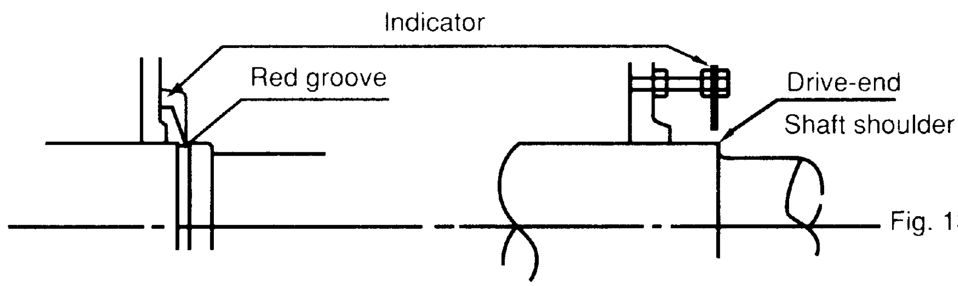


Fig. 13

5.6.2 Regular examination

(a) Periodical change of oil
The oil reservoirs of self (not flood) lubricated bearings should be drained and refilled about every six (6) months. More frequent changes may be needed on high speed (3600 rpm) motors or if severe oil discoloration or contamination occurs. In conditions where contamination does occur, it may be advisable to flush the reservoir with kerosene to remove any sediment before new oil is added. Proper care must be taken to thoroughly drain the reservoir of the flushing material before refilling with the new oil.
Refill the reservoir to the center of oil sight glass with a rust and oxidation inhibited turbine grade oil. Refer to the outline and lubrication nameplate for the correct viscosity.
(b) Quantity of lubrication oil
Please refer to the lubrication nameplate for oil quantity.
(c) Oil viscosity
(d)

ISO	Equivalents	Viscosity (SUS/100°F)
VG32	Esso Teresso 32	150
VG46	Esso Teresso 46	200
VG68	Esso Teresso 68	300

5.6.3 Disassembly

⚠ **Prior to disassembling, ensure the power supplies are disconnected and there are no moving parts.**

The bearing sleeve is of the spherically seated, self-aligning type. The opposite drive end bearing is normally insulated for larger motors (or when specified). On some motors, the insulation is bonded to the spherical seat of the bearing housing.

ATTENTION!
Extreme care must be exercised in removing the bearing sleeve from the insulated support to avoid damaging this insulation.

The following is the recommended procedure for removing the bearing sleeve:

(a) Remove the oil drain plug in the housing bottom and drain the oil sump.

(b) Remove all instrumentation sensors that are in contact with the bearing sleeve. These would include resistance temperature detectors, thermocouples, thermometers, etc..

(c) Remove the socket head bolts holding the bearing cap and the inner air seal. The end cover plate must also be removed if the non-drive end bearing is being disassembled. Remove the bearing cap and top half of the inner air seal. Place them on a clean, dry surface to avoid damage to the parting surfaces.

(d) Remove the top half of the bearing sleeve using suitable eyebolts in the tapped holes provided. Lift the bearing top straight up and avoid any contact with the shoulders of the shaft journals that might damage the thrust faces of the bearing. Place on a clean, dry surface taking care to prevent damage to either the parting surfaces or the locating pins that are captive n the top bearing half.

(e) Remove the screws at the partings in the oil ring and dismantle the ring by gently tapping the dowel pin ends with a soft face mallet. Remove the ring halves and immediately reassemble them to avoid any mix up I parts or damage to the surfaces at the partings.

(f) Pull up on the garter spring surrounding the floating labyrinth seal and carefully slip out the top half. Rotate the garter spring until the lock is visible. Twist counter-clockwise to disengage the lock, remove the garter spring then rotate the lower half of the seal out of the groove in the bearing housing. Note the condition of these floating labyrinth seals. If they are cracked or chipped, they must be replaced. Do not attempt to reuse a damaged seal.

(g) To remove the bottom bearing half, the shaft must be raised a slight amount to relieve pressure on the bearing. On the drive end, this can be done by jacking or lifting on the shaft extension. Protect the shaft. On the non-drive, jacing or lifting can be done using bolts threaded into the tapped holes provided in the shaft end.

(h) Roll the bottom bearing half to the top of the shaft journal and then lift it using suitable eyebolts threaded into the holes provided. Again avoid any contact with the shaft shoulders that could damage the bearing thrust faces. Place the lower bearing half on a clean, dry surface to protect the parting surfaces.

Use extreme care when rolling out the lower bearing half. Keep the hands and fingers well clear of any position where they might be caught by the bearing half if it were accidentally released and rotated back to its bottom position. Serious personal injury could result.

(i) Protect the shaft journal by wrapping it with clean, heavy paper or cardboard.

5.6.4 Re-assembly

Bearing re-assembly is basically a reverse of the disassembly procedures outlined above, with the following suggestions:

(a) The interior of the bearing housing should be cleaned and then flushed with clean oil or kerosene.

(b) The bearing halves and the shaft journal should be wiped clean using lint-free cloth soaked with clean oil.

(c) All parts should be carefully inspected for nicks, scratches, etc., in any contract surfaces. Such imperfections should be removed by an appropriate method such as stoning, scraping, filling, etc., followed by thorough cleaning.

(d) Before installing the floating labyrinth seal halves, observe their condition. Do not attempt to use a cracked or chipped seal. The bottom half seal has a set of drilled holes in its side face. These must be place at the bottom toward the inside of the bearing so that accumulating oil may drain back into the housing.

(e) Put a bead of Curil-T around the seal half O.D.'s on both sides adjacent to the garter spring groove. This will prevent oil by-passing the seal around its outside.

(f) Place the bottom seal half on top of the shaft and roll it into position. Install the top half and insert the garter spring pulling up on both ends to permit engaging the lock. Run a bead of Curil-T around the O.D's on both sides adjacent to the garter spring groove on this half also.

(g) Carefully reassemble the two oil ring halves. Inspect the dowel pins for burrs and straightness and make any corrections required. Do not force the ring halves together. Excessive force may alter the roundness or flatness of the oil ring which can change its oil delivery performance.

(h) Some of the pipe plugs in the housing are metric thread type. These are identified as those, which have a copper, lead, or similar material washer. If these plugs are removed, be careful not to lose the washers. Before re-assembly, inspect the washers and replace them as required.

(i) Before installing the bearing cap, observe the position of the floating labyrinth seal. The "tab" must be on top to engage the pocket. Failure to position the seal properly will result in damage when the cap is assembled.

ATTENTION!

(1) Curil-T is the only approved compound for use in the assembly of the bearings on this motor. Other products may harden and impede the operation.

(2) During the re-assembly of the bearing parts, a thin layer of Curil-T should be applied to all gaskets and machined interface surfaces. This suggestion does not apply to the machined surfaces of the bearing liner halves.

(3) When seating the bearing shell, apply a thin layer of lube oil at the spherical surface of the liner. Slowly roll the lower bearing liner into the bearing housing making sure that the splinted surface of the liner and the housing are flush. Gradually lower the shaft onto the bearing. The weight of he shaft will help rotate the bearing liner so that the babbitt surface of the liner will match the slope of the journal. Sometimes it is required to use a rubber mallet to tap lightly on the bearing housing while slowly rolling the shaft to help this seating operation.

5.7 Maintenance of slip ring (For Wound Rotor Motors only)

Ensure motor is disconnected from power supplies and there are no accessible moving parts before maintenance operation.

5.7.1 Adjustment of carbon brush

(a) Brush pressure for normal operation:

- Electro-graphite brush…..0.2~0.25 kg/cm²
  When frequent vibrations are evident or the brush is small (area below 0.5 cm²), the pressure should be greater than as shown.

(b) Adjustment of brush pressure:

The brush pressure should be adjusted to keep normal operation as it wears.

- The brush pressure may be reduced after use, so it is necessary to re-adjust. For adjustment, please turn adjusting screw, pressure adjusting pin or pressure adjusting plate as shown in Fig. 14 to obtain the correct tension (=0.23 x brush cross sectional area in cm²) ±10% kg.

(c) Brush pressure need not be adjusted if constant force spring is used as shown in Fig. 15 and Fig. 16.

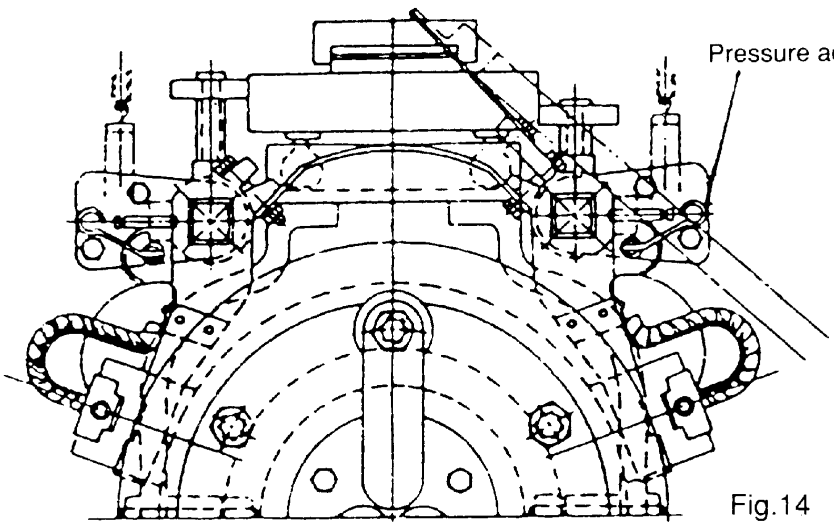


Fig.14

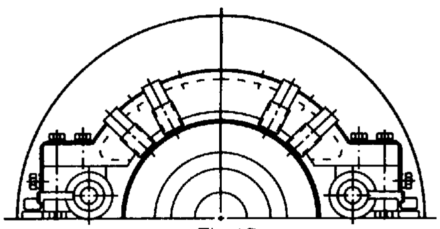


Fig.15

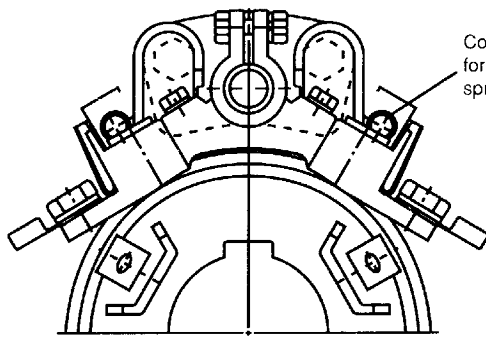


Fig.16

5.7.2 Brush replacement

The carbon brush is a part of the equipment which is easily worn away, replace it after it is worn to ½ ~ ¾ of original size.

(a) Brush material

The brush material is important to the performance of the motor. Only the most appropriate materials are chosen by TWMC, and are listed on the nameplate of the motor. It is important to know this when you replace the brush, so a recommended type is used.

(b) Dimensions

Brush, holder and gap between them, please refer to CNS 2322 C4051 or JIS C2802.

ATTENTION!
The gap between a brush and it holder is important for good performance and safety of the motor.

(c) Adjustment of new brushes (Shown in Fig. 17)

(1) Polish the new brush with a file until is assumes the appropriate contour of the slip ring which it touches.

(2) Place sand-paper (JIS R6252 No. 40…50) on the slip ring with the abrasive face of the paper against the brush to induce a closer contact by rubbing against each other.
(3) Repeat item 2 with fine sand –paper (JIS R6252 No. 100 to 200) until the contact surface between brush and slip ring exceeds 80%.
(4) Finally, clean the contaminated slip ring and brush with clean cloth or compressed air.

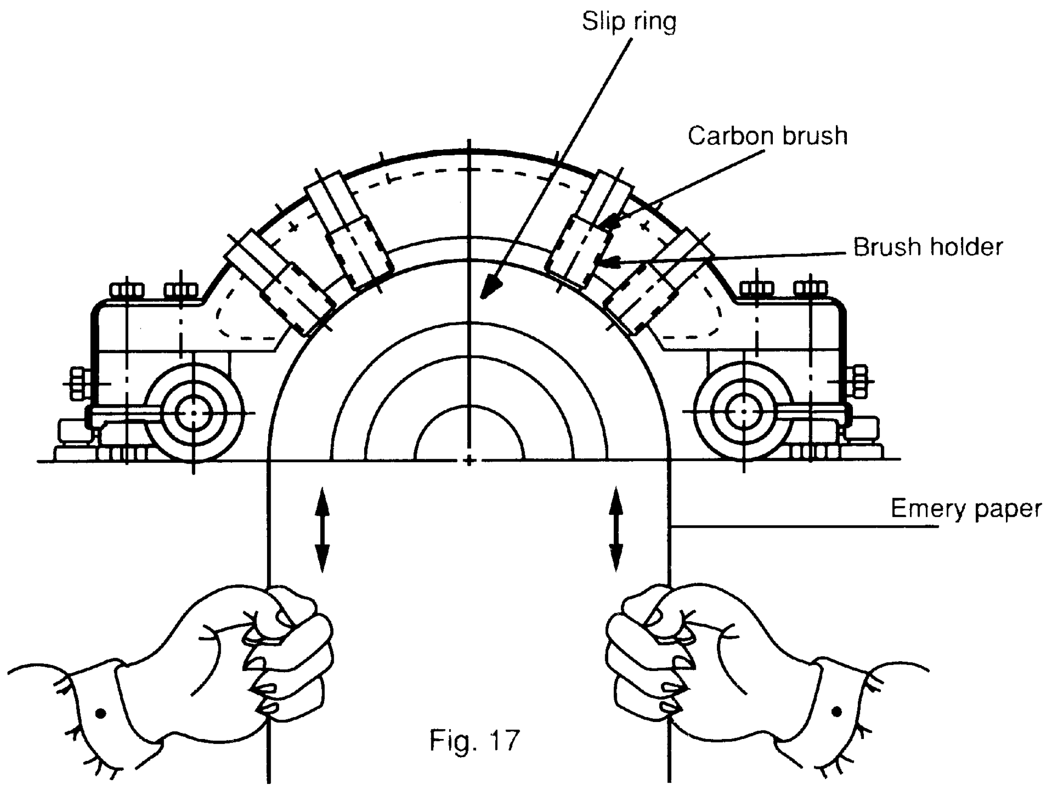


Fig. 17

5.8 Maintenance of non-reverse ratchet mechanism (For Vertical high Thrust Motor only)

5.8.1

In the pump piping system, a check valve and a stop valve should be installed in the discharge line. The check valve, placed between the pump and the stop valve, is to protect the pump from reverse flow and excessive backpressure. The stop valve is used in priming, starting and when shutting down the pump. It is advisable to close the stop valve before stopping the pump. This is especially important when the pump is operated against a high static head.

TWMC vertical high thrust motors are equipped with non-reverse ratchet (N.R.R.) mechanism only when requested by the pump manufacturer. Typical construction of the N.R.R. mechanism is shown as Fig 18 below.

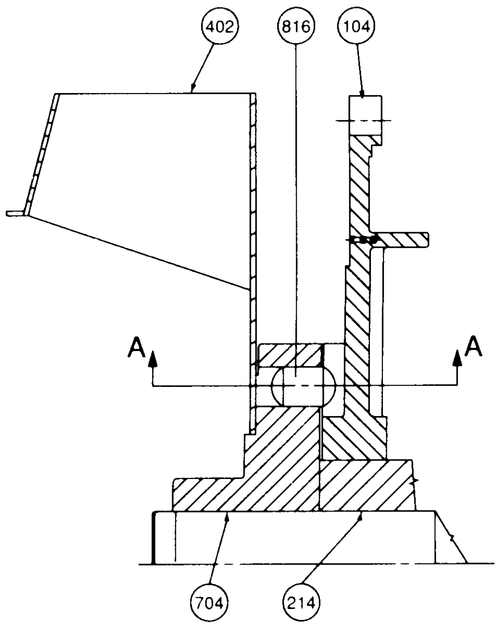
The N.R.R. mechanism keeps the pump and motor from rotating in the reverse direction. Thus prevents damage from over-speeding and damage to water-lubricated pump shaft bearings when, on shutdown, the falling water column tends to drive the pump in the reverse direction. In normal operation, the ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed. When power is removed, the speed decreases and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.

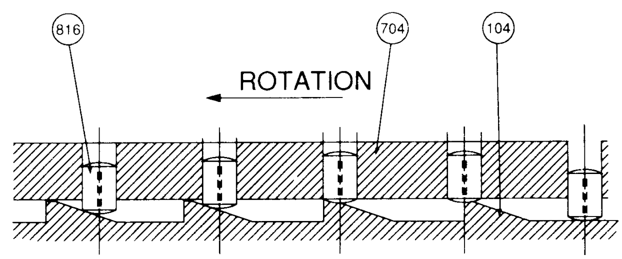
5.8.2

The service life of ratchet pins depends not only on the reverse shock load between the pin and ratchet tooth when pump stopped but also the frequency of pump starting and stopping while in service. Provided that the pins are deformed due to this reverse shock load, then the up and down motion of the ratchet pins could be sluggish or jammed and that unusual noises shall arise.

The recommended replacement period for these ratchet pins is every three (3) years. If the reverse shock load is greater than 30% of motor rated torque or the starting frequency is more than twice per day, then the replacement period should be halved.

ATTENTION!
The check valve and stop valve in the discharge line should be regularly inspected and maintained to assure the normal function of these valves. This is important to protect the pump and motor from damage and increase the service life of the N.R.R. mechanism.





SECTION A-A

ITEM	NAME
104	RATCHET
214	BEARING SEAT
402	EXTERNAL FAN
704	RATCHET PIN CARRIER
816	RATCHET PIN

Fig. 18

6. FAULT FINDING AND RECOGNITION

Kinds of Breakdown	Symptoms	Possible Causes	Remedies
Fail to start without load	Motionless and soundless	Power-off	Consult power company
		Switch-off	Switch-on
		No fuse	Install fuse
		Broken wiring	Check wiring and repair
		Broken lead	Check wiring and repair
		Broken windings	Check windings and repair
	Fuse blowing. (Automatic switch trips off, slow start with electromagnetic noise)	Short circuit of circuit switches	Check circuit switches and replace
		Incorrect wiring	Check wiring according to nameplate
		Poor contact at terminal	Lock tightly
		Windings grounded	Factory repair
		Broken windings	Factory repair
		Poor contact of circuit switches	Check and repair
		Broken wiring	Check and repair
		Poor contact of starting switches	Check and repair
		Short circuit of starting switches	Check and repair
		Incorrect connections of starting switches	Connect according to nameplate
Loading after start	Fuse blowing. Fail to restart due to trip-off of automatic switch	Insufficient capacity of fuse	Replace fuse if wiring permits
		Overload	Lighten load
		High load at low voltage	Check circuit capacity and reduce load
	Overheating motor	Overload or intermittent overload	Lighten load
		Under-voltage	Check circuit capacity and power source
		Over-voltage	Check power source
		Ventilation duct clogged	Remove the foreign matter in the duct
		Ambient temperature exceeds 40°C	Correct insulation class to B or F, or lower ambient temperature
		Friction between rotor and stator	Factory repair
		Fuse blown (Single-phase rotating)	Install the specified fuse
		Poor contact of circuit switches	Check and repair
		Poor contact of circuit starting switches	Check and repair
		Unbalance three-phase voltage	Check circuit or consult power company

Kinds of Breakdown	Symptoms	Possible Causes	Remedies
Loading after start	Speed falls sharply	Voltage drop	Check circuit and powers source
		Sudden overload	Check machine
		Single-phase rotating	Check circuit and repair
	Switch overheat	Insufficient capacity of switch	Replace switch
		High load	Lighten load
	Bearing over-heating	High belt tension	Adjust belt tension
		Slack belt tension	Adjust belt tension
		Misalignment between motor and machine shafts	Re-align
		Over speed of bearing outer-ring	Adjust bracket
		High bearing noise	Replace the damaged bearing
Noise	Electromagnetic noise induced by electricity	Occurrence from its first operation	May be normal
		Sudden sharp noise and smoking	Short circuit of windings should be repaired at the factory
	Bearing noise	Noise of low shishi or Thru-Thru	May be normal
		Kala-Kala as a result of poor lubrication	Grease
		Kulo-Kulo as a result of poor lubrication	Clean bearing and grease
		Sa-Sa or larger noise	Replace the damaged bearing
	Mechanical noise caused by machinery	Loose belt sheave	Adjust key and lock the screw
		Loose coupling or skip	Adjust the position of couplings, lock key and screw
		Loose screw on fan cover	Lock fan cover screw tightly
		Fan rubbing	Adjust fan position
		Rubbing as a result of ingression of foreign matter	Clean motor interior and ventilation ducts
		Wind noise	Noise induced by air flowing through ventilation ducts
		Induced by conveyance machine	Repair machine
Vibration	Electromagnetic vibration	Short circuit of winding	Factory repair
		Open circuit of rotor	Factory repair
	Mechanical vibration	Unbalanced rotor	Factory repair
		Unbalanced fan	Factory repair
		Broken fan blade	Replace fan
		Unsymmetric centers between belt sheaves	Align central points
		Central points of couplings do not lie on the same level	Adjust the central points of couplings to the same level
		Improper mounting installation	Lock the mounting screws
		Motor mounting bed is not strong enough	Reinforce mounting bed

Remarks:

(1) Circuit switches: These include knife switches, electromagnetic switches, fuse and other connection switches etc.

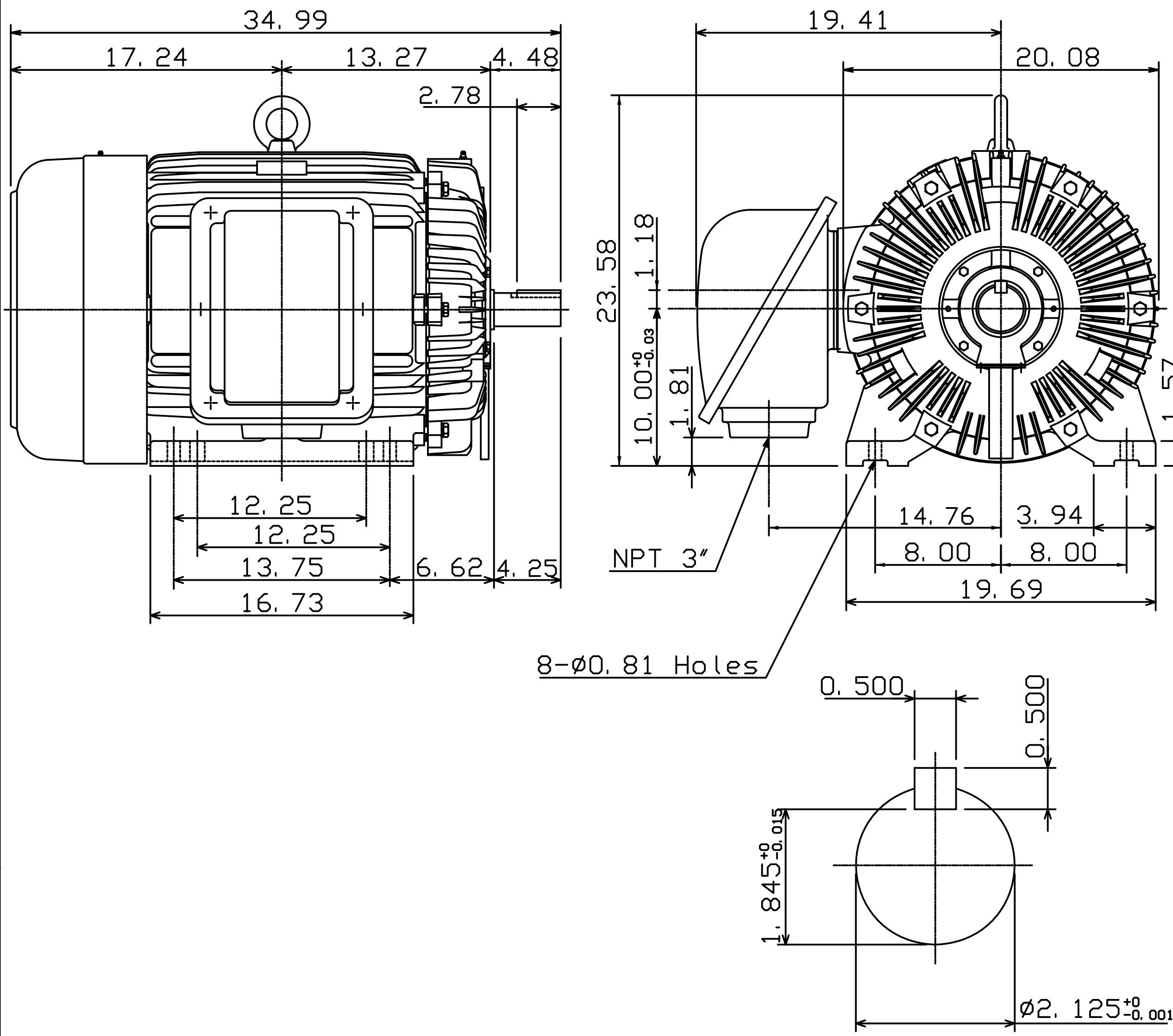
(2) Starting switches: These include Delta-Star starters, compensate starters, reactance starters, resistor starters, starting controller’s etc.

DATE	OUTLINE DIMENSIONS	MOTOR TYPE:
Sept. 6, 2005	3-PHASE INDUCTION MOTOR	AEEANE
CAT. #: N1002		FRAME NO. 405TS

Pole	HP	kW	Hz	VOLT	Syn. Speed r/min(rpm)
2	100	74.6	60	230/460	3600

Ins	Rating	Dimension in	Approx Weight	Bearings
F	CONT.	inch	1184	DE: 6313C3 NDE: 6313C3

Totally Enclosed Fan Cooled Type. Squirrel-cage Rotor.



DWN.	K. L. KUO	01·08·05	TECO Westinghouse	DWG NO.
CHKD.	C. H. KAO	01·28·05		31049M241570
APPD.	M. C. TSAI	01·28·05		

TECO Westinghouse

ISSUED	PERFORMANCE DATA	ENCLOSURE
03/08/05	3-PHASE INDUCTION MOTOR	TEFC
TYPE		CATALOG#
AEEANE		N1002

NAMEPLATE INFORMATION

OUTPUT		POLE	FRAME SIZE	VOLTAGE	HZ	RATED AMBIENT	INS. CLASS	NEMA DESIGN	TIME RATING	SERVICE FACTOR
HP	KW									
100	75	2	405TS	230/460	60	40°C	F	B	CONT.	1.15

TYPICAL PERFORMANCE

FULL LOAD RPM	EFFICIENCY				POWER FACTOR			MAXIMUM POWER FACTOR CORRECTION
	FULL LOAD		3/4 LOAD %	1/2 LOAD %	F. L. %	3/4 LOAD %	1/2 LOAD %	
	MIN. %	NOM. %						
3560	92.4	93.6	95	95	91.5	90.5	88	15 KVAR

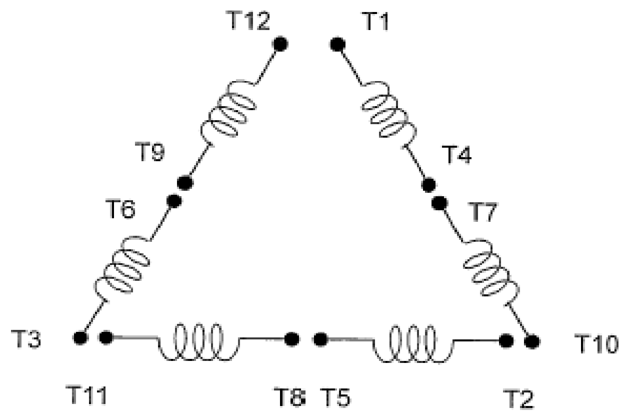
CURRENTS									NEMA KVA CODE LETTER
NO LOAD			FULL LOAD			LOCKED ROTOR			
AT 208 VOLT	AT 230 VOLT	AT 460 VOLT	AT 208 VOLT	AT 230 VOLT	AT 460 VOLT	AT 208 VOLT	AT 230 VOLT	AT 460 VOLT	
42.46	38.40	19.20	242.16	219.00	109.50	1603.37	1450.00	725.00	G

TORQUE				INERTIA			ACCEL TIME	
FULL LOAD lb-ft	LOCKED ROTOR %FLT	PULL UP %FLT	BREAK DOWN %FLT	ROTOR WR^2 lb-ft^2	NEMA LOAD WK^2 lb-ft^2	MAX ALLOWABLE WK^2 lb-ft^2	NEMA LOAD WK^2 Sec	MAX ALLOWABLE WK^2 Sec
147.5	150	130	280	10.773	92	183	3.90	7.35

SAFE STALL TIME IN SECONDS		ALLOWABLE STARTS PER HOUR		SOUND PRESSURE LEVEL @ 3 FT dB(A)
COLD	HOT	COLD	HOT	
17	12	2	1	95

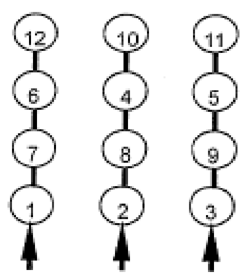
APPROVED:	M. PRATER	DRAWING NO.	31057N1002	REVISION 0

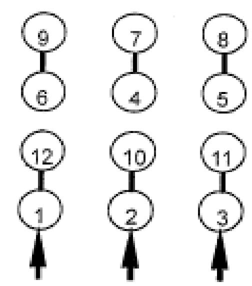
DATE:	CONNECTION DIAGRAM	CATALOG NO.:
July 26, 2005		**N1002**



SCHEMATIC - Δ / Y CONNECTION

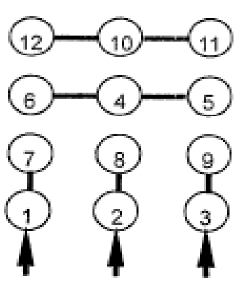
ACROSS THE LINE CONNECTION

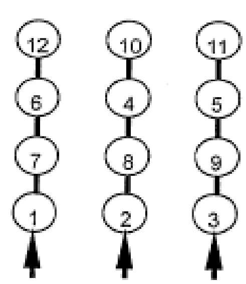


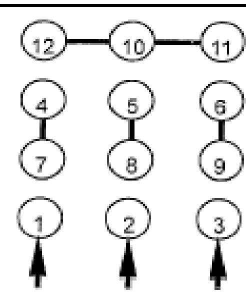


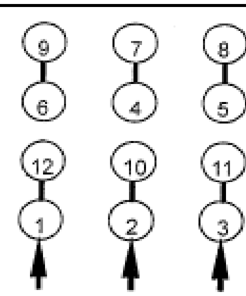
LINE 230 VOLT CONNECTION	LINE 460 VOLT CONNECTION

WYE START-DELTA RUN CONNECTION









LINE	LINE	LINE	LINE
230 VOLT START	230 VOLT RUN	460 VOLT START	460 VOLT RUN

TECO Westinghouse

DWG NO.
DAC-1565-4

OPERATION
&
MAINTENANCE
MANUAL
FOR
THREE PHASE
INDUCTION
MOTORS

TECO-Westinghouse Motor Company
5100 North IH-35
Round Rock, Tx. 78681

INDEX PAGE

1. INTRODUCTION

This and the following instruction address the more common situations encountered in motor installation, operation and maintenance. For the TWMC motor warranty to be and to remain in effect, the motor must be installed and operated in strict accordance with the outline drawing, motor nameplates and these instructions and must not be altered or modified in any unauthorized manner.

During the installation and operation of motors in heavy industrial applications there is a danger of live electrical parts and rotating parts. Therefore to prevent injury and/or damage the basic planning work for installation, transportation, assembly, operation, etc... needs to be done and checked by authorized and competent personnel only.

Since these instructions cannot cover every eventuality of installation, operation and maintenance, the following points should be considered and checked.

- The technical data and information on permissible use such as assembly, connection, ambient and operating conditions given in the related catalogue, operating instructions, nameplates and other production documentation.
- The general erection and safety regulations.
- The local and plant-specific specifications and requirements.
- The proper use of transport, lifting devices and tools.
- The use of personal protective equipment.

Following indications should be observed when reading these instructions.

Safety instructions are marked as follows:

Warning of electric hazards for personnel.

Warning of dangers for personnel.

ATTENTION!
Warning of damage for the motor or installation.

2. ACCEPTING, INSPECTION, STORAGE, TRANSPORTATION

Inspection upon receipt
Check to following points upon receipt:

- Are the nameplate ratings identical with what you ordered?
- Are dimensions and color in compliance with your specifications?
- Are the nameplate ratings for space heater, thermal protector, temperature detector, etc. identical with what you ordered?
- Is there any damage?
- Are all accessories and accompanying instruction manuals in good order?
- Please ensure that the arrow head indicator really indicates direction of rotation.
- If there are any specific requirements, please ensure they are in conformity with your specifications.

2.1 Storage
When motors are not in operation, the following precautionary measures should be undertaken to assure best performance.

2.2 Place
(a) High and dry, well ventilated without direct sun, dust or corrosive gas.
(b) Not located near to a boiler or freezer.
(c) Entirely free form vibration and easy for movements.
(d) Motors should be put on pallets to prevent moisture.

2.3 Moisture prevention
Since moisture can be very detrimental to electrical components, the motor temperature should be maintained about 3ºC above the dew point temperature by providing either external or internal heat. If the motor is equipped with space heaters, they should be energized at the voltage shown by the space heater nameplate attached to the motor. Incandescent light bulbs can be placed within the motor to provide heat. However, if used, they must not be allowed to come in contact with any parts of the motor because of the concentrated hot spot that could result.

2.4
Even during storage, the insulation resistance should be kept above the specified values.
(a) For measurement of insulation resistance and acceptable standard values, please refer to measures stated in 3.1.2 "Measurement of insulation resistance".
(b) Insulation resistance test should be performed once every three months.

2.5

If the motor is not in operation for a long period (one week and above) after installation or has been in operation but stopped for a period of time, the following precautions must be taken.

(a) Protect the motor as measures stated in 2.2.3.
(b) Insulation resistance test should be performed as stated in 2.2.4.

2.6 Bearing protection

(a) If the motor has been provided with a shaft shipping brace to prevent shaft movement during transit, it must be removed before operating the motor. It is very important that this brace be re-installed exactly as it was originally, before the motor is moved form storage or any time when the motor is being transported. This prevents axial rotor movement that might damage the bearings.
(b) Motors equipped with sleeve bearings are shipped from the factory with the bearing oil reservoirs drained. In storage, the oil reservoirs should be properly filled to the center of the oil level gauge with a good grade of rust inhibiting oil. To keep the bearing journals well oiled and to prevent rusting, the motor shaft should be rotated several revolutions about every month ensuring the shaft does not come to rest in its original position. While the shaft is rotating, it should be pushed to both extremes of the endplay.
(c) Motors with anti-friction bearings are properly lubricated with the correct grade of grease at the factory and no further greasing is required in storage. The shaft should be rotated several revolutions about every month to maintain proper distribution of the grease within the bearings.
(d) Tilt-pad bearings are a type of sleeve bearing used in special design applications. Due to the nature of this bearing, a loose oil ring for delivering lubricant cannot be provided. Therefore, during the storage internal, oil must be periodically manually introduced into the pads and housing to prevent the occurrence of oxidation of the precision machined components.
    (1) Remove the pipe plug from the bearing cap located above the tilt-bearing shell.
    (2) Pour in approximately one cup of oil every month and rotate the shaft a few revolutions about every two (2) weeks.
    (3) For long periods of storage, the oil that accumulates in the housing should be removed.

ATTENTION!
Care should be taken to keep parts such as fitting surfaces, key, shaft extension and axial central hole from any collision with foreign matter. Grease should also be generously applied to prevent rusting.

2.7 Transportation

To keep the rotating parts of motors from moving, thus preventing damage and scratching during transportation, they should be held securely with a locking device. Remove all transit clamps before operating the motor. It is very important that this device be reinstalled exactly as it was originally, before the motor is moved from storage or any time when the motor is being transported. The vertical mounting type motors should be transported in the vertical position.

⚠ **Do not use the hoisting hook/eyebolts to lift more that the motor itself. They are designed to support the motor only. Make sure the hoisting hook is correctly attached to the eyebolt(s)/lug(s) are fully screwed in before hoisting. Also note such parts as fan cover, ventilation box, bracket, slip-ring, etc. may have their own hoisting lugs which can only carry their own weight. Nothing extra should be attached while hoisting.**
Do not twist the steel wires and make sure the eyebolts have been firmly screwed and the sling angle is correct.

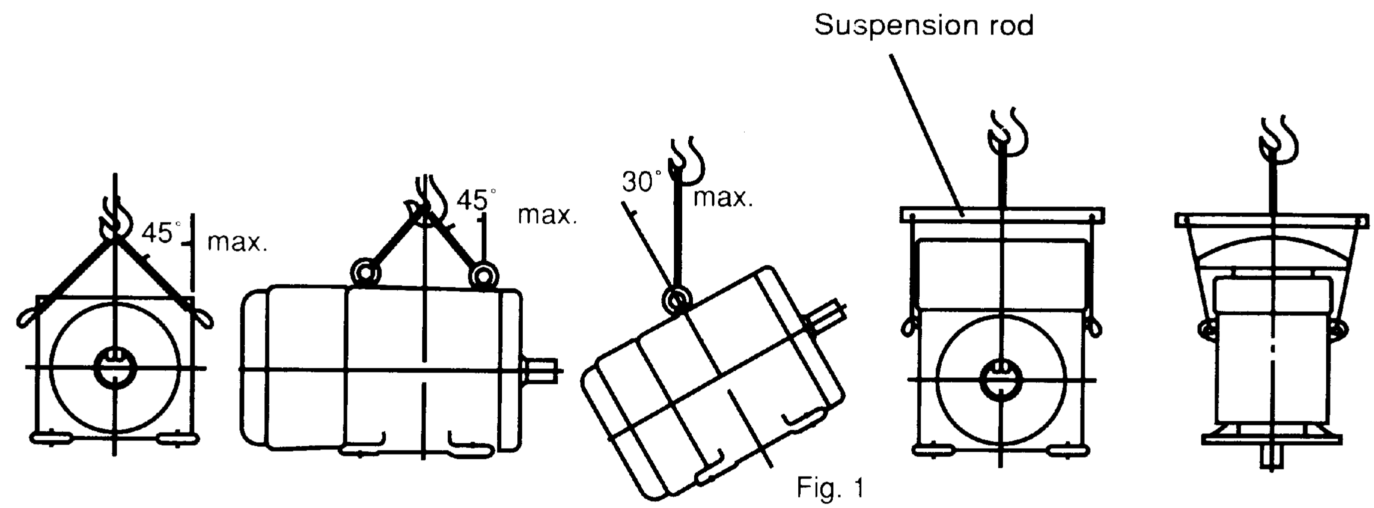


Fig. 1

3 INSTALLATION

Site and environment for motor installation
3.1.1
Standard environment and site conditions for the installation of motors are usually set as follows:
(a) Ambient temperature: -10~40ºC
(b) Humidity: Relative humidity below 90%RH for totally enclosed types, and below 80%RH for semi-enclosed types.
(c) Elevation: below 1000 meters or 3300 feet.
(d) Harmful gases, liquids, dusts, high moisture should be absent.
(e) Foundations should be strong and free of vibration.

If there are any special environmental conditions, please inform TWMC prior o ordering.

3.1.2 Ventilation and space
(a) Installation area should be well ventilated.
(b) The installation space should be large enough to facilitate heat dissipation and maintenance.

3.2 Foundation
3.2.1
Use rigid and solid sole plate or common bed as foundation.
For best motor performance, it is advisable to use a sole plate or common bed, particularly when using a shaft coupling.

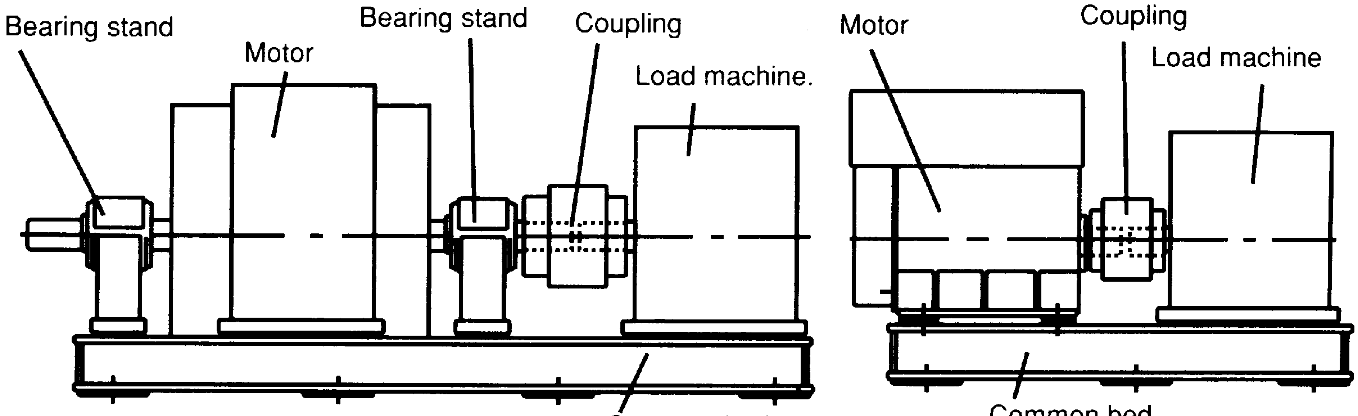


Fig. 2

3.2.2 Installation

(a) Select an appropriate foundation surface for the sole plate or common bed, which will be, considered the ultimate level.
(b) Align the position of the common bed with reference to that level.
(c) Align the level accuracy at least at four points such as bearing mounting, shaft extension etc. The accuracy should be within 0.04mm or .0015 inches
(d) Sole plate or common bed should be embedded in concrete foundation as illustrated in Fig. 3. Stiff pads should also be installed beneath the wedges, which are welded together at various spots about 400-500mm (15.75-19.70 inches) apart etc., to enable the foundation to carry evenly the weight of the whole motor.
(e) The base should be sturdy and rigid to keep it flat and level.
(f) Make sure the mortar and concrete are completely dry, and the precision of the level is acceptable, and then set the motor on the mounting foundation.
(g) Accurately install shaft couplings, belt sheaves etc., then weld the wedges solid to prevent untoward change in position.

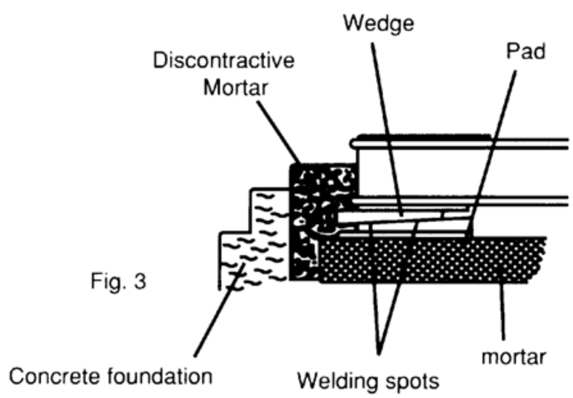


Fig. 3

3.2.3 The foundation of vertical induction motors: (Also the foundation of pump)

(a) Foundation of motor/pump must be rigid and secure to provide adequate support. There must be no vibration, twisting, misalignment etc. due to inadequate foundations.
(b) A massive concrete foundation is preferred in order to minimize vibration. Rigidity and stability are enhanced by prop plate and foundation bolt. As shown in Fig. 4.

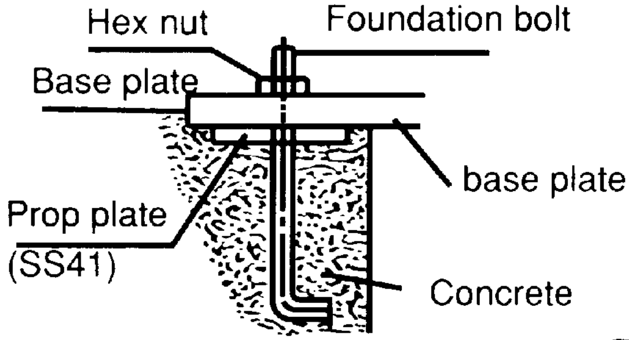


Fig. 4

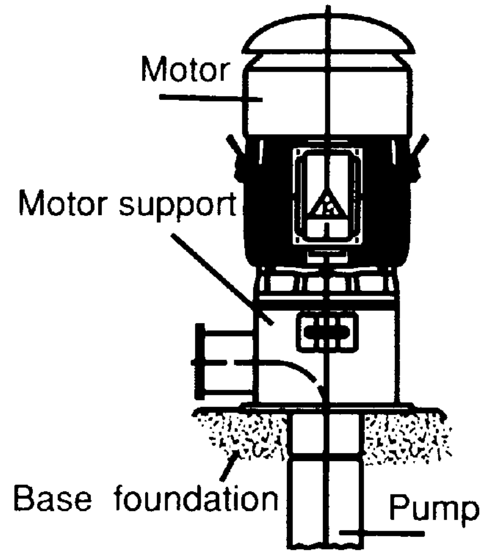


Fig. 5

3.2.4 Installation of vertical motors:

(a) All mounting surfaces must be clean and level.
(b) Foundation must be leveled at least at 4 points and guaranteed to be below 0.04mm (.0015 in.) flat and level.
(c) Make sure the mortar and concrete are completely dry, and the precision of the level is acceptable, and then set the motor on the mounting foundation.
(d) Accurately install shaft couplings.

3.3 Installation of shaft coupling

ATTENTION!
Motors must always be accurately aligned, and this applies especially where they are directly coupled.
Incorrect alignment can lead to bearing failure, vibration and even shaft fracture. As soon as bearing failure or vibration is detected, the alignment should be checked.

3.3.1

Field application of a coupling to the motor shaft should follow the procedures recommended by the coupling manufacturer. The motor shaft extension must not be subjected to either extreme heat or cold during coupling installation.

ATTENTION!
Basically, the coupling should be heated and pushed onto the shaft extension with slight axial force. Do not hammer coupling to prevent bearing damage.

3.3.2

Although the sleeve bearings are equipped with thrust faces, these are intended only to provide momentary axial restraint of rotor movement either during start-up or when operating the motor disconnected from the driven equipment. They must not be operated under a constant thrust load unless they were originally designed for this condition.

Motors with either sleeve or anti-friction bearings are suitable for connection to the driven load through a flexible coupling. Coupling solidly to the load is not acceptable. With sleeve bearings, the flexible coupling should be of the limited end float type to prevent the possibility of any end thrust from load being transmitted to the motor bearings, which could cause bearing damage. The recommended limits of end float are as follows:

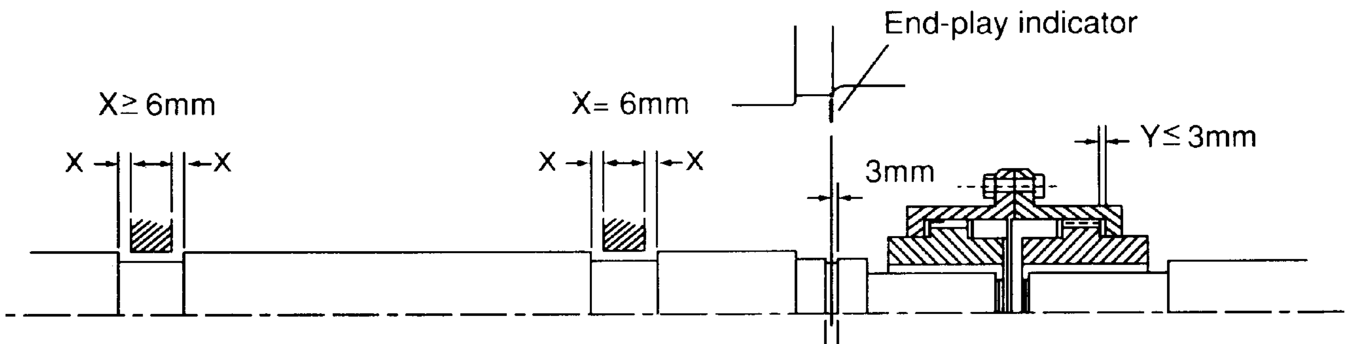


Fig. 6

(a) When the motor is in operation after installation, be sure that the end-play indicator is within the 6mm (.236 in.) of the groove on the shaft or aligned to the shaft shoulder immediately outboard of the drive-end bearing to assure there is low friction between shaft and bearing.
(b) Unless otherwise specified, the designed end-play value X of the groove for TWMC motors in general is within 6mm (.236 in.) as illustrated in Fig. 6. In essence, the endplay indicator is adjusted to point at the center of the groove or the drive-end shaft shoulder; thus X equals to 6±1mm or so, and the endplay value (Y) of the couplings should equal or be smaller than 3mm (.118 in.).
(c) If the desired value Y is grater than 3mmm (.118 in.) caused for instance by a thrust load and/or load machine with large end-play, please inform TWMC prior to entering an order.

3.3.3
In aligning the motor (and rotor) axially with the driven equipment, consideration should be given not only to the endplay indicator position but also to axial shaft expansion and increase in shaft centerline height due to thermal effects. In general, the axial shaft growth for motors can be disregarded since neither bearing is fixed and any shaft growth due to temperature increase will produce an elongation away from the coupling.

Shaft height growth (change in shaft centerline elevation) for TEFC machines can be calculated as follows:

$$\Delta = (0.0005'') \times (\text{motor foot to shaft £ dimension})$$

For non-TEFC machines, divide the number by 2.

3.3.4
It is desirable, in normal operation that the motor operates on its magnetic center, so that no axial force is exerted on the coupling.

The motor shaft and the driven shaft should be aligned within the following tolerances in both angular and parallel alignment:

Unit: mm

TIR	Range of rotating speed	Solid coupling	Flexible coupling
C	2500 rpm and above	0.03	0.03
	Below 2500 rpm	0.04	0.05
A	2500 rpm and above	0.03	0.03
	Below 2500 rpm	0.03	0.04

Angular misalignment is the amount by which the centerlines of driver and driven shafts are skewed. It can be measured using a dial indicator set up as shown in Fig. 7. The couplings are rotated together through 360 degrees so that the indicator does not measure runout of the coupling hub face. The shafts should be forced against either the in or out extreme of their end float while being rotated.

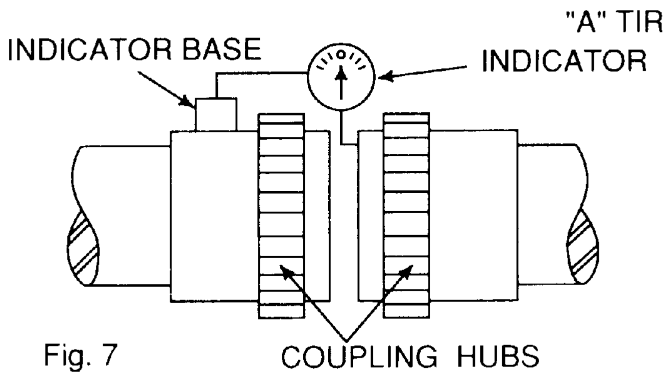


Fig. 7
TIR=Total indicator reading (by dial indicator)

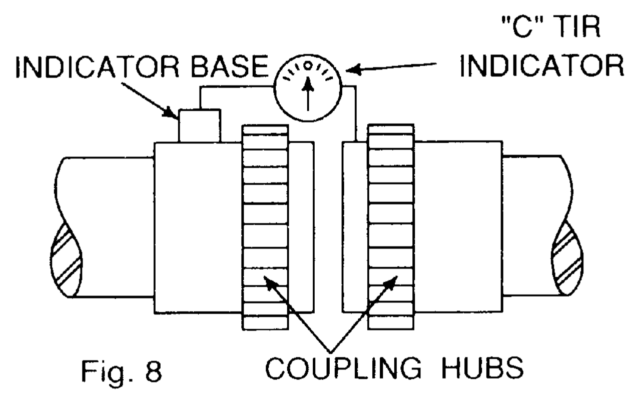


Fig. 8

Parallel misalignment is the amount by which the centerlines of the driver and driven shafts are out of parallel. It can be measured using a dial indicator set up as shown in Fig. 8. Again, the couplings are rotated together through 360 degrees so that the indicator does not measure runout of the coupling hub outside diameter.

3.3.5
After the motor has been properly aligned with the driven equipment and the hold-down bolts have been installed and tightened, for motors with fabricated frames, at least two dowel pins should be installed in two diagonally opposite motor feet.

3.3.6 Installation of shaft coupling: (Vertical hollow shaft motor only)
Bolted Coupling as shown in Fig. 9

(a) Bearings are provided to absorb some upward shaft thrust when the coupling is fitted.
(b) The coupling is fastened with bolts.
(c) This coupling type is not auto-release type.

Note: Standard high thrust motors can absorb momentary up-thrust load up to 30% of the standard down thrust load. If the up-thrust is long in duration (over 10 Seconds) and/or exceeds 30% of the standard high thrust rating, special design arrangements are required and standard motor is not suitable.

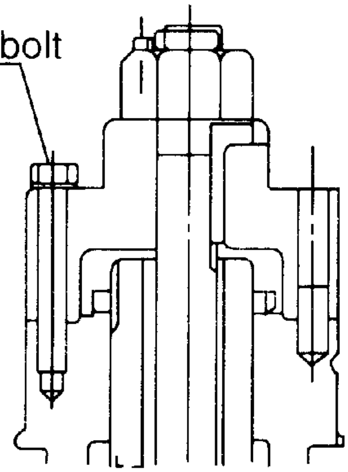


Fig. 9

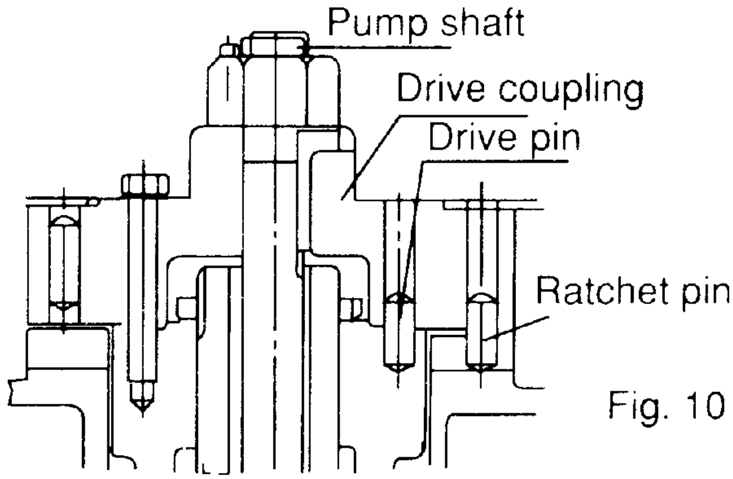


Fig. 10

3.3.7 Non-reverse ratchet/coupling, as Fig. 10 (If necessary)

The non-reverse coupling is also a bolted type and,

(a) It prevents the pump and motor from rotating in the reverse direction.
(b) It also prevents damage form over speeding and damage to pump shaft and bearings.
(c) The ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed.
(d) When power is removed, speed decreases, and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.
(e) When installing the non-reverse coupling, do not use lubricant. Lubricant will interfere with proper operation. The top half of the coupling should seat solidly on the lower half and the pins should touch the bottom of the pockets between the teeth in the plate.
(f) As with the bolted coupling, the up-thrust capabilities are 30% of the standard high thrust rating for down thrust.

ATTENTION!
Do not apply non-reverse ratchets on applications in which the pump reversal time from shutdown (the instant the stop button is pressed) to zero speed is less than one second.

3.4 Installation for belt drive

In general, power transmission though direct flexible coupling is appropriate for large motors. Such motors are not suitable for belt, chain or gear connection unless specially designed for such service. However, for small and medium motors of which outputs within the ranges shown on table below, it is acceptable to use belt transmission as indicated. Beyond these ranges, do not apply belt sheaves unless specially designed.

3.4.1

The diameter ratio between conveyance sheaves should not be greater than 5 to 1 for flat belts, and 8 to 1 for V-belts. It is also advisable to limit the belt velocity to under 35m/sec (115 ft/sec) to limit belt abrasion and vibration. The smaller the outer diameter of the V-belt sheave, the greater the shaft bending stress will be. If the bending stress is in excess of the shaft fatigue stress, the shaft may break. Therefore, please inform TWMC when you have decided the size of the sheaves and the length of the belts upon ordering.

ATTENTION!
Place the sheave and belt as close as possible to the motor body (it is advisable to make x as shown in Fig. 11 equal to 0) to reduce the bending moment and improve shaft life.

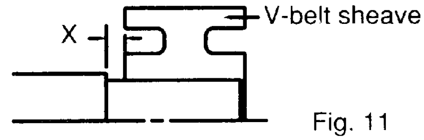


Fig. 11

3.4.2 Table of belt-sheave application for general electric motors

Output (KW/HP)			V-Belt Sheave							
			Conventional V-Belts				Narrow V-Belts			
4P	6P	8P	V-Belt Type	Number Of Belts	Min. PCD (mm)	Max Width (mm)	V-Belt Type	Number Of Belts	Min. PCD (mm)	Max Width (mm)
11/15	-	-	B	4	160	82	3V	4	125	48
-	11/15	-	B	5	170	101	3V	5	140	59
-	-	11/15	B	5	190	101	3V	6	160	69
15/20	-	-	B	5	170	101	3V	6	125	69
-	15/20	-	B	5	224	101	3V	6	160	69
-	-	15/20	C	4	224	111	5V	3	180	60
18.5/25	-	-	B	5	200	101	3V	6	140	69
-	18.5/25	-	C	4	224	111	5V	3	180	60
-	-	18.5/25	C	5	224	136	5V	4	180	78
22/30	-	-	B	5	224	101	5V	6	160	69
-	22/30	-	C	5	224	136	3V	4	180	78
-	-	22/30	C	5	250	136	5V	4	200	78
30/40	-	-	C	5	224	136	5V	4	180	78
-	30/40	-	C	5	265	136	5V	4	224	78
-	-	30/40	C	6	265	162	5V	5	224	95
37/50	-	-	C	6	224	162	5V	4	200	78
-	37/50	-	C	6	265	162	5V	4	224	78
-	-	37/50	C	7	280	187	5V	5	250	95
45/60	-	-	C	6	265	162	5V	4	224	78
-	45/60	-	C	7	280	187	5V	5	224	95
-	-	45/60	C	7	315	187	5V	6	250	113
55/75	-	-	C	7	265	187	5V	5	224	95
-	55/75	-	C	8	300	213	5V	6	250	113
-	-	55/75	D	5	355	196	5V	6	280	113
75/100	-	-	C	8	315	213	5V	6	250	113
-	75/100	-	D	6	355	233	5V	6	315	113
-	-	75/100	D	6	400	233	5V	6	355	113
-	90/120	-	D	6	400	233	5V	6	355	113
-	-	90/120	D	6	425	233	8V	4	355	124
-	110/150	-	D	7	400	270	8V	4	355	124
-	132/175	110/150	D	7	450	270	8V	4	400	124
-	160/200	132/175	D	9	450	344	8V	4	450	124

3.5 Conveyance with chain or gear

3.5.1

Make sure the loading capacity of shaft and bearings is appropriate for the size and installation position (overhung) of chain and gear. If necessary, please contact us to ensure the shaft and bearings will meet your requirements.

3.5.2
Pay close attention to ensure the parallelism of shafts.

3.5.3
The teeth of couplings should be correctly and precisely matched; the force conveyance centers should lie on the same line.

3.5.4
There should be no skip, jumping, vibration or unusual noises.

ATTENTION!
Do not hammer the conveyance devices such as couplings, belt sheaves, chain wheels, gears etc. onto the shaft. Those shaft fitments should be fitted and removed only by means of suitable devices. Heat shrinking may be a better alternative to avoid damaging bearings and components.

The exposed rotating parts should be covered to prevent accidents.

3.6 Electrical connections
All interconnecting wiring for controls and grounding should be in strict accordance with local requirements such as the USA National Electrical Code and UK IEE wiring regulations. Wiring of motor and control, overload protection and grounding should follow the instructions of connection diagrams attached to the motor.

3.6.1 Power
The rated conditions of operation for the motor are as shown on the nameplate. Within the limits, given below, of voltage and frequency variation from the nameplate values, the motor will continue to operate but with performance characteristics that may differ from those at rated conditions:

±10% of rated voltage
±5% of rated frequency
±10% combined voltage and frequency variation so long as frequency variation is no more than ±5% of rated.

Operating the motor at voltages and frequencies outside of the above limits can result in both unsatisfactory motor performance and damage to or failure of the motor.

3.6.2
The main lead box furnished with the motor has been sized to provide adequate space for the make-up of the connections between the motor lead cables and the incoming power cables.

The bolted joints between the motor lead and the power cables must be made and insulated in a workman-like manner following the best trade practices.

3.6.3
Either fabricated motors or fan cooled cast frame, motors are all provided with grounding pads or bolts.

The motor must be grounded by proper connection to the electrical system ground.

3.6.4
The rotation direction of the motor will be as shown by either a nameplate on the motor or the outline drawing. The required phase rotation of the incoming power for this motor rotation may also be stated. If either is unknown, the correct sequence can be determined in the following manner: While the motor is uncoupled from the load, start the motor and observe the direction of rotation. Allow the motor to achieve full speed before disconnecting it from the power source. Refer to the operation section of these instructions for information concerning initial start-up. If resulting rotation is incorrect, it can be reversed by interchanging any two (2) incoming cables.

3.6.5 Auxiliary devices
Auxiliary devices such as resistance temperature detectors, thermocouples, thermoguards, etc., will generally terminate on terminal blocks located in the auxiliary terminal box on the motor. Other devices may terminate in their own enclosures elsewhere on the motor. Such information can be obtained by referring to the outline drawing. Information regarding terminal designation and the connection of auxiliary devices can be obtained from auxiliary drawings or attached nameplates.
If the motor is provided with internal space heaters, the incoming voltage supplied to them must be exactly as shown by either a nameplate on the motor or the outline drawing for proper heater operation.

Caution must be exercised anytime contact is made with the incoming space heater circuit as space heater voltage is often automatically applied when the motor is shutdown.

4. OPERATION

4.1 Examination before start
4.1.1
When motors are installed in good manner, ensure the wiring is according to the diagram. Also, the following points should be noted:
(a) Make sure all wiring is correct.
(b) Ensure the sizes of cable wires are appropriate and all connections are well made for the currents they will carry.
(c) Ensure all connections are properly insulated for the voltage and temperature they will experience.
(d) Ensure the capacity of fuses, switches, magnetic switches and thermo relays etc. are appropriate and the contactors are in good condition.
(e) Make sure the frame and terminal box are grounded.
(f) Make sure that the starting method is correct.
(g) Make sure switches and starters are set at their right positions.
(h) Motor heaters must be switched off when the motor is running.

4.1.2 Measurement of insulation resistance

During and immediately after measuring, the terminals must not be touched as they may carry residual dangerous voltages. Furthermore, if power cables are connected, make sure that the power supplies are clearly disconnected and there are no moving parts.

(a) For rated voltage below 1000V, measured with a 500VDC megger.
(b) For rated voltage above 1000V, measured with a 1000VDC megger.
(c) In accordance with IEEE 43, clause 9.3, the following formula should be applied:

$$R \geq \left(\frac{\text{Rated voltage (v)}}{1000} + 1 \right) \times 10 (M\Omega)$$

(d) On a new winding, where the contaminant causing low insulation resistance is generally moisture, drying the winding through the proper application of heat will normally increase the insulation resistance to an acceptable level. The following are several accepted methods for applying heat to the winding:
   (1) If the motor is equipped with space heaters, they can be energized to heat the winding.
   (2) Direct current (as from a welder) can be passed through the winding. The total current should not exceed approximately 50% of rated full load current. If the motor has only three leads, two must be connected together to form one circuit through the winding. In this case, one phase will carry the fully applied current and each of the others, one-half each. If the motor has six leads (3 mains and 3 neutrals), the three phases should be connected into one series circuit.

Ensure there is adequate guarding so live parts cannot be touched.

   (3) Heated air can either blown directly into the motor or into a temporary enclosure surrounding the motor. The source of heated air should preferably be electrical as opposed to fueled (such as kerosene) where a malfunction of the fuel burner could result in carbon entering the motor.

ATTENTION!
Caution must be exercised, when heating the motor with any source of heat other than self contained space heaters, to raise the winding temperature at a gradual rate to allow any entrapped moisture to vaporize and escape without rupturing the insulation. The entire heating cycle should extend over 15-20 hours.

Insulation resistance measurements can be made while the winding is being heated. However, they must be corrected to 40ºC for evaluation since the actual insulation resistance will decrease with increasing temperature. As an approximation for a new winding, the insulation resistance will approximately halve for each 10ºC increase in insulation temperature above the dew point temperature.

(e) Should the resistance fail to attain the specified value even after drying, careful examination should be undertaken to eliminate all other possible causes, if any.

4.1.3 Power Source
(a) Ensure the capacity of the power source is sufficient.
(b) Ensure the supply voltage and frequency ratings are identical to those on the nameplate.
(c) Voltage variation should be confined to within ±10% of the rated value and the phase to phase voltages should be balanced.

4.1.4 Bearing lubrication

(a) For sleeve bearing motors, the oil reservoir must be filled with oil to the correct level. On self-lubricated bearings, the standstill oil level will be at the center of the oil gauge. The proper oil is a rust and oxidation inhibited, turbine grade oil. Refer to the lubrication nameplate for the recommended viscosity.

(b) Motors, which are supplied with provision for flood lubrication, have an inlet orifice to meter the oil flow to the bearing. Refer to the outline drawing for these values. If the supply pressure does not match that stated on the outline, the orifice size must be adjusted to produce the specified flow rate. The drain adapter (also provided) has a weir plate fixed to the inside of the pipe to permit the establishment of the proper oil level. This weir plate must be located at the bottom of the pipe and must be parallel to the plane of the motor feet. To ensure optimum flow, the drain line should be vented to the atmosphere.

Oil inlet temperature:	Normal below 50ºC
	Alarm 60ºC
	Trip 65ºC

(c) If the motor is in storage for over three (3) months, refilling of some new oil should be undertaken before operation to prevent bearing damage due to dry friction. The oil level should be kept at the center of the oil gauge. If necessary, drain some oil after refilling.

(d) Motors that have been designed with anti-friction bearings for use with an oil mist lubrication system have been packed at the factory with a small amount of grease for short test runs. Continuous running should not be considered unless the oil mist system is installed and operating.

(e) Grease lubricant type

(1) The bearings have been well greased at the factory before delivery. However, regreasing is required if a significant period has elapsed between manufacture and use or in storage

(2) All motors with ZZ bearings will have SHELL Alvania R3 (*Lithium base grease*). All motors with open bearings will have Polyrex EM (polyurea base grease).

4.1.5 Cooling water for the cooler on water-cooled motors

Make sure the quality, volume and inlet temperature of cooling water for the motors are normal before the machine is in operation.

Water: General tower water or industrial water.
Volume: Please see outline drawing

Inlet temperature:	Normal below 30ºC
	Alarm 35ºC
	Trip 40ºC

ATTENTION!
Make sure all locks, which fasten the movable parts of the motors during transportation, are dismantled and the shaft can rotate freely.

ATTENTION!
Ensure there is no foreign matter or tools inside the motors before starting motors.

4.1.6
Make sure the transmission system, including belts, screws, bolts, nuts and set pins are in good condition.

The keys fitted to the shaft extensions are held by plastic tape only to prevent them from falling out during transportation or handling. The shaft key shall be removed to avoid flying out, when the motor is operated prior to the couplings etc. being fitted to the shaft extension.

4.1.7
Make sure the items above are examined. Test the motor running with or without load. Record and check according to “Maintenance” at 15-minute intervals during the first three hours of operation. Then regular examinations should take place at longer intervals. If all goes well the motor can be classified as “in good order”.

4.2 Starting operation

4.2.1 Starting load

Initially run the motor unloaded prior to coupling to other machines. Unless otherwise specified, a motor usually starts with light load, which is then gradually increased, proportional to the square of the speed and at last reaches 100% load at full load speed.

4.2.2 Starting

Too frequent starts can be harmful to the motors. The following restrictions should be observed:

- (a) Motor can be restarted should the initial start fail. Two starts are generally permissible when the motor is cold.
- (b) Motor can be started only once when it is at normal running temperature.
- (c) Should additional starts be necessary beyond the conditions stated above, the following restrictions should be noted:
  - (1) Let the motor cool down for 60 minutes before restarting, fully loaded.
  - (2) Let the motor cool down for 30 minutes before restarting, unloaded.
  - (3) Two inching starts can be regarded as one normal start.

ATTENTION!
If the motor rotor fails to start turning within one or two seconds, shut off the power supply immediately.
Investigate thoroughly and take corrective action before attempting a restart.

Possible reasons for not starting are:

(1) Too low a voltage at the motor terminals.
(2) The load is too much for the rotor to accelerate.
(3) The load is frozen up mechanically.
(4) All electrical connections have not been made.
(5) Single-phase power has been applied.
(6) Any combination of the above.

4.2.3 Rotating direction

(a) Most TWMC motors are bi-directional. However, when some special types, such as high speed 2-Pole, certain large capacity motors, those with a non-reversing ratchet etc., should rotate in one direction, please ensure the rotation is in conformity with the directional arrow-mark shown on the attached nameplate.

(b) To reverse a bi-directional motor, cut the power and wait until the motor stops. Then interchange any two of the three phases.

4.2.4 Power source, Voltage, Current

(a) Ensure the voltage and frequency of the power source are identical to the ratings shown on the nameplate.

(b) Voltage variation should be confined to within ±10% of the rating and the three phase voltages should be in full balance

(c) Ensure the motor phase currents, when without load, are within ±5% of the average values.

4.2.5

Frequency variation should be confined to within ±5% of the rating. The aggregate variation of voltage and frequency should be confined to within ±10% of the absolute value of the ratings.

Starting time and unusual noises

ATTENTION!
Starting time is longer for the motors with large inertia. However, if starting time is longer than usual or if there is difficulty in starting, or there is abnormal noise, do not run the motor and refer to TWMC Service representative.

4.2.6 Sleeve bearing oil rings (sleeve bearing types only)

As the oil ring is used to carry lubricant to sleeve bearings, frequently check to ensure the oil ring is in motion.

4.2.7 Bearing temperature rise

Following the initial start-up, the bearing temperatures should be closely monitored. The rate of rise in bearing temperature is more indicative of impending trouble than is the actual temperature.

ATTENTION!
If the rate of rise in temperature is excessive or if the motor exhibits excessive vibration or noise, it should be shut down immediately and a thorough investigation made as to the cause before it is operated again.

If the bearing temperature rise and motor operation appear to be normal, operation should continue until the bearing temperature stabilizes.

Recommended limits on bearing temperature are as follows:

Sleeve Bearings	**Total measured temperature**
● By permanently installed detector	90ºC
● By temporary detector on top of the bearing sleeve near the oil ring	85ºC

Anti-Friction Bearings	**Total measured temperature**
● By permanently installed detector	100ºC
● By temporary detector measuring the outside of the bearing housing	95ºC

ATTENTION! (For sleeve bearing)
(1) It must be noted that when operating flood lubricated sleeve bearings without outside lubrication supplied, the bearing temperature must not be allowed to exceed 85ºC total temperature
(2) Under normal condition, for the self-lube bearing, the rate of temperature rise should be from 11 to 14ºC for the first ten (10) minutes after starting up and approximately 22ºC at thirty (30) minutes. The rate of bearing temperature rise is a function of the natural ventilation and operating conditions.
(3) When the rate of bearing temperature rise is less than 1ºC per half-hour, the bearing temperature is considered to be stabilized.
(4) If the total bearing temperature exceeds 95ºC, the motor should be shut down immediately.

Noise and Vibration

ATTENTION!
Any abnormal noise or vibration should be immediately investigated and corrected. Increased vibration can be indicative of a change in balance due to mechanical failure of a rotor part, a stator winding problem or a change in motor alignment.

5. MAINTENANCE

5.1 Major points in regular inspections and maintenance.

For safety, maintenance and repairs must only be carried out by properly trained personnel.

Some testing, such as insulation resistance, usually requires the motor to be stopped and isolated from power supplie(s).

Routine inspection and maintenance are usually performed by looking, listening, smelling and simple meters.

High temperature may arise under operating conditions on the motor surfaces, so that touching should be prevented or avoided. Keep away from moving and live parts. Unless deemed necessary, do not remove guards whilst assessing the motor.

Timely replacement of worn parts can assure longevity and prevent breakdown.

Routine inspection and regular inspection and maintenance are important in preventing breakdown and lengthening service life.

Owing to the varied time and circumstances, motors are used, it is difficult to set the items and periods for regular inspection and maintenance. However, as a guide it is recommended to be performed periodically according to factory maintenance program. Generally, the inspection scope determined by the following factors:

(a) Ambient temperature.
(b) Starting and stopping frequency.
(c) Troublesome parts usually affecting motor functions.
(d) Easily abraded parts.
(e) The important position of motor in the operational system of a factory should be duly recognized. Therefore, its health and wellbeing should be fully protected especially when it is operating in severe conditions.

5.2 Motor windings:

(a) Measurement of insulation resistance and standards to determine quality of insulation resistance, please refer to measures stated in 3.1.2 "Measurement of insulation resistance".
(b) Inspection of coil-ends:
 (1) Grease and dust accumulated on coils may cause insulation deterioration and poor cooling effect.
 (2) Moisture must not accumulate. Keep coils warm when motor is not in use if moisture can be seen.
 (3) Discoloring. This is mainly caused by overheating.
(c) Ensure no untoward change of wedges from original position.
(d) Ensure the binding at the coil end is in its normal position.

5.3 Clean the interior of the motor:

(a) After a motor is in operation for some time, accumulation of dust, carbon powder and grease etc., on the inside is unavoidable, and may cause damage. Regular cleaning and examination is necessary to assure top performance.
(b) Points to note during cleaning:
 (1) If using compressed air or blower:
  (a) Compressed air should be free of moisture.
  (b) Maintain air pressure at 4 kg/cm^2, since high pressure can cause damage to coils.
 (2) Vacuum
 Vacuum cleaning can be used, both before and after other methods of cleaning, to remove loose dirt and debris. It is a very effective way to remove loose surface contamination from the winding without scattering. Vacuum cleaning tools should be non-metallic to avoid any damage to thee winding insulation
 (3) Wiping
 Surface contamination on the winding can be removed by wiping using a soft, lint-free wiping material. If the contamination is oily, the wiping material can be moistened (not dripping wet) with a safety type petroleum solvent. In hazardous locations, a solvent such as inhibited methyl chloroform may be used, but must be used sparingly and immediately removed. While this solvent is non-flammable under ordinary conditions, it is toxic and proper health and safety precautions should be followed while using it.

ATTENTION!
Solvents of nay type should never be used on windings provided with abrasion protection. Abrasion protection is a gray, rubber-like coating applied to the winding end-turns.

⚠ **Adequate ventilation must always be provided in any area where solvents are being used to avoid the danger of fire, explosion or health hazards. In confined areas (such as pits) each operator should be provided with an airline respirator, a hose mask or a self-contained breathing apparatus. Operators should wear goggles, aprons and suitable gloves. Solvents and their vapors should never be exposed to open flames or sparks and should always be stored in approved safety containers.**

(4) Keep core ducts completely clean. The difference in temperature rise could be around 10°C before and after cleaning

5.4 Clean the exterior of the motor:

(a) On open ventilated motors, screens and louvers over the inlet air openings should not be allowed to accumulate any build-up of dirt, lint, etc. that could restrict free air movement.

ATTENTION!
Screens and louvers should never be cleaned or disturbed while the motor is in operation because any dislodged dirt or debris can be drawn directly into the motor.

(b) If the motor is equipped with air filters, they should be replaced (disposable type) or cleaned and reconditioned (permanent type) at a frequency that is dictated by conditions. It is better to replace or recondition filters too often than not often enough.
(c) Totally enclosed air to air cooled and totally enclosed fan cooled motors require special cleaning considerations. The external fan must be cleaned thoroughly since any dirt build-up not removed can lead to unbalance and vibration. All of the tubes of the air-to-air heat exchanger should be cleaned using a suitable tube brush having synthetic fiber bristles (not wire of any type).

5.5 Maintenance of anti-friction bearings

5.5.1 Frequency of re-lubrication:
The life of grease varies greatly as a result of types of model, revolution speed, temperature, operational conditions etc. It is, therefore, impossible to be precise about replenishment intervals. However, for normal direct coupling transmission, the periods shown as Table 1 may be used as a guide.

Remarks:
(a) The periods shown in Table 1 should be halved where bearings are used for belt drive and/or in dirty or high ambient temperature or high humidity environments.
(b) Please refer to the lubrication nameplate, if attached to the motor.
(c) For bearing numbers outside the range of Table 1, please contact TWMC

(d) If the periods referred to in Table 1 for drive-end bearing and opposite drive-end are different, for the convenience of maintenance operation, please take the shorter one the required grease replenishment period of these bearings.

5.5.1 Kinds of grease:

All motors with ZZ bearings will have SHELL Alvania R3 (lithium base grease). All motors with open bearings will have Polyrex EM (polyurea base grease).
Certain T-frame models will utilize special grease and will be noted on the lubrication nameplate. Please us identical grease or its equivalents when maintaining lubrication schedule.

ATTENTION!
Do not mix different kinds of grease.
Mixing grease with different type of thickeners may destroy its composition and physical properties. Even if the thickeners are of the same type, possible differences in the additive may cause detrimental effects.

5.5.2 Grease quantity

The amount of grease per replenishment depends on the type, size and construction of the bearings. The maximum amount of one replenishment for each bearing is shown in Table 2.

5.5.3 Re-greasing

⚠ **If re-lubrication is to be performed when the motor is running, stay clear of rotating parts.**

It is advisable to re-grease when the motor is running to allow the new grease to be evenly distributed inside the bearing.
Before re-greasing, the inlet fitting should be thoroughly cleaned to prevent any accumulated dirt from being carried into the bearing with the new grease. The outlet of grease drainage should be opened to allow the proper venting of old grease.

Use a grease gun to pump grease through grease nipple into the bearings. After re-greasing, operate the motor for 10-30 minutes to allow any excess grease to vent out.

TABLE 1.

Bearing Number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM	3000 RPM	3600 RPM
	6210										
	12									2000 Hrs.	
	13										
	14									1000 Hrs.	
	15										
	16									720 Hrs.	
	17							2000 Hrs.			
62XX	18			3000 Hrs.							
63XX	20										
72XX	22										
73XX	24							1500 Hrs.			
	26										
	28					2000 Hrs.		1000 Hrs.			
	30										
	32							500 Hrs.			
	34					1500 Hrs.					
	36										
	38			2000 Hrs.		1000 Hrs.					

Bearing Number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
	NU214								
	15							2000 Hrs.	
	16								
	17								
	18			3000 Hrs.				1500 Hrs.	
	20								
	22							1000 Hrs.	
	24								
NU2XX	26					2000 Hrs.			
NU3XX	28							500 Hrs.	
	30								
	32								
	34			2000 Hrs.		1000 Hrs.			
	36								
	38	2000 Hrs.							
	40								
	44			1000 Hrs.					
	48	1000 Hrs.							

Bearing Number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
	22220							300 Hrs.	
	22								
	24		1000 Hrs.			500 Hrs.			
	26								
	28								
	30					300 Hrs.			
222XX	32			500 Hrs.					
223XX	34								
	36								
	38	500 Hrs.							
	40			300 Hrs.					
	44								
	48	300 Hrs.							

TABLE 2.

Bearing No.		Amount of replenishment	Bearing No.		Amount of replenishment
62XX 72XX NU2XX 2222XX	6210	30 g	63XX 73XX NU223XX 223XX	6310	40 g
	6212	40		6312	60
	6213	50		6313	80
	6214	50		6314	80
	6215	60		6315	100
	6216	60		6316	100
	6217	80		6317	120
	6218	80		6318	120
	6220	100		6320	160
	6222	120		6322	220
	6224	120		6324	270
	6226	140		6326	300
	6228	160		6328	400
	6230	180		6330	450
	6232	200		6332	500
	6234	250		6334	600
	6236	300		6336	700
	6238	350		6338	800
	6240	400		6340	900
	6244	450		6344	900
	6248	500		6348	900

*Fill new grease until it overflows and the old grease is entirely replaced.

5.5.4 Oil re-lubrication (For oil lubrication types only)

Maintain proper lubrication by checking the oil level periodically and adding oil when necessary. Because of the initial clearing action of the bearing and the expansion of the oil as it comes up to operating temperature, the oil level will be higher after the motor has been in operation for a while than it is with the motor at standstill.
Overfilling should be avoided not only because of the possibility that expansion may force the oil over the oil sleeve and on to the rotor, but also because too high an operating oil level prevents the bearing form clearing itself of excess oil. The resultant churning can cause extra loss, high temperatures, and oxidized oil. If, during operation, the oil level goes above the maximum shown on the sight gauge, drain enough oil to bring the level back within the recommended operating range. **Do not permit the operating level to fall below the minimum shown on the gauge.**

ATTENTION!
Should it ever become necessary to add excessive amount of make-up oil, investigate immediately for oil leaks.

Change the oil at regular intervals. The time between oil changes depends upon the severity of operating conditions and, hence, must be determined by the motor user. Two or three changes a year is typical, but special conditions, such as high ambient temperature, may require more frequent changes. Avoid operating the motor with oxidized oil.
Use only good grade, oxidation-corrosion-inhibited turbine oils produced by reputable oil companies.

The viscosity of the oil to be used depends upon the type and size of the bearings, its load and speed, the ambient temperature, and the amount and temperature of the cooling water (if used)). The lubrication nameplate or instructions with each motor specifies the viscosity range of oil suitable for average conditions. The usual oil viscosity range of oil suitable for average conditions. The usual oil viscosity recommendations are summarized in Table 3. Operation in ambient temperatures that are near or below freezing may require preheating the oil or the use of special oil. Whenever the motor is disassembled for general cleaning and reconditioning, the bearing housing may be washed out with a suitable cleaning solvent. Be sure that the oil-metering hole is clear, and then dry the housing thoroughly before re-assembly, and ensure all traces of cleaning solvent have been removed.

TABLE 3 Oil Viscosity**

Bearing function and location	Bearing Type	Oil Viscosity - SSU	
		@ 100°F	@ 200°F
Thrust Bearing	72XX, 73XX Angular contact ball And/or (62XX, 63XX)	150	45
	Spherical roller	300	53
	Plate (Kingsbury Type)	300	53

**Remark: When a lubrication nameplate attached to the motor, use lubrication oil it stipulates.

5.5.5 Cleaning and installation of bearings

(a) Apply the proper amount of grease to the disassembled parts of the bearing after they have been thoroughly cleaned with high quality cleaning oil. Then protect them from contamination before and during assembly.

(b) Bearing installation

ATTENTION!
Before installing the bearings, make sure that the shaft mounted parts inside the bearings are in place before installation.

Since the bearing is a high precision component, it is important to avoid ingression of dust and foreign matter, and hammering during cleaning and installation. Use extreme care and insure clean conditions during installation and assembly.

ATTENTION!
The best way for bearing installation is heat shrinking. Knocking and hammering during installation should be avoided absolutely.

The bearing should be heated in a bath of clean oil at a temperature of approximately 80°C. After warming, slide the bearings in place quickly and nimbly so that it has not shrunk before being fully in position.
Grease the bearing after the temperature returns to normal, and then reassemble the motor.

5.6 Maintenance of sleeve bearings

5.6.1 Daily inspections

(a) Ensure the volume and quality of lubrication oil are in compliance with specifications.

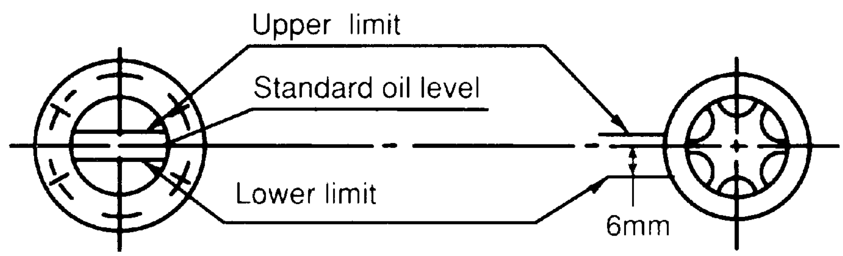


Fig. 12

(b) Ensure there is motion of the oil ring and it is not clamped.
(c) The indicator of the shaft endplay should be restricted within the specified range of the red groove of the shaft or the ±3mm (.118 in.) range of the drive-end shaft shoulder, or the bearing may be damaged.

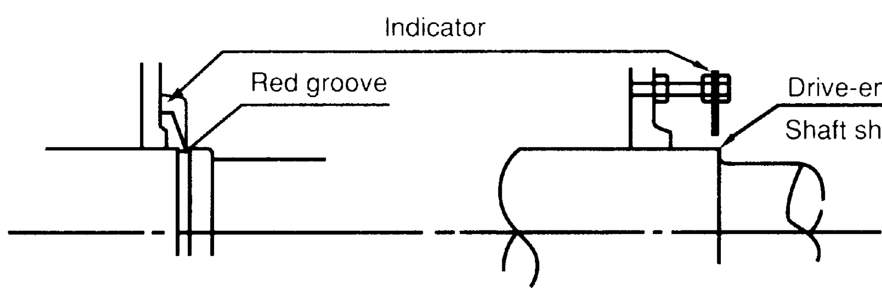


Fig. 13

5.6.2 Regular examination

(a) Periodical change of oil
The oil reservoirs of self (not flood) lubricated bearings should be drained and refilled about every six (6) months. More frequent changes may be needed on high speed (3600 rpm) motors or if severe oil discoloration or contamination occurs. In conditions where contamination does occur, it may be advisable to flush the reservoir with kerosene to remove any sediment before new oil is added. Proper care must be taken to thoroughly drain the reservoir of the flushing material before refilling with the new oil.
Refill the reservoir to the center of oil sight glass with a rust and oxidation inhibited turbine grade oil. Refer to the outline and lubrication nameplate for the correct viscosity.
(b) Quantity of lubrication oil
Please refer to the lubrication nameplate for oil quantity.
(c) Oil viscosity
(d)

ISO	Equivalents	Viscosity (SUS/100°F)
VG32	Esso Teresso 32	150
VG46	Esso Teresso 46	200
VG68	Esso Teresso 68	300

5.6.3 Disassembly

Prior to disassembling, ensure the power supplies are disconnected and there are no moving parts.

The bearing sleeve is of the spherically seated, self-aligning type. The opposite drive end bearing is normally insulated for larger motors (or when specified). On some motors, the insulation is bonded to the spherical seat of the bearing housing.

ATTENTION!
Extreme care must be exercised in removing the bearing sleeve from the insulated support to avoid damaging this insulation.

The following is the recommended procedure for removing the bearing sleeve:

(a) Remove the oil drain plug in the housing bottom and drain the oil sump.

(b) Remove all instrumentation sensors that are in contact with the bearing sleeve. These would include resistance temperature detectors, thermocouples, thermometers, etc..

(c) Remove the socket head bolts holding the bearing cap and the inner air seal. The end cover plate must also be removed if the non-drive end bearing is being disassembled. Remove the bearing cap and top half of the inner air seal. Place them on a clean, dry surface to avoid damage to the parting surfaces.

(d) Remove the top half of the bearing sleeve using suitable eyebolts in the tapped holes provided. Lift the bearing top straight up and avoid any contact with the shoulders of the shaft journals that might damage the thrust faces of the bearing. Place on a clean, dry surface taking care to prevent damage to either the parting surfaces or the locating pins that are captive n the top bearing half.

(e) Remove the screws at the partings in the oil ring and dismantle the ring by gently tapping the dowel pin ends with a soft face mallet. Remove the ring halves and immediately reassemble them to avoid any mix up I parts or damage to the surfaces at the partings.

(f) Pull up on the garter spring surrounding the floating labyrinth seal and carefully slip out the top half. Rotate the garter spring until the lock is visible. Twist counter-clockwise to disengage the lock, remove the garter spring then rotate the lower half of the seal out of the groove in the bearing housing. Note the condition of these floating labyrinth seals. If they are cracked or chipped, they must be replaced. Do not attempt to reuse a damaged seal.

(g) To remove the bottom bearing half, the shaft must be raised a slight amount to relieve pressure on the bearing. On the drive end, this can be done by jacking or lifting on the shaft extension. Protect the shaft. On the non-drive, jacing or lifting can be done using bolts threaded into the tapped holes provided in the shaft end.

(h) Roll the bottom bearing half to the top of the shaft journal and then lift it using suitable eyebolts threaded into the holes provided. Again avoid any contact with the shaft shoulders that could damage the bearing thrust faces. Place the lower bearing half on a clean, dry surface to protect the parting surfaces.

Use extreme care when rolling out the lower bearing half. Keep the hands and fingers well clear of any position where they might be caught by the bearing half if it were accidentally released and rotated back to its bottom position. Serious personal injury could result.

(i) Protect the shaft journal by wrapping it with clean, heavy paper or cardboard.

5.6.4 Re-assembly

Bearing re-assembly is basically a reverse of the disassembly procedures outlined above, with the following suggestions:

(a) The interior of the bearing housing should be cleaned and then flushed with clean oil or kerosene.

(b) The bearing halves and the shaft journal should be wiped clean using lint-free cloth soaked with clean oil.

(c) All parts should be carefully inspected for nicks, scratches, etc., in any contract surfaces. Such imperfections should be removed by an appropriate method such as stoning, scraping, filling, etc., followed by thorough cleaning.

(d) Before installing the floating labyrinth seal halves, observe their condition. Do not attempt to use a cracked or chipped seal. The bottom half seal has a set of drilled holes in its side face. These must be place at the bottom toward the inside of the bearing so that accumulating oil may drain back into the housing.

(e) Put a bead of Curil-T around the seal half O.D.'s on both sides adjacent to the garter spring groove. This will prevent oil by-passing the seal around its outside.

(f) Place the bottom seal half on top of the shaft and roll it into position. Install the top half and insert the garter spring pulling up on both ends to permit engaging the lock. Run a bead of Curil-T around the O.D's on both sides adjacent to the garter spring groove on this half also.

(g) Carefully reassemble the two oil ring halves. Inspect the dowel pins for burrs and straightness and make any corrections required. Do not force the ring halves together. Excessive force may alter the roundness or flatness of the oil ring which can change its oil delivery performance.

(h) Some of the pipe plugs in the housing are metric thread type. These are identified as those, which have a copper, lead, or similar material washer. If these plugs are removed, be careful not to lose the washers. Before re-assembly, inspect the washers and replace them as required.

(i) Before installing the bearing cap, observe the position of the floating labyrinth seal. The "tab" must be on top to engage the pocket. Failure to position the seal properly will result in damage when the cap is assembled.

ATTENTION!
(1) Curil-T is the only approved compound for use in the assembly of the bearings on this motor. Other products may harden and impede the operation.
(2) During the re-assembly of the bearing parts, a thin layer of Curil-T should be applied to all gaskets and machined interface surfaces. This suggestion does not apply to the machined surfaces of the bearing liner halves.
(3) When seating the bearing shell, apply a thin layer of lube oil at the spherical surface of the liner. Slowly roll the lower bearing liner into the bearing housing making sure that the splinted surface of the liner and the housing are flush. Gradually lower the shaft onto the bearing. The weight of he shaft will help rotate the bearing liner so that the babbitt surface of the liner will match the slope of the journal. Sometimes it is required to use a rubber mallet to tap lightly on the bearing housing while slowly rolling the shaft to help this seating operation.

5.7 Maintenance of slip ring (For Wound Rotor Motors only)

Ensure motor is disconnected from power supplies and there are no accessible moving parts before maintenance operation.

5.7.1 Adjustment of carbon brush

(a) Brush pressure for normal operation:

- Electro-graphite brush…..0.2~0.25 kg/cm²

  When frequent vibrations are evident or the brush is small (area below 0.5 cm²), the pressure should be greater than as shown.

(b) Adjustment of brush pressure:

The brush pressure should be adjusted to keep normal operation as it wears.

- The brush pressure may be reduced after use, so it is necessary to re-adjust. For adjustment, please turn adjusting screw, pressure adjusting pin or pressure adjusting plate as shown in Fig. 14 to obtain the correct tension (=0.23 x brush cross sectional area in cm²) ±10% kg.

(c) Brush pressure need not be adjusted if constant force spring is used as shown in Fig. 15 and Fig. 16.

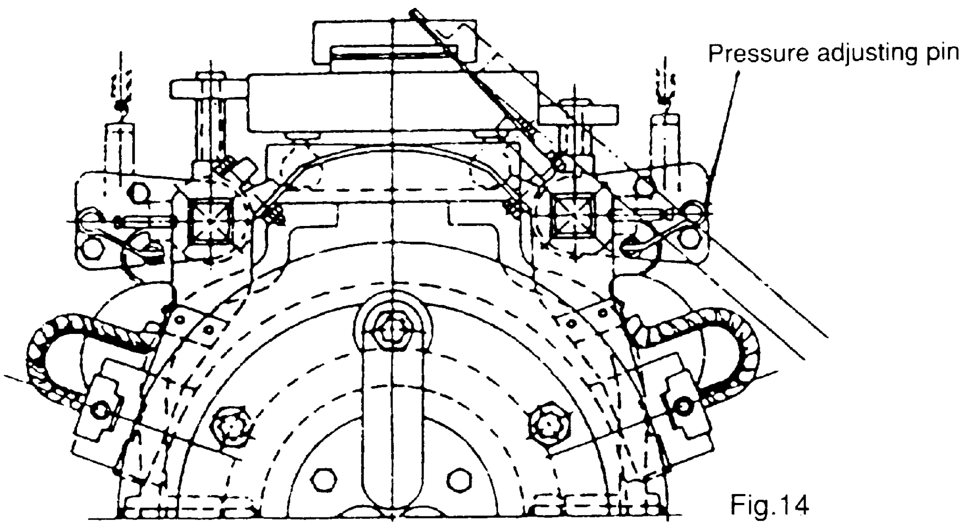


Fig.14

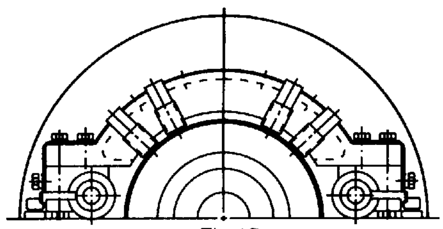


Fig.15

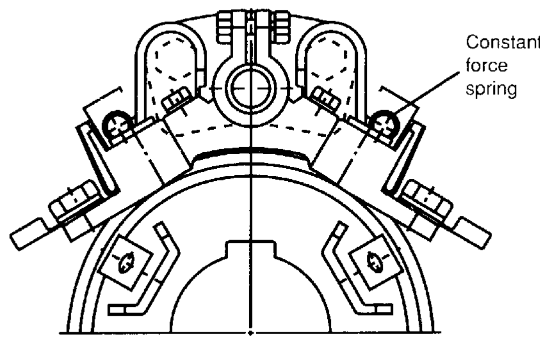


Fig.16

5.7.2 Brush replacement

The carbon brush is a part of the equipment which is easily worn away, replace it after it is worn to ½ ~ ¾ of original size.

(a) Brush material

The brush material is important to the performance of the motor. Only the most appropriate materials are chosen by TWMC, and are listed on the nameplate of the motor. It is important to know this when you replace the brush, so a recommended type is used.

(b) Dimensions

Brush, holder and gap between them, please refer to CNS 2322 C4051 or JIS C2802.

ATTENTION!
The gap between a brush and it holder is important for good performance and safety of the motor.

(c) Adjustment of new brushes (Shown in Fig. 17)

(1) Polish the new brush with a file until is assumes the appropriate contour of the slip ring which it touches.

(2) Place sand-paper (JIS R6252 No. 40…50) on the slip ring with the abrasive face of the paper against the brush to induce a closer contact by rubbing against each other.
(3) Repeat item 2 with fine sand –paper (JIS R6252 No. 100 to 200) until the contact surface between brush and slip ring exceeds 80%.
(4) Finally, clean the contaminated slip ring and brush with clean cloth or compressed air.

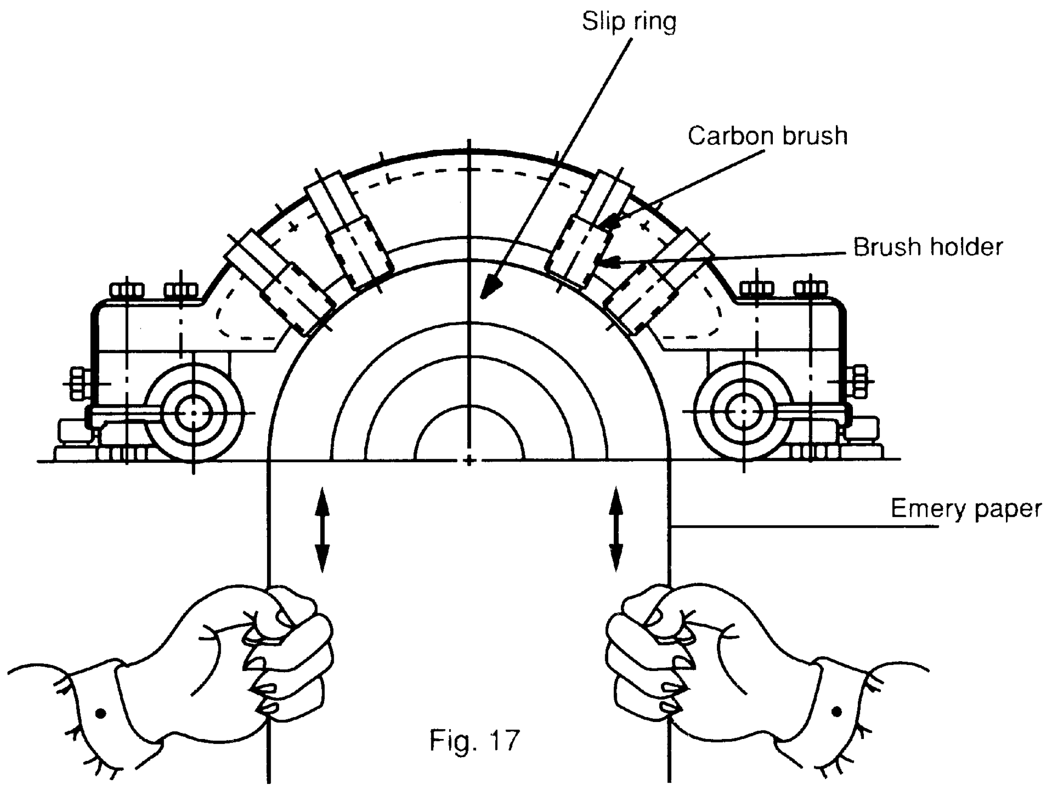


Fig. 17

5.8 Maintenance of non-reverse ratchet mechanism (For Vertical high Thrust Motor only)

5.8.1

In the pump piping system, a check valve and a stop valve should be installed in the discharge line. The check valve, placed between the pump and the stop valve, is to protect the pump from reverse flow and excessive backpressure. The stop valve is used in priming, starting and when shutting down the pump. It is advisable to close the stop valve before stopping the pump. This is especially important when the pump is operated against a high static head.

TWMC vertical high thrust motors are equipped with non-reverse ratchet (N.R.R.) mechanism only when requested by the pump manufacturer. Typical construction of the N.R.R. mechanism is shown as Fig 18 below.

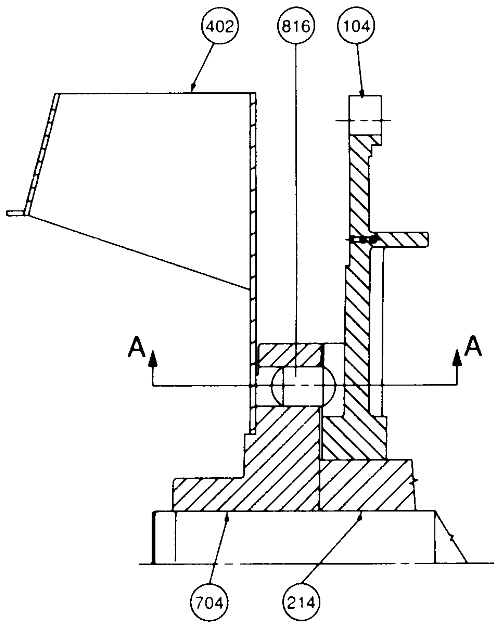
The N.R.R. mechanism keeps the pump and motor from rotating in the reverse direction. Thus prevents damage from over-speeding and damage to water-lubricated pump shaft bearings when, on shutdown, the falling water column tends to drive the pump in the reverse direction. In normal operation, the ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed. When power is removed, the speed decreases and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.

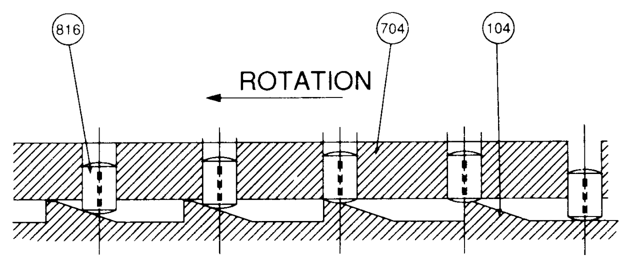
5.8.2

The service life of ratchet pins depends not only on the reverse shock load between the pin and ratchet tooth when pump stopped but also the frequency of pump starting and stopping while in service. Provided that the pins are deformed due to this reverse shock load, then the up and down motion of the ratchet pins could be sluggish or jammed and that unusual noises shall arise.

The recommended replacement period for these ratchet pins is every three (3) years. If the reverse shock load is greater than 30% of motor rated torque or the starting frequency is more than twice per day, then the replacement period should be halved.

ATTENTION!
The check valve and stop valve in the discharge line should be regularly inspected and maintained to assure the normal function of these valves. This is important to protect the pump and motor from damage and increase the service life of the N.R.R. mechanism.





SECTION A-A

ITEM	NAME
104	RATCHET
214	BEARING SEAT
402	EXTERNAL FAN
704	RATCHET PIN CARRIER
816	RATCHET PIN

Fig. 18

6. FAULT FINDING AND RECOGNITION

Kinds of Breakdown	Symptoms	Possible Causes	Remedies
Fail to start without load	Motionless and soundless	Power-off	Consult power company
		Switch-off	Switch-on
		No fuse	Install fuse
		Broken wiring	Check wiring and repair
		Broken lead	Check wiring and repair
		Broken windings	Check windings and repair
	Fuse blowing. (Automatic switch trips off, slow start with electromagnetic noise)	Short circuit of circuit switches	Check circuit switches and replace
		Incorrect wiring	Check wiring according to nameplate
		Poor contact at terminal	Lock tightly
		Windings grounded	Factory repair
		Broken windings	Factory repair
		Poor contact of circuit switches	Check and repair
		Broken wiring	Check and repair
		Poor contact of starting switches	Check and repair
		Short circuit of starting switches	Check and repair
		Incorrect connections of starting switches	Connect according to nameplate
Loading after start	Fuse blowing. Fail to restart due to trip-off of automatic switch	Insufficient capacity of fuse	Replace fuse if wiring permits
		Overload	Lighten load
		High load at low voltage	Check circuit capacity and reduce load
	Overheating motor	Overload or intermittent overload	Lighten load
		Under-voltage	Check circuit capacity and power source
		Over-voltage	Check power source
		Ventilation duct clogged	Remove the foreign matter in the duct
		Ambient temperature exceeds 40°C	Correct insulation class to B or F, or lower ambient temperature
		Friction between rotor and stator	Factory repair
		Fuse blown (Single-phase rotating)	Install the specified fuse
		Poor contact of circuit switches	Check and repair
		Poor contact of circuit starting switches	Check and repair
		Unbalance three-phase voltage	Check circuit or consult power company

Kinds of Breakdown	Symptoms	Possible Causes	Remedies
Loading after start	Speed falls sharply	Voltage drop	Check circuit and powers source
		Sudden overload	Check machine
		Single-phase rotating	Check circuit and repair
	Switch overheat	Insufficient capacity of switch	Replace switch
		High load	Lighten load
	Bearing over-heating	High belt tension	Adjust belt tension
		Slack belt tension	Adjust belt tension
		Misalignment between motor and machine shafts	Re-align
		Over speed of bearing outer-ring	Adjust bracket
		High bearing noise	Replace the damaged bearing
Noise	Electromagnetic noise induced by electricity	Occurrence from its first operation	May be normal
		Sudden sharp noise and smoking	Short circuit of windings should be repaired at the factory
	Bearing noise	Noise of low shishi or Thru-Thru	May be normal
		Kala-Kala as a result of poor lubrication	Grease
		Kulo-Kulo as a result of poor lubrication	Clean bearing and grease
		Sa-Sa or larger noise	Replace the damaged bearing
	Mechanical noise caused by machinery	Loose belt sheave	Adjust key and lock the screw
		Loose coupling or skip	Adjust the position of couplings, lock key and screw
		Loose screw on fan cover	Lock fan cover screw tightly
		Fan rubbing	Adjust fan position
		Rubbing as a result of ingression of foreign matter	Clean motor interior and ventilation ducts
		Wind noise	Noise induced by air flowing through ventilation ducts
		Induced by conveyance machine	Repair machine
Vibration	Electromagnetic vibration	Short circuit of winding	Factory repair
		Open circuit of rotor	Factory repair
	Mechanical vibration	Unbalanced rotor	Factory repair
		Unbalanced fan	Factory repair
		Broken fan blade	Replace fan
		Unsymmetric centers between belt sheaves	Align central points
		Central points of couplings do not lie on the same level	Adjust the central points of couplings to the same level
		Improper mounting installation	Lock the mounting screws
		Motor mounting bed is not strong enough	Reinforce mounting bed

Remarks:

(1) Circuit switches: These include knife switches, electromagnetic switches, fuse and other connection switches etc.

(2) Starting switches: These include Delta-Star starters, compensate starters, reactance starters, resistor starters, starting controller’s etc.

D-6
Equalization Tank Mixer M-1
Static Mixer M-2

PREPARED FOR:

Naval Weapons Industrial Reserve
C/O Tetratech EC-GM-38 GW Remediatio
100 Broadway Avenue
Bethpage, NY 11714

General Installation & Operation Instructions

for Top Entering Agitators

Pro Quip

August 15, 2008

Naval Weapons Industrial Reserve
C/O Tetratech EC-GM-38 GW Remediatio
100 Broadway Avenue
Bethpage, NY 11714

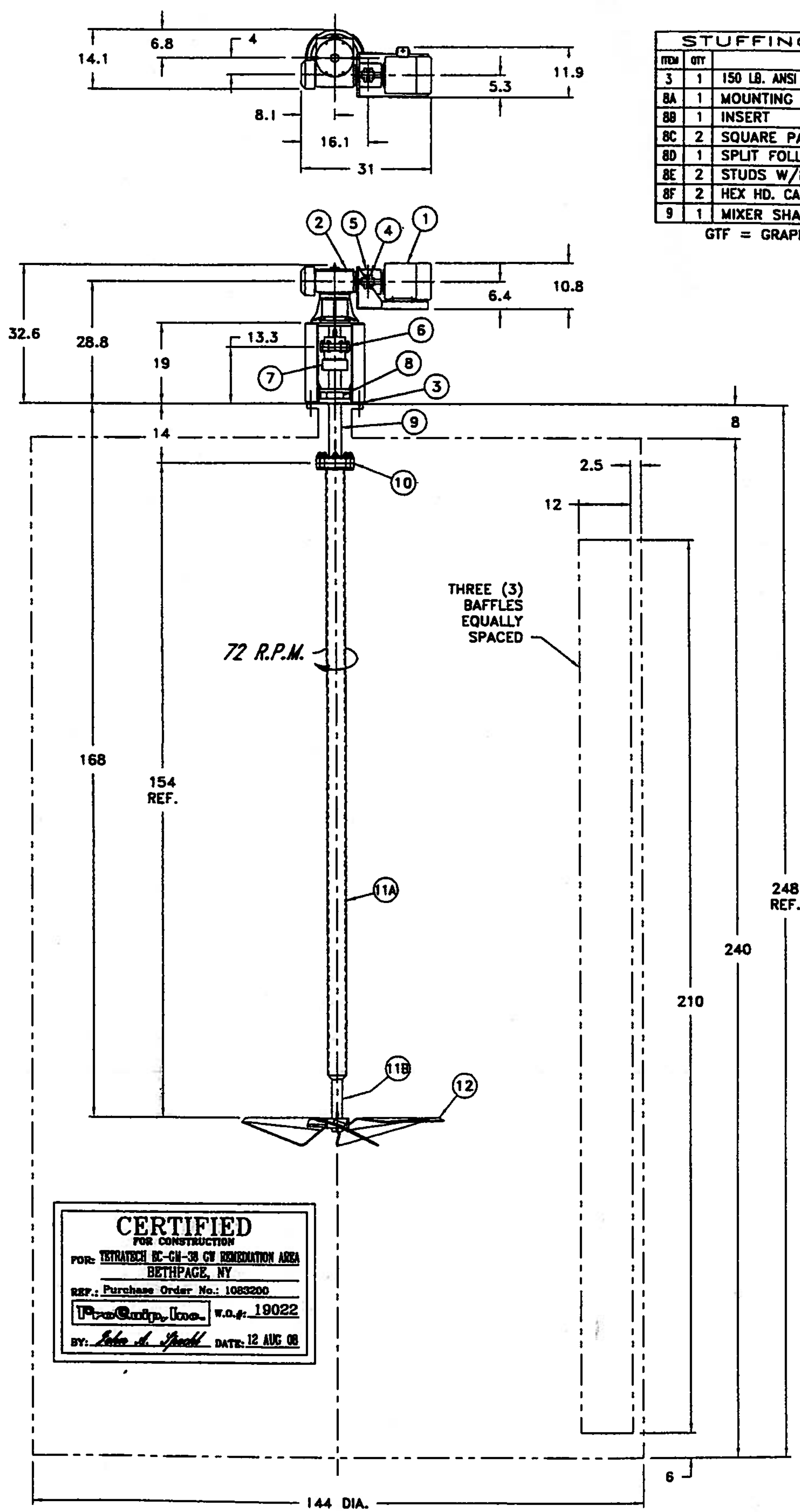
WORK ORDER NO.:	**19022**
QUANTITY.:	**1**
SERIAL NO.:	**19022**
MODEL NO.:	**3ZES25B**
DRAWING NO.:	**4C348400 (Rev.0)**
TAG ITEM.:	**016542-17,000 Gallon Tank Agitator**

PURCHASE ORDER NO.: **1083200**

PURCHASED BY.:

OEC Fluid Handling, Inc.
140 Cedar Spring Road
P.O. Box 2807
Spartanburg, SC 29304

Authorized Representative.:
OEC Fluid Handling Inc.
P.O. Box 2807
Spartanburg, SC 29304
864-573-9200
FAX No.: 864-573-9299

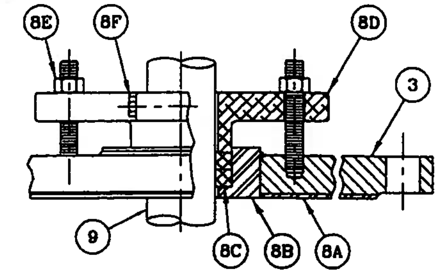


CERTIFIED
FOR CONSTRUCTION
FOR: TETRATECH EC-GM-38 GW REMEDIATION AREA
BETHPAGE, NY
REF.: Purchase Order No.: 1083200
ProQuip, Inc. W.O.#: 19022
BY: [signature] DATE: 12 AUG 08

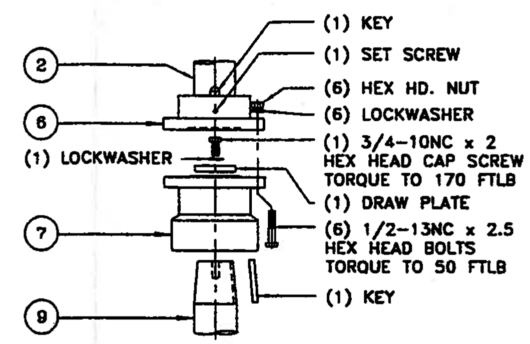
STUFFING BOX B.O.M.			
ITEM	QTY	ITEM DESCRIPTION	MATERIAL
3	1	150 LB. ANSI (ASA) MOUNTING FLANGE	C/ST'L.
8A	1	MOUNTING FLANGE FACING	316 S.S.
8B	1	INSERT	316 S.S.
8C	2	SQUARE PACKING RINGS	GTF
8D	1	SPLIT FOLLOWER	ALUMINUM
8E	2	STUDS W/HEX HD. NUTS	C/ST'L.
8F	2	HEX HD. CAP SCREWS W/NUTS	C/ST'L.
9	1	MIXER SHAFT	316 S.S.

GTF = GRAPHITE TEFLON FILAMENT

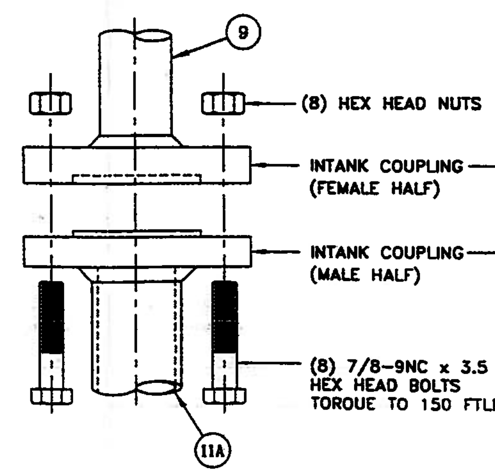
STUFFING BOX ASSEMBLY DETAIL



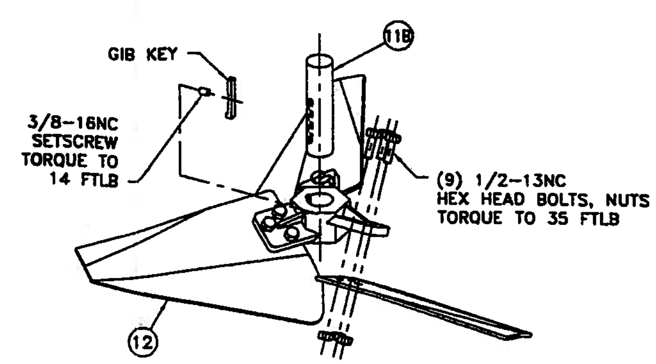
LOW SPEED COUPLING ASSEMBLY



INTANK COUPLING ASSEMBLY



HI-FLOW IMPELLER ASSEMBLY



CERTIFIED OUTLINE & DIMENSION DRAWING

CUSTOMER: OEC FLUID HANDLING, INC.
LOCATION: SPARTANBURG, SC
PURCHASE ORDER No.: 1083200
SHIP CUSTOMER: TETRATECH EC-GM-38 GW REMEDIATION AREA
SHIP LOCATION: BETHPAGE, NY

ProQuip WORK ORDER: 19022 SERIAL: 19022
QUANTITY: (1) WETTED PARTS MAT'L.: 316 S.S. WEIGHT: 800 lbs.

LOAD DATA FOR MIXER SUPPORT DESIGN

VERTICAL DOWNWARD FORCE: 800 lbs.
DYNAMIC TORQUE: 5,300 lbs-in.
VARYING DYNAMIC OVERTURNING MOMENT 14,000 lbs-in.
MIXER SUPPORT DESIGN MUST CONSIDER BOTH MECHANICAL STRENGTH AND RIGIDITY. SUPPORT MUST BE STIFF ENOUGH TO AVOID PERCEPTABLE DRIVE MOVEMENT WHILE MIXER IS OPERATING. TANK, BAFFLES, AND SUPPORTS ARE NOT FURNISHED BY ProQuip.

MINIMUM TANK OPENING: (NOTE-1)

ITEM	PART No.	ITEM DESCRIPTION
1		MOTOR – 3 HP; 1800 RPM; 230/460 V; 3 Ph; 60 Hz FRAME: 182T TYPE: TEFC
2		REDUCER: ZE-25
3		BASE: 8"-150 LB. (RF) ANSI FLANGE (NOTE-2)
4		HIGH SPEED COUPLING
5		HIGH SPEED COUPLING GUARD
6		LOW SPEED COUPLING: 7 DIA.
7		LOW SPEED REMOVABLE COUPLING: 7 DIA.
8		STUFFING BOX: (2) RING (SEE DETAIL)
9		UPPER SHAFT: 3 DIA., SOLID
10		INTANK COUPLING: 9.1 DIA.
11A		INTERMEDIATE SHAFT: 4.5 DIA., TUBULAR
11B		LOWER SHAFT: 2.5 DIA., SOLID
12		IMPELLER: 50 DIA., HI-FLOW, (3) BLADE

GENERAL NOTES:

1. MINIMUM TANK OPENING: 16 DIA. TO ALLOW PASSAGE OF THE LARGEST WELDED WETTED PART INTO THE VESSEL.
2. MOUNTING FLANGE DETAILS:
   ANSI SIZE: 8"-150 LB.
   OUTSIDE DIAMETER: 13.5
   BOLT CIRCLE: 11.75
   No. OF HOLES: 8
   BOLT HOLE DIA.: 0.88
   MOUNTING FLANGE HOLES STRADDLE MIXER CENTERLINES.
   MOUNTING FLANGE FASTENERS & GASKET SUPPLIED BY OTHERS.
3. ITEMS No. 1 THRU 6 WILL BE SHIPPED AS ONE (1) COMPLETE ASSEMBLY. ITEMS No. 7 THRU 12 AND ALL INTANK FASTENERS WILL BE SHIPPED SEPARATE FOR FIELD ASSEMBLY BY OTHERS. ITEM No. 12 IS A FOUR (4) PIECE BOLTED CONSTRUCTION ATTACHING TO THE SHAFT WITH A GIB KEY AND SETSCREW.
4. ALL DIMENSIONS ARE IN INCHES.

CHG NO.	REV. BY / CHK'D BY	DATE	DESCRIPTION OF CHANGE

ProQuip, Inc. 850 E. Highland Rd. Macedonia, Ohio 44056 (330) 468-1850

SCALE NTS | BY J.A. SPECHT
DATE 8 JUL 08 | CK'D. | APP'D.

3ZES25B AGITATOR AND
GENERAL TANK ARRANGMENT
TAG ITEM: 016542 – 17,000 GALLON TANK AGITATOR

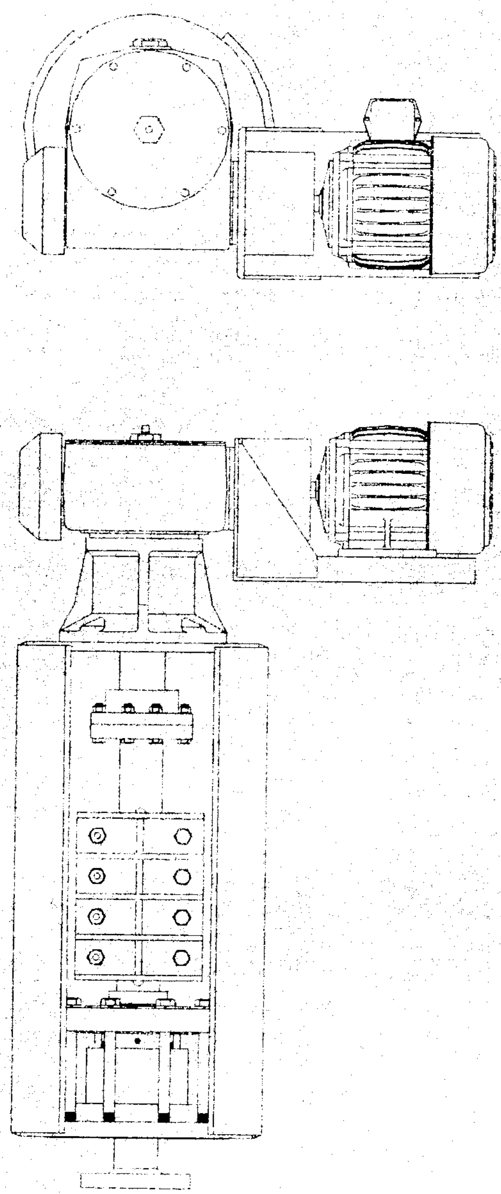
DRAWING NUMBER 4C348400 REV. 0

DRAWING NUMBER 4C348400 REV 0

T:\T\Tetratech\19022\19022.dwg

Y/Z SERIES AGITATORS

Service Manual



Pro Quip, Inc.

DESIGNERS and MANUFACTURERS
OF AGITATION EQUIPMENT

850 East Highland Road
Macedonia, Ohio, 44056-2190 USA
(330) 468-1850 / Fax (330) 467-3724
www.proquipinc.com

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TABLE OF CONTENTS

INTRODUCTION

This Service Manual provides information and instructions for the installation, operation, and maintenance of ProQuip Y-Series and Z-Series Top Entering Agitators. To obtain optimum performance and trouble free service from this equipment, follow all instructions carefully. If the unit is furnished with shaft seals, lubricator or other optional accessories, refer to the supplementary instructions included with this manual.

The drive unit size referred to in this manual can be obtained from the unit Model Number. The first letter in the Model Number refers to the reducer series, a Y or a Z, and the second letter refers to the size in that series. For example, a ProQuip Model 15YHX30 uses a size YH drive unit and a Model 5ZFS25 uses a size ZF drive unit. See Figure 1 for typical units.

Your unit is shipped with temporary protection against dust and weather during transportation. If it is not to be installed immediately, the unit should be prepared and stored in accordance with the Storage Instructions.

Ultimate credit for long service and dependable operation of the agitator belongs to the mechanics and maintenance personnel on the job who carefully install the unit, make the mounting rigid and level, accurately align shafts and couplings, and ensure that the unit receives proper lubrication and regular maintenance. The details of these important jobs are the subject of this manual.

Before proceding, read all ***WARNING*** and ***CAUTION*** notes. Read all specific instructions before any attempt is made to install or assemble the agitator and any auxiliary or optional equipment.

INSTALLATION INSTRUCTIONS

CAUTION: Heed all warning tags.

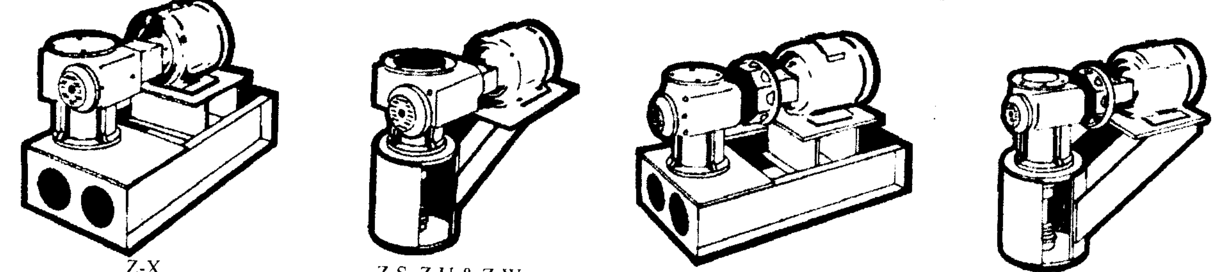
Agitators are normally shipped knocked-down into the following assemblies:

- Power package
- Shaft
- Impellers

Read the following general instructions and all other pertinent specific instructions before any attempt is made to install or assemble the agitator to avoid unnecessary damage or problems.

- Check equipment against packing list to ensure that all required parts have been received.
- Obtain proper mounting bolts and flange gasket, if required. Refer to the Certified Outline and Dimension Drawing included with this manual for proper sizes.
- Clean all mating surfaces such as intank coupling faces, turbine bores, shaft, drive quill, etc.
- Install power package on tank as described in the Power Package Installation Section. Note that if the shaft is longer than the tank is deep the shaft is installed before the power package.
- Install shaft. *HANDLE CAREFULLY.* Do not allow shaft to bend during installation, as this may cause vibration problems during operation. Lift or move shaft in a vertical position whenever possible. Support long shafts at several points, or on a pallet when moved or stored in a horizontal position. On units with shaft seals, protect shaft from scratches or nicks in the seal area. Ensure that shaft coupling

FIGURE 1 TYPICAL DRIVE UNIT ARRANGEMENTS



Z-X BEAM MOUNT UNIT — Z-S, Z-U & Z-W FLANGE MOUNT UNIT — Y-X BEAM MOUNT UNIT — Y-S, Y-U & Y-W FLANGE MOUNT UNIT registers are properly engaged and coupling faces are pulled tightly together.

- Mount impeller(s) on shaft. Install steady bearing, stabilizer ring, or other accessory equipment if used. Make certain all bolts, set screws and keys are properly installed, tightened and torqued. Rotate agitator by hand to check that nothing binds and that shaft does not run out excessively, more than 1/8 inch per 10 feet of shaft length [3.1 mm per 3m of shaft length].
- On units with shaft seals, install and lubricate as shown in this manual.
- Wire the motor in accordance with motor instructions and all applicable Codes. Check that output shaft direction of rotation is correct
- Ensure that agitator is lubricated in accordance with the Lubrication Instructions and Preventive Maintenance Sections.

POWER PACKAGE INSTALLATION

The agitator power package is normally shipped as a complete assembly including the motor, flexible motor coupling or belts and sheaves, gear drive unit, coupling guards and low speed coupling half; all assembled on a base, ready for mounting on the tank. Mixers with integral shaft seals include part or all of the seal assembly with the power package assembly. All bolts should be tested for tightness and the motor alignment checked to ensure that they have not been disturbed during shipment or handling. The power package may then be mounted on the support structure or mounting flange.

Note that the gear drive unit has been shipped without oil, but has been sluiced with an oil-soluble rust inhibitor, which need not be removed. Before operating, be sure the drive is filled to the proper level with the correct lubricant, in accordance with the Lubrication Instructions Section.

Also, note that some agitators will require the shaft to be installed in the tank before the power package can be mounted. This depends on various relative dimensions and seal arrangements including shaft size and length, tank height, access openings, shaft seal type, etc. Review the Shaft Installation Section to decide the order of assembly for your mixer.

MOUNTING AND LEVELING:

Mount the mixer with output shaft vertical, unless it has been specifically ordered for mounting in another position. If it is necessary to mount the unit in a different position from that for which it was ordered, consult the factory for suitability first.

Leveling is important not only to prevent unbalanced shaft forces, but also to prevent oil from spilling over the top of the drywell in the gear drive unit.

Flange mounted mixers with integral shaft seals, models ending in --S, --U, --W, cannot normally be leveled at the mounting flange because the gasket must be compressed to hold tank pressure. Instead the tank itself must be leveled so the mounting nozzle face is horizontal.

> ***CAUTION:*** Never level the mixer by shimming under the gear drive unit. This will cause misalignment and malfunctioning of the shaft seal located at the mounting flange.

For beam-mounted mixers, align unit by placing broad flat shims under all mounting feet. Start at the low speed shaft end and level across the length then the width of the unit. Check with a feeler gauge to make certain that all feet are supported, to prevent distortion of the housing when the unit is bolted down.

After unit is bolted down, align the motor to the drive unit input shaft. See separate manufacturer's instructions for motor coupling alignment. Motors and other components may become misaligned, not only during handling but also from deflection of supports. Always check alignment after installation, and realign motor if necessary. After alignment, install coupling guard before operating unit, as required by OSHA.

Beam-mounted mixers with separate shaft seal assemblies must be assembled with their shafts before leveling, so that the seal can be properly aligned at the same time.

MOTOR SUPPORT BASES:

The weight, location and starting torque of the motor will cause some bases to deflect and twist. This movement is within allowable engineered limits. If the customer considers the movement excessive outboard supports may be used to stiffen the arrangement.

MOTOR COUPLING CONNECTION:

The performance and life of any coupling depends largely upon how well the coupling is installed and serviced. Always check alignment after installation. Refer to the coupling manufacturer's manual for specific instructions.

Couplings normally furnished have a close clearance fit and should slide easily onto shafts. Spread tapered bushings with a wedge for clearance until positioned on the shaft. For interference fit coupling or pulley hubs, heat to a maximum of 275 °F [135 °C] and slide onto shaft.

> ***WARNING:*** Do not drive coupling hub, sheave or pulley onto the motor or reducer shaft. An endwise blow on the shaft may damage gears and bearings. Do not hammer.

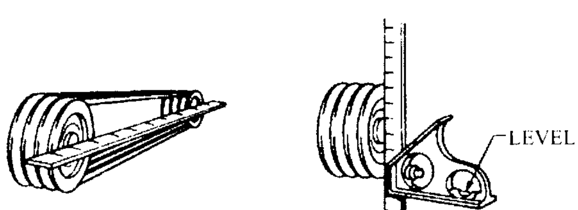
PULLEY OR SHEAVE BELT DRIVES:

Align the motor shaft and input shaft of the gear drive unit square and parallel by placing a straight edge across the faces of the sheaves, refer to Figure 2. Check horizontal shaft alignment by placing one leg of a square against the face of each sheave, with the spirit level on the horizontal leg of the square.

FIXED SPEED BELT ADJUSTMENT:

The ideal tension is the lowest tension at which the belt will not slip under peak load conditions. Over-tightening belts shortens bearing and belt life. Check the belt tension frequently during the first 48 hours of operation. Keep belts free from foreign material that may cause slippage. Inspect periodically, and tighten the belts if they are slipping. Reinstall guard during operation.

FIGURE 2 ALIGNMENT OF BELT DRIVES



VARIABLE SPEED BELT ADJUSTMENT:

Variable speed belts are self-adjusting. Check movement range to provide desired speed variation. Set stops to limit travel to that range, to avoid excessive belt and sheave wear.

INSTALLATION AND ASSEMBLY OF SHAFTS

> ***CAUTION:*** Be sure power is locked out before installing shafts and impellers or entering tank. Consult applicable local and national codes for safety procedures.

GENERAL NOTES:

SHAFT HANDLING:

Careful handling is important when installing the agitator shaft because even a small "set" can cause later vibration problems. Therefore, it is important to lift or move the shaft in a vertical position whenever possible. When horizontal, a long shaft should be supported at several points or on a skid. On units with shaft seals, protect the shaft from scratches or nicks in the seal area.

COUPLINGS:

Most flanged couplings have registers for accurate alignment. When assembling, make sure that the faces are clean, the registers are piloted together properly and the faces are pulled together tightly all around. Always use a torque wrench to ensure proper engagement without over-stressing the bolts.

TWO PIECE SHAFTS:

Some shafts are furnished in two pieces with an intank coupling. These are usually bolted together before installation in the tank, unless there is not enough room to maneuver the shaft as one piece. See Figure 3 and assemble as follows:

- Clean faces and make sure registers have no nicks or burrs.
- Install bolts with the heads down and the nuts up when the shaft is in the operating position.
- Tighten bolts in a criss-cross pattern to the values in Appendix A.

- Be sure registers pilot together and that flange faces pull together all around.

ALL-WELDED SHAFT/IMPELLER ASSEMBLIES:

These are often awkward to handle, so are usually installed in the tank before mounting the power package assembly. They are usually coated with either a rubber or polymer lining or else have a polished or sanitary finish. Special care must be taken to protect the coating or finish against damage during installation.

INSTALLATION PROCEDURE:

The procedure depends on shaft length, type of shaft seal and mixer power package mounting arrangement. The mixer model designation contains a group of three letters beginning with a Y or Z, such as YHX or ZHX. From the third letter determine the Section to use:

- **--X** units: Use the Installation of Shaft with Welded Coupling Half Section, unless the upper end of the shaft has a removable coupling, see Figure 3, in which case use the Installation of Shaft with Removable Coupling Section.
- **--S** units: Use the Installation of Shafts with Removable Coupling Section.
- **--U** and **--W** units: Use the Installation of Shafts for Flange-Mounted Units with Mechanical Seals.

INSTALLATION OF SHAFTS WITH WELDED COUPLINGS:

Refer to Figure 3 for coupling assembly.

- If mixer has a separate vapor seal, install seal on shaft near coupling, with larger diameter toward the lower end of the shaft.
- Insert shaft into tank. If tank cover has a clearance hole smaller than the coupling diameter, the shaft must be inserted through the hole from above before mounting the power package assembly.
- Clean coupling faces and make sure the register has no nicks or burrs.
- Raise shaft up and bolt coupling to power package output coupling. Tighten bolts in a criss-cross sequence to the torque value in Appendix A. Be sure the registers pilot together and the faces pull together tightly all around.

FIGURE 3 STANDARD FLANGED COUPLINGS

WELDED COUPLING HALF

REMOVABLE COUPLING HALF

INTANK COUPLING

NOTE: LOCKWASHERS ARE USED WITH CARBON STEEL BOLTS ONLY. STAINLESS STEEL COUPLING SHOWN.

INSTALLATION OF SHAFTS WITH REMOVABLE COUPLINGS:

Refer to Figure 3 for coupling assembly.

Remove coupling half from mixer shaft before installing. Determine if your unit uses a steady bearing, if the shaft is longer than the tank is deep or if the suspended shaft is shorter than the tank depth and follow the appropriate steps.

For a one piece shaft that is longer than the tank is deep or a mixer with a steady bearing:

- Before installing the power package lower the shaft through the mixer mounting nozzle with the tapered end up.
- Install impeller hubs on shaft according to the Installation and Assembly of Impellers Section. Slide shaft into steady bearing, if used. Lower shaft the rest of the way into vessel.
- Carefully lower power package, or separate shaft seal, over shaft extension and mount on tank nozzle. Be sure to install the flange gasket.
- Raise shaft up through the stuffing box so that the entire tapered section is above the stuffing box by about 4 to 6 inches [100 to 150 mm]. Prevent scraping of shaft against stuffing box because scratch marks could cause a leak.
- Support the shaft firmly from the bottom at this height. Never lift or support shaft by the impellers, as this could damage them.
- Clean mating surfaces on shaft and coupling. Insert key and thrust plate.
- Bolt coupling half to shaft as shown in Figure 3. Tighten center draw bolt, with lockwasher, to torque in Appendix A. Coupling should move down evenly on tapered joint.
- Drive the coupling down on the taper. Use either a soft-faced hammer or a piece of wood to protect coupling face. Retighten bolt to torque value. Continue to alternate driving and tightening until bolt will not tighten further. Be sure key does not wedge and cause coupling to cock.
- Wipe coupling faces clean. Raise shaft and install body-bound flange bolts. Tighten bolts uniformly in a criss-cross pattern to value from Appendix A. Be sure faces are pulled tightly all around. Lockwashers are not used.

For a suspended shaft shorter than the tank depth:

- After the power package is installed lower the agitator shaft, with the tapered end up, through the man-way into the vessel. Impeller hubs may be installed at this time, see Installation and Assembly of Impellers Section.
- Raise shaft up through the stuffing box so that the entire tapered section is above the stuffing box by about 4 to 6 inches [100 to 150 mm]. Prevent scraping of shaft against stuffing box because scratch marks could cause a leak.
- Support the shaft firmly from the bottom at this height. Never lift or support shaft by the impellers, as this could damage them.
- Clean mating surfaces on shaft and coupling. Insert key and thrust plate.
- Bolt coupling half to shaft as shown in Figure 3. Tighten center draw bolt, with lockwasher, to required torque per Appendix A. Coupling should move down evenly on tapered joint.
- Drive the coupling down on the taper. Use either a soft-faced hammer or a piece of wood to protect coupling face. Retighten bolt to torque value. Continue to alternate driving and tightening until bolt will not tighten further. Be sure key does not wedge and cause coupling to cock.
- Wipe coupling faces clean. Raise shaft and install body-bound flange bolts. Tighten bolts uniformly in a criss-cross pattern to value from Appendix A. Be sure faces are pulled tightly all around. Lockwashers are not used.

INSTALLATION OF SHAFTS FOR FLANGE-MOUNTED UNITS WITH MECHANICAL SEALS:

Refer to Figure 3 for coupling assembly.

- All mechanical seal units have an intank coupling a few inches below the mounting flange. Since this coupling will normally be located inside the neck of the tank nozzle, where it is relatively inaccessible, the shaft must be attached before mounting the power package assembly on the tank.
- Insert the shaft into the tank. Impeller hubs may be installed at this time, see the Installation and Assembly of Impellers Section.
- Support the shaft at the bottom or at the tank nozzle so the coupling is a few inches above the nozzle. Clean mating coupling faces.

- Lower power package until coupling can be bolted together.

  IMPORTANT: Bolts must be inserted from below so that the nuts will be on top of the coupling.

  Tighten bolts in a criss-cross pattern to the value from Appendix A. Be sure the registers pilot together and that the faces pull together tightly all around.

- Install power package assembly by following the Power Package Installation Section.

INSTALLATION AND ASSEMBLY OF IMPELLERS

After the shaft is installed, attach impellers as described below and as shown on the Certified Dimension Drawing. If the end of the shaft is close to the tank bottom, it is often easier to install the hubs before installing the shaft. Refer to the Certified Dimension Drawing and specifications for your unit to find the type of impellers used on your mixer. Note that lockwashers are not used on stainless steel and other high alloy bolts.

KEYLESS IMPELLERS:

Many low power mixers (3 HP or less) are furnished with impellers that do not have keyways. These have one or two setscrews for attachment, and there will usually be a machined flat on the shaft. Slide the hub onto the shaft. Tighten one setscrew against the flat and the other (if used) against the shaft. Torque to value specified in Appendix A, Table VI.

KEYED IMPELLERS:

Attach hub to shaft with key and setscrew as shown on the Certified Dimension Drawing, and then bolt blades to hub. Note that the hub must be above the keyway to install the key in the shaft. Tighten fasteners to the torque specified in Appendix A, Table VI.

HIFLOW IMPELLERS:

For HiFlow impellers with triangular hub, you may find wrench clearances to be tight when attaching the blades. This occurs often with upper impellers, where the shaft runs entirely through the hub. Experience has shown that it may be easier to insert the bolts through the holes from inside BEFORE sliding the hub onto the shaft, then installing the nuts on the outside. Note that lockwashers are not used on stainless steel and other high alloy bolts. Some HiFlow impellers have the key head facing up, refer to the Certified Dimension Drawing.

SPECIAL IMPELLERS:

Installation of other impeller designs such as paddles, gates, anchors, etc. is similar to the turbines in the previous section. Refer to special instructions that accompany other special impeller designs.

FINAL AGITATOR ASSEMBLY AND STARTUP

Check that power package is mounted correctly. Align and install separate shaft seal (tank mounted) and steady bearing, if used. Use the installed mixer shaft to align these before fastening them in place. Install any accessory items such as bolt-on impeller stabilizer ring, seal lubricator, etc.

Make final electrical connections and install any required safety guards or devices. Lubricate agitator and any mechanical seals or stuffing boxes according to Lubrication Instructions Section. Ensure breather vent is installed.

Make certain all tools and supplies have been removed from the tank. If conditions permit, rotate the unit by hand to check for any obstructions.

When power is available, jog the unit for an instant to verify proper rotation direction. Most ProQuip agitators rotate clockwise when viewed from above, *EXCEPT* those with upflow HiFlow impellers, which normally operate counterclockwise.

RUNNING TEST:

If conditions allow, conduct an initial running test. Fill the tank with water to a level of one impeller diameter over the lower main impeller. Start the mixer and allow it to run for several minutes under load. Check for leaks, noises, or other abnormalities, then shut the unit down and recheck oil levels. Add oil to maintain levels if necessary.

THE UNIT IS NOW READY FOR OPERATION.

LUBRICATION INSTRUCTIONS

The following instructions apply primarily to the gear drive unit. See separate instructions for shaft seals and special accessory items. Before installation, note oil fill (HC-3) and drain (H-2) locations for access; see the appropriate Figure for your drive size in Appendix C.

> *CAUTION:* All units shipped from the factory *WITHOUT OIL.*

The most important factor in the life of your mixer drive is use of the correct lubricant, changed at proper intervals. The recommended lubricating oil for ambient temperatures in the 30 - 100 °F [0 - 38 °C] range is an AGMA No. 7 or No. 8 *petroleum derived steam cylinder oil compounded with 4% - 5% acidless tallow additive.* Oil should be non-foaming type to prevent loss over the drywell.

Operation on a tank of hot liquid, lack of ventilation, or exposure to direct sun may create a "local ambient" at the drive unit that is higher than the surroundings. This should be considered when choosing the proper lubricant.

For ambient temperatures of 30 - 100 °F [0 - 38 °C], AGMA No. 7 is recommended for operation at output speeds above 70 rpm, AGMA No. 8 is recommended for slower output speeds. If the ambient temperature is continuously above 70 °F [21 °C] AGMA No. 8 is preferred regardless of mixer speed. The viscosity of AGMA No. 7 compound is approximately 135 SSU at 210 °F [30 CSt at 100 °C] and No. 8 is approximately 175 SSU at 210 °F [38 CSt at 100 °C]. Some brand names of typical oils, and their manufacturer, can be found in Table III.

> *NOTE: NEVER USE* ordinary motor oils, EP oils, automotive transmission or rear end oils, or greases. Some suppliers may suggest oils with "inactive" sulfur-phosphorus additives instead of the compounded cylinder oils specified above. We *DO NOT* recommend their use, except for cold weather operation as described in the following section.

TABLE I
Approximate Oil Capacities

Unit Size	Gallons	Liters	Unit Size	Gallons	Liters
			ZC	0.33	1.25
YE	0.7	2.6	ZE	0.5	1.96
YF	1.1	4.2	ZF	0.8	3.0
YG	1.8	6.8	ZG	1.5	5.7
YH	3.0	11.4	ZH	2.5	9.5
YJ	3.9	14.9	ZJ	2.8	10.6
YK	5.9	22.3	ZK	5.0	18.9
YL	7.2	27.3	ZL	5.9	22.3
YM	13.1	49.6	ZM	11.0	41.6

HIGH AND LOW TEMPERATURE OPERATION

When temperatures are outside the standard 30 - 100 °F [0 - 38 °C] range, a suitable high or low temperature lubricant should be used. Alternately, an all-weather synthetic lubricant described in the Synthetic Lubricant Section of this Manual may be chosen. Consult factory for recommendations if temperatures exceed limits shown.

LOW TEMPERATURES:

AGMA No. 7 oil may be used in temperatures down to 15 °F [-9 °C], if mixer operates continuously. Cold mixers may experience starting problems if the oil temperature is below its pour point, usually 25 - 40 °F [-4 - 4 °C]. If

TABLE II
Cold Weather Lubricants

Min. Ambient Temperature		Max. Ambient Temperature		Approximate Viscosity
°F	°C	°F	°C	SSU @ 210°F [SSU @ 100°C]
0	-18	60	16	120
-10	-23	55	13	100
-20	-29	50	10	75
-30	-34	45	7	55

such starting difficulties occur consult the factory or consider a synthetic all-weather oil.

For operation in lower ambient temperatures, cold weather oil should be used since AGMA No. 7 oils may not provide proper lubrication. Use either all-weather synthetic oil or AGMA worm gear oil with *INACTIVE* sulfur-phosphorus additives as shown in Table II.

Change back to standard oil when the minimum temperature returns to 30 °F [0 °C].

HIGH TEMPERATURES:

AGMA No. 8 oils usually allow limited operation in temperatures up to 125 °F [50 °C], but *ONLY* if the actual oil temperature remains below 200 °F [90 °C]. To check, operate the unit at least one hour at full load, the hottest conditions; then shut it off and measure the oil temperature immediately.

If a unit operates in the sun at ambient temperatures over 100 °F [38 °C], then special measures should be taken to protect it from solar energy. This can consist of a canopy over the unit or reflective paint on the unit, to prevent the gear drive sump temperature from exceeding the allowable maximum of 200 °F [90 °C].

SYNTHETIC LUBRICANTS

Mobil Oil SHC-634 is an excellent "all-weather" synthetic lubricant, suitable for the ambient temperature range from -25 to 140 °F [-30 to 60 °C].

SYNTHETIC LUBRICANT CHANGES:

Synthetic lubricant change intervals can be extended up to 1 year, based on operating temperatures and lubricant life and performance. Most lubricant suppliers will test oils and assist in establishing optimum changing frequency.

REUSE OF SYNTHETIC LUBRICANT:

It may be possible to reuse synthetic lubricant if it can be filtered clean and free of discoloration, solids, contaminants and water. Do not reuse if viscosity has changed more than 5% from original. Laboratory analysis is recommended. Filter size must be 40 micron or less.

GREASE LUBRICATION

All bearings have been lubricated at the factory with lithium-base NLGI #2 grease. Grease these bearings by the schedule specified in the Preventive Maintenance Section. Before installing the unit, note the location of all of the grease fittings for access.

PACKED STUFFING BOX:

See separate instructions for assembly, startup, and maintenance.

TABLE III
Recommended Lubricants by Manufacturer

AGMA Compound	#7C	#8C
Ambient Temperature Range	15 to 60 °F [-9 to 16 °C]	50 to 125 °F [10 to 52 °C]
Manufacturer	Compounded Steam Cylinder Oil	
Amoco Chemical Corp. Chevron Oil Co.	Amoco Cylinder Oil # 460 Chevron Cyl. Oil W ISO 460	Amoco Cylinder Oil # 680 Chevron Cyl. Oil W ISO 680
Citgo Petroleum Corp. Continental Oil Co.	Citgo Cyl. Oil 400-5 INCA Oil 460	Citgo Cyl. Oil 680-7 INCA Oil 680
Exxon Company, U.S.A. Mobil Oil Corp.	Cylesstic TK 460 600W Cylinder Oil	Cylesstic TK 680 600W Super Cyl. Oil
Phillips Petroleum Co. Shell Oil Company	Hector 460S Valvata Oil J 460	Hector 630S Valvata Oil J680
Texaco Inc. Union Oil Co. of California	Vanguard Cylinder Oil 460 Union Steaval B110 Union St.A	Texaco Honor Cyl. Oil 680 Union Steaval B165

NOTE: Table includes brands already tested for effectiveness and approved for use. Contact factory for information on approvals of brands not listed here.

PREVENTIVE MAINTENANCE

After the first 30 to 40 hours of operation, your agitator should be running at peak efficiency. During this period the hardened, ground and polished worm burnishes the bronze gear, spreading the tooth contact across the full face of the gear and work hardening the surface of the bronze. This beneficial process will be apparent by a slight sloughing of metal from the bronze surface.

After the first 150 hours of operation, drain and flush housing to remove any particles of bronze which may have been burnished from gear.

Operating temperature of the drive unit depends on the ambient temperature and the loading conditions. It is not unusual for the case below the oil level to be hot to the touch, over 140 °F [60 °C]. The lubricants recommended in the Lubrication Instructions Section are suitable for continuous operation up to 190 °F [88 °C]. Problems inherent in continuous operation at higher temperatures will be minimized by keeping the fan and the fan housing unobstructed and by keeping the drive housing as free from dust and dirt as possible. Should it be necessary to operate the unit continuously in an excessively hot or closely confined area where air does not circulate freely, an oil temperature check should be made after the unit is run in. If the oil temperature remains above 190 °F [88 °C], please consult the factory for recommendations.

Oil Filling and Changes

Remove the air vent (HC-3) and the bushing (HC-2) it fits into and pour oil through this port to approximately halfway up bronze gear. The correct level will be midway in the sight glass (H-1) or on the upper mark of the dipstick if so equipped. Be sure to allow time for the oil to fill all parts of the case and reach a stable level.

> ***CAUTION:*** Do not overfill. Some rise will occur as the oil heats during operation and any excess oil will overflow the drywell, diluting the bearing grease and leaking out the oil seal.

The oil should be changed every six months for normal service, or every three months for severe service. In moist or dusty conditions, or for continuous operation near the maximum temperature, more frequent changes may be required.

When changing oil, the unit should be drained as soon as possible after it is shut off. This reduces the time needed to drain the oil completely and prevents any water, sludge or particles from settling out of oil and remaining in the reducer to contaminate the new oil.

Between Oil Changes:

Check oil level periodically with unit stopped. Add oil if needed. The air vent (HC-3) should be checked to be sure it is not clogged. Clogged air vents can produce pressure build-up in the reducer that causes oil to leak out.

Check units in intermittent service weekly for water contaminated lubricant as follows:

- With mixer off, let gear box cool to ambient temperature.
- Loosen bottom drain plug (H-2) and drain some lubricant into a small container.
- Examine for water or discolored, creamy-looking lubricant. If present, drain until uncontaminated oil flows out.
- Refill to proper level with correct lubricant.

Reducer Oil Seals

As illustrated in Figure 4, lip-type oil seals are used on both shafts. The high speed shaft oil seal (W-5 on Z-Series or PY-3 on Y-Series) has a dust excluding second lip. During initial operation this seal may heat the shaft considerably and tend to leak slightly until the Buna-N sealing lip is run in and properly seated. Even after run in, a slight seepage of oil through the seal is necessary for proper lubrication of the lip.

If the unit is subjected to chemicals not compatible with the seal or to abrasive dust, it is important to provide guards, where possible, to prevent accumulations at the seal area.

Bearing Lubrication:

See the Lubrication Section for grease selection and bearings that require regreasing. Regrease the required bearings when changing the oil in the gear drive unit, or every 3000 to 4000 hours of operation, whichever occurs first.

> ***NOTE:*** Avoid over-greasing bearings or greasing more often than necessary. Both of these can shorten bearing life.

MOTORS AND COUPLINGS:

See manufacturer's instructions for routine maintenance. Most standard couplings furnished on Y/Z-Series units do not require lubrication. Check manufacturer's instructions for variable speed sheaves or special couplings specified by the user.

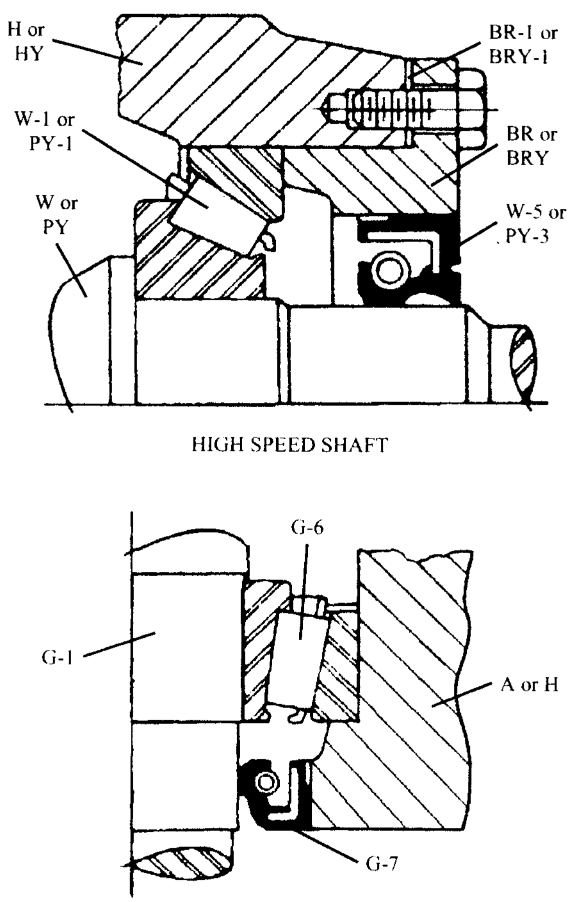
TROUBLESHOOTING

For the following problems a few possible causes and their associated remedies are listed. If any of the problems persist, consult the factory for recommendations.

EXCESSIVE NOISE AND VIBRATION:

- The reducer mounting may not be sufficiently rigid. Tighten foot bolts and check mounting stiffness.

FIGURE 4 OIL SEAL ASSEMBLIES



HIGH SPEED SHAFT

LOW SPEED SHAFT

The movement of the reducer should not be noticeable to the eye.

- The couplings may be misaligned. Realign the couplings.
- Check entire agitator for loose parts, breaks or cracks. Retighten all bolts.
- Reducer gears may be excessively worn. Check shimming for proper tooth contact. Make certain the reducer is not overloaded and keep the oil clean.
- Bearings may be worn or faulty. Check the alignment, adjustment and possible overloading. Clean and flush reducer housing. Replace any worn bearings and add new lubricant as required.
- Shaft endplay or backlash may be excessive. Check for proper shimming and worn bearings or gears.

OVERHEATING:

- Oil level may be low or type of oil is incorrect. See the Lubrication Instructions Section and check for proper oil, oil level and change intervals.
- Check for excessive churning of oil during operation. Drain any excess oil.
- Air flow to reducer may be obstructed. Check that cooling fan(s) are receiving proper air flow and are not clogged with dust or dirt. Avoid high surrounding ambient temperatures.
- Shaft endplay may be too low. Check and readjust bearings to proper fit.
- New reducers or gearing can display higher temperatures until they are fully run in. Allow unit to time to run in and recheck temperature.
- Units operating in direct sunlight can overheat. Shade unit or apply a reflective paint.

OIL LEAKAGE:

- Unit may have loose covers or end plates. Check for torn gaskets and tighten all bolts.
- Oil seals may be worn or damaged. Inspect and replace old oil seals as rewired. Avoid inserting new seals over sharp edges.
- Unit may be overfilled. Check level and drain to midway of sight glass.
- Check that the air vent is not clogged with dust and dirt so that pressure does not build up and force oil out.

STORAGE INSTRUCTIONS

The equipment should be stored indoors in a clean, dry location. *OUTDOOR STORAGE IS NOT RECOMMENDED.* The temperature should be regulated to prevent condensation in the motor and the gear drive unit.

- Store the agitator power package in its normal operating position so that the motor drains are at the lowest point. Breather vents and drains must be fully operational or the drain plugs removed from the motor. Rotate the motor and gear reducer several rotations by hand to ensure that lubricant is well distributed in the bearings. Repeat every 30 days.
- Mixer shafts may be stored either in a vertical position (preferred), or horizontally on their shipping skids. Protect shaft from being stepped on or having other material stacked on top of it.
- If unit is to be stored longer than four months, outdoors, or where condensation may form then follow the long-term instructions below.
- Units may be stored or deactivated and left on line for up to four months in a dry environment without special precautions.

Long Term and Outdoor Storage:

To store the unit outdoors or for extended periods of time, follow the above procedure, plus the following:

- Megger motor windings and record value of insulation resistance.
- For long term indoor storage, fill the unit to the proper level with a rust inhibiting oil, such as Shell VSI.
- For outdoor storage, fill the unit completely with oil. It will be necessary to drain excess oil before operating unit.
- Make certain all machined steel parts have a coating of heavy grease or other rust-preventive coating. Oil, grease, or otherwise protect all carbon steel agitator components.
- Clean, dry storage is recommended. If stored outdoors, or where danger of condensation exists, it is desirable to keep the motor and gear reducer warm (above dew point) by supplying auxiliary heat.
- If stored outdoors, cover the power package with a tarpaulin to protect it from the weather while allowing it to breathe. *DO NOT USE* plastic or other impervious coverings as they may trap moisture and promote condensation.
- Be sure to rotate mechanism at least every thirty days and check protective coatings periodically.
- Every 3 to 6 months, inspect for condensation, water in the oil/rust inhibitor, and add or renew oil/rust inhibitor.

Termination of Storage:

Follow standard installation instructions, plus the following additional steps.

- Drain oil and refill to operating level with proper lubricant.
- Thoroughly clean the rust preventative from all mating surfaces that must be assembled together, including any bolt spot-face areas.
- If any internal rusting from condensation has occurred, consult ProQuip for advice.
- Before applying power, megger the motor windings for correct insulation resistance. Various motor manufacturers specify the following minimum readings for their motors:

Reliance Electric:
  1/2 of value before storage
Marathon Electric, Siemens and U.S. Motors:
  1.2 Megaohms for 200V or 230V motors
  1.5 Megaohms for 460V or 575V motors
  3.3 Megaohms for 2300V motors

NOTE: If value has dropped below those listed above, consult with motor manufacturer for proper procedure for drying motor insulation.

GENERAL SERVICE INFORMATION

The drive unit size referred to in this section can be obtained from the unit Model Number. The first letter in the Model Number refers to the reducer series, a Y or a Z, and the second letter refers to the size in that series. For example, a ProQuip Model 15YHX30 uses a size YH drive unit and a Model 5ZFS25 uses a size ZF drive unit. Where applicable, follow the instructions that are specific for your drive unit series and size.

Drawing locations for parts are given in parenthesis where applicable. Refer to the Parts Lists in Tables VII, VIII and IX located in Appendix B and the Assembly Drawings in Figures 7 thru 15 in Appendix C.

REPAIR AND REPLACEMENT PARTS

When ordering parts please provide the Contract Number, Serial Number and agitator Model Number shown on the ProQuip agitator nameplate. Also include the reference assembly drawing number, part number and name of each part required. Please give complete shipping instructions. See Appendices B and C.

When returning parts to the factory, please tag each part with the ProQuip agitator nameplate data for identification.

Your ProQuip representative is always available to assist in your maintenance problems. Please contact either the factory or the sales office nearest you with any questions or comments you may have.

GEAR REDUCER DISASSEMBLY

Prior to disassembling the reducer, read the entire disassembly procedure and the Gear Reducer Assembly Section that follows.

- The drive unit should be drained of oil
- Remove the flanged low speed coupling half. This coupling has been shrunk on at the factory to a light interference fit of about 0.0005 inches per inch of shaft diameter. To remove, loosen the setscrew over the key (G-8), then remove coupling with a puller or press. Do not hammer coupling off.
- Remove couplings, shaft keys, fan housing (F-2) and fan (F).
- Match mark all covers and housings.
- *Z-SERIES DRIVES:*
  Remove both worm bearing retainers (BR) and disengage worm (W) from gear (G).
  Y-SERIES DRIVES:
  Remove the helical housing cover (HY), helical gear (GY) and pinion (PY).
- Unbolt the primary housing cover (HC) and pull gear (G) off of the gear shaft (G-1).
- Slide worm assembly (W, W-1) out of housing (H).
- *SIZE **-C** DRIVES:*
  Loosen the drywell setscrew (D-1), unscrew and lift out the drywell (D). Remove the drywell O-ring (D-2).
  *SIZE **-E**, **-F**, **-G**, **-H**, **-J**, **-K**, **-L** AND **-M** DRIVES:*
  Lift out the drywell (D). Separate housing (H) from adapter (A) and remove upper bearing outer race (G-6).
- Pull gear shaft (G-1), with bearings (G-6), out of the unit. Remove lower bearing outer race (G-6) and the lower oil seal (G-7).
- Clean parts and protect them from dirt and moisture until reducer is reassembled.

GEAR REDUCER ASSEMBLY

When reinstalling the flanged lower coupling half, make sure both the shaft and coupling bore are clean and free from any foreign matter or particles which might make later removal difficult. The coupling may either be pressed on or heated in an oil bath to approximately 250 °F [121 °C] and shrunk on. After installation, check the coupling for proper mounting by measuring the runout. When the shaft and coupling have cooled to room temperature, place an indicator against the face of the coupling in the area between the boltholes and the register, and rotate the unit by hand. Total indicated runout of the coupling face should be 0.004" [0.10 mm] maximum.

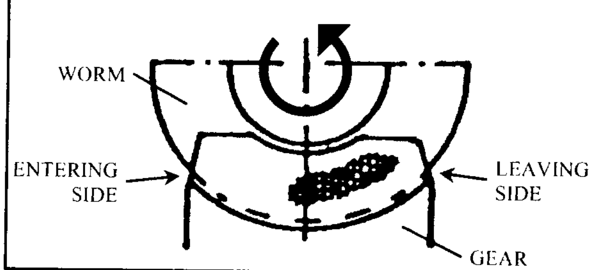
CAUTION: Never hammer the coupling on or off, as this can damage the bearings or spring a shaft.

When a new worm, gear or bearing is installed in your drive unit, the assembly procedure affects the life expectancy of all rotating parts as well as the quietness of operation. The important assembly procedures are establishment of correct axial endplay on worm shaft and gear shaft and proper tooth contact pattern between worm and gear. Worm gears are produced to allow for deflection and provide an entry gap on "entering side" of the gear tooth. Contact on the driving face of the gear tooth is required on the "leaving side" of the tooth as shown in Figure 5.

Contact should be checked after the worm and gear have been installed with Prussian Blue coating on worm threads and orange lead on gear teeth. With the contact on the "leaving side" of the gear tooth, as the worm deflects under load, the contact moves toward the center of the gear but still maintains some gap for lubrication on the "entering side".

- Obtain required replacement parts, including shims, seals and gaskets.
- Clean old sealing compound from metal-to-metal and shim-to-metal surfaces. Apply new sealant. Use Scotch Grip Industrial Adhesive No. 847 (3M Company, St. Paul, Minnesota., USA) or equivalent.
- Drive outer race of lower gear shaft bearing (G-6) into adapter (A) or housing (H) on ZC drives.
- Shrink or press both bearings (G-6) onto gear shaft (G-1).
- Insert shaft assembly into housing (H) from top. Install outer race of upper bearing (G-6).
- *SIZE* ***-C*** *DRIVES:*
  Place O-ring (D-2) on drywell (D). Screw drywell into housing (H) for axial shaft endplay of 0.000" to 0.002" [0.00 to 0.05mm] and tighten setscrew (D-1).
  SIZE ***-E, -F*** *AND* ***-G*** *DRIVES:*
  Bolt primary housing (H) to adapter (A), with shim pack (A-1). Note that the drywell (D) is installed later. Adjust shim pack thickness to obtain 0.000" to 0.002" [0.00 to 0.05 mm] axial endplay.
  SIZE ***-H, -J, -K, -L*** *AND* ***-M*** *DRIVES:*
  Install drywell (D) with shim pack(A-1). Adjust shim pack thickness to obtain 0.000" to 0.002" [0.00 to 0.05 mm] axial endplay.
- *SIZE* ***ZC, ZE, ZF, ZG*** *AND* ***ZH*** *DRIVES:*
  Insert outer race of fan end worm bearing (W-1) and install bearing retainer (BR) with 0.020" [0.51 mm] shim pack (BR-1).
  SIZE ***ZJ, ZK, ZL*** *AND* ***ZM*** *DRIVES:*
  Install input end bearing retainer (BR) using sealant.
  SIZE ***YE, YF, YG*** *AND* ***YH*** *DRIVES:*
  Insert outer race of bearing (W-1) nearest input end into worm bore and install helical housing (HY) with gasket (HY-1) and sealant.
  SIZE ***YJ, YK, YL*** *AND* ***YM*** *DRIVES:*
  Install helical housing (HY) with gasket (HY-1) and sealant.
- *SIZE* ***-C, -E, -F, -G*** *AND* ***-H*** *DRIVES:*
  Shrink or press worm bearings (W-1) on worm shaft (W). Coat worm threads with Prussian Blue.
  SIZE ***-J, -K, -L*** *AND* ***-M*** *DRIVES:*
  Shrink radial bearing assembly (W-1) on input end of worm shaft (W). Install thrust bearing assembly (W-1) with the bearing spacer (W-2), locknut (W-3) and lockplate (W-4). Coat worm threads with Prussian Blue.
- *SIZE* ***ZC, ZE, ZF, ZG*** *AND* ***ZH*** *DRIVES:*
  Insert worm shaft assembly into worm bore. Install outer race of input end bearing (W-1) and bearing retainer (BR) with 0.020" [0.51 mm] shim pack (BR-1). Check axial end play of worm shaft (W). Add or remove an equal thickness of shims from each end of worm shaft to adjust endplay. Proper endplay is 0.003" to 0.007" [0.08 to 0.18mm] for Size ZC drives and 0.006" to 0.010" [0.15 to 0.25mm] for Size ZE, ZF, ZG and ZH Drives.
  SIZE ***ZJ, ZK, ZL*** *AND* ***ZM*** *DRIVES:*
  Loosely insert worm shaft assembly into bore through the fan end of housing (H). Do not push worm (W) all the way in. Leave loose to allow gear (G) installation.
  SIZE ***YE, YF, YG*** *AND* ***YH*** *DRIVES:*
  Insert worm shaft assembly into worm bore. Install outer race of fan end bearing (W-1) and fan end bearing retainer (BR) with proper shim

FIGURE 5 PROPER GEAR TOOTH CONTACT PATTERN



pack (BR-1) to provide 0.002" to 0.004" [0.05 to 0.10 mm] axial endplay of worm shaft (W).

*SIZE **YJ, YK, YL** AND **YM** DRIVES:*

Loosely insert worm shaft assembly into bore through the fan end of housing (H). Do not push worm (W) all the way in. Leave loose to allow gear (G) installation.

- *SIZE **-C, -E, -F** AND **-G** DRIVES:*

  Remove bearing retainer (BR) and shim pack (BR-1) from the input end of a Z-Series worm shaft and the fan end of a Y-Series worm shaft. Retain shim pack for later reinstallation.

  *SIZE **-H** DRIVES:*

  Remove bearing retainer (BR) and shim pack (BR-1) from the input end of a Z-Series worm shaft and the fan end of a Y-Series worm shaft. Retain shim pack for later reinstallation. Bolt housing (H) to adapter (A) with gasket (A-1) and sealant.

  *SIZE **-J, -K, -L** AND **-M** DRIVES:*

  Bolt housing (H) to adapter (A) with sealant.

- Coat teeth of gear (G) with orange or red lead. Install gear with key (G-2) and trial shim pack (G-5). Tighten locknut (G-3) against gear shoulder.
- Engage worm (W) and gear (G) and install shim pack (BR-1), or gasket (BR-1) on Size -J and -K drives, and bearing retainer (BR) removed previously.
- Determine proper rotation of gear (G). Turn worm (W) by hand and observe tooth contact pattern.
- See Figure 5. If necessary, adjust thickness of shim pack (G-5) by repeating the above steps until proper contact pattern is obtained. Final shim pack should be at least 0.005" [0.13 mm] thick. Note that worm bearing retainer (BR) and shim pack (BR-1) must be properly tightened in position when observing tooth contact pattern to get proper adjustment.
- *SIZE **-C** DRIVES:*

  Secure gear (G) with locknut (G-3) and lockplate (G-4).

  *SIZE **-E, -F** AND **-G** DRIVES:*

  Remove gear (G) and install drywell (D) with sealant. Secure gear with locknut (G-3) and lockplate (G-4).

  *SIZE **-H, -J, -K, -L** AND **-M** DRIVES:*

  Secure gear (G) with locknut (G-3) and lockplate (G-4).

- Reinstall worm bearing retainer (BR) with shim pack (BR-1) from above. Install cover (HC).
- ***Z**-SERIES DRIVES:*

  Install shaft oil seals (G-7, W-5), fan (F) and fan housing (F-2). Grease seals before sliding them on shafts. Proceed to the Final Assembly Check Before Installation.

  Y-SERIES DRIVES:

  Install helical gear (GY) and pinion (PY) as described in the following section.

Y-SERIES INSTALLATION OF HELICAL GEAR AND PINION:

- Assemble bearing (PY-2) on pinion shaft (PY).
- Install gear (GY) and pinion (PY) together, seating pinion bearing (PY-2) in helical housing (HY) and gear (G) on worm shaft (W).
- Secure gear (GY) with gear shaft hex bolt (GY-3), lockplate (GY-2), thrust washer (GY-1), and hex bolts.
- Install helical housing cover (HY) with sealant.
- Install shim pack (BRY-1) of proper thickness with seal plate (BRY) to provide 0.005" to 0.007" [0.13 to 0.18 mm] axial endplay in pinion shaft (PY).
- After adjustment of endplay and tooth contact, install oil seals on pinion shaft (PY-3), on worm shaft at fan end (W-5) and on gear shaft (G-7). Grease seals before sliding them on shafts.
- Install fan (F) and fan housing (F-2) on worm shaft (W).

FINAL ASSEMBLY CHECK BEFORE INSTALLATION:

- Hand rotate the gear train by turning the input shaft. Be certain that the output shaft makes at least one complete revolution. Check for binding or irregularities.
- Check for proper installation of all vents, plugs and fittings.
- Refer to the Installation Instructions Section of this manual to reinstall the unit.

APPENDIX A
FASTENER TORQUE TABLES

IMPORTANT NOTE: If lubricant or "anti-seize" compound is used, use a tightening torque of approximately 70% of the value shown in the table.

TABLE IV
Reducer Coupling Bolts

Bolt Size	Unit Size	ft.-lbs.	N-m
1/2 - 13 UNC	YE thru YG ZC thru ZG	40	54
3/4 - 10 UNC	YH ZH	160	217
7/8 - 9 UNC	YJ & YK ZJ & ZK	270	366
1 - 8 UNC	YL & YM ZL & ZM	400	542

TABLE V
Removable Coupling Bolts

Bolt Size	Shaft Size		Torque	
	in.	mm	ft.-lbs.	N-m
1/2 - 13 UNC	1.25 - 2.00	32 - 51	50	68
5/8 - 11 UNC	2.50	64	100	136
3/4 - 10 UNC	3.00 - 4.00	76 - 102	160	217

TABLE VI
Intank Fasteners

Bolt Size	ft.-lbs.	N-m
5/16 - 18 UNC	8	11
3/8 - 16 UNC	15	20
1/2 - 13 UNC	35	47
5/8 - 11 UNC	70	95
3/4 - 10 UNC	100	136
7/8 - 9 UNC	150	203
1 - 8 UNC	225	305
1 1/8 - 7 UNC	300	407
1 1/4 - 7 UNC	400	542
1 1/2 - 6 UNC	700	949

APPENDIX B
TABLE VII
Parts List for Sizes -C, -E, -F and -G

DRAWING LOCATION	DESCRIPTION	QUANTITY REQUIRED							PART NUMBER
		ZC	ZE	YE	ZF	YF	ZG	YG	
A	Adapter		1	1	1	1	1	1	04
A-1	Shim Pack		1	1	1	1	1	1	21
A-2	Grease Fitting	1	1	1	1	1	1	1	15
A-3	Relief Fitting	1	1	1	1	1	1	1	16
BR	Bearing Retainer	2	2	1	2	1	2	1	06
BR-1	Shim Pack	1	1	1	1	1	1	1	19
BRY	Seal Plate			1		1		1	64
BRY-1	Shim Pack			1		1		1	74
BT-01	Hex Bolt - 1/4" x 3/4"	8		6		4		4	
BT-02	Hex Bolt - 1/4" x 7/8"			10					
BT-12	Hex Bolt - 5/16" x 1"		8	4	8	14			
BT-13	Hex Bolt - 5/16" x 1-1/4"					2			
BT-21	Hex Bolt - 3/8" x 1"							2	
BT-22	Hex Bolt - 3/8" x 1-1/4"							12	
BT-3	Hex Bolt - 7/16" x 1-1/4"						8	4	
BT-6	Hex Bolt - M6-1		6	6	6	6			
BT-7	Hex Bolt - M10-1.5						6	6	
BT-8	Hex Bolt - M12-1.75		6	6	6	6			
BT-9	Hex Bolt - M16-2						6	6	
D	Drywell	1	1	1	1	1	1	1	05
D-1	Setscrew - Cup Pt.	1							05A
D-2	O-Ring	1							05B
F	Fan	1	1	1	1	1	1	1	25
F-1	Fan Locking Sleeve						1	1	25A
F-1	Setscrew - Cone Pt.	1	1	1	1	1			30
F-2	Fan Housing	1	1	1	1	1	1	1	27
F-3	Fan Housing Support	1	1	1	1	1	1	1	26
F-4	Caplug	1	1	1	1	1	1	1	27A
F-5	Hex Head Taptite Screw	4	4	4	4	4	4	4	28
G	Gear	1	1	1	1	1	1	1	36
G-1	Gear Shaft	1	1	1	1	1	1	1	31
G-2	Key	1	1	1	1	1	1	1	33
G-3	Locknut	1	1	1	1	1	1	1	37
G-4	Lockplate	1	1	1	1	1	1	1	38
G-5	Shim Pack	1	1	1	1	1	1	1	20
G-6	Bearing	2	2	2	2	2	2	2	32

APPENDIX B
TABLE VII (cont.)
Parts List for Sizes -C, -E, -F and -G

DRAWING LOCATION	DESCRIPTION	QUANTITY REQUIRED							PART NUMBER
		ZC	ZE	YE	ZF	YF	ZG	YG	
G-7	Oil Seal	1	1	1	1	1	1	1	35
G-8	Key	1	1	1	1	1	1	1	34
GY	Helical Gear			1		1		1	85
GY-1	Thrust Washer			1		1		1	81
GY-2	Lockplate			1		1		1	82
GY-3	Gear Shaft Hex Bolt			1		1		1	70
H	Primary Housing	1	1	1	1	1	1	1	01
H-1	Sight Glass	1	1	1	1	1	1	1	17
H-2	Pipe Plug	1	1	1	1	1	1	1	12
HC	Primary Housing Cover	1	1	1	1	1	1	1	02
HC-1	O-Ring	1							41
HC-2	Hex Bushing		1	1	1	1	1	1	14
HC-3	Air Vent		1	1	1	1	1	1	14A
HC-3	Air Vent	1							02A
HY	Helical Housing Assembly			1		1		1	62, 63, 69
HY-1	Gasket			1		1		1	71
HY-2	Special Stud			4		4		4	67
HY-3	Hex Nut			4		4		4	88
HY-4	Pipe Plug			4		4		4	72
HY-5	Pipe Plug			1		1		1	62A
LW-0	Lockwasher - 1/4"	4		14		4		4	
LW-1	Lockwasher - 5/16"		4		4	14			
LW-2	Lockwasher - 3/8"			4				12	
LW-3	Lockwasher - 7/16"						4	4	
LW-6	Lockwasher - M6		6	6	6	6			
LW-7	Lockwasher - M10						6	6	
LW-8	Lockwasher - M12		6	6	6	6			
LW-9	Lockwasher - M16						6	6	
PY	Helical Pinion			1		1		1	84
PY-1	Bearing			1		1		1	78
PY-2	Bearing			1		1		1	77
PY-3	Oil Seal			1		1		1	73
PY-4	Key			1		1		1	83
W	Worm	1	1	1	1	1	1	1	22
W-1	Bearing	2	2	2	2	2	2	2	23
W-5	Oil Seal	2	2	1	2	1	2	1	24
W-6	Key	1	1	1	1	1	1	1	29

APPENDIX B
TABLE VIII
Parts List for Sizes -H, -J and -K

DRAWING LOCATION	DESCRIPTION	QUANTITY REQUIRED						PART NUMBER
		ZH	YH	ZJ	YJ	ZK	YK	
A	Adapter	1	1	1	1	1	1	04
A-1	Gasket	1	1					06
A-2	Grease Fitting	1	1	1	1	1	1	29
A-3	Relief Fitting	1	1	1	1	1	1	28
A-4	Hex Pipe Reducer Bushing	1	1	1	1	1	1	27
BR	Bearing Retainer - Fan End	1	1	1	1	1	1	03B
BR	Bearing Retainer - Drive End	1		1		1		03F
BR-1	Gasket			1	1			14
BR-1	Shim Pack	1	1					14
BR-1	Gasket					1	1	10A
BRY	Seal Plate		1		1		1	51
BRY-1	Shim Pack		1		1		1	52
BT-11	Hex Bolt - 5/16" x 7/8"		4		4		4	
BT-22	Hex Bolt - 3/8" x 1-1/4"		14					
BT-3	Hex Bolt - 7/16" x 1-1/4"	8	4					
BT-41	Hex Bolt - 1/2" x 1"	4	4					
BT-42	Hex Bolt - 1/2" x 1-1/4"			8	4			
BT-43	Hex Bolt - 1/2" x 1-1/2"	6	6		14	12	20	
BT-44	Hex Bolt - 1/2" x 1-3/4"	12	12					
BT-51	Hex Bolt - 5/8" x 1"			4	4	4	4	
BT-52	Hex Bolt - 5/8" x 2"			12	12	12	12	
CS	Cap Screw			6	6	6	6	12
D	Drywell	1	1	1	1	1	1	05
D-3	Shim Pack	1	1	1	1	1	1	15
EB	Shoulder Eyebolt	2	2	2	2	2	2	10
F	Fan	1	1	1	1	1	1	31
F-1	Setscrew - Cone Pt.	1	1	1	1	1	1	35
F-2	Fan Housing	1	1	1	1	1	1	33
F-3	Fan Housing Support	2	2	2	2	2	2	32
F-4	Caplug	1	1	1	1	1	1	33A
F-5	Hex Head Taptite Screw	4	4	4	4	4	4	34
G	Gear	1	1	1	1	1	1	40
G-1	Gear Shaft	1	1	1	1	1	1	19
G-2	Key	1	1	1	1	1	1	22
G-3	Locknut	1	1	1	1	1	1	24
G-4	Lockplate	1	1	1	1	1	1	25
G-5	Shim Pack	1	1	1	1	1	1	16
G-6	Bearing - Upper Output	1	1	1	1	1	1	20
G-6	Bearing - Lower Output	1	1	1	1	1	1	21

APPENDIX B
TABLE VIII (cont.)
Parts List for Sizes -H, -J and -K

DRAWING LOCATION	DESCRIPTION	QUANTITY REQUIRED						PART NUMBER
		ZH	YH	ZJ	YJ	ZK	YK	
G-7	Oil Seal	1	1	1	1	1	1	18
G-8	Key	1	1	1	1	1	1	23
GY	Helical Gear		1		1		1	61
GY-1	Thrust Washer		1		1		1	62
GY-2	Lockplate		1		1		1	63
GY-3	Gear Shaft Hex Bolt		1		1		1	64
H	Primary Housing	1	1	1	1	1	1	01
H-1	Sight Glass	1	1	1	1	1	1	07
H-2	Pipe Plug	2	2	2	2	2	2	37
HC	Primary Housing Cover	1	1	1	1	1	1	02
HC-2	Hex Bushing	1	1	1	1	1	1	38
HC-3	Air Vent	1	1	1	1	1	1	38A
HY	Helical Housing Assembly		1		1		1	45, 47, 49
HY-1	Gasket		1		1		1	71
HY-2	Special Stud		4		4		6	53
HY-3	Hex Nut		4		4		6	74
HY-4	Pipe Plug		4		4		3	56
HY-5	Pipe Plug		4		4		4	76
LW-1	Lockwasher - 5/16"		4		4		4	
LW-2	Lockwasher - 3/8"		12					
LW-3	Lockwasher - 7/16"	4	4					
LW-4	Lockwasher - 1/2"	24	24	10	22	6		
LW-5	Lockwasher - 5/8"			18	18	24	41	
PY	Helical Pinion		1		1		1	60
PY-1	Bearing		1		1		1	59
PY-2	Bearing		1		1		1	58
PY-3	Oil Seal		1		1		1	57
PY-4	Key		1		1		1	65
W	Worm		1		1		1	39T
W	Worm	1		1		1		39B
W-1	Bearing - Fan End	1	1					30B
W-1	Bearing Assembly			1	1	1	1	42
W-1	Bearing - Drive End	1	1	1	1	1	1	30F
W-2	Bearing Assembly Spacer			1	1	1	1	41
W-3	Bearing Assembly Locknut			1	1	1	1	43
W-4	Bearing Assembly Lockplate			1	1	1	1	44
W-5	Oil Seal	2	1	2	1	2	1	17
W-6	Key	1	1			1	1	26
W-6	Key			1				26B
W-6	Key				1			26T

APPENDIX B
TABLE IX
Parts List for Sizes -L and -M

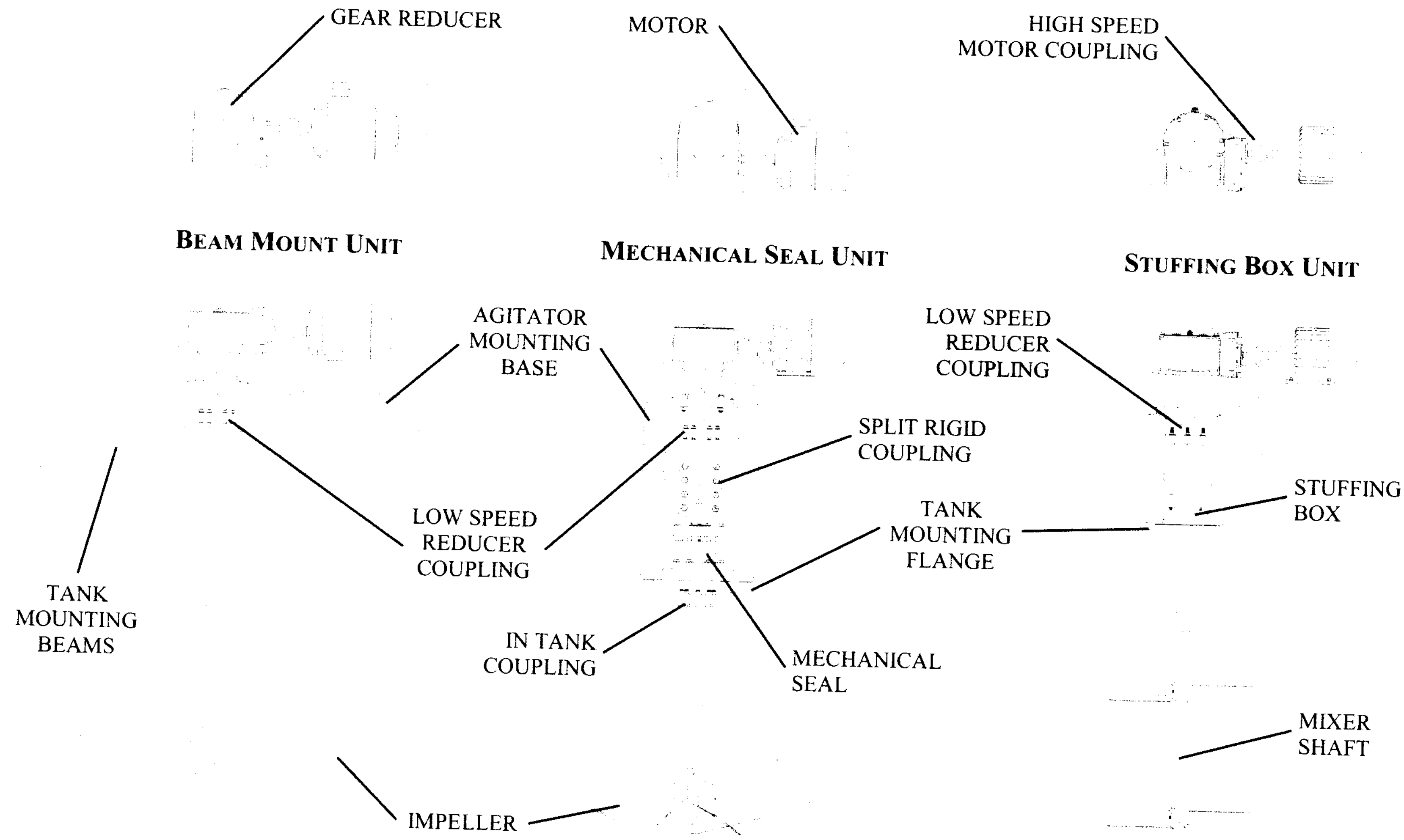
DRAWING LOCATION	DESCRIPTION	QUANTITY REQUIRED ZL	YL	ZM	YM	PART NUMBER
A	Adapter	1	1	1	1	04
A-2	Grease Fitting	1	1	1	1	29
A-3	Relief Fitting	1	1	1	1	28
A-4	Hex Pipe Reducer Bushing	1	1	1	1	27
BR	Bearing Retainer	1		1		03
BR	Bearing Retainer	1	1	1	1	06
BR-1	Gasket	1	1	1	1	14
BRY	Seal Plate		1		1	51
BRY-1	Shim Pack		1		1	52
BT-31	Hex Bolt - 7/16" x 1"		4		4	
BT-43	Hex Bolt - 1/2" x 1-1/2"		14		14	
BT-51	Hex Bolt - 5/8" x 1"	4	4	4	4	
BT-53	Hex Bolt - 5/8" x 1-1/2"	6	6	6	6	
BT-54	Hex Bolt - 5/8" x 2-1/4"	12	12	12	12	
BT-61	Hex Bolt - 3/4" x 1-1/2"		1		1	
BT-62	Hex Bolt - 3/4" x 3"	8	8	8	8	
D	Drywell	1	1	1	1	05
D-3	Shim Pack	1	1	1	1	15
EB	Shoulder Eyebolt	2	2	2	2	10
F	Fan	1	1	1	1	31
F-1	Setscrew - Cone Pt.	1	1	1	1	35
F-2	Fan Housing	1	1	1	1	33
F-3	Fan Housing Support	2	2	2	2	32
F-4	Caplug		1		1	33A
F-4	Caplug	1		1		36
F-5	Hex Head Taptite Screw	4	4	4	4	34
F-6	Guard	1	1	1	1	32A
G	Gear	1	1	1	1	66
G-1	Gear Shaft	1	1	1	1	19
G-2	Key	1	1	1	1	22
G-3	Locknut	1	1	1	1	24
G-4	Lockplate	1	1	1	1	25
G-5	Shim Pack	1	1	1	1	16
G-6	Bearing	2	2	2	2	20

APPENDIX B
TABLE IX (cont.)
Parts List for Sizes -L and -M

DRAWING LOCATION	DESCRIPTION	QUANTITY REQUIRED				PART NUMBER
		ZL	YL	ZM	YM	
G-7	Oil Seal	1	1	1	1	18
G-8	Key	1	1	1	1	23
GY	Helical Gear		1		1	61
GY-1	Thrust Washer		1		1	62
GY-2	Lockplate		1		1	63
H	Primary Housing	1	1	1	1	01
H-1	Sight Glass	1	1	1	1	07
H-2	Pipe Plug	2	2	2	2	37
HC	Primary Housing Cover	1	1	1	1	02
HC-2	Hex Bushing	1	1	1	1	38
HC-3	Air Vent	1	1	1	1	38A
HY	Helical Housing Assembly		1		1	40, 47, 49
HY-1	Gasket		1		1	71
HY-2	Special Stud		6		6	53
HY-3	Hex Nut		6		6	74
HY-4	Pipe Plug		4		4	56
HY-5	Pipe Plug		4		4	76
LW-3	Lockwasher - 7/16"		4		4	
LW-4	Lockwasher - 1/2"		12		12	
LW-5	Lockwasher - 5/8"	24	24	24	24	
LW-61	Lockwasher - 3/4"	8	8	8	8	
PY	Helical Pinion		1		1	60
PY-1	Bearing		1		1	59
PY-2	Bearing		1		1	58
PY-3	Oil Seal		1		1	57
PY-4	Key		1		1	65
W	Worm	1	1	1	1	39
W-1	Bearing	1	1	1	1	30
W-1	Bearing Assembly	1	1	1	1	42
W-2	Bearing Assembly Spacer	1	1	1	1	41
W-3	Bearing Assembly Locknut	1	1	1	1	43
W-4	Bearing Assembly Lockplate	1	1	1	1	44
W-5	Oil Seal	2	1	2	1	17
W-6	Key	1		1		26

APPENDIX C, FIGURE 6

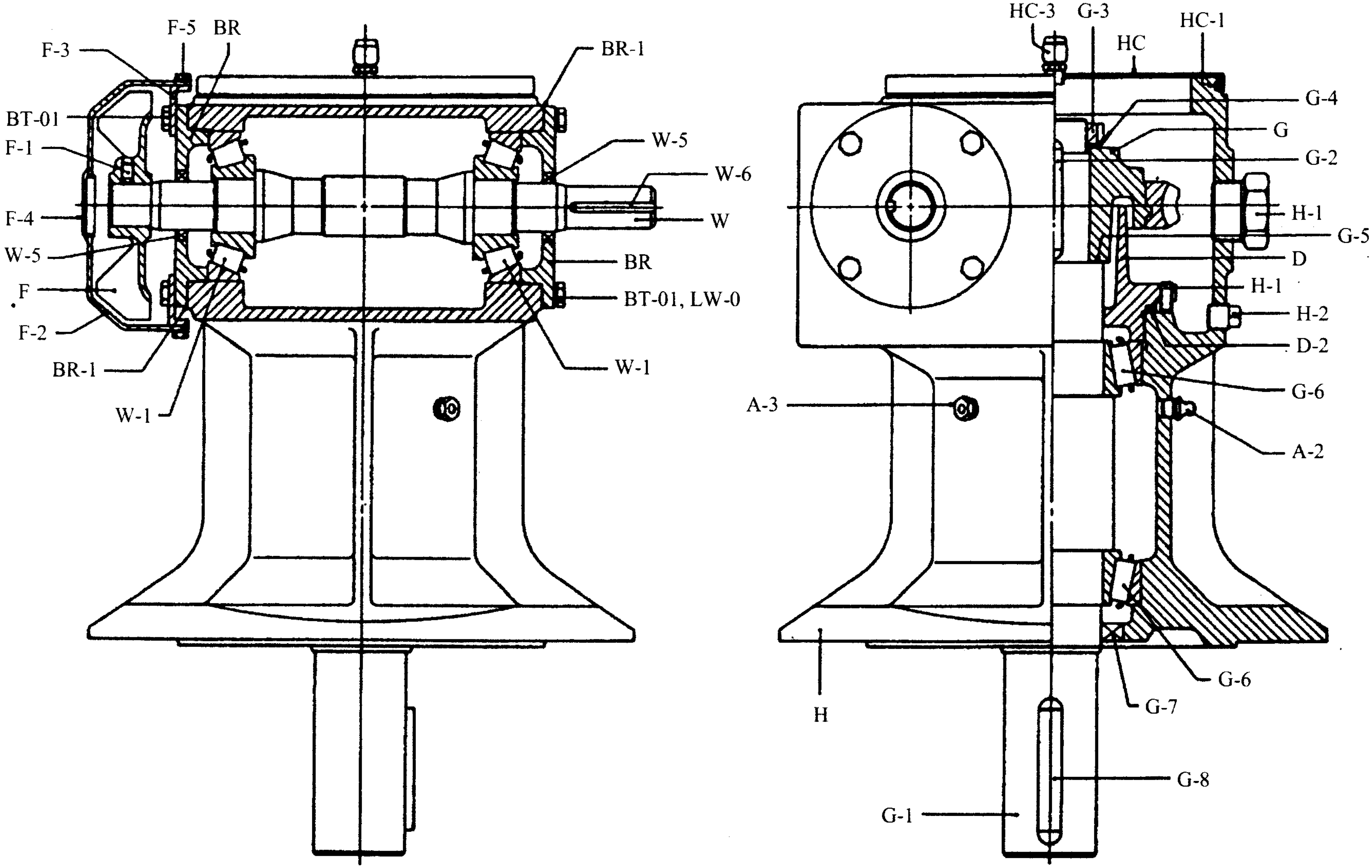
TYPICAL AGITATOR COMPONENTS



NOTE: SEE THE CERTIFIED OUTLINE AND DIMENSION DRAWING SUPPLIED WITH THIS MANUAL FOR THE SPECIFIC COMPONENTS OF YOUR UNIT

APPENDIX C, FIGURE 7

ZC DRIVE ASSEMBLY



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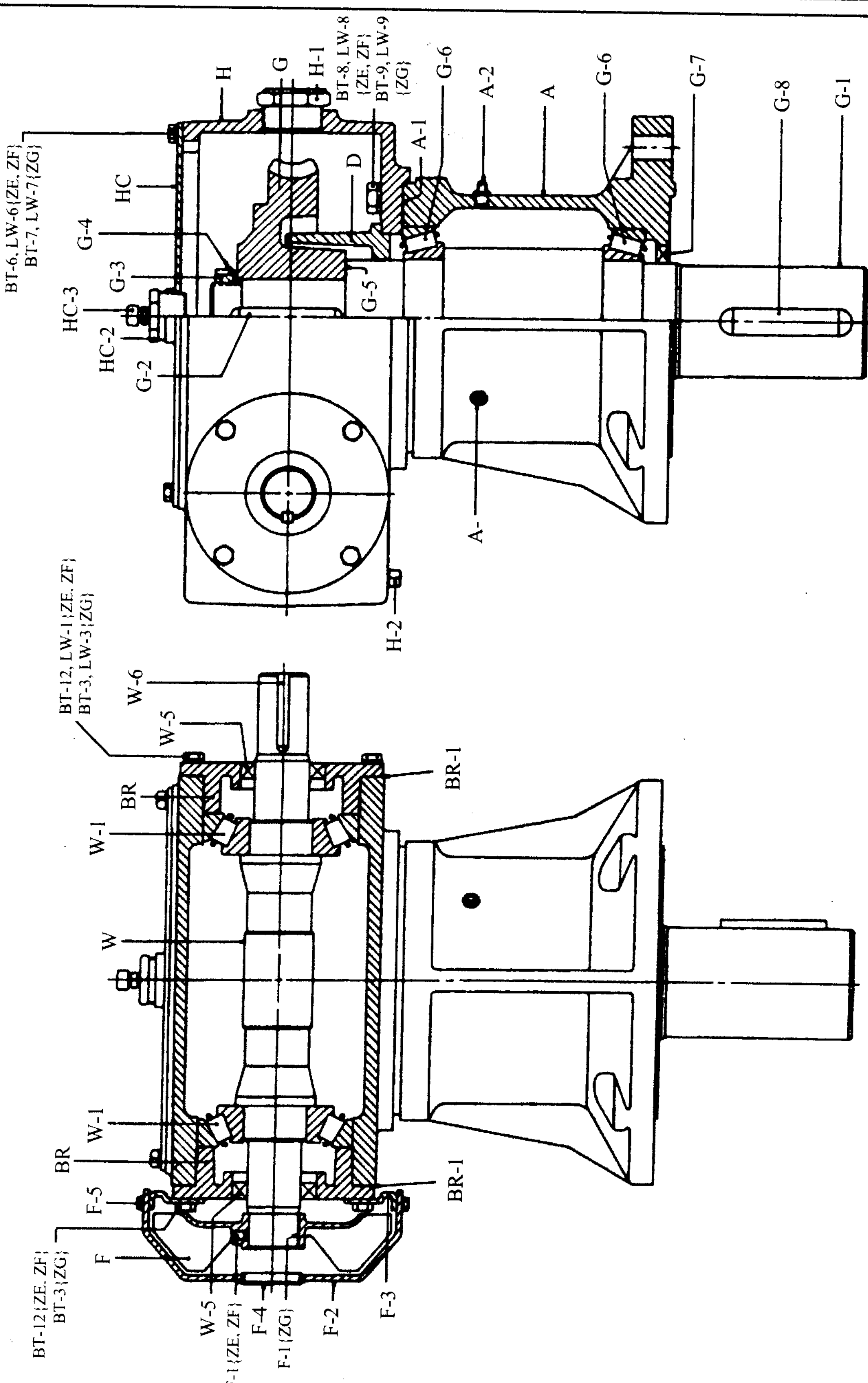
APPENDIX C, FIGURE 8

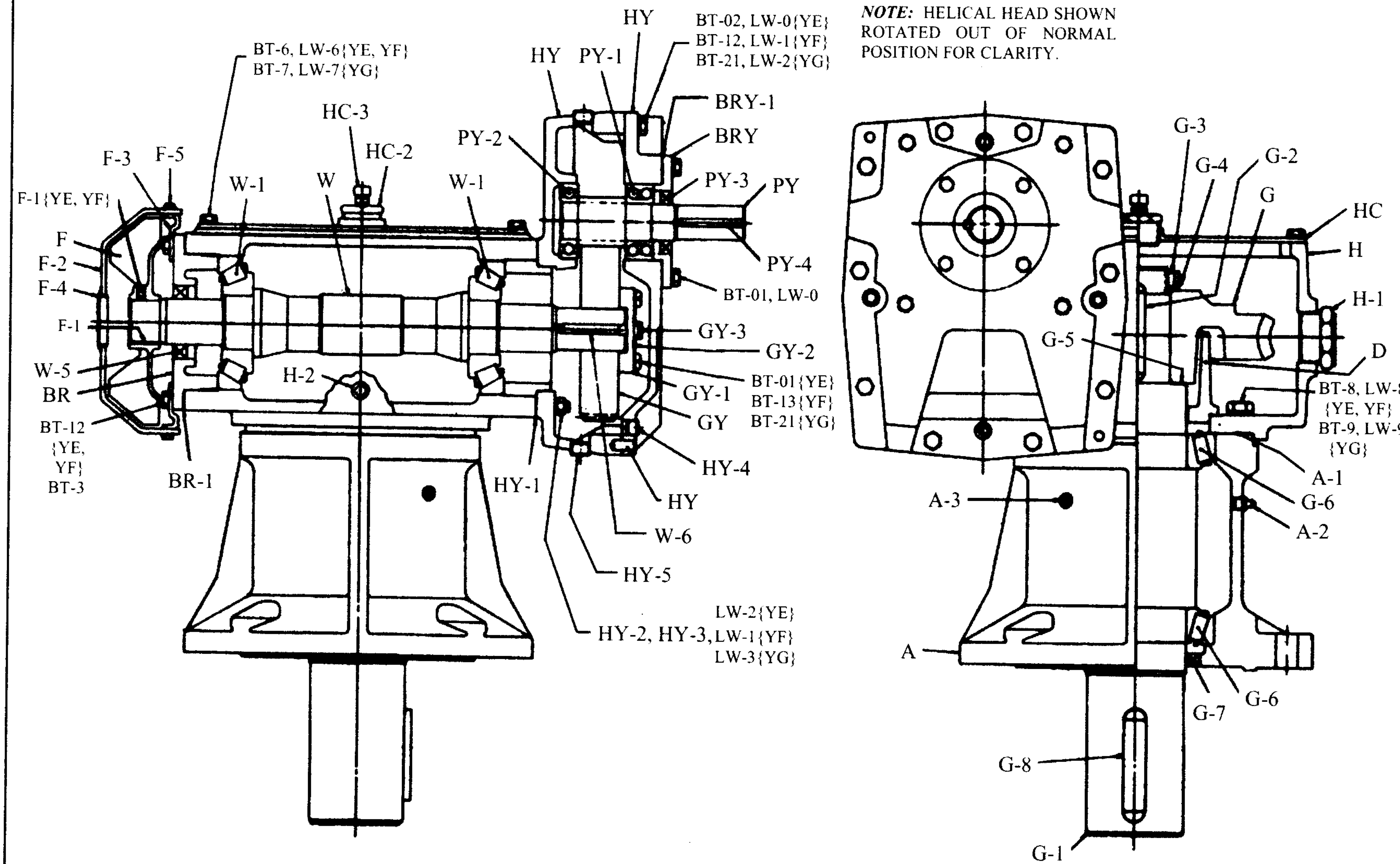
ZE, ZF & ZG DRIVE ASSEMBLY



APPENDIX C, FIGURE 9

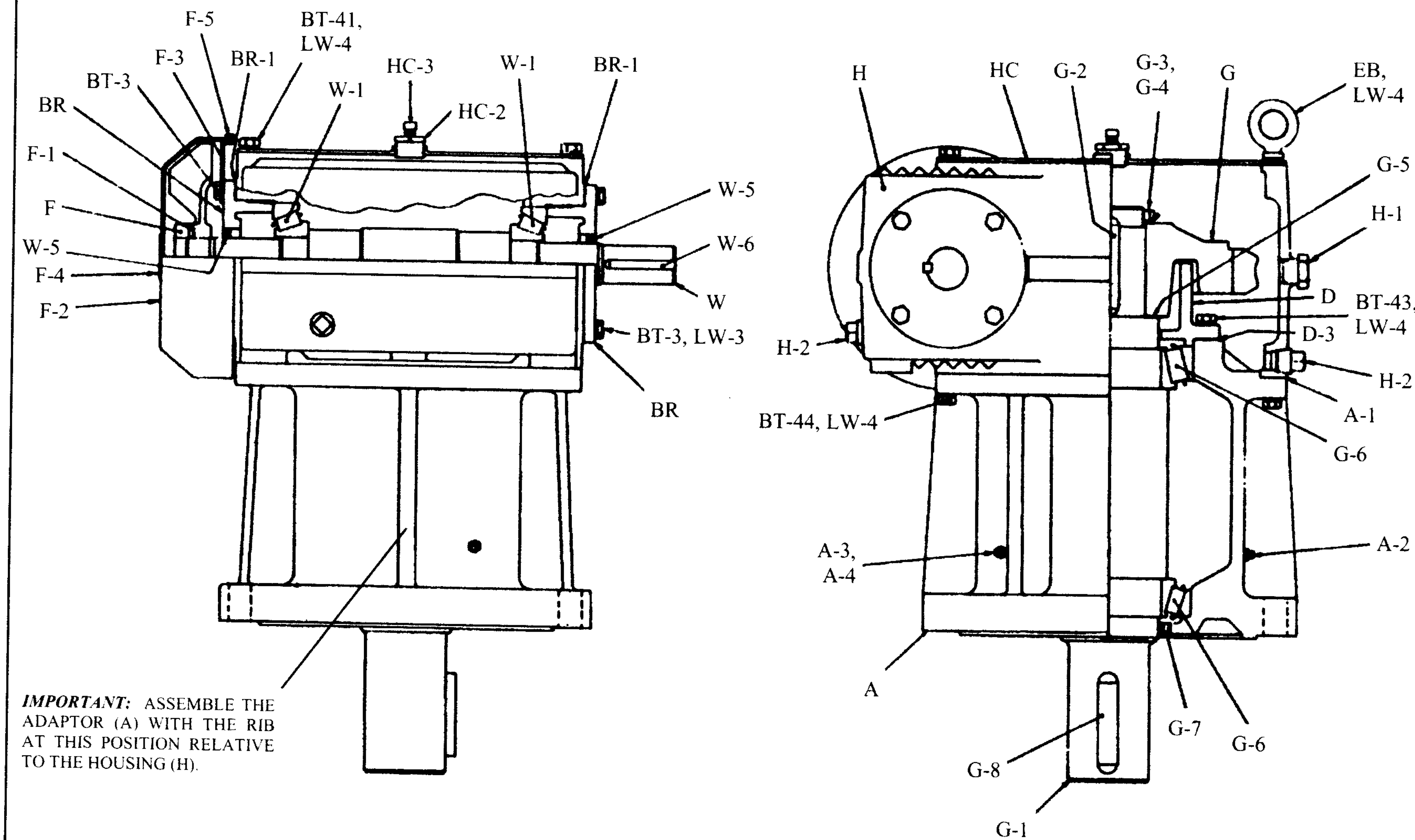
YE, YF & YG DRIVE ASSEMBLY

NOTE: HELICAL HEAD SHOWN ROTATED OUT OF NORMAL POSITION FOR CLARITY.



APPENDIX C, FIGURE 10

ZH DRIVE ASSEMBLY

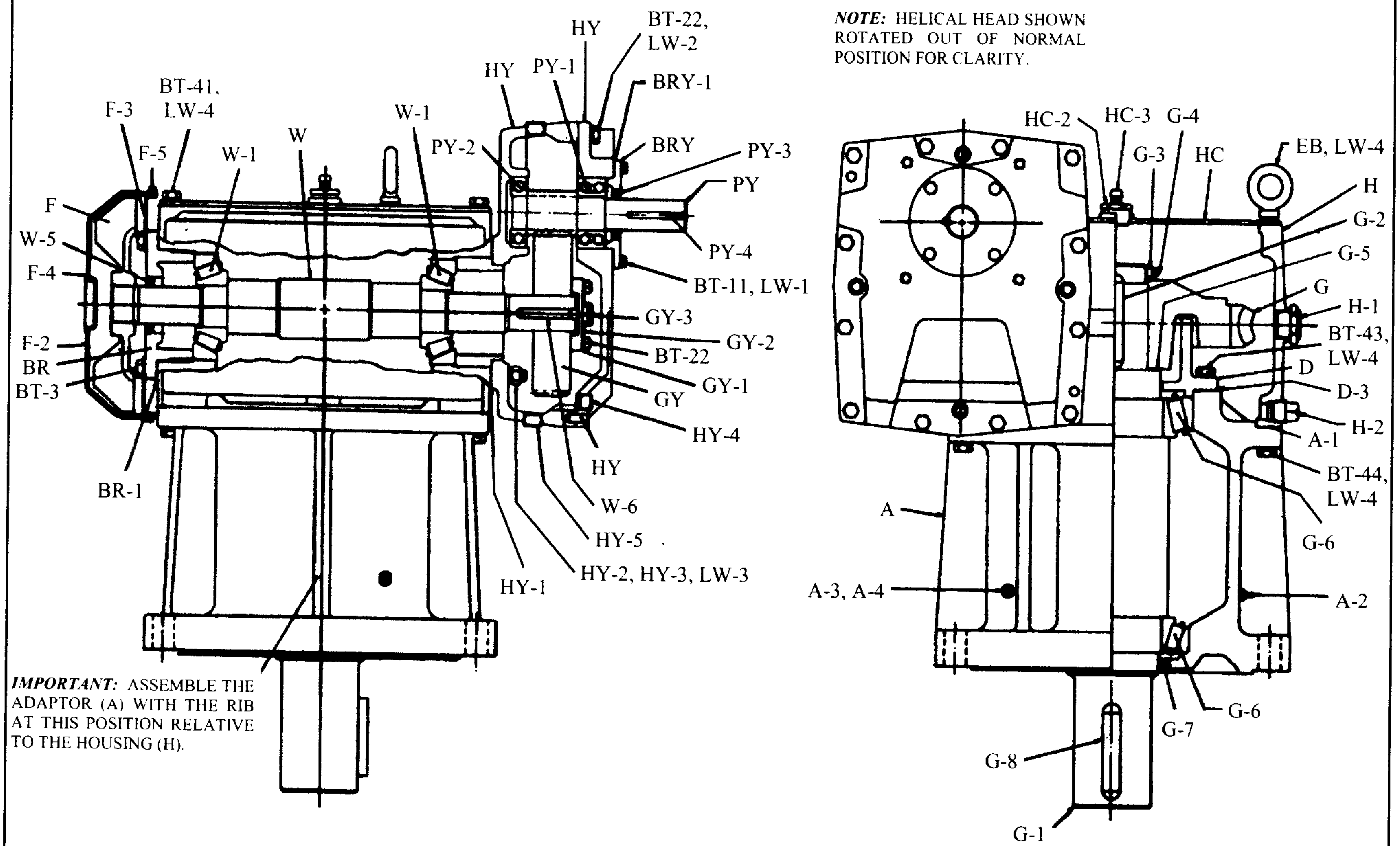


IMPORTANT: ASSEMBLE THE ADAPTOR (A) WITH THE RIB AT THIS POSITION RELATIVE TO THE HOUSING (H).

APPENDIX C, FIGURE 11

YH DRIVE ASSEMBLY

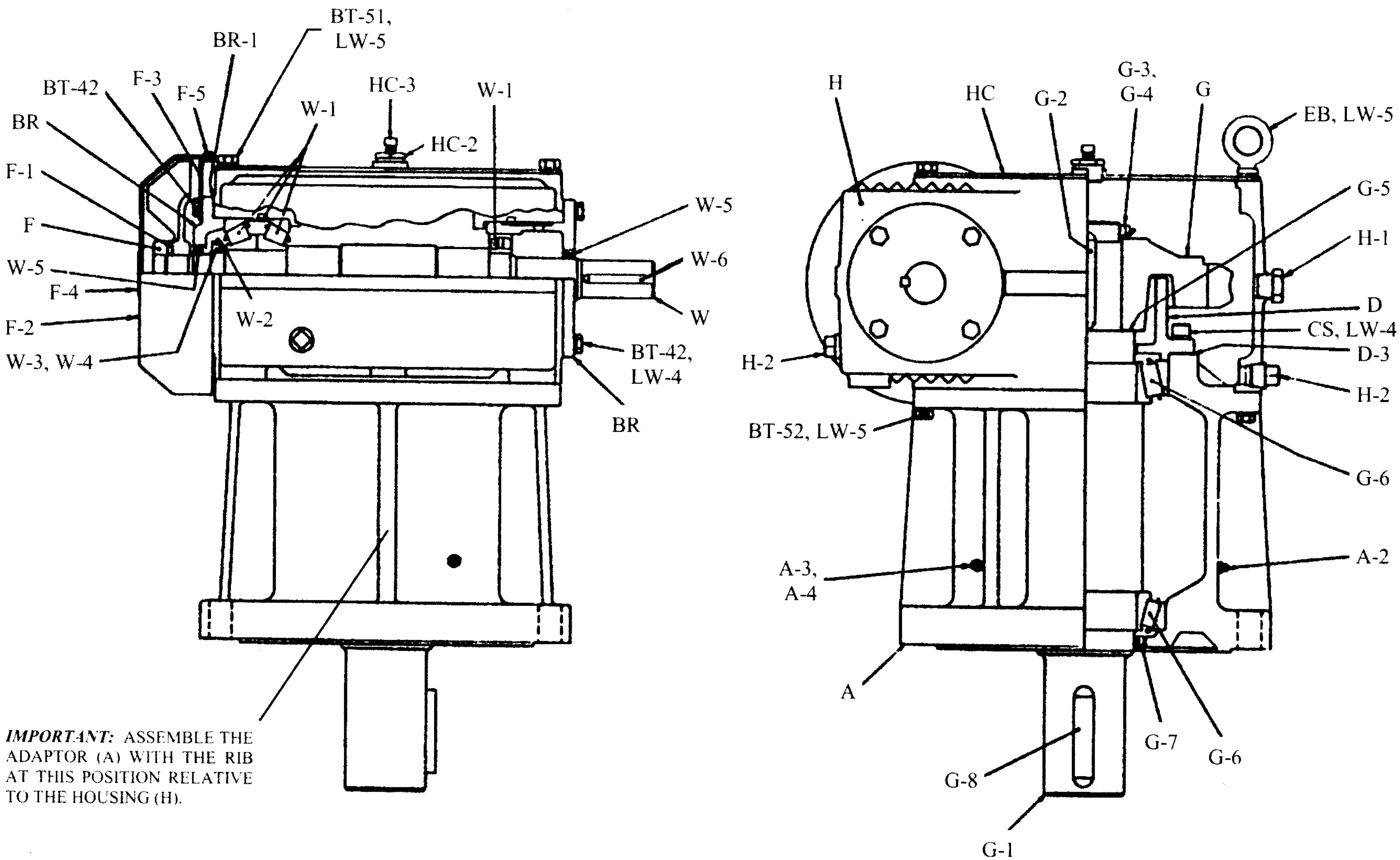
NOTE: HELICAL HEAD SHOWN ROTATED OUT OF NORMAL POSITION FOR CLARITY.



IMPORTANT: ASSEMBLE THE ADAPTOR (A) WITH THE RIB AT THIS POSITION RELATIVE TO THE HOUSING (H).

APPENDIX C, FIGURE 12

ZJ DRIVE ASSEMBLY

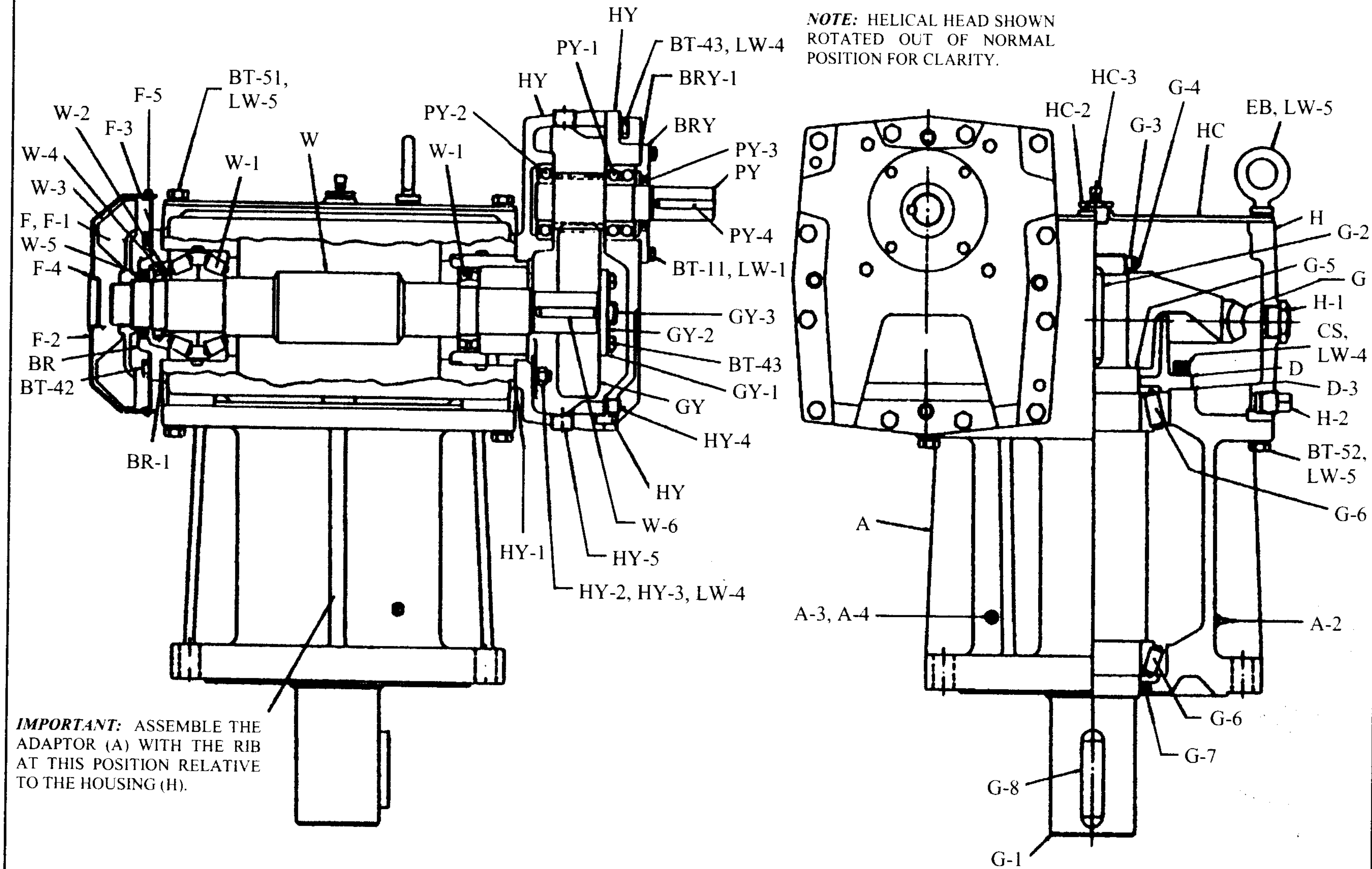


IMPORTANT: ASSEMBLE THE ADAPTOR (A) WITH THE RIB AT THIS POSITION RELATIVE TO THE HOUSING (H).

APPENDIX C, FIGURE 13

YJ DRIVE ASSEMBLY

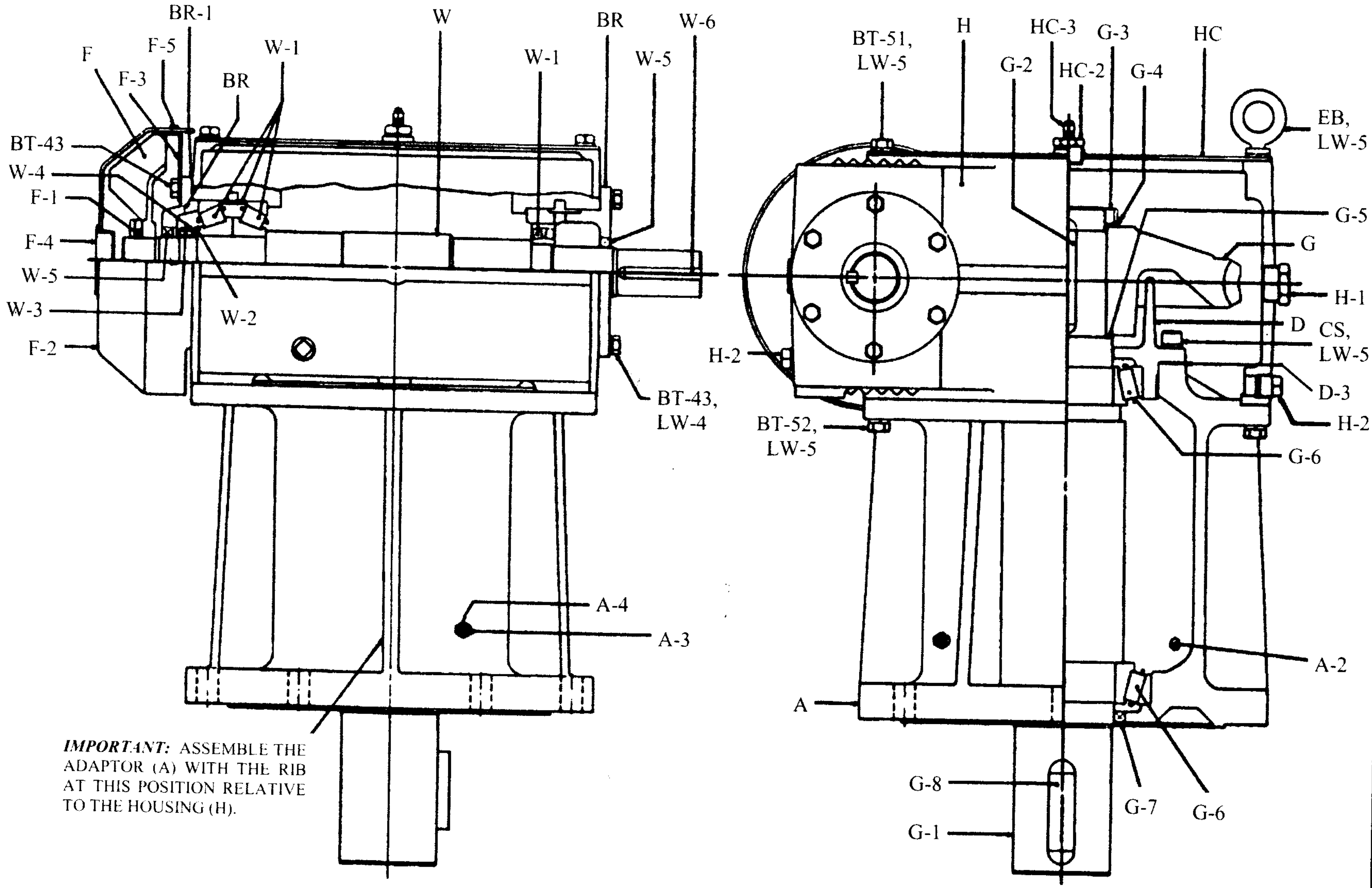
NOTE: HELICAL HEAD SHOWN ROTATED OUT OF NORMAL POSITION FOR CLARITY.



IMPORTANT: ASSEMBLE THE ADAPTOR (A) WITH THE RIB AT THIS POSITION RELATIVE TO THE HOUSING (H).

APPENDIX C, FIGURE 14

ZK DRIVE ASSEMBLY

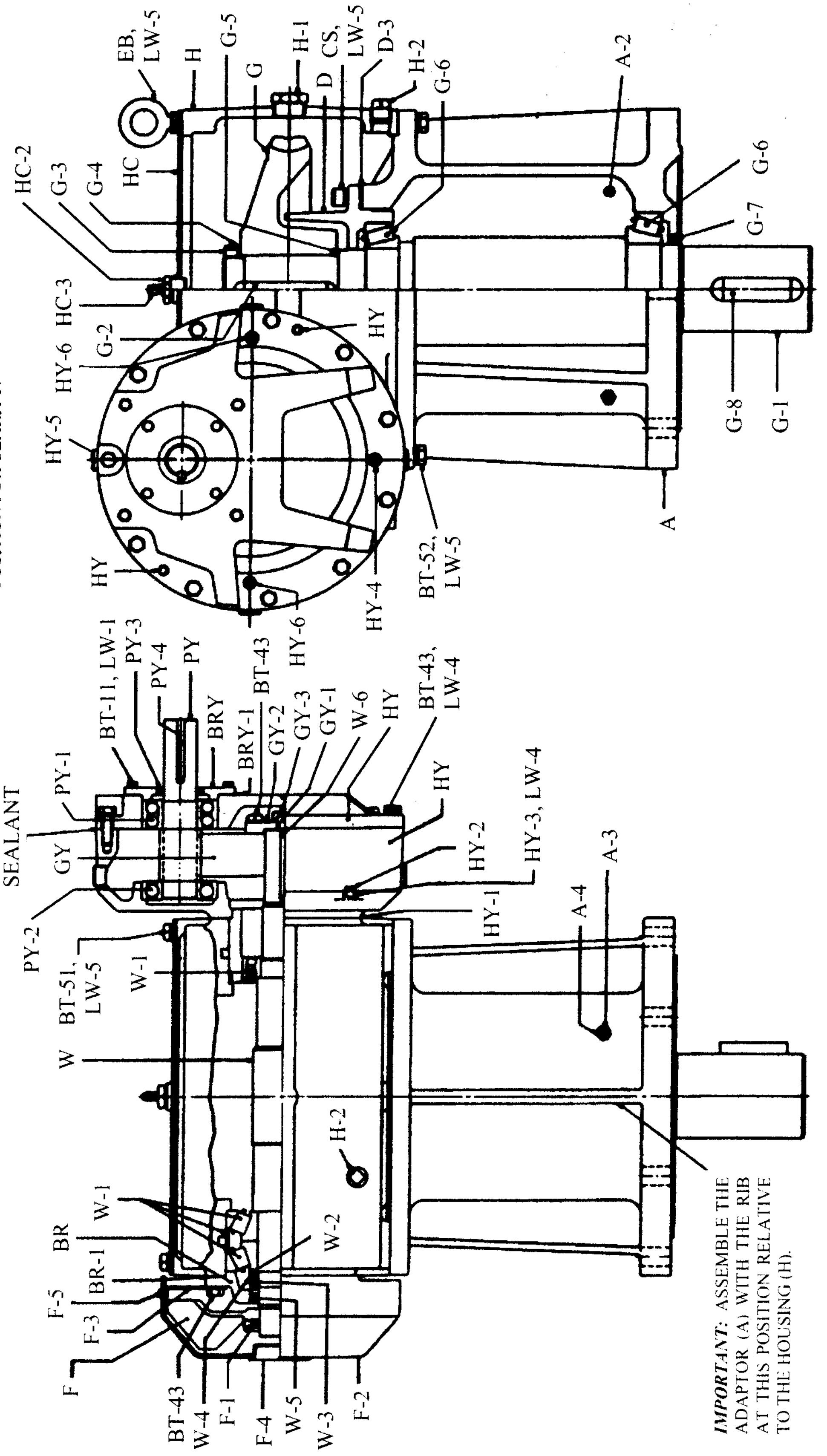


IMPORTANT: ASSEMBLE THE ADAPTOR (A) WITH THE RIB AT THIS POSITION RELATIVE TO THE HOUSING (H).

APPENDIX C, FIGURE 15

YK DRIVE ASSEMBLY

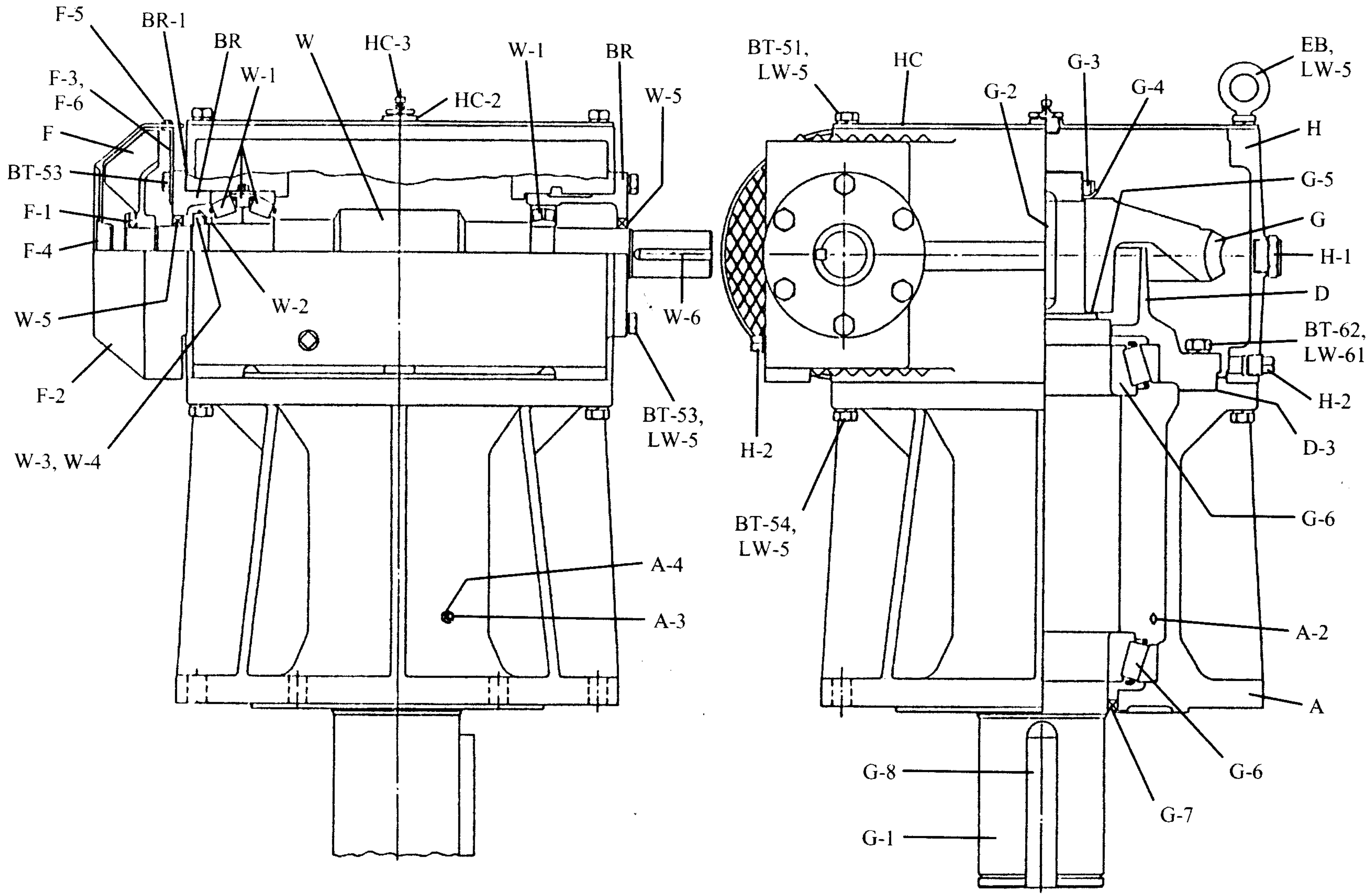
NOTE: HELICAL HEAD SHOWN ROTATED OUT OF NORMAL POSITION FOR CLARITY.



IMPORTANT: ASSEMBLE THE ADAPTOR (A) WITH THE RIB AT THIS POSITION RELATIVE TO THE HOUSING (H).

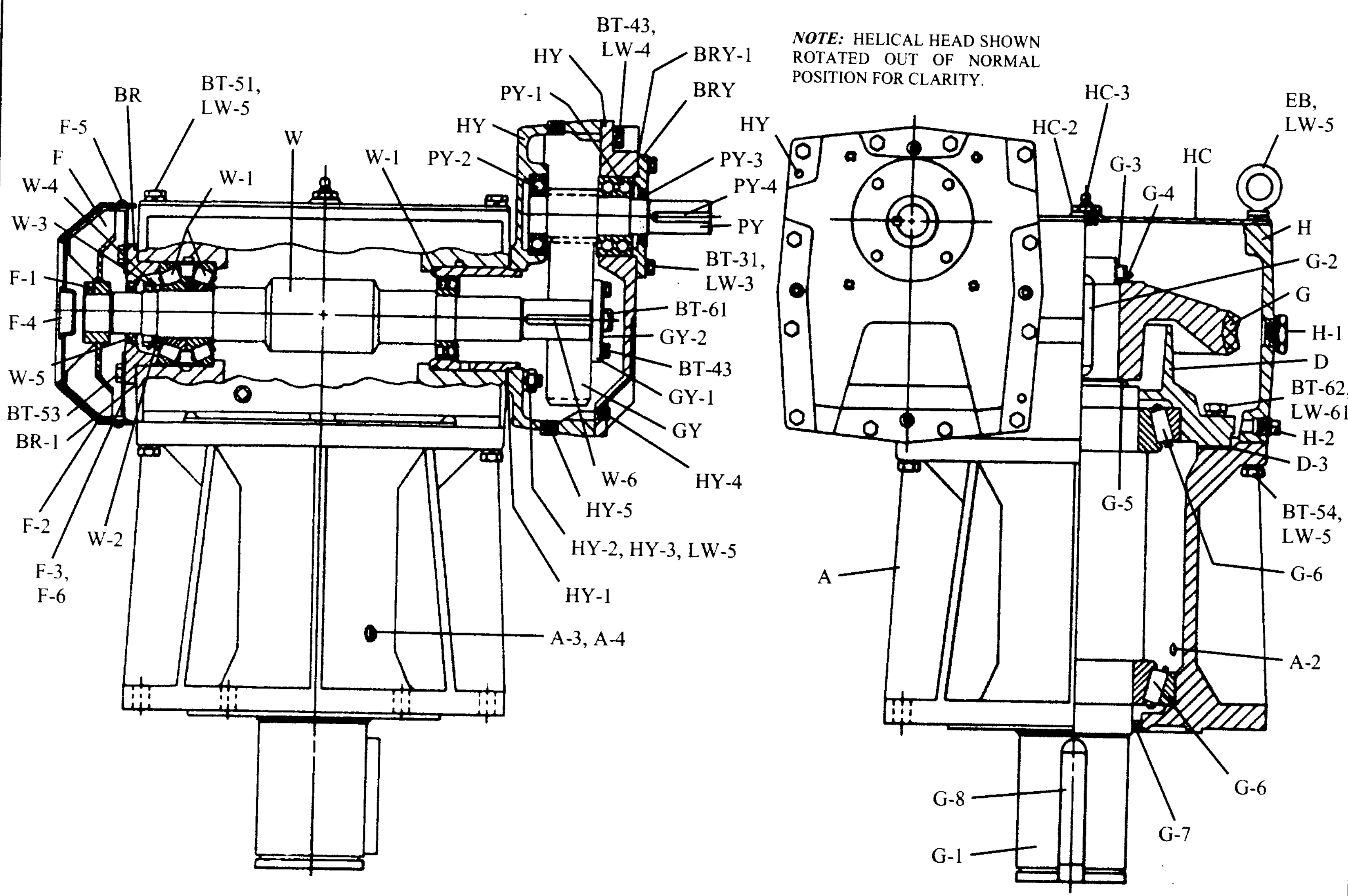
APPENDIX C, FIGURE 16

ZL & ZM DRIVE ASSEMBLY



APPENDIX C, FIGURE 17

YL & YM DRIVE ASSEMBLY



Pro Quip, Inc.

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0503

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E-mail: application@proquipinc.com

RECOMMENDED SPARE PARTS LIST

FOR ZE GEAR BOX

PART NO.	QTY.	DESCRIPTION	PRICE/each
		Gearbox Parts	
18	1	SHIM SET	$45.65
19	1	SHIM SET	$41.64
20	1	SHIM SET	$49.36
21	1	SHIM SET	$67.65
22	1	WORM SHAFT	$1273.50
23	2	WORM SHAFT BEARINGS	$200.97
24	2	WORM SHAFT OIL SEALS	$42.46
32	2	GEAR SHAFT BEARINGS	$152.46
35	1	GEAR SHAFT OIL SEAL	$19.06
36	1	BRONZE WORM GEAR	$1172.25
37	1	LOCKNUT	$43.40
38	1	LOCKWASHER	$12.50

Complete Gearbox–minus low speed coupling $3,775.50

Low Speed Coupling Half $291.60

Recommended spare parts for minimum maintenance time. Spare parts are normally available in stock from the factory.

When ordering – state model & serial No., plus part No. & part name.
Minimum order is $50.00.

All prices are FOB factory Macedonia, Ohio.
Prices are subject to change without notice.

Terms: Net 10 days.
All applicable taxes to be assumed by purchaser.

3/08 (DP)
dd:\partlist\ZE gearbox

SURE-FLEX® COUPLINGS

TB Wood's

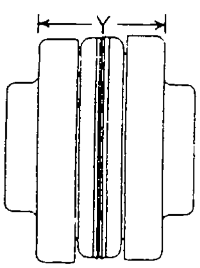
Installation Instructions

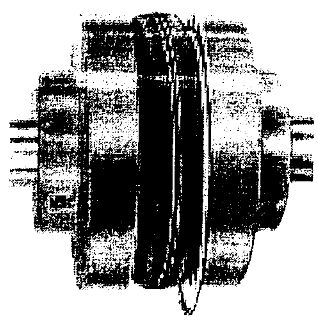
Sure-Flex flanges (outer metallic parts) and sleeves (inner elastomeric members) come in many sizes and types. First, determine the size and type of components being used. Remove all components from their boxes, and loosely assemble the coupling on any convenient surface. (Do not attempt to install the wire ring on the two-piece E or N sleeve at this time.) Also check maximum RPM values in the table against operating speed. All rubber sleeves (EPDM and Neoprene) have the same ratings for a given size and may be used interchangeably. However, because rubber and Hytrel sleeves have completely different ratings, they never should be used interchangeably.

1 Inspect all coupling components and remove any protective coatings or lubricants from bores, mating surfaces and fasteners. Remove any existing burrs, etc. from the shafts.

2 Slide one coupling flange onto each shaft, using snug-fitting keys where required. When using Type B flanges, follow the instructions furnished with the Sure-Grip bushing.

3 Position the flanges on the shafts to approximately achieve the Y dimension shown in the table. It is usually best to have an equal length of shaft extending into each flange. Move one flange to its final position. Torque fasteners to proper values. Slide the other flange far enough away to install the sleeve. With a two-piece sleeve, do not move the wire ring to its final position; allow it to hang loosely in the groove adjacent to the teeth.

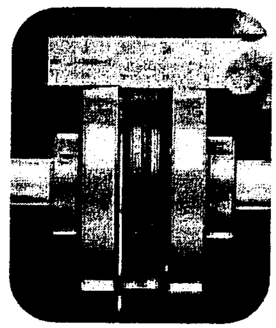




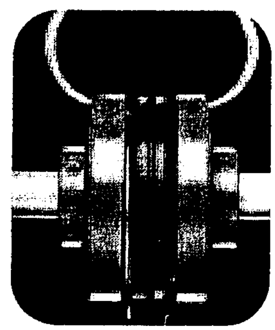
4 Slide the loose flange on the shaft until the sleeve is completely seated in the teeth of each flange. (The "Y" dimension is for reference and not critical.) Secure the flange to the shaft. Different coupling sleeves require different degrees of alignment precision. Locate the alignment values for your sleeve size and type in the table.

5 Check parallel alignment by placing a straight-edge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling without rotating the coupling. If the maximum offset exceeds the figure shown under "Parallel" in the table, realign the shafts.

6 Check angular alignment with a micrometer or caliper. Measure from the outside of one flange to the outside of the other at intervals around the periphery of the coupling. Determine the maximum and minimum dimensions without rotating the coupling. The difference between the maximum and minimum must not exceed the figure given under "Angular" in the table. If a correction is necessary, be sure to recheck the parallel alignment.



Parallel



Angular

MAXIMUM RPM AND ALLOWABLE MISALIGNMENT

(Dimensions in inches)

Sleeve Size	Maximum RPM	Types JE, JN, JES, JNS, E & N			*Type H & HS		
		Parallel	Angular	Y	Parallel	Angular	Y
3	9200	.010	.035	1.188	...	...	...
4	7600	.010	.043	1.500	...	...	...
5	7600	.015	.056	1.938	...	...	...
6	6000	.015	.070	2.375	.010	.016	2.375
7	5250	.020	.081	2.563	.012	.020	2.563
8	4500	.020	.094	2.938	.015	.025	2.938
9	3750	.025	.109	3.500	.017	.028	3.500
10	3600	.025	.128	4.063	.020	.032	4.063
11	3600	.032	.151	4.875	.022	.037	4.875
12	2800	.032	.175	4.688	.025	.042	5.688
13	2400	.040	.195	6.688	.030	.050	6.625
14	2200	.045	.242	7.750	.035	.060	7.750
16	1500	.062	.330	10.250	...	...	...

Note: Values shown above apply if the actual torque transmitted is more than 1/4 the coupling rating. For lesser torque, reduce the above values by 1/2.

*Type H and HS sleeves **should not** be used as direct replacements for EPDM or Neoprene sleeves.

7 If the coupling employs the two-piece sleeve with the wire ring, force the ring into its groove in the center of the sleeve. It may be necessary to pry the ring into position with a blunt screwdriver.

8 Install coupling guards per OSHA requirements.

CAUTION: Coupling sleeves may be thrown from the coupling assembly with substantial force when the coupling is subjected to a severe shock load or abuse.

Bulletin 251

INSTALLATION AND OPERATING INSTRUCTIONS
PROQUIP LOW PRESSURE 2 RING & 3 RING STUFFING BOXES

PACKING THE STUFFING BOX:

1. If this is an existing box to be repacked, remove the old packing carefully, keeping the rings for examination. Clean the stuffing box and examine for signs of wear, overheating, or damage. Repair if necessary. Check the stuffing box drawing for the number of packing rings required. Be sure to check the packing for correct size.

2. Install the packing as individual rings; never wind it in a spiral. Measure the proper length by winding it around the shaft above the stuffing box or another shaft of the same diameter. Cut the packing square at the ends with a razor blade or a very sharp knife. Try the first ring to see that it fits and that the joint closes, before cutting the additional rings.

3. Install each ring individually, tamping it with a packing tool until it is seated and the joint is tight. Stagger the joints at 90° to 120° offsets. Do not insert more than one ring at a time, nor depend on the follower to seat the rings.

4. Apply a process-compatible lubricant on the shaft portion covered by the packing. The purpose of the packing is to control leakage, not to prevent it. Packings must leak to perform properly, otherwise they will burn up. "Teflon" packings are especially sensitive in this respect.

START UP:

1. Tighten the follower finger-tight only.

2. Turn the mixer on and run it at atmospheric pressure for 5 to 10 minutes. Tighten down 1/2 turns on the follower bolts. Never tighten more than one turn on bolts at one time and let the mixer run about five minutes between each tightening. The total amount of tightening will vary, depending on the degree of tamping, the operating pressure and the softness of the packing.

MAINTAINING THE STUFFING BOX:

1. Apply process-compatible lubricant periodically around the shaft at the top of the packing, as required to avoid scoring of the shaft.

2. Do not over-tighten the follower nuts; over-tightening will create heat which can destroy the packing and damage the shaft.

ProQuip, Inc.
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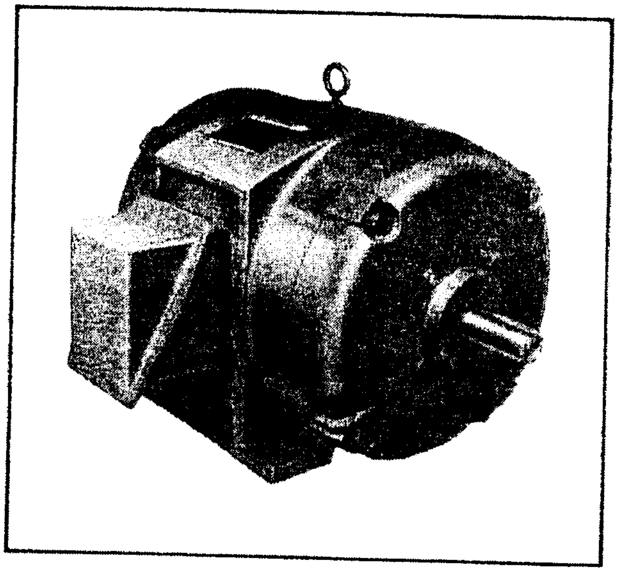
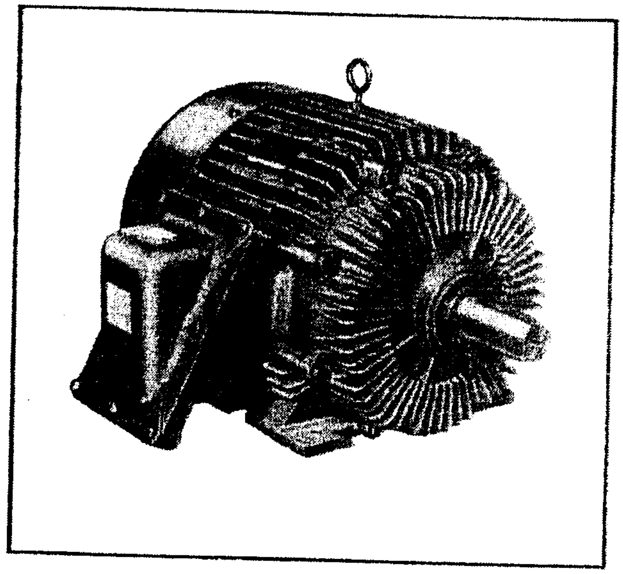
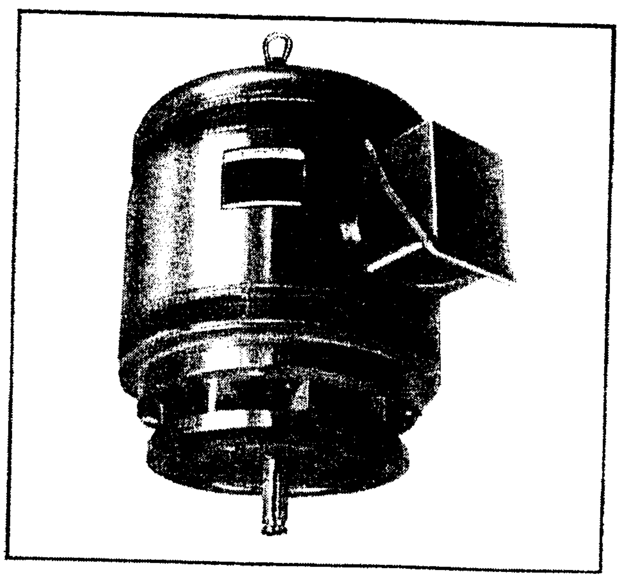
MARATHON ELECTRIC

Standard Induction Motors







Installation, Operation, & Maintenance Instructions

WARNING

These instructions must be followed to ensure safe and proper installation, operation and maintenance of the motor. They should be brought to the attention of all persons who install, operate or maintain this equipment.

GENERAL INFORMATION

Marathon Electric motors are all fully factory tested and inspected before shipping. Damage during shipment and storage can occur. Motors not correctly matched to the power supply and/or the load will not operate properly. These instructions are intended as a guide to identify and eliminate these problems before they are overlooked or cause further damage.

ACCEPTANCE

Check carefully for any damage that may have occurred in transit. If any damage or shortage is discovered, do not accept until an appropriate notation on the freight bill is made. Any damage discovered after receipt of equipment should be immediately reported to the carrier.

STORAGE

A. Keep motors clean
   1. Store indoors
   2. Keep covered to eliminate airborne dust and dirt.
   3. Cover openings for ventilation, conduit connections, etc. to prevent entry of rodents, snakes, birds, and insects, etc.

B. Keep motors dry
   1. Store in a dry area indoors
   2. Temperature swings should be minimal to prevent condensation.
   3. Space heaters are recommended to prevent condensation.
   4. Treat unpainted flanges, shafts, and fittings with a rust inhibitor.
   5. Check insulation resistance before putting motor into service. (Consult manufacturer for guidelines).

C. Keep Bearings Lubricated
   1. Once per month, rotate shaft several turns to distribute grease in bearings.
   2. If unit has been stored more than one year, add grease before start-up. (Refer to lubrication procedure).

INSTALLATION

UNCRATING AND INSPECTION

After uncrating, check for any damage which may have been incurred in handling. The motor shaft should turn freely by hand. Repair or replace any loose or broken parts before attempting to use the motor.

Check to be sure that motor has not been exposed to dirt, grit, or excessive moisture in shipment or storage before installation.

Measure insulation resistance (see operation). Clean and dry the windings as required.

Never start a motor which has been wet without having it thoroughly dried.

SAFETY

Motors should be installed, protected and fused in accordance with latest issue of National Electrical Code, NEMA Standard Publication No. MG 2 and local codes.

Eyebolts or lifting lugs are intended for lifting the motor only. These lifting provisions should never be used when lifting or handling the motor with other equipment (i.e. pumps, gear boxes, fans or other driven equipment) as a single unit. Be sure the eyebolt is fully threaded and tight in its mounting hole.

Eyebolt lifting capacity ratings is based on a lifting alignment coincident with the eyebolt centerline. Eyebolt capacity reduces as deviation from this alignment increases. See NEMA MG 2.

Frames and accessories of motors should be grounded in accordance with National Electrical Code (NEC) Article 430. For general information of grounding refer to NEC Article 250.

Rotating parts such as pulleys, couplings, external fans, and shaft extensions should be permanently guarded.

LOCATION

In selecting a location for the motor, consideration should be given to environment and ventilation. A motor with the proper enclosure for the expected operating condition should be selected.

The ambient temperature of the air surrounding the motor should not exceed 40°C (104°F) unless the motor has been especially designed for high ambient temperature applications. The free flow of air around the motor should not be obstructed.

The motor should never be placed in a room with a hazardous process, or where flammable gases or combustible material may be present, unless it it specifically designed for this type of service.

1. Dripproof (open) motors are intended for use indoors where atmosphere is relatively clean, dry and non-corrosive.
2. Dripproof (open) fire pump motors are to be installed in a Type 2 dripproof environment as defined in NEMA 250.
3. Totally enclosed motors may be installed where dirt, moisture and corrosion are present, or in outdoor locations.
4. Explosion proof motors are built for use in hazardous locations as indicated on the motor's UL Listing Mark plate. Consult UL, NEC, and local codes for guidance.

Refer to Marathon Electric for application assistance.

FLOOR MOUNTING

Motors should be provided with a firm, rigid foundation, with the plane of four mounting pads flat within .010" for 56 to 210 frame; .015" from 250 through 500 frame. This may be accomplished by shims under the motor feet. For special isolation mounting, contact Marathon Electric for assistance.

V-BELT DRIVE

1. Select proper type and number of belts and sheaves. Excessive belt load will damage bearings. Sheaves should be in accordance to NEMA Spec. MG-1 or as approved by the manufacturer for a specific application.
2. Align sheaves carefully to avoid axial thrust on motor bearing. The drive sheave on the motor should be positioned toward the motor so it is as close as possible to the bearing.

REDUCED VOLTAGE STARTING

Motors used on reduced voltage starting, should be carefully selected based upon power supply limitations and driven load requirements. The motors starting torque will be reduced when using reduced voltage starting. The elapsed time on the start step should be kept as short as possible and should not exceed 5 seconds. It is recommended that this time be limited to 2 seconds. Refer to Marathon Electric for application assistance.

OPERATION

> WARNING
>
> **Disconnect and lock out before working on motor or driven equipment.**

BEFORE INITIAL STARTING

1. If a motor has become damp in shipment or in storage, measure the insulation resistance of the stator winding.

$$\text{Minimum Insulation Resistance In Megohms} = 1 + \frac{\text{Rated Voltage}}{1000}$$

Do not attempt to run the motor if the insulation resistance is below this value.

2. If insulation resistance is low, dry out the moisture in one of the following ways:
   a. Bake in oven at temperature not more than 90°C (194°F).
   b. Enclose motor with canvas or similar covering, leaving a hole at the top for moisture to escape, and insert heating units or lamps.
   c. Pass a current at low voltage (rotor locked) through the stator winding. Increase the current gradually until the winding temperature, measured with a thermometer, reaches 90°C (194°F). Do not exceed this temperature.
3. See that voltage and frequency stamped on motor and control nameplates correspond with that of the power line.
4. Check all connections to the motor and control with the wiring diagram.
5. Be sure rotor turns freely when disconnected from the load. Any foreign matter in the air gap should be removed.
6. Leave the motor disconnected from the load for the initial start (see following caution). Check for proper rotation. Check for correct voltage (within ±10% of nameplate value) and that it is balanced within 1% at the motor terminals. After the machine is coupled to the load, check that the nameplate amps are not exceeded. Recheck the voltage level and balance under load per the above guidelines.

Shut down the motor if the above parameters are not met or if any other noise or vibration disturbances are present. Consult NEMA guidelines or the equipment manufacturer if any questions exist before operating equipment.

> CAUTION
>
> **For motors nameplated as "belted duty only", do not run motor without belts properly installed.**

COLLECTOR RINGS (Wound Rotor Motors Only)

The collector rings are sometimes treated at the factory to protect them while in stock and during shipment. The brushes have been fastened in a raised position. Before putting the motor into service, the collector rings should be cleaned to remove this treatment. Use a cleaning fluid that is made for degreasing electrical equipment. All of the brushes must be released and lowered to the collector surface. Keep the rings clean and maintain their polished surfaces. Ordinarily, the rings will require only occasional wiping with a piece of canvas or non-linting cloth. Do not let dust or dirt accumulate between the collector rings.

BRUSHES (Wound Rotor Motors Only)

See that the brushes move freely in the holders and at the same time make firm, even contact with the collector rings. The pressure should be between 2 and 3 pounds per square inch of brush surface.

When installing new brushes, fit them carefully to the collector rings. Be sure that the copper pigtail conductors are securely fastened to, and make good contact with, the brushholders.

ALLOWABLE VOLTAGE AND FREQUENCY RANGE

If voltage and frequency are within the following range, motors will operate, but with somewhat different characteristics than obtained with correct nameplate values.

1. Voltage: Within 10% above or below the value stamped on the nameplate. On three phase systems the voltage should be balanced within 1%. A small voltage unbalance will cause a significant current unbalance.
2. Frequency: Within 5% above or below the value stamped on the nameplate.
3. Voltage and Frequency together: Within 10% (providing frequency above is less than 5%) above or below values stamped on the nameplate.

CLEANLINESS

Keep both the interior and exterior of the motor free from dirt, water, oil and grease. Motors operating in dirty places should be periodically disassembled and thoroughly cleaned.

CONDENSATION DRAIN PLUGS

All explosion proof and some totally enclosed motors are equipped with automatic drain plugs, they should be free of oil, grease, paint, grit and dirt so they don't clog up. The drain system is designed for normal floor (feet down) mounting. For other mounting positions, modification of the drain system may be required, consult Marathon Electric.

SERVICE

> WARNING
>
> **Disconnect power before working on motor or driven equipment. Motors with automatic thermal protectors will automatically restart when the protector cools. Do not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.**

These instructions do not cover all details or variations in equipment nor provide for every possible condition to be met in connection with installation, operation or maintenance. Should additional information be desired for the purchaser's purposes, the matter should be referred to the manufacturer.

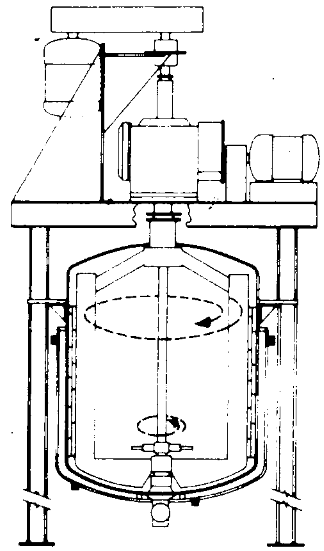
MOTOR TROUBLE SHOOTING CHART

Your motor service and any trouble shooting must be handled by qualified persons who have proper tools and equipment.

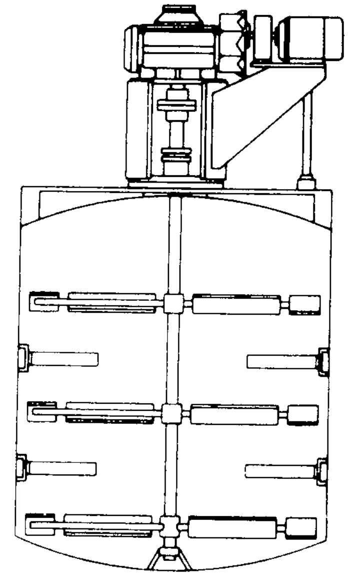
TROUBLE	CAUSE	WHAT TO DO
Motor fails to start	Blown fuses	Replace fuses with proper type and rating
	Overload trips	Check and reset overload in starter.
	Improper power supply	Check to see that power supplied agrees with motor nameplate and load factor.
	Improper line connections	Check connections with diagram supplied with motor
	Open circuit in winding or control switch	Indicated by humming sound when switch is closed. Check for loose wiring connections. Also see that all control contacts are closing.
	Mechanical failure	Check to see if motor and drive turn freely. Check bearings and lubrication.
	Short circuited stator	Indicated by blown fuses. Motor must be rewound.
	Poor stator coil connection	Remove end bells, locate with test lamp.
	Rotor defective	Look for broken bars or end rings.
	Motor may be overloaded	Reduce load.
Motor stalls	One phase may be open	Check lines for open phase.
	Wrong application	Change type or size. Consult manufacturer.
	Overload	Reduce load.
	Low voltage	See that nameplate voltage is maintained. Check connection.
	Open circuit	Fuses blown, check overload relay, stator and pushbuttons.
Motor runs and then dies down	Power failure	Check for loose connections to line, to fuses and to control.
Motor does not come up to speed	Not applied properly	Consult supplier for proper type.
	Voltage too low at motor terminals because of line drop.	Use higher voltage on transformer terminals or reduce load. Check connections. Check conductors for proper size.
	Starting load too high	Check load motor is supposed to carry at start.
	Broken rotor bars or loose rotor	Look for cracks near the rings. A new rotor may be required as repairs are usually temporary.
	Open primary circuit	Locate fault with testing device and repair.
Motor takes too long to accelerate and/or draws high amp	Excessive load	Reduce load.
	Low voltage during start	Check for high resistance. Adequate wire size.
	Defective squirrel cage rotor	Replace with new rotor.
	Applied voltage too low	Get power company to increase power tap.
Wrong rotation	Wrong sequence of phases	Reverse connections at motor or at switchboard.
Motor overheats while running under load	Overload	Reduce load.
	Frame or bracket vents may be clogged with dirt and prevent proper ventialation of motor.	Open vent holes and check for a continuous stream of air from the motor.
	Motor may have one phase open	Check to make sure that all leads are well connected.
	Grounded coil	Locate and repair.
	Unbalanced terminal voltage	Check for faulty leads, connections and transformers.
Motor vibrates	Motor misaligned	Realign.
	Weak support	Strengthen base
	Coupling out of balance	Balance coupling.
	Driven equipment unbalanced	Rebalance driven equipment.
	Defective bearings	Replace bearing.
	Bearings not in line	Line up properly.
	Balancing weights shifted	Rebalance motor.
	Polyphase motor running single phase	Check for open circuit.
	Excessive end play	Adjust bearing or add shim.
Unbalanced line current on polyphase motors during normal operation	Unequal terminal volts	Check leads and connections.
	Single phase operation	Check for open contacts.
	Unbalanced voltage	Correct unbalanced power supply.
Scraping noise	Fan rubbing air shield	Remove interference.
	Fan striking insulation	Clear fan.
	Loose on bedplate	Tighten holding bolts.
Noisy operation	Airgap not uniform	Check and correct bracket fits or bearing.
	Rotor unbalance	Rebalance.
Hot bearings general	Bent or sprung shaft	Straighten or replace shaft.
	Excessive belt pull	Decrease belt tension.
	Pulleys too far away	Move pulley closer to motor bearing.
	Pulley diameter too small.	Use larger pulleys.
	Misalignment	Correct by realignment of drive.
Hot bearings ball	Insufficient grease	Maintain proper quantity of grease in bearing.
	Deterioration of grease or lubricant contaminated	Remove old grease, wash bearings thoroughly in kerosene and replace with new grease.
	Excess lubricant	Reduce quantity of grease, bearing should not be more than 1/2 filled.
	Overloaded bearing	Check alignment, side and end thrust.
	Broken ball or rough races	Replace bearing, first clean housing thoroughly.

Special designs for special problems

To mix adhesives in 500 gallon batches within a specified time under either full vacuum or under pressure, ProQuip designed an agitator which consists of two concentric impellers, rotating in opposite directions at different speeds. A separately powered high speed impeller rotates within the low speed outer impeller making easy work of mixing adhesives.



For making polymers which start with water-like consistencies and end up with viscosities from 250,000 cp. to 700,000 cp., ProQuip furnished a complete 4500 gallon unit with specially designed, doubly-pitched paddles for center downthrust and outer upthrust. Horizontal baffles, a 40 HP 4-speed motor and a jacketed reactor completed ProQuip's solution to the problem.



PROQUIP's Qualifications to serve you:

ProQuip, Inc., established in 1969, is a total spectrum company with its own design, engineering, manufacturing and R&D staff. The company has its own efficient machining and assembly facilities.

ProQuip designs and manufactures quality process equipment at competitive prices using a complete, standard range of drive units which can be applied to virtually any process needs, in a viscosity range from water-like to more than one million centipoises. Such equipment has been successfully installed and is operating in every imaginable industry from chemical processing to adhesives, from food processing to mining, from pharmaceuticals to ceramics, from paints and plastics to rubber and paper.

ProQuip has acheived major success in providing mixers for potable water and waste water treatment, both industrial and municipal.

This encompasses designing, building and supplying side entering mixers and portable mixers. And where something special was needed for an unusual application, ProQuip has created custom units of unique design.

ProQuip continues to grow in capacity, in its knowledge of mixing applications and in its concern for solving your mixing problems.

GUARANTEE

ProQuip, Inc. accepts full responsibility for furnishing suitable equipment which shall be fit for the purpose for which it is required, and for its successful operation under the conditions for which it was specified.

ProQuip, Inc.

DESIGNERS and MANUFACTURERS
OF AGITATION EQUIPMENT

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Installation, Operation and Maintenance Instructions

for AC Induction Motors
56- 6800 Frames (NEMA)
63 – 280 Frames (IEC)

A REGAL-BELOIT COMPANY

MARATHON ELECTRIC

Contact Motor Customer Service at:

Phone: (715) 675-3311

www.marathonelectric.com

Form 5554E

INSTALLER: PLEASE LEAVE THIS MANUAL FOR THE OWNER'S USE
OWNER: READ AND SAVE THESE INSTRUCTIONS

SAFETY INSTRUCTIONS

⚠ This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ WARNING
Before installing, using, or servicing this product, carefully read and fully understand the instructions including all warnings, cautions, & safety notice statements. To reduce risk of personal injury, death and/or property damage, follow all instructions for proper motor installation, operation and maintenance.

These instructions are not intended as a complete listing of all details for installation, operation, and maintenance. If you have any questions concerning any of the procedures, STOP, and call the appropriate Regal-Beloit motor company.

Table of Contents

1.0 INSTALLER/OWNER/OPERATOR RESPONSIBILITY:

1.1 ELECTRICAL SAFETY

WARNING: ELECTRICAL SHOCK HAZARD

Electrical connections shall be made by a qualified electrical personnel in accordance with all applicable codes, ordinances and sound practices. Failure to follow these instructions could result in serious personal injury, death and/or property damage. Only qualified personnel who are familiar with the applicable National Code (USA = NEC) and local codes should install or repair electrical motors and their accessories.

WARNING: ELECTRICAL LIVE CIRCUIT HAZARD

Do not touch electrically live parts. Disconnect, lockout and tag input power supply before installing or servicing motor (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.

WARNING: ELECTRICAL GROUNDING HAZARD

Failure to properly ground motors, per the National Electrical Code (NEC) Article 430 and local codes may cause serious injury or death to personnel. For general information on grounding refer to NEC Article 250. (Also see "Ground Connections section 3.4.4").

WARNING: AUTOMATIC RESET PROTECTOR HAZARD

Do not use automatic reset protectors if automatically restarting the motor will place personnel or equipment at risk. . Failure to follow this instruction could result in serious personal injury, death and/or property damage

WARNING: MANUAL RESET PROTECTOR HAZARD

If a tripped manual reset thermal protector is exposed to a temperature less than –7°C (20°F) it may reset and restart the motor automatically. If an application requires a motor with a manual reset thermal protector that will be operated at temperatures less than –7°C (20°F) contact the manufacturer to review the application / motor requirements. Failure to follow this instruction could result in serious personal injury, death and/or property damage

1.2 MECHANICAL SAFETY

WARNING: LOOSE PARTS HAZARD

Before starting the motor, remove all unused shaft keys and loose rotating parts to prevent them from flying off. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING: ROTATING PARTS HAZARD

Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

1.3 ENVIRONMENTAL SAFETY

WARNING: HAZARDOUS LOCATIONS

(1) The NEC and the local authority having jurisdiction must be consulted concerning the installation and suitability of motors for use in Hazardous Locations. The local authority having jurisdiction must make the final determination of what type of motor is required. The application and operation is beyond the control of the motor manufacturer.

(2) Division 1 Hazardous Locations motors can only be modified or reworked by the manufacturer or a facility that is Listed under UL's category "Motors and Generators, Rebuilt for use in Hazardous Locations". Failure to follow these instructions could result in serious personal injury, death and/or property damage.

(3) Do not use a Hazardous Locations motor with a Variable Frequency Drive (VFD) unless the motor nameplate specifically states that the motor is suitable for use on Pulse Width Modulated (PWM) type VFD power. In addition, the nameplate must be marked with the inverter rating; for example, "2:1 CT", "2 to 1 Constant Torque", etc.

2.0 RECEIVING AND INSPECTION

2.1 INITIAL INSPECTIONS

2.1.1 CHECK PACKING LIST AND INSPECT the packaging to make certain no damage has occurred in shipment. If there is visible damage to the packaging, unpack and inspect the motor immediately. Claims for any damage done in shipment must be made by the purchaser against the transportation company.

2.1.2 TURN MOTOR SHAFT by hand to be certain that it rotates freely. Note: Shaft seals and bearing seals may add drag.

2.1.3 CHECK NAMEPLATE for conformance with purchase order requirements and compliance with power supply and control equipment requirements.

2.2 HANDLING:

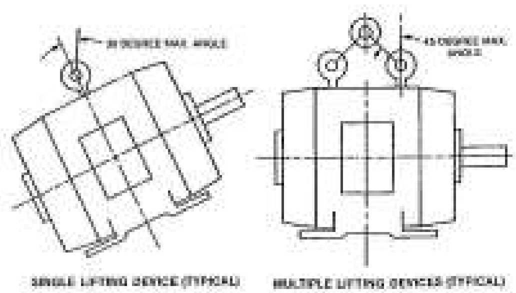
WARNING: FALLING OBJECT HAZARD

Eyebolts or lifting lugs, where provided, are intended for lifting only the motor and accessories mounted by the motor manufacturer (unless specifically stated otherwise on the motor). Utilizing the motor lifting provision to lift other components such as pumps and gear boxes could result in serious personal injury, death and/or property damage.

WARNING: FALLING OBJECT HAZARD

Before using the lifting provision, check the eyebolts and/or other lifting means to assure they are not bent or damaged and are completely threaded, seated & secured to the motor. Equipment to lift motor must have adequate lifting capacity. While lifting the motor DO NOT stand under or in the vicinity of the motor. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

2.2.1 LIFTING ANGLE LIMITATIONS



2.3 STORAGE: Motors, not put into service immediately, must be stored indoors in a clean, dry location. Avoid locations with large temperature swings that will result in condensation. Motors must be covered to eliminate airborne dust and dirt. If the storage location exhibits high vibration, place isolation pads under motor to minimize damage to motor bearings.

2.3.1 BEARING LUBRICATION: Bearings are grease packed at the factory; relubrication upon receipt of motor or while in storage is not necessary. If stored more than one year, add grease per lubrication instructions (Table 4-4) before start-up.

2.3.2 SHAFT ROTATION: It is recommended that the motor shaft be rotated 5 to 10 rotations every three months to distribute the grease in the bearings. This will reduce the chance for corrosion to form on the bearing rolling elements and raceways. Note: Shaft seals and bearing seals may add drag.

2.3.3 DAMP OR HUMID STORAGE LOCATIONS: Treat unpainted flanges, shafts, and fittings with a rust inhibitor. Apply appropriate power to the motor's space heaters (if so equipped)

3.0 INSTALLATION AND OPERATION

⚠ **WARNING:** Only qualified personnel who are familiar with the appropriate national code, local codes and sound practices should install or repair electrical motors and their accessories. Installation should conform to the appropriate national code as well as local codes and sound practices. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠ **WARNING: ELECTRICAL LIVE CIRCUIT HAZARD**
Do not touch electrically live parts. Disconnect, Lockout and Tag input power supply before installing or servicing motor (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.

3.1 LOCATION

3.1.1 SELECTING A LOCATION: Consideration should be given to environment and ventilation. Motors should be installed in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and vibration. A motor with the proper enclosure for the expected operating condition should be selected. Provide accessible clearance for cleaning, repair, service, and inspections (See section 3.1.3 for construction clearances). The location should be considered for possible future motor removal / handling. The free flow of air around the motor should not be obstructed.

3.1.2 AMBIENT TEMPERATURE LIMITS: The ambient temperatures of the air inlet to the motor should not exceed 40°C (104°F) or be less than -30°C (-22°F) unless the motor nameplate specifically states an ambient temperature outside of these limits. The ambient inside an enclosure built around the motor shall not exceed the nameplate ambient. For ambient temperatures outside of these limits consult the motor manufacturer.

⚠ **CAUTION: INSULATION DEGRADATION WARNING**
Insulation at high temperatures ages at an accelerated rate. Each 10°C increase in temperature reduces the insulation life by one half.

⚠ **WARNING: HAZARDOUS LOCATIONS AMBIENT LIMIT:** Division 1 Hazardous Locations motors shall **NOT** be operated below –25°C (-13°F) ambient. (Low temperatures reduce the component mechanical properties.)

3.1.3 CONSTRUCTION SELECTION per LOCATION:

3.1.3.1 DRIPPROOF (OPEN) MOTORS are intended for use indoors where the atmosphere is relatively clean, dry, and non-corrosive. Recommended a minimum clearance of ½ the shaft height between vent openings and the nearest obstruction.

3.1.3.2 TOTALLY ENCLOSED MOTORS are suitable for indoor or outdoor standard service applications.

TEAO or AOM (Totally Enclosed Air Over) motors must be mounted in the air stream. When the motor nameplate states a minimum airflow the motor must be mounted in an air stream meeting this minimum value.

TEFC (Totally Enclosed Fan Cooled) motors must meet a minimum distance of ½ the shaft height between the fan guard grill openings and the nearest obstruction.

3.1.3.3 HAZARDOUS LOCATIONS MOTORS: Hazardous Locations motors are intended for installations in accordance with NEC Article 500. For all installations involving Hazardous Locations motors, consult the applicable national codes, local codes, and the authority having jurisdiction.

Division 1 Installations – includes Class I & II: Use only motors that are UL Listed and CSA Certified or UL Listed and UL Certified for Canada. These motors bear a separate nameplate that includes the UL Listing Mark and CSA Certification Mark or includes the UL Listing Mark and the UL Mark for Canada. This plate also bears the phrase: " Electric motor for Hazardous Locations" and is marked with the Class, Group and Operating Temperature Code.

Division 2 Installations – Class I only: Use only motors that are CSA Certified and bear the CSA Certification Mark. These motors include a phrase on the main motor nameplate that indicates the motor is CSA Certified for Class I, Division 2 / Zone 2 locations.

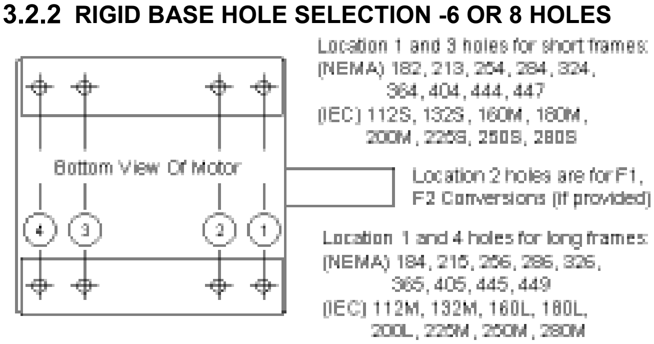
Division 2 Installation – Class II only: Use only Class II motors as described above under "Division I Installations".

⚠ **WARNING: EXPLOSION HAZARD**
A motor should never be placed in an area with a hazardous process or where flammable gases or combustible materials may be present unless it is specifically designed and nameplated for this type of service. Hazardous Locations motors are intended for installations in accordance with NEC Article 500. For all installations involving Hazardous Locations motors, consult the NEC, local codes, and the authority having jurisdiction. Failure to follow these instructions could result in serious personal injury, death and/or property damage. (For other limitations see section 1.3)

3.2 MOUNTING MOTOR:

3.2.1 RIGID BASE (FOOTED): The motor must be securely installed to a rigid foundation or a mounting surface to minimize vibration and maintain alignment between the motor shaft and the load's shaft. The mounting surfaces of the four mounting pads must be flat within 0.01 inches for 210 frame & smaller; 0.015 inches for 250 frame & larger. [IEC 0.25 mm for 130 frame & smaller, 0.38 mm for 160 frame & larger]. This may be accomplished by shims under the motor feet. For special isolation mounting, contact manufacturer for assistance

3.2.2 RIGID BASE HOLE SELECTION -6 OR 8 HOLES



3.2.3 VERTICAL MOUNTING:

CAUTION: ENCLOSURE PROTECTION CAUTION: Most Dripproof rigid base (footed) motors do **NOT** meet "Dripproof" requirements when mounted vertically. If the motor is located in unprotected environments, the addition of a drip cover may be available. Drip covers not available for cast iron rigid base motors.

⚠ **WARNING: FALLING OBJECT HAZARD**
The lifting provision on standard horizontal footed motors is not designed for lifting the motor in a vertical shaft up or shaft down position. (see 2.2.1 lifting angles). Lifting method / provisions for

mounting a rigid base (footed) motor vertically is the responsibility of the installer.

VERTICAL SHAFT DOWN: Most standard horizontal motors thru 449 Fr. (excluding brake motors) can be mounted in a vertical shaft down orientation. For vertical brake motors see section 3.3.6.2.

VERTICAL SHAFT UP:

WARNING: HAZARDOUS LOCATIONS VERTICAL MOUNT: Hazardous locations motors must **NOT** be mounted vertically shaft up without approval by the motor manufacturer. Without proper retaining provisions the rotor may move axially and contact components, creating a spark hazard.

Belted or Radial Load when mounted vertically: The following frame sizes / constructions with applied (axial) down loads within the limit stated are acceptable when mounted vertical shaft up.

Table 3-1 Belted or Radial Load Applications (All speeds)

Frame Size	Enclosure	Construction	Shaft Up OK	Max Applied Down Load[3]
56	TEFC & ODP	Steel	Yes	25 lbs
140	TEFC	Steel & Cast Iron	Yes	25 lbs
	ODP	Steel	Yes	25 lbs
180	TEFC	All	Yes	35 lbs
	ODP	Steel	Yes	35 lbs
210	TEFC	All	Yes	40 lbs
	ODP	Steel	Yes	40 lbs
250	TEFC	All	Yes	40 lbs
	ODP	Steel	Yes	40 lbs
		Cast Iron	No[2]	N/A
280-320	320 TTFC models	Cast Iron	Eng[1]	N/A
	All Other TEFC	Cast Iron & Aluminum	Yes	30 lbs
	ODP	Cast Iron	No[2]	N/A
	TEFC & ODP	Steel	Build Up Only[4]	N/A
360 & Up	TEFC	Cast Iron	Build Up Only[4]	N/A
	ODP	Cast Iron	No[2]	N/A
	TEFC & ODP	Steel	Build Up Only[4]	N/A

Notes:

1 For TEFC model numbers beginning with 324TTFC or 326TTFC consult the motor manufacturer to determine if a build up motor is required.

2 The max applied down load is any applied load external to the motor, including such things as sheave weight, fan loads, axial belt force, pump load, etc. If the application is direct drive with no applied radial load, consult the motor manufacturer.

3 "Build-up only", refers to motors that are specifically ordered and built for shaft up applications. It does not imply that all build-up motors are suitable for shaft up applications.

3.3 APPLICATION ASSEMBLY TO MOTOR:

CAUTION: EQUIPMENT DAMAGE:
Do not connect or couple motor to load until correct rotational direction is established.

3.3.1 GENERAL: PROPER ALIGNMENT
of the motor and driven equipment minimizes vibration levels, maximizes bearing life, and extends the overall life of the machinery. Consult the drive or equipment manufacturer for more information.

CAUTION: BEARING FAILURE
During assembly do NOT force components onto the shaft. Striking or hammering the component may result in bearing damage.

3.3.2 DIRECT COUPLING:
Use flexible couplings if possible. For applications that apply radial, axial or moment loading on the motor shaft see section 3.3.3.

CAUTION: BEARING FAILURE
Unless approved by the motor manufacturer do **NOT** direct couple a vertical shaft up or roller bearing motor. Direct coupling a vertical shaft up motor or a motor with a roller bearing may result in bearing damage.

3.3.3 DIRECT CONNECTED:
Radial loading for direct connected equipment (gears, fans etc.) must be approved by the motor manufacturer unless within the maximum overhung load limits (Table 3-2). Combined loading (axial, radial and/or moments) must be approved by motor manufacturer. For belted loads see section 3.3.4.

Table 3-2 Maximum Radial Load (lbf) @ Middle of the Shaft Extension Length

Frame Number	Motor Rated RPM			
	3600	1800	1200	900
143T	106	166	193	210
145T	109	170	199	218
182T	187	230	261	287
184T	193	237	273	301
213T	319	317	470	510
215T	327	320	480	533
254T	500	631	729	793
256T	510	631	736	820
284T	-	866	990	1100
286T	-	871	1005	1107
324T	-	950	1100	1215
326T	-	950	1113	1230
364T	-	1078	1365	1515
365T	-	1078	1380	1540
404T	-	1388	1590	1762
405T	-	1400	1610	1780
444T	-	1580	1795	2005
445T	-	1520	1795	1985
447T	-	1455	1765	1985
449T	-	1640	1885	2130

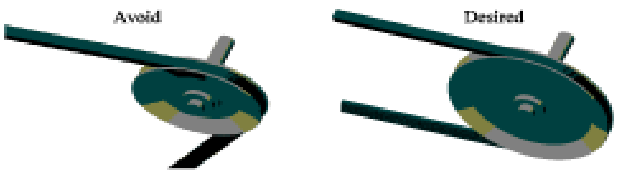
Values based on 26,280 hrs B-10 Life
For "End of Shaft" Load multiply value by 0.88
To convert from lbf to N multiply value by 4.4482.

3.3.4 BELTED:
The goal of any belted system is to efficiently transmit the required torque while minimizing the loads on the bearings and shafts of the motor and driven equipment. This can be accomplished by following four basic guidelines:

1. Use the largest practical sheave diameter.
2. Use the fewest number of belts possible.
3. Keep sheaves as close as possible to support bearings.
4. Tension the belts to the lowest tension that will still transmit the required torque without slipping. It is normal for V-belts to squeal initially when line starting a motor

3.3.4.1 Sheave Diameter Guidelines:
In general, smaller sheaves produce greater shaft stress and shaft deflection due to increased belt tension. See Table 3-3 for recommended minimum sheave diameters. Using larger sheaves increases the contact with belts which reduces the number of belts required. It also increases the belt speed, resulting in higher system efficiencies. When selecting sheaves, do not exceed the manufacturer's recommended maximum belt speed, typically 6,500 feet per minute for cast iron sheaves. Determine belt speed by the following formula:

Figure 1



BELT SPEED (Ft/min) = $\frac{Shaft\ RPM\ x\ 3.14\ x\ Sheave\ Dia\ (inches)}{12}$

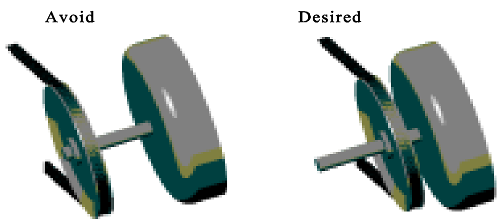
3.3.4.2 Number of Belts

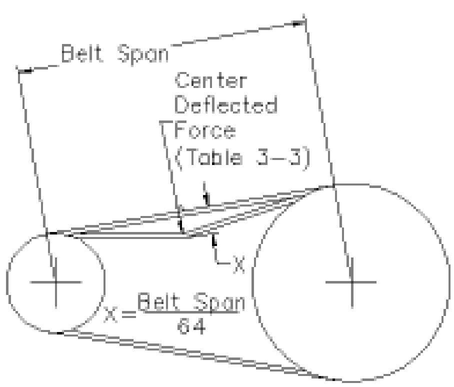
In general, use the fewest number of belts that will transmit the required torque without slipping. See Table 3-3 for recommended maximum number of belts. Each belt adds to the tension in the system, which increases load on the shafts and bearings. Belts are most efficient when operated at or near their rated horsepower.
If the sheaves have more grooves than the number of belts required, use the grooves closest to the motor.

3.3.4.3 Sheave Location

Install sheaves as close to the housing as possible to increase the bearing life of the motor and driven equipment

Figure 2





3.3.4.4 Belt Tension

CAUTION: Equipment Failure Caution
Belt tensioning by feel is **NOT** acceptable. Tensioning by "feel" can be very misleading, and can damage motor and equipment.
It is normal for V-belts to squeal initially when line starting a motor.

In general, belt tensions should be kept as loose as possible while still transmitting the required torque without slipping. Belt tensions must be measured with a belt tension gage. These inexpensive gages may be obtained through belt manufacturers, or distributors.

Proper belt tension is determined by measuring the force required to deflect the center of the belt a given distance. The proper deflection (in inches) is determined by dividing the belt span in inches by 64. Calculate the proper deflection and then see Table 3-3 for the required “Deflected Force” to achieve that deflection.
After tensioning the belt, rotate the sheaves for several rotations or operate the system for a few minutes to seat belts into the grooves, then re-tension the belts. New belts will stretch during use, and should be retensioned after the first eight hours of use.

Table 3-3 Recommended Minimum Sheave Diameters, Belt Type, Number of Belts and Deflected Force

Motor Hp	1200 rpm				1800 rpm				3600 rpm			
	Min Sheave Dia (in)	Belt Type	Max # of Belts	Avg. Deflected Force (lbs)	Min Sheave Dia (in)	Belt Type	Max # of Belts	Avg. Deflected Force (lbs)	Min Sheave Dia (in)	Belt Type	Max # of Belts	Avg. Deflected Force (lbs)
0.75	2.2	3VX	1	3.4	2.2	3VX	1	2.2	2.2	3VX	1	1.2
1	2.4	3VX	1	4.0	2.2	3VX	1	3.1	2.2	3VX	1	1.6
1.5	2.4	3VX	2	3.1	2.4	3VX	2	2.1	2.2	3VX	1	2.5
2	2.4	3VX	3	2.8	2.4	3VX	2	2.9	2.4	3VX	1	2.7
3	3.0	3VX	2	3.3	2.4	3VX	3	2.9	2.4	3VX	2	2.3
5	3.0	3VX	3	4.0	3.0	3VX	3	3.7	2.4	3VX	3	2.5
7.5	3.8	3VX	4	4.7	3.0	3VX	4	4.1	3.0	3VX	2	4.2
10	4.4	3VX	4	5.4	3.8	3VX	4	4.3	3.0	3VX	3	3.8
15	4.4	3VX	5	5.4	4.4	3VX	4	5.4	3.8	3VX	3	4.4
20	5.2	3VX	6	6.0	4.4	3VX	6	4.8	4.4	3VX	3	5.0
25	6.0	3VX	7	5.6	4.4	3VX	7	5.2	4.4	3VX	4	4.7
30	6.8	3VX	7	5.9	5.2	3VX	7	5.3	**Contact Motor Manufacturer when Belting 3600 rpm Motors Greater than 25 HP**			
40	6.8	5VX	4	11.6	6.0	3VX	7	6.0				
50	8.2	5VX	4	14.6	6.8	3VX	8	5.9				
60	8.2	5VX	5	14.1	7.4	5VX	4	13.3				
75	10.0	5VX	5	14.5	8.6	5VX	4	14.3				
100	10.0	5VX	6	16.0	8.6	5VX	6	13				
125	12.0	5V	7	14.1	10.5	5V	6	13.1				
150	13.2	5V	7	15.4	10.5	5V	7	13.4				
200	15.0	5V	8	16.0	13.2	5V	8	13.1				
250	15.0	8V	6	27.6	14.0	5V	9	13.8				
300	16.0	8V	7	27.1	14.0	5V/**8V**	11 / **7**	23.4				
350	16.5	8V	7	30.3	14.5	5V/**8V**	12 / **7**	26.0				
400	17.5	8V	8	29.1	15.0	5V/**8V**	13 / **8**	25.7				
450	18	8V	8	31.6	16.0	5V/**8V**	14 / **9**	25.2				
500	18.5	8V	9	30.7	16.5	5V/**8V**	15 / **9**	26.9				
600					17.5	8V	11	26.3				
700					19.0	8V	12	27.3				
800					20.0	8V	13	28.2				

Notes:

1. Horsepower is the nameplate motor horsepower, and RPM is the motor (driver) speed.
2. Minimum sheave diameters are from NEMA standards where applicable.
3. **For variable speed applications or values outside these recommendations, consult motor manufacturer.**
4. Selections are based on a 1.4 service factor, 5 to 1 speed ratio and various Power Transmission Manufacturers' catalogs.
5. These selections are for Narrow V-belt sections only. Consult manufacturer for details on conventional V-belt sections (A, B, C, D and E), or other belt types.
6. "Average Deflected Force is per section 3.3.4.4 of this document and is the force required to deflect the center of a belt 1/64 of the belt span distance. Tolerance on this force is ±1 lbf for forces ≤10 lbs, and ±2 lbs for forces >10 lbs as measured utilizing a belt tension gage.
7. When more than one belt is required the belts must be a matched set (matched for length).
8. If possible, the lower side of the belt should be the driving side to increase the length of wrap on the sheave).
9. For belted loads do not exceed 125% of 60 Hz operating RPM.

3.3.5 VFD (Variable Frequency Drives) OPERATION:

WARNING: VFD Motors with Reset Thermal Protectors
UL Recognition, UL Listing, or CSA certification does not apply to motors that are equipped with a manual or automatic reset thermal protector when the motor is operated on VFD power.

WARNING: Power Factor Correction Capacitors:
Power factor correction capacitors should never be installed between the drive and the motor.

CAUTION: VFD / Motor Setup:
It is the responsibility of the startup personnel during set up of the VFD / motor system to properly tune the drive to the motor for the specific application per the VFD user manual. The correct voltage boost and volts per hertz settings are application dependent and unique to each motor design. Failure to connect over temperature devices (when provided) will void the warranty.

3.3.5.1 Overspeed Capability:

Belted loads: Do not exceed 125% of 60 Hz operating RPM.

Table 3-4 Maximum Safe Continuous Speed (RPM) For Coupled and Direct Connected Loads

NEMA / [IEC] Frame Size	2-Pole	4, 6, or 8 Pole
56-180 [80-110]	7200 *	5400 *
210-250 [130-160]	5400 *	4200*
280 [180]	5400 *	3600
320 [200]	4500 *	3600
360 [225]	4500 *	2700
400-440 [250-280]	3600	2700
>440 [>280]	3600	1800

* = Fan cooled motors (Totally Enclosed & Hazardous Locations Motors) are limited to a maximum safe continuous speed of 4000 RPM **For higher speeds or shortened duty cycle contact motor manufacturer**

3.3.5.2 Cable Lengths: For optimum insulation life, limit VFD to motor cable lengths of general purpose motors to Table 3-5 values. Definite purpose VFD motors may accommodate longer cable lengths. For additional information contact motor manufacturer.

Table 3-5 Max Cable Lengths General Purpose Motors

These values are based on 3 kHz carrier frequency. Add suitable VFD output-side filters when exceeding the listed values.

Frame Size	230V	460 V	575 V
NEMA 56-320	600 ft.	125 ft.	40 ft.
NEMA 360-5011	1000 ft.	225 ft.	60 ft.
IEC 80-200	180 m.	40 m.	12 m.
IEC 225-280.	300 m.	70 m.	18 m.

3.3.5.3 VFD Grounding: Equipment grounding conductors may be run in the same conduit as the AC motor power leads. This wire must be used as the equipment ground for the motor and not as the fourth current carrying wire of a "WYE" motor circuit. The grounded metal conduit carrying the output power conductors can provide EMI shielding, but the conduit does not provide an adequate ground for the motor; a separate grounding conductor must be used. Grounding the motor neutral (WYE) of a VFD powered motor may result in a VFD ground fault trip. Improper grounding of an inverter fed motor may result in frame voltages in excess of 500 Volts. Refer to Grounding section 3.4.4

3.3.5.4 VFD – Single Phase:

CAUTION: SINGLE PHASE MOTOR FAILURE:

Single Phase motors are **NOT** suitable for use on VFD power. Connecting a Single Phase Motor to a VFD voids the warranty.

3.3.5.5 Stray Voltage on Accessory Leads:

VFD's will couple stray (common-mode) voltage to motor-mounted RTDs, thermistors, thermostats and space heaters. The leads of these elements must be properly insulated and control input circuits must be designed to withstand this common-mode voltage.

3.3.6 ACCESSORIES / PROVISIONS:

3.3.6.1 General: Carefully read and understand the accessory manufacturer's instructions, supplied with motor. Contact the manufacturer for additional information.

3.3.6.2 Brake Motors:

⚠ CAUTION: Vertical Motor Premature Brake Failure

Motors with brakes that are designed for vertical applications are equipped with springs to support the brake pressure plate. Mounting a horizontal brake motor vertically shaft up or down may require a pressure plate spring modification. Failure to modify the brake for the vertical application may result in premature brake failure. If in question, consult brake literature or brake manufacturer.

Brake Solenoid Wiring: Do NOT connect the brake solenoid to the output of a VFD. The brake solenoids must be wired to 50/60 Hz line power

3.3.6.3 Space Heaters:

Motors provided with space heaters have two leads that are brought into the conduit box or into an auxiliary box. These leads are marked "H1", "H2" ("H3", "H4" if a second space heater is supplied). See the space heater nameplate on motor for heater rating.

⚠ WARNING: DIVISION 2 EXPLOSION HAZARD

The space heater temperature rating when used in Class I, Division 2 motors shall **NOT** exceed 80% of the auto ignition temperature of the hazardous gas or vapor. See the space heater nameplate on motor for heater Temperature Code and heater rating. Failure to follow this instruction could result in serious personal injury, death and/or property damage

3.3.6.4 Thermal Protection:

General Information: When thermal protection is provided, one of the following will be stamped on the nameplate:

1. **"THERMALLY PROTECTED"** This motor has built in thermal protection. Thermal protectors open the motor circuit electrically when the motor overheats or is overloaded. The protector cannot be reset until the motor cools. If the protector is automatic, it will reset itself. If the protector is manual, disconnect motor from power supply. After protector cools (five minutes or more) press the reset button and reapply power to the motor. In some cases a motor is marked "Auto" and the connection diagram on the motor will identify T'Stat leads – see "2 " below. (See warnings on Manual and Automatic reset protectors - section 1.1)

2. **"WITH OVERHEAT PROTECTIVE DEVICE"**: This motor is provided with an overheat protective device that does not directly open the motor circuit. Motors nameplated with this phrase have either thermostats, thermisters or RTD's. The leads to these devices are routed into the motor conduit box or into an auxiliary box. The lead markings are defined on the nameplate (normally "P1", "P2") . The circuit controlled by the overheat protection device must be limited to a maximum of 600 volts and 360 volt-amps. See connection decal provided inside the terminal box cover. Failure to connect these over temperature devices (when provided) will void the warranty.

   ⚠ WARNING: EXPLOSION HAZARD

   For Hazardous Locations motors provided with thermostats UL and the NEC require connection of thermostat leads into the control portion of a manual reset start circuit. Failure to follow this instruction could result in serious personal injury, death and/or property damage

Resistance Temperature Detectors (RTD): When winding and/or bearing RTDs are provided the RTD lead markings are defined on the nameplate. (Normally "R1", "R2", "R3" etc.)

3.3.6.5 RTD Alarm & Trip Settings:

Tables 3-6 & 3-7 are suggested initial RTD alarm and trip settings. For motors found to operate significantly below these values the settings may be reduced accordingly.

Table 3-6 Winding RTD – Temperature Limit (°C) 40 °C Max Ambient

Motor Load	Class B Temp Rise≤ 80°C		Class F Temp Rise≤ 105°C	
	Alarm	Trip	Alarm	Trip
Up to 1.0 SF	130	140	155	165
>1.0 to 1.15 SF	140	150	160	165

Table 3-7 Bearing RTD – Temperature Limit (°C) 40 °C Max Ambient

Ambient	Alarm	Trip
Up to 40°C	95	100
> 40°C	110	115
Bearings that are Heat Stabilized to 150 °C	130	135

3.3.7 GUARDS:

⚠ WARNING: ROTATING PARTS HAZARD

When devices are assembled to the motor shaft, be sure to install protective devices such as belt guards, chain guards, and shaft covers. These devices must protect against accidental contact with extremities, hair, and clothing. Consider the application and provide guarding to protect personnel. Remove all unused shaft keys and loose rotating parts to prevent them from flying off and causing bodily injury. Failure to follow this warning could result in serious personal injury, death and/or property damage.

3.4 ELECTRICAL CONNECTIONS:

WARNING: ELECTRICAL HAZARDS
Before proceeding read Section 1-1 on Electrical Safety. Failure to follow the instructions in Section 1-1 could result in serious personal injury, death and/or property damage

3.4.1 POWER SUPPLY / BRANCH CIRCUIT

WARNING: POWER SUPPLY INCOMPATIBILITY HAZARD
Check power supply to make certain that voltage, frequency and current carrying capacity are in accordance with the motor nameplate. Failure to match motor nameplate values could result in serious personal injury, death and/or property damage

WARNING: BRANCH CIRCUIT SUPPLY HAZARD
Motor and control wiring, fusing, overload protection, disconnects, accessories and grounding must always conform to the applicable electrical codes as well as local codes and sound practices.

3.4.1.1 Branch Circuit Supply to a motor should include a disconnect switch, short circuit current fuse or breaker protection, motor starter (controller) and correctly sized thermal elements or overload relay protection.

3.4.1.2 Fuses, Breakers, Overload Relays

Short Circuit Current Fuses or Breakers are for the protection of the branch circuit. Starter or motor controller overload relays are for the protection of the motor. Each of these should be properly sized and installed per the applicable electrical codes as well as local codes and practices.

WARNING: PROTECTIVE DEVICE DISABLED HAZARD
DO NOT bypass or disable protective devices. Protection removal could result in serious personal injury, death and/or property damage

3.4.1.3 AC Power Supply Limits

Motors are designed to operate within the following limits at the motor terminals:

1- AC power is within +/- 10 % of rated voltage with rated frequency applied. (Verify with nameplate ratings) **OR**

2- AC power is within +/- 5% of rated frequency with rated voltage **OR**

3- A combined variation in voltage and frequency of +/- 10% (sum of absolute values) of rated values, provided the frequency variation does not exceed +/-5% of rated frequency.

4- For 3 phase motors the line to line full load voltage must be balanced within 1%.

5- If the motor is rated 208-230V, the voltage deviations must be calculated from 230V.

CAUTION: Reduced Motor Performance
Operation outside of these limits will degrade motor performance and increase operating temperature.

3.4.2 TERMINAL BOX:

3.4.2.1 Conduit Opening: For ease of connections,
motors are typically provided with large terminal boxes. Most motors have conduit access in 90 degree increments, the terminal box conduit opening is typically provided via knockouts, holes with covers, or the terminal box is rotate-able. Fabricated conduit boxes may have a removable plate for the installer to provide correctly sized hole(s).

3.4.2.2 Hazardous Locations Motors:

WARNING: EXPLOSION HAZARDS
(1) Terminal Boxes mounted to motor with a pipe nipple: If a pipe nipple mounted terminal box is removed or rotated it must be reassembled with a minimum of five full threads of engagement.
(2) Component Removal: Do not set a terminal box component on its machined surfaces. Prior to component reassembly wipe clean all machined surfaces.
(3) Machined Surface Gap (Hazardous Locations Terminal Boxes): The gap between mating surfaces with the machined terminal box MUST BE LESS THAN 0.002 inches. This gap must be checked with a feeler gage along the entire perimeter. If there is visible damage to the mating surfaces, or if the gap between these surfaces exceeds 0.002 inches, DO NOT complete the installation and contact the motor manufacturer. Failure to follow these instructions could result in serious personal injury, death and/or property damage

3.4.3 LEAD CONNECTIONS

Electrical connections to be made per nameplate connection diagram or separate connection plate. In making connections follow the applicable electrical code as well as local codes and practices.

WARNING: ELECTRICAL CONNECTION HAZARD
Failure to correctly connect the motor leads and grounding conductor can result in injury or death. Motor lead connections can short and cause damage or injury if not well secured and insulated.

3.4.3.1 Wire Size (Single Phase) Requirements

The minimum wire size for Single Phase, 115 & 230 Volt Circuits must meet table 3-8 for a given distance between motor and either Fuse or Meter Box.

Table 3-8 Minimum Wire Gage Size Single Phase 115 & 230 Volt Circuits

	Distance (Feet) - Motor to Fuse or Meter Box							
Motor	**100 Ft.**		**200 Ft.**		**300 Ft.**		**500 Ft.**	
HP	**115**	**230**	**115**	**230**	**115**	**230**	**115**	**230**
1/4	14	14	10	12	8	10	6	8
1/3	12	14	10	12	6	10	4	8
1/2	10	12	8	10	6	8	4	6
3/4	10	12	6	10	4	8	2	6
1	8	10	6	8	4	6		4
1 1/2	4	10	0	8		6		4
2		8		6		4		2
3		8		6		4		2
5		6		4		2		0

3.4.3.2 Extension Cords (Single Phase Motors):

Where an extension cord(s) is utilized to provide power to the motor the extension cord(s) must be…(1) the proper gauge size per table 3-8, (2) in good working condition (3) properly grounded.

3.4.4 GROUND CONNECTION(S):

WARNING: ELECTRICAL GROUNDING HAZARD
For general information on grounding (USA) refer to NEC Article 250. Improper grounding of an inverter fed motor may result in frame voltages in excess of 500 Volts. In making the ground connection, the installer must make certain that a good electrical connection is obtained between motor and grounding lead. Failure to properly ground motors, per the applicable national code (such as NEC Article 430) and local codes may cause serious injury or death to personnel.

Primary "Internal" Ground: A grounding conductor must be connected to the grounding terminal provided in the terminal housing. This grounding terminal is either a ground screw, ground lug, or a tapped hole to be used with a separately provided ground screw. The internal grounding feature is accessible inside the terminal housing and must be used as the primary grounding connection.
Secondary "External" Ground: Some motors are provided with a supplemental grounding terminal located on the external surface of the motor frame or feet. This external terminal is for supplemental bonding connections where local codes permit or require such connection

3.4.5 START UP:

WARNING: ELECTRICAL SHOCK HAZARD:
Be certain that all connections are secure and the conduit box cover is fastened in place before electrical power is connected. Failure to follow these instructions could result in serious personal injury, death, and/or property damage.

WARNING: LOOSE & ROTATING PARTS HAZARD
Before proceeding read Section 1-2 on Mechanical Safety. Failure to follow the instructions in Section 1-2 could result in serious personal injury, death and/or property damage

WARNING: EXCESSIVE SURFACE TEMPERATURE HAZARD
Motors with the temperature code stated on the nameplate are designed to operate within this limit. Improper application or operation can cause the maximum surface temperature to be exceeded. A motor operated in a Hazardous Location that exceeds this surface temperature limit increases the potential of igniting hazardous materials. *Therefore, motor selection, installation, operation, and maintenance must be carefully considered to ensure against the following conditions:* (1) Motor load exceeds service factor value, (2) Ambient temperature above nameplate value, (3) Voltages outside of limits (3.4.1.3), (4) Loss of proper ventilation, (5) VFD operation exceeding motor nameplate rating, (6) Altitude above 3300 feet / 1000 meters, (7) Severe duty cycles, (8) Repeated starts, (9) Motor stall, (10) Motor reversing, and (10) Single phase operation. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

CAUTION: HOT SURFACE
Normal motor surface temperatures may exceed 90 ° C (194° F). Touching the motor frame may cause discomfort or injury. Surface temperatures should only be measured with suitable instruments and not estimated by hand touch.

3.4.5.1 Start Up - No Load Procedure

1. **Check Instructions:** Before startup carefully read and fully understand these instructions including all warnings, cautions, and safety notice statements.
2. **Motor out of storage after more than three months:** Check winding insulation integrity with a Megger. If winding resistance to ground is less than 1.5 Meg-ohms consult the local authorized service shop before energizing the motor.
3. **Check Installation: Mechanical** - Check tightness of all bolts and nuts. Manually rotate the motor shaft to ensure motor shaft rotates freely. Note: Shaft & bearing seals will add drag.
   Electrical - Inspect all electrical connections for proper terminations, clearance, mechanical tightness and electrical continuity. Be sure to verify connections are made per the nameplate connection diagram or separate connection plate. Replace all panels and covers that were removed during installation before energizing the motor.
4. **Energize Motor: Check Rotation**
   If practical check motor rotation before coupling to the load. Unlock the electrical system. Momentarily provide power to motor to verify direction of rotation. If opposite rotation is required, lock out power before reconnecting motor. If motor has a rotational arrow only operate the motor in the rotation identified. Reapply power to ensure proper operation.
5. **Record No Load Amps, Watts & Voltage:**
   Recommend - To establish a baseline value check and record the no load amps, watts, and voltage.

3.4.5.2 Start Up – Load Connected Procedure

1. **Check Instructions:** Before startup carefully read and fully understand these instructions including all warnings, cautions, & safety notice statements.
2. **Coupling Installation:** Check that the connected equipment is properly aligned and not binding. Check that all guards and protective devices are properly installed.
3. **Energize Motor:** When all personnel are clear of the machine, apply power and verify that the load is not transmitting excessive vibration back to the motor though the shaft or the foundation. Verify that motor amps are within nameplate rating. For repeated starts see 3.4.5.3. The equipment can now be fully loaded and operated within specified limits as stated on the nameplate.

3.4.5.3 Jogging and/or Repeated Starts

Do not start more than twice in succession under full load. Repeated starts and/or jogs of induction motors can cause overheating and immediate failure. Contact the motor manufacturer if it is necessary to repeatedly start or jog the motor.

4.0 MAINTENANCE:

WARNING: Hazardous Locations Motor Repair HAZARD:
Division 1 Hazardous Locations motors can only be modified or repaired by the manufacturer or a facility that is Listed under UL's category "Motors and Generators, Rebuilt for use in Hazardous Locations". Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING: ELECTRICAL SHOCK HAZARD
Electrical connections are to be made by qualified electrical personnel in accordance with all applicable codes, ordinances and sound practices. Failure to follow these instructions could result in serious personal injury, death and/or property damage. Only qualified personnel who are familiar with the applicable national codes, local codes and sound practices should install or repair electric motors and their accessories.

WARNING: ELECTRICAL LIVE CIRCUIT HAZARD
Do not touch electrically live parts. Disconnect, lockout and tag input power supply before installing or servicing motor (includes accessory devices).

4.1 GENERAL INSPECTION

Inspect the motor approximately every 500 hours of operation or every three months, whichever occurs first. Keep the motor clean and the ventilation and fin openings clear. The following steps should be performed at each inspection:

4.1.1 VENTILATION: Check that the ventilation openings and/or exterior of the motor is free of dirt, oil, grease, water, etc, which can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.

4.1.2 INSULATION: Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. If winding resistance to ground is less than 1.5 Meg-ohms consult the local authorized service shop before re-energizing the motor.

4.1.3 ELECTRICAL CONNECTIONS: Check all electrical connectors to be sure that they are tight.

4.2 LUBRICATION & BEARINGS:

The lubricating ability of grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Longer bearing life can be obtained if the listed recommendations are followed:

NOTE: If lubrication instructions are provided on the motor nameplate, the nameplate instructions will supersede these instructions. Motors marked "Permanently Lubricated" do not require additional service.

CAUTION: BEARING / MOTOR DAMAGE WARNING
Lubricant should be added at a steady moderate pressure. If added under heavy pressure bearing shield(s) may collapse. Over greasing bearings greatly increases bearing friction and can cause premature bearing and/or motor failure.

4.2.1 GREASE TYPE (unless nameplate states otherwise):
Nameplate Ambient Temperature between -30°C (-22°F) to 65°C (150°F) inclusive: Recommended grease for standard service conditions is Mobil Polyrex ® EM. Equivalent and compatible greases include: Texaco Polystar RB, Rykon Premium #2, Pennzoil Pen 2 Lube, Chevron SRI & Mobil SHC 100.

Nameplate Ambient Temperature below -30°C (-22°F): Special low temperature grease is recommended, such as Aeroshell 7 or Beacon 325 for ball bearings and Mobil SHC 100 for roller bearings.

Nameplate Ambient Temperature above 65°C (150°F): Dow Corning DC44 or equivalent, a special high temperature grease is required. Note that Dow Corning DC44 grease does not mix with other grease types.

4.2.2 BEARING OPERATING TEMPERATURE:

CAUTION: HOT SURFACE

The external surface temperature of the end shield (bracket) bearing hub may reach 100° C (212° F) during normal operation. Touching this surface may cause discomfort or injury. Surface temperatures should only be measured with suitable instruments and not estimated by hand touch.

For RTD settings see Table 3-7.

4.2.3 LUBRICATION INTERVALS: (For motors with regreasing provisions)

Eq. 4.2 <u>Lubrication Interval</u> = [(Table 4-1) hrs] x [Interval Multiplier (Table 4-2)] x [Construction Multiplier (Table 4-3)]

Table 4-1 Lubrication Intervals (Hours) These values are based on average use.

NEMA / [IEC] Frame Size	Operating Speed – RPM (See Table 3.4 for Maximum Operating Speed)					
	<7200	<5400	<4500	<3600	<1800	<1200
56-180 [80-110]	2500 Hrs.	4000 Hrs	5000 Hrs	6000 Hrs.	17000 Hrs.	20000 Hrs.
210-250 [130-160]		2500 Hrs	4000 Hrs	5000 Hrs.	12000 Hrs.	16000 Hrs.
280 [180]		2000 Hrs	3000 Hrs	4000 Hrs.	10000 Hrs.	14000 Hrs.
320 [200]			2000 Hrs	3000 Hrs.	9000 Hrs.	12000 Hrs.
360 [225]			1500 Hrs	2000 Hrs.	8000 Hrs.	10000 Hrs.
400-440 [250 – 280]				1500 Hrs.	4000 Hrs.	7000 Hrs.
>440 [>280]				1000 Hrs.	3000 Hrs.	5000 Hrs.

Seasonal Service: If motor remains idle for more than six months, Lubricate at the beginning of the season, then follow lubrication interval.

Do not exceed maximum safe operating speed Table 3-4 without manufacturer's approval

Table 4-2 Service Conditions

Use highest level Multiplier: Maximum Ambient Temperature and Contamination are independent factors

Severity of Service	Maximum Ambient Temperature	Atmospheric Contamination	Multiplier
Standard	Less than 40° C (104° F)	Clean, Slight Corrosion, indoors, less than 16 hrs per day	1.0
Severe	Above 40° C (104° F) to 50° C	Moderate dirt or Corrosion or outdoors or more than 16 hrs per day	0.5
Extreme	Greater than 50° C or Class H Insulation	Severe dirt or Abrasive dust or Corrosion	0.2

Table 4-3 Construction Multiplier

Construction	Multiplier
Angular Contact or Roller Bearing	0.5
Vertical Motor	0.5
All others	1.0

Table 4-4 Relubrication Amounts

Frame Size		Volume		
NEMA	**IEC**	**Cu. In.**	**Fluid oz**	**ml**
48-56	80	0.25	0.14	4.0
143-145	90	0.25	0.14	4.0
182-184	110	0.50	0.28	8.0
213-215	130	0.75	0.42	12.5
254-256	160	1.00	0.55	16.0
284-286	180	1.50	0.83	25.0
324-326	200	2.00	1.11	33.0
364-365	225	3.00	1.66	50.0
404-405	250	3.80	2.11	62.0
444-449	280	4.10	2.27	67.0
>449	>280	4.50	2.50	74.0

For regreasing while operating multiply volume by 125%.

4.2.4 LUBRICATION PROCEDURE: (For Motors with Regreasing Provisions)

CAUTION: BEARING DAMAGE WARNING

Added grease must be compatible with the original equipment's grease. If a grease other than those stated in 4.2.1 is to be utilized contact the motor manufacturer. Nameplate information supersedes section 4.2.1 (GREASE TYPE). New grease must be free of dirt. Failure to follow these instructions and procedure below may result in bearing and/or motor damage.

For an extremely dirty environment, contact the motor manufacturer for additional information.

LUBRICATION PROCEDURE:

1. Clean the grease inlet plug or zerk fittings prior to regreasing.
2. (If present) Remove grease drain plug and clear outlet hole blockage.

CAUTION: GREASE DRAIN PLUGGED:

Old grease may completely block the drain opening and must be mechanically removed prior to regreasing. Forcing a blocked drain open by increased greasing pressure may collapse bearing shields and / or force excess grease through the bearings and into the motor.

3. Add grease per Table 4-4
4. Re-install grease inlet and drain plugs (if removed).

⚠ WARNING: EXPLOSION HAZARD

Do NOT energize a Hazardous Locations motor without all grease fittings properly installed.

4.2.5 EXAMPLE: LUBRICATION

Assume - NEMA 286T (IEC 180), 1750 RPM Vertical motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 4-1 list 10,000 hours for standard conditions.
2. Table 4-2 classifies severity of service as "Severe" with a multiplier of 0.5.
3. Table 4-3 lists a multiplier value of 0.5 for "Vertical"
4. (Eq. 4.2) Interval = 10,000 hrs x 0.5 x 0.5 = 2500 hrs

Table 4-4 shows that 1.5 in^3 of grease is to be added.

Relubricate every 2,500 hrs of service with 1.5 in^3 of recommended grease.

4.3 TROUBLE-SHOOTING

⚠ WARNING: READ INSTRUCTIONS:

Before trouble-shooting a motor, carefully read and fully understand the warnings, cautions, & safety notice statements in this manual.

⚠ WARNING: Hazardous Locations Motor Repair:

Motors nameplated for use in Division 1 Hazardous Locations can only be disassembled, modified or repaired by the plant of manufacturer or a facility that is Listed under UL's category "Motors and Generators, Rebuilt for use in Hazardous Locations". Failure to follow these instructions could result in serious personal injury, death and/or property damage

CAUTION: DISASSEMBLY APPROVAL REQUIRED:

Motor disassembly must be performed by a party approved by the motor manufacturer. To disassemble the motor without approval voids the warranty.

4.3.1 GENERAL TROUBLE-SHOOTING WARNINGS

1. **DISCONNECT POWER TO THE MOTOR BEFORE PERFORMING SERVICE OR MAINTENANCE.**
2. **Discharge all capacitors before servicing motor.**
3. **Always keep hands and clothing away from moving parts.**
4. **Be sure required safety guards are in place before starting equipment.**
5. **If the problem persists contact the manufacturer.**

4.3.2 Motor Trouble-shooting Cause / Corrective Action - Table 4-5

Issue:		Likely Cause:	Corrective Action:
Motor fails to start upon initial installation:			
	A.)	Supply voltage is too low or is severely unbalanced (one phase is low or missing).	(1) Check power supply fuses (2) Match motor lead wiring to nameplate connection diagram and supply voltage (3) Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3). Correct as needed (4) Obtain correct motor to match actual supply voltage.
	B.)	Motor leads are miswired at conduit box.	
	C.)	Driven load exceeds motor capacity	(1) Verify that motor & load turn freely (2) Disconnect motor from load & ensure motor turns freely. Note: Roller bearings make noise when motor is uncoupled and shaft is rotated (3) Verify that motor starts when disconnected from load (4) Remove excessive / binding load if present.
	D.)	Load is jammed.	
	E.)	Fan guard is bent and making contact with fan	Replace fan guard & fan (if blades are damaged)
	F.)	VFD with power factor capacitors installed	Remove power factor correction capacitors if equipped
	G.)	VFD with motor neutral lead grounded	Ensure that motor neutral lead is ungrounded
	H.)	VFD programmed incorrectly	(1) Repeat checks listed above (2) Verify that VFD current limit and starting boost are set correctly (5) Double-check motor and feedback parameter settings and VFD permissives (6) Repeat autotune (for vector drives) procedure (7) Consult VFD supplier.
Motor has been running, then slow down, stalls, or fails to restart:			
	A.)	Supply voltage has drooped or has become severely unbalanced	(1) Replace fuse or reset circuit breaker. Allow motor to cool down before resetting manual protector on motor. **Warnings** - See section 1.1 for automatic and manual reset protector warnings (2) Verify that rated and balanced supply voltage has been restored before restarting motor. Measure voltage during restart. Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3).
	B.)	Motor is overloaded	(1) Verify that motor & load turn freely. Repair binding components as needed (2) Reduce driven load to match motor capacity or increase motor size to match load requirements.
	C.)	Motor bearings are seized	
	D.)	Load Is jammed.	
	E.)	VFD will not restart motor after tripping	(1) Check fault codes on VFD and follow VFD troubleshooting procedures (2) Verify that VFD input voltage is balanced and within limits (3) Remove excessive mechanical load if present.
	F.)	Capacitor failure on single phase motor (if equipped)	**Warning: Potential Shock Hazard**: Contact service shop to check capacitor.
Motor takes too long to accelerate:			
	A.)	Motor leads are not connected correctly	Match motor lead wiring to nameplate diagram.
	B.)	Supply voltage has drooped or become severely unbalanced.	(1) Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3). Correct as needed (2) Obtain correct motor to match actual supply voltage.
	C.)	Load exceeds motor capability	Determine correct motor size and contact motor representative to obtain replacement motor.
	D.)	Faulty start capacitor (Single Phase)	Motor may be too small for load. Record acceleration time. Start capacitors may fail if acceleration time exceeds 3 seconds.
	E.)	Mechanical Failure	(1) Check to make sure motor & load turn freely (2) Disconnect motor from load & ensure motor turns freely
Motor rotates in the wrong direction:			
	A.)	Incorrect wiring connection at motor	[Single Phase] Reconnect motor according to wiring schematic provided. Note: Some motors are non-reversible
			[Three Phase] Interchange any two power supply (phase) leads.
Motor overheats or overload protector repeatedly trips			
	A.)	Driven Load is excessive	(1) If motor current exceeds nameplate value, ensure that driven load has not increased. Correct as needed. (2) If new motor is a replacement, verify that the rating is the same as the old motor. If previous motor was a special design, a general purpose motor may not have the correct performance.
	B.)	Ambient temperature too high	Most motors are designed to operate in an ambient up to 40 °C. (See section 4.2.2 Hot Surface Caution)
	C.)	Motor cooling fins and/or vent openings blocked	Remove foreign materials – clear vent openings, fan guard air inlets and frame fins (TEFC motors)
	D.)	Insufficient Air Flow	TEAO (Totally Enclosed Air Over) motors: Measure airflow next to motor surface and obtain minimum requirements from motor manufacturer.

E.)	Motor is started too frequently	See section 3.4.5.3
F.)	Supply voltage too low, too high, or unbalanced	(1) Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3) Correct as needed (2) Reconnect motor per input voltage (3) Obtain correct motor to match power supply.

Motor Vibrates

A.)	Motor misaligned to load.	Realign load
B.)	Load out of balance (Direct drive application)	(1) Ensure that load is dynamically balanced: (2) Remove motor from load and inspect motor by itself. Verify that motor shaft is not bent. Rule of thumb is 0.002" runout for shafts extension lengths up to 3.00". Add 0.0005" per every additional inch of shaft length beyond 3.00".
C.)	Uneven tension on multiple belts	Mixing new with used belts. Replace multiple belt applications with a complete set of matched belts.
D.)	Driven load operating at resonant point / natural frequency.	(1) De-energize motor and record vibration as load coasts from 100% speed to 0 RPM. If vibration drops immediately, vibration source is electrical. If levels do not drop immediately, source is mechanical (2) Redesign system to operate below the resonant point (3) On VFD-driven loads, program skip frequencies to bypass resonant points (4) Increase carrier frequency to obtain <3% THD current (5) On variable torque loads reduce volts/hertz below base speed.
E.)	VFD torque pulsations	(1) Adjust VFD to obtain <3% THD current @ rated motor current (2) Adjust VFD stability for smooth operation. Vector drives may be unstable at light load.
F.)	Motor miswired at terminal box	Match motor lead wiring to nameplate connection diagram.
G.)	Uneven, weak or loose mounting support.	Shim, strengthen or tighten where required.
H.)	Motor bearings defective	Test motor by itself. If bearings are bad, you will hear noise or feel roughness. Roller bearings are normally noisy when operated without load. If sleeve bearing, add oil per nameplate instructions. For motors with regreasing provisions, add grease per relubricating instructions (see section 4.2.3). If noise persists contact warranty service.
I.)	Motor out of balance	Disconnect from load. Set motor on rubber pads on solid floor. Secure a ½ height key in shaft keyway and energize from balanced power supply @ rated voltage. Record vibration levels and compare with appropriate standards. If excessive vibration persists contact motor manufacturer.

Bearings repeatedly fail.

A.)	Load to motor may be excessive or unbalanced	(1) If belt drive check system per section 3.3.4. (2) Other than belting, check loading on motor shaft. An unbalanced load will also cause the bearings to fail. (3) Check runouts of mating components, such as a C-face and pump flange.
B.)	Bearings contaminated.	Motor enclosure not suitable for environment. Replace with correct enclosure construction
C.)	Incorrect grease or bearings for ambient extremes.	See section 4.2.1
D.)	VFD bearing damage	Ground brush, common mode filter, or insulated bearings must be added. Contact motor manufacturer.

Motor, at start up, makes a loud rubbing, grinding, or squealing noise.

A.)	Contact between rotating and stationary components	Belt squeal during across the line starting is normal: (1) Verify that supply voltage is within limits (see section 3.4.1.3). (2) Ensure that motor lead wiring matches nameplate connection diagram: (3) Isolate motor from load. (4) To locate point of contact turn motor shaft by hand. (5) If point of contact is not located contact motor service shop.

Start capacitors repeatedly fail.

A.)	The motor acceleration time is too long	Motor may be too small for load. Record acceleration time. Start capacitors may fail if acceleration time exceeds 3 seconds.
B.)	Motor is being started too frequently	Excessive starting will damage motor capacitors. Contact motor manufacturer if motor is started more than 20 times/hour or if acceleration time exceeds 3 seconds.
C.)	Motor voltage low	Verify that voltage at the motor terminals is within limits (see section 3.4.1.3).
D.)	Defective start switch inside motor	Motor internal switch failure overheats start capacitor. Contact service shop or motor manufacturer.

Run capacitor fails.

A.)	High ambient temperature	Verify that the ambient does not exceed motor's nameplate value

	B.)	Input voltage exceeds limit	Verify that voltage to the motor terminals is within limits (see section 3.4.1.3).
	C.)	Power surge to motor (caused by lightning strike or other high transient voltage).	If a common problem, install surge protector.

Static Mixer Data Sheet

Contact Information

Fields marked with an asterisk are required

First Name*	Ben	Last Name*	Ketterer		
Company*	Tetra Tech, EC	Address*	820 Town Center Drive		
City*	Langhorne	State*	Pennsylvania	Zip*	19047
Phone*	215-702-4097	E-mail*	ben.ketterer@tteci.com		
Fax	215-702-4045	Item Number			

Operating Conditions for Each Fluid

		Component				
		1*	2*	3	4	Mixture
Flowrate*	Fluid Name*	Process Water	30%Sodium Hydro			
	Min. GPM	600	0.1			
	Norm. GPM*	800	0.25			
	Max. GPM	1000	0.5			
Viscosity (CPS)		1	10			
Density lbs/ ft3		62.4	82			
Temperature F°		70				
Pressure PSIG		20				

Max. Allowable Pressure Drop	5	Flow Direction	Horizontal	Pipe Operates Full of Liquid?	Yes

Mechanical Design Data

Pipe Diameter*	10 inch	Housing Schedule*	Sch. 80	Other	
Design Temp. (F°)	100	Lined Pipe	No	Type	Select One
Design Pressure (PSI)	75	End Connection*	Flanged	Other	
Max. Length Available		If Flanged	150 lb. RFWN	Other	
		Injection Port*	Yes		
		Type	FNPT	Size	1 inch

Is Jacket for Heating/Cooling Required? Select One | Is Food Grade Sanitary Finish Required? Select one

Materials of Construction

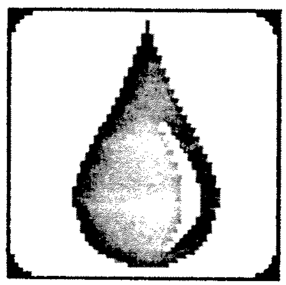
Pipe/Flanges*	PVC	Comments	
Mixing Elements*	PVC		

Submit by Email | Print Form

D-7
Air Stripper

5/27/94

AIR STRIPPER



Operation, Installation and Maintenance Manual

Remedial Systems Inc.

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APPENDICES

INTRODUCTION

Remedial Systems' Air Strippers are the most economical process equipment for removing dissolved volatile organic chemicals (VOC's) from water. Air stripping is a simple, easy to automate process. Contaminated water is introduced into the top of a vertical tower and dispersed by a liquid distribution system over a bed of specially designed material (packing). This packing creates a large water surface area by breaking the contaminated liquid into fine droplets as it flows toward the bottom of the tower. Air is blown counter-current to the water flow, through the packing. VOC's pass from the liquid phase into the upward flowing air. The effluent air is emitted from the top of the tower into the atmosphere unless air purification is desired, in which case vapor phase carbon, a catalytic incinerator, etc. can be supplied.

The size of the air stripper and its components is determined by the contaminant concentration and properties, water flow rate, and desired removal efficiency.

INSPECTION AND OFF-LOADING

Inspect the air stripper upon delivery for any damage which may have occurred in shipment. Areas susceptible to damage may be the air inlet, siphon drain, or influent piping support brackets. If the tower is damaged, Remedial Systems, Inc. (RSI) should be notified immediately. The off loading personnel should note the extent of damage and sign and date the bill of lading. A claim should be filed with the delivering freight carrier.

The air stripper must be carefully removed from the truck so the tower is not damaged. (See Appendix A for details). Components for the air stripper are supplied in a separate carton.

SYSTEM INSTALLATION

When erecting the tower for system operation, be sure it is installed on a foundation which provides adequate support under full load operating conditions. Even if a mounting skid is used, a concrete pad or other properly designed structure must be installed as a foundation. The length and width of this pad are dependent upon the diameter of the air stripper and other components in the treatment system. Thickness of the concrete pad depends on local soil and frost conditions. A local qualified civil engineer should be contacted to determine these dimensions.

The anchor bolts to be used are to be of adequate size to properly support the air stripper. These bolts can be set either during the curing of the concrete or after it has dried. Orientation and positioning of the bolts are per the air stripper drawing. Please note that the air stripper tie down lugs are not flush with the bottom of the tower. In order to avoid damage during installation, these lugs are set approximately one-half inch up from the bottom of the tower. Steel bar stock may be used as shims in order to compensate for this distance.

To turn the air stripper upright, use the lifting eyes provided and use a bridle or spreader bar so that the load is distributed evenly (see Appendix A for details). Equipment needed for this procedure depends on the size and weight of the air stripper. A crane or boomtruck should be used in most instances.

Once the anchor bolts have been set, the shims are in place, and the tower has been lowered onto the bolts, the hardware should be installed and secured to properly support the air stripper. If the air stripper has a diameter 36" or larger, felt paper, foam, rubber, or grout should be used under the bottom of the tower. This will aid in supporting the tower and shimming for alignment.

Guy wires and turnbuckles must be used to further support the tower unless otherwise noted. RSI suggests using one quarter inch or three eighths inch aircraft cable installed via eye bolts which are evenly spaced around the perimeter of the top flange. The wires should be installed at a 45 degree angle with respect to the tower and at a horizontal distance from the bottom of the tower which is equal to its overall height.

The next step toward system start up involves the plumbing and electrical connections. Any valves and/or piping should be independently and adequately supported and accepted piping and valve practices must be followed for proper system operation.

BLOWER/INSTRUMENT INSTALLATION

The blower (Appendix E) should be bolted to the concrete pad, mounting skid, or blower stand at a distance from the tower so a flexible duct can be used to connect the blower discharge to the tower air inlet. Flexible duct is used so that any vibrations from the blower during operation are not transmitted to the tower and air inlet.

A properly sized flexible duct should be used in making the connection between the blower and tower. In instances where the blower discharge is a different size than the air inlet, RSI provides a transition piece so the connection can be easily made. An air damper is provided on the blower, in most cases, so the air flowrate can be adjusted to fluctuating water flowrates and misting effects can be minimized.

Once the blower has been bolted in place and it is connected to the tower air inlet, it must be wired to a power source such as the Remedial Systems' Control Panel or another adequate power source. The electrical installation should be performed by a licensed electrician according to national, state, and local codes.

The temperature gauge (Appendix C) should be threaded into the 1/2" port provided in the tower shell. The Magnehelic gauge (Appendix C) should be installed next. Using the hardware provided with this gauge, plug the high and low pressure ports located on the side of the gauge. Thread the 1/4" nipple into the 1/4" x 1/8" elbow and screw this assembly into the 1/4" NPT port in the top of the viewport. The 1/8" nipple should be facing forward. Install the 1/8" coupling into this assembly and thread the 1/8" inch fitting into the high pressure port located on the back of the gauge. Leave the low pressure port on the back of the gauge open to atmosphere. This gauge is used to measure the approximate pressure drop across the packed section of the tower. It provides valuable operating data in case of problems due to packing plugging or fouling. The gauge is sized according to tower and blower characteristics. See your original RSI quotation or air stripper drawing for approximate reading. (See Appendix C for instrumentation installation.) Consult the RSI Control Panel Manual for proper control panel installation and wiring.

SYSTEM START-UP AND MAINTENANCE

Now that all connections have been made, the air stripper and other components in the recovery and treatment process may be started. During initial start-up, as well as during each and every monitoring period, water temperature, differential pressure reading, packing fouling, and influent water flowrate should be checked and their status noted. A general overview of the entire system should also be noted. Throughout the monitoring period, influent and effluent water samples, in addition to those items mentioned above, are extremely important in evaluating system operation.

> **NOTE:** The air stripper needs a minimum of 72 hours of "packing wetting" upon start up so that the packing media reaches peak efficiency. This can be accomplished using clean or recycled water. An effluent water sample taken during this start-up period may not exhibit efficient stripping.

OPTIONAL ACCESSORIES

RSI can provide optional accessories with its air strippers. RSI level switches and blower fail safe switches are intrinsically safe and require no outside source of power other than the signal voltage provided by the control panel. Likewise, no special wiring in hazardous areas is required. Installation of some of the most common accessories is discussed below.

1. Mist Eliminator

This multi-layer polypropylene pad is installed in the tower above the spray nozzle assembly on the support brackets provided. Its function is to eliminate any misting or raining of water from the top of the tower.

2. Blower Fail Safe Switch

RSI Control Panels can provide blower fail safe circuitry that will sense loss of air flow and in turn will shut down influent water supply pumps. The Blower Fail Safe Switch is connected to the port on the front side of the air inlet. Details on hook-up are included with the switch (Appendix C) and in the RSI Control Panel Operator's Manual.

3. Emergency High Level Switch

This is used to shut down any influent water supply pumps if the tower sump backs up with water due to effluent piping or infiltration gallery plugging. This switch is threaded into the 2 inch port provided in the tower at an elevation just below the air inlet. A 2" x 1" PVC bushing is used to install the switch in the coupling. Details are provided with the switch (Appendix C) and with the RSI Control Panel Manual.

4. Transfer Pump

A transfer pump may be used to move the air stripper effluent water to another point in the treatment process or to an end discharge point which is either upgradient or too far away for gravity drainage. Proper piping and valving procedures must be followed. Details on installation are included with the pump and in the RSI Control Panel Manual.

5. Level Controls

Additional level controls can be provided for proper pump operation. The switches are similar to the Emergency High Level Switch previously described, or may be on a vertical probe as described below under Sight Glass. If they are horizontal switches, the High Level Switch is installed in the port located just below the emergency high port and the Low Level Switch is installed in the port just above the drain. Exact installation instructions are provided with the switches and in the RSI Control Panel Manual.

6. Visual Cleanout Port

If a visual cleanout port is provided, it should be covered by an opaque curtain to prevent sunlight from entering the tower and promoting biological growth on the packing.

7. Sight Glass

A sight glass can be provided for two purposes. First, it allows easy checking of the water level in the sump. This is often helpful for checking proper operation or for troubleshooting. Second, the sight glass can contain a vertical probe with float switches. This can be used in lieu of the three separate switches for level control and emergency high level alarm. The sight glass is installed in the two ports provided in the sump. If a probe is also provided, it threads into the top of the sight glass. Details are provided with the probe (Appendix C) and with the RSI Control Panel Manual.

8. Mounting Skid

Installation of the air stripping system on a mounting skid is the same as previously discussed. Please note that for stability and safety reasons, a mounting skid should be anchored to another type of support, such as a concrete pad.

TROUBLE SHOOTING

As previously stated, air stripping is a simple and economical process. During the operation of such a system, however, certain situations may arise which need to be addressed. Some of the more common occurrences are discussed below. It is important to notify RSI immediately when any of these situations occur so that they can be properly addressed.

1. Low Tower Efficiency

It is unlikely that the actual efficiency of the air stripping tower will be less than the designed efficiency. However, if this does occur, it could be for one of the following reasons: (1) The system is not operating within the original design criteria and should be adjusted to within these levels. (2) The packing media is fouled. This can be checked by reading the differential pressure gauge and noting any increase in pressure across the tower. Also, the appearance of the packing can be noted through the visual viewport. If there is evidence of precipitate or growth build up the packing media can be changed or the RSI Packing Cleaning System can be installed to wash the packing while it remains inside the tower. (3) The blower may be rotating in the wrong direction. Check this by briefly starting the blower and watching as it slows down to make sure it is rotating correctly. (4) The tower is not level, and therefore water is running down the walls and short circuiting the packing. The tower must be plumb within 0.02"/ft, and if not, this should be corrected.

2. Blower Motor Overheating

If the blower motor appears to be overheating, the condition of the bearings should be checked. Noisy bearings may need to be replaced. The voltage supply should be within +/- 10% of the rated voltage (see RSI Control Panel Manual). Also, the air inlet should be checked for any blockage.

NOTE: Provided with each RSI Air Stripping System is a copy of this installation manual, as well as blower data and a drawing of the tower designed for your specific site. Should you have any questions regarding your air stripper do not hesitate to contact the factory in Foxboro, Massachusetts. Phone: 508-543-1512.

Appendix A

HANDLING AND INSTALLATION OF AIR STRIPPERS

INTRODUCTION

Your RSI air stripper will give you long term corrosion-free performance when it is handled and installed in accordance with these specifications. Failure to comply with these provisions shall invalidate the warranty (Appendix B).

The Purchaser is fully responsible for proper inspection, handling and installation, and shall insure that good workmanship practices and construction procedures are followed during the handling and installation of the air stripper, regardless of the inclusions or omissions of any applicable suggestion in these instructions. The Purchaser also accepts all liability for loss or damage to the air strippers or contents resulting from improper handling and/or installation. Unknown situations or conditions not covered in this specification must be the responsibility of the Purchaser. The presence of a Company Representative at the site does not relieve the Purchaser of his responsibility for proper handling and installation.

INSPECTION

Inspect your air stripper immediately upon receipt. Claims for any damage which might have occurred in transit should be filed promptly with the delivering carrier.

RSI air strippers are skidded or blocked for shipment in accordance with the carrier's rules and are thoroughly inspected prior to shipment. Nevertheless, damage can occur in transit. The air stripper must be inspected both inside and outside.

Inspection should include a complete check for:

(a) External surface damage such as: cuts, penetrations, delaminations, fractured areas, etc.

(b) Nozzle damage such as: broken nozzles or flanges, gouged flange faces, etc.

(c) Internal surface damage such as: crazing, white areas with star-shaped surface cracks, etc.

HANDLING

RSI air strippers are designed to withstand normal handling procedures; and because of their relatively light weight they are easy to handle. Here are some normal precautions to follow to avoid damage:

1. Proper rigging practices should be observed at all times. Hoisting equipment operators should attach a guide line to prevent the air stripper from swinging out of control.
2. Do not drop the air stripper or allow it to fall hard in the process of inverting, turning, or moving.
3. Do not slide the air stripper. If it necessary to rotate the stripper, caution must be taken to avoid rolling over any fittings or flanges.
4. In working around the air stripper, care should be taken to prevent tools from striking it or being dropped inside it. Ladders used inside or outside in contact with the air stripper must be wooden or have rubber protection on both ends and not be permitted to scratch the surface.
5. Under no conditions should chains or cables be put around the air stripper.
6. Lift only by the top lifting eyes. Check the hex nuts before using the lifting eyes to make certain they have not become loose in transit.
7. When storing the air stripper on the ground prior to installation, leave it on the shipping cradles with their padding and tie downs so the stripper cannot roll due to winds or sloping elevations.

OFF LOADING

Air strippers are shipped on shipping cradles or saddles. An accepted practice for removing an air stripper from a box trailer utilizes a boom truck or backhoe. Align the boom with the trailer. Extend the boom into the trailer and above the air stripper. Attach a spreader bar (or other acceptable lifting device) to the air stripper and lift the stripper off the bed of the trailer high enough to clear. Once the stripper is in proper position, carefully drive the truck and trailer forward until the stripper clears. Do not move the boom truck until the stripper is clear of the trailer. Lower the stripper to the ground and proceed as required.

Large air strippers are shipped on a flatbed truck and strapped to the truck bed. The recommended method for removing and placing such an air stripper is to lift with slings and a spreader bar. Place the slings to balance the load and use a guide line to keep the load under control. Use canvas or nylon slings or rope a minimum of 1" wide. If the air stripper is not going to be installed onto its foundation right away, set it onto the ground with the shipping cradles and padding where needed and tie down.

If the air stripper is over 30' in length, and depending upon its weight, it may be necessary to use two lifting cranes with single or double slings since a sufficiently long spreader bar may be impractical.

INSTALLATION

Care must be taken in turning air strippers into their proper upright position. To turn air strippers upright, use the lifting eyes and a bridle or spreader bar to avoid bending it out-of-round. It is important to use heavy washers or plates on both sides of the flange to prevent any damage to the bolt hole or the flange. Air strippers which are shipped with mounting lugs for bolting to structural supports cannot be pivoted on these fittings in the process of turning upright. When the air stripper is hanging upright, it can then be set into position on the structural support prepared for it.

Air strippers must be installed on a foundation which provides firm and continuous support over the entire bottom area. The foundation must have sufficient strength to support the weight of the air stripper under operating conditions without any sagging, and it must provide even, restricted settling in local soil conditions. A local qualified civil engineer should be consulted for the foundation design and construction.

The support foundation can be either a properly designed reinforced concrete pad; or, if elevated mounting is required, a properly designed structure with a sufficiently heavy platform to meet the preceding requirements. Fiberglass air strippers need not be grouted, although the absence of any kind of insulation between foundation and air stripper puts a high degree of importance on the pad being smooth and clean. Should the foundation be rough, 1/2" thick sheets of 2# density polyurethane foam or 15# roofing felt is recommended as insulation.

All tie down lugs must be used to secure the air stripper to its pad. Shim under the lugs whenever there is any space beneath them before tightening down. Valves and piping attached to the air stripper nozzles shall be independently supported. Follow accepted good piping practices.

Appendix D

PACKING HANDLING, INSTALLATION, AND MAINTENANCE

SHIPMENT, STORAGE, AND HANDLING

Shipment Description - Packing is shipped to location by contract motor freight trucks. Standard shipping containers are corrugated cardboard boxes containing 10 cubic feet of packing each.

Storage and Handling - Plastic packings are shipped in cardboard boxes which are not designed for outside storage. Care should be taken when handling boxes to prevent boxes from tearing open or corners becoming crushed.

1. Inside Storage of Standard Boxes

a Stack boxes on wooden pallets or on level floor so that there is not danger of water or condensation. Make sure the entire bottom of each box is fully supported

b Do not stack boxes more than three (3) high and tape boxes together as a group If the packing is to be stored in a climate with high humidity (90% or more) for extended period of time, then reduce stacked height to two boxes

c. Do not put any load on top of stacked boxes. Never allow any person to climb on or store other equipment on top of any of the boxes

2. Outside Storage of Standard Boxes

a Outside storage of standard boxes is not recommended, however, if no other alternative is available, follow recommended stacking as inside storage to maximum of two high.

b. Completely cover boxes with weatherproof canvas or plastic. It is important that there is air circulation among the boxes so that condensation does not form on the inside of the cover.

c. Boxes of packing stored outdoors will not support any load. Make sure rain water, ice or snow do not build up on top of the covered boxes.

INSTALLATION INSTRUCTIONS

1. General Information

There are many ways to install plastic random packing. Installation procedures vary depending on the column diameter, size of packing, packed bed height, and position of other internals. Generally, if common sense is used, problems can be avoided. For small diameter columns of less than 30 inches, it is usually easier to load through lower level manways or use a chute to lower the packing to the support level. For larger columns, it may be possible to place men inside so that complete boxes or bags can be lowered and manually dumped. Extreme caution should be used in this procedure to make sure the packing support is designed to hold the combined load of the workmen and the packing. Another method is to attach a rope on the top of a bucket and another on the bottom and lower the packing to the desired level. The rope attached to the bottom would then be used to tip the bucket over. Finish all welding or other work that produces hot sparks before installing any packing. Test the dimensional compatibility of the individual packing pieces with the openings in the support grid. Make sure that it is not possible for packing to squeeze through any openings

2. Installation Procedures

a. Distribute packing pieces in a random manner and never let them free fall more than 15 feet. In cold weather (temperature below 45°F), particular care must be taken in handling and installing plastic packing due to increased brittleness.

b. Make sure the packing fills all the space in the packed bed section. Pay particular attention to the manyways and irregular spaces.

c. Check the position of sensors when they become buried in packing. Be careful not to drop packing on sensitive process measurement devices.

d. If workmen are in the tower, use plywood to distribute their load over as large an area as possible. Never exert a concentrated load onto a few of the individual packing pieces. Check with the packing support manufacturer for loading limits before placing men inside the tower.

e. Before completing the packing installation, consult the installation procedures of the bed limiter, liquid distributor, and other internal components to see if partial installation of these parts is required before packing installation is completed.

f. Be careful not to leave any foreign materials in the packed bed section. Make sure all plywood, boxes and bags are removed.

g. If procedures are not clearly understood by the personnel installing the packing, they should call the packing manufacturer for additional information required.

3. Performance Test

Polypropylene material is hydrophobic in nature. To assure performance results that will meet the specifications, it is essential that the packing be conditioned prior to conducting a performance test. Conditioning the packing means running water over the packing for a minimum of three (3) days. Following this procedure will assure the packing being fully wetted, hence, hydrophilic. Reports from the field indicated the difference in performance, conditioned vs. non-conditioned, can vary as much as 30 percent to 40 percent in mass transfer.

PROCEDURE FOR PACKING MAINTENANCE

1. Cleaning

As the packing accumulates scaling the pressure indicated by the differential pressure gauge will begin to increase. When the differential pressure increases enough to reduce the air flow produced by the blower by 20 percent or more, the packing should be replaced or if an acid wash system is available, cleaned with a dilute (5%) sulfuric acid solution. Consult RSI for other cleaning solutions if desired.

2. Replacement

a. Turn off system leaving stripper blowers on with their dampers wide open for 3 to 4 hours. This will allow most of the packing to dry out.

b. Remove the curtain and transparent window from the visual clean out port. Packing material will begin to flow freely from the air stripper tower.

c. Usually burlap bags or small dumpster-like containers are used to catch the falling packing.

d. To slow the flow of packing, the visual window can be pivoted on the top bolt of the clean out port to throttle the flow or a 2 x 6 board can be used as a throttle.

e. Occasionally, it may be necessary to "Stoke" the packing with a board or rod to break up any "bridging effect" that may develop.

3. Disposal

The drying out process should drive off any VOCs that may be dissolved in the water hung up on the packing surfaces. There will be a considerable amount of scale on the packing surfaces but if the influent water analysis given in the specifications is accurate the dried out packing should not be a hazardous material and disposal in a non-hazardous landfill or with a plastic recycler should be possible. The packing can also be washed off with a high pressure nozzle or wand in an open tank with a drain. Since the packing is 94% void space it can be processed in a compactor to reduce the disposal volume.

4. Acid Washing

Dilute mineral acids and hydrogen peroxide are effective cleaning agents for random dumped polypropylene packings. Because of the possibility of forming trihalomethanes, sulfuric instead of hydrochloric acid is typically used. Dilute concentrations 3-5% are sufficient. Pumping at a flow of 3 gpm/ft^2 of packing, at a minimum, of acid for about 15-20 minutes is usually adequate to clean the packing so that the pressure drop is restored to within 0.2" static water column of its original clean pressure drop. The spent acid will need to be disposed of or if possible, blend off with some suitable alkaline waters.

Another alternative would be to meter the 5% sulfuric solution into the influent water line of the stripping towers. A properly sized and constructed metering pump, in-line static mixer, pH sensor and controller are needed as well as an acid storage tank. By maintaining the pH of the water entering the stripping tower at a set point below a pH of

5, virtually all the iron, manganese and calcium ions will remain in solution preventing nearly all scaling from these metal sources. To determine acid usage cost for an acidification system consult Remedial Systems office for an estimate. The minimum data needed for such a system estimate would be:

Water Flow (gpm)

Temperature (°F)

Dissolved Iron Concentration (ppm)

Hardness as Calcium Carbonate

Alkalinity (as CO_3)

pH

TDS

Other methods such as chemical treatment using sequestering agents and biocides are available from Remedial Systems. Greensand filters are also used to remove dissolved iron and manganese under certain conditions. Since each situation is site specific, it is advisable to consult our sales department to discuss your particular scaling problem before choosing a method. In the vast majority of sites the most economical system is to periodically replace the scaled or plugged packing with new material.

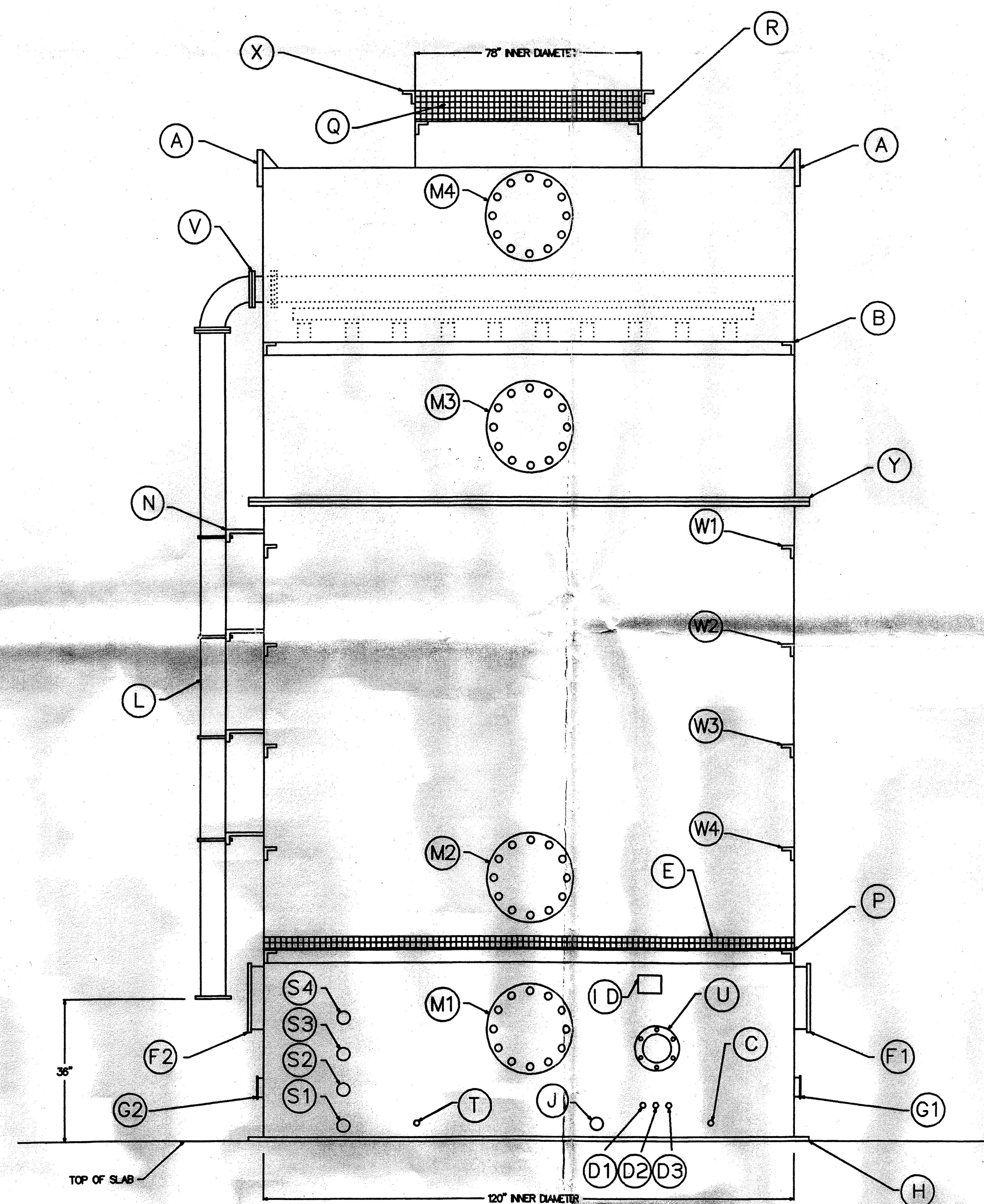
ITEM	QTY.	SIZE (in.)	ELEV. (in.)	ORIENT. (deg.)	DESCRIPTION
A	4	2	540	0,EVERY 90	LIFTING EYE*
B	1	120	504	–	TOP OF LIQUID DISTRIBUTOR SUPPORT*
C	1	1/2	4	45	TEMPERATURE GAUGE PORT
D1	1	3/8	36	292.5	SAMPLE PORT*
D2	1	3/8	331	292.5	SAMPLE PORT*
D3	1	3/8	487	292.5	SAMPLE PORT*
E	1	1 1/2	181	–	FRP PACKING GRATE
F1	1	30"x30"	163	0	BLOWER INLET*
F2	1	30"x30"	163	180	BLOWER INLET*
G1	1	8	16.15	22.5	WATER OUTLET*
G2	1	8	16.15	202.5	WATER OUTLET*
H	1	132	0	–	BOTTOM OF BASEPLATE(REF. PT. ELEV.)*
ID	1	–	60	22.5	RSI NAMEPLATE
J	1	2	2	315	CLEARWELL DRAIN
L	1	10	–	270	INLET PIPE*
M1	1	24	84	235	CLEARWELL ACCESS MANWAY*
M2	1	24	197	90	PACKING ACCESS MANWAY*
M3	1	24	486	90	LOWER LIQUID DISTRIBUTOR MANWAY*
M4	1	24	522	0	UPPER LIQUID DISTRIBUTOR MANWAY*
N	4	10	A/R	270	U-BOLT PIPE SUPPORT W/SS HARDWARE
P	1	120	181	–	TOP OF PACKING GRATE SUPPORT*
Q	1	78	558	–	DEMISTER
R	1	78	558	–	TOP OF DEMISTER SUPPORT*
S1	1	1/2	60	90	FLOAT SWITCH PORT
S2	1	1/2	72	90	FLOAT SWITCH PORT
S3	1	1/2	96	90	FLOAT SWITCH PORT
S4	1	1/2	108	90	FLOAT SWITCH PORT
T	1	1	2	337.5	LEVEL TRANSMITTER PORT
U	1	16	135	315	CLEARWELL OVERFLOW*
V	1	10	526	270	WATER INLET FLANGE*
W1	1	120	457	–	WALL WIPER*
W2	1	120	397	–	WALL WIPER*
W3	1	120	337	–	WALL WIPER*
W4	1	120	277	–	WALL WIPER*
X	1	78	564	–	TOP OF EXHAUST STACK*
Y	1	128	468	–	FIELD FLANGE*
Z1	1	–	–	45	LADDER & PLATFORMS TO M2 & M4 #
Z2	1	–	–	135	LADDER & PLATFORM TO M3 #

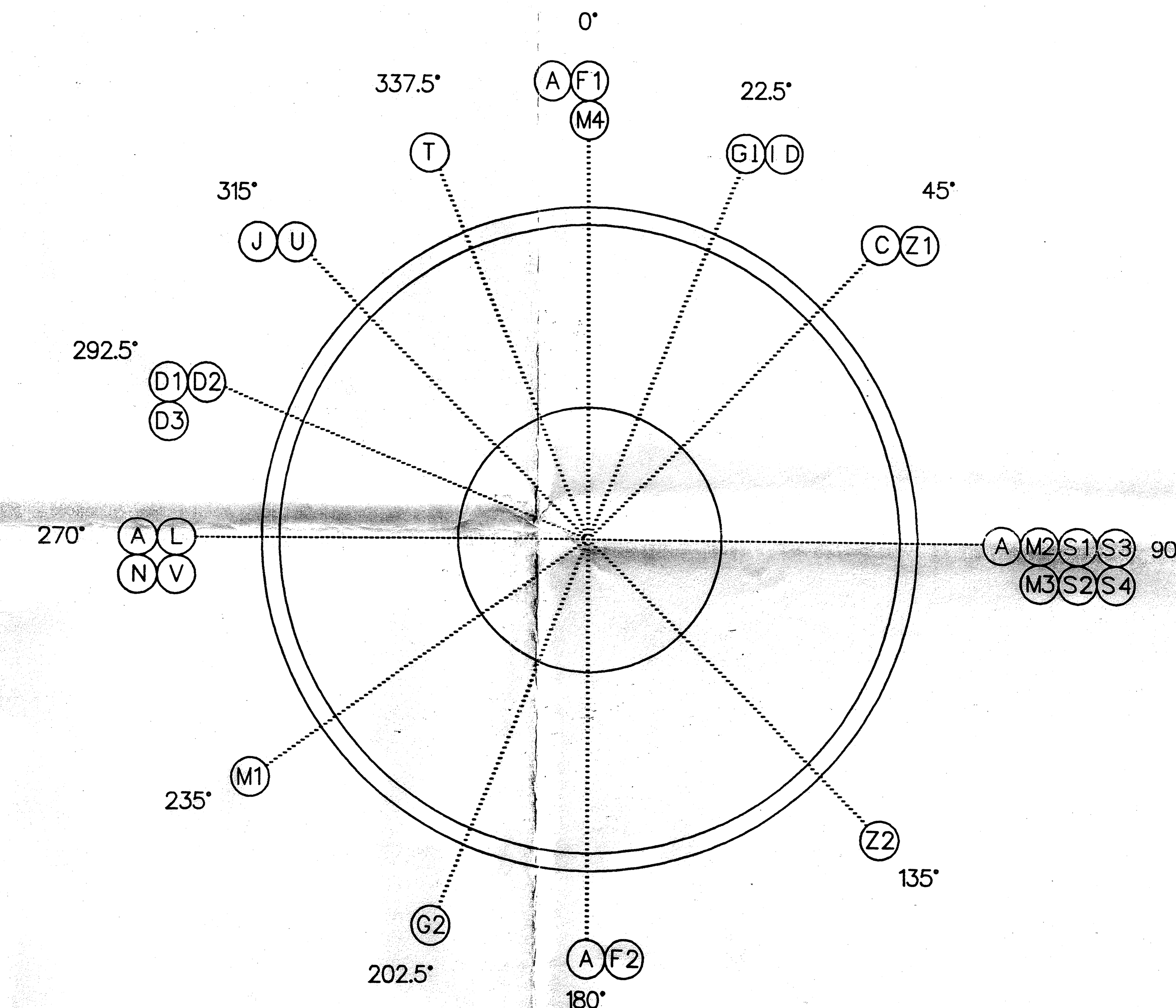
ALL ELEVATIONS ARE CENTERLINE DISTANCES UNLESS NOTED.
* SEE DRAWING DETAILS
# DESIGN PER TOWER MANUFACTURER. SEE SPECIFICATIONS.

GENERAL NOTES:

1. SHELL IS 5000 SERIES STRUCTURAL ALUMINUM. ALL EXTERNAL SURFACES MUST BE PROTECTED FROM SCRATCHING, GOUGING, ETC. DURING FABRICATION. FINAL APPEARANCE OF TOWER SHALL BE NEAT AND CLEAN. PAPER PROTECT ON ALL EXTERNAL SURFACES.
2. ALL ALUMINUM PIPE AND FITTINGS ARE SCHEDULE 40.
3. ALL WELDS CONTINUOUS WELDED BOTH SIDES, 1/4" BEAD UNLESS NOTED. ALL EXTERNAL WELDS SHALL BE FINISHED PER ASAB 46, WIRE SHELL WELDS MAY BE ONE SIDE IF FULL PENETRATION CAN BE ACHIEVED. WELD FROM OUTSIDE.
4. NOZZLE PROJECTIONS ARE 8" FROM INSIDE STRIPPER WALL UNLESS OTHERWISE NOTED.
5. NOZZLES ARE 25 PSI RATING WITH 150# DRILLING.
6. ALL FLANGE BOLT HOLES TO STRADDLE PRINCIPAL STRIPPER CENTER LINES (0–180,90–270) AXIS AT PLAN VIEW.
7. ALL FLANGES, MANWAYS AND VIEWPORTS SHALL BE PROVIDED WITH FASTENERS AND 1/8" NEOPRENE GASKETS UNLESS NOTED.
8. ALL FASTENERS ARE 18–8 STAINLESS STEEL.
9. ALL CONNECTION 4 IN. AND LARGER ARE GUSSETED FLANGES UNLESS NOTED.
10. ALL WELDING PERSONNEL MUST BE CERTIFIED IN ACCORDANCE WITH THE LATEST ASME BOILER AND PRESSURE VESSEL CODE.
11. DRAWINGS MUST BE STAMPED BY N.Y. STATE P.E. AS BEING CAPABLE OF WITHSTANDING SNOW, WIND AND EARTHQUAKE LOADS PER N.Y. STATE BUILDING CODE OR AMERICAN NATIONAL STANDARD INSTITUTE CODE, WHICHEVER IS GREATER. 100 MPH MIN. WIND LOADING.
12. WALL THICKNESS: BOTTOM 8', 1/4", TOP 39', 3/16". TO BE REVIEWED BY P.E. AND ADJUSTED IF NECESSARY.
13. TOLERANCES:
    DIAMETERS >36": ± 0.500"
    DIAMETERS >12": ± 0.250"
    ALL OTHER DIAMETERS: ± 0.125"
    ALL BOLT HOLE LOCATIONS: ± 0.063"
    VERTICAL ELEVATIONS: ± 0.250"
    ALL OTHER DIMENSIONS: ± 0.125"

OVERALL HEIGHT OF TOWER AND STACK – 564"
PACKING SUPPORT GRATE HEIGHT – 168"
TOTAL HEIGHT OF PACKING – 300"





Z1 Z2 NOT SHOWN ON ELEVATION VIEW

REV	DATE	DESCRIPTION
A	10/25/94	CH. U FR. 18". ADD TOLERANCES.
B	10/26/94	CH. EL. OF Q.R FR. 560".
C	11/14/94	CH. EL. OF B.D2.D3.E.F1. F2.G1.G2.M1.M2.M3.M4.P.S1. S2.U.V.W1.W2.W3.W4.Y. CH. S FR. SIGHT GLASS. CH. ORIENT. OF T. CH. TOP 17' FR. 1/4" THK.
D	11/23/94	CH. WALL THICKNESS. CH. WELD SPEC. CH. DIA. OF Y.
E	12/2/94	CH. EL. OF D2.D3.F1.F2.S1. S2.S3.S4.U.E.M2.P.V.

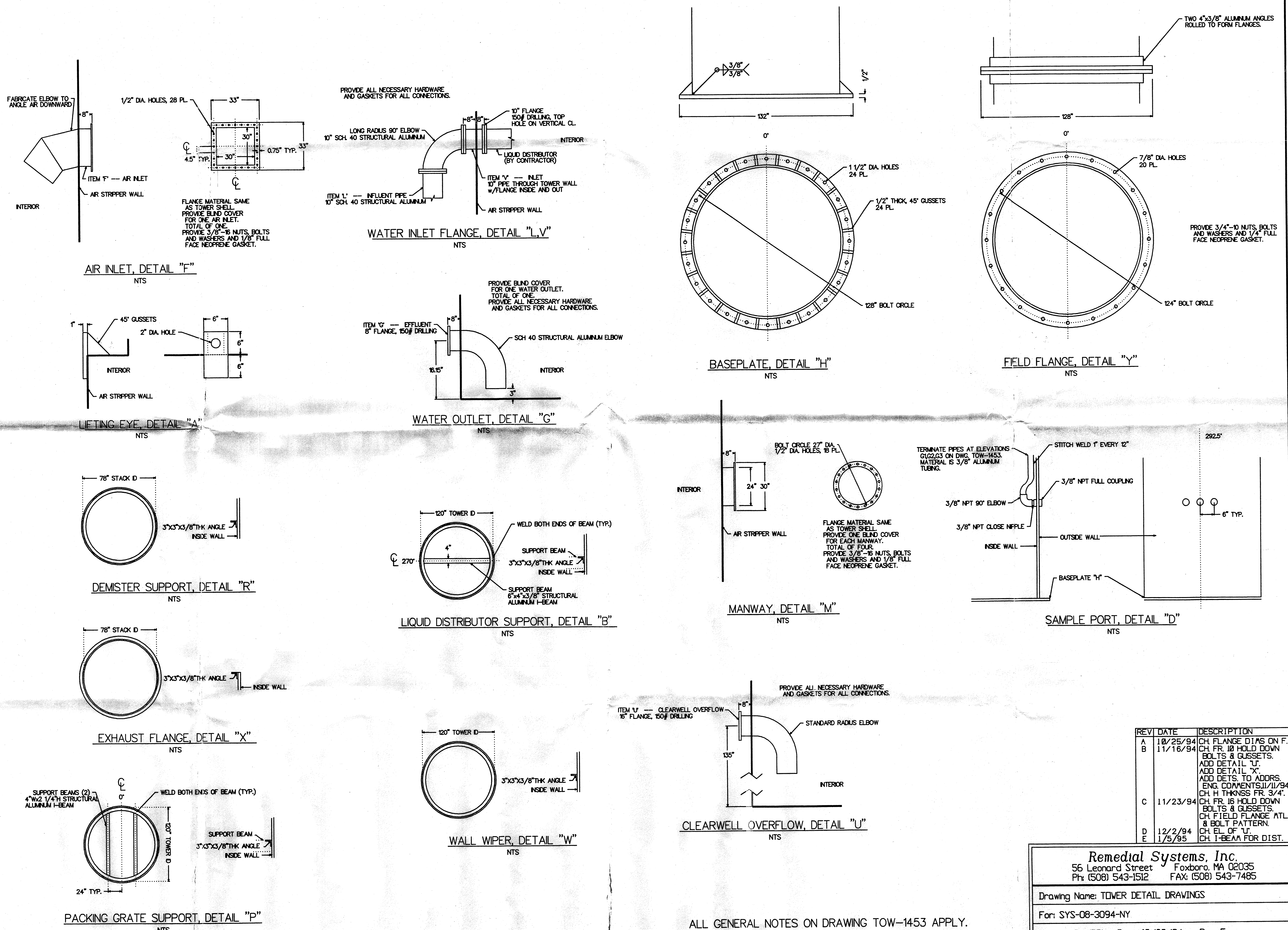
Remedial Systems, Inc.
56 Leonard Street Foxboro, MA 02035
Ph: (508) 543-1512 FAX: (508) 543-7485

Drawing Name: TOWER LAYOUT DRAWING

For: SYS-08-3094-NY

Drn by: BJ (BB) Date: 10/20/94 Rev: E

File Name: TOW-1453 Scale: NTS



ALL GENERAL NOTES ON DRAWING TOW-1453 APPLY.

REV	DATE	DESCRIPTION
A	10/25/94	CH. FLANGE DIMS ON F.
B	11/16/94	CH. FR. 10 HOLD DOWN BOLTS & GUSSETS. ADD DETAIL "U". ADD DETAIL "X". ADD DETS. TO ADDRS. ENG. COMMENTS 11/11/94. CH. H THKNSS FR. 3/4".
C	11/23/94	CH. FR. 16 HOLD DOWN BOLTS & GUSSETS. CH. FIELD FLANGE MTL. & BOLT PATTERN.
D	12/2/94	CH. EL. OF "U".
E	1/5/95	CH. I-BEAM FOR DIST.

Remedial Systems, Inc.
56 Leonard Street Foxboro, MA 02035
Ph: (508) 543-1512 FAX: (508) 543-7485

Drawing Name: TOWER DETAIL DRAWINGS

For: SYS-08-3094-NY

Drn by: BJ (BB) Date: 10/20/94 Rev: E

File Name: DET-1453 Scale: NTS

D-8
Air Stripper Heater

Chromalox®

Installation Operation

and

RENEWAL PARTS IDENTIFICATION

SERVICE REFERENCE	
DIVISION 4	SECTION ADH
SALES REFERENCE (Supersedes PF438-3)	PF438-4
	161-057949-001
DATE SEPTEMBER, 2004	

Type ADH and ADHT Air Duct Heaters

Specifications — Table A

Model	Approx. Net. Wt. (Lbs.)	Model	Approx. Net. Wt. (Lbs.)	Volts	Phase	kW	No. Elements	No. Mtg. Holes 9/32" Dia.	No. Circuits	Dimensions (In.) A	B	C	D	E	H	K	L	M
ADH-005	8	ADHT-005	10	480	3	5	3	10	1	5-5/8	20-3/8	28-1/8	4	1/4	2-1/2	3-1/2	11-1/8	9-1/2
ADH-010	15	ADHT-010	20	480	3	10	6	10	1	7-5/8	20-3/8	28-1/8	6	1/4	3-1/2	3-1/2	11-1/8	9-1/2
ADH-015	25	ADHT-015	30	480	3	15	9	12	1	9-5/8	20-3/8	28-1/8	8	1/4	3	3-1/2	11-1/8	9-1/2
ADH-020	35	ADHT-020	40	480	3	20	12	14	1	11-5/8	20-3/8	28-1/8	10	1/4	2-3/4	3-1/2	11-1/8	9-1/2
ADH-025	40	ADHT-025	50	480	3	25	15	14	1	13-5/8	20-3/8	28-1/8	12	1/4	3-1/4	3-1/2	11-1/8	9-1/2
ADH-030	55	ADHT-030	65	480	3	30	18	14	1	15-5/8	20-3/8	28-1/4	14	3/8	3-3/4	3-1/2	11-1/8	9-1/2
ADH-035	65	ADHT-035	80	480	3	35	21	14	1	17-5/8	20-3/8	28-1/4	16	3/8	4-1/4	3-1/2	11-1/8	9-1/2
ADH-040	70	ADHT-040	90	480	3	40	24	14	2	19-5/8	20-3/8	28-1/4	18	3/8	4-3/4	3-1/2	11-1/8	9-1/2
ADH-045	80	ADHT-045	100	480	3	45	27	14	2	21-5/8	20-3/8	28-1/4	20	3/8	5-1/4	3-1/2	11-1/8	9-1/2
ADH-050	90	ADHT-050	110	480	3	50	30	14	2	23-5/8	20-3/8	28-1/4	22	3/8	5-3/4	3-1/2	11-1/8	9-1/2
ADH-060	105	ADHT-060	130	480	3	60	36	18	2	27-5/8	20-3/8	28-1/4	26	3/8	4-1/2	3-1/2	11-1/8	9-1/2
ADH-080	140	ADHT-080	175	480	3	80	48	22	4	35-5/8	20-3/8	28-1/4	34	3/8	4-3/8	3-1/2	11-1/8	9-1/2
ADH-090	160	ADHT-090	200	480	3	90	54	22	5	39-5/8	20-3/8	28-1/4	38	3/8	4-7/8	3-1/2	11-1/8	9-1/2
ADH-100	175	ADHT-100	220	480	3	100	60	22	5	43-5/8	20-3/8	28-1/4	42	3/8	5-3/8	3-1/2	11-1/8	9-1/2
—	—	ADHT-120	205	480	3	120	36	18	4	27-5/8	35	42-7/8	26	3/8	4-1/2	3-1/2	11-1/8	9-1/2
ADH-144	165	—	—	480	3	144	48	22	4	35-5/8	35	42-7/8	34	3/8	4-3/8	3-1/2	11-1/8	9-1/2
—	—	ADHT-160	270	480	3	160	48	22	8	35-5/8	35	42-7/8	34	3/8	4-3/8	3-1/2	11-1/8	9-1/2
ADH-162	185	—	—	480	3	162	54	22	6	39-5/8	35	42-7/8	38	3/8	4-7/8	3-1/2	11-1/8	9-1/2
—	—	ADHT-180	305	480	3	180	54	22	6	39-5/8	35	42-7/8	38	3/8	4-7/8	3-1/2	11-1/8	9-1/2
ADH-216F	240	—	—	480	3	216	72	22	6	27-5/8	35	42-7/8	26	3/8	4-1/2	3-7/8	20	18-3/8
—	—	ADHT-240F	400	480	3	240	72	22	8	27-5/8	35	42-7/8	26	3/8	4-1/2	3-7/8	20	18-3/8
ADH-270F	300	—	—	480	3	270	90	22	8	33-5/8	35	42-7/8	32	3/8	5-1/2	3-7/8	20	18-3/8
—	—	ADHT-300F	500	480	3	300	90	22	10	33-5/8	35	42-7/8	32	3/8	5-1/2	3-7/8	20	18-3/8

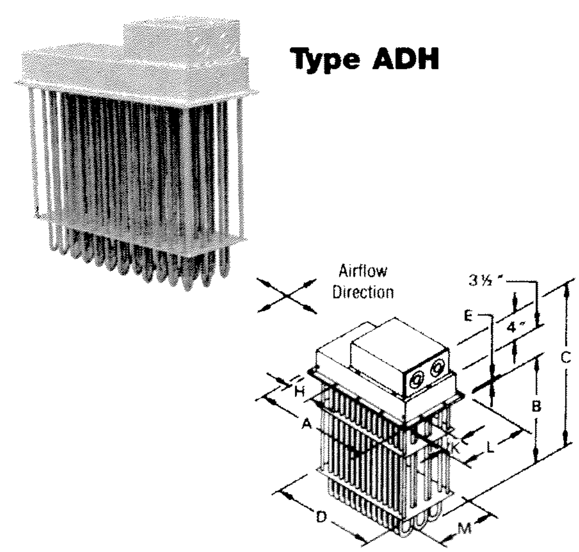


Figure 1 — Dimensions

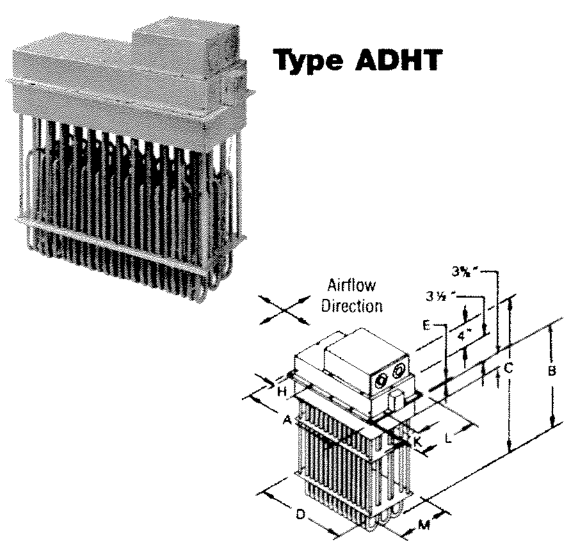


Figure 2 — Dimensions

GENERAL

⚠WARNING

FIRE/EXPLOSION HAZARD. This heater is not intended for use in hazardous atmospheres where flammable vapors, gases, liquids or other combustible atmospheres are present as defined in the National Electrical Code. Failure to comply can result in personal injury or property damage.

1. Heater construction characteristics —
   - A. Alloy sheathed tubular elements, .475" diameter
   - B. Steel flange
   - C. Stainless steel support construction
   - D. High temperature alloy terminals and connections
   - E. Replaceable individual heating elements
   - F. Wiring terminals located outside the heated zone
2. **Maximum Temperatures** — Types ADH and ADHT process air heaters can generally be used at the following maximum temperatures shown, provided the minimum air velocity is maintained uniformly through the heater.

Air Velocity (Ft./Sec.)	Max. Outlet Air Temp. (°F)	
	ADH	ADHT
4	800	1050
9	800	1100
16	800	1150
25	800	1200
36	800	1200

CAUTION: *Do not energize heater in air with a velocity less than 1 Ft. Per Second.*

3. The heater may be bolted to the duct with the terminal housing and flange at the top, at either side or at the bottom.
4. Several heaters may be mounted in tandem so long as proper controls are used to limit the maximum temperature attained.
5. Installation with duct transitions in some air distribution systems, the duct heater may be considerably larger than the ductwork and the duct area must be increased by a sheet metal transition. The slope of the transformation piece on the upstream side of the equipment is limited to 30° as indicated in Figure 3. On the leaving side, the slope should not be more than 45°.
6. Use moisture proof terminal cover in atmospheres bearing corrosive fumes or excessive moisture.
7. Use explosion resistant heaters in explosive atmospheres and reduce current rating to elements.
8. Gas tight design — Achieved by the use of threaded fittings with fiber washers to attach heating elements to flange — prevents leakage of ducted air into terminal housing.
9. Overtemperature protection — Thermocouple fastened to the element sheath surface and wired to a terminal block can be provided for accurate overheat protection (standard on ADHT models).
10. Flange mounting gasket — Packed separately with each duct heater to minimize air leakage between the flange and air duct. Refer to Table B and Figure 4.

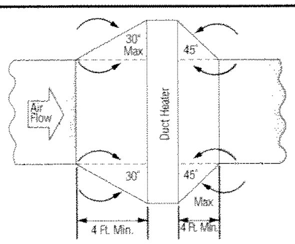


Figure 3

Specifications — Table B

Flange Gasket Part No.	Flange Size	Used On ADH and ADHT
168-055429-001	11-1/8 x 5-5/8	5 kW
168-055429-002	11-1/8 x 7-5/8	10 kW
168-055429-003	11-1/8 x 9-5/8	15 kW
168-055429-004	11-1/8 x 11-5/8	20 kW
168-055429-005	11-1/8 x 13-5/8	25 kW
168-055429-006	11-1/8 x 15-5/8	30 kW
168-055429-007	11-1/8 x 17-5/8	35 kW
168-055429-008	11-1/8 x 19-5/8	40 kW
168-055429-009	11-1/8 x 21-5/8	45 kW
168-055429-010	11-1/8 x 23-5/8	50 kW
168-055429-011	11-1/8 x 27-5/8	60, 120 kW
168-055429-013	11-1/8 x 35-5/8	80, 144, 160 kW
168-055429-014	11-1/8 x 39-5/8	90, 162, 180 kW
168-055429-015	11-1/8 x 43-5/8	100 kW
168-055429-017	20 x 27-5/8	216, 240 kW
168-055429-018	20 x 33-5/8	270, 300 kW

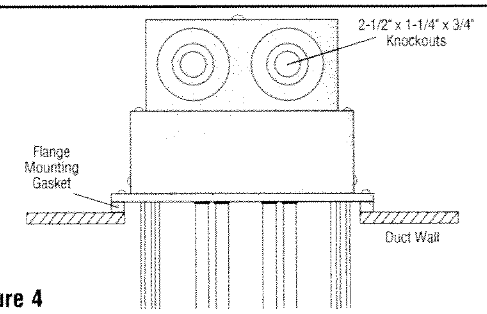


Figure 4

INSTALLATION

⚠WARNING

ELECTRIC SHOCK HAZARD. Disconnect all power before installing or servicing heater. Failure to do so could result in personal injury or property damage. Heater must be installed by a qualified person in accordance with the National Electrical Code, NFPA 70.

⚠WARNING

The system designer is responsible for the safety of this equipment and should install adequate back-up controls and safety devices with their electric heating equipment. Where the consequences of failure could result in personal injury or property damage, back-up controls are essential.

1. Locate and position heater in duct in accordance with both process requirements and recommendations given.
2. Refer to Figures 1 and 2, layout "D" and "M" dimensions on duct mounting face established in step 1.
3. With tools suitable for sheet metal work, cut layout opening in duct.
4. In general, heaters less than 35 pounds in weight may be mounted directly in opening without additional duct reinforcement if duct installation and condition permits. To fasten heater to duct wall use #14 pan or round head self-tapping screws. The flange mounting gasket supplied with the heater is recommended for insertion between heater flange and duct to minimize air leakage.
5. For heater weights greater than 35 pounds (see Specifications Table A, page 1) due consideration should be given to; (a) mechanically strengthening duct work with, for example, angle irons or chains (see Figure 5), and (b) heat insulating duct line in immediate area of heater location to prevent excessive heat loss. Consult your local sheet metal contractor.

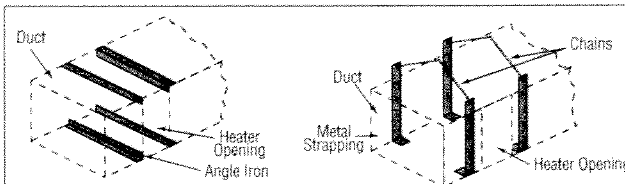


Figure 5

INSTALLATION (cont'd.)

6. In high ambient temperature operations, least corrosive action and least oxidation to the terminals will occur if the heaters are mounted with the terminals in the coolest possible ambient, usually on the bottom or side of the duct.
   A. Minimum duct size is "A" or "L" dimension +3/8" and "B" dimension +1-5/8".

⚠WARNING

HAZARD OF FIRE. Since these heaters are capable of developing high temperatures, extreme care should be taken to:

A. Avoid installing heaters in an atmosphere containing combustible gases and vapors.
B. Avoid contact between heater and combustible material.
C. Keep combustible materials far enough away to be free of the effects of high temperatures.

ADH Low temperature duct heaters — can be fastened directly to the sheet metal duct work with bolts or sheet metal screws.

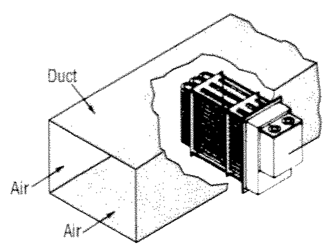


Figure 6

ADHT High temperature duct heaters — are generally mounted on field fabricated stand off supports from the ductwork to position the heater such that the 3" insulation housing is in the same plane as the duct insulation.

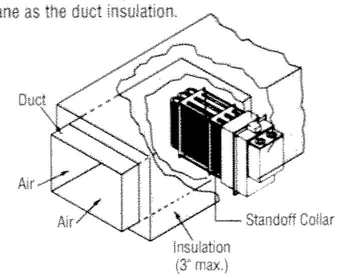


Figure 7

Temperature Control Instructions

1. A Chromalox thermal cutout or thermostat is recommended for overheat protection and control of heater and process. Consult local Chromalox representative.
2. In general, place thermostat sensing element close to the heating elements, near top of duct, at right angles to the direction of air flow, and on the downstream side of the heater. Thermostat, provided with a manual reset button, is separately mounted.
3. For heater protection, the indicated maximum temperature of the control unit should be 50°F less than the actual maximum air temperature that will be permitted, to allow for overshoot.
4. Single circuit heater elements may be wired into two circuits to allow for partial heating and control. *It is important* to have thermal control wired into all electric power circuits, so that all elements may be protected from overheat.

WIRING

⚠WARNING

ELECTRIC SHOCK HAZARD. Any installation involving electric heaters must be performed by a qualified person and must be effectively grounded in accordance with the National Electrical Code to eliminate shock hazard.

1. All wiring should be done in accordance with National Electrical Code and with local codes by a qualified person.
2. Connect air heaters to same line voltage, phase, and frequency as on heater nameplate.
3. Teflon insulated nickel plated copper wire or bus bar is recommended for power connections to heater terminals and for wiring runs in heated zones. When ambient temperature in heated zone exceeds that for which insulated wire is recommended use bare nickel-plated copper with porcelain beads, tubing or bus bar. Consult local Chromalox representative.
4. Users should install adequate back-up controls and safety devices with their electric heating equipment. Selection of controls, thermostat, SCR units, contactors and etc. depends on the degree of accuracy required, reliability, electrical rating of heater and economic considerations.
5. Below is an example of a standard ADH-015, 480V 3 Ø 15 kW, wired with recommended back-up controls. (Figure 8)
6. Individual terminal blocks with 1/4-20 threaded stud type terminals are provided for each circuit to permit quick positive attachment of circuit wiring conductors (one terminal block per circuit). (Figure 9)

Terminal block
(303-027852-001)
X Circuit label indicated here.

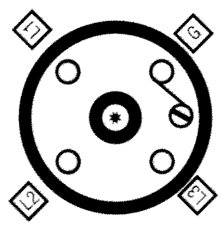


Figure 9

ADH-015, 15 kW 480V 3ø, 1 Circuit
(9) - 480V, 1667 Watt Elements

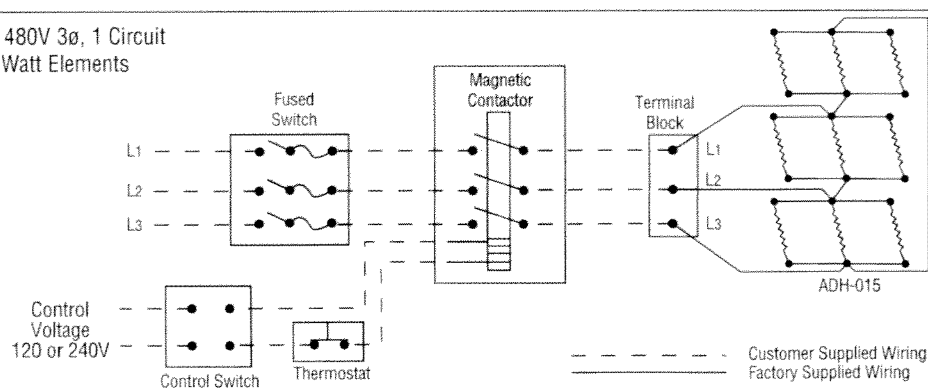


Figure 8

OPERATION

Do not operate heater at voltages in excess of that stamped on the heater since excess voltage will shorten heater life.

MAINTENANCE

⚠WARNING

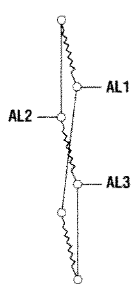
ELECTRIC SHOCK HAZARD. Disconnect all power before installing or servicing heater. Failure to do so could result in personal injury or property damage. Heater must be installed by a qualified person in accordance with the National Electrical Code, NFPA 70.

1. Periodically clean terminals and terminal covers of dust and corrosion to maintain good electrical connections and to permit rapid heat dissipation. Use airblast, and be careful to avoid damage to mica insulation.
2. Check for loose terminal connections. Tighten as necessary.

WIRING DIAGRAMS

ADH-005, ADHT-005

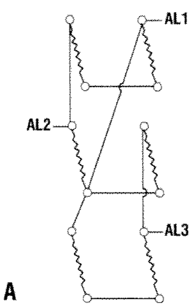
1 Circuit, 3 Elements per Heater



Circuit A

ADH-010, ADHT-010

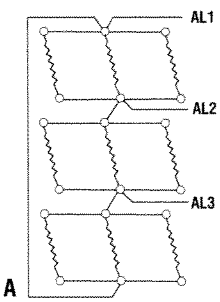
1 Circuit, 6 Elements per Heater



Circuit A

ADH-015, ADHT-015

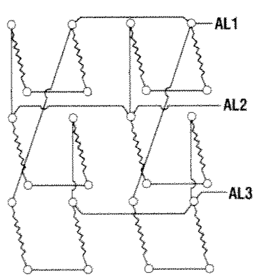
1 Circuit, 9 Elements per Heater



Circuit A

ADH-020, ADHT-020

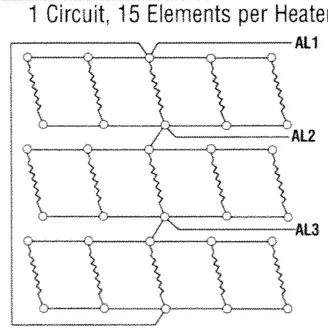
1 Circuit, 12 Elements per Heater



Circuit A

ADH-025, ADHT-025

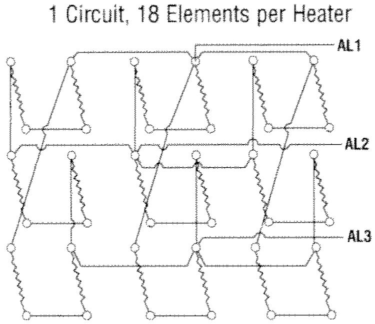
1 Circuit, 15 Elements per Heater



Circuit A

ADH-030, ADHT-030

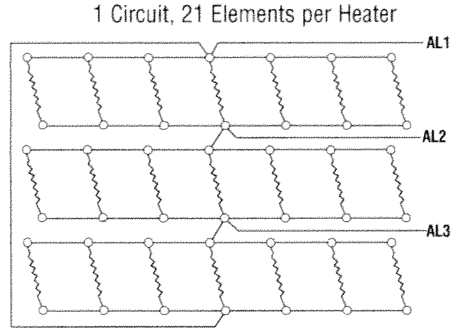
1 Circuit, 18 Elements per Heater



Circuit A

ADH-035, ADHT-035

1 Circuit, 21 Elements per Heater

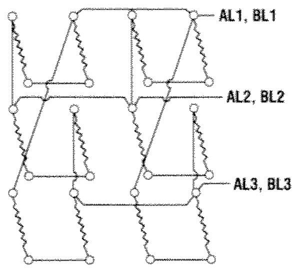


Circuit A

WIRING DIAGRAMS

ADH-040, ADHT-040

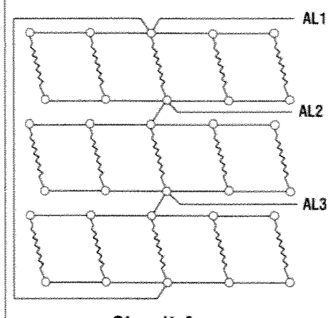
2 Circuits per Heater, Circuit A, B, 12 Elements per Circuit,
24 Elements per Heater



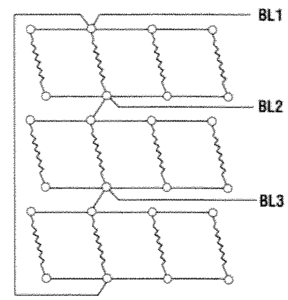
Typical Circuit

ADH-045, ADHT-045

2 Circuits per Heater, Circuit A, 15 Elements,
Circuit B, 12 Elements, 27 Elements per Heater



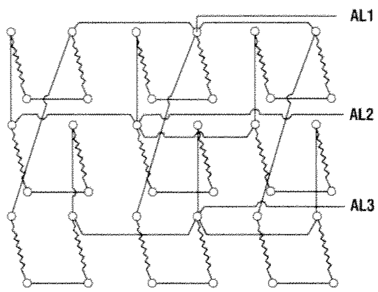
Circuit A



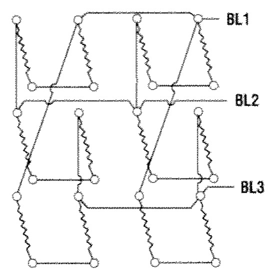
Circuit B

ADH-050, ADHT-050

2 Circuits per Heater, Circuit A 18 Elements, Circuit B 12 Elements, 30 Elements per Heater



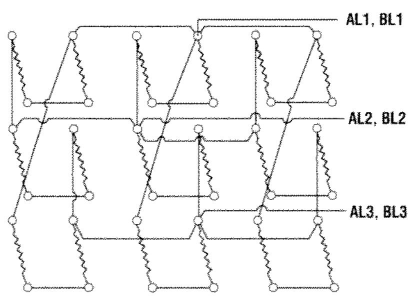
Circuit A



Circuit B

ADH-060, ADHT-060

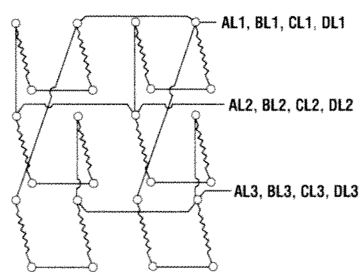
2 Circuits per Heater, Circuit A, B,
18 Elements per Circuit, 36 Elements per Heater



Typical Circuit

ADH-080, ADHT-080

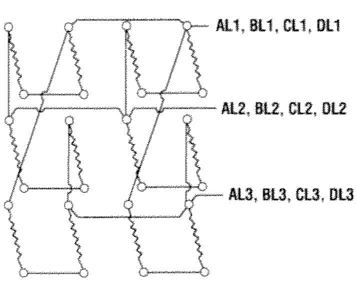
4 Circuits per Heater, Circuit A, B, C, D,
12 Elements per Circuit, 48 Elements per Heater



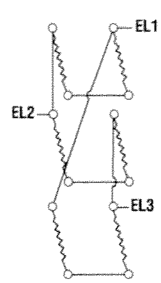
Typical Circuit

ADH-090, ADHT-090

5 Circuits per Heater, Circuit A, B, C, D, 12 Elements per Circuit,
Circuit E, 6 Elements, 54 Elements per Heater



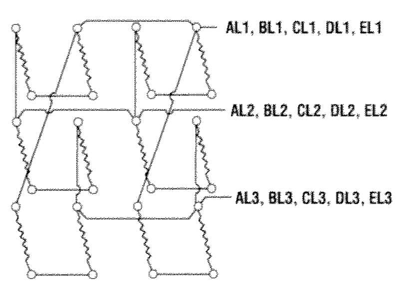
Circuit A, B, C, D



Circuit E

ADH-100, ADHT-100

5 Circuits per Heater, Circuit A, B, C, D, E,
12 Elements per Circuit, 60 Elements per Heater

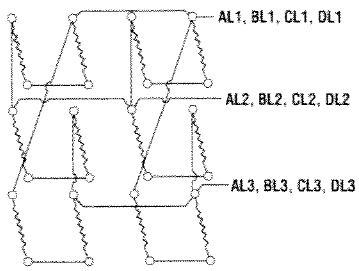


Typical Circuit

WIRING DIAGRAMS

ADHT-120

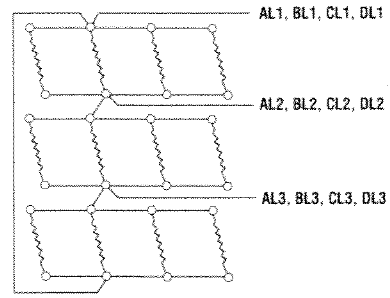
4 Circuits per Heater, Circuit A, B, C, D,
9 Elements per Circuit, 36 Elements per Heater



Typical Circuit

ADH-144

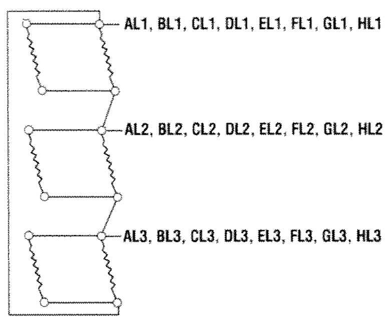
4 Circuits per Heater, Circuit A, B, C, D,
12 Elements per Circuit, 48 Elements per Heater



Typical Circuit

ADH-160

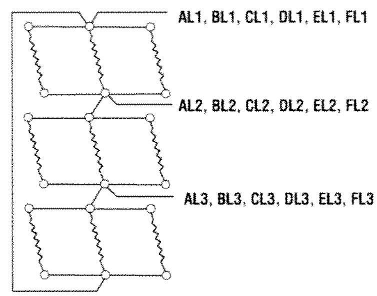
8 Circuits, Circuit A, B, C, D, E, F, G, H,
6 Elements per Circuit, 48 Elements per Heater



Typical Circuit

ADH-162, ADHT-180

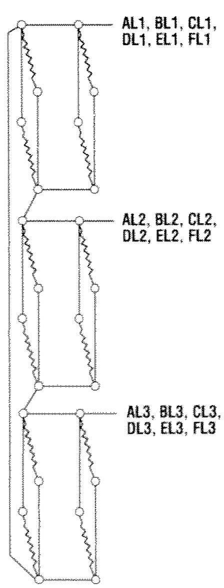
6 Circuits, Circuit A, B, C, D, E, F,
9 Elements per Circuit, 54 Elements per Heater



Typical Circuit

ADH-216F

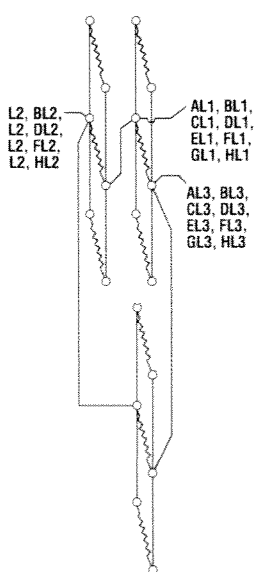
6 Circuits,
Circuit A, B, C, D, E, F,
12 Elements per Circuit, 72
Elements per Heater



Typical Circuit

ADHT-240F

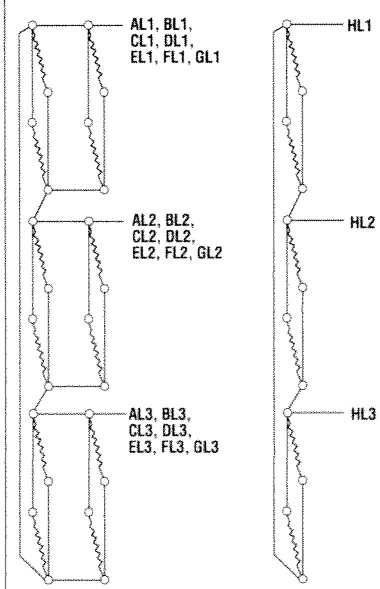
8 Circuits,
Circuit A, B, C, D, E, F, G, H,
9 Elements per Circuit, 72
Elements per Heater



Typical Circuit

ADH-270F

8 Circuits,
Circuits A, B, C, D, E, F, G,
12 Elements per Circuit, Circuit H,
6 Elements, 90 Elements per Heater

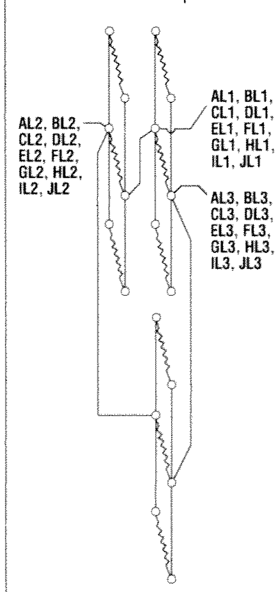


Circuit A - G

Circuit H

ADH-300F

10 Circuits,
Circuit A, B, C, D, E, F, G, H, I, J,
9 Elements per Circuit,
90 Elements per Heater



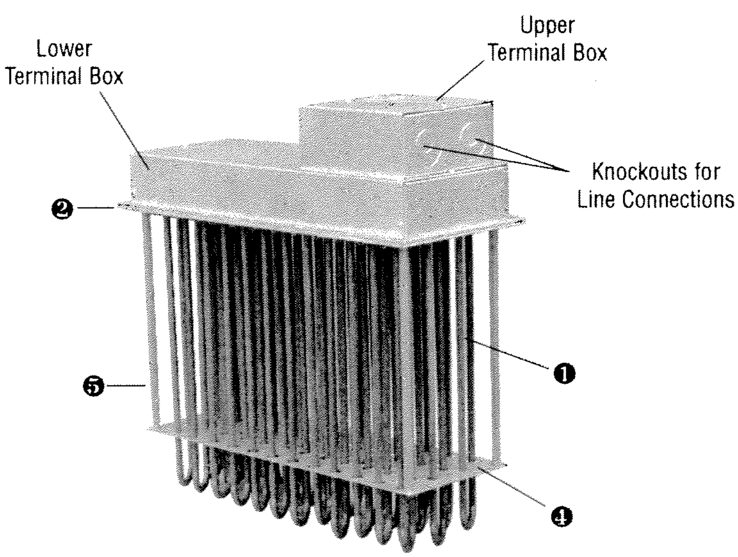
Typical Circuit

RENEWAL PARTS IDENTIFICATION — TYPE ADH

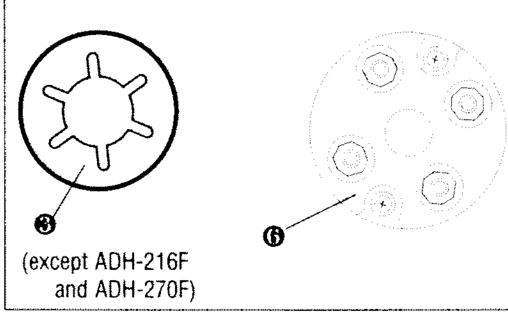
Model	❶ Individual Replacement Element	❷ Flange	❸ * Element Retaining Clip	❹ Element Spacer Plate	❺ Support Rod Spacers	❻ Terminal Block Assembly
ADH-005	393-055440-007 (3)	121-055367-001	272-511327-001 (6)	271-055370-001	242-055376-001 (4)	303-027852-001
ADH-010	393-055440-006 (6)	121-055367-002	272-511327-001 (12)	271-055370-002	242-055376-001 (4)	303-027852-001
ADH-015	393-055440-007 (9)	121-055367-003	272-511327-001 (18)	271-055370-003	242-055376-001 (4)	303-027852-001
ADH-020	393-055440-006 (12)	121-055367-004	272-511327-001 (24)	271-055370-004	242-055376-001 (4)	303-027852-001
ADH-025	393-055440-007 (15)	121-055367-005	272-511327-001 (30)	271-055370-005	242-055376-001 (4)	303-027852-001
ADH-030	393-055440-006 (18)	121-055367-006	272-511327-001 (36)	271-055370-006	242-055376-001 (4)	303-027852-001
ADH-035	393-055440-007 (21)	121-055367-007	272-511327-001 (42)	271-055370-007	242-055376-001 (4)	303-027852-001
ADH-040	393-055440-006 (24)	121-055367-008	272-511327-001 (48)	271-055370-008	242-055376-001 (4)	303-027852-001 (2)
ADH-045	393-055440-007 (27)	121-055367-009	272-511327-001 (54)	271-055370-009	242-055376-001 (4)	303-027852-001 (2)
ADH-050	393-055440-006 (30)	121-055367-010	272-511327-001 (60)	271-055370-010	242-055376-001 (4)	303-027852-001 (2)
ADH-060	393-055440-006 (36)	121-055367-011	272-511327-001 (72)	271-055370-011	242-055376-001 (4)	303-027852-001 (2)
ADH-080	393-055440-006 (48)	121-055367-013	272-511327-001 (96)	271-055370-013	242-055376-001 (5)	303-027852-001 (4)
ADH-090	393-055440-006 (54)	121-055367-014	272-511327-001 (108)	271-055370-014	242-055376-001 (6)	303-027852-001 (5)
ADH-100	393-055440-006 (60)	121-055367-015	272-511327-001 (120)	271-055370-015	242-055376-001 (6)	303-027852-001 (5)
ADH-144	393-055440-009 (48)	121-055367-013	272-511327-001 (96)	271-055370-013 (2)	242-055376-001 (10)	303-027852-001 (4)
ADH-162	393-055440-009 (54)	121-055367-014	272-511327-001 (108)	271-055370-014 (2)	242-055376-001 (12)	303-027852-001 (6)
ADH-216F	393-055440-171 (72)	121-055367-032		271-055370-866 (2)	242-055376-001 (12)	303-027852-001 (6)
ADH-270F	393-055440-171 (90)	121-055367-033		271-055370-867 (2)	242-055376-001 (12)	303-027852-001 (8)

NOTE: Number in parentheses ( ) indicates the quantity of that part required.
* Older heaters may have retaining channels instead of clips. Contact Factory for part number and quantity.

ADH Replacement Element Rating		
Part No.	**Volts**	**Watts**
393-055440-171 (w/ftgs)	480	3000
393-055440-006	240	1667
393-055440-007	480	1667
393-055440-009	480	3000



Other Parts Common to all Heaters

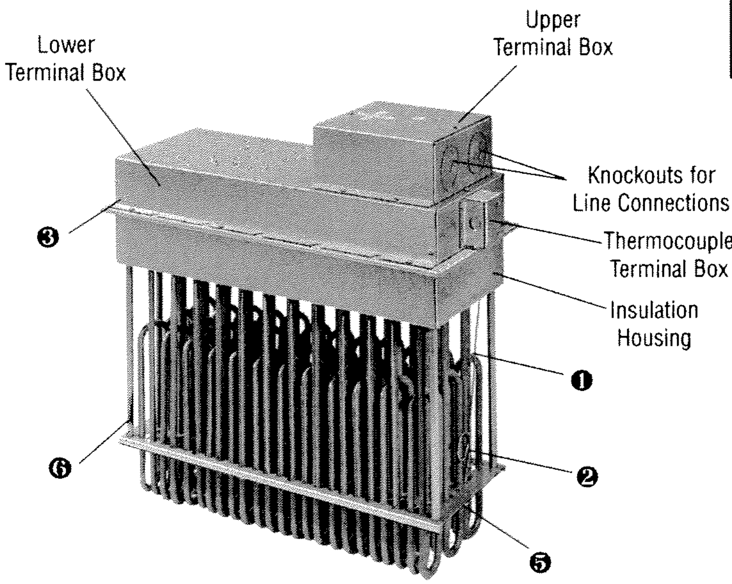


RENEWAL PARTS IDENTIFICATION — TYPE ADHT

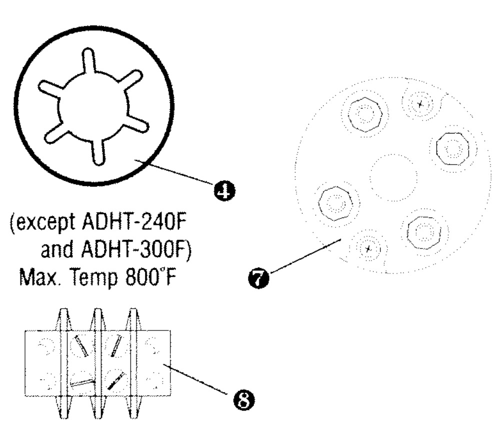
Model	1 Individual Replacement Element	2 Thermocouples	3 Flange	4 * Element Retaining Clip	5 Element Spacer Plate	6 Support Rod Spacers	7 Terminal Block Assembly	8 Thermocouple Terminal Block
ADHT-005	393-055441-007 (3)	309-122380-003	121-055367-001	272-511327-001 (6)	271-055370-016	242-055376-002 (4)	303-027852-001	303-122014-002
ADHT-010	393-055441-006 (6)	309-122380-003	121-055367-002	272-511327-001 (12)	271-055370-017	242-055376-002 (4)	303-027852-001	303-122014-002
ADHT-015	393-055441-007 (9)	309-122380-003	121-055367-003	272-511327-001 (18)	271-055370-018	242-055376-002 (4)	303-027852-001	303-122014-002
ADHT-020	393-055441-006 (12)	309-122380-003	121-055367-004	272-511327-001 (24)	271-055370-019	242-055376-002 (4)	303-027852-001	303-122014-002
ADHT-025	393-055441-007 (15)	309-122380-003	121-055367-005	272-511327-001 (30)	271-055370-020	242-055376-002 (4)	303-027852-001	303-122014-002
ADHT-030	393-055441-006 (18)	309-122380-003	121-055367-006	272-511327-001 (36)	271-055370-021	242-055376-002 (4)	303-027852-001	303-122014-002
ADHT-035	393-055441-007 (21)	309-122380-003	121-055367-007	272-511327-001 (42)	271-055370-022	242-055376-002 (4)	303-027852-001	303-122014-002
ADHT-040	393-055441-006 (24)	309-122380-003	121-055367-008	272-511327-001 (48)	271-055370-023	242-055376-002 (4)	303-027852-001 (2)	303-122014-002
ADHT-045	393-055441-007 (27)	309-122380-003	121-055367-009	272-511327-001 (54)	271-055370-024	242-055376-002 (4)	303-027852-001 (2)	303-122014-002
ADHT-050	393-055441-006 (30)	309-122380-003	121-055367-010	272-511327-001 (60)	271-055370-025	242-055376-002 (4)	303-027852-001 (2)	303-122014-002
ADHT-060	393-055441-006 (36)	309-122380-003	121-055367-011	272-511327-001 (72)	271-055370-026	242-055376-002 (4)	303-027852-001 (2)	303-122014-002
ADHT-080	393-055441-006 (48)	309-122380-003	121-055367-013	272-511327-001 (96)	271-055370-028	242-055376-002 (5)	303-027852-001 (4)	303-122014-002
ADHT-090	393-055441-006 (54)	309-122380-003	121-055367-014	272-511327-001 (108)	271-055370-029	242-055376-002 (6)	303-027852-001 (5)	303-122014-002
ADHT-100	393-055441-006 (60)	309-122380-003	121-055367-015	272-511327-001 (120)	271-055370-030	242-055376-002 (6)	303-027852-001 (5)	303-122014-002
ADHT-120	393-055441-009 (36)	309-122380-003	121-055367-011	272-511327-001 (72)	271-055370-026 (2)	242-055376-002 (8)	303-027852-001 (4)	303-122014-002
ADHT-160	393-055441-009 (48)	309-122380-003	121-055367-013	272-511327-001 (96)	271-055370-028 (2)	242-055376-002 (10)	303-027852-001 (8)	303-122014-002
ADHT-180	393-055441-009 (54)	309-122380-003	121-055367-014	272-511327-001 (108)	271-055370-029 (2)	242-055376-002 (12)	303-027852-001 (6)	303-122014-002
ADHT-240F	393-055441-159 (72)	309-122380-003	121-055367-032		271-055370-833 (2)	242-055376-002 (12)	303-027852-001 (8)	303-122014-002
ADHT-300F	393-055441-159 (90)	309-122380-003	121-055367-033		271-055370-834 (2)	242-055376-002 (12)	303-027852-001 (10)	303-122014-002

NOTE: Number in Parentheses ( ) indicates the quantity of that part required.
* Older heaters may have retaining channels instead of clips. Contact Factory for part number and quantity.

ADHT Replacement Element Rating		
Part No.	**Volts**	**Watts**
393-055441-159 (w/ftgs)	480	3333
393-055441-006	240	1667
393-055441-007	480	1667
393-055441-009	480	3333



Other Parts Common to all Heaters



Chromalox®
PRECISION HEAT AND CONTROL
2150 N. RULON WHITE BLVD., OGDEN, UT 84404
Phone: 1-800-368-2493 www.chromalox.com

TA - W4 - EF
Litho in U.S.A.

D-9
Bag Filters

WARNING-SAFETY INFORMATION

1.) The housings in this catalog, if improperly used, can cause serious injury or death.

2.) Always wear proper protective clothing for the liquid being filtered. Check your M.S.D.S. for any instructions or suggestions.

3.) Do not run housing in excess of the rated pressure or temperature found on the housing tank label. (See warning #1)

4.) Check chemical compatibility of selected o-ring and housing material before housing installation.

5.) Do not open a housing when the system is under pressure; always relieve all pressure through housing before opening of housing lid.

6.) Stop all flow of liquid *before opening of lid*.

7.) Bolt housing to floor, as tipping may occur when lid is opened.

OPERATING INSTRUCTIONS

MULTI-ROUND LIQUID BAG MODELS

Do not operate over 150 PSI working pressure

MODEL **1818**: maximum flow rate of **400** gallons per minute

MODEL **2224**: maximum flow rate of **600** gallons per minute

MODEL **2424**: maximum flow rate of **800** gallons per minute

MODEL **3030**: maximum flow rate of **1200** gallons per minute

MODEL **3636**: maximum flow rate of **1600** gallons per minute

MODEL **4242**: maximum flow rate of **2000** gallons per minute

MODEL **4848**: maximum flow rate of **3500** gallons per minute

READ THE WARNING/SAFETY INFORMATION ON BACK BEFORE PROCEEDING

The housing you have purchased is manufactured with the highest quality materials and with the greatest pride to offer you a superior in-line housing for industrial applications.

If there is any damage to the housing or element, a **CLAIM MUST BE FILED WITH THE FREIGHT CARRIER.** SHIPPER WILL NOT ACCEPT RETURNS WITHOUT PRIOR AUTHORIZATION, UNAUTHORIZED SHIPMENTS WILL BE REFUSED.

A. RECEIVING INSTRUCTIONS

1. Uncrate the housing(s) and discard any shipping materials.
2. Place housing in the desired location on a flat surface, securing the four support legs to the base.

B. INSTALLATION INSTRUCTIONS

flow to the housing should be turned off

1. Place housing on pipe connections:
   a. **N.P.T. / Coupling style** - Krystil Klear does not recommend using any type of liquid sealant due to contamination of the pipe that may occur.
   b. **Flange style** - put a small amount of clean, heavy oil on one side of the gaskets, place oiled side down onto existing flanges to hold gaskets.
2. Please note the labeling of the inlet and outlet connections for proper installation. Tighten housing with proper tension to seal housing on existing pipe or flange. Note: housing has been factory pressure tested to assure a leak proof vessel. If leaking occurs, check for improper connections.
3. Remove lid from housing by turning eye nuts until loosened and swing them down. Using the Lid Lift Handle, swing the lid until full view of the inner housing area is gained.
4. Check inner housing and pipe connections for foreign material and discard any items that have entered during shipping or unpacking.
5. Make sure that the strainer baskets are pushed fully into housing grooves. If using a filter bag, seat bag fully into strainer basket to assure a leak-proof seal between bag and basket. For best results, bag should be fully extended into the basket.
6. Close lid and alternately tighten the eye nuts until lid is fully seated onto the O-Ring gasket.
7. Housing is now ready for start-up.

C. START-UP OF HOUSING

1. Loosen vent plug to allow air to escape from housing
   Slowly open the inlet to gradually fill the housing body.
2. When housing body is full (liquid escapes from top vent), close the vent.
3. Open the outlet connection and fully open the inlet connection.
   Housing is now operating properly.

D. REMOVAL OF SPENT ELEMENT:

1. When the housing reaches your pre-determined differential pressure, stop flow to the housing and relieve housing pressure through housing drain. Remove enough liquid to show top of basket flange.
2. Loosen eye nuts on housing and, using the Lid Lift Handle, swing the lid to gain full access to the inside of housing.
3. If using a liquid bag, pull the element out of basket and discard the element in accordance with any required local and federal laws.
4. Remove filter baskets and clean thoroughly.
5. Housing debris and sludge should be removed to prolong filter efficiencies.
6. Replace filter baskets and bags into housing as noted in B-5 thru C-3 above.

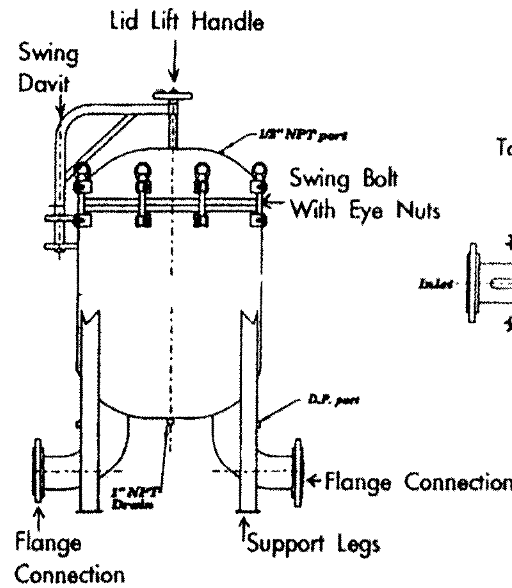
E. RECOMMENDED MAINTENANCE

Periodic checks should be made on all housing lid and basket o-rings to ensure no cuts or damage has incurred that would cause the housing not to seal. If housing parts become damaged or worn, replace immediately

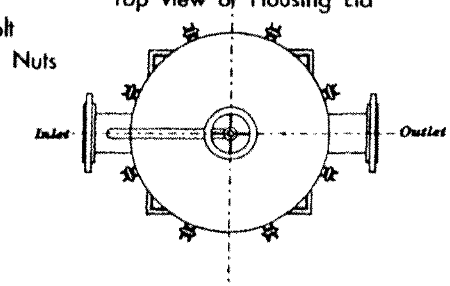
PART NUMBER	DESCRIPTION
* LB	Buna Lid O-ring
88BB	Buna Basket O-ring
LLHM	Lid Lift Handle
ENM	Eye Nut
REM	Rod End
CBAM	Clevis Bolt Assembly
PER APPLICATION **	Filter Bags
PER APPLICATION **	Filter Basket

* insert first two digits of housing model # (18, 22, 24, 30, 36, 42 or 48)

** Full line of replacement bags and baskets available



Top view of Housing Lid



D-10

Liquid-phase Granulated Activated Carbon Unit

OPERATION AND MAINTENANCE MANUAL LIQUID PHASE CARBON ADSORPTION SYSTEM

Naval Weapons Industrial Reserve Plant GM38 Area

Bethpage, NY

TIGG Corporation
1Willow Ave
Oakdale, PA 15071
Ph: (724)703-3020
Fax: (724)703-3026

December 2008

1.0 INTRODUCTION

The following sections discuss the design, process conditions and recommended operating procedures for a ***Liquid Phase Carbon Adsorption System***. This system was fabricated for Tetra Tech EC, Inc and will be located at the Naval Weapons Industrial Reserve Plant GM-38 Area Ground water remediation site in Bethpage, NY.

The system utilizes granular activated carbon for the adsorption of volatile and semi-volatile organic compounds in a polishing mode from the groundwater following an air stripper. The system was designed with a total of three carbon adsorption vessels. It is intended that most of the time two vessels will treat the water in a parallel operational mode with one vessel in standby. When a vessel becomes spent, the third vessel will be brought into service allowing the other two vessels time to be serviced. The system with three vessels as supplied, offers many operational modes which can be seen in Chart #1.

Scope of Supply

TIGG CORPORATION is supplying three, 8' diameter x 7.33' long straight side carbon adsorption vessels. These vessels are designed and constructed in accordance with ASME section VIII Division I with a pressure rating of 100 psi. Vessels are not ASME Code stamped. Each vessel was hydrostatically tested at 130 psi. See section 2 System drawings C08-1218 for a drawing of the vessel.

Vessels are lined with Sherwin-Williams DuraPlate DP235 NSF epoxy per the manufacturers specified installation recommendations. Each vessel was tested for pinhole free lining. Exterior of the vessels are painted with a Sherwin-Williams KemKromic primer and Urethane top coat providing exceptional protection and shine.

The underdrain system is fabricated out of PVC pipe and slotted PVC laterals. An internal PVC inlet distributor is supplied in each vessel to help promote plug flow. See drawing C08-1220 in section 2.0.
A piping skid was supplied with a total of four customer hookup points. These points are Inlet Water, Treated water, Inlet Backwash and Effluent backwash. It is the responsibility of others to hook up the piping past the flanged pipe rack supplied. A total system assembly can be seen in section 2 drawing C08-1217. Other than the process piping supplied on the referenced drawing, a carbon steel vent pipe/pressure relief rupture disk has been supplied on each vessel and a 3" carbon discharge pipe is supplied for a slurry discharge if required.

A tie-in point for utility water connection (2") via a Cam-Lok fitting on the vent pipe can be used for carbon slurry water supply is provided. Also, a compressed air connection (1") for the purposes of aiding carbon transfers is provided on the vent line. The compressed air connection has a brass ball valve and Cam-Lok fitting for hose coupling. See drawing C08-1233 for the vent line assembly.

The pressure relief system on each vessel consists of a 2" graphite rupture disk designed for 100 psig working pressure. The discharge from the rupture disk terminates in a Cam-Lok fitting for a hose connection. One spare rupture disk is provided with the system.

Each carbon vessel contains 8,000 lbs of TIGG 5D 08x30 Activated Carbon for the removal and treatment of organic compounds.

1.1.1 Installation Requirements

The installation contractor shall be responsible for off loading of the vessels (see Section 8), setting the vessels on a concrete foundation appropriately constructed for the weight of the vessels, installation of the anchor bolts, setting the vessels in place, and bolting the vessels to the anchors.

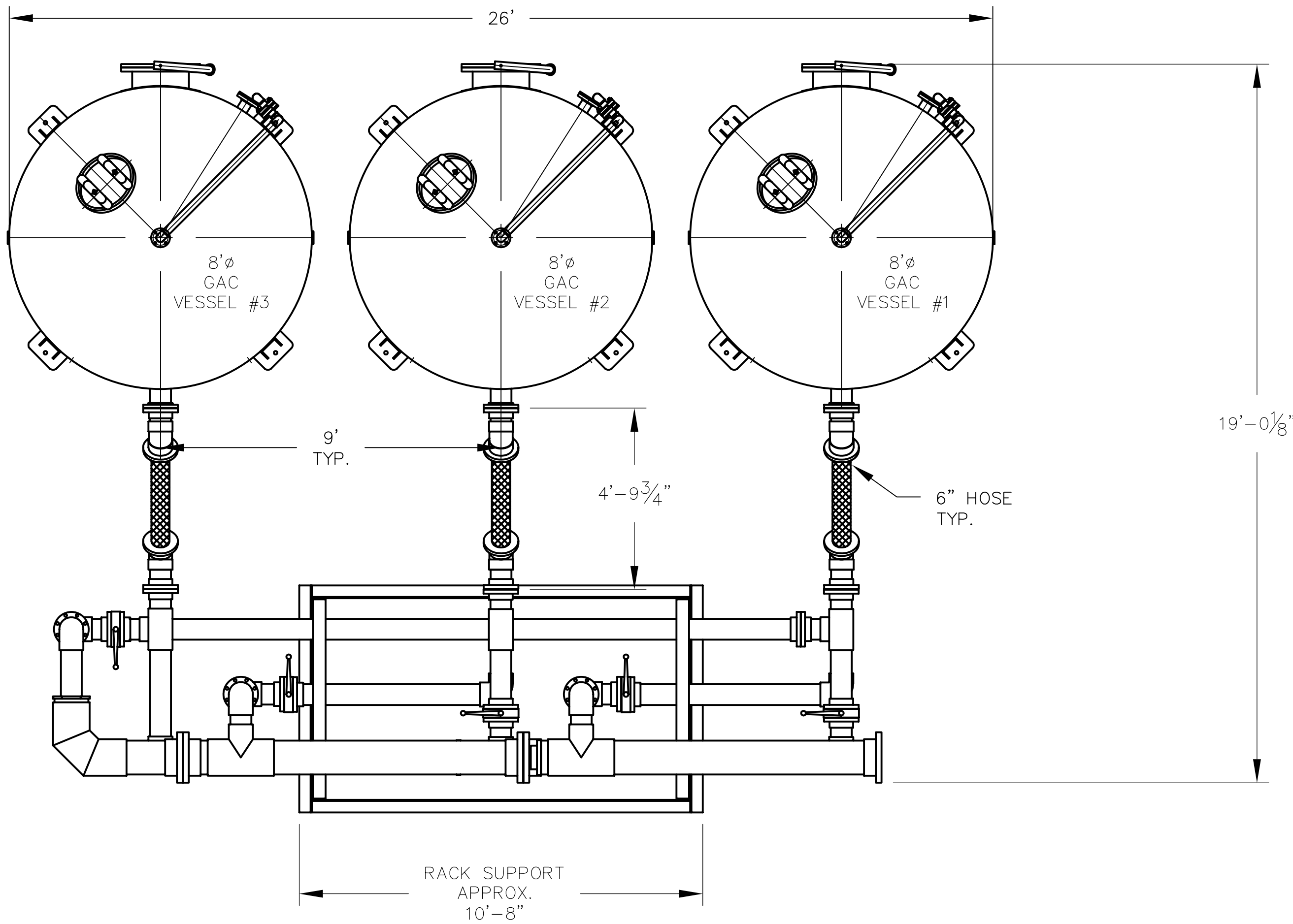
In addition, the contractor shall supply and install the influent supply, effluent discharge, backwash supply, and backwash discharge piping to the vessels.

Utility piping to be provided includes, uncontaminated water @ 100 gpm and 30 psig for hydraulic carbon transfer; uncontaminated water @ 625 gpm and 30 psig for a period of 15 minutes for backwash.

The Groundwater Treatment Plant shall have the capability of managing 9000 gallons of backwash water per event and 4000 gallons of slurry transfer water generated during carbon transfer operations.

The installation contractor is responsible for loading the initial 8,000 pounds of carbon charge into each vessel (see Section 4.2.1 for instructions for carbon filling).

2.0 **SYSTEM DRAWINGS**



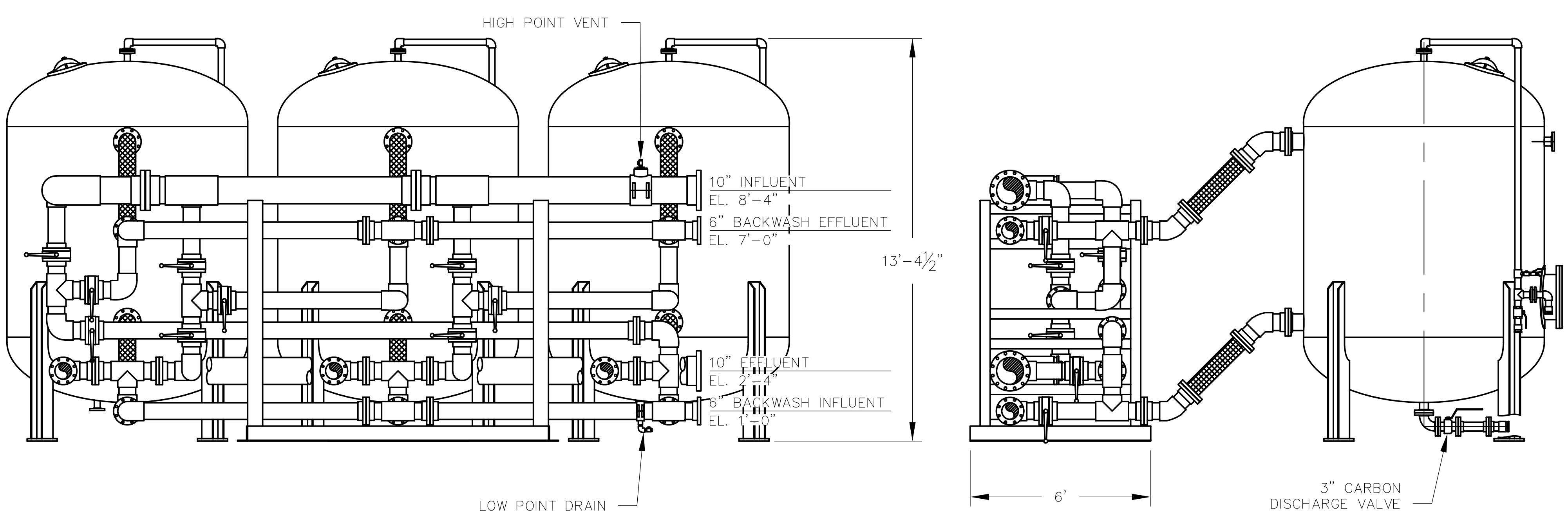
*NOTE:

PIPING M.O.C. SCH 80 PVC

PROCESS VALVES ON PIPE RACK ARE BUTTERFLY TYPE,

10" EFFLUENT HEADER SHOWN WITH SECTIONS REMOVED

FOR CLERITY.



FOR CUSTOMER APPROVAL

NO.	REVISION	BY	DATE
A	REVISE LAYOUT WITH CURRENT RACK	JB	7/15/08

PROJECT

TERTRA TECH

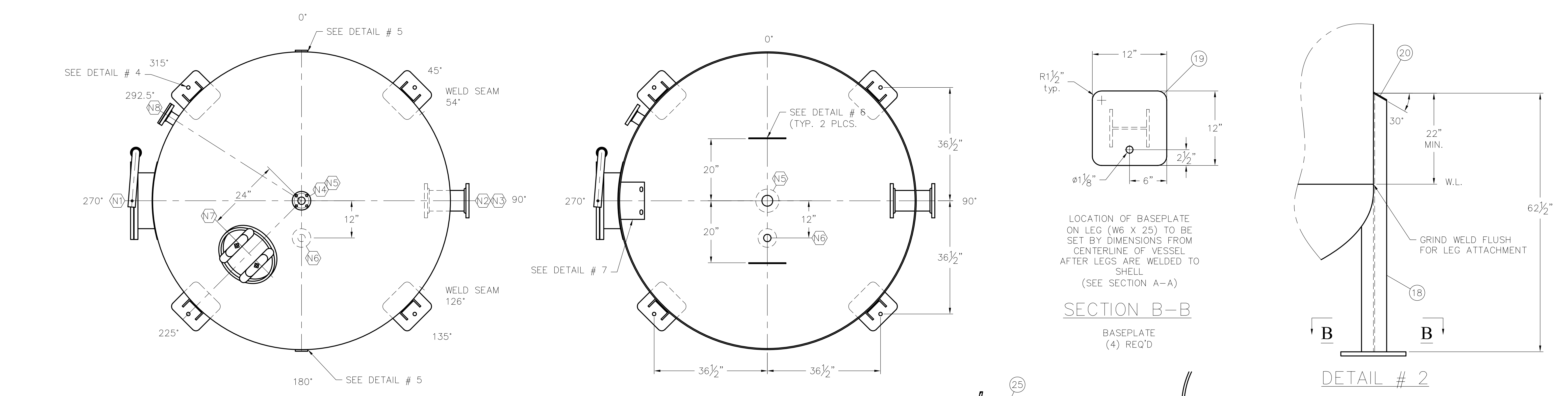
PROJ. NO.	CS GROU080205
P.O. NO.	

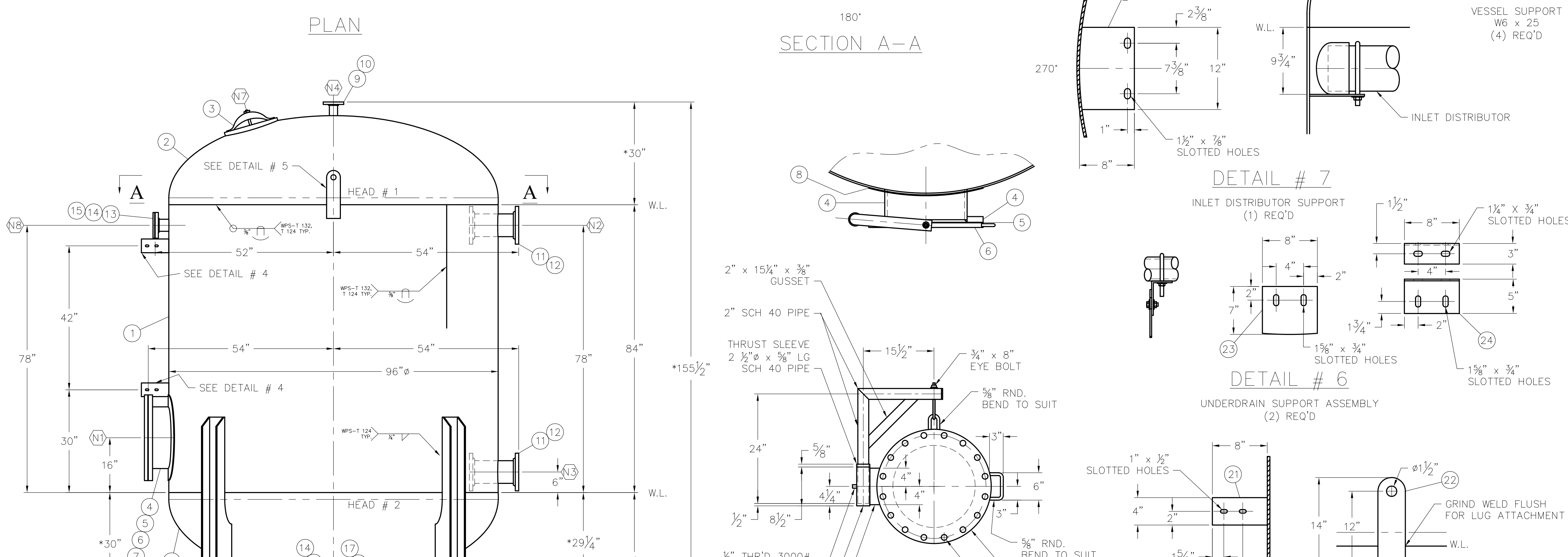
DRAWN BY	JB
DESIGN BY	BB
CHKD. BY	BB
DATE	6/20/08
SCALE	NTS

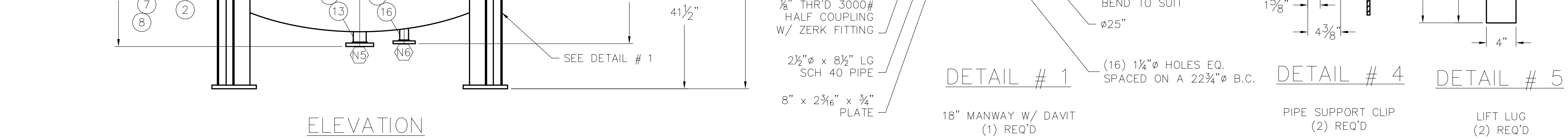
TIGG corporation

SYSTEM LAYOUT

DWG. NO. C08-1217 REV. A







DESIGN CODE AND CONDITIONS:
CODE: N/A EDITION: N/A ADDENDA: N/A
RADIOGRAPHY: NONE
PWHT: NONE
INTERIOR FINISH: DP 235
EXTERIOR FINISH: ALKYD PRIMER W/ URETHANE TOP COAT
VOLUME: 495 FT^3 FLUID: H_2O
WEIGHT: DRY 5336 LBS AIR PRESSURE TEST: N/A LBS
MAWP: 100 PSI AT 125°F
MDMT: 0°F AT 100 PSI
TEST PRESSURE: 130 PSI WITH: H_2O FOR 20 MIN. MINIMUM
CORROSION ALLOWANCE: 0"

GENERAL NOTES:

CONSTRUCTION:

ALL WELDS SHALL BE NEAT IN APPEARANCE, FREE OF SLAG AND OTHER DEFECTS.
VESSEL SHALL BE CLEANED OF SCALE, OIL, WELD SPATTER AND ALL OTHER FOREIGN MATTER BEFORE HYDROSTATIC TESTING.
REMOVE ALL SHARP EDGES ON NOZZLES – ⅛" RADIUS MIN.
FLANGES SHALL STRADDLE CENTERLINES

TOLERANCE: +⅛" −⅛"
PERMISSIBLE OUT OF ROUNDNESS OF CYLINDRICAL AND CONICAL SHELLS SHALL NOT EXCEED 1% OF THE NOMINAL DIAMETER. THIS TOLERANCE SHALL BE INCREASED TO 2% WHEN THE CROSS SECTION PASSES THROUGH OR WITHIN 1 ID OF OF A FITTING.
MAXIMUM MISALIGNMENT OF BUTT JOINTS IS LIMITED TO: CATEGORY A,B,C OR D UP TO ½" THICK – ¼"
HEAD TO SHELL WELD IS CATEGORY B

ITEM	QTY.	DESCRIPTION	MATERIAL
25	1	INLET DISTRIBUTOR SUPPORT 8"x7"x¼"	304 S.S.
24	2	SUPPORT ADJUSTER 8"x8"x¼"	304 S.S.
23	2	UNDERDRAIN SUPPORT 8"x7"x¼"	304 S.S.
22	2	LIFT LUG 14"x4"x½"	SA-36
21	2	PIPE SUPPORT CLIP 8"x4"x¼"	SA-36
20	2	LEG CAP 6⅜" x 3¾" x ¼"	SA-36
19	2	BASE PLATE- 12"x 12" x 1"	SA-36
18	4	LEG – W6 x 25 (62½" LONG)	SA-36
17	1	2" 150# FFSO FLANGE	SA-105
16	1	2" SCH 40 PIPE	SA-106-B
15	1	3" FABRICATED FLANGE ½" tk.	SA-516-70
14	2	3" 150# FFSO FLANGE	SA-105
13	2	3" SCH 40 PIPE	SA-106-B
12	4	6" 150# FFSO FLANGE	SA-105
11	2	6" SCH 40 PIPE	SA-106-B
10	1	2" 150# LAP JOINT FLANGE	SA-105
9	1	2" SCH 40 PIPE	SA-234-WPB
8	1	25"ø x ⅛" tk. GASKET	NEOPRENE
7	1	25"ø x ³⁄₁₆" tk. RE-PAD	SA-516-70
6	1	18"ø x 1" tk. FABRICATED BLND. FLANGE	SA-516-70
5	1	18"ø x 1¼" tk. FABRICATED FLANGE	SA-516-70
4	1	18"ø SCH 40 PIPE	SA-106-B
3	1	18"x14"x¾"x3" ELL. MANWAY	SA-675-70
2	2	96"ø x ⅜" x 2" S.F. 2:1 ELL. HEAD	SA-516-70
1	1	96"ø x 84" x ⅜" SHELL	SA-516-70

BILL OF MATERIALS

MARK	SERVICE	DESCRIPTION	LOCATION
N8	CARBON IN	3" FLANGE	SHELL
N7	MANWAY	14" x 18" ELL. MANWAY	HEAD # 2
N6	DRAIN	2" FLANGE	HEAD # 1
N5	CARBON OUT	3" FLANGE	HEAD # 1
N4	VENT	2" FLANGE	HEAD # 2
N3	OUTLET	6" FLANGE	SHELL
N2	INLET	6" FLANGE	SHELL
N1	MANWAY	18" FLANGE	SHELL

NOZZLE SCHEDULE

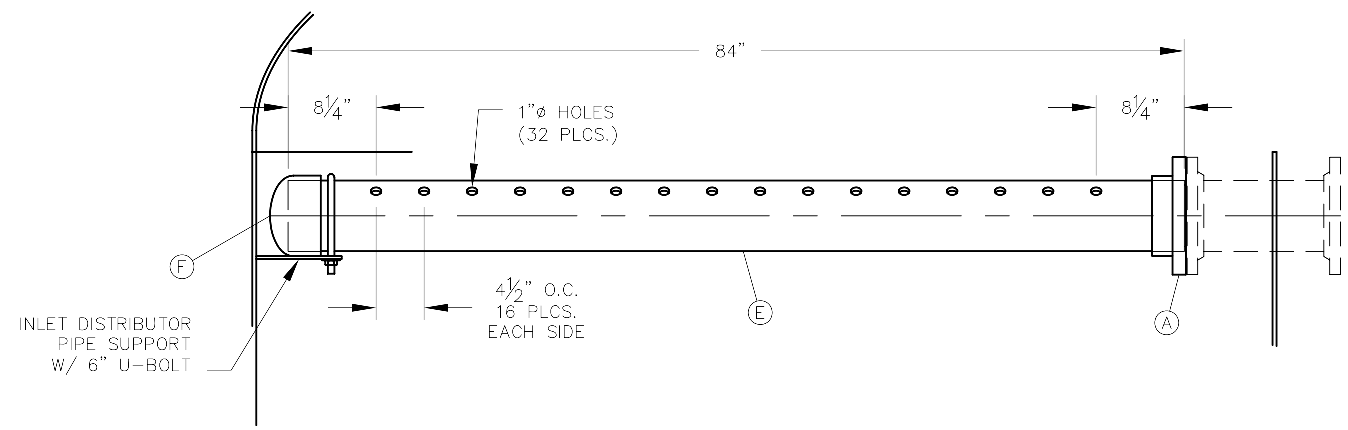
NO.	REVISION	BY	DATE
1	REMOVE BASE	JB	7/7/08

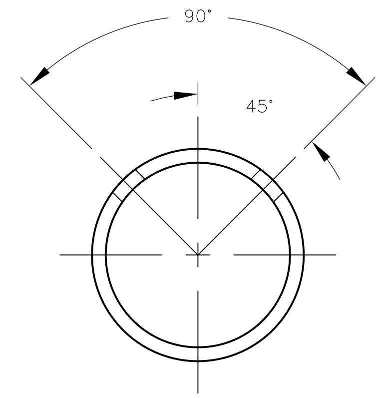
PROJECT	TETRA TECH
PROJ. NO.	CS GROU080205
P.O. NO.	
DRAWN BY	JB
DESIGN BY	BB
CHKD. BY	BB
DATE	6/25/08
SCALE	NTS

TIGG corporation

VESSEL FABRICATION

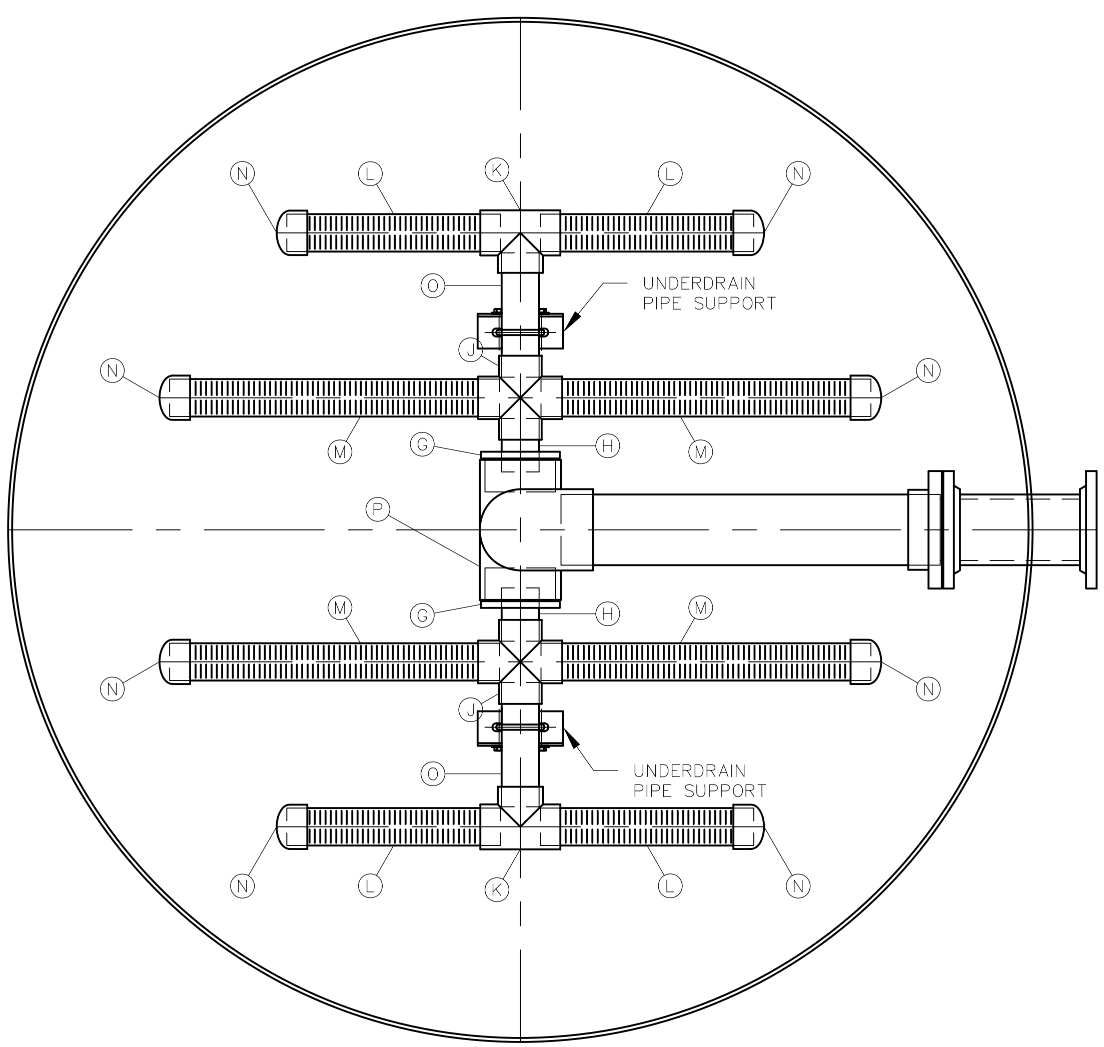
DWG. NO. C08-1218 REV. 1



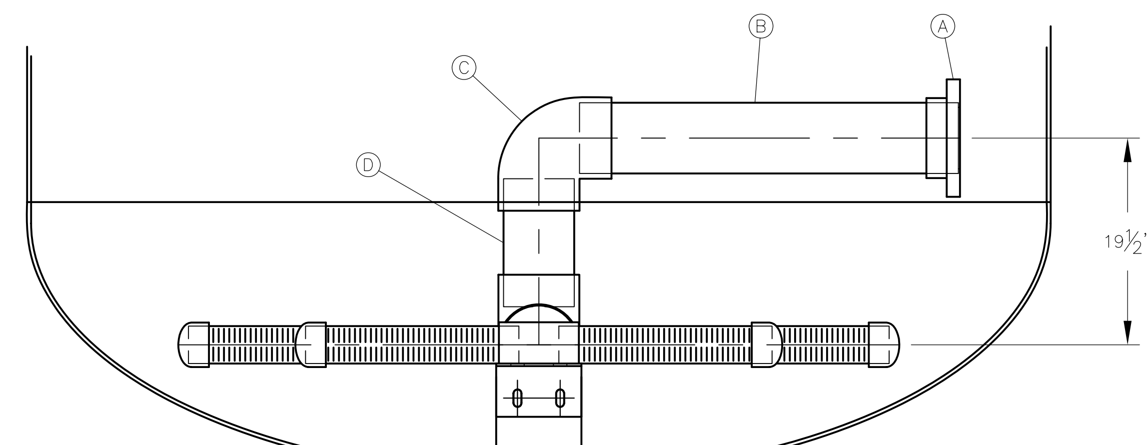


BILL OF MATERIALS

	PART	SIZE	MATERIAL	SCH.	QTY.
A	FLANGE (SOC) VAN STONE STYLE	6"	PVC	150#	2
B	PIPE (APPROX. 35½" LONG)	6"	PVC	80	1
C	90° ELBOW (SOC)	6"	PVC	80	1
D	PIPE (APPROX. 12" LONG)	6"	PVC	80	1
E	PIPE (APPROX. 84" LONG)	6"	PVC	80	1
F	CAP	6"	PVC	80	1
G	RED. BUSH. (SPIG X SOC)	6" X 3"	PVC	80	2
H	PIPE (APPROX. 5" LONG)	3"	PVC	80	2
J	CROSS (SOC)	3"	PVC	40	2
K	TEE (SOC)	3"	PVC	80	2
L	0.010" SLOTTED PIPE (APPROX 20" LONG)	3"	PVC	40	4
M	0.010" SLOTTED PIPE (APPROX 31" LONG)	3"	PVC	40	4
N	END CAP (SOC)	3"	PVC	40	8
O	PIPE (APPROX. 11¾" LONG)	3"	PVC	80	2
P	TEE (SOC)	6"	PVC	80	2
	GASKET	6"	NEOPRENE		2
	BOLT SET (4½" LONG)	¾"	GALV.		16



N2–INTERNAL PLAN VIEW



N2–INTERNAL ELEVATION VIEW

NO.	REVISION	BY	DATE
1	REVISED TO SHOW 6" TEE IN B.O.M.	JB	7/24/08

PROJECT

TETRA TECH

PROJ. NO. CS GROU080205

P.O. NO.

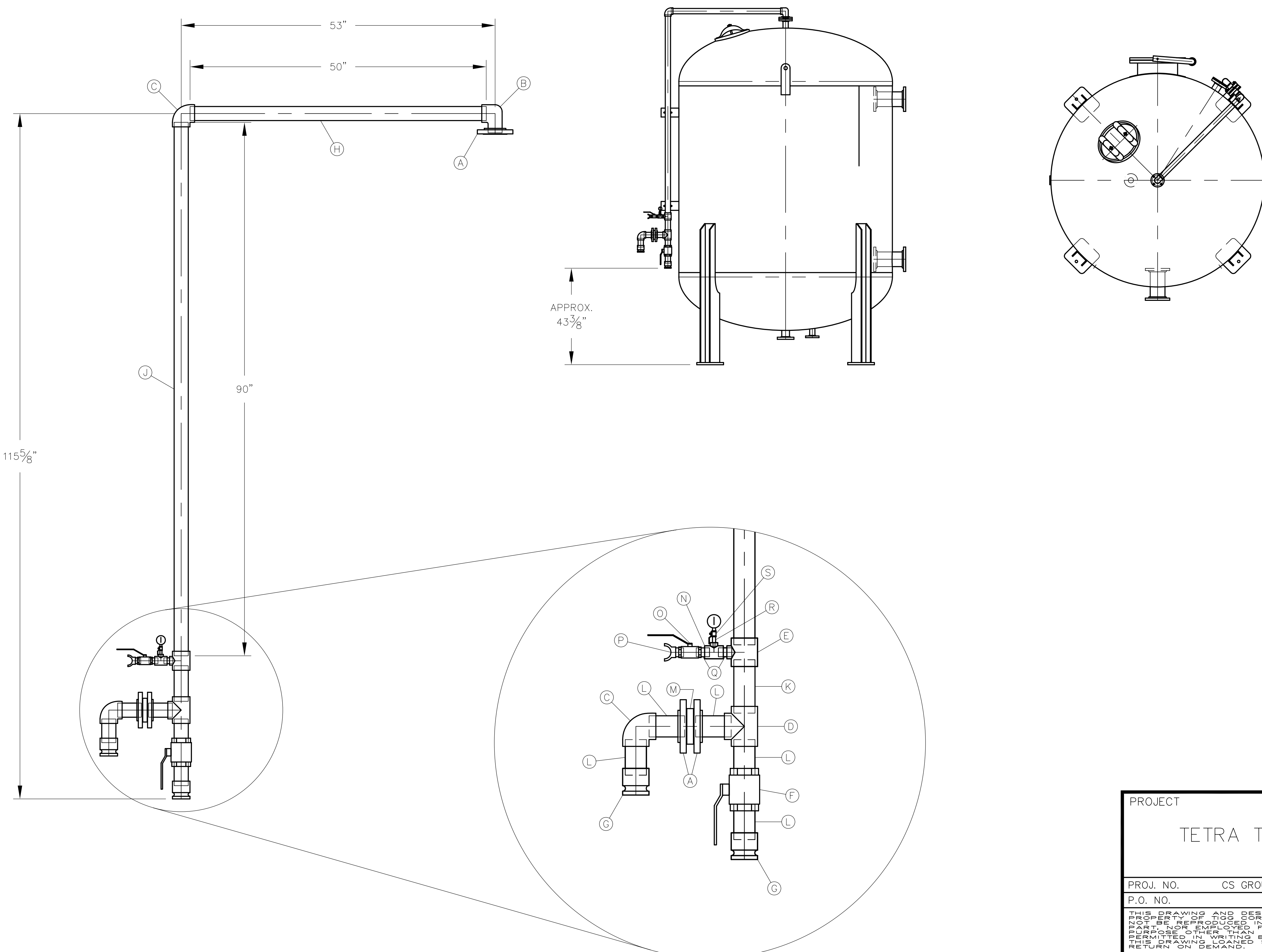
DRAWN BY	JB
DESIGN BY	BB
CHKD. BY	BB
DATE	6/26/08
SCALE	NTS

TIGG corporation

INTERNALS

DWG. NO. C08–1220

REV. 1



T	1	PRESSURE GAUGE (75 PSI)	
S	1	¼" BALL VALVE	BRASS
R	1	¼" NIPPLE T.B.E. (⅞" LONG)	BCS
Q	2	¾" NIPPLE T.B.E. (1½" LONG)	BCS
P	1	¾" CHICAGO AIR FITTING	BCS
O	1	¾" BALL VALVE	BRASS
N	1	¾" X ¾" X ¼" RED. TEE (FNPT)	BCS
M	1	2" RUPTURE DISK (75 PSI)	GRAPHITE
L	5	2" NIPPLE T.B.E. (4" LONG)	BCS
K	1	2" NIPPLE T.B.E. (6" LONG)	BCS
J	1	2" SCH 40 PIPE (90" LONG)	BCS
H	1	2" SCH 40 PIPE (50" LONG)	BCS
G	2	2" MALE CAMLOCK FITTING	ALUMINIUM
F	1	2" BALL VALVE	BRASS
E	1	2" x 2" x ¾" RED. TEE (FNPT)	BCS
D	1	2" TEE (FNPT)	BCS
C	2	2" 90° ELBOW (FNPT)	BCS
B	1	2" 90° STREET ELBOW	BCS
A	3	2" THREADED FLANGE	BCS
ITEM	QTY.	DESCRIPTION	MATERIAL

BILL OF MATERIALS

NO.	REVISION	BY	DATE

PROJECT

TETRA TECH

PROJ. NO. CS GROU080205

P.O. NO.

DRAWN BY	JB
DESIGN BY	BB
CHKD. BY	BB
DATE	7/15/08
SCALE	NTS

TIGG corporation

VENT ASSEMBLY

DWG. NO. C08-1233

REV. 0

TABLE 2.1
LIQUID PHASE CARBON ADSORPTION SYSTEM VALVES

Valve Number	SERIES 1-2	SERIES 1-2 BW-3	SERIES 2-3	SERIES 2-3 BW-1	SERIES 3-1	SERIES 3-1 BW-2	PARALLEL 1,2	PARALLEL 2,3	PARALLEL 1,2,3	PARALLEL 1,2 BW 3	PARALLEL 2,3 BW 1	PARALLEL 1,3 BW 2
V-1	C	C	C	O	C	C	C	C	C	C	O	C
V-2	C	C	C	C	C	O	C	C	C	C	C	O
V-3	C	O	C	C	C	C	C	C	C	O	C	C
V-4	C	C	C	O	C	C	C	C	C	C	O	C
V-5	C	C	C	C	C	O	C	C	C	C	C	O
V-6	C	O	C	C	C	C	C	C	C	O	C	C
V-7	O	O	C	C	C	C	O	C	O	O	C	O
V-8	C	C	O	O	C	C	O	O	O	O	O	C
V-9	C	C	C	C	O	O	C	O	O	C	O	O
V-10	O	O	C	C	O	O	O	C	O	O	C	O
V-11	O	O	O	O	C	C	O	O	O	O	O	C
V-12	C	C	O	O	O	O	C	O	O	C	O	O
V-13	C	C	C	C	O	O	C	C	C	C	C	C
V-14	O	O	C	C	C	C	C	C	C	C	C	C
V-15	C	C	O	O	C	C	C	C	C	C	C	C
V-16	C	C	C	C	O	O	O	C	O	O	C	O
V-17	O	O	C	C	C	C	O	O	O	O	O	C
V-18	C	C	O	O	C	C	C	O	O	C	O	O

3.1 Design Basis

The design basis for this operation is as follows:

Influent type	Air Stripper Ground water
Flow rate	1100 gpm average
	1400 gpm maximum
Temperature	75°F maximum
	33°F minimum
Pressure	100 psig
Carbon fill	8,000 lbs per vessel
Superficial contact time	6.5 *min @ 1100 gpm*
Backwash rate	500 - 600gpm
Contaminants	4 ppb TCE influent water

3.2 Carbon Vessel

Vessel Nomenclature	GAC1, GAC2, GAC3
Outer Diameter	96 in
Straight Side	88 in
Design Pressure	100 psig
Design Temperature	33-75° F
Material	SA 516-70 Carbon Steel
Lining	Sherwin Williams DP235 two coats
Exterior Paint	Sherwin Williams Kemkromik Primer followed by Sherwin Williams Shurthane top coat.
Approximate Weight	5400 *lbs empty; 55,000 lbs full (carbon and water)*

3.3 Piping

Piping associated with the carbon vessels is constructed with Sch 80 PVC materials. TIGG drawing C08-1217 (see Section 2.0) depicts the external pipe provided with the carbon vessels.

3.4 Valves - Process

Asahi Pool PRO butterfly valves with manual hand lever operator are provided.

3.5 Gaskets

Flange gaskets are EPDM rubber 1/8"tk per ANSI bolt pattern.

3.6 Underdrains

A header lateral underdrain system has been provided for this application. It is constructed of PVC pipe and slotted .010 PVC laterals.

3.7 Rupture Disk

Rupture disks on the carbon vessels are 2" graphite disks with a burst pressure rating of 100psi. They are referenced on DWG C08-1233.

3.7 Hose Adapters

Hose adapters on the carbon discharge, drain, carbon fill, and city water pipelines are PT Coupling Co. "Part A" 316 SS Cam-Lok style adapters.

Spare parts that may be required include rupture discs, underdrain laterals, pressure gages, valves and strainers if required. These parts are shown in Appendix and may be ordered through TIGG

Corporation

4.0 PROCESS DESCRIPTION AND OPERATING PROCEDURES

The carbon adsorption system provided by TIGG Corporation consists of three vessels (GAC 1-3) and a PVC pipe rack shown in the drawing section 2. This system was design as a polishing carbon treatment system where the maximum flow would be 1400 GPM and 1100 GPM normal operating conditions. When running maximum flow, three vessels must be run in parallel to achieve good organic compound removal. Each vessel is rated for 500 gpm maximum flow so if it is desired to run two units and leave the remaining unit in standby, the total flow should be reduced to less than 1000 gpm.
The mode and valve operation on this versatile pipe system can be seen on the valve sequencing Table 2.1. The system can be use in series mode with reduced flows and the series flow is always forward. Such as: Vessel 1 to 2 or 2 to3 or 3 to 1.

4.1 Mode of Operation

Please refer to section 4.0 and Table 2.1.

4.2 STARTUP PROCEDURES

The following steps outline the procedures to follow prior to placing the vessels in service. Table 2.1 identifies the valve number and function description for the valves associated with each GAC vessel.

4.2.1 Initial Carbon Fill

Initially, carbon will be loaded into the vessels via,"dry fill" method by the on site contractor. The contractor will fill the vessel with water as prescribed below (approximately 1000 gallons) and then allow carbon to flow out of 1000 lbs super sacks into the vessel until the initial 8000 lbs of carbon is loaded. This will allow the contractor to initially set the vessels and fill the carbon prior to any piping being installed. Deaerating and prewetting will follow and is described step in 4.2.3. Following final assembly prior to the startup of processing contaminated water this step is required.

Subsequent carbon exchanges following the initial fill will be done in this same manner:
In order to protect the liquid collector (under drain) system, ***uncontaminated water must be added to the vessel prior to adding the carbon***. A sufficient amount of water should be added such that the water level is at least 2 feet above the collector, or approximately 1,000 gallons. Water can be added through the 2" vent line connection on side of the carbon adsorber or by opening the top manway and letting a hose drape over for filling. When adding city or clean uncontaminated water, all valves shall remain closed except for the vent valve and the compressed air valve (1").

Fresh carbon will arrive in bulk 1100 or 1000 lbs supersaks.

It is essential that two actions be taken prior to placing an adsorber online. They are:

1) The carbon particles have been classified/segregated (Section 4.2.2); and,

2) All of the air has been removed from the carbon pores (Section 4.2.3).

If these steps are not completed, premature breakthrough of the organics can occur and thus there may be poor utilization of the carbon.

4.2.2 Backwashing to Segregate the Carbon

The carbon should always be segregated in each bed prior to the adsorbers being placed on-line. This is important so that the carbon particles will always return to their same relative position in the bed after each backwashing operation. If the bed is not segregated, the carbon particles will change position and the adsorption zone (where adsorption is occurring) will be disturbed. This results in poor utilization of the carbon and early breakthrough of organics.

Initial backwashing should be performed at a rate of 10 to 12 gpm/ft^2 or 500-600 gpm for 15 to 20 minutes. ***Uncontaminated*** water is preferred for this and all subsequent backwashing operations.

Backwashing of each vessel is accomplished by isolating the vessel to be backwashed. To isolate the vessel, close the treated water effluent valves and the influent valves. Once the vessel has been isolated the vessel can be backwashed. To initiate backwash, open the backwash discharge valve for the adsorber to be backwashed, (see Table 2.1). Start the back wash pump and open the backwash supply valve for the adsorber to be backwashed.

After backwashing is complete, close the backwash supply valve, shut down the pump and close the backwash discharge valve.

Subsequent to backwashing, the system is ready to be deaerated/prewetted as described in the following section.

4.2.3 Deaerating / Prewetting

As discussed previously, it is necessary to ensure that the carbon bed is properly deaerated prior to placing the unit in service. This is required to ensure proper flow though the bed to eliminate channeling, reduce pressure drop, and prevent premature breakthrough.

A bed of carbon consists of the following:

Void volume	-	40%
Pore volume	-	40%
Carbon skeleton	-	20%

A relatively long time is required for water to enter the pores and displace the air since the pores in dry carbon are filled with air and some adsorbed oxygen. Approximately 90% of the pores may be filled with water after 24 hours at ambient temperature (70° F).

In order to have the carbon pre-wetted, the adsorber should remain filled with water for at least 24-48 hours with the 2” vent line valve open. Having this valve open will permit trapped air to escape. After the carbon is pre-wetted, the bed should be backwashed for 10 to 15 minutes, prior to being placed on-line. It is good practice to repeat the backwash cycle after 2 or 3 days operation in order to remove any remaining air which collects in the bed.

4.3 Initial Operation

Assuming the vessels have been filled with carbon, properly pre-wetted and segregated as described in the preceding sections, the system is ready to be placed on-line for treating the contaminated water. The vessels should now be topped off with water and readied for operation by closing vent valves and opening the process inlet and outlet valves to the adsorbers required for treatment. (see Table 2.1).

Prior to introducing water into the adsorbers, ensure that the adsorbers influent valves are open on the vessels. Pressurize the influent line with the supply pumps and then slowly open the discharge valves to process water. **CAUTION - Sudden opening and closing of the valves could cause pre-mature failure of the rupture disks. Again please refer to Table 2.1.**
Note: A PVC pipe rack was supplied with the carbon adsorption vessels and before any water is processed, it is recommended practice that all the pipes are filled with fresh water and high point vents be used to remove air from the piping. If air is allowed to stay in the piping, pressure drop through the piping system may increase.

4.4 Effluent Sampling / Changeout Determination

During operation, water samples should be taken on a regular basis from the discharge water, to monitor the mass transfer zone (MTZ) in each adsorber. After several cycles, it should be possible to determine how the MTZ moves and to predict when carbon exchange is required. If the MTZ is short, the concentration of the contaminants at the sample port will eventually equal the concentration in the influent.

The long term frequency for sampling the effluent of each vessel can be determined after the carbon in the adsorber has been changed two or three times. The effluent concentration of the contaminants should be plotted as a function of gallons treated. Assuming the influent concentration is essentially constant, it will be possible to determine when sampling should begin prior to the expected time to remove the spent carbon.

Once it has been determined that the carbon in the vessel is saturated with contaminants, then the standby vessel should be placed into service. Open the effluent valve on the standby adsorber, and then slowly open the inlet valve on the vessel to allow the process flow to enter the vessel. Once the standby vessel is on-line, the spent vessel can be taken out of service. The spent vessel is then isolated and the procedures should be followed for carbon change-out (section 7).

4.5 Suspended Solids / Backwashing

If there are suspended solids in the influent these may be filtered by the carbon bed. If this occurs they will collect on top of the bed and the pressure drop across the bed will increase. When the differential pressure drop across the system is 5 to 8 psi above the initial clean bed pressure drop, the vessels should be backwashed. This operation should remove the solids and the differential pressure drop should return to normal. If it is necessary to backwash a vessel, the valve positions should be adjusted to block the vessel out of the process stream and open the valves to the backwash feed and return lines. The backwash flow rate should be adjusted such that the carbon bed is expanded but no carbon exits the bed. For each vessel, with 8,000 pounds of carbon, there is sufficient space above the carbon bed for 30 – 40% percent expansion.

Experience will determine the required backwash period. When backwashing is completed, the pump must be shut off and the vessel with fresh carbon can be placed on-line.

4.6 MAINTENANCE

The fixed bed carbon system is designed to require minimal maintenance. The following items should be inspected with regard to the carbon vessels, ancillary piping, valves and gages.

1) Internal inspection of a vessel should be performed each time carbon is removed.

2) Inspect the lining to verify it has not been damaged. If damage has occurred or been compromised in any way, it must be repaired prior to putting the vessel back in service.
3) Inspect the underdrain laterals in the collector to insure they are intact and not plugged.
4) Pressure gages should be checked periodically to insure proper operation.
5) Piping and valving should be periodically inspected for signs of wear and/or leakage.

4.7 SHUTDOWN

The adsorption system is designed to operate continuously, 24 hours per day, 365 days per year. A short-term shutdown, as discussed below, is defined as a shutdown period that is expected to last less than 48 to 72 hours.

4.7.1 Short-Term Shutdown

A short-term shutdown is most likely to occur during weekend shutdown or routine maintenance of the system. During a short-term shutdown, the adsorbers may remain filled with water unless work is being performed on the adsorbers themselves. It may be necessary to close the inlet/outlet valves to prevent any siphoning or drainage from the vessels.

4.7.2 Long-Term Shutdown

A long-term shutdown is most likely to occur during spent carbon change-out, changes in the system configuration, major maintenance, etc. During a long-term shutdown the adsorbers should be completely drained to minimize potential for biological growth and bed septic condition.

The adsorbers are drained of excess water draining the vessels through the effluent water pipe until no water continues to run. After that water is allowed to drain, open the bottom 1” brass ball valve to drain the remaining water from the vessel. This drain should remain open for some time to allow water draining from the carbon to exit. **Do not open** the bottom 3” stainless steel ball valve at this time as carbon will be removed by doing so.

4.8 MINIMUM SAFETY PRECAUTIONS

All electrical, mechanical and rotating machinery constitute a potential hazard, particularly for those not familiar with the design, construction and operation. Accordingly, adequate safeguards (including use of protective equipment when necessary) should be taken with this equipment to safeguard the public (including minors) from injury and to prevent damage to the equipment, its’ associated system and the premises. Refer to the site specific health and safety plan (prepared by others) for site specific health risks and safety precautions to be undertaken when operating and maintaining this equipment.

The operation, maintenance and repair of this equipment should be undertaken only by personnel qualified to do so. All such personnel should be thoroughly familiar with the equipment, the associated system and controls, and the procedures set forth in this manual. Proper care, procedures and tools must be used in handling, lifting, installing, operating, maintaining and repairing this equipment to prevent personal injury and/or property damage.

ACTIVATED CARBON CAN REDUCE OXYGEN LEVELS IN CONFINED SPACES. USE AND COMPLY WITH ALL APPLICABLE CONFINED SPACE ENTRY PROCEDURES WHEN ENTERING ADSORBER VESSELS CONTAINING CARBON, OR FROM WHICH CARBON HAS BEEN REMOVED.

Contaminated water may contain chemicals or biological contaminants which could be harmful if exposed to the skin, inhaled or ingested. Accordingly, personnel who may be exposed directly to the mists produced by water jets or compressed air should wear appropriate OSHA protective equipment.

4.9 TROUBLESHOOTING

This section is intended to identify a portion of the more common problems which may be encountered during the operation of a granular activated carbon system. The following "cause and effect" discussion is not intended to be all inclusive since situations and circumstances will vary with each individual system by virtue of design, operating philosophy, etc. Therefore, this section should only be considered as a guideline for troubleshooting.

4.9.1 General

The problems which arise generally fall under the following categories:

- Excessive carbon losses
- High pressure drop
- Poor adsorption and inefficient carbon usage

4.9.2 Excessive Carbon Losses

Generally, it is reasonable to expect 3% to 5% carbon loss for the following reason:

1) The fines in fresh carbon (up to 5%) may be washed out during the backwashing operation.

2) Backwashing causes the carbon particles to become rounded over time. Experience shows that the mean particle diameter can decrease 5 to 10 percent due to abrasion. This results in a reduction in the volume of carbon in the system because smaller, more rounded granules tend to pack more efficiently.

4.9.3 High Pressure Drop in the Adsorber

High pressure drop in the adsorber can be caused by:

1) Air in the carbon bed,

2) Suspended solids in the influent,

3) Plugging of the collector (under drain), and/or

4) Excessive carbon fines.

4.9.3.1 Air in the Carbon Bed

As discussed in Section 6.3, air in the carbon bed is generally caused by inadequate wetting of the carbon granules. Adherence to the startup procedures should eliminate this as a potential problem.

4.9.3.2 Suspended Solids in the Influent

If suspended solids are present in the influent water they will generally be filtered on top of the carbon bed. If this becomes a serious problem, causing excess pressure buildup and relatively frequent backwash cycles, pretreatment of the influent stream may be required.

4.9.3.3 Plugging of the Collector (Under drain)

Openings in the underdrain nozzles are designed such that small carbon particles may pass through without plugging. In some cases the characteristics of the water are such that oils, bacterial growth, etc. may migrate through the carbon and plug the underdrain nozzles. Usually a vigorous backwash will alleviate the problem.

4.9.4 Poor Adsorption and Inefficient Carbon Usage

Poor adsorption and inefficient carbon usage may be caused by the following:

1) Channeling caused by air and /or suspended solids in the carbon bed - Refer to Sections 4.2.1 and 4.2.2
2) Carbon saturation from organics - Change the carbon.
3) Increase in influent concentration of organics - Compare influent analyses.
4) Change in types of organics in the influent - Compare influent analyses.
5) Presence of non-adsorbable organics - Compare influent analyses.
6) Change of pH of influent water - Compare influent analyses.
7) Backwashing without segregating the carbon prior to startup - Refer to Section 4.2.

4.9.5 Carbon in the Effluent Line

Carbon may pass into the effluent line if the slotted pipe laterals fail(s). If carbon is detected, the particle size should be determined. If the particle size is greater then 0.012 inch, it is probable that a lateral pipe has been damaged or loosened from the header pipe.

5.0 SYSTEM PRESSURE DROP

Pressure drop when running 1100 gpm through three vessels will be approximately 3 psi. Total pressure drop across the system depending on valve configuration can be approximately 5 psig total.

6.0 GAC SPECIFICATION – See Attached Document Appendix A

7.0 DETAILED CARBON CHANGE-OUT PROCEDURE

When contaminant saturation has been identified in a vessel, the vessel will be taken off-line and isolated from the process stream as identified in Section 4.4. The carbon in the vessel must then be removed and replaced with fresh carbon. When it is determined that carbon should be removed from a vessel, the procedure discussed in the following sections should be followed.

7.1 Removing Spent Carbon in a Slurry Form

There are two options to remove the carbon as slurry. One option is to use air as the motive force. The other is to use water as the motive force. For this design, water is the preferred method of choice.

7.1.1 Connections

The carbon slurry outlet line located on the bottom center of each vessel should be connected with a hose to a receiving container prior to carbon removal. For this size adsorber the container is usually a bulk trailer. The container should have a drain for removing the excess water from the carbon (prior to transportation).
A 2” water connection (CamLok) end is provided for fresh water supply to aid in the slurry process. This is normally the vent line when the vessel is being filled but can serve to introduce carbon flush water also.

7.1.2 Carbon Transfer

To ensure a proper transfer of carbon from the adsorber, it is necessary to isolate the vessel from the process stream and to close any vent valves. This is required for pressurization of the adsorber vessel.

7.1.2.1 Carbon Transfer from Adsorber – using compressed air

To initiate the carbon transfer process for an Adsorber follow the steps detailed below:
1) Prepare for carbon removal by closing all valves and any other sample or flush valves that maybe open at that time. **Install a steel blind spacer or flange on the inlet and outlet 6” connection to the vessel so that the PVC piping is isolated from the vessel with a steel blind flange.**
2) With the vessel full of water, add compressed air to the top head by connecting the 1” ball valve on the vent line to the compressed air line. When the top of the vessel reaches 10-15 psi, open the carbon discharge valve (3” full port carbon discharge ball valve) and carbon should begin to flow through the transfer line.
3) There should be sufficient water in the vessel to remove the majority of the spent carbon. However, some carbon may remain in the adsorber due to the angle of repose of the carbon, which is 25 to 30 degrees. This left over carbon is called the carbon heel. This amount may be as much as 2,000 to 3,000 pounds. The remaining carbon can be removed by either introducing water into the vessel through the underdrain via the backwash lines (carbon effluent) or by flushing it out with a hose by accessing the vessel through one of the manways.
4) Close the 1” ball valve in the vent line and open the 2” vent valve as soon as air exits the discharge line.
5) When pressure in the vessel is essentially atmospheric, prepare to add water for a period of 5 to 10 minutes. This should cause the carbon bed heal to slump.
6) Close the carbon discharge valve and open the backwash valve (supplied by others) to introduce water to the vessel.
7) After 5 minutes, close the backwash valve to isolate the adsorber
8) Close vent valve.
9) Open the air supply valve to pressurize the vessel as in step 2. Open the carbon discharge valve and transfer the balance of the carbon to the trailer.
10) When the carbon removal process is completed, close the carbon discharge valve and prepare to add fresh carbon as described in Section 4.2.1.

<u>Note</u>: *After completing steps 1 through 10, there is still the possibility of a portion of spent carbon remaining in the bottom head. Therefore, open the manway to inspect the vessel. Depending on the quantity and location of the carbon, it may be necessary to use a hose to wash it into the bottom of the head and/or repeat the above backwashing/air pressure steps after closing the manway.*

7.1.2.2 Carbon Transfer from Adsorber – using total water slurry preferred method

To initiate the carbon transfer process for an Adsorber follow the steps detailed below:

1) Prepare for carbon removal by closing all valves and any other sample or flush valves.
2) Complete a backwash of the vessels as described in Section 4.2.2
3) Insure the vessel is full of water. Open the 6" influent valve and push approximately 100 gpm of clean or treated water through the vessel. A pressure of 10 – 20 psi at this flow rate should transfer the carbon to the bulk trailer. The carbon discharge valve will need to be opened after the pressure on the tank has been allowed to build to this level or slightly higher. Carbon will usually be pushed out at a rate of 1-3 lbs carbon/gal of water. However, there must be continuous flow. Once all the carbon is out of the vessel, an inspection through the manway may result in a wash down of any hanging carbon and a repeat of this step to push the remaining carbon back to the bulk trailer.

Also, during this process, the bulk trailer will need to be drained at a rate similar to the fill of 100 gpm. Usually the draining will require frequent stopping and starting of the feed to the 3" discharge line. This stopping and starting can be accomplished by closing the carbon discharge valve. When this occurs, the pressure on the pump must be either maintained so as not to rupture the pressure disk or it must be shut down to avoid over pressurization.

4) When the carbon removal process is completed, close the carbon discharge valve and all the process valves and prepare to add fresh carbon as described in Section 4.2.1.

Note: *After completing steps 1 through 3 there is still the possibility of a portion of spent carbon remaining in the bottom head. Therefore, open the manway to inspect the vessel. Depending on the quantity and location of the carbon, it may be necessary to use a hose to wash it into the bottom of the head and/or repeat the above backwashing/air pressure steps after closing the manway.*

8.0 INSTALLATION

8.1 Unpacking

When the fixed bed carbon system is delivered to the jobsite, it should be checked thoroughly to ensure that all required items have been received and the filter equipment is free of any shipping damage ***prior to signing the bill of lading***.

8.2 Rigging

All equipment will arrive at the job site via flat bed trailer. The vessels will arrive on their sides, in wooden cradles. The pipe rack, peripheral piping sections and miscellaneous parts will either be directly secured to the truck bed or will arrive in crates or appropriate shipping containers. The vessel should be rigged for lifting by qualified workers. The vessel should be removed from the truck in a horizontal position by a dual block crane. Lift the vessel from the truck by the lifting lugs on the top head ***and*** the tailing pick point located by strapping the vessel legs high and tight. Vessels should never be rigged and maneuvered into an upright position by the tilt up method, as severe damage to the vessel legs could result.

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Appendix A

TIGG 5D 1240
Virgin Liquid Phase Coal Based Activated Carbon

DESCRIPTION

TIGG 5D 1240 is a granular activated carbon made from selected grades of bituminous coal. The range of pore sizes can accommodate organic molecules of varied size. The higher adsorption energy pores of this activated carbon permit the attainment of 100% removal of most organics from water and other liquids.

TYPICAL PROPERTIES

U.S Sieve, 90 wt% min	12 x 40*
Iodine Number, mg/g, min	950
Apparent Density, (dense packing)	
g/cc	0.43 – 0.48
lbs/ft^3	27 – 30
Moisture - wt% max (as packaged)	3
Hardness No. - min	95
Abrasion No. - min	80

* Size 0830 is also available.

TYPICAL APPLICATIONS

This activated carbon can be used to remove:

- BTEX and other organic compounds from ground water
- Organic compounds from wastewater
- Organic compounds from potable water
- Trace organics from process streams such as alcohols, glycerine, MEA, acids, etc.

Standard packaging of the activated carbon is in 55 pound bags or 1100 pound supersaks.

Wet drained activated carbon adsorbs oxygen from the air. Therefore, when workers need to enter a vessel containing wet activated carbon, they should follow confined space/low oxygen level procedures. Activated carbon dust does not present an explosion hazard.

Last Revision
5/08

1 Willow Avenue
Oakdale, PA 15071
(724) 703-3020 Phone
(724) 703-3026 Fax
info@tigg.com
www.tigg.com

Part # A6003591-1

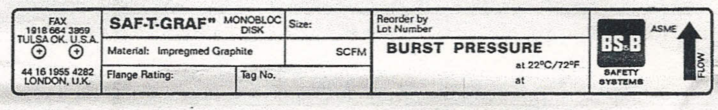
BS&B SAFETY SYSTEMS, L.L.C.
BAS&B SAFETY SYSTEMS LTD.

SAF-T-GRAF ® RUPTURE DISK

INSTALLATION INSTRUCTIONS

BULLETIN
77-85001

- NEW INSTALLATIONS
- REPLACEMENT OF DISKS IN EXISTING INSTALLATIONS
- ORDER REPLACEMENT DISKS BY LOT NUMBER



SELECT PROPER LOCATION

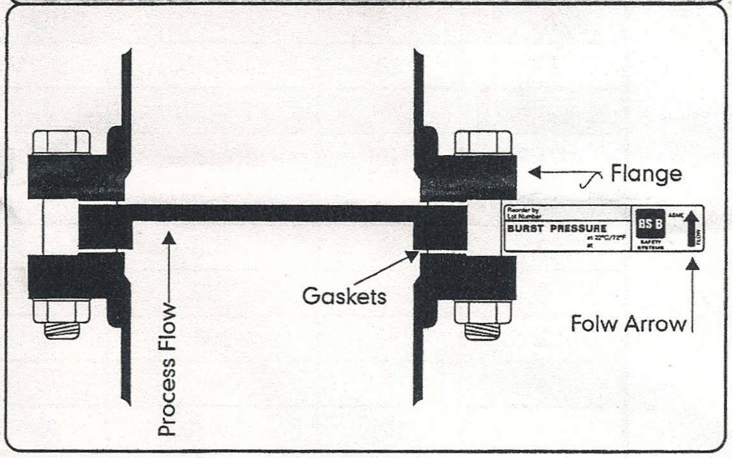
CAUTION-VENT TO SAFE AREA

1. Check the location. Do not locate where personnel or property could be exposed to product and fragments from graphite rupture disks being discharged through the vent opening. Any equipmwnt or property in the vicinity of discharge could be damged.
2. Consider recoil or "kickback ." Recoil is the force the system will experience upon rupture. Recoil (lbs.) Is approximately twice the disk rating (psig) times the relief area (in.^{2}). Provide adeuqate support to piping and conections. If the discharge is free-vented, a baffle plate mounted on the vent opening with extra length studs will minimize recoil.
3. Provide adequate support for the downstream vent piping. The rupture disk should not be subjected to excessive structural bending stresses.
4. The rupture disk must match the companion flange size and rating.
5. Flange materials should be compatible with your process.

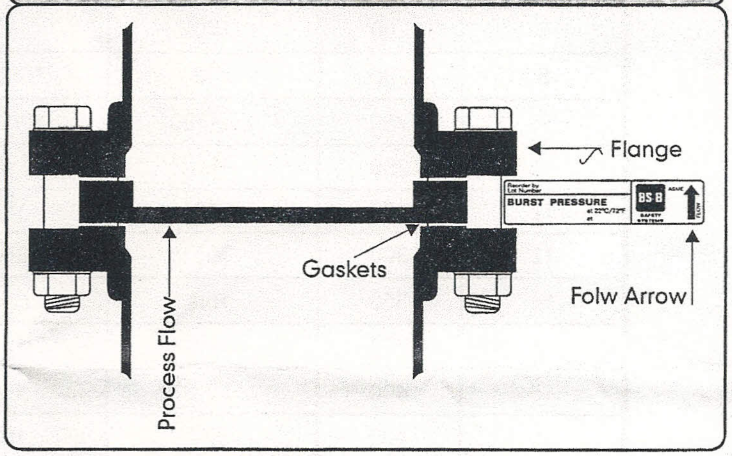
BEFORE YOU INSTALL THE RUPTURE DISK

1. Inspect Flange.
   Clean seating surfaces of both flanges before installing rupture disk. Pits, dirt or grit can damage rupture disk or cause leakage.
2. Inspect Rupture Disk.
   Handle rupture disk carefully it is a precision instrument. Examine disk surfaces before installing. DO NOT INSTALL THE DISK IF THERE IS ANY DAMAGE. A damaged disk is any disk with visible nicks, scatches it must not be installed. Installation of a damaged disk may result in premature rupture of the disk. However, even if damaged, it will still open completely below the disk's rated pressure.
3. Disk materials should be compatible with your process. NOTE: Corrosion and service conditions may affect disk life thus requiring periodic change.

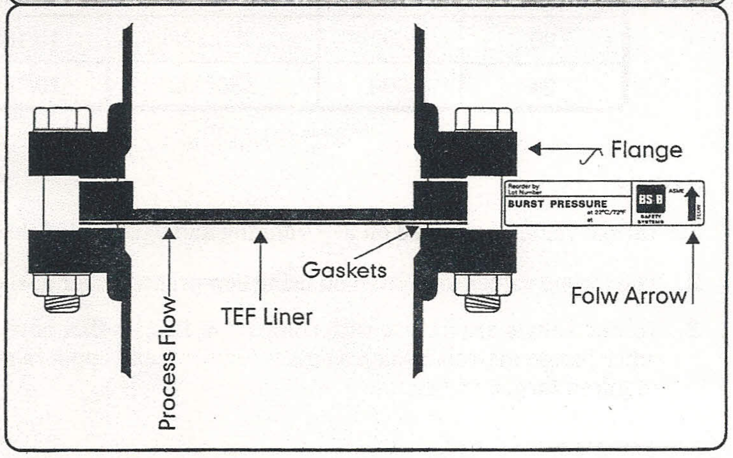
MONOBLOC



INVERTED MONOBLOC



INVERTED MONOBLOC WITH LINER



INSTALL THE GRAPHITE RUPTURE DISK

1. Insert the rupture disk in the pressure system. MAKE SURE FLOW ARROW ON NAMEPLATE POINTS THE DIRECTION YOU WANT FLOW TO OCCUR UPON RUPTURE.

2. Install studs with nuts. Tighten all nuts finger-tight before torquing. Evenly torque the studs to the values in the table below. Even torque can be achieved by applying 1/4 of desired final torque to each stud. Repeat pattern by torquing to 3/4 of the desired final torque. Then, using same pattern, torque to full specified torque. Do not over torque. Uneven or excessive torquing may cause a premature burst.

TORQUE TABLE

SIZE		COMPANION FLANGE RATING			TORQUE	
Inches	mm	ANSI	DIN & AFNOR	JIS	ft • lb	N • m
1/2	15	150/300	10/16/25/40	10/16/20/30	6	8
3/4	20	150/300	10/16/25/40	10/16/20/30	8	11
1	25	150/300	10/16/25/40	10/16/20/30	10	14
1 1/2	40	150/300	10/16/25/40	10/16/20/30	14	19
2	50	150	10/16/25/40	10	20	27
2	50	300	—	16/20/30/40	10	14
3	80	150	—	—	40	55
3	80	300	10/16/25/40	10/16/20/30	26	36
4	100	—	—	16/20/30/40	24	33
4	100	150/300	10/16/25/40	—	30	41
6	100	150	10/16/25/40	—	40	55
6	100	300	—	16/20/30/40	31	43
8	200	150	10	—	50	69
8	200	300	16/25/40	10/16/20/30	38	52
10	250	150/300	10/16/25	10/16/20	60	82
10	250	—	40	30/40	50	69
12	300	150	10/16	—	70	96
12	300	300	25/40	10/16/20/30/40	58	80
14	350	150	—	—	75	103
14	350	300	10/16/25/40	10/16/20/30	63	86
16	400	150	16/25	10/16/20/30/40	84	115
16	400	300	10/40	—	68	93
18	450	150	—	—	87	119
18	450	300	10/16	10/16/20	75	103
20	500	150/300	10/16/25/40	10/16/20	85	117
24	600	150/300	10/16/25/40	10/16/20	85	117

NOTES:

1. Torque values are based on free running and lightly oiled threads .

2. The torque values are based on using compressed fiber gaskets. Do not use spiral wound, fiber-filled gaskets.

3. Torque values are for use with companion flanges that have a minimum yield strength of 25,000 PSI. Consult BS&B when using other flange materials such as glass lined, when suppliers recommend a maximum torque value which is lower than the BS&B required torque value.

LIMITATIONS OF WARRANTIES

BS&B Safety Systems, Inc. warrants its products against defective workmanship and material under normal and proper use in service for a period of twelve (12) months from the date of sihpment, when owned by the original buyer and only when subject to normal operating conditions outlined by Buyer when the order is placed; except that, rupture disks are not guaranteed except to burst within specified pressure ranges at temperatures specified at the time of sale.

Where the products involved include a rupture disk inside a rupture disk holder, each must be of the proper type to be utilized with its mating part as otherwise recommended by and manufactured by BS &B. BS&B specifically disclaims any warranty and any and all liability for damages, either direct or indirect, incidental or consequential arising from the use of rupture disk assemblies not wholly comprised of BS&B manufactured products.

Any article not manufactured by BS&B and which is sold hereunder is sold only under such warranties as the manufacturer thereof extends to BS&B and which BS&B to can pass through to the Buyer and enforce with reasonable effort.

Because of the effects of corrosion or erosion caused by acids, chemicals, fumes, rust, dirt, debris and other factors of storage, use, and installation, over which BS&B has no control, BS&B makes no other warranties beyond those expressly stated in this limited warranty.

THE EXPRESSED WARRANTIES HEREINBEFORE GIVEN BY BS&B SAFETY SYSTEMS, INC. ARE EXCLUSIVE AND IN LIEUOF ALL WARRANTIES EXPRESSED OR IMPLIED, BY OPERATION OF LAW OR OTHERWISE, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

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AN ISO 9001 CERTIFIED COMPANY

D-11
Vapor-phase Granulated Activated Carbon Unit

SIEMENS Water Technologies

Rev. 2 – 8/20/08

RB Series – Vapor Phase Adsorbers

Installation and Start-Up Instructions

IMPORTANT: Read all instructions prior to start-up

WARNING

The adsorption of organic compounds onto activated carbon generates heat. In rare instances, adsorbed compounds may also react on the carbon surface to generate additional heat. If these heat sources are not properly dissipated, the carbon bed temperature may rise to the point where the carbon can ignite, leading to a fire or other hazardous condition. Please see the Appendix of this document for a description of industry-accepted engineering practices to assure the dissipation of heat and safe operation of the carbon bed. In certain applications where the risk of ignition is significant, activated carbon may not be a recommended treatment technology. Please contact your Technical Sales Representative for more details.

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TABLE OF CONTENTS

1.0 INTRODUCTION

This manual covers a general description of the equipment and operating procedures for Siemens Water Technologies Corp. Westates™ Brand RB Series Air Treatment Adsorbers utilizing activated carbon for removal of Volatile Organic Compounds (VOC's). RB Series adsorbers are designed to provide many years of trouble free service. To achieve this, the RB Series equipment must be properly handled and installed to obtain the desired results. Failure to do so can cause premature equipment malfunctions and/or undesirable System performance.

The Purchaser is fully responsible for proper inspection, unloading and installation of the RB Series Adsorber, and shall insure that quality workmanship practices and construction procedures are followed throughout. The Purchaser also accepts all liability for the loss of or damage to any equipment resulting from the improper handling and/or installation, regardless of the inclusion or omission of any applicable suggestions in this manual. Unknown situations or conditions not covered in this manual are the responsibility of the Purchaser.

1.1 GLOSSARY

Adsorbate:	Any substance that is or can be adsorbed.
Adsorber:	A vessel designed to hold activated carbon.
Bed Depth:	The amount of carbon expressed in length units, which is parallel to the flow of a stream and through which the stream must pass.
Breakthrough:	The first appearance in the effluent of an adsorbate of interest at certain specified conditions
Reactivated Carbon:	Previously used activated carbon that has been thermally reactivated.
Spent Carbon:	Carbon that has adsorbed the maximum amount of organic material.
Underdrain:	Device designed to permit an evenly distributed flow of air while retaining the carbon in the vessel.

1.2 IMPORTANT MESSAGES AND WARNINGS

This manual should be in the possession of the personnel who operate and maintain RB Series Adsorbers. The purpose of this manual is for instruction and to advise operators and maintenance personnel. This manual will remain a valuable resource for the safe, economical, efficient operation and maintenance of RB Series Adsorbers. Failure to properly follow instructions, failure to take notice of warnings, and failure to take proper precautions and preventive measures may be dangerous and could cause serious injury, equipment damage, and environmental problems.

Mechanical modifications or substitutions of parts on equipment that may affect structural or operational safety shall not be made without prior manufacturer's approval or engineer's advice. Modifications other than those approved may defeat protective features originally designed into the equipment and its controls; and therefore, shall not be made.

Unauthorized personnel should be kept away from this equipment at all times. Only qualified personnel who have been properly instructed in this equipment's proper operation and maintenance requirements and in its potential hazards shall be allowed to operate and maintain it.

1.3 RECEIVING

Immediately upon receipt and prior to removal from the truck trailer, railcar or shipping container, inspect the RB Series Adsorber for damage. Claiming any damage that may have occurred in transit should be filed promptly with the delivering carrier. The unloading operation should be delayed until the carrier's representative has completed his inspection of the damaged equipment, otherwise a damage claim may not be honored. The inspection should include as a minimum:

1. External surface damage.
2. Damage such as broken nozzles, valves, pipes, etc.
3. Equipment damage at contact points.
4. Unpacking and inspection of all packaged equipment and accessories.
5. Internal lining.

1.4 UNLOADING AND HANDLING

When unloading and handling the RB Series Adsorber, extreme care should be taken as not to damage it. Regardless of the type of equipment being handled, certain precautionary measures must be implemented such as:

1. Insure the lifting equipment can withstand the total intended load.
2. Always use lifting eyes and brackets.
3. Never position the lifting equipment where damage to the equipment load may occur.
4. When using a forklift, make sure the forks are long enough to extend past the intended load. This prevents accidental punctures on the underside of the equipment crates, boxes and skids that may damage the equipment itself.
5. Use spreader bars.
6. Do not slide, drag or push equipment across surfaces. Always lift to move into position.
7. Do not roll, drop or throw equipment or accessories.
8. Lifting cables and/or straps must not be attached to, or permitted to come in contact with nozzles, flanges, gussets, pipes, shafts, painted surfaces, or any other accessory that may be damaged by contact.
9. When equipment is being lifted, proper rigging practices should be observed and a guide- line should be attached to prevent impact damage caused by swinging into contact with other object.
10. Never set on or roll over an equipment fitting and never use a fitting as a lifting point.
11. Prevent tools, hooks, etc. from striking the RB Series Adsorber.

1.5 ASSEMBLY INSTRUCTIONS

RB Series Adsorbers are self-supporting and therefore require no special stand or support pad.
The area for locating the RB Series Adsorber should be near level and flat and capable of supporting the following operating weights:

When placing the RB Series Adsorber in its permanent location make sure that the end that opens up is positioned so that it can be fully opened for access to the interior of the RB Series Adsorber for cleaning purposes.

Remove protective shipping plugs from inlet and outlet and save them for future storage and shipping. Only experienced personnel should perform off-loading and assembly. All safety measures associated with off loading and structural assembly must be followed.

Once the RB Series Adsorber has been positioned in its permanent position, remove the top manway covers and examine the carbon bed. Care should be taken to level the carbon bed. If the carbon media is not level and the bed depth is not uniform, channeling may occur through the carbon bed that may result in premature breakthrough.

Note: Remember that low oxygen content may exist in vessels containing activated carbon. Therefore, caution must be exercised when entering the adsorber. Confined space entry procedures should be followed.

Reinstall the manway covers with gaskets. Connect influent vent to the RB Series Adsorber inlet connection located at one end close to the top of the unit. Connect effluent vent to the outlet connection located on the opposite end close to the bottom of the unit.

2.0 EQUIPMENT DESCRIPTION

2.1 GENERAL DESCRIPTION

RB Series Adsorbers are rectangular carbon steel vessels containing Westates™ brand activated carbon for the removal of various organic contaminants from air and gas streams. The RB Series vessels feature continuous welded construction with epoxy coated interior. The units are primed and finished with polyurethane exterior paint. An FRP grid covered by a polypropylene screen supports the activated carbon inside.

2.2 PROCESS DESCRIPTION

RB Series Adsorbers are designed to remove volatile organic compounds from air and gas streams. Depending upon the individual unit, flow configurations are downflow or horizontal flow across the carbon bed. Contaminated air enters through an inlet connection located one end of the RB Series Adsorber and flows through the carbon bed, in which volatile organic compounds are removed by adsorption. Clean air flows out through an outlet connection located at the opposite end from the inlet connection.

2.3 OPERATING DESCRIPTIONS

The design operating conditions and characteristics for RB Series Adsorbers are as follows:

Unit	RB5	RB10	RB20	RB12HV
Maximum Flow (scfm)	5,000	9,000	12,000	18,000
Superficial Velocity at Max. Flow (ft/min)	83	60	80	75
Flow Configuration	Downflow	Downflow	Downflow	Horizontal Flow
Maximum Temperature	140°F	140°F	140°F	140°F
Maximum Pressure (“ w.c.)	28	28	28	28
Maximum Vacuum (“ w.c.)	14	14	14	14
Quantity of Carbon (lbs.)	5,000	10,000	20,000	12,000

3.0 START-UP

3.1 SAFETY

Any piece of equipment can be dangerous if operated improperly. Safety is ultimately the responsibility of those operating and maintaining the equipment. All personnel operating and maintaining the RB Series Adsorber and its proper implementation must be familiar with all of the adsorber components, and observe all OSHA, federal, state and local safety codes and requirements. The personnel should also be active participants in an approved plant-wide health and safety program.

Failure to properly follow instructions and failure to take proper safety precautions is dangerous and can cause serious personal injury, needless equipment damage, and unnecessary environmental harm. Mechanical modifications and/or substitutions of parts on equipment that will affect structural, operational, or environmental safety should not be made. Modifications may defeat protective features originally designed into the equipment and control; and therefore, should not be made.

The following is a partial list of precautions to follow but in no case neither is the list exhaustive nor is it intended to be. Operators and maintenance personnel should expand on this list after first reviewing the RB Series Adsorber and its operation with the appropriate health and safety authorities.

- Keep areas clean. A clean work area is a much safer area.
- Keep all equipment guards in place. If removed to service the equipment, make sure the guards are replaced properly.
- Wear eye and face protection around rotating and pumping equipment and whenever working around or handling chemicals. Be especially cautious for splash when disconnecting piping, valves and fittings.
- Wear ear protection if necessary.
- Wear proper apparel. Do not wear loose clothing, or jewelry, which could be caught in machinery.
- Wear a proper respirator around chemicals and in areas where vapors and/or gases may be present.
- Non-skid footwear is recommended. Always wear protective gloves when feasible.
- Remove adjusting screws or wrenches. Form a habit of checking to see that all tools are removed from equipment.
- Make sure all personnel are familiar with OSHA approved Material Safety Data Sheets for all hazardous materials they may come in contact with.

3.2 OXYGEN DEMAND CREATED BY ACTIVATED CARBON INCONFINED VESSELS

Research efforts have confirmed that wet granular activated carbon confined in large vessels creates an oxygen demand, which is hazardous to human health and can cause death unless proper safety precautions are observed.

Studies conducted have shown that low oxygen content exists in vessels containing wet carbon. Laboratory experiments conducted since that time also have revealed that commercial activated carbons in a wet or moist condition will lower the oxygen content of an isolated space. Preliminary indications of this research are:

1. The phenomenon occurs with wet activated carbon of all common types.
2. The rate of oxygen uptake naturally varies with the degree of exposure of the wet carbon to the air. Thus, it is relatively rapid in a drained bed.
3. There is some indication of a limit to carbon's capacity for oxygen, but until more is known, it would be prudent to assume that all carbon (fresh, used, reactivated) will also exhibit this characteristic. Similarly, although these tests were run with water, it should be assumed that the phenomenon would occur in other liquid and vapor systems.

NOTE:
ALL CONFINED SPACES, INCLUDING THOSE CONTAINING ACTIVATED CARBON, SHOULD BE PRESUMED TO BE HAZARDOUS. APPROPRIATE SAFETY MEASURES SHOULD ALWAYS BE TAKEN BEFORE ENTERING, AS WELL AS WHEN WORKERS ARE IN A CONFINED SPACE. OSHA REGULATIONS APPLICABLE TO RESPIRATORY PROTECTION IN OXYGEN-DEFICIENT ATMOSPHERES SHOULD BE STRICTLY FOLLOWED.

3.3 CARBON INSTALLATION

RB Series Adsorbers are shipped with the carbon pre-installed.

3.4 PLACING THE RB SERIES ADSORBER IN OPERATION

Connect influent vent to the RB Series Adsorber inlet connection located at one end of the unit. Connect effluent vent to the outlet connection located on the opposite end of the unit. Standard connection sizes are:

Unit	RB5	RB10	RB20	RB12HV
Inlet Connection	16” O.D. (round)	18” x 60”	18” x 60”	30” x 30”
Outlet Connection	16” O.D. (round)	18” x 60”	18” x 60”	Two 18” x 24”

Note that alternative connection sizes are available – your unit’s connection sizes may vary from the above table.

3.5 SPENT CARBON REMOVAL

Once the carbon has reached its capacity for the contaminants being removed from the air stream, the carbon will have to be replaced. In some cases, a new RB Series Adsorber will be shipped to the site and the spent adsorber will be removed. In other cases, the unit may remain on site and the carbon removed via vacuum.

In the case of vacuum removal, remove all manway covers and remove carbon with vacuum equipment. Care should be used to protect the screening. Do not force sharp pickups or probes through the carbon bed against the screen. Make sure all the spent carbon is removed from the RB Series Adsorber and placed into DOT approved containers (i.e. lined Super Sacks or drums). Siemens Water Technologies can provide this carbon removal service; contact your Technical Sales Representative for details.

Spent carbon disposal options include reactivation, landfill, or incineration. Siemens Water Technologies operates three permitted reactivation facilities in the United States. A Spent Carbon Profile form must be completed and a sample of the spent carbon analyzed to obtain approval to accept the spent carbon at one of these facilities. Contact your Technical Sales Representative for more details.

3.6 REFILLING THE RB SERIES ADSORBER

If spent carbon is removed on-site via vacuum, then the unit can be filled with replacement carbon on-site. Prior to filling the empty vessel with activated carbon, the support screens should be checked for holes or tears. If damage is observed, contact your local Siemens Water Technologies service branch (see Section 5.6).

After the support screens have been examined and determined to be in good working order, the media can be loaded through the top three (3) manways. A crane or cherry picker will be required to lift the approximately 1000 lb. Super Sacks over the manways. The spout at the bottom of the Super Sack can placed into the manways so to avoid spillage. Make sure that the carbon is level so that the depth is constant across the bed. If the carbon media is not level and the bed depth is not uniform, channeling may occur through the carbon bed that may result in premature breakthrough.

After fill of the carbon is complete, reinstall the manway covers with gaskets.

Siemens Water Technologies can provide this carbon fill service; contact your Technical Sales Representative for details.

4.0 SYSTEM MONITORING

It is the responsibility of the user to monitor the RB Series Adsorber during operation. The VOC concentration from the unit should be monitored in order to determine when the carbon becomes spent. The RB Series Adsorber will effectively remove the VOC's until breakthrough occurs. When the VOC concentration in the effluent exceeds the treatment objective, the carbon is considered spent. At that time the spent carbon will need to be removed and replaced with fresh carbon as described in the prior section. Spent carbon must be properly profiled according to all applicable regulations prior to disposal.

4.1 Monitoring Log

The following is a suggested format for a monitoring log. This list is meant as a suggestion only and is by no means complete. A daily log is suggested for the first week of operation and then a weekly log thereafter.

- Record the pressure drop across the adsorber.
- Record VOC emissions into and out of the adsorber.
- Record the flow rate through the adsorber.
- Record all equipment maintenance, calibrations, system cleaning, repairing and any parts replacement. (i.e., carbon changeout), etc.
- Record any unusual occurrences, shutdowns, breakdowns, etc.
- Record the voltage & amperage draw on the fan's motor.
- Record the date and time when each item is logged and have the operator sign the log.

We recommend that the top of the carbon bed inside of the RB Series Adsorber be periodically inspected to ensure a level and uniform carbon bed surface and that any foreign material be removed. This inspection should occur quarterly or whenever maintenance on the unit is performed.

5.0 MAINTENANCE

5.1 SHUTDOWNS

5.1.1 SYSTEM SHUTDOWN

1. Turn fan switch to **OFF** position
2. Close inlet damper (provided by others) and outlet damper (provided by others).
3. Close any other openings to completely seal the RB Series Adsorber to keep out air and moisture

5.1.2 EXTENDED SHUTDOWNS

Nothing further needs to be done for extended shutdowns. Again make sure that all openings to the atmosphere are closed.

5.2 EMERGENCY OPERATION

- **DO NOT PLACE YOURSELF IN ANY DANGER**
- **Please refer to the Appendix of this manual (Recommendations to Avoid Thermal Excursions in Activated Carbon Canisters) for recommended procedures to follow in the event of excessive heatup or ignition of the carbon bed.**

5.3 MINOR MAINTENANCE

The RB Series Adsorber has no moving parts and therefore there is no need for routine maintenance. However, routine inspection of the liner, supports and screen is recommended during spent carbon replacement. After the spent carbon has been removed and prior to installation of the fresh carbon, inspect the interior of the unit. If repairs are needed on the screens or if the interior lining is in need of repair contact your local Siemens service branch (see section 5.6).

5.4 MAJOR MAINTENANCE

Call your local Siemens service branch (see section 5.6).

5.5 SYSTEM TROUBLESHOOTING

The following list may be useful in responding to system malfunctions. If in doubt please contact your local Siemens service branch (see section 5.6).

Problem	Possible Cause	Corrective Action
High Pressure Drop or low air flow across system	• **Buildup of salts in carbon bed** • **Foreign object blocking flow path** • **Bed had become wet**	• **Clean or replace carbon** • **Remove object(s)** • **Blow dry air through bed** • **Check damper position (*)**
VOC's present in effluent from unit	• **Carbon capacity has been exceeded** • **Channeling of flow through bed**	• **Replace carbon** • **Level and redistribute carbon**

(*) Check the airflow against the design airflow. If the airflow is too low, open the inlet damper further. If the airflow is too high, restrict the airflow until the design airflow is achieved.

5.6 SIEMENS WATER TECHNOLOGIES CONTACT INFORMATION

FOR ADDITIONAL INFORMATION PLEASE CONTACT
ONE OF THE FOLLOWING CUSTOMER AND TECHNICAL SERVICE CENTERS:

Southwest Region	Gulf Coast Region	Mid-Atlantic Region	Mid-West Region	Northwest Region	Southeast Region	New England Region
(800) 659-1771	(800) 659-1723	(800) 659-1717	(708) 345-7290	(800) 659-1718	(225) 744-3153	(800) 659-1717

APPENDIX:
Recommendations to Avoid Thermal Excursions in Activated Carbon Canisters

SIEMENS

Water Technologies

Rev. 2.2 – 8/20/08

Recommendations to Avoid Thermal Excursions in Activated Carbon Adsorbers

What leads to a thermal excursion? When the organic compounds in the vapor phase are adsorbed onto the surface of activated carbon, heat associated with this adsorption process is released. This liberated heat is referred to as the "heat of adsorption." The heat of adsorption is directly proportional to the organic concentrations being adsorbed on the carbon. The higher the concentration, the greater will be the heat of adsorption. A thermal excursion can occur when heat is generated in a carbon bed at a rate that is faster than the rate at which the heat can be transferred out of the carbon bed. As the temperature increases, the oxidation initiation temperatures of the organic compounds that are adsorbed on the carbon surface are exceeded and their rapid oxidation begins to take place. This rapid oxidation can lead to a further rise in the temperature of the carbon bed until the ignition temperature of the activated carbon itself is reached. This phenomenon generally occurs in situations where the organic concentrations are high (>5000ppm) and the flow rates are low (<25 fpm) and intermittent.

Another factor that can lead to a thermal excursion can be attributed to the heat of reaction resulting when one compound reacts with itself or with another or from the heat of decomposition when a compound decomposes on the carbon surface. These processes, chemical reaction and decomposition, can lead to a significant temperature rise within the carbon bed if the heat is not transferred out of the carbon fast enough. Ketones are typical of compounds that are highly reactive when adsorbed on a carbon surface with enough heat being generated to lead to a bed fire. Operating at low flow with high concentrations of ketones is not recommended.

The following recommendations are suggested for high VOC concentrations and intermittent low flow situations:

1. Prior to putting the carbon adsorber into service, add water to the adsorber until the moisture content of the carbon bed is approximately 20-25 wt. %. Add the designated gallons of water to the corresponding Vent-Scrub™ and RB Series Vapor Phase Adsorbers:

Vent-Scrub™ 200:	6 gallons	RB5 :	150 gallons
Vent-Scrub™ 400:	12 gallons	RB10 :	300 gallons
Vent-Scrub™ 1000:	30 gallons	RB12HV:	360 gallons
Vent-Scrub™ 2000:	60 gallons	RB20:	600 gallons
Vent-Scrub™ 3000:	90 gallons		
Vent-Scrub™ 8000:	240 gallons		

   Remove the top manway(s) and evenly distribute the water across the top of the carbon bed. This process should reduce the temperature rise resulting from the heat of adsorption and assist in keeping the carbon adsorber cool. Siemens Water Technologies Corp. does not recommend soaking of the entire carbon bed with water because this will reduce the capacity of the carbon for adsorbing VOC's and greatly increase carbon usage. We recommend adding only enough water to have the moisture content at 20-25 wt. %. Water can be added through the top manway. **Note that addition of water is not normally recommended for Midas® OCM activated carbon.** The auto ignition temperature for Midas® OCM is approximately 1000°F. This is higher than any other odor control activated carbon on the market and makes Midas® OCM less susceptible to hot spot formation and bed fires and therefore is safer to use in most applications.

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2. Thermal excursions can be avoided and bed hot spots can be detected at a very early stage when they are more easily controlled by monitoring the effluent gas from the carbon adsorber for the presence of carbon monoxide (CO) with a CO monitor (assuming CO is not present in the inlet). If the CO concentration exceeds 1500 ppmv, then steps should be taken. Refer to Number 10 below.

3. Install a flame arrestor between the carbon adsorber and the vapor source located within 10 pipe diameters of the inlet of the carbon adsorber.

4. Install a fusible link with suitable melting point at the inlet of the vapor phase carbon adsorber. A fusible link alone may not prevent a flashback. The "hot spot" can act as an ignition source yet not transfer enough heat to the vapor to melt the fusible link. The combination of the fusible link with a flame arrestor should be adequate to prevent a flashback provided the flame arrestor stops the propagation of the flame.

5. Install a check valve after the carbon adsorber. This prevents air from being drawn back through the carbon adsorber when the source tank is being pumped down. If the carbon adsorber is already hot, the additional air will provide oxygen needed to sustain combustion.

6. Operate at less than 25% of the LEL (lower explosive limit). Lowering of the VOC concentration to below this level can be accomplished by adding dilution air or nitrogen to the vapor stream.

7. Verify the carbon adsorber has been electrically grounded.

8. If the carbon adsorber was used previously at another unit, feel the entire length of the carbon adsorber for signs the bed may be overheating and for the possible presence of “hot” spots (**WARNING: use caution as the adsorber vessel may be hot enough to cause burns**). This is only a preliminary check for problems. “Hot” spots in the carbon bed away from the sides cannot be detected by feeling to see if the carbon adsorber is warm to the touch. Thermal paint on the sides of the vessel can be used to visually detect hot spots.

9. The temperature of the vapor entering the carbon adsorber should not exceed 120ºF.

10. The exit gas temperature should not exceed 150ºF.

    If the exit gas temperature exceeds 150°F or an elevated concentration of CO is detected in the adsorber effluent, carry out the following steps:

    Step 1 Stop the flow of VOC's into the carbon adsorber by switching to clean air.
    Step 2 Immediately monitor the exhaust from the carbon adsorber for the presence of carbon monoxide (CO) using a portable CO monitor.
    Step 3 If the CO concentration is less than 1500 ppmv continue to allow fresh air to enter the carbon adsorber. When the CO concentration returns to ambient levels and the temperature drops to 100°F or lower, the carbon adsorber is ready for reuse.
    Step 4 If the CO in the carbon adsorber exhaust is greater than 1500 ppmv and continues to rise, isolate the carbon adsorber immediately.
    1. Loosen the bolt on the top manway.
    2. Cap the outlet.
    3. Flood carbon adsorber with water through the inlet.
    4. If the inlet is blocked, flood the carbon adsorber through manway.

    If a CO monitor is not available, flood carbon adsorber immediately following the detection of a high exhaust temperature using directions in step 4 above.

11. When high concentrations are expected the carbon adsorber must be monitored every 5 - 10 minutes for VOC's and CO.

12. When the carbon adsorbers are spent, the inlet and outlet should be capped prior to it being moved to storage in preparation for shipment.

13. A continuous nitrogen sweep on the carbon adsorbers can be used. We suggest 1-2 cfm for tank breathing applications. If a check valve is not placed after the carbon adsorber, the nitrogen flow would need to be increased to account for the air that would be drawn back through the carbon adsorber when pumping out of the vapor source tank. **We do NOT recommend a nitrogen sweep on Midas® OCM activated carbon, as oxygen and moisture are required in order for the media to remove H_2S from the vapor stream.**

For applications where there is a risk of exotherm, ask your Technical Sales Representative about our LoRise line of oxidation resistant carbons. This line of specialty carbon products may help reduce the risk of exotherm within the carbon bed.

FOR ADDITIONAL INFORMATION PLEASE CONTACT
ONE OF THE FOLLOWING CUSTOMER AND TECHNICAL SERVICE CENTERS:

Southwest Region	Gulf Coast Region	Mid-Atlantic Region	Mid-West Region	Northwest Region	Southeast Region	New England Region
(800) 659-1771	(800) 659-1723	(800) 659-1717	(708) 345-7290	(800) 659-1718	(225) 744-3153	(800) 659-1717

Water Technologies

RB-Series Roll-off Adsorbers

SIEMENS

APPLICATIONS

The RB-Series adsorbers are well suited for the removal of VOC's from high flow air streams and other emission control applications. Some typical applications for the RB-Series adsorbers include:

- Industrial plant emissions
- Soil vapor extraction (SVE) remediation system off-gases
- Controlling emissions from waste processing operations (i.e., tank cleaning)
- VOC removal from air stripper off-gases
- Backup VOC control device for thermal oxidizers.

INSTALLATION, OPERATION AND MONITORING

The frequency of adsorber exchange will depend on operating parameters that affect carbon loading such as VOC type and concentration, temperature, relative humidity, superficial gas velocity, carbon type (coconut shell or coal) and other factors.

Siemens offers state-of-the-art computer modeling programs, for carbon consumption estimates and optimization of system performance.

Siemens can also provide monitoring services utilizing the appropriate type of field monitoring equipment. The monitoring method used and equipment required will depend on the types of VOC's being captured and on the regulatory compliance requirements.

When an adsorber exchange is required, a fresh adsorber will be delivered from any one of our regional locations. The adsorber containing spent carbon is removed from the site using a roll-off or flat bed trailer and shipped to our reactivation facility where the adsorber is emptied, inspected and refilled. The spent carbon is reactivated and recycled.

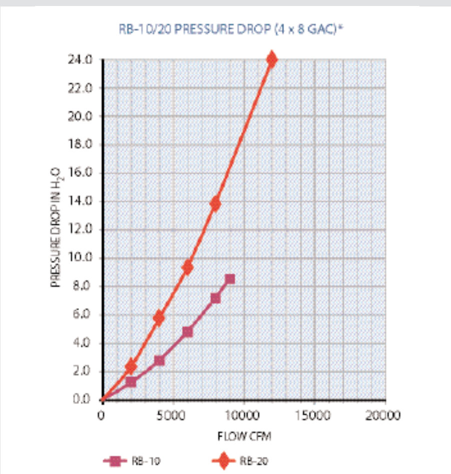
BENEFITS AND DESIGN FEATURES:

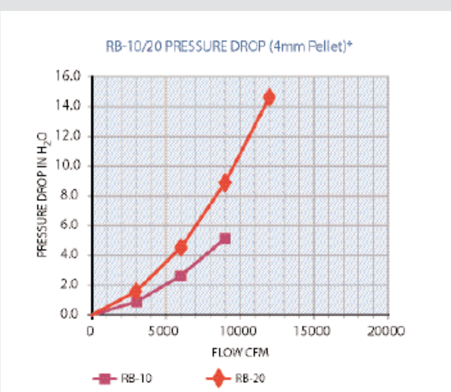
- RB-Series adsorbers are transported with carbon installed, thereby eliminating the need for on-site carbon handling.
- Available for sale or rental.
- Delivery/Pickup via rolloff truck eliminates the need for on-site loading/unloading equipment.
- Various inlet/outlet connection adapters available at no additional costs.
- Can be supplied with pelletized carbon for lower pressure drop.
- Deep carbon bed depths (a minimum of three feet) allow for the efficient removal of VOC's.
- Applications to 18,000 scfm.

SPECIFICATIONS		
	RB-10	RB-20
Outside Dimensions (LxWxH):	21'x8'6"x7'	21'x8'6"x 8'6"
Inlet/Outlet[1] (I.D.)	12"x25"	12"x25"
Interior Coating (SSPC-SP10)	Epoxy	Epoxy
Exterior Coating (SSPC-SP6)	Epoxy/Urethane	Epoxy/Urethane
Cross Sectional Area (Sq. Ft.)	150	150
Empty Weight/Operating Weight (lbs.)	7,500/17,500	10,500/30,500
Approx. Carbon Bed Weight (lbs.)	10,000	20,000
Flow, SCFM (max.)	9,000	12,000
Pressure, inches w.c. (max.)	28	28
Vacuum, inches w.c. (max.)	14	14
Temperature, F (max.)	140°	140°

1Can be adapted with 8", 10" or 12" 150# flanged connections for the RB-10 and with 8", 10", 12" or 14" 150# flanged connections for the RB-20.

For detailed dimensional information or drawings, contact your local Siemens Water Technologies sales representative.





RB-Series Safety Considerations

The adsorption of organic contaminants on activated carbon is an exothermic process, i.e. involves the release of heat.

Certain chemical compounds such as ketones, aldehyes, organic acids and organic sulfur compounds may form reactive species on the carbon surface and under certain conditions may lead to a high temperature rise. If you are unaware or unsure of reactions that may occur, appropriate tests should be performed before installing the RB-Series adsorbers.

At high VOC concentrations of organic compounds the heat of adsorption can lead to an increase in carbon bed temperature. The heat can be controlled by a number of techniques such as dilution of the inlet flow, nitrogen blanketing of the carbon system or prewetting of the carbon bed with water.

All information presented herein is believed reliable and in accordance with accepted engineering practice. Siemens makes no warranties as to completeness of information. Users are responsible for evaluating individual product suitability for specific applications. Siemens assumes no liability whatsoever for any special, indirect or consequential damages arising from the sale, resale or misuse of its products.

Siemens
Water Technologies

Environmental Services
2430 Rose Place
Roseville, MN 55113
800.525.0658 phone

information.water@siemens.com

WS-RB-DS-1206

HYDROSIL
INTERNATIONAL LTD.

- **HS-600 provides a significantly longer service life than potassium hydroxide impregnated carbon.**

Hydrosil HS-600 has 3.6 pounds of active ingredient as compared to 1.6 pounds of active ingredient (32 pounds per cubic foot times 5.0%). Mathematically, the service life of HS-600 is 125% greater.

- **HS-600 is effective on a broader spectrum of gaseous pollutants.**

Potassium permanganate used in the Hydrosil HS-600 production process chemically produces manganese dioxide (MnO_2) and manganese tetraoxide (MnO_4), in addition to potassium hydroxide (KOH). Manganese dioxide/tetraoxide is effective in removing sulfur dioxide, nitrogen dioxide, chlorine dioxide and mercaptans. These chemicals are not present in potassium hydroxide impregnated carbon. Typically corrosive pollution in a plant environment is caused by a broad group of chemicals and potassium hydroxide impregnated carbon is too focused to handle this broad spectrum.

- **HS-600 does not support combustion.**

Potassium hydroxide impregnated carbon will support combustion.

- **HS-600 provides a visual indicator when the media is spent.**

The manganese dioxide/tetraoxide produces a purple color, which evolves to a dull brown as the media is spent. Testing is the only reliable way of knowing the remaining productive service life of the media. Visual indications are useful in prioritizing the need to test.

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www.hydrosilintl.com

HYDROSIL
INTERNATIONAL LTD.

Effectiveness of Chemisorption on Chlorinated Solvents

- Mechanism of removing vinyl chloride in air with potassium permanganate

Activated carbon is used to remove many chlorinated solvents in air streams. If the isotherm (adsorption capacity) is good this is the best method. In the case of low molecular weight chlorinated solvents this isotherm is not very good. In these cases we must use other mechanisms for the removal of the pollutant gas. The alternative to adsorption/absorption is to have the gas adsorbed into a substrate and have a chemical reaction to neutralize or oxidize the pollutant. This mechanism is understood to be chemisorption.

Potassium permanganate is a very good chemical to perform both the neutralization and oxidization process in air. When potassium permanganate is hydrated it will form three compounds. These compounds are potassium hydroxide, manganese tetraoxide and manganese dioxide. The in the case of vinyl chloride the manganese tetraoxide will oxidize the vinyl chloride into potassium chloride and carbon dioxide. The potassium chloride will remain in the pore structure of the substrate that contains the hydrated potassium permanganate.

Hydrosil impregnates a molecular sieve of zeolite with 6% by weight potassium permanganate. This media is called HS-600. Field applications of this media in removing vinyl chloride from air streams have been proven to be efficient and economically better than that of activated carbon. In field studies, the spent media was tested and determined that it did not pose a hazardous waste. The spent material was disposed in a landfill. In using this media, a representative sample should be tested for hazardous materials prior to disposal in a landfill as a non-hazardous waste.

It should be noted that if other higher molecular weight chlorinated substances are present in the air stream it is advisable to place activated carbon scrubber systems prior to the potassium permanganate system. This will increase the efficiency of the systems and result in decreased operating costs.

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HYDROSIL
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REACTION FOR THE REMOVAL OF VINYL CHLORIDE USING POTASSIUM PERMANGANATE

The reaction of permanganate ion with vinyl chloride monomer is outlined in Figure 1. The reaction produces 1,2 dihydroxy, chloroethane, an addition product, and a precipitate of manganese dioxide. A short description of the reaction is also included below. The typical oxidation reaction for an alkene by permanganate ion may be found in any general organic chemistry text.

The oxidation of an alkene leads to the formation of a compound with hydroxyl groups on the carbon atoms that were involved in the double bond, a 1,2 diol. Manganese (VII) in permanganate ion is ultimately reduced to manganese (IV) in manganaese dioxide. The carbon atoms of the double bond are oxidized. Even if no base is added at first, the solution becomes progressively more basic as the reaction proceeds.

In this oxidation reaction, the two hydroxyl groups become attached to the same face of the double bonds. The permanganate ion is believed to add to the double bond to give a cyclic intermediate, a manganate ester. The first step of this reaction is the syn (same side) addition of permanganate ion to the double bond. This intermediate breaks down in the presence of water to give the cis-1,2 diol. Thus, there are no appreciable quantities of chlorine gas or formaldehyde formed in the reaction.

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Reaction Mechanism of Permanganate Ion with VCM (Vinyl Chloride Monomer)

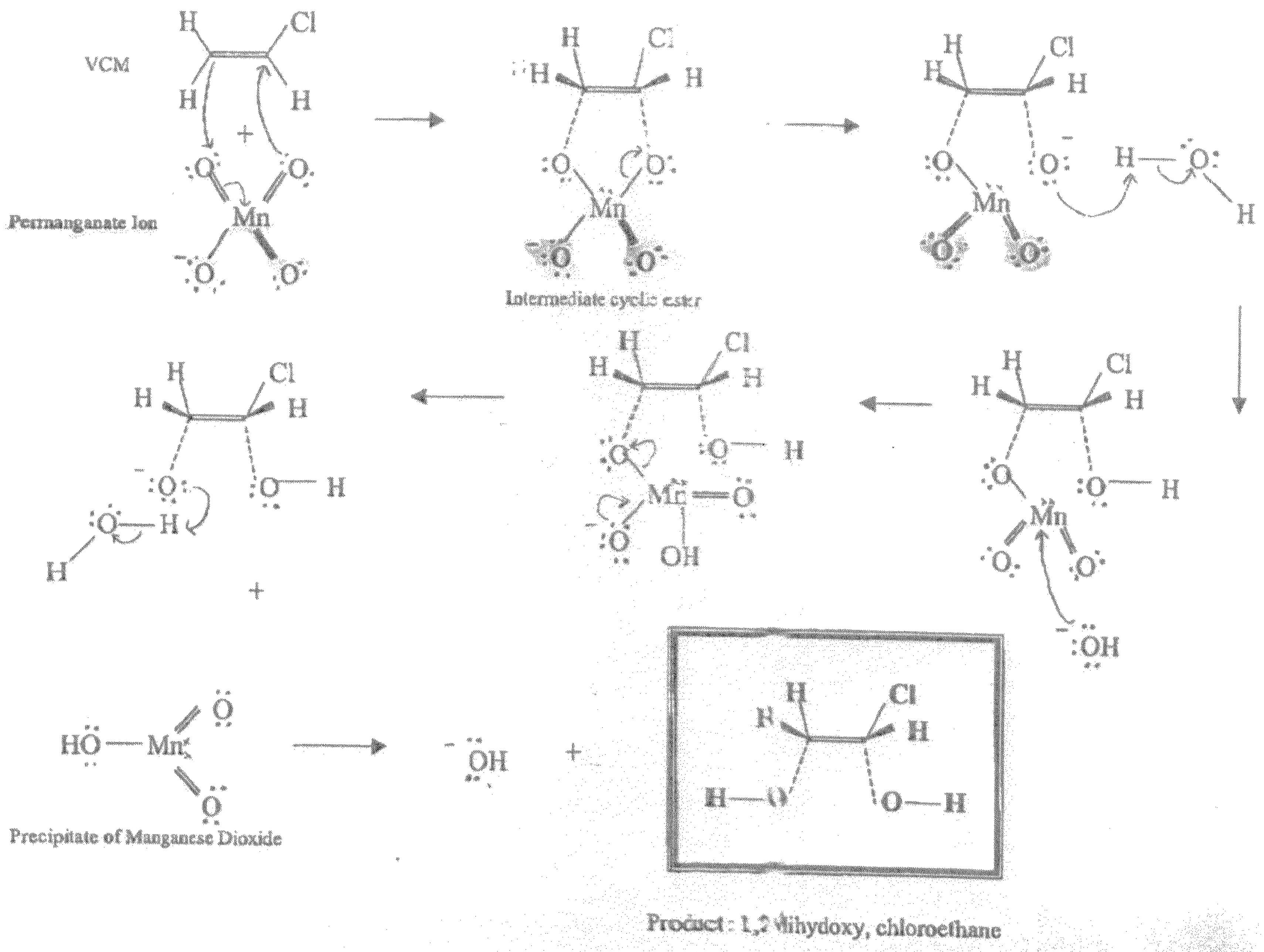

FIGURE 1

HYDROSIL
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Remaining Service Life

The percentage of available potassium permanganate and the density of the gas phase media can be correlated to the active service life left in the product. If the media in the adsorber is Hydrosil HS-600 or an activated alumina based product, the following schedule can be followed:

Hydrosil HS-600 Percentage of Potassium Permanganate (% by weight)		Activated Alumina Percentage of Potassium Permanganate (% by weight)
2.2 to 6.0	**SAFE**	2.6 to 4.0
1.6 to 2.2	**BORDERLINE**	1.9 to 2.6
1.2 to 1.6	**CHANGE**	1.4 to 1.9
0.0 to 1.2	**CHANGE IMMEDIATELY**	0.0 to 1.4

The comments are intended to mean the following:

SAFE	- Reanalyze in 90 days
BORDERLINE	- Change in 30-60 days
CHANGE	- Change in 30 days, breakthrough could occur quickly under plant "spill" conditions
CHANGE IMMEDIATELY	- Change Immediately

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HYDROSIL
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Hydrosil HS-600

Hydrosil vigorously controls the production process. Data is reviewed and maintained on each batch as it is being produced through and including the moisture content of the HS-600 being delivered to our customer.

- **HS-600 Specifications**

The potassium permanganate impregnated media shall have no less than 3.6 pounds of potassium permanganate per cubic foot, a bulk density of no less than 60 pounds per cubic foot, a moisture content of 12-15% by weight and shall not dust. The media shall have an irregular particle size of 4 x 8 mesh.

The performance characteristics of the air filtration media shall meet or exceed a service life of no less than 72 hours for breakthrough of hydrogen sulfide at the following test conditions:

Media Bed Volume: 76.00 cubic centimeters
Bed Configuration: 2.54 cm (id) x 15.00 cm
Flow Rate: 3000 (+/- 100) ml/minute
Relative Humidity: 70%
Challenge Gas: hydrogen sulfide
Challenge Gas Concentration: 10 (+/- 0.25) PPM

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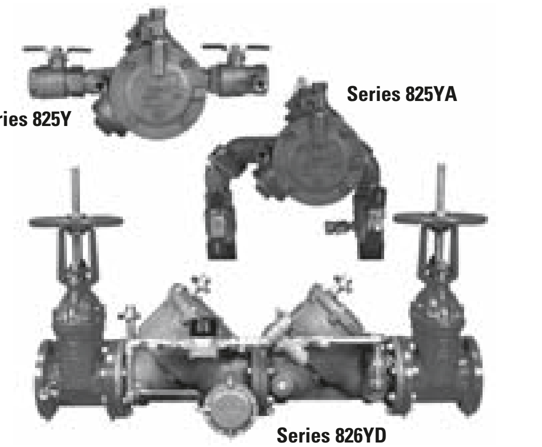
D-12
Backflow Preventer

INSTALLATION, OPERATION, MAINTENANCE

Operation and Maintenance Manual

Reduced Pressure Backflow Prevention Assemblies

Models 825Y, 825YA, 825, 825D, 825YD & 826YD



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Read and understand this manual prior to installing, operating or servicing this equipment.

FEBCO®

Feature and Operating Procedures

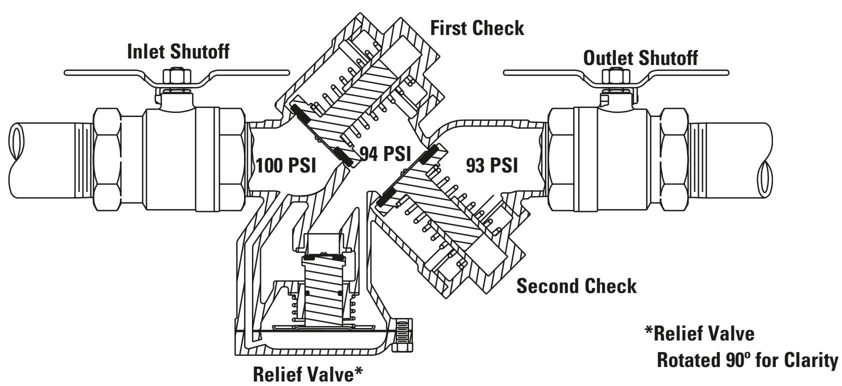
Reduced Pressure Backflow Preventer

FEBCO manufactures several models of Reduced Pressure Backflow preventers. The Model 825Y and 825YA are available in sizes 3/4–2" with bronze body and cover as standard. Other materials are available. The FEBCO Model 825 sizes 21/2–10" were manufactured with cast iron. The FEBCO Model 825 Type D and 825 Type YD sizes 21/2"–10" are manufactured with standard body material of ductile iron.

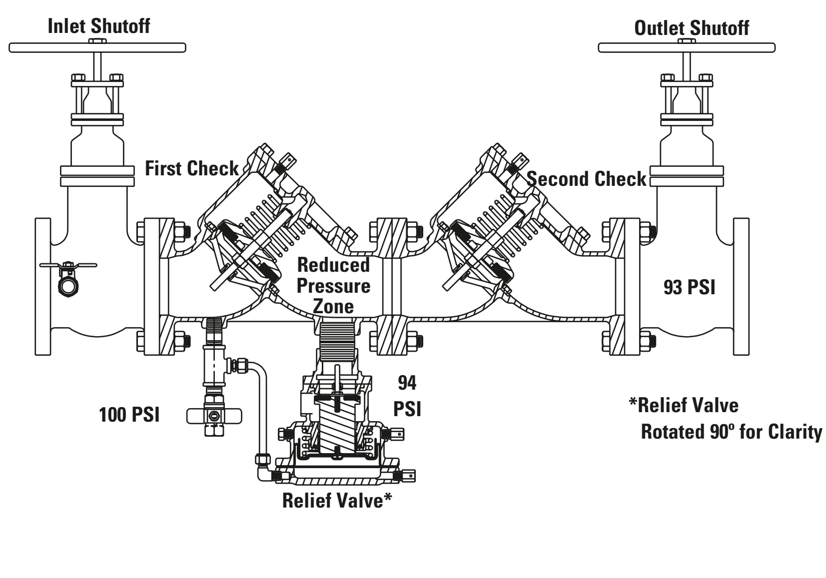
The FEBCO Reduced Pressure Backflow preventer assembly consists of two independently operating, spring loaded check valves with a pressure differential relief valve located between the two checks. The pressure drop across the first check valve is approximately 6.0 psid with no flow. The relief valve consists of a hydraulically balanced diaphragm with the high pressure side hydraulically connected to the upstream side of the first check. The low pressure side is hydraulically connected to the reduced pressure zone, thus the relief valve remains closed during normal operation. The low pressure side of the diaphragm is spring loaded to force the relief valve open when the pressure drop across the first check (and across the diaphragm) reduces to approximately 2.5 psid. A complete assembly includes two shut-off valves and four test cocks.

Example sectional views below show typical components and flow passages with corresponding pressure readings (no flow conditions) at the various locations within the assembly.

Model 825Y (3/4–2")
Figure No. 1



Model 825YD (21/2–10")
Figure No. 2



Installation Guidelines

Proper installation of the assembly is essential to the protection of the water supply

1. The assembly should be installed in a horizontal position with a minimum clearance of 12" between the relief valve discharge port and floor or grade, and a minimum of 18" horizontal clearance around the unit for access and ease of testing and maintenance of the relief valve.
2. Approval agencies do not recommend installation of a Reduced Pressure Assembly in a pit. Flooding of the pit can result in cross connection contamination. If local codes permit installation of a Reduced Pressure Assembly in a pit, adequate drainage must be provided to prevent the pit from flooding under maximum discharge conditions.
3. Placement of the assembly should be planned where water discharged from the relief port will not be objectionable or cause damage to property and/or equipment.
4. To be approved by the University of Southern California Foundation for Cross-Connection Control and Hydraulic Research (USC), the assembly must be purchased and installed with resilient seated shutoffs to ensure bubble tight closure for more consistent results during testing. CAUTION: Open and close resilient seated shut-offs slowly to prevent water hammer damage to the system and assembly.
5. Since the FEBCO Reduced Pressure Assembly is designed to be serviced while in line, the unit need not be removed from the line during servicing.
6. Ensure the supply water pressure does not exceed the manufacturer's maximum water pressure rating of the assembly to avoid damage to the system or the assembly caused by system pressure. In addition, protection must be provided against thermal water expansion, extreme backpressure and/or water hammer.
7. Most field problems occur because dirt or debris present in the system at the time of installation becomes trapped in the first check seating area resulting in continuous discharge from the relief valve in a static or backflow condition. THE SYSTEM SHOULD BE FLUSHED BEFORE THE ASSEMBLY IS INSTALLED. However, to effectively flush the system after the assembly has been installed, remove the internal components of both checks and open the inlet shut-off to allow water to flow for a sufficient time to flush debris from the line and assembly. If debris In the water system continues to cause fouling, a strainer can be installed upstream of the assembly.

Typical Installations

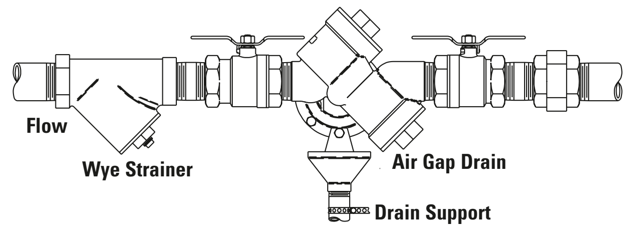
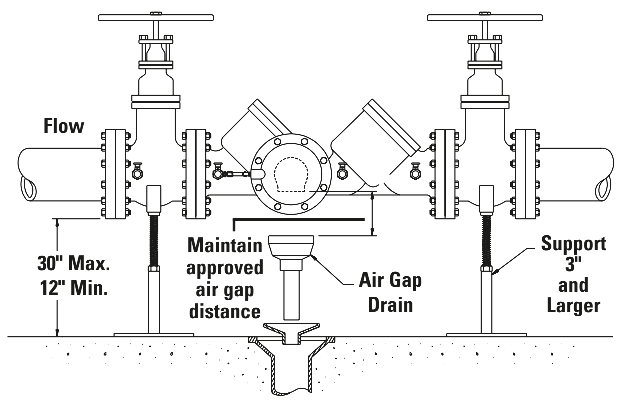


Figure No. 3



Indoor Installation

Figure No. 4

Freeze Protection Procedure

The reduced pressure backflow prevention assembly is subject to damage if the internal water is allowed to freeze. It is suggested that all assemblies be installed with resilient seated shutoffs so that a drip tight closure can be achieved to prevent refilling of the assembly after the freeze protection procedure is performed. The unit must be protected from freezing by a heated enclosure, draining, insulation using heat tape, or other suitable means. However, the unit must always be accessible for testing and maintenance. If the system will be shut down during freezing weather, use the following procedure to drain internal passages.

The Model 825YA can be removed from the line as a winterizing procedure. See Figure 5 for proper ball valve procedure.

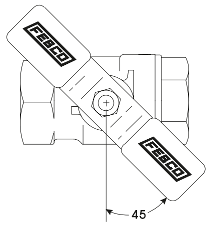


Figure No. 5

Model 825Y ($^3/_4$–2") Reduced Pressure Zone and Relief Valve Freeze Protection

1. Slowly close the main shutoff valve upstream of the assembly, which provides water to the system.
2. Drain system water upstream of the first check by means other than through the assembly.

Check Valve Draining Procedure

3a. First check (zone) Open #2 and #3 test cocks. All water between the first and second check valves will drain through the relief valve port.

3b. Second check (downstream)—Remove the second check cap, spring and disc holder. All water downstream of the second check (that is higher than the outlet shutoff valve) will drain through the body.

Relief Valve Draining Procedure

4a. If device is equipped with optional drain plugs, remove plugs in the relief valve cover and body. Open #2 and #3 test cocks. All water will drain through plug holes.

4b. For standard models (not equipped with optional drain plugs) loosen the relief valve cover and allow water to drain from both sides of the diaphragm.

Ball Valve ShutOff Draining Procedure

5a. If the assembly has been installed with ball valve shutoff valves, they must also be properly drained to prevent freeze damage. After draining procedure has been completed on the backflow prevention assembly, position all ball valve shut-offs and test cocks in a half open/half closed (45 degree) position. (see Figure 5)

5b. Open the ball valve approximately 45 degrees while draining the pipeline and assembly to allow water between the ball and valve body to drain. Leave the ball valve in this position for the winter to prevent freeze damage.

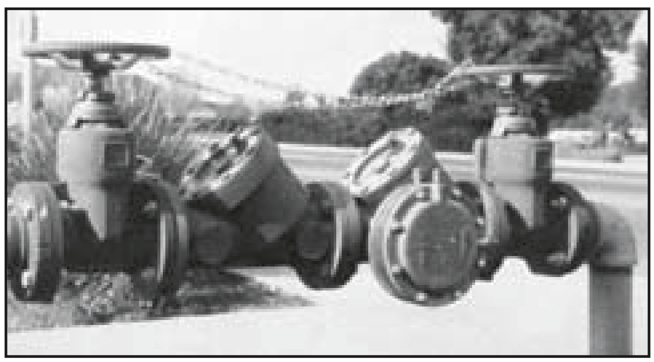
5c. The ball valves must be fully closed before the system is repressurized. OPEN AND CLOSE BALL VALVES SLOWLY TO PREVENT DAMAGE TO THE SYSTEM CAUSED BY WATER HAMMER.

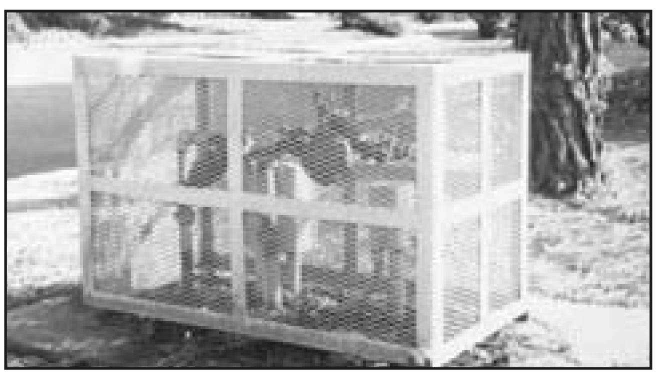
Model 825, 825D and 825YD ($2^1/_2$–10") Reduced Pressure Zone and Relief Valve Freeze Protection

1. Slowly close supply valve within freeze protected area, open air bleed valves on No. #1 check valve and relief valve (3 places), and open No. #2 and #3 test cocks. Water within the zone will be drained to the lowest point of the relief valve discharge port (relief valve seat). A minor amount of water will remain in the bottom of the valve body, but this is not sufficient to cause freezing damage.
2. With this procedure, about one-half of the relief valve will be drained. To drain the relief valve on Models 825 and 825D, loosen the relief valve cover bolts and allow the relief valve to drain. Retighten bolts before repressurizing system. To drain relief valve on Models 825YD, open the two air bleeds (one on the body, the other on the cover), then remove drain plugs. Replace drain plugs before repressurizing system.
3. The system design must provide a means for draining upstream of the #1 check valve and downstream of the #2 check valve. Test cocks #1, #2, and #4 and the air bleed valve on #2 check valve may be opened to allow air to enter to assist in draining. Depending on system design, these sections should be able to be drained to the pipe centerline.
4. Position the assembly shutoff valves and test cocks in the half open/half closed position to allow complete draining of the assembly shutoff valve bodies and test cocks.
5. Some units contain a drain plug in the bottom of the second check body. Open test cocks and remove plug to drain.

Vandalism Protection Procedure

1. If the unit is installed where vandalism may be a problem, the assembly should be protected and secured. On 3/4–2" units the handles of shutoff valves can be removed to discourage tampering. On $2^1/_2$–10" units a chain can be looped between shutoffs and locked in position to prevent tampering with shutoff valves. Test cock handles can also be removed. On backflow prevention assemblies installed in conjunction with fire sprinkler systems, an alarm can be placed on the OS&Y shut-off valves that will sound if unauthorized closure should occur.
2. A protective cage can be installed over the unit to discourage vandals. If a cage is used, it should be installed so that adequate clearance is available for maintenance and testing or it should be completely removable. Also allow for any discharge from the relief valve to fully drain from the protective cage.
3. Some units include screw driver adjusted test cocks for vandal resistance.





General Service Procedures

General Service Instructions applicable to all models and sizes.

1. FEBCO backflow prevention assemblies can be serviced with commonly available tools and are designed for ease of maintenance. The assemblies are designed to be serviced in line, so the unit should not need to be removed from the line during servicing.
2. The most common cause of check fouling and relief valve discharge is dirt and debris in the seating areas. The line should be flushed clean of debris before installation of the assembly. To flush the line after installation of the assembly, slowly close the inlet shutoff valve, remove the covers and internal assemblies of both check valves and open the inlet shutoff valve to allow sufficient flow of water through the assembly to clear all sand, debris, etc. from the line. If debris in the water continues to cause fouling, a strainer may be installed upstream of the assembly.

3. Rinse all parts with clean water before reassembly.
4. Do not use any petroleum based oil, grease, solvent or pipe dope on any parts unless instructed to do so. Use only water resistant lubricants that comply with FDA requirements for use in potable water systems.
5. Carefully inspect diaphragms, seals and seating surfaces for damage or debris. If the check valve seat disc has been severely cut at the seat ring diameter, the assembly has been subjected to extremely high and repeated back pressure. Either thermal water expansion or water hammer are the most likely causes. If back pressure persists, consider installation of a pressure relief valve downstream of the assembly.
6. Use caution to avoid damaging any guiding surfaces while handling parts. Do not force parts together. The o-ring seals used in FEBCO assemblies require only a small tightening force to ensure a positive seal.
7. Test unit after servicing to ensure proper operation.

8. Refer to applicable parts list and figures for visual aid information

Figure No. 6

Suggested Tool Kits
Model 825Y (3/4–2")
• 1 Crescent wrench (10")
• 1 Medium Phillips screwdriver
• 1 Medium straight blade screw driver
• Allen head wrench (3/16" & 1/4" size)
• 1 Thin blade knife or reamer
• 1 Socket (1/2" and 9/16" size)
• Differential pressure test kit
• FDA approved lubricant
• Needle nose pliers
Model 825, 825D and 825YD (2½–10")
• 1 Crescent wrench (12")
• 1 Medium Phillips screw driver
• 1 Medium straight blade screw driver
• 1 Set of drive sockets (3/8" or 1/2")
• 1 Spring removal tool (see page 33)
• 1 Torque wrench
• Differential pressure test kit
• FDA approved lubricant

Troubleshooting Procedure

With Differential Pressure Gauge

SYMPTOM NO. 1:
CHECK DIFFERENTIAL ACROSS NO. 1 CHECK VALVE

READING	PROBLEM
2 to 3 PSID	Leak in No. 1 or No. 2 check valve
6 to 8 PSID and steady	Malfunctioning pressure relief valve
2 to 7 PSID fluctuating	Inlet pressure fluctuating

With Differential Pressure Gauge

SYMPTOM NO. 2:
CHECK DIFFERENTIAL ACROSS NO. 1 CHECK VALVE

READING	PROBLEM
2 to 3 PSID	Leak in No. 1 or No. 2 check valve
6 to 8 PSID and steady	Malfunctioning pressure relief valve

Without Differential Pressure Gauge

SYMPTOMS NO. 1 AND NO. 2:
A) Close Gate Valve No. 2

RESULT	PROBLEM
If discharge stops	Leak in No. 2 check valve
If discharge does not stop	Go to "B"

B) Open No. 4 testcock to produce a flow greater than differential relief valve discharge

RESULT	PROBLEM
If discharge stops	Leak in No. 1 check valve
If discharge does not stop	Malfunctioning pressure relief valve

Troubleshooting Guide

SYMPTOM:	CAUSE:	SOLUTION:
1. Continuous discharge from relief valve during NO-FLOW condition (discharge stops with water flow). With this symptom, the pressure drop across the No. 1 check valve would be 2 to 3 PSID. If a flow of water (more than the discharge) is created through the valve, the pressure drop should increase to approximately 7 PSID.	a. Debris fouling No. 1 check valve.	a. Inspect and clean.
	b. Outlet pressure higher than inlet pressure and debris fouling No. 2 check valve.	b. Inspect and clean.
	c. Disc holder/stem not moving freely in guide(s).	c. Inspect for dirt or other foreign material.
	d. Damaged seat or seat disc.	d. Inspect and replace. Seat disc can be reversed.
	e. Leakage at o-ring on the seat ring or disc holder/ stem (825, 825D, 825YD).	e. Inspect and replace o-ring.
	f. Leakage under seat disc due to dirt or damage disc holder or disc.	f. Inspect and replace or repair.
	g. Leakage through diaphragm due to stretched holes or cut (825 & 835YD).	g. Inspect and replace diaphragm.
2. Intermittent discharge from relief valve during NO-FLOW condition. With this symptom, the pressure drop across the No. 1 check valve would be varying from about 2 to 7 PSID.	a. Inlet line pressure variations causing relief valve to discharge:	a. Elimate or reduce pressure variations.
	b. Pressure surges (water hammer) causing relief valve to discharge as pressure wave passes through "ZONE."	b. Eliminate or reduce pressure surges.
3. Continuous discharge from relief valve during FLOW and NO-FLOW conditions. With this symptom, the pressure drop across the No. 1 check valve would be 7 PSID or more at all times.	a. Seat disc dislodged from cavity in the in the main stem (this can be caused by pressure surges during initial filing of system lines.)	a. Reposition disc in main stem cavity. Repressurize system slowly.
	b. Debris fouling the relief valve seat.	b. Inspect and clean.
	c. Debris fouling the relief valve seat passage.	c. Inspect and clean.
	d. Dirt or scaling jamming main stem or spring button.	d. Inspect and clean or replace.
	e. Leakage at main stem or o-ring/diaphram.	e. Inspect and clean or replace o-ring and/or main stem.
	f. Jammed main stem due to excessive torque on center bolt (825 and 825D).	f. Do not exceed 15 inch-pound torque on main stem center bolt.

Troubleshooting Guide (Continued)

SYMPTOM:	CAUSE:	SOLUTION:
4. Relief valve does not open above 2.0 psid during field testing.	a. Outlet gate valve not closed completely.	a. Check for debris blocking gate.
	b. Plugged low pressure hydraulic passage (from "ZONE" to inner diaphragm).	b. Inspect and clean.
	c. Improper alignment of internal parts during reassembly (causing high resistance to movement).	c. Disassemble and center the button, spring and main stem.
	d. Jammed main stem due to excessive torque on center bolt (825 and 825D only).	d. Do not exceed 15 inch-pound torque on main stem center bolt.
5. First check pressure drop is low (less than 5 psid) during field testing.	a. Debris fouling first check seat.	a. Inspect and clean.
	b. Debris fouling second check seat with backpressure.	b. Inspect and clean.
	c. Inlet pressure variations causing inaccurate gauge reading.	c. Eliminate pressure variations.
	d. Disc holder not perpendicular to stem (therefore, disc not parallel to seat ring) (825, 825D and 825YD).	d. Inspect and reassemble if required. NOTE: Spring must be removed when tightening disc holder to stem.
	e. Damaged seat or seat disc.	e. Inspect and replace as required.
	f. Worn guide, bushings or stem.	f. Inspect and replace as required.
	g. Guide not properly seated in cover (825, 825D and 825YD only).	g. Inspect and reassemble.
6. Discharge from drain hole in relief valve spacer (825 and 825D only).	a. Leakage under diaphragm retaining screw (8 places).	a. Apply thin layer of sealant around each thread, insert on bottom and reassemble.
	b. Leakage under diaphragm at main stem diameter.	b. Apply thin layer of sealant on button at the main stem diameter. DO NOT EXCEED 15 INCH POUNDS when tightening center bolt.
	c. Hole in diaphragm.	c. Replace diaphragm with fabric side towards the button.
7. Second check fails to hold back pressure during field testing.	a. Outlet gate valve not closed completely.	a. Check for debris blocking gate.
	b. Debris fouling second check seat.	b. Inspect and clean.
	c. Disc holder/stem not moving freely in guide(s).	c. Inspect for dirt or other foreign material.
	d. Disc holder not perpendicular to stem (therefore, disc not parallel to seat ring) (825, 825D & 825YD).	d. Inspect and reassemble if required. NOTE: SPRING MUST BE REMOVED WHEN TIGHTENING DISC HOLDER TO STEM.
	e. Damaged seat or seat disc.	e. Inspect and replace as required.
	f. Worn guide, bushings or stem.	f. Inspect and replace as required.
	g. Guide not properly seated in cover (825, 825D & 825YD only).	g. Inspect and reassemble.

Note: If check valve seat disc has been severely cut at the seat ring diameter, the assembly is being subject to extremely high and repeated back pressure. Either thermal water expansion or water hammer are the most likely causes.

Field Testing Procedures

Purpose of Test

To test the operation of the DIFFERENTIAL PRESSURE RELIEF VALVE and CHECK VALVE.

Equipment Required for Test

Differential Pressure Gauge test kit. Equal to the RPTK1 (shown on page 13).

Test Differential Relief Valve

The Differential relief valve must operate to keep the zone between the two check valves at least 2 psi less than the supply pressure.

1. Slowly close the outlet shut-off on the discharge side of the backflow preventer.
2. Open air bleeds and test cocks until all air from the check valves is released.
3. Connect the “high” side of the differential pressure gauge to test cock #2 and the “low” side to test cock #3.
4. Open test cock #2 and test cock #3 and bleed all air from the hose and gauge.
5. Slowly open the bypass valve needle #1 until the differential gauge needle starts to drop. Hold the bypass in this position and observe the reading on the gauge at the moment the first discharge is noted from the relief valve. The differential pressure at the time the relief valve opens must be no lower than 2 psi.
6. Close the bypass needle valve.

Test Check Valve 1

The check valve must be at least 3 psi more than the relief valve opening pressure.

1. Open test cock #4 to flow a small amount of water through the unit to restore normal pressures.
2. Observe the differential gauge with bypass valve #1 closed and test cock #2 and #3 open. The gauge should remain at a reading of at least 3 PSI above the relief valve. If it drops below this, the check valve is leaking and must be serviced.

Test Check Valve 2

The check valve must be tight against reverse flow under all pressure differentials.

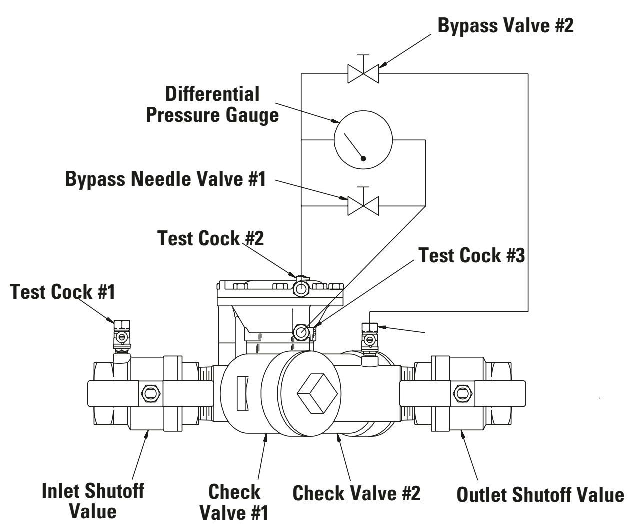
1. Connect the “high” side of the differential pressure gauge to test cock #4 (3rd hose).
2. Open test cock #4. With bypass needle valve #1 closed and bypass valve #2 open, observe gauge reading. The differential pressure should not drop to the relief valve opening point.

Restore Operation

1. Restore all valves and test cocks to their original positions. Open and close resilient seated shut-offs slowly to prevent damage to the system and assembly.

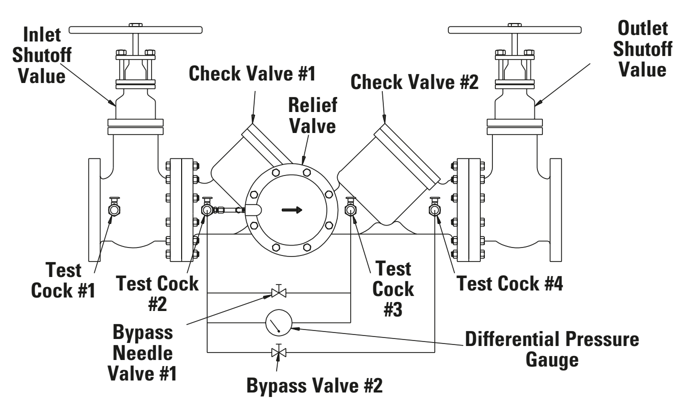
FEBCO Model 825Y (¾–2") Reduced Pressure Assembly

Figure No. 7



FEBCO Model 825YD (2½–10") Reduced Pressure Assembly

Figure No. 8



Field Testing Procedures (Continued)

Test for the 826YD

This device is tested with the same procedure as the Model 825YD. However, the bypass 825Y 3/4" valve must be isolated from the mainline valve using the 3/4" ball valves during the test and tested separately.

Proper Bypass Operations

Flow 3 GPM through the bypass by opening the mainline test cock #4. Use the flow meter for this measurement (1 gallon flow in a 20 second time period). After the flow rate has been set, collect the discharge flow in a container for 20 seconds. The volume of water collected should be one gallon.

Restore Operation

After testing restore all valves to their original positions.

Note: This is a suggested typical test method. Check with your local code for approved test procedures in your area.

Testing with the FEBCO Test Kit

The FEBCO Test Kit includes gauge, complete with hoses, fittings, adapters and laminated instructions in a compact plastic case. The FEBCO Test Kit includes a differential pressure gauge used to test all approved Reduced Pressure Assemblies including the FEBCO Models 825Y, 825YA, 825YD Reduced Pressure Assemblies and the 826YD Reduced Pressure Detector Check.

FEBCO Model 826YD (2½–10") Reduced Pressure Assembly

Figure No. 9

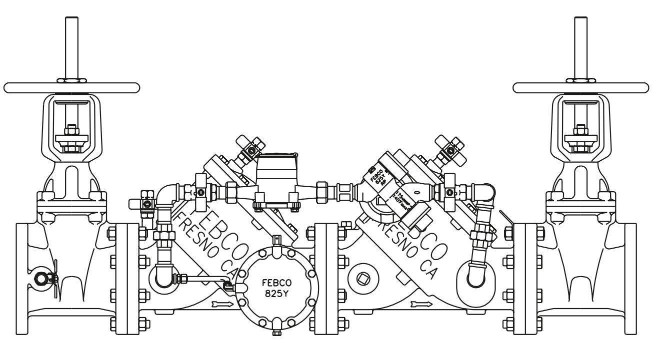
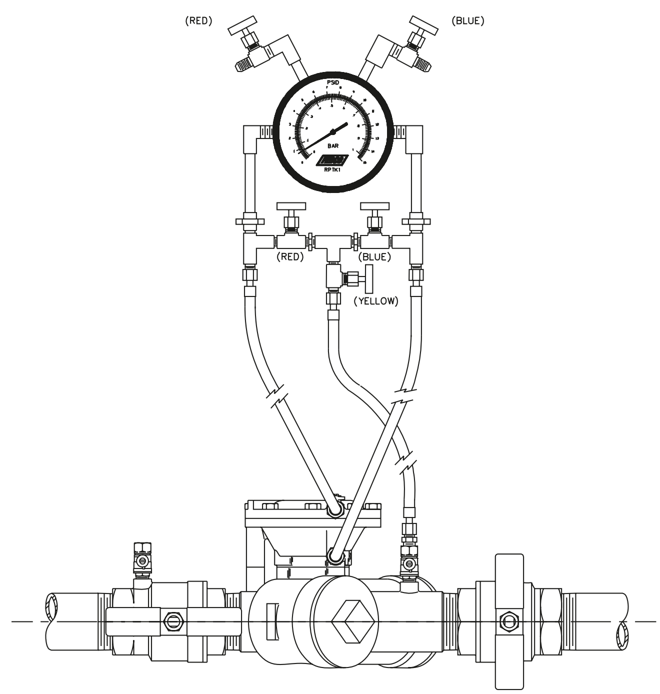


Figure No. 10



Service Procedure 825Y and YA ($^3/_4$–2")

1. Check Valve Inspection/Repair Model 825Y ($^3/_4$–2") (See Figure No. 11)

a. Close inlet and outlet shut-off valves. Bleed residual pressure by opening first the #4 test cock, then the #3 and #2 test cocks. See Figure No. 7 for test cock locations

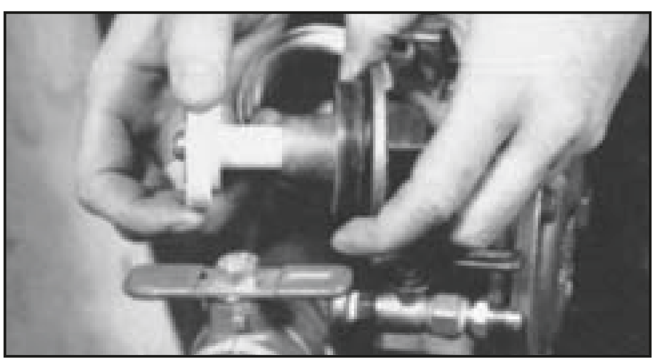
b. Unscrew Cap using appropriate size wrench.

CAUTION: Cap is spring loaded. First check spring force on $^3/_4$" to 1$^1/_2$" is 10 lb. First check spring force on 1$^1/_2$" to 2" is 28 lb. Retain cap with appropriate amount of hand force to avoid injury. Second check spring force is approximately $^1/_4$ of the first check spring.

c. Remove the spring and disc holder assembly.

d. Inspect guiding bore of the cap and poppet stem for any buildup of calcium or other mineral deposits. If this condition exists, it may be removed with the careful use of an appropriate size reamer or a thin blade knife. $^3/_4$–1$^1/_4$" cap —$^5/_8$" (.6250) reamer 1$^1/_2$–2" cap—$^7/_8$" (.8750) reamer.

e. Check disc holder and stem movement in the guide to ensure they move freely. Debris can inhibit proper movement.



2. Check Valve Seat Replacement Model 825Y ($^3/_4$–2") (See Figure No. 11)

a. Hold disc holder assembly in one hand and remove screw and disc washer.

CAUTION: The use of pliers or other tools may damage the guiding surfaces and require unnecessary replacement. Do not scratch or mark sealing or guiding surfaces.

b. Inspect seat disc for wear or cuts remove old seat disc and install new, or turn used disc over if new seat disc is not available.

NOTE: The seat discs are symmetrical. It is usually possible to turn the disc over and obtain an effective seal.

c. If the seat disc has been severely cut along the seat ring diameter, the assembly is being subjected to extremely high back pressure from thermal water expansion, water hammer or other causes of excessive water pressure. Seat discs damaged in such a manner should be replaced and not turned over to be reused.

3. Check Valve Reassembly Model 825Y ($^3/_4$–2") (See Figure No. 11)

a. Position the disc in the cleaned holder and retain with disc washer and screw. CAUTION: DO NOT OVERTIGHTEN SCREW, SECURE WITH APPROXIMATELY 12 INCH-LBS.

b. Position the spring around the centering ring of the disc holder and reinsert the disc holder assembly into the check body.

NOTE: Ensure the heavy check spring is installed in the No. 1 check valve or the valve will not operate properly and a continuous discharge may occur.

c. Apply a thin coating of FDA approved lubricant on the o-ring in the cap and thread cap onto the check valve body using the appropriate sized wrench.

Service Procedure 825Y and YA ($^{3}/_{4}$–2") (Continued)

d. Close the #4, #3, and #2 test cocks and slowly open first the inlet and then outlet shutoff valves and return the assembly to service. See Figure No. 7 for test cock locations.

e. Test the assembly to ensure it is operating properly.

4. Relief Valve Inspection/Repair Model 825Y ($^{3}/_{4}$–2") (See Figure No. 11)

a. Slowly close the inlet and outlet shutoff valves and bleed off the residual pressure by opening first test cocks # 4, then # 3 and # 2. See Figure No. 7 for test cock locations.

b. Remove capscrews, diaphragm cover, diaphragm and port bushing of relief valve.

c. Remove the integral relief valve assembly by pulling straight out of the body to remove the internal assembly.

d. Remove the disc washer and seat disc by unthreading the screw.

e. To remove spring and/or main stem from the guide, keep unit compressed and remove the screw (item 18) located in the center of the button. Push the main stem through the guide and remove the o-ring from the main stem. Inspect and clean or replace o-ring and seat disc as required. Clean all parts thoroughly with clean water before reassembly.

5. Relief Valve Seat Removal Model 825Y ($^{3}/_{4}$–2")

Standard only on units manufactured after October of 1988 with serial numbers higher than listed below. See Figure No. 11 for exploded view of this relief valve.

Serial #'s of new Model 825Y with replaceable valve seat ring:

$^{1}/_{4}$" Serial No. S6528 and above

1" Serial No. S6163 and above

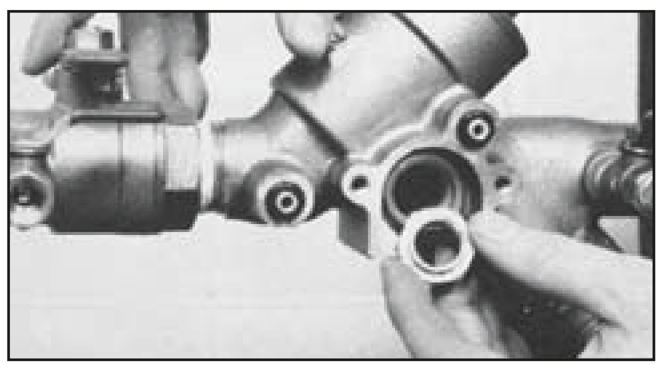
1$^{1}/_{2}$" Serial No. S5710 and above

2" Serial No. S5089 and above

a. While relief valve is disassembled, remove the two Allen head socket capscrews using the appropriate sized Allen head wrench. ($^{3}/_{16}$" Allen head wrench for $^{3}/_{4}$" and 1" assemblies, and $^{1}/_{4}$" Allen head wrench for 1$^{1}/_{2}$" and 2" assemblies.)

b. Pull the relief valve body from the main valve body. Pull the discharge shield from the seat ring

c. Remove seat ring with the appropriate sized socket or needle nose pliers. Use care to avoid damage to the seat edge. Replaceable relief valve seat is standard only on units manufactured after October of 1988.



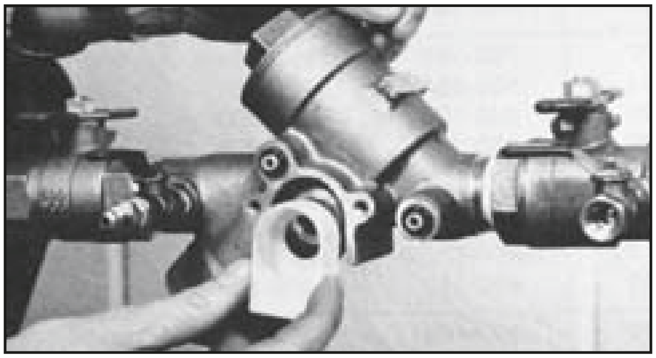
d. Inspect seat ring, o-rings, bushings, and gasket seals for damage. Rinse all parts with clean water before reassembly.

Service Procedure 825Y and YA (3/4–2") (Cont.)

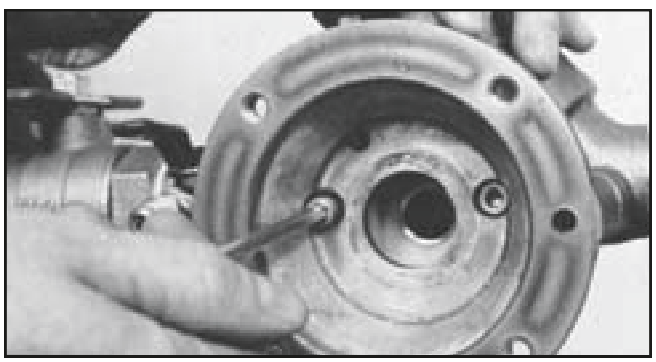
6. Relief Valve Reassembly Model 825Y (3/4–2") (See Figure No. 11)

a. Lubricate the seat ring o-ring with FDA approved lubricant and thread seat ring into the valve body until seated. Do not over tighten. (Replaceable relief valve seat ring standard on units manufactured after October of 1988.)

b. Position the discharge shield over the seat ring diameter and, taking care not to damage the two flow passages, reinstall o-rings and guide bushings.



c. Carefully place the relief valve body over the bushing and tighten the two capscrews to retain the relief valve body to the main valve body. New capscrew sealing washers should be installed to avoid leakage.



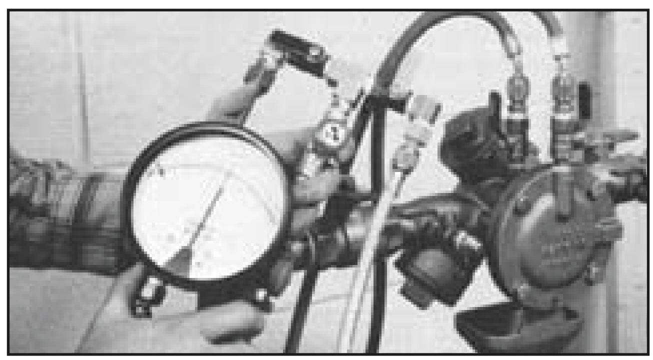
d. Lubricate the o-rings and main stem using FDA approved lubricant. Place the main stem and spring into the guide and replace the flat head screw located at the center button.

e. Place the disc washer and seat disc in position and retain with machine screw. Depress the diaphragm button to ensure it is free moving.

f. Place the relief valve module into the relief valve body and mount the diaphragm. Be careful to position the diaphragm over the port bushing. Replace the relief valve cover and tighten the capscrews.

g. After completing reassembly by, slowly open the inlet shut-off valve. Then bleed air from each chamber and from the relief valve cover by opening test cocks # 4, # 3, and # 2. See Figure No. 7 for test cock locations. Slowly open outlet shut-off valve and return the valve to service.

h. Test the assembly to ensure it is operating properly.



Model 825Y and YA (3/4–2") Parts

Model 825Y & YA Part Numbers (Sizes ¾–2″)

ITEM NO.	DESCRIPTION	QTY.*	SIZE ¾"	SIZE 1"	SIZE 1¼"	SIZE 1½"	SIZE 2"
3	Bushing	3	500-290	500-290	500-290	500-290	500-290
4	O-ring	2	398-202-72	398-202-72	398-202-72	398-202-72	398-202-72
5	Gasket	2	340-078	340-078	340-078	340-079	340-079
6	Capscrew	2	515-513-05	515-513-05	515-513-05	515-514-06	515-514-06
7	Cap	2	101-134	101-134	101-134	101-135	101-135
8	O-ring	2	398-226-72	398-226-72	398-226-72	398-235-72	398-235-72
9	Disc Holder	2	500-270	500-270	500-270	500-278	500-278
10	Seat Disc	2	400-099	400-099	400-099	400-103	400-103
11	Washer	2	300-084	300-084	300-084	300-108	300-108
12	Screw	2	516-543-03	516-543-03	516-543-03	516-543-03	516-543-03
13	Spring (Inlet)	1	630-125	630-125	630-125	630-137	630-137
14	Spring (Outlet)	1	630-115	630-115	630-115	630-118	630-118
15	Bolt	4	511-514-06	511-514-06	511-514-06	-----	-----
15	Bolt	8	-----	-----	-----	511-515-07	511-515-07
16	Cover	1	101-029	101-029	101-046	101-035	101-035
17	Diaphragm	1	400-101	400-101	400-101	400-104	400-104
18	Screw	1	700-107	700-107	700-107	519-513-03	519-513-03
19	Button	1	500-284	500-284	500-284	300-107	300-107
20	Spring	1	630-126	630-126	630-126	630-138	630-138
21	Mainstem	1	500-273	500-273	500-273	500-280	500-280
22	O-ring	1	398-113-72	398-113-72	398-113-72	398-120-72	398-120-72
23	Guide	1	500-277	500-277	500-277	500-281	500-281
24	O-ring	1	398-022-72	398-022-72	398-022-72	398-127-72	398-127-72
25	Seat Disc	1	400-102	400-102	400-102	400-105	400-105
26	Washer	1	300-104	300-104	300-104	300-105	300-105
27	Screw	1	700-137	700-137	700-137	519-513-03	519-513-03
101	Seat Ring (Relief Valve)	1	200-779	200-779	-----	200-780	200-780
102	O-ring (Relief Valve)	1	398-019-72	398-019-72	-----	398-026-72	398-026-72
103	Elbow (YA only)	2	101-194	101-195	-----	101-189	101-190
104	O-ring (YA only)	2	398-223-72	398-223-72	-----	398-230-72	398-230-72

* Quantity required per valve.

Shutoffs: Model 825Y & YA

ITEM NO.	DESCRIPTION	QTY.*	SIZE ¾"	SIZE 1"	SIZE 1¼"	SIZE 1½"	SIZE 2"
29	Ball Valve (Inlet)	1	781-053	781-054	781-055	781-056	781-057
29A	Ball Valve (Outlet)	1	781-048	781-049	781-050	781-051	781-052
30	Testcock	4	781-074	781-074	781-075	781-075	781-075

* Quantity required per valve.

Model 825Y, 825YR and YA (3/4–2") Parts (Cont.)

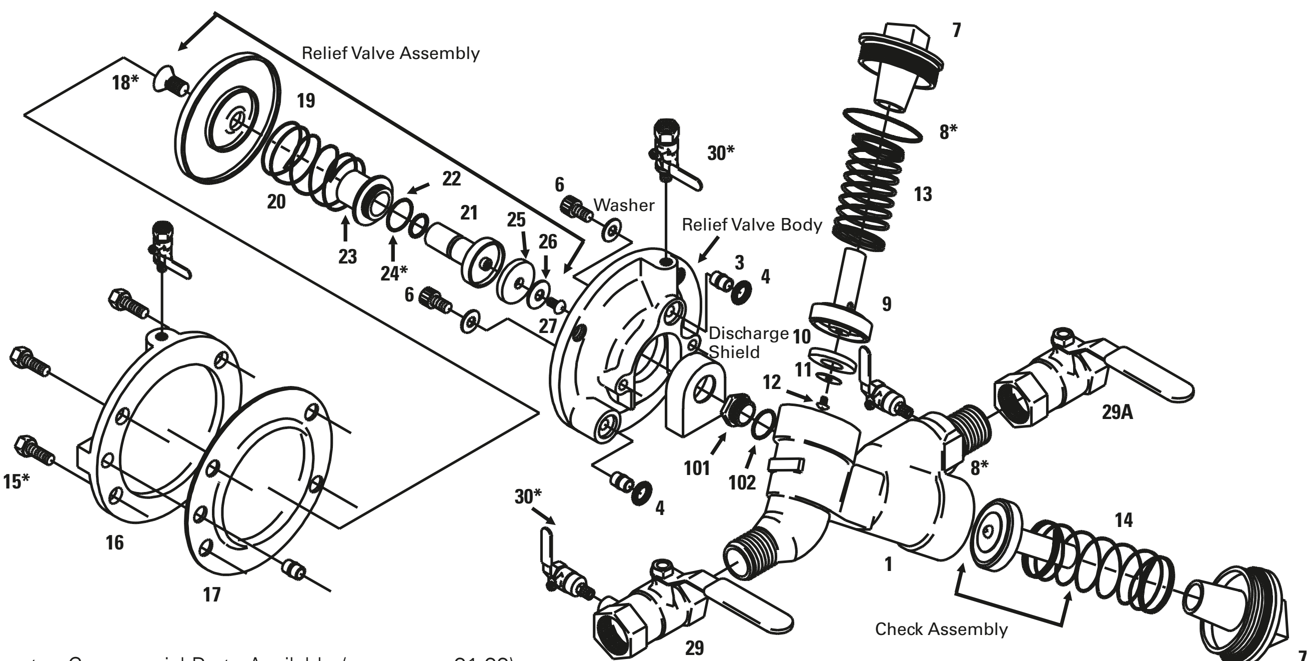
Assemblies / Kits: Model 825Y & YA

DESCRIPTION	QTY.*	SIZE 3/4"	SIZE 1"	SIZE 1 1/4"	SIZE 1 1/2"	SIZE 2"
Check Valve Rubber Kit (2 ea. 8, 10)	1 Kit	905-042	905-042	905-042	905-053	905-053
Relief Valve Rubber (1 ea. 17, 22, 24, 25)	1 Kit	905-043	905-043	905-043	905-054	905-054
Check Valve Assembly (1 ea. 8, 9, 10, 11, 12)	2 Assy.	905-044	905-044	905-044	905-055	905-055
Relief Valve Assembly (1 ea. 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27)	1 Assy.	905-045	905-045	905-045	905-056	905-056
RV Seat Ring Kit (101, 102)	1 Kit	905-113	905-113	-----	905-114	905-114
Complete Rubber Parts Kit (3, 4, 5, 8, 10, 17, 22, 24, 25, 102)	1 Kit	905-111	905-111	905-111	905-112	905-112
825YR Seat Ring Repair Kit (35, 36)	1 Kit	905-280	905-280	-----	905-281	905-281

* Quantity required per valve.

Model 825Y (3/4–2")

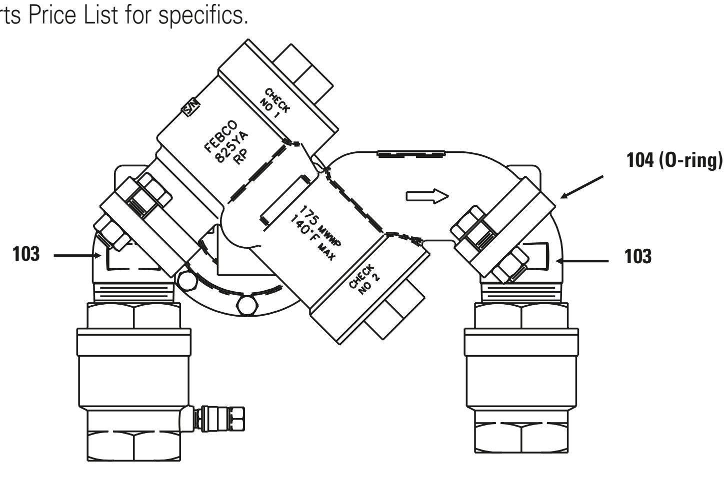
Figure No. 11



* Denotes Commercial Parts Available (see pages 31-33).
Unit is shown with ball valve shutoffs.
Some parts are sold in kits only. Consult Parts Price List for specifics.

Model 825YA (3/4–2")

Figure No. 12



Service Procedures 825, 825D, 825YD and 826YD (2½–3")

1. Check Valve Disassembly Models 825, 825D and 825YD (Sizes 2½–3") (See Figure No. 13)

a. Slowly close outlet shutoff valve and inlet shutoff valve. Bleed residual pressure by opening #4, #3 and # 2 test cocks. See Figure No. 8 for test cock location.

b. Remove cover bolts uniformly while holding cover in place. Remove cover.

CAUTION: Spring is retained in body by cover.

c. Lift check assembly from body being careful not to damage internal epoxy coating.

d. If necessary, un-thread bushing (item 4A) from cover.

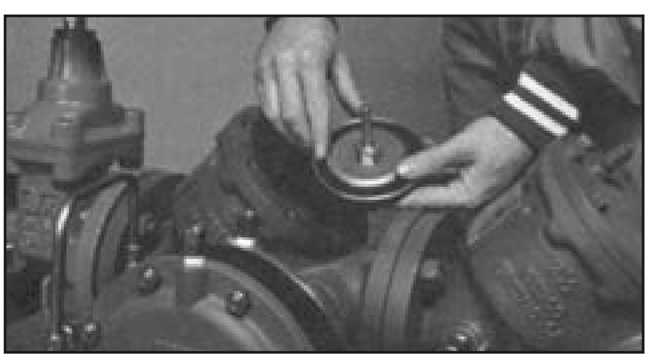
2. Check Assembly Repair Models 825 825D and 825YD (Sizes 2½–3") (See Figures No. 15 & 16)

a. Un-thread nut on stem and remove disc washer and seat disc.

b. Inspect seat disc for wear or damage. Replace with new seat disc or turn used disc over if new disc is not available.

NOTE: The discs are symmetrical. It is usually possible to turn the disc over and obtain an effective seal.

c. If the seat disc has been severely cut along the seat disc ring diameter, the assembly is being subjected to extremely high back pressure from thermal water expansion, water hammer, or other causes of excessive water pressure. A disc damaged in such a manner should be replaced and not turned over to be reused.



3a. Valve Seat Removal (Sizes 2½–3") Threaded-in Seat Ring Type Models Model 825 (See Figure No. 13)

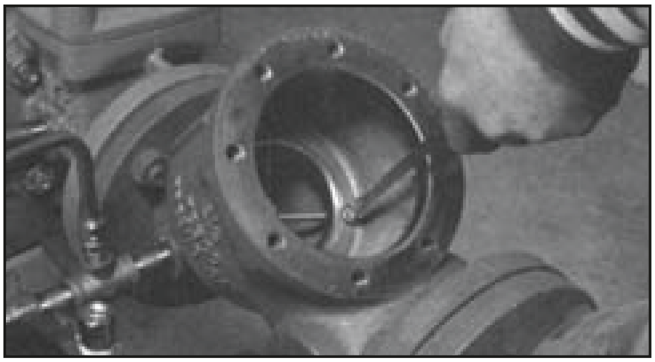
1. Remove seat ring by un-threading in counterclockwise direction being careful not to damage the internal epoxy coating in valve. A tool to aid in this process is described in Figure No. 21 on page 30.

2. Remove bushing and bushing nut (item 2A & 2B).
3. Remove o-ring.

Service Procedures 825, 825D, 825YD and 826YD (2½–3") (Continued)

3b. Valve Seat Removal (Sizes 2½–3") Bolted in Seat Ring Type Models 825D & 825YD (See Figure No. 14)

1. Remove the three capscrews and washers retaining the seat ring.



2. Pull the seat ring from the valve body being careful not to damage the internal epoxy coating of valve.
3. If necessary, un-thread the bushing (Item 2A) from the seat ring.
4. Remove the o-ring.

4a. Valve Seat Reassembly (Sizes 2½–3') Threaded-in Seat Ring Type Models Model 825 (See Figure No. 13)

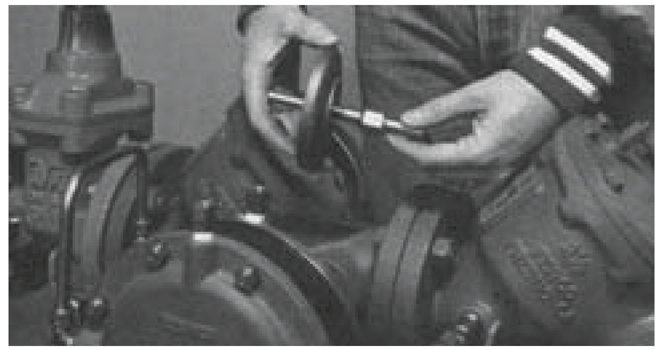
1. Lubricate o-ring with FDA approved lubricant and replace on seat ring.
2. Reinsert bushing into seat ring center.
3. Thread seat ring into valve body in clockwise direction being careful not to damage the internal epoxy coating of valve.

4b. Valve Seat Reassembly (Sizes 2½–3") Bolted-in Seat Ring Type Models Model 825D & 825YD (See Figure No. 14)

1. Lubricate o-ring with FDA approved lubricant and replace in seat ring.
2. Thread bushing into seat ring.
3. Place the seat ring carefully into body and retain with three capscrews and washers being careful not to damage the internal epoxy coating of valve.

5. Check Valve Reassembly (Sizes 2½–3") (See Figures No. 15 & 16)

a. Position the disc in the cleaned holder and retain with disc washer. Insert stem into disc holder, replace the nut on stem and tighten.



NOTE: On older Model 825 valves, the disc holder is sealed to the stem with a sealant. If the seal is broken, the stem and holder must be cleaned and new sealant applied. Newer valves, Models 825D and 825YD, use an o-ring so a sealant is not required.

b. Thread bushing into cover.

c. Carefully place stem of check assembly into seat ring bushing. Replace spring centering diameter on the disc washer.

NOTE: Be sure the heavier spring (6 psi) is placed in first check and lighter spring (2 psi) is placed in second check or the unit will not operate properly and discharge from the relief valve could occur. The wire diameter is visibly thicker on the heavier spring and thinner on the lighter spring. Care should be taken to avoid damaging internal epoxy coating of valve.

d. Place cover on check body securing spring and stem into cover.

e. Bolt cover onto check body while holding cover in place with appropriate hand force. Spring will be retained in body by cover.

f. Slowly open inlet shutoff valve. Bleed air from valve by opening first the # 4 test cock, then the # 3, # 2 and # 1 test cocks and air bleeds on all covers. See Figure No. 8 for test cock locations.

g. Slowly open outlet shutoff valve and return the valve to service.

h. Test the assembly to ensure it is operating properly.

Service Procedures 825, 825D and 825YD (4–10")

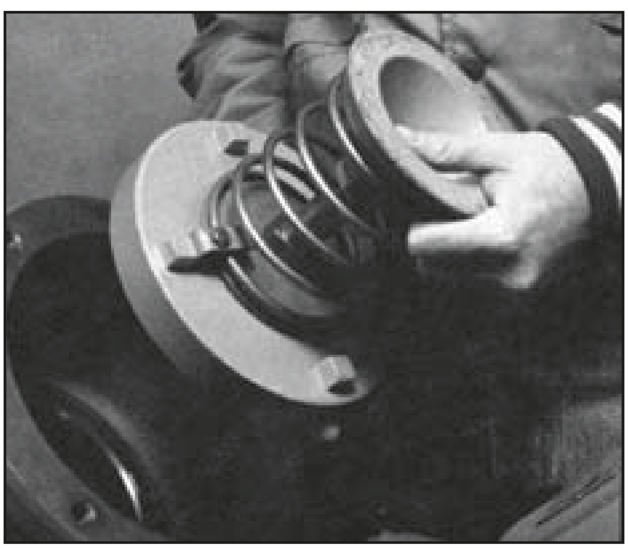
1. Check Valve Disassembly (Sizes 4–10") (See Figures No. 15 & 16)

a. Slowly close outlet gate valve then slowly close inlet gate valve. Bleed residual pressure by opening first the #4 test cock, then #3, and #2 test cocks. See Figure No. 8 for test cock locations.

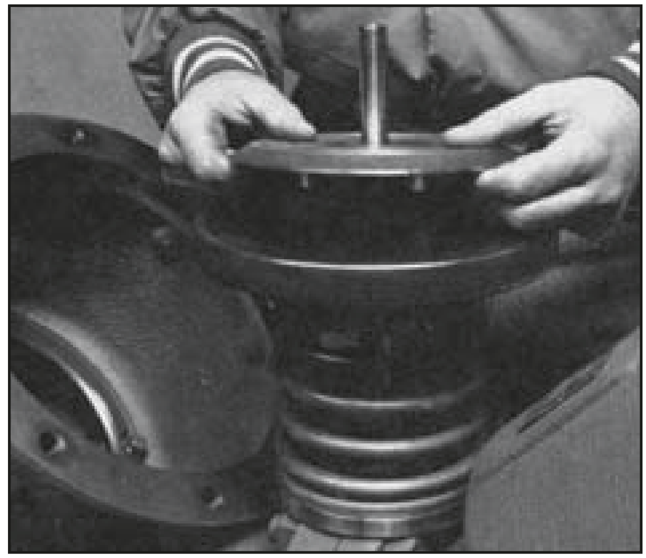
b. Remove cover bolts and cover. Unscrew bolts uniformly to avoid binding of the cover. The spring will push the cover approximately 1/2 inch off the top of the valve body.

2. Seat Disc Removal (Sizes 4–10')

CAUTION: The newer model 825 cast iron units have threaded disc holders with four (4) cast lugs, (6 lugs on 10" assemblies), 1/2" high located on back side, outside the spring diameter. If the Model 825 you are servicing does not have these lugs, SPRING TENSION MUST BE RELEASED BY USING THE SPRING REMOVAL TOOL BEFORE FURTHER DISASSEMBLY. DO NOT ATTEMPT TO REMOVE SPRING TENSION ON OLDER MODEL 825s WITHOUT THE USE OF THIS TOOL. SEE SPRING REMOVAL INSTRUCTIONS. Newer Models 825, 825D and 825YD assemblies have the disc holder threaded on the stem. Therefore, the seat disc can be removed without releasing spring tension on these newer models.



a. Un-thread retaining nut from stem and remove disc washer and seat disc.



b. Inspect seat disc for wear or damage. Replace with new seat disc or turn used disc over if new disc is not available.

NOTE: The discs are symmetrical. It is usually possible to turn the disc over and obtain an effective seal.

c. If the seat disc has been severely cut along the seat disc ring diameter, the assembly is being subjected to extremely high back pressure from thermal water expansion, water hammer, or other causes of excessive water pressure. A seat disc damaged in this manner should be replaced and not turned over for reuse.

d. Remove disc holder from stem.

NOTE: On older Model 825 valves, the disc holder is sealed to the stem with a sealant. If the seal is broken, the stem and holder must be cleaned and new sealant applied. Newer valves, Models 825D and 825YD use an o-ring so a sealant is not required.

3. Spring Removal (Sizes 4–10") (See Figures No. 15 & 16)

CAUTION: TO AVOID POSSIBLE INJURY, DO NOT ATTEMPT TO REMOVE SPRING TENSION WITHOUT THE USE OF THE SPRING REMOVAL TOOL SHOWN IN FIGURE NO. 20 ON PAGE 30. ON OLDER MODEL 825 VALVES, IT IS NECESSARY TO REMOVE THE SPRING BEFORE THE RUBBER SEAT DISC CAN BE REMOVED.

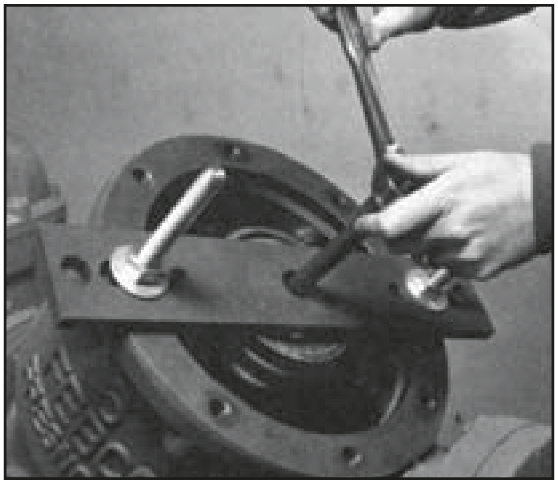
a. Leave check assembly in body.

b. Install long studs in body 180 degrees apart.

c. Place spring removal tool over stud and retain with nuts. (See Figure No. 20 for dimensions.)

Service Procedures 825, 825D and 825YD (4–10") (Continued)

d. Un-thread capscrew (Item 7A) using 9/16" hex socket.



e. Release spring tension by un-threading nuts on long studs. Use alternating turns to keep tool parallel to valve body.

f. Remove spring guide and stem assembly.

g. Remove guide bushing by un-threading.

4a. Valve Seat Removal (Sizes 4–10") Threaded-in Seat Ring Type Model 825 (See Figure No. 13)

1. Remove check valve as described above.
2. Remove seat ring by un-threading in the counterclockwise direction. For ease of removal, Figure No. 21 on page 30 defines a simple tool for this purpose.

3. Remove bushing and bushing nut if used (bushing and nut is used on older Model 825).
4. Remove o-ring.

4b. Valve Seat Removal (Sizes 4–10") Bolted in Seat Ring Type Model 825D and 825YD (See Figure No. 14)

1. Remove check valve as described above.
2. Remove the three capscrews and washers retaining the seat ring.
3. Pull the seat ring from the valve body.
4. Un-thread the bushing (Item 2A) from the seat ring.
5. Remove the o-ring.

5a. Valve Seat Reassembly (Sizes 4–10") Threaded-in Seat Ring Type Models Model 825 (See Figure No. 13)

1. Lubricate o-ring with FDA approved lubricant. Reposition the o-ring in the seat ring groove.
2. Replace the bushing and bushing nut (if used) in the seat ring (the bushing and nut is used on older Model 825).
3. Thread the seat ring into the seating area in a clockwise direction. Be careful not to damage internal epoxy coated surfaces.

5b. Valve Seat Reassembly (Sizes 4–10") Bolted-in Seat Ring Type Models Model 825D and 825YD (See Figure No. 14)

1. Lubricate o-ring with FDA approved lubricant. Reposition the o-ring in the seat ring groove.
2. Thread the bushing into the seat ring.
3. Place the seat ring carefully into the valve body and retain with three capscrews and washers being careful not to damage the internal expoxy coated surfaces.

6. Check Valve Reassembly Models 825, 825D and 825YD

a. Use reverse procedure for assembly.

b. Make sure the o-ring is properly placed in the groove. Do not force the cover into the body.

c. Do not damage epoxy coated surfaces.

d. Test unit to ensure proper operation.

Model 825 (2½–10") Parts

Check Valve Body: Model 825

ITEM NO.	DESCRIPTION	QTY.*	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
2	Seat Ring	2	780-273	780-274	780-275	780-276	780-277	780-278
2A	Bushing	2	780-280	780-280	780-281	780-281	780-282	780-282
3	Guide	2	-----	-----	190-001	190-002	190-003	190-004
4	Cover	2	780-306	780-307	780-308	780-309	780-310	780-311
4A	Bushing	2	780-312	780-312	780-313	780-313	780-313	780-313
5	Disc Holder	2	190-013	190-014	190-005	190-006	190-007	190-008
6	Disc Washer	2	190-016	190-017	190-009	190-010	190-011	190-012
7	Stem	2	780-332	780-333	780-334	780-335	780-336	780-337
7A	Screw	2	-----	-----	511-515-08	511-515-08	511-515-08	511-515-08
7B	Washer	2	-----	-----	780-338	780-338	780-338	780-338
9	Spring (Outlet)		780-341	780-342	780-343	780-344	780-345	780-346
10	Spring (Inlet)		780-349	780-350	780-351	780-352	780-353	780-354
11	Seat Disc	2	780-357	780-358	780-359	780-360	780-361	780-362
12	O-ring	2	398-238-72	398-246-72	398-254-72	398-264-72	398-273-72	780-095
13	Capscrew	16	511-516-08	511-516-08	511-517-08	511-519-12	511-520-12	
13	Capscrew	24	-----	-----	-----	-----	-----	511-520-14
14	O-ring	2	398-244-72	398-252-72	398-263-72	398-272-72	398-451-72	740-102
15	Locknut	2	521-547-00	521-547-00	521-550-00	521-550-00	521-551-00	521-551-00
16	Gasket	3	780-365	780-366	780-367	780-368	780-369	780-370
17	Bolt	12	511-019-18	511-019-20	-----	-----	-----	-----
17	Bolt	24	-----	-----	521-019-22	521-020-26	521-020-28	-----
17	Bolt	36	-----	-----	-----	-----	-----	511-021-30
17A	Nut	12	521-019-00	521-019-00	-----	-----	-----	-----
17A	Nut	24	-----	-----	521-019-00	521-020-00	521-020-00	-----
17A	Nut	36	-----	-----	-----	-----	-----	521-021-00
40	Plug Cock	4	781-047	781-047	781-047	781-048	781-048	781-048
41	Nipple	4	571-181-44	571-181-44	571-181-44	571-181-55	571-181-55	571-181-55
50	Air Bleed	4	9594A110	9594A110	9594A110	9594A110	9594A110	9594A110
51	O-ring	2	398-014-72	398-014-72	398-116-72	398-116-72	398-118-72	398-118-72
121	Relief Valve Assem.	1	902-440L	902-440L	902-446L	902-446L	902-446L	902-446L

* Quantity required per valve.

Shutoffs: Model 825

ITEM NO.	DESCRIPTION	QTY.*	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
42	Resilient Sealed NRS (Inlet)	2	781-005	781-006	781-007	781-008	781-009	781-010
42	Resilient Sealed OS&Y (Inlet)	2	780-891	780-893	780-895	780-897	780-899	780-901
42A	Resilient Sealed NRS (Outlet)	2	781-011	781-012	781-013	781-014	781-015	781-016
42A	Resilient Sealed OS&Y (Outlet)	2	780-890	780-892	780-894	780-896	780-898	780-900

* Quantity required per valve.

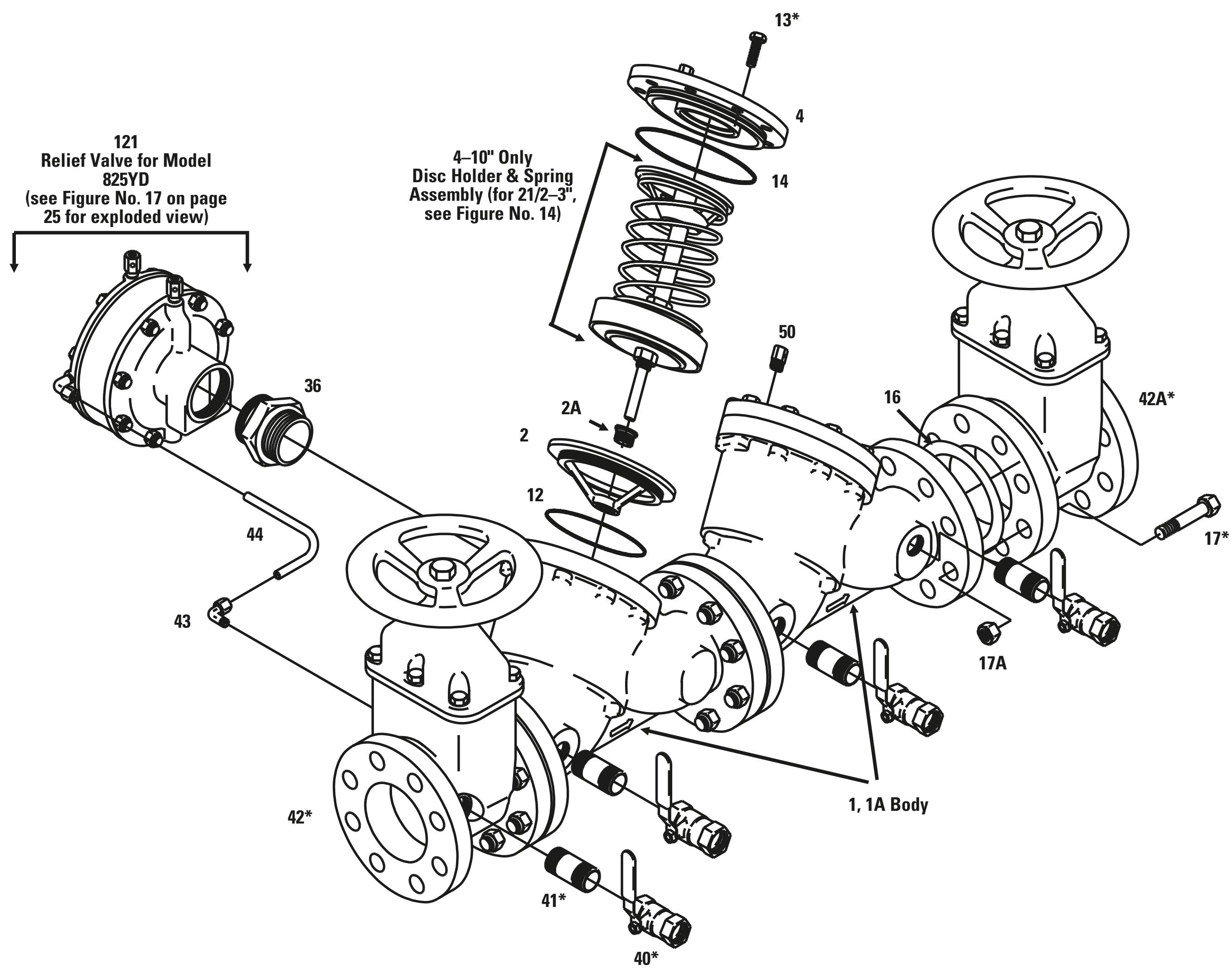
Model 825 (2½–10") Parts (Continued)

Assemblies / Kits: Model 825

DESCRIPTION	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
**Relief Valve Assembly (121) (825)	905-526	905-100	905-101	905-101	905-522	905-522
(825D)	905-100	905-100	905-100	905-101	905-522	905-522
Spring Assembly #1 Check (3, 4A, 5, 6, 7, 7A, 10, 11, 15, 51)	905-085	905-087	902-466	902-468	902-470	902-472
Spring Assembly #2 Check (3, 4, 5, 6, 7, 7A, 7B, 9, 10, 11, 15, 51)	905-086	905-088	902-467	905-469	902-471	902-473
Seat Ring Kit (2, 2A, 12)	902-386	902-385	902-384	902-383	902-382	902-381
Rubber Parts, CI & DI Boddies (11, 14, 51)	905-059	905-060	905-061	905-062	905-063	905-064
Relief Valve Kit (Rubber Parts) (26, 27, 32, 39, 49, - 2 ea.)	905-066	905-066	905-067	905-067	905-067	905-067
LG Mounting Kit (16, 17, 17A, 40, 41, Both Ends)	905-036	905-037	905-038	905-039	905-040	905-041

**825YD Relief valve is used for replacement. See Figure 18 on page 26 for details.
* Quantity required per valve.

Model 825 (2½–10") Cast Iron Body
Figure No. 13



* Denotes Commercial Parts Available (see pages 31-33).
Some parts are sold in kits only. Consult Parts Price List for specifics.

Model 825 Type D and YD (2½–10") Parts

Check Valve Body: Model 825D & 825YD

ITEM NO.	DESCRIPTION	QTY.*	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
2	Seat Ring	2	101-145	101-144	101-136	101-137	101-138	101-139
2A	Bushing	2	500-291	500-291	500-292	500-292	780-282	780-282
2C	Washer	6	360-079	360-079	360-078	360-078	360-078	360-078
2D	Capscrew	6	519-513-04	519-513-04	511-514-06	511-514-06	511-514-06	511-514-06
3	Guide	2	-----	-----	190-001	190-002	190-003	190-004
4	Cover	2	902-497	902-498	902-499	902-500	902-501	902-502
4A	Bushing	2	780-312	780-312	780-313	780-313	780-313	780-313
5	Disc Holder	2	190-013	190-014	190-005	190-006	190-007	190-008
6	Disc Washer	2	190-016	190-017	190-009	190-010	190-011	190-012
7	Stem	2	780-332	780-333	780-334	780-335	780-336	780-337
7A	Screw	2	-----	-----	511-515-08	511-515-08	511-515-08	511-515-08
7B	Washer	2	-----	-----	780-338	780-338	780-338	780-338
9	Spring (Outlet)		780-341	780-342	780-343	780-344	780-345	780-346
10	Spring (Inlet)		780-349	780-350	780-351	780-352	780-353	780-354
11	Seat Disc	2	780-357	780-358	780-359	780-360	780-361	780-362
12	O-ring (Seat Ring)	2	398-237-72	398-242-72	398-253-72	398-263-72	398-272-72	398-274-72
13	Capscrew	16/24	511-516-08	511-516-08	511-517-10	511-519-12	511-520-12	511-520-14
14	O-ring (Cover)	2	398-346-72	398-354-72	398-365-72	398-374-72	398-379-72	398-381-72
15	Locknut	2	521-547-00	521-547-00	521-550-00	521-550-00	521-551-00	521-551-00
16	Gasket	3	780-365	780-366	780-367	780-368	780-369	780-370
17	Bolt	10	511-019-18	511-019-20	-----	-----	-----	-----
17	Bolt	18	-----	-----	511-019-22	511-020-26	511-020-28	
17	Bolt	36	-----	-----	-----	-----	-----	511-021-30
17A	Nut	14	521-019-00	521-019-00	-----	-----	-----	-----
17A	Nut	30	-----	-----	521-019-00	521-020-00	521-020-00	-----
17A	Nut	36	-----	-----	-----	-----	-----	521-021-00
17B	Stud	2	513-019-26	513-019-26	-----	-----	-----	-----
17B	Stud	6	-----	-----	513-019-26	513-020-32	513-020-32	-----
39	Nipple	1	573-181-81	573-181-81	573-181-81	573-183-11	573-183-11	573-183-11
40	Plug Cock	4	781-047	781-047	781-047	781-048	781-048	781-048
41	Nipple	3	571-181-44	571-181-44	571-181-44	571-181-55	571-181-55	571-181-55
41A	Nipple	2	571-181-43	571-181-43	571-181-43	571-181-53	571-181-53	571-181-53
41B	Tee		571-131-42	571-131-42	571-131-42	571-131-52	571-131-52	571-131-52
43	Tube Fitting 90º	1	571-231-23	571-231-23	571-231-23	571-231-23	571-231-23	571-231-23
43A	Tube Fitting	1	571-211-23	571-211-23	571-211-23	571-211-23	571-211-23	571-211-23
50	Air Vent	4	9594A110	9594A110	9594A110	9594A110	9594A110	9594A110
51	O-ring	2	398-014-72	398-014-72	398-116-72	398-116-72	398-118-72	398-118-72

* Quantity required per valve.

(See Page 24 for Assemblies and Kits)

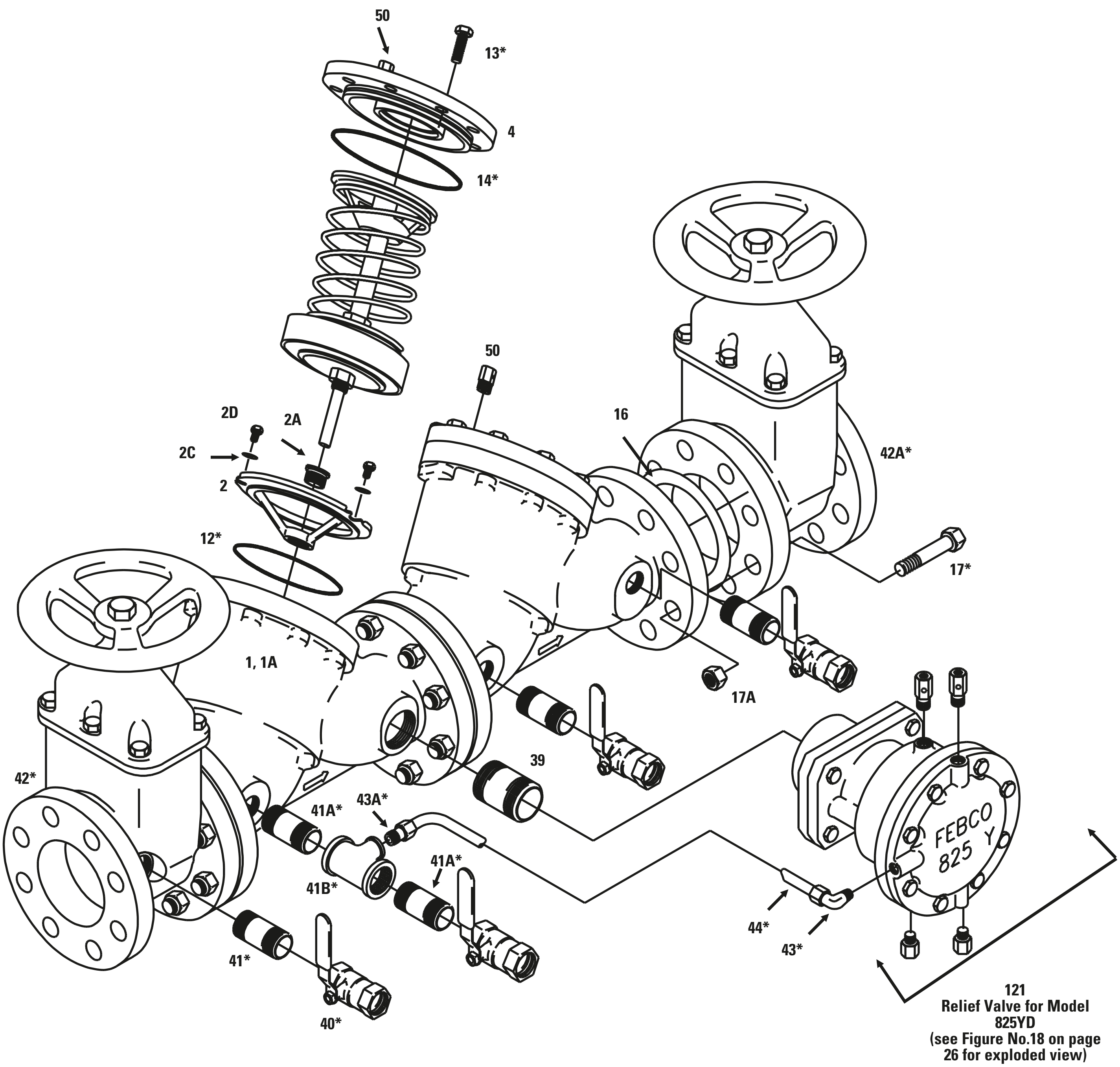
Shutoffs: Model 825D & 825YD

ITEM NO.	DESCRIPTION	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
42	Resilient Sealed NRS (Inlet)	781-005	781-006	781-007	781-008	781-009	781-010
42	Resilient Sealed OS&Y (Inlet)	780-891	780-893	780-895	780-897	780-899	780-901
42A	Resilient Sealed NRS (Outlet)	781-011	781-012	781-013	781-014	781-015	781-016
42A	Resilient Sealed OS&Y (Outlet)	780-890	780-892	780-894	780-896	780-898	780-900

(Parts List continued on page 24)

Model 825D and 825YD (2 1/2–10")

Figure No. 14



* Denotes Commercial Parts Available (see page 31-33).
Some parts are sold in kits only. Consult Parts Price List for specifics.

Model 825 Type D and YD (2½–10") Parts

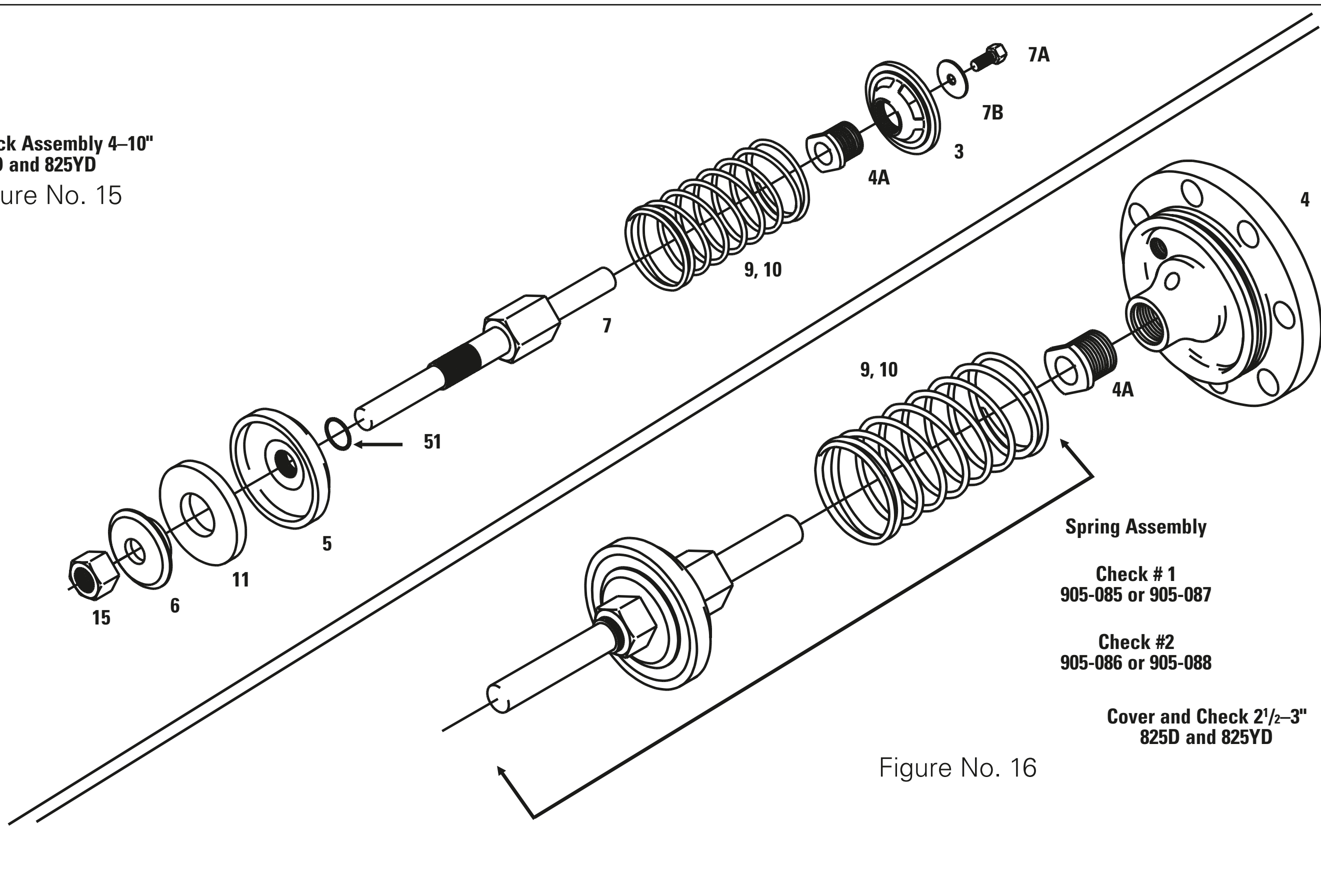
Assemblies / Kits: Model 825D

DESCRIPTION	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
Spring Assembly #1 Check (3, 4A, 5, 6, 7, 7A, 7B, 10, 11, 15, 51)	905-085	905-087	902-466	902-468	902-470	902-472
Spring Assembly #2 Check (3, 4A, 5, 6, 7, 7A, 7B, 9, 10, 11, 15, 51)	905-086	905-088	902-467	905-469	902-471	905-473
Rubber Parts, CI & DI Bodies (11, 14, 51)	905-059	905-060	905-061	905-062	905-063	905-064
Relief Valve Kit (Type D Only)	902-440	902-440	902-440	902-446	902-446	902-446
Relief Valve Kit (26, 27, 32, 39, 49 -2 ea.) - Rubber Parts	905-066	905-066	905-066	905-067	905-067	905-067
LG Mounting Kit (16, 17, 17A, 17B, 40, 41, Both Ends)	905-036	905-037	905-038	905-039	905-040	905-041

Assemblies / Kits: Model 825YD

DESCRIPTION	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
Spring Assembly #1 Check (3, 4A, 5, 6, 7, 7A, 7B, 10, 11, 15, 51)	905-085	905-087	902-466	902-468	902-470	902-472
Spring Assembly #2 Check (3, 4A, 5, 6, 7, 7A, 7B, 9, 10, 11, 15, 51)	905-086	905-088	902-467	905-469	902-471	905-473
Seat Ring Kit (2, 2A, 2C, 2D, 12)	902-386YD	902-385YD	902-384YD	902-383YD	902-382YD	902-381YD
Rubber Parts, CI & DI Boddies (11, 14, 51)	905-059	905-060	905-061	905-062	905-063	905-064
Large Mounting Kit (16, 17, 17A, 17B, 40, 41, Both Ends)	905-036	905-037	905-038	905-039	905-040	905-041
Relief Valve Assy (Type YD Only) (21 - 50)	905-100	905-100	905-100	905-101	905-101	905-101
Relief Valve Kit - Rubber (26, 27, 27A, 31A, 32)	905-102	905-102	905-102	905-102	905-102	905-102
Relief Valve Seat Ring Kit (22A, 22B, 36, 36A, 36B)	905-103	905-103	905-103	905-103	905-103	905-103
Internal Modular Assembly - Relief Valve Kit	905-104	905-104	905-104	905-104	905-104	905-104

Check Assembly 4–10"
825D and 825YD
Figure No. 15



Cover and Check 2½–3"
825D and 825YD

Figure No. 16

Model 825 and 825D (2½–10") Parts

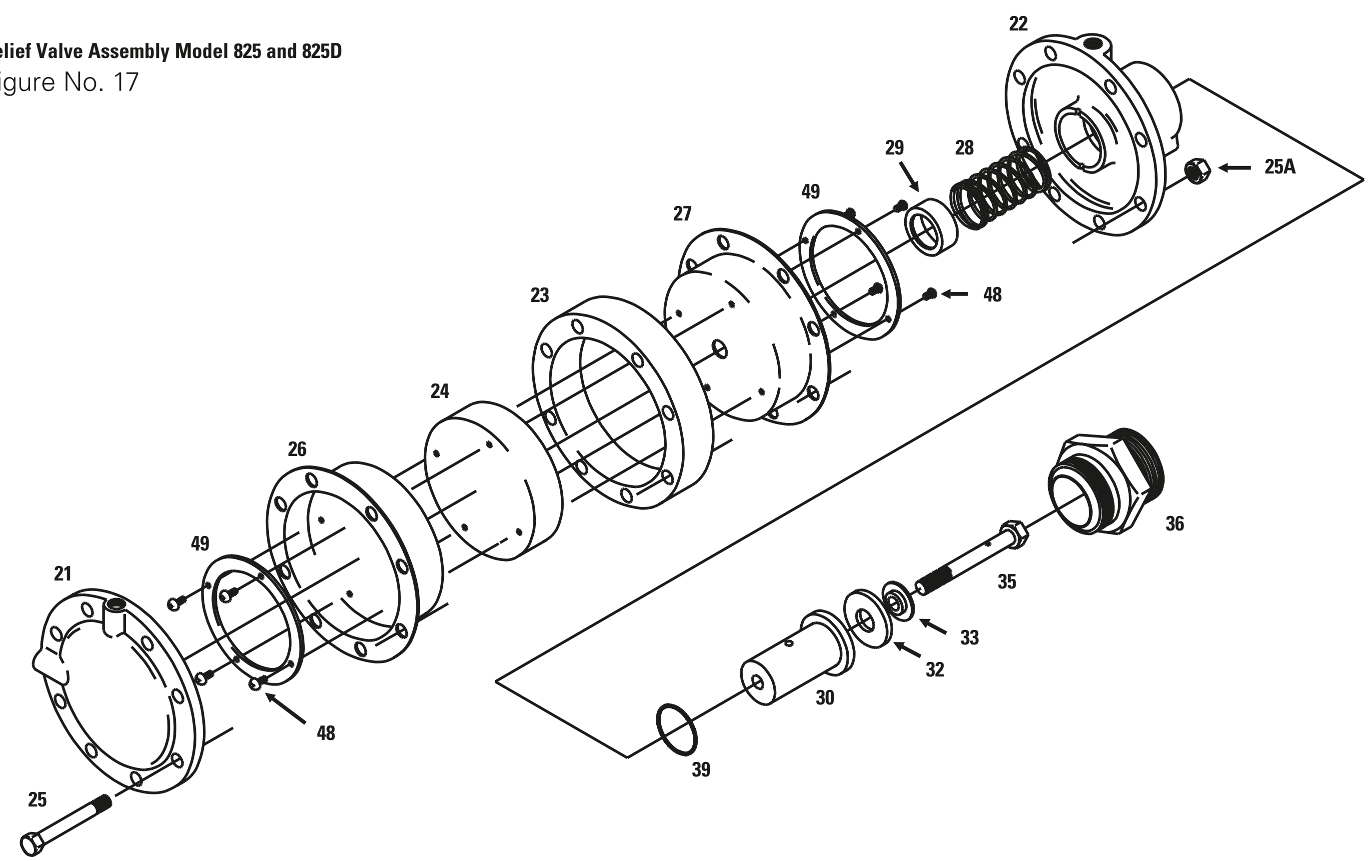
Relief Valve Body: Model 825 & 825D

ITEM NO.	DESCRIPTION	QTY.*	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
21	Diaphragm Cover	1	780-372	780-372	780-372	780-372	780-372	780-372
23	Diaphragm Spacer	1	780-377	780-377	780-377	780-377	780-377	780-377
24	Diaphragm Button	1	780-379	780-379	780-379	780-379	780-379	780-379
25	Bolt	8	511-515-22	511-515-22	511-515-22	511-515-22	511-515-22	511-515-22
25A	Nut	8	521-515-00	521-515-00	521-515-00	521-515-00	521-515-00	521-515-00
26	Diaphragm	1	780-381	780-381	780-381	780-381	780-381	780-381
27	Diaphragm	1	780-383	780-383	780-383	780-383	780-383	780-383
28	Spring	1	780-385	780-385	780-386	780-386	780-386	780-386
29	Spring Button	1	780-388	780-388	780-389	780-389	780-389	780-389
30	Main Stem	1	780-391	780-391	780-392	780-392	780-392	780-392
32	Seat Disc	1	780-395	780-395	780-395	780-395	780-395	780-395
33	Disc Washer	1	780-397	780-397	780-398	780-398	780-398	780-398
35	Orifice Bolt	1	780-399	780-399	780-399	780-399	780-399	780-399
36	Seat Ring (825)	1	780-402	780-403	780-404	780-404	780-405	780-405
36	Seat Ring (825D)	1	780-403	780-403	780-403	780-404	780-405	780-405
39	O-ring	1	398-222-72	398-222-72	398-330-72	398-330-72	398-330-72	398-330-72
48	Capscrew	8	700-137	700-137	700-137	700-137	700-137	700-137
49	Daphragm Washer	2	780-415	780-415	780-415	780-415	780-415	780-415

* Quantity required per valve.

Relief Valve Assembly Model 825 and 825D

Figure No. 17



* Denotes Commercial Parts Available (see page 31-33).

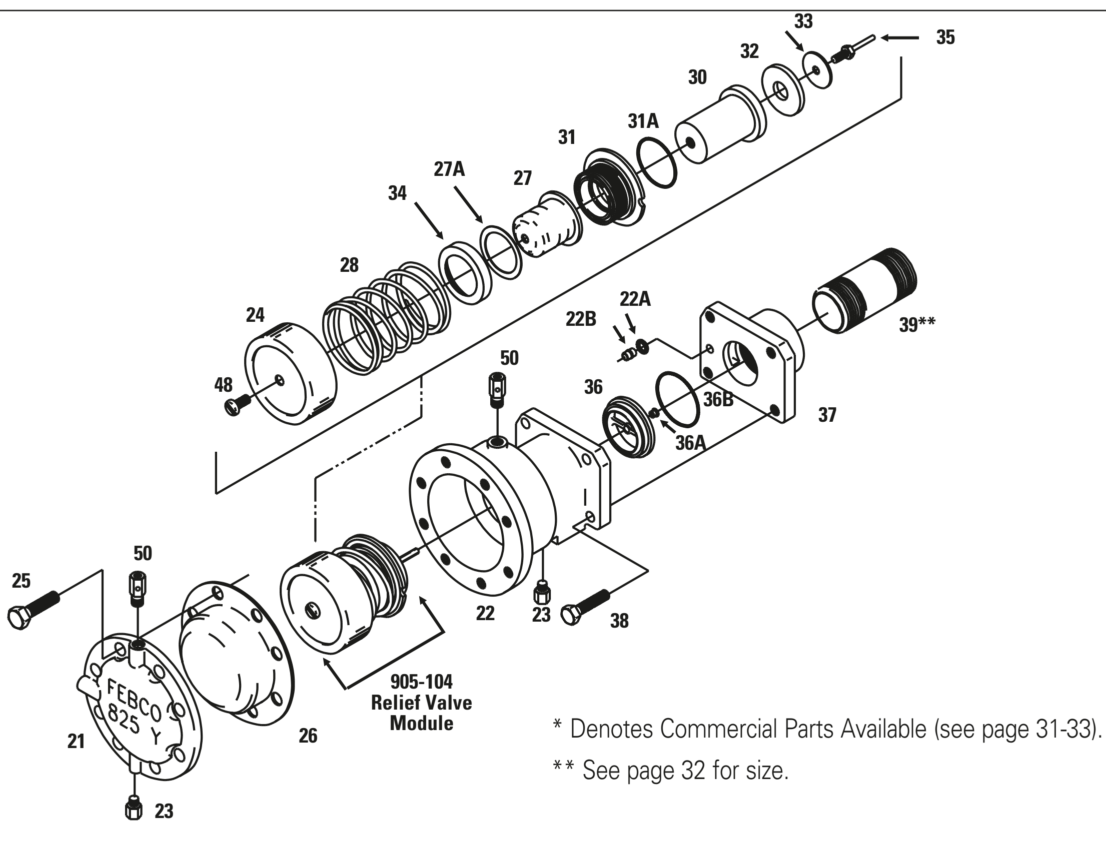
Model 825 Type YD (2½–10") Parts

Relief Valve Body: Model 825YD

ITEM	DESC.	QTY.	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
21	Cover-RV	1	101-113	101-113	101-113	101-113	101-113	101-113
22	Body-RV	1	101-112	101-112	101-112	101-112	101-112	101-112
22A	O-ring	1	398-202-72	398-202-72	398-202-72	398-202-72	398-202-72	398-202-72
22B	Bushing	1	500-290	500-290	500-290	500-290	500-290	500-290
24	Diaphragm Button	1	300-118	300-118	300-118	300-118	300-118	300-118
25	Capscrew	8	511-515-08	511-515-08	511-515-08	511-515-08	511-515-08	511-515-08
26	Diaphragm - Outer	1	400-108	400-108	400-108	400-108	400-108	400-108
27	Diaphragm - Inner	1	400-109	400-109	400-109	400-109	400-109	400-109
27A	Slip Ring	1	340-103	340-103	340-103	340-103	340-103	340-103
28	Spring	1	630-128	630-128	630-128	630-128	630-128	630-128
30	Main Stem	1	500-298	500-298	500-298	500-298	500-298	500-298
31	Upper Guide	1	101-114	101-114	101-114	101-114	101-114	101-114
31A	O-ring	1	398-145-72	398-145-72	398-145-72	398-145-72	398-145-72	398-145-72
32	Seat Disc	1	780-395	780-395	780-395	780-395	780-395	780-395
33	Disc Washer	1	300-119	300-119	300-119	300-119	300-119	300-119
34	Retainer	1	101-116	101-116	101-116	101-116	101-116	101-116
35	Lower Guide	1	240-102	240-102	240-102	240-102	240-102	240-102
36	Seat Ring		101-115	101-115	101-115	101-115	101-115	101-115
36A	Bushing	1	500-299	500-299	500-299	500-299	500-299	500-299
36B	O-ring		398-229-72	398-229-72	398-229-72	398-229-72	398-229-72	398-229-72
37	Mountain Plate	1	101-143	101-143	101-143	101-142	101-142	101-142
38	Capscrew	4	511-514-07	511-514-07	511-514-07	511-514-07	511-514-07	511-514-07
39	Nipple	1	573-181-81	573-181-81	573-181-81	573-181-81	573-181-81	573-181-81
48	Capscrew		519-513-04	519-513-04	519-513-04	519-513-04	519-513-04	519-513-04
50	Air Bleed		9594A110	9594A110	9594A110	9594A110	9594A110	9594A110

Relief Valve Model 825YD

Figure No. 18



* Denotes Commercial Parts Available (see page 31-33).

** See page 32 for size.

Model 826 Type YD (2½–10") Parts

Relief Valve with Bypass: Model 826YD

REF NO.	DESCRIPTION	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
9	1st Check Spring	780-349	780-350	630-142	630-143	630-144	630-145
9	2nd Check Spring	630-140	630-141	780-778	780-779	780-780	780-781
42	Resilient Wedge OS&Y Gate Valve	780-891	780-893	780-895	780-897	780-899	780-901
61	Bypass Kit	905-127	905-127	905-127	905-127	905-127	905-127
61B	Meter (Std. - Gal.)	780-666	780-666	780-666	780-666	780-666	780-666

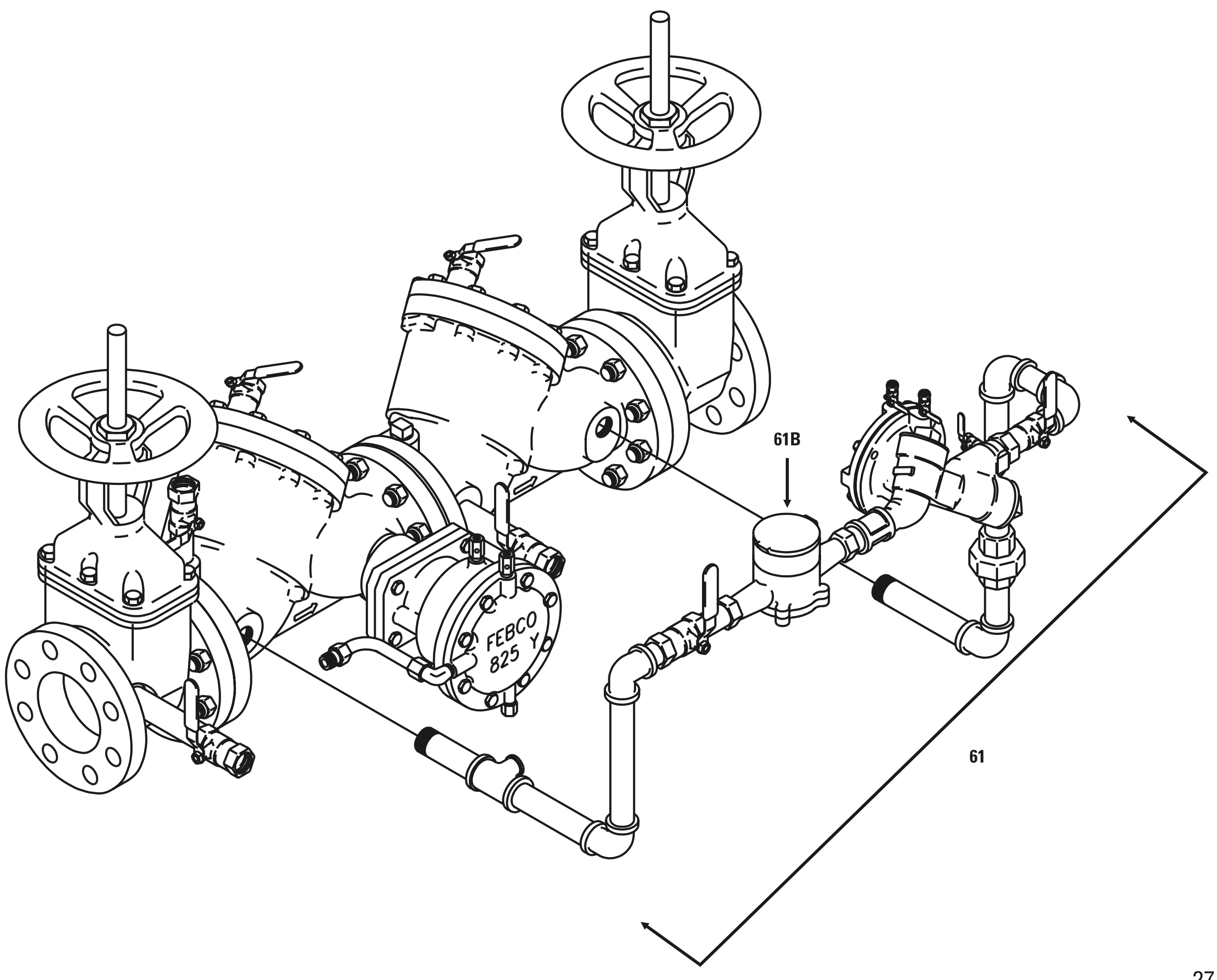
The following information, combined with the information in this Manual, gives you all the necessary technical information for the 826YD.

For information on Installation, Servicing, Field Testing and Trouble Shooting, please refer to those section in this Maintenance Manual.

The items listed above are used only on the Model 826YD and are not interchangeable with the Model 825YD.

Model 826YD

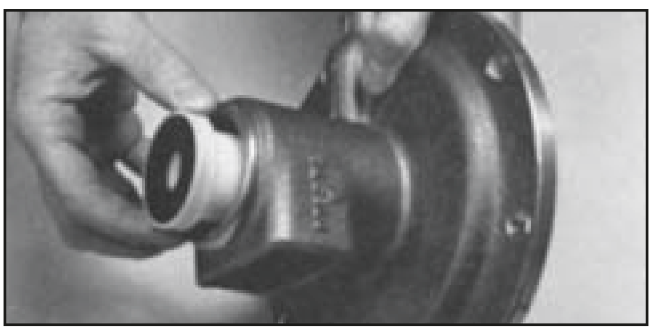
Figure No. 19



Service Procedures
Relief Valve 825, 825D and 825YD (2½–10")

1a. Relief Valve Disassembly Non-Modular Type Relief Valve Models 825 and 825D (See Figures No. 13 and 17)

1. Remove copper tubing from relief valve body.
2. Un-thread the relief valve completely from the check valve body, leaving the seat ring in the check valve body.
   NOTE: If the seat ring is removed with the relief valve, the seat ring must be un-threaded from the relief valve diaphragm plate, being careful not to damage the seat ring threads and seating surface.
3. Remove cover bolts and nuts, diaphragm cover and spacer from the relief valve assembly.
4. Turn the relief valve upside down, un-thread screw (Item 35) using a 9/16 hex socket, and remove diaphragm assembly, spring button and spring.
5. Un-thread screw (Item 48) and remove diaphragm washer and diaphragm from diaphragm button.
6. Push main stem out of bottom of relief valve body.
7. Remove o-ring from body.

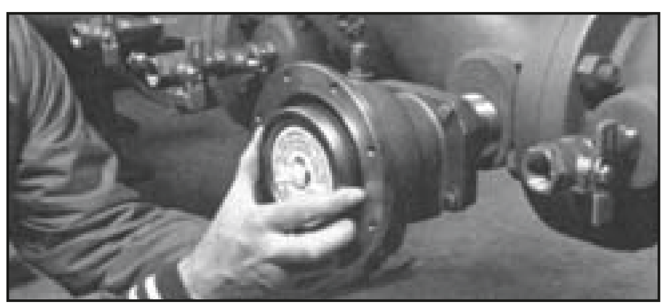


2a. Relief Valve Reassembly Non-Modular Type Relief Valve Model 825 and 825D (See Figure No. 17)

1. Assemble washer, outer diaphragm, spacer, diaphragm button, inner diaphragm and washer by securing with capscrews to form diaphragm assembly. When installing diaphragms, make sure side of diaphragm marked "button side" (fabric side) is toward diaphragm button and that diaphragm is not pinched.
2. Lubricate main stem o-ring with FDA approved lubricant. Place seat disc on main stem and place disc washer on seat disc.
3. Slide main stem bolt through main stem assembly and place inside relief valve body cavity with main stem bolt protruding.
4. Position spring over bolt and fit diaphragm assembly over spring. Compress diaphragm assembly into spring until main stem bolt threads into diaphragm assembly. Secure using a torque wrench. DO NOT TIGHTEN MAIN STEM BOLT BEYOND 15 INCH-LBS. OR DISTORTION OF THE MAIN STEM (ITEM 30) WILL OCCUR.
5. Thread seat ring into main valve body and thread relief valve into seat ring.
6. Reconnect copper tubing to relief valve.
7. Slowly open inlet shut-off valve and bleed air by opening first test cock #4, then test cocks #3, and #2 and all air bleeds.
8. Slowly open outlet shut-off valve and return the valve to service.
9. Test the assembly to ensure it is operating properly.

3a. Relief Valve Seat Disc Replacement Modular Type Relief Valve Model 825YD (See Figure No. 18)

1. Disconnect sensing tubing. Remove relief valve cover (Item 21) by loosening cover bolts (Item 25) and remove the outer diaphragm (Item 26).
2. Grasp the relief valve button (Item 24) with one hand. Insert fingers into the rectangular relief valve port on the bottom of the relief valve and apply force to the seat disc. Pull the relief valve module straight out from the body. DO NOT TWIST.
3. Place the relief valve module on a flat surface. Holding the main stem with one hand, loosen and remove the lower guide (Item 35) and disc washer (Item 33). Remove the rubber seat disc (Item 32) and turn over or replace as required. Inspect all parts and clean using clean water. Refer to section 5a on replacing relief valve diaphragms if this procedure is necessary.
4. Replace the disc washer and lower guide and tighten. Lubricate the o-ring (Item 31a), with FDA avpproved lubricant. Insert the relief valve module into relief valve body, using your fingers to help guide the lower guide into the bushing (Item 36a) on the relief valve seat ring. Push the module straight in. DO NOT TWIST.
5. If the relief valve module does not have a center label piece covering the screw (Item 48), inspect the screw for burrs. If a burr is visible, remove or cover burr with a piece of flexible tape. This will protect the surface of the diaphragm.
6. Replace the diaphragm, placing the fabric side against the button.



   Work the rolled edge into the space between the module and the body making sure it is not pinched or buckled.
7. Replace the cover, tighten the cover bolts, and reconnect the sensing tubing. Return to service and test the assembly to ensure proper operation.

Service Procedures
Relief Valve 825, 825D and 825YD (2½–10") (Cont.)

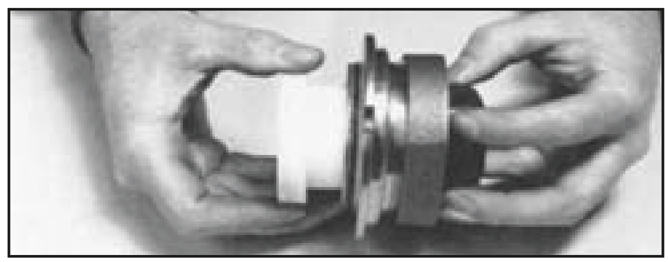
4a. Relief Valve Seat Ring Replacement Modular Type Relief Valve Model 825YD (See Figures No. 14 & 18)

1. Disconnect sensing tubing. Loosen and remove the four mounting bolts (Item 38) from the adapter. Remove the relief valve.
2. Pull the seat ring (Item 36) out from the relief valve body and inspect for damage. Replace as required.
3. Reposition the relief valve to the adapter insuring the o-ring (Item 36b) is properly positioned. Tighten the mounting bolts.
4. Reconnect the sensing tubing. Return to service and test the assembly to ensure proper operation.

5a. Relief Valve Inner Diaphragm Replacement / Modular Type Relief Valve Model 825YD (See Figure No. 18)

1. Disconnect the sensing tubing. Remove the cover (Item 21) by loosening and removing cover bolts (Item 25).
2. Remove the outer diaphragm (Item 26). Grasp the relief valve button (Item 24) with one hand. Insert your fingers into the rectangular relief valve port on the bottom of the relief valve and apply force to the seat disc. Pull the relief valve module straight out DO NOT TWIST.
3. Remove the lower guide (item 35) and disc washer (item 33). Place the relief valve module upside down on a clean flat surface. Remove the center label piece protecting the screw head and save this piece for reassembly. With one hand apply force sufficient to hold the button against the main stem. Keep the spring (Item 28) compressed (spring is approximately 35 lbs.) while unscrewing the pan head screw (item 48). Remove the screw and relieve the spring tension. Remove the button and spring.
4. Remove the main stem and un-thread the retainer (Item 34) from

the upper guide (Item 32). Remove the slip ring (Item 27a) and inner diaphragm (item 27). Inspect, clean and replace parts as required.
5. To reassemble, position the bead on the inner diaphragm into the groove of the upper guide. Place the slip ring over the diaphragm. Lubricate the retainer threads using an FDA approved lubricant and thread the retainer onto the upper guide. Tighten to 60 inch-lbs. of torque.
6. Insert the main stem into the diaphragm and "roll" the diaphragm into position by grasping the end of the diaphragm and main stem with one hand and push the upper guide towards your other hand.
7. Test to make sure diaphragm is positioned properly by sliding the upper guide back and forth through the full travel. It must move freely and easily.
8. Once the inner diaphragm has been rolled, force the end of the main stem snug against the end of the inner diaphragm. The



screw hole in the end of the main stem should be visible.
9. Replace the spring and button and tighten the screw while holding the button in place.
10. Make sure the screw (Item 48) is free of burrs that may cut the outer diaphragm. Reposition the center label piece, that you have saved during disassembly, over the screw head.
11. Replace the disc washer and lower guide insuring that the seat disc is clean and in position. Lubricate the upper guide o-ring (Item 31a) using an FDA approved lubricant, to ease installation. DO NOT USE LUBRICANT ON ANY OTHER PART.
12. Position the relief valve module back into the body using your finger to help guide the lower guide into the relief valve seat ring bushing. Push the module straight in. DO NOT TWIST.
13. Replace the outer diaphragm, placing the fabric side against the button. Work the rolled edge into the space between the module and the body, makings sure it is not pinched or buckled.
14. Replace the cover, tighten the cover bolts, and reconnect the sensing tubing. Return the valve to service and test to ensure proper operation.

Spring Removal Tool

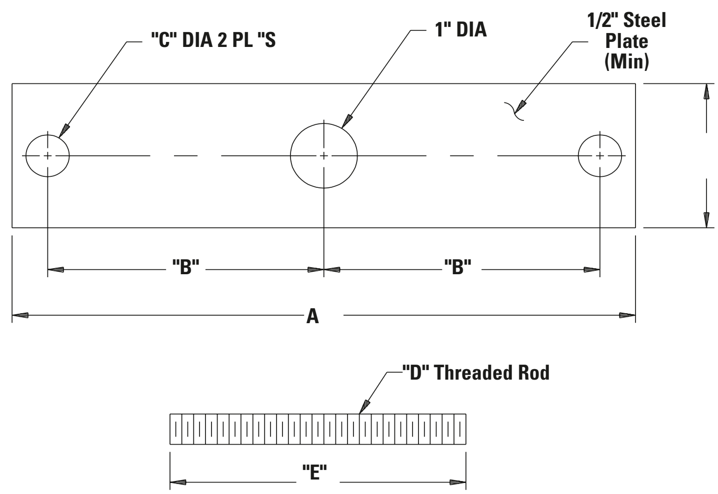
Dimensions (Inches)					
Valve Size	A	B	C	D	E
4"	9 1/2	4 1/4	5/8	1/2 - 13	5 1/2
6"	12 1/2	5 5/8	3/4	5/8 - 11	5 1/2
8"	14 1/4	6 3/8	7/8	3/4 - 10	7
10"	16 1/2	7 1/2	7/8	3/4 - 10	7

NOTE: This information is provided to expedite servicing of FEBCO products. One tool may be fabricated for use on all required sizes by drilling all holes at appropriate dimensions in a single steel plate of maximum required length. See pages 18 & 19 for instructions on use.

To order a FEBCO spring removal tool order part number 905-121.

CAUTION: To avoid possible injury during use, do not fabricate tool from lesser strength material or to smaller dimensions than the minimums shown.

Figure No. 20



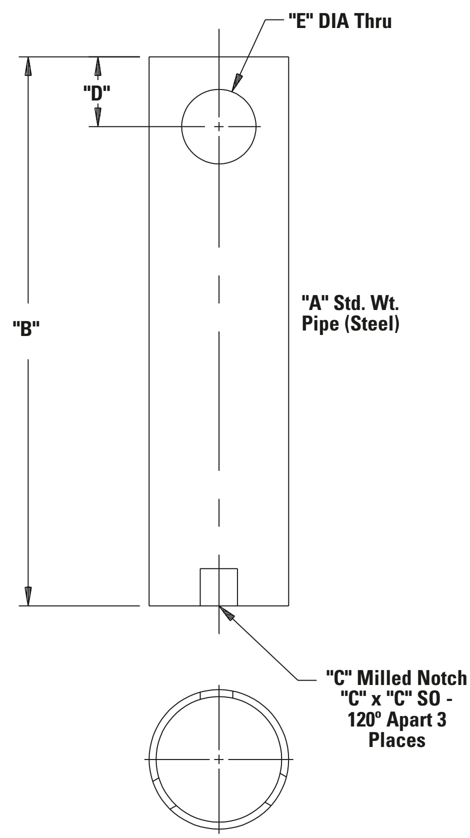
Seat Ring Tool

For Model 825 Only.

Dimensions (Inches)					
Valve Size	**A**	**B**	**C**	**D**	**E**
1 1/2"	1 1/2	6	3/8	3/4	3/4
2"	1 1/2"	6	3/8	3/4	3/4
2 1/2"	2 1/2"	8	1/2	1	1
3"	3	8	1/2	1	1
4"	4	9	1/2	1	1
6"	6	10	5/8	1	1
8"	8	12	5/8	1	1
10"	8	12	5/8	1	1

NOTE: This information is provided to expedite servicing of FEBCO products. See pages 16 & 19 for instructions on use.

Figure No. 21



Commercial Parts for Refief Valve - Model 825 & 825 D (1½–10")

Item No.	DESC.	Material	SIZE 1½"	SIZE 2"	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
25/ 25A	Bolt & Nut	ST STL	3/8-16 x 2½ (8)	3/8-16 x 2½ (8)	3/8-16 x 2¾ (8)	3/8-16 x 2¾ (8)	3/8-16 x 2¾ (8)	3/8-16 x 2¾ (8)	3/8-16 x 2¾ (8)	3/8-16 x 2¾ (8)
39	O-ring	BUNA-N	568-214 1 x 1¼ x 1/8	568-222 1½ x 1¾ x 1/8	568-222 1½ x 1¾ x 1/8	568-222 1½ x 1¾ x 1/8	568-330 2 1/8 x 2½ x 3/16	568-330 2 1/8 x 2½ x 3/16	568-330 2 1/8 x 2 1/8 x 3/16	568-330 2 1/8 x 2½ x 3/16
48	Cap Screw	ST STL	10-32 x ½ Socket Head (8)	10-32 x ½ Socket Head (8)	10-32 x ½ Socket Head (8)	10-32 x ½ Socket Head (8)	10-32 x ½ Socket Head (8)	10-32 x ½ Socket Head (8)	10-32 x ½ Socket Head (8)	10-32 x ½ Socket Head (8)

Commercial Parts for Main Valve - Model 825 (1½–10")

Item No.	DESC.	Material	SIZE 1½"	SIZE 2"	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
2B	Bushing Nut	ST STL	7/16-20 Hex (2)	9/16-18 Hex (2)	9/16-18 Hex* (2)	9/16-18 Hex* (2)	7/8-14 Jam* (2)	7/8-14 Jam* (2)		
7A	Screw	ST STL					3/8-16 x 1 (2)	3/8-16 x 1 (2)v	3/8-16 x 1 (2)	3/8-16 x 1 (2)
12	O-ring	BUNA-N	568-228 2¼ x 2½ x 1/8 (2)	568-231 2 5/8 x 2 7/8 x 1/8 (2)	568-238 3½ x 3¾ x 1/8 (2)	568-246 4½ x 4¾ x 1/8 (2)	568-254 5½ x 5¾ x 1/8 (2)	568-264 7½ x 7¾ x 1/8 (2)	568-273 9¾ x 10 x 1/8 (2)	10 5/16 x 10 9/16 x 1/8 (2)
13	Cap-Screw	ST STL	½-13 x 1¼ (8)	3/8-16 x 7/8 (12)	7/16-14 x 1 (16)	7/16-14 x 1 (16)	½-13 x 1¼ (16)	5/8-11 x 1½ (16)	¾-10 x 1½ (16)	¾-10 x 1¾ (24)
14	O-ring	BUNA-N	568-234 3 x 3¼ x 1/8 (2)	568-240 3¾ x 4 x 1/8 (2)	568-244 4¼ x 4½ x 1/8 (2)	568-252 5¼ x 5½ x 1/8 (2)	568-263 7¼ x 7½ x 1/8 (2)	568-272 9½ x 9¾ x 1/8 (2)	568-451 11 x 11½ x ¼ (2)	12¾ x 13 x 1/8 (2)
15	Lock-Nut	ST STL	3/8-24 (15)	1/24-20 (15)	½-20 (15)	½-20 (15)	¾-16 (15)	¾-16 (15)	7/8-14 (15)	7/8-14 (15)
17	Bolt & Nut	STEEL	½-13 x 1¾ (12)	5/8-11 x 2 (12)	5/8-11 x 2¼ (12)	5/8-11 x 2½ (12)	5/8-11 x 2¾ (24)	¾-10 x 3 (24)	¾-10 x 3¼ (24)	7/8-9 x 3½ (36)
40	Test Cocks	BRASS	¼" IPS (4)	¼" IPS (4)	½" IPS (4)	½" IPS (4)	½" IPS (4)	¾" IPS (4)	¾" IPS (4)	¾" IPS (4)
51	O-ring	BUNA-N			568-014 ½ x 5/8 x 1/16	568-014 ½ x 5/8 x 1/16	568-116 ¾ x 1 5/16 x 3/32	568-116 ¾ x 1 5/16 x 3/32	568-118 7/8 x 1 1/16 x 3/32	568-118 7/8 x 1 1/16 x 3/32

These parts are commercially available through most hardware distributors or retailers. Gate valves, testcocks, flange gaskets, etc., are also commercially available, but not listed.

* Denotes parts only used on valves manufactured prior to 1981.

Commercial Parts for Main Valve - Model 825Y (3/4–2")

Item No.	DESC.	Material	SIZE ¾"	SIZE 1"	SIZE 1¼"	SIZE 1½"	SIZE 2"
4	O-ring	BUNA-N	568-202	568-202	568-202	568-202	568-202
6	Cap Screw	ST STL	¼-20 x ⅝ Allen Head	¼-20 x ⅝ Allen Head	¼-20 x ⅝ Allen Head	15⁄16-18 x ¾ Allen Head	15⁄16-18 x ¾ Allen Head
8	O-ring	BUNA-N	568-226	568-226	568-226	568-235	568-235
12	Screw	ST STL	¼-28 x ⅜ Pan Head	¼-28 x ⅜ Pan Head	¼-28 x ⅜ Pan Head	¼-28 x ⅜ Pan Head	¼-28 x ⅜ Pan Head
15	Bolt	ST STL	15⁄16-18 x ¾ Hex Head	15⁄16-18 x ¾ Hex Head	15⁄16-18 x ¾ Hex Head	⅜-16 x ⅞ Hex Head	⅜-16 x ⅞ Hex Head
18	Screw	ST STL	¼-20 x ⅜ 80° Flat Head	¼-20 x ⅜ 80° Flat Head	¼-20 x ⅜ 80° Flat Head	¼-20 x ⅜ 80° Flat Head	¼-20 x ⅜ 80° Flat Head
22	O-ring	BUNA-N	568-113	568-113	568-113	568-120	568-120
24	O-ring	BUNA-N	568-022	568-022	568-022	568-127	568-127
27	Screw	ST STL	10-32 x ⅜ Round Head	10-32 x ⅜ Round Head	10-32 x ⅜ Round Head	¼-20 x ½ Round Head	¼-20 x ½ Round Head
28	Plug	BRASS	⅛" IPS	⅛" IPS	⅛" IPS	¼" IPS	¼" IPS
29	Gate Valve (w side tap)	BRONZE BRONZE	¾" NPT ⅛" IPS Side Tap	1" NPT ⅛" IPS Side Tap	1¼" NPT ¼" IPS Side Tap	1½" NPT ¼" IPS Side Tap	2" NPT ¼" IPS Side Tap
30	Test Cock	BRONZE	⅛" IPS	⅛" IPS	¼" IPS	¼" IPS	¼" IPS
102	O-ring	BUNA-N	568-019	568-019		568-026	568-026

Commercial Parts for Relief Valve - Model 825YD (2½–10")

Item No.	DESC.	Material	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
22A	O-ring	BUNA-N	568-202 ¼ x ½ x ⅛	568-202 ¼ x ½ x ⅛	568-202 ¼ x ½ x ⅛	568-202 ¼ x ½ x ⅛	568-202 ¼ x ½ x ⅛	568-202 ¼ x ½ x ⅛
25	Cap Screw	ST STL	⅜-16 x 1 (8)	⅜-16 x 1 (8)	⅜-16 x 1 (8)	⅜-16 x 1 (8)	⅜-16 x 1 (8)	⅜-16 x 1 (8)
31A	O-ring	BUNA-N	568-145 2 9⁄16 x 2¾ x 3⁄32	568-145 2 9⁄16 x 2¾ x 3⁄32	568-145 2 9⁄16 x 2¾ x 3⁄32	568-145 29⁄16 x 2 ¾ x 3⁄32	568-145 29⁄16 x 2 ¾ x 3⁄32	568-145 29⁄16 x 2 ¾ x 3⁄32
36B	O-ring	BUNA-N	568-229 2⅜ x 2⅝ x ⅛	568-229 2⅜ x 2⅝ x ⅛	568-229 2⅜ x 2⅝ x ⅛	568-229 2⅜ x 2⅝ x ⅛	568-229 2⅜ x 2⅝ x ⅛	568-229 2⅜ x 2⅝ x ⅛
38	Cap Screw	ST STL	5⁄16-18 x ⅞ Hex (4)	5⁄16-18 x ⅞ Hex (4)	5⁄16-18 x ⅞ Hex (4)	5⁄16-18 x ⅞ Hex (4)	5⁄16-18 x ⅞ Hex (4)	5⁄16-18 x ⅞ Hex (4)
39	Pipe Nipple	ST STL	1 ½" IPS x Close	1 ½" IPS x Close	1 ½" IPS x Close	2" IPS x Close	2" IPS x Close	2" IPS x Close
48	Cap Screw	ST STL	¼-20 x ½ Pan Head	¼-20 x ½ Pan Head	¼-20 x ½ Pan Head	¼-20 x ½ Pan Head	¼-20 x ½ Pan Head	¼-20 x ½ Pan Head

These parts are commercially available through most hardware distributors or retailers. Gate valves, testcocks, flange gaskets, etc., are also commercially available, but not listed.

* Denotes parts only used on valves manufactured prior to 1981.

Commercial Parts for Main Valve - Model 825D & 825YD (2½–10")

Item No.	DESC.	Material	SIZE 2½"	SIZE 3"	SIZE 4"	SIZE 6"	SIZE 8"	SIZE 10"
2D	Screw	ST STL	¼-20 x ½ (6)	¼-20 x ½ (6)	5/16-18 x ¾ (6)	5/16-18 x ¾ (6)	5/16-18 x ¾ (6)	5/16-18 x ¾ (6)
7A	Screw	ST STL			⅜-16 x 1 (2)	⅜-16 x 1 (2)	⅜-16 x 1 (2)	⅜-16 x 1 (2)
12	O-ring	BUNA-N	568-237 3⅜ x 3⅝ x ⅛ (2)	568-242 4 x 4¼ x ⅛ (2)	568-253 5⅜ x 5⅝ x ⅛ (2)	568-263 7¼ x 7½ x ⅛ (2)	568-272 9½ x 9¾ x ⅛ (2)	568-274 10 10¼ x ⅛ (2)
13	Cap-Screw	ST STL	7/16-14 x 1 (16)	7/16-14 x 1 (16)	½-13 x 1¼ (16)	⅝-11 x 1½ (16)	¾-10 x 1½ (16)	¾-10 x 1¾ (16)
14	O-ring	BUNA-N	568-346 4⅛ x 4½ x 3/16 (2)	568-354 5⅛ x 5½ x 3/16 (2)	568-365 7 x 7⅜ x 3/16 (2)	568-374 9¼ x 9⅝ x 3/16 (2)	568-379 11 x 11⅜ x 3/16 (2)	568-381 12 x 12⅜ x 3/16 (2)
15	Lock-Nut	ST STL	½-20 (15)	½-20 (15)	¾-16 (15)	¾-16 (15)	⅞-14 (15)	⅞-14 (15)
17	Bolt & Nut	STEEL	⅝-11 x 2¼ (12)	⅝-11 x 2½ (12)	⅝-11 x 2¾ (24)	¾-10 x 3 (24)	¾-10 x 3¼ (24)	⅞-9 x 3½ (36)
40	Test Cocks	BRASS	½" IPS (4)	½" IPS (4)	½" IPS (4)	¾" IPS (4)	¾" IPS (4)	¾" IPS (4)
41	Nipple		571-181-44 Size (3)	571-181-44 Size (3)	571-181-44 Size (3)	571-181-55 Size (3)	571-181-55 Size (3)	781-181-55 Size (3)
41A	Nipple		571-181-43 Size (2)	781-181-43 Size (2)	781-181-43 Size (2)	571-181-53 Size (2)	781-181-53 Size (2)	781-181-53 Size (2)
41B	Tee		571-131-42 Size	781-131-42 Size	781-131-42 Size	571-131-52 Size	781-131-52 Size	781-131-52 Size
43	Tube Fit. 90º		571-231-23 Size	571-231-23 Size	571-231-23 Size	571-231-23 Size	571-231-23 Size	571-231-23 Size
43A	Tube Fit.		571-211-23 Size	571-211-23 Size	571-211-23 Size	571-211-23 Size	571-211-23 Size	571-211-23 Size
51	O-ring	BUNA-N	568-014 ½ x ⅝ x 1/16 (2)	568-014 ½ x ⅝ x 1/16 (2)	568-116 ⅝ x ¾ x 1/16 (2)	568-116 ⅝ x ¾ x 1/16 (2)	568-118 ¾ x ⅞ x 1/16 (2)	568-118 ¾ x ⅞ x 1/16 (2)

These parts are commercially available through most hardware distributors or retailers. Gate valves, testcocks, flange gaskets, etc., are also commercially available, but not listed.

* Denotes parts only used on valves manufactured prior to 1981.

How to Order Repair Parts

1) Locate item number and kit number in this maintenance manual.
2) Verify the size of the valve the parts are to be used on.
3) Provide full model number. On large assemblies (21/2–10"), the model number is located on the name plate. On small assemblies (3/4–2"), the model number is cast on the body.
4) Identify the "type" code on 21/2–10" size valves (Ductile Iron bodies use Type D or YD code on name plate).
5) Give part number. Provide new part number if appropriate.
6) A serial number (located on the I.D. plate) will assist in ordering the proper kits.
7) Some parts are sold only in kit form.

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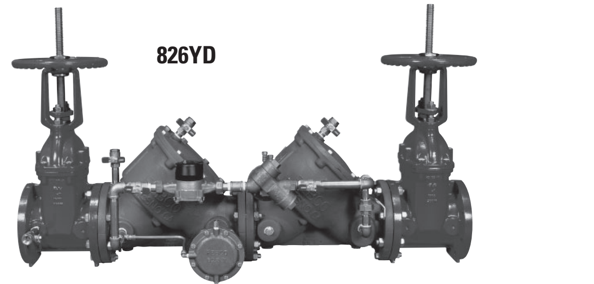
ISO 9001-2000 CERTIFIED

SPECIFICATION SHEET FEBCO®

Series 826YD

Reduced Pressure Detector Assemblies

Size: 2½" - 10" (65mm - 250mm)



The FEBCO Series 826YD Reduced Pressure Detector Assemblies designed for use in used applications with Automatic fire sprinkler systems containing toxic substances.

Features

- The DuraCheck, features all stainless steel check assemblies for corrosion resistance, reduced fouling and longer valve life.
- DuraCast, ductile iron body for superior strength, corrosion resistance and lighter weight. By-pass line has water meter in series with an approved reduced pressure assembly.
- Low Head Loss
- Approved by the Foundation for Cross-Connnection Control and Hydraulic Research at the University of Southern California.
- End Detail is Flanged

Operation

In a nonflow condition, check valves on the by-pass and mainline units are closed with pressure between the checks, called the zone, being maintained at least 5psi (35 kPa) lower than the inlet pressure and the relief valve is maintained closed. If the differential between the zone and the upstream pressure drops to 2psi (14kPa), the differential relief valve will open, maintaining proper zone differential. The by-pass reduced pressure backflow preventer will operate identically to the mainline assembly.

The by-pass opens to detect initial flow and the mainline opens for all other flows.

Models

- Less Gates
- Air Gap Drain
- Left hand by-pass
- Remote Reader
- Meter CFM/GPM

Approvals

- Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California.*

ASSE 1047   CLASSIFIED UL *   FM Approved *

* Valves must be supplied with resilient seated shutoff valves for USC and FM approvals to be in effect. UL and FM Listings only applicable with approved OS&Y gates.

Specifications

Reduced pressure detector assembly shall consist of a mainline reduced pressure configured backflow assembly in parallel with a reduced pressure by-pass assembly.

Flow curves shall be documented by independent laboratory testing. Mainline valve bodies and covers shall be manufactured of ductile iron ASTM A-536, Grade 65-45-12 and shall be flanged, ANSI B 16.1, Class 125, internal and external fusion epoxy coating.

The by-pass shall consist primarily of a bronze water meter in series with a bronze reduced pressure backflow preventer.

All low flow demands up to a minimum of 3 gpm (0.189 L/s) are to pass only through the by-pass meter and meter-size reduced pressure assembly and be accurately recorded. All flows above that of 3 gpm will pass through both the line-size reduced pressure assembly and by-pass without accurate registration by or damage to the meter.

Shutoff valves and testcocks shall be resilient seated with full flow characteristics and are to be considered integral to the assembly. The mainline shut-offs are also to be OS&Y, UL/FM for fireline service.

Reduced pressure detector assemblies shall be rated 175psi CWWP (32°F to 140°F), factory assembled and tested to assure proper mainline/by-pass balance and cross over performance. Reduced pressure detector assemblies shall be FEBCO Series 826YD or prior approved equal.

Note: The gap drain is not designed to catch the maximum discharge possible from the relief valve. The installation of FEBCO air gap with the drain line terminating above a floor drain will handle any normal discharge or nuisance spitting through the relief valve. However, floor drain size may need to be designed to prevent water damage caused by a catastrophic failure condition. Do not reduce the size of the drain line from the air gap fitting.

Pressure – Temperature

Maximum Working Pressure:	175psi (12.1 bar)
Hydrostatic Test Press:	350psi (24.1 bar)
Temperature Range:	32ºF to 140ºF (0ºC to 60ºC)

Materials

Main Valve Body:	Ductile iron grade 65-45-12 epoxy coated internal 10-20 mils
Internal Check Assembly:	Stainless Steel
Trim:	Bronze
By-Pass Valve Body:	Bronze
By-Pass Meter:	Totalizing, 1 to 20 gpm, size 5/8" x 3/4"
Main Valve Shutoffs:	OS&Y, UL/FM
Elastomers:	Nitrile and Nitrile/ fabric reinforced

Remote reading flow meters available.

Job Name ____________________

Job Location ____________________

Engineer ____________________

Approval ____________________

Contractor ____________________

Approval ____________________

Contractor's P.O. No. ____________________

Representative ____________________

Installation

The Reduced Pressure Detector Assembly should be installed horizontally with a suggested minimum clearance of 12" (300mm) between the assembly and the floor or grade. They must be installed where discharge from the relief valve will not be objectionable and can be positively drained away. They should be installed where easily accessible for testing and maintenance and must be protected from freezing. Thermal water expansion and/or water hammer downstream of the backflow preventer can cause excessive pressure. Excessive pressure situations should be eliminated to avoid possible damage to the system and assembly.

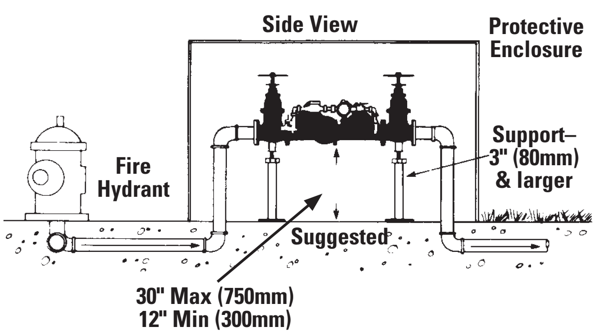
Dimensions – Weights

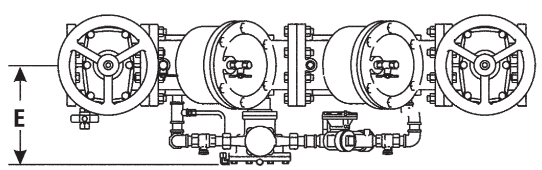
Size: 2½" - 10" (65 - 250mm)

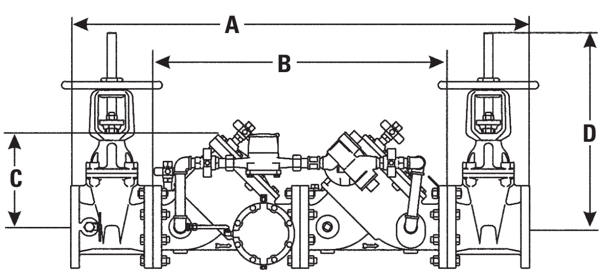
SIZE (DN)		DIMENSIONS										WEIGHT			
		A		B		C		D		E		gates		less gates	
in.	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*lbs.*	*kgs.*	*lbs.*	*kgs.*
2½	65	37¼	946	22⅛	562	7½	191	16⅜	416	10¼	260	243	534.6	134	294.8
3	80	41¾	1061	25⅝	651	8½	216	22¼	565	10½	267	298	655.6	154	338.8
4	100	50 7/16	1281	32⅜	822	11	279	23¼	591	11	279	469	1031.8	194	426.8
6	150	59¾	1518	38⅝	981	14	356	30¼	765	12	305	752	1654.4	397	873.4
8	200	69 3/16	1757	46⅛	1172	18	457	37¾	959	13	330	1207	2655.4	537	1181.4
10	250	84¼	2140	58⅛	1476	22	559	48	1219	14	356	1617	3557.4	957	2105.4

Dimensions shown are nominal, allowance must be made for normal manufacturing tolerances.

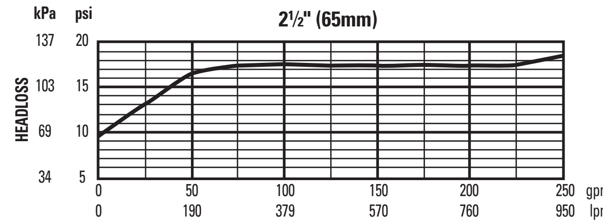
FEBCO MODEL 826YD

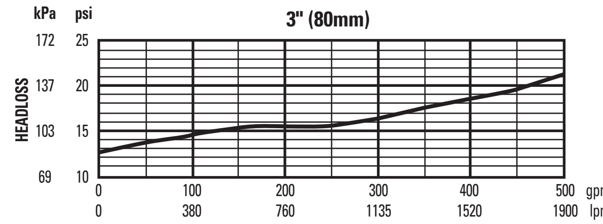


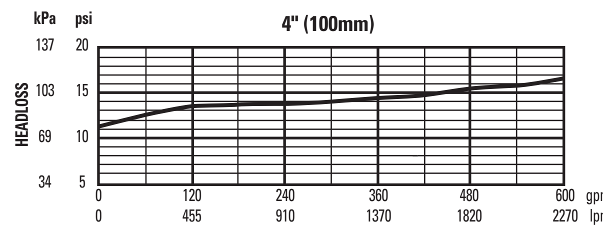


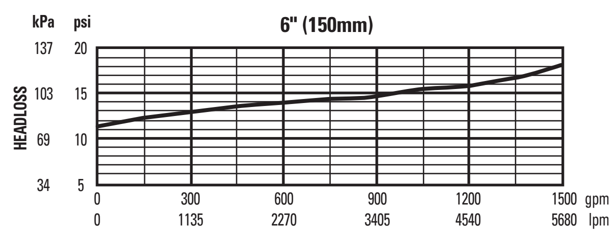


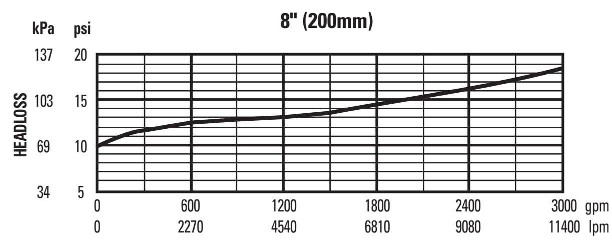
Capacity

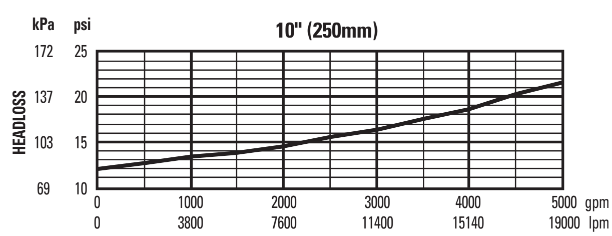












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ISO 9001 CERTIFIED

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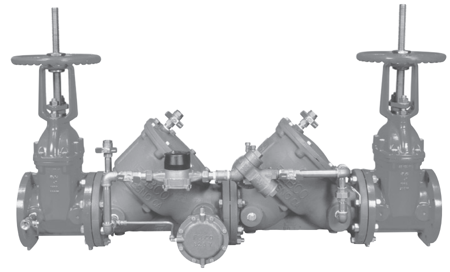
INSTALLATION INSTRUCTIONS

Series 825YD, 826YD

Reduced Pressure Zone Assemblies
Reduced Pressure Detector Assemblies

Sizes: 2½" – 10" (65 – 250mm)



826YD

Installation Instructions

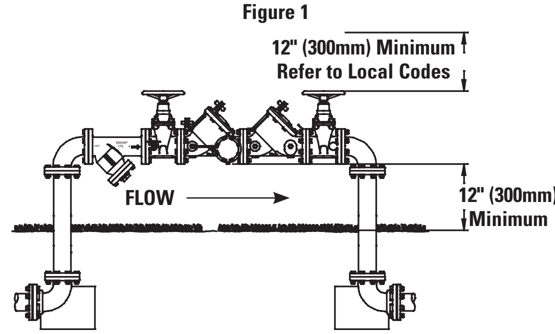
1. Consult local codes for specific installation requirements and restrictions applicable to your area. It is recommended that system supply pressure be at least 20psi (133kPa).
2. These instructions apply to series 825YD, and 826YD size 2½" to 10" (65-250mm) only. The valves may be installed only in the horizontal orientation as shown.
3. The valve assembly must be installed where it is accessible for periodic testing and maintenance. Clearances shown in the installation views apply to exterior, interior and pit/vault installations and are only recommendations. These minimums do not apply to removable protective enclosures. Refer to local codes for actual requirements in your area.
4. PRIOR TO INSTALLING THE VALVE INTO THE LINE, FLUSH THE SUPPLY LINE OF ALL FOREIGN MATERIAL. Failure to flush the supply line may cause the check valves to become fouled and require disassembly and cleaning.
5. DO NOT LIFT THE ASSEMBLY BY CONNECTING TO THE GATE VALVE HANDWHEELS OR STEMS.
6. After installation SLOWLY fill the assembly with water and bleed air from the body using the #2, # 3 and # 4 test cocks. Test the valve assembly to ensure correct operation.

   NOTE: All assemblies are tested at the factory for proper operation and leakage. If the valve does not pass the field test, it is most likely due to a fouled check valve. This is not covered by the factory warranty. The valve cover(s) must be removed and the check seats inspected and cleaned. Any damage or improper operation caused by pipeline debris or improper installation/start-up is not included in the factory warranty.

   In case of a possible warranty claim, contact your local supplier or FEBCO Representative. DO NOT REMOVE THE VALVE ASSEMBLY FROM THE PIPELINE.
7. The assembly must be protected from freezing and excessive pressure increases. Pressure increases can be caused by thermal expansion or water hammer. These excessive pressure situations must be eliminated to protect the valve and system from possible damage.

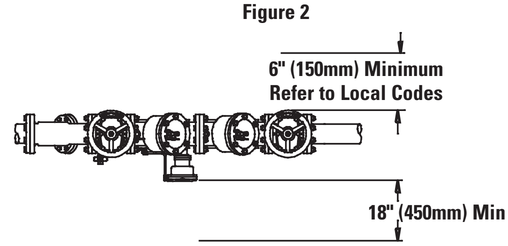
Typical Installation

Figure 1



HORIZONTAL INSTALLATION OF THE RP SERIES 825YD
(Side View)
(Shown With Strainer)

Figure 2



HORIZONTAL INSTALLATION OF THE RP SERIES 825YD
(Top View)
(Shown With Strainer)

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Service and Maintenance

Service Procedure

Close the outlet shutoff valve, then close the inlet shutoff valve. Bleed residual pressure from the assembly by opening the #4, #3, and # 2 test cocks in this sequence.

General

1. Detailed maintenance manuals are available from your local FEBCO representative.
2. Rinse all parts with clean water prior to reassembly.
3. DO NOT USE ANY PIPE DOPE, OIL, GREASE OR SOLVENT ON ANY PARTS unless instructed to do so.
4. Do not force parts. Parts should fit together freely. Excess force may cause damage and render the assembly inoperable.
5. Carefully inspect seals and seating surfaces for debris or damage.
6. After servicing, repressurize the assembly and test to ensure proper operation.

Check Valve Disassembly

1.
CAUTION: The cover retains the spring on 2½" - 3" (65 - 80mm) valve sizes. Remove the cover capscrews uniformly while holding the cover in place. Carefully reduce hand force on the cover to relieve spring compression.

   The check module on the 4" - 10" (100 - 250mm) valve sizes retains the spring. Unscrew the capscrews uniformly to avoid binding the cover in the body bore. The spring will push the cover approximately ½" off the top of the body.
2. Lift the spring and check assembly 2½" - 3" (65 - 80mm) or check module 4" - 10" (100 - 250mm) from the body.
3. Inspect and clean debris from the disc and seat ring. Replace any damaged parts.
4. Use the reverse procedure to assemble. If necessary, apply a thin film of FDA/NSF approved grease to cover the O-ring. Install the capscrews and tighten in a uniform cross pattern.

Relief Valve Disassembly

1. Remove the capscrews holding the cover to the relief valve body, and remove the cover.
2. Remove the diaphragm and pull the internal assembly from the body. It may be helpful to push the internal assembly with your fingers through the discharge opening.
3. Inspect for debris, damage or fouling of the seat disc. Clean or replace the rubber disc as required.
4. Reposition the internal assembly and diaphragm into the body. Install the cover and cap screws.

Field Test Procedure

FEBCO recommends the use of the appropriate test method presented in the ASSE Series 5000 manual that is consistent with your local codes.

Troubleshooting

PROBLEM	CAUSE	SOLUTION
1. Continuous relief valve discharge	a. Debris on check seating surfaces	Disassemble and clean
	b. Debris on relief valve seating surfaces	Disassemble and clean
2. Intermittent relief valve discharge	a. Inlet pressure fluctuations	Eliminate fluctuations
	b. Downstream pressure surges	Eliminate surges
3. Low flows passing through mainline valve (RPDA)	a. Mainline check fouled	Disassemble and clean
	b. Bypass line plugged	Disassemble and clean

Note: The gap drain is not designed to catch the maximum discharge possible from the relief valve. The installation of FEBCO air gap with the drain line terminating above a floor drain will handle any normal discharge or nuisance spitting through the relief valve. However, floor drain size may need to be designed to prevent water damage caused by a catastrophic failure condition. Do not reduce the size of the drain line from the air gap fitting.

CALIFORNIA PROPOSITION 65 WARNING

WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

(California law requires this warning to be given to customers in the State of California.)

For more information: www.watts.com/prop65

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D-13
Gate Valves

Gate Valve

Standard Features

- Straight-through flow with minimal pressure drop
- Unique sliding cylindrical plug design provides larger seating area than conventional gate valves
- Made of durable, corrosion resistant plastic
- No metal to media contact anywhere in valve
- Clean-out (drain) plug in bottom area of valve body
- Rated for full vacuum service
- Light weight for easier and economical installation
- Positive bubble-tight shut-off
- Visual position indicator

Options

- 2" square operating nut
- Stem extensions
- Locking handles
- Electric actuation, up to 3"
- FKM seals

Caution

- Never remove valve from pipeline under pressure.
- Always wear protective gloves and goggles.

Specifications

Sizes: 1-1/2" – 14"
Body: High Impact PVC
Models: Flanged (ANSI)

Types/Sizes: "P" Type: PP, 1-1/2" – 14"
Seals: EPDM, FKM(Optional)

Sizes 1 1/2" - 14" PVC/PP/EPDM/FKM Models available with NSF-61 Certification

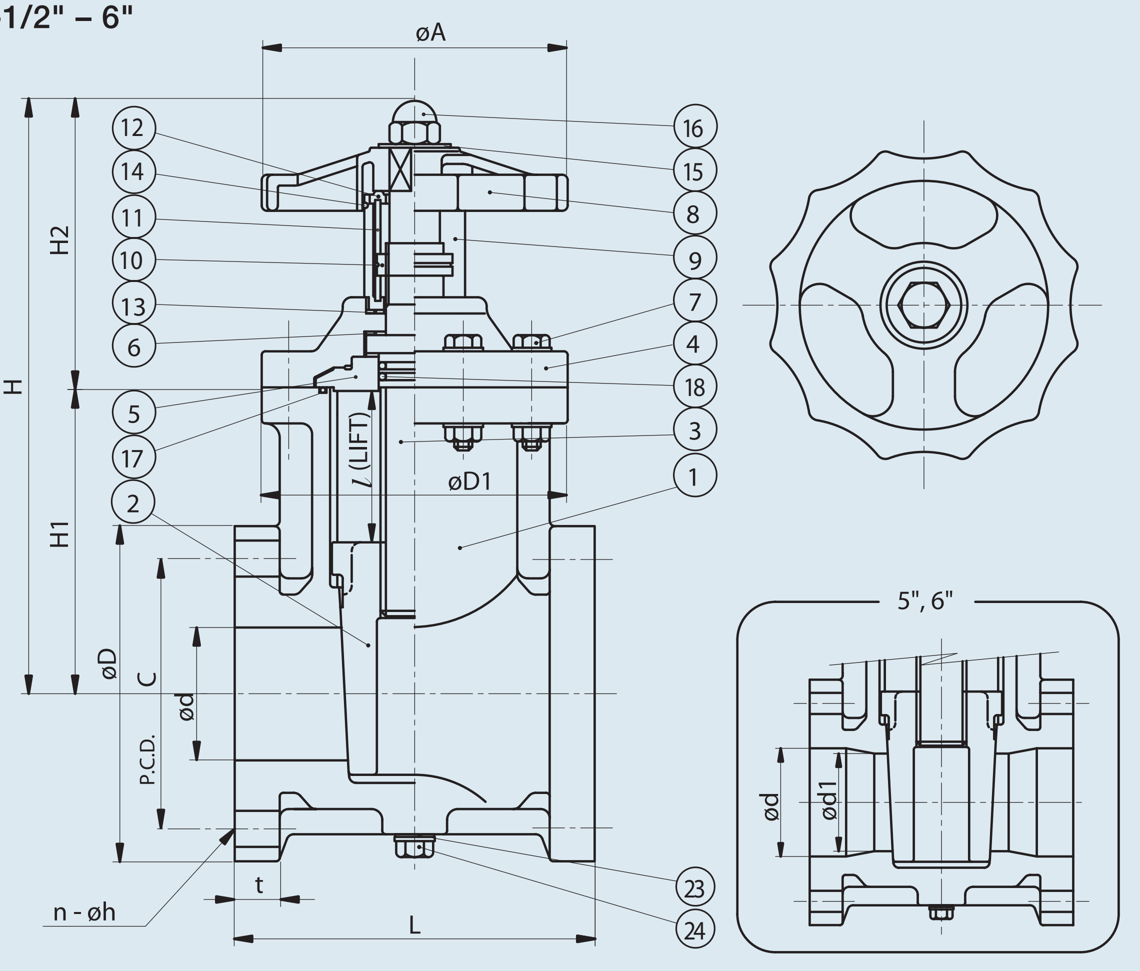
Type P Parts (Sizes 1-1/2" – 6")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC
2	Gate (Plug)	1	PP
3	Stem	1	PVC
4	Bonnet (A)	1	PVC
5	Bonnet (B)*	1	PVC
6	Thrust Bearing	1 Set	PP
7	Bolt, Nut, Washer	-	Stainless Steel 304
8	Hand Wheel	1	PP
9	Indicating Cover	1	PC
10	Indicating Ring	1	PVC
11	Guide Pin	1	Stainless Steel 304
12	Guide Pin Holder	1	PVC
13	Gasket	1	EPDM
14	O-Ring (A)	1	EPDM
15	Washer	1	PVC
16	Nut	1	Stainless Steel 304
17	O-Ring (B)	1	EPDM, Others
18	O-Ring (C)	2	EPDM, Others
23	Sheet Gasket	1	EPDM, Others
24	Plug	1	PVC

* Stem holder

Type P Gate Valves

Sizes 1-1/2" – 6"



Troubleshooting

What if fluid still flows when fully closed?

1. Body or plug is worn or damaged. Replace.
2. Seat is worn or damaged. Replace.
3. Foreign material caught at the bottom of body. Needs cleaning.

What if handle does not engage with stem?

1. Stem damaged or broken. Change stem.
2. Engaging part of stem and/or plug damaged or broken. Need to replace stem and/or plug.

What if there are leaks between bonnet and body?

1. Bolts are not tightened properly. Tighten diagonally and evenly.
2. O-ring between body and bonnet damaged or worn. Change O-ring.

Dimensions (Sizes 1-1/2" – 6")

NOMINAL SIZE				ANSI CLASS 150											
INCHES	mm	d	d1	D	C	n	h	L	t	D1	A	l	H1	H2	H
1 1/2	40	1.57	-	5.00	3.88	4	0.62	6.50	0.87	4.72	4.72	1.93	4.21	5.20	9.41
2	50	1.97	-	6.00	4.75	4	0.75	7.01	0.91	5.12	5.12	2.36	5.28	5.35	10.63
2 1/2	65	2.56	-	7.00	5.50	4	0.75	7.48	0.94	6.10	6.10	2.95	5.98	5.91	11.89
3	80	2.95	-	7.50	6.00	4	0.75	7.99	0.98	6.69	6.69	3.35	6.69	6.10	12.79
4	100	3.94	-	9.00	7.50	8	0.75	9.02	1.06	7.68	7.68	4.33	8.15	6.42	14.57
5	125	4.92	4.33	10.00	8.50	8	0.88	10.24	1.06	9.25	9.25	4.61	8.94	7.09	16.03
6	150	5.91	5.12	11.00	9.50	8	0.88	10.51	1.06	10.63	10.63	5.43	10.35	7.17	17.52

Pressure vs. Temp.

(PSI, WATER, NON-SHOCK)

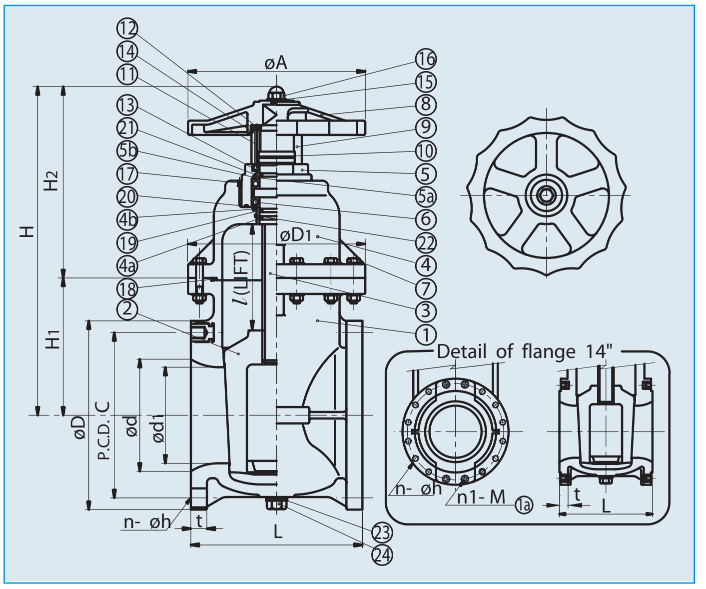
NOMINAL SIZE		30° F 120° F
INCHES	mm	
1 1/2 - 8	40-200	150
10	250	110
12-14	300-350	75

Type P Parts (Sizes 8" – 14")

PARTS			
NO.	DESCRIPTION	PCS.	MATERIAL
1	Body	1	PVC
2	Gate (Plug)	1	PP
3	Stem	1	PVC
4	Bonnet (A)	1	PVC
4a	Bush (A)	1	PP
4b	Knock Pin (A)	1	PP
5	Bonnet (B)*	1	PVC
5a	Bush (B)	1	PP
5b	Knock Pin (B)	1	PP
6	Thrust Bearing	1 Set	High Carbon Chromium
7	Bolt, Nut, Washer	-	Stainless Steel 304
8	Hand Wheel	1	PP
9	Indicating Cover	1	PC
10	Indicating Ring	1	PVC
11	Guide Pin	1	Stainless Steel 304
12	Guide Pin Holder	1	PVC
13	Gasket	1	EPDM
14	O-Ring (A)	1	EPDM
15	Washer	1	PVC
16	Nut	1	Stainless Steel 304
17	Screw	1	Stainless Steel 304
18	O-Ring (B)	1	EPDM, Others
19	O-Ring (C)	3	EPDM, Others
20	O-Ring (D)	1	EPDM, Others
21	O-Ring (E)	1	EPDM, Others
22	O-Ring (F)	1	EPDM, Others
23	Sheet Gasket	1	EPDM, Others
24	Plug	1	PVC
1a	Body Metal Inserts**	-	Copper Alloy

* Stem holder
** 8" and 12" sizes: 4 inserts; 14" size: 8 inserts

Sizes: 8" – 14"



Cv Values

NOMINAL SIZE		Cv
INCHES	mm	
1 1/2	40	130
2	50	180
2 1/2	65	415
3	80	470
4	100	690
5	125	1000
6	150	1400
8	200	2900
10	250	3700
12	300	5200
14	350	7000

Weight (POUNDS)

NOMINAL SIZE		FLANGED
INCHES	mm	
1 1/2	40	7.50
2	50	10.20
2 1/2	65	13.00
3	80	16.60
4	100	22.00
5	125	29.00
6	150	42.00
8	200	68.50
10	250	95.00
12	300	150.00
14	350	188.00

Sample Specification

All Gate Valves shall be constructed of High Impact PVC and have no metal-to-media contact. The gate shall be a tapered cylindrical plug design PVC shall conform to ASTM D1784 Cell Classification 12454-A, & PP to ASTM D4101 Cell Classification PP0210B67272. Valves shall have a pressure rating of 150 psi at 70 degrees F sizes 1-1/2" through 8", 110 psi at 70 degrees F size 10", and 75 psi at 70 degrees F sizes 12" and 14". The valve shall have a non-rising stem, come standard with sealed position indicator, clean-out plug and EPDM or FKM seals as manu-factured by Asahi/America Inc.

Dimensions (Sizes: 8" – 14")

NOMINAL SIZE				ANSI CLASS 150												
INCHES	mm	d	d1	D	C	n	h	n1 – M	L	t	D1	A	l	H1	H2	H
8	200	7.72	6.61	13.50	11.75	6	0.88	2 – 3/4 UNC	11.50	1.10	12.20	12.20	7.09	9.45	13.27	22.72
10	250	9.72	8.27	16.00	14.25	12	0.98	-	14.96	1.18	14.17	14.17	8.90	10.63	16.54	27.17
12	300	11.73	10.04	19.00	17.00	10	0.98	2 – 7/8 UNC	15.75	1.22	16.14	16.14	10.75	12.60	18.90	31.50
14	350	13.70	11.69	21.00	18.75	8	1.14	4 – 1 UNC	16.93	1.26	17.32	17.91	12.56	12.20	23.62	35.83

Serial No.	H – V011E – 3

Gate Valves (C type)

P type (Standard : Plug)

S type (Soft seal)

User's Manual

Contents

ASAHI AV VALVES

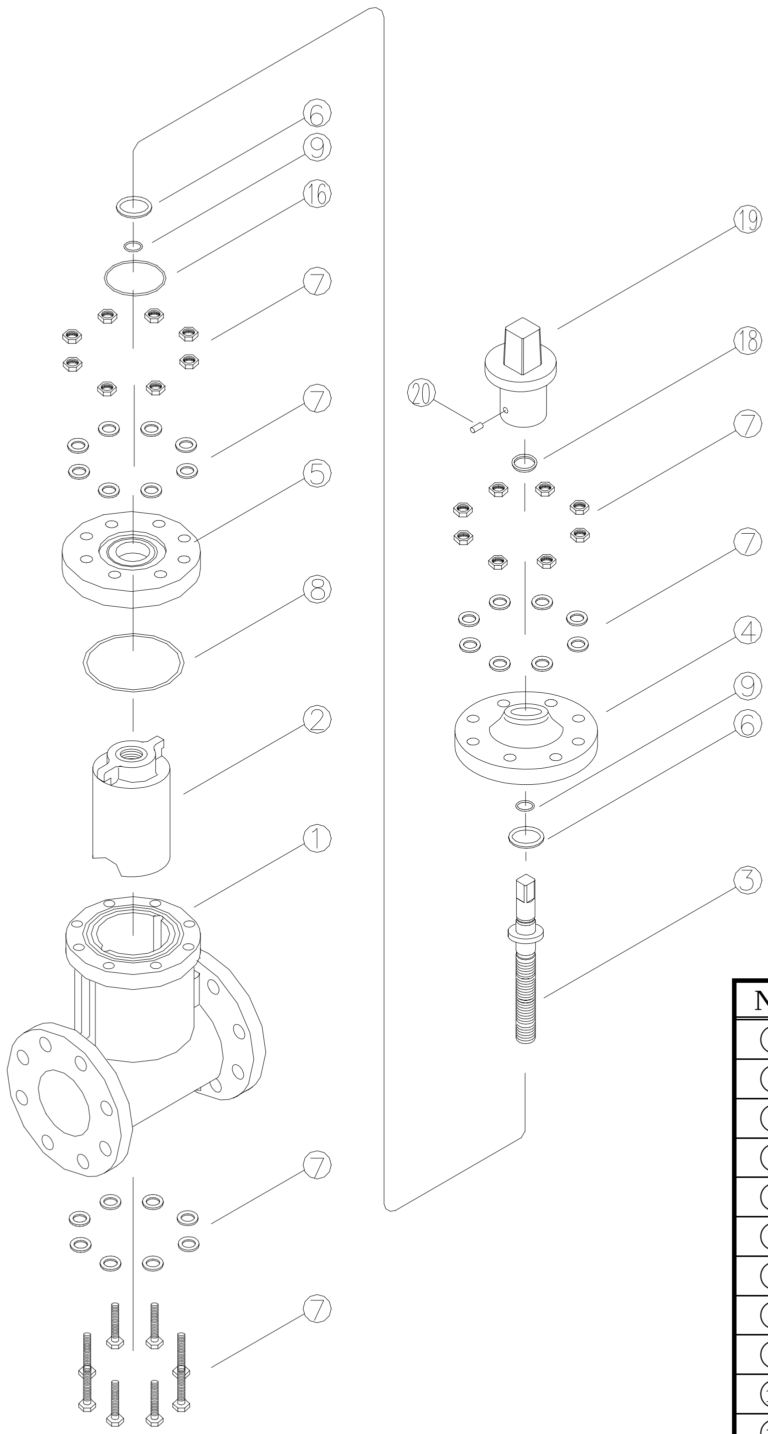
(1) General operating instructions

- Operate the valve within the pressure v.s. temperature range.
  (The valve can be damaged by operating beyond the allowable range.)
- Select a valve material that is compatible with the media, refer to “CHEMICAL RESISTANCE ON ASAHI AV VALVE”.
  (Some chemicals may damage incompatible valve materials.)
- Do not use the valve to fluid containing slurry. (The valve will not operate properly.)
- Do not use the valve on condition that fluid has crystallized.
  (The valve will not operate properly.)
- Do not step on the valve or apply excessive weight on valve. (It can be damaged.)
- Do not exert excessive force in closing the valve.
- Make sure to consult a waste treatment dealer to dispose of the valves.
  (Poisonous gas is generated when the valve is burned improperly.)
- Allow sufficient space for maintenance and inspection.
- Keep the valve away from excessive heat or fire. (It can be deformed, or destroyed)
- Set valve support on the valve.
- Keep the valve away from places of direct sunlight, water and dust. Use cover to shield the valve.
  (The valve will not operate properly.)
- Do not use AV valves in a place where they may become submerged in water.
  (Submergence will make AV valve fail.)

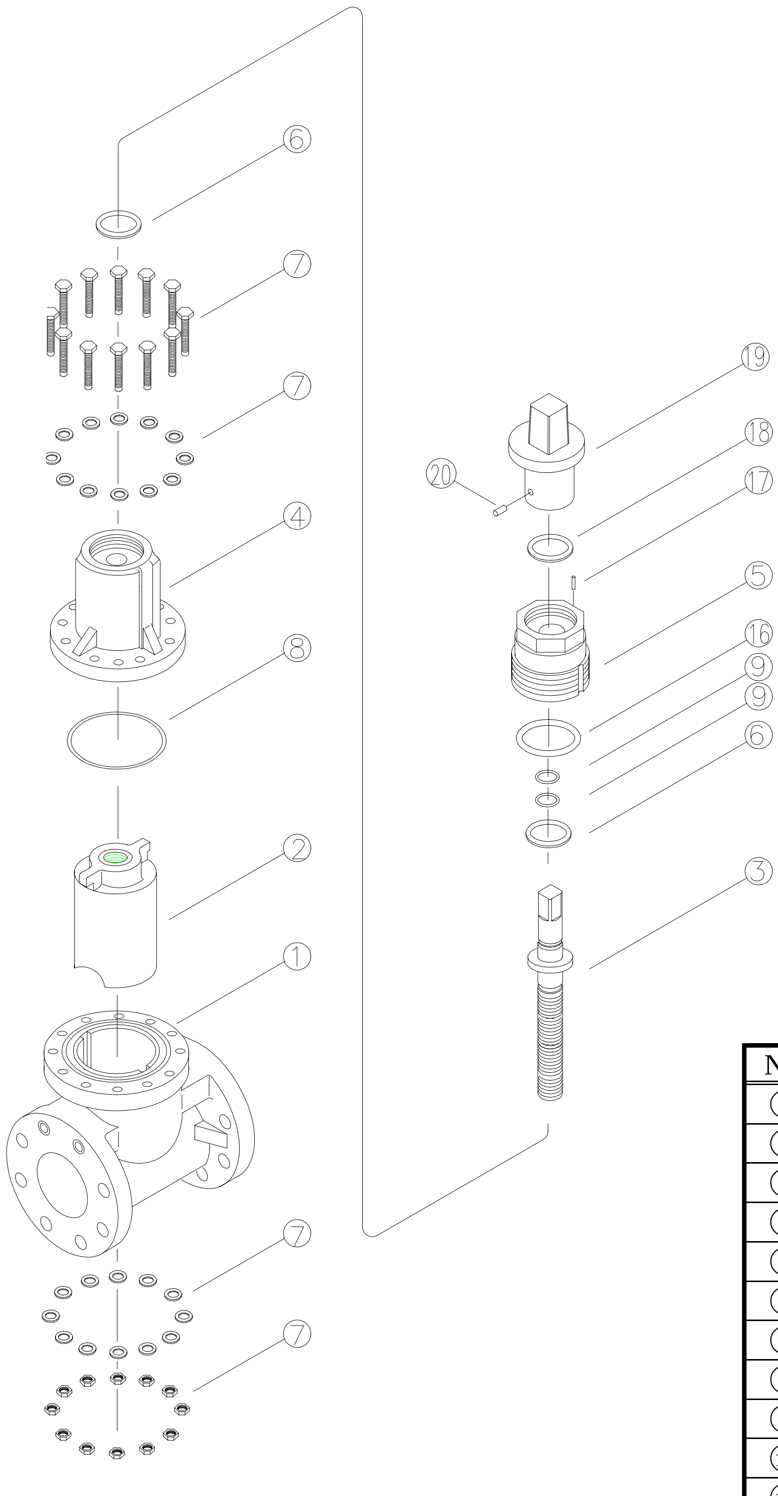
(2) General instructions for transportation, unpacking and storage

- Keep the valve packed in the carton or box as delivered until installation.
- Keep the valve away from any coal tar, creosote (antiseptic for wood), termite insecticide, vermicides, and paint.
  (This could cause swelling and damage the valve.)
- Do not impact or drop the valve. (It can be damaged.)
- Avoid scratching the valve with any sharp object.

(3) Name of parts

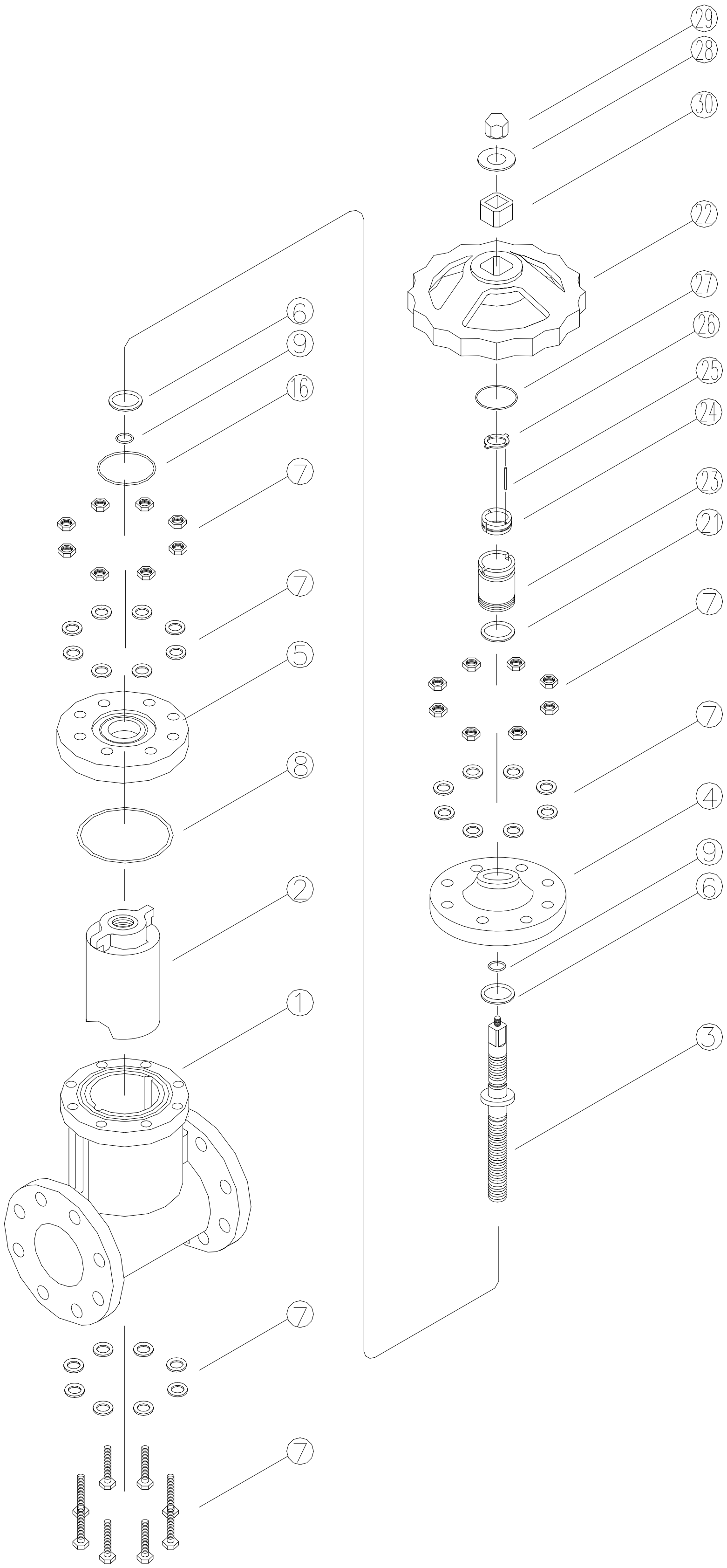


No.	DESCRIPTION
1	Body
2	Gate
3	Stem
4	Bonnet (A)
5	Bonnet (B)
6	Thrust ring
7	Bolt-nut (A)
8	O-ring (B)
9	O-ring (C)
16	O-ring (D)
17	Set screw (A)
18	Dust seal
19	Cap (A)
AV Gate valve P-type 40mm ($1^1/_2$")-150mm (6") Cap Metal stem	

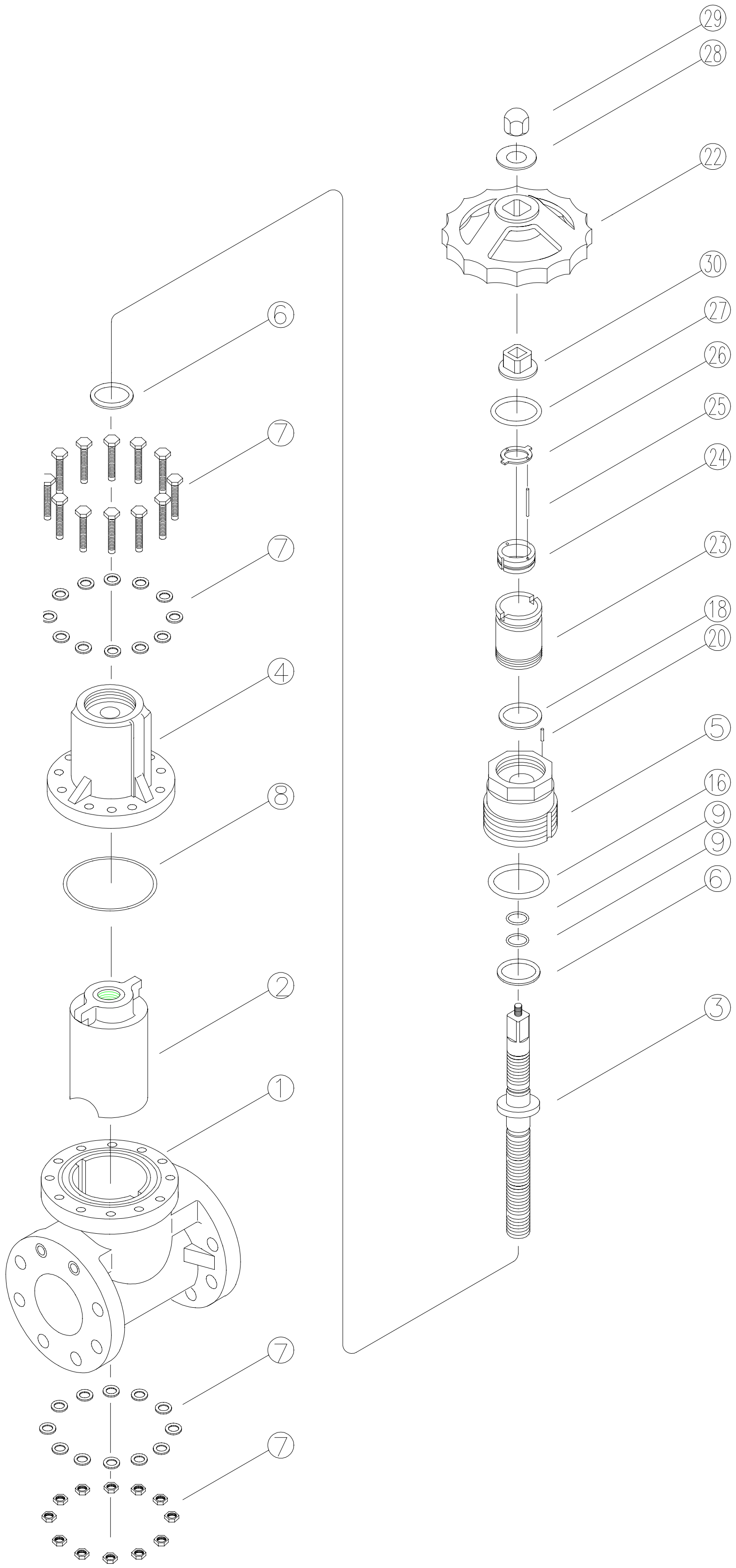


No.	DESCRIPTION
①	Body
②	Gate
③	Stem
④	Bonnet (A)
⑤	Bonnet (B)
⑥	Thrust ring
⑦	Bolt-nut (A)
⑧	O-ring (B)
⑨	O-ring (C)
⑯	O-ring (D)
⑰	Set screw (A)
⑱	Dust seal
⑲	Cap (A)
⑳	Set screw (B)

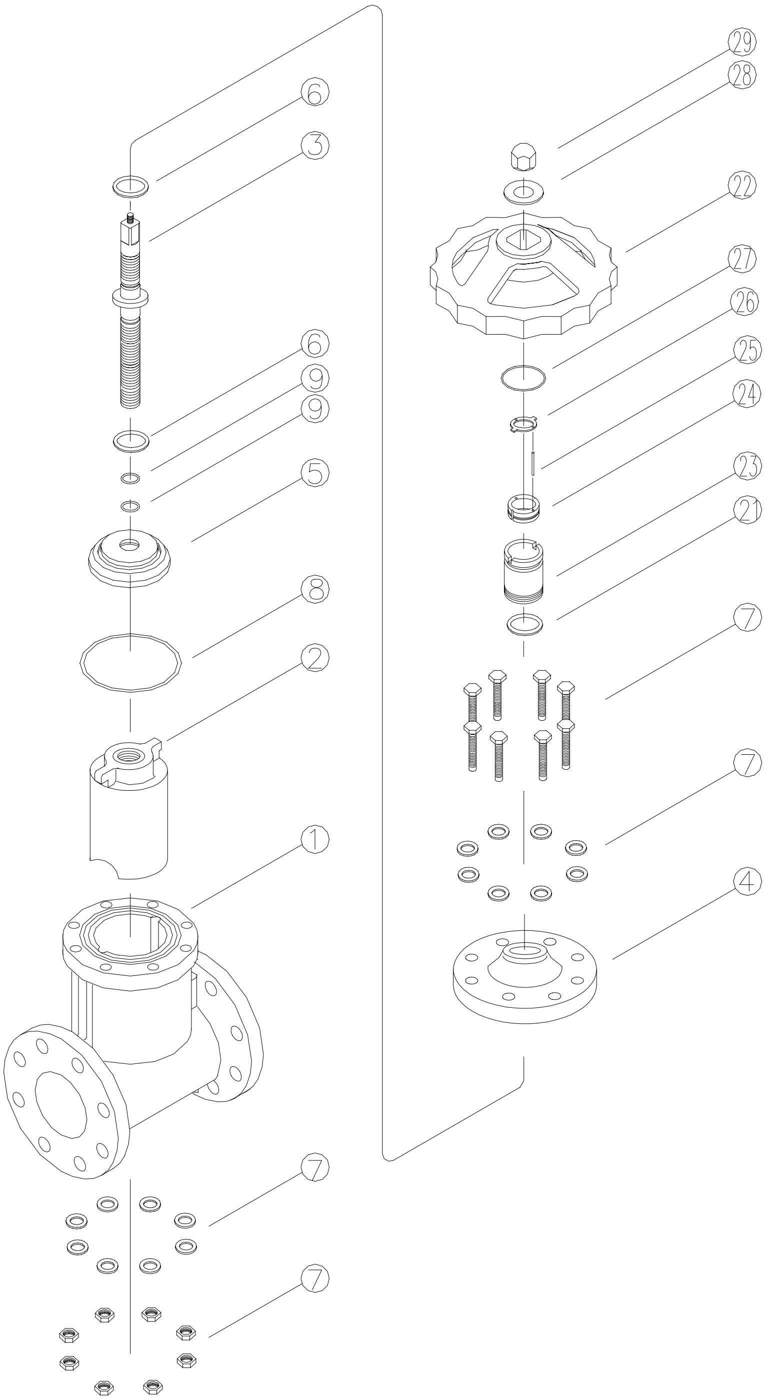
AV Gate valve P-type
200mm (8”)-350mm (14”)
Cap
Metal stem



No.	DESCRIPTION
①	Body
②	Gate
③	Stem
④	Bonnet (A)
⑤	Bonnet (B)
⑥	Thrust ring
⑦	Bolt-nut (A)
⑧	O-ring (B)
⑨	O-ring (C)
⑯	O-ring (D)
⑱	Dust seal
㉒	Handle
㉓	Indicating cover
㉔	Indicating ring
㉕	Guide pin
㉖	Guide pin holder
㉗	O-ring (G)
㉘	Washer
㉙	Box nut
㉚	Handle bush
AV Gate valve P-type 40mm ($1^1/_2$")-150mm (6") Round handle Metal stem	

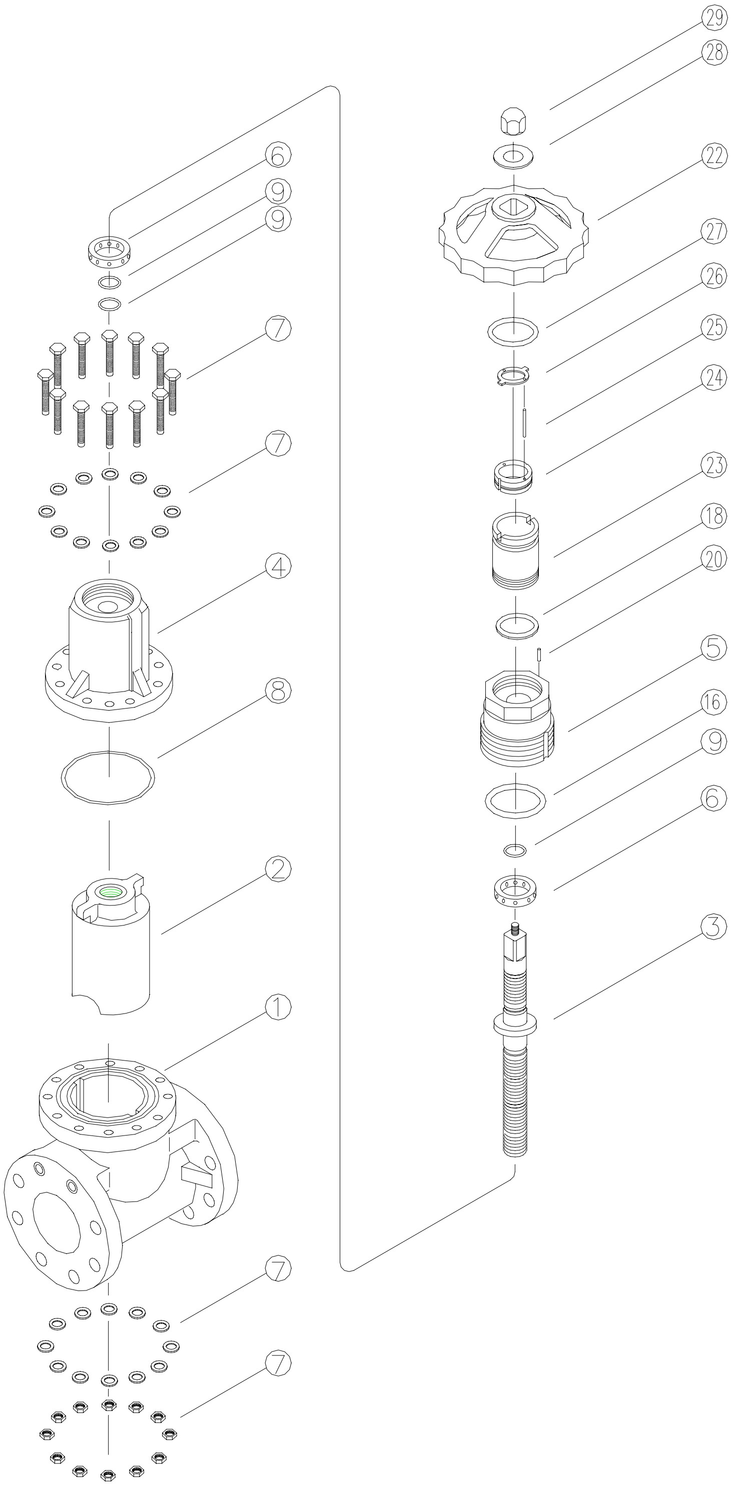


No.	DESCRIPTION
1	Body
2	Gate
3	Stem
4	Bonnet (A)
5	Bonnet (B)
6	Thrust ring
7	Bolt-nut (A)
8	O-ring (B)
9	O-ring (C)
16	O-ring (D)
18	Dust seal
20	Set screw
22	Handle
23	Indicating cover
24	Indicating ring
25	Guide pin
26	Guide pin holder
27	O-ring (G)
28	Washer
29	Box nut
30	Handle bush
AV Gate valve P-type 200mm (8")-350mm (14") Round handle Metal stem	



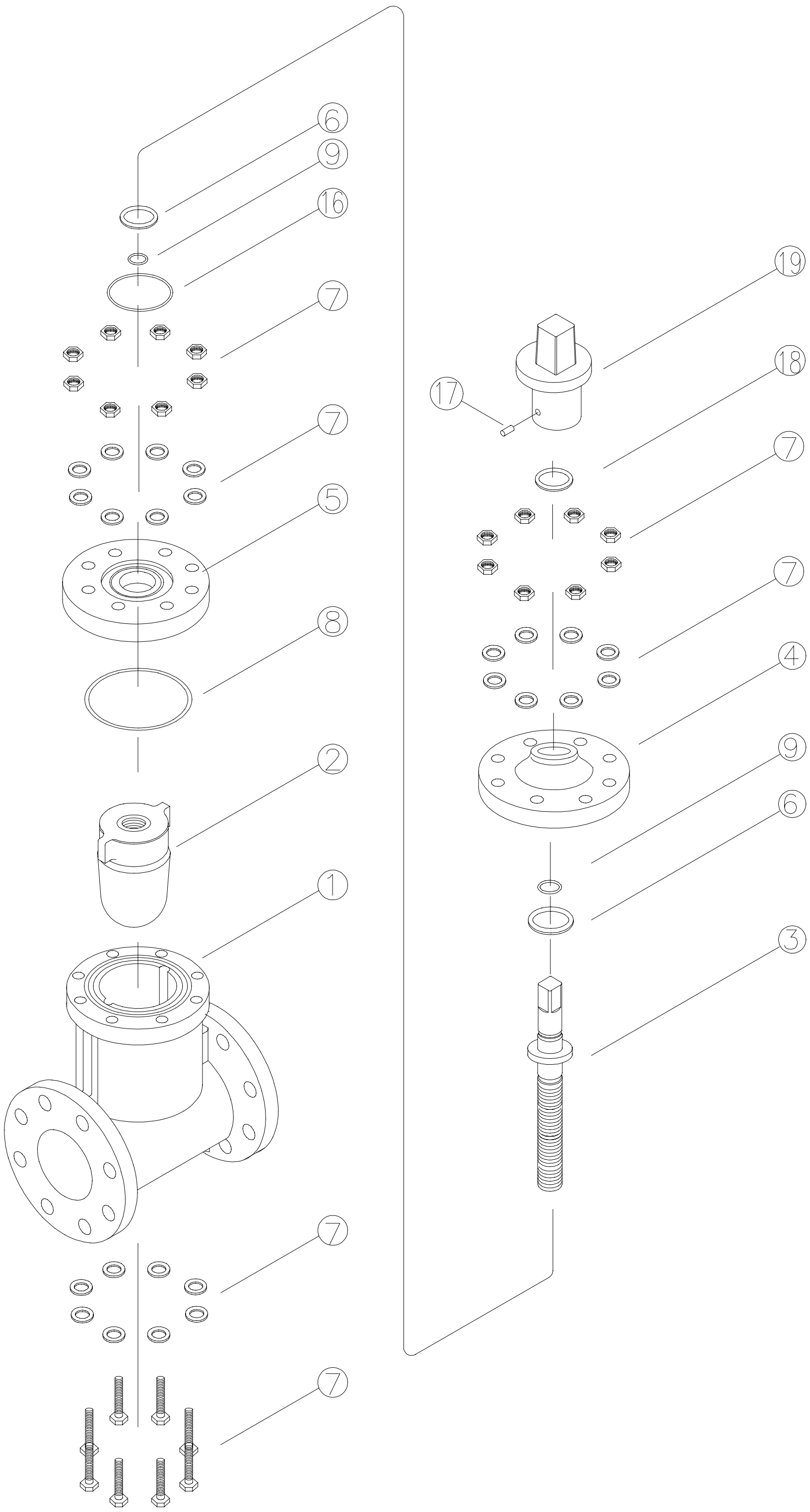
No.	DESCRIPTION
1	Body
2	Gate
3	Stem
4	Bonnet (A)
5	Bonnet (B)
6	Thrust ring
7	Bolt-nut (A)
8	O-ring (B)
9	O-ring (C)
16	O-ring (D)
18	Dust seal
20	Set screw (B)
22	Handle
23	Indicating cover
24	Indicating ring
25	Guide pin
26	Guide pin holder
27	O-ring (G)
28	Washer
29	Nut

AV Gate valve P-type
40mm ($1^1/_2$")-150mm (6")
Round handle
PVC stem
Non - rising

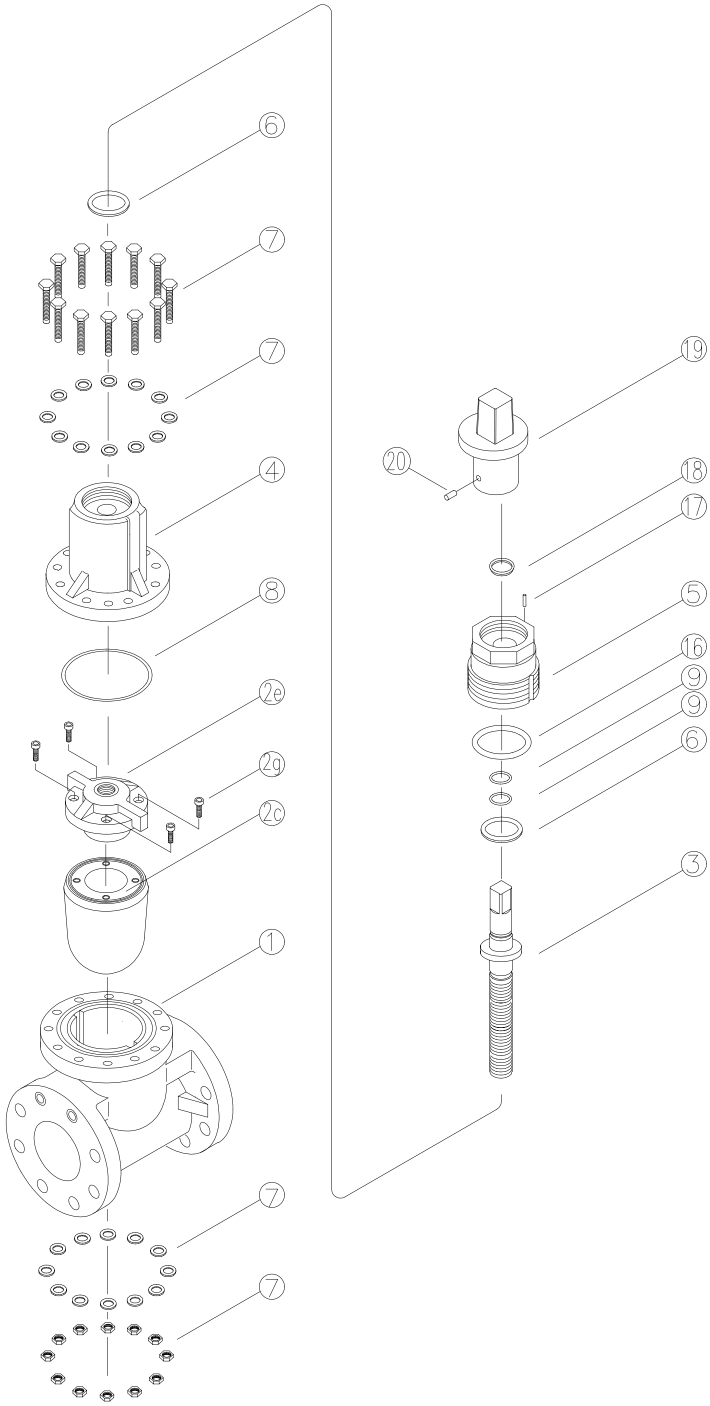


No.	DESCRIPTION
①	Body
②	Gate
③	Stem
④	Bonnet (A)
⑤	Bonnet (B)
⑥	Thrust bearing
⑦	Bolt-nut (A)
⑧	O-ring (B)
⑨	O-ring (C)
⑯	O-ring (D)
⑱	Dust seal
⑳	Set screw (B)
㉒	Handle
㉓	Indicating cover
㉔	Indicating ring
㉕	Guide pin
㉖	Guide pin holder
㉗	O-ring (G)
㉘	Washer
㉙	Box nut

AV Gate valve P-type
200mm (8”) -350mm (14”)
Round handle
PVC stem
Non - rising

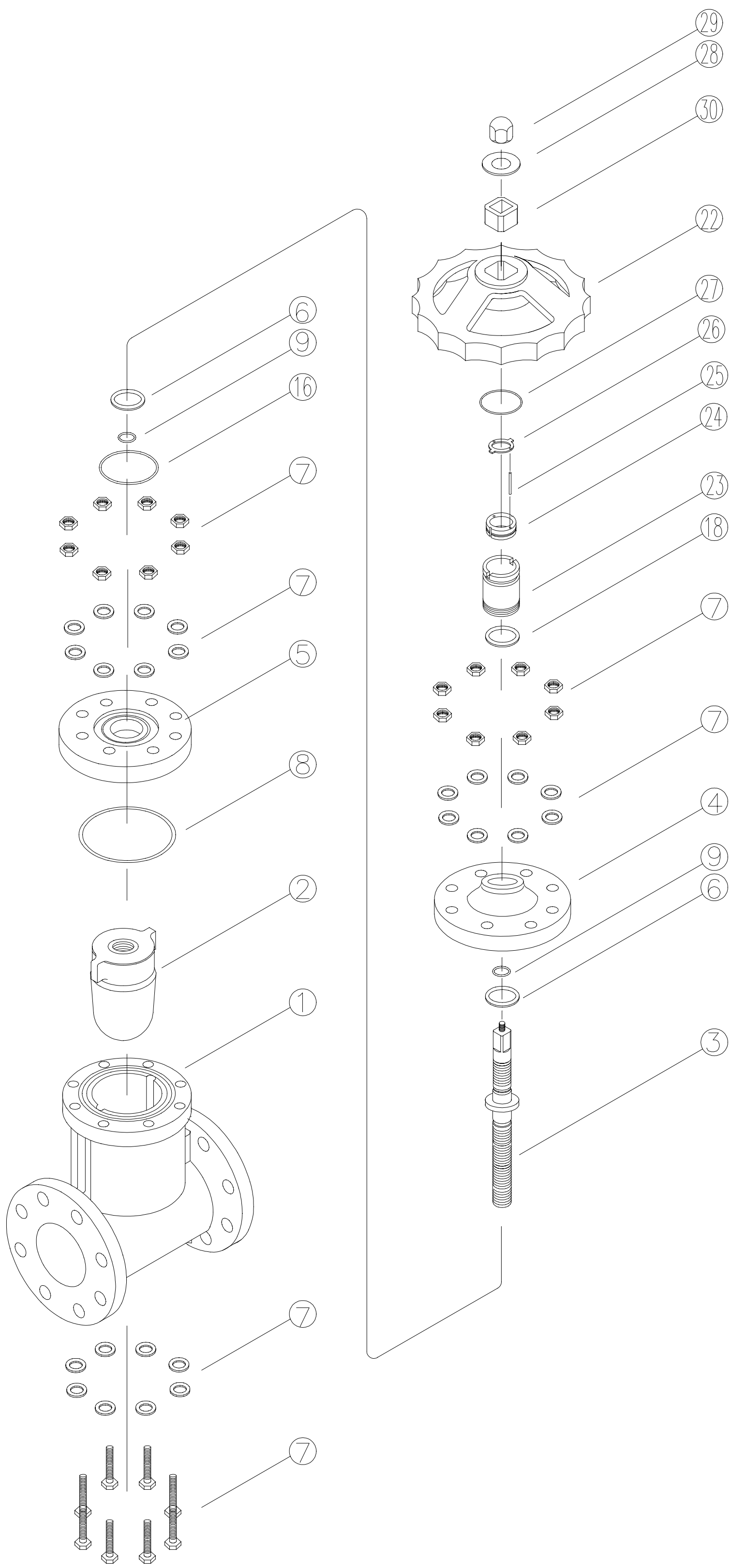


No.	DESCRIPTION
1	Body
2	Gate
3	Stem
4	Bonnet (A)
5	Bonnet (B)
6	Thrust ring
7	Bolt-nut-washer
8	O-ring (B)
9	O-ring (C)
16	O-ring (D)
17	Set screw (A)
18	Dust seal
19	Cap (A)
AV Gate valve S-type 40mm ($1^1/_2$")-150mm (6") Cap Metal stem	



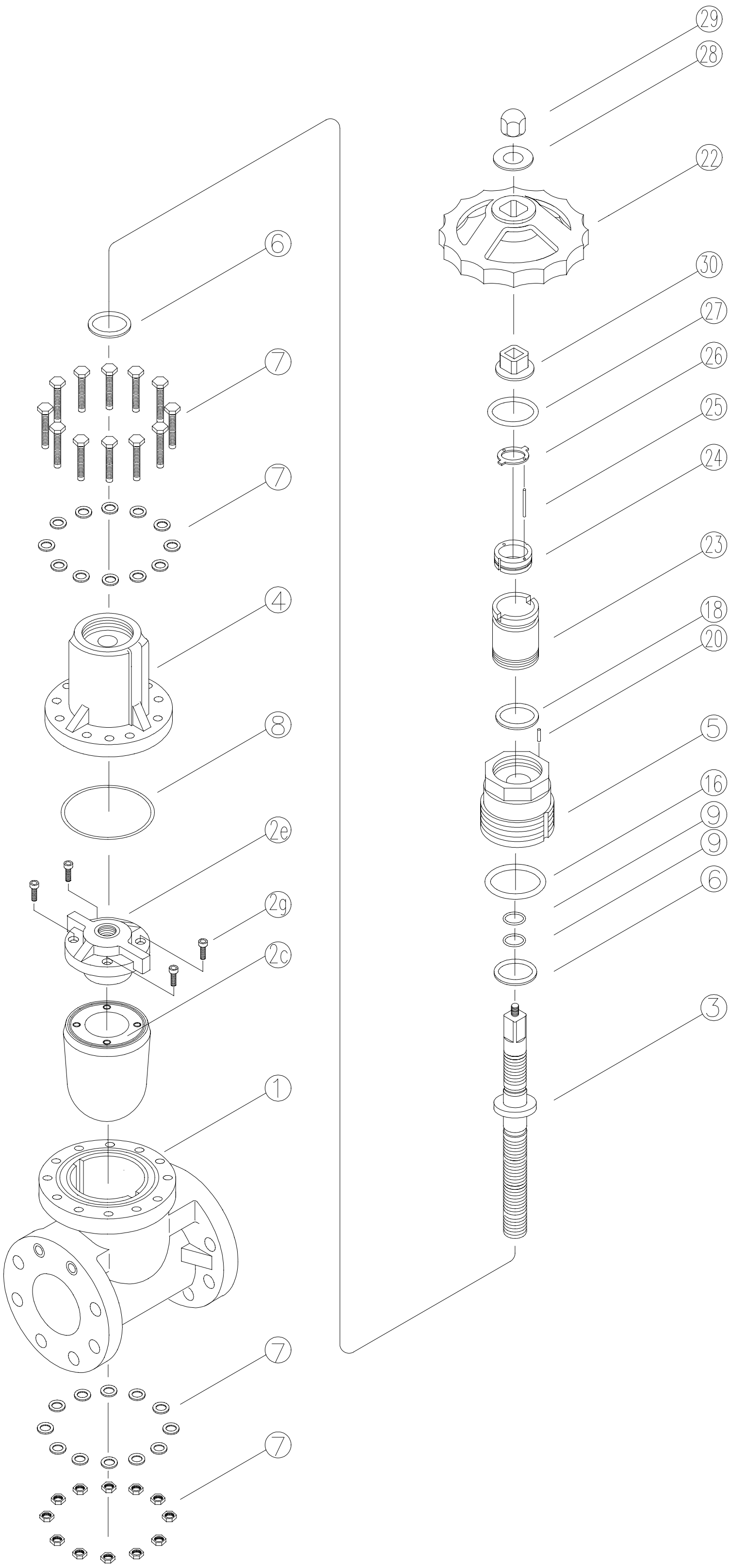
No.	DESCRIPTION
1	Body
2c	Gate (A)
2e	Gate (B)
2g	Bolt (A)
3	Stem
4	Bonnet (A)
5	Bonnet (B)
6	Thrust ring
7	Bolt-nut (A)
8	O-ring (B)
9	O-ring (C)
16	O-ring (D)
17	Set screw (A)
18	Dust seal
19	Cap (A)
20	Stem screw (B)

AV Gate valve S-type
200mm (8”)
Cap
Metal stem

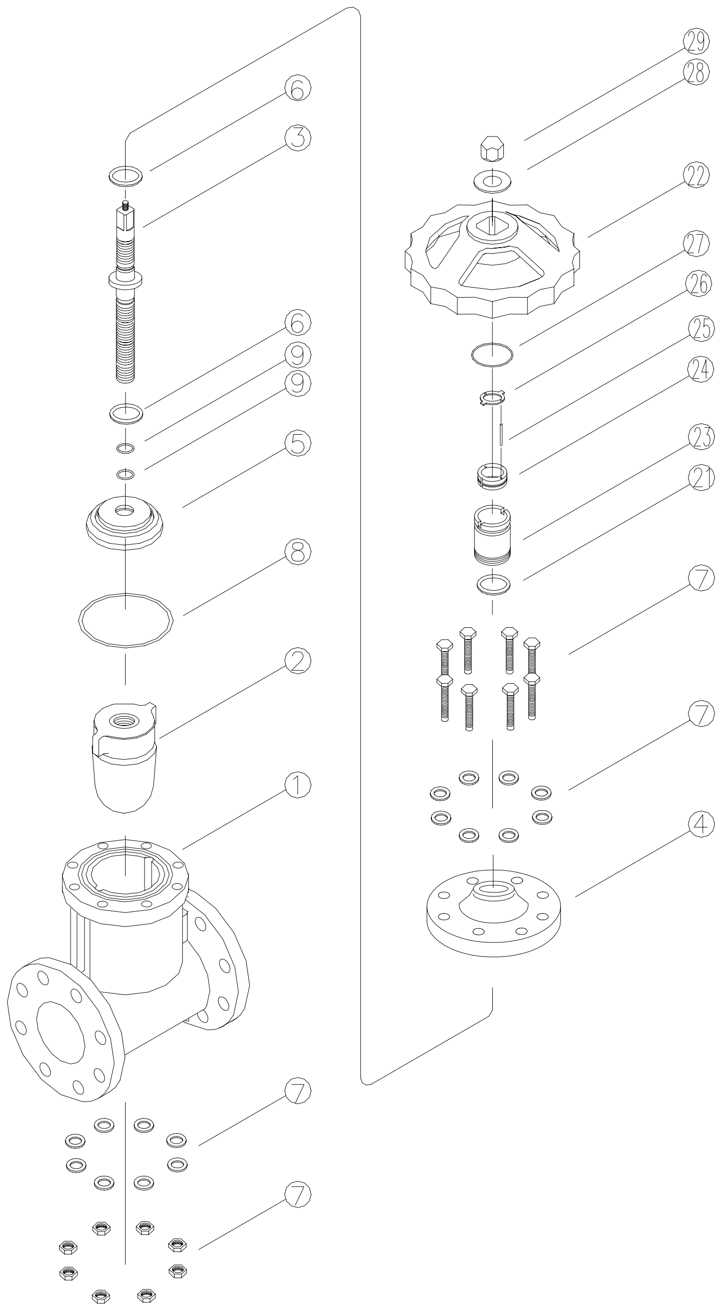


No.	DESCRIPTION
1	Body
2	Gate
3	Stem
4	Bonnet (A)
5	Bonnet (B)
6	Thrust ring
7	Bolt-nut (A)
8	O-ring (B)
9	O-ring (C)
16	O-ring (D)
18	Dust seal
22	Handle
23	Indicating cover
24	Indicating ring
25	Guide pin
26	Guide pin holder
27	O-ring (G)
28	Washer
29	Nut
30	Handle bush

AV Gate valve S-type
40mm ($1^1/_2$")-150mm (6")
Round handle
Metal stem

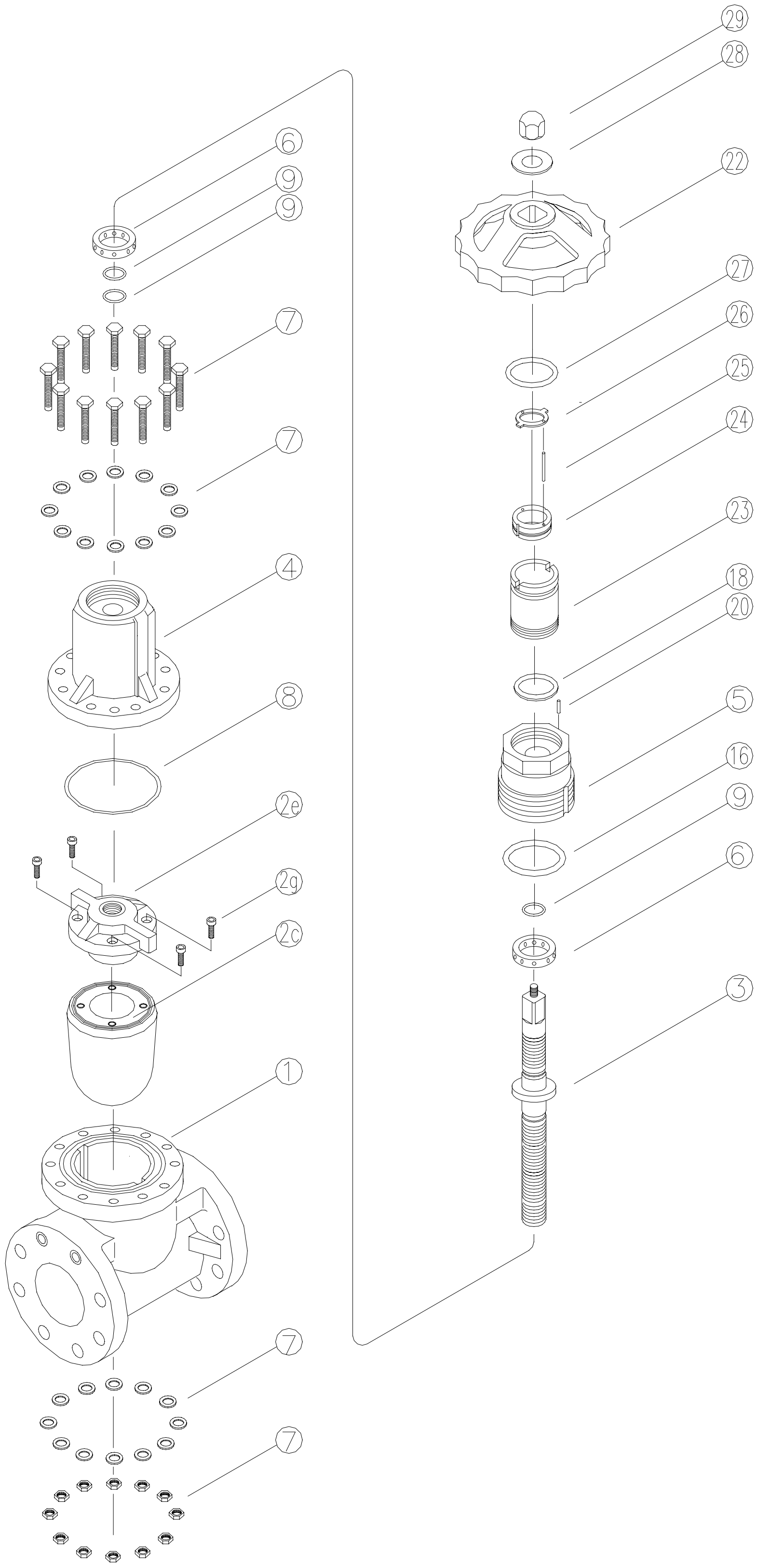


No.	DESCRIPTION
1	Body
2c	Gate (A)
2e	Gate (B)
2g	Bolt (A)
3	Stem
4	Bonnet (A)
5	Bonnet (B)
6	Thrust ring
7	Bolt-nut (A)
8	O-ring (B)
9	O-ring (C)
16	O-ring (D)
18	Dust seal
20	Set screw (B)
22	Handle
23	Indicating cover
24	Indicating ring
25	Guide pin
26	Guide pin holder
27	O-ring (G)
28	Washer
29	Box nut
30	Handle bush
AV Gate valve S-type 200mm (8”) Round handle Metal stem	



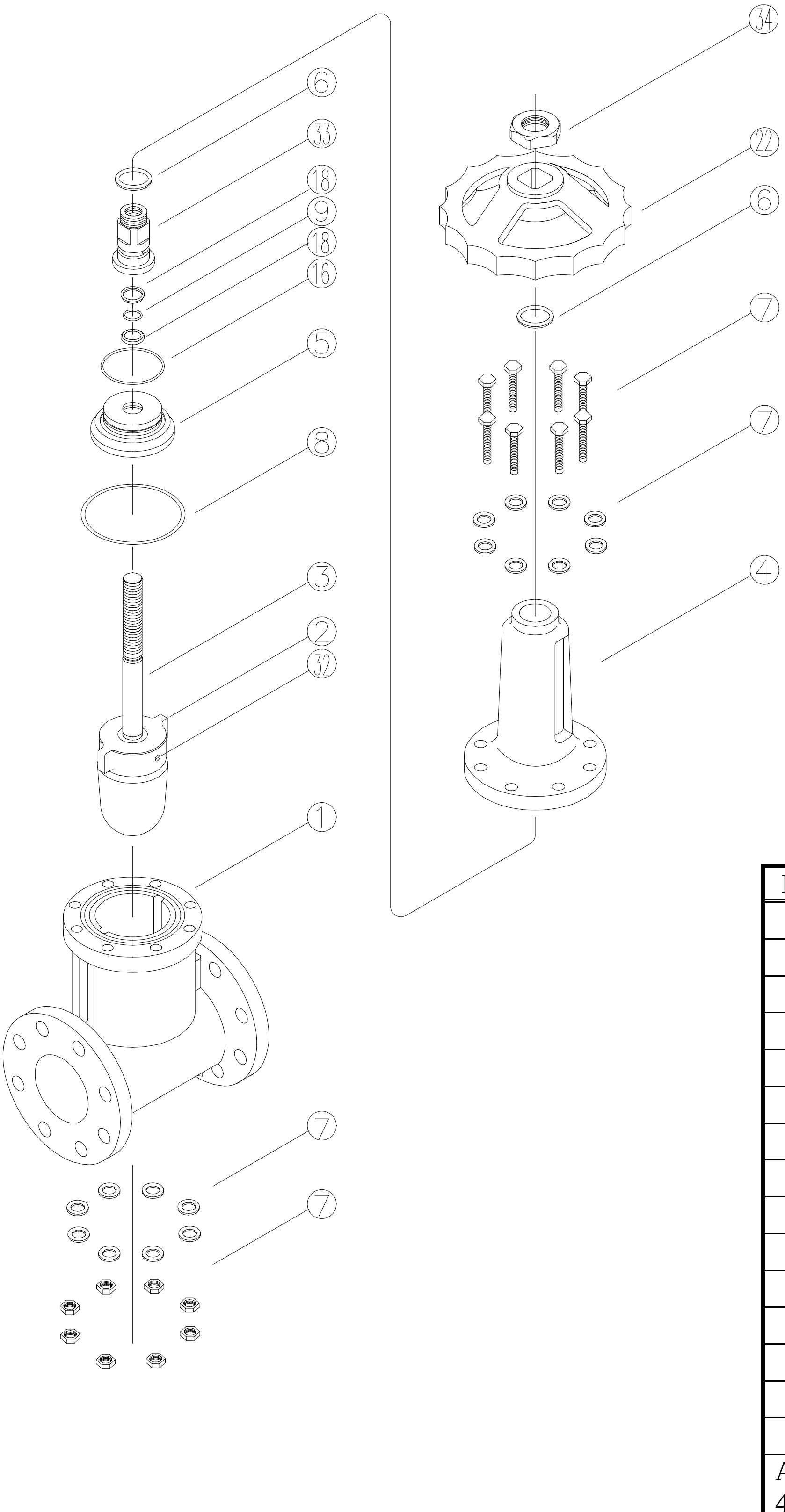
No.	DESCRIPTION
①	Body
②	Gate
③	Stem
④	Bonnet (A)
⑤	Bonnet (B)
⑥	Thrust ring
⑦	Bolt-nut (A)
⑧	O-ring (B)
⑨	O-ring (C)
⑯	O-ring (D)
⑱	Dust seal
⑳	Set screw (B)
㉒	Handle
㉓	Indicating cover
㉔	Indicating ring
㉕	Guide pin
㉖	Guide pin holder
㉗	O-ring(G)
㉘	Washer
㉙	Nut

AV Gate valve S-type
50mm (2”)-150mm (6”)
Round handle
PVC stem
Non - rising

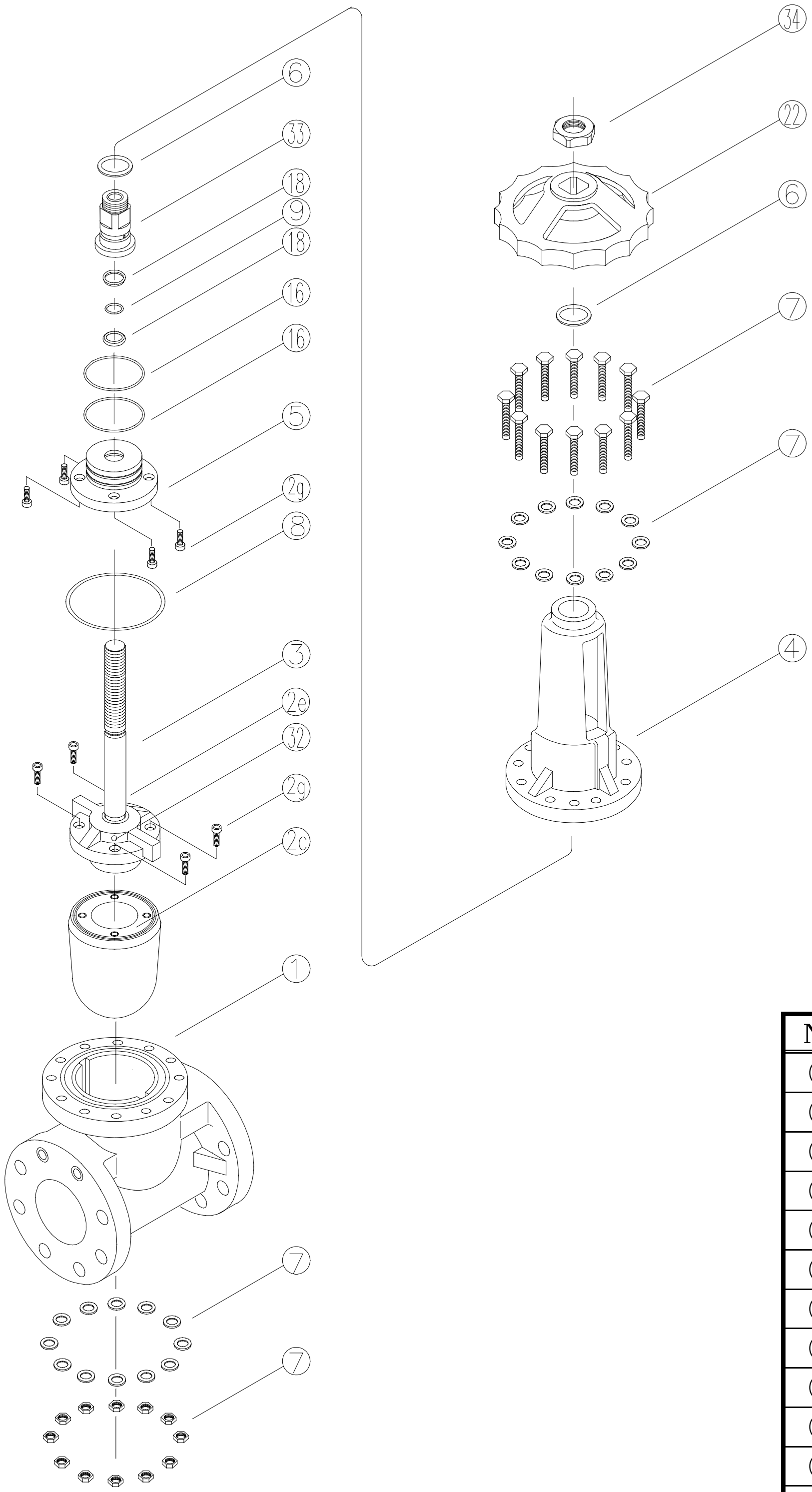


No.	DESCRIPTION
1	Body
2a	Bolt
2c	Gate(A)
2e	Gate(B)
3	Stem
4	Bonnet(A)
5	Bonnet(B)
6	Thrust ring
7	Bolt-nut(A)
8	O-ring(B)
9	O-ring(C)
16	O-ring(D)
18	Dust seal
20	Set screw(B)
22	Handle
23	Indicating cover
24	Indicating ring
25	Guide pin
26	Guide pin holder
27	O-ring(G)
28	Washer
29	Box nut

AV Gate valve S-type
200mm (8”)
Round handle
PVC stem
Non - rising



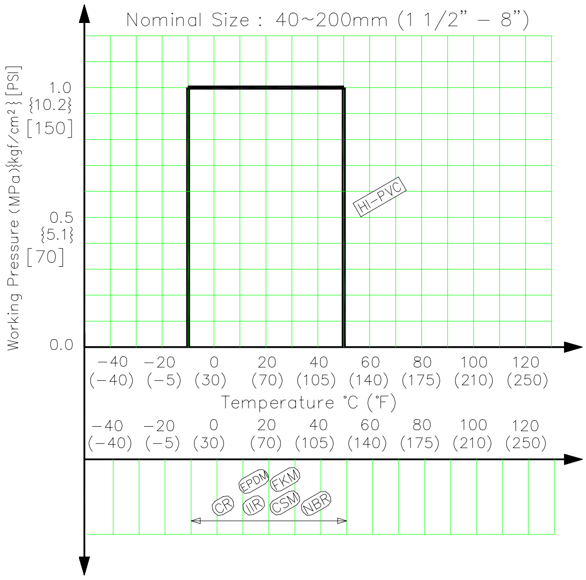
No.	DESCRIPTION
1	Body
2	Gate
3	Stem
4	Bonnet (A)
5	Bonnet (B)
6	Thrust ring
7	Bolt-nut (A)
8	O-ring (B)
9	O-ring (C)
16	O-ring (D)
18	Dust seal
22	Handle
32	Pin (A)
33	Sleeve
34	Nut
AV Gate valve S-type 40mm (1 1/2")-150mm (6") External threaded type	

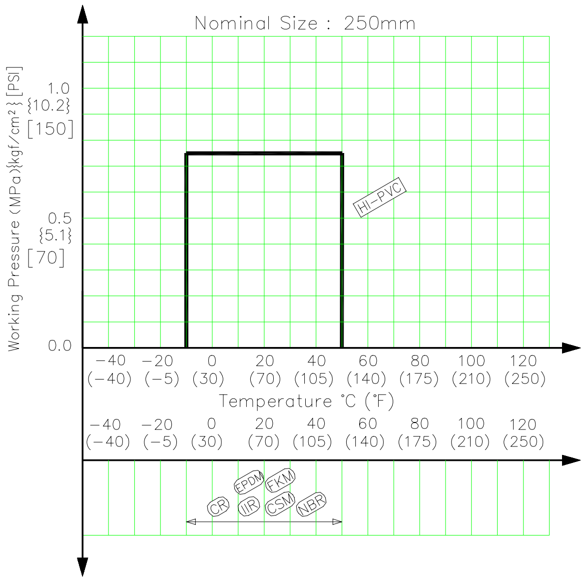


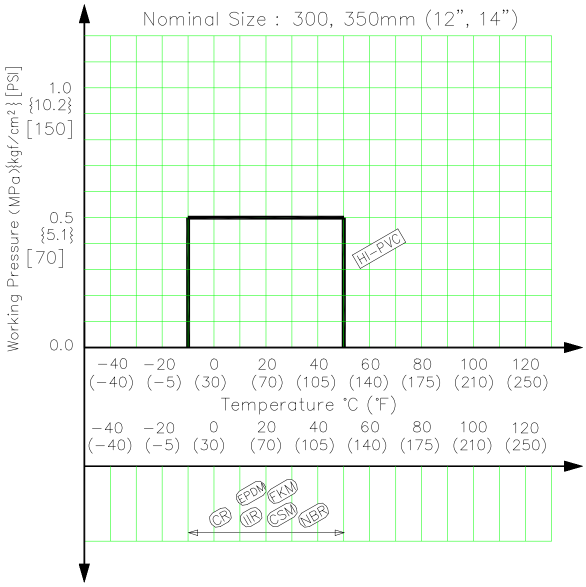
No.	DESCRIPTION
1	Body
2c	Gate(A)
2e	Gate(B)
2g	Bolt(A)
3	Stem
4	Bonnet
5	Bush
6	Thrust ring
7	Bolt-nut (A)
8	O-ring (B)
9	O-ring (C)
16	O-ring (D)
18	Dust seal
22	Handle
32	Pin (A)
33	Sleeve
34	Nut

AV Gate valve S-type
200mm (8”)
External threaded screw type

(4) Comparison between operating temperature and pressure







Caution

Do not operate the valve beyond the range or the published working temperature and pressure.
(The valve can be damaged.)

(5) Installation procedure

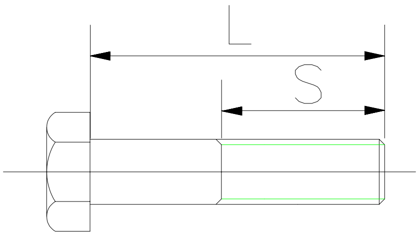
Necessary items

- Torque wrench
- Spanner wrench
- Bolt-nut-washer (For many flanges specification)
- AV gasket

(When a non-AV gasket is used, a different tightening torque specification should be followed.)

Procedure

1) Set the AV gasket between the flanges.
2) Insert washers and bolts from the pipe side, insert washers and nuts from the valve side, then temporarily tighten them by hand.



Dimension of insert bolt

Nom. Size mm (inch)	Water supply standard AV TS Flange				Water supply standard Steel Flange JIS G5524 ・G5521				JIS 10K standard AV TS Flange				Water supply standard Steel Flange JIS G2212			
	Bolt-nut Nom size	Washer Nom size	L	S	Bolt-nut Nom size	Washer Nom size	L	S	Bolt-nut Nom size	Washer Nom size	L	S	Bolt-nut Nom size	Washer Nom size	L	S
40 ($1^{1}/_{2}$”)	-	-	-	-	-	-	-	-	M16	16	65	38	M16	16	70	38
50 (2”)	M16	16	70	38	M16	16	70	38	M16	16	70	38	M16	16	70	38
65 ($2^{1}/_{2}$”)	-	-	-	-	-	-	-	-	M16	16	75	38	M16	16	75	38
75(80) (3”)	M16	16	80	38	M16	16	80	38	M16	16	75	38	M16	16	75	38
100 (4”)	M16	16	80	38	M16	16	80	38	M16	16	80	38	M16	16	80	38
125 (5”)	M16	16	85	38	M16	16	80	38	M20	20	85	46	M20	20	85	46
150 (6”)	M16	16	85	38	M16	16	85	38	M20	20	85	46	M20	20	85	46
200 (8”)	M16	16	90	38	M16	16	85	38	M20	20	90	46	M20	20	90	46
250 (10”)	M20	20	95	46	M20	20	90	46	M22	22	95	50	M22	22	95	50
300 (12”)	M20	20	95	46	M20	20	95	46	M22	22	95	50	M22	22	100	50
350 (14”)	-	-	-	-	M22	22	95	50	M22	22	100	50	M22	22	100	50

Dimension of insert bolt

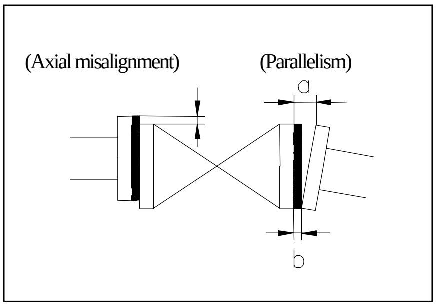
Nom. Size mm (inch)	Water supply standard AV TS Flange				Water supply standard Steel Flange JIS G5524 ・G5521				JIS 10K standard AV TS Flange				Water supply standard Steel Flange JIS G2212			
	Bolt-nut Nom size	Washer Nom size	L	S	Bolt-nut Nom size	Washer Nom size	L	S	Bolt-nut Nom size	Washer Nom size	L	S	Bolt-nut Nom size	Washer Nom size	L	S
200 (8”)	-	-	-	-	-	-	-	-	M20	20	55	46	M20	20	50	46
300 (12”)	-	-	-	-	-	-	-	-	M22	22	60	50	M22	22	60	50
350 (14”)	-	-	-	-	M22	22	55	All thread	M22	22	60	50	M22	22	60	50

Caution

The parallelism and axial misalignment of the flange surface should be under the values shown in the following table to prevent damage the valve.
（A failure to observe them can cause destruction due to stress application to the pipe）

Unit: mm (inch)

Nom. Size	Axial Misalignment	Parallelism (a-b)
40-150mm (1 1/2”-6”)	1.5 (0.06)	1.5 (0.06)
200-350mm (8”-14”)	2.0 (0.08)	2.0mm (0.08)

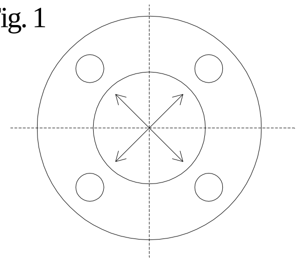


3) Tighten the bolts and nuts gradually with a torque wrench to the specified torque level in a diagonal manner. (Refer to fig.1.)

Recommended torque value Unit：N-m{kgf-cm}[lb-inch]

Nom. Size	Torque value	Nom. Size	Torque value
40 (1$^1/_2$”)	20.0{204}[177]	150 (6”)	40.0{408}[355]
50 (2”)	22.5{230}[200]	200 (8”)	55.0{561}[488]
65 (2$^1/_2$”)	22.5{230}[200]	250 (10”)	55.0{561}[488]
80 (3”)	30.0{306}[266]	300 (12”)	60.0{612}[532]
100 (4”)	30.0{306}[266]	350 (14”)	60.0{612}[532]
125 (5”)	40.0{408}[355]	-	-

Fig. 1



Caution

Avoid excessive tightening. (The valve can be damaged.)

Threaded type

Necessary items

- Sealing tape（A non-sealing tape can cause leakage.）
- Strap wrench（Do not use Pipe wrench.）

Caution

Make sure that threaded connections are plastic x plastic.
（Metallic thread might destroy the body cap）

Procedure

1) Wind a sealing tape around the external thread of joint, leaving the end (about 3mm) free.
2) Tighten the external thread of joint and the body lightly by hand.
3) Using a spanner wrench, screw them in by turning 90-180 degrees carefully without damaging them.

Caution

Avoid excessive tightening. (The valve can be damaged.)

(6) Operating Procedure

○ Turn the handle gently to open or close.
(For the left open valve, turn the handle clockwise to close and counter clockwise to open. For the right open valve, turn the handle to the reverse side of left open valve.)

○ The cap type should not be forced to operate as it dose not have any travel indicators.

(7) Disassembling Method for replacing parts

Necessary items

● Allen wrench ● Spanner wrench

<Disassembly>

Procedure
1) Remove the cap with a hexagon wrench.
(Ask the nearest blanch about the round handle type. Other types, except from the round handle and any parts related to the valve travel indicate, are the same procedure as the cap type.)
2) Bonnet (A) and bonnet (B) can be removed with the stem by loosening the bolt not.

<Assembly>

Procedure
Carry out the assembly work in the reverse procedure of its disassembly.

(8) Inspection items

○Inspect the follow items;

(1)	Check for flaws, cracks, or deformation on the valve.
(2)	Check for leaks to the outside.
(3)	Check for the deformation of seat or disc due to improper installation of valve.
(4)	Check for the smoothness of handle operation.

(9) Troubleshooting

Problem	Cause	Treatment
Fluid leaks from by in the full closed position.	The seat is scratched or worn.	Replace the body or the gate.
	Foreign matter is in the valve.	Clean the valve.
	The gate is scratched or worn.	Replace the body or the gate.
Fluid leaks to the valve.	The O-ring is scratched or worn.	Replace the o-ring.
	The bolt-nut is loose.	Retighten the bolt-nut.
The handle does not operate smoothly.	Foreign materials have adhered.	Clean the valve.
	Deformation. (Due to heat etc.)	Replace parts.
The valve does not operate.	The stem is broken.	Replace the stem.
	The engagement between the stem and the gate is broken.	Replace the stem and the gate.

(10) Handling of residual and waste materials

Caution

In discarding remaining or waste materials, be sure to ask waste service company.
(Poisonous gas is generated.)

(11) Inquiries

ASAHI ORGANIC CHEMICALS INDUSTRY CO., LTD.

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Tel : (1) 781-321-5409 Fax : (1) 781-321-4421

Distributor

Gate Valves (C type)

ASAHI *AV* VALVES

Information in this manual is subject to change without notice. 2003.5

D-14
Ball Valves

HAYWARD INDUSTRIAL PRODUCTS
INSTALLATION OPERATION & MAINTENANCE
OF TRUE UNION BALL VALVES

PLEASE READ THE FOLLOWING INFORMATION PRIOR TO INSTALLING AND USING HAYWARD VALVES, STRAINERS, FILTERS, AND OTHER ASSOCIATED PRODUCTS. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN SERIOUS INJURY.

1. Hayward guarantees its products against defective material and workmanship only. Hayward assumes no responsibility for damage or injuries resulting from improper installation, misapplication, or abuse of any product.
2. Hayward assumes no responsibility for damage or injury resulting from chemical incompatibility between its products and the process fluids to which they are subjected. Compatibility charts provided in Hayward literature are based on ambient temperatures of 70F and are for reference only. Customer should always test to determine application suitability.
3. Consult Hayward literature to determine operating pressure and temperature limitations before installing any Hayward product. Note that the maximum recommended fluid velocity through any Hayward product is eight feet per second. Higher flow rates can result in possible damage due to the water hammer effect. Also note that maximum operating pressure is dependent upon material selection as well as operating temperature.
4. Hayward products are designed primarily for use with non-compressible liquids. They should NEVER be used or tested with compressible fluids such as compressed air or nitrogen.
5. Systems should always be depressurized and drained prior to installing or maintaining Hayward products.
6. Temperature effect on piping systems should always be considered when the systems are initially designed. Piping systems must be designed and supported to prevent excess mechanical loading on Hayward equipment due to system misalignment, weight, shock, vibration, and the effects of thermal expansion and contraction.
7. Because PVC and CPVC plastic products become brittle below 40F, Hayward recommends caution in their installation and use below this temperature.
8. Published operating torque requirements are based upon testing of new valves using clean water at 70F. Valve torque is affected by many factors including fluid chemistry, viscosity, flow rate, and temperature. These should be considered when sizing electric or pneumatic actuators.
9. Due to differential thermal expansion rates between metal and plastic, transmittal of pipe vibration, and pipe loading forces DIRECT INSTALLATION OF METAL PIPE INTO PLASTIC CONNECTIONS IS NOT RECOMMENDED. Wherever installation of plastic valves into metal piping systems is necessary, it is recommended that at least 10 pipe diameter in length of plastic pipe be installed upstream and downstream of the plastic valve to compensate for the factors mentioned above.

SOCKET CONNECTION:

Socket end connections are manufactured to ASTM D2467-94. Solvent cementing of socket end connections to pipe should be performed per ASTM specifications D2855-87. Cut pipe square. Chamfer and deburr pipe. Surfaces must be cleaned and free of dirt, moisture, oil and other foreign material. Remove assembly nuts and end connectors from valve body. Slide assembly nuts, with threads facing valve, onto pipe to which the end connector is to be cemented. Apply primer to inside socket surface of end connector. Never allow primer or cement to contact valve ball or end connector o-ring sealing surfaces, as leaking may result. Use a scrubbing motion. Repeat applications may be necessary to soften the surface of the socket. Next, liberally apply primer to the male end of the pipe to the length of the socket depth. Again apply to the socket, without delay apply cement to the pipe while the surface is still wet with primer. Next apply cement lightly, but uniformly to the inside of the socket. Apply a second coat of cement to the pipe, and assemble the end connector to the pipe, rotating the end connector 1/4 turn in one direction as it is slipped to full depth on to the pipe. The end connector should be held in position for approx. 30 seconds to allow the connection to "set". After assembly wipe off excess cement. Full set time is a minimum of 30 minutes at 60 to 100 F. Full cure time should be based on the chart below.

JOINT CURE SCHEDULE:

The cure schedules are suggested as guides. They are based on laboratory test data, and should not be taken to be the recommendations of all cement manufacturers. Individual manufacturer's recommendations for their particular cement should be followed.

	Test Pressures for Pipe Sizes ½" to 1-1/4"		Test Pressures for Pipe Sizes 1-1/2" to 3"		Test Pressures for Pipe Sizes 4" & 5"		Test Pressures for Pipe Sizes 6" to 8"	
Temperature Range During Cure Period(B) °F(°C)	Up to 180 PSI (1240 kPa)	Above 180 to 370 PSI (1240 to 2550 kPa)	Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI (1240 to 2172 kPa)	Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI (1240 to 2172 kPa)	Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI (1240 to 2172 kPa)
60 to 100 (15 to 40)	1 hour	6 hours	2 hours	12 hours	6 hours	18 hours	8 hours	1 day
40 to 60 (5 to 15)	2 hours	12 hours	4 hours	1 day	12 hours	36 hours	16 hours	4 days
20 to 40 (-7 to 5)	6 hours	36 hours	12 hours	3 days	36 hours (A)	4 days (A)	3 days (A)	9 days (A)
10 to 20 (-15 to 7)	8 hours	2 days	16 hours	4 days	3 days (A)	8 days (A)	4 days (A)	12 days (A)
Colder than 10 (-15)	Extreme care should be exercised on all joints made where pipe, fittings or cement is below 10°F.							

A: It is important to note that at temperatures colder than 20°F on sizes that exceed 3 in., test results indicate that many variables exist in the actual cure rate of the joint. The data expressed in these categories represent only estimated averages. In some cases, cure will be achieved in less time, but isolated test results indicate that even longer periods of cure may be required.

B: These cure schedules are based on laboratory test data obtained on Net Fit Joints (NET FIT=in a dry fit the pipe bottoms snugly in the fitting socket without meeting interference).

THREADED CONNECTION:

Threaded end connections are manufactured to ASTM specifications D2464-88. F437-88 and ANSI B2.1. Wrap threads of pipe with Teflon tape of 3 to 3-1/2 mil thickness. The tape should be wrapped in a clockwise direction starting at the first or second full thread. Overlap each wrap by, 1/2 the width of the tape. The wrap should be applied with sufficient tension to allow the threads of a single wrapped area to show through without cutting the tape. The wrap should continue for the full effective length of the thread. Pipe sizes 2" and greater will not benefit with more than a second wrap, due to the greater thread depth. To provide a leak proof joint, the pipe should be threaded into the end connection "hand tight". Using a strap wrench only. (Never use a stillson type wrench) tighten the joint an additional 1/2 to 1-1/2 turns past hand tight. Tightening beyond this point may induce excessive stress that could cause failure.

FLANGED CONNECTION:

Flange bolts should be tight enough to slightly compress the gasket and make a good seal, without distorting or putting excessive stress on the flanges. Suitable washers should be used between the bolt head and flange and the nut and flange. Bolts should be tightened in alternating sequence.

RECOMMENDED FLANGE BOLT TORQUE

FLANGE SIZE	BOLT DIA.	TORQUE FT. LBS.	FLANGE SIZE	BOLT DIA.	TORQUE FT. LBS.
1/2	1/2	10-15	2	5/8	15-25
3/4	1./2	10-15	2-1/2	5/8	20-25
1	1/2	10-15	3	5/8	20-25
1-1/4	1/2	10-15	4	5/8	20-25
1-1/2	1/2	10-15	6	3/4	30-40

NOTE: USE WELL LUBRICATED METAL BOLTS AND NUTS. USE SOFT RUBBER GASKETS.

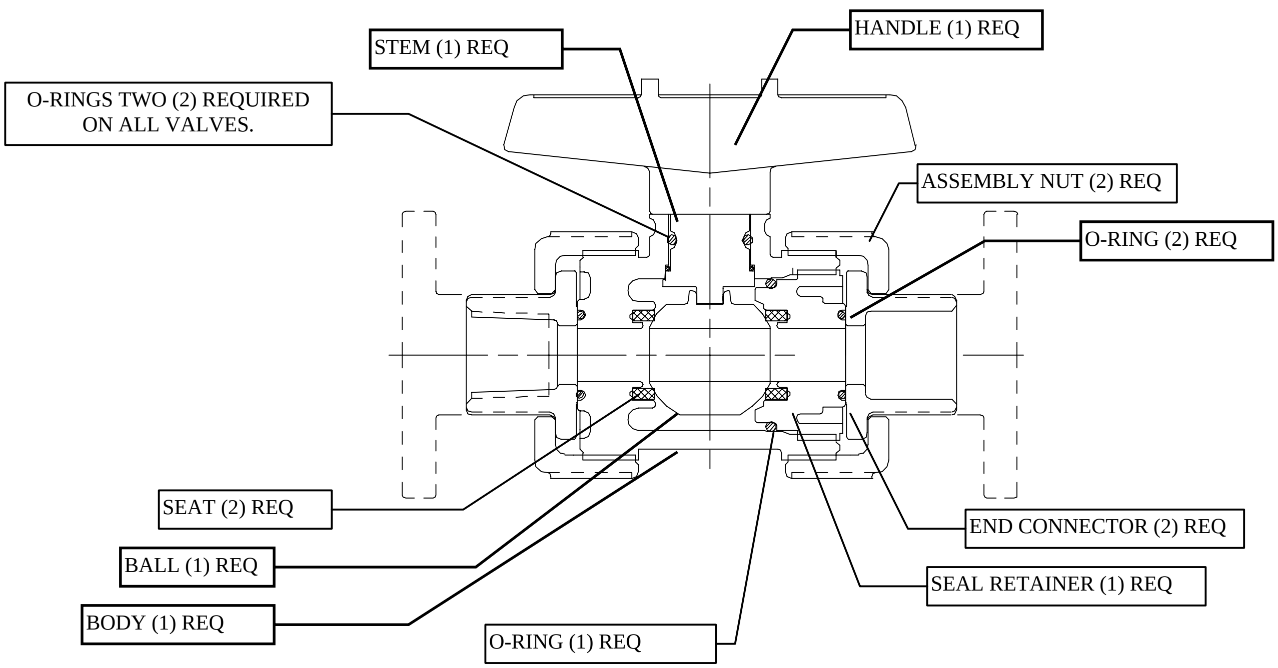
ADJUSTMENT:

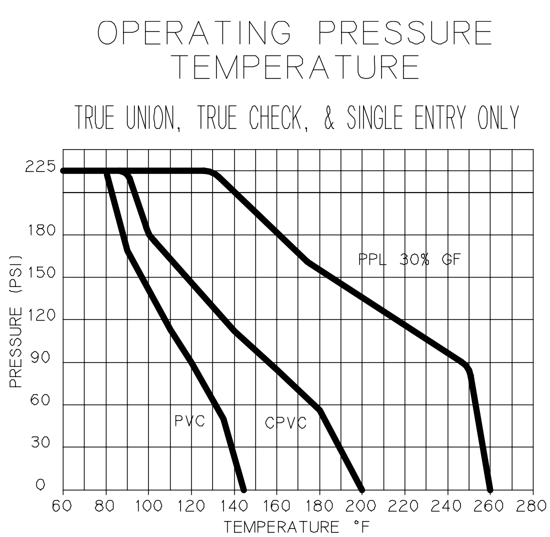
EXTREME CAUTION MUST BE TAKEN WHEN WORKING ON THIS VALVE.
THE PIPING SYSTEM MUST BE DEPRESSURIZED AND DRAINED. PROPER CARE MUST BE TAKEN. CONSULT M.S.D.S. (MATERIAL SAFETY DATA SHEETS) INFORMATION REGARDING YOUR SPECIFIC APPLICATION.

Remove the assembly nut and end connector from the “adjust” end of the body, or the complete valve body from the piping system. The front face of the seal retainer indicates which direction of rotation tightens or loosens the seal retainer, with the word “tighten” and a directional arrow, and the word “loosen” and a directional arrow. Direction of rotation may vary depending on date of manufacture. The Assembly nut should be installed on the valve “hand tight”. Using a strap wrench only the joint may be tightened 1/2 to 3/4 of a turn past hand tight.

REPAIR:

Follow the adjustment sequence and information above, but rotating the seal retainer completely in the “loosen” direction and remove it from valve body. The o-rings and seals are now accessible for replacement using a “seal” repair kit. Carefully remove the o-rings from their respective locations taking care not to scratch their sealing surfaces. Insert o-rings and re-assemble. See table below.





Recommended valve stem torque to rotate the ball 360° when valve is reassembled.

VALVE SIZE	TORQUE IN*LB
1/2”	40
3/4”	50
1”	60
1 1/2”	70
2”	80
3” & 2 1/2”	140
4” & 6”	170

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ECR 968S
File: 08H7.DOC

D-15
Check Valves

HAYWARD INDUSTRIAL PRODUCTS
INSTALLATION, OPERATION & MAINTENANCE
OF TRUE UNION BALL CHECK VALVES

PLEASE READ THE FOLLOWING INFORMATION PRIOR TO INSTALLING AND USING HAYWARD VALVES, STRAINERS, FILTERS, AND OTHER ASSOCIATED PRODUCTS. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN SERIOUS INJURY.

1. Hayward guarantees its products against defective material and workmanship only. Hayward assumes no responsibility for damage or injuries resulting from improper installation, misapplication, or abuse of any product.
2. Hayward assumes no responsibility for damage or injury resulting from chemical incompatibility between its products and the process fluids to which they are subjected. Compatibility charts provided in Hayward literature are based on ambient temperatures of 70F and are for reference only. Customer should always test to determine application suitability.
3. Consult Hayward literature to determine operating pressure and temperature limitations before installing any Hayward product. Note that the maximum recommended fluid velocity through any Hayward product is eight feet per second. Higher flow rates can result in possible damage due to the water hammer effect. Also note that maximum operating pressure is dependent upon material selection as well as operating temperature.
4. Hayward products are designed primarily for use with non-compressible liquids. They should NEVER be used or tested with compressible fluids such as compressed air or nitrogen.
5. Systems should always be depressurized and drained prior to installing or maintaining Hayward products.
6. Temperature effect on piping systems should always be considered when the systems are initially designed. Piping systems must be designed and supported to prevent excess mechanical loading on Hayward equipment due to system misalignment, weight, shock, vibration, and the effects of thermal expansion and contraction.
7. Because PVC and CPVC plastic products become brittle below 40F, Hayward recommends caution in their installation and use below this temperature.
8. Published operating torque requirements are based upon testing of new valves using clean water at 70F. Valve torque is affected by many factors including fluid chemistry, viscosity, flow rate, and temperature. These should be considered when sizing electric or pneumatic actuators.
9. Due to differential thermal expansion rates between metal and plastic, transmittal of pipe vibration, and pipe loading forces DIRECT INSTALLATION OF METAL PIPE INTO PLASTIC CONNECTIONS IS NOT RECOMMENDED. Wherever installation of plastic valves into metal piping systems is necessary, it is recommended that at least 10 pipe diameter in length of plastic pipe be installed upstream and downstream of the plastic valve to compensate for the factors mentioned above.

SOCKET CONNECTION:

Socket end connections are manufactured to ASTM D2467-94. Solvent cementing of socket end connections to pipe should be performed per ASTM specifications D2855-87. Cut pipe square. Chamfer and deburr pipe. Surfaces must be cleaned and free of dirt, moisture, oil and other foreign material. Remove assembly nuts and end connectors from valve body. Slide assembly nuts, with threads facing valve, onto pipe to which the end connector is to be cemented. Apply primer to inside socket surface of end connector. Never allow primer or cement to contact valve ball or end connector o-ring sealing surfaces, as leaking may result. Use a scrubbing motion. Repeat applications may be necessary to soften the surface of the socket. Next, liberally apply primer to the male end of the pipe to the length of the socket depth. Again apply to the socket, without delay apply cement to the pipe while the surface is still wet with primer. Next apply cement lightly, but uniformly to the inside of the socket. Apply a second coat of cement to the pipe, and assemble the end connector to the pipe, rotating the end connector 1/4 turn in one direction as it is slipped to full depth on to the pipe. The end connector should be held in position for approx. 30 seconds to allow the connection to "set". After assembly wipe off excess cement. Full set time is a minimum of 30 minutes at 60 to 100 F. Full cure time should be based on the chart below.

JOINT CURE SCHEDULE:

The cure schedules are suggested as guides. They are based on laboratory test data, and should not be taken to be the recommendations of all cement manufacturers. Individual manufacturer's recommendations for their particular cement should be followed.

Temperature Range During Cure Period(B) °F(°C)	Test Pressures for Pipe Sizes 1/2 to 1-1/4 In. Up to 180 PSI (1240 kPa)	Above 180 to 370 PSI (1240 to 2550 kPa)	Test Pressures for Pipe Sizes 1-1/2 to 3 In. Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI 1240) to 2170 kPa)	Test Pressures for Pipe Sizes 4 to 5 In. Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI (1240 to 2170 kPa)	Test Pressures for Pipe Sizes 6 to 8 In Up to 180 PSI (1240 kPa)	Above 180 to 315 PSI (1240 to 2170 kPa)
60 to 100 (15 to 40)	1 h	6 h	2 h	12 h	6 h	18 h	8 h	24 h
40 to 60 (5 to 15)	2 h	12 h	4 h	24 h	12 h	36 h	16 h	48 h
20 to 40 (-7 to 5)	6 h	36 h	12 h	72 h	36 h A	4 days A	3 days A	9 days A
10 to 20) (-15 to 7)	8 h	48 h	16 h	96 h	72 h A	8 days A	4 days A	12 days A
Colder than 10 (-15)	Extreme care should be exercised on all joints made where pipe, fittings or cement is below 10°F.							

A: It is important to note that at temperatures colder than 20°F on sizes that exceed 3 in., test results indicate that many variables exist in the actual cure rate of the joint. The data expressed in these categories represent only estimated averages. In some cases, cure will be achieved in less time, but isolated test results indicate that even longer periods of cure may be required.

B: These cure schedules are based on laboratory test data obtained on Net Fit Joints (NET FIT=in a dry fit the pipe bottoms snugly in the fitting socket without meeting interference).

THREADED CONNECTION:

Threaded end connections are manufactured to ASTM specifications D2464-88. F437-88 and ANSI B2.1. Wrap threads of pipe with Teflon tape of 3 to 3-1/2 mil thickness. The tape should be wrapped in a clockwise direction starting at the first or second full thread. Overlap each wrap by, 1/2 the width of the tape. The wrap should be applied with sufficient tension to allow the threads of a single wrapped area to show through without cutting the tape. The wrap should continue for the full effective length of the thread. Pipe sizes 2" and greater will not benefit with more than a second wrap, due to the greater thread depth. To provide a leak proof joint, the pipe should be threaded into the end connection "hand tight". Using a strap wrench only. (Never use a stillson type wrench) tighten the joint an additional 1/2 to 1-1/2 turns past hand tight. Tightening beyond this point may induce excessive stress that could cause failure.

FLANGED CONNECTION:

Flange bolts should be tight enough to slightly compress the gasket and make a good seal, without distorting or putting excessive stress on the flanges. Suitable washers should be used between the bolt head and flange and the nut and flange. Bolts should be tightened in alternating sequence.

RECOMMENDED FLANGE BOLT TORQUE. USE WELL-LUBRICATED METAL BOLTS AND NUTS. USE SOFT RUBBER GASKETS.

FLANGE SIZE	BOLT DIA.	TORQUE FT. LBS.	FLANGE SIZE	BOLT DIA.	TORQUE FT. LBS.
1/2	1/2	10-15	2	5/8	15-25
3/4	1./2	10-15	2-1/2	5/8	20-25
1	1/2	10-15	3	5/8	20-25
1-1/4	1/2	10-15	4	5/8	20-25
1-1/2	1/2	10-15	6	3/4	30-40

ORIENTATION:

It is recommended that these valves be installed no closer than 10 pipe diameters from a pump. At least 5 pipe diameters should be between these valves and an elbow.

As in all plastic piping the maximum fluid velocity is 8 feet per second. This velocity minimizes the effects of valve closure and pump start up or shut down.

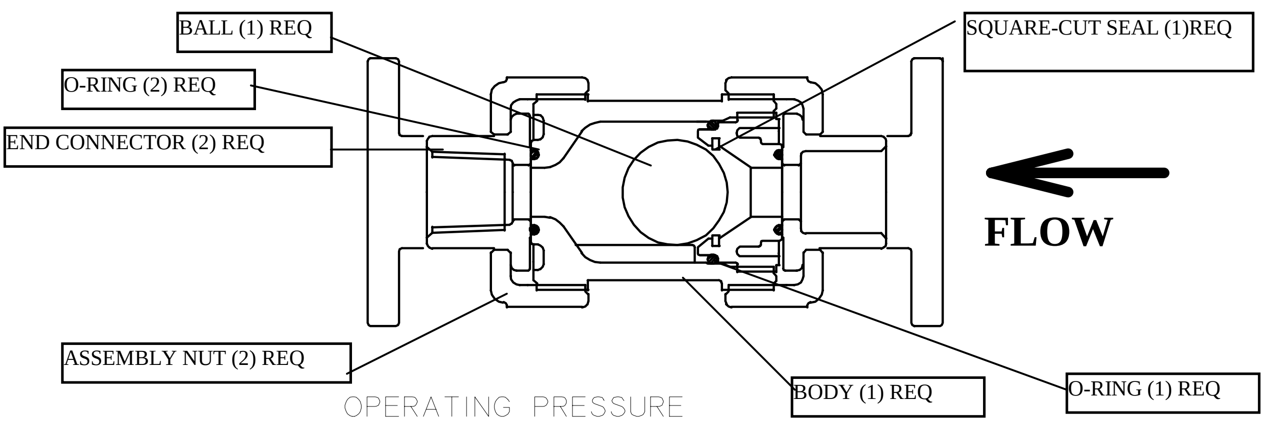
Note flow direction when installing. The ball will not float. This valve can be used in an upflow line but not in a downflow line. In horizontal installations standard line drop will generally not allow ball to seat.

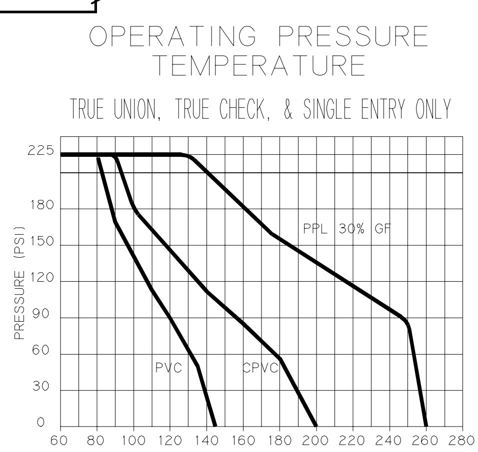
REPAIR:

EXTREME CAUTION MUST BE TAKEN WHEN WORKING ON THIS VALVE.
THE PIPING SYSTEM MUST BE DEPRESSURIZED AND DRAINED. PROPER CARE MUST BE TAKEN. CONSULT M.S.D.S. (MATERIAL SAFETY DATA SHEETS) INFORMATION REGARDING YOUR SPECIFIC APPLICATION.

Remove the assembly nut and end connector from the "adjust" end of the body, or the complete valve body from the piping system. The front face of the seal retainer indicates which direction of rotation tightens or loosens the seal retainer, with the word "tighten" and a directional arrow, and the word "loosen" and a directional arrow. Direction of rotation may vary depending on date of manufacture.

Rotate the seal retainer completely in the "loosen" direction and remove it from valve body. The o-rings and seals are now accessible for replacement using a "seal" repair kit. Carefully remove the o-rings from their respective locations taking care not to scratch their sealing surfaces. Use a non-petroleum base lubricant to lubricate the o-rings, and re-assemble the valve.





TCIS REV C
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ECR 819R

D-16
Flowmeters

Model ST98
Flowmeter

Firmware Revisions 2.XX
Doc. No. 06EN003291 Rev. A

US PATENTS PENDING

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

FCI®

FLUID COMPONENTS INTERNATIONAL LLC
1755 La Costa Meadows Dr. San Marcos, CA. 92078-5115 USA

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Model ST98 Flowmeter

Firmware Revisions 2.XX
Doc. No. 06EN003291 Rev. A

US PATENTS PENDING

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8/5/99REV. -
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By Mail

Fluid Components Intl
1755 La Costa Meadows Dr.
San Marcos, CA 92069
Attn: Customer Service Department

By Phone

Contact the area FCI regional representative. If a field representative is unable to be contacted or if a situation is unable to be resolved, contact the FCI Customer Service Department toll free at 1 (800) 854-1993.

By Fax

To describe problems in a graphical or pictorial manner, send a fax including a phone or fax number to the regional representative. Again, FCI is available by facsimile if all possibilities have been exhausted with the authorized factory representative. Our fax number is 1 (760) 736-6250; it is available 7 days a week, 24 hours a day.

By E-Mail

FCI Customer Service can be contacted by e-mail at: sales_technical_support@fluidcomponents.com.

Describe the problem in detail making sure a telephone number and best time to be contacted is stated in the e-mail.

International Support

For product information or product support outside the contiguous United States, Alaska, or Hawaii, contact your country's FCI International Representative or the one nearest to you. See the list on the following pages.

After Hours Support

For product information visit FCI's Worldwide Web at www.fluidcomponents.com. For product support call 1 (800) 854-1993 and follow the prerecorded instructions. A person from the Technical Support Staff will be paged and promptly return the call.

Appendix C contains a detailed explanation of the FCI customer service policy on returns, adjustments, in-field or factory repair, in- or out-of-warranty.

REVISIONS

REV.	DESCRIPTION	DATE	AUTHOR
-	INITIAL RELEASE	08/05/99	ROY SANDERS
A	See Change Bars. Major changes are due to new 2.xx Software and Revised circuit boards to Rev. A or Later.	03/01/00	ROY SANDERS

Contents

Figures

Tables

Symbols

The following symbols are used throughout the manual to draw attention to items or procedures that require special notice or care.

Caution: Warns of possible **personal danger** to those handling the equipment.

Alert: May cause possible **equipment damage**.

Note: Contains important information.

1. General Information

Description

The model ST98 is a thermal mass flowmeter for air or gas measuring applications. The ST98 consists of a flow element, a flow transmitter, and an enclosure. An in-line flow element is used for smaller diameter pipe or tubing sizes and, for pipe sizes greater than 2-1/2 inches (40 mm bore), an insertion flow element is used. The flow element's process connections can be threaded or flanged.

The ST98 flow transmitter accepts AC or DC input power and the output signal can be set for either a standard range current or voltage. A display is optional. An RS-232C serial I/O port provides setup, monitoring and troubleshooting access using either *FCI*'s model FC88 Programmer or a PC-compatible computer.

The ST98 enclosures provide environmental protection for the flow transmitter. The flow transmitter can be integrally mounted with the flow element or remotely separated from it. Hazardous location local and remote enclosures are optional.

Theory of Operation

The flow element of the model ST98 uses the thermal dispersion operating principle: A low-powered heater produces a temperature differential between two resistance temperature detectors (RTDs) by heating one of the RTDs. Mass flow rate changes cool the heated RTD and cause a proportional change in the temperature differential between the RTDs. The instrument's flow transmitter converts the RTD temperature differential into a scaled output signal and an optional indicated display value.

The signal from the unheated RTD is used to provide an indication of the air or gas temperature on the optional display.

Insertion Sensing Element

The sensing element consists of two thermowells (hollow tubes) that when inserted into the flow process allows an unimpeded flow inside the process line. A heated RTD is inserted into the top thermowell. A reference RTD (with no heater) is inserted into the bottom thermowell. In order to correctly orient the sensing element a flow arrow has been etched onto a machined flat portion of the sensing element. See Figure 1-1 for a view of the sensing element.

The element is inserted into the process media through a hole drilled into the process line.

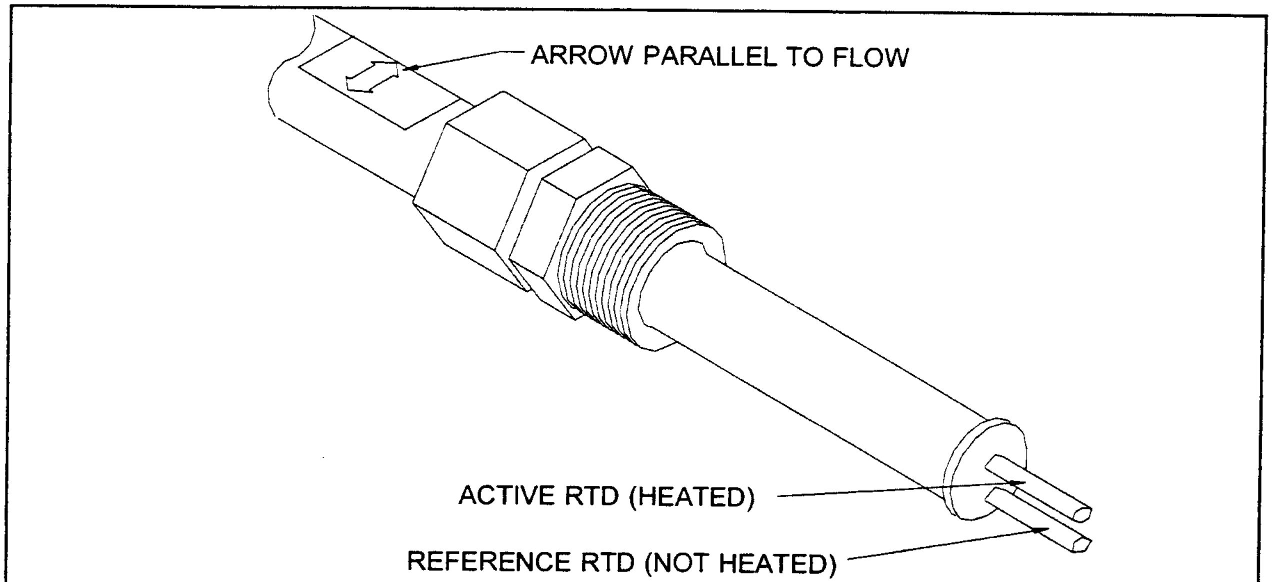


Figure 1-1 View of the Sensing Element

In-Line Sensing Element (Flow Tee)

The in-line sensing element is made in the same way as the insertion type of flow element is. To correctly orient the in-line sensing element, a flow arrow has been etched onto one side of the sensing element.

The in-line flow element is inserted in the process line with the flow arrow pointing in the same direction of flow. See Figure 1-2 for a cutaway view of the in-line element.

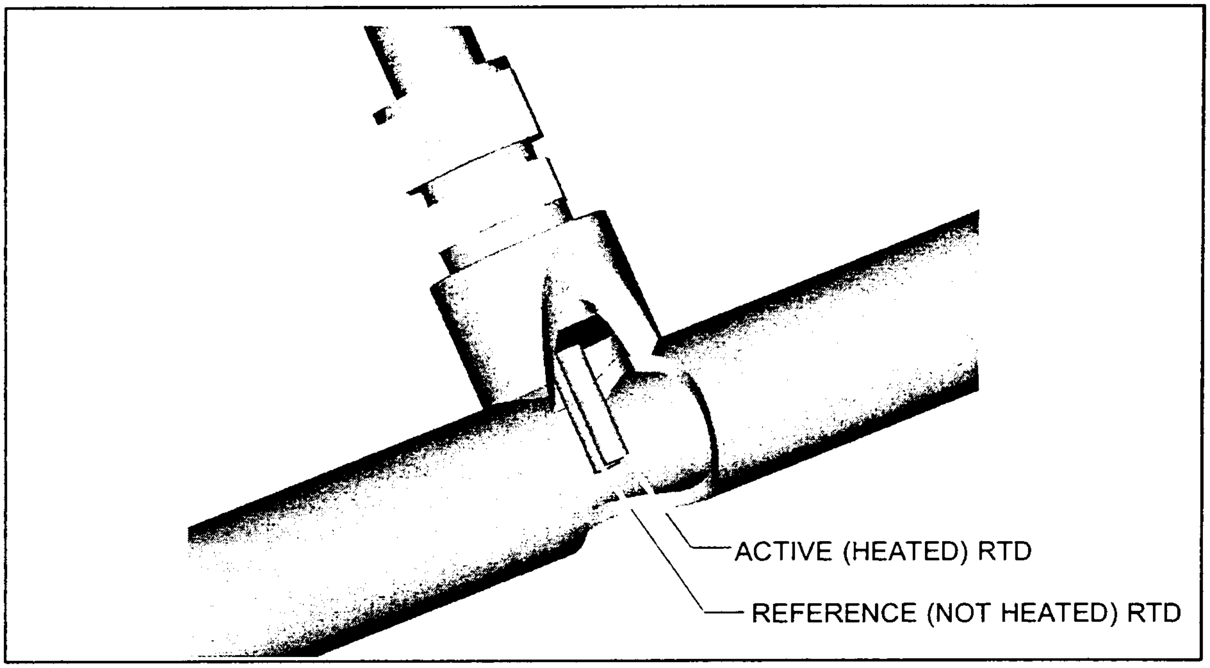


Figure 1-2. Cut-Away View Of The In-Line Flow Element Tube

Transmitter Electronics

The transmitter electronics convert the sensing element's RTD temperature differential into a flow signal that is read on a display . The transmitter also produces an analog output flow signal suitable to interface with process controls. The output is a representation of the amount of flow or temperature present in the process. The flow output is transmitted on a source milliamp output and / or voltage output. Both the flow output and process temperature can be displayed on an optional LCD display.

There are 2 kinds of enclosures available for the electronics:

1. Standard:
   Polyester Coated Carbon Steel Rated NEMA/CSA Type 4X (equivalent to IP66) and Division 2 (Ex n), Rating is pending. (This is a 6 X 6 X 4 Inch Square Enclosure.) (152.4 X 152.4 X 101.6 mm)
2. Optional:
   Aluminum rated for Hazardous Location use Class I and II, Division 1 and 2, Group B, C, D, E, F, G (previously referred to as NEMA 7 and EEx d IIc) resists the effects of weather and corrosion. (This is a 4.8 X 9.31 Inch Cylindrical Enclosure.) (121.8 X 236.47 mm)

Instrument Configuration

The instrument can be in integral arrangement (the electronics and the sensing element are combined in one enclosure), or the instrument can be in a remote arrangement (the electronics and sensing element are in separate enclosures).

In the case of a remote enclosure, the standard configuration of the sensing element (local) enclosure is an aluminum rated for Hazardous Location use Class I and II, Division 1 and 2, Group B, C, D, E, F, G (previously referred to as NEMA7) and EEx d IIC and resists the effect of weather and corrosion. The dimensions are 4.68 X 4.82 inches (119 X 122 mm) and is cylindrical in nature.

Technical Specifications

- **Process Connection**

  Insertion Configuration:
  Soft Seal or Metal Ferrule (Can be Stainless Steel or Hastelloy C):
  3/4 inch male NPT or Flanged
  Inline Configuration:
  1.0 inch tubing, 1.0, 1.5 or 2.0 inch SCH 40 pipe, Female NPT, Male NPT, Butt Weld or Flanged.

- **Insertion U-Length**

  Beginning as low as 1.0 inch (25.4 mm) to 21 inches (533 mm).

- **Sensing Element Material**

  All wetted surfaces are 316 Stainless Steel, with all-welded construction. Hastelloy C-276 is optionally available.

- **Operating Temperature**

  Control circuit:
  Ambient temperature configuration:
  0 to 140°F (-18 to 60°C).
  Sensing element:
  Standard temperature configuration:
  -40 to 350°F (-40 to 177°C).

- **Operating Pressure**

  0 to 250 psig [0 to 17 bar(g)]. (Derated with Teflon ferrule.)

- **Flow Range**

  Insertion:
  0.75 to 600 SFPS (0.006 to 0.23 NMPS)
  Inline:
  0.0062 to 1850 SCFM (0.01 to 3140 Nm^3/h)

- **Signal Output**

  4-20 mA, 700 ohms maximum load
  0-5, 1-5 and 0-10 Volts DC 100K ohms minimum load

- **Accuracy**

  Flow accuracy:
  ±1 % reading + 0.5% full scale
  Temperature accuracy:
  ±2°F (display only, flow rate must be greater than 1 SFPS).

- **Repeatability**

  ±0.5% of reading.

- **Input Power**

  A.C. Input: 100-240 VAC 50/60 Hz. 17 Watts Maximum 120 mA Maximum.
  D.C. Input: 22-30 VDC 250 mA Maximum 7.5 Watts Maximum.

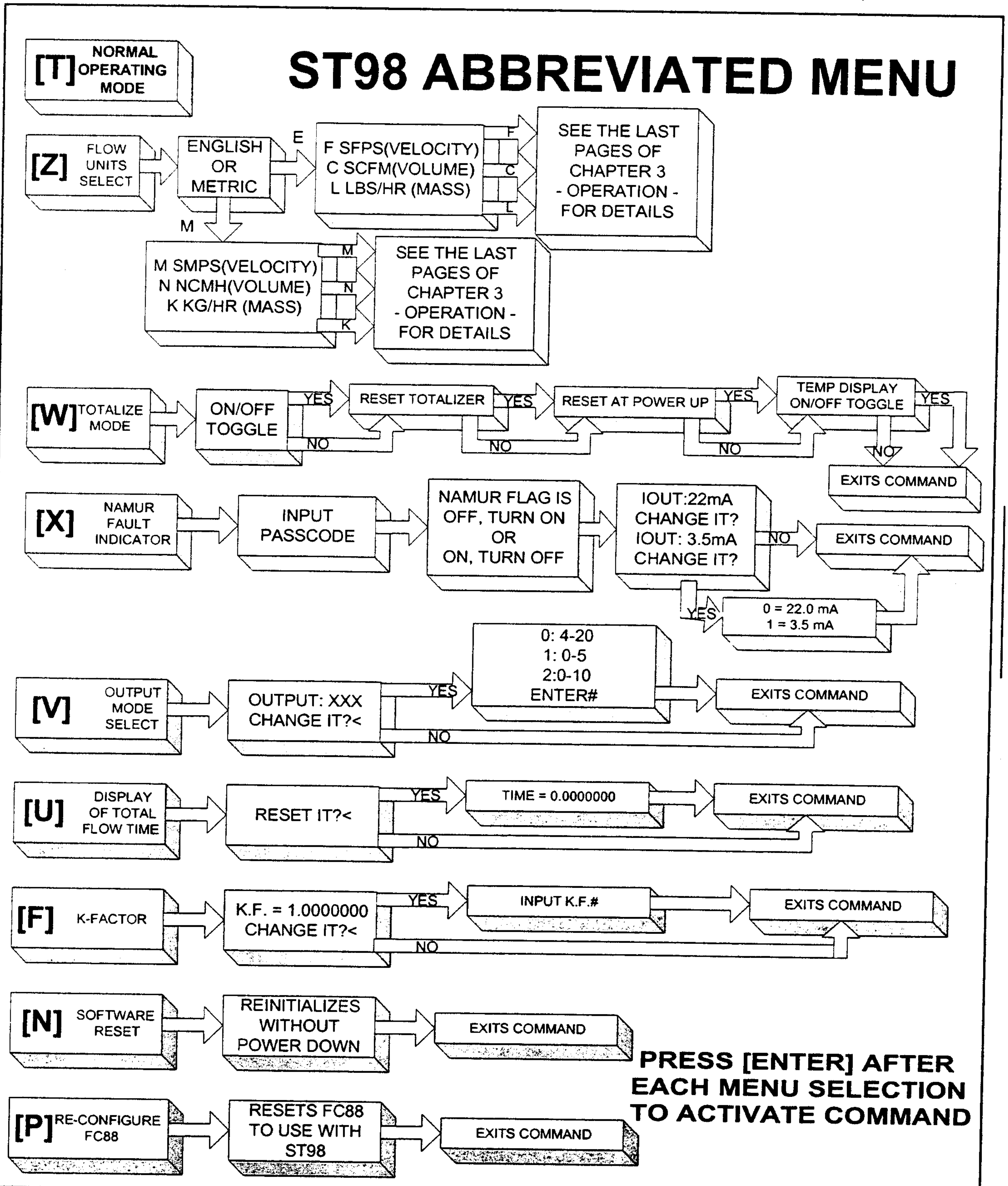
- **Pending Approvals**

  FM, CSA, CENELEC, CE Marking
  (EMC Directive 89/336/EEC)

Quick Start Menu (Abbreviated)

The following menu shows how to use the most frequently accessed functions of the instrument. For a complete menu and explanation see Chapter 3 - Operation.

Table 1-1. Quick Start Menu (Abbreviated Menu, See Chapter 3 For Full Details)



2. Installation

Receiving/Inspection

- Unpack carefully.
- Verify that all items in the packing list are received and are correct.
- Inspect all instruments for damage or contaminants prior to installation.

If the above three items are satisfactory, proceed with the installation. If not, then stop and contact a customer service representative.

Packing/Shipping/Returns

These issues are addressed in Appendix C - Customer Service.

Factory Calibration Note

The instrument is factory calibrated to the flow range specified in the order. There is no need to perform any verification or calibration steps prior to installing and placing the instrument in service.

Pre-Installation Procedure

Caution: Only qualified personnel should install this instrument. Install and follow safety procedures in accordance with the current National Electrical Code. Ensure that power is off during installation. Any instances where power is applied to the instrument will be noted in this manual. Where the instructions call for the use of electrical current, the operator assumes all responsibility for conformance to safety standards and practices.

Alert: The instrument is not designed for weld-in-place applications. Never weld to process connection or a structural support.

Damage resulting from moisture penetration of the enclosure(s) is not covered by product warranty.

The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the circuit board assemblies. See below for ESD details.

Use Standard ESD Precautions

Use standard ESD precautions when opening an instrument enclosure or handling the flow transmitter. FCI recommends the use of the following precautions: Use a wrist band or heel strap with a 1 megohm resistor connected to ground. If the instrument is in a shop setting there should be static conductive mats on the work table and floor with a 1 megohm resistor connected to ground. Connect the instrument to ground. Apply antistatic agents to hand tools to be used on the instrument. Keep high static producing items away from the instrument such as non-ESD approved plastic, tape and packing foam.

The above precautions are minimum requirements to be used. The complete use of ESD precautions can be found in the U.S. Department of Defense Handbook 263.

Prepare or Verify Flow Element Location

Prepare the process pipe for installation or inspect the already prepared location to ensure that the instrument will fit into the system.

Mount the flow element at least 20 diameters downstream and 10 diameters upstream from any bends or interference in the process pipe or duct to achieve the greatest accuracy.

Verify Dimensions

The ST98 Insertion Models have an adjustable insertion length ferrule until it is locked into position. Verify all dimensions before locking the fitting in place. See the appropriate figures in Appendix A.

Note: Two types of ferrules are available. One type of ferrule is made from Teflon. This can be tightened and loosened repeatedly at different places on the flow element. The other type of ferrule is made from Stainless Steel. This ferrule can only be tightened in one place on the flow element. The Stainless Steel Ferrule makes an indentation into the flow element for a more firm fit.

The ST98 In-Line Model's flow element has a tube or pipe length and diameter that is specified at the time of order. This dimension should be double checked with the process line.

Verify Flow Direction for Flow Element Orientation and Placement

The insertion ST98 flow element comes with flat areas machined on the flow element near the enclosure end of the flow element. Etched on the flow element is a flow arrow indicating the direction of flow. See Figure 2-1.

Align the ST98 flow element during installation so the flat areas are parallel to the direction of the process media flow, and the flow arrow points in the direction of process media flow.

A flow direction arrow is etched on the in-line ST98 tube or pipe and should be pointing in the direction of flow.

Failing to install the flow element correctly will reduce the accuracy of the flow meter.

Verify The Serial Number Of The Flow Element and the Electronics

The ST98 flow element has a serial number near the flat machined area or flow arrow. The same number is on the main electronics circuit board, and on the tag of the electronics enclosure. These numbers have to match because the flow element and the electronics are a matched set. Failure to observe serial numbers will cause inaccurate readings.

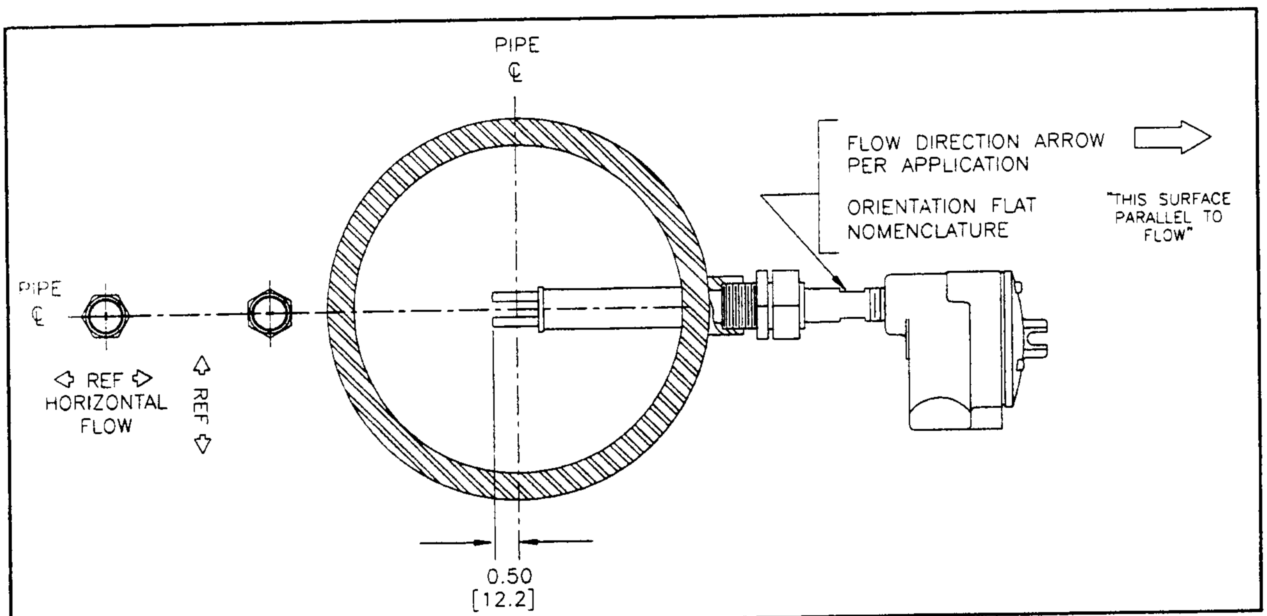


Figure 2-1. Model ST98 Insertion Flow Element (Remote) Showing Orientation

Install Insertion Flow Element

Note: The instrument accuracy will be reduced if the media flow is reversed from the flow direction of the flow arrow machined on the flow element or if the flats are not parallel, within ±1° of the flow direction.

Install the flow element as specified for the process connection type used.

Compression Fitting Mounting (Insertion Mounting Only)

1. Determine the inside diameter of the process pipe at the predetermined location. Calculate 1/2 of the inside diameter. Add 0.50 inch (12.7 mm) to the dimension. Add the pipe wall thickness. Mark the flow element at this length.
2. Insert the flow element fitting into the process pipe and tighten per ANSI B16.5 torque specifications. Use appropriate sealants as required. Measure the length of the ferrule that is above the pipe. Mark this dimension above the first mark on the flow element.
3. Position the flow element in the process pipe so that the last mark is above the ferrule. The flow element is now placed at 0.50 inch (12.7 mm) past the center of the process pipe as shown in Figure 2-1.
4. Adjust the flow element so the flats are parallel to flow ±1°, and the flow arrow is in the direction of flow.
5. Ensure that the insertion length is correct before tightening the compression fitting. Readjustment of the metal ferrule is not possible after tightening because the fitting crimps onto the flow element pipe. The Teflon ferrule is readjustable.
6. Hold the fitting body steady with a backup wrench and tighten the nut one and one-quarter turns past what is hand tight. Now the flow element is sealed and locked into place.

Caution: Be sure there is no pressure in the process line before the instrument is removed.

To remove the flow element, loosen the nut (Step 6) and unscrew the ferrule (Step 2).

NPT Pipe Thread Mounting (Insertion Mounting Only)

Alert: DO NOT change the orientation of the flow element in the enclosure more than 180° as the interconnecting RTD and heater wiring could be stressed and damaged. DO NOT apply any torque to the flow element enclosure - only apply to NPT pipe surface itself.

Note: When mounting the flow element to the process pipe, it is important that a lubricant/sealant is applied to the male threads of all connections. A lubricant/sealant compatible with the process environment should be used. All connections should be tightened firmly. To avoid leaks do not overtighten or cross-thread connections.

The pipe thread configuration is similar to what is shown in Figure 2-1. Apply sealant compatible with the process media to male threads. Carefully insert into process mount. Threads are right-handed. Tighten with an open-end wrench on the hexagonal surface provided. Rotate until snug and continue to turn until flat is horizontal to process flow.

Flanged Ferrule Mounting (Insertion Mounting Only)

1. One of the configurations that can be ordered is a flange that has NPT threads. The flange can be screwed onto the instrument's ferrule. If the flange is sperate from the ferrule screw on the flange and apply a lubricant/ sealant to the male threads and torque using ANSI B16.5 specifications. If the flange is already present, proceed to the next step.
2. Measure the U-Length of the flow element (from the flange face to the end of the flow element). Subtract 0.50 inch (12.7 mm) from the U-Length. The process' flanged mating surface for the flow element should be high enough above the pipe for proper mounting of the flow element as follows: Measure the inside diameter

of the process pipe at the predetermined location. Calculate 1/2 of the inner diameter. Add the pipe wall thickness. Add the length the customers flange is above the pipe. The length above the pipe should be adjusted to match the U-Length minus the 0.50 inch (12.7 mm) dimension.

3. Apply the appropriate gasket and/or sealant to flange mount faces as required.
4. Attach the process mating flange with care. The mating surface should be oriented so the flow element flats are parallel to flow, within ±1°, and the flow arrow on the flow element should be pointing in the same direction as the flow.
5. Attach with a bolt, two flat washers, lock washer and nut for each bolt hole; apply lubricant/sealant to the male threads and torque. Refer to ANSI B16.5 specifications.

In-Line Mounting

There are several different ways the in-line model ST98 instrument can be mounted into the process line. The different ways the flow element can be mounted are as follows:

- Threaded male NPT mount
- Threaded female NPT mount
- Raised face flange mount
- Butt Weld mount

Figure 2-2 shows a Butt Weld, 2 inch Schedule 40 pipe, in-line model ST98:

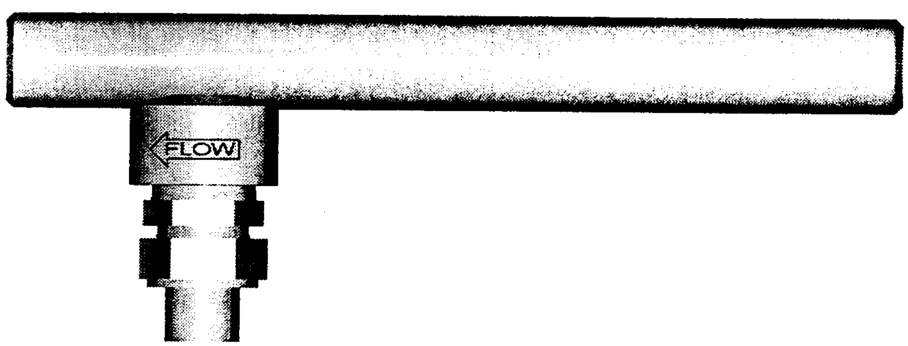


Figure 2-2. Model ST98 In-Line Butt Weld Mount

Mount the in-line Model ST98 as follows:

1. Verify that the process media flow is in the same direction as the flow arrow (see Figure 2-2).
2. For flange mounted instruments, apply the appropriate gasket and / or sealant to flange mounts as required.
3. For NPT mounted instruments, apply the appropriate sealant to the threads as required.
4. Mate (or weld the Butt Weld instrument) the instrument to the process line.
5. For flange mounts, attach the instrument with a bolt, two flat washers, lock washer and a nut for each bolt hole. Apply lubricant/sealant to the male threads of bolts or to the NPT threads and torque. Refer to ANSI B16.5 torque specifications.

Install Flow Transmitter

Alert: In applications where the flow element is located in an explosive environment, isolate the conduit before it leaves the environment. A potting Y may be used to provide the isolation.

Note: FCI recommends installing an input power disconnect switch and fuse near the flow transmitter to interrupt power during installation, maintenance, calibration, and troubleshooting procedures.

Make all electrical connections through the 3/4 inch NPT ports in the enclosure. Run all electrical cables through appropriate conduit or protective sheathing.

Caution: Ensure that all power is off before wiring any circuit.

Minimum Wire Size

If the instrument is used in the remote configuration, a shielded, 8 conductor cable should be used between the local and remote enclosure. Table 2-1 shows the smallest (maximum AWG number) copper wire that should be used in the cable and in other wiring. Use a lower gauge of wire for less of a voltage drop. Contact FCI concerning greater distances than those listed in the table. The sensing element cable for the remote option must be shielded. The maximum wire size of the non-power connectors in the instrument is 16 AWG. The maximum wire size of the power connectors in the instrument is 12 AWG.

Note: All 8 conductors for the sensing element must be used for proper operation of the flow meter.

Table 2-1. Maximum AWG Number

Connection	Maximum Distance for AWG					
	10 ft. (3 m)	50 ft. (15 m)	100 ft. (31 m)	250 ft. (76 m)	500 ft. (152 m)	1000 ft. (310 m)
Input Power	20	18	18	16	16	14
Sensing Element Cable (Remote Instrument)	24	24	24	18	16	16
Analog Output	24	24	24	18	16	16

Aluminum Enclosure Installation (Cylindrical Enclosure)

1. To wire the instrument remove the customer connection cover from the instrument by loosening the Allen head screw at the base of the cover. Unscrew the cover shown in Figure 2-3.
2. Install conduit between the local (if used) and the remote enclosure, the power source and customer monitoring circuits. Provide watertight hardware and apply thread sealant to all connections to prevent water damage.
3. Connect the milliamp and/or DC voltage output to the termination (customer connection) board as required. Refer to Figure 2-4 for connection information.
4. Connect the operating power to the customer termination board by removing the input wiring kit from the strain relief bracket (see Figure 2-4 for the bracket location). This kit contains a filter bead and three cable ties. For remote instruments only, the kit also contains 2 wire terminals for a ground wire to be placed between the flow element enclosure and the electronics enclosure.
5. Strip the incoming power wires to approximately 5/16 of an inch.
6. Attach the filter bead over the safety ground wire as shown in Figure 2-4 using 2 cable ties to secure the bead on the wire. The last cable tie should be about 3 inches from the end of the wire.
7. Attach the power wires to Terminal Strip TS1 (for AC) or TS4 (for DC) as shown in Figure 2-4. Secure the wires going to the Terminal Strip with a cable tie, secured to the cable tie bracket on the customer connection board.
8. For remote instruments only, (the flow element is in a separate enclosure from the electronics): Loosen the Allen head screw on the electronics cover. Unscrew the cover.

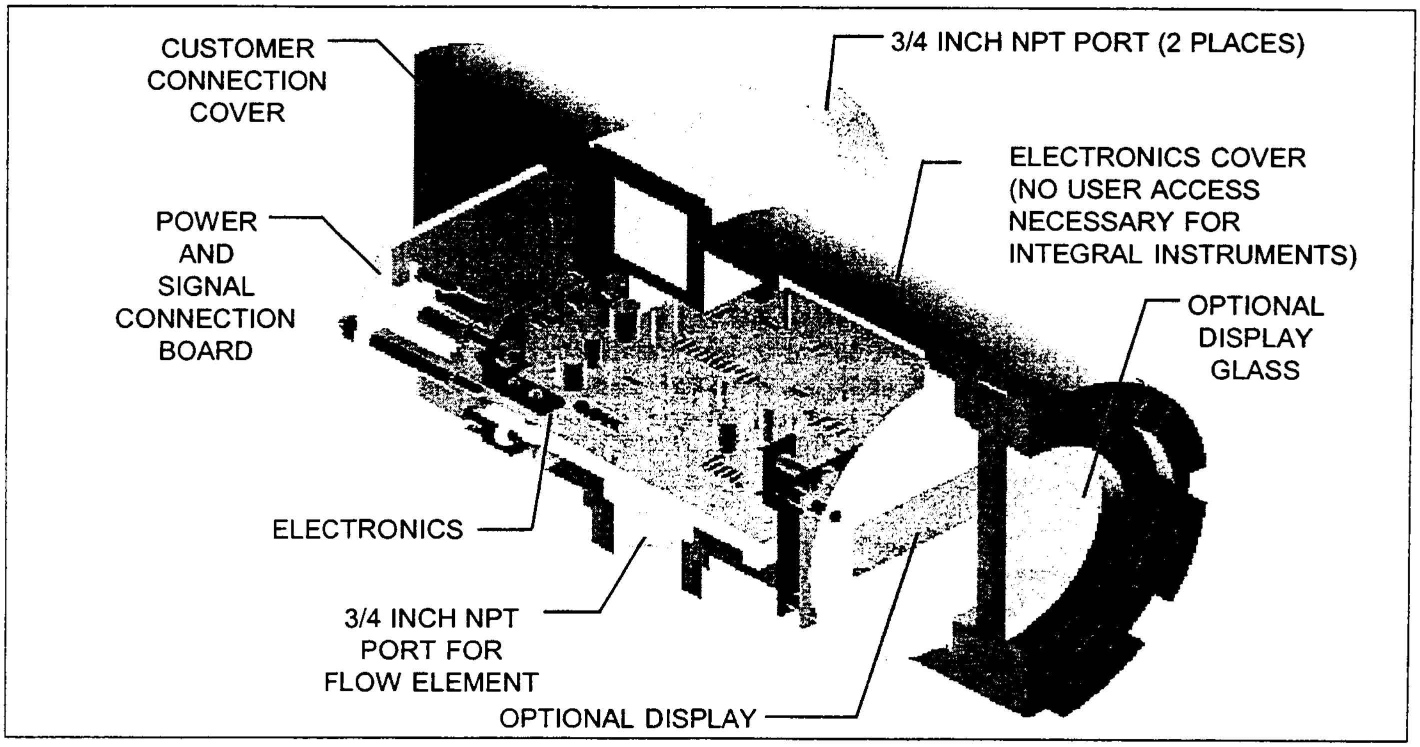


Figure 2-3. Circuit Board Placement

9. For remote instruments only: The flow element wires should be routed through the 3/4 inch NPT port for the flow element as shown in Figure 2-3. Connect the flow element wires to TS2 on the electronics assembly according to Figure 2-5. Connect the cable shield to HTR RTN. Leave the other end of the shield floating. A 14 AWG ground wire should also be routed between the enclosures (wire terminals are supplied in the kit).

Note: Connecting the shield in any other way will decrease the accuracy of the instrument. See Figure 2-4 for the wiring diagram.

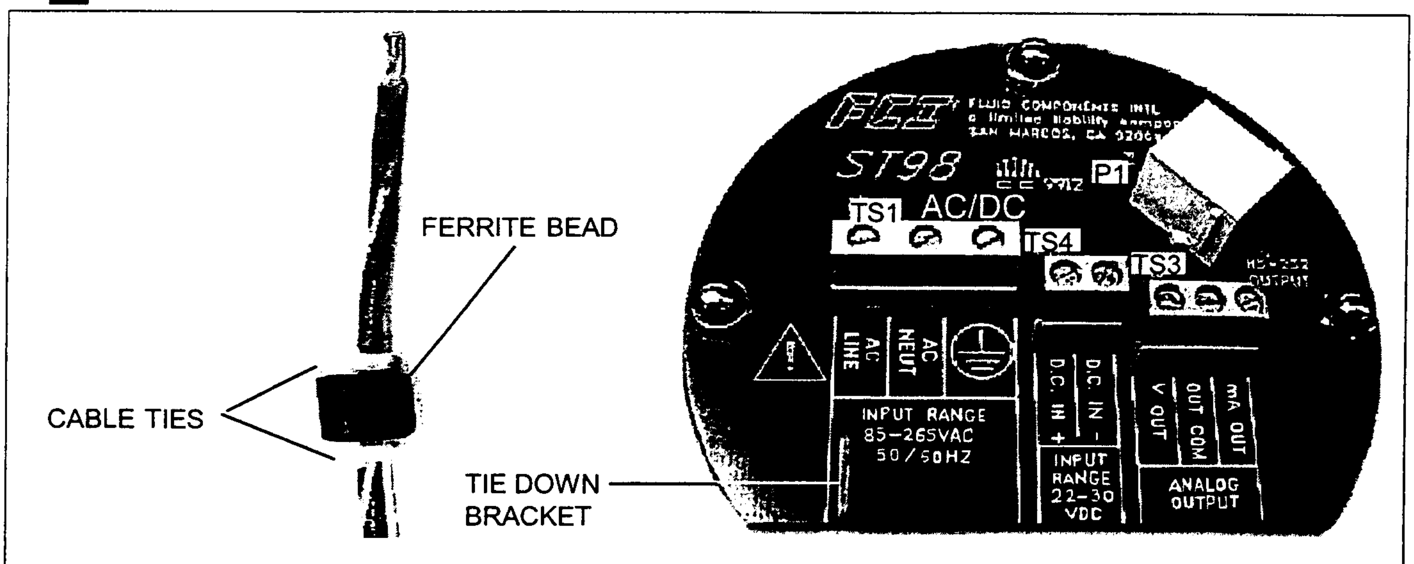


Figure 2-4. Customer Connection Board

Caution: Be sure an earth ground wire is connected to the ground terminal (see Figure 2-4). On a remote configuration, connect an earth ground wire to the ground screw in the local enclosure. This is for the purpose of safety.

10. If a wire comes loose from the instrument during installation, refer to Chapter 5 - Troubleshooting for a complete instrument wiring diagram.

11. For remote instruments only: Screw on the electronics cover and tighten the Allen head screw.
12. Screw on the customer connection cover and tighten the Allen head screw.
13. There are enough threads on the flow element so the flow transmitter enclosure can be rotated for ease of viewing the display LCD if the option is present. Be sure the flow arrow still points in the direction of flow and the flat is parallel to the flow.
14. Verify proper installation. Ensure that the assemblies are secure and the wiring is correct.

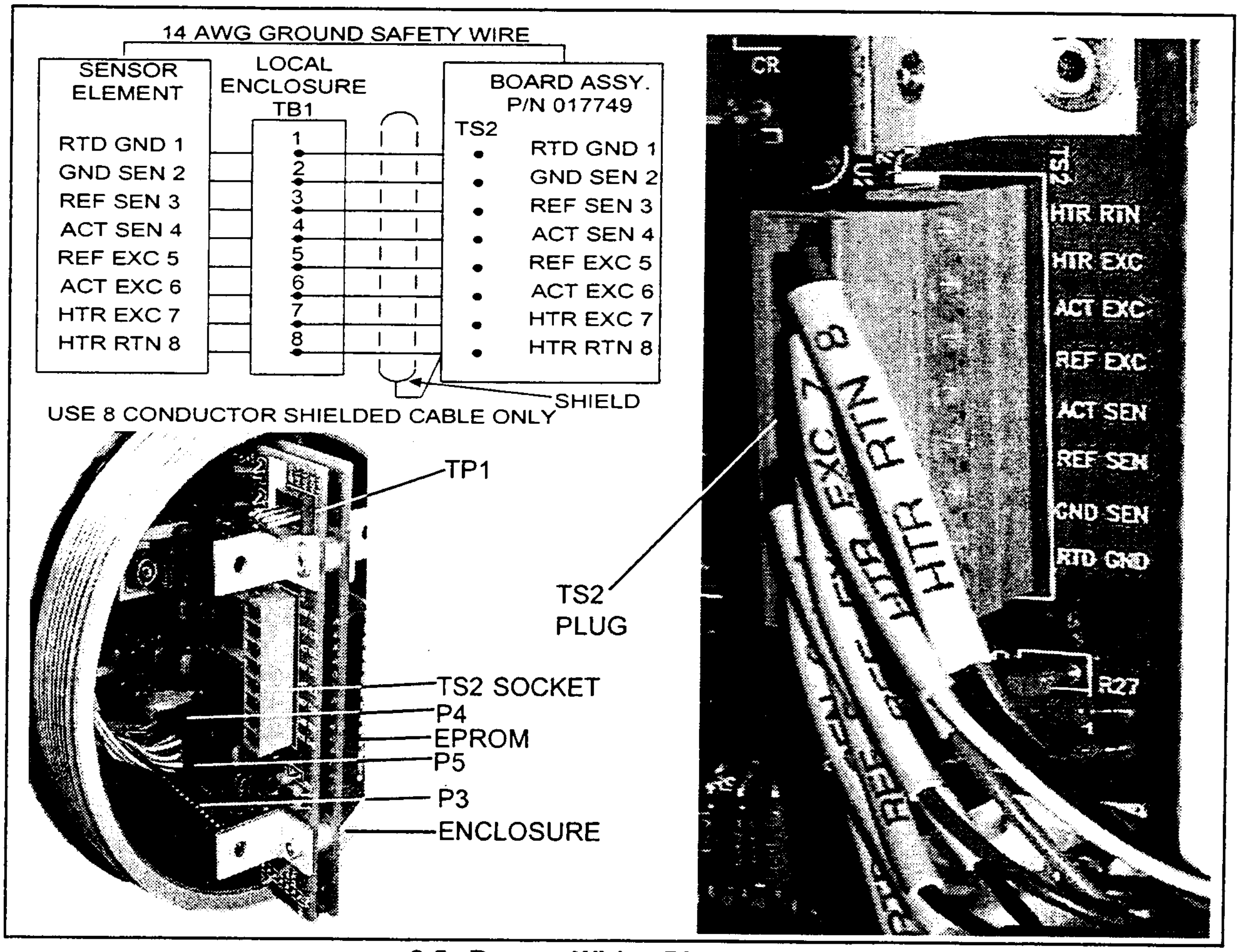


Figure 2-5. Remote Wiring Diagram

Caution: Ensure that all power is off before wiring any circuit.

Carbon Steel Enclosure Installation (6 X 6 Carbon Steel Enclosure)

1. To wire the instrument loosen 3 cover hold down screws and open the cover. See Figure 2-6.
2. Install conduit between the local (if used) and the remote enclosure, the power source and customer monitoring circuits. Provide watertight hardware and apply thread sealant to all connections to prevent water damage .
3. Connect the milliamp and/or DC voltage output to the termination (customer connection) board as required. Refer to Figure 2-4 for connection information.
4. Connect the operating power to the customer termination board by removing the input wiring kit from the strain relief bracket (see Figure 2-4 for the bracket location). This kit contains a filter bead and three cable ties. For remote instruments only, the kit also contains 2 wire terminals for a ground wire to be placed between the flow element enclosure and the electronics enclosure.
5. Strip the incoming power wires to approximately 5/16 of an inch.
6. Attach the filter bead over the safety ground wire as shown in Figure 2-4 using 2 cable ties to secure the bead on the wire. The last cable tie should be about 3 inches from the end of the wire.

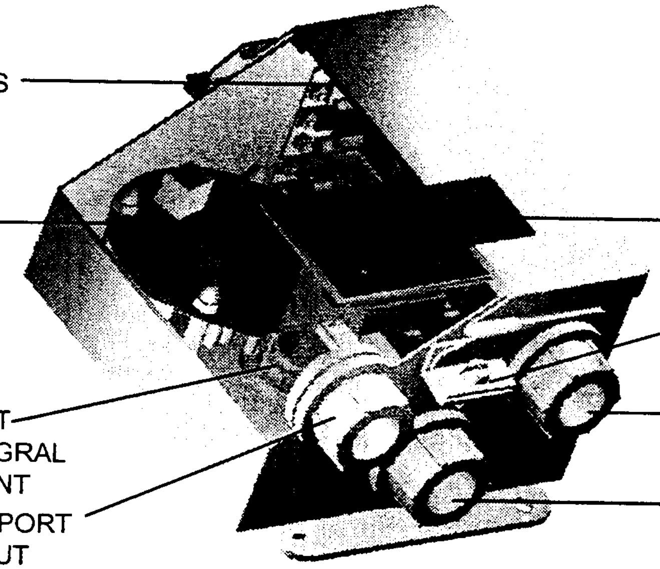


Figure 2-6. Optional Carbon Steel Enclosure

7. Attach the power wires to Terminal Strip TS1(for AC) or TS4 (for DC) as shown in Figure 2-4. Secure the wires going to the Terminal Strip with a cable tie, secured to the cable tie bracket on the customer connection board.
8. For remote instruments only, (the flow element is in a separate enclosure from the electronics): The flow element wires should be routed through the 3/4 inch NPT port for the flow element as shown in Figure 2-6. Connect the flow element wires to TS2 on the electronics assembly according to Figure 2-5. Connect the cable shield to HTR RTN. Leave the other end of the shield floating.

Note: Connecting the shield in any other way will decrease the accuracy of the instrument. See Figure 2-5 for the wiring diagram.

Caution: Be sure a grounded wire is connected to the ground terminal (see Figure 2-4) or to the enclosure ground screw. This is for the purpose of safety.

9. If a wire comes loose from the instrument during installation, refer to Chapter 5 - Troubleshooting for a complete instrument wiring diagram.
10. Close the cover and tighten the hold down screws.
11. There are enough threads on the flow element so the flow transmitter enclosure can be rotated for ease of viewing the display LCD if the option is present. Be sure the flow arrow still points in the direction of flow and the flat is parallel to the flow.
12. Verify proper installation. Ensure that the assemblies are secure and the wiring is correct.

Remote Hardware Location (Option)

The outline dimensions shown in Appendix A show the physical dimensions for the proper mounting of the flow element and transmitter electronics enclosure. Select a location for the flow transmitter within 1000 feet (310 M) of the flow element. Pigtail flow elements can not be located more than 10 feet (3 M) from the flow transmitter. This location should be easily accessible with enough room to unscrew the enclosure top at any time. Secure the enclosure to a surface capable of providing support. Use appropriate hardware to secure the enclosure.

Note: In cases where a pigtail flow element cable must be extended, a 9 position terminal strip must be used. All 8 conductors and the shield wire must have an exclusive terminal landing for proper operation. See Table 2-1 for the minimum wire gauge to use.

Wiring the In-Line Flow Element (Option)

Electrically the in-line flow element is the same as the model ST98 insertion flow element. Wire the instrument using the local enclosure or remote enclosure and/or the pigtail wiring methods above.

Serial Communication (Hyper Terminal Hook-Up)

The RJ-12 (P1) connector on the customer connection board provides RS-232 communication with the user. An FC88 Communicator can be plugged in for periodical re-configuration and/or diagnostics, or personal computer can be plugged in instead of the FC88 Communicator. See Figure 2-4 for the location of P1. This connection is a RJ-12 communication (phone) jack. Figure 2-7 represents the connection between the serial port and the host device.

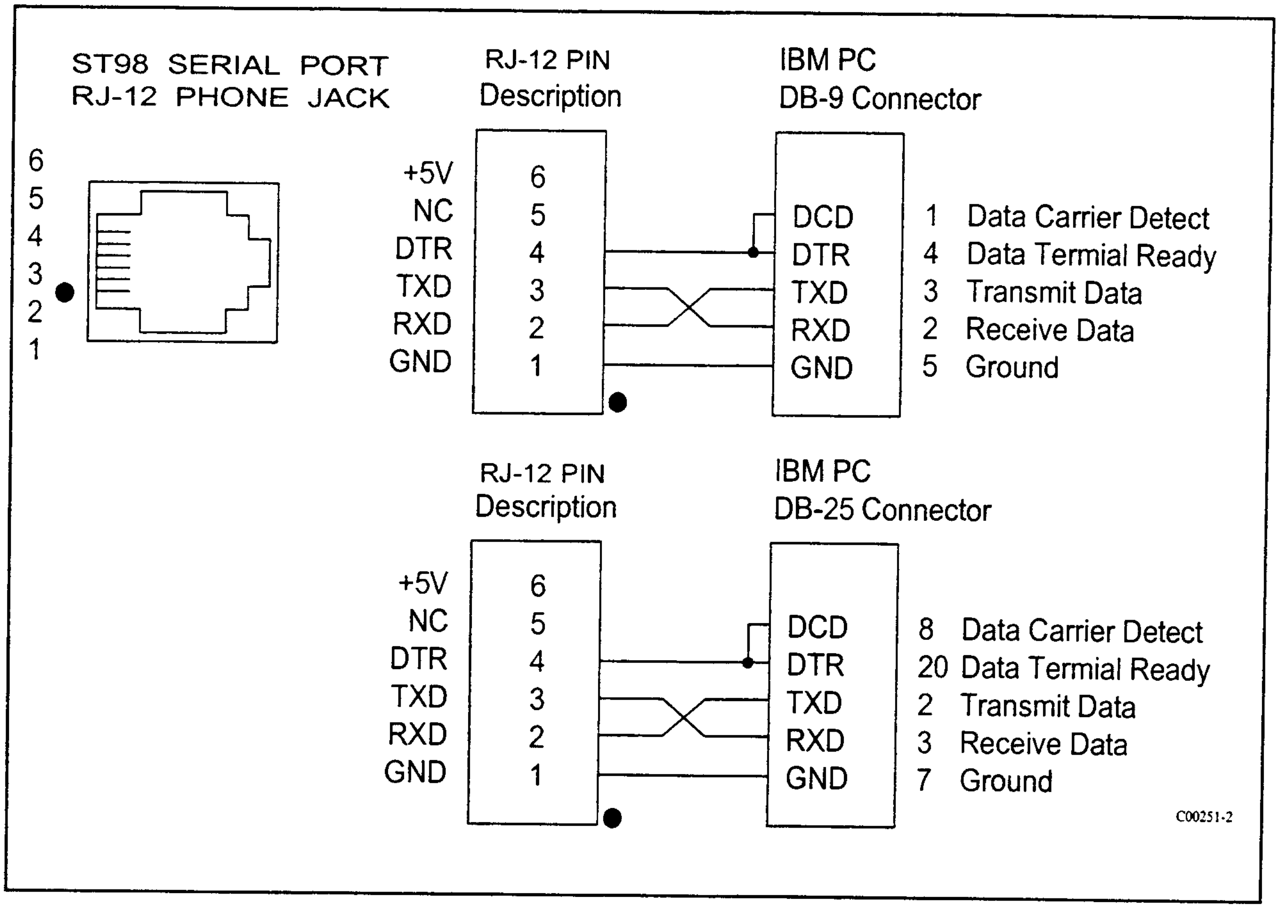


Figure 2-7. Wiring Diagram, DB-9 and DB25 PC Connectors

FCI recommends using the ST98 PC Interface Kit P/N: 014108-01 to connect the flow transmitter to a personal computer. The Kit includes operation instructions and an adaptor for the RJ-12 to serial connection. Connect one end of the interface kit to the RJ-12 port and the other end to a DB pin connector. Plug the connector into the COM1 or COM2 port in the back of the computer terminal.

See instructions on how to use the serial communications in the next chapter.

Remote Enclosure Bracket Installation

The remote enclosure can be rotated at various points around a 360° axis and bolted in place using 1/4-20 hardware. See Figure 2-8.

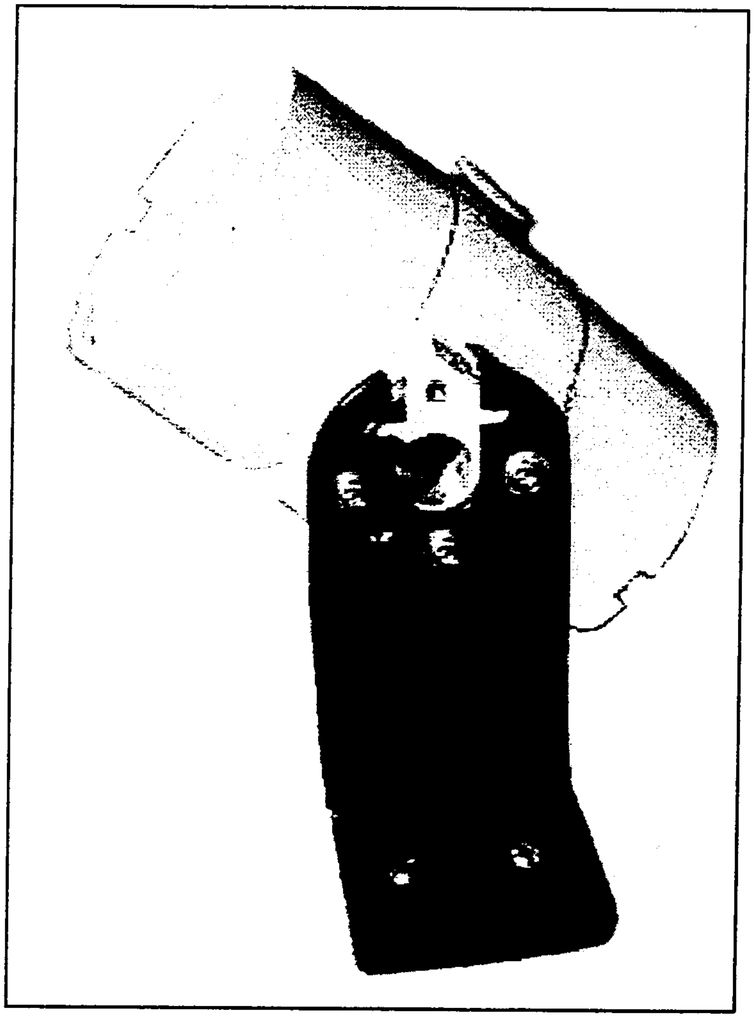


Figure 2-8. Remote Bracket Installation

Apply Power

The input power should not be turned on until the installation has been completed with all connections verified, power and signal connection board assembly screwed down and the instrument ready to operate. Be sure any external circuit breakers are on.

3. Operation

Alert: The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See Chapter 2, Installation for ESD details.

Introduction

The instrument has been configured and calibrated to customer specifications. Each instrument contains distinct operating limits and units of measurement. This chapter will show how to determine and manipulate the configuration of the instrument.

Start Up

Verify the wiring before applying power. Verify the correct power connections have been made to the flow transmitter. If the instrument does not have a display, plug in an FC88 Hand Held Communication unit or other compatible communication device into P1 of the customer connection board.

1. Apply power.
2. When operating power is applied to the instrument the following messages will be displayed:

   "FCI ST98",
   "Initialization!",
   "Heater On!"

3. Wait 5 minutes for the instrument to warm-up and stabilize.
4. The instrument automatically enters the flow metering mode. The instrument's display (if present), and /or the FC88 display will show the normal operation.

Note: If the FC88 does not display the monitored results properly, press [P] to re-configure the FC88 to the operation of the ST98.

The flow meter displays an output signal that is representative of the calculated current process media flow.

If the display does not appear, or is out-of-range for the expected values, turn the power off and proceed to Chapter 5 -Troubleshooting.

Using an FC88 Communicator

An FC88 is a hand held communicator that is plugged into the flow meter which controls the various functions of the ST98. Plug in the FC88 to P1 of the customer connection board. See Figure 2-4 for details.

This instrument is convenient, compact, and obtains its operating power from the flow transmitter. It provides a keypad for operator input and a display for system output.

Menu Control and Organization

Most entries require at least two key strokes; a letter and the [ENTER] key, or one or more numbers and the [ENTER] key. All user entries begin at the Input Mode?< prompt except when the instrument is in the Main Function Mode (just press the letter and [ENTER] to make an entry).

A user entry is indicated by brackets [ ] being placed around the entry. Y/N refers to Yes (Y), save or change parameter or No (N) do not save or change parameter unless otherwise specified.

Backspaces are made using the backspace [BKSP] key.

Some entries are case sensitive between numbers and letters. Be sure the SHIFT key is pressed to indicate the correct case. A square after the prompt caret indicates the FC88 is in lower case. A slightly raised rectangle in the same spot indicates the FC88 is in the upper case.

It is recommended that the FC88 be plugged into the instrument before power is applied. If the FC88 is plugged in while the instrument power is on and the FC88 does not respond, press [ENTER], if there is no response press [P], if there is still no response Press [N].

Note: Some entries require a pass code (942) to continue programming the instrument. The instrument will prompt the user when this is necessary. Do not change any parameters that require this code unless there is an absolute understanding of the instrument's operation. Incorrect changes can cause an inaccurate or a non-operational instrument. The figures in the "Delta "R" Table would need to be re-input.

The user can not exit some routines unless all entries are completed or the power is recycled.

The top level of the menu is shown below. Press the large letter in the Figure 3-1 to activate a command.

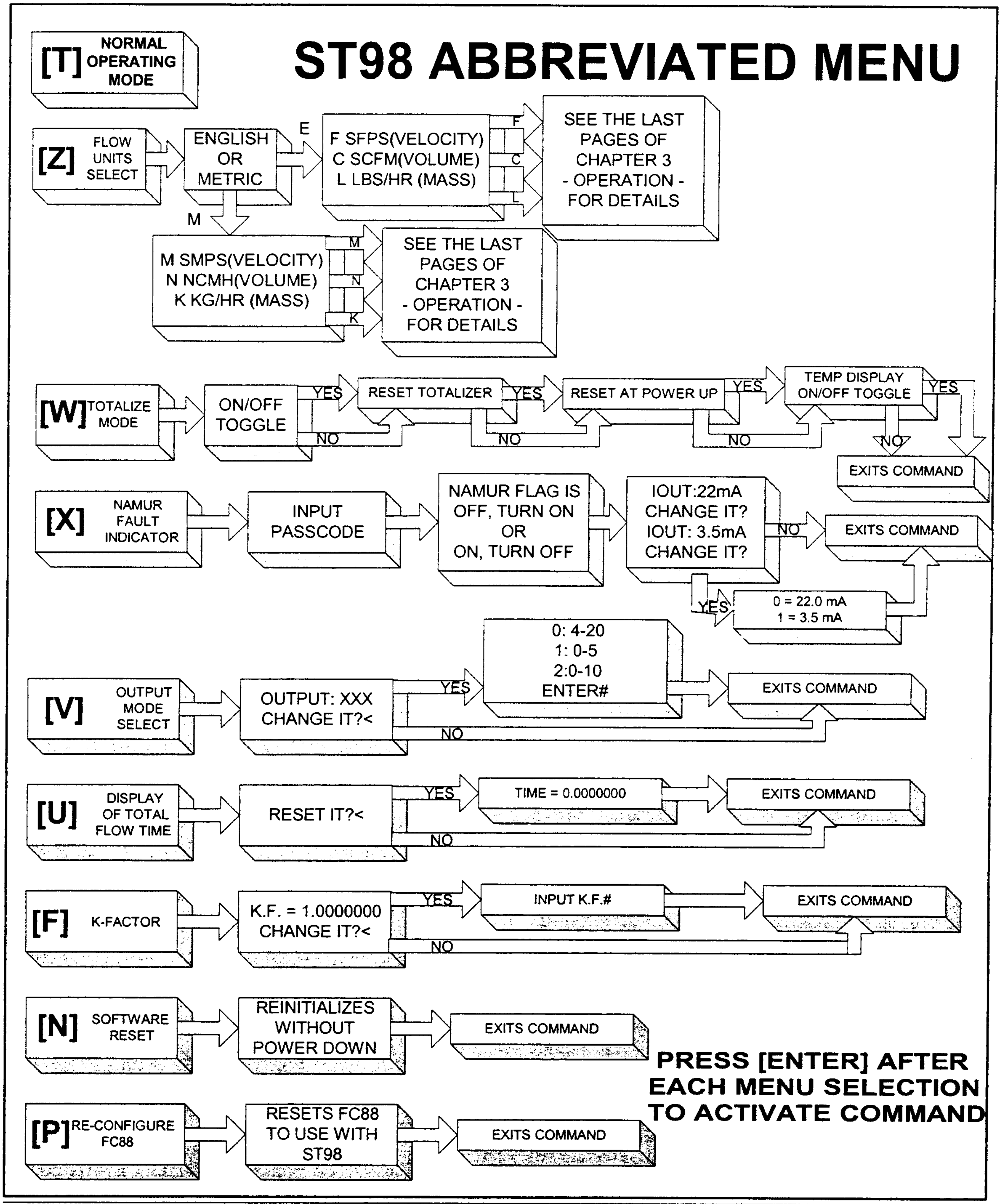
A	**Analog Input** Rotate through the 8 analog input channels	N	**Software Reset** Re-initialize instrument without removing power
B	**Sensor Balance** Balance or rebalance Flow Element	O	**Select Sensor Heater Current** HIGH (90 mA) or LOW (75 mA)
C	**Calibrate Display** Display A/D Delta-R and Ref-R data values	P	**Re-configure FC88 Unit** Reset the FC88 hand held to ST98 format
D	**Diagnostic** Check out functional conditions of the unit	Q	**Undefined**
E	**Sensor Current Select** Displays 2.0 mA - 1k ohm	R	**Delta-R, Ref-R, CB Temp, -8/+20 V** Display Delta-R, Ref-R resistor values, etc.
F	**K-Factor** K-Factor entered by user.	S	**Save/Restore USER Save and FACTORY** Calibration data saved and restored
G	**EEPROM** **PW = available when needed** EEPROM byte locations - read/ write.	T	**Normal Operating Mode** Display flow rate, temperature, totalized flow
H	**Heater** Toggle heater circuit - OFF/ ON.	U	**Display Total Flow Time** Total time (min) in T mode since last reset
I	**Output Current Adjust** Manually set output: 4-20 mA, display output load	V	**NAMUR Output Fault Indicator** NAMUR flag, select fault indicator
J	**Serial/Customer Numbers** Enter Serial No. and Customer Order No.	W	**Totalizer Mode** Enable totalized flow w/wo temperature
K	**Constants Setup** Setup curve fit, TC parameters, and other data	X	**NAMUR Output Fault Indicator** Toggle NAMUR flag(on/off) select fault indicator
L	**Calibrate Outputs** Outputs - Heater Current, 4 mA, 20 mA levels.	Y	**Undefined**
M	**Min/Max A/D Limits** Set minimum and maximum A/D limits	Z	**Flow Units Select** Select flow units (3 English , 3 Metric)

Figure 3-1. Menu Selections Chart

Quick Start Menu (Abbreviated)

The following menu shows how to use the most frequently accessed functions of the instrument. See Figure 3-1 for the complete menu. A complete menu explanation follows this Table.

Table 3-1. Quick Start Menu (Abbreviated Menu, See Chapter 3 For Full Details)



Detailed Menu Description

This section describes the menu of commands. The commands are listed in alphabetical order with no order of priority.

Note: Menu Commands are initiated by pressing the appropriate character key followed by the ENTER key.

COMMAND:

A. Analog Input

Summary:

Permits the user to display the Analog To Digital (A/D number) of the eight analog input channels. The A/D number has a span of 0-4096 counts which is proportional to 0-4 V at the input to the A/D converter. Channels 0 through 3 receive a signal voltage that has been amplified by a factor of nine. Channels 4 through 7 are not amplified.

These numbers can help a technician determine the cause of a problem with the installation or operation of the flowmeter. FCI recommends making a note of these readings.

Description:

When command [A] [ENTER] is pressed, the instrument will respond by displaying the signal for Channel 0. Continually pressing the [ENTER] key displays the rest of the channels and will rotate back to channel 0 following the Channel 7 selection. This command is useful in trouble shooting incorrectly wired instruments and open flow elements. This is a view only selection, the user has no other input commands.

Channel Number	Signal Name	Purpose and Symptom
0	ACT_SEN - REF_SEN ***Raw Delta-R x Gain (»9)***	Raw flow signal with a gain of 9, used for high flow rate.
1	-8 Volt Supply Monitor	Check for -8 Volt Supply limits.
2	Sensed mA Output Load Monitor	Used in calculating the output load in ohms.
3	+20 Volt Supply Monitor	Check for +20 Volt Supply limits.
4	ACT_SEN - REF_SEN *Raw Delta-R*	Raw flow signal with gain of 1, used for lower flow rate.
5	HTR_SEN - GND *Sensed Heater Voltage*	Check the condition of the heater.
6	Circuit Board Temperature Monitor	Check for Circuit Board Temperature limits.
7	REF_SEN - GND_SEN *Sensed Ref-R*	Used to measure the reference sensor for process temp.

Example:

Pressing [A] [Enter] displays "Ch(0): xxxx"
[Enter] displays "Ch(1): xxxx"
[Enter] displays "Ch(2): xxxx"
[Enter] displays "Ch(3): xxxx"
[Enter] displays "Ch(4): xxxx"
[Enter] displays "Ch(5): xxxx"
[Enter] displays "Ch(6): xxxx"
[Enter] displays "Ch(7): xxxx"
[Enter] displays "Ch(0): xxxx"

Note: Pressing [Q] [ENTER] at any time will exit this menu item and display "Input mode ?<".

COMMAND:

B. Sensor Balance

Summary:

Permits the instrument's flow element to be balanced or rebalanced. **A passcode must be entered.** This function has already been performed at the factory. This function should only be performed if there is a new flow element installed or a re-calibration is necessary.

Description:

For the instrument to function properly, the flow element and electronics need to be balanced. Balancing means that at the same temperature, the RTD's in the flow element should be at the same resistance. Due to physical differences in the RTD's, the current needs to be adjusted for one of the RTD's so that they will both have the same voltage. The differential should be as close to zero as possible. A passcode is necessary to enable this command. The instrument will either balance itself or it can be done manually.

Note: Use M (Manual) command when the circuit board or flow element has been replaced and where the balance value representing the digitized current used for balancing has been written down.

If the Heater was ON prior to sensor balancing, be sure to turn the Heater back ON after the RTD's have been balanced.

Example:

Pressing [B] [ENTER] will display "**Enter Code #**"
Press in the passcode [ENTER]. "**Enter temp. #**" will be displayed.
After the temperature is entered, "**Auto or Manual?**" and "**Enter A or M<**" are displayed.
Pressing [A] [ENTER] will display "**xxx xxxx Balancing**". Then "**Balanced!**" will appear on line 1 and "**Saved! xxx**" will appear on line 2.
If [M] [ENTER] is pressed instead of [A] [ENTER], the prompt "**Enter Balance #**" will be displayed. Once the balance value [xxx] is entered, the balanced value entered appears on line 1 and "**Saved!**" is displayed on line 2. After a couple of seconds "**Saved! xxx**" will be displayed on line 1 and "**Input mode?<**" will be displayed on line 2. (*Typical Balance values are; 234-237. Factory Balance # is on in the Delta R Table.)*

COMMAND:

C. Calibrate Display

Summary:

Displays A/D Delta-R and Ref-R. Data values are useful for calibration. The instrument is calibrated at the factory. This function does not need to be performed unless the instrument has been repaired or needs to be re-calibrated.

Description:

The flow element RTD's need to be interpreted by the electronics as a function of flow-rate. This is done by recording the raw signal A/D values at certain flow points and then curve-fitting the points using an equation to linearize the output at the calibrated flow-rate. This command makes it possible to view both the raw A/D Delta-R value, which is the difference between the Active and Reference RTD, and the Ref-R value, which is for the Reference RTD. This is a view only selection, the user has no other input commands.

Example:

Pressing [C] [ENTER] will display "**d= xxxx R= xxxx**". The display is updated continuously.

Note: Pressing [ENTER] at any time will exit this menu and display "**Input mode?<**"

COMMAND:

D. Diagnostic

Summary:

Permits the user to check the functional conditions of the instrument.

Description:

This mode displays all of the critical and peripheral variables that are stored in RAM (operational data area). By pressing the [Enter] or the [U]/[+] key, the data is displayed in an ascending order. By pressing the [P]/[-] key, data is displayed in a descending order. Pressing the [Q] key at any time will exit the Diagnostics menu. The ST98 functional data in RAM is saved in the USER area of the Non-Volatile Memory (NVM). The user has the option to save user data to the USER Save area of NVM at any time. At completion of the FCI calibration, the data was saved to the FACTORY area of NVM. Each of these data areas may be viewed by the user (Refer to Menu item 'S' for more detail on saving and restoring the NVM data areas).

Example:

At BOOTUP or RESET, the following is displayed: **"Initialization!"**, with **"FCI ST98"** flashing, followed by **"Heat On!"**.

Pressing D [Enter] will display "**USER Displayed**" followed by "**Change it ? <**". If 'N' or [Enter] is pressed, USER data is displayed. If [Y] is pressed, **"1=USER Save"** followed by "**2=FACTORY**" is displayed. Pressing a '1' or '2' will cause the respective NVM data to be displayed: **"Version X.XX"** (also displayed at BOOTUP or RESET).

The rest of the values will be displayed by pressing the [**Enter**] key after each value.

"Serial Number ",
"xxxxxxxxx",
"Customer Number",
"xxxxxxxxx",
"Curve fit: x",

NOTE: Curve fit = 0, is for "**single poly fit**"; Curve fit = 2, is for "**two poly fit**"

The following values are typical:

If Curve fit = 2 was chosen, the instrument will display "**two poly fit**" on line 1 and "**Brkpt: 1432**" on line 2.

"**Poly Segment 1**" are "**C1** = 79.3892", "**C2** = -2.362808", "**C3** = 28.23582", "**C4** = -104.3832", "**C5** = 1.070937".

"**Poly Segment 2**" are **"C1** = 69.04044", "**C2** = -8.793838, "**C3** = 206.3617", "**C4** = -1544.267", "**C5** = 39.06467".

"**Balance:** 237", "**Outz:** 432", "**Outf:** 2144", "**Heater_I**: 3070", "**Factor:** 1.00000", "**Eu:** 70 (F)", "**Tot:** 0", "**Tottemp:** 0", "**Tflow**: 0.000000", "**Rollover:** 1E6", "**Roll cnt:** 0", "**Outmode:** 0", "**Max A/D:** 6500", "**Min A/D:** 200", "**Kfactor:** 1.0000", "**Zero:** 0.0000", "**Sensor: 0**", "**Tslp:** 0.23759989", "**Refr:** 1800.00", "**Caltemp:** 70.00", "**Toff:** -351", "**Tcslp:** 0.17139990", "**Tcslp0:** 0.00000", "**Tcslp2:** 0.000000", "**Maxflow:** 150.00", "**Minflow:** 1.5000", "**Density:** 0.07491590", "**Line_size0**: 1.0000000", "**Line_size1**: 0.0000000", "**F.S.:** 128.0000".

Note: Pressing [Q] [ENTER] at any time will exit this menu item and display "**Input mode ?<**".

COMMAND:

E. Sensor Current Select

Summary:

None.

Description:

None.

Example:

Pressing [E] [ENTER] will always display "**2.0 ma - 1k ohm**".

COMMAND:

F. K-Factor

Summary:

Permits the user to enter a K-Factor.

Description:

If the user determines that the flow rate output should be "biased", a user supplied K-Factor can be applied to modify the final flow reading from the calibrated flow rate.

Example:

Pressing [F] [ENTER] will display "**K.F. = 1.0000000**" on line 1 and "**Change it?<**" on line 2. Pressing [N] [ENTER] will display "**Input mode?<**". Pressing [Y] [ENTER] will display "**Enter K.F.#**". Press in the new K-Factor. Press [ENTER]. The new factor is saved and "**Input mode ?<**" is displayed.

COMMAND:

G. EEPROM

Summary:

For maintenance only. **A passcode must be entered.**

Description:

EEPROM byte locations can be read or modified.

Example:

N/A

COMMAND:

H. Heater

Summary:

Permits the user to toggle the heater circuit **OFF** and **ON**.

Description:

Useful whenever the heater needs to be turned off and on manually, i.e., while balancing the flow element or trouble shooting the instrument.

Example:

Pressing [H] [ENTER] will display "**Heater OFF!**" or "**Heater ON!**" on line 1 depending on which state was last active. "**Input mode ?<**" is displayed on line 2.

COMMAND:

I. Output Current Adjust

Summary:

Permits the user to manually vary the output from **4 mA** to **20 mA** by entering a value of 0 to 1000.

Description:

This diagnostic command allows the user to vary the output for troubleshooting purposes, Entering 0 will set the output current to 4 mA. Entering 500 sets the output to 12 mA. Entering 1000 sets the output to 20 mA. Also displayed is the output load in ohms.

Example:

Pressing [I] [ENTER] will display "**Enter # (0-1000)**". Pressing [0] will display "**4 mA**" followed by "**Load: xxx ohms**".

COMMAND:

J. Serial Number, Customer Order Number

Summary:

For FCI Calibration personnel only. **A passcode must be entered.**

Description:

None.

Example:

N/A.

COMMAND:

K. Constants Setup

Summary:

Permits the instrument to be placed in setup mode. **A passcode must be entered.**

Description:

In order for the instrument to function properly, certain constant values and curve fitting parameters must be supplied to be able to compute a verifiable flow rate for display. This command consists of four sections and is password protected. Section (1) is available whenever default constant values need to be reloaded into the EEPROM (the default data is automatically loaded at boot-up if a new or "cleared" EEPROM is detected). Section (2) consists of selecting the best curve fit equation in order to linearize the input signal. The two Curve Fit selections are: **0 = 2nd order polynomial** and **2 = two 2nd order polynomials**. Section (3) consists of making available the temperature compensation factors for modification. (Section 4) allows for the maximum flow and minimum flow parameters to be modified along with the standard density of the medium of calibration.

Example:

Pressing [K] [Enter] will display "**Enter Code #**". Press in the passcode. Pressing [Enter] will display "**Defaults? <**". Pressing 'Y' [Enter] will setup the required initial values, pressing an 'N' or [Enter] will skip to the next prompt, "**Curve Fit = x**", "**Change it ?<**". Pressing a 'Y' will display "**0=Poly, 1=Log**" on first line and "**2=Two Seg Poly**" on the second line to allow choosing one of the three. If "**Two Seg Poly**" is selected, then "**Brkpt xxxx**" is displayed on the first line and "**Change it?<**" is displayed on second line. Pressing 'Y' will display "**Enter Brkpt #**". Pressing an 'N' or [Enter] will skip to the next prompt, "**Input Coeffs?<**" and pressing a 'Y' will display "**c1 = xxxxxxx**" so the coefficients can be entered for either "**0=Poly, 1=Log**" selections. If "**2=Two Seg Poly**" is selected, "**Segment one ?<**" is displayed. Pressing a 'Y' will display "**c1 = xxxxxxx**" followed by "**Change it?>**". If 'Y' is pressed, a coefficient value must be entered or else the next coefficient will be displayed, etc. After coefficients are entered or 'N' or [Enter] is pressed, the next prompt is “**Segment two?<**”, Again, pressing a ‘Y’ will display “**c1 = xxxxxx**” so the coefficients can be entered. After the coefficients are entered or an [N] [ENTER] or [Enter] is pressed, the next prompt is “**Input Tempcos?<**“. Pressing a [Y][ENTER] will display the following prompts:

“**tslp** 0.237599”, “**Change it?** <”. Pressing a [Y][ENTER] will allow the user to input a new value.

Pressing [N] [ENTER] or [Enter] will go to the next prompt which is,

“**Ref. R:** 1480”, “**Change it?** <”. Pressing a [Y][ENTER] will allow the user to input a new value.

Pressing [N] [ENTER] or [Enter] will go to the next prompt which is,

“**Caltemp:** 68”, “**Change it?** <”. Pressing a [Y][ENTER] will allow the user to input a new value.

Pressing [N] [ENTER] or [Enter] will go to the next prompt which is,

“**toff:** 357.0000”, “**Change it?** <“. Pressing a [Y][ENTER] will allow the user to input a new value, a

Pressing [N] [ENTER] or [Enter] will go to the next prompt which is,

“**tcslp: 0.1713999**”, “**Change it?** <”. Pressing a [Y][ENTER] will allow the user to input a new value, a

Pressing [N] [ENTER] or [Enter] will go to the next prompt which is,

“**tcslp0:** 0.0000000”, “**Change it?** <”. Pressing a [Y][ENTER] will allow the user to input a new value, a

Pressing [N] [ENTER] or [Enter] will go to the next prompt which is,

“**tcslp2:** 0.00000”, “**Change it?** <”. Pressing a [Y][ENTER] will allow the user to input a new value, a

Pressing [N] [ENTER] or [Enter] will go to the next prompt which is,

“**Max. Flow** = 150.00000”, “**Change it?** <”. Pressing a [Y][ENTER] will allow the user to input a new value,

Pressing [N] [ENTER] or [Enter] will go to the next prompt which is,

“**Min. Flow** = 1.5000000”, “**Change it?** <”. Pressing a [Y][ENTER] will allow the user to input a new value. Pressing [N] [ENTER] or [Enter] will go to the next prompt which is,

“**dens.** = 0.074914”, “**Change it?** <”. Pressing a [Y][ENTER] will allow the user to input a new value. Pressing [N] [ENTER] or [Enter] will go to the next prompt which is “**Input Mode?<**”.

Note: Pressing [Q] [ENTER] at any time will exit this menu item and display "**Input Mode?<**".

COMMAND:

L. Calibrate Outputs

Summary:

Permits user to calibrate the outputs - 4 mA level, 20 mA level and heater current. **A passcode must be entered.** The instrument is calibrated at the factory. This command does not need to be done unless the instrument needs a re-calibration.

Description:

In order for the user to calibrate the output currents, a digital-to-analog converter (DAC) is set to the correct values so that on power-up, all the currents are reset properly each time. This is accomplished by monitoring the output currents while adjusting input to the DAC until the correct output values are reached. Both course and fine adjustment controls are available for calibration.

Example:

Pressing [L] [ENTER] will display "**Enter Code #**". Press in the passcode. Press [ENTER]. "**L, U, H, Q** (quit) or **D** (done)> will be displayed. "**L**" is for the **4 mA** adjustment, "**U**" is for the **20 mA** adjustment, '**H**' is for the heater current adjustment, "**Q**" is for exiting the menu at any time, and "**D**" is for exiting the menu when the user is finished entering parameters. After making a selection, "**[ENTER] to save**" is displayed on line 1, and "**(U)up (P)down**" is displayed on line 2. If [ENTER] is pressed, "**L, U, H or D (Done)>**" is displayed. If [U] or [P] is pressed, "**(F)fast/slow**" is displayed on line 1 and "**DAC: xxxxx**" is displayed on line 2, where 'xxxxx' is an increasing or decreasing **DAC** count. Pressing [U] or [P] will increase or decrease the DAC count in the fast mode. Repeated pressing of [U] or [P] in the slow mode will increase or decrease the DAC count in increments. To change to from fast action to slow action, press the [F] key - repeated key presses will toggle from fast to slow to fast etc. To accept the DAC value for the selected output current, press [ENTER]. When all outputs have been calibrated, press [D] (done) - the final DAC count values will be displayed and a **Reset** command will be invoked.

Note: **ADJUSTMENT of the HEATER will affect the CALIBRATION.** Notify FCI Customer Service for assistance. It is necessary to use precision instruments to perform this calibration.
Pressing [Q] [ENTER] at any time will exit this menu item and display "**Input mode?<**.

COMMAND:

M. Min/Max A/D Limits

Summary:

Permits minimum and maximum limits to be imposed on the A/D output data when calculating flow rate. **A passcode must be entered.**

Description:

Depending on the raw A/D input, there may be instances when the linearization of the data produces what is known as a 'fishhook' at either end of the flow rate spectrum. This effect may make the displayed flow to appear increasing or decreasing opposite to the actual flow rate. The correct selection of constraint values will eliminate the undesired effect.

Example:

Pressing [M] [ENTER] will display "**Enter Code #**"

Press in the passcode. Press [Enter] "**Max A/D:** xxxx" and "**Change it ?<**" will be displayed. If [Y] [ENTER] is pressed, "**Enter Max A/D #**" will be displayed. Entering new the maximum A/D calibrated will remove the high end 'fishhook'. After the value is entered or [N] [ENTER] is pressed, "**Min A/D:** xxxx" and "**Change it ?<**" will be displayed. If [Y] [ENTER] is pressed, "**Enter Min A/D #**" will be displayed. Entering the new minimum A/D number calibrated will remove the low end 'fishhook'.

Note: Pressing **Q** [ENTER] at any time will exit this menu item and display "**Input mode?<**".

COMMAND:

N. Software Reset

Summary:

Permits the instrument to be initialized without removing power.

Description:

Sometimes it becomes necessary to initialize the instrument. (i.e. when entering new constants, troubleshooting, or when power interruption is not practical.)

Example:

Pressing [N] [ENTER] will display "**Restart - Wait!**" followed by the initialization display: "**FCI ST98**", "**Initialization!**", "**Heater ON!**", "**Version x.xx**" and "**Scale = 1.00000**".
Finally, "**Input mode<**", is displayed.

COMMAND:

O. Select Sensor Heater Current

Summary:

Permits the user to select the correct flow element heater current. **A passcode must be entered.**

Description:

The user must select the correct heater current for the flow element in use. After entering the Passcode, the current value is displayed followed by "**Change it?**". If [N] [ENTER] is pressed, "**Input mode?<**" will be displayed, if [Y] [ENTER] is pressed, "**2 = 90mA LO#**" followed by "**3 = 75mA LO**", followed by "**4 = 90mA MD**" followed by "**5 = 75mA MD**" are displayed. After a choice is made, the heater will be turned **ON** and "**Input mode?<**" will be displayed.

If a display with LO is chosen, software flags are set to inform the user if temperature values are over range (below -50 or above 350 °F). If a display with MD is chosen, the higher temperature range software flags set.

The "LO" and "MD" designation refers to the temperature range of the sensing element. "LO" is the standard range (-50 to 350°F). "MD" is the medium range (-100 to 500°F). "MD" is not available with early production units. The "LO" and "MD" selections set up the proper over temperature and under temperature limits so the temperature error message indicates correctly.

Example:

Pressing [O] [Enter] - Refer to the description.

Note: If the FC88 is displaying "**4 = 90mA MD**" and "**5 = 75mA MD**" and the user needs to see the value for 2 or 3, press [ENTER]. The values of 2 and 3 will be re-displayed for a few seconds.

Pressing [Q] [ENTER] at any time will exit this menu item and display "**Input mode?<**".

COMMAND:

P. Re-configure the FC88 Unit

Summary:

Permits the hand-held FC88 unit to be reset without having to manually program the FC88.

Description:

Sometimes it becomes necessary to re-initialize the hand-held unit due to inadvertent keystroke entries or if the FC88 had been used on another instrument. (i.e. FlexMasster.)

Example:

Pressing [P] [ENTER] will display "**FC88 Reset**". After a few seconds delay "**Input mode ?<**" will be displayed.

Note: If the FC88 has been used on a device using 80 characters (four line display), the character '-' will be displayed instead of '**P**' until the FC88 has been reset to use 32 characters (two line display).

COMMAND:

Q. Undefined

COMMAND:

R. Delta-R, Ref-R, CB Temp, -8 V and +20 V Supply

Summary:

Displays **A/D Delta-R** and **Ref-R** as resistance values, Circuit Board Temperature, -8 Volt Supply, and +20 Volt Supply.

Description:

The user may select to view any of the four displays available; A/D Delta-R, and Ref-A/D counts as resistance, the Circuit Board Temperature, the -8 Volt, or the +20 Volt supply. These readings are for reference only and should not be used to check the calibration.

Example:

Pressing R [Enter] will display "**RES=1, TEMP=2**" followed by "**-8V=3, +20V=4**". If "1" is selected, the display is continually updated with "**Resistance**" on the first line and "**r=xxx R=xxxx**" on the second line. Selection "2" displays "**CB Temperature**" followed by "**xx.x degrees x**" which is updated continuously. Selection "3" displays "**-8 Volt Supply**" followed by "**-8.xxx volts**" which is updated continuously. If "4" is selected, "**+20 Volt Supply**" followed by "**+20.xxx volts**" which is displayed continuously.

Note: Pressing [ENTER] at any time will exit this menu item and display "**Input mode?<**".

COMMAND:

S. Save and/or Restore USER-Save, FACTORY

Summary:

Permits the user to save normal operational data to a User-Save area of the EEPROM. Also permits the User to restore normal operational data from the User-Save or FACTORY area of the EEPROM. Calibration data is saved in the FACTORY area of the EEPROM with the factory calibration before the meter leaves FCI. The factory data can not be changed in the field.

Description:

None.

Example:

Pressing S [Enter] will display "**Restore User**" followed by "**from USER SAVE?** ". If 'Y' is pressed, "**Restore Page(x)**" is displayed, followed by "**Please wait**", "**Completed!**", and then "**Restart!**". If 'N' is pressed, "**Restore User**" is displayed, followed by "**from FACTORY?**". The same information is displayed as restore from User Save. If no data exists in either area, "**Data Empty!!!**" is displayed. Next, "**Save USER?**" is displayed. If 'Y' is pressed, "**USER Save Pg(x)**" followed by "**Please wait**" and then "**Completed!**" is displayed. This is followed by "**Save FACTORY?**". If 'Y' is pressed, the prompt "**Enter Code #**" asks the user to enter the password and, if correct, "**FACTORY Pg(x)**", "**Please wait**", and finally "**Completed!**" are displayed.

COMMAND:

T. Normal Operating Mode

Summary:

Permits the user to displays the flow rate and media temperature or the flow rate and totalized flow.

Description:

This is the default operating mode and displays the flow rate (default units of measure are SFPS). Another display is the totalized flow that is multiplexed with the temperature readout. The default units will not permit a totalized flow to be displayed.

Example:

T [ENTER] will display "53.0 **SFPS**" on line 1, and "70.8 **Degrees F**" on line 2 (example based on default units).

Note: If another function needs to be accessed, just press the letter and [ENTER] to go the command. **"Input mode?<"** will not be displayed in the normal operating mode.

COMMAND:

U. Display Total Flow Time

Summary:

Total time the unit has been operating in the Normal Operating mode since the last reset.

Description:

This function operates in conjunction with the totalize mode for computing the totalized flow. This function can be reset by the user. The time units are in minutes.

Example:

Pressing [U] [ENTER] will display "**Time** = 3456.3305" on the first line. "**Reset it?** <" is displayed on the second line. Pressing a [Y] [ENTER] will reset the total time to 0. Pressing a [N] [ENTER] or [Enter] will keep the current time. Next, "Tot: xxxxxx" is displayed on the first line. "**Reset it?** <" is displayed on the second line. Pressing [Y] [ENTER] resets the totalizer value to zero. Pressing [N] [ENTER] keeps the current totalizer values.

COMMAND:

V. Output Mode Select

Summary:

Permits the user to select one of the three (3) output modes.

Description:

Output mode menu selection:

Menu Setting	mA Output	V Output
0 = 4-20 mA	4 -20 mA	1-5 Vdc
1 = 0-5 Vdc	0-20 mA	0-5 Vdc
2 = 0-10 Vdc	Do Not Use	0-10 Vdc

Example:

Pressing V [ENTER] will display "**Output: xxxxxxx**" on the first line and "**Change it ?<**" displayed on the second line. xxxxxxx will either be "**4 - 20mA**", "**0 - 5 Volts**", or "**0 - 10 Volts**" depending on previous selection. Pressing [N] [ENTER] or [ENTER] after the "**Change it?<**" prompt will give "**Input mode ?<**". Pressing [Y] [ENTER] will display "**0: 4-20, 1: 0-5, 2: 0-10 #**". Entering one of the values (0, 1, or 2) selects the desired output and "**Input mode ?<**" is displayed.

Note: Selecting 1, 2, or 3 may require a wiring change on the Customer Connection circuit board.

COMMAND:

W. Totalizer Mode

Summary:

Permits the instrument to display a totalized flow with or with out intermittent display of temperature.

Description:

The instrument must be in one of the following flow units (SCFM, Lbs/Hr, NCMH, Kg/Hr) (see command Z) to display the totalized flow. Totalized flow can be reset to zero at any time or whenever power is interrupted.

Example:

Pressing W [ENTER] will display "**Totalizer is <**" on the first line. "**ON, turn OFF ?**" or "**OFF, turn ON ?**" is displayed on the second line (depending on the initial state). Pressing a [Y] [Enter] will change the totalizer state. Whether the state is changed or a [N] [ENTER] or [ENTER] is pressed, "**reset Totalizer**" and "**at this time ?**" are displayed. Pressing [Y] [ENTER] will zero the totalizer. Pressing [N] [ENTER] or [ENTER] gives no change. Next displayed is "**reset Totalizer**" and "**during Powerup?**". Pressing [Y] [ENTER] sets a flag where pressing [N] [ENTER or [ENTER] displays "**Temp display is**" followed by "**ON, turn OFF ?**" or "**OFF, turn ON?**" (depending on the initial state). Pressing [Y] [ENTER] will change states and display "**Input mode ?<**".

Note: Totalizer data is saved in the EEPROM approximately every 15 minutes.

COMMAND:

X. NAMUR Output Fault Indicator

Summary:

Permits the user to toggle the Fault Detection on and select the NAMUR Fault detection indicators. **A password must be entered.**

Description:

Faults, i.e., heater short or open conditions, detected by the instrument will send an alarm to the host system by one of two methods: If the output mode is "4-20 **mA**", the user may indicate the fault by setting the output "**alarm**" to 22.0 **mA** or 3.5 **mA**; if the output mode is "0-5 **Volts**" or "0-10 **Volts**", the output "**alarm**" is pulsed from zero (0) volts to one (1) volt about once every 7 seconds. (The voltage mode is not a NAMUR requirement.) The NAMUR Fault Detection system is enabled by the NAMUR OFF/ON flag.

Example:

Pressing X [ENTER] will display "**Enter Code #**". Enter the passcode. Press [Enter], "**NAMUR flag is**" displayed on the first line and "**ON, turn OFF?**" or "**OFF, turn ON?**" is displayed on the second line (depending on the initial state). Pressing [Y] [ENTER] will change the Fault flag state; Pressing [N] [ENTER] or [ENTER], creates no change. If the output mode is "4-20 **mA**", and Alarm output of "22 **mA**" or "3.5 **mA**" can be selected. If the output mode is "0-5 **Volts**" or "0-10 **Volts**", "**VOUT: 0 Volts**" is displayed followed by "**Input mode?<**". Pressing [Q] [ENTER] at any time will exit this menu and display "**Input mode?<**".

COMMAND:

Y. Undefined.

COMMAND:

Z. Flow Units Select

Summary:

Permits user to select one of six flow units - three (3) English and three (3) Metric. Output is automatically scaled by selecting new full scale and new zero.

Description:

Depending on the flow units desired, the user should select one of the following;

	Velocity	**Volume**	**Mass**
English	SFPS	SCFM	LB/HR
Metric	SMPS	NCMH	KG/HR

The user can also scale the output based on the calculated maximum flow rate and the new full scale that is chosen. The volume and mass flow units require specific line size dimensions. Typically, flow rate ranges are 100:1 but can be adjusted to 10:1 by entering a new full scale and/or zero level. In this mode, the instrument will not accept any turn down ratios lower than 10:1. If an attempt is made to enter a lower value, an error will be displayed and an opportunity to reenter is given.

Example:

Note: Pressing [Q] [ENTER] at any time will exit the menu. All data will return to the original values prior to entering this menu.

Velocity (English)

Pressing [Z] [ENTER] will display "**E for English or**" followed by "**M for Metric**". Press an [E] [ENTER] and the next prompt is "**F SFPS, C SCFM**" followed by "**or L LBS/HR**". Press an [F] [ENTER] and the next prompt is "**Max = xxx.xxxxxx**" followed by "**Change F.S. ?<**". Press [Y] [ENTER] and enter a new value, or else press [N] [ENTER] or [ENTER]. The next prompt is "**Zero = x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Save ?<**". Press [Y] [ENTER] and the new values are saved to the EEPROM. The last prompt is "**Input mode ?<**".

Volume (English)

Pressing [Z] [ENTER] will display "**E for English or**" followed by "**M for Metric**". Press an [E] [ENTER] and the next prompt is "**F SFPS, C SCFM**" followed by "**or L LBS/HR**". Press [C] [ENTER] and the next prompt is "**R round duct or**" followed by "**S rectangular <**". Press [R] [ENTER] and the next prompt is "**Diameter: inches**" "**x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. If [S] [ENTER] is pressed, the next prompt is "**Inches Wide**" "**x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Inches High**". "x.xxxxxx" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Max = xxx.xxxxxx**" followed by "**Change F.S. ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Zero = x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Save ?<**". Press [Y] {ENTER] and the new values are saved. The last prompt is "**Input mode ?<**".

Mass Flow (English)

Pressing Z [ENTER] will display "**E for English or**" followed by "**M for Metric**". Press [E] [ENTER] and the next prompt is "**F SFPS, C SCFM**" followed by "**or L LBS/HR**". Press [L] [ENTER] and the next prompt is "**R round duct or**" followed by "**S rectangular <**". Press [R] [ENTER] and the next prompt is "**Diameter: inches**" "**x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. If [S] [ENTER] is pressed, the next prompt is "**Inches Wide**" "**x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Inches High**", "**x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Max = xxx.xxxxxx**" followed by "**Change F.S. ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Zero = x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Save ?<**". Press [Y] [ENTER] and the new values are saved. The last prompt is "**Input mode ?<**".

Velocity (Metric)

Pressing [Z] [ENTER] will display "**E for English or**" followed by "**M for Metric**". Press an [M] [ENTER] and the next prompt is "**M SMPS, N NCMH**" followed by "**or K KG/HR**". Press an [M] [ENTER] and the next prompt is "**F.S. = xxx.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Zero = x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Save ?<**". Press 'Y' and the new values are saved. The last prompt is "**Input mode ?<**".

Volume (Metric)

Pressing [Z] [ENTER] will display "**E for English or**" followed by "**M for Metric**". Press an [M] [ENTER] and the next prompt is "**M SMPS, N NCMH**" followed by "**or K KG/HR**". Press an [N] [ENTER] and the next prompt is "**R round duct or**" followed by "**S rectangular** <". Press [R] [ENTER] and the next prompt is "**Diameter: Mn**" "**x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. If [S] [ENTER] is pressed, the next prompt is "Mn **Wide**" "**x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Mn High**", "**x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Max = xxx.xxxxxx**" followed by "**Change F.S. ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Zero = x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Save ?<**". Press [Y] [ENTER] and the new values are saved. The last prompt is "**Input mode ?<**".

Mass Flow (Metric)

Pressing [Z] [ENTER] will display "**E for English or**" followed by "**M for Metric**". Press an [M] [ENTER] and the next prompt is "**M SMPS, N NCMH**" followed by "**or K KG/HR**". Press [K] [ENTER] and the next prompt is "**R round duct or**" followed by "**S rectangular** <". Press [R] [ENTER] and the next prompt is "**Diameter: Mn**" "**x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. If [S] [ENTER] is pressed, the next prompt is "**Mn Wide**" "x.xxxxxx" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Mn High**", "**x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Max = xxx.xxxxxx**" followed by "**Change F.S. ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Zero = x.xxxxxx**" followed by "**Change it ?<**". Press [Y] [ENTER] and enter a new value or else press [N] [ENTER] or [ENTER]. The next prompt is "**Save ?<**". Press [Y] [ENTER] and the new values are saved to the EEPROM. The last prompt is "**Input mode ?<**".

Note: Pressing [Q] at any time will exit the menu. All data will retain the original values prior to entering the menu.

Using Procomm Software (Option)

If the Procomm software was ordered the customer will receive a 3-1/2 inch floppy disk. Make a back up copy of the disk that is compatible to the PC.

1. Insert the backup copy into the disk drive.
2. At the dos prompt (A: or B:) type in PROCOMM. This will execute the program.
3. After a few moments the Procomm logo will appear. Pressing any key will remove the logo.
4. Press the Caps Lock button and check the Caps Lock light to ensure it is on.
5. Press Alt-P to ensure that communication settings are set for COM1 or COM2, 9600 Baud, 8 Bit, 1 Stop Bit, and No Parity. Press the ESC key to exit.
6. Press the ENTER key. The screen should read "Input Mode? or Port # #".
7. Enter any of the AF Series single letter commands to execute a function.

Some additional Procomm commands to know:

Alt-X	Exit	Alt-V	View Files	PgUp	Send Files	PgDn	Receive Files
Alt-Z	Colors	Alt-C	Clear Screen				

Using Windows Terminal

If the PC has Windows installed, use the program, Terminal, to communicate with the flowmeter. Terminal is usually located in Accessories. Double-click on the Terminal Icon to execute the program.

1. Go to Settings.
2. Click on Communications.
3. Set for COM1 or COM2, 9600 Baud, 8 Bit, 1 Stop Bit, and No Parity. Press OK.
4. Press the ENTER key to see the Input Mode? prompt.
5. Enter any of the ST98 single letter commands to execute a function.

4. Maintenance

Caution: To avoid hazards to personnel, ensure that all environmental isolation seals are properly maintained.

Alert: The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See Chapter 2, Installation for ESD details.

The FCI instrument requires little maintenance. There are no moving parts or mechanical parts subject to wear in the instrument. The sensor assembly which is exposed to the process media is all stainless steel construction.

Maintenance

Without detailed knowledge of the environmental parameters of the application surroundings and process media, FCI cannot make specific recommendations for periodic inspection, cleaning, or testing procedures. However, some suggested general guidelines for maintenance steps are offered below. Use operating experience to establish the frequency of each type of maintenance.

Calibration

Periodically verify the calibration of the output and recalibrate if necessary. See Chapter 5 - Troubleshooting. FCI recommends every 18 months at a minimum.

Electrical Connections

Periodically inspect cable connections on terminal strips and terminal blocks. Verify that terminal connections are tight and physically sound with no sign of corrosion.

Remote Enclosure

Verify that the moisture barriers and seals protecting the electronics in the local and remote enclosures are adequate and that no moisture is entering those enclosures.

Electrical Wiring

FCI recommends occasional inspection of the system's interconnecting cable, power wiring and flow element wiring on a "common sense" basis related to the application environment. Periodically the conductors should be inspected for corrosion and the cable insulation checked for signs of deterioration.

Flow Element Connections

Verify that all seals are performing properly and that there is no leakage of the process media. Check for deterioration of the gaskets and environmental seals used.

Flow Element Assembly

Periodically remove the flow element for inspection based on historical evidence of debris, foreign matter, or scale build-up and appropriate plant shutdown schedules and procedures. Check for corrosion, stress cracking, and/or build-up of oxides, salts, or foreign substances. The thermowells must be free of excessive contaminants and be physically intact. Any debris or residue build-up could cause inaccurate switching. Clean the flow element, as necessary, with a soft brush and available solvents (compatible with Stainless Steel).

5. Troubleshooting

Caution: Only qualified personnel should attempt to test this instrument. The operator assumes all responsibilities for safe practices while troubleshooting.

Alert: The electronics contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the electronics. See Chapter 2, Installation for ESD details.

Quick Check

Verify the serial numbers of the flow element and electronics match.
Verify all cables are seated firmly.
Verify all customer connections are correct.
Verify the wiring is per the wiring diagram in Chapter 2.
Verify the installation is correct as shown in Chapter 2.
Check customer fuses and power switches.
Press [P] to reconfigure the FC88 to the proper 2 line display.
Press [N] to reset the software.

General Function Check

Once the flow meter has been installed and turned on, the instrument can be checked for proper operation by performing the NAMUR functional checks. The following tools will be required for this check.

Tools Needed - General Function Check -

FC88 Communicator or Computer with Interface Kit - Contact a Field Representative or Customer Service to purchase an FC88 or computer interface kit.
Digital Multimeter (DMM)
Allen Wrench 1/16 Inch (for aluminum, circular enclosure)
Medium size flat blade Screwdriver (for steel, square enclosure)

NAMUR Fault Indication

NAMUR NE43 is a German fault detection standard that lets the user know if there is a fault within the instrument. The fault indicator can be turned on or off with the **X** menu function as described in Chapter 3 - Operation.

When the indicator is on and a fault is detected the 4-20 mA output will be driven to less than or equal to 3.5 mA, or 22 mA or greater, depending upon what the user chooses. If a voltage output was selected, the output will be driven from 0 to 1 volt every 7 seconds. The voltage fault indicator is not part of the NAMUR NE43 standard.

When the NAMUR Fault indication is turned on (Menu **X**), the faults will be displayed when the instrument is in the normal operation mode (Menu **T**).

In a few cases there may be two error indications when there is only one fault. A single fault can cause multiple problems with the instrument, therefore there are more than one fault indications. The fault indications shown in the **T** mode are prioritized in the order of where the problem will most likely be found.

Example: Error codes are: "Sensor Error" "Overtemp Head"
There is most likely a sensor element wiring problem that is creating an over temperature fault situation.

Procedure

Open the enclosure to expose the customer connection board.

Connect the FC88 or computer to the RS-232 Jack (P1).

Set the FC88 communicator or computer to display the **T** mode.

Turn on the NAMUR fault flag (menu **X**).

Compare the fault indication from the T mode with Table 5-1. Follow the instructions provided in the table.

Table 5-1. NAMUR Fault Listing

Indicated Faults	Possible Causes
Nothing displayed on the FC88 or the optional display. No display on the FC88 no display on the optional display.	Power is not applied to the instrument. Power is not correctly applied to the customer connection board. There is a green LED that lights when AC power is applied. It is on the back side of the customer circuit board behind P1 (it is hard to see). If it is blinking remove power and contact customer service.
No display on the FC88. There is a display on the optional LCD display.	Press [P] [ENTER] on the FC88 to reset it. If there is no response connect it to another ST98 (if present) to verify operation. Replace the cable between the ST98 and the FC88 if there is no operation. If no operation contact customer service.
No fault indicated. Output mA or Vout operates correctly.	Verify the NAMUR option is activated [X] [ENTER]. If there is no fault indicated, verify the heater is on [H] [ENTER]. If there is no fault indicated, proceed to the installation and Application Verification procedure.
No fault indicated but the 4-20 mA (or Voltage) output is not transmitting.	Go to the Instrument Output Check procedure.
Sensor Error.	Wiring to the sensing element may be incorrect. One or more of the sense or excitation wires may be disconnected or shorted. The active or reference RTD is either open or shorted. Check the wiring (see Appendix A) and the sensor resistance as shown later in this chapter.
OverTemp Head!!	The process temperature has exceeded the maximum temperature rating of the flow element (350°F). Verify the temperature of the process. If the temperature is over 350°F, remove the flow element from the process. Damage to the flow element will occur. Contact customer service.
UnderTemp Head!!	The process temperature has exceeded the minimum temperature rating of the flow element (-50°F). Verify the temperature of the process. If the temperature is under -50°F, remove the flow element from the process. Damage to the flow element will occur. Contact customer service.
Open Heater!!	The flow element's heater has exceeded the maximum resistance allowed (approximately 170 ohms) or is disconnected. This limit also includes the cable resistance in remote installations. The heater fault flag will come on in cases when the heater is turned off (using the menu key [H] [ENTER]). Check the wiring and the sensor resistance.
Shorted Heater!!	The flow element's heater has exceeded the minimum resistance allowed (approximately 90 ohms) or it is shorted. This limit also includes the cable resistance on remote installation. The heater fault flag will come on in cases when the heater is turned off (using the menu key [H] [ENTER]). Check the wiring and the sensor resistance.

Application Verification

After verifying that the flow meter is functioning, review the application parameters as shown below to verify the calibration matches the process media.

Equipment Needed

Flow Instrument Calibration Data
Process Parameters and Limits

Check Serial Numbers

Verify that the serial number of the flow element and the flow transmitter electronics are the same. The flow element and the flow transmitter are a matched set and cannot be operated independently of each other.

Check the Instrument Installation

Review the information in Chapter 2 - Installation, to verify correct mechanical and electrical installation.

Verify that the flow element is mounted at least 20 diameters downstream and 10 diameters upstream from any bends or interference in the process pipe or duct.

Check for Moisture

Check for moisture on the flow transmitter. Moisture on the flow transmitter may cause intermittent operation.

Check for moisture on the flow element. If a component of the process media is near its saturation temperature it may condense on the flow element. Place the flow element where the process media is well above the saturation temperature of any of the process gases.

Check Application Design Requirements

Application design problems may occur with first time application instruments, although the design should also be checked on instruments that have been in operation for some time. If the application design does not match field conditions, errors occur.

1. Review the application design with plant operation personnel and plant engineers.
2. Ensure that plant equipment such as pressure and temperature instruments conform to the actual conditions.
3. Verify operating temperature, operating pressure, line size, and gas medium.

Verify Standard Versus Actual Process Conditions

The flowmeter measures the mass flow rate. The mass flow rate is the mass of the gas flowing through a pipe per time. Other flow meters, such as an orifice plate or a pitot tube, measure the volumetric flow rate. The volumetric flow rate is the volume of gas per time. If the readings displayed do not agree with another instrument, some calculations may be necessary before comparing them. To calculate the mass flow rate, the volumetric flow rate, and the pressure and temperature, the point of measurement must be known. Use the following equation to calculate the mass flow rate (Standard Volumetric Flow rate) for the other instrument:

Equation:

$$Q_S = Q_A \times \frac{P_A}{T_A} \times \frac{T_S}{P_S}$$

(Metric: Where bar(a) and °K are used for pressure and temperature.)

Where:

Q_A = Volumetric Flow Q_S = Standard Volumetric Flow
P_A = Actual Pressure T_A = Actual Temperature
P_S = Standard Pressure T_S = Standard Temperature
PSIA and °R are used for pressure and temperature units.

Example:

(Metric: P_S = 1.01325 bar(a)

T_S=21.1°C (294.1K))

Q_A = 1212.7 ACFM Q_S = 1485 SCFM

P_A = 19.7 PSIA T_A = 120°F (580°R)

P_S = 14.7 PSIA T_S = 70°F (530°R)

$$\left(\frac{1212.7\ \text{ACFM}}{1}\right)\left(\frac{19.7\ \text{PSIA}}{580°\ \text{R}}\right)\left(\frac{530°\ \text{R}}{14.7\ \text{PSIA}}\right) = 1485\ \text{SCFM}$$

Verify the Calibration Parameters

The instrument uses a set of predetermined calibration parameters to process flow signals. Most of these parameters should not change. A data package located at the rear of this manual contains the "ST98 Delta R Data Sheet". This contains the calibration ST98 parameters stored in the flow transmitter at the factory. To verify that these parameters have not changed, complete the following:

1. Identify the appropriate Delta R Data sheets by serial number of the instrument.
2. Press [D] [ENTER] to examine each of the parameters. The [ENTER] key allows scrolling one message at a time. Use Table 5-2 to verify parameters with the Delta R Data sheet ST98 Parameters.

Table 5-2. Diagnostic Test Sequence on Display

Serial No.		eu:	
Cust. No.		curvefit:	
scale:		outmode:	
*c1:		*maxflow:	
*c2:		*minflow:	
*c3:		*Max A/D:	
*c4:		tot:	
*c5:		tflow:	
*c6:		*Min A/D:	
*c7:		*Density:	
*c8:		K-Factor:	
*c9:		zero:	
*c10		*sensor:	
*caltemp:		*tslp:	
*balance:		*tcslp0:	
*outz:		*tcslp:	
*outf:		*tcslp2:	
*heater i:		line size0	
*toff:		line size1:	
factor:		F.S.:	

If parameters that have an asterisk (*) have changed, this may indicate a problem. Customer Service should be contacted. If the parameters have not changed, continue with the next section.

Check the Hardware

Equipment Required

FC88 Communicator or Computer with Interface Kit - Contact a Field Representative or Customer Service to purchase an FC88 or computer interface kit.
Digital Multimeter (DMM)
Allen Wrench 1/16 Inch (for aluminum, circular enclosure)
Flat blade Screwdriver (for steel, square enclosure)

Troubleshooting the Flow Element

Use Table 5-3 to determine if the flow element is wired correctly or has failed. Table 5-3 is for resistances at a process temperature of about 70 degrees. To determine the exact resistance at another process temperature use the temperature versus resistance table in Appendix A.

Turn off the input power to the instrument. Unplug TS2 from the circuit board assembly and measure the resistances as shown in Table 5-3.

See Figure 5-1 for component placement and Figure 5-2 for a view of the plug. If the instrument is set up in a remote configuration (flow element enclosure separate from the control circuit enclosure), and the ohm readings are incorrect disconnect the flow element cable at the local (flow element) enclosure. Measure the resistance as shown in Table 5-3. Figure 5-3 shows the terminal block configuration.
If the resistance is correct then the cable between the enclosures is probably bad or not connected properly (loose, corroded, or connected to the wrong terminal).

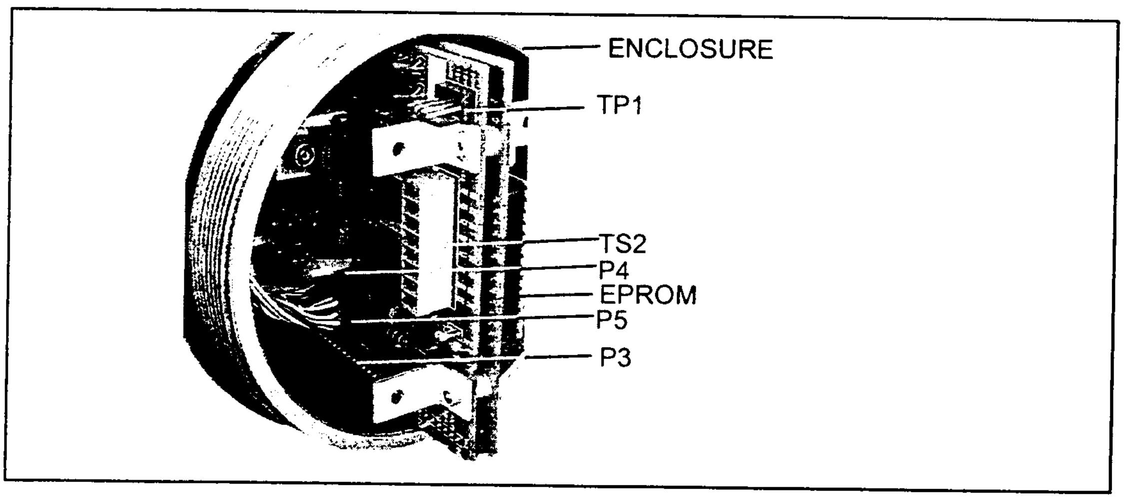
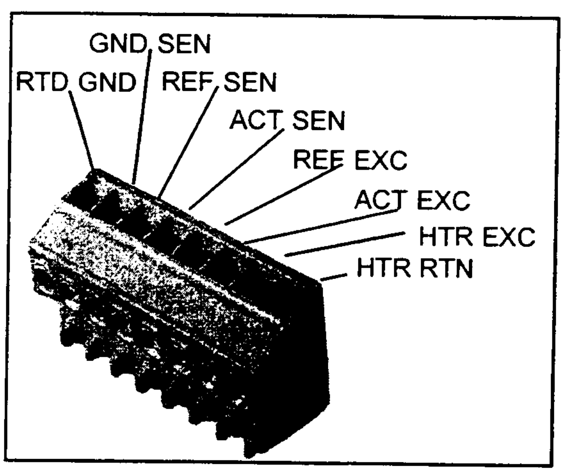


Figure 5-1. Component Identification



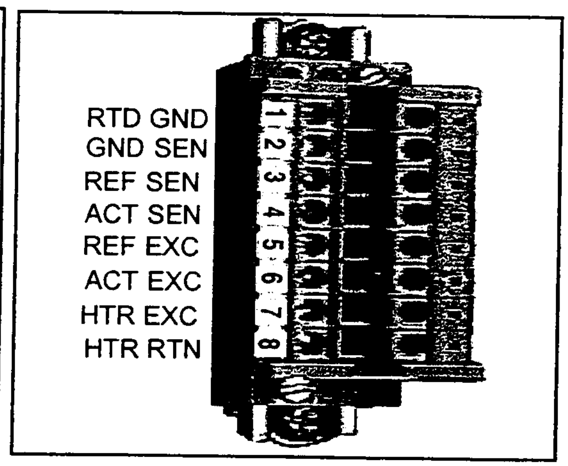


Figure 5-2. TS2 Connector Plug **Figure 5-3. Terminal Block In Local Enclosure**

Table 5-3. Flow Element Resistance at TS2 or Local Terminal Block

LUG OR PIN NUMBER	RESISTANCE
(7) HTR EXC TO (8) HTR RTN	110 - 118 OHMS
(4) ACT SEN TO (2) GND SEN	1.1K OHM
(3) REF SEN TO (2) GND SEN	1.1K OHM
(3) REF SEN TO (4) ACT SEN	2.2K OHMS
(1) RTD GND TO (2) GND SEN	0 OHMS
(4) ACT SEN TO (6) ACT EXC	0 OHMS
(3) REF SEN TO (5) REF EXC	0 OHMS
SHIELD TO HTR RTN (8) (REMOTE INSTALLATIONS)	

The resistance of the Active and Reference sensor will depend on the temperature of the sensing element. Refer to the "Temperature Versus Resistance" Table in Appendix A.

When measuring the resistance of the flow element through a long remote cable, the cable resistance must be subtracted from the measurement. The residual resistance of the DVM and its leads should also be considered. See Table 5-4 to calculate the resistance for copper wire. Each wire gauge size number increase represents a factor of 1.26 resistance increase over the previous size. Moving three gauge sizes higher doubles the resistance. To convert the table values to ohms per meter, multiply the value by 0.0394.

Table 5-4. Resistance Versus Wire Size (AWG)

AWG Size	Ohms Per 1000 Feet
14	2.52
15	3.18
16	4.02
17	5.05
18	6.39
19	8.05
20	10.1
21	12.8
22	16.2
23	20.3
24	25.7

Check the Flow Element Voltages

Use the following voltage measurements if power cannot be easily removed from the instrument or if resistance measurement fail to resolve the problem. Be sure the sensor heater current is set to 75 mA LO by pressing [O] on the FC88 and selecting the heater current. Be sure to set the heater current back to where it was before beginning this procedure. Make the voltage measurements found in Table 5-5 at terminal strip TS2 on the flow transmitter, or on the Local Terminal Block.

Table 5-5. Approximate Flow Element Voltages AT 70° F

LUG OR PIN NUMBER	VOLTAGE*
(7) HTR EXC TO (8) HTR RTN	Approximately 6.79 VDC
(4) ACT SEN TO (6) ACT EXC	Approximately 0.00 VDC
(3) REF SEN TO (5) REF EXC	Approximately 0.00 VDC
(5) REF EXC TO (1) RTD GND	Approximately 2.20 VDC
(6) ACT EXC TO (1) RTD GND	Approximately 2.21 - 2.82 VDC**
(4) ACT SEN TO (3) REF SEN	Approximately 0.24 VDC**

Cable resistance of the remote flow element will affect the TS2 voltage readings at the electronics enclosure.

*Voltages varies with Temperature and Flow and the Sensor Heater Current Selection.

**Voltage will vary with the process flow rate.

Verification Of The Electronics

Check the Flow Transmitter Voltages

Check the voltages in Table 5-6 being sure the volt meter is in the volt mode. Using the DVM in the current mode will damage the flow transmitter.

Table 5-6. Instrument Voltages

PIN NUMBER	VOLTAGE
P3-1 TO P3-5	-9 TO -5 VDC
P3-1 TO P3-6	+5 ± 0.2 VDC
P3-1 TO P3-11	+2 ± 0.01 VDC
TP1 +15 TO TP1 GND	+15 ± 0.5 VDC
TP1 +20 TO TP1 GND	+20 ± 0.5 VDC
TP1 +10 TO TP1 GND	+10 ± 0.01 VDC

If the voltage checks correspond to Table 5-6, the electronics are functioning properly.

Transmitter Circuit Calibration Check (Delta R Verification)

Equipment Needed

FC88 Communicator or equivalent
DVM
Original Delta R Data Sheet - Match By Serial Numbers
2 Precision Decade Resistance Boxes, 0.1% (Largest Steps: 1K Ohm, Smallest Steps 0.01 Ohms)
10 feet of wire, 22 to 18 AWG
Small Flat Blade Screwdrivers, 3/32 and 1/8 inches wide blades.
Small Wire Cutters
Small Wire Strippers

Procedure

1. Turn power off.
2. Mark all wires connected to terminal strip TS2 (or the terminal block for remote instruments) so they may be reconnected to the proper terminals. Disconnect the wires.
3. Connect the resistance decade boxes to terminal strip TS2 (or the terminal block for remote instruments) as shown in Figure 5-4. Check the Delta R Data sheet for the nominal resistance value. Set the decade boxes for the nominal resistance value ±0.01%.
4. Turn the power on and allow the instrument 5 minutes to stabilize.
5. Press [T] [ENTER] to view the normal operating mode. Adjust the active and reference decade boxes. Verify the parameters on the FC88 change.

If the display changes, proceed to the next section. If the display is frozen the instrument is malfunctioning. Contact Customer Service.

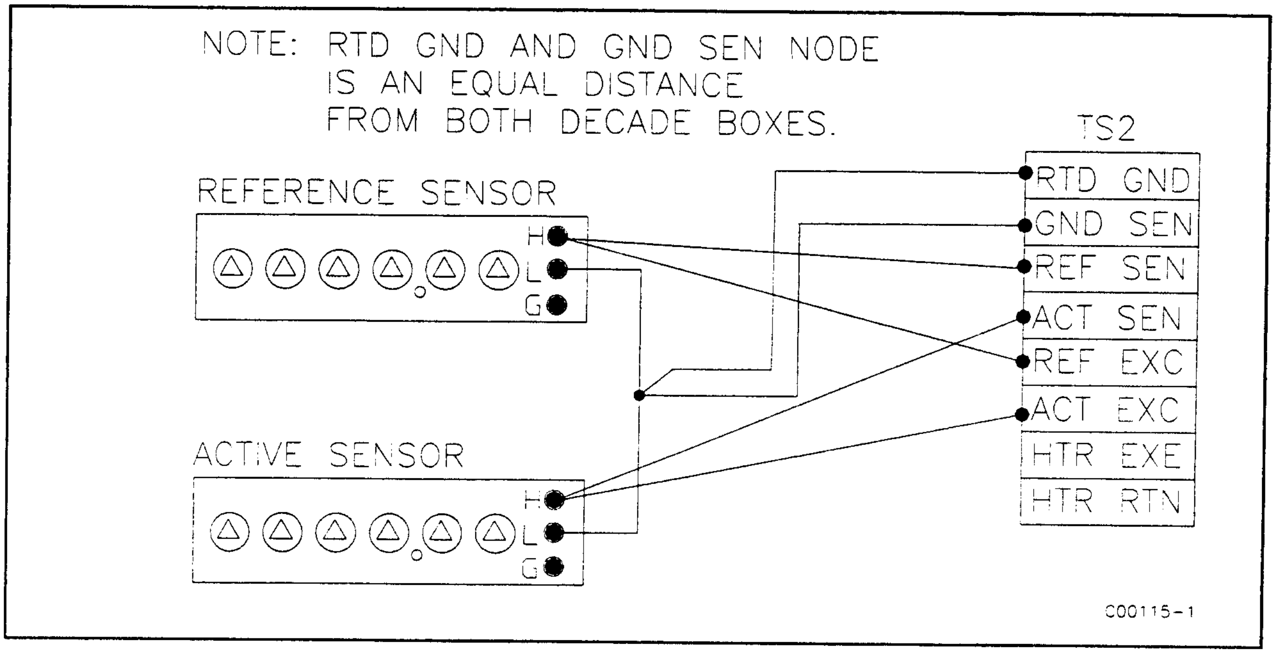


Figure 5-4. Decade Box Connections

Instrument Output Check

Alert: If the mA output is being used on the flow transmitter, the receiver must have a resistance range of 0 to 700 ohms, including the cable resistance.

To vary the output, follow the procedure below:

1. Press [I] then [ENTER] on the FC88. "Enter #(0 01000)" will be displayed on the FC88. Press [0] for minimum output or [500] for an output that is in the center of the range or [1000] for a maximum output.
2. Check the receiver and verify that it agrees with what is being sent.
3. When the above step is verified press [ENTER].

If the receiver is not responding to the signal being sent, remove the power from the instrument. Disconnect the output cable (TS3) and connect a current meter to "mA OUT". Apply power to the instrument and go through the [I] routine to check the output locally. If the mA output responds correctly then there is a problem with the cable or receiver. If there is no response form the mA output, there may be a configuration error or the output circuit is inoperative.

The voltage output option can also be checked with the [I] menu and can help solve problems with the 4-20 mA output

Alert: When finished with troubleshooting be sure that environmental seals are intact and properly installed when securing enclosure lids. Damage resulting from moisture penetration of the Local or Remote Enclosure is NOT covered by product warranty.

Spares

FCI recommends one of each of the following should be kept as a spare: One identically set up ST98 Flow meter. Contact FCI for specific recommendations.

Defective Parts

Before returning any equipment to FCI, please obtain an RA number for authorization, tracking, and repair/ replacement instructions. If a return is required, remove defective instrument, replace with spare, calibrate, then return defective instrument to FCI freight prepaid for disposition.

Customer Service

1. In the event of problems or inquiries regarding the flowmeter, please contact the regional or country authorized FCI Field Agent. There is an extensive list of these representatives at the front of this manual.
2. Before contacting the FCI representative, please be sure that all the applicable information is near so that a more effective, efficient and timely response may be provided.
3. Refer to Appendix C for specific Customer Service policy provisions.

Appendix A. Drawings

All dimensions are shown in inches. Brackets [ ] indicate dimensions in millimeters.

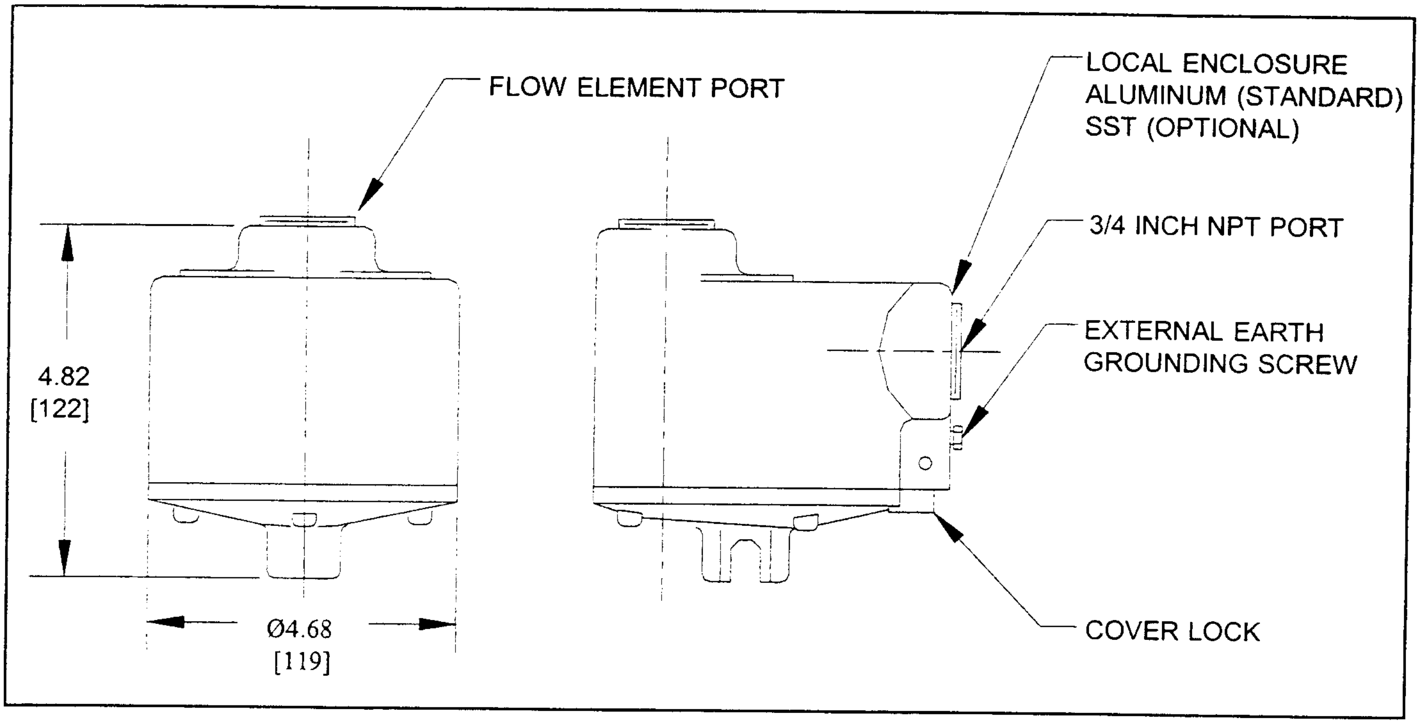


Figure A-1. Local Enclosure, NEMA Type 4X and Hazardous Location (Aluminum Enclosure Shown)

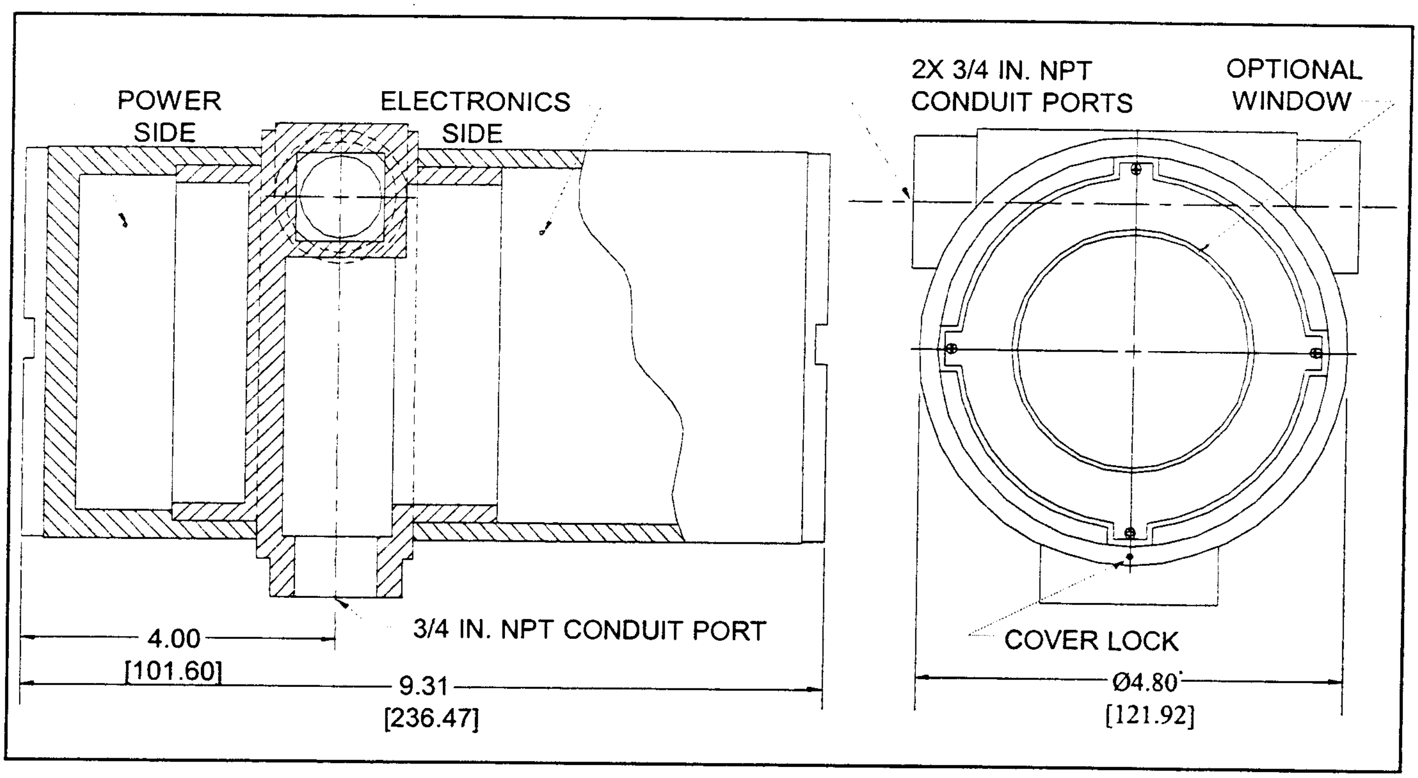


Figure A-2. Remote Aluminum Double Ended Enclosure NEMA 4X and Hazardous Location

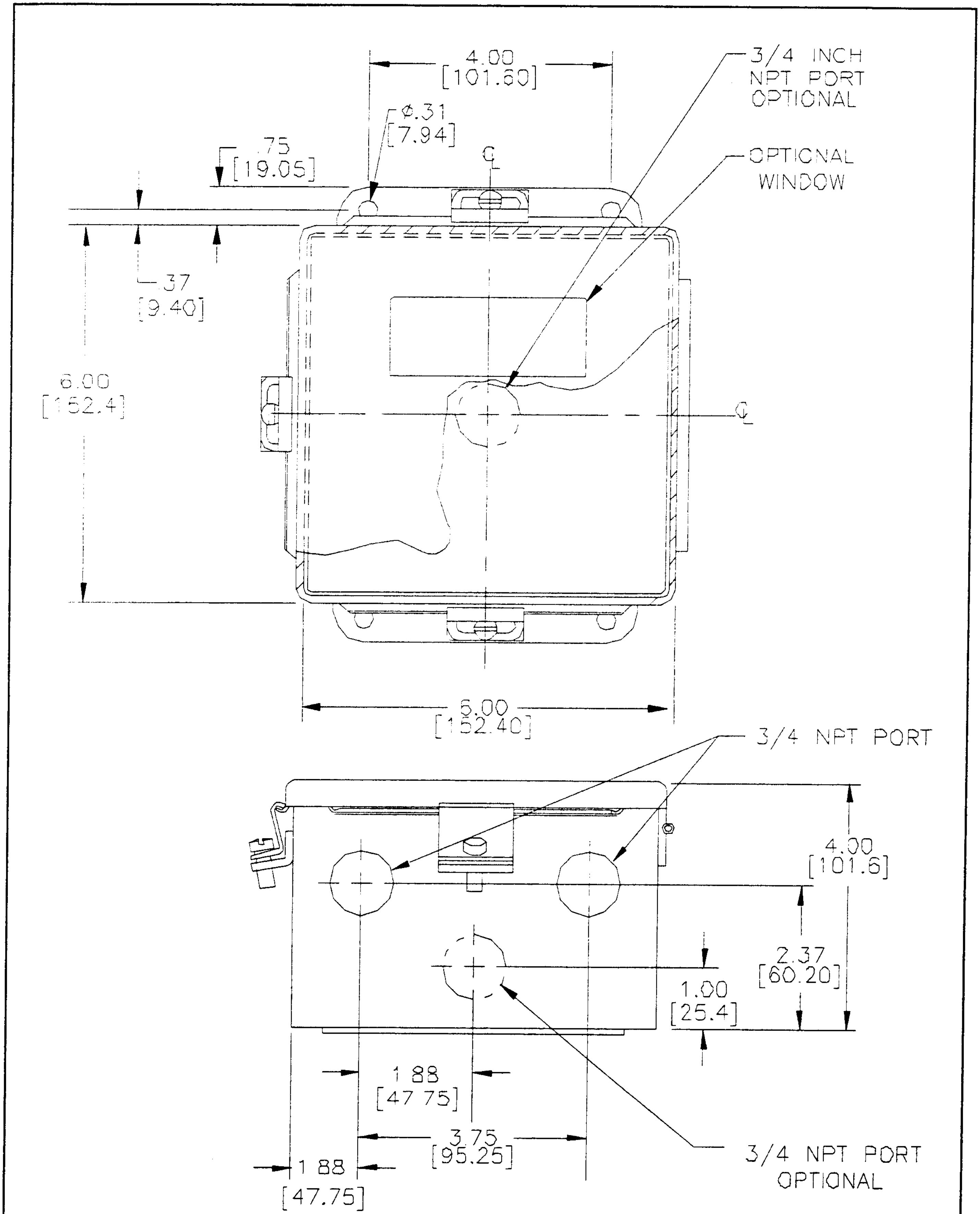


Figure A-3. Remote or Local Enclosure, Carbon Steel

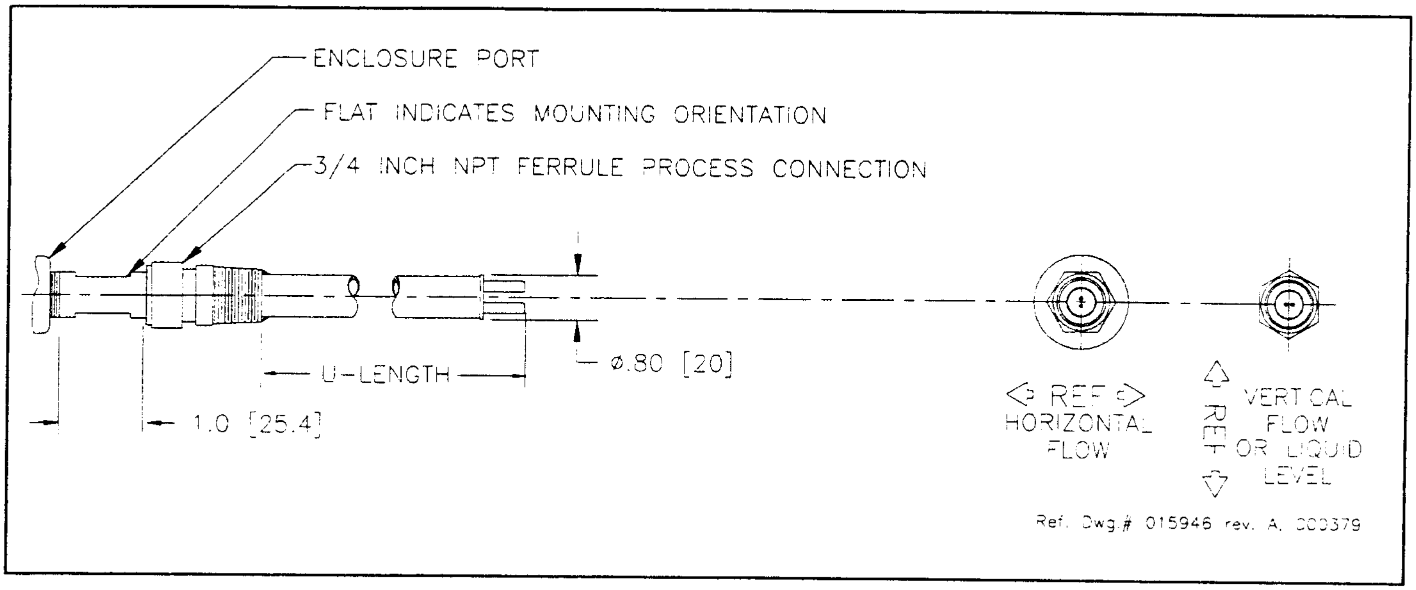


Figure A-4. 3/4 Inch Ferrule NPT Process Connection

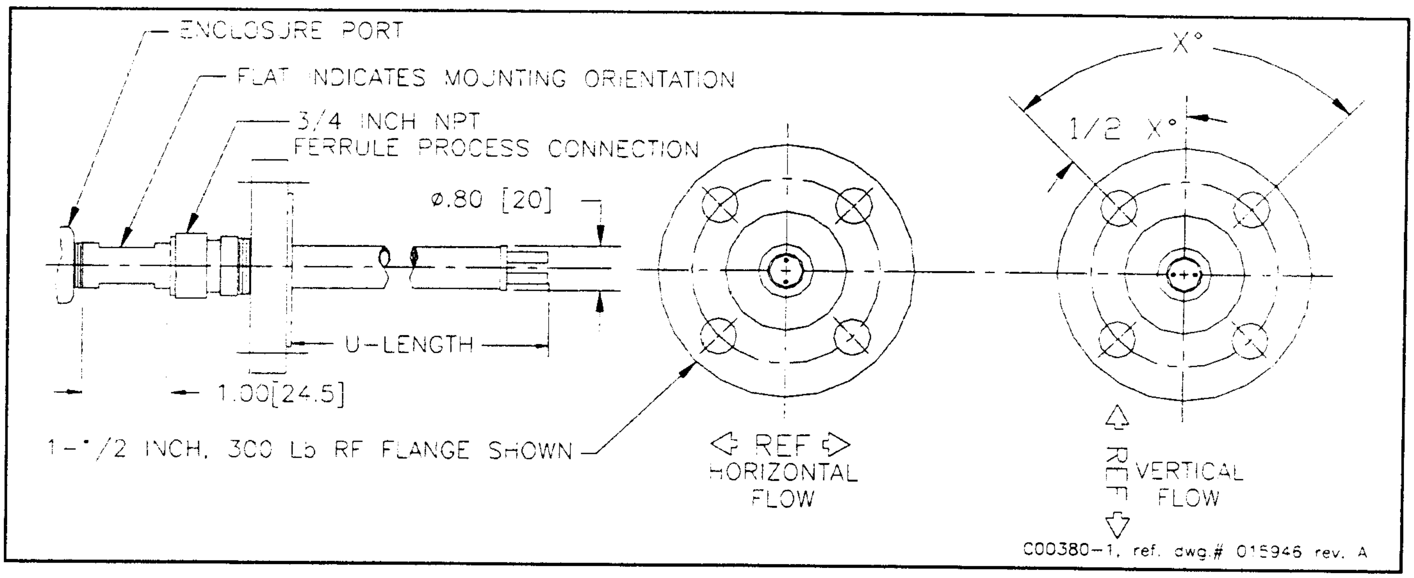


Figure A-5. 3/4 Inch Ferrule NPT With Flange Process Connection

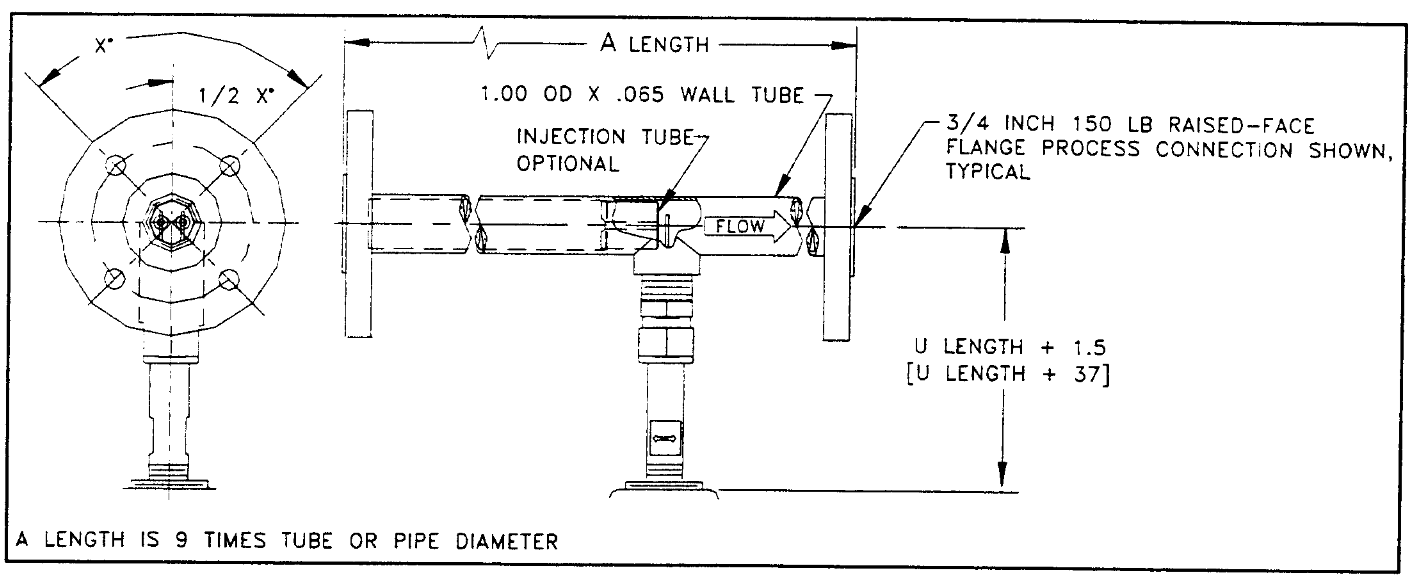


Figure A-6. In-Line Flanged Process Connection

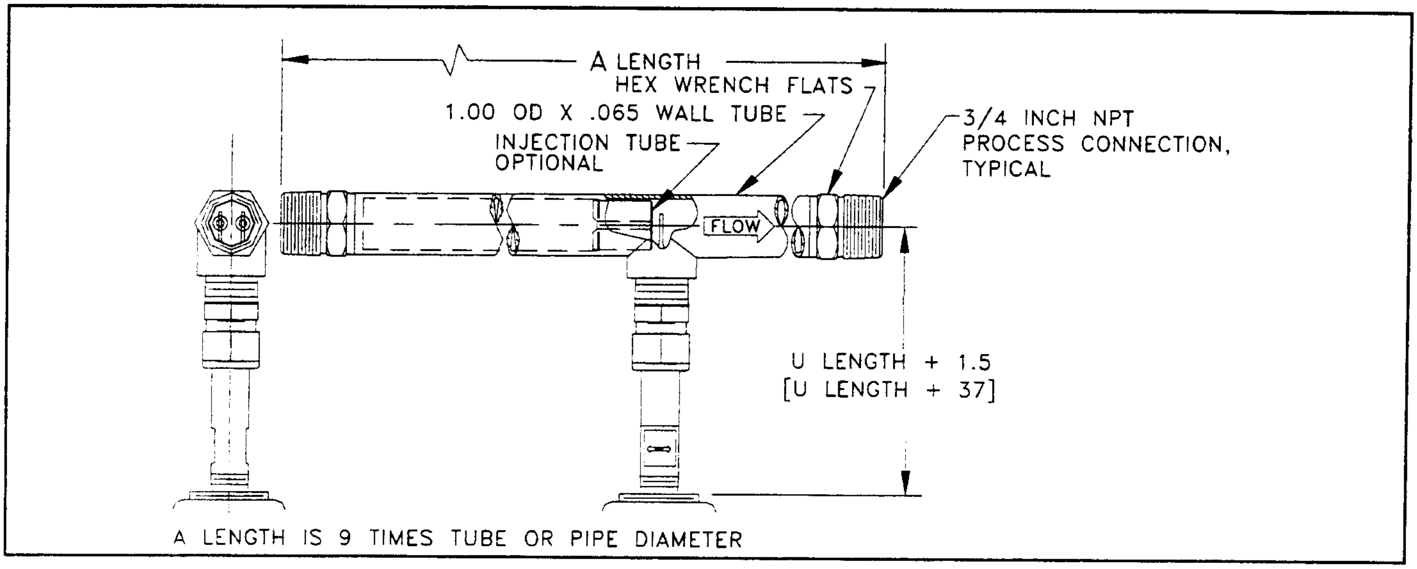


Figure A-7. In-Line NPT Process Connection

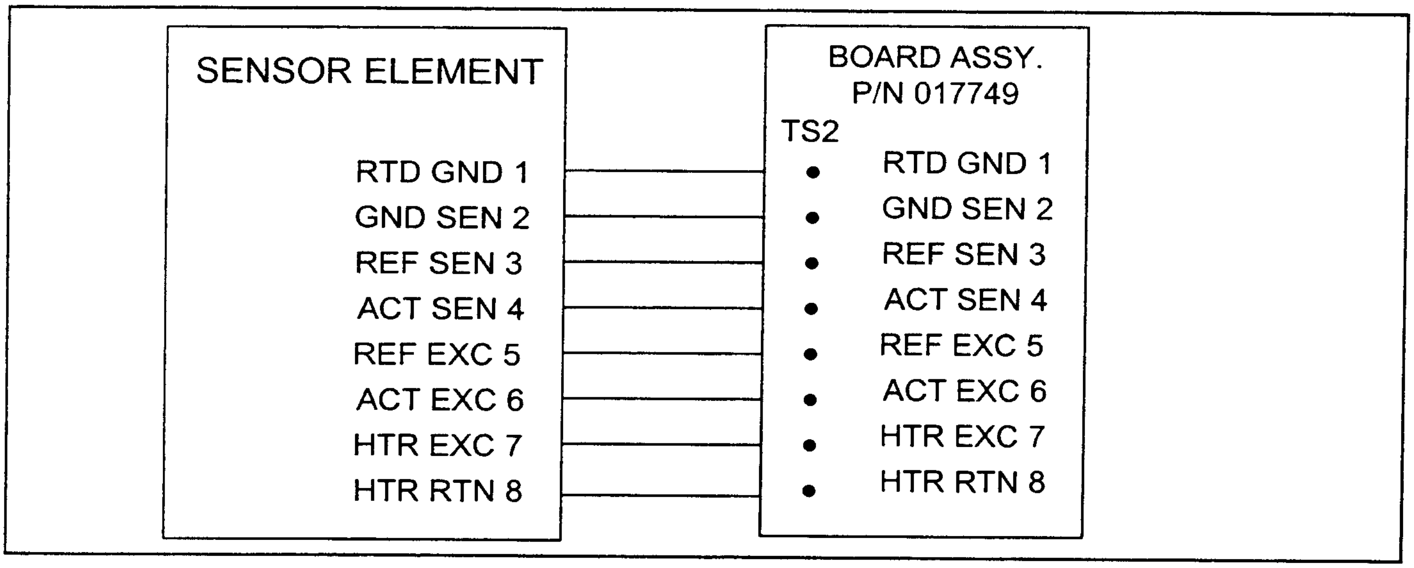


Figure A-8. Integral Option Wiring Diagram

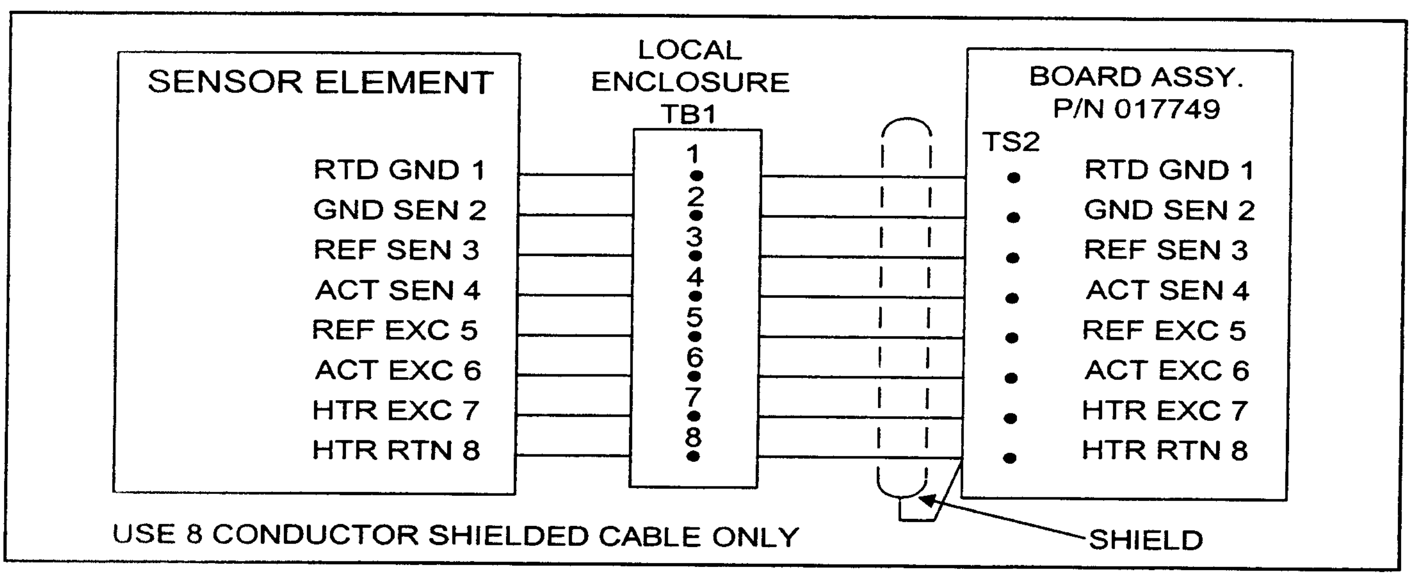


Figure A-9. Remote Wiring Diagram

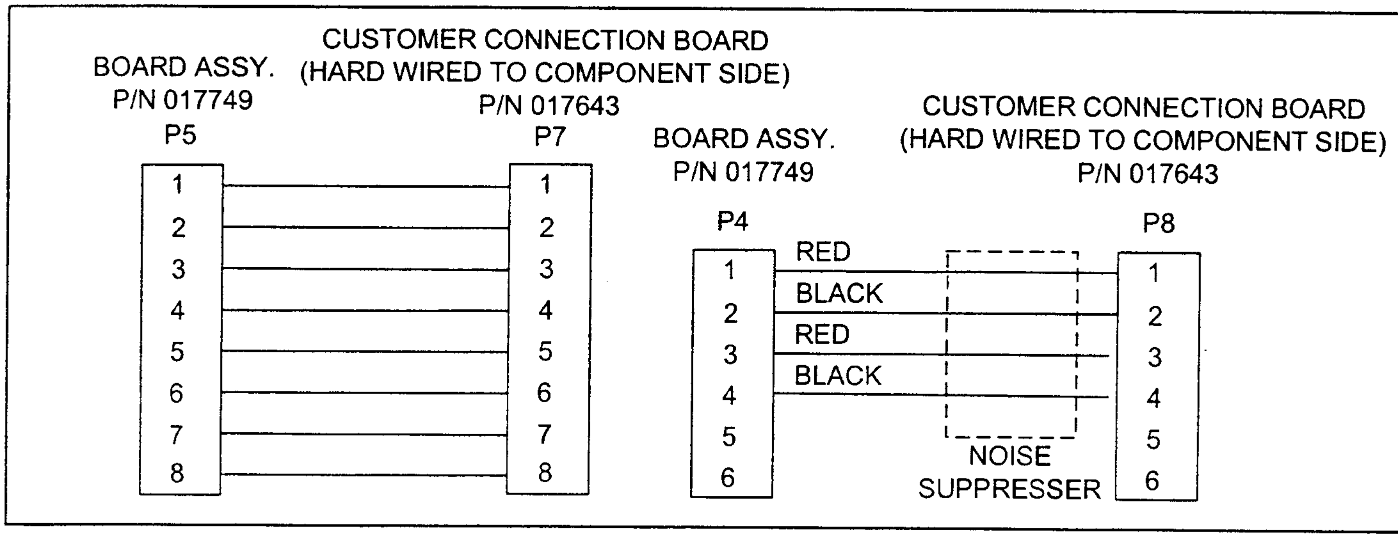


Figure A-10. Wiring Diagram Between Circuit Boards

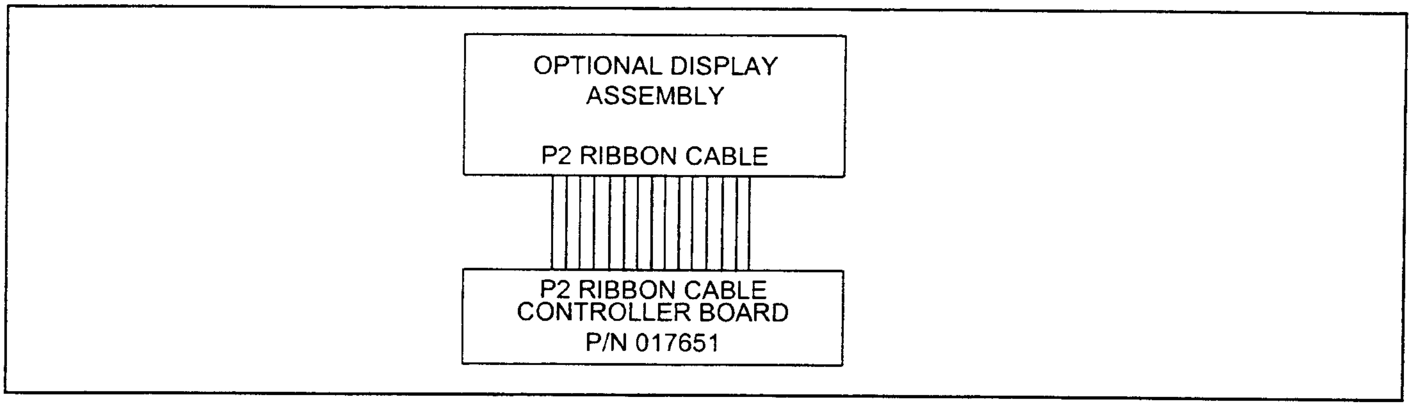


Figure A-11. Optional Display Ribbon Cable Connection

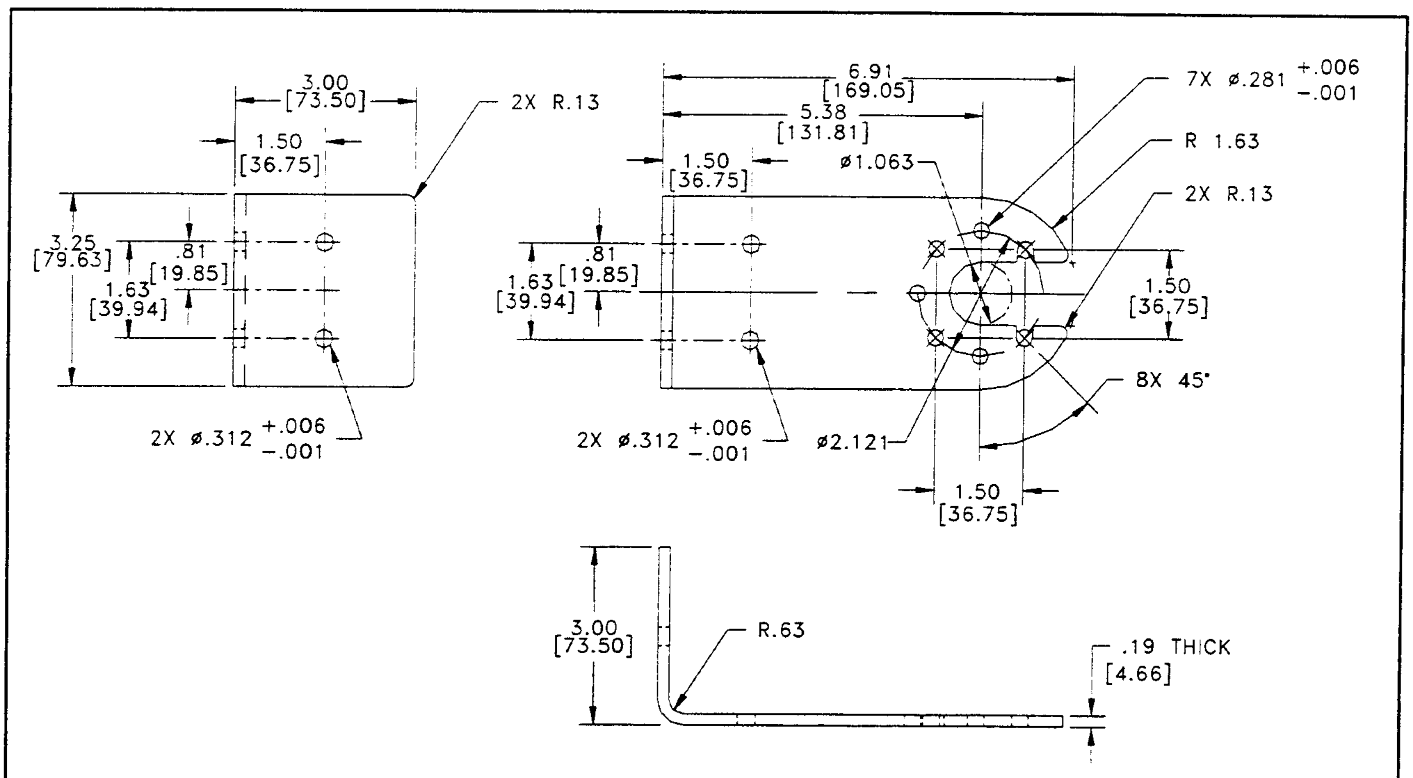


Figure A-12. Remote Mounting Bracket (Hazardous Location Enclosure Only)

0.00375 OHMS/OHMS/°C 1000 OHMS PLATINUM

TEMPERATURE VERSUS RESISTANCE
(Sheet 1 of 3)

T(°F)	OHMS	T(°F)	OHMS	T(°F)	OHMS	T(°F)	OHMS
-40	846.614	3	938.457	46	1029.598	89	1120.046
-39	848.758	4	940.584	47	1031.710	90	1122.141
-38	850.902	5	942.711	48	1033.821	91	1124.236
-37	853.045	6	944.838	49	1035.931	92	1126.330
-36	855.188	7	946.964	50	1038.042	93	1128.424
-35	857.331	8	949.090	51	1040.152	94	1130.517
-34	859.473	9	951.216	52	1042.261	95	1132.610
-33	861.615	10	953.341	53	1044.370	96	1134.703
-32	863.756	11	955.466	54	1046.479	97	1136.795
-31	865.897	12	957.590	55	1048.587	98	1138.887
-30	868.038	13	959.714	56	1050.695	99	1140.978
-29	870.178	14	961.838	57	1052.803	100	1143.069
-28	872.318	15	963.961	58	1054.910	101	1145.160
-27	874.457	16	966.084	59	1057.017	102	1147.250
-26	876.596	17	968.207	60	1059.124	103	1149.340
-25	878.734	18	970.329	61	1061.230	104	1151.429
-24	880.873	19	972.451	62	1063.335	105	1153.518
-23	883.010	20	974.572	63	1065.441	106	1155.607
-22	885.148	21	976.693	64	1067.546	107	1157.695
-21	887.285	22	978.814	65	1069.650	108	1159.783
-20	889.421	23	980.934	66	1071.755	109	1161.870
-19	891.558	24	983.054	67	1073.859	110	1163.957
-18	893.693	25	985.174	68	1075.962	111	1166.043
-17	895.829	26	987.293	69	1078.065	112	1168.129
-16	897.964	27	989.412	70	1080.168	113	1170.215
-15	900.099	28	991.530	71	1082.270	114	1172.300
-14	902.233	29	993.648	72	1084.372	115	1174.385
-13	904.367	30	995.766	73	1086.474	116	1176.470
-12	906.500	31	997.883	74	1088.575	117	1178.554
-11	908.633	32	1000.000	75	1090.676	118	1180.637
-10	910.766	33	1002.117	76	1092.776	119	1182.720
-9	912.899	34	1004.233	77	1094.876	120	1184.803
-8	915.030	35	1006.349	78	1096.976	121	1186.885
-7	917.162	36	1008.464	79	1099.075	122	1188.967
-6	919.293	37	1010.579	80	1101.174	123	1191.049
-5	921.424	38	1012.694	81	1103.272	124	1193.130
-4	923.555	39	1014.808	82	1105.371	125	1195.210
-3	925.685	40	1016.922	83	1107.468	126	1197.290
-2	927.814	41	1019.036	84	1109.566	127	1199.370
-1	929.944	42	1021.149	85	1111.663	128	1201.449
0	932.073	43	1023.262	86	1113.759	129	1203.528
1	934.201	44	1025.374	87	1115.855	130	1205.607

0.00375 OHMS/OHMS/°C 1000 OHMS PLATINUM

TEMPERATURE VERSUS RESISTANCE
(Sheet 2 of 3)

T(°F)	OHMS	T(°F)	OHMS	T(°F)	OHMS	T(°F)	OHMS
132	1209.762	175	1298.661	218	1386.609	261	1473.427
133	1211.839	176	1300.717	219	1388.641	262	1475.431
134	1213.916	177	1302.773	220	1390.673	263	1477.434
135	1215.992	178	1304.829	221	1392.705	264	1479.436
136	1218.068	179	1306.884	222	1394.736	265	1481.438
137	1220.143	180	1308.939	223	1396.766	266	1483.439
138	1222.218	181	1310.993	224	1398.795	267	1485.439
139	1224.293	182	1313.047	225	1400.824	268	1487.439
140	1226.367	183	1315.100	226	1402.853	269	1489.437
141	1228.440	184	1317.152	227	1404.880	270	1491.435
142	1230.513	185	1319.204	228	1406.907	271	1493.432
143	1232.586	186	1321.256	229	1408.934	272	1495.429
144	1234.658	187	1323.307	230	1410.959	273	1497.424
145	1236.730	188	1325.357	231	1412.985	274	1499.419
146	1238.801	189	1327.407	232	1415.009	275	1501.413
147	1240.872	190	1329.456	233	1417.033	276	1503.407
148	1242.942	191	1331.505	234	1419.056	277	1505.399
149	1245.012	192	1333.553	235	1421.079	278	1507.391
150	1247.082	193	1335.601	236	1423.101	279	1509.382
151	1249.151	194	1337.648	237	1425.122	280	1511.372
152	1251.219	195	1339.695	238	1427.142	281	1513.361
153	1253.287	196	1341.741	239	1429.162	282	1515.350
154	1255.355	197	1343.786	240	1431.182	283	1517.338
155	1257.422	198	1345.831	241	1433.200	284	1519.325
156	1259.488	199	1347.875	242	1435.218	285	1521.311
157	1261.554	200	1349.919	243	1437.235	286	1523.296
158	1263.620	201	1351.962	244	1439.252	287	1525.281
159	1265.685	202	1354.005	245	1441.268	288	1527.264
160	1267.750	203	1356.047	246	1443.283	289	1529.247
161	1269.814	204	1358.089	247	1445.298	290	1531.229
162	1271.878	205	1360.130	248	1447.311	291	1533.210
163	1273.941	206	1362.170	249	1449.324	292	1535.191
164	1276.003	207	1364.210	250	1451.337	293	1537.170
165	1278.066	208	1366.249	251	1453.349	294	1539.149
166	1280.127	209	1368.288	252	1455.360	295	1541.127
167	1282.189	210	1370.326	253	1457.370	296	1543.104
168	1284.249	211	1372.363	254	1459.380	297	1545.080
169	1286.310	212	1374.400	255	1461.389	298	1547.056
170	1288.369	213	1376.436	256	1463.397	299	1549.030
171	1290.429	214	1378.472	257	1465.404	300	1551.004
172	1292.487	215	1380.507	258	1467.411	301	1552.977
173	1294.546	216	1382.541	259	1469.417	302	1554.948
174	1296.603	217	1384.575	260	1471.422	303	1556.919

0.00375 OHMS/OHMS/°C 1000 OHMS PLATINUM

TEMPERATURE VERSUS RESISTANCE

(Sheet 3 of 3)

T(°F)	OHMS
304	1558.890
305	1560.859
306	1562.827
307	1564.795
308	1566.761
309	1568.727
310	1570.692
311	1572.656
312	1574.619
313	1576.581
314	1578.542
315	1580.502
316	1582.462
317	1584.420
318	1586.378
319	1588.334
320	1590.290
321	1592.245
322	1594.198
323	1596.151
324	1598.103
325	1600.054
326	1602.004
327	1603.953
328	1605.901
329	1607.848
330	1609.794
331	1611.739
332	1613.683
333	1615.626
334	1617.568
335	1619.509
336	1621.449
337	1623.388
338	1625.326
339	1627.263
340	1629.200
341	1631.135
342	1633.069
343	1635.002
344	1636.933
345	1638.864
346	1640.794
347	1642.723
348	1644.651
349	1646.577
350	1648.503

Appendix B. Glossary of Terms

A/D number Analog to Digital number.

Area Cross-sectional area for a process line.

$$\text{Area of a Circular duct} = \pi r^2 \text{ or } \pi\left(\frac{\text{I.D.}}{2}\right)^2$$

Area of rectangular duct = Length x Width

COM1
COM2 Serial ports located on a personal computer.

DelR The active RTD A/D number minus the reference RTD A/D number.

DVM Digital Voltmeter.

EPROM Erasable Programmable Read Only Memory.

Firmware Software plus hardware. The software is written and then stored in a hardware EPROM chip.

Flow Element The portion of the flow meter that is contains the thermowells, RTDs, and produces a signal with a defined relationship to the flow rate.

Flow Transmitter The portion of the flow meter that conditions, converts, and scales the flow element signal.

RefR The A/D number corresponding to the reference RTD resistance.

RTD A Resistance Temperature Detector operates on the principle of change in resistance as a function of temperature.

SFPS Standard Feet Per Second.

ΔR The difference between two resistance values.

ΔT The difference between two temperature values.

ST98 Parameter Definitions

A. ANALOG INPUT Menu Function.

Channel 0 - 7 Analog signals describing inputs to the electronics.

B. SENSOR BALANCE Menu Function.

Code A passcode (942) is required to continue into the menu selection.

Balance# A number found in the D portion of the menu. This number electronically matches the active and reference RTD's when the heater is off.

C. CALIBRATE DISPLAY Menu Function.

d=xxx The display of Delta-R in the Calibrate Display menu.

r=xxx The display or Ref-R in the Calibrate Display menu.

D. DIAGNOSTIC Menu Function.

Single Poly Fit The polynomial equation used by the electronics to interpret the signal from the flow element.

Two Poly Fit The equation used by the electronics to interpret the signal from the flow element.

Brkpt This is the break point (Delta-R) between the two poly fit equations.

Poly Segment 1 The first group of polynomial equations used to detect flow.

Poly Segment 2 The second group of polynomial equations used to detect flow.

C1 - C5 Calibration equation coefficients.

Balance A number used to balance or match the active and reference RTD's when the heater is off.

Outz An A/D number representing 4 mA. This is set during calibration.

Outf An A/D number representing 20 mA. This is set during calibration.

Heater I An A/D number representing heater current. This is set during calibration.

Factor This is a conversion factor that is multiplied by SFPS to convert to customer units.

Eu The ASCII code for engineering units are as follows:

English			Metric		
ASCII code	Letter code	Engineering Units	ASCII code	Letter code	Engineering Units
70	F	ft./sec.	77	M	SMPS
67	C	SCFM	78	N	NCMH
76	L	lbs./hr.	75	K	kg./hr.

Tot A 1 after the Tot indicates the Totalizer is turned on. A 0 after the Tot indicates the Totalizer is turned off.

Tottemp A 1 after the Tottemp indicates the Totalizer Temperature display is turned on. A 0 after Tottemp indicates the Totalizer Temperature display is turned off.

Tflow This is the totalized flow in volumetric or mass units, it will change as the instrument totalizes flow.

Rollover The place where the totalizer will roll over to zero. (1E9)

Roll cnt Counts the number of times the Totalizer has rolled over to zero.

Outmode The output mode is symbolized as follows:

Number that indicates output selection.		
0	1	2
4-20 mA	0-5 VDC	0-10 VDC

Max A/D High end cut-off A/D number. Prevents false low flow readings.

Min A/D Low end cut-off A/D number. Prevents false high flow readings.

Kfactor User programmable correction factor. The corrected output equals K times the output.

Zero An adjustment that establishes at what flow rate the flow transmitter's output is at its minimum (4 mA, 0 VDC). 0.00 is for zero based

	applications. Minimum flow is for non-zero based applications.
Sensor	This lets the user know what resistance is being used for the RTD's. A 2 indicates a 1K ohm resistance.
Tslp	Slope coefficient for the temperature equation. *Caltemp = (Ref R)(tslp + Toff)*
Refr	Abbreviation for Reference Resistance.
Caltemp	Temperature at calibration. *Caltemp = (Ref R)(tslp) + toff*
Toff	Temperature offset.
Tcslp	The second slope coefficient for the temperature compensation equation.
Tcslp0	The third slope coefficient for the temperature compensation equation.
Tcslp2	The first slope coefficient for the temperature compensation equation.
Maxflow	Maximum calibrated flow in Standard Feet Per Second (SFPS).
Minflow	Minimum calibrated flow in Standard Feet Per Second (SFPS).
Density	The molecular weight of media is entered here. The software back calculates to the standard density of the media which is used when converting from mass to volumetric units. $M' = r \cdot Q.$ M' = *Mass Flow Rate* r = *Density* Q = *Volumetric Flow Rate.*
Line size0	This field indicates the diameter of a round duct or the length of a rectangular duct. The shape of the duct is dependent on the next field.
Line size1	This field indicates the width of a rectangular duct if it contains a value greater than zero. If the value is zero, then it indicates a round duct.
F.S.	This is the full scale value, in customer units, which gives the maximum output signal (20mA, 5 VDC, or 10 VDC).
E. SENSOR CURRENT SELECT	Menu Function.
Sensor Current Select	2.0 ma - 1k ohm is always displayed.
F. K-FACTOR	Menu Function.
K.F.	An abbreviation for K-Factor. A factor the user can input to modify the final flow reading from the calibrated flow rate.
G. EEPROM	Menu Function.
EEPROM	Only the factory has access to this area.
H. HEATER	Menu Function.
Heater Off	The user can turn the heater off.
Heater On	The user can turn the heater on.
I. OUTPUT CURRENT ADJUST	Menu Function.
Enter #	Entering a number (0-1000) will force the output to a corresponding level.
DAC	Digital to Analog Converter number corresponds to output level.
J. SERIAL NUMBER, CUSTOMER ORDER	

NUMBER	Menu Function.
S/N and CO No.	Only the factory has access to this area.
K. CONSTANTS SETUP	Menu Function.
Parameter Definitions	See the parameters in Menu Function D.
L. CALIBRATE OUTPUTS	Menu Function.
(U)p (P)down	Increases or decreases the DAC count.
(F)fast/slow	This controls the speed of the DAC counting.
M. MIN/MAX A/D LIMITS	Menu Function.
Max A/D	High end cut-off A/D number. Prevents false low flow readings.
Min A/D	Low end cut-off A/D number. Prevents false high flow readings.
N. SOFTWARE RESET	Menu Function.
Software Reset	Resets instrument without removing power.
O. SELECT SENSOR HEATER CURRENT	Menu Function.
xxxLO **xxxMD**	Choosing xxxLO sets software flags to show user if flow values are out of range. Choosing xxxMD does not set any software flags.
P. RECONFIGURE THE FC88 UNIT	Menu Function.
FC88 Reset	Re-configures the FC88 so it will function properly in conjunction with the ST98.
R. A/D CALIBRATE RESISTANCE	Menu Function.
A/D Delta-R	The difference between the RTD resistances as used by the A/D converter.
A/D Ref-R	The reference RTD resistance as used by the A/D converter.
r = xxx	A/D Delta-R resistance
R = xxx	A/D Ref-R resistance.
S. AUTO SCALE	Menu Function.
Auto Scale ON	Always on.
T. NORMAL OPERATING MODE	Menu Function.
U. DISPLAY TOTAL FLOW TIME	Menu Function.
Time	Time in minutes since the last reset
Reset	Resets time to zero.
V. OUTPUT MODE SELECT	Menu Function.
Output	Displays the selected instrument output (4-20 mA, 0-5 VDC, 0-10 VDC, 1-5 VDC).
W. TOTALIZER MODE	Menu Function.
Totalizer is	The Totalizer can be toggled on or off. If it is on, the results are displayed on the second line of the normal operating mode window.
Reset Totalizer	The Totalizer can be reset to 0 with this command.
During Powerup	The Totalizer can be automatically reset each time power is applied to the instrument.

Temp Display is The temperature display can be toggled on or off. If it is on, the results are displayed on the second line of the normal operating mode window. If the Totalizer is also on the totalized value and the temperature value will be alternately displayed.

X. NAMUR OUTPUT FAULT INDICATOR Menu Function.

NAMUR Flag is This function can be toggled on or off at this command.

Z. FLOW UNITS SELECT Menu Function.

Flow Units Are:

	Velocity	Volume	Mass
English	SFPS	SCFM	LLB/HR
Metric	SMPS	NCMH	KG/HR

Max = This is the maximum value, in the customer's units, that the instrument can display.

F.S. This is the full scale value, in customer units, which gives the maximum output signal. This value can be input as anything less than the max value from above.

Zero This establishes at what flow rate the flow transmitter's output is at its minimum output. It is 0.00 for zero based applications. For non-zero based applications the zero is at minimum flow.

Appendix C. Customer Service

Point of Contact

Your point of contact for service, or return of equipment to FCI is your authorized FCI service representative.

Reference Documents

- Return Authorization Request/Certificate of Non-Contamination (Document 1)
- Warranties (Document 2)

Documents 1 and 2 are included in this appendix.

Hardware Return Procedure

Complete a Return Authorization (RA) Request/Certificate of Non-Contamination form (Document 1). Mail or fax it to FCI Customer Service Department. After FCI issues an RA number, complete the following steps.

1. Thoroughly clean the hardware.
2. Package each instrument with protective packing material similar to the original FCI shipment cartons indicated below. **All damage occurring in transit is the customer's responsibility.**
   a. Instruments weighing less than 25 pounds each are to be covered with protective wrap, i.e. bubble wrap or surrounded with "popcorn". Instruments weighing greater than 60 pounds or extending more than four feet should be secured in wooden crates by bolting the sensing element assembly in place.
   b. Protect the sensing element with a cardboard tube or other sturdy wrapping as shown below.
   c. Protect the electronics with an Anti-Static bag like the one shown below.
   d. Do not pack more than four small instruments in each carton.
   e. Packages weighing in excess of 70 pounds or with a combined length and girth of more than 138 inches cannot be shipped by United Parcel Service. Larger packages or crates should be shipped by carriers who specialize in the transport of industrialized instrumentation.
   f. The RA number should be noted on the packing list and marked clearly on the outside of the box.
3. Prepay freight to the FCI receiving door.

Shipping/Handling Charges

All Shipping (Warranty and Nonwarranty Repairs or Returns)

The customer prepays all shipping, freight, duty/entry and handling charges from the customer site to the FCI door. If the customer does not prepay, FCI will invoice the customer for the charges that appear on the freight bill. Address the return equipment to:

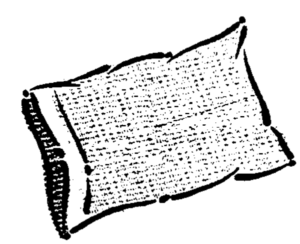
FLUID COMPONENTS INTL

1755 LA COSTA MEADOWS DRIVE

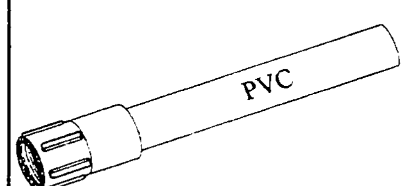
SAN MARCOS, CA. 92069

ATTN: REPAIR DEPT.

RA NUMBER: ____________________



Anti-Static Bag



Probe protector

Warranty Repairs or Returns

FCI prepays ground transportation charges for return of freight to the customer's door. FCI reserves the right to return equipment by the carrier of our choice.

International freight, handling charges, duty/entry fees for return of equipment are paid by the customer.

Nonwarranty Repairs or Returns

FCI returns repaired equipment to the customer either collect or prepaid and adds freight charges to the customer invoice.

Return to Stock Equipment

The customer is responsible for all shipping and freight charges for equipment that is returned to FCI stock from the customer site. These items will not be credited to customer's account until either all freight charges are cleared or until the customer agrees to have any freight costs incurred by FCI deducted, along with applicable return to stock charges, from the credit invoice. (Exceptions are made for duplicate shipments made by FCI.)

If any repair or return equipment is received at FCI, freight collect, without prior factory consent, FCI bills the sender for these charges.

Field Service Procedures

Field Service Requests

Contact your FCI field representative to request field service.

A field service technician is dispatched to the site from either the FCI factory or one of the FCI representative offices. After the work is complete, the technician completes a preliminary field service report at the customer site and leaves a copy with the customer.

Following the service call, the technician completes a formal, detailed service report. The formal report is mailed to the customer within five days of the technician's return to the factory or office.

Rates

All field service calls are billed at the prevailing rates as listed in the FCI Price Book unless specifically excepted by the FCI Customer Service Manager. FCI reserves the right to bill for travel times at our discretion.

Customers are charged for shipping costs related to the transfer of equipment to and from the job site. They are also invoiced for field service work and travel expenses by FCI's Accounting Department.

Document 1.
FCI RETURN AUTHORIZATION REQUEST

Customer Information

R.A. Number:

Name of Company Returning Hardware ____________________

Contact Name: ____________ Phone # ____________ Fax # ____________

Customer Bill to Address: ____________ Ship to: ____________

Purchase Agent Contact: ____________ Phone # ____________ Fax # ____________

Product Information

Model Number(s) ____________ Serial Number(s) ____________

Sending: Electronics only ☐ Sensor only ☐ Complete unit ☐ Number of units ____

Failure Symptoms ____________________

Troubleshooting done in the field by: FCI representative ☐ or by Customer ☐ ____________

Action to be taken by FCI: Recalibrate ☐ Electronics Repair ☐ Sensor Element Repair ☐ Upgrade ☐ Other ☐

(Note: Re-calibration/Re-certification requires the completion of a new Application Data Sheet)

Authorization to repair, if under: $500 ☐ $1000 ☐ Purchase Order Reference: ____________

Probe Protector Requested ☐ Antistatic Bag Requested ☐

Process Flow Media: ____________________

Who is your FCI factory technical contact: ____________________

Note: FCI will charge a handling fee on all non-warranty evaluations.

Have you contacted your local FCI representative for assistance? _____ yes _____ no

Decontamination Information

Exposure to hazardous materials is regulated by Federal, state (California), County and City laws and regulations. These laws provide FCI's employees with the right to know the hazardous materials with which they come in contact while handling our products. Consequently, our employees must have access to data regarding the hazardous materials which the equipment has been exposed to in your process(es). Accordingly, prior to returning your instrument for repair, please sign the certification below and thoroughly comply with the instructions, if applicable.

I certify that the item(s) has (have) been thoroughly and completely cleaned and if the item(s) has (have) been exposed to or contacted by a hazardous material, hazardous substance or toxic materials or substances that the undersigned can assure the returned item(s) has (have) been thoroughly and completely decontaminated and neutralized of such substances and contamination. I have also attached a Material Safety Data Sheet (MSDS) which covers all hazardous material, hazardous substance or toxic materials or substances exposed to or contacted by the instrument. Furthermore, I understand that this Certificate, or providing a MSDS, shall not waive our responsibility to provide a neutralized, decontaminated, and clean product for repair to FCI.

Authorized Signature ____________________ Date ____________

Cleanliness of a returned item or the acceptability of the MSDS shall be at the sole discretion of FCI.
Any returned item which does not comply with these instructions shall be returned to you at your expense.

Document 2. Warranties

Warranties

Goods furnished by the Seller are to be within the limits and of the sizes published by the Seller and subject to the Seller's standard tolerances for variations. All items made by the Seller are inspected before shipment, and should any of said items prove defective due to faults in manufacture or performance under Seller approved applications, or fail to meet the written specifications accepted by the Seller, they will be replaced or repaired by Seller at no charge to Buyer provided return or notice of rejection of such material is made within a reasonable period but in no event longer than one (1) year for non-calibration defects and one (1) year for calibration defects from date of shipment to Buyer, and provided further, that an examination by Seller discloses to Seller's reasonable satisfaction that the defect is covered by this warranty and that the Buyer has not returned the equipment in a damaged condition due to Buyer's or Buyer's employees', agents', or representatives' negligence and Buyer has not tampered, modified, redesigned, misapplied, abused, or misused the goods as to cause the goods to fail. In addition, this warranty shall not cover damage caused by Buyer's exposure of the goods to corrosive or abrasive environments. Moreover, Seller shall in no event be responsible for (1) the cost or repair of any work done by Buyer on material furnished hereunder (unless specifically authorized in writing in each instance by Seller), (2) the cost or repair of any modifications added by a Distributor or a third party, (3) any consequential or incidental damages, losses, or expenses in connection with or by reason of the use of or inability to use goods purchased for any purpose, and Seller's liability shall be specifically limited to free replacement, or refund of the purchase price, at Seller's option, provided return or rejection of the goods is made consistent with this paragraph, and the Seller shall in no event be liable for transportation, installation, adjustment, loss of good will or profits, or other expenses which may arise in connection with such returned goods, or (4) the design of products or their suitability for the purpose for which they are intended or used. Should the Buyer receive defective goods as defined by this paragraph, the Buyer shall notify the Seller immediately, stating full particulars in support of his claim, and should the Seller agree to a return of the goods, the Buyer shall follow Seller's packaging and transportation directions explicitly. In no case are the goods to be returned without first obtaining a return authorization from the Seller. Any repair or replacement shall be at Seller's factory, unless otherwise directed, and shall be returned to Seller transportation prepaid by Buyer. If the returned goods shall prove defective under this clause they will be replaced or repaired by Seller at no charge to Buyer provided the return or rejection of such material is made within a reasonable period, but in no event longer than (1) year from the date of shipment of the returned goods or the unexpired terms of the original warranty period whichever is later. If the goods prove to be defective under this paragraph, the Buyer shall remove the goods immediately from the process and prepare the goods for shipment to Seller. Continued use or operation of defective goods is not warranted by Seller and damage occurring due to continued use or operation shall be for Buyer's account. Any description of the goods contained in this offer is for the sole purpose of identifying them, and any such description is not part of the basis of the bargain, and does not constitute a warranty that the goods will conform to that description. The use of any sample or model in connection with this offer is for illustrative purposes only, is not part of the basis of the bargain, and is not to be construed as a warranty that the goods will conform to the sample or model. No affirmation of that fact or promise made by the Seller, whether or not in this offer, will constitute a warranty that the goods will conform to the affirmation or promise. THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES WITH RESPECT TO THE GOODS OR THEIR INSTALLATION, USE, OPERATION, REPLACEMENT OR REPAIR, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS OF PURPOSE; AND THE GOODS ARE BEING PURCHASED BY BUYER "AS IS". SELLER WILL NOT BE LIABLE BY VIRTUE OF THIS WARRANTY OR OTHERWISE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL LOSS OR DAMAGE RESULTING FROM THE USE OR LOSS OF USE OF THE GOODS.

Safety Instructions for the use the ST98 Flexmasster in Hazardous Areas
Approval KEMA 02 ATEX 2042 for II 2G Ex d IIC T4
II 2D Ex tD A21 T 100°C IP66

Dansk	Sikkerhedsforskrifter	Italiano	Normative di sicurezza
Deutsch	Sicherheitshinweise	Nederlands	Veiligheidsinstructies
English	Safety instructions	Português	Normas de segurança
Υπ	Υπ_δεί_εις ασφαλείας	Español	Instrucciones de seguridad
Suomi	Turvallisuusohjeet	Svenska	Säkerhetsanvisningar
Français	Consignes de sécurité		

(DK) Dansk- Sikkerhedsforskrifter

Disse sikkerhedsforskrifter gælder for Fluid Components, ST98 Flexmasster EF-typeafprøvningsattest-nr. KEMA 02 ATEX 2042 (attestens nummer på typeskiltet) er egnet til at blive benyttet i eksplosiv atmosfære kategori II 2 G.
1) Ex-anlæg skal principielt opstilles af specialiseret personale.
2) ST98 Flexmasster skal jordforbindes.
3) Klemmerne og elektronikken er monteret i et hus, som er beskyttet af en eksplosionssikker kapsling med følgende noter:

- Gevindspalten mellem huset og låget er på en sådan måde, at ild ikke kan brede sig inden i det.
- Ex-„d" tilslutningshuset er forsynet med et 1" NPT og/eller 3/4" NPT gevind for montering af en Ex-„d" kabelindføring, der er attesteret iht. EN50018/EN60079-1
- Det er vigtigt at sørge for, at forsyningsledningen er uden spænding eller eksplosiv atmosfære ikke er til stede, før låget åbnes og når låget er åbent på „d" huset (f.eks. ved tilslutning eller servicearbejde).
- Låget på „d" huset skal være skruet helt ind, når apparatet er i brug. Det skal sikres ved at dreje en af låseskruerne på låget ud.

(D)(A) Deutsch-Sicherheitshinweise

Diese Sicherheitshinweise gelten für die Fluid Components, ST98 Flexmasster flowmeter gemäß der EG-Baumusterprüfbescheinigung Nr. KEMA 02 ATEX 2042 (Bescheinigungsnummer auf dem Typschild) der Kategorie II 2 G.
1) Die Errichtung von Ex-Anlagen muss grundsätzlich durch Fachpersonal vorgenommen werden.
2) Der ST98 Flexmasster muß geerdet werden.
3) Die Klemmen und Elektroniken sind in einem Gehäuse in der Zündschutzart druckfeste Kapselung („d") eingebaut.

- Der Gewindespalt zwischen dem Gehäuse und dem Deckel ist ein zünddurchschlagsicherer Spalt.
- Das Ex-"d" Anschlussgehäuse besitzt ein 3/4" und/oder 1" NPT Gewinde für den Einbau einer nach EN50018/EN60079-1 bescheinigten Ex-"d" Kabeleinführung.
- Es ist sicherzustellen, dass vor dem Öffnen und bei geöffnetem Deckel des „d" Gehäuses (z.B. bei Anschluss oder Service- Arbeiten) entweder die Versorgungsleitung spannungsfrei oder keine explosionsfähige Atmosphäre vorhanden ist.
- Der Deckel des „d" Gehäuses muss im Betrieb bis zum Anschlag hineingedreht sein. Er ist durch eine der Deckelarretierungsschrauben zu sichern.

(GB)(IRL) English- Safety instructions

These safety instructions are valid for the Fluid Components, ST98 Flexmasster flowmeter to the EC type approval certificate no. KEMA 02 ATEX 2042 (certificate number on the type label) for use in potentially explosive atmospheres in Category II 2 G.
1) The installation of Ex-instruments must be made by trained personnel.
2) The ST98 Flexmasster must be grounded.
3) The terminals and electronics are installed in a flame proof and pressure-tight housing with following notes:

- The gap between the housing and cover is an ignition-proof gap.
- The Ex-"d" housing connection has a 1" and/or 3/4 " NPT cable entry for mounting an Ex-d cable entry certified acc. to EN50018/EN60079-1.
- Make sure that before opening the cover of the Ex"d" housing, the power supply is disconnected or there is no explosive atmosphere present (e.g. during connection or service work).
- During normal operation: The cover of the "d" housing must be screwed in completely and locked by tightening one of the cover locking screws

(GR) Υπ_δεί_εις ασφαλείας

Αυτές οι οδηγίες ασφαλείας ισχύουν για τα Ροόμετρα της Fluid Components τύπου ST98 Flexmasster που φέρουν Πιστοποιητικό Εγκρίσεως Ευρωπαϊκής Ένωσης, με αριθμό πιστοποίησης KEMA 02 ATEX 2042 (ο αριθμός πιστοποίησης βρίσκεται πάνω στην ετικέτα τύπου του οργάνου) για χρήση σε εκρηκτικές ατμόσφαιρες της κατηγορίας II 2 G.

1) Η εγκατάσταση των οργάνων με αντιεκρηκτική προστασία πρέπει να γίνει από εξειδικευμένο προσωπικό.
2) Το όργανο τύπου ST98 Flexmasster πρέπει να είναι γειωμένο.
3) Τα τερματικά ηλεκτρικών συνδέσεων (κλέμες) και τα ηλεκτρονικά κυκλώματα είναι εγκατεστημένα σε περίβλημα αντιεκρηκτικό και αεροστεγές σύμφωνα με τις ακόλουθες παρατηρήσεις:

- Το κενό ανάμεσα στο περίβλημα και στο κάλυμμα είναι τέτοιο που αποτρέπει την διάδοση σπινθήρα.
- Το "Ex-d" αντιεκρηκτικό περίβλημα, έχει ανοίγματα εισόδου καλωδίου με διάμετρο ¾ ή/και 1 ίντσα NPT, κατάλληλα για τοποθέτηση υποδοχής αντιεκρηκτικού καλωδίου πιστοποιημένης κατά EN50018/EN60079-1
- Βεβαιωθείτε ότι πριν το άνοιγμα καλύμματος του του "Ex-d" αντιεκρηκτικού περιβλήματος, η τάση τροφοδοσίας είναι αποσυνδεδεμένη ή ότι δεν υφίσταται στη περιοχή εκρηκτική ατμόσφαιρα (π.χ. κατά τη διάρκεια της σύνδεσης ή εργασιών συντήρησης)
- Κατά τη διάρκεια ομαλής λειτουργίας: Το κάλυμα του "d" καλύμματος αντιεκρηκτικού περιβλήματος πρέπει να είναι εντελώς βιδωμένο και ασφαλισμένο, σφίγγοντας μία από τις βίδες ασφαλείας του περιβλήματος.

(FIN) Suomi - Turvallisuusohjeet

Nämä turvallisuusohjeet koskevat Flud Components, ST98 Flexmasster EY-tyyppitarkastustodistuksen nro. KEMA 02 ATEX 2042 mukaisesti (todistuksen numero näkyy tyyppikilvestä) käytettäessä räjähdysvaarallisissa tiloissa luokassa II 2G.

1) Ex-laitteet on aina asennettava ammattihenkilökunnan toimesta.
2 ST98 Flexmasster on maadoitettava.
3) Syöttöjännitteen kytkemisessä tarvittavat liittimet ja elektroniikka on asennettu koteloon jonka rakenne kestää räjähdyspaineen seuraavin lisäyksin :

- Kotelon ja kannen välissä on räjähdyksen purkausväli.
- Ex-d liitäntäkotelossa on 3/4" NPT ja/tai 1" NPT kierre EN50018/EN60079-1 mukaisen Ex-d kaapeliläpiviennin asennusta varten
- Kun "d"-kotelon kansi avataan (esim. liitännän tai huollon yhteydessä), on varmistettava, että joko syöttöjohto on jännitteetön tai ympäristössä ei ole räjähtäviä aineita.
- "d" -kotelon kansi on kierrettävä aivan kiinni käytön yhteydessä ja on varmistettava kiertämällä yksi kannen lukitusruuveista kiinni.

(F)(B)(L) Consignes de sécurité

Ces consignes de sécurité sont valables pour le modèle ST 98 Flexmasster de la société Fluid Components (FCI) conforme au certificat d'épreuves de type KEMA 02 ATEX 2042 (numéro du certificat sur l'étiquette signalétique) conçu pour les applications dans lesquelles un matériel de la catégorie II2G est nécessaire.

1) Seul un personnel spécialisé et qualifié est autorisé à installer le matériel Ex.
2) Les ST98 Flexmasster doivent être reliés à la terre.
3) Les bornes pour le branchement de la tension d'alimentation et l'électronique sont logées dans un boîtier à enveloppe antidéflagrante avec les notes suivantes :

- Le volume entre le boîtier et le couvercle est protégé en cas d'amorçage.
- Le boîtier de raccordement Ex-d dispose d'un filetage ¾" NPT et/ou 1" NPT pour le montage d'un presse-étoupe Ex-d certifié selon la EN50018/EN60079-1.
- Avant d'ouvrir le couvercle du boîtier « d » et pendant toute la durée où il le restera (pour des travaux de raccordement, d'entretien ou de dépannage par exemple), il faut veiller à ce que la ligne d'alimentation soit hors tension ou à ce qu'il n'y ait pas d'atmosphère explosive.
- Pendant le fonctionnement de l'appareil, le couvercle du boîtier « d » doit être vissé et serré jusqu'en butée. La bonne fixation du couvercle doit être assurée en serrant une des vis d'arrêt du couvercle.

(I) Italiano - Normative di sicurezza

Queste normative di sicurezza si riferiscono ai Fluid Components, ST98 Flexmasster secondo il certificato CE di prova di omologazione n° KEMA 02 ATEX 2042 (numero del certificato sulla targhetta d'identificazione) sono idonei all'impiego in atmosfere esplosive applicazioni che richiedono apparecchiature elettriche della Categoria II 2 G.
1) L'installazione di sistemi Ex deve essere eseguita esclusivamente da personale specializzato.
2) I ST98 Flexmasster devono essere collegati a terra.
3) I morsetti per il collegamento e l'elettronica sono incorporati in una custodia a prova di esplosione („d") con le seguenti note:

- La sicurezza si ottiene grazie ai cosidetti „interstizi sperimentali massimi", attraverso i quali una eventuale accensione all'interno della custodia non può propagarsi all'esterno o raggiungere altre parti dell'impianto.
- La scatola di collegamento Ex-d ha una filettatura 3/4" e/o 1" NPT per il montaggio di un passacavo omologato Ex-d secondo EN 50 018.
- Prima di aprire il coperchio della custodia „d" (per es. durante operazioni di collegamento o di manutenzione) accertarsi che l'apparecchio sia disinserito o che non si trovi in presenza di atmosfere esplosive.
- Avvitare il coperchio della custodia „d" fino all'arresto. Per impedire lo svitamento del coperchio é possibile allentare una delle 2 viti esagonali poste sul corpo della custodia, incastrandola nella sagoma del coperchio.

(NL)(B) Nederlands - Veiligheidsinstructies

Deze veiligheidsinstructies gelden voor de Fluid Components, ST98 Flexmasster overeenkomstig de EG-typeverklaring nr. KEMA 02 ATEX 2042 (nummer van de verklaring op het typeplaatje) voor gebruik in een explosieve atmosfeer volgens Categorie II 2G.
1) Installatie van Ex-instrumenten dient altijd te geschieden door geschoold personeel.
2) De ST98 moet geaard worden.
3) De aansluitklemmen en de electronika zijn ingebouwd in een drukvaste behuizing met de volgende opmerkingen:

- De schroefdraadspleet tussen de behuizing en de deksel is een ontstekingsdoorslagveilige spleet.
- De Ex-d aansluitbehuizing heeft een ¾" of een 1" NPT schroefdraad voor aansluiting van een volgens EN 50 018 goedgekeurde Ex- 'd' kabelinvoer.
- Er moet worden veilig gesteld dat vóór het openen bij een geopende deksel van de 'd' behuizing (bijv. bij aansluit- of servicewerkzaamheden) hetzij de voedingsleiding spanningsvrij is, hetzij geen explosieve atmosfeer aanwezig is.
- De deksel van de 'd' behuizing moet tijdens bedrijf tot aan de aanslag erin geschroefd zijn. Hij moet door het eruit draaien van een van de dekselborgschroeven worden geborgd.

(P) Português - Normas de segurança

Estas normas de segurança são válidas para os Fluid Components, ST98 Flexmasster conforme o certificado de teste de modelo N.° KEMA 02 ATEX 2042 (número do certificado na plaqueta com os dados do equipamento) são apropriados para utilização em atmosferas explosivas categoria II 2 G.
1) A instalação de equipamentos em zonas sujeitas a explosão deve, por princípio, ser executada por técnicos qualificados.
2) Os ST98 Flexmasster precisam ser ligados à terra.
3) Os terminais e a electrónica para a conexão da tensão de alimentação estão instalados num envólucro com protecção contra ignição á prova de sobrepressão com as seguintes notas :

- A fenda entre o envólucro e a tampa deve ser á prova de passagem de centelha.
- O envólucro de conexão Ex-"d" possui uma rosca 1" NPT e/ou 3/4" NPT para a entrada de cabos Ex-"d" certificado conforme a norma EN 50 018.
- Deve-se assegurar que, antes de abrir a tampa do armário „d" (por exemplo, ao efectuar a conexão ou durante trabalhos de manutenção), o cabo de alimentação esteja sem tensão ou que a atmosfera não seja explosiva.
- Durante a operação, a tampa do envólucro „d" deve estar aparafusada até o encosto. A tampa deve ser bloqueada, por um dos parafusos de fixação.

(E) Español - Instrucciones de seguridad

Estas indicaciones de seguridad son de aplicación para el modelo ST98 Flexmasster de Fluid Components, según la certificación CE de modelo Nº KEMA 02 ATEX 2042 para aplicaciones en atmósferas potencialmente explosivas según la categoría II 2 G (el número de certificación se indica sobre la placa informativa del equipo).

1) La instalación de equipos Ex tiene que ser realizada por personal especializado.
2) Los ST98 Flexmasster tienen que ser conectados a tierra.
3) Los bornes de conexión y la unidad electrónica están montados dentro de una caja con protección antideflagrante y resistente a presión, considerándose los siguientes puntos:

- La holgura entre la rosca de la tapa y la propia de la caja está diseñada a prueba contra ignición.
- La caja tiene conexiones eléctricas para entrada de cables con rosca 3/4" y/o 1" NPT, donde deberán conectarse prensaestopas certificados Exd según EN50018/EN60079-1.
- Antes de la apertura de la tapa de la caja "Exd" (p. ej. durante los trabajos de conexionado o de puesta en marcha) hay que asegurar que el equipo se halle sin tensión o que no exista presencia de atmósfera explosiva.
- Durante el funcionamiento normal: la tapa de la caja antideflagrante tiene que estar cerrada, roscada hasta el tope, debiendose asegurar apretando los tornillos de bloqueo.

(S) Svenska - Säkerhetsanvisningar

Säkerhetsanvisningarna gäller för Fluid Components, Flödesmätare typ ST98 Flexmaster enligt EG-typkontrollintyg nr KEMA 02 ATEX 2042 (intygsnumret återfinns på typskylten) är lämpad för användning i explosiv gasblandning i kategori II 2 G.

1) Installation av Ex- klassade instrument måste alltid utföras av fackpersonal.
2) ST98 Flexmaster måste jordas.
3) Anslutningsklämmorna och elektroniken är inbyggda i en explosions och trycktät kapsling med följande kommentar:

- Spalten mellan kapslingen och lockets gänga är flamsäker.
- Ex-d kapslingen har en 3/4" och / eller 1" NPT gänga för montering av en EN50018/EN60079-1 typkontrollerad Ex- „d" kabel förskruvning
- När Ex- „d"-kapslingens lock är öppet (t.ex. vid inkoppling - eller servicearbeten) ska man se till att enheten är spänningslös eller att ingen explosiv gasblandning förekommer.
- Under drift måste Ex - d"-kapslingens lock vara iskruvad till anslaget. För att säkra locket skruvar man i en av lockets insex låsskruvar .

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Approval Information

EC Information

FCI® FLUID COMPONENTS INTERNATIONAL LLC

EC DECLARATION OF CONFORMITY Model ST98

We, *Fluid Components Intl*, located at 1755 La Costa Meadows Drive, San Marcos, California 92078-5115 USA, declare under our sole responsibility that the **ST98 Series Flowmeter Product Family**, models ST98/ST98L, to which this declaration relates, are in conformity with the following standards and Directives

ATEX Directive 94/9/EC

KEMA Quality B.V. (0344): Utrechtseweg 310, 6812 AR, Arnhem, The Netherlands.

EC-Type Examination Certificate Number: KEMA 02ATEX2042 satisfies EN60079-0:2004, EN61241-0:2006, EN60079-1:2004, EN61241-1:2004 and 50281-1-1:1998 requirements.

EMC Directive 89/336/EEC of May 3, 1989 of the **European Union:**

Immunity specifications: EN 50082-2: 1995; EN 61000-4-2 1995; EN 61000-4-4 1995; EN 61000-4-8 1995; ENV 50140 1993 and ENV 50204

Emissions specification: EN55011 1991 Group 1 Class B and CISPR 11 1990 Group 1 Class B.

Low Voltage Directive 73/23/EEC:

Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use- IEC 61010-10 1990 +A1 1992, +A2 1995.

Pressure Equipment Directive (PED) 97/23/EC:

The ST98 Model does not have a pressure bearing housing and is therefore not considered as pressure equipment by itself according to article 1, section 2.1. The Model ST98L is in conformity with the sound engineering practices as defined in the Pressure Equipment Directive (PED) 97/23/EC article 3, paragraph 3.

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March, 2008

Eric Wible
Eric Wible 2008.03.11 13:56:21 -07'00'

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ISO9001:2000/AS9100 Certified

Doc No. 23EN000009D

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2. Installation

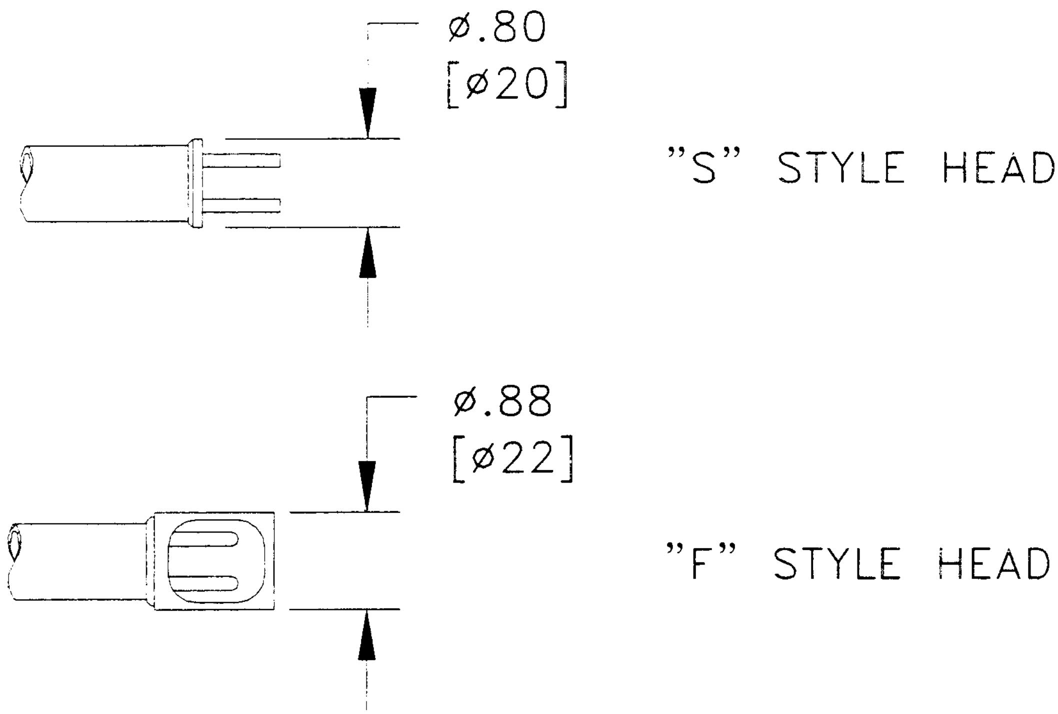
The following information should be included on page 2-4 under the heading of In-Line Mounting.

ST98L FLOW ELEMENT REMOVAL AND INSTALLATION

If the flow element needs to be removed from the tee section for any reason, *do not* allow the element to rotate during the removal/installation process. Flats are supplied on the flow element to hold the element from rotating during removal/installation.

Due to ATEX approval requirements, remote ST98 units with a local probe enclosure will have a 1"NPT conduit port not a ¾" NPT reducer as indicated on the outline dimensional drawings.

The new 'F' Style head with protective shroud, shown below, started shipping in January 2006.



ST98 TOTALIZER Introduction

The ST98 with software version 2.32 provides for an easy, quick and efficient way to display locally the complete Totalizer Value for the ST98 Flowmeter.

The Complete Totalizer value is kept in 2 separate internal registers; one that accumulates the totalize value up to a value of 1E6, and the other register that accumulates the totalize value in increments of 1E6, up to a value of 65,000E6.

The ST98 displays each register value independently on the second line of the local ST98 Display in sequence, sharing the line with the Process Temperature value.

The maximum totalized value that the ST98 can accumulate and display is 65,000,999,999.999.

ST98 TOTALIZER Selection and Setup

For the ST98 to totalize flow, two things must happen; the flow units must be set to mass flow or volumetric units (SCFM, Lbs/Hr, NCMH, Kg/Hr.), and the TOTALIZER mode must be selected, and setup.

TOTALIZER Mode setup
Confirm that the ST98 is in mass flow or volumetric units. If not, select the Flow units first.

1. Connect the FC88 to the ST98.

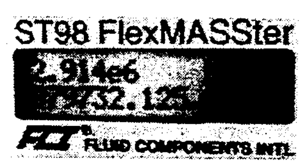
2. Press the "W" key in the FC88. This will take you through a series of prompts that will help you select and setup the Totalizer Mode. Make sure to select "Totalizer ON", respond Yes to "reset Totalizer" and select ON for the "Temp Display" if you wish to display the Process Temperature.

3. Make sure to put the ST98 back into "Process Data Collection" Mode when you are finished setting up the Totalizer. The ST98 is put into the "Process Data Collection" mode, by pressing the "T" key on the FC88. The FC88 can be disconnected from the ST98 at this time.

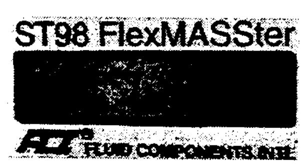
ST98 TOTALIZER Display and Operation

When the Totalizer Mode has been selected and is operational, the ST98 will display the complete Totalizer value by displaying in sequence on the second line of the display the "Active Totalizer" register value, followed by the Rollover Counter" Register, and last the "Process Temperature" Value. Each will display for approximately 5 seconds, then the sequence will repeat it self.

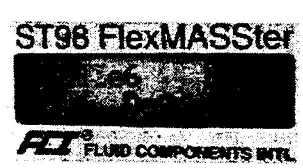
Line 1: Real time flow value (NCMM)
Line 2: Active Totalizer value (NCM)



Line 1: Real time flow value (NCMM)
Line 2: Totalizer Rollover counter (NCM)



Line 1: Real time flow value (NCMM)
Line 2: Real time temperature (°C)



The "Rollover Counter" data can also be viewed using the "D" command in the FC88 Configurator.

CABLE GLANDS AND CONDUIT FITTINGS

All cable glands and conduit fittings, including conduit plugs, must meet or exceed the area approval where unit is being installed.

Quick Start

Edition 12/2007 Revision 01

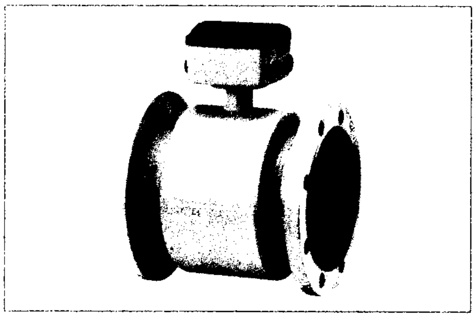
SITRANS F M MAG 3100/3100HT/3100P/5100W

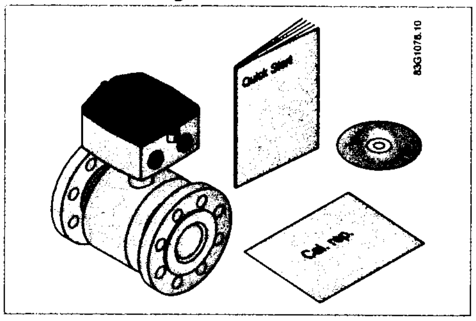
SITRANS F M

(EN) Electromagnetic flowmeter, types MAG 3100/3100HT/3100P/MAG 5100W
(DE) Magnetisch-induktive Messaufnehmer, Typen MAG 3100/3100HT/3100P/MAG 5100W
(FR) Capteur d'eau électromagnétique de types MAG 3100/3100HT/3100P/MAG 5100W
(ES) Sensor de caudal másicos electromagnético tipos MAG 3100/3100HT/3100P/MAG 5100W

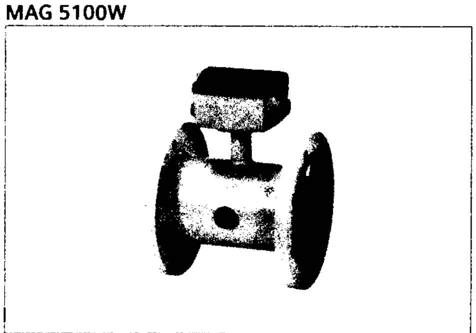
(EN) Items Supplied (FR) Pièces fournies
(DE) Lieferumfang (ES) Ítems suministrados

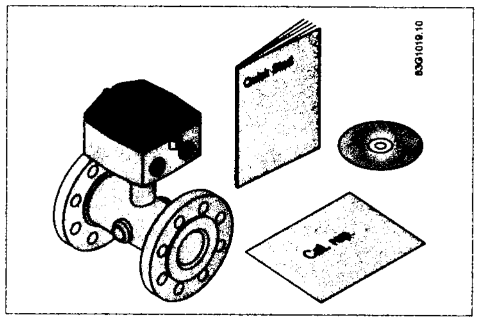
MAG 3100/MAG 3100 HT/MAG 3100 P





MAG 5100W





(EN) For more information see the operating manual on the enclosed CD-ROM.
(DE) Weitere Informationen siehe Bedienhandbuch auf der beigefügten CD-ROM.
(FR) Pour plus de détails se reporter manuel d'utilisation sur le CD-ROM fourni.
(ES) Más detalles en manual del usuario en el CD-ROM.

SIEMENS

(EN) General instructions (FR) Instructions générales
(DE) Allgemeine Hinweise (ES) Instrucciones generales

(EN) English

Before installing, including in hazardous areas, refer to the operating manual on the enclosed CD-ROM for detailed safety regulations, information and specifications which must be observed when installing.
Changes can occur. Documentation and approvals can be found on the internet at www.siemens.com/flowdocumentation

Caution!
Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance. Only qualified personnel should install or operate this instrument.

(DE) Deutsch

Vor dem Einbau, einschließlich in Ex-Bereichen, lesen Sie das Bedienhandbuch auf der beigefügten CD-ROM. Dieses enthält die beim Einbau zu beachtenden Sicherheitsvorschriften, Hinweise und technischen Daten. Änderungen sind vorbehalten. Dokumentationen und Zulassungen finden Sie im Internet unter www.siemens.com/flowdocumentation

Vorsicht!
Der einwandfreie und sichere Betrieb des Produktes setzt sachgemäßen Transport, sachgemäße Lagerung, Aufstellung und Montage sowie sorgfältige Bedienung und Instandhaltung voraus. Inbetriebsetzung und Betrieb dieses Gerätes/Systems dürfen nur von qualifiziertem Personal vorgenommen werden.

(FR) Français

Avant l'installation, y compris en zone dangereuse, veuillez consulter les consignes de sécurité, les informations et les spécifications dans le manuel d'utilisation correspondant, disponible sur le CD-ROM fourni.
Sous réserve de modifications. Vous trouverez l'ensemble des documents et agréments dans l'internet sous l'adresse www.siemens.com/flowdocumentation.

Prudence!
Le fonctionnement fiable et sécuritaire du produit implique le respect des consignes de transport, de stockage, de montage et de mise en service ainsi qu'une utilisation et maintenance soigneuses. Seul le personnel qualifié doit installer ou utiliser l'instrument.

(ES) Español

Antes de la instalación, incluso en áreas peligrosas, por favor refiérase al manual en el CD-ROM adjunto para consultar reglamentaciones de seguridad, información y especificaciones detalladas que deben ser observadas al realizar la instalación.
Puede haber cambios. La documentación y las aprobaciones pueden ser halladas en Internet en www.siemens.com/flowdocumentation.

¡Precaución!
El funcionamiento correcto y fiable del producto requiere un transporte, almacenamiento, colocación y montaje adecuados así como una utilización y mantenimiento cuidadosos. Este instrumento sólo debe ser instalado y utilizado por personal calificado.

English

⚠ For safety reasons it is important that the following points are read and understood before the installation of the equipment:

- Installation, connection, commissioning and service must be carried out by personnel which is qualified and authorized to do so.
- It is the responsibility of the customer that the instructions and directions provided in the Quick Start and in the operating manual on the enclosed CD-ROM are read, understood and followed by the relevant personnel before installing the equipment.
- In applications with working pressures/media that can be dangerous to people, surroundings, equipment or others in case of pipe fracture, we recommend that special precautions such as special placement, shielding or installation of a security guard or a security valve should be made when the sensor is being installed.
- Siemens Flow Instruments can provide assistance with the selection of sensor parts in contact with the media. However, the full responsibility for the selection rests with the customer and Siemens Flow Instruments can take no responsibility for any failure due to material incompatibility.
- Equipment used in hazardous areas must be Ex-approved and marked for Europe, FM for USA and CSA for Canada. It is required that the special conditions for safe use provided in the manual and in the Ex certificate are followed!
- Installation of the equipment must comply with national regulations. For example EN 60079-14 for the European Community.
- Repair and service must be carried out by approved Siemens Flow Instruments personnel only.

Deutsch

⚠ Aus Sicherheitsgründen ist es wichtig, dass Sie die folgenden Punkte lesen und verstehen, bevor Sie das System installieren:

- Installation, Anschluss, Inbetriebnahme und Wartung müssen von Personal ausgeführt werden, das entsprechend qualifiziert ist.
- Es liegt in der Verantwortung des Kunden, dass das betreffende Personal vor der Installation des Gerätes die Anweisungen und Richtungsangaben in diesem Quick Start und im Bedienhandbuch auf der beigefügten CD-ROM liest, versteht und befolgt.
- Bei Betriebsdrücken/Medien, die im Falle eines Rohrbruchs gefährlich sein könnten für Menschen, Umgebung, Geräte und dergleichen, empfehlen wir, bei der Installation des Messaufnehmers besondere Vorkehrungen zu treffen. Zum Beispiel spezielle Platzierung, Abschirmung, Installation eines Sicherheitsschutzes oder eines Sicherheitsventils.
- Siemens Flow Instruments kann Sie durch Abschätzung der chemischen Beständigkeit der medienberührten Messaufnehmerteile unterstützen. Es liegt jedoch in der Verantwortung des Kunden, welche Werkstoffe gewählt werden. Siemens Flow Instruments übernimmt keine Verantwortung, wenn der Messaufnehmer korrodiert!
- Geräte, die in explosionsgefährdeten Bereichen eingesetzt werden, müssen Ex-zugelassen sein. Sie müssen außerdem für Europa das Ex-Kennzeichen, für die USA das FM-Kennzeichen und für Kanada das CSA-Kennzeichen tragen. Die Sicherheitsvorschriften, die im Bedienhandbuch und im Ex-Zertifikat angeführt sind, müssen befolgt werden!
- Der Einbau der Geräte muss den nationalen Bestimmungen entsprechen. Beispiel: EN 60079-14 für die Europäische Union.
- Reparatur und Wartung dürfen nur von Personal durchgeführt werden, das von Siemens Flow Instruments zugelassen ist.

(FR) Instruction de sécurité (ES) Instrucción el seguridad

(FR) Français

Pour des raisons de sécurité il est important de se familiariser avec les consignes suivantes.

- L'installation, les raccordements électriques, la mise en service et l'entretien de l'appareil doivent être réalisés uniquement par le personnel qualifié et autorisé.
- Le client est responsable de la bonne installation de l'appareil en conformité avec les instructions et les consignes fournies dans le Quick Start et le manuel d'utilization fournis sur le CD-ROM. Le personnel habilité doit prendre connassaince de ces informations avant l'installation.
- Si la rupture éventuelle d'une conduite dans l'application peut donner lieu à des conditions ou à des pressions dangereuses pour le personnel, le milieu ou le matériel, prévoir un emplacement spécifique, un blindage, une séparation ou une vanne de sécurité lors de l'installation du capteur.
- Siemens Flow Instruments est à votre disposition pour vous aider à évaluer la résistance chimique des composants du capteur en contact avec le milieu. Toutefois, le client est entièrement responsable du choix des matériaux et Siemens Flow Instruments décline toute responsabilité en cas de corrosion du capteur.
- Les appareils utilisés en zone dangereuse doivent être certifiés : Ex (Europe), FM (USA) et CSA (Canada). Il est impératif de respecter les consignes spécifiques fournies dans le mode d'emploi ainsi que sur le certificat Ex.
- L'appareil doit être installé en accord avec les normes et réglementations locales en vigueur. Par exemple : pour le EU la norme EN 60079-14.
- Seul le personnel technique Siemens Flow Instruments est autorisé à intervenir sur l'appareil pour la réparation et l'entretien.

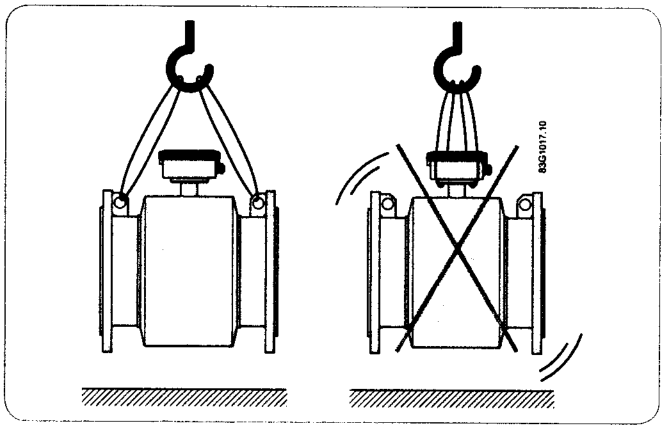
(ES) Español

Por motivos de seguridad es importante leer y entender las siguientes instrucciones antes de instalar el aparato:

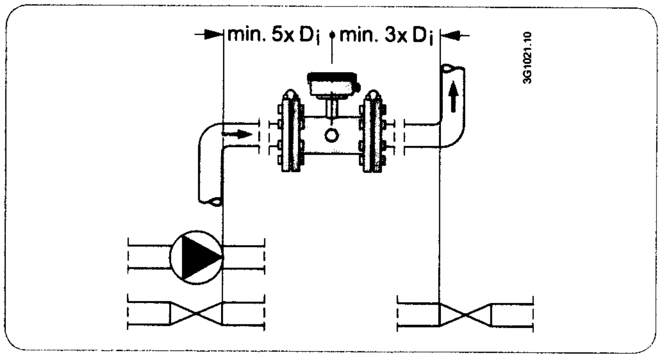
- La instalación, conexión, puesta en marcha y mantenimiento deberán correr a cargo exclusivamente de personal cualificado y autorizado.
- El cliente es responsable de garantizar el respeto de las instrucciones y directivas proporcionadas en el Quick Start y en el manuel incluidos en el CD-ROM. El personal encargado deberá leer y comprender la documentación antes de instalar el aparato.
- En aplicaciones que tengan presiones de funcionamiento o sustancias que puedan resultar peligrosas para las personas, el entorno, el equipo y otros en caso de romperse una tubería, recomendamos tomar precauciones particulares como colocarlo en un lugar especial, disponer un blindaje o instalar una protección o válvula de seguridad durante la instalación.
- Siemens Flow Instruments ayuda a estimar la resistencia química de las piezas del sensor que están en contacto con el producto, pero la responsabilidad definitiva de la elección del material recae exclusivamente sobre el cliente, por lo que Siemens Flow Instruments no asume ninguna responsabilidad en caso de corrosión del sensor.
- Los aparatos utilizados en zonas peligrosas deben disponer de certificado para uso en entornos explosivos y llevar las siglas Ex para Europa, FM para EE.UU. y CSA para Canadá. Es obligatorio seguir las instrucciones específicas proporcionadas en el manual y en el certificado Ex (protección contra explosiones).
- La instalación del aparato tiene que cumplir la normativa nacional. Por ejemplo: EN 60079-14 para Dinamarca.
- Las reparaciones y el mantenimiento sólo los pueden realizar personadas homologadas por Siemens Flow Instruments.

(EN) Installation conditions
(DE) Installationsbedingungen
(FR) Condition pour l'installation
(ES) Condiciones de montaje

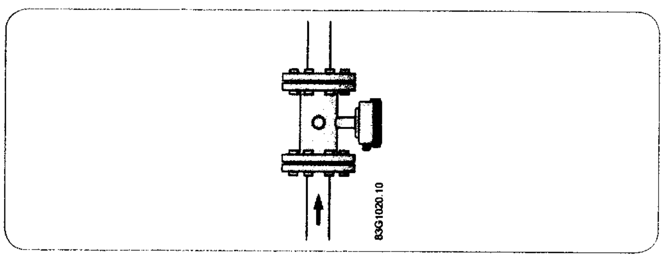
(EN) Handling
(DE) Handhabung
(FR) Manipulation
(ES) Manipulación



(EN) Inlet and outlet conditions
(DE) Einlass- und Auslassbedingungen
(FR) Conditions d'entrée/de sortie
(ES) Condiciones de entrada/salida



(EN) Recommended Flow direction
(DE) Empfohlene Fließrichtung
(FR) Sens de l'écoulement recommandé
(ES) Sentido de flujo recomendado



(EN) For more information see the operating manual on the enclosed CD-ROM.
(DE) Weitere Informationen siehe Bedienhandbuch auf der beigefügten CD-ROM.
(FR) Pour plus de detail consulter le manuel d'utilisation sur le CD-ROM fourni.
(ES) Para más información ver el manual del usuario en el CD-ROM.

EN Installation conditions
DE Installationsbedingungen
FR Condition pour l'installation
ES Condiciones de montaje

EN Flow conditions

⚠ The pipe must be completely filled with liquid!

DE Fließbedingungen

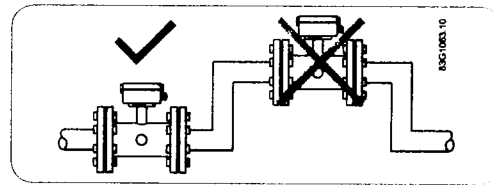
⚠ Das Rohr muss vollständig mit Flüssigkeit gefüllt sein!

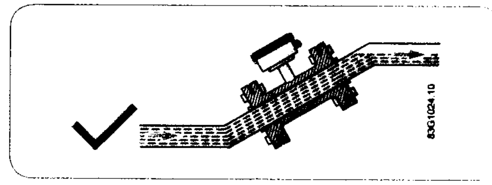
FR Conditions d'écoulement

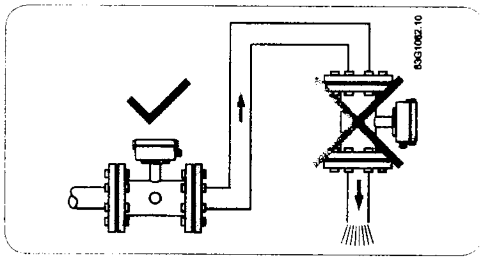
⚠ Veiller à ce que la conduite soit entièrement remplie de liquide!

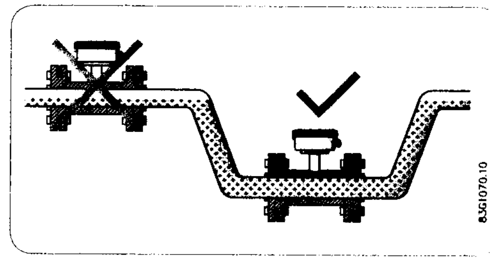
ES Condiciones de caudal

⚠ ¡La tubería debe estar completamente llena de líquido!







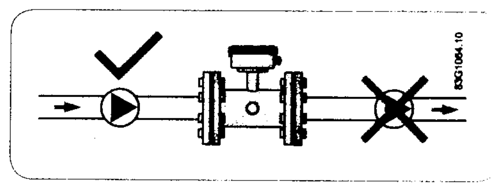


EN ⚠ **Avoid vacuum!**

DE ⚠ **Vermeiden Sie Vakuum!**

FR ⚠ **Tenir à l'écart des installations sous vide!**

ES ⚠ **¡Evitar el vacio total!**

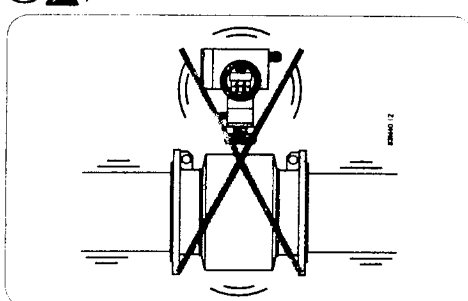


EN ⚠ **Avoid vibrations!**

DE ⚠ **Vermeiden Sie Vibrationen!**

FR ⚠ **Tenir à l'écart des vibrations!**

ES ⚠ **¡Evitar las vibraciones!**

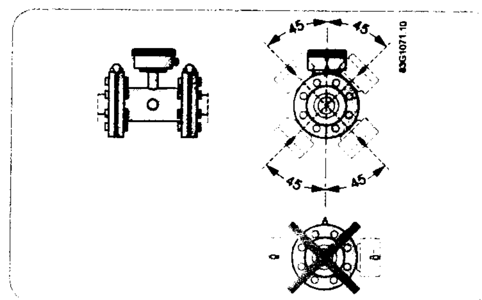


EN Horizontal pipes

DE Horizontale Rohre

FR Conduites horizontales

ES Conductos horizontales



Potential equalisation
Potentialausgleich
Egalisation de potentiel
Ecualización de potencial

EN Use flowmeter inlet protection when measuring abrasive liquids!

DE Verwenden Sie einen Einlaufschutz beim Messen aggressiver Flüssigkeiten!

FR Si les liquides mesurés sont abrasifs prévoir une protection au point d'entrée du débitmètre.

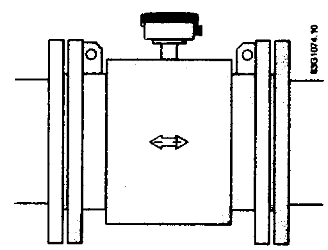
ES ¡Para medir líquidos abrasivos la entrada del caudalímetro debe estar adecuadamente protegida!

EN With earthing electrodes (no futher action necessary)

DE Mit Erdungselektroden (keine weitere Handlung nötig)

FR Capteur équipé d'électrodes de terre (ne nécessite aucune action ultérieure)

ES Con eléctrodos de puesta a tierra (no requieren ulteriores intervenciones)

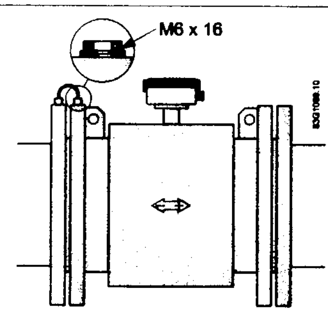


EN Without earthing electrodes (MAG 3100 PTFE/PFA) in conductive pipes

DE Ohne Erdungselektroden (MAG 3100 PTFE/PFA) in leitenden Rohren

FR Sans électrodes de mise à la terre (MAG 3100 PTFE/PFA), conduites conductrices

ES Sin eléctrodos de puesta a tierra (MAG 3100 PTFE/PFA), tuberías conductoras

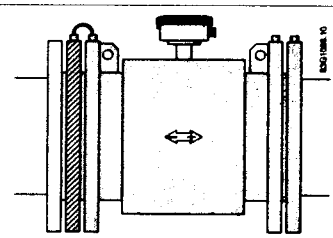


EN Without earthing electrodes in non-conductive pipes

DE Ohne Erdungselektroden in nichtleitenden Rohren

FR Sans électrodes de mise à la terre, conduites non conductrices

ES Sin eléctrodos de puesta a tierra, tuberías no conducturas



EN For cathodic protection of pipe systems see the operating manual on the enclosed CD-ROM.

DE Kathodischer Schutz der Rohrsysteme siehe die Bedienhandbuch auf der beigefügten CD-ROM.

FR La protection cathodique des tuyauteries et conduites est décrite dans le mode d'emploi sur le CD-ROM foumi.

ES La protección catódica de las tuberías está en les manuel del usuario en el CD-ROM suministrado.

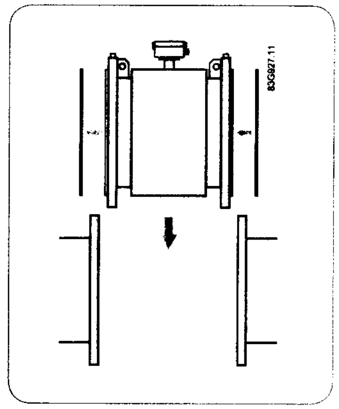
(EN) Mounting (FR) Montage
(DE) Montage (ES) Montaje

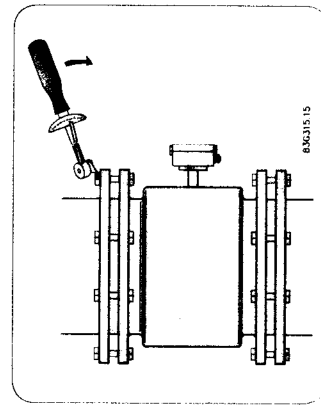
(EN) Use proper gaskets!

(DE) Verwenden Sie passende Dichtungsringe!

(FR) Utiliser des joints adaptés.

(ES) Utilizar juntas de estanquedidad adecuadas.





(EN) The following torque values are calculated on the basis of use of gaskets. For further calculations of preconditions refer to the operating manual on the enclosed CD-ROM.

(DE) Die folgenden Drehmomentwerte wurden unter der Annahme berechnet, dass Dichtungsringe verwendet werden. Für weitere Berechnungen siehe Bedienhandbuch auf der beigefügten CD-ROM.

(FR) Les valeurs de couple de serrage sont calculées en tenant compte de l'utilisation de joints. Pour plus de calculs relatifs aux conditions requises se reporter manuel d'utilisation sur le CD-ROM fourni.

(ES) Los valores de torsión se calculan en base a la utilización de juntas. Para más cálculos ver el manual de usuario en el CD-ROM.

(EN) For more information see the operating manual on the enclosed CD-ROM.

(DE) Weitere Informationen siehe Bedienhandbuch auf der beigefügten CD-ROM.

(FR) Pour plus de detail consulter le manuel d'utilisation sur le CD-ROM fourni.

(ES) Para más información ver el manual del usuario en el CD-ROM.

DN		MAG 3100 - Max. torque / Max. Drehmoment / Couples maximum / Pares máximos													
		PN 6		PN 10		PN 16		PN 25		PN 40		PN 63		PN 100	
mm	inch	Nm	F/Lbs	Nm	F/Lbs	Nm	F/Lbs	Nm	F/Lbs	Nm	F/Lbs	Nm	F/Lbs	Nm	F/Lbs
15	½"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	7	N/A	N/A	N/A	N/A
25	1"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16	12	N/A	N/A	50	37
40	1½"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	34	25	N/A	N/A	100	74
50	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	46	34	90	66	140	103
65	2½"	10	7	N/A	N/A	25	18	N/A	N/A	34	25	64	47	110	81
80	3"	25	18	N/A	N/A	25	18	N/A	N/A	42	31	82	61	130	96
100	4"	25	18	N/A	N/A	25	18	N/A	N/A	72	53	136	100	190	140
125	5"	25	18	N/A	N/A	32	24	N/A	N/A	114	84	200	148	250	185
150	6"	25	18	N/A	N/A	50	37	N/A	N/A	144	106	275	203	210	155
200	8"	25	18	50	37	52	38	105	77	185	137	330	244	400	295
250	10"	25	18	50	37	88	65	160	118	300	221	500	369	550	406
300	12"	50	37	62	46	117	86	170	125	320	236	525	387	700	517
350	14"	50	37	60	44	120	89	240	177	450	332	750	554	1200	886
400	16"	50	37	88	65	170	125	330	244	650	480	1100	812	N/A	N/A
450	18"	56	41	92	68	170	125	320	236	570	421	N/A	N/A	N/A	N/A
500	20"	53	39	103	76	230	170	390	288	740	546	N/A	N/A	N/A	N/A
600	24"	81	60	161	119	350	258	560	413	1220	900	N/A	N/A	N/A	N/A
700	28"	100	74	200	148	304	224	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
800	32"	140	103	274	202	386	285	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
900	36"	172	127	288	213	408	301	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1000	40"	180	133	382	282	546	403	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1200	48"	252	186	395	292	731	539	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1400	54"	330	244	503	371	736	543	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1600	66"	380	280	684	505	913	674	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1800	72"	382	282	771	569	937	692	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2000	78"	432	319	867	640	1128	832	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(EN) The torque values are calculated on the basis of use of gaskets.

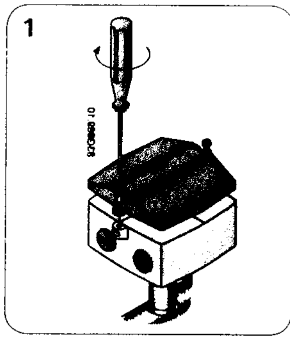
(DE) Die Drehmomentwerte wurden unter der Annahme berechnet, dass Dichtungsringe verwendet werden.

(FR) Le valeurs de couple de serrage sont calculées en tenant compte de l'utilisation de joints.

(ES) Los valores de torsión se calculan en base a la utilización de juntas.

DN		MAG 5100W - Max. torque / Max. Drehmoment / Couples max. / Pares máx.									
		PN10		PN16		PN40		Class 150		AWWA	
mm	inch	Nm	F/Lbs	Nm	F/Lbs	Nm	F/Lbs	Nm	F/Lbs	Nm	F/Lbs
25	1"	N/A	N/A	N/A	N/A	10	7	7	5	N/A	N/A
40	1½"	N/A	N/A	N/A	N/A	16	12	9	7	N/A	N/A
50	2	N/A	N/A	25	18	N/A	N/A	25	18	N/A	N/A
65	2½"	N/A	N/A	25	18	N/A	N/A	25	18	N/A	N/A
80	3"	N/A	N/A	25	18	N/A	N/A	34	25	N/A	N/A
100	4"	N/A	N/A	25	18	N/A	N/A	26	19	N/A	N/A
125	5"	N/A	N/A	29	21	N/A	N/A	42	31	N/A	N/A
150	6"	N/A	N/A	50	37	N/A	N/A	57	42	N/A	N/A
200	8"	50	37	50	37	N/A	N/A	88	65	N/A	N/A
250	10"	50	37	82	61	N/A	N/A	99	73	N/A	N/A
300	12"	57	42	111	82	N/A	N/A	132	97	N/A	N/A
350	14"	60	44	120	89	N/A	N/A	225	166	N/A	N/A
400	16"	88	65	170	125	N/A	N/A	210	155	N/A	N/A
450	18"	92	68	170	125	N/A	N/A	220	162	N/A	N/A
500	20"	103	76	230	170	N/A	N/A	200	148	N/A	N/A
600	24"	161	119	350	258	N/A	N/A	280	207	N/A	N/A
700	28"	200	148	304	224	N/A	N/A	N/A	N/A	200	148
750	30"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	240	177
800	32"	274	202	386	285	N/A	N/A	N/A	N/A	260	192
900	36"	288	213	408	301	N/A	N/A	N/A	N/A	240	177
1000	40"	382	282	546	403	N/A	N/A	N/A	N/A	280	207
1050	42"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	280	207
1100	44"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	290	214
1200	48"	395	292	731	539	N/A	N/A	N/A	N/A	310	229

(EN) Remote installation (FR) Installation déportée
(DE) Getrennte Montage (ES) Instalación remota

1


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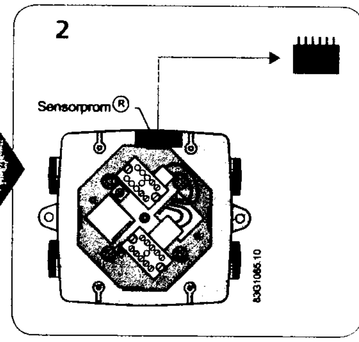

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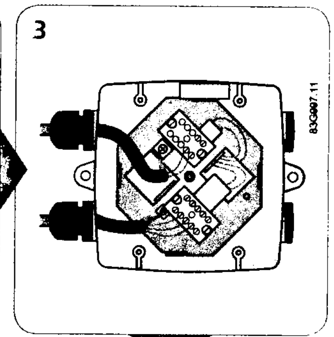
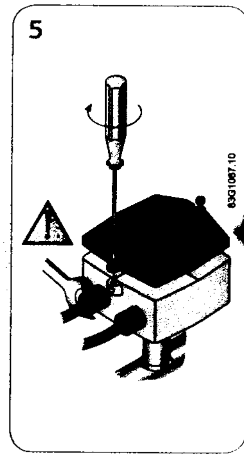


(EN) ⚠ Make sure cable glands are firmly sealed!

(DE) ⚠ Stellen Sie sicher, dass die Kabelverschraubungen fest verschlossen sind.

(FR) ⚠ Veiller à ce que les presse étoupes soient étanches!

(ES) ⚠ ¡Comprobar el sellado adecuado de los prensaestopas¡

5


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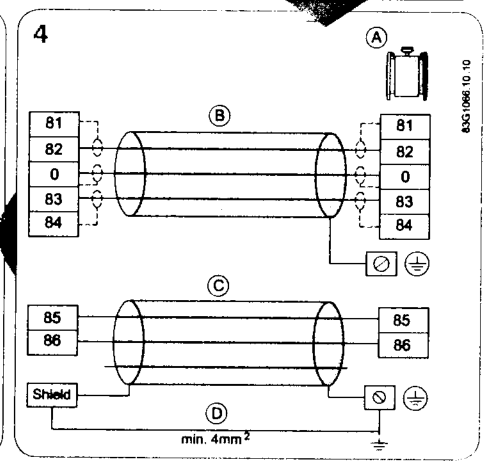


(EN) Relocation of Sensorprom (fig. 2)
Refer to the relevant transmitter Quick Start

(DE) Umstecken des Sensorprom (Abb. 2)
Siehe Quick-Start des entsprechenden Messumformers

(FR) Repositionner le Sensorprom (fig. 2)
Se reporter au guide de Quick Start.

(ES) Reposicionar Sensorprom (fig. 2)
Ver la guía de Quick Start

(EN) Electrical connection (fig. 4)
Ⓐ Sensor, Ⓑ Electrode cable, Ⓒ Coil cable, Ⓓ Only required for ATEX applications!

For cable specifications see the operating manual on the enclosed CD-ROM.

(DE) Raccordement électrique (Abb. 4)
Ⓐ Messaufnehmer, Ⓑ Elektrodenkabel, Ⓒ Spulenkabel, Ⓓ Nur für ATEX-Anwendungen erforderlich!

Kabelspezifikationen siehe Bedienhandbuch auf der beigefügten CD-ROM.

(FR) Conexión eléctrica (fig. 4)
Ⓐ Capteur, Ⓑ câble d'electrode, Ⓒ Câble charge, Ⓓ Requis uniquement pour les applications ATEX!

Pour plus de détails sur le câblage se reporter manuel d'utilisation sur le CD-ROM fourni.

(ES) Conexión eléctrica (fig. 4)
Ⓐ Sensor, Ⓑ x, Ⓒ Cable cargador, Ⓓ Sólo para aplicaciones ATEX!

Más detalles acerca del cableado en el manual del usuario en el CD ROM.

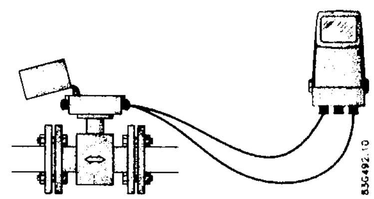
(EN) Potting kit for IP 68 application
⚠ Do not use with ATEX sensors!

(DE) Silikongel für IP 68 Aufgaben
⚠ Nicht mit ATEX Messaufnehmer verwenden

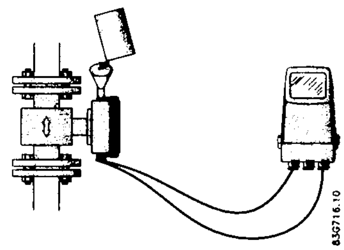
(FR) Kit d'empotage pour application IP 68
⚠ Ne pas associer à des capteurs ATEX !

(ES) Kit de encapsulado para aplicación IP 68
⚠ ¡No utilizar con sensores ATEX!

Horizontal



Vertical

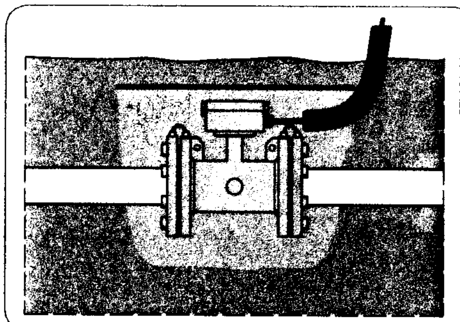


(EN) Recommendation for direct burial of remote sensor
⚠ Check for visible damages in paint finish! Use protection conduit! Protect sensor with pea gravel.

(DE) Empfehlung für die direkte Erdverlegung entfernter Messaufnehmer
⚠ Prüfen Sie die Oberfläche auf sichtbare Schäden! Verwenden Sie eine Schutzisolierung. Schützen Sie den Messaufnehmer mit Split.

(FR) Suggestion pour l'enfouissement direct du capteur à distance
⚠ Vérifier que la surface peinte ne présente pas de dommages visibles. Utiliser un conduit de protection. Protéger le capteur avec du gravillon.

(ES) Sugerencia para enterrar directamente el sensor remoto
⚠ ¡Revise el revestimiento de pintura para comprobar que no presente daños o imperfecciones! ¡Utilizar un conducto de protección! Proteger el sensor con gravilla.



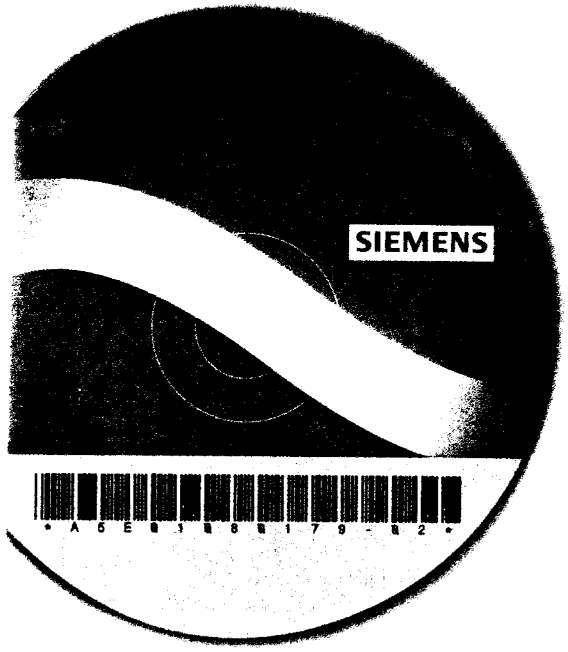
(EN) For more information see the operating manual on the enclosed CD-ROM.

(DE) Weitere Informationen siehe Bedienhandbuch auf der beigefügten CD-ROM.

(FR) Pour plus de detail consulter le manuel d'utilisation sur le CD-ROM fourni.

(ES) Para más información ver el manual del usuario en el CD-ROM.

SITRANS F M MAG 3100/3100 Ex/5100W



SIEMENS FLOW INSTRUMENTS A/S
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DENMARK
www.siemens.com/flow

Order no.: A5E01223060-01
SFIDK.PQ.027.F1.83

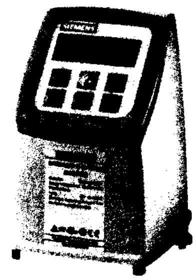
A5E01223060-01

Quick Start SITRANS F M
MAG 5000 & MAG 6000 IP 67, 19"

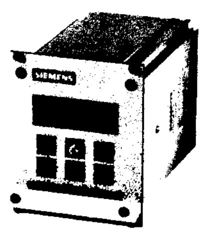
SITRANS F M

(EN) Electromagnetic flowmeter transmitter types MAG 5000 & MAG 6000
(DE) Messumformer für magnetisch-induktive Durchflussmesser Typ MAG 5000 & MAG 6000
(FR) Transmetteurs pour débitmètres magnéto-inductifs types MAG 5000 & MAG 6000
(ES) Transmisor para los caudalímetros electromagnéticos tipos MAG 5000 y MAG 6000

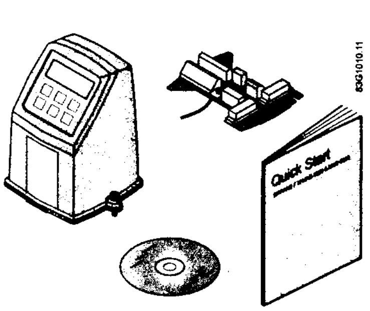
MAG 5000 & MAG 6000, IP 67

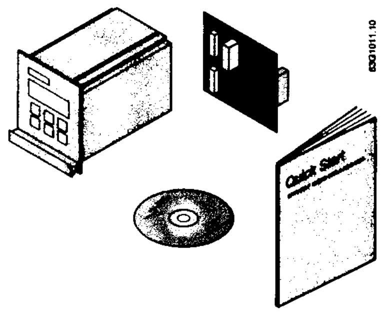


MAG 6000 19"



(EN) Items Supplied (DE) Lieferumfang (FR) Pièces fournies (ES) Ítems suministrados





(EN) For more information see operating manual on enclosed CD-ROM.
(DE) Weitere Informationen siehe Handbuch auf beigefügter CD-ROM.
(FR) Pour plus de detail consulter le Manuel d'utilisation sur le CD-ROM fourni.
(ES) Para más información ver el Manual de funcionamiento en el CD-ROM.

SFIDK.PQ.027.A3.83

A5E01222827-03

SIEMENS

(EN) General instructions (FR) Instructions générales
(DE) Allgemeine Hinweise (ES) Instrucciones generales

(EN) English

Before installing, including in hazardous areas, please refer to the manual on the enclosed CD-ROM for detailed safety regulations, information and specifications which must be observed when installing.
Changes can occur. The most recent documentation and approvals can be found on the Internet at www.siemens.com/flowdocumentation

Warning
Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance. Only qualified personnel should install or operate this instrument.

(DE) Deutsch

Vor Einbau, einschließlich in Ex-Bereichen, lesen Sie die Betriebsanleitung auf der beigefügten CD-ROM. Sie enthält die beim Einbau zu beachtenden Sicherheitsvorschriften, Hinweise und technischen Daten. Änderungen sind vorbehalten. Aktuelle Dokumentationen und Zulassungen finden Sie im Internet unter www.siemens.com/flowdocumentation

Warnung
Der einwandfreie und sichere Betrieb des Produktes setzt sachgemäßen Transport, sachgemäße Lagerung, Aufstellung und Montage sowie sorgfältige Bedienung und Instandhaltung voraus. Inbetriebsetzung und Betrieb dieses Gerätes/Systems dürfen nur von qualifiziertem Personal vorgenommen werden.

(FR) Français

Avant l'installation, y compris en zone dangereuse, veuillez consulter les consignes de sécurité, les informations et les spécifications dans le manuel d'utilisation correspondant, disponible sur le CD fourni.
Sous reserve de modifications. Vous trouverez l'ensemble des documents et agréments actualisés dans l'internet sous l'adresse www.siemens.com/flowdocumentation

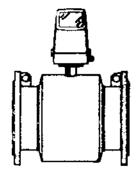
Avertissement
Le fonctionnement fiable et sécuritaire du produit implique le respect des consignes de transport, de stockage, de montage et de mise en service ainsi qu'une utilisation et maintenance soigneuses. Seul le personnel qualifié doit installer ou utiliser l'instrument.

(ES) Español

Antes de la instalación, incluso en áreas peligrosas, por favor refiérase al manual en el CD ROM adjunto para consultar reglamentaciones de seguridad, información y especificaciones detalladas que deben ser observadas al realizar la instalación.
Puede haber cambios. La documentación y las aprobaciones más recientes pueden ser halladas en Internet en www.siemens.com/flowdocumentation.

Advertencia
El funcionamiento correcto y fiable del producto requiere un transporte, almacenamiento, colocación y montaje adecuados así como una utilización y mantenimiento cuidadosos. Este instrumento sólo debe ser instalado y utilizado por personal calificado.

(EN) Compact installation (FR) Montage compact
(DE) Kompakte Montage (ES) Instalación compacta



(EN) Ensure power is off before installation!

Ⓐ Connect as shown to register flow reading.
Ⓑ Connect PE (ground) wire.
Ⓒ Connect power supply.
Ⓓ Connect output cable.

(DE) Prüfen Sie vor dem Einbau, ob das Gerät stromlos ist!

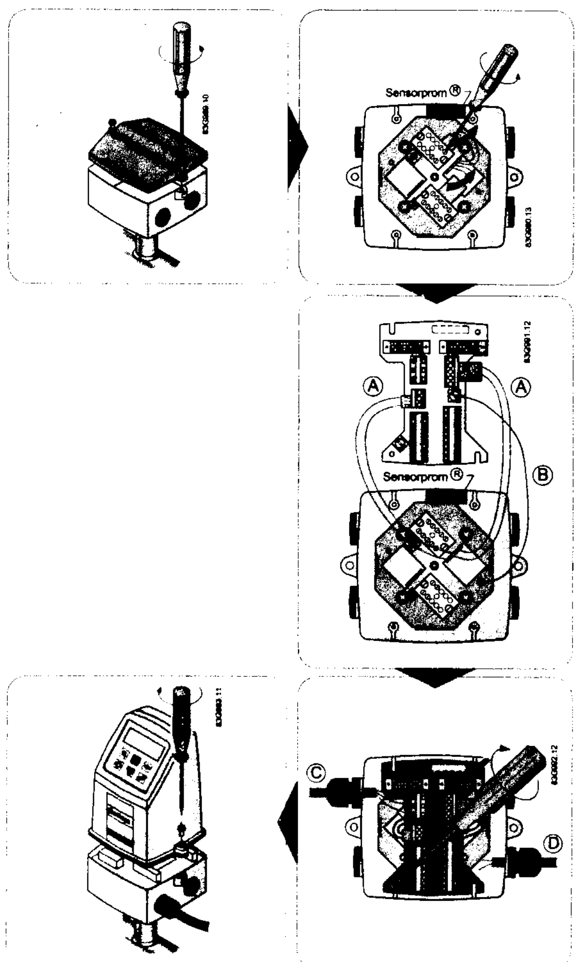
Ⓐ Wie abgebildet anschließen, um Durchflussdaten aufzuzeichnen.
Ⓑ PE-Schutzleiter anschließen.
Ⓒ Stromversorgung anschließen.
Ⓓ Ausgangskabel anschließen.

(FR) Vérifier que le système soit hors tension avant de l'installer!

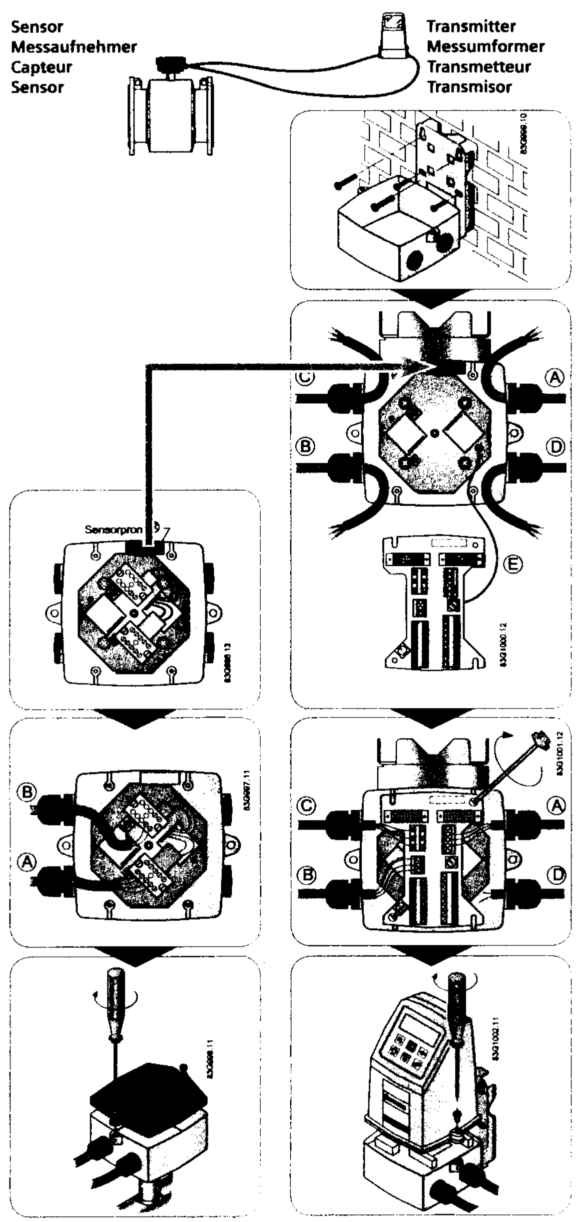
Ⓐ Connecter tel qu'illustré pour enregistrer les mesures de débit.
Ⓑ Connecter le conducteur de protection PE.
Ⓒ Connecter l'alimentation.
Ⓓ Connecter le câble de sortie.

(ES) ¡Cerciórese de que la alimentación está apagada antes de la instalación!

Ⓐ Conecte como es mostrado para registrar la lectura de caudal.
Ⓑ Conecte el alambre PE.
Ⓒ Conecte la alimentación.
Ⓓ Conecte el cable de salida.



(EN) Remote installation (FR) Montage séparé
(DE) Getrennte Montage (ES) Instalación remota



(EN) Ensure power is off before installation!
Relocate Sensorprom as shown.
(A) Connect electrode cable.
(B) Connect coil cable, keep separate from A.
(C) Connect power supply.
(D) Connect output cable.
(E) Connect PE (ground) wire.

Warning
PE wire must be connected to PE terminal.
Coil cable shield must be connected to SHIELD terminal. Insulate core shield.

(DE) Prüfen Sie vor Einbau, ob das Gerät stromlos ist!
Sensorprom wie abgebildet umsetzen
(A) Elektrodenkabel anschließen.
(B) Spulenkabel anschließen, getrennt von A halten.
(C) Stromversorgung anschließen.
(D) Ausgangskabel anschließen.
(E) PE-Schutzleiter anschließen.

Warnung
PE-Draht an PE-Klemme anschliessen.
Spulenkabel-Abschirmung an Schirmanschluss anschliessen. Schirm isolieren.

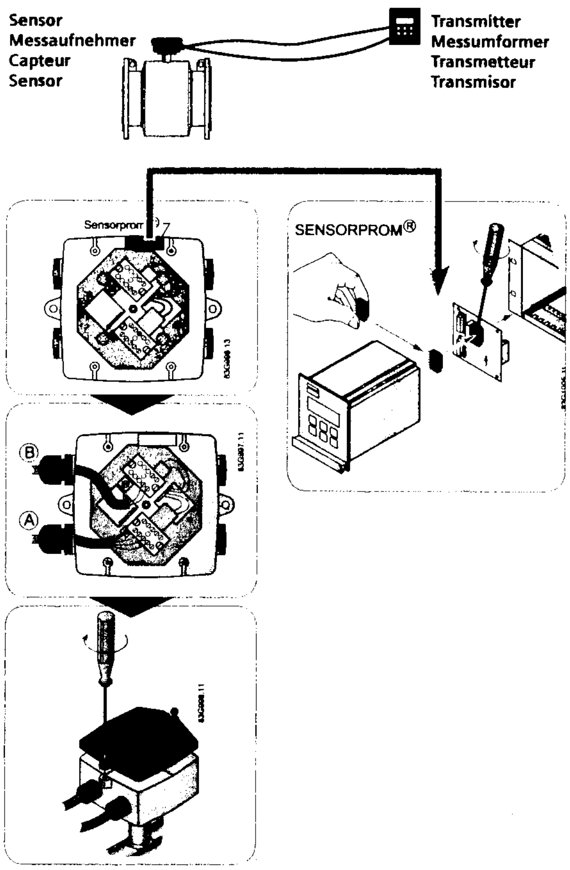
(FR) Vérifier que le système soit hors tension avant de l'installer!
Déplacer le Sensorprom tel qu'illustré.
(A) Connecter le câble d'électrode.
(B) Connecter le câble de bobine, éloigner de A.
(C) Connecter l'alimentation.
(D) Connecter le câble de sortie.
(E) Connecter le conducteur de protection PE.

Avertissement
Le fil de masse doit être raccordé à la vis de masse. La tresse de masse du câble des bobines doit être raccordée comme indiqué sur le schéma isoler la tresse de masse.

(ES) Cerciórese de que la alimentación está apagada antes de la instalación!
Cambie de lugar el Sensorprom tal como es mostrado.
(A) Conecte el cable del electrodo.
(B) Conecte el cable de la bobina, y manténgala separada de A.
(C) Conecte la alimentación.
(D) Conecte el cable de salida.
(E) Conecte el alambre PE.

Advertencia
El cable de tierra debe de ser conectado al terminal PE. La pantalla de la manguera de la bobina debe de ser contectada al terminal de pantalla. Aisle la pantalla principal.

(EN) Remote installation (DE) Getrennte Montage
(FR) Montage séparé (ES) Instalación remota



(EN) Ensure power is off before installation!

Relocate Sensorprom as shown.
Ⓐ Connect electrode cable.
Ⓑ Connect coil cable, keep separate from A.
For transmitter cabling, see manual on CD-ROM.

(DE) Prüfen Sie vor Einbau, ob das Gerät stromlos ist!

Sensorprom wie abgebildet umsetzen.
Ⓐ Elektrodenkabel anschließen.
Ⓑ Spulenkabel anschließen, getrennt von A halten.
Angaben zur Verdrahtung des Messumformers finden Sie auf der Betriebsanleitung auf der CD-ROM.

(FR) Vérifier que le système soit hors tension avant de l'installer!

Déplacer le Sensorprom tel qu'illustré.
Ⓐ Connecter le câble d'électrode.
Ⓑ Connecter le câble de bobine, éloigner de A.
Pour le raccordement du transmetteur consulter le manuel sur le CD-ROM.

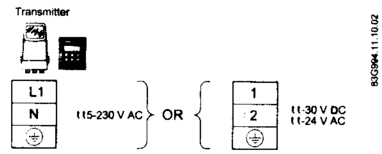
(ES) Cerciórese de que la alimentación está apagada antes de la instalación!

Cambie de lugar el Sensorprom tal como es mostrado.
Ⓐ Conecte el cable del electrodo.
Ⓑ Conecte el cable de la bobina, y man téngala separada de A.
Para el cableado del transmisor, vea el manual en el CD ROM.

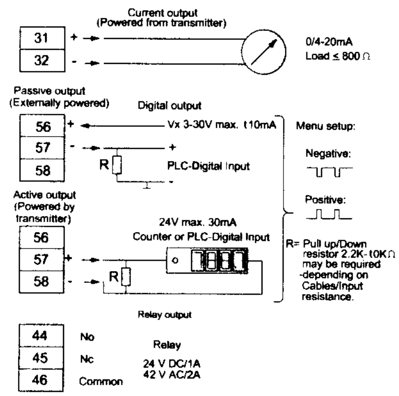
(EN) For more information see operating manual on enclosed CD-ROM.
(DE) Weitere Informationen siehe Handbuch auf beigefügter CD-ROM.
(FR) Pour plus de detail consulter le Manuel d'utilisation sur le CD-ROM fourni.
(ES) Para más información ver el Manual de funcionamiento en el CD-ROM.

(EN) Electrical Connection

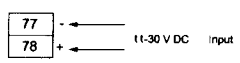
Power supply



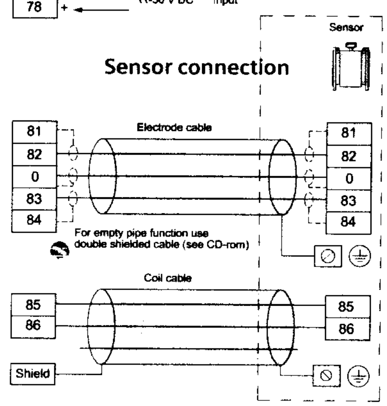
Outputs



Digital input

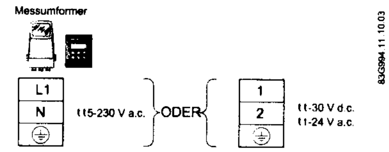


Sensor connection

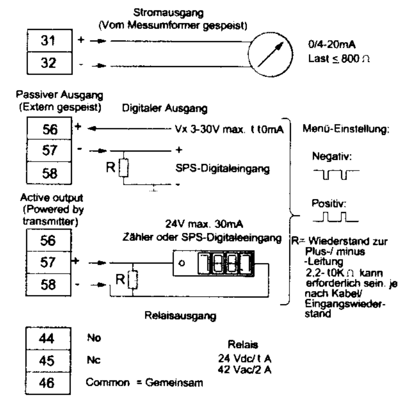


(DE) Elektrischer Anschluss

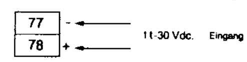
Stromversorgung



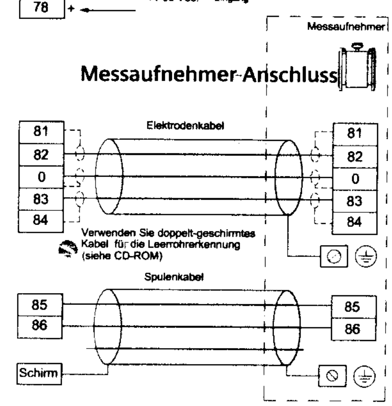
Ausgänge



Digitaleingang

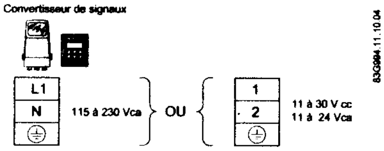


Messaufnehmer-Anschluss

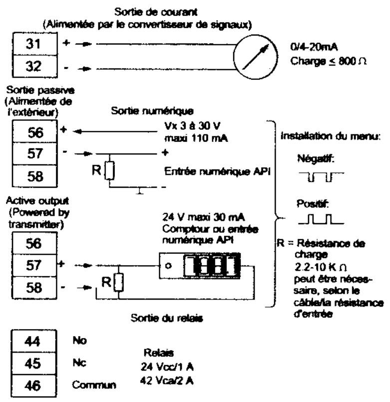


(FR) Raccordement électrique

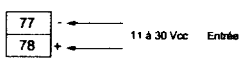
Alimentation



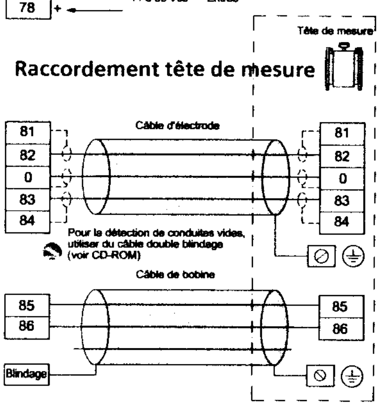
Sorties



Entrée numérique

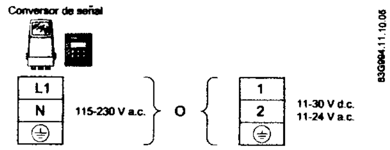


Raccordement tête de mesure

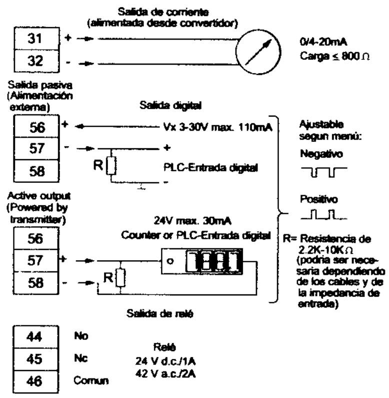


(ES) Conexiones eléctricas

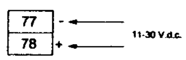
Alimentación



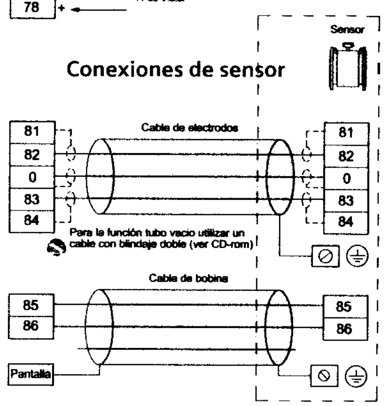
Salidas

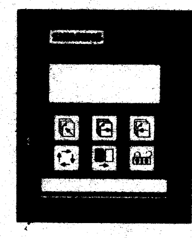


Entrada digital

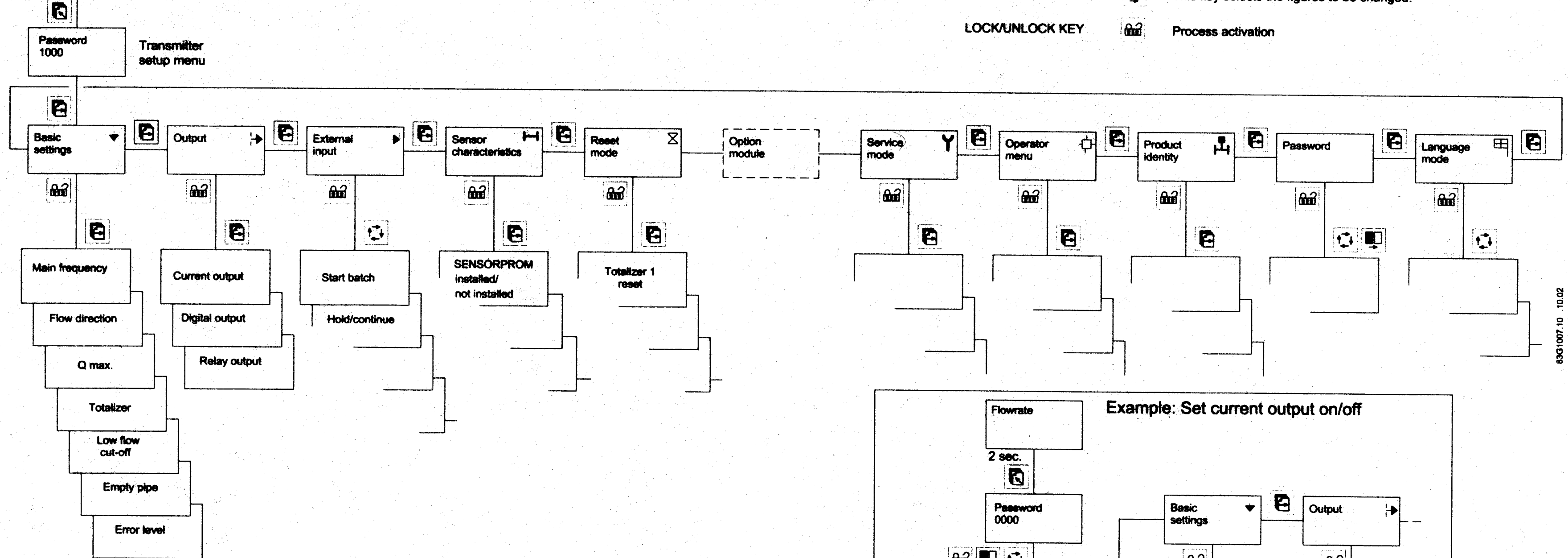


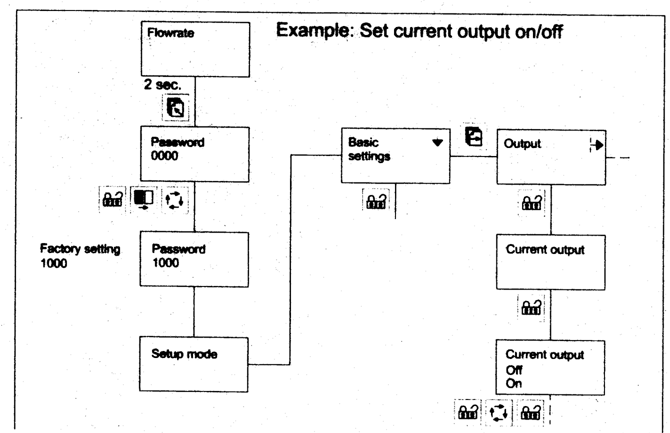
Conexiones de sensor





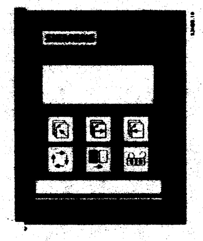
TOP UP KEY		This key (hold 2 sec.) is used to switch between operator menu and setup menu. In the transmitter setup menu, a short press will cause a return from a submenu
PAGE FORWARD KEY		This key is used to step forwards through the menus.
PAGE BACK KEY		This key is used to step backwards through the menus.
CHANGE KEY		This key changes the settings or numerical values.
SELECT KEY		This key selects the figures to be changed.
LOCK/UNLOCK KEY		Process activation



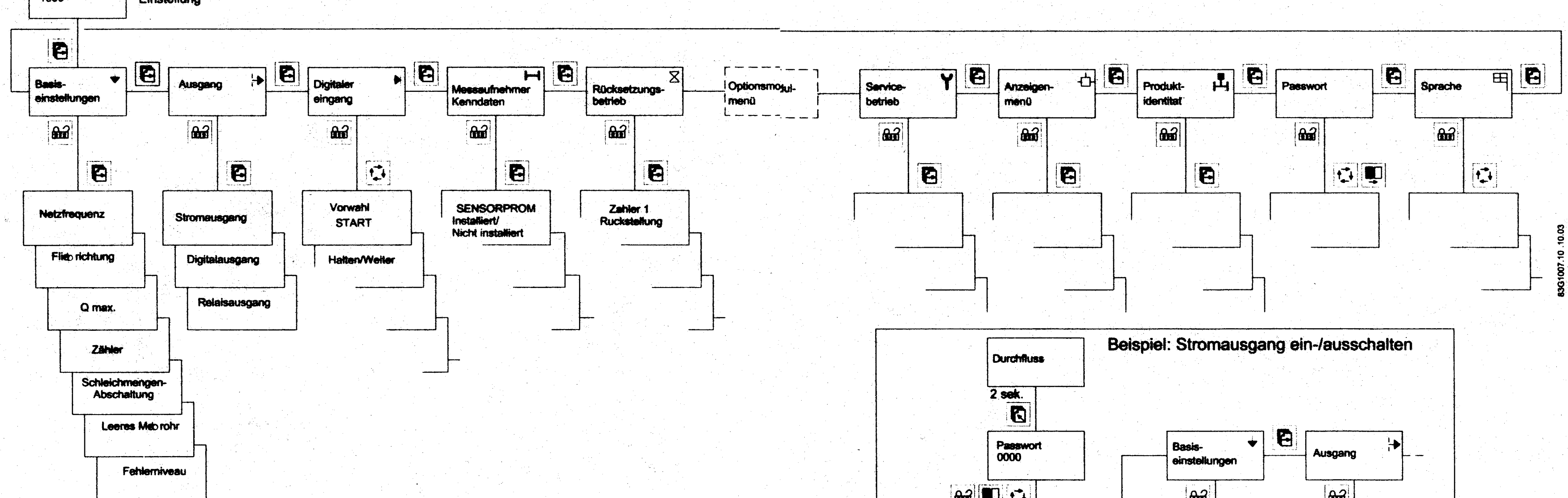


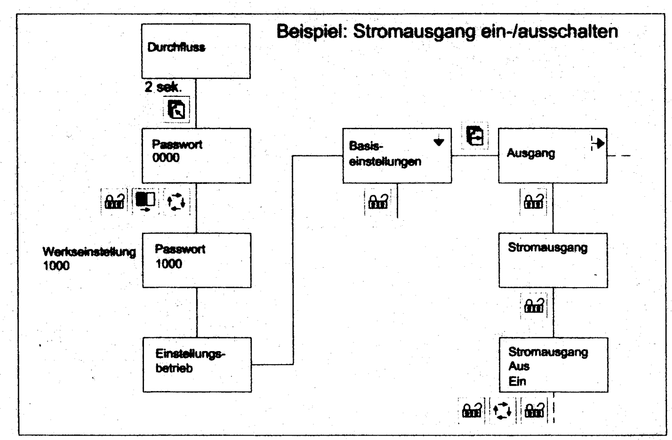
For detailed settings please refer to the operating manual on the enclosed CD-ROM.

Inbetriebnahme

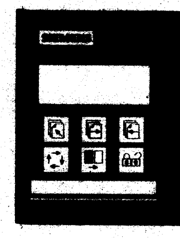


GRUNDSTELLUNG	Diese Taste bitte 2 Sek. drücken um zwischen Anzeigemenü und Einstellmenü zu wechseln. Ein kurzes antippen dieser Taste im Einstellmenü wechselt von einem Untermenü zurück.
BILD VORWÄRTS	Mit hilfe dieser Pfeiltaste bewegt man sich in einem Menü von einem Menupünkt zum Nächsten.
BILD ZURÜCK	Mit Hilfe dieser Pfeiltaste bewegt man sich in einem Menü zurück zum vorigen Menüpunkt.
ÄNDERUNG	Durch Drücken dieser Taste werden Einstellungen, Zahlenwerte und Einheiten geändert
AUSWAHL	Durch Drücken dieser Taste werden zu ändernde Werte ausgewählt
SPERREN/ENTSPERREN	Durch Drücken dieser Taste werden zu ändernde Einstellugen entsperrt, neue Werte gespeichert und Untermenüs aufgerufen

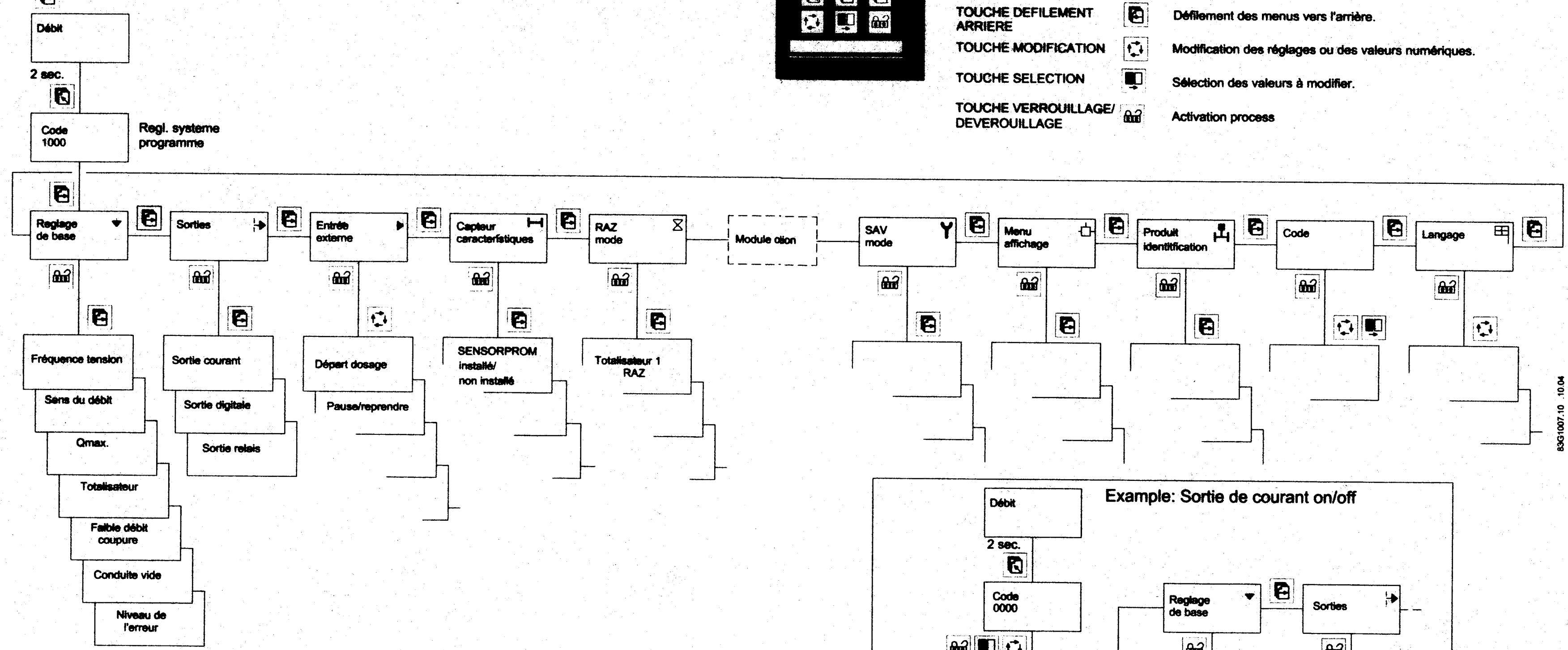


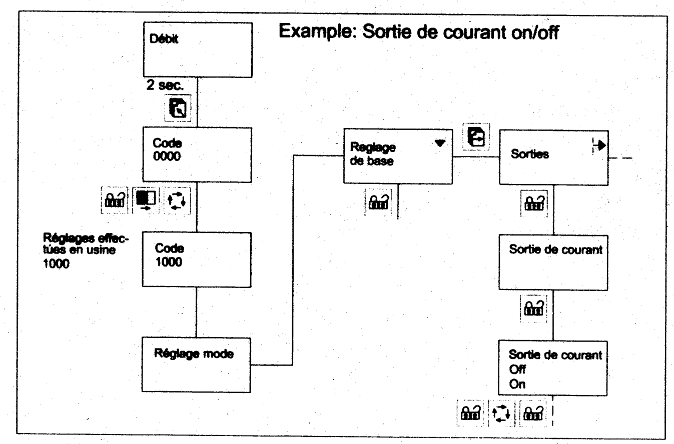


Genauere Angaben zu den Einstellungen finden Sie im Handbuch auf der beigefügten CD-ROM.

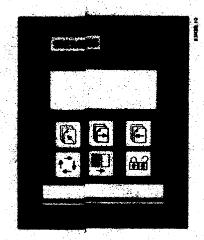


TOUCHE DEBUT		Cette touche (maintenir 2 sec.) permet de basculer du menu affichage au menu réglage. Dans le menu réglage, une impulsion peut entraîner le retour au sous-menu
TOUCHE DEFILEMENT AVANT		Défilement des menus vers l'avant. Seule touche normalement utilisée par l'opérateur.
TOUCHE DEFILEMENT ARRIERE		Défilement des menus vers l'arrière.
TOUCHE MODIFICATION		Modification des réglages ou des valeurs numériques.
TOUCHE SELECTION		Sélection des valeurs à modifier.
TOUCHE VERROUILLAGE/ DEVEROUILLAGE		Activation process

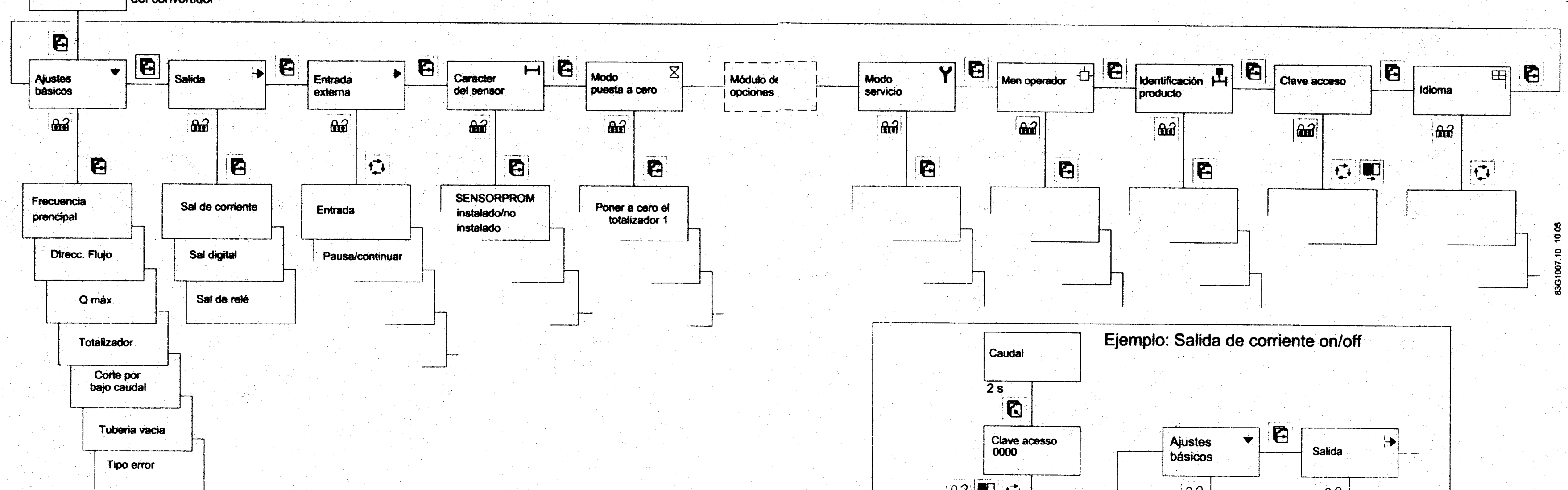


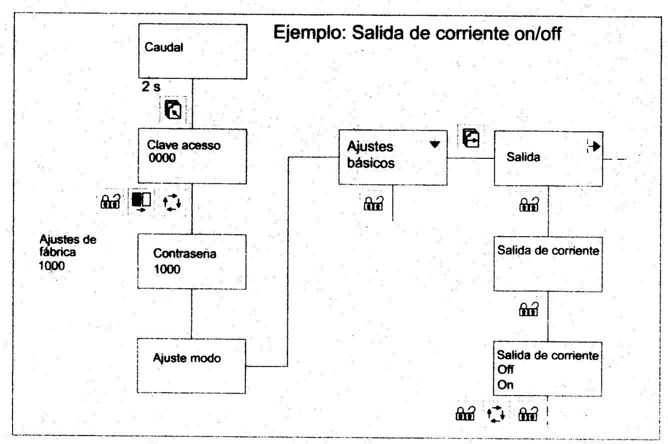


Pour plus de détails sur les réglages consulter le manuel sur le CD-ROM fourni.



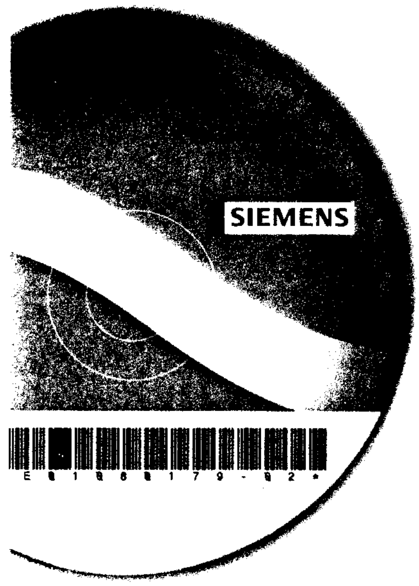
Tecla FLECHA ARRIBA		Esta tecla (manteniéndola pulsada 2s) se utiliza para cambiar entre el menú del operador y el menú de configuración. En el menú de configuración del convertidor, una pulsación breve hace volver desde un submenú.
Tecla AVANZAR PÁGINA		Esta tecla se utiliza para avanzar por los menús.
Tecla RETROCEDER PÁGINA		Esta tecla se utiliza para retroceder por los menús.
Tecla CAMBIAR		Esta tecla cambia los ajustes o valores numéricos.
Tecla SELECCIONAR		Esta tecla selecciona los valores que se desea cambiar.
Tecla BLOQUEAR/DESBLOQUEAR		Activación del proceso.





Para los ajustes detallados, por favor refiérase al manual en el CD ROM adjunto.

SITRANS F M MAG 5000 & MAG 6000



(EN) Troubleshooting

Two flashing triangles in the display indicate a fault.

For more troubleshooting information please see CD-ROM.

(DE) Fehlersuche

Zwei blinkende Dreiecke in der Anzeige weisen auf einen Fehler hin.

Weitere Angaben zur Fehlersuche finden Sie im Handbuch auf der beigelegten CD-ROM.

(FR) Dépannage

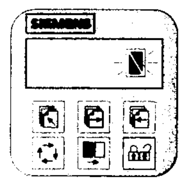
Deux triangles clignotants dans l'affichage indiquent une erreur.

Pour plus de détails sur le dépannage veuillez consulter le CD-ROM.

(ES) Resolución de problemas

Dos triángulos centelleantes en la pantalla indican una falla.

Para más información sobre resolución de problemas, por favor vea el CD ROM.



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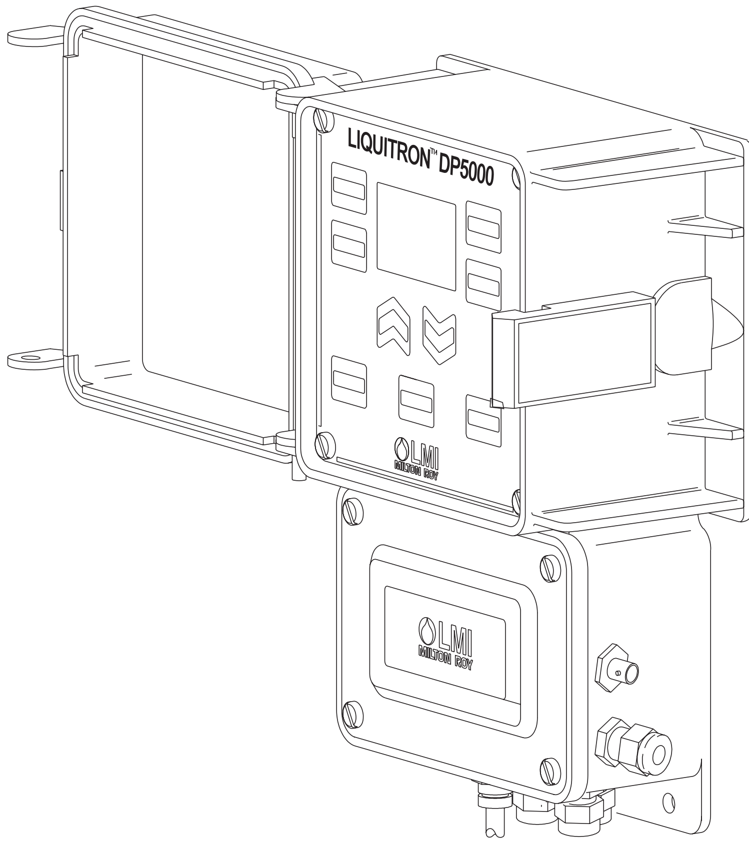
D-17

pH Controller, pH Transmitter, pH Electrode

Instruction Manual

Liquitron™ DP5000 Series pH Controller



For file reference, please record the following data:

Model No: ______________________

Serial No: ______________________

Installation Date: ______________________

Installation Location: ______________________

When ordering replacement parts for your LMI Controller or accessory, please include the complete Model Number and Serial Number of your unit.

LMI MILTON ROY

201 Ivyland Road
Ivyland, PA 18974 USA
TEL: (215) 293-0401
FAX: (215) 293-0445
http://www.lmipumps.com

ISO9001 REGISTERED COMPANY

Replaces same of Rev. F 4/01
1756.G 2/06

Contents

1.0 Introduction

The Liquitron™ DP5000 Series pH Controllers are designed for a variety of industrial pH applications including metal finishing, water treatment, printed circuit board manufacturing and waste treatment.

The DP5000 is a microprocessor-based pH controller with a backlit customized display and tactile keypad for ease of programming. The DP5000 allows independent programming of control methods (‘ON/OFF’ or ‘PROPORTIONAL’) for acid (Pump A) or base (Pump B) dosage. Independent high and low pH alarms may be set with activation of the ‘Alarm relays.’ A third relay output is available for activating a solenoid valve or other devices.

The controller is compatible with any pH electrode that generates a mV signal and allows incorporation of platinum 1000 W automatic temperature compensation (ATC) elements. Two point or single point pH calibrations may be performed. Timer functions for pump ‘Run’ time and solenoid ‘Delay’ times can be programmed to operate a solenoid pump valve. An ‘Advanced Menu’ allows selection of special features such as a ‘Point 3’ (inflection point) for the control profiles of the acid or alkali pumps for finer control. The DP5000 features continuous non-volatile memory back-up, voltage selection, pre-amplifier outputs, flow and level switch inputs as standard. 4-20 mA recorder output is optional.

2.0 Unpacking

Your carton will contain the items shown in Figure 1. Please notify the carrier immediately if there are any signs of damage to the controller or its parts. Contact your LMI Distributor if any of the parts are missing.

There is a number label on the inside cover of the unit; for easy reference, you should note the model and serial numbers on the front cover of this instruction manual.

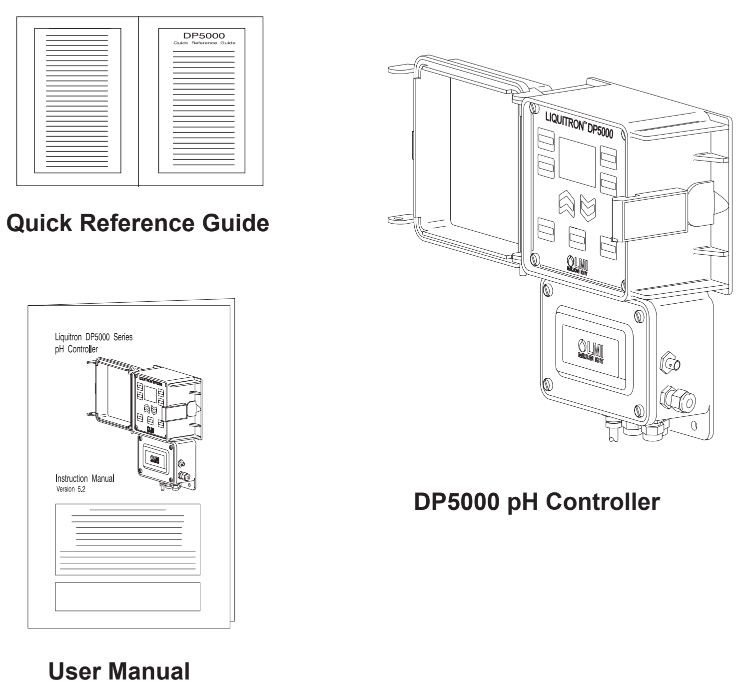


Figure 1: Unpacking Items

3.0 Installation

Pre-Installation

Be sure that the unit has a plug and voltage code compatible with the power source that you intend to use.

Environment

The housing is corrosion and spray resistant but should not be subjected to excessive spray or ambient temperature over 122° F (50° C). Never immerse the unit.

Installation

The DP5000 Controller should be mounted on a solid, stable surface. pH adjustment pumps should be installed following the manufacturer's recommendations. For installations requiring longer cables, consult your distributor. The electrode installation will vary, depending on the process used. In general, the temperature electrode and pH electrode should be mounted together, and placed far enough downstream from the source of pH adjusting solution that sufficient mixing may occur, but close enough to eliminate hydraulic lag time of response. Refer to the typical installation diagrams on the following page.

3.1 Mounting the Electronic Enclosure

The DP5000 control module is supplied with integral wall mounting flanges. It should be hung with the display at eye level, on a vibration-free structure, in a location where liquids will not be splashed on it. All four (4) top-mounting holes should be used for structural stability. The control module requires the following clearances:

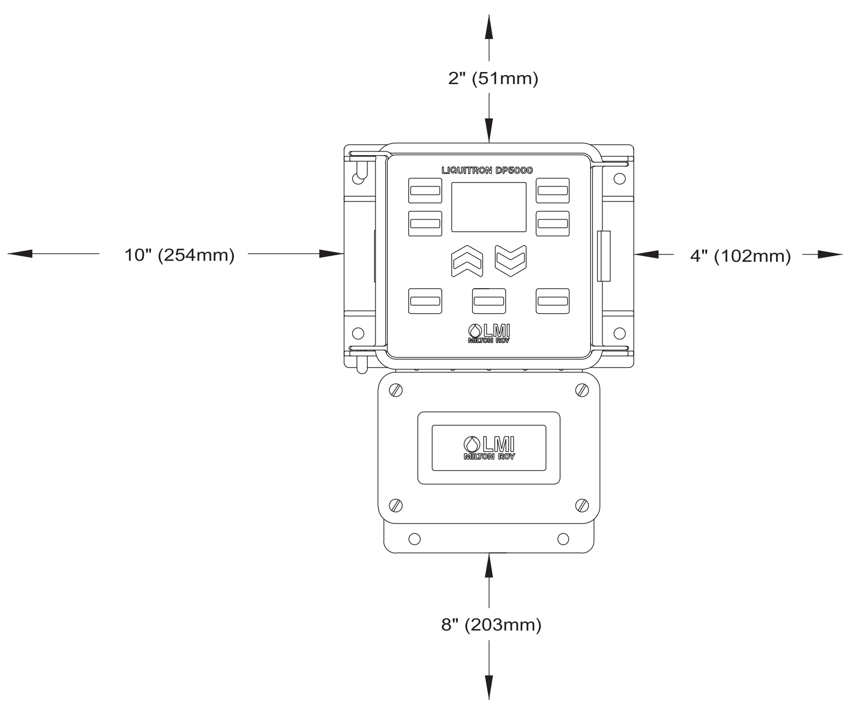


Figure 2: Minimum Clearances

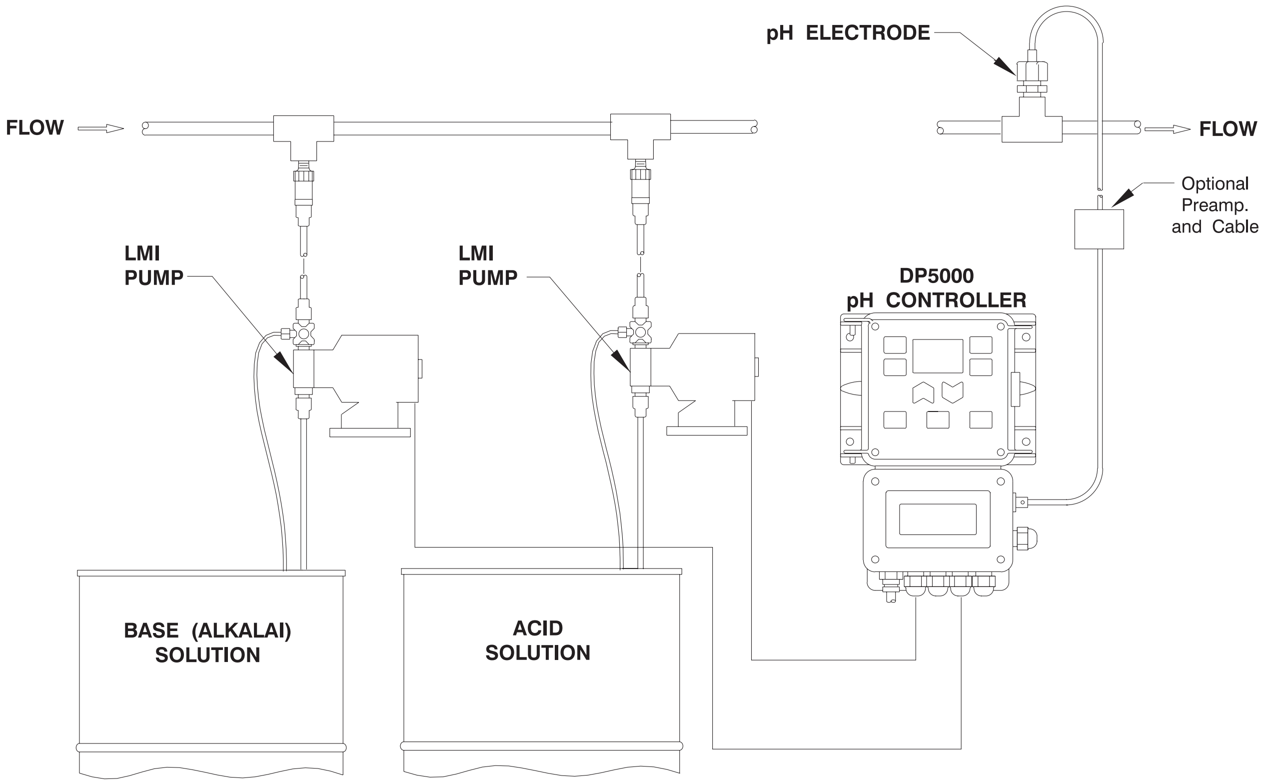


Figure 3A: Typical In-Line Installation

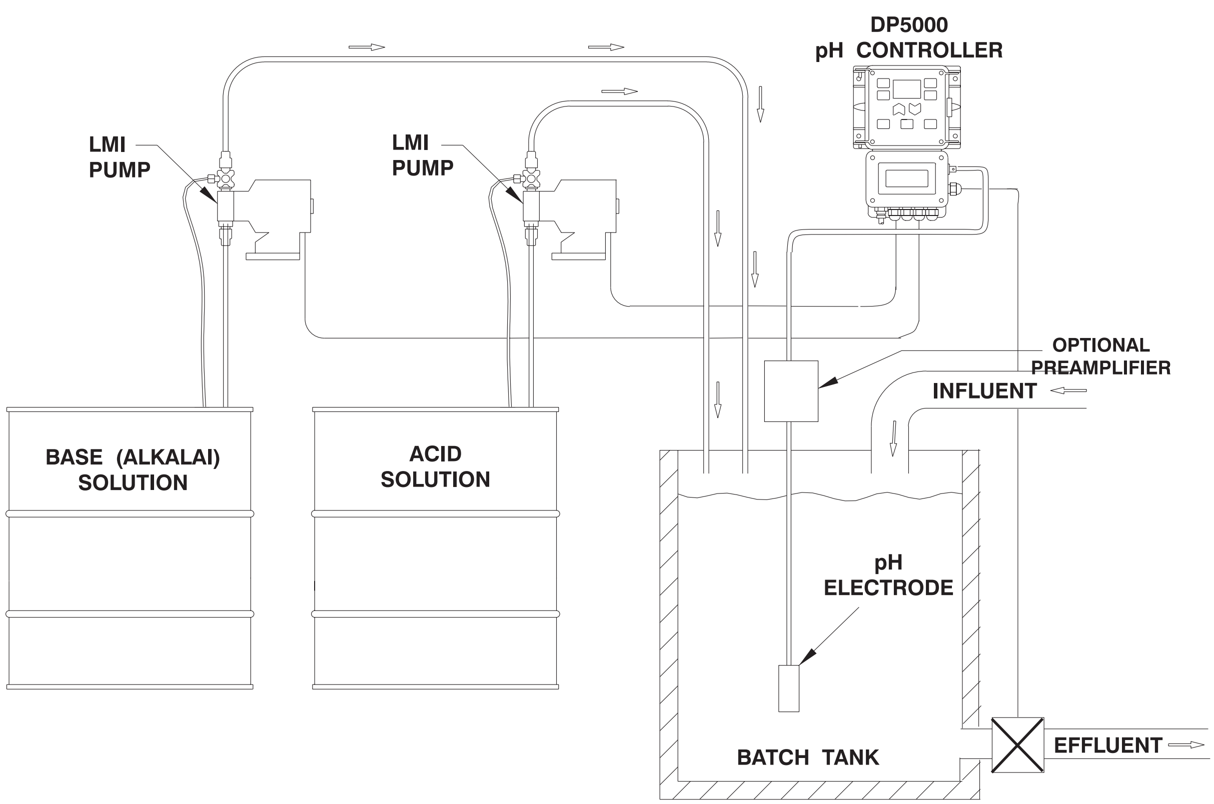
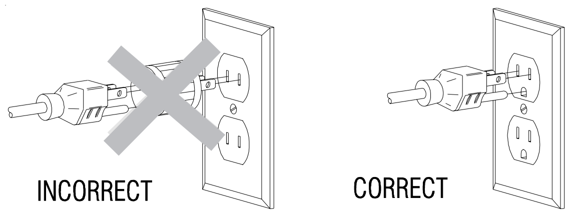


Figure 3B: Typical Batch Installation

3.2 Electrical Installation

Electrical Connections

To reduce the risk of electrical shock, the control or metering pump must be plugged into a ground outlet with ratings conforming to the data on the control panel. It must be connected to a good ground. DO NOT USE ADAPTERS! All wiring must conform to local electrical codes.



Electrical installation of the DP5000 Series pH Controllers consists of plugging the control module into a proper line outlet. Based on model number, the following voltages and receptacles are required:

DP5000-1A **DP5000-1B,** 115 V, 60 Hz USA Cord	**DP5000-3A** **DP5000-3B** 230 V, 50 Hz, DIN Cord	**DP5000-6A** **DP5000-6B** 230 V, 50 Hz AUS/NZ Cord	**DP5000-01A** **DP5000-01B** 115 V, 60 Hz No Cord
DP5000-2A **DP5000-2B** 230 V, 60Hz USA Cord	**DP5000-5A** **DP5000-5B** 230 V, 50 Hz UK Cord	**DP5000-7A** **DP5000-7B** 230 V, 50Hz SWISS Cord	**DP5000-02A** **DP5000-02B** 230 V, 50/60Hz No Cord

Connect the pH adjustment pump(s) to the terminal strip for 'ON/OFF' control (connect to receptacles directly for 115 V models) or to cables for 'PROPORTIONAL' control. Connect the pH electrode to the BNC connector on the right side of the control module. Take care not to twist or strain the wires. If equipped, connect the ATC cable (1000 Ω at 32° F [0° C]) through the cable gland below the BNC connector to the terminal strip. You may optionally connect an alarm, solenoid, flow switch and low level switch. You may also connect the mA connections (with the option fitted). The ± 5 V supply for electrode pre-amplification is also accessed on the terminal strip. There is a 500 Ω maximum resistance for 4-20 mA option (refer to Figures 4 and 5).

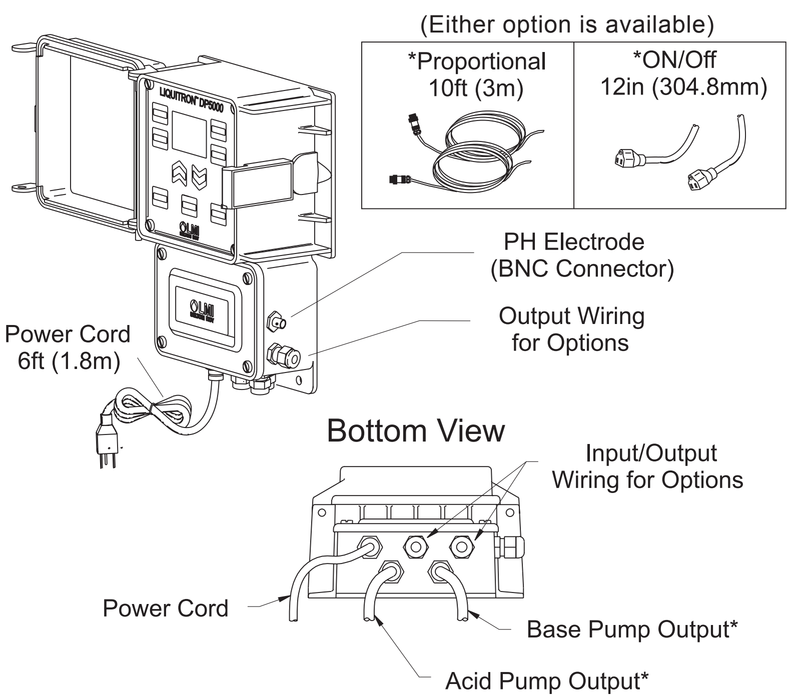
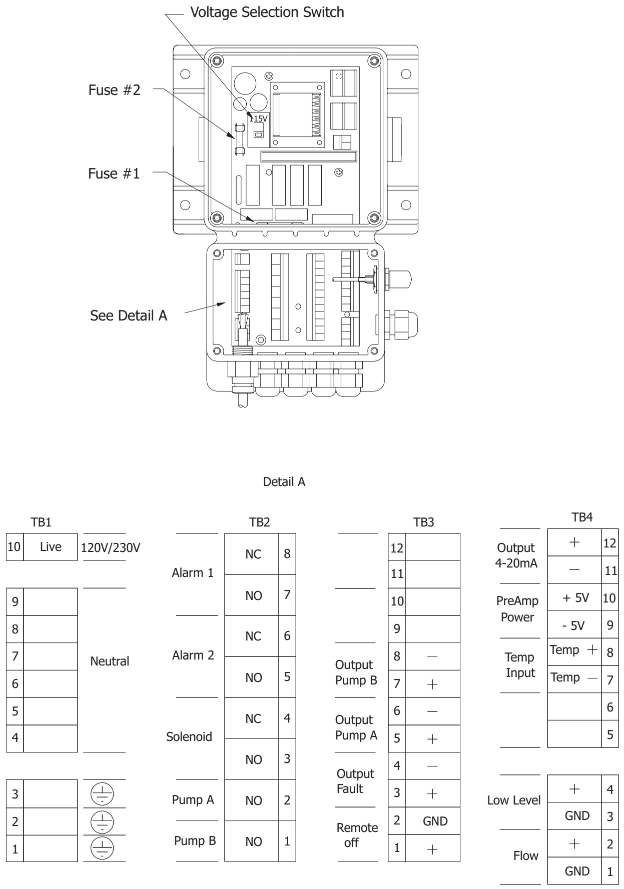


Figure 4: Electrode and Pump Connections



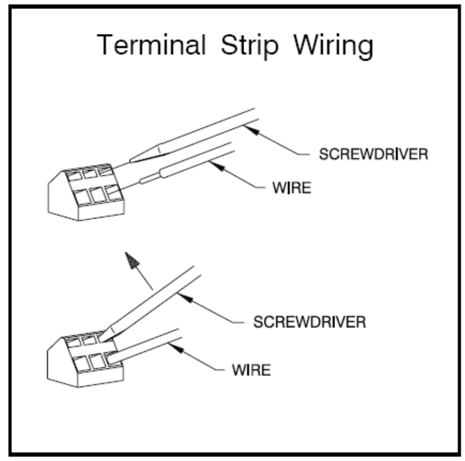


Figure 5: Terminal Strip

3.2.1 Terminal Board Signal Description

Terminal blocks are TB1-TB4 from left to right, and Pin 1 is at the bottom of each terminal block.

TB1 Terminal Strip

TB1 Pin 1-Pin 3 .... Earth connection (one for input power connection)
TB1 Pin 4-Pin 9 .... Neutral power connection (one for input power connection)
TB1 Pin 10 .... AC Mains live input

TB2 Terminal Strip

TB2 Pin 1 .... Form A contact closed when Pump B (base) is ON
TB2 Pin 2 .... Form A contact closed when Pump A (acid) is ON
TB2 Pin 3-4 .... Form C contact activated, (if programmed) when pH is within programmed limits (solenoid pump)
TB2 Pin 5-6 .... Form C contact activated when Alarm Setpoint 2 exceeded (powered output contacts)
TB2 Pin 7-8 .... Form C contact activated when Alarm Setpoint 1 exceeded (powered output contacts)

TB3 Terminal Strip

TB3 Pin 1-2 .... Opto isolated input - low or short stops pumps (OFF on display)(Remote OFF)
TB3 Pin 3-4 .... Opto isolated output - low when alarm condition exists
TB3 Pin 5-6 .... Opto isolated output - pulse train to drive Pump A
TB3 Pin 7-8 .... Opto isolated output - pulse train to drive Pump B
TB3 Pin 9-10 .... Spare, not programmed
TB3 Pin 11-12 .... Spare, not programmed

TB4 Terminal Strip

TB4 Pin 1-2 .... Opto isolated input - flow switch input (add jumper if no flow switch is used)
TB4 Pin 3-4 .... Opto isolated input - level switch input (add jumper if no level switch is used)
TB4 Pin 5-6 .... Spare, not programmed
TB4 Pin 7-8 .... Temperature input (from platinum RTD probe) (polarity sensitive)
TB4 Pin 9-10 .... Power voltage source for preamp
TB4 Pin 11-12 .... 4-20 mA output proportional to pH (programmable limits) (optional) (polarity sensitive)

3.2.2 Field Wiring Instructions

Typical US field installation would include a 6 ft (2 m) AC cord wired and two (2) 1 ft (30 cm) AC receptacles (‘ON/OFF’ mode) or two (2) 10 ft (3 m) pump drive cables (‘PROPORTIONAL’ mode) installed. A BNC receptacle would be installed for the pH probe.

Connect the two (2) pumps appropriately. Install the probe, run the cable back to the controller and attach to BNC receptacle. If the probe is farther than 25 ft (7.6 m) from the controller, a pre-amp may be desirable to reduce noise effects. If this is the case, run +5 V/-5 V as required by your preamp. Current draw must not be greater than 10 mA.

If a flow switch and/or low-level tank switch is available, run wires to the controller - entering through one of the spare cable ports. Remove the appropriate jumper(s) and attach the external wires. Polarity does not matter. Wire size #20-22 is adequate.

Alarm relays 1 and 2 are provided to signal an out of tolerance condition externally. These are Form C contacts, providing a common, a normally open and a normally closed connection.These terminals provide power output.

A solenoid drive relay is provided that can be connected to drain a tank when the pH is within programmed limits. This form C contact provides a common, a normally open and a normally closed connection. A delay can be programmed after initially entering this programmed zone, to allow conditions to settle within the tank. The duration of solenoid ON time is separately programmable. Wire size #16-18 is adequate. These terminals provide output power (main voltage).

The optional 4-20 mA PCB provides a fully programmable 4-20 mA output based on the pH readings. The optional PCB plugs into the back of the computer pc board, as shown in Figure 6.

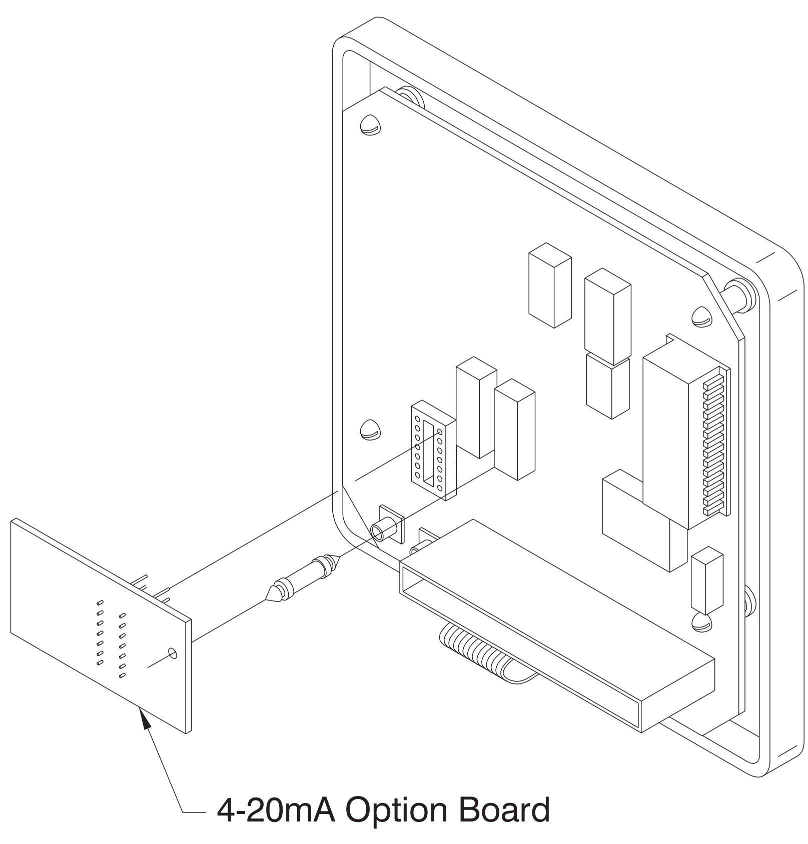


Figure 6: Circuit Board

3.3 pH Adjustment Pump(s)

There are two (2) versions of the DP5000, one is the ‘ON/OFF’ Output and the second is ‘PROPORTIONAL’ Output.

The **On/Off Output** DP5000 pH Controller will operate any pH adjustment pump(s) which operate on the same line voltage as the controller itself. Combined continuous controlled load must not exceed 4A @ 115 V or 2A @ 230 V. To ensure efficient control, the pumps should be capable of delivering at least 150% of the maximum pumping requirement. Install and calibrate the pumps according to the manufacturer's recommendations.

The **Proportional Output** DP5000 pH Controller will operate any LMI A9, A7, B9, B7, C9, C7, E7 or L7 pump, or any other pump which operates by providing direct proportional response to a modulated pulse input signal. The pumps must be set to the ‘external’ control mode. To ensure efficient control, the pumps should be capable of delivering at least 150% of the maximum pumping requirement. Install and calibrate the pumps according to the manufacturer’s recommendations.

3.4 Keypad and Display

The DP5000 pH Controller menu allows the user to input all the variables necessary to customize the controller for the application. The keypad is used for all programming (see Figure 7).

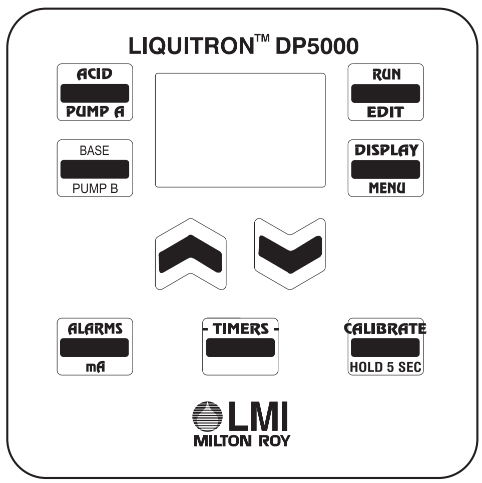
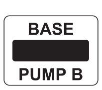


Figure 7: Keypad

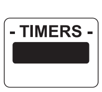
Keys:

This key is used to set up the control profile for the acid dosing pump. (Holding the key for five (5) seconds will allow priming of Pump A) (Factory setting 90 SPM).



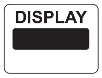
This key is used to set up the control profile for the base (alkali) dosing pump. (Holding key for five (5) seconds will allow priming of Pump B) (Factory setting 65 SPM).

This key is used to program the high and low alarm points and hysteresis (ON/OFF mode). It also allows programming of the mA output when installed.



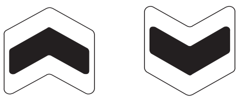
This key is used to program ‘run times’ for Pumps A and B, ‘delay times’ 1 and 2 for actuating and controlling a solenoid valve (when programmed ‘ON’ in the advanced features menu). This key also allows setting of the ‘manual temperature’ and the controller response rate Δ pH. If pump run time is over 11:01 hours, the run time is disabled. The pump will not be stopped and will run continuously.

This key when pressed will display details of the last successful electrode calibration. (Holding this key for five (5) seconds will allow entry into a new calibration procedure [single or two point]).



Pressing this key will cause the display to alternate showing various settings. (Holding the key for five (5) seconds will allow entry to the ‘advanced features’ menu).

This key is used for starting and stopping (run or edit) the pumps and changing set points in the controller. It changes the mode of the controller from ‘RUN’ to ‘OFF.’



These keys are used to change values on the display.

Simultaneously pressing these two (2) keys will lock the keypad to prevent casual tampering. Pressing them a second time will unlock the keypad. (Wait five (5) seconds between locking and unlocking).

4.0 OPERATION

4.1 Default Settings

In the default mode, as shipped from the factory without any extended features programmed in the ‘menu’, the controller is set to operate two (2) dosing pumps towards a single desired pH region as defined by the set points. It will do this in one of two ways, ‘ON/OFF’ or ‘PROPORTIONAL,’ shown graphically below:

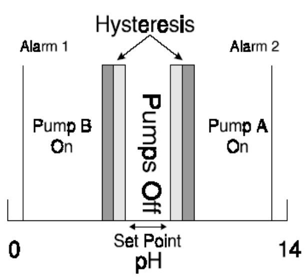


Figure 8: ON/OFF Control

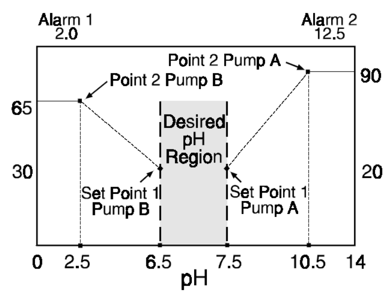
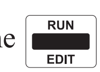
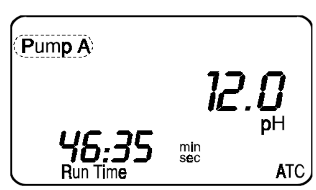


Figure 9: Proportional

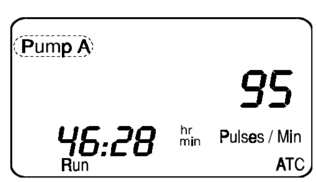
When the unit is plugged in, the computer powers up and the display illuminates. The display flashes the pH reading and ‘OFF’. This indicates the pumps will not operate and the unit is in the ‘OFF’ mode. When the  key is pressed the controller starts and switches into the ‘RUN’ mode.

Example: (Proportional Controller)

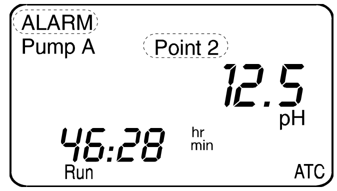
This display shows a pH value of 12.0. Pump A is flashing indicating that the acid pump is in operation. The pump will stop pumping after 46:35 minutes if set point is not reached.

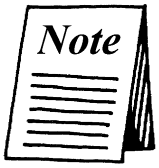


For two (2) seconds in every eight (8) seconds the display shows pump speed in pulses/minute. The pulses/minute displayed relates to the pump that is in operation.



When the pH value exceeds the programmed pH alarm point (12.5), the ‘ALARM’ flashes and the alarm relay is activated.

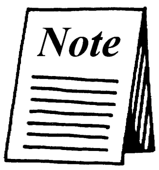




Throughout this manual, the term ‘pulse’ is used to describe the mechanical stroke of the pump, as strokes per minute (SPM).

4.1.1 Proportional Mode

The unit is shipped preset at the factory for the ‘PROPORTIONAL’ or ‘ON/OFF’ mode. To change the unit to the opposite mode see ‘Advanced Menu List,’ Option 2, on page 20.



Controller must be in ‘OFF’ mode to program changes.

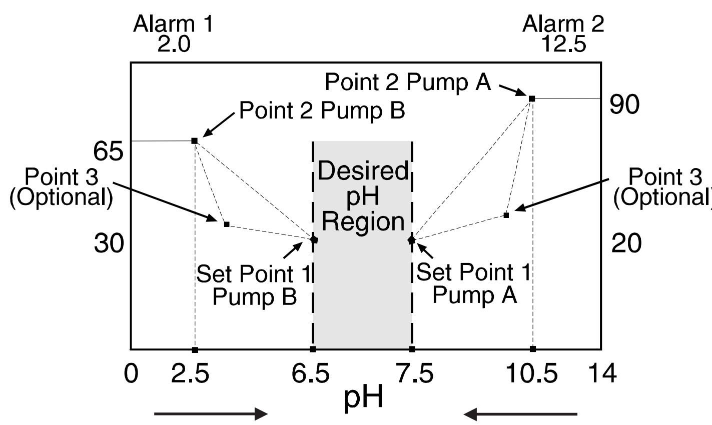
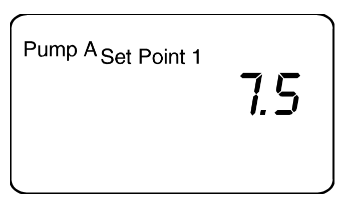


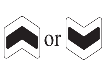
Figure 10: Pump A Control Profile

Pressing 

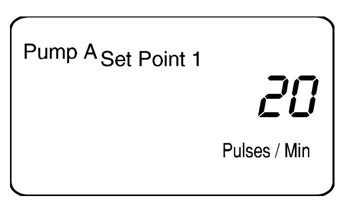
switches the mode back and forth from RUN’ to ‘OFF’. The pH set points and pump speed (pulses/min) can be changed only in the ‘OFF’ mode.



(1) ...... Press 

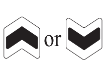
(2) ...... Press 

to the increase/decrease the pH value of Set Point 1 for turning on ‘Pump A’.



(3) ...... Press 

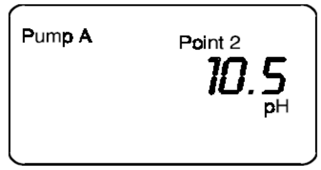
again.

(4) ...... Press 

to increase/decrease pump speed (pulse/min) for set point 1.

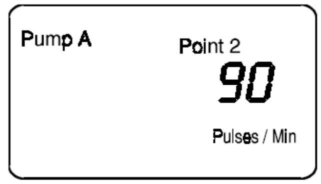
(5) ...... Press 

again.



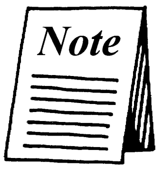
(6) ...... Press or to increase/decrease the pH for Set Point 2.

(7) ...... Press ACID PUMP A again.



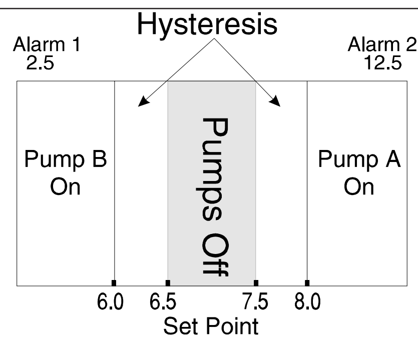
(8) ...... Press or to increase/decrease pump speed (pulse/min) for Set Point 2.

'Pump B' (Base Pump) is programmed in a similar way.

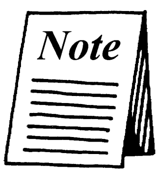


Set points 1 and 2 must be separated by 0.5 pH minimum. If 'Point 3' is selected in the Advanced Features Menu, the user will be prompted to enter a pH value for Set Point 3 and a Pump Speed at Set Point 3. Set points 1 and 3, 2 and 3 must be separated by 0.1 pH minimum.

4.1.2 On / Off Mode



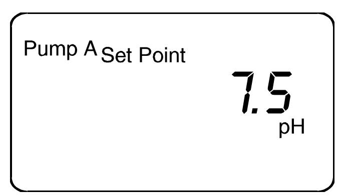
Pump A Control Profile



Controller must be in 'OFF' mode to program changes.

- *Hysteresis values can be set as low as 0.1 pH*
- *Lowest setpoint value for pump B is 1pH*
- *Highest setpoint value for pump B is 12 pH*
- *Lowest setpoint value for pump A is 2 pH*
- *Highest setpoint value for pump A is 13 pH*

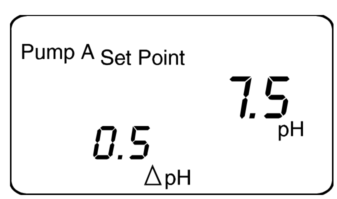
For 'ON/OFF' controllers with relay outputs (instead of pulse outputs) each pump is programmed as follows:



(1) ...... Press ACID PUMP A ....to display Set Point.

(2) ...... Press or to increase/decrease pH Set Point.

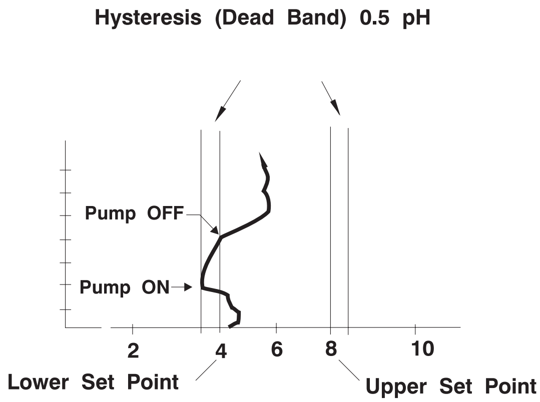
(3) ...... Press ACID PUMP A to save programmed Set Point.

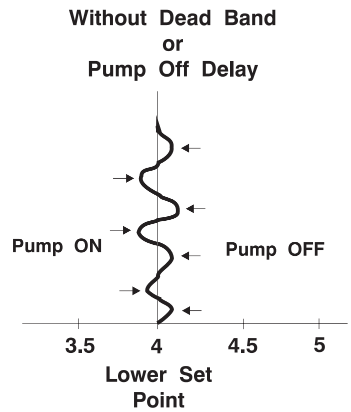


(4) ...... Press or to program Δ pH (Hysteresis) period for relay. In this example, 'Pump A' will turn on at a pH of 8.0 (set point + Δ pH). 'Pump A' will turn off when pH drops to 7.5.

'Pump B' (Base Pump) is programmed in a similar way.

In this example, 'Pump B' will turn on at a pH of 3.5 (set point - Δ pH) and will turn off when pH reaches 4.0.





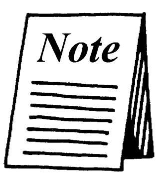
It is highly recommended that the hysteresis (pump off function) be used to prevent relay chatter.

The function of the hysteresis is to prevent pump relay chattering. It operates by allowing the pump to be turned on when the control point plus (or minus) the hysteresis value has been met, but does not allow the pump to turn off until the control point has been met. The chosen value will be used for both upper and lower set points.

The hysteresis, or dead band, designates how many pH units beyond set point the pump runs before turning off. Any value from 0 to 14.00 is acceptable. If use of this function is undesirable, set it to 0.

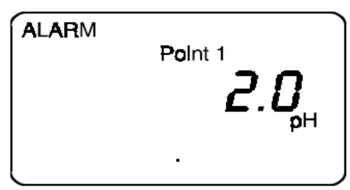
Example: If the lower set point is pH 4.0 and the hysteresis has been set at 0.50, a falling pH will cause the pump to activate at pH 3.50 and it will run until reaching set point (4.0).

4.2 Alarms



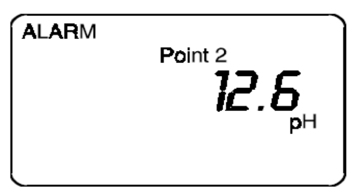
Controller must be in 'OFF' mode to program change Set Points.

(1) ...... Press ALARMS mA to display Alarm data.



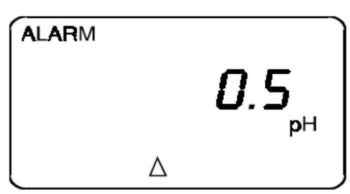
(2) ...... Press ▲ or ▼ to program Alarm Point 1 (low pH).
(Pump B)

(3) ...... Press ALARMS mA to save Alarm Point 1 value and to move to Alarm Point 2.



(4) ...... Press ▲ or ▼ to program Alarm Point 2 (high pH).
(Pump A).

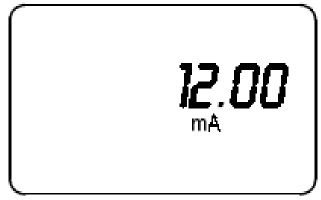
(5) ...... Press ALARMS mA to save Alarm Point 2 value and to move to Alarm Hysteresis.



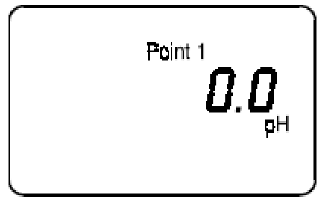
(6) ...... Press ▲ or ▼ to program Alarm Hysteresis.
This is the point where the alarm turns off.

If the 4-20 mA option board is installed, the following screens will appear. If these do not appear and the 4-20 mA PCB is installed, go to Section 4.6, Advanced Menu, and program option “7” to “1” and option “6” to “1”.

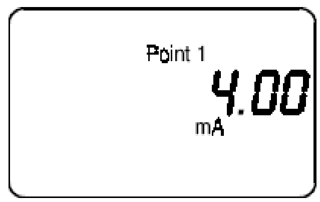
(7) ...... Press ALARMS mA to display current mA output value.



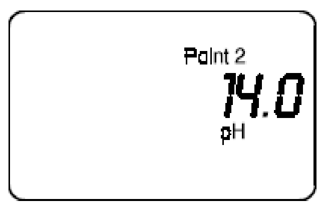
(8) ...... Press ALARMS mA again to program the 4-20 mA output.



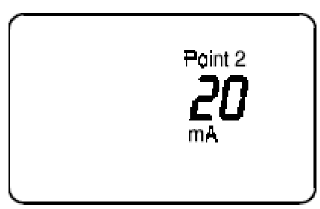
(9) ...... Press or to select the pH value for Point 1 mA output. Default is 4 mA = 0 pH, 20 mA =14 pH.



(10) .... Press again. Press or to select the mA value at Point 1.



(11) .... Press ALARMS mA again. Press or to select the pH value for Point 2 mA output.

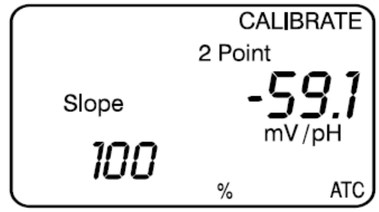


(12) .... Press ALARMS mA again. Press or to select the mA value at Point 2.

4.3 Calibration (Viewing Last Calibration Data)

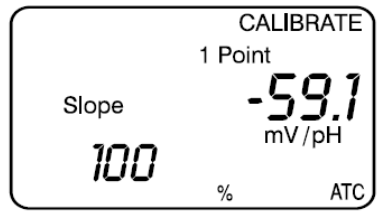
Press the 

key once.



CALIBRATE will be visible and the ‘mV/pH’ and ‘%’ (slope) of the previous calibration will be displayed. The display will alternate between ‘mV/pH’ and ‘° C.’

‘2 Point’ indicates that the previous calibration was a two-point calibration.



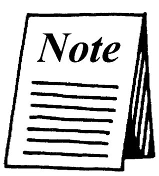
‘1 Point’ indicates that the previous calibration was a one-point calibration.

4.4 New Calibration

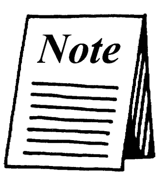
For two-point calibration, the default settings are Buffer 1 = 7.00 pH and Buffer 2 = 10.00 pH but these values may be changed.

Because it is not always possible to transfer the temperature probe from the process to the pH buffer, automatic temperature probe detection can be switched off in pH calibration mode.

The calibration parameters (temperature, ATC [automatic temperature compensation] or manual, buffer pH and one or two point calibration) of the previous calibration are the initial values for the current calibration.



If the LMI temperature cable and probe are connected, then the computer automatically selects and uses this ATC (automatic temperature compensation) during calibration. If no temperature probe is connected, then ‘MANUAL’ will be selected during calibration. You must manually measure the temperature of the process being controlled and enter that value here.

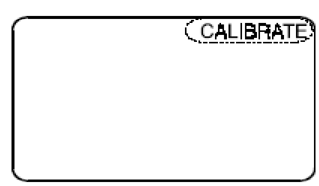


The unit must be placed in the ‘OFF’ mode. The unit cannot be calibrated in the ‘Run’ mode.

Calibration (e.g., 2 Point)

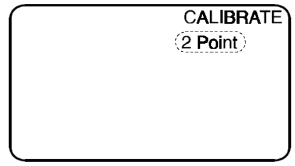
(1) ...... 

+ 5 seconds



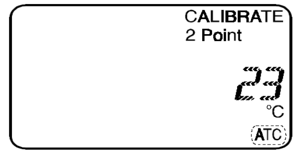
Hold the ‘CALIBRATE’ key down for five (5) seconds.
‘CALIBRATE’ will start flashing.

(2) ...... Press CALIBRATE HOLD 5 SEC again.

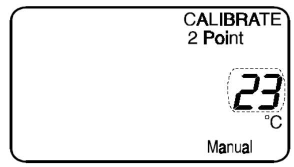


'2 Point' will start flashing. Use the or keys to toggle between '1 Point' and '2 Point.'

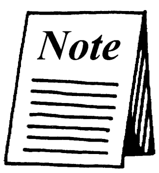
(3) ...... Press CALIBRATE HOLD 5 SEC again. 'ATC' (or 'MANUAL') will start flashing. Use the or keys to toggle between 'ATC' and 'MANUAL' temperature.



(4) ...... Press CALIBRATE HOLD 5 SEC again. Use or keys to program actual temperature of buffer.

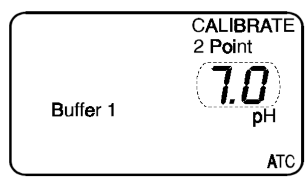


It is not possible to program temperature if 'ATC' is selected.

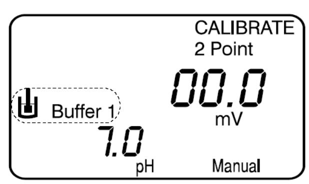


Automatic temperature probe detection can be over-ridden in pH calibration mode. If the ATC probe is not connected, the controller will not detect it and only the 'MANUAL' temperature option above will be displayed.

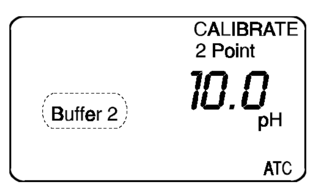
(5) ...... Press CALIBRATE HOLD 5 SEC again. The 'Buffer 1' value will start flashing. Use or keys to program 'Buffer 1' pH (or leave at 7.0).

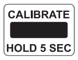


(6) ...... Press CALIBRATE HOLD 5 SEC again. The symbol will prompt you to put the probe in 'Buffer 1'. Wait for the mV value to settle.

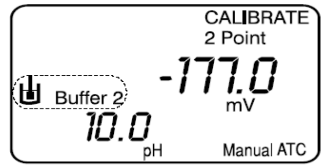


(7) ...... Press CALIBRATE HOLD 5 SEC again. This will accept the first calibration value and will display the 'Buffer 2' pH. Use or keys to program 'Buffer 2' (or leave) as desired.



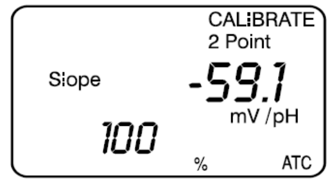
(8) ...... Press 

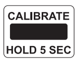
again and the  symbol will prompt you to put the probe in ‘Buffer 2’. Wait for the mV value to settle.



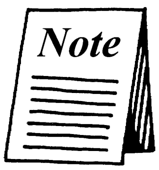
(9) ...... Press 

again. This will accept the second calibration value and will display the ‘mV/pH’ (and ‘%’ Slope) result of the calibration.



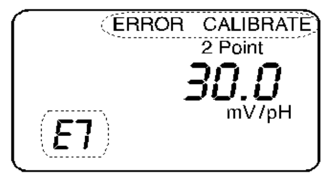
(10) .... Press 

again to accept this calibration and exit calibration mode. Press any other key to abort calibration.



For a single-point calibration, only one (1) buffer is used. The theoretical value for pH 7.00 is used to complete the Calibration Curve.

If the calibration is unsuccessful (slope < 70% or offset > ± 30 mV) and ‘ERROR CALIBRATE’ and ‘E7’ are displayed; the calibration should be repeated or else the controller reverts to using the ‘last successful’ calibration performed.



A slope of less than 70% indicates a dirty/faulty probe or contaminated buffer.

4.5 Pump Timers and Solenoid Valve Control Timers

It is not possible to change timer values while in ‘RUN’ mode. Unit must be in the ‘OFF’ mode to change values and settings.

Pump Run Time:
This timer is set to the maximum time the pump can be on. If the timer is set to over 11:01 hours, the pump will run continuously.

This timer is started when a pump is on and the pH value is outside the set points. The controller will stop the pumps when the time reaches ‘0’ and activate ‘ALARMS.’ The run time is reset each time the pH enters the desired set point region.

Solenoid Delay Pump Valve Time:
The Solenoid Valve Relay output may be activated when the pH is within the set points for the time specified by ‘Delay 1.’ This may be used for system integration and for emptying a batch tank etc.

The ‘Delay 1’ Timer defines the period to allow pH and system parameters to settle.

The ‘Delay 2’ Timer (ON time) defines how long the valve will stay open. When these Delay Timers are active, pump dosing cannot take place but the DP5000 will monitor the pH. The ‘Delay 2’ timer starts when the outputs are activated. If the pH drifts outside of the set point and range, the solenoid relay will be deactivated.

If a ‘Delay 2’ time goes below one hour, then the display will change to ‘minutes : seconds’ from ‘hours : minutes.’

Setting Timers:

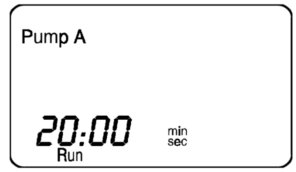
Note

The unit must be in the 'OFF' (edit) mode to change the timer settings.

For proportional mode pump run time must be set above 11 HR 01 Min to ensure continuous operation.

(1) ...... Press the - TIMERS - key to view the run time for 'Pump A'.

(2) ...... Use or to adjust to desired maximum run time.

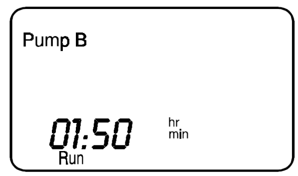


Note

The 'hr : min' will change to 'min : sec' automatically as the run time is reduced below one (1) hour.

(3) ...... Press the - TIMERS - key to advance to run time for 'Pump B'.

(4) ...... Use or to adjust to desired maximum run time.



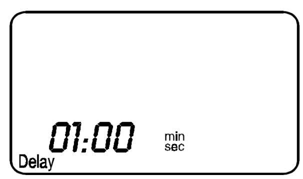
Note

The 'hr : min' will change to 'min : sec' automatically as the run time is reduced below one (1) hour.

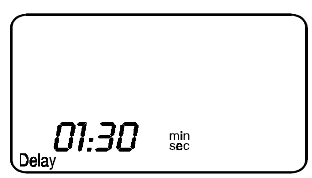
Delay Timers are factory set in the deactivated mode. *The 'Delay 1 and Delay 2' Timers are activated/deactivated in the 'Advanced Features Menu.' These screens will not display when the delay option is deactivated.*

Solenoid Valve Control:

(5) ...... Press the - TIMERS - key to advance to 'Delay 1' time (if activated). 'Delay 1' is the wait time after pH enters the desired region, before the Solenoid is activated.



(6) ...... Press the - TIMERS - key to advance to 'Delay 2' time (if activated). 'Delay 2' is the Solenoid 'ON' time.



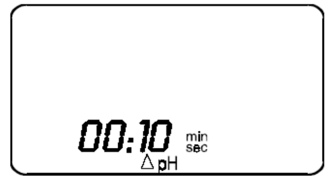
Note

If the pH should go out of the desired range during 'Delay1' or 'Delay 2', the Solenoid cycle will terminate.

It will start again from zero when pH re-enters the desired region. If pH remains in the desired region, the controller will enter 'OFF' mode at the end of the Solenoid 'ON' time. The controller turns 'ON', again in one minute and the cycle repeats.

(7) ...... Press 

key to advance to 'Response Rate'. This is programmed in Δ pH units.



The smoothing of the input signal is determined by delta (pH) time. The 'Response Rate' is the time that the computer display takes before it updates the pH readings.

The following values can be programmed (min : sec):
00 : 01 00 : 10 00 : 20 00 : 30. . . . . . . 04 : 00 (In increments of 10 seconds)

When 00 : 01 is programmed the controller responds to a change in input in one (1) second.

If 00 : 10 is selected the controller responds to a change in input in ten (10) seconds. (i.e., the value displayed is the average of the 10 previous 1 second readings.)

Examples: The sampling time (delta) is 00 : 10 and the current reading is 2.00 pH.

When the pH input is increased instantaneously to 12.00 pH, the display will respond as follows:

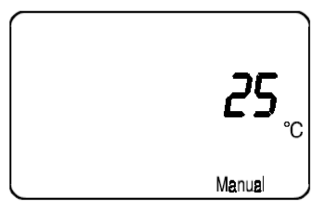
Seconds	0	1	2	3	4	5	6	7	8	9	10	11
pH	2	3	4	5	6	7	8	9	10	11	12	12

If the sampling was 00 : 01 seconds, the response would be:

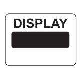
Seconds	0	1	2	3	4	5	6	7	8	9	10	11
pH	2	12	12	12	12	12	12	12	12	12	12	12

Press the 

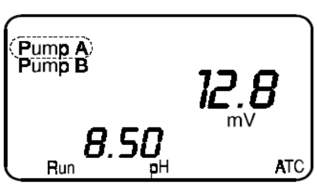
key to advance to set temperature.
This setting is relevant when no temperature probe (1000 Ω platinum RTD) is connected.



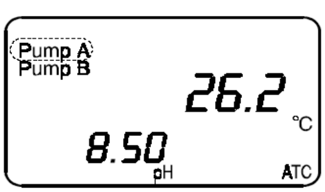
Display Key:

While in the Run Mode the 

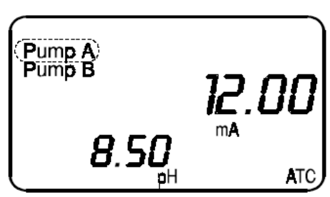
key can be pressed once to display current parameters. Each screen will come up for three (3) seconds and then returns to pH display or System Run automatically (screens shown below are: mV, °C, and mA).



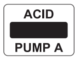
+ 3 Seconds



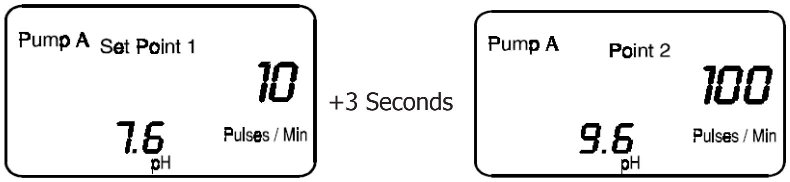
+ 3 Seconds



Similarly, the Pump Control Points can be displayed while in the 'RUN' Mode by pressing the 'Pump A' or 'Pump B' keys once.

Press 

and the following screens display:



4.6 Advanced Menu:

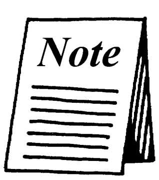
Holding the 

key for five (5) seconds accesses the 'Advanced Features' Menu, and allows these settings to be changed.

Press the 'DISPLAY/MENU' key for five (5) seconds while the controller is in the 'EDIT'or 'OFF' mode.

The first item displayed is the software revision. Pressing 'Display/Menu' again cycles to the first option. The first number is the option. The second is the setting. Use the  or  to change the setting.

Option	Setting	
1	1 0	Control returns to **Run** 60 seconds after last keypress **Run/Edit** key is **On/Off**
2	1 0 2	**On/Off** Control **Proportional** Control (and **On/Off**) **Proportional** Control
3	1 0	Point 3 Programming Enabled Point 3 Programming Disabled (Two point only)
4	1 0	Solenoid programmed to switch on after programmed time'DELAY 1' and to switch **Off** after programmed time 'DELAY 2' Solenoid Disabled
5	1 0	(NA)
6	1 0	mA Enabled - Option Board must be fitted mA Disabled
7	1 0	Allows editing of #5 & #6 Lockout #5 and #6



The Option Board (37830) is required for Option 6.

5.0 Maintenance

5.1 pH Electrode and Cable

The most frequently replaced part is the pH electrode (not supplied with controller), which will deteriorate with age. Refillable electrodes should be checked for level frequently, and replenished with filling solution as necessary. An electrode may also fail because of:

- aging (slow response to changing pH)
- coatings over the glass bulb (slow response to changing pH)
- abrasion of the glass bulb (shift in calibration)
- chemical attack
- breakage

If you experience instability or lack of response, check the electrode, replace if necessary and recalibrate. Follow manufacturer's recommendation for cleaning the electrode.

Take care not to damage input cables, or allow the connections to get wet.

6.0 Troubleshooting

Troubleshooting and repair of the malfunctioning unit should only be attempted by qualified personnel using caution to ensure safety and limit unnecessary damage.

Should an error or alarm condition occur, the controller will alert the operator by flashing an ‘ERROR MESSAGE’. These messages are depicted on the following page with a brief explanation.

6.1 Error Messages

Note *Turn system off to clear error message.*

Display	Meaning
E 1	**E1 = LOW LEVEL SWITCH**
E 2	**E2 = FLOW SWITCH**
E 3	**E3 = ALARM 1: LOW pH (PUMP B)**
E 4	**E4 = ALARM 2: HIGH pH (PUMP A)**
E 5	**E5 = Pump B ‘LOCKOUT**
E 6	**E6 = Pump A ‘LOCKOUT**
E 7	**E7 = CALIBRATION ERROR** **Probe is out of Manufacturer’s Limits**
E 9	**E9 = FAULTY/DISCONNECTED PROBE**

7.0 DP5000 Specifications

Power Requirements	115 VAC ±15%, 60 Hz 230 VAC ±15%, 50 Hz Voltage input selectable via a selector switch located on the I/O PCB.
Inputs	Flow Switch, Remote ON/OFF, Spares. All low voltage inputs active low, i.e., the active state is when the switch is closed. The switch must be capable of switching 2 mA at ± 15 VDC.
Outputs	Pulse Pump A and B, Alarm. All low voltage outputs capable of switching 2 mA at + 24 VDC. The pulse output frequency range will be 0-100 per minute. The pulse output active low. The pulse width 100 ms in the active (low) state.
Output Type:	Opto-Isolated NPN transistor open collector configuration.
Keypad	Nine key membrane keypad with tactile response.
Material:	(The switches are multiplexed 3 x 3.)
Actuation Force:	Polyester with a hard coat finish
Travel:	2.6 N to 3.3 N
Termination Connector:	0.65 mm 6-way gold plated Berg clincher type 65801-035
Temperature Input	The temperature input interfaces to a platinum 1000 ohm RTD probe.
Probe:	PT1000 (Platinum, 1000 Ω base resistance)
Circuit Accuracy:	± 0.9° F (± 0.5° C)
Temperature Display:	32° F to 212° F (0° C to100° C)
Temperature Resolution:	± 1.8° F (± 1° C)
pH Probe Input	
Accuracy:	± 0.02 pH (500M Ω probe ambient cycle 32° F to 113° F [0° C to 45° C])
Resolution:	0.01 pH
Input pH Range:	0-14 pH
Input Impedance Differential:	10^{13} Ω
Input Impedance Common:	10^{16} Ω
ESD Protection:	700 V
Relays	Fuse protected
Alarm Relays (2):	Electromechanical
Solenoid Valve Relay (1):	115/230 VAC, 10 A/6 A
Current/Voltage Rating:	10A, 115 VAC or 6A, 230 VAC
Contact Type:	Normally open and normally closed contacts (FORM C) Change over relay
Pump ON/OFF Relay (2)	115 V/230 VAC, 10 A/6 A (NO)
(ON/OFF CONTROL)	ON/OFF Relays are Fuse Protected (FORM C). Normally open relay
Fuse:	4 A, 250 VAC time delay (Anti-surge)
LCD Display	
Operating Voltage:	5 V
Operating Temperature	32° F to +122° F (0° C to +50° C)
Viewing Area:	1.2 x 1.8 inches (30 x 46 mm)
Backlight:	An 8 emitter (dual LED type), double row, reflective backed, backlight module will be used. The light output color and reflective backing color will be high performance green.
Memory Backup	EEPROM
Data Retention No Power:	10 year minimum

Pre-amplifier
Output Voltages

Voltage:	± 5 V
Output Voltage Tolerance:	± 5% maximum
Current Output:	± 10 mA maximum

Optional Output

4-20 mA Load:	500 Ω maximum resistance
Accuracy:	± 0.2 mA - The 4-20 mA isolated

Control Outputs	
(Pump A / Pump B)	Opto-Isolated Open Collector (2 mA)
(Proportional Control)	
Fault:	Opto-Isolated Open Collector (2 mA)

Control Inputs	
Remote ON / OFF:	Opto-Isolated (2 mA)
Flow Switch:	Opto-Isolated (2 mA)
Low Level Input:	Opto-Isolated (2 mA)
Aux (spare):	Opto-Isolated (2 mA)

Environmental	Printed Circuit Boards conformally coated
Operating Temperature:	32° F to 122° F (0° C to 50° C)
Enclosure:	IEC IP65, NEMA 4X

Mechanical	Two printed circuit boards (3 if option installed)
Control Board:	(Microcontroller & Display) - Low Voltage
Terminal/Power Board:	Transformer, fuses, terminal blocks, relays
Option Board:	(4-20 mA output) - Low Voltage

8.0 Program Log

For record keeping, a program log is provided below.

	Proportional		ON/OFF	Proportional		ON/OFF
	Pt 1	Pt 2		Pt 1	Pt 2	
Pump A Set Point	7.5	10.5	7.5			
Pump A Pulses/Min	20	90	/ / /			
Pump B Set Point	6.5	2.5	6.5			
Pump B Pulses/Min	30	65	/ / /			
Hysteresis 1	/ / /	/ / /	0.5			
Hysteresis 2	/ / /	/ / /	0.5			

	Alarms	
Alarm 1	2.0 pH	
Alarm 2	12.5 pH	
Hysteresis	0.5 pH	

	mA Response	
Current Low	4.0 mA	
Signal Low	0.0 pH	
Current High	20.0 mA	
Signal High	14.0 pH	

	Timers	
Pump A On-Time	20:00 Min	
Pump B On-Time	30:00 Min	
Sampling Time	00:10 Min	
Delay to Solenoid ON	5:00 Min	
Solenoid On-Time	20:00 Min	

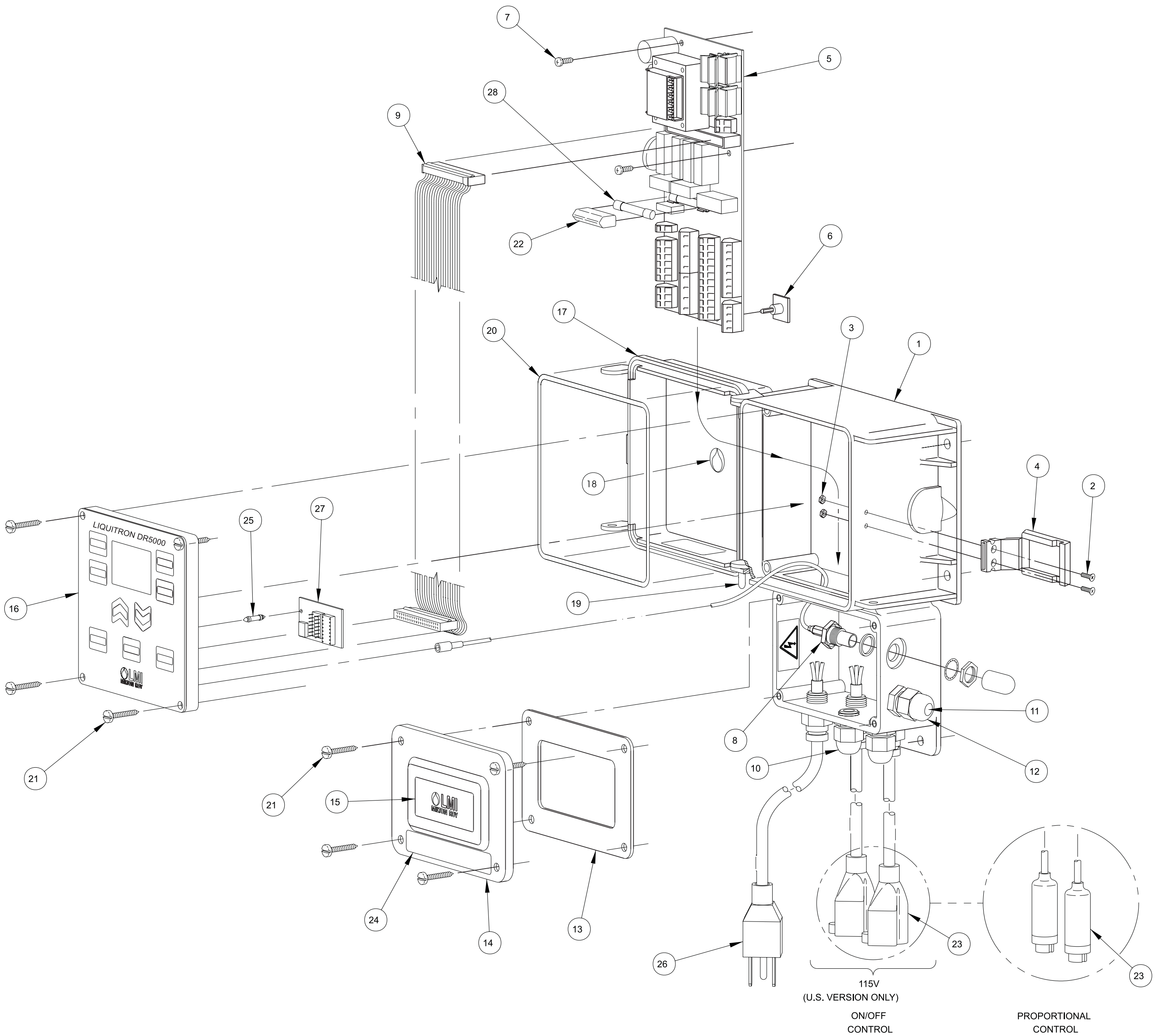
Temperature	24° C	

	Calibration	
Number of Points	2	
Buffer Temperature	Manual	
Buffer Temperature	24	
Buffer 1	7.0	
Buffer 2	10.0	

9.0 Parts List

Key No.	Part No.	Description
1	34691	Housing, Machined
2	32186	Screw, 4-40 x .37
3	32187	Nut, 4-40 Flush
4	32209	Latch, Machined
5	34270	I/O Board Assembly
6	34716	Standoff, Self Adhesive
7	31632	Screw, #6 x .38
8	34329	BNC Cable Assembly
9	34330	Ribbon Cable Assembly
10	25957-1	Cord Clamp (PG-9) Clamp for female outlet power cord)
11	36810	Dowel
12	31571	Clamp, Cord (PG-9) Clamp for 4pin cable
13	34074	Gasket, Foam
14	34088	Cover, Utility Box
15	30588	Label LMI Logo
16	37524	Front Panel Assembly
17	31617	Cover, Liquitron™
18	32094	Label, Housing cover LMI
19	32211	Cap, .125 x .38
20	32352	O-Ring, Sponge
21	32395	Screw, Self-Tapping
22	34911	Cover, Fuse
23	35711	Cord, Power, 115V, NEMA 15-R - DP5000-XA (On/Off)
	33636	4-Pin Cable - DP5000-XB (Proportional)
24	34930	Terminal Cover Label
25	34315	PCB Support
26	30749	Power Cord 115V - DP5000-1A/B
	30751	Power Cord 220V US - DP5000-2A/B
	30752	Power Cord DIN - DP5000-3A/B
	34783	Cord Assembly UK - DP5000-5A/B
	30754	Power Cord AUST - DP5000-6A/B
	34784	Cord Assembly SWISS - DP5000-7A/B
27	37830	4-20mA Circuit Board Assembly
28	35712	Fuse, 4A Time Delay

10.0 Exploded View



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Signet 8750-1 pH/ORP Transmitter

English

3-8750.090-1 Rev. F 3/06 English

⚠ **CAUTION!**

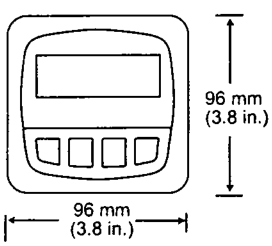
- Remove power to unit before wiring input and output connections.
- Follow instructions carefully to avoid personal injury.

1. Installation

ProcessPro transmitters are available in two styles: panel mount and field mount. The panel mount is supplied with the necessary hardware to install the transmitter. This manual includes complete panel mounting instructions.
Field mounting requires a separate mounting kit. The 3-8050 Universal kit enables the transmitter to be installed virtually anywhere. Detailed instructions for field installation options are included with the 3-8050 Universal kit.

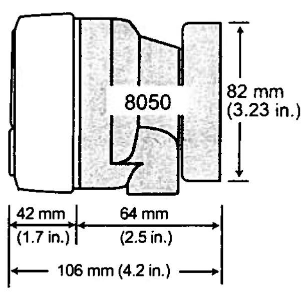
1.1 Panel Installation

1. The panel mount transmitter is designed for installation using a 1/4 DIN Punch. For manual panel cutout, an adhesive template is provided as an installation guide. Recommended clearance on all sides between instruments is 1 inch.
2. Place gasket on instrument, and install in panel.
3. Slide mounting bracket over back of instrument until quick-clips snap into latches on side of instrument.
4. To remove, secure instrument temporarily with tape from front or grip from rear of instrument. DO NOT RELEASE. Press quick-clips outward and remove.



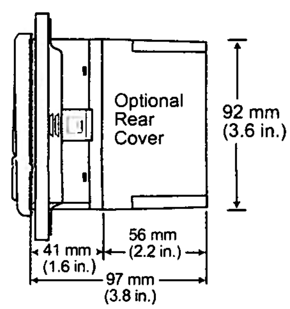
FRONT VIEW

Field Mount & Panel Mount



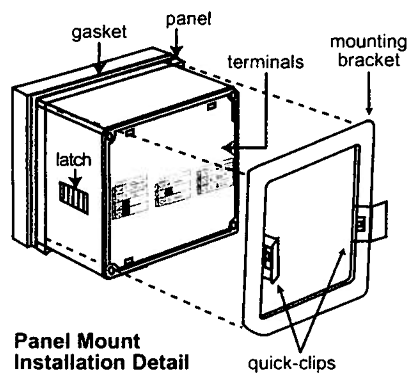
SIDE VIEW

Field Mount



SIDE VIEW

Panel Mount



Panel Mount Installation Detail

2. Specifications

General

Compatible electrodes:
Signet 3-2720 pH/ORP Preamplifier/3-271X Electrodes
Accuracy: ± 0.03 pH, ± 2 mV ORP
Enclosure:

- Rating: NEMA 4X/IP65 front
- Case: PBT
- Panel case gasket: Neoprene
- Window: Polyurethane coated polycarbonate
- Keypad: Sealed 4-key silicone rubber
- Weight: Approx. 325g (12 oz.)

Display:

- Alphanumeric 2 x 16 LCD
- Contrast: User selected, 5 levels
- Update rate: 1 second

Electrical

- Power: 12 to 24 VDC ±5%, regulated, 21 mA max.

Sensor input range:

- pH: 0.00 to 14.00 pH
- temp. (pH only) 3K Balco, -25 to 120°C (-13 to 248°F)
- ORP: -1000 to +2000 mV, isolated
  (10KΩ I.D. resistance T+, T-)

Current output:

- 4 to 20 mA, isolated, fully adjustable and reversible
- Max loop impedance: 50 Ω max. @ 12 V
  325 Ω max. @ 18 V
  600 Ω max. @ 24 V
- Update rate: 0.5 seconds
- Accuracy: ±0.03 mA @ 25°C, 24 V

Open-collector output:

- Isolated, 50 mA sink or source, 30 VDC max. pull-up voltage
- Programmable for:
  - Hi or Lo w/adjustable hysteresis
  - Proportional pulse (400 pulses per minute maximum)

Environmental

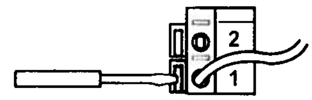
- Operating temperature: -10 to 70°C (14 to 158°F)
- Storage temperature: -15 to 80°C (5 to 176°F)
- Relative humidity: 0 to 95%, non-condensing
- Maximum altitude: 2000 m (6562 ft)
- Insulation category: II
- Pollution degree: 2

Standards and Approvals

- CE, UL listed
- Immunity: EN50082-2
- Emissions: EN55011 Class B
- Manufactured under ISO 9001 and ISO 14001

3. Electrical Connections

⚠ **Caution:** Failure to fully open terminal jaws before removing wire may permanently damage instrument.



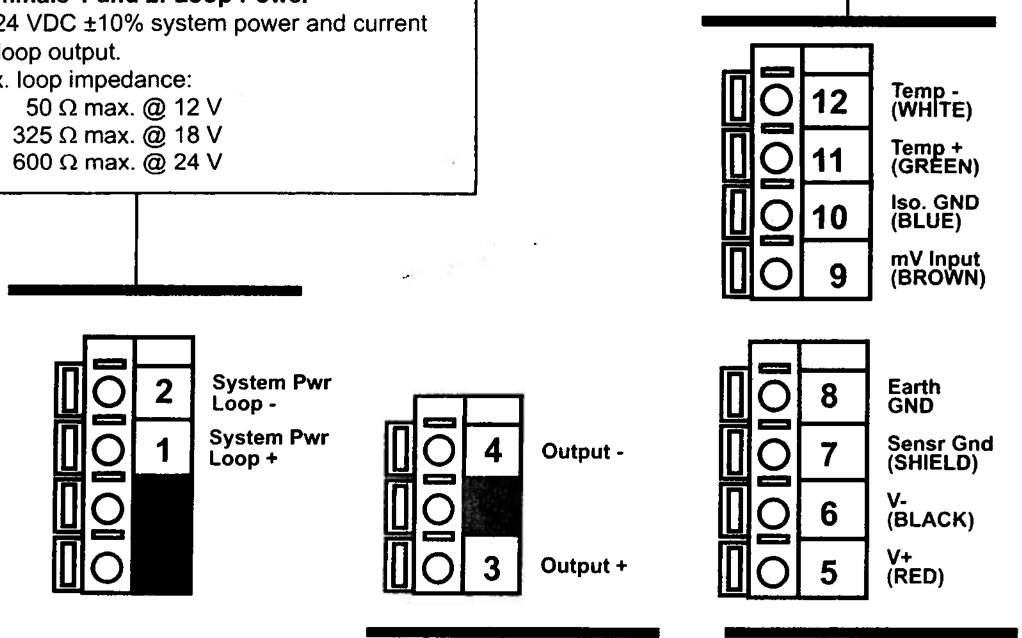
Wiring Procedure
1. Remove 0.5 - 0.625 in. (13-16 mm) of insulation from wire end.
2. Press the orange terminal lever downward with a small screwdriver to open terminal jaws.
3. Insert exposed (non-insulated) wire end in terminal hole until it bottoms out.
4. Release orange terminal lever to secure wire in place. Gently pull on each wire to ensure a good connection.

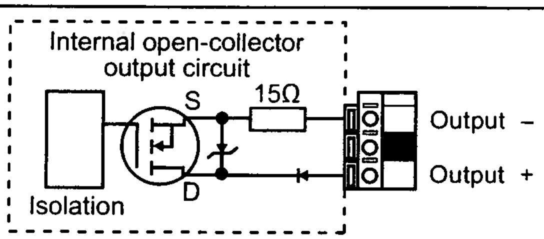
Wiring Removal Procedure
1. Press the orange terminal lever downward with a small screwdriver to open terminal jaws.
2. When fully open, remove wire from terminal.

Wiring Tips:
- Do not route sensor cable in conduit containing AC power wiring. Electrical noise may interfere with sensor signal.
- Routing sensor cable in grounded metal conduit will help prevent electrical noise and mechanical damage.
- Seal cable entry points to prevent moisture damage.
- Only one wire should be inserted into a terminal. Splice double wires outside the terminal.

Terminals 9-12: Sensor connections
9-10 are mV (pH or ORP) input from the electrode.
11-12 are Temperature input from the electrode

Terminals 1 and 2: Loop Power
12-24 VDC ±10% system power and current loop output.
Max. loop impedance:
50 Ω max. @ 12 V
325 Ω max. @ 18 V
600 Ω max. @ 24 V

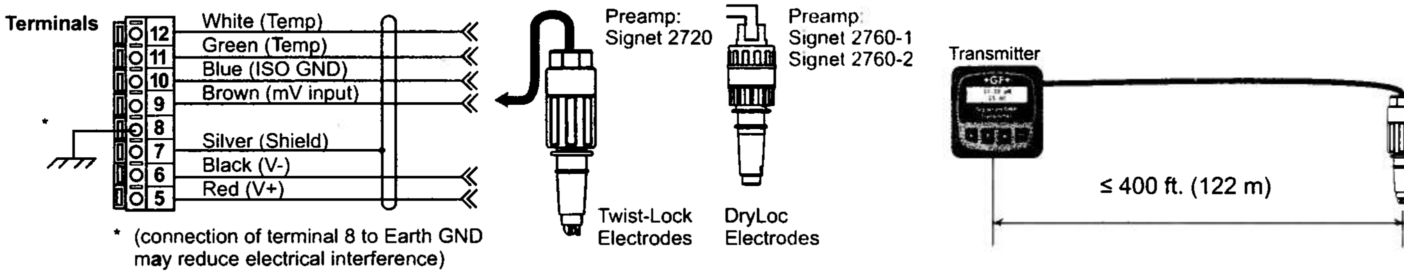




Terminals 3 and 4: Open-collector Output
A transistor output, programmable in CALIBRATE menu as:
- High or Low setpoint with adjustable hysteresis
- Proportional pulse up to 400 pulses per minute
- May be disabled (Off) if not used.

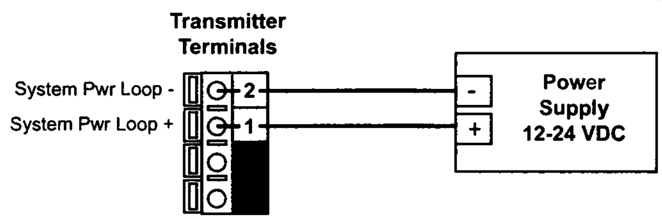
Terminals 5-8: Preamplifier power and grounds
5-6 are DC voltages from the 8750 to power the preamplifier.
7-8 are ground terminals for the sensor and for earth ground.

3.1 Sensor Input Connections

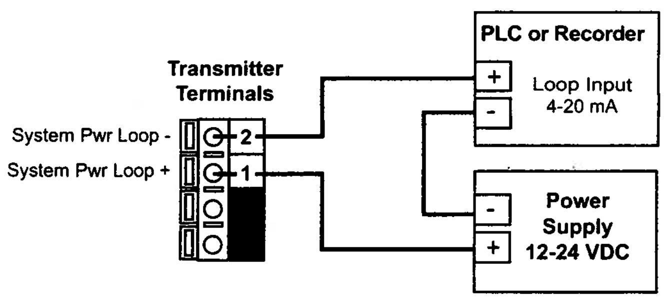


3.2 System Power/Loop Connections

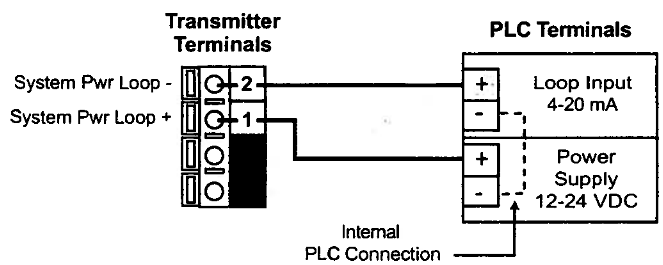
Stand-alone application, no current loop used



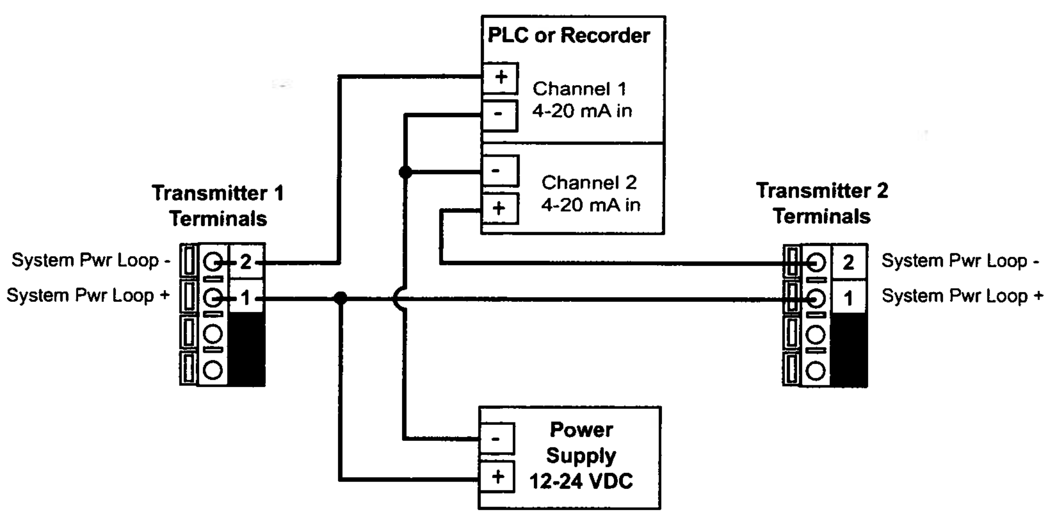
Connection to a PLC/Recorder, separate supply



Connection to a PLC with built-in power supply



Example: Two transmitters connected to PLC/Recorder with separate power supply



3.3 Open Collector Output

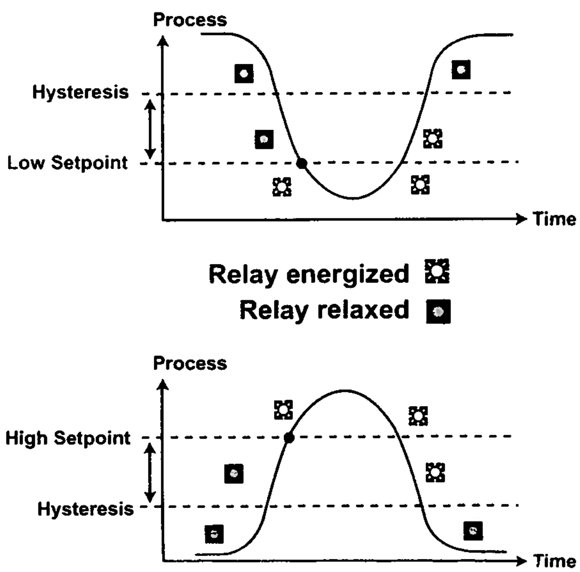
The Open Collector output can be used as a switch that responds when the process value moves above or below a setpoint, or it can be used to generate a pulsing signal with a rate proportional to the process value.

- **Low:**

Output triggers when process variable is less than the setpoint. The output will relax when the process moves above the setpoint plus the hysteresis value.

- **High:**

Output triggers when process variable is greater than the setpoint. The output will relax when the process variable moves below the setpoint plus the hysteresis value.

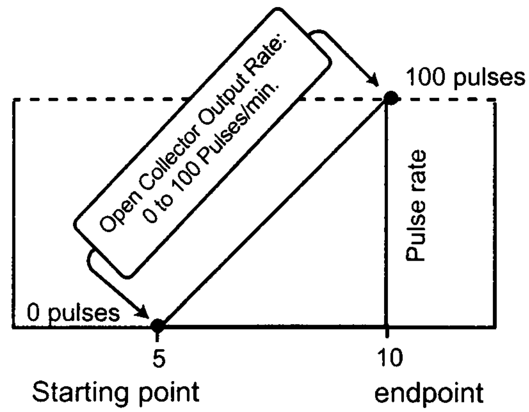


- **Proportional Pulsing**

The Open Collector output will generate a 100 mS pulse at the rate defined by settings in the CALIBRATE menu (see page 6)

In the example below:

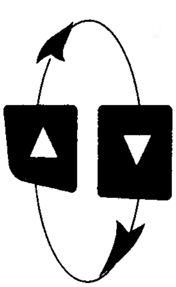
- The output will be 0 pulses/min. at pH values less than 5.0.
- The output will be 50 pulses/min. at 7.5 pH.
- The output will be 100 pulses/min. at pH values above 10 pH.



VIEW Menu

- During normal operation, ProcessPro displays the VIEW menu.
- When using the CALIBRATE or OPTIONS menus, ProcessPro will return to the VIEW menu if no activity occurs for 10 minutes.
- To select the item you want displayed, press the UP or DOWN arrow keys. The items will scroll in a continuous loop. Changing the display selection does not interrupt system operations.
- No key code is necessary to change display selection.
- Output settings cannot be edited from the VIEW menu.

View Menu for pH



Display	Description
7.00 pH 12.6 °C	Monitor the Temperature input from the sensor. This is the permanent view display.
All of the displays below are temporary. The permanent display will return after ten minutes.	
Input: 307 mV	Monitor the millivolt input from the electrode. Use this display to determine the relative condition of your electrode during periodic calibration. (7 pH buffer = 0 mV, ±50 mV)
Loop Output: 14.16 mA	Monitor the 4-20 mA Loop output.
Last CAL: 06-30-01 >	Monitor date for scheduled maintenance or date of last calibration.
EASY CAL: >	Easy Cal is the fastest and simplest periodic calibration method. Requires 4 pH, 7 pH and 10 pH. (Any two)

ProcessPro Editing Procedure:

Step 1. Press and hold ENTER key:
- 2 seconds to select the CALIBRATE menu
- 5 seconds to select the OPTIONS menu.

Step 2. The Key Code is UP-UP-UP-DOWN keys in sequence.
- After entering the Key Code, the display will show the first item in the selected menu.

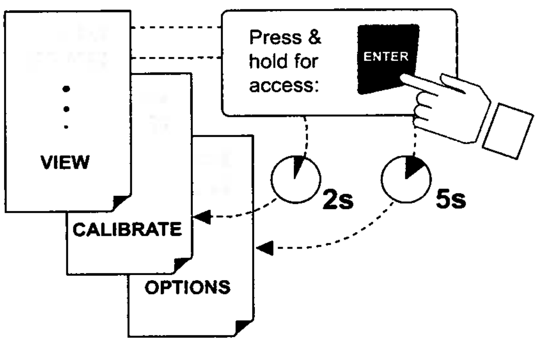
Step 3. Scroll menu with UP or DOWN arrow keys.

Step 4. Press RIGHT ARROW key to select menu item to be edited.
- The first display element will begin flashing.

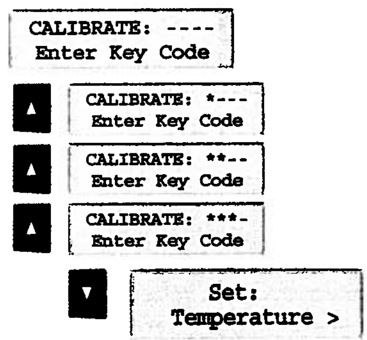
Step 5. Press UP or DOWN keys to edit the flashing element.
- RIGHT ARROW key advances the flashing element.

Step 6. Press ENTER key to save the new setting and return to Step 3.

Notes on Step 1:
- The View Menu is normally displayed.
- The CALIBRATE and OPTIONS menus require a KEY CODE.



Notes on Step 2:
If no key is pressed for 5 minutes while display is showing "Enter Key Code", the display will return to the VIEW menu.

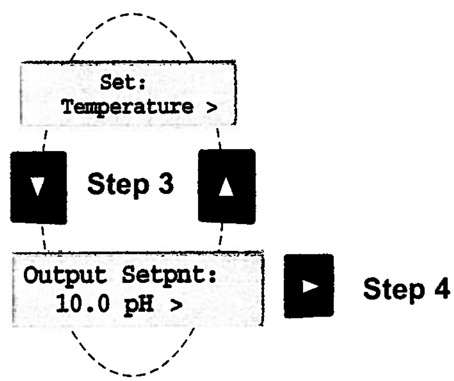


First item in CALIBRATE menu

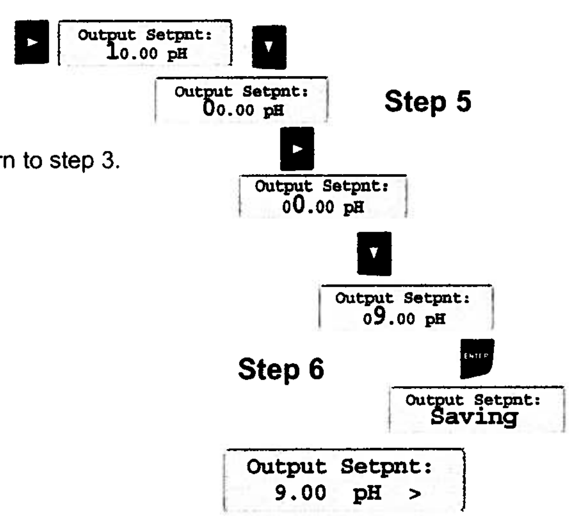
Notes on Steps 3 and 4:
- Refer to pages 6 and 7 for complete listing of menu items and their use.
- From the Step 3 display, pressing the UP and DOWN keys simultaneously will return the display to the VIEW menu.
- If no key is pressed for 10 minutes, display will also return to the VIEW menu.

Step 3: Finished Editing?

Press the UP and DOWN keys simultaneously after saving the last setting to return to normal operation.



Notes on Steps 5 and 6:
- All output functions remain active during editing.
- Only the flashing element can be edited.
- RIGHT ARROW key advances the flashing element in a continuous loop.
- Edited value is effective immediately after pressing ENTER key.
- If no key is pressed for 10 minutes unit will restore the last saved value and return to step 3.
- Step 6 (pressing ENTER key) always returns you to Step 3.
- Repeat steps 3-6 until all editing is completed.



Step 5: Made an Error?

Press the UP and DOWN keys simultaneously while any element is flashing. This will recall the last saved value of the item being edited and return you to Step 3.

Calibrate Menu for pH

Display (Factory settings shown)	Description
Set: Temperature >	Provides a maximum 25°C offset to match temperature measurement to external reference.
Set: Standard >	Applies a linear offset to the pH measurement. The ideal value is the average pH of your application. (A sample of your application at process temperature is recommended.)
Set: Slope >	Applies a slope to the pH measurement. The slope value and the standard value must be at least 2 pH units apart. The ideal values are the minimum and maximum values of your process.
Loop Range: pH 0.00 → 14.00 >	Select the minimum and maximum values for the 4-20 mA Current loop output.
Output Source: pH >	Select pH or Temperature as the source for the Open Collector Output.
Output Mode: Low >	Select the mode of operation for the Open Collector output: High, Low or proportional Pulse. The signal may be disabled if not in use.
Output Setpnt: 4.00 pH >	In Low or High Mode, the Open Collector output will be activated when the pH reaches this value.
Output Hys: 0.50 pH >	In Low or High mode, the Open Collector output will be deactivated at Setpoint ± Hysteresis, depending on High or Low Setpoint selection. (See details on page 4.)
Output Range: pH 4.00 → 8.00 > Output PlsRate: 120 Pulses/min >	If the output is in PULSE mode, set the start and end point of the range and also set the maximum pulse rate. (The maximum PULSE rate setting is 400 pulses per minute.) The combined Output Range and Pulse rate settings shown here indicate: "Start pulsing when the pH value is 4 and increase the pulse rate up to the maximum of 120 pulses per minute when the pH value reaches 8"
Last CAL: 12-9-06 >	Use this "note pad" to record important dates, such as annual recertification or scheduled maintenance.

EASY CAL Procedure - pH

- This procedure simplifies system calibration using standard 4.0, 7.0, 10.0 pH buffers only. If these pH buffers are not available, calibrate the system via the CALIBRATE menu, using the STANDARD and SLOPE settings.
- Access the CALIBRATE menu and set sensor temperature before performing EASY CAL for new electrode installations.
- Access EASY CAL menu from the view menu.

```
EASY CAL: ----
Enter Key Code
```

Press UP, UP, UP, DOWN buttons in sequence to enter menu, XXXX will appear during code entry.

To Calibrate:	Response:	To Accept:

`Place Sensor in` `pH Buffer #1`
Place electrode tip in first pH buffer
pH 7.0 = 0 mV
pH 4.0 = 177
pH 10 = -177
Limit ± 50 mV
	`6.90 pH` `-005 mV`
	Allow for stabilization
	30 seconds*
		`6.90 pH` `-005 mV`
		ENTER to accept
		`7.00 pH` `-005 mV`

`Place Sensor in` `pH Buffer #2`
Place electrode tip in second pH buffer.
	`3.93 pH` `+179 mV`
	Allow for stabilization
	30 seconds*
		`3.93 pH` `+179 mV`
		Press ENTER to accept second buffer calibration.
		`4.00 pH` `+179 mV`

To exit menus and return to VIEW press UP and DOWN button at the same time	Display returns to VIEW Menu in 10 minutes or when ENTER is pressed	`Good Easy Cal` `Press <ENTER>`

Theoretical mV values

pH @ 25°C	mV
2	+296
3	+237
4	+177
5	+118
6	+59
7	+0
8	-59
9	-118
10	-177
11	-237
12	-296

Options Menu for pH

Display (Factory settings shown)	Description
`Contrast:` `3 >`	Adjust the LCD contrast for best viewing. A setting of 1 is lower contrast, 5 is higher. Select lower contrast if the display is in warmer ambient surroundings.
`Averaging:` `Off >`	OFF provides the most instantaneous output response to changes in input value. LOW averaging = 4 seconds, HIGH averaging = 8 seconds of input signal. Longer averaging produces more stable display and output response.
`Output Active:` `Low >`	Active HIGH: This setting is used to turn a device (pump, valve) ON at the setpoint. Active LOW: This setting is used to turn a device OFF at the setpoint.
`Loop 1 Adjust:` `4.00 mA >` `Loop 1 Adjust:` `20.00 mA >`	Adjust the minimum and maximum current output. The display value represents the precise current output. Adjustment limits: • 3.80 mA < 4.00 mA > 5.00 mA • 19.00 mA < 20.00 mA > 21.00 ma Use this setting to match the 8750 loop output to any external device.
`Test Loop1:` `>`	Press UP or DOWN keys to manually order any output current value from 3.6 mA to 21.00 mA to test current loop output.
`Test Output1:` `>`	Press UP or DOWN keys to manually toggle the state of the open collector output.

Calibrate Menu for ORP

Display (Factory settings shown)	Description
Set: Standard >	Applies a linear offset to the ORP measurement. The ideal value is the average pH of your application. (A sample of your application at process temperature is recommended.)
Set: Slope >	Applies a slope to the ORP measurement. The slope value and the standard value must be at least 120 mV apart. The ideal values are the minimum and maximum values of your application.
Loop Range: mV -1000 → +1000 >	Select the minimum and maximum ORP values for the 4-20 mA Current loop output. Minimum range is -1000 mV; Maximum range is +2000 mV.
Output Mode: Off >	Select the desired mode of operation for the Open Collector output: High, Low or proportional Pulse. The signal may also be disabled if not in use.
Output Setpnt: -500 mV >	In Low or High Mode, the Open Collector output will be deactivated when the ORP reaches this value.
Output Hys: 10 mV >	In Low or High mode, the Open Collector output will be deactivated at Setpoint ± Hysteresis, depending on High or Low Setpoint selection. (See details on page 4.)
Output Range: mV -500 → +500 > Output PlsRate: 120 pulses/min >	If the output is in PULSE mode, set the start and end point of the range and also set the maximum pulse rate. (The maximum PULSE rate setting is 400 pulses per minute.) The combined Output Range and Pulse rate settings shown here indicate: "Start pulsing when the ORP value is -500 and increase the pulse rate up to the maximum of 120 pulses per minute when the ORP value reaches +500"
Last Cal: 06-30-01 >	Use this "note pad" to record important dates, such as annual recertification or scheduled maintenance.

EASY CAL Procedure - ORP

- This procedure simplifies system calibration using standard 4.0 pH and 7.0 pH buffers **saturated with Quinhydrone**. To calibrate using any other ORP buffer solutions, use the Standard and Slope functions in the CALIBRATE menu.
- Access EASY CAL menu from the view menu.

EASY CAL: ---- Enter Key Code	Press UP, UP, UP, DOWN buttons in sequence to enter menu, **** will appear during code entry.

To Calibrate:	Response:	To Accept:
Place Sensor in ORP Buffer #1 Place electrode tip in first pH buffer; pH 7.0 87 mV pH 4.0 264 mV	*ORP: + 84 mV Input: + 82 mV Allow for stabilization 30 seconds*	*ORP: + 84 mV Input: + 82 mV ENTER to accept *ORP: + 87 mV Input: + 82 mV
Place Sensor in ORP Buffer #2 Place electrode tip in second (different) pH buffer. pH 4.0 264 mV pH 7.0 87 mV	*ORP: +262 mV Input: +260 mV Allow for stabilization 30 seconds*	*ORP: +262 mV Input: +260 mV Press ENTER to accept second buffer calibration. *ORP: +264 mV Input: +260 mV
To exit menus and return to VIEW press UP and DOWN button at the same time	Display returns to VIEW Menu in 10 minutes or when ENTER is pressed	Good Easy Cal Press <ENTER>

* For best results, gently stir the submerged electrode for approximately 5 seconds during the stabilization period. Large temperature differences from process fluids to buffers may require longer stabilization time.

Technical notes:
The difference between the actual mV and value shown is a good indication of the condition of the electrode.
Differences in excess of 50 mV may indicate a need to service the electrode.

Options Menu for ORP

Display (Factory settings shown)	Description
Contrast: 3 >	Adjust the LCD contrast for best viewing. A setting of 1 is lower contrast, 5 is higher. Select lower contrast if the display is in warmer ambient surroundings.
Averaging: Off >	OFF provides the most instantaneous output response to changes in input value. LOW averaging = 4 seconds, HIGH averaging = 8 seconds of input signal. Longer averaging produces more stable display and output response.
Output Active: Low >	Active HIGH: This setting is used to turn a device (pump, valve) ON at the setpoint. Active LOW: This setting is used to turn a device OFF at the setpoint.
Loop 1 Adjust: 4.00 mA > Loop 1 Adjust: 20.00 mA >	Adjust the minimum and maximum current output. The display value represents the precise current output. Adjustment limits: • 3.80 mA < 4.00 mA > 5.00 mA • 19.00 mA < 20.00 mA > 21.00 ma Use this setting to match the 8750 loop output to any external device.
Test Loop1: >	Press UP or DOWN keys to manually order any output current value from 3.6 mA to 21.00 mA to test current loop output.
Test Output1: >	Press UP or DOWN keys to manually toggle the state of the open collector output.

Troubleshooting - pH

Display Condition	Possible causes	Suggested Solutions
During EasyCal: "Out of Range Use Manual CAL"	1. Required 4, 7 or 10 buffers not being used. 2. Sensor is depleted too severely to use EasyCal	1. Use pH 4, 7, 10 buffers 2. Clean probe and retry EASY CAL. 3. Use Manual calibration for Standard and Slope if mV offset exceeds 50 mV.
During EasyCal: "Same Buffer"	Sensor was not moved from buffer #1 to buffer #2.	1. Place sensor in correct buffer solution. 2. Use fresh buffer.
During CALIBRATE Std: "Standard too close to Slope!"	1. pH Standard value within 2 pH units of Slope value 2. pH Sensor efficiency is inadequate	1. Use pH values at least 2 pH units apart. 2. Clean pH sensor; replace if necessary 3. Use fresh buffer.
During CALIBRATE Slope: "Slope too close to Standard!"	1. pH Slope value within 2 pH units of Standard value 2. pH Sensor efficiency is inadequate	1. Use pH values at least 2 pH units apart. 2. Clean pH sensor; replace if necessary 3. Use fresh buffer.
During CALIBRATE: "Out of Range Check Sensor"	1. No temperature or mV signal from sensor detected. 2. No connection between pH sensor and preamplifier.	1. Check all wiring, contacts in preamplifier. 2. Verify sensor is securely installed. 3. Replace pH sensor.
During normal operation: Constant "15.00 pH" or constant "0.00 pH" with good temp value	mV input is less than 0 pH or greater than 15 pH.	1. Recalibrate system. 2. Replace pH sensor 3. Replace preamplifier.
During normal operation: "Check Sensor?"	1. No temperature or mV signal from sensor detected. 2. No connection between pH sensor and preamplifier.	1. Check all wiring, contacts in preamplifier. 2. Verify sensor is securely installed. 3. Replace pH sensor.

The mV value from the sensor when placed in a 7 pH buffer represents the sensor offset. Signet recommends servicing/replacing the sensor when the offset exceeds 50 mV.
The 3-2759 pH/ORP system tester allows simple system troubleshooting.

Troubleshooting - ORP

Display Condition	Possible causes	Suggested Solutions
During EasyCal: "Out of Range Use Manual CAL"	1. Required 4, 7 buffers with quinhydrone not being used. 2. Sensor is depleted too severely to use EasyCal.	1. Use pH 4, 7 buffers saturated with quinhydrone. 2. Clean probe and retry EASY CAL. 3. Use Manual calibration for Standard and Slope if mV offset exceeds 50 mV.
During EasyCal: "Same Buffer"	Sensor was not moved from buffer #1 to buffer #2.	1. Place sensor in correct buffer solution. 2. Use fresh buffer.
During CALIBRATE Std: "Standard too close to Slope!"	1. ORP Standard value within 120 mV of Slope value. 2. ORP Sensor efficiency is inadequate.	1. Use ORP values at least 120 mV apart. 2. Clean ORP sensor; replace if necessary. 3. Use fresh buffer.
During CALIBRATE Slope: "Slope too close to Standard!"	1. ORP Slope value within 120 mV of Standard value. 2. ORP Sensor efficiency is inadequate.	1. Use ORP values at least 120 mV apart. 2. Clean ORP sensor; replace if necessary 3. Use fresh buffer.
During CALIBRATE: "Out of Range Check Sensor"	1. No mV signal or sensor id from sensor detected. 2. No connection between ORP sensor and preamplifier.	1. Check all wiring, contacts in preamplifier. 2. Verify sensor is securely installed. 3. Replace ORP sensor.
During normal operation: Constant "-1000" or constant ""+2000"	mV input is less than -999 or greater than +1999.	1. Recalibrate system. 2. Replace pH sensor. 3. Replace preamplifier.
During normal operation: "Check Sensor?"	1. No temperature or mV signal from sensor detected. 2. No connection between ORP sensor and preamplifier.	1. Check all wiring, contacts in preamplifier. 2. Verify sensor is securely installed. 3. Replace ORP sensor.

Ordering Information

Mfr. Part No.	Code	Description
3-8750-1	159 000 053	pH/ORP transmitter Field mount
3-8750-1P	159 000 054	pH/ORP transmitter Panel mount
3-8750-2	159 000 055	pH/ORP transmitter Field mount with relays
3-8750-2P	159 000 056	pH/ORP transmitter Panel mount with relays
3-8750-3	159 000 057	pH/ORP transmitter Field mount with single input/dual output
3-8750-3P	159 000 058	pH/ORP transmitter Panel mount with single input/dual output

Accessories

Mfr. Part No.	Code	Description
3-2714	198 844 300	Twist-Lock Flat pH electrode
3-2714-HF	198 844 305	Twist-Lock Flat pH hydrofluoric acid resistant electrode (<2%)
3-2716	198 844 302	Twist-Lock Bulb pH electrode
3-2716-DI	198 844 306	Twist-Lock Bulb pH electrode for process liquids (< l00 μs)
3-2715	198 844 301	Twist-Lock Flat ORP Electrode
3-2717	198 844 303	Twist-Lock Bulb ORP Electrode
3-2720	198 864 602	Twist-Lock Preamplifier, ¼ in. NPT
3-2720-2	198 864 603	Twist-Lock Preamplifier, ISO 7/1-R 3/4
P31542	198 801 630	Red sensor cap for in-line installations
P31542-3	159 000 464	Blue sensor cap for in-line installations
3-2759	159 000 762	pH/ORP system tester (includes bypass adapter)
3-2759.393	159 000 765	2720 Adapter Cable
P31515-0P200	159 000 630	PVC Pipe Adapter
P31515-0C200	159 000 631	CPVC Pipe Adapter
P31515-0V200	159 000 459	PVDF Pipe Adapter
1220-0021	198 801 186	O-ring, FPM (standard)
1224-0021	198 820 006	O-ring, EPR
1228-0021	198 820 007	O-ring, Kalrez®
3-8050	159 000 184	Universal mounting kit
3-8050.395	159 000 186	Splashproof rear cover
3-8050.396	159 000 617	RC Filter kit (for relay use)
3-8052	159 000 188	3/4" Integral mounting kit
3-8052-1	159 000 755	3/4" NPT mount junction box
3-0000.596	159 000 641	Heavy duty wall mount bracket
3-0700.390	198 864 403	pH buffer kit
3-8050.392	159 000 640	Model 200 retrofit adapter
3-5000.598	198 840 225	Surface mount bracket
3-5000.399	198 840 224	5 x 5 inch adapter plate for +GF+ Signet retrofit
3-9000.392	159 000 368	Liquid-tight connector kit, 3 sets, 1/2 in. NPT
3-9000.392-1	159 000 839	Liquid-tight connector kit, 1 set, 1/2 in. NPT
3-9000.392-2	159 000 841	Liquid-tight connector kit, 1 set, PG 13.5
7300-7524	159 000 687	24 VDC Power Supply 7.5 Ω, 300mA
7300-1524	159 000 688	24 VDC Power Supply 15 Ω, 600mA
7300-3024	159 000 689	24 VDC Power Supply 30 Ω, 1.3 A
7300-5024	159 000 690	24 VDC Power Supply 50 Ω, 2.1 A
7300-1024	159 000 691	24 VDC Power Supply 100 Ω, 4.2 A
3-3719-11	159 000 804	pH/ORP Wet-Tap, 1½ in. NPT
3-3719-21	159 000 805	pH/ORP Wet-Tap, 2 in. NPT
3-3719-12	159 000 806	pH/ORP Wet-Tap, ISO 7/1-R 1.5
3-3719-22	159 000 807	Wet-Tap Assembly, ISO 7/1-R 2
3-2716-WT	159 000 809	Twist-Lock pH Electrode (use with 3719 Wet-Tap)
3-2717-WT	159 000 811	Twist-Lock ORP Electrode (use with 3719 Wet-Tap)
2007-0225	159 000 812	PP Clamp-on Saddle, 2.5 in. x 1½ in. (ASTM, NPT)
2007-0230	159 000 813	PP Clamp-on Saddle, 3 in. x 1½ in. (ASTM, NPT
2007-0240	159 000 814	PP Clamp-on Saddle, 4 in. x 1½ in. (ASTM, NPT)
2007-0260	159 000 815	PP Clamp-on Saddle, 6 in. x 2 in. (ASTM, NPT)
2007-0280	159 000 816	PP Clamp-on Saddle, 8 in. x 2 in. (ASTM, NPT)
2007-0210	159 000 817	PP Clamp-on Saddle, 10 in. x 2 in. (ASTM, NPT)
2007-0212	159 000 818	PP Clamp-on Saddle, 12 in. x 2 in. (ASTM, NPT)

+GF+

George Fischer Signet, Inc., 3401 Aerojet Avenue, El Monte, CA 91731-2882 U.S.A. • Tel. (626) 571-2770 • Fax (626) 573-2057
For Worldwide Sales and Service, visit our website: www.gfsignet.com • Or call (in the U.S.): (800) 854-4090

Printed in U.S.A. on recycled paper

Signet DryLoc™ pH and ORP Electrodes

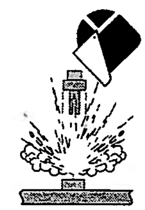
For all Signet DryLoc™ Electrodes:
2754-2757 Standard electrodes
2764-2767 Differential Electrodes
2774-2777 Combination Electrodes

English

3-2754.090 Rev. E 3/06 English

WARNING!

SAFETY INSTRUCTIONS
1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or faceshield during installation/service.
5. Do not alter product construction.
6. When using chemicals or solvents care should be taken and appropriate eye, face, hand, body, and/or respiratory protection should be used.



1. Specifications

General

Compatibility: Signet 2750 Electronics; Signet 2760 Preamplifiers

Operating Range:
- pH: 0 to 14 pH
- ORP (Redox): 2765, 2767: ±1500 mV; 2755, 2757: ±2000 mV; 2775, 2777: ±1500 mV

Wetted Materials (2764 and 2774 series):
- Body: PPS (Ryton®)
- Reference junctions: PTFE (Teflon™)
- Sensing surface: Glass membrane (pH); Platinum (ORP)
- O-rings: FPM
- Solution ground: carbon graphite (2764 series only)

Wetted Materials (2754-2757 Series):
- Body: CPVC
- Reference junctions: UHMW Polyethylene
- Sensing surface: Glass membrane (pH); Platinum (ORP)
- O-rings: FPM

Reference Electrolyte:
- 2754 series electrodes: solidified acrylamide gel, KCl
- 2764 series electrodes: Equitransferant reference buffer acrylamide KNO_3 salt bridge
- 2774 series electrodes: acrylamide gel, KNO_3 / KCl

Reference Element: Ag/AgCl

Temperature Sensor:
- pH: 3KΩ, PT1000 or 300Ω
- ORP: 10 KΩ, PT1000 or 300Ω

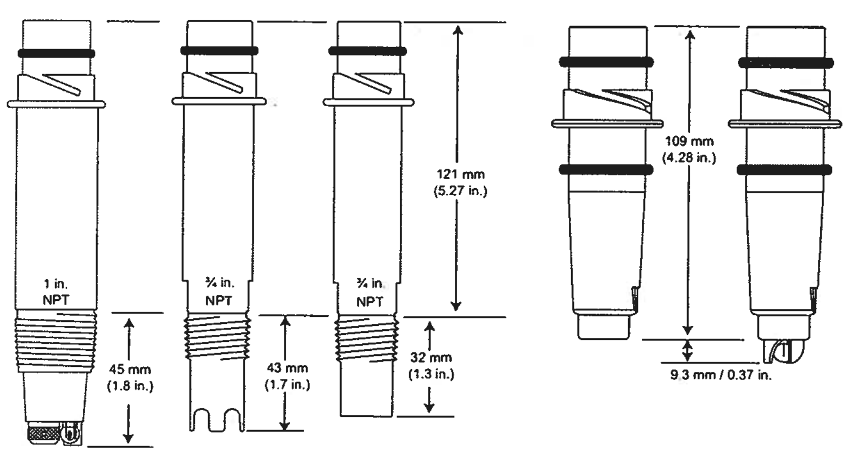
Temperature response time τ:
- 2754 electrodes: 140 s
- 2756 electrodes: 196 s
- 2764, 2774, 2776 series: 20 s

Maximum Temperature/Pressure:
Operating Temperature:
- 2764 series: 0°C to 95°C (32°F to 203°F)
- 2774 series: 0°C to 85°C (32°F to 176°F)
- 2754 series: 0°C to 85°C (32°F to 176°F)

Max. Operating Pressure: 6.89 bar @ 95°C (100 psi @ 203°F)
Storage Temperature: >0°C (32°F)
Shipping Weight: 0.25 kg (0.55 lbs.)

Standards & Approvals
- Manufactured under ISO 9001:2000 for Quality

2764 series Differential electrode
2774 series Bulb electrode
2776 series Flat electrode
2754 & 2755 Flat electrode
2756 & 2757 Bulb electrode



4. ORP Electrode Calibration
ORP electrodes are designed to ensure linearity during their lifespan. The following sections define proper electrode operation.

4.1 Offset (STD)
- Electrode offsets are usually caused by clogged reference junctions or by aged or contaminated reference solution/wire.
- Offsets should be checked in pH 7 buffer saturated with quinhydrone @ 25°C. The theoretical output is +86 mV. Any deviation from +86 mV is the ORP electrode offset (i.e. +90 mV).
- Quinhydrone is the oxidizer measured by the ORP electrode and is required for calibration. To measure ORP electrode offset, saturate 50 mL of pH 4 and pH 7 buffers with ⅛ g quinhydrone:

	4 pH w/Quinhydrone			**7 pH w/Quinhydrone**		
Temp:	20°C	25°C	30°C	20°C	25°C	30°C
ORP:	268 mV	263 mV	258 mV	92 mV	86 mV	79 mV

A new ORP electrode measures these values ±15 mV. The electrode continues to be functional until the offset from these values exceeds 50 mV. Electrodes with offset greater than 50 mV should be cleaned and replaced if necessary.

4.2 Slope (SLP)
ORP slope errors are generally caused by contamination of the platinum electrode surface. Cleaning the electrode surface will usually restore proper values, response time, and stability. See section 5: Maintenance and Cleaning.

Many systems require both pH and ORP calibration. To conserve calibration reference solutions, use pH 7 and 4 buffers for pH calibration first. ORP calibration can be performed with the same buffers by adding quinhydrone.

5. Maintenance and Cleaning

5.1 Maintenance
Variables can affect long term pH or ORP electrode life. For this reason, a maintenance log is recommended for trend analysis. When storing boxed sensors, lay the sensor flat to maximize hydration of the glass surface. Keep the glass surface wet at all times. Soak the sensor tip in pH 4.0 buffer during system maintenance intervals. In-line applications should be plumbed with a depression (trap) so liquid is maintained around the sensor tip. If the sensor dehydrates, soak the sensor tip in pH 4 buffer for 24 to 48 hours, then visually inspect the electrode for surface cracks, swelling, or discoloration. Severely dehydrated electrodes cannot be restored to normal operation.

5.2 Cleaning
Cleaning techniques vary depending on the type of coating present on the glass electrode surface or reference junction.
- Soft coatings can be removed by vigorous stirring, or with directed spray of an applicable detergent or solvent onto the glass surface. Chlorine bleach or mild detergent can be used to remove soft coatings. Always rinse electrode tip in clean water after cleaning.
- Hard coatings can be chemically removed. Use the least harsh chemical which will remove the contaminant within two (2) minutes without attacking the materials of construction. e.g. calcium carbonate may be removed with a 5% HCL (muriatic acid) solution.
- Oily or organic coatings can be removed with detergents or an appropriate solvent that does not attack the materials of construction e.g. isopropyl alcohol may be used but acetone must be avoided to prevent damage to the CPVC sensor body.
- ORP electrode surface (platinum rod) can be gently sanded with 600 grit wet and dry silicone or carbide sandpaper, jewelers rouge, crocus cloth, or very fine steel wool.

5.3 Differential Electrodes
Differential electrodes have a replaceable salt bridge and the electrolyte chamber can be refilled.
The electrolyte chamber should be full. If any fluid is audible when shaken, the chamber should be refilled.
Refill the electrolyte chamber when the electrode offset exceeds 50 mV.
The salt bridge should be replaced when performance becomes sluggish, or if the output is erratic or inaccurate.

Replacing the salt bridge
Parts Required: Salt Bridge (order number 3864-0001) and Differential Reference Solution (order number 3864-0002)
Tools Required: small pliers
1. Remove sensor from mounting.
2. Hold upside down and unscrew salt bridge using a pair of small pliers. Be careful not to damage the glass bulb!
3. Drain the depleted reference solution and dispose of properly.
4. Fill reference chamber with fresh reference solution (approx. 30 ml).
5. Replace salt bridge and screw finger tight. Solution will drip out while screwing in salt bridge. Use pliers to turn approximately ¼ turn past finger-tight.
6. Perform calibration (standard and slope) before returning the system to service.

NOTE:
The refillable electrolyte chamber in 2764 series Differential electrodes may leak during storage and shipping. Check the fluid and refill before installation if necessary.

WARNING!
Wear appropriate eye, face, hand, body, and respiratory protection when using chemicals or solvents.

Signet DryLoc™ pH and ORP Electrodes

For all Signet DryLoc™ Electrodes:
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2774-2777 Combination Electrodes

English

3-2754.090 Rev. E 3/06 English

WARNING!

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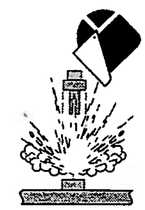
1. Depressurize and vent system prior to installation or removal.
2. Confirm chemical compatibility before use.
3. Do not exceed maximum temperature/pressure specifications.
4. Wear safety goggles or faceshield during installation/service.
5. Do not alter product construction.
6. When using chemicals or solvents care should be taken and appropriate eye, face, hand, body, and/or respiratory protection should be used.



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- O-rings: FPM
- Solution ground: carbon graphite (2764 series only)

Wetted Materials (2754-2757 Series):
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- Sensing surface: Glass membrane (pH), Platinum (ORP)
- O-rings: FPM

Reference Electrolyte:
- 2754 series electrodes: solidified acrylamide gel, KCl
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Reference Element: Ag/AgCl

Temperature Sensor:
- pH: 3KΩ, PT1000 or 300Ω
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Temperature response time τ:
- 2754 electrodes: 140 s
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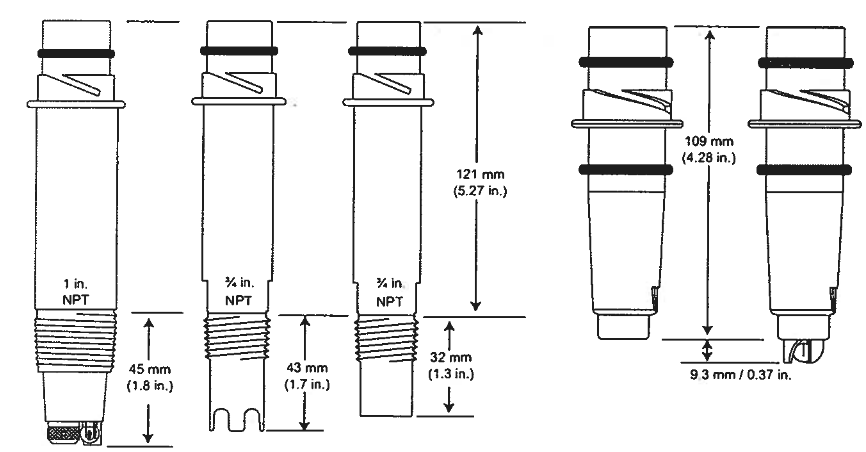
- 2764, 2774, 2776 series: 20 s

Maximum Temperature/Pressure:
Operating Temperature:
- 2764 series: 0°C to 95°C (32°F to 203°F)
- 2774 series: 0°C to 85°C (32°F to 176°F)
- 2754 series: 0°C to 85°C (32°F to 176°F)

Max. Operating Pressure: 6.89 bar @ 95°C (100 psi @ 203°F)
Storage Temperature: >0°C (32°F)
Shipping Weight: 0.25 kg (0.55 lbs.)

Standards & Approvals
- Manufactured under ISO 9001:2000 for Quality

2764 series Differential electrode | 2774 series Bulb electrode | 2776 series Flat electrode | 2754 & 2755 Flat electrode | 2756 & 2757 Bulb electrode



4. ORP Electrode Calibration
ORP electrodes are designed to ensure linearity during their lifespan. The following sections define proper electrode operation.

4.1 Offset (STD)
- Electrode offsets are usually caused by clogged reference junctions or by aged or contaminated reference solution/wire.
- Offsets should be checked in pH 7 buffer saturated with quinhydrone @ 25°C. The theoretical output is +86 mV. Any deviation from +86 mV is the ORP electrode offset (i.e. +90 mV).
- Quinhydrone is the oxidizer measured by the ORP electrode and is required for calibration. To measure ORP electrode offset, saturate 50 mL of pH 4 and pH 7 buffers with ⅛ g quinhydrone:

	4 pH w/Quinhydrone			**7 pH w/Quinhydrone**		
Temp:	20°C	25°C	30°C	20°C	25°C	30°C
ORP:	268 mV	263 mV	258 mV	92 mV	86 mV	79 mV

A new ORP electrode measures these values ±15 mV. The electrode continues to be functional until the offset from these values exceeds 50 mV. Electrodes with offset greater than 50 mV should be cleaned and replaced if necessary.

4.2 Slope (SLP)
ORP slope errors are generally caused by contamination of the platinum electrode surface. Cleaning the electrode surface will usually restore proper values, response time, and stability. See section 5: Maintenance and Cleaning.

Many systems require both pH and ORP calibration. To conserve calibration reference solutions, use pH 7 and 4 buffers for pH calibration first. ORP calibration can be performed with the same buffers by adding quinhydrone.

5. Maintenance and Cleaning

5.1 Maintenance
Variables can affect long term pH or ORP electrode life. For this reason, a maintenance log is recommended for trend analysis. When storing boxed sensors, lay the sensor flat to maximize hydration of the glass surface. Keep the glass surface wet at all times. Soak the sensor tip in pH 4.0 buffer during system maintenance intervals. In-line applications should be plumbed with a depression (trap) so liquid is maintained around the sensor tip. If the sensor dehydrates, soak the sensor tip in pH 4 buffer for 24 to 48 hours, then visually inspect the electrode for surface cracks, swelling, or discoloration. Severely dehydrated electrodes cannot be restored to normal operation.

5.2 Cleaning
Cleaning techniques vary depending on the type of coating present on the glass electrode surface or reference junction.
- Soft coatings can be removed by vigorous stirring, or with directed spray of an applicable detergent or solvent onto the glass surface. Chlorine bleach or mild detergent can be used to remove soft coatings. Always rinse electrode tip in clean water after cleaning.
- Hard coatings can be chemically removed. Use the least harsh chemical which will remove the contaminant within two (2) minutes without attacking the materials of construction. e.g. calcium carbonate may be removed with a 5% HCL (muriatic acid) solution.
- Oily or organic coatings can be removed with detergents or an appropriate solvent that does not attack the materials of construction e.g. isopropyl alcohol may be used but acetone must be avoided to prevent damage to the CPVC sensor body.
- ORP electrode surface (platinum rod) can be gently sanded with 600 grit wet and dry silicone or carbide sandpaper, jewelers rouge, crocus cloth, or very fine steel wool.

5.3 Differential Electrodes
Differential electrodes have a replaceable salt bridge and the electrolyte chamber can be refilled.
The electrolyte chamber should be full. If any fluid is audible when shaken, the chamber should be refilled.
Refill the electrolyte chamber when the electrode offset exceeds 50 mV.
The salt bridge should be replaced when performance becomes sluggish, or if the output is erratic or inaccurate.

Replacing the salt bridge
Parts Required: Salt Bridge (order number 3864-0001) and Differential Reference Solution (order number 3864-0002)
Tools Required: small pliers
1. Remove sensor from mounting.
2. Hold upside down and unscrew salt bridge using a pair of small pliers. Be careful not to damage the glass bulb!
3. Drain the depleted reference solution and dispose of properly.
4. Fill reference chamber with fresh reference solution (approx. 30 ml).
5. Replace salt bridge and screw finger tight. Solution will drip out while screwing in salt bridge.
   Use pliers to turn approximately ¼ turn past finger-tight.
6. Perform calibration (standard and slope) before returning the system to service.

NOTE:
The refillable electrolyte chamber in 2764 series Differential electrodes may leak during storage and shipping. Check the fluid and refill before installation if necessary.

WARNING!
Wear appropriate eye, face, hand, body, and respiratory protection when using chemicals or solvents.

D-18
Level Switch and Level Transducer

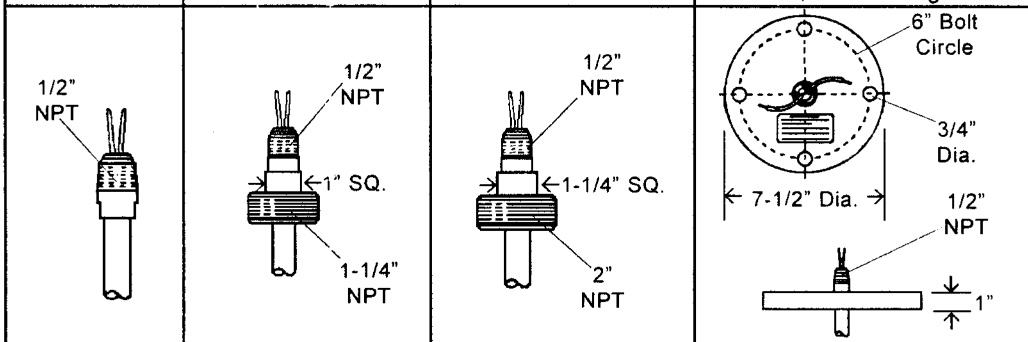
Gems Sensors

Series LS-800, LS-800 Adjustable Multi-Station Level Switches

(Includes LS-800's with Temperature Sensors)

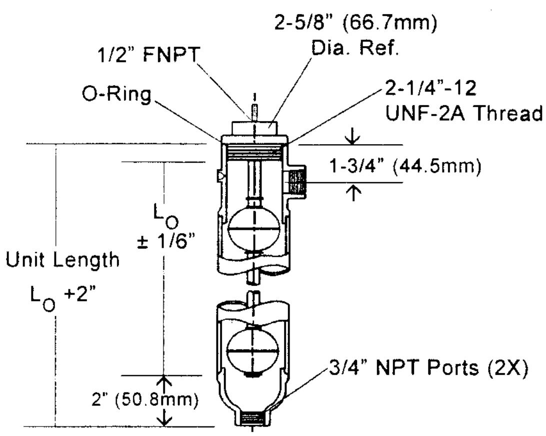
Installation Multi-station level switches install vertically in tank top (mounting up) or in tank bottom (mounting down). Level switches will operate normally inclined up to 30°.

Mounting Types
*Note: Units greater than 72" overall length are supplied with collars with setscrews (made of same material as stem and mounting), in place of float-stop rings. Collars are optional on units less than 72" overall length. Units requiring 316 SS float stops must be special-ordered with 316 SS collars instead of grip rings.



	Type 1 1/2" NPT	Type 2 1-1/4" NPT	Type 3 2" NPT	Type 4 3" Dia., 150# Flange
Stem and Mounting Material	Brass or 316 Stainless Steel			Flange: Carbon Steel or 316 SS Stem: 316 SS
Max. Length (LO)	36"	60"	140"	
Mounting Position	Vertical ±30° Inclination			
*Float Stops (See *Note Above)	Brass Units: Beryllium Copper Grip Rings; Stainless Steel Units: S.S. ARMCO PH-15-7MO Grip Rings			

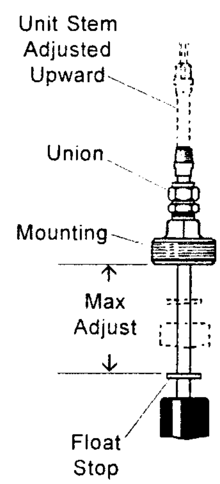
Type 5 - External Mount



Housing Material	Brass	316 Stainless Steel
Stem & Mounting	Brass	316 Stainless Steel
Port Sizes	3/4" NPT	
Max. Length (LO)	120"	
*Float Stops	Beryllium Copper	S. S. ARMCO PH-15-7 MO

LS-800 Adjustable Mounting

Adjustable mounting is available for LS-800 Series Mounting Types 2, 3, and 4. A special cinch nut on the mounting allows the stem to travel up or down for fine tuning of the actuation points. The extent of adjustment depends on the unit length and the distance from the mounting to the highest float stop.



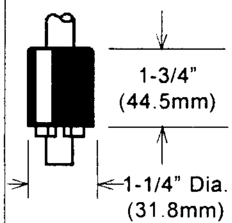
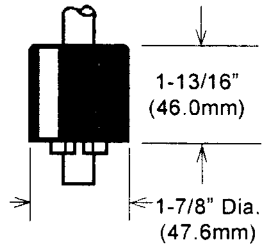
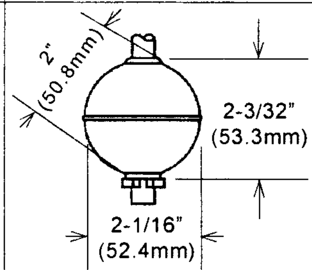
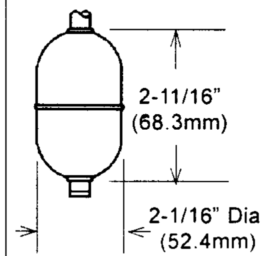
Note

Maximum overall length is limited to 72" with this option.

Installation Procedure for Model LS-802 - Two-Piece Level Switch

1. Unpack unit from shipping crate.
2. Position unit near tank and unstrap stem assemblies.
3. The lower stem section (section with floats) can be inserted into tank to facilitate ease of installation, but must be retained to install upper section.
4. With lower stem in desired position, insert tube coupling from upper stem section into lower section. Tighten coupling nut securely to stem (~ 1 turn past handtight). Check and tighten the upper section nut, if necessary.
5. Cable exiting from the upper section conduit connector can be lightly pulled taught through grommet to prevent excess cable slack in upper stem.
6. Install unit in tank and tighten mounting plug.
7. Connect level switch wires per wiring diagram.

Float Types

Float Material	Buna N		316 Stainless Steel	
Compatible Mounting Types	2	1, 3, 4, 5	1, 3, 4, 5 (Units <72")	3, 4, 5 (Units >72")
Float Dimensions				
Part Number	**26032**	**10558**	**14569**	**15666**
Operating Temperature	Water: To 180°F (82.2°C) Oil: -40°F to +230°F (-40°C to 110°C)		-40°F to +300°F (-40°C to +148.9°C)	
Min. Media Specific Gravity	.75	.55	.75	.75

Pressure Ratings Chart
(PSI, Max.)

			Float Part Number			
			26032	10558	14569	15666
Mounting Type	1, 2, 3		150		750	300
	4		150			
	5	Brass	100 @ +70°F (21.1°C)			
		316 S.S.	150		750	300

Wiring Color Codes

	SPST Switches			SPDT Switches 20 VA				
Wiring	Group I	Group II		Group III		Group IV		
Com. Wire	Black	None		Black		None		
	NO/NC	Sw. Com.	NO/NC	NO	NC	Sw. Com.	NO	NC
L1	Red	Red	Red	Red	Wh/Red	Red	Wh/Red	Wh/Blk/Red
L2	Yellow	Yellow	Yellow	Yellow	Wh/Yel	Yellow	Wh/Yel	Wh/Blk/Yel
L3	Blue	Blue	Blue	Blue	Wh/Blu	Blue	Wh/Blu	Wh/Blk/Blu
L4	Brown	Brown	Brown	Brown	Wh/Brn	Brown	Wh/Brn	Wh/Blk/Brn
L5	Orange	Orange	Orange	Orange	Wh/Orn	Orange	Wh/Orn	Wh/Blk/Orn
L6	Gray	Gray	Gray	Gray	Wh/Gray	Gray	Wh/Gray	Wh/Blk/Gra

Notes:
1. Multi-station units included in shaded areas of chart can be supplied in UL-recognized configurations.
2. Wire size is #18 AWG for units of UL-recognized configurations and #22 AWG (Teflon) for non-UL- recognized configurations.
3. Units with 50 or 100 VA switches are not UL-recognized.

Electrical Specifications

Switch (N.O. or N.C.):

SPST: 20 VA or 100 VA

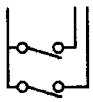
SPDT: 20 VA

Lead Wires: #22 AWG, 24" L., Polymeric

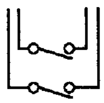
Typical Wiring Diagrams

For clarity, only two actuation levels are shown in each group diagram.

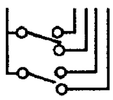
Group I SPST



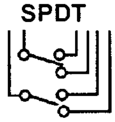
Group II SPST



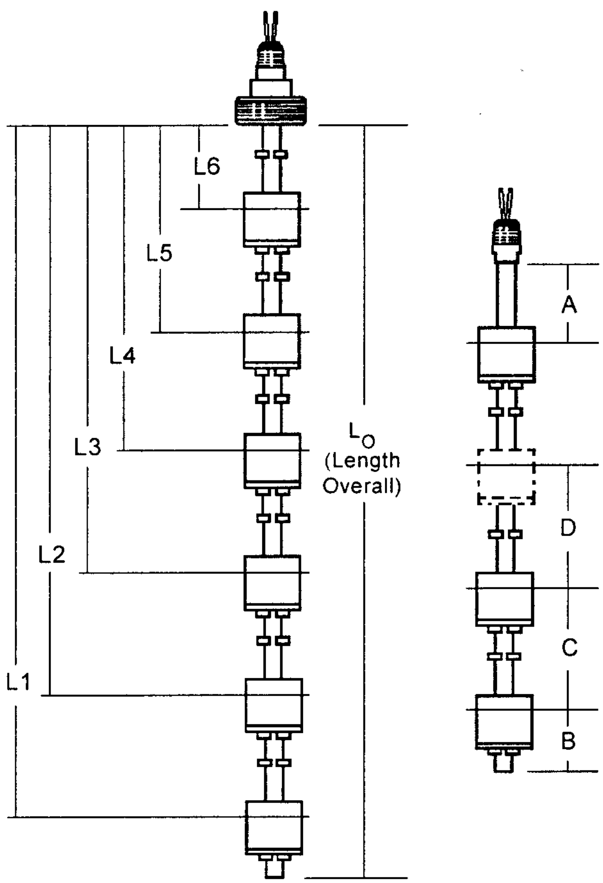
Group III SPDT



Group IV SPDT



Actuation Level Dimensions



*Actuation level distances and L_O (overall unit length) are measured from inner surfaces of mounting plug or flange.

** Length Overall L_O = L_1 + Dimension B. See mounting types for maximum length values.

Switch Ratings - Maximum Resistive Load

VA	Volts	Amps AC	Amps DC
10 General Use	0-50	.2	.13
	120	.08	N.A.
	100	N.A.	.1
20 Pilot Duty	1-30	.4	.3
	120	.17	.13
	240	.08	.06
50 General Use	0-50	0.5	0.5
	120	.4	.4
	240	.2	.2
100*	120	.8**	N.A.
	240	.4	N.A.

* Level switch units with 50 VA and 100 VA swtiches are not UL recognized or CSA approved.

** Limited to 50,000 operations

Switch actuation levels are determined following the guidelines below:

All units 72" or less length overall with stainless steel or Buna N floats. Also Type 5 units over 72" length overall with Buna N floats:

A = 1-1/2" minimum distance to highest level (2", Type 5 only)
B = 2" minimum distance from end of unit to lowest level
C = 3" minimum distance between levels
D = 1/4" minimum distance between actuation levels (Note: One float for two levels can be used only when low level is N.C. dry and high level is N.O. dry.)

Types 1, 3, 4 and 5 units with stainless steel float P/N 15666:

A = 1-5/8" minimum distance to highest level (2", Type 5 only)
B = 2-1/2" minimum distance from end of unit to lowest level
C = 4" minimum distance between levels
D = 1/4" minimum distance between actuation levels (Note: One float for two levels can be used only when low level is N.C. dry and high level is N.O. dry.)

Notes:

1. A, B, and C dimensions are based on liquid specific gravity of 1.0.

2. One float for two levels can be used only when 20VA switch is used.

3. Actuation levels are calibrated on descending fluid level, with water as types for maximum length values. the calibrating fluid, unless otherwise specified.

4. Tolerance on actuation levels is ±1/8".

Integrated Temperature Sensors Options

1. Thermistor for Continuous Indication

- Excellent Repeatability

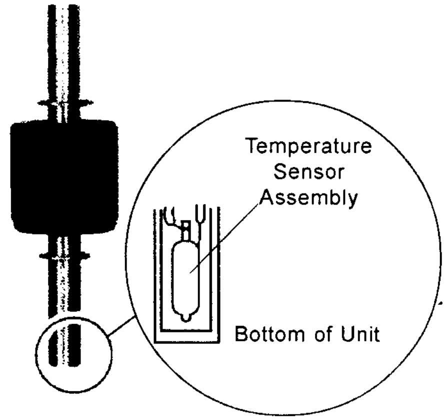
Value: 10,000 ohms @ 77°F (25°C)

Tolerance: ±0.2°C from 32°F to 158°F (0°C to 70°C)

Operating Temperature: 302°F (150°C), Max.

Alpha @ 25°C: -4.39%/°C

Dissipation Constant: 1mW/°C in Still Air
8 mW/°C in Oil Bath



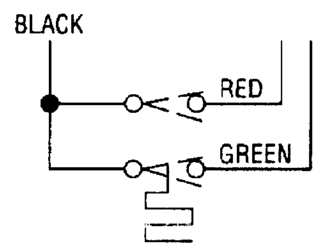
Note
End of unit stem must be submerged a minimum of 2-3/4" for level switch actuation.

2. Thermostat for Switch Action

- Settings from 150°F to 175°F
- Open or close switch on increasing temperature

Note
Contact Gems Sensors for Additional Information.

Typical Wiring Diagram



Return Policy

Returns are accepted on stock items up to 30 days from date of order. You must contact our Returns Department for a Return Authorization (RA) number. Return the goods - freight prepaid - in the original container and include original packing slip. C. O. D. returns are not accepted. Gems reserves the right to apply restocking charges.

Tel: 860-793-4357
Fax: 860-793-4563

Important Points:

- Gems products must be maintained and installed in strict accordance with the National Electrical Code and the applicable Gems product instruction Bulletin that covers installation, operation and proper maintenance. Failure to observe this information may result in serious injury or damages.
- For hazardous area applications involving such things as, but not limited to, ignitable mixtures, combustible dust and flammable materials, use an appropriate explosionproof enclosure or intrinsically safe interface device.
- *** Warning: To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.
- Please adhere to the pressure and temperature limitations shown throughout this catalog for our level and flow sensors. These limitations must not be exceeded. These pressures and temperatures take into consideration possible system surge pressures/ temperatures and their frequencies.
- Selection of materials for compatibility with the media is critical to the life and operation of Gems products. Take care in the proper selection of materials of construction, testing is required.
- NSF-approved sensors are made of materials approved for potable water applications according to Standard 61.
- Stainless steel is generally regarded as safe by NSF and FDA.
- Life expectancy of switch contacts varies with application. Contact Gems if life cycle testing is required.
- Ambient temperature changes do affect switch set points, since the gravity of a liquid can vary with temperature.
- Our sensors have been designed to resist shock and vibration. However, shock and vibration should be minimized.
- Filter liquid media containing particulate and/or debris to ensure the proper operation of our products.
- Electrical entries and mounting points in an enclosed tank may require liquid/vapor sealing.
- Our sensors must not be field-repaired.
- Physical damage sustained by product may render it unserviceable.

Gems Sensors

Gems Sensors Inc.
One Cowles Road
Plainville, CT 06062-1198
Toll-Free: 1-800-378-1600

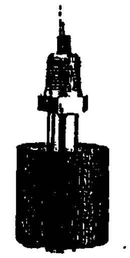
OMEGA

LVK-10/LVK-20/LVK-30

Level Switch

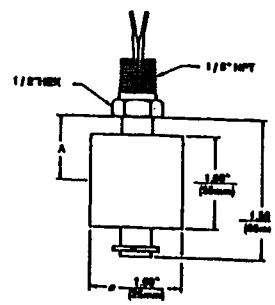
INSTRUCTION SHEET

M2597/1296



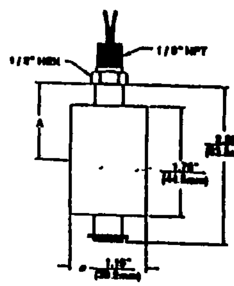
LVK-10, LVK-11
Buna N General Purpose
Single Point Detector

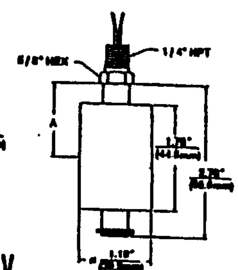
Features:
- Small, compact size
- Reliable long life performance
- Precise repeatability
- Highly resistant to shock and vibration
- Stem available in 316 Stainless Steel or Brass
- Switch Rating 10VA



LVK-20, LVK-21, LVK-22, LVK-23
Intermediate Size
General Purpose Detector

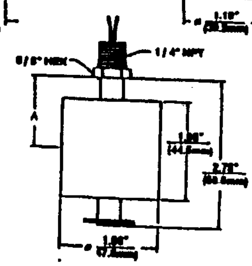
Features:
- Highly reliable, yet inexpensive
- Compact, narrow displacement
- Stem available in 316 Stainless Steel or Brass
- Long operating life
- Switch Rating LVK-20, LVK-22 is 20VA
- Switch Rating LVK-21, LVK-23 is 100VA





LVK-30, LVK-31, LVK-32, LVK-33
Large Size
General Purpose Detector

Features:
- Large float provides maximum displacement in high viscosity fluids
- Can be easily extended to multiple float arrangement up to 72" long
- Rugged design for heavy duty service
- Stem is available in 316 Stainless Steel or Brass
- Switch Rating LVK-30, LVK-32 is 20VA
- Switch Rating LVK-31, LVK-33 is 100VA



A = Actuation point is approximately midway of float travel in liquid with a specific gravity of 1.0

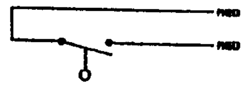
	Maximum Pressure	Temp. Operating Range	Mounting	Leads	Recommended Minimum Liquid SP GR
LVK-10, LVK-11	150 PSI (10.3 bar)	-40° to 225°F (-40° to 107°C) in oil to 180°F (82°C) in water	1/8" NPT	22 AWG, 24" long	.50
LVK-20, LVK-21, LVK-22, LVK-23	150 PSI (10.3 bar)	-40° to 225°F (-40° to 107°C) in oil to 180°F (82°C) in water	1/8" NPT-1/4" NPT	18 AWG, 24" long	.56
LVK-30, LVK-31, LVK-32, LVK-33	150 PSI (10.3 bar)	-40° to 225°F (-40° to 107°C) in oil to 180°F (82°C) in water	1/4" NPT	18 AWG, 24" long	.55

Electrical Data

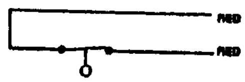
Standard Reed switches are SPST or SPDT.
The diagrams below show the typical wiring

Form A - Single Pole / Single Throw

Normally Open Dry

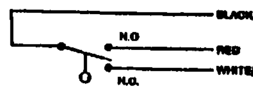


Normally Closed Dry



Form C SPDT - Single Pole / Double Throw

SPDT Dry Condition



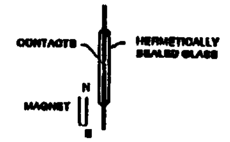
Each individual level switch varies in rating depending on the unit. See the chart below for electrical ratings.

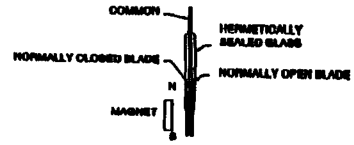
Switch Ratings Max - Resistive Loads

Contact Rating	Volts	Amps AC	Amps DC
10VA	0-50	.20	.13
	120	.08	.05
	240	.04	NA
20VA	0-50	.40	.30
	120	.17	.13
	240	.08	.08
50VA	0-50	.50	.50
	120	.41	.41
	240	.20	.20
100VA	120	.83	NA
	240	.41	NA

NOTE: Above ratings are for resistive loads only

The reed switch is designed for reliability to millions of cycles. To ensure long life and repeatability, see the contact protection information below.





Contact Protection

In order to take advantage of the long life, highly reliable characteristics of a reed switch, it is essential to provide protection when switching inductive loads.

When current is interrupted, the inductance of the load generates a high frequency voltage, which appears across the switch contacts. If the voltage is large enough, it can cause arcing. Arcing can cause contacts to weld to each other, resulting in unreliable switching performance. It is essential to protect the circuit, by suppressing the voltage to prevent arcing.

This can be accomplished through the use of a diode for DC circuits (figure 1) and a resistor - capacitor network for AC circuits (figure 2).

Figure 1
DC Contact Protection

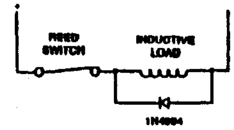
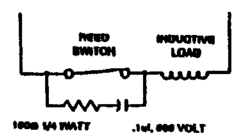
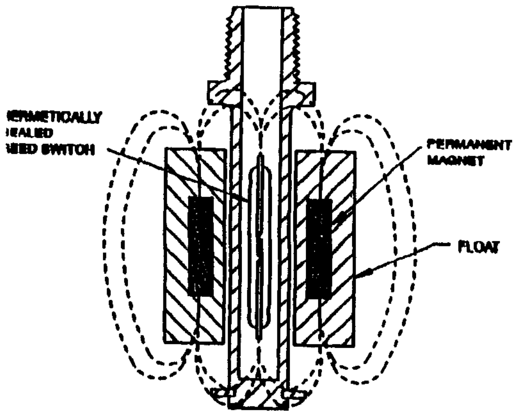


Figure 2
AC Contact Protection



Often there is a requirement to control significant loads such as pumps and motors, or to perform a control function as simple as the automatic refilling of a tank. These operations can be performed reliably with the selection of one of the following supplemental relays.

PART NUMBER	DESCRIPTION	FUNCTION	TIME DELAY
LVCN -130	PUMP UP PUMP DOWN CONTROLLER	LATCHED 12 AMP SPDT RELAY	.15 TO 60 SECONDS
LVCN -140	SINGLE SENSOR CONTROLLER	12 AMP SPDT RELAY	.15 TO 60 SECONDS
LVCN -120	THREE SENSOR CONTROLLER	TWO 12 AMP SPDT OUTPUT RELAY	.15 TO 60 SECONDS
SSR24OAC10	SOLID STATE RELAY	10 AMP, AC CONTROL SIGNAL RELAY	NO



Design Considerations

- Pressure
- Temperature
- Mounting
- Termination
- Media Characteristics, such as
  - Specific gravity
  - Corrosive characteristics
  - Viscosity
- Actuation Point(s)
- Materials of Construction
- Switch life / Switch load

General Information

- Please refer to the current carrying limitations of the reed switches and provide protection when needed.
- Do not exceed pressure and temperature limitations listed at any time.
- Please take into consideration material of construction and chemical / media compatibility when selecting a level switch.
- Temperature changes that affect specific gravity of media may vary actuation points.
- Media that contains debris may cause float to hang up and require more frequent maintenance.
- Care should be taken to provide moisture protection and media isolation at threaded mounting areas and wire termination points.

Principle of Operation

The hermetically sealed reed switch located inside the stem is actuated by a magnetic field created by a magnet equipped float. As the float rises and falls with the liquid level, the magnetic field passing the switch causes the switch to either open or close.

Omega switches can be mounted from tank top, tank bottom or can be easily adapted for side mounting. Switches will operate normally with up to a 30 degree tilt from vertical.

Switch Configuration

Most single point switches with a SPST (single pole, single throw) switch operate in either a Normally Open (NO) or Normally Closed (NC) mode in the dry condition. All switches are shipped in the Normally Open dry mode. To change from the Normally Open to the Normally Closed mode, carefully remove the clip at the end of the stem, remove the float, reverse the float, then reinstall the float. After replacing the float and end clip, the operation will be Normally Closed. All Teflon switches are non-reversible and must be ordered in either the NC or NO mode.

Single Pole, Double Throw (SPDT), switches offer both NO and NC mode. Selection is made simply by choosing the black and red wire for NO operation or the black and white/red wire for NC operation.

Maintenance

Maintenance of the OMEGA level switches is minimal. Floats and stems should be inspected periodically for buildup on the stem which could cause float hangup and or significant buildup on the float that could change specific gravity of the float.

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OMEGA®

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It is the policy of OMEGA to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

The information contained in this document is believed to be correct but OMEGA Engineering, Inc. accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.

WARNING: These products are not designed for use in, and should not be used for, patient connected applications.

MADE IN USA

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of 13 months from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit should malfunction, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR WARRANTY RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR NON-WARRANTY REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. P.O. number to cover the COST of the repair,
2. Model and serial number of product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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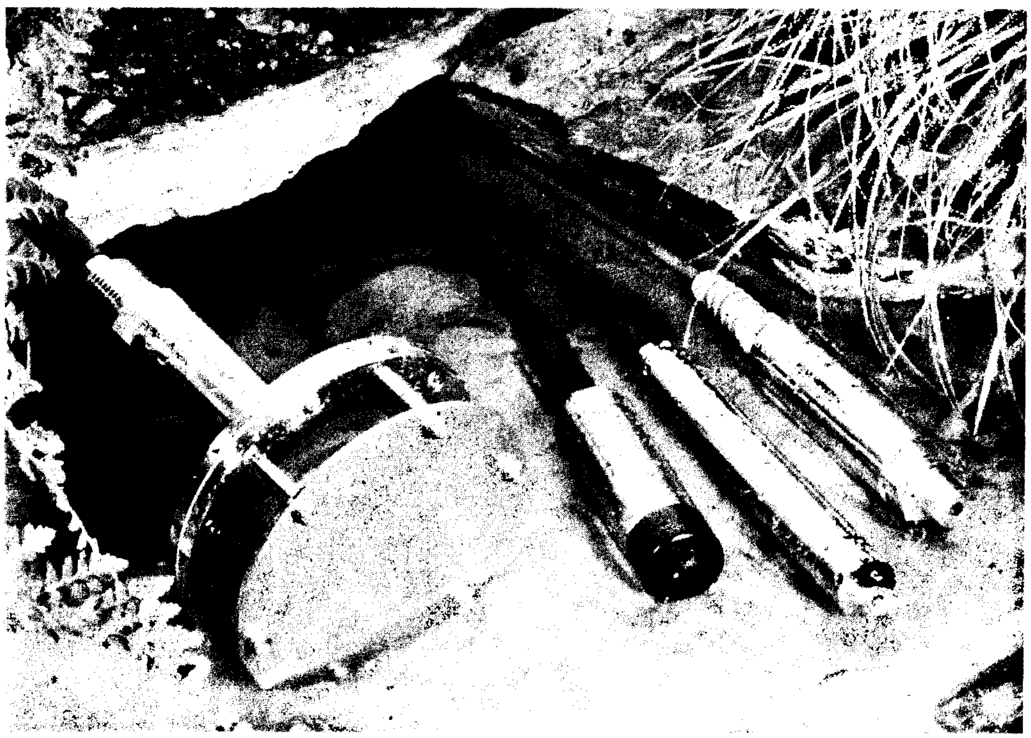
Esterline
Pressure Systems

KPSI™ Level and Pressure Transducers User's Manual

16th Edition

April 2008



Sensing the Environment™

Visit us on the web:
www.PressureSystems.com

On-line Transducer Store:
www.LEVELandPRESSURE.com

Our Company

Pressure Systems is an ISO9001:2000 certified U.S. manufacturer of submersible and above ground pressure transducers for environmental, industrial and municipal applications. Our KPSI™ Level and Pressure Transducers have been specified in thousands of projects throughout the United States, Canada and Europe by geologists, system integrators, national engineering firms and a variety of government agencies. Typical applications include, but are not limited to, pump control, tank level monitoring, sewage lift station operation, reservoirs, weirs, flumes, site remediation, watershed management, storm water/well monitoring, pump/pipeline pressures and compressor pressures.

Website and E-Mail

You may visit our website at www.PressureSystems.com to look at our latest new product releases, application notes, product certifications and specifications, as well as Intrinsic Safety control installation drawings. E-mail your questions and comments to us: sales@PressureSystems.com.

E-commerce

Orders may be placed on-line by visiting our e-commerce site *(www.LevelandPressure.com)* or by contacting the factory or local representative.

Applicable Products

This manual provides information applicable to the use of the following KPSI Level and Pressure Transducers:

Series 169/173; 116/126
Series 200
Series 700/710/720/730/735
Series 320/330/335/340
Series 300DS
Series 27/28/30/35
Series 705
Series 750

Please note: Series 500 and waterMONITOR have separate manuals.

Series 770 has a separate manual to address use of the Re-Range System.

Table of Contents

1.0 Product Description

General Characteristics

Our submersible pressure transducers use isolated-diaphragm sensors that are specifically designed for use with hostile fluids and gases. These sensors utilize a silicon pressure cell that has been fitted into a stainless steel or titanium package with an integral, compliant stainless steel or titanium barrier diaphragm. This sensor assembly is housed in a rugged 316 stainless steel or titanium case which provides for a variety of level ranges from 2.5 ft (0.75 m) H_2O through 4614 ft (1408 m) H_2O and pressure inputs from 0-1 (7 kPa) through 0-15000 psi (103 mPa). Our devices feature internal signal conditioning. Standard outputs are 4-20 mA , mV and VDC.

All units containing active electronic components have surge and reverse polarity protection. For ease of use in the field, our transducers are permanently laser engraved with our logo and name, wiring information, part number (P/N), serial number (S/N), date of manufacture (DOM), range, excitation and output. Pressure transducers are offered in diameters of 1.0 (25 mm) and 0.75 inches (19 mm).

Care and Handling

Our submersible transducers are designed for rugged use. However, they need protection from over pressure and sharp impact. When lowering them into a liquid, penetrate the surface slowly and only to the depth necessary. Avoid dropping the unit from above the surface. Clean all transducers by rinsing them in a mild detergent. Direct probing of the diaphragm or attempts to remove protective screens will damage the sensor, voiding the warranty.

Calibration

All pressure transducers are shipped with calibration information unique to each transducer. Make sure you keep each calibration report. However, should you misplace your calibration sheet, you can contact the factory and request a duplicate. All KPSI Transducer calibrations are traceable to the National Institute of Standards and Technology (NIST).

Intrinsic Safety Approvals

Most of our products have UL, CUL, and FM certification for intrinsic safety. Their respective installation control drawings can be downloaded from our website. Several of our product lines also carry ABS approval. Most products are CE compliant to EN61000-6-4:2001 and EN 61000-6-2:2001. CE compliant units are labeled accordingly.

2.0 Product Accessories and Options

Nose Caps

There are several different user-installable nose caps for the 700, 710, 720, 730, 735 submersible pressure transducers. The ported nose cap (Delrin) (P/N 42-01-1314A) with #8-32UNC-2B threaded hole is best used where weights are required and for those installations where users may encounter sharp, protruding objects. The open-face cap (P/N 42-30-6659) which allows maximum contact with the liquid media is ideal for wastewater and "greasy" applications where clogging of the sensor is a concern. The 1/4" male NPT pressure cap (P/N 42-01-64154) are not only useful for calibration purposes but also allows the device to be used as a submersible or above ground pressure transducer. The piezometer cap (P/N 42-30-66765) allows the unit to be buried in saturated soil without damage to the sensor diaphragm. We also provide 1/4" British pipe thread connections (G 1/4 and M14x1.5). Please contact Customer Service for details.

WARNING: Caution must be exercised when inserting a screw into the nose cap as the maximum insertion length should not exceed 0.175".

810 SuperDry™ Vent Filter or 815 Aneroid Bellows

All submersible transducers with vented gauge format are supplied with a protective barrier that guards against moisture buildup in the cable vent tube. The 810 SuperDry™ vent filter is installed free of charge and is guaranteed to operate maintenance free for one year. We also offer the 815 Aneroid Bellows as a maintenance free option that can be used on submersibles with accuracies of: ±1%, ±0.5%, or ±0.25% FSO. These barriers ensure reliable operation and long life as they protect sensitive electronic components from mildew and prevent the formation of a liquid column in the vent tube. Any such liquid column directly affects calibration of the transducer.

Sacrificial Anodes

Our sacrificial anodes are made from a special zinc alloy formulated to guarantee continued effectiveness over long periods. Because the anodes are 95% galvanic, they will not corrode unless there is an electrolytic demand. The anode maintains a high driving potential throughout its 12 month life, is self-sluffing and always exposes new zinc for the best possible protection. For those applications where cable buoyancy is a problem, the sacrificial anode can be substituted for hanging weights.

Sacrificial Anodes provide cathodic protection against galvanic corrosion for our submersible pressure transducers. Galvanic corrosion occurs when dissimilar metals are placed in contact with an electrolyte. This condition causes a potential difference to exist between the two metals, causing electron flow between them. Corrosion of the less corrosion-resistant metal is increased and attack of the more resistant metal is decreased. The 820 Sacrificial Anode is clamped to the exterior of a one-inch bore submersible transducer. We also offer a 1" diameter pencil anode, the 825, that attaches to the nose cap of either a 3/4" or 1" bore submersible transducer.

Absolute/Sealed Gage Transducer

The sealed gage option for submersible transducers eliminates the need for a vent filter. The standard output of a sealed gauge transducer is 4 mA at 14.70 psia. Before ordering a sealed gauge transducer, the customer should determine the altitude (above sea level) of the installation and inform PSI's Customer Service of this value before order entry. During manufacture, the output of the transducer will be adjusted to compensate for the altitude difference, if applicable.

Polyurethane & ETFE Jacketed Cable

Most installations of our submersible pressure transducers connect our polyurethane or ETFE cable to a junction box. From this junction box (P/N 840), users typically run their own cable to the required instrumentation. Polyurethane-jacketed cable is used for most applications while ETFE material is recommended for more aggressive environments.

Specifications for our standard polyurethane and ETFE jacketed cable are as follows:

Specifications	Standard Submersible Cable
Weight	0.05 lbs/ft (0.07 kg/m)
Min. OD	0.28" (7.10 mm)
Max OD	0.31" (7.87 mm)
Conductors	4 - 22 AWG
Insulation **Conductors** **Outer jacket**	 PVC Polyurethane or ETFE
Shield	36 gauge spiral tinned copper wire foil shield with drain wire
Vent Tube	polyethylene, .060" ID (1.52 mm)

- **Chemical resistance of polyurethane:** Potable Water, Wastewater, Borax, Butane, Animal Fat, Carbonic Acid, Citric Acid, Cod Liver Oil, Corn Oil, Glycerin, Glycol, Mineral Oils, Potassium Nitrate, Potassium Sulfate, Silicone Oils, Stoddard Solvent, Tannic Acid (10), Tartaric Acid, Turbine Oil.

- **Chemical resistance of ETFE:** Acetic Acid (Glacial), Acetic Anhydride, Acetone, Aluminum Chloride, Anti-Freeze, Bromine, Calcium Chloride, Calcium Hydroxide, Chlorine, Copper Chloride, Ferrous Chloride, Hydrochloric Acid, Ketones, Lacquer Thinners, Sulfuric Acid.

The vented cable termination end is specially prepared at the factory to eliminate the potential for moisture migration. Where the lead wires emerge from under the jacket, there's potting material and a shrink tube "boot", every effort should be made to leave this feature intact. Should the cable be longer than needed for the installation, it is recommended that the excess length be accommodated in a service loop and that the potted end of the cable **NOT** be shortened.

The cable attached to this instrument is specifically engineered for submersible applications. The polyurethane outer jacket provides long term reliability under most conditions. The cable should be handled carefully, however, as the jacket may be subject to cutting should it be "raked" over extremely sharp edges. To guard against water incursion should an inadvertent minor cut occur, we have incorporated an exclusive "water block" feature immediately beneath the jacket. The cable is fully shielded, with the shield connected to the metal housing at the transducer end and terminated in a drain wire at the termination or user end. The shield should always be terminated to a good earth ground, unless the transducer is installed in an area where galvanic corrosion is known to be a serious problem.

Lightning Protection

Lightning and surge protection for the 0-5 VDC and SDI-12 (Option 012) and 4-20 mA (Option 009) output are available. This is achieved through the use of 2 protectors, one is integral to the transducer housing and one is provided for the outside line located at the surface and grounded to a DIN-Rail. Please remember this option must be factory installed at the time of order entry or as a factory upgrade. **This option cannot be installed in the field.**

Featuring quick response and low clamping voltages, these devices protect against fast rising voltage transients as well as severe current surges associated with lightning discharges up to 20,000 amperes. Following a surge, the protector automatically restores the line to normal operation and awaits the next surge without having to reset a breaker or replace a fuse. **Transducers installed with this option have a lifetime warranty *against damage due to voltage surge, when this 2-part option is properly installed.***

Please note: When using the lightning protection option on 4-20 mA products, users should take into account the additional series resistance of this option when selecting the loop power supply. This option will increase total loop resistance by 88 Ohms.

½" Male NPT Conduit Fitting

Submersible pressure transducers can be attached to a rigid conduit and the cable run through the conduit. To achieve this, all of our submersible transducers can be fitted with an optional ½" NPT male conduit fitting (specify "Electrical Connection Option 4" when ordering) where the cable exits the transducer. This fitting can be mated to a standard rigid conduit.

Variety of Electrical Outputs

Most applications call for a 0-5 VDC, 4-20 mA or a 0-100 mV output. But where necessary, our transducers offer a broad choice of possibilities including, among others, 0-10 VDC, 0-2.5 VDC, or ratiometric mV/V.

Reverse Signal Output

For some applications, it is important to know how far the water is from the top of the tank or the surface of the ground. If specified by the customer, our factory can set the transducer so that zero pressure reads full scale electrical output and maximum pressure reads zero electrical output.

Temperature Output

A temperature output option is available for most transducesr having 4-20 mA pressure output. The temperature sensor requires an excitation of 9-30 VDC and is calibrated for a temperature range of 0 to 50°C or -20 to 60°C with an accuracy of ±4°C.

Cable Hanger

We can supply an optional cable hanger (P/N 12-90-0931) to help end users secure the cable. The cable hanger can be positioned anywhere on the cable by pushing the ends together. Once positioned, the cable hanger expands and provides a snug grip on the cable.

When mounting the transducer in a well casing, the cable hanger can be secured to a hook on the well plate or an eye bolt may be attached to the side of the well casing. The cable hanger loop is then secured to the eye bolt by using any number of types of fasteners. A similar technique can be used when working in stilling wells for surface water level measurement. In this case, the loop-end of the cable hanger can be attached directly to a screw or bolt bored into the still well shelf.

Cable Splicing Kit

Our field-installable cable splice kit (P/N 830) allows you to splice polyurethane and ETFE cable. It is most commonly used for well applications where the more expensive ETFE cable is required for suspension in corrosive media where the liquid level is fairly shallow, but the well is hundreds of feet in depth. It is also used in emergency situations where cable must be spliced together to get an application up and running.

3.0 Installation & Maintenance Tips

General Installation Procedures

The following is important installation and preventive maintenance information. Our Customer Service or Applications Engineering Support staff can provide additional instruction.

1. **Transducer Anchors:** Most users either suspend our submersible transducers in stilling wells or attach them to rigid conduit. This is done to prevent damage to the transducer from shock caused by water turbulence. It is not advisable to tie your transducer to a pump or to piping, as any problem with the transducer could require that the pump be pulled from the installation. This could prove to be *very expensive*. (Please refer to the Cable Anchoring Schemes drawing in **Appendix A**.)

   Some applications use our optional bracket (P/N 49-06-00PC) to clamp the transducer to a fixed object (i.e., wall, ladder, step) or require the unit to be suspended without any protective still well or attachment device. In all installations, care should be taken to ensure no damage occurs to the cable as cable damage represents one of the most frequent causes of transducer failure.

2. **Transducer Submersion:** Damage to submersible cable is one of the most frequent causes of transducer failure. Lower your transducer into the liquid slowly, making sure the cable does not drag over sharp edges and only to the depth necessary. Avoid dropping the unit from the surface.

3. **SuperDry™ Vent Filter (Desiccant) or Aneroid Bellows Installation** (For vented gage pressure format only) ***Always*** install a desiccant vent filter or aneroid bellows immediately after transducer installation. Failure to use one or the other could result in premature failure of the transducer; which would not be covered by warranty. If you use a desiccant filter, you should establish a regular maintenance schedule. You should change your vent filter when it is 75% spent (pink color). Replacement filters are available at a nominal cost from the factory. Do not remove the old vent filter until a new one is available. The most common failure mode of our transducers is moisture and corrosion damage due to lack of use or maintenance of the vent filter. This will allow air into the desiccant filter and allows the transducer to properly vent with changes in barometric pressure.

   To install/replace either the aneroid bellows or the vent filter, simply unplug the old unit from the vent tube and plug the 0.062" x 1" stainless steel connector tube (supplied with each filter or bellows) into the vent tube. (Installation and mounting instructions are supplied with each aneroid bellows and vent filter.) The diagram on page A-4 shows typical vent filter and aneroid bellows hookups.

4. **Cable Protection** An inexpensive way to protect the cable from damage is to order the submersible pressure transducer with a ½" conduit attachment. Connect an inexpensive flexible 5/8" garden hose to the ½" conduit fitting with an equally inexpensive female PVC ½" NPT x 3/4" NHT swivel fitting, available at your local hardware store.

5. **Bending of Cable** Our polyurethane and ETFE jacketed cables are quite flexible. Care needs to be taken to ensure that when bending the cable to suit your installation you do not crimp the vent tube inside the cable. Consequently, do not bend the cable more than a radius of 1 inch.

6. **Cable Compression** Many users require a compression fitting to secure our ETFE and polyurethane jacketed cable as it enters a junction box. Care needs to be taken that you do not over-tighten the fitting so as to damage the cable.

7. **4-20 mA Wiring** When connecting a 2-wire 4-20 mA transducer to a typical power supply and mA meter, verify that the meter has an input impedance of at least 10 Ohms. If you are unsure of the input impedance, then a 10 Ohm resistor may be placed in series with the meter and transducer. Connect the + (red) lead of the transducer to the + terminal of the power supply. If the 10 Ohm resistor is required, connect it to the - (black) lead of the transducer. Use a short length of 22-24 AWG wire to connect the + terminal of the meter to the resistor (if it is required) or the - (black) wire of the transducer. Connect the - terminal of the meter to the - terminal of the power supply with a length of 22-24 AWG wire. Connect the drain wire from the transducer to a good earth ground. (See **Appendix**, page **A-2** for wiring diagram.) Please refer to "**Maximum Cable Lengths and Minimum Supply Voltage**" in **Appendix C**, page **C-2** to verify minimum loop supply voltage requirements.

8. **VDC Wiring** To connect a 3 wire VDC output transducer to a typical power supply and the voltmeter, connect the - terminal of the power supply to the - input terminal of the meter with a length of 22-24 AWG wire. Connect the - excitation (black) lead of the transducer to the - input terminal of the meter. Connect the + input terminal of the meter to the signal lead (white) of the transducer. Connect the + terminal of the power supply to the + lead (red) of the transducer. Connect the drain wire to a good earth ground. (See **Appendix A**, **page A-2**.)

9. **The Series 750** comes standard with a field removable diaphragm protector (one-inch or 25 mm standoff). The diaphragm protector can easily be taken off by removing six (6) fasteners located on the bottom of the unit.

10. **Sealed-Gage Transducer Configured For Altitude Above Sea Level** Since sealed-gauge transducers are normally calibrated at sea level, there may be considerable error induced when used at a higher elevation. If the transducer was calibrated without taking into consideration the difference in atmospheric pressure at sea level and the higher elevation, an offset error will occur. In order to eliminate error due to this difference, the customer must identify the elevation where the transducer will be installed. The nominal atmospheric pressure at the location is calculated and the transducer will be ranged accordingly. Not all KPSI Transducers are available in a sealed pressure format. Please refer to the appropriate datasheet for availability.

11. **Position Sensitivity** The transducer should be installed so that the diaphragm located behind the nose cap is oriented in a vertical position, otherwise the unit could exhibit an offset.

General Maintenance Tips

1. **Desiccant Maintenance**

   If you use a desiccant vent filter, you should establish a regular maintenance schedule. You should change your vent filter when it is 75% spent (pink color). Replacement filters are available at a nominal cost from the factory. Do not remove the old vent filter until a new one is available. Remember that Pressure Systems' improved 810 SuperDry™ Vent Filter are designed to be effective for at least one year before requiring replacement.

2. **Clogged Nose Piece or Dirty Diaphragm**

   Either of these conditions could result in erroneous readings from your transducer.

   WARNING: NEVER attempt to clean your transducer's nose piece or diaphragm with a sharp or hard object. This could dent the sensor diaphragm and cause permanent damage to the transducer.

   Your transducer may be cleaned in accordance with the procedures listed in step 4, below.

3. **Cleaning your transducer**

   Materials required:
   - Plastic bowls 8-12 inches (200-300 mm) in diameter and 4-6 inches (100 - 150 mm) deep
   - Supply of clean, lint-free cleaning rags
   - 32 ounce bottle of "The Works-Tub and Shower Cleaner" (a mild detergent) manufactured by Lime-O-Sol Company in Ashley, IN 46705 and available locally through Wal-Mart, K-Mart, Target, and Ace Hardware stores at $2 to $4 per bottle

   Preparation: Prior to cleaning your pressure transducer, ensure that all procedures have been followed in the proper cleaning of the cable and transducer to remove any hazardous materials. The vent filter (or bellows) must be properly attached. The cable should be coiled to ensure ease of handling and it must be protected against the possibility of accidental abrasion and/or penetration of the cable jacket by sharp objects. A lead length of 1 to 1 ½ feet (0.3 - 0.45 m) of cable from the transducer should be allowed to facilitate handling during cleaning. The protective covering (or similar protective device) that is shipped with each transducer should be attached to the transducer at all times. It should only be removed prior to installation or cleaning.

   Your work surface needs to be clean and free of clutter and large enough to accommodate all materials required in addition to the transducer and cable. Fill one of the bowls with fresh water, one with a mild detergent mixed with water and the last with 16 ounces (0.45 kg) of "The Works".

Cleaning:

Step 1: Holding the cable 6 inches (150 mm) from the transducer, immerse the unit in the bowl containing the mild detergent and stir for 20-30 seconds. Remove and rinse in the bowl containing the fresh water, using the same stirring motion used in the mild detergent. Rinse and wipe dry.

Step 2: Holding the body of the transducer with one hand so that you are looking at the retaining screen protecting the sensor, carefully remove the sensor nose piece by simply unscrewing it from the sensor body. *Do not touch the sensor diaphragm with your finger or any other object. Also, do not try to dry the inside portion of the transducer, as you risk damaging the pressure sensor.*

Step 3: Place the transducer in a vertical position with the pressure sensing end facing downward in the bowl containing "The Works" solution for approximately 15-20 seconds. Rinse in the bowl containing clean water and wipe dry the external casing only. Place the protective screen in the same solution for 15-20 seconds, rinse and wipe dry.

Step 4: Holding the transducer in a vertical position so that you can see the face of the pressure sensor, screw the protective nose piece back into place.

4.0 Warranty and Product Return Procedure

Any transducer/transmitter that is less than 2 years old (see DOM) which does not meet the product's specifications and exhibits **no obvious physical damage to the housing, sensor, or cable (cuts),** will be replaced under warranty.

Units 2-3 years old: Units that fall within this age group and exhibit no obvious physical damage to the housing, sensor, or cable (cuts), may be replaced at a discounted list price.

Units greater than 3 years old: Units that fall within this age group are not replaced under warranty.

Merchandise Return Procedures

Contact the **Applications Support Group** or the **Customer Service Department** at Pressure Systems if your transducer is not operating properly. Our staff is available for troubleshooting at **(757) 865-1243** or toll free at **1-800-328-3665** during normal working hours, Eastern time. If your transducer or accessory needs to be returned to Pressure Systems, obtain a *Returned Merchandise Authorization* (RMA) from the Customer Service Department prior to shipment. Be prepared to supply the following information when requesting the RMA:

- Part number
- Serial number
- Complete description of problems/symptoms
- **Bill To** and **Ship To** address
- Purchase order number (not required for warranty repairs)
- Customer contact and telephone number

The above information, including the RMA number, must be on the customer's shipping documents that accompany the equipment to be repaired. Pressure Systems also requests that the outside of the shipping container be labeled with the RMA number to assist in tracking the repairs. All equipment should be sent to the following address:

ATTN: KPSI TRANSDUCER REPAIR DEPARTMENT (7-digit RMA number)
Pressure Systems, Inc.
34 Research Drive
Hampton, Virginia 23666

Prior to returning to Pressure Systems, the transducer and cable must be cleaned per instructions provided on the cleaning certificate supplied when the transducer was delivered. The certificate can also be found on Pressure Systems website:

www.PressureSystems.com/cleaning.html

The completed certificate must accompany the transducer when shipped to Pressure Systems. If the transducer has been used in media other than potable water, PSI customer service must be notified at the same time an RMA number is requested. PSI reserves the right to reject any shipment deemed to be unsanitary or environmentally unsafe to handle. If these guidelines are not met, the package will be sent back unopened and at the customer's expense. ***Please include the attached vent filter or aneroid bellow with each returned transducer.***

Pressure Systems will return warranty items prepaid via UPS GROUND. If the customer desires another method of return shipment, Pressure Systems will prepay and add the shipping charges to the repair bill.

Incoming freight charges are the customer's responsibility. The customer is also responsible for shipping charges to and from Pressure Systems for all equipment not under warranty.

Once the return is received, it typically takes 5-10 working days for the technician to make a fault determination.

A cable reconnect fee will be charged when the customer requests a different length of cable.

Restocking Policy

Pressure Systems does allow standard products to be returned for credit in the event it is no longer required, providing the products are in new and unused condition. A restocking fee will be assessed depending on the model type and variety.

A **25% restocking fee** applies to the following models, providing they are vented-gage pressure format and pressure ranges above 3 psig (20 kPa) and below 100 psig (690 kPa).

27	116	320	700	720
28	169	342	705	750
Display Meters - all models			710	

A **50% restocking fee** applies to the following models. This also applies to all other models with sealed-gage and absolute pressure formats as well as vented-gage pressure formats with pressure ranges below 3 psig (20 kPa) and above 100 psig (690 kPa).

30	173	330	500	735
35	200	335	waterMONITOR	773
126	300DS	343	730	

NOTE: Expedite premiums and shipping charges are non-refundable.

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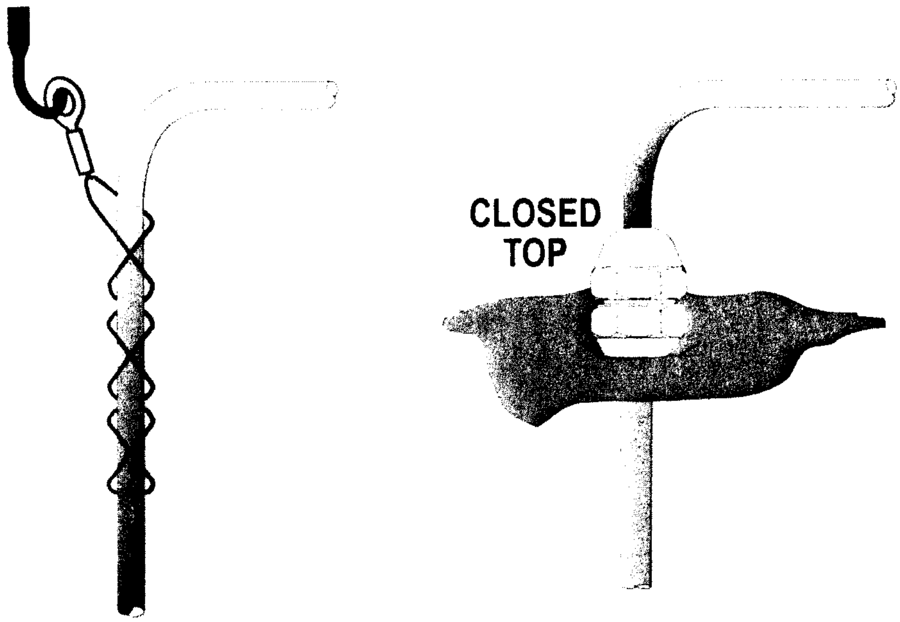
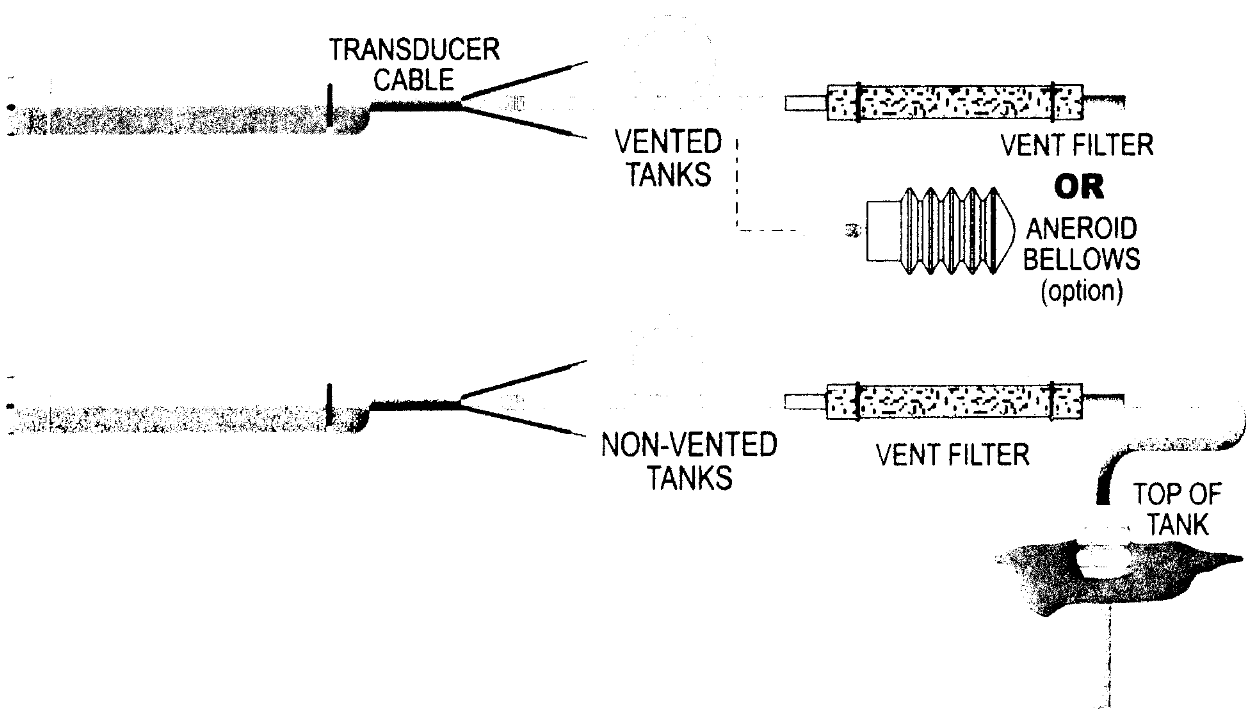
Appendix A

Drawings and Diagrams

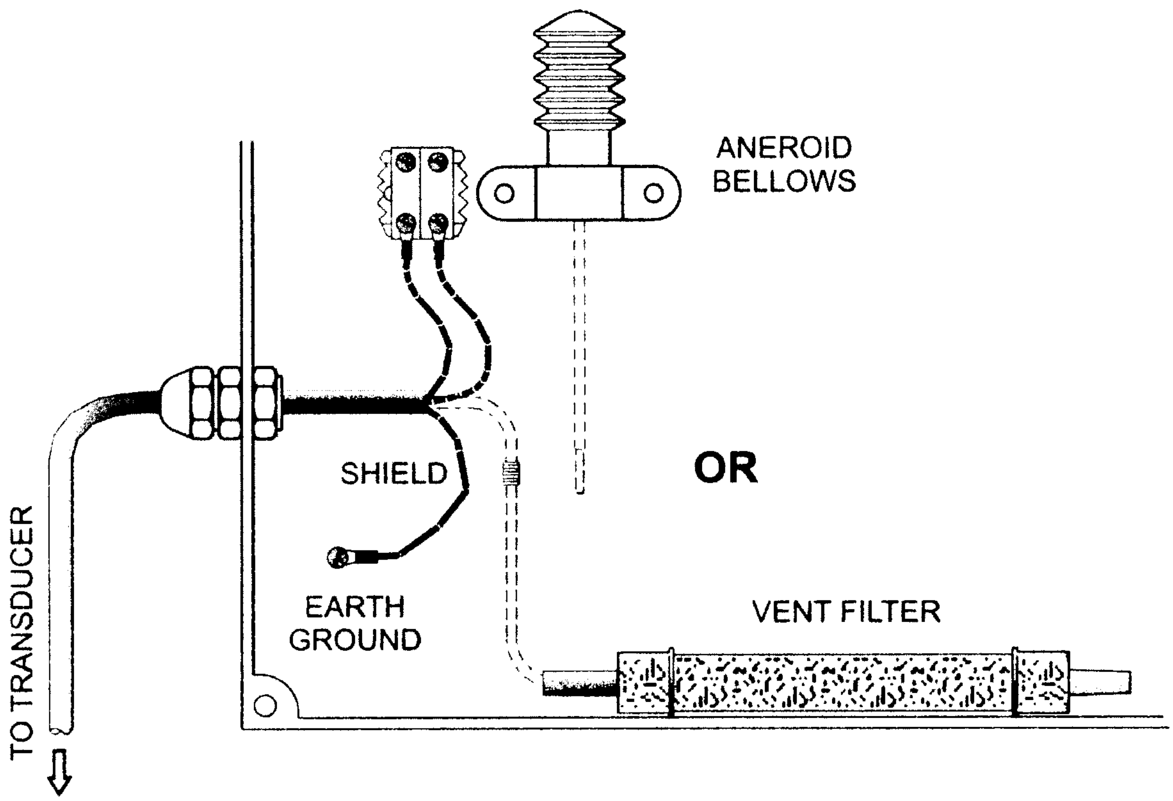
Cable Anchoring Schemes



Reference Connection Schemes



Submersible Cable Termination



Appendix B

1. **Question:** What installation ideas do you have to help me get rid of electrical noise interfering with the signal?

   Answer: An ounce of prevention goes a long way. Either try to eliminate the source of noise or move the transducer as far away from it as possible. We strongly encourage you to secure our cable shield to a good earth ground and that you use a 4-20 mA signal output. Armed with these precautions and the fact that many of our transducers are CE approved for electromagnetic interference, you should have few problems.

2. **Question:** The cable on the submersible transducer always seems to get cut and damaged. What am I doing wrong?

   Answer: This is the most common problem that our users encounter. Make sure that all of your colleagues and staff understand the importance of handling the cable with care. The cable should not be bent around rough or sharp edges. Always use a cable reel during transport. Where possible, suspend the unit in a perforated 2" (50 mm) PVC pipe and thread the cable through protective conduit to the nearest junction box.

3. **Question:** I have an application where the transducer is frequently damaged by voltage spikes. What can be done to prevent this?

   Answer: At a minimum, make sure the cable shield is connected to an earth ground as near as possible to the transducer. We can provide a surge protection kit for both our below and above ground transducers and transmitters. See page 4. These kits will handle typical spikes that might come in through the power lines as well as surges that travel through the ground due to nearby lightning strikes

4. **Question:** How much impact shock can your submersible transducers withstand?

   Answer: Our transducers are not shock tested and the lower pressure ranges can be damaged if dropped from several feet onto an unforgiving surface like concrete. We recommend that the protective shipping foam remain in place until the unit is installed.

5. **Question:** What is the response time of your transducer?

   Answer: From initial power up, the transducer output will stabilize within a fraction of a second. The frequency response is rather low, probably less than 1 kHz, but it depends on the application, the media, plumbing, etc. Call our factory for application assistance if frequency response is critical in your application.

6. Question: How do I attach your vent filter or aneroid bellows to my cable vent tube?

Answer: The vent filter can be mounted anywhere convenient, preferably out of the weather. It can be mounted in any position and connects to the cable vent tube via the extension tube with metal connector tube provided. The aneroid bellows must be mounted in a way that its movement is not encumbered. It is provided with a mounting base.

7. Question: What is the best way to mark my cable?

Answer: Use white vinyl marking tape available from your local hardware or electronic stores. These same stores may also sell cable marking kits.

8. Question: Any ideas for preventing marine growth on your submersible transducers?

Answer: You might want to try waterproof grease. Remove the threaded nose cap to facilitate applying the grease. **Take care not to damage the diaphragm when applying the grease and not to trap air bubbles against the sensing diaphragm.**

9. Question: How many pressure measurements can you make before the diaphragm on the pressure sensor fails?

Answer: In normal operation - millions of cycles. We find that transducer failure is rarely due to diaphragm fatigue.

10. Question: What is the turnaround time on repairs?

Answer: Once we receive a unit into our facility it takes less than 10 working days to complete an evaluation.

11. Question: What is the longest length of cable you have attached to a submersible transducer?

Answer: Two thousand feet (610 meters).

12. Question: Why do you use 316 SS housings and sensors for your standard transducers?

Answer: It offers a good combination of corrosion resistance and reasonable cost. As an option, we do offer titanium for more aggressive environments.

13. Question: What wire gauge should I limit myself to when connecting to your 22 AWG wire?

Answer: Use 22 AWG or heavier.

14. Question: Does it make any difference if I mount the transducer in a vertical or horizontal position?

Answer: Yes. Our units will experience a certain amount of position sensitivity. You should mount it in a vertical position throughout the measurement cycle. If you lay the transducer down, the user must realize than an offset will occur.

15. Question: What happens when you freeze your transducer in a column of water?

Answer: We have frozen our submersibles in a container of water in a home freezer, with no resulting damage. However, depending on the pressure range of the unit, over pressure of the unit is possible. In harsh environments where debris is common and ice shifts, you might expect damage to both the transducer and cable.

16. Question: Why would I choose a KPSI Transducer versus a competitor?

Answer: Reliable, long lasting products
Rapid delivery
Lightning protection lifetime warranty
Excellent pre & post sales/application support
No hassle service

Appendix C

Troubleshooting Techniques

Quick Check Procedure

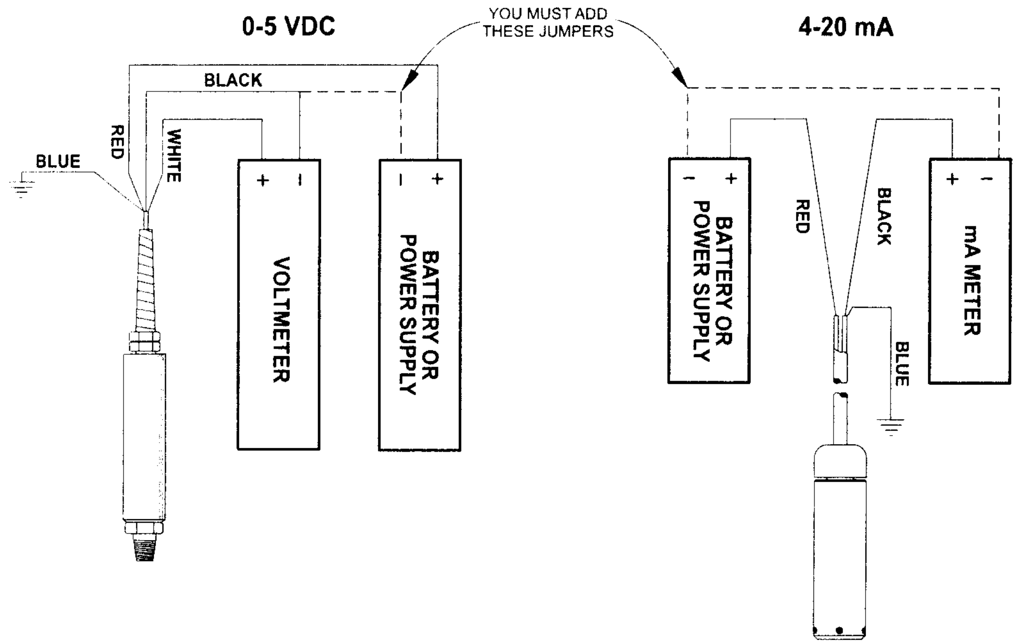
The following is a quick field checkout procedure for KPSI Level and Pressure Transducers. It will be referred to throughout the troubleshooting section.

Should a problem be encountered with a transducer or transmitter, it is sometimes helpful to test the transducer independently from the rest of the system, thereby establishing where to concentrate the troubleshooting effort.

On the next page is a simple hookup diagram for the most common types of electrical output, a 0-5 VDC transducer and a 4-20 mA transmitter. In either case, the "power supply" can be a common 12 volt lantern battery, or even a 9 volt transistor radio battery, although the lifetime of a 9 volt battery will be limited. The meter should be a digital type capable of reading at least 2 digits to the right of the decimal point. Use 22 gage or heavier hookup wire or clip leads for jumpers. If your unit has other than a 0-5 VDC or 4-20 mA output, please call Applications Support at **(800) 328-3665** for assistance.

Once your transducer is correctly configured per one of the diagrams below, orient the transducer in a vertical position with the pressure port down and then read the zero output on your meter. For a 0-5 VDC output, the zero should be between 0 and 0.10 volts, and for a 4-20 mA output, between 3.80 and 4.20 mA. For Series 300, the values do not change for VDC output but the values for mA are between 3.88 and 4.12 mA. If the output is outside of these limits, you may, at your option, choose to troubleshoot the transducer per the suggested measurements shown below. Otherwise, contact our Customer Service Department at **(800) 328-3665** for a Return Material Authorization number (RMA).

If the zero output is within these limits, the problem will more than likely be found elsewhere in your system.



When an error is observed at a customer's installation, it is important to determine if the fault lies in the transducer or the instrument reading the transducer signal, ie. digital panel meter, programmable logic controller, etc. . To do this, a second instrument should be used to confirm the observations. The second instrument may be a handheld DMM (Digital Multi-Meter) or a dedicated milliammeter capable of reading 4-20 mA of current to a resolution of at least 0.1 mA. The diagram above illustrates the attachment of the meter in series with the black (negative signal) wire of the transducer using a 9-30 VDC power supply for transducer excitation. Some suggested power supplies are:

- 1 - 12 VDC automotive battery.
- 2 - 6 VDC lantern batteries connected in series (for a total of 12 VDC).
- 2 - 9 VDC transistor batteries connected in series (for a total of 18 VDC).

Batteries are suggested to power the transducer during testing to eliminate the possibility that line noise is passing through an improperly filtered, grounded, or damaged power supply. All measurements should be recorded and sent to Pressure Systems along with the transducer to assist in the evaluation process.

Further Measurements:

0-5 VDC	Should read:	4-20 mA	Should read:
+Excitation (white) to Shield (drain)	> 2.5 Mohms	+Excitation (red) to Shield (drain)	> 2.5 Mohms
-Excitation (black) to Shield (drain)	> 2.5 Mohms	-Excitation (black) to Shield (drain)	> 2.5 Mohms
+Output (red) to Shield (drain)	> 2.5 Mohms	Shield (drain) to Housing	< 2 ohms
Shield (blue) to Housing	< 2 ohms		

Maximum Cable Lengths and Minimum Supply Voltage

The maximum length of cable to be used with our submersible transducers is largely dependent upon the type of electrical output of the transducer. For a 0-5 VDC output, a maximum cable length of 100 feet (30 m) is recommended. A voltage output is more susceptible to electrical interference than a 4-20 mA signal. A 4-20 mA signal can be transmitted much longer distances, depending upon such factors as temperature, wire size, length of the wire, power supply, and voltage requirements of any devices to be powered. At 25°C the 22 AWG conducting copper wire used in our polyurethane jacketed cable has a resistance of 16.45 ohms per 1000 feet (304 m).

Using Ohms Law (E=IR) where E=voltage, I=current and R =resistance, one finds that a 20 mA signal requires .329 volts to drive it along 1000 feet (304 m) of 22 AWG copper wire (E=16.45 x .020). This drop is seen on both the supply and return wire for a total loop voltage drop of 0.658 volts

To find out how much voltage is required to drive our Series 700 submersible pressure transducer's 4-20 mA signal 10,000 feet, just add the minimum power requirement of the 700 (9 VDC) to the resistance offered by 10,000 feet (3048 m) of our polyurethane jacketed cable (10,000÷1000 x .658=6.58). The resulting power requirement is 15.58 VDC (9 + 6.58).

Connect the cable shield (drain wire) to a good earth ground. This will protect the transducer from relatively minor transient voltages. The only exception to this rule is if high rates of electrolytic corrosion have been previously experienced with grounded submersible devices. In this case it may be better to leave the shield disconnected.

Please note: When using products with the lightning protection option on 4-20 mA products, users should take into account the additional series resistance of this option when selecting the loop power supply. This option will increase total loop resistance by 88 Ohms.

Troubleshooting Techniques

1. **Symptom**: ***Transducer fails to give output of any kind.***

Procedure: Isolate the problem to either the transducer or the power supply/readout. See the Quick Check Procedures (above) for this check. If it can be determined that the transducer is no longer operable, remove it from service for further analysis. If the transducer output falls within the limits described above, the fault lies somewhere else in your system.

2. **Symptom**: ***Transducer has failed and has been removed for analysis.***

Procedure: Inspect the cable for physical damage. Cuts in the cable jacket can result in liquid incursion into the transducer housing, which can cause permanent damage. If operational, the cable can be repaired by using a splice kit (P/N 830) supplied by Pressure Systems.

Inspect the transducer housing. It should be intact and free of corrosion. If the outer surface of the transducer is pitted, this could be an indication of galvanic corrosion caused by stray ground currents. If this is the case, the transducer will probably require replacement. If the external case exhibits none of these characteristics, carefully unscrew the nosepiece and look into the pressure sensing end of the transducer. The concentric rings of the sensing diaphragm should be visible. If they are not, it could be that residue has accumulated on the diaphragm, preventing it from responding properly to pressure changes. The transducer can be cleaned by gently swishing the transducer back and forth in a bucket of warm, soapy water until the residue softens and washes off. (See **Cleaning Your Transducer**, page 10.) ***Under no circumstances should any object or tool be used to remove residue from the sensing diaphragm or else permanent damage will be done.*** If cleaning the diaphragm does not solve the problem, the transducer should be returned to the factory for repair or replacement.

3. **Symptom**: ***Transducer develops a negative offset and gets worse over time (actual level exceeds specified level).***

Procedure: This may be a sign that moisture has entered the reference (vent) tube in the cable and is inside the transducer housing. This is usually the result of not maintaining the desiccant vent filter or of operating the transducer without a desiccant filter or aneroid bellows. If caught early enough, the transducer can be saved by coiling the cable and transducer in a pan and baking it in an oven at 50^0C (122^0F) for a minimum of 2 hours. *Be careful that the oven temperature does not exceed 50^0C (122^0F)* or both the transducer and the cable can be damaged. **Alternatively**, suspend <u>both</u> the cable and transducer in a vertical position (with vent tube down), overnight to allow water to drain from the transducer and vent tube.

4. **Symptom**: ***Transducer suddenly fails during or just after a nearby lightning event.***

Procedure: This failure is usually caused by overvoltage due to ground transients resulting from a direct or indirect lightning event. These transients can travel distances of a mile or more. The transducer may be returned to the factory for repair and optional retrofit of our ***lightning protection system.*** This system carries a lifetime warranty against transducer damage due to lightning.

5. **Symptom**: ***Transducer response to pressure/level input changes becomes sluggish.***

Procedure: This is usually a sign that the pressure sensing end of the transducer has become fouled with residue. The transducer must be removed from service and the pressure sensing diaphragm cleaned as described in Item 2, (warm, soapy water). If fouling persists, the transducer may be replaced with a Series 750 (wide mouth) transducer, which is specifically designed for trouble-free operation in a high residue environment.

6. **Symptom**: ***Output reading is within limits but "freezes" at one point.***

Procedure: In certain environments "crust" may form over the sensing diaphragm, preventing the sensor from identifying change in level. Removing the transducer from service and cleaning it (as described in Item 2) will generally solve the problem. To combat marine growth, you might try wrapping the transducer with copper wire similar to that found in wire scouring pads for cleaning dishes. Marine growth occurs on the copper and eventually erodes the copper and drops off or the copper is manually removed during routine maintenance. Alternatively, there are various companies that will impregnate/coat the 316 stainless steel with anti-fouling chemicals of coatings. Level sensors temporarily removed from the well or sump should not be stored dry, but should be stored in a bucket of fresh water in order to prevent "crust" formation.

7. **Symptom**: ***Readings increase very slowly over time.***

Procedure: Our cable is shipped coiled and consequently takes time to straighten when installed. Attaching a weight to the transducer (e.g., one of our sacrificial anodes) will help. To prevent cable stretch with lengths greater than 200 feet (60 m), secure the Kevlar fibers (just under the cable jacket) to your junction box or other secure object.

8. **Symptom**: ***No electrical output from your transducer.***

Procedure: Check all electrical connections to ensure they are correct and secure. Double check your power supply or use a battery (as described previously) to ensure the transducer is getting power. If all checks OK, the problem could be a circuit board or the sensor in your transducer. The unit must be returned to the factory for evaluation. The most probable cause of this type of failure is damage to the submersible cable jacket allowing water to leak down the cable and into the transducer housing or lightning damage.

9. **Symptom**: ***Formation of marine growth on a submersible transducer.***

Procedure: Certain transducer construction materials, for example, 316 stainless steel, attract marine life (snails) and algae. Clean the transducer diaphragm by soaking it in a bucket of warm water with a non-aggressive cleaning solution. You can also coat the transducer with marine grease. This may be the most effective and inexpensive way to protect your transducer.

10. **Symptom:** ***Submersible transducer exhibits corrosion or pitting on body or diaphragm***

Procedure: Dissimilar metals (for example, your transducer housing and your pump housing) in an electrolytic environment (fluid in your well) can lead to *galvanic corrosion* of the metal that is nearer the anodic end of the galvanic series. Likewise, a voltage potential between the ground wire of the transducer and the ground of other equipment in the well can lead to *galvanic corrosion*. Installation of a P/N 820 or 825 sacrificial anode will help protect your transducer from *galvanic corrosion*. Our sacrificial anodes are made of a zinc alloy that, being nearer the anodic end of the galvanic series than the 316 stainless steel or titanium housing of the transducer, will corrode before the transducer.

11. **Symptom:** ***The transducer is buried in dirt or silt and the readings seem to be erroneous.***

Procedure: Use of a piezometer nosepiece in this application would help. This nosepiece can be easily installed in the field and features a very fine screen to keep dirt from fouling the diaphragm, but allows the diaphragm to sense moisture levels.

12. **Symptom:** ***Transducer has an offset error.***

Procedure: Our submersible transducers perform best when the sensing end is pointing in a downward manner. Keep in mind that you can experience offset error due to the position sensitivity or orientation change of the sensor. Offset errors are more prominent in low pressure applications with the sensing end of the transducer lying flat or pointing upward.

13. Symptom: ***I am testing a Series 700 4-20mA sensor for use with our data logger. On page A-2 of the KPSI Level and Pressure Transducers User's Manual, I see the standard 4-20mA configuration. Does the recording channel of my data logger become the mA meter?***

Procedure: Most data loggers cannot measure current (mA) directly. When this is the case a load resistor must be used to convert the current (mA) output into an appropriate voltage. If the User's Manual for your particular instrument does not illustrate a preferred method for recording current (mA) data then you should attach your transducer signal wires to your data logger in the following manner.

Transducer red wire - Data Logger Excitation Terminal
(The minimum excitation for a Series 700 Transducer is 9VDC)
Transducer black wire – Data Logger signal input (+) terminal

Attach a Load resistor between the Data Logger signal input (+) terminal and the Data Logger signal input (-) terminal.

Attach a separate piece of wire between the Data Logger signal input (-) and analog ground.

In this configuration you will turn your data logger into a milliammeter. The size of your load resistor can be calculated in the following manner.

D/0.02=R

Where:

Data logger input range = D
Full scale output of transducer = 0.02 A (20 mA)
Load Resistor Value = R

Pick an appropriate standard value

250 Ohms results in 1 to 5 VDC at 4 and 20 mADC
125 Ohms results in 0.5 to 2.5 VDC (500 to 2500 mVDC) at 4 and 20 mADC

At this point the discussion needs to address IR loss (voltage drop) in series circuits. Note that Series 700 transducers need a minimum of 9 VDC to operate correctly. When the transducer is operating correctly it will output a current which, when driven through a resistor, will generate some amount of voltage drop. If the resistor value is 250 Ohms then the voltage measured across that resistor will be 0.004 A * 250 Ohms = 1.000 VDC and 0.020 A * 250 Ohms = 5 VDC. Notice that, if the available voltage from the data logger is12 VDC then 12 VDC - 5 VDC = 7 VDC which is less than the voltage required by the transducer to operate. If this scenario were to occur the transducer would actually stop functioning correctly when its output reached 12 mADC (50 % of transducer full scale range). In this case the appropriate choice for a load resistor value is 125 Ohms.

14. Symptom: ***I have a Series 700 4-20mA transducer rated for 7.5 PSIG attached to a pressure source that is outputting 7.5 PSIG. With 20VDC being supplied I am getting 19.94 mA. I can't find the upper range allowance for the sensor, but this seems low to me. Does this mA reading fall into the acceptable range for the sensor with the settings I've specified?***

Procedure: When evaluating a transducer it is sometimes convenient to make some broad generalizations in order to rapidly determine the condition of the unit. In general, transducers that output a 4-20 mADC signal have a 16 mADC span (4 - 20 = 16). If the transducers accuracy is reported as being some percentage of its full-scale pressure range then the following table could be used in conjunction with the instructional notations to determine whether a more detailed analysis of data quality is required.

Model	Accuracy	Accuracy in mADC
700	1.00%FS	±0.16 ma
710	0.50%FS	±0.08 ma
720	0.25%FS	±0.05 ma
730	0.10%FS	±0.016 ma
735	0.05%FS	±0.008 ma

In order to approximately determine how many milliamps a transducer should output at a given depth.

1. Determine the depth (in feet) at which the transducer is sited.
2. Divide the depth value (from step 1) by the transducer full-scale range (in feet). - Record the value.
3. Multiply the value calculated in step 2 by 16 (the transducer span in milliamps).
4. Add 4 to the product of step 3. This is the approximate value in milliamps that should be output by the transducer at its current depth.

In order to approximately determine the depth of a transducer (in feet) using a given value of milliamps.

1. Divide the full-scale range of the transducer (in feet) by 16. Record this value.
2. Subtract 4 from the milliamp output of the transducer. Record this value
3. Multiply the result of step one by the result of step 2. This is the approximate depth at which the transducer is sited.

If the resulting numbers are reasonably close to some verified value for current water depth, then the unit is functioning. In order to determine the quality of measurement, additional steps need to be performed.

Appendix D

Calibration Calculations

Pressure Systems ships a calibration sheet with every water level transducer. This sheet lists the actual values that were output by the transducer, when it was being manufactured, at several different pressures. In addition, two coefficients are provided that can be used to calculate the actual depth from any given mA output value. These coefficients are derived from a Least Squares Best Fit Straight Line (BFSL) calibration using the data listed on the datasheet. Our accuracy specification is referenced to the line described by the BFSL coefficients and so the transducer may not output exactly 4 mADC at zero pressure and 20 mADC at full-scale. As an example here is an example of data for a typical transducer.

Test Date	3/24/2005		
Test Time	7:32:54		
Zero Pressure	0		
Full Pressure	6		
Pressure Units	psig		
Serial No	402751		
Model No	700-140-0006		
Excitation	9-30 VDC		
Output	4-20 mA		
Electrical	2-wire	Cable	Termination
EC1	RED: +SUPPLY		
EC2	BLACK: - SUPPLY		
EC3	BLUE: SHIELD		

SUMMARY OUTPUT

	Coefficients
Offset	-1.489789766
Sapn	0.373836306

Calibration Data			Verification Data	
mA	*True PSIG*	*Predicted PSIG*	*Residual Error*	*Error%FS*
3.9875	0.0024	0.000882505	0.001517495	0.0253%
7.1905	1.202	1.198280195	0.003719805	0.0620%
10.4085	2.3976	2.401285428	-0.003685428	-0.0614%
13.6176	3.5986	3.600963519	-0.002363519	-0.0394%
16.8214	4.8001	4.798660227	0.001439723	0.0240%
20.0258	5.9998	5.996581337	0.003218663	0.0536%
16.8217	4.7994	4.798772428	0.000627572	0.0105%
13.622	3.5997	3.602608398	-0.002908398	-0.0485%
10.411	2.4004	2.402220019	-0.001820019	-0.0303%
7.1941	1.1984	1.199626005	-0.001226005	-0.0204%
3.9876	0.0024	0.000919889	0.001480111	0.0247%

In this case, even though the offset or 0 PSIG output was 3.9875 mADC and the full-scale point was 20.0258 mADC the unit actually performed better than its specified accuracy of 1.0% of full-scale range as indicated in the Error % FS column.

The calculation for pressure is illustrated below:

PSIG = (Span*Output (in mA)) + Offset

Or, using the coefficients listed above,

PSIG = (0.373836306 * Output (in mA)) + (-1.489789766)

And, to convert to feet of water

Feet H_2O = PSIG * 2.3073

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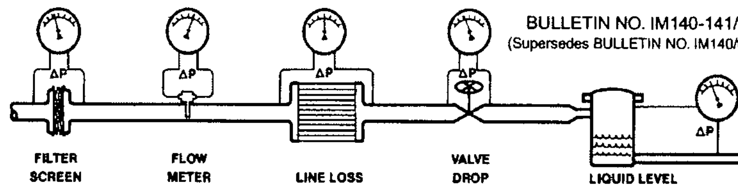
D-19

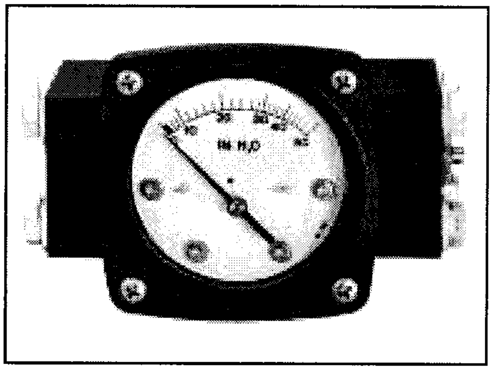
Differential Pressure Switch and Transmitter

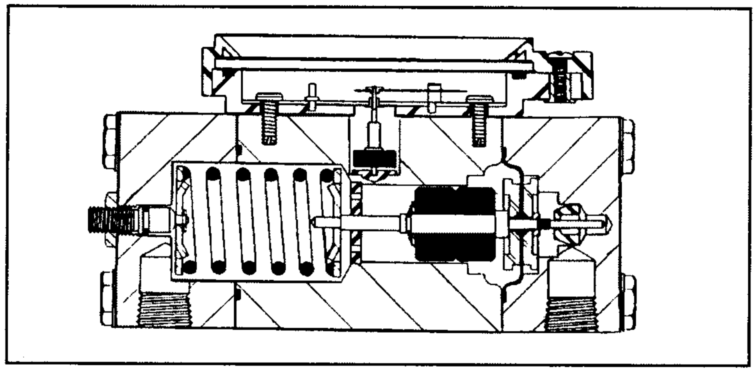
Mid-West® Instrument

BULLETIN NO. IM140-141/02
(Supersedes BULLETIN NO. IM140/01)



Model 140/141 Series
Installation and Operating Instructions





INSPECTION

Before installation check the nameplate on each instrument against the receiving paperwork and the intended application for correct part number, materials of construction, working pressure, dial range, etc. If equipped with switches, check electrical rating, type of enclosure, etc. Inspect for shipping damage and, if damaged, report it immediately.

NOTE - Before attempting repairs contact your local Mid-West Representative or our factory. Failure to do so will void any warranty.

PRODUCT DESCRIPTION

The Model 140/141 "Series" is a medium range differential pressure instrument available as a switch, a gauge, or both. See "Part Numbering System", (Fig. 6) for available options.

A flexible elastomer diaphragm and calibrated range spring are moved by differential pressure. A pair of magnets, coupled with the diaphragm, transmit this motion through the wall of the pressure housing to a follower magnet attached to an indicating pointer. The rotation of the follower magnet causes the pointer to track movement of internal magnet and indicate the differential on the dial scale.

When equipped with switches, a contact is made, or broken, by the magnetic field of the internal magnets.

The diaphragm is totally supported upon reaching full travel in either direction, providing full over-range protection to the rated working pressure of the housing.

INSTALLATION

Model 140/141 "Series" is calibrated and tested prior to shipment and is ready for immediate installation. Use of the following installation procedures should eliminate potential damage and provide optimum trouble-free operation.

1. CONNECTIONS

1/4" FNPT is provided as standard but check paperwork for connections ordered. There are two connections on the housing identified as "hi" and "lo" for high pressure and low pressure.

Be sure these get plumbed to the proper connections on your system. Improper connection will not damage the instrument, but it will not function properly.

Flexible tubing is recommended to minimize effect of any vibration that may exist.

2. INSTRUMENT LOCATION

On liquid service, the instrument should be mounted **below** the process connections to facilitate self-bleeding. On gas service, it should be located **above** the process connections to promote self-draining. If the process contains particulates, a "pigtail" loop or drop leg (manometer "U-tube" configuration) in the tubing will minimize the possibility of it migrating into the instrument.

3. PANEL MOUNTING

Gauges with 2-1/2" dials can only be mounted through the **rear** of the panel. Make the proper panel cutout as indicated in (Fig. 5). Remove the (4) bezel screws. Insert the gauge front through the rear of the panel and reinstall the bezel screws through the front of the panel and into the gauge bezel. Tighten the screws securely, alternating in a **diagonal** pattern.

Gauges with 3-1/2" dial must be mounted from the front of the panel. Contact factory for mounting information and dimensional data.

The Gauges with 4-1/2" dial must be mounted from the **front** of the panel. Make the cutout as shown in (Fig. 5). Insert the four (4) panel mounting studs, finger tight, into the metal inserts located in the rear of the bezel. Insert the gauge through the panel aligning the panel mounting studs with the holes in the panel. Install the four (4) #8-32 nuts onto the studs and tighten securely.

4. PIPE MOUNTING

An optional pipe mounting kit is available for mounting the gauge to a 2" vertical or horizontal pipe.

5. TROUBLE SHOOTING

A. Gauge does not indicate differential.

i. Check for proper hook up, high to "hi" and low to "lo" ports.

ii. Make certain block valves are open and, if using a 3-valve manifold, that the equalizer (balance) valve is closed.

iii. If i & ii check out correctly, verify that there is pressure to the instrument.

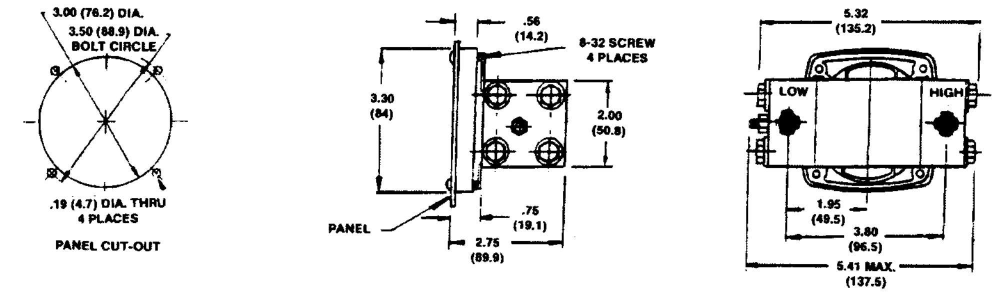
iv. If there is pressure to the instrument, check to determine that there is differential across the unit being monitored. If so, contact the factory for assistance and/or an "RGA" (Return Goods Authorization) number to return the instrument for repair or replacement.

B. Gauge accuracy and set point problems:

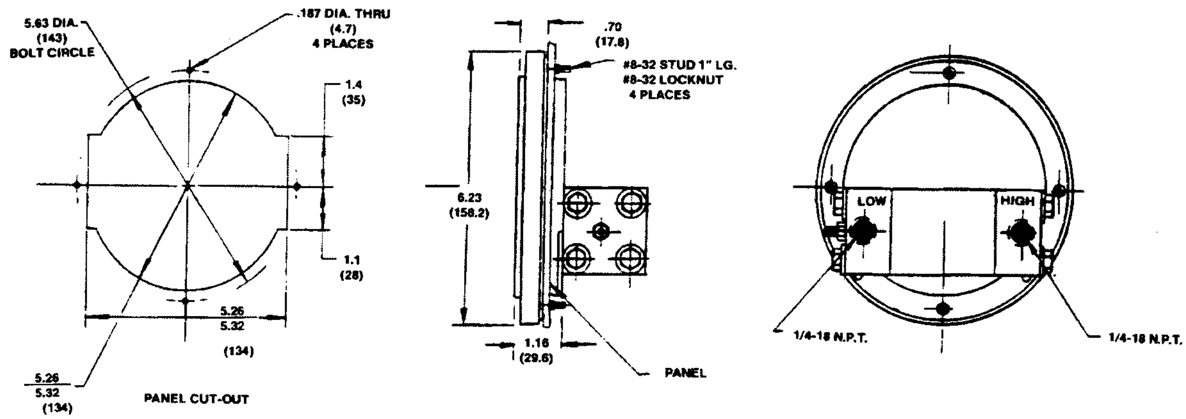
i Verify gauge is not in an electromagnetic/magnetic environment. i.e.; close proximity to high current power lines.

ii All others, contact the factory for assistance.

MODEL 140 - 2-1/2 INCH PLASTIC DIAL ASSY. (STANDARD)



MODEL 140 - 4-1/2 PLASTIC INCH DIAL ASSY. (OPTIONAL)



(Fig. 5)

NOTES:
1. Drawings show standard gauge nominal dimensions. (not to scale)
2. Dimensions shown in parentheses are in millimeters.
3. Mounting Dimensions for 3-1/2" & 4-1/2" Alum. Dial Assys. – Contact Factory

Manufacturer reserves the right to change specifications without prior notice. All dimensions in inches and millimeters.

STANDARD MODEL SPECIFICATIONS

Model 141 0-50" H2O thru 0-25 PSID
Model 140 over 0-25 PSID thru 0-100 PSID

140/141-AA-00-OO

3000 P.S.I.G. Working Pressure Aluminum Body, Buna N Diaphragm and Seals, 316 Stainless Steel Internal Metal Parts, Ceramic Magnets, Teflon Guide Bushings, 1/4" FNPT Back Connections, 2-1/2" Round Dial in Corrosion Resistant Engineering Plastic Case with Shatter-Resistant Acrylic Lens.

DIFFERENTIAL RANGE & ACCURACY

0-50 to 0-400" H_2O (125 mbar to 1 bar) or equivalent	0-15 thru 0-100 PSID. (1 to 7 bar) or equivalent
±5% Full Scale (Ascending)	+ 3-2-3% Full Scale (Ascending)

PART NUMBERING SYSTEM (Fig. 6)

☐☐☐ - ☐☐ - ☐☐ - ☐☐☐☐ - ☐☐☐

① **BASIC MODEL NUMBER**

② **MATERIAL**
- A. Aluminum **(3000 P.S.I.G.)**
- B. Brass **(1500 P.S.I.G.)**
- S. 316 S.S. **(3000 P.S.I.G.)**
- Z. Special **(Uncoded Options)**

③ **DIAL SIZE**
- A. 2-1/2" Round Engrd. Plastic Housing Assy.
- C. 4-1/2" Round Engrd. Plastic Housing Assy.
- E. 3-1/2" Round Anod. Alum. Housing Assy.
- G. 4-1/2" Round Anod. Alum. Housing Assy.
- T. Non-Indicating Differential Pressure Switch Only (Select Appropriate Electrical Options)
- Z. Special (Uncoded Options)

④ **SEALS & DIAPHRAGM**
- 0. Buna N **(Standard)**
- 1. *Viton **(60" H_2O & Above)**
- 2. Silicone
- 4. Neoprene **(25 PSID & Below)**
- 5. Ethylene Propylene
- 9. Special **(Uncoded Options)**

⑤ **CONNECTIONS**
- 0. 1/4" FNPT Back Connections **(Standard)**
- 2. Dual 1/4" FNPT Top and Bottom Connections **(Non-Switch Units Only)**
- 4. 7/16"-20 Str. Thd. O-Ring (Back Connections)
- 5. 1/2" FNPT S.S. Adaptors
- 9. Special **(Uncoded Options)**

* Viton® is a registered trademark of DuPoint Dow Elastomers

NOTE: NOT ALL OPTIONS AVAILABLE IN COMBINATION WITH OTHER OPTIONS.

⑥ **OPTIONS (Up to four options)**
- 0. None
- A. Reversed High/Low Process Connections
- B. DIN2353 12-S (12 mm) Steel Tube Fittings (2)
- F. Pipe Mounting Kit **(Not Available with Both Reversed Port and Switches)**
- L. Liquid Fill (not available with maximum follower pointer) (not available with 3-1/2" dial)
- M. Maximum Indicator Follower Pointer
- T. Oxygen Cleaning
- U. S.S. Tag mounted w/S.S. Wire
- V. S.S. Tag mounted w/S.S. Screws
- W. Wall mounting kit
- X. Chemical Seals
- Z. Special **(Uncoded Options)**

⑦ **ELECTRICAL CONFIGURATIONS**
(Switch Adjustable Range 10-90% except where stated below)
(Up to three options)
- 0. None
- A. One (1) Reed Switch In NEMA 4X Enclosure
- B. Two (2) Reed Switches in NEMA 4X Enclosure
- C. One (1) Reed Switch In Explosion Proof Enclosure with **C.S.A & U.L.** Listing (1)(2)
- D. Two (2) Switches in Explosion Proof Enclosure with **C.S.A & U.L.** Listing (1)(2)
- E. One (1) Reed Switch In NEMA 4X Aluminum Enclosure; **C.S.A & U.L. Div 2** Listing (3)
- F. Two (2) Reed Switches in Nema 4X Aluminum Enclosure; **C.S.A & U.L. Div 2** Listing (3)
- Z. Special **(Uncoded Options)**

(1) Complete Assembly Certified Class 1, Div. 1, Groups C & D, Class II, Div. I, Groups E, F & G.
(2) For Explosion-proof assemblies use the Model 140 (not 141) to build Model Number. Unit is available for the ranges specified for 140 and 141.
(3) Complete Assembly Certified Class 1, Division 2, Groups A, B, C, & D; Class II, Division 2, Groups F & G.

⑧ **ELECTRICAL SPECIFICATIONS**
(For Resistive Loads)
- A. S.P.D.T., 3 Watts, 0.25 Amp, 125 VAC/VDC
- B. S.P.S.T., 25 Watts, 0.5 Amp, 230 VAC/VDC
- Z. Special **(Uncoded Options)**

Manufacturer reserves the right to change specifications without prior notice.

PROOF PRESSURE: Two times rated working pressure.

TEMPERATURE LIMITATIONS: -40°F(-40°C) to +200°F (+93°C). These limits are based on the entire instrument being saturated to these temperatures. System (process) temperatures may exceed these limitations with proper installation.

STANDARDS: All Model 140/141 Series differential pressure gauges either conform to and/or are designed to the requirements of the following standards:

ASME B1.20.1	NACE MR0175
ASME B40.1	NEMA Std. No. 250
CSA-C22.2 No. 14.25 and 30	SAE J514
EN-61010-1	UL Std. No. 50,508 and 1203

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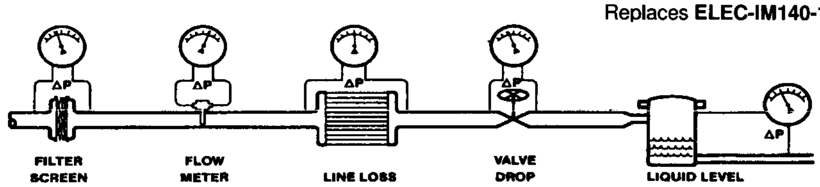


Model 140 /141 Electrical
Installation and Operating Instructions

ELECTRICAL

Gauges with switches have one or two SPST or SPDT hermetically sealed adjustable set point reed switch assemblies. Resistive load ratings and capabilities for each reed switch type are defined as follows:

Type	SPST(Norm Open)	SPDT
*Power	25 W	3W
Max. Current	0.5 Amps	0.25 Amps
Max. Voltage	240 VAC/VDC	125 VAC/VDC
Setting (F.S.)	15% to 90%	15% to 90%
Hysterisis (Max/Nom)	15% / 8% Full Scale(F.S.)	10% / 5% Full Scale(F.S.)
Repeatability	1% F.S.	1% F.S.

* **Product of the switching voltage and current shall not exceed the power rating of the device.**

Provide standard protection techniques for the switch contacts for capacitive and inductive loads. Use current limiting techniques near the switch to protect the contacts due to high inrush (i.e.; in line resistor or inductor) for long cable interfaces. Provide clamping devices at or near inductive loads (i.e.; relay). Long cable runs can be considered both inductive and capacitive, therefore also clamp across the switch. We recommend for **long cable** runs of 70 feet or greater that you use the SPST switch or use a current limiting resistor wired in series and located near the switch. Contact the factory if you need assistance. Please note that the SPST switch is available in only the **Normally Open** configuration

Both switch types are field adjustable from 15% to 90% of full scale reading of the gauge.. All switches come with a decal to identify adjustment direction to increase the set point. To set the switch at a desired set point on increasing pressure apply pressure to the gauge for the desired set point. Adjust the switch so that it is adjusted above the set point (normally open contacts are open) and slowly decrease the set point until the switch activates (normally open contact closes). Remove pressure and slowly reapply to determine the actual setting. This process can be repeated to achieve a more accurate setting.

All switch functionalities shown are with the gauge at 0 PSID. The SPST switches are available in the Normally Open configuration only.

Use the Mid-West Power Relay 1000TR or equivalent relay for loads above the switch rating.

The following warnings apply to all gauge options with electrical interface.

WARNING: ELECTRICAL CONNECTIONS SHOULD BE PERFORMED BY QUALIFIED PERSONNEL AND MEET THE REPRESENTATIVE COUNTRY'S NATIONAL ELECTRICAL CODE.

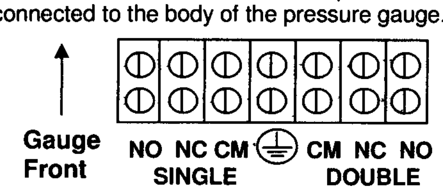
WARNING: FAILURE TO CONNECT TO THE PROTECTIVE CONDUCTOR TERMINAL MAY RESULT IN A SHOCK HAZARD.

WARNING: REMOVAL OR REPLACEMENT OF INSTRUMENT HARDWARE VOIDS ALL WARRANTIES AND CONFORMANCES TO ANY STANDARDS (EXCEPT COVERS AND OR SWITCH ADJUST PLUGS).

NEMA 4X (Plastic Weatherproof Enclosure) (A & B options)

The reed switch(es) are located inside the enclosure, on the top of the pressure housing, and are connected to a 7 position terminal strip. An opening is provided at the rear of the enclosure for a 1/2" flexible weather-proof cable or conduit connector (supplied by customer). Upon request the hole may be sized to accommodate a PG-11 cable gland connector.

Remove the switch enclosure cover by removing the (4) screws. Insert wires through an appropriate (not supplied) weatherproof connector into the enclosure and connect to the terminal strip per the terminal strip diagram shown below or on the underside of the switch enclosure cover. The center connection is for connection of a protective conductor and is connected to the body of the pressure gauge.



The terminal strip will accept wires in the range of 22 Awg - 16 Awg.. Reinstall the cover, gasket, and (4) screws. (Fig. 3) after connection of field wiring.

Wiring for the SPST switches is connected between NO and CM connections on the terminal strip. **Normally closed switches are not available.**

Access holes and plugs are provided for external adjustment of the switches if required.

Division II Hazardous Ratings (E ,F, & W) options):

The **E, F, & W** Electrical Configurations are 3rd party certified to both Canadian and U.S. standards for **Class I, Division II, Groups A, B, C, & D, Class II, Groups F & G** hazardous environments

Interface is identical to the plastic weatherproof enclosure with the exception of a ½" FNPT conduit interface.

NEMA 7 (Explosion-proof) Enclosure (C & D options)

WARNING: THE COVER AND/OR SWITCH ADJUST ACCESS PLUGS MUST NEVER BE REMOVED WHEN THERE IS POWER TO THE UNIT. MAKE ALL ADJUSTMENTS IN A NONHAZARDOUS AREA.

The gauge and switches are mounted inside the enclosure. A 1/2"-14 FNPT conduit connection is provided in the bottom side of the enclosure. A proper explosion proof, dust tight sealing fitting with appropriate sealing cement must be used when making connections to the 24", 18 Awg. wire leads.

Adjustment of the set point can be accomplished by removing the switch adjustment access plug(s). Insert the screw driver through the hole into the switch adjustment slot and rotate until the desired set point is reached. A clockwise rotation will increase the set point for the right side switch access and a clockwise rotation will decrease the set point for left switch access. Do not use excessive force. Reinstall the access plugs for **5 full threads of engagement** after completion.

SPDT Switch leads are color coded and labeled as follows:

White- 1 or 2 Com (1 Right Access 2 Left Access)
Black- 1 or 2 NC
Red - 1 or 2 NO

SPST Switch leads are black in color and are labeled:

1 or 2 Com (1 Right Access 2 Left Access)
1 or 2 NO

A green / yellow wire is provided for proper electrical bonding of the enclosure chassis.

Enclosures with SPDT and SPST switches comply with NEC Class 1, Groups C & D, Class 2 Groups E, F, & G, NEMA 7 & 9, and are CSA & UL listed.

Transmitter Option: (T & W) Electrical Configuration)

The Model 140/141 Transmitter is intended for use in General Purpose Locations (T electrical configuration) or Division 2 locations (W electrical configuration). In both cases the enclosure carries a NEMA 4X IP65 environmental rating.

The transmitter assembly as a component has passed numerous European EMC standards (ie; Compliance to IEC EN61326). Contact the factory if additional low pass filtering is necessary.

The Model 140/141 indicating / non-indicating differential pressure transmitter is a 2 wire loop powered microprocessor based 4-20 ma transmitter. The magnetic angle sensor & electronics senses the angle (relative to the transmitter sensor) of the magnet which moves linearly in the bore. Each transmitter is individually calibrated to the gauge using an 11 point calibration linearization technique. This method results in a <2% full scale accuracy for the upper 80% of the range.

In addition an external zero pin is available for simple remote zeroing (instead of supplied local zero) after installation. The zero switch for Hazardous Locations is hermetically sealed.

Caution:
Do not attempt to reposition the transmitter assembly within the enclosure. This voids the warranty and will "knock" the unit out of calibration. Disassembly and re-assembly of any internal process parts will also require the unit to be re-calibrated. Calibration must be performed at the factory.

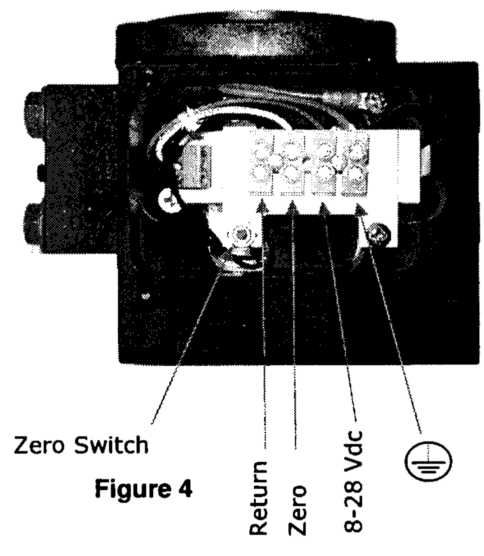


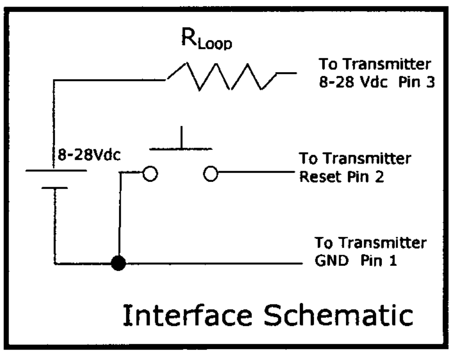
Figure 4

The weather-proof enclosure comes standard with a ½" FNPT conduit interface. Internal to the enclosure is a 4 position terminal strip. The terminal strip accepts wire sizes 22 AWG – 16 AWG. Connections are defined in Figure 4.

Connect loop power between the connections labeled 8-28 Vdc and RTN. Connect the protective conductor wire to the terminal with the ⏚ symbol. A zero pushbutton is also included. Zero the transmitter with the transmitter powered and no differential pressure applied by depressing the switch for a minimum of 2 seconds.

The maximum loop resistance is 1000 ohms (@ 28Vdc Input). Use the following formula to determine the maximum loop resistance at other input voltages:

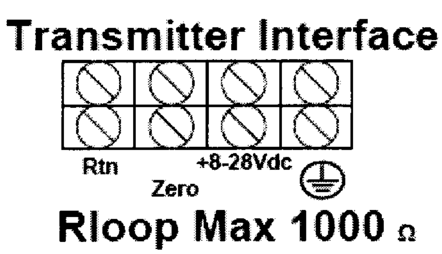
((Vs – 8) *1000)/ 20



Interface Schematic

The interface schematic shows an implementation of the Remote Zero function. The supplied unit incorporates an internal pushbutton for zeroing the unit locally.

Occasionally the transmitter may require a "re-zero". The "re-zero" may be necessary due to stray magnetic fields or a change in temperature from when the unit was originally calibrated.



<u>Trouble Shooting</u>

1. Switch doesn't function. (Assuming Indication is good)

   i. Make sure that the switch load does not exceed the specified wattage rating of the switch. (steady-state and transient). Contact factory for assistance for excessive loads, otherwise proceed to the next step.

   ii. Perform a continuity check of the switch contacts by trying to actuate the switch using an external magnet. An operational switch usually indicates a problem with the gauge. If not operational proceed to the next step.

   iii. Verify the reed switch wires are connected to the terminal strip (NEMA 4X enclosure only). Contact the factory for assistance if the switch is connected and/or request an "RGA" number.

2. **Transmitter doesn't function**

   A. Make sure you have supplied power (proper voltage) to the unit.

   B. Check that you are wiring to the correct Interface terminals.

   C. Check the transmitter interfaces to the terminal board for loose connections.

   D. Make sure that the loop resistance does not exceed the specified rating.

3. Gauge accuracy and set point problems:

   i. Verify gauge is not in an electromagnetic / magnetic environment. i.e.; close proximity to high current power lines.

   ii. All others, contact the factory for assistance.

4. When contacting the factory please have the following information available if possible:

   1. Gauge / Switch Serial Number

   2. Model Number of the Gauge / Switch

   3. Description of the problem and events prior to failure.

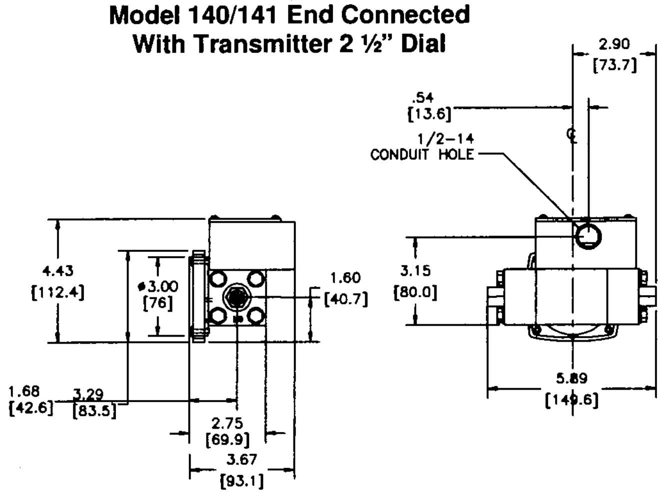
   4. Interface Information such as switching voltage, switching current, cable lengths, etc.

TRANSMITTER SPECIFICATIONS:

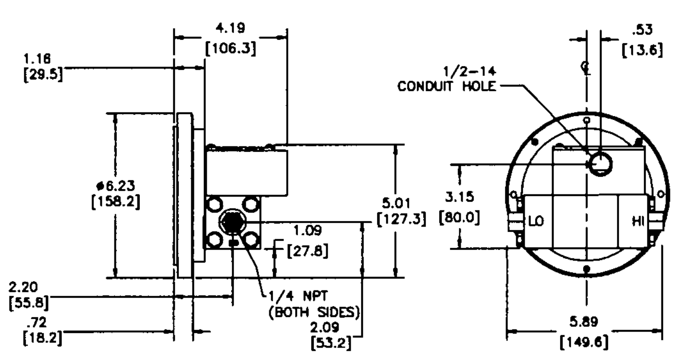
	Transmitter Specifications: (Calibrated on Increasing pressure)				Comments:
	Differential Pressure Range	0-50" H_2O to 0 -100 PSID			
	Leakage	None Hi to Lo			
	Pressure (Ratings)				
	Max Working	See Specifications			
	Gauge Accuracy	2%			ASME B40.100 GRADE B
	Operating Temperature (Max.)	-20° F - 150° F			
	ELECTRICAL:				
		Min	**Typ**	**Max**	
	Transmitter Accuracy (FSR)			2%	Upper 80% of Full Scale Range
	Supply Voltage (3) (Vdc)	8		28	Pin 3 Reverse Polarity Protected
	Output Current (ma)				
	Zero Floating (2)	4.0 – 20.1 ma	4.0 – 21.0	4.0 – 22.0	Pin 2
	Zeroed (1 connected to 2)		8		
	Voltage (Pin 2 to 1)	4.8		6.3	
	Zero Time (seconds)	2			
	Max Loop Resistance (ohms)			1000	
	Max Loop Resistance Formula	((Vs – 8)*1000)/ 20			
	INTERFACE:				
	Electrical:				
	Connections:	4 Position Terminal Strip; ½" NPT Conduit 1= Rtn, 2= Zero, 3 = 8-28 Vdc In 4= Chassis			22 Awg – 16Awg Wire
	Environmental Rating:	NEMA 4X			
	Certifications:	CSA (Canadian & US Standards; Division 2 Locations)			

Transmitter Dimensional

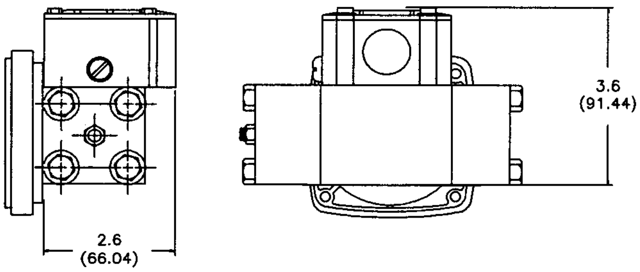
Electrical Configuration: T or W
Model 140/141 End Connected
With Transmitter 2 ½" Dial



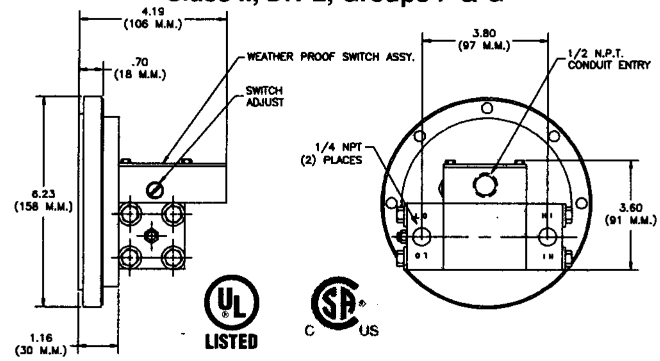
Electrical Configuration: T or W
Model 140/141 End Connected
With Transmitter 4 ½" Dial



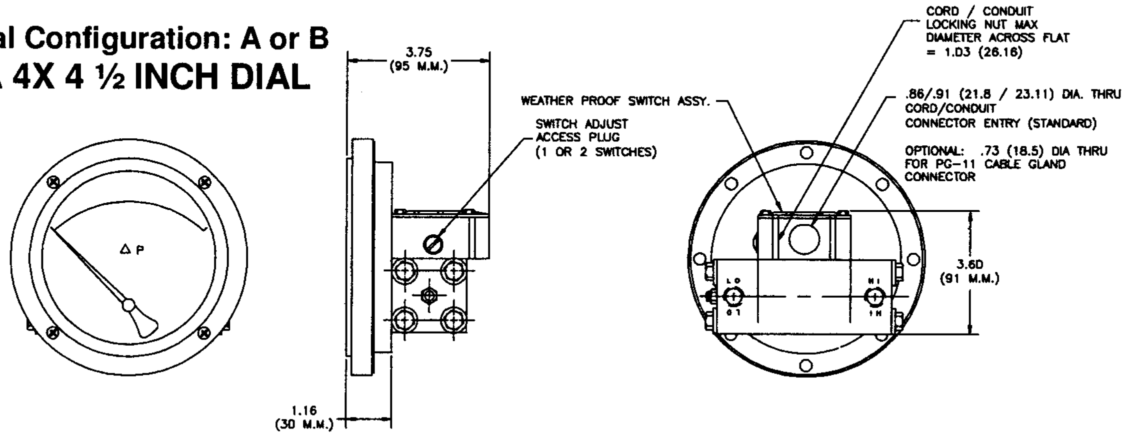
Electrical Configuration: A or B
NEMA 4X 2 ½ INCH DIAL



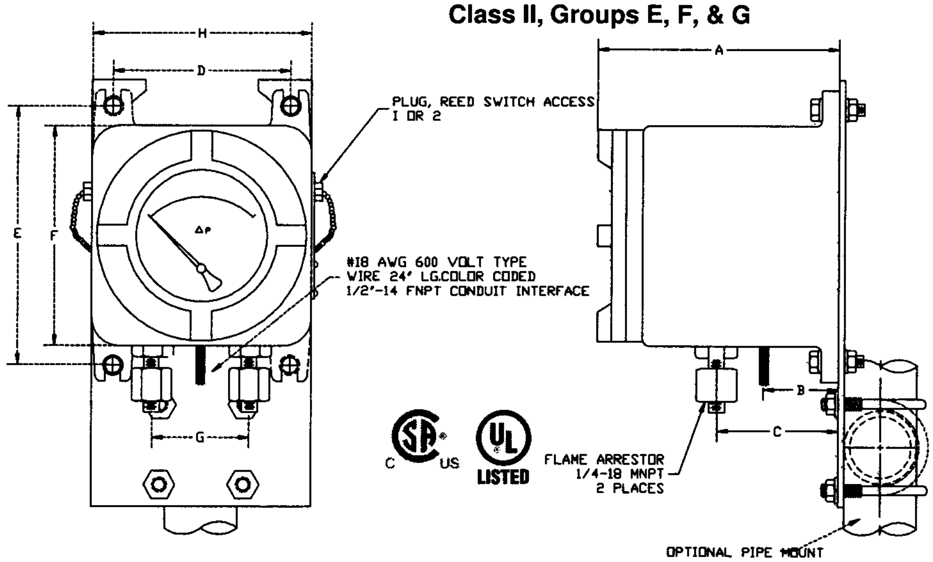
Electrical Configuration: E or F
NEMA 4X METAL ENCLOSURE
Class I, Div. 2, Groups A, B, C,D
Class II, Div 2, Groups F & G



Electrical Configuration: A or B
NEMA 4X 4 ½ INCH DIAL



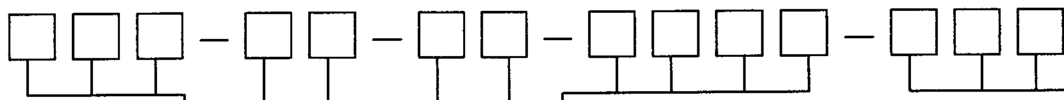
Electrical Configuration: C or D
Explosion-Proof Enclosures Class I, Groups C & D
Class II, Groups E, F, & G



Dial Size

DIM	2 ½	2 ½	4 ½
A	7.12 (180.9)	6.53 (163.3)	8.50 (215.9)
B	4.15 (105.4)	2.12 (53.84)	2.50 (62.5)
C	3.15 (80.01)	3.12 (79.24)	4.35 (110.5)
D	6.00 (152.4)	6.56 (166.6)	6.25 (158.8)
E	8.75 (222.2)	7.75 (196.9)	9.12 (231.6)
F	7.35 (186.7)	6.68 (169.7)	7.75 (196.9)
G	3.80 (96.52)	3.80 (96.52)	3.80 (96.52)
H	8.12 (206.3)	7.43 (188.7)	7.75 (196.9)

PART NUMBERING SYSTEM



① **BASIC MODEL NUMBER**

② **MATERIAL**
- A. Aluminum (3000 P.S.I.G.)
- B. Brass (1500 P.S.I.G.)
- S. 316 S.S. (3000 P.S.I.G.)
- Z. Special

③ **DIAL SIZE**
- A. 2-1/2" Round Dial **(Standard)**
- C. 4-1/2" Round Dial
- E. 3-1/2" Round Anod. Alum. Dial Assy.
- G. 4-1/2" Round Anod. Alum. Dial Assy.
- T. Differential Pressure Switch Only **(Without Indication)**. Selection Appropriate Electrical Options
- Z. Special (Uncoded Options)

④ **SEALS & DIAPHRAGM**
- 0. Buna N **(Standard)**
- 1. Viton® **(60" H 2 O & Above)**
- 2. Silicone
- 4. Neoprene **(25 PSID & Below)**
- 5. Ethylene Propylene
- 9. Special (Uncoded Options)

⑤ **CONNECTIONS**
- 0. 1/4" FNPT Back Connections **(Standard)**
- 2. Dual 1/4" FNPT Top and Bottom Connections **(Non-Switch Units Only)**
- 3. ¼" FNPT Bottom Connections
- 4. 7/16"-20 Str. Thd. O-Ring Back Connections
- 5. ½" FNPT S.S. Adaptors
- 6. Dual 7/16"-20 Str. Thd. O-Ring Top/Bottom Connections **(Non-Switch Units Only)**
- 8. ¼" FNPT end connections (not available with C & D Electrical Configuration) (1)
- 9. Special (Uncoded Options)

⑥ **OPTIONS (Up to four options)**
- O. None
- A. Reversed High/Low Process Connections (Not available with Electrical options C, D, T & W)
- F. Pipe Mounting Kit (CS) (Not Available with Both Reversed Port and all electrical options)
- G. Pipe Mounting Kit (SS) (Not Available with Both Reversed Port and all electrical options)
- L. Liquid Fill (not available with max follower pointer) (not available with 3 ½" dial)
- M. Maximum Indicator Follower Pointer
- T. Oxygen Cleaning
- U. S.S. Tag w/S.S. Wire
- V. S.S. Tag w/S.S. Screws (Contact factory on switch options)
- W. Wall Mounting Kit
- X. Chemical Seals (Contact factory for accuracy)
- Z. Special (Uncoded Options)

NOTE: NOT ALL OPTIONS AVAILABLE IN COMBINATION WITH OTHER OPTIONS.

⑦ **ELECTRICAL CONFIGURATIONS**
(Switch Adjustable Range 15-90% except where stated below)
- O. None
- A. One (1) Reed Switch in NEMA4X Enclosure
- B. Two (2) Reed Switches in NEMA4X Enclosure
- C. One (1) Switch in Exp. Proof Enclosure (2)
- D. Two (2) Switches in Exp. Proof Enclosure. (2)
- E. One (1) Reed Switch in NEMA 4X / IP66 Aluminum Enclosure, Division 2 Locations (3)
- F. Two (2) Reed Switches in NEMA 4X / IP66 Aluminum Enclosure, Division 2 Locations (3)
- T. 4-20 mA Transmitter in NEMA 4X/IP66 Aluminum Enclosure.
- W. 4-20 mA Transmitter in NEMA 4X/ IP66 aluminum enclosure, Division 2 Hazardous Locations. (3)
- Z. Special

⑧ **ELECTRICAL SPECIFICATIONS**
- A. SPDT., 3 Watts, 0.25 Amp, 125 VAC/VDC
- B. SPST, **Normally Open**, 25 Watts, 0.5 Amp, 230 VAC/VDC
- T. 4-20 mA Transmitter (Loop Powered 8-28 VDC Input) (+/- 2% Accuracy, 20-100% of scale, Ascending)
- Z. Special

(1) 2000 PSIG SWP for Stainless Steel & Aluminum
(2) Complete assembly 3rd party Certified, Class I, Division 1, Groups C & D, Class II, Division 1, Groups E, F, & G
(3) Complete assembly 3rd party Certified, Class I, Division 2, Groups A, B, C & D, Class II, Division 2, Groups F & G

PROOF PRESSURE: 2X Working Pressure
WORKING PRESSURE: 3,000 PSI (AL, SS) 1500 PSI (Brass)

Warranty: 5 Years Transmitter (1 Year)

TEMPERATURE LIMITS: -40°F to + 200°F (Switch Options); -20° F TO + 150° F (Transmitter Option)
These limits are based on the entire instrument being saturated to these temperatures. System (process) temperatures may exceed these limitations with proper installation. Contact our customer service representative for details.

CE Marking Statements:

The Electrical Configurations A,B, E, & F of this product are CE marked in compliance with the Low Voltage Directive to EN-61010-1.

These products shall not be placed in an Explosive atmosphere as defined by the ATEX Directive 94/9/EC except if evaluated to be "Simple Apparatus".

They may be classified as simple apparatus. However, the evaluation to the relevant portions of the applicable standards and clearly identifying the product as simple apparatus shall be the responsibility of the end user.

The Pressure Equipment Directive has been determined to be **non applicable for CE marking**. These products are manufactured in accordance with article 3, paragraph 3 of the directive, "sound engineering practice". They fall below category I for non-hazardous gases, hazardous liquids, & non-hazardous liquids. This product also falls below category I for hazardous gases at or below 200 bar.

Simple Apparatus NEC 504.2

The A, B, E, & F Electrical configurations of this product meet the simple apparatus definition as defined in NEC 504.2 of Article 504 (Intrinsically Safe Systems). Because of this classification, equipment listing is not required (504.4) and ordinary wiring methods shall be permitted (504.20). Proper installation of this product in a hazardous location to the applicable requirements is the responsibility of the end user / equipment installer.

EMC Directive:

The transmitter design has been evaluated to and passed the following "EN" Standards as they relate to the EMC directive. However, the units are not CE marked for compliance to the EMC directive.

IEC EN61326:1997 Environment Industrial, Electrical Equipment for measurement, Control and Laboratory use,
EMCrequirements from which:

EN55011:1998Emission standard for Industrial, Scientific and Medical Equipment, Class A
EN61000-4-2:1995 Electrostatic discharge (ESD) immunity
EN61000-4-3:1996 Radiated EM field immunity
ENV50204:1995 Radiated EM field immunity from digital telephones (GSM)
EN61000-4-4:199 5Electrical fast transient (EFT) immunity
EN61000-4-5:1995 Surge immunity
EN61000-4-6:1996RF conducted immunity
EN61000-4-8:1993 Power Frequency magnetic field

Warning: The suitability of the application and installation of this differential pressure switch / transmitter is the responsibility of the end user. The applicable certifications, listings apply to the differential pressure switch / transmitter only.

Mid-West®
Instrument
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(586)254-6500 FAX (586)254-6509
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Web Page: www.midwestinstrument.com

D-20
Temperature Control Switch

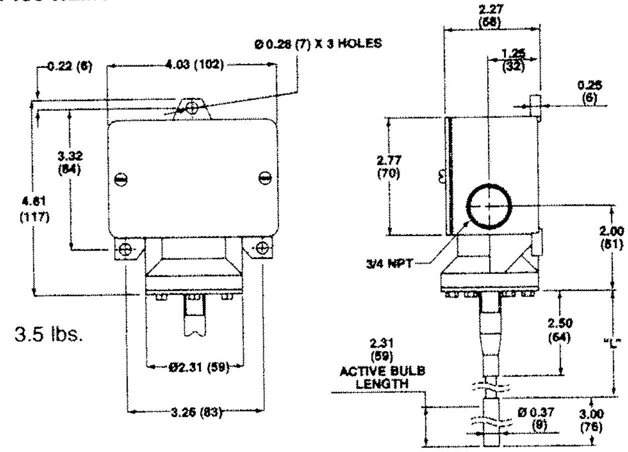
APPENDIX E

Preventative Maintenance Matrix

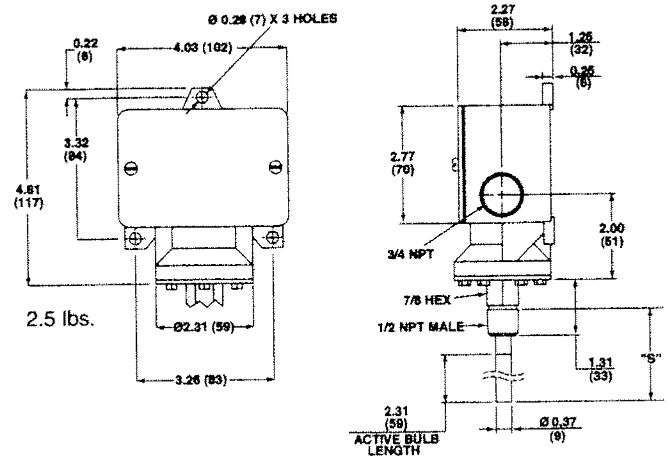
Installation and Maintenance Instructions for T400 & T700 ASHCROFT® Snap Action Switches for Temperature Control

ASHCROFT®

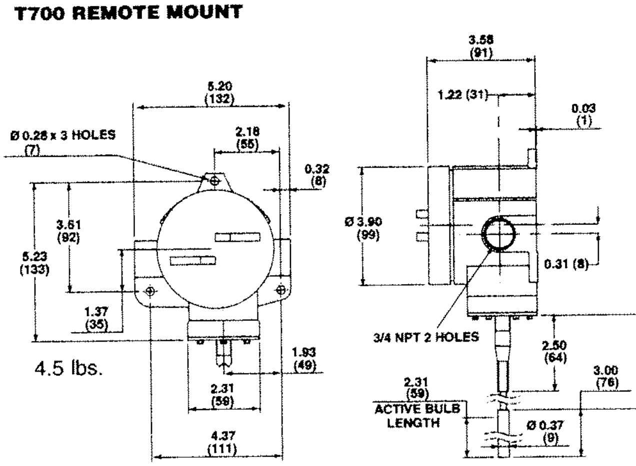
T400 REMOTE MOUNT



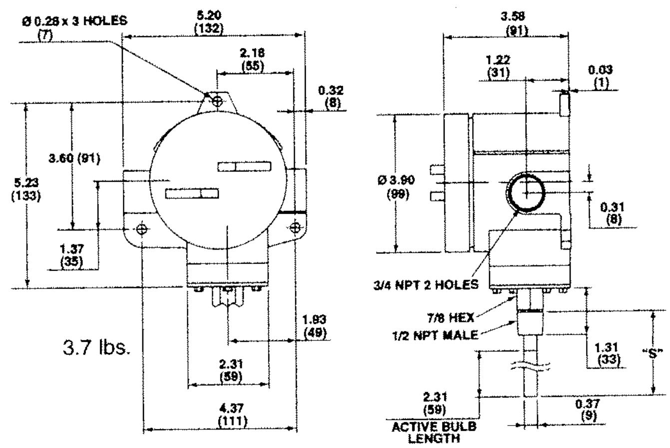
T400 DIRECT MOUNT



T700 REMOTE MOUNT



T700 DIRECT MOUNT



STEM LENGTH – INCHES					
S	2.75	4.0	6.0	9.0	12.0
LINE LENGTH – FEET					
L	5.0	10.0	15.0	20.0	25.0

INTRODUCTION

The Ashcroft® temperature switch is a precision built U.L. and C.S.A. approved control device which features a mechanical snap action switch. Controllers are available for operation on temperature with fixed or variable differential. Also, manual reset types are available for operation on increasing or decreasing temperature. The manual reset types remain tripped until reset by pressing a button on the top of the enclosure. The standard electrical switch is SPDT and is available with various electrical characteristics. Two SPDT switch elements mounted together are available except on variable deadband and manual reset types. Bulb material is stainless steel.

The Ashcroft snap action temperature switch is furnished in the standard NEMA 4/4X and explosion proof NEMA 7 and 9 enclosure styles. Both enclosures are epoxy coated aluminum castings.

INSTALLATION

These controls are precision instruments and should never be left with internal components exposed. During installation insure that covers are in place and conduit openings are closed except when actually working on the control. Good piping practice requires the use of a thermowell for installation where pressure may be applied to the thermal system. The thermowell provides protection against physical damage as well as corrosive effects of media flow. Use of a thermowell also facilitates removal of the bulb from the process line without disturbing the process. Standard thermowell materials include brass, steel and stainless steel; other materials are available upon request. Selection should be based on corrosion resistance requirements and process pressure.

MOUNTING T400 AND T700 SERIES

There are three holes external to the enclosure for surface mounting. Location of these holes is shown on the general dimension drawing.

A. Direct - Mounted Controls

These controls have a ½ NPT threaded adapter and may be attached directly or indirectly by means of a thermowell to equipment to be controlled. **When installing or removing control always use the wrench flats or hex above the threads. Do not twist the housing.**

Installation and Maintenance Instructions for T400 & T700 ASHCROFT® Snap Action Switches for Temperature Control

ASHCROFT®

B. Remote Mounted Controls

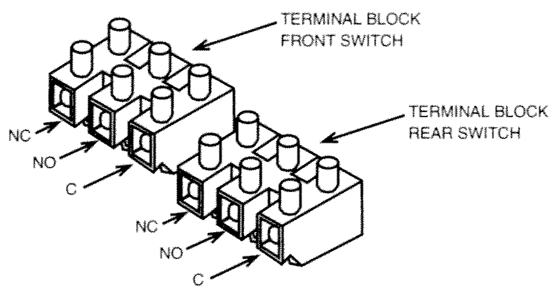
Two types of union bushings are available to install a remote mounted bulb into a thermowell or other ½ NPT threaded hole. A non-pressure tight type consists of a bushing, split grommet and compression nut. To use this, the bulb is inserted through the nut and the split grommet is slipped into the capillary between the compression nut and the bushing. After positioning the bulb as desired tighten the nut to the bushing. This will lock the capillary at the desired location. The pressure tight type is clamped to the bulb after insertion by tightening the compression nut. To use this, the union bushing is screwed into the ½ NPT threaded hole. The compression nut and sleeve are slipped onto the bulb which is then inserted into the union bushing. The bulb is then positioned and the compression nut is hand tightened pus 2¼ turns. This will lock the capillary at the desired location.

ELECTRICAL CONNECTIONS

Remove cover

T400 Series – two screws hold cover to enclosure

T700 Series – cover unscrews



CONDUIT CONNECTIONS

Note – It is recommended that Teflon® tape or other sealant be used on conduit, bushing or plug threads to ensure integrity of the enclosure.

T400 Series standard – one ¾ NPT conduit hole right side.

T700 Series standard – two ¾ NPT conduit holes with one permanent plug. NEMA 7 & 9 enclosures require proper conduit seals and breathers as per the National Electrical Code.

T400 & T700 series – XJL variation – ¾ to ½ NPT reducing bushing supplied.

T400 Series – XJK variation – two ¾ NPT conduit holes.

T400 SERIES

SPDT – Wire directly to the switch according to circuit requirements. On controls with pilot lights wire lights according to circuit diagram on inside of cover. See special wiring instruction tag for single switches with two pilot lights and dual switches with one or more lights.

2-SPDT – Dual switching elements consist of two SPDT switches mounted together in a bracket. Switches are calibrated to have simultaneous operation within 1% of range either on increasing or decreasing pressure but not in both directions. Wire directly to the front and rear switch according to circuit requirements. Leads are provided on rear switch color coded as follows:

Common	– White
Normally Closed	– Red
Normally Open	– Blue

When hermetically sealed switch element (s) are supplied, the lead color coding is as follows:

Common	– White
Normally Closed	– Red
Normally Open	– Blue

T700 SERIES

SPDT – Wire directly to the switch according to circuit requirements.

2-SPDT – Wire to front switch terminal block (left) and rear switch terminal block (right) as marked. Strip insulation 5⁄16″, insert in proper terminal connector and tighten clamping screw to secure.

ADJUSTMENT OF SETPOINT

T400 & T700 Series – A single setpoint adjustment nut (⅞″) is located centrally at the bottom on the inside of the enclosure.

The bulb of the control should be immersed in a bath at the desired setpoint temperature. Optimum performance will be obtained if the bulb is fully immersed. Allow five minutes for initial stabilization.

As received, the temperature switch will normally be set to approximately 90% of the indicated range. After stabilization, turn the adjustment nut until switch changes mode. Direction of turning is indicated on a label affixed to the inside of the control enclosure. When setpoint has been achieved raise and lower temperature to insure that the setpoint is correct.

After installation of the control replace cover to insure electrical safety and to protect internal parts from the environment.

T450 and T750 VARIABLE DEADBAND SWITCHES

Deadband is varied by rotating the wheel on the precision switch. When viewed from the front of the enclosure, rotation to the left increases deadband – rotation to the right decreased deadband. Letters on the wheel may be used as a reference. Deadbands obtainable will vary from 0.5% to 9% of pressure range depending on range segment and type of diaphragm.

ADJUSTMENT OF SETPOINT

As received, the temperature switch will normally be set to approximately 90% of range. Rotate the wheel on the MICRO SWITCH all the way to the right; this will provide smallest deadband. Increase bath temperature to the required setpoint and turn the adjustment nut until the switch changes mode. Lower the bath temperature to reset the switch. Rotate the wheel on the MICRO SWITCH until the desired deadband is obtained. The upper setpoint will be changing upward with this adjustment. Lower the bath temperature to reset the switch. Raise the bath temperature to the desired setpoint and turn the adjusting nut until the switch changes mode. Lower the bath temperature and check reset point and deadband.

T428 & T429 MANUAL RESET SWITCHES

Dress wire leads from switch terminals so as not to interfere with or touch reset button.

Note – As indicated above, adjustment of setpoint is made by use of ⅞″ nut. Precision switch element mounting screws and bracket adjusting screw are factory sealed and should not be tampered with.

GM-38 Area Groundwater Remediation
Groundwater Treatment Plant
NWIRP Bethpage, NY

PREVENTATIVE MAINTENANCE MATRIX

EQUIPMENT DESCRIPTION	ITEM	ACTIVITY	FREQUENCY
Recovery Well RW-1	Vault Level probe	Check and clean well cap, seals, and fittings Check, clean, and verify calibration. Check transducer indicating dessicant filter. Replace if color is pink.	Semi-annually Semi-annually Monthly
Recovery Well RW-3	Vault Level probe	Check and clean well cap, seals, and fittings Check, clean, and verify calibration Check transducer indicating dessicant filter. Replace if color is pink.	Semi-annually Semi-annually Monthly
Pump P-1 in RW-1	Pump Motor and VSD	Check and clean strainer and check valve Check as per manufacturer's instructions	Semi-annually Semi-annually
Pump P-2 in RW-3	Pump Motor and VSD	Check and clean strainer and check valve Check and clean as per manufacturer's instructions	Semi-annually Semi-annually
RW-1 Influent Flow Meter FQIT-101	Instrument	Verify calibration	Semi-annually
RW-3 Influent Flow Meter FQIT-102	Instrument	Verify calibration	Semi-annually
Equalization Tank	Level probe pH probe Tank insides	Check, clean, and verify calibration Check, clean, and calibrate. Replace electrode (if necessary) Clean bottom and tank walls	Semi-annually Every 2 weeks Semi-annually
Mixer M-1	Motor Reduction Gear/Bearing Impeller	Clean motor frame and shaft Lubricate motor bearings Clean and lubricate as per manufacturer's instructions Clean mixer shaft and impeller	Monthly Annually Quarterly Annually
Air Stripper Feed Pumps P-3A P-3B	Pump Motor and Bearings VSD	Inspect impeller and clean Clean motor frame and shaft Lubricate bearings Check as per manufacturer's instructions	Annually Monthly Quarterly Semi-annually
Air Stripper Feed Flow Meter FQIT-103	Instrument	Verify calibration	Semi-annually
Blower B-1	Fan Motor and Bearings VSD	Inspect impeller and clean Clean motor frame and shaft Lubricate bearings Check as per manufacturer's instructions	Annually Monthly Semi-annually Semi-annually
Blower B-1 Discharge Flow Meter FQIT-105	Instrument	Verify calibration	Semi-annually
Air Stripper AS-1	Tower insides Demister Pad Liquid Distributor Packing	Inspect and clean Inspect, clean, and replace demister pad, liquid distributor, and Jaeger Tripack (if necessary) as per manufacturer's instructions	Semi-annually
Air Stripper Sump	Sump	Check and clean bottom and walls	Semi-annually
Liquid Carbon Feed Pumps P-4A P-4B	Pump Motor and Bearings VSD	Inspect impeller and clean Clean motor frame and shaft Lubricate bearings Check as per manufacturer's instructions	Annually Monthly Quarterly Semi-annually

Air Stripper Recirculation Line Flow Meter FQIT-106	Instrument	Verify calibration	Semi-annually

GM-38 Area Groundwater Remediation
Groundwater Treatment Plant
NWIRP Bethpage, NY

PREVENTATIVE MAINTENANCE MATRIX

EQUIPMENT DESCRIPTION	ITEM	ACTIVITY	FREQUENCY
Bag Filters Vessel F-1A Vessel F-1B	Vessel and Filter Basket O-rings	Inspect and clean filter baskets and insides of vessel Inspect and replace (if necessary)	Quarterly Every bag replacement
Liquid-phase Granulated Activated Carbon Vessel LGAC-1 Vessel LGAC-2 Vessel LGAC-3	Vessel insides Lining Collector	Inspect the insides of the vessel, the lining, under drain laterals in the collector, and rupture disks as per manufacturer's instructions	Every carbon replacement
Caustic Feed Pumps P-6A P-6B	Pump Diaphragm	Calibrate speed and stroke Replace the Liquifram^{TM}, cartridge valves, seal rings/valve balls, multifunction valve cap assembly, and injection check valve spring	Semi-annually Annually
Treated Effluent pH	pH probe	Check, clean, and calibrate. Replace electrode (if necessary)	Every 2 weeks
Stormwater Manhole Flow Meter FQIT-108	Instrument	Verify calibration	Semi-annually
Injection Well IW-1 Flow Meter FQIT-109	Instrument	Verify calibration	Semi-annually
Air Stream Heater H-1	Heating Element	Inspect heating element and clean dust and corrosion from terminals and terminal covers	Quarterly
Vapor-phase Granulated Activated Carbon Vessel VGAC-1 Vessel VGAC-2 Vessel VGAC-3	Vessel insides Lining Supports Screen	Inspect the insides of the vessel, the lining, supports and screen	Every carbon or HS-600 replacement
Blower B-2	Fan Motor and Bearings VSD	Inspect impeller and clean Clean motor frame and shaft Lubricate bearings Check as per manufacturer's instructions	Annually Monthly Semi-annually Semi-annually
Blower B-2 Discharge Flow Meter FQIT-B2	Instrument	Verify calibration	Semi-annually
GWTP Sump Pumps P-5A P-5B	Pump	Check oil level, inspect power cable and seals, inspect impeller and clean	Quarterly
GWTP Sump	Metal Grating Sump	Check condition of metal grating Check and clean (if necessary)	Monthly Quarterly
Air Stripper Containment Sump Pump P-7	Pump	Check oil level, inspect power cable and seals, inspect impeller and clean	Quarterly
Air Stripper Containment Sump	Sump	Check and clean (if necessary)	Quarterly
Valves	Valves	Check for leaks, inspect condition of handles, seals, and seats	Monthly
Piping	Piping and supports	Check piping for leaks, check condition of supports	Monthly