

Operation and Maintenance Manual MCB Camp Lejeune Groundwater Treatment System

Volume IV of VII

Submitted to:

DEPARTMENT OF THE NAVY
Contract No. N62470-93-D-3032

Submitted by:



**OHM Remediation
Services Corp.**
A Subsidiary of OHM Corporation

5335 Triangle Parkway, Suite 450
Norcross, GA 30092

OHM Project No. 16032

November 1996

TABLE OF CONTENTS

Volume I

- 1.0 SYSTEM OPERATIONS 1-1
 - 1.1 General Process Description 1-1
 - 1.1.1 Shallow Groundwater Influent Flow and Iron Removal System 1-1
 - 1.1.2 Deep Groundwater Influent Flow 1-1
 - 1.1.3 Air Stripping 1-10
 - 1.1.4 Cartridge Filtration and GAC Adsorption 1-10
 - 1.1.5 Treated Effluent Storage and Discharge 1-10
 - 1.2 Operating Restart 1-10
 - 1.2.1 Pre-Startup Checklist 1-10
 - 1.2.2 Security and Site Access 1-10
 - 1.2.3 Health and Safety 1-12
 - 1.2.4 Key Contacts and Site Personnel 1-12
 - 1.2.5 Equipment Labels 1-26
 - 1.2.6 Baseline Readings 1-26
 - 1.3 Groundwater Treatment System Startup 1-27
 - 1.3.1 Introduction and Purpose 1-27
 - 1.3.2 General Startup Sequence 1-27
 - 1.3.3 Initial Startup 1-29
 - 1.3.3.1 Motor Rotation 1-29
 - 1.3.3.2 Turn On Pump Seal Water 1-29
 - 1.3.3.3 To Initiate Shallow Aquifer Influent Flow 1-30
 - 1.3.3.4 Initiate Metals Precipitation 1-30
 - 1.3.3.5 Initiate Deep Aquifer Influent Flow 1-31
 - 1.3.3.6 Flow Equalization in Groundwater Storage Tank 1-32
 - 1.3.3.7 Air Stripper, Cartridge Filter, and Carbon Absorber Feed Preparation 1-32
 - 1.3.3.8 To Begin the Flow from T-110 to Air Stripper, Cartridge Filters and Carbon Adsorbers 1-33
 - 1.3.4 Normal Shut Down 1-34
 - 1.3.4.1 Normal Shut Down - Case 1 (Maintain Tanks Half-full) 1-34
 - 1.3.4.2 Normal Shut Down - Case 2 (Maintain Tanks Full) ... 1-35
 - 1.3.4.3 Normal Shut Down - Case 3 (Maintain Tanks at Low Level) 1-36
 - 1.3.5 Post Shutdown Procedures 1-37
 - 1.3.6 Miscellaneous Equipment Startup and Shut Down 1-37
 - 1.3.6.1 Startup and Shut Down of Sludge Pump to T-140 ... 1-37
 - 1.3.6.2 Startup and Shut Down of Filter Press (X-140) 1-38
 - 1.3.6.3 Sludge Recycle 1-39
 - 1.3.6.4 Backwash GAC Carbon Adsorber 1-40
 - 1.3.6.5 Backwash Water to X-130 1-41
 - 1.3.6.6 Transfer Water from Sump T-025 1-42
 - 1.3.6.7 Transfer Water from Sump T-115 1-42
 - 1.4 Normal Operations and Controls 1-43
 - 1.4.1 Normal Operations 1-43
 - 1.4.2 Instrumentation and Control System 1-44

TABLE OF CONTENTS - CONTINUED

1.4.3	Groundwater Extraction System	1-45
	1.4.3.1 Shallow Groundwater Extraction System (Dwg P-3) ..	1-50
	1.4.3.2 Deep Aquifer Extraction System	1-52
1.4.4	Iron Removal System	1-53
	1.4.4.1 Mix Tank	1-53
	1.4.4.2 Clarifier	1-55
	1.4.4.3 Sludge Thickener	1-56
	1.4.4.4 Sludge Dewatering Press	1-56
	1.4.4.5 Head Tank	1-56
	1.4.4.6 Chemical Storage	1-57
1.4.5	Groundwater Storage and Feed System	1-58
	1.4.5.1 Groundwater Storage Tank and Feed System	1-58
	1.4.5.2 Groundwater Storage and Feed System Instrumentation and Control	1-58
	1.4.5.3 Chemical Storage	1-60
1.4.6	Air Stripping System	1-60
	1.4.6.1 Air Stripper Column and Equipment	1-60
	1.4.6.2 Air Stripper System Instrumentation and Control	1-61
1.4.7	Liquid Granular Activated Carbon (GAC) Adsorber System .	1-62
	1.4.7.1 Cartridge Filters	1-62
	1.4.7.2 GAC Adsorbers	1-63
1.4.8	Effluent Storage and Discharge System	1-63
	1.4.8.1 Effluent Storage Tank and Discharge Equipment	1-63
	1.4.8.2 Effluent Storage Tank and Discharge Instrumentation and Control	1-64
1.4.9	Secondary and Utility Systems	1-65
	1.4.9.1 Backwash Water Holding Tank	1-65
	1.4.9.2 Compressed Air System	1-66
	1.4.9.3 Building Drainage System and Containment Sump	1-66
	1.4.9.4 Sanitary Pump Station	1-67
1.5	Emergency Operations	1-67
	1.5.1 Equipment Malfunction	1-67
	1.5.1.1 Pump Failure	1-67
	1.5.1.2 Air Stripper Blower Failure	1-68
	1.5.1.3 Water Tank Failure	1-68
	1.5.1.4 GAC Carbon Filter Malfunction	1-68
	1.5.1.5 Cartridge Filter Malfunction	1-69
	1.5.1.6 Automatic Flow Control Valve Malfunction	1-69
	1.5.1.7 Caustic Tank Failure	1-69
	1.5.1.8 Acid Tank Failure	1-70
	1.5.1.9 Air Compressor Failure	1-70
	1.5.2 Emergency Shutdown Procedures	1-70
	1.5.3 Guidance on Emergency Operations of Utility Systems	1-70
	1.5.3.1 Power Failure	1-70
	1.5.3.2 Potable Water Failure	1-71
	1.5.3.3 Natural Gas Failure	1-71
	1.5.3.4 Compressed Air Failure	1-71
1.6	Critical Alarms and Autodialer	1-72

TABLE OF CONTENTS - CONTINUED

2.0	MAINTENANCE AND TROUBLESHOOTING	2-1
2.1	Introduction	2-1
2.2	Operator Service Requirements	2-1
2.3	Troubleshooting	2-1
2.4	Environmental Conditions	2-5
2.5	Preventive Maintenance	2-5
2.6	Corrective Maintenance	2-5
2.7	Troubleshooting Guides and Diagnostic Techniques	2-13
2.8	Wiring Diagrams and Control Diagrams	2-13
3.0	SAFETY PRECAUTIONS AND STANDARD OPERATING PROCEDURES	3-1
3.1	Introduction	3-1
3.2	Material Safety Data Sheets	3-1
3.3	Health and Safety Standard Operating Procedures	3-1
4.0	PERFORMANCE SAMPLING AND MONITORING	4-1
4.1	Introduction	4-1
4.2	Sampling Procedures	4-4
4.3	Quality Assurance/Quality Control (QA/QC) Samples	4-5

TABLES

Table 1.1	Major Equipment List	
Table 1.2.1	Pre-Startup Check List	
Table 1.2.2	Key Contact List	
Table 1.2.3	Vendor Contact List	
Table 1.2.4	Instrumentation List	
Table 1.2.5	Process Valve List	
Table 1.4.1	Expected Flow from Each Well	
Table 1.4.2	Groundwater Treatment System Influent and Effluent Characteristics	
Table 1.4.3	Interlock Table	
Table 2.1	Weekly Lubrication and Maintenance Check List	
Table 2.2	Monthly Lubrication and Maintenance Check List	
Table 2.3	6-month or Greater Lubrication and Maintenance Check List	
Table 2.4	Daily Check List	
Table 2.5	Weekly Check List	
Table 2.6	System Down Report	
Table 2.7	Maintenance and Repairs Report	
Table 1.6.1	Critical Alarms for Groundwater Treatment Plan	
Table 4.1	Effluent Treatment Criteria and Remediation Goals	
Table 4.2	Performance Sampling Summary	
Table 4.3	Laboratory Reporting Limits	
Table 4.4	Monitoring Wells	

TABLE OF CONTENTS - CONTINUED

APPENDICES

Appendix A Volume II:

- I Table of Contents
- II Major Equipment List and Contact List
- III Equipment Manuals
 - A. Air Stripper (C-200), Stripper Blower (D-200)
 - B. Cartridge Filters (F-220 A/B/C)
 - C. Carbon Filters (X-220 A/B)
 - D. Lamella Clarifier (X-131)

Appendix B Volume III:

- I Table of Contents
- II Major Equipment List and Contact List
- III Equipment Manuals
 - E. Plate Filter Press (X-140)
 - F. Refrigerated Compressed Air Dryer (X-150C)
 - G. Air Compressor (X-150 A/B)
 - H. Pumps-
 - Air stripper feed pump (P-110 A,B), Section 1
 - Sump pump (P-025 & P-025A), Section 2
 - Containment area sump pump (P-115), Section 2
 - Jet mixing pump & system (P-120), Section 3
 - Caustic feed pump (P-121), Section 4
 - Sludge blowdown pump (P-143), Section 5
 - Supernatant transfer pump (P-145), Section 1
 - Spent backwash water pump (P-205), Section 6
 - Acid feed pumps (P-211, P-212), Section 4
 - Well pumps (P-100, P-102, P-104, P-300, P-302, P-304, P-101, P-103, P-105, P-301), Section 7
 - Backwash water pump (P-241), Section 1
 - Reuse water pump (P-245), Section 6
 - GAC adsorber feed pumps (P-220 A/B), Section 1
 - Filter press feed pump (P-141), see section on Filter Press
 - Metal scavenger/coagulant pump (X-132A), to be purchased

Appendix C Volume IV:

- I Table of Contents
- II Major Equipment List and Contact List
- III Equipment Manuals
 - I Tanks-
 - Groundwater storage tank (T-110), Section 1
 - Caustic storage tank (T-121), Section 2
 - Sludge thickening tank (T-140), Section 3
 - Head tank (T-145), Section 4
 - Backwash water holding tank (T-205), Section 5
 - Acid storage tank (T-211), Section 6
 - Stripper effluent holding tank (T-220), refer to section on air stripper
 - Treated effluent holding tank (T-240), Section 5
 - Mix tank (X-130) & air diffusers, Section 7
 - J. Liquid Polymer Feed System (X-132)

TABLE OF CONTENTS - CONTINUED

- K. Mixer (A-130)
- L. Control and Computer System
- M. Control Instrumentations
- N. Control Cabinet/Panel & Wiring Diagrams
- O. Metering manhole, Parshall Flume & Ultrasonic Flow Meter

Appendix D Volume V:

- I Table of Contents
- II Major Equipment List and Contact List
- III Equipment Manuals - Miscellaneous and building equipment
 - P. Transformer
 - Q. Well Houses
 - R. Roll Up Doors
 - S. Room Air Conditioning Unit
 - T. Bathroom Fixtures
 - U. Water Heater
 - V. Roof Fans and Exhaust Fans
 - W. Building Gas Heaters
 - X. Ventilation Louvers
 - Y. Roof Insulation
 - Z. Autodialer
 - AA. Miscellaneous Electrical Equipment

Appendix E Volume VI:

- I Table of Contents
- II Programmable Logic Controller (PLC) System and Instrumentation
 - A. List of Contractor/Subcontractors/Manufacturers/Suppliers
 - B. Operation and Maintenance Manual for Programmable Logic Controller (PLC) System
 - C. Logic Tables
 - D. Series 90-70 Programmable Controller Reference Manual
 - E. Logicmaster 90, Series 90-30/20 Micro Programming Software User's Manual

Appendix F Volume VII:

- I Table of Contents
- II Programmable Logic Controller (PLC) System and Instrumentation
 - F. Cimplicity MMI for Windows NT, Cimplicity MMI for Windows 95, Cimplicity Server for Windows NT, Device Communication Manual
 - G. TCP/IP Ethernet Communications for the Series 90-70 PLC User's Manual
 - H. Operation and Maintenance Manual for PC Workstation
 - I. Operation and Maintenance Manual for Instrumentation
 - J. SM 3000 Smart Meter User's Manual (34-ST-25-08C 05/95)
 - K. ST 3000 Smart Transmitter Series 100E and Series 900 and SFC Smart Field Communicator Model STS 103 Installation Guide (34-ST-33-31A 08/95)

TABLE OF CONTENTS - CONTINUED

- L. Instruction Manual for Model 1181PH/ORP Two-Wire Transmitters (P/N 5101181PH November 1995)
- M. Installation and Operating Instructions for Drexelbrook Series 508-45, -46, -47, -49 Universal II Level Transmitters using 408-8200 Series Cote-Shield Electronics (EDO#5-95-250 408-8200-LM)
- N. Signet 8510 Compak Flow Transmitter Instructions
- O. Installation and Operating Instructions for Model L-6 Float Switch (Bulletin E-20)
- P. Approved Submittal Data on Motor Controllers, Dry Type Transformers, Panelboards, Well Pump Panel and Fixtures
- Q. List of Qualified Permanent Servicing Organizations for Support of the Programmable Logic Controller (PLC) System and Instrumentation Equipment

TABLE 1.1

<p align="center">MAJOR EQUIPMENT LIST MCB Camp Lejeune - Groundwater Treatment System OHM Project #16032</p>			
Item ID#	Component	Item ID#	Component
C - 200	Air stripping column	T - 220	Stripper effluent holding tank
F - 220A/B/C	Cartridge filter	T - 240	Treated effluent holding tank
K - 200	Air stripper column fan	X - 130	Mix Tank
P - 025	Building drainage pump (wet well)	A - 130	Mixer
P - 025A	Building drainage pump (wet well)	X - 131	Inclined plate clarifier
P - 110A	Air stripper feed pump	X - 132	Liquid polymer feed system
P - 110B	Air stripper feed pump (back-up)	X - 132A	Metal scavenger/Coagulant pump
P - 115	Containment area sump pump	X - 140	Plate and frame filter press
P - 120	Jet mixing pump	X - 150A/B	Air compressors
P - 121	50% NaOH feed pump	X - 150C	Refrigerated air dryer
P - 141	Filter press feed pump	X - 150D	Compressed air receiver
P - 143	Sludge blowdown pump	X - 150F	Compressed air oil separator
P - 145	Supernatant transfer pump	X - 150G	Compressed air particulate filter
P - 205	Spent backwash water pump	X - 220A	GAC adsorber
P - 211	93% H ₂ SO ₄ feed pump	X - 220B	GAC adsorber
P - 212	93% H ₂ SO ₄ feed pump	P - 100	SRW-1 shallow well pump
P - 241	Backwash water pump	P - 102	SRW-2 shallow well pump
P - 245	Reuse water pump	P - 104	SRW-3 shallow well pump
P - 220A	GAC adsorber feed pump	P - 300	SRW-4 shallow well pump
P - 220B	GAC adsorber feed pump (back-up)	P - 302	SRW-5 shallow well pump
T - 025	Building drainage wet well	P - 304	SRW-6 shallow well pump
T - 110	Groundwater storage tank	P - 101	DRW-1 deep well pump
T - 121	50% NaOH storage tank	P - 103	DRW-2 deep well pump
T - 140	Sludge thickening tank	P - 105	DRW-3 deep well pump
T - 145	Head tank	P - 301	DMW-1 monitoring well pump
T - 205	Backwash water holding tank		
T - 211	93% H ₂ SO ₄ storage tank		

TABLE 1.2.2

<p align="center">KEY CONTACT LIST MCB Camp Lejeune - Groundwater Treatment System OHM Project #16032</p>			
Company/Agency	Contact	Title	Phone Number
OHM Site			910-451-2390
OHM Personnel	Jim Dunn	Project Manager	770-734-8072
	Alan Whitt	Project Supervisor	910-451-2599
	Randy Smith	Project Supervisor	910-451-2599
	Dwayne Currie	Deputy Program Manager	770-453-7707
	Phil Verbout	Sr. Electrical Engineer	713-775-7631
	Steve Grant	Site H & S Officer	910-451-2390
	Terry Whitt	Sr. Project Chemist	770-453-7686
	Greg Gilles	Technical Manager	770-453-7687
	Kai Mak	Sr. Project Engineer	770-453-7607
	Tom McCrory	Sr. Project Hydrogeologist	770-453-7663
	Angelo Liberatore	Reg. H & S Manager	770-453-7671
Stone & Webster	Chuck Lawrence	QC Engineer	615-755-9753
MCB Camp	Vann Marshburn	Supervising Engineer	910-451-2583
	Lt. Cheryl Hansen	A-ROICC	910-451-2581
	John Cotton	Construction Inspector	910-451-5006
LANTDIV	Kate Landman	RPM	804-322-4811
	Jerry Haste	COTR	804-444-8422
IRD/EMD	Neal Paul		910-451-5068
	Tom Morris		910-451-5068
NC DEHNR	Patrick Watters	Superfund RPM	910-353-3558
EPA-Region IV	Gena Townsend	RPM	404-347-3066
Southerland Electric	Scott Sosa	Project Manager	910-347-1754
Hatcher Construct.	Donald Hatcher	Owner/PM	910-285-7633
N.E. Construction	Tom DeLong	Project Manager	910-733-2801

TABLE 1.2.3

VENDOR CONTACT LIST MCB Camp Lejeune - Groundwater Treatment System OHM Project #16032				
Company	Equipment	Contact	Phone / Fax Number	
Industrial Sales	Valves, gauges, fittings, pumps	Gene Wells	910-763-5126	910-763-3207
P.R. Bradley & Assoc.	Meter pumps, Lightning mixer	Mike Wolfe	770-998-1956	770-998-0119
Drillers Services Inc.	Wells, well pumps	Terry Yount	800-334-2308	704-322-7674
Industrial Plastics	Plastic pipe & fittings	Steve Bailey	770-844-7324	912-748-8327
Carolina Plastic Supply	HDPE pipe & fittings	Marc Davis	704-588-0541	704-588-5742
Goulds Pumps Inc.	Pumps	Joe Ruggiero	770-446-3369	770-446-3651
Boart Longyear	Downwell tubing	Bob Beyer	770-469-2720	770-498-2841
Palmer Manufacturing	FRP Tanks (T-110)	Scott Case	770-925-4855	770-925-4869
Northeast Construction	Buildings	Steve Straper	910-353-3558	910-353-3005
Proco Products		Sylvia Augusto	800-344-3246	209-943-0242
Atlanta Rod	Nuts/ bolts	Mary White	770-889-2136	706-356-2940
Hilti Corp.	Nuts/bolts, fastners	David Holloway	800-879-8000	800-879-7000
Eco Equip. Inc.	Jet mixer pump system	Steve Hart	770-345-2118	770-345-2699
Hertz Equipment		Steve Koroly	910-799-9751	910-395-2405
Fowler Manf.	Platforms	Doug Wolcott	904-246-4886	904-241-8056
Chet Adams	Elec. & Gas Heaters	E. Adams	919-851-6331	919-851-6371
Ingersall Rand	Air compressors	Gary Michael	770-936-6200	770-936-8210
R&W Construction	Tanks, structure steel	Wayne Pierce	910-455-1830	910-455-9163
Ladder Distr. Inc.		Carl Jacobsen	770-447-9057	770-447-9057
Cowen Supply	Piping hardware	Greg Southwell	404-351-6351	404-351-1259
C.M. Kemp Manf.	Dri-breather	Venita Gornew	410-761-5100	410-766-9105
Envirotrol	Carbon filter system	Tim Sokol	412-741-2030	412-741-2670
Pumping Systems Inc.	Diaphragm Air pumps	Michael Konopa	770-458-9555	770-455-9133
Filtration Tech.	Cartridge/Air filters	Scott Matthews	919-859-0124	919-859-0370
Gray Bar Elect.	Electric material supplies	Doyle Strickland	770-441-5580	770-446-7693

TABLE 1.2.3 (Cont.)

VENDOR CONTACT LIST MCB Camp Lejeune - Groundwater Treatment System OHM Project #16032			
Company	Equipment	Contact	Phone/Fax Number
Dewy Brothers	Manhole rings & covers	Pat Miller	800-931-9391
Hercules Steel	Influent box	Claude Scott	910-488-5110 910-488-4040
National Environ. Systems	Air Stripper tower	Pixie Terreault	508-761-6611 508-761-6898
Saws controls	Ceramic Air diffusers	Larry Sears	770-993-4392 770-998-2430
Delta Sales	Eyewash stations	Gene Waters	770-934-9960 770-934-6865
Hugo Jahnz & Assoc.	Plastic tanks	Ansley Jimmerson	770-889-1732 770-887-7405
Engineered Fiberglass	FRP Well Building	Clarence Kazmir	770-475-2242 770-664-6906
Jenkins Gas & Oil	LP tank	Keith McGouden	910-455-1711 910-346-9404
George Selke Co.	HDPE tanks	Mike Callahan	770-925-4855 770-925-4869
Hoffman & Hoffman	Roof fans	Bill Poole	919-781-8011 919-787-6019
Tracon Inc.	Meter manhole		770-475-2242 770-664-6906
Parkson Corp.	Lamella separator	Larry Sears	770-993-4392 770-998-2430
Tindall Concrete	Concrete Manholes	Fred Bosket	864-576-3230 864-587-8828
J.L. Pierce Surveying	Surveyor	J. Pierce	
Semblex Inc.	Polymer feed system	Steve Hart	770-345-2118 770-345-2699
Netsch Filter	Filter press	Robert N. Hanks	610-363-8010 610-363-0971
High Rise Service Co. Inc.	Acid containment area coating	Donnie Cannon	910-371-2325
ISCO Inc.	Ultrasonic Effluent Flowmeter		800-228-4373
Lightnin c/o Bradley & Assoc.	Mixer (A-130)	Mike Wolfe	404-998-1956
Tencarva Machinery Co.	Service all Goulds Pumps	Scott Hudson	910-799-8800 910-799-8801
Utility Precast Inc.	Electric manholes	Tommy McClellan	704-596-6283 704-596-6289

Table 1.2.3 (Cont.)			
US Foundry & Manufacturing Corp.	Electrical manhole rings & cover	Steve Douglass	404-696-8810 404-696-9482
Worth Chemical Corp.	50% Caustic	Stan Tew	864-574-2785
KOCH Sulfur Products Co.	93% Sulfuric acid	Ray Wilson	800-414-2243
Betz Entec, Inc.	Polymer, metal scavenger chemicals	Barry Owings	919-783-7071 919-783-7093
Halliday Prods.	Alum access frame	Jim Cook	407-298-4470 407-298-4534
G.E. Supply	Transformer & Elec. Equip. Supplies	Dave Whinsile	404-840-4196
Bertsch Co.	Pipe fittings	Bunnie	419-666-6605 419-666-3344

**APPENDIX I
TANKS**

OHM ID NUMBER	TANK DESCRIPTION	SECTION
T - 110	Groundwater Storage Tank	1
T - 121	Caustic Storage Tank	2
T - 140	Sludge Thickening Tank	3
T - 145	Head Tank	4
T - 205	Backwash Water Holding Tank	5
T - 211	Acid Storage Tank	6
T - 220	Stripper Effluent Holding Tank	refer to section on air stripper
T - 240	Treated Effluent Holding Tank	5
X - 130	Mix Tank & Air Diffusers	7

APPENDIX I

SECTION 1

TANK DATA

TANK T - 110

Manufacturer: The George Seelke Co.

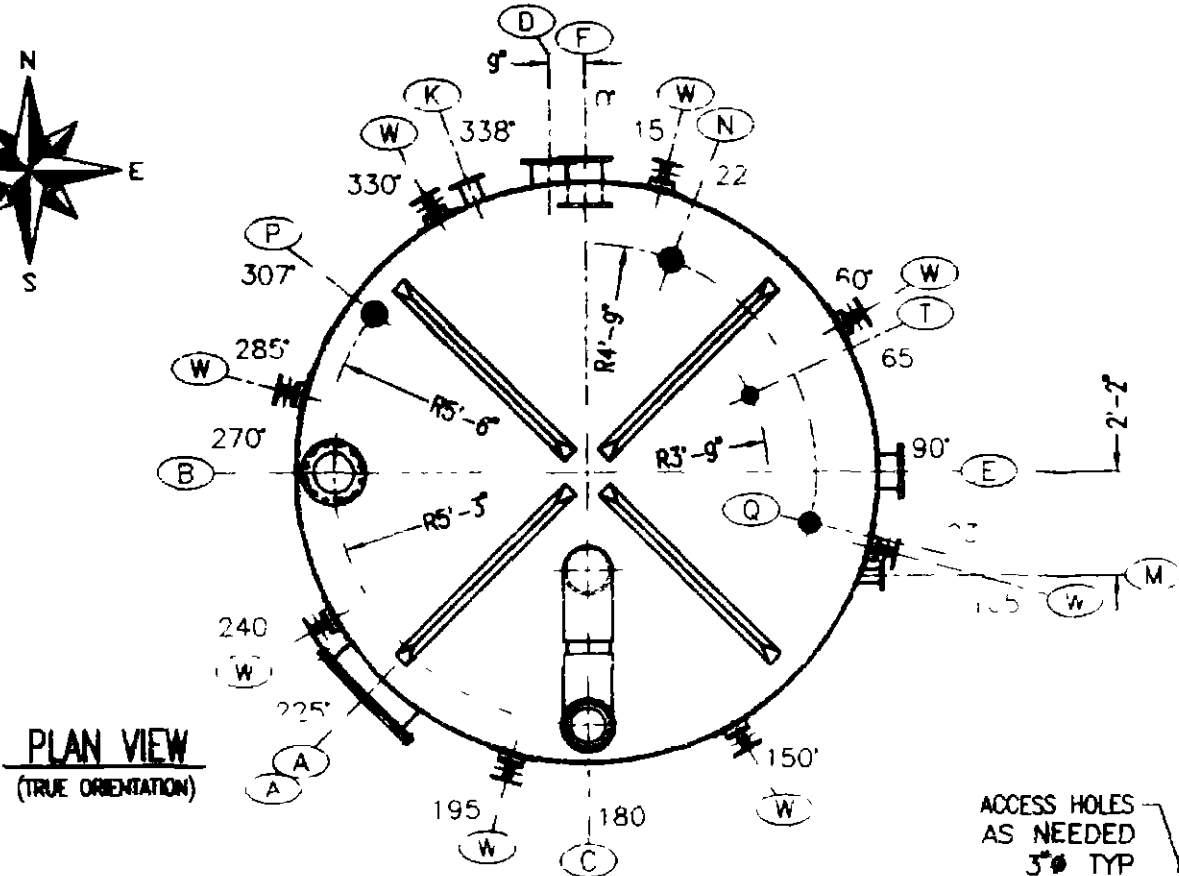
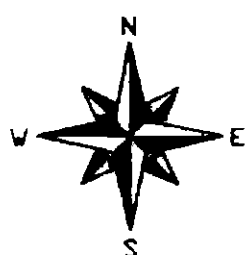
Size: 12 x 26'

Manufacturer

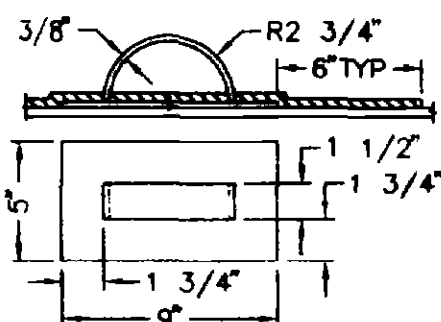
Contact: Deborah Brown

Phone

Number: (770) 925-4855

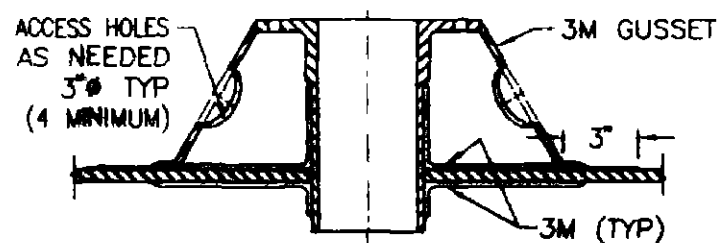


PLAN VIEW
(TRUE ORIENTATION)



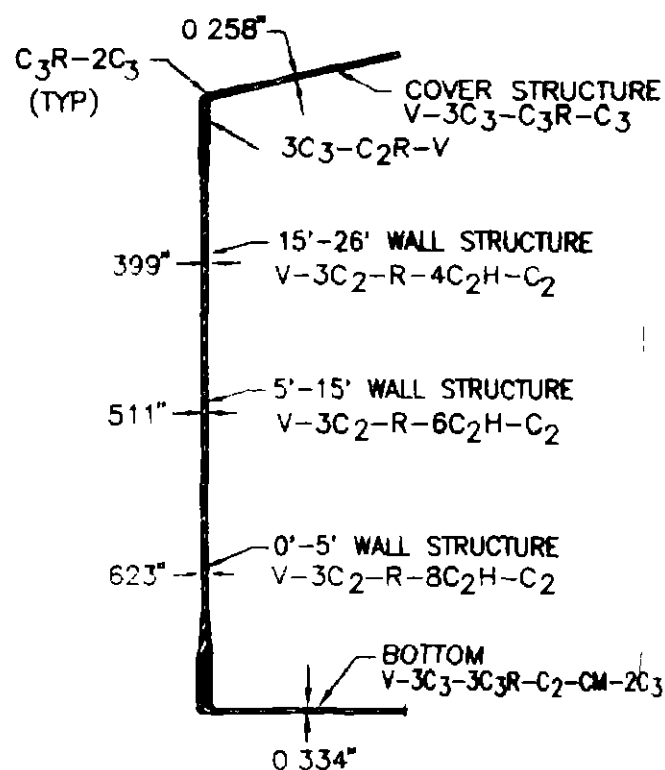
#1 LIFT EYE DETAIL

NTS



TYPICAL CONICAL GUSSET

NTS



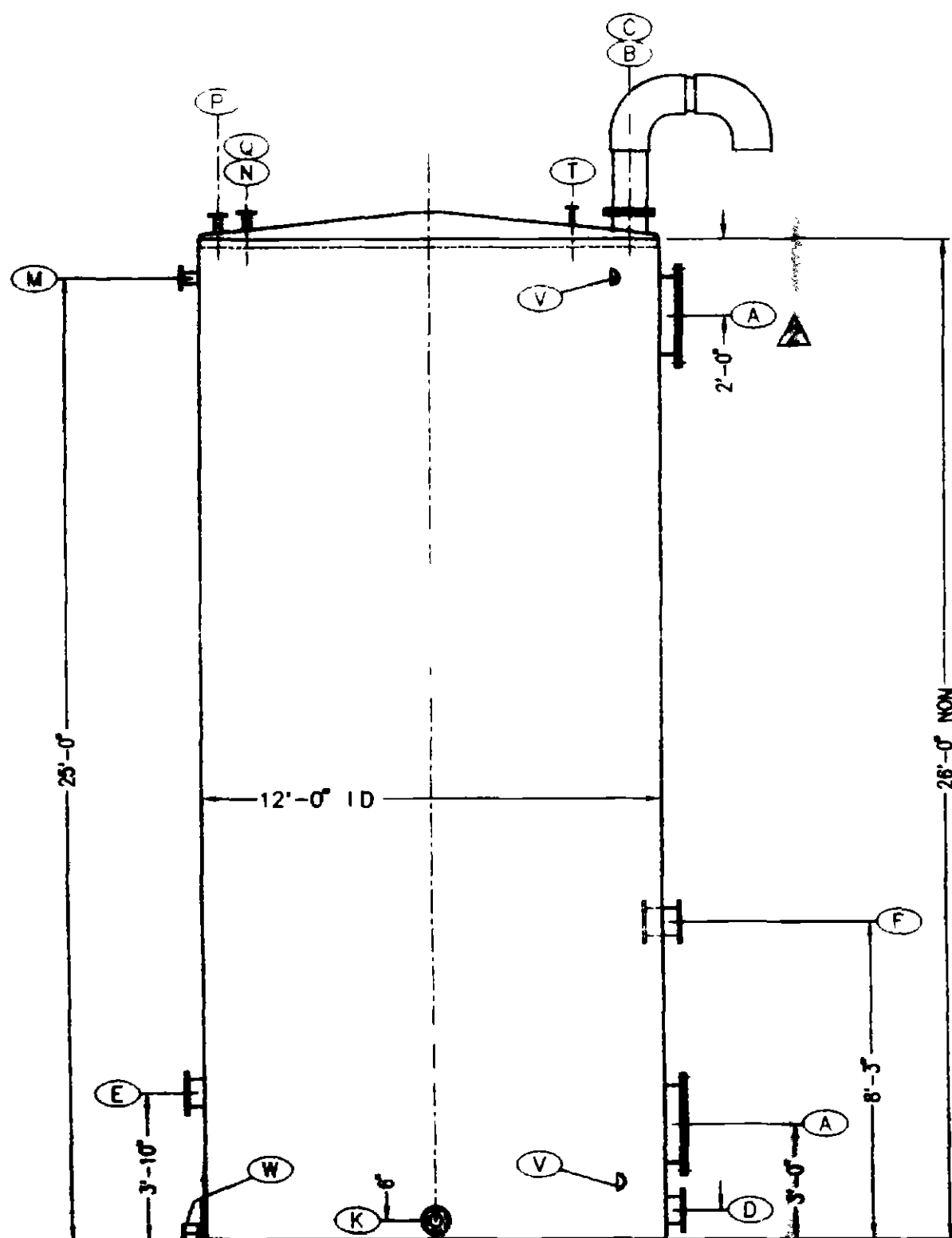
12' X 26' WALL STRUCTURE

NTS

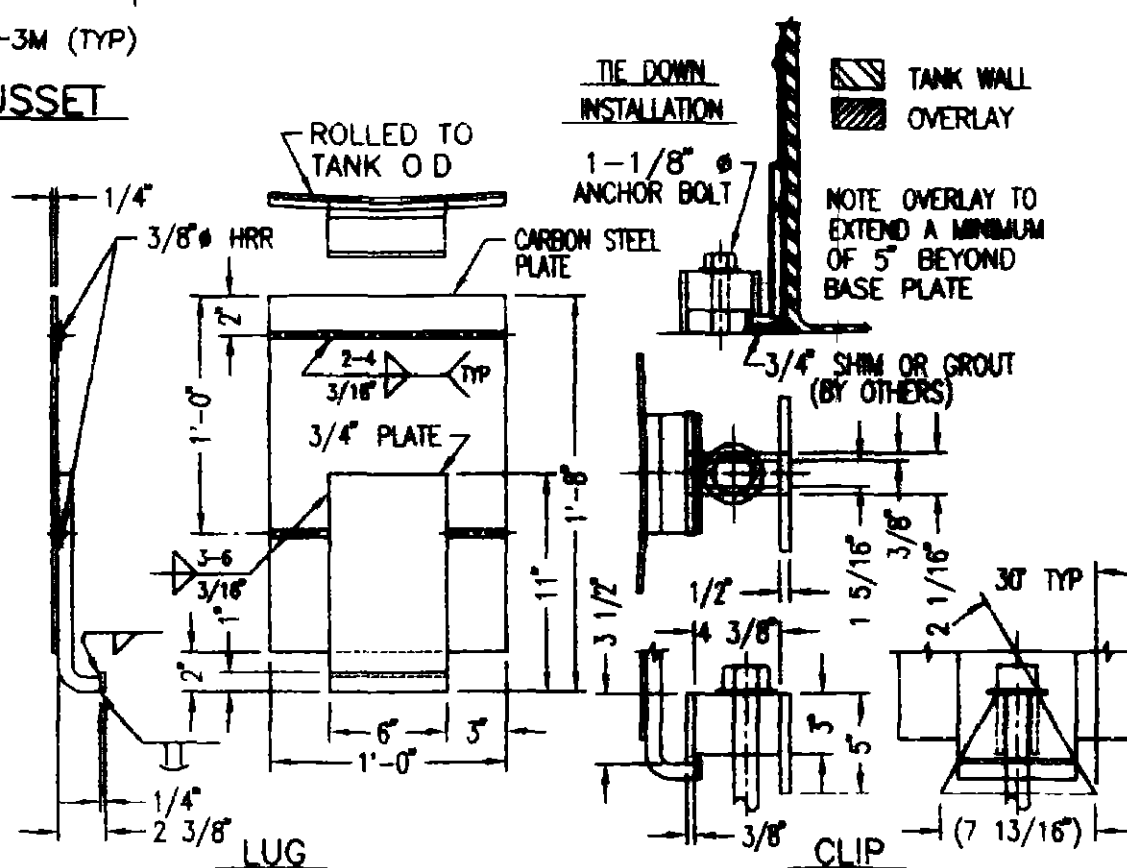
QC CHK		SCHEDULE OF FITTINGS			
SYM	QTY	DESCRIPTION	SERVICE	PROJ.	
A	2	24" MANWAY W/HWR	ACCESS	6"	
B	1	10" FF FLANGE	DEEP GROUNDWATER FEED	6"	
C	1	10" FF FLANGE W/ J-VENT ASSY	VENT		
D	1	8" FF FLANGE	P-120 SUCTION	6"	
E	1	8" FF FLANGE	P-110 SUCTION	6"	
F	1	8" FF FLANGE- DOUBLE FLANGE	P-120 DISCHARGE	6"	
G					
H					
J					
K	1	4" FF FLANGE	DRAIN	6"	
L					
M	1	3" FF FLANGE	P-110 RECYCLE	6"	
N	1	2" FF FLANGE	BUILDING DRAIN FEED	6"	
P	1	2" FF FLANGE	CONTAINMENT PUMP FEED	6"	
Q	1	1-1/2" FF FLANGE	P-145 FEED	6"	
R					
S					
T	1	1/2" FF FLANGE	H2SO4 FEED	6"	
U					
V	4	LIFTING EYE, PALMER STD (FACTORY TO LOCATE)			
W	8	TIE-DOWN, #3 ANCHOR			
X					
Y					

NOTES:

- STRUCTURAL LAYER ANALYSIS
 C₂ = CHOP 27% E GLASS REINFORCEMENT 0.033"
 C₃ = CHOP 27% E GLASS REINFORCEMENT 0.043"
 CM = COREMAT 0.043"
 H = HOOP WOUND 50% E GLASS REINFORCEMENT 0.023"
 M = 1.5 oz RANDOM STRAND MAT 0.043"
 R = 24 oz WOVEN ROVING 0.033"
 V = C-VEIL 0.010"
- NOZZLE FLANGES TO BE FFWN (FLAT-FACED WELD-NECK) W/150# DRILLING & 50# RATING (UNLESS OTHERWISE NOTED)
- FLANGES INSTALLED IN SHELL WILL BE INSTALLED W/BOLT HOLES STRADDLING THE TANKS VERTICAL OR HORIZONTAL Q. FLANGES INSTALLED IN THE HEADS WILL BE INSTALLED W/BOLT HOLES STRADDLING THE 0°-180° & 90°-270° Q'S
- NOZZLES TO BE CONICALLY GUSSETED.
- VENT TO BE OF AN EQUAL OR LARGER DIAMETER OF ANY AND ALL NOZZLES, THUS ALLOWING ADEQUATE AIR FLOW WHEN FILLING OR DRAINING TANK. THIS IS REQUIRED TO AVOID CREATING INTERNAL PRESSURE OR VACUUM. OTHERWISE - WARRANTY IS NULL AND VOID.
- TIE DOWNS TO BE POSITIONED AS NOTED. THE ANCHOR BOLT CIRCLE IS APPROXIMATELY Ø12'-11 1/4" ± 1/2". THIS DIMENSION IS DUE TO MANUFACTURING VARIABLES WE RECOMMEND THAT THE ANCHOR BOLTS NOT BE SET UNTIL AFTER TANK DELIVERY
- TANK EXTERIOR TO BE PIGMENTED: TAN
- GASKET MATERIAL REQUIRED: STANDARD NON-ASBESTOS
- TANK TO BE SET ON GROUT BED, BY OTHERS (SEE GROUT DETAIL)
- TANK TO BE HYDROSTATIC TESTED BY FILLING W/WATER.
- ALL DIMENSIONS SHOWN AS NOMINAL (NOM) ARE ±1-1/2%.

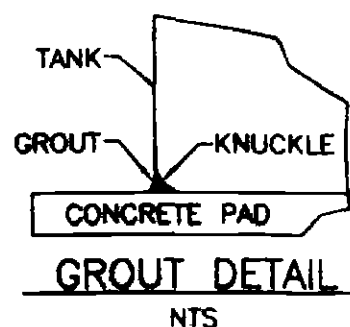


ELEVATION VIEW
(NOT TRUE ORIENTATION)



STANDARD # 3 TIE DOWN LUG DETAIL

NTS (5000 LB DESIGN)



NTS

SYM	DESCRIPTION	CHG. BY	DATE	DRW. BY
△				
△				
△				
△	ADDED TOP SIDEWALL LINING BACK TO EXISTING	DLF	8/14/88	DLF
△	REVISED TO MATCH O&M DRAWINGS; REMOVED FITTINGS NOT CALLED OUT ON O&M SET.	SAC	5/18/88	DLF
SYM	DRAWING REVISIONS	CHG. BY	DATE	DRW. BY

TANK # T-110

DESIGN CONDITIONS	MATERIAL CONSTRUCTION
PRESSURE: ATMOSPHERIC/-2"WC	LINER RESIN: RECHOLD 9100
TEMPERATURE: AMBIENT	LINER MATERIAL: C-VEIL
CONTENTS: CONTAMINATED GROUNDWATER	STRUCTURE RESIN: ISO
SPECIFIC GRAVITY: 1.0	STRUCTURE MATERIAL: E GLASS
EMPTY WEIGHT: 6,200# NOM	UV INHIBITOR: STD
CAPACITY: 20,000 GAL	MFG. SPEC: ASTM D-3299
WIND VELOCITY: 110 MPH	SEISMIC ZONE: 1
SCALE: 1/4"=1'-0" DATE: 5/3/85	

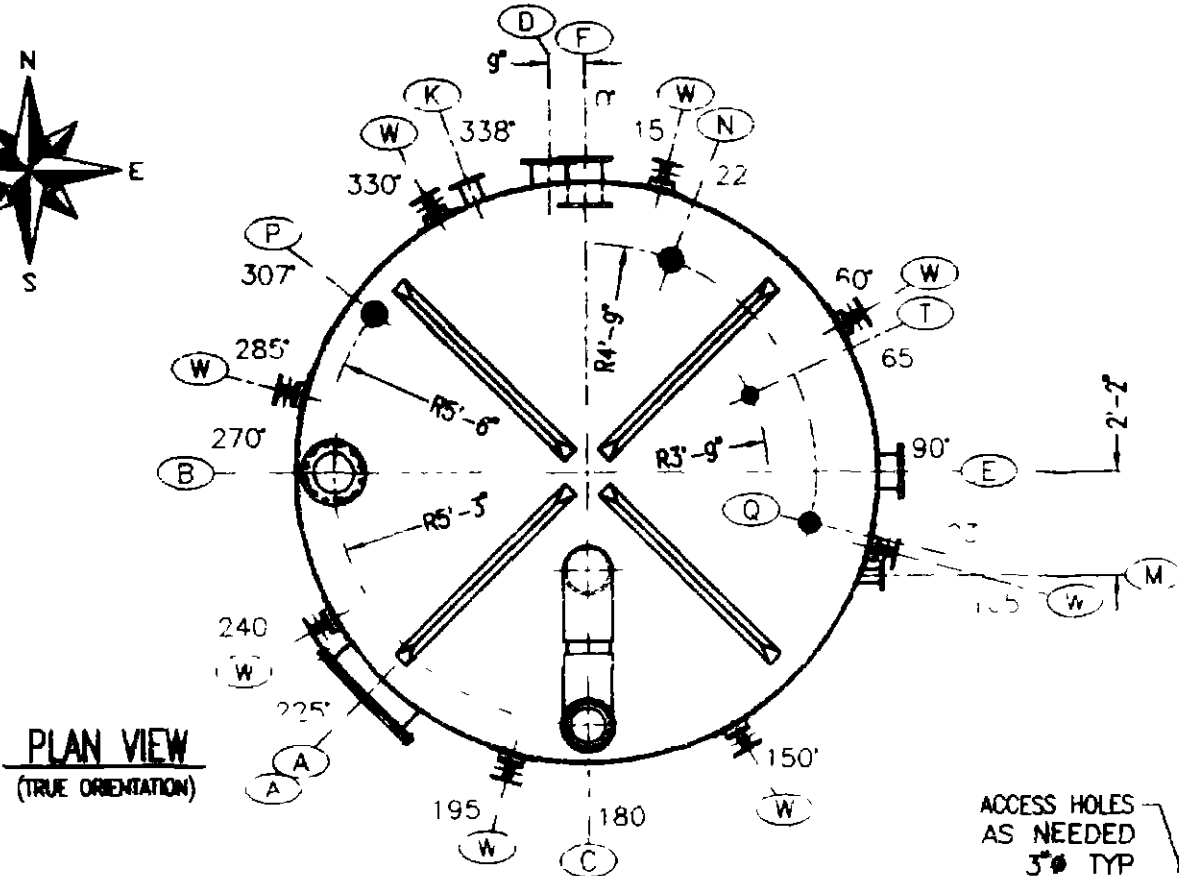
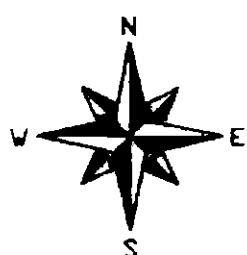
Palmer MFG. & TANK INC.
GARDEN CITY, KANSAS.

OHM REMEDIATION (GEO. SEELKE)

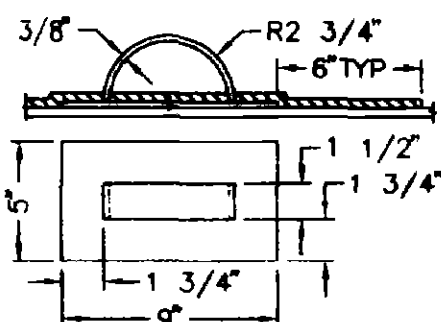
12' X 26'-0" TANK 4966

REVISED DRAWING - PLEASE DESTROY ALL PREVIOUS PRINTS

02350HH01X

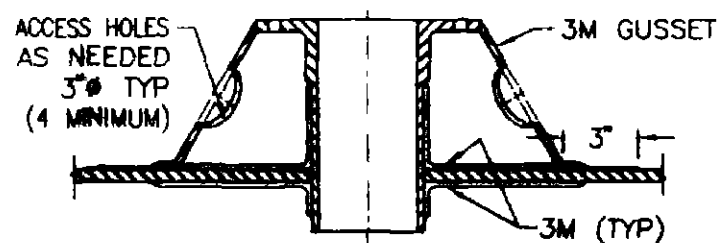


PLAN VIEW
(TRUE ORIENTATION)



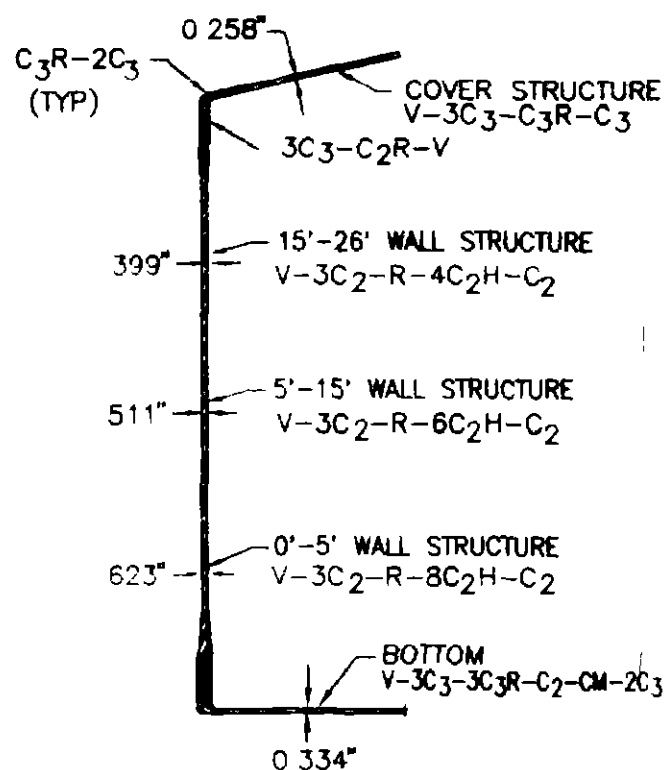
#1 LIFT EYE DETAIL

NTS



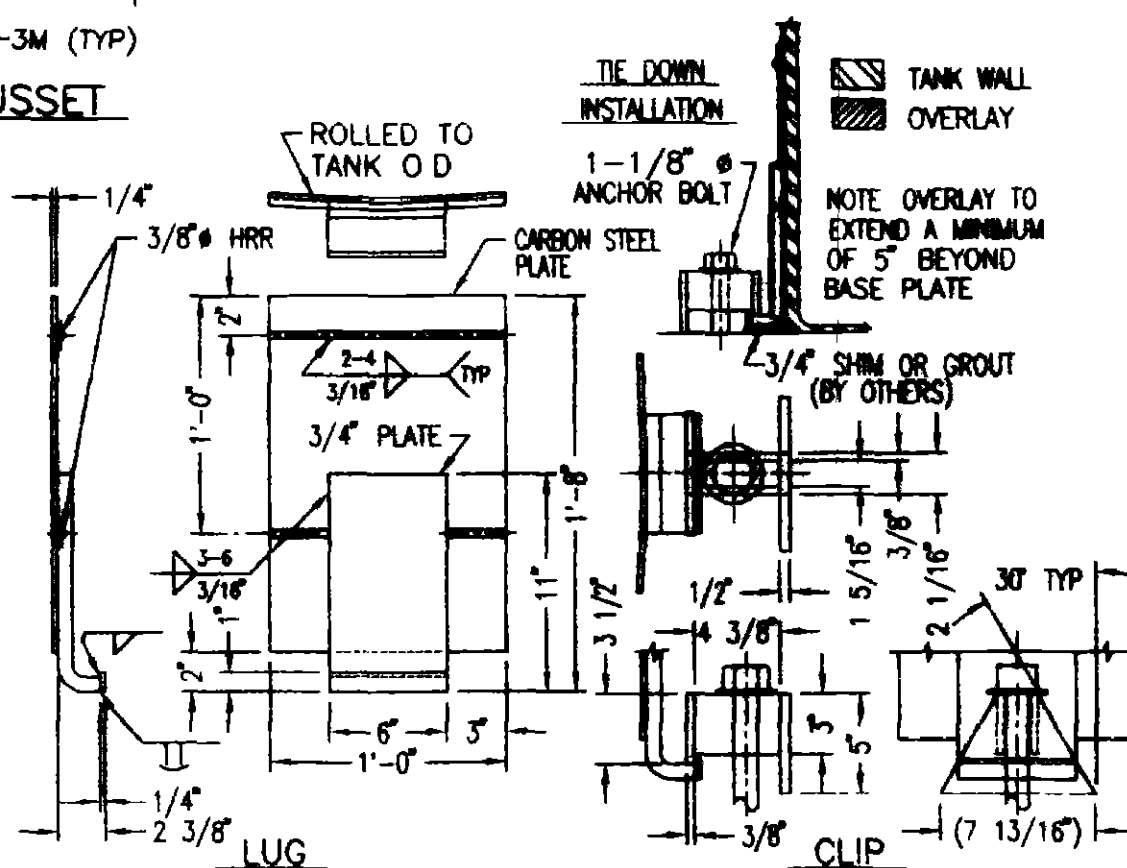
TYPICAL CONICAL GUSSET

NTS



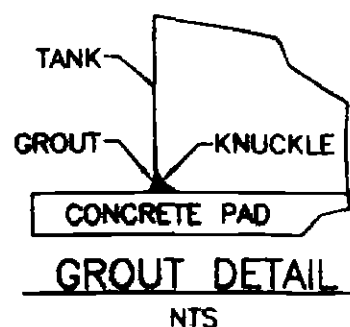
12' X 26' WALL STRUCTURE

NTS



STANDARD # 3 TIE DOWN LUG DETAIL

NTS (5000 LB DESIGN)

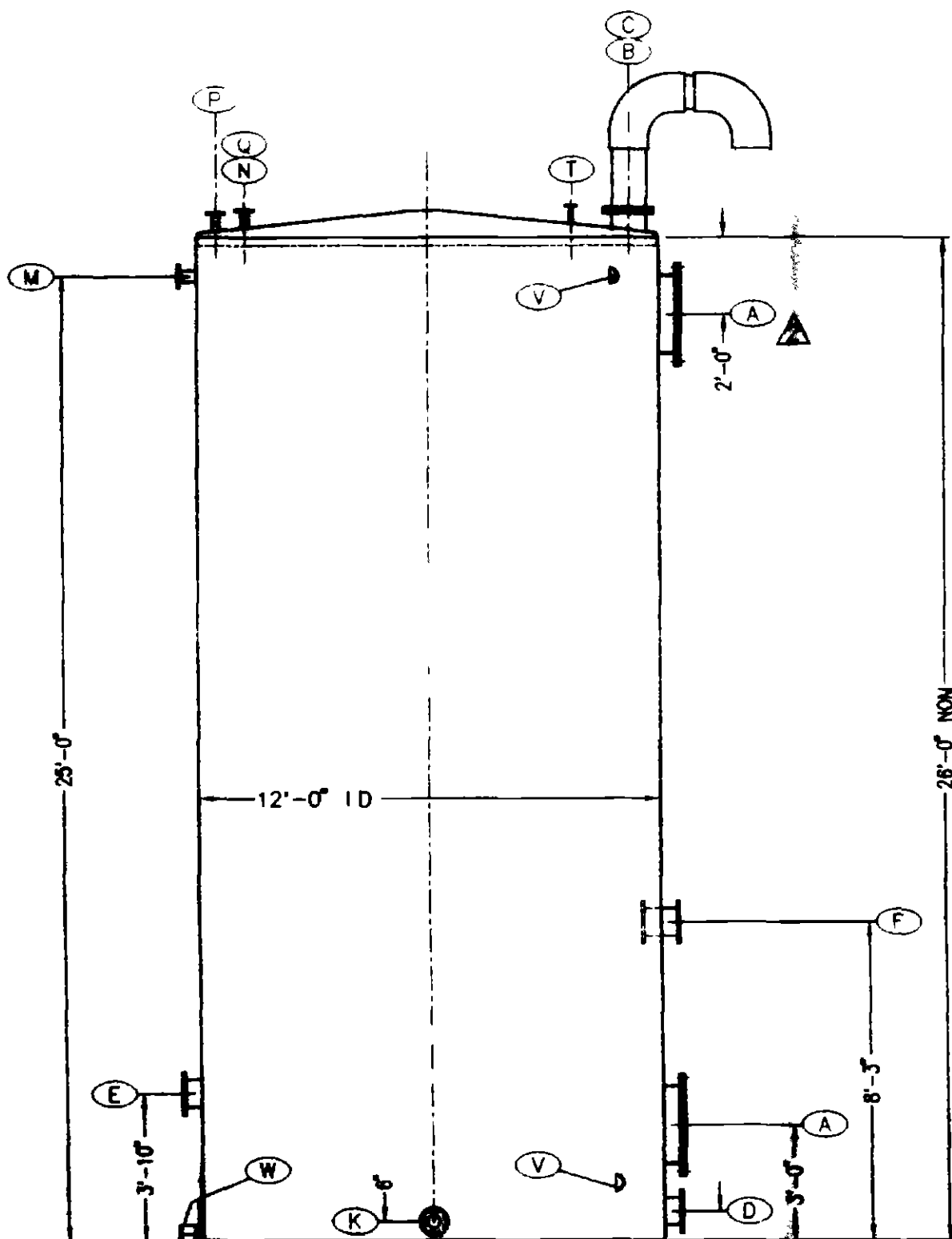


NTS

QC CHK		SCHEDULE OF FITTINGS			
SYM	QTY	DESCRIPTION	SERVICE	PROJ.	
A	2	24" MANWAY W/HWR	ACCESS	6"	
B	1	10" FF FLANGE	DEEP GROUNDWATER FEED	6"	
C	1	10" FF FLANGE W/ J-VENT ASSY	VENT		
D	1	8" FF FLANGE	P-120 SUCTION	6"	
E	1	8" FF FLANGE	P-110 SUCTION	6"	
F	1	8" FF FLANGE- DOUBLE FLANGE	P-120 DISCHARGE	6"	
G					
H					
J					
K	1	4" FF FLANGE	DRAIN	6"	
L					
M	1	3" FF FLANGE	P-110 RECYCLE	6"	
N	1	2" FF FLANGE	BUILDING DRAIN FEED	6"	
P	1	2" FF FLANGE	CONTAINMENT PUMP FEED	6"	
Q	1	1-1/2" FF FLANGE	P-145 FEED	6"	
R					
S					
T	1	1/2" FF FLANGE	H2SO4 FEED	6"	
U					
V	4	LIFTING EYE, PALMER STD (FACTORY TO LOCATE)			
W	8	TIE-DOWN, #3 ANCHOR			
X					
Y					

NOTES:

- STRUCTURAL LAYER ANALYSIS
 C₂ = CHOP 27% E GLASS REINFORCEMENT 0.033"
 C₃ = CHOP 27% E GLASS REINFORCEMENT 0.043"
 CM = COREMAT 0.043"
 H = HOOP WOUND 50% E GLASS REINFORCEMENT 0.023"
 M = 1.5 oz RANDOM STRAND MAT 0.043"
 R = 24 oz WOVEN ROVING 0.033"
 V = C-VEIL 0.010"
- NOZZLE FLANGES TO BE FFWN (FLAT-FACED WELD-NECK) W/150# DRILLING & 50# RATING (UNLESS OTHERWISE NOTED)
- FLANGES INSTALLED IN SHELL WILL BE INSTALLED W/BOLT HOLES STRADDLING THE TANKS VERTICAL OR HORIZONTAL C. FLANGES INSTALLED IN THE HEADS WILL BE INSTALLED W/BOLT HOLES STRADDLING THE 0°-180° & 90°-270° C'S
- NOZZLES TO BE CONICALLY GUSSETED.
- VENT TO BE OF AN EQUAL OR LARGER DIAMETER OF ANY AND ALL NOZZLES, THUS ALLOWING ADEQUATE AIR FLOW WHEN FILLING OR DRAINING TANK. THIS IS REQUIRED TO AVOID CREATING INTERNAL PRESSURE OR VACUUM. OTHERWISE - WARRANTY IS NULL AND VOID.
- TIE DOWNS TO BE POSITIONED AS NOTED. THE ANCHOR BOLT CIRCLE IS APPROXIMATELY Ø12'-11 1/4" ± 1%. THIS DIMENSION IS DUE TO MANUFACTURING VARIABLES WE RECOMMEND THAT THE ANCHOR BOLTS NOT BE SET UNTIL AFTER TANK DELIVERY
- TANK EXTERIOR TO BE PIGMENTED: TAN
- GASKET MATERIAL REQUIRED: STANDARD NON-ASBESTOS
- TANK TO BE SET ON GROUT BED, BY OTHERS (SEE GROUT DETAIL)
- TANK TO BE HYDROSTATIC TESTED BY FILLING W/WATER.
- ALL DIMENSIONS SHOWN AS NOMINAL (NOM) ARE ±1-1/2%



ELEVATION VIEW
(NOT TRUE ORIENTATION)

TANK # T-110

DESIGN CONDITIONS	MATERIAL CONSTRUCTION
PRESSURE: ATMOSPHERIC/-2"WC	LINER RESIN: RECHOLD 9100
TEMPERATURE: AMBIENT	LINER MATERIAL: C-VEIL
CONTENTS: CONTAMINATED GROUNDWATER	STRUCTURE RESIN: ISO
SPECIFIC GRAVITY: 1.0	STRUCTURE MATERIAL: E GLASS
EMPTY WEIGHT: 6,200# NOM	UV INHIBITOR: STD
CAPACITY: 20,000 GAL	MFG. SPEC: ASTM D-3299
WIND VELOCITY: 110 MPH	SEISMIC ZONE: 1
SCALE: 1/4"=1'-0" DATE: 5/3/05	

Palmer MFG. & TANK INC.
GARDEN CITY, KANSAS.

OHM REMEDIATION (GEO. SEELKE)

12' X 26'-0" TANK 4966

SYM	DRAWING REVISIONS	CHG. BY	DATE	DRW. BY
△				
△				
△				
△	ADDED TOP SIDEWALL LINING BACK TO EXISTING	DLF	8/14/05	DLF
△	REVISED TO MATCH OHM DRAWINGS; REMOVED FITTINGS NOT CALLED OUT ON OHM DES.	SAC	5/18/05	DLF

REVISED DRAWING - PLEASE DESTROY ALL PREVIOUS PRINTS

02350HH01X

APPENDIX I

SECTION 2

TANK DATA

TANK T - 121

Manufacturer: Hugo Jahnz & Associates, Inc.

Size: 1000 Gallon Upright Tank

Manufacturer

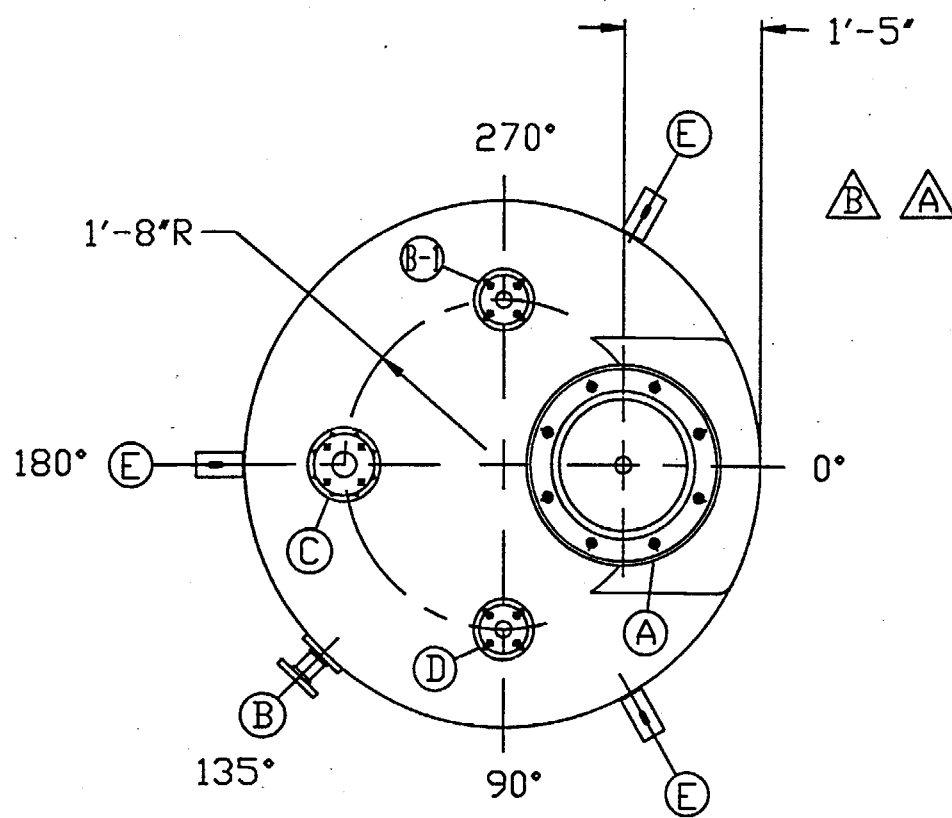
Contact: Mrs. Stacey Posey

Phone

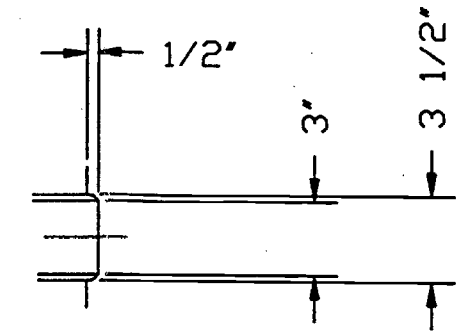
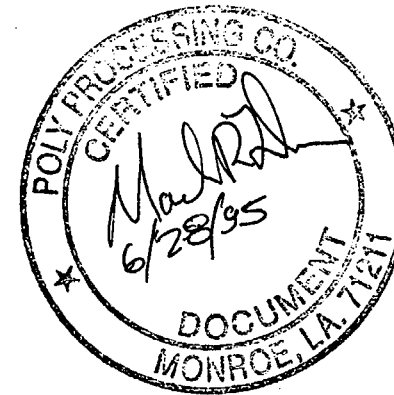
Number: (770) 887-7405

HJA10CA

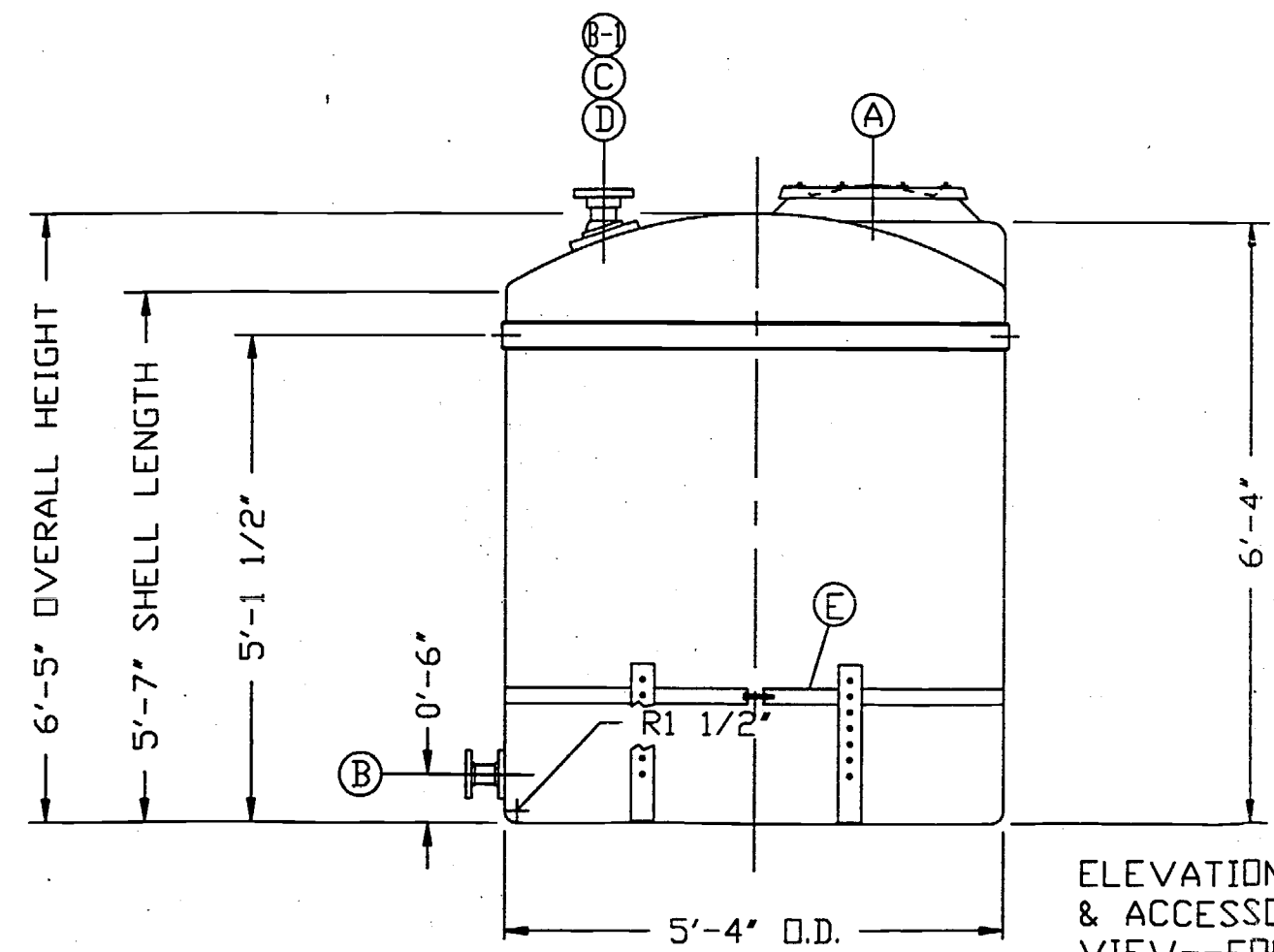
REV. A' DESCRIPTION READ "TWO-FLG. FTG." BY:M.D. 6/20/95 CK: ✓
 REV. B' DID READ DRAIN BY:M.D. 6/27/95 CK: DR



NOZZLE SCHEDULE					
SERVICE	MK	SIZE	FITTING	DEG	ELEV
MANWAY	A	19"	(8)-BOLT COVER W/GSKT./PE	0°	TOP
DRAIN	B	2"	TWO-FLG. FTG. W/FLG. ADAPT./PVC W/GSKT./EPDM W/BOLTS/SS	135°	0'-6"
FILL	B-1	2"	UNI-BALL DOME FTG. W/FLG. ADAPT./PVC W/GSKT./EPDM W/BOLTS/SS	270°	TOP
VENT	C	3"	UNI-BALL DOME FTG. W/FLG. ADAPT./PVC W/GSKT./EPDM W/BOLTS/SS	180°	TOP
FILL	D	2"	UNI-BALL DOME FTG. W/FLG. ADAPT./PVC W/GSKT./EPDM W/BOLTS/SS	90°	TOP
TIE-DOWN SYSTEM	E	--	USE (3) 48" BANDS W/(3) ANCHOR CLIPS/MS EPOXY COATED	SEE PLAN	SEE ELEV



DETAIL "A" STIFFENER BAND
 SCALE: 1 1/2"=1'-0"



ELEVATIONS ONLY--NOZZLES & ACCESSORIES ROTATED INTO VIEW--FOR TRUE ORIENTATION SEE PLAN VIEW.

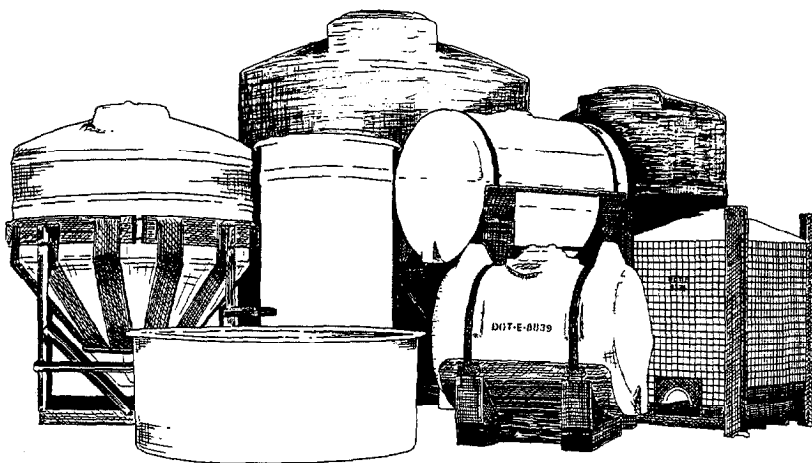
- NOTES
1. THIS IS A COMPUTER GENERATED DRAWING. DO NOT REVISE BY HAND.
 2. COMPUTER DWG. NAME "HJA10CA."
 3. DIMENSIONS MAY VARY SLIGHTLY DUE TO VARIATIONS IN MULTIPLE MOLDS.
 4. 4 1/2" WIDE MOLDED IN GALLONAGE MARKERS @ APPROX. 9° UP TO 900 GAL. AVOID WHEN PLACING FITTINGS.
 5. TANK DESIGNED FOR 1.9 Sp.G. MATERIAL @ 100°F/ATMOSPHERIC PRESSURE.
 6. TANK TO BE HYDROTESTED.
 7. TAG ALL PAPERWORK: P.O.#1004729.

TANK T-121		SERVICE: 50% CAUSTIC EX. HVY. WALL/NATURAL	
1000 GALLON UPRIGHT TANK			
SCALE: 1/2"=1'-0"	POLY PROCESSING CO.		DR. M. DENHAM
DATE: 5/23/95	-DIVISION OF ABELL CORPORATION-		CK. D. RECTOR
HJA PD# 0553	SHEET:	DWG. NO.	REV.
FOR: OHM REMEDIATION SERVICES	1 OF 1	PPC052495-2	B

02350HH02Z

MANUAL

Tank Installation, Use And Maintenance Guidelines



**PLEASE TAKE A MOMENT AND
READ THESE INSTRUCTIONS**

Poly Processing Company's polyethylene tanks are the most efficient, economical and durable vessels offered for storing corrosives and other fluids. Observing the few precautions described in this manual may prevent major problems later.

GUIDELINES

Poly Processing
COMPANY

Division Of Abell Corporation
Box 4150, Monroe, LA 71211
Additional Plant Location In Winchester, VA
Phone (318) 343-7565 • FAX (318) 343-8795

TABLE OF CONTENTS

I. SAFETY CONSIDERATIONS	2
II. RECEIVING YOUR TANK	2
III. IF THERE IS A PROBLEM	2
IV. OFF-LOADING	3
V. UNINSTALLED PARTS	3
VI. FOUNDATIONS AND SUPPORTS	3
VII. LOCATION CONSTRAINTS	3
VIII. INSTRUCTIONS FOR INSTALLATION OF FITTINGS	3
■ BULKHEAD FITTINGS	4
■ TWO-FLANGE FITTINGS	5
■ STAINLESS STEEL FITTINGS	6
■ "UNIVERSAL DOME" FITTINGS (BULKHEAD FITTING STYLE)	7
■ "UNIVERSAL DOME" FITTINGS (FLANGE STYLE)	8
IX. ELECTRIC HEAT TRACING SYSTEMS	8
X. TANK RESTRAINT SYSTEMS	9
XI. HORIZONTAL TANK STANDS	10
■ SMALL HORIZONTAL TANK STANDS	10
■ LARGE HORIZONTAL TANK STANDS	12
XII. LADDER INSTALLATION	14
XIII. SIGHT GLASS ASSEMBLIES	14
XIV. VENTS	15
XV. DROP PIPE SUPPORT PIPES & BRACKETS	15
XVI. LIMITATIONS	16

PROTECT YOUR WARRANTY – READ CAREFULLY

I. SAFETY CONSIDERATIONS

Safety should be the primary consideration and is the shared responsibility of all people involved in an operation. This manual does not profess to address all of the safety problems associated with the use of polyethylene tanks. It is the responsibility of the user of this manual to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to the use of tank(s).

MATERIAL SAFETY DATA SHEETS - The products which are stored in tanks may require health and safety considerations. Obtain and read MSDS sheets for any chemical stored in the tank. Take the necessary precautions of the MSDS.

CONFINED SPACES - The interior of a tank is considered to be a confined space and must be entered by permit only. Adequate preparations should be made as necessary such as lock out of all electrical circuit of internal equipment, all lines to the tank blinded off, adequate ventilation provided, adequate and safe lighting provided, tank decontaminated, safety watches and emergency procedures established, all safety equipment procured and personnel trained in its use before entry into the tank.

LADDERS - Ladders are designed for access of one person to the manway. Ladders are not designed for multiple persons or heavy equipment.

HYDROTESTING - After a tank has been installed with its fittings and accessories in place, hydrotest with standing water for at least two hours before putting into service.

DOMEL LOADING - Exercise extreme caution when walking or standing on the dome of a polyethylene tank. Polyethylene is a very flexible material and does not afford sure footing.

SPILL PROTECTION - Hazardous chemicals may require secondary containment to protect against spills getting into the environment. For additional information on secondary containment, please contact your local Poly Processing Company distributor.

GENERAL SAFETY OF AREA AND PLANT - Before the tank is ordered, preparations should be made to ensure safe, adequate space is available for the tank and accessories. Head room must be considered as well as provision to transport the tank to the desired location. If the tank is to be indoors, a plan must be in place to transport the tank to the desired location assuring that access through doorways and around obstructions is adequate. Special consideration should be made so that there are no electrical hazards present. Good housekeeping in the area is always a prime consideration for safety.

OSHA AND OTHER REGULATIONS - There may be Federal, State, Local, or internal regulations that apply as well.

II. RECEIVING YOUR TANK

Upon receipt of your tank, INSPECT IMMEDIATELY for obvious defects. Parts and accessories are often secured and/or shipped inside the tank. Open the packages, inspect and account for all parts against the packing slip. Any discrepancies should be noted on both the driver's delivery copy and your packing list. We urge you to IMMEDIATELY NOTIFY your Authorized Distributor of any problems.

III. IF THERE IS A PROBLEM

DAMAGED MERCHANDISE OR OTHER PROBLEMS - Failure to report damaged/lost merchandise within the time limitations may mean you relinquish your rights to claim. Despite our best efforts, merchandise is sometimes damaged/lost in transit. Always inspect your merchandise on the day you receive it. Obvious damage should be noted on the freight bill or shipping invoice and the driver should initial the notation. Hidden damage must be reported to the carrier within THREE (3) WORKING DAYS. Any damaged/lost items can be reported to your Authorized Distributor or the factory and we will work to replace your damaged or missing merchandise as quickly as possible.

Poly Processing Company
Customer Service Department
Phone (318) 343-7565
FAX (318) 343-8795

RETURN MERCHANDISE AUTHORIZATION POLICY - This policy requires that returned goods must be clean and free from chemical residue. You must have a RMA (Return Merchandise Authorization) Number to be used with the return of merchandise to Poly Processing Company. This insures that we correctly identify the merchandise being returned and you receive the proper credit and service in the handling of your claim. To receive an RMA Number please contact the Customer Service Department as noted above. Please have your packing slip available to provide the necessary information to complete the RMA. Please use this RMA Number in any correspondence, shipping papers or paper work involved with the return of the merchandise. Please maintain this RMA Number until the claim is resolved. All material should be shipped freight PREPAID unless prior arrangements have been made. Shipments made on a freight collect basis are subject to refusal. A RESTOCKING FEE will be assessed on new and unused equipment being returned after fifteen (15) days. All items are subject to inspection to assess credit value.

IV. OFF-LOADING

While rotationally-molded tanks are extremely durable, damage can occur to the tanks and fittings if they are improperly handled. Avoid all sharp blows or sharp edges. Do not allow the tanks to be rolled over the fittings. Whenever possible, use a crane or other suitable lifting equipment to remove the tanks from the trailers. Make sure the off-loading area is clear of rocks, sharp stones, or other objects which could damage the tank. Prior to installation, protect the tank from rolling, toppling or being struck while in the off-load area.

V. UNINSTALLED PARTS

Parts must sometimes be shipped uninstalled to prevent damage in transit. These parts can usually be found bagged or boxed INSIDE the tank. Please check before reporting missing parts.

VI. FOUNDATIONS AND SUPPORTS

Although a concrete pad provides the best foundation for vertical flat bottom tanks, a smooth level base of sand, pea gravel, or fine soil confined so that it will not wash is sufficient for any flat bottom tank less than 8,000 gallons capacity. Tanks 8,000 gallons and above require reinforced concrete base or other factory-approved base. IMFO tanks require the same base requirements as vertical flat bottom tanks with provision made for the IMFO outlet. Spherical, horizontal, and cone-bottom tanks all require specifically designed support. To avoid inadequate or improperly designed supports, any support structure not of Poly Processing Company's design must be approved in writing or **ALL WARRANTIES ARE VOID**. Consult the Technical Services Department at (318) 343-7565 for approval or recommendation on any foundations or tank supports.

VII. LOCATION CONSTRAINTS

Poly Processing Company's polyethylene tanks are tough, durable, and suitable for both indoor and outdoor service. However, there are location constraints which should be considered prior to placement of a tank into service. Some of these considerations are: secondary containment requirements; placement in flood plains; placement in areas where seismic or wind forces may be experienced (lateral, seismic, anti-flotation, and wind restraint systems may be required for these areas); ambient and process temperatures above 100°F; adjacent equipment; and work in surrounding areas such as welding. These are only some of the location constraints to be considered. This manual does not profess to include all location constraints that may occur.

It is the responsibility of the end user to ensure that all location constraints applicable are taken into consideration. The installer should check any Federal, State, Local, or internal regulations that may apply to the tank installation. A thorough evaluation of location constraints should be done prior to installation. Contact the factory with questions concerning specific location constraints.

VIII. INSTRUCTIONS FOR INSTALLATION OF FITTINGS

GENERAL RULES

1. It is very important when locating your tank fittings to be extremely careful to consider the fitting contact inside the tank. The fitting must not rest against any portion of the tank that will not allow a complete seal of the fittings. These surfaces are the curved knuckle radii, molded ribs, etc. If a hole is drilled incorrectly the entire tank may be a total loss.
2. The use of a proper size hole saw is recommended for cutting fitting holes. A sabre saw can be used if hole saws are not available. The hole must be precisely cut, however.
3. Before using or purchasing a hole saw, measure the outside diameter of the portion of the fitting that must go through the hole. It is most important to match the diameter of the saw cup to the O.D. of the fitting.
4. In the case of thick wall tanks (+1/2") some sanding on the inside of the tank may have to be done to get a good sealing surface. This must be done very carefully and to the bare minimum necessary. If the holes were drilled at the factory the sanding should have been done there. Check to ensure even wall thickness around the holes to within 1/32".
5. Tools you will need for installing tank fittings;
 - 1/2" drill motor or a sabre saw for very large holes
 - Hole saw sized to the O.D. of the fitting portion to be put through the wall
 - Drills to the size of the bolts used +1/16"
 - Pocket knife
 - Adjustable wrench
 - A strap or chain wrench for some large fittings
 - Marker to lay out holes
6. Poly Processing Company strongly recommends the use of expansion joints for all plumbing connections. **RIGID PIPING MUST NOT BE USED.** The use of rigid piping or the failure to provide for the expansion of the tank will void all warranties.
7. Flange adapters will be shipped loose. Installation on site will be required. Exercise caution when installing to avoid cross-threading. **DO NOT FORCE FITTINGS.**

■ BULKHEAD FITTINGS

1. Remove the large fitting nut from the fitting body. Note that the gasket is located immediately below this nut. The gasket and remainder of the fitting should be set aside for later use.
2. Using the nut as a template, locate the desired position of the fitting. Trace the nut inside and out. Draw a line through the center of the traced outline from each of the points of the nut (See illustration). This will locate the center of the fitting.
3. Drill the tank with a hole saw. Remove any flashing with your pocket knife.
4. Working from the inside of the tank, slide the fitting body through the hole in the tank. The gasket should be between the back of the shoulder of the fitting and the inside wall of the tank.
5. Install the large fitting nut on the outside of the tank. Tighten the nut securely, hand tight plus one half turn to three quarter turn. Care should be taken to prevent the fitting body from turning during this process. The gasket may creep from between the fitting and the tank wall.
6. Inspect the gasket to make sure it has not crept from the shoulder of the fitting. If so, loosen the nut on the outside of the tank. The gasket will jump back into place. Retighten the nut carefully.
7. Piping such as a flange adapter should be threaded into the fitting now. Teflon sealant tape or other thread sealant should be applied to all pipe threads.
8. Hydrotest the tank with standing water for at least two hours before putting into service.

NOTE: Some bulkhead fittings have left hand threads for the large fitting nut.

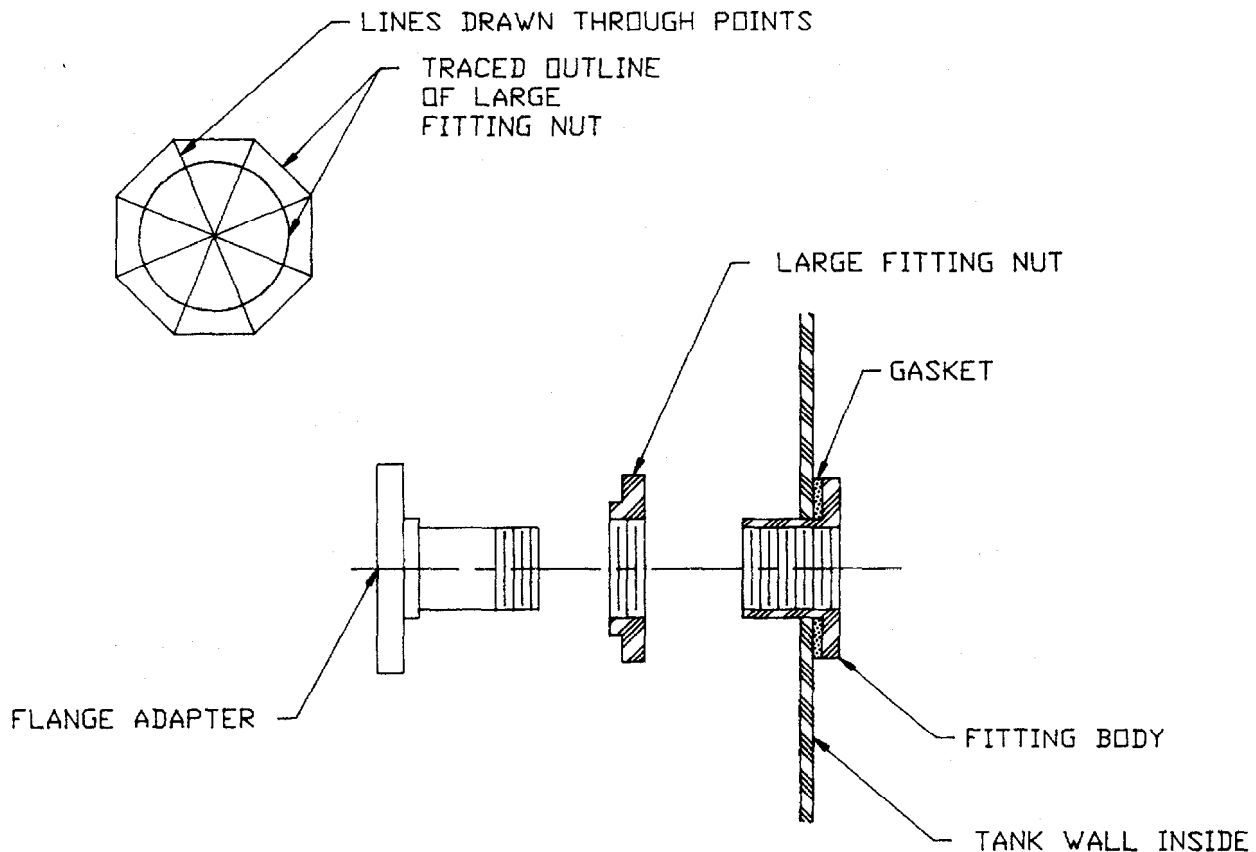


ILLUSTRATION
(F:\NDWG\FITTING\ASMBHF)

■ TWO-FLANGE FITTINGS

1. Disassemble the fittings as shipped. If the holes are not drilled, place the flange against the tank in the desired location and use as a template for drilling the holes. When using 316 SS bolts be sure to lubricate their threads.
2. With their gaskets on them place the studs through their holes with the plastic head on the inside of the tank, threads on the outside.
3. Place the full face flange gasket over the bolts on the outside surface of the tank.
4. Place the flange over the gasket and stud threads with the snout of the flange facing out.
5. Put the washers and nuts on the stud.
6. Tighten nuts in same manner as putting a head on an engine block, i.e.: tighten a little on each nut bringing the flange up to the gasket evenly. Tighten until the gasket is fully compressed (Approximately 15/20 ft. lbs. on a torque wrench).
7. Inspect fitting. Gasket should be compressed and the outer flange drawn down evenly.
8. Piping such as a flange adapter should be threaded into the fitting now. Teflon sealant tape or other thread sealant should be applied to all pipe threads.
9. Hydrotest the tank with standing water for at least two hours before putting into service.

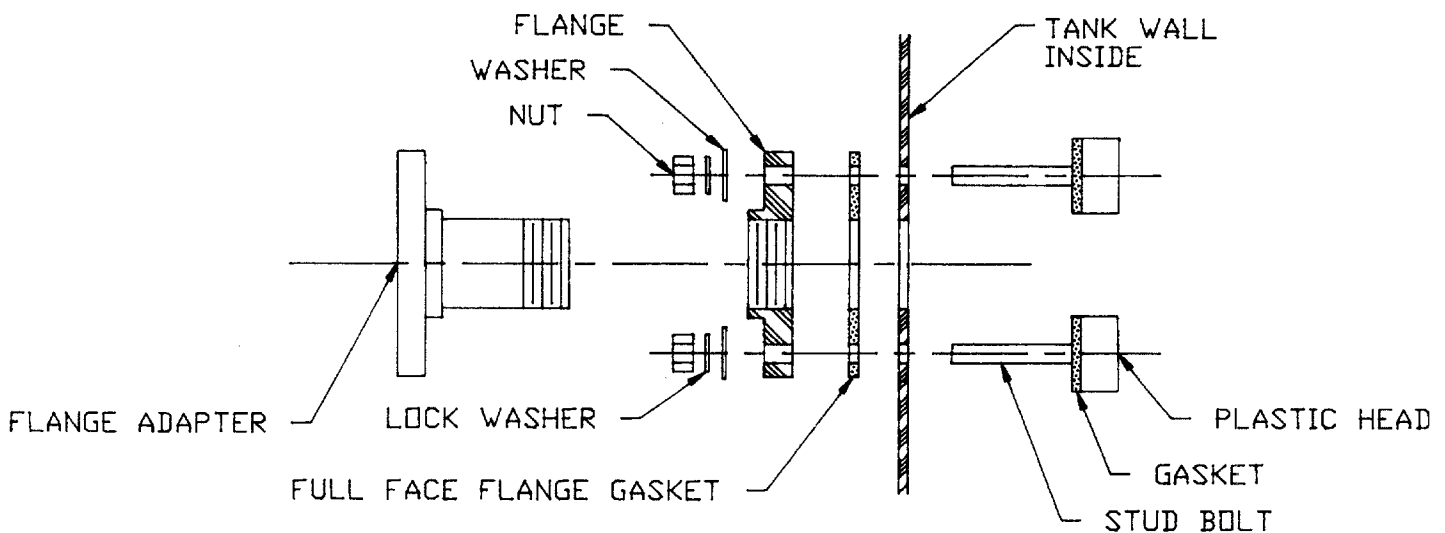


ILLUSTRATION
(F:\DWG\FITTING\ASM2FLG)

■ STAINLESS STEEL FITTINGS

1. Disassemble the stainless steel fitting by removing the nuts from the stud bolts. Remove the 1/8" thick stainless steel outer plate. Set the remainder of the fitting along with the nuts and washers aside.
2. Using the outer plate as a template, mark the hole patterns on the outside of the tank.
3. Find the center of the large "tank fitting" hole by drawing an "X" through the center of the bolt holes (See illustration).
4. With the drill motor and hole saw, drill out the pipe fitting hole. Please note that the hole to be drilled in the tank may be much smaller than the hole in the outer plate that was used as a template. The hole saw should match the O.D. of the portion of the fitting that must go through the hole in the tank.
5. Next drill out the stud bolt holes using the 9/16" drill bit for fittings with 1/2" diameter studs or a 3/8" drill bit for fittings with 5/16" diameter studs.
6. Trim any flashing from the holes with a pocket knife.
7. You are now ready to insert the tank fitting. With the gasket on the studs against the back plate of the fitting, install the fitting from the inside of the tank. Slide the outer plate onto the stud bolts that are protruding from the tank wall.
8. Replace the washers and nuts on the stud bolts. Tighten the nuts. Tighten a little on each nut bringing the outer plate down to the wall of the tank evenly. Tighten until the gasket on the inside of the tank is fully compressed. **1/2" nuts should be torqued to 30 ft. lbs., 5/16" nuts to 12 ft. lbs.**
9. Inspect the fitting. The gasket should be compressed. The outer stainless steel plate should conform to the wall of the tank.
10. Hydrotest the tank with standing water for at least two hours before placing into service.

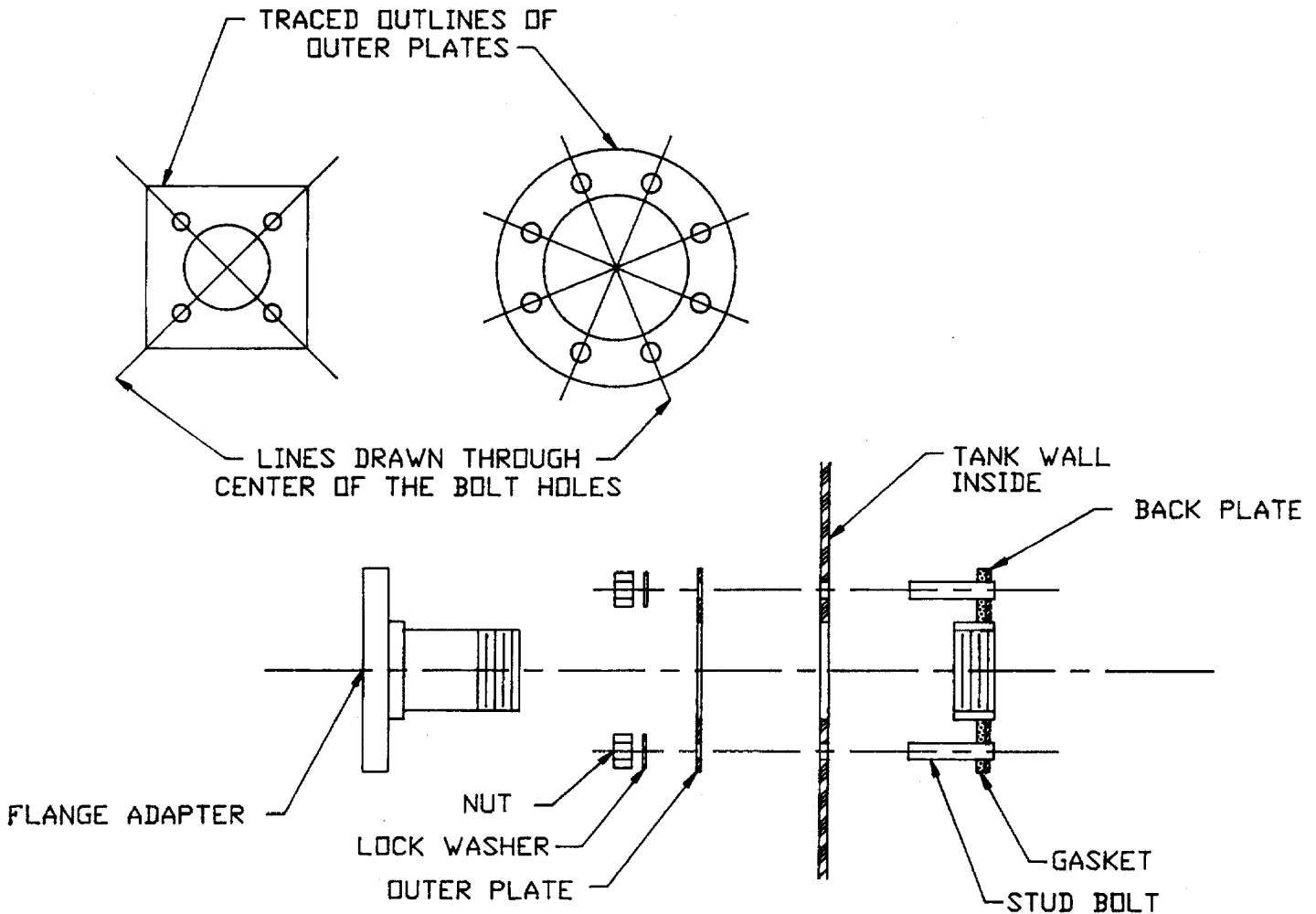


ILLUSTRATION
(F:\DWG\FITTING\ASMSSFTG)

■ "UNIVERSAL DOME" FITTINGS (BULKHEAD FITTING STYLE)

1. Remove the large fitting nut from the fitting body. Note that the gasket is located immediately below this nut. The gasket and remainder of the fitting should be set aside for later use.
2. Using the nut as a template, locate the desired position of the fitting. Trace the nut inside and out. Draw a line through the center of the traced outline from each of the points of the nut (See illustration). This will locate the center of the fitting.
3. Drill the tank with a hole saw. Remove any flashing with your pocket knife.
4. Working from the inside of the tank, slide the fitting body through the hole in the tank. The gasket should be between the back of the shoulder of the fitting and the inside wall of the tank.
5. Install the large fitting nut on the outside of the tank. Tighten the nut securely, hand tight plus one half turn to three quarter turn.
6. Inspect the gasket to make sure it has not jumped from the shoulder of the fitting. If so, loosen the nut on the outside of the tank. The gasket will jump back into place. Retighten the nut carefully.
7. Piping such as a flange adapter should be threaded into the "ball" of the fitting now. Teflon sealant tape or other thread sealant should be applied to all pipe threads. Piping may be adjusted to any angle desired within the limits of the fitting.
8. Note, universal ball fittings are adjusted at the factory to provide vertical entry into the tank dome. (They sometimes are knocked out of adjustment during transit.) If necessary gently loosen the ball retainer ring located on top of the fitting ball, adjust to desired angle, and then tighten retainer ring.
9. Hydrotest the tank with standing water for at least 2 hours before putting into service.
10. For a flanged connection Flange Adaptors may be used.

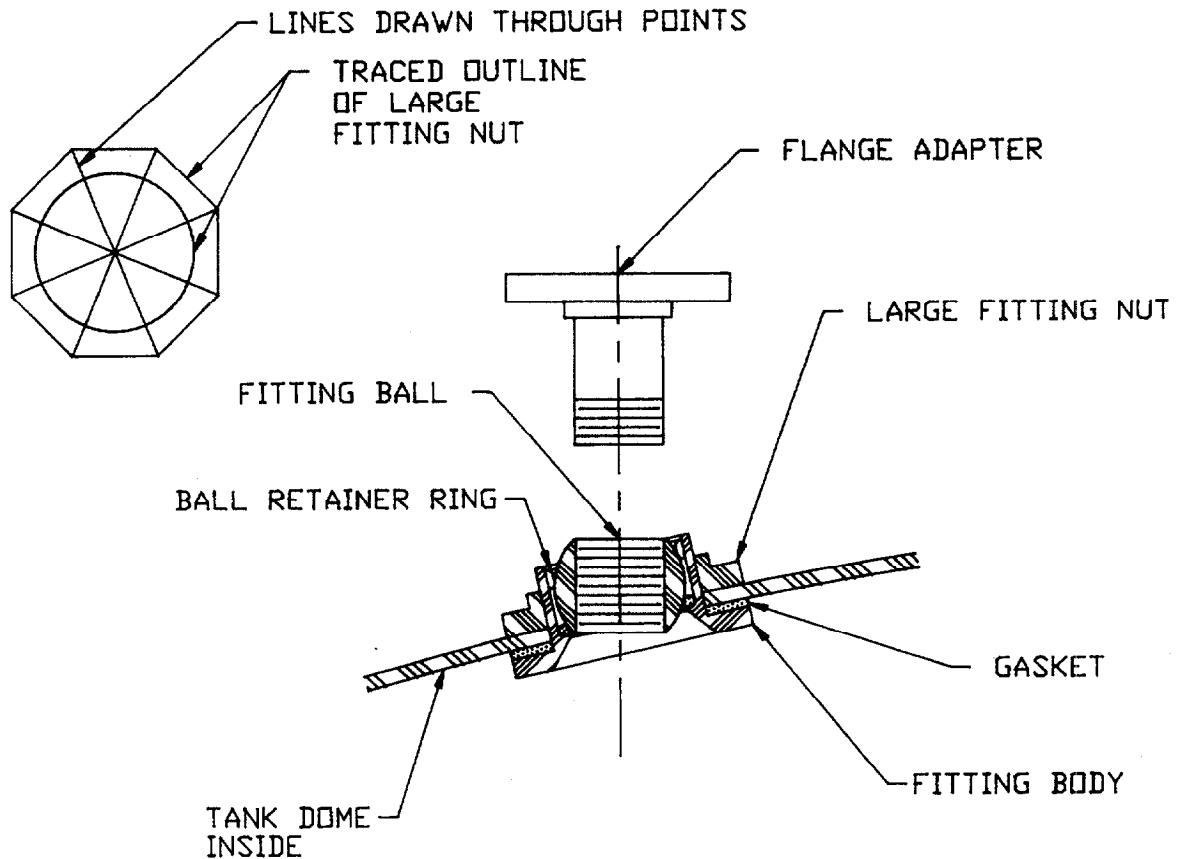


ILLUSTRATION
(F:\DWG\FITTING\ASMUDBS)

■ "UNIVERSAL DOME" FITTINGS (FLANGE STYLE)

1. Disassemble the fitting as shipped.
2. If the holes are not drilled, place the full face flange gasket against the tank in the desired location and use as a template.
3. Drill the center hole using the proper size hole saw.
4. Drill the bolt holes using a 9/16" bit.
5. Remove any flashing with a pocket knife.
6. From the outside of the tank, reach through the center hole and place the threaded end of the stud bolts with their gaskets on them through the bolt holes on the inside.
7. Place the full face flange gasket over the stud bolts on the outside surface of the tank.
8. Place the flange style universal dome fitting over the stud bolts and the full face flange gasket.
9. Put the washers and nuts on the stud bolts. (Note: When using 316 SS be sure to lubricate the threads.)
10. Tighten a little on each nut bringing the fitting down to the gasket evenly. Tighten until the gasket is fully compressed (Approximately 15/20 ft. lbs. on a torque wrench).
11. Inspect the fitting and the gaskets. The gaskets should be compressed and the fitting should be drawn down evenly.
12. Piping such as a flange adapter should be threaded into the ball of the fitting now. Teflon sealant tape or other thread sealant should be applied to pipe threads. Piping may be adjusted to any angle desired within the limits of the fitting.
13. Note, universal dome fittings are adjusted at the factory to provide vertical entry into the tank dome. They are sometimes knocked out of adjustment during transit. If necessary, gently loosen the ball retainer ring located on top of the ball, adjust to desired angle and tighten the ball retainer ring.
14. Hydrotest the tank with standing water for at least two hours before putting into service.

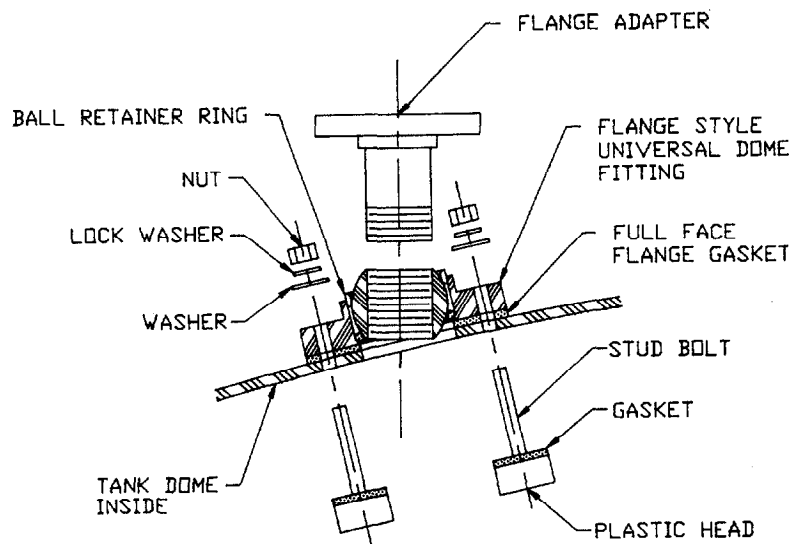


ILLUSTRATION
(F:\DWG\FITTING\ASMUDFS)

IX. ELECTRIC HEAT TRACING SYSTEMS

HANDLING

Please exercise caution when off-loading insulated tanks. The insulation used is a polyurethane foam and may be easily torn or gouged. If this occurs, consult the factory for repair instructions and materials.

HEAT TRACING SYSTEMS

Standard heat tracing systems use an econo-trace cable with dual thermostats. Unless otherwise specified the system is 115 VAC. This system utilizes two thermostats – one for control and one for overload or safety. Both thermostats must be set to the desired temperature by the customer. To properly use the system set one thermostat at the temperature you wish to maintain and the second approximately 20° higher. The higher thermostat setting will act as a safety overload in the event of a thermostat failure.

INSTALLATION

Connect the power wire from the box on the tank to 115/120 VAC. A copy of "Troubleshooting Electric Heat Tracing on Non-Metallic Vessels" is included with the shipping papers for tanks with Electric Heat Tracing.

X. TANK RESTRAINT SYSTEMS

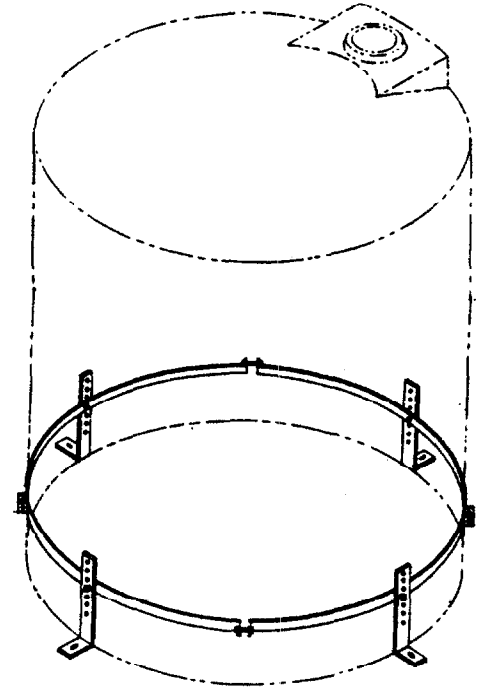
The Poly Processing Tie Down System is an effective, easily assembled method of anchoring your tank to a concrete slab.

To assemble the system you will need:

1. Concrete anchor bolts (1/2" size max.)
2. A method to install these bolts (unless pre-set)
3. A ratchet wrench with a 9/16" socket and a 3/4" socket
4. An adjustable wrench (i.e., crescent wrench)

To assemble the system:

1. Locate the tank on the slab.
2. Lay out all the contents of the hold down system and check to ensure that all parts are included. (See the list below.)
3. Insert a 1/2" x 1" long carriage bolt provided into each of the square holes punched in the bands. The threaded end of the carriage bolt should stick out in the same direction as the bent ends of the band (i.e., away from the tank).
4. After the bands have all been joined with the 3/8" Ø x 5" Lg. bolts orient them in such a manner that the 1/2" carriage bolt protruding from each band is in a desirable location. This is an **IMPORTANT STEP**, as these bolts provide the attachment to the anchor clips.
5. Raise the bands to the desired height and install the anchor clips onto the protruding bolts. By installing the clips one at a time, the bands can be "leveled" quite easily. Note that there are many holes in the vertical leg of the anchor clip to allow adjustment above or below any fitting on the tank. Tighten the anchor clips onto the bands.
6. After checking to make sure the bands are level, tighten the 3/8" x 5" long bolts to draw the bands securely to the tank.
7. Mark the slot locations of the anchor clips on the slab. Remove the clips from the bands and install the concrete anchor bolts into the slab. **IF THE ANCHOR CLIPS ARE PROPERLY PRESET, THIS STEP MAY BE OMITTED.**
8. Replace the anchor clips and secure to both the slab and the tank bands.
9. Recheck all bolts.



Parts List For Tie-Down System

Tank O.D.	Gallons	No. & Size of Bands	No. Anchor Clips	No. 3/8" Ø X 5" Lg. Bolts W/Washers & Nuts	No 1/2" Ø X 1" Lg. Carriage Bolts W/Nuts
1' - 11"	55,100	(2) 35"	2	2	2
2' - 7"	150, 200	(2) 48"	2	2	2
3' - 10"	300, 400	(4) 35"	4	4	4
4' - 0"	550, 800	(3) 48"	3	3	3
5' - 4"	525, 805, 1000, 1200, 1500	(4) 48"	4	4	4
6' - 5"	550 MR	(2) 65" & (2) 48" or (4) 58-5/8"	4	4	4
7' - 1" or 7' - 2"	1100, 1450, 2000 IMFO, 2500 IMFO, 3000 IMFO	(4) 65"	4	4	4
7' - 10" or 8' - 0"	2000, 2500, 3000, 4000, 5000, 1600 MR	(4) 72"	4	4	4
10' - 0"	3000 MR, 6400, 6400 IMFO, 6400 MR, 7000, 8500, 8500 MR	(2) 72" (2) 111"	6	4	6
11' - 11"	4200, 4300 IMFO, 6400, 6400 IMFO, 8000, 8000 IMFO, 10000, 10000 IMFO, 12000, 12000 IMFO	(4) 111"	8	4	8

NOTE: Poly Processing Company's Tie Down Restraint System is for lateral restraint only and has no seismic or wind load ratings. Special restraint systems with seismic and/or wind load requirements will be quoted on a case by case basis. For restraint systems with seismic and/or wind load requirements contact the factory.

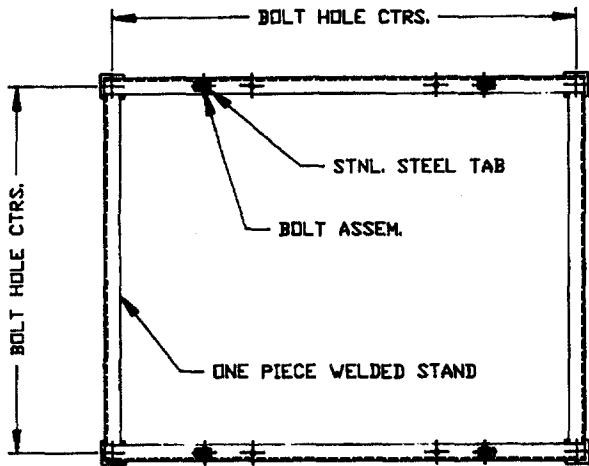
XI. HORIZONTAL TANK STANDS

NOTE: HORIZONTAL TANK STANDS ARE DESIGNED TO BE ERECTED ON LEVEL CONCRETE (OR OTHER APPROVED SURFACES) SUPPORT PADS. WE STRONGLY RECOMMEND THAT TANK STANDS BE BOLTED TO THE SUPPORT PADS. (Please see the section marked "Foundations and Supports" on page 3.)

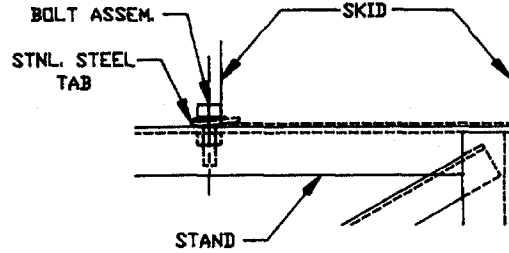
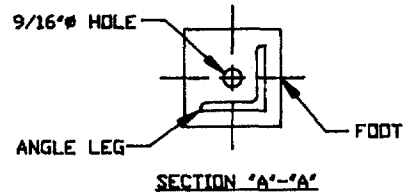
■ SMALL HORIZONTAL TANK STANDS

Stands for small horizontal tanks (tanks up to and including 500 gallons in capacity) are normally designed as one piece welded units. The stands are shrink wrapped for protection during shipping.

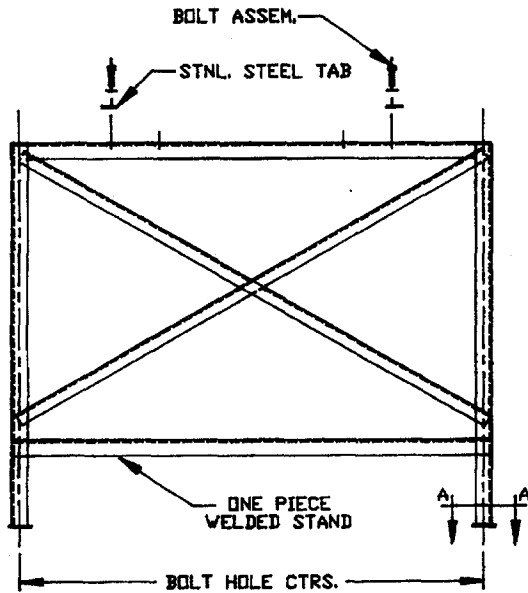
1. **CHECK TO ENSURE THAT ALL COMPONENTS HAVE BEEN RECEIVED.** The shrink wrapped package should contain:
 - (A.) Welded one piece stand
 - (B.) Four (4) stainless steel tabs and four (4) bolt assemblies attached to the top of the stand.
A bolt assembly consists of (1) 1/2-13 bolt 2" long, (2) washers, (1) lock washer, and (1) 1/2-13 nut.



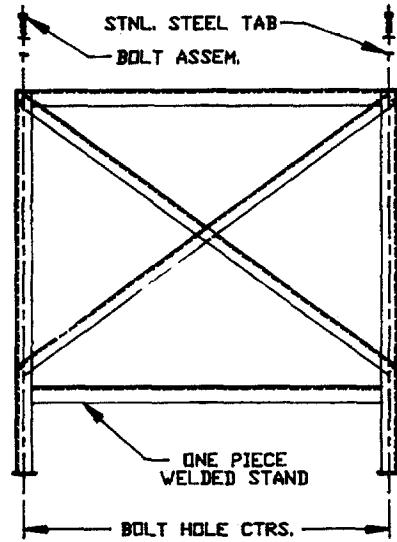
PLAN VIEW



TANK & SKID ASSEMBLY ATTACHMENT DETAIL
SIDE VIEW



SIDE VIEW



END VIEW

ILLUSTRATION
(F:\DWG\METAL\ASHSSTD)

Anchor Bolt Spacing For Small Horizontal Tank Stands

Tank Size	Distance Between Anchor Bolt Holes On Side View	Distance Between Anchor Bolt Holes On End View
150 gal.	58"	29-1/2"
200 gal. 32" dia.	58"	29-1/2"
200 gal. 38" dia.	36-1/2"	35-1/2"
300 gal.	58"	35-1/2"
400 gal.	58"	45-1/2"
500 gal.	58"	45-1/2"

In addition to the above you will need:

- (1) Wrenches for tightening the bolt assemblies
 - (2) A forklift, crane or other suitable lifting device
 - (3) Anchor bolts -- (4) required each stand
 - (4) A wrench to fit the anchor bolts
 - (5) A tape measure
 - (6) A framing square
 - (7) A chalk line
2. **INSTALL THE STAND.** Carefully set the stand up in the location required ensuring that the foundation upon which the stand rests is level.
 3. **INSTALL THE ANCHOR BOLTS.** After the stand has been set up, measure the hole centers in the feet of the stand. 9/16" diameter holes have been provided in the feet of the stand. If larger holes are required they will need to be drilled out. Lay out the anchor bolts. Install the anchor bolts in the foundation. It may be necessary to move the stand to install the anchor bolts. It is extremely important that the bolts be laid out accurately and square. If the stand was moved to install the anchor bolts, lift the stand over the anchor bolts and settle into place. Attach the anchor bolt nuts and tighten.
 4. **PLACE THE TANK IN THE SKID ON THE STAND.** With a forklift, crane, or other lifting device, raise the tank and skid unit onto the stand being careful to not damage the skid or paint. You will note that there are four (4) holes located in the top of each stand. Center the tank and skid unit on the stand. NOTE: The formed flat bar bases of the tank skid will lie close to these holes but will not cover the holes. The holes will lie between the formed flat bar bases of the tank skid.
 5. **INSTALL THE STAINLESS STEEL TABS.** Stainless steel tabs are used to attach the skid to the stand. See "Attachment Detail--Side View" in the illustration on page 10. Place the hole of one of the stainless steel tabs over one of the holes in the top of the stand. Use one of the bolt assemblies to attach the tab to the stand. Place the long side of the tab over the formed flat bar base of the skid. Snug the nut onto the bolt--do not tighten at this time. Attach the remaining tabs to the stand in the same way placing the long side of the tab over the formed flat bar base of the skid. Tighten all the bolts attaching the skid to the stand.
 6. **HYDROTEST.** The factory recommends that all tanks be hydrotested before being placed into service.

■ LARGE HORIZONTAL TANK STANDS

Stands for large horizontal tanks (tanks over 500 gallons in capacity) are designed to be broken down for shipping to reduce freight costs. The components of the stand are packaged and shrink wrapped for protection during shipping.

1. **CHECK TO ENSURE THAT ALL COMPONENTS HAVE BEEN RECEIVED.** The shrink wrapped package should contain:
 - (A.) Upright leg units
 - (B.) Side angle braces
 - (C.) One (1) cloth bag containing stainless steel tabs and bolt assemblies. A bolt assembly consists of (1) 1/2-13 bolt 2" long, (2) washers, (1) lock washer, and (1) 1/2-13 nut.

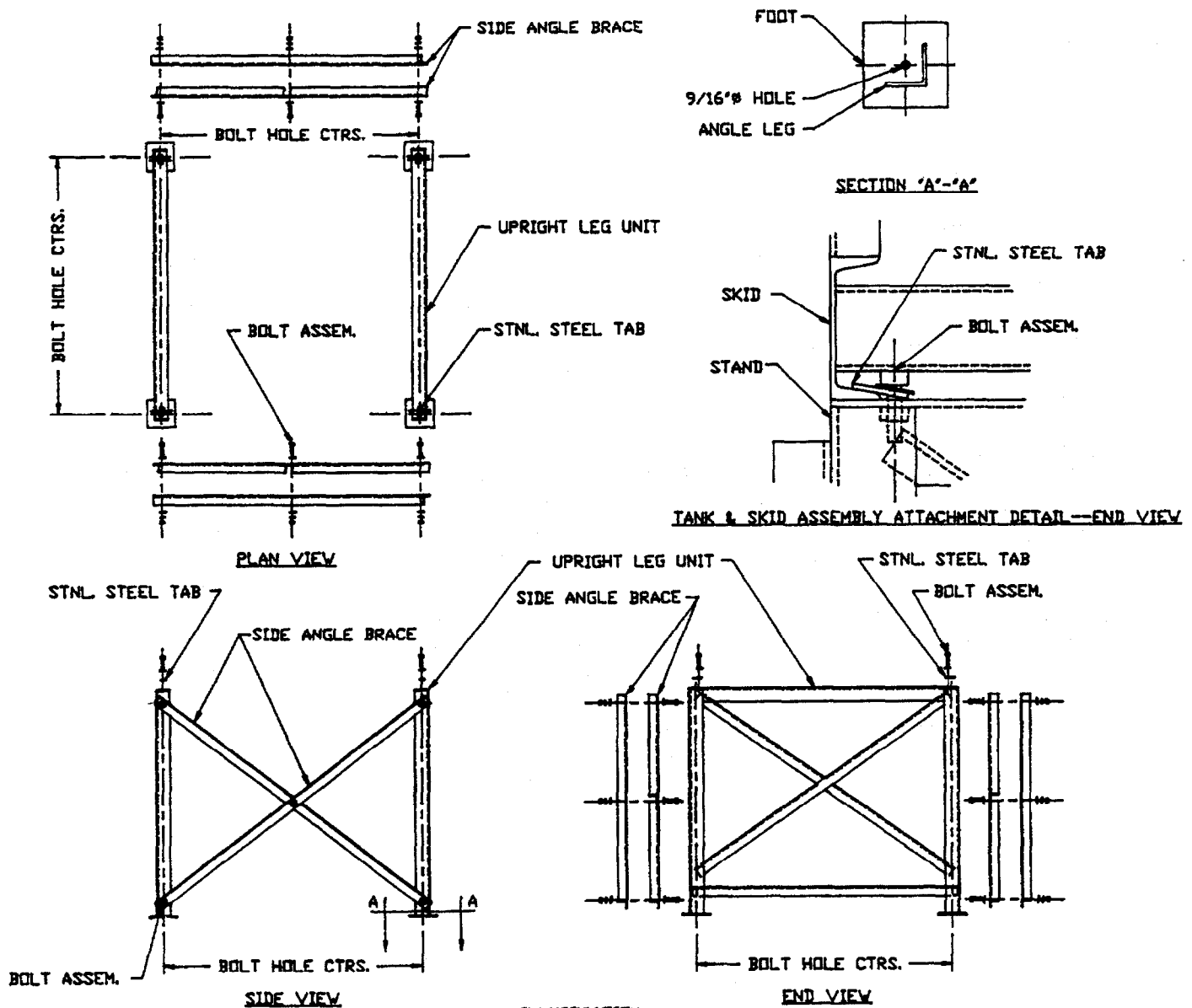


ILLUSTRATION
(C:\DWG\METAL\ASMSTD)

Components For Large Horizontal Tank Stands

Tank Size	No. Upright Leg Units	No. Side Angle Braces	No. Of Bolt Assemblies	No. Of Tabs	Distance Between Anchor Bolt Holes In Upright Leg Units	Distance Between Upright Leg Units
750 gal.	2	4	14	4	46"	62"
1,000 gal.	2	4	14	4	54"	55"
1,025 gal.	3	8	22	6	45"	48-1/2"
1,625 gal.	3	8	22	6	54"	51-1/2"
2,000 gal.	3	8	22	6	54"	57"
2,500 gal.	4	12	30	8	54"	52" on ends 54" in ctr.

In addition to the above you will need:

- (1) Wrenches for tightening the bolt assemblies
 - (2) A forklift, crane or other suitable lifting device
 - (3) Anchor bolts -- (2) required each upright leg unit
 - (4) A wrench to fit the anchor bolts
 - (5) A tape measure
 - (6) A framing square
 - (7) A chalk line
2. **INSTALL THE UPRIGHT LEG UNITS.** Carefully stand up the upright leg units placing them so that the anchor bolt holes in the feet are on the proper grid. See chart above for grid.
 3. **INSTALL THE SIDE ANGLE BRACES.** Install the side angle braces between the upright leg units using the bolt assemblies provided. The side angle braces when properly installed form X's. The side angle braces will be notched out where necessary to allow the vertical leg to lie flat. Lay the side angle braces out on the ground before installing to determine which side angle brace fits next to the upright leg unit and which side angle brace fits on top of another side angle brace. For stands where there are more than two (2) upright leg units this is a very important step. On stands where there are more than three (3) upright leg units, bolt the angle brace "X" to the center upright leg units first. Bolt the side angle braces to the upright leg units and bolt the cross pieces together in the center of the "X".
 4. **INSTALL THE ANCHOR BOLTS.** After the stand has been completely assembled, measure the hole centers in the feet of the upright leg units. 9/16" diameter holes have been provided in the feet of the upright leg units. If larger holes are required they will need to be drilled out. Lay out the anchor bolts. Install the anchor bolts in the foundation. It may be necessary to move the stand to install the anchor bolts. It is extremely important that the bolts be laid out accurately and square. If the stand was moved to install the anchor bolts, lift the stand over the anchor bolts and settle into place. Attach the anchor bolt nuts and tighten.
 5. **PLACE THE TANK IN THE SKID ON THE STAND.** With a forklift, crane, or other lifting device, raise the tank and skid unit onto the stand being careful to not damage the skid or paint. You will note that there are two (2) holes located in the top of each upright leg unit of the stand. Center the tank and skid unit on the stand. The channel iron runners of the skid will be at right angles to the upright leg units. NOTE: the channel iron runners of the tank skid will lie close to these holes but will not cover the holes. The holes will lie inside the channel iron runners of the tank skid.
 6. **INSTALL THE STAINLESS STEEL TABS.** Stainless steel tabs are used to attach the skid to the stand. See "Attachment Detail--End View" in the illustration on page 12. Place the hole of one (1) of the stainless steel tabs over one of the holes in the top of the upright leg unit of the stand. Use one of the bolt assemblies to attach the tab to the stand. Place the long side of the tab over the flange of the channel iron runner of the skid. Snug the nut onto the bolt--do not tighten at this time. Attach the remaining tabs to the stand in the same way placing the long side of the tab over the flange of the channel iron runner of the skid. Tighten all the bolts attaching the skid to the stand.
 7. **HYDROTEST.** The factory recommends that all tanks be hydrotested before being placed into service.

XII. LADDER INSTALLATION

1. Locate the ladder band or bands that have (2) 1/2" square holes punched approximately 20" apart. From the bolts provided, insert two 1/2" x 1-1/2" long carriage bolts such that the threaded end of the bolt sticks out in the same direction as the bent ends of the band (i.e., away from the tank).
2. Bolt the ladder band(s) to the attachment legs of the ladder.
3. Stand the ladder up against the tank in the position desired. Mark the holes at the ladder base where the anchor bolts go.
4. Remove the ladder and install concrete anchors (or whatever type anchors are required by the surface on which the tank is resting).
5. Replace the ladder in its desired position. Using a stepladder or approved personnel lifting device, bolt the remaining bands around the tank.
6. Snug all connections.

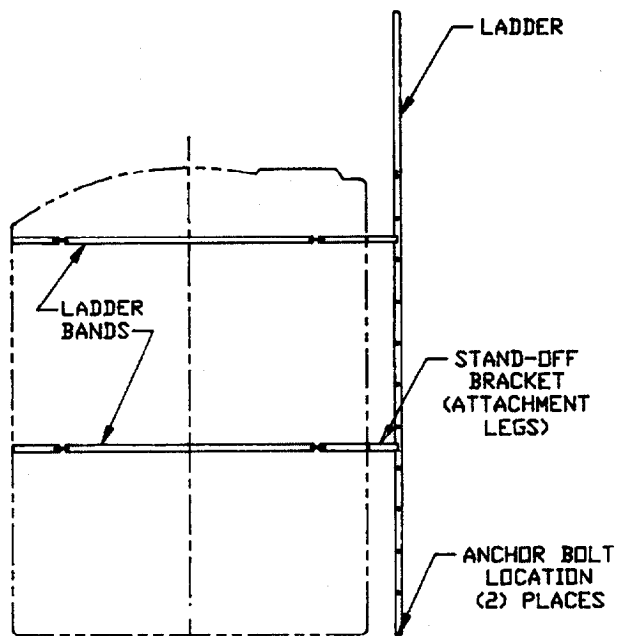


ILLUSTRATION
(F:\DWG\METAL\ASMLDR)

XIII. SIGHT GLASS ASSEMBLIES

Sight glass assemblies are made up complete at the factory when ordered with your tank. They are usually shipped "loose" since they can easily be damaged in transit. To install a sight glass assembly, "break" the two unions apart on either end of the sight glass. Screw the short nipple and one half of the union into the sight glass fittings which have been mounted onto the tank wall at the factory. Rejoin the unions on the assembly and tighten carefully to complete the installation. For your convenience and ease of assembly, drawings of standard sight glass assemblies are shown below. (Also, see instructions on "Uninstalled Parts" on page 3.)

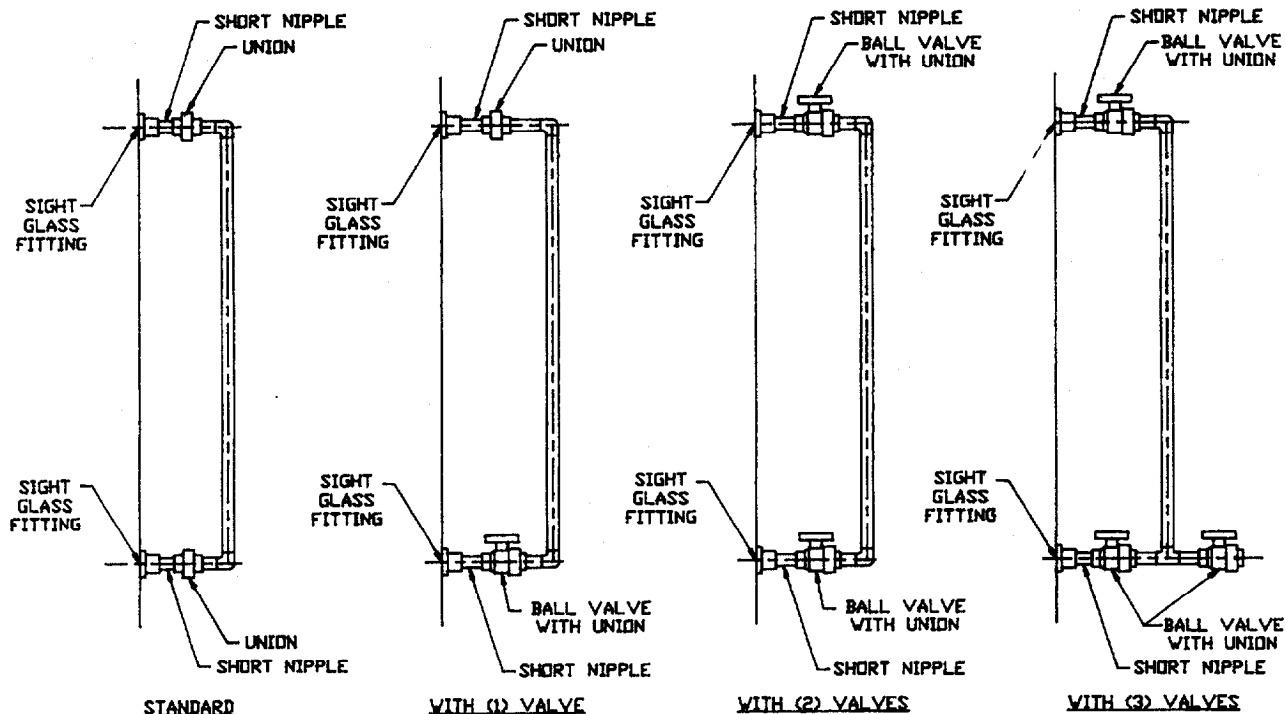


ILLUSTRATION
(F:\DWG\FITTING\ASMSG)

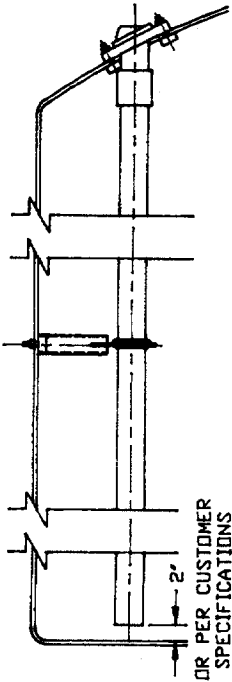
FOR FITTING DETAILS SEE
DRAWING NO. PPC011691-1
"SIGHT GLASS ASSEMBLIES"

XIV. VENTS

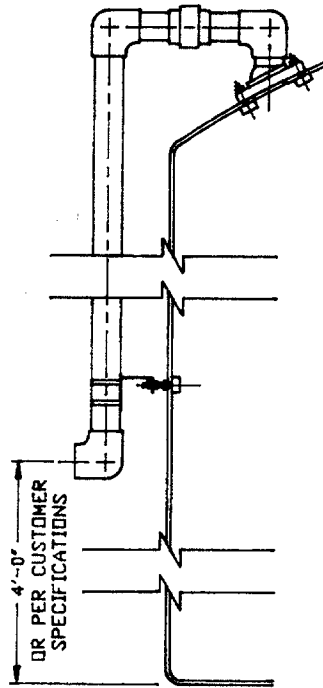
2" vents and larger will not be installed to protect against breakage. Installation will require threading the vent into the proper fitting.

XV. DROP PIPE SUPPORT PIPES & BRACKETS

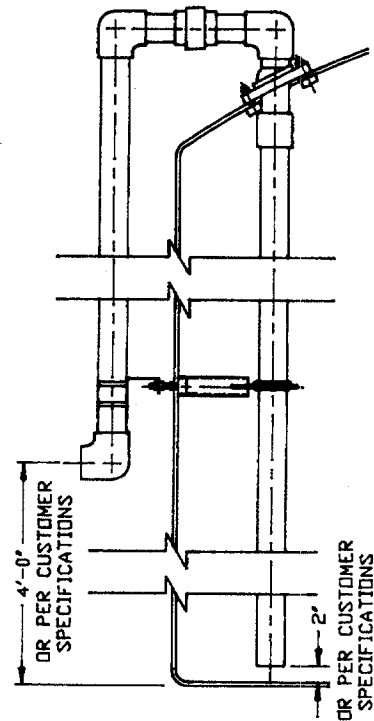
Poly Processing Company has a variety of fill assemblies for both vertical and horizontal tanks. We term these assemblies "drop pipes" and offer internal, external, and internal/external drop pipe assemblies. Standard drop pipes require at least one drop pipe support bracket, usually a special bolt which extends through the tank wall and may be tightened with a wrench. Drop pipes and downpipe brackets are often shipped "loose" to prevent damage in transit. They will require a minimal amount of assembly. For your convenience and ease of assembly, drawings of standard drop pipe assemblies are shown below. (Also, see instructions on "Uninstalled Parts" on page 3.)



INTERIOR DROP PIPE



EXTERIOR DROP PIPE



COMBINATION DROP PIPE

FOR FITTING DETAILS SEE
DRAWING NO. PPC102593-1
'DROP PIPE ASSEMBLIES'

XVI. LIMITATIONS

USE LIMITATIONS – The effects of elevated temperatures (100°F or greater) are predictable and expected. With 150°F as the temperature limitation for continuous duty, applications with requirements over 100°F will require greater wall thickness to maintain the required hoop stress and should be addressed to the Technical Services Department. Intermittent duty (1 to 2 hours in 24 hours) up to 180°F may be acceptable under certain circumstances. External heat sources should be kept away from the tank as they will impair its life.

CHEMICAL COMPATIBILITY – The compatibility of the chemical to be stored, with the tank and fittings, should have been determined before ordering the tank. However, the use of the tank may change and it is important to be sure that the tank and fittings are compatible with the chemical. All products to be stored should be in accordance with the latest Poly Processing Company Chemical Resistance Chart. Always check for compatibility of chemicals not listed on the Chemical Resistance Chart with the Customer Service Department. *It should be noted that the effect of the storage of sulfuric acid, hydrochloric acid, and aqua ammonia darkens the tank over time and this is not an indication of weakness or failure of the tank. This change of color is simply a reaction of the reagent with the additives in the plastic (e.g., UV stabilizers, anti-oxidants, etc.).*

FITTINGS AND VENTS – Tank fittings are installed and sealed at the factory per your specifications. Temperature variations, road vibrations and other factors may influence these fittings, requiring minor adjustments before use. All bolted fittings should have the outer nuts checked before the tank is hydrotested or put into service. Non-bolted fittings have at least one outer nut which should be checked as well. **REMEMBER – PLASTIC FITTINGS CANNOT BE TIGHTENED LIKE STEEL.** Review that portion of the manual related to the particular fitting involved for complete instructions for installation.

The biggest trouble spot with tank fittings is improper plumbing. All piping and valves must be supported. All plumbing lines need a flexible connection in the line to allow the tank to "flex". Rotationally-molded tanks expand and contract as they are filled and emptied. They actually get their "toughness" from this ability to flex. **RIGID PIPING SHOULD NOT BE USED.** Be sure that all vents, pressure relief devices, vacuum relief devices, fill assemblies, and other connecting accessories are clear of any obstruction before attempting to use.

LIMITED WARRANTY & LIABILITY

Poly Processing Company warrants all standard products manufactured and furnished by it for a period of TWO YEARS from date of shipment from its factory to be free from defects in the material and workmanship, and further warrants all upright storage tanks for an additional three years on a prorated basis. This warranty does not address custom molded products as they are warranted individually by product at the time of creation. Poly Processing Company warrants all parts, fittings and accessories manufactured by it for a period of ONE YEAR from date of shipment from its factories to be free from defects in the material and workmanship. These warranties are subject to the following:

1. Products must be used in accordance with the chemical resistance table and the temperature limitations furnished by the manufacturer.
2. Products must be mounted and supported in a manner approved by the manufacturer.
3. Where special warranty limitations address the storage or transport of particular materials, due to reactions which might occur under conditions outside the control of the manufacturer, those limitations expressly apply.
4. Warranty does not cover misuse, fire, accident, negligence, or unauthorized alterations to the product.
5. Liability of the Manufacturer under this warranty (and under any other warranty, expressed or implied, statutory or otherwise) is limited to repair, or at the Manufacturer's option, replacement of defective product which is shown to have been defective when shipped, and only then if the Manufacturer is notified of the defects within the warranty period and items in question are promptly delivered to its factory on Old Sterlington Rd., Monroe, La., transportation charges prepaid. Manufacturer's liability hereunder shall not be enforceable until such equipment has been fully paid for. Except to the extent expressly assumed herein, Manufacturer's liability for incidental and consequential damage is hereby excluded to the full extent permitted by the applicable law. Manufacturer's liability as stated herein cannot be altered or enlarged except by a writing signed by an officer of the Manufacturer.

LIMITED WARRANTY AND LIABILITY

Poly
Processing
COMPANY

Division Of Abell Corporation
Box 4150, Monroe, LA 71211
Additional Plant Location In Winchester, VA
Phone (318) 343-7565 • FAX (318) 343-8795

APPENDIX I

SECTION 3

TANK DATA

TANK T - 140

Manufacturer: Hugo Jahnz & Associates, Inc.

Size: 640 Gallon Sludge Tank

Manufacturer

Contact: Mrs. Stacey Posey

Phone

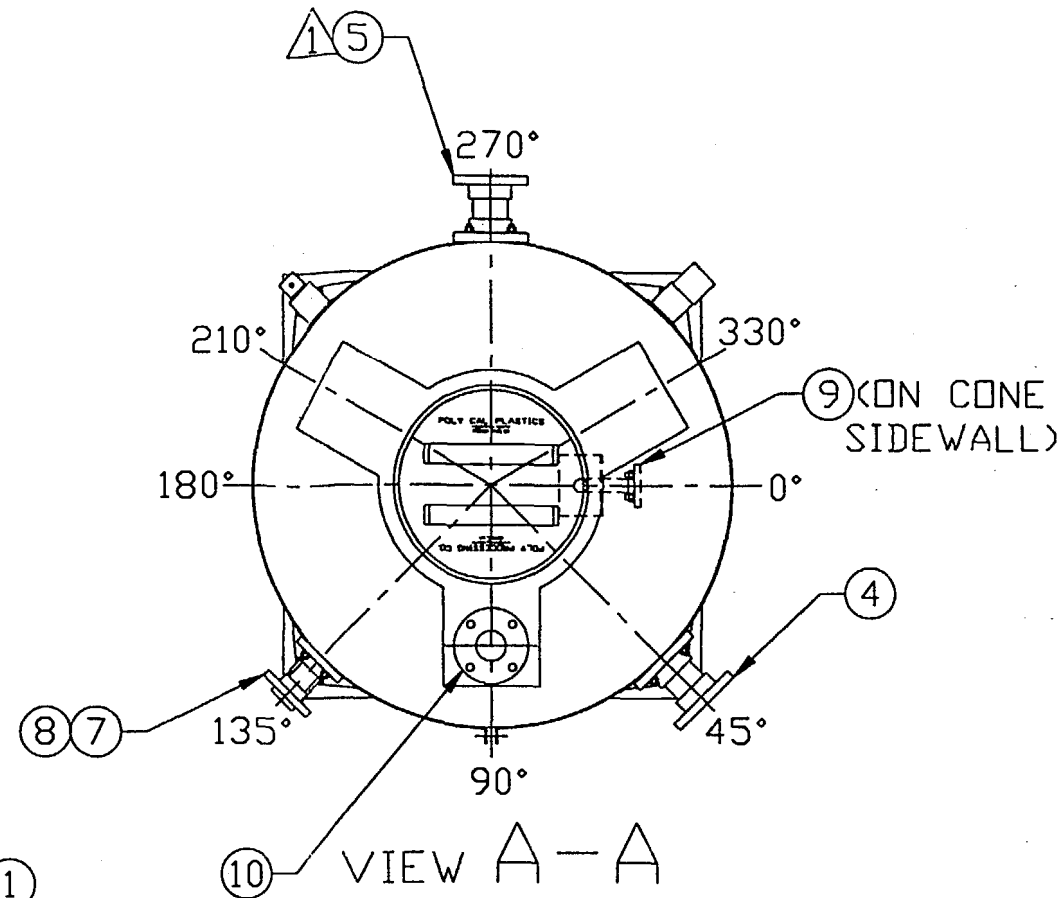
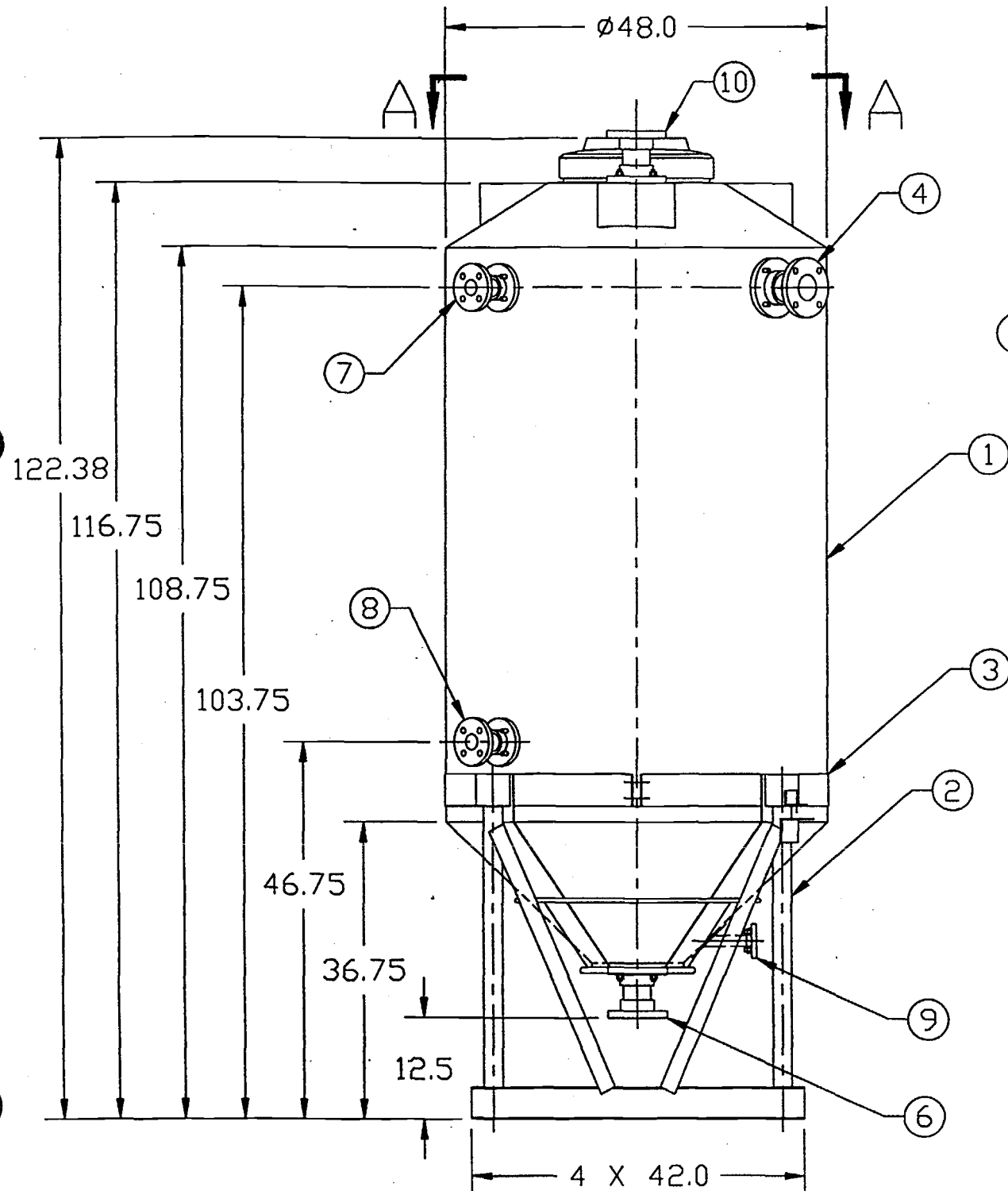
Number: (770) 887-7405

NOTE:

△ LOCATE AT SAME ELEVATION AS FIND NO. 8.

LTR	REVISION DESCRIPTION	DATE/BY

CERTIFIED
M. Jahn



QTY	PART OR IDENT NO.	NOMENCLATURE OR DESCRIPTION	FIND
1	SP1294-S	SPOOL ASSY, 3' 150# FLANGES W/NIPPLE, PVC; SST BOLTS	10
1	SP1271-S	FITTING, 1" MADE HORIZ W/ 150# FLANGE, PVC; SST BOLTS	5
1	SP1293-S	SPOOL ASSY, 2' 150# FLANGES W/NIPPLE, PVC; SST BOLTS	8
1	SP1293-S	SPOOL ASSY, 2' 150# FLANGES W/NIPPLE, PVC; SST BOLTS	7
1	SP1294-S	SPOOL ASSY, 3' 150# FLANGES W/NIPPLE, PVC; SST BOLTS	6
1	SP1294-S	SPOOL ASSY, 3' 150# FLANGES W/NIPPLE, PVC; SST BOLTS	5
1	SP1294-S	SPOOL ASSY, 3' 150# FLANGES W/NIPPLE, PVC; SST BOLTS	4
1	SP66-B	BASKET	3
1	SPCL	SP66-A STAND WITH 6" ADDED HEIGHT	2
1	SPC66	TANK, 650 GALLON CONE BOTTOM, EX HVY WALL (1.9 SP GR) NATURAL	1

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES TANK DIMS INCHES: +/- 1.0 FITTING LOCATION DIMS INCHES: +/- .5 ANGLES +/- 2.5° DO NOT SCALE DRAWING	CUSTOMER OHM REMEDIATION	
	DESIGN/VENDOR HUGO JAHNZ	DATE 06/16/95
	DRAWN T. HEACOX	DATE 06/16/95
	CHECK	
CONFIDENTIAL PROPERTY OF POLY PROCESSING CO NOT FOR REPRINT OR USE WITHOUT PERMISSION OF POLY PROCESSING CO	CUSTOMER APPROVAL	
	FILE SPC66HJ1	DATE 06/29/95

POLY PROCESSING COMPANY
WESTERN REGION

8055 SOUTH ASH STREET
P.O. BOX 80
FRENCH CAMP, CA 95231
TELEPHONE: (209) 982-490
TELEFAX: (209) 982-0455

TITLE
650 GALLON SLUDGE TANK T-140

PLOT SCALE 1 : 20	DWG NO. W950616-1	REV
SHEET 1 OF 1		

02350HH03Z

APPENDIX I

SECTION 4

TANK DATA

TANK T - 145

Manufacturer: Hugo Jahnz & Associates, Inc.

Size: 550 Gallon Upright Tank

Manufacturer

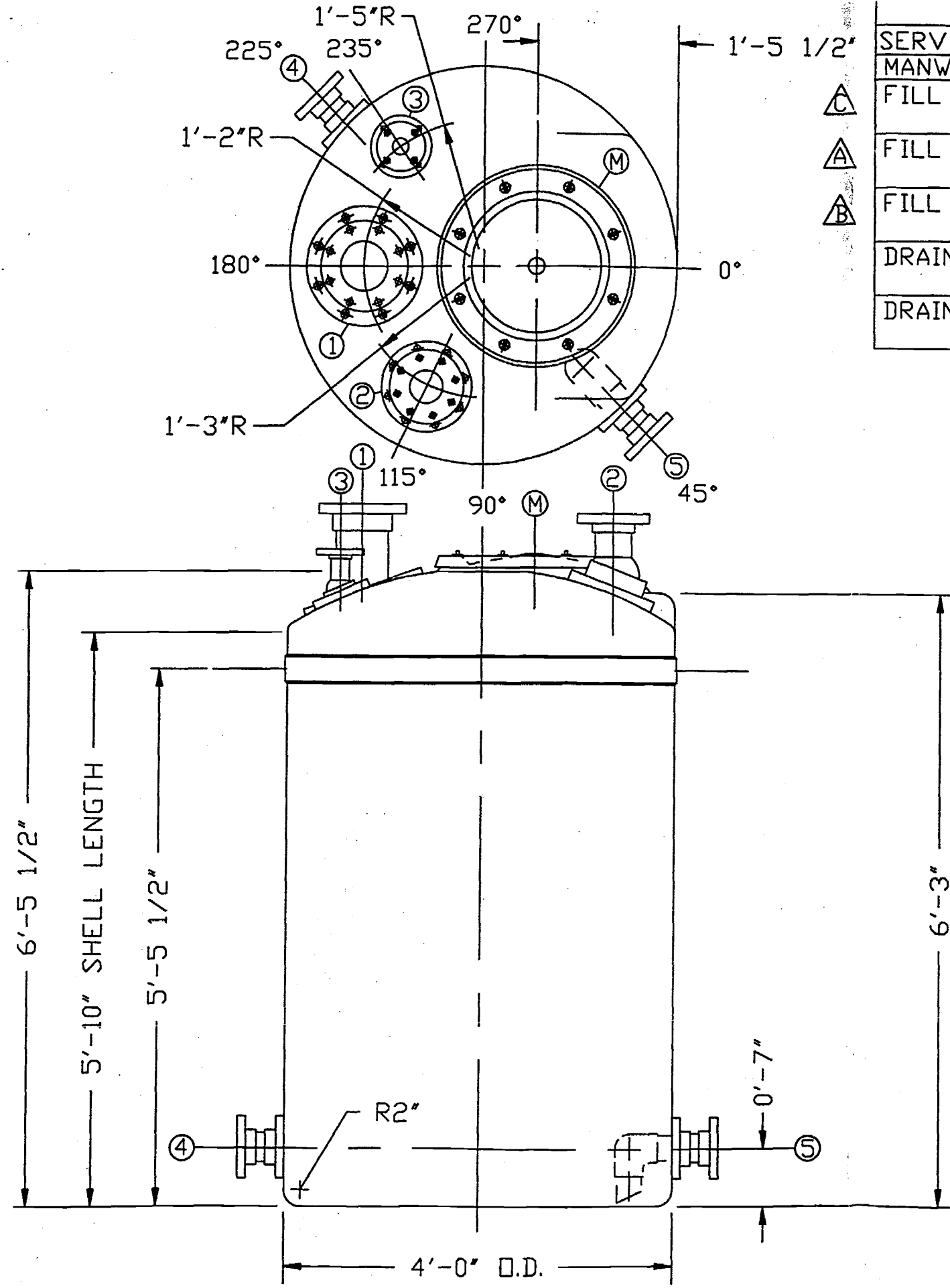
Contact: Mrs. Stacey Posey

Phone

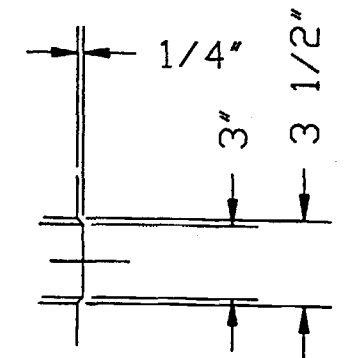
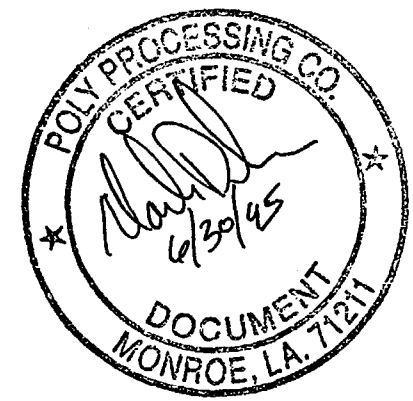
Number: (770) 887-7405

HJA55WT

REV. "A" FIG. "2" WAS AT 235° BY:M.D. 6/28/95 CK:
 REV. "B" FIG. "3" WAS AT 90° BY:M.D. 6/28/95 CK:
 REV. "C" FLG. ADDED TO ELEV. & PLAN BY:M.D. 6/30/95 CK:SR



NOZZLE SCHEDULE					
SERVICE	MK	SIZE	FITTING	DEG	ELEV
MANWAY	M	19"	(8)-BOLT COVER W/GSKT./PE	0°	TOP
FILL	1	6"	THRU-THE-DOME FTG. W/FLG. ADAPT./PVC W/GSKT./EPDM W/BOLTS/SS	180°	TOP
FILL	2	4"	UNI-BALL DOME FTG. W/FLG. ADAPT./PVC W/GSKT./EPDM W/BOLTS/SS	115°	TOP
FILL	3	2"	UNI-BALL DOME FTG. W/FLG. ADAPT./PVC W/GSKT./EPDM W/BOLTS/SS	235°	TOP
DRAIN	4	3"	TWO-FLG. FTG. W/FLG. ADAPT./PVC W/GSKT./EPDM W/BOLTS/SS	225°	0'-7"
DRAIN	5	3"	TWO-FLG. FTG. W/FLG. ADAPT. W/SIPHON/PVC W/GSKT./EPDM W/BOLTS/SS	45°	0'-7"



DETAIL "A"--STIFFENER BAND
 SCALE: 1 1/2"=1'-0"

ELEVATIONS ONLY--NOZZLES
 & ACCESSORIES ROTATED INTO
 VIEW--FOR TRUE ORIENTATION
 SEE PLAN VIEW.

- NOTES
1. THIS IS A COMPUTER GENERATED DWG. DO NOT REVISE BY HAND.
 2. COMPUTER DWG. NAME "HJA55WT".
 3. 4 1/2" WIDE MOLDED IN GALLONAGE MARKERS @ APPROX. 15° UP TO 550 GAL. AVOID WHEN PLACING FITTINGS.
 4. DIMENSIONS MAY VARY SLIGHTLY DUE TO VARIATIONS IN MULTIPLE MOLDS.
 5. TANK DESIGNED FOR 1.9 Sp.G. MATERIAL @ 100°F/ATMOSPHERIC PRESSURE.
 6. TAG ALL PAPERWORK: P.O.#1004730.

TANK T-145
 SERVICE: WATER-TANK T-145
 EX. HVY. WALL/NATURAL

DWG. TITLE: 550 GALLON UPRIGHT TANK
 SCALE: 3/4"=1'-0"
 DATE: 5/23/95
 HJA PO# 0491-2
 FOR: OHM REMEDIATION SERVICES

POLY PROCESSING CO.
 -DIVISION OF ABELL CORPORATION-
 DR: M. DENHAM
 CK: D. RECTOR
 SHEET: 1 OF 1
 DVG. NO. PPC052495-1
 REV. C

0225044047

APPENDIX I

SECTION 5

TANK DATA

TANK T - 205 & T - 240

Manufacturer: The George Seelke Co.

Model: 535040 XLPE

Size: 12,500 gallon

Manufacturer

Contact: Deborah Brown

Phone

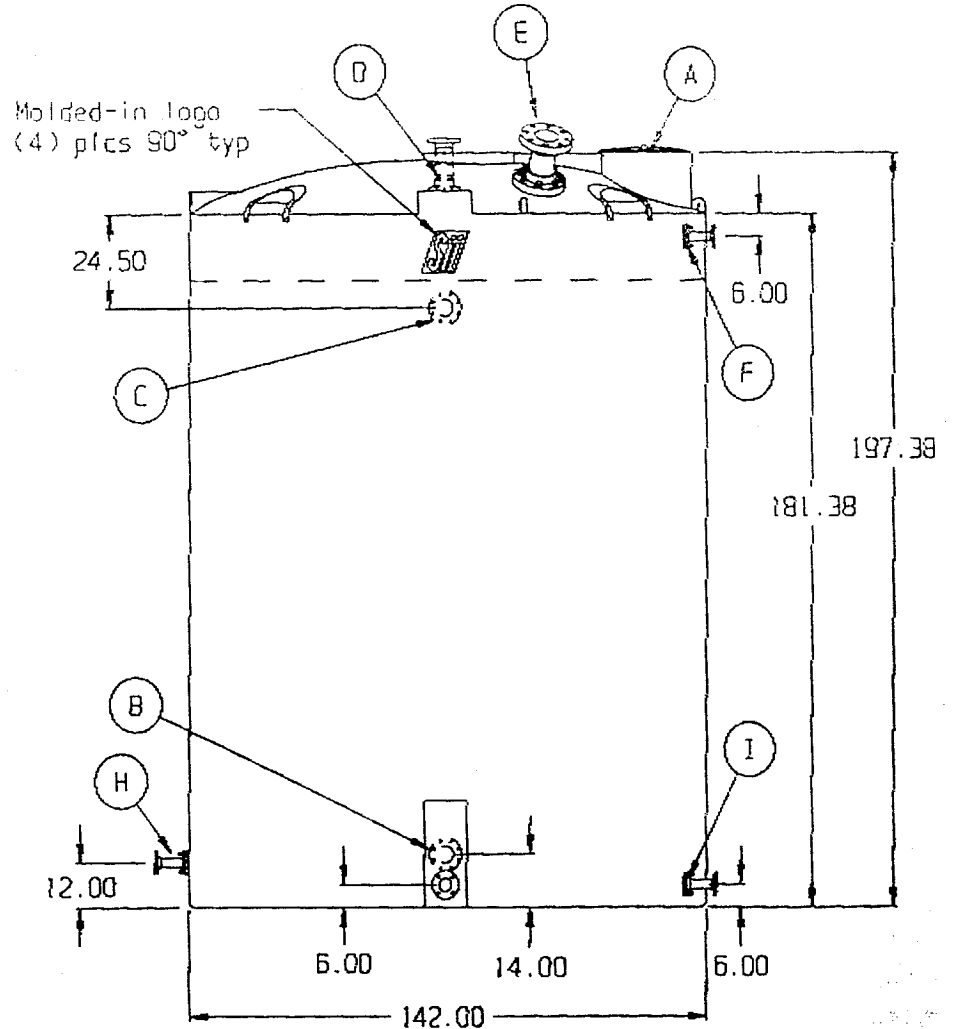
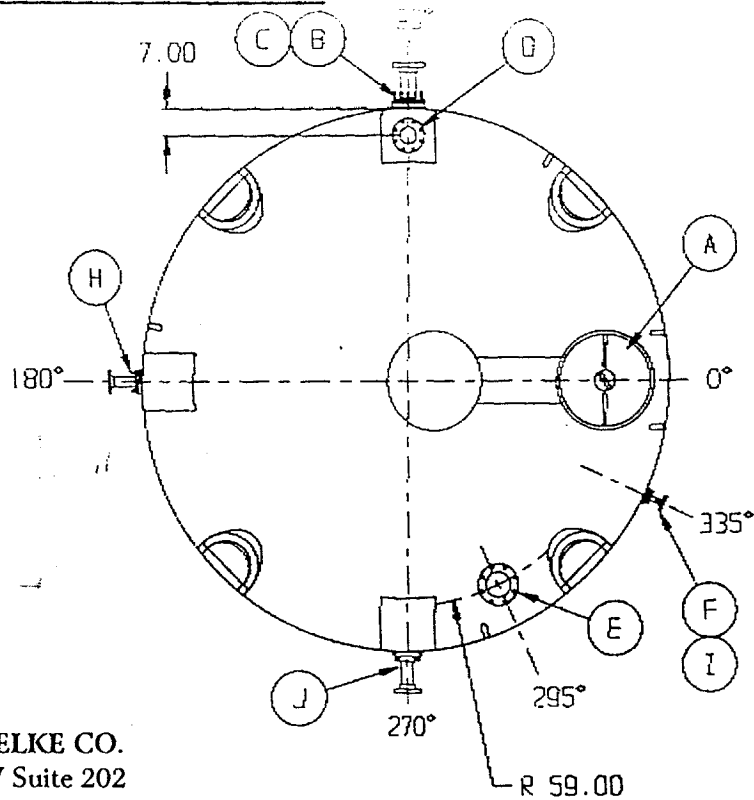
Number: (770) 925-4855

OHM REMEDIATION SERVICES

P.O.# 1004237

TANK T-205

(all dimensions in inches)



THE GEORGE SEELKE CO.
331 Arcado Rd. NW Suite 202
Lilburn, GA 30247-2841
(770)925-4855 (770)925-4869 fax

- A. 24" PE THREADED MANWAY W/22" ACCESS (P/N 347352)
- B. 4" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342076)
- C. 4" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342076)
- D. 4" PVC THREADED BH FTG W/BUNA-N GASKETS & PVC FLANGE ADAPTER (P/Ns 373001 & 347344)
- E. 6" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342077)
- F. 2" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342074)
- H. 2" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342074)
- I. 2" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342074)
- J. 3" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342075)

ALL FITTINGS ARE INSTALLED THEN REMOVED AND REPACKAGED IN ORDER TO ELIMINATE DAMAGE IN SHIPMENT

PART # TANK: 535040
XLPE/NATURAL
1.5 SPGR - ASTM/E
REF# 1121 05/15/

12,500 GALLON FLAT BOTTOM TANK

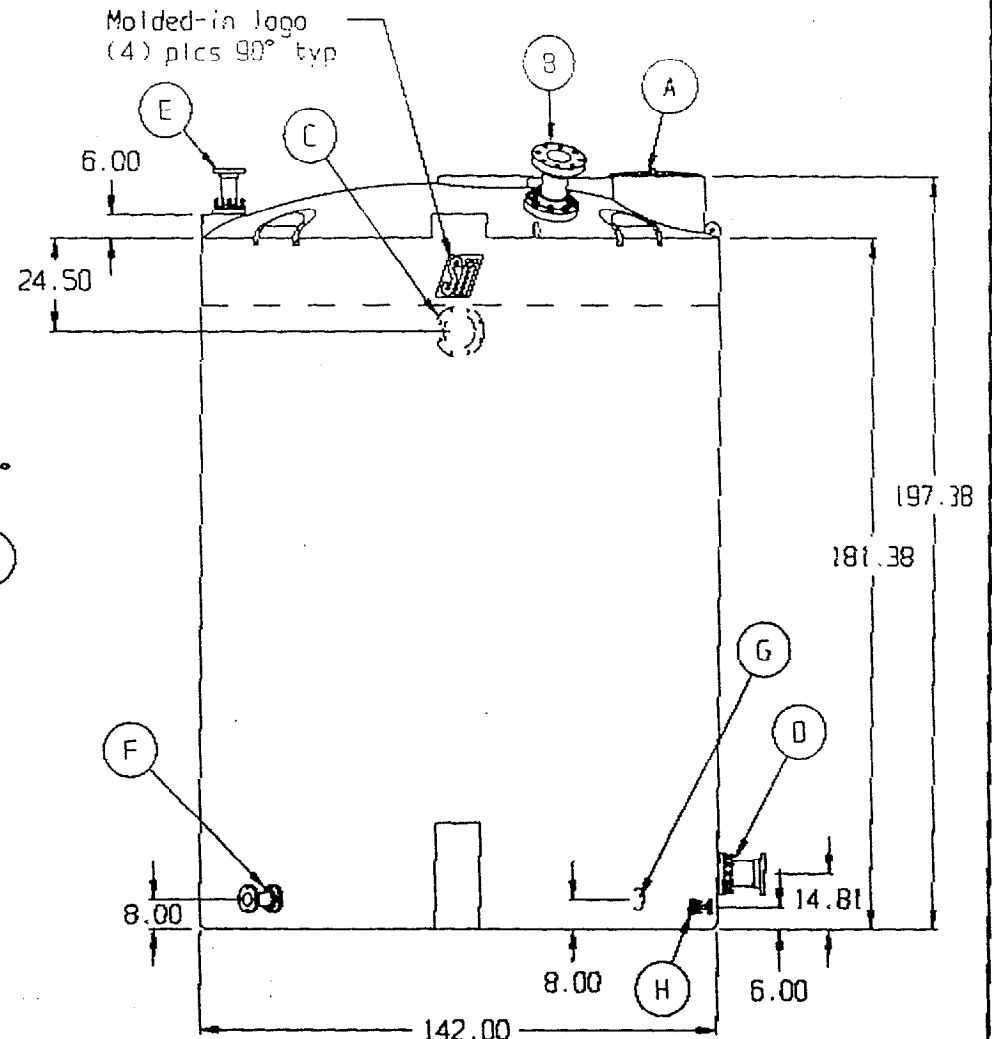
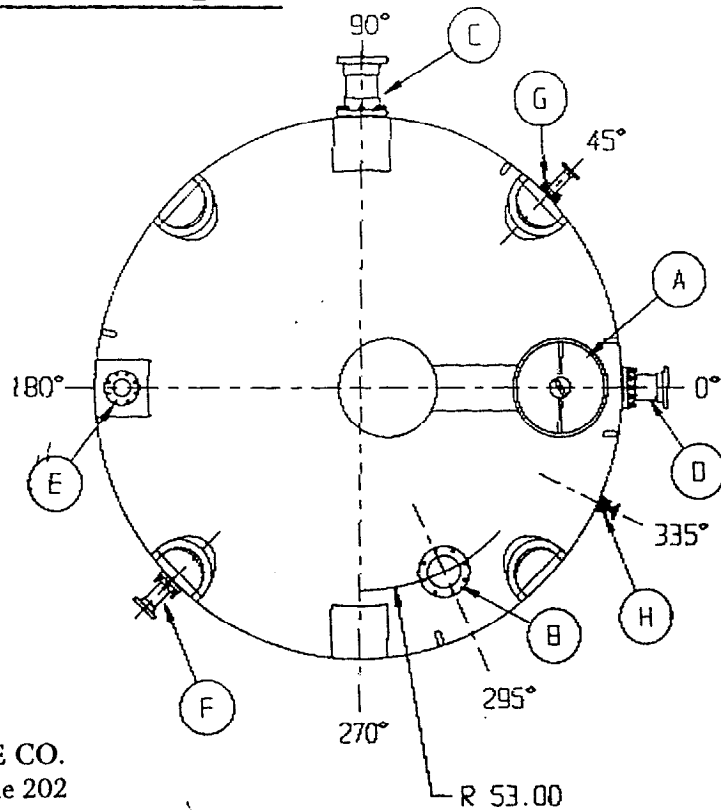
DIN LUBRI INDUSTRIES INC.

OHM REMEDIATION SERVICES

P.O. # 1004237

TANK T-240

(all dimensions in inches)



THE GEORGE SEELKE CO.
 331 Arcado Rd. NW Suite 202
 Lilburn, GA 30247-2841
 770)925-4855 (770)925-4869 fax

- A. 24" PE THREADED MANWAY W/22" ACCESS (P/N 347352)
- B. 8" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 347297)
- C. 8" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 347297)
- D. 6" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342077)
- E. 4" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342076)
- F. 3" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342075)
- G. 2" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342074)
- H. 1" PVC DBL FLANGE, BOLTED FTG W/BUNA-N GASKETS, 316 SS BOLTS, & PVC FLANGE ADAPTER (P/Ns 373001 & 342071)

ALL FITTINGS ARE INSTALLED THEN REMOVED AND REPACKAGED IN ORDER TO ELIMINATE DAMAGE IN SHIPMENT

PART # TANK: 535040
 XLPE/NATURAL

SUNBELT INDUSTRIES, INC.

APPENDIX I

SECTION 6

TANK DATA

TANK T - 211

Manufacturer: Hugo Jahnz & Associates, Inc.

Size: 2000 Gallon Upright Tank

Manufacturer

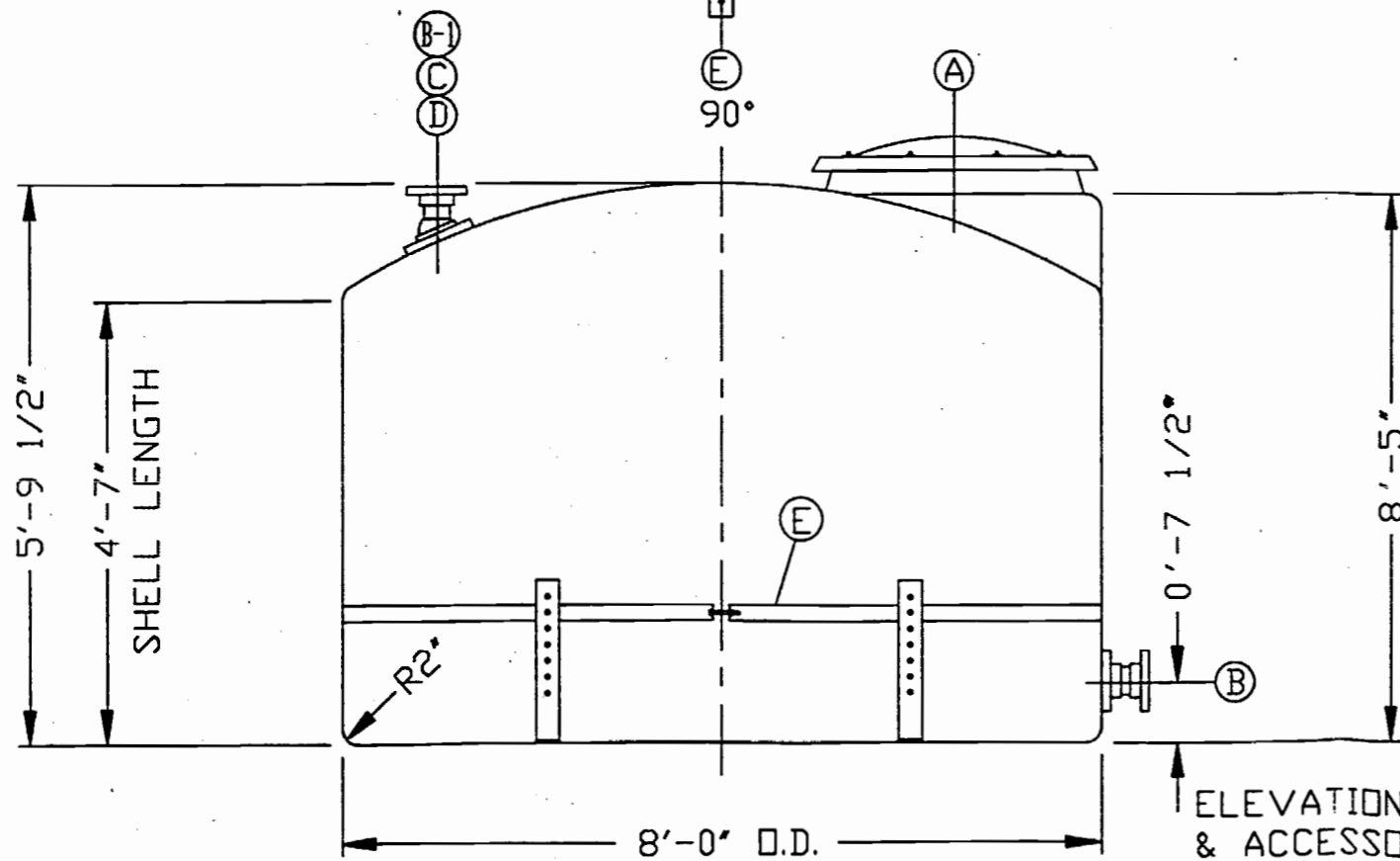
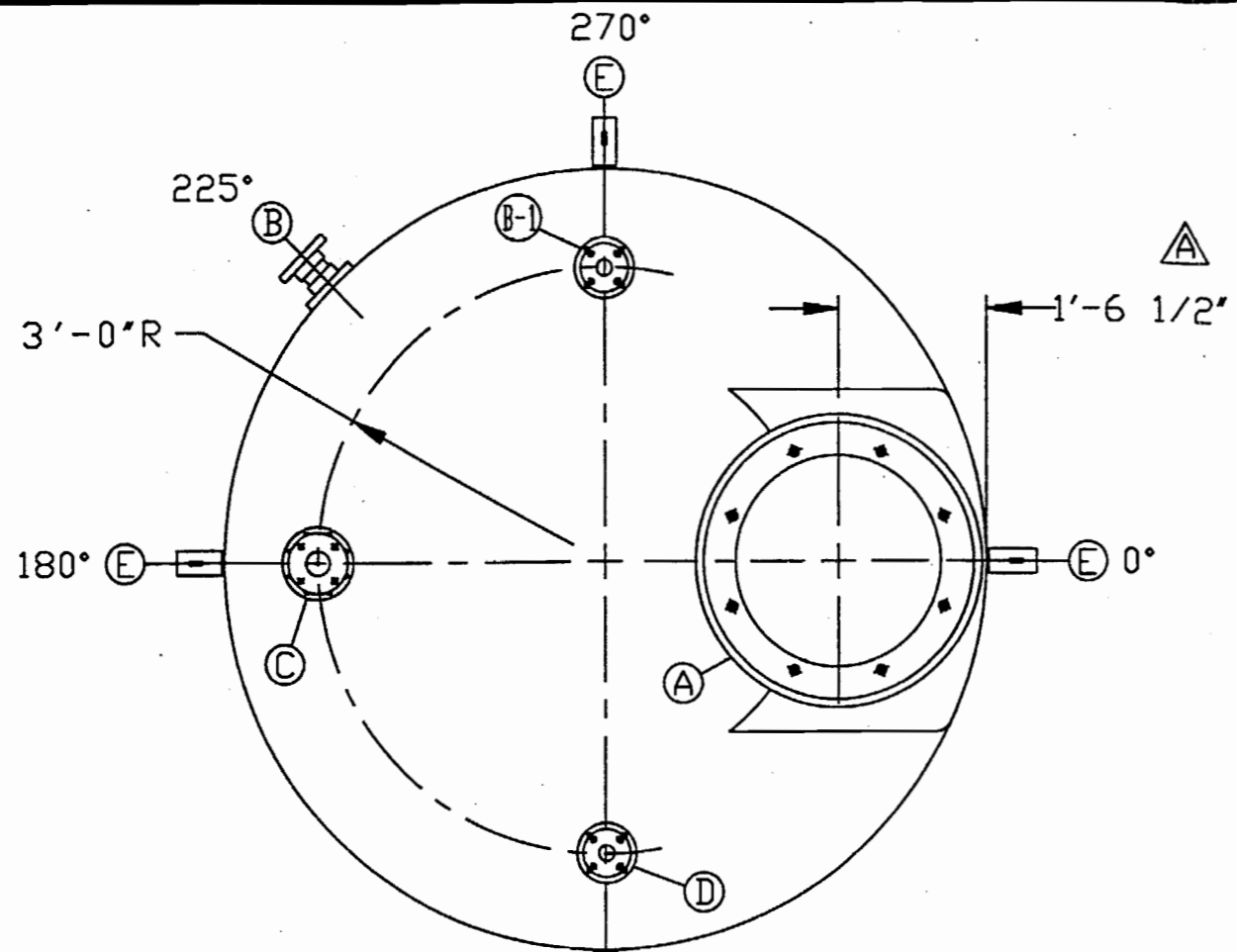
Contact: Mrs. Stacey Posey

Phone

Number: (770) 887-7405

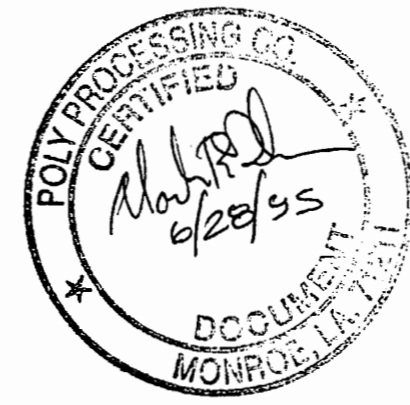
HJA20SA

REV. A GSKT. MAT'L. WAS EPDM BY:M.D. 6/20/95 CK:JY



ELEVATIONS ONLY--NOZZLES & ACCESSORIES ROTATED INTO VIEW--FOR TRUE ORIENTATION SEE PLAN VIEW.

NOZZLE SCHEDULE					
SERVICE	MK	SIZE	FITTING	DEG	ELEV
MANWAY	A	24"	(8)-BOLT COVER W/GSKT./PE	0°	TOP
DRAIN	B	3"	TWO-FLG. FTG. W/FLG. ADAPT./PVC W/GSKT./VITON W/BOLTS/SS	225°	0'-7 1/2"
--	B-1	2"	UNI-BALL DOME FTG. W/FLG. ADAPT./PVC W/GSKT./VITON W/BOLTS/SS	270°	TOP
VENT	C	3"	UNI-BALL DOME FTG. W/FLG. ADAPT./PVC W/GSKT./VITON W/BOLTS/SS	180°	TOP
FILL	D	2"	UNI-BALL DOME FTG. W/FLG. ADAPT./PVC W/GSKT./VITON W/BOLTS/SS	90°	TOP
TIE-DOWN SYSTEM	E	--	USE (4) 72" BANDS W/(4) ANCHOR CLIPS/MS EPOXY COATED	SEE PLAN	SEE ELEV



- NOTES**
1. THIS IS A COMPUTER GENERATED DWG. DO NOT REVISE BY HAND.
 2. COMPUTER DWG. NAME "HJA20SA".
 3. DIMENSIONS MAY VARY SLIGHTLY DUE TO VARIATIONS IN MULTIPLE MOLDS.
 4. 5" WIDE MOLDED IN GALLONAGE MARKERS @ APPROX. 12° STARTING @ 100 GAL. IN 200 GAL. INCREMENTS UP TO 1900 GAL. AVOID WHEN PLACING FITTINGS.
 5. TANK DESIGNED FOR 1.9 Sp.G. MATERIAL @ 100°F/ATMOSPHERIC PRESSURE.
 6. TANK TO BE HYDROTESTED.
 7. TAG ALL PAPERWORK: P.D.#1004730.

TANK T-211	
SERVICE: 93% SULFURIC ACID EX. HVY. WALL/NATURAL	
DWG. TITLE: 2000 GALLON UPRIGHT TANK	
SCALE: 1/2"=1'-0"	POLY PROCESSING CO. -DIVISION OF ABELL CORPORATION-
DATE: 8-11-92	
HJA PO# 0554	DR. M. DENHAM
FOR: OHM REDEIATION SERVICES	CK. D. RECTOR
SHEET: 1 OF 1	DWG. NO. PPC052495-3 A
REV.	

APPENDIX I

SECTION 7

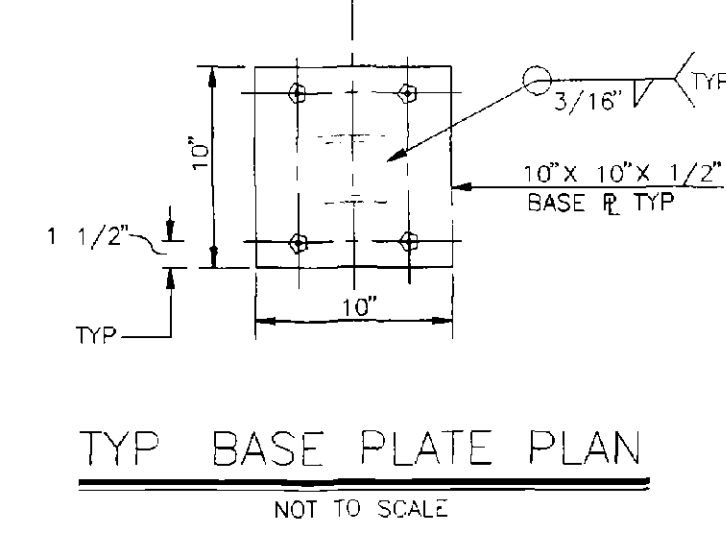
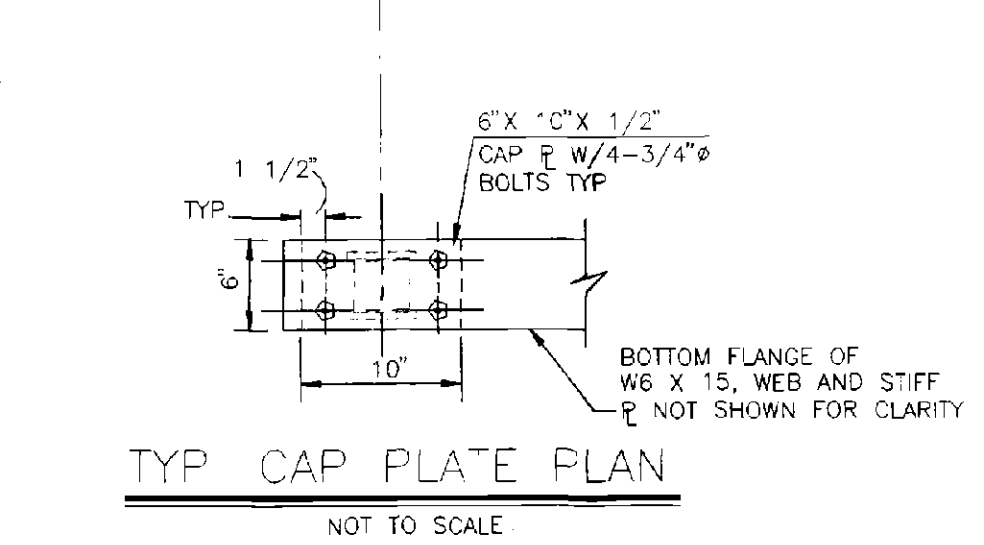
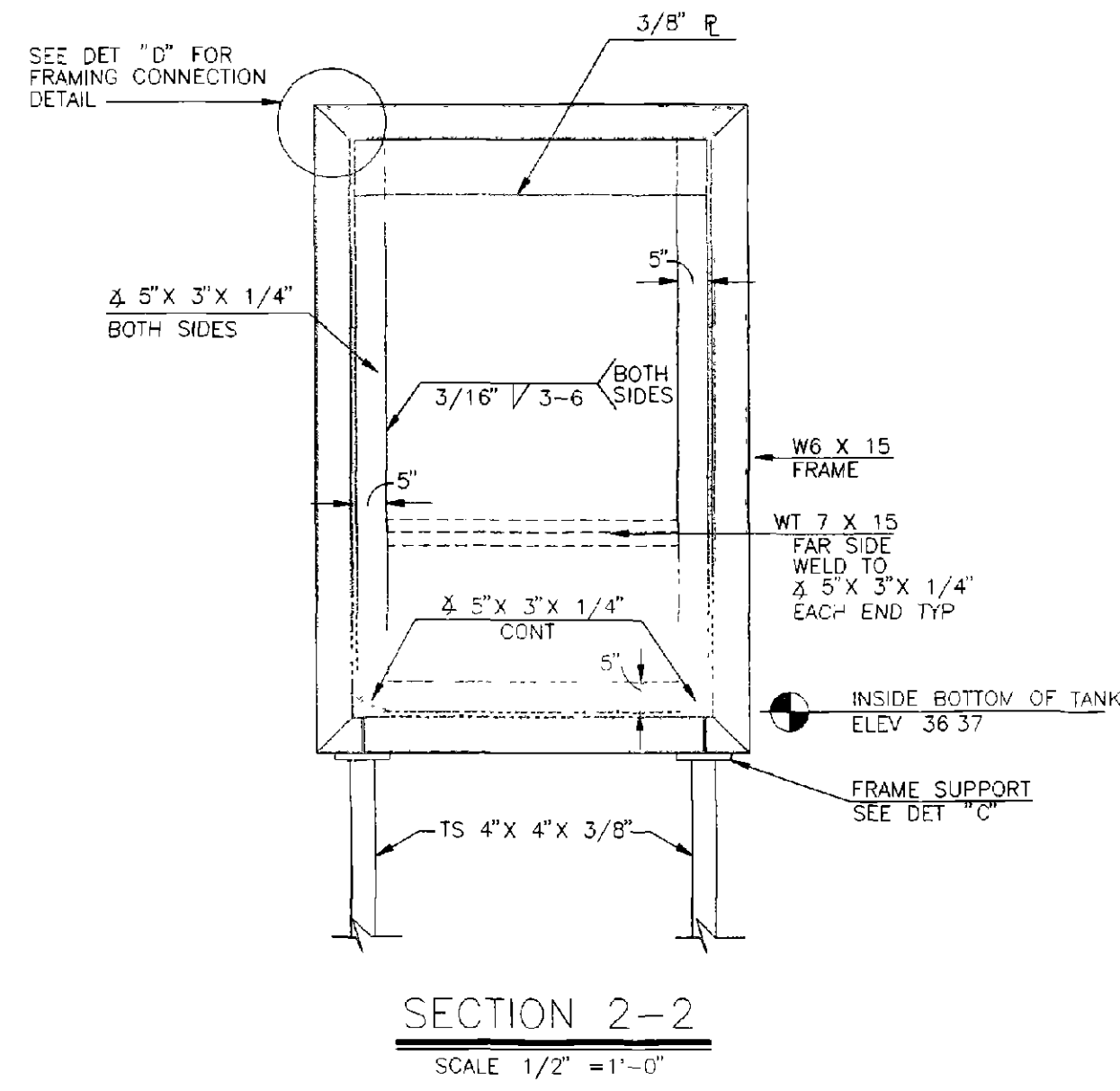
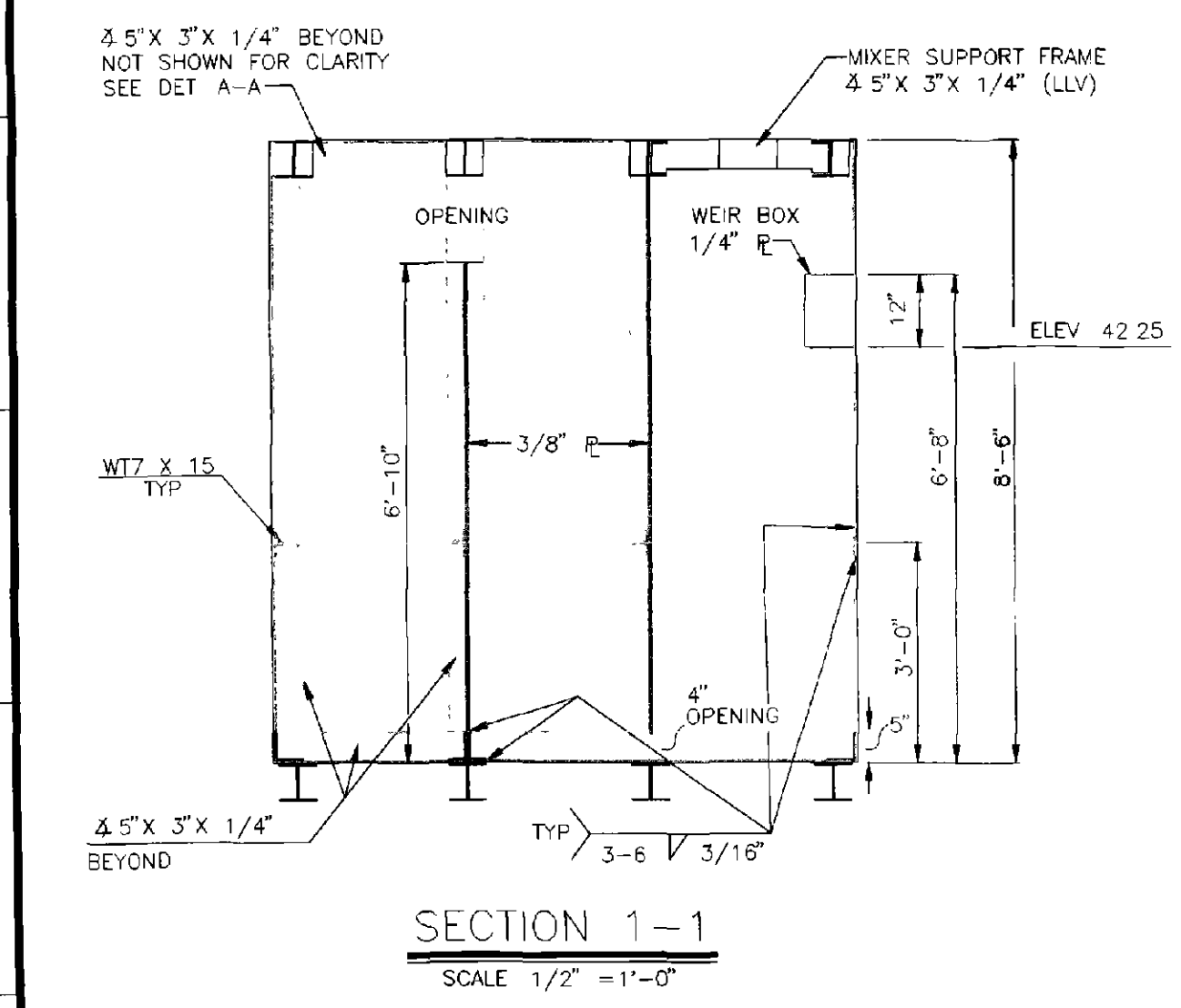
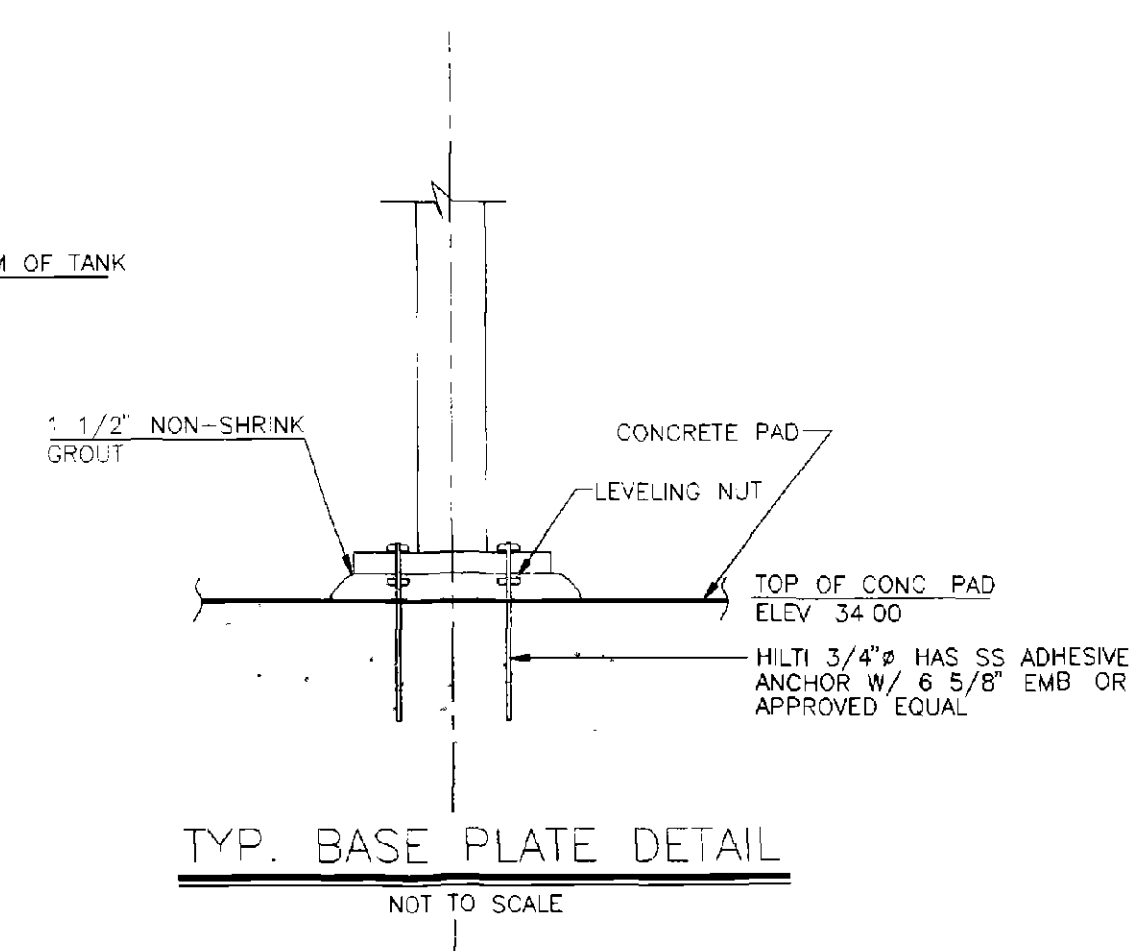
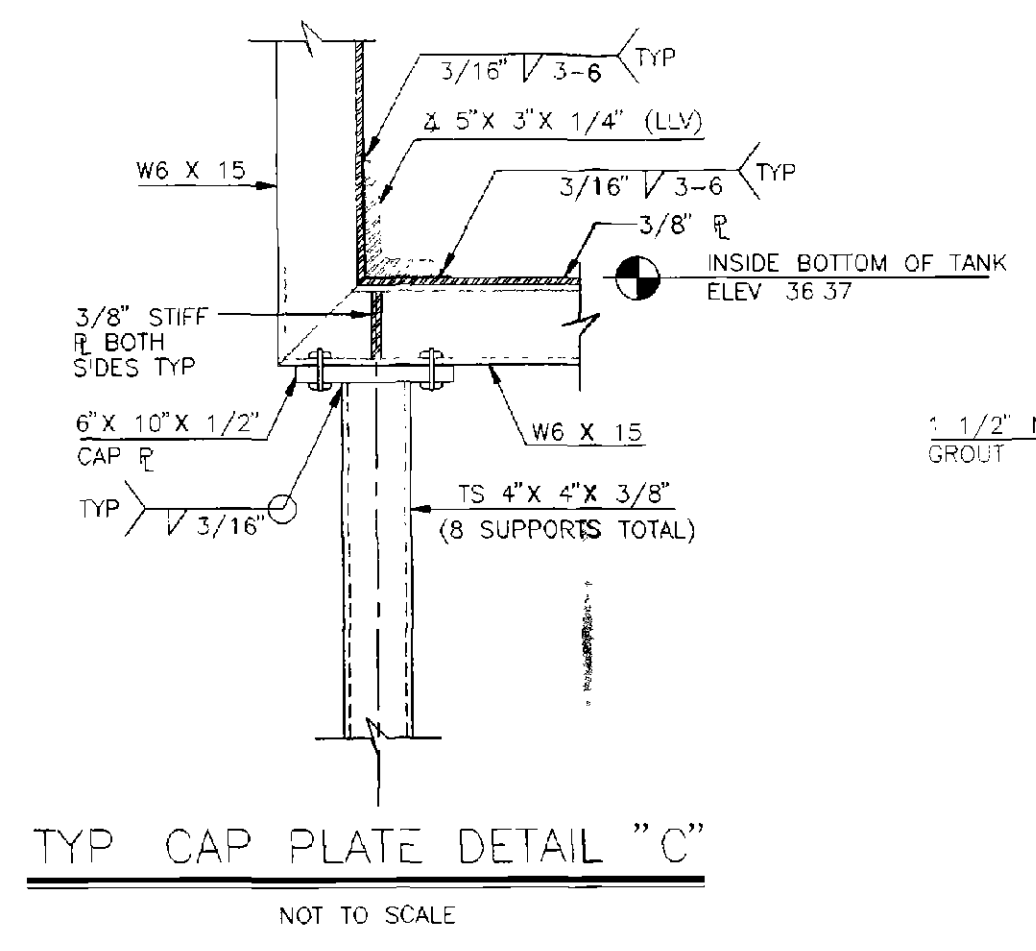
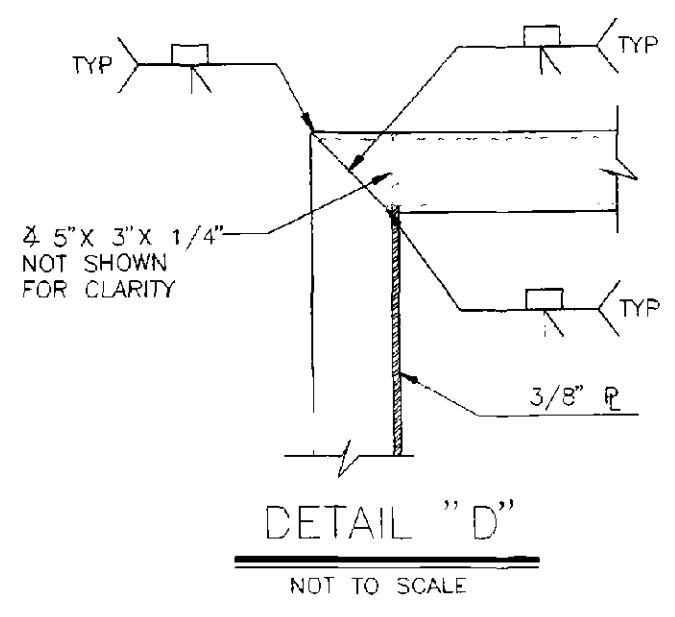
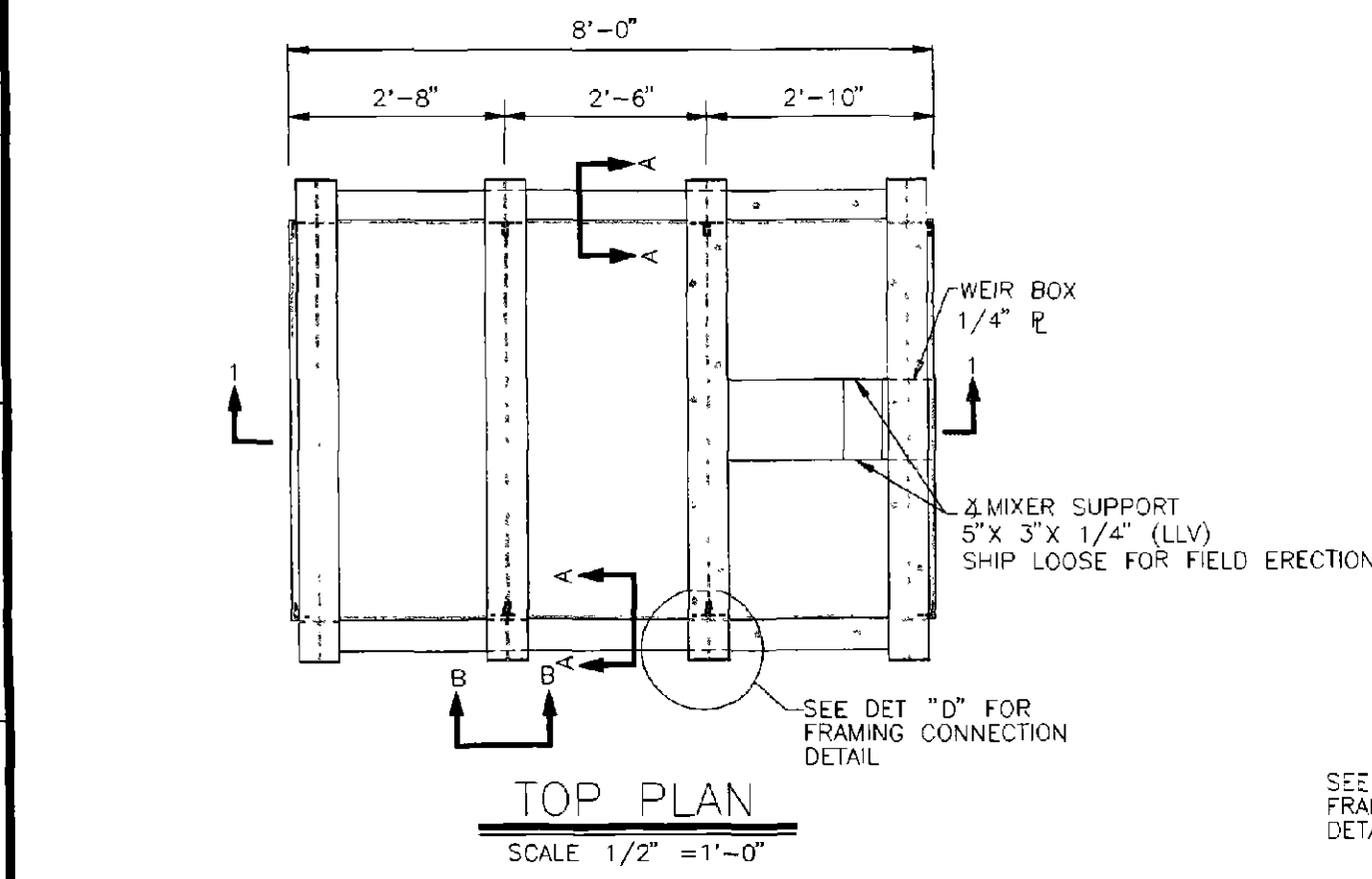
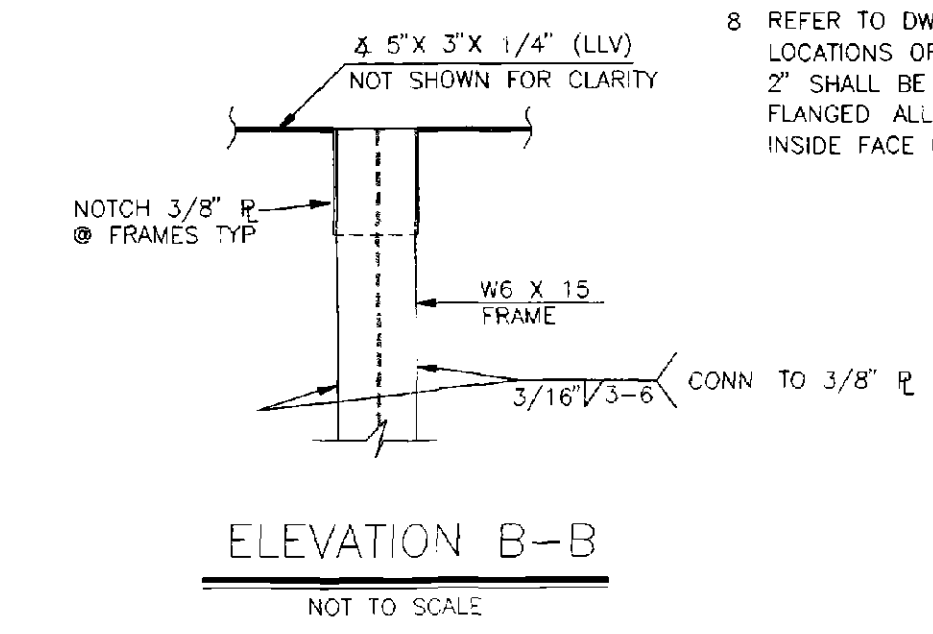
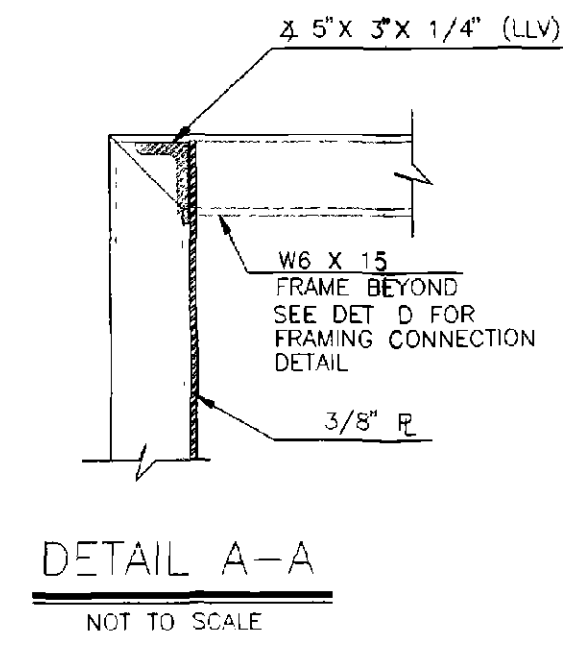
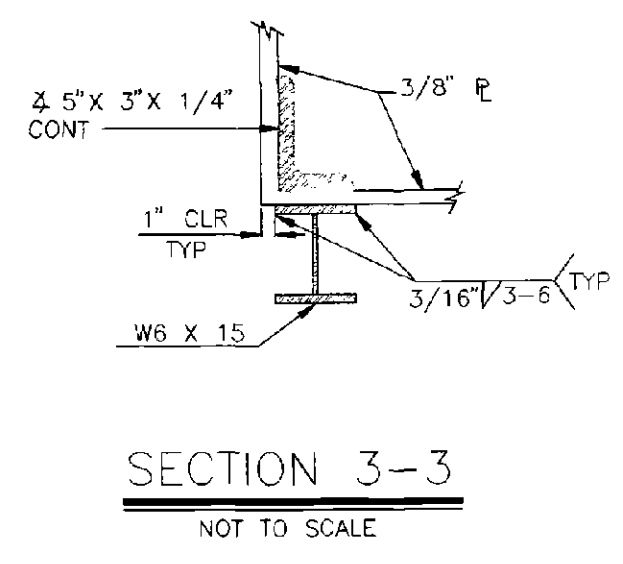
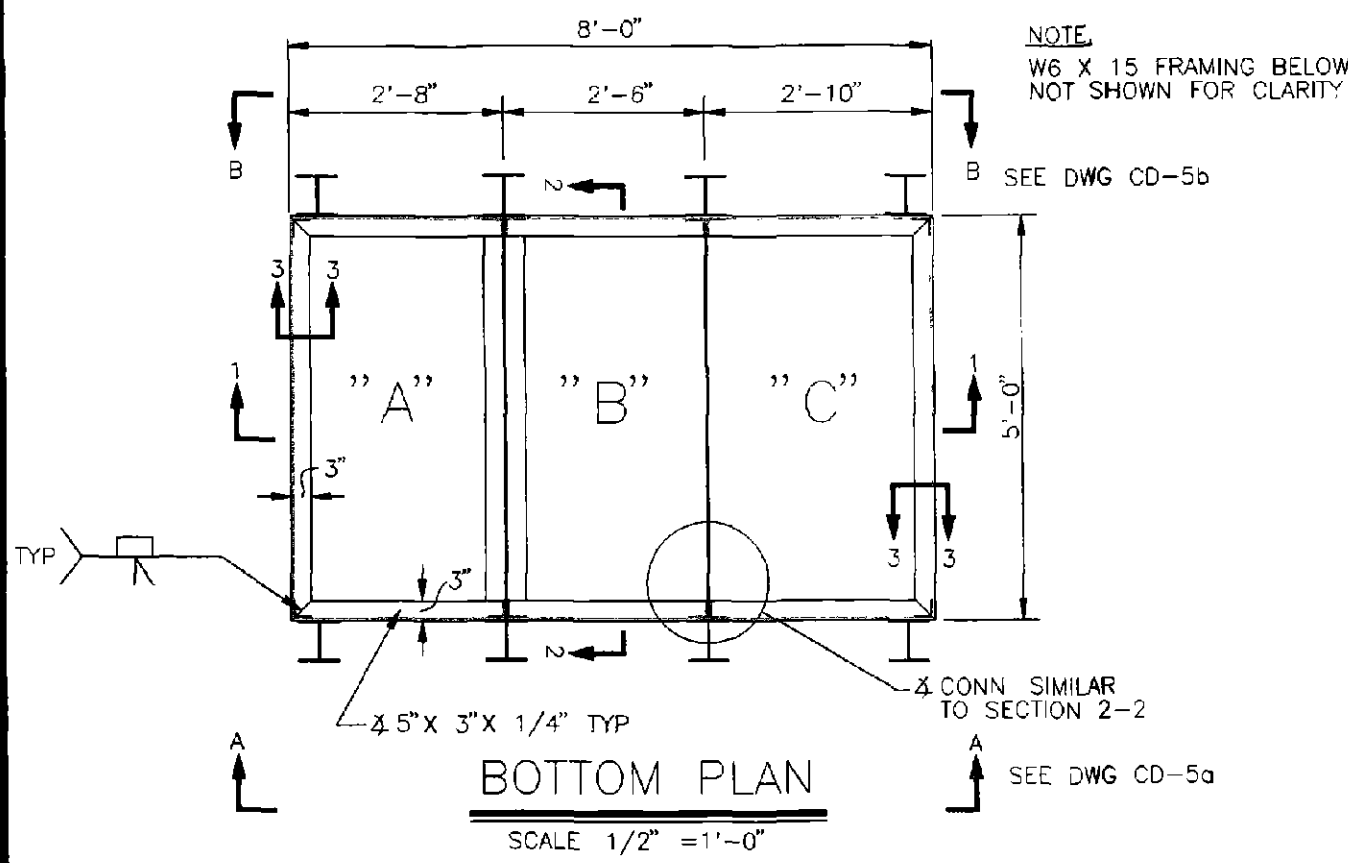
THREE CHAMBER MIX TANK (INFLUENT BOX), X-130

&

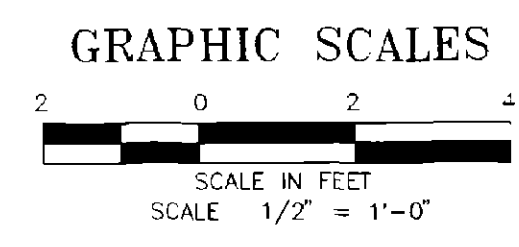
AIR DIFFUSERS

GENERAL NOTES:

- 1 STEEL CONSTRUCTION SHALL CONFORM TO THE SPECIFICATION AND CODES OF THE AISC CONSTRUCTION MANUAL, NINTH EDITION
- 2 ALL STRUCTURAL SHAPES, BARS, PLATES, AND SHEETS SHALL BE ASTM A-36 STEEL
- 3 ALL BOLTS SHALL BE A325 BOLTS WITH THREADS EXCLUDED FROM THE SHEAR PLANE(S) BOLTS SHALL BE HOT DIPPED GALVANIZED UNO
- 4 WELDING SHALL CONFORM TO AWS CODE FOR ARC AND GAS WELDING IN BUILDING CONSTRUCTION WELDER SHALL BE CERTIFIED ALL WELDS SHALL BE E70
- 5 STEEL SHALL BE PAINTED IN ACCORDANCE WITH THE SPECIFICATION
- 6 PROVIDE 1" WIDE X 1/4" THICK BAR WELDED TO 3/8" PLATE AT PIPE PENETRATION LOCATIONS
- 7 LEAK TEST SHALL BE PER SPECIFICATION
- 8 REFER TO DWG CD-5a AND CD-5b FOR HORIZONTAL AND VERTICAL LOCATIONS OF ALL PIPE PENETRATIONS ALL PIPE CONNECTIONS BELOW 2" SHALL BE NPT ALL PIPE CONNECTIONS ABOVE 2" SHALL BE 150# FLANGED ALL FLANGE SHALL BE 4" FROM OUTSIDE OF TANK WALL TO INSIDE FACE OF FLANGE



NOTE:
PROVIDE PRE-DRILLED HOLES FOR 5/8" BOLTS @ 18" O.C. FOR THE PLEXIGLASS COVER W/ GASKET SEAL OWNER TO FURNISH PLEXIGLASS COVER



OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED _____ PROJECT MANAGER _____ DATE _____
APPROVED _____ SR PROJECT ENGINEER _____ DATE _____
APPROVED _____ DEPT MANAGER _____ DATE _____

REVISIONS						
ZONE	REV	DESCRIPTION	BY	DATE	APP	
	1	ISSUE FOR REVIEW & APPROVAL	OHM	4/21/95		

THE INFORMATION OR DATA CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY AND THE PROPERTY OF OHM REMEDIATION SERVICE CORP (OHM), AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY PRIOR WRITTEN CONSENT OF OHM. COPYRIGHT © OHM REMEDIATION SERVICES CORP., 1994

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION NORFOLK, VIRGINIA

LANTDIV RAC CONTRACT N82470-93-D-3032 DELIVERY ORDER NO 0015

OPERABLE UNIT NO 2 MARINE CORPS BASE, CAMP LEJEUNE, N C

MECHANICAL

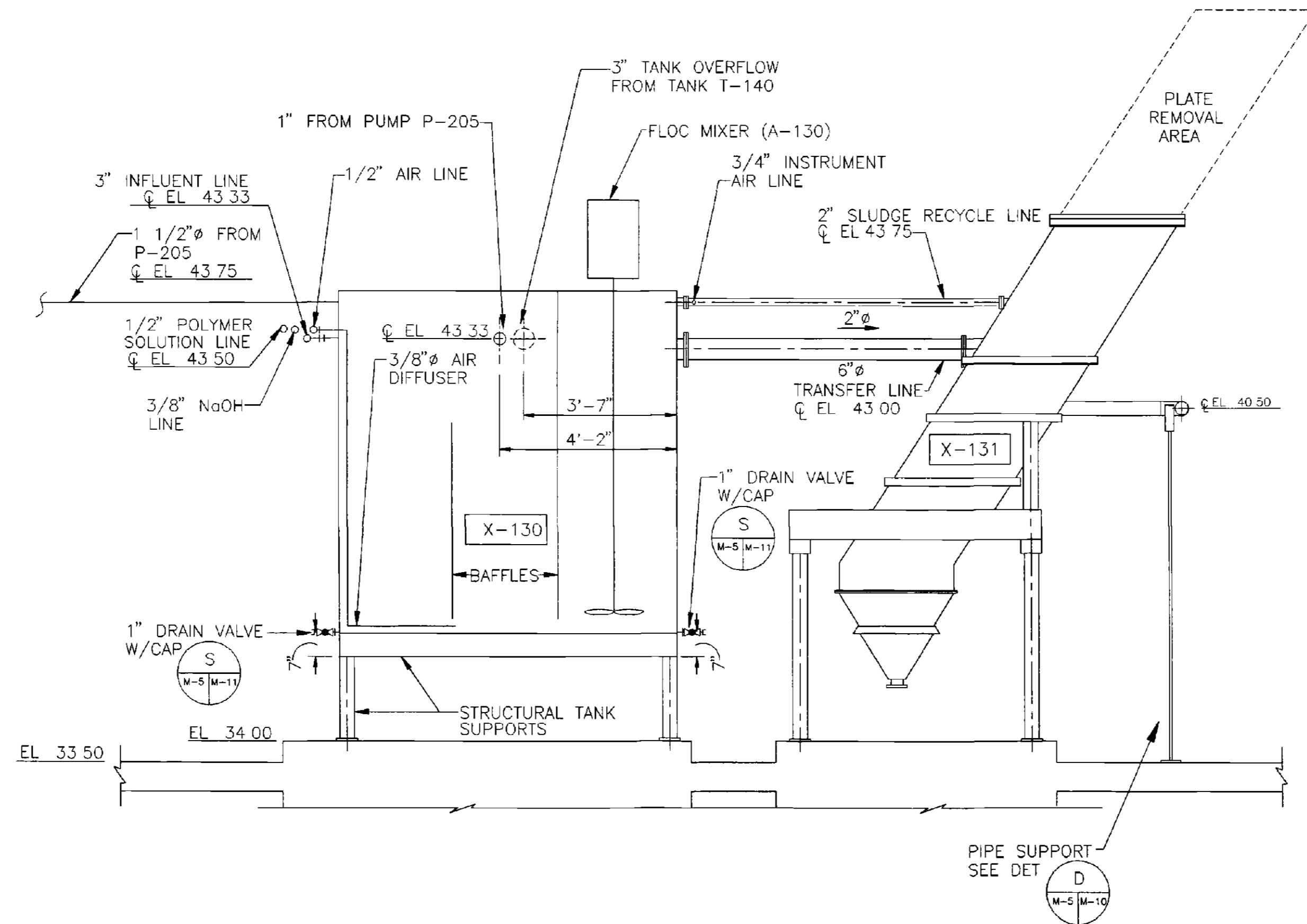
INFLUENT BOX & DETAILS

DRAWING NUMBER
CD-5

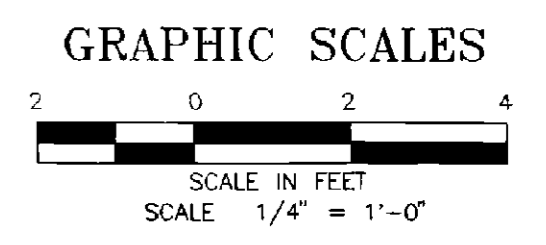
SHEET NUMBER
1 OF 1

DATE
4 2 95

02350HH BIX



MECHANICAL PIPING VIEW A-A



OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED _____ DATE _____
PROJECT MANAGER

APPROVED _____ DATE _____
SR PROJECT ENGINEER

APPROVED _____ DATE _____
DEPT MANAGER

AT FULL SCALE
(IF NOT 2" = SCALE ACCORDINGLY)

CADD FILE CD-5a DWG

DRAWN J. COLLINS

DESIGNED B. MATTHEWS

CHECKED _____

CHECKED _____

REVISIONS					
ZONE	REV	DESCRIPTION	BY	DATE	APP

THE INFORMATION OR DATA CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY AND THE PROPERTY OF OHM REMEDIATION SERVICE CORP (OHM), AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY PRIOR WRITTEN CONSENT OF OHM, COPYRIGHT © OHM REMEDIATION SERVICES CORP, 1994

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION NORFOLK, VIRGINIA

LANTDIV RAC CONTRACT N62470-93-D-3032 DELIVERY ORDER NO 0015

OPERABLE UNIT NO 2 MARINE CORPS BASE, CAMP LEJEUNE, N.C.

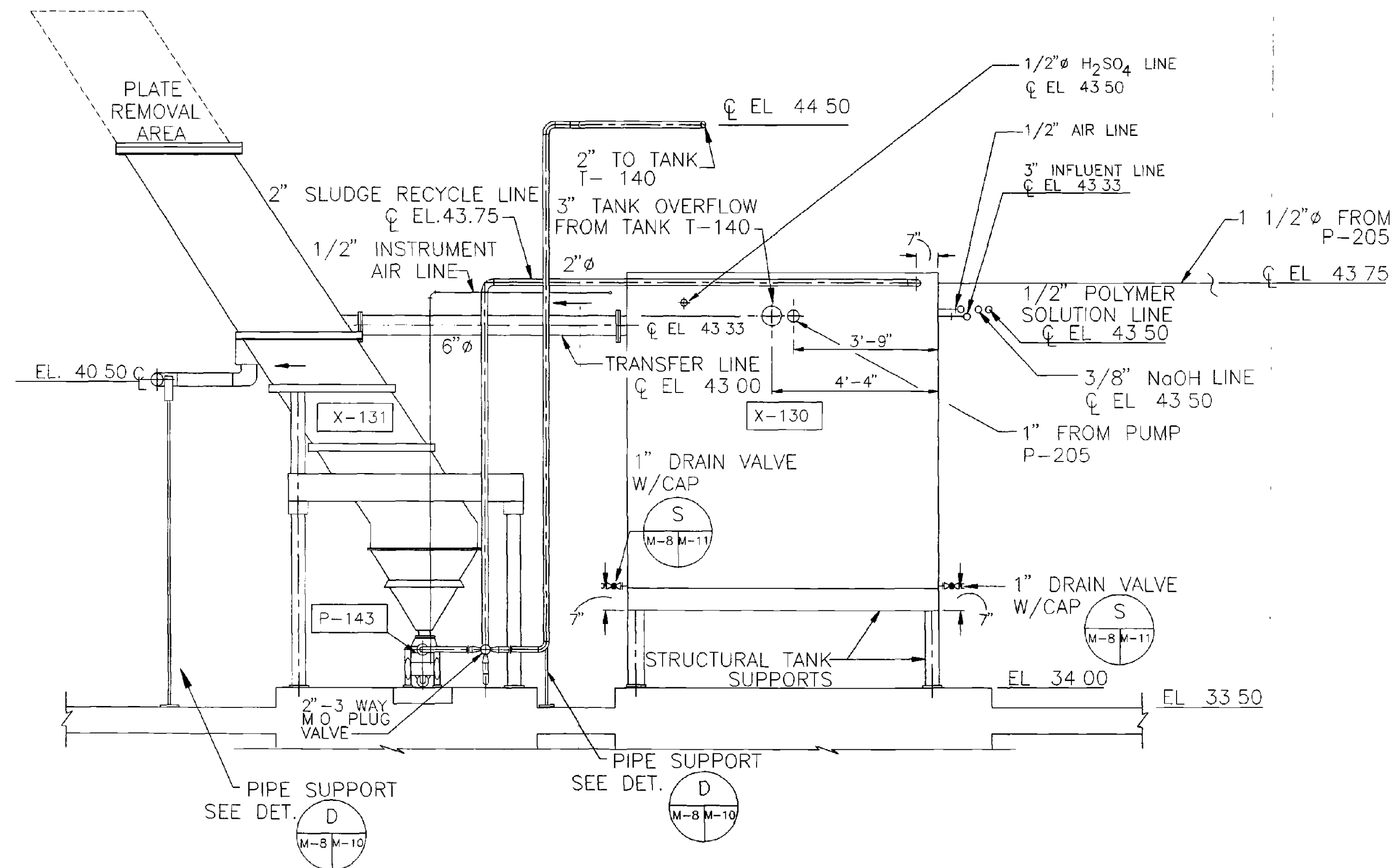
MECHANICAL

TANK SECTION

DRAWING NUMBER
CD-5a

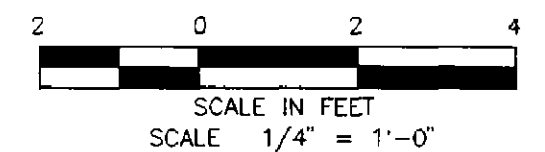
SHEET NUMBER
_ of _

DATE
4/21/95



MECHANICAL PIPING VIEW B-B

GRAPHIC SCALES



OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED _____ PROJECT MANAGER _____ DATE _____
APPROVED _____ SR PROJECT ENGINEER _____ DATE _____
APPROVED _____ DEPT MANAGER _____ DATE _____

AT FULL SCALE
(IF NOT 2" SCALE ACCORDINGLY)
CADD FILE CD-5b DWG
DRAWN J COLLINS
DESIGNED _____
CHECKED _____
CHECKED _____

REVISIONS					
ZONE	REV	DESCRIPTION	BY	DATE	APP
	1	ISSUE FOR REVIEW & APPROVAL	OHM	4/21/95	

THE INFORMATION OR DATA CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY AND THE PROPERTY OF OHM REMEDIATION SERVICE CORP (OHM), AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY PRIOR WRITTEN CONSENT OF OHM. COPYRIGHT © OHM REMEDIATION SERVICES CORP, 1994

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION NORFOLK, VIRGINIA
LANTDIV RAC CONTRACT N62470-93-D-3032 DELIVERY ORDER NO 0015
OPERABLE UNIT NO. 2 MARINE CORPS BASE, CAMP LEJEUNE, N.C.

MECHANICAL
TANK SECTION

DRAWING NUMBER
CD-5b
SHEET NUMBER
_ of _
DATE
4/21/95

A B C D E F G H I J K L M N O P

**DIFFUSED AERATION
PRODUCTS**

TABLE OF CONTENTS

FineAir Specification	FD Spec Form A
FineAir Disk Drawing	FAD-100
I. Unloading & Storage Instructions	FD-1040
II. Installation Instructions	FD-1021
III. Assembly Instructions	FD-1023
IV. Start-Up Procedures	FD-1024
V. Operating Procedures	FD-1025
VI. Basin Shut-Down Procedures	FD-1026
VII. Start-Up Procedures Following an Unplanned Interruption	FD-1027
VIII. Troubleshooting	FD-1028
IX. Cleaning Procedures	FD-1029

**DIFFUSED AERATION
PRODUCTS****FINEAIR CERAMIC DISK DIFFUSER SPECIFICATION**

Each air diffuser assembly shall incorporate a porous ceramic diffuser element, a flow control device, provisions for connection to the diffuser holder installed on the air distribution header piping, and a rubber gasket to effect the required sealing.

The diffuser element shall be composed of crystalline fused alumina (aluminum oxide) with a suitable ceramic bonding material. The individual alumina grains shall be thoroughly joined together with the bonding material to form a strong, uniformly porous and otherwise flat, homogeneous structure. It shall be disk shaped, nominally 9 inches in diameter and 3/4 inches thick.

A threaded PVC retaining nut approximately 10 inches in diameter shall hold the diffuser element in place. Diffuser element gaskets shall be formed from channel rubber to completely enclose the outer edge of the diffuser element. This shall create a seal between the diffuser and the holder and a second seal between the diffuser and the retaining nut. Diffuser element gaskets shall be suitable for withstanding the action of the wastewater.

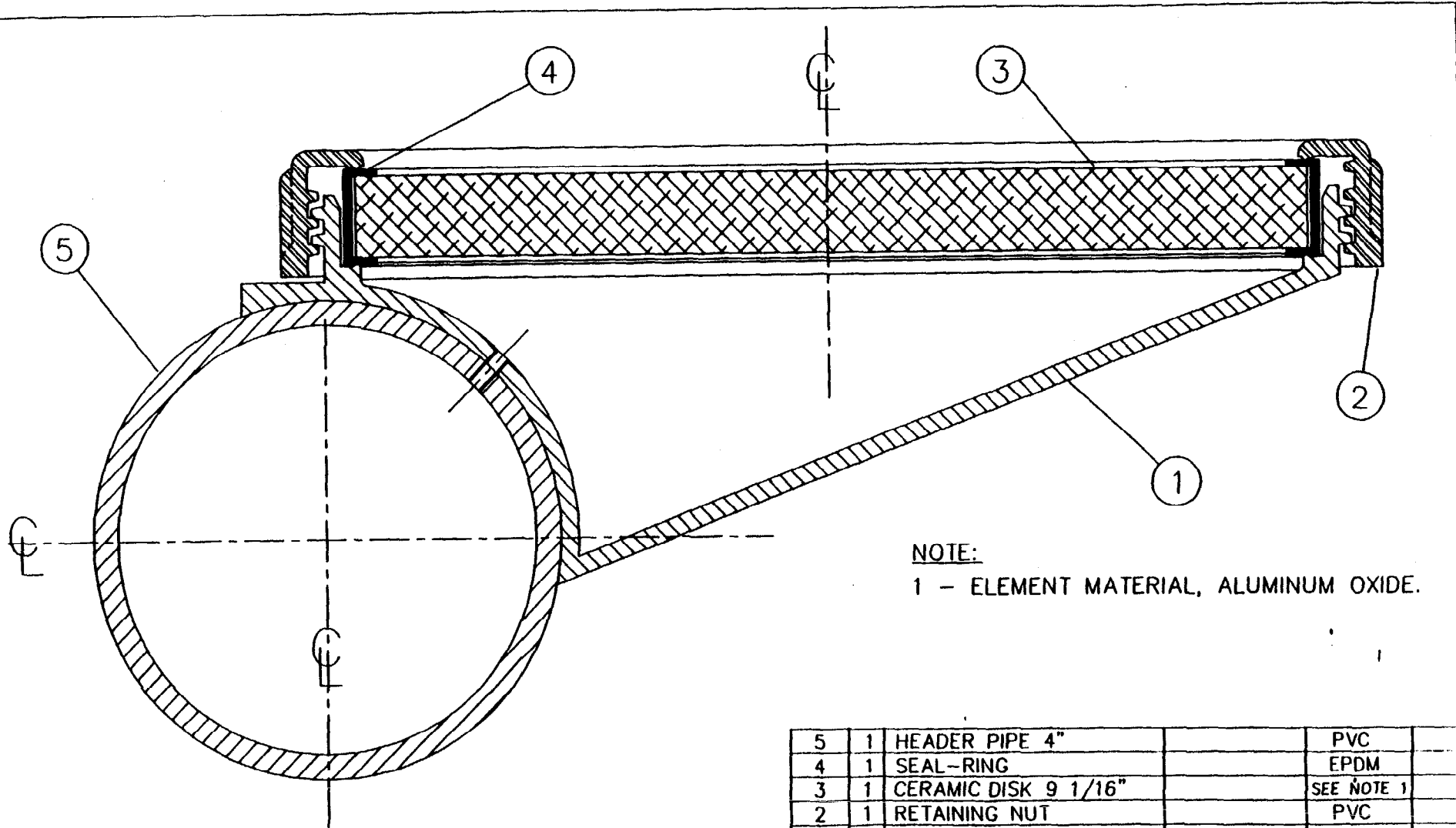
Each diffuser holder (saddle) shall be molded from PVC and shall have an integral control orifice sized to give minimum headloss while assuring proper distribution. The orifice shall be straight through design to facilitate cleaning. The air release of the orifice shall be designed such that the air entering the diffuser assembly shall be distributed evenly under the horizontal surface of the diffuser element.

Each diffuser consists of:

- One (1) - Diffuser element composed of bonded crystalline aluminum oxide formed into a 9" disk
- One (1) - Diffuser element holder (saddle) solvent welded onto a 4-1/2 inch diameter PVC pipe
- One (1) - PVC threaded retaining nut
- One (1) - Diffuser element channel rubber gasket

The diffuser components shall be factory inspected and shipped for assembly by the customer.


This drawing and all appurtenant matter contains information proprietary to PARKSON CORPORATION and is intended for use only upon demand and must not be reproduced, copied, loaned, revealed, nor used for any purpose other than that for which it is specifically furnished without expressed written consent of PARKSON CORPORATION.



ASSEMBLY
SECTIONAL VIEW

NOTE:
1 - ELEMENT MATERIAL, ALUMINUM OXIDE.

Item No.	Qty.	Description	Reference	Material
5	1	HEADER PIPE 4"		PVC
4	1	SEAL-RING		EPDM
3	1	CERAMIC DISK 9 1/16"		SEE NOTE 1
2	1	RETAINING NUT		PVC
1	1	DISK SADDLE		"

Parkson CORPORATION  <small>A SUBSIDIARY OF A. JOHNSON & CO. INC.</small>	FINE AIR CERAMIC DISK DIFFUSER	Drawn: G.E.G. 3-08-90 Scale: NONE	Checked: _____ Approved: _____
		Drw. No. FAD - 100	Rev. _____

REV.	DESCRIPTION	By/date	Ckd/date

DIFFUSED AERATION PRODUCTS

FD-1040

FINEAIR CERAMIC DISK DIFFUSER SYSTEM

UNLOADING & STORAGE INSTRUCTIONS

Upon receipt of aeration equipment from Parkson Corporation, the following instructions should be followed. Any damage or inconsistencies found in the equipment due to handling or storage not conducted as outlined below shall be the liability of the receiver.

*NOTE:

NOTIFICATION OF EQUIPMENT LOST OR DAMAGED IN TRANSIT IS THE RESPONSIBILITY OF THE RECEIVER AND MUST BE NOTED ON THE SHIPPING PAPERS AT THE TIME OF ACCEPTANCE OF THE LOAD. PARKSON CORPORATION MUST BE NOTIFIED OF ERRORS OR SHORTAGES IN SHIPMENT WITHIN 14 DAYS OF RECEIPT OF THE SHIPMENT. SHORTAGE CLAIMS WILL NOT BE ACCEPTED WITHOUT PROPER NOTIFICATION. NO RETURNS WILL BE ACCEPTED WITHOUT WRITTEN AUTHORITY.

DISK DIFFUSERS:

The diffuser sealing gaskets are placed on the disks at the factory. The disks are then packed in cardboard boxes, 14 to a box. These boxes are then loaded onto a skid. A full skid with up to 45 boxes can weigh 2500 lbs. The skids should be stored in a clean and dry environment. If stored outside, cover the skids to prevent water from attacking the packing material.

PVC GRID PIPING:

The PVC diffuser holders are installed on the PVC grid piping at the factory. This piping is packaged in crates suitable for shipping and storage providing certain storage precautions are taken:

1. In warm climates the piping must be adequately supported at all times. Improper storage can result in pipe deformation making it difficult to attain a level installation.

UNLOADING & STORAGE INSTRUCTIONS

Page 2 of 2

2. In cold climates (temperatures below 36°F) PVC becomes brittle and is subject to fracture and breakage due to a lowered impact resistance.
3. The header pipes should be stored on a level flat surface. They should NOT be stored in piles.
4. Protect the piping from the elements. Do not store it in a dirty environment or direct sunlight. Prolonged, direct sunlight can cause the pipe to become brittle.

The PVC diffuser retaining nuts are shipped in a separate crate with the piping.

STAINLESS STEEL PIPING:

The stainless piping is shipped in individual pieces and should be handled as such. Although not as susceptible to bending, care should be taken not to dent or crush the pipe.

Stainless steel pipe should not be blocked or transported with carbon steel materials. Any area of abrasion on stainless steel pipe by carbon steel or other similar metals should be wire brushed by a stainless steel brush before installation.

EXPANSION JOINTS:

The PVC compression couplings and tees are shipped assembled without the O-rings. This is to protect the O-rings from harsh environmental conditions until they are ready for installation.

ACCESSORIES:

All pipe supports, gaskets, nuts, bolts, and other accessories are shipped wrapped or boxed and strapped on pallets. The boxes are cardboard and susceptible to deterioration when exposed to weather elements, and should be covered for protection. All boxes of accessories are numbered and can be referenced directly to the packing slip.

MOP/na

3/90

G:/TEMP/FD-1040

DIFFUSED AERATION PRODUCTS

FD-1021

FINEAIR CERAMIC DISK DIFFUSER SYSTEM

INSTALLATION INSTRUCTION

Proper installation of the piping system and diffusers is critical to attain the desired plant efficiency. The elevation of all the diffusers must be within $\pm 1/4"$.

Review all of the plans, drawings and instructions associated with the system before attempting installation.

1. Clean the walls and floor of the basin for installation.
2. Remove any existing equipment which will not be part of the new system.
3. Inspect and inventory the equipment to be installed.
4. Locate and mark the centerlines of the piping manifold and grid runs. Beginning from the drop pipe locate the pipe supports.
5. Install manifold pipe supports and bottom pipe support clamps. Adjust all pipe supports to hold the pipe at the same elevation.
6. Install grid run manifolds cleaning them inside as they are installed. (Note the instructions for the designated pipe couplings.)
7. Locate, mark and install the grid run diffuser pipe (Header) supports. Adjust all pipe supports to hold the diffusers at the same elevation.
8. Clean and install the grid run diffuser piping. Adjust the piping rotationally so the saddles are level from one side to the other. Ensure that the pipe support positions do not interfere with the disk saddles. There must be a pipe support at each expansion coupling and at the midspan.

9. Secure pipe by installing the top support clamp.
10. Clean out the piping using the high velocity air blow-down procedure.
 - A. This method requires approximately three times the normal design airflow for effective cleaning.
 - B. The piping nearest the blower should be cleaned first. Ensure that the valves are adjusted to blow-down the appropriate section.
 - C. Remove one screw-on compression cap at a time from each corner of the grid. Blow-down the riser, manifold and grid piping one-quarter of each grid at a time. Replace the end cap when finished.
11. Install the Fineair Disk Diffuser.

DIFFUSED AERATION PRODUCTS

FINEAIR CERAMIC DISK DIFFUSER SYSTEM

DISK DIFFUSER ASSEMBLY INSTRUCTION

1. Inspect the PVC disk holder attached to the grid (Header) pipe. Make sure there are no foreign materials present and that the sealing surface is clean.
2. Inspect the control orifice to make sure it is clean and free of any obstructions.
3. Inspect the ceramic disk to be installed to make sure it is free of any chips or cracks.
4. Inspect the sealing gasket around the disk to make sure it is not torn, and that the entire square edge of the disk is enclosed by the gasket.
5. Place the disk and gasket assembly into the disk holder on the pipe.
6. Inspect a PVC retaining nut to make sure it is clean and undamaged.
7. Place the nut on the disk holder and rotate it clockwise until tight.

NOTE: Should it become necessary to shut-down a diffuser system and leave it inoperative for an extended period, remove the disk and gasket assembly. Then replace the retaining nut to prevent thread damage. Also, plug the orifice in the disk holder to prevent fouling.

MOP
g:/temp/FD-1023
3/90

DIFFUSED AERATION PRODUCTS

FD-1024

FINEAIR CERAMIC DISK DIFFUSER SYSTEM

START-UP PROCEDURES

NOTE: CERAMIC DISK DIFFUSERS SHOULD NOT BE ALLOWED TO SIT SUBMERGED IN PROCESS WATER WITHOUT AIR FLOW THROUGH THE DIFFUSERS.

1. The aeration basin to be put into service should be inspected. The basin should be cleaned of all installation equipment, piping and any other articles which are not part of the aeration system. All aeration piping should be purged of all dust and foreign matter by the high velocity air blow-down procedure described in the Installation Instructions.
2. Open the moisture blow-off assembly for every aeration diffuser grid system in the basin.
3. Inspect the blower(s) to be put into service. The air filtration system should be new or recently cleaned and properly installed. Start the blower and adjust the air supply to allow between 0.5 and 1.0 SCFM of airflow per disk.
4. Begin filling the basin with clean water making sure that the water is not allowed to fall onto any of the systems components. When the water level reaches the top of the pipe stop the filling process and inspect the system to make sure all of the diffusers are level with the water.
5. Continue filling the basin until the diffusers are submerged by approximately 2 to 4 inches of water. Observe the aeration pattern created by the disks for the following:
 - a. uneven distribution
 - b. coarse bubbling
 - c. disks that aren't bubbling

Should any of these conditions be observed, refer to the section on Troubleshooting.

6. Inspect the tubing for the pressure monitoring system. Air should be flowing freely from the tubing and all of the connections should be secure.
7. Fill the basin with process water carefully blending the process streams to prevent foaming. Maintain air flow as the water depth increases.
8. When the water reaches the operating level the moisture blow-off valves may be closed.
9. Adjust the air flow rates as to attain the desired dissolved oxygen concentrations or so that the air flow is no less than 0.5 SCFM/DISK. At air flow less than 0.5 SCFM/DISK uneven distribution may result. At air flow rates greater than 3.0 SCFM/DISK, headloss becomes an important consideration.
10. Take the pressure monitoring tube for the disk holder tap and plug it. This will keep air flowing through the disk and prevent any solids from settling on it.

MOP/na
3/90
G:/TEMP/FD-1024

DIFFUSED AERATION PRODUCTS

FD-1025

FINEAIR CERAMIC DISK DIFFUSER SYSTEM

OPERATING PROCEDURES

For proper systems operation it is necessary to monitor and keep records of the aeration systems conditions.

1. The air flow rate should be adjusted to maintain the desired dissolved oxygen concentration or at a minimum of 0.5 SCFM/DISK. The rate is controlled by throttling the valves on the feed pipe to each grid. The proper operating range is 0.5-3.0 SCFM/DISK.
2. The system pressure should be measured as soon as the basin is put into service. At this time, the diffusers headloss and operating conditions should be at their optimum. All subsequent pressure readings should be taken with the plant at the same water depth and air flow rate. These readings will be compared to the initial ones to evaluate the aeration system performance.
3. The system should be put through a procedure called "Air Bumping" once a week. To do this the air flow rate to the disks is raised to 3.0 SCFM/DISK. This rate is maintained for approximately one-half hour and returned to normal.
4. Each moisture blow-off valve should be opened on a routine basis. This is to check for the collection of moisture due to condensation in the system.
5. Regular observations of the aeration pattern on the surface of the basin should be made. The surface should be surveyed for uniformity of air bubble size and any signs of course bubbling.

MOP/na
3/90
G:/TEMP/FD-1025

DIFFUSED AERATION
PRODUCTS

FD-1026

FINEAIR CERAMIC DISK DIFFUSER SYSTEM

BASIN SHUT-DOWN PROCEDURES

NOTE: THE CERAMIC DISK DIFFUSER SHOULD NOT BE ALLOWED TO SIT SUBMERGED IN PROCESS WATER WITHOUT AIR FLOW THROUGH THE DIFFUSER.

1. Open each moisture blow-off valve. Purge any water which may have accumulated in the system due to condensation or by any other means. Close the valve.
2. Begin removing water from the basin by the most convenient and efficient method available. As the water level decreases, the air flow may be decreased but maintain a positive air flow at all times. The basin walls should be hosed off as they become exposed.
3. The draining process should be stopped momentarily to inspect the system when the water level is approximately 6 inches above the diffuser. Note any areas in the system which show signs of coarse bubbling or improper distribution of air.
4. Continue to drain the basin. As the diffusers become exposed hose them off to remove any scum or debris which may have accumulated. The air flow may be shut off once the water level is below the diffusers.

Note: IT IS IMPORTANT TO SCHEDULE THE BASIN DRAINING TIME PROPERLY. IF THE DIFFUSERS ARE NOT HOSED OFF SOON AFTER EXPOSURE TO AIR THE SUBSTANCES ON THEM CAN DRY AND MAY REQUIRE MORE ELABORATE AND LABOR INTENSIVE METHODS OF CLEANING.

CARE SHOULD ALSO BE TAKEN SO AS NOT TO ALLOW WATER TRAPPED IN THE CERAMIC MATERIAL TO FREEZE.

5. Clean off the aeration piping and basin floor with a medium pressure hose. The basin is now ready to be worked in.
6. If the basin is to be taken out of service for a significant period of time it will be necessary to protect the equipment from prolonged exposure to direct sunlight. Fill the basin with clean water until the piping is submerged to a depth of at least six feet.

MOP/na
3/90
G:/TEMP/FD-1026

DIFFUSED AERATION PRODUCTS

FD-1027

FINEAIR CERAMIC DISK DIFFUSER SYSTEM

START-UP PROCEDURES FOLLOWING AN UNPLANNED INTERRUPTION

Ceramic disk diffusers should not be allowed to sit submerged in process water without air flow through the disk. This situation could allow unfiltered liquid to enter the system resulting in internal disk fouling. Should air flow be lost for more than a few minutes the following procedure should be performed to reduce the possibility of this type of damage.

1. Close the main air supply valve to the system.
2. Re-start the air supply as soon as possible.
3. Open all the moisture blow-off valves to all the grids in the basin.
4. Slowly increase the airflow to the system from 0-3.0 SCFM/DISK over a period of about 10 minutes. A sudden increase in pressure will create a water surge in the system.
5. Monitor the moisture blow-off valves. When the fluid discharge from the valve discontinues it may be closed.
6. Operate the system at higher than average air flow rates (1.5-3.0 SCFM/DISK) for a period of several hours.
7. After several hours recheck the moisture blow-off valves for any residual drainage.
8. Return the system to normal operating conditions.

MOP/na
3/90
G:/TEMP/FD-1027

DIFFUSED AERATION PRODUCTS

FD-1028

FINEAIR CERAMIC DISK DIFFUSER SYSTEM

TROUBLESHOOTING

This section (including FD-1028 & FD-1028A) contains descriptions of conditions which may occur in a diffused aeration system. The suggested remedy for each condition may not be the only available course of action due to the individuality of each system. Should you choose to apply a method not suggested please inquire as to the effectiveness of the method.

Call: Parkson Corporation
Aeration Products Division
2727 N.W. 62nd Street
Ft. Lauderdale, FL 33309
(305) 974-6610

- OR -

Your local representative.

MOP/na
Rev. 12/16/92 WBC
G:/TEMP/FD-1028
attach: FD-1028A

CERAMIC DISK DIFFUSER SYSTEM

TROUBLESHOOTING

<u>CONDITION</u>	<u>PROBABLE CAUSE</u>	<u>ACTION</u>
Disk coarse bubbling	Disk not sealing against retaining nut and holder	Remove disk and examine the holder and retaining nut surfaces. They should be smooth and free of any pits, cracks, or cuts. Clean the surfaces of any debris and replace the disk.
	Disk chipped or cracked Gasket torn or cut	Remove disk and examine. Replace if necessary. Remove gasket and examine. Replace if necessary.
Coupling coarse bubbling	Coupling not secured properly	Tighten coupling. If bubbling persists, remove coupling and examine sealing device (O-rings, etc.) Replace device if necessary. Assemble coupling according to instructions.

CERAMIC DISK DIFFUSER SYSTEM

TROUBLESHOOTING

<u>CONDITION</u>	<u>PROBABLE CAUSE</u>	<u>ACTION</u>
Uneven air distribution	Some disks have absorbed more fluid than others	Close off air supply to system for six or seven seconds. Quickly re-open the air supply. Repeat if necessary.
No air from disks	Insufficient air flow	Take air flow and system pressure measurements. Increase air flow.
	Disk elevation is incorrect	If this is the case, the disks immediately next to this one on the same pipe will not be functioning either. Raise the disk until it is the same elevation as the rest of the system.
	Orifice between pipe and saddle is clogged	Remove disk. Probe the orifice with a small diameter rod approximately 1 foot in length to remove any foreign matter. When air flow resumes, replace disk.
	Disk has absorbed some fluid	Tap the disk lightly, wetted disks do not pass air as readily as dry ones.

CERAMIC DISK DIFFUSER SYSTEM

TROUBLESHOOTING

<u>CONDITION</u>	<u>PROBABLE CAUSE</u>	<u>ACTION</u>
No air from disk	Disk is fouled	Refer to section FD-1029, Ceramic Disk Cleaning.
Reduced airflow with increased pressure	Air side fouling due to improper air filtration	Inspect the blower air filtration system. Clean and/or replace filters. Increase frequency of scheduled maintenance. Disks will need to be removed and cleaned or gas cleaned.
	Air-side fouling due to solids in distribution system	Open moisture blow-off and sample any fluid which emerges. If a large quantity of fluid high in solids appears there is probable a leak in the system. Look for any signs of coarse bubbling on the basin surface. The disk will need to be removed and cleaned or gas cleaned. The piping end caps should be removed and the piping inspected and flushed out if necessary.

DIFFUSED AERATION PRODUCTS

FD-1029

FINEAIR CERAMIC DISK DIFFUSER SYSTEM

CERAMIC DISK CLEANING PROCEDURES

Ceramic disk diffuser systems lose efficiency with time. A condition known as fouling occurs due to high water hardness, sliming or repeated on/off cycling of the aeration system. Materials collect and adhere to the surface of the disk causing an increase in headloss resulting in a decrease in the air flow. Fouling can also occur internally due to improper maintenance and operation of the air filtration system.

In the event that the disks do become fouled, it will be necessary to clean them. The method employed to clean the disks should be determined by the severity of their condition. Several disks from different areas of the basin should be removed and inspected to determine which method should be used.

1. High Pressure Water Washing:

This cleaning method is effective for the removal of the organic growths and slime which contribute to water side disk fouling. The basin must be drained to expose the disks so they can be cleaned in place. A high pressure stream of water (approximately 80 psi) is directed at the disks surface to wash off any attached growth. The average cleaning time for each disk depends on the extent of this growth and can vary from 10 to 60 seconds per disk. This procedure should be conducted every 6 to 12 months.

2. Acid Solution Disk Cleaning:

This cleaning method is effective for the removal of deposits on the disk caused by inorganic precipitants. These deposits create an increase in system headloss and are caused by water hardness and industrial wastes.

PAGE 1 OF 3

- a). All surface fouling must be removed with a high pressure hose as in the above technique.
- b). Apply approximately 50 milliliters of a 50% solution of industrial grade muriatic acid directly to the diffuser surface. Allow 5 to 10 seconds for the application of the acid to each disk. This may be done with a hand operated sprayer.

WARNING: MURIATIC ACID IS A DANGEROUS CHEMICAL AND PROPER PRECAUTIONS SHOULD BE TAKEN WHEN IT IS IN USE. ALL PERSONNEL WHO MAY COME IN CONTACT WITH THE SOLUTION MUST WEAR PROTECTIVE CLOTHING. FULL RUBBER RAIN GEAR INCLUDING BOOTS, PANTS, JACKET AND GLOVES AND A FACE SHIELD ARE REQUIRED. THE WORK AREA SHOULD BE PROPERLY VENTILATED TO PREVENT THE BUILD-UP OF ANY FUMES. A SAFETY MAN SHOULD STAND BY AT THE TOP OF THE BASIN WITH A PERSONAL AIR SUPPLY SYSTEM. APPROXIMATELY 3 TO 4 INCHES OF WATER SHOULD COVER THE BASIN FLOOR TO PROTECT IT FROM ANY ACID SPILLAGE.

Allow the acid to soak in the disks for approximately 30 minutes.

- c). Evacuate all personnel from the basin. Turn on the air supply and adjust the airflow to 1 SCFM per disk. Aerate the disks with the acid solution for approximately 10 minutes. This forces the acid from the disk and creates agitation to aid in the removal of the precipitants.
- d). With the air supply running hose the acid from the disks. This should be done from the top of the basin.
- e). Finally, clean the diffusers with a high pressure nozzle at close range for approximately 5 to 10 seconds each.

This procedure will return the disks to a nearly new condition with respect to appearance and headloss. It should be performed every 18 to 24 months or as the system conditions dictate.

3. HCL Gas Cleaning:

This cleaning method is effective for the removal of deposits caused by chemical precipitants and the destruction of biological foulants. It is not necessary to drain the basin or remove the diffusers. There is very little labor involved and the plant processes are not significantly interrupted.

WARNING: HCL GAS IS AN EXTREMELY CORROSIVE AND TOXIC SUBSTANCE. ALL PLANT PERSONNEL MUST READ AND FULLY UNDERSTAND THE MANUFACTURER'S MATERIAL SAFETY DATA SHEET AND HANDLING INSTRUCTIONS BEFORE ANY HCL GAS EQUIPMENT IS OPERATED AT A FACILITY.

- a). Open the moisture blow-off valve and purge the aeration grid of any moisture which may have accumulated in the system. Close the valve when moisture stops.
- b). Connect the pressure monitoring panel and determine the diffuser headloss according to the pressure monitoring panel instructions.
- c). Put on all required safety equipment.
- d). Carefully follow the procedures outlined by the HCL GAS CLEANING SYSTEM INSTRUCTIONS (if gas cleaning system is supplied).
- e). Adjust the airflow rate to the diffuser grid system.
- f). Store all gas cleaning equipment properly and safely.

The gas cleaning procedure is covered in more detail in the HCL GAS CLEANING INSTRUCTIONS (if gas cleaning system is supplied).

4. Disk Re-Firing:

This cleaning method is effective for both internal and external disk fouling. The disks are removed from the basin and fired in a kiln. The cycle consists of steadily raising the temperature in the kiln to 1550°F over a period of 4 hours. That temperature is then maintained for 4 more hours, followed by a 24 hours cooling cycle.

There are a number of other cleaning techniques. Steam cleaning and sand blasting are effective methods of removing water side fouling but they are costly and time consuming. Gas cleaning can be accomplished with other gases but they are not normally as effective as using HCL gas.

The ceramic disk cleaning frequency depends on the system condition. It is recommended that every 6 to 12 months, each tank should be drained for high pressure hosing of diffusers. And every 18-24 months, each tank should be drained and cleaned with acid solution as outlined above.

MOP/na
3/90
G:/TEMP/FD-1029

PolyMax[®]

PolyMax[®]
is manufactured by



SEMBLEX[®]

1635 W. Walnut
Springfield, MO 65806-1643
Phone (417) 866-1035
Facsimile (417) 866-0235

PolyMax® is Manufactured by Semblex®

1635 West Walnut
Springfield, Missouri 65806

Telephone: 417-866-1035

Facsimile: 417-866-0235

OPERATION AND MAINTENANCE MANUAL

**OHM REMEDIATION SERVICES CORPORATION
CAMP LEJEUNE, JACKSONVILLE, NC
PURCHASE ORDER NO. 1005910
SEMBLEX JOB NO. 95051856-PM**

JUNE 12, 1995

Semblex & PolyMax are registered trademarks
of Mace Industries, Incorporated

©1986 - 1995 Semblex



TABLE OF CONTENTS

MODELS 4001 - 4005

	<u>Section</u>
<u>Warranty and Registration</u>	i
<u>PolyMax Data Sheet</u>	ii
<u>Safety Precautions</u>	1
<u>Introduction - PolyMax</u>	2
<u>How the PolyMax Works on Polymer Concentrate</u>	3
PolyMax - Provides Three Benefits	3-A
Theory of Polymeric Flocculating Agents	3-B
Optimization of Polymer Dosage	3-C
<u>PolyMax Equipment</u>	4
List of Major Components	4-A
Equipment Drawings	4-B
List of Optional Accessories Provided	4-C
<u>Installation</u>	5
Receiving & Unpacking	5-A
Location of Unit	5-B
Utilities and Facilities Required	5-C
Connections and Hook-Up	5-D
<u>Operation</u>	6
Introduction to the Dual Feed PolyMax Units	6-A
Inlet Dilution Water System	6-B
Polymer Concentrate System	6-C
Control Panel	6-D
Inlet Dilution Water and Pump Settings	6-E

<u>Operation - Continued</u>	
Solenoid Operated Diaphragm Pump	6-F
Reserved	6-G
Start-up of the Polymax	6-H
<u>Calibration</u>	7
<u>Shutdown, Cleaning, Troubleshooting, & Maintenance</u>	8
Shutdown and Cleaning	8-A
Preventative Maintenance	8-B
Troubleshooting Guide and Abbreviated Maintenance Schedule ...	8-C
<u>Spare Parts Ordering Information</u>	9
<u>Assembly Component Manuals</u>	10
Standard Components	10-A
Inlet Water Low Flow Rate Shutdown Switch	
Inlet Water Solenoid Valve	
Inlet Water Rotameter	
Diaphragm Type Polymer Concentrate Pump	

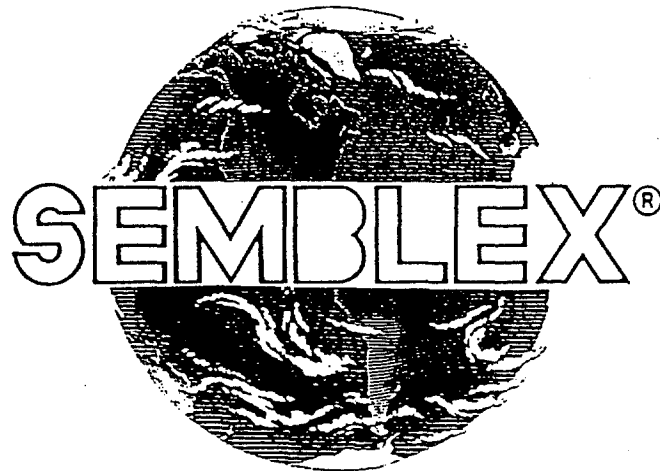


WARNING

BECAUSE OF THE POSSIBLE DANGER TO PERSON(S) OR PROPERTY FROM ACCIDENTS WHICH MAY RESULT FROM THE IMPROPER USE OF PRODUCTS, IT IS IMPORTANT THAT CORRECT PROCEDURES BE FOLLOWED: PRODUCTS MUST BE USED IN ACCORDANCE WITH THE ENGINEERING INFORMATION SPECIFIED IN THE OPERATION AND MAINTENANCE MANUAL. PROPER INSTALLATION, MAINTENANCE AND OPERATIONAL PROCEDURES MUST BE OBSERVED. THE INSTRUCTION IN THE OPERATION AND MAINTENANCE MANUAL MUST BE FOLLOWED. INSPECTIONS SHOULD BE MADE AS NECESSARY TO ASSURE SAFE OPERATION UNDER PREVAILING CONDITIONS. PROPER GUARDS AND OTHER SUITABLE SAFETY DEVICES OR PROCEDURES AS MAY BE DESIRABLE OR AS MAY BE SPECIFIED IN SAFETY CODES SHOULD BE PROVIDED AND MAY OR MAY NOT BE PROVIDED BY SEMBLEX AND/OR ITS PARENT OR SISTER COMPANIES, NOR ARE THE RESPONSIBILITY OF SAID COMPANIES.

**TAKE THE
TIME . . .
SAFETY
LASTS A
LIFETIME**





INTRODUCTION

THIS EQUIPMENT IS AMONG THE FINEST AVAILABLE TODAY. BY INVESTING A SMALL AMOUNT OF TIME READING THESE OPERATION AND MAINTENANCE INSTRUCTIONS, IT WILL AID YOUR INITIAL START-UP, SHORTEN DOWN TIME, SHOULD IT OCCUR, AND EXTEND THE LIFE OF YOUR SEMBLEX EQUIPMENT.

KEEP THIS OPERATION AND MAINTENANCE MANUAL HANDY FOR EASY REFERENCE AND HAVE MAINTENANCE PERSONNEL INCLUDE NOTES OF THEIR OWN FOR FUTURE USE.

THESE INSTRUCTIONS ARE INVALUABLE. DO NOT DISCARD AFTER YOUR START-UP IS COMPLETED. THE INFORMATION CONTAINED IN THIS MANUAL IS ESSENTIAL FOR THE SAFE OPERATION OF YOUR SEMBLEX EQUIPMENT, AND THE MAINTENANCE OF YOUR EQUIPMENT. REPLACEMENT COPIES OF THIS MANUAL ARE AVAILABLE FROM SEMBLEX FOR A MODERATE COST. (417) 866-1035

DIRECT ANY QUESTIONS CONCERNING YOUR SEMBLEX EQUIPMENT WHICH ARE NOT COVERED IN THIS MANUAL TO THE REPRESENTATIVE THROUGH WHOM THE EQUIPMENT WAS PURCHASED, IF YOUR EQUIPMENT WAS PURCHASED DIRECT FROM SEMBLEX, THEN CALL SEMBLEX @ 417-866-1035 OR FAX 417-866-1035.

SEMBLEX CUSTOM EQUIPMENT
A DIVISION OF MACE INDUSTRIES
1635 WEST WALNUT STREET
SPRINGFIELD, MO. 65806



SEMBLEX

1635 W. Walnut Street
Springfield, MO 65806-1643

Phone 417/866-1035
Facsimile 417/866-0235

SEMBLEX® EQUIPMENT WARRANTY AND SERVICE

WARRANTY

For the benefit of the original user only, Semblex warrants that the equipment of our manufacture will be free from defects in material and workmanship when installed, operated and maintained under design conditions and in accordance with our written instructions. Semblex will replace or repair, FOB our factories or other locations designated by us, any parts returned which examination shall show to have failed under normal use and service by the original user, normal wear and tear excepted. Warranties will expire eighteen (18) months after shipment or twelve (12) months after start up, whichever occurs first. Expendable items such as V-belts and filter media are excluded from this warranty.

This warranty, including the stated remedies, is expressly made by Semblex and accepted by purchaser in lieu of all other warranties, and Semblex disclaims any implied warranty of merchantability or fitness for any particular purpose. We will not be liable for any consequential, incidental or liquidated damages, and in no event shall be liable for any amount in excess of the purchase price of the equipment. Semblex makes no warranties, express or implied, that the equipment sold will meet any particular contract specifications.

This warranty shall not apply to equipment or parts thereof which have been altered or repaired outside of a Semblex factory or damaged by improper installation, application, erosion or corrosion of any sort, or subjected to misuse, abuse, neglect or accident. Semblex will make no allowance or reimbursement for repairs, alterations, replacements or work of any kind done or ordered by others without Semblex' prior written authorization. This warranty does not include any installation, removal or freight expenses that might be associated with warranty repair or replacement. Repair, replacement or refund of the purchase price by Semblex, at our sole option, shall be the exclusive remedy for breach of this warranty.

Semblex makes no warranty with respect to parts, accessories, or components manufactured by others. The warranty, applicable to such items, is that offered by their respective manufacturers and will be passed through Semblex to the original user.

START UP AND SERVICE

Unless specifically stated in our quotation, installation, start up, service supervision and training are not included in our pricing. These responsibilities shall be the exclusive responsibility of the purchaser.

A trained factory serviceman is available at the rate stated in our quotation with all travel and living expenses billed at cost. Service charges are based on a standard eight (8) hour work day with time charged from the date of departure from his home office to the date of his return. Overtime and weekend travel will be charged at time and one-half and double-time respectively.



SEMBLEX

Semblex Parts Department
1635 W. Walnut
Springfield, MO 65806-1643
PH: 417-866-1035/FAX: 417-866-0235

IMPORTANT

**THE FOLLOWING WARRANTY PAGE MUST
BE COMPLETED AND SENT
TO**

**SEMBLEX CUSTOM EQUIPMENT
1635 WEST WALNUT ST.
SPRINGFIELD, MO. U.S.A. 65806**

**PRIOR TO THE UNLIKELY
EVENT OF A WARRANTY CLAIM**

THANK YOU!

WARRANTY REGISTRATION AND FACILITY REPORT

To properly register and warranty your new equipment, please fill out this form and mail it to:

Semblex Custom Equipment Assemblers
1635 W. Walnut
Springfield, Missouri 65806-1643
Attn: O&M Manuals Department

SEMBLEX JOB NO. _____
(Can be found on first page of O & M)

Facility - complete name and address
(where unit is installed)

City of Main office name & address
(if applicable)

_____	_____
_____	_____
_____	_____
_____	_____

Facility Contacts

Lead Operator - _____ Phone: _____
Purchasing - _____ Phone: _____

SERIAL NO. AND/OR MODEL NO.

_____	_____
-------	-------

APPLICATION

- | | |
|--|---|
| <input type="checkbox"/> Industrial | <input type="checkbox"/> Centrifuge _____ |
| <input type="checkbox"/> Municipal | <input type="checkbox"/> Belt Press _____ |
| <input type="checkbox"/> Waste Treatment | <input type="checkbox"/> Drying Bed _____ |
| <input type="checkbox"/> Potable Water | <input type="checkbox"/> Clarifier _____ |
| <input type="checkbox"/> Process | <input type="checkbox"/> DAF _____ |

TYPE OF POLYMER (IF APPLICABLE)

- | | | |
|-----------------------------------|-----------------------------------|-----------------------------------|
| <input type="checkbox"/> Emulsion | <input type="checkbox"/> Solution | <input type="checkbox"/> Dry |
| <input type="checkbox"/> Cationic | <input type="checkbox"/> Anionic | <input type="checkbox"/> Nonionic |

Brand: _____ Product No.: _____

Signature: _____

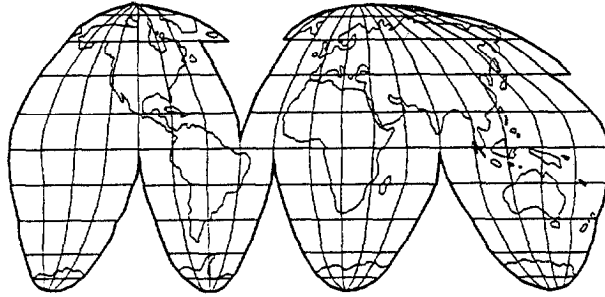
Title: _____

IF APPLICABLE

Contractor: _____

Architect: _____

SPARE AND REPLACEMENT PARTS ORDERING INFORMATION



**SEMBLEX CUSTOM EQUIPMENT
A DIVISION OF MACE INDUSTRIES
PARTS DEPARTMENT
1635 W. WALNUT STREET
SPRINGFIELD, MISSOURI, U.S.A. 65806**

**PHONE (417) 866-1035
ASK FOR SPARE PARTS DEPARTMENT
OR
FAX (417) 866-0235 (24 HOURS A DAY)**

Faster service can be given on spare or replacement parts if you give the following information at the time of your request:

- Model Number of Product and/or Equipment Number
- Semblex Job Number (Example: 93010000-PF)
- Part Number (if given)
- Quantity Needed
- P.O. Number/Bill to and Ship to Address

**ALL PARTS WILL BE SHIPPED F.O.B. SPRINGFIELD, MISSOURI, USA, AT PRICES IN
EFFECT AT TIME OF SHIPMENT**



SEMBLEX

1635 W. Walnut Street
Springfield, MO 65806-1643

Phone 417/866-1035
Facsimile 417/866-0235

POLYMAX® DATA SHEET

CUSTOMER:	OHM REMEDIATION SERVICES CORPORATION
PURCHASE ORDER NO:	1005910
JOB:	CAMP LEJEUNE, JACKSONVILLE, NC
POLYMAX EQUIPMENT:	(1) 4002-100/1.0
DILUTION WATER:	10 TO 100 GPH
DIAPHRAGM PUMP:	A151-86 PMX
PUMP CAPACITY:	0.01 TO 1.0 GPH
STANDARD GROUP OF ACCESSORIES	
OPTIONS:	
(1) FLOOR STAND, SS	PN 4102
(1) CALIBRATION KIT, 250 ML	4114
(1) DRUMPIPE - STANDPIPE	4119
SERIAL NO:	1767
SEMBLEX JOB NO:	95051856-PM

The data sheet lists the important information one would need to order spare or replacement parts.

To expedite order fulfillment, please have this data handy.



SEMBLEX

1635 W. Walnut Street
Springfield, MO 65806-1643

Phone 417/866-1035
Facsimile 417/866-0235

Section 1 **Safety Precautions**

Polymers are a relatively benign chemical; however, extended contact with the skin should be avoided.

Spilled polymer concentrate or diluted solutions will make the floor extremely slick; hence, proper housekeeping is of paramount importance.

Wipe up and/or thoroughly hose down and clean any areas where polymer has been spilled. Use solvents or adsorbents as recommended by the polymer manufacturer for clean up.

WARNING!!

**BEFORE OPERATING OR SERVICING ANY EQUIPMENT,
READ THE INSTRUCTION MANUAL.**

BE THOROUGHLY FAMILIAR WITH THE EQUIPMENT.

**FOLLOW THE SAFETY PRECAUTIONS AS DETAILED IN
THIS MANUAL.**

Obtain the **Material Safety Data Sheet (M.S.D.S.)** for each polymer you are using. This information is available from the polymer manufacturer.

Read the **M.S.D.S.** and implement safe handling procedures for the polymer.

Follow the plant safety rules.

CAUTION!

A CAUTION! statement means:

- **Danger may be present**
- **Equipment might be damaged**
- **Operational problems could be created.**

WARNING!

A WARNING! statement means:

- **Danger IS present**
- **Extra precautions are necessary to insure safety.**

Section 2

Introduction

The equipment you have is the finest available today to mix, blend and age polymer. PolyMax is a state-of-the-art polymer blending system that combines conventional in-line mixers with a revolutionary new mixing technology.

These mixing/blending devices, combined with a unique labyrinth for aging, result in a compact total blending and aging system. The PolyMax will **mix, dilute** and **age** polymers used by water and waste water treatment plants.

By investing a small amount of time in reading these Installation, Operation, and Maintenance Instructions, you will find information to help with your initial start up and extend the life of the equipment.

Keep these instructions handy for easy reference. Maintenance personnel may wish to add notes for their future use.

These instructions are quite valuable. Do not discard after start up is completed.

The information provided is essential for safe operation, maintenance, and for use by new employees.

Replacement copies are available from Semblex for a moderate cost.

Direct any questions concerning this equipment which are not covered in this manual to the representative through whom the equipment was purchased or contact Semblex Direct.

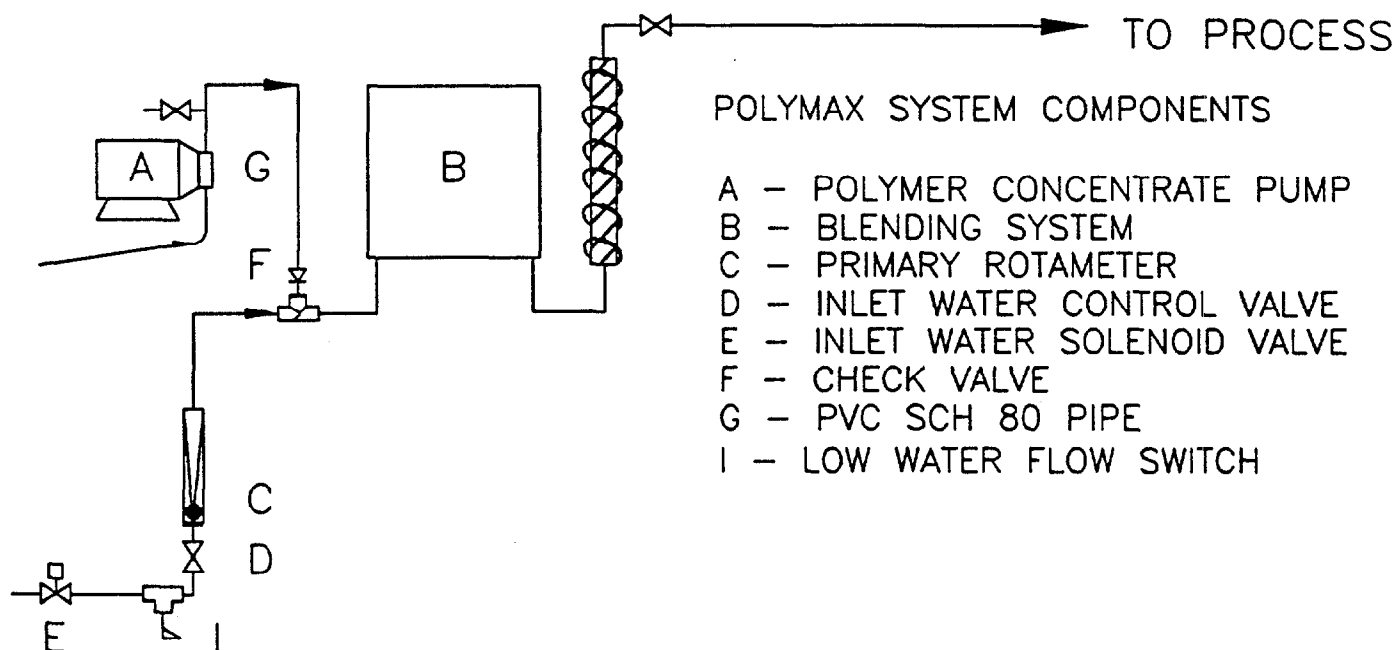
SEMBLEX

1635 W. Walnut Street
Springfield, Missouri 65806

Telephone: (417) 866-1035
Facsimile: (417) 866-0235



Abbreviated Description of Operation



Incoming dilution water is introduced into the unit via an inlet solenoid valve (E) which is controlled by an ON - OFF switch.

The inlet dilution water volume is adjusted using the flow control valve (D) and rotameter (C).

Polymer concentrate is metered into the unit by a variable speed diaphragm pump (A). A check valve (F) prevents back flow of water into the concentrated polymer line. Please see Section 4, List of Major Components and Equipment Drawings.

Polymer and water flows through the mixing - blending - activation system (B), discharging a homogeneous, blended and activated dilute solution to the process.

A dilution water flow switch (I) provides a permissive start contact for the metering pump (A). That is, the inlet water flow rate must be above the set point of the flow switch. If the metering pump will not operate, increase the primary inlet dilution water flow rate.

Section 3

How the PolyMax Works on Polymer Concentrate

POLYMAX - PROVIDES THREE BENEFITS

Organic polymers are extremely long-chain molecules with molecular weights often in the hundred of thousands or millions. As such, they are quite fragile and subject to degradation with violent mixing, pumping, or agitation.

The PolyMax uses gentle pumping and mixing to prepare and activate the polymer. This gentle mixing serves to protect the long-chain molecules. No "high-energy", "high-shear" mixers, or centrifugal mixing pumps are needed.

Thin-film technology affects complete mixing. The labyrinth - detention chamber activates each polymer molecule by providing a finite aging time which allows the polymer to uncoil.

This thin-film concept and extended detention time in the PolyMax maximize polymer activation and efficiency while reducing the operating cost.

The PolyMax, by Semblex, accomplishes the **three** critical operations that are necessary to effectively use polymeric flocculating agents (polyelectrolytes).

1. MIXES/BLENDS

The highly viscous and difficult-to-blend "neat" polymer concentrate is combined with dilution water.

The inlet mixing block initially combines the dilution water and concentrated polymer in a thin film, dynamic environment which virtually eliminates fisheyes.

Further mixing is affected by the unique in-line baffles and three in-line mixers. This entire mixing system provides a totally mixed, diluted polymer solution.

2. POLYMER AGING

The aging/detention chamber provides the time necessary for proper aging of the polymer. Concentrated neat polymer molecules are coiled similar to a watch spring.

Proper aging time must be provided for the polymer to uncoil and activate. Thus, the detention chamber, with its labyrinth flow and multiple baffles, imparts gentle back-mixing. This design insures plug flow through the chamber allowing sufficient time for aging.

3. DILUTE METERING

The precise metering of the diluted polymer is accomplished using the metering pump and dilution water rotameter. This combination provides an extremely consistent flow of diluted polymer solution.

The entire operation is accomplished with few moving parts. These parts are the water solenoid valve, rotameters, and metering pump. This virtually eliminates maintenance problems inherent with other systems that rely on mechanical mixers.

The PolyMax Blending System will provide years of service when operated and maintained as described in this manual.



POLYMAX®

THEORY OF POLYMERIC FLOCCULATING AGENTS

"Polymers" are long chain organic polymers that are very complex molecules. They possess some peculiar and interesting physical characteristics.

Because they are very high molecular weight, they are extremely viscous when dissolved in a water solution. Even at a one (1) percent or less diluted concentration, these solutions look much like thick syrup.

Polymers are quite expensive but also highly effective. Therefore, they are utilized in very diluted concentrations.

Polymers are a flocculation or coagulating chemical. These long chain organic molecules act like fly paper attracting suspended solids in the water.

The suspended solids "stick to" the polymer by coagulating or thickening the solids into "globules" enhancing the settling of solids.

In more technical terms, these long chain polymers possess either a negative charge (cationic), a positive charge (anionic), or a neutral charge (non-ionic). The polymer will attract the suspended solid particles of the opposite charge.

Where Do These Polymers Work in the Treatment Plant?

Coagulation and flocculation are used in several areas of a water or waste water treatment plant.

Polymers are used in solid separation equipment; i.e., the gravity settling tanks (which are the clarifiers), thickeners, dissolved air flotation units, and flocculator clarifiers. Diluted polymer is introduced into the waste water flowing to these units to help coagulate the suspended solids and enhance settling.

Typical diluted polymer concentrations are 0.10 to 0.25 percent. One to three parts per million are rough dosage rates.

The settled sludge from clarifiers and thickeners are often dewatered in centrifuges, belt filter presses, and other dewatering devices.

Diluted polymeric flocculation agents are added in larger quantities to help coagulate the suspended solids and enhance the dewatering system.

In fact, modern centrifuges and belt filter presses could not operate without the addition of the appropriate organic flocculating chemicals.

Diluted polymer concentrations of 0.25 to 1.00 percent are used for dewatering. Dosages vary widely from 5 to 90 pounds per ton of dry solids depending on the effectiveness of polymer used.

Another area of polymer usage is final filtration.

The small amount of suspended solids left in clarifier overflow is coagulated by the

addition of minute amounts of diluted polymeric flocculating agent immediately prior to granular media filtration.

The addition of polymer enhances the filtration and final clarity of the effluent exiting the treatment plant.

Diluted polymer concentrations of 0.05 to 0.10 percent in dosages of 0.5 to 1.0 part per million are typically used.

Why Do We Need Special Polymer Feed Equipment?

Polymers must be mixed and pumped as gently as possible. These organic polymers are extremely long-chain molecules with molecular weights often in the hundreds of thousands or millions.

Any type of violent mixing or pumping such as adding vigorous energy to the polymer solution will fracture the molecules rendering them less effective.

For this reason high-energy propellers, mixers, and centrifugal pumps must be avoided when handling, blending, mixing, and pumping polymer solutions.

Concentrated polymer comes in several forms.

"Neat" polymer is concentrated polymer received in liquid form as a solution. Generally, this is the easiest form of polymer to mix and requires only gentle blending for dilution.

Either a diaphragm or gear pump can be used to pump liquid neat polymer. Selection of the type of pump depends primarily on the required capacity.

Emulsified polymers are those that are "emulsions" whose appearance is milky and opaque.

These polymers are more difficult to mix and dilute requiring a much longer mixing and dilution time. Diaphragm pumps should be used for emulsion polymers.

Dispersion polymers are very similar to the emulsified polymers, except the extremely fine particles of solid polymer are "dispersed" within the liquid.

This type of polymer concentrate would look similar to water based latex paint. These polymers mix quite similarly to the emulsified concentrates.

There is another category of liquid solution polymers worth describing.

These are the "Mannich" type of polymers. These polymer solutions are manufactured by various companies relatively close to the water treatment plant.

The active polymer concentrations within these solutions are usually between four to six percent. The remaining solution is water and other chemicals.

Although they easily dissolve in water, they are extremely difficult to pump as they are received from the supplier. They have the consistency of "Jello".

Special consideration and design must be given to over sizing concentrated polymer lines and providing oversized inlet and outlet ports on the gear type metering pumps used to meter the Mannich polymer.

Another type of polymer is dry polymers.

They are received in 40 to 80 pound bags or super sacks and look similar to table salt or sugar. These polymers are the most difficult to mix into a solution as each individual particle requires thorough wetting.

If each particle is not thoroughly wetted, the end result is a "fisheye", which is a globule of unmixed polymer. A prewetting device, such as Chemix® or Semblex System 1000, is used for this purpose. Consult Semblex for details.

Why Dilute the Polymers?

Polymers work best in diluted concentrations for two reasons.

First, since flocculating polymers are extremely effective, they can be used in very low dosages.

For clarification and sedimentation, polymer dosage in the one to three parts per million range is common.

One gallon of polymer per one million gallons of waste water for a one part per million dosage is all that may be required in many cases.

Accordingly, the polymers are diluted down to a concentration of 0.1 to 0.5 weight percent when used for clarification in order to accurately meter into the water or waste water.

Polymer dosages for dewatering equipment are somewhat higher and polymer concentrations will vary anywhere from 0.25 to 2.00 percent by weight when they are used for dewatering.

Consult polymer manufacturers for their

recommended diluted concentrations.

Secondly, because polymers are very expensive, diluting the polymers allows the maximum utilization of each individual molecule when mixing into a large flow of waste water.

By using diluted concentrations, each molecule is spread out allowing each molecule to act as an individual piece of "fly-paper" attracting the oppositely charged suspended solid particles to aid in sedimentation or dewatering.

What is "Aging"?

The organic polymer flocculating agents, in concentrated form, appear as coiled springs.

After the polymer is diluted, a finite amount of time is required for each molecule to uncoil and "straighten out". The long chain polymers, completely uncoiled, provide the maximum potential for coagulation of suspended solids.

Polymer manufacturers indicate that there is no substitute for aging time, nor will "high energy" applied to the polymer solution shorten this aging time.

Therefore, the aging time is important for maximum utilization of these polymeric flocculating chemicals.

The optimum aging time of different polymers varies widely and the polymer manufacturer should be consulted for their recommendations. The optimum aging time from the start of blending to completion of aging may vary anywhere from 5 to 30 minutes, depending on the individual polymer used.



The longer chain and more expensive polymers generally require a longer mixing and aging time. Likewise, they are more effective in coagulation and sedimentation. Often the yearly operating cost of purchasing polymers is second only to the electric utility bill in the total cost of operating a plant.

It is vitally important to dilute, mix, and properly age polymers to obtain the maximum utilization and effectiveness to minimize operating costs.

Even a small increase in polymer activation and efficiency can amount to several thousand dollars savings per year.

PolyMax is the only compact polymer blending device that has an extended aging-detention chamber to properly activate organic polymer molecules.

Why Use A Specific Polymer?

There are literally tens of thousands of polymers available on the market today.

They vary in cost, ease of blending - mixing, and effectiveness. Water and waste water varies widely in physical characteristics from plant to plant, within a plant, even from day to day.

Different types of polymeric flocculating agents work better in different plants and even seasonal changes may require a change of polymers.

Jar tests run by the plant chemist or the polymer manufacturer determine the effectiveness of different polymers in coagulating and aid in dewatering.

What Are Jar Tests?

Jar tests are a method of determining the effectiveness of polymers in coagulating the suspended solids.

A predetermined volume of diluted polymer is added to a beaker of waste water, stirred, and the settling rate observed over a period of time.

The faster the solids settle, the more effective the polymer. Selecting the proper polymer involves not only its effectiveness but its cost and ease of mixing into the solution.

What About the PolyMax?

The PolyMax polymer mixing, aging, and metering system incorporates state-of-the-art design and components to effectively provide diluted, completely mixed and aged polymer for each stage of the process.

The thin-film technology affects gentle, yet unusually homogeneous mixing.

The labyrinth - detention chamber, unique with PolyMax, insures proper aging for maximum polymer activation.

Consult the Operation and Maintenance Manual for details on each component relative to servicing and maintenance of the equipment.



Optimization of Polymer Dosage

The **real secret** to a highly successful PolyMax operation is the optimization of the polymer dosage. Only with the PolyMax is this possible because the unit prepares a completely mixed, blended, and properly aged diluted polymer solution with extreme consistency.

The objective is to add just enough polymer to effectively coagulate (floculate) the solids in the water being treated.

Optimization of polymer use requires the gradual reduction of polymer dosage over a period of time. Patience is required, especially in larger systems, as changes in the floc formation may take several hours in a large clarifier or settling tank.

Likewise, the effects of polymer dosage on dewatering equipment, like belt presses, may be based on analysis of the cake or the calculation of the output. Changes in the polymer concentration tend to show up much more quickly in dewatering equipment.

Observe the floc formation (or dewatering). **Gradually reduce** the volume of polymer concentrate input by 8 to 10 percent increments.

Time how long it takes to observe the results. Continue to reduce the polymer volume in similar increments allowing adequate time for the change to show results.

This procedure is continued until the floc formation (or dewatering) begins to deteriorate.

At this point, **gradually increase** the volume of polymer concentrate by 2 to 3 percent increments. Allow enough time for results to show. Continue increasing the dosage as necessary and return to the optimum floc formation (dewatering).

Literally **thousands of dollars per year** in polymer costs **can be saved** by this procedure. This can only be accomplished by using a state-of-the-art unit, such as the PolyMax, which produces a uniform and homogeneous, mixed - aged polymer day in and day out.

Once the polymer dosage is optimized, changes should be made only if the water or waste water characteristics change.

Should different polymer concentrates be used, repeat the optimization process. Polymers are quite different in how well the various concentrates perform.

The best method is to monitor the cost of the polymer per ton of dry sludge. The lower the polymer cost per ton, the lower the cost of operation.

Section 4

List of Major Components

POLYMAX MODELS 4002 - 4003

Page 1 of 2

NO.	DESCRIPTION
1	POLYMER INLET, 1/2 INCH, NPT
2	WATER INLET, 1/2 INCH, NPT
3	DILUTE POLYMER OUTLET, 3/4 INCH, NPT AND BALL VALVE
4	DRAIN, 1/2 NPT
5	RESERVED
6	POLYMER INLET SUCTION TUBING, 4 FT., 5/8 INCH I.D.
7	METERING PUMP
7A	PRIMING PETCOCK, 1/4 INCH
8	CHECK VALVE
9	RESERVED
10	RESERVED
11	INLET WATER ROTAMETER AND ADJUSTING VALVE
12	RESERVED
13	CONTROL PANEL PLATE
14	POWER, ON - OFF - (REMOTE) SWITCH
15	POWER, ON LIGHT, GREEN
16	PUMP AND SOLENOID ON - OFF SWITCH
17	PUMP AND SOLENOID ON LIGHT, RED
18	LOW WATER FLOW SHUTDOWN SWITCH
19	LOW WATER FLOW LIGHT, RED
20	POWER CONNECTION AND CABLE, 120 V / 60 Hz / 1 PHASE, 6 FT.
21	CASE, STEEL
22	DETENTION CHAMBER - CLEAR ACRYLIC
23	DETENTION CHAMBER TOP PLATE, 1 INCH CLEAR ACRYLIC
24	DETENTION CHAMBER BOTTOM PLATE, 1 INCH CLEAR ACRYLIC
25	INLET WATER SOLENOID VALVE
26	ELECTRICAL ENCLOSURE
27	INLET POLYMER MIXING BLOCK
28	RESERVED
29	MIXING ELLS AND PVC PIPE, SCH 80
30	IN-LINE MIXERS

Section 4
List of Major Components

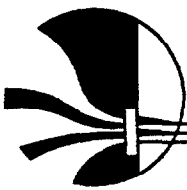
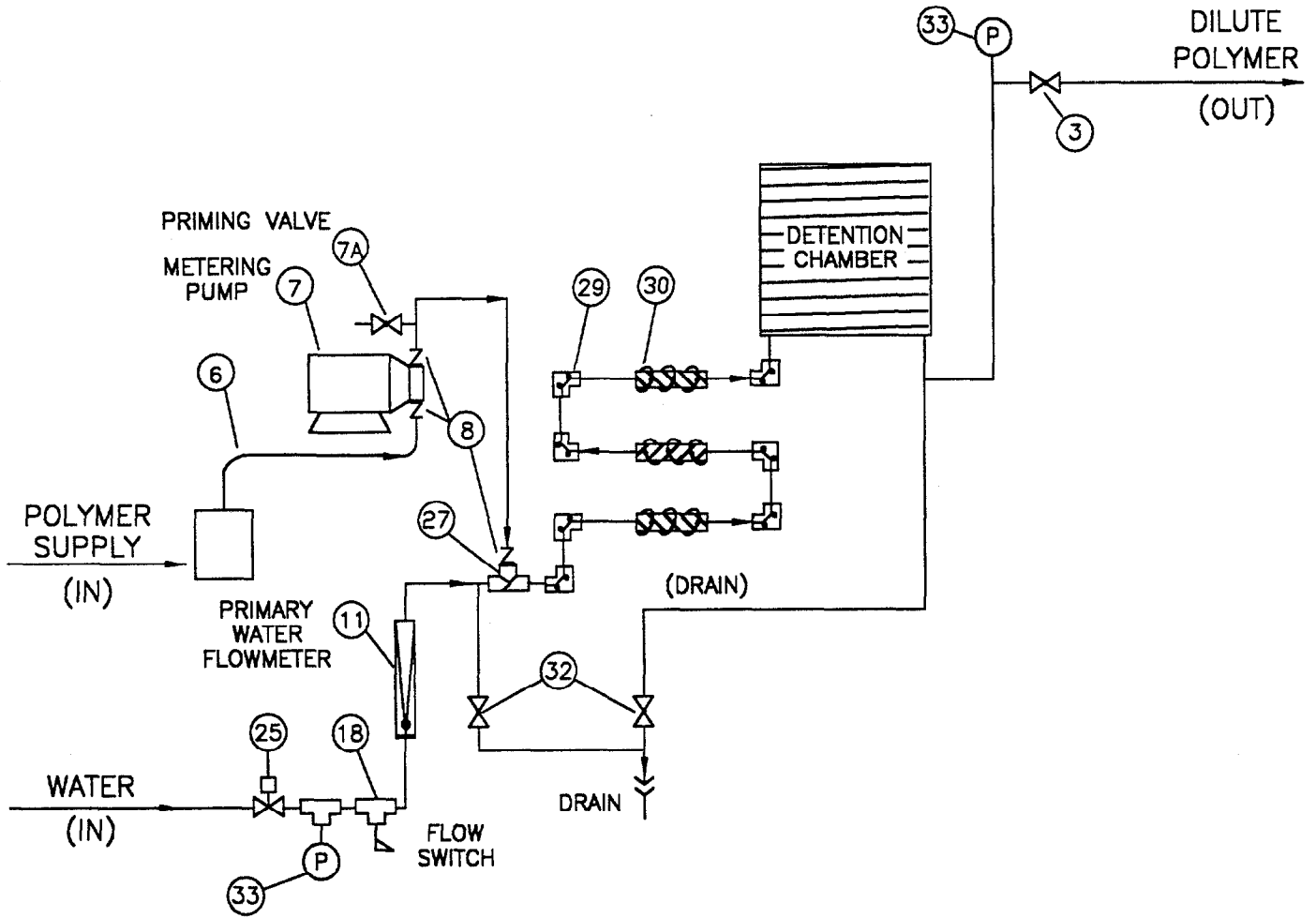
POLYMAX MODELS 4002 - 4003

Page 2 of 2

NO.	DESCRIPTION
31	RESERVED
32	BACK WASH AND DRAIN BALL VALVES
33	PRESSURE GAUGE, 0-100 PSIG, 2 1/2 INCH DIAL, LIQUID FILLED
34	RESERVED
35	SIDE SHEETS
36	SIDE SCREWS
37	MOUNTING FEET
38	FEET ANCHOR SCREWS
39	STAINLESS STEEL RODS
40	STAINLESS STEEL NUTS AND WASHERS FOR RODS
41	INTERNAL LIGHT, 40 WATT
42	RESERVED
43	SERIAL NAMEPLATE
44	RESERVED
45	RESERVED
46	ROD SLEEVE, POLYETHYLENE
47	RESERVED
48	RESERVED
49	RESERVED
50	RESERVED
51	FLEXIBLE TUBING TO DRAIN UNIT

MODELS 4001 TO 4003

SEE SECTION 4
LIST OF MAJOR COMPONENTS



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

DRAWN BY B.D.D.

SCALE N.T.S.

APP'D *Wdg*

DATE 1/26/93

POLYMAX

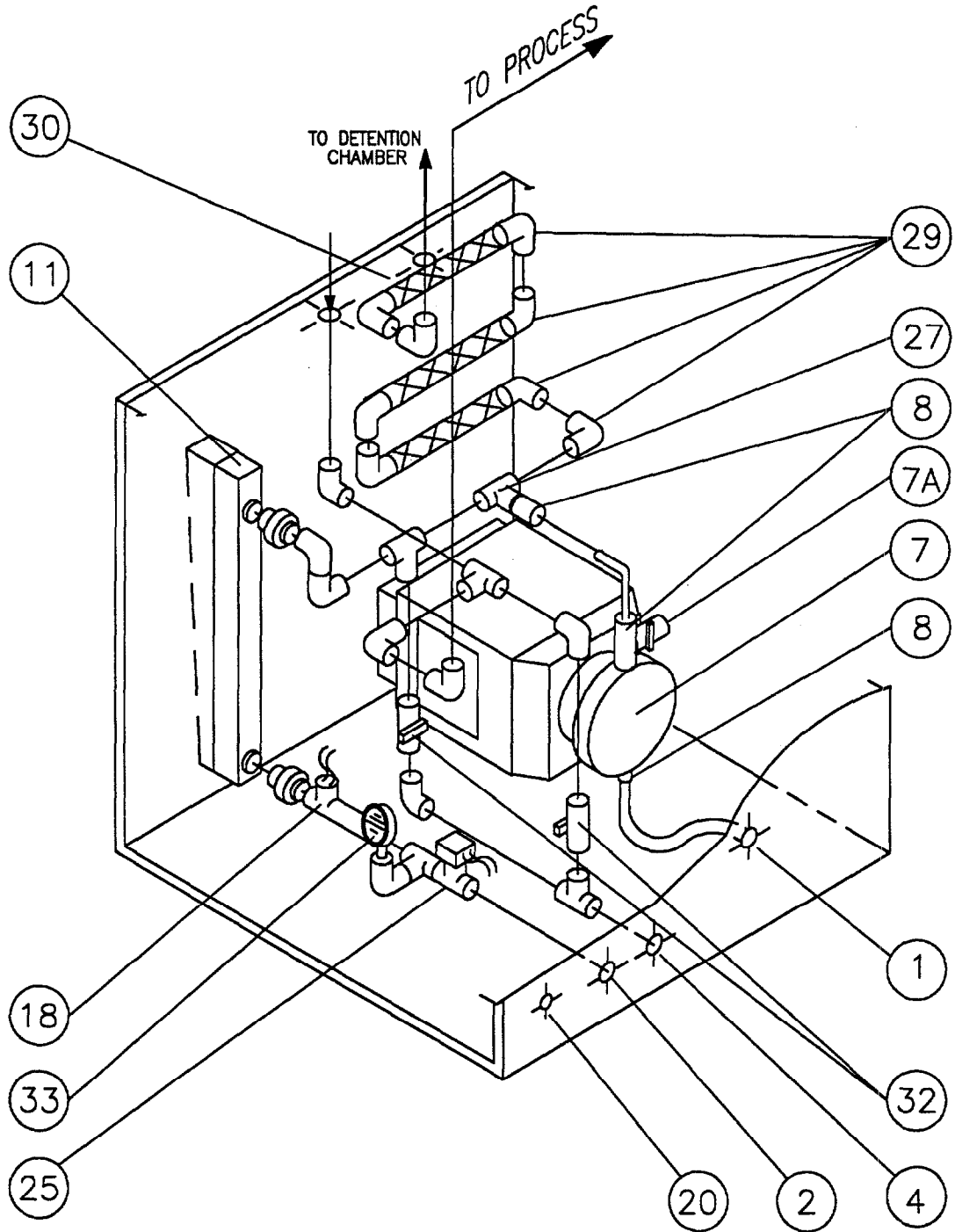
FLOW SCHEMATIC

DRAWING NO.

1856-FD-01-03

MODELS 4001 TO 4003

SEE SECTION 4
LIST OF MAJOR COMPONENTS



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

POLYMAX

PIPING ISOMETRIC

DRAWN BY DJH

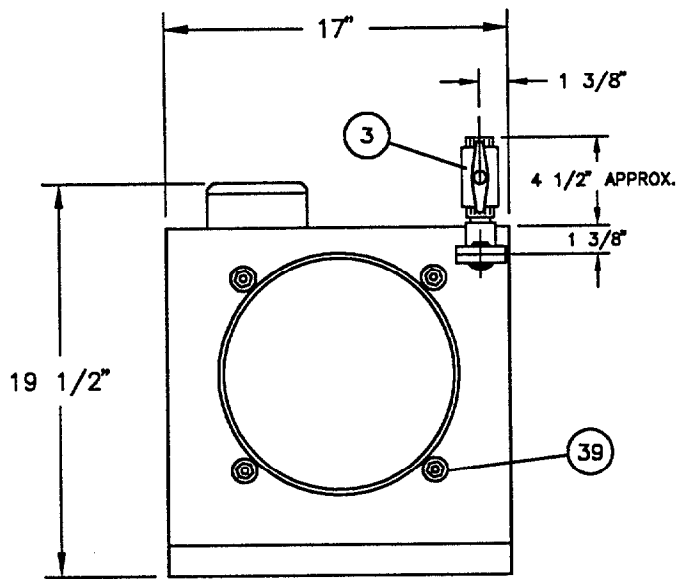
APP'D *[Signature]*

DRAWING NO.

SCALE N.T.S.

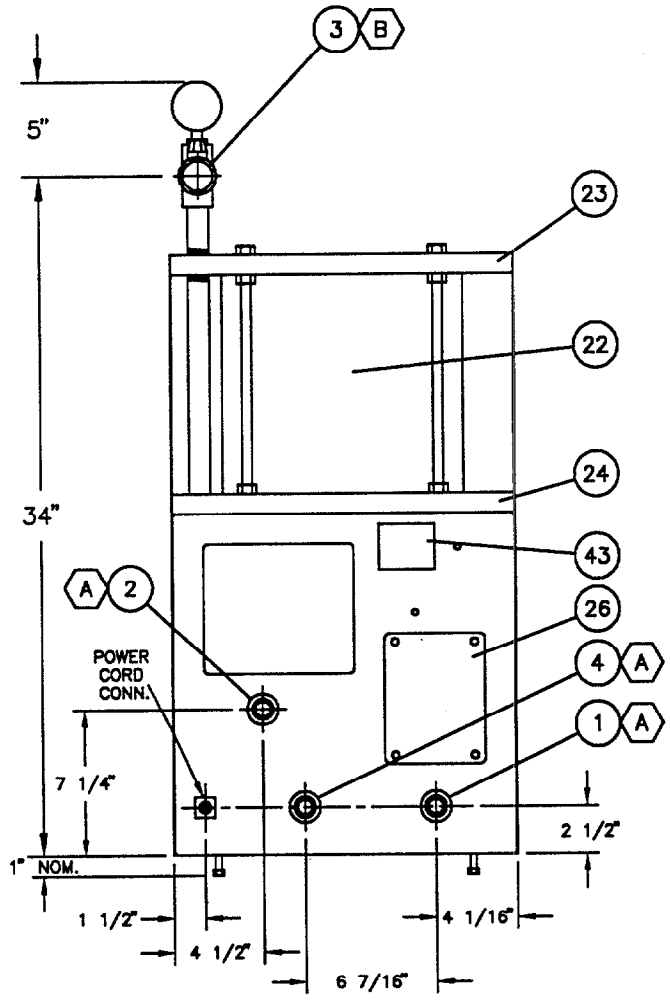
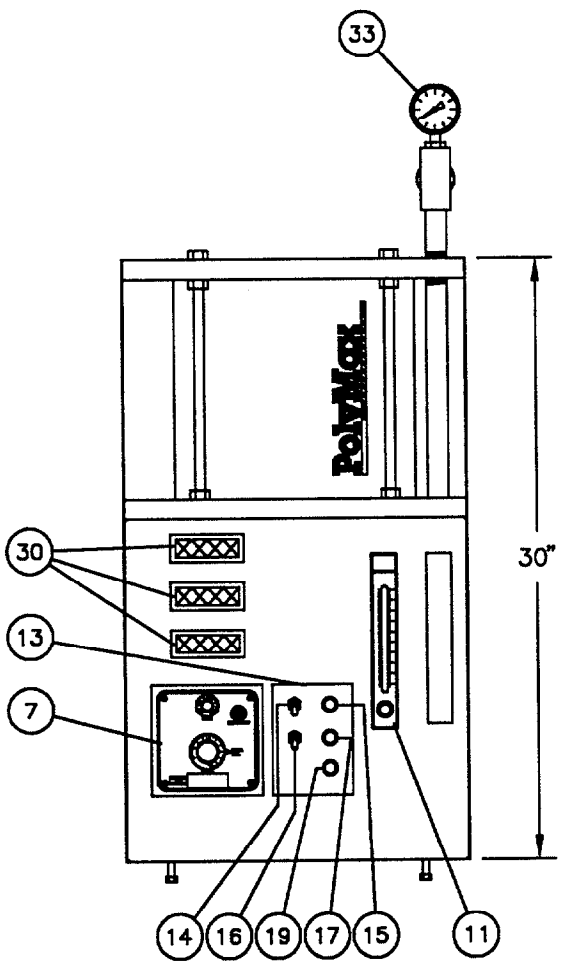
DATE 2/15/93

1856-PI-01-03



MODELS 4001 TO 4003
 SEE SECTION 4
 LIST OF MAJOR COMPONENTS
 19 1/2" D X 17" W X 40" H

CONNECTIONS	
A	1/2 IN.
B	3/4 IN.



SEMBLEX
 CUSTOM EQUIPMENT ASSEMBLERS
 SPRINGFIELD, MISSOURI

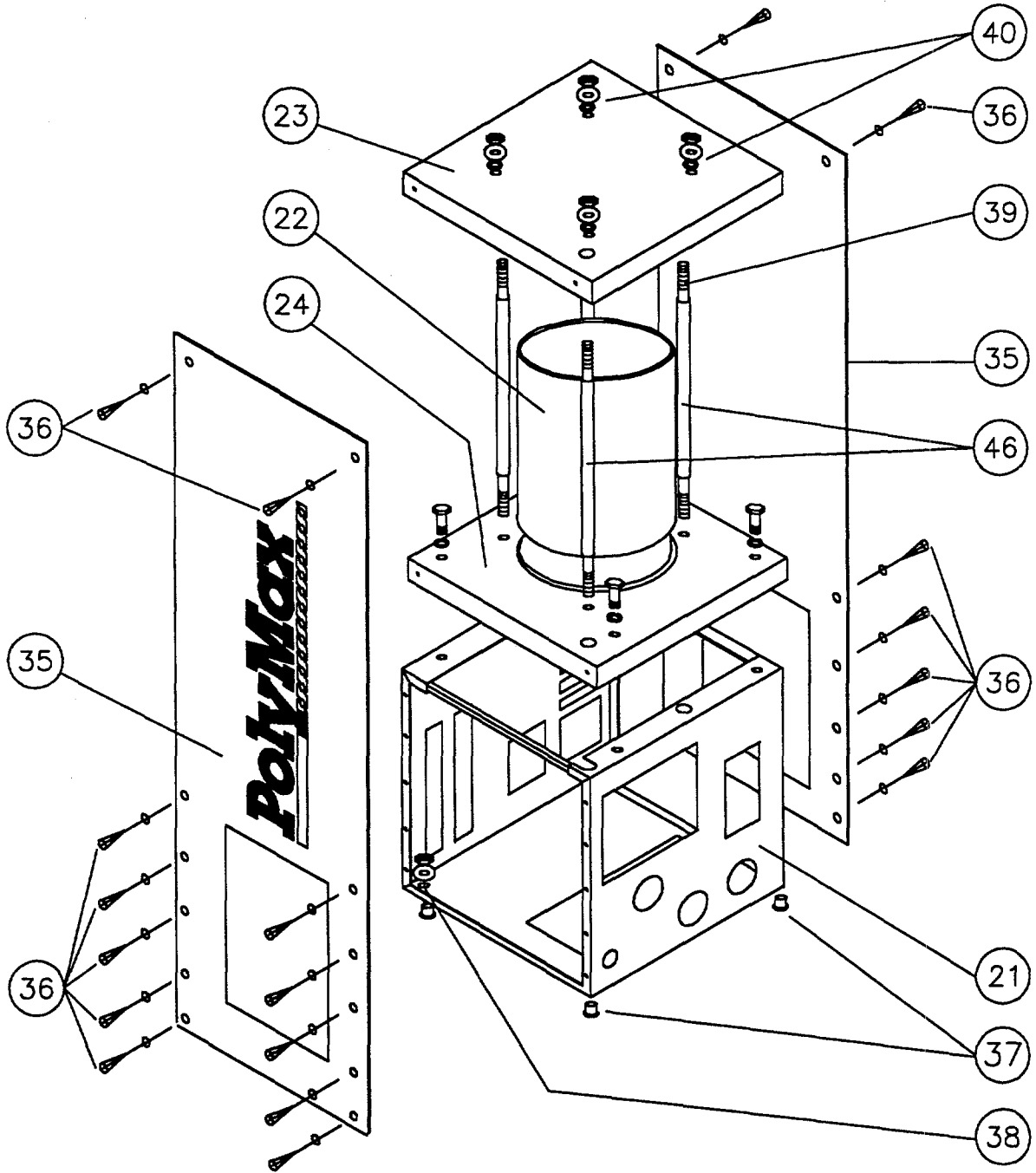
POLYMAX
 GENERAL ARRANGEMENT

DRAWN BY DLK APP'D [Signature]
 SCALE N.T.S. DATE 11/22/93

DRAWING NO. 1856-GA-01-03

MODELS 4001 TO 4005

SEE SECTION 4
LIST OF MAJOR COMPONENTS



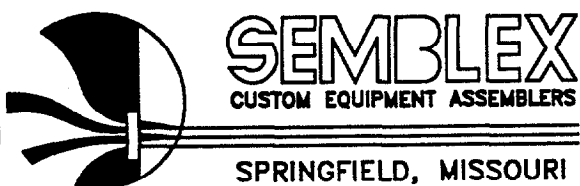
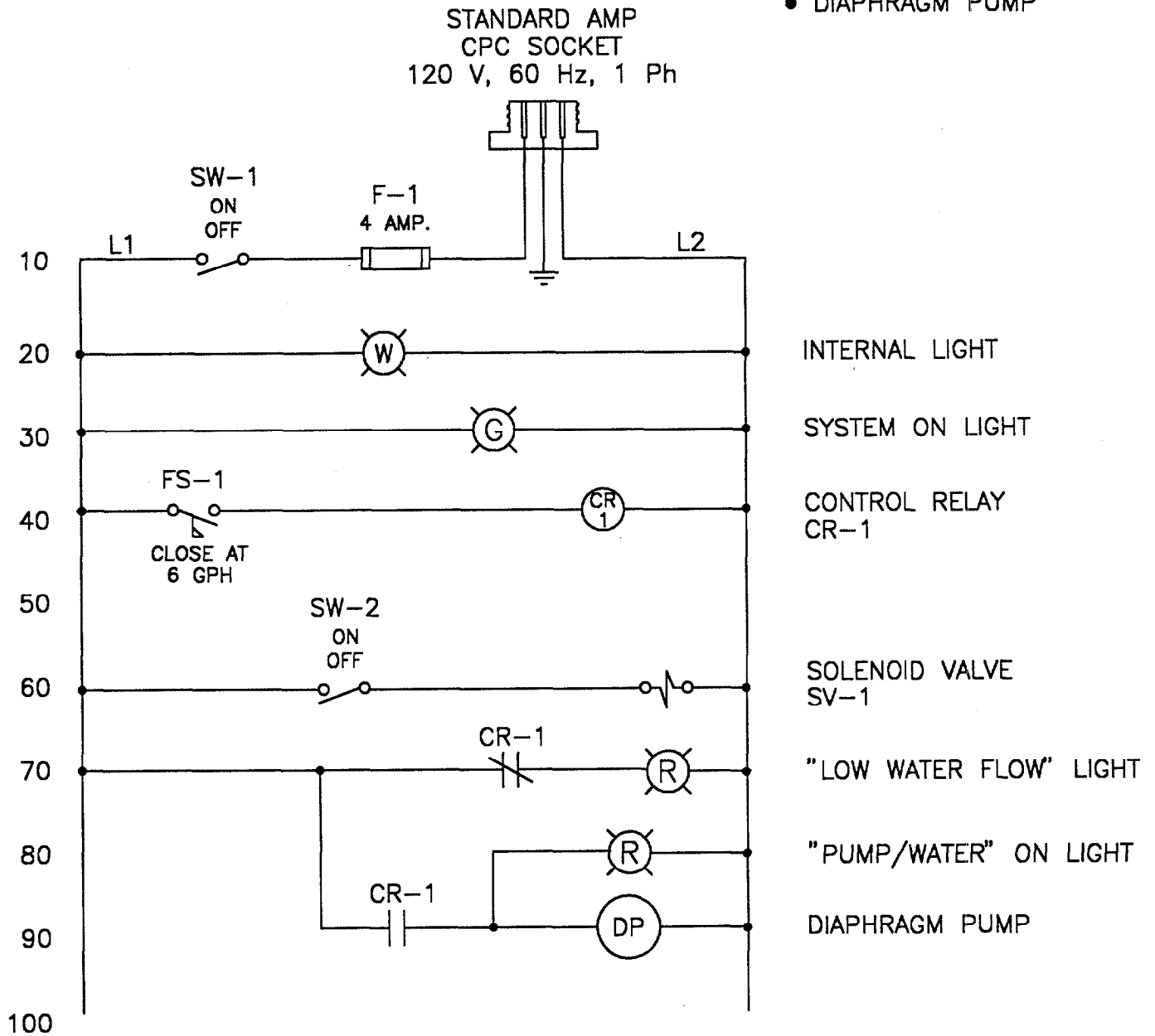
SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

		POLYMAX	
		CASE ISOMETRIC	
DRAWN BY	DJH	APP'D	[Signature]
SCALE	N.T.S.	DATE	2/29/92
		DRAWING NO.	
		1856-CI-01-05	

POLYMAX ELECTRICAL SCHEMATIC

- DIAPHRAGM PUMP



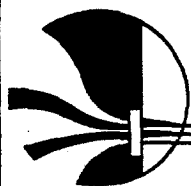
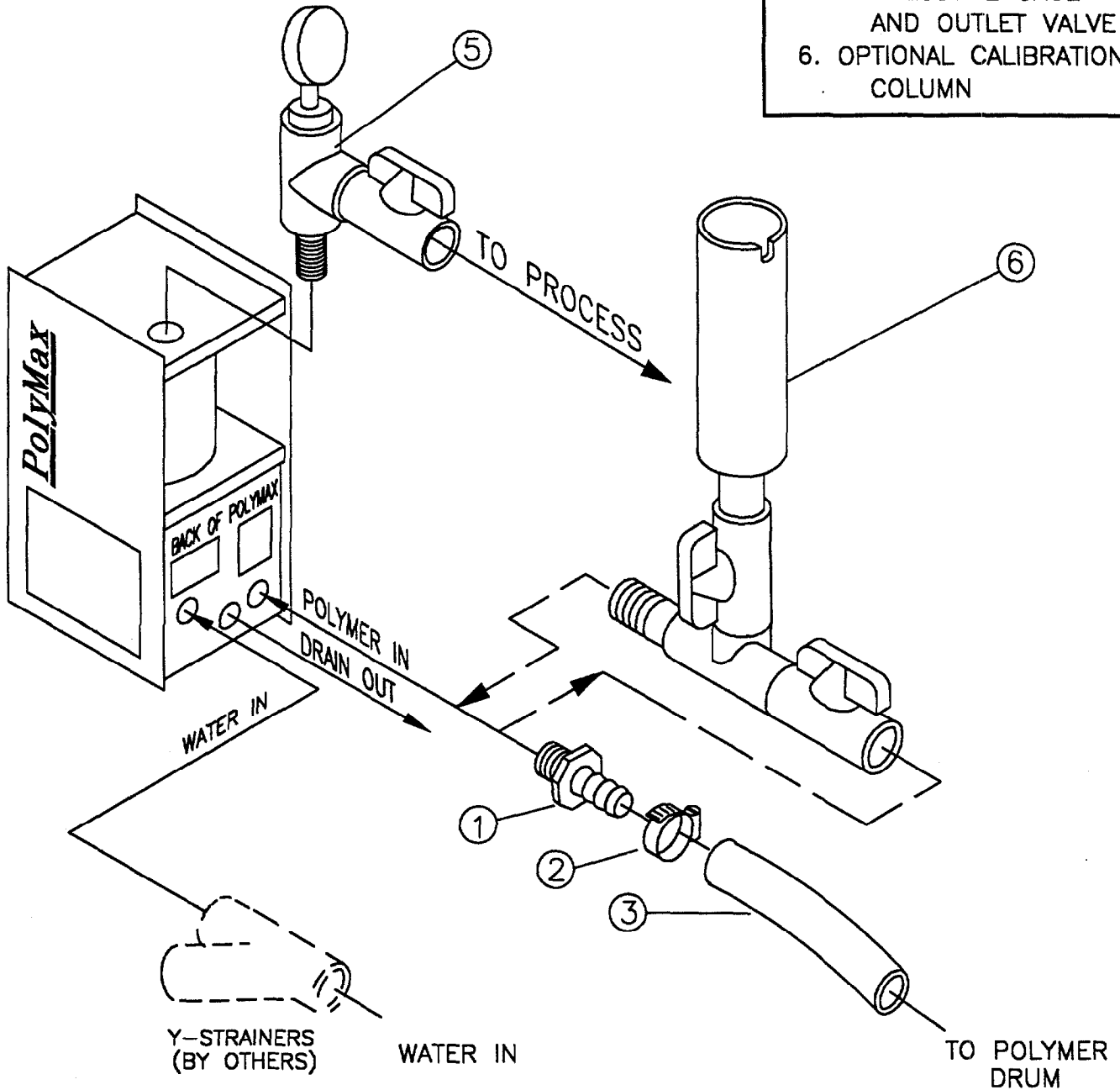
POLYMAX	
ELECTRICAL SCHEMATIC	
DRAWN BY	APP'D
DDM	<i>[Signature]</i>
SCALE	DRAWING NO.
N.T.S.	1856-EL-
	DATE
	01/06/93

MODELS 4001 TO 4005

TYPICAL ASSEMBLY
INSTALL COMPONENTS TO ACCOMODATE SYSTEM.

LOOSE ITEMS BY SEMBLEX

1. MNPT HOSE BARB, PVC
2. STAINLESS STEEL HOSE CLAMP
3. VINYL TUBING
4. NOT USED
5. OUTLET ASSEMBLY WITH PRESSURE GAGE AND OUTLET VALVE
6. OPTIONAL CALIBRATION COLUMN



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

POLYMAX

LOOSE ITEMS

DRAWN BY DLK

APP'D

DRAWING NO.

SCALE N.T.S.

DATE 11/29/93

1856-LI-01-05

List of Accessories

POLYMAX MODELS 4001 TO 4005

STANDARD ACCESSORIES WITH POLYMAX

PART NO.

POLYMAX SPARE PARTS KIT	4100	←
INLET WATER LOW FLOW SHUTDOWN SWITCH	4124	←
METERING PUMP PRIMING KIT	4127	←
(STANDARD ON UNIT WITH DIAPHRAGM PUMP)		

OTHER ACCESSORIES AVAILABLE FROM POLYMAX:

FLOOR STAND		
304 STAINLESS STEEL	4102	←
WALL SHELF		
304 STAINLESS STEEL	4104	
PRESSURE RELIEF VALVE	4105	
WATER PRESSURE REGULATOR AND GAUGE		
1/2 INCH	4110	
1 INCH	4112	
PUMP CALIBRATION KIT		
GRADUATED CYLINDER, BALL VALVE, AND TUBING FOR CONNECTION TO POLYMAX PUMP INLET		
250 ml	4114	←
2000 ml	4115	
4000 ml	4116	
DRUMPIPE/STANDPIPE - FOR INSERTION INTO VERTICAL		
55 GAL. DRUM TO ENABLE COMPLETE DRAINING	4119	←
POST DILUTOR - ADDITIONAL DOWNSTREAM DILUTION WITH VALVE, ROTAMETER, AND IN-LINE MIXER ASSEMBLY		
72-600 GPH	4121	
120-1200 GPH	4122	

List of Accessories

POLYMAX MODELS 4001 TO 4005

<u>OTHER ACCESSORIES AVAILABLE FROM POLYMAX - CONTINUED:</u>	<u>PART NO.</u>
55 GALLON DRUM CART AND STAND - FOR MOVING DRUMS AND TO ALLOW HORIZONTAL DRAINING	4129
55 GALLON DRUM DOLLY	4132
BACK FLOW PREVENTER	
LOW HAZARD, 1/2"	4133
LOW HAZARD, 3/4"	4134
HIGH HAZARD, 3/4"	4135
METERING PUMP SPARE PARTS KIT	4138
EXTENDOR, PROVIDES 28 GAL. ADDITIONAL DETENTION FOR AGING	4140
DRY POLYMER MIXER - PREPARATION UNIT, GIVES YOUR POLYMAX DRY POLYMER CAPABILITIES	4143
DRUM PLUG WRENCH	4147
DRUM ADAPTER - FOR DRAINING DRUMS IN THE HORIZONTAL POSITION	4149
DRUM PRESSURE - VACUUM RELIEF VALVE - 2 IN DRUM BUNG	4150
REMOTE CONTROLLER - DIAPHRAGM PUMP	4151
CORPORATION STOP	4152
DIGITAL CONTROLLER (4-20 mA) - DIAPHRAGM PUMP	4153
REMOTE/MANUAL CONTROLLER (4-20 Ma) - DIAPHRAGM PUMP	4156
REMOTE CONTROLLER (4-20 mA) - DIAPHRAGM PUMP	4157
NEMA 4X ENCLOSURE - POLYMAX CASE - FRP	4158
NEMA 4X ENCLOSURE - REMOTE/MANUAL CONTROLLER - SS	4159
STAINLESS STEEL POLYMAX CASE	4160
EXPLOSION PROOF CONSTRUCTION	4161

OTHER SPECIAL EQUIPMENT CAN BE ASSEMBLED TO YOUR SPECIFICATIONS





SPECIFICATION

STANDARD POLYMAX SPARE PARTS KIT

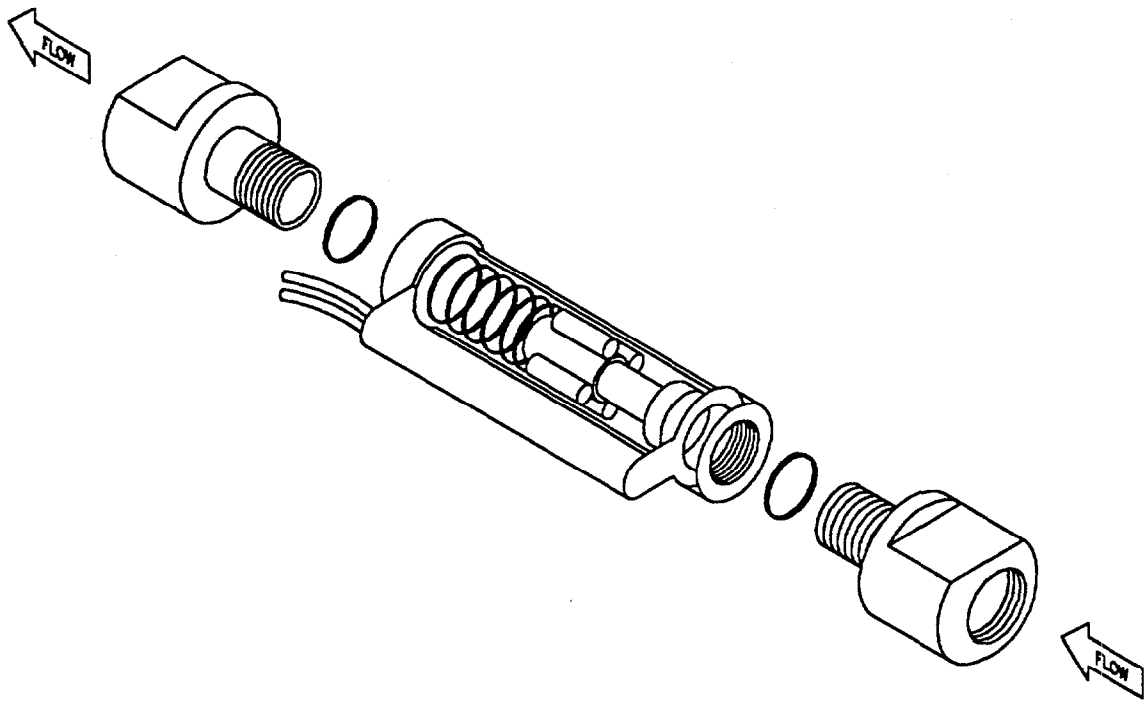
<u>Quantity</u>	<u>Description</u>	<u>Part No.</u>
(2)	Instrument Light Bulb	4238
(2)	O-Ring for Pipe Unions	4241



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

		POLYMAX	
		SPARE PARTS KIT	
DRAWN BY	DLK	APP'D	DRAWING NO. 1856-4100
SCALE	N.T.S.	DATE	
		1/29/93	



SPECIFICATIONS

LOW WATER FLOW SHUTDOWN SWITCH

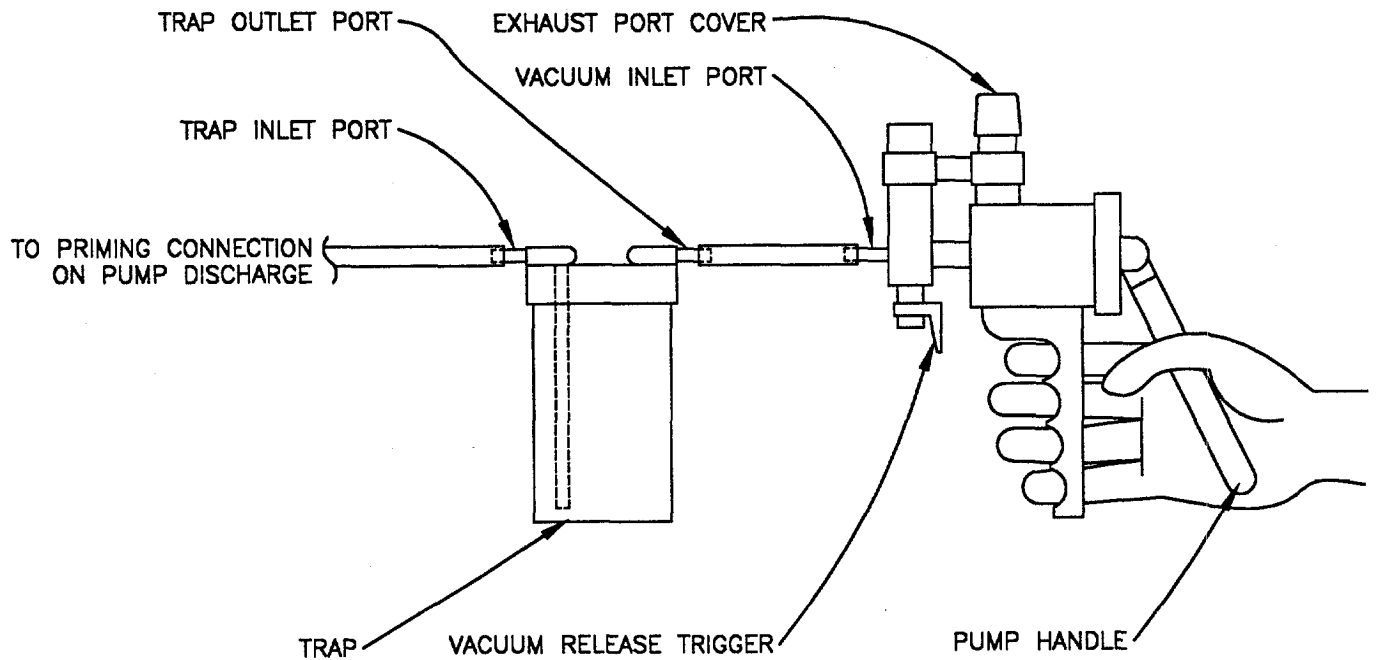
MANUFACTURE:	COMPAC ENGINEERING INC.
SERIES:	5-21-PP
NUMBER:	3958
ADJUSTABLE RANGE:	FIXED
PORT SIZE:	1/4 IN. NPT FEMALE ADAPTORS
MAXIMUM OPERATING TEMPERATURE:	194°F
BODY & SHUTTLE CONSTRUCTION:	POLYPROPYLENE
OTHER WETTED PARTS:	SPRING: TITANIUM METAL O-RINGS: FLOROCARBON RUBBER
PRESSURE RATING:	200 PSI
SET POINT:	PRESET AT 6 GPH
SWITCH:	SPST, 3.36 VA
LEAD WIRES:	NO. 20 AWG
LENGTH:	3 9/16 IN.
WIDTH:	1 1/8 IN.



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

		POLYMAX	
		WATER FLOW SWITCH	
DRAWN BY	DJH	APP'D	DRAWING NO. 1856-4124C
SCALE	N.T.S.	DATE		5/13/93



CAUTION:

1. DO NOT try to disassemble the pump. It is self lubricating and permanently sealed at the factory.
2. DO NOT allow liquids to be drawn into pump. They will attack the internal mechanism.
3. STOP pumping when fluid enters trap.
4. Vapors from volatile acids and solvents will also harm the inside of the pump. If liquids or vapors should inadvertently be pumped into the unit, remove exhaust port cover and quickly flush unit thoroughly with clean water. Aim pump so that no harm is done when liquid shoots from exhaust port. Replace cover, and pump in air to dry out
5. DO NOT immerse pump or use solvents for cleaning. Simply wipe with mild detergent solution to remove surface dirt.

HOW TO USE:

1. Before using your new pump, look for the vacuum release trigger. (See above illustration). MAKE SURE THE TRIGGER IS CENTERED BEFORE PUMPING TO ASSURE CORRECT OPERATION AND PREVENT VACUUM LEAKS.
2. Attach one end of tubing to the vacuum inlet port of the pump and the other end to the trap outlet port, making sure the connections are tight.
3. Attach one end of the second piece of tubing to the priming petcock provided on the discharge side of the diaphragm pump and the other end to the trap inlet port.
4. Begin the squeezing pump handle until polymer enters the trap. Air is exhausted at the rate of 16cc/stroke.
5. If the vacuum doesn't hold, move trigger gently, and make sure it's centered before pumping again.
6. Pressing the vacuum release trigger will release all or part of the vacuum without disconnecting the pump from the line.



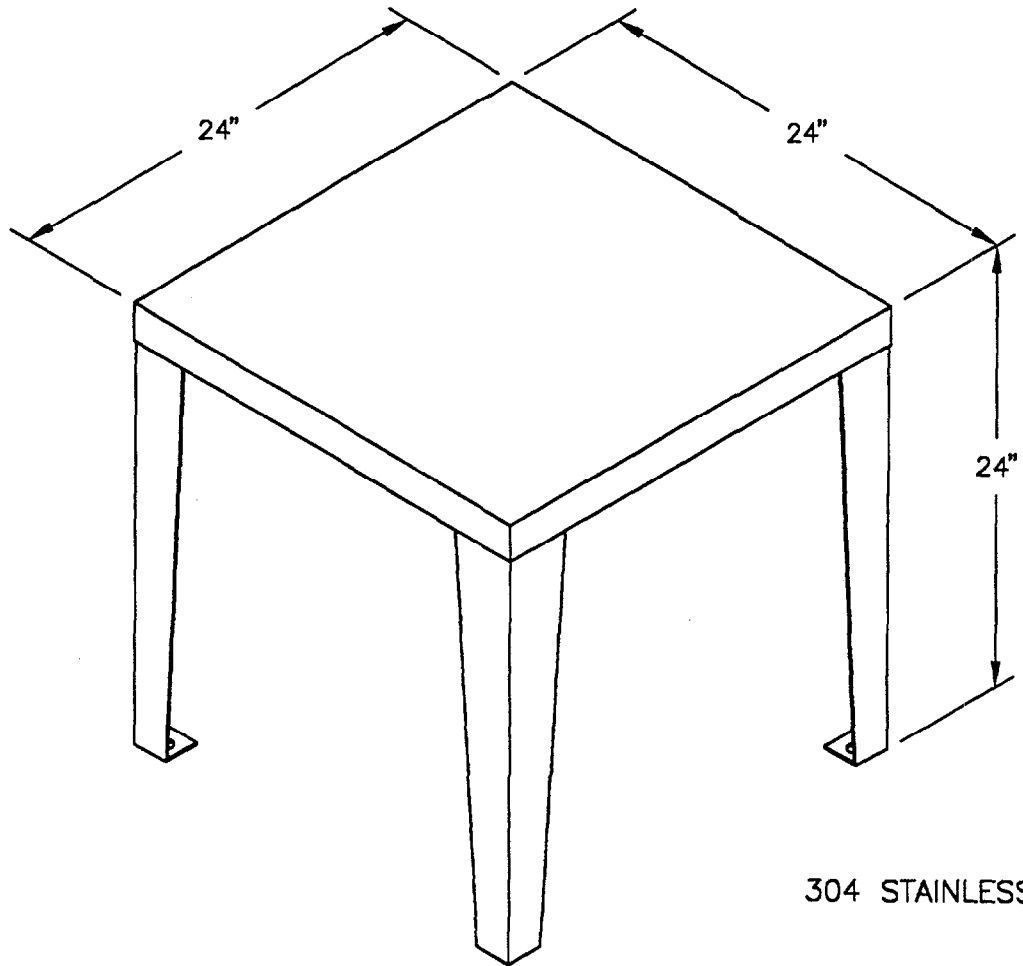
SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

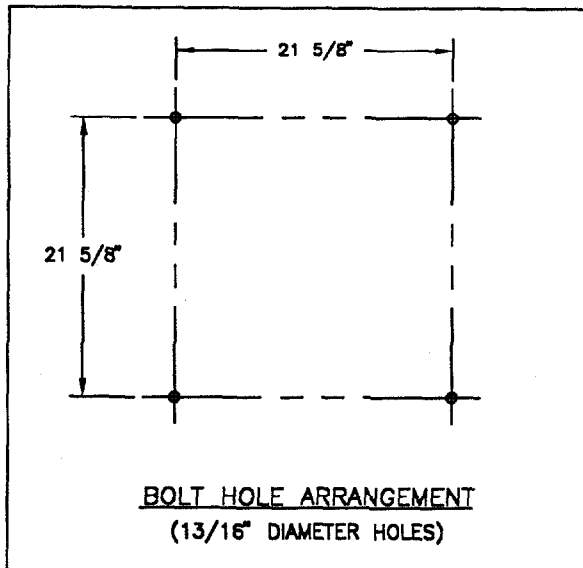

POLYMAX
HAND PRIMING PUMP

DRAWN BY DJH APP'D DATE 6/13/95
SCALE N.T.S.

DRAWING NO. 1856-4127

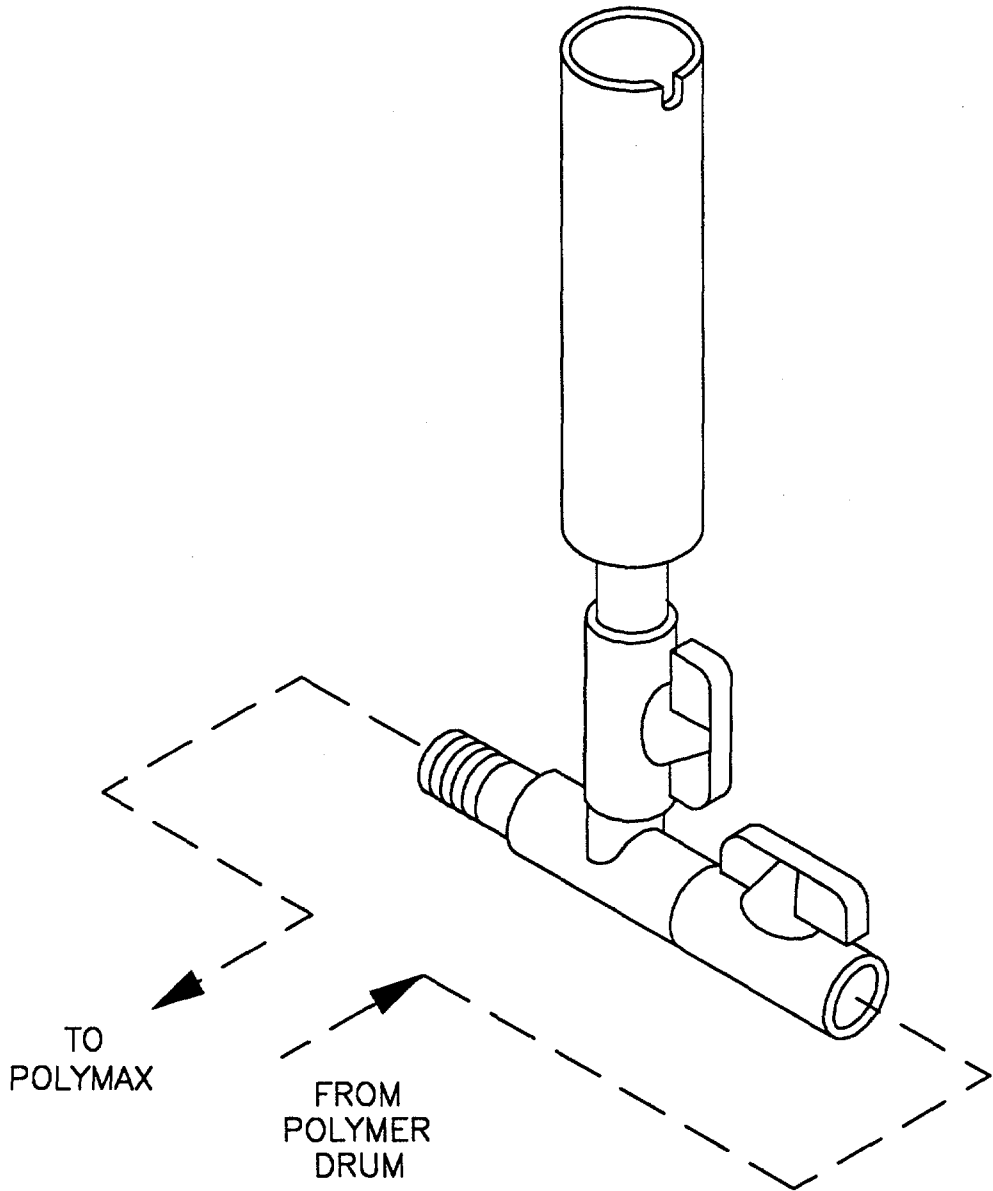


304 STAINLESS STEEL





SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS
SPRINGFIELD, MISSOURI

		POLYMAX	
		FLOOR STAND	
DRAWN BY	DLK	APP'D	DRAWING NO. 1856-4102
SCALE	N.T.S.	DATE		12/01/93



4114.20	500 ML, 1/2" PIPE
4114.10	250 ML, 1/2" PIPE
PN	DESCRIPTION



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS
SPRINGFIELD, MISSOURI

POLYMAX		DRAWING NO. 1856-4114.20
CALIBRATION KIT		
DRAWN BY O.D.C.	APP'D <i>[Signature]</i>	
SCALE N.T.S.	DATE 5/6/94	

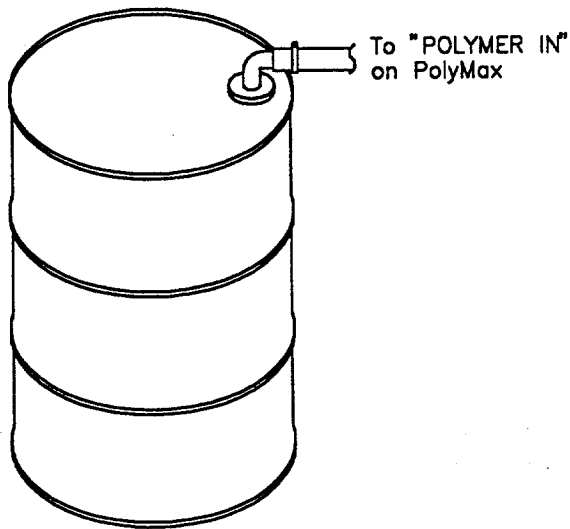
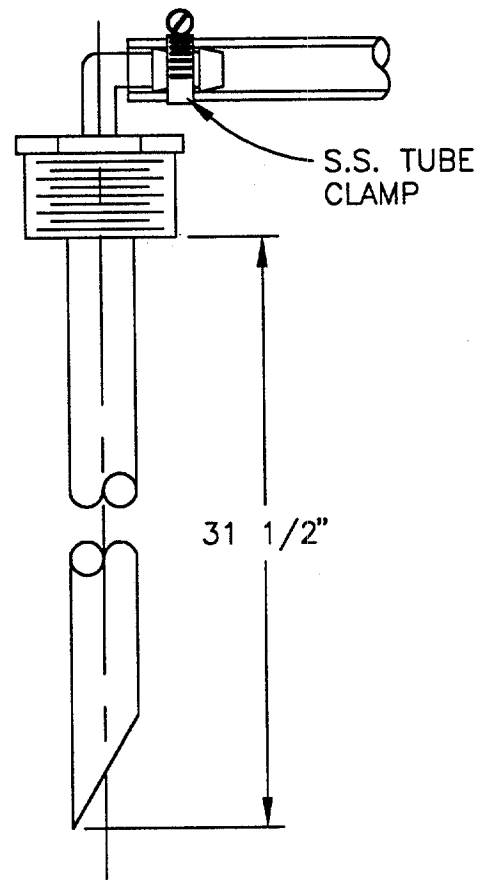


Illustration 1

DRUMPIPE-STANDPIPE™



INSTALLATION INSTRUCTIONS:

1. Position the drum so the drum bung is on top of the drum.
(see illustration 1)
2. Insert the pipe into the 55 gal. drum in the vertical position.
3. Hand tighten the 2 inch NPT threaded drum fitting into drum bung.
4. Connect 5/8 inch tubing from pump inlet to tube fitting on the DRUMPUMP-STANDPIPE using S.S. tube clamps, provided with the PolyMax.
5. Position the S.S. tube clamps over the hose barb as shown above.
6. Tighten the S.S. tube clamps snugly.

SAFETY NOTE:

Before opening the sealed drum, obtain a copy of the Material Safety Data Sheet (M.S.D.S.). Read the M.S.D.S. and use safe handling procedures for the polymer.



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

DRAWN BY DLK

SCALE N.T.S.

APP'D

DATE 6/12/95

POLYMAX

DRUMPIPE-STANDPIPE™

DRAWING NO.

1856-4119

Section 5

Installation Of The PolyMax

5-A RECEIVING & UNPACKING

PolyMax will arrive in a protective box or wooden crate.

Inspect the equipment for any evidence of shipping damage or loss. It is important to make a written note on the receiving copy of the Bill of Lading.

With the box or crate upright, remove the top and sides. Lift the PolyMax from the box or crate. Insure the following items are also received:

1. 4 ft. of 5/8 in. vinyl tubing
2. Stainless steel hose clamps (2)
3. Suction tubing adaptor fitting
4. Outlet assembly with pressure gauge and ball valve.
5. Two spare O-rings for pipe unions
6. Two spare instrument lamp bulbs
7. Hand priming pump kit and collection bottle.

Check the Shipping List for the various items provided to fulfill the order.

Carefully examine the PolyMax for any concealed damage which may have occurred in shipment.

To file a freight claim, immediate notification of the freight carrier is necessary.

Disregard any condensation of moisture in the detention chamber. All PolyMax units are factory tested prior to shipment; therefore, some moisture may remain after these tests.

5-B LOCATION OF THE UNIT

Proper location of the PolyMax is important for long-term operation.

POLYMER INLET ARRANGEMENT

The more viscous the concentrated "neat" polymer, the more important the location. Locate your PolyMax as close to the concentrated polymer container as possible.

Positioning the unit next to a 55 gallon drum of polymer is ideal. Use of the optional PolyMax Floor Stand, PN 4102, will facilitate ease of operation.

The concentrated polymer diaphragm pump has inlet suction capabilities that vary depending on the viscosity of polymer.

CAUTION!

The maximum suction lift capability is about 3.5 ft. for the diaphragm pump.

It is best to locate the polymer drum on the same level as the polymer inlet to the PolyMax unit. This will allow the diaphragm pump to properly meter the concentrated polymer.

CAUTION!



Avoid Direct Sunlight and Non-potable Water.

If the PolyMax is located in direct sunlight, algae may build up within the labyrinth detention chamber in some cases. If non-potable water is being used for dilution, direct sunlight will accelerate algae growth.

5-C UTILITIES AND FACILITIES REQUIRED

The following services must be available for proper operation:

1. Electrical Power

Electrical connection to a 120 Volt, grounded circuit according to the code requirements for the operating environment.

2. Inlet Dilution Water

A potable water source with at least 50 psig, minimum, inlet water pressure and sufficient flow volume for the maximum dilution water flow is required. If available, 60-65 psig inlet water pressure is ideal.

3. Close to Polymer Concentrate

The PolyMax should be installed as close as possible to the polymer concentrate container or supply.

4. Storage for Polymer Concentrate

An open area for moving and storing polymer concentrate containers may be needed. This, of course, depends upon the design of the plant, the type of polymer concentrate, and the amount of polymer concentrate used per day or month.

5-D CONNECTIONS AND HOOK-UP

On the back of the PolyMax Unit are several connection points.

CAUTION!

To avoid breaking the plastic parts, use extra special care when installing!

Do NOT use teflon tape on any part of the PolyMax Unit!

CAUTION! (CONTINUED)

Use Rectorseal No. 5 or other soft set thread sealant approved for use on PVC pipe.

Do NOT use metal pipe thread sealant. This may cause the fittings to break!

All fittings should be hand tight!

Do not tighten pipe fittings or assemblies with pliers, pipe wrenches, or other tools!

Use a strap wrench only when absolutely necessary.

THE CONNECTION POINTS ARE:

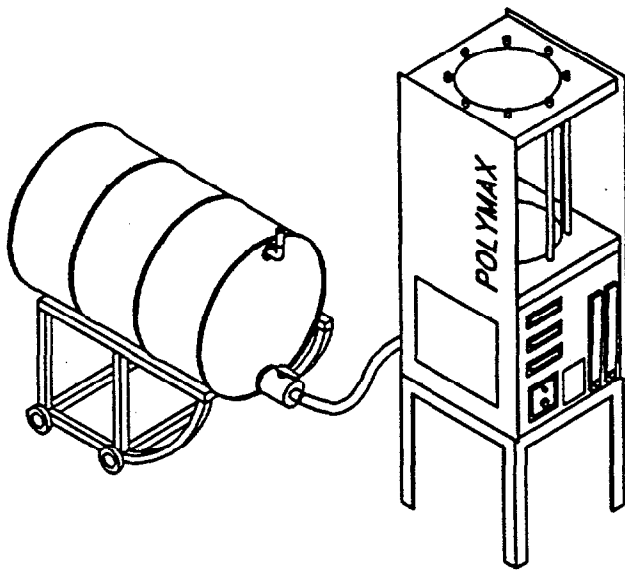
1. Polymer Inlet

Use the suction tubing hose barb adapter supplied with the PolyMax and flexible vinyl tubing to connect the polymer source to the polymer inlet.

The polymer concentrate may be supplied in 5 gallon containers, 55 gallon drums, portable tanks, or from bulk storage tanks.

POLYMER FEED FROM A DRUM





The ideal configuration for polymer feed from a drum is to use the Semblex Drum Cart, PN 4129.

A valved connection with a hose barb fitting must be screwed into the 2-inch drum outlet bung.

Connect the polymer concentrate drum outlet to the PolyMax polymer inlet. Use the drum cart/cradle to tip the drum into a horizontal position.

A quick connection system and drum vent is also suggested, such as the Horizontal Drum Adapter, Semblex PN 4149.

Another alternative is to insert flexible tubing to the bottom of a vertical polymer drum or other container, after priming the pump.

During operation, watch for air bubbles within the clear tubing. These air bubbles may "vapor lock" the pump and cause the pump to lose suction. This may appear as an unexplained loss of pump priming.

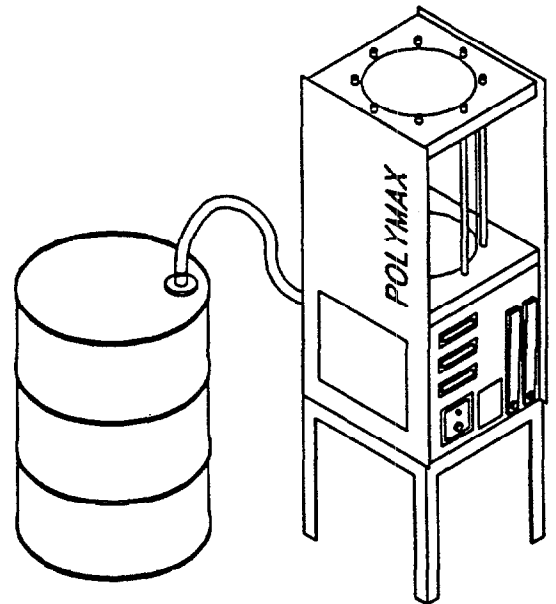
Alternatively, the Semblex Drumpipe -

Standpipe, PN 4119, may be purchased from Semblex.

The Drumpipe - Standpipe provides a rigid suction pipe with a special drum fitting.

The Drumpipe - Standpipe assures more complete emptying of the polymer drum and complete use of the valuable polymer concentrate.

A simple "straightener" pipe may be made by drilling several holes through the bottom of a 1-1/2 inch PVC pipe with its length slightly taller than the drum.



Insert this PVC pipe into the drum and slip the flexible tubing into this "standpipe".

Many suppliers will provide polymer concentrates in portable tanks or in bulk quantities. Depending upon the amount of polymer used at the plant, the operator will have improved ease of operation.

Potential cost savings may also be provided by using the larger containers or bulk containers.

2. Water Inlet

This is the water inlet for preparing the diluted polymer solution. The fitting may be connected to a hose or rigid pipe.

The water pressure at the PolyMax inlet must be a minimum of 50 psig for proper operation.

The volume of water available at this pressure must provide enough flow for the unit maximum water setting.

The pressure drop across the PolyMax, when diluting polymer concentrates at maximum flow, is about 15 to 20 psig.

Semblex recommends the installation of a shut off valve on the inlet water supply line. The valve should be located as close as possible to the PolyMax unit.

Potable water is recommended to prepare and dilute the polymer concentrate.

If non-potable water is used, it must be clean and free of suspended solids.

A filter or Y-strainer should be installed on the inlet water to keep various solids out of the inlet water piping, water solenoid valve, and water flow switch.

The suspended solids will consume a portion of the prepared polymer solution, coagulate suspended solids, and dramatically increase the need to clean the detention chamber.

If potable (tap, city, or drinking) water is used for dilution, a back flow preventer

must be installed on the water line. This prevents the back flow of diluted polymer into the water supply line.

Consult your City, State, or Local Codes for the exact device required. A PolyMax accessory, the back flow preventer, PN 4133, PN 4134, or PN 4135 (See Section 4, Accessories) may be purchased for this purpose.

Semblex will need the exact Code requirements before supplying a back flow preventer. Installation of the back flow preventer is the responsibility of the Owner/Operator.

3. Diluted Polymer Output To The Process

The outlet is located on the top or back of the unit. Connect the piping from the outlet of the PolyMax to the injection point.

Important: The injection point should be ahead of a pump or into an "atmospheric" tank.

The inlet water pressure should be at least equal to the pressure drop across the PolyMax plus the discharge head.

4. Reserved

5. Drain

The drain outlet connection is located on the back of the unit and is used to drain the labyrinth and the internal piping. The drain is also used for back-flushing and cleaning the PolyMax.

PolyMax units are provided with clear, vinyl

tubing which is precut to allow for easy assembly.

Connect the drain to a safe location, such as a floor drain.

Please see the drawings located in Section 4 for help in assembling the drain system.

6. Reserved

7. Electrical Connection

See Section 4, Electrical Schematic, for information about the electrical connections. The Schematic will show the necessary electrical wiring connections for the options included with this system.

The standard PolyMax may be plugged into any standard, grounded, 15 or 20 amp, fused electrical outlet.

WARNING!

Follow plant safety rules before opening the control panel or any electrical enclosure!

If provided with a power cord, do not remove the grounding pin on the plug as the operator could be dangerously shocked.

The supply amperage requirement varies from approximately 4 to 7 amps on units with a diaphragm metering pump.

Some units are provided with terminals for direct power input into the unit.

Units may be provided with optional terminals for interface with control systems.

Typical connections may include Remote Start - Stop terminals, alarm, polymer unit failure, run signal contacts or other interconnections.

If the polymer concentrate metering pump provided is to follow a 4-20 mA, 24 VDC, input signal by others, the PolyMax must be connected to this signal.

See the Electrical Schematic included in Section 4 for more information.

8. Start-Up

With the Polymax installation complete, the system is ready for start up.

Additional start up and operation information is presented within Section 6, Operation of the PolyMax.

Priming of the polymer concentrate metering pump is described in Section 6, Operation of the PolyMax, included in this manual.

With the:

- Inlet water connected
- Polymer supply available
- Outlet connection installed
- Electrical power available

the system is ready for start up and operation.

Section 6

Operation Of The PolyMax

Operation of the PolyMax is quite simple.

Once set and calibrated, the unit needs only periodic monitoring to insure sufficient polymer concentrate will be available.

One should check to see that the inlet water supply is available.

Before start up of the unit, check the following:

1. Installation

Assure the PolyMax was installed using the information presented in Sections 4 and 5 of this manual.

Assure that all piping connections to the PolyMax are secure and leak free before starting the unit.

Test the PolyMax installation with dilution water. Potential leaks are much easier to fix before the polymer concentrate is added to the system.

The polymer concentrate will make the solution very slick and uncomfortable to work around.

2. Read

Read the instruction manual and be thoroughly familiar with the operation of the unit before starting.

3. Electrical Switches

Assure all electrical switches on the front panel, metering pump control panel, and any

other special switches or disconnects are in the "Off" position.

4. Inlet Water Rotameter Valve

Each inlet water rotameter valve, immediately below the rotameter on the front of the unit, should be closed. The valve is closed when turned all the way clockwise.

6-A RESERVED

6-B INLET DILUTION WATER SYSTEM

1. Type of Inlet Dilution Water

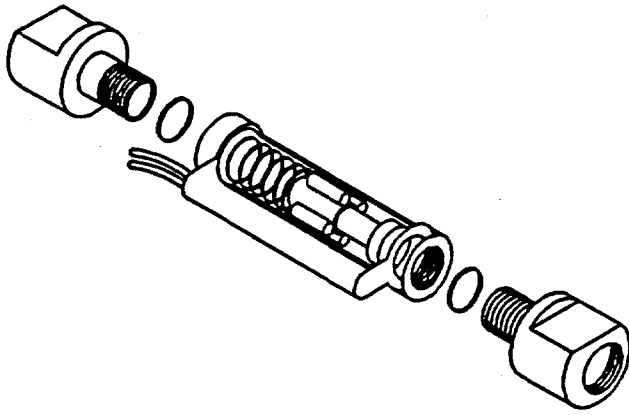
Potable water is recommended to mix polymer concentrate. Polymer concentrate is an organic chemical and is an ideal food for microbes.

Polymer left in a blending unit, even overnight, can rapidly go septic contributing to bacteria growth on the inside of PolyMax.

If non-potable water is used, an inlet water filter or strainer plus periodic flushing with household bleach is recommended.

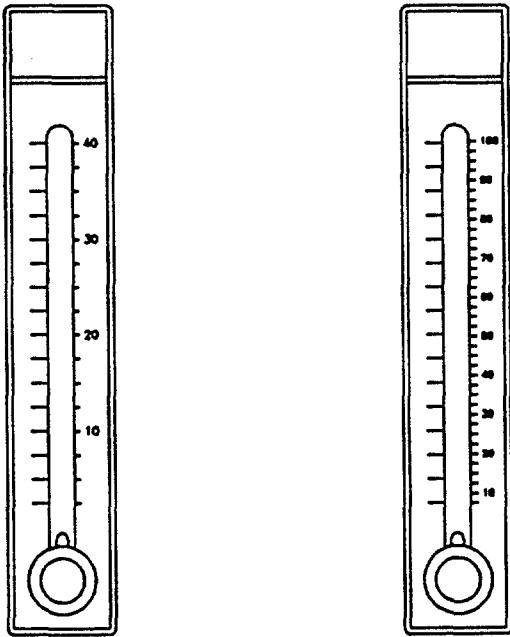
2. Inlet Dilution Water

Allow the inlet dilution water to flow through the PolyMax during start up. A low water flow switch will keep the metering pump "Off" until sufficient water is flowing through the PolyMax.



The metering pump will not start until enough water is flowing through the PolyMax for proper dilution.

Ideal inlet water pressure for the PolyMax is 60-65 psig.



40 GPH OR 100 GPH

INLET WATER ROTAMETER

Do not open the inlet water rotameter adjusting valve too far. The valve may "pop out" for maintenance. This could cause an unexpected flow of water out of the valve body.

Balance the water flow before starting the metering pump.

3. Reserved

4. Set the Secondary Rotameter

The Secondary Rotameter, if supplied, is used for downstream dilution.

The rotameter must be set at a flow equal to or less than the flow of the Primary Rotameter.

This will prevent a venturi action which causes a lowering of the level in the aging - detention chamber.

5. Inlet Water Pressure

The PolyMax uses the incoming water pressure and metering pump injection pressure as the energy source to mix and activate the polymer and water mixture.

The pressure drop across the PolyMax, during normal operation with polymer concentrate, will vary from 15 to 20 psig.

The pressure drop depends on the polymer used, the polymer concentration, the volume of flow through the unit, and other components in the piping system to the process.

6. Reserved

6-C POLYMER CONCENTRATE SYSTEM

1. Reserved
2. Set the Metering Pump

The polymer concentrate pump will have to be set for the needed pumping volume.

During start up, set the pump at a low flow rate, for example, say 10 to 20 percent of capacity, then gradually increase the metering pump capacity to the desired output.

The best pump setting on the diaphragm pump is a low stroke length setting (bottom dial) and a higher speed setting (upper dial).

The objective is to minimize the volume of each pumping stroke and maximize the number of strokes.

3. Changing Polymer Concentrates

CAUTION!

If the type of polymer concentrate is changed, make sure the PolyMax is thoroughly cleaned, leaving no residue of the first polymer.

Some polymers react with each other and create a "silicone rubber" type blockage.

The PolyMax must be thoroughly cleaned and the metering pump must be free of the old polymer.

See Section 8-A, Shutdown and Cleaning, for more information.

4. Priming of the Polymer Concentrate Pump

Depending on the PolyMax Model, size, and type of pump, the metering pump may require priming for initial operation.

On "water-like" additives, priming may not be necessary as the pump does have some suction capabilities.

On more viscous polymers manual priming may be necessary.

THE PUMP WILL NOT RUN UNLESS SUFFICIENT WATER IS FLOWING THROUGH THE POLYMAX FOR DILUTION

If the PolyMax is connected to a bulk tank or other polymer concentrate transfer piping system, great patience may be required.

All the air will have to be removed from the bulk piping system.

Systems using Mannich type polymer concentrate can be especially difficult to prime. Due to the high viscosity of the polymer concentrate, several minutes or even an hour or more may be needed for the Mannich polymer to fill the piping system.

TO PRIME THE METERING PUMP:

METHOD A

Insert the vinyl tubing into the drum of polymer concentrate.

Start the dilution water and metering pump.

Observe the polymer tubing.

See if the pump, by itself, transfers liquid polymer.

Open the priming valve and allow air to

escape from the system.

One should see movement of the liquid polymer concentrate toward the PolyMax Unit.

When you see the pump head fill with polymer, close the priming valve.

If the pump does not self-prime after 4 to 5 minutes, proceed to **Method B**.

CAUTION!

DO NOT OPERATE THE PUMP "DRY" FOR OVER 5 MINUTES OR THE PUMP MAY BE DAMAGED.

METHOD B

The hand priming pump may be used to pull a vacuum at the priming valve. Each metering pump has a vent/priming valve (labcock) on the pump outlet.

Connect the hand priming pump to the clear tubing.

With the priming valve open and using the hand priming pump, pull a vacuum on the system. This will draw the air out of the system and the polymer concentrate into the pump head.

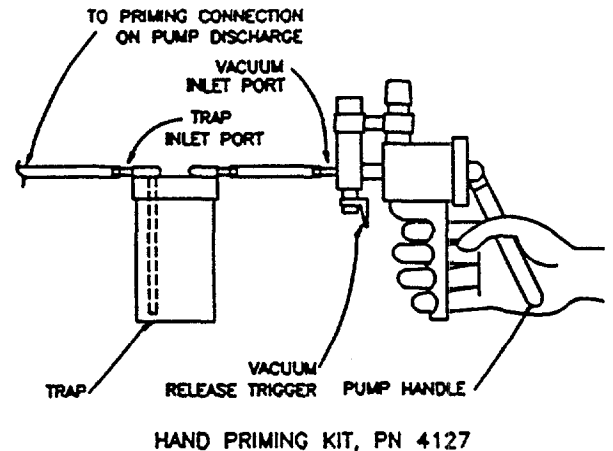
When you see the pump head filled with polymer, close the priming valve.

CAUTION!

Be careful not to draw polymer into the hand priming pump reservoir.

Immediately clean the priming pump and

reservoir with warm water, if contaminated with polymer.



METHOD C

Hold the loose end of the transfer hose above the pump and fill with polymer.

Turn the pump - water switch "On" and allow the pump to operate for a few seconds filling the pump head.

Turn off the pump and refill the hose.

Submerge the end of the tube into the polymer concentrate container.

The pump is now primed and ready for operation.

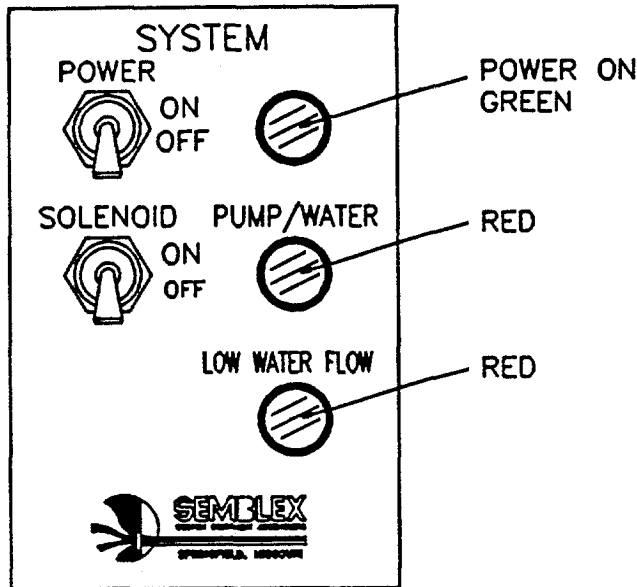
6-D CONTROL PANEL

The NEMA 4X enclosed control panel on the front of the PolyMax unit may have two or three switches and lights depending on the size and type of unit. Please see Section 4 for optional equipment included with this unit.

Additional control panel instructions may be

included within Section 4.

1. The "On - Off" switch (green light) turns the main power to the unit on or off.



2. The pump selector switch provides power to the metering pump and the inlet water solenoid valve.
3. An internal convenience light is energized when the main power is on.
4. Each individual pump also has its own "On - Off" controls. The controls for the diaphragm pump are located on the front of the pump.

6-E INLET DILUTION WATER AND PUMP SETTINGS

Before starting the unit, the operator should have some idea of the dosage rate, amount of polymer required, and the percent diluted polymer concentration needed by the process.

This data is obtained from laboratory jar tests, dewatering tests, or prior experience.

Generally, to coagulate suspended solids in water or waste water, a good starting point might be 3-5 parts per million (mg/l) polymer per volume of water.

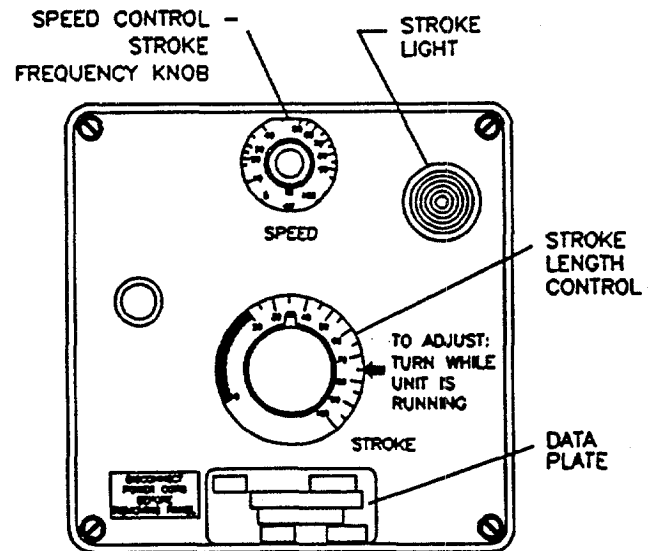
For dewatering, start with 15 pounds of polymer per ton of dry solids.

Polymers are normally diluted from 0.1 to 0.5 percent by weight (wt. %). That is, 1 to 5 parts of polymer per one thousand parts of water leaving the PolyMax.

6-F SOLENOID OPERATED DIAPHRAGM PUMP

The solenoid operated diaphragm pump has both a stroke length and speed adjustment knob. The two, in combination, determine the output of the pump.

DIAPHRAGM PUMP CONTROL PANEL



The best pump settings for injecting polymer concentrate are to maximize the speed and to minimize the stroke length.

The diaphragm type pump head may clog with contaminated polymer concentrate or other chemicals and will adversely affect the pumping rate.

Check and clean the ball check valves and pump head as necessary.

CAUTION!

The diaphragm pump check valves have small stainless steel balls and springs that can be easily lost.

Make sure upon reassembly that all balls and springs are properly located.

Check the black hypalon O-ring seat under the stainless steel ball checks. The O-rings do require replacement periodically. If the pump seems to be losing capacity, new O-rings may be needed.

WARNING!

DO NOT USE TEFLON TAPE TO SEAL THE CHECK VALVE ASSEMBLY! THE TEFLON TAPE COULD CAUSE THE PUMP HEAD TO CRACK, LEAK, AND FAIL.

If the check valve is leaking, either the O-ring should be replaced or the tube fitting should be reconnected.

See the diaphragm type polymer concentrate pump instructions included within Section 10 of this Manual.

DIAPHRAGM PUMP AND DILUTION WATER SETTINGS

EXAMPLE CALCULATIONS:

Formula:

Maximum
Pump Output X Speed X Stroke = Capacity

Example (1)

Maximum pump output 8 gph
Speed setting 75%
Stroke length setting 30%

$$8 \text{ gph} \times 0.75 \times 0.30 = 1.8 \text{ gph}$$

Example (2)

Maximum pump output 8 gph
Speed setting 100%
Stroke length setting 25%

$$8 \text{ gph} \times 1.00 \times 0.25 = 2.0 \text{ gph}$$

Example (3)

Maximum pump output 1 gph
Speed setting 50%
Stroke length setting 50%

$$1 \text{ gph} \times 0.50 \times 0.50 = 0.25 \text{ gph}$$

Example (4)

Maximum pump output 4.5 gph
Speed setting 100%
Stroke length setting 75%

$$4.5 \text{ gph} \times 1.00 \times 0.75 = 3.38 \text{ gph}$$

DILUTED POLYMER SOLUTION - BY VOLUME

To prepare a certain percent concentration of dilute polymer solution, the following calculations need to be made.

Example (5)

Prepare 400 gph of 1/2 (0.5) percent by volume dilute polymer for use in dewatering of sludge. The maximum capacity of the polymer concentrate pump is 8 gph.

- a. Set the Primary Rotameter at 400 gph or 6.6 gpm

$$400 \text{ gph} \div 60 \text{ min/hr} = 6.6 \text{ gpm}$$

- b. Set the Secondary Rotameter, if supplied, at zero

- c. Calculate the volume of polymer concentrate needed.

$$400 \text{ gph} \times 0.005 = 2.0 \text{ gph}$$

- d. Since the pump has two adjustment knobs, many operators leave the speed setting at 100% and adjust the stroke downward.

$$\text{Stroke} = (2 \text{ gph} \div 8 \text{ gph}) \times 100 = 25\%$$

Hence, set the stroke length knob at 25 percent.

Example (6)

Assume 400 gph of diluted polymer solution, at a concentration of one (1) percent, by volume is desired. Again, assume the polymer concentrate pump has a maximum capacity of 8 gph.

- a. Set the Primary Rotameter at 400 gph or 6.6 gpm

$$400 \text{ gph} \div 60 \text{ min/hr} = 6.6 \text{ gpm}$$

- b. Set the Secondary Rotameter, if supplied, at zero

- c. Calculate the volume of polymer concentrate needed.

$$400 \text{ gph} \times 0.010 = 4.0 \text{ gph}$$

- d. Since the pump has two adjustment knobs, many operators leave the speed setting at 100% and adjust the stroke downward.

$$\text{Stroke} = (4 \text{ gph} \div 8 \text{ gph}) \times 100 = 50\%$$

Hence, set the stroke length knob at 50 percent.

Example (7)

Units with secondary dilution or Post Dilution

Assume 800 gph of 0.4 vol % polymer and a polymer concentrate pump with a maximum capacity of 4.5 gph.

- a. Calculate the volume of polymer concentrate needed.

$$800 \text{ gph} \times 0.004 = 3.2 \text{ gph}$$

- b. Since the pump has two adjustment knobs, many operators leave the speed setting at 100% and adjust the stroke downward.

$$\text{Stroke} = (3.2 \text{ gph} \div 4.5 \text{ gph}) \times 100 = 71\%$$

Set the stroke length knob at about 71 percent.

- c. Set the Primary rotameter to 7 gpm (420 gph)

- d. Primary Water Volume +
Secondary Water Volume +
Polymer Pump Volume =
Total Diluted Polymer Volume

Therefore:

$$\begin{aligned} & \text{Total Diluted Polymer Volume} - \\ & \text{Primary Water Volume} - \\ & \text{Polymer Pump Volume} = \\ & \text{Secondary Water Volume} \end{aligned}$$

$$800 \text{ gph} - (7 \times 60) \text{ gph} - 3.2 \text{ gph} =$$

$$800 - 420 - 3.2 = 377 \text{ gph}$$

$$377 \text{ gph} \div 60 \text{ min/hr} = 6.3 \text{ gpm}$$

Thus, set the Secondary dilution water rotameter at 6.3 gpm

Note: The Secondary dilution water rotameter should always be set less than or equal to the primary dilution water rotameter.

Many polymers have upward concentration limits on their ability to be diluted and effectively used. This upward concentration limit varies widely.

With many polymers it is from 1.5 to 2.0 percent by weight. Consult the polymer manufacturer for information on the specific polymer in use.

6-G RESERVED

6-H START UP OF THE POLYMAX

1. Check the Valves

- a. Assure both drain valves are closed.
- b. Check the three (3) way valves to see that they are set properly.
- c. Are the inlet dilution water supply valves open?

- d. Be sure the diluted solution outlet valves are open to a safe area!
- e. Close the rotameter valves by turning clockwise.

2. Power

- a. Turn on the power switch
- b. Turn on the pump - water switch. The control panel face will show the available settings.

3. Inlet Dilution Water

WARNING!

Watch the outlet pressure gauge! If the pressure exceeds about 25 psig, an outlet valve may be closed or the injection point may be plugged!

- a. Gradually turn the rotameter adjustment knob counter-clockwise, to increase the inlet dilution water flow rate.
- b. Allow the labyrinth to fill.
- c. Adjust the water flow rate to the required setting.

4. Polymer Concentrate Pump

- a. Prime the pump if needed. See Section 6-C, Part 4.
- b. Adjust the polymer concentrate metering pump to the required setting.

If emulsion polymer concentrate is used, the clear water in the in-line mixers and labyrinth detention chamber will turn milky

colored as the polymer disperses into the water.

If a solution or Mannich type of polymer concentrate is used, the clear concentrate can be seen blending with the dilution water within the in-line mixers.

Once the unit's initial start up is completed and proper settings established, the PolyMax may be switched off and restarted with the "On - Off" switch or other control system.

Section 7

Calibration Of The Metering Pump

Metering pump calibration is generally important only during initial start up of the PolyMax.

Once the polymer dosages are calculated from jar tests or laboratory tests, the data may be used for the full scale plant operation.

The metering pump settings may be calculated using this information.

It is not critical that the inlet dilution water rotameter be calibrated. The dilution water may have a variance of ± 5 percent and will not significantly affect the process.

The viscosity of the polymer concentrate or additive may affect the metering pump capacity.

Thus, a change in the polymer used in the plant may affect the metering pump capacity and performance.

The downstream outlet pressure at the injection point of the diluted polymer solution also has an affect on pump capacity.

To calibrate the pump, all connections should be made and the inlet water rotameter set at approximately 75% of the maximum capacity.

The inlet hose to the metering pump should be inserted into a graduated cylinder of at least 1,000 ml capacity which is filled with polymer concentrate.

Run the metering pump until all the air is purged from the pump inlet.

Refill the graduate, turn on the metering pump and precisely measure the volume of polymer used.

Record the following:

The beginning volume of the polymer concentrate

The ending volume of polymer concentrate

The metering pump settings

And the pumping time.

EXAMPLE: DIAPHRAGM PUMP

Stroke length = 50%

Stroke speed = 100%

Thus: $1.00 \times 0.50 = 50\%$ of capacity

Beginning Volume	980 ml
Ending Volume	<u>760 ml</u>
	220 ml

Pump Time:

$1.8 \text{ min.} \div 60 \text{ min/hr} = 0.03 \text{ hr}$

Volume Pumped:

$220 \text{ ml} \div 3785 \text{ ml/gal} = 0.058 \text{ gal}$

Pump Capacity = Volume \div Time

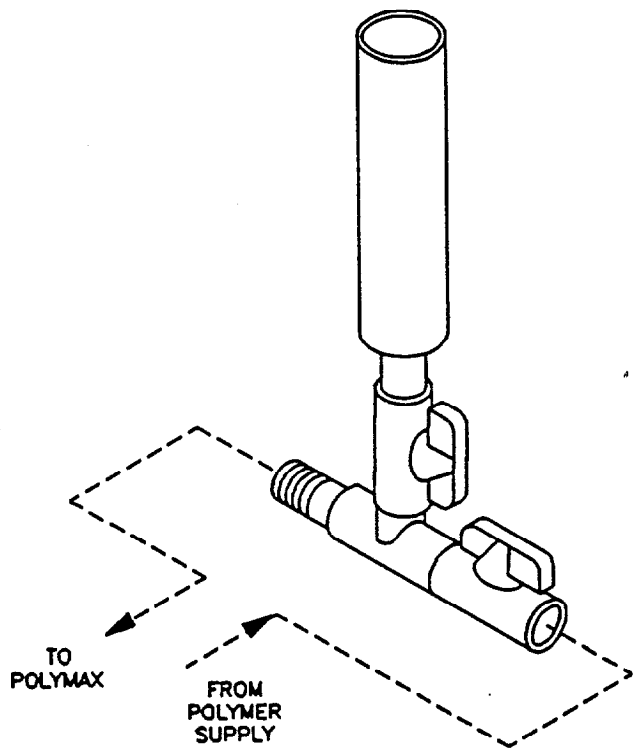
$0.058 \text{ gal.} \div 0.03 \text{ hr} = 1.93 \text{ gal/hr}$

Plot the speed setting in percent versus gallon per hour (gph) on the data sheet within this manual or graph paper.

One should record the capacity of the pump at four or more different data points. Many operators use 25%, 50%, 75%, and 100% of capacity.

The pumping rate should be throughout the operating range of the metering pump. A straight line should result.

Calibration Column



A calibration column is specifically designed for metering pump calibration. This useful accessory eliminates much of the work, mess, and error in calibration.

The plastic graduate has a bottom feed - drain, a valve, and fittings for connection to the pump inlet.

See List of PolyMax Accessories for various sizes available.

POLYMAX PUMP CAPACITY TESTING SHEET

JOB NUMBER _____

JOB NAME _____

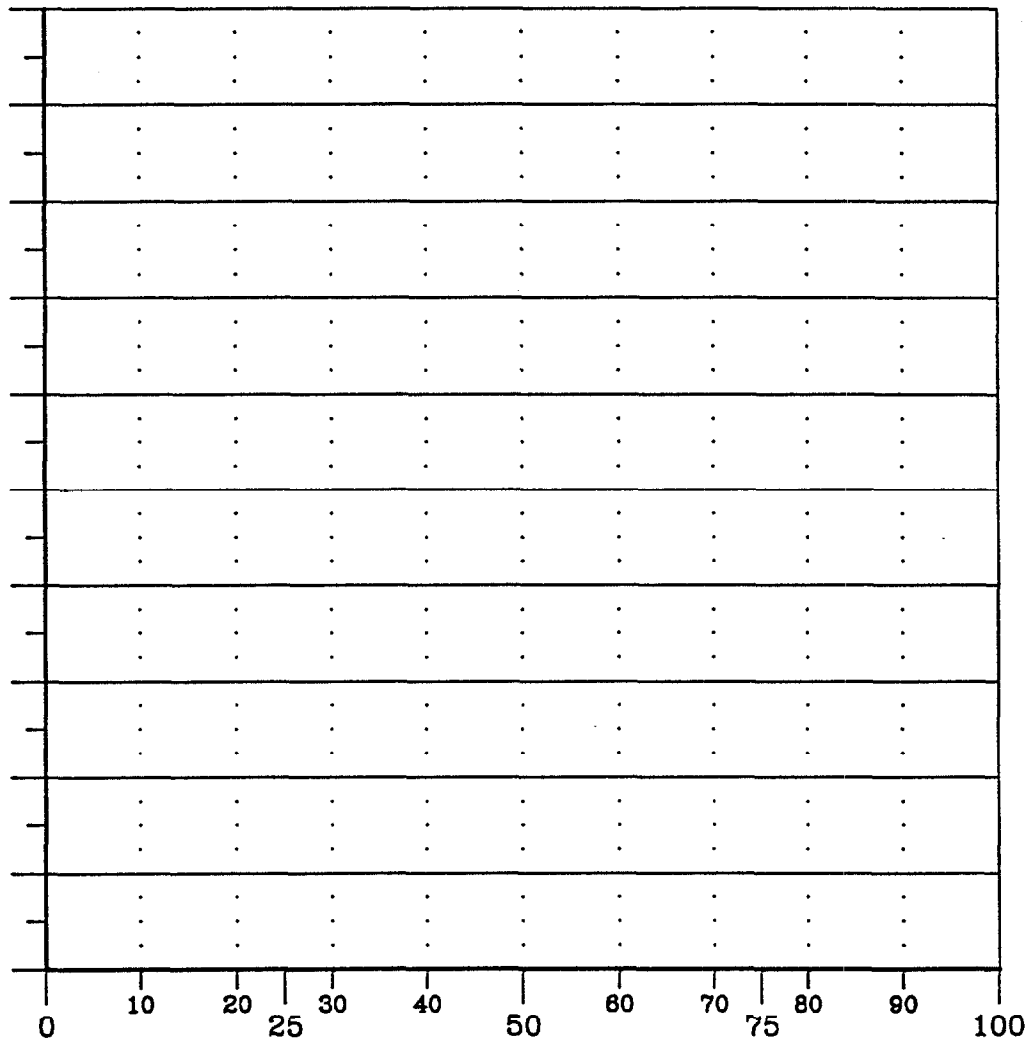
POLYMAX MODEL _____

POLYMAX SN _____

PUMP MODEL(S) _____

DATE _____

GALLON
PER
HOUR
(GPH)



PERCENT PUMP CAPACITY

Manual 4-20 mA, 24 Volt, DC, Signal

Polymer type Emulsion Mannich Semi-dilute Other _____

Polymer MFG. _____ Phone No. _____

Code name / Number _____

Tested By: _____ Date _____

Approved By: _____ Date _____

POLYMAX

PUMP CAPACITY TESTING SHEET

JOB NUMBER _____

JOB NAME _____

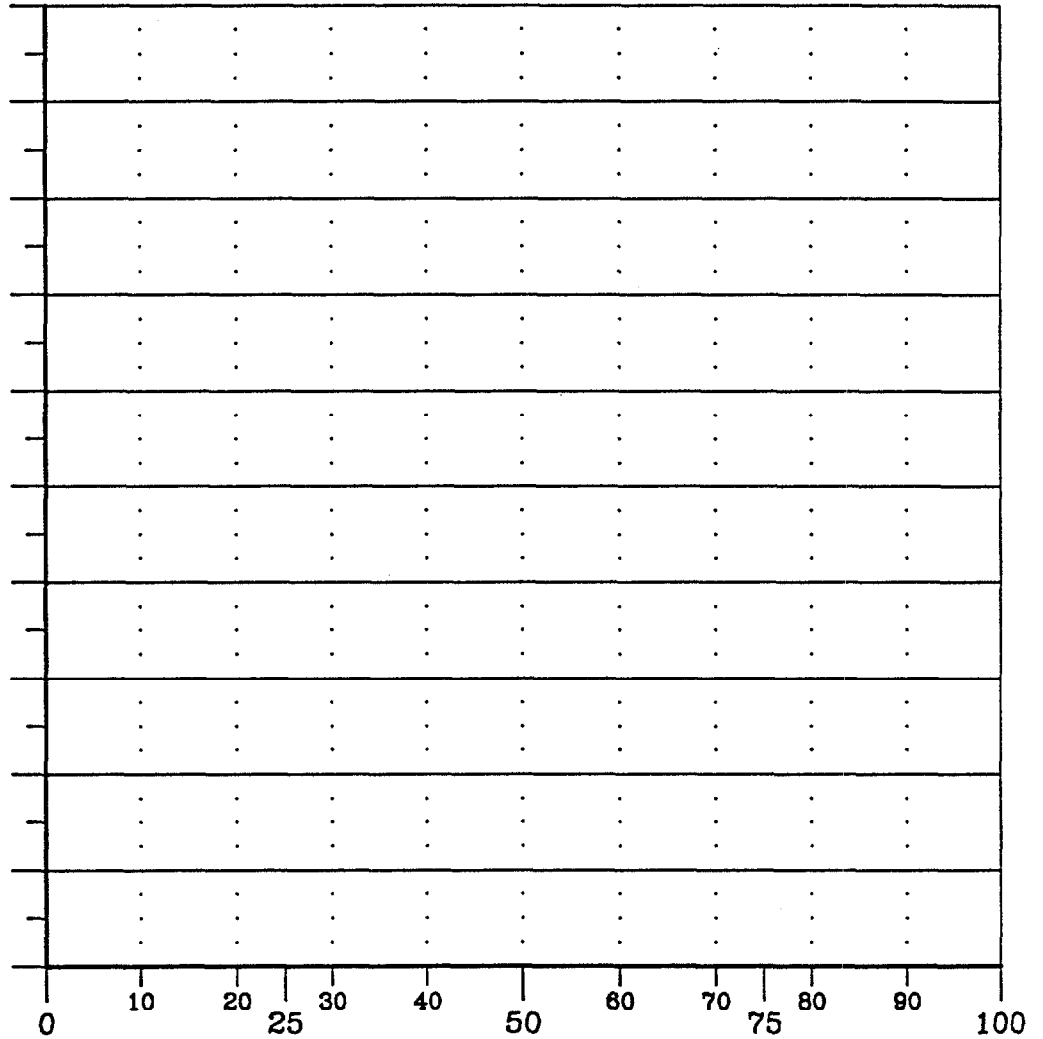
POLYMAX MODEL _____

POLYMAX SN _____

PUMP MODEL(S) _____

DATE _____

GALLON
PER
HOUR
(GPH)



PERCENT PUMP CAPACITY

Manual 4-20 mA, 24 Volt, DC, Signal

Polymer type Emulsion Mannich Semi-dilute Other _____

Polymer MFG. _____ Phone No. _____

Code name / Number _____

Tested By: _____ Date _____

Approved By: _____ Date _____

Section 8

Shutdown, Cleaning, Troubleshooting & Maintenance

8-A SHUTDOWN AND CLEANING

There are few moving parts within the PolyMax.

These are the metering pump, rotameter and solenoid valve.

Because of the unique and carefully planned design, maintenance is greatly simplified.

Shutdown and Cleaning

If PolyMax is used for one shift in a dewatering operation, flush and clean the unit before shutdown. Shut down the polymer concentrate pump by turning the pump off.

If the PolyMax is shut down for extended weekends or longer periods of time, the PolyMax should be thoroughly flushed with clean water and drained.

There are two drain valves inside the PolyMax that allow draining of the unit and back flushing. These valves greatly assist in cleaning and draining the unit.

WARNING!

Test the cleaning solution one plans to use.

Some polymer concentrates will react with small amounts of water and plug the piping.

Mix a small sample of the polymer concentrate with various cleaning agents.

If the polymer concentrate dissolves, a

cleaning solvent could be used. If the polymer concentrate "gels" and does not dissolve, one should try another cleaning solvent.

If water has to be used; again, test the polymer concentrate. If white, solid, stringy chunks are formed, use extra caution. Water should eventually clean the equipment.

CAUTION!

If water is used and reacts with the polymer concentrate, always dry the system completely.

The inlet polymer concentrate piping, metering pump, metering pump discharge valves and piping should be completely dry.

Household bleach, mineral oil, new motor oil, warm water, and concentrated salt solutions are cleaning solvents for some polymeric flocculating agents.

The polymer supplier may also have recommendations regarding the selection of cleaning solvents.

Avoid using strong organic solvents such as kerosene, acetone, xylene, or other types of strong organic solvents.

These types of solvents may, under certain circumstances, dissolve the PVC piping or other plastic components.

If you have questions about the compatibility of various solvents and the PolyMax, please call your Semblex

Representative or Semblex Direct.

Removal of Algae and Microbes

One of the best ways to clean the PolyMax clear acrylic detention chamber and in-line mixers is to fill the PolyMax completely with full strength household bleach.

Fill the unit and let stand for 3 to 4 hours. The bleach will kill the bacteria and algae growth on the walls.

The optional pump inlet calibration column may be used to feed the bleach solution through the metering pump.

After soaking the unit for several hours or overnight, thoroughly flush the PolyMax with clean water.

Removal of Polymer Solution and Residue

For short term shutdown over a weekend, flush the unit using dilution water.

To flush the PolyMax, stop the polymer metering pump and allow the dilution water to flow through the unit for 30 to 60 minutes or longer.

Observe water flowing through the unit. When the in-line mixers are clear, the unit is clean.

The diaphragm pump is turned off by turning the speed knob counter-clockwise until it clicks off or move the switch to "Off".

Flushing allows the mixed polymer to be removed from the unit. Use the two ball valves with red handles on the inside of the unit to backwash and drain.

For long term shutdown, consult the polymer manufacturer for the best way to remove the polymer from the metering pump. The unit should be flushed free of polymer and drained.

Removal of Polymer Concentrate from the Metering Pump

Remove the flexible inlet hose from the drum and insert into a bucket of mineral oil, warm water, new motor oil, or other polymer solvent. Pump the liquid through the metering pump and into the system.

Avoid adding water to the bulk polymer drum or polymer concentrate piping. Protect the drum from moisture or accidental spraying and rain water.

Small quantities of water will cause most emulsion or dispersion polymer concentrates to clot, gel and become stringy.

The solids can and will, sooner or later, plug the metering pump. The partially activated polymer will not activate and is wasted.

In high humidity areas, an optional polymer drum desiccant dryer is available from Semblex. The Part Number is PN 4180.

As the drum "breathes" from temperature changes, the dryer will adsorb the moisture in the air.

Open the drain valve, close the dilute polymer outlet valve, start the pump, and open the rotameter to flush and clean the polymer from the unit.

The drain valves inside the PolyMax allow back washing which greatly facilitates cleaning.

To Help Prevent Frequent Cleaning Problems:

An in-line strainer or filter for the inlet water line ahead of the PolyMax will help trap suspended solids. The suspended solids will coagulate and form a floc inside the PolyMax. This causes the floc to "stick" inside the PolyMax.

If non-potable water, recycled water, reclaimed water, or other type of reused water is used for dilution, trapping suspended solids is especially important.

If the PolyMax is located in direct sunlight, algae may build up within the labyrinth detention chamber.

If non-potable water must be used for dilution, direct sunlight will accelerate algae growth. The result could be a need for more frequent cleaning.

In some areas, the potable inlet dilution water contains various dissolved solids; that is, "hard water".

Very few polymer concentrates may react with the dissolved minerals within the dilution water. A heavy, "lime scale" deposit may be formed within the unit.

These scales can be very difficult to remove safely. Should one need help or assistance, please contact the Semblex Representative in the area or Semblex Direct.

8-B PREVENTATIVE MAINTENANCE

Additional preventative maintenance and disassembly of various components is described in Section 10, Assembly Component Manuals.

General maintenance of components and principal items follows:

Inlet Water Solenoid Valve

It is not uncommon for the inlet water solenoid valve to plug with grit, scale, and dirt from the incoming water. The valve can be easily disassembled and grit cleaned from the diaphragm.

Slow bleeding of water through the valve, the valve not closing or opening, when energized, or no water flow (with all other valves open) are all symptoms of a plugged solenoid valve.

Rotameter

Grit, dirt, and particulates can likewise plug up and cause the flow adjustment valve and the ball in the rotameter to malfunction.

The rotameter can be partially removed from the front of the PolyMax by disconnecting the unions.

This allows enough room to move the rotameter a couple of inches away from the front panel for easy removal and cleaning.

Inlet Water Flow Switch

The flow switch is used to monitor the inlet water flow rate. Should the water flow fall below the set point, the polymer concentrate metering pump would shut off.

This feature avoids injection of raw polymer concentrate without enough dilution water and avoids plugging the mixing system.

Polymer Concentrate Mixing Piping

The PVC piping from the inlet mixing tee through the three in-line mixers and to the

inlet of the detention chamber is essentially a continuous mixing unit.

No maintenance is required unless concentrated polymer is allowed to sit for long periods of time. The polymer could partially dry and plug the piping.

All tees and ells downstream of the mixing tee contain special baffles that are ported to allow for drainage, mixing, and to prevent air binding.

If the unit becomes plugged, disassemble the piping using the convenient unions and clean thoroughly.

CAUTION!

Avoid losing the sealing o-ring in each union. To prevent leaks, the o-ring must be in place.

Soak the assemblies in cleaning solution or warm water. See Shutdown and Cleaning, this Section, for more information.

Call Semblex Direct for additional advice or for replacement parts.

Detention Chamber - Labyrinth

No maintenance is required except to keep the chamber clean and free of concentrated polymer.

Flushing with clear water upon shutdown will sufficiently clean the chamber and labyrinth.

See Shutdown and Cleaning, this Section, for more information.

Labyrinth Disassembly and Reassembly

Note the orientation of the labyrinth tubing before removal.

WARNING!

To avoid injury and damage to the unit, assemble the labyrinth tubing exactly as it was originally installed. All labyrinth tubing systems are installed with exactly the same orientation.

If the labyrinth is ever disassembled, care should be taken to insure that the tubing is not kinked or otherwise restricted. This is especially important to avoid reinstallation of the tubing.

The stainless steel rods that hold the labyrinth assembly together should be were factory tightened to about 5 to 10 ft. lb.

Upon reassembly, the rods should be tightened enough to hold the assembly together.

Test the labyrinth for leaks with water. Check the tube fittings should a leak be discovered.

Should you encounter problems or need additional information, please contact Semblex Direct.

WARNING!

If any polymer is spilled, immediately clean the floor or work area.

Polymer makes the work area and floor very slick!

Controls and Fuses

The electrical power for the unit is 120 volt,



60 Hz, single phase. The instrument lamps (bulbs) will eventually burn out requiring replacement.

Order replacement bulbs from your local electrical supply house or Semblex Direct.

The unit is fused. If the PolyMax is overloaded or short circuited, the power fuse could blow and would need replacing.

This fuse is located on the back of the electrical control panel inside the PolyMax.

The diaphragm type metering pump has a system of fuses within the metering pump. Should the pump fail to operate, check for power to the PolyMax. If the internal light and instrument lamps glow, the fuse within the diaphragm pump should be checked.

WARNING!

Follow plant safety rules before opening a pump control panel or any electrical enclosure!

8-C TROUBLESHOOTING GUIDE AND ABBREVIATED MAINTENANCE SCHEDULE

Note: The PolyMax has electrical overload protective devices. The entire unit is fused (See electrical schematic).

WARNING!

Follow plant safety rules before opening a pump control panel or any electrical enclosure!

The diaphragm type pump has overload internal fuses. If a fuse is burned out, replace with the same kind and type of fuse.

The following Troubleshooting Guide provides suggestions to solve problems.

Each major component manual also has a troubleshooting guide for the item.

As an example, the diaphragm pump manual also has useful information about solving diaphragm pump problems.

The PolyMax Abbreviated Maintenance Schedule also presents items to check periodically.

Again, more detailed information about the various system components is contained within the PolyMax Manual.

If additional information is needed, please contact the Semblex Representative which provided the equipment or, if preferred, contact Semblex Direct.

TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
No Water Flow	Inlet Valve Closed	Check Water Supply Valves
	No Electrical Power	Turn On Power Switch or Power Supply Defective Switch Fuse Burned Out Power Not Connected
	Clogged Solenoid	Check and Service Solenoid Check Solenoid Electrical
	Clogged Rotameter	Remove and Clean
Water Will Not Shut Off	Worn Solenoid Valve Parts	Rebuild or Replace the Solenoid Valve
	Clogged Solenoid Valve	Clean Solenoid Valve
Electrical Buzzing or Noisy	Supply Voltage Problem	Check Power Source - Should be 110 to 120 Volt
	Burned Out Relay Coil	Replace Relay
	Inlet Water Pressure	Water Pressure Too High or Low
Rotameter Ball Sticks	Rotameter Partially Plugged	Disassemble and Clean the Rotameter
Piping Leaks	Missing O-Rings Union Loose	Replace O-Rings Hand Tighten Unions
Diaphragm Pump Doesn't Run	Inlet Water Flow Too Low	Increase Inlet Water Flow Rate
	No Power	PolyMax Plugged In? Turn On Pump Switch Test Pump Switch and Replace If Defective Internal Pump Fuse Burned Out Test Pump Electronics and Solenoid
Air Bubbles in Pump Discharge Line	Air Leak in Inlet Piping	Check for a Loose Fitting on the Inlet of the Pump Tighten Inlet Piping
Diaphragm Pump Runs, But at Reduced or No Output Capacity	Ruptured Diaphragm	Replace Pump Diaphragm
	Pump Diaphragm Chambers Plugged or "Solid Chunks" Visible in the Pump Head	Disassemble Pump Head and Clean Inspect and Clean Inlet and Outlet SS Ball and Springs Inspect and Clean Black Hypalon Seal Rings
	Pump Loses Prime or Air Bubbles Appear in the Acrylic Pump Head	Follow Pump Priming Instructions and Re-prime. Tiny Air Leaks in the Inlet Piping Cause Trouble PolyMax Location May be Too Far from the Polymer Supply The Polymer May be Too Viscous - Raise Polymer Source to the Same Elevation as the Pump Inlet.

POLYMAX ABBREVIATED MAINTENANCE SCHEDULE

ITEM OR COMPONENT	CHECK FOR	FREQUENCY	ACTION ¹
Check Polymer Supply	Level in drum or container	Daily	Plan for additional Polymer; change drums; refill container
Check PolyMax and Operating Area	Polymer leaks	Daily	Shut down unit, clean, repair leaks
Observe PolyMax	Proper mixing and control settings	Daily	Reset controls if needed
Inspect PolyMax Mixing Elements and Labyrinth	Build up of foreign materials	Weekly	Clean as required See O & M, Section 8
Check PolyMax Water Flow Switch	Shut Off of Polymer Metering Pump at Set Point	Monthly	See O & M, Section 8 & 10
Check Rotameter	Visible Contamination or Algae Growth	Monthly	Clean as required See O & M, Section 10, Rotameter
Check Solenoid Valve	Proper Operation, Tight Shut Off, Etc.	Monthly	Clean - repair as required. See O & M Section 10, solenoid valve
Metering Pump	Calibrate Pump At 25, 50, 75, & 100% Capacity	Quarterly	See O & M, Section 7, Calibration
Check Stock of Recommended Spare Parts	Still on site and available	Quarterly	Reorder if missing - See O & M, Section 9, for details
Check PolyMax Inlet Water	Potential for "Water Hammer" or Hydraulic Shock	Upon Installation and then Quarterly	Excess pressure surges may damage the equipment

1. See Section 10, Troubleshooting and Maintenance, PolyMax Operation and Maintenance Manual
2. If Non-Potable water is used, clean strainer (by others) weekly.

Section 9

Spare Parts Ordering Information

SPARE PARTS ORDERING INFORMATION

A Parts List is included in this Operation and Maintenance Manual. The information from the list is quite useful in ordering spare parts. Please feel free to photocopy the List for your use in requesting the current price of your selected parts.

Prompt service can be given for spare or replacement parts if Semblex has the following information:

1. The Manufacturer's name, model number, and serial number, if applicable. The Parts List includes most of the frequently requested items.
2. If a PolyMax Part Number can be located from the manual, the number is quite useful; however, we maintain extensive project records and the information can be retrieved from our files.
3. We will need the exact quantity requested of each item. Don't forget to order spares, if needed.
4. Order fulfillment information will be requested. To complete the order we will need:
 - Preferred Shipping Carrier Information
 - Regular Service, Second Day, or Overnight Delivery
 - Bill To Address
 - Shipping Address (Most Carriers Cannot Deliver to a Post Office Box Number)
 - Purchase Order Number
5. Parts will be invoiced F.O.B., Springfield, MO, at the prices in effect at the time of shipment.

The Semblex Representative for your area will be happy to assist in obtaining prices and receiving purchase orders. Should you prefer, please contact Semblex Direct.

ORDER ADDRESS:

**SEMBLEX
SPARE PARTS DEPARTMENT
1635 W. WALNUT STREET
SPRINGFIELD, MISSOURI 65806**

TELEPHONE: 417-866-1035

FACSIMILE: 417-866-0235



Recommended Spare Parts

<u>Qty.</u>	<u>Description</u>	<u>Part No.</u>
2	Instrument light bulb *	4238
2	O-Ring for pipe unions *	4241
1	LMI pump repair kit	4138
1	Standard 40 watt incandescent light bulb	----

* Spare parts shipped with unit

Recommended spare fuses for unit are as follows:

<u>QTY</u>	<u>DESCRIPTION</u>	<u>PART NO</u>
2	Main line fuse	Buss MDL - 1-1/4", glass, dual element, size as noted on electrical drawing.
2	Diaphragm pump	Internal to pump, Littlefuse, 1-1/4", #312, glass, Buss cross reference - MTH, 1-1/4", non-time delay

Prompt service can be given on spare or replacement parts if the following information is provided:

1. Manufacturer's name, model number and serial number (if applicable). Semblex job number will also aid in expediting your order.
2. Part number, if given.
3. Exact quantity needed.
4. Type of transportation, purchase order number, bill to and ship to address.

All parts will be invoiced F.O.B. Springfield, Missouri, unless otherwise instructed at prices in effect at time of shipment.

Direct orders to:

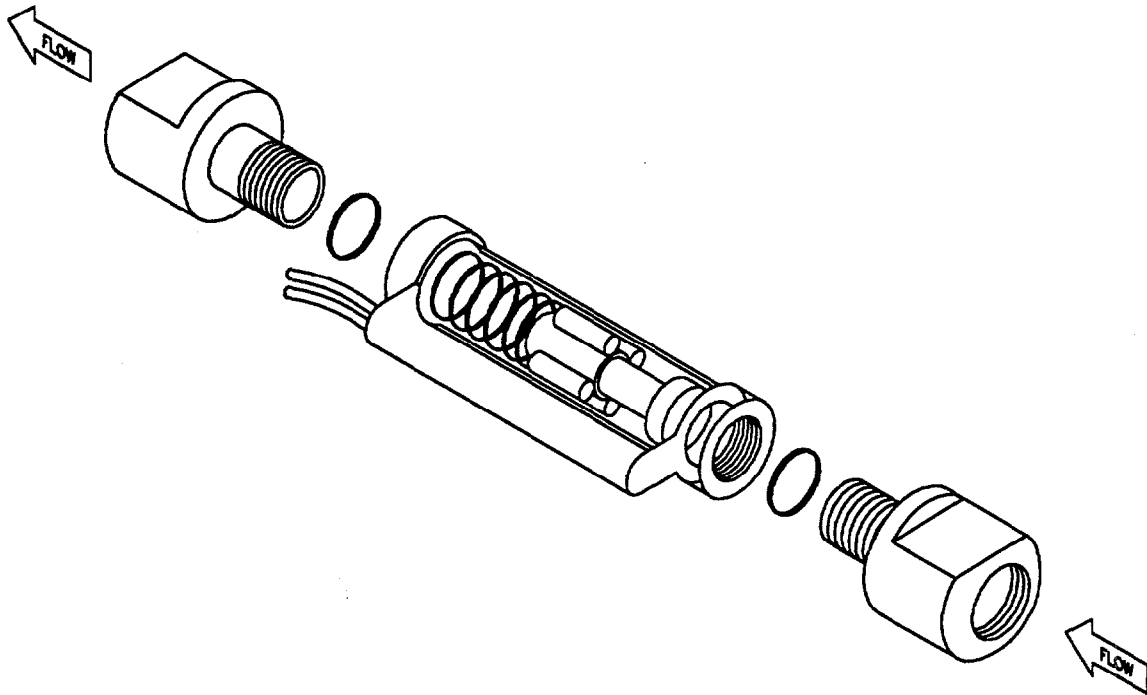
Spare Parts Department

SEMBLEX
1635 W. Walnut Street
Springfield, Missouri 65806

Telephone: (417) 866-1035
Facsimile: (417) 866-0235



Section 10
Assembly Component Manuals



SPECIFICATIONS

LOW WATER FLOW SHUTDOWN SWITCH

MANUFACTURE:	COMPAC ENGINEERING INC.
SERIES:	5-21-PP
NUMBER:	3958
ADJUSTABLE RANGE:	FIXED
PORT SIZE:	1/4 IN. NPT FEMALE ADAPTORS
MAXIMUM OPERATING TEMPERATURE:	194°F
BODY & SHUTTLE CONSTRUCTION:	POLYPROPYLENE
OTHER WETTED PARTS:	SPRING: TITANIUM METAL O-RINGS: FLOROCARBON RUBBER
PRESSURE RATING:	200 PSI
SET POINT:	PRESET AT 6 GPH
SWITCH:	SPST, 3.36 VA
LEAD WIRES:	NO. 20 AWG
LENGTH:	3 9/16 IN.
WIDTH:	1 1/8 IN.



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

DRAWN BY

DJH

APP'D

DATE 5/13/93

SCALE

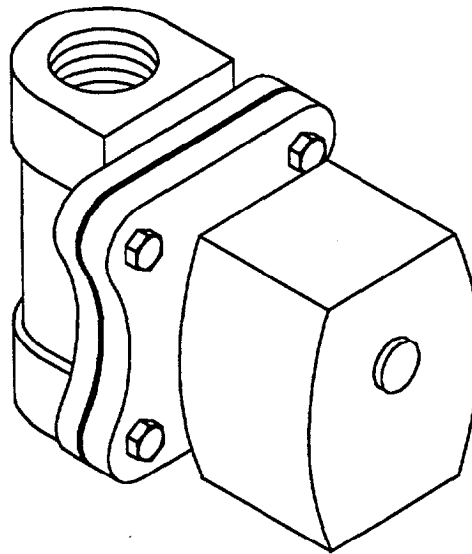
N.T.S.

DRAWING NO.

1856-4124C

POLYMAX

WATER FLOW SWITCH



SPECIFICATION
WATER SOLENOID VALVE

MANUFACTURER:	ASCO RED-HAT II
MODEL:	JKF8210G2
PIPE SIZE:	1/2 IN.
ORIFICE SIZE:	5/8 IN.
FLOW FACTOR:	4 Cv
OPERATING PRESSURE DIFFERENTIAL:	
MINIMUM	5 PSIG
MAXIMUM	150 PSIG
NORMAL AMBIENT TEMPERATURE RANGE:	32°F TO 125°F
MAXIMUM FLUID TEMPERATURE:	180°F
BODY CONSTRUCTION:	BRASS
TYPE OF CONSTRUCTION:	DIAPHRAGM
DIAPHRAGM, O-RINGS, GASKETS:	BUNA "N"
ELECTRICAL:	120V, AC, 60Hz, 1Ph
APPROVALS:	UL LISTED
OPERATION WHEN DE-ENERGIZED:	CLOSED



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

		POLYMAX	
		1/2" WATER SOLENOID VALVE	
DRAWN BY	DLK	APP'D	DRAWING NO. 1856-4082
SCALE	N.T.S.	DATE		11/02/93

INSTALLATION AND MAINTENANCE INSTRUCTIONS

2-WAY INTERNAL PILOT OPERATED SOLENOID VALVES
DIAPHRAGM TYPE - 3/8, 1/2 AND 3/4 N.P.T.
NORMALLY CLOSED OPERATION

BULLETINS

8210

8211



Form No. V-5848

DESCRIPTION

Bulletin 8210's are 2-way, normally closed internal pilot operated solenoid valves. Valve bodies and bonnets are of brass construction. Standard valves have a General Purpose, NEMA Type I Solenoid Enclosure.

Bulletin 8211's are the same as Bulletin 8210's except the solenoids are equipped with an enclosure which is designed to meet NEMA Type 4, Watertight; NEMA Type 7 (C or D) Hazardous Locations - Class I, Group C or D and NEMA Type 9 (E, F or G) Hazardous Locations - Class II, Groups E, F or G. The Explosion-Proof/Watertight Solenoid Enclosures are shown on separate sheets of Installation and Maintenance Instructions. Form Numbers V-5380 and V-5391.

OPERATION

Normally Closed: Valve is closed when solenoid is de-energized and opens when solenoid is energized.

MANUAL OPERATOR (Optional)

Valves with Suffix 'MO' in the catalog number are provided with a manual operator which allows manual operation when desired or during an interruption of electrical power. To operate valve manually, push in knurled cap and rotate clockwise 180°. Disengage manual operator by rotating knurled cap counterclockwise 180° before operating electrically.

MANUAL OPERATOR LOCATION (Refer to Figures 1 and 3)

Manual operator (when shipped from factory) will be located over the valve outlet. Manual operator may be relocated at 90° increments by rotating valve bonnet. Remove bonnet screws (4) and rotate valve bonnet with solenoid to desired position. Replace bonnet screws (4) and torque in a crisscross manner to 110 ± 10 inch pounds.

If valve is installed in the system and is operational, proceed in the following manner: **WARNING: Depressurize valve and turn off electrical power supply.**

1. Remove retaining cap or clip and slip the entire solenoid enclosure off the solenoid base sub-assembly. **CAUTION: When metal retaining clip disengages, it will spring upwards.**
2. Remove bonnet screws (4) and rotate valve bonnet to desired position.
3. Replace bonnet screws (4) and torque in a crisscross manner to 110 ± 10 inch pounds. Replace solenoid enclosure and retaining clip or cap.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage and service.

TEMPERATURE LIMITATIONS

For maximum valve ambient and fluid temperatures, refer to chart. The temperature limitations listed are for UL applications. For non-UL applications, higher ambient and fluid temperature limitations are available. Consult factory. Check catalog number on nameplate to determine maximum temperatures.

CONSTRUCTION	COIL CLASS	CATALOG NUMBER PREFIX	MAX. AMBIENT TEMP. °F	MAX. FLUID TEMP. °F
A-C Construction (Alternating Current)	A	None or DA	77	180
	F	DF or FT	122	180
	H	HT	140	180
D-C Construction (Direct Current)	A, F or H	None, FT or HT	77	150

POSITIONING/MOUNTING

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertical and upright so as to reduce the possibility of foreign matter accumulating in the core tube area. For mounting bracket (optional feature) dimensions, refer to Figure 2.

PIPING

Connect piping to valve according to markings on valve body. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter the valve and cause operational difficulty. Pipe strain should be avoided by proper support and alignment of piping. When tightening the pipe, do not use valve as a lever. Wrenches applied to valve body or piping are to be located as close as possible to connection point.

IMPORTANT: For the protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on the service conditions. See Bulletins 8600, 8601 and 8602 for strainers.

WIRING

Wiring must comply with Local and National Electrical Codes. Housings for all solenoids are provided with connections for 1/2 inch conduit. The general purpose solenoid enclosure may be rotated to facilitate wiring by removing the retaining cap or clip. **CAUTION: When metal retaining clip disengages, it will spring upwards. Rotate to desired position. Replace retaining cap or clip before operating.**

NOTE: Alternating Current (A-C) and Direct Current (D-C) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid including the solenoid base sub-assembly and core assembly.

SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the hand only for an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

WARNING: Turn off electrical power supply and depressurize valve before making repairs. It is not necessary to remove the valve from the pipe line for repairs.

CLEANING

A periodic cleaning of all solenoid valves is desirable. The time between cleanings will vary, depending on media and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive leakage or noise will indicate that cleaning is required.

PREVENTIVE MAINTENANCE

1. Keep the medium flowing through the valve as free from dirt and foreign material as possible.
2. While in service, operate the valve at least once a month to insure proper opening and closing.
3. Periodic inspection (depending on media and service conditions) of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any parts that are worn or damaged.

ASCO Valves



IMPROPER OPERATION

1. **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies that the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown-out fuses, open circuited or grounded coil, broken lead wires or splice connections.
2. **Burned-Out Coil:** Check for open circuited coil. Replace coil if necessary.
3. **Low Voltage:** Check voltage across coil leads. Voltage must be at least 85% of nameplate rating.
4. **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
5. **Excessive Leakage:** Disassemble valve and clean all parts. Replace worn or damaged parts with a complete Spare Parts Kit for best results.

COIL REPLACEMENT (Refer to Figures 1, 2 and 3)

Turn off electrical power supply and disconnect coil lead wires. Proceed in the following manner:

1. Remove retaining cap or clip, nameplate and cover. CAUTION: When metal retaining clip disengages, it will spring upwards.
2. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub-assembly. For D-C Construction, slip spring washer, coil and insulating washers off the solenoid base sub-assembly. Insulating washers are omitted when a molded coil is used.
3. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts.

CAUTION: Solenoid must be fully reassembled as the housing and internal parts are part of and complete the magnetic circuit. Place insulating washers at each end of coil, if required.

VALVE DISASSEMBLY

Depressurize valve and turn off electrical power supply. For A-C Construction, refer to Figures 1 and 2. For D-C Construction, refer to Figure 3. Proceed in the following manner:

1. Disassemble valve in an orderly fashion. Pay careful attention to exploded views provided for identification of parts.
2. Remove retaining cap or clip and slip the entire solenoid enclosure off the solenoid base sub-assembly. CAUTION: When metal retaining clip disengages, it will spring upwards.
3. Unscrew solenoid base sub-assembly and remove bonnet gasket, core assembly and core spring.
4. For A-C Construction without manual operator, remove valve bonnet screws (4). Remove solenoid base sub-assembly, core assembly and core spring.
5. Remove diaphragm spring (A-C Construction only), diaphragm assembly and body gasket.
6. For normal maintenance, it is not necessary to disassemble the manual operator unless external leakage is evident. To disassemble, remove stem pin, manual operator stem, stem spring and stem gasket.
7. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.

VALVE REASSEMBLY

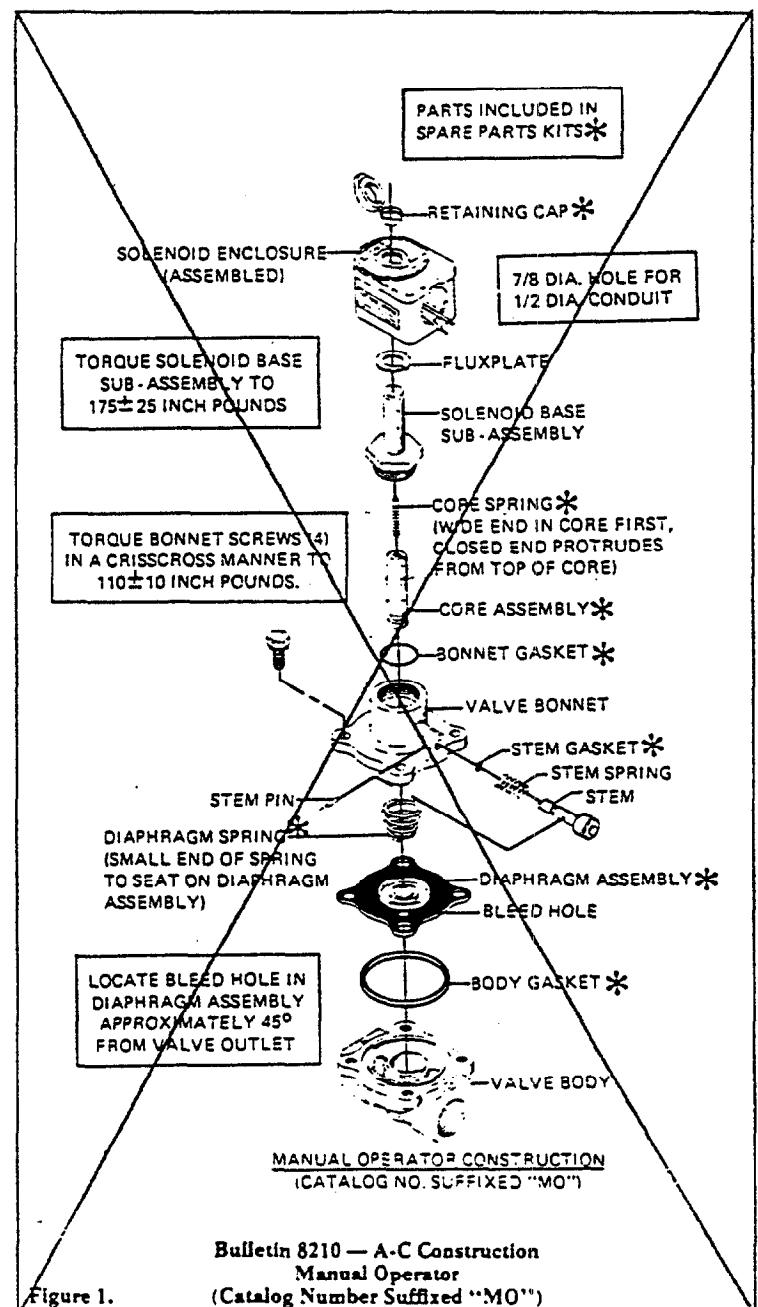
1. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts.
2. Replace body gasket and diaphragm assembly. Locate bleed hole in diaphragm assembly approximately 45° from valve outlet.
3. Replace valve bonnet and bonnet screws. Torque bonnet screws (4) in a crisscross manner to 110 ± 10 inch pounds.
4. For A-C Construction, the diaphragm spring, core assembly and core spring must be installed prior to assembly of bonnet as this is the solenoid base sub-assembly. Be sure diaphragm spring is installed properly. Closed turns of spring to seat on diaphragm assembly. For valves with a manual operator (see Figure 1), the small end of diaphragm spring seats on diaphragm assembly.
5. Install core spring in core assembly. Be sure core spring is inserted into core assembly with wide end in first. Closed end protrudes from top of core assembly.
6. Replace bonnet gasket, core assembly, core spring and solenoid base sub-assembly. Torque solenoid base sub-assembly to 175 ± 25 inch pounds.
7. If removed, replace manual operator stem gasket, stem spring, stem and stem pin.
8. Replace solenoid enclosure and retaining cap or clip.
9. After maintenance, operate the valve a few times to be sure of proper opening and closing.

SPARE PARTS KITS

Spare Parts Kits and Coils are available for ASCO valves. Parts marked with an asterisk (*) are supplied in Spare Parts Kits.

ORDERING INFORMATION FOR SPARE PARTS KITS

When Ordering Spare Parts Kits or Coils Specify Valve Catalog Number, Serial Number and Voltage.



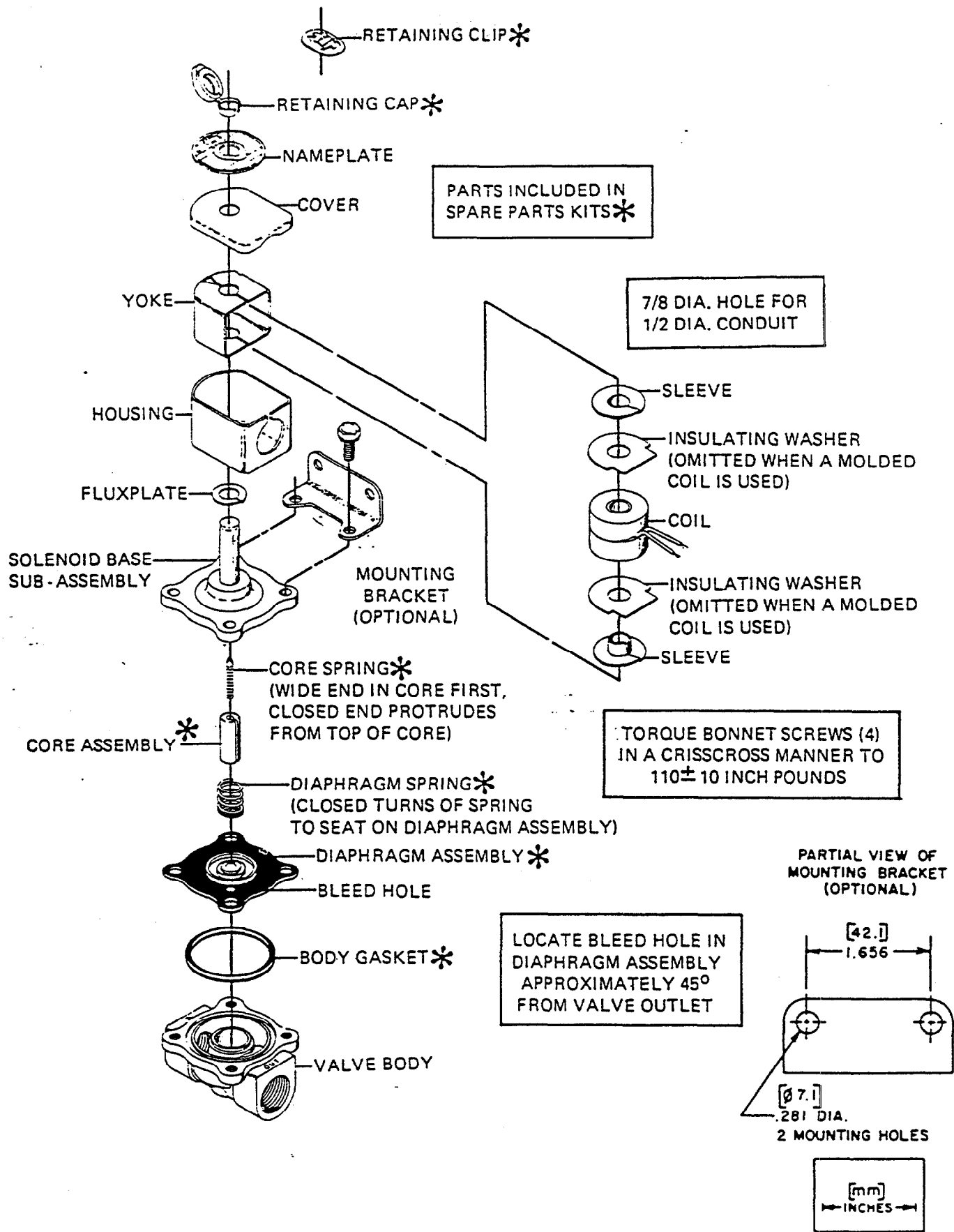
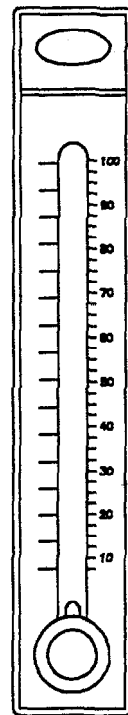
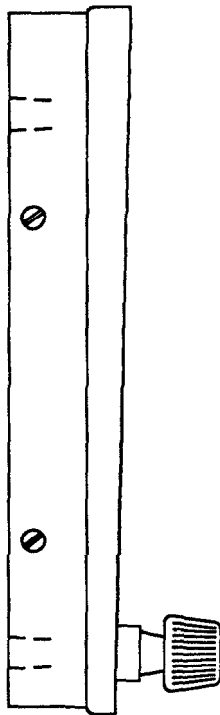


Figure 2.

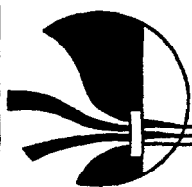
Bulletin 8210 — A-C Construction
General Purpose Solenoid Enclosure Shown.
For Explosion-Proof/Watertight Solenoid Enclosure used on Bulletin 8211, see Form No. V-5391.



SPECIFICATION

INLET WATER ROTAMETER
AND ADJUSTING VALVE

MANUFACTURER:	DWYER
MODEL:	RMB-85-SSV
CAPACITY, WATER:	10 TO 100 GPH
SCALE LENGTH:	5 IN.
METERING VALVE:	STAINLESS STEEL
ACCURACY:	2% OF FULL SCALE
TEMPERATURE RATING:	130°F, MAXIMUM
PRESSURE RATING:	70 PSIG, MAXIMUM
WETTED METAL PARTS:	STAINLESS STEEL
METER BODY, BEZEL, TUBE AND FLOAT STOPS:	POLYCARBONATE
O-RINGS:	NEOPRENE & BUNA "N"
PIPE CONNECTIONS:	1/4 IN. NPT
OVERALL LENGTH:	8 1/2 IN.
PIPE CONNECTIONS, CENTER TO CENTER:	6 1/2 IN.
WIDTH, VALVE FULL OPEN:	1 3/4 IN.
BODY WIDTH:	1 1/4 IN.



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

POLYMAX

INLET WATER ROTAMETER

DRAWN BY

DLK

APP'D

DRAWING NO.

SCALE

N.T.S.

DATE

1/02/93

1856-4087

RATEMASTER[®] FLOWMETER

Installation and Operating Instructions

DIMENSIONS & MOUNTING INFORMATION

DIMENSIONS — IN INCHES			
	RMA	RMB	RMC
A	4-9/16	8-1/2	15-1/8
B	3	5-7/16	12 1/4
C	1/8 NPT CONN. 1-5/8" 18-32 THDS.	1/4 NPT CONN. 3-15/16 1/4-20 THDS.	1/2 NPT CONN. 8-3/4 3/8-24 THDS.
D	1	5/8	1
E	1-1/16	1-7/8	2-3/4
F	1-5/16	1-3/4	2-7/8
G	1/11	1	1-7/11
H	1	1-7/16	2-11/32
I (OPEN)	1-3/8	1-13/16	2-1/2
J	3/4	1-1/4	2
K	4-13/16	8-3/4	15-3/8
L	1	1 1/2	2-1/4

PANEL CUT OUT (FOR FLUSH MOUNTING)

HIGH	8-5/8	8-9/16	15-3/16
WIDE	7/8	1-5/16	2-1/16

PANEL HOLE SIZES (FOR SURFACE MOUNTING)

PIPE	7/16	5/8	15/16
BOLT	1/4	9/32	11/32

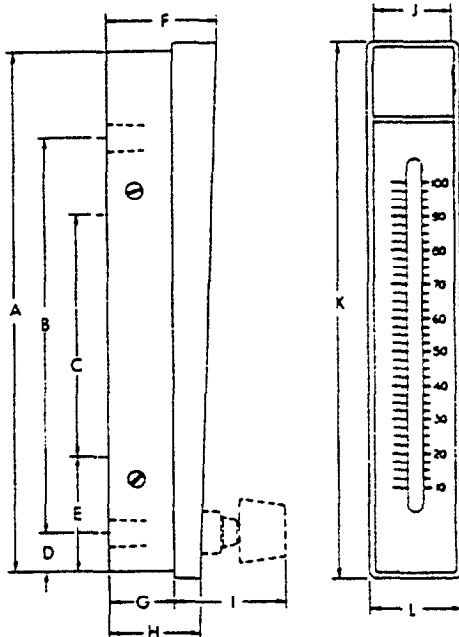


Figure 1

Dwyer Rate-Master[®] Series RM Flowmeters are furnished in three models (see Figure 1) each available in a broad choice of flow ranges with direct reading scales for air, gas or water. Installation, operation and maintenance are very simple and only a few common sense precautions must be observed to assure long, trouble-free service.

CAUTION

Rate-Master(R) flowmeters are designed to provide satisfactory long term service when used with air, water or other compatible media. Refer to factory for information on questionable gases or liquids. Avoid solutions of acids, bases or salts having a pH below 5.0 or above 8.5. Caustic solutions, anti-freeze (ethylene glycol) and aromatic solvents should definitely not be used.

CALIBRATION

Each Dwyer flowmeter is calibrated at the factory. If at any time during the meter's life, you wish to recheck its calibration, do so only with devices of certified accuracy. **DO NOT** attempt to check the Dwyer Rate-Master[®] Flowmeter with a similar flowmeter as seemingly unimportant variations in piping and back pressure may cause noticeable differences in the indicated reading. If in doubt, return your Dwyer flowmeter to the factory. It will be calibration checked for you at no charge.

Before proceeding with the installation of your Dwyer Rate-Master Flowmeter, check to be sure you have the model and flow range you require.

LOCATION

TEMPERATURE, PRESSURE, ATMOSPHERE, AND VIBRATION: Rate-Master Polycarbonate Flowmeters are exceptionally tough and strong. They are designed for use at pressures up to 100 PSI and temperatures up to 130 deg. F. **DO NOT EXCEED THESE LIMITS!** The installation should not be exposed to strong chlorine atmospheres or solvents such as benzene, acetone, carbon tetrachloride, etc. The mounting panel should be free of excessive vibration since it may prevent the unit from operating properly.

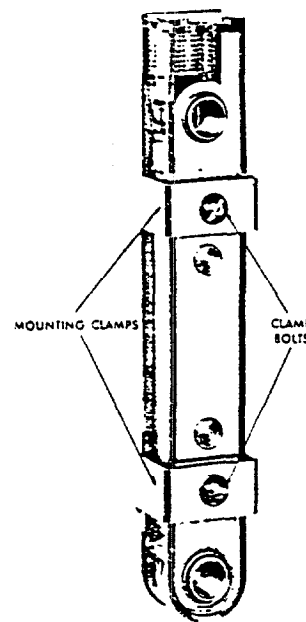


Figure 2

INLET PIPING RUN: It is good practice to approach the flowmeter inlet with as few elbows and restrictions as possible. In every case the inlet piping should be at least as large as the connection to the flowmeter i.e. 1/8" Iron Pipe Size for RMA, 1/4" IPS for RMB and 1/2" IPS for RMC. Length of inlet piping makes little difference for normal pressure fed flowmeters.

For flowmeters on vacuum air service the inlet piping should be as short and open as possible. This will allow operation near atmospheric pressure and thereby insure the accuracy of the device. (Note that for vacuum air service the flow control valve if any, should be on the discharge side of the flowmeter. Either the TMV unit or a separate in line valve may be applied.)

DISCHARGE PIPING: As on the inlet, discharge piping should be at least as large as the flowmeter connection. In addition, for pressure fed flowmeters on air or gas service the discharge piping should be as short and open as possible. This will allow operation of the flow tube at near atmospheric pressure and insure the accuracy of the device. This is of less importance on water or liquid flowmeters since the flowing medium is generally incompressible and moderate back pressure will not affect the accuracy of the instrument as calibrated.

POSITION AND MOUNTING

All Rate-Master Flowmeters must be mounted in a vertical position with the inlet connection at the bottom rear and outlet at top rear.

BEZEL OR THROUGH PANEL MOUNTING: Make the panel cutout using the appropriate dimensions from Figure 1. Flowmeter must fit into the panel freely without force or squeeze.

Insert the Rate-Master Flowmeter from the front of the panel and install the mounting clamps from the rear, insert and tighten the clamp bolts in the locations shown in Figure 2. Do not exceed 5 in. lbs. Make connections to inlet and outlet ports using small amount of RTV sealant or Teflon[®] thread tape to avoid leakage. Avoid excess torque which may damage flowmeter body.

RATEMASTER FLOWMETER

Instructions

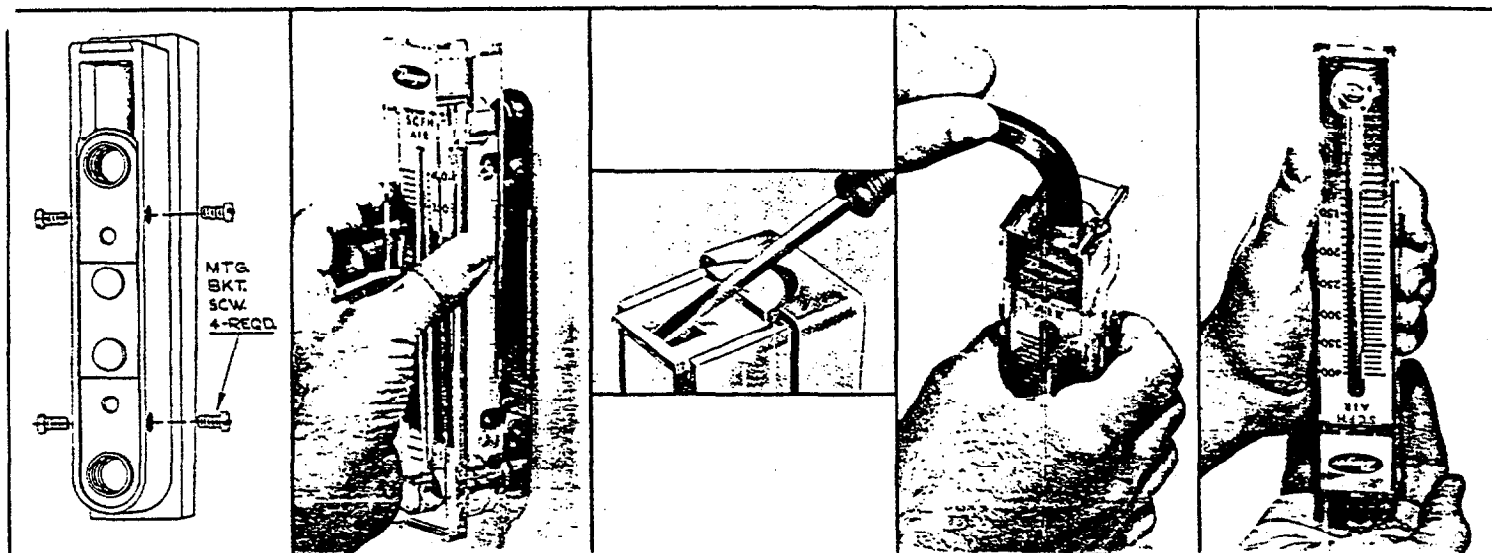


Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

SURFACE MOUNTING: Drill appropriate holes in panel using the dimensions shown in Figure 1. Hold the flowmeter in position in front of the panel and install the clamp bolts through the panel from the rear. (The mounting clamps may be used as washers if desired by installing them backwards or straightening them out.) Pipe up inlet and discharge following the directions in previous sections.

SURFACE MOUNTING ON PIPING ONLY: An alternate method of surface mounting omitting the clamp bolts and supporting the Rate-Master Flowmeter on the connecting piping only is possible. For this method extra long or straight pipe threads should be used so that nuts may be run onto the pipe and later tightened against the back of the panel to retain the unit in proper position. Use the appropriate hole layout information from Figure 1, but omit the small holes.

MOUNTING ON PIPING ONLY WITHOUT PANEL: For a temporary or laboratory type installation, the panel may be omitted altogether and the flowmeter installed directly in rigid piping. Its light weight permits this without difficulty.

OPERATION

To start system, open the valve slowly to avoid possible damage. Rate of flow is read at the point of maximum horizontal width for spherical floats or at the top of the largest diameter for non-spherical floats. Control valves on BV and SSV models are turned clockwise to reduce flow, counter clockwise to increase flow. A nylon insert is provided in the threaded section of the valve stem to give a firm touch to the valve and to prevent change of setting due to vibration.

CAUTION

Do not completely unscrew valve stem unless flowmeter is unpressurized and drained of any liquid. Removal while in service will allow gas or liquid to flow out front of valve body and could result in serious personal injury. For applications involving high pressure and/or toxic gasses or fluids, special non-removable valves are available on special order. Contact factory for details.

MAINTENANCE

The only maintenance normally required is occasional cleaning to assure reliable operation and good float visibility.

DISASSEMBLY: The flowmeter can be disassembled for cleaning simply as follows:

1. Remove valve knob from RMB or RMC — BV or SSV units by pulling the knob forward. It is retained by spring pressure on the stem half-shaft so that a gentle pull will remove it. On RMA-BV or SSV models, turn the valve knob counter-clockwise until the threads are disengaged. Then withdraw the stem from the valve by gently pulling on the knob.

2. Remove the four mounting bracket screws located in the sides of the flowmeter. See Figure 3.

Pull the flowmeter body gently forward away from the back plate and pipe thread connections. Keep the body parallel with the back plate to avoid undue strain on the body. Leave the piping connections intact. There is no need to disturb them. See Figure 4.

3. Remove the slip cap with a push on a screwdriver as shown in Figure 5. Remove the plug-ball stop as shown in Figure 6 using allen wrench sizes as follows: Model RMA — 1/4", Model RMB — 1/2", and Model RMC — 3/4".

4. Take out the ball or float by inverting the body and allowing the float to fall into your hand as shown in Figure 7. (Note: It is best to cover the discharge port to avoid losing the float through that opening.)

CLEANING: The flow tube and flowmeter body can best be cleaned with a little pure soap and water. Use of a bottle brush or other soft brush will aid the cleaning. Avoid benzene, acetone, carbon tetrachloride, alkaline detergents, caustic soda, liquid soaps (which may contain chlorinated solvents), etc. and avoid prolonged immersion which may harm or loosen the scale.

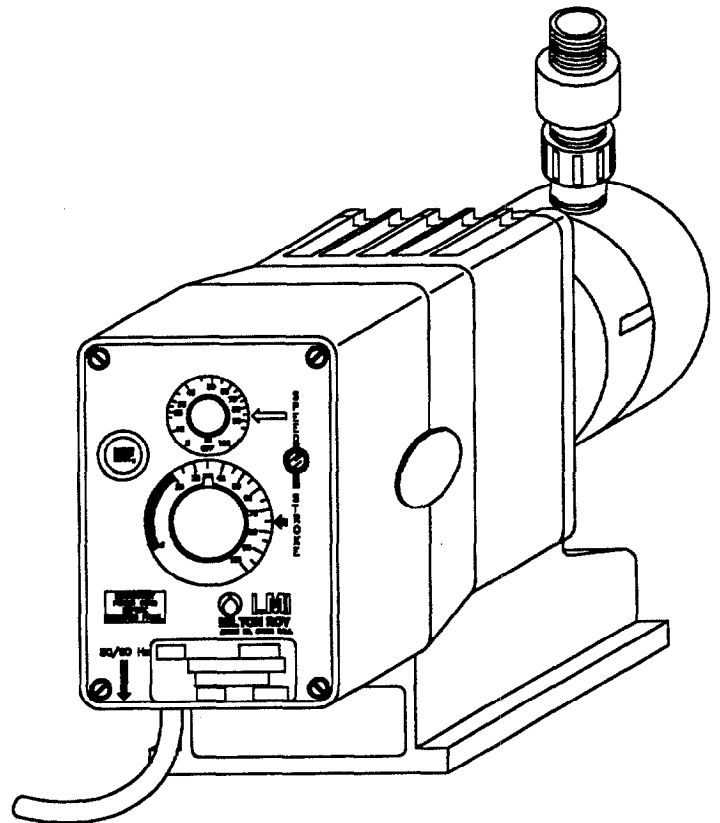
REASSEMBLY: Simply reverse Steps 5A, 1 through 4 and place back in service. A little stop cock grease or petroleum jelly on the "O" rings will help maintain a good seal as well as facilitate assembly. No other special care is required.

ADDITIONAL INFORMATION

For additional flowmeter application information, conversion curves, factors and other data covering the entire line of Dwyer Rate-Master Flowmeters, send for Bulletin F-41.

ADVANTAGES OF LMI ELECTRONIC PUMPS

- **PRESSURE LIMITED** - NO MECHANICAL LINKAGE. WHEN BACK PRESSURE EXCEEDS THE STRENGTH OF THE MAGNETIC FORCE DEVELOPED BY THE POWER COIL, THE PUMP STOPS STROKING. NO DAMAGE WILL OCCUR TO THE PUMP.
- **CONSTANT DISCHARGE VELOCITY/BETTER VALVE ACTION** - ACTUAL SPEED OF EACH DISCHARGE STROKE REMAINS THE SAME, NO MATTER HOW LOW THE STROKE FREQUENCY IS SET. SHARP VALVE ACTION IS NOT SACRIFICED WHEN PUMP SPEED IS REDUCED.
- **WIDE RANGEABILITY** - BOTH STROKE LENGTH AND STROKE FREQUENCY ARE ADJUSTABLE AND HAVE A MULTIPLYING EFFECT. A PRACTICAL ADJUSTABILITY RANGE OF 200 TO 1 IS COMMON.
- **EASY ADAPTABILITY TO AUTOMATIC CONTROL** - STANDARD A AND B SERIES PUMPS ARE EQUIPPED TO RESPOND TO AN EXTERNAL SWITCH CLOSURE SUCH AS THAT DELIVERED BY THE LMI FLOWMETER-PULSER. THEY CAN ALSO RESPOND TO STANDARD ANALOG INSTRUMENT SIGNALS BY MEANS OF THE LMI LIQUITRON CONVERTER. VERSIONS ARE AVAILABLE TO RESPOND TO A 4-20 MILLIAMPER DC INSTRUMENT SIGNAL DIRECTLY WITHOUT INTERVENING INSTRUMENTATION.
- **SIMPLICITY OF MOVING UNIT** - ONLY ONE MOVING UNIT, THE ARMATURE-DIAPHRAGM ASSEMBLY. REQUIRES NO LUBRICATION IN SERVICE. NO ROTATING MASSES SUCH AS MOTOR OR REDUCTION GEARS.
- **MODULAR CONSTRUCTION** - COMPONENTS AND MAJOR ASSEMBLIES EASILY REPLACED. NO SOLDERING REQUIRED TO REPLACE ANY PART OF THE LMI PUMP.
- **TOTALLY ENCLOSED** - CORROSION PROOF GLASS FIBER REINFORCED POLYPROPYLENE HOUSINGS KEEP PUMP PROTECTED FROM CHEMICALS AND ATMOSPHERE.
- **LOW CONSUMPTION OF ELECTRICAL ENERGY** - LMI PUMPS USE POWER ONLY DURING THE DISCHARGE PORTION OF EACH STROKE THUS CAUSING MINIMUM ELECTRICAL CONSUMPTION AND LOW HEAT GENERATION. NO VENTILATION IS REQUIRED.
- **INDEPENDENT OF POWER LINE FREQUENCY** - LMI PUMPS CAN OPERATE WITH ANY LINE FREQUENCY FROM 25 TO 66 Hz WITHOUT CHANGE IN OUTPUT OR DAMAGE TO THE PUMP.



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

POLYMAX

DIAPHRAGM METERING PUMP

DRAWN BY DLK

APP'D

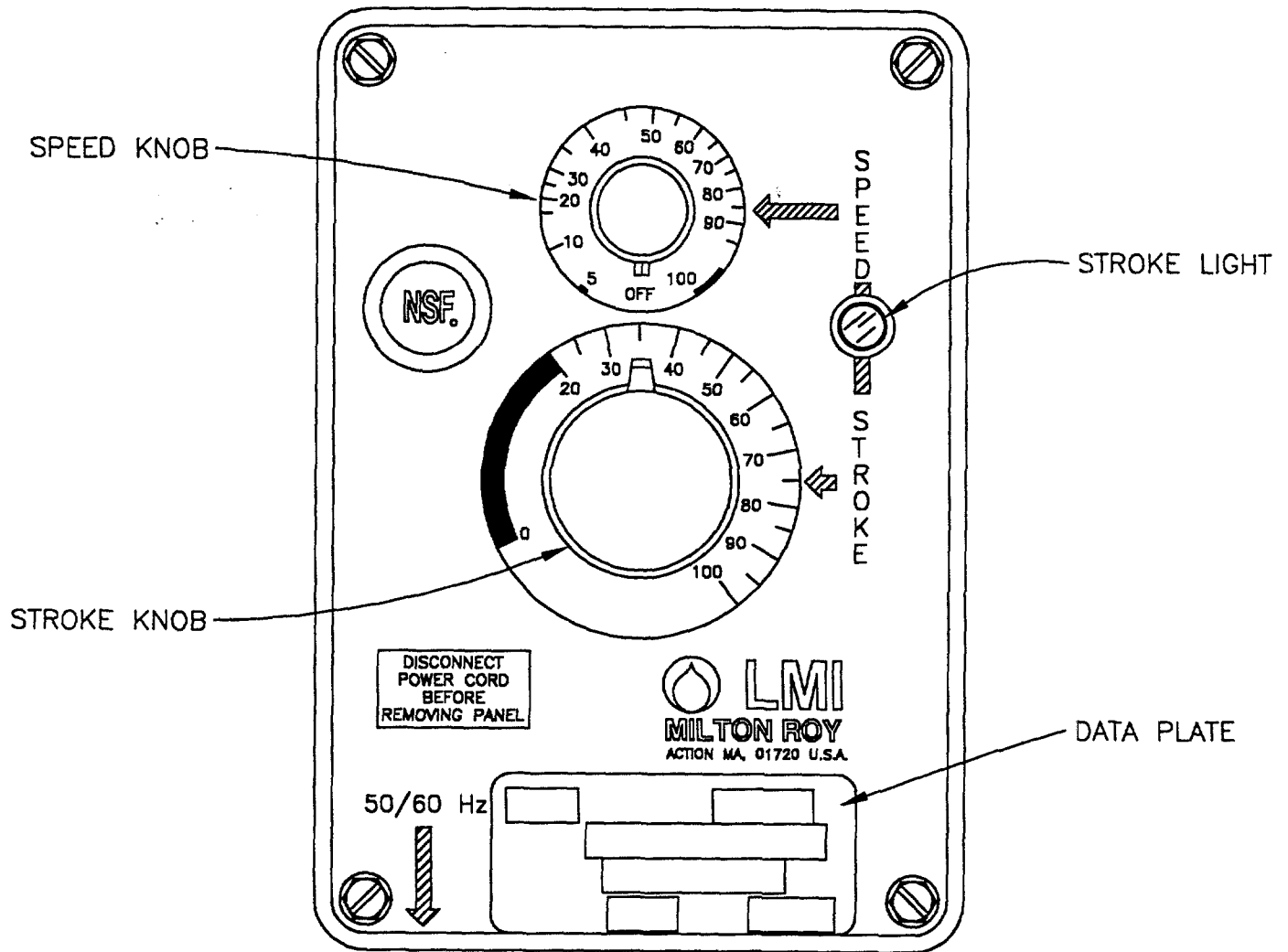
DRAWING NO.

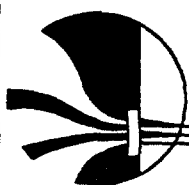
SCALE N.T.S.

DATE 11/10/93

1856-DA

Series A1 Control Panel Detail



 <p>SEMBLEX CUSTOM EQUIPMENT ASSEMBLERS SPRINGFIELD, MISSOURI</p>	POLYMAX		DRAWING NO. 1856-A'
	DIAPHRAGM METERING PUMP		
	DRAWN BY DLK SCALE N.T.S.	APP'D <i>[Signature]</i> DATE 11/08/93	

POLYMAX

SOLENOID-OPERATED NEAT POLYMER DIAPHRAGM PUMPS

SPECIFICATIONS AND DATA

100 SERIES - MANUAL OPERATION

~~700 SERIES - REMOTE 4-20 CAPABILITY WITH OPTIONAL LIQUITRON[®] OR A/D -
CURRENT TO FREQUENCY CONVERTOR~~

PUMP MODEL	A151-86 PMX A751-86 PMX		B121-86 PMX B721-86 PMX		B131-76 PMX B731-76 PMX		C131-20 PMX C731-20 PMX	
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
OUTPUT CAPACITY								
GALLONS PER HOUR	0.01	1.0	0.012	2.5	0.022	4.5	0.04	9.0
LITERS PER HOUR	0.038	3.79	0.05	9.5	0.085	17.0	.17	34.0
ML OR CC PER MIN.	0.63	63.0	0.79	158	1.42	284.0	2.84	568.0
OUTPUT PER STROKE ML OR CC	0.13	0.63	0.16	1.58	0.28	2.84	.57	5.68
STROKES PER MIN. ADJUSTABLE	5	100	5	100	5	100	5	100
STROKE LENGTH (0-100% ADJUSTABLE) RECOMMENDED MIN.	20%		10%		10%		10%	
MAXIMUM INJECTION PRESSURE	110 PSI (7.6 BAR)		100 PSI (6.9 BAR)		50 PSI (3.5 BAR)		60 PSI (4.1 BAR)	
PEAK INPUT POWER	150 watts		248 watts		248 watts		420 watts	
AVERAGE INPUT POWER ⊕ MAXIMUM SPEED	22 watts		29 watts		29 watts		56 watts	
HEIGHT, MAX.	8" (203 mm)		8" (203 mm)		8" (203 mm)		9.25" (235 mm)	
LENGTH, MAX.	9.25" (235 mm)		10.75" (273 mm)		10.75" (273 mm)		11.00" (280 mm)	
WIDTH, MAX.	4.05" (103 mm)		5.72" (146 mm)		5.72" (146 mm)		5.72" (146 mm)	
SHIPPING WEIGHT	10 lbs (4.55 kg)		15 lbs (6.9 kg)		15 lbs (6.9 kg)		19 lbs (8.7 kg)	

VOLTAGE: 115 VOLTS AC, 50/60 Hz, SINGLE PHASE
~~200-240 VOLTS AC, 50/60 Hz, SINGLE PHASE AVAILABLE~~

LIQUITRON[®] IS A REGISTERED TRADEMARK OF LIQUID METRONICS CORPORATION



SEMBLEX
CUSTOM EQUIPMENT ASSEMBLERS

SPRINGFIELD, MISSOURI

DRAWN BY DLK
SCALE N.T.S.

APP'D
DATE 11/10/93

POLYMAX

METERING PUMP DATA

DRAWING NO.

1856-DP

ELECTRONIC METERING PUMPS

INSTALLATION MAINTENANCE TROUBLESHOOTING

Please record the following data:
(Information on Pump Box and Pump Data Plate)

Pump Model Number: A151-86 PMX
Pump Serial Number: _____
Installation Date: _____
Installation Location: _____

When ordering replacement parts for your LMI
Metering Pump or accessory, please include the
complete model number and serial number of your unit.

CONTENTS

- 1.0 INTRODUCTION
- 2.0 RESERVED
- 3.0 PRE-INSTALLATION INSTRUCTIONS
- 4.0 INSTALLATION
- 5.0 METHODS OF EXTERNAL TRIGGERING
- 6.0 START-UP & ADJUSTMENT
- 7.0 CALIBRATION
- 8.0 SPARE PARTS REPLACEMENT
& ROUTINE MAINTENANCE
- 9.0 PROPER ZEROING/
KNOB REPLACEMENT
- 10.0 TROUBLESHOOTING
- 11.0 EPU RESISTANCE CHART

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 A, B, C, J, P, Z Series pumps.

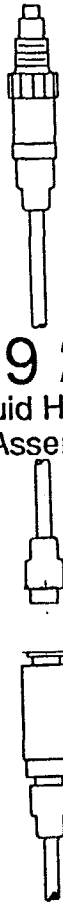
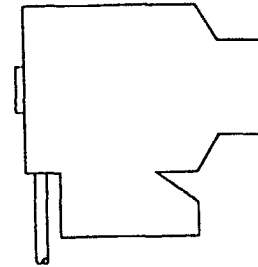
EXAMPLE:

Your pump consists of two parts:

1. The Drive Assembly and
2. The Liquid Handling Assembly.

A 151
Drive

- 192S
Liquid Handling
Assembly



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.

3.1 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). Re-assemble 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

Your Liquid Handling Assembly Sheet lists the materials of construction included in the liquid handling portion of your pump. Should you have any further compatibility questions on your LMI Metering Pump, review the LMI Pump Selection Guide and Chemical Resistance Chart for compatibility. If this sheet is not available to you, call your local LMI distributor, or the LMI Customer Service Department for further information.



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 maximum compatibility with the pump operation. It is recommended that all tubing be shielded to prevent possible injury in case of rupture or accidental damage.



Fittings And Machine Threads

All fittings should be hand tightened to a maximum of 1/8 - 1/4 turn after the fitting contacts the seal ring. DO NOT OVERTIGHTEN FITTINGS. Overtightening or use of a pipe wrench can cause damage to the fittings, seal rings, or pump head, causing the pump to LOSE PRIME OR NOT FUNCTION.

All LMI pumps have straight 3/4"-16 or 1"-12 machine threads on the head and fittings and are sealed by the seal rings. DO NOT use Teflon tape or pipe dope to seal threads.



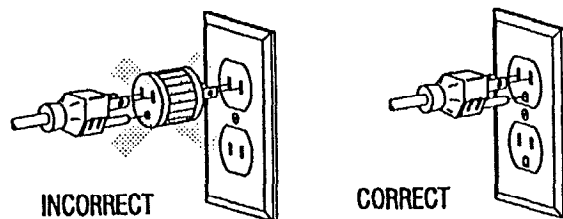
Plumbing

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.



Electrical Connections

All wiring must conform to local electrical codes. The PolyMax[®] should 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!**



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.

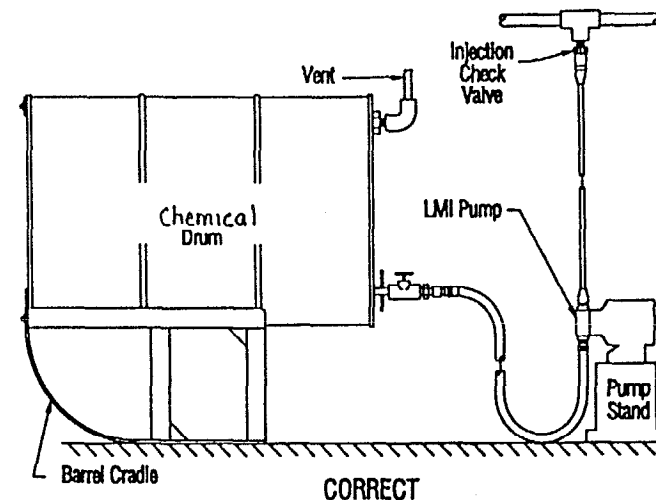
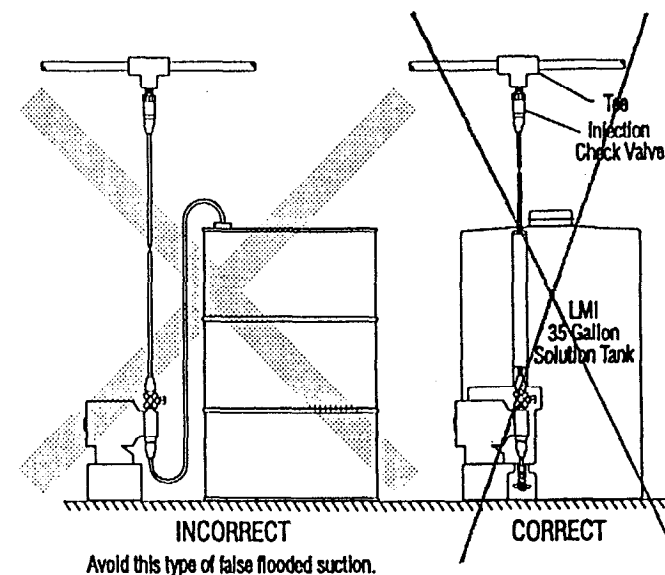
4.2 Pump Mounting

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 3 1/2 feet (1.0 m) for solutions having a specific gravity of water. For denser solutions, consult the factory.

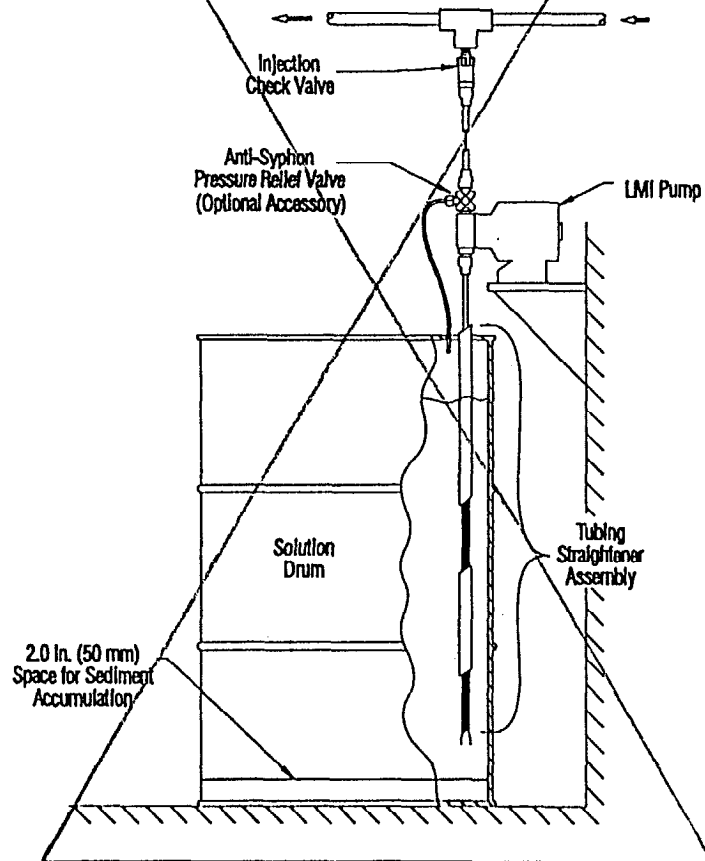
Your LMI metering pump must be mounted so that the suction and discharge valves are vertical. **NEVER** position pump head and fittings horizontally.

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.



4.2B3 Suction - Shelf Mount

The pump may be mounted on a shelf (customer supplied) maintaining a suction lift of less than 3 1/2 feet (1.0 m). An LMI mounting kit (part number 10461) is available for securing the pump to a shelf.



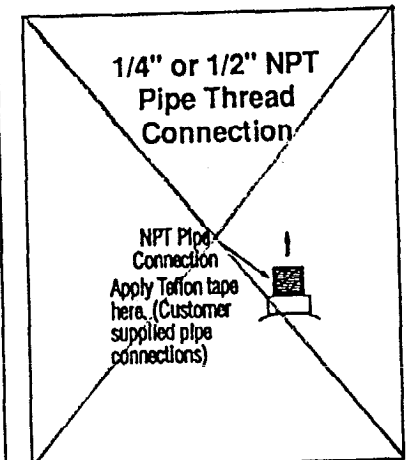
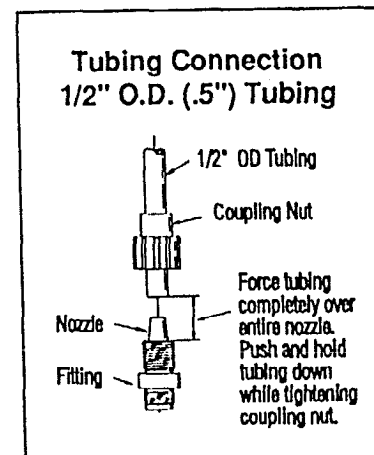
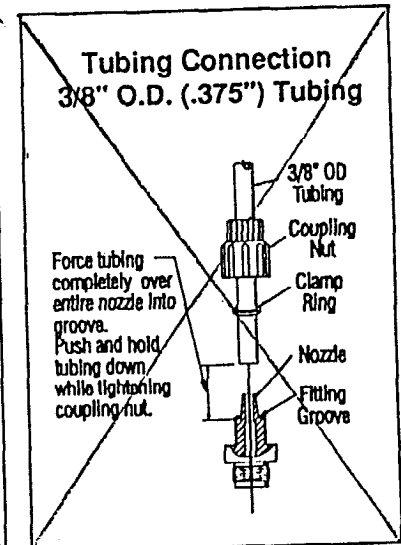
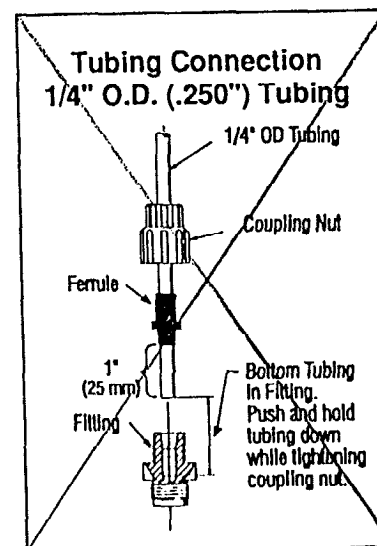
4.3 Tubing Connections



- 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 the vinyl tubing.

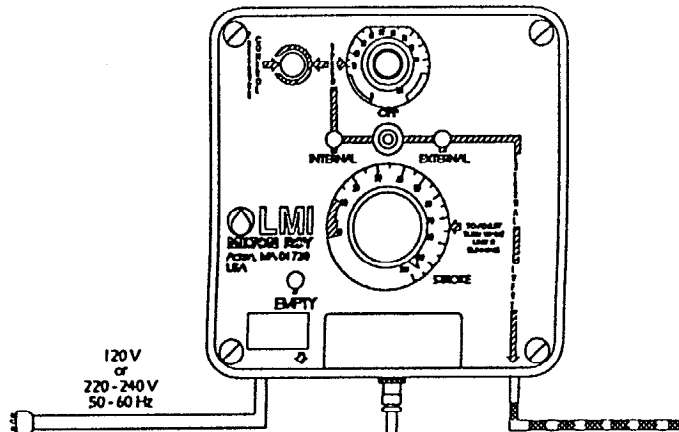
C. Before installation, all tubing must be cut with a clean square end.

DO NOT USE PLIERS OR PIPE WRENCH ON COUPLING NUTS OR FITTINGS.



NOTE: See Metric Liquid Handling Sheet for metric tubing connections.

5.0 METHODS OF EXTERNALLY TRIGGERING OR PACING A7, B7, C7 AND D7 PUMPS



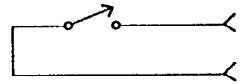
120 V
or
220 - 240 V
50 - 60 Hz

Optional
Low Level
Sensor
Part No. 29190

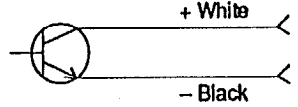
or
Remote
Start/Stop
Start (Open)
Stop (Closed)

Methods of Triggering Metering (Dosing) Pumps

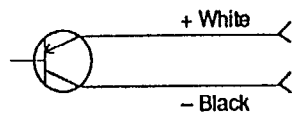
1. Switch Closure
Switch closing
triggers pump



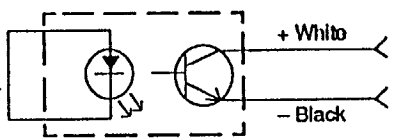
2. NPN Transistor
Base goes high
to trigger pump



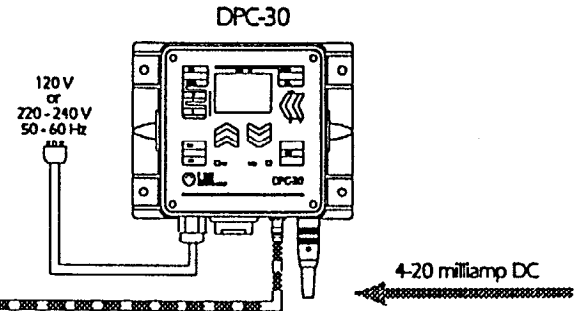
3. PNP Transistor
Base goes low
to trigger pump



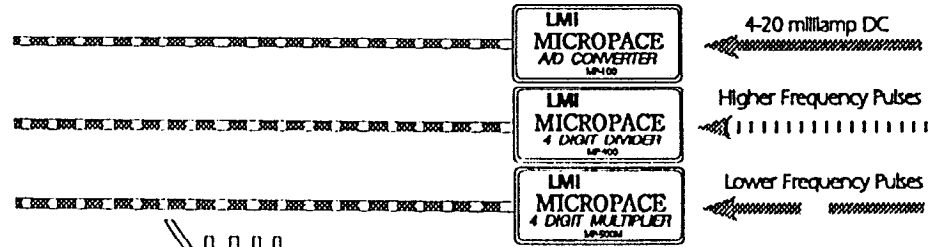
4. Opto
Isolator



Note:
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.



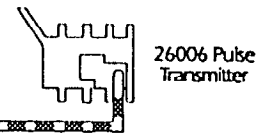
4-20 milliamp DC



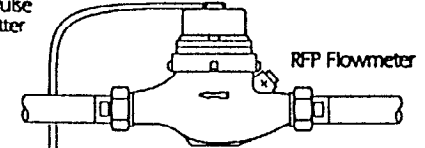
4-20 milliamp DC

Higher Frequency Pulses

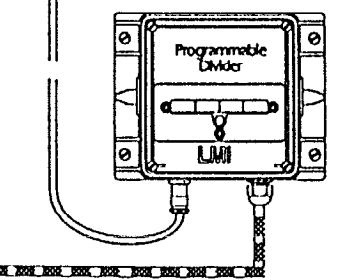
Lower Frequency Pulses



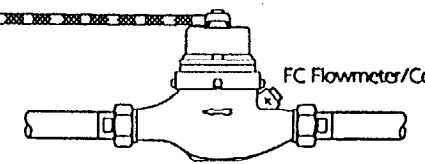
26006 Pulse
Transmitter



RFP Flowmeter



Programmable
Divider



FC Flowmeter/Contactor

6.0 START-UP and ADJUSTMENT


NOTE: The pump is normally self-priming if suction lift is $3\frac{1}{2}$ ft. (1.0m) or less and the steps below are followed.


NOTE: Pumps are shipped from the factory with water in the pump head to aid in priming.

6.1 Output Adjustment Controls

Note: Manual series pumps controls are not equipped with pressure control.


In most external controlled pumps the uppermost set of knobs on the control panel serve a dual purpose. The smallest of these knobs (inner knob of this concentric knob) is Pressure Control. The larger knob directly underneath is Speed Control. Graduation markings for the small Pressure Control Knob are etched in yellow on the Speed Knob itself. Graduations for the Speed Knob appear directly on the face of the control panel. The largest knob below is Stroke Control.

1. **Pressure Control Adjustment:** 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:** Speed control provides adjustment of the percent of maximum strokes per minute. Turning this knob clockwise  increases stroke frequency.

Note A7 Series Only: When operating pump in external mode, the speed control knob should be turned fully counter clockwise . A click indicates pump is in external mode.

Note A34 and A37 Series Only: Pump comes equipped with a range selector switch

which provides high or low speed adjustment. The high setting provides speed adjustments between 8-100 strokes per minute. The low setting provides accurate speed adjustments between 1-12.5 strokes per minute, for applications requiring infrequent stroking.

3. **Stroke Adjustment:** Stroke control provides adjustment of percent of maximum Liquifram[®] (diaphragm) travel. Turning this knob clockwise  increases percent output per stroke.


6.2 Start-Up/Priming for Pump Supplied with 4-FV



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 a pressure control knob, turn knob fully clockwise. 

3. If your pump is equipped with a 4-FV, grip both the yellow and black knobs, 1/4 turn or pull and hold open.
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 4-FV. Once this happens, 1/4 turn or release the knobs 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.
7. Proceed to output adjustment, Section 6.4.

NOTE: If the pump does not self-prime, remove the 4-FV 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.

6.3 Start-Up/Priming without 4-FV



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 prime 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 a pressure control knob, turn knob 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.

NOTE: If the pump does not self-prime, see the PolyMax manual.

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.

TOTAL PUMP OUTPUT

Calculate the total output of the pump as follows:

$$\text{PUMP OUTPUT} = \text{MAX PUMP OUTPUT} \times \% \text{SPEED} \times \% \text{STROKE}$$

Example: A151-192S

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:

$24.0 \times 0.60 \times 0.70 = 10.08$ GPD (gallons per day)
Divide by 24 (hours in one day) to calculate in gallons per hour

Note: If pump is not equipped with speed adjustment, calculate by Max Pump Output x % Stroke only.

7.0 CALIBRATION - SEE POLYMAX MANUAL

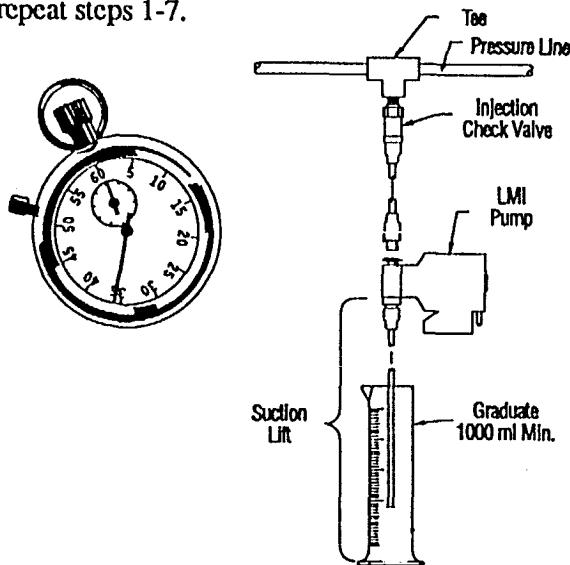
Once installation is complete and the approximate output has been determined, the pump should be calibrated to adjust speed and stroke for your actual desired output.

1. If equipped, make certain Pressure Control Knob is turned fully clockwise ☺
2. 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).



3. Place the tubing in a graduated container with a volume of 1000 ml or more.
4. Plug in and switch pump to Internal Mode. Pump until all the air is exhausted from the suction line and head.
5. Turn the pump off. Refill graduated container to a level starting point.

NOTE: If pump is equipped with pressure control, see Section 7.1 before proceeding.

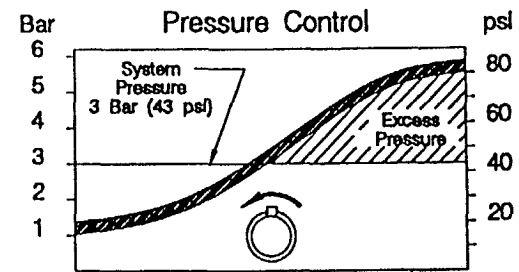
6. Using a stopwatch or timer, turn the pump on for a measured amount of time (50 pump strokes minimum). The longer the time period, the more confident you can be of the results. Be sure to count the number of strokes during the calibration period when making comparisons.
7. Turn the pump off. Note the time elapsed in relation to volume displaced in the graduate. Now, calculate the output in the time unit you choose (minutes, hours, days, etc.).
8. If the output is too low or too great, adjust speed and or stroke, estimating required correction and repeat steps 1-7.



7.1 Pressure Control

Adjust Pressure Control: While unit is running, turn Pressure Control Knob slowly counter-clockwise  until unit just begins to stall. From this stall point, now turn Pressure Control Knob clockwise  from 1 to 1 1/2 graduation marks. This is the optimum pressure control setting for your application.

NOTE: Increase setting if back pressure is increased.



Adjust pressure control to reduce heat, shock, pulsations and prolong pump life.

7.2 Calibration Procedure - On-Site Volumetric Calibration in External Mode

1. Since pump output is governed by an external device such as Flowmeter-Pulsar, Liquitron™ Current-to-Frequency Converter 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 tubing inlet in a graduated container with a volume of 500 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 - See Section 7.1.
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: 500ml in 100strokes=5.0ml perstroke.

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.

8.0 SPARE PARTS REPLACEMENTS ROUTINE MAINTENANCE

8.1 Depressurizing the Discharge Line (For Pumps Equipped with a 4-FV only).



WARNING: ALWAYS wear protective clothing, face shield, safety glasses and gloves when performing any maintenance or replacement on your pump.



WARNING: 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 to off.



WARNING: Be sure your relief tubing is connected to your 4-FV and runs back to your solution drum or tank.

2. 1/4 turn or pull on both the yellow and black knobs on the 4-FV. The discharge line is now depressurized. Keep valve open until solution drains back down the discharge tubing into solution drum or tank. Then release or 1/4 turn knobs to normal position.

8.2 Liquifram® (Diaphragm) Replacement



WARNING: ALWAYS wear protective clothing, face shield, safety glasses and gloves when working near or performing any maintenance or replacement on your pump. See MSDS Sheet 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® seal rings, valve balls, 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®, the valve balls, seal rings and the injection check valve spring should also be replaced. See next section (8.3). A Spare Parts Kit (SP-#) containing these parts may be obtained from your local distributor. (See the Liquid Handling Assembly Sheet for Spare Parts Kit Part Number).

- Carefully depressurize, drain, and disconnect the discharge line (See Section 8.1 in this manual). Place the tube inlet 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.

Note: If the liquid cannot be pumped due to Liquifram® rupture, using protective gloves, carefully disconnect the suction and discharge tubing. Remove the four screws to the head and immerse the head in water or other neutralizing solution.

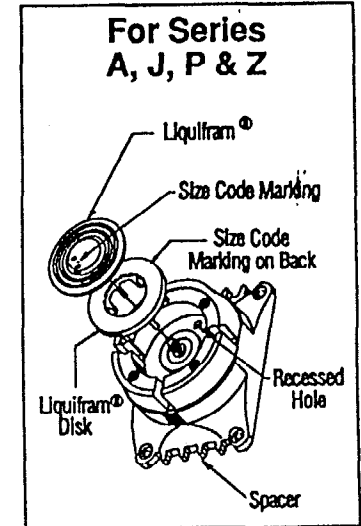
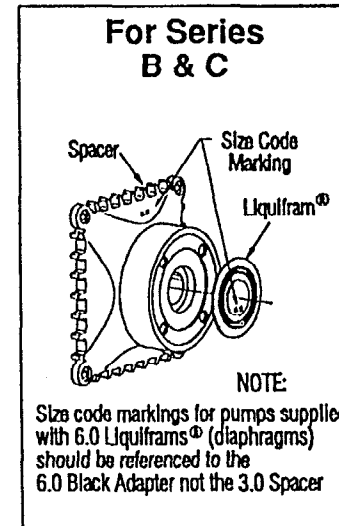
- Start the pump. While running, set the stroke knob to zero and turn the pump off.

NOTE: See Section 9.0 for proper zeroing.

- With the unit off, unscrew the Liquifram® by carefully grasping the outer edge of the Liquifram® 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).
- Reinstall the disk so the alignment pin on the disk (if present) seats in the recessed hole in the EPU.



WARNING: Take care not to scratch the Teflon face of the new Liquifram®.

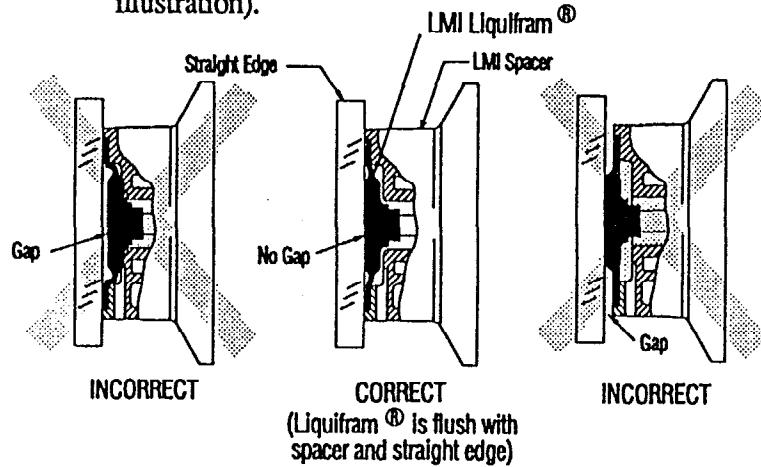


- Start the pump and turn the stroke knob to the setting indicated below on Stroke Setting Chart which matches the pump model number located on the pump dataplate. With the pump stroking (running), screw on the new Liquifram® clockwise until the center begins to buckle inwards. Stop the pump.

Liquifram® Stroke Setting Chart

Pump Series	Stroke Knob Setting
All A, J, P, Z Series B11, B71, B12, B72, B13, B73 D11, D71, D12, D72, D10, D70 C11, C71, C12, C72, C10, C70 E50, E51, E52	90%
All L Series	85%
B14, B74 D13, D73 C13, C73, C77, C78 E53	70%
D14, D74 C14, C74 E54	50%
All U and M Series	100% but Liquifram® must be bottomed completely. Do Not Use Straight Edge.

- 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).



- Once the Liquifram[®] is properly positioned, remount the pump head to the spacer using the four (4) screws. Tighten in a crisscross pattern. After one week of operation, recheck the screws and tighten if necessary.

8.3 Seal Ring, Ball and Injection Check Valve Spring Replacement



WARNING: ALWAYS wear protective clothing, face shield, safety glasses and gloves when working on or performing any maintenance or replacement on your pump. See MSDS Sheet from solution supplier for additional precautions.

- Refer to the Liquid Handling Assembly Sheet included with your pump for the proper Spare Parts Kit number. (SP-#)
- Carefully depressurize and disconnect the discharge line (See Section 8.1 in this manual). Place the tube inlet 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 tube out and continue to pump 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 gloves, carefully disconnect the tubing and four screws to remove the head. Immerse the head in water or other neutralizing solution.

IMPORTANT: Before disassembling valves, note the orientation of seal ring and ball. (See illustration)

- Carefully disconnect one tubing connection and fitting at a time and remove the worn seal ring and ball.

Carefully loosen scaling by prying side to side using a small screw driver through the center hole of the seal ring.

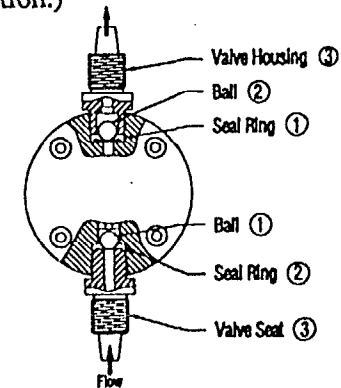
- Install new seal ring and ball in each location. **IMPORTANT:** Note correct orientation.

- Install the new spring in the Injection Check Valve. (I.C.V.)



WARNING: Depressurize and drain pipeline (or isolate I.C.V. point using valves) so that I.C.V. can safely be disassembled.

(Refer to Liquid Handling End Sheet for proper assembly orientation.)



Order of Installation

Note: Order of assembly changes depending on valve location

9.0 CHECKING PUMP FOR PROPER ZEROING (STROKE KNOB)

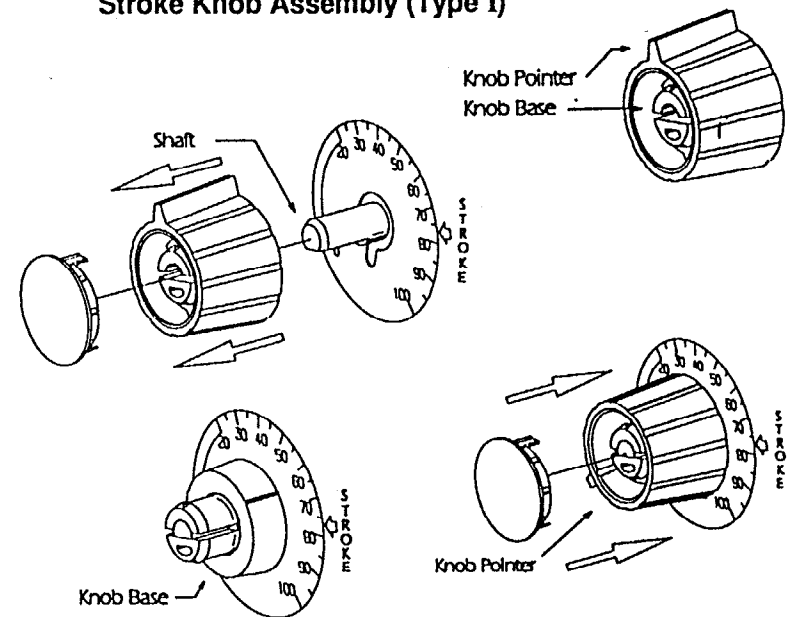
1. With pump running, turn stroke knob counter clockwise toward zero or end of black or red band.
2. LISTEN to the clicking as the pump is running. The pump should operate quietly at the zero position (no clicking).
3. If the pump continues to click at zero or stops clicking before zero is reached, the pump zero must be reset. (See Section 9.1 or 9.2)

9.1 Type I - Push on Knob

Rezeroing 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)



9.2 Type II Collet Knob

Rezeroing 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.

TROUBLESHOOTING (continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
Leakage at tubing	1. Worn tubing ends.	1. Cut tubing about 1 inch (25 mm) off tubing and then replace as before.
	2. Loose or cracked fitting.	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. Worn seal rings.	3. Replace balls and seal rings. (See Section 8.3) Spare Parts (SP-#)
	4. Solution attacking Liquid Handling Assembly material.	4. Consult LMI or your local distributor for alternate materials.
Low Output or Failure to Pump Against Pressure	1. Pump's maximum pressure rating is exceeded by injection pressure.	1. Injection pressure cannot exceed pump's maximum pressure. See pump data plate.
	2. Worn Seal Rings.	2. Worn seal rings may need replacement. (See Section 8.3) Spare Parts (SP-#)
	3. Ruptured Liquifram®.	3. Replace Liquifram®. (See Section 8.2)
	4. Incorrect stroke length.	4. Check zero on pump/Re-zero pump. (See Section 9.0)
	5. Tubing run on discharge may be too long.	5. Longer tubing runs may create frictional losses sufficient to reduce pump's pressure rating. Consult factory for more information.
	6. Clogged tubing inlet.	6. Remove tubing and clean.
Failure to Run	1. Pump not turned on or plugged in.	1. Turn on or plug in pump.
	2. EPU failure.	2. Disassemble pump and measure the resistance of the EPU across the EPU wires. Resistance reading should be in accordance to the table (See Section 11.0). Also check EPU leads to ground. Consult supplier or factory.
	3. Pulsar failure.	3. The pulsar should be replaced if EPU checks out OK. Consult supplier or factory.
Excessive Pump Output	1. Syphoning.	1. Move injection point to a pressurized location.
	2. Little or no pressure at injection point.	2. If pressure at injection point is less than 25 psi, call SEMBLEX.
	3. Excessive strokes per minute.	3. Replace pulsar or resistor. Consult factory.

10.0 TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	SOLUTION
Pump Will Not Prime	1. Pump not turned on or plugged in.	1. Turn on pump/plug in pump.
	2. Output dials not set properly.	2. Always prime pump with speed at 80% and stroke at 100%.
	3. Tubing inlet not in vertical position on bottom of tank.	3. Tubing must be vertical. Install straightener.
	4. Pump suction lift too high.	4. Maximum suction lift is 5 ft. (1.5 m) Pumps with High Viscosity Liquid Handling Assemblies require flooded suction.
	5. Suction tubing is curved or coiled in tank	5. Suction tubing must be vertical. Use tubing straightener.
	6. Fittings are over tightened.	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. Air trap in suction valve tubing.	7. Suction tubing should be as vertical as possible. AVOID FALSE FLOODED SUCTION! (See Section 4.2A)
	8. Too much pressure at discharge. (Pumps without 4-FV)	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.
Pump Loses Prime	1. Solution container ran dry	1. Refill container with solution and reprime (See Section 6.0)
	2. Tubing inlet is not in a vertical position on the bottom of the tank.	2. Tubing must be vertical
	3. Pump suction lift is too high.	3. Maximum suction lift is 3' (1.0m). Pumps with High Viscosity Liquid Handling Assemblies require flooded suction.
	4. Suction tubing is curved or coiled in tank or tubing inlet has floated to top of solution.	4. Suction tubing must be vertical. Install straightener.
	5. Fittings are overtightened.	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. Air trap in suction valve tubing.	6. Suction tubing should be as vertical as possible. AVOID FALSE FLOODED SUCTION! (See Section 4.2A)
	7. Air leak on suction side.	7. Check for pinholes, cracks. Replace if necessary.

11.0 EPU RESISTANCE CHART

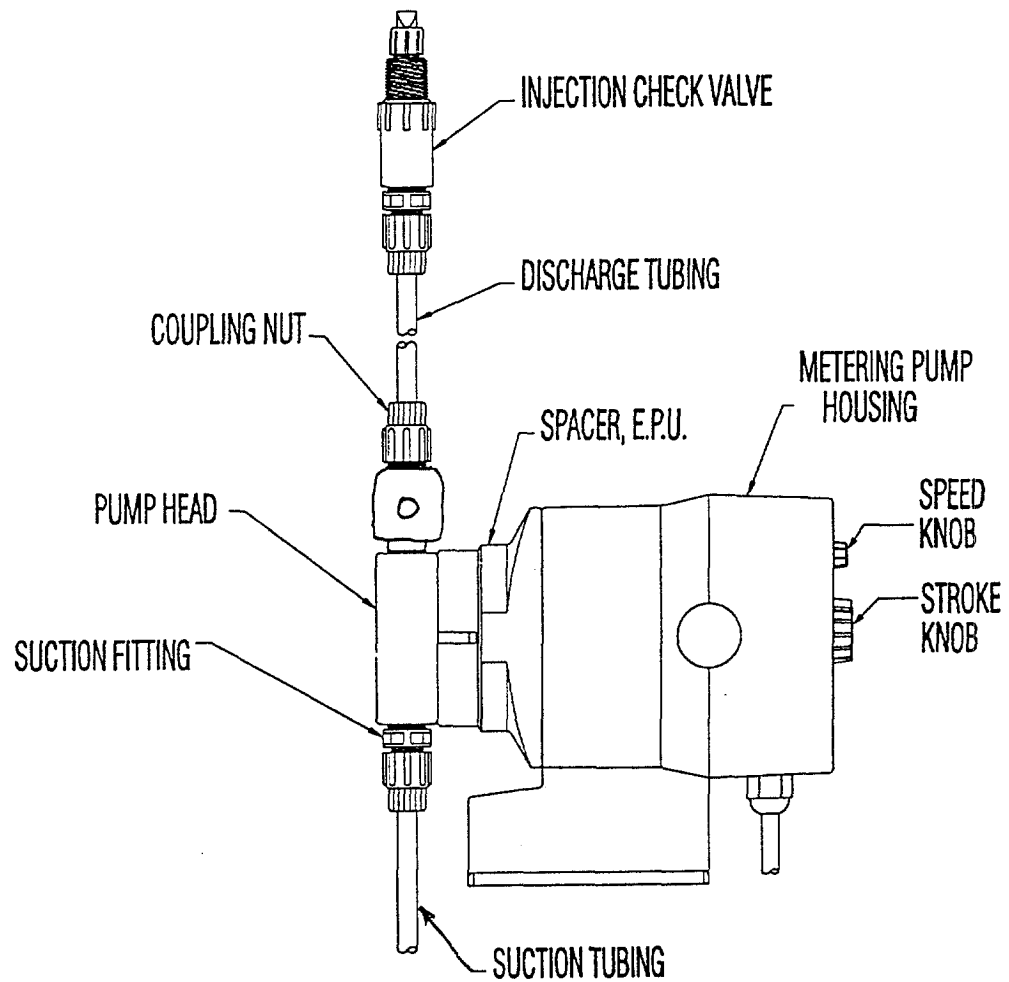
Pump Series	Voltage	Coil Resistance (Ohms) * @ 20°C (68° F)
A14, A15, A16, A34, A37 A74, A75, A76 J02, J03, J04, J05, J06 J13, J15, J16 PW4, PW5, PW6 P04, P05, P06 P14, P15, P16 U01, U02, U03	115 VAC 230 VAC	76 - 87 307 - 353
A17, A77, A18, A78 Z14, Z15 P02, P03 P12, P13	115 VAC 230 VAC	152 - 176 583 - 671
J54D, J55D, J56D	12 VDC	1.1 - 1.3
D10, D11, D12, D13, D14 D70, D71, D72, D73, D74 E50, E51, E52, E53, E54	115 VAC 230 VAC	25.7 - 29.6 97 - 112
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
C77, C78	115 VAC 230 VAC	14.4 - 16.6 57.7 - 66.3

* EPU checked within 10 hours of operation
can increase coil resistance reading as
much as 20%

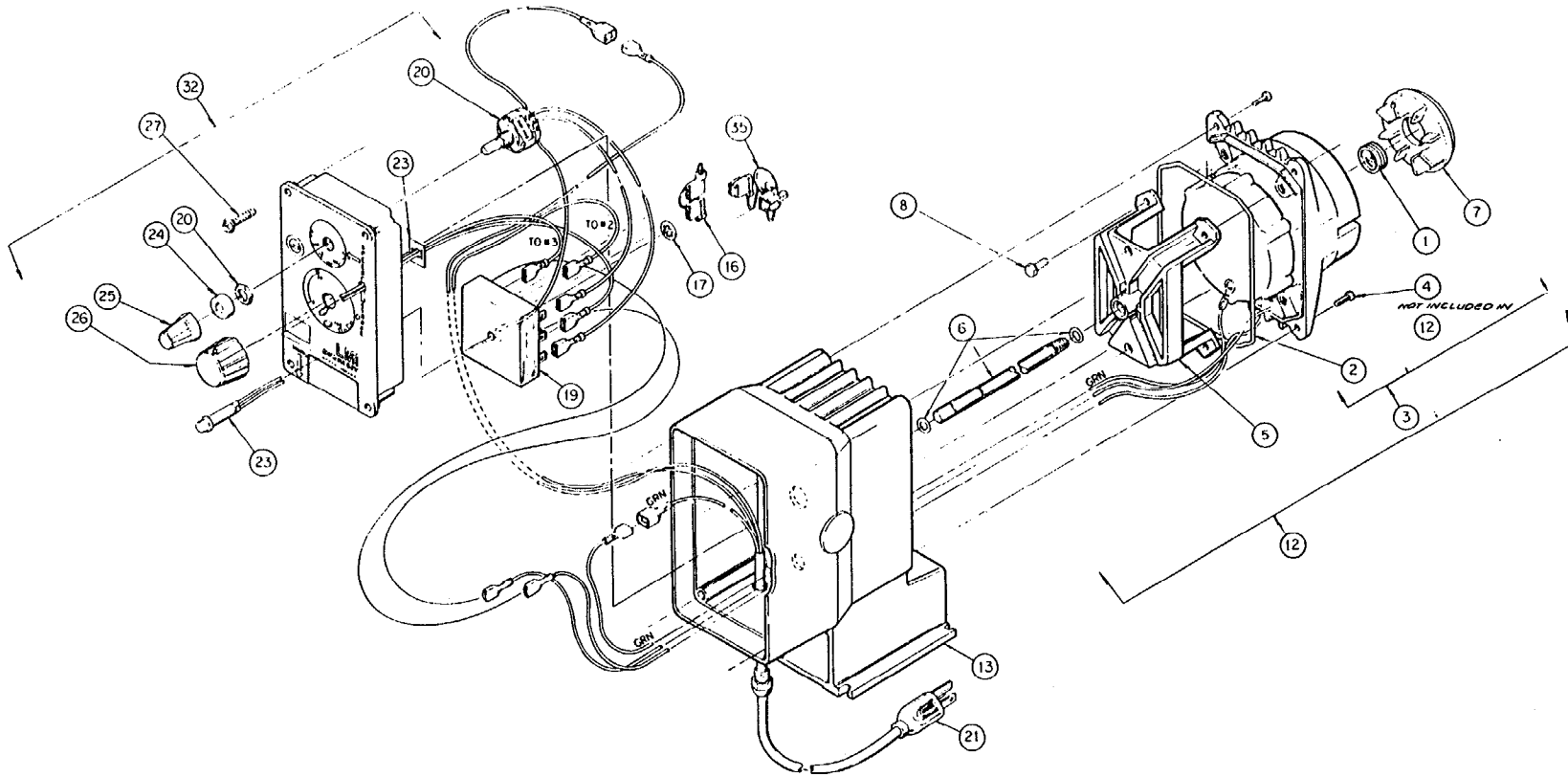
Series A1 Instruction Supplement

- Metering Pump Component Diagram
- Drive Assembly Exploded View Diagram
- Drive Assembly Parts List
- Control Panel Detail
- Wiring Diagram

Metering Pump Component Diagram



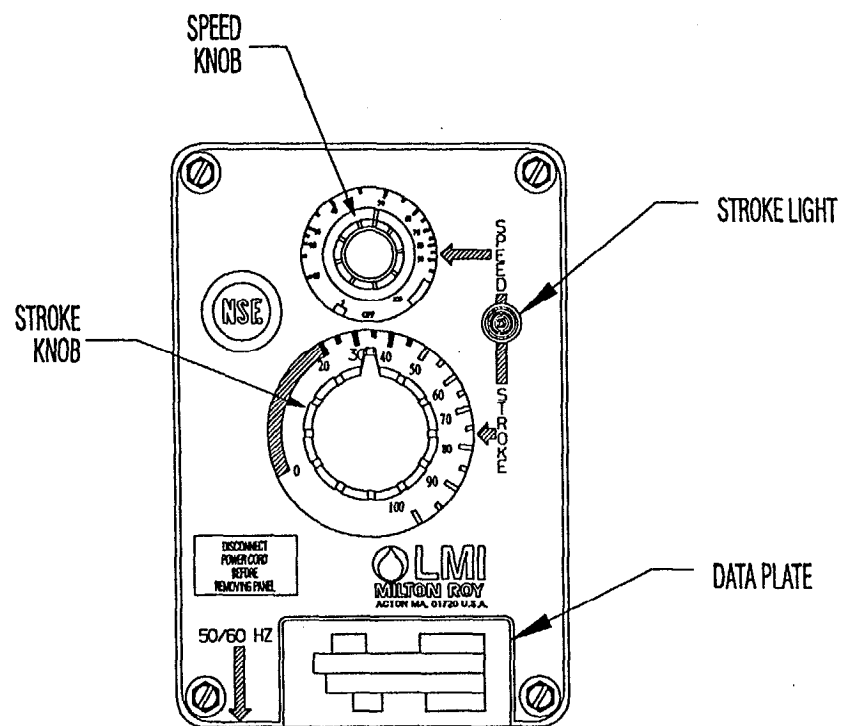
Series A1 Drive Assembly Exploded View Diagram



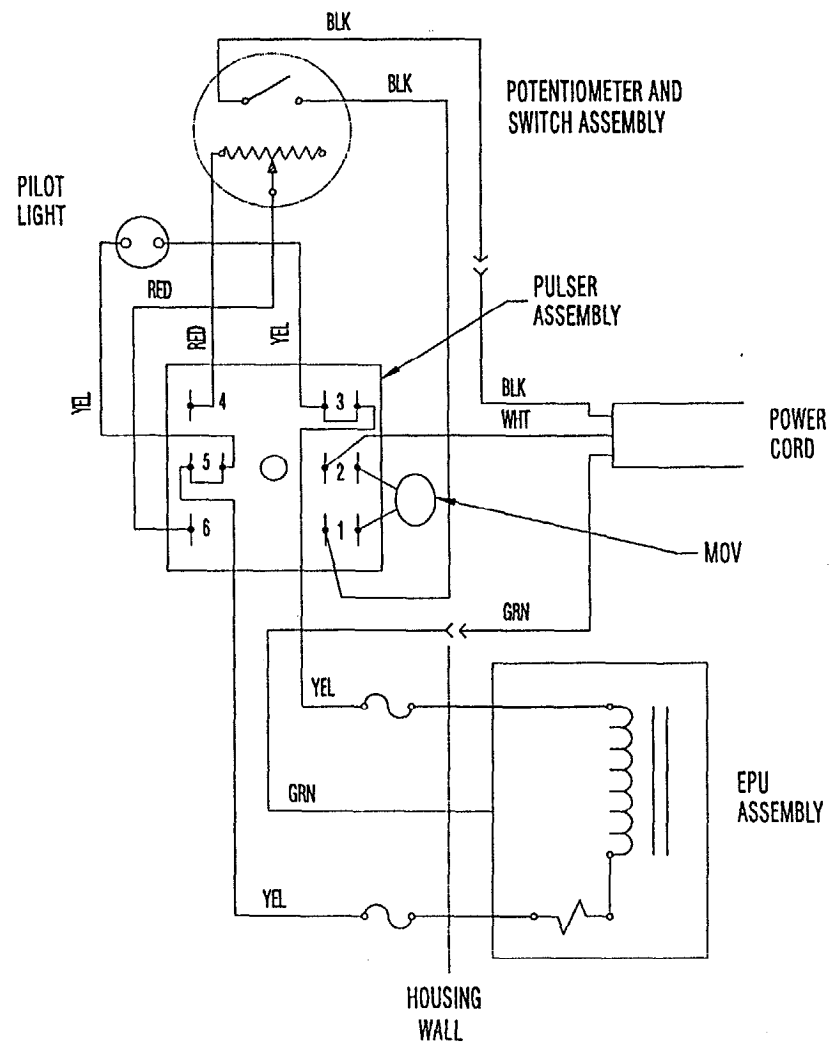
Series A1 Drive Assembly Parts List

Key No.	Model Series	Part No.	Description	Qty.	Key No.	Model Series	Part No.	Description	Qty.			
1	A14(A15) A16, A17, A18	10973	Seal	1	19	A141(A151) A161, A171, A181	10150	Pulser, 120 V	1			
2	A14(A15) A16, A17, A18	10166	O-Ring	1		A142, A152, A162, A172, A182						
3	A141	28085	EPU ASM w/Disk, 120 V	1		A143, A153, A163, A173, A183	10268	Pulser, 240 V	1			
	A142, A143, A145, A146, A147	28086	EPU ASM w/Disk, 240 V	1		A145, A155, A165, A175, A185						
	(A151)	27465	EPU ASM w/Disk, 120 V	1		A146, A156, A166, A176, A186						
	A152, A153, A155, A156, A157	27466	EPU ASM w/Disk, 240 V	1		A147, A157, A167, A177, A187						
	A161	27467	EPU ASM w/Disk, 120 V	1	20	A14(A15) A16, A17, A18				30830	Potentiometer Assembly	1
	A162, A163, A165, A166, A167	27468	EPU ASM w/Disk, 240 V	1		A141(A151) A161, A171, A181	29033	Power Cord Assembly, 120 V	1			
	A171	29272	EPU ASM w/Disk, 120 V	1	21	A142, A152, A162, A172, A182	29039	Power Cord Assembly, 240 V	1			
	A172, A173, A175, A176, A177	29273	EPU ASM w/Disk, 240 V	1		A143, A153, A163, A173, A183	29042	Power Cord Assembly, 220-240 V, DIN	1			
	A181	29274	EPU ASM w/Disk, 120 V	1		A145, A155, A165, A175, A185	29044	Power Cord Assembly, 200-240 V, UK	1			
A182, A183, A185, A186, A187	29275	EPU ASM w/Disk, 240 V	1		A146, A156, A166, A176, A186	29046	Power Cord Assembly, 200-240 V, AUST	1				
4	A14(A15) A16, A17, A18	30306	Screw	4		A147, A157, A167, A177, A187	29048	Power Cord Assembly, 200-240 V, SWISS	1			
5	A14(A15) A16, A17, A18	26838	Bracket Stroke Adjustment	1	23	A141(A151) A161, A171, A181	10181-G	Pilot Light, 120V	1			
6	A14(A15) A16, A17, A18	31768	Adjustment Shaft Assembly	1			A142, A152, A162, A172, A182					
7	A14, A17	29445	Disk, 0.5	1			A143, A153, A163, A173, A183	10423-B	Pilot Light, 240 V	1		
	(A15) A18	29437	Disk, 0.9	1			A145, A155, A165, A175, A185					
	A16	29442	Disk, 1.8	1			A146, A156, A166, A176, A186					
8	A14(A15) A16, A17, A18	32498	Screw	4			A147, A157, A167, A177, A187					
12	A141	31915	EPU w/Stroke Adjustment & Disk	1	24	A14(A15) A16, A17, A18	30803				Gasket	1
	A142, A143, A145, A146, A147	31916	EPU w/Stroke Adjustment & Disk	1	25	A14(A15) A16, A17, A18	30709				Knob	1
	(A151)	31911	EPU w/Stroke Adjustment & Disk	1	26	A14(A15) A16, A17, A18	31890	Knob Asm	1			
	A152, A153, A155, A156, A157	31912	EPU w/Stroke Adjustment & Disk	1	27	A14(A15) A16, A17, A18	30306	Screw	4			
	A161	31913	EPU w/Stroke Adjustment & Disk	1	32	A141(A151)	30386	Control Panel Assembly, 120 V	1			
	A162, A163, A165, A166, A167	31914	EPU w/Stroke Adjustment & Disk	1			A142, A152	30387	Control Panel Assembly, 240 V	1		
	A171	31917	EPU w/Stroke Adjustment & Disk	1			A143, A145, A146, A147	30397	Control Panel Assembly, 240 V	1		
	A172, A173, A175, A176, A177	31918	EPU w/Stroke Adjustment & Disk	1			A153, A155, A156, A157					
	A181	31919	EPU w/Stroke Adjustment & Disk	1			A161	30444	Control Panel Assembly, 120 V	1		
A182, A183, A185, A186, A187	31920	EPU w/Stroke Adjustment & Disk	1			A162	30445	Control Panel Assembly, 240 V	1			
						A163, A165, A166, A167	30446	Control Panel Assembly, 240 V	1			
						A171	30437	Control Panel Assembly, 120V	1			
					A172	30438	Control Panel Assembly, 240V	1				
13	A14(A15) A16, A17, A18	30324	Housing	1		A173, A175, A176, A177	30439	Control Panel Assembly, 240V	1			
16	A141(A151) A161, A171, A181	10626	Varistor Asm 120 V	1		A181	30440	Control Panel Assembly, 120 V	1			
	A142, A152, A162, A172, A182					A182	30441	Control Panel Assembly, 240 V	1			
	A143, A153, A163, A173, A183					A183, A185, A186, A187	30442	Control Panel Assembly, 240 V	1			
	A145, A155, A165, A175, A185	10627	Varistor Asm 240 V	1	35	A142, A152, A162, A172, A182	25628	Varistor Asm 240 V USA	1			
	A146, A156, A166, A176, A186											
	A147, A157, A167, A177, A187											
17	A14(A15) A16, A17, A18	10422	Ring, Retaining	1								

Series A1 Control Panel Detail



Series A1 Wiring Diagram



LIQUID HANDLING ASSEMBLIES

LE-20PMX

LE-76PMX

LE-86PMX

CAUTION

When pumping chemicals make certain that all tubing is securely attached to the fittings. It is recommended that tubing or pipe lines be shielded to prevent possible injury in case of rupture or accidental damage. Always wear protective clothing when working on or near chemical metering pump.

MATERIAL

Fittings	Polypropylene
Seal Rings	Hypalon
Balls	Stainless Steel
Head	Acrylic
Liquifram	Teflon Face
Springs	Stainless Steel
Suction	.938" O.D. Vinyl

A. FLOODED SUCTION (PREFERRED METHOD)

1. Mount pump 12" above floor with head extending beyond mounting so suction tubing curves gently away from pump to prevent kinking.
2. Install 1/2" or 3/4" shut off valve, with at least 3/4" clear way through valve, into reservoir. This is necessary to stop flow from reservoir while servicing pump.
3. Install barbed connector (one of two supplied) into valve. Attach 15/16" O.D. Vinyl tubing to barbed connector; secure with hose clamp provided (use shortest length of suction tubing practical).
4. Connect other end of suction tubing to barbed suction fitting at pump and secure with hose clamp provided.

B. SUCTION LIFT (PUMP SITTING ON BARREL; MAXIMUM LIFT 3.5 FT.)

1. Connect suction tubing to barbed suction fitting on pump. Secure with hose clamp provided.
2. Cut tubing so it will only reach within 1" of bottom of barrel.

3. If tubing curl is a problem fabricate 1" PVC pipe as tube straightener (pipe should be slightly longer than depth of barrel for ease of removal).
4. Place tubing straightener over suction tubing and lower into barrel.

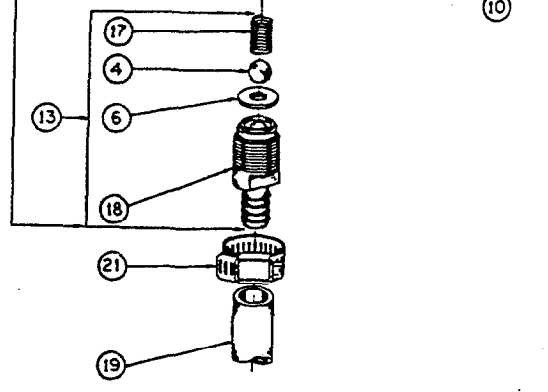
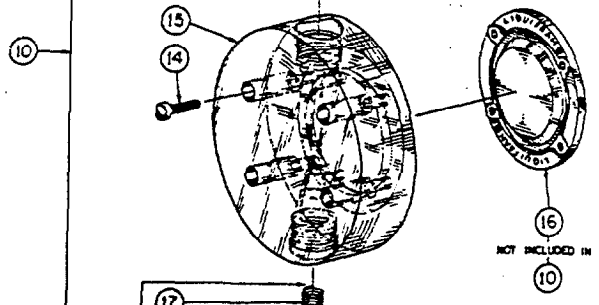
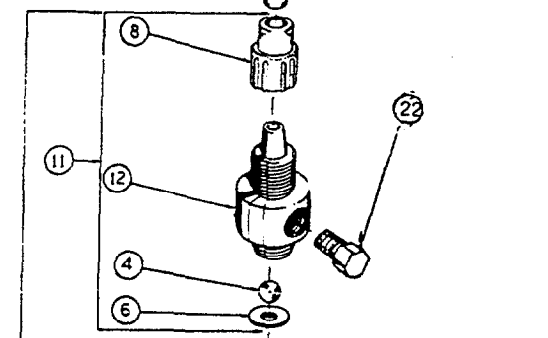
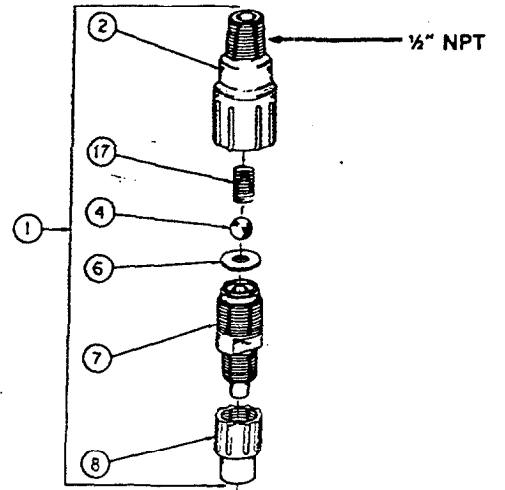
C. PRIMING

1. Pump is shipped pre-primed with water. If pump has lost its water prime, pre-prime with water using 100% stroke and 50% speed setting.
2. Make final installation except for injection connection at far end of tubing.
3. Open valve in suction line if installed.
4. Set pump at 100% stroke length and 50% speed. Start pump.
5. After all air is expelled from head, connect tubing at far end to connector. Open valve at injection point if installed. Adjust discharge rate to desired amount using longest stroke and slowest speed practical.
6. If difficulty is experienced on initial prime apply vacuum to discharge tubing by suitable means, such as hand suction pump. This should not reoccur after pump is primed with a viscous liquid.

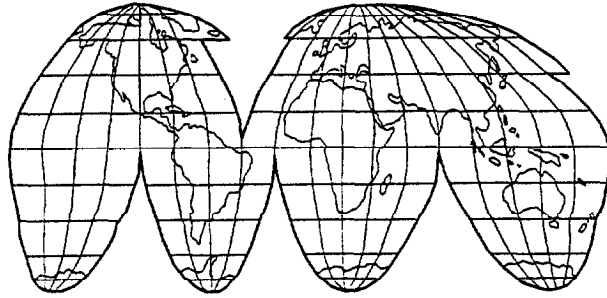
NOTE:

Threaded connections into pump head are 1"-12 straight threads. Do not use Teflon tape. These joints are sealed by seal ring valve seats (Ref. 6 on exploded view)

KEY NO.	FOR LE-	PART NO.	DESCRIPTION	Qty.
1	20PMX, 76PMX, 86PMX	30069	Injection Check Valve Asm.	1
2	20PMX, 76PMX, 86PMX	25108	Injector Fitting	1
4	20PMX, 76PMX, 86PMX	25042	Ball, SS	3
6	20PMX, 76PMX, 86PMX	10128	Seal Ring, Hypalon	3
7	20PMX, 76PMX, 86PMX	25106	Valve Seat, Polypropylene	1
8	20PMX, 76PMX, 86PMX	10411	Coupling Nut, Polypropylene	2
9	20PMX, 76PMX, 86PMX	10142-10	Tubing, Polyethylene, .5" O.D.	1
10	20PMX	30077	Head Asm, LE-20PMX	1
10	76PMX	30070	Head Asm, LE-76PMX	1
10	86PMX	30074	Head Asm, LE-86PMX	1
11	20PMX, 76PMX, 86PMX	30072	Discharge Valve Asm.	1
12	20PMX, 76PMX, 86PMX	25605	Valve Housing PP	1
13	20PMX, 76PMX, 86PMX	30071	Suction Valve Asm.	1
14	20PMX, 76PMX, 86PMX	10340	Screw, 10-24 x 3/4" S.S.	4
15	20PMX	10524-3	Head, 3.0	1
15	76PMX	25540	Head, 1.8	1
15	86PMX	25550	Head, 0.9	1
16	20PMX	25319	Liquifram, 3.0	1
16	76PMX	10305	Liquifram, 1.8	1
16	86PMX	10302	Liquifram, 0.9	1
17	20PMX, 76PMX, 86PMX	25558	Spring, SS	2
18	20PMX, 76PMX, 86PMX	25649	Valve Seat, Polypropylene, Barbed	1
19	20PMX, 76PMX, 86PMX	25651-3.5	Tubing, Vinyl, .938" O.D.	1



SPARE AND REPLACEMENT PARTS ORDERING INFORMATION



**SEMBLEX CUSTOM EQUIPMENT
A DIVISION OF MACE INDUSTRIES
PARTS DEPARTMENT
1635 W. WALNUT STREET
SPRINGFIELD, MISSOURI, U.S.A. 65806**

**PHONE (417) 866-1035
ASK FOR SPARE PARTS DEPARTMENT
OR
FAX (417) 866-0235 (24 HOURS A DAY)**

Faster service can be given on spare or replacement parts if you give the following information at the time of your request:

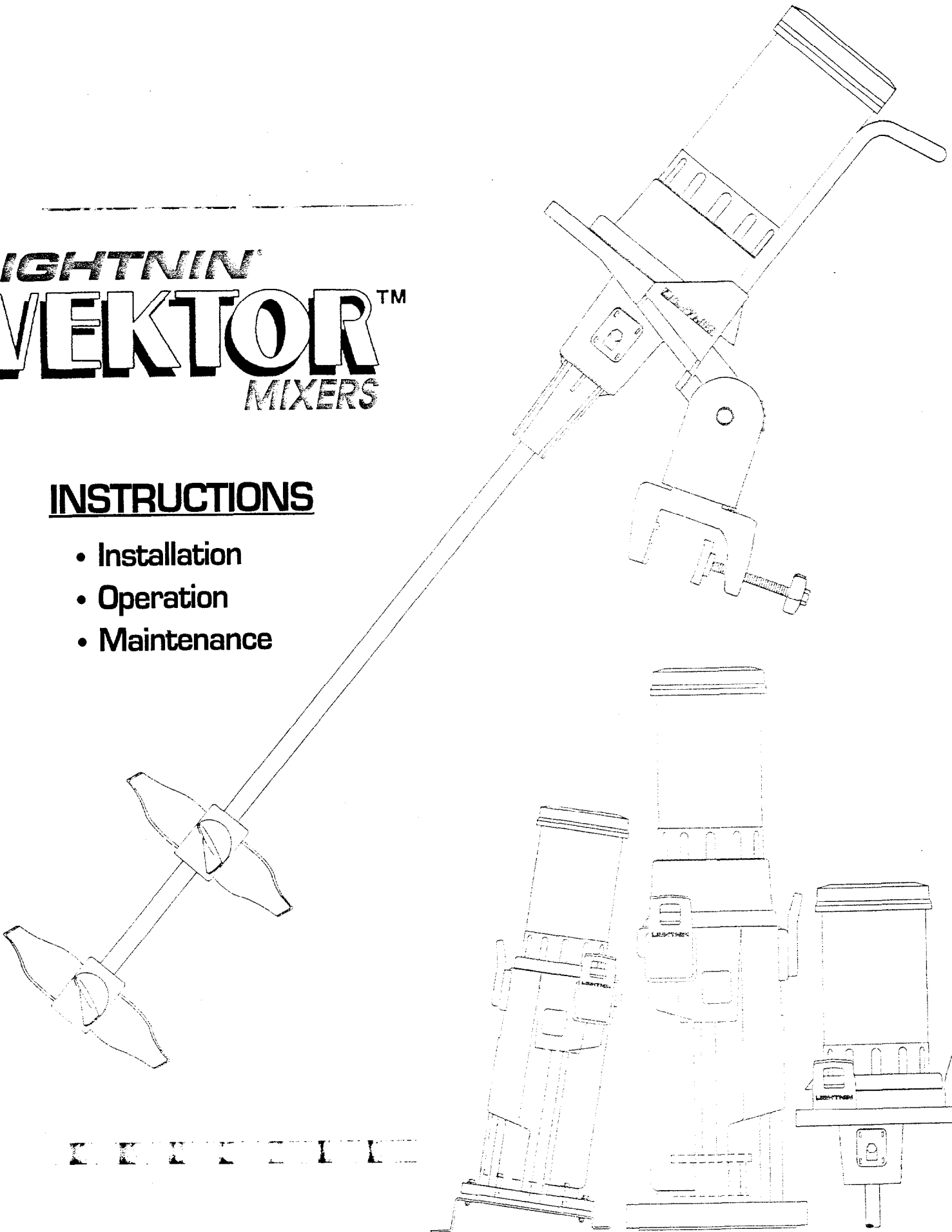
- Model Number of Product and/or Equipment Number
- Semblex Job Number (Example: 93010000-PF)
- Part Number (if given)
- Quantity Needed
- P.O. Number/Bill to and Ship to Address

**ALL PARTS WILL BE SHIPPED F.O.B. SPRINGFIELD, MISSOURI, USA, AT PRICES IN
EFFECT AT TIME OF SHIPMENT**

LIGHTNIN[®] VEKTOR[™] MIXERS

INSTRUCTIONS

- Installation
- Operation
- Maintenance



LIGHTNIN®

A UNIT OF GENERAL SIGNAL

MODEL V6Q25R
 ORDER NO. E46686
 SERIAL NO. 95E4668601
 CUST. P.O. 1010343

LIGHTNIN SALES OFFICE:
 P.R. BRADLEY & ASSOCIATES
 1293 MINHINETTE DRIVE
 P.O. BOX 1579
 ROSWELL, GA 30077
 PHONE: 404-998-1956
 FAX: 404-998-0119
 SALES SERVICE REP.: Mike Wolfe

MIXER SPECIFICATIONS

BASE	OUTPUT TYPE: SINGLE REDUCTION		OUTPUT RPM: 273		PART NUMBER
MOTOR	TYPE: DC-SCR				
	HP: .33	VOLTS: 90	CYCLE:		
	PHASE:	SPEED: 1800	ENCLOSURE: TEFC		
MOTOR KIT					869693PSP
MOTOR CONTROLS					
MACHINE	TYPE: OPEN TANK		DRIVE SHAFT TYPE: QUILL		835165PSP
MOUNTING	TYPE: PLATE				869728PSP
SHAFT	DIA.: 1.00	MAT'L: 316 SS	LENGTH (FMB): 84.00		219153316
	COUPLING TYPE: QUILL		LENGTH (FL): 82.87		
IMPELLERS	QUANTITY: 1				
	TYPE	BLADE CODE	DIA.	MATERIAL	STABILIZER
UPPER					
MIDDLE					
LOWER	A310		13.58	316 L	YES
SPACING	UPPER		LOWER		
TAGGING INFORMATION					

ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.

DESIGN INFORMATION			TANK DIMENSIONS (in)	
CRITICAL SPEED:	188	RPM	MOUNTING TYPE:	
CRITICAL SPEED RATIO:	1.453		TANK SHAPE:	
TOTAL MIXER WEIGHT:	85.76	lb	DIAMETER:	OVERALL HEIGHT:
TORQUE:	150.44	in-lb	TOP TYPE:	TOP DIMENSION:
BENDING MOMENT:	814.16	in-lb	BOTTOM TYPE:	BOTTOM DIMENSION:
DOWNWARD LOAD:	202.82	lb	END TYPE:	END DIMENSION:
			NOZZLE TYPE:	NOZZLE DIMENSION:
			BEAM HEIGHT:	LENGTH:
			WIDTH:	STRAIGHT SIDE:
			LONG OFFSET:	SHORT OFFSET:
			BAFFLES:	BAFFLE QUANTITY:
			OFFSET:	BAFFLE WIDTH:
			BAFFLE LENGTH:	BAFFLE OFFWALL:

O H M CORP
 5335 TRIANGLE PKWY
 NORCROSS GA
 30092 USA
 BILL MATTHEWS

REVISION:

DATE:

LIGHTNIN®

INST.No.IT-2714

REVISED:

MIXERS AND AERATORS:

© 1991

PAGE 1

TABLE OF DRAWINGS AND INSTRUCTIONS

FOR **LIGHTNIN®** VEKTOR™ MIXER

MODEL V6Q25R

TITLE	PAGE
SPECIFICATION SHEET _____	1
TABLE OF DRAWINGS AND INSTRUCTIONS _____	2
SAFETY CHECK LIST _____	3
SAFETY INSTRUCTIONS _____	4
INSTALLATION DRAWING _____	6
MIXER ASSEMBLY DRAWING _____	7
BEARING HOUSING ASSEMBLY DRAWING _____	8
GEAR HOUSING ASSEMBLY DRAWING _____	9
GENERAL INSTRUCTIONS _____	10
MIXER INSTALLATION _____	10
BOLT TORQUES _____	10
SHAFT AND IMPELLER INSTALLATION _____	11
SHAFT REMOVAL _____	11
OPERATION AND LUBRICATION _____	12
DISASSEMBLY INSTRUCTIONS _____	13
ASSEMBLY INSTRUCTIONS _____	15
MOTOR DATA _____	APPENDIX "A"
MOTOR DRAWING	
MOTOR INSTRUCTIONS	
ELECTRONIC CONTROLS ADJUST-A-MIX	
ACCESSORIES FOR ADJUST-A-MIX	
IMPELLER DATA _____	APPENDIX "B"
IMPELLER DRAWING	
SPARE PARTS DATA _____	APPENDIX "C"
SPARE PARTS LIST	
LIGHTNIN GUARANTEE/SALES OFFICES	
AFTERMARKET SERVICE PROGRAM PORTABLE MIXERS	

LIGHTNIN
A UNIT OF GENERAL SIGNAL

SAFETY CHECK LIST

IMPORTANT

All **LIGHTNIN**® VEKTOR™ Mixers are provided with properly designed lifting devices and safety covers to avoid potential injury and/or equipment damage. The following SAFETY CHECK LIST should be THOROUGHLY REVIEWED AND ADHERED TO before operating or performing maintenance on the mixer. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS INJURY.

1. Use only the lifting device provided on your unit to install the mixer. Use shouldered eyebolts and tighten securely to handle component parts. We strongly recommend that the hoist rings be of safety swivel type with 360° rotational capability.
2. DO NOT connect the motor to the power source until all components are assembled, the mixer is installed, and all hardware is tightened to the proper torque which is specified in the operation and maintenance manuals supplied by **LIGHTNIN**.
3. DO NOT operate shaft sealing devices at temperatures or pressures higher than those specified in the manual or on the nameplates.
4. DO NOT service the mixer until you have followed your "Control of Hazardous Energy Sources" (lockout, tagout procedure) as required by OSHA 29 CFR Part 1910.
5. DO NOT touch rotating mixer parts.
6. DO NOT operate mixer for service other than its intended use.
7. DO NOT make any field changes or modifications (horsepower, output speed, shaft lengths, impellers, etc.) without reviewing the changes with your **LIGHTNIN** Sales Representative or the **LIGHTNIN** Customer Service Department.
8. DO NOT operate mixer until you have checked the following items:
 - A. Make sure the mixer is properly grounded.
 - B. Ensure all protective guards and covers are installed.
 - C. Ensure all detachable components are securely coupled to the mixer.
 - D. Thoroughly REVIEW and ADHERE TO the mixer operating instructions supplied by **LIGHTNIN**.
 - E. Ensure the mixer output shaft rotates freely by hand.
 - F. Ensure all personnel and equipment are clear of rotating parts.
 - G. Ensure all external connections (electrical, hydraulic, pneumatic, etc.) have been completed in accordance with all applicable codes and regulations.
9. DO NOT enter the mixing vessel UNLESS:
 - A. The mixer power supply is locked out (follow Item number 4).
 - B. The mixer shaft is firmly attached to the mixer drive or the shaft is supported securely from below.
 - C. You have followed applicable confined space regulations.

IMPORTANT: READ THIS SECTION THOROUGHLY
SAFETY INSTRUCTIONS

IF YOU DO NOT UNDERSTAND ANY PORTION OF THESE INSTRUCTIONS DO NOT ATTEMPT TO INSTALL OR OPERATE THIS MIXER! CONTACT YOUR LIGHTNIN REPRESENTATIVE FOR ANY QUESTIONS YOU MAY HAVE CONCERNING SAFETY OR THESE INSTRUCTIONS

Your **LIGHTNIN® VEKTOR®** mixer is equipped with safety labels which contain specific instructions pertaining to the safe handling and operation of the mixer. For your protection, you must understand that failure to follow the safety instructions imprinted on the safety labels or failure to follow the safety instructions printed in this instruction manual may result in serious personal injury or death. In addition, failure to adhere to safety instructions may cause damage to property or equipment.

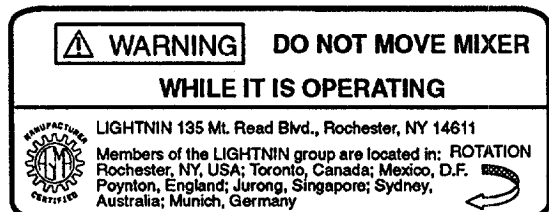
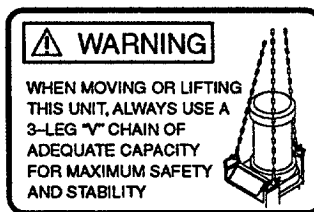
In this publication, and on the mixer safety labels, the words DANGER, WARNING and CAUTION may be used to signify special instructions to be observed by the installer or user. These instructions warn of potential hazards concerning service, installation or operation if the instructions are performed incorrectly, carelessly or are ignored. Safety instructions alone cannot eliminate the hazards they signal. Strict compliance with these special instructions, along with safe work habits and simple "common sense" are major accident prevention measures.

CAUTION – Signals unsafe practices or hazards which could cause minor personal injury or property damage

WARNING – Signals unsafe practices or hazards which could cause severe personal injury or death.

DANGER – Signals immediate hazards which will probably cause severe personal injury or death.

This mixer should be equipped with the following safety labels. If any of the labels are missing, damaged or otherwise illegible, **DO NOT** install, service or operate the mixer. Contact your **LIGHTNIN** representative immediately for instructions.



UPGRADE YOUR VEKTOR MIXER WITH A DIGITAL LCD TACHOMETER. CALL YOUR LIGHTNIN SALES ENGINEER FOR DETAILS.

VEKTOR

MODEL NO. _____

SERIAL NO. _____

LIGHTNIN®
MIXER SHAFT INSTALLATION

- DANGER** ISOLATE AND LOCK-OUT POWER.
- PUSH MACHINED END OF SHAFT INTO QUILL UNTIL SHAFT LATCH IS ENGAGED.

MIXER SHAFT REMOVAL

- POSITION RED INDICATOR IN WINDOW BY ROTATING SHAFT.
- LIFT AND HOLD SHAFT FIRMLY TO SUPPORT THE FULL WEIGHT OF THE SHAFT AND IMPELLER(S).
- ROTATE YELLOW BUTTON 1/4 TURN (CW) AND PRESS BUTTON TO RELEASE SHAFT.

LIGHTNIN

A UNIT OF GENERAL SIGNAL

GENERAL SAFETY INSTRUCTIONS

WARNING – The following instructions must be followed when installing, using or servicing the mixer. Failure to do so may result in injury, death or damage to property or equipment.

MOVING, INSTALLING OR LIFTING

WARNING – When moving, installing or lifting this mixer, always use equipment which is rated to carry the full load of the mixer. **DO NOT** attempt to lift the mixer by hand. Failure to follow these instructions could cause severe injury, death or damage to property. Consult the appropriate section of this manual for installation instructions.

SUPPLYING POWER TO THE MIXER

WARNING – **DO NOT** attempt to connect a power source to this mixer unless you are licensed or certified to do so. Failure to follow this instruction could cause severe injury, death or damage to property.

USING THE MIXER

WARNING – Before operating this mixer, be sure it has been properly installed and secured to the mixer's support structure. Follow the specific installation instructions provided in this manual.

WARNING – **DO NOT** use this mixer for any purpose other than that for which it was originally specified or intended.

WARNING – Never touch a mixer, which has an electric motor, or any part of an electrical service line cord or conduit, while your hands or feet are wet or if you are standing on a wet or damp surface. Failure to follow this instruction may result in severe electrical shock or death.

WARNING – Never attempt to move or adjust a mixer while it is running.

DANGER – Never touch any rotating part of a mixer with bare hands, gloved hands or any other part of your body, or with any hand held object. Rotating parts include, but are not limited to, the mixer shaft, impeller(s), set screws, hardware, couplings, mechanical seals and motor fans.

SERVICING THE MIXER

WARNING – Eye protection must be worn at all times while servicing this mixer. Failure to follow this instruction may result in severe injury or death.

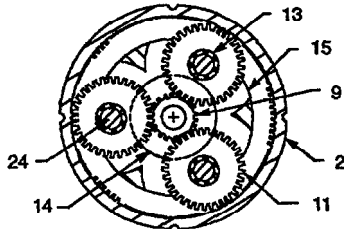
WARNING – Never attempt to clean or service the mixer, or any part of it, while the mixer is running, or while it is connected to a power source. Always turn the mixer off and disconnect the power before cleaning or servicing.

CAUTION – When repairing the mixer, or replacing parts, use only factory authorized parts and procedures. Failure to do so may result in damage to the mixer or injury to the user.

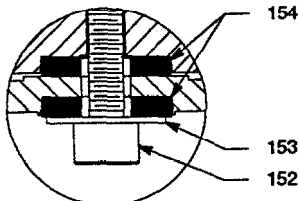
WARNING – When a mixer is running, the motor temperature rises. This is a normal occurrence, but the motor temperature may be high enough to cause burns to the hands or any other part of the body. Do not touch a mixer motor until it cools for at least one hour. Also, the upper part of a mixer shaft that is in contact with the motor will also be hot. When removing the mixer shaft, do not touch the motor end of the shaft. Failure to follow these instructions may result in severe personal injury.

NOTES:

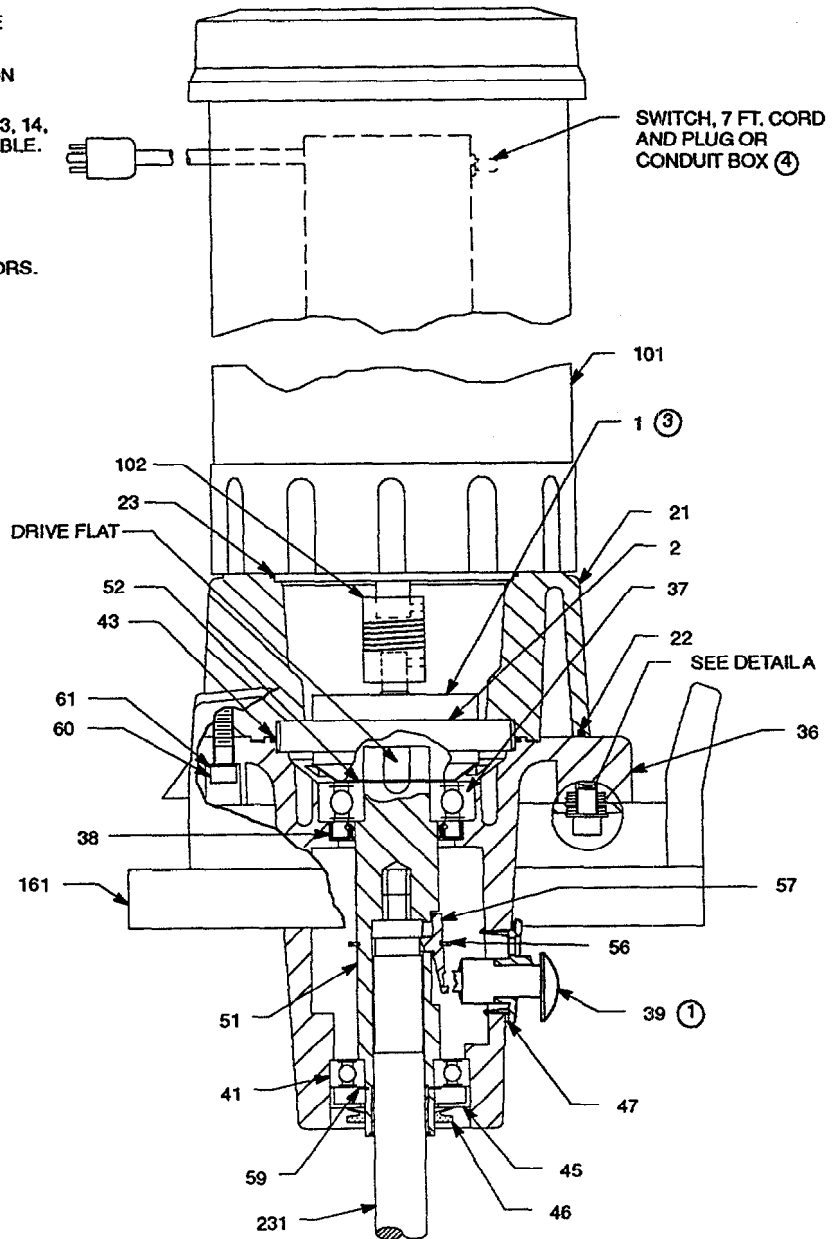
- ① SHAFT RELEASE (ITEM 39) SHOWN 90° COUNTERCLOCKWISE OUT OF POSITION.
RIGID/RIGID OR RIGID/REMOVABLE COUPLING CONSTRUCTION IS ALSO AVAILABLE.
- ② GEAR CARRIER ASSEMBLY (CONSISTING OF ITEMS 9, 11, 12, 13, 14, 15 & 24) IS SOLD AS A SET. INDIVIDUAL ITEMS ARE NOT AVAILABLE.
- ③ AS STANDARD, SWITCH, CORD AND GROUNDED PLUG ARE FURNISHED ON FRACTIONAL HORSEPOWER, SINGLE PHASE, TENV/TEFC MOTORS. ALL OTHER TENV/TEFC MOTORS ARE FURNISHED WITH A CONDUIT BOX. CONDUIT BOX NOT FURNISHED ON EXPLOSION PROOF MOTORS.



GEAR CARRIER ASSEMBLY



DETAIL A



WHEN ORDERING PARTS, SPECIFY:
DRAWING NUMBER, PART NAME, ITEM NUMBER,
AND UNIT MODEL & SERIAL NUMBER

© LIGHTNIN
1994

ALL EQUIPMENT DESIGN AND APPLICATION DATA SHOWN HEREIN AND RELATED KNOW-HOW IS CONFIDENTIAL AND THE PROPERTY OF THE LIGHTNIN GROUP OF COMPANIES. NO USE OR DISCLOSURE THEREOF MAY BE MADE WITHOUT OUR WRITTEN PERMISSION.

A UNIT OF GENERAL SIGNAL

LIGHTNIN

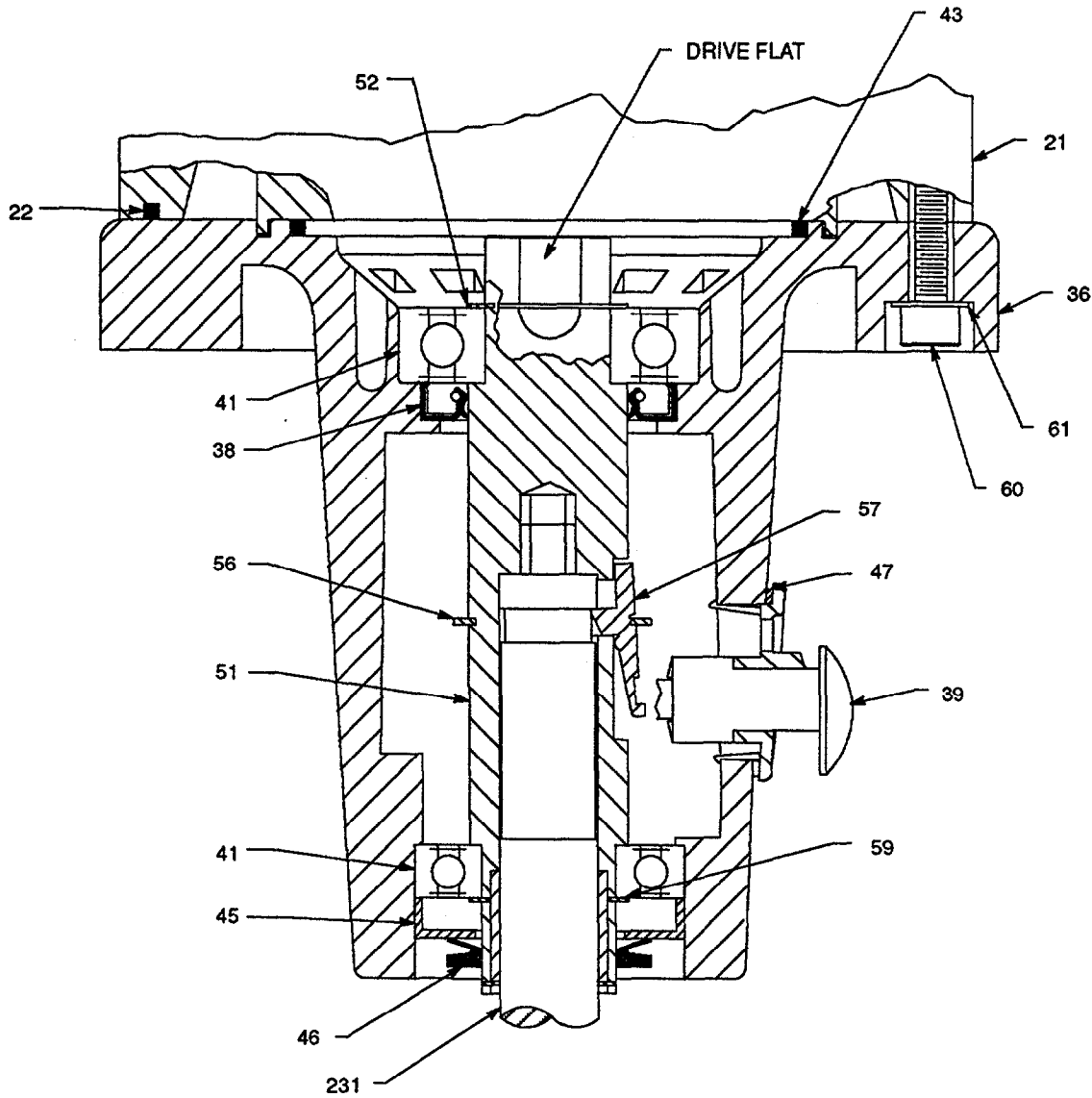
MIXERS AND AERATORS
ASSEMBLY DRAWING

V5, 6Q18 THRU V5, 6Q55
SINGLE REDUCTION GEAR DRIVE
PLATE MOUNTED OPEN TANK MIXER
WITH DRIVE QUILL

45	COUNTERFACE
43	O-RING
41	BEARING
39	SHAFT RELEASE
38	OIL SEAL
37	BEARING
36	BEARING HOUSING
24	PLANET DOWEL PIN
23	O-RING
22	O-RING
21	GEAR HOUSING
15	CARRIER BODY
14	HARDENED COIN
13	NEEDLE BEARING
	THRUST WASHER (NOT SHOWN)
	PLANET GEAR
	SUN GEAR
2	RING GEAR
1	GEAR CARRIER ASSEMBLY ③

231	MIXER SHAFT
161	MOUNTING PLATE
154	ISOLATION MOUNT
153	WASHER
152	SOCKET HEAD CAP SCREW
102	DRIVE COUPLING ASSEMBLY
101	MOTOR
61	WASHER
60	SOCKET HEAD CAP SCREW
59	RETAINING RING
57	SHAFT LATCH
56	RETAINING RING
52	RETAINING RING
51	DRIVE QUILL
47	GASKET
46	V-RING

ITEM	PART NAME	ITEM	PART NAME
------	-----------	------	-----------



WHEN ORDERING PARTS, SPECIFY:
DRAWING NUMBER, PART NAME, ITEM NUMBER
AND UNIT MODEL & SERIAL NUMBER

47	GASKET	231	MIXER SHAFT
46	V-RING	61	WASHER
45	COUNTER FACE	60	SOCKET HEAD CAP SCREW
43	O-RING	59	RETAINING RING
41	BEARING	57	SHAFT LATCH
39	SHAFT RELEASE	56	RETAINING RING
38	OIL SEAL	52	RETAINING RING
36	BEARING HOUSING	51	DRIVE QUILL
22	O-RING		
21	GEAR HOUSING		
ITEM	PART NAME	ITEM	PART NAME

ALL EQUIPMENT DESIGN AND APPLICATION DATA SHOWN
HEREIN AND RELATED KNOW-HOW IS CONFIDENTIAL AND
THE PROPERTY OF THE LIGHTNIN GROUP OF COMPANIES.
NO USE OR DISCLOSURE THEREOF MAY BE MADE WITHOUT
OUR WRITTEN PERMISSION.

A UNIT OF GENERAL SIGNAL



LIGHTNIN

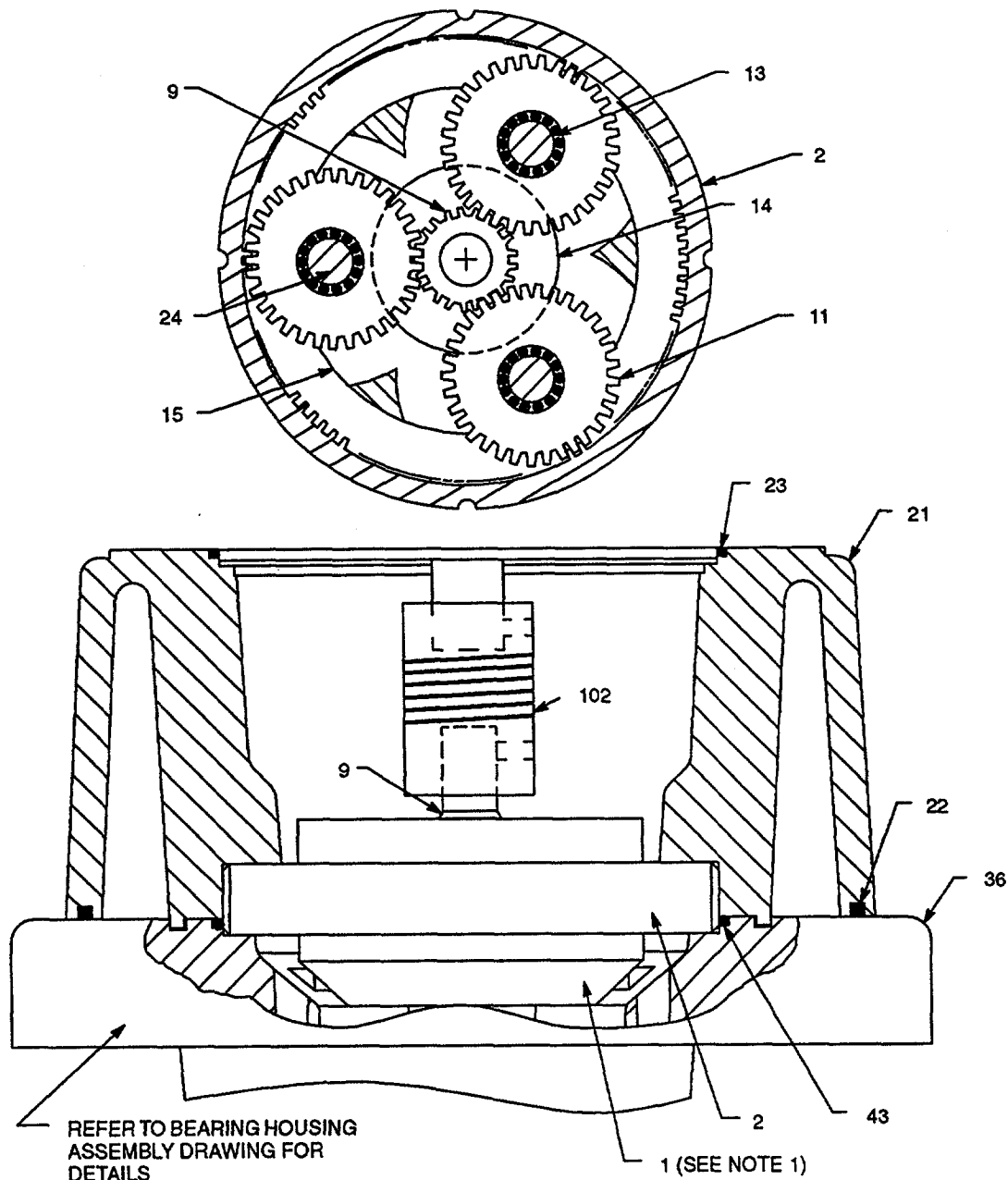
MIXERS AND AERATORS
ASSEMBLY DRAWING

1 SIZE GEAR DRIVE
BEARING HOUSING
1/2" - 1" & 16 - 25mm SHAFT

© LIGHTNIN
1994

DRAWING NO. L-17439A

PAGE 2



REFER TO BEARING HOUSING ASSEMBLY DRAWING FOR DETAILS

WHEN ORDERING PARTS, SPECIFY:
DRAWING NUMBER, PART NAME, ITEM NUMBER
UNIT MODEL & SERIAL NUMBER

15	CARRIER BODY	102	DRIVE COUPLING
14	HARDENED COIN	43	O-RING
13	NEEDLE BEARING	36	BEARING HOUSING
12	THRUST WASHER	24	PLANET DOWEL PIN
11	PLANET GEAR	23	O-RING
9	SUN GEAR	22	O-RING
2	RING GEAR	21	GEAR HOUSING
1	GEAR CARRIER ASSEMBLY		
ITEM	PART NAME	ITEM	PART NAME

◆ NOT SHOWN

NOTE:

1. GEAR CARRIER ASSEMBLY (ITEM 1) CONSISTS OF:
SUN GEAR (ITEM 9), PLANET GEARS (ITEM 11), THRUST WASHERS (ITEM 12),
NEEDLE BEARINGS (ITEM 13), HARDENED COIN (ITEM 14), CARRIER BODY (ITEM 15)
AND PLANET DOWEL PINS (ITEM 24). CARRIER ASSEMBLY IS SOLD AS A SET,
INDIVIDUAL ITEMS ARE NOT AVAILABLE.

© LIGHTNIN
1994

ALL EQUIPMENT DESIGN AND APPLICATION DATA SHOWN
HEREIN AND RELATED KNOW-HOW IS CONFIDENTIAL AND
THE PROPERTY OF THE LIGHTNIN GROUP OF COMPANIES.
NO USE OR DISCLOSURE THEREOF MAY BE MADE WITHOUT
OUR WRITTEN PERMISSION.

A UNIT OF GENERAL SIGNAL



LIGHTNIN

MIXERS AND AERATORS
ASSEMBLY DRAWING

1 SIZE
GEAR HOUSING
SINGLE REDUCTION
MODEL "P", "Q", "C" & "S"

DRAWING NO. L-17446

**GENERAL INSTRUCTIONS
VEKTOR® FIXED MOUNT GEAR DRIVE MIXER
WITH MOUNTING PLATE**

SECTION 1 – INITIAL INSPECTION, SHIPPING ARRANGEMENTS

- 1.1 Check the shipping crates and your **LIGHTNIN**® VEKTOR® mixer for possible shipping damage. Report any damage immediately to the carrier and our factory.
- 1.2 The mixer and impellers are packed together. The mixer shaft, if over 1200mm (48 inches) long, is packed in a separate container.
- 1.3 Do not remove any protective coatings or wrappings until the mixer is ready to be put into service. If the mixer is stored, store only in an indoor, clean, dry location with controlled temperatures of 15° C to 40° C (59° F to 104° F).
- 1.4 For units with electronic tachometer, refer to Tachometer Instructions.

SECTION 2 – MIXER INSTALLATION

WARNING: EYE PROTECTION MUST BE WORN AT ALL TIMES WHILE SERVICING THIS MIXER.

- 2.1 Refer to Installation Drawing for:
 - a. Proper mixer mounting and location.
 - b. Proper minimum impeller off-bottom and relative spacing for dual impeller applications.
- 2.2 Lift the mixer from its crate by the three cast-in lifting handles provided (see Figure 1).

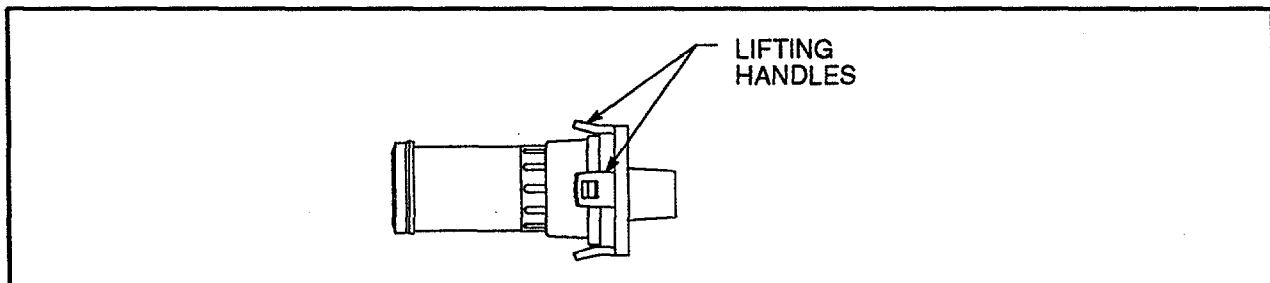


Figure 1

- 2.3 Bolt the mounting plate (161) to the tank support structure using the appropriate length M12, class 8.8 hardware.

2.4 BOLT TIGHTENING TORQUE RECOMMENDATIONS

Inadequately or improperly tightened hardware can loosen due to vibration or the reactions imposed by fluid forces. This can result in reduced equipment service life or damage and failure.

Recommended torques for tightening the bolts and screws on your **LIGHTNIN** mixer are listed in Table 1 for your general reference.

UNLESS SPECIFICALLY LISTED ELSEWHERE IN THE DETAILED INSTRUCTIONS, TIGHTEN THE MIXER AND MOUNTING HARDWARE TO THE RECOMMENDED TORQUE IN TABLE 1.

Certain assembly connections may require special torques which are not listed in the table. These torques can be found in the detailed assembly and disassembly sections of this manual. REVIEW THIS MANUAL CAREFULLY TO DETERMINE WHERE SPECIAL TORQUES ARE REQUIRED.

LIGHTNIN

A UNIT OF GENERAL SIGNAL

All bolts should be coated with oil, grease, or an anti-seize compound whenever possible. The threads and bearing face of bolt heads and/or nuts should be lubricated. If it becomes necessary to make a dry threaded connection, multiply the values in the table by 1.33.

ALL BOLTS SHOULD BE RETIGHTENED AFTER THE UNIT HAS BEEN RUN UNDER LOAD FOR TWO (2) WEEKS, AND AT EACH SCHEDULED SHUT-DOWN THEREAFTER.

BOLT THREAD SIZE	TORQUE Newton meters (N·m)	TORQUE Foot pounds (Ft-lbs)
M6	9	7
M8	22	16
M10	44	32
M12	75	55

Table 1 – Recommended Tightening Torques for Lubricated Hardware

SECTION 3 – SHAFT AND IMPELLER INSTALLATION

- 3.1 Install the impeller(s) on the mixer shaft (231) by tightening the set screws in the impeller hub to the value shown on the Impeller Assembly drawing. Refer to the Installation Drawing for recommended dual impeller spacing if two impellers are supplied. Refer to the Impeller Assembly drawing for general impeller orientation. Proper impeller rotation is shown by an arrow on the mixer nameplate.
- 3.2 Clean the mixer shaft (231) end and drive quill (51) thoroughly.
- 3.3 Grasp the mixer shaft approximately 500mm (20 inches) below the shaft top and insert the mixer shaft completely into the drive quill.
- 3.4 When the shaft has been inserted to its proper depth, the shaft latch (57) will be forced into the shaft support groove, thus supporting the weight of the mixer shaft. Move the shaft up and down approximately 3mm (.13 inch) to ensure that the shaft is being supported by the shaft latch.

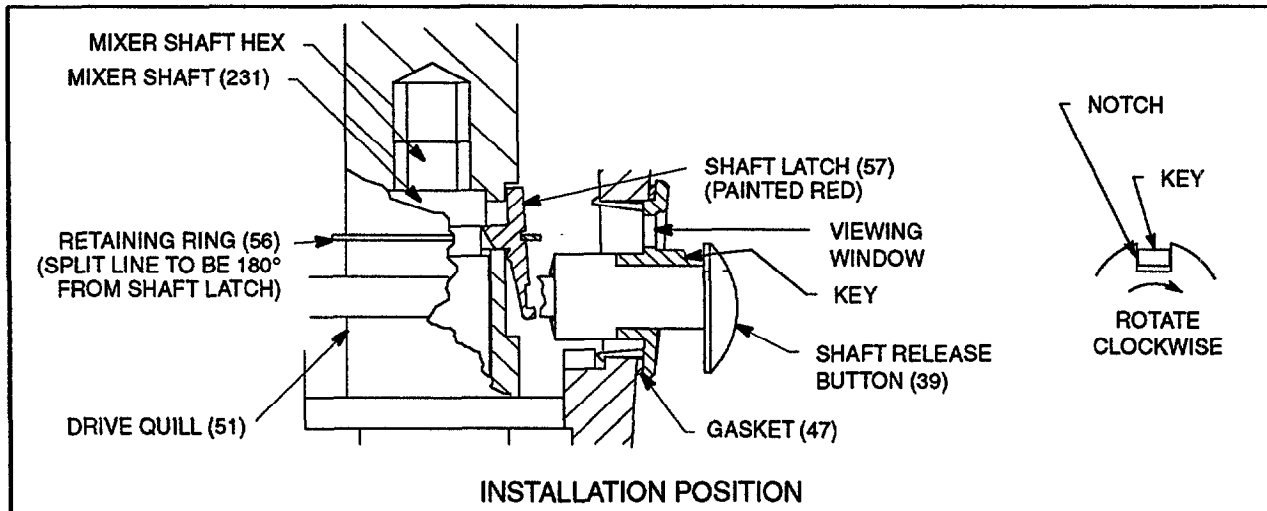


Figure 2 - Shaft Latch

SECTION 4 – SHAFT REMOVAL

CAUTION: DO NOT PUSH THE SHAFT RELEASE BUTTON WHILE THE MIXER IS RUNNING.

- 4.1 Position the red shaft latch (57) in the indicator window.
- 4.2 Support the mixer shaft (231) and move it up slightly to take the load off the shaft latch (57).

LIGHTNIN

A UNIT OF GENERAL SIGNAL

- 4.3 Rotate the yellow shaft release push-button clockwise. Align the push button notch with the raised key, and press to disengage shaft. See Figure 2.
- 4.4 The shaft will be released from the drive quill, and can then be slid free from the mixer.

CAUTION: THE UPPER PORTION OF THE MIXER SHAFT (231) MAY BE HOT TO THE TOUCH. ONCE REMOVED FROM THE DRIVE QUILL (51), DO NOT GRASP THE UPPER 500mm (20 inches) OF THE MIXER SHAFT.

SECTION 5 – MIXER OPERATION

- 5.1 The **LIGHTNIN VEKTOR** mixer is designed for continuous operation and normally needs no additional maintenance.
- 5.2 Variable speed units have certain critical speed ranges where the unit should not be operated during draw-off condition, or operated in air.

CAUTION: THESE CONDITIONS MUST BE AVOIDED WHEN THE UNIT IS BEING OPERATED WITH A VARIABLE SPEED DRIVE. IT IS ALSO NOT RECOMMENDED TO OPERATE THE MIXER WITH EXTREME VORTEXING OR SURGING OF THE LIQUID BEING MIXED.

- 5.3 At the end of two weeks service, check the housing cap screws (60 & 152) and mixer mounting hardware for tightness.

WARNING: AT THE OF THE MIXING CYCLE, IT IS GOOD PRACTICE TO TURN OFF THE MIXER BEFORE THE TANK HAS BEEN DRAINED TO A LEVEL WHICH WILL RESULT IN EXCESSIVE SPLASHING. THIS MAY RESULT IN SHAFT DAMAGE.

SECTION 6 – LUBRICATION

- 6.1 Your **LIGHTNIN VEKTOR** mixer has been lubricated at the factory with the correct type and amount of high quality lubricants. Lubricant cleanliness is protected by properly designed closures.
- 6.2 All mixer bearings are the sealed type and are pre-packed with lubricant. Relubrication of these bearings is not necessary.
- 6.3 The gear chamber of the **LIGHTNIN VEKTOR** mixer has been factory filled with a grease suitable for ambient temperature ranges of -20°C to $+50^{\circ}\text{C}$ (-4°F to $+122^{\circ}\text{F}$). Under normal operating conditions, this lubricant need not be changed until the unit has been dismantled for some reason. Refer to Table 2 for lubricant specifications.
- 6.4 Under adverse operating conditions, periodic changes of lubricant may be necessary. Adverse conditions are defined as operating in a very humid, dust laden, chemical atmospheres, or where wide variations in ambient temperature occurs. Such adverse conditions can lead to deterioration of lubricant compounds and additives and it is recommended that the condition of the grease be checked within six months of start-up.

Refer to Section 7 for instructions on disassembling the gear unit.

NOTE: THE GEAR CHAMBER SHOULD BE FILLED TO 25mm (ONE INCH) FROM THE TOP OF THE GEAR CHAMBER. ALL O-RINGS SHOULD BE CHECKED FOR INTEGRITY AND BE REPLACED IF THEY ARE DEFORMED, CUT OR DETERIORATED.

LIGHTNIN
A UNIT OF GENERAL SIGNAL

Recommended Grease		Gear Housing Capacity	
Manufacturer	Products	kg	Pounds
LIGHTNIN	LIGHTNIN SHC 0	.45	1

Table 2 – Lubricant Recommendations & Capacity

6.5 CHANGING GEAR LUBRICANT

NOTE: VEKTOR gear sets are initially lubricated at the factory with **LIGHTNIN SHC 0** grease. This is the optimum lubricant. It will give the best performance, and is available from **LIGHTNIN**. An alternate grease, Mobilith SHC 007 can be used, but assembly and disassembly will be more difficult due to the fluid nature of this grease. Greater care must be taken during assembly and disassembly to ensure the grease remains in the gear chamber.

- a. Make sure the gear housing (21) is vertical to prevent spillage.
- b. Remove all old grease from the gear chamber and wipe clean.
- c. Pack the chamber with fresh grease (see Table 2). Paddle the grease to fill voids and remove air pockets, rotating the shaft and shaking the housing while paddling.
- d. Check for free movement of all components by rotating the drive shaft. If satisfactory, refer to Section 8 and complete assembly.

SECTION 7 – DISASSEMBLY INSTRUCTIONS

WARNING: DISCONNECT MOTOR LEADS OR OTHERWISE LOCK-OUT POWER SUPPLY BEFORE SERVICING THE MIXER. EYE PROTECTION MUST BE WORN.

NOTE: FOR UNITS WITH ELECTRONIC TACHOMETER, REFER TO THE TACHOMETER INSTRUCTIONS FOR REMOVAL INFORMATION.

7.1 GENERAL – VEKTOR mixers are precision manufactured and assembled to provide long, trouble free service when properly maintained. If it becomes necessary to disassemble the unit, careful precise reassembly is necessary.

Refer to assembly drawing for location of parts.

Equipment that will be required to service the mixer, in addition to standard mechanics tools, is a rubber mallet, retaining ring pliers, arbor press and torque wrench.

When disassembling the mixer, clean adjacent external surfaces to prevent dirt from entering the housings.

It is recommended that V-ring, oil seal, O-rings and non-metallic gaskets be replaced when the mixer is disassembled.

The following Spare Parts Kits are recommended and are available from **LIGHTNIN**:

Bearing Kit and Drive Quill Kit

LIGHTNIN

A UNIT OF GENERAL SIGNAL

7.2 SEAL REPLACEMENT

Inspect V-ring, oil seal and O-rings for nicks, gouges and deformities. When replacing seals:

- a. Coat the lips of seals with bearing grease.
- b. Install oil seal and V-ring with the lip facing the direction indicated on the bearing housing assembly drawing.
- c. Coat the section of the shaft sealing surface with oil. If the oil seal or V-ring must pass over a keyway, wrap the shaft with thin paper or tape, coat with grease and pass the seal over.

7.3 BEARING REPLACEMENT

Inspect the bearings carefully and replace if necessary.

- a. Old bearings can be removed with a puller or an arbor press.
- b. New bearings can be pressed on the shafts. Be careful to apply load only to the inner race.
- c. Make sure the bearings are tightly seated against the shaft or housing shoulders with no clearance.

7.4 MOTOR REMOVAL

When the gear carrier assembly (1) IS NOT being replaced, it will be necessary to hold the relative orientation of the planet gears (11) by having either the ring gear (2) or sun gear (9) engaged with the planet gears at all times.

- a. Remove the mixer from the tank and remove the mixer shaft as outlined in Section 4.
- b. Loosen and remove the mixer hardware (152 & 153) connecting the mounting plate (161) to the bearing housing (36), being careful not to lose the isolation mounts (154).
- c. Set the mixer upright on a workbench.
- d. Remove the four socket head cap screws (60) holding the bearing housing (36) and gear housing (21) to the electric motor or air motor(101).
- e. Lift the motor (101), drive coupling (102) and sun gear (9) off the gear housing.
CAUTION: The gear housing is filled with grease that may be in a semi-liquid condition. Once the socket head cap screws (60) are removed, the gear housing is no longer bolted to the motor. To prevent any leakage, hold the gear housing in place by hand when the motor is being removed.
- f. Remove the sun gear (9) from the drive coupling (102) and examine for wear. IF REUSABLE, replace the sun gear into the gear mesh.
- g. Hold the sun gear in place and lift the gear housing off the bearing housing. It may be necessary to GENTLY tap the gear housing with a rubber mallet to get the gear housing to separate from the bearing housing. Use care so as not to damage the gear housing rabbet.
- h. Again, hold the sun gear (9) and gear carrier (1) in place and remove the ring gear (2).
- i. Remove the sun gear and gear carrier as an assembly. Tape these parts together to prevent the sun gear from accidental removal. Remove any remaining old lubricant.

7.5 BEARING MODULE DISASSEMBLY

- a. Place the bearing housing (36) upright on a workbench.
- b. Remove retaining ring (52).
- c. Place the bearing housing upright in a press, and press out the drive quill (51), bearing (41), counter face (45) and V-ring (46).
- d. Remove V-ring and counter face from the drive quill. A new V-ring must be installed.
- e. Remove the retaining ring (59) from the drive quill and remove the bearing (41).
- f. Turn the bearing housing over and press out the upper bearing (37) and oil seal (38).
- g. Inspect the bearings (37 & 41). Replace if there is excessive wear.

LIGHTNIN

A UNIT OF GENERAL SIGNAL

7.6 QUILL DISASSEMBLY

- a. Remove the shaft latch retaining ring (56).
- b. Remove the shaft latch (57) from the drive quill (51).

SECTION 8 – ASSEMBLY INSTRUCTIONS

NOTE: FOR UNITS WITH ELECTRONIC TACHOMETER, REFER TO TACHOMETER INSTRUCTIONS FOR INSTALLATION INFORMATION.

The following Spare Parts Kits are recommended and are available from **LIGHTNIN**:

Bearing Kit and Drive Quill Kit

8.1 QUILL ASSEMBLY

- a. Place the shaft latch (57) in the groove provided, and slide the retaining ring (56) up from the bottom (shaft bushing end) of the drive quill into position shown in Figure 2. The split in the retaining ring should be 180° away from the shaft latch. When installing, extend the retaining ring only as far as necessary to slide it over the shaft and latch. **DO NOT** over extend the retaining ring, as this may decrease the tension on the shaft latch.

8.2 BEARING MODULE ASSEMBLY

- a. Install the oil seal (38) in the bearing housing (36) with the seal cavity facing the flange of the bearing housing. It is necessary to position the oil seal below the bearing shoulder.
- b. Press the lower bearing (41) onto the drive quill (51) bearing journal. The bearing must seat against the drive quill shaft shoulder with no visible gap.
- c. Install the lower external retaining ring (59).
- d. Press the drive quill assembly into the bearing housing (36) from the bottom until the bearing seats on the housing shoulder.
- e. Turn the bearing housing over, support the assembly on the drive quill (51) and install the upper bearing (37) by pressing it into the bearing housing (36) and onto the drive quill (51).
- f. Install the upper external retaining ring (52).
- g. Support the bearing housing assembly in an upright position by the bolting flange, and press the drive quill downward until the bearing (41) shoulders on the retaining ring (59). This will relieve any locked in axial load on the bearing created during assembly.
- h. Turn the bearing housing over and press counter face (45) in place so that it seats against the bearing (41) as shown in Figure 3.
- i. Install the V-ring (46) onto the drive quill shaft so that it seats against the counter face (45) to the dimension shown in Figure 3.

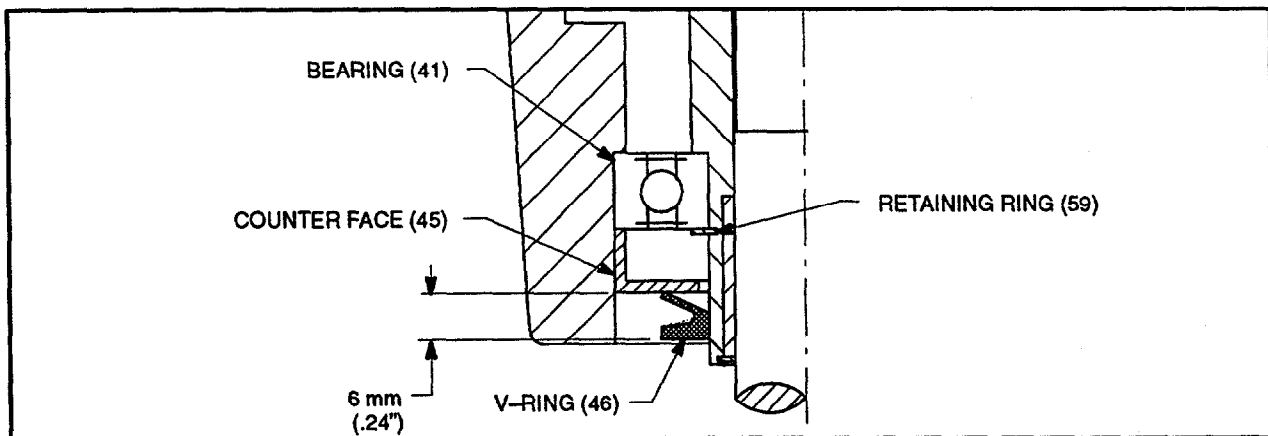


Figure 3 – V-ring Installation

LIGHTNIN

A UNIT OF GENERAL SIGNAL

8.3 GEAR HOUSING ASSEMBLY

- a. **PACK THE GEAR CARRIER (1)** with grease and rotate the gears several times to distribute the grease to the needle bearings (13). Refer to Section 6 for lubricant recommendations.
- b. Align the flats on the inside of the gear carrier (1) with the flats on the drive quill (51). Place the gear carrier and sun gear (9) assembly onto the drive quill.
- c. Install ring gear (2) and O-ring (43) in the gear housing (21).
- d. Examine the "D" shaped O-ring groove in the gear housing and remove any traces of old lubricant or O-ring material. Once clean, apply grease in the groove to hold the O-ring in place during assembly.
- e. Install O-ring (22) in its groove on the gear housing.
- f. Align the gear housing rabbet with the groove in the bearing housing (36). Align the bolt holes in the gear housing with the holes in the bearing housing, and the bosses in the gear housing with the grooves in the ring gear (2).
- g. Install the gear housing over the ring gear and onto the bearing housing (36). It may be necessary to GENTLY tap the gear housing with a rubber mallet in order to seat the gear housing against the bearing housing with no visible gaps between surfaces. Use care so as not to damage the gear housing rabbet.
- h. Remove the sun gear (9) from the gear carrier (1).
- i. Place drive coupling assembly (102) on motor shaft if necessary.
- j. Install the sun gear (9) into the drive coupling (102) until it shoulders against the drive coupling. Tighten the two set screws to 9 N·m (7 ft-lbs).
- k. Set the elevation of the sun gear to the dimension shown in Figure 4 and tighten the remaining two coupling set screws to 9 N·m (7 ft-lbs).
- l. Fill the gear housing with lubricant to approximately 25mm (1 inch) from the top. Refer to Section 6 for lubricant recommendations.

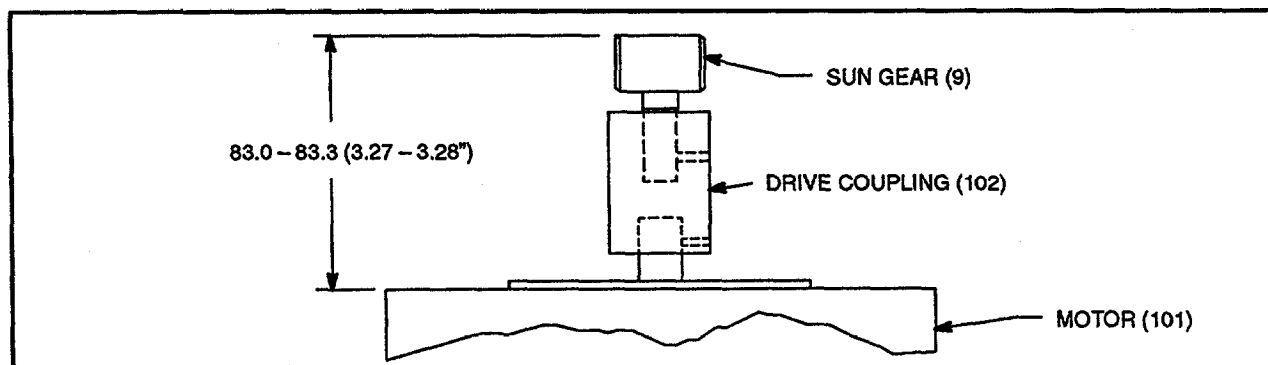


Figure 4 - Sun Gear Placement

8.4 FINAL ASSEMBLY

- a. Refer to machine assembly drawing for correct electric motor conduit box or plug cord orientation.
- b. Position the motor on the gear housing. Use care so as not to damage the O-ring (23).
- c. Secure the motor (101), gear housing (21) and bearing housing (36) with socket head cap screws (60) and washers (61). Alternately tighten cap screws to 22 N·m (16 ft-lbs) to ensure that all components are drawn evenly together.
- e. Install isolation mounts (154) in the bearing housing (36) and mounting plate (161). To aid assembly, it may be useful to hold isolation mounts in place with a small amount of silicone adhesive.
- f. Bolt the mounting plate (161) to the bearing housing (36) using socket head cap screws (152) and washers (153). Alternately tighten hardware to 22 N·m (16 ft-lbs) to ensure that all components are drawn evenly together.

LIGHTNIN
A UNIT OF GENERAL SIGNAL

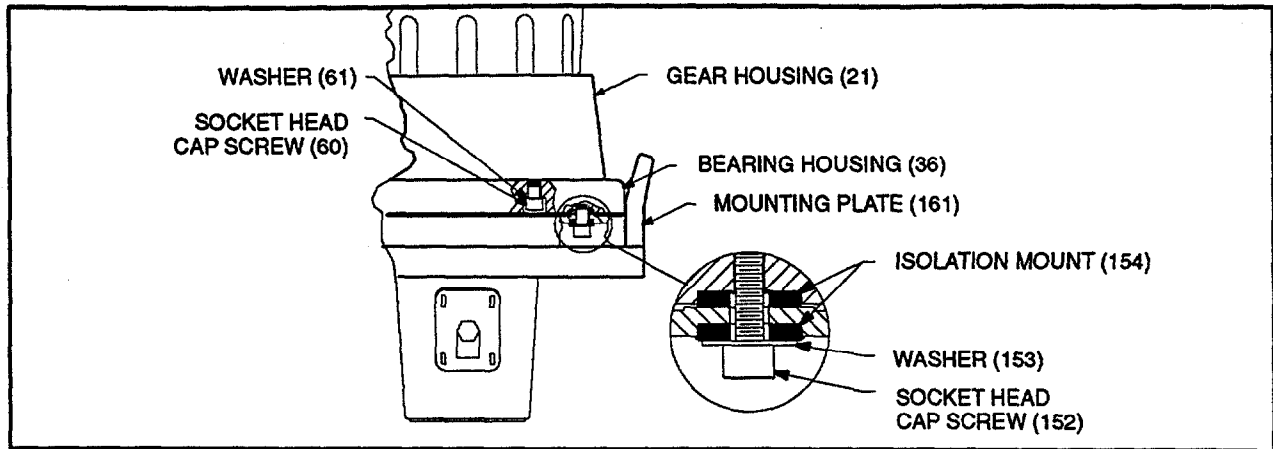


Figure 5 – Isolation Mounts and Hardware

APPENDIX "A"

MOTOR DATA

ELECTRIC MOTOR INSTRUCTIONS

SECTION 1 – INITIAL INSPECTION

1.1 Care is taken at the factory to assure that the motor arrives at its destination in first class condition. If there is evidence of rough handling or damage in shipment, file a claim at once with the carrier and notify our factory.

Examine the outside of the motor carefully for damage, with particular attention to the conduit box, fans and covers. Check nameplate for correct speed, kilowatt, voltage, hertz and phase for conformance with power supply. See Section 1.3 for warning on explosion-proof motors.

1.2 GENERAL DATA:

- a. Single phase totally enclosed motors are wired at our factory for correct rotation.
- b. All three phase and explosion-proof motors must be field wired for proper rotation. If rotation does not agree with nameplate, reverse any two line leads.
- c. Dual voltage motors must be wired for the desired voltage. Refer to the connection diagrams provided on the motor nameplate, inside the conduit box cover or in this manual.
- d. Refer to Section 2 for motor maintenance and storage instructions.

1.3 WARNING

• **EXPLOSION-PROOF MOTORS** – These motors are constructed to comply with the U.L. Label Service Procedure manual. When repairing and reassembling a motor that has an Underwriter's Label, it is imperative that the unit be reinspected and;

1. All original fits and tolerances must be maintained
2. All plugs and hardware to be securely fastened
3. Any part replacements, including hardware, be accurate duplicates of the originals

REPAIR WORK ON EXPLOSION-PROOF MOTORS CAN ONLY BE DONE BY THE ORIGINAL MANUFACTURER. VIOLATIONS OF ANY OF THE ABOVE ITEMS WILL INVALIDATE THE SIGNIFICANCE OF THE U.L. LABEL.

• **EXPLOSION-PROOF MOTORS ARE EQUIPPED WITH AN INTERNAL CIRCUIT INTERRUPTING DEVICE WHICH TRIPS WHEN OVER HEATING OCCURS. THIS THERMAL PROTECTION CIRCUIT WILL RESET AUTOMATICALLY WHEN UNIT COOLS.**

• If the thermal protector continues to trip, some abnormal condition exists. This condition must be corrected before motor will operate normally.

• **ALWAYS DISCONNECT POWER LINE BEFORE SERVICING ANY PART OF THE MIXER.** Unexpected motor start-up may occur after the thermal protection circuit trips.

1.4 After unpacking and inspection to see that all parts are in good condition, turn the shaft by hand to be sure there are no obstructions to free rotation. Equipment which has been in storage should be tested prior to being put into service.

a. It is best to check the insulation resistance of the stator winding with a megohmmeter. If resistance is lower than one megohm, consult **LIGHTNIN**.

b. Motors are shipped from the factory with sealed, shielded bearings properly packed with grease and ready to operate. Bearings are not regreaseable.

LIGHTNIN

A UNIT OF GENERAL SIGNAL

1.5 WIRING – Examine the nameplate data to see that it agrees with the power circuit to which the motor is to be connected. The motor is guaranteed to operate successfully with frequency not more than 5% and voltage not more than 10% above or below the nameplate data, or combined variation of voltage and frequency of not more than 10% above or below nameplate data. Efficiency, power factor and current may vary from nameplate data.

1.6 Connect the motor leads to a power source that matches the line voltage and wiring diagram specified on the motor nameplate.

1.7 Check impeller shaft rotation by jogging the motor until it is determined that rotation is correct.

1.8 CAUTION

Repeated trial starts can overheat the motor (particularly for across-the-line starting). If repeated trial starts are made, allow sufficient time between trials to permit heat to dissipate from the windings or rotor to prevent overheating. Starting currents are several times running currents, and heating varies as the square of the current. Do not exceed 12 starts per hour.

1.9 WARNING

The frames and other metal exteriors of motors should be grounded to limit their potential to ground in the event of accidental connection or contact between live electrical parts and the metal exteriors. All motors should be grounded through the conduit box. Explosion-proof motors have an integral ground lead for grounding.

1.10 WARNING

Before starting motor, remove all unused shaft keys and loose rotating parts to prevent them from flying off.

1.11 Start motor and operate at minimum load prior to filling the tank or basin. Look for any unusual condition.

The motor should run smoothly with little noise. If the motor should fail to start and produces a decided hum, it may be that the load is too great for the motor or that it has been connected improperly. Shut down immediately and investigate for trouble.

SECTION 2 – MOTOR MAINTENANCE AND STORAGE

Electric motors or other prime movers are not prepared by **LIGHTNIN** for indoor storage beyond 12 months in a dry ambient atmosphere with controlled temperatures, or 6 months in a dry ambient atmosphere with no temperature control. **OUTDOOR STORAGE OF ELECTRIC MOTORS IS NOT RECOMMENDED BY ANY MOTOR MANUFACTURER.** For information on storage periods beyond those shown, consult **LIGHTNIN**.

2.1 To insure continued reliable operation of electric motors, the following basic rule applies: **KEEP THE MOTOR CLEAN AND DRY.** Motors should be inspected, and output shaft rotated, at a minimum of 6 month intervals with increased frequency as needed depending upon the type of motor and the service.

2.2 Terminal connections and assembly hardware may loosen from vibration during service and should be tightened.

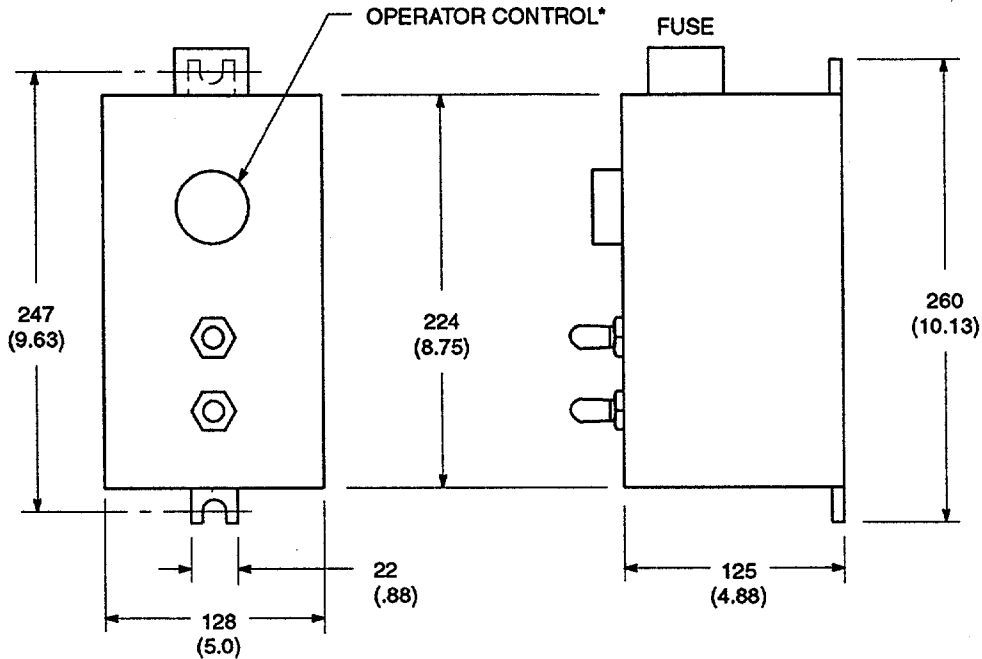
2.3 Insulation resistance should be checked at operative temperature and humidity conditions to determine possible deterioration of insulation due to excessive moisture or extremes in operating environment. If wide variations are detected, motors should be reconditioned.

2.4 LUBRICATION - The ball bearing has deep grooved, double shielded sealed bearings with sufficient lubricant packed into the bearings by the manufacturer for "life lubrication". The initial lubricant is supplemented by a supply packed into larger reservoirs in the end shield at time of assembly. No grease fittings are provided, as the initial lubrication is adequate for up to 10 years of operation under normal conditions.

LIGHTNIN
A UNIT OF GENERAL SIGNAL

2.5 STORAGE REQUIREMENTS FOR MOTORS – These extended storage requirements must be followed to allow the submission of a valid warranty claim.

- a. The motors, if not mounted, are to be stored in the original containers in a clean, dry, protected warehouse.
- b. The storage area is to be free from any vibration and from extremes in temperature.
- c. Windings to be megged at the time equipment is put in storage. At the time of removal from storage, the resistance reading must not have dropped more than 50% from the initial reading. Any drop below this point, consult **LIGHTNIN**.
- d. All external parts and motors subjected to corrosion should be protected by a corrosive resistant coating.



NEMA 4/12 ENCLOSURE

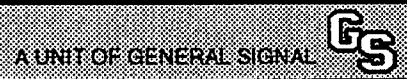
PART NO.	KW	A-C INPUT VOLTS	A-C INPUT AMPS	A-C INPUT FREQUENCY	D-C ARMATURE VOLTAGE	D-C ARMATURE AMPS
271056*	.18	115	3.1	50/60 Hz	90	2.5
	.25		4.2			3.7
	.37		6.2			5.0
	.55		9.4			7.5
	.75		12.5			10.0
271057	.37	230	3.1		180	2.5
	.55		4.7			3.7
	.75		6.2			5.0
	1.1		9.4			7.5
	1.5		12.5			10.0

* PART NO. 271056 NOT FURNISHED WITH OPERATOR CONTROL.

NOTES:

1. A-C LINE VOLTAGE VARIATION IS $\pm 10\%$.
2. A-C LINE FREQUENCY VARIATION AT 50/60 Hz IS ± 2 Hz.
3. MAXIMUM LOAD IS 150% FOR ONE (1) MINUTE.
4. SPEED REGULATION VOLTAGE FEEDBACK IS 2-5% (95% LOAD CHANGE).
5. SPEED REGULATION TACHOMETER FEEDBACK IS 1% (95% LOAD CHANGE).

ALL EQUIPMENT DESIGN AND APPLICATION DATA SHOWN HEREIN AND RELATED KNOW-HOW IS CONFIDENTIAL AND THE PROPERTY OF THE LIGHTNIN GROUP OF COMPANIES. NO USE OR DISCLOSURE THEREOF MAY BE MADE WITHOUT OUR WRITTEN PERMISSION.



LIGHTNIN

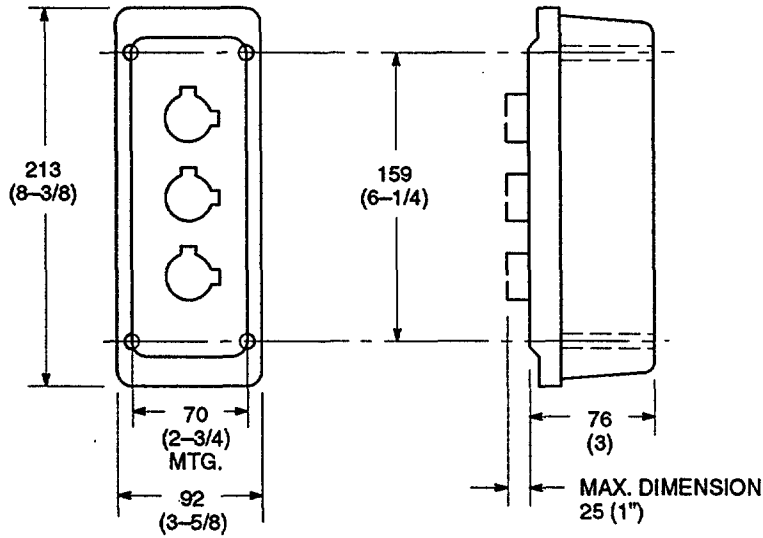
MIXERS AND AERATORS

ALL DIMENSIONS ARE IN MILLIMETERS (INCHES)

D-C MOTOR CONTROLLER

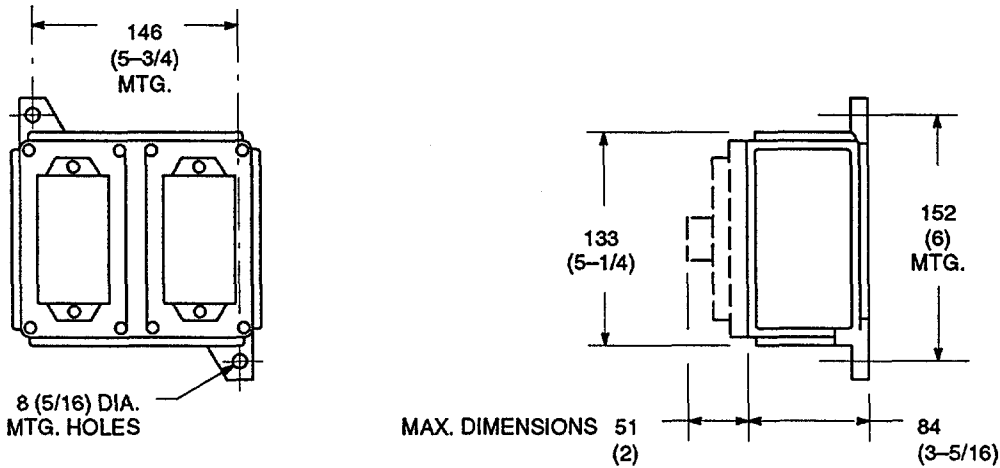
© 1993

OPERATOR'S STATIONS FOR 1/4 THRU 3 HP MOTOR SPEED CONTROLS



THREE UNIT STATION

Figure 1 - NEMA 4/12 OPERATOR'S STATION (PART NUMBER 123876PSP)



THREE FUNCTION STATION

Figure 3 - NEMA 7/9 EXPLOSION-PROOF OPERATOR'S STATION (PART NUMBER 808551PSP)

ALL EQUIPMENT DESIGN AND APPLICATION DATA SHOWN HEREIN AND RELATED KNOW-HOW IS CONFIDENTIAL AND THE PROPERTY OF THE LIGHTNIN GROUP OF COMPANIES. NO USE OR DISCLOSURE THEREOF MAY BE MADE WITHOUT OUR WRITTEN PERMISSION.

A UNIT OF GENERAL SIGNAL



LIGHTNIN

MIXERS AND AERATORS

ALL DIMENSIONS ARE IN MILLIMETERS (INCHES)

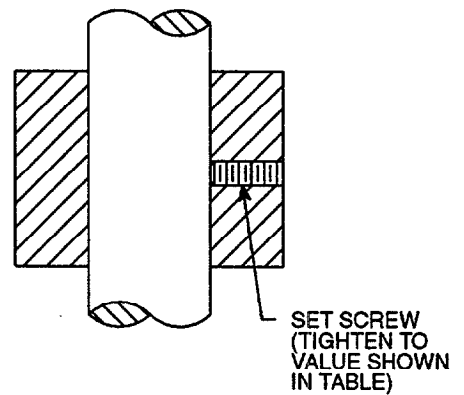
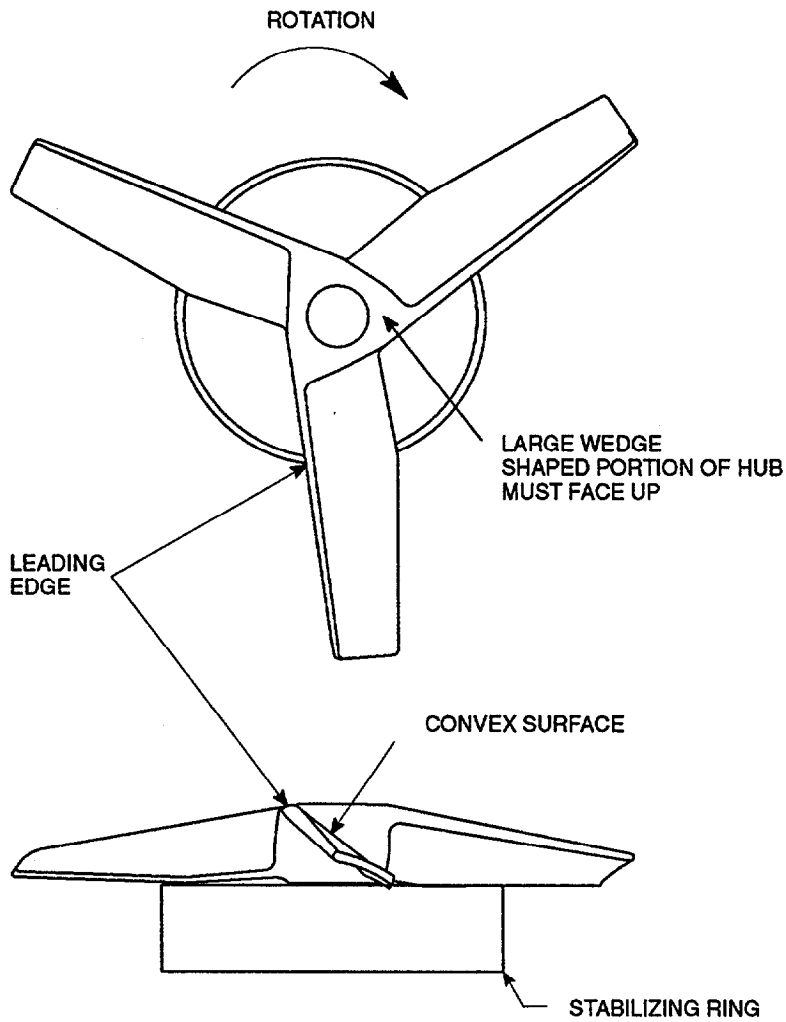
**ACCESSORIES
FOR ADJUST-A-MIX
ELECTRONIC CONTROLS**

© 1993

DRAWING NO. DS-P-107

APPENDIX "B"

IMPELLER DATA



SET SCREW SIZE	TORQUE Newton meters (N·m)	TORQUE Foot pounds (Ft-lbs)
M6	8	6
M8	10	7.5
M10	20	15

Set Screw Torque

ALL EQUIPMENT DESIGN AND APPLICATION DATA SHOWN HEREIN AND RELATED KNOW-HOW IS CONFIDENTIAL AND THE PROPERTY OF THE LIGHTNIN GROUP OF COMPANIES. NO USE OR DISCLOSURE THEREOF MAY BE MADE WITHOUT OUR WRITTEN PERMISSION.

A UNIT OF GENERAL SIGNAL



LIGHTNIN

MIXERS AND AERATORS
ASSEMBLY DRAWING

**A-310 IMPELLER
ASSEMBLY
WITH STABILIZER**

© 1991

DRAWING NO. L-17100A

PAGE 1

APPENDIX "C"

SPARE PARTS DATA

The Lightnin Guarantee

LIGHTNIN guarantees that in the case of a failure of any mixer, which you feel is our responsibility, we will repair or replace it to your satisfaction or we will refund the purchase price. This guarantee applies for the first full year you use your mixer, or 18 months after we ship it, whichever comes first.

Portable mixers were the very first Lightnin products back in 1923. We still occasionally discover an original model going strong after 50 years' service or more.

Every day, we see Lightnin Mixers operating continuously around the clock after 20 years or more. But that's how we build them. For years and years of non-stop mixing.

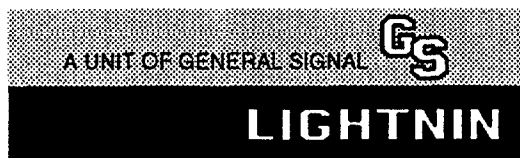
for prompt service call your LIGHTNIN® sales engineer located on the first page of this instruction manual.

They can save you time and money and provide you with mixers and aerators guaranteed to do the job.

Atlanta, GA	404-998-1956	Minneapolis, MN	612-881-7271
Baton Rouge, LA	504-752-0267	New Orleans, LA	504-752-0267
Boston, MA	508-887-2384	New York City, NY	201-228-1830
Cedar Rapids, IA	319-362-7273	Pensacola, FL	904-477-8776
Charleston, WV	304-422-4755	Philadelphia, PA	609-386-5104
Charlotte, NC	704-334-3700	Phoenix, AZ	602-275-3185
Chattanooga, TN	615-894-2958	Pittsburgh, PA	412-788-6800
Chicago, IL	708-773-2580	Richmond, VA	804-323-6100
Cincinnati, OH	513-489-2850	Rochester, NY	716-482-9640
Clearwater, FL	813-573-5294	Roseland, NJ	201-228-1830
Cleveland, OH	216-659-3157	Salt Lake City, UT	801-487-5200
Dallas, TX	214-238-1919	San Francisco, CA	510-609-1400
Denver, CO	303-757-4981	San Juan, P.R.	809-765-6969
Detroit, MI	313-478-4070	St. Louis, MO	314-349-3370
Honolulu, HI	808-847-3261	Seattle, WA	206-556-1750
Houston, TX	713-661-1177	Toronto, CN	416-781-6105
Indianapolis, IN	317-846-6104	Tucson, AZ	602-884-9710
Jacksonville, FL	904-783-6000	Tulsa, OK	918-627-1920
Kansas City, MO	816-525-1350	Vancouver, WA	206-694-9175
Lakeland, FL	813-646-0559		
Los Angeles, CA	818-760-4100		
Memphis, TN	901-382-8700		
Milwaukee, WI	414-774-4050		

**Or call us at
716-436-5550**

Patent Pending on the design details shown in this instruction manual



LIGHTNIN 135 Mt. Read Blvd., Rochester, NY 14603

Telephone (716) 436-5550 FAX (716) 436-5589

Members of the Lightnin group are located in Rochester, NY, U.S.A.; Toronto, Canada; Mexico, D.F.; Poynton, England; Milan, Italy; Jurong, Singapore; Sydney, Australia; Rio de Janeiro, Brazil; Nienhagen, Munich, Germany

© 1991 LIGHTNIN

Lightnin Sales Engineers are located in principal cities around the world

LIGHTNIN

AFTERMARKET SERVICE PROGRAMS PORTABLE MIXERS

Contact your *LIGHTNIN* Representative for additional information regarding any of these programs

MIXER FIXER KITS

A simple, economical option regarding purchasing of parts to rebuild a *LIGHTNIN* mixer. Available for all current style "Classic" and VEKTOR portable units. All parts are labeled for ease of identification..

RECOMMENDED PARTS INVENTORY

A program which compiles a comprehensive list of *LIGHTNIN* mixers and advises recommended quantities of spare parts to minimize inventory. The RPI program also provides a cross-reference of parts to other *LIGHTNIN* mixers within the plant. The program is offered at no charge.

PIT STOP / REPAIR

A pre-established repair program for all Portable mixer models. There are three (3) levels of repair, the one used depends on the years of service the mixer has experienced. A one (1) year warranty applies to all repairs.

Shipment: 1 week

SERVICE CENTERS

LIGHTNIN has two (2) Service Centers that can repair or rebuild any *LIGHTNIN* equipment. Service Centers are located in Wytheville, VA and Chicago, IL

REPAIR DEPOT

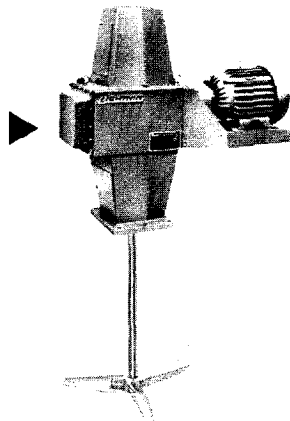
The Rochester, NY facility which manufactures all portable mixers also serves as a repair depot for all portable mixers.

SERVICE MECHANICS

LIGHTNIN has a team of qualified personnel which can rebuild any *LIGHTNIN* equipment at the customers facility. They can also offer installation and start-up service as well.

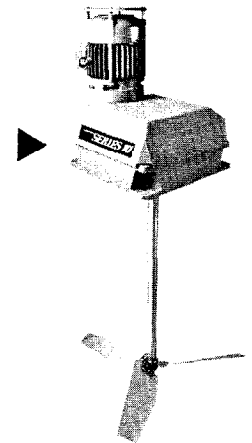
**Double and Triple Reduction
Top Entering Turbine-
Type Mixers**

1 to 1250 HP,
open or closed tanks.
Special design mixers
to 5000 HP.



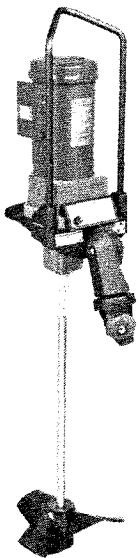
**Single Reduction
Top Entering Turbine-
Type Mixers**

1 to 25 HP,
open or closed tanks.



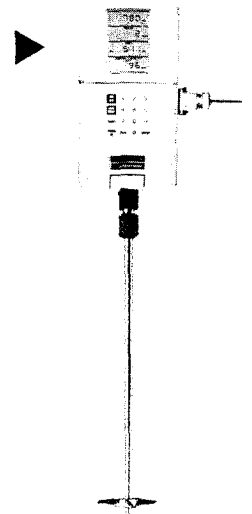
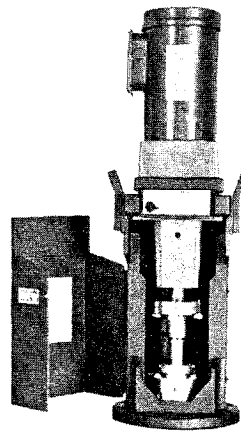
**Clamp Mount
Portable Mixers**

1/4 to 3 HP,
direct or gear drive,
open or closed tanks.



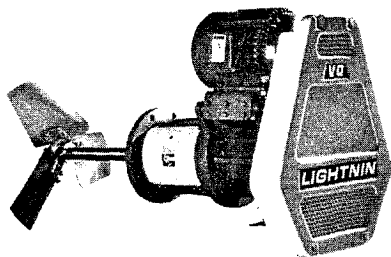
Laboratory Mixers

for a wide range
of applications in
small volumes.

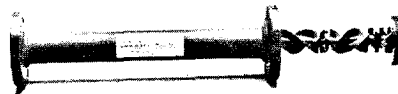


Fixed Mount Mixers

1/4 to 3 HP,
direct or gear drive,
open or closed tanks.

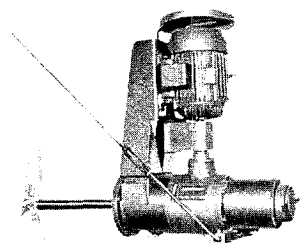


**Side Entering
Belt Drive Mixers**
Sizes to 500 HP.



The Lightnin Inliner

Designed specifically for
turbulent or laminar flow.
Individual elements can be
indexed for precise control
of inline blending.



**Side Entering
Gear Drive Mixers**
Sizes to 500 HP.

Contact your Lightnin Sales Engineer who are located in principal cities around the world.



LIGHTNIN, a unit of General Signal

135 Mt. Read Blvd., P.O. Box 1370, Rochester, New York 14623
Telephone: (716) 436-5550 Telex: 97-8244 Fax: (716) 436-5589

Members of the LIGHTNIN group are located in Rochester, N.Y., U.S.A.; Toronto, Canada; Mexico, D.F.; Poynton, England; Jurong, Singapore; Sydney, Australia; Milan, Italy; Rio de Janeiro, Brazil.

SOIL and GROUNDWATER REMEDIATION
Operable Sites No. 2, Site 6 and 82
Camp Lejeune, North Carolina
Contract #N62470-93-D-3032

Control and Computer System
Instrumentation Submittal
for
Southerland Electric Co.
by
Process Control Services, Ltd.



PROCESS CONTROL SERVICES, LTD.



P.O. BOX 98 • SEAFORD, VIRGINIA 23696-0098 • (804) 898-4332 • FAX (804) 898-8625

October 15, 1995

Mr. Scott Sosa, Project Manager

Southerland Electric Company
P.O. Box 626
Jacksonville, NC 28541

Re: Soil and Groundwater REMEDIATION , Camp Lejeune, N.C.

Dear Mr. Sosa:

The comments below need to be included in the submittal Package for the above job.

A) The submitted General Electric PLC, Push buttons, pilot lights, and switches are used to match existing equipment at Camp Lejeune provided in Waste Water Pump Stations we have completed or will complete shortly.

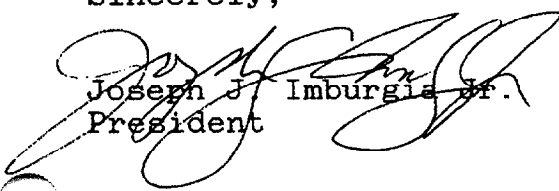
B The General Electric software "CIMPLICITY In Touch" is an enhanced version of Wonderware. This software has been developed to included the latest General Electric drivers for this PLC to the "Wonderware" package.

C) The computer as specified will not have the hard drive space needed to operate the software provided so we have provided a larger unit at no additional charge.

D) The Honeywell "Smart" transmitters were used where ever possible to allow Camp Lejuene's instrument personnel to use the existing programmer. The contract drawings show in the instrument section 2" flanges but the piping drawings show 4" on some tank taps. We could match tank flange. Please advise which is correct.

Please contact me if you have questions.

Sincerely,


Joseph J. Imburgia Jr.
President

Soil and Groundwater Remediation
Operable Unit No. 2, Sites 6 and 82
MCB Camp Lejeune, Jacksonville, North Carolina
RAC Contract No. N62470-93-D-3032
Delivery Order No. 0015

Instrumentation and Control Equipment Submittal

TABLE of CONTENTS

TAB	DESCRIPTION
<i>PART I</i>	
A	Hoffman enclosure
B	General Electric <ol style="list-style-type: none">1) Programmable Controller2) Push Buttons3) Pilot Lights4) Selector Switch5) Breakers
C	IDEC - Relays
D	International Power - Power Supply
E	Edwards - Alarm Horn
F	Joslyn - Surge Supressor
G	Gateway 2000 Computer and Touch Screen Monitor
H	Panasonic - Printer
I	Wonderware Software (CIMPLICITY)
<i>PART II</i> Instrumentation	
J	Honeywell Transmitters <ol style="list-style-type: none">1) Flanged Level Transmitters2) Flanged Pressure Transmitter3) Differential Pressure
K	Rosemount - pH Meters and Sensors
L	Kent - Turbine Flow Meters
M	Signet - Paddle Wheel Flow Meter
N	Control Level Switch - Float Switch

O McDonnell & Miller - Flow Switch
P W.E. Anderson - Liquid Level Switch
Q Mercoid - Pressure Switch
R Ashcroft - Pressure Gauges
S DRAWINGS PC9506 1 TO 7

OHM REMEDIATION SERVICES CORPORATION
5335 TRIANGLE PARKWAY, SUITE 450
NORCROSS, GEORGIA 30092
(404) 729-3900

SOIL AND GROUND WATER REMEDIATION
OPERABLE UNIT NO. 2, SITES 6 AND 82
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

CONTRACT NO. N62470-93-C-3032

SPECIFICATION SECTION: 16910

SUBMITTAL FOR: PLC SYSTEM AND CONTROL WIRING INTERFACE

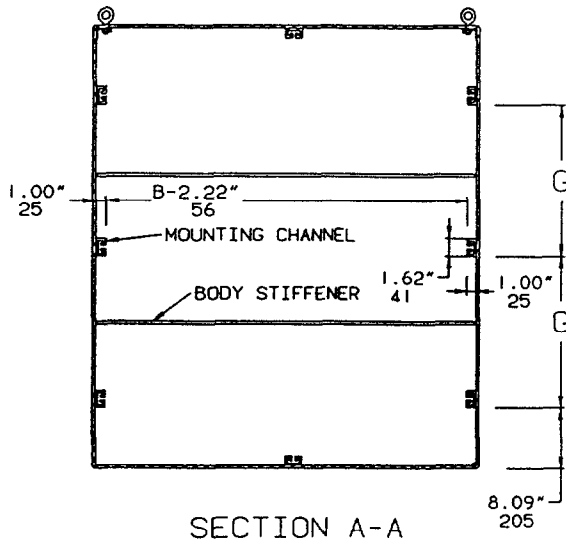
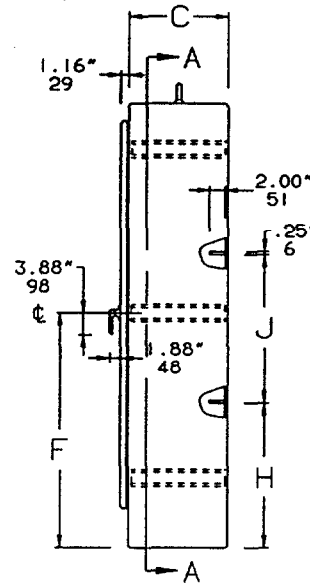
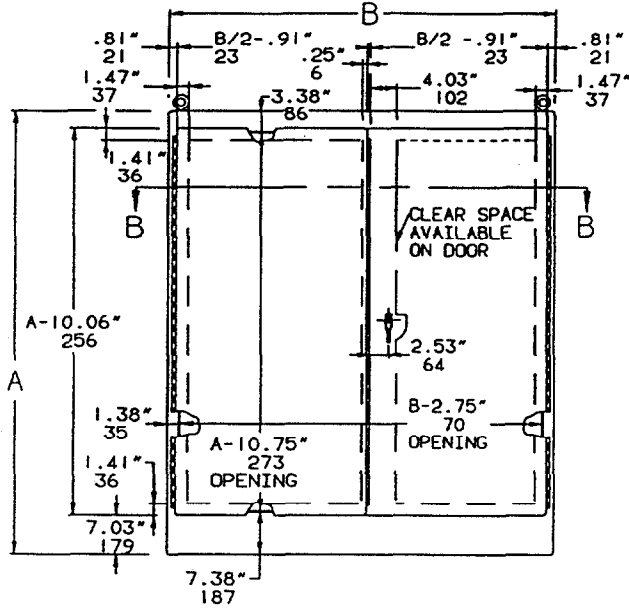
<u>ITEM NO.</u>	<u>SPEC PAR</u>	<u>SD-NO/ITEM DESCRIPTION/MANUFACTURER</u>
1	1.4.1A	SD-02 PROGRAMMABLE LOGIC CONTROLLER - GE
2	1.4.1B	SD-02 PC WORKSTATION SOFTWARE - GE
3	1.4.1C	SD-02 PC WORKSTATION - GATEWAY 2000
4	1.4.2A	SD-04 WORKING DRAWINGS FOR PLC SYSTEM - PCS



Free-Standing Type I2 Enclosures

Bulletin A30

Two-Door Single Access



C2489-1

- NOTE:
- Four lifting eyes are furnished if C = 30.06 (764) or more.
 - See pages 543, 547, and 550 for section views A-A and B-B showing accessories.
 - Removable 12.00 x 12.00 (305 x 305) data pocket.

Inch
Millimeter

Standard Sizes Two-Door Single Access Free-Standing Type I2 Enclosures

Enclosure Catalog Number	Enclosure Size A x B x C		F		G		H		J		
	inch	(millimeter)	inch	(mm)	inch	(mm)	inch	(mm)	inch	(mm)	
A-604818FSD	60.06	48.06 x 18.06	(1526 x 1221 x 472)	32.03	(814)	23.12	(587)	19.88	(505)	20.03	(509)
A-724818FSD	72.06	48.06 x 18.06	(1830 x 1221 x 472)	38.03	(966)	29.12	(740)	23.88	(607)	24.03	(610)
A-726018FSD	72.06	60.06 x 18.06	(1830 x 1526 x 472)	38.03	(966)	29.12	(740)	23.88	(607)	24.03	(610)
A-727218FSD	72.06	72.06 x 18.06	(1830 x 1830 x 472)	38.03	(966)	29.12	(740)	23.88	(607)	24.03	(610)
A-904820FSD	90.06	48.06 x 20.06	(2288 x 1221 x 510)	47.03	(1195)	38.12	(968)	29.88	(759)	30.03	(763)
A-907220FSD	90.06	72.06 x 20.06	(2288 x 1830 x 510)	47.03	(1195)	38.12	(968)	29.88	(759)	30.03	(763)
724824FSD	72.06	48.06 x 24.06	(1830 x 1221 x 611)	38.03	(966)	29.12	(740)	23.88	(607)	24.03	(610)
A-726024FSD	72.06	60.06 x 24.06	(1830 x 1526 x 611)	38.03	(966)	29.12	(740)	23.88	(607)	24.03	(610)
A-727224FSD	72.06	72.06 x 24.06	(1830 x 1830 x 611)	38.03	(966)	29.12	(740)	23.88	(607)	24.03	(610)
A-907224FSD	90.06	72.06 x 24.06	(2288 x 1830 x 611)	47.03	(1195)	38.12	(968)	29.88	(759)	30.03	(763)
A-726036FSD	72.06	60.06 x 36.06	(1830 x 1526 x 916)	38.03	(966)	29.12	(740)	23.88	(607)	24.03	(610)
A-907236FSD	90.06	72.06 x 36.06	(2288 x 1830 x 916)	47.03	(1195)	38.12	(968)	29.88	(759)	30.03	(763)

Millimeter dimensions () are for reference only; do not convert metric dimensions to inch.



NEMA EIA



Industrial Enclosures

Free-Standing

SINGLE-DOOR SINGLE ACCESS ENCLOSURES

SINGLE-DOOR DUAL ACCESS ENCLOSURES

TWO-DOOR SINGLE ACCESS ENCLOSURES

TWO-DOOR DUAL ACCESS ENCLOSURES

Panels

Catalog Number	Description	Panel Size	A-60A1BFS	A-72A1BFS	A-72B1BFS	A-72C1BFS	A-90A1BFS	A-90B1BFS	A-90C1BFS	A-72A1DFS	A-72B1DFS	A-72C1DFS	A-90A1DFS	A-90B1DFS	A-90C1DFS	A-72A1BFS	A-72B1BFS	A-72C1BFS	A-90A1BFS	A-90B1BFS	A-90C1BFS	A-72A1DFS	A-72B1DFS	A-72C1DFS	A-90A1DFS	A-90B1DFS	A-90C1DFS	
A-60P48F1	Full Panel	48.00 x 44.00 (1219 x 1118)																										
A-72P48F1	Full Panel	60.00 x 44.00 (1524 x 1118)																										
A-72P48F2	Half Panel	30.88 x 44.00 (784 x 1118)																										
A-90P48F1	Full Panel	78.00 x 44.00 (1981 x 1118)																										
A-60P48F2	Half Panel	39.88 x 44.00 (1013 x 1118)																										
A-72P60F1	Full Panel	60.00 x 56.00 (1524 x 1422)																										
A-72P60F2	Half Panel	30.88 x 56.00 (784 x 1422)																										
A-72P72F1	Full Panel	60.00 x 68.00 (1524 x 1727)																										
A-72P72F2	Half Panel	30.88 x 68.00 (784 x 1727)																										
A-90P72F1	Full Panel	78.00 x 68.00 (1981 x 1727)																										
A-90P72F2	Half Panel	39.88 x 68.00 (1013 x 1727)																										

Center Panel Supports

Catalog Number	Description																												
A-60FSCPS	Center Panel Support																												
A-72FSCPS	Center Panel Support																												
A-90FSCPS	Center Panel Support																												

Clamping Nuts

Catalog Number	Description	For																											
A-PS1420CN	1/2"-20 Clamping Nut (Qty.20)	Special Use																											
A-PS51616CN	5/16"-18 Clamping Nut (Qty 20)	Special Use																											

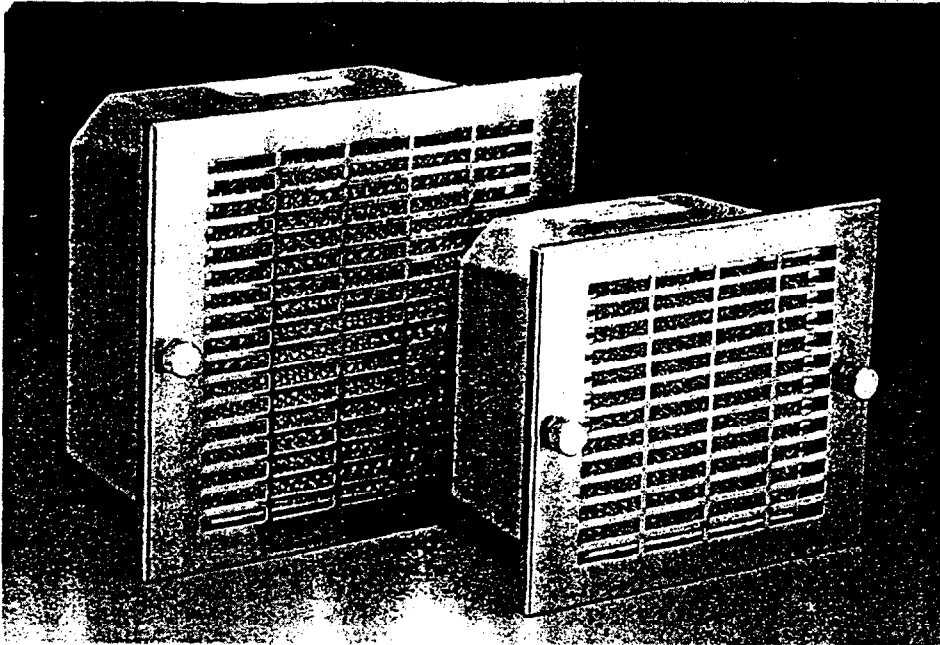
Casters

Catalog Number	Description	Size																											
D-MCKC	Set of 4 Casters	4 high x 3 diameter																											

Millimeter dimensions () are for reference only; do not convert metric dimensions to inch.

- ¹ Requires heavy duty panel supports.
- ² Requires center panel support(s).
- ³ Fits in top half or bottom half of enclosure.
- ⁴ Will not fit if other panels are also installed in same enclosure.

Hoffman®



Cooling Fan Package

Application

Designed for use in enclosures where space is limited and reliable cooling is required. Powered by 115 volt or 230 volt AC, 60/50 Hertz (Hz) single phase motors and available in three sizes with nominal airflows of 100, 240, 560 cubic feet per minute (CFM). These fans deliver filtered air into the enclosure with minimum space requirements. The Cooling Fan Package is designed to be the air inlet of a cooling system, while an exhaust grille and filter is the air outlet. The Cooling Fan Package and exhaust grille and filter must be ordered separately.

Construction

- Fan package consists of fan, air filter, composite air plenum, composite finger guard, and stainless steel grille
- Washable filter provides good arrestment of airborne dirt with minimal pressure drop
- New, durable composite air plenum takes up minimal enclosure space. Plenum permits even airflow through the filter for maximum filtering efficiency. An integral and removable finger guard on either side of the plenum adds safety and convenience.
- Air filter can be accessed for cleaning from outside the enclosure
- Stainless steel grille has captivated thumbnuts for easy removal and many narrow slots for low resistance to airflow
- Rugged aluminum or zinc venturi blocks for durability and maximum heat transfer
- Rigid fan frame eliminates breakage and grounding problems

- Dynamically balanced impellers molded from polycarbonate material
- 100 CFM fan is impedance protected and uses permanently lubricated sleeve bearings
- 240 and 560 CFM fans have ball bearing construction and split capacitor motors that are thermally protected to avoid premature failure
- Engineered for 20,000 hours of continuous operation without lubrication or service
- Fans have leadwires for power connection with ends stripped 1/2 inch (25 millimeters)
- All mounting hardware is furnished
- Consult your local Hoffman sales office for information on modifications to this product

Finish

Fan housing is black. Composite plenum is gray. Grille is brushed stainless steel.


Industry Standards

UL Component Recognized
CSA listed (fan only)



Accessories

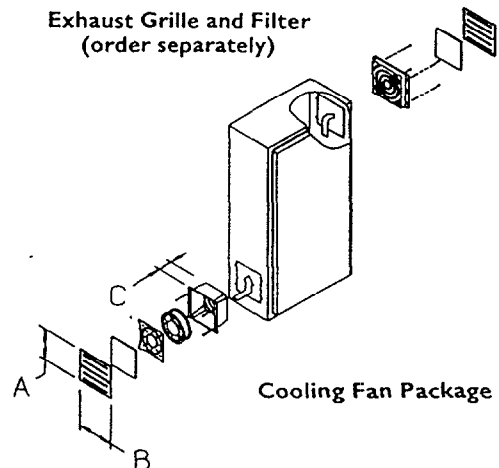
Exhaust Grille and Filter, page 570
Filter Adhesive, page 569
Temperature Control Switch, page 571

 For complete information on air conditioners, heat exchangers and other climate control products, see Hoffman's Specifier's Guide for Climate Control Products. Use reply card to order.

Installation

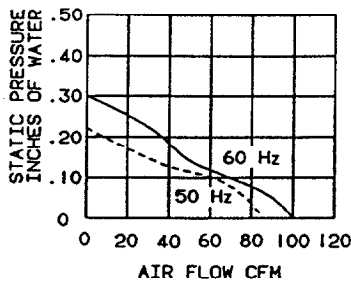
Fan packages can be installed on any surface of an enclosure. They are most effective when the fan assembly is located on the lower side of the enclosure and the exhaust grille is positioned near the top on the opposite side of the enclosure. This installation assists heat transfer by causing slightly more turbulence and also prolongs the working life of the fan since it is located in the path of the cooler air entering the enclosure. **An additional exhaust grille and filter is required and should be located on the side of the enclosure opposite the fan package. Exhaust grille and filters must be ordered separately.** Cooling Fan Packages and exhaust grilles can be turned 90° for mounting on narrow enclosures. Clearance consideration must be given for the enclosure panel and components since the fan package extends into the enclosure. Enclosure cutout dimensions are given below.

Exhaust Grille and Filter (order separately)

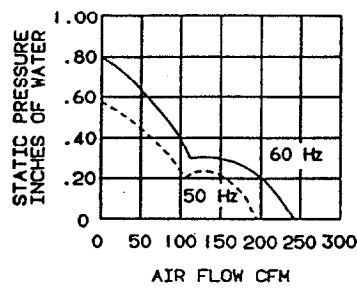


Cooling Fan Package

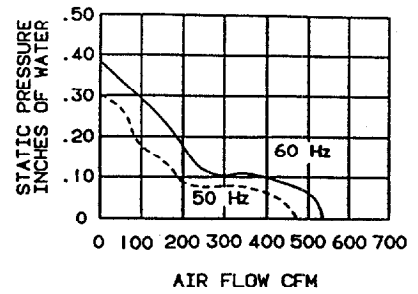
Performance Curve for 4" Fan*



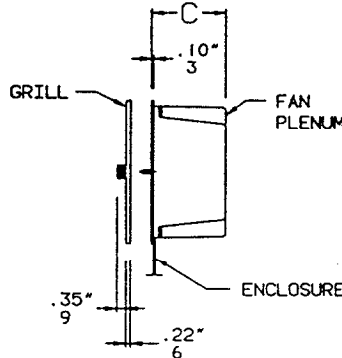
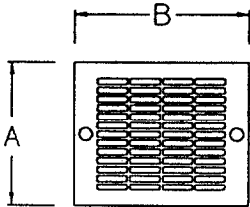
Performance Curve for 6" Fan*



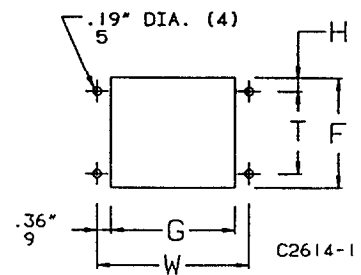
Performance Curve for 10" Fan*



*Performance curves represent fan performance only.



Mounting Cut-Out Dimensions



Inch
Millimeter

Standard Sizes and Cut-Out Dimensions

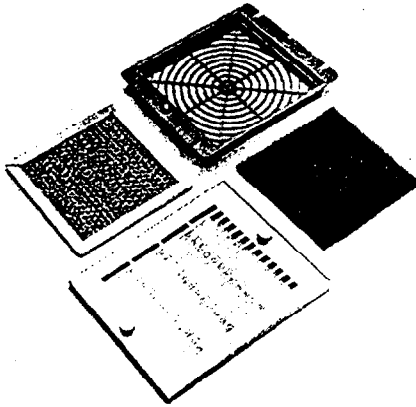
Catalog Number	Dimensions AxBxC	Description	F	G	H	T	W
A-PA4AXFN1 * A-PA4AXFN2	6.11x7.38x2.28 (155x187x58)		3.50 (89)	3.50 (89)	0.77 (20)	1.12 (28)	6.39 (162)
* A-EXGR4 * A-FLTR6		Exhaust Grille & Filter Filter Replacement	5.66 (144)	5.66 (144)	0.77 (20)	4.12 (105)	6.39 (162)
A-PA6AXFN1 * A-PA6AXFN2	7.16x8.86x3.12 (182x225x79)		7.16 (182)	7.16 (182)	1.33 (34)	4.50 (114)	7.89 (200)
* A-EXGR6 * A-FLTR6		Exhaust Grille & Filter Filter Replacement	7.16 (182)	7.16 (182)	1.33 (34)	4.50 (114)	7.89 (200)
A-PA10AXFN1 * A-PA10AXFN2	11.16x13.00x5.25 (283x330x133)		11.16 (283)	11.16 (283)	2.14 (54)	6.88 (175)	11.89 (302)
* A-EXGR10 * A-FLTR10		Exhaust Grille & Filter Filter Replacement	11.16 (283)	11.16 (283)	2.14 (54)	6.88 (175)	11.89 (302)

Millimeter dimensions () are for reference only; do not convert metric dimensions to inch.

* An intake grille and filter are included with each fan package. An exhaust grille and filter are normally required for each installation. Additional grille and filter packages must be ordered separately.

* NEW CATALOG ITEMS

Technical/Performance Data							Service Temperature	Noise	Weight
Catalog Number	CFM 50/60 Hz	Watts	Voltage	Hz	Amps	Motor RPM	°F (°C)	SIL (db)	lb. (kg.)
A-PA4AXFN1	85/100	21	230	50/60	.21	2500/3000	120 (49)	38	4.3 (1.95)
A-PA4AXFN2	85/100	22	230	50/60	.16	2500/3000	120 (49)	38	4.3 (1.95)
A-PA6AXFN1	200/240	33	230	50/60	.31	2850/3400	122 (50)	50	5.4 (2.45)
A-PA6AXFN2	200/240	43	230	50/60	.19	2850/3400	122 (50)	50	5.4 (2.45)
A-PA10AXFN1	480/560	36	230	50/60	.35	1350/1650	140 (60)	48	11.4 (5.17)
A-PA10AXFN2	480/560	36	230	50/60	.19	1350/1650	140 (60)	48	11.4 (5.17)



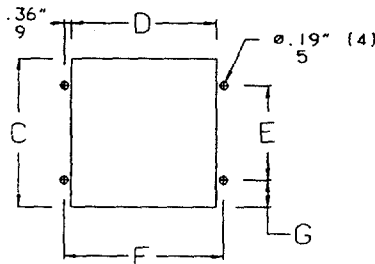
Exhaust Grille and Filter for Cooling Fan Packages

Used at air discharge side of fan package cooling systems. One grille and filter are included with each Cooling Fan Package for air inlet. An additional grille and filter are normally required for air outlet. Grille is 16

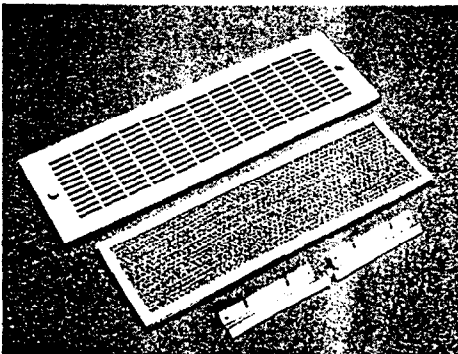
gauge stainless steel. Exhaust grille is designed for safety and low resistance to air flow (63% open). Expanded aluminum air filter is easily removed for cleaning from outside the enclosure. Mounting hardware is furnished.

Catalog Number	Grille Size	C	D	E	F	G
A-EXGR4	6.11x7.38 (155.2x187.5)	5.66 (143.8)	5.66 (143.8)	4.12 (104.6)	6.39 (162.3)	0.77 (19.6)
A-EXGR6	7.61x8.88 (193.3x225.6)	7.16 (181.9)	7.16 (181.9)	4.50 (114.3)	7.89 (200.4)	1.33 (33.8)
A-EXGR10	11.62x13.00 (295.1x330.2)	11.16 (283.5)	11.16 (283.5)	6.88 (174.8)	11.89 (302.0)	2.14 (54.4)

Millimeter dimensions in () are for reference only; do not convert metric dimensions to inch.



Mounting Cut-Out Dimensions

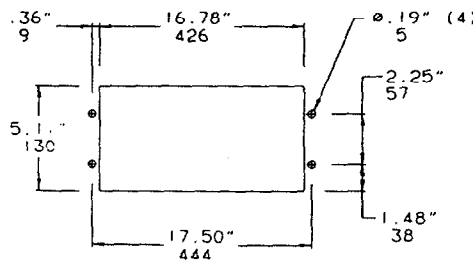


Exhaust Grille and Filter for Blower Package

Located at air discharge side of an enclosure using Blower Package A-DB275. Polished stainless steel grille is 65% open and offers low resistance to air flow. Expanded aluminum filter (included with each grille) is easily removed for cleaning from outside the enclosure. Mounting hardware is furnished.

Catalog Number	Dimensions AxB	Filter Size
A-EXGR275	5.75x19.00 (146x483)	4.98x16.56 (126x421)

Millimeter dimensions () are for reference only; do not convert metric dimensions to inch.



Mounting Cut-Out Dimensions

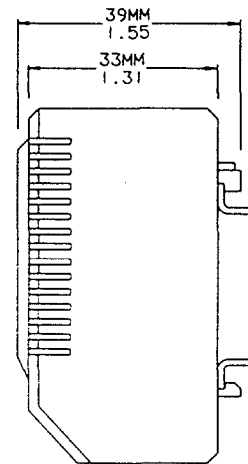
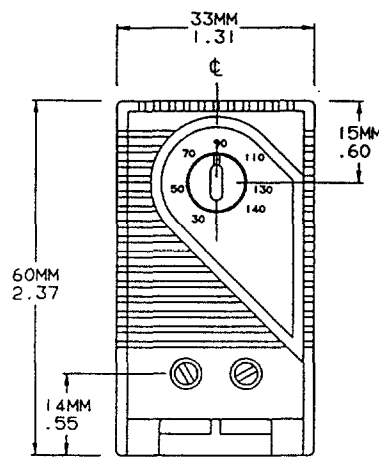
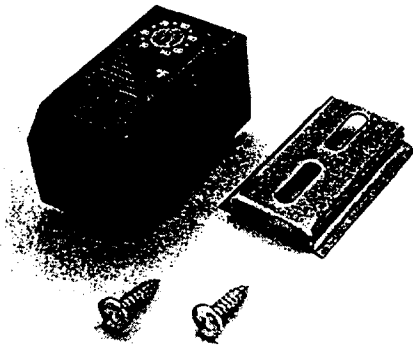
C2793-1

Temperature Control Switches

These easy to install thermostats are designed to regulate and monitor air temperature in switch-gear enclosures that are set up to operate with heaters, fans, filter ventilators, heat exchangers, and/or signal transmitters. Thermostat NC (catalog number A-TEMNC) is specifically designed for use with heaters, while thermostat NO (catalog number A-TEMNO) is designed to control fans, filter ventilators, or for switching signal transmitters in the event of overheating. Both thermostats have a bi-metallic adjustable set point range of 30 to 140°F. When the enclosure reaches the predetermined set point, temperature contacts in the controller are activated and

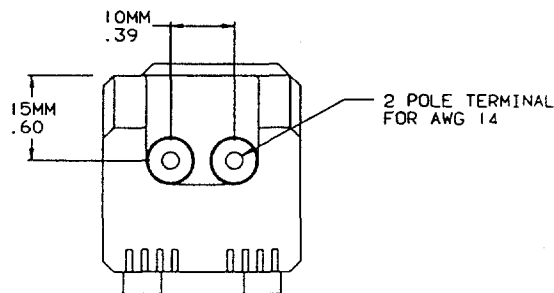
the fan or heater automatically begins to operate. Thermostats prolong the life expectancy of heaters and fans by curtailing their operating hours and also increase the working efficiency of electrical components by exposing them to fewer contaminants from the surrounding environment. Connections consist of 2-pole terminal for AWG 14 (0.04 in²). Provision for both panel mounting and DIN rail mounting. Housing is plastic UL94-V0. Protection rating IEC IP30, UL and CSA

Component Recognized.



DIN 3 TYPE MOUNTING RAIL (TS 35 X 7.5)

C2624-1



Catalog Number	Contact Type	Switching Capacity
A-TEMNC	NC (normally closed), quick-acting	10 A (1) AC 120 V
A-TEMNO	NO (normally open), quick-acting	10 A (1) AC 120 V

Chapter
2

Series 90-70 PLC Hardware Description

Introduction to the Series 90-70 PLC

The Series 90-70 PLC continues the family concept by offering nine logic processors (Central Processing Units), each with different levels of performance. The processors feature single slot construction, high speed boolean logic processing, configurable memory allocation, a built-in serial port., and LED status indicators.

The Series 90-70 PLC offers all the PLC features you expect in a world class PLC. A

full instruction set simplifies programming, register memory simplifies data handling, and a built-in real-time clock is available for convenient time stamping.

The Series 90-70 CPUs use a common instruction set. Programs are fully transferable between compatible CPUs making program movement between different processors easy. The Series 90-70 PLC offers a truly open architecture based on the VME standard.

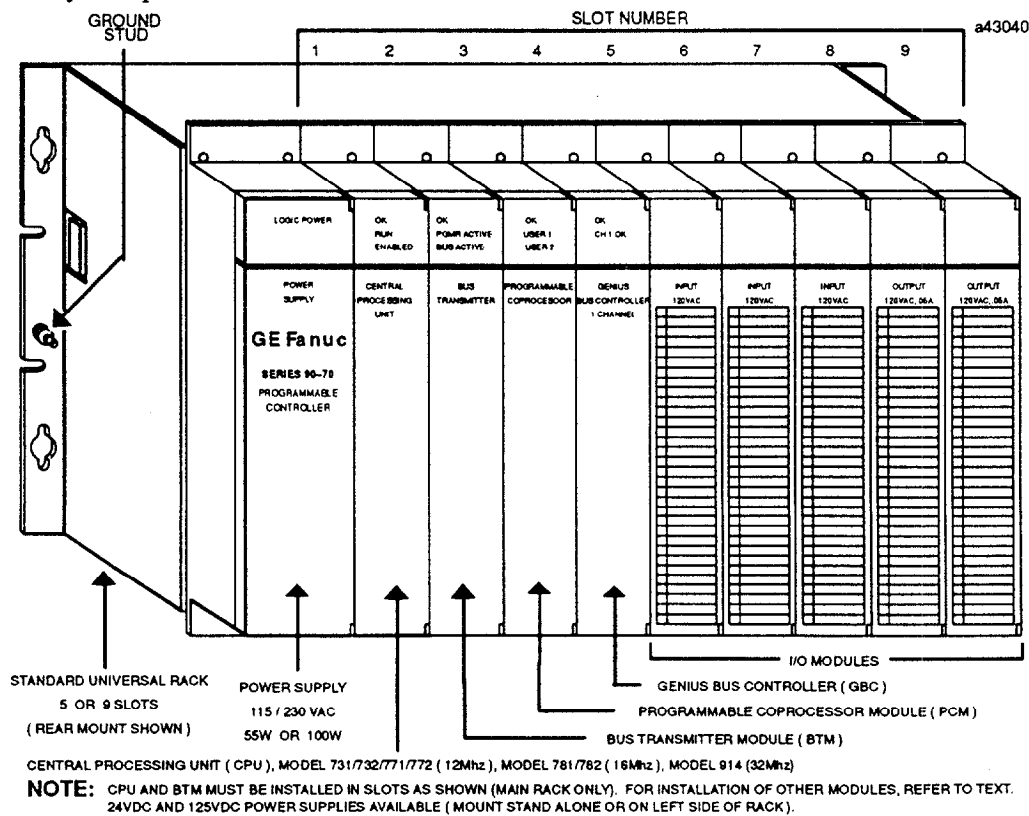


Figure 2-1. Example of a Series 90-70 Programmable Logic Controller

All CPUs are closely coupled to the VME backplane, providing high-speed movement of data to I/O, coprocessors, and intelligent modules. Embedded VME Read/Modify/Write commands facilitate integration of 3rd party VME boards.

A VME qualification program has been established by GE Fanuc to help minimize any potential problems resulting from integration of products from multiple vendors when purchased for use in a Series 90-70 PLC system.

Traditional PLC Features

The Series 90-70 PLC combines the desired features of the traditional PLC with a host of improvements and product enhancements. Features traditionally found in most PLC's, include:

- An industrial computer that has been hardened to operate reliably in the harsh environment commonly encountered in the factory;
- Familiar relay ladder diagram programming for user created programs.
- I/O control through user logic programming;
- Instruction set designed specifically for the industrial control and process environment;
- Communications with cell controllers, operator interface terminals, dumb terminals, personal computers, and similar devices.

Series 90-70 PLC Features

To these features, the Series 90-70 PLC adds an impressive array of new features including:

- A high density single slot CPU;
- Logicmaster 90 programming software;
- An industry standard VMEbus interface between component boards;
- High density (32 points) AC and DC I/O on a single board;
- Easy module keying, which prevents plugging-in a wrong I/O module type;
- Two-rack operation from one power supply;

- Both discrete and analog interrupts for fast system response with standard hardware;
- Extensive system and module diagnostics for ease of troubleshooting;
- A battery-backed calendar/clock built into the CPU;
- A Configuration Software package which provides for easy system configuration;
- Software configurable analog modules;
- An alarm processor fault diagnostic function;
- Structured relay ladder programming;
- No jumpers or DIP switches to set on boards;
- Genius I/O subsystem.

Series 90-70 PLC Product Description

The Series 90-70 PLC has many other desirable features, including user memory which is expandable up to 512 Kbytes, a built-in serial port, a fast boolean coprocessor (**.4 μ s per instruction**), a fixed scan time option, and up to 64 hardware interrupts.

A long-life Lithium backup battery maintains the contents of the CMOS RAM memory under no-power conditions and can be replaced with power on. Your application programs can be password protected for selective security.

The Series 90-70 PLC is available in standard Series 90-70 or VME Integrator racks. Standard racks are available as a 19 inch wide (rack/panel mount), and a 13 inch wide rack (panel mount). The standard racks are physically identical, whether used as a CPU rack, or an I/O expansion rack. VME Integrator racks are available as a 19 inch wide rear (panel) mount and a 19 inch wide front (rack) mount.

A standard 19 inch rack can contain 9 modules plus power supply, or power supply connection; the 13 inch rack can contain 5 modules plus power supply, or power supply connection. Rack slots are identified, from left to right, as PS, then slots

1 through 9 for the 19 inch rack, and PS, then slots 1 through 5 for the 13 inch rack.

The VME Integrator racks have 17 slots to allow easy integration of 3rd party VME modules into a Series 90-70 PLC system. These racks can be used for 3rd party modules and all Series 90-70 CPU and I/O configurations, with the exception of redundancy applications. These racks have backplane connectors spaced on 0.8 inch centers to accommodate 3rd party VME modules (Series 90-70 modules use two of these slots).

Power supplies are available in several versions to handle the various load and voltage requirements of many different modules. Available versions include two AC input source, and two DC input source supplies. An external user supplied power supply can be used to power a Series 90-70 PLC when used in conjunction with a

Power Supply Adapter module. These combinations allow you to select the appropriate supply for your application.

Models of Series 90-70 PLC CPU

The CPU for the Series 90-70 PLC is available in nine different models. The difference between CPUs is the processing speed, I/O capacity, and user memory size as shown in Table 2-1. Additionally, the models 732, 772, 782, and 914 support floating point calculations. The CPU models 788 and 789 are required for Genius Triple Modular Redundancy systems. The CPU914 provides rapid processing speeds through the use of an 80486DX microprocessor operating at 32 Megahertz. For more information about the new CPU models 788, 789, and 914, consult you GE Fanuc authorized PLC distributor or your local GE Fanuc sales representative.

Table 2-1. Series 90-70 CPU Capacities

CPU Model	Speed (MHz)	Processor	Input Points	Output Points	On-Board User Memory	Expansion Memory (KBytes)	Floating Point Math
731	12	80C186	512 †	512	32K (Bytes)	not available	No
732	12	80C186	512 †	512	32K (Bytes)	not available	Yes
771	12	80C186	2048 ‡	2048	not available	64/128/256/512	No
772	12	80C186	2048 ‡	2048	not available	64/128/256/512	Yes
781	16	80386DX	12288 *	12288	not available	256FM***/256/512	No
782	16	80386DX	12288 *	12288	not available	256FM***/256/512	Yes
788	16	80386DX	352**	352	not available	256/512	No
789	16	80386DX	12288 *	12288	not available	256/512	No
914	32	80486DX	12288 *	12288	not available	512 ****	Yes

† The total number of Input points and Output points on CPU models 731/732 cannot exceed 512.

‡ The total number of Input points and Output points on CPU models 771/772 cannot exceed 2048.

* The total number of Input points and Output points on CPU models 781/782/789/914 cannot exceed 12288.

** The total number of Input points and Output points on CPU models 788 cannot exceed 352.

*** 256KBytes w 256 KBytes non-volatile flash memory.

**** 512KBytes of memory is standard with the CPU model 914.

Standard Series 90-70 PLC Racks

The rack in which the CPU resides requires a power supply (or a two-rack power cable for use when one power supply provides power for two racks), a CPU module installed in slot 1, and an optional Bus Transmitter Module (BTM) installed in slot 2. The Bus Transmitter Module can be used to provide a high speed parallel communications

link to the programmer and to additional racks.

The remaining slots can contain combinations of I/O or intelligent modules to suit the needs of your application. If the rest of the modules in a CPU rack are high-density 32 point I/O modules, a 5-slot rack can accommodate up to 128 total I/O points, while a 9-slot rack can accommodate up to 256 total I/O points.

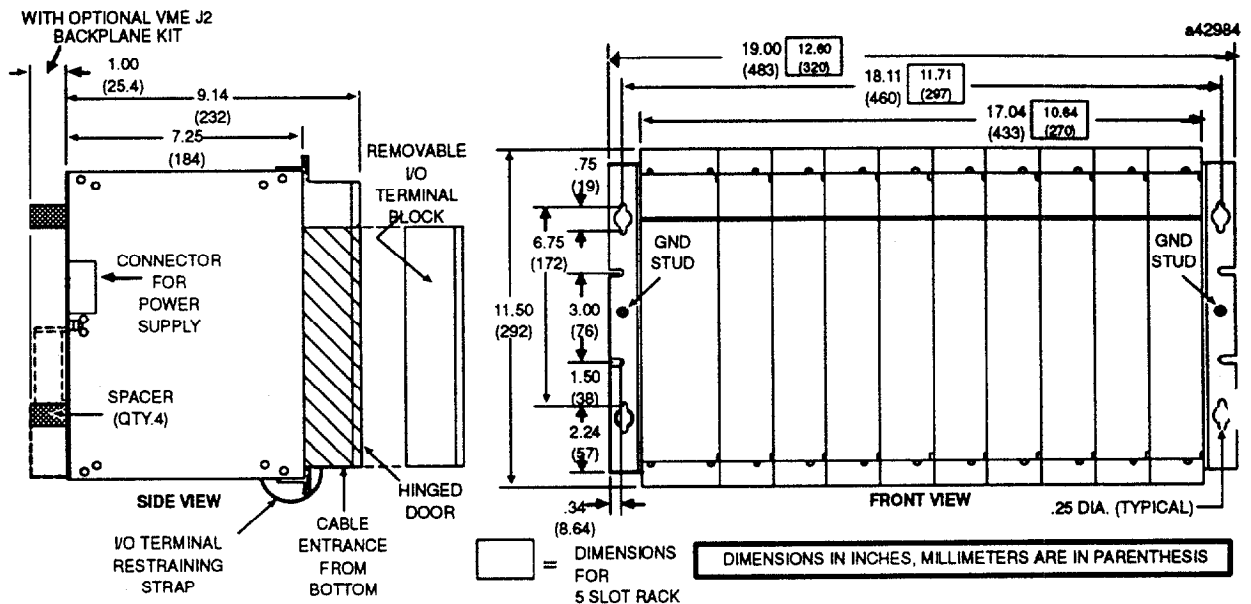


Figure 2-2. Standard Rack Outline and Dimensions

Series 90-70 PLC modules are installed in either a 5-slot (IC697CHS750) rear mount, 9-slot (IC697CHS790) rear mount, or a 9-slot (IC697CHS791) front mount universal rack. Additionally, a slot is provided for a power supply. The racks are identical as far as the height and depth of modules they will accept. The 5-slot rack is 12.6 inches (320 mm) wide, and the 9-slot racks are 19 inches (483 mm) wide. The 5-slot rack is usually referred to as a 13 inch rack. The rack slots are identified, from left to right, as PS - then slots 1 through 5, for the 13 inch rack; and as PS - then slots 1 through 9 for the 19 inch racks. The first slot at the left in each rack must contain the power supply or the power supply connection for that rack.

The slot adjacent to the power supply in the main rack (also called rack 0) must always contain the CPU module. Rack sizes may be mixed in a system installation to suit the requirements of your application. Racks may be panel mounted or rack mounted.

VME Integrator Racks

The VME Integrator Rack can be used for 3rd party VME modules and all Series 90-70 CPU and I/O configurations, except redundancy applications. This rack has a 17-slot backplane and is designed to provide easy integration of 3rd party VME modules into a Series 90-70 PLC system. *Integration of 3rd Party VME modules must*

be in accordance with guidelines described in the *User's Guide to Integration of 3rd Party VME Modules, GFK-0448B, or later.*

Backplane connectors are spaced on 0.8 inch centers to accommodate 3rd party VME modules. Series 90-70 modules each use two of these slots. *Standard Series 90-70 racks have slots spaced on 1.6 inch centers for Series 90-70 modules.* VME modules that require 0.8" spacing for installation may not fit in standard Series 90-70 racks (IC697CHS750/790/791).

Each rack configuration will accept one power supply in the leftmost module position, and either (1) 17 3rd Party VME modules, (2) 9 Series 90-70 modules, or (3) a combination of Series 90-70 and 3rd Party VME modules. Note that the power supply capacity may limit the maximum number of modules in a rack. *No more than three VME modules can be used in a rack with Series 90-70 modules.*

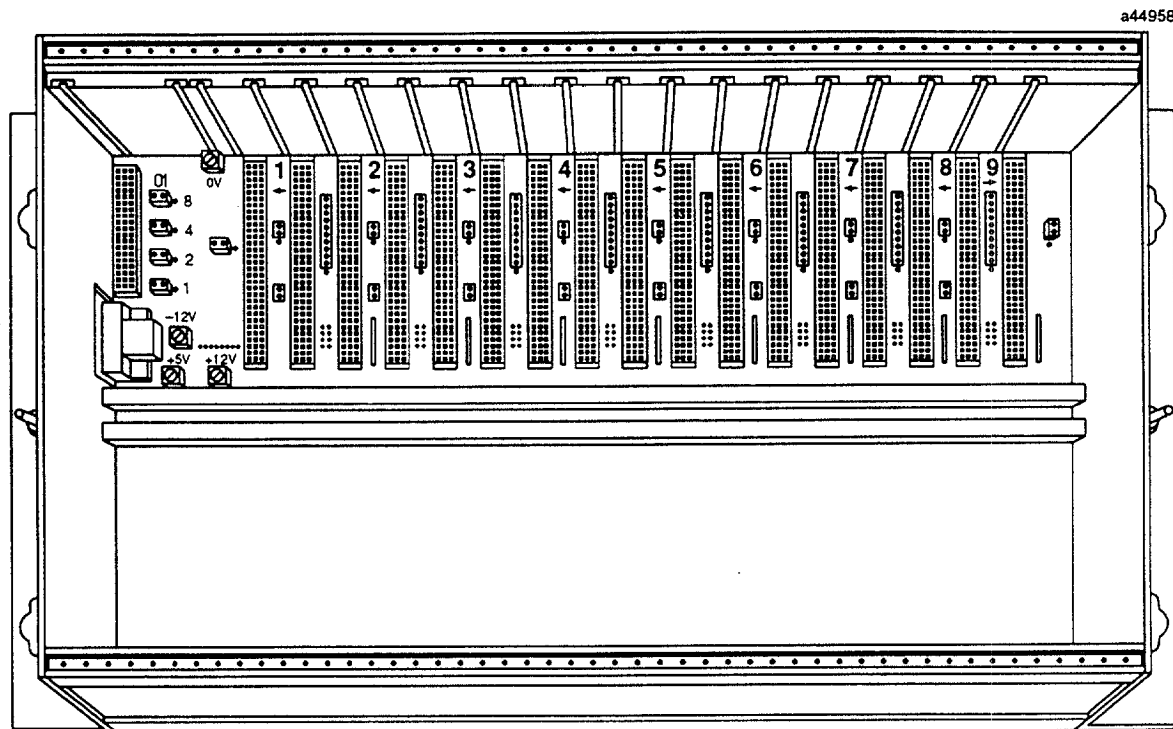


Figure 2-3. VME Integrator Rack

The flexibility of these racks to allow both 3rd party VME and Series 90-70 modules is accomplished through the use of jumpers on the backplane to configure slots. The VME Integrator rack is factory configured to accept standard Series 90-70 modules. Integration of 3rd party VME modules is done by moving these jumpers to different positions. The exact jumper configuration depends on the requirements of each 3rd Party VME module.

Two racks can be interconnected to share a single power supply (120/240 VAC ver-

sions and 24 VDC version; the 125 VDC power supply cannot be used to power two racks) for applications having extended I/O requirements. A Power Supply Extension Cable kit (IC697CBL700) is available for such applications. There are also four "power cube" screw connections (+5V, +12V, -12V, 0V) on the backplane for use with the Power Supply Adapter module or a Series 90-70 power supply when used to supply power to an optional P2 backplane. *These connections are not intended for direct connection to a 3rd Party power supply.*

Each rack provides slot sensing for rack-type I/O modules. No jumpers or DIP switches on the I/O modules are required for module addressing of these modules. Rack dimensions are shown in the follow-

ing illustration. Slots are 0.8" wide except the power supply slot which is 2.4" wide.

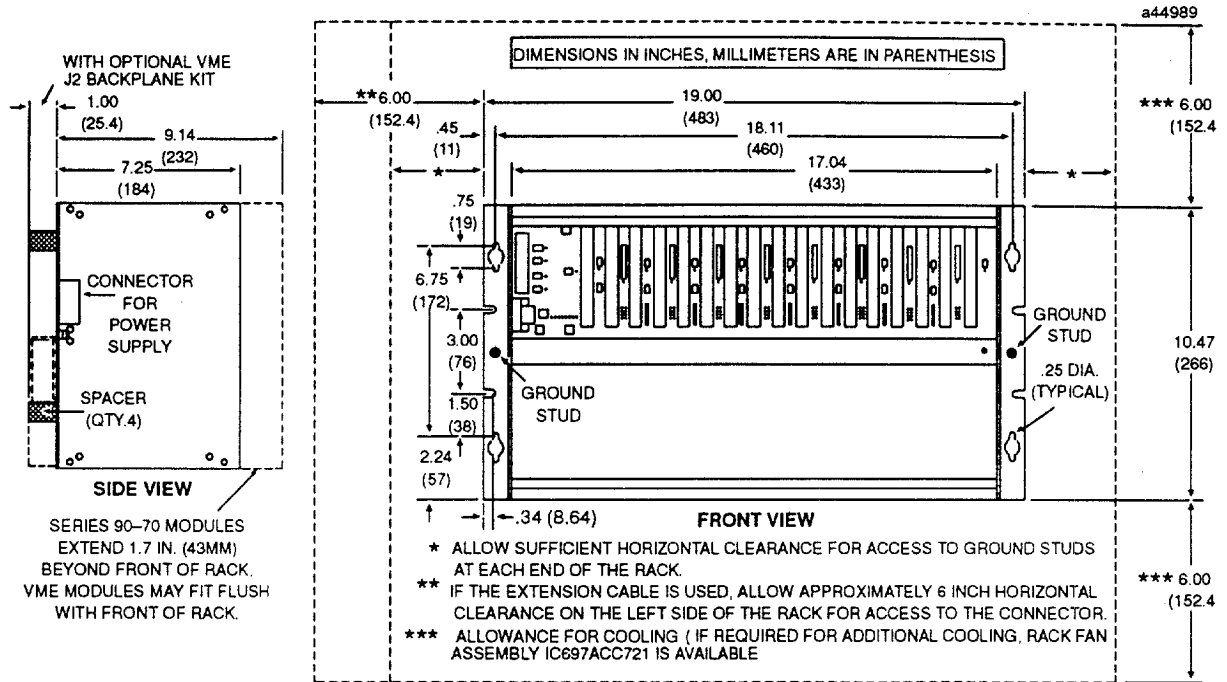


Figure 2-4. VME Integrator Rack Dimensions

VME Integrator Rack Configuration

A series of jumper positions are located on the backplane near each slot. These jumpers provide for flexibility in the types of modules to be installed, either VME modules in single slots (0.8 inch spacing between centers) or Series 90-70 modules, which require two slots (1.6 inch spacing between centers). GE Fanuc module slots are indicated by a number and an arrow; also the slot is marked 1A through 9A.

Slot Addressing

The Series 90-70 PLC system allows user configuration of I/O point references for modules in a VME Integrator rack without the need for board address DIP switches or jumpers. The address structure is described below. Configuration is done with the configurator function of the Logicmaster 90-70 Programming Software package.

Rack numbers are configured the same as the standard Series 90-70 racks

Rack Mounting Criteria

Racks must be mounted in a horizontal orientation (as shown in illustrations in this text). These racks do not require a fan for cooling as long as sufficient space is left around the rack when it is mounted. Installation instructions supplied with each rack provide a guide to recommended distances that should be allowed to maintain proper air flow through the modules.

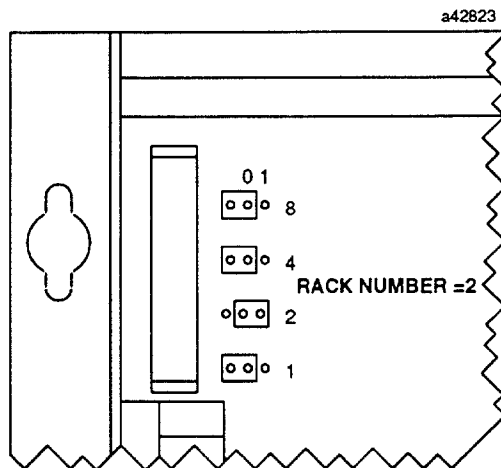
I/O Expansion System

If more I/O is required in the Series 90-70 PLC control system than can be contained in a single rack, additional racks can be added to the system. Up to a maximum of eight (including the CPU rack) racks can be included in a local I/O expansion system.

Multiple racks in a system are identified by a unique number between 0 and 7, which

is assigned to each rack by configuring a group of four rack number jumpers which are located on the backplane next to the power supply slot. Rack number 0 (assigned to the CPU rack) must always be present in a system.

Rack numbers assigned to other racks in a system do not need to be contiguously numbered; they can be randomly assigned. However, for proper system operation rack numbers must not be duplicated in a multiple rack system.



**Figure 2-5. Rack Number Jumpers
(Shown with Rack Two Selected)**

Local I/O Expansion Racks

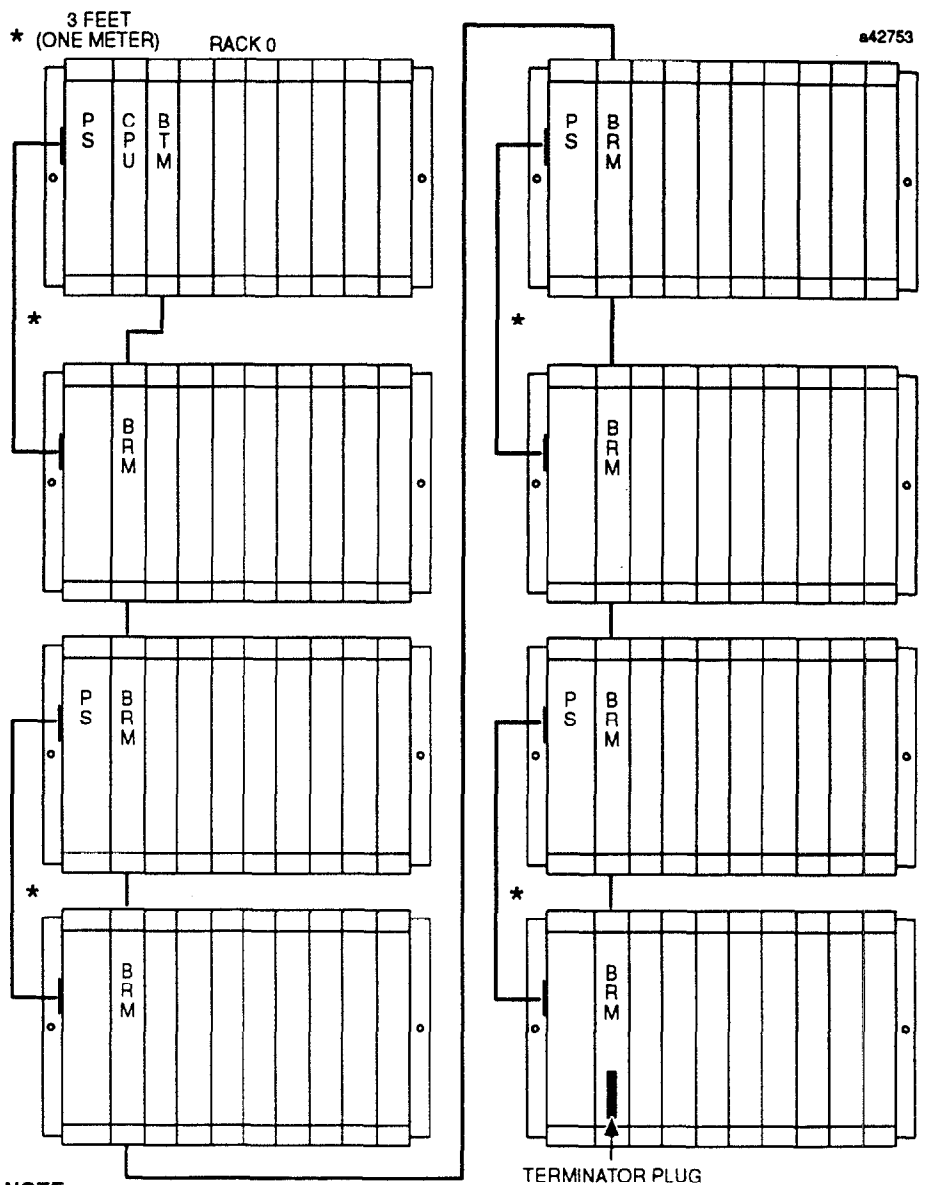
Expansion racks in a local I/O expansion system connect to the CPU through an 18 twisted-pair cable (called the I/O cable) with one end connected to the lower connector on a Bus Transmitter Module installed in the CPU rack in slot 2, and the other end connected to the top connector on a Bus Receiver Module (BRM) installed in slot 1 in an expansion rack. Each additional rack is then connected in a daisy chain through I/O cables connected to the top and bottom connectors on the BRMs.

Table 2-2. Cables for Connecting Expansion Racks

Catalog Number	Length
IC600WD005	5 feet (1.5 meters)
IC600WD010	10 feet (3.0 meters)
IC600WD025	25 feet (7.5 meters)
IC600WD050	50 feet (15.0 meters)

The total cable length from the CPU rack to the last expansion rack may be a maximum of 50 feet (15 meters). I/O cables are available in various lengths from 5 to 50 feet (0.6 to 15 meters) as shown in Table 2-2. Additionally, a single power supply can power two racks (within listed current limits) when connected by an available cable three feet (1 meter) in length.

The maximum number of racks permitted in a local system is eight (CPU rack plus seven expansion racks).



NOTE:
TOTAL LENGTH OF ALL INTERCONNECTING CABLES FROM BTM TO LAST BRM IS 50 FEET MAXIMUM (15 meters). ALL RACKS MUST BE AT SAME GROUND POTENTIAL (8 RACKS MAXIMUM).

Figure 2-6. Example of a Local I/O Expansion System Maximum Configuration

The I/O bus in an expanded system must be terminated by installing an I/O bus Terminator plug on the bottom connector of the last BRM in the system. This Terminator plug contains a resistor pack configured for proper I/O bus termination.

If there are more than two racks in an expansion system, the intermediate expansion racks must not have the Terminator plug installed.

Remote Expansion System

The expansion racks may also be used at a location remote from the CPU when a Remote I/O Scanner module (IC697BEM733) is included in the rack to interface to a Genius bus. This is done by installing a Remote I/O Scanner in one or more racks and connecting them to a Genius bus. More than one remote rack can be included in the remote expansion system. This scheme allows up to 1024 discrete inputs and 1024 discrete outputs, or 64 analog in-

puts and 64 analog outputs to be included in a *remote drop*. Additionally, Bus Transmitter, Bus Receiver, Programmable Coprocessor, Graphics Display Coprocessor, and CIMPLICITY 90-Alphanumeric Display Coprocessor modules can be included in a remote drop. A remote drop is made up of the Remote I/O Scanner and the modules it serves on the Genius bus. Remote racks can be located up to 7500 feet from the Genius Bus Controller to which they are connected.

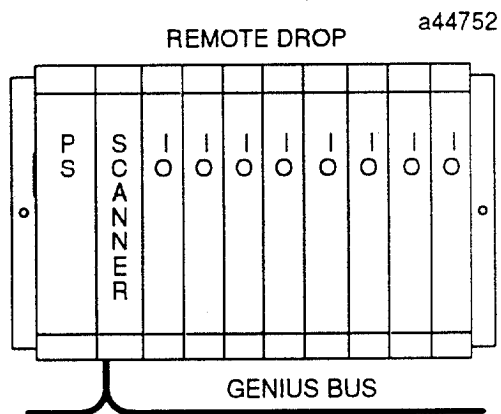


Figure 2-7. Location of Remote I/O Scanner in a Remote I/O Expansion System

General Specifications

General specifications for the Series 90-70 PLC are provided in the following table.

Most Series 90-70 modules are UL listed and CSA certified (for status of individual modules, consult your local GE Fanuc PLC distributor, or local GE Fanuc sales office.

Table 2-3. General Specifications for the Series 90-70 Programmable Logic Controller

Typical Execution Time	Boolean Contacts, Ams per K elements
Maximum number of Discrete I/O Points	512, any mix (CPU Model 731/732) 2048, any mix (CPU Model 771/772) 12228, any mix (CPU Model 781/782, 789, 914) 352, any mix (CPU Model 788)
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	-40° to +85° C (-40° to +185° F)
Humidity	5% to 95% non-condensing
Vibration	3.5 mm, 5-9 Hz: 1.0 G 9-150 Hz
Shock	15 g's for 11 msec
Complies with Standards	
IEC	435, 380
JIS	C 0912, JIS C 0911
DIN	435, 380
UL	508, 1012
CSA	C22.2 No. 142, C22.2
NEMA/ICS	2-230.40
ANSI/IEEE	C-37.90A-1978
VDE	805, 806, 871-877
FCC	15J Part A
VME	System designed to support the VME standard C.1
FM	Class 1, Division 2
AC Power Source	
Voltage	120 or 240 VAC
Frequency	47 to 63 Hz
Output Power (maximum)	55 or 100 watts (depending on model)
DC Power Source	
Voltage	24 VDC or 125 VDC (depending on model)
Output Power (maximum)	90 watts (24 VDC PS), 60 watts (125 VDC PS)
Rack Weight (approximate, filled)	
9 slot	15 pounds (6.8 kg)
5 slot	9 pounds (4 kg)
Rack Dimensions	
9 slot (standard Series 90-70 rack and 17 slot VME Integrator rack)	Height: 10.5" (267mm) Width: 19.0" (483mm) Depth: 7.25" (184mm) Note that Depth = 9.14" (232mm) with Series 90-70 module installed.
5 slot	Height: 10.5" (267mm), Width: 12.6" (320mm) Depth: 7.25" (184mm), same note as above
Back-up Battery Type	Lithium, long-life
Battery Shelf Life, no Load	8 to 10 years at 25° C (77° F)
Typical Battery Life, Loaded	6 months at 40° C ambient (104° F) for all CPUs, PCM, ADC, and GDC

† Not all modules are FM certified, see your GE Fanuc PLC distributor or GE Fanuc sales representative for applicable modules.

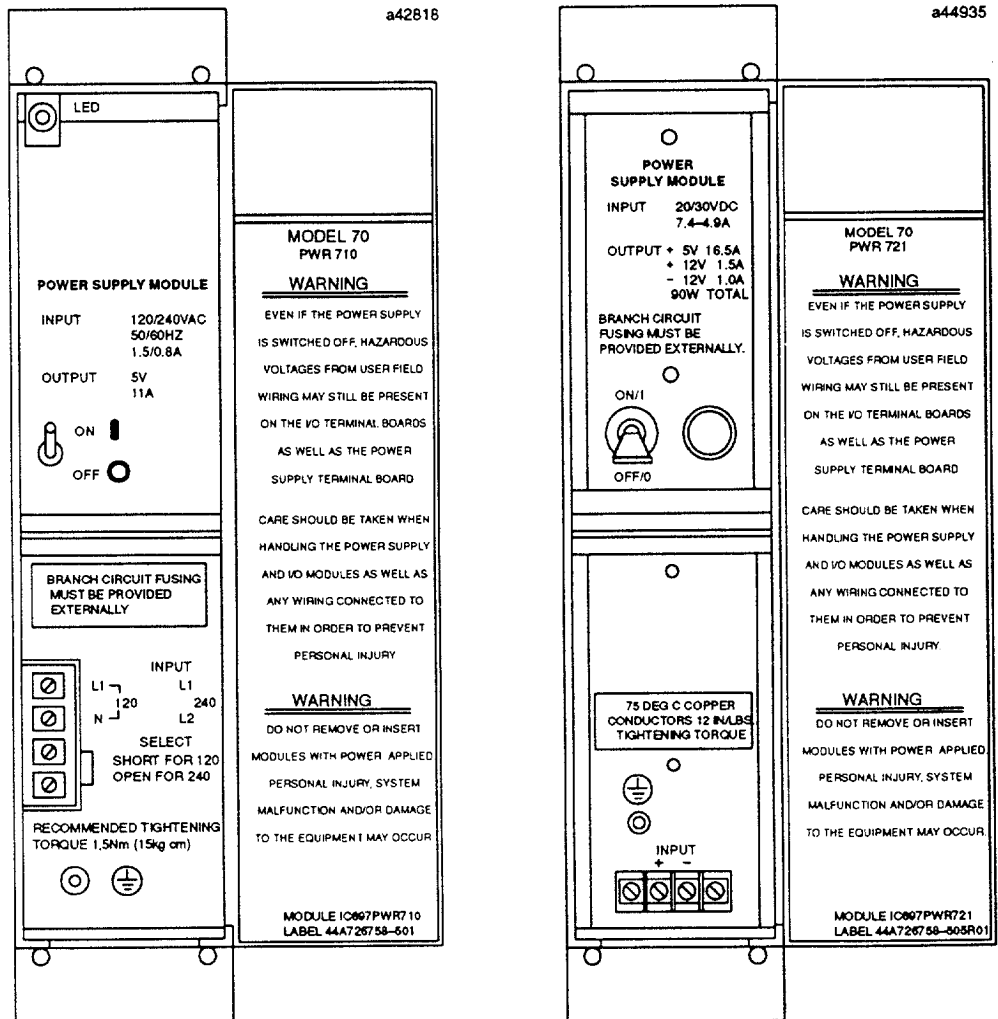
Series 90-70 PLC Power Supply

The power supply for the Series 90-70 PLC is available in four versions:

- IC697PWR710, 120/240 VAC input, +5 VDC output, 55 watts
- IC697PWR711, 120/240 VAC input, +5 and 12 VDC outputs, 100 watts
- IC697PWR721 (with PSA), 24 VDC input, +5 and ±12 VDC outputs, 90 watts
- IC697PWR731 (with PSA), 125 VDC input, +5 and ±12 VDC outputs, 60 watts

Four versions of the power supply are available to handle the differing load and voltage requirements of various modules. For load ratings of modules, refer to the Series 90-70 Installation Manual, GFK-0262.

The AC power supply plugs into the left-most slot (labeled #PS) of the rack directly to the backplane through a connector - no wiring required. The input source of AC or DC power connects to the Series 90-70 PLC system through a group of protected connections on the power supply faceplate. On the AC input versions, a jumper must be configured on the two bottom terminals for either 120 or 240 VAC to match the power source.



AC Power Supply

DC Power Supply

Figure 2-8. Example of Series 90-70 Power Supplies

The 55 watt AC power supply should be sufficient to handle the load requirements for most racks, however if the total load requirements are to be greater than 55 watts (and/or a module requires ± 12 VDC, e.g. Broadband MAP Interface or some third party boards) the 100 watt AC input, or 60 or 90 watt DC input power supply must be used.

The 24 VDC and 125 VDC power supplies require a Power Supply Adapter (PSA) module, catalog number IC697PWR720, which is an interface between these two power supplies and the Series 90-70 rack backplane. The PSA is included with the power supplies when ordered as catalog numbers IC69PWR721 (24 VDC PS) or IC697PWR731 (125 VDC PS). The 24 or 125 VDC power

supply can be mounted on the left side of the Series 90-70 rack, or by attaching a bracket to the right side of the power supply the supply can be used in a stand alone installation and mounted separately on a panel.

The following figure shows a typical installation of a DC input power supply with the required Power Supply Adapter module. Note that for the installation as shown, the power supply is mounted on the left side of the Series 90-70 rack.

Detailed information on mounting the DC power supplies can be found in the data sheet included with each supply - GFK-0624 for the 24 VDC power supply and GFK-0625 for the 125 VDC power supply.

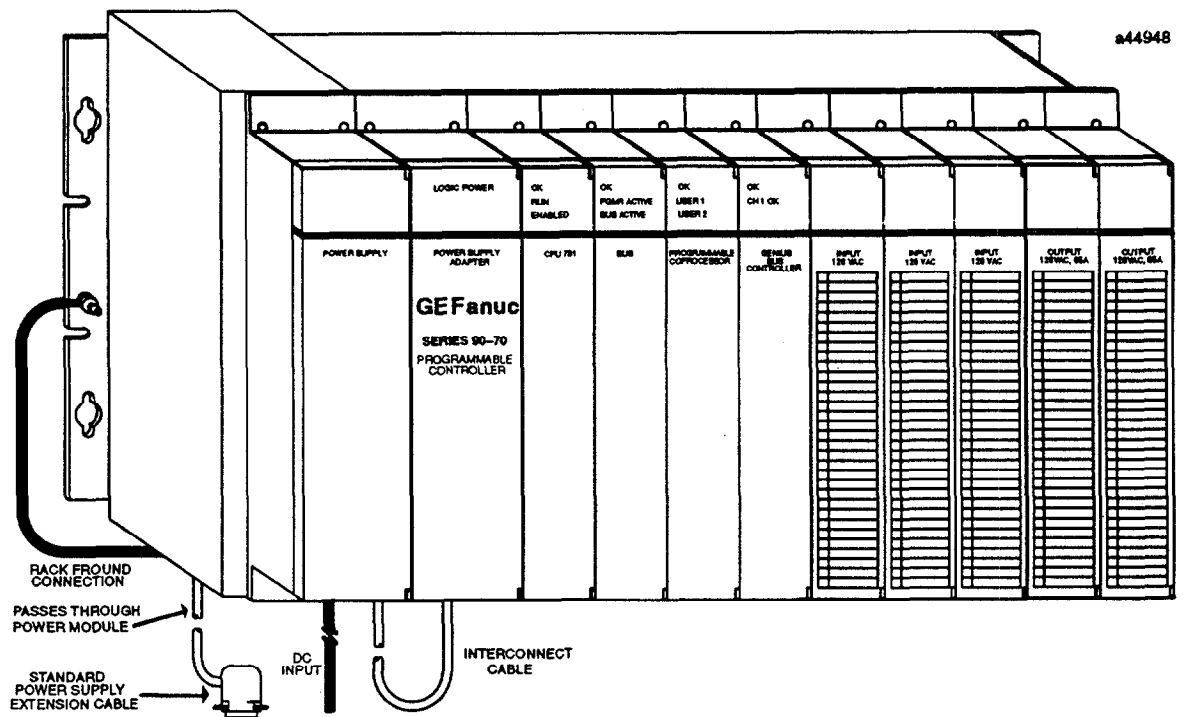


Figure 2-9. DC Power Supply Installation: Left Side of Series 90-70 Rack

Power Supply Adapter

The Power Supply Adapter Module (PSA) is a single-slot module that plugs into the power supply slot, which is the leftmost slot in a Series 90-70 rack. The PSA module must be connected to an external power supply through a cable. The external power supply can be a GE Fanuc power supply

module or other external power supply. The PSA allows use of 3rd Party power supplies which meet published specifications. For those applications where maintaining power to the rack is a must, a second power supply can be connected to the terminal board on the PSA to provide power supply redundancy.

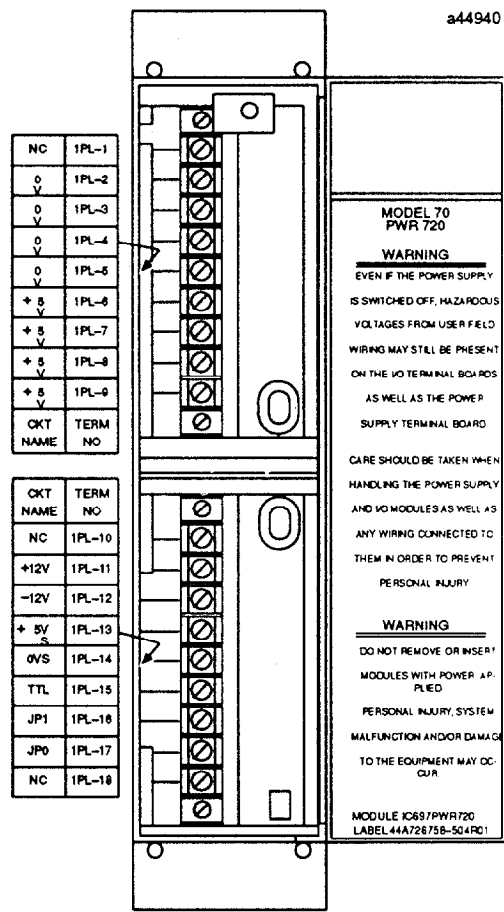


Figure 2-10. Power Supply Adapter Module

The PSA module is installed in the power supply slot (leftmost slot) and connects to either the 24 or 125 VDC power supply through a cable installed in the power supply. The free end of the cable should have spring spade or ring lugs which must be connected to designated terminals on a terminal board on the front of the PSA. This terminal board is accessed by opening the hinged door on the PSA module.

The +5, +12, and -12 VDC outputs, as well as the 5V remote sense, which are generated by an external power supply are connected to the Series 90-70 rack backplane through the PSA. The maximum currents

that can be supplied to the backplane through the PSA are: 18 amps on the +5 volt output, 2 amps on the +12 volt output, and 1 amp on the -12 volt output.

The PSA monitors the +5 volt output and the ttl compatible Input Power OK signal (TTL) from the external power supply. The Input Power OK signal (TTL) indicates that the external power supply input voltage is adequate to maintain hold-up time for an orderly system shutdown. The PSA also develops two backplane signals, AC-FAIL* and SYSRESET*, which are for the power-up/power-down sequence.

It is recommended that the external power supply have a +5V Remote Sense. When the Remote Sense is connected to the PSA terminal board (positive remote sense to +5VS and negative to 0VS) the +5 volts at the backplane will be regulated to the level set by the power supply.

The Power Supply Adapter Module operates from +5 VDC power which it receives from the +5 VDC power bus on the Series 90-70 rack backplane. The PSA can be used in an application with the 24 VDC PS whereby a single external power supply can provide power for two racks. When used in this application, the Power Supply Adapter module must be installed in the first rack.

For more information on the Power Supply Adapter module, refer to GFK-0626, which is the data sheet for that module.

DC Power Supply Mounting Options

The following two figures show the mounting options, including dimensions,

for the DC power supplies as used in a Series 90-70 PLC installation.

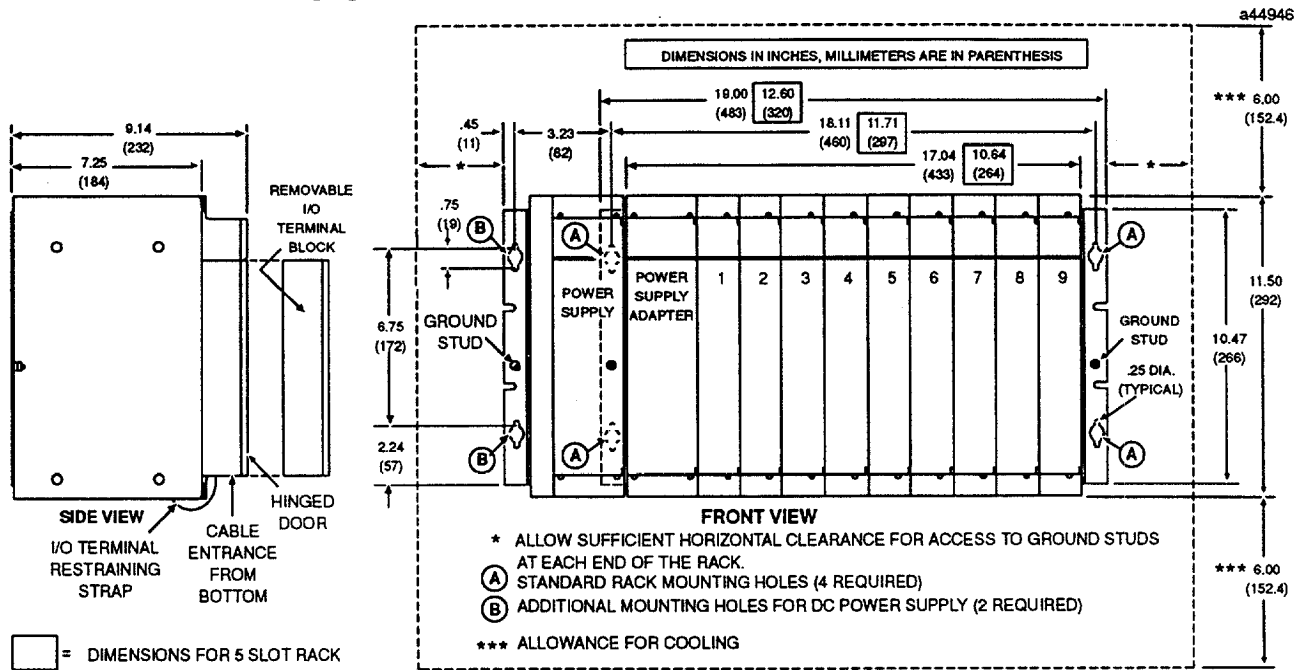


Figure 2-11. Rack Mounting Dimensions with DC Power Supply Attached

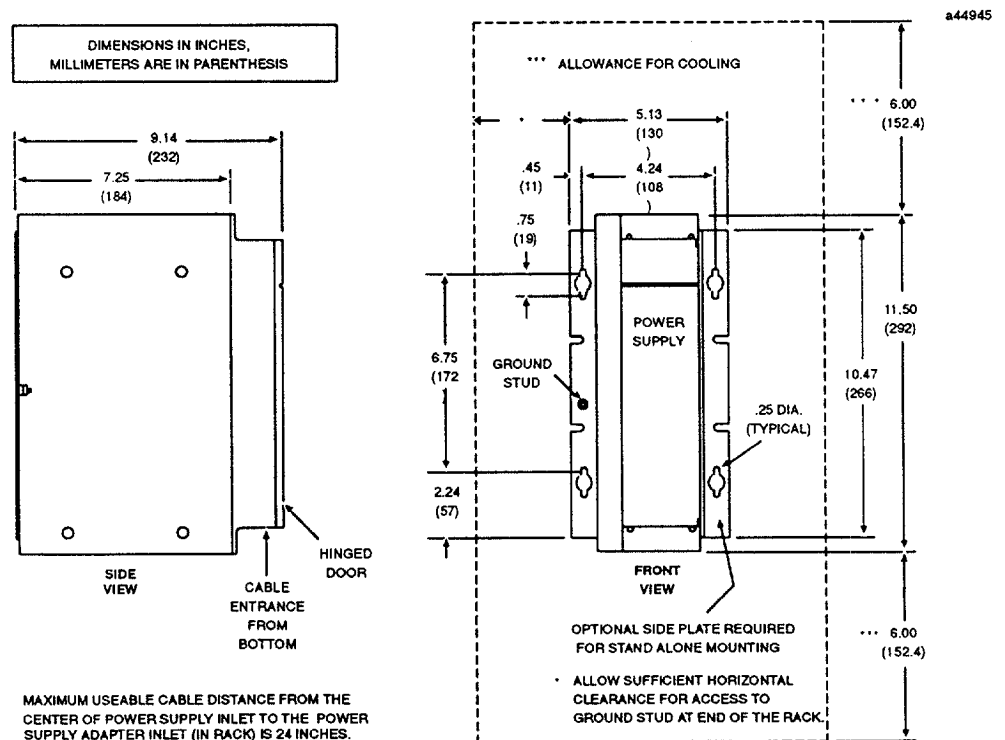


Figure 2-12. DC Power Supply, Stand Alone Installation

Rack Fan Assembly

The Rack Fan Assembly, is an easily installed accessory for use with Series 90-70 nine-slot racks. It is available in two versions, one version for 120 VAC operation, catalog number IC697ACC721) and one for 240 VAC operation, catalog number IC697ACC724). The fan assembly consists of three fans wired in parallel. This fan assembly provides additional rack cooling for installations where heat buildup could

be a problem. The fans have a low noise level and are assembled using ball bearings for extended life. The only tool needed for installation of the fan assembly is a #2 Phillips screwdriver.

The following illustration shows the position of the fan assembly when it is mounted on a rack. Note that it is mounted on the bottom of the rack with air flow from the bottom towards the top of the rack.

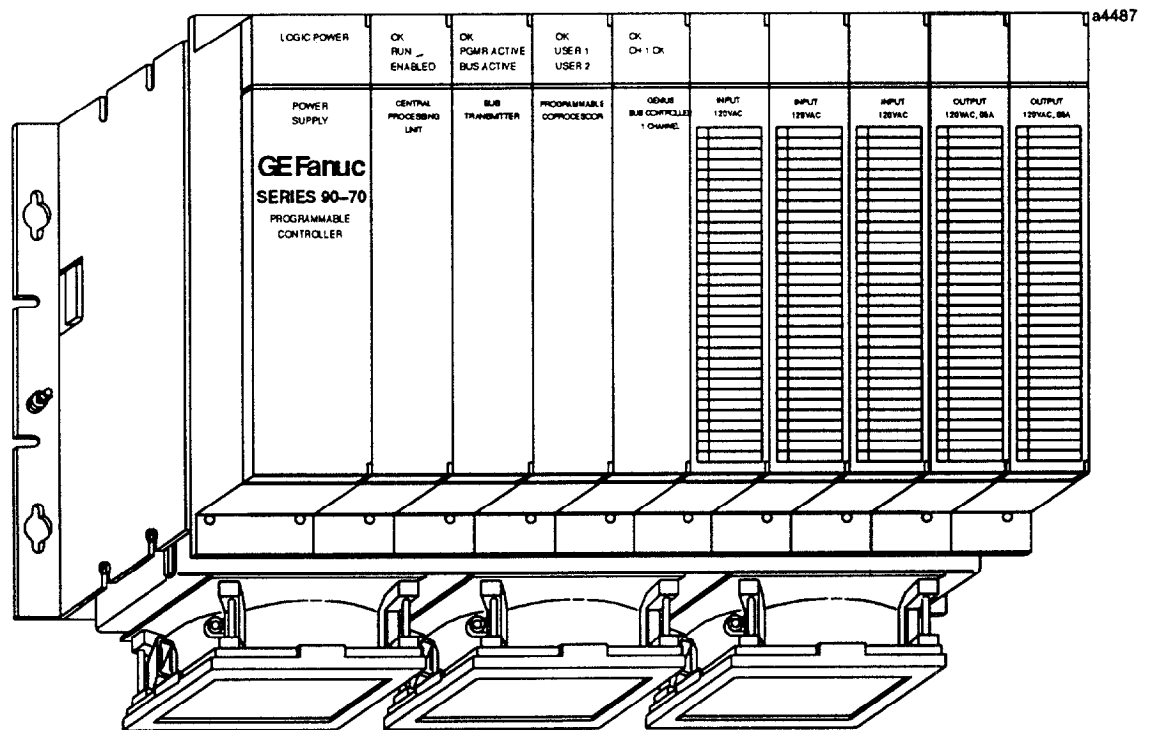


Figure 2-13. Fan Assembly Mounted in Rack

The three fans on the fan assembly are wired in parallel. The fan on the left (looking at front of rack) has a three foot cable to be wired to the 120 or 240 VAC power source. The other two fans are connected through a cable/connector assembly to this fan. It is recommended that the fans be wired to the same source of power as the Series 90-70 PLC so that the fans are energized regardless of whether or not the PLC is energized. This will ensure that the fans are running when the PLC is active.

This fan assembly is currently compatible with Series 90-70 racks having the following catalog number:

- IC697CHS790D, or later versions
- IC697CHS791D, or later versions
- IC697CHS782, or later versions
- IC697CHS783, or later versions

Blank Slot Interrupt Jumper

The Blank Slot Interrupt Jumper, catalog number IC697ACC722 (6 per pack), is an accessory which has been designed to allow you to reserve a slot in the Series 90-70 rack for future expansion. The Blank Slot Interrupt jumper consists of a single connector which is mounted on a board that

easily connects to the backplane connector in the selected slot.

This jumper, when installed in a blank slot, allows for continuation of the interrupt signal through the backplane. Use of this board is required when there are modules installed to its right which may interrupt the CPU.

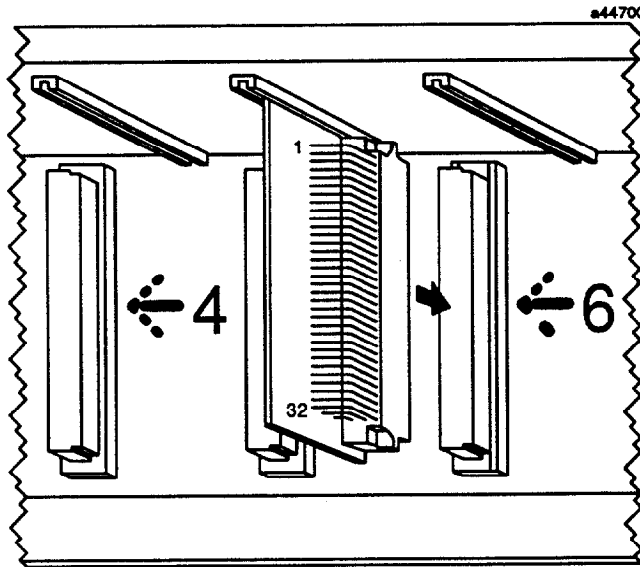


Figure 2-14. Installation of Blank Slot Interrupt jumper

The Blank Slot Interrupt jumper, when installed, must be added to the system configuration using the Logicmaster 90 Configuration Software. For more information, refer to GFK-0262, the Series 90-70 Installation Manual.

Module Load Capacity

The following table shows the DC load required by each module. When specifying a power supply, both the individual and the maximum power ratings for all output voltages must be considered. The maximum power rating of the 11 amp AC power

supply is 55 watts across all voltages. The maximum power rating of the 18 amp AC power supply is 100 watts. Maximum power rating of the 16.5 amp DC supply is 90 watts, and the 12 amp DC supply is 60 watts. All ratings in the table are given in amperes.

Table 2-4. Module Load Capacity (in amps)

Catalog Number	Module	+5 VDC	+12 VDC	-12 VDC
IC697CPU731/732	CPU 731/732	1.0		
IC697CPU771/772	CPU 771/772, with Expansion memory (all sizes)	1.2		
IC697CPU781/782	CPU 781/782, with Expansion Memory (all sizes)	1.6		
IC697CPU788/789	CPU 788/789, with Expansion Memory (all sizes)	1.6		
IC697CPU914	CPU914	2.6		
IC697BEM711	Bus Receiver	0.8		
IC697BEM713	Bus Transmitter	1.4		
IC697BEM721	I/O Link Interface (each optical adapter)	1.0 0.2		
IC697BEM731	Genius Bus Controller	1.3		
IC697BEM733	Remote I/O Scanner	0.8		
IC697PCM711	Programmable Coprocessor Module	1.0		
IC697CMM711	Communications Coprocessor Module	0.7		
IC697CMM721 †	Carrierband MAP Interface	1.0	.10	.15
IC697CMM731 †	Broadband MAP Interface	1.7	.60	.30
IC697CMM741 †	MMS-Ethernet Controller	1.2	.50	
IC697ADC701	Alphanumeric Display Coprocessor	1.0		
IC697GDC701	Graphics Display Coprocessor	1.2		
IC697MDL240	120 VAC Isolated, Input, 16 points	0.25		
IC697MDL241	240 VAC Isolated, Input, 16 points	0.25		
IC697MDL250	120 VAC Input, 32 points	0.35		
IC697MDL251	120 VAC Input, 16 points	0.35		
IC697MDL252	12 VAC, 32 points	0.3		
IC697MDL253	24 VAC, 32 points	0.3		
IC697MDL254	48 VAC, 32 points	0.3		
IC697MDL640	125 VDC Positive/Negative Logic, 16 points	0.3		
IC697MDL650	24 VDC Input, 32 points	0.3		
IC697MDL651	TTL, Negative Logic Input, 32 points	.53		
IC697MDL652	12 VDC Positive/Negative Logic Input, 32 points	0.30		
IC697MDL653	24 VDC Positive/Negative Logic Input, 32 points	0.30		
IC697MDL654	48 VDC Positive/Negative Logic Input, 32 points	0.30		
IC697MDL340	120 VAC Output, 16 points	0.25		
IC697MDL341	120/240 VAC Isolated 2A Output, 16 points	0.25		

Table 2-4. Module Load Capacity (in amps)- continued

Catalog Number	Module	+5 VDC	+12 VDC	
IC697MDL350	120 VAC Output, 32 points	0.5		
IC697MDL740	24/48 VDC Output, 16 points	0.25		
IC697MDL750	24/48 VDC Output, 16 points	0.15		
IC697MDL752	12 VDC 0.5A Output, 32 points	0.25		
IC697MDL753	5/48 VDC 0.5A Negative Logic Output, 32 points	0.25		
IC697MDL940	Relay Output, 16 points	0.75		
IC697ALG230	Analog Input Base Converter	0.80		
AD697SLP711	State Logic Processor	1.0		
IC697ALG440	Analog Input Current Expander	0.40		
IC697ALG441	Analog Input Voltage Expander	0.40		
IC697ALG320	High Level Analog Output, Voltage/Current	1.66		

† These modules require ± 12 VDC: use the 100 watt (IC697PWR711), 90 watt (IC697PWR721, or 60 watt (IC697PWR731) power supply for correct operation.

Power Supplied to Two Racks

Most Series 90-70 PLC power supplies can provide power for one or two racks (depending upon total rack power requirements). Connection from the rack with the power supply to the second rack is made through a two-rack cable IC697CBL700) three feet (one meter) in length. This configuration is cost effective since only one power supply is needed for two racks.

Note

The 125 VDC input power supply (IC697PWR732) can only be used to power one rack.

A single power supply can provide power for two racks under the following conditions:

- Only the 5 VDC power is required in the second rack, and the total power required by both racks must be within the capability of the power supply.
- The total current drawn by all modules in the second rack is less than 5.2 amperes.
- The two racks must be mounted in close proximity as limited by the three foot cable described above.

The dual rack configuration is shown in the following figure.

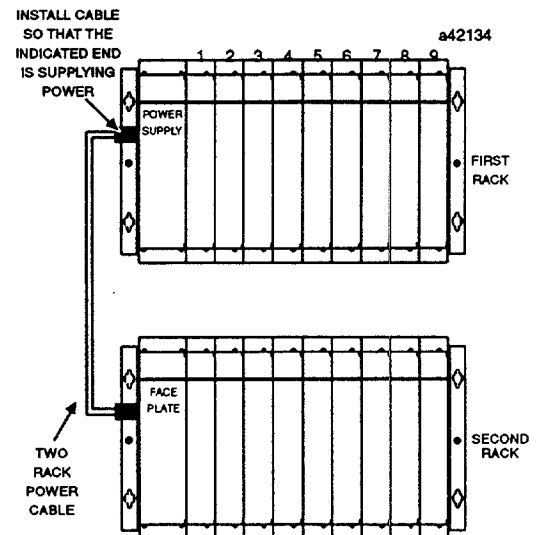


Figure 2-15. Two Racks Sharing One Power Supply

Central Processing Unit (CPU)

As previously described, the CPU for the Series 90-70 PLC is available in nine versions; Models 731, 732, 771, 772, 781, 782, 788, 789, and 914. The Series 90-70 PLC CPU contains an 80186, 80386, or 80486 microprocessor (see Table 2-1) as the main processing element, on board memory (fixed configuration or expansion memory board depending on model), a dedicated VLSI processor for performing boolean operations and interfaces to a serial port and the system bus.

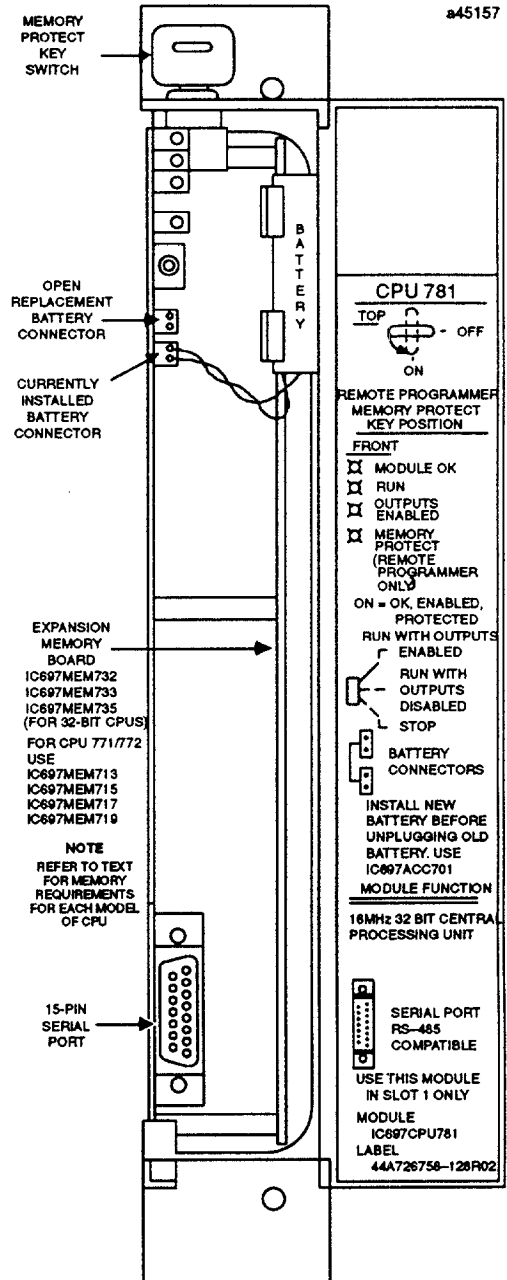
The CPU914 with an 80486 microprocessor offers an exceptionally fast processing speed of 32 MHz. *The CPU914 will be available in mid-1993 (for availability, consult your local GE Fanuc PLC distributor, or GE Fanuc sales office).*

The microprocessor provides all fundamental sweep and operation control, plus execution of non-boolean functions. Boolean functions are handled by a dedicated, VLSI Boolean Coprocessor (BCP) designed by GE Fanuc.

Additionally, CPU models 732, 772, 782, and 914 have an 80X87 Floating Point Math Coprocessor which gives those models the ability to perform floating point math calculations.

Watchdog Timer

The CPU provides a watchdog timer to detect certain failure conditions. The value of this timer is software selectable by the user. The valid range of the watchdog timer is 10 milliseconds to 2550 milliseconds with the default value being 200 milliseconds. The watchdog timer resets at the beginning of each sweep.



Note that CPU models 731 and 732 have a fixed memory configuration and do not require an expansion memory board

Figure 2-16. Common Features of Series 90-70 CPU's

CPU Features

The CPU selected as the logic processor for the Series 90-70 PLC must always reside in Slot 1 in the main rack, which is usually referred to as the CPU rack. An example of the CPU for the Series 90-70 PLC is shown in the Figure 20.

CPU Mode Switch

A three-position toggle switch, accessed from the front, is vertically mounted at the top of the CPU board. This switch selects one of three operating modes for the CPU: either *RUN WITH OUTPUTS ENABLED*, *RUN WITH OUTPUTS DISABLED*, or *STOP*. The top position of the switch is Run with Outputs Enabled. With the switch in this position, the CPU executes all portions of the sweep normally.

The middle position is Run with Outputs Disabled. When the switch is in this position, the CPU executes all portions of the sweep normally, but outputs are held in their default state, and therefore remain unchanged. The bottom position is STOP. With the switch in this position, the CPU only communicates with the programmer and other devices, recovers faulted modules, and outputs are disabled.

Memory Protect Keyswitch

For the added security of memory protection, the CPU models 781, 782, 788, 789, and 914 have a remote programmer memory protect keyswitch on the module. This keyswitch allows you to manually lock program and configuration data. When the keyswitch is in the "protected" position, program and configuration data can only be changed by a programmer connected parallel (via the Bus transmitter Module).

CPU Status LEDs

There are three (four for CPUs with the Memory Protect keyswitch) LEDs mounted at the top of the board which indicate the current state of the CPU. The LEDs are ON when the CPU is running. They are OFF or flashing to indicate special or failure conditions.

The top LED (OK) is an indicator of the health of the CPU and is ON when the CPU is functioning properly. This LED flashes when the CPU executes the power-up diagnostics and when the system has failed; however, when in this state, the CPU can still communicate with the programmer. The LED is OFF when the system has failed and the CPU cannot communicate with the programmer.

The middle LED (RUN) is an indicator of the RUN/STOP status of the CPU. It is ON when the CPU is in the RUN/ENABLE or RUN/DISABLE mode. When the CPU is in the STOP mode, the LED is OFF. The bottom (or third) LED (ENABLED) indicates the state of the outputs. This LED is ON when outputs are enabled, and OFF when outputs are disabled. The fourth LED on CPUs with the Memory Protect keyswitch is ON if the keyswitch is in the "protected" or "ON" position; OFF when the keyswitch is in the memory protect "OFF" position.

Battery Connectors

The Lithium battery, catalog number IC697ACC701, that backs up the CMOS memory has a cable wired to it with a connector that plugs into one of two identical battery connectors on the board. This scheme allows the battery to be replaced, if required, without the need to power-down the system. The battery being replaced is not disconnected until the new battery is connected, which minimizes the possibility of losing data.

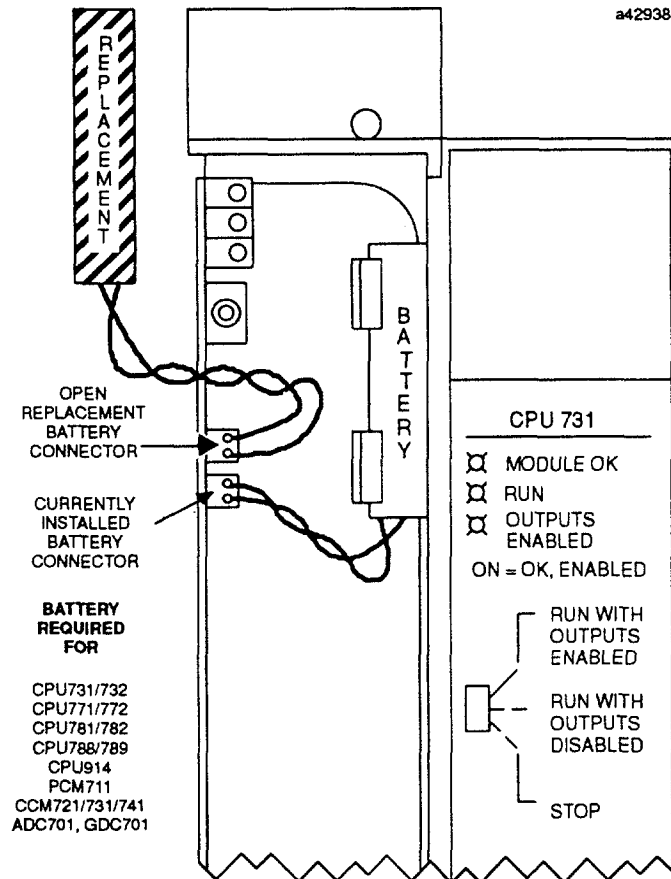


Figure 2-17. Location of CMOS Memory Backup Battery

Serial Port Connector

The 9-pin D-connector at the bottom of the module provides the connection to an RS-485 serial port. This port is compatible with the RS485 interface specification. This port provides a connection through an RS-485 to RS-232 converter to the standard serial COM port on the serial device, or to a 25-pin connector on the programmer's Work Station Interface board. The Work Station Interface is physically installed in the programmer (an IBM computer); the connector is located on the rear of the Work Station Interface board.

Logic Memory for Series 90-70 PLCs

The type of logic memory in the Series 90-70 PLC is CMOS RAM. CMOS RAM is an acronym commonly used for Complementary Metal-Oxide Semiconductor, Random Access Memory. CMOS RAM is a

fast, highly reliable, low power memory that can easily be examined (read) and changed (written to). However, CMOS RAM memory is volatile, which means that it can lose its content if power is removed.

To retain the contents of CMOS RAM memory under no-power conditions, a back-up battery is provided in the form of a lithium battery.

Because of the low power drain of Series 90-70 PLC memory devices, a lithium battery can maintain the contents of memory without application of another power source for approximately 6 months. The storage, or shelf life, of a new lithium battery is typically 8 to 10 years.

The Model 731 and 732 CPUs have 32K bytes of on-board memory available for application program and register data storage. The total user memory size for the Model 771, 772, 781, and 782 CPUs can be custom-

ized to suit the requirements of your application and is determined by selection of an expansion memory board which is installed on the main CPU board. The Model 914 CPU comes with a 512K Byte memory board installed on the module.

CMOS Expansion Memory Boards

Storage of user developed programs and register data on the Model 771 and 772 CPU requires a memory expansion board which mounts on the main CPU board. The memory expansion board has battery-backed CMOS RAM memory devices for program storage.

These same boards can also be used with the Programmable Coprocessor Module for memory expansion. Four versions of this memory expansion board are available.

Table 2-5. Expansion Memory Boards, CPU Models 771/772 and PCM

Catalog Number	Memory Size
IC697MEM713	64K Bytes
IC697MEM715	128KBytes
IC697MEM717	256K Bytes
IC697MEM719	512K Bytes

The CPU Models 781 and 782, 788, 789, and 914 use a different expansion memory board. These expansion memory boards are arranged in a 32-bit memory configuration and can only be used on the CPUs models listed above.

These memory boards are not compatible with the model 771 and 772 CPUs or the PCM. Three versions of the 32-bit memory expansion board are available.

Table 2-6. 32-Bit Expansion Memory Boards

Catalog Number	Memory Size
IC697MEM732 (1)	256K Bytes with 256K Bytes non-volatile flash memory.
IC697MEM733 (2)	256KBytes
IC697MEM735 (2) (3)	512K Bytes

(1) For CPU781, 782

(2) For CPU788, 789

(3) Factory installed on CPU914

The expansion memory boards are easily installed on the CPU or PCM module by mounting them on a connector provided for that purpose. Memory on the boards is backed-up by the Lithium battery mounted on the CPU faceplate.

Bus Transmitter Module

The Bus Transmitter Module (BTM), catalog number IC697BEM713, when included in a system must reside in the CPU rack in slot 2. This module is the link from the CPU rack to expansion racks if more than one rack is required in the Series 90-70 PLC system. The BTM is a high speed parallel interface that propagates the I/O bus signals to a Bus Receiver Module in the first I/O expansion rack. The BTM also provides a high speed parallel connection to the programmer.

BTM Status Indicators

There are three LED status indicators on the BTM. The top LED, labeled OK, indicates that the CPU has completed its power-up configuration of the BTM and has polled each system expansion rack. The middle LED, labeled PGMR ACTIVE, provides an indication that the PLC and the attached programmer are communicating. The bottom LED, labeled BUS ACTIVE, provides an indication of the communications status of the expansion bus.

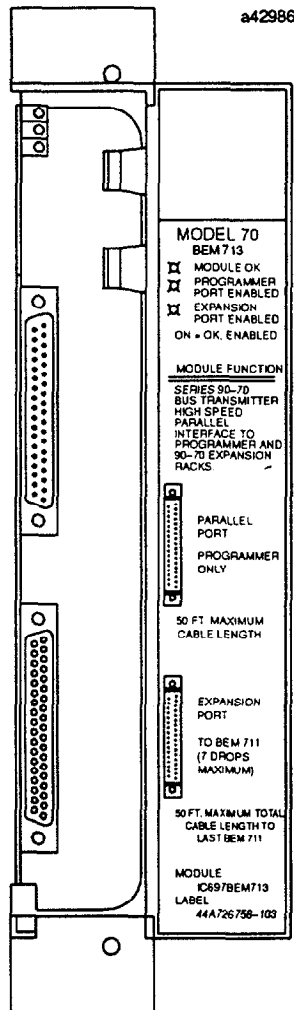


Figure 2-18. Bus Transmitter Module

Bus Transmitter Module Connectors

There are two connectors on the front of the BTM. The top one connects to a Work Station Interface (WSI) board installed in the programmer (an IBM Personal Computer or compatible computer) for the Series 90-70 PLC. This connection is made through a programmer cable having a maximum length of 50 feet (15 meters). This cable (catalog number IC600WD005A) is wired the same as the cable used to connect the BTM's lower connector to a Bus Receiver Module in the first expansion rack.

However, the programmer cable is different from the I/O cable in that the exit direction from the connector hood at the WSI end is from the side rather than the end. These

cables may be interchanged in an emergency, but the specified programmer cable is preferred. Both BTM connectors are D-Type sub-miniature connectors and have 37-pins. The top one is a male connector, while the lower one is a female connector.

Bus Receiver Module

The Bus Receiver Module (BRM), catalog number IC697BEM711, must be installed in slot 1 of each expansion rack in a system so that the rack can interface to the I/O Bus. This is the link from the CPU to the I/O Bus for I/O modules installed in an expansion rack.

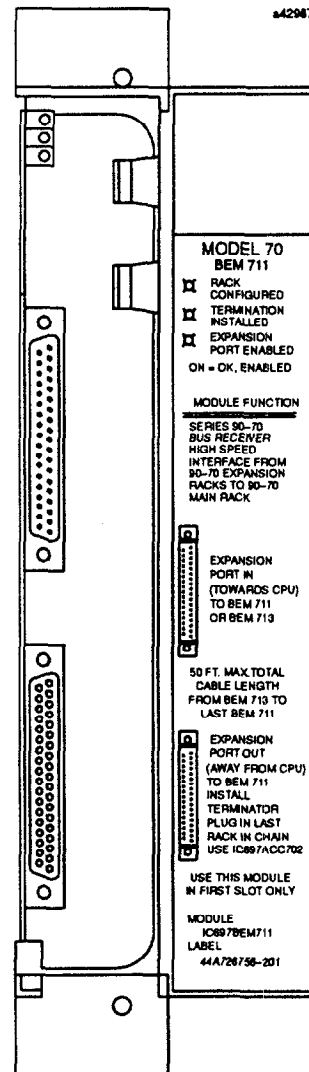


Figure 2-19. Bus Receiver Module

The BRM in the first expansion rack connects to the BTM in the CPU rack through a parallel I/O Bus cable. This cable is connected to the bottom connector on the BTM, and to the top connector on the BRM. The next rack to be included in the I/O Bus chain is connected to the lower connector on the BRM in the first expansion rack and the top connector of the BRM in the next rack.

Connection of the I/O expansion racks in this daisy-chain fashion continues until the required number or a maximum of 7 expansion racks is connected. The total cable length of all cables between racks on the I/O Bus cannot exceed 50 feet (15 meters).

The I/O Bus signals are terminated at the end of the bus by installing a resistor pack, located inside of a Terminator plug (catalog number IC697ACC702) on the bottom connector of the BRM module installed in the last I/O expansion rack in the system. Each BRM module has a Terminator plug with it when shipped from the factory.

Bus Receiver Module Status Indicators

There are three LEDs located at the top of the BRM which are labeled: OK, LAST RACK, and BUS ACTIVE. The top LED is the board OK LED, and is ON when the CPU completes its power-up configuration of the expansion rack and at least one module in that rack responds to the CPU requests for information.

The middle LED is the Last Rack LED and is ON when the I/O bus terminator plug is

installed in the bottom connector of this BRM, and is Off when it is not installed. The bottom LED, BUS ACTIVE, is an indicator of the operating status of the expansion bus. This LED is ON when the BRM has detected activity on the expansion bus within the last 500 ms, otherwise it is OFF.

Bus Receiver Module Connectors

The BRM has two connectors mounted on the front of the board. The top connector is for the I/O cable connection to either the lower connector on a BTM in the CPU rack or the lower connector on a previous or upstream BRM. The lower connector is for an I/O cable connection to the upper connector of a BRM in another expansion rack.

The I/O cable is an 18 twisted-pair cable with a ground shield and is the same type as the cable used to connect the Work Station Interface board to the upper connector on the BTM in the CPU rack. The total maximum cable length from the CPU rack to the most distant expansion rack, which must be at the same ground potential as all other racks, is 50 feet. Standard I/O bus cables that meet this specification may be purchased in lengths of 5, 10, 25, and 50 feet.

The following figure shows how the expansion racks are connected through the BTM in the CPU rack to BRMs in the expansion racks in a local expansion system. Note that the total length of the cable between all racks can be no more than 50 feet.

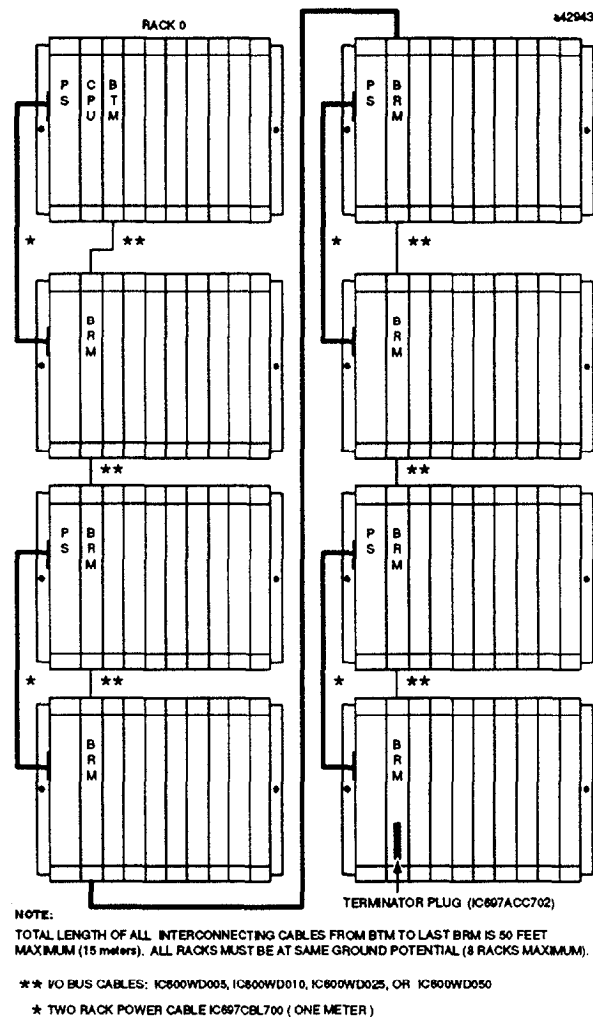


Figure 2-20. Expansion Rack Connections

Genius Bus Controller

The Bus Controller (GBC), catalog number IC697BEM731, for the Series 90-70 PLC interfaces the Series 90-70 PLC to a Genius I/O communications system (refer to Chapter 5 for more information on Genius I/O). This system can be I/O control using Genius I/O blocks, or it can be a Genius Local Area Network. Configuration of the GBC is simple by use of the configurator functions of the LogiCmaster 90 software.

Each Genius I/O bus can have up to 30 Genius I/O blocks connected to it. Any type

of Genius I/O block, as long as it is a phase B block, may be connected to these buses. *Genius dual-bus redundancy* configurations are also supported. This protects against GBC and Genius bus failures by connecting up to 30 blocks to a pair of GBCs and a pair of Genius buses with Bus Switching Modules.

The GBC supports directed communications initiated by a Communication Service Request from the CPU. Faults which are reported by the GBCs are managed by the PLC Alarm Processor Function which time stamps and queues faults in a table.

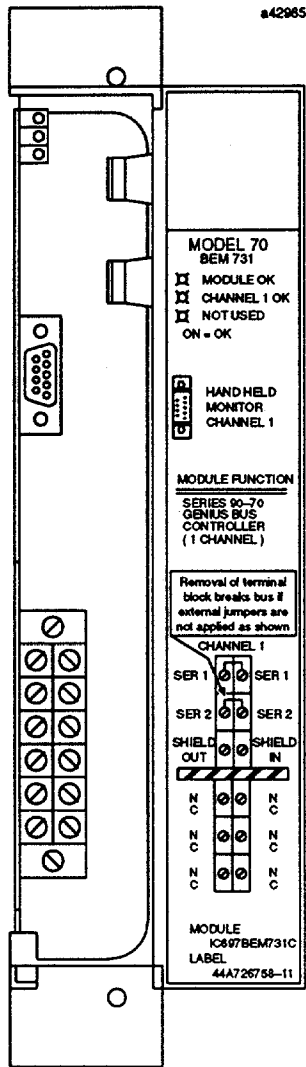


Figure 2-21. Series 90-70 Genius Bus Controller Module

Bus Controller Operation

The GBC contains an 80186 microprocessor as its main processing element, a 6303 microcontroller for communicating with the Genius I/O bus, on board memory, a custom VLSI chip for interfacing to the Genius I/O bus, and an interface to the Genius I/O bus.

The 80186 microprocessor handles all interfacing with the system bus, passing I/O commands and data between the CPU and the 6303 microcontrollers. The GBC thereby removes from the CPU direct manage-

ment of the Genius I/O links. I/O data, background messages and status information move between blocks on the Genius I/O links and the CPU.

As a safety feature, a watchdog timer protects each Genius I/O link. This timer is periodically reset by the Genius Bus Controller software. If it should ever expire, the microcontroller on the board ceases functioning and the Link LED turns off. If this happens the Genius I/O blocks connected on the link will default their outputs to the appropriate predetermined state. The cause of the link failure must be determined to re-establish communications.

GBC Features of Interest to the User

A GBC can be installed in any slot in any rack in the system, except for slot 1 in the CPU rack which is always reserved for the CPU module, or slot 1 in an I/O expansion rack, which is reserved for the Bus Receiver Module. Refer to the illustration of the Genius Bus Controller for the location of the items described in the following text.

GBC Status Indicators

The GBC has three LEDs for status indication. The top LED is an indicator of the health (state) of the board, and the middle LED is an indication that communications is OK on the Genius I/O bus; the bottom LED is not used. When the board is functioning properly, the top two LEDs will be ON. These LEDs are either flashing or OFF to indicate special or failure conditions.

GBC Connectors

A GBC has two connectors for communications with the Genius I/O bus. A dedicated nine-pin connector provides a connection to the Genius I/O Hand-Held Monitor. Bus connections are made through a 12-point removable terminal board. Six of these terminals are used for connection to the Genius I/O bus. A GBC may be located on either end or in the middle of the bus.

The Genius I/O Bus

The Genius I/O bus physically consists of a shielded, twisted pair cable which connects the Genius Bus Controller to up to 31

other devices. These may be Genius I/O Blocks, Hand-Held Monitors, Bus Controllers, or Remote I/O Scanners. An example of a Genius I/O bus is illustrated in the following figure.

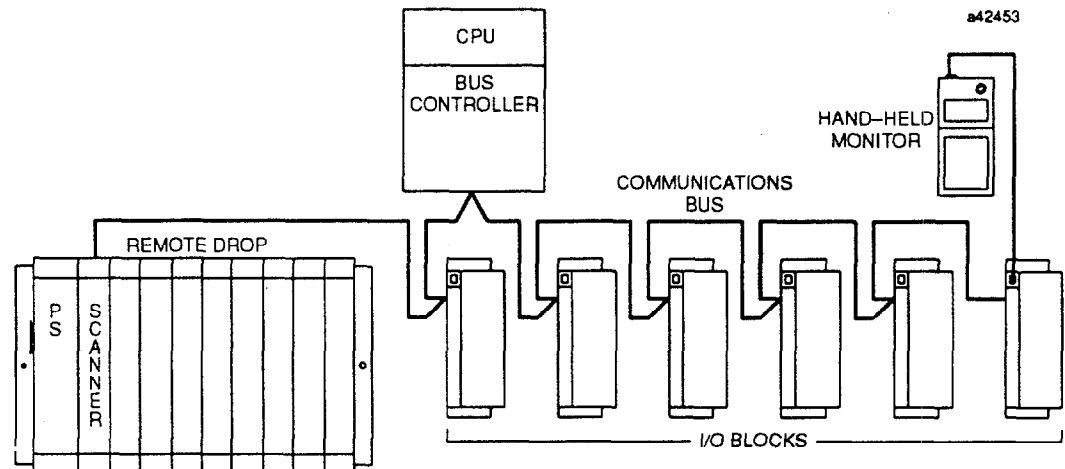


Figure 2-22. Example of Devices on a Genius I/O bus

Remote I/O Scanner

The Remote I/O Scanner, catalog number IC697BEM733, allows Series 90-70 I/O to be distributed on the Genius I/O link at a location remote from the Series 90-70 CPU. This module is installed in a standard 5 or 9 slot Series 90 rack. This subsystem is referred to as a remote rack.

The Remote I/O Scanner operates similar to a Series 90-70 CPU in that it controls all I/O functions within the remote rack it resides in, however it does not perform any logic solution. All I/O data for that rack is communicated to and from the Series 90-70 CPU over the Genius I/O link. The Remote I/O Scanner and the modules it serves make up a remote drop on the Genius bus.

A remote drop can have up to eight racks, linked by Bus Transmitters and Bus Receiver modules. The maximum distance from the first rack to the last rack in a remote drop is 50 feet.

The Remote I/O Scanner can handle any mix of discrete and analog base converter I/O modules with up to 1024 inputs and 1024 outputs, or up to 64 analog input channels

and 64 analog output channels, or any combination that does not exceed a 128 byte input and 128 byte output limit (regardless of the number of racks in a remote drop).

A remote drop can include all currently available discrete modules, analog modules, and analog expander modules. It can also include Bus Transmitter, Bus Receiver, Programmable Coprocessor, Graphics Display Coprocessor, and Alphanumeric Display Coprocessor modules.

A remote drop cannot have any I/O module interrupts, bus controllers, communications modules, or other modules that depend on COMREQ instructions for their operation.

The Remote I/O Scanner also supports both CPU and Genius bus redundancy. For more information on redundancy, refer to the Remote I/O Scanner User's Manual, GFK-0579 (version A or later).

Use of analog expander, PCM, GDC, and ADC modules requires the use of catalog number IC697BEM733B or later of the Remote I/O Scanner module. This version is also required for redundancy installations and in order to have more than one rack in the remote drop.

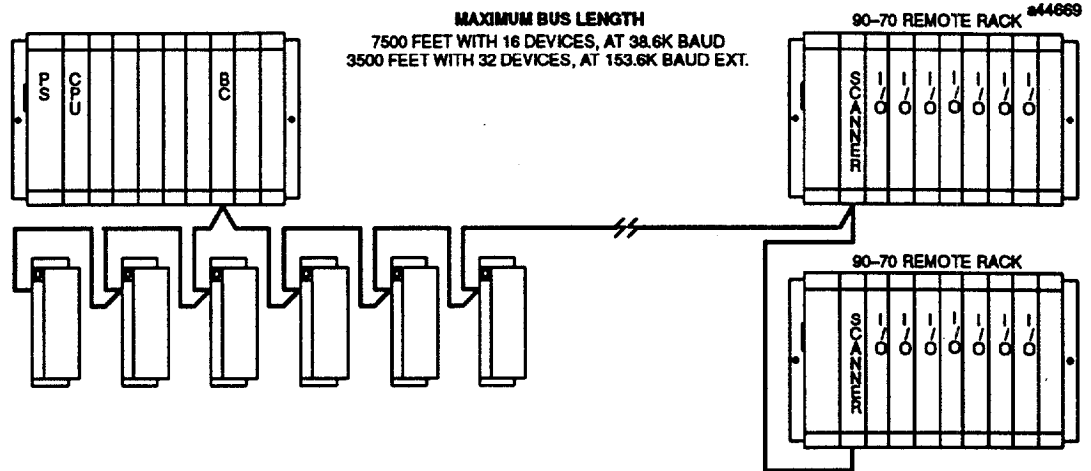


Figure 2-23. Example of Remote I/O Scanner Location on Genius Bus

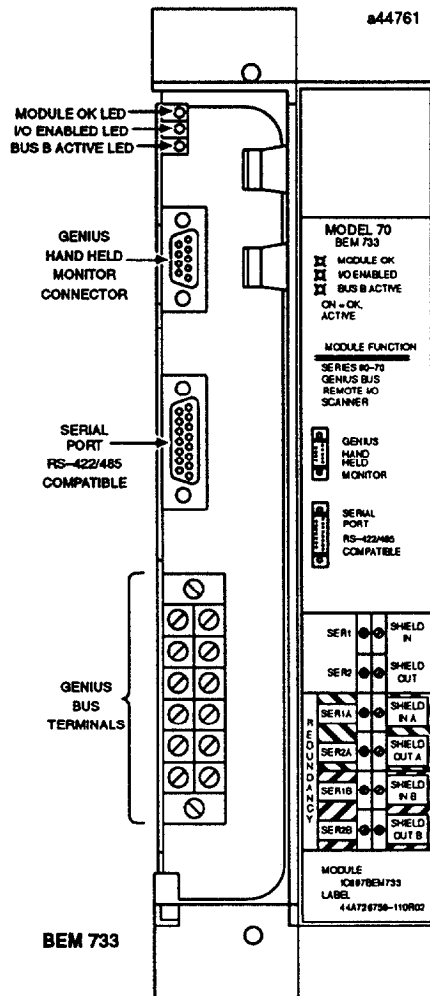


Figure 2-24. Remote I/O Scanner Module

Remote I/O Scanner Operation

The Remote I/O Scanner contains two separate, but closely linked, microprocessor systems. An 80186 microprocessor controls all activity within the remote rack, which includes configuration, programmer communication, and I/O scanning. A 64180 microprocessor along with a custom VLSI device handles all Genius communications. These two microprocessor systems are coupled together through shared memory. All I/O data, as well as diagnostic and system specific data, is passed through this memory.

A 15-pin connector provides an RS-422/RS-485 compatible serial port for connection to a Work Station Interface board installed in the programming computer. A 9-pin connector, located directly below the LEDs, is a dedicated port for attaching a Genius Hand-Held Monitor. The Genius bus is physically connected through a removable terminal board identical to the board on the Genius Bus Controller module.

LED Status Indicators

The Remote I/O Scanner module has three LEDs labeled from top to bottom, OK, I/O ENABLED, and BUS B ACTIVE. The OK LED (Module OK) turns on to indicate that the module has passed its diagnostic tests following power-up. It may also flash to indicate that certain error conditions have occurred.

The I/O ENABLED LED turns on when I/O points in the remote rack are being serviced with data received from the controller. It will turn off if any of the following conditions occur:

- The Genius bus linking the Remote I/O Scanner to the Genius Bus Controller is cut or otherwise seriously disrupted.
- The Series 90-70 PLC is Stopped (in STOP mode), or is configured in a manner that prevents the Genius Bus Controller from servicing the remote rack.
- The Remote I/O Scanner has been placed in STOP mode and has not been returned to RUN mode.

The I/O ENABLED LED may also flash under certain conditions.

The BUS B ACTIVE LED turns on whenever Genius Bus B is active in redundant bus configurations where the Remote I/O Scanner has been configured as the Bus Switching Module Controller. *This feature requires version B, or later, of the Remote I/O Scanner module.* The BUS B ACTIVE LED is off under all other conditions. For detailed information on the Remote I/O Scanner, refer to GFK-0579, the Series 90-70 Remote I/O Scanner User's Manual.

Programmer Connection to CPU The programmer running Logicmaster 90 software can communicate with the Series 90-70 PLC through a Work Station Interface board installed in the programming computer, or it can connect to the CPU from the Standard Series COM Port through an RS-232 to RS-422 converter.

Work Station Interface (WSI)

The programmer can communicate with the Series 90-70 PLC on a high speed parallel link, or on an RS422 compatible serial link through a Work Station Interface (WSI) board.

The WSI board (two versions available) resides in a slot in the computer which executes the programming software, rather than in a PLC slot. This computer can be a

Workmaster, Workmaster II or Cimstar industrial computer, or an IBM PC-XT, PC-AT, PS/2 or compatible Personal Computer. The WSI board is included with Logicmaster 90 software and is installed in the Workmaster II computer at the factory. The following figures show the location of the WSI board in a system.

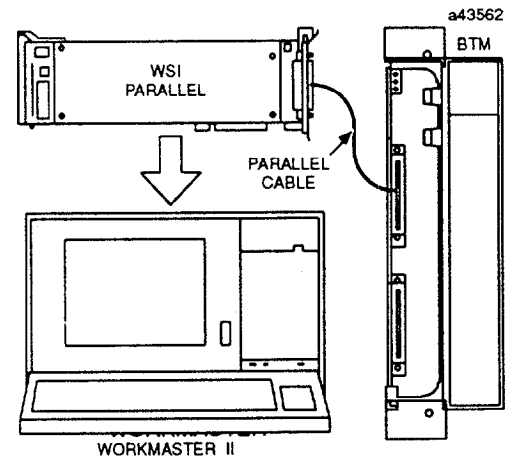


Figure 2-25. Workmaster II to Parallel Work Station Interface

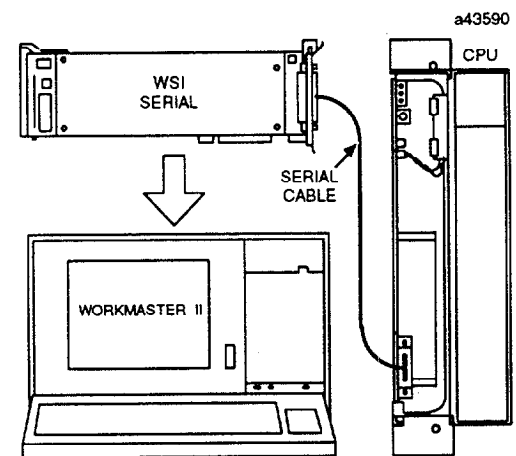


Figure 2-26. Workmaster II to Serial Work Station Interface

The WSI contains an 80188 microprocessor as the main processing element, on-board memory, an interface to the host computer bus, and provides a parallel interface to the CPU. The parallel interface allows the WSI to communicate with the CPU in the same manner as other intelligent Series 90-70 PLC option modules. The WSI operating soft-

ware is downloaded from the programmer when the Logicmaster 90 program is initialized.

The standard serial communications connection will require using the RS-422/RS-485 to RS-232 converter (IC690ACC900), or for those applications using multidrop configurations or requiring isolation - the isolated repeater/converter (IC655CCM590), or the RS-422/RS485 to RS-232 miniconverter (IC690ACC901).

WSI Status Indicators

The WSI board has two LEDs which can be seen only when the computer's cover is partially disassembled. The LED on the WSI main board flashes during the power-up diagnostics. If a board failure is detected by the power-up diagnostics, the LED will turn off and remain off, otherwise it is on. If this condition should occur, it is an indication that the board needs to be replaced. A second LED, located on the daughter board, is normally ON during a communications session and for 500 ms after receiving a message from the CPU; otherwise, it is OFF.

WSI Connectors

There is one 37-pin connector for parallel or serial communications. The connection to the PLC is from this connector, through a parallel I/O cable (catalog number IC647CBL703) to the top connector on the BTM, or through a serial cable (catalog number IC647CBL704) to the serial port connector on the CPU. The parallel I/O cable connection can no more than 50 feet (15 meters).

The serial connection can be configured in a system for multidrop communications up to 4000 feet (1220 meters), and communications to Series 90-30 PLCs as well. An illustration of a typical multidrop configuration can be found at the end of this chapter.

Programmable Coprocessor Module

The Programmable Coprocessor Module (PCM), catalog number IC697PCM711, is a general purpose microcomputer on a single board which enhances the functionality of the Series 90-70 PLC.

The PCM has two serial ports, each with its own port connector, for interfacing to serial RS232/485 devices. It supports the GE Fanuc CCM communications protocol, the Mega-Basic programming language, and is programmed using a Workmaster, Workmaster II or Cimstar industrial computer, or an IBM or compatible Personal Computer.

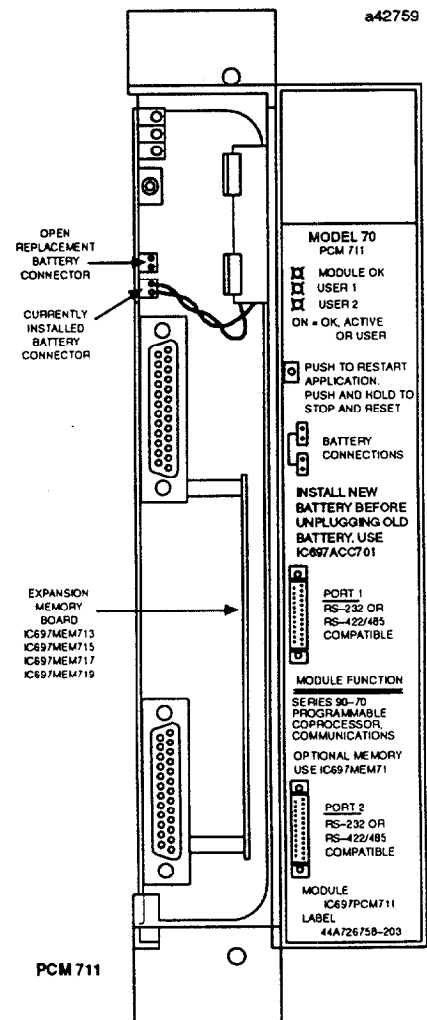


Figure 2-27. Programmable Coprocessor Module

The PCM has 128K bytes of on-board CMOS battery-backed user memory which may be expanded up to 640K bytes by installing an available memory expansion board on the PCM. These are the same memory expansion boards available for use with the CPU models 771 and 772. Even with fully expanded memory the PCM still requires only one slot in a rack. The mode of operation is selected by a combination of PCM software configuration and user wiring.

PCM Architecture

The (PCM) board contains an 80186 microprocessor as its main processing element, on-board memory, an interface to the system bus and the serial ports, and a watchdog timer. The 80186 microprocessor handles all processing and operation control on the board. The 72001 Advance Multi-Purpose Serial Controller controls the interface to the serial ports. The PCM has 128K bytes battery backed RAM Memory, and up to 512K bytes battery backed expansion RAMs.

An application program is not required in the PLC CPU to use the PCM. The PCM can be installed in any I/O slot in any rack in the system (installation in a remote drop requires version B, or later, of the Remote I/O Scanner module).

Dual Tasking Capability

Since up to 63 PCMs can be supported by a single Series 90-70 PLC system, up to 63 separate 80186-based coprocessors can be assigned by the user to computing, filing, and communications tasks. This architecture frees the CPU for more critical real time tasks. For example, as a file server, several PCMs each with a file of up to 512K bytes may divide the task of file lookup.

In addition, the two serial ports on each of the PCM's could then be used for other functions, such as a bar code reader interface, at the same time the PCM is performing a file server function. The PCM can

run two simultaneous CCM tasks or one MegaBasic and one CCM task.

PCM Status Indicators

Three LEDs, labeled MODULE OK, USER1, and USER2, are visible through the clear plastic lens at the top of the module. The top LED, MODULE OK, is an indicator of the current status of the module. This LED is ON when the module has successfully completed it's power-up diagnostics, configuration data for the module is good, and the module is functioning normally.

The LED is off when a module malfunction has been detected during the power-up diagnostics, or the module has failed during operation. A blinking LED indicates that the configuration data downloaded from the programmer to the PLC does not match current configuration data stored in the PCM module.

The function of the middle and bottom LEDs can be assigned by the user through programming. Typically, they are used to indicate activity on the serial ports and can be defined to display any combination of the following serial port status:

- Transmit on serial port 1
- Receive on serial port 1
- Transmit on serial port 2
- Receive on serial port 2
- Transmit on backplane
- Receive on backplane
- Application task defined

Restart/Reset Pushbutton

A Restart/Reset pushbutton is located below the USER2 LED. This pushbutton is used in conjunction with the PCM OK LED to reinitialize the PCM module, by initiating a hard or soft reset. A *hard reset* is initiated if the pushbutton is depressed continuously for 5 seconds or more. The PCM will perform a reset operation and reinitialize to the factory default configuration. All user tasks and CCM tasks will be stopped.

A *soft reset* is initiated if the pushbutton is depressed for less than 5 seconds. The PCM

will be reinitialized from the user's configuration data, any active I/O and timer requests will be cancelled, and a power cycle will also attempt to restart the software in the user configuration mode.

PCM Serial Port Connectors

Two serial port connectors provide connec-

tions to the PCM's serial interfaces. Access to these connectors is provided by opening the hinged door on the module. These ports are identified as PORT 1 and PORT 2; both ports support RS-232 and RS-485 modes which are configurable through user programming.

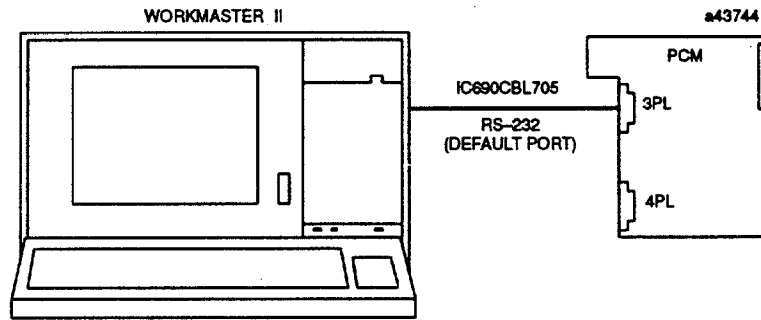


Figure 2-28. PCM to Workmaster II or PS/2 Computer

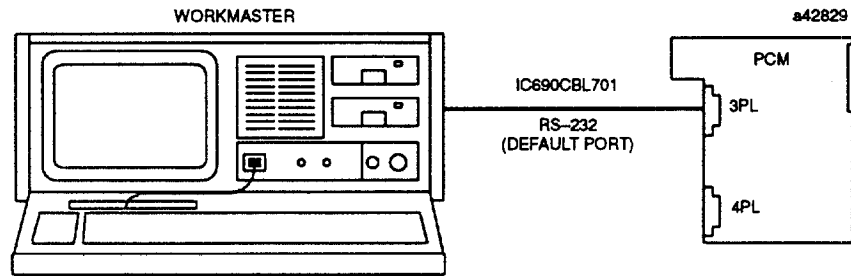


Figure 2-29. PCM to Workmaster or PC-XT Computer

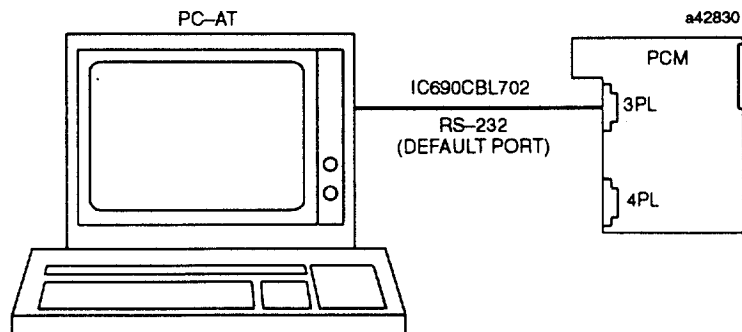


Figure 2-30. PCM to PC-AT Computer

Although either port can be used for most purposes, certain operations require a specific port to be used. Port 1 can be used in

higher performance applications since it supports DMA (Direct Memory Access) transfers. Port 1 is used for connecting the

programming device with PCM Programming and Configuration software.

Three prewired cables are available to connect the PCM to the programming device. Examples of programmer to PCM connections are shown in Figures 2-28, 2-29, and 2-30.

perform CIMPLICITY 90 display, report, and alarm functions through an Operator Interface Terminal, which can be a GE Fanuc OIT or Mini OIT, a VT100 compatible terminal, or a Workmaster II, or IBM compatible personal computer running TERME.

PCM Backup Battery Connectors

Two identical battery connectors are on the board for connection to the lithium backup battery for on-board and expansion board CMOS RAM memory. Two connectors are provided as a convenience in the event that the battery requires replacement.

The battery currently installed can remain connected until the new battery is connected to the unused connector. The connector wired to the lithium backup battery cable plugs into one of the connectors. The battery can be replaced with the rack powered-on.

PCM Option Connector

An option connector, located at the bottom of the PCM board, allows installation of additional user expansion memory. A memory expansion board may be added to the PCM board (required for MegaBasic programs). These memory expansion boards are the same boards that can be installed on the Model 771 or 772 CPU to increase its total on-board memory capacity.

Four memory expansion boards are available: 64, 128K, 256K, or 512K Bytes (see Table 2-4). The memory expansion board mounts on a single connector on the PCM.

Alphanumeric Display Coprocessor Module

The Alphanumeric Display Coprocessor (ADC) Module, catalog number IC697ADC701, is a coprocessor to the Series 90-70 PLC CPU and is used in a CIMPLICITY 90-ADS system. It is programmed to

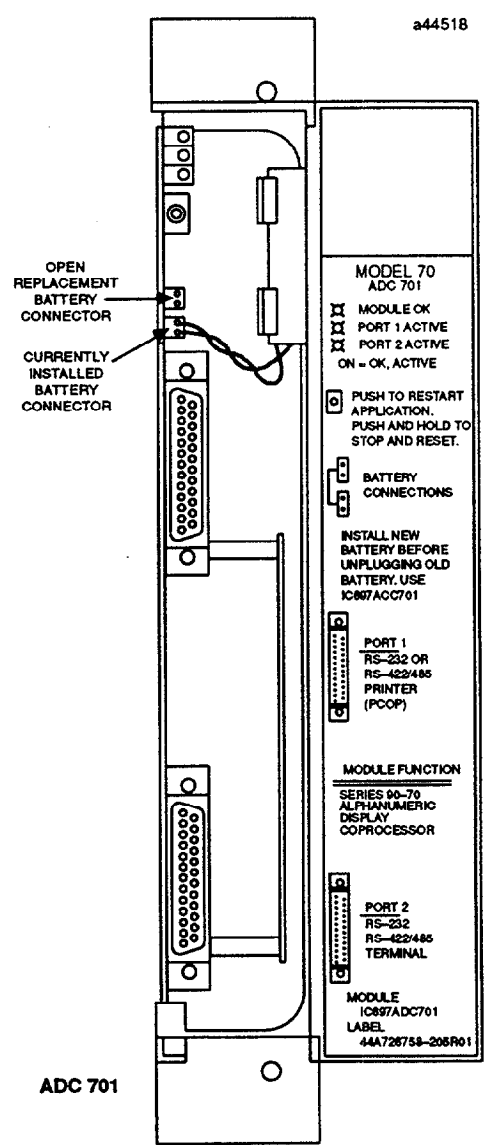


Figure 2-31. Alphanumeric Display Coprocessor Module

The ADC communicates with the Series 90-70 CPU over the system backplane. Multiple Alphanumeric Display Coprocessors can be supported in a single Series 90-70 PLC system and can be located in either the main rack or expansion racks. It can be used in a remote drop when version B, or later, of the Remote I/O Scanner module is present.

ADC Programming and Configuration

A Workmaster II, Workmaster, or an IBM-compatible PC, XT, AT, or PS/2 computer with PCM Development Software (PCOP) installed connects to the top port. The default setting is 19,200 bps. The PCM Development Software is used to configure the serial port parameters and to install the CIMPLICITY 90 software onto the ADC. Refer to the the CIMPLICITY 90-ADS User's Manual, GFK-0499, for details of operation.

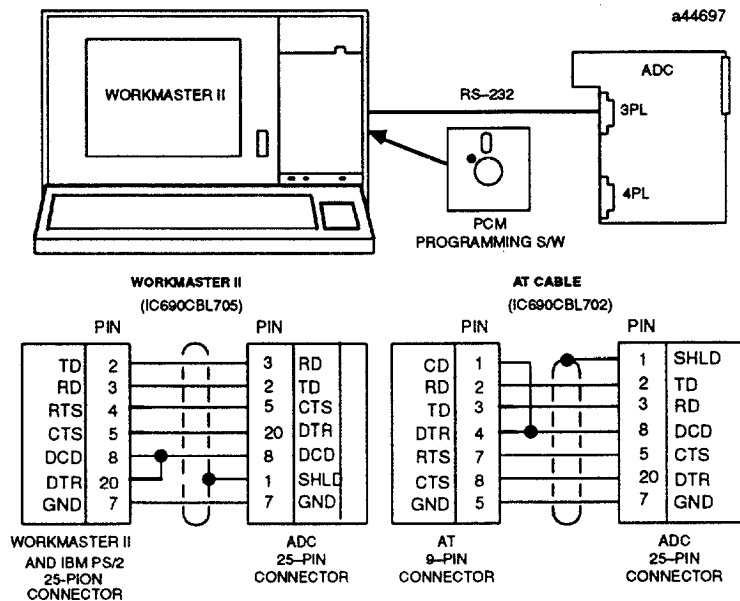


Figure 2-32. Example of PCM Development System Connection to ADC

Graphics Display Coprocessor

The Graphics Display Coprocessor (GDC) Module, catalog number IC697GDC701, is a coprocessor to the Series 90-70 PLC CPU. It is programmed to perform CIMPLICITY-70 display functions when coupled with the CIMPLICITY System 3000 Graphics Display Terminal (GDT).

The GDC communicates with the Series 90-70 CPU over the system backplane. Many Graphics Display Coprocessors can be supported in a single Series 90-70 PLC system and can be located in either the main rack, expansion racks, or in a remote drop when version B, or later, of the Remote I/O Scanner module is present.

GDC Programming and Configuration

A Workmaster II, Workmaster, or an IBM-compatible PC, XT, AT, or PS/2 computer with PCM Development Software (PCOP) installed connects to the top port as shown below. The default setting is 19,200 bps. PCM Development Software is used to configure serial port parameters and to install the CIMPLICITY-70 software onto the GDC. Refer to the the CIMPLICITY-70 Graphics Display System User's Manual, GFK-0534, for details of operation.

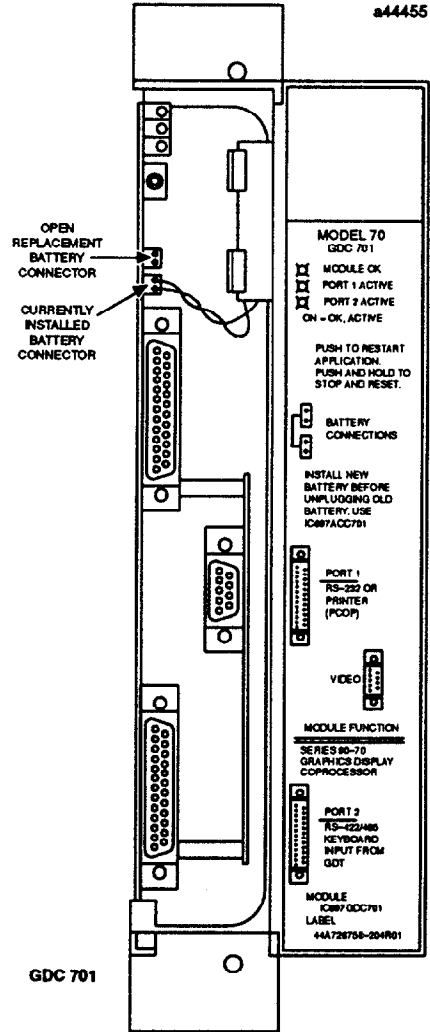


Figure 2-33. Graphics Display Coprocessor Module

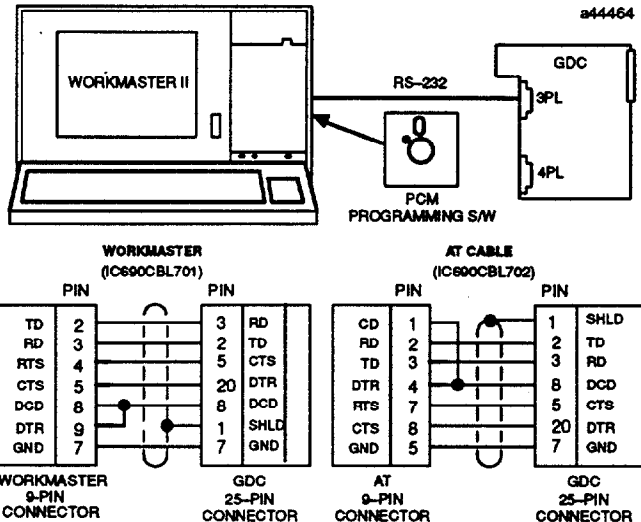


Figure 2-34. Example of PCM Development System Connection to GDC

Carrierband MAP Interface Module

The Carrierband MAP Interface module, catalog number IC697CMM721, is a member of the family of GENet Factory LAN hardware and software products. The GENet family of products provides high performance solutions for interconnecting automation controllers and for integrating them into multi-vendor networks. The Series 90-70 LAN Interface module provides direct connection for a Series 90-70 PLC to an IEEE 802.4 carrierband network.

The GENet Factory LAN architecture is

based on standards set forth in the Manufacturing Automation Protocol (MAP) specification. MAP is the single networking scheme that allows all the vendors involved in automating a factory to work on a common communications architecture.

The Carrierband MAP Interface module supports the MAP specification version 3.0. The MAP protocol software is loaded into Random Access Memory on the LAN Interface module. This allows easy upgrade to a new revision of software without modification to the hardware.

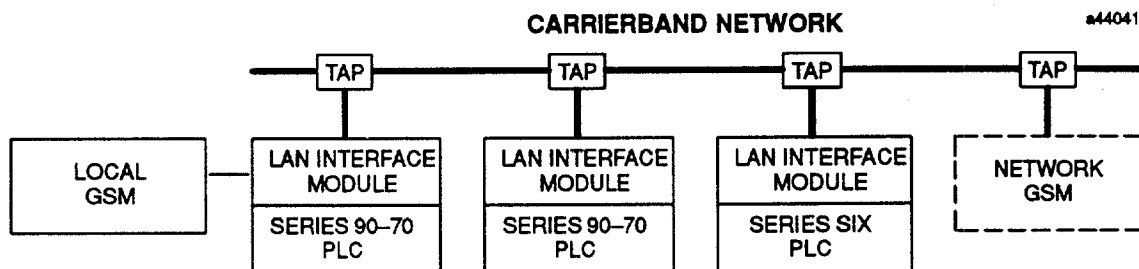


Figure 2-35. LAN Interface Module Connects Series 90-70 PLCs to a Carrierband Network

Features of the Carrierband MAP Interface

The features of the GENet Factory LAN Interface module are described briefly here. For a more complete description, see the appropriate section in the *GENet Factory LAN Series 90-70 PLC Network Interface User's Manual*, GFK-0418.

The Carrierband MAP Interface is a single-slot module composed of a factory-assembled digital controller and modem. The entire LAN Interface occupies only a single slot in the Series 90-70 PLC rack. The following figure illustrates the LAN Interface module as part of the network.

The Carrierband MAP Interface connects the PLC directly to the carrierband network through the 5 Mbps modem daughterboard

on the module. Intermediate devices such as bridges or gateways are not required. The direct connection provides the high performance required for real-time control applications.

Communications software is downloaded to the LAN Interface and stored in RAM memory. This makes it easy to upgrade the communications software simply by downloading it again rather than by physical replacement of ROM-chips. An on-board battery provides memory retention that prevents loss of the communication software due to power loss for at least six months.

Features of the Carrierband MAP Interface Module are illustrated in the following figure.

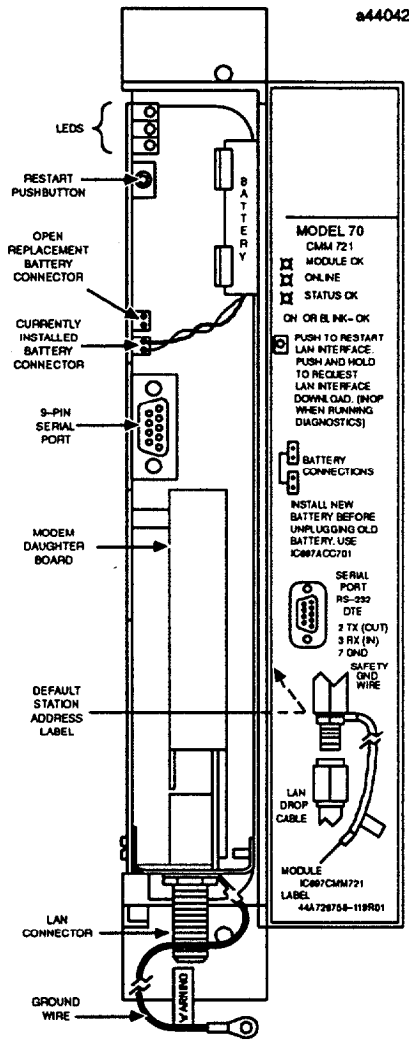


Figure 2-36. Carrierband MAP Interface Module

The LAN Interface provides many built-in maintenance and diagnostic features. Three diagnostic LED's distinguish faults between the module, the network, and module states that require maintenance action.

Default station address permits requesting and accepting a download of software from a centralized management station elsewhere on the LAN. Software switches permit the LAN Interface to operate independently of the PLC application software to facilitate early system checkout.

Note

The LAN Interface modules require that the Series 90-70 PLC rack provide +12 VDC and -12 VDC power. They must be installed in a rack that is powered by the 100 watt AC (IC697PWR711), the 90 watt DC (IC693PWR721), or the 60 watt DC (IC697PWR731) power supply.

Broadband MAP Interface Module

The Broadband MAP Interface module, catalog number IC697CMM731, provides direct connection for a Series 90-70 Programmable Logic Controller (PLC) to an IEEE 802.4 Broadband network.

The GENet Factory LAN architecture is based on standards set forth in the Manufacturing Automation Protocol (MAP) specification. MAP is the single networking scheme that allows all the vendors involved in automating a factory to work on a common communications architecture.

The Series 90-70 LAN Interface module supports the MAP specification version 3.0. The MAP protocol software is loaded into Random Access Memory on the LAN Interface module. This allows upgrade to a new revision of software without modification to the hardware. The following figure illustrates the LAN Interface module as part of the network.

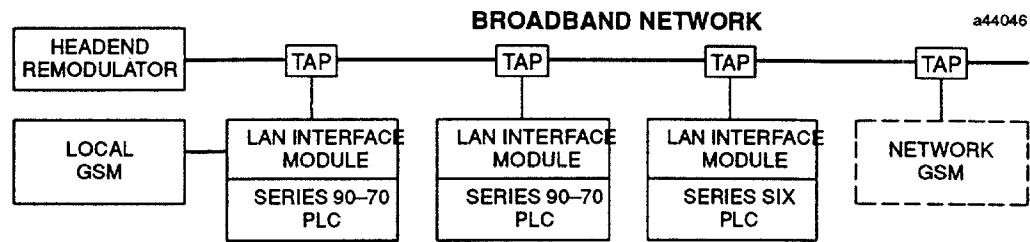


Figure 2-37. LAN Interface Module Connects Series 90-70 PLCs to a Broadband Network

Features of the Broadband MAP Interface

The features of the Broadband MAP Interface module are described briefly here. For a more complete description see the appropriate section in *GENet Series 90-70 PLC Network Interface User's Manual, GFK-0418*.

This LAN Interface, for broadband application, is composed of separate controller and modem boards interconnected by a flat ribbon cable. The module plugs directly into two slots in a Series 90-70 PLC rack. The Broadband MAP Interface connects the PLC directly to the broadband network through the 10 Mbps modem. Intermediate devices such as bridges or gateways are not required. The direct connection provides the high performance required for real-time control applications.

The communications software is downloaded to the LAN Interface and stored in Random Access Memory. This makes it easy to upgrade the communications software simply by downloading it again rather than by physical replacement of ROM-chips. An on-board battery provides memory retention that prevents loss of the communication software due to power loss for at least six months.

The Broadband MAP Interface provides many built-in maintenance and diagnostic features. Three diagnostic LEDs distinguish faults between the module, the network, and module states that require maintenance action. Default station address permits requesting and accepting a download of software from a centralized management station elsewhere on the

LAN. Software switches permit the LAN Interface to operate independently from the PLC application software to facilitate early system checkout.

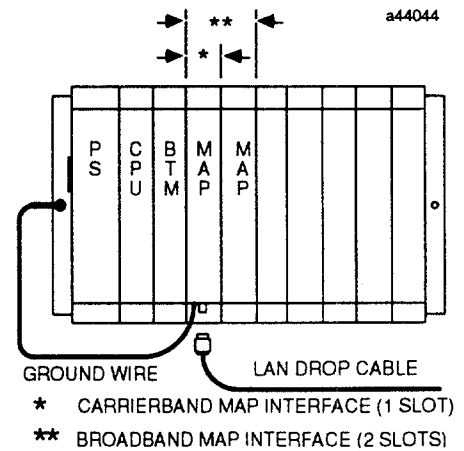


Figure 2-38. Example of Broadband MAP Interface Module Location in a Series 90-70 PLC Rack

Broadband Networks: Broadband networks are designed to handle medium to large-size applications with hundreds of stations as a typical number that might be attached. Broadband networks can extend over cable distances as far as 10km. GENet broadband complies with the IEEE 802.4 broadband standard and operates at 10 Mbps.

Broadband cable plant design and installation must be in accordance with IEEE 802.7 and requires special expertise. GE Fanuc Automation recommends that you contract professional specialists for these services. Consult your GE Fanuc sales representative

or field service office for help in identifying local specialists.

Controller Board

The digital controller board, catalog number IC697CMM798, connects the LAN Interface to the backplane of the Series 90-70 PLC, allowing data to flow to and from the PLC. It contains RAM storage for LAN communication software that is downloaded to the board using the GENet System Manager (GSM). The GSM is a separate computer running GSM software that is available from GE Fanuc Automation. Features of the Controller are shown in the following figure.

Three LEDs are located at the top of the LAN Interface module. The Restart pushbutton is located immediately below the LEDs. The battery and battery holder is located to the right of the LEDs. The battery connectors are located on the controller board between the Restart button and the 9-pin connector to the serial port. The LAN connector, mounted on the modem daughterboard, is positioned downward on the lower front edge of the LAN Interface module. Also exiting from the lower front edge of the module is a safety ground wire.

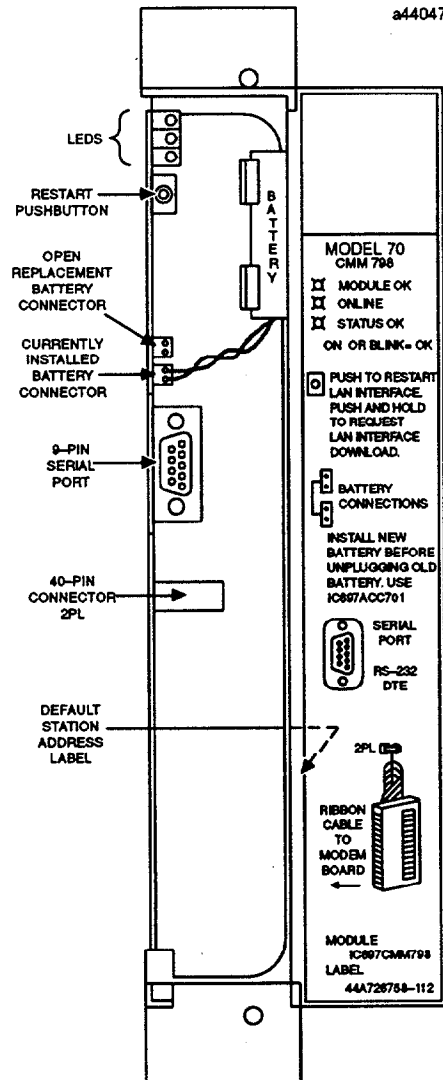


Figure 2-39. Broadband MAP Interface Controller Board

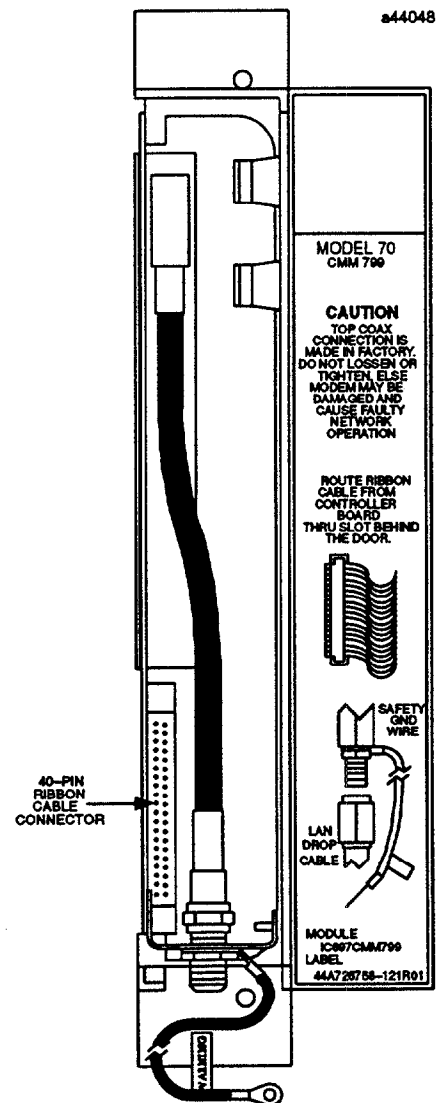


Figure 2-40. Broadband MAP Interface Modem Board

Modem Board

The modem (modulator/demodulator), catalog number IC697CMM799, provides the electrical and mechanical interface to the user-provided IEEE 802.4 coaxial drop cable.

The broadband modem occupies a slot by itself and must be positioned directly to the left of the controller module in the Series 90-70 PLC rack. The Type II broadband modem board used with the Series 90-70 PLC is frequency agile; this means that it is not limited but can be programmed to operate on any of the three MAP recommended broadband channels.

MMS-Ethernet LAN Controller

The MMS-Ethernet LAN Controller, catalog number IC697CMM741, is a single-slot board which provides an 802.3-standard 15-pin D-connector for attachment of a user-supplied AUI (or transceiver) cable. The AUI cable connects to a user-supplied transceiver

that is directly connected to the Ethernet trunk cable. Transceivers are available to operate on a variety of media including thick-wire coaxial cable (10Base5) and thinwire coaxial cable (10Base2).

The MMS-Ethernet Controller supports the MMS (Manufacturing Message Specification - ISO 9506) communications protocol over a 7-Layer ISO protocol stack.

The MMS-Ethernet executable software is loaded into Random Access Memory (RAM) on the MMS-Ethernet Controller module. This software can be loaded either serially from the Local GENet System Manager (GSM) or across the Ethernet network from the Network GSM. This allows upgrade to a new revision of software without modification to the hardware.

Figure 2-41 shows the relationship between the MMS-Ethernet Controller and the Local and Remote GSMs.

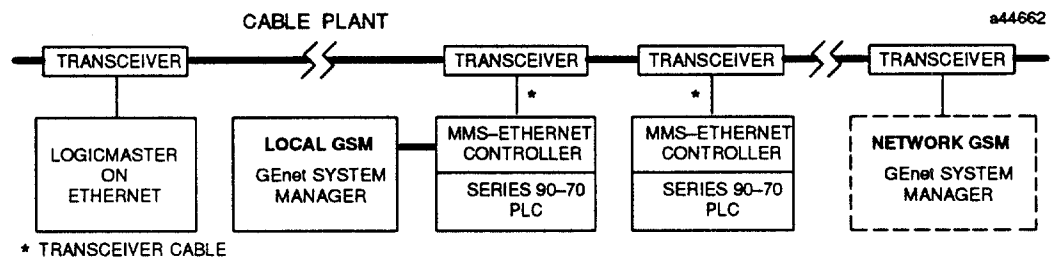


Figure 2-41. MMS-Ethernet Controller Connects Series 90-70 PLCs to an 802.3 LAN

Features of the MMS-Ethernet Controller

The features of the MMS-Ethernet controller are briefly described in the following paragraphs. For a more complete description, see the appropriate section in *GENet Factory LAN for Series 90-70 PLCs MAP 3.0 and MMS-Ethernet User's Manual, GFK-0533*.

Module Physical Description

The MMS-Ethernet Controller can be plugged directly into the Series 90-70 CPU rack or expansion rack. The MMS-Ethernet Controller is a single-slot module that is con-

nected via a user-provided transceiver cable to an external transceiver. The transceiver is attached directly to the IEEE 802.3 network cable. The MMS-Ethernet Controller operates at 10 MB/S on the network.

The MMS-Ethernet Controller provides many built-in maintenance and diagnostic features. The three diagnostic LED's indicate operating conditions which may require maintenance action as: module, the network, and module states.

A Default Station Address permits requesting and accepting a download of software from a centralized management station elsewhere on the LAN. "Soft Switches" permit

tailoring the MMS-Ethernet Controller to your needs without jumpers or switches on the board which simplifies module replacement.

The MMS-Ethernet Controller is a special-purpose microcontroller. It contains RAM storage for LAN communication software that is downloaded to the board using the GENet System Manager (GSM). A GSM is optional software residing on a separate computer which is available from GE Fanuc Automation. The following figure shows the physical layout of the MMS-Ethernet Controller.

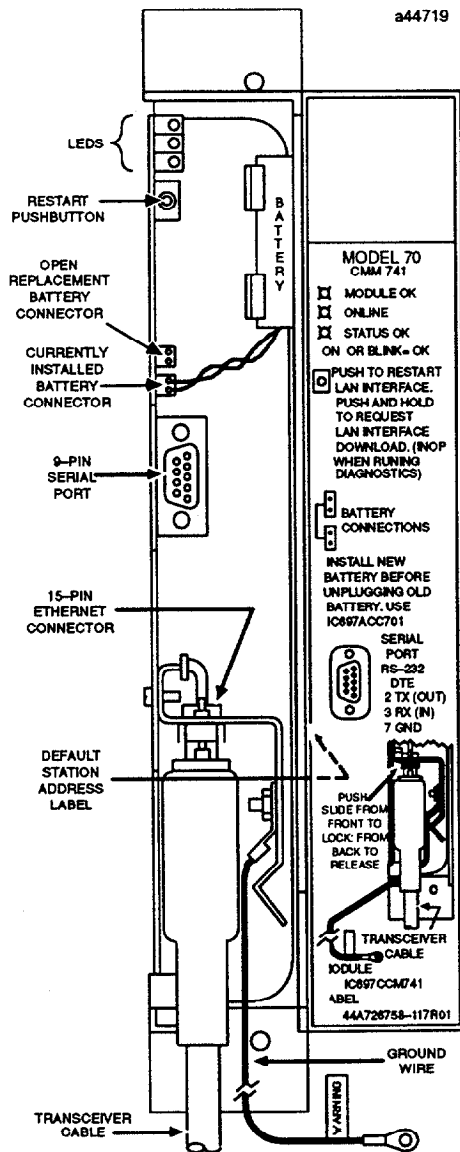


Figure 2-42. MMS-Ethernet Controller Board

IEEE 802.3 Media

Various Ethernet media can be interconnected by appropriate repeaters. Capabilities and limitations are defined in IEEE 802.3I "System Considerations for Multi-Segment 10 Mbps Baseband Networks".

The MMS-Ethernet Controller can be used on any of the following media by an appropriate (user supplied) transceiver cable and transceiver. IEEE 802.3 specifies the definitive requirements of each of these media.

Thickwire Ethernet: The thickwire Ethernet (10Base5) uses a 0.4 inch diameter 50-ohm coaxial cable. The maximum length of a cable segment (single span of cable) is 150 feet (500 meters). The distance between any two stations must meet certain cable-length requirements. A maximum of 100 stations is allowed on a thickwire Ethernet segment. A segment can be connected to longer network lengths using repeaters. A terminator has to be attached to each end of a trunk cable segment.

Thinwire Ethernet: The Thinwire Ethernet (10Base2) uses a less expensive 0.2 inch diameter 50-ohm coaxial cable. The maximum length of a thinwire cable segment is 55 feet (185 meters). A maximum of 30 stations is allowed on a thinwire Ethernet segment.

Communications Coprocessor Module

The Communications Coprocessor Module (CMM), catalog number IC697CMM711, provides both communications control (CCM) and remote terminal (RTU) functionality.

CCM and RTU are available on either or both serial ports in any of four possible configurations: CCM/CCM, CCM/RTU, RTU/CCM, RTU/RTU. Simultaneous communications is provided on both ports at up to 19.2 Kbps of full duplex data communications. The CCM protocol can operate as a master, slave, or peer device, while the RTU Modbus protocol operates as a slave only.

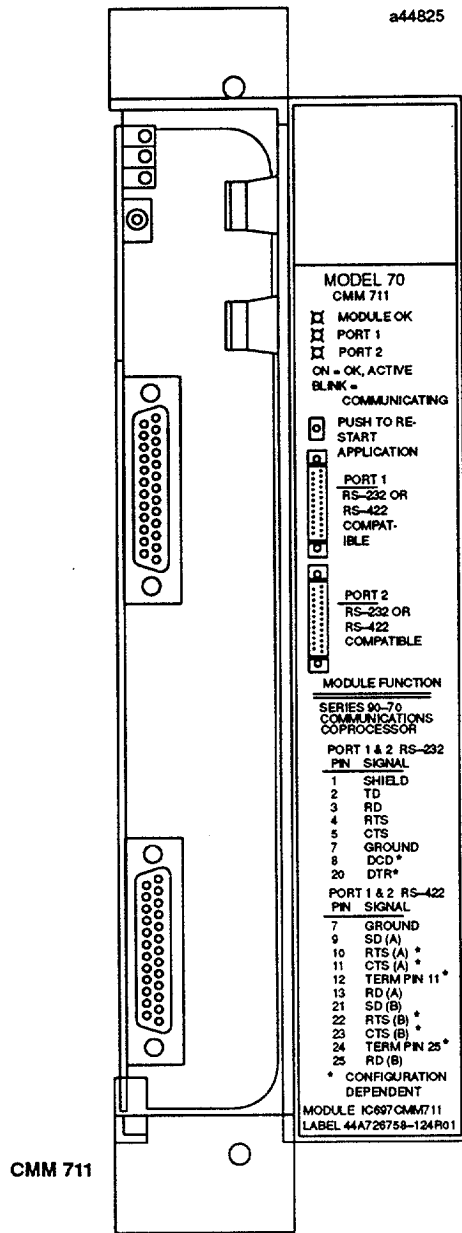


Figure 2-43. Communications Coprocessor Module

The CMM provides both RS-232 and RS-485 Interfaces and communicates with the PLC CPU over the backplane. Many CMMs can be placed in a Series 90-70 PLC system as illustrated by Figure 2-40.

Series 90 PLC functions provided by the CMM module in the CCM mode of operation are: read/write of register, input and output tables; bit set/clear of inputs and outputs; read of scratch pad; Q sequence

(slave response); and the ability to modify the diagnostic status word.

In the master and peer CCM configurations, the CMM module initiates communications with remote devices through application ladder programs communications requests (COMREQs).

The RTU mode of operation is a query/response protocol used for communicating between the CMM and a host computer. The host computer is the master device and transmits the query to the RTU slave which responds to the master. In RTU mode, only slave configuration is available.

In the RTU slave protocol the following functions are provided: read input and output tables, read analog input, read register table, read scratchpad, and read exception status, force a single or multiple output(s), preset a single or multiple register(s), report the device type, and perform loopback maintenance.

Module Physical Description

The CMM module is a single-slot module that plugs into either the Series 90 PLC main or expansion rack. There are three status LEDs located at the top of the CMM module. The top LED indicates the condition of the module. The middle LED indicates activity on port 1, and the bottom LED indicates activity on port 2. The restart pushbutton located immediately beneath the LEDs is used to reinitialize communications.

There are two serial ports. Both ports are accessed through a 25-pin female connector and both provide RS-232 and RS-422/RS-485 communication. There are no user DIP switches or jumpers on this board for configuration. However, the board must be configured before operation using LogiMASTER 90.

System Configuration

The following figure illustrates a typical CMM interface installation into a Series 90 PLC system. Note that CMM modules can be installed in the CPU rack and any of the expansion racks.

PLC system. Note that CMM modules can be installed in the CPU rack and any of the expansion racks.

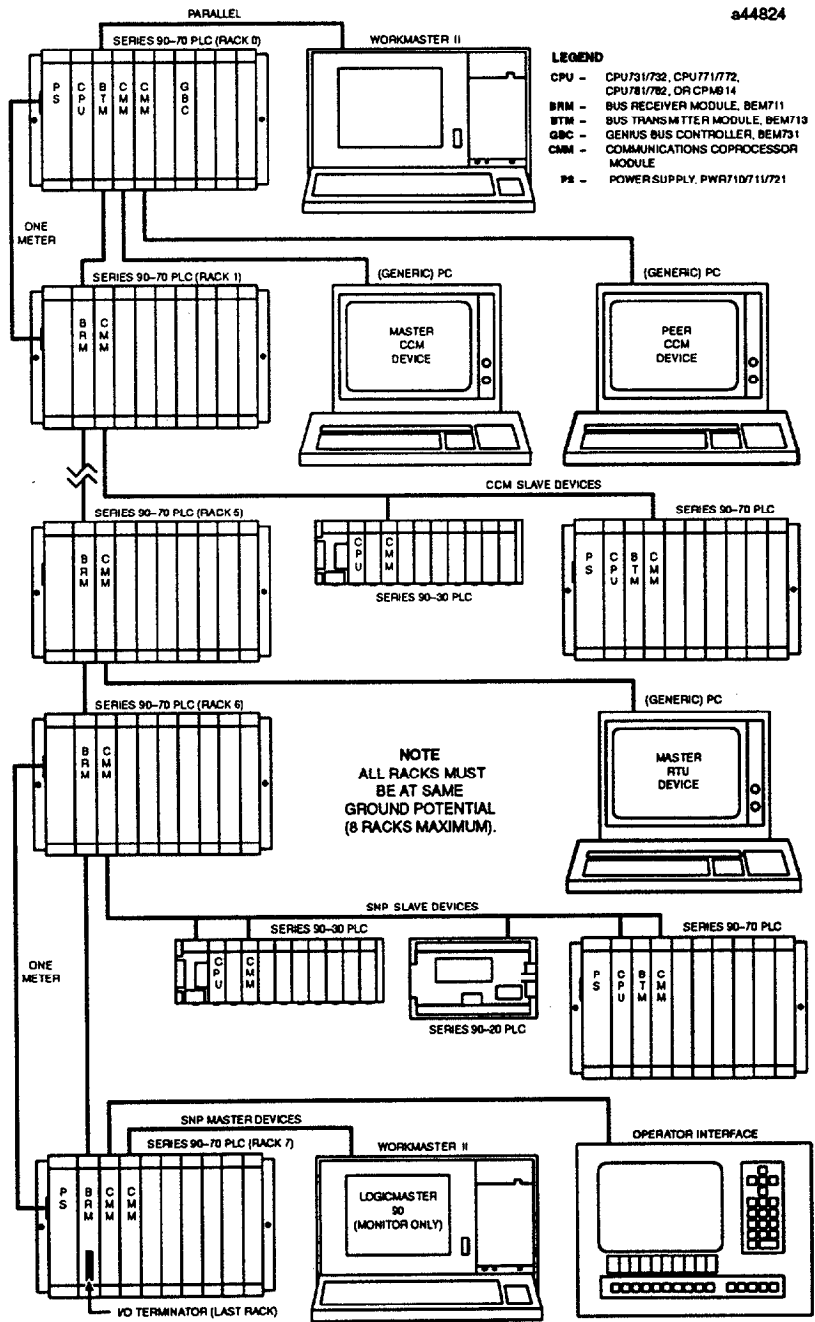


Figure 2-44. Example of Multiple CMM Modules in a Series 90-70 PLC System

I/O Link Interface Module

The Series 90-70 I/O Link Interface Module (IC697BEM721) is used to interface a Series 90-70 PLC to GE Fanuc and Fanuc products which may also be placed on the proprietary Fanuc I/O Link. The Fanuc I/O Link is a serial interface that provides high-speed exchange of I/O data between a master device and up to 16 slaves.

Up to four I/O Link Interface Modules can be installed in a Series 90-70 PLC. They can be located in the CPU rack and in expansion racks. Each I/O Link Interface Module can

be used in either master or slave mode.

Two I/O Link Interface Modules are shown in the example system illustrated on the next page - one in the CPU rack and the other in an expansion rack. Each module is set up as a master with its own I/O Link. In this example, both of the I/O Link Interface Modules exchange data with Power Mate CNCs. Usually, when there are multiple I/O Link Modules in the same PLC, they are on separate I/O Links as shown here. However, it is possible to have more than one I/O Link Interface Module in the Series 90-70 connected to the same link, if that suits the needs of the application.

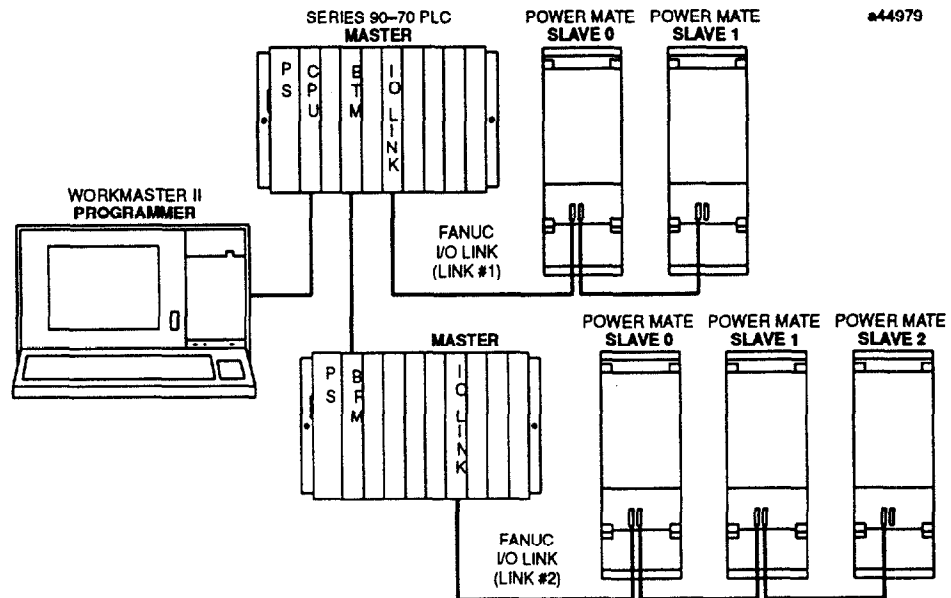


Figure 2-45. Example of I/O Link Interface Module in a Series 90-70 PLC System

Master or Slave Operation

When used as a master, an I/O Link Interface Module can receive up to 1024 discrete inputs from devices on the I/O Link, and send up to 1024 discrete outputs. Potential slave devices include the Series 90-30 PLC and the Power Mate CNC.

When used as a slave, the Series 90-70 I/O Link Interface Module can receive up to 64 discrete inputs from the master, and send up to 64 discrete outputs. The master may be another Series 90-70 PLC, a Series 15, Series 16, or Series 18 CNC, a Series 0 Model C CNC, or an F-D Mate CNC. The Series 90-70 PLC and Series 0 CNC can be used as either master or slave.

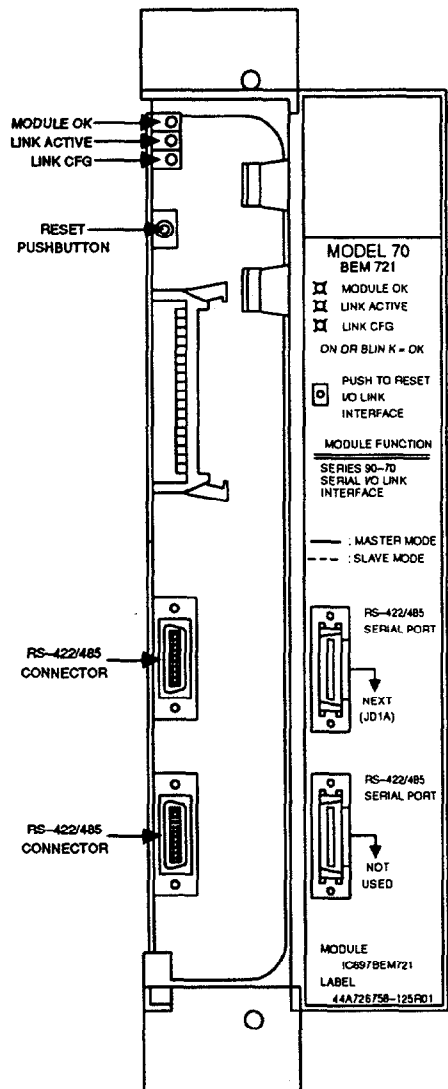


Figure 2-46. I/O Link Interface Module

The Series 90-70 I/O Link Interface Module is provided with two application software diskettes (catalog number IC641SWP708), a 3-1/2 inch and a 5-1/4 inch diskette. The contents of these diskettes is the same.

This application software can be used to integrate up to four I/O Link Interface Modules into the PLC's application program. There are three Program Blocks on a diskette. Each will transfer I/O data between the module and the PLC, perform diagnostics functions, and transfer application program commands to the module.

Module Description

The I/O Link Interface Module has three LEDs that show its operating, configuration, and communications status. The Reset pushbutton provides a convenient means of reset if a failure occurs. If the module is being used as a master, pushing the Reset button resets both the module and operation of the link. The application program must be used to re-initialize the link. If the module is being used as a slave and a fault has caused the module to stop operating, pushing the Reset button resets the module while the rest of the link continues to function.

Serial Ports

The front of the module has two 20-pin, D connector, RS-422/485 serial ports. These ports are used for connection to the I/O Link.

State Logic Processor Module

The State Logic Processor Module (SLP), catalog number AD697SLP711, provides real time multi-tasking control for machine and process applications. It can also be programmed to perform computations, data acquisition, data communications and operator interface functions. The SLP is programmed using the English Control Language Programming System (ECLiPS) software package. It communicates with the PLC CPU over the backplane and can access user and system data. Many SLPs can be supported in a single Series 90-70 PLC system and each SLP can support up to 1024 inputs and 1024 outputs.

The PLC CPU and SLP modules together in the Series 90-70 PLC provide a dual processor architecture which can be used in a wide variety of applications. The SLP provides total state logic control, including diagnostic and simulation capabilities, for those applications requiring reduced development and startup times. For those applications where both ladder logic and state logic programming is desired, the dual processor architecture allows a user to create both ladder logic and state logic application programs in any combination for efficient parallel processing solutions.

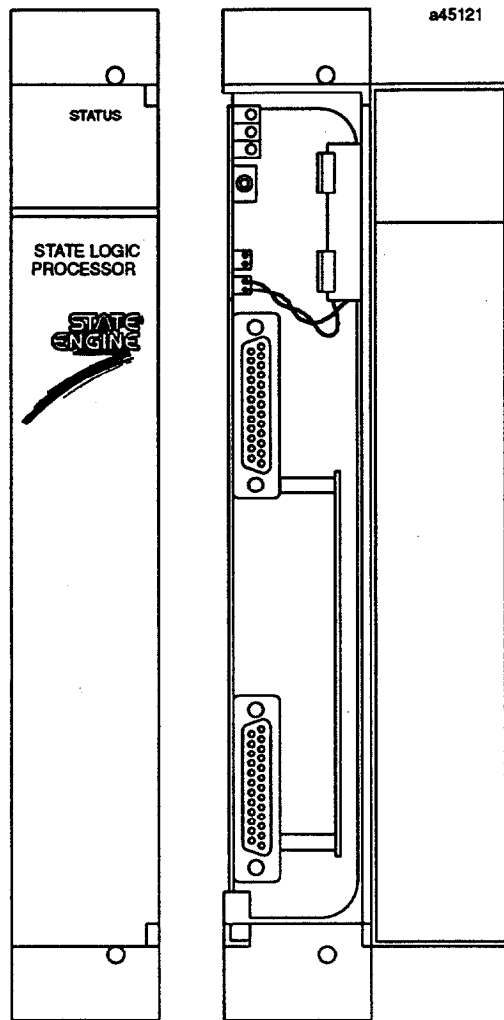


Figure 2-47. State Logic Processor Module

In Series 90-70 PLC ladder logic control systems, the SLP module can be added to provide high level machine and process level diagnostics which can drastically reduce total system downtime. Also, the SLP module can provide machine or process simulation capabilities to Series 90-70 PLC ladder logic control systems to help reduce debug and startup times.

There are no user DIP switches or jumpers on this module for configuration. However, the module must be configured into the overall PLC system using Logicmaster 90-70 configurator software.

An IBM-compatible PC-XT or AT computer with the ECLIPS programming system software installed is connected to port 1, (top port) as shown in the following figure.

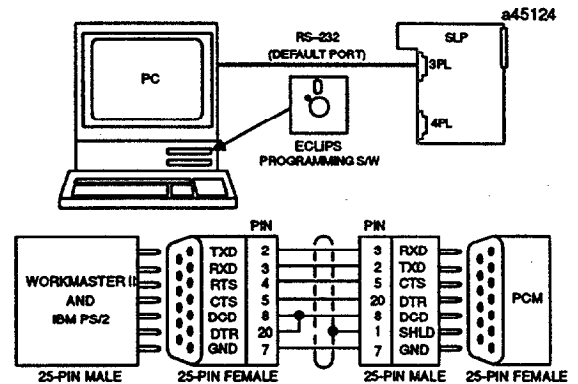


Figure 2-48. Development PC System Running ECLIPS and its Connection to the State Logic Processor Module

The top port is the default programming port, but the SLP can also be configured to be programmed through port 2, the bottom port. The Default setting is 19,200 bps. Both ports can be configured independently as RS-422/RS-485 or RS-232 serial ports for operation with a variety of serial devices such as operator interfaces, bar code readers, weigh scales, etc. One of the two ports can also be configured to communicate with the CCM2 protocol as a slave typically for use with operator interface terminals. Refer to the State Logic Processor User's Guide for details of operation.

Three Status LEDs are on the SLP module as shown above. The top LED indicates the condition of the module and is ON during normal operation. The bottom two LEDs are not used and will always be off.

One pushbutton is provided. Push and hold the pushbutton for less than 5 seconds will simply restart the user application program if it was configured to "auto-run" at power up. Push and hold for more than 5 seconds and the module is reinitialized and the user application program must be reloaded.

Chapter 4

Series 90-70 PLC I/O System

Overview of Series 90-70 I/O System

The Series 90-70 PLC I/O system provides the interface between the Series 90-70 PLC and user supplied input and output devices. The I/O system supports Model 90-70 rack-type I/O as well as the Genius I/O system. The Genius I/O system can in-

clude Genius I/O blocks, and with the addition of a Remote I/O Scanner on the Genius I/O bus Series 90-70 I/O can be distributed at a location remote from the CPU rack. In addition to supporting these two I/O subsystems, LAN Interface modules, PCMs, and third party VME modules are supported.

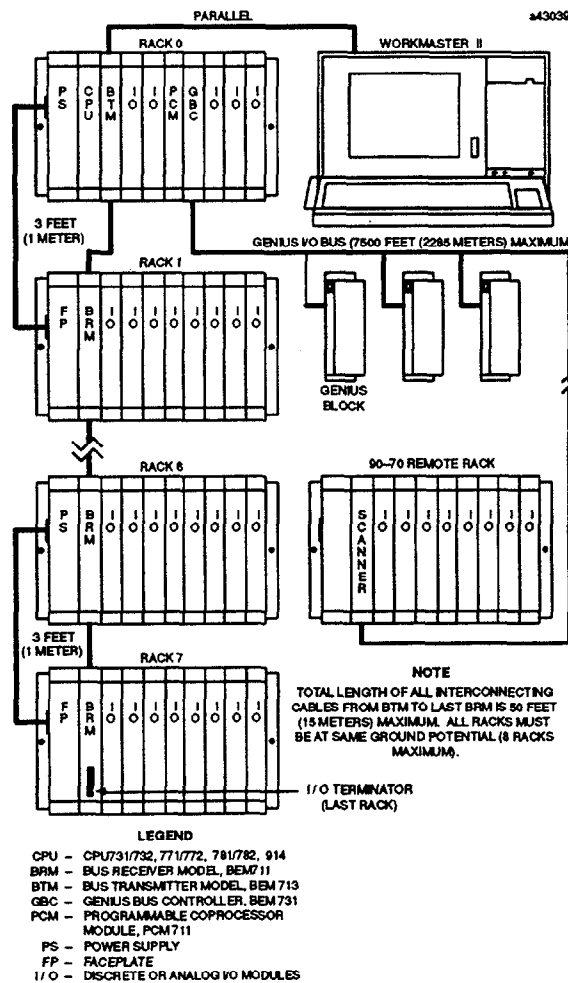


Figure 4-1. Typical Series 90-70 I/O System

A Series 90-70 PLC I/O System configuration has few limitations. All discrete modules, analog modules, intelligent modules, coprocessor, communications, and other such modules can be located anywhere along the I/O Bus in a local system configuration.

A Genius Bus Controller (GBC) provides an interface between the Series 90-70 PLC CPU and one Genius bus for each Bus Controller in the system. The Series 90-70 PLC I/O system can support multiple GBCs with up to 30 blocks and a Hand-Held Monitor (HHM) connected to each Genius bus. All Genius I/O blocks may be used with the Series 90-70 (refer to the Genius I/O User's Manual for information on individual Genius I/O blocks).

Additionally Series 90-70 discrete, analog, and most intelligent modules can be distributed on the Genius I/O link when located in remote drops linked by a Remote I/O Scanner in the first remote rack (up to eight racks on a remote drop). A remote link cannot have communications modules or modules that depend on COMREQ instructions for their operation.

The Series 90-70 PLC I/O system is VME compatible. This allows certain 3rd party VME boards to reside in the system. However, use of 3rd party hardware can pose compatibility problems. As an aid to our customers in identifying those 3rd party boards that have already been qualified, GE Fanuc maintains a list of those qualified 3rd party VME boards.

The criteria for VME board qualification is described in GFK-0448, which is the *User's Guide to Integration of 3rd Party VME modules for the Series 90-70 PLC*. Contact your local GE Fanuc PLC distributor, or GE Fanuc sales representative for further information on compatible 3rd party VME products.

Series 90-70 Rack-Type I/O Subsystem

The rack-type I/O subsystem for the Series 90-70 PLC is the Series 90-70 PLC I/O. I/O modules are referred to as *Model 70 I/O*. Model 70 I/O modules plug directly into the Series 90-70 PLC backplane. I/O modules can be installed in any available I/O slot in the CPU rack, or in any I/O slot in an expansion rack.

The Series 90-70 PLC I/O system does not require a dedicated I/O Controller, as with other I/O subsystems. However, if more than one rack is required in a system, the I/O bus signals must be propagated to the added racks through a Bus Transmitter Module in the CPU rack to a Bus Receiver Module in the I/O expansion rack.

Each succeeding I/O expansion rack in the chain must have a Bus Receiver Module installed to continue the I/O bus through to the last rack in the system. In a single rack system, the CPU performs the I/O interface functions. A maximum configured Series 90-70 I/O local system supports up to 63 Model 70 I/O modules. Additionally, when Series 90-70 I/O is distributed on a Genius Bus in a remote drop with a Remote I/O Scanner, a much larger maximum system configuration is possible, depending on the number of drops and the baud rate of the Genius communications link. For details of I/O configuration using remote drops, refer to the *Series 90-70 Remote I/O Scanner User's Manual, GFK-0579*.

Model 70 I/O Module Types

Model 70 PLC I/O modules are available as five types: discrete inputs and outputs, analog inputs and outputs, and intelligent I/O modules. The Series 90-70 rack-mounted I/O system offers a full line of discrete I/O modules which will interface to most sensors and actuators. With the wide variety of available voltages, density, and current ratings a module well suited to virtually any application can be chosen.

Analog inputs can be cost-effectively multiplexed up to 120 circuits per rack. Inter-

rupts may be configured from input point 1 of any DC or analog input module. Input filters may be selected to be 1 ms or 10 ms time constants on any DC input module. The circuit status of each I/O point is indicated by a green LED mounted at the top of the module and viewable through the clear plastic lens cover.

Each of the I/O modules has an insert installed between the inside and outside surface of the hinged door. One side of the insert (viewed with the hinged door in the closed position) has space to record circuit identification information for each point

on the module, while the opposite or inside surface has a circuit wiring diagram, and the module type and catalog number. The outside edge of the insert is color coded to quickly identify the module as a high voltage (red) or low voltage (blue) type.

Discrete I/O Modules

Most discrete modules have either 16 or 32 points, depending on the type of module. Important features and benefits for the discrete I/O modules, and available module types are listed in the following tables.

Table 4-1. Discrete I/O Module - Features and Benefits

Feature	Benefit
16 and 32 point modules	High I/O density in a limited space
Mechanical keying	Prevents putting wrong type of module in a configured slot
Software configured	Eliminates DIP switches and jumpers and maintains flexibility
Connector system accepts 40 No. 14 AWG wires	Easy to wire
Connector system has large labels	Easy to read labels and wiring diagrams
One configurable interrupt point on each DC input module	Standard product can be applied in time critical applications

Table 4-2. Available Discrete I/O Module types

Module Type	Model 70 Input	Model 70 Output	Genius I/O
5 VDC	32 point	32 point, .5A	32 point, .5A
12 VDC	32 point	32 point, .5A	32 point, .5A
24 VDC	32 point	32 point, .5A; 16 point, 2A	32 point, .5A; 16 point, 2A
48 VDC	32 point	32 point, .5A; 16 point, 2A	16 point, 2A
125 VDC	16 point	not available	8 point, 2A
12 VAC	32 point	not available	not available
24 VAC	32 point	not available	not available
48 VAC	32 point	not available	not available
120 VAC	16 and 32 point 16 point isolated	32 point, .5A; 16 point, 2A	8 point, 2A; 16 point Input
120/240 VAC		12 point isolated	8 point, 2A isolated
240 VAC	16 point isolated	16 point, 2A	n/a
Relay		16 points	16 points

Analog I/O Modules

The Series 90-70 I/O system includes high-level analog input system modules and a high level analog output module ($\pm 10\text{VDC}$, 0 to +10VDC, 4 to 20mA) that interface to most analog sensors and transducers. These modules provide 14-bit resolution. An input expander provides a very easy, user friendly means of cost effectively inputting large numbers of analog signals. All Series 90-70 and Genius I/O analog modules automatically put data in word memory, thereby simplifying programming data access. Also, scaling of Inputs can be done by the board per user defined configuration. Embedded into the programmer and logic process are high

and low value alarm contacts for simplified integration into ladder logic.

For applications requiring distributed I/O, RTD inputs, or thermocouple inputs, the Genius I/O system provides the ideal solution. The Genius analog products provide a cost effective means of distributing analog I/O. Some applications have specialized analog requirements; high sampling rates, specialized signals, or 16-bit resolution are not uncommon. Through the GE Fanuc 3rd party VME qualification program a whole new vista of I/O options has been opened. You can select from a large list of specialty options for a wide variety of applications. Analog I/O module options are listed in the following table.

Table 4-3. Analog I/O Module Options

Module Type	Model 70 I/O	Genius I/O	3rd Party VME
High level analog output	4 channel	2 channel †	Yes
High level analog input	8 channel	4 channel †	Yes
Analog input multiplexer	16 channel/board: 120 channels maximum per 1 input module	No	Yes
RTD	not available	Yes	Yes
Thermocouple	not available	Yes	Yes
Other: strain gauge, 16-bit resolution, etc.	not available	future	Yes

† Combined I/O on one block.

Intelligent I/O Modules

With the Series 90-70 PLC system, you have available a full compliment of intelligent I/O modules which are tightly coupled to the Series 90-70 CPU. The intelligent I/O modules are configurable through user friendly interfaces to allow the customization to suit the application.

Genius I/O intelligent modules (such as the Genius PowerTRAC power monitor) are also fully operational with the Series

90-70 I/O system.

The Series 90-70 3rd party VME qualification program provides a means of selecting additional intelligent modules to be used with the Series 90-70 PLC system. 3rd party VME modules are available in a wide variety of functions providing the capability to simplify systems integration by embedding what were previously stand-alone subsystems directly into the Series 90-70 PLC rack. This scheme replaces costly, low performance interfaces with a direct, high speed backplane interface.

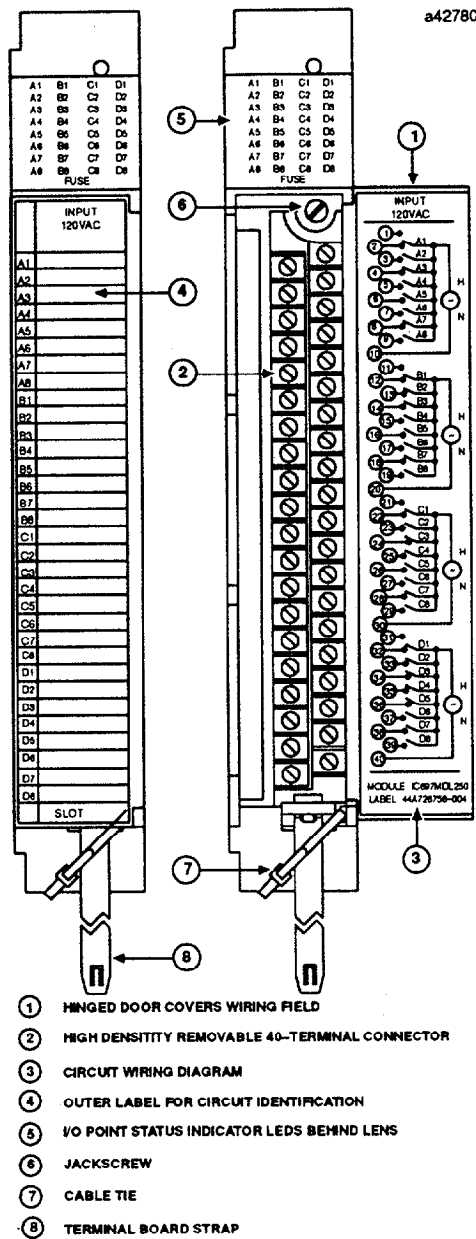


Figure 4-2. Features of a Typical Model 70 I/O Module

I/O Module Features

All Model 70 I/O modules are retained in their slots by molded latches that automatically snap onto the upper and lower rails of the rack when the module is fully inserted into its slot. For applications where racks will be installed in high vibration areas, screws can be used to further secure the modules in the rack. A cable tie is molded into the bottom front of each module, which provides a convenient place to

secure a cable tie wrapped around the wire bundle.

Detachable Terminal Boards

All Model 70 I/O modules have as a standard feature detachable field wiring terminal boards. This convenient feature makes it easy to prewire field wiring to the user supplied input and output devices, and to replace modules in the field without disturbing existing field wiring.

The I/O connector terminals will accept up to one AWG #14 wire or two AWG #16 wires. Wires are routed out of the bottom of the terminal board cavity and secured by a cable tie as previously described. A terminal board strap on the bottom of the terminal board fastens to a slot in the bottom card guide grill to securely fasten the terminal board to the rack.

Mechanical Keying

All of the Model 70 I/O modules are mechanically interlocked by means of a key to prevent the accidental interchange of one module type for another. For example, you would not want to have a DC Output module inserted into a slot where the terminal board has been wired for an AC Input module. The mechanical key is a safeguard to help prevent this from happening.

A unique key is provided with each module. When a module is initially installed in a rack, the key automatically latches onto the center rail on the backplane, where it remains when a module is removed. Only the correct module type can then be inserted into that rack slot.

I/O Module Addressing

Module addressing is determined by the position (slot number) in the rack in which it is installed. There are no jumpers to be positioned or DIP switch settings required for addressing of modules. Actual reference addresses for each module are assigned by the user with the configuration function of the Logicmaster 90 software package. The configurator function of Logicmaster 90 allows the user to assign reference addresses to the I/O modules on a slot-by-slot basis.

Table 4-4. Series 90-70 I/O Modules

Catalog Number †	Points	Description	Data Sheet Number
<i>Discrete Input Modules</i>			
IC697MDL240	16	Input 120 VAC Isolated	GFK-0375
IC697MDL241	16	Input 240 VAC Isolated	GFK-0376
IC697MDL250	32	Input 120 VAC	GFK-0084
IC697MDL251	16	Input 120 VAC	GFK-0718
IC697MDL252	32	Input 12 VAC	GFK-0756
IC697MDL253	32	Input 24 VAC	GFK-0757
IC697MDL254	32	Input 48 VAC	GFK-0784
IC697MDL640	32	Input 125 VDC, Positive/Negative Logic	GFK-0719
IC697MDL650	32	Input 24 VDC, Positive Logic	GFK-0080
IC697MDL651	32	Input TTL	GFK-0377
IC697MDL652	32	Input 12 VDC, Positive/Negative Logic	GFK-0378
IC697MDL653	32	Input 24 VDC, Positive/Negative Logic	GFK-0379
IC697MDL654	32	Input 48 VDC, Positive/Negative Logic	GFK-0380
<i>Discrete Output Modules</i>			
IC697MDL340	16	Output 120 VAC, 2A	GFK-0082
IC697MDL341	12	Output 120/240 VAC, 2A, Isolated	GFK-0382
IC697MDL350	32	Output 120 VAC, 0.5A	GFK-0081
IC697MDL740	16	Output 24/48 VDC, 2A, Positive Logic	GFK-0086
IC697MDL750	32	Output 24/48 VDC, 0.5A, Positive Logic	GFK-0085
IC697MDL752	32	Output 12 VDC, 0.5A	GFK-0381
IC697MDL753	32	Output 5 to 48 VDC, 0.5A	GFK-0383
IC697MDL940	16	Output relay, 2A	GFK-0384
<i>Analog Modules</i>			
IC697ALG230	-	Analog Input, High Level (8 channels)	GFK-0385
IC697ALG440	-	Analog Expander, Current (16 channels)	GFK-0385
IC697ALG441	-	Analog Expander, Voltage (16 channels)	GFK-0385
IC697ALG320	-	Analog Output, Current/Voltage (4 channels)	GFK-0388
<i>Intelligent I/O Modules</i>			
IC697ADC701	-	Alphanumeric Display Coprocessor	GFK-0521
IC697BEM731	-	Genius Bus Controller	GFK-0165
IC697CMM711	-	Communications Coprocessor Module	GFK-0370
IC697CMM721	-	Carrierband MAP Interface	GFK-0368
IC697CMM731	-	Broadband MAP Interface	GFK-0369
IC697CMM741	-	MMS-Ethernet LAN Interface	GFK-0532
IC697GDC701	-	Graphics Display Coprocessor	GFK-0519
IC697PCM711	-	Programmable Coprocessor Module	GFK-0164
IC697BEM733	-	Remote I/O Scanner	GFK-0539
IC697BEM721	-	I/O Link Interface	GFK-0645

† Some of the above I/O modules and applicable data sheets may not be available at the time this manual is printed. For current availability consult your GE Fanuc PLC distributor, or local GE Fanuc sales representative.

Module Location in Main (CPU) Rack

Two versions of Series 90-70 PLC racks are available; one has 5 slots (plus power supply slot), the other has 9 slots (plus power supply slot). Module placement in both size racks is the same; the only difference being the number of modules the rack can contain.

The first slot to the left is for the power supply or power supply connection (used when one power supply supplies power to two racks) to that rack. The next slot, labeled SLOT 1 on the backplane, in the main or CPU rack (rack 0) must always contain the CPU module. If rack 0 is the only rack in a system, the remaining 4 or 8 slots may contain either intelligent modules or I/O modules.

The Bus Transmitter Module provides a high speed parallel connection to the programmer. The Bus Transmitter Module, if present, must be installed in slot 2, adjacent to the CPU. If a serial connection is to be used for communications with the programmer, the BTM is not required in a single rack system, since the serial connection is made to the serial port on the CPU.

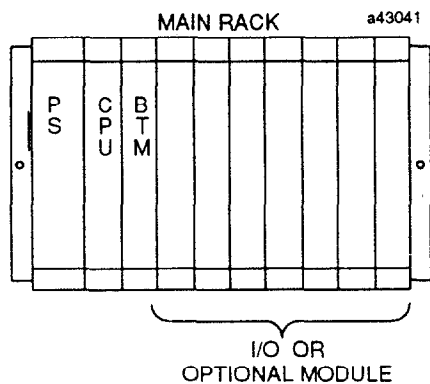


Figure 4-3. Main Rack Configuration

Module Location in Local Expansion System

When a Series 90-70 PLC application is such that it requires expansion racks to be

included in the local system, slot 2 in rack 0 (CPU rack) must contain a Bus Transmitter Module (BTM).

The bottom connector of the Bus Transmitter Module is wired to the first physical expansion rack by connecting it to the top connector of a Bus Receiver Module (BRM) through an I/O cable. The bottom connector of this Bus Receiver Module is then connected to the top connector of the Bus Receiver Module installed in the next expansion rack. This process of connecting racks through Bus Receiver Modules is continued until all of the required racks in the system are connected in a chain.

The BTM and BRMs transmit information relative to system status, input/output data and other messages between the CPU and all attached devices. Bus expansion racks do not have all of the VME signals available in the CPU rack, therefore certain modules must be installed in the main (CPU) rack.

The Bus Receiver Module controls the bus in an expansion rack. In the main rack, the CPU provides the system clock and acts as the bus arbitrator.

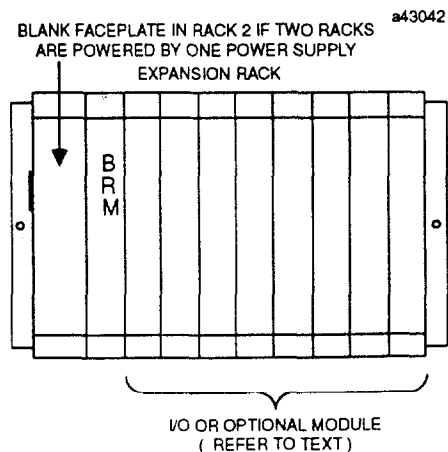


Figure 4-4. Expansion Rack Configuration

A BRM must reside in slot 1 of an expansion rack. Model 70 I/O modules can be placed in any available I/O slot in the rack. When intelligent modules are installed in a rack (PCM, GBC), all slots to the left of these modules must be occupied for proper operation.

The Series 90-70 PLC CPU communicates (parallel communications) with the programmer through the top connector on the BTM. Only the programmer may be attached to this connector.

Distance Between Racks

The maximum cable distance from the main (CPU) rack to the last expansion rack is 50 feet (15 meters). When expansion racks are mounted in the same or nearby cabinets, there may be no more than a total of 50 feet of cable connecting all racks.

Since none of the daisy-chained signals (all at the same ground potential) are broken at a rack, any rack can be independently powered down without affecting the operation of the rest of the system (if the LOSS_OF_RACK fault is configured as a non-fatal fault). However, whenever a rack is powered-off it does generate a LOSS_OF_RACK fault in the PLC fault table. Until the rack is powered back on and all modules recovered, I/O points residing in that rack are considered to be faulted.

crete input and output modules, analog input (includes base converter and expander modules) and output modules, PCM, and ADC modules.

The remote rack cannot have any I/O module interrupts, bus controllers, communications modules, or any other modules that depend on COMREQ instructions for their operation. As shown in the following figure a Remote I/O Scanner and the I/O modules in the rack with it make up a remote drop on the Genius bus.

A remote drop can include any mix of discrete and analog input and output modules, up to a total of 1024 discrete inputs and 1024 discrete outputs, or 64 analog inputs and 64 analog outputs. Any mix of discrete and analog modules can be used, as long as the total amount of data does not exceed 128 bytes of inputs and 128 bytes of outputs (8 discrete points represent one byte and 1 analog channel uses 2 bytes).

Model 70 I/O Modules

There are five types of Model 70 I/O modules available that can be used in a Series 90-70 PLC system.

- Discrete input and output
- Analog input and output
- Intelligent option modules

The following paragraphs provide an overview of the Series 90-70 PLC I/O modules. Circuit descriptions and wiring information for each of the I/O modules can be found in the data sheet that is included with each module (see Table 4-4).

Discrete Input Modules

Discrete input modules convert AC and DC input power levels to the logic levels required by the Series 90-70 PLC. An optical coupler provides isolation between the incoming signal and the logic.

The input module gathers data regarding the state of each input point and provides it upon demand to the CPU. When input point 1 on DC input boards is configured as an interrupt, the input module also interrupts the CPU when an input occurs on point 1.

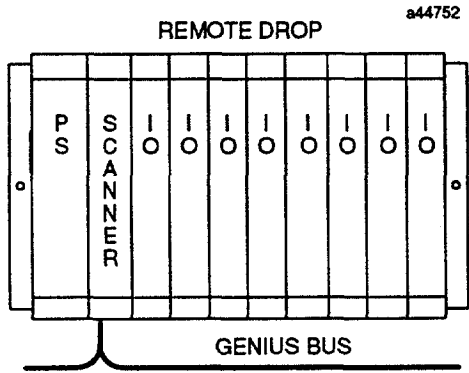


Figure 4-5. Remote I/O Scanner Location in Rack

Module Location in a Remote Rack

When a remote rack is included in a system as a drop on a Genius I/O link, certain restrictions apply when installing modules. The Remote I/O Scanner module must be located in slot 1, next to the power supply. The rest of the slots can contain any mix of dis-

Discrete Output Modules

Discrete output modules convert and isolate logic levels into AC and DC power levels for driving real-world devices. A power semiconductor provides the drive for each output point.

The output module receives data regarding the desired state of each output point from the CPU, and controls the outputs. It also controls the default state when ordered to do so by the CPU or when it detects a system failure. You can configure the default state for outputs (through Logicmaster 90 configuration software) to either *Off* or *Hold Last State* on a per module basis.

Discrete I/O Module LEDs

An LED block with four columns of eight LEDs is mounted at the top of each discrete I/O board. A bezel that overlays the block has a letter/number identification for each LED. Each LED indicates the state of the logic (*ON* or *OFF*) for the corresponding input or output point. *The LED does not indicate the state of the power connection.* All discrete I/O board, regardless of the number of points and type (input or output) use the same LED block.

For 32-point modules, all LEDs are used; for 16-point modules the first four LEDs (from the top) in each column are used: A1 through A4, B1 through B4, C1 through C4, and D1 through D4. An LED at the bottom of the fuse block indicates status of on-board fuses for output modules. If any of the fuses should blow, this LED will turn on.

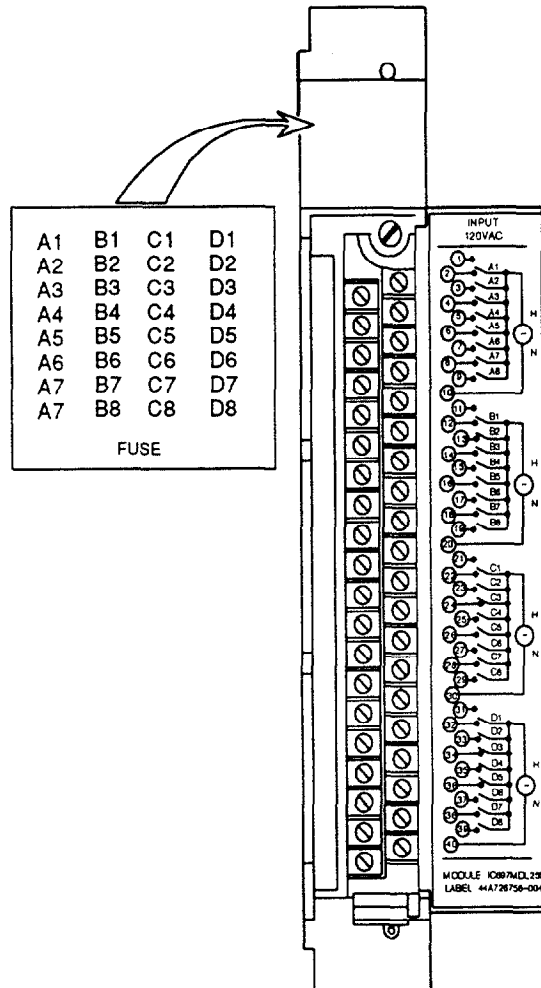


Figure 4-6. I/O Point Status Indicator LEDs for Discrete I/O Modules

Discrete I/O Module Wiring Connections

The removable connector for field wiring on discrete I/O modules has terminals for connections to the external AC or DC power source, power return, and field devices supplied by the user. Each discrete I/O

module, regardless of type (input or output) uses an identical 40-terminal connector. A wiring connection diagram for each discrete I/O module can be found in the data sheet for each module. An example of this terminal board is shown in the following figure.

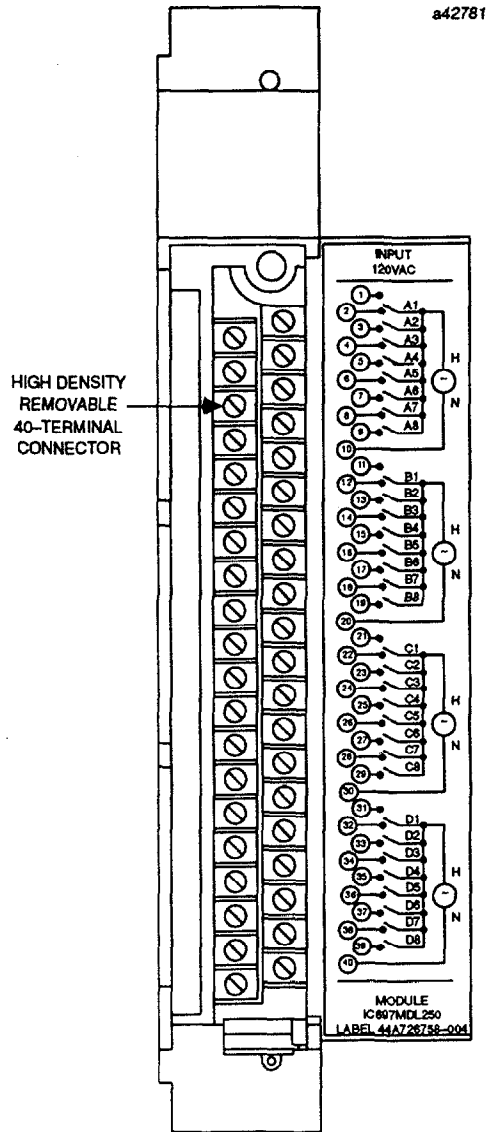


Figure 4-7. Discrete I/O Module Terminal Board

Analog Input Modules

Model 70 Analog Input Modules include a high-level eight channel module (base converter), an analog expander 16 channel current module and an analog expander 16 channel voltage module.

High-Level Analog Input Module

The high-level input module contains eight high-speed analog inputs, a low-speed expansion input channel which can be shared by multiple expander modules, a 14-bit A/D (Analog to Digital) converter, 16-bit microprocessors, and the backplane interface to the system.

Analog Input Expander Modules

The expander modules contain 16 current or 16 voltage input channels, an analog multiplexer and a serial interface to the expander bus. Analog data from the expander modules is transmitted to the analog input module on the expander bus. Up to seven expander modules can be interfaced to an analog input module to expand the number of inputs to 120.

The high-level analog input module and its associated expander modules must be installed in the same rack with the high-level analog input module in the lowest slot position of the group. It is recommended that the expander modules be installed to the right of the analog input module and in adjacent consecutive slots to assure contiguous addressing beginning with the address assigned to the analog input module.

Analog Input Characteristics

Each analog channel is capable of converting an analog input signal to a digital signal which can be used as required by the application. With no analog expansion modules present, all eight channels of the input module are updated every 2.8 milliseconds.

The input ranges for these analog inputs can be -10 to +10 volts and 4 to 20 mA. Each channel of the high level analog input module is individually soft configurable, with the configurator software, for either voltage or current ranges, user scaling, alarm limits and diagnostics. Built-in resistors are selectable at the terminal board for current inputs.

The expander module is also soft configurable and is available in two versions: one with all current inputs and one with all voltage inputs. Resolution of the converted signal is 14 bits binary (1 part in 16384), including sign, resolving 1.25 millivolts on voltage range, or 50 microamps on current range. The input data format is 2's complement binary.

Wiring Connections to Analog Input Channels

Connection to the analog input modules from user devices is made to screw terminals on a removable 40-terminal connector. A circuit wiring diagram for high-level analog input modules and expander modules can be found in the data sheet included with each module and is also printed on the inside surface of the label in the module's hinged door.

The expansion channel bus connections consist of two differential wire pairs which must be connected between the expander modules and the analog input module. This connection must be made with shielded, twisted pair cable to the 40-terminal connector.

Analog Module Status Indicator

The high-level analog input modules have two LEDs located at the top front of the module. The top LED, labeled *BOARD OK*, indicates that the board has powered-up, passed its power-up diagnostic tests, and has received good configuration data. The second LED, labeled *PORT OK*, is an indication that the expander bus is connected and operating properly.

High/Low Alarm Function

The high-level analog input module input points have a High/Low Alarm function which indicates that an input is outside of a range of upper and lower limits set by the user with the configuration software.

When a high or low alarm limit is exceeded, the appropriate fault contacts are set, which will be either --[HIALR]-- or --[LOALR]--, and the fault will automatically be logged in the Alarm Fault Table.

Analog Output Modules

Model 70 Analog Output Modules are available in two versions: an Output Analog Voltage/Current module that allows each channel to be configured for either current or voltage, and an Output Analog Voltage module that provides voltage outputs only. Each of the analog output modules has four channels.

High-Level Analog Output Modules

The high-level analog output module is available as one configurable module having both voltage and current outputs. This module contains four high-speed analog outputs, separate 14-bit D/A (Digital to Analog) converters, a 16-bit microprocessor and the backplane interface to the system. The high-level analog output system accepts digital data from the PLC CPU and converts this data to analog outputs for use as required by the application.

Analog Output Characteristics

Each analog channel is capable of converting a digital signal to an analog signal. Operating ranges for the output channels are -10 to +10 volts for voltage outputs and 4 to 20 mA for current outputs. Resolution of the converted signal is 14 bits binary (1 part in 16384) for a -10 to +10 VDC output, and 13 bits binary (1 part in 8192) for a 4 to 20 mA output. Calibration is set at the factory and stored in a non-volatile memory (EEPROM) which eliminates the need for

manual calibration by the user. The proper calibration for each channel on the analog output module, which can be configured for either voltage or current, is set by the configurator software as are scaling and diagnostic features.

Wiring Connections to Analog Output Channels

Connection to the analog output modules from user devices is made to screw terminals on a removable 40-terminal connector. A circuit wiring diagram for high-level analog output modules can be found in the data sheet included with each module and on the inside surface of the label in the module's hinged door.

Module Status Indicator

The analog output modules have one LED which is located at the top front of the module. This status indicator, labeled BOARD OK, indicates that the board has powered-up, passed its power-up diagnostic tests, and has received good configuration data.

Intelligent Option Modules

The following paragraphs provide a brief description of the Intelligent Module options for the Serie 90-70. For a more complete description, refer to Chapter 2.

Operator Interface Systems

The Series 90-70 PLC supports two integrated operator interface systems which are high performance, cost effective, and easy to configure. Two basic systems are offered: a pixel graphics system and a character graphics system. These two systems allow a wide range of applications to be served.

CIMPLICITY-70 Graphics Display System

The CIMPLICITY-70 Graphics Display System (GDS) is a high performance, low cost pixel-based, interactive color operator interface system. It is available as a single

slot module (Graphics Display Coprocessor) that contains graphics processing circuits to update screens in less than 200 msec. The module features powerful screen building tools, a large array of graphics functions (e.g. object rotate, scaling, movement, and fill), built-in trending capability, and RGB monitor capability. The module has high speed access to the Series 90-70 CPU register and I/O memory through the backplane which provides for fast updates.

The CIMPLICITY-70 GDS system allows the operator to monitor, display, and supervise automated process plant facilities. Multiple systems allow you to operate multiple independent workstations from a single PLC platform. It also includes a Recipes function that allows control of an automated process by downloading predetermined sets of values to the PLC.

A companion Graphics Display Terminal is available from GE Fanuc. This is a Nema 4 (14 inch) industrial monitor specifically designed for the Cimplicity system that can be mounted 1000 feet from the Graphics Display Module.

CIMPLICITY 90-ADS

CIMPLICITY 90-ADS (Alphanumeric Display System) is a low cost character graphic operator interface system. This display system consists of three elements: the Series 90-70 Alphanumeric Display Coprocessor Module (ADC), an operator interface terminal, which can be a GE Fanuc OIT, Mini OIT, Mini Touch OIT, a VT100 compatible terminal, or a Workmaster II computer or IBM compatible Personal Computer, and the applicable configuration software. The configuration software allows for fast screen creation, thereby simplifying the creation of the operator interface.

Additional information on these products can be obtained from your GE Fanuc PLC distributor or local GE Fanuc PLC sales representative.

Series 90-70 PLC Communications

Serial communications is a necessary element for any PLC system. The Series 90-70 supports various communications systems and protocols. The Series 90-70 PLC supports the core GE Fanuc communications systems, which are CCM, Genius, MAP (Manufacturing Automation Protocol), MMS (Manufacturing Message Specification) and the Series 90 Protocol (SNP). The availability of these systems simplifies connecting a Series 90-70 PLC to existing GE Fanuc products.

CCM Communications

CCM communications is an integral part of the Programmable Coprocessor Module and is run as a task on one serial port, or both serial ports of the PCM. Also, an available Communications Coprocessor Module (CMM) provides communications control (CCM) and remote terminal (RTU) functionality. The Communications Coprocessor Module provides both the RS-232 and RS-485 interfaces and communicates with the Series 90-70 CPU over the backplane.

Genius Communications

The Genius Bus Controller supports the Genius LAN (Local Area Network) functionality. Global data and datagrams are also supported. Default settings make it a simple procedure to configure a standard network capable of running global data.

MAP Communications

GE Fanuc provides both Carrierband and Broadband embedded MAP (Manufacturing Automation Protocol) interfaces for the Series 90-70 PLC. Both of these modules are members of the GENet Factory LAN hardware and software products. The Carrierband Interface resides on a single-slot board which can be located in any I/O slot on the parallel I/O bus. The Broadband Interface is a two-board option (Controller board and Modem board) which can also reside in any

I/O slot on the parallel I/O bus. Both MAP Interfaces support the MAP specification version 3.0.

MMS Communications

The MMS-Ethernet LAN Controller module is a single board option which is a member of the GENet Factory LAN hardware and software products. This module supports the MMS (Manufacturing Message Specification - ISO 9506) communications protocol over a 7-Layer ISO protocol stack.

The MAP and MMS LAN Interface boards require 12 VDC, which means that the 100 watt power supply must be used in the rack in which they reside. Multiple MAP and MMS Interfaces may be used in a single Series 90-70 PLC system.

Series 90 Protocol (SNP) Communications

The Series 90 Protocol is a serial protocol used in the Series 90 PLC family to communicate between a host device and the Programmable Logic Controller (PLC) CPU through the CPU's serial port. A protocol is a set of rules that define an orderly transmission of data. In the case of SNP, it is a set of rules that establishes and maintains a serial communications link between a Master

(host device running the master implementation of the SNP protocol) and a Slave (Series 90 PLC CPU). SNP is a Master/Slave protocol where the master initiates all communications and the slave responds to the master's requests. There is no peer-to-peer capability with the SNP protocol (i.e., a PLC cannot be the master; the PLC can only be a slave).

SNP is a half-duplex protocol that uses the RS-485 (enhanced version of RS-422) electrical interface. Several system configurations are possible. There may be just one PLC on the serial link (direct, point-to-point port connection), or there may be many Series 90 PLCs on a serial link (multi-drop port connection). Only one SNP master may be on a multi-drop link. SNP also supports communication over modems.

An RS-422/RS-485 to RS-232 converter (catalog number IC690ACC900) is available for your applications requiring RS-232 devices to be connected to the RS-485 serial port on the Series 90-70 CPUs. Where isolation is required, the RS-422 Isolated Repeater/RS-232 Converter (catalog number IC655CCM590) can be used in place of the RS-422/RS-485 to RS-232 converter. In addition to converting from RS-232 to RS-422/485 communications, this unit provides ground isolation where a common ground cannot otherwise be established between components.

Table 4-5. GE Fanuc Communications Modules

Catalog Number	Module Description
IC697CMM711	Communications Coprocessor Module - offers both CCM and RTU functionality
IC697CMM721	Carrierband MAP Interface - supports MAP 3.0
IC697CMM731	Broadband MAP Interface - supports MAP 3.0
IC697CMM741	MMS-Ethernet LAN Controller - supports MMS communications protocol

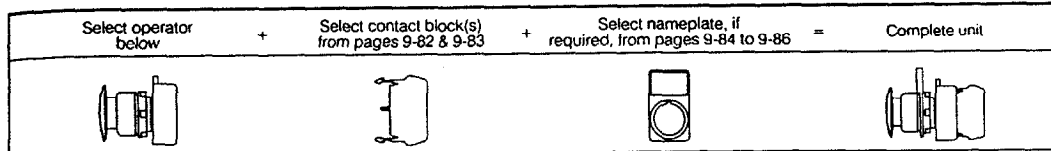
C-2000™ Push Buttons

600 Volts Max. AC/300 Volts Max. DC
10 Amps. Continuous AC/2.5 Amps. Continuous DC

Mushroom-Head Push Buttons



Selection Process



Operators

Momentary & Push To Latch

Replace asterisk (*) in momentary catalog number with color code from colors table below.

Replace dagger (†) in push to latch-key to release catalog number with key code from keys table below.

Style	Head Diameter	Momentary		Red Push To Latch-Turn Release		Red Push To Latch-Key To Release	
		Catalog No.	List Price GO-10GC	Catalog No.	List Price GO-10GC	Catalog No.	List Price GO-10GC
Polished Chrome	28mm	P9CEM3*N	16.50	P9CER3RN	38.50	-	-
	40mm	P9CEM4*N	16.50	P9CER4RN	38.50	P9CEC4RN†	53.50
	60mm	P9CEM6*N	18.50	-	-	-	-
Satin Chrome	28mm	P9MEM3*N	16.50	P9MER3RN	38.50	-	-
	40mm	P9MEM4*N	16.50	P9MER4RN	38.50	P9MEC4RN†	53.50
	60mm	P9MEM6*N	18.50	-	-	-	-
Round Engineered Plastic	28mm	P9XEM3*N	16.50	-	-	-	-
	40mm	P9XEM4*N	16.50	P9XER4RA	38.50	P9XEC4RA†	53.50
	60mm	P9XEM6*N	18.50	-	-	-	-
Square Engineered Plastic	29mm	P9SEM3*N	16.50	-	-	-	-
	40mm	-	-	P9SER4RA	38.50	P9SEC4RA†	53.50

Catalog numbers shown in bold are positive action push buttons as defined in IEC 947-5. Fully depressing the button guarantees that the NC contacts have been opened by purely mechanical means. Less than full depression of the button guarantees that the NC contacts have not been opened.

Push-Pull

Replace asterisk (*) in catalog number with color code from colors table below.

Style	Head Diameter	2-Position Maintained		3-Position Maintained Push-Momentary Pull		3-Position Momentary Push-Momentary Pull	
		Catalog No.	List Price GO-10GC	Catalog No.	List Price GO-10GC	Catalog No.	List Price GO-10GC
Polished Chrome	40mm	P9CET4*N1	21.50	P9CET4*N2	31.00	P9CET4*N3	31.00
Satin Chrome	40mm	P9MET4*N1	21.50	P9MET4*N2	31.00	P9MET4*N3	31.00
Round Engineered Plastic	40mm	P9XET4*N1	21.50	P9XET4*N2	31.00	P9XET4*N3	31.00
Square Engineered Plastic	40mm	P9SET4*N1	21.50	P9SET4*N2	31.00	P9SET4*N3	31.00

*Colors

Color	Black	Red	Green	Yellow
*Color Code	N	R	V	G

†Keys (Set Of 2)

Key Number	Specialⓐ											Coloredⓑ				
	3095	9901	9902	9903	9904	9905	9910	9916	9919	3353	R455 (Ronis)	73033 (Yellow)	73034 (Black)	73037 (Red)	73038 (Blue)	73040 (Orange)
†Key Code	95	01	02	03	04	05	10	16	19	53	55	33	34	37	38	40

ⓐ To order with other than standard key code (95), add \$4.00 to List Price, GO-10GC.

Dimensional drawings on page 9-64

Selection & drawing

data..... pages 9-50, 9-51

Accessories pages 9-87 to 9-95

Technical data pages 9-52 to 9-57

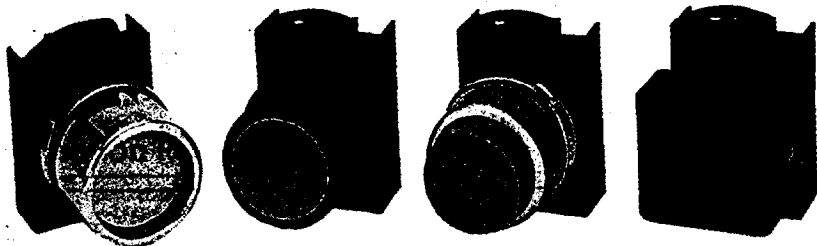
PUSH BUTTONS

9

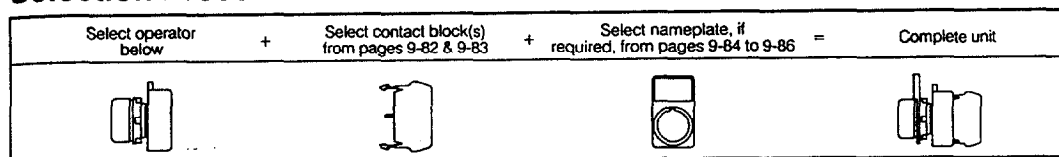
C-2000™ Push Buttons

600 Volts Max. AC/300 Volts Max. DC
10 Amps. Continuous AC/2.5 Amps. Continuous DC

Standard Push Buttons



Selection Process



Operators

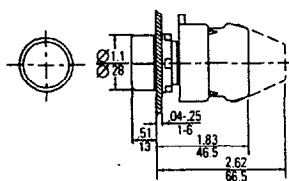
Replace asterisk (*) in catalog number with color code digit from colors table below.

Style	Flush Catalog No.	Extended Catalog No.	Recessed Catalog No.	List Price, GO-10GC
● Polished Chrome	P9CPN * G	P9CPN * S	P9CPN * E	1.50
○ Satin Chrome	P9MPN * G	P9MPN * S	P9MPN * E	1.50
● Round Engineered Plastic	P9XPN * G	P9XPN * S	—	1.50
□ Square Engineered Plastic	P9SPN * G	P9SPN * S	—	1.50

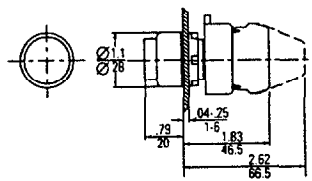
*Colors

Color	Black	Red	Green	Yellow	Blue	White	Brown	Gray	No Cap [Ⓞ]
*Color Code	N	R	V	G	L	B	M	H	O

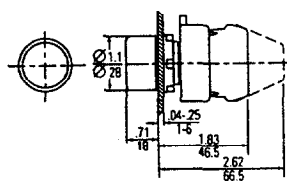
Ⓞ When ordering operator with no cap, deduct \$1.00 from List Price.



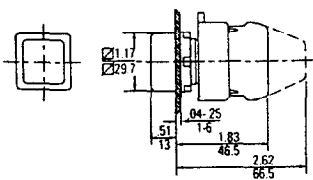
Round Flush Push Button



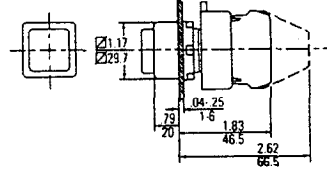
Round Extended Push Button



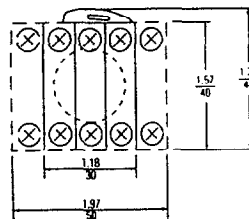
Round Recessed Push Button



Square Flush Push Button



Square Extended Push Button



Typical Back Side View

Dimensions shown in Inches
Millimeters

Selection & drawing data pages 9-50, 9-51
Accessories pages 9-87 to 9-95
Technical data pages 9-52 to 9-57
Specially marked caps page 9-87

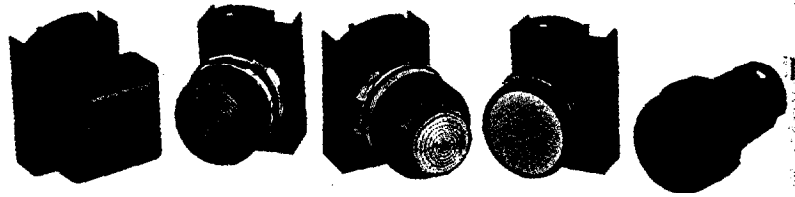


GE Push Buttons

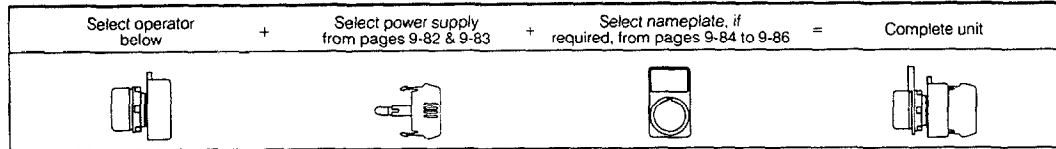
PL 1-3

C-2000™ Push Buttons

600 Volts Max. AC/300 Volts Max. DC
10 Amps. Continuous AC/2.5 Amps. Continuous DC



Pilot Lights Selection Process



Operators

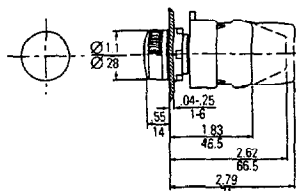
Replace asterisk (*) in catalog number with color code digit from colors table below.

Style	Lighting	Catalog No.	List Price GO-10GC
Polished Chrome	Diffused	P9CL * D	6.00
	Refracted	P9CL * R	6.00
	Glass Lens	P9CL * V	18.50
	No Lens or Diffuser	P9CL00	5.00
Satin Chrome	Diffused	P9ML * D	6.00
	Refracted	P9ML * R	6.00
	Glass Lens	P9ML * V	18.50
	No Lens or Diffuser	P9ML00	5.00
Round Engineered Plastic	Diffused	P9XL * D	6.00
	Refracted	P9XL * R	6.00
	No Lens or Diffuser	P9XL00	5.00
Square Engineered Plastic	Diffused	P9SL * D	7.00
	No Lens	P9SL00	6.00
Unibloc	Full Voltage, Diffused	P9XU * DD0	12.00
	Full Voltage, Refracted	P9XU * RD0	12.00
	Resistor, Diffused	P9XU * DRN	23.00
	Resistor, Refracted	P9XU * RRN	23.00
	Full Voltage, No Lens or Diffuser	P9XU00D0	11.00
	Resistor, No Lens or Diffuser	P9XU00RN	22.00

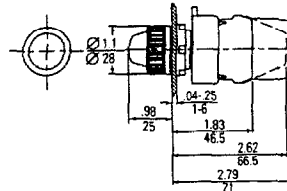
Ⓛ Available only as a pilot light, Unibloc combines an indicator light and power source in one unit, producing a savings for the customer. Full voltage versions do not include lamp; select lamp from p. 9-95. Resistor versions are 130V (ac/dc) and include BA9S 130V/2W lamp.

*Colors

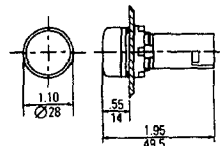
Color	Red	Green	Yellow	Blue	White	Orange	Clear
*Color Code	R	V	G	L	B	A	I



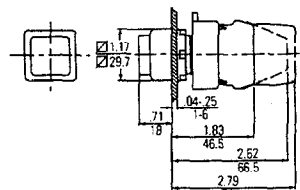
Round Indicating Light



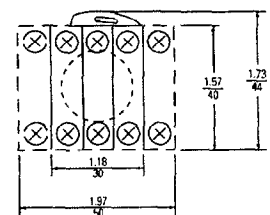
Round Indicating Light - Glass Lens



Round Indicating Light - Unibloc



Square Indicating Light



Typical Back Side View

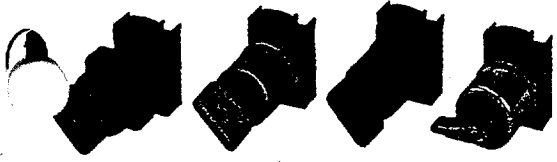
Dimensions shown in Inches
Millimeters

Selection & drawing data pages 9-50, 9-51
 Accessories pages 9-87 to 9-95
 Technical data pages 9-52 to 9-56
 Special marked diffusers 9-98

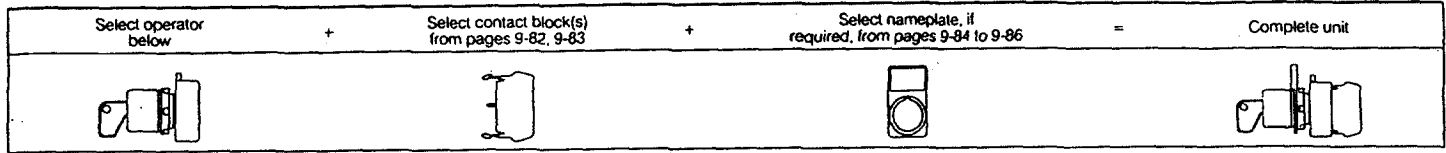
9 PUSH BUTTONS

C-2000™ Push Buttons

600 Volts Max. AC/300 Volts Max. DC
10 Amps. Continuous AC/2.5 Amps. Continuous DC
2-Position Key Selector Switches



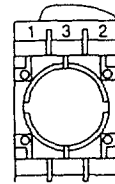
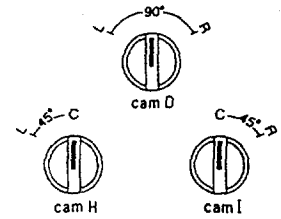
Selection Process



Operators

Replace asterisk (*) in catalog number with style code from styles table below.
Replace dagger (†) in catalog number with key code from keys table below.

Cam	Key Removal	Maintained		Spring Return		
		Catalog No.	List Price GO-10GC	From Left	From Right	List Price GO-10GC
D	L	P9*SCD0A†	43.50	-	P9*SCD5A†	56.50
	R	P9*SCD0E†	43.50	-	-	-
	L-R	P9*SCD0K†	43.50	-	-	-
I	C	P9*SCI0C†	43.50	-	P9*SCI5C†	56.50
	R	P9*SCI0E†	43.50	-	-	-
	C-R	P9*SCI0N†	43.50	-	-	-
H	L	P9*SCH0A†	43.50	-	-	-
	C	P9*SCH0C†	43.50	P9*SCH1C†	-	56.50
	L-C	P9*SCH0H†	43.50	-	-	-



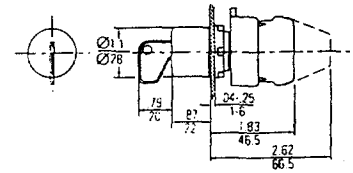
*Styles

Style	<input type="radio"/> Polished Chrome	<input type="radio"/> Satin Chrome	<input checked="" type="radio"/> Round Engineered Plastic	<input type="checkbox"/> Square Engineered Plastic
*Style Code	C	M	X	S

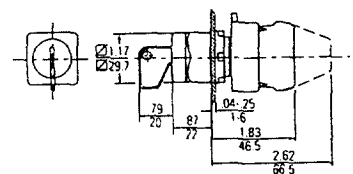
Cams

Note position of contact block for cam selection.

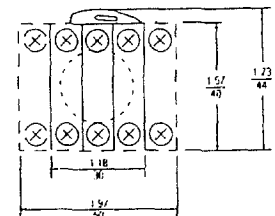
*Cam Code	⌚	⌚	⌚	Screw Terminal Contact Block		Quick Connect Terminal Contact Block	
				Position 1	Position 2	Position 1	Position 2
D	0	-	X	-	P9B10VN	-	P9B10FN
	X	-	0	P9B01VN	-	P9B01FN	-
	0	-	X	P9B11VN	-	-	-
	X	-	0	-	-	-	-
I	-	0	X	-	P9B10VN	-	P9B10FN
	-	X	0	P9B01VN	-	P9B01FN	-
	-	0	X	P9B11VN	-	-	-
	-	X	0	-	-	-	-
H	X	0	-	-	P9V10VN	-	P9B10FN
	0	X	-	P9B01VN	-	P9B01FN	-
	X	0	-	P9B11VN	-	-	-
	0	X	-	-	-	-	-



Round Key Selector Switch



Square Key Selector Switch



Typical Back Side View

Dimensions shown in Inches
Millimeters

†Keys (Set of 2)

Key Number	Std.		SpecialⓄ										ColoredⓄ				
	3095	9901	9902	9903	9904	9905	9910	9916	9919	3353	R455 (Ronis)	73033 (Yellow)	73034 (Black)	73037 (Red)	73038 (Blue)	73040 (Orange)	
† Key Code	95	01	02	03	04	05	10	16	19	53	55	33	34	37	38	40	

Ⓞ To order with other than standard key code (95), add \$4.00 to List Price, GO-10GC.

Selection & drawing data: pages 9-50, 9-51. Accessories: pages 9-92, 9-93. Technical data: pages 9-52 to 9-57.

Prices and data subject to change without notice

1995 Issue



GE Molded Case Circuit Breakers

Molded Case Circuit Breakers

Spectra RMS™, Spectra RMS™ with MicroVersaTrip Plus™ Trip Units, Spectra RMS™ with MicroVersaTrip PM™ Trip Units, Thermal Magnetic and J/K with MicroVersaTrip® RMS-9 and MVT-4 Trip Units

How to Order

Q Line

- Thermal Magnetic Circuit Breakers
- Molded Case Switches

The catalog number as shown in the following pages includes the complete breaker or switch. TQD and TJD breakers are complete with Cu/Al line and load lugs.

Spectra RMS

• Circuit Breakers

Determine the required breaker frame, IC rating, and load requirements. Select frame, trip unit (rating plug), and lug if required, catalog numbers from the tables on pages 4-18 and 4-19. Select field mounted internal accessory catalog numbers, if required, on page 4-47. Select field-mounted external accessory catalog numbers, if required, on pages 4-48 through 4-65. Order as separate items. For Spectra™ breakers with MicroVersaTrip Plus trip units or MicroVersaTrip PM Trip Units refer to page 4-26 through 4-35.

• Mag-Break Motor Circuit Protectors

Determine the required frame and ampere requirements. Select frame, trip unit (rating plug), and lug, if required, catalog numbers from the table on page 4-42. Select accessories as noted above for circuit breakers. The same accessories are used with both circuit breakers and motor circuit protectors. Order as separate items.

• Molded Case Switches

Determine the required frame and ampere requirements. Select frame and lug, if required, catalog numbers from the table on page 4-20. Rating plugs are not used. Select accessories as noted above for circuit breakers. Internal accessories do not require dummy trips. The same accessories are used with both circuit breakers and molded case switches. Order as separate items.

Unless otherwise noted, all circuit breakers are UL Listed in file E-11592. Molded case switches are UL Listed in file E-57546. Field installable Internal Accessories are UL Listed in file E-57253. Distribution Cable Accessories for MicroVersaTrip Plus Trip Units and MicroVersaTrip PM Trip Units are UL Listed in file E-57253.

E 150 Line

- Thermal Magnetic Circuit Breakers
- Magnetic Circuit Breakers
- Molded Case Switches

The catalog numbers as shown in the following pages include the complete breaker or switch. All devices listed come with Cu/Al line and load lugs. If line lugs are not required on a breaker, eliminate "WL" from catalog number; for molded case switches see page 4-3. Unless otherwise noted, all circuit breakers are UL Listed in file E-11592. Molded case switches are UL Listed in file E-57546.

F 225 Line

- Thermal Magnetic Circuit Breakers
- Magnetic Circuit Breakers
- Molded Case Switches

These breakers are available with either non-interchangeable trips (designated Type TFJ) or interchangeable trips (designated Types TFK/THFK). When ordering Type TFJ, catalog number includes

complete breaker, trip unit, Cu/Al line and load lugs *factory assembled*. If line lugs are not required on a breaker, eliminate "WL" from catalog number, and subtract price of line lugs from price of complete breaker. If interchangeable trip (Types TFK/THFK) is required order one of two ways. "Complete circuit breaker" price includes frame, trip, Cu/Al line and load lugs. Units will be shipped unassembled unless specified on order "must be factory assembled." If line lugs are not required on a breaker, eliminate "WL" from catalog number, and subtract price of line lugs from price of complete breaker. To order the frame, trip, and lugs separately, select the required components from table. Magnetic breakers must be ordered as components. A complete breaker consists of frame, trip unit, one line lug per pole and one load lug per pole. Price of "Complete Circuit Breaker" vs. ordering frame, trip and line and load lugs separately is the same.

Molded case switches can also be ordered as complete units (designated TFK---Y) or as separate components. They are UL Listed only as complete units. To indicate required lugs, see page 4-3.

Unless otherwise noted, all circuit breakers are UL Listed in file E-11592. Molded case switches are UL Listed in file E-57546.

J 600 Line

- Thermal Magnetic Circuit Breakers
- Magnetic Circuit Breakers
- Molded Case Switches

These breakers are available with either non-interchangeable trip (designated Type TJJ) or interchangeable trip (designated Type TJK and THJK). Type TJJ catalog numbers include frame, trip, Cu/Al line and load lugs *factory assembled*. If line lugs are not required on the breaker, eliminate "WL" from catalog number, and subtract price of line lugs from price of complete breaker.

TJK breakers are available in two frames, 400-ampere frame (125 to 400 amperes) and 600-ampere frame (250 to 600 amperes). Trip units are not interchangeable between frames.

"Complete Circuit Breaker" price includes frame, trip unit, Cu/Al line and load lugs. Unit will be shipped unassembled unless order specifies "must be factory assembled." If line lugs are not required, eliminate "WL" from catalog number and subtract price of line lugs from price of complete breaker.

To order the frame, trip, and lugs separately, select the required components from table. Magnetic breakers must be ordered as components. A complete breaker consists of frame, trip, and one line and one load lug *per pole*.

Price of ordering "Complete Circuit Breaker" vs. frame, trip and line and load lugs separately is the same.

Molded case switches can also be ordered as complete units (designated Type TJK---Y) or as separate components. They are UL Listed only as complete units. To indicate required lugs, see page 4-3.

Unless otherwise noted, all circuit breakers are UL Listed in file E-11592. Molded case switches are UL Listed in file E-57546.

(continued on next page)

Molded Case Circuit Breakers

K 1200 Line

- Thermal Magnetic Circuit Breakers
- Magnetic Breakers
- Molded Case Switches

These breakers are available only with interchangeable trip units. Two frame sizes are available, the 800-ampere frame (300 to 800 amperes) and the 1200-ampere frame (600 to 1200 amperes). Trip units are not interchangeable between frames.

"Complete Circuit Breaker" price includes frame, trip, Cu/Al line and load lugs. Units will be shipped unassembled unless specified "must be factory assembled." If line lugs are not required on the breaker, eliminate "WL" from catalog number and subtract price of line lugs.

To order the frame, trip and lugs separately, select the required components from table. Magnetic circuit breakers must be ordered as components. A complete breaker consists of frame, trip and one line and one load lug per pole. Price of ordering "Complete Circuit Breaker" vs. frame, trip and line and load lugs separately is the same.

Molded case switches can also be ordered as complete units (designated Type TKMA--Y) or as separate components. They are UL Listed only as complete units. To indicate required lugs, see the table below.

Unless otherwise noted, all circuit breakers are UL Listed in file E-11592. Molded case switches are UL Listed in file E-57546.

3 Frame - 1000/1600/2000 Amp Molded Case Circuit Breakers

- Solid state MicroVersaTrip Plus™ or MicroVersaTrip PM™ trip unit
- Interchangeable trip unit via rating plugs
- 65 and 100 kA ratings available
- Standard and 100% rated versions
- Uses standard Power Break® accessories
- Stationary/manual only

Current Limiting Circuit Breakers

- 150, 225, 400 and 600 ampere frame sizes
- UL Listed interrupting ratings are 200 kA at 240 and 480 volts ac maximum and 50 kA at 600 volts ac maximum.
- Thermal magnetic construction

Circuit Breakers with MicroVersaTrip Trip Units

- Solid state construction with MicroVersaTrip RMS-9 digital rms sensing microprocessor trip units.
- Available in J and K frame construction with ampere ratings from 60-1200A.

For ordering information see pages 4-36 through 4-41. UL Listed, file E-11592. All breakers are UL Listed in file E-11592.

Tri-Break® Line

- Integrally Fused Thermal Magnetic Circuit Breakers
- Integrally Fused Magnetic Circuit Breakers
- Integrally Fused Molded Case Switches

These breakers are available in four types. Type TB1 (15-100 amperes) catalog numbers include frame, trip, line and load lugs, and current limiters all *factory assembled*. Types TB4 (125 to 400 amperes), TB6 (300 to 600 amperes) and TB8 (600 to 800 amperes) include frame, trip and limiters, *factory assembled*, but do not include line or load lugs. If line and load lugs are required, order separately. Unless otherwise noted, TB1, TB4, TB6, TB8 breaker components are UL Listed in file E-42263. Fused molded case switches are UL Listed in file E-57546.

Mag-Break® Line

- Magnetic only circuit breakers (motor circuit protectors).

These breakers are available only with non-interchangeable adjustable magnetic trip, in frame Types E, F, J, K, and Tri-Break. All breakers are shipped factory assembled, complete with Cu/Al line and load lugs.

All magnetic only circuit breakers and limiters are UL component recognized in files E-11592 and E-66390 respectively unless otherwise noted.

Accessories

Order accessories from the appropriate table:

Thermal Magnetic Circuit Breakers, Magnetic Circuit Breakers, and Molded Case Switches®—pages 4-48 to 4-65.

MicroVersaTrip RMS-9 or 4-function Solid State Circuit Breakers—pages 4-48 to 4-65.

- ① Installation of accessories in molded case switches requires dummy trip; see page 4-51 for information. Dummy trip not required for Tri-Break or Q Line molded case switches.

Spectra RMS™ Breakers — pages 4-47 to 4-65.

Spectra RMS™ Breakers with MicroVersaTrip Plus™ Trip Units or MicroVersaTrip PM™ Trip Units — Pages 4-32 to 4-35 and 4-47 to 4-65.

Molded Case Circuit Breaker and Switch Terminal Configuration Code

Order standard Cu/Al lugs by using suffix codes presented. Order lugs separately if special lugs are required. For optional lugs, see page 4-62.

Breaker/Switch Type	Suffix				
	Blank	WL	XL	X2	LL
TQQ/TJD	Load Lugs Only	Line and Load Lugs	—	Line Lugs Only	No Lugs
Molded Case Breakers, Thermal Magnetic	Load Lugs Only	Line and Load Lugs	—	Line Lugs Only	No Lugs
Molded Case Switch	Line and Load Lugs	—	No Lugs	Line Lugs Only	Load Lugs Only
Spectra RMS Breakers	No Lugs	Order Lugs Separately			
J,K MicroVersaTrip Breakers	No Lugs	Order Lugs Separately			
Mine Duty Breakers	No Lugs	Order Lugs Separately			
Mag-Break Breakers	Line and Load Lugs	—	—	—	—

For E150 circuit breakers suffix XL is used to specify "no lugs".

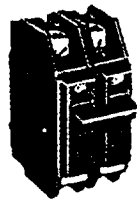
4 MOLDED CASE CIRCUIT BREAKERS



GE Circuit Breakers and Disconnects

Thermal Magnetic Molded Case Circuit Breakers

120/240 Volts
10-100 Ampere
Q Line



THQC22020WL



THQB2115



THHC22020WL



THHB2115

Ampere Rating	10.000 AIC				22.000 AIC				65.000 AIC			
	THOC Lug-lug [ⓐ]		TOB, THOB Bolt-on		Lug-lug [ⓐ]		Bolt-on		TXOC Lug-lug [ⓐ]		TXOB Bolt-on	
	Catalog Number	List Price, GO-135B	Catalog Number	List Price, GO-135B	Catalog Number	List Price, GO-135B	Catalog Number	List Price, GO-135B	Catalog Number	List Price, GO-135B	Catalog Number	List Price, GO-135B

Single-pole, 120/240 Volts ac[ⓐ]

15	THOC1115WL	20.25	THOB1115	19.75	THOC1115WL	35.50	THOB1115	35.00	TXOC1115WL	63.50	TXOB1115	63.50
20	THOC1120WL	20.25	THOB1120	19.75	THOC1120WL	35.50	THOB1120	35.00	TXOC1120WL	63.50	TXOB1120	63.50
25	THOC1125WL	20.25	THOB1125	19.75	THOC1125WL	40.50	THOB1125	39.00	TXOC1125WL	64.50	TXOB1125	63.50
30	THOC1130WL	20.25	THOB1130	19.75	THOC1130WL	40.50	THOB1130	39.00	TXOC1130WL	64.50	TXOB1130	63.50
35	THOC1135WL	20.25	THOB1135	19.75	THOC1135WL	40.50	THOB1135	39.00	-	-	-	-
40	THOC1140WL	20.25	THOB1140	19.75	THOC1140WL	40.50	THOB1140	39.00	-	-	-	-
45	THOC1145WL	20.25	THOB1145	19.75	THOC1145WL	40.50	THOB1145	39.00	-	-	-	-
50	THOC1150WL	20.25	THOB1150	19.75	THOC1150WL	40.50	THOB1150	39.00	-	-	-	-
60	THOC1160WL	20.25	THOB1160	19.75	THOC1160WL	40.50	THOB1160	39.00	-	-	-	-
70	THOC1170WL	39.00	THOB1170	38.00	THOC1170WL	52.00	THOB1170	51.00	-	-	-	-

Two-pole, 120/240 Volts ac[ⓐ]

15	THOC2115WL	43.50	THOB2115	43.50	THOC2115WL	83.50	THOB2115	82.50	TXOC2115WL	157.00	TXOB2115	154.00
20	THOC2120WL	43.50	THOB2120	43.50	THOC2120WL	83.50	THOB2120	82.50	TXOC2120WL	157.00	TXOB2120	154.00
25	THOC2125WL	43.50	THOB2125	43.50	THOC2125WL	83.50	THOB2125	82.50	TXOC2125WL	157.00	TXOB2125	154.00
30	THOC2130WL	43.50	THOB2130	43.50	THOC2130WL	83.50	THOB2130	82.50	TXOC2130WL	157.00	TXOB2130	154.00
35	THOC2135WL	43.50	THOB2135	43.50	THOC2135WL	83.50	THOB2135	82.50	-	-	-	-
40	THOC2140WL	43.50	THOB2140	43.50	THOC2140WL	83.50	THOB2140	82.50	-	-	-	-
45	THOC2145WL	43.50	THOB2145	43.50	THOC2145WL	83.50	THOB2145	82.50	-	-	-	-
50	THOC2150WL	43.50	THOB2150	43.50	THOC2150WL	83.50	THOB2150	82.50	-	-	-	-
60	THOC2160WL	43.50	THOB2160	43.50	THOC2160WL	83.50	THOB2160	82.50	-	-	-	-
70	THOC2170WL	83.50	THOB2170	82.50	THOC2170WL	129.00	THOB2170	126.00	-	-	-	-
80	THOC2180WL	116.00	THOB2180	113.00	THOC2180WL	188.00	THOB2180	183.00	-	-	-	-
90	THOC2190WL	16.00	THOB2190	113.00	THOC2190WL	188.00	THOB2190	183.00	-	-	-	-
100	THOC21100WL	16.00	THOB21100	113.00	THOC21100WL	188.00	THOB21100	183.00	-	-	-	-

Two-pole, 240 Volts ac[ⓐ]

15	THOC22015WL	116.00	THOB22015	113.00	THOC22015WL	159.00	THOB22015	156.00	-	-	-	-
20	THOC22020WL	116.00	THOB22020	113.00	THOC22020WL	159.00	THOB22020	156.00	-	-	-	-
25	THOC22025WL	116.00	THOB22025	113.00	THOC22025WL	159.00	THOB22025	156.00	-	-	-	-
30	THOC22030WL	116.00	THOB22030	113.00	THOC22030WL	159.00	THOB22030	156.00	-	-	-	-
35	THOC22035WL	116.00	THOB22035	113.00	THOC22035WL	159.00	THOB22035	156.00	-	-	-	-
40	THOC22040WL	116.00	THOB22040	113.00	THOC22040WL	159.00	THOB22040	156.00	-	-	-	-
45	THOC22045WL	116.00	THOB22045	113.00	THOC22045WL	159.00	THOB22045	156.00	-	-	-	-
50	THOC22050WL	116.00	THOB22050	113.00	THOC22050WL	159.00	THOB22050	156.00	-	-	-	-
60	THOC22060WL	116.00	THOB22060	113.00	THOC22060WL	159.00	THOB22060	156.00	-	-	-	-
70	THOC22070WL	152.00	THOB22070	148.00	THOC22070WL	200.00	THOB22070	196.00	-	-	-	-
80	THOC22080WL	173.00	THOB22080	170.00	THOC22080WL	240.00	THOB22080	235.00	-	-	-	-
90	THOC22090WL	173.00	THOB22090	170.00	THOC22090WL	240.00	THOB22090	235.00	-	-	-	-
100	THOC22100WL	173.00	THOB22100	170.00	THOC22100WL	240.00	THOB22100	235.00	-	-	-	-

Three-pole, 240 Volts ac[ⓐ]

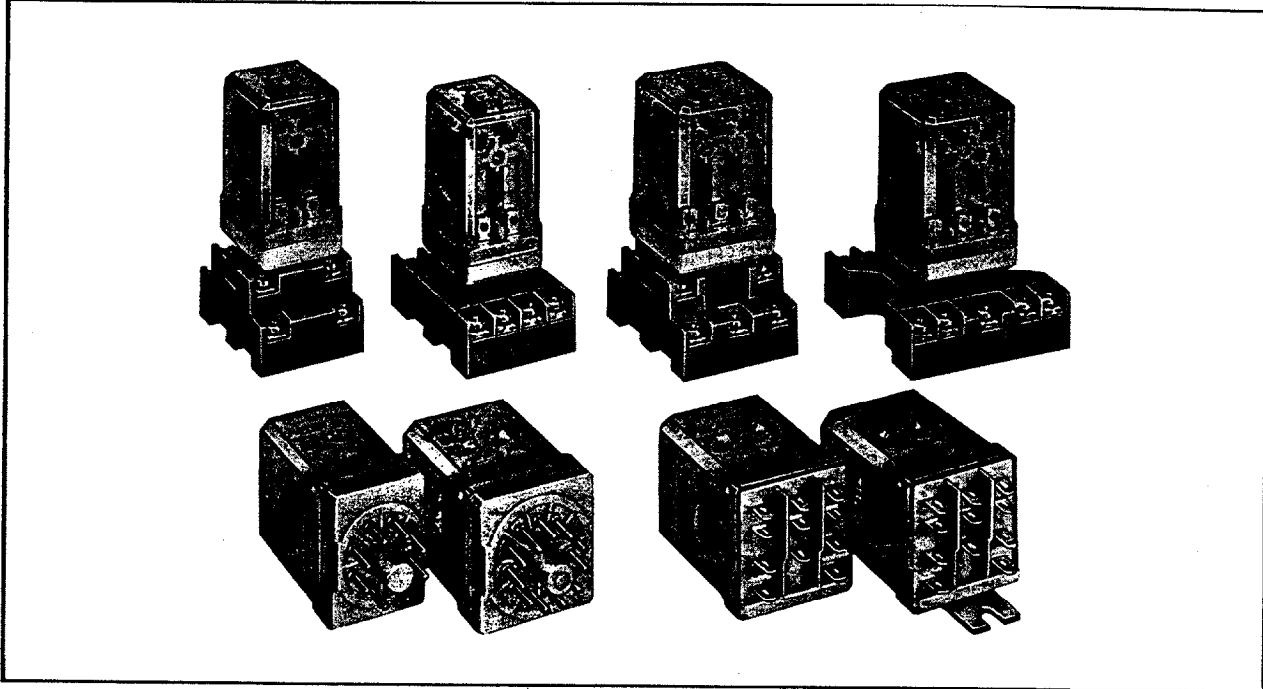
15	THOC32015WL	211.00	THOB32015	139.00	THOC32015WL	216.00	THOB32015	212.00	TXOC32015WL	267.00	TXOB32015	263.00
20	THOC32020WL	211.00	THOB32020	139.00	THOC32020WL	216.00	THOB32020	212.00	TXOC32020WL	267.00	TXOB32020	263.00
25	THOC32025WL	211.00	THOB32025	139.00	THOC32025WL	216.00	THOB32025	212.00	TXOC32025WL	267.00	TXOB32025	263.00
30	THOC32030WL	211.00	THOB32030	139.00	THOC32030WL	216.00	THOB32030	212.00	TXOC32030WL	267.00	TXOB32030	263.00
35	THOC32035WL	211.00	THOB32035	139.00	THOC32035WL	216.00	THOB32035	212.00	-	-	-	-
40	THOC32040WL	211.00	THOB32040	139.00	THOC32040WL	216.00	THOB32040	212.00	-	-	-	-
45	THOC32045WL	211.00	THOB32045	139.00	THOC32045WL	216.00	THOB32045	212.00	-	-	-	-
50	THOC32050WL	211.00	THOB32050	139.00	THOC32050WL	216.00	THOB32050	212.00	-	-	-	-
60	THOC32060WL	211.00	THOB32060	139.00	THOC32060WL	216.00	THOB32060	212.00	-	-	-	-
70	THOC32070WL	278.00	THOB32070	175.00	THOC32070WL	267.00	THOB32070	263.00	-	-	-	-
80	THOC32080WL	202.00	THOB32080	199.00	THOC32080WL	314.00	THOB32080	307.00	-	-	-	-
90	THOC32090WL	202.00	THOB32090	199.00	THOC32090WL	314.00	THOB32090	307.00	-	-	-	-
100	THOC32100WL	202.00	THOB32100	199.00	THOC32100WL	314.00	THOB32100	307.00	-	-	-	-


ⓐ Requires mounting plate. See page 16-22.
ⓑ UL Listed as HACR.


ⓐ UL Listed as SWD (Switching Duty) rated. Suitable for switching 120-volt ac fluorescent lighting loads.

RR SERIES HEAVY-DUTY/GENERAL PURPOSE

HEAVY-DUTY POWER TYPE RELAYS LARGE CAPACITY 10A—1,2,3-POLES



 **UL Recognized**
File No. E67770
E59804
E64245

 **CSA Certified**
File No. LR35144

GENERAL

IDEC's Yellow Series relays are a heavy-duty general purpose relay, with large 10 amp contact capacity. RR Series relays are characterized by their high reliability, long life and are suited for use in industrial grade equipment, small control equipment, communications equipment, etc.

IDEC RR Series relays are available in pin and blade type terminals, each with 2- and 3-pole double throw contacts. Blade type one-pole contacts also available.

IDEC RR Series relays are UL recognized and CSA certified.

FEATURES

- The contact mechanism is secured directly to a molded resin base to eliminate the intermediate plate.
- Simple construction using the least possible number of components.
- Available in UL recognized and CSA certified types.
- Available with check button for test operation and indicator lights.
- Complete line of sockets and socket accessories available for flexible application.

TYPE LIST

Terminal Style	Contact Configuration	Basic Type	W/Indicator Light	W/Check Button	Side Flange	Side Flange W/Check Button
P,PA (Pin)	DPDT	RR2P-U	RR2P-UL	RR2P-UC	—	—
	3PDT	RR3PA-U	RR3PA-UL	RR3PA-UC	—	—
B,BA (Blade)	SPDT	RR1BA-U	RR1BA-UL	RR1BA-UC	RR1BA-US	RR1BA-USC
	DPDT	RR2BA-U	RR2BA-UL	RR2BA-UC	RR2BA-US	RR2BA-USC
	3PDT	RR3B-U	RR3B-UL	RR3B-UC	RR3B-US	RR3B-USC

NOTE: RR1BA and RR2BA are U.S. standard size.

idec RR SERIES HEAVY-DUTY/GENERAL PURPOSE

SPECIFICATIONS

Contact Material	Silver (AG)
Contact Resistance	30mΩ maximum (initial value)
Operate Time	25ms maximum
Release Time	25ms maximum
Power Consumption	AC: Approx. 3VA (50Hz), 2.5VA (60Hz); DC: Approx. 1.5W
Insulation Resistance	100MΩ minimum (measured w/500V DC megger)
Dielectric Strength	Pin Type (RR2P, RR3PA) Bet. live and non-live parts: 1,500V AC, 1 minute Bet. contact circuit and operating coil: 1,500V AC, 1 minute Bet. contact circuits: 1,500V AC, 1 minute (1,000V AC bet. NO-NC contacts)
	Blade Type (RR1BA, RR2BA, RR3B) Bet. live and non-live parts: 2,000V AC, 1 minute Bet. contact circuit and operating coil: 2,000V AC, 1 minute Bet. contact circuits: 2,000V AC, 1 minute Bet. contacts of same polarity: 1,000V AC, 1 minute
Frequency Response	1,800 operations/hour
Temperature Rise	Coil: 153°F (85°C) max. Contact: 117°F (65°C) max.
Vibration Resistance	0 to 6g (55Hz maximum)
Shock Resistance	10g minimum
Life Expectancy	Electrical: Over 500,000 operations (120V, 50/60Hz, 10A) Mechanical: Over 10,000,000 operations
Operating Temperature	-22°F to +158°F (-30°C to +70°C)

COIL RATINGS

Rated Voltage (V)	Rated Current (mA) ±15% @68°F		Coil Resistance (Ω) ±10% @68°F	Maximum Continuous Applied Voltage @68°F	Minimum Operate Voltage @68°F
	60 Hz	50 Hz			
AC	6	420	490	110% of rated voltage without overheating	80% of rated voltage
	12	210	245		
	24	105	121		
	120	18	21		
	240	10.5	12.5		
DC	6	240		110% of rated voltage without overheating	80% of rated voltage
	12	120			
	24	60			
	48	30			
	110	13.5			

CONTACT RATINGS

UL RATED

Voltage (V)	Resistive (A)	Inductive (A)
240AC	10	7
30DC	10	7

CSA RATED/NOMINAL RATING

Voltage (V)	Resistive (A)	Inductive (A)
120AC	10	7.5
240AC	10	7
30DC	10	7.5
110DC	—	0.5

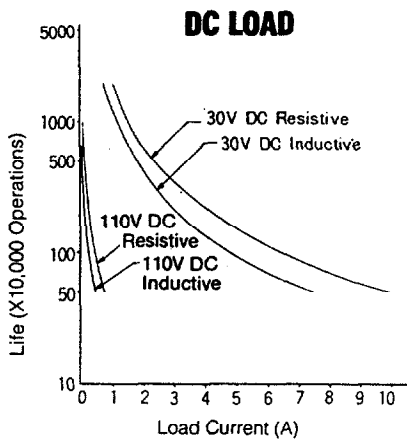
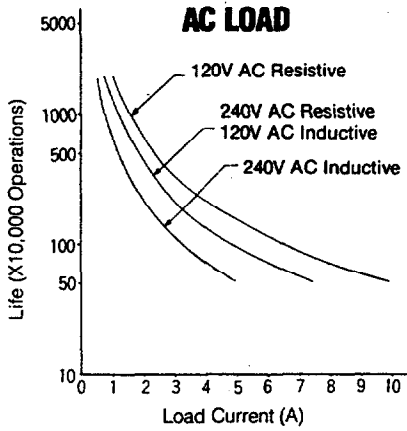
HORSEPOWER RATING

Voltage	Motor Load
120V AC	1/4 hp
240V AC	1/3 hp

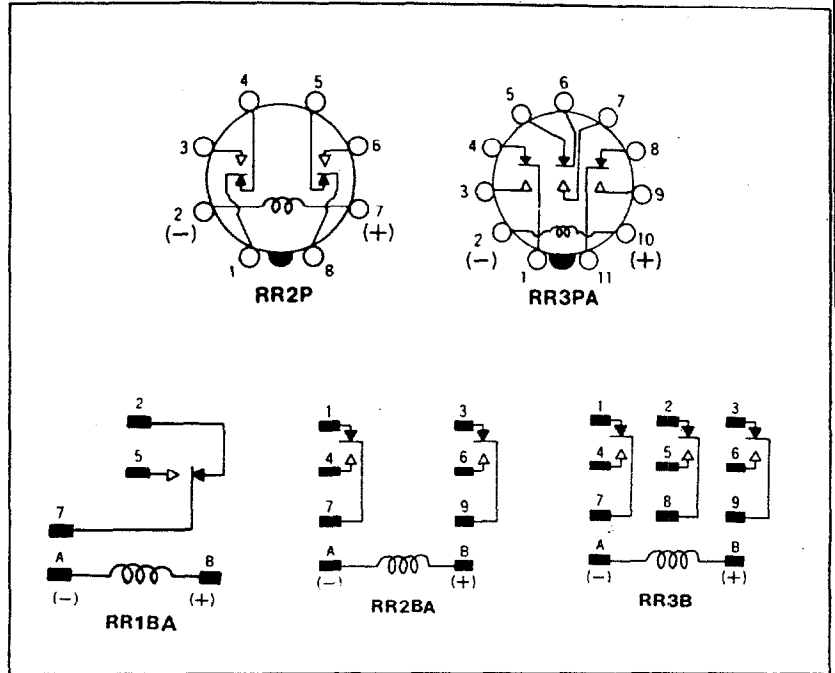
RR SERIES

HEAVY-DUTY/GENERAL PURPOSE

ELECTRICAL LIFE



CIRCUIT DIAGRAM



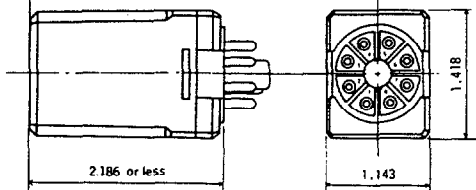
RELAY DIMENSIONS

Dimensions in inches.

PIN TYPE

RR2P

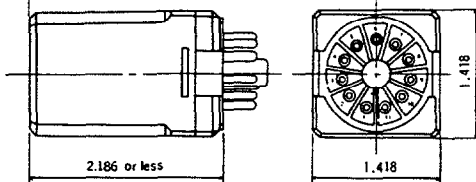
Total length from panel surface including socket
SR2P-05: 3.327 (3.445) or less, SR2P-51: 2.482 (2.679) or less



Dimensions in the () include hold-down spring

RR3PA

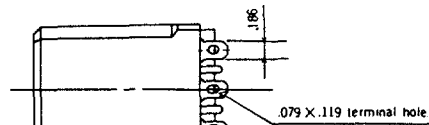
Total length from panel surface including socket
SR3P-05: 3.327 (3.445) or less, SR3P-51: 2.482 (2.679) or less



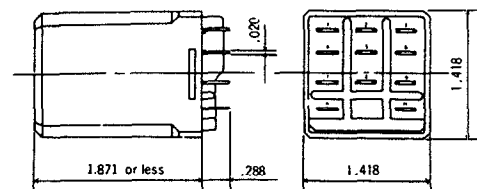
Dimensions in the () include hold-down spring

BLADE TYPE

RR1BA, RR2BA, RR3B



Total length from panel surface including socket
SR3B-02: 2.876 (2.994) or less, SR3B-51: 2.206 (2.364) or less



Dimensions in the () include hold-down spring

Description

The International Power open frame series are a high reliability line of power supplies designed to operate over the wide range of A.C. power sources found worldwide. This feature simplifies your inventory and service consideration by allowing the use of one standard power supply regardless of destination.

These models are designed to meet many domestic and European regulatory agency requirements. If you plan to distribute your products worldwide, obtaining necessary agency approvals can be greatly simplified by specifying the International Power open frame series.

Features

- VDE transformer construction
- 100/120/220/230-240 VAC input
- OVP on 5 volt outputs
- $\pm .05\%$ regulation
- Remote sense on most outputs
- Industry standard case size
- Full rated to 50°C
- Foldback/current limit
- Two hour burn-in
- Two-year warranty
- U.L. recognized - File #E84242
- C.S.A. Certified - File #LR52143
- T.U.V. Licensed
- Chassis notched for A.C. input
- Input accepts .110 x .032 fast-on or solder connection. Not available on F case models

Specifications

- AC Input:**
100/120/220/240 VAC +10%, -13%. 47-63 Hz.
Tolerance for 230 VAC operation is +15%, -10%.
Derate output current 10% for 50 Hz operation.
See chassis A.C. connection table for jumper and line fusing requirements.
-
- DC Output:**
See Voltage/Current Rating Charts.
Adjustment range $\pm 5\%$ minimum.
Voltage nonadjustable on "3 terminal regulator" outputs of models IHAD12 and IHAD15.
-
- Line Regulation:**
 $\pm .05\%$ for a 10% line change.
Exceptions: $\pm .01\%$ for F case models
 $\pm 1\%$ for IHAD12 and IHAD15
 $\pm 0.5\%$ for all other outputs using "3 terminal regulators."
-
- Load Regulation:**
 $\pm .05\%$ for a 50% load change.
Exceptions: $\pm .02\%$ for F case models
 $\pm 1\%$ for IHAD12 and IHAD15
 $\pm 0.5\%$ for all other outputs using "3 terminal regulators."
-
- Output Ripple:**
5V through 15V models: 5.0 mV PK-PK maximum.
(3.0 mV PK-PK maximum for F case models)
24V through 250V models: 3.0 mV PK-PK plus .02% of output voltage, maximum.
All "3 terminal regulator" outputs: 0.2% PK-PK maximum.
-
- Transient Response:**
Less than 50 μ sec for a 50% load change.
-
- Short Circuit and Overload Protection:**
Automatic current limit/foldback.

- Overvoltage Protection:**
Provided on 5V outputs where indicated. Set at 6.2V $\pm 0.4V$.
Other outputs use optional overvoltage protectors IOVP12 and IOVP24.
-
- Remote Sensing:**
See Voltage/Current Rating Charts. Provided on outputs where indicated.
-
- Stability:**
 $\pm 0.3\%$ for 24 hours after warm-up.
-
- Temperature Ratings:**
Operating:
0°C to 50°C full rated, derated linearly to 40% at 70°C. (ICP197 requires 50 CFM forced air over heatsink area for full 50A output.)
- Storage:**
-40°C to 85°C.
-
- Temperature Coefficient:**
.01%/°C typical, .03%/°C maximum.
-
- Efficiency (typical):**
5V outputs: 45%
12V and 15V outputs: 55%
24V through 250V outputs: 60%
-
- Master/Slave Operation:**
Provided on F case models only. For parallel operation of up to 6 units.
-
- Vibration:**
Per MIL-STD-810D, Method 514.3, Category 1, Procedure I.
-
- Shock:**
Per MIL-STD-810D, Method 516.3, Procedure III.
-
- EMI/RFI:**
These linear power supplies have inherently low conducted and radiated noise levels. For most system applications they will meet the requirements of FCC Docket 20780 for Class B equipment and VDE 0871 for Class B.

Safety Specifications

All models exceed the following safety standards

- Leakage Current
Line to Ground (maximum) 0.05 mA
- Creepage Distance
Live Parts to Dead Metal (minimum) .345" (9.0mm)
- Dielectric Withstand Voltage (minimum)
Input to Ground (minimum) 3750 VRMS
Input to Outputs (minimum) 3750 VRMS
Outputs to Ground (minimum) 500 VDC

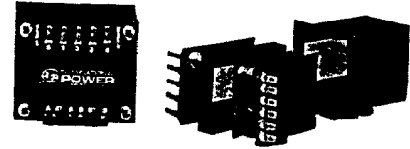
Safety Agencies

UL Recognized: File Number E84242
 CSA Certified: File Number LR52143
 TUV Licensed: Contact Factory for Details on IEC-950,
 VDE-0806 and UL 1950

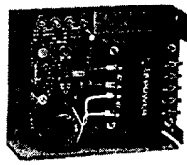
Transformers

International Power, Open Frame Transformers feature separate, fully enclosed, primary and secondary coils.

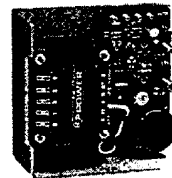
Meets Safety Requirements of:
 VDE, UL, CSA, BPO, IEC, CEE and ECMA



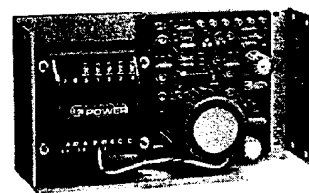
A Case



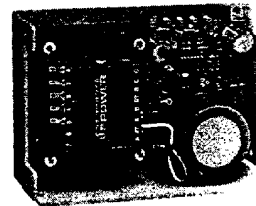
B Case



C Case



D Case



N Case

Single Output, Linear Voltage/Current Rating Chart

SINGLE OUTPUT MODELS

MODEL	VOLTAGE/ CURRENT	CASE SIZE
5 VOLTS		
IHA5-1.2/OVP	5V @ 1.2A**	A
IHA5-1.5/OVP	5V @ 1.5A*	B
IHB5-3/OVP	5V @ 3A*	B
IHC5-6/OVP	5V @ 6A*	C
IHN5-9/OVP	5V @ 9A*	N
IHD5-12/OVP	5V @ 12A*	D
IHE5-18/OVP	5V @ 18A*	E
IF5-25/OVP	5V @ 25A*	F
IG5-35/OVP	5V @ 35A*	F
ICP197	5V @ 50A*	F
12 VOLTS		
IHA15-0.5	12V @ 0.5A**	A
IHA15-0.9	12V @ 0.9A*	B
IHB12-1.7	12V @ 1.7A*	B
IHC12-3.4	12V @ 3.4A*	C
IHN12-5.1	12V @ 5.1A*	N
IHD12-6.8	12V @ 6.8A*	D
IHE12-10.2	12V @ 10.2A*	E
IF15-15	12V @ 16A*	F

SINGLE OUTPUT MODELS

MODEL	VOLTAGE/ CURRENT	CASE SIZE
15 VOLTS		
IHA15-0.5	15V @ 0.5A**	A
IHA15-0.9	15V @ 0.9A	B
IHB15-1.5	15V @ 1.5A*	B
IHC15-3	15V @ 3A*	C
IHN15-4.5	15V @ 4.5A*	N
IHD15-6	15V @ 6A*	D
IHE15-9	15V @ 9A*	E
IF15-15	15V @ 15A*	F
24 VOLTS		
IHA24-0.5	24V @ 0.5A*	B
IHB24-1.2	24V @ 1.2A*	B
IHC24-2.4	24V @ 2.4A*	C
IHN24-3.6	24V @ 3.6A*	N
IHD24-4.8	24V @ 4.8A*	D
IHE24-7.2	24V @ 7.2A*	E
IF24-12	24V @ 12A*	F

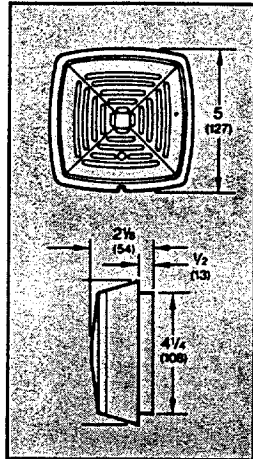
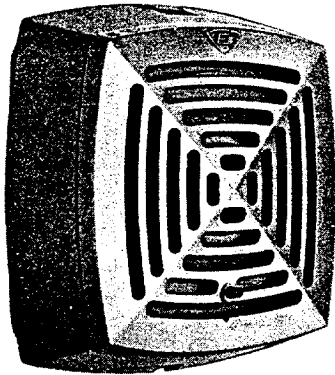
*Remote Sense Provided
 **Not International Series

SINGLE OUTPUT MODELS

MODEL	VOLTAGE/ CURRENT	CASE SIZE
28 VOLTS		
IHA24-0.5	28V @ 0.5A*	B
IHB28-1	28V @ 1.0A*	B
IHC28-2	28V @ 2.0A*	C
IHN28-3	28V @ 3.0A*	N
IHD28-4	28V @ 4.0A*	D
IHE28-6	28V @ 6.0A*	E
IF24-12	28V @ 10A*	F
48 VOLTS		
IHB48-0.5	48V @ 0.5A	B
IHB48-0.5-105	48V @ 7.5A	B
IHC48-1	48V @ 1.0A	C
IHC48-1-105	48V @ 1.5A	C
IHD48-3	48V @ 3.0A*	D
IHE48-4	48V @ 4.0A*	E
IF48-8	48V @ 8.0A**	F
135-265 VOLTS		
IHB155-0.12	135-170V @ .12A	B
IHB200-0.12	175-210V @ .12A	B
IHB250.0.1	215-265V @ .10A	B

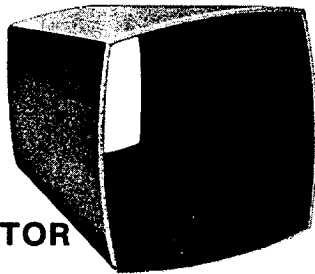
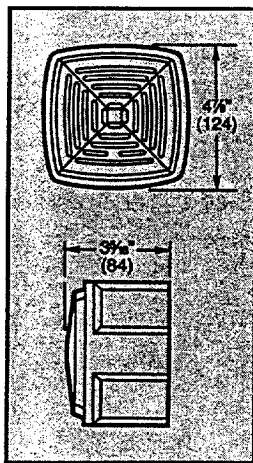
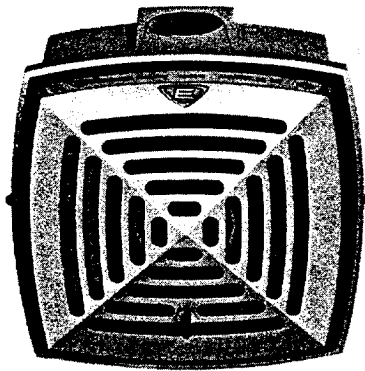
GRILLE TYPE

For general broadcast coverage. Convenient, simple Adaptable mounting. Projects only 2" from mounting surface. Mounts on any single gang box or 3 1/4", 3 1/2" or 4" octagon box, 4" square box or behind flush mounted grille. See page A7 for product description.



WEATHERPROOF TYPE

For outdoor applications. Die-cast weatherproof box with bonderized sage gray finish. Mounts on conduit or any flat surface. Drilled and tapped 3/4"-14 NPT on top and has knockouts bottom and rear.



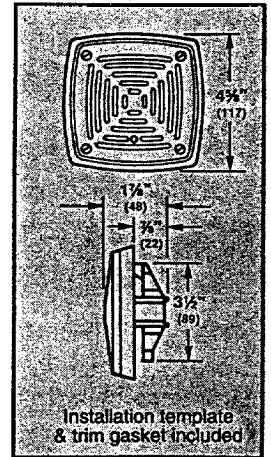
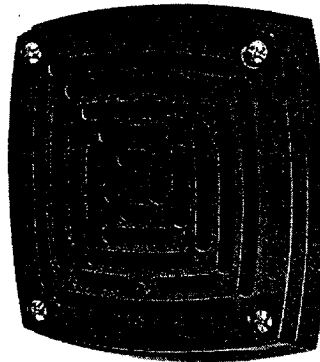
PLASTIC PROJECTOR

Cat. No.	Type	Description
872-P0	Projector Only	Plastic Projector for 872/873 is available as separate item. Snaps onto any Adapthorn.

SEMI FLUSH/PANEL MOUNT TYPE

Designed for Semi-flush Panel mounting, also suitable for installation on 4" Square box. Supplied with trim gasket. Volume adjustable screw is conveniently located on front of horn. Installation template included.

AVAILABLE March 1992



STANDARD AC SERIES

Cat. No.	Type	Volts AC	Amps	VA	DC Coll Res. (Ohms)	dB at 10Ft.
870-G5	Flush	24V AC*	.63	15	5.2	103
870-N5		120V AC*	.13	15	150	
870-R5		240V AC*	.06	15	580	
870P-G5	Panel Mounted	24V AC*	.63	15	5.2	
870P-N5		120V AC*	.13	15	150	
870P-R5		240V AC*	.06	15	580	
872-G5	Projector	24V AC*	.63	15	5.2	
872-N5		120V AC*	.13	15	150	
872-R5		240V AC*	.06	15	580	
874-G5	Grille	24V AC*	.63	15	5.2	
874-N5		120V AC*	.13	15	150	
874-R5		240V AC*	.06	15	580	
876-G5	Weather-Proof	24V AC*	.63	15	5.2	
876-N5		120V AC*	.13	15	150	
876-R5		240V AC*	.06	15	580	

* 50/60 Hz UL Listed and FM approved.

STANDARD DC SERIES

Cat. No.	Type	Volts DC	Amps	VA	DC Coll Res. (Ohms)	dB at 10Ft.
871-G1	Flush	24	.16	3.5	24	101
871-P1		125	.025	3.5	600	
871P-G1	Panel Mounted	24	.16	3.5	24	
871P-P1		125	.025	3.5	600	
873-G1	Projector	24	.16	3.5	24	
873-P1		125	.025	3.5	600	
875-E1	Grille	12	.27	3.5	6	
875-G1		24	.16	3.5	24	
875-J1		32	.11	3.5	40	
875-P1		125	.025	3.5	600	
875-S1		250	.014	3.5	2400	
877-G1		Weather-Proof	24	.16	3.5		24
877-P1	125		.025	3.5	600	

UL Listed.

For Hazardous Location Models See Page A20.

JUSLYN

TECHNICAL DATA

10910, 23.1D



MODEL 1250-32

SURGITRON[®]

SURGE ARRESTER

110-175V RMS, 50-60 Hz

2 Wire, Single Phase

Listed by Underwriters Laboratories Inc.

For this reason, this power arrester has widespread use in computer installations and microwave stations as well as in the telephone, railroad, and petroleum industries.

With increased use of sensitive electronics such as computers, air conditioning controls and video recorders in homes, low voltage arresters are needed to prevent damage from electrical surges. These arresters are ideally suited for this and are designed for easy installation at fuse boxes and similar locations.

Long life and maintenance free operation, even in heavy surge conditions, make this unit the perfect arrester for remote and unattended stations, or stations with no back-up circuits available. The arrester is enclosed in a moisture proof housing to ensure reliable operation in any environmental condition.

METHOD OF OPERATION

When a surge voltage exceeds the normal system voltage the arrester instantaneously conducts the surge to ground. The arrester continues to conduct the surge to ground until the surge has passed and the system voltage has returned to normal. The arrester automatically restores itself to its normal operating condition without interruption of service and with no necessity to replace fuses or to reset circuit breakers.

DISTINCTIVE FEATURES

1. Instantaneous and reliable response in any environment.
2. Absolutely no interruption of power nor drop in voltage during or after passage of a surge.
3. Extremely long life with dependable protection.
4. Low voltage clamping level even with high current surges.
5. Ability to withstand surge currents up to 20,000 amps peak (8 x 20 μ sec wave) and survive.
6. Reliable and equal performance in either polarity.

APPLICATION

The power arrester model 1250-32 is designed to protect against transients caused by lightning, induction, switching surges and EMP.

The instantaneous response makes it particularly effective in preventing damage to delicate solid state electronic equipment.

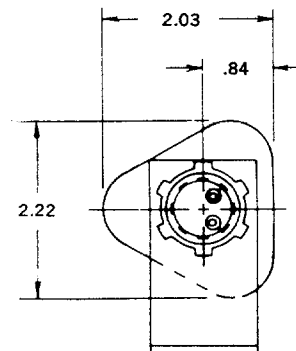
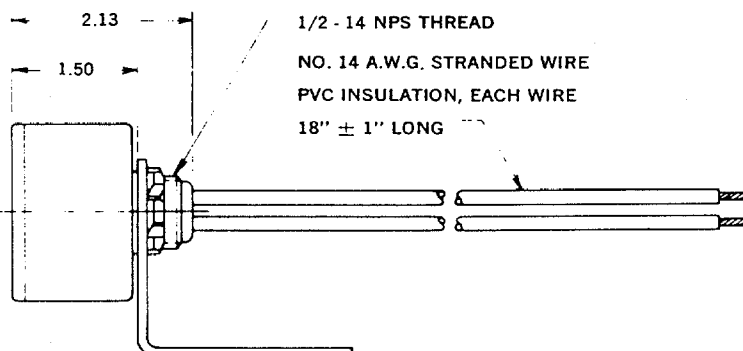
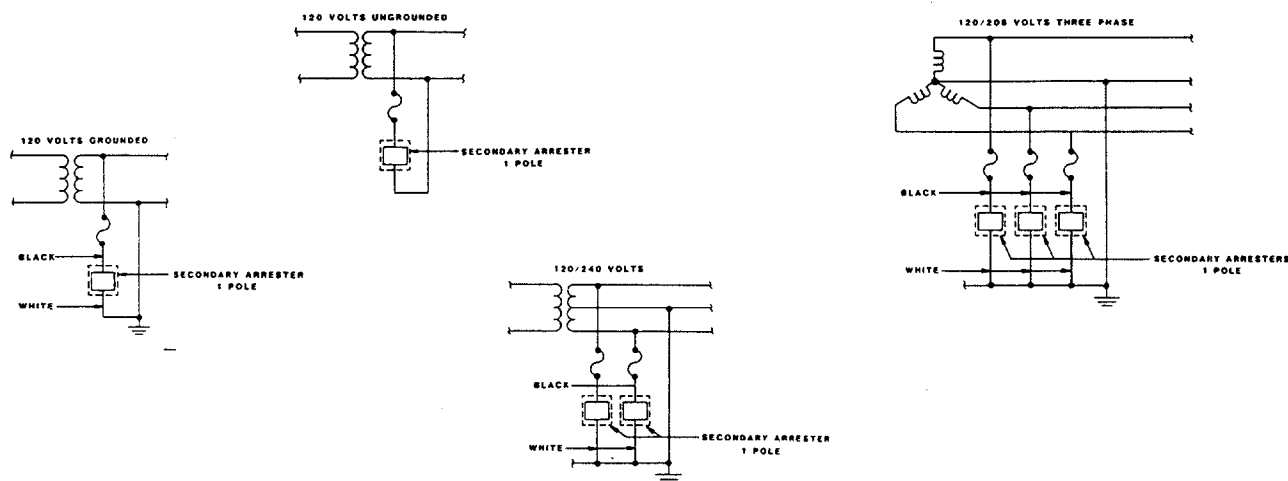
*Covered by one or more of the following patents:

3,312,868	3,320,462	3,353,066	3,388,274	3,413,587	3,448,337	4,132,915
3,535,582	3,543,207	3,564,473	3,588,576	3,811,064	3,813,577	3,828,290

SPECIFICATIONS

APPLICATION	120V RMS, Single Phase 2-wire 50/60 Hz
Voltage Rating:	110-175 Vrms Phase to Neutral
Power Rating	Unlimited
Response Time	Instantaneous (No Delay — Continuous Conduction)
Response with Rate-of-Rise of 10kV/μs	Less than 350V pk
Discharge Voltage 8x20μsec Wave with 5,000 Amps 10,000 Amps	650 V Nom. 750 V Nom.
Minimum Life 1.5 KA 8x20μsec wave	2500 Operations
Extreme Duty Discharge Capacity (8x20μsec wave)	20,000 Amps Peak
Power Consumption	Less than 30 Milliwatts
Operating Temperature Range	-40°F to +140°F
Maximum Operating Altitude	12,000 Feet
Shipping Weight:	Approx. .5 pound

CONNECTION DIAGRAMS



JOSLYN
ELECTRONIC SYSTEMS

6868 CORTONA DRIVE
SANTA BARBARA RESEARCH PARK
POST OFFICE BOX 817
GOLETA, CALIFORNIA 93116
TELEPHONE (805) 968-3551
TELEX 181824



The Best Features

Gateway 2000® beats the competition to the punch with the world's best features!

TelePath 28.8™ Fax/Modem Communication Center

Access a world of information at the touch of a button using the TelePath 28.8 fax/modem Communication Center. Standard or available as an upgrade on all Gateway desktop systems, the TelePath has a 28,800bps modem and a 14,400bps fax. Combined with the included FaxWorks™ software, it provides a complete Communication Center. You get an answering machine and access to today's online world. Also included with the TelePath 28.8 fax/modem Communication Center are trial memberships to CompuServe®, America Online® and Prodigy®.

Software

You can have action and excitement for the whole family — and the tools to conquer all *your* special missions. Gateway outfits you with incomparable software applications on all our systems. Choose a Family PC™ multimedia system and be transfixed by Gateway's new Generations Software Collection including 51 software programs! Professional Gateway PCs include Microsoft® Office Professional 4.3, the world's number-one selling software suite. And all Gateway desktop PCs include MS Windows® for Workgroups 3.11 — the fastest version of Windows available (today).

Vivitron™ Monitors

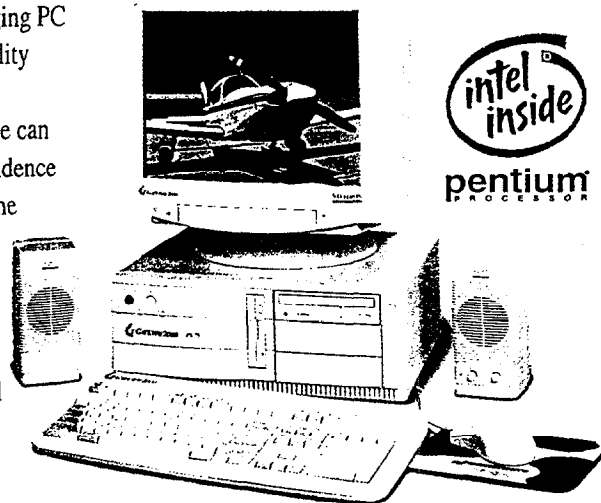
Electric color, a razor-sharp focus and crystal clear images — all from a Gateway 15- or 17-inch Vivitron monitor! These monitors feature Sony® Trinitron® tube technology — technology that the most discerning viewers have relied on for decades.

The Best Service and Support

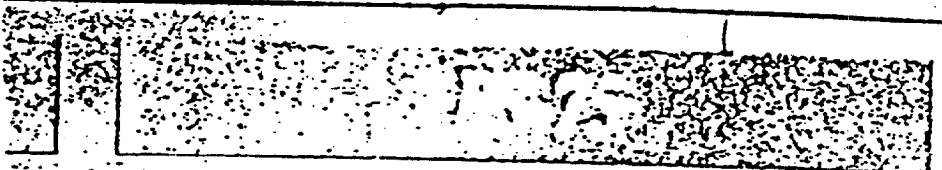
Gateway 2000 delivers another powerful blow to the competition by providing all our customers with award-winning, toll-free technical support for the life of their Gateway system! All Gateway desktop systems and monitors are also covered by a three-year limited warranty. Write or call us for a free copy of our warranty.

The Best Quality

For nearly 10 years, Gateway 2000 has prevailed when it comes to bringing PC buyers the highest-quality computer components available — the best we can possibly offer. The evidence speaks for itself with the MS Mouse, Gateway's programmable AnyKey® keyboard, and of course, our trademark cow-spotted boxes!



GATEWAY2000

- 
- Intel 75MHz Pentium Processor*
 - 8MB EDO Performance-Enhanced Memory
 - 1GB 10ms IDE Hard Drive
 - B ■ PCI Enhanced IDE Interface
 - 32-Bit PCI Graphics Accelerator w/ 1MB DRAM
 - 4X CD-ROM
 - 3.5" Diskette Drive
 - 0 ■ 15" .25dp Vivitron Color Monitor
 - 7-Bay Desktop Case
 - 101-Key Keyboard & MS Mouse 2.0
 - MS-DOS 6.22 & WFW 3.11
 - Microsoft Windows 95 Upgrade
 - MS Office Professional 4.3,** Bookshelf* & Money 3.0
 - 3-Year Limited Parts Warranty

Communications & Storage

TelePath™ 28.8 Fax/Modem Communication Center

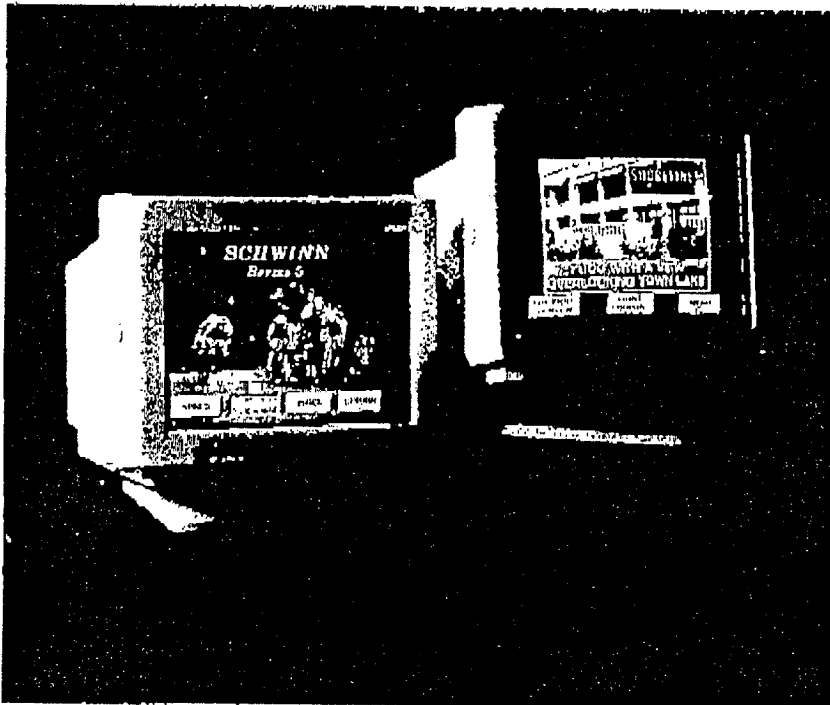
Revolutionize your communication needs with the TelePath 28.8 fax/modem Communication Center. Internal fax/modem, 28,800bps modem, V.34, with 14,400bps fax capability. Sends and receives faxes, and sends and saves voice messages. Includes CD containing CompuServe®, Prodigy®, and America Online® trial memberships. **\$149** (TelePath 14.4K Fax/Modem \$79)

Colorado Memory Systems® Jumbo™ 1400 TBU

CMS Jumbo 1400 internal-tape backup unit with up to 1.36GB compressed (680MB native) storage capacity per tape. Comes with MS Windows™ and DOS® software, one tape and cable. **\$199**

GOLDSTAR® 14" Touch Frames

Modular design offers clip-on installation and plug-and-play capability.



Carroll Touch now offers two non-invasive clip-on scanning infrared touch frames for the Goldstar® 14" Plus and SVGA series monitors. The all solid-state touch frames feature a clip-on bezel that easily and aesthetically integrates with the analog RGB monitors in a matter of seconds. Easy-to-use, the new clip-on touch frames are ideal for point-of-sale, training, interactive kiosks, or any application where a simple, intuitive interface is required.

The Goldstar® touch frame is part of the new modular design strategy from Carroll Touch, giving users a flexible family of plug-compatible touch frames and controllers. As with all of Carroll Touch's modular products, the Goldstar® 14" touch frames come with a comprehensive five year warranty.

The Goldstar® 14" touch frames are available with any of CT's modular controllers including: a Software-Based, Hardware-Based, PC/104, or RS-232 Controller. Each frame independent controller is equipped with digital circuitry and provides true plug-and-play capability. Available as part of an Add-Touch® or Total-Touch® system, the Goldstar® 14" Touch Frames are compatible with the following monitors.

1423 PLUS
1425 PLUS
1430 PLUS
1450 PLUS
1453 SVGA
1460 SVGA



Carroll Touch
a subsidiary of AMP Incorporated

	Resolution and Z-Axis	Transmissivity	Activation, Parallax and Response Time	Stylus Type	Sensor Drift and Calibration	Integration	Reliability
Capacitive Overlay	1024 x 1024 physical, no Z-axis	85 - 92%	Tactile activation, no parallax, 15 - 25ms	Requires conductive stylus. Unable to simultaneously detect gloved and ungloved finger. No stylus limitation.	Subject to drift. Requires repetitive calibration.	Invasive and non-invasive. Optical bonding required for optimum display clarity.	Sensor - 20,000,000 touches per point Controller - >186,000 hrs. MTBF
Force Vector	0.025" physical, plus Z-axis	100%	Tactile activation, no Parallax, 250ms		Subject to drift. Requires complex calibration.	Non-invasive, independent of display type	80,000 hrs. MTBF
Guided Acoustic Wave	0.0125" physical, plus Z-axis	92%	Tactile activation, no parallax, 18 - 40ms	Requires soft, energy absorbing stylus	Not subject to drift	Invasive, optical bonding required for optimum display clarity	Not currently specified
Resistive Overlay	256 x 256 to 4096 x 4096 physical, no Z-axis	55 - 78%	Tactile activation, no parallax, 13 - 18ms	No stylus limitation	Subject to drift. Requires repetitive calibration.	Invasive, optical bonding required for optimum display clarity	Sensor - 2,000,000 touches per point Controller - 86,000 - 118,000 hrs. MTFB
Scanning Infrared	0.25" physical, 0.125" logical, no Z-axis	100%	Proximity activation, parallax, 18 - 40ms	No stylus material limitation. Minimum stylus diameter 5/16".	Not subject to drift	Invasive and non-invasive	>138,000 hours MTBF
Strain Gage	4096 x 4096 physical, plus Z-axis	92%	Tactile activation, Parallax, †	No stylus limitation	Subject to drift. Requires complex calibration.	Invasive and non-invasive.	Not published by manufacturer
Surface Acoustic Wave	0.030" physical, plus Z-axis	92%	Tactile activation, no parallax, 53 - 58ms	Requires soft, energy absorbing stylus	Not subject to drift	Invasive, optical bonding required for optimum display clarity	Sensor - 50,000,000 touches per point Controller - 86,000 - 118,000 hrs. MTBF

* Manufacturer's published data.
† Data not furnished by manufacturer

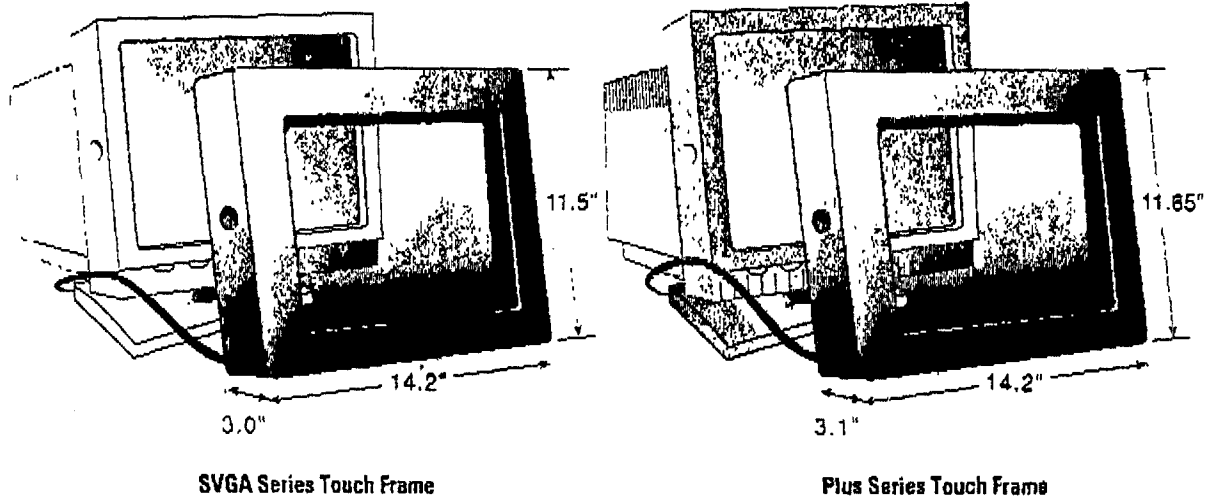
Environmental Considerations*

	Durability/Resistance to Vandalism	NEMA Ratings, Moisture Resistance	Dust and Dirt Resistance	Chemical Resistance	Vibration and Shock Resistance	Ambient Light	Temperature Humidity, and Altitude
Capacitive Overlay	Difficult to scratch, conductive layer is subject to wear, glass overlay is breakable	NEMA 12 NEMA 4	Will operate with moderate dust and dirt, excessive accumulation may affect performance	Not affected by general purpose cleaning solutions	Tolerant of vibration, thick glass overlay moderately susceptible to shock	Unaffected by ambient light	Sensor - 0° to 70° C Controller - 0° to 70° C, 0 to 95% non-condensing humidity, 90,000 ft. (9,000 m)
Force Vector	Display and platform must be secured against theft	NEMA 12	Not affected by dust and dirt	Not affected by general purpose cleaning solutions	Sensitive to vibration and shock	Unaffected by ambient light	0° to 50° C, 0 to 95% non-condensing humidity, alt. not spec'd
Guided Acoustic Wave	Difficult to scratch, glass overlay is breakable	NEMA 12 NEMA 4	Not affected by dust and dirt	Not affected by general purpose cleaning solutions	Tolerant of vibration, thin glass overlay susceptible to shock	Unaffected by ambient light	0° to 50° C, 0 to 95% non-condensing humidity, alt. not spec'd
Resistive Overlay	Sensor is vulnerable to scratches and abrasions, glass overlay can be broken	NEMA 12 NEMA 4	Not affected by dust and dirt	Not affected by general purpose cleaning solutions. Chemicals which affect polyester should not be used.	Tolerant of vibration, thin glass overlay susceptible to shock	Unaffected by ambient light	0° to 50° C, 0 to 95% non-condensing humidity, 15,000 ft. (4,500 m)
Scanning Infrared	Not susceptible to scratching, no overlay to break, completely solid state, no exposed parts	NEMA 12 NEMA 4	Will operate with moderate dust and dirt, excessive accumulation may affect performance	Not affected by general purpose cleaning solutions. Chemicals which affect polycarbonates should not be used.	Tolerant of vibration and shock	Varies by manufacturer, custom designs required for direct sunlight	0° to 55° C 0 to 95% non-condensing humidity, 10,000 ft. over full temp. range
Strain Gage	Difficult to scratch, glass overlay is breakable	NEMA 12	Not affected by dust and dirt	Not affected by general purpose cleaning solutions	Sensitive to vibration and shock	Unaffected by ambient light	0° to 50° C, 0 to 95% non-condensing humidity, 7,000 ft.
Surface Acoustic Wave	Difficult to scratch, glass overlay is breakable	NEMA 12	Will operate with moderate dust and dirt	Not affected by general purpose cleaning solutions	Tolerant of vibration, thin glass overlay susceptible to shock	Unaffected by ambient light	0° to 50° C, 0 to 95% non-condensing humidity, 15,000 ft. (4,500 m)

S P E C I F I C A T I O N S

TOUCH RESOLUTION	1/4-inch physical resolution with 1/8-inch enhanced resolution
FRAME SIZE	X-axis = 40 optopairs, Y-axis = 30 optopairs
OPERATING MODES	Enter Point, Tracking, Continuous, Exit Point, Add Exit Point (modifier)
FRAME SCAN RATE	25-50 scans/second (controller dependent)
POWER REQUIREMENTS	+ 12V (LED Drive voltage) and + 5V (Logic and analog circuits), both supplied through the touch controller (See touch controller specifications for requirements)
COMMUNICATIONS	Modular Digital Interface (frame to controller)
OPERATING ENVIRONMENT	
Temperature	0°C to 50°C (32°F to 122°F)
Humidity	0% to 95% non-condensing
Altitude	10,000 ft. (3,048 m) full temperature range
STORAGE ENVIRONMENT	
Temperature	-20°C to 75°C (-4°F to 167°F)
Humidity	0% to 95% non-condensing
FLAMMABILITY	PWBs = UL-94V-0 Inner Bezel = UL-94V-2 Outer Bezel = UL-94V-HB
CONNECTORS	8-pin RJ-45 phone cable/jack (power and control)

D I M E N S I O N S



ORDERING INFORMATION

To order, specify the order number and description from the chart below. For more information, contact your Carroll Touch representative.

ADD-TOUCH®—INCLUDES TOUCH FRAME AND SOFTWARE DRIVERS

8100-9450-01 Goldstar® 14" Touch Frame — PLUS SERIES
Compatible with the following Goldstar® monitors:
1423 PLUS (VGA), 1425 PLUS (VGA), 1430 PLUS (SVGA)

8100-9670-01 Goldstar® 14" Touch Frame — SVGA SERIES
Compatible with the following Goldstar® monitors:
1453 SVGA (SVGA/.30 dot pitch), 1460 SVGA (SVGA/.28 dp)

TOTAL-TOUCH®—INCLUDES INTEGRATED CRT, TOUCH FRAME, AND SOFTWARE DRIVERS

8001-4306-01 Goldstar® 1423 PLUS (VGA/.30 dot pitch)
8001-4305-01 Goldstar® 1453 PLUS (SVGA/.30 dot pitch)
8001-4303-01 Goldstar® 1460 PLUS (SVGA/.28 dot pitch)
8001-4330-01 Goldstar® 1460 SVGA (SVGA/.28 dot pitch)

MODULAR CONTROLLERS (required)

8200-3222-01	Software-Based Controller
8200-3224-01	Hardware-Based Controller
8200-3228-01	PC/104 HBC Controller 12V
8200-3228-5V	PC/104 HBC Controller 5V
8200-3228-01	PC/104 SBC Controller 12V
8200-3228-5V	PC/104 SBC Controller 5V
8100-9396-01	RS-232 Controller

CONTROLLER OPTIONS

0100-3385-00	Power Supply, RS-232-110V wallmount
6200-0301-01	Modular RS-232 Cable

RELATED MANUALS

2970-0002-01	Goldstar® Touch Frame Installation Guide
2950-0012-01	Touch System Diagnostics User's Guide

Hardware- Based Controller

On-board processor
matches speed with
performance

The Hardware-Based Controller (HBC) is a scanning infrared touch controller for use with the full line of Carroll Touch modular touch frames for CRTs and flat panel displays. Residing on an AT-compatible half-card, the HBC is part of the Carroll Touch family of modular, plug-and-play products.

The HBC contains an on-board microcontroller unit (MCU) which makes it the fastest in the Carroll Touch line of modular controllers. Power is obtained from the PC bus, and a selectable I/O address and interrupt provide the interface to the host computer.

The HBC also offers fast and easy installation, and will stand up to continued use and still assure many years of the reliable performance that has made Carroll Touch the leader in infrared touch technology.

Backed by a five year warranty, the HBC meets the challenge when reliability is essential and quality is demanded.



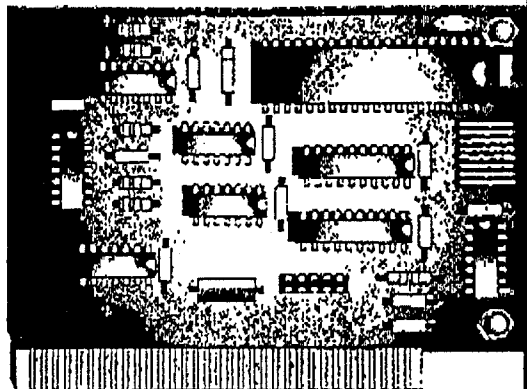
CARROLL TOUCH
TOUCH PRODUCTS

AN AMP COMPANY

DIMENSIONS

Height: 4.1"

Width: 3.1"



MDI Frame Connector
(8-pin telephone socket)

SPECIFICATIONS

FRAME SCAN RATE	20-50 scans/second (frame size dependent)
REPORTING MODES	Coordinate, scan
OPERATING MODES	Enter Point, Tracking, Continuous, Exit Point, Add Exit Point (Modifier)
POWER REQUIREMENTS	+12V +/- 10% 85 mA typical, 200 mA maximum -5V +/- 5% 110 mA typical, 165 mA maximum, with typical MDI touch frame attached, power provided through the ISA bus of the PC
COMMUNICATIONS	8-bit ISA bus
DATA FLOW CONTROL	Interrupt or polling
OPERATING ENVIRONMENT	
Temperature	0°C to 50°C (32°F to 122°F)
Humidity	0% to 95% non-condensing
Altitude	10,000 ft (3,048m) full temperature range
STORAGE ENVIRONMENT	
Temperature	-20°C to 75°C (-4°F to 167°F)
Humidity	0% to 95% non-condensing
CERTIFICATION	UL-1950, UL-1262 CSA C22.2 NO 950
CONNECTORS	
Power Supply	ISA bus PC connector
Touch Frame	8-pin modular phone jack

ORDERING INFORMATION

Modular Controllers are compatible with the full line of Carroll Touch modular touch frames for CRTs and flat panel displays. For more information, contact your Carroll Touch representative.

RELATED MANUALS

2970-0004-01	Hardware-Based Controller Installation Guide
2950-0012-01	Touch System Diagnostics User's Guide

3200-3224-01 HARDWARE-BASED CONTROLLER

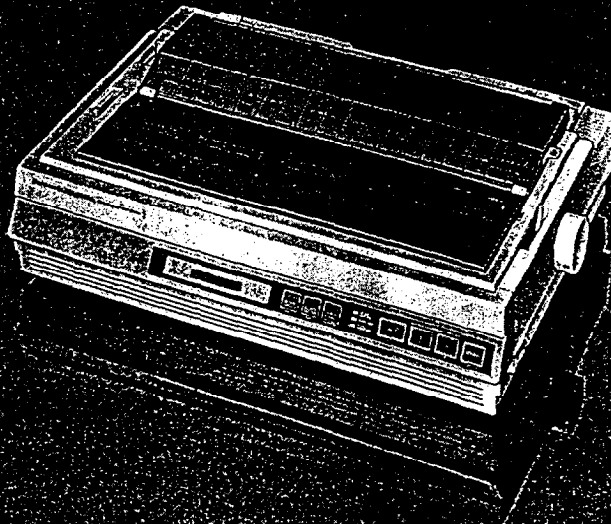
ITEM # (3)

10710, 2-9

Operating Instructions

Impact Dot Matrix Printer

KX-P2624



Panasonic

Before operating this unit, please read these instructions completely

Introduction

	Font	Print line size 8" or 13.6"
Maximum number of characters per line (cpl):	Pica (10 cpi)	80 / 136 cpl
	Elite (12 cpi)	96 / 163 cpl
	Micron (15 cpi)	120 / 204 cpl
	Compressed (17 cpi)	137 / 233 cpl
	Elite Compressed (20 cpi)	160 / 272 cpl
	Pica Elongated (5 cpi)	40 / 68 cpl
	Elite Elongated (6 cpi)	48 / 81 cpl
	Micron Elongated (7.5 cpi)	60 / 102 cpl
	Compressed Elongated (8.5 cpi)	68 / 116 cpl
	Elite Compressed Elongated (10 cpi)	80 / 136 cpl

	Font	Speed
Printing Speed of characters per second (cps):	Draft-Pica	200 cps
	Draft-Elite	240 cps
	Draft-Micron	300 cps
	LQ-Pica	66 cps
	LQ-Elite	80 cps
	LQ-Micron	100 cps
	SLQ-Pica	33 cps
	SLQ-Elite	40 cps

Printing Direction: User selectable between Unidirectional (one way printing) or Bidirectional (Printing in both directions)

Line Feed Time: Approximately 90 milliseconds for one line, using 1/6 inch (4.2 mm) line feeding (2.5 ips at Form Feed)

Paper Feed: User selectable between pull/push tractor feed, for use with fanfold paper or friction feed for use with single sheet and envelopes

- Paper Used: Fanfold paper:
Width: 4 to 15.5 inches (102 to 394 mm)
Weight:
pull mode: 18 to 24 pounds (68 to 90 g/m²)
push mode: 16 to 24 pounds (60 to 90 g/m²)
Single Sheet:
Width: 4 to 16.5 inches (102 to 420 mm)
Height: 5 to 14.3 inches (127 to 363 mm)
Weight: 14 to 24 pounds (53 to 90 g/m²)
Envelopes: Standard business type, e.g.:
#6, #10 (refer to Appendix E)
- Copies: Original plus three non-carbon copies
- Paper Thickness: The total thickness of sheets fed through the
printer must not exceed 0.32 millimeters or 0.013
inches
- Operating 10 to 35°C, {50 to 95°F}
Environment: 30 to 80% humidity
Note: Please allow the printer to stabilize at an
acceptable room temperature before powering up
- Storage Environment: . . . -20 to 60°C, {-4 to 140°F}
10 to 90% humidity
- Head Service Life: Approximately 200 million strokes
- Ribbon: Seamless fabric ribbon cassette
Ink color: black
Yield: Approx. 3 million characters in draft
mode (rolling ASCII)
- Dimensions: 590 (W)×398 (D)×172 (H) mm
{23.2×15.7×6.8 inches}
- Mass {Weight}: Approximately 15.3 kg {33.7 pounds}

1.2 Specifications

Power requirements:	} Please refer to the nameplate located on the rear of the printer.
Frequency:	
Current:	
Interface:	Centronics parallel RS-232C serial interface board (option; KX-PS11, KX-P19)
Print Fonts:	3 Draft (Pica, Elite, Micron) 7 Letter Quality (Courier, Prestige, Bold PS, Script, Sans Serif, Roman, Orator) 1 Super Letter Quality (Roman)
Software Emulation: . . .	Epson LQ-1050, IBM Proprinter XL24E
Character Sets:	96 ASCII characters 96 Italic ASCII characters 33 International characters 14 language sets plus 1 legal 33 Italic International characters 14 language sets plus 1 legal 38 Multilingual characters 158 IBM-PC special characters sets 1 & 2
Dot Configuration:	Dot diameter $\frac{1}{127}$ th of an inch (0.2 mm)
	Draft LQ SLQ
Matrix	
(Hor. x Ver.)	9x24 30x24 30x48
Dot pitch	
(Horizontal)	$\frac{1}{120}$ " $\frac{1}{360}$ " $\frac{1}{360}$ " (0.21 mm) (0.07 mm) (0.07 mm)
(Vertical)	$\frac{1}{180}$ " $\frac{1}{180}$ " $\frac{1}{360}$ " (0.14 mm) (0.14 mm) (0.07 mm)



ITEM # ()

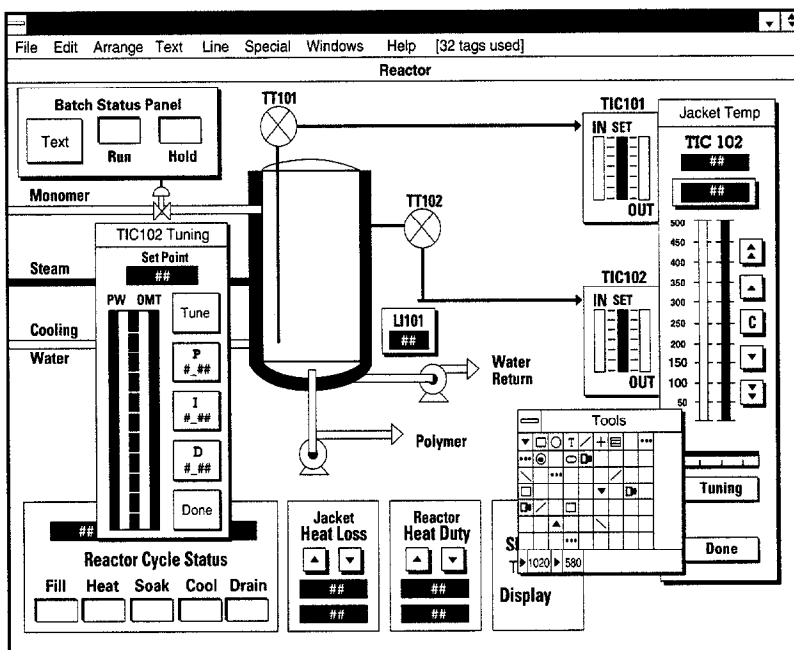
CIMPLICITY® Systems

CIMPLICITY InTouch 5.0

CIMPLICITY InTouch 5.0 brings the power of MS-Windows™ to the man-machine interface. This full-featured software package offers an unbeatable combination of speed, flexibility, and ease of use to applications ranging from industrial automation, process control, and supervisory monitoring. As a result, CIMPLICITY InTouch 5.0 reduces development, project, and life cycle costs while offering comprehensive factory monitoring and control.

CIMPLICITY InTouch 5.0 is a versatile, intuitive tool that can be adapted to a number of industries, including automotive, aerospace, oil and gas, chemical, petrochemical, food processing, beverage, pharmaceuticals, pulp and paper, pipelines, water and waste water treatment, and transportation. With CIMPLICITY InTouch 5.0, you can quickly create operator interfaces and develop data acquisition, monitoring, and control applications, whether you work in discrete or continuous process environments.

CIMPLICITY InTouch 5.0 also brings you the advantages of dynamic data exchange and superior connectivity. "FastDDE," a proprietary extension to DDE, allows up to 100 times the throughput of normal DDE transactions. NetDDE creates a new standard for interactive, peer-to-peer connectivity, permitting exchange of information and data between multiple machines on the same network or over networks between different operating environments. And of course, CIMPLICITY InTouch 5.0 is fully compatible with other Windows products.



CIMPLICITY InTouch 5.0 combines powerful revolutionary features with the ease and flexibility of a Windows based product.

CIMPLICITY InTouch 5.0: Full-Featured Yet Easy to Use

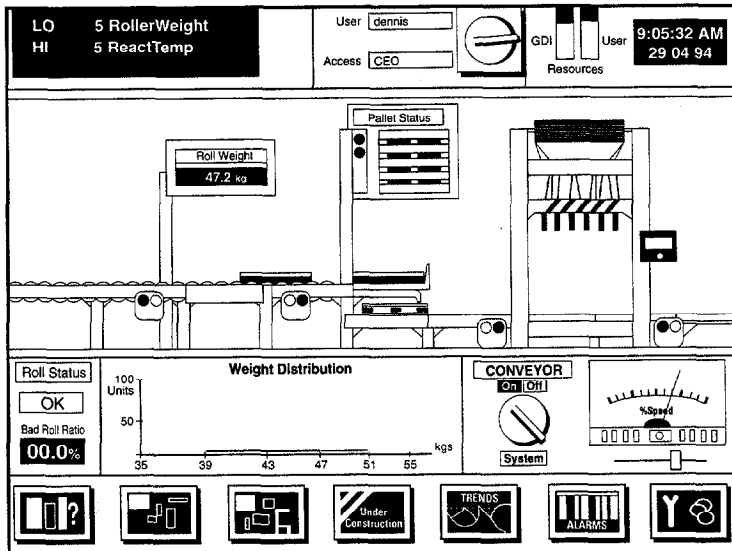
CIMPLICITY InTouch 5.0 contains a host of practical features selected for their utility and designed for ease of use.

► Application Development Features

Object-Oriented Graphics (Drawing and Editing Tools). Easy-to-configure applications mean faster development times. With CIMPLICITY InTouch 5.0, you can tap powerful object-oriented design tools for quick drawing, arranging, aligning, layering, spacing, rotating,

inverting, duplicating, cutting, copying, pasting erasing, and more. These tools are available in a configurable Toolbox or from standard pull-down menus.

Version 5.0 new features make application development even easier. Users can apply Undo/Redo with up to 25 definable levels of Undo. "Grid" and "Snap to Grid" commands make layout easier. Other innovations include fast switch between WindowViewer and WindowMaker screens, 3D dialogs, and tag counts that can be displayed in title bars.



CIMPLICITY InTouch 5.0 gives you a moment-by-moment snapshot of real-time conditions as well as a picture of your overall process.

► Operational Features

Standard User Interface (Multitasking). Because CIMPLICITY InTouch 5.0 is a true Windows program, you can move quickly from one application to another without reloading them. You can display development and runtime environments side by side or run two Windows applications simultaneously.

Symbol Library. The symbol library contains hundreds of clip-art graphic symbols, an important feature when you need to create custom applications rapidly.

Animation Links. Animation links may be used alone or in combinations to provide complex size, color movement, and/or position changes. You can tie discrete, analog, and string touch inputs; value output; and horizontal and vertical sliders to such screen effects as discrete and action buttons; show and hide window push-buttons; line, fill, and text color; object height and width; vertical and horizontal position; percent fill; visibility; sound and action scripting; blinking; and rotation.

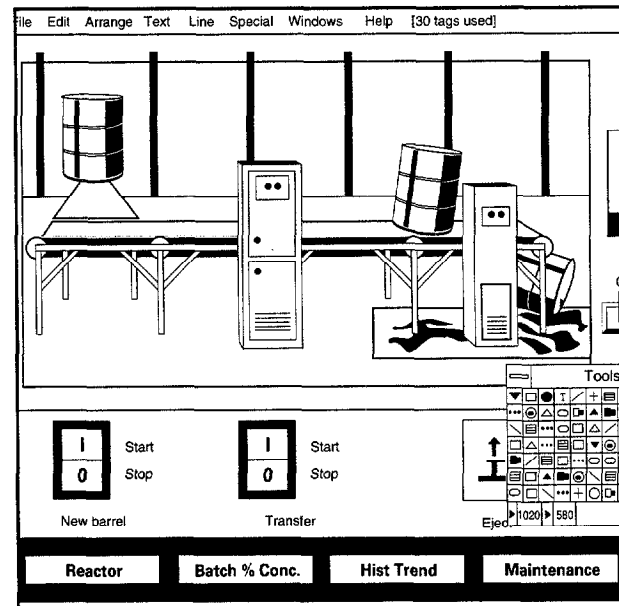
Script Editor. The CIMPLICITY InTouch 5.0 script editor allows for rapid prototyping, background calculations, and simulation. Action scripts may be invoked on discrete conditions; when Windows are open; when they are being opened or when they are closed; when data changes value, when operators depress buttons; or when alarms occur.

All script functions are available in menu form, including data variables, and all formatting functions are displayed as icons adjacent to the script window. New scripting functions added in release 5.0 include string manipulation, math functions, file I/O, application running, hexadecimal and scientific numerical representation. The script editor itself has been enhanced to include find/replace and convert. It now offers up to 256 character expressions.

Dynamic Data Exchange. CIMPLICITY InTouch 5.0 users can share data with other Windows applications for custom management reporting. CIMPLICITY InTouch 5.0 DDE servers are written as stand-alone Windows applications, incorporating both standard DDE and "fastDDE."

Application Control. From within CIMPLICITY InTouch 5.0, you can start and control other applications or send key macros to them.

Password Protection. With our built-in log-on feature, you can assign up to 10,000 access levels. The event logging program space provides extensive capability for password access and conditional operations.



Extensive Alarm capabilities provide timely, meaningful information to prompt immediate operator action and simplify troubleshooting.

► Monitoring, Alarm, and Reporting Features

Real-time Database. CIMPLICITY InTouch 5.0 supports discrete, real, integer, and string data as well as dynamic point configurations (up to 32,767 points). You can also export or import data from other databases, spreadsheets, and editors.

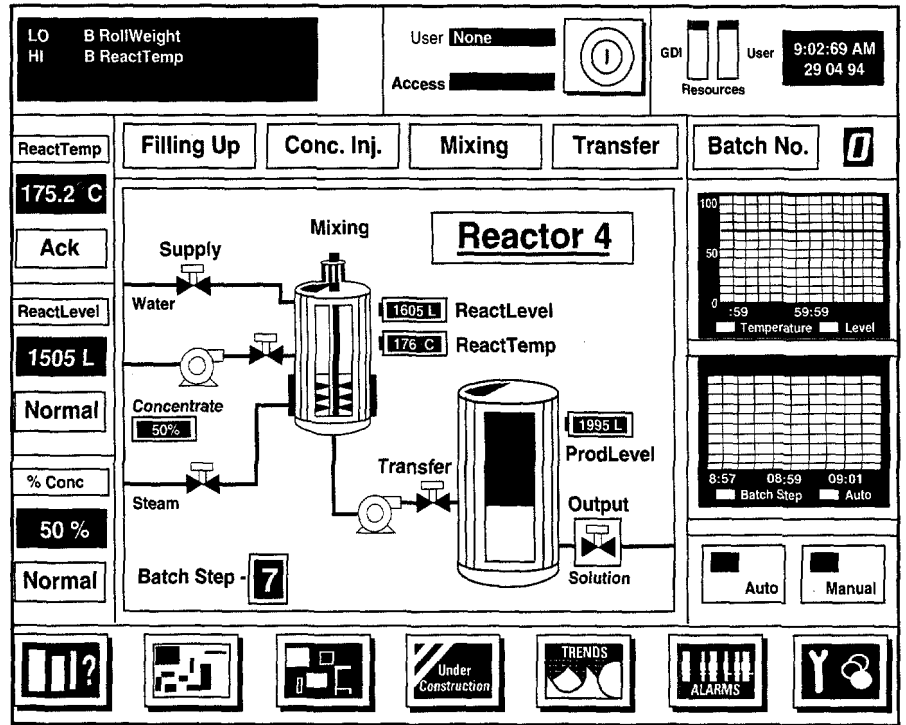
Real-time and Historical Trends. Users can display as many as four pens at a time in historical trend charts, with such features as run-time tagname selection, value at cursor display, zooming, scrolling, and centering. There is no limit to the number of charts per screen or application, and charts can be logged to disk or printed in addition to being displayed.

Extensive Alarm Capabilities. With CIMPLICITY InTouch 5.0, it is easy to configure and prioritize alarms (from 1 to 999). You can establish up to eight hierarchical alarm groups of 16 subgroups each, and you can view all alarms or any subset either as an alarm summary or history.

Calculations. CIMPLICITY InTouch 5.0 supports logical and mathematical expressions. The user can utilize single precision floating point numbers, while internal calculations use double precision floating point numbers. Version 5.0 adds the following new functions: string manipulation, math functions, file I/O, application running, hexadecimal and scientific numerical representation.

Optimized Polling. Only points that appear on screen, alarm points, historically logged points, or points in background logic are polled, allowing the highest possible throughput.

Series 90™ Fault Table. CIMPLICITY InTouch 5.0 displays I/O and PLC faults from a Series 90 Protocol-style display similar to the one used in GE Fanuc's Logicmaster™ software.



► Connectivity Features

NetDDE. NetDDE allows DDE between applications running in such diverse operating environments as Windows, OS/2™, VAX™/VMS™, and UNIX™ over a range of network protocols including NETBIOS™, TCP/IP, DECnet™, Serial, LanManager, and Novell.

Bundled GE Drivers. CIMPLICITY InTouch 5.0 supports the Series 90™ Protocol, Genius™ bus, and CCM2.

► Other Features

Multimedia Presentation. CIMPLICITY InTouch 5.0 supports real-time video, so you can incorporate multimedia presentations tied to actions or conditions.

Accommodates a Variety of Pointing Devices. You can use any pointing device—from mouse to trackball to light pen to touch screen—supported by Windows.

Extensibility Toolkit. This software package

The Recipe Manager Option provides flexible, recipe handling capability, fully integrated into the CIMPLICITY InTouch 5.0 MMI system.

CIMPLICITY InTouch 5.0: Options

allows users to customize and extend the capabilities of CIMPLICITY InTouch 5.0 to their specific needs. The toolkit includes the Wizard Development Kit, the Script Enhancement Kit, and the Idea Toolkit with visual basic connectivity.

Statistical Process Control (SPC) Option. With SPC capabilities at the operator level, users have a powerful tool to improve the quality of the process and, ultimately, the product. All charts and limits are user configurable.

Recipe Manager. With the recipe option, users can create, modify, and download a recipe or machine set-up parameter from within CIMPLICITY InTouch 5.0 without having to go out to the PLC/process system program.

Structured Query Language (SQL) Access Option. This module provides access to virtually all common database sets, including ORACLE, SyBase, and more. In addition, SQL incorporates the ODBC library calls, which adhere to the Open Data Base Connectivity standard.

CIMPLICITY Support

GE Fanuc provides technical support for registered CIMPLICITY InTouch users under warranty or under the software

maintenance agreement. CIMPLICITY Technical support can be reached by calling 800-762-6498 or (518) 464-4607.

Technical Specifications

Hardware	Minimum 386 PC with 2MB RAM (4MB recommended especially when used with other Windows applications) and hard-disk
Software	MS DOS (version 3.3 or later) & MS Windows (Version 3.1 or later or Windows for Workgroups)
Extended Memory	Up to 16MB extended memory fully accessible
Networking	Supports any standard NETBIOS network, Ethernet, Novell, Token Ring, Arcnet, etc. plus DECnet, TCP/IP, and Serial

Ordering Information

For further information about CIMPLICITY InTouch 5.0 or any other CIMPLICITY Systems product, consult your local GE Fanuc Automation Representative or CIMPLICITY Systems Distributor

©CIMPLICITY is a registered trademark of GE Fanuc Automation, North America, Inc. Series 90™, LogicMaster™, and Genius™ are registered trademarks of GE Fanuc Automation, Inc. All other trademarks and registered trademarks are the property of their respective owners.

All specifications are subject to change without notice



GE Fanuc Automation

For the location of your nearest GE Fanuc sales representative or authorized distributor contact:

GE Fanuc Automation North America, Inc.
USA and Canada 1 800 648-2001
Europe (352) 727979-1



ISO 9001
Reg. #A2003



Certificate #
FM13400



REGISTERED
A Division of CSA

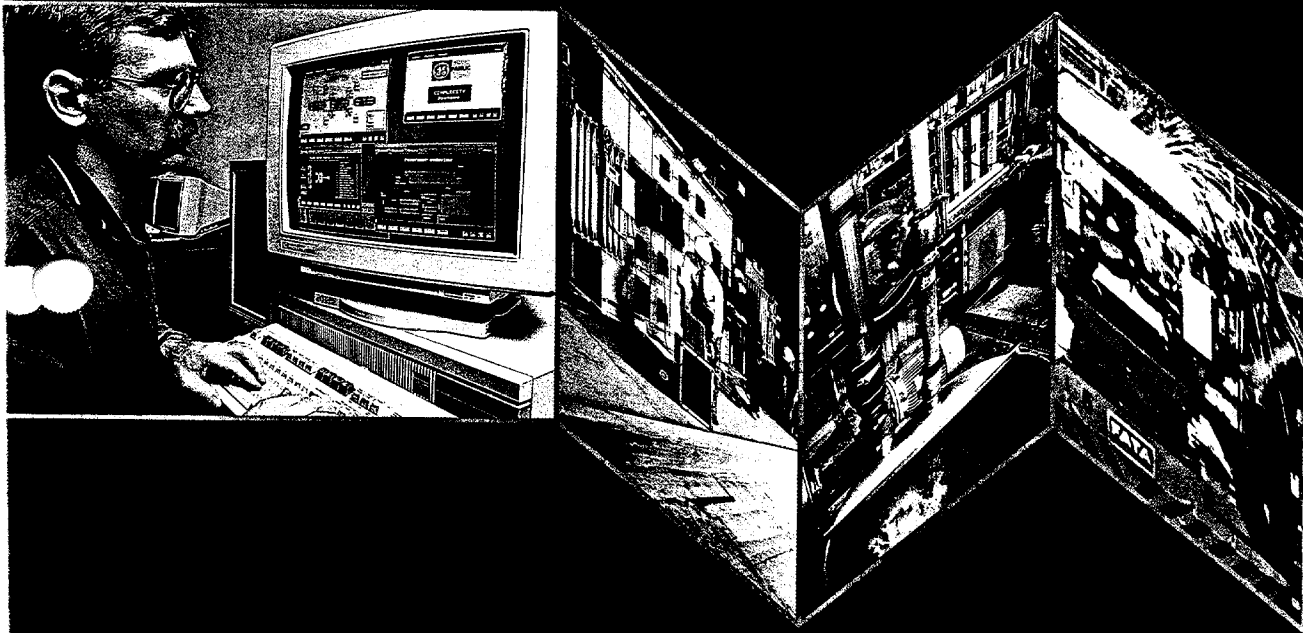
GFA-137A
5M 4/95



FANUC

CIMPLICITY® Systems

Integrating People With The Process



Supervisory Monitoring and Control Products and Systems

Our Vision Of Excellence



Our goal is to give our customers the flexibility and range of features essential to meeting their objectives.

ISO 9001 manufacturer, meeting the most stringent and comprehensive quality requirements in product design, manufacturing, and service. To assure international acceptance of this certification, we have successfully obtained registration with the Underwriters Laboratories (USA), the British Standards Institute (UK) and the Quality Management Institute of the Canadian Standards Association (Canada).

Our goal is to create products that are simple to install and easy to use—and that give our customers the flexibility and range of features essential to meeting their objectives.

Quality is more than a slogan at GE Fanuc. It's our guiding principle.

The Beauty Of CIMPPLICITY

GE Fanuc's line of CIMPPLICITY products bears all the hallmarks of our commitment to quality and service. CIMPPLICITY is a powerful family of

At GE Fanuc, we've set ourselves a straightforward challenge: to improve our customers' productivity with the best industrial automation technology, reliability, and service worldwide.

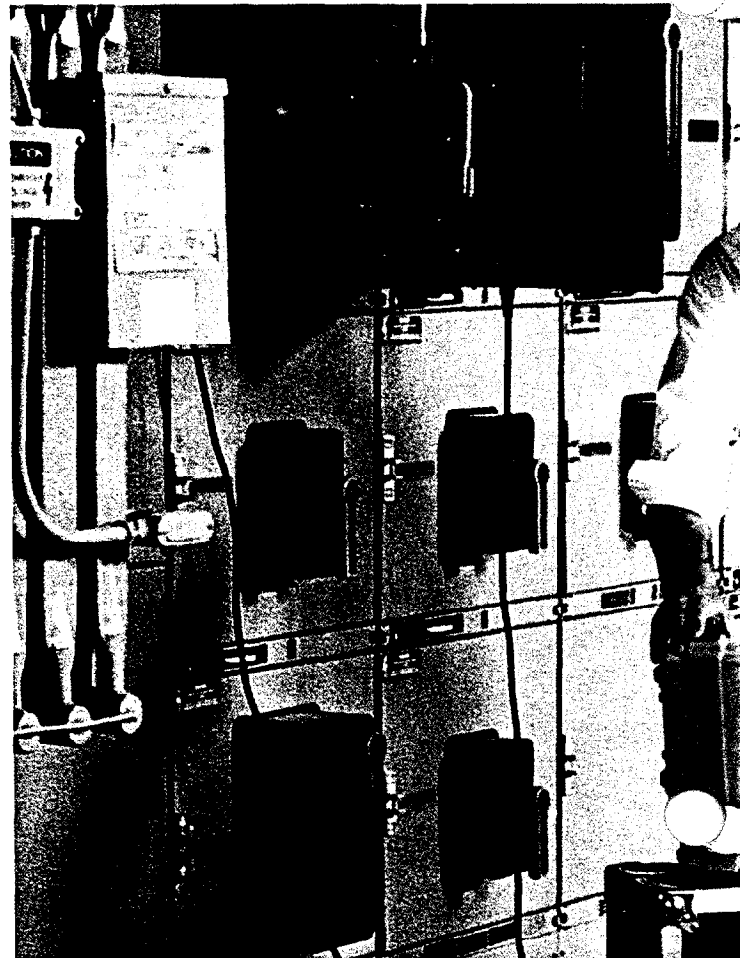
As part of this commitment, we became one of the first companies in the United States to qualify as a certified

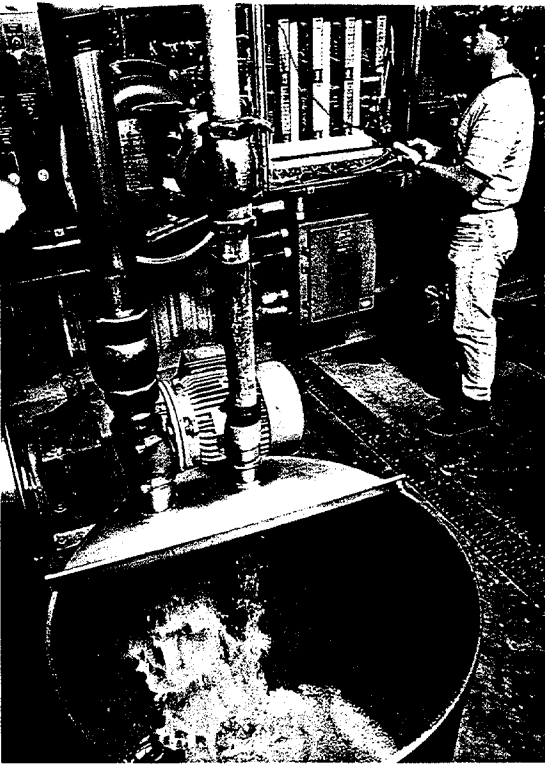
software solutions that provide superior levels of plant-wide supervisory monitoring and control. The philosophy behind CIMPPLICITY is to create products that create long-lasting value for our customers.

CIMPPLICITY is designed for multi-vendor computer environments, allowing customers to adopt the latest, market-driven improvements in technology to their applications. CIMPPLICITY's hybrid architecture and open interface design enables it to mesh seamlessly with other systems, reducing the need for custom, one-shot solutions to application problems. And all our CIMPPLICITY products conform to industry-wide standards, reducing risk and increasing utility.

The result is true CIMPPLICITY, a series of time-tested products that have proven their worth in a host of industries and applications, providing business around the world with the competitive edge necessary to stay ahead in today's markets—and to meet the challenge of the new century.

CIMPPLICITY is the proven solution for automation, process control, and supervisory monitoring applications in a variety of industries.





versatile tool for increasing productivity, improving quality, and reducing costs.

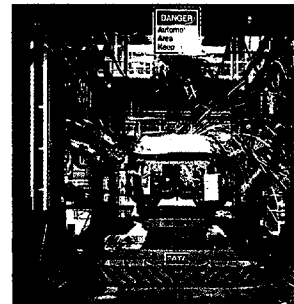
The CIMPLICITY Systems Energy Miser solution turns energy into competitive advantage by enabling companies to gather a comprehensive picture of energy usage, to monitor energy usage in real time, and, most critically, to pursue a customized energy management strategy that yields real savings.

The automotive industry relies on CIMPLICITY Systems in a variety of interrelated applications, including plant-wide conveyor/equipment supervisory control and monitoring, plant shop tracking and routing, assembly data collection, statistical process control, and power management. In each application, GE Fanuc customers rely on CIMPLICITY to operate, manage, and maintain production facilities. Their investment in CIMPLICITY solutions is a key component of their continuous improvement programs.

CIMPLICITY Systems provide an important supervisory tool in the food industry for batch processing and packaging applications. Continually monitoring the status and progress of each batch, CIMPLICITY compares current trends with those recorded from previous batches. Recipes are easily developed, modified, and put into effect by the operator. And CIMPLICITY Systems detailed data collection makes it easy to produce reports for immediate or long-term use.

Other industries benefiting from CIMPLICITY's powerful features include chemical, transportation, communications and resource-based industries.

Companies in a variety of industries use CIMPLICITY as a versatile tool for increasing productivity, improving quality, and reducing costs.



CIMPLICITY In Action

CIMPLICITY is the proven solution for industrial automation, process control, and supervisory monitoring applications. Companies in a variety of industries use CIMPLICITY as a

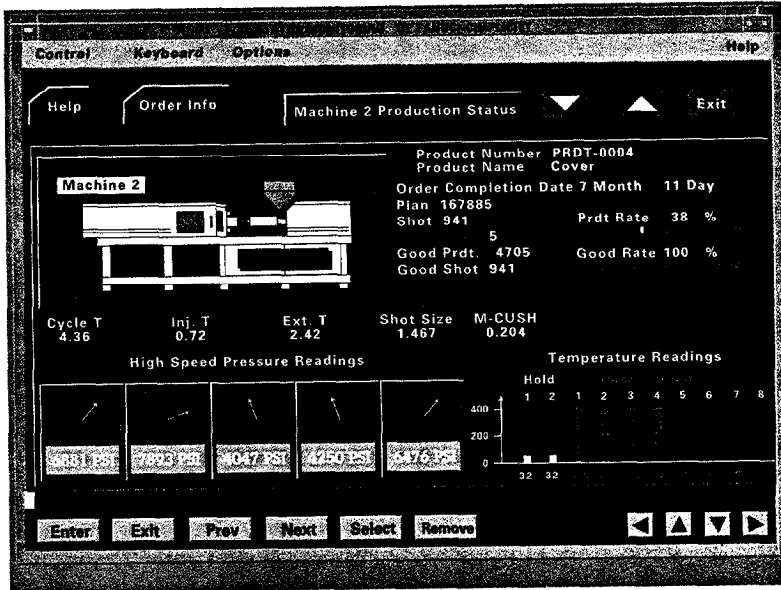


Opening A Window To Your Process

Five Windows On CIMPLICITY

When it comes to industrial monitoring and control, timely, comprehensive information is the key to making better decisions—faster. CIMPLICITY has been designed expressly to give

you a moment-by-moment snapshot of real-time conditions and an overall grasp of process. For minimum downtime and maximum productivity, you can't beat CIMPLICITY.



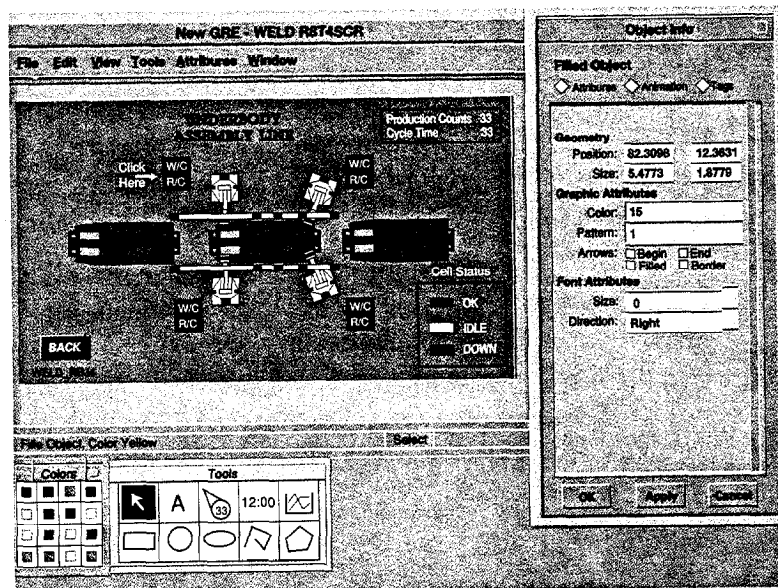
CIMPLICITY has been designed expressly to give you both a moment-by-moment snapshot of real-time conditions and an overall grasp of your process that's crucial for making strategic decisions.

CIMPLICITY SYSTEMS User Interface

The CIMPLICITY user interface provides an easily understood environment that makes process control and monitoring a snap. No matter what CIMPLICITY functions you use, each has a common look and feel, making it easy to move from one function to another. The CIMPLICITY user interface provides on-line help and supports multi-windows, touch-screens, function keys, mouse and other pointers, modems, and more.

CIMPLICITY SYSTEMS Graphic Status Monitoring: Application Animation

CIMPLICITY's high impact graphic screens reflect the real-time status of your production machinery. Using the graphic editor and color palette for quick screen development, you can set position, color, blink, rotation, and fill size to change along with your process. And for the times when it's helpful to examine the data behind the pictures, you can embed trend and bar charts.

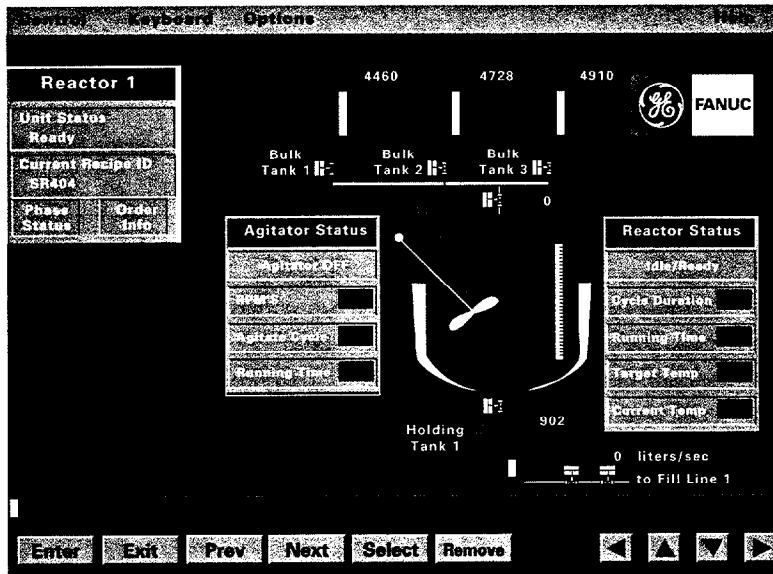


Each function has a common look and feel, making it easy to move from one function to another.



Alarm Management: A Call to Action

CIMPLICITY alarm management doesn't simply inform you that your system is malfunctioning, it gives you the information you need to react immediately. CIMPLICITY displays alarms generated from data collection points, CIMPLICITY application modules, and device drivers directly on your graphic screens, making it easy to grasp system problems. CIMPLICITY alarm messages provide timely, meaningful information to prompt the most appropriate operator action and simplify troubleshooting.

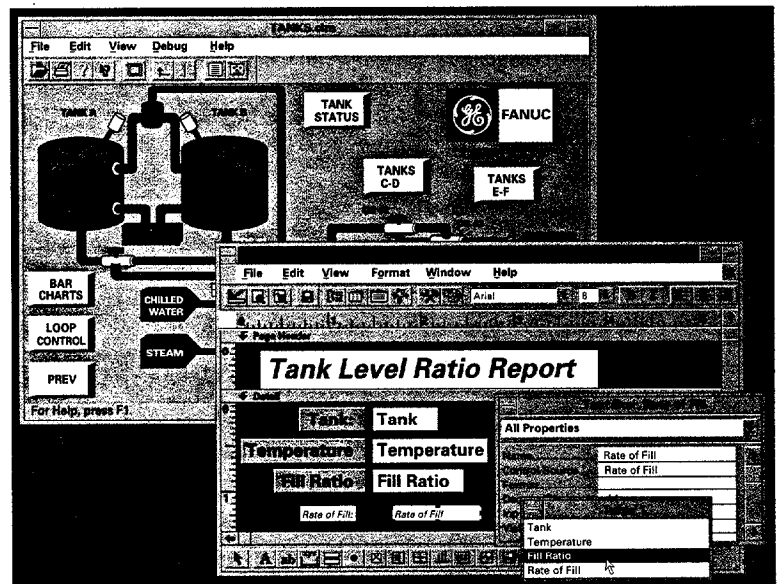


CIMPLICITY gives you the critical information you need to react immediately.



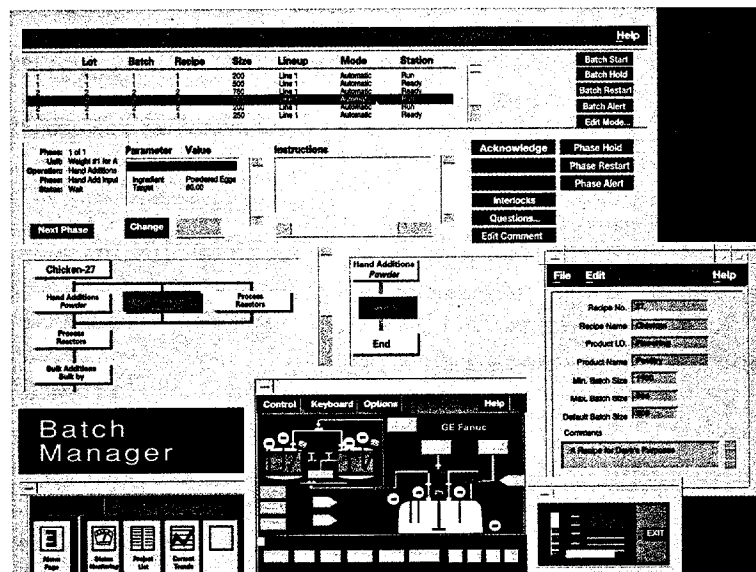
Logging and Reporting: A Time-Saving Advantage

CIMPLICITY simplifies the process of defining and generating standard format reports on logged point, alarm, and system event data. And you can set CIMPLICITY to generate reports automatically, depending on time of day, periodic cycle, or system event. And to make sure you make the most of these reports, CIMPLICITY produces them in the form you need. They can be printed, displayed, written to file, and exported to spreadsheets or other systems.



Interactive On-Line Configuration: Getting the Fit You Need

CIMPLICITY gives you the tools to get your system up and running quickly. Configuring points, alarms, reports, and other system characteristics is simply a matter of filling in blanks at CIMPLICITY prompts. And you can always change on-line configuration on the fly, without having to shut your system down.



CIMPLICITY gives you the tools to get your system up and running quickly and to keep your system running with a minimum of downtime.

Creating The System To Match Your Application

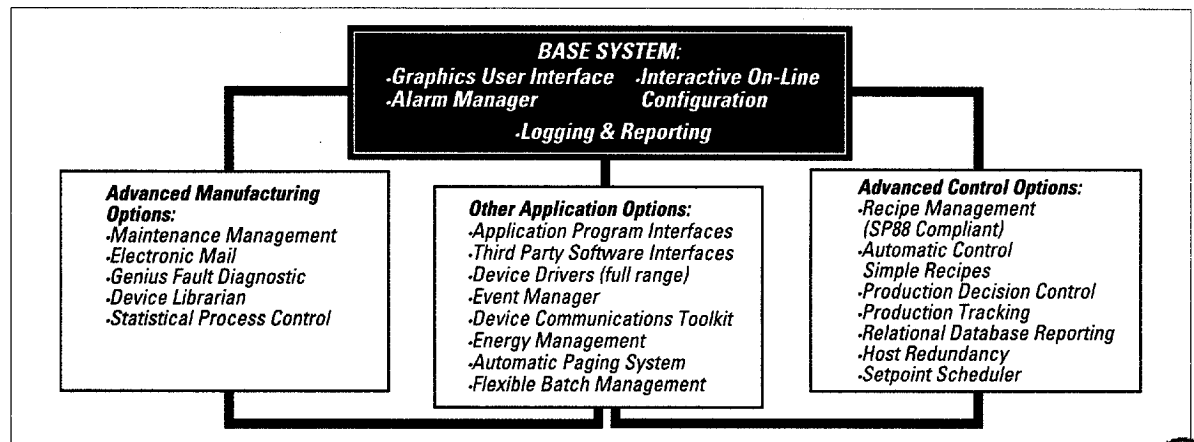
CIMPLICITY is a powerful set of application modules integrated around a common platform. You can easily upgrade or add option modules, creating a system that grows and adapts as your needs change.

CIMPLICITY Systems include such advanced manufacturing options as Genius™ fault diagnostics and statistical process control; a full suite of application options, from third-party software-interfaces and a wide range of device

drivers to specific application packages like Energy Miser™ and CIMplastics™; as well as advanced control options such as recipe management and production decision control.

No matter what your objective, whether you're trying to improve batch processing, materials tracking, energy efficiency, or you're working to meet other challenges in industrial monitoring and control, you'll find a solution in CIMPLICITY.

Building from the versatile base system, you can add the options that suit your needs.



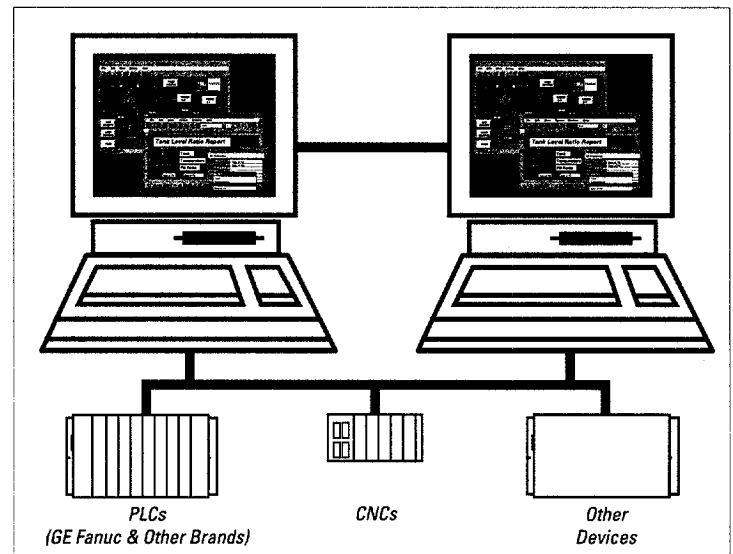
Encompassing A Variety Of Standards For Universal Process Control

Supporting a Full Range of Communication Protocols

With CIMPLICITY, you can be assured of high-speed, distributed communication among GE Fanuc PLCs, other PLCs, CNCs, and intelligent I/O.

Linking Different Standards

CIMPLICITY offers a non-proprietary solution that works seamlessly across many computers and operating systems. As a result, you can develop a single system, capable of integrating existing technology, with the versatility to tackle a wide range of industrial automation, process control, and supervisory monitoring applications.



High-speed, event-driven communications to production devices.

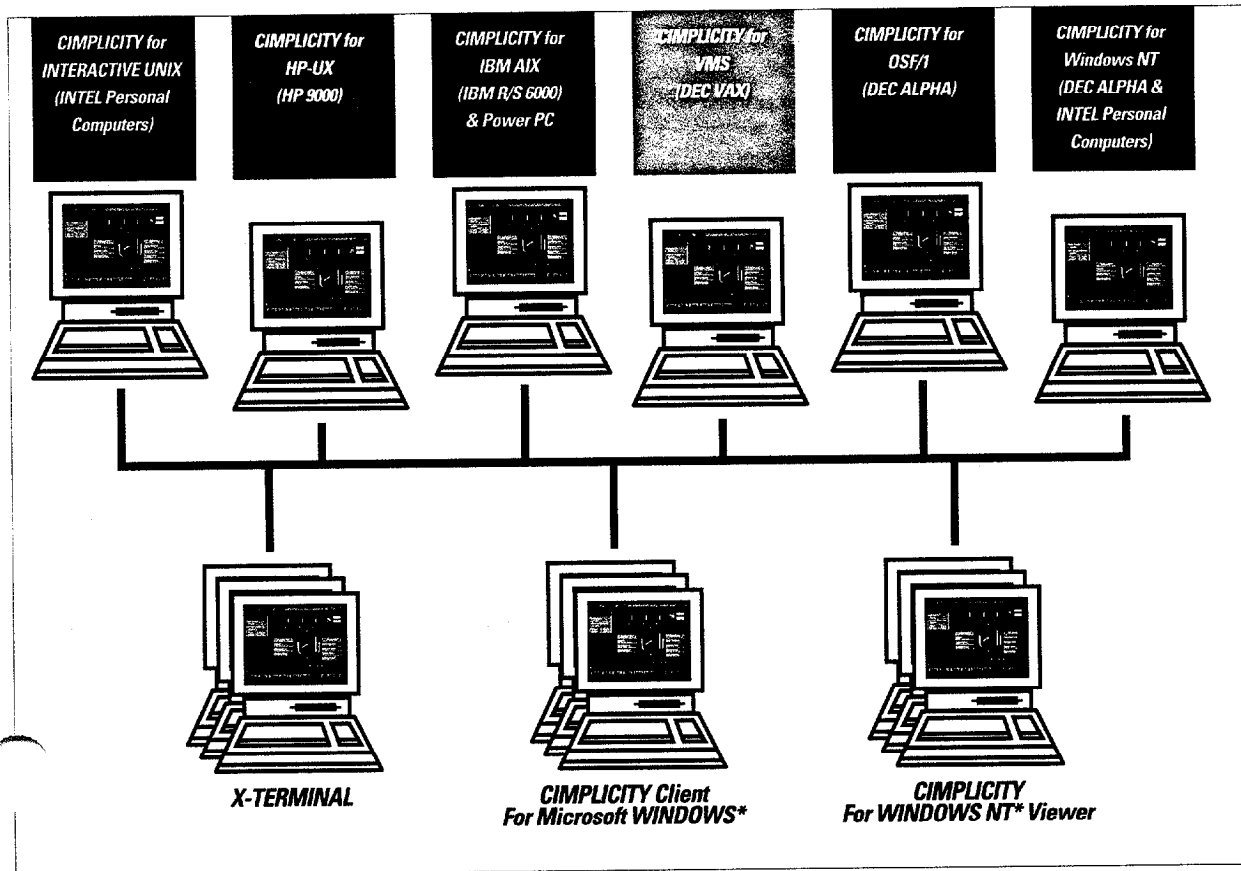
Support for a variety of communications networks services, and data types.

Optimized data collection, including unsolicited, polled, triggered, on change, and on demand.

Driver customization toolkit.

CIMPLICITY: A Client/Server Architecture

CIMPLICITY Incorporates a Powerful Family of Supervisory Monitoring and Control Software Products:



- *CIMPLICITY Windows Features:**
- CIMPLICITY integrated with Microsoft Windows
 - Direct support of DDE Aware Applications
 - Integration with 3rd party objects through OLE Automation
 - Remote dialup access
 - Simple installation and use

With CIMPLICITY's Open Architecture, you can use a variety of computers and display devices including:

- IBM RISC/6000 Systems and Power PC
- Personal computers based on 81386/80486 and Pentium chips
- Digital Equipment VAXStation and Alpha Systems
- Hewlett-Packard 9000 Series Systems
- Display devices including Xterminals, consoles, projector screens and terminal emulators

CIMPLICITY Software Systems include:

- CIMPLICITY System-I/U
- CIMPLICITY System-D/V
- CIMPLICITY System-H/U
- CIMPLICITY System-D/AU
- CIMPLICITY System-RS/U
- CIMPLICITY InTouch
- CIMPLICITY Client For Microsoft Windows
- CIMPLICITY For Windows NT Viewer
- CIMPLICITY For Windows NT

Packaged Solutions and Products for Industrial Automation, Process Control, and Supervisory Monitoring Applications

CIMplastics: A bundled solution for monitoring and controlling the injection molding process in plastics applications, CIMplastics gives you the ability to reduce shot times, narrow process limits to achieve zero scrap, and implement variable process control procedures.

CIMPLICITY BCS: A distributed system for batch control and data acquisition, CIMPLICITY BCS is software flexible and equipment and process independent. These qualities allow for quick and easy recipe creation. Based on ISA's SP88 batch standard, CIMPLICITY BCS allows you to model a processing plant, create new process lines, manage recipes, and schedule and execute batches, among other functions.

Energy Management: GE Fanuc's CIMPLICITY Energy Management System helps you gain a comprehensive picture of energy usage, monitor energy usage in real time, and pursue an energy management strategy. You can use preconfigured solutions or develop your own customized solution tailored to realize substantial savings for your facility.

CIMPLICITY Alert: A powerful integrated wireless monitoring system consisting of application software and an alphanumeric wireless paging system. CIMPLICITY Alert automatically links key personnel, regardless of their location in a plant, with the information they need to make a timely response.

CIMPLICITY Systems Technical Specification Summary

Hardware:	80386, 80486 and Pentium PCs Hewlett-Packard 9000 Systems	Digital Equipment VAX/ALPHA Systems IBM® RISC System/6000™ Power PC and POWER2 Architecture™	
Operating Systems:	INTERACTIVE UNIX® VMST™ IBM AIX™	OSF/1 HP-UX Microsoft® Windows™	
Monitor Resolution:	Up to 1280 x 1024		
Pointing Device:	Mouse, Trackball, Touchscreen, Function Keyboards, Bar Code		
Network:	Ethernet (TCP/IP or DECnet™ protocol)		
Communications Protocols:	Genius™ SNP CCM-2 VME bus Ethernet	TIWAY Allen-Bradley Data Highway Plus Allen-Bradley Data Highway Modbus™ RTU Modbus Plus™ <i>Other protocols can be developed using the optional device communication toolkit</i>	Greco Minifile™ DCN-O NetDDE
Additional Library of 3rd Party Developed Drivers	Square D, Siemens, Telemecanique		
Data Collection:	Polled, unsolicited, triggered, arrays, on demand, structures, redundant device support, cabling redundancy		
Database Size:	Unlimited, based only on computer resources available		
Alarms:	Multiple levels of security; colors; scrolling, groups, custom help, sort and filter		
Data Logging and Reporting:	Production, event, and alarm data captured automatically; relational database interface; compression, circular, rollover files, SQL Server		
Architecture:	Distributed; client server, message-based; multi-user, multiple computers; Microsoft Windows or X Window System™, Host redundancy, full dynamic on-line configuration		
Additional advantages CIMPLICITY Systems offer:	<ul style="list-style-type: none"> · Twenty years of experience in the business · International language support · Wide range of services including technical support, installation and training · Tight integration of factory devices including PLCs, CNCs and Intelligent I/O · GE Fanuc Automation has numerous CIMPLICITY Systems installed in many customer sites worldwide, and we continue to add new customers requiring real-world low to high-end industrial applications. · ISO9001 certification 		

CIMPLICITY is a registered trademark of GE Fanuc Automation North America, Inc.
 IBM is a registered trademark of International Business Machines Corporation
 Microsoft is a registered trademark of Microsoft Corporation
 UNIX is a registered trademark of UNIX System Laboratories, Inc.
 Genius, CIMplastics, and Energy Miser are trademarks of GE Fanuc Automation North America, Inc.

DECnet and VMS are trademarks of Digital Equipment Corporation
 Minifile is a trademark of Greco Systems, Inc.
 Modbus and Modbus Plus are trademarks of Modicon, Inc.
 RISC System/6000 and AIX are trademarks of International Business Machines Corporation
 Windows is a trademark of Microsoft Corporation
 X Window System is a trademark of Massachusetts Institute of Technology



GE Fanuc Automation

For the location of your nearest GE Fanuc sales representative or authorized distributor contact:

GE Fanuc Automation North America, Inc.
 Information Center
 USA and Canada 1 800 648-2001
 Europe (352) 727979-1
 Asia Pacific 65-566-4918



GFA-1
 15M 7/95

OHM REMEDIATION SERVICES CORPORATION
5335 TRIANGLE PARKWAY, SUITE 450
NORCROSS, GEORGIA 30092
(404) 729-3900

SOIL AND GROUND WATER REMEDIATION
OPERABLE UNIT NO. 2, SITES 6 AND 82
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

CONTRACT NO. N62470-93-C-3032

SPECIFICATION SECTION: 16920

SUBMITTAL FOR: INSTRUMENTATION INSTALLATION

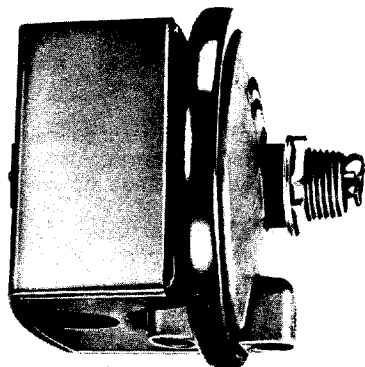
<u>ITEM NO.</u>	<u>SPEC PAR</u>	<u>SD-NO/ITEM DESCRIPTION/MANUFACTURER</u>
1	1.3.1A	SD-02 SYSTEM INSTRUMENTATION
2	1.3.2A	SD-04 SCHEMATIC DIAGRAMS



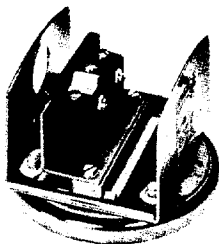
SERIES
1800

Low Differential Pressure Switches for General Industrial Service

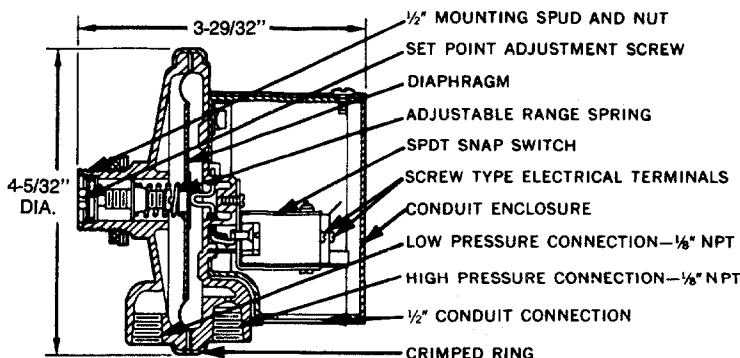
Compact, economically priced switches in 9 standard ranges. Set points from 0.07" to 85" W.C. Repetitive accuracy within 2%. U.L. and C.S.A. listed, F.M. approved.



Model 1823 pressure switch. U.L. and C.S.A. listed, F.M. approved.



Series 1823 pressure switch. Conduit enclosure removed to show electric switch.



Construction and dimensions. Series 1823 pressure switches.

One of our most popular pressure switches. Combines small size and low price with 2% repeatability for enough accuracy for all but the most demanding applications. Set point adjustment inside the mounting spud permits mounting switch on one side of a wall or panel with adjustment easily accessible on the opposite side.

U.L. and C.S.A. listed, F.M. approved.

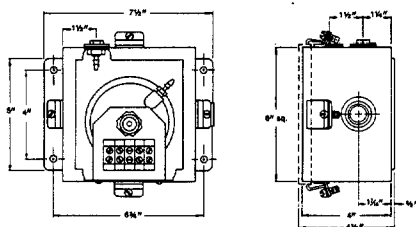
***Model 1823 shown; (1823 replaces 1820, 1821 and 1822 which are similar).**

Environmental (MIL) Switch

Unlisted Model 1820 can be furnished with special snap switch sealed against the environment for high humidity and/or for government applications. Similar to standard Model 1823 except dead band is slightly greater. Specify Model 1820 (Range No.) "MIL" in ordering.

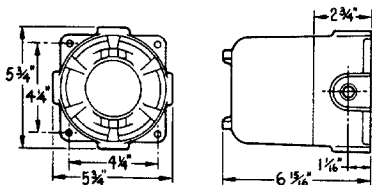
Weatherproof Enclosure

16 ga. steel enclosure for unusually wet or oily conditions. Withstands 200 hour salt spray test. Gasketed cover. Weight 5½ lbs. Switch must be installed at factory. Specify "WP" in addition to switch catalog number.



Explosion-Proof Housing

Cast iron base and aluminum dome cover. Approximate weight 7½ lbs. Specify "EXPL" in addition to switch catalog number.



PHYSICAL DATA

Temperature limits: -30°F for dry air or gas to 180°F. (-20 to 180°F, 1823-00)

Maximum surge pressure: 25 psig

Rated pressure: 10 psig.

Pressure connections: 1/8" NPT.

Electrical rating: 15 amps, 120-480 volts, 60 Hz. A.C. Resistive 1/8 H.P. @ 125 volts, 1/4 H.P. @ 250 volts, 60 Hz A.C. Derate to 10 amps for operation at high cycle rates.

Wiring connections: 3 screw type, common, normally open and normally closed.

Set point adjustment: Screw type inside mounting spud.

Housing: Aluminum die casting. Steel fittings zinc plated, dichromate dipped for 200 hour salt spray test.

Diaphragm: Molded silicone rubber with aluminum support plate.

Calibration Spring: Stainless steel.

Mounting spud: 1/2" pipe thread.

Weight: 1 lb., 5 oz.

Installation: Diaphragm vertical.

SERIES 1823 SWITCHES: OPERATING RANGES AND DEAD BANDS. U.L. and C.S.A. Listed, F.M. Approved.

Model Number	Operating Range Inches, W.C.	Approximate Dead Band	
		At Min. Set Point	At Max. Set Point
1823-00	0.07 to 0.22	0.05	0.05
1823-0	0.15 to 0.5	0.06	0.06
1823-1	0.3 to 1.0	0.08	0.08
1823-2	0.5 to 2.0	0.10	0.12
1823-5	1.5 to 5.0	0.14	0.28
1823-10	2.0 to 10	0.18	0.45
1823-20	3 to 22	0.35	0.70
1823-40	5 to 44	0.56	1.1
1823-80	9 to 85	1.3	3.0

Suggested Specification

Differential pressure switches shall be diaphragm operated with 4" diaphragm to actuate a single pole double throw snap switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. Motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage. Switches shall be Dwyer Instruments, Inc. Catalog No. 1823-_____ for the required operating ranges.

How to Order: See price list, Bulletin S-26.

SERIES 1823 DIFFERENTIAL PRESSURE SWITCHES
 Specifications – Installation & Operating Instructions – Parts List



INSTALLATION

1. Select a location free from excessive vibration where oil or water will not drip upon the switch. See special housings for unusual conditions.
2. **While not required, positioning the pressure connections down is recommended.** Mount the switch with the diaphragm in a vertical plane. Switch must be recalibrated for each change in operating position.
3. Connect switch to source of pressure differential. Metal tubing with 1/4" O.D. is recommended but any tubing system which will not restrict the air flow is satisfactory. Note that the low pressure connection may be made to the 1/2" spud at the back of the switch if desired. If so connected, drill 1/16" diameter holes in the Spring Retainer flange (PN 1823-309) and the head of Adjustment Screw (PN 1823-289) to provide opening to the switch interior and plug the other low pressure connection.
4. Electrical connections to the standard single pole, double throw snap switch are provided by means of screw terminals marked "common", "norm open", and "norm closed". The normally open contacts close and the normally closed contacts open when pressure increases beyond the set point.
5. Switch loads should not exceed the maximum specified current rating of 15 amps resistive. Switch capabilities decrease with

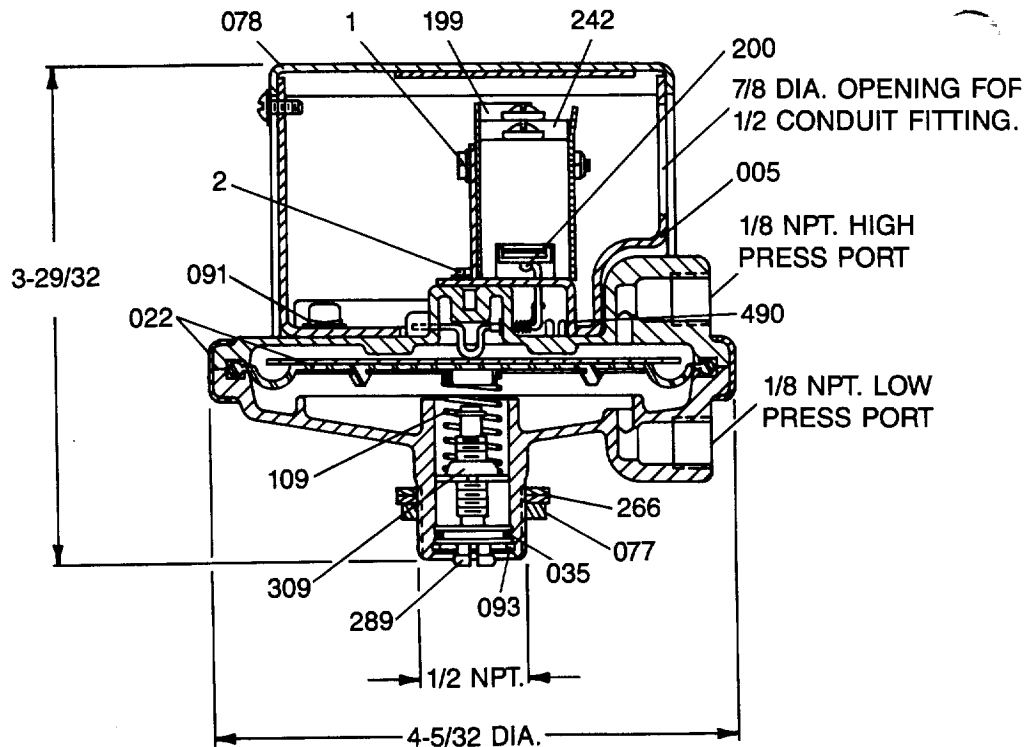
high load inductance or rapid cycle rates. Whenever an application involves one or more of these factors, the user may find it desirable to limit the switched current to 10 amps or less in the interest of prolonging switch life.

ADJUSTMENT

1. If the switch has been factory preset, check the set-point before placing in service to assure it has not shifted in transit.
2. If switch has not been preset or it is desired to change the set point, observe the following procedure:
 - a. To adjust the set point turn the slotted Adjustment Screw (PN 1823-289) clockwise to increase the set point and counter-clockwise to decrease the set point.
 - b. The following is a recommended procedure for calibrating or checking calibration: Use a "T" assembly with three rubber tubing leads, all as short as possible and the entire assembly offering minimum flow restriction. Run one lead to the pressure switch, another to a manometer of known accuracy and appropriate range, and apply pressure through the third tube. Make final approach to the set point slowly. Note that manometer and pressure switch will have different response characteristics due to different internal volumes, lengths of tubing, oil drainage, etc. Be certain switch is checked in position it will assume in use, i.e., vertical, horizontal, etc.

CROSS SECTIONAL VIEW

Part No.	Name
1823-005	Conduit Enclosure (1)
1823-022	Switch Body Assembly — Aluminum die casting with silicone diaphragm and aluminum support plate. (1)
1823-035	"O" Ring 1/2" x 5/8" (1)
1823-077	Mounting Nut — 1/2" Electrical Nut — Steel (1)
1823-078	Conduit Cover Assembly (1)
1823-091	Conduit Enclosure Fasteners — Tinnerman Speed Nut (4)
1823-093	Retaining Ring (1)
1823-109	Calibration Spring — Stainless Steel (1)
1823-199	Insulation Shield — 1/32" Thick Hard Fibre (1)
1823-200	Switch Button — Nylon (1)
1823-242	Snap Switch — SPDT (1)
1823-266	Mounting Washer — 1-5/32" O.D. x .844" I.D. — Steel (2)
1823-289	Calibration Adjustment Screw (1)
1823-309	Calibration Spring Retainer — Brass (1)
1823-490	Switch Bracket — Steel (1)
1823-1H	#6-32 x 1 Steel Screw #6L Brass Washer #6-32 Lock Nut
1823-2H	#6-32 x 5/16" Steel Screw



When corresponding with the factory regarding 1800 series switch problems, please refer to the call-out numbers in this view to assure proper identification. Be sure to include the operating range and any optional features. Field service is not recommended. Contact the factory for service information.

Litho in U.S.A. 3/94
 ©Copyright 1994, Dwyer Instruments, Inc.
 F.R. No. 24-440256-00

ST 3000 Series 900 Smart Transmitter Flange Mounted Liquid Level Model STF924 0 to 400 inH₂O (0 to 1000 mbar)

Specification

LIT - *
PIT - 108

Function

Honeywell's microprocessor-based ST 3000 Flange Mounted Liquid Level Transmitter (Figure 1) measures head pressure caused by changes in liquid level and transmits an output signal proportional to the measured variable. The output signal is transmitted in either an analog 4-20 mA format or in digital format for communicating digitally with TDC 3000. The selection of the output in an analog or digital communications mode is made through the SFC Smart Field Communicator.

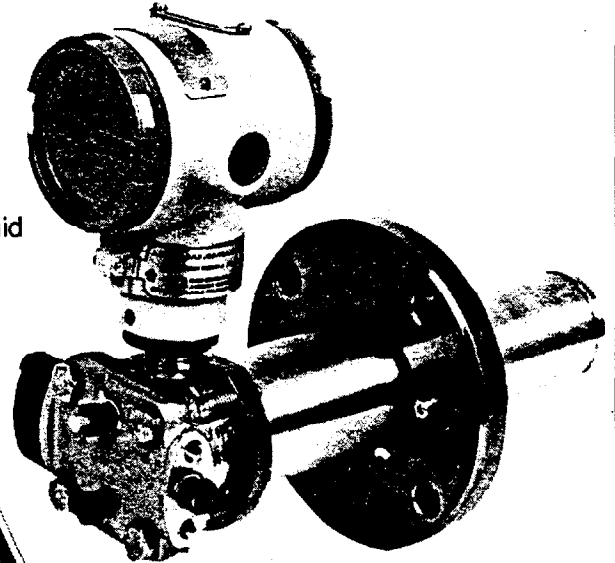
This model measures pressures from 0 to 25 inH₂O up to 0 to 400 inH₂O (0-37.5 mbar to 0-1000 mbar). The flange mount design will always have the flange attached to the high pressure side of the meter body and all performance specifications hold for upper range values (URV) of -400 to +400 inH₂O. Thus the flange mount can be applied for either gaseous or liquid reference leg (open or closed tank) applications without regard to flange position.

Description

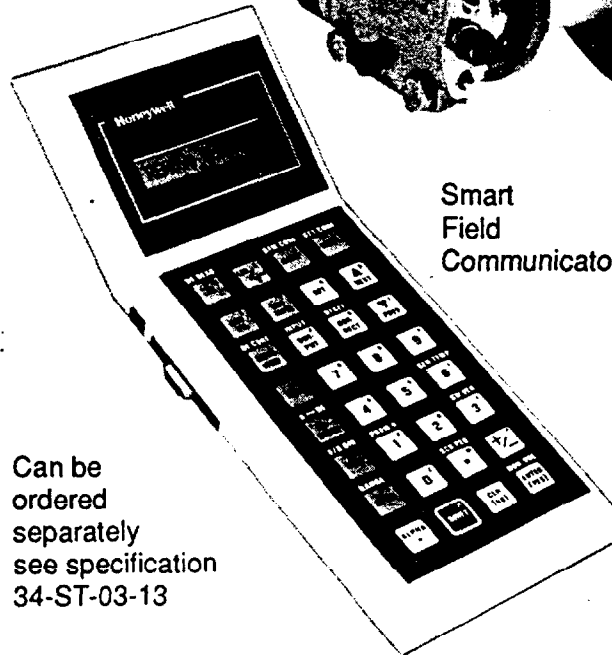
The measuring means is a piezoresistive sensor, which actually contains three sensors in one: a differential pressure sensor, a temperature sensor, and a static pressure sensor. Microprocessor-based electronics provide major improvements: higher span-turndown ratio, improved temperature and pressure compensation, and improved accuracy.

The flange-mounted transmitter is available with a flush or extended diaphragm. In the flush-mounted model, the diaphragm is mounted flush with the gasket surface of a 3 inch, Class 150 or 300 ANSI flange. In the extended-diaphragm model, the diaphragm is attached to a 2.86 inch diameter stainless steel extension tube having standard extensions of 2, 4 or 6 inches. The effective diameter of this tube may be increased to 3.75 inches with the addition of an optional sleeve. This extension tube is then mounted to the gasket surface of either a 3 or 4 inch, Class 150 or 300 ANSI flange. This transmitter also includes a 3-A Sanitary Flange Mount version designed for mounting on a sanitary tank

Flange Mounted Liquid Level Transmitter



Smart Field Communicator



Can be ordered separately see specification 34-ST-03-13

Figure 1—Flange mounted liquid level transmitter

spud with a 2 or 6-inch extension using a Ladish 4-inch Tri-Clamp. For this model, consult specification 34-ST-03-26 dated 4/90 or later.

The ST 3000 transmitter can replace any 4 to 20 mA output pressure transmitter in use today, and operates over a standard two-wire system. ST 3000 features two-way communication between the operator and the transmitter through a communication link called the SFC Smart Field Communicator.

The SFC can be connected anywhere that you can access the transmitter signal lines and provides the capabilities of transmitter adjustments and diagnostics from remote locations, such as the control room.

The transmitter's meter body and electronics housing resist shock, vibration, corrosion, and moisture. The electronics housing contains a compartment for the single-board electronics, which is isolated from an integral junction box.

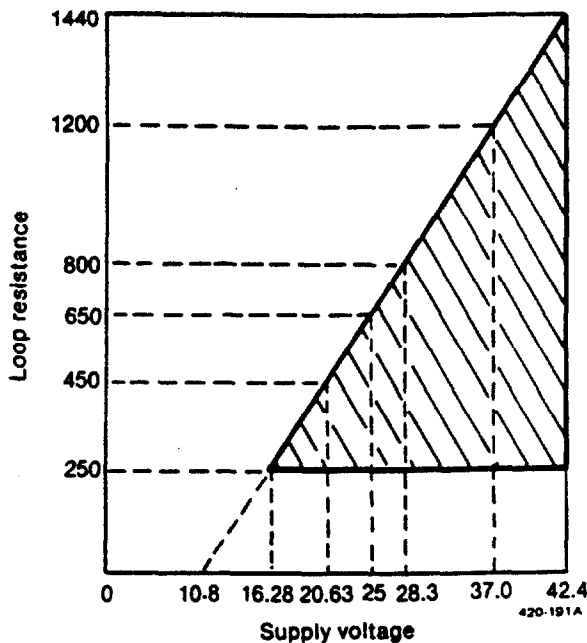
Specifications

Operating Conditions

	Reference Condition	Rated Condition	Operative Limits	Transportation and Storage
Ambient Temperature	°C 25 ± 1	- 25 to 70	- 40 to 85	- 55 to 125
	°F 77 ± 2	- 13 to 158	- 40 to 185	- 67 to 257
Meter Body Temperature	°C 25 ± 1	- 25 to 70*	- 40 to 110	- 55 to 125
	°F 77 ± 2	- 13 to 158*	- 40 to 230	- 67 to 257
Process Interface Temperature	°C 25 ± 1	- 25 to 70*	- 40 to 175**	- 55 to 125
	°F 77 ± 2	- 13 to 158*	- 40 to 350**	- 67 to 257
Humidity	% 10-55	0-100	0-100	0-100
Supply Voltage and Load Resistance	(See Figure 2.)			
Overpressure (Flange Rating)				
ANSI Class 150	0	265 psi (18 bar)	210 psi (14 bar)	
ANSI Class 300	0	690 psi (48 bar)	640 psi (44 bar)	
In Vacuum Region	mmHgA Atmospheric	Atmospheric to 25	Atmospheric to 2	

*For CTFE fill fluid, the rating is - 15 to 110°C (5 to 230°F).

**For CTFE fill fluid, maximum temperature rating is 150°C (300°F).



NOTE: A minimum of 250 ohms of loop resistance is necessary to support communication. Loop resistance equals barrier resistance plus wire resistance plus receiver resistance. Also, 45 volt operation is permitted if not an intrinsically safe installation.

Figure 2—Supply voltage/loop resistance chart

Specifications (continued)**Performance Under Rated Conditions**

Upper Range Limit	400 inH ₂ O (1000 mbar)
Turndown Ratio	16:1
Minimum Span	25 inH ₂ O (37.5 mbar)
Zero Elevation and Suppression	No limit (except minimum span) within ± 100% URL. Specifications valid from - 100% to + 100% URL.
Accuracy (Reference) (includes combined effects of linearity, hysteresis, and repeatability)†	<p><i>Analog Mode:</i> ± 0.10% of calibrated span or upper range value (URV), whichever is greater, terminal based. For URV below reference point (50 inH₂O), accuracy equals: $0.05 + 0.05 \left(\frac{50 \text{ inH}_2\text{O}}{\text{span inH}_2\text{O}} \right) \text{ or } 0.05 + 0.05 \left(\frac{125 \text{ mbar}}{\text{span mbar}} \right) \text{ in } \% \text{ span}$</p> <p><i>Digital Mode:</i> ± 0.075% span</p>
Combined Zero and Span Temperature Effect per 28°C (50°F)	<p><i>Analog Mode:</i> ± 0.6% span. For URV below reference point (50 inH₂O), effect equals: $0.225 + 0.375 \left(\frac{50 \text{ inH}_2\text{O}}{\text{span inH}_2\text{O}} \right) \text{ or } 0.225 + 0.375 \left(\frac{125 \text{ mbar}}{\text{span mbar}} \right) \text{ in } \% \text{ span}$</p> <p><i>Digital Mode:</i> Same as above</p>
Combined Zero and Span Static Pressure Effect per 300 psi (21 bar)	<p><i>Analog Mode:</i> ± 0.40% of span <i>Digital Mode:</i> Same</p>
Output (two-wire)	4 to 20 milliamps, or digital communications mode
Supply Voltage Effect	0.005% span per volt
Damping Time Constant	Adjustable from 0 to 32 seconds digital damping
RFI Protection (Standard)	Negligible effect (20 to 1000 MHz at 30 volts per meter)

†Accuracy includes residual error after averaging successive readings.

Specifications (continued)

Physical

Materials

Process Interface

Wetted parts flange side:

Barrier diaphragm: 316 SS, Hastelloy C
Gasket ring: 316 SS, Hastelloy C*
Extension tube: 316 SS

Wetted parts on side opposite flange:

Barrier diaphragm: 316 SS, Hastelloy C
Process head and adaptor flange: Carbon steel, 316 SS, Hastelloy C*

Process Head Gasket (reference side):

Teflon

Bolting:

Carbon steel or A-286 SS (NACE)

Sanitary Flange Mount:

All parts are 316 SS

Mounting Flange
(not process wetted)

Zinc chromate plated carbon steel or 304 SS (excluding Sanitary version)

Fill Fluid

Silicone oil or CTFE (Chlorotrifluoroethylene)

Electronic Housing

Low-copper aluminum — Meets NEMA 4 (watertight) and NEMA 7 (explosion-proof)

Process Connections

Reference Leg Side:

1/4" NPT female (1/2" NPT with adapter)

Tank Side:

Flange: 3 inch or 4 inch, Class 150 or 300 ANSI; DN80-PN40 or DN100-PN40 DIN flange
Extended Diaphragm: 2, 4, or 6 inches
Sanitary Flange Mount: 4 inch sanitary tank spud with Ladish 4 inch Tri-Clamp

Wiring

Accepts up to 16 AWG (1.5 mm diameter)

Mounting

(See Figure 3.)

Dimensions

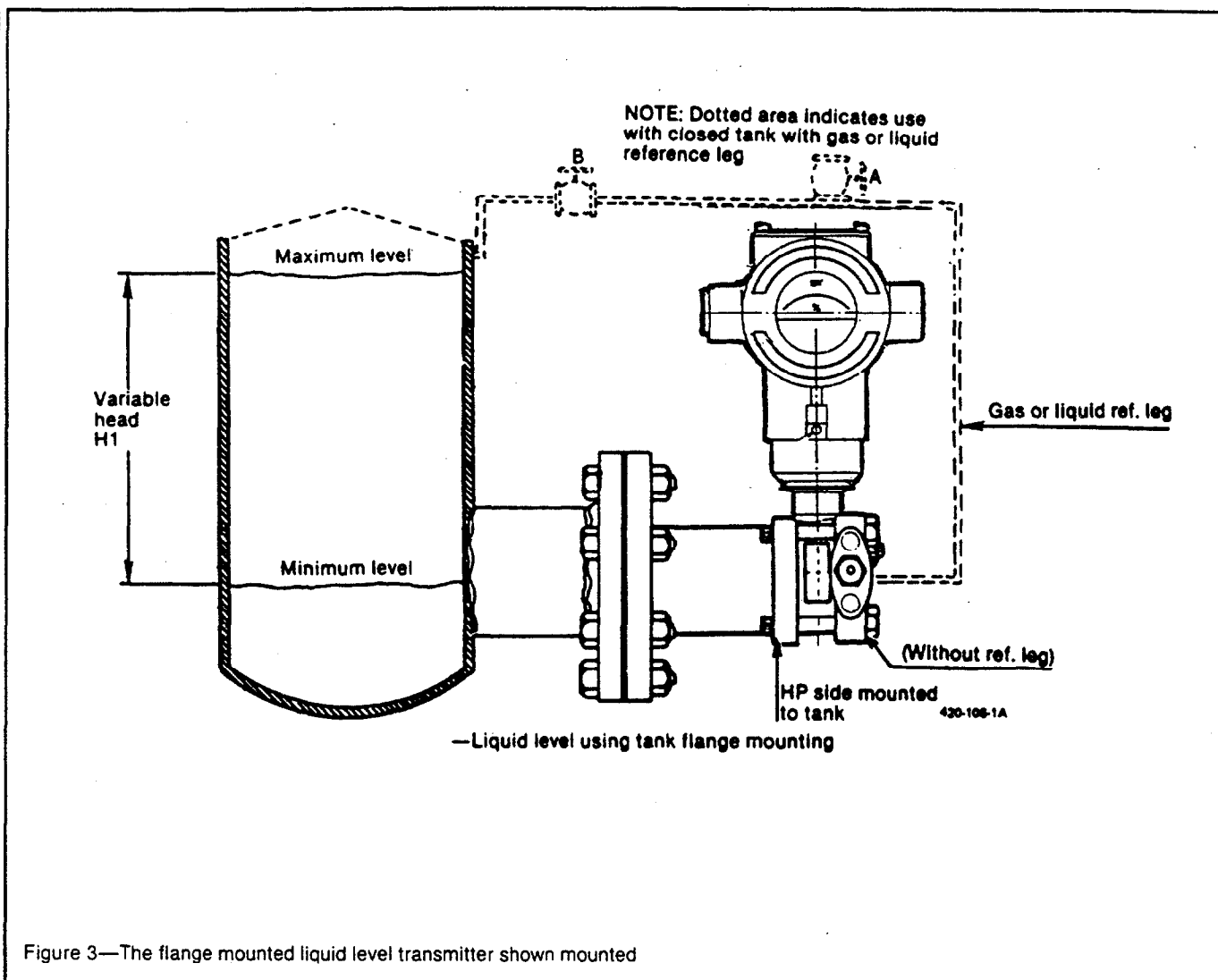
(See Figures 4 and 5.)

Net Weight (flush model)

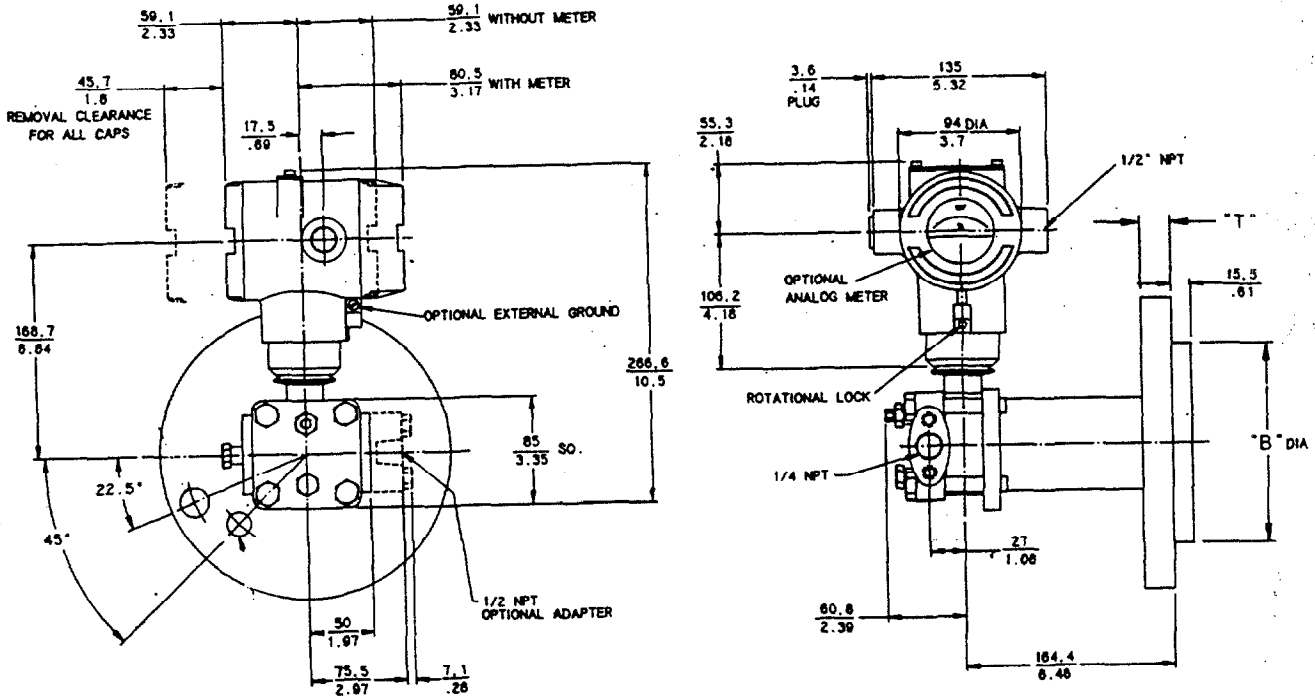
12 kg (26.5 lbs)

Hazardous Conditions

Designed to meet requirements of explosion-proof and intrinsically safe systems for North American classifications Class I, Groups A, B, C, and D, Division I, European (CENELEC) EEx, ia, IIC, T5, and BASEEFA Type N.



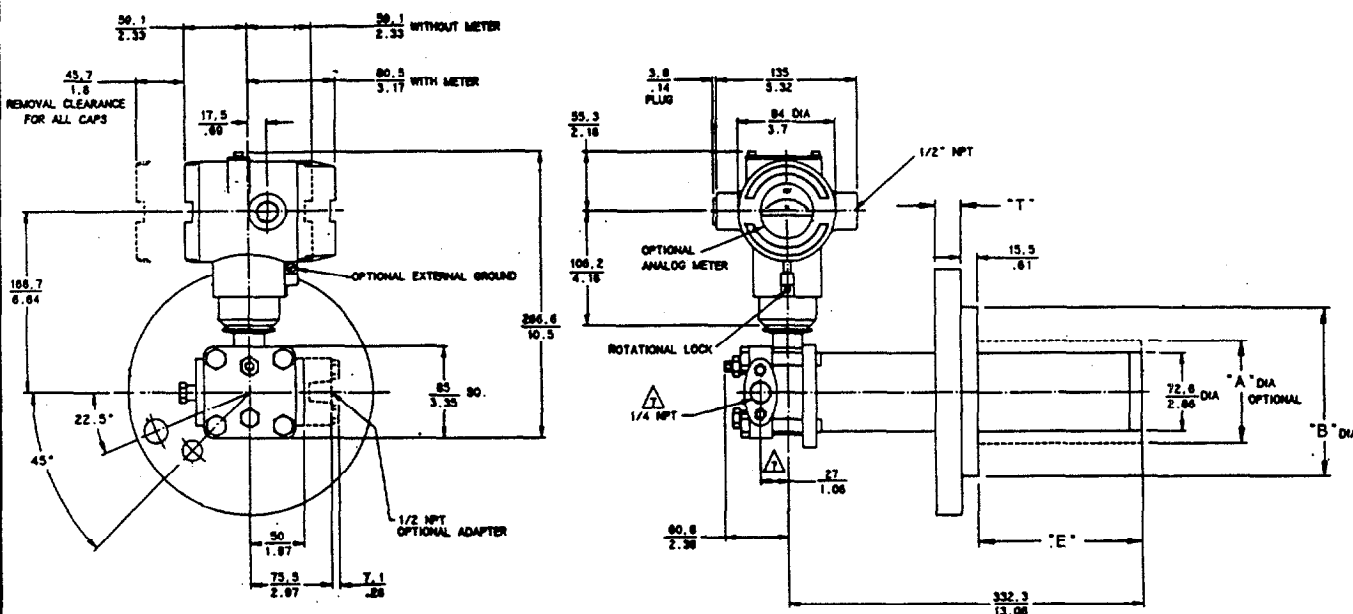
Reference Dimensions: $\frac{\text{millimetres}}{\text{inches}}$



Description		T Flange Thickness	D Flange Dia.	H Bolt Hole Dia.	Number of Holes	Bolt Circles	B Gasket Ring Dia.
Flush Diaphragm	3 inch, ANSI Class 150	$\frac{24}{0.94}$	$\frac{190.5}{7.50}$	$\frac{19}{0.75}$	4	$\frac{152.4}{6.00}$	$\frac{127}{5.00}$
	3 inch, ANSI Class 300	$\frac{28.4}{1.12}$	$\frac{209.6}{8.25}$	$\frac{22.4}{0.88}$	8	$\frac{168.1}{6.62}$	$\frac{127}{5.00}$
	DIN DN80-PN40	$\frac{24}{0.94}$	$\frac{200}{7.87}$	$\frac{18}{0.71}$	8	$\frac{160}{6.30}$	$\frac{138}{5.43}$

Figure 4—Approximate mounting dimensions for flush diaphragm type

Reference Dimensions: $\frac{\text{millimetres}}{\text{inches}}$



Description	T Flange Thickness	D Flange Dia.	H Bolt Hole Dia.	Number of Holes	Bolt Circles	A Optional Ext. Dia.	B Gasket Ring Dia.	Extension E			
								E 2 inch	E 4 inch	E 6 inch	
Extended Diaphragm	3 inch, ANSI Class 150	$\frac{24}{0.94}$	$\frac{190.5}{7.50}$	$\frac{19}{0.75}$	4	$\frac{152.4}{6.00}$	N/A	127 5.00			
	3 inch, ANSI Class 300	$\frac{28.4}{1.12}$	$\frac{209.6}{8.25}$	$\frac{22.4}{0.88}$	8	$\frac{168.1}{6.62}$	$\frac{95.2}{3.75}$	127 5.00	50.8 2.00	101.6 4.00	152.4 6.00
	DIN DN80-PN40	$\frac{24}{0.94}$	$\frac{200}{7.87}$	$\frac{18}{0.71}$	8	$\frac{160}{6.30}$		138 5.43			
	4 inch, ANSI Class 150	$\frac{24}{0.94}$	$\frac{228.6}{9.00}$	$\frac{19}{0.75}$	8	$\frac{190.5}{7.50}$		157.2 6.19			
	4 inch, ANSI Class 300	$\frac{31.8}{1.25}$	$\frac{254}{10.0}$	$\frac{22.4}{0.88}$	8	$\frac{200.2}{7.88}$		157.2 6.19	50.8 2.00	101.6 4.00	152.4 6.00
	DIN DN100-PN40	$\frac{24}{0.94}$	$\frac{235}{9.25}$	$\frac{23}{0.90}$	8	$\frac{190.5}{7.50}$		162 6.38			

Figure 5—Approximate mounting dimensions for extended diaphragm type

Options

Custom Tag

A stainless steel nameplate stamped with customer information and wired onto the transmitter.

Indicating Meter

An indicating meter with 0 to 100% linear scales.

Lightning Protection

A pipe nipple with circuitry that protects the transmitter from transient surges induced by nearby lightning strikes.

Ordering Information

Contact your nearest Honeywell sales office, or

Honeywell Industrial Automation and Control Division
14841 N. Black Canyon Highway
Phoenix, AZ 85023-3099

In Canada — Honeywell Limited
155 Gordon Baker Road
Willowdale, Ontario
M2H 3N7

ST 3000 Series 900 Smart Transmitter Model Selection Guide Flange Mounted Liquid Level

INSTRUCTIONS

- Select the desired Key Number. The arrow to the right marks the selection available.
- Make one selection from each Table, I and II, using the column below the proper arrow. Select as many Table III options as desired (if no options are desired, specify 00). A dot (•) denotes unrestricted availability. A letter denotes restricted availability. Restrictions follow Table IV.

Key Number I II III (Optional) IV
+ X X X X

KEY NUMBER	Selection	Availability
Span		
0-25 to 0-400 inH ₂ O / 0-62.2 to 0-1000 mbar	STF924	↓
0-5 to 0-100 psi / 0-0.35 to 0-7 bar	STF932	↓
0-25 to 0-400 inH ₂ O / 0-62.2 to 0-1000 mbar	STF92F	↓
0-5 to 0-100 psi / 0-0.35 to 0-7 bar	STF93F	↓

← LIT
PIT

TABLE I METER BODY

Materials	Design	Ref. Hd.	Vent/Drain Valve	Barrier Diaphragms	Diaphragm Plate	Extension								
	Flush	Carbon Steel	316 SS	316 SS	316 SS	316 SS	N/A	A	•					
Hast C					316 SS	W		•						
Hast C					Hast C	B		•						
316 SS		316 SS	316 SS	316 SS	316 SS	N/A	E	•						
				Hast C	316 SS		X	•						
				Hast C	Hast C		F	•						
Hast C		Hast C	Hast C	Hast C	Hast C	Hast C	N/A	J	•					
								Carbon Steel	316 SS	316 SS	316 SS	316SS	M	•
													Hast C	Hast C	N	•
316 SS	316 SS	316 SS	316 SS	Hast C	316 SS	316SS	R	•						
							Hast C	Hast C	S	•				
Pseudo Flange	Carbon Steel	316 SS	316 SS	316 SS	N/A	N/A	A	•						
				Hast C			Hast C	B	•					
	316 SS	316 SS	316 SS	Hast C	Hast C	N/A	N/A	E	•					
Fill Fluid (Meter Body and Flange)			Silicone			1	•	•						
			CTFE			2	•	•						
Process Connection	Reference Head		Flange											
	1/4" NPT		High Pressure Side		.....		___ A	•					
	1/4" NPT		Low Pressure Side		.....		___ C	•					
	1/2" NPT (with Adapter)		High Pressure Side		.....		___ H	t					
	1/2" NPT (with Adapter)		Low Pressure Side		.....		___ K	t					

Availability

STF9

TABLE II FLANGE ASSEMBLY

			Selection	24 32	2F 3F	
No Selection			0	.	.	
Flange	3" ANSI Class 150 3" ANSI Class 300 DN80-PN40 DIN 4" ANSI Class 150 4" ANSI Class 300 DN100-PN40 DIN	Carbon Steel	1 2 3 4 5 6	y y y . . .		
	3" ANSI Class 150 3" ANSI Class 300 DN80-PN40 DIN 4" ANSI Class 150 4" ANSI Class 300 DN100-PN40 DIN	304 SS	A B C D E F	y y y . . .		
	2" Pseudo Flange on Standard DP ANSI Class 150 with Vent/Drain 3" ANSI Class 150 w/o Vent/Drain	316 SS	R P		.	
Gasket Ring	No Selection		0	.	.	
	Flush Design	316 SS Hast C	1 2	g g		
	Extended Design	316 SS	5	v		
Extension	No Selection		0	.	.	
	Flush		F	h		
		Diameter	Length			
	2.86 inches (for 3" or 4" spud)	2 inches	2 inches	1	v	
		4 inches	4 inches	2	v	
6 inches		6 inches	3	v		
3.75 inches (optional for 4" spud)	2 inches	2 inches	5	v		
	4 inches	4 inches	6	v		
	6 inches	6 inches	7	v		
No Selection			0	.	.	

TABLE III OPTIONS

None	00	.	.
Adapter Flange - 1/2" NPT ST Steel	S1	.	.
Adapter Flange - 1/2" NPT Hastelloy C	T1	.	.
Modified DIN Process Head - 316 S.S.	DN	z	z
Lightning Protection	LP	.	.
Analog Meter (0-100 even, 0-10 square root)	ME	.	.
A286SS (NACE) Bolts and 304SS (NACE) Retaining Ring for Head and 316SS (NACE) Bolts for Adapter.....	CR	.	.
Custom Calibration and I.D. in Memory	CC	.	.
Transmitter Configuration	TC	.	.
Write Protection	WP	.	.
Local Zero and Span	ZS	.	.
Stainless Steel Customer Tag	TG	.	.
Additional Warranty - 1 year	W1	.	.
Additional Warranty - 2 years	W2	.	.
Additional Warranty - 3 years	W3	.	.
Additional Warranty - 4 years	W4	.	.

Table III is continued on the following page.

STF9 Availability

TABLE III OPTIONS (continued)

Approval Body	Approval Type	Location or Classification	Selection	Availability	
				24/32	2F/3F
Factory Mutual	Explosion Proof	Class I, Division 1, Groups A, B, C, D	F1D3	•	•
	Dust Ignition Proof	Class II, III, Division 1, Groups E, F, G			
	Non-Incendive	Class I, Division 2, Groups A, B, C, D			
	Intrinsically Safe	Class I, II, III, Division 1, Groups A, B, C, D, E, F, G			
CSA	Explosion Proof	Class I, Division 1, Groups B, C, D	C1C3	•	•
	Dust Ignition Proof	Class II, III, Division 1, Groups E, F, G			
	Intrinsically Safe	Class I, II, III, Division 1, Groups A, B, C, D, E, F, G			
PTB	Intrinsically Safe	EEx ia IIC T5 Suitable for Zone 0	P0D2	•	•
BASEEFA	Type N	Ex N II T6 Zone 2, Group II areas for any mixtures in an industrial environment, also complying with IEC T6 temperature classification	B2D5	r	r
SAA	Intrinsically Safe	EEx ia IIC T4	A0CA	•	•
	Non-Incendive	Ex n IIC T6			
LCIE	Explosion Proof	EEx d IIC T6	LCIE	r	r

TABLE IV

Factory Identification	XXXX	•	•
------------------------------	------	---	---

RESTRICTIONS

Restriction Letter	Available Only With		Not Available With	
	Table	Selection	Table	Selection
b	I	M __, N __, R __, S __		
g	I	A __, B __, E __, F __, J __, W __, X __		
h	III	Approval Bodies pending		
r	II		5	6, 7
t	Select only one option from this group.			
v	Select from Table III.			
y	I	M __, N __, R __, S __		
z	II		5	
	I	E __, R __		

ST 3000 Series 900 Smart Transmitter Differential Pressure Model STD924

0 to 400 inH₂O (0-1000 mbar)

Specification

Function

Honeywell's microprocessor-based ST 3000 Differential Pressure Transmitter (Figure 1) measures differential pressures and transmits an output signal proportional to the measured variable. The output signal is transmitted in either an analog 4-20 mA format or in digital format for communicating digitally with TDC 3000. The selection of the output in an analog or digital communications mode is made through the SFC Smart Field Communicator.

This model measures differential pressures as low as 0 to 25 inH₂O, up to 0 to 400 inH₂O (0-62 mbar to 0-1000 mbar). Both linear and square root output conformity are available from the same electronics module.

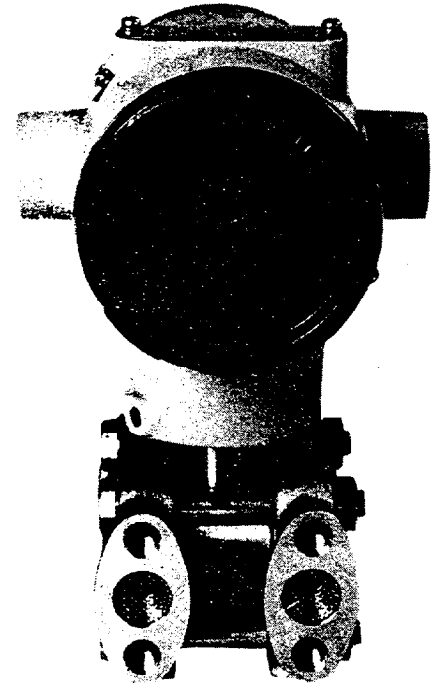
Description

The measuring means is a piezoresistive sensor, which actually contains three sensors in one: a differential pressure sensor, a static pressure sensor and a temperature sensor. Microprocessor-based electronics provide major improvements: higher span-turndown ratio, improved temperature and pressure compensation, and improved accuracy.

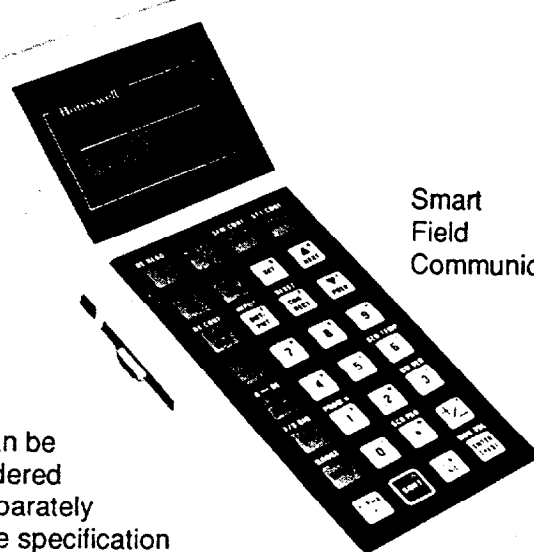
The ST 3000 transmitter can replace any 4-20 milliamp output pressure transmitter in use today, and operates over a standard two-wire system. ST 3000 features two-way communication between the operator and the transmitter through a communication link called the SFC Smart Field Communicator. The SFC can be connected anywhere that you can access the transmitter signal lines and provides the capabilities of transmitter adjustments and diagnostics from remote locations, such as the control room.

The transmitter's meter body and electronics housing resist shock, vibration, corrosion, and moisture. The electronics housing contains a compartment for the single-board electronics, which is isolated from an integral junction box. The single-board electronics is replaceable, and interchangeable with any other ST 3000/Series 900 model.

PDIT - 220A
220B



DP Transmitter



Smart
Field
Communicator

Can be
ordered
separately
see specification
34-ST-03-13

420-200

Figure 1—Differential Pressure Transmitter

Specifications

Operating Conditions

	Reference Condition	Rated Condition	Operative Limits	Transportation and Storage
Ambient Temperature	°C 25 ± 1	- 25 to 70	- 40 to 85	- 55 to 125
	°F 77 ± 2	- 13 to 158	- 40 to 185	- 67 to 257
Meter Body Temperature	°C 25 ± 1	- 25 to 70*	- 40 to 110	- 55 to 125
	°F 77 ± 2	- 13 to 158*	- 40 to 230	- 67 to 257
Humidity	% 10-55	0-100	0-100	0-100
Supply Voltage and Load Resistance	(See Figure 2.)			
Overpressure	psi 0	3000 psi (210 bar)	3000 psi (210 bar)†††	
In Vacuum Region (Min Press)	mm Hg Abs atmospheric	25	2 (Short term)	

Performance Under Rated Conditions

Upper Range Limit	400 inH ₂ O (1000 mbar)
Turndown Ratio	16:1
Minimum Span	25 inH ₂ O (62 mbar)
Zero Elevation and Suppression	- 5% to + 100% URV
Accuracy (Reference) (includes combined effects of linearity, hysteresis, and repeatability)**†	<i>Analog Mode:</i> ± 0.10% calibrated span or upper range value (URV), whichever is greater, terminal based. <i>Digital Mode:</i> ± 0.075% span
Combined Zero and Span Temperature Effect per 28°C (50°F)**	<i>Analog Mode:</i> ± 0.40% of span For URV below reference point (50 inH ₂ O), accuracy equals: $0.3 + 0.1 \left(\frac{50 \text{ inH}_2\text{O}}{\text{span inH}_2\text{O}} \right)$ in % span <i>Digital Mode:</i> ± 0.30% of span $0.2 + 0.1 \left(\frac{50 \text{ inH}_2\text{O}}{\text{span inH}_2\text{O}} \right)$ in % span
Combined Zero and Span Static Pressure Effect per 1000 psi**	<i>Analog Mode:</i> ± 0.40% of span For URV below reference point (80 inH ₂ O), accuracy equals: $0.15 + 0.25 \left(\frac{80 \text{ inH}_2\text{O}}{\text{span inH}_2\text{O}} \right)$ in % span <i>Digital Mode:</i> same
Output (two-wire)	4 to 20 milliamps, or digital communications mode
Supply Voltage Effect	0.005% span per volt
Damping Time Constant	Adjustable from 0 to 32 seconds digital damping
RFI Protection (Standard)	Negligible effect (20 to 1000 MHz at 30 volts per meter)

Physical

Materials	
Process Interface	<i>Process Barrier Diaphragms:</i> 316L SS, Hastelloy C-276, Monel,†† Tantalum†† <i>Process Head:</i> 316 SS, Carbon Steel, Monel, Hastelloy <i>Head Gaskets:</i> Teflon, Viton†† <i>Bolting:</i> Carbon steel, A-286 SS (NACE)
Mounting Bracket	Carbon Steel (zinc plated)
Fill Fluid	Silicone oil or CTFE (chlorotrifluoroethylene)
Electronic Housing	Low Copper Aluminum Meets NEMA 4 (watertight) and NEMA 7 (explosion-proof)
Process Connections	1/4 inch NPT (optional 1/2 NPT with adapter)
Wiring	Accepts up to 16 AWG (1.5 mm diameter)
Mounting	(See Figure 3.)
Dimensions	(See Figure 4.)
Net Weight	4.1 Kg (9 lbs)
Hazardous Conditions	Designed to meet requirements of explosion-proof and intrinsically safe systems for North American classifications Class I, Groups A, B, C, and D, Division I, European (CENELEC) EEx, ia, IIC, T5, and BASEEFA Type N.

*For CTFE fill fluid, the rating is - 15 to 70°C (5 to 158°F).

**Specification does not apply to ST 3000 with tantalum, monel, or hastelloy barrier diaphragms.

†Accuracy includes residual error after averaging successive readings.

††Consult Phoenix for availability.

††† - 25 to - 40°C (- 13 to - 40°F) overpressure limit 2000 psi (140 bar)

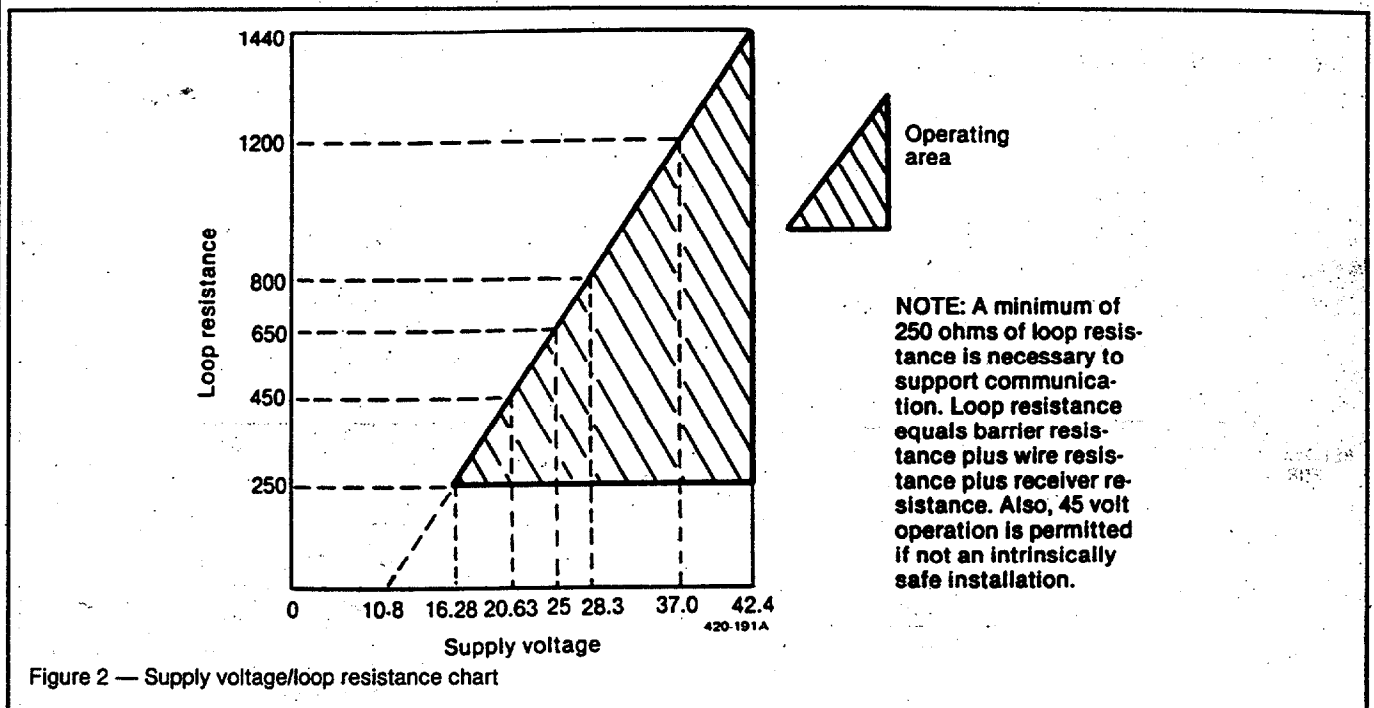


Figure 2 — Supply voltage/loop resistance chart

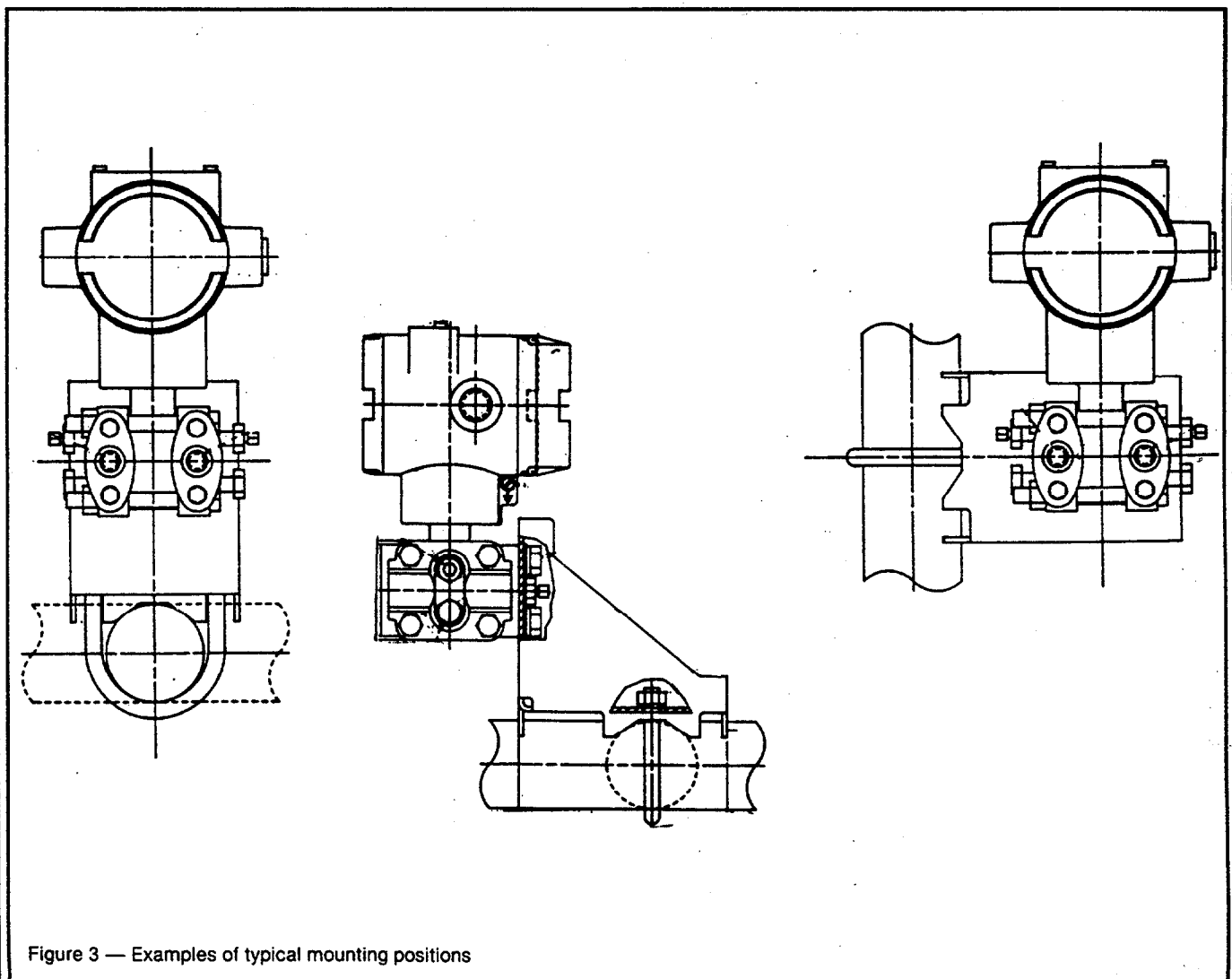


Figure 3 — Examples of typical mounting positions

Reference Dimensions: $\frac{\text{millimetres}}{\text{inches}}$

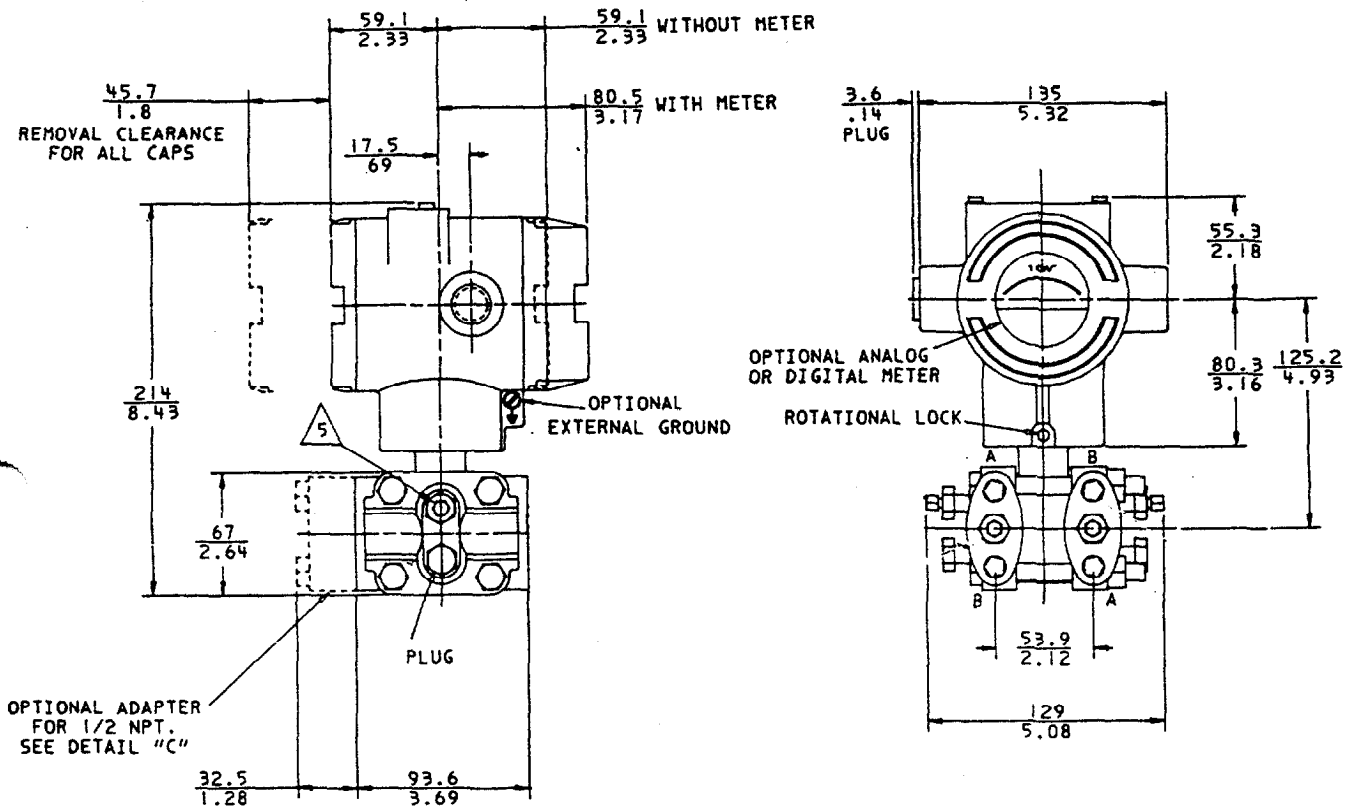


Figure 4 — Approximate mounting dimensions

Options

Mounting Bracket

A carbon steel bracket suitable either for horizontal or vertical mounting on a two inch pipe or for wall mounting.

Indicating Meter

An indicating meter with 0 to 10 square root or 0 to 100% linear scales.

Lightning Protection

A pipe nipple with circuitry that protects the transmitter from transient surges induced by nearby lightning strikes.

Ordering Information

Contact your nearest Honeywell sales office, or

Honeywell Industrial Automation and Control Division
14841 N Black Canyon Hwy
Phoenix, AZ 85023

In Canada: Honeywell, Limited
155 Gordon Baker Road
Willowdale, Ontario
M2H 3N7

ST 3000 Series 900 Smart Transmitter Model Selection Guide

Differential Pressure (DP)

INSTRUCTIONS

- Select the desired key number. The arrow to the right marks the selections available.
- Make one selection from each table, I and II, using the column below the proper arrow. Select as many Table III options as desired (if no options are desired, specify 00). A dot (•) denotes unrestricted availability. A letter denotes restricted availability. Restrictions follow Table IV.

Key Number I II III (Optional) IV
----- - - - + XXXX

KEY NUMBER	Selection	Availability		
Span				
0-25" to 0-400" H ₂ O/0-62.2 to 0-1000 mbar Body Rating: 3000 psi (210 bar)	STD924	↓		
0-5 psi to 0-100 psi/0-.35 to 0-7 bar Body Rating: 3000 psi (210 bar)	STD930		↓	
0-100 psi to 0-3000 psi/0-7 to 0-210 bar Body Rating: 3000 psi (210 bar)	STD974			↓

TABLE I METER BODY

Materials of Construction	Process Heads	Vent/Drain Valves and Plugs	Barrier Diaphragms	A	B	C	D	E	F	G	H	J	K	L
	Carbon Steel	316 St. St.	316 St. St.											
	Carbon Steel	316 St. St.	Hastelloy C	•	•	•								
	Carbon Steel	316 St. St.	Monel	•	•	•								
	Carbon Steel	316 St. St.	Tantalum	•	•	•								
	316 St. St.	316 St. St.	316 St. St.	•	•	•								
	316 St. St.	316 St. St.	Hastelloy C	•	•	•								
	316 St. St.	316 St. St.	Monel	•	•	•								
	316 St. St.	316 St. St.	Tantalum	•	•	•								
	Hastelloy C	Hastelloy C	Hastelloy C	v	v	v								
	Hastelloy C	Hastelloy C	Tantalum	v	v	v								
	Monel	Monel	Monel	v	v	v								
Fill Fluid	Silicone				1	•	•	•						
	CTFE				2	•	•	•						
Process Head Configuration	1/4" NPT				A	•	•	•						
	1/2" NPT with Adapter (on 1/4" NPT Head) ...				H	t	t	t						

TABLE II

No Selection	00000	•	•	•
--------------------	-------	---	---	---

TABLE III OPTIONS

None	00	•	•	•
Adapter Flange - 1/2" NPT St. Steel	S2	•	•	•
Adapter Flange - 1/2" NPT Hastelloy C	T2	•	•	•
Adapter Flange - 1/2" NPT Monel	V2	•	•	•
Modified DIN Process Heads - 316 S.S.	DN	w	w	w
Viton Head Gaskets (1/2" Adapter Gaskets are special)	VT	z	z	z

Table III is continued on the next page.

STD 9

TABLE III OPTIONS (continued)			Selection	24	30	74
Mounting Bracket			MB	.	.	.
Lightning Protection			LP	.	.	.
Analog Meter (0-100 even, 0-10 square root)			D ME	.	.	.
Local Zero and Span			ZS	.	.	.
A286SS (NACE) Bolts and 302/304SS (NACE) Nuts for Heads and 316SS (NACE) Bolts for Adapters			CR	.	.	.
Stainless Steel Customer Tag			TG	.	.	.
Flat Mounting Bracket			FB	.	.	.
Side Vent/Drain (End Vent Drain is standard)			SV	.	.	.
Custom Calibration and I.D. in Memory			CC	.	.	.
Transmitter Configuration			TC	.	.	.
Write Protection			WP	.	.	.
Additional Warranty - 1 year			W1	.	.	.
Additional Warranty - 2 years			W2	.	.	.
Additional Warranty - 3 years			W3	.	.	.
Additional Warranty - 4 years			W4	.	.	.
Approval Body	Approval Type	Location or Classification				
Factory Mutual	Explosion Proof	Class I, Div. 1, Groups A,B,C,D	F1D3	.	.	.
	Dust Ignition Proof	Class II, III, Div. 1, Groups E,F,G		.	.	.
	Non-Incendive	Class I, Div. 2, Groups A,B,C,D		.	.	.
	Intrinsically Safe	Class I, II, III, Div. 1, Groups A,B,C,D,E,F,G		.	.	.
SA	Explosion Proof	Class I, Div. 1, Groups B,C,D	C1C3	.	.	.
	Dust Ignition Proof	Class II, III, Div. 1, Groups E,F,G		.	.	.
	Intrinsically Safe	Class I, II, III, Div. 1, Groups A,B,C,D,E,F,G		.	.	.
PTB	Intrinsically Safe	EEx ia IIC T5 Suitable for Zone 0	P0D2	.	.	.
BASEEFA	Type N	Ex N II T6 Zone 2, Group II areas for any mixtures in an industrial environment, also complying with IEC T6 temperature classification	B2D5	r	r	r
SAA	Intrincally Safe	EEx ia IIC T4	A0CA	.	.	.
	Non-Incentive	Ex n IIC T6		.	.	.
LCIE	Explosion Proof	EEx d IIC T6	LCIE	r	r	r

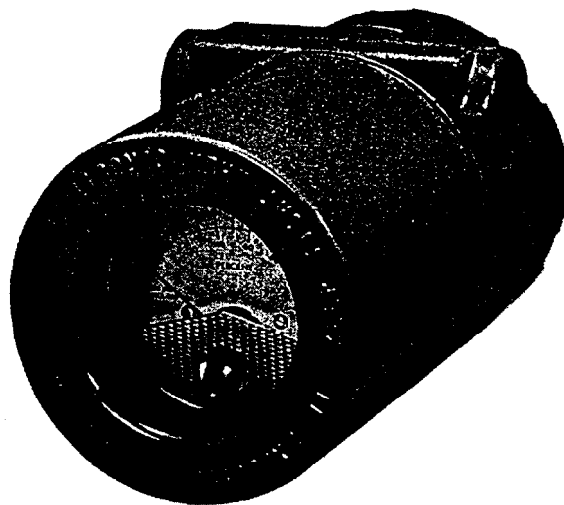
TABLE IV						
Factory Identification	XXXX	.	.	.	.	.

RESTRICTIONS						
Restriction Letter		Available Only With		Not Available With		
b	r	t	v	w	z	
■						Select only one option from this group
	■					Select adapter from Table III
		■				Approval Bodies pending
			■			Includes side vent drain — no price add
						I B____, F____, J____, D____ H____, K____
						I E____

Model 1181 pH/ORP *AE/AIT-200A,B,130*

Two-Wire Transmitters

- TWO-WIRE FIELD MOUNTED TRANSMITTERS. Ideal for multiple loop installations where central data processing and control are required. Field mounting near the sensor for ease in routine calibration.
- NEMA 4X WEATHERPROOF, CORROSION-RESISTANT, DUAL COMPARTMENT HOUSING provides maximum circuit protection for increased reliability in industrial environments.
- HAZARDOUS AREA INSTALLATION. Certified NEMA 7B explosion-proof and intrinsically safe when used with an approved sensor and safety barrier.
- COMMONALITY OF PARTS reduces inventory required to support different field measurements.
- SWITCH SELECTABLE RANGES further reduces inventory by permitting calibration of one Model to virtually any Tag Number requiring the same measurement.
- EXTERNAL ZERO AND SPAN, 20-turn potentiometers provide for fine calibration of the isolated 4-20 mA output signal.



FEATURES AND APPLICATIONS

The Rosemount Analytical Two-Wire field mounted transmitters, with the appropriate sensors, are designed to continuously measure the pH, ORP, Conductivity, Dissolved Oxygen, or Free Residual Chlorine in industrial processes.

The Model 1181 Transmitters include all the circuitry necessary for the measurement and transmission of an isolated 4-20 mA linear signal. Measurement range selection is made through internal range switches that are easily accessed by removing a housing cover. No further disassembly is required. A matrix is provided which conveniently indicates the proper switch position. Range selection can be made without the use of the instruction manual. Fine calibration of the 4-20 mA signal is accomplished with the 20-turn external Zero and Span potentiometers.

The electronic printed circuits are protected from the environment by the NEMA 4X weatherproof, corrosion resistant enclosure. The printed circuit cards plug into a moisture barrier which is isolated from the field wiring and calibration terminals.

Routine field calibration does not require exposing the electronics to harsh industrial environments. All PCBs are conformal coated for maximum protection. The PCBs are removed as a unit and may be individually replaced. The transmitter housing covers are sealed with large cross sectional O-rings and need not be replaced each time the cover is removed.

The Model 1181 is available with or without an analog or digital display. The digital display may be calibrated in engineering units and the analog display features multiple scales in engineering units.

The transmitters are certified explosion-proof, NEMA 7B, and intrinsically safe when installed with an approved barrier and sensor. Hazardous area certificates are provided by BASEEFA to CENELEC regulations, FM, CSA, SAA, SEV, and TUV. CSA has determined that the moisture barrier qualifies as Factory Sealed which means Explosion Proof Y fittings and sealing compound are not required for installation when this approval is selected.

Continued on page 2

ROSEMOUNT[®] ANALYTICAL

FISHER-ROSEMOUNT[™] Managing The Process Better[™]

Accessory items are available for the two-wire transmitters. The Model 515 Isolated Power Supply provides power for up to 20 transmitters. Two transmitters may be wired directly to the power supply. For more than two transmitters, junction boxes are available, each accommodating wiring for a maximum of ten transmitters. Remote alarms are available with indepen-

dently adjustable set points and hysteresis. Contacts of the Model 230A may be specified for high/low, high/high, or low/low operation. The impedance of the Model 230A Alarm Module is less than 100 ohms. For further information on the Models 515 and 230A, please refer to their respective product data sheet.

PHYSICAL SPECIFICATIONS – GENERAL

Enclosure: NEMA 4X, weatherproof and corrosion-resistant
NEMA 7B, explosion proof

Hazardous Area Classification:

Explosion Proof:

- FM: Class I, Groups B, C, & D, Div. 1
- Class II, Groups E, F, & G, Div. 1
- Class III
- CSA: Class I, Groups C & D
- Class II, Groups E, F, & G
- Class III, Encl 4
- Class I, Groups A, B, C, & D, Div. 2
- Encl 4, Factory Sealed

Intrinsic Safety:

- FM: Class I, II, & III, Div. 1
- CSA: Class I, Groups A, B, C, & D, Encl 4 Temperature Code T4
- CENELEC: Ex ia IIB T4
- SAA: Class I, Zone O, Ex ia IIC T5

Display:

- Analog: plug in, 90 degree, 2.5 inch diameter
- 1181pH: dual scale, 0-100% & 0-14pH
- 1181ORP: dual scale, 0 center, ±1.0 & 0-100%
- Digital: 3.5 digit, LCD, adjustable range in engineering units

Recommended Cable: Transmitter to Power Supply
Two Wire, 18 AWG, shielded, Belden 8760 or equal
(Rosemount Analytical P/N 9200001)

Weight/Shipping Weight:

- 1181pH, ORP:
- Blind: 1.44 kg/1.89 kg (3.18 lbs/4.18 lbs)
- Analog/Digital: 2.15 kg/2.6 kg (4.74 lbs/5.75 lbs)

PERFORMANCE SPECIFICATIONS – GENERAL

Power Supply Requirements: (See Load/Supply Chart)

Lift Off Voltage: Blind & Analog: 10 VDC
Digital: 12.5 VDC

Maximum Operating Power: 40 milliwatts

Output: Blind & Analog: Isolated 4-20 mA into 700 ohms at 24 VDC
Digital: Isolated 4-20 mA into 575 ohms at 24 VDC

Input/Output Isolation: 600 Volts

Ambient Temperature: -30° to 55°C

Ambient Humidity: 0-99% RH

Digital Display Accuracy: 0.1% reading ±1.0 count

Analog Display Accuracy: ±2.0%

External Zero: ±7.5% full scale

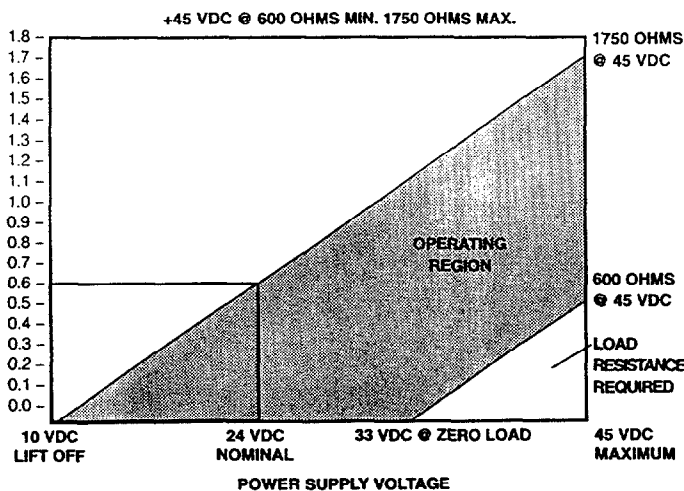
External Span: ±7.5% full scale

Shock: 10G maximum for 10 milliseconds

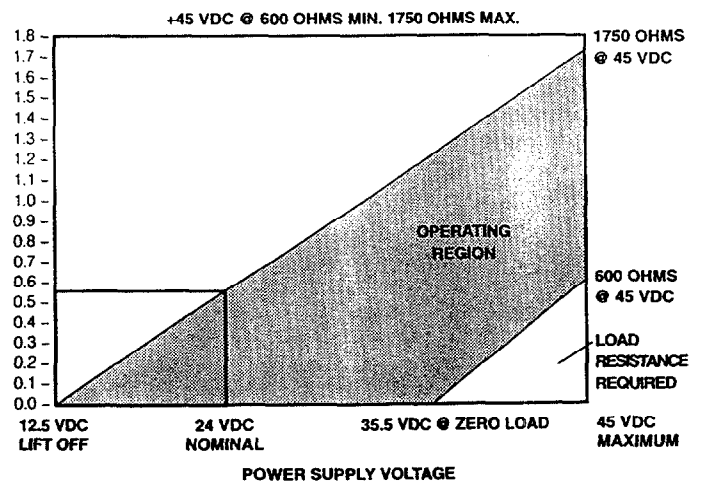
Vibration: 0.025 inches double amplitude 5 to 50 Hz for 2 hours

RFI: 1.0% for radio frequencies in the 27 to 500 mHz range

**BLIND & ANALOG DISPLAY
LOAD/POWER SUPPLY REQUIREMENTS**



**DIGITAL DISPLAY
LOAD/POWER SUPPLY REQUIREMENTS**



The **Model 1181pH** Transmitter measures over the full range of 0-14 pH. The 4-20 mA isolated output may be field calibrated to represent any 2 to 14 pH span. Two digital displays are offered with the 1181pH. The Code 04 LCD display receives its input from the pH preamplifier. The advantage of the Code 04 display is that it will continue to display the measured pH regardless of the calibrated output. The Code 06 LCD display and the analog display receive their input from the 4-20 mA loop current and will display pH to the calibrated output only.

The **1181pH** Transmitter is available with an integral preamp. The Code 43 integral preamp is for use with sensors having a PT100 temperature compensator and the Code 44 internal preamp is for use with the Rosemount Analytical standard 3K temperature compensator. An integral preamp is not compatible with the Code 04 LCD display and Code 02 Blind. These options require a Tall Housing Cover (P/N 3002468). The maximum recommended distance between the sensor and integral preamp is 15 feet (4.5 meters).

PERFORMANCE SPECIFICATIONS @ 25°C

(Electronics only)

Measurement Range: 0-14 pH

Internal Range Select: Any 2 to 14 pH span in one pH steps

Accuracy: $\pm 0.1\%$ full scale

Stability: $\pm 0.1\%$ /month

Repeatability: ± 0.1 pH

Temperature Coefficient: ± 0.0028 pH/°C full scale

Automatic Temperature Compensations: 0-100°C

RECOMMENDED SENSORS:

Model 300 Retractable pH Sensor

Model 320B Flow Through pH Sensor

Model 320HP High Purity pH Sensor

Model 328A Steam Sterilizable pH Sensor

Model 381 Insertion/Submersion/Flow pH Sensor

Model 385 Retractable pH Sensor

Model 399 Disposable pH Sensor

The **Model 1181ORP** Transmitter measures over the range of ± 1200 mV. The 4-20 mA isolated output may be calibrated to represent any 200 to 2400 mV range.

PERFORMANCE SPECIFICATIONS @ 25°C

Measurement Ranges: Span: 200 mV to 2400 mV in 200 mV steps

Zero: 0 to ± 2400 mV in 200 mV steps

Accuracy: $\pm 0.1\%$ full scale

$\pm 0.2.0$ mV full scale

Stability: $\pm 0.1\%$ full scale/month

± 2.0 mV/month, non-cumulative

Repeatability: $\pm 0.1\%$ full scale

± 2.0 mV/month

Temperature Coefficient: ± 200 ppm/°C full scale

± 0.4 mV/°C full scale

Automatic Temperature Compensations: N/A

RECOMMENDED SENSORS:

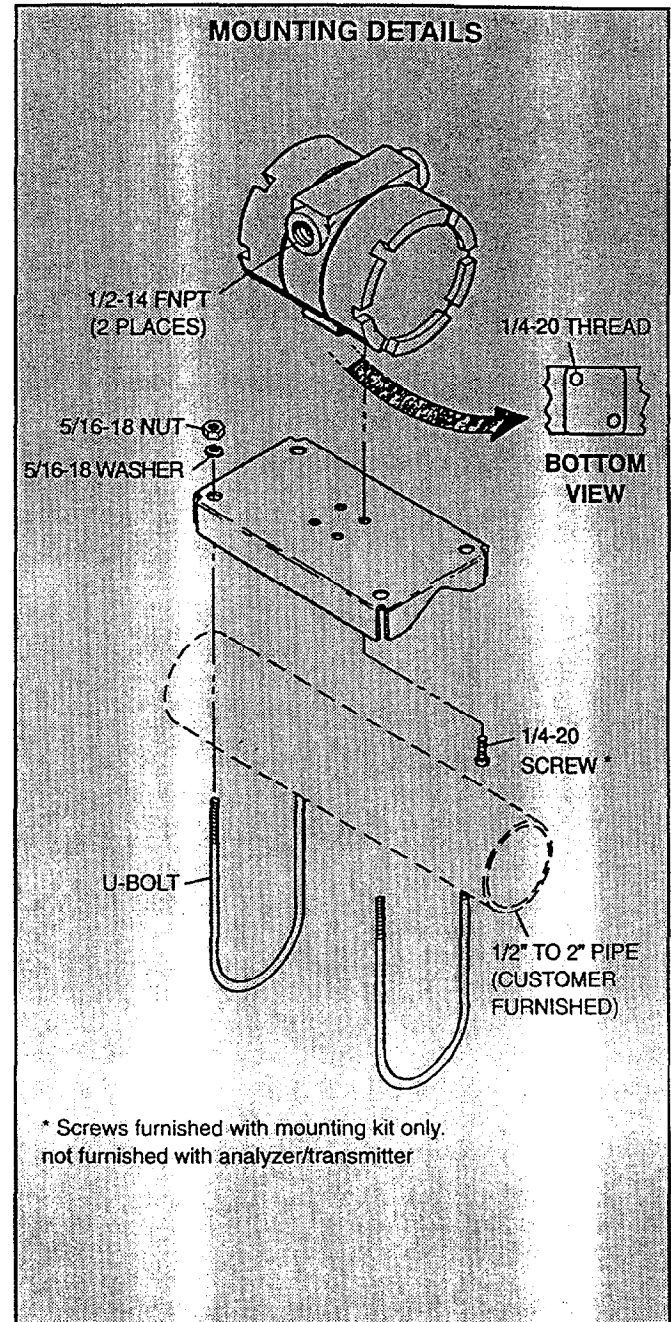
Model 300 Retractable ORP Sensor

Model 330B Flow Through ORP Sensor

Model 381 Insertion/Submersion/Flow ORP Sensor

Model 385 Retractable ORP Sensor

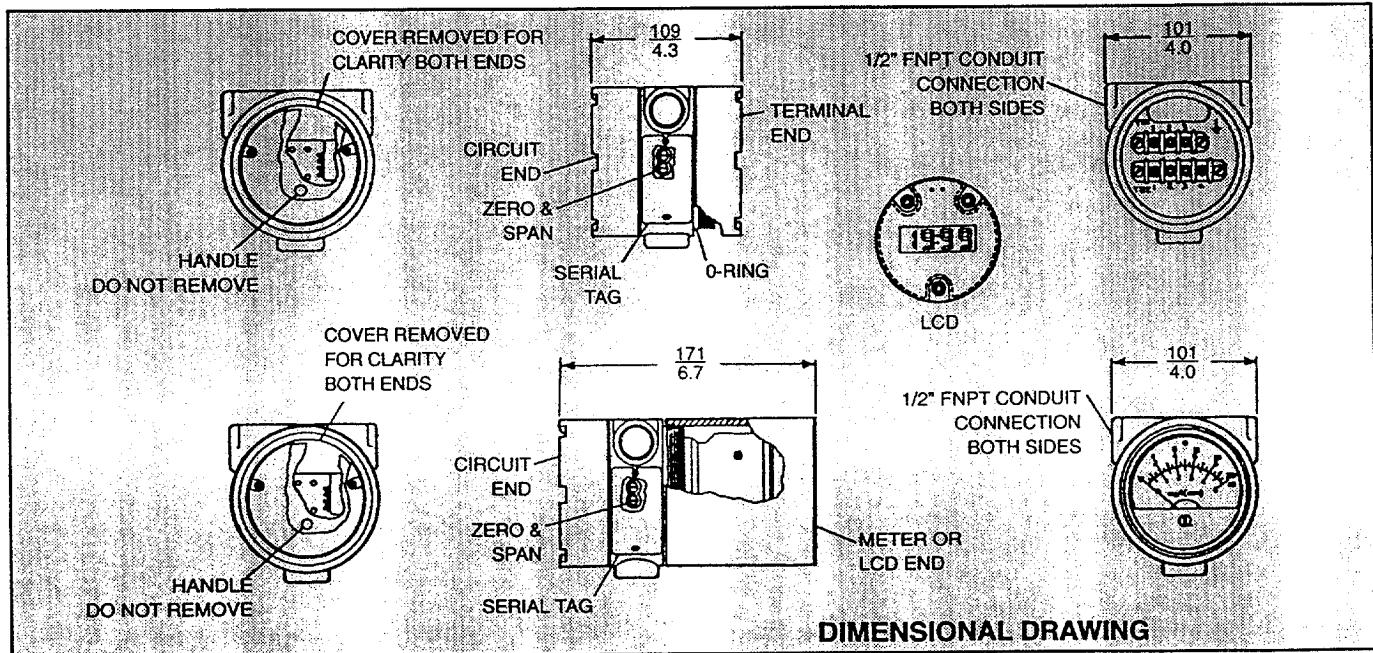
Model 399 Disposable ORP Sensor



ORDERING INFORMATION

Model 1181 Two Wire Transmitter is housed in a NEMA 7B explosion-proof, NEMA 4X weatherproof, corrosion-resistant enclosure and includes all the circuitry necessary for measurement and transmission of an isolated 4-20 mA signal. The transmitter may be selected with or without an analog or digital display.

MODEL						
1181	TWO-WIRE TRANSMITTER					
CODE INPUT (Required Selection)						
pH	pH measurement in an aqueous solution					
ORP	Oxidation Reduction Potential					
CODE DISPLAY (Required Selection)						
01	FM and CSA approved analog display					
02	Blind, without indication					
03	FM and CENELEC approved analog display					
04	Digital display, pH only (not available with Codes 43 & 44)					
06	FM, CSA, & CENELEC approved digital display					
CODE OPTIONS						
07	Two-inch pipe/wall mounting bracket					
11	Stainless steel nameplate (specify marking)					
CODE PREAMP OPTIONS						
43	Integral Preamp compatible with PT100 T.C. (not available with 1181 ORP)					
44	Integral Preamp compatible with 3.0K T.C. (standard)					
CODE AGENCY APPROVALS						
67	FM Explosion proof and Intrinsically Safe					
69	CSA Explosion proof and Intrinsically Safe					
73	CENELEC Intrinsically Safe					
1181	pH	01	07-11	44	67	EXAMPLE



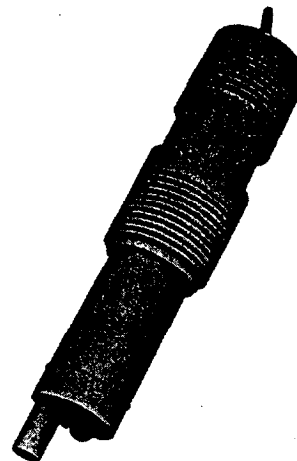
Rosemount Analytical Inc.
 2400 Barranca Parkway
 Irvine, CA 92714 USA
 Tel: (714) 863-1181

ROSEMOUNT ANALYTICAL

FISHER-ROSEMOUNT™ Managing The Process Better™

pH/ORP Sensor

- ONE-PIECE CONSTRUCTION is convenient and economical where minimal troubleshooting and maintenance downtime are of prime importance.
- RUGGED TEFZEL¹ BODY for maximum chemical resistance and completely sealed to eliminate sensor leakage.
- DOUBLE JUNCTION REFERENCE CELL provides longer sensor life in process solutions containing poisoning ions.



FEATURES AND APPLICATIONS

The Rosemount Analytical Model 399 Sensor measures the pH or the Oxidation Reduction Potential (ORP) of aqueous solutions in pipelines, open tanks, or ponds. It is suitable for virtually all applications where a low cost, disposable sensor is required. The combination electrode features a ceramic junction constructed in an annular design around the pH/ORP sensitive membrane. The double junction reference cell configuration is resistant to process solutions containing ammonia, chlorine, cyanides, sulfides, or other poisoning ions.

The sensor is housed in a molded Tefzel¹ body with Viton¹ O-rings, making it virtually indestructible and chemical resistant. Complete encapsulation eliminates leakage or high humidity problems traditionally found in other pH/ORP designs. The simplified construction, designed with user convenience in mind, does not require electrolyte (KCl) replenishment or any high maintenance troubleshooting procedures.

The Rosemount Analytical pH/ORP method features an integral preamplifier to convert the high impedance pH or ORP mV signal into a stable, noise-free signal with transmission capability of up to three miles. The Rosemount Analytical method has become the industry standard for pH/ORP measurement reliability.

Installation is easily achieved through the wide variety of mounting configurations. The Model 399 features 1 inch (MNPT) front and rear facing connections for insertion, submersion or flow through pH and ORP applications.

¹ Tefzel and Viton are registered trademarks of E.I. du Pont de Nemours and Company.

PHYSICAL SPECIFICATIONS

Materials of Construction:

Tefzel¹, glass, ceramic and Viton¹

Process Connections: 1 inch MNPT

Interconnecting Cable:

5 conductor, 10 or 32 feet cable undressed (integral preamp)
10 feet coax cable (remote preamp)

Measured Range:

pH: 0-14
ORP: -1500 to +1500 mV

Temperature Compensation:

Automatic 0 to 85°C (32° to 185°F)
Temperature compensation is not required for 399 ORP when used with Models 1060, 1023 or 1181 ORP

Maximum Pressure:

690 kPa (100 psig) at 65°C (see Graph A)

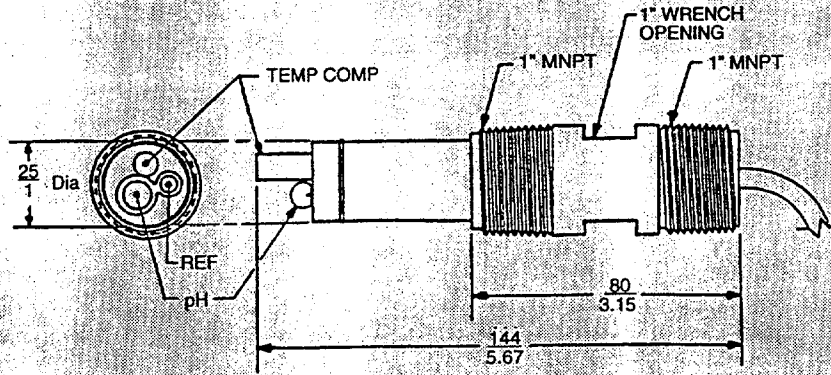
Weight/Shipping Weight:

0.45 kg/0.9 kg (1 lb/2 lbs.)

ROSEMOUNT[®] ANALYTICAL

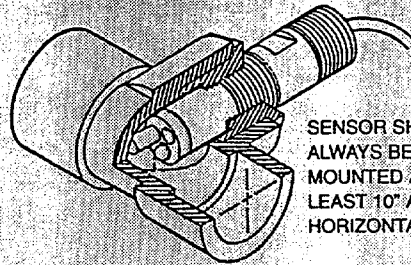
FISHER-ROSEMOUNT[™] Managing The Process Better[™]

MOUNTING AND DIMENSIONAL DRAWINGS

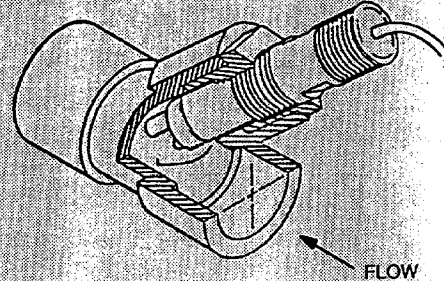


FLOW THROUGH INSTALLATION

1-1/2" SCHED 80
CPVC TEE WITH 1"
FNPT CONNECTIONS
(CODE 16) STRAIGHT
FLOW SHOWN

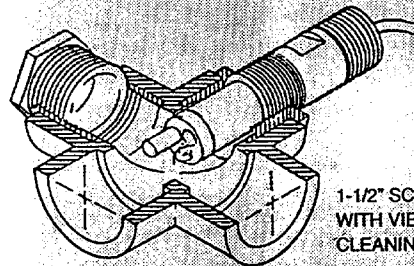
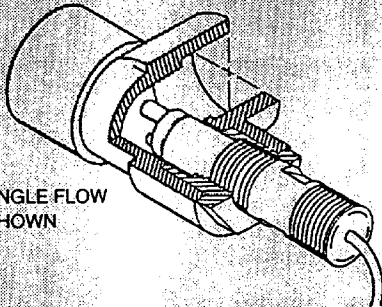


1-1/2" PIPE "Y"

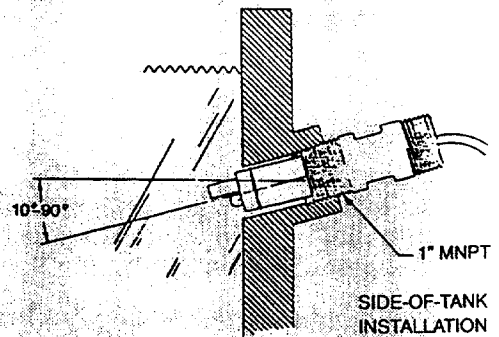
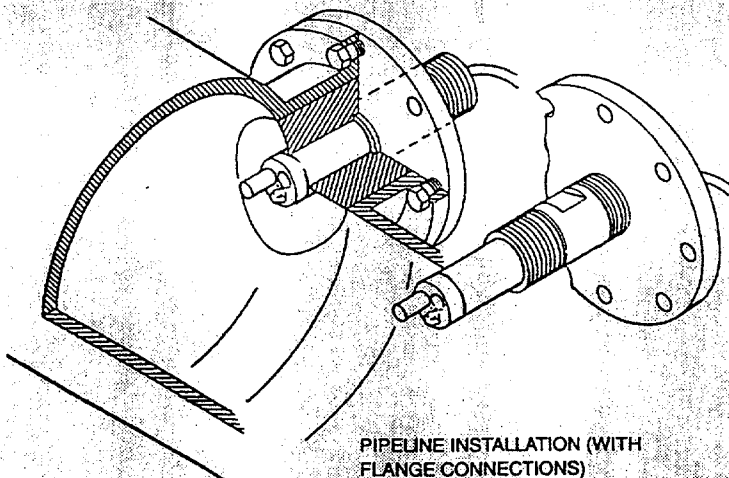


SENSOR SHOULD
ALWAYS BE
MOUNTED AT
LEAST 10" ABOVE
HORIZONTAL

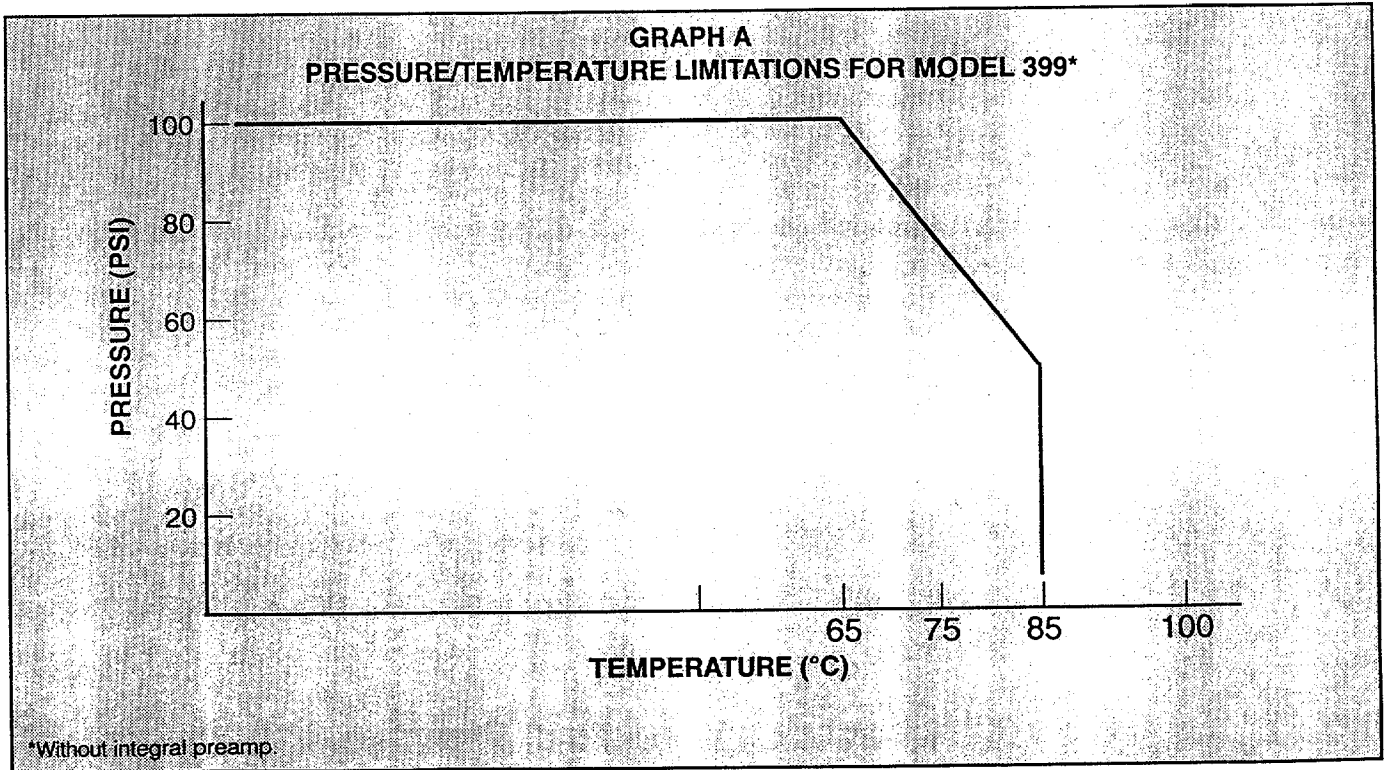
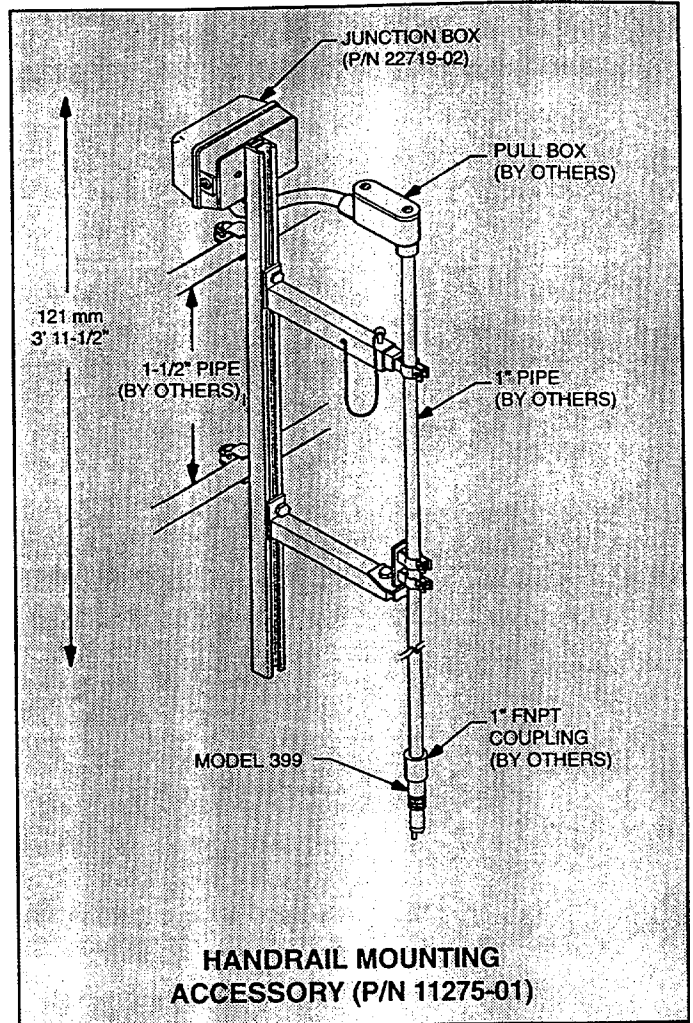
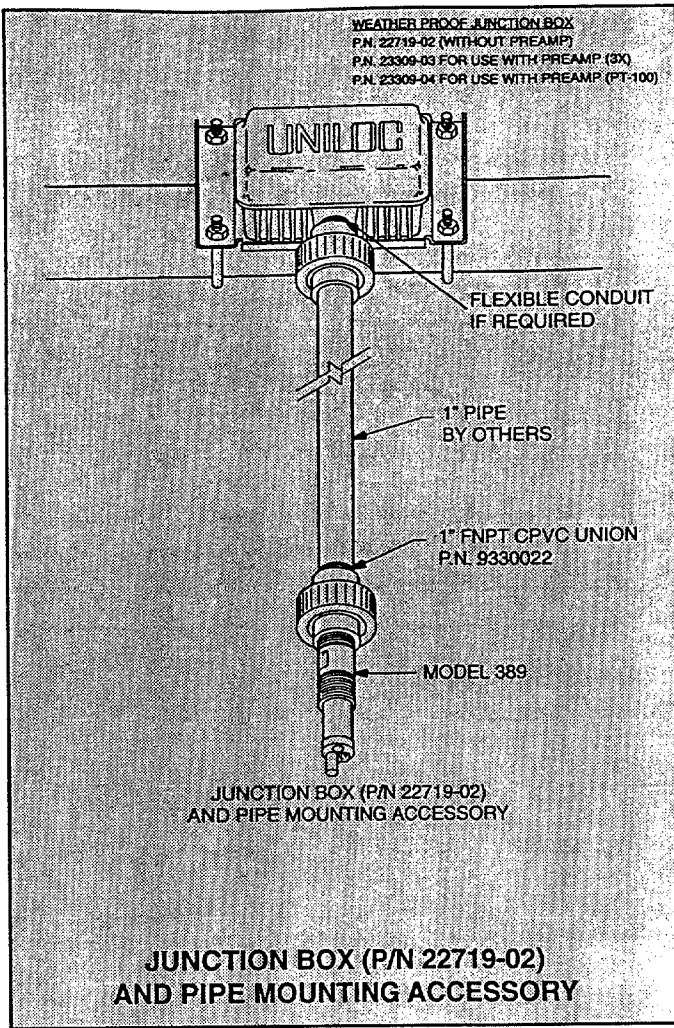
ANGLE FLOW
SHOWN



INSERTION INSTALLATIONS



SUBMERSION INSTALLATIONS



ORDERING INFORMATION

The Model 399 pH/ORP Sensor is housed in a molded Tefzel¹ body with 1 inch MNPT threads suitable for insertion, submersion or flow through installation. The sensor includes a general purpose pH electrode or a platinum ORP electrode and a double junction gel filled reference electrode. The Model 399 pH is available with or without an integral hermetically sealed preamplifier. The Model 399 ORP is available only with an integral hermetically sealed preamplifier. Automatic temperature compensation is standard with the Model 399 pH but is not required on the Model 399 ORP (except when used with the Model 1054A ORP Microprocessor Analyzer). Two cable lengths are offered for the pH sensor (3.0 m or 10 m). A 10 meter cable (32.8 feet) is available for the ORP sensor.

MODEL	DISPOSABLE pH SENSOR	DISPOSABLE ORP SENSOR
399 pH		
399 ORP		

CODE	OPTIONS	399 pH (Must Select One)
01	10 ft. cable with integral preamp for Models 1181pH & 1050	
05	32 ft. cable with integral preamp for Models 1181pH & 1050	
03	10 ft. cable with integral preamp for Model 1003	
06	32 ft. cable with integral preamp for Model 1003	
07	10 ft. cable with integral preamp for Model 1054A, 2054 & 2081 pH	
08	32 ft. cable with integral preamp for Model 1054A, 2054 and 2081 pH	
02	10 ft. coax cable for remote preamp, 3K ohm TC (Models 1181, 1050 & 1003)	
09	10 ft. coax cable for remote preamp, PT-100 TC (Models 54pH, 1054A, 2054 & 2081 pH)	

CODE	OPTIONS	399 ORP (Must Select One)
30	32 ft. cable with integral preamp for Models 1181ORP & 1060	
31	32 ft. cable with integral preamp for Model 1023	
32	32 ft. cable with integral preamp for Model 1054A ORP	

CODE	OPTIONS
11	Stainless steel nameplate (specify marking)
16	1-1/2 inch CPVC tee with 1 inch FNPT connections

399 pH	01	11	EXAMPLE
---------------	-----------	-----------	----------------

¹ Tefzel and Viton are registered trademarks of E.I. du Pont de Nemours and Company.

Rosemount Analytical Inc.
 2400 Barranca Parkway
 Irvine, CA 92714 USA
 Tel: (714) 863-1181

© Rosemount Analytical Inc. 1994

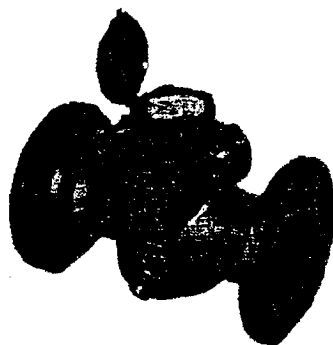
ROSEMOUNT[®] ANALYTICAL

FISHER-ROSEMOUNT[™] Managing The Process Better[™]

Specification Sheet

Kent Turbine Meters Model T-3000 Bronze, Magnetic Drive, Round Flanged Ends

Sizes 4" - 8" **FE/FIG 101**



Description

Operation. The T-3000 Turbine Meter is designed for installation where occasional low and moderate to high sustained flows are demanded. Water passes through the meter without a change in flow direction, driving a helix rotor in direct proportion to the quantity of water passing through the meter. Rotor revolutions are transferred to a register by appropriate reduction gearing and a magnetic drive.

Compliance to Standards. The T-3000 Turbine Meter complies with all performance and material requirements of the American Water Works Association Standard C-701, Class II In-Line (High-Velocity) Type, as most recently revised.

Installation. The meter must be installed in a clean pipeline, free from any foreign materials. Install the meter with direction of flow as indicated by the arrow cast in the meter case. The meter may be installed in horizontal or inclined lines. It is recommended that a Kent Plate Strainer be used to protect the turbine and help reduce the effects of turbulence. The installer should consider a bypass pipe with gate valves for use during maintenance and a downstream test plug for future field testing.

Application. The meter is for use in **POTABLE COLD WATER** up to 120° F (50° C) and working pressures up to 150 psi. The meter will perform with accuracy registration of 100% ± 1 1/2% within the normal flows*. Both pressure loss and accuracy tests are made before shipment. No adjustments need be made before installation.

Construction. The meter consists of a main case, a measuring element, a case cover and a magnetically driven register

Specifications

**103
105**

	4"	6"	8"
95% - 101% Accuracy GPM	7	15	25
* 98.5%-101.5% Accuracy GPM	10-1250	20-2500	30-3500
Continuous Flow GPM	1000	2000	2800
Maximum Flow GPM	1250	2500	3500
Operating Pressure psi	150	150	150
Operating Temperature°F	120	120	120

Sweep Hand Registers

	4"	6"	8"
US Gallons	100	1000	1000
Cubic Feet	10	100	100
m ³ - Cubic Meters	1	10	10
Imperial Gallons	100	1000	1000

Capacity of Register

	4"	6"	8"
US Gallons (millions)	100	1000	1000
Cubic Feet (millions)	10	100	100
m ³ Cubic Meters (millions)	1	10	10
Imperial Gallons (millions)	100	1000	1000

Register Type

Permanently sealed direct reading register.

Materials

Main Case	Bronze
Top Cover Plate	Bronze
Body O-Ring	Neoprene Rubber
Case Bolts	Stainless Steel
Measuring Element	Polyphenylene Oxide
Rotor	Polypropylene
Rotor Bushings	PTFE Compound
Rotor Thrust Bearing	Ceramic Jewel
Rotor Spindle	Tungsten Carbide
Undergearing	Polyacetal Resin
Register Lens	Tempered Glass
Register Housing and Lid	Synthetic Polymer or Bronze
Register Can	90% Copper Alloy

assembly. The main case is cast in bronze with raised characters showing model, size and direction of flow. The case has a throated inlet. A case dowel pin is inserted for locating the bronze cover plate. The measuring element assembly consists of the rotor, straightening vanes, accuracy regulator, spindles and gears, filters and undergear assembly. The measuring element is attached to the underside of the cover with four stainless steel screws and washers, one insert of which is placed eccentrically in the cover. The internal regulator assembly is interconnected with an external regulator shaft located on top of the cover allowing meter calibration without depressurizing the test bench or meter service. The regulator is protected by a tamperproof device. The main case and cover are assembled with an O-ring gasket and stainless steel bolts. The register assembly is secured to the cover with a tamperproof screw and is hinged over the inlet throat. However, the register can be rotated and locked in any 360 degree position therein.

Register. The register is contained within a 90% copper seamless can which is vacuum purged then filled with a dry nitrogen gas to eliminate condensation. The 1/4" true tempered glass lens is domed and secured in an "L" shaped gasket, then roll sealed. To assure easy reading, the totalizer wheels are large and color coded. The applicable size, model, registration, part number and date code are printed on the calibrated dial face. Moving clockwise during operation, the extra thin sweep hand does not interfere with meter reading, and the flow indicator will detect plumbing leaks.

Magnetic Drive. The magnetic drive design eliminates miscoupling associated with right angle drives. Torque is absorbed in the undergear assembly below the driving magnet. Consequently, the driving magnet at all flows is turning slowly, assuring magnetic coupling with the register assembly. The undergearing is protected by an encasement appropriately filtered.

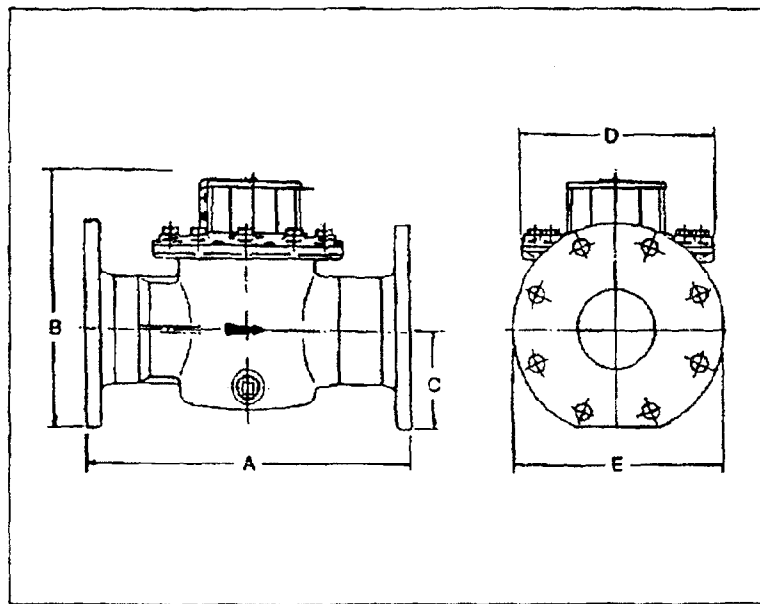
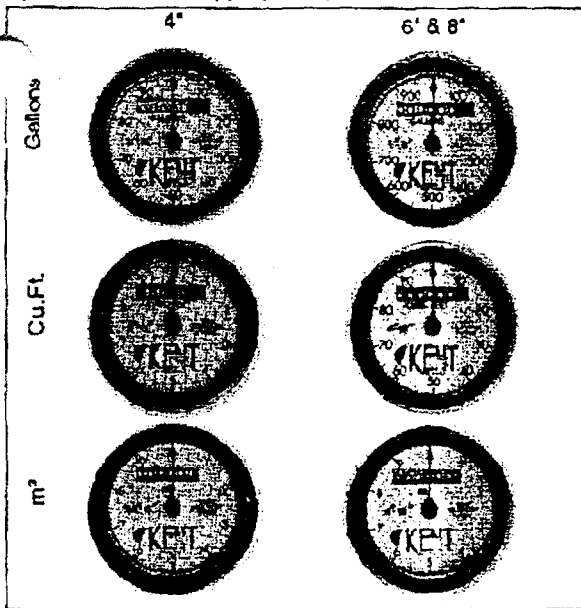
Connections. These meters are available with eight-bolt round flanged end connections. Round flanged connections conform to ANSI B16.1 cast-iron pipe flange, Class 125. Both bronze and cast-iron companion flanges are available. The companion flanges are faced, drilled and tapped with ANSI B2.1 internal taper pipe thread and conform to ANSIB16.1 cast-iron pipe flange, Class 125.

Maintenance. The measuring element with integral straightening vanes can be removed, repaired or replaced without removing the main case from the service line. Blank cover plates are available for use during repair. Pretested and calibrated measuring elements with cover plates and registers are available for exchange or purchase from Kent's warehouses in the U.S. and Canada. In addition, Kent Meters, Inc. maintains a fully equipped and staffed repair facility in Ocala, Florida.

SCANCODER® Electronic Meter Read (EMR). Kent's EMR system permits electronic interrogation of the encoder register's six number wheels. The 2-wire encoder register features an optional waterproof glass lens and potted terminals for flooded pit installations, expanded data field to include reading, programmable ten digit serial number, registration type billable units and special security number. A simple checksum, standard error codes and cable lengths up to three hundred (300) feet, are all standard features.

Dimensions and Net Weights

Meter Size	Dimensions (inches)					Weight (lbs.)
	A	B	C	D	E	
4"	14	10 3/4	4 3/16	8 3/16	9	51 1/2
6"	18	13 3/8	5 1/4	10 15/16	11	90
8"	20	16 1/16	6 15/16	11 7/16	13 7/16	168



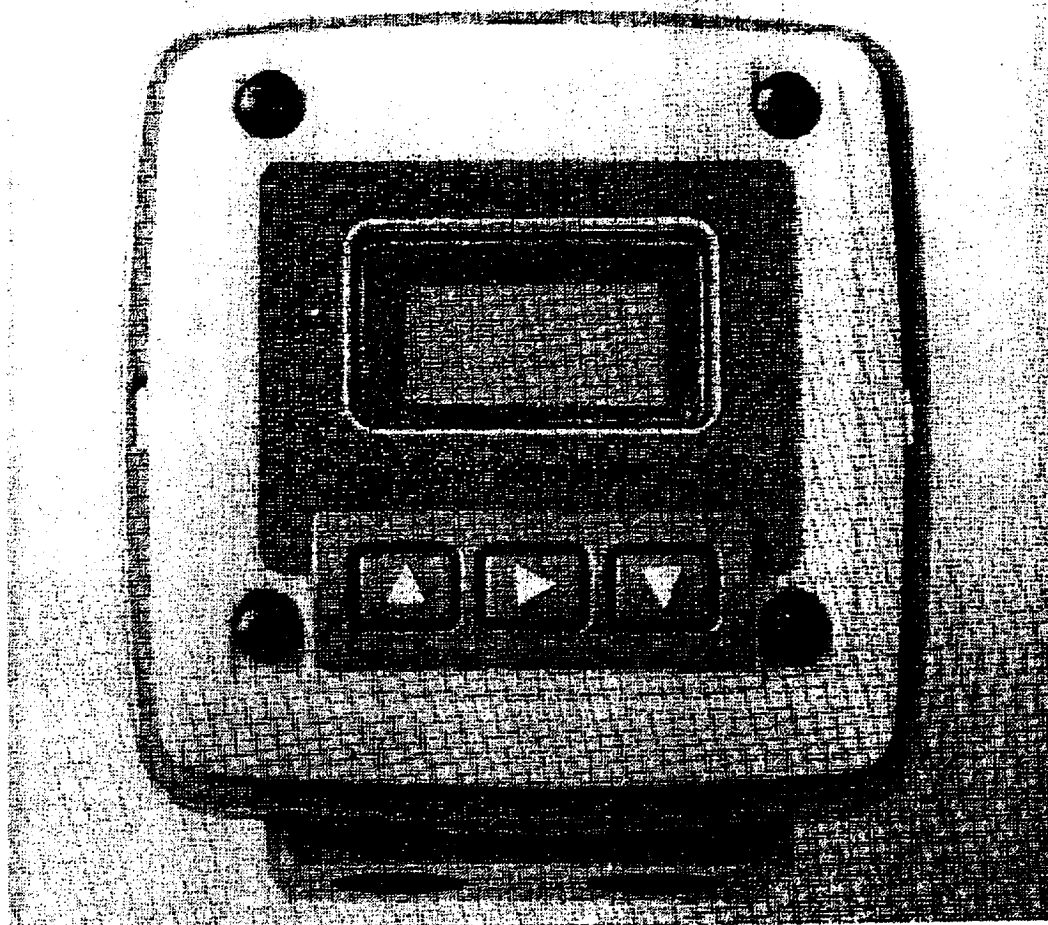
The company's policy is one of continuous product improvement and the right is reserved to modify the specifications contained herein without notice. These products have been manufactured with current technology in accordance with applicable AWWA Standards.

Kent Meters, Inc.
P.O. Box 1852
Ocala, Florida 34478-1852
Tel Florida 904-732-4670
Outside Florida TOLL FREE 800-874-0890
Inside Florida TOLL FREE 800-356-6829
FAX: 904-368-1950

Kent Meters, Inc.
1200 Aerowood Drive-#35
Mississauga, Ontario
Canada L4W 2S7
Tel: 905-238-9622
FAX: 905-238-5640

An ABB Kent Meter Division Company
Distributed by:

T3-BZ-232/07-94/SS/5M



- 2-wire loop powered system or 4-wire system for powered sensors
- Flow rate & totalizer indication
- Complete software setup and operation
- NEMA 4X/IP65 package
- Universal mounting kit accommodates pipe and surface installations
- Compatible with all SIGNET flow sensors (ordered separately)
- Optically Isolated frequency output

Signet specializes in providing simple, affordable solutions to fluid monitoring and control. SIGNET 8510 and 8511 Compak Flow Transmitters are a prime example of this commitment.

The 4 to 20 mA loop output is compatible with programmable logic control systems, while an additional frequency output provides a flow signal for additional Signet equipment.

Three pushbutton keys control all setup and system calibration functions in this microprocessor-based instrument. The 8-digit alphanumeric LCD shows flow rate, totalization, and setup instructions in clear language.

The polypropylene enclosure is rated NEMA 4X/IP65 to protect the unit in harsh environments.

These units are designed for panel mounting, with captive self-tapping screws to simplify installation. Optional hardware kits accommodate pipe and surface installations, or select the traditional integral configuration.

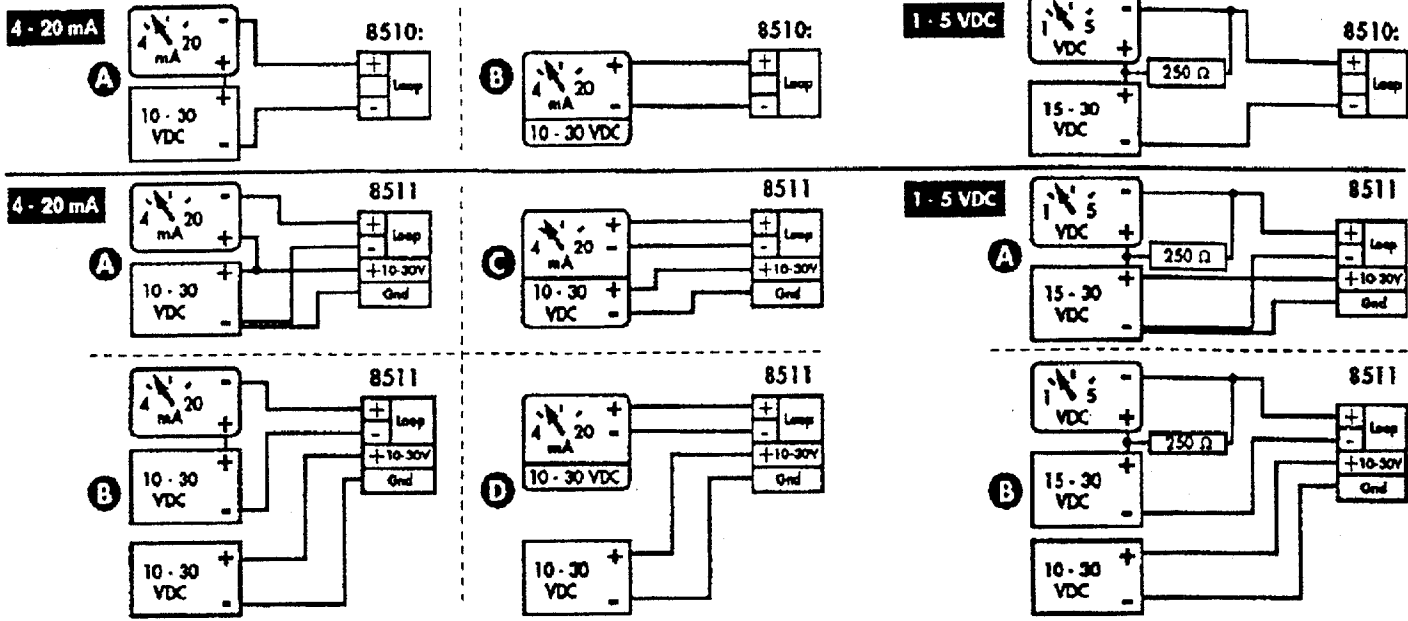
The 8510 2-wire version can be mated with all non-powered Signet flow sensors. The 8511 4-wire version is compatible with both powered and non-powered Signet flow sensors. Either option allows you to tailor your system to meet your specific application requirements.

SIGNET Compak Flow Transmitters are the tool you need today to meet your industrial fluid monitoring and control challenges.

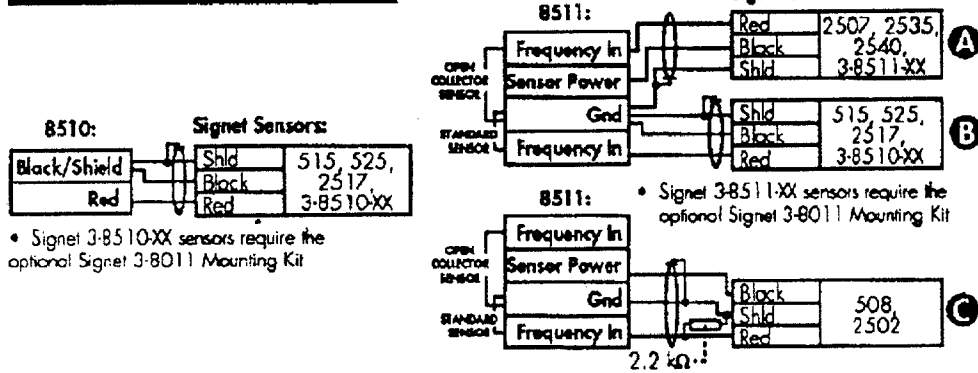
**FIT -
107, 110
220, 106**

Wiring

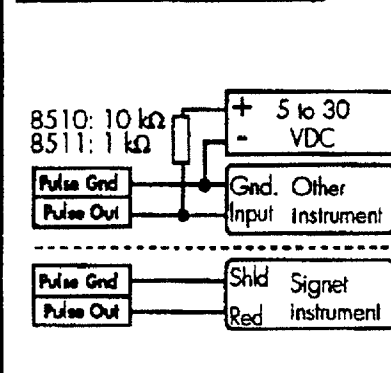
A. Loop Power Wiring



B. Compatible Sensor Wiring



C. Pulse Output Wiring



Specifications

General Data

Enclosure rating: NEMA 4X/IP65
 Enclosure material: Glass-filled polypropylene
 Enclosure gasket: Silicone rubber (captive)
 Enclosure screws: 8-32, self-tapping black oxide (captive)
 Display type: 8-digit alpha-numeric dot matrix
 Display ranges: Flow, 0.01 to 9999.,
 Resettable/permanent totalizers, 0 to 99999999,
 Loop current, 3.90 to 21.00 mA
 Display accuracy: Flow, $\pm 0.1\%$ of reading,
 Totalizers, $\pm 0.03\%$ of reading
 Loop resolution: $\pm 5 \mu\text{A}$
 Loop accuracy: $\pm 0.050 \text{ mA}$

Electrical Data

Loop power: 10 to 30 VDC
 Unit power:
 8510: Uses loop power
 8511: 10 to 30 VDC @ 120 mA max.

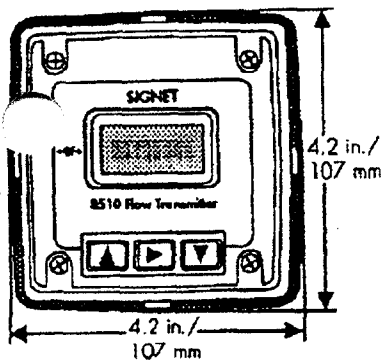
Electrical Data

Current output: 4 to 20 mA (adjustable)
 Loop impedance: 1Ω max. @ 10 VDC
 100Ω max. @ 12 VDC
 1000Ω max. @ 30 VDC
 Frequency range:
 8510: 5 to 500 Hz max.
 8511: 5 to 10 kHz
 Pulse output: Sensor frequency, optically isolated open-collector transistor, max. current sink 3.6 mA @ 30 VDC (8510), 10 mA @ 30 VDC (8511)
 Sensor power:
 8510: None
 8511: 5 VDC @ 100 mA max., short circuit protected
 Loop isolation:
 8510: N/A
 8511: 500 VDC to unit power

Ambient Conditions

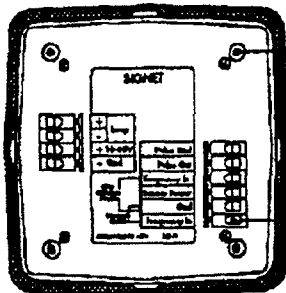
Operating temp.: -15 to $70 \text{ }^\circ\text{C}$ / 5 to $158 \text{ }^\circ\text{F}$
 Storage temp.: -15 to $80 \text{ }^\circ\text{C}$ / 5 to $176 \text{ }^\circ\text{F}$
 Specifications subject to change without notice

Dimensions



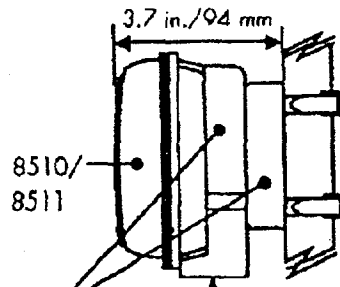
8510 (top view)

8510/8511 (side view)



8511 (bottom view)

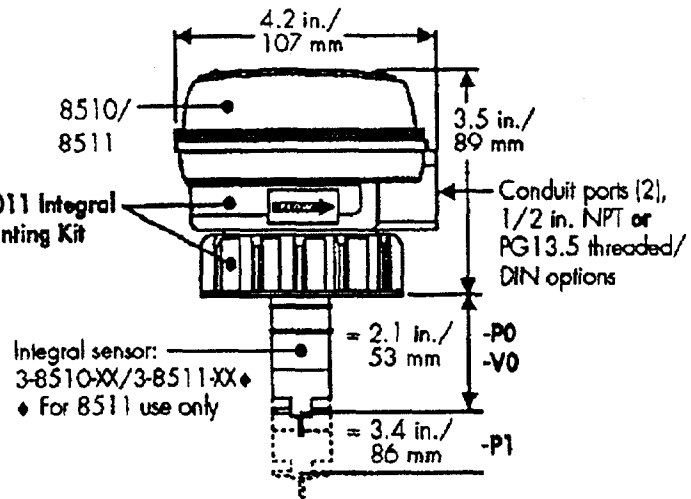
- Captive 8-32 self-tapping screws (4)
- Captive silicone rubber gasket
- Spring-type terminal connectors



3-8010 Universal Mounting Kit

Conduit ports (2), 1/2 in. NPT or PG13.5 threaded/DIN options

3-8011 Integral Mounting Kit



Integral sensor:
3-8510-XX/3-8511-XX
♦ For 8511 use only

Conduit ports (2),
1/2 in. NPT or
PG13.5 threaded/
DIN options

= 2.1 in./
53 mm -P0
-V0
= 3.4 in./
86 mm -P1

Ordering Information

Transmitters

Part no.	Description
3-8510	8510 Compak Flow Transmitter (2-wire version)
3-8511	8511 Compak Flow Transmitter (4-wire version for open collector/powered sensor)

Panel Mounting: No additional hardware required.

Mounting Options

Part no.	Description
3-8010	Universal mounting kit (1/2 in. NPT ports)
3-8010-D	Universal mounting kit (PG13.5 threaded/DIN ports)
3-8011	Integral mounting kit (1/2 in. NPT ports)
3-8011-D	Integral mounting kit (PG13.5 threaded/DIN ports)

Integral Sensor Options

Compatibility: 3-8510/3-8511 transmitters

Part No.	Housing	Rotor Pin	O-rings	Pipe Size	Rotor
3-8510-P0	Polypropylene	Titanium	Viton®	0.5 to 4.0 in.	PVDF (black)
3-8510-P1	Polypropylene	Titanium	Viton®	5.0 to 8.0 in.	PVDF (black)
3-8510-V0	PVDF	Hastelloy C	Viton®	0.5 to 4.0 in.	PVDF (natural)

Compatibility: 3-8511 transmitter

Part No.	Housing	Rotor Pin	O-rings	Pipe Size	Rotor
3-8511-P0	Polypropylene	Titanium	Viton®	0.5 to 4.0 in.	PVDF (black)
3-8511-P1	Polypropylene	Titanium	Viton®	5.0 to 8.0 in.	PVDF (black)
3-8511-V0	PVDF	Hastelloy C	Viton®	0.5 to 4.0 in.	PVDF (natural)

SIGNET

Signet Scientific Company, 3401 Aerojet Avenue, El Monte, CA 91731-2882/U.S.A., Phone (818) 571-2770, Fax (818) 573-2057

Representative Offices

U.S.A. George Fischer, Inc., 2882 Dow Avenue, Tustin, CA 92680-7285/U.S.A., Toll Free Phone (800) 854-4090, Fax (714) 731-6201

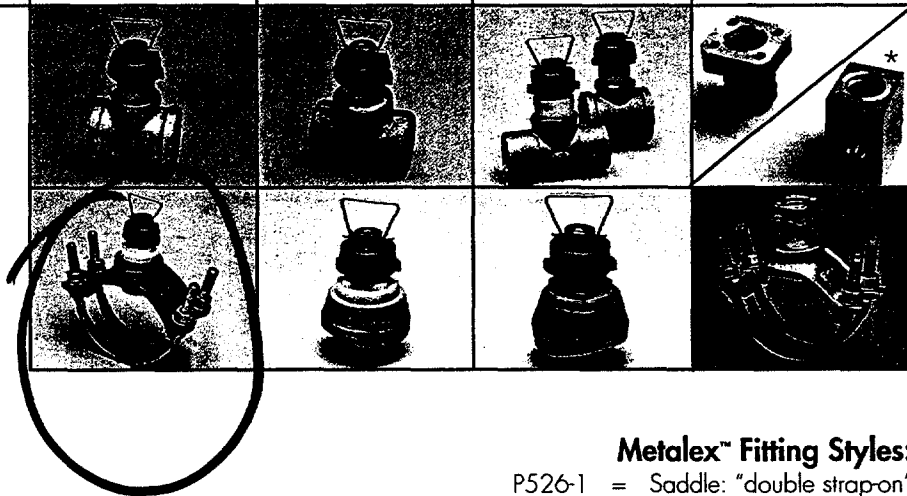
CH Georg Fischer Rohrlleitungssysteme AG, CH-8201 Schaffhausen/Schweiz, Tel. 053/81 11 11, Telex 89 70 70 64 g f ch, Fax 053/25 91 30

SIN George Fischer Pte Ltd., 15 Kaki Bukit Road 2, KB Warehouse Complex, Singapore 1441, Tel: 65/747 0611, Fax: 65/747 0577

Sensor Installation Fittings

525

Pipe Material	Iron	Carbon Steel	Copper/Bronze (Brass)	Metalex
Pipe Size	Part No.	Part No.	Part No.	Part No.
1/2"	N/A	CS4T005	CUKT005	P526-2005*
3/4"	N/A	CS4T007	CUKT007	P526-2007*
1"	IR4T010	CS4T010	CUKT010 BR4T010	P526-2010*
1 1/4"	IR4T012	CS4T012	CUKT012 BR4T012	P526-2012
1 1/2"	IR4T015	CS4T015	CUKT015 BR4T015	P526-2015
2"	IR4T020 IR8S020	CS4T020	CUKT020 BR4T020	P526-2020 P526-1020
2 1/2"	IR8S025	CS4W025	BR4B025	P526-2025 P526-1025
3"	IR8S030	CS4W030	BR4B030	P526-2030 P526-1030
4"	IR8S040	CS4W040	BR4B040	P526-2040 P526-1040
5"	IR8S050	CS4W050	BR4B050	P526-2050 P526-1050
6"	IR8S060	CS4W060	BR4B060	P526-2060 P526-1060
8"	IR8S080	CS4W080	BR4B080	P526-2080 P526-1080
10"	IR8S100	CS4W100	BR4B100	P526-2100 P526-1100
12"	IR8S120	CS4W120	BR4B120	P526-2120 P526-1120



Metalex™ Fitting Styles:

- P526-1 = Saddle: "double strap-on"
- P526-2 = Mini-Tap: "weld-on"

Please contact your SIGNET distributor for special fitting requirements not covered in this chart.

MERCURY CONTROL LEVEL SWITCH

AN ADJUSTABLE STABILIZATION WEIGHT IS FASTENED TO THE CABLE BY MEANS OF NYLON 66 STRAIN RELIEF CONNECTOR AND BUSHING.

UL AND CSA APPROVED CONSTANT SERVICE CORD APPROVED FOR WET WELL APPLICATIONS (16/2)

A FUNNEL MOUTH CABLE ENTRY ON THE BOTTOM OF THE WEIGHT ALLOWS LONG RADIUS BENDING OF THE CABLE TO VIRTUALLY ELIMINATE WIRE FLEXING FATIGUE.

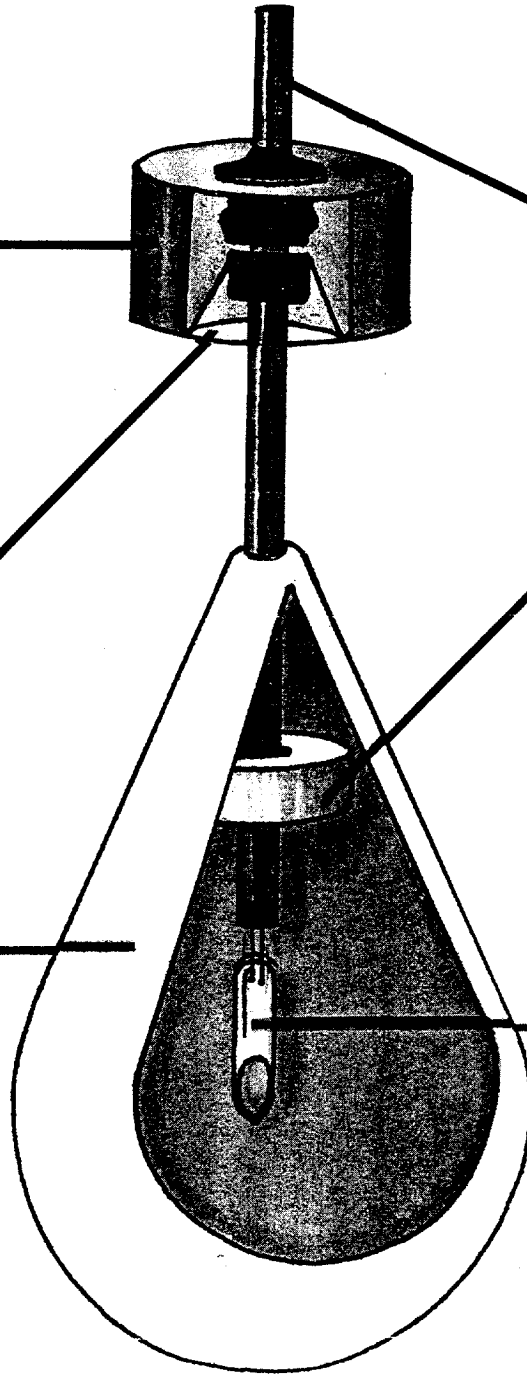
INTERNAL STABILIZATION WEIGHT KEEPS THE SWITCH BOUNCE TO A MINIMUM IN TURBULANT WET WELLS. THIS WILL REDUCE CONTACT CHATTER AND EXTEND SWITCH LIFE.

DENSE POLYURETHANE FOAM FLOAT MOLDED UNDER PRESSURE, INSURES TOTAL PENETRATION AND WATERPROOF ENCAPSULATION.

THE MERCURY SWITCH IS CUSTOM MADE FOR LEVEL SWITCH APPLICATIONS. THE CONTACTS AND MERCURY SLUG ARE DESIGNED TO WITHSTAND CONTACTOR INRUSH CURRENT WITHOUT BURNING OR BOUNCE. (SWITCH RATED AT 2 A CONTINUOUS 115/230 V)

THE INTERNAL WEIGHT ALLOWS FOR A LONGER RADIUS BEND WHICH EXTENDS CORD LIFE AND ALLOWS FOR A MORE POSITIVE SWITCHING EVEN WHEN FLOATING DEBRIS IS IN THE BASIN.

LSL - *
 LSH - *
 LSHH - *
 LSA - *
 LSM - *
 AVAILABLE IN NORMALLY OPEN OR NORMALLY CLOSED.



S P E C I F I C A T I O N S

EXTERNAL WEIGHT — EXTERNAL WEIGHT IS ADJUSTABLE, CAST IRON, PAINTED AND FASTENED TO CABLE BY MEANS OF NYLON 66 STRAIN RELIEF CONNECTOR AND BUSHING. THE WEIGHT HAS A FUNNEL MOUTH CABLE ENTRY ON THE BOTTOM WHICH ALLOWS FOR A LONG RADIUS BENDING OF THE CORD THAT VIRTUALLY ELIMINATES WIRE FLEXING FATIGUE. THE WEIGHT IS APPROX. 28 OZ. (2 1/4" X 1 1/5").

ALLOWS FOR A MORE POSITIVE SWITCHING EVEN WHEN FLOATING DEBRIS IS IN THE BASIN.

CORD — THE CORD IS 16/2 SJOW-SJOWA UL AND CSA APPROVED FOR WET WELL APPLICATIONS, CONSTANT SERVICE, 600 VOLT, BLACK AND LENGTH REQUIRED.

SWITCH — MERCURY SWITCH IS CUSTOM MADE FOR LEVEL CONTROL SWITCH APPLICATIONS. THE CONTACTS AND MERCURY SLUG ARE DESIGNED TO WITHSTAND CONTACTOR INRUSH CURRENT WITHOUT BURNING OR BOUNCE. THE SWITCH IS FILLED WITH HIGH GRADE MERCURY, FILLED WITH INERT GAS AND HERMETICALLY SEALED. THE PROPER AMOUNT OF MERCURY IS CAREFULLY CONTROLLED TO INSURE MAXIMUM

CONTACT RATING WITHOUT SACRIFICING ENDURANCE FROM PHYSICAL SHOCK. THE MERCURY AND CONTACTS ARE CONTAINED IN A HIGH QUALITY GLASS ENVELOPE WHICH INSURES THAT NO WETTING OF THE SWITCH WALLS WILL OCCUR (WETTING IS WHEN MERCURY ADHERES TO THE WALL OF THE SWITCH ENVELOPE ALLOWING SMALL AMOUNTS OF CURRENT TO BE CONDUCTED, COMMON IN STEEL TYPE SWITCHES). 2 AMP RATING CONTINUOUS 115/230 VOLT.

FLOAT — THE FLOAT IS A DENSE, SOLID POLYURETHANE MATERIAL MOLDED UNDER PRESSURE WHICH INSURES A TOTAL PENETRATION AND WATERPROOF ENCAPSULATION. THE COLOR IS LIGHT BROWN AND THE TOTAL DISPLACEMENT IS 15 OZ. APPROX. 3" X 5" PEAR SHAPED.

McDonnell FS8W Vapor-Proof Flow Switch

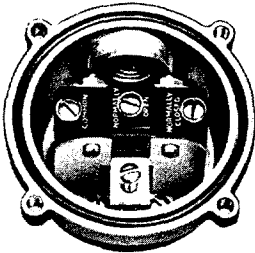
All Models now NEMA 4X rated

FS-100, 102, 104
16920, 1.3.1A

Provides NEMA 4X (Watertight, Dust-tight, Corrosion Resistant) construction in an economically priced, compact-size flow switch. Particularly suited for use in areas of high humidity, and for out-of-doors installation. Has adjustment for sensitivity to flow, packless construction, wetted parts of brass, solder and Monel. Individual paddles are adaptable for pipe 1" to 3"; extended paddles for larger pipe is also included. Installs in tee or welding neck in horizontal pipe; 1" threaded connection.

Maximum pressure 150 psi
Maximum temperature, 225 F.

McDONNELL QUALITY THROUGHOUT

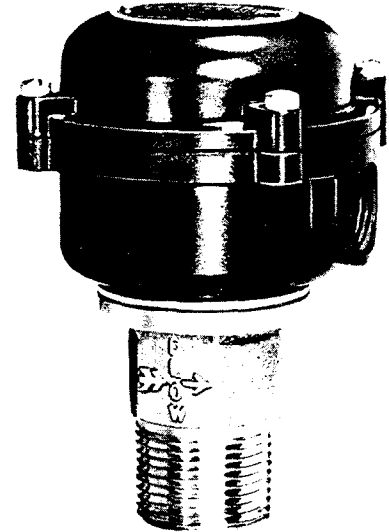


Packless Construction—Monel bellows seals switch assembly from the line.

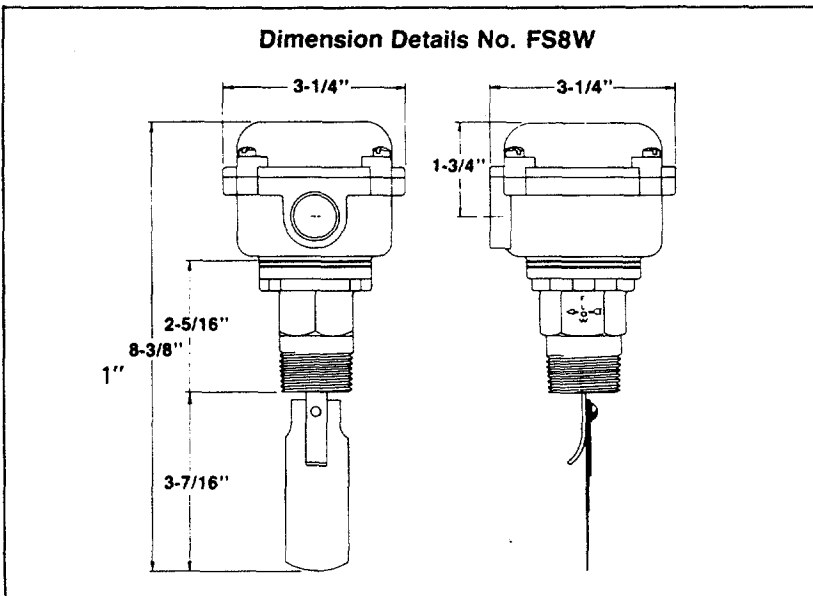
Adjusting Screw—Provides easy way to adjust sensitivity to flow.

Conduit Connection—Threaded to accept standard vapor-proof connectors.

Easy Wiring—Cover removable for easy access to terminals. No danger of kinked wires interfering with operation.



No. FS8W
Extended paddle
for larger pipe
included.



FLOW RATES REQUIRED TO ACTUATE NO. FS8-W FLOW SWITCH

Flow rates in gallons per minute (GPM) shown in black. Velocity in feet per second (FPS) shown in gray.

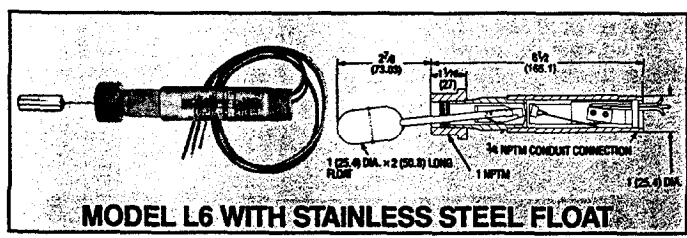
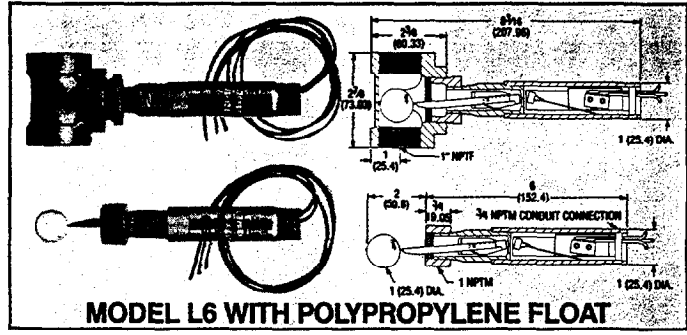
Pipe Size in Which Flow Switch Installed			1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	5"	6"
Factory or Minimum Adjustment	Flow	GPM	4.9	7.5	9.4	13.7	17.9	24.2	35.3	48.6	60.3
		FPS	1.82	1.60	1.48	1.31	1.20	1.05	0.99	0.78	0.67
	No Flow	GPM	3.4	5.3	6.7	9.4	12.1	16.4	27.0	37.4	46.8
		FPS	1.25	1.14	1.05	0.90	0.81	0.71	0.66	0.60	0.52
Maximum Adjustment	Flow	GPM	17.6	29.0	37.8	56.4	71.3	89.0	118.0	178.0	245.0
		FPS	6.53	6.23	5.95	5.39	4.78	3.87	2.98	2.86	2.72
	No Flow	GPM	15.0	24.6	32.2	47.4	59.2	72.5	105.0	160.0	225.0
		FPS	5.56	5.28	5.07	4.53	3.97	3.15	2.64	2.57	2.50

*Equipped with extended paddle trimmed to pipe size. Flow rates are averages which may vary ± 10% from tabulated values.



Model L6 FLOTECT™ Liquid Level Switch

Explosion-proof. Easy in-wall or external installation.
Small size; up to 2000 PSIG operating pressure.



Explosion-Proof; U.L. and C.S.A. Listed -
Class I, Groups A†, B, C, D
Class II, Groups E, F, G.
CENELEC: EExd IIC T6 (T amb = 75°C)
(†Group A, stainless steel body only).

PHYSICAL DATA

- Temperature Limits: 220°F (105°C) max.
- Operating Pressure: (Polypropylene float) to 2000 PSIG (140KG/CM²) (304SS float) to 350 PSIG (25KG/CM²).
- Electrical Rating: One (or two) SPDT snap action micro-switch. 5 amp 125/250 VAC.
- Wiring Connections: 18" (460MM) leads, 18 gauge.
- Minimum Specific Gravity: (Polypropylene float) 0.9 S.G. (round SS float) 0.7 S.G. (cylindrical SS float) 0.5 S.G.
- Wetted Materials: Style B-S-3-0. Brass 301SS, Polypropylene, Ceramic. Style B-S-3-A, Style B-S-3-C; Brass 301SS, 304SS Ceramic. Style S-S-3-0; 303SS, 301SS, Polypropylene, Ceramic. Style S-S-3-A, S-S-3-C; 303SS, 301SS, 304SS, Ceramic.
- Switch Body: Brass 3/4" NPT conduit conn. For S.S. switch housing change model number to L6EPS.
- Piping Connection: 1" NPT
- Installation: Horizontal w/index arrow pointing down.
- Weight: Appx. 1 lb. (.5KG); appx. 1 3/4 lb. (.8KG) w/external chamber.

LSH - *
LSHH - *
LSL - *

Model L6 FLOTECT Level Switches

MODEL NO.	BODY	INSTALLATION	FLOAT	PRESSURE RATING, PSI (KG/CM ²)	MINIMUM SPECIFIC GRAVITY
L6EPB-B-S-3-0	Brass	Side Wall Mounting	Solid Polypropylene	1000 (70)	0.9
L6EPB-B-S-3-A	Brass	Side Wall Mounting	Stainless Steel - Cyl.	200 (14)	0.5
L6EPB-B-S-3-C	Brass	Side Wall Mounting	Stainless Steel - Rd.	350 (25)	0.7
L6EPB-B-S-3-B	Brass	With External Float Chamber	Solid Polypropylene	250 (18)	0.9
L6EPB-B-S-3-H	Brass	With External Float Chamber	Stainless Steel - Rd.	250 (18)	0.7
L6EPB-S-S-3-0	Stainless Steel	Sidewall Mounting	Solid Polypropylene	2000 (140)	0.9
L6EPB-S-S-3-A	Stainless Steel	Sidewall Mounting	Stainless Steel - Cyl.	200 (14)	0.5
L6EPB-S-S-3-C	Stainless Steel	Sidewall Mounting	Stainless Steel - Rd.	350 (25)	0.7
L6EPB-S-S-3-S	Stainless Steel	With External Float Chamber	Solid Polypropylene	2000 (140)	0.9
L6EPB-S-S-3-L	Stainless Steel	With External Float Chamber	Stainless Steel - Rd.	350 (25)	0.7

*For C.S.A. Listed switch (includes junction box) add suffix CSA to model number.
*For CENELEC Certified switch (includes junction box) add suffix CN to model number (with stainless steel floats only).
For DPDT switch change seventh character in model to D.
MT option. High temperature [400°F (205°C) construction] available on all models with stainless steel floats.
MV option. Gold contact for dry circuits. Rated 0.1A @ 125 VAC.

The compact Flotect Model L6 Level Switch is designed and built for years of trouble-free service in a wide variety of process liquid level applications. Machined from brass or stainless steel bar stock, the body is leak proof, eliminating the possibility of the process media entering the switch housing. The float lever pivoted within the body moves when the process liquid displaces the solid polypropylene or stainless steel float. A magnet on the opposite end of the float lever controls a second magnet on the switch actuating lever located in the switch housing. Maintenance is easy since the electrical assembly can be removed for inspection or replacement without removing the entire switch. The stainless steel float lever arm and the polypropylene or stainless steel float are compatible with most process fluids.

The Flotect Model L6 is sensitive to level changes of less than 1/2" (12MM) and is U.L./C.S.A. Listed for explosion-proof service - Class I, Groups A†, B, C & D and Class II, Groups E, F & G. C.S.A. model furnished with optional junction box.
(†Group A, stainless steel body only).

Suggested Specification:
Automatic explosion-proof level switches shall be operated by a (solid polypropylene) (stainless steel) float actuating one (two) single pole, double throw switch(es) rated at 5 amps, 125/250 VAC. Motion of the float shall actuate switch by action of a magnet which controls the switch inside the one-piece switch body. Switches shall be W.E. Anderson model no. L6 _____.



SERIES AP

A Division of DWYER INSTRUMENTS, INC.

Diaphragm Operated Pressure Switches

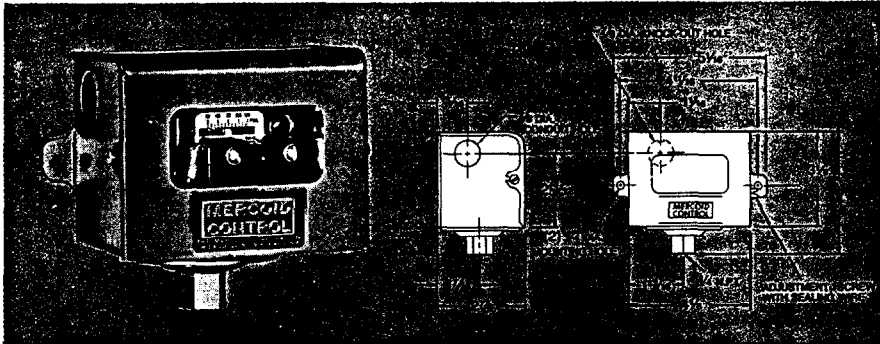
Visible setpoint adjustment compact, low cost



PSL 152

PHYSICAL DATA

Temperature Limits: -30° F to 150° F.
 Pressure connection: 1/4" NPT female.
 Electrical Rating:
 Mercury: SPDT 4A @ 120V, 2A @ 240V AC/DC.
 Snap: SPDT 15A @ 120VAC., 8A @ 240VAC.
 Conduit Opening: 1/2" conduit.
 Wiring Connections: 3 screw type, common, normally open and normally closed.
 Set Point Adjustment: Screw type - adjustable from outside cover.
 Housing and Cover: Painted steel.
 Wetted Parts: Steel, solder, Buna N/Nylon (316SS, Teflon available).
 Weight: 2 lbs. net.
 Installation: Mercury switch unit - vertical, snap-switch unit - any position.



Reliable and convenient, series AP pressure switch is a compact low cost switch for instrument air or other low pressure applications. Visible set point and external adjustment add convenience. Used on air, noncorrosive gas or liquid service compatible with wetted parts.

Suggested Specification:

Pressure switches shall be Mercoïd Series AP(- - -) operated by Buna N diaphragm. Set point shall be visible, and shall be externally adjustable without shutting down process. Deadband shall be fixed. Switch shall incorporate (hermetically sealed mercury switch) (SPDT snap switch).

SERIES AP SWITCHES - OPERATING RANGES AND DEAD BANDS					
Model Number	Operating Range	Switch Type SPDT	Switch Dead Band		Maximum Pressure
			Low	High	
AP-153-38	10-70-50 WC	Mercury	5 WC	6 WC	15 psig
AP-153-37	1-30 psig	Mercury	0.5 psig	1.5 psig	60 psig
AP-153-39	10-25 psig	Mercury	1 psig	10 psig	160 psig
AP-702(-)153-38	10-70-50 WC	Snap	5 WC	10 WC	15 psig
AP-702(-)153-37	1-30 psig	Snap	0.75 psig	1.5 psig	60 psig
AP-702(-)153-39	10-25 psig	Snap	3 psig	7 psig	160 psig

SERIES CS

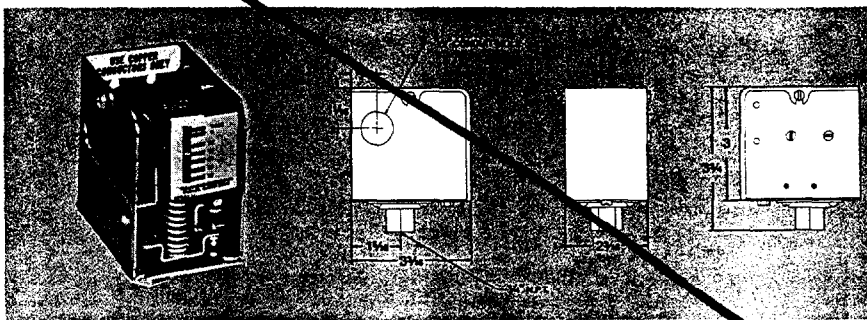
Low Cost Diaphragm Operated Pressure Switches

Visible set points, fixed deadband



PHYSICAL DATA

Temperature Limits: -30° F to 150° F.
 Pressure Connections: 1/4" NPT.
 Electrical Rating: SPDT, AC 15A @ 120V., 8A @ 240V; 1/8 HP @ 120V., 1/4 HP @ 240V.
 Conduit Opening: 1/2".
 Wiring Connections: 3 screw type, common, normally open, and normally closed.
 Set Point Adjustment: Screw type, inside cover.
 Housing: Galvanized steel.
 Diaphragm: Buna N/Nylon.
 Calibration Spring: Plated steel.
 Weight: 1/2 lb.
 Installation: Any position.



Model CS combines advanced design and precision construction with small size and low price. Unit is ideal for instrument panels, small compressors and general industrial applications. Visible set point and easy to wire SPDT snap switch reduce installation time. Operates in any position and is vibration resistant.

Suggested Specification:

Pressure switches shall be operated with Buna N/Nylon reinforced diaphragm. Units shall have fixed deadband. Set point(s) shall be easily adjustable. Set point(s) shall be visible on calibrated scale(s). Motion of diaphragm shall be transmitted to the switch button via a direct mechanical linkage. Switches shall be Mercoïd Model (CS-...).

Model CS - Fixed Deadband				
Model No.	Adjustable Operating Range	Fixed Deadband Maximum	Adjustable Deadband	Max. Pressure
CS-1	1-30 Hg. Vac.	1.5 Hg.	No	30 psig
CS-3	1-100 WC	7 WC	No	30 psig
CS-10	1-10 psig	0.7 psig	No	30 psig
CS-30	1-30 psig	1.0 psig	No	50 psig
CS-150	10-150 psig	5 psig	No	175 psig

16920, 1.3.14

ASHCROFT

PI - *

Duralife Movement Pressure Gauge Type 1009, Grade 1A (1.0% F.S.)

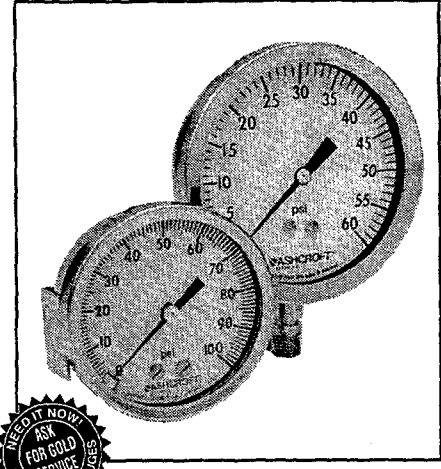
- 2½" and 3½" case sizes.
- 100mm case size (XMG).
- All welded construction.
- Duralife suspended movement.
- Stainless steel construction.
- Overload and underload stops.
- Field liquid fillable.
- 1% Full scale accuracy ASME grade 1A.
- Limited five year warranty.

This unique gauge offers all welded construction. The tip/tube and tube/socket joints are welded. The case/socket joint is also welded construction and provides a permanent seal in the event that liquid filling is required.

The stainless steel construction is ideal for applications where corrosion is a factor.

The movement has both an overload and underload stop to prevent disengagement of the gears in the event of over or under pressure.

The gauges are offered in a dry version (which can be field filled), and a liquid filled version which is usually recommended for severe services.



STANDARD RANGES ⁽⁴⁾⁽⁵⁾⁽⁶⁾

Pressure psi	kg/cm ² - bar	kPa
0/15	0/1	0/100
0/30	0/1.6	0/160
0/60	0/4.0	0/350
0/100	0/6.9	0/690
0/160	0/6	0/600
0/200	0/10	0/1,000
0/300	0/16	0/1,600
0/400	0/25	0/2,500
0/600	0/40	0/4,000
0/800	0/60	0/6,000
0/1,000	0/100	0/10,000
0/1,500	0/160	0/16,000
0/2,000	0/250	0/25,000
0/3,000	0/400	0/40,000
0/4,000	0/600	0/60,000
0/5,000	0/1,000	0/100,000
0/6,000		
0/7,500		
0/10,000		
0/15,000		
Vacuum		
30"/0 Hg	-1/0	-100/0
Compound		
30" Hg/15 psi	-1/0/1.5	-100/0/150
30" Hg/30 psi	-1/0/3	-100/0/300
30" Hg/60 psi	-1/0/5	-100/0/500
30" Hg/100 psi	-1/0/9	-100/0/900
30" Hg/150 psi	-1/0/15	-100/0/1,500
30" Hg/300 psi	-1/0/24	-100/0/2,400

205, 230 A, B, C, D 104, 102, 100, 106, 291
103, 101, 105, 110 A, B, C, 290

BOURDON SYSTEM SELECTION

Ordering Code	Bourdon Tube & Tip Material ⁽¹⁾	Socket Material	Tube Type	Range Selection Limits (psi)	NPT Conn. ⁽²⁾⁽⁷⁾
AW	AISI 316 stainless steel	Bronze	C-Tube	VAC/800	¼
AW	AISI 316 stainless steel	Bronze	Helical	1,000	¼
SW	AISI 316 stainless steel	AISI 316 stainless steel	C-Tube	VAC/800	¼ & ½ ⁽³⁾
SW	AISI 316 stainless steel	AISI 316 stainless steel	Helical	1,000/15,000	¼ & ½ ⁽³⁾

- (1) For selection of the correct bourdon system material, see the media application table on page 136.
- (2) ½ NPT available lower connect only.
- (3) ½ NPT available 3½" lower SW system only.
- (4) Type 1009 gauges may be ordered with metric single scale dial: kPa, bar or kg/cm².
- (5) Dual scale dials will be supplied with standard metric inner scale and equivalent psi outer scale or with standard psi inner scale and equivalent metric outer scale—please specify.
- (6) Special logos and scales available upon request.
- (7) ¼" JIS, BSP or DIN threads available on SW systems. See bulletin GS-4

TO ORDER THIS 1009 DURALIFE MOVEMENT PRESSURE GAUGE

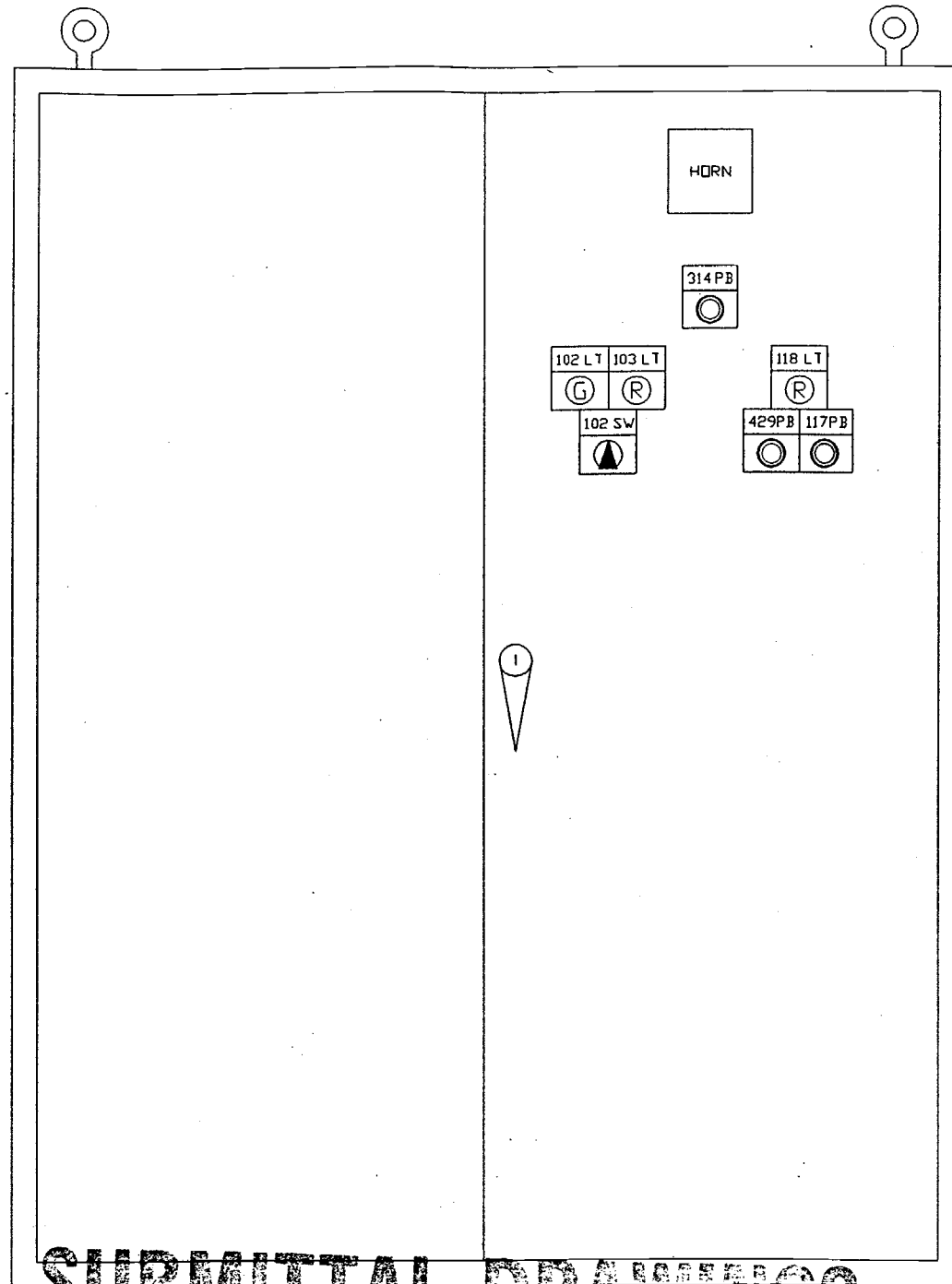
Select: 35 1009 SW 02L XXX 1000 psi

- Dial size—2½", 3½" _____
- Case type—1009 _____
- Tube and socket material _____
- Connection size—¼(01), ½(02) ½(04) _____
- Connection location—Lower(L), Back(B) _____
- Optional Features—See page 80 _____
- Standard pressure range—1,000 psi _____

Accessories: see pages 130-133

ITEM # (2/4)
 PAGES 1-7

16910.1.4.2A
 16920.1.3.2A

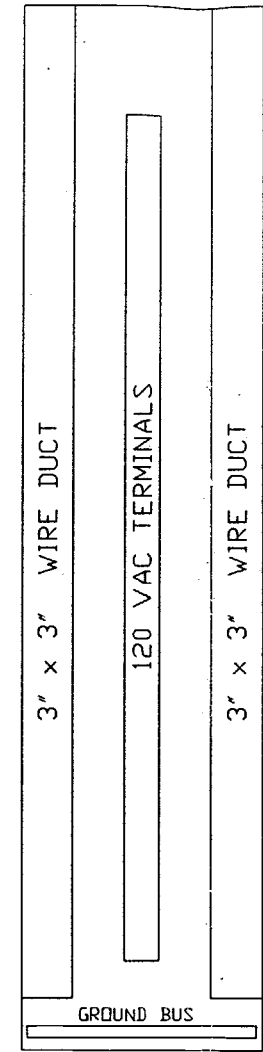


SUBMITTAL DRAWINGS

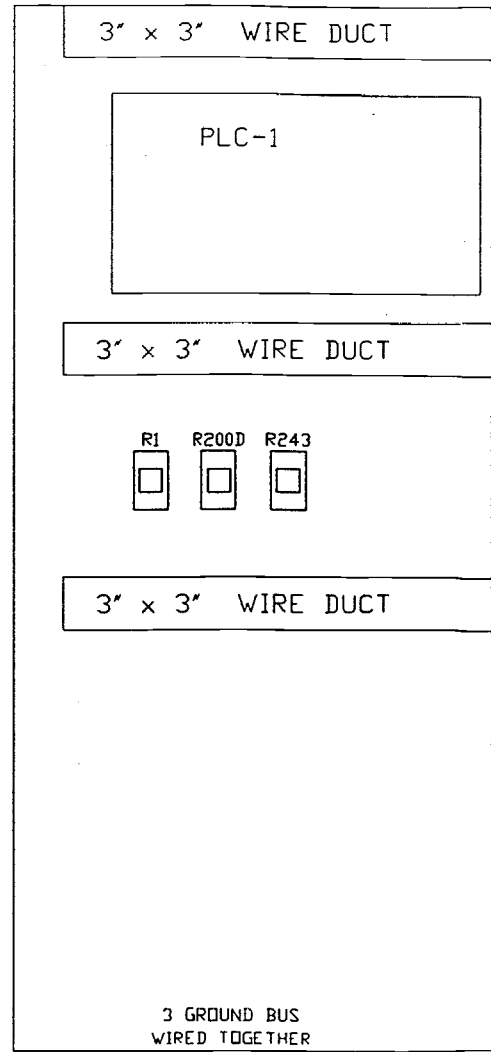
FRONT VIEW

ONLY

NOT FOR CONSTRUCTION

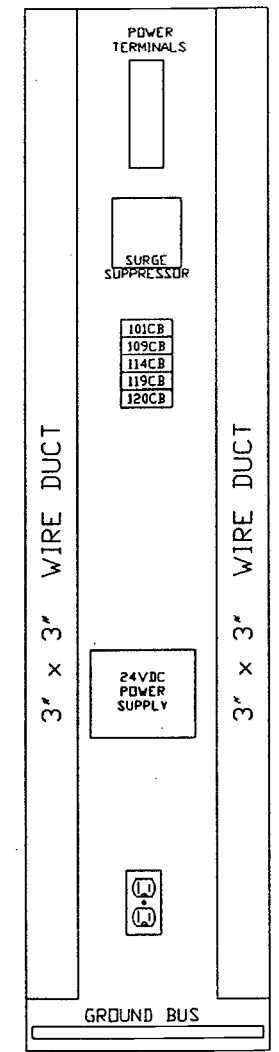


LEFT SIDE PANEL

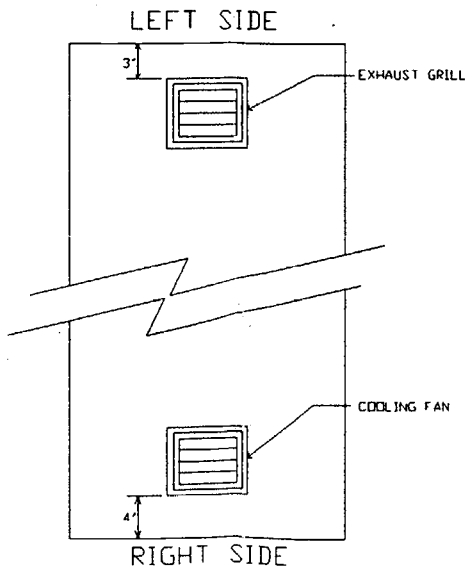


BACK PANEL

INTERIOR

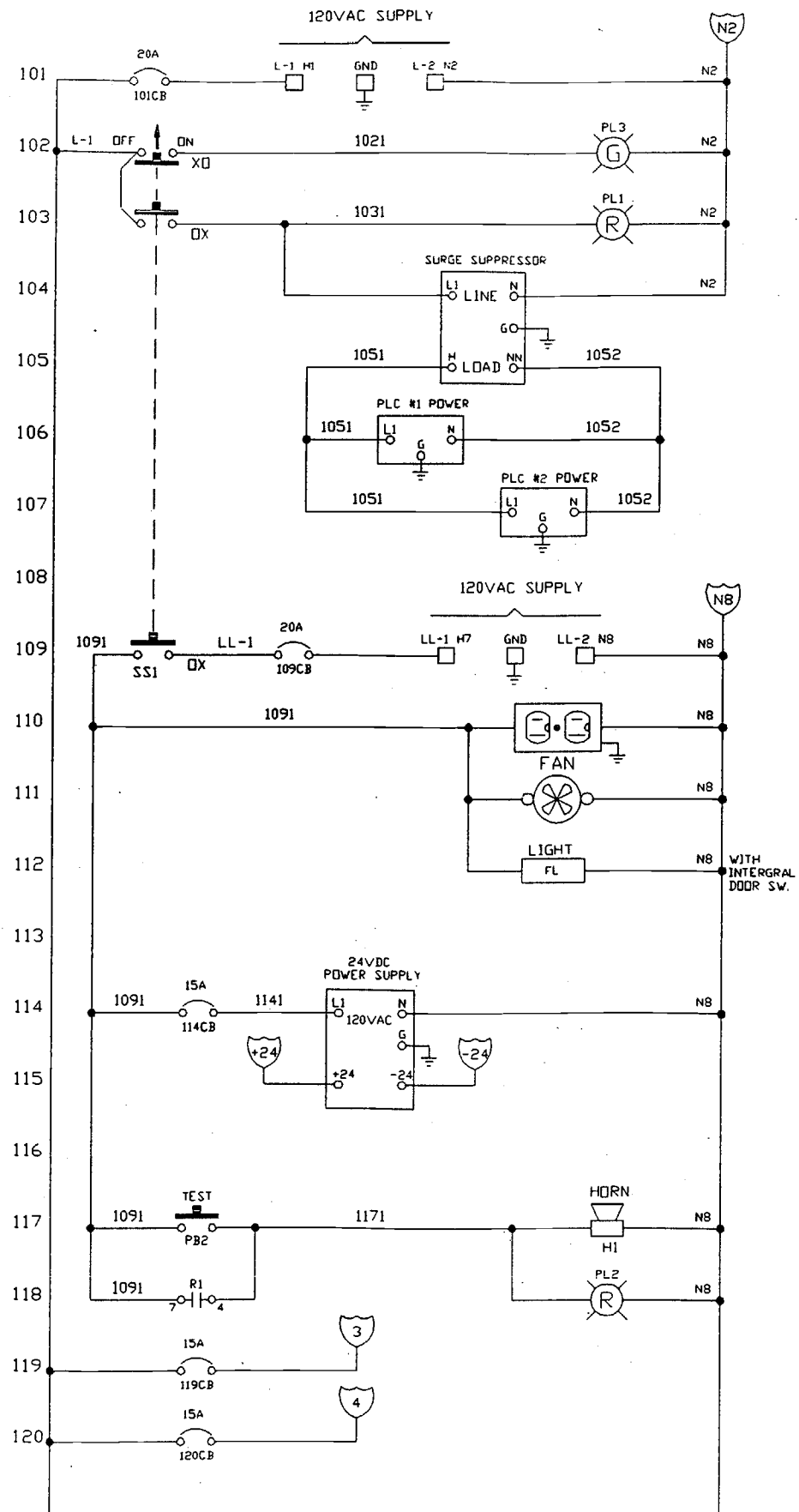


RIGHT SIDE PANEL



DESIGNED BY	RD	DATE	05/25/95
CHECKED BY		DATE	
APP. BY			
APP. BY			
CADD NO.			
ASSEMBLY	SCALE	SIZE	DWG NO.
REFERENCE	INSTR		
PROCESS CONTROL SERVICES, LTD P.O. BOX. 98 SEAFORD, VIRGINIA			
ATLANTIC DIVISION SOIL AND GROUNDWATER REMEDIATION			
RECOVERY WELL SYSTEM PLC CONTROL PANEL			
PANEL LAYOUT			
		D	PC9506 1/7
			REV -

02350HHB2Z



PLC-1

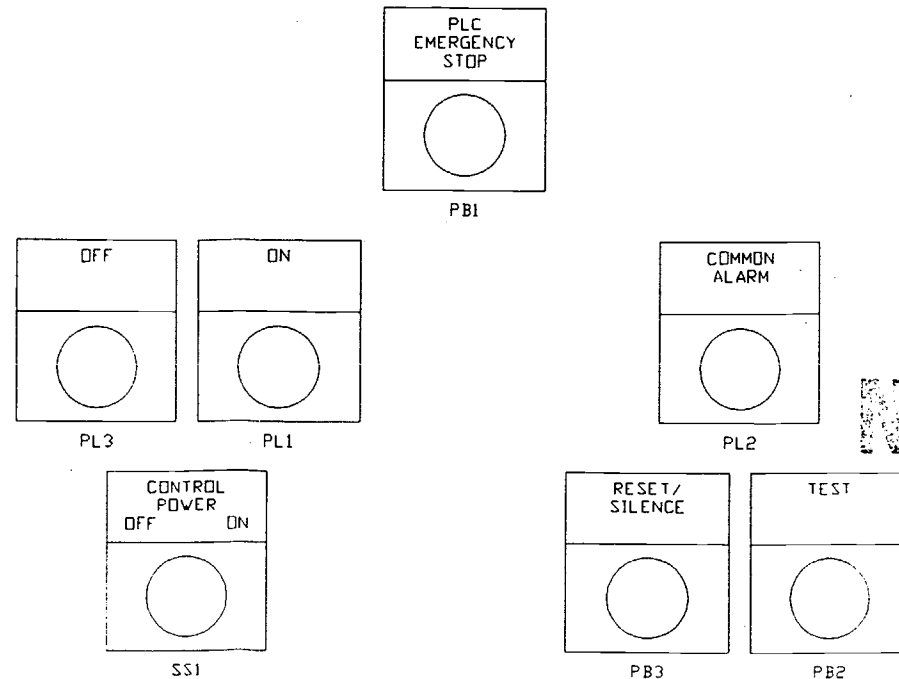
SLOT	1	2	3	4	5	6	7	8	9								
POWER SUPPLY	IC697PWR710	CPU	IC697CPU772	TRANSMITTER	IC697BEM713	DI	IC697MDL240	DI	IC697MDL240	DO	IC697MDL341	DO	IC697MDL341	DO	IC697MDL341	SPACE	SPACE

RACK
IC697CHS790

PLC-2

SLOT	1	2	3	4	5	6	7	8	9								
POWER SUPPLY	IC697PWR710	RECEIVER	IC697BEM711	AI	IC697ALG230	AI	IC697ALG230	AI	IC697ALG230	AI	IC697ALG230	AI	IC697ALG230	AD	IC697ALG320	AD	IC697ALG320

RACK
IC697CHS790



LEGEND PLATES

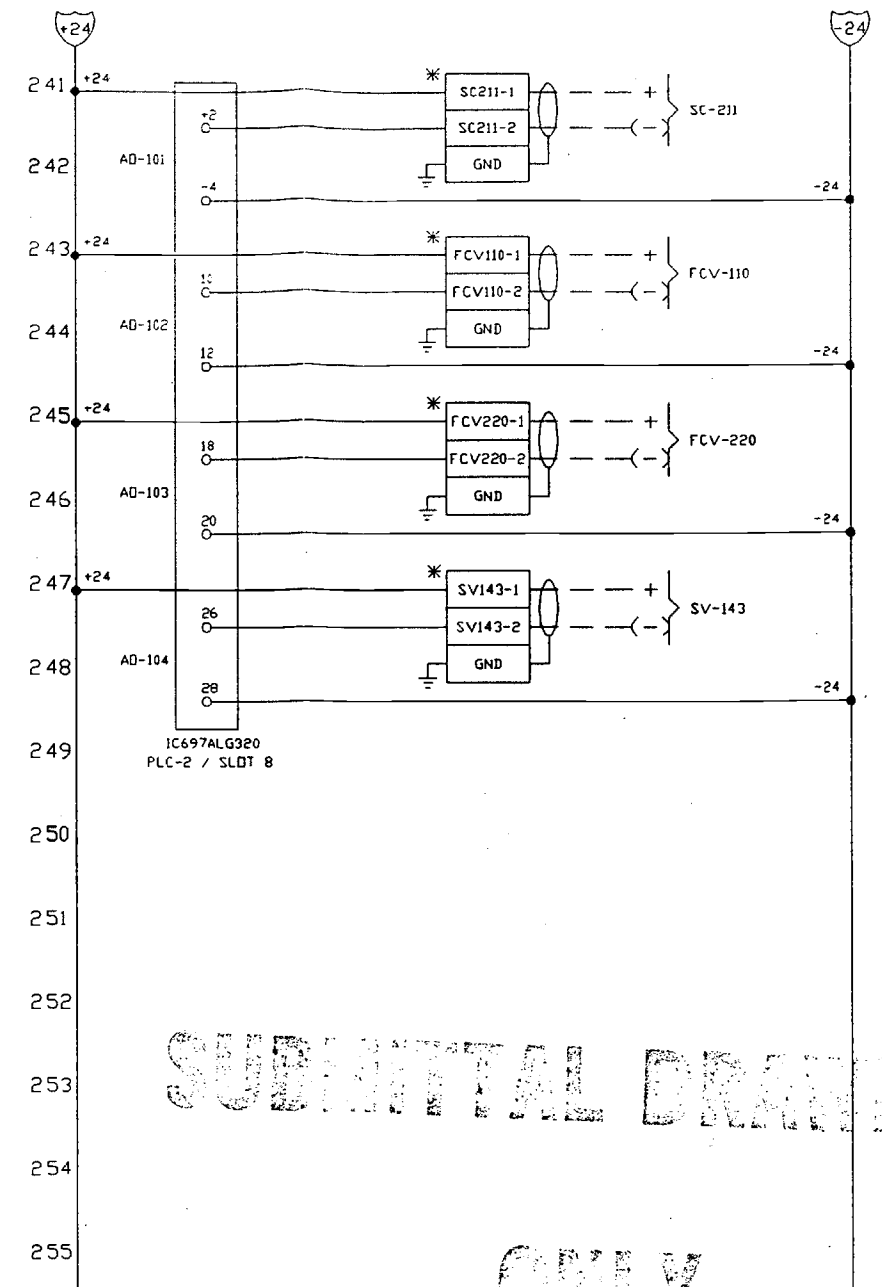
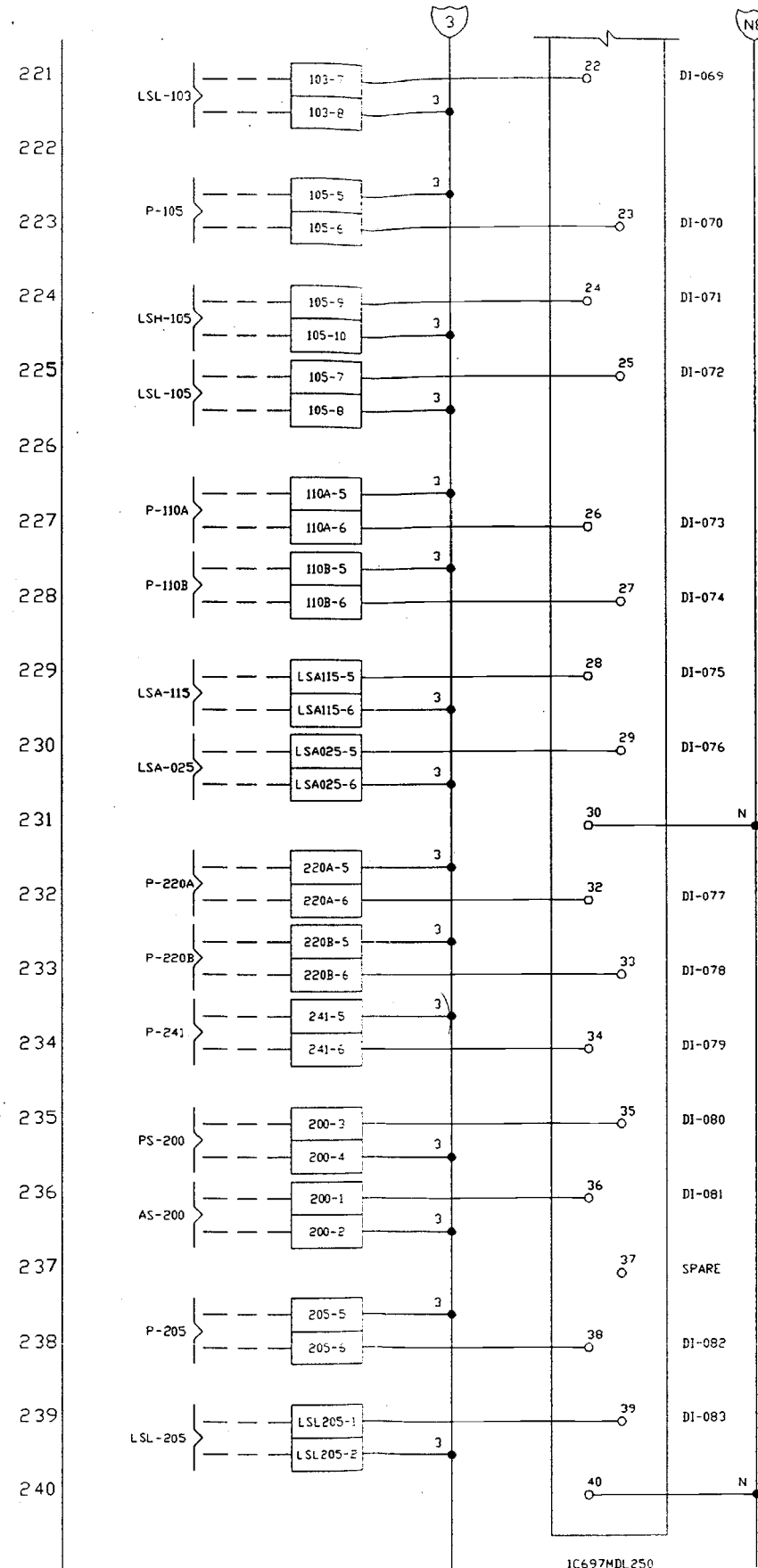
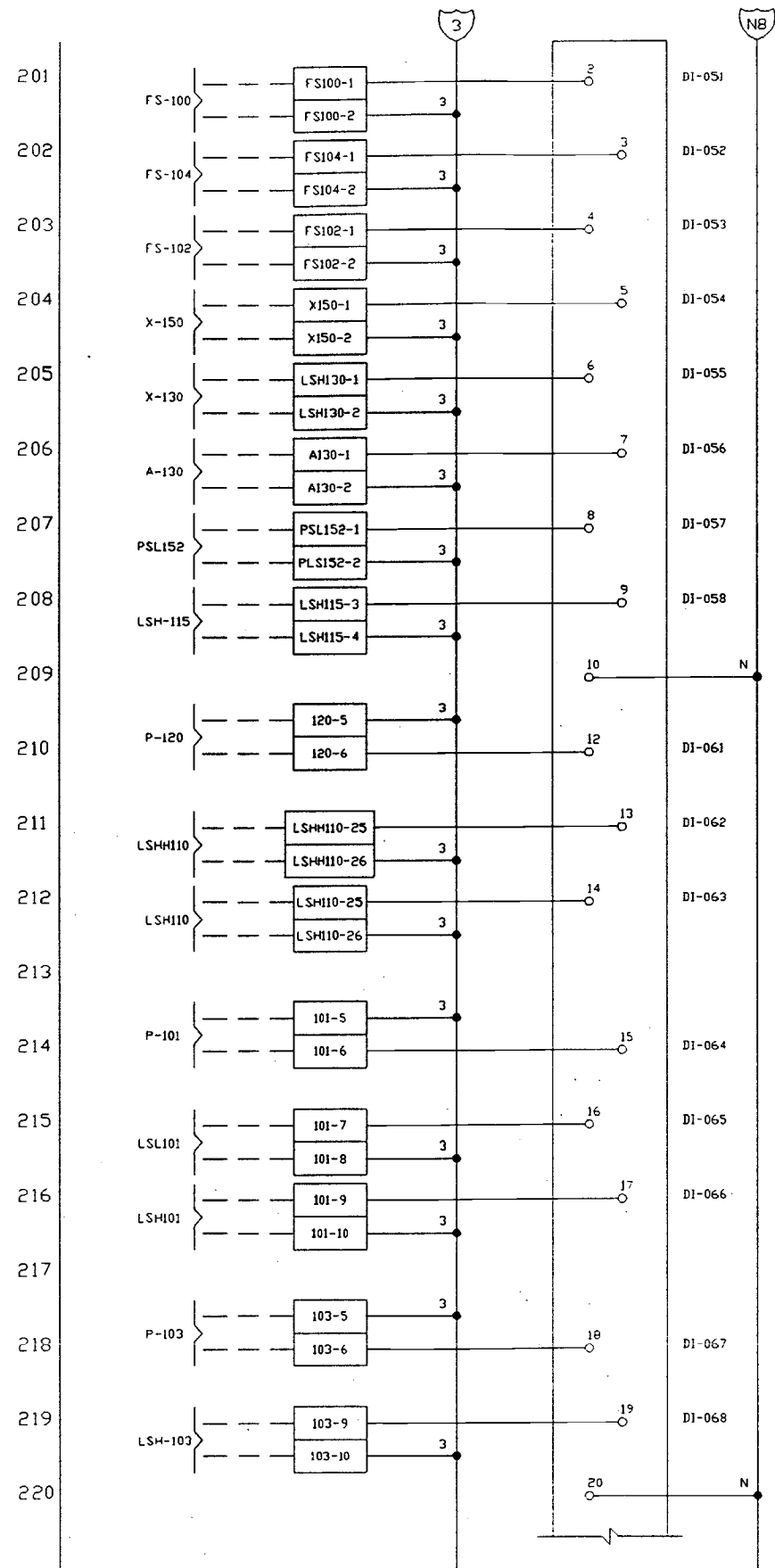
SUBMITTAL DRAWINGS

ONLY

NOT FOR CONSTRUCTION

REV	DATE	BY	CHK	APP
RD	06/25			
APP				
APP				
SCALE	SIZ	DRG NO.	REV	
		D	PC9506 2/7	-

PROCESS CONTROL SERVICES, LTD
P.O. BOX 98 SEAFORD, VIRGINIA
ATLANTIC DIVISION
SOIL AND GROUNDWATER REMEDIATION
RECOVERY WELL SYSTEM
PLC CONTROL PANEL
POWER DIAGRAM & PLC LAYOUT



SUBMITTAL DRAWINGS
ONLY

NOT FOR CONSTRUCTION

* = FUSED TERMINAL BLOCK

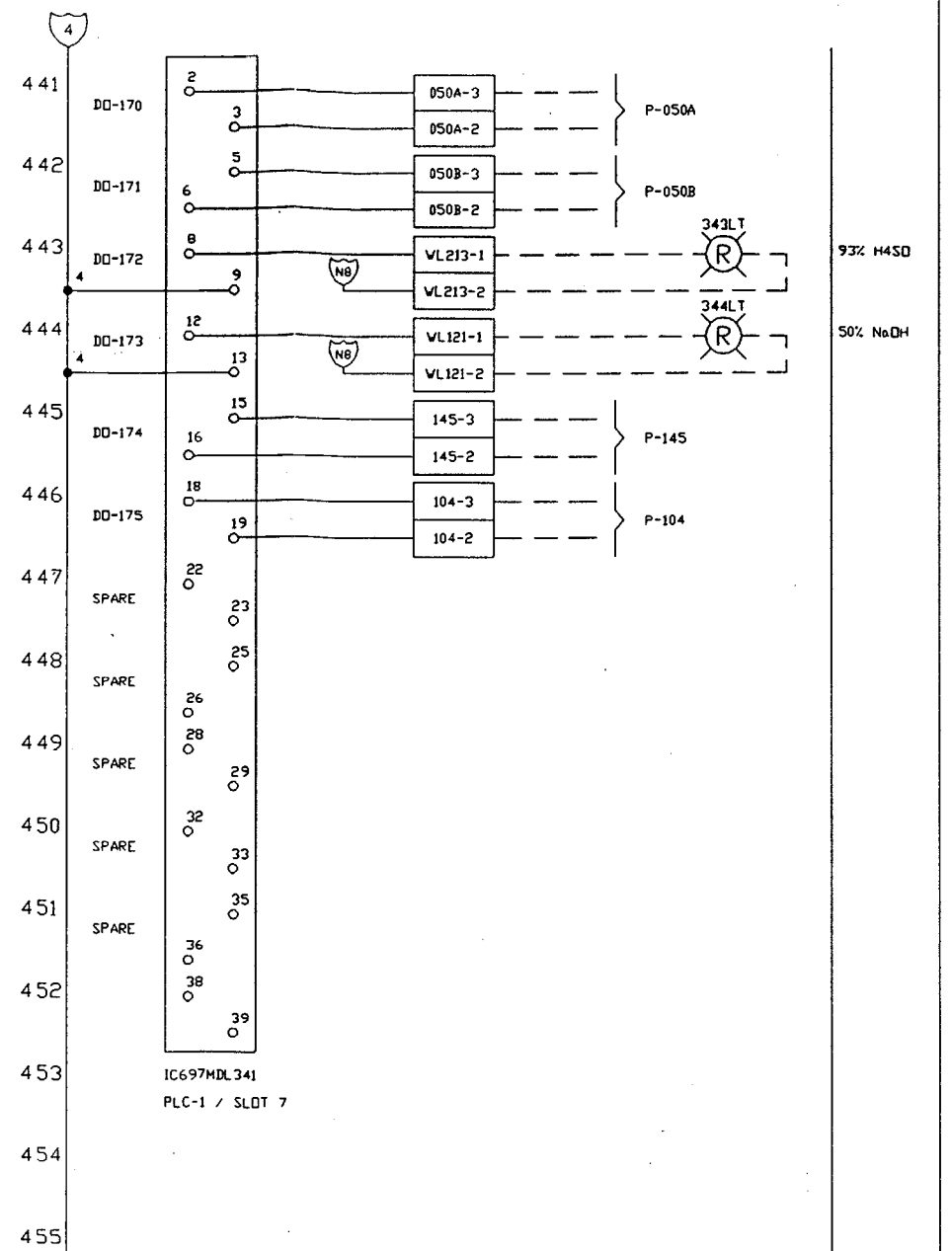
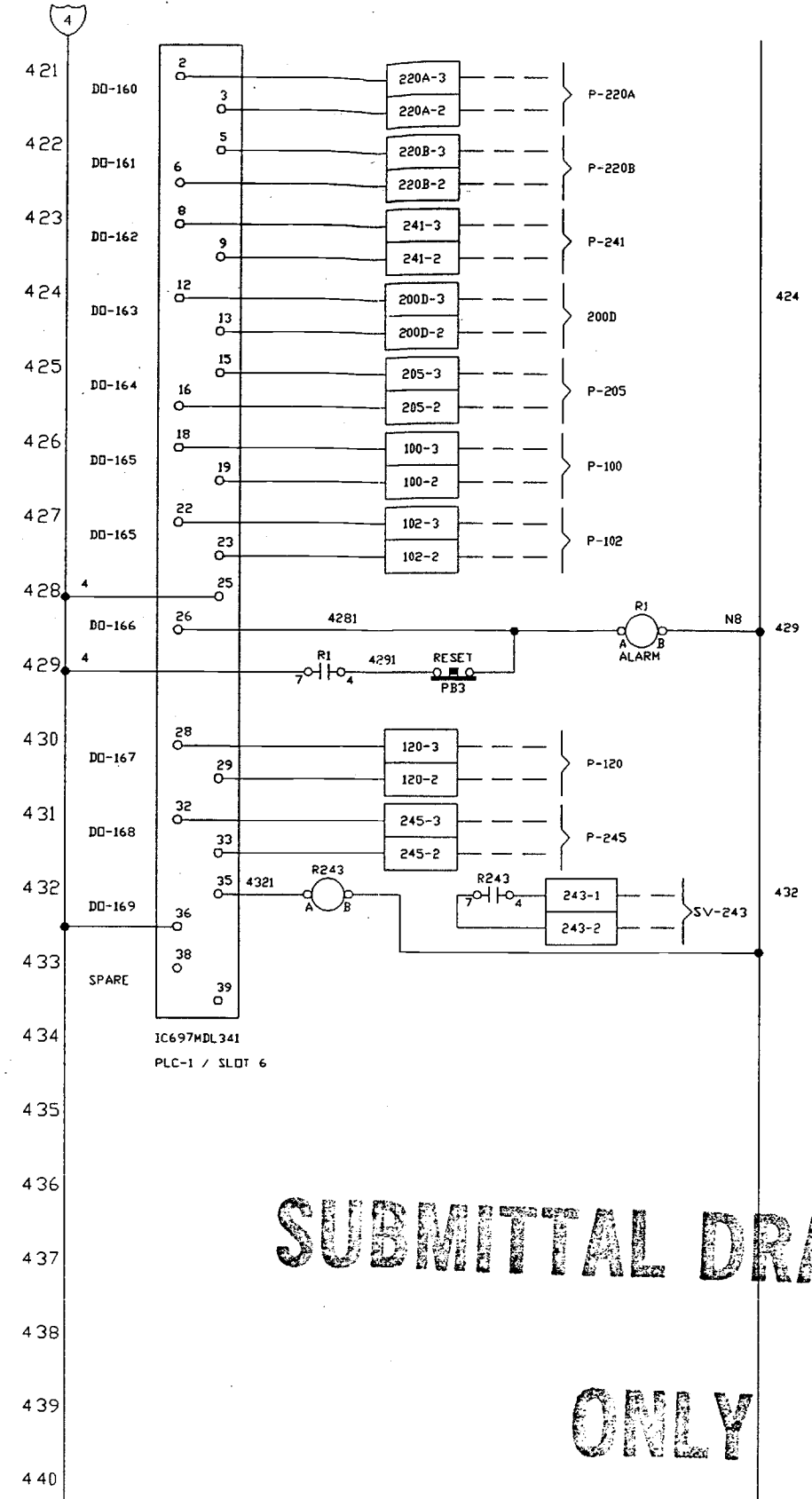
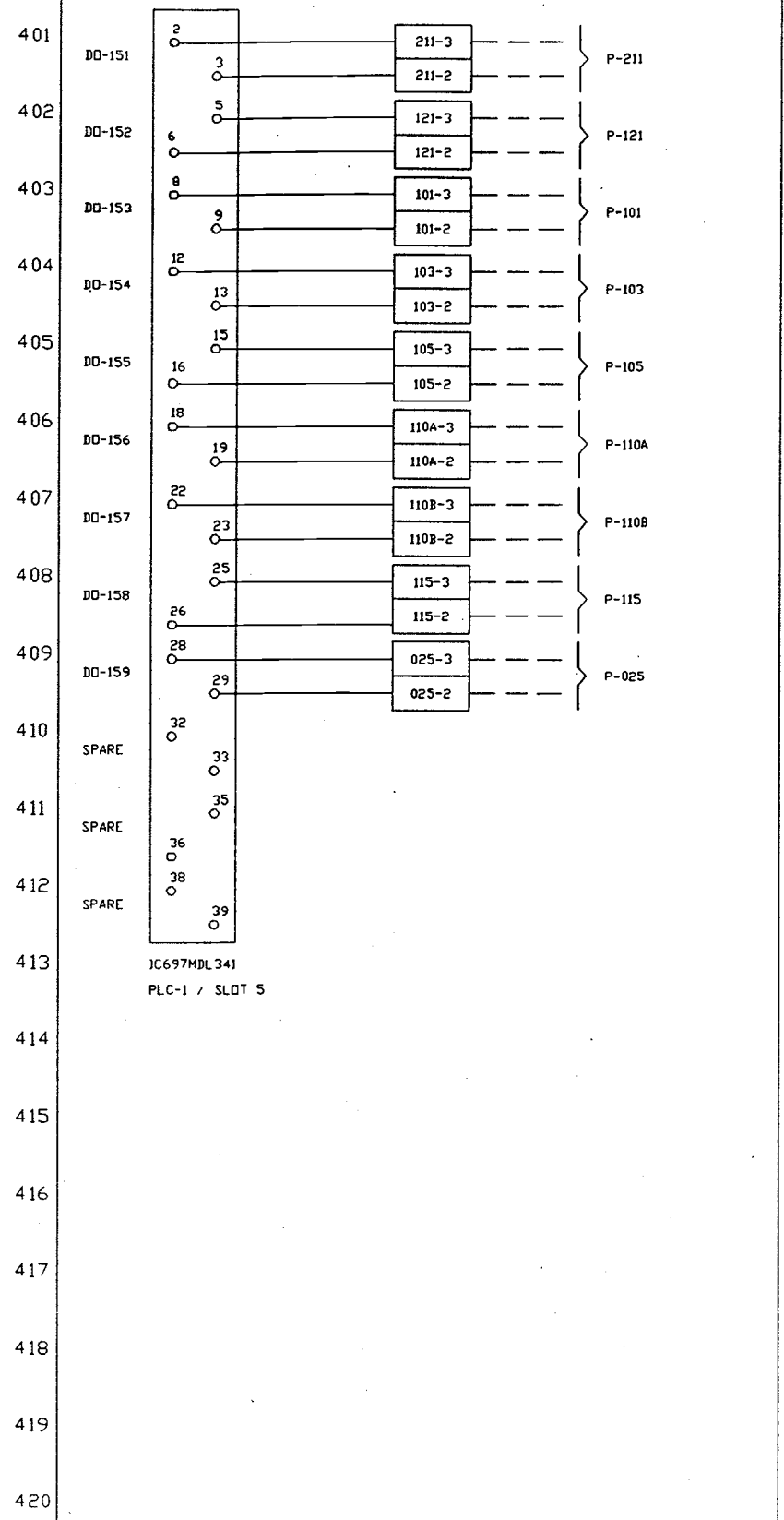
REV. NO.	1	2	3	4	5	6	7	8	9	10
DATE										
DR.	RD									
CHK.										
APP.										
APP.										
CADD NO.										
ASSEMBL.										
REFERENCE										
SCALE		SIZE		DWG. NO.		REV.				
		D		PC9506		3/7				

PROCESS CONTROL SERVICES, LTD
P.O. BOX 98 SEAFORD, VIRGINIA

ATLANTIC DIVISION
SOIL AND GROUNDWATER REMEDIATION
RECOVERY WELL SYSTEM

PLC CONTROL PANEL

WIRING DIAGRAM / D. INPUT & A. OUTPUTS

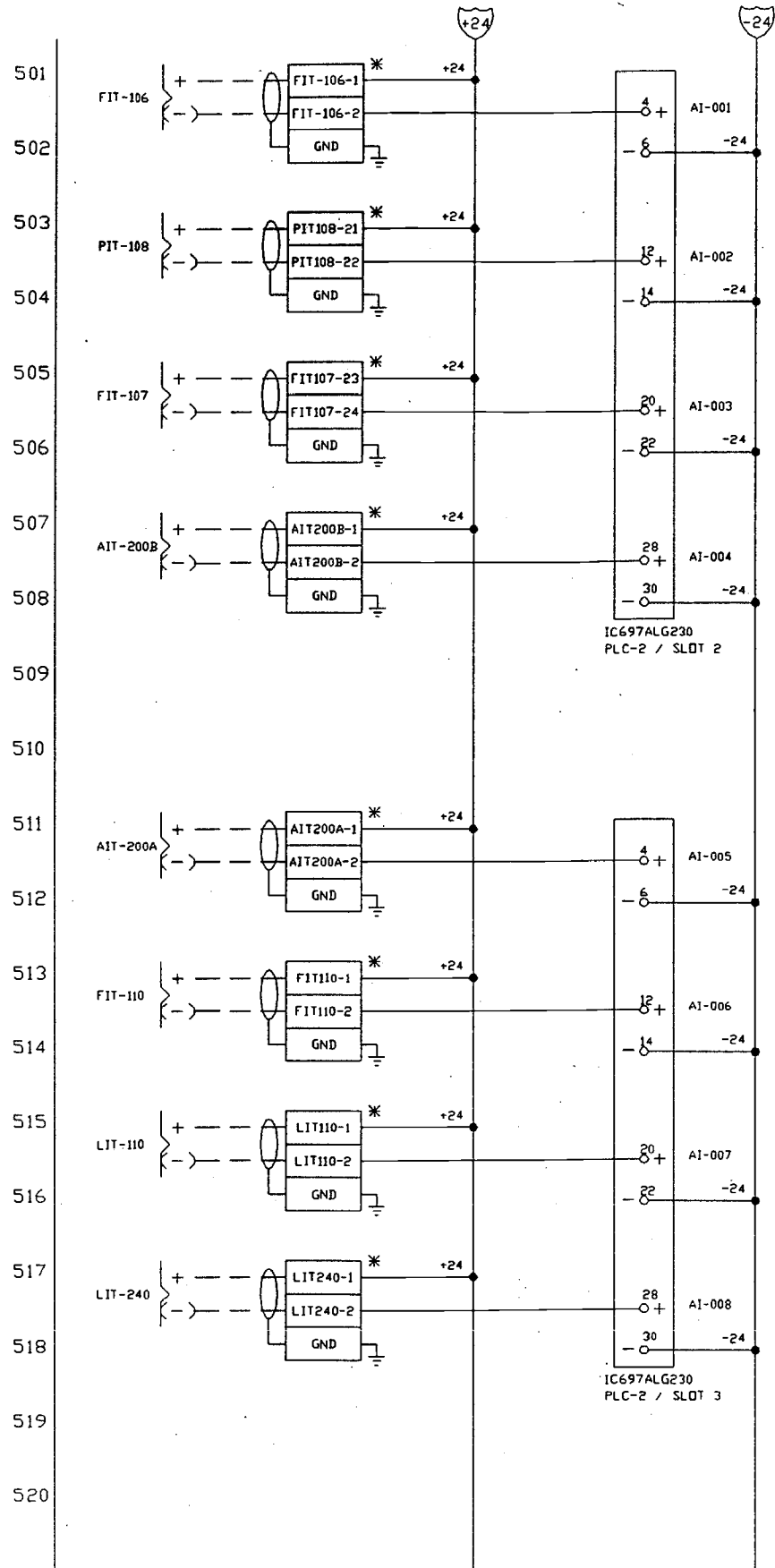


SUBMITTAL DRAWINGS

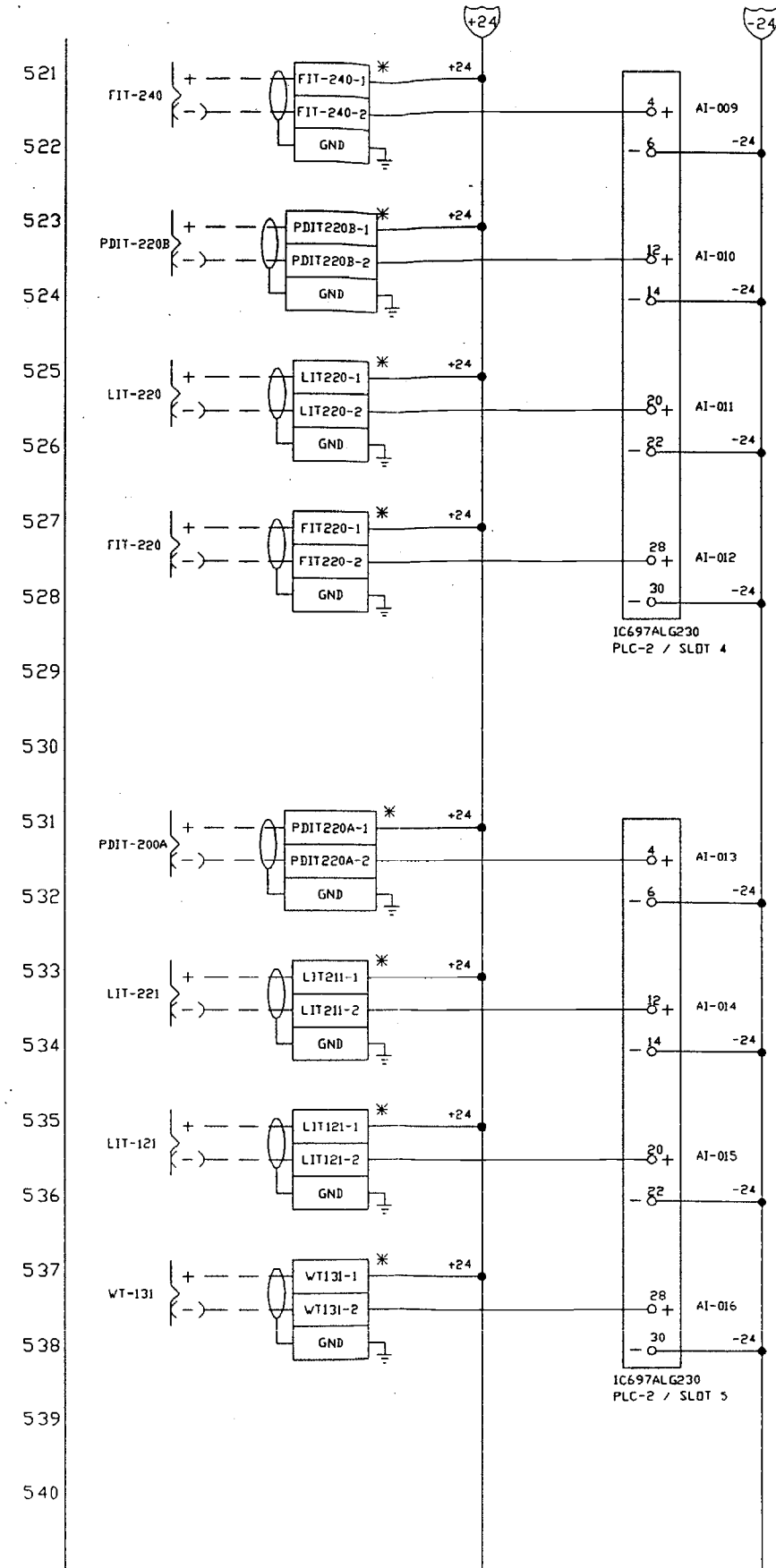
ONLY

NOT FOR CONSTRUCTION

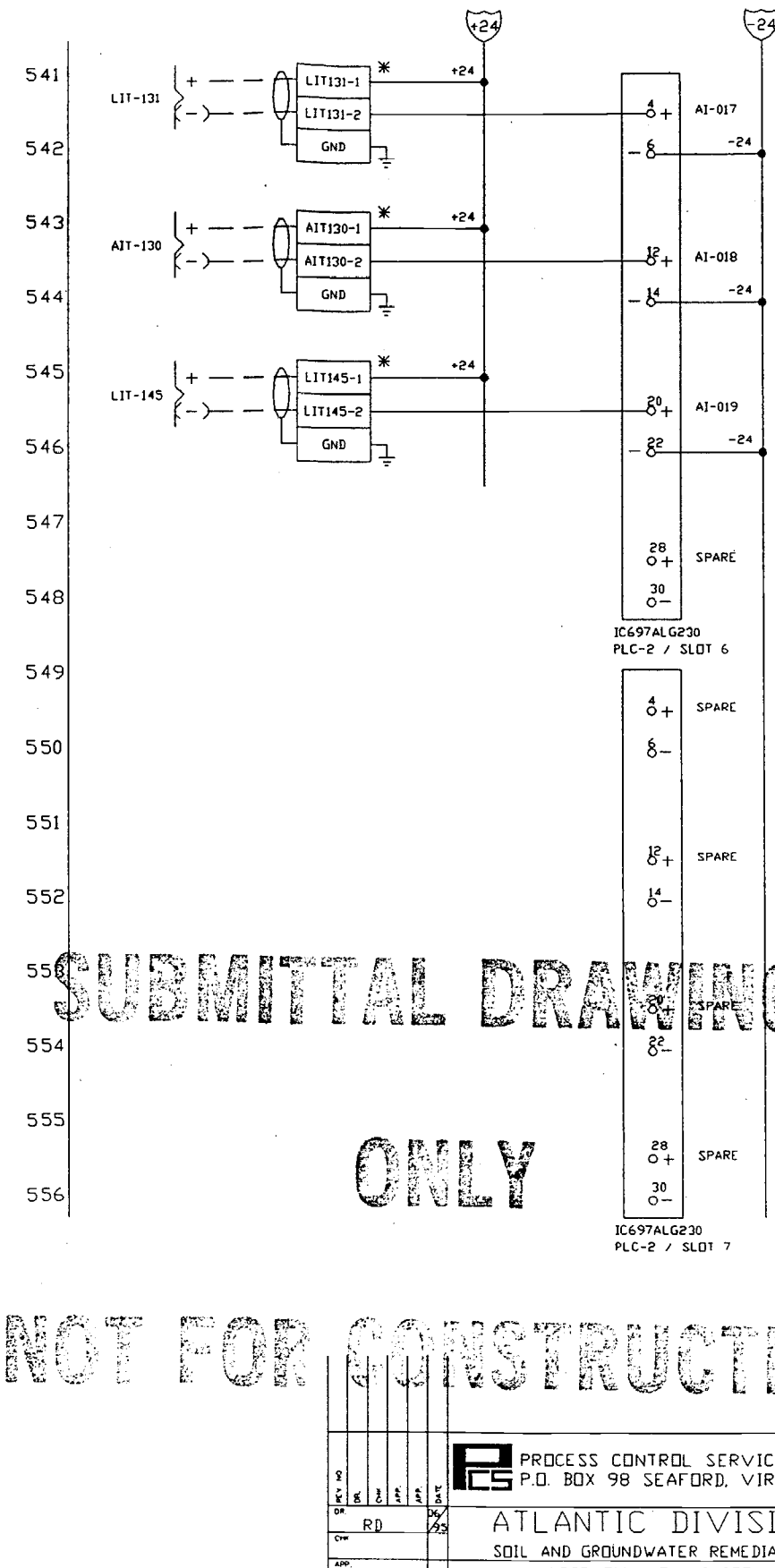
PROCESS CONTROL SERVICES, LTD P.O. BOX 98 SEAFORD, VIRGINIA	
ATLANTIC DIVISION	
SOIL AND GROUNDWATER REMEDIATION	
RECOVERY WELL SYSTEM	
PLC CONTROL PANEL	
WIRING DIAGRAM / DISCRETE OUTPUT	
SCALE	DWG NO.
REV	D PC9506 5/7



IC697ALG230
PLC-2 / SLOT 2



IC697ALG230
PLC-2 / SLOT 4



IC697ALG230
PLC-2 / SLOT 6

* = FUSED TERMINAL BLOCK

SUBMITTAL DRAWINGS

ONLY

NOT FOR CONSTRUCTION

		PROCESS CONTROL SERVICES, LTD. P.O. BOX 98 SEAFORD, VIRGINIA	
DR: RD CWN:		ATLANTIC DIVISION SOIL AND GROUNDWATER REMEDIATION RECOVERY WELL SYSTEM PLC CONTROL PANEL	
CADD NO:		WIRING DIAGRAM / ANALOG INPUTS	
ASSY NO:	SCALE:	SHEET: D	DWG NO: PC9506 6/7
REFERENCE:	MICRO:	REV:	-

BILL OF MATERIAL

INSTRUMENTATION

CAT. NO.	VENDOR	DESCRIPTION	QTY.
CONTROL PANEL			
A-726024FSD	HOFFMAN	CONTROL PANEL - 72.06"x60.06"x24.06" NEMA 12 & 13 - GASKETED	1
A-72P30F1	HOFFMAN	FULL INTERIOR BACKPANEL	1
A-72SMP14	HOFFMAN	FULL INTERIOR SIDE PANEL	2
A-72FSCPS	HOFFMAN	CENTER SUPPORT BAR	1
A-PA-PA4AXFN	HOFFMAN	COLLING FAN	2
A-TEMND	HOFFMAN	THERMOSTAT	1
A-EXGR4	HOFFMAN	EXHAUST GRILL	1
-	-	LIGHT W/ DOOR SWITCH	1
-	-	RECEPTACLE & BOX	1
PLC			
IC697CPU772	G.E.	CPU,2K I/O,FLOATING POINT MATH	1
IC697MEM713	G.E.	EXPANSION MEMORY, 64K	1
IC697CHS790	G.E.	9 SLOT RACK	2
-	-	-	1
IC697PWR710	G.E.	120/240 VAC, 55 WATT POWER SUPPLY	2
IC697ALG230	G.E.	ANALOG INPUT, 4 CHANNEL	6
IC697ALG320	G.E.	ANALOG OUTPUT	2
IC697MDL250	G.E.	120VAC, 32PT. INPUT	2
IC697MDL341	G.E.	120VAC,2AMP, 12PT ISOLATED OUTPUT	3
IC697BEM713	G.E.	BUS TRANSMITTER	1
IC697MEM711	G.E.	BUS RECEIVER	1
IC600VD005	G.E.	I/O EXPANSION CABLE	1
IC641SWP706	G.E.	PROGRAMMING SOFTWARE	1
HE693SNPCBL	G.E.	CPU PROGRAMMER CABLE	1

CAT. NO.	VENDOR	DESCRIPTION	TAG	QTY.
DEVICES				
IHD24-4.8	International	24 VDC POWER SUPPLY		1
RR3BU	IDEC	CONTROL RELAY	R	3
THQC1120WL	G.E.	BREAKER, 15AMP, 10K AIC	CB	2
THQC1115WL	G.E.	BREAKER, 15AMP, 10K AIC	CB	3
TQCBMPA3	G.E.	BREAKER MOUNT		2
P9XEM4RN-P9B01VR	G.E.	RED MUSHROOM HEAD PUSHBUTTON	PB1	1
P9XPNG-P9B10VN	G.E.	BLACK PUSHBUTTON	PB2,3	2
P9XSCDOK95-P9B11VN/P9B10VN	G.E.	2 POSITION SWITCH KEY OPERATED	SS1	1
P9XLRR-P9PTNVJ	G.E.	RED LIGHT	PL1,2	2
P9XLVR-P9PTNVJ	G.E.	GREEN LIGHT	PL3	1
-	-	DEVICE LEGEND PLATES		6
B75-N5	EDWARDS	ALARM HORN		1
1250-32	Joslyn	SURGE SUPPRESSOR		1
-	-	-		-

CAT. NO.	VENDOR	DESCRIPTION	TAG	QTY.
L6EPB-B-D-3-C	W. E. ANDERSON	Liquid Level Switch with 2" Flange Adaptor	LSH-110, 130,205 LSHH-110 LSL-205	5
AP153-39	MERCOID	Pressure Switch	PSL-152	1
35 1009AW-02L-XXX-*	ASHCROFT	Pressure Gauges Ranges 0-100 PSI 0-60 PSI	PI-100-105 PI-110A,B,C PI211 PI-220A,B,C,D PI-240 PI-241	17
3-3510-8011-PI	SIGNET	Paddle Wheel Flow Meter	FE/FIT-106, 107, 110, 220	4
T3000-4'	KENT	Turbine Flow Meter	FE/FIQ 101, 103, 105	3


INSTRUMENTATION

CAT. NO.	VENDOR	DESCRIPTION	TAG	QTY.
STD924-A1A-0000-MB,DM,ZS	HONEYWELL	Differential Pressure Transmitter	PDIT-220A, B	2
STF924-A1A-OR10F0-ME,ZS	HONEYWELL	Flanged Level Transmitter	LIT-110 121, 220 221,245 145	4
STF932-A1A-OR10F-ME,ZS	HONEYWELL	Flanged Mounted Pressure Transmitter	PIT-108	1
1181PH-01-07	ROSEMOUNT	pH TRANSMITTER	AE/AIT-200A,200B, 130	3
399-01-01	ROSEMOUNT	pH Sensor		
CLS20NDW	CONTROL LEVEL SWITCH	Float Switch	LSL-025, 115,050A LSH-025, 115 LSHH-050B LSA-025, 115, 050B LSM-050A	9
FS8W	MCDONNELL & MILLER	Flow Switch	FS-100, 102, 104	3

SUBMITTAL DRAWINGS

ONLY

NOT FOR CONSTRUCTION

 PROCESS CONTROL SERVICES, LTD. P.O. BOX 98 SEAFORD, VIRGINIA	
ATLANTIC DIVISION SOIL AND GROUNDWATER REMEDIATION RECOVERY WELL SYSTEM PLC CONTROL PANEL BILL OF MATERIAL	
DATE: _____ DRAWN BY: RD CHECKED BY: _____ APP. BY: _____ CADD NO: _____	SCALE: _____ SHEET NO: D TOTAL SHEETS: PC9506 7/7 REV: -



SUBMITTAL FORM

PO BOX 1519
ROSWELL, GA 30077
PHONE (404) 664-6513
FAX (404) 664-6906

Customer: OHM Remediation Services Corp.
5335 Triangle Parkway Ste. 450
Norcross, GA 30092

Customer P.O. No.: 1002733
Submittal Date: March 16, 1995

REF: MCB Camp LeJeune Effluent
Outfall line

- Approved _____
- Approved as noted _____
- Not approved _____
- Resubmit _____

Item	Quantity	Description
A	1	Tracom FRP metering manhole, 4'- 0" dia. by 7'- 0" deep, with dome top, FRP ladder, 2" NPT coupling, and Parshall flume, size 6", with inlet and outlet adapters, 8" pipe stubs, and 8" x 8" flexible boots.

SUBMITTAL REVIEW

REVIEW IS FOR GENERAL COMPLIANCE WITH CONTRACT DOCUMENTS. NO RESPONSIBILITY IS ASSUMED FOR CORRECTNESS OF DIMENSIONS OF DETAILS. THE CONTRACTOR/SUPPLIER SHALL ASSUME FULL RESPONSIBILITY FOR DEVIATIONS FROM CONTRACT REQUIREMENTS NOT SPECIFICALLY INDICATED ON THIS SUBMITTAL.

NO EXCEPTIONS MAKE CORRECTIONS NOTED
 AMEND AND RESUBMIT REJECTED - SEE REMARKS

Date 4/4/95 By B. Matthews

OHM REMEDIATION SERVICES CORP.
NORCROSS, GEORGIA

PACKAGED METERING MANHOLE

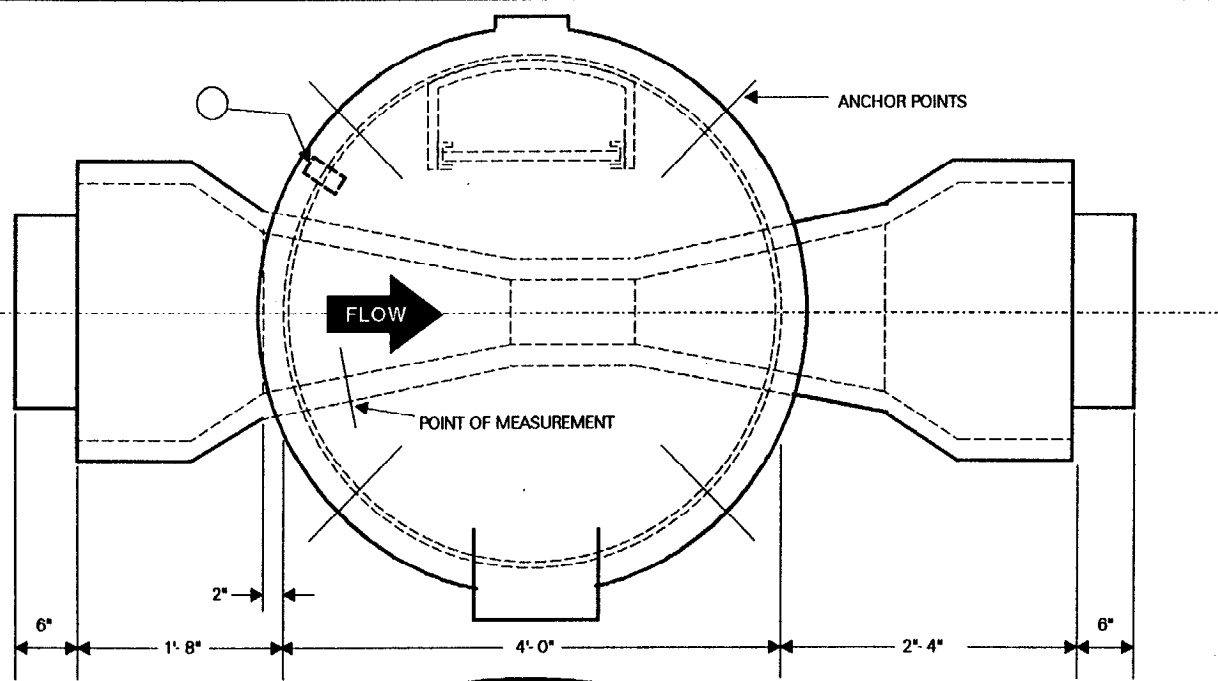
The packaged metering manhole will be 48" diameter corrosion-resistant fiberglass reinforced plastic (FRP), with sealed fiberglass bottom, fiberglass dome lid, fiberglass access ladder and metering flume. The manhole will be equipped with hold-down brackets for anchoring the unit to a concrete slab. A one-half inch (1/2") thick expanded polystyrene bead board will be supplied for placement on the concrete slab under the manhole.

The packaged metering manhole will be furnished with a full opening, domed fiberglass cover equipped with a stainless steel hinge and stainless steel hasp for locking. The cover will be of sufficient strength to withstand a 1,000 pound top load. The cover will overlay the manhole and seat on a Neoprene seal to prevent dirt, rain, and debris from getting into the manhole.

The manhole will be provided with a Parshall flume, size 6", with inlet and outlet adapters, and 8" pipe stubs. Two (2) flexible boots with stainless steel clamps to connect pipe stubs to existing 8" PVC pipes will be supplied.

Also provided will be a 2" NPT coupling in the manhole wall for wiring or sampling access.

The packaged metering manhole will be as manufactured by TRACOM, Inc., of Roswell, Georgia, Phone: (404)664-6513.

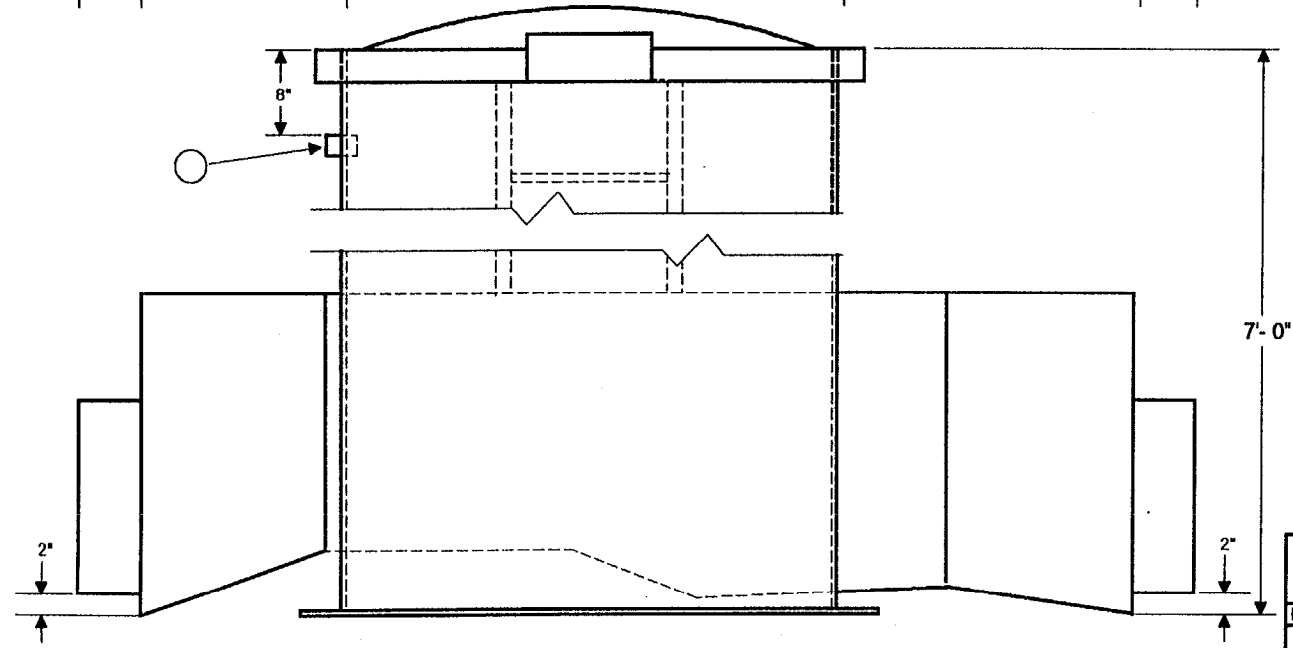


1. MANHOLE TO BE FABRICATED TO ASTM-3753 SPECIFICATIONS, WITH FRP LADDER.
2. FIBERGLASS DOME TOP, FULL DIAMETER, HINGED AND LOCKABLE
3. PARSHALL FLUME, SIZE 6", WITH INLET AND OUTLET ADAPTERS.
4. 2" NPT COUPLING

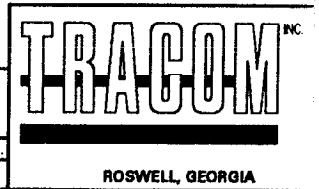
OPTIONS

- 2 PVC Pipe Stubs, Size 8"
- 2 Flexible Couplings, to mate with 8" PVC _____ type pipes.
- _____ Stilling Well, _____ dia.¹ L R²
- _____ Stainless Steel Bubble Tube¹ L R
- _____ Stainless Steel Sample Tube L R²
- _____ Ultrasonic Mounting Bracket¹ SS PVC L R²
- _____ Staff Gauge¹ L R²
- _____ Submerged Probe Cavity¹ L R² Type Probe: _____
- _____ pH Probe Sleeve L R²
- _____ Grating Over Flume
- _____ Other _____
- _____ Other _____

¹ Located at the Point of Measurement.
² Located on the Left or Right Side When Looking in the Direction of Flow



FIBERGLASS METERING MANHOLE WITH 6" PARSHALL FLUME		
DRAWING NO.	DATE	REVISION NO.
M4D-PA06	JAN. 1995	0

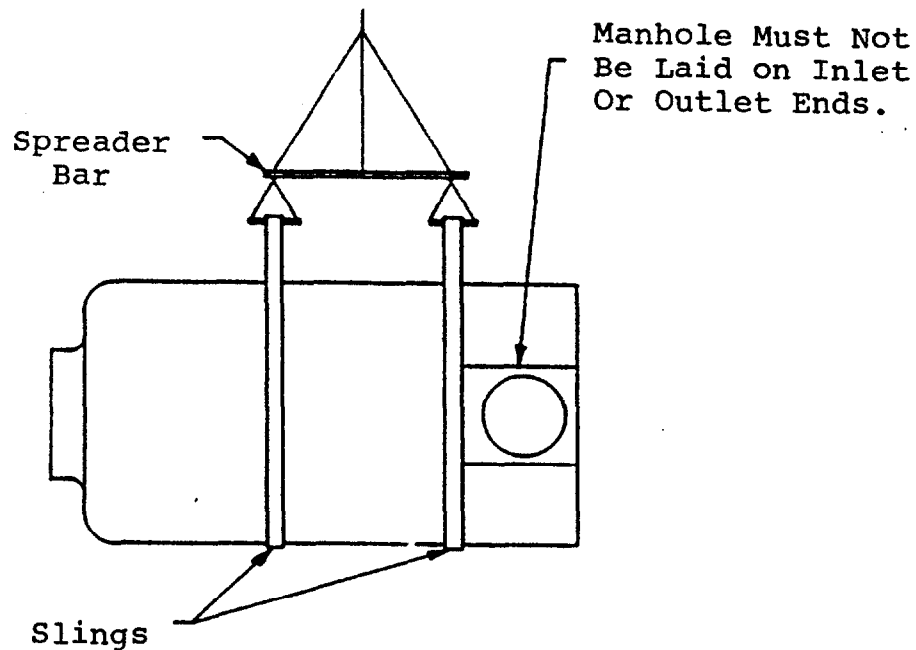


PREFABRICATED METERING MANHOLE - INSTALLATION INSTRUCTIONS

I. Follow all instructions provided by project engineers in the form of blue prints, spec's, etc.

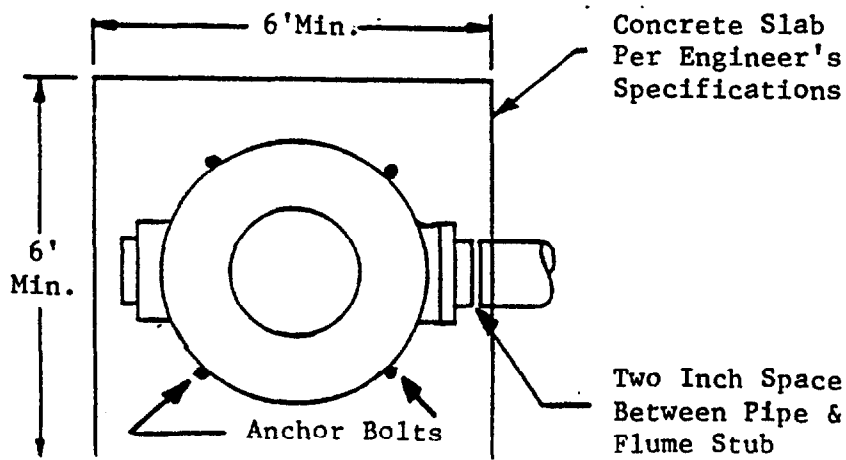
A -- UNLOADING

Use a spreader bar and fabric sling for handling, as shown. Do **NOT** use cable or chain.



B -- SITE

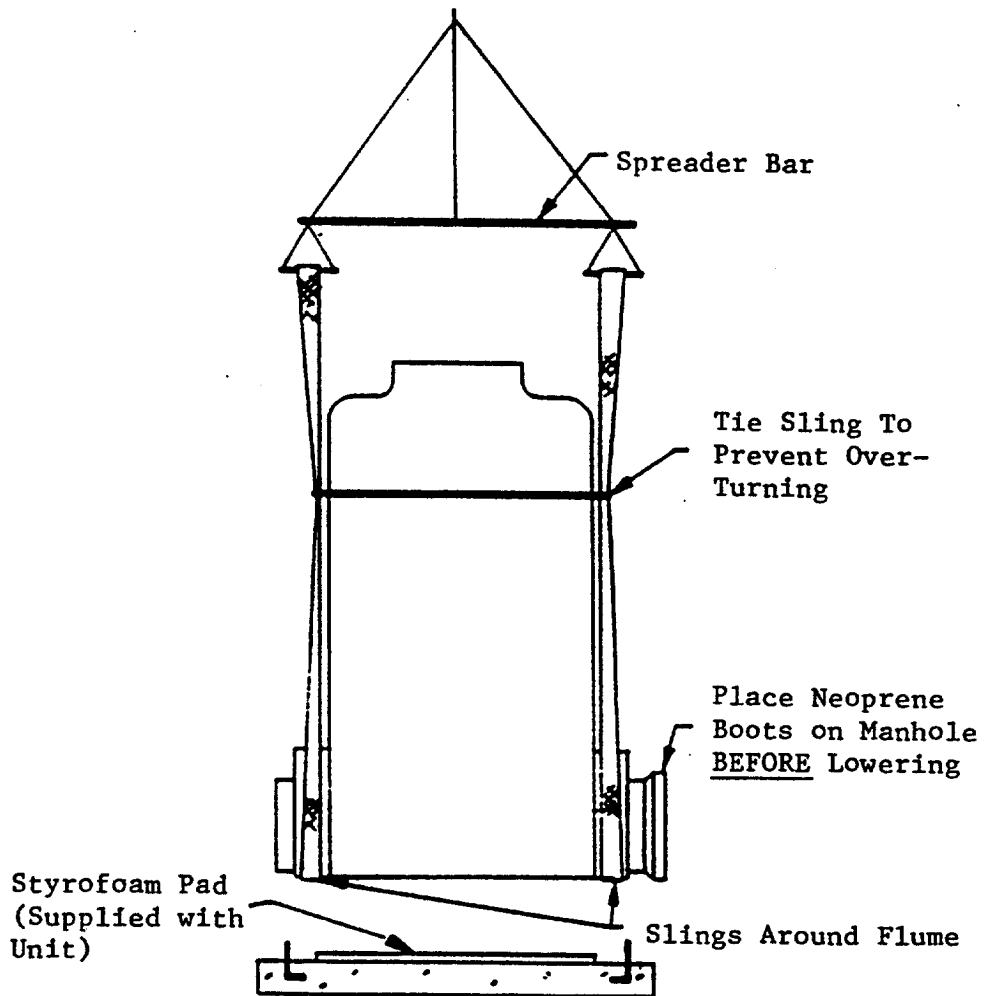
Excavation at site should be wide enough for manhole and safe working area. Concrete slab must be level to 1/8" and surface troweled smooth.



(Continuation of PREFABRICATED METERING MANHOLE INSTALLATION INSTRUCTIONS ...)

C -- PLACING MANHOLE ON SLAB

Level slab with grout, if necessary, to 1/8". Place styrofoam pad on concrete. Attach flexible Neoprene boots to pipe connections on manhole. Use fabric sling for handling, as shown.



Secure anchor bolts. Do not tighten completely. Check level of flume and adjust, as required.

(Continuation of PREFABRICATED METERING MANHOLE INSTALLATION INSTRUCTIONS ...)

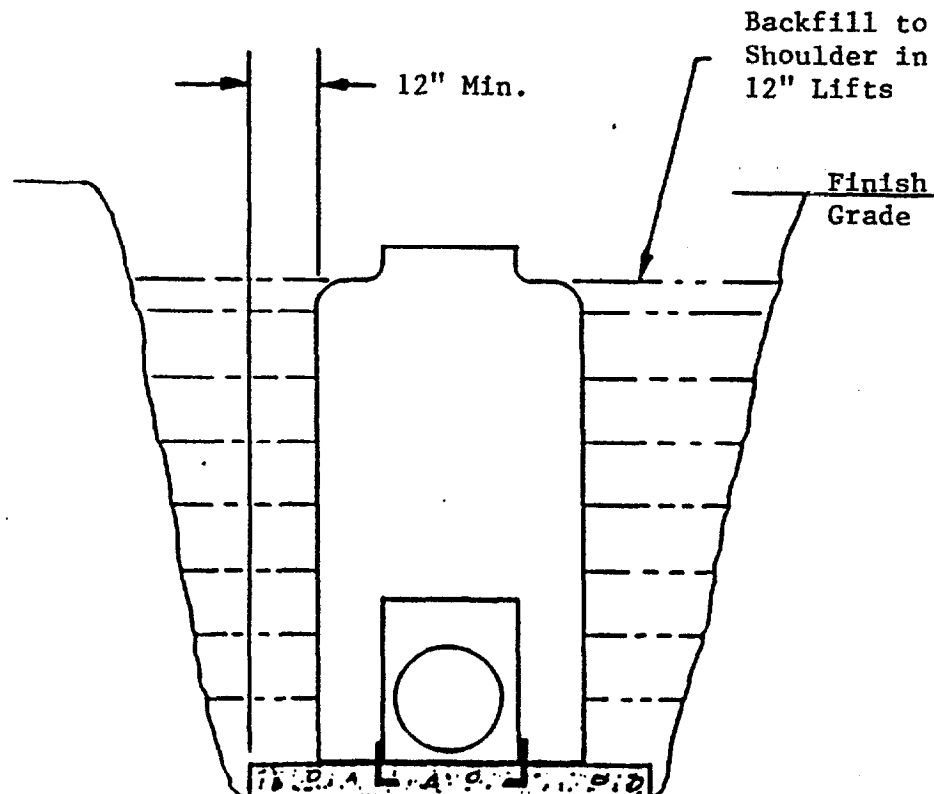
D -- BACKFILLING

A gravel material naturally round 1/4" to 3/8" size is best for backfill material since it compacts easily.

Groundwater or surface runoff should not be permitted to accumulate in open excavation around manhole which has not been completely backfilled.

If native soil is to be used for backfill, large soil lumps, rocks, concrete, etc. over 1" size must be removed. Backfill should be placed evenly around manhole in maximum lifts of 12".

Soil conditions vary, thus knowledgeable engineering advice is suggested to assure proper backfilling materials and procedures are used.





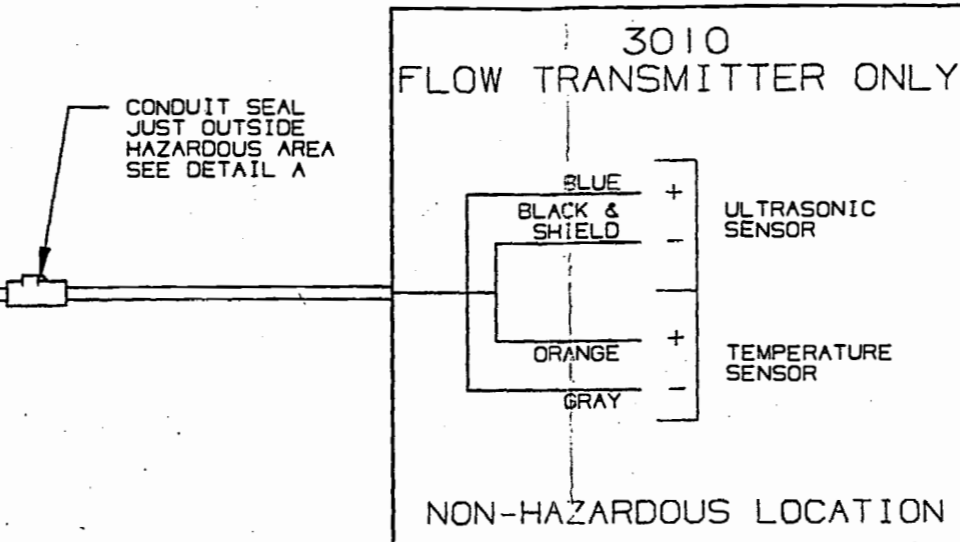
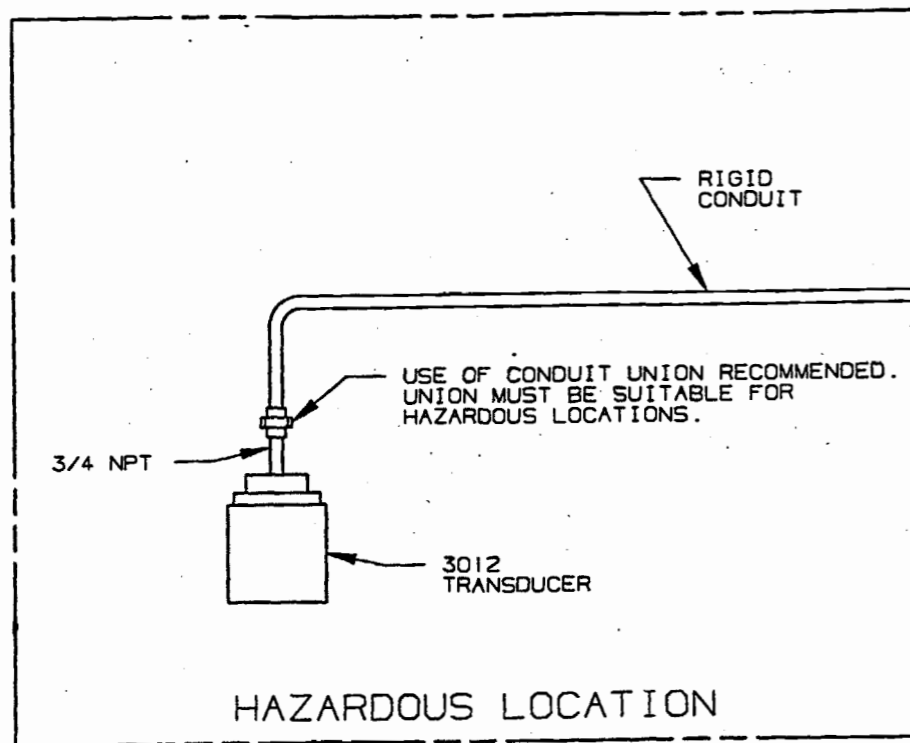
P.O. BOX 1519
ROSWELL, GA 300
404/664-6513
FAX 404/664-6906

(Continuation of PREFABRICATED METERING MANHOLE INSTALLATION INSTRUCTIONS ...)

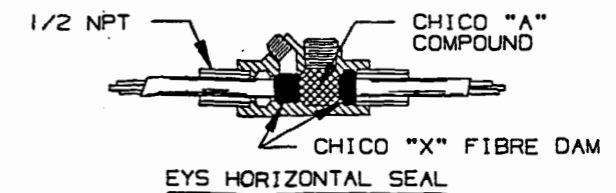
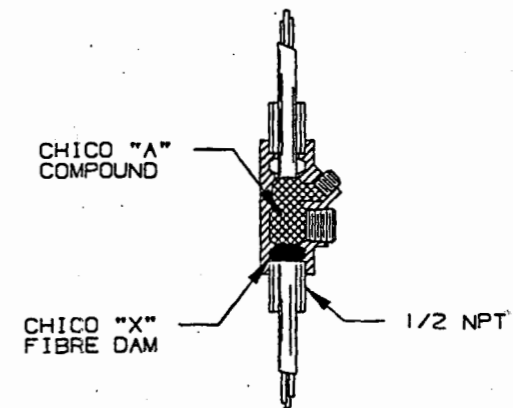
E -- FINISH

The void under and around flume inside manhole should be filled with grout to the top and sloped to drain toward the flume.

REVISIONS					
REV.	ECN NO.	DESCRIPTION OF CHANGE	BY	CHK'D BY	DATE CHANGED
B	5487	REVISED NOTES AND REPRESENTATION OF CONDUITS	T. SCHAAL	J. DELHAY	031694



CROUSE-HINDS EYS 216 CONDUIT SEAL WITH CHICO "A" SEALING COMPOUND, IS APPROVED FOR EXPLOSION-PROOF APPLICATIONS (NEC CLASS I, GROUPS C & D, DIVISION 1)



DETAIL A
TYPICAL APPROVED SEAL

NOTES:

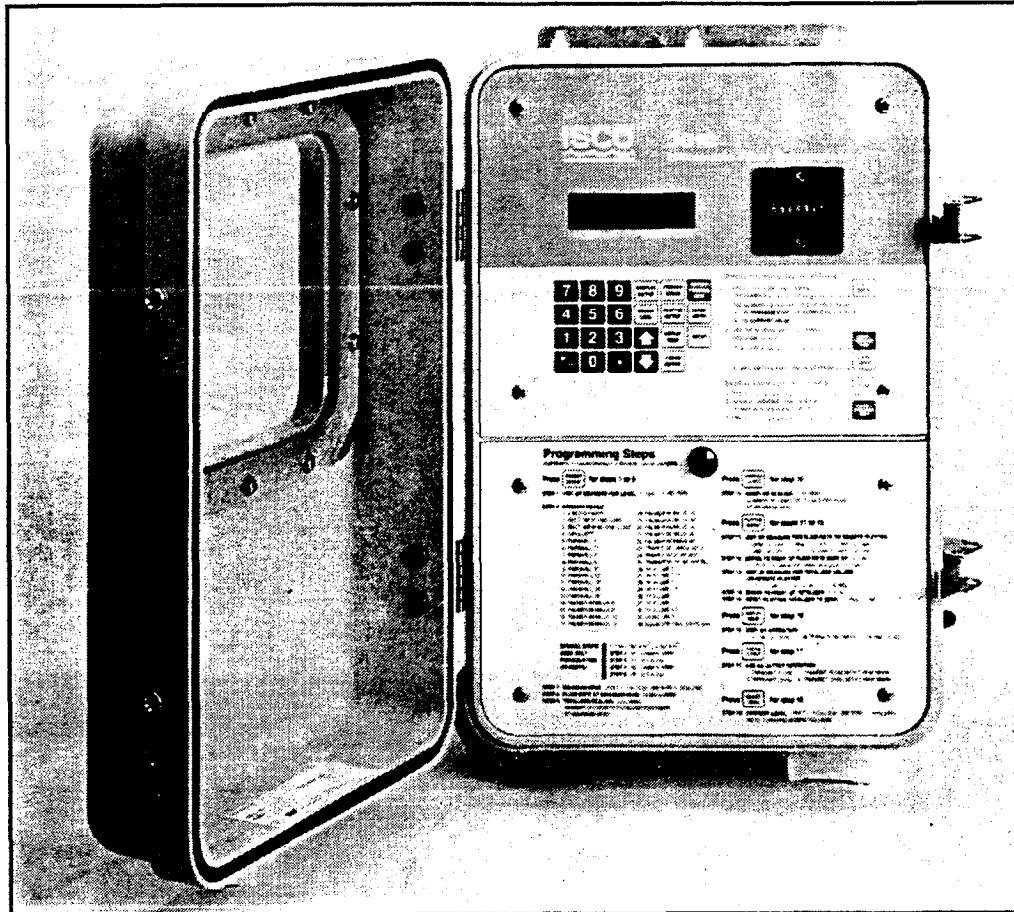
- SUITABLE FOR CLASS I, DIV. 1, GROUP C & D.
- THE MODEL 3012 TRANSDUCER AND MODEL 3010 FLOW TRANSMITTER ARE SUITABLE FOR HAZARDOUS LOCATION APPLICATIONS ONLY WHEN INSTALLED AS SHOWN IN THIS CONTROL DRAWING.
- RIGID CONDUIT IN THE HAZARDOUS LOCATION SHALL BE GROUNDED TO A PROPER ELECTRICAL GROUND.
- BONDING BETWEEN CONDUIT CONNECTIONS SHALL BE PROVIDED AS PART OF THE INSTALLATION.
- INSTALL IN HAZARDOUS LOCATION USING CLASS I, DIVISION 1, WIRING METHOD(S) PER THE NEC (ANSI/NFPA 70) ARTICLE 501-4(a).
- NOT APPROVED FOR USE IN HAZARDOUS ATMOSPHERES CONTAINING KETONES, ALCOHOLS, ESTERS OR ACIDS.

FMRC CONTROLLED DRAWING. NO CHANGES WITHOUT PRIOR FMRC APPROVAL. P.C. ENG. <i>LP Niblan</i>	 ISCO, INC. ENVIRONMENTAL DIV. DO NOT SCALE FRACTION = --1/64" XX = --.010" XXX = --.005" UNLESS OTHERWISE NOTED	MODEL	3012	BY	DATE	
		TITLE	CONTROL DRAWING - 3012 HAZARDOUS LOCATION INSTALLATION	DRAWN	J. DELHAY	101292
		MATERIAL INV. NO.	N/A	CHECKED	R. HODGES	020394
		MATERIAL DESCRIPTION	N/A	APPROVED	D. DAVIS	020394
		FINISH	N/A	SHEET	OF	
				1	1	
			DRAWING NO.	REV.		
			603403175	B		

02350HH06Z

INSTRUCTION MANUAL

Model 3010 FLOW METER



Part #60-3404-070

COPYRIGHT 1994, 1995

ISSUED: November 17, 1994

Revision B April 4, 1995

531 Westgate Boulevard
Lincoln, Nebraska, 68528-1586 USA

PHONE: (402) 474-2233

Toll Free: (800) 228-4373

FAX: (402) 474-6685

ISCO®

FOREWORD

This instruction manual is designed to help you gain a thorough understanding of the operation of the equipment. Isco recommends that you read this manual completely before placing the equipment in service.

Although Isco designs reliability into all equipment, there is always the possibility of a malfunction occurring. You can use this manual to help in diagnosing and repairing the malfunction, if possible.

If the malfunction persists, call or write the Isco Customer Service Department for assistance. (Address: Isco Inc., Environmental Division, 531 Westgate Boulevard, Lincoln, NE 68528-1586; Phone: [800] 228-4373 or [402] 474-2233.) Simple difficulties can often be diagnosed over the phone. If it is necessary to return the equipment to the factory for service, please follow the shipping instructions provided by the Customer Service Department, including the use of the **Return Authorization Number** specified. **Be sure to include a note describing the malfunction.** This will aid in the prompt repair and return of the equipment.

Isco welcomes suggestions that would improve the information presented in this manual or enhance the operation of the equipment itself.

MODEL 3010

TABLE OF CONTENTS

Paragraph No.	Title	Page No.
1.0	INTRODUCTION.....	1-1
1.1	Manual Organization.....	1-1
1.2	Description.....	1-1
1.2.1	Interfacing Equipment.....	1-2
1.3	Description of the Ultrasonic Level Sensor.....	1-2
1.4	Controls, Indicators, and Terminal Blocks.....	1-3
1.5	Technical Specifications.....	1-3
2.0	OPERATING PROCEDURES.....	2-1
2.1	Operating Theory.....	2-1
2.1.1	Ultrasonic Level Sensor Theory and Applications.....	2-1
2.1.2	Error Factors Affecting Performance of the Ultrasonic System.....	2-2
2.2	Controls and Indicators.....	2-4
2.2.1	Keypad Layout and Functions.....	2-4
2.2.2	Display.....	2-4
2.2.3	Power Failures.....	2-4
2.3	Programming.....	2-5
2.3.1	Programming Overview.....	2-5
2.3.2	List of Program Steps.....	2-7
2.3.3	Detailed Description of Programming Sequence.....	2-7
2.3.4	Equations Used in Flow Conversion.....	2-11
2.3.5	Default Program.....	2-11
2.4	Programming Examples.....	2-11
2.4.1	Programming for a Parshall Flume.....	2-11
2.4.2	Programming for a Cipolletti Weir.....	2-13
2.4.3	Programming with the Equation (Device # 34).....	2-16
2.4.3.1	Programming Example Using an Equation.....	2-17
2.4.3.2	Rectangular Weirs with End Contractions.....	2-18
2.4.3.3	Programming Example for a Rectangular Weir with End Contractions.....	2-19
3.0	INSTALLATION AND WIRING.....	3-1
3.1	General Comments on Installation.....	3-1
3.2	General Wiring Comments.....	3-2
3.2.1	Connection to a Power Source.....	3-2
3.2.2	Wiring the Ultrasonic Level Sensor.....	3-3
3.2.3	Connection to an Isco Sampler.....	3-4
3.2.4	Connection to a Non-Isco Sampler.....	3-5
3.3	Safety Considerations.....	3-5
3.3.1	General Safety Procedures.....	3-6
3.3.2	Lethal Atmospheres in Sewers.....	3-10
3.4	General Considerations for Installing the Ultrasonic Level Sensor.....	3-11
3.4.1	Mounting the Ultrasonic Level Sensor.....	3-12
3.4.2	Minimization of Level Measurement Errors.....	3-16
4.0	OPTIONAL EQUIPMENT.....	4-1
4.1	High-Low Alarm Relay Box.....	4-1
4.2	Connection to an Isco Model 2312 Plotter.....	4-6
4.2.1	Connection to Other External Serial Device.....	4-7
4.3	Remote Totalizer.....	4-7
4.4	Characterization PROM.....	4-8
4.5	Extension Cables for the Ultrasonic Level Sensor.....	4-9
4.6	Connection to the Model 2410 Circular Chart Recorder.....	4-10

MODEL 3010

5.0	ROUTINE MAINTENANCE AND TROUBLESHOOTING	5-1
5.1	Care of Flow Meter Case	5-1
5.2	Care of the Ultrasonic Level Sensor and Cables	5-1
5.2.1	Cable Inspection.....	5-1
5.3	Access to Mechanical and Electrical Components.....	5-2
5.4	Fuse Replacement	5-2
5.5	Display Warnings	5-4
5.6	Hints on Troubleshooting.....	5-4
5.6.1	Preliminary Troubleshooting Steps	5-4
5.6.2	Precautions for Servicing AC-Powered Equipment	5-5
5.6.3	Precautions for Servicing CMOS Circuitry	5-6
5.7	Circuit Boards.....	5-7
5.7.1	Terminal Board	5-7
5.7.2	CPU Board	5-8
5.8	Replacement Parts List	5-8
5.9	Accessory Parts List.....	5-8

LIST OF ILLUSTRATIONS

Figure No.	Title	Page No.
1.2-1	Model 3010 Flow Meter	1-1
1.4-1	Model 3010 Front Panel	1-4
1.4-2	Inside View of Flow Meter, Showing Connectors.....	1-5
2.3-1	Simplified Flow Chart for the Model 3010 Flow Meter.....	2-6
3.1-1	View of Latch, Showing Lock Passages	3-1
3.4-1	Ultrasonic Level Sensor "Dead Band".....	3-13
3.4-2	Mounting the Ultrasonic Level Sensor	3-14
3.4-3	Ultrasonic Floor Mount	3-16
3.4-4	Foam and Oil on the Surface of the Flow Stream.....	3-18
3.4-5	Small Pipes and Narrow Channels	3-18
4.1-1	High-Low Alarm Relay Box (Cover Removed)	4-2
4.1-2	Interconnection of Model 3010 and Alarm Boxes	4-3
4.1-3	Component Layout for the High-Low Alarm Relay Box.....	4-4
4.1-4	Schematic Diagram for the High-Low Alarm Relay Box	4-5
4.2-1	Model 2312 Plotter.....	4-6
4.3-1	Remote Totalizer	4-8
4.5-1	Quick-Disconnect Box.....	4-9
5.5-1	Component Layout for the Terminal Strip PCB.....	5-10
5.5-2	Schematic Diagram for the Terminal Strip PCB.....	5-11
5.5-3	Component Layout for the CPU Printed Circuit Board	5-11
5.5-4	Schematic Diagram for the CPU Printed Circuit Board	5-13
5.5-5	Component Layout for the Ultrasonic Printed Circuit Board	5-14
5.5-6	Schematic Diagram for the Ultrasonic Printed Circuit Board	5-15
5.5-7	Schematic Diagram for the Gate Array	5-16
5.5-8	Illustrations for the Replacement Parts List	5-17

LIST OF TABLES

Table No.	Title	Page No.
1.4-1	Controls, Indicators, and Wiring Terminals of the Model 3010 Flow Meter	1-6
1.5-1	Technical Specifications of the Model 3010 Flow Meter.....	1-7

MODEL 3010

2.3-1	Primary Measuring Devices	2-8
2.3-2	Equations Used in Model 3010 Built-In Flow Conversions.....	2-12
2.4.3-1	Values of N1 for Flow Rate in CFS	2-20
2.4.3.2	Values of N2 for Flow Rate in CFS	2-20
3.3-1	Hazardous Gases	3-7
5.6-1	Replacement Parts List.....	5-14
5.6-2	Accessory Parts List.....	5-19

MODEL 3010

MODEL 3010

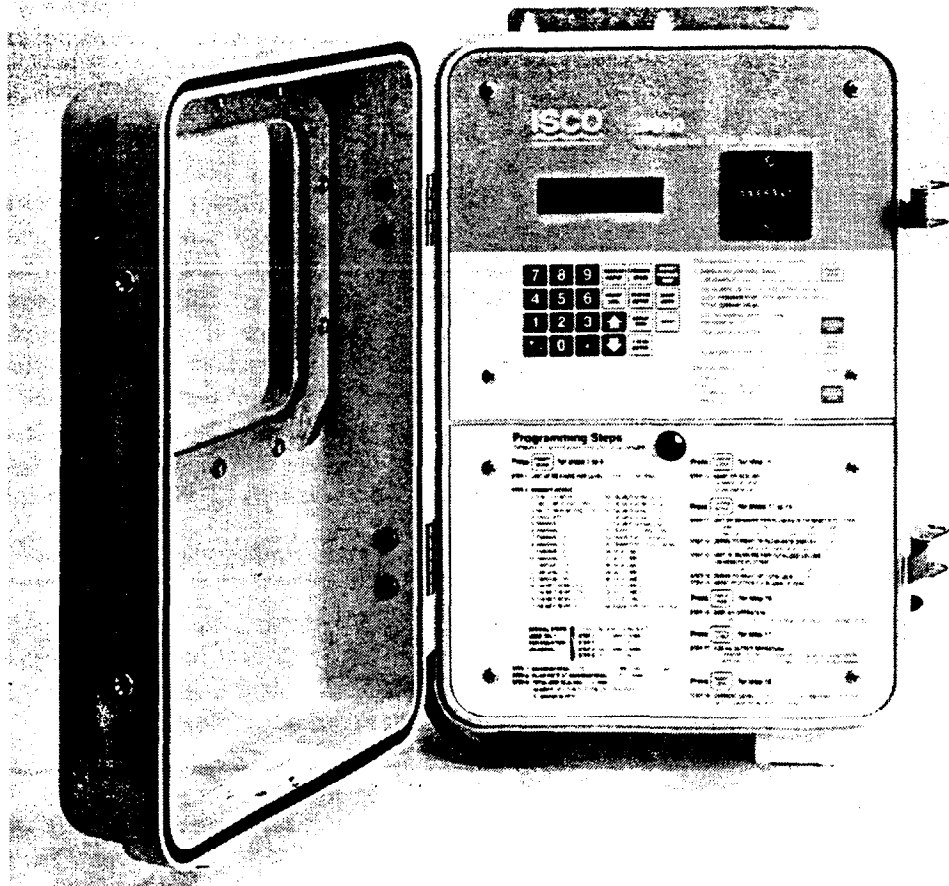
CHAPTER 1

1.0 INTRODUCTION - The first chapter of the Model 3010 Instruction Manual provides a general introduction to the flow transmitter. It includes a brief discussion of the organization of the manual, an overall description of the flow transmitter, and technical specifications.

1.1 Manual Organization - The purpose of this manual is to provide the information necessary to program, operate, maintain, and service the Model 3010 Flow Transmitter. To accomplish this, the manual is organized into five chapters. This first chapter is a general introduction to the flow transmitter. The second chapter contains information on operation, programming, and some examples of programming for specific objectives. The third chapter provides installation instructions. The fourth chapter describes available options and their use. The fifth chapter contains maintenance information and servicing tips to assist you in correcting problems that may occur.

1.2 Description - The Model 3010, shown in Figure 1.2-1, uses ultrasonic level measurement. You normally use the flow transmitter with some type of primary measuring device to measure flow rate in an open channel. The Model 3010 uses level-to-flow rate conversions derived from a stored equation, covering the majority of open channel flow measurement situations. If needed, you can enter the coefficients and powers of the flow equation. However, you can use most standard weirs and flumes without the need for the equation.

Figure 1.2-1 Model 3010 Flow Transmitter



MODEL 3010

You program the Model 3010 two different ways. Either select the number of a choice listed on the flow transmitter front panel label and enter that number on the keypad, or enter a numeric value for steps requesting that a value be selected from a given range. A 6-digit LCD (Liquid Crystal Display) prompts the you through setup, displays the choice for the current programming step, and displays level or flow rate. You can order the Model 3010 with an optional Characterization PROM (Programmable Read-Only Memory) containing customized flow curves for primary devices not supported by the standard unit. If you do not order the flow transmitter with the Characterization PROM and a particular installation requires custom programming, you must return the unit to the factory for modification. You will also have to return it to the factory if you need any subsequent changes made to the custom flow rate curves.

1.2.1 Interfacing Equipment - The Model 3010 Flow Transmitter will work with the following equipment:

Isco Manufactured

Models 2700, 2900, and 3700 Portable Sequential Samplers
Models 2710, 2910, and 3710 Portable Composite Samplers
Model 2700R, 2900R, and 3700R Refrigerated Sequential Sampler
Model 2710R, 2910R, and 3710R Refrigerated Composite Sampler
Model 2700FR and 3700FR Refrigerated Sequential Sampler
Model 2710FR and 3710FR Refrigerated Composite Sampler

Options and Accessories

Characterization PROM (Supports specific customer-selected primary measuring device.) Factory-installed only.

Resettable 7-digit mechanical flow totalizer. (A nonresettable flow totalizer is a standard feature of the Model 3010.)

High-Low Alarm Relay Box

Model 2410 Circular Chart Recorder

Model 2312 Plotter (Isco remote plotter)

Quick-Disconnect Box (*non-hazardous locations only*)

Ultrasonic Level Sensor Cable Clamp and Spreader Bar

Ultrasonic Mount, Calibration Target, Cable Stiffener, and Sunshade

Remote Totalizer

Flow Transmitter-to-Sampler Connect Cable

1.3 Description of the Model 3012 Ultrasonic Level Sensor - The Model 3012 Ultrasonic Level Sensor measures liquid level without contacting the flow stream. The level sensor consists of an ultrasonic transducer and associated electronics mounted in a housing, and a shielded cable that connects to the flow transmitter. This cable lets you suspend the level sensor by the cable alone over a flow stream in temporary installations. For permanent installations, a mounting bracket is available to attach the ultrasonic level sensor securely to the mounting surface. The level sensor is provided with a 50-foot cable (15.2 meters). For distances greater than 50 feet, *in non-hazardous installations only*, you may use the Quick-Disconnect Box (a type of splice box). The maximum distance between the flow transmitter and the level sensor is 1,000 feet (305 meters).

WARNING

For installation in *hazardous areas*, as defined by the National Electrical Code, refer to drawing 60-3403-175 and any applicable local codes. For cable lengths greater than 50 feet, consult the factory. The Quick-Disconnect Box is not approved for use in hazardous locations.

The Model 3012 Ultrasonic Level Sensor mounts over the flow stream, and periodically transmits an ultrasonic pulse to the surface of the stream. The water surface reflects the

MODEL 3010

echo of the pulse back from the stream to the level sensor. The elapsed time between pulse and return echo is proportional to the distance from the level sensor to the liquid surface. The Model 3010 uses this time/distance relationship and a referenced "zero" point in the flow stream to calculate liquid level. Then, by applying values specific for the primary device in use, the Model 3010 calculates flow rate from the measured level. The Model 3012 Ultrasonic Level Sensor has a temperature probe built into its housing to measure ambient air temperature. The Model 3010 uses this temperature measurement to compensate for inaccuracies in ultrasonic measurement caused by changes in the air temperature between the transducer and the flow stream.

"Setup" Step - The Model 3010 has a special feature to help you correctly align the ultrasonic level sensor. This "Setup" step, as it is called, lets you adjust the ultrasonic level sensor over the flow stream while an assistant watches the number appearing on the flow transmitter's display. As long as the number on the display is increasing, the sensor is approaching optimal alignment. When the highest reading appears on the display, the level sensor is in proper alignment. If you continue to adjust the level sensor, the number displayed will begin to fall, as you have gone past the optimal alignment.

Labels - The Model 3010 comes with a set of adhesive labels to permit the display and the mechanical totalizer to express greater values than the number of digits available on the display. Where extremely large flow volumes are involved, you can add trailing zeroes to the display to make more meaningful numbers. To provide a reference for your programming there are adhesive labels for units of measure you can attach to the flow transmitter.

1.4 Controls, Indicators, and Terminal Blocks - Table 1.4-1 lists the controls, indicators, and terminals for wiring to the Model 3010, and briefly describes their functions. Refer to Figure 1.4-1 for a view of the controls and indicators, and Figure 1.4-2 for a view of the terminal blocks.

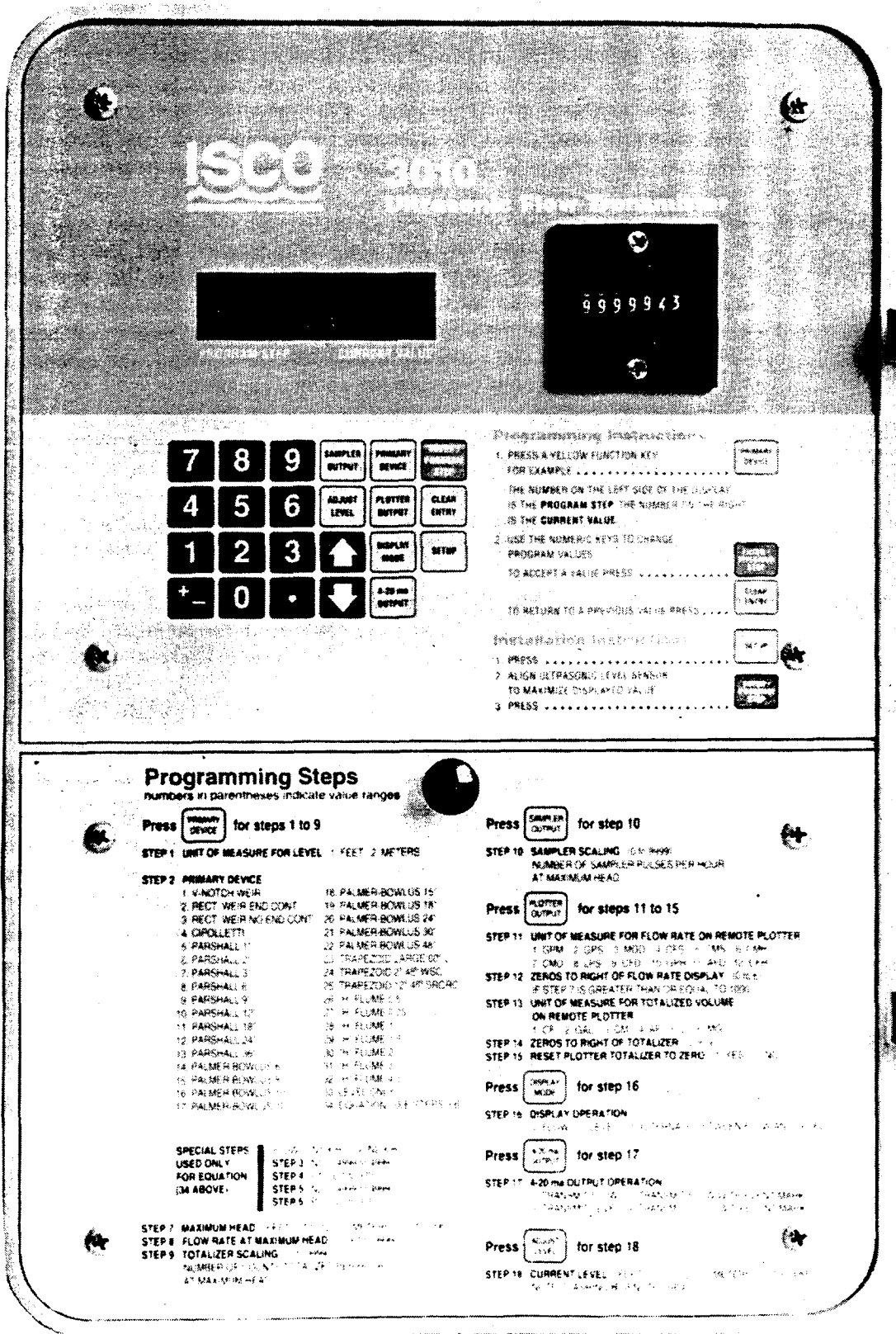
1.5 Technical Specifications - The technical specifications for the Model 3010 are listed in Table 1.5-1.

NOTE

Throughout this manual we describe various accessories available for the Model 3010 Flow Transmitter. We have listed the part numbers for all these items on an **Accessory Parts List**, that you will find at the back of the **Replacement Parts List**. You can obtain part numbers for other Isco equipment by calling the factory.

MODEL 3010

Figure 1.4-1 Model 3010 Front Panel



Programming Steps

Numbers in parentheses indicate value ranges

Press **PRIMARY DEVICE** for steps 1 to 9

STEP 1 UNIT OF MEASURE FOR LEVEL 1 FEET 2 METERS

STEP 2 PRIMARY DEVICE

- | | |
|---------------------------|--------------------------|
| 1 V-NOTCH WEIR | 18 PALMER-BOWLUS 15 |
| 2 RECT. WEIR END CONT. | 19 PALMER-BOWLUS 18 |
| 3 RECT. WEIR NO END CONT. | 20 PALMER-BOWLUS 24 |
| 4 CIPOLLETTI | 21 PALMER-BOWLUS 30 |
| 5 PARSHALL 1' | 22 PALMER-BOWLUS 48 |
| 6 PARSHALL 2' | 23 TRAPEZOID LARGE 00' |
| 7 PARSHALL 3' | 24 TRAPEZOID 2' 48" W/SO |
| 8 PARSHALL 6' | 25 TRAPEZOID 2' 48" S/SO |
| 9 PARSHALL 9' | 26 1" FLUME 0.5 |
| 10 PARSHALL 12' | 27 1" FLUME 1.0 |
| 11 PARSHALL 18' | 28 1" FLUME 1.5 |
| 12 PARSHALL 24' | 29 1" FLUME 2.0 |
| 13 PARSHALL 36' | 30 1" FLUME 3.0 |
| 14 PALMER-BOWLUS 6 | 31 1" FLUME 4.0 |
| 15 PALMER-BOWLUS 8 | 32 1" FLUME 5.0 |
| 16 PALMER-BOWLUS 10 | 33 1" FLUME 6.0 |
| 17 PALMER-BOWLUS 12 | 34 1" FLUME 7.0 |

SPECIAL STEPS USED ONLY FOR EQUATION (34 ABOVE)

STEP 3	1.0000	1.0000	1.0000
STEP 4	1.0000	1.0000	1.0000
STEP 5	1.0000	1.0000	1.0000
STEP 6	1.0000	1.0000	1.0000

STEP 7 MAXIMUM HEAD 1.0000

STEP 8 FLOW RATE AT MAXIMUM HEAD 1.0000

STEP 9 TOTALIZER SCALING NUMBER OF PULSES PER HOUR AT MAXIMUM HEAD

Press **SAMPLER OUTPUT** for step 10

STEP 10 SAMPLER SCALING 0.00000 NUMBER OF SAMPLER PULSES PER HOUR AT MAXIMUM HEAD

Press **PLOTTER OUTPUT** for steps 11 to 15

STEP 11 UNIT OF MEASURE FOR FLOW RATE ON REMOTE PLOTTER

- | | | | | | |
|-------|-------|-------|--------|--------|--------|
| 1 GPM | 2 GPM | 3 MGD | 4 CFS | 5 MS | 6 CMH |
| 7 CMH | 8 LPS | 9 USG | 10 MPH | 11 AND | 12 CMH |

STEP 12 ZEROS TO RIGHT OF FLOW RATE DISPLAY 0000

IF STEP 11 IS GREATER THAN OR EQUAL TO 0000

STEP 13 UNIT OF MEASURE FOR TOTALIZED VOLUME ON REMOTE PLOTTER

- | | | | | | |
|------|-------|-------|-------|-------|------|
| 1 CF | 2 GAL | 3 CAT | 4 ACP | 5 LBS | 6 MS |
|------|-------|-------|-------|-------|------|

STEP 14 ZEROS TO RIGHT OF TOTALIZER 0000

STEP 15 RESET PLOTTER TOTALIZER TO ZERO YES NO

Press **DISPLAY MODE** for step 16

STEP 16 DISPLAY OPERATION 0.0000

Press **4-20 mA OUTPUT** for step 17

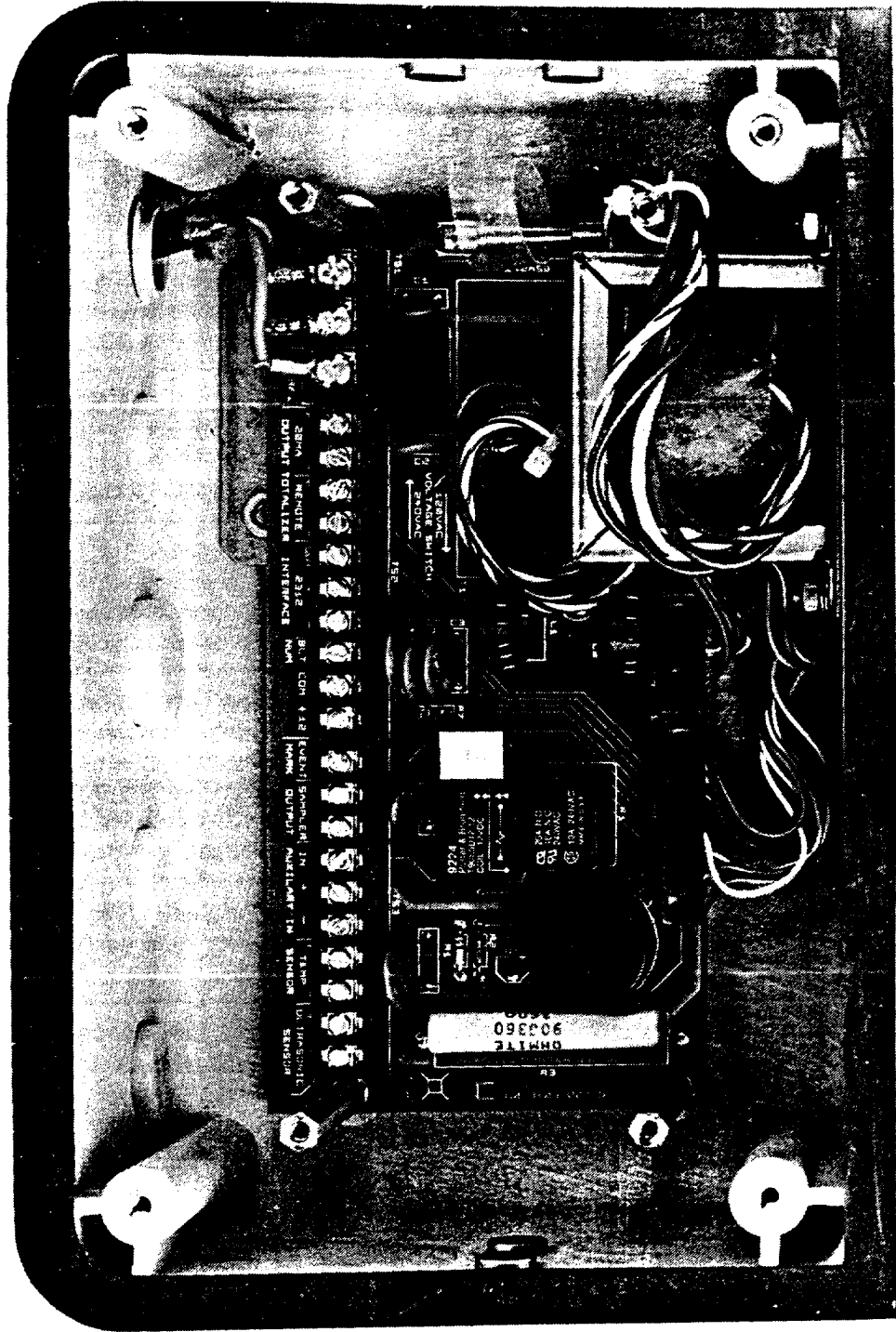
STEP 17 4-20 mA OUTPUT OPERATION 0.0000

Press **ADJUST LEVEL** for step 18

STEP 18 CURRENT LEVEL 0.0000

MODEL 3010

Figure 1.4-2 Inside View of Flow Transmitter, Showing Terminal Blocks



MODEL 3010

Table 1.4-1
 Controls, Indicators, and Wiring Terminals
 of the Model 3010 Flow Transmitter

CONTROLS	SETTINGS	FUNCTION
Keypad	None Specific	23 key, 6-column matrix - Program flow transmitter through keystrokes prompted by messages on the display. See Section 2.2.2.
INDICATORS	READING	FUNCTION
Display	Multifunction	6-digit, 7-segment liquid crystal display (LCD). Prompts you through program setup; displays current menu selections, displays level or flow rate. See Section 2.2.3.
TERMINALS	TYPE	FUNCTION
Power	3 # 8 screws on block TS1. <i>Large</i> Terminals 1, 2, & 3.	Connects 120 VAC power to flow transmitter. # 1 - Hot; # 2 - Ground; # 3 - Neutral
4-20 mA Output	2 # 6 screws on block TS2. Terminals 4 & 5.	Provides standard 4-20 mA current loop output (variable with level or flow rate) to be used to control compatible equipment such as a circular chart recorder or a chlorinator.
Remote Totalizer	2 # 6 screws on block TS2. Terminals 6 & 7.	Connects flow transmitter to external mechanical -type remote totalizer.
Model 2312 Interface	3 # 6 screws on block TS2. Terminals 8, 9, & 10.	Connects flow transmitter to Isco Model 2312 Plotter to provide hard copy printout of level or flow rate activity. Also drives alarm relay box.
Bottle Number	2 # 6 screws on block TS2. Terminals 11 & 12.	Provides Bottle Number input signal to flow transmitter from an Isco automatic wastewater sampler.
Event Mark	2 # 6 screws on TS2. Terminal 13 - + 12 VDC Terminal 14 - Event Mark	Provides Event Mark input signal to flow transmitter from an Isco sampler.
Sampler Output	2 # 6 screws on TS3 Terminal 15 - Sampler Terminal 16 - Dry Contact	Provides flow pulse from flow transmitter to flow pace an Isco sampler.
Ultrasonic Level Sensor & Temperature Sensor	4 # 6 screws on block TS3. Terminals 20, 21, 22, & 23.	Provides connection for ultrasonic level sensor and temperature sensor.

MODEL 3010

Table 1.5-1
 Technical Specifications of the Model 3010 Flow Transmitter

MODEL 3010 FLOW TRANSMITTER	
Size:	15 1/4" high × 10 5/8" wide × 7 3/8" deep. (38.7 cm high × 27 cm wide × 18.7 cm deep.)
Weight:	10 pounds (4.5 kg)
Material:	High-impact molded polystyrene structural foam.
Type:	Self-certified NEMA 4X Enclosure.
Power:	104-127 VAC, 0.075 amp, 50 to 60 Hz. <i>or</i> 210-260 VAC, 0.038 amp, 50 to 60 Hz. (See Chapter 3.)
Overcurrent protection:	1/2 amp. slow-blow fuse
Display type:	6-character, 7-segment, alphanumeric backlit liquid crystal.
Display modes:	Level, flow rate, and alternate between level and flow rate.
Built-in level-to-flow rate conversions:	Weirs: V-notch, Rectangular with and without end contractions, Cipolletti. Flumes: Parshall, Palmer-Bowlius, Trapezoidal, "H." Equation: Two-term power equation. Optional: Characterization PROM with any level-to-flow rate relationship.
Level-to-flow rate conversion accuracy:	1% full-scale
Sampler output:	Isolated contact closure, rated 1 amp at 48 VDC.
Sampler input:	Event marks, bottle numbers.
Analog output:	Isolated 4 – 20 mA into 0 to 1,000 ohms; level or flow rate, with or without sampler event marks. Accuracy: 1% of full-scale.
Serial data port:	Compatible with Isco Model 2312 Plotter and High-Low Alarm Relay Box.
Compatible Isco recording devices:	Model 2410 Circular Chart Recorder, Model 2312 Plotter.
Totalizer:	7-digit mechanical counter, non-resettable.
External totalizer output:	12 VDC pulse
Operating temperature:	-20°F to 140°F (-30°C to 60°C.)
Storage temperature:	-50°F to 150°F (-46°C to 66°C.)
Relative Humidity	0 - 100%

MODEL 3010

Table 1.5-1
 Technical Specifications of the Model 3010 Flow Transmitter (Continued)

MODEL 3012 ULTRASONIC LEVEL SENSOR							
Size:	3.6" diameter × 6.9" long (9.1 cm × 17.5 cm)						
Weight:	3 lb. (1362 g), plus cable weight, approx. 1 lb. (454 g) for 50 feet						
Cable diameter and length:	0.3" (1 cm) diameter, 50 feet (15.2 m)						
Maximum operating distance	1,000 feet between flow transmitter and ultrasonic level sensor using level sensor with 50-foot cable, 950-foot extension cable and Quick-Disconnect Box. <i>(Note: Not for hazardous locations.)</i>						
Level measurement method:	Ultrasonic level sensor mounted above the flow stream.						
Range - Minimum: Maximum:	2 feet (0.61 m) from sensor to liquid at 100% level. 12 feet (3.7 m) from sensor to liquid at minimum level.						
Span:	0 to 10 feet (0 to 3 m)						
Level resolution:	0.004 foot (0.12 cm)						
Level measurement accuracy: (At 72°F, [22°C] still air, and 40-70% relative humidity.)	<table border="0"> <tr> <td>Head (Level) Change*</td> <td>Maximum Error</td> </tr> <tr> <td>1.0 foot (0.31 m) or less:</td> <td>± 0.02 foot (± 0.006 m) at 72°F (22°C).</td> </tr> <tr> <td>1.0 to 10 feet (0.31-3.05 m):</td> <td>± 0.03 foot (± 0.009 m) at 72°F (22°C).</td> </tr> </table> <p>*Actual vertical distance between the sensor and the liquid surface.</p>	Head (Level) Change*	Maximum Error	1.0 foot (0.31 m) or less:	± 0.02 foot (± 0.006 m) at 72°F (22°C).	1.0 to 10 feet (0.31-3.05 m):	± 0.03 foot (± 0.009 m) at 72°F (22°C).
Head (Level) Change*	Maximum Error						
1.0 foot (0.31 m) or less:	± 0.02 foot (± 0.006 m) at 72°F (22°C).						
1.0 to 10 feet (0.31-3.05 m):	± 0.03 foot (± 0.009 m) at 72°F (22°C).						
Beam angle:	8 degrees.						
Operating temperature range (ambient):	-22°F to 140°F (-30°C to 60°C).						
Storage temperature range:	-40°F to 158°F (-40°C to 70°C).						
Compensated temperature range:	-22°F to 140°F (-30°C to 60°C).						
Max. temp. error within compensated range (per degree of temperature change):	$\pm 0.000085 \times D$ per °C } (Where "D" is the distance in feet from $\pm 0.000047 \times D$ per °F } the transducer to the liquid surface.)						
Optional:	Level sensor extension cable is available in custom lengths up to 950 feet (289 m). <i>NOTE:</i> Use the Quick-Disconnect Box to connect the level sensor with the extension cable. <i>(Non-hazardous locations only.)</i> See ultrasonic accessories. (Chapter 3.)						

MODEL 3010

CHAPTER 2

2.0 OPERATING PROCEDURES - This chapter of the manual tells how to program the flow transmitter. There are also sections on the operating theory, control and indicator descriptions, setup procedures, and programming examples.

2.1 Operating Theory - When measuring flow rate, the Model 3010 normally uses a primary measuring device (weir or flume) or other open channel flow arrangement, where a known relationship exists between level and flow rate. The level measuring device is an Ultrasonic Level Sensor that measures the liquid level in the flow stream. The flow transmitter electronically converts the level reading into a properly-scaled flow rate value. The flow transmitter also provides standard flow-related output signals to be used for:

- Flow-proportional sampler pacing.
- Recording flow-rate information on an external printer/plotter or circular chart recorder.
- Connection to a 4 - 20 mA compatible device.
- Tripping remote high and low alarm relays

The flow transmitter contains microprocessor-controlled circuitry to calculate level and flow rates from the signals produced by the level sensor. It stores programming instructions and operates the display. A backlit alphanumeric liquid crystal display (LCD) shows level and flow-rate information. The display also prompts programming of the flow transmitter during initial setup or subsequent changes. Auxiliary equipment used with the Model 3010 connects to the terminal blocks on the printed circuit board in the bottom section of the flow transmitter case.

2.1.1 Model 3012 Ultrasonic Level Sensor Theory and Applications - The Model 3012 Ultrasonic Level Sensor is mounted over the flow stream. It measures liquid level by emitting an ultrasonic pulse and then measuring the time it takes for the echo to return from the surface of the liquid. The Model 3012 Ultrasonic Level Sensor consists of an enclosure with a single transducer acting both as the pulse transmitter and the echo receiver. Since the speed of the pulse through the air varies with temperature, the level sensor has temperature compensation built in. A sensor mounted inside the enclosure measures the ambient air temperature. The microprocessor program automatically compensates for speed-of-sound changes caused by air temperature changes.

Transducer Operation - The Model 3012 Ultrasonic Level Sensor emits a strong ultrasonic pulse several times a second. After transmitting the pulse, the flow transmitter electronically switches the level sensor transducer into a receiver or microphone, ready to receive or hear the echo reflected back from the flow stream. The transducer converts the echo sound into a small pulse that the circuitry in the flow transmitter amplifies and detects to produce an "echo received" signal. The time between the transmitted pulse and received echo is proportional to the distance between the transducer and the surface of the stream. The flow transmitter uses this distance to determine the liquid level in the stream.

Validity Tests and Error Display - The flow transmitter subjects the measured level to several validity tests. If the unit cannot obtain a valid level, it repeats the process. Meanwhile, the last good level reading will continue to appear on the display. If, after approximately four minutes, the flow transmitter cannot obtain a valid reading, the Model 3010 will show EE 80 on the display. In such instances, it may be necessary to realign the level sensor or check the operation of the flow transmitter.

MODEL 3010

Ambient Air Temperature Factor - The Model 3010 uses an ultrasonic-distance measurement technique based on the speed of sound in air. Since the speed of sound in air varies with temperature (approximately 1% for 10°F variation), you must provide compensation. The level sensor uses the air temperature sensor and microprocessor-based compensation to accurately account for air temperature variations. See also Section 2.1.2.

Return Echo Amplifier Compensation - The signal strength of the returned echo depends on several factors including the distance from the transducer to the water surface. For every 2 1/2-foot increase in the distance between the transducer and the liquid surface, the strength of the returned echo decreases by half, so designers must compensate the gain of the return echo amplifier for distance. As the distance increases between the transducer and the liquid surface, the gain of the echo amplifier increases with time to compensate for the decreasing signal strength of the echo. This type of amplifier, whose gain characteristic is based on a repeating time interval, is referred to as a "ramp-gain" amplifier.

2.1.2 Error Factors Affecting Performance of the Ultrasonic System - Several external factors can influence both the initial pulse and reflected sound wave, causing the ultrasonic measurement system to produce errors. These factors fall broadly into two classes.

(1) **Velocity Errors** - These errors result when the flow transmitter is unable to accurately calculate the velocity of sound. Without going into the causes of these errors, we can say that they are "proportional" errors, in that the degree of error increases as the distance between the level sensor and the surface of the flow stream increases.

(2) **Echo Detection Errors** - These errors arise from problems the flow transmitter can have measuring the time between transmitting the ultrasonic pulse and receiving the echo. Anything that absorbs sound can cause these errors. This makes the echo amplifier detect the returned signal either earlier or later than intended in the design of the "ramp-gain" amplifier. Errors of this sort will generally be of an "absolute" nature; the distance between the transducer and the water will not affect them to any great extent.

Error Factors and Flow Transmitter Compensation - Following are specific factors affecting the accuracy of the Model 3010 with the measures used for compensation of the more significant factors.

Barometric Pressure - The velocity of sound is essentially independent of barometric pressure. Changes in barometric pressure provide no significant cause of error.

Beam Angle - The flow transmitter must only respond to surfaces within a specific area. The transducer can only "see" items inside a "cone" whose apex is the ultrasonic transducer. The beam angle is the angle across this cone. If the beam angle is too wide, the flow transmitter will detect unwanted surfaces, such as the walls of the channel. If the beam angle is too narrow, setup of the installation is difficult and the flow transmitter may never detect an echo.

Humidity - The velocity of sound varies only slightly with humidity (maximum 0.35% at 68°F). Because the effect is small, the Model 3010 does not provide compensation for humidity. Humidity, however, does have an effect on the reduction of the echo. Under extreme humidity conditions, the reduction of the sound wave may be inconsistent with the characteristics of the "ramp-gain" amplifier, causing an echo detection error.

Noise - Background noise can interfere with the operation of the flow transmitter. The unit must filter out this noise, or it may trigger on the noise rather than the returned echo. The Model 3010 uses a tuned circuit to filter out unwanted noise outside the operating frequency.

MODEL 3010

Noise in the operating frequency range (≈ 49 kHz) can render the system unstable. The unit uses software algorithms to eliminate most sporadic noise pulses occurring within the flow transmitter's operating frequency range.

Surface Objects - Objects or foam floating on the surface of the flow stream can absorb or weaken the ultrasonic pulse. If the foam or material reduce the pulses enough, the unit will lose the echo altogether. In less severe cases, there may be an echo detection error.

Temperature - The velocity of sound at a given temperature may be approximated by the following equation:

$$\text{Velocity} = 1050 \times \sqrt{[1 + (\text{Temperature} \div 459.67)]}$$

Where velocity is in feet per second and temperature is in degrees F.

Temperature changes have a significant effect on the velocity of sound (approximately 7% between 32°F and 104°F). This variable is significant enough to require compensation. Consequently, the Model 3010 provides temperature compensation. There is a temperature sensor embedded in the level sensor. However, the temperature of the level sensor and air may not be exactly the same, and the temperature sensor cannot measure temperature perfectly. As a result, the equations used to calculate the velocity of sound in air are approximations, including the equation shown above.

Waves - Waves or extreme turbulence on the surface of the flow stream can deflect the sound energy so it does not return to the transducer. Waves may also make the sound return to the transducer by an indirect path. In the first case, the flow transmitter will not receive an echo. In the second case, the additional time lapse will cause an echo error that will appear as an incorrect level reading. The Model 3010 has a software algorithm to reject occasional readings that deviate substantially from normal. However, if the waves are severe, the flow transmitter will not function and will indicate a "no echo" condition.

Wavelength - You can determine the wavelength of sound by dividing the velocity of the sound by the frequency. The frequency of the Model 3010 is about 49 kHz. You can find the length of a 49 kHz sound wave by dividing 1,125 feet /second by 49,000, which is 0.02296 feet or 0.276 inches.

Wave (Echo) Detect Error - Under ideal conditions the transducer can detect the same wave front of the returning echo. However, any noise or abnormal attenuation may cause some transducers to detect an earlier or a later wave. When the attenuation of the returned echo does not match the gain slope of the amplifier, the circuit will eventually detect a different cycle of the returned echo as the distance changes. The impact of this wave-detect error is determined by the wavelength.

Wind - Wind can blow the sound away or significantly reduce the intensity of the returned echo. Narrow beam angles, advantageous for measuring small flow streams, are a disadvantage in this situation. Likewise, greater distances to the surface of the flow stream are more affected by wind.

Substantial Effects Possible - You can readily see that some of these factors may have a significant impact on the accuracy of the Model 3010 Flow Transmitter. Plan and execute your installations with care. You can reduce the effects of these factors substantially by following the suggestions for ultrasonic level sensor installation found in Section 2.6.2.

2.2 Controls and Indicators - The controls of the Model 3010 Flow Transmitter are shown in Figure 1.4-1. The operation and use of the keypad are described in the following sections. You can only operate the keypad (to change the program) with the door open. You can view the LCD and totalizer through the window without opening the door.

MODEL 3010

2.2.1 Keypad Layout and Functions - The keypad is mounted in the Model 3010 front panel. The keypad has 23 keys arranged in six vertical columns. See **Figure 1.4-1**. The function of each key is as follows:

↓ (ARROW DOWN) - Use this key in the **LEVEL ADJUST** step of the program; you can use it in place of the number keys to decrease the level shown on the display.

↑ (ARROW UP) - Use this key with the display in the **LEVEL ADJUST** step of the program; you can use it instead of the number keys to increase the level shown on the display.

CLEAR ENTRY - This key lets you return to a previous entry of a program step. **NOTE:** Pressing the key twice in succession will exit you from the program.

. (**DECIMAL**) - Use this key with the number keys when entering numeric values into the program.

ENTER/PROGRAM STEP - Pressing this key will allow you to enter changes made to the program into memory. To access the program, first press one of the yellow **FUNCTION KEYS**. (See below.) Pressing one of the **FUNCTION KEYS** stops the program and allows you to make changes. After the you make the change and it appears on the display, pressing **ENTER/PROGRAM STEP** will enter the change into memory. It is also possible to step through the program retained in memory by pressing this key. The number of the program step will appear on the left side of the display and the number of the current selection (or value entered) will appear next to it.

NUMBER KEYS - Use the number keys to enter numeric values into the program. You can also use them to make a selection from the options displayed on the label.

+ /- (PLUS OR MINUS) - Use this key to enter positive or negative numbers when programming an equation.

FUNCTION KEYS - These keys let you enter the program of the Model 3010 at specific steps so you can change selections or numerical values. These keys govern specific programming steps, and will be described elsewhere. Refer to **Section 2.3.3** for the detailed descriptions of the **FUNCTION KEYS**.

2.2.2 Display - The flow transmitter display shows programming choices. After you complete programming and installation, the display shows the present flow rate and/or level. There are three operating modes for the display: level, flow rate, or an alternation between the two. You can see the display through the window when the door is closed. The display is a 6-digit, 7-segment liquid crystal. The letter **H** on the left side of the display indicates level (or **Head**). For better visibility in low light conditions, the LCD is lighted.

2.2.3 Power Failures - If there is a power failure, the LCD will blank and the flow transmitter will stop operating. Momentary power failures (less than three seconds) should not affect the operation of the unit, as power stored in the filters will provide some carryover for a brief period of time. However, if power is off long enough for the display to blank, flow pulses to the sampler will stop, as will the mechanical totalizer and the totalizer signal sent to the external plotter, which will be reset. The unit will not be able to recognize changes in level during the time power is off. However, memory will retain the program selections made during setup and when power is restored, you won't need to reprogram the flow transmitter.

2.3 Programming - The display helps program the Model 3010 Flow Transmitter. You enter program quantities and control certain functions through the keypad. The number of the selected entry appears on the display. The display also indicates operational status, and guides you through the programming sequence by showing the step programmed. Each time you press a key, the unit will beep.

MODEL 3010

Refer to Figure 2.3-1 for a flowchart showing programming. At the back of this manual is a worksheet on which you may write program selections.

2.3.1 Programming Overview - Remember that the flow transmitter always has a program in it, stored in memory, even if it is only the default program installed at the factory. To program the Model 3010, first select one of the yellow **FUNCTION KEYS** and press it. The display will show the step number on the left and the number of the choice currently selected (or the numerical value entered for steps requiring a value) on the right. You will not need to program all steps. For example, if there is no Model 2312 Remote Plotter, you would skip **Steps 11 to 15**, all involved with operation of the plotter.

The program steps are printed on the flow transmitter label, and normally programming proceeds in a logical manner, starting with **Step 1**, which sets level in feet or meters. **Step 2** selects the **primary measuring device**. Then you select **maximum head, flow rate at maximum head, and totalizer scaling**. If you aren't using any other equipment with the Model 3010, you need to program only **Step 16, DISPLAY OPERATION**, and **Step 18, LEVEL ADJUST**. If you are installing the unit for the first time, use the **SETUP KEY** to optimize transducer alignment. Then you use the level adjust step to calibrate the level sensor.

You only make selections in **Steps 10 through 15** and **Step 17** when the flow transmitter is connected with associated equipment. **Step 10** governs the relationship between the flow transmitter and a sampler. **Steps 11 - 15** control the output to an Isco High-Low Alarm Relay Box (a device to turn equipment on or off when flow reaches or falls below preset levels), or a Model 2312. The Model 2312 is an electromechanical printer that records level or flow information from the Model 3010 on a strip chart to provide a "hard copy" of information provided by the flow transmitter.

Step 17 determines the operation of the 4 - 20 mA current loop output. Examples of equipment that operate from the 4 - 20 mA current loop are the Isco Model 2410 Circular Chart Recorder and process equipment, such as a chlorinator.

After you have installed and programmed the flow transmitter the first time, it is not necessary to completely reprogram the unit to enter any changes. Instead, simply select the yellow **FUNCTION KEY** where you want to make a change and press **ENTER/PROGRAM STEP** until the desired step is reached; then enter the change.

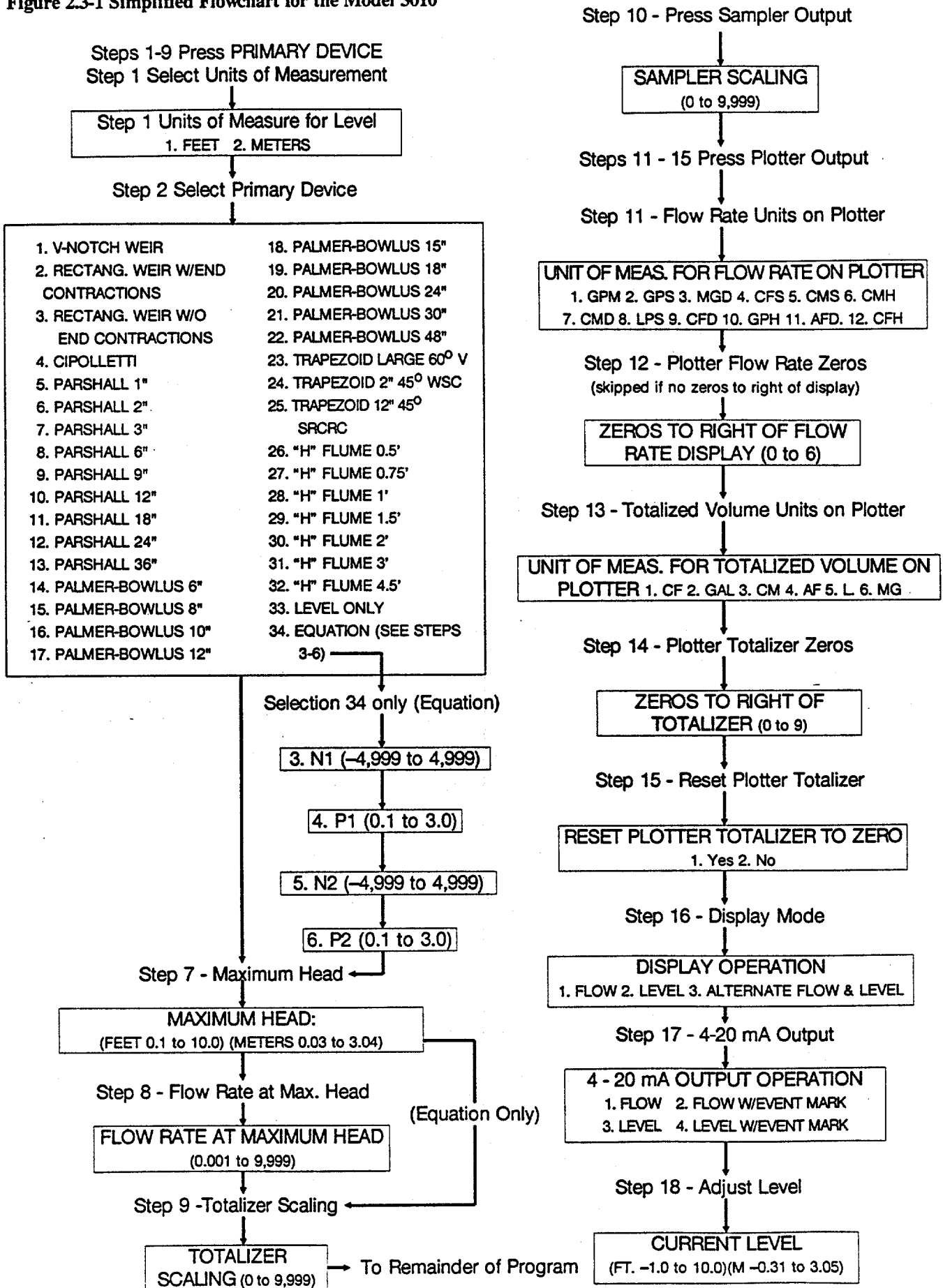
Automatic Program Advance - After you press **ENTER/PROGRAM STEP**, the display will automatically advance to the next step and show the current choice or value entered for that step; the process continues until you have made selections for all steps necessary to complete the step sequence you have selected, or you press the **CLEAR ENTRY** key twice to exit the program.

Note that you can do all programming for the Model 3010 in the shop, except for **SETUP** (concerned with sensor alignment) and the **ADJUST LEVEL** step, which you must do at the job site after completing the installation.

2.3.2 List of Program Steps - Following is a list of the program steps used in the Model 3010 along with the choices available or applicable range of values. After the list there is a detailed explanation of the purpose for each step and the choices offered.

1. Units of Measure for Level (Feet or Meters).
2. Primary Device (See list of devices on page 2-8 or refer to flow transmitter front panel label.)

Figure 2.3-1 Simplified Flowchart for the Model 3010



MODEL 3010

NOTE: Steps 3 to 6 are programmed only if # 34, Equation, is chosen in Step 2.

3. N1 (-4,999 to 4,999)
4. P1 (0.1 to 3.0)
5. N2 (-4,999 to 4,999)
6. P2 (0.1 to 3.0)

7. Maximum Head in — (0.1 to 12.0 Feet) (0.03 to 3.66 Meters)
8. Flow Rate at Maximum Head (0.001 to 9999)
9. Totalizer Scaling (Number of counts totalized per hour of flow at maximum head; 0-9,999.)

NOTE: Program step 10 only if the flow transmitter is connected to a sampler.

10. Sampler Scaling (Number of sampler pulses per hour at maximum head; 0-9,999.)

NOTE: Program steps 11 to 15 only if there is an Isco Model 2312 Plotter installed.

11. Unit of Measure for Flow Rate on Remote Plotter
 1. GPM 2. GPS 3. MGD 4. CFS 5. CMS 6. CMH
 7. CMD 8. LPS 9. CFD 10. GPH 11. AFD 12. CFH

12. Zeros to Right of Flow Rate Display (0 to 6) if value of Step 7 is ≥ 1000

13. Unit of Measure for Totalized Volume on Remote Plotter
 1. CF 2. GAL 3. CM 4. AF 5. L 6. MG

14. Zeros to Right of Totalizer (0 to 9)

15. Reset Plotter Totalizer to Zero (1. Yes 2. No)

16. Display Operation (1. Flow rate 2. Level 3. Alternate between the two)

NOTE: Program step 17 only if the Model 3010 controls other external process equipment which operates from the standard 4-20 mA current loop.

17. 4 - 20 mA Output Operation (level, flow rate, with or without event mark.)
 1. Transmit Flow Rate 2. Transmit Flow Rate with Event Mark
 3. Transmit Level 4. Transmit Level with Event Mark

18. Adjust Level - Current Level in: (Feet -1.0 to 12.5) (Meters -0.31 to 3.81)

2.3.3 Detailed Description of Programming Sequence - Following is an explanation for each of the program steps from the list above.

Step 1 - The first step determines whether the flow transmitter displays level in feet or meters.

Step 2 - In this step of the programming sequence, identify the primary measuring device used; then choose the number referring to that device from the list printed on the label or in the table on the next page. The Model 3010 supports 32 common primary measuring devices. If you wish to use the flow transmitter to measure level only, select # 33. If you want to use the general flow equation, select # 34, and continue as follows.

Steps 3 to 6 - These steps will only appear on the display and be used when you select # 34, Equation. These steps allow you to program the values N1, P1, N2, and P2 for the general flow equation:

$$Q (\text{flow rate}) = K \times (N1 \times H^{P1} + N2 \times H^{P2})$$

(See Section 2.4.3 for a detailed discussion about the equation.) With any choice but # 34 in Step 2, the program advances automatically to Step 7.

MODEL 3010

Table 2.3-1
Primary Measuring Devices

1. V-NOTCH WEIR	20. PALMER-BOWLUS 24"
2. RECTANG. WEIR W/END CONTRACTIONS	21. PALMER-BOWLUS 30"
3. RECTANG. WEIR NO END CONTRACTIONS	22. PALMER-BOWLUS 48"
4. CIPOLLETTI WEIR	23. TRAPEZOID LARGE 60° V
5. PARSHALL 1"	24. TRAPEZOID 2" 45° WSC
6. PARSHALL 2"	25. TRAPEZOID 12" 45° SRCRC
7. PARSHALL 3"	26. "H" FLUME 0.5'
8. PARSHALL 6"	27. "H" FLUME 0.75'
9. PARSHALL 9"	28. "H" FLUME 1'
10. PARSHALL 12"	29. "H" FLUME 1.5'
11. PARSHALL 18"	30. "H" FLUME 2'
12. PARSHALL 24"	31. "H" FLUME 3'
13. PARSHALL 36"	32. "H" FLUME 4.5'
14. PALMER-BOWLUS 6"	33. LEVEL ONLY
15. PALMER-BOWLUS 8"	34. EQUATION (SEE STEPS 3-6)
16. PALMER-BOWLUS 10"	35. CHARACTERIZATION PROM (this
17. PALMER-BOWLUS 12"	PROM is optional and will not appear on
18. PALMER-BOWLUS 15"	your machine unless you have ordered it
19. PALMER-BOWLUS 18"	with the flow transmitter. See Chapter 4.

Step 7 - MAXIMUM HEAD - The Model 3010 will request entry of a value for MAXIMUM HEAD. The display will show the value already in memory. You can enter possible values from 0.1 to 10 feet (0.31 to 3.04 meters). Note that you should always select a value for maximum head that is reasonable for your particular application, rather than the maximum value allowable, as the *accuracy* of the level-to-flow rate conversion is based on this value.

Step 8 - Step 8 requests entry of flow rate at maximum head. Values range from of 0.001 to 9999. Remember to base the flow rate at maximum head on the value for maximum head you entered in Step 7, rather than the maximum head allowable for the device. This information is available from the manufacturer of the primary measuring device used. The information is also available from tables published for specific devices in the *Isco Open Channel Flow Measurement Handbook*.

If the value you enter is greater than 9,999, round it off and reduce it to a number the display can show. For example, 32,537 GPM is greater than the four digits available on the display. So, first you round the number to 32,540 and then enter the four most significant digits into the flow transmitter: 3 - 2 - 5 - 4. To show the overflow from the display, attach a "0" label to the right of the display to indicate the value displayed is in tens of gallons rather than gallons. Finally, attach a units of measurement label for the appropriate units, in this case, "GPM."

Note also that if the installation includes a Model 2312 Plotter, enter the same flow rate units in Step 11 and the same number of zeroes in Step 12. For the example just given of 32,537 GPM, you would enter 1 (GPM) in Step 11 and 1 in Step 12.

Step 9 - In Step 9, the flow transmitter will ask for scaling for the flow totalizer. This is the number of counts on the totalizer per hour of flow at maximum head. The value entered ranges from 0 to 9,999. Note that the selection of the number of counts per hour is based on flow at maximum head, so the actual number of counts per hour may be much lower. Note also that if your installation includes a Model 2312 Plotter, the units of measure selected for this step will also be entered for the Model 2312 in Step 13 and the number of zeroes in Step 14. For example, if you want to totalize in cubic feet and the flow rate at maximum head is 72.5 CFS:

$$72.5 \text{ CFS} \times 60 \text{ sec./min.} \times 60 \text{ min./hr.} = 261,000 \text{ cubic feet per hour (CFH)}$$

MODEL 3010

For this example, let's make each count on the totalizer equal to 1,000 cubic feet.

$$261,000 \text{ CFH} + 1,000 \text{ CF/count} = 261 \text{ counts per hour}$$

You would then enter 2 - 6 - 1 for this step. In this instance you would place three "0" labels and the CF label to the right of the display. If the Model 3010 is connected to a Model 2312, you would then enter 1 (CF) in Step 13 and 3 in Step 14.

Step 10 - In Step 10, the flow transmitter requests selection of sampler scaling (flow pulses to the sampler). You don't need to program this step unless the Model 3010 is being used with a sampler. The purpose of this program step is to provide signals to the sampler to run its own program. The range is from 0 to 9,999 pulses per hour. Determine this number the same way as in Step 9, previously. Note that selection of the number of flow pulses to the sampler per hour is based on *flow rate at maximum head*, so the actual number of pulses per hour will probably be considerably lower. Determine the number chosen by the volume of flow that must pass through the primary device before a sample is taken, rather than a particular interval of time.

For example, assume the flow rate at maximum head for a particular installation is 32,540 GPM.

$$32,540 \text{ GPM} \times 60 \text{ min./hr.} = 1,952,400 \text{ gallons per hour (GPH)}$$

We want to send a flow pulse to the associated sampler every 10,000 gallons.

$$1,952,400 \text{ GPH} \div 10,000 \text{ gallons per pulse} = 195 \text{ pulses per hour.}$$

You would then enter 1 - 9 - 5. If you programmed the associated sampler to take a sample every 50 pulses, it will take a sample every 500,000 gallons.

$$10,000 \text{ gallons per pulse} \times 50 \text{ pulses per sample} = 500,000 \text{ gallons per sample}$$

If you programmed the sampler to take a sample every 200 pulses, it will take a sample every 2,000,000 gallons.

$$10,000 \text{ gallons per pulse} \times 200 \text{ pulses per sample} = 2 \text{ million gallons per sample}$$

Steps 11 to 15 - Plotter Output - You only need to program these steps if your installation includes an Isco Model 2312 Plotter. Selections made in Steps 11 - 15 determine the operation of the Model 2312. The selections made here *do not affect* operation of the Model 3010. However, you should choose values consistent with the choices you made for earlier steps.

Step 11 - Units of Measure for Flow Rate on Remote Plotter - There are several selections for units of measure available here. The selection you make will be the units printed out on the chart of the Model 2312 Plotter. You should select the same units you selected for Step 8.

Step 12 - Zeros to the Right of the Flow Rate Display (0 to 6) - Program this step with the number of zeroes overflowing the display from the value entered in Step 8. Note that the remote plotter displays flow rate with scientific notation. For example, a plotter display of 5.57E+ 3 would equal 5.57×10^3 , which is the same as $5.57 \times 1,000$ and that would be 5,570. Consequently, in this case there is no need to add labels to the plotter display.

Step 13 - Units of Measure for Totalized Volume on Remote Plotter - Again, selection is dependent on the units of measure you selected for a previous step, in this case, Step 9.

Step 14 - Zeros to Right of Totalizer (0 to 9) - This step allows you to add the correct number of trailing zeros to the plotter's totalizer to make meaningful numbers from large flow rates.

MODEL 3010

The number you select is the same as the number of zeroes overflowing the display in Step 9. Again, these are actually expressed on the plotter's display in terms of scientific notation, so there is no need to add stickers to the plotter's display.

Step 15 - Reset Plotter Totalizer to Zero - This step allows you the option of resetting the totalizer on the remote plotter. It does not affect the mechanical totalizer on the Model 3010. An example of where you might use this is for studies of flow over specific periods of time. It might be convenient to reset the flow totalizer between each study. This is a user/application-determined option. *Note that the totalizer is reset whenever power is turned off.*

Step 16 - Display Operation - This step lets you choose the method of display most useful for your particular application. Choose between displaying 1. Flow Rate or 2. Level, or select 3. Alternate which will cause the display to switch between level and flow rate. This step defines the display when the flow transmitter is in normal operation. The appearance of the letter H on the left side of the display designates level (or Head).

Step 17 4 -20 mA Output Operation - This step determines how associated external equipment connected to the Model 3010 through the 4-20 mA current loop will operate. The selection of 1. Flow Rate and 3. Level are user/application specified. The selections of 2. Flow Rate with Event Mark and 4. Level with Event Mark are *specifically intended for use only* with the Isco Model 2410 Circular Chart Recorder to indicate on the chart that an associated wastewater sampler has taken a sample.

CAUTION

Do not transmit level or flow rate with event marks to any external equipment other than a circular- or strip-chart recorder. Transmission of event marks causes momentary jumps of the 4 - 20 mA loop current to 100% (full-scale) operation. This will cause erratic operation of some process control equipment and could possibly have hazardous consequences with certain equipment.

This output, a variable DC current of 4 - 20 mA, changes with the level or flow rate measured by the Model 3010: 4 mA = 0% flow or 0 level; 20 mA = 100% flow rate, full-scale, or maximum head. The 4 - 20 mA current output is a standard industrial control format. It provides an analog (variable) signal to associated process equipment that must respond to the changing conditions measured by the flow transmitter. The operation of such equipment is like a lamp controlled by a dimmer. You can make the lamp can burn at many levels of brightness between fully off and fully on. Compare this with equipment that is either fully on or off.

Step 18 - Adjust Level - This step allows you to adjust the measured level for the Model 3010. Acceptable values range from -1 to 12.5 feet (-0.304 to 3.81 meters). There are various ways to calibrate the level sensor after you have installed it, depending on the primary device used. Make your measurement from the zero (level) point of the primary device to the surface of the flow stream very carefully, to determine the level in the flow stream. Commonly, you would use a measuring staff. Then enter this level into the Model 3010 by adjusting the displayed level with the up and down arrow keys, or by entering the desired value with the numeric keys. The flashing letter H denotes head (level).

NOTE

If the flow transmitter shows a negative level or flow rate during initial setup and displays codes with EE on the left side of the display, adjust the level (Step 18) to a positive value and then make the entries necessary for selecting a primary device. This should stabilize the display.

MODEL 3010

The SETUP STEP - This feature helps align the level sensor. For proper operation you must place the sensor so the echo comes only from the liquid surface and not from the sides or walls of the channel. To use the **SETUP** feature, you install the level sensor and have it operating. There need not be an echo, as "0" will be displayed. After you select this step, a value will appear on the screen if there is an echo. If no number appears, first try to align the level sensor to the point where a number does appear. The higher the number is, the better the alignment. Adjust the level sensor until the highest reading appears on the display.

2.3.4 Equations Used in Flow Conversion - The equations used for flow conversions in the Model 3010 Flow Transmitter are in Table 2.3-2. Note that the equations provided for primary devices with data-only flow conversions (Palmer-Bowlus, "H" and Trapezoidal flumes), are approximations that fit the manufacturer's data within 1% of full-scale. If you want to use level-to-flow rate conversions other than those built in, select # 34, equation in Step 2. Section 2.4.3 has a discussion of the use of the general flow equation (Q [flow rate] = $K \times (N1 \times H^{P1} + N2 \times H^{P2})$) that is followed by two programming examples, including a rectangular weir with end contractions. If you encounter an unusual situation, such as a compound weir, you could consider the *Characterization PROM Option* (see Chapter 4).

NOTE

Programming the Model 3010 with the general flow equation is rather complicated. Please do not attempt programming with the equation without first studying the explanation and examples presented in Section 2.4.3.

2.3.5 "Default" Program - Program the flow transmitter with selections appropriate for your particular installation. When Isco ships the flow transmitter, there is already a "default" program in memory, used to test the unit. This is only an "example" program to allow testing of the unit as it is manufactured. It is not intended to fit any particular application.

2.4 Programming Examples - In the following sections are examples showing the keystrokes necessary to program the Model 3010 for specific applications. When programming the flow transmitter, note that the number on the left side of the display is the **PROGRAM STEP**, while the number on the right is the value currently held in memory.

2.4.1 Programming for a Parshall Flume - In this example, we will program the Model 3010 to select a 6-inch Parshall flume with a maximum head of 1.5 feet. Flow rate will be displayed in GPM. The flow rate at maximum head in GPM is 1754 GPM. You can either get this value from the flume manufacturer or you can find it in the *Isco Open Channel Flow Measurement Handbook*. We want the totalizer to totalize in gallons, and the 4 - 20 mA output to transmit level with 100% equal to 1.5 feet. Assume that the level is 0.75 feet. Attach the "GPM" sticker to the right of the display.

Calculations for Example 1: The totalizer will read out in gallons. To find the flow per hour at maximum head, multiply the flow in GPM by 60 (1754 gallons per minute \times 60 minutes per hour = 105,240 gallons per hour). The totalizer scaling value can only be a value from 0 to 9,999. Since 105,240 is larger than 9,999, we divide by 100 (105,240 \div 100 = 1,052).

1. Press the **PRIMARY DEVICE** key.

2. Select units of measure for level. To select feet, press 1.

The display will show:



Then press the **ENTER/PROGRAM STEP** key.

MODEL 3010

Table 2.3-2

Equations Used in Model 3010

Built-in Level-to-Flow Rate Conversions

Note: Q = flow rate in units (CFS, GPM, MGD, etc.)

K = constant specific for each device and for the units of measure selected

H = head in feet

Type and # of Device	Flow Equation	Type and # of Device	Flow Equation		
1.V-Notch Weir	$Q = KH^{2.5}$	14-22. Palmer-Bowlus Flume*	$Q = KH^{1.9**}$ $Q = KH^{1.9}$ $Q = KH^{1.9}$ $Q = KH^{1.9}$ $Q = KH^{1.9}$ $Q = KH^{1.9}$ $Q = KH^{1.9}$ $Q = KH^{1.9}$ $Q = KH^{1.9}$ $Q = KH^{1.9}$		
2.Rectangular Weir With End Contractions	$Q = K(1.034H^{1.5} - 0.034H^{2.5})$ (See Section 2.4.3)			14. 6"	
3. Rectangular Weir Without End Contractions	$Q = KH^{1.5}$			15. 8"	
4. Cipoletti Weir	$Q = KH^{1.5}$			16. 10"	
5-13. Parshall Flume	$Q = KH^{1.55}$ $Q = KH^{1.55}$ $Q = KH^{1.55}$ $Q = KH^{1.58}$ $Q = KH^{1.53}$ $Q = KH^{1.52}$ $Q = KH^{1.53}$ $Q = KH^{1.53}$ $Q = KH^{1.54}$	23-25. Trapezoidal Flume*	$Q = KH^{2.58**}$ $Q = KH^{2.32}$ $Q = KH^{2.29}$		
				5. 1"	23. Large 60° V
				6. 2"	24. 2" 45° WSC
		7. 3"		25. 12" 45° SRCRC	
		8. 6"		26.-32. "H" Flume	$Q = KH^{2.31**}$ $Q = KH^{2.31}$ $Q = KH^{2.31}$ $Q = KH^{2.31}$ $Q = KH^{2.31}$ $Q = KH^{2.31}$ $Q = KH^{2.31}$ $Q = KH^{2.31}$
		9. 9"	26. 0.5'		
		10. 12"	27. 0.75'		
		11. 18"	28. 1.0'		
		12. 24"	29. 1.5'		
		13. 36"	30. 2.0'		
	31. 3.0'				
	32. 4.5'				

*Palmer-Bowlus and Trapezoidal Flumes manufactured by Plasti-Fab, Tualatin, Oregon.

**Flow Equations for Palmer-Bowlus, "H," and Trapezoidal Flumes are approximations that fit data within 1% of full-scale flow rate.

3. Select the primary device from the list shown on the front panel. To select a 6-inch Parshall Flume, press 8.

The display will show:

2 8

Then press the ENTER/PROGRAM STEP key.

4. Enter the maximum expected head in feet. For this example, press 1 - . (decimal) - 5.

The display will show:

7 1.5

Then press the ENTER/PROGRAM STEP key.

5. Enter the flow at maximum head, 1754 GPM. Press 1 - 7 - 5 - 4.

The display will show:

8 1754

Then press the ENTER/PROGRAM STEP key. Place the "GPM" label to the right of the display.

MODEL 3010

6. To enter the totalizer scaling, calculated above, press 1 - 0 - 5 - 2.

The display will show:

9 1052

Then press the ENTER/PROGRAM STEP key. The totalized flow in gallons would be the totalizer value \times 100, so attach two "0" labels and the "GAL" label to the right of the display.

The display will show:

XXXX (flow rate)

7. Press the DISPLAY OPERATION key to set the display. Press 1.

The display will show:

16 1

Then press the ENTER/PROGRAM STEP key.

The display will show:

XXXX (flow rate)

8. Press the 4-20 MA OUTPUT key to select the information to transmit. For this example, we want to transmit level. To select "transmit level," press 3.

The display will show:

17 3

Then press the ENTER/PROGRAM STEP key.

The display will show:

XXXX (flow rate)

9. Press the ADJUST LEVEL key to set the current level in feet. To set the liquid level or head to 0.75 feet, press . (decimal) - 7 - 5.

The display will show:

H .75 (the "H" will flash.)

Then press the ENTER/PROGRAM STEP key.

The display will show:

XXXX (flow rate)

2.4.2 Programming for a Cipolletti Weir - In this example we will go through the programming steps necessary to select a 10-foot Cipolletti weir with a maximum head of 2 feet. Flow rate will be displayed in GPM. The flow rate at maximum head, found in the *Isco Open Channel Flow Measurement Handbook*, is 42,740 GPM. The totalizer will totalize in cubic feet and a flow pulse will go to the sampler every 1,000 gallons. The plotter output will transmit flow rate units of GPM and flow units of cubic feet. The display will alternate between level and flow rate. Set up the 4-20 mA output to transmit flow rate with event marks, with 100% equal to flow rate at maximum head. Assume the level, measured with a staff gauge or other measuring device, to be 1.5 feet.

Calculations for Example 2: The flow rate at maximum head, 42,740 GPM, is larger than four digits. Divide by 10 so that flow rate at maximum head is less than 9,999. The value entered into the Model 3010 will then be only 4 digits long ($42,740 \div 10 = 4,274$). Place a "0" label and the "GPM" label to the right of the display.

For this example, we will program the totalizer to read out in cubic feet. To do this find the total flow per hour at maximum head. The flow rate at maximum head in CFS is 95.23 CFS. $95.23 \text{ CFS} \times 60 \text{ seconds per minute} \times 60 \text{ minutes per hour} = 342,828 \text{ cubic feet per hour (CFH)}$.

MODEL 3010

The number you enter into the Model 3010, to totalize in cubic feet, would be 3,428 ($342,828 \div 100 = 3,428$) which is the above result rounded to 4 digits. Place 2 "0" labels and the "CF" label to the right of the totalizer. The flow transmitter will send a flow pulse to the sampler every 1,000 gallons. First, we must find the flow per hour of flow rate at maximum head, which is $42,740 \text{ GPM} \times 60 \text{ minutes per hour} = 2,564,400$ gallons per hour (GPH). We want to send a flow pulse to the sampler every 1,000 gallons. So we take $2,564,400 \text{ gallons per hour} \div 1,000 \text{ gallons per flow pulse} = 2,564$ flow pulses per hour. If you have programmed the sampler to take a sample every 5,000 pulses, the sampler will take a sample every 5 million gallons. ($1,000 \text{ gallons per pulse} \times 5,000 \text{ pulses per sample} = 5 \text{ million gallons per sample}$.)

1. Press the PRIMARY DEVICE key.
2. Select units of measure for level. To select feet, press 1.

The display will show: / /

Then press the ENTER/PROGRAM STEP key.

3. Select the correct primary device from the list shown on the front panel. To select a Cipolletti weir, press 4.

The display will show: 2 4

Then press the ENTER/PROGRAM STEP key.

4. Enter the maximum head in feet that you expect to see at the primary measuring device. For this example, the maximum head is 2 feet. Press 2.

The display will show: 7 2

Then press the ENTER/PROGRAM STEP key.

5. Enter the flow rate at maximum head. The value for this is 4274, so press 4 - 2 - 7 - 4.

The display will show: 8 4274

Then press the ENTER/PROGRAM STEP key. The flow rate will be the value shown on the display times 10. Place a "0" label and the "GPM" label to the right of the display.

6. Enter the totalizer scaling. To totalize the flow in cubic feet, enter 3 - 4 - 2 - 8.

The display will show: 9 3428

Then press the ENTER/PROGRAM STEP key. The totalized flow in cubic feet will be the totalizer value $\times 100$. Place 2 "0" labels and the "CF" label to the right of the totalizer.

The display will show: XXXX (flow rate)

7. Press the SAMPLER OUTPUT key to program sampler pacing. To enter the number calculated above, press 2 - 5 - 6 - 4.

MODEL 3010

7. Press the **SAMPLER OUTPUT** key to program sampler pacing. To enter the number calculated above, press 2 - 5 - 6 - 4.

The display will show:

10 2564

Then press the **ENTER/PROGRAM STEP**.

The display will show:

XXXX

(flow rate)

8. Press the **PLOTTER OUTPUT** key to set up the output for the Model 2312 Plotter. The first requirement is to select the units of flow rate displayed on the plotter. Press 1 to select **GPM**.

The display will show:

11 1

Then press the **ENTER/PROGRAM STEP** key.

9. Enter the number of zeros to the right of the display for flow. Since the maximum flow rate was 4,274 in tens of gallons per minute and the actual flow was 42,740 GPM, there is 1 zero to the right of the display. Press 1.

The display will show:

12 1

Then press the **ENTER/PROGRAM STEP** key.

10. The unit of measure for totalized flow was cubic feet, selection 1 on the front panel; press 1.

The display will show:

13 1

Then press the **ENTER/PROGRAM STEP** key.

11. Totalized flow in Step 9 was hundreds of cubic feet. Since hundreds would have two zeros to the right of the totalizer, press 2.

The display will show:

14 2

Then press the **ENTER/PROGRAM STEP** key.

12. To reset the totalizer on the remote plotter (Model 2312) to 0, press 1.

The display will show:

15 1

Then press the **ENTER/PROGRAM STEP** key.

The display will show:

XXXX

(flow rate)

13. Press the **DISPLAY MODE** key. To alternate between level and flow rate, press 3.

The display will show:

16 3

Then press the **ENTER/PROGRAM STEP** key.

The display will show:

XXXX

(flow rate)

MODEL 3010

14. Press the 4-20 MA OUTPUT key to select the information transmitted.

To transmit flow rate with event mark, press 2.

The display will show: 17 2

Then press the ENTER/PROGRAM STEP key.

The display will show: XXXX (flow rate)

15. Press the ADJUST LEVEL key to set the current level in feet. To set the liquid level to 1.5 feet press 1 - . (decimal) - 5.

The display will show: H 1.5 (the H will flash).

Then press the ENTER/PROGRAM STEP key.

The display will show: XXXX (flow rate)

2.4.3 Programming with the Equation (Device # 34) - You use the equation to calculate flow in applications where you cannot use the standard devices provided with the Model 3010. You can also use the special equation for *rectangular weirs with end contractions* if you need a more accurate level-to-flow rate conversion than the one programmed into the Model 3010. When designing the Model 3010, we selected the coefficients of the flow equation for rectangular weirs with end contractions to have a crest-to-maximum-head ratio of 2.5 to 1 (crest length divided by maximum head equals 2.5).

This ratio provides an equation equal to the programmable equation in the flow transmitter only when this ratio (2.5 to 1) is met. However, it is within 2% of full flow accuracy for crest-to-maximum-head ratios of 2 to 10. If you need greater accuracy than this, then you must select # 34, the equation. (See Section 2.4.3.2)

You program the equation into the Model 3010 in the general form:

$$Q = N1(H^{P1}) + N2(H^{P2})$$

Where: Q = flow rate

N1, N2 = constants for the programmed equation

H = normalized head = actual head in feet ÷ maximum head in feet

P1, P2 = exponents

Your own specific equation will begin in the form:

$$Q = n1(h^{P1}) + n2(h^{P2})$$

Where: Q = flow rate

n1, n2 = constants for your equation

h = actual head in feet

P1, P2 = exponents

To convert your equation into the one that you will program into the Model 3010, you must calculate the constants N1 and N2:

$$N1 = n1(H_{max}^{P1})$$

$$N2 = n2(H_{max}^{P2})$$

Where: H_{max} = maximum head in feet

MODEL 3010

Note that $N1 + N2 =$ flow rate at maximum head.

The following example involves programming the Model 3010 with an equation.

2.4.3.1 Programming Example Using an Equation - The flow transmitter installation has a device whose level-to-flow rate conversion follows the equation:

$$\text{Flow} = 4.3 \times \text{level}^{2.5} + 0.6 \times \text{level}^{1.3} \text{ GPS}$$

The maximum head is 2.5 feet. Flow rate will be displayed in GPS. The totalizer will totalize in gallons. We want to set the display to alternate between level and flow rate. We will assume the level is 0.75 feet.

From the equation, we can see that:

$$\begin{aligned} n1 &= 4.3 \\ P1 &= 2.5 \\ n2 &= 0.6 \\ P2 &= 1.3 \end{aligned}$$

We also know that $H_{\max} = 2.5$.

We must calculate $N1$ and $N2$.

$$\begin{aligned} N1 &= n1(H_{\max}^{P1}) = 4.3(2.5^{2.5}) = 4.3(9.88) = 42.49 \\ N2 &= n2(H_{\max}^{P2}) = 0.6(2.5^{1.3}) = 0.6(3.29) = 1.97 \end{aligned}$$

Therefore, the values programmed into the Model 3010 are:

$$\begin{aligned} N1 &= 42.49 \\ P1 &= 2.5 \\ N2 &= 1.97 \\ P2 &= 1.3 \end{aligned}$$

These values correspond to the equation

$$Q = 42.49H^{2.5} + 1.97H^{1.3} \text{ GPS}$$

Flow rate at maximum head is $N1 + N2 = 42.49 + 1.97 = 44.46 \text{ GPS}$

Place the "GPS" label to the right of the display.

To totalize in gallons, find the flow at maximum head in gallons per hour, which is $44.46 \text{ GPS} \times 60 \text{ seconds per minute} \times 60 \text{ minutes per hour} = 160,056 \text{ gallons per hour (GPH)}$. To make each count on the totalizer equal to 1000 gallons, divide 160,056 GPH by 1,000 ($160,056 \text{ GPH} \div 1,000 \text{ gallons per count} = 160 \text{ counts per hour}$). The result, 160, is the value you enter into the Model 3010. Place 3 "0" labels and the "GAL" label to the right of the totalizer.

1. Press the **PRIMARY DEVICE** key.
2. Select units of measure for level. To select feet, press 1.

The display will show:



Then press the **ENTER/PROGRAM STEP** key.

MODEL 3010

3. Select entry of an equation (# 34) from the list of primary devices shown on the front panel; press 3 - 4.

The display will show:

2 34

Then press the ENTER/PROGRAM STEP key.

4. To enter the value for N1, press 4 - 2 - . (decimal) - 4 - 9.

The display will show:

3 42.49

Then press the ENTER/PROGRAM STEP key.

5. To enter the value for P1, press 2 - . (decimal) - 5.

The display will show:

4 2.5

Then press the ENTER/PROGRAM STEP key.

6. To enter the value for N2, press 1 - . (decimal) - 9 - 7.

The display will show:

5 1.97

Then press the ENTER/PROGRAM STEP key.

7. To enter the value for P2, press 1 - . (decimal) - 3.

The display will show:

6 1.3

Place the "GPS" label to the right of the display.
Then press the ENTER/PROGRAM STEP key.

8. To enter the maximum expected head for the above equation, press 2 - . (decimal) - 5.

The display will show:

7 2.5

Then press the ENTER/PROGRAM STEP key.

9. To program the totalizer, enter the constant calculated above by pressing 1 - 6 - 0.

The display will show:

9 160

Then press the ENTER/PROGRAM STEP key. The totalizer will now totalize in thousands of gallons. Place 3 "0" labels and the "GAL" label to the right of the totalizer.

The display will show:

XXXX

(flow rate)

10. Press the DISPLAY MODE key and press 3 to set the display to alternate between flow rate and level.

The display will show:

16 3

Then press the ENTER/PROGRAM STEP key.

MODEL 3010

The display will show:

XXXX

(flow rate)

11. Next press the ADJUST LEVEL key. Enter the value for the head by pressing . - 7 - 5.

The display will show:

H .75

Then press the ENTER/PROGRAM STEP key.

The display will show:

XXXX

(flow rate)

2.4.3.2 Rectangular Weirs with End Contractions - The level-to-flow rate conversion for rectangular weirs with end contractions is:

$$Q = 3.33(L - 0.2h)h^{1.5} \text{CFS}$$

Where: Q = flow rate in CFS

h = actual head in feet

L = length of the crest of the weir in feet

The coefficients of the standard flow rate equation for the rectangular weir with end contractions, in primary device # 2, are for a crest-to-maximum head ratio of 2.5 to 1 (crest length ÷ maximum head = 2.5). If you need greater accuracy than this, you should use the special equation. This equation is of the general form:

$$Q = N1(H^{P1}) + N2(H^{P2})$$

Where: Q = flow rate

N1, N2 = constants

H = normalized head = actual head in feet / maximum head in feet

P1, P2 = exponents

To change the level-to-flow rate conversion for a rectangular weir with end contractions into an equation that you can program into the 3010, you must calculate the constants N1 and N2:

$$N1 = 3.33(L)(H_{max}^{1.5})$$

$$N2 = 3.33(-0.2)(H_{max}^{2.5})$$

Where: L = length of the crest of the weir in feet

Hmax = maximum head in feet

Note that N1 + N2 = flow rate at maximum head

Note that if you want to use a different flow rate than CFS, you must convert these values from CFS to the desired units of measure.

For example, consider a 4-foot rectangular weir with end contractions and a maximum head of 2 feet. For flow rate in CFS, the values for N1 and N2 would be:

$$N1 = 3.33(4)(2^{1.5}) = 37.67$$

$$N2 = 3.33(-0.2)(2^{2.5}) = -3.767$$

For a rectangular weir with end contractions, always use:

$$P1 = 1.5$$

$$P2 = 2.5$$

MODEL 3010

Table 2.4.3-1
Values of N1 for Flow Rate in CFS

Max. Head (H _{max})	Crest Length in Feet									
	1.00	1.50	2.00	2.500	3.00	4.00	5.00	6.00	8.00	10.00
0.50	1.177	1.766	2.355	2.943	3.532	4.709	5.887	7.064	9.419	11.77
0.75		3.244	4.326	5.407	6.489	8.652	10.81	12.98	17.30	21.63
1.00			6.660	8.325	9.990	13.32	16.65	19.98	26.64	33.30
1.25				11.63	13.96	18.62	23.27	27.92	37.23	46.54
1.50					18.35	24.47	30.59	36.71	48.94	61.18
2.00						37.67	47.09	56.51	75.35	94.19
2.50							65.81	78.98	105.3	131.6
3.00								103.8	138.4	173.0
4.00									213.1	266.4
5.00										372.3

Table 2.4.3-2
Values of N2 for Flow Rate in CFS

H _{max}	0.50	0.75	1.00	1.25	1.50	2.00	2.50	3.00	4.00	5.00
N2	-0.118	-0.324	-0.666	-1.163	-1.835	-3.767	-6.581	-10.38	-21.31	-37.23

Therefore, you would program the following equation into the flow transmitter for a 4-foot rectangular weir with end contractions and a maximum head of 1 foot:

$$Q = 37.67(H^{1.5}) - 3.767(H^{2.5}) \text{ CFS}$$

For your convenience, we have provided the values for N1 and N2 for various crest lengths and maximum heads in Tables 2.4.3-1 and 2.4.3-2. Note that these values are for flow rates in CFS. Again, if a flow rate other than CFS is desired, it is necessary to convert these values from CFS to the desired units of measure.

2.4.3.3 Programming Example for a Rectangular Weir with End Contractions - The following example shows how to enter an equation (# 34) for a rectangular weir with end contractions. This example uses a 6-foot rectangular weir with end contractions with a maximum head of 2 feet. We will display flow rate in GPM. We will totalize flow in cubic feet. Assume that the level is 0.75 feet.

Calculations for example 4: From the tables above, find the values for N1 and N2 for a rectangular weir with end contractions with a 6-foot crest length and maximum head of 2 feet:

$$\begin{aligned} N1 &= 56.51 \\ N2 &= -3.767 \end{aligned}$$

MODEL 3010

For a rectangular weir with end contractions, always use:

$$\begin{aligned} P1 &= 1.5 \\ P2 &= 2.5 \end{aligned}$$

Because these values are in CFS, we must convert from CFS to GPM by multiplying by 448.8.

$$\begin{aligned} N1 &= 56.51 \times 448.8 = 25,362 \\ N2 &= -3.767(448.8) = -1,691 \end{aligned}$$

Because N1 and N2 must be in the range of -4,999 to 4,999, we must divide both these numbers by 10.

$$\begin{aligned} N1 &= 25,362 \div 10 = 2,536 \\ N2 &= -1691 \div 10 = -169 \end{aligned}$$

Therefore, we have:

$$\begin{aligned} N1 &= 2,536 \\ P1 &= 1.5 \\ N2 &= -169 \\ P2 &= 2.5 \end{aligned}$$

Note that flow rate at maximum head is:

$$\begin{aligned} N1 + N2 &= 56.51 - 3.767 = 52.74 \text{ CFS or} \\ N1 + N2 &= 25,362 - 1691 = 23,672 \text{ GPM} \end{aligned}$$

Place a "0" label and the "GPM" label to the right of the display.

To totalize in cubic feet, we must first calculate the total flow per hour of flow rate at maximum head. $52.74 \text{ CFS} \times 60 \text{ seconds per minute} \times 60 \text{ minutes per hour} = 189,864$ cubic feet per hour (CFH). For each count on the totalizer to be equal to 1,000 cubic feet, divide by 1,000. Consequently, $189,864 \text{ CFH} \div 1,000 \text{ cubic feet per count} = 190$ counts per hour (rounded off). Enter 190 for the totalizer scaling. Place 3 "0" labels and the "GAL" label to the right of the totalizer.

1. Press the PRIMARY DEVICE key.

2. Select units of measure for level. To select feet, press 1.

The display will show:

| |

Then press the ENTER/PROGRAM STEP key.

3. Select entry of a user equation from the list of primary devices shown on the front panel. Press 3 - 4.

The display will show:

2 34

Then press the ENTER/PROGRAM STEP key.

4. To enter the value for N1, press 2 - 5 - 3 - 6.

The display will show:

3 2536

Then press the ENTER/PROGRAM STEP key.

5. To enter the value for $P1$, press 1 - . - 5.

MODEL 3010

The display will show:

4 1.5

Then press the ENTER/PROGRAM STEP key.

6. To enter the value for N2, press +/- - 1 - 6 - 9.

The display will show:

5 -169

Then press the ENTER/PROGRAM STEP key.

7. To enter the value for P2, press 2 - . - 5.

The display will show:

6 2.5

Place one "0" label and the "GPM" label to the right of the display.
Then press the ENTER/PROGRAM STEP key.

8. To enter the maximum head, press 2.

The display will show:

7 2

Then press the ENTER/PROGRAM STEP key.

9. To program the totalizer in thousands of cubic feet, enter 190. Press 1 - 9 - 0.

The display will show:

9 190

Place 3 "0" labels and the "GAL" label to the right of the totalizer.
Then press the ENTER/PROGRAM STEP key.

The display will show:

XXXX

(flow rate)

10. Press the DISPLAY MODE key and press 1 to display flow rate.

The display will show:

16 1

Then press the ENTER/PROGRAM STEP key.

The display will show:

XXXX

(flow rate)

11. Press the ADJUST LEVEL key to set the current level in feet. Press . - 7 - 5.

The display will show:

H .75

(the H will flash.)

Then press the ENTER/PROGRAM STEP key.

The display will show:

XXXX

(flow rate)

MODEL 3010

CHAPTER 3

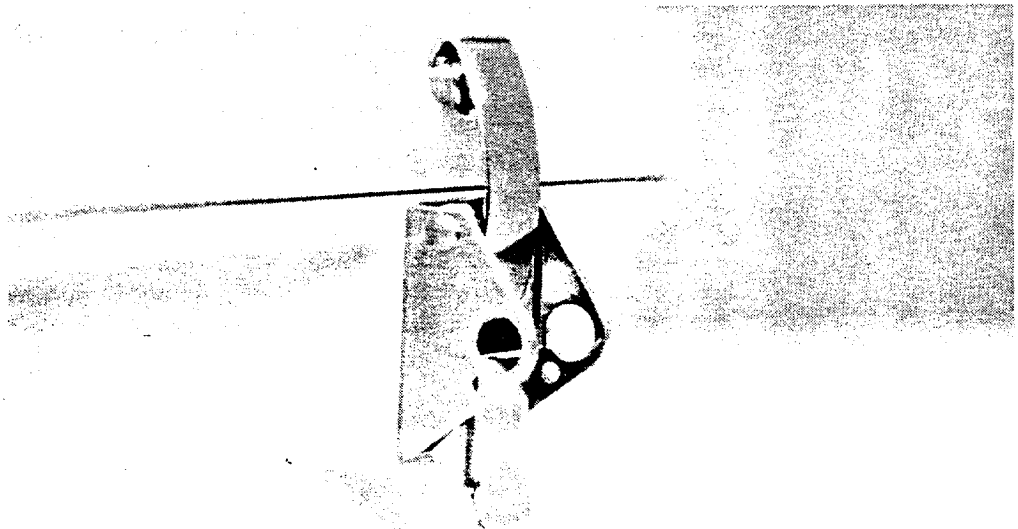
3.0 INSTALLATION AND WIRING - This chapter provides information on installing the Model 3010 Flow Transmitter, the Model 3012 Ultrasonic Level Sensor, and describes connection of a Model 3010 to a sampler.

3.1 General Comments on Installation - You can use the Model 3010 for portable or temporary installations. However, you will generally make your installation permanent, as you must connect the unit to a commercial power source. You can install the flow transmitter either inside or out, but inside installation is preferable, particularly in areas with extremes of heat, cold, or moisture. The flow transmitter is housed in a strong weather-resistant plastic case, but you should avoid installation where the case will be exposed to full sunlight. This is particularly true in warm climates, where it is important to prevent overheating the electronic components. (The flow transmitter contains heaters to help maintain proper operating temperatures for the electronics in severely cold weather.)

Avoid Possibility of Submersion and Installation in Unsecured Locations - The flow transmitter has a seal on the door, and operation in wet environments is permissible, but *never* install the unit where there is any possibility of submersion. This is not only bad for the Model 3010, but there is also the possibility of electric shock from the presence of AC power inside the unit. Always try to locate outside installations in relatively secure areas to minimize the possibility of tampering or vandalism. Keep the case closed, latched, and locked, except when programming, wiring, or servicing. See Figure 3.1-1 for a picture of the Model 3010 latches.

Location of the Flow Transmitter - Because it uses an ultrasonic level sensor, the Model 3010 does not have to be mounted directly above the primary device, or even close to the flow stream. You can install the flow transmitter at a convenient, protected location and run the cable to the level sensor. For example, if you mount the level sensor in a manhole, you can mount the unit above the surface of the ground for protection and easy accessibility. Then you will need to enter the manhole only once, for level sensor installation and calibration. Install the Model 3010 Flow Transmitter and the Model 3012 Ultrasonic Level Sensor no further apart than 1,000 feet (304.8 meters).

Figure 3.1-1 View of Case Latch, Showing Lock Shackle



MODEL 3010

Portable Operation - You can use the Model 3010 for temporary monitoring of a flow stream, limited by the 1,000 foot distance to the transducer and by the ready availability of AC power for the flow transmitter. For portable use, attach a 6-foot. (or longer) 3-wire AC power cord to the large power input terminals on the left side of the unit (TS1). Connect Line (black or brown wire) to TS1-1, Ground (green or green/yellow wire) to TS1-2, and Neutral (white or blue wire) to TS1-3. Use *Stahlin* fittings (see Section 3.2) to seal the line cord and level sensor cable and provide strain-relief where they enter the case. This lets you plug the unit into an electrical outlet like any appliance. Use of a line cord and wall receptacle is *not recommended* for permanent installations, both for safety and reliability. Even if you use the flow transmitter as a portable instrument, you should make the installation carefully, always considering the safety of any personnel working in the area. *Do not* run cables so they cause people to trip, or are at risk of damage by machinery.

3.2 General Wiring Comments - The following sections tell how to wire the Model 3010 to the level sensor and other equipment. Additional wiring information (for accessories) is located in Chapter 4. There are various types of wire used with the Model 3010. In some instances, you can use your own cable; in others, such as the level sensor, use only Isco-supplied cable. When we describe a particular cable, match this cable and stay within the given limits. In installations where there are serious problems with electrical noise, some maximum distances may not be possible, especially for data lines. Local codes vary widely; some jurisdictions require all wiring in conduit; others, only the AC connection. Make all non-conduit connections to the Model 3010 with watertight fittings.

Mounting and Wiring - The Model 3010 has a stainless mounting plate on the back to attach the case to a wall. Use hardware suitable for the surface where you mount the unit. There are 3 - $\frac{3}{8}$ " holes 3 inches apart. Since the holes are slotted, you can hang the case over $\frac{3}{16}$ " hardware, or if you want a more secure mounting, screw $\frac{5}{16}$ " hardware directly through the holes. The bottom of the case has five holes threaded for either conduit fittings or, if code permits, *Stahlin fittings*. These fittings (available from Isco) are threaded plastic compression bushings that permit watertight cable entry into an enclosure. Use these fittings if you don't wire the unit with conduit. Four of the holes in the bottom of the flow transmitter cabinet are threaded for $\frac{1}{2}$ " conduit, and the remaining hole accepts $\frac{3}{4}$ " conduit. Use **conduit clamps** to support the conduit; do not rely on the cabinet to support the weight of the conduit. The Model 3010 Flow Transmitter is an AC-powered device intended for permanent connection to the line; install it in accordance with all applicable codes.

NOTE

The Model 3012 Ultrasonic Level Sensor that is used with the Model 3010 Flow Transmitter is *approved* by Factory Mutual (FM) for use in "hazardous locations" as defined by the National Electrical Code. However, you *must* make the installation according to control drawing 60-3403-175.

Isco ships this drawing with each Model 3010, or you can request a copy. We cannot include the drawing in this manual because it is a Factory Mutual-controlled document, whereas this manual is not. The Model 3010 Flow Transmitter is *not* approved for use in hazardous locations; the cabinet is not "X-proof" (explosion-proof) and some of the components inside are capable of producing arcs. You *must* install the Model 3010 *outside* the hazardous area, in compliance with the National Electrical Code or local codes, whichever authority has jurisdiction. See also page 3-5.

3.2.1 Connection to a Power Source - The Model 3010 requires a 120- or 240-volt, 50-60 Hz alternating current power input. Isco recommends connecting the Model 3010 to *its own separate branch circuit* in the main breaker panel or local branch panel. Mark the breaker as to its use. A separate cutoff switch next to the main panel, clearly labeled, is even better.

MODEL 3010

In any case, connect the flow transmitter to the commercial power supply so no one can accidentally turn it off or have it shut down by the failure of other equipment connected to the same circuit. A 15 ampere breaker is sufficient. *Do not* attach the flow transmitter to a circuit that already has other equipment on it. *Do not* connect the Model 3010 to a circuit controlled by an unrestricted ordinary wall switch.

Voltage Selector Switch - A slide switch above TS1 selects 120- or 240-volt operation. *Make sure this switch is in the right position for the available voltage.* If the switch is in the wrong position either the fuse will blow or inadequate voltage will prevent the flow transmitter from operating correctly. Connect Black (or whatever color serves as hot) to Terminal 1 (Hot), Ground to Terminal 2 (Ground), and White (neutral) to Terminal 3 (Neutral) of TS1.

WARNING

Hazard of electrocution! - You can be killed if you accidentally contact the AC power supplied to the Model 3010. Do not attempt to wire the Model 3010 "live" nor perform any work on the unit with power connected and the protective covers removed.

Be careful working around the terminals where the AC comes in, especially if the flow transmitter is in a wet area. Turn off the breaker or cutoff switch if you need to change the wiring, replace the fuse, or do any other service function requiring removal of the covers. *Do not* introduce power cords or the Model 3010 into any environment where there may be flammable liquids or explosive vapors as part of the flow stream. Sparks made during testing or servicing could ignite the fumes, causing fire or an explosion.

3.2.2 Wiring the Model 3012 Ultrasonic Level Sensor - (Instructions on the physical installation of the level sensor are found in Section 3.4; this section covers the wiring only.) You can connect the ultrasonic level sensor two different ways—with the Quick-Disconnect Box or, within 50 feet of the flow transmitter, by wiring the level sensor directly to the Model 3010.

Optional Quick-Disconnect Box and Extension Cables (*Non-hazardous installations only*) - If the distance between the level sensor and the flow transmitter exceeds 50 feet, Isco offers extension cable and a Quick-Disconnect Box. This device is a plastic junction box with a cover and terminal strip. It serves as a splice box between the level sensor and an extension cable. The extension cable then runs to the Model 3010. Custom-length extension cables are available from Isco. Lengths of as much as 950 feet (289 meters) are available as a special order. Use only Isco-supplied cable. Other types may not work. Consult the factory for details. Inside the Quick-Disconnect Box, connect each wire of the level sensor cable to the matching wires of the extension cable, using the terminal block. The maximum recommended distance is 1,000 feet (305 meters). Greater distances than this can cause electrical problems, specifically that the echo signal drops too low for the flow transmitter to detect and process, particularly when the air is cold.

Preparing the Cable - If you are unfamiliar with shielded-type cables used for electronic signals, read this section carefully. The transducer cable is different from ordinary signal cable. It contains a braided shield wire around the inside conductors. If it is necessary to cut the cable to size or strip the ends, do so very carefully to avoid nicking the insulation or damaging the shield. The plastic outer jacket should be stripped back about 1 1/2 inches. This will expose enough wire to connect to the terminals without risk of short-circuiting them. Use a knife to score the outer jacket; then bend the end of the wire in your hand to break the jacket on the score line. Do not cut completely through the jacket or you may damage the inner conductors. Pull off the jacket; you will see the braided shield. Push it back with your fingers. You will see a bare stranded wire and a layer of foil around several insulated conductors. Cut off the braided shield, but leave the drain wire.

MODEL 3010

Peel and remove the foil layer from the inner wires. You should now see red, orange, gray, and violet wires and also a pair covered with blue foil and cellophane. Remove the foil and cellophane from this last pair and you will find a blue, black, and another bare stranded drain wire. Twist this bare wire together with the bare wire exposed earlier. Then strip the black wire and twist it together with the two drain wires. You can cut off the red and violet wires. They are unnecessary in this application.

Connecting the Level Sensor Cable - The transducer cable attaches to the last four terminals on the far right side of the flow meter terminal strip board (TS3). They are labeled **TEMP. SENSOR + -** and **ULTRASONIC SENSOR + -**. Connect the cable from the level sensor (or disconnect box) as follows:

ORANGE	TEMP. SENSOR +	TS3
GRAY	TEMP. SENSOR -	TS3
BLUE	ULTRASONIC SENSOR +	TS3
BLACK & SHIELD	ULTRASONIC SENSOR -	TS3

The signals consist of a DC level on the temperature sensor and approximately 450 volts RMS on the ultrasonic transducer. While this voltage is quite high, there is no shock hazard, as the current is low and the frequency is well above the range of perceptibility by the human nervous system. This signal is somewhat difficult to characterize in power terms, as it consists of short bursts of 48 kHz energy, followed by an echo, followed by a period of no voltage, and repeated several times a second. Whether you install the wiring in conduit depends on codes and the needs of the application. Do *not* pull the cable through conduits already containing AC or any other type of wiring.

WARNING

Installations made in "hazardous locations" (as defined by the National Electrical Code) require the use of conduit for sensor wiring. The Model 3010 must be installed *outside* the hazardous area. Refer to drawing # 60-3403-175 for details on installation in hazardous locations. Also consult local codes.

3.2.3 Connection to an Isco Sampler - The Model 3010 can control a sampler in a flow-proportional sampling mode. Flow-proportional sampling means that the 3010 signals the sampler after a specific flow volume has passed, rather than after a period of time. In this way, the sampler and flow transmitter are able to compensate for varying flow rates. The flow transmitter works with any of the Isco Samplers listed in Section 1.2.1. If you use the Model 3010 with an Isco sampler in a flow-proportional sampling system, you must connect them together. The flow transmitter sends and receives signals from the sampler. You can connect an Isco sampler and the flow transmitter together two different ways.

Sampler Located Within 25 Feet - If an Isco sampler is less than 25 feet from the Model 3010, a 25-foot connect cable is available from Isco that has wire terminations on one end and a 6-pin M/S Connector on the other. The M/S connector is plugged into the sampler and the wire terminations are attached to the appropriate terminals of the Model 3010. There are 5 wires in the cable. Connection of the wires to the Model 3010 is as follows:

RED	(no connection)	—
BLACK	COM	TS2
BROWN	SAMPLER OUTPUT	TS3
GREEN	BTL NUM	TS3
WHITE	EVENT MARK	TS3

Important! - Connect a jumper wire from + 12 on TS2 to the *remaining* SAMPLER OUTPUT terminal on TS3. (This is necessary to complete the circuit for the flow pulses to an Isco Sampler.)

MODEL 3010

Sampler Located Further Than 25 Feet - For distances between the flow meter and sampler greater than 25 feet, Isco has a kit consisting of a 6-pin M/S connector that attaches to a field-supplied cable. Follow the instructions supplied with the kit to attach the connector to your cable. The connector plugs into the sampler. Wire the cable to the flow transmitter terminals as above. Your cable should meet the following specifications:

- 4 wire, # 18 AWG minimum conductor size
- 1000 feet maximum length
- Sheathed cable suggested for nonconduit installations (to protect the wires.)

If the wire colors are the same as described for the Isco-supplied cable above, the following order of connection to the M/S connector in the kit is recommended:

BLACK	Pin B	COMMON
BROWN	Pin C	FLOW PULSE
GREEN	Pin D	BOTTLE NUMBER
WHITE	Pin E	EVENT MARK

Don't forget to add the jumper between + 12 on TS2 and the *unused* SAMPLER OUT terminal. If the wire colors are different than those of the Isco connect cable, it will be your responsibility to see that the connections to the pins on the M/S connector for the sampler connect to the correct terminals in the Model 3010 Flow Transmitter.

3.2.4 Connection to a Non-Isco Sampler - You can connect the Model 3010 to a non-Isco sampler. Most samplers of other manufacturers require a different flow-proportional signal from Isco samplers, usually an isolated contact closure. The SAMPLER OUTPUT terminals on TS3 provide an isolated contact closure rated for up to 1 Ampere at 48 VDC. Wire the sampler and flow transmitter according to the instructions in the sampler manual.

Connection to Other Equipment - There are other options and accessories which may be used with the Model 3010 Flow Transmitter. Among these devices are:

- Remote Totalizer
- Model 2312 Remote Plotter
- Model 2410 Circular Chart Recorder
- High/Low Alarm Box

Information on these options and accessories and their use is provided in Chapter 4.

3.3 Safety Considerations - While you will generally install the Model 3010 Flow Transmitter above ground in relatively safe environments, you may have to locate the level sensor in a sewer or manhole. Before attempting installation of the level sensor in such a hazardous location, please review the following safety information carefully.

In field installations of Model 3010 Flow Transmitters and associated equipment, the safety of the personnel involved should be the foremost consideration. No project is so important or deadline so critical as to justify the risk of human life. The following sections provide safety procedures for working in and around manholes and sewers. The first section offers general safety advice; the second section deals with the special problem of poisonous gases found in sewers.

WARNING

The Model 3010 Flow Transmitter is not approved for use in "hazardous locations" as defined by the National Electrical Code. The Model 3012 Ultrasonic Level Sensor *is* approved for use in "hazardous locations" when installed in accordance with control drawing 60-3403-175. Note that you must always mount the Model 3010 *outside* the hazardous area.

CAUTION

Before any flow transmitter is installed, the proper safety precautions must be taken. The following discussions of safety procedures are only general guidelines. Each situation in which you install a flow transmitter varies. You must take into account the individual circumstances you are in. Additional safety procedures, other than those discussed here, may be required.

3.3.1 General Safety Procedures - The following procedures are those used by Black & Veatch, a respected consulting firm, and are published here by their kind permission.

"Field personnel must keep safety uppermost in their minds at all times. When working above ground, rules of common sense and safety prevail. However, when entering manholes, strict safety procedures must be observed. Failure to do so could jeopardize not only your own life, but also the lives of other crew members.

"1. Hazards. There are many hazards connected with entering manholes. Some of the most common hazards are:

"Adverse Atmosphere. The manhole may contain flammable or poisonous gases or the atmosphere may be deficient in oxygen. Forced ventilation may be necessary.

"Deteriorated Rungs. Manhole steps may be corroded and not strong enough to support a man. It may be difficult to inspect the rungs because of poor lighting.

"Traffic. Whenever manholes are located in the traveled way, barricades and warning devices are essential to direct traffic away from an open manhole.

"Falling Object. Items placed near the manhole opening may fall and injure a worker in the manhole.

"Sharp Edges. Sharp edges of items in or near a manhole may cause cuts and bruises.

"Lifting Injuries. Unless proper tools are used to remove manhole covers, back injuries or injuries to hands and feet may result.

"2. Planning. Advance planning should include arrangements for test equipment, tools, ventilating equipment, protective clothing, traffic warning devices, ladders, safety harness, and adequate number of personnel. Hasty actions may result in serious injuries. Time spent in the manhole should be kept to a minimum.

"3. Adverse Atmosphere. (Refer to Table 3.3-1.) Before entering a manhole, tests should be made for explosive atmosphere, presence of hydrogen sulfide, and oxygen deficiency. Since combustible or toxic vapors may be heavier than air, the tests on the atmosphere must be run at least $\frac{3}{4}$ of the way down the manhole.

"Whenever adverse atmosphere is encountered, forced ventilation must be used to create safe conditions. After the ventilating equipment has been operated for a few minutes, the atmosphere in the manhole should be retested before anyone enters.

"When explosive conditions are encountered, the ventilating blower should be placed upwind to prevent igniting any gas that is emerging from the opening. When a gasoline engine blower is used, it must be located so that exhaust fumes cannot enter the manhole.

MODEL 3010

Table 3-3-1
Hazardous Gases

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air = 1	Physiological Effect*	Max. Safe 60 Min. Exposure ppm.	Max. Safe 8 Hr. Exposure ppm	Explosive Range (% by vol. in air.) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Ammonia	NH ₃	Irritant and poisonous. Colorless with characteristic odor.	0.60	Causes throat and eye irritation at 0.05%, coughing at 0.17%. Short exposure at 0.5% to 1% fatal.	300 to 500	85	16 25	Near top. Concentrates in closed upper spaces.	Sewers, chemical feed rooms.	Detectable odor at low concentrations.
Benzene	C ₆ H ₆	Irritant, colorless, anesthetic.	2.77	Slight symptoms after several hours exposure at 0.16% to 0.32%. 2% rapidly fatal.	3,000 to 5,000	25	1.3 7.1	At bottom.	Industrial wastes, varnish, solvents.	Combustible gas indicator.
Carbon Bisulfide	CS ₂	Nearly odorless when pure, colorless, anesthetic. Poisonous.	2.64	Very poisonous, irritating, vomiting, convulsions, psychic disturbance.	—	15	1.3 44.0	At bottom.	An insecticide.	Combustible gas indicator.
Carbon Dioxide	CO ₂	Asphyxiant. Colorless, odorless. When breathed in large quantities may cause acid taste. Non-flammable. Not generally present in dangerous amounts unless an oxygen deficiency exists.	1.53	Cannot be endured at 10% more than a few minutes, even if subject is at rest and oxygen content normal. Acts on respiratory nerves.	40,000 to 60,000	5,000	— —	At bottom; when heated may stratify at points above bottom.	Products of combustion, sewer gas, sludge. Also issues from carbonaceous strata.	Oxygen deficiency indicator.
Carbon Monoxide	CO	Chemical asphyxiant. Colorless, odorless, tasteless. Flammable. Poisonous.	0.97	Combines with hemoglobin of blood. Unconsciousness in 30 min. at 0.2% to 0.25%. Fatal in 4 hr. at 0.1%. Headache in few hours at 0.02%.	400	50	12.5 74.0	Near top, especially if present with illuminating gas.	Manufactured gas, flue gas, products of combustion, motor exhausts. Fires of almost any kind.	CO Ampoules.
Carbon Tetrachloride	CCl ₄	Heavy ethereal odor.	5.3	Intestinal upset, loss of consciousness, possible renal damage, respiratory failure.	1,000 to 1,500	100	— —	At bottom.	Industrial wastes, solvent, cleaning.	Detectable odor at low concentrations.
Chlorine	Cl ₂	Irritant. Yellow-green color. Choking odor detectable in very low conc. Non-flammable.	2.49	Irritates respiratory tract. Kills most animals in a very short time at 0.1%.	4	1	— —	At bottom.	Chlorine cylinder and feed line leaks.	Detectable odor at low concentrations.
Formaldehyde	CH ₂ O	Colorless, pungent, suffocating odor.	1.07	Irritating to the nose.	—	10	7.0 73.0	Near bottom.	Incomplete combustion of organics. Common air pollutant, fungicide.	Detectable odor.
Gasoline	C ₅ H ₁₂ to C ₉ H ₂₀	Volatile solvent. Colorless. Odor noticeable at 0.03%. Flammable.	3.0 to 4.0	Anesthetic effects when inhaled. Rapidly fatal at 2.4%. Dangerous for short exposure at 1.1 to 2.2%.	4,000 to 7,000	1,000	1.3 6.0	At bottom.	Service stations, garages, storage tanks, houses	1. Combustible gas indicator 2. Oxygen deficiency indicator.**
Hydrogen	H ₂	Simple asphyxiant. Colorless, odorless, tasteless. Flammable.	0.07	Acts mechanically to deprive tissues of oxygen. Does not support life.	—	—	4.0 74.0	At top.	Manufactured gas, sludge digestion tank gas, electrolysis of water. Rarely from rock strata.	Combustible gas indicator.
Hydrogen Cyanide	HCN	Faint odor of bitter almonds. Colorless gas.	0.93	Slight symptoms appear upon exposure to 0.002% to 0.004%. 0.3% rapidly fatal.	—	10	6.0 40.0	Near top.	Insecticide and rodenticide.	Detector tube.

*Percentages shown represent volume of gas in air.

**For concentration over 0.3%.

MODEL 3010

Table 3.3-1
Hazardous Gases, Continued

Gas	Chemical Formula	Common Properties*	Specific Gravity or Vapor Density (Air = 1)	Physiological Effects	Max. Safe 60 Min. Exposure (ppm)	Max. Safe 8 Hr. Exposure (ppm)	Explosive Range (% by vol. in air.) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Hydrogen Sulfide	H ₂ S	Irritant and poisonous volatile compound. Rotten egg odor in small concentrations. Exposure for 2 to 15 min. at 0.01% impairs sense of smell. Odor not evident at high concentrations. Colorless. Flammable.	1.19	Impairs sense of smell, rapidly as concentration increases. Death in few minutes at 0.2%. Exposure to 0.07 to 0.1% rapidly causes acute poisoning. Paralyzes respiratory center.	200 to 300	20	4.3 45.0	Near bottom, but may be above bottom if air is heated and highly humid.	Coal gas, petroleum, sewer gas. Fumes from blasting under some conditions. Sludge gas.	1. H ₂ S Ampoule. 2. 5% by weight lead acetate solution.
Methane	CH ₄	Simple asphyxiant. Colorless, odorless, tasteless, flammable.	0.55	Acts mechanically to deprive tissues of oxygen. Does not support life.	Probably no limit, provided oxygen percentage is sufficient for life.	—	5.0 15.0	At top, increasing to certain depth.	Natural gas, sludge gas, manufactured gas, sewer gas. Strata of sedimentary origin. In swamps or marshes.	1. Combustible gas indicator. 2. Oxygen deficiency indicator.
Nitrogen	N ₂	Simple asphyxiant. Colorless, tasteless. Non-flammable. Principal constituent of air (about 79%).	0.97	Physiologically inert.	—	—	— —	Near top, but may be found near bottom.	Sewer gas, sludge gas. Also issues from some rock strata.	Oxygen deficiency indicator.
Nitrogen Oxides	NO	Colorless	1.04	60 to 150 ppm causes irritation and coughing. Asphyxiant. 100 ppm dangerous. 200 ppm fatal.	50	10	— —	Near bottom.	Industrial wastes. Common air pollutant.	NO ₂ detector tube.
	N ₂ O	Colorless, sweet odor	1.53							
	NO ₂	Reddish-brown. Irritating odor. Deadly poison	1.58							
Oxygen (in air)	O ₂	Colorless, odorless, tasteless. Supports combustion.	1.11	Normal air contains 20.8% of O ₂ . Man can tolerate down to 12%. Min. safe 8 hr. exposure, 14 to 16%. Below 10%, dangerous to life. Below 5 to 7% probably fatal.	—	—	— —	Variable at different levels.	Oxygen depletion from poor ventilation and absorption, or chemical consumption of oxygen.	Oxygen deficiency indicator.
Ozone	O ₃	Irritant and poisonous. Strong electrical odor. Strong oxidizer. Colorless. At 1 ppm, strong sulfur-like odor.	1.66	Max. naturally occurring level 0.04 ppm. 0.05 ppm causes irritation of eyes and nose. 1 to 10 ppm causes headache, nausea; can cause coma. Symptoms similar to radiation damage.	0.08	0.04	— —	Near bottom.	Where ozone is used for disinfection.	Detectable odor at 0.015 ppm.
Sludge Gas	—**	Mostly a simple asphyxiant. May be practically odorless, colorless.	Variable	Will not support life.	No data. Would vary widely with composition.		5.3 19.3	Near top of structure	From digestion of sludge.	See components.
Sulfur Dioxide	SO ₂	Colorless, pungent odor. Suffocating, corrosive, poisonous, non-flammable.	2.26	Inflammation of the eyes. 400 to 500 ppm immediately fatal.	50 to 100	10	— —	At bottom, can combine with water to form sulfurous acid.	Industrial waste, combustion, common air pollutant.	Detectable taste and odor at low concentrations.
Toluene	C ₇ H ₈	Colorless. Benzene-like odor	3.14	At 200 - 500 ppm, headache, nausea, bad taste, lassitude.	200	100	1.27 7.0	At bottom.	Solvent.	Combustible gas indicator.
Turpentine	C ₁₀ H ₁₆	Colorless, characteristic odor.	4.84	Eye irritation. Headache, dizziness, nausea, irritation of the kidneys.	—	100	0.8 —	At bottom.	Solvent, used in paint	1. Detectable odor at low concentrations. 2. Combustible gas indicator.
Xylene	C ₈ H ₁₀	Colorless, flammable.	3.66	Narcotic in high concentrations. Less toxic than benzene.	—	100	1.1 7.0	At bottom.	Solvent.	Combustible gas indicator.

* Percentages shown represent volume of gas in air.

** Mostly methane and carbon dioxide with small amounts of hydrogen, nitrogen, hydrogen sulfide, and oxygen; occasionally traces of carbon monoxide.

MODEL 3010

"If testing equipment is not available, the manhole should be assumed to contain an unsafe atmosphere and forced ventilation must be provided. It should never be assumed that a manhole is safe just because there is no odor or the manhole has been entered previously.

"4. Entering Manholes. Since the top of the manhole is usually flush with the surrounding surface, there may not be anything for the person who is entering the manhole to grab on to steady himself. Persons who are entering manholes should not be permitted to carry anything in their hands as they enter the manhole, to ensure that their hands are free to hold on or grab if they slip. A good method for entering a manhole is to sit on the surface facing the manhole steps or ladder, with the feet in the hole and the arms straddling the opening for support. As the body slides forward and downward, the feet can engage a rung, and the back can rest against the opposite side of the opening. If there is any doubt about the soundness of the manhole steps, a portable ladder should be used.

"A person should never enter a manhole unless he is wearing personal safety equipment, including a safety harness and hard hat. Two persons should be stationed at the surface continuously while anyone is working inside a manhole, to lift him out if he is overcome or injured. One man cannot lift an unconscious man out of a manhole. The persons stationed at the surface should also function as guards to keep people and vehicles away from the manhole opening.

To avoid a serious injury, a person should not be lifted out of a manhole by his arm unless it is a dire emergency.

"When more than one person must enter a manhole, the first person should reach the bottom and step off the ladder before the second one starts down. When two men climb at the same time, the upper one can cause the lower one to fall by slipping or stepping on his fingers.

"5. Traffic Protection. In addition to traffic cones, markers, warning signs, and barricades, a vehicle or heavy piece of equipment should be placed between the working area and oncoming traffic. Flashing warning signals should be used to alert drivers and pedestrians. Orange safety vests should be worn by personnel stationed at the surface when the manhole is located in a vehicular traffic area.

"6. Falling Object. All loose items should be kept away from the manhole opening. This applies to hand tools as well as stones, gravel and other objects.

"7. Removing the Covers. Manhole covers should be removed with a properly designed hook. Use of a pick ax, screwdriver, or small pry bar may result in injury. A suitable tool can be made from $\frac{3}{4}$ -inch round or hex stock. Two inches of one end should be bent at a right angle and the other end should be formed into a D-handle wide enough to accommodate both hands. Even with this tool, care must be exercised to prevent the cover from being dropped on the toes. The 2-inch projection should be inserted into one of the holes of the cover, the handle grasped with both hands, and the cover lifted by straightening the legs, which have been slightly bent at the knees.

"8. Other Precautions. Other precautions which should be taken when entering a manhole are:

"Wear a hard hat.

"Wear coveralls or removable outer garment which can readily be removed when the work is completed.

"Wear boots or nonsparking safety shoes.

"Wear rubberized or waterproof gloves.

"Wear a safety harness with a stout rope attached.

MODEL 3010

“Do not smoke.

“Avoid touching yourself above the collar until you have cleaned your hands.

“9. Emergencies. Every member of the crew should be instructed on procedures to be followed in cases of an emergency. It is the duty of each crew chief to have a list of emergency phone numbers, including the nearest hospital and ambulance service, police precinct, fire station, and rescue or general emergency number.

“10. Field Equipment. The following equipment will be available for use:

Blowers	Flashlights	Hard Hats	Ropes
Breathing Apparatus	Mirrors	Harnesses	Safety Vests
Coveralls	Gas Detectors	Manhole Irons	Traffic Cones
First Aid Kits	Gas Masks	Pick Axes	Waders”
Emergency Flashers	Gloves	Rain Slickers	

3.3.2 Lethal Atmospheres in Sewers - The following is an article written by Dr. Richard D. Pomeroy, and published in the October 1980 issue of “Deeds & Data” of the WPCF. Dr. Pomeroy is particularly well known for his studies, over a period of nearly 50 years, in the field of the control of hydrogen sulfide and other odors in sewers and treatment plants. He has personally worked in a great many functioning sewers. In the earlier years he did so, he admits, with little knowledge of the grave hazards to which he exposed himself.

“It is gratifying that the subject of hazards to people working in sewers is receiving much more attention than in past years, and good safety procedures are prescribed in various publications on this subject. It is essential that people know and use correct procedures.

“It is less important to know just what the hazardous components of sewer atmospheres are, as safety precautions should in general be broadly applicable, but there should be a reasonable understanding of this subject. It is disturbing to see statements in print that do not reflect true conditions.

“One of the most common errors is the assumption that people have died from a lack of oxygen. The human body is able to function very well with substantially reduced oxygen concentrations. No one worries about going to Santa Fe, New Mexico, (elev. 2100 meters), where the partial pressure of oxygen is equal to 16.2% (a normal atmosphere is about 21%) oxygen. When first going there, a person may experience a little ‘shortness of breath’ following exercise. People in good health are not afraid to drive over the high passes in the Rocky Mountains. At Loveland Pass, oxygen pressure is 13.2% of a normal atmosphere. At the top of Mt. Whitney, oxygen is equal to 12.2%. Many hikers go there, and to higher peaks as well.

“After adequate acclimation, they may climb to the top of Mt. Everest, where oxygen is equal to only 6.7%.

“The lowest oxygen concentrations that I have observed in a sewer atmosphere was 13%. It was in a sealed chamber, near sea level, upstream from an inverted siphon on a metropolitan trunk. A man would be foolish to enter the chamber. Without ventilation, he might die, but not from lack of oxygen.

“It seems unlikely that anyone has ever died in a sewer from suffocation, that is, lack of oxygen. Deaths have often been attributed to ‘asphyxiation.’ This is a word which, according to the dictionary, is used to mean death from an atmosphere that does not support life. The word has sometimes been misinterpreted as meaning suffocation, which is only one kind of asphyxiation.

“In nearly all cases of death in sewers, the real killer is hydrogen sulfide. It is important that this fact be recognized. Many cities diligently test for explosive gases,

MODEL 3010

which is very important, and they may measure the oxygen concentration, which usually is unimportant, but they rarely measure H₂S. Death has occurred where it is unlikely that there was any measurable reduction in the oxygen concentration. Wastewater containing 2 mg/l of dissolved sulfide, and at a pH of 7.0, can produce in a chamber with high turbulence, a concentration of 300 ppm H₂S, in the air. This is considered to be a lethal concentration. Many people have died from H₂S, not only in sewers and industries, but also from swamps and from hot springs. In one resort area, at least five persons died from H₂S poisoning before the people were ready to admit that H₂S is not a therapeutic agent. Hardly a year passes in the U.S. without a sewer fatality from H₂S as well as deaths elsewhere in the world.

"The presence of H₂S in a sewer atmosphere is easily determined. A bellows-and-ampoule type of tester is very satisfactory for the purpose, even though it is only crudely quantitative. When using a tester of this type, do not bring the air to the ampoule by way of a tube, as this may change the H₂S concentration. Hang the ampoule in the air to be tested, with a suction tube to the bulb or bellows.

"Lead acetate paper is very useful as a qualitative indicator. It cannot be used to estimate the amount of sulfide, but it will quickly turn black in an atmosphere containing only a tenth of a lethal concentration.

"Electrodes or other similar electrical indicating devices for H₂S in the air have been marketed. Some of them are known to be unreliable, and we know of none that have proved dependable. Do not use one unless you check it at frequent intervals against air containing known H₂S concentrations. A supposed safety device that is unreliable is worse than none at all.

"Remember that the nose fails, too, when it comes to sensing dangerous concentrations of H₂S.

"Various other toxic gases have been mentioned in some publications. It is unlikely that any person has been asphyxiated in a sewer by any of those other gases, except possibly chlorine.

"The vapor of gasoline and other hydrocarbons is sometimes present in amounts that could cause discomfort and illness, but under that condition, the explosion hazard would be far more serious. The explosimeter tests, as well as the sense of smell, would warn of the danger. Pipelines in chemical plants might contain any number of harmful vapors. They, too, are sensed by smell and explosimeter tests if they get into the public sewer. Such occurrences are rare.

"The attempt to instill a sense of urgency about real hazards is diluted if a man is told to give attention to a long list of things that in fact are irrelevant.

"Be very careful to avoid high H₂S concentrations, flammable atmospheres, and hazards of physical injuries. Remember that much H₂S may be released by the stirring up of sludge in the bottom of a structure. Obey your senses in respect to irritating gases, such as chlorine (unconsciousness comes suddenly from breathing too much.) Be cautious about strange odors. Do not determine percent oxygen in the air. There is a danger that the result will influence a man's thinking about the seriousness of the real hazards. Most important, use ample ventilation, and do not enter a potentially hazardous structure except in a good safety harness with 2 men at the top who can lift you out."

3.4 General Considerations for Installing the Model 3012 Ultrasonic Level Sensor - The location of the ultrasonic level sensor depends on the method of level-to-flow rate conversion used. You generally use the Model 3010 Flow Transmitter with some type of primary measuring device, such as a weir or flume. The location of the level sensor over the primary device depends on the type of primary device used. The primary device manufacturer usually specifies the head-measuring point for a given type of device.

MODEL 3010

For example, the head-measuring point of a weir is at least 3 times the maximum expected head upstream from the weir plate; for Parshall flumes, the head measuring point is $\frac{1}{3}$ of the way into the converging section; and for Palmer-Bowlus flumes, the head measuring point is $\frac{1}{2}$ pipe diameter upstream from the entrance to the flume. Refer to the *Isco Open Channel Flow Measurement Handbook* and to manufacturer's information about the primary device for more details.

User-Determined Mounting Location - If you measure flow by some other means, such as a gravity-flow equation (Manning) or by calibrating a section of the flow channel, you should determine the location of the ultrasonic level sensor. Base this location on the hydraulic characteristics of the site and the method of level-to-flow rate conversion used.

NOTE

In open channel installations, where flow rate may exceed half of full pipe, place the transducer as close as possible to the midpoint between the pipe entrance and exit of the U-Channel to ensure sensing over the *least turbulent* flow.

"Dead Band" - Mount the ultrasonic level sensor as close to the maximum expected level as possible. This minimizes many of the undesirable characteristics of ultrasonic distance measurement. However, you must mount the ultrasonic level sensor at least two feet higher than the maximum expected level, as shown in Figure 3.6-1. This is because of a two-foot "dead band" directly below the level sensor where no measurements can be taken.

Distances Between the Level Sensor and Flow Transmitter - Extension cables in customer-specified lengths of 50 to 1,000 feet are available as a special order to connect to the ultrasonic level sensor to achieve lengths greater than 50 feet. Consult the factory for further information. Connect the extension cables together inside the Quick-Disconnect Box. You can cut off any extra cable if desired. Prepare the cable as described in the Wiring Section (3.2.2) earlier in this chapter. Follow the instructions supplied with the Quick-Disconnect Box. Install the box with either conduit and appropriate fittings, or with Stahlin fittings to secure the cables if conduit is not required. Mount the Quick-Disconnect Box in a safe place well above the maximum expected level.

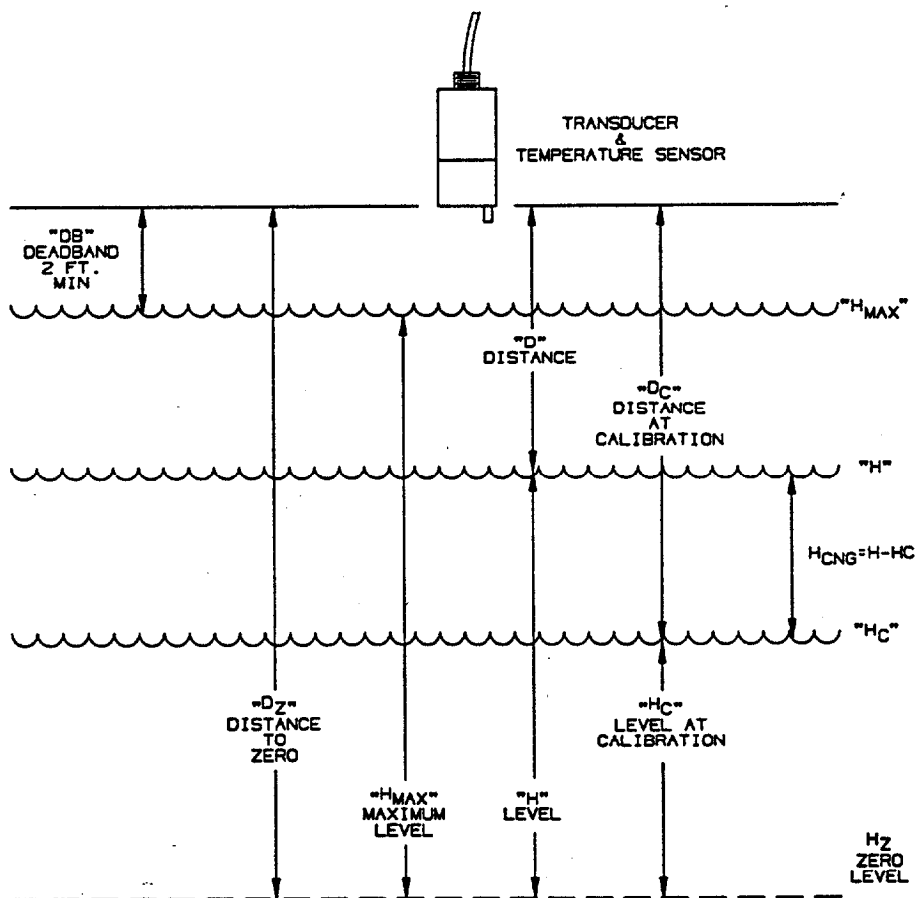
Accidental Submersion Harmless - Since both ends of the ultrasonic level sensor are completely sealed, submersion will not hurt it. However, you should avoid prolonged submersion. Remember that submersion will keep the flow transmitter from reporting level even if the level sensor is not damaged. Prolonged submersion or submersion in dirty or greasy flow streams may coat the surface of the transducer with enough solid matter to make it fail to transmit or receive the ultrasonic pulse until cleaned. Mount the ultrasonic level sensor high enough above the flow stream to avoid submersion under normal circumstances.

3.4.1 Mounting the Ultrasonic Level Sensor - There are several ways you can mount the level sensor over the flow stream. Determine which method best fits your application. Figure 3.6-2 shows mounting examples. The ultrasonic level sensor has a $\frac{3}{4}$ " male pipe thread with a conduit locknut to connect it to a mounting bracket or cable stiffener. Isco also offers an optional mounting bracket to mount the level sensor. Figure 3.6-2 shows this bracket. If you are mounting the level sensor in a hazardous location, follow the installation instructions in the control drawing 60-3403-175 and any applicable local codes.

Optional Ultrasonic Floor Mount - This device is a small stand with a flat base and an adjustable arm. There is a clamp on the arm to hold the level sensor. This unit provides a simple, portable means of suspending a level sensor over a flow stream. You can take the mount with you into the manhole easily because it is compact and collapsible. Anchor the mount with a sandbag across its base. You can use the Ultrasonic Floor Mount in both temporary and permanent installations. See Figure 3.4.3.

MODEL 3010

Figure 3.4-1 Ultrasonic Level Sensor "Dead Band"



DEAD BAND: The nonuseable distance (2 feet) between the level sensor and the liquid surface. This requires that at maximum level the liquid surface must be at least 2 feet from the level sensor.

DISTANCE "D" is the distance from the level sensor to the liquid surface. For the Model 3010, this can be from 2 to 12 feet.

"Dc" is the distance from the level sensor to the liquid surface at the time that the Level "H" was calibrated.

"Dz" is the distance from the level sensor to the zero datum point (zero level) "Hz" of the primary device. **NOTE:** Errors caused by velocity-of-sound errors will be multiplied by the distance from the transducer to the water surface "D." As the distance "D" is increased, the possible error increases.

LEVEL: The depth of the water above the primary device's zero datum point. **NOTE:** May also be referred to as "HEAD." In this manual "level" and "head" are interchangeable terms. The Model 3010 calculates level using the following formula: $H = Dz - D$.

"Hc" is the level at the time the flow transmitter was calibrated.

"H" is the level at the time that a measurement is to be made.

"H" is shown above "Hc." However, if the level had dropped after calibration, "H" would be below "Hc."

Level Change: "Hcng" is the change in level over time. The maximum change of level for which the Model 3010 can operate is 10 feet. $H_{cng} = H - H_c$.

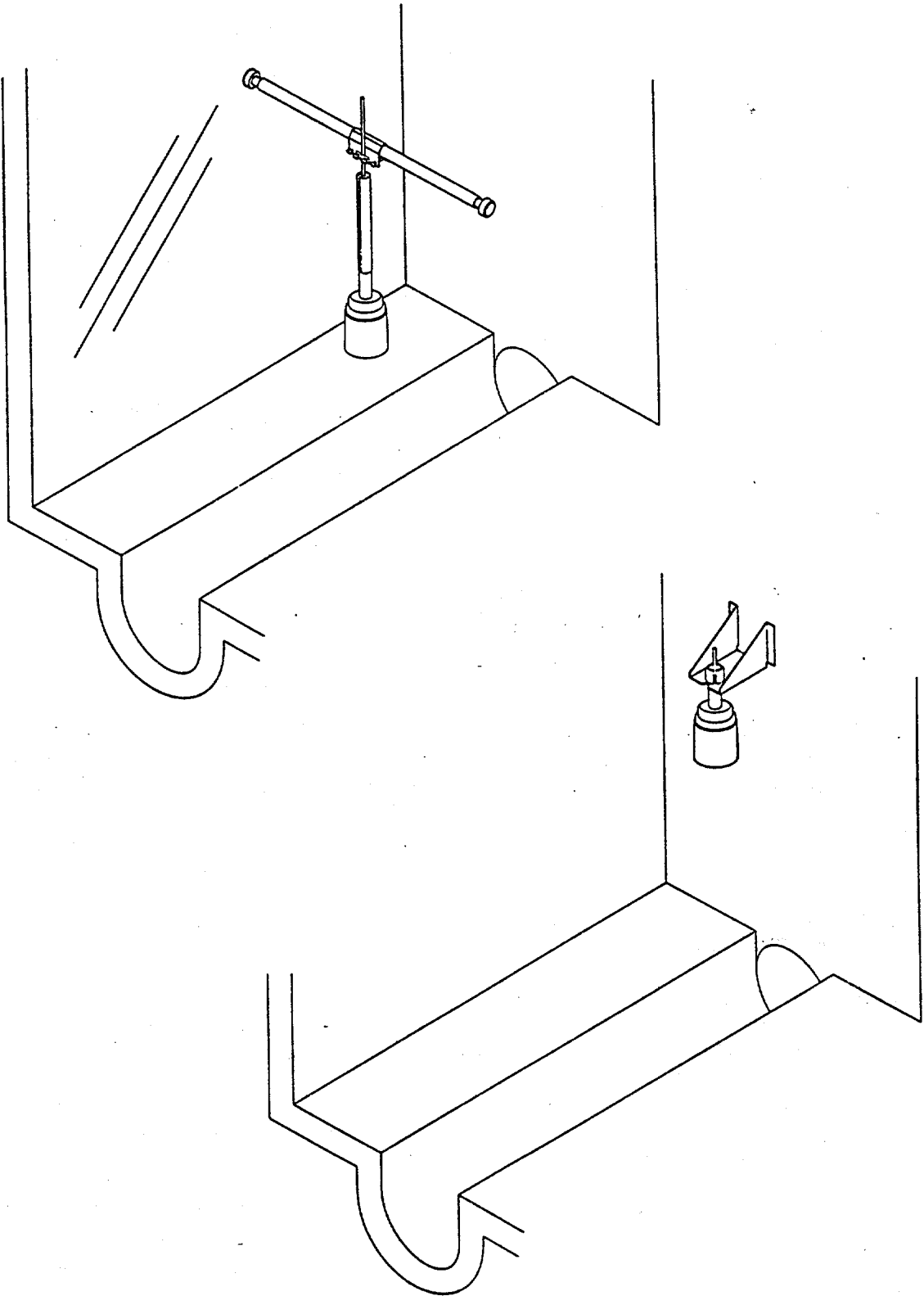
MAXIMUM HEAD: "Hmax" is the maximum head (level) which the flow transmitter can measure. For the Model 3010, this is limited to 12 feet or less. Since the largest level change that the Model 3010 can respond to is 10 feet, the unit will have a minimum level of greater than 0 feet if the maximum level is greater than 10 feet.

TEMPERATURE: Since temperature significantly affects the velocity of sound, temperature measurement is made by the Model 3010 Flow Transmitter to provide compensation.

Calibration Temperature: "Tc" is the temperature at the sensor at the time the system is calibrated. (Not shown on drawing.)

Temperature Change: "Tcng" is the change in the temperature after the head was calibrated. $T_{cng} = T - T_c$. **NOTE:** The temperature is used to calculate the velocity of sound in air, which is used to calculate the distance "D" to the liquid surface, and the head. Any error in the temperature "T" causes an error that is proportional to the distance "D."

Figure 3.4-2 Mounting the Ultrasonic Level Sensor



MODEL 3010

Figure 3.4-2 (Continued) Mounting the Ultrasonic Level Sensor

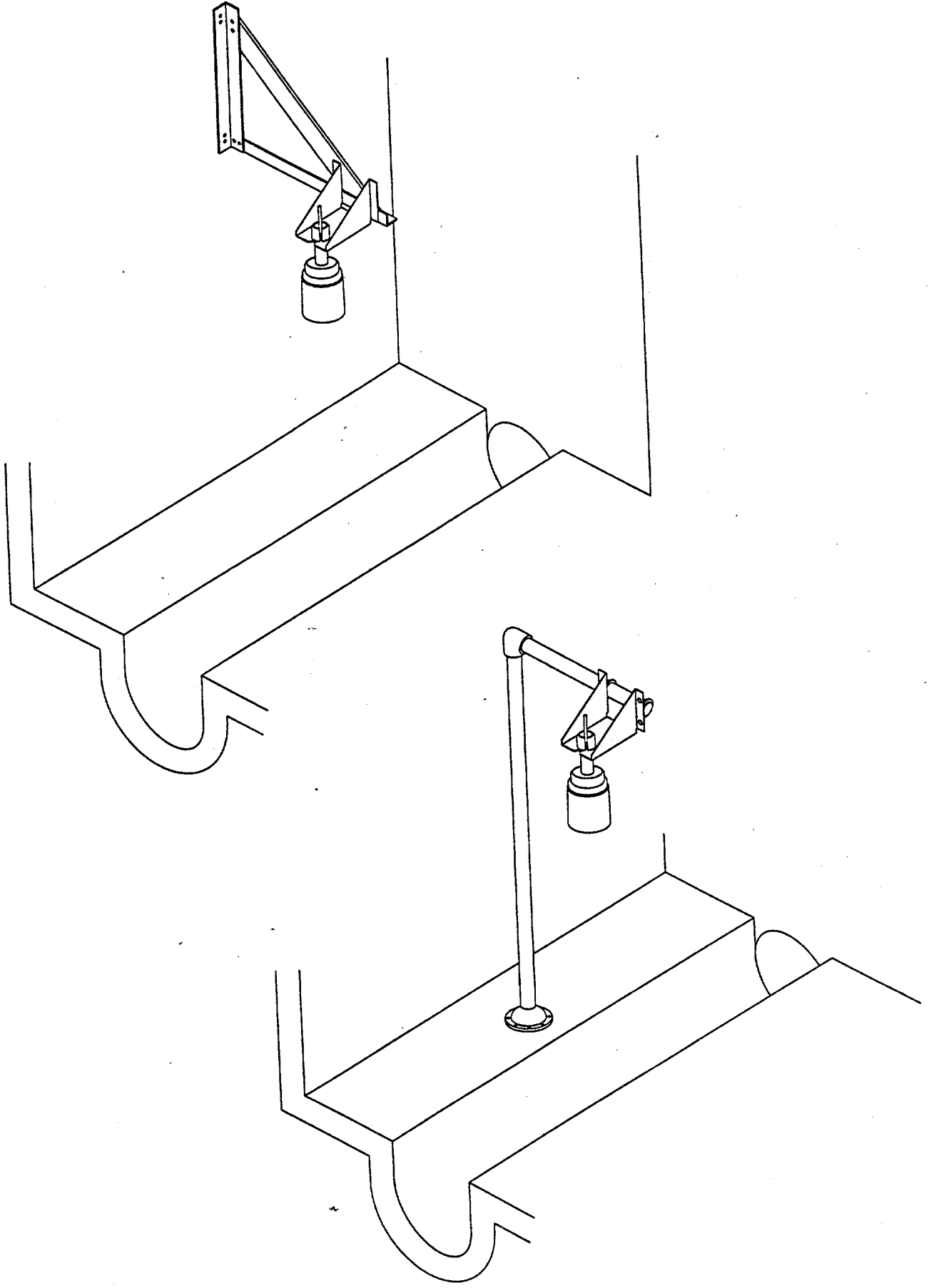
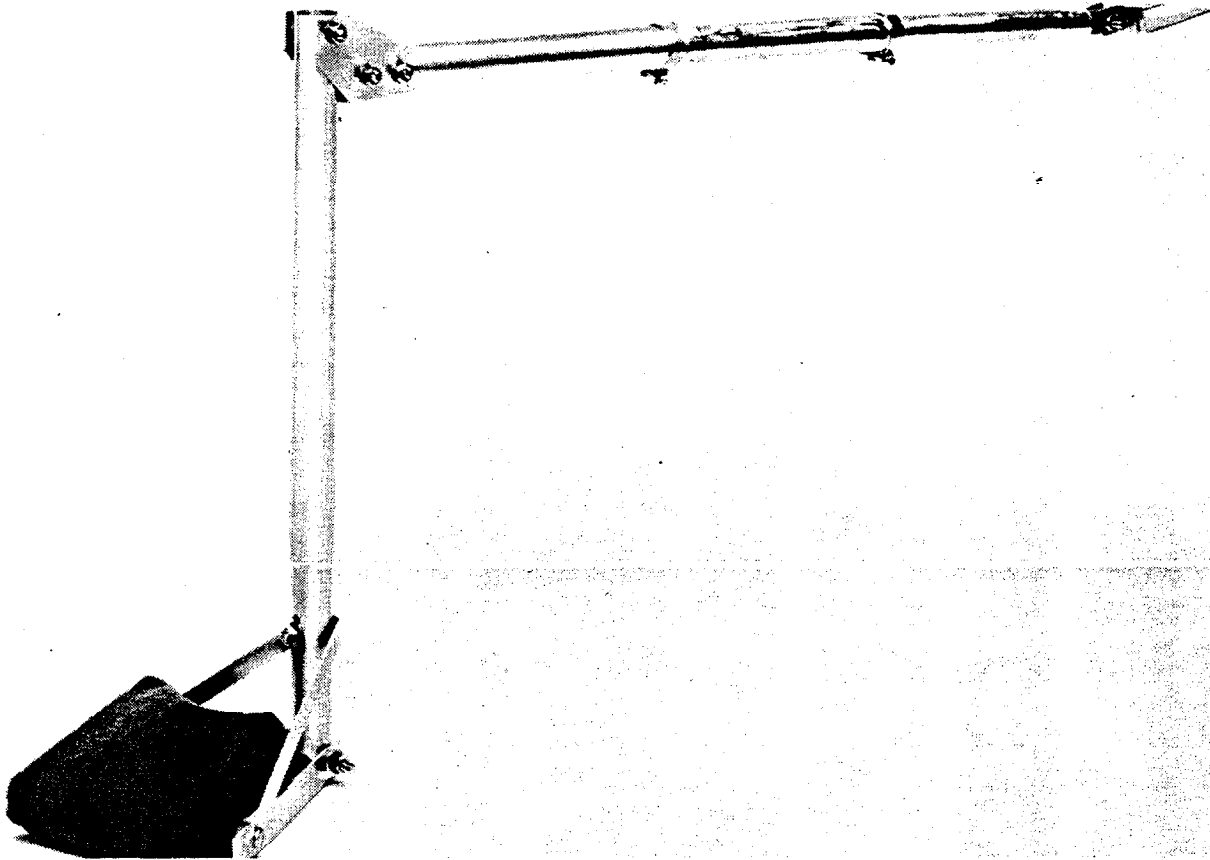


Figure 3.4.3 Ultrasonic Floor Mount



Simple Suspension of the Ultrasonic Level Sensor - You can also suspend the level sensor from its cable. The cable stiffener, an optional accessory that is weighted, forces the ultrasonic level sensor to hang plumb.

Use a Level - When you are mounting the ultrasonic level sensor, place it over the center of the flow stream and use a circular bubble level to align the level sensor vertically. This is very important, since misalignment may result in erratic or erroneous level readings, caused by the echo bouncing off the walls of the channel.

3.4.2 Minimization of Level Measurement Errors - In order to minimize measurement errors with the Model 3010 Flow Transmitter, observe the following precautions installing the ultrasonic level sensor. These are listed in the approximate order of their significance. Section 2.1.2 discusses the factors affecting accuracy of ultrasonic measuring.

Avoid Temperature Differences - Avoid installations where the ultrasonic level sensor will operate at a different temperature than the air between the sensor and the stream (through which the ultrasonic beam passes). The temperature sensor inside the ultrasonic level sensor provides the flow transmitter with temperature readings taken from the surrounding air. If the level sensor operates at a different temperature than the surrounding air, the flow transmitter will base temperature compensation on the temperature of the level sensor rather than the air. This will lead to significant errors.

Use a Sunshade in Outdoor Applications - This situation is most likely to occur where the ultrasonic level sensor is installed outside and is directly exposed to the sun. In such installations, provide a sunshade to keep the sun from shining directly on the level sensor, as sunlight will raise the temperature of the housing significantly higher than the surrounding air. Isco has an optional sunshade available for its ultrasonic level sensors.

MODEL 3010

Serious Errors Possible from Temperature Differences - Errors caused by the ultrasonic level sensor operating at a different temperature than the ambient can be quite serious. For example, with a distance of only 2 feet and a temperature difference of 35°F, the level error is:

$$\text{Level Error} = 0.001 \times 35 \times 2 = 0.070 \text{ foot (about 1 inch)}$$

Temperature differences between the level sensor and the flow stream surface will lead to velocity errors because the level sensor is at a different temperature than the air. Also, air layers of different temperatures between the level sensor and the flow stream surface will cause an abnormal reduction in the strength of the ultrasonic pulse, causing possible loss of the return echo.

An example of how this could actually happen is as follows: Suppose the level sensor were mounted over a flow stream discharged from a processing plant. Because heat is used in the processing plant, the temperature of the stream and the air over it is approximately 100°F. Now suppose the ultrasonic level sensor is mounted 3 feet above the current level and it is deep winter, with a temperature of 0°F. All this is quite possible in "real world" terms, and from the formula above, you can see that the error in this case would be substantially greater than the example given with the formula.

Avoid Wind Currents - If possible, always install the ultrasonic level sensor in a location protected from air currents. Wind reduces the strength of the ultrasonic pulse and echo. This causes the flow transmitter to have difficulty detecting the return echo. In severe cases, it is possible for the flow transmitter to lose the echo completely.

Avoid Excessive Distances Between Level Sensor and Flow Stream - Although you cannot mount the ultrasonic level sensor closer than two feet from the maximum level of the flow stream, Isco recommends keeping the mounting as close to the two-foot limit as possible. The reason is that any error made by the flow meter in calculating the velocity of sound in the air is multiplied by the distance from the level sensor to the surface of the flow stream. Minimizing the distance will minimize the error.

Calibrate at the "Expected" Temperature - Calibrate the level reading at a temperature as close as possible to that expected during operation. For small level changes, you can determine the error due to temperature by the product of the distance (from the transducer to the flow stream surface) and the temperature change. Calibrating the flow transmitter at the same temperature as the expected operating temperature will minimize this error.

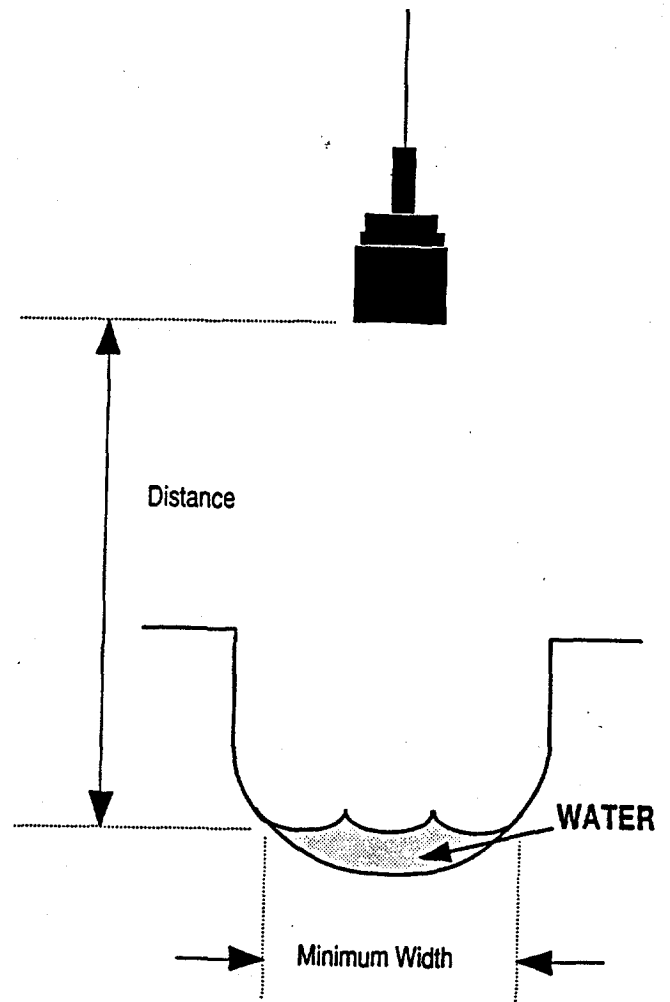
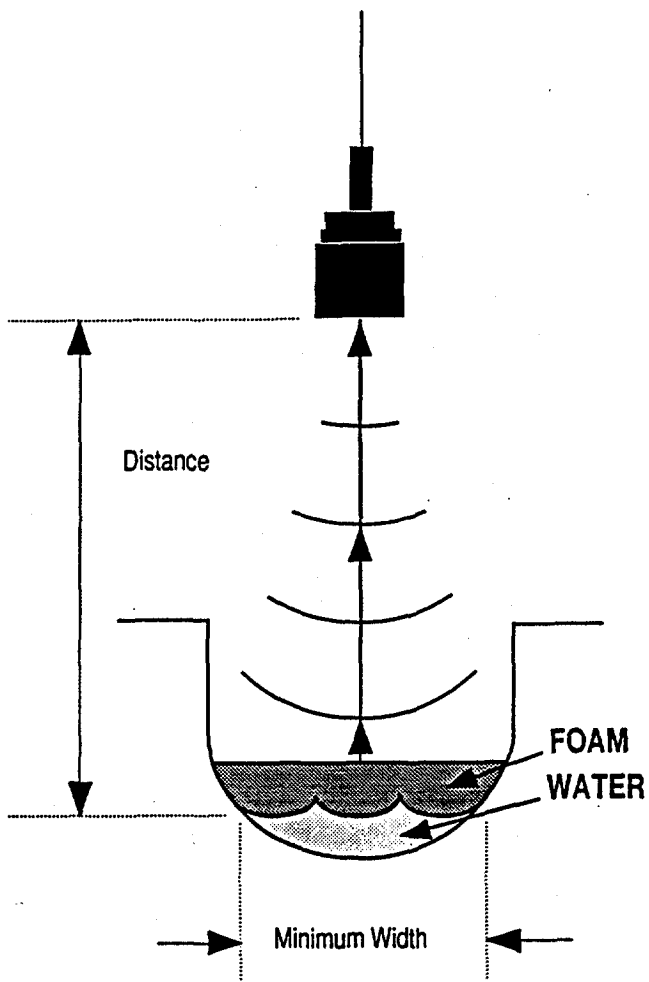
Calibrate the "Zero Level" at a Point Similar to Expected Level - You can reduce errors by calibrating the "Zero Level" as close as possible to that expected during operation.

Avoid Water Condensate - The ultrasonic level sensor will not operate properly if the bottom surface collects water droplets. This may occur if water condenses on the transducer surface as a result of high ambient humidity. Some people have found that mounting the ultrasonic level sensor horizontally and aiming it at a 45° angled reflector will keep water from collecting on the level sensor's radiating surface.

Avoid Foam, Oil, and Turbulence - If the flow stream surface is absorbent (such as with foam) or very irregular (such as highly turbulent water), the ultrasonic echo may not reflect back to the ultrasonic level sensor correctly. This can result in a false measurement or no measurement at all. If the foam is reflective, the system will detect the top of the foam rather than the liquid surface. Also, if grease or oil are floating on the flow stream surface, the level sensor will detect that rather than the liquid surface; see Figure 3.4-4.

MODEL 3010

Figure 3.4-4 Foam and Oil on the Surface of the Flow Stream Figure 3.4-5 Small Pipes and Narrow Channels



MODEL 3010

Small Pipes and Channels - Small circular pipes, narrow channels, and small flumes may also cause problems with ultrasonic distance measurement. Since the ultrasonic pulse expands outwards at a beam angle of approximately 8° as it travels away from the ultrasonic level sensor, it may strike the sides of a channel or the sloping sides of a circular pipe with low flow. This can result in false echoes and incorrect level readings. The term "small channels" generally refers to "U" shaped channels and pipe inverts 10" in diameter and less. The term "small flumes" generally refers to 1" and 2" Parshall flumes. It should be noted that the level measuring point for many types of flumes (Palmer-Bowlus, etc.) is not in the flume, but upstream in the invert of the pipe; for these types of flumes the section of interest is in the pipe invert, not in the flume itself. You should take care in the use of 10" or smaller Palmer-Bowlus and similar flumes.

Determining Suitability - The channel to be measured can be "prequalified" by a simple equation which will determine whether the channel is wide enough to allow correct positioning of the ultrasonic sensor. Since the beam angle is 8° , the equation is:

$$\text{Minimum Width} = .14 \times \text{Distance}$$

Where **Distance** is the distance from the bottom of the ultrasonic level sensor to the minimum expected level, as shown in **Figure 3.4-5**.

Possible Alternatives - Because of the characteristics of ultrasonic liquid measurement, there may be some installations where the ultrasonic method is either unreliable or inaccurate. In these instances it is worthwhile to consider use of the submerged probe level sensor (Isco Model 3020 Flow Transmitter). Isco also manufactures a complete line of portable AC or battery-powered flow meters, both recording and nonrecording types. The Model 3210 is an ultrasonic unit. The Model 3220 uses a submerged probe. The Model 3230 uses the bubbler technique. For situations involving very low flow rates, Isco offers the Model 3240 Variable Gate Flow Meter. Information on these companion units to the Model 3010 is available from their respective manuals or from the factory.

MODEL 3010

MODEL 3010

CHAPTER 4

4.0 OPTIONAL EQUIPMENT - This chapter of the Model 3010 Instruction Manual describes optional equipment available for use with the flow transmitter and how to connect the options to the Model 3010. The following options are available:

- High-Low Alarm Relay Box
- Model 2312 Plotter
- Remote Totalizer
- Custom-Programmed Characterization PROM
- Extension Cables for the Ultrasonic Level Sensor
- Model 2410 Circular Chart Recorder

User-Installed Options - You can install any of the above-listed options except the Characterization PROM any time. You must return the unit to the factory for installation of the PROM.

CAUTION

All wiring between the Model 3010 Flow Transmitter and related equipment must conform to the National Electrical Code or local codes, whichever authority has jurisdiction. You should make installations suitable for wet locations.

WARNING

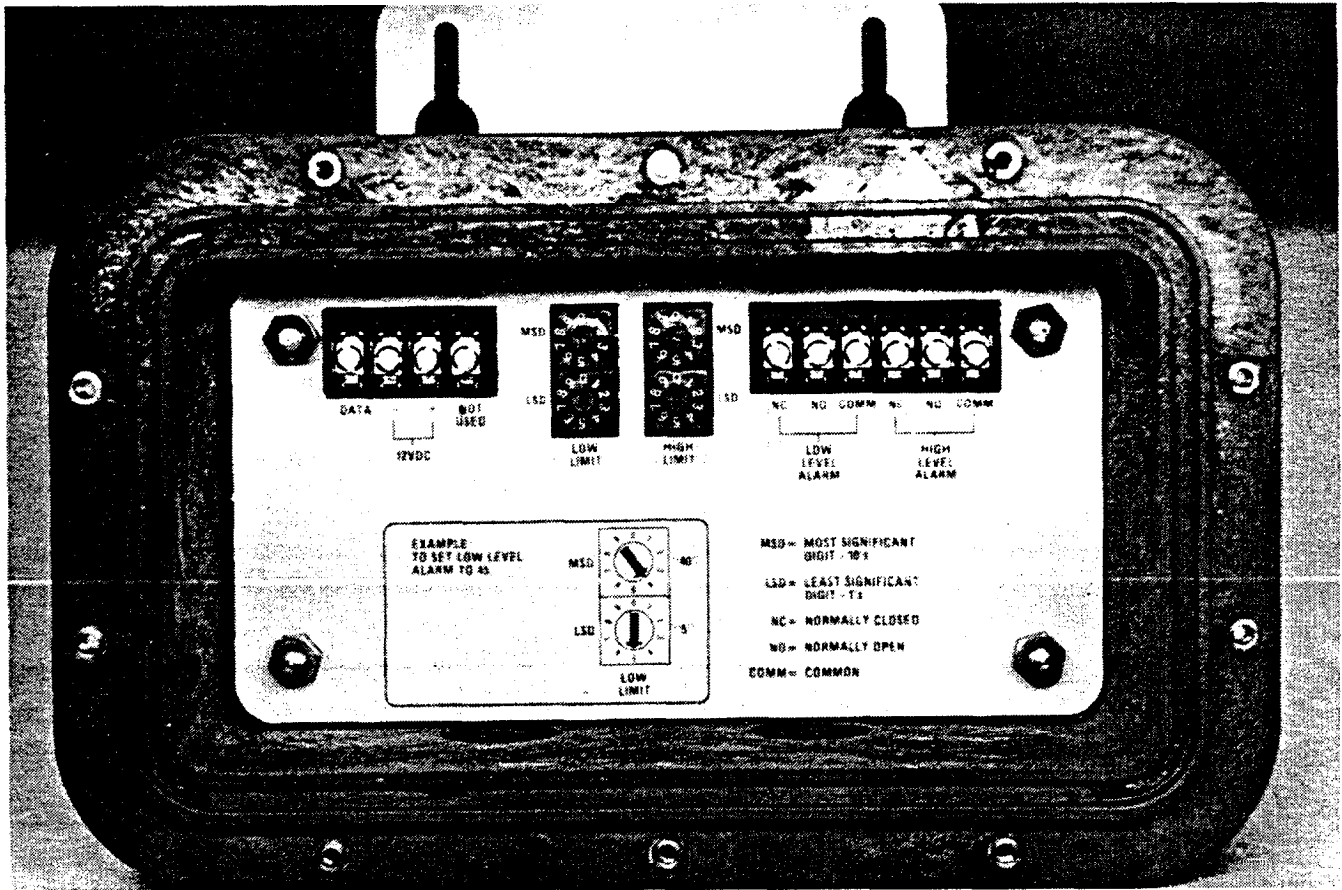
Hazard of electrocution! - You can be killed if you accidentally contact the AC power supplied to the Model 3010. Do not attempt to wire or troubleshoot while the flow transmitter is "live." Disconnect power at the breaker panel or cutoff switch before performing any work on the flow transmitter.

4.1 High-Low Alarm Relay Box - (See Figure 4.1-1) Isco offers an accessory that monitors flow rate information provided by the Model 3010. Relays trip when flow rate falls below or exceeds preset limits. High and low set points are user-selected and range from 0% to 99% in 1% increments. Output from the unit is the switching of form C (SPDT) relay contacts. Two relays are provided: one for high alarm and the other for low. The availability of form C contacts (both NO [normally open] and NC [normally closed] contacts) means that you can either turn loads on or off. Relay contacts are rated for 3 amperes maximum at 24 volts AC or DC. The unit operates on 12 VDC supplied from the Model 3010. Current consumption in standby condition is approximately 10 mA. In alarm condition (both relays operated), current increases to 180 mA.

Setting the Limit Switches - The High-Low Alarm Relay Box contains a microprocessor that compares serial data from the Model 3010 to set values for high and low alarm trip-points for the relays. Rotary switches inside the alarm box set the trip points. Setup is quite simple. There are two rotary switches for each limit. The switches labeled **MSD** (*most significant digit*) determine the first digit of the percentage entered as a set point. For example, if you want to enter a low limit of 18%, you would set the **LOW LIMIT MSD** switch at 1. Then you set the second digit, the 8, on the other switch, the one labeled **LOW LIMIT LSD** (*least significant digit*). Use the same method to program the **HIGH LIMIT** switch. Suppose you want to set the high limit at 79%. You would set the **HIGH LIMIT MSD** switch at 7 and the **HIGH LIMIT LSD** switch at 9.

MODEL 3010

Figure 4.1-1 High-Low Alarm Relay Box (Cover Removed)



Installation - The alarm box is made of high-strength plastic and is easy to install. Mount the unit with the 2 slotted holes in the stainless steel plate on the back of the case. The slots accommodate up to 3/16" hardware. Drill 2 mounting holes on 3" centers. Threaded holes in the box allow the use of either 1/2" conduit fittings or Stahlin fittings (see Section 3.2). The alarm box is suitable for use in damp locations, but do not install it where there is possibility of submersion. In low temperature ambients, install the alarm box indoors or in a heated location. The minimum operating temperature of the microprocessor is 32° F (0° C).

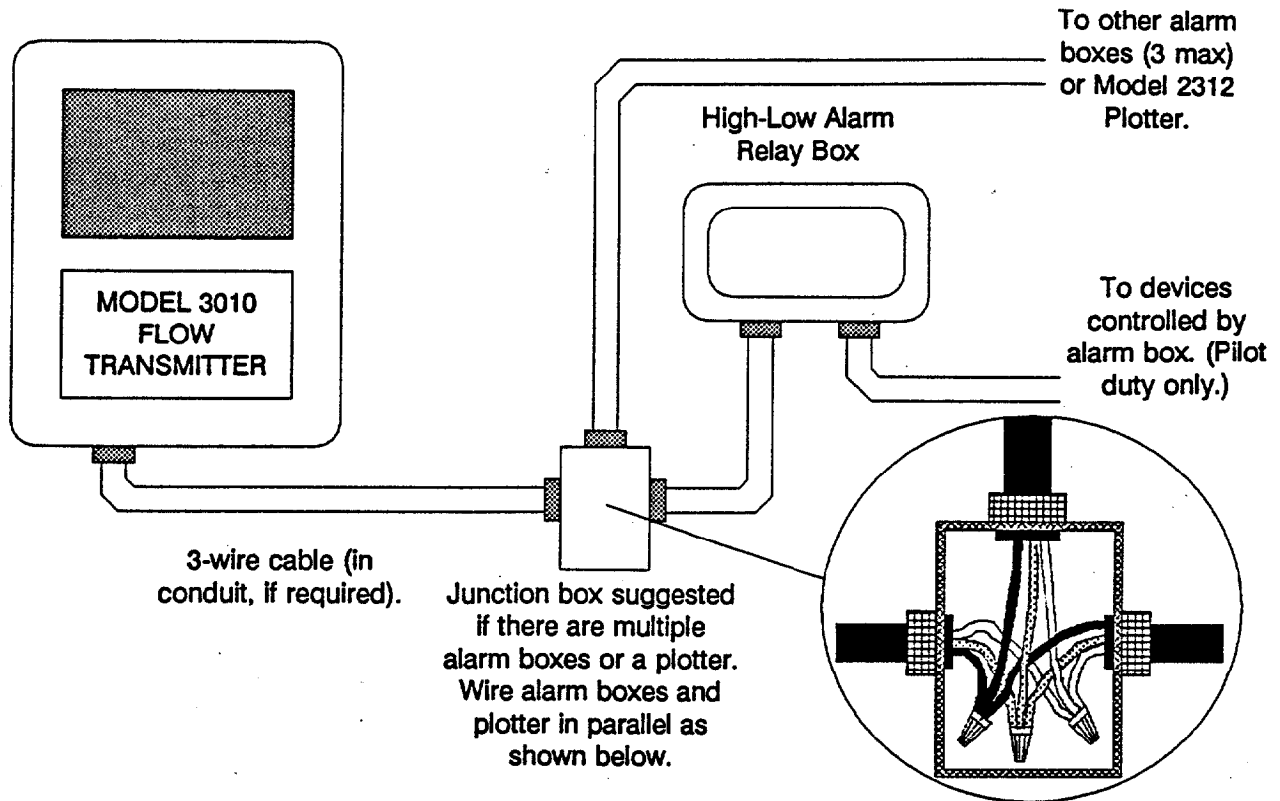
Wiring - Connection of the alarm box to the Model 3010 requires 3 wires. A typical cable has the following 3 colored wires in it: black, white, and red. Connect the wires between the Model 3010 and the High-Low Alarm Relay Box as follows:

Terminals in Model 3010	Terminal Strip #	Wire Colors	Terminals in Alarm Box
2312 INTERFACE +	TS2	BLACK	+ 12VDC
2312 INTERFACE -	TS2	WHITE	- 12VDC
2312 INTERFACE OUT	TS2	RED	DATA

You can use as many as 4 alarm boxes with the same flow transmitter. Wire all the boxes in PARALLEL to the same connections shown in the table above. The wire colors shown are for example only. Any color of wire or cable is acceptable, but *make sure* the connections end up the same as those shown. The maximum recommended distance between the Model 3010 and the alarm box is 250 feet (76 meters). The recommended wire gauge for interconnection cable is # 18 AWG. In electrically noisy environments, Isco suggests use of shielded cable.

MODEL 3010

Figure 4.1-2 Interconnection of Model 3010 and Alarm Boxes



To connect external devices to the high-level alarm relay:

Use **NO** and **COMM** for devices to turn **ON** when the high alarm trips.
Use **NC** and **COMM** for devices to turn **OFF** when the high alarm trips.

To connect external devices to the low-level alarm relay:

Use **NO** and **COMM** for devices to turn **ON** when the low alarm trips.
Use **NC** and **COMM** for devices to turn **OFF** when the low alarm trips.

Wire gauge and the length of the cable run depend on the device being controlled. Suggested limits are 1,000 feet maximum cable run and #18 AWG wire size.

CAUTION

For safety, do not connect line-powered devices (120 VAC or higher) directly to the relay contacts. Use the alarm box for low-voltage (below 30 volts) pilot control only.

Circuit Description - Refer to the Component Layout, Figure 4.1-3, and the Schematic Diagram, Figure 4.1-4, for details on the alarm box. 12 VDC enters the board on terminals Ø3 (+) and Ø2 (-) of terminal strip P1 and is distributed to the relay coils K1 and K2 and the 78L05 voltage regulator which provides 5 VDC to the rest of the circuit. Serial data and Microprocessor U1 provide temperature stability. Serial data from the Model 3010 enters the board on terminal Ø1 of terminal strip P1 and is fed to the microprocessor by transistor Q1. An internal UART in the microprocessor reads the percent of flow rate transmitted from the Model 3010 and compares this reading with the high and low set points entered in BCD from the rotary switches SW1-4. Transistors Q2-3 provide drive for the alarm relay coils. Note that the contacts of both relays, brought out on strip P2, are electrically isolated from the rest of the circuitry.

MODEL 3010

Figure 4.1-3 Component Layout for the High-Low Alarm Relay Box

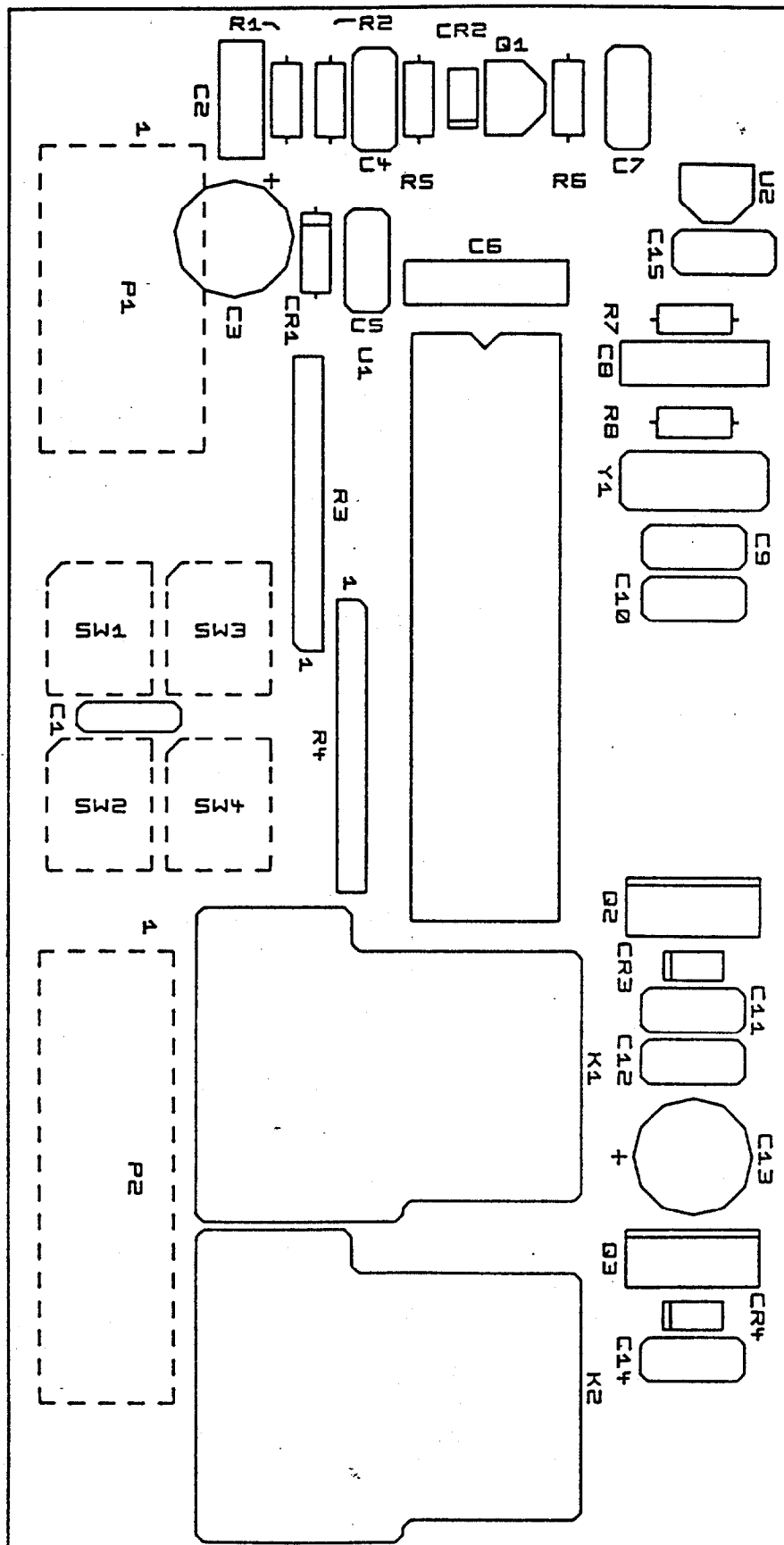
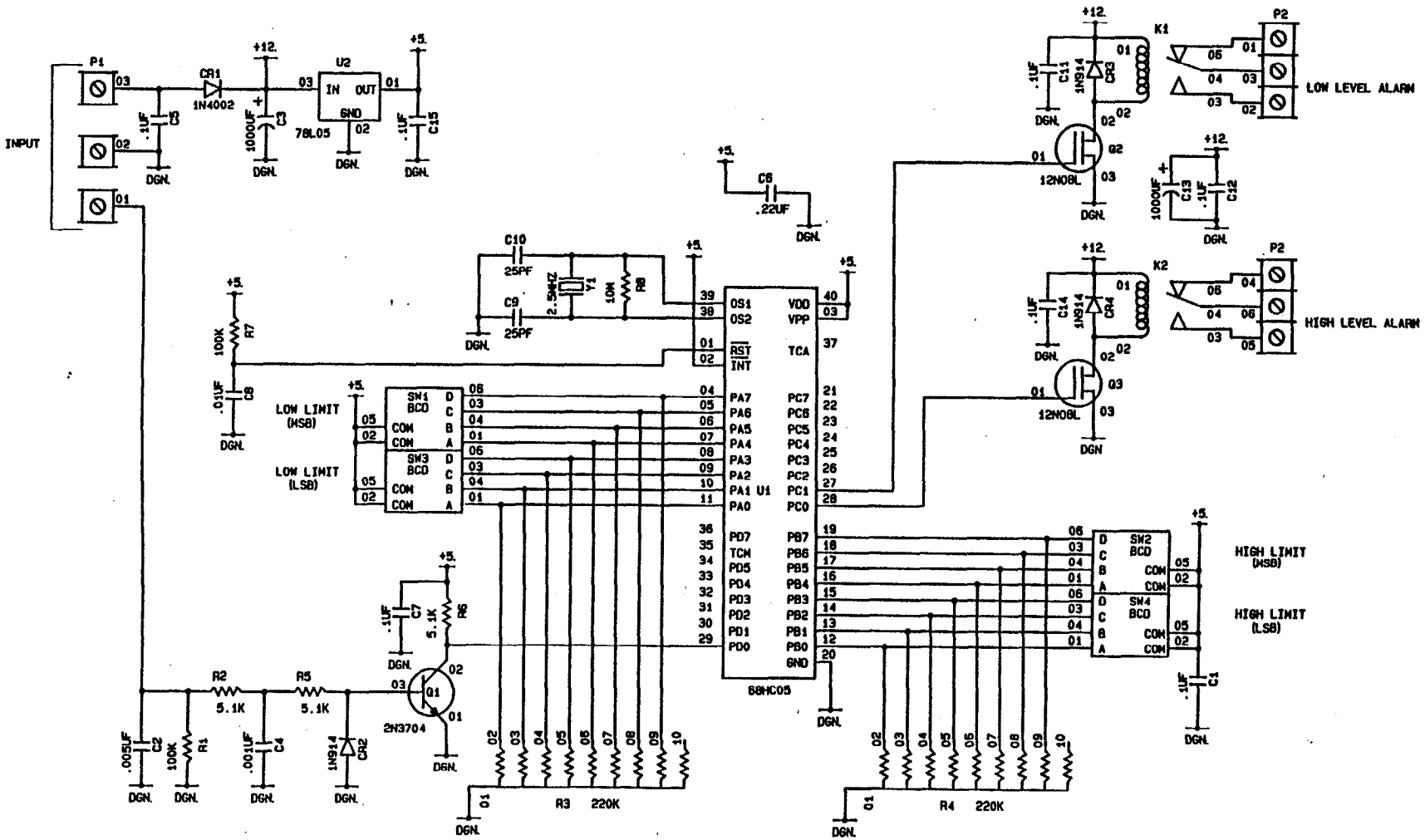
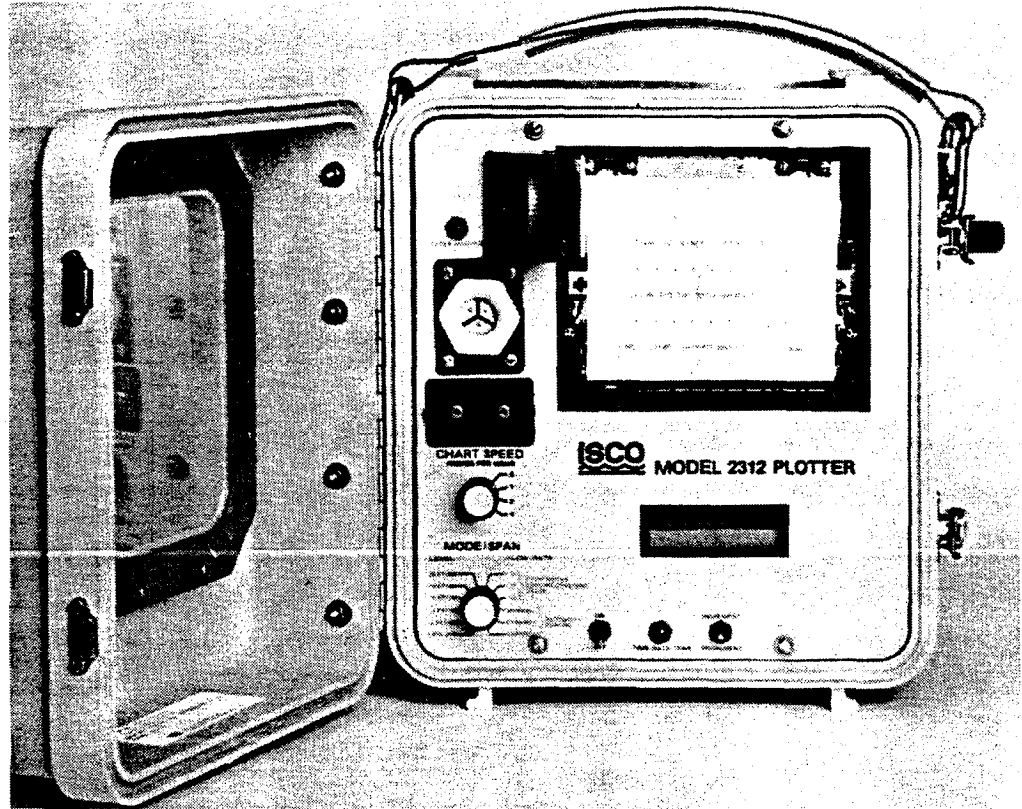


Figure 4.1-4 Schematic Diagram for the High-Low Alarm Relay Box



MODEL 3010

Figure 4.2-1 Model 2312 Plotter



4.2 Connection to an Isco Model 2312 Plotter - The Isco Model 2312 Plotter is available for the Model 3010. This device generates a stripchart record of flow rate versus time and a printed record of incremental total flow values referenced to a real time and date. You can connect the Model 2312 to the Model 3010 any time. The Model 3010 transmits data to the Model 2312 through a serial data loop. You can use both a Model 2312 and High-Low Alarm Boxes on the same data loop.

Installation - The Model 2312 is built in a structural-foam plastic enclosure, with a stainless steel mounting bracket attached to the back of the enclosure. The 3 slotted holes punched in the plate will accommodate $\frac{3}{16}$ " hardware. The mounting holes are on 3" centers.

NOTE

Do not install the Model 2312 Plotter outdoors unless the climate is very mild. The printer manufacturer does not specify use of the printer mechanism below 40°F (5°C) and it may operate erratically.

Wiring the Model 2312 to the Model 3010 - The plotter connects to the flow transmitter with a special 25-foot (7.6 meter) cable available from Isco. The cable has wire terminations on one end; the other has a 3-pin M/S connector. To connect the cable to the plotter, attach the 3-pin M/S connector on the cable to the **FLOW METER** connector on the side of the case. Attach the other end of the cable (wire terminations) to the **2312 INTERFACE** terminals inside the flow transmitter case on **TS2**. The connections are as follows:

BLACK	2312 INTERFACE +	TS2
GREEN	2312 INTERFACE -	TS2
WHITE	2312 INTERFACE OUT	TS2

MODEL 3010

For distances from 25 to 250 feet, you can use cable of your own selection. The cable should have 3 wires with # 18 AWG conductors. Electrically noisy environments may affect the quality of data transmitted, in which case you may have to use shielded cable. You will still have to use the 25-foot flow transmitter-to-plotter cable with your own cable to have the 3-pin M/S connector necessary to plug into the Model 2312. You must splice the 2 cables in a junction box, or you may also use a Quick-Disconnect Box like that used with the ultrasonic level sensor. Beyond 200 feet Isco recommends use of a special Y-Connect Cable and a separate power supply for the Model 2312. Consult the factory for more information about this cable.

NOTE

The Model 2312 Plotter normally receives its operating power from the Model 3010. While average power requirements are modest, peak currents of **3 Amperes** are needed to start the plotter motor. Isco recommends locating the Model 2312 no more than **200 feet** from the flow transmitter unless using a separate power supply.

Wiring the Model 2312 and Alarm Boxes Together - It is possible to have both a Model 2312 and High-Low Alarm Boxes wired to the Model 3010. All that is necessary is to make sure the wires from + , - and OUT of the 2312 INTERFACE terminals on TS2 in the Model 3010 connect to the same terminals at both the alarm box and the Model 2312 interconnect cable. You can run wiring from the Model 3010 to the alarm boxes and then to the Model 2312, or you can run two separate cables from the Model 3010, one to the alarm boxes and the other to the Model 2312, if location of either unit makes a common line impractical. Remember to stay within the distance limits given for both devices. Also, the alarm box has a terminal strip for wiring, while the Model 2312 has a 3-pin M/S connector. Therefore, it is better to connect the cable from the Model 3010 to the alarm boxes *first* and then continue on to the Model 2312. If you must put the wiring in conduit, *do not* use any conduit already containing other data lines or AC wiring inside.

4.2.1 Connection to Other External Serial Device - You can also use the terminals marked 2312 INTERFACE as a simplex serial output port providing ASCII level and flow-rate data for remote transmission. Every 30 seconds, the flow transmitter transmits a line of data which includes level, units of level measurement, percentage of maximum flow rate, maximum flow rate, a total-flow value, units of flow, sample number, and bottle number. If you are using the flow transmitter with an Isco sampler, the data line also includes an indication of a sampling event. You can transmit this data line to a computer, or connect it locally (within 250 feet) to a device capable of interpreting serial data, such as a video display terminal or a printer. The specifications for this serial data output are as follows: **300 baud, 7 data bits, 2 stop bits, even parity.** The printed (or displayed) line contains 110 characters and will appear similar to the following:

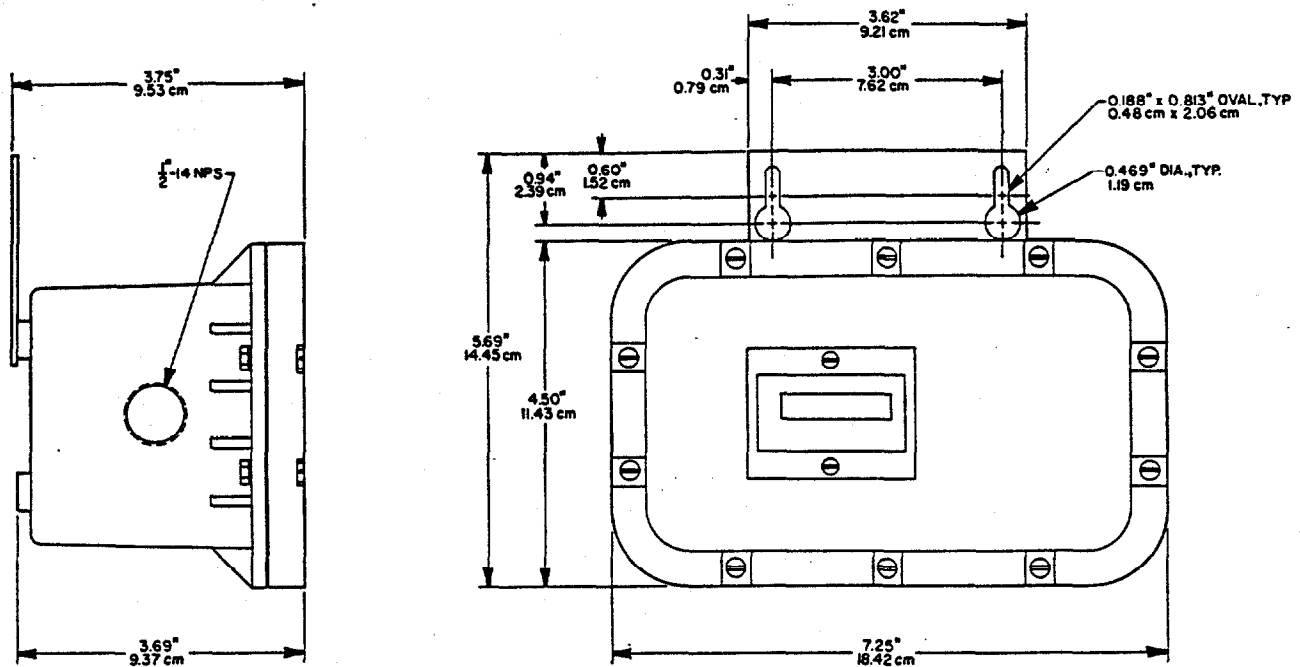
```
+ 01.409F 100.00% 2.500+ 0 CFS    0001533+ 0 CF    00 00
```

The first number is the level in feet. The second number is the percentage of flow rate at maximum head. The third number is maximum flow rate; the fourth is units of flow. The fifth is total flow and units of total flow. The sixth and seventh numbers are sample number and bottle number. The last two characters (not displayed) are a 'CR' (carriage return) and an 'LF' (line feed). The large gaps between some of the words indicate extra character spaces which are defined for a Model 2312, but not for the Model 3010.

4.3 Remote Totalizer - Isco offers a remote totalizer (Figure 4.3-1) for use with the Model 3010. It consists of a 7-digit, nonresettable mechanical counter mounted in a plastic enclosure similar to the alarm box and the Quick Disconnect Box. Mount the remote totalizer the same way as those units. See Section 4.1 for mounting details.

MODEL 3010

Figure 4.3-1 Remote Totalizer



Wiring - Connect the remote totalizer to the Model 3010 with a 2-wire cable. Use your own cable. If the installation is not in conduit, use Stahlin compression fittings to secure the cable to the enclosure. Isco recommends sheathed cable to protect the wires and to seal properly through the Stahlin fittings. Minimum wire size is # 18 AWG. Maximum distance between the Model 3010 and the remote totalizer is 1,000 feet (304.8 meters). Connect one wire of the cable to the + REMOTE TOTALIZER terminal in the flow transmitter on TS2. Connect the other wire to the - REMOTE TOTALIZER terminal in the flow transmitter. At the totalizer, connect the + wire to terminal 1 on the terminal strip and connect the - wire to terminal 2 on the terminal strip inside the enclosure.

4.4 Characterization PROM - You can program and change the details for flow rate through many different common primary devices simply by changing the program described in Chapter 2 or by entering values for the standard flow equation. Thus, the Model 3010 has generally eliminated the need for a Characterization PROM. However, if you face an unusual situation which is not supported by the choice of devices listed in Chapter 2 and on the flow meter's front panel, Isco will custom-program an IC to your specifications.

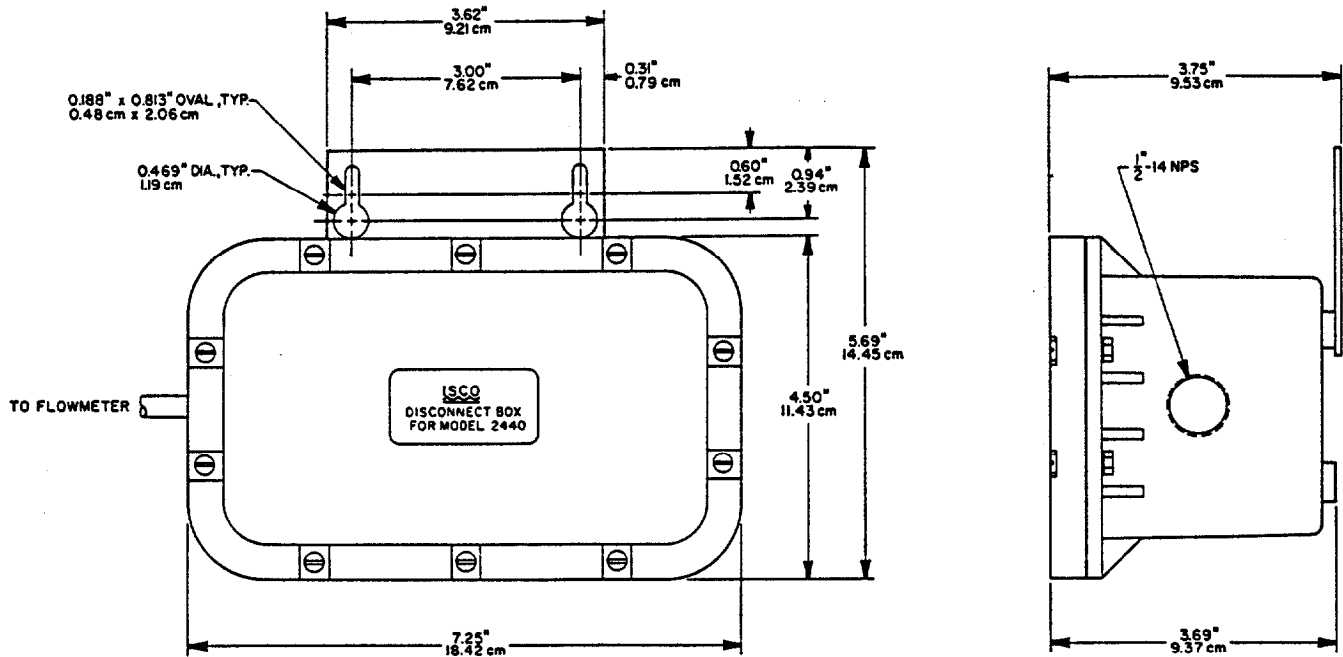
NOTE

The Characterization PROM used in the Model 3010 is not the same as that used in other Isco flow meters. Characterization PROMs programmed for other Isco flow meters (such as the 2870 or the 3200 series) will not work in the Model 3010.

Examples of flow situations where the Characterization PROM would be useful are compound weirs and flows involving the *Manning Equation*. You should only consider this option for flow transmitters dedicated to particular sites, as Isco cannot reprogram the PROM if the application changes later. The Characterization PROM can only support one device or application. Consult the factory for further information. If you need a Characterization PROM with your Model 3010, specify your intention at the time of the order. Otherwise, you must return the Model 3010 to the factory for programming and installation of the PROM.

MODEL 3010

Figure 4.5-1 Quick-Disconnect Box



NOTE

You must fill out a **Primary Device Characterization PROM Specification Sheet** to order the custom-programmed Characterization PROM. These specification sheets are available from Isco.

4.5 Extension Cables for the Ultrasonic Level Sensor - The ultrasonic level sensor used with the Model 3010 Flow Transmitter has a 50-foot (15.2 m) cable attached. Strip this cable and expose the wires. Connect these wires to the **ULTRASONIC SENSOR** and **TEMP SENSOR** terminals as described in Section 3.2.3. The cable can be cut to size, as necessary. For distances greater than 50 feet splice the ultrasonic level sensor to an extension cable inside an Isco Quick-Disconnect Box. Custom lengths of special cable from 50 to 950 feet are available from Isco as a special order.

NOTE

If you install the ultrasonic level sensor in a "hazardous location," as defined by the National Electrical Code, you must not use the Quick-Disconnect Box, nor install the Model 3010 inside the hazardous area. Refer to the control drawing **60-3403-175** for information on installation inside hazardous areas.

Connecting the Cables - The cable is custom-made for the ultrasonic application and contains a shielded pair, and four other wires inside another shield. You will not use all the conductors in the cable; you can simply cut off the red and violet wires. Use care in preparing the cable ends. Because this cable is unusual, we strongly urge that you use only Isco-supplied cable. Other cables will either be unshielded or will have all conductors shielded, which could cause electrical problems. See the installation section in Section 3.2.3 for information on how to strip and prepare the ultrasonic level sensor cable for wiring.

MODEL 3010

The extension cable is different from the cable attached to the transducer. The extension cable consists of a coaxial cable and a twisted pair all within a vinyl sheath. Remove about two inches of the outer sheath. Remove about one inch of the jacket on the coax. Twist the braided shield of the coax (the black cable inside the cable with a center conductor and surrounding shield) and remove the foil shield.

Installing the Quick-Disconnect Box - The Quick-Disconnect Box is a surface-mounted plastic enclosure similar to that used for the High-Low Alarm Relay Box described at the beginning of this chapter. Install this box the same way. See Section 4.1 for mounting details. Introduce the cables into the box with either conduit or Stahlin cord-grip fittings as code permits in your area. Strip the cables and attach them to the terminal strip inside the box. Connect cables are shown in the drawing accompanying the extension cable. Do not install the Quick-Disconnect Box where it may be subject to submersion or abuse. If you do not use any of the holes in the enclosure, make sure you replace the plugs.

4.6 Connection to the Model 2410 Circular Chart Recorder - The Model 2410 is a circular chart recorder manufactured for Isco. Its general application is to record varying level or flow-rate information on a circular chart paper record over a period of time. The time period is either 24 hours or seven days depending on which version of the Model 2410 you select. You must connect the Model 2410 to commercial 120 VAC power to drive its chart motor. This is described in detail in the manual supplied with each unit. The pen recording the level or flow rate on the chart is driven by the 4-20 mA output signal from the Model 3010. Contact the factory for additional information about the Model 2410.

Wiring - Select a 2-wire cable for interconnection. The conductors should be # 18 AWG and the wires should be color-coded. Maximum length is 1,000 feet. The recorder manufacturer suggests the use of *shielded* cable and this may be necessary in some instances, such as when the wire run is long, or where high electrical background noise is a problem. Where you make the installation with conduit, *do not run* the signal wires in the same conduit with AC power wiring.

Connect the cable to the 20 MA OUTPUT terminals of the Model 3010. Note which color conductor is on which terminal. For example, if the wires are black and white, connect the black wire to the + terminal of the 20 MA OUTPUT and the white wire to the - terminal of the 20 MA OUTPUT. Next, locate TB2 in the lower right-hand corner of the Model 2410 cabinet. Connect the + wire (black in this example) to terminal 1 of TB2 and the - wire (white in this example) to terminal 2 of TB2. Refer to the manual supplied with the Model 2410 for further information.

MODEL 3010

CHAPTER 5

5.0 ROUTINE MAINTENANCE AND TROUBLESHOOTING - This chapter of the Model 3010 Instruction Manual provides instructions on maintenance necessary to keep the flow transmitter in good operating condition. There are sections on cleaning the case and maintaining the ultrasonic level sensor, accessing mechanical and electrical components, fuse replacement, and the repair of CMOS circuitry. Also included are a general troubleshooting section, a replacement parts list, and an accessory parts list.

Familiarization With Maintenance Procedures Recommended - Isco recommends you become completely familiar with the routine maintenance presented here. While the Model 3010 is built to withstand severe field conditions, it will function best and remain most reliable if you perform these simple maintenance procedures.

5.1 Care of the Flow Transmitter Case - Normally the flow transmitter case should require little or no maintenance. In very dirty installations, the window may eventually become clouded. Clean it with a soapy rag, or spray it with an aerosol of mild detergent, and then wipe it dry with a clean, soft cloth. *Do not use* abrasives or any kind of solvent on the window, or the plastic may become scratched or cracked. Make sure the lid is tightly latched. Use compressed air to blow away dust and debris from the case.

Care of the Case Seal - Periodically inspect the case seal and clean it if necessary. The ridge around the edge of the back of the cabinet forms a seal with the groove in the cabinet door. Keep this seal free of dirt, sand, etc. If it isn't, clean it carefully with a damp cloth. The rubber gasket in the lid should also be clean; if not, you can clean it with a small brush and a damp cloth. If you do any cleaning while the case is open, be careful not to allow any dirt or debris to fall inside the flow transmitter case. If you install the flow transmitter outdoors and do not maintain the seals properly, they may leak, causing damage and eventual failure of the components inside.

Preventing Moisture Damage - To prevent damage to internal components, keep the lid tightly latched at all times, except when necessary to access the front panel to change the program. *Do not operate* the flow transmitter routinely with the case open; this exposes the internal components to dirt and moisture. This is particularly true when the flow transmitter is installed outdoors or in wet locations. *Do not operate* the flow transmitter with the protective cover over the wiring removed; this creates a shock hazard.

5.2 Care of the Ultrasonic Level Sensor and Cables - The ultrasonic level sensor requires little periodic maintenance. It is completely encapsulated to protect it from the environment. The level sensor's transmitting surface is rubber. *Do not scratch or score* the surface; or dig in the rubber; you may damage the transducer. *Do not drop* the assembly nor attempt to take it apart. The level sensor contains no user-serviceable parts. If the level sensor's bottom surface becomes contaminated due to long-term use or inadvertent submersion, it may not operate correctly (lost echo). If this happens, clean the ultrasonic level sensor. Clean the case with a brush. Clean the bottom surface of the level sensor with a soft brush, detergent and water.

5.2.1 Cable Inspection - Inspect the cables connecting the ultrasonic level sensor to the flow transmitter periodically for deterioration caused by physical abuse or exposure to the elements. Replace damaged cables because they may hinder or prevent proper operation of the ultrasonic level sensor.

MODEL 3010

In permanent installations, always install cables so they are not at risk of damage from other activity in the area. In temporary installations, avoid leaving cables where people can trip over them or heavy equipment can run over them. Cables exposed to abuse will fail and should be installed in conduit for protection.

5.3 Access to Mechanical and Electrical Components - The flow meter cabinet is divided into two sections, upper and lower. The upper section contains the circuitry for the microprocessor, the keypad, the driver for the ultrasonic level sensor, the totalizer, and the display. The board containing this circuitry (CPU) is enclosed in an aluminum shield for isolation and protection. Cables with connectors on both ends pass through the partition separating the sections to the lower section which contains the Terminal circuit board. See Figure 5.3-1 for a view of the aluminum cover and the cables. All wiring to the flow transmitter is connected to terminals on this board, which also contains the transformer, the beeper, sampler output relay, and fuse. This circuit board is covered with a protective shield to prevent accidental shock from touching the AC wiring below.

Accessing the Terminal PCB - First, remove the 4 screws holding the lower section face plate to the cabinet. This will expose the protective cover over the Terminal board. Remove the 4 screws from the protective cover. Pull out the cover. The Terminal board is now accessible.

WARNING

Hazard of electrocution! You can be killed if you touch the AC connections exposed on this board. Do not wire or attempt troubleshooting with power connected. Disconnect power at the breaker panel or cutoff switch before changing the fuse, wiring, or removing the circuit boards.

Accessing the Flow Transmitter PCB - First, remove the 4 Phillips screws holding the upper section face plate to the cabinet. Carefully lift off the plate. The main circuit board is inside the aluminum housing. See Figure 5.3-2. Remove the nuts holding the aluminum shield. Lift off the aluminum shield. Note the 2 connectors with cables coming from the lower section of the case. Disconnect them at either end by pulling vertically from the board.

CAUTION

The Flow Transmitter circuit board contains CMOS semiconductors, which are easily destroyed by the discharge of static electricity. Do not attempt to make repairs at the job site. Return the board to the factory for servicing or make repairs at an appropriately-equipped service area. See also Section 5.6.3

5.4 Fuse Replacement - With the lower section of the cabinet open, you can change the fuse. The fuse is located on the Terminal PCB on the left side of the board. It is visible when the protective cover is off. See Figure 1.4-2. The fuse is labeled F1. The proper size for this fuse is:

1/2 amp., Slow Blow

Always replace a blown fuse with one of the same rating. Using a larger fuse could cause serious damage to the flow transmitter and could even cause a fire hazard by burning up the transformer if there is a severe short on the secondary. ***Turn off power before changing the fuse.*** If the new fuse blows immediately after power is restored, there is a serious problem. Either have qualified personnel repair the flow transmitter or return it to the factory for repair.

MODEL 3010

5.5 Display Warnings - The Model 3010 LCD displays various error messages to warn the user of problems in the program, or difficulties inside the flow transmitter. Messages will generally assume the format of:

EE - X

(the X represents a number or numbers from 1-80.)

As mentioned in Chapter 2, a message of *EE-80* indicates a failure to detect a return echo. A message of *EE-19* indicates that the temperature probe in the ultrasonic level sensor is disconnected. Other codes are indicative of software errors and are of no particular concern to the user. If they appear, exit the program by pressing CLEAR ENTRY twice and start the programming sequence over. *A repeated error message which will not clear or which prevents programming is indication of a serious internal problem and may require service.*

5.6 Hints on Troubleshooting - The electronic circuitry of the Model 3010 is solid-state and its reliability is high. If the unit fails to work properly, the problem is most likely a mechanical failure. Be sure to check items such as poor wiring connections or dirty surface on the ultrasonic level sensor before assuming the flow transmitter has failed.

CAUTION

Do not attempt to service the Model 3010 Flow Transmitter unless you are skilled in the analysis and repair of digital circuits. You must also know how to work safely with AC-powered equipment.

If the technical information presented in the following sections is not clear to you, please do not attempt to go any further than changing the fuse, or cleaning the ultrasonic level sensor.

Please refer all other repairs to qualified service personnel or organizations. Improperly-made repairs may cause far more serious damage to the unit than the original problem.

If Serious Problems Occur - If you suspect an electronic problem, Isco strongly recommends you call our Isco Customer Service Department at (800) 228-4373 or (402) 474-2233 outside the U.S.A. The service department will advise you how to return the Model 3010 to the factory. Due to the complex nature of microprocessor-based circuitry, specialized knowledge and instrumentation are required for troubleshooting. The Isco service department has trained technicians and specially-designed equipment necessary for timely, efficient repairs. If you still wish to attempt repairs, the Isco Customer Service Department is available to provide advice and information on servicing.

Processor Servicing Complicated - Servicing circuitry controlled by a microprocessor is difficult when the program that controls it is not understood completely, especially when there is no way to know whether the microprocessor and memory are good. Therefore, when attempting to isolate problems within the unit, assume the CPU and memory are working properly until you have exhausted attempts to find problems in the rest of the circuitry. We advise you to do this for two reasons: first, the likelihood of failure is far greater on transistor drive circuits (heavier currents pass through here), than on the CPU or memory. Second, it is doubtful whether the repair facility would have the time or equipment to do worthwhile troubleshooting (beyond changing components) on the CPU or memory.

5.6.1 Preliminary Troubleshooting Steps - Following are suggested areas to check before attempting to service the microprocessor CPU and associated circuitry.

MODEL 3010

- *Check the fuse and the 120 VAC supply for the flow transmitter.*

Sometimes equipment appears to have failed completely when the real problem is only disconnection of the AC power source. Either a blown fuse, or someone accidentally flipping off the breaker can cause this. Also make sure the voltage selector switch on the terminal printed circuit board is in the correct position.

- *Look for evidence of physical damage.*

You can usually identify readily burned or broken components, broken wires, overheated components, burned foil traces on the board, stuck or inoperative switches, loose or wrong connections, or evidence of water damage.

- *Consider the possibility of a lightning strike.*

Unexplainably large numbers of bad semiconductors, burnt components or parts of the board are indications that lightning has struck nearby. A close hit can destroy most of the components on the board, especially the semiconductors. In such cases, you are better off to replace the board outright, rather than attempt to make repairs.

- *Look for shorted or open diodes and transistors.*

Semiconductors, particularly power-handling ones, are prone to failure from short-circuiting, and you can usually identify this with an ordinary ohmmeter. Note however, that you cannot identify failed power MOS semiconductors this way.

- *Check to see that voltage regulators are working properly.*

Properly working voltage regulators should operate within 5% of their rated value or better. A low 5-volt rail is an almost certain sign of trouble. Check to see there is no abnormal current draw in part or all of the circuitry. (Abnormal current draw will usually be indicated by the noticeable overheating of a voltage regulator, current-limiting resistor, or some other part of the circuit.)

- *Make sure the crystal oscillator is running and at the proper frequency.*

5.6.2 Precautions for Servicing AC Powered Equipment - The Model 3010 Flow Transmitter is a low-voltage, DC-powered device, and hazardous voltages are not present on the CPU board. However, the unit converts power from 120 or 240 VAC to the DC used to run the flow transmitter. As a result, hazardous voltages *are* present on the 3 terminals of TS1 and some other places. Because of the shock hazard, Isco suggests the following:

- *Use a 1:1 isolation transformer.*

An isolation transformer separates the power needed for the flow transmitter from the commercial power supply, relieving the danger of electrocution from accidental grounding. Such transformers are available from electrical and electronic supply houses in various sizes. Regulated versions are even available. A 50 VA rating is sufficient for working on the Model 3010. Any knowledgeable technician can also "make" an isolation transformer by connecting two identical transformers (voltage and VA rating) back-to-back. You should still be very careful however, because the isolation transformer only isolates you from the grounded AC system. The voltage coming out of the isolation transformer is hazardous, easily carrying enough current to kill.

- *Use a GFCI-protected outlet.*

MODEL 3010

If you cannot find an isolation transformer, at least make sure the AC power source is protected by a *GFCI* (Ground Fault Circuit Interrupter) breaker or outlet. If there is accidental grounding, the GFCI will trip quickly, stopping the current flow.

- *Avoid working on the terminal board while it is connected to AC.*

Make use of visual and low-voltage continuity and resistance checks as much as possible on this circuit board.

- *If you must work on the terminal board with power applied, use extreme caution.*

Do not touch any part of the high voltage side of the circuit (TS1, fuse and transformer primary) with fingers or hands. Use *insulated* tools only. Remember that the voltage here is potentially fatal whether grounding is involved or not. Note that in general, the components on the terminal board (other than the fuse) are relatively unlikely to fail. It would be more worthwhile to concentrate troubleshooting on the CPU circuit board.

Use of an isolation transformer will eliminate the possibility of shocks resulting from accidental grounding. Use of a GFCI will disconnect the power source quickly in case of an accidental ground. While wrist grounding is necessary for the safe servicing of CMOS components (see the following section), do not use a "hard" ground (less than 10,000 ohms), because that will cause any shock received to be severe or even fatal, due to the excellent connection between body and earth ground. Instead, use a grounding strap with at least *one megohm* resistance, which is adequate for discharging static while at the same time safe for working with higher voltages.

5.6.3 Precautions for Servicing CMOS Circuitry - Most of the circuitry in the Model 3010 Flow Transmitter is made up of CMOS components. Because of the oxide gate structure of these devices, they are extremely susceptible to destruction caused by the discharge of static electricity through their inputs. Note that many of the driver transistors in the Model 3010 are power MOS devices; they are as susceptible to static damage as CMOS ICs. Because of this risk, you must take certain precautions when working on these circuits.

Hazard of Static Electricity - The voltage levels present from static buildup caused by walking over carpeted floors, movement of woolen or synthetic clothes over chair seats, workbenches, etc., are high enough to destroy CMOS circuitry when performing repair work. Ideally, you should ground all tools, soldering irons, etc., and you should do repair work on a grounded metal workbench, with grounding straps worn on your wrists. It is recognized that in most field repair situations, such precautions are impractical. However, you ought to avoid certain extreme hazards.

- *Never perform any work in a room with a carpeted floor.*
- *Always roll up workclothes' sleeves so that your arms are in contact with the working surface.*
- *Avoid using a work surface made of an extremely good insulator.*

Avoid plastic counter tops or glass as they are good insulators. A metal surface is best, but do not let components connected to the AC line touch a metal surface, particularly a grounded one. Wood or compressed wood byproduct surfaces are marginal and we do not recommend them for use in winter or for severely dry environments. Conductive grounding mats are available for workstations and are the best solution for discharging static and allowing safe repair of AC-powered equipment.

MODEL 3010

- *The degree of hazard depends on the level of humidity.*

Be particularly careful if the work area is extremely dry, or if the work is being done in the winter, when forced heating and cold outdoor temperatures make relative humidity levels very low. Installing a humidifier in the work area is a good idea.

- *Keep yourself grounded when handling disassembled equipment.*

If you have opened a unit for repair, make an effort always to touch the metal chassis before touching any of the circuit components. Note, however, the precautions about working on AC-powered equipment outlined in Section 5.6.2.

- *Be especially careful handling the CMOS integrated circuits when they are separated from the rest of the circuitry.*

Simply being connected to the rest of the circuitry provides some protection. Most of the circuitry is well-protected from damage caused by static discharge when the unit is powered up. However, never replace an IC when the unit is turned on.

- *Always transport individual CMOS semiconductors and built-up printed circuit boards in conductive packaging.*

Foil is satisfactory; metallized plastic bags are also available and work well. Ordinary plastic bags and "pink poly" are not satisfactory unless the IC legs or leads are also pressed into a block of black conductive foam. If replacement components do not come in marked, protective packaging, do not use them. They may already be destroyed.

- *Once assembled and soldered, printed circuit boards are easily damaged by improper repair procedures.*

Do not attempt to remove components, particularly ICs, from printed circuit boards unless you are skilled at this procedure. You can find a defective component, change it, and the unit will still not work if too much heat or pressure break the foil traces or pulls the copper cores out of holes on the board. The simplest method for removing ICs is to cut off the legs at the chip body, remove the chip, and then unsolder the legs from the board one at a time. Finally, clear the holes with a vacuum pump or solder sucker.

Contact Customer Service - If trouble symptoms persist and cannot be located, call the Customer Service Department, at (800) 228-4373. Outside the U.S.A. call (402) 474-2233.

5.7 Circuit Boards - The Model 3010 is a microprocessor-based instrument that executes a program stored in its program memory. The circuitry (hardware) is discussed below. Because of the difficulty and specialized equipment necessary to check program "software," its detailed description is beyond the scope of this manual. The Model 3010 Flow Transmitter contains three printed circuit boards. The keypad is mounted under an aluminum plate just behind the top front panel. It connects to the ultrasonic board with a cable and connector. The CPU and ultrasonic board are inside the chassis in the top section of the flow transmitter. The display is attached to the ultrasonic board.

5.7.1 Terminal Board - The terminal strip board is mounted in the bottom section of the flow transmitter cabinet under a protective cover. All field and power wiring brought into the flow transmitter is connected to this board. Connectors carry power and various signals to the CPU board which is mounted in the upper half of the flow transmitter cabinet in an aluminum housing. Switch SW1 selects the input power voltage—120 or 240 volts.

WARNING

Hazard of electrocution! You can be killed if you touch the AC connections exposed on this board. Do not attempt troubleshooting with power connected. Otherwise, Isco recommends only visual inspection or simple continuity checking with no power applied to the board.

AC power enters the board on TS1 and energizes the transformer T1 primary. F1, a ½ Ampere slow-blow fuse, protects the entire circuit. C1, C2, L1, and L2 provide transient suppression. Transistor Q1 drives the beeper. The relay provides flow pulses to the sampler. The remainder of the board essentially carries logic level signals from the main CPU board to the various terminals on TS2 and TS3.

5.7.2 CPU Board - Typically an integrated circuit contains one or more related functions and is generally referred to in only one part of the circuit description. However, on this board we use a Gate Array (U4) which contains enough circuitry to replace an entire board. To make as much use of this chip as possible, we used many of its elements for different functions all over the circuit. Because of this, we will refer to the Gate Array many times in discussions of both the CPU and Ultrasonic boards. Because the Gate Array has the complexity of a printed circuit board, the manual includes a schematic of the chip and there will be a detailed description of it.

U6 is the microprocessor which controls the flow transmitter. U5 is an EPROM used to store the program for the microprocessor. U3 is a RAM where all temporary information and machine status are stored. Part of U4 is used to decode the address bus signals from the microprocessor selecting the ROM and RAM when they are needed.

Q9 converts the event mark into a 5-volt logic signal. Q10 converts bottle count into a 5-volt logic signal. The digital circuit for counting pulses on the bottle count and event mark signals is in U4.

Two signals from U4 supply both phases of the ultrasonic transmit signal, then buffered by U15. The outputs of U15 drive Q11 and Q12 which are the high power drivers for the ultrasonic transducer. This high power signal then goes through T1, which steps the voltage up to several hundred volts. L1, CR11 and CR12 block this high voltage transmit signal and pass the low voltage signal from the return echo. The low voltage return echo signal goes to the ultrasonic board where it is used to determine the distance between the transducer and water.

U16 is the + 12 volt regulator. U14 is the + 5 volt regulator. U17 is the -12 volt regulator. U13 is a + 12 volt regulator for the external circuits so if some of the external wiring is shorted or damaged, the flow transmitter will not quit or be damaged. U18 is a 5-volt regulator used for the optically isolated 4 to 20 mA current driver.

The signal driving Q2 and Q3 comes from U4. These transistors drive optical isolators U7 and U8, which provide electrical isolation for the 4 to 20 mA circuit. U7 and U8 send digital signals to U9, which converts these digital signals to an analog voltage level. U10, Q4, and R23 then convert this signal into a current where 4 mA represents 0% and 20 mA represents 100%.

CR10 and half of U12 form a voltage reference for U11 and the temperature sensor in the ultrasonic transducer. U11 is used to convert a voltage signal from the temperature sensor into a digital number. The digital signal from U11 is sent to U4 where it is read by the microprocessor.

MODEL 3010

The second half of U12 and transistors Q7 and Q8 form the output driver for the Model 2312 output. Q1 is the output driver for the totalizer. Q6 is the output driver for the remote totalizer. Q5 is the output driver for the sampler output.

5.7.3 Ultrasonic Board Description - U3 is a frequency divider circuit used by the microprocessor to control the frequency of the signal transmitted to the ultrasonic transducer. It receives signals from the Gate Array on the CPU board that cause it to change its output frequency to the optimal value for the transducer. U1 and U2 form a voltage-controlled oscillator (VCO) driven by U3. U1, U2, and U3 work together to form a phase-locked loop that does the frequency control described above.

U16 is a D/A converter which provides a voltage to half of U15. U15 converts this voltage to a current that is proportional to the digital number stored in U16 by the microprocessor. This current is used for gain control in one of the circuits in U14. U17 and the rest of U15 works the same as described above to provide gain control for the other amplifier in U14. These two gain control blocks amplify the return echo and provide compensation for changes in the size of the return echo.

U9, U10, and U11 provide gain and filtering for the return echo. U8 rectifies and filters the return echo. U6 and U7 detect the return echo and cause circuitry in the gate array on the CPU board to collect and store a data point. U4 is a timer that provides timing used by the gate array to collect and store the data. U5 provides blanking for the ultrasonic to prevent data collection when there is not a valid return echo.

U12 and U13 receive information from the gate array which is used to drive the LCD display.

5.7.4 Gate Array Description - In the upper right corner of the Gate Array schematic there is a box labeled "decode." This box is the address decoding circuitry used for ROM and RAM chip selects. There are five other boxes labeled "decode," used to decode the I/O ports. Some of these decoders select external devices, such as the D - A converters and the display drivers on the Ultrasonic board. Others select ports and functions which are inside the gate array, such as the three output buffers labeled "RD8" in the lower right corner.

These RD8 outputs are used to drive the EEPROM, reset event marks and bottle counts, turn on the beeper, drive the 4 to 20 mA output, sampler output, totalizer output and output row strobes to the key board. The HX244 in the lower right corner is an input buffer used to read data in from the EEPROM, and from the keyboard column lines.

The box labeled "C16BARD" to the left of the ports, is a counter which divides the frequency of the microprocessor clock to lower frequencies. These lower frequencies are used by the temperature A/D converter and by the ultrasonic data collection circuit.

In the bottom center part of the schematic there are four C16BARDs and two HX374. These are counters and latches used to input data from the temperature A - D converter.

In the lower left corner are 2 C16BARD counters, a HX244 latch and a FORD flipflop. These are used to count bottle numbers and event marks.

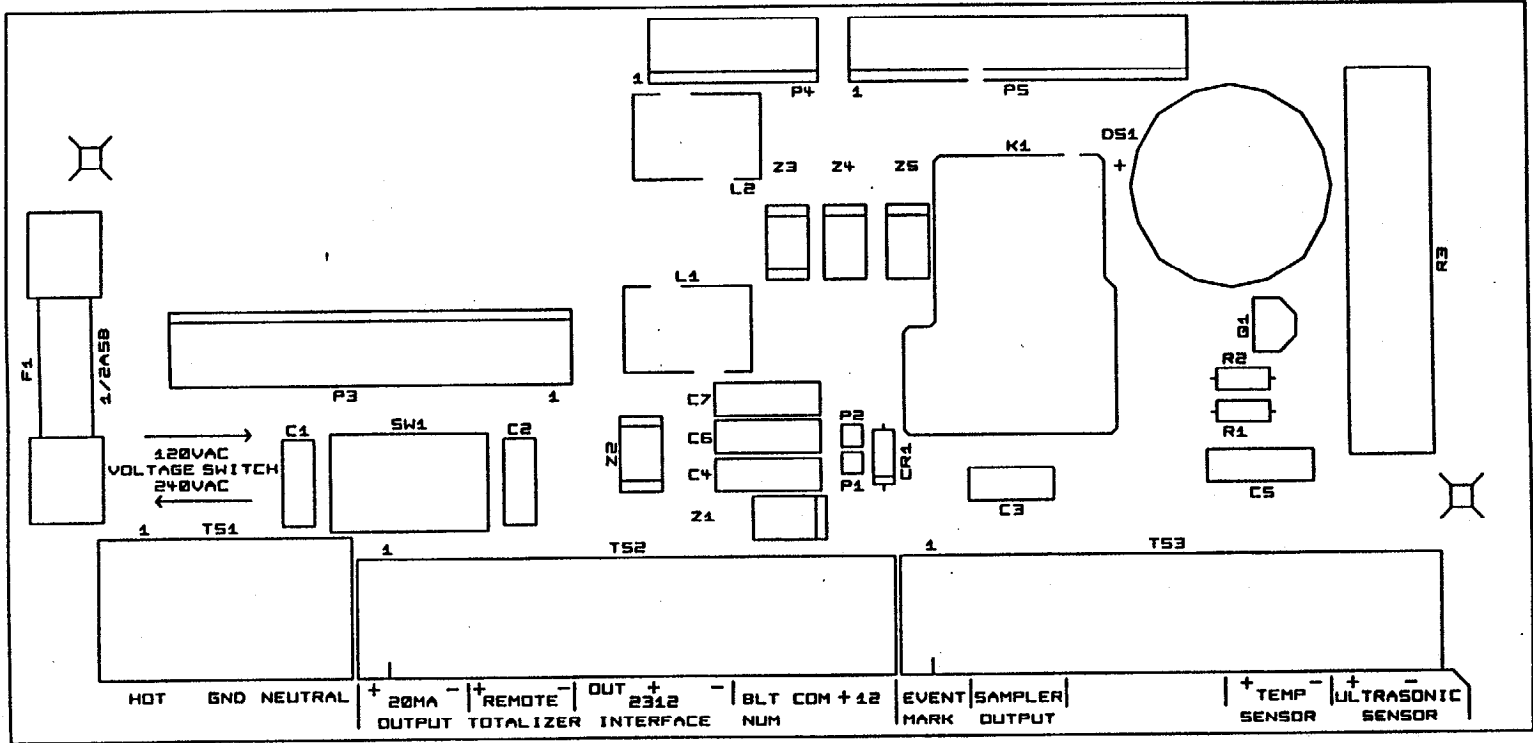
From the center of the schematic to the middle of the left side are six C16BARD counters, two HX374 latches, five FORD flipflops and one FTORD flipflop. This part of the circuit is used to collect time and amplitude information from the return echo.

MODEL 3010

There are two flipflops, an FTO and an FDRD, in the top left corner of the schematic. These are used to generate both phases of the ultrasonic transmit pulse. The circuits labeled OBUFZ, IBUFs, TBUFs and BPADs in the top center portion of the schematic are tristate buffers used to interface with the microprocessor data bus.

- 5.8 Replacement Parts List** - You can find a list of common replacement parts for use with the Model 3010 Flow Transmitter at the end of this chapter. When ordering a replacement part, be sure to include the Isco assembly or part number, a complete description, and the serial number of the flow transmitter on which the part is going to be used.
- 5.9 Accessory Parts List** - You can find a list of optional and accessory parts used with the Model 3010 Flow Transmitter at the end of the **Replacement Parts List** described in Section 5.8 above. When ordering an optional or accessory part, include the model number (if given), description, and Isco part number.

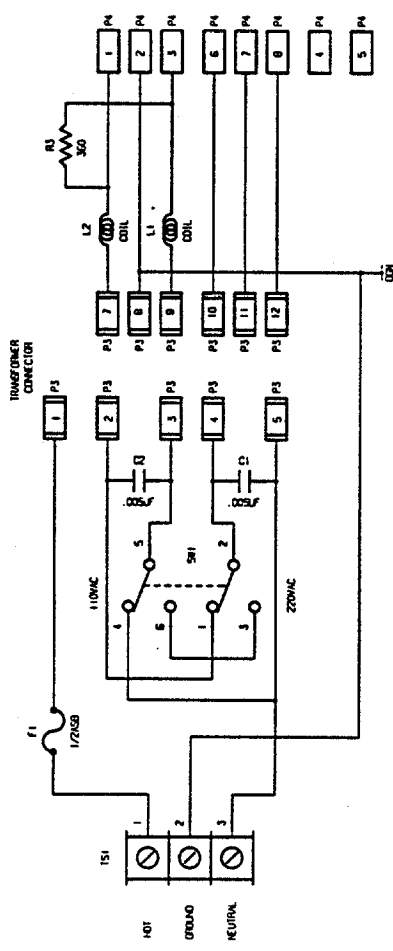
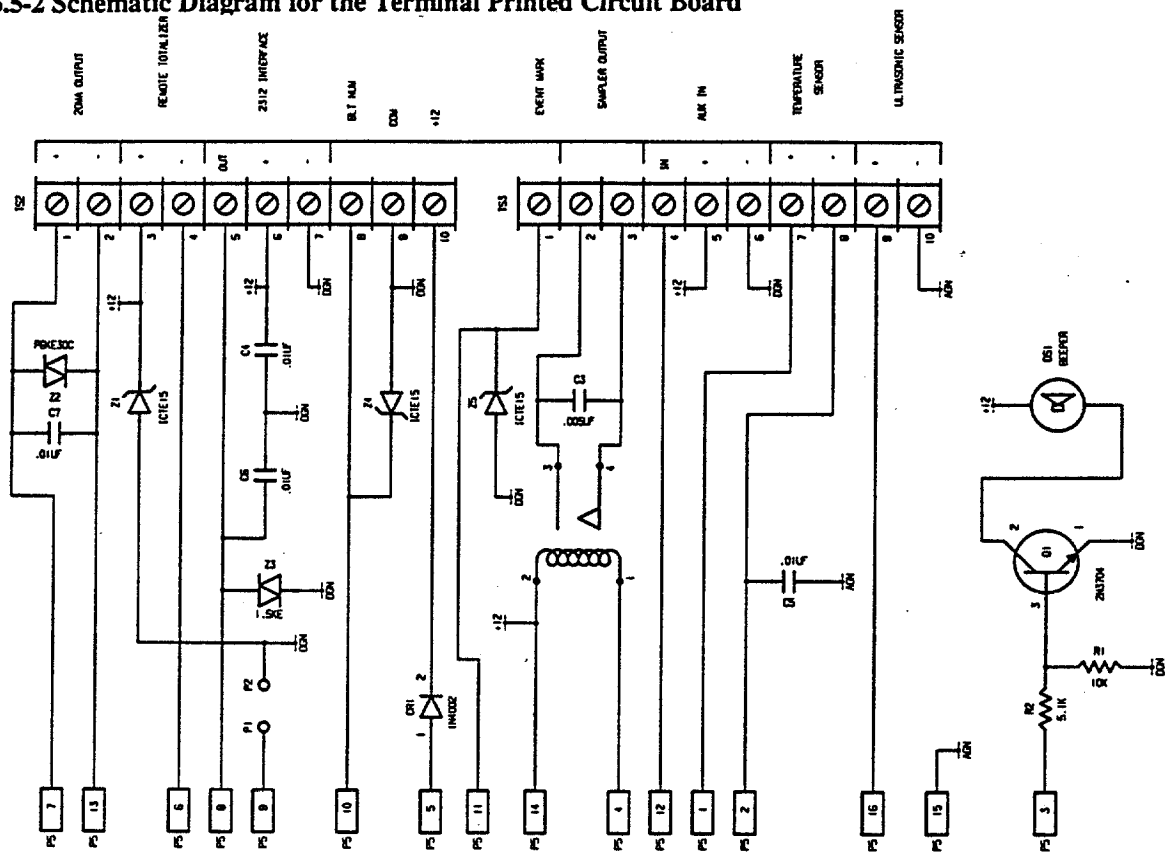
Figure 5.5-1 Component Layout for the Terminal Printed Circuit Board



60 3403 185 C

MODEL 3010

Figure 5.5-2 Schematic Diagram for the Terminal Printed Circuit Board



T1 WIRING	
WIRE COLOR	PIN #
VIOLET	1
WHITE/BLACK	2
BLACK	3
WHITE/BLUE	4
BLUE	5
GREEN	6
OPEN	7
WHITE/GREEN	8
GREEN	9
BROWN	10
WHITE/BROWN	11
BROWN	12

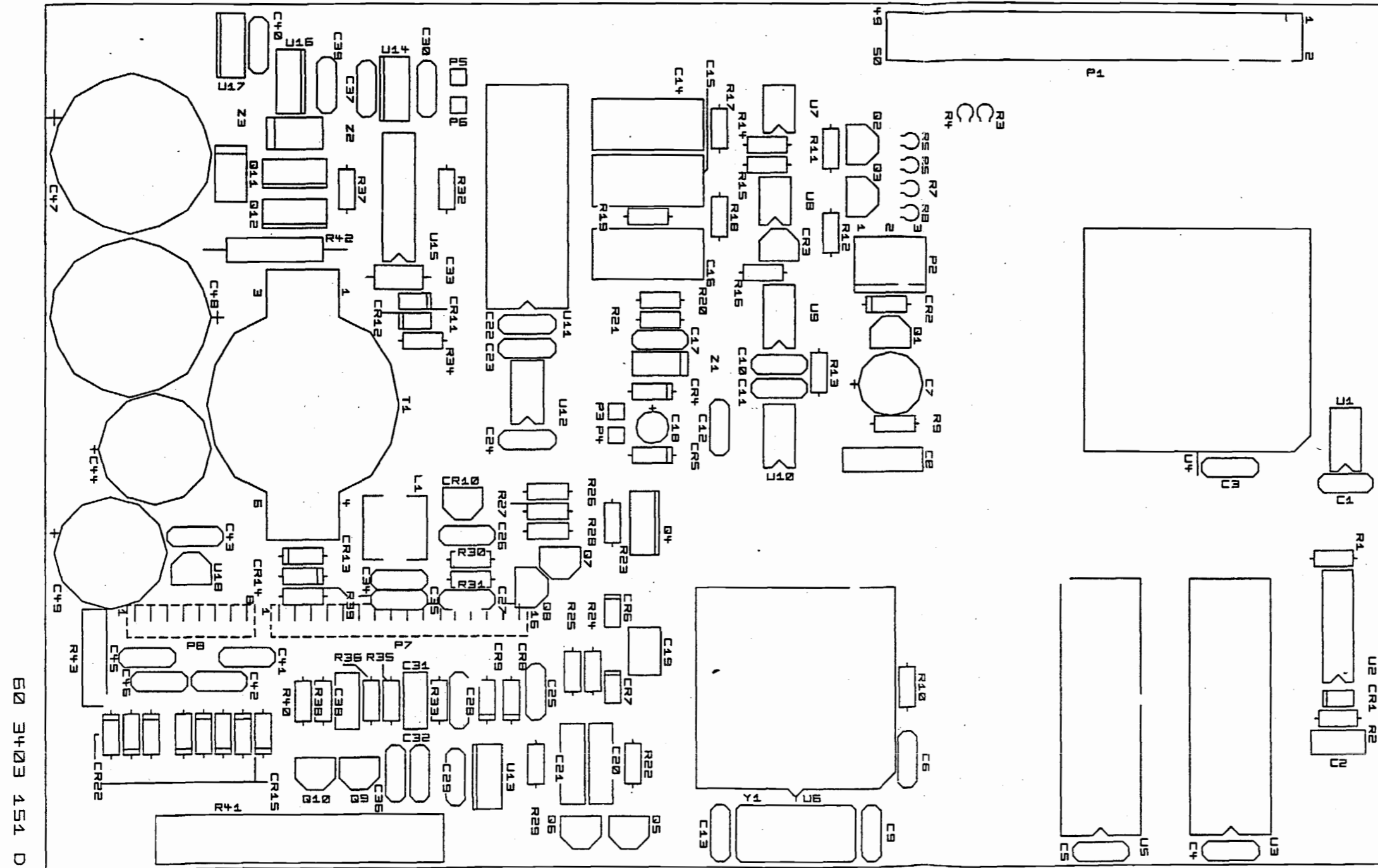
CPU PDB TO TERMINAL PDB WIRING ADDRESS PIN TO PIN CONNECTIONS	
CPU PDB P2-3010, P7-3010*	P5-TERMINAL PDB
1 - ULTRASONIC TRANSMIT.....	16 - ULTRASONIC TRANSMIT.....
2 - ULTRASONIC GROUND.....	15 - ULTRASONIC GROUND.....
3 - SAMPLER OUTPUT.....	14 - SAMPLER OUTPUT.....
4 - 4-ZONA CURRENT OUTPUT.....	13 - 4-ZONA CURRENT OUTPUT.....
5 - KEY.....	12 - KEY.....
6 - EVENTMARK IN.....	11 - EVENTMARK IN.....
7 - BOTTLE COUNT.....	10 - BOTTLE COUNT.....
8 - RESET.....	9 - RESET.....
9 - 2312 OUTPUT.....	8 - 2312 OUTPUT.....
10 - 4-ZONA CURRENT OUTPUT.....	7 - 4-ZONA CURRENT OUTPUT.....
11 - REMOTE TOTALIZER.....	6 - REMOTE TOTALIZER.....
12 - EVENTMARK OUT.....	5 - EVENTMARK OUT.....
13 - SAMPLER OUTPUT.....	4 - SAMPLER OUTPUT.....
14 - BEEPER.....	3 - BEEPER.....
15 - TEMPERATURE PROBE.....	2 - TEMPERATURE PROBE.....
16 - TEMPERATURE PROBE.....	1 - TEMPERATURE PROBE.....

CPU PDB P5-3010, P8-3010*	
P4-TERMINAL PDB	P4-TERMINAL PDB
1 - ISOLATED 24VAC.....	8 - ISOLATED 24VAC.....
2 - ISOLATED 24VAC CT.....	7 - ISOLATED 24VAC CT.....
3 - ISOLATED 24VAC.....	6 - ISOLATED 24VAC.....
4 - KEY.....	5 - KEY.....
5 - KEY.....	4 - KEY.....
6 - 24VAC IN.....	3 - 24VAC IN.....
7 - 24VAC CT.....	2 - 24VAC CT.....
8 - 24VAC IN.....	1 - 24VAC IN.....

FOR PDB # 50-3403-105 C

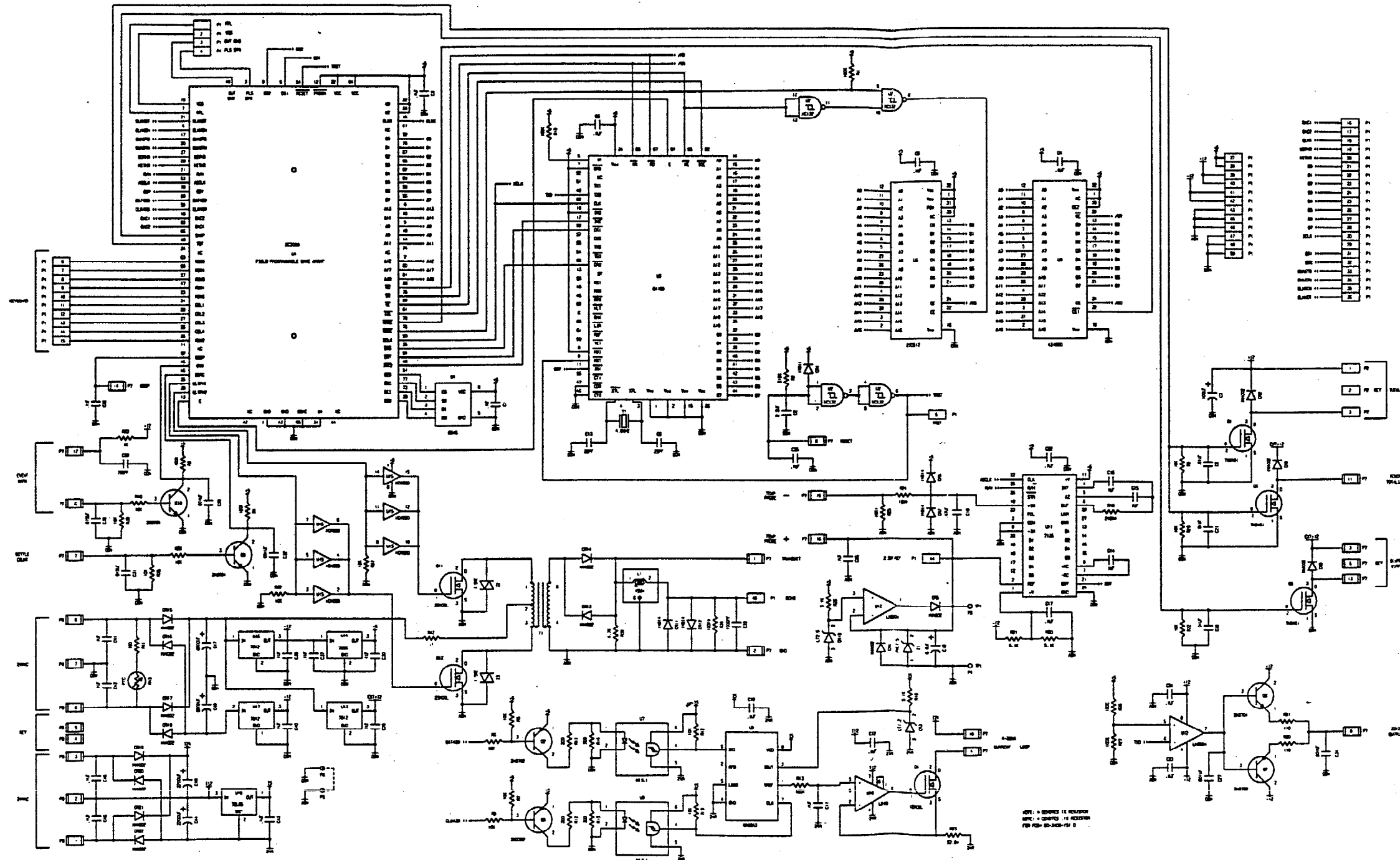
MODEL 3010

Figure 5.5-3 Component Layout for the CPU Printed Circuit Board



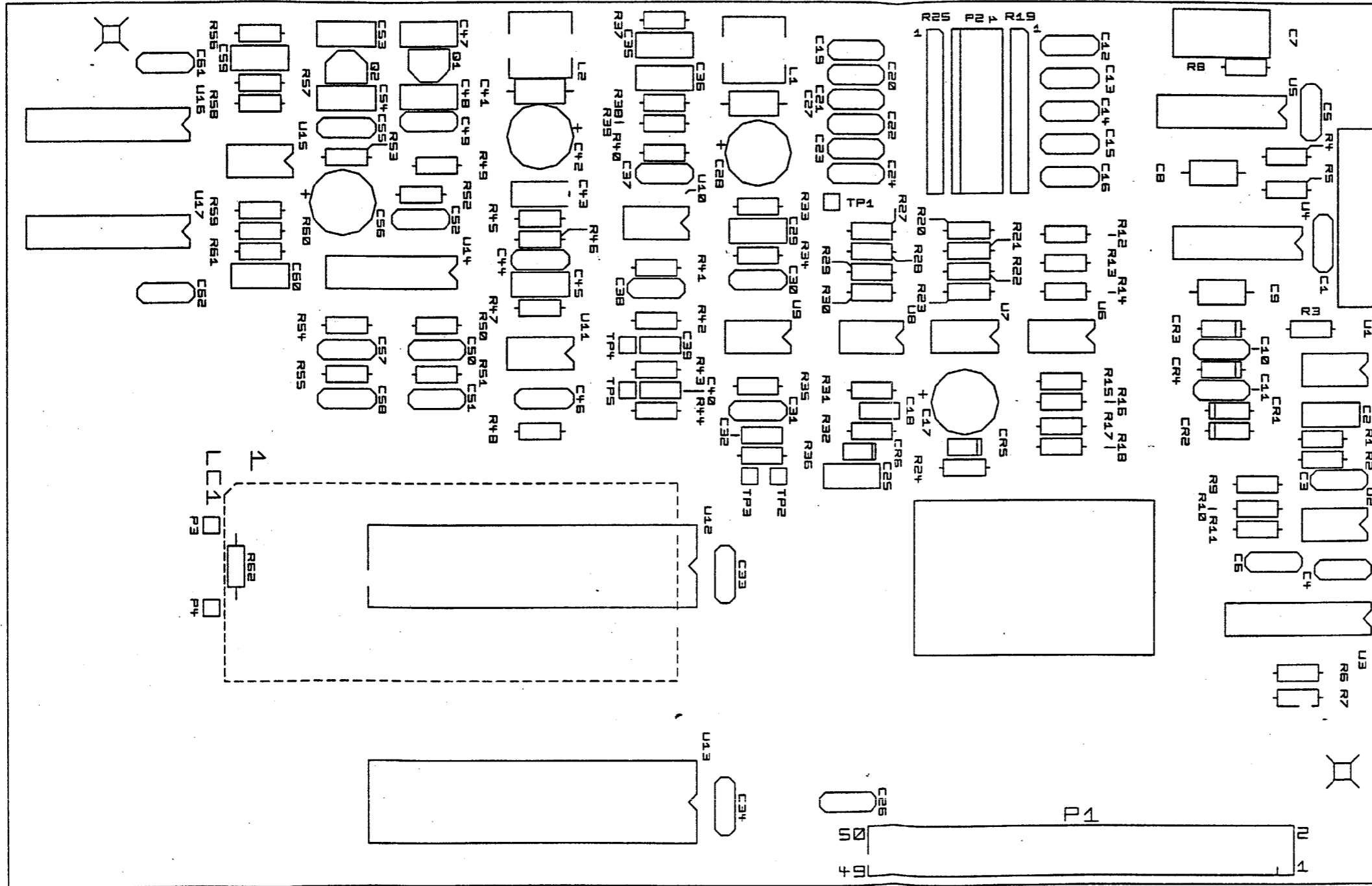
02350HH B3Z

Figure 5.5-4 Schematic Diagram for the CPU Printed Circuit Board



MODEL 3010

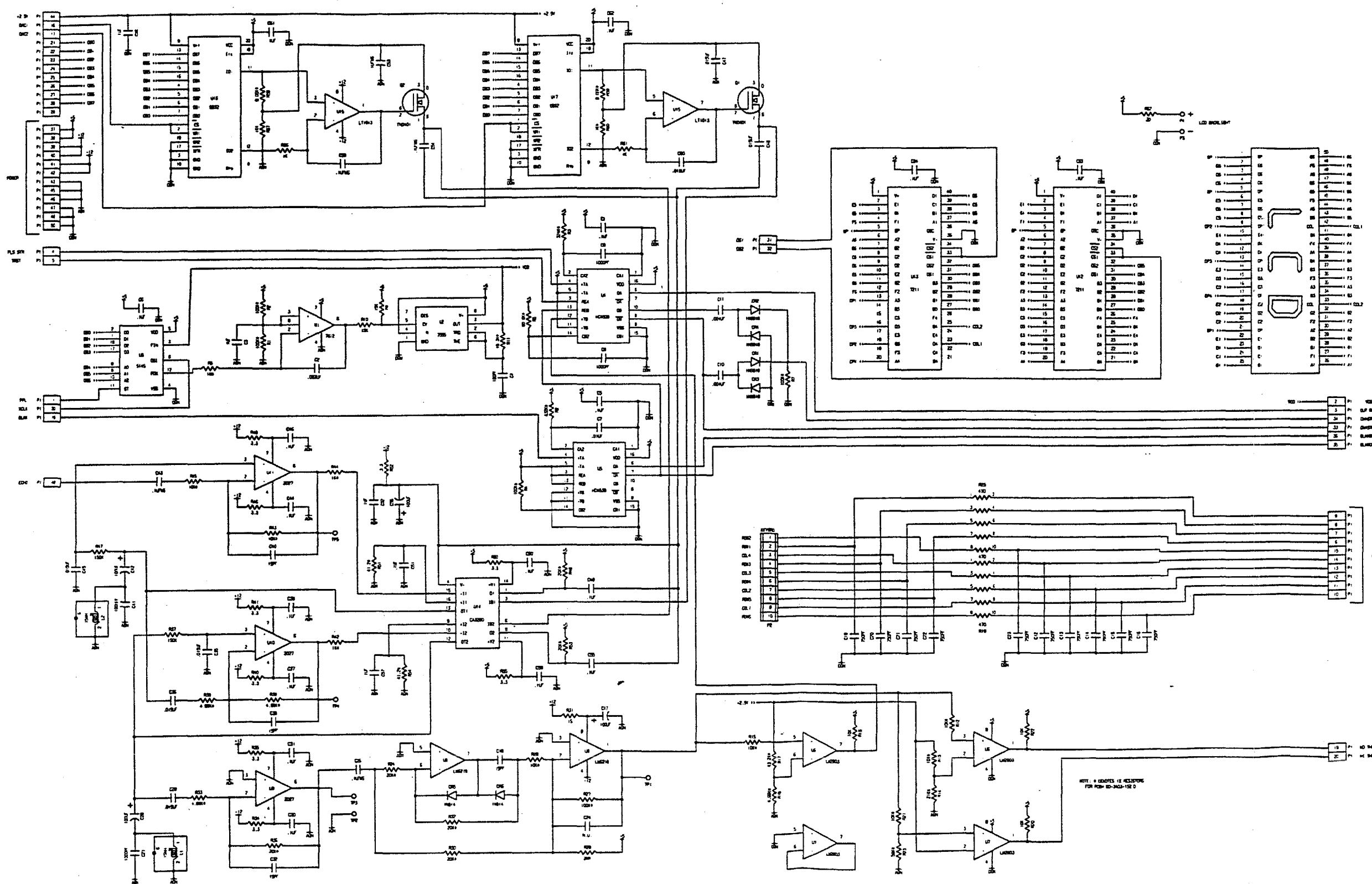
Figure 5.5-5 Component Layout for the Ultrasonic Printed Circuit Board



50 3403 152 D

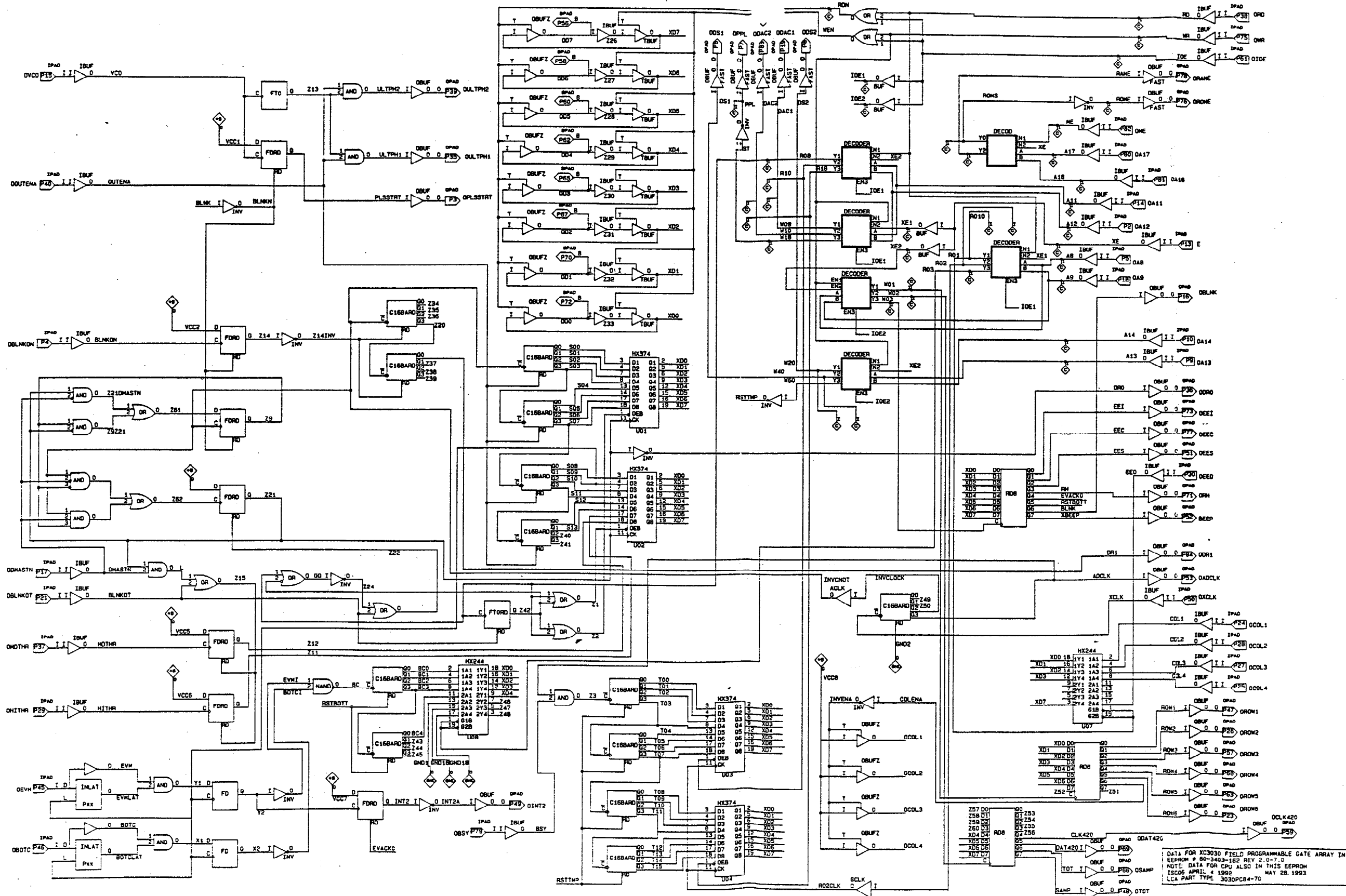
MODEL 3010

Figure 5.5-6 Schematic Diagram for the Ultrasonic Printed Circuit Board



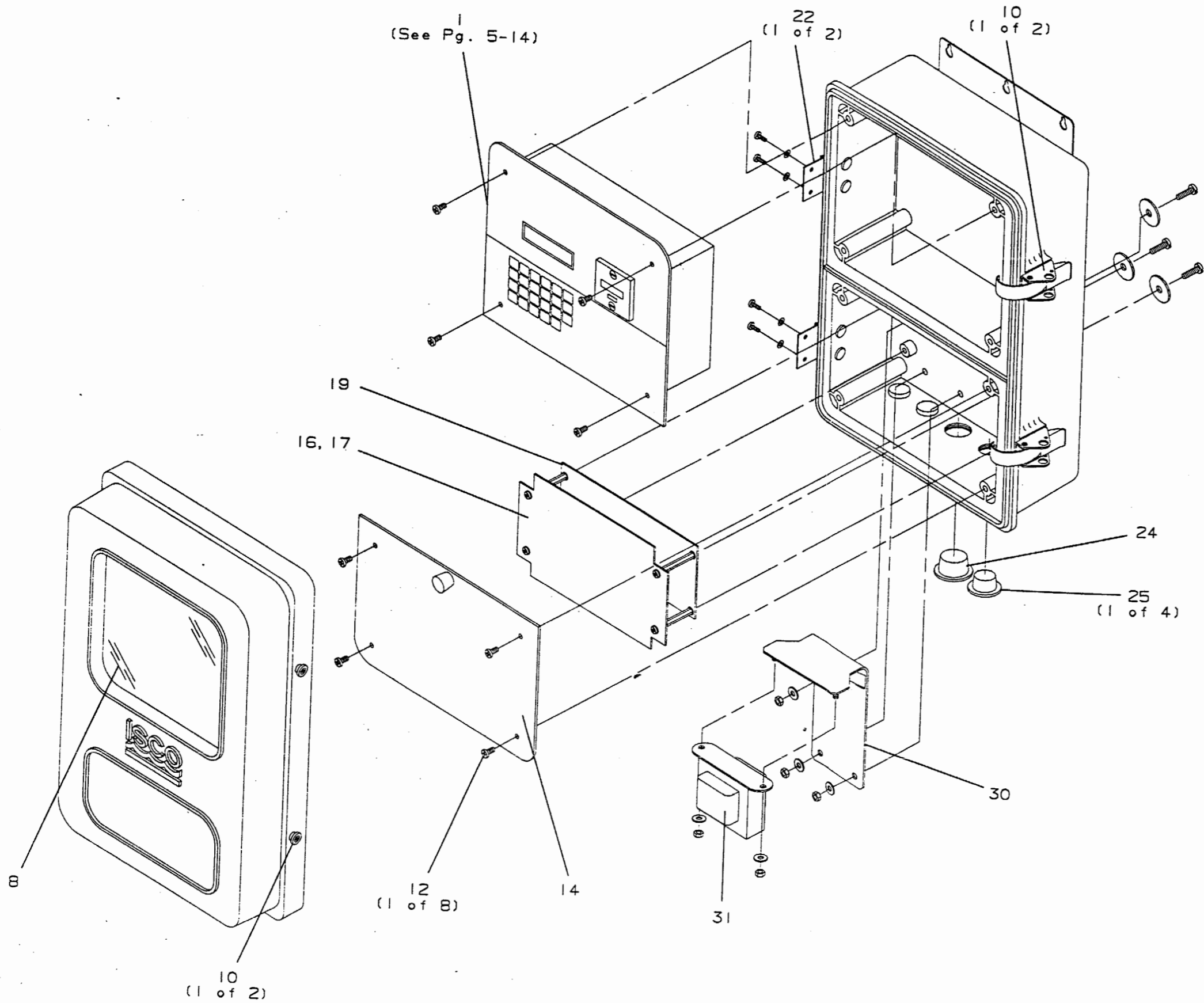
MODEL 3010

Figure 5.5-7 Schematic Diagram for the Gate Array. (For reference only.)



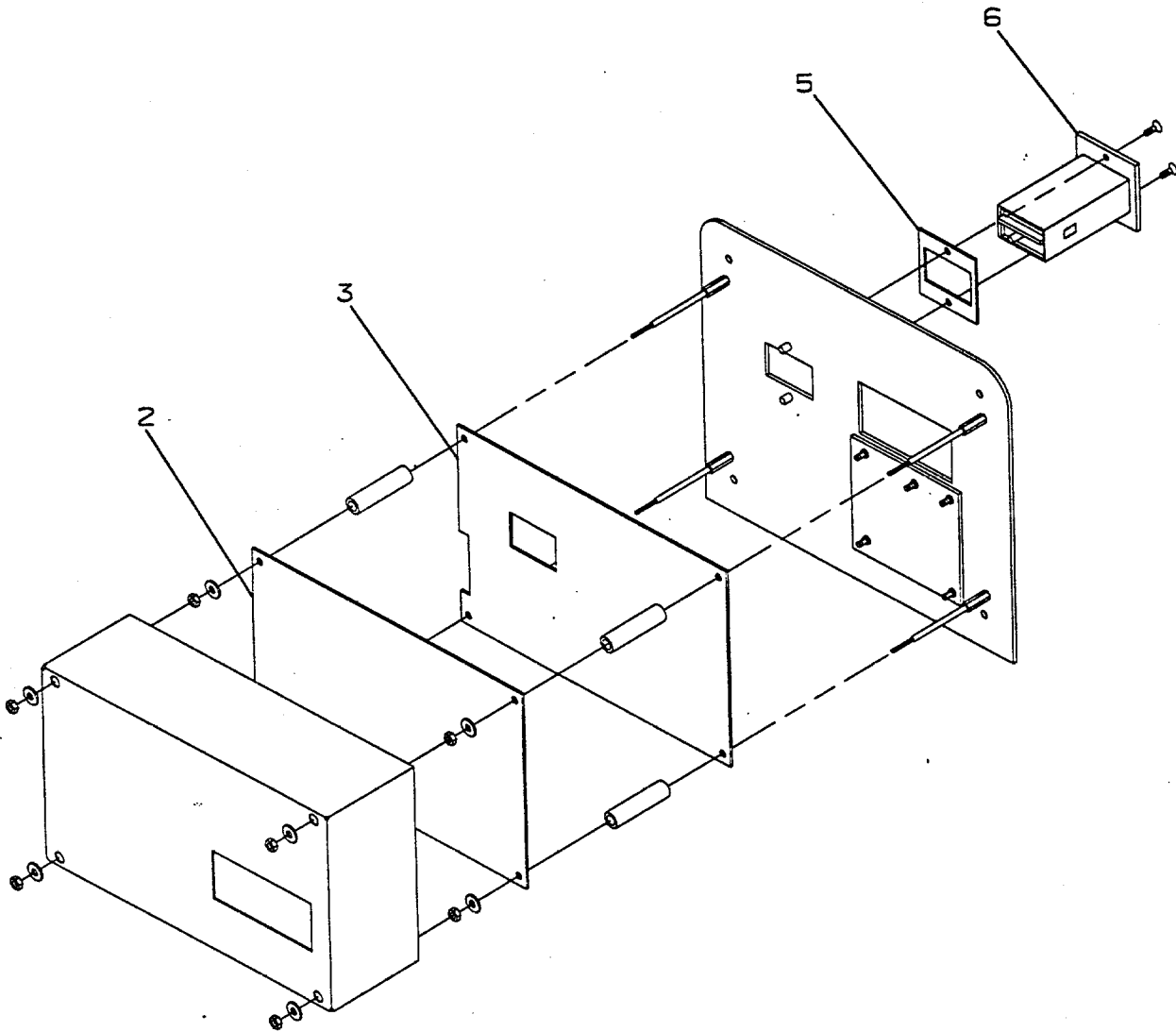
MODEL 3010

Figure 5.5-8 Illustrations for the Replacement Parts List



MODEL 3010

Figure 5.5-8 Illustrations for the Replacement Parts List, continued



**MODEL 3010 (FM)
REPLACEMENT PARTS LIST**

REV 7-94

ITEM NO.	COMPLETE ASSEMBLY	INDIVIDUAL PARTS	DESCRIPTION
1	603404071		Control Panel Assembly - FM
2		603404065	PCB Assy - CPU U/S
3		603404066	PCB Assy Ultrasonic
4*		603404075	Wiring Assy FM
5		603403035	Gasket Totalizer
6		152000100	Impulse Counter 12VDC Maxmar
7			
8		603213032	Window
9*		603403088	Window Gasket
10		109080100	Draw Latch Southco # 97-50-313-12
11*		611863073	Window Support # 1 - Irr.
12		231019506	Scr SS SST PH P 8-32 x 3/8
13			
14	603404063		Lower Cover Assy Metric
15			
16		603403072	Warning Shield
17		603403075	Label Warning Shield
18			
19	603404072		Terminal Strip Assy FM
20*		411031130	Fuse .50A 250V SB 3AG
21			
22		603403040	Hinge Case
23			
24		109030907	Caplug Tapered 3/4"
25		109030906	Caplug Tapered 1/2"
26			
27*		603403034	Gasket Upper Panel

*Not Shown

**MODEL 3010
ACCESSORY PARTS LIST**

REV 11-92

Model No.	Part No.
Model 3010 Flow Transmitter (with ultrasonic level sensor, manual, and Flow Data Handbook and 25 foot cable on the ultrasonic level sensor)	68-3010-001

Options

Model No.	Part No.
Model 3010 Characterization PROM	Call factory

Accessories and Spare Parts

Model No.	Part No.
Model 3012 Ultrasonic Level Sensor only with 25 ft. cable	60-3404-067
Quick-Disconnect Box for the ultrasonic level sensor	60-3404-052
Extension Cables for the Quick-Disconnect Box - 25 ft.	68-3010-023
50 foot	68-3010-024
100 foot	68-3010-025
250 foot	68-3010-026
Sunshade for the ultrasonic level sensor	60-3004-142
Spreader Bar (to suspend the ultrasonic level sensor in manhole)	60-3004-110
Cable Clamp (for hanging the ultrasonic level sensor from a spreader bar)	60-3004-129
Mounting Bracket for the ultrasonic level sensor	60-2443-092
Floor Mount for the ultrasonic level sensor	60-3004-117
Cable Straightener for the ultrasonic level sensor	60-3213-061
Calibration Target for the ultrasonic level sensor	60-3004-143
Sampler Connector Kit (3000 Series Flow Transmitter to Isco Sampler)	68-3010-013
<i>NOTE: Use with user-supplied 5-wire cable only, 1000 foot maximum</i>	
Connect Cable, 3000 Series Flow Transmitter to Isco Sampler - 25 ft.	60-3404-051
Flow Meter to Sampler "Y" Connect Cable	60-3704-081
High-Low Alarm Relay Box	60-3404-028
High-Low Alarm Relay Box Instruction Manual	60-3403-071
Remote Totalizer (Eight digit nonresettable)	68-2440-019
Connect Cable (3000 Series Flow Transmitter to Model 2312 Plotter - 25 foot)	60-3404-050
Power Supply (to power a Model 2312 Plotter located more than 200 feet from Flow Transmitter)	60-1684-046
"Y" Connect Cable (to connect power supply, Model 2312, and Model 3010 together)	60-2314-021
Connect Cable (3000 Series Flow Transmitters to Model 2410 Circular Chart Recorder) - 25 ft.	68-3010-009
50 ft.	68-3010-010
100 ft.	68-3010-011
250 ft.	68-3010-012
Watertight Cord Grip Fittings (Stahlin Fittings) 0.187" to 0.250" diameter cable	209-0076-05
For 0.250" to 0.312" diameter cable	209-0076-04
For 0.312" to 0.375" diameter cable	209-0076-03
For 0.375" to 0.437" diameter cable	209-0076-06
For 0.437" to 0.500" diameter cable	209-0076-07
For 0.500" to 0.562" diameter cable	209-0076-08
AC Power Cord (includes watertight cord grip fitting)	68-2410-001
Isco <i>Open Channel Flow Measurement Handbook</i>	60-3003-041

**MODEL 3010
PROGRAMMING WORKSHEET**

REV. 2-94

This worksheet will help you to program the Model 3010. Circle your selections with a pencil. Where numeric values are required, write them in. Then program the Flow Transmitter by entering the values you selected on the worksheet.

NOTE

You will usually not need to make selections for every step shown below. Some steps are only required when you use the Model 3010 with other equipment. Study the programming section in Chapter 2. The Model 3010 Flow Transmitter will reject invalid entries. Keep this sheet as a record of your program.

Step 1: Units of Measurement. 1. Feet 2. Meters _____

Step 2: Primary Device. Press PRIMARY DEVICE.

1. V-NOTCH WEIR
2. RECTANGULAR WEIR WITH END CONTRACTIONS
3. RECTANGULAR WEIR WITHOUT END CONTRACTIONS
4. CIPOLLETTI WEIR
5. 1" PARSHALL FLUME
6. 2" PARSHALL FLUME
7. 3" PARSHALL FLUME
8. 6" PARSHALL FLUME
9. 9" PARSHALL FLUME
10. 12" PARSHALL FLUME
11. 18" PARSHALL FLUME
12. 24" PARSHALL FLUME
13. 36" PARSHALL FLUME
14. 6" PALMER-BOWLUS FLUME
15. 8" PALMER-BOWLUS FLUME
16. 10" PALMER-BOWLUS FLUME
17. 12" PALMER-BOWLUS FLUME
18. 15" PALMER-BOWLUS FLUME
19. 18" PALMER-BOWLUS FLUME
20. 24" PALMER-BOWLUS FLUME
21. 30" PALMER-BOWLUS FLUME
22. 48" PALMER-BOWLUS FLUME
23. LARGE 60° V TRAPEZOIDAL FLUME
24. 2" 45° WSC TRAPEZOIDAL FLUME
25. 12" 45° SRCRC TRAPEZOIDAL FLUME
26. 0.5' "H" FLUME
27. 0.75' "H" FLUME
28. 1' "H" FLUME
29. 1.5' "H" FLUME
30. 2' "H" FLUME
31. 3' "H" FLUME
32. 4.5' "H" FLUME
33. LEVEL ONLY
34. EQUATION (SEE STEPS 3-6) _____

Steps 3-6: Equation. You will only use Steps 3-6 if you select # 34 "EQUATION" in Step 2. Otherwise, go directly to Step 7. The values for the components of the general flow equation are entered in Steps 3-6. See the examples in Chapter 2 and also the *Flow Measurement Handbook*. The equation: $Q = K[(N1 \times H^{P1}) + (N2 \times H^{P2})]$

- Step 3: N1 (-4,999 to + 4,999) _____
- Step 4: P1 (0.1 to 3.0) _____
- Step 5: N2 (-4,999 to + 4,999) _____
- Step 6: P2 (0.1 to 3.0) _____

Step 7: Enter Maximum Head in Feet _____
(range: 0.1 to 10.0)

Step 8: Enter Flow Rate at Maximum Head _____
(range: 0.001 to 9,999)

Step 9: Enter Totalizer Scaling _____
(range: 0 to 9,999)

You will program Step 10 only if the Model 3010 is connected to a sampler. Press SAMPLER OUTPUT.

Step 10: Enter Sampler Scaling _____
(range: 0 to 9,999)

You will program Steps 11 to 15 only if the Model 3010 is connected to a Model 2312 Plotter. Press PLOTTER OUTPUT.

Step 11: Enter Units of Measure for Flow Rate on the Remote Plotter (1-12) _____
1. GPM 2. GPS 3. MGD 4. CFS 5. CMS 6. CMH
7. CMD 8. LPS 9. CFD 10. GPH 11. AFD 12. CFH

Step 12: Enter Zeroes to the right of the Flow Rate Display (range: 0 to 6) _____

Step 13: Enter Units of Measure for Totalized Volume on Remote Plotter _____
1. CF 2. GAL 3. CM 4. AF 5. L 6. MG

Step 14: Enter Zeroes to the Right of the Totalizer (range: 0 to 9) _____

Step 15: Reset Plotter Totalizer to Zero?
1. Yes 2. No _____

Step 16: Display Operation. Press DISPLAY MODE.
1. Flow Rate 2. Level 3. Alternate Between Flow Rate and Level _____

You will program step 17 only if you use the 4-20 mA output. Press the 4-20 ma OUTPUT key.

Step 17: 4-20 mA Output Operation. 1. Transmit Flow Rate 2. Transmit Flow Rate With Event Mark 3. Transmit Level 4. Transmit Level With Event Mark _____

Step 18 is included for reference only; you must program level only at the installation site.

Step 18: Current Level in Feet. Press ADJUST LEVEL.
(range -1.0 to 12.5) _____

MODEL 3010

INDEX

4-20 mA Output
Programming 2-10

C

Cables
 Inspection 5-1
Characterization Prom 4-7
Circuit Description
 CPU, Terminal Boards 5-7
CMOS Circuitry
 Precautions 5-6
Controls 1-6

D

Default Program 2-11
Display (LCD) 2-4
 Programming 2-10
 Warnings 5-4

E

Envelope Detection 2-3
Equation 2-8
 Discussion 2-16
 Programming Example 2-16
External Serial Device
 Connection to 4-7

F

Flow Conversion Equations 2-11
 Table 2-12
Flow Rate at Maximum Head 2-8
Fuse Replacement 5-2

H

Hazardous Gases 3-7
High-Low Alarm Relay Box 4-1

I

Indicators 1-6
Installation
 (of Flow Transmitter) 3-1

K

Keypad
 Layout and Functions 2-4

L

Level Adjust 2-10

M

Maximum Head 2-8
Model 2312 Plotter
 Connection to 4-3
 Programming 2-9
Model 2410 Circular Chart Recorder 4-9

P

Power Source 3-2
Primary Measuring Devices 2-7
Programming 2-5
 Examples 2-11, 2-16, 2-19
 Flowchart 2-6
 Step Descriptions 2-7

Q

Quick-Disconnect Box 3-3, 3-12, 4-8

R

Rectangular Weir with End Contractions
 Programming Example 2-19
 Equation 2-16
 Values for N1 and N2 2-20
 Programming Example Using the Equation .. 2-18
Replacement Parts List 5-15, 5-18

S

Safety 3-5
 In Troubleshooting Procedures 5-5
Sampler
 Connection to (Isco) 3-4
 Connection to (Non-Isco) 3-5
 Programming 2-9
 Programming Example 2-14
Setup 1-3, 2-11

T

Technical Specifications 1-7
Terminals 1-6
Totalizer
 Programming 2-9
 Programming Example 2-11, 2-13, 2-17, 2-21
 Remote Totalizer 4-7
Troubleshooting 5-4

U

Ultrasonic Level Sensor

- Applications and Theory 2-1
- Care and Maintenance 5-1
- Dead Band 3-12
- Description 1-2
- Envelope Detection..... 2-5
- Error Factors 2-2
- Extension Cables 4-8
- Installation 3-11
- Mounting..... 3-12
- Quick-Disconnect Box 3-3, 3-12, 4-8
- Reducing Level Measurement Errors 3-16
- Setup 1-3, 2-11
- Wiring 3-3

Ultrasonic Floor Mount 3-12

one year, limited Warranty

Please read before instrument setup.

ISCO INSTRUMENTS HAVE A ONE YEAR LIMITED WARRANTY COVERING BOTH PARTS AND LABOR. Should any instrument become defective due to faulty parts or workmanship within the guarantee period, it will be repaired at the factory at no charge to the customer. Isco will pay SURFACE transportation charges both ways within the contiguous United States if the instrument proves to be defective WITHIN 30 DAYS from the date of shipment. Throughout the remainder of the guarantee period, the customer will pay transportation charges to return the defective instrument to Isco, and Isco will pay SURFACE transportation charges to return the repaired instrument to the customer. Isco will not pay air freight or packing and crating charges. The warranty period begins with the shipping date of the instrument to the original purchaser. All requests for warranty service must be received within the warranty period.

At the convenience of Isco, Isco may reimburse the customer to have the repairs per-

formed by a qualified technician in the customer's locality. Authorization must be granted prior to the time any repair is performed.

ISCO'S EXCLUSIVE LIABILITY IS LIMITED TO REPAIR OR REPLACEMENT OF DEFECTIVE INSTRUMENTS. UNDER NO CIRCUMSTANCES IS ISCO LIABLE FOR CONSEQUENTIAL DAMAGES. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES AND OBLIGATIONS AND ISCO SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. The following are not covered by this warranty: Expendable items such as charts, pens, suction and pump tubing and glassware; damage due to corrosion, abuse, accident or alteration; and suitability for any specific purpose.

OUTSIDE THE WARRANTY PERIOD, REPLACEMENT PARTS AND REPAIR LABOR ARE GUARANTEED FOR 90 DAYS.

The warrantor is Isco, Inc., Lincoln, Nebraska, U.S.A.

INSTRUCTIONS FOR RETURNING INSTRUMENTS FOR REPAIR.

Before returning any instrument for repair, call or write our service department for instructions. Simple difficulties can often be diagnosed over the phone.

Pack the instruments carefully, preferably in its original carton, and ship to the attention of the service department. U.P.S. or motor freight is generally the best method except for very small, non-fragile items which can be sent by insured parcel post. **BE SURE TO ENCLOSE A NOTE EXPLAINING THE DEFECT AND A PURCHASE ORDER AUTHORIZING THE REPAIR.**

Return equipment to:

Isco, Inc.-Environmental Division
531 Westgate Blvd.
Lincoln, NE 68528-1586, U.S.A.

Mailing Address: P.O. Box 82531, Lincoln, NE 68501-2531, U.S.A.

Phone: (402) 474-2233 or (800) 228-4373 (U.S.A.)

Fax: (402) 474-6685

The logo for ISCO, featuring the word "ISCO" in a bold, sans-serif font with a registered trademark symbol. Below the text is a stylized graphic consisting of three horizontal, wavy lines that resemble a wave or a decorative underline.

June, 1995

Please Tell Us How We're Doing



Please rate our equipment, documentation, and other support by answering the following questions. Please fold and return this postage paid mailer when completed.

Your answers and suggestions will help us provide you with better products and better service.

If you would like to talk to us, please call us at (800) 228-4373 or (402) 474-2233.

Thank you.

Product & Model Number _____

Approximate Date of Installation _____

Your Name _____

Title _____

Company Name _____

Address _____

City/State/Zip _____

Phone Number _____

Please rate our initial sales support:

	Excellent	Very Good	Good	Fair	Poor
1. Isco brochures:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Isco price lists:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Isco's support prior to purchasing:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Isco's local sales representation:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Please rate our packaging and shipping:

1. Condition of packaging:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Condition of equipment after unpacking:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Please rate our products:

1. Appearance of equipment:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Operation and instruction manual:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Performance of our equipment:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Dependability of our equipment:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Accuracy of our equipment:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Features provided on our equipment:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Please rate our after sales support:

1. Did you need training or help with the set-up from your local Isco sales representative?.....	<input type="checkbox"/> Yes <input type="checkbox"/> No				
If yes, how did we perform?.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The sales support you have received is:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The cooperation & response time on our 800 toll free line was:.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Your overall satisfaction with Isco:..... Excellent Very Good Good Fair Poor

Any suggestions for improvements or additional features on this product: _____

Any suggestions for improving the operation and instruction manual: _____

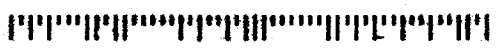
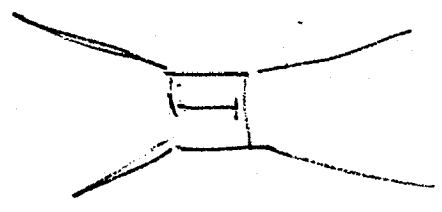
Any suggestions for improving our sales and product service: _____

Other suggestions or comments: _____

(Additional space for suggestions on reverse side)

Additional Suggestions: _____

fold here

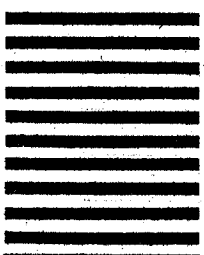


PO Box 82531
Lincoln NE 68501-9916



POSTAGE WILL BE PAID BY ADDRESSEE

BUSINESS REPLY MAIL
FIRST-CLASS MAIL PERMIT NO. 1186 LINCOLN, NE



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

