Mechanical Solutions Inc.

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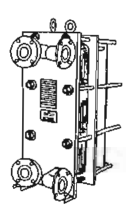
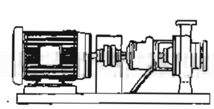
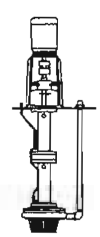
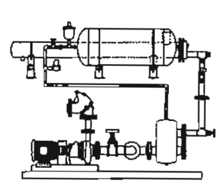
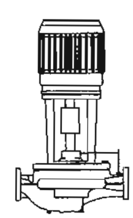
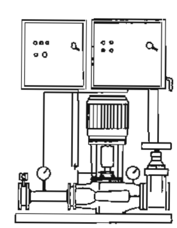
PROJECT:
THE CHILDREN'S SCHOOL
ENGINEER:
VZH&S
CONTRACTOR:
EASTERN MECHANICAL
SPECIFICATION SECTION:
15500
EQUIPMENT DESCRIPTION:
Operation & Maintenance Manuals Refer To Attached Equipment List

BILL OF MATERIAL

Item	Qty	Description	Weight
A	2	(PHWP-1,2) Armstrong Model 4380 2x2x6 Vertical In Line Pump rated for 77 gpm at 23' of head with a 1HP, ODP Standard Efficient Motor, 208V-3P and 1800RPM	140
	2	2-1/2" Armstrong Model FTV-2.5 Triple Duty Valve with Flanged Connections. #570200-376	39
	2	2-1/2" Metraflex Model TF Wye Strainer - Flanged. TF-2.5	36
	2	2.5" Metraflex Butterfly Valve, Lug Body, 10 Position Lever. 2.5-BVALVE	12
B	2	(SHWP-1,2) Armstrong Model 4380 2x2x8 Vertical In Line Pump rated for 77 gpm at 40' of head with a 2HP, ODP Standard Efficient Motor, 208V-3P and 1800RPM	172
	2	2-1/2" Armstrong Model FTV-2.5 Triple Duty Valve with Flanged Connections. #570200-376	39
	2	2-1/2" Metraflex Model TF Wye Strainer - Flanged. TF-2.5	36
	2	2.5" Metraflex Butterfly Valve, Lug Body, 10 Position Lever. 2.5-BVALVE	12
C	2	(HWRP-1) Armstrong Model 1050 1.5B Circulator rated for 48 gpm at 14' of head with 1/3HP, ODP Motor, 208V-3P and 1800RPM.	48
D	1	(AS-1) 3" Armstrong Model VAS-3 Vortex Air Separator with Stainless Steel Strainer.#570289-002	130
E	1	(ET-1) Armstrong Model AX-60V Vertical Diaphragm Type Expansion Tank, ASME, 34 Gallon Tank, 12.5 Gallon Acceptance. #572006-100	110
	1	3/4" Metraflex Model MV-15A High Capacity Air Vent.	10
	1	3/4" Armstrong Model HRD-70 Pressure Reducing Valve. #207936-300	20
F	1	John Woods Model JWVF-27-005 5 Gallon Shot Feeder	37
I	2	(VFD-SHWP-1,2) Square D Variable Frequency Drive to operate 2HP, 208V-3P motor with bypass.	150
		Griswold Valves	
A	1	(VAV-1)Griswold Model 4PCPP2QS22UPH Coil Package.	
B	1	(VAV-2) Griswold Model 4PCPP2QS22UPH Coil Package.	
C	1	(VAV-3) Griswold Model 4PCPP2QS22UPH Coil Package.	
D	1	(VAV-4) Griswold Model 4PCPP2QS22UPH Coil Package.	

E	1	(UH) Griswold Model 4PCPP2QS22UPH Coil Package.
F	1	(HWC-1) Griswold Model 4PCPP2QS32UPI Coil Package.
G	1	(HWC-2) Griswold Model 4PCPP2QS22UPH Coil Package.

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FILE NO.:	43.80
DATE:	Feb. 16, 2006
SUPERSEDES:	43.80
DATE:	Aug. 15, 1997

INSTALLATION AND OPERATING INSTRUCTIONS

COMMERCIAL PUMPS

Series 4300, 4360 & 4380 Vertical In-Line Pumps

INTRODUCTION

This document contains specific information regarding the safe installation, operating and maintenance of Vertical In-Line pumps and should be read and understood by installing, operating and maintenance personnel. The equipment supplied has been designed and constructed to be safe and without risk to health and safety when properly installed, operated and maintained. The instructions following must be strictly adhered to. If clarification is needed on any point please contact Armstrong quoting the equipment serial number.

WARNING SYMBOLS

Safety instruction where an electrical hazard is involved.

Safety instruction where non-compliance would affect safety risk.

Safety instruction relating to safe operation of the equipment. (ATTENTION)

INSTRUCTIONS FOR SAFE USE

No installation of this equipment should take place unless this document has been studied and understood. Handling, transportation and installation of this equipment should only undertaken by trained personnel with proper use of lifting equipment. See later diagrams for lifting advice. Refer to the pump nameplate for pump speed, pressure and temperature limitations. The limits stated must not be exceeded without written permission from Armstrong.

TEMPERATURE

Where under normal operating conditions the limit of 68°C/155°F (Restricted Zone) for normal touch, or 80°C/176°F (Unrestricted Zone) for unintentional touch, may be experienced, steps should be taken to minimize contact or warn operators/users that normal operating conditions will be exceeded. In certain cases where the temperature of the pumped liquid exceeds the above stated temperature levels, pump casing temperatures may exceed 100°C/212°F and not withstanding pump insulation techniques appropriate measures must be taken to minimize risk for operating personnel.

NOISE LEVELS

Estimated Pumping Unit Sound Power Level, Decibels, A-Weighted, at 1 m /3 ft. from unit.

	1200 rpm				1800 rpm				3600 rpm			
Frame	ODP		TEFC		ODP		TEFC		ODP		TEFC	
Designation	hp	dB-A	hp	dB-A	hp	dB-A	hp	dB-A	hp	dB-A	hp	dB-A
140	0.75 - 1	65	0.75 - 1	64	1 - 3	70	1 - 2	70	1.5 - 3	76	1.5 - 2	85
180	1.5 - 2	67	1.5 - 2	67	3 - 5	72	3 - 5	74	5 - 7.5	80	3 - 5	88
210	3 - 5	72	3 - 5	71	7.5 - 10	76	7.5 - 10	79	10 - 15	82	7.5 - 10	91
250	7.5 - 10	76	7.5 - 10	75	15 - 20	80	15 - 20	84	20 - 25	84	15 - 20	94
280	15 - 20	81	15 - 20	80	25 - 30	80	25 - 30	88	30 - 40	86	25 - 30	95
320	25 - 30	83	25 - 30	83	40 - 50	84	40 - 50	89	50 - 60	89	40 - 50	100
360	40 - 50	86	40 - 50	86	60 - 75	86	60 - 75	95	75 - 100	94	60 - 75	101
400	60 - 75	88	60 - 75	90	100 - 125	89	100	98	125 - 150	98	100	102
440	100 - 125	91	100 - 125	94	150 - 200	93	125 - 150	102	200 - 250	101	125 - 150	104

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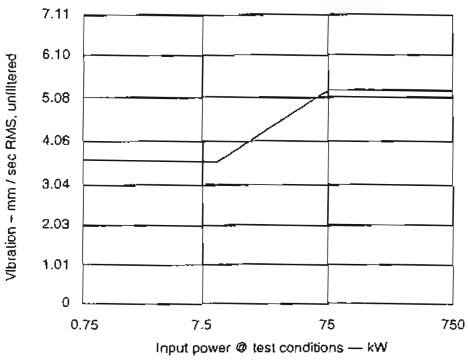
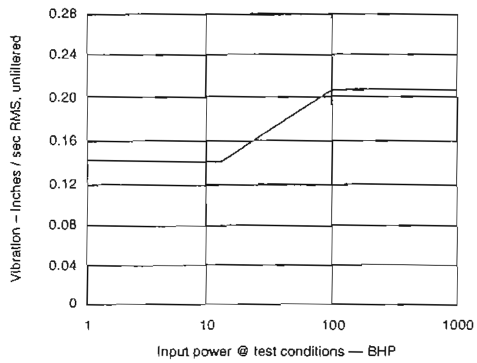
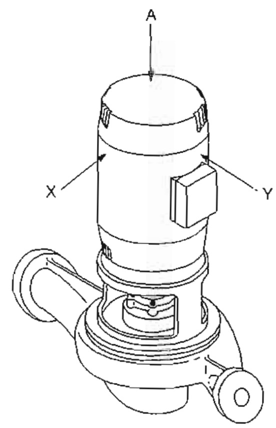
VIBRATION LEVELS

Armstrong Vertical In-Line pumps are designed to meet vibration levels set by Hydraulic Institute Standard HI Pump Vibration 9.6.4. Standard levels are as detailed below:







Vertical In-Line

STORAGE

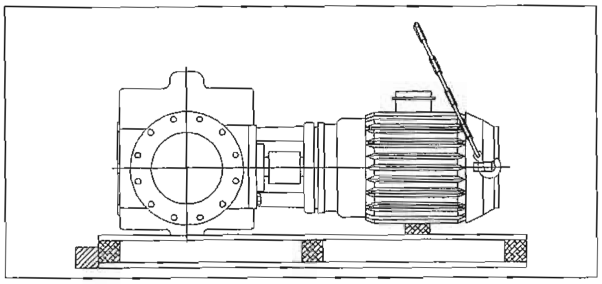
Pumps not immediately placed into service, or removed from service and stored, must be properly prepared to prevent excessive rusting. Pump port protection plates must not be removed until the pump is ready to connect to the piping.
Rotate the shaft periodically (At least monthly) to keep rotating element free and bearings fully functional.
For long term storage, the pump must be placed in a vertical position in a dry environment.
Internal rusting can be prevented by removing the plugs at the top and bottom of the casing and drain or air blow out all water to prevent rust buildup or the possibility of freezing. Be sure to reinstall the plugs when the unit is made operational. Rustproofing or packing the casing with moisture absorbing material and covering the flanges is acceptable. When returning to service be sure to remove the drying agent from the pump.

UNCRATING

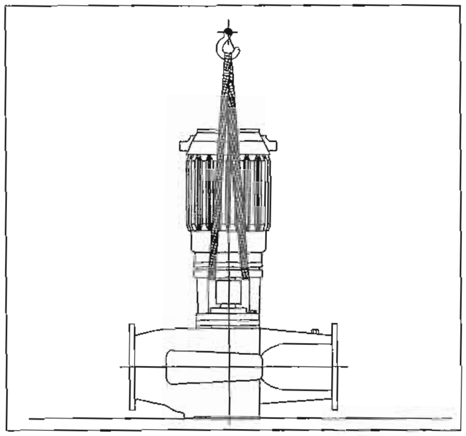
Armstrong Vertical In-Line pumps are thoroughly inspected before shipment to assure they meet with your order requirements. After removing the pump from the crate, make sure the equipment is in good order and that all components are received as called for on the packing list. Any shortages or damage should be reported immediately. Use extreme care in handling the unit, placing slings and hooks carefully so that stress will not be imposed on the pump. NEVER PLACE CABLE SLINGS AROUND THE PUMP SHAFT. The eye bolts or lifting lugs on the motor are intended for lifting only the motor and not the complete unit.

HANDLING LARGE VIL UNITS

One effective way of lifting a large Series 4300 unit from the shipment pallet following uncovering the unit is to place lifting hooks through the motor lifting rings or straps around the upper part of the motor and carefully lift sufficiently to stand the pump vertically. Lift only sufficiently to remove the pallet then lower onto a flat surface. The pump and motor unit will free-stand on the casing ribs. Remove the coupling guard and place (2) lifting straps through the pump/motor pedestal, one on each side of the motor shaft and secure to the lifting device. With the straps in place, using a spacer bar if necessary to protect the motor fan cover, the whole assembly can now be lifted securely and placed in position in the piping.



Secure pallet and lift pump vertical using motor eye-bolts lift only to clear pallet then sit on the flat surface



Remove coupling guard and place lifting straps on each side of coupling, use spacer bar if necessary to protect motor fan cover.

IMPORTANT:
Do not run the pump for any length of time under very low flow conditions or with the discharge valve closed. To do so could cause the water in the casing to reach super heated steam conditions and will cause premature failure and could cause serious and dramatic damage to the pump and surrounding area.

INSTALLATION

1. LOCATION

- In open systems, locate the unit as close as practical to the liquid being pumped, with a short, direct suction pipe. Ensure adequate space is left above and around the unit for operation, maintenance, service and inspection of parts.
- In closed systems, where possible, the pumps should be installed immediately downstream of the expansion tank / make-up connection. This is the point of zero pressure change and is necessary for effective pump operation. Do not install more than one expansion tank connection into any closed hydronic system.
- Electric motor driven pumps should not be located in damp or dusty location without special protection.
- Airflow into the motor and/or motor fan should not be obstructed.

2. INSTALLATION

- *When installing vertical in-line pumps, an important consideration to accrue full added-value from the pump design is to ensure that the pump is pipe-mounted and free to 'float' with any movement, expansion and contraction of the piping. Should any vertical in-line pump use supports to the structure it is imperative that no pipe strain is imposed on the pump flanges. Tell-tale pieces of equipment such as springs or 'waffle' style isolation pads that distort with pressure to indicate added piping weight, should be used under pump supports should the pump not be truly pipe mounted.*
- Recommended installation arrangements are:
  - 2.1. Piping supported at ceiling with additional floor mounted pipe-stools, isolated from the structure by 'waffle' isolation pads, under the Armstrong Suction Guide and Flo-Trex Valve. (Fig. 2.1a) The majority of Series 4300 pumps are installed in this manner. Should additional space saving be required the discharge spool piece and Flo-Trex valve may be replaced by a long-radius elbow and the Flo-Trex valve field converted to a straight-through valve and installed in the vertical discharge pipe. (Fig 2.1b)
  - 2.2. Supported from the ceiling by pipe hangers. (Fig. 2.2) This could be at sufficient height to use zero floor space.
  - 2.3. Floor mounted saddle supports. (Fig. 2.3) Typical for condenser water pumps where cooling tower base is at mechanical room elevation.

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2.4. Where required, additional floor support may be used as shown in Fig. 2.4. Note that the pump should not be rigidly attached to the column. Leave a small gap between pump and column or install a 'waffle' isolation pad under the pump. It is critical that piping be installed in such a manner that the pump does not become a pipe support.

2.5. Flange mounted stanchion plates can be used on pump flanges. Fig. 2.5a indicates stanchion plates as pump legs that may be supplied for installation convenience. As with Fig. 2.4, 'waffle' style isolation pads must be used under the legs and pipe hangers adjusted to ensure the pump casing is not a piping support. Fig. 2.5b uses the stanchion plates along with seismically rated isolation pads or snubbers to restrain the pump during a seismic event. Again it must be stressed that pipe hangers carry the weight of the equipment as seismic components are designed only to restrain the equipment during a seismic event.

2.6. DO NOT support the unit by the motor eye bolts (Fig. 2.6) or by any other part of the motor.

2.7. DO NOT rigidly connect the pump to a permanent base (Fig. 2.7). This is similar to the notes under Fig. 2.4. Note that if the pump must be connected to a permanent base, the pump becomes a base-mounted unit and must be isolated from the piping by flexible connectors and the base isolated from the building structure on an inertia base.

2.8. Close coupled in-line units (Series 4360 & 4380) up to 15 hp / 11 kW may be installed with the shaft horizontal. (Fig. 2.8) For horizontal mounting of large units or Series 4300 Split-Coupled style consult the factory.

2.9. Many Vertical In-Line pumps are piped successfully into grooved piping systems. In-line pumps are supported well by grooved piping however flange adapter locking devices or a welded flange at the pump should be used to prevent the possibility of pipe mounted pumps from rotating in the piping. Armstrong offers grooved suction and discharge piping accessories with inherent locking devices to prevent this possibility. The Armstrong grooved piping accessories are versions of the suction guides (Diffusers) and Flo-Trex (Triple-Duty) valves detailed in the Pump Piping section below.

IMPORTANT:
All Series 4300 pumps contain a tapped hole in the motor bracket above the discharge flange (see Fig. 2.10) for draining the well. Pipe this drain hole to a floor drain to avoid overflow of the cavity caused by collecting chilled water condensate or from seal failure.

3. PUMP PIPING - GENERAL

- Never connect a pump to piping, unless extra care is taken to measure and align the piping flanges well. Always start piping from pump.
- Use as few bends as possible and preferably long radius elbows.
- Do not use flexible connectors on the suction or discharge of a vertical in-line pump, unless the pump is rigidly mounted to a foundation.
- Ensure piping exerts no strain on pump as this could distort the casing causing breakage or early failure due to pump misalignment.
- All conecting pipe flanges must be square to the pipework and parallel to the pump flanges.
- Suction and discharge pipes may be increased or decreased at pump nozzle to suit pump capacity and particular conditions of installation. Use eccentric reducers on suction connection with flat side uppermost.
- Layout the suction line with a continual rise towards the pump without high points, thus eliminating possibility of air pockets that may prevent the pump from operating effectively.
- A strainer of three or four times the area of the suction pipe, installed in the suction line, will prevent the entrance of foreign materials into the pump. 3/16" (5 mm) diameter perforations in the strainer is typical.
- In open systems, test suction line for air leaks before starting; this becomes essential with long suction line or static lift.
- Install, at the pump suction, a straight pipe of a length equivalent to 4 or 6 times its diameter; this becomes essential when handling liquids above 120°F (49°C). Armstrong suction guides may be used in place of the straight pipe run and in-line strainer.
- Install an isolation valve in both suction and discharge lines on flooded suction application; these valves are used primarily to isolate the pump for inspection or repair
- Install a non-slam non-return check valve in discharge line between pump and isolation valve to protect pump from excessive back pressure and to prevent water running back through the pump in case of driver failure on open systems. An Armstrong Flo-Trex valve may be used in place of non-return check valve and isolation valve on pump discharge.

A **CAUTION:**
The discharge valve only is to be used to throttle pump flow, not the suction valve. Care must be taken in the suction line layout and installation, as it is usually the major source of concern in centrifugal pump applications

4. ALIGNMENT

- Alignment is unnecessary on close-coupled pumps, Series 4360 & 4380, as there is no shaft coupling.
- Series 4300 units are accurately aligned at the factory prior to being shipped and do not need re-aligning when installed.
- Alignment on a Series 4300 unit may be verified by assuring an equal and parallel gap between coupling halves on both sides of the coupling.

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OPERATION

5. STARTING PUMP

- Ensure that the pump turns freely by hand, or with some mechanical help such as a strap and lever on larger pumps. Ensure that all protective guarding is securely fixed in position.
- The pump must be fully primed on start up. Fill the pump casing with liquid and rotate the shaft by hand to remove any air trapped in the impeller. On Series 4300 any air trapped in the casing as the system is filled must be removed by the manual air vent in the seal flush line. Series 4360 & 4380 units are fitted with seal flush/vent lines piped to the pump suction area. When these units operate residual air is drawn out of the pump towards the suction piping.
- "Bump" or energize the motor momentarily and check that the rotation corresponds with the directional arrow on the pump casing.
- To reverse rotation of a three phase motor, interchange any two power leads.
- Start the pump with the discharge valve closed and the suction valve open, then gradually open the discharge valve when the motor is at operating speed. The discharge valve may be "cracked" or open slightly at start up to help eliminate trapped air.
- When stopping the pump: Close the discharge valve and de-energize the motor.
- DO NOT run the pump against a closed discharge valve for an extended period of time. (A few minutes maximum)
- Star-Delta motor starters should be fitted with electronic/mechanical interocks that have a timed period of no more than 40 mili-seconds before switching from star (Starting) to delta (Run) connection yet allow the motor to reach full star (Starting) speed before switching to delta (Run).
- Should the pump be noisy or vibrate on start-up a common reason is overstated system head. Check this by calculating the pump operating head by deducting the suction pressure gauge value from the discharge gauge reading. Convert the result into the units of the pump head as stated on the pump nameplate and compare the values. Should the actual pump operating head be significantly less than the nameplate head value it is typically permissable to throttle the discharge isolation valve until the actual operating head is equal to the nameplate value. Any noise or vibration usually disappears. The system designer or operator should be made aware of this soon as some adjustment may be required to the pump impeller diameter or drive settings, if applicable, to make the pump suitable for the system as installed.

> **CAUTION:**
> Check rotation arrow prior to operating the unit. The rotation of all Armstrong Vertical In-Line units is "clockwise" when viewed from the drive end. (Looking from on top of / behind the motor)

6. GENERAL CARE

- Vertical In-Line pumps are built to operate without periodic maintenance, other than motor lubrication on larger units. A systematic inspection made at regular intervals, will ensure years of trouble-free operation, giving special attention to the following:
  - Keep unit clean
  - Provide the motor with correctly sized overload protection
  - Keep moisture, refuse, dust or other loose particles away from the pump and ventilating openings of the motor.
  - Avoid operating the unit in overheated surroundings (Above 100°F/40°C).

> **WARNING:**
> Whenever any service work is to be performed on a pumping unit, disconnect the power source to the driver, LOCK it OFF and tag with the reason. Any possibility of the unit starting while being serviced must be eliminated.

- If mechanical seal environmental accessories are installed, ensure water is flowing through the sight flow indicator and that filter cartridges are replaced as recommended. (See Armstrong files 43.85 & 43.86 for seal environmental instructions).

7. LUBRICATION

Pump

- Lubrication is not required. There are no bearings in the pump that need external lubrication service.
- Large Series 4300 units are installed with a shaft bushing located beneath the impeller that is lubricated from the pump discharge. This bearing is field removable for service on the 20x20x19 size without disturbing the motor or other major pump components.
- Service instructions for the lower bearing is to be found on File No: 43.805.

Motor

- Follow the lubrication procedures recommended by the motor manufacturer. Many small and medium sized motors are permanently lubricated and need no added lubrication. Generally if there are grease fittings evident the motor needs periodic lubrication. None if not.
- Check the lubrication instructions supplied with the motor for the particular frame size indicated on the motor nameplate.

Mechanical Seal

- Mechanical seals require no special attention. The mechanical seal is fitted with a flush line. The seal is flushed from discharge of the pump casing on Series 4300 pumps and is flushed/vented to the suction on close coupled pumps, Series 4360 & 4380.
- The Series 4300 pump is flushed from the pump discharge because the mechanical seal chamber is isolated from the liquid in the pump by a throttle bushing. Because the seal chamber is isolated, seal environmental controls such as filters and separators, when installed in the Series 4300 flush line are very effective, as only the seal chamber needs cleansing, and will prolong seal life in HVAC systems.
- Do not run the pump unless properly filled with water as the mechanical seals need a film of liquid between the faces for proper operation.
- Mechanical seals may 'weep' slightly at start-up. Allow the pump to continue operating for several hours and the mechanical seal to 'seat' properly prior to calling for service personnel.
- The following Armstrong files are available for mechanical seal replacement instructions:
  - Series 4360: File 6040.60
  - Series 4380: File 43.81
  - Series 4300: P-Base and TCZ Motor Frames – File 43.83
    TC Motor Frame – File 43.88

8. SYSTEM CLEANLINESS

- Before starting the pump the system must be thoroughly cleaned, flushed and drained and replenished with clean liquid.
- Welding slag and other foreign materials, "Stop Leak" and cleaning compounds and improper or excessive water treatment are all detrimental to the pump internals and sealing arrangement.
- Proper operation cannot be guaranteed if the above conditions are not adhered to.

NOTE:
Particular care must be taken to check the following before the pump is put into operation:

A. Pump primed?
B. Rotation OK?
C. Lubrication OK?
D. Pipe work properly supported?
E. Voltage supply OK?
F. Overload protection OK?
G. Is the system clean?
H. Is the area around the pump clean?

WARRANTY

Does not cover any damages to the equipment resulting from failure to observe the above precautions. Refer to Armstrong General Terms and Warranty sheet. Contact your local Armstrong representative for full information.

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INSTALLATION LAYOUTS

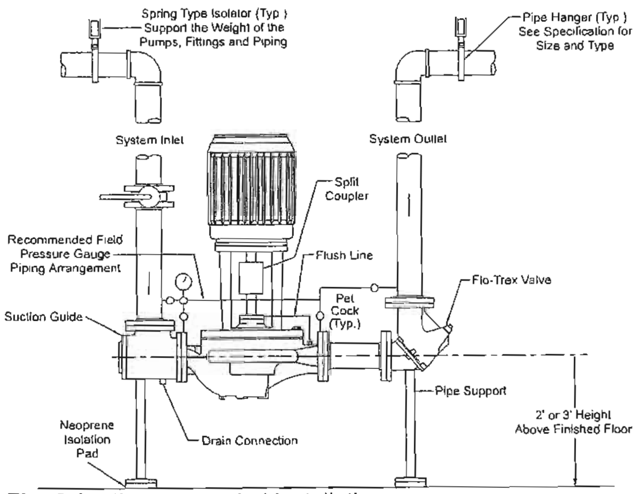

Fig. 2.1a Recommended Installation

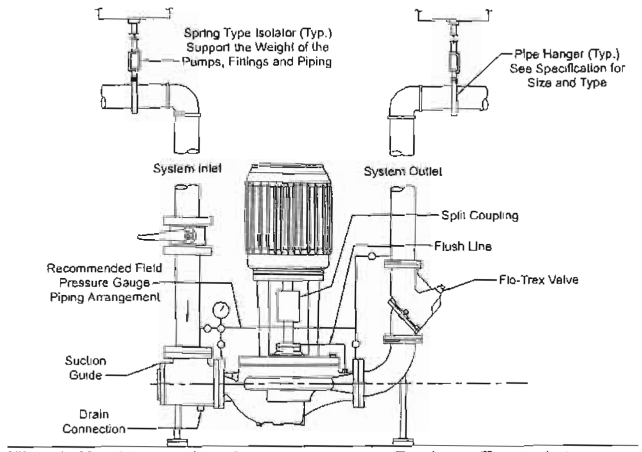

Fig. 2.1b Alternative Arrangement to Reduce Footprint

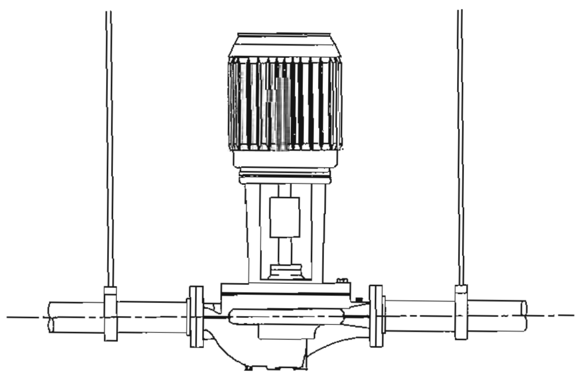
Fig. 2.2 Pipe Hanger Support

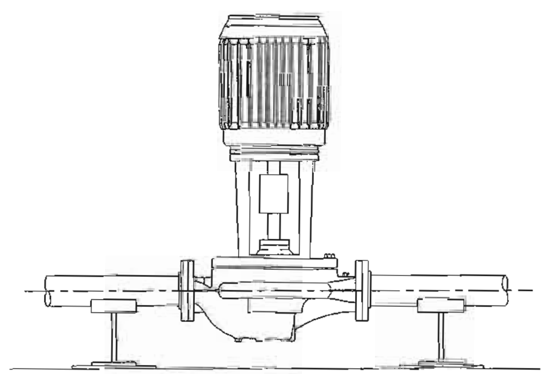
Fig. 2.3 Floor Saddle Support

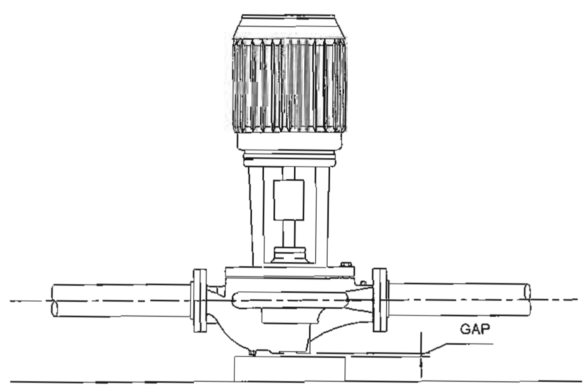

Fig. 2.4 Additional Floor Support

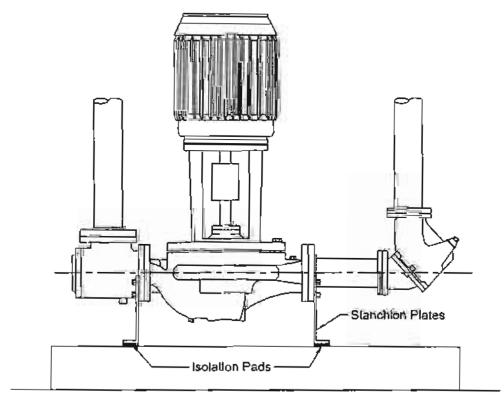

Fig. 2.5a Mounting VIL with Stanchion Plates

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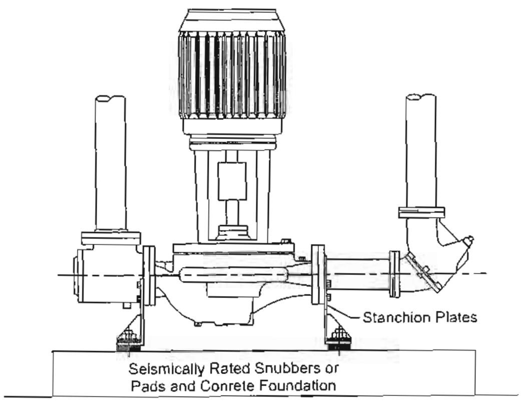


Fig. 2.5b Seismic Region Installation

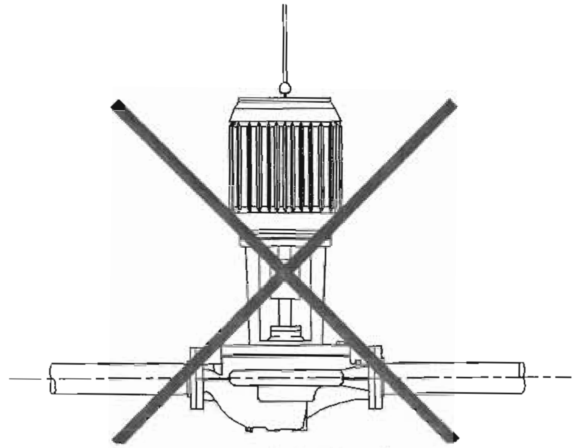


Fig. 2.6 Not Recommended – Hanging

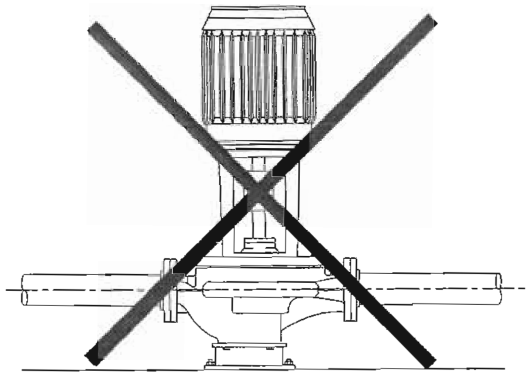


Fig. 2.7 Not Recommended – Rigid Base

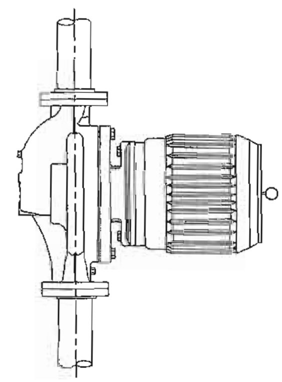


Fig. 2.8 Horizontal Mounting

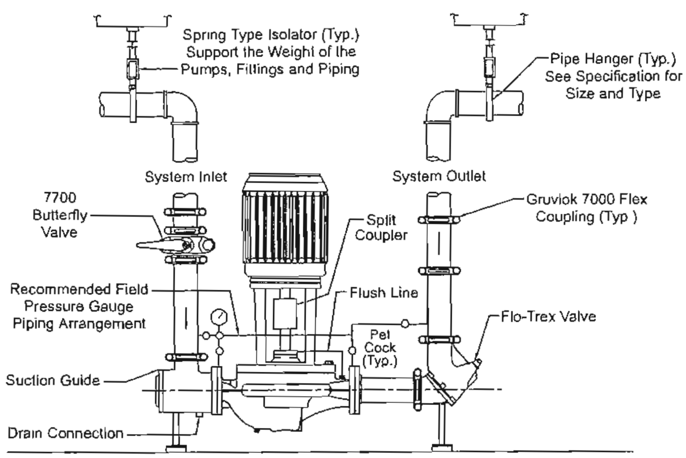


Fig. 2.9 Mounting in Grooved Pipe systems

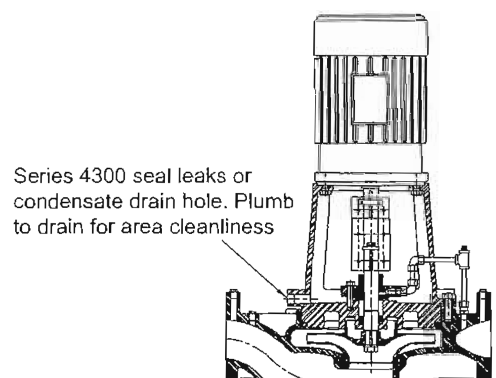


Fig. 2.10 Seal leaks or condensate drain hole. Plumb to drain for area cleanliness.

S. A. Armstrong Limited
23 Bertrand Avenue
Toronto, Ontario
Canada, M1L 2P3
T: (416) 755-2291
F (Main): (416) 759-9101

Armstrong Pumps Inc.
93 East Avenue
North Tonawanda, New York
U.S.A. 14120-6594
T: (716) 693-8813
F: (716) 693-8970

Armstrong Holden Brooke Pullen
Wenlock Way
Manchester
United Kingdom, M12 5JL
T: +44 (0) 161 223 2223
F: +44 (0) 161 220 9660

ARMSTRONG SUBMITTAL

Series 4380
2x2x6
Close Coupled Vertical In-Line Centrifugal Pump

Project Number: 062306	**Representative:** Mechanical Solutions
Name: The Children's School	121 Commerce Way, South Windsor, CT
Reference:	Phone: 860-290-1564, Fax: 860-290-1825
Location:	**Order No:** **Date:**
Engineer:	**Submitted by:** Julie Kirk **Date:** 12/4/2006
Contractor: Eastern Mechanical	**Approved by:** **Date:** 12/4/2006

PUMP DESIGN DATA

Tag Num:	PHWP-1,2
Service:	
Location:	
No. of Pumps:	2
Capacity:	77 usgpm
Head:	23 ft
Piping:	Single
Suction Pressure:	0 ft
Liquid:	Water, sg= 1.00, 70 °F
Viscosity:	31 ssu
Branch Sizes:	Suction= 2 in, Discharge= 2 in

MOTOR DESIGN DATA

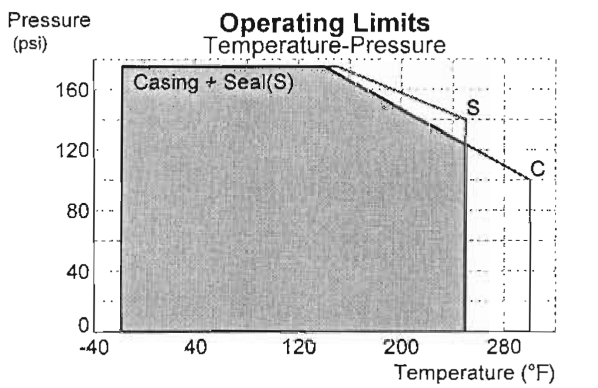
Motor Supplier:	Factory Choice
Motor Size:	1 hp @ 1800 rpm
Frame Size:	143JM
Enclosure:	ODP
Cycle/Phase/Voltage:	60/3/208 (Dedicated)
Motor Eff:	Std
Insulation:	Class "B" Insulation (266.0 °F)
Starter Config:	DOL
Full Load/Starting (A)	4.0 / 33.2

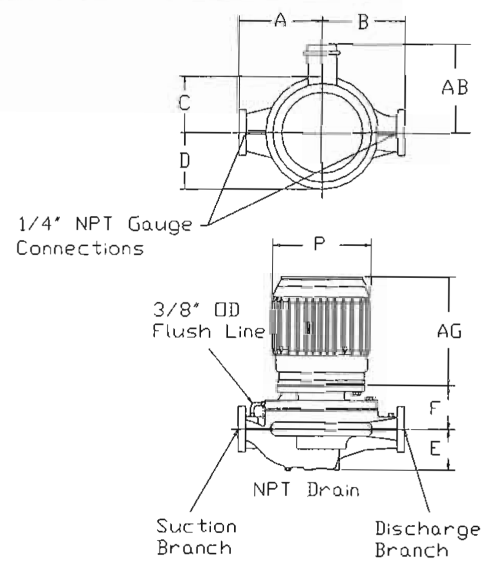
MATERIALS OF CONSTRUCTION

Construction	BF (Bronze Fitted)
ANSI Flange Rating	125 lb. (Cast Iron)
Volute	Cast Iron (A48-30)
Impeller	Bronze (B584-844)
Shaft Sleeve	Bronze (B584-844)
Flush Line	Bronze (B584-844)
Casing Gasket	Confined Non-Asbestos Fiber
Motor Shaft	Carbon Steel

MECHANICAL SEAL DESIGN DATA

Manufacturer	John Crane
Manu. Code [JC 21]	JC 21, OF171
Seal Type	Inside Unbalanced
Rotating Face	Carbon
Stationary Seat	Silicon Carbide
Secondary Seal	EPDM
Springs	Stainless Steel
Rotating Hardware	Stainless Steel



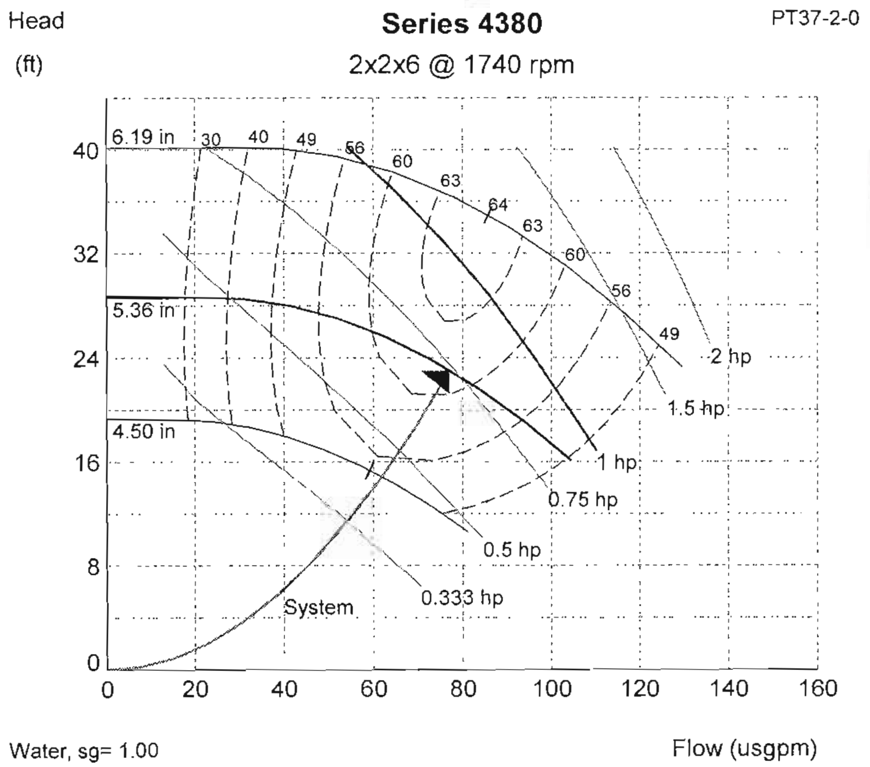


DIMENSIONAL DATA (in, lbs, hp) NOT for CONSTRUCTION

Suct.	Disch.	A	B	C	D	E	Drain	P.Wgt	F	AG	P	AB	M.Wgt
2	2	8	7	4.88	4.88	4.88	0.25	110	3.75	11	7.5	6	30

ARMSTRONG SUBMITTAL

Series 4380
2x2x6
Close Coupled Vertical In-Line Centrifugal Pump



--- Admin Data ---
Tag Num: PHWP-1,2
Service:
Location:

--- Motor Data ---
Motor Size: 1 hp
Motor Speed: 1800 rpm

--- Design Duty Point ---
Flow: 77 usgpm
Head: 23 ft
Impeller: 5.36 in

--- Performance Data ---
- NPSHR: 6.216 ft
- Eff. @ Design: 60.86 %
- BHP @ Design: 0.73 hp
- %Mtr Safety: 36.09%
- BEP @ Design Imp.: 61.26 % @ 72.4 usgpm
- Impeller Max BHP @ Flow: 0.88 hp @ 104.3 usgpm
- %max imp. range: 50.85 %
- Outlet Velocity: 7.36 ft/s

OPTIONAL EQUIPMENT	
Motor	Dedicated Nameplate Voltage

PAWP 1,2

Pump Parts

Model No. 4380 2x2x6

ARMSTRONG

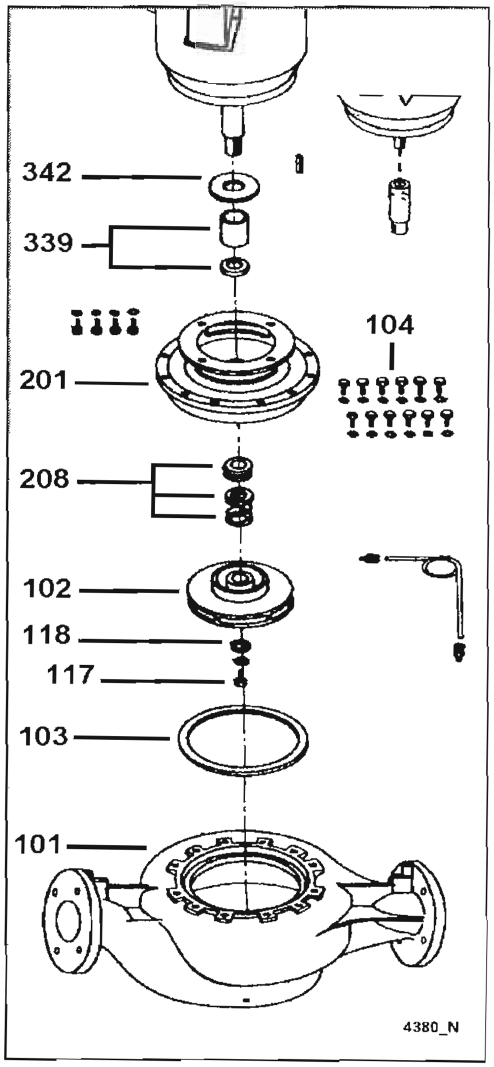
Frame S1 **Material** Bronze Fitted

Description New Style Vertical-In-Line, Split Coupler, Equal Suction & Discharge Size

Volute 250#	101	427038-031
Volute 125#	101	427037-011
Impeller	102	427109-041
Volute Gasket	103	426401-002
Volute Capscrews	104	1/2-13NCx1 1/4"
Impeller Capscrews	117	911900-114
Impeller Washer	118	426472-001
Combination M/P Brkt	201	426746-011
Coverplate	201	
Mech. Seal Assy.	208	9475000-991
Shaft or Shaft Sleeve Kit	339	810150-150

If a part field is blank, then this model does not contain that part

Comments: Small Frame = 7/8" impeller bore



ARMSTRONG SUBMITTAL

Series 4380
2x2x8
Close Coupled Vertical In-Line Centrifugal Pump

Project Number: 062306		**Representative:** Mechanical Solutions	
Name: The Children's School		121 Commerce Way, South Windsor, CT	
Reference:		Phone: 860-290-1564, Fax: 860-290-1825	
Location:		**Order No:**	**Date:**
Engineer:		**Submitted by:** Julie Kirk	**Date:** 12/4/2006
Contractor: Eastern Mechanical		**Approved by:**	**Date:** 12/4/2006

PUMP DESIGN DATA

Tag Num:	SHWP-1,2
Service:	
Location:	
No. of Pumps:	2
Capacity:	77 usgpm
Head:	40 ft
Piping:	Single
Suction Pressure:	0 ft
Liquid:	Water, sg= 1.00, 70 °F
Viscosity:	31 ssu
Branch Sizes:	Suction= 2 in, Discharge= 2 in

MOTOR DESIGN DATA

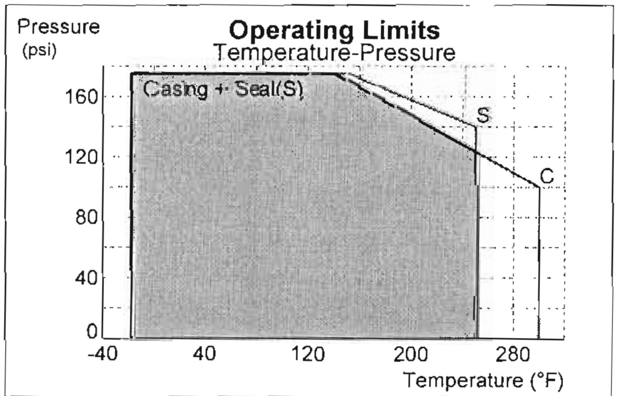
Motor Supplier:	Factory Choice
Motor Size:	2 hp @ 1800 rpm
Frame Size:	145JM
Enclosure:	ODP
Cycle/Phase/Voltage:	60/3/208
Motor Eff:	Std
Insulation:	Class "B" Insulation (266.0 °F)
Starter Config:	DOL
Full Load/Starting (A)	7.5 / 55.3

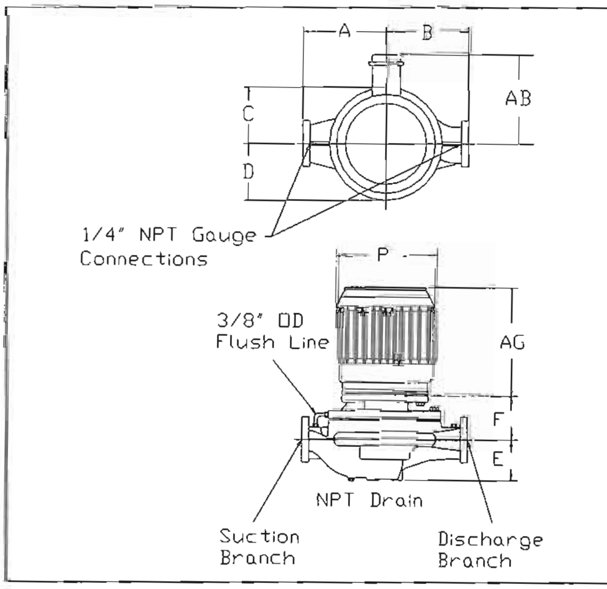
MATERIALS OF CONSTRUCTION

Construction	BF (Bronze Fitted)
ANSI Flange Rating	125 lb. (Cast Iron)
Volute	Cast Iron (A48-30)
Impeller	Bronze (B584-844)
Shaft Sleeve	Bronze (B584-844)
Flush Line	Bronze (B584-844)
Casing Gasket	Confined Non-Asbestos Fiber
Motor Shaft	Carbon Steel

MECHANICAL SEAL DESIGN DATA

Manufacturer	John Crane
Manu. Code [JC 21]	JC 21, OF171
Seal Type	Inside Unbalanced
Rotating Face	Carbon
Stationary Seat	Silicon Carbide
Secondary Seal	EPDM
Springs	Stainless Steel
Rotating Hardware	Stainless Steel



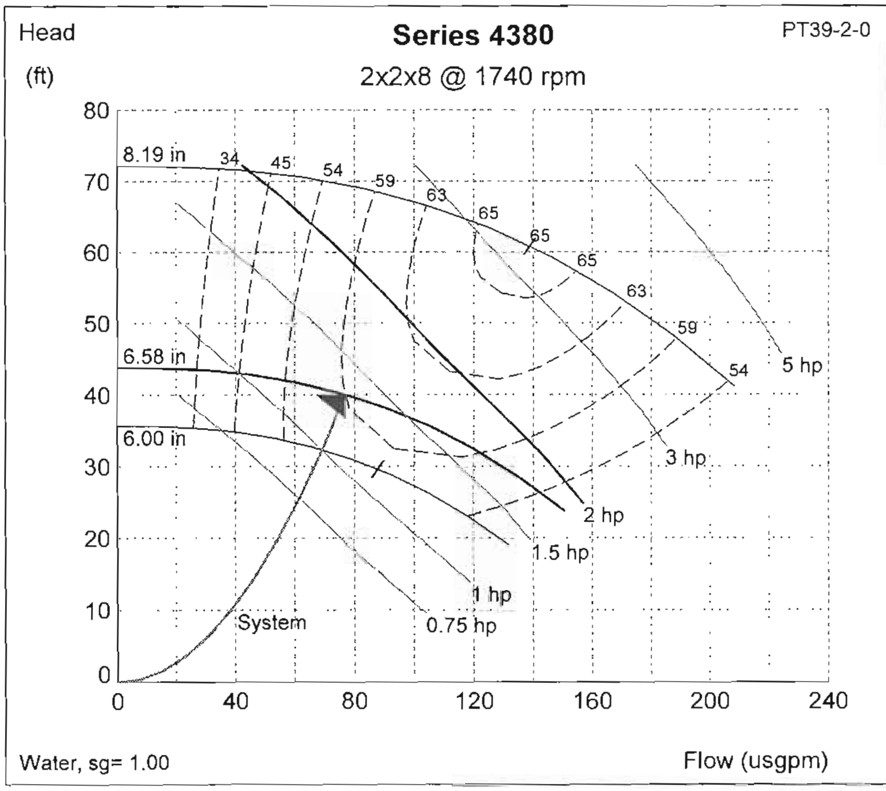


DIMENSIONAL DATA (in, lbs, hp) NOT for CONSTRUCTION

Suct.	Disch.	A	B	C	D	E	Drain	P.Wgt	F	AG	P	AB	M.Wgt
2	2	9.5	8.5	5.75	5.75	5.13	0.25	137	3.75	12	7.5	6	35

ARMSTRONG SUBMITTAL

Series 4380 2x2x8 Close Coupled Vertical In-Line Centrifugal Pump



--- Admin Data ---
Tag Num: SHWP-1,2
Service:
Location:

--- Motor Data ---
Motor Size: 2 hp
Motor Speed: 1800 rpm

--- Design Duty Point ---
Flow: 77 usgpm
Head: 40 ft
Impeller: 6.58 in

--- Performance Data ---
- NPSHR: 4.034 ft
- Eff. @ Design: 58.97 %
- BHP @ Design: 1.32 hp
- %Mtr Safety: 51.65%
- BEP @ Design Imp.: 60.51 % @ 100.4 usgpm
- Impeller Max BHP @ Flow: 1.83 hp @ 150.5 usgpm
- %max imp. range: 26.58 %
- Outlet Velocity: 7.36 ft/s

SAWP 1,2

Pump Parts **Model No.** 4380 2x2x8 **ARMSTRONG**

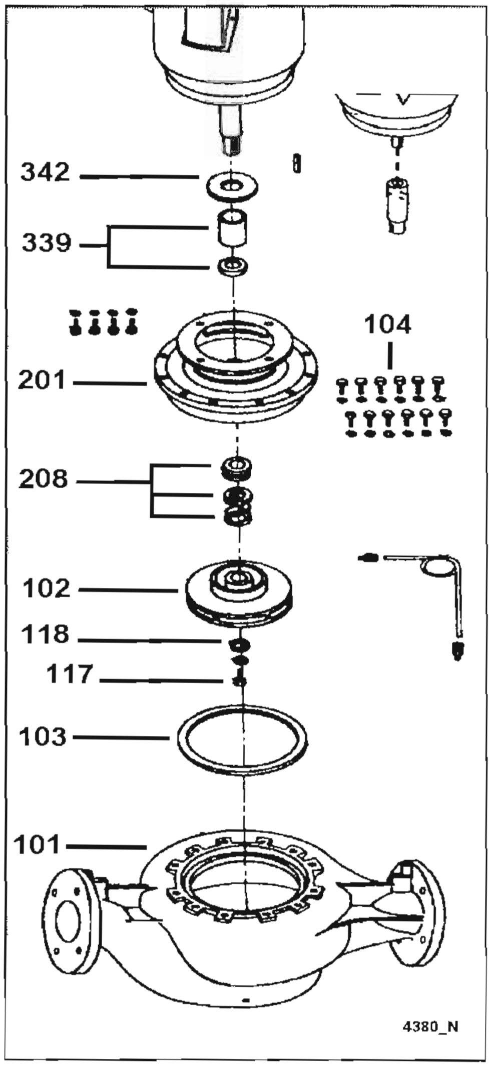
Frame S1 **Material** **Bronze Fitted**

Description **New Style Vertical-In-Line, Split Coupler, Equal Suction & Discharge Size**

Volute 250#	**101**	**427048-031**
Volute 125#	**101**	**427047-011**
Impeller	**102**	**427121-041**
Volute Gasket	**103**	**426401-003**
Volute Capscrews	**104**	**5/8-11NCx1 1/2"**
Impeller Capscrews	**117**	**911900-114**
Impeller Washer	**118**	**426472-001**
Combination M/P Brkt	**201**	**426749-011**
Coverplate	**201**	
Mech. Seal Assy.	**208**	9975000-991
Shaft or Shaft Sleeve Kit	**339**	**810150-150**

If a part field is blank, then this model does not contain that part

Comments: Small Frame = 7/8" impeller bore



ARMSTRONG

FILE NO.:	10.80
DATE:	June 15, 1991
SUPERSEDES:	5010.65 (U.S.A.)
DATE:	Sept. 25, 1987
SUPERSEDES:	10.65 (CAN)
DATE:	Feb. 14, 1989

INSTALLATION AND OPERATING INSTRUCTIONS
IN LINE CIRCULATING PUMPS

MODELS S-25 to S-69, H-32 to H-68, and Series 1050 & 1060

***CAUTION:** ALWAYS DISCONNECT POWER SUPPLY FROM MOTOR BEFORE SERVICING.*

INSTALLATION For convenience, Armstrong Circulators generally are installed in vertical pipelines, but may be changed easily on the job for horizontal pipelines or for opposite flow directions. To make the change, remove the body capscrews, taking care body gasket is kept in position, and rotate body to desired direction at 90° or 180° from the original position.

With arrow on body pointing in direction of flow, insert body capscrews and tighten evenly. (On Models S-25 to S-57, H-32 to H-54 and Series 1050 (1B to 2B), a gap between bearing bracket and pump body (volute) is normal. Do no overtighten body capscrews!) Turn pump shaft manually at coupler to make sure shaft turns freely and impeller does not rub in body. Always install with motor shaft in a horizontal position with pump oil cups or oil well cover on top.

Models S-25 to S-46 and H-32 to H-41 are shipped for down-discharge. All other models are shipped for up-discharge as pumps of this size usually are installed to pump upward on hydronic systems, so the point of zero pressure change - namely, the compression tank connection - can be made easily to the system on the suction aide of the circulator.

The pump should be installed in a position to permit proper lubrication and servicing. Motor and bearing bracket are to be kept free of insultation. Pump and motor unit are designed to be supported by the *inline piping only. Do not* support in any other manner. A height of approximately 4 feet above floor is recommended. When placing pump between flanges, tighten flange bolts evenly and do not tighten excessively.

Gate vales should be installed on discharge and auction side of pump to facilitate service. On larger pump sizes, a check valve should be located on discharge side of pump between pump body and gate valve to prevent damage due to water hammer.

SYSTEM CLEANLINESS Before starting the pump, the system must be thoroughly cleaned, flushed and drained, then replenished with clean liquid. Welding slag and other foreign materials, "stopleak" and cleaning compounds, excessive or improper water treatment - all are detrimental to the pump internals. Guarantee will be void if any of these conditions are allowed is exist. (Refer to File No. 6090.645 - Design and Care of Closed Hydronic Systems.)

STARTING UP The pump must be fully primed on start-up. Fill system piping and pump body with liquid and vent complete system, turning pump by hand to dislodge air from body. Make sure fittings and drain valves are airtight, then add any additional fill required.

Check motor electrics against available supply, then start pump making sure rotation is correct. When viewed from motor end, rotation is counter-clockwise on Models S-25 to S-46 and H-32 to H-41. On all other models, rotation is clockwise. If pressure does not develop, stop pump, re-check, vent and fill. Never attempt to fill system when pump is running.

LUBRICATION

CAUTION: STOP MOTOR BEFORE LUBRICATION, DO NOT OVER-OIL OR SPILL ON RESILIENT MOTOR RINGS. DO NOT FORCE OIL INTO CUPS, AND STOP IF CUP FILLS BEFORE ADDITION OF SPECIFIED AMOUNT.

PUMP LUBRICATION Immediately after pump is installed and before running, slowly add the oil (SAE 30 non-detergent regular, supplied with pump) to pump oil cup, located on top of bearing bracket:

S-25 to S-57, H-32 to H-54 and Series 1050 (1B to 2B)	1/2 oz.
S-69, H-63 to H-58, Series 1050 (1-1/2D, 2D) and Series 1060 (3D)	3-3/4 oz.

At the start of each following heating season, lubricate with SAE 30 oil. For Models S-25 to S-57, H-32 to H-54 and Series 1050 (1B to 2B), add approximately 1/2 oz. (Lubricate every 6 months for high temperature or constant operation.) On Models S-69, H-63 to H-68, Series 1050 (1-1/2D, 2D) and Series 1060 (3D), be sure oil is visible at the top and center of window on side of bracket and maintain this level at all times.

MOTOR LUBRICATION

CAUTION: STOP MOTOR BEFORE LUBRICATING. DO NOT OVER-OIL OR SPILL ON RESILIENT MOTOR RINGS.

This motor has been lubricated properly at the factory. At the start of each following heating season, however, *on motors with oil cups,* and 15 drops SAE 30 non-detergent oil to each motor cup.

If motor is fitted with grease fittings, follow the motor manufacturer's recommended procedure. Motors without oil cups or grease fittings are custom-greased for several years operation and require little or no attention.

SEAL REPLACEMENT Remove pump bracket from body. Remove the impeller, damaged seal assembly, ceramic insert and rubber cup. Clean the recess in bearing bracket coverplate and install a new retainer cup and ceramic Check the condition of the shaft sleeve. If scored, replace the shaft assembly. Otherwise, clean shaft extension and polish sleeve with fine crocus cloth, using a rotating motion, if required.

Press against coupler end of shaft to take up and play while pressing new seal firmly against the stationary face. A slight amount of clean vaseline may be put on shaft sleeve to assist installation. Press down firmly and evenly, using 2 screwdrivers and pushing against the 4 ears of driving band (the metal ring around rubber bellows), or around top outer edge of driving band on Models S-25 to S-57, H-32 to H-54 and Series 1050 (1B to 2B).

Do no use spring washer on Models S-25, S-35 and H-32 current style circulators, where recess to locate spring is provided on impeller hub.

Continue pressing against coupler end of shaft, re-mount impeller and re-assemble the seal bearing assembly into body. If necessary, install a new body gasket and clean gasket surface of both volute and bracket.

CAUTION: Before operating pump, carefully check:

1. IS THE PUMP PRIMED?
2. IS ROTATION CORRECT?
3. IS PUMP PROPERLY LUBRICATED?
4. DOES THE POWER SUPPLY AGREE WITH DATA ON MOTOR NAMEPLATE?
5. IS OVERLOAD PROTECTION PROVIDED?
6. IS THE SYSTEM CLEAN?

FOR DOMESTIC WATER SYSTEMS USE BRONZE BODY PUMPS.

File No.: 9.10
Date: August 15, 1997
Supersedes: 9.10
Date: May 17, 1982

SCHEDULE G

TERMS OF SALE AND WARRANTY

ARMSTRONG PUMPS INC. ("ARMSTRONG")

1. ARMSTRONG Terms: The following terms shall prevail over and cancel any other or different terms or conditions of Customer's purchase order. ARMSTRONG'S acceptance of Customer's order shall not be construed as an acceptance of printed or inserted provisions on Customer's order form which are inconsistent with or additional to these terms and conditions, unless specifically accepted in writing by an authorized Officer of ARMSTRONG. No sales representative, agent, or employee of ARMSTRONG is authorized to alter, vary or waive any of these terms and conditions. Such changes require the written approval of an authorized Officer of ARMSTRONG.
2. Acceptance of Orders: All orders are subject to formal acceptance at Head Office by an authorized Officer of the Company.
3. Prices: *Federal, State, Municipal and Provincial taxes* [including without limitation Goods & Services tax] extra, if applicable, unless otherwise stated.
   Prices quoted are firm for 30 days from date of quotation.
   Prices will remain firm to time of shipment, provided:
   a) Delivery is accepted as goods are available.
   b) The customer will accept delivery six months or less from date of his order.
   c) Approval data is returned within 30 days from date of submission.
4. Terms: Net 30 days from date of invoice, unless otherwise stated. 2% per month interest (24% per annum) will be charged on all overdue accounts. These terms are subject to credit approval; otherwise, terms are cash with order or C.O.D.
5. Minimum Billing: Minimum billing of each customer order will be $150.00.
6. Confirmation of Telephone Orders: Orders are accepted by telephone for the convenience of the customer and must be promptly confirmed in writing. Such orders should be clearly marked as 'CONFIRMATION'; otherwise they may be duplicated.
7. Returned Goods: No goods may be returned without first obtaining a Returned Goods number from ARMSTRONG. Application must include invoice number and date of original shipment.
   a) All goods returned will be subject to a re-handling charge - minimum 25% of invoice amount. Minimum charge of $50.00 will apply.
   b) If, upon inspection, the goods are found to be in need of reconditioning or repair, an additional deduction will be made and the customer will be advised of the total re-handling charge that will apply.
   c) All goods approved for return must be clearly tagged with RG number and have transportation charges prepaid and will be accepted for credit on the basis of original invoiced prices, and must be received by Armstrong within 30 days of return approval.
   d) Goods which are assembled to order [this includes all pumps, systems, heat exchangers and replacement tube bundles], obsolete, used, non-stock, or over 18 months old (from date of shipment), are not returnable.
8. Warranty: ARMSTRONG warrants Armstrong-manufactured products to be free from defects in material and workmanship under normal use and service for a period of one year from date of shipment [except Circulators and Hydronic Specialties which are for a period of two years from date of shipment] when installed and used in accordance with our printed instructions [normal wear and tear excepted]. Note: All mechanical seal warranties are restricted to those failures at start-up and must be reported to the factory within 48 hours. Our obligations shall be limited to the repair of parts or replacement of any parts at our option, f.o.b. factory (or f.o.b. Authorized Armstrong Service facility located in user's territory where such facility is available and services the product in question) which may prove defective under normal use and service during the warranty period and which our examination shall disclose to be defective. This warranty shall not apply to any goods which have been subject to accident, alteration, abuse, misuse, tampering, negligence, damage by flood, fire or act of God or where the goods have been improperly installed, maintained or subjected to certain types and/or improperly applied water treatment or other system additives. ARMSTRONG shall not be liable for service, labour or transportation charges or for damages for delay caused by defective material or workmanship or for personal injuries or damage to property caused directly or indirectly by any Armstrong-manufactured product or by its use or operation experienced by the customer or any other person whatsoever. THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED. NO REPRESENTATIVE OR OTHER PERSON IS AUTHORIZED OR PERMITTED TO MAKE ANY WARRANTY OR ASSUME FOR US ANY LIABILITY NOT STRICTLY IN ACCORDANCE WITH THE FOREGOING. THE FOREGOING WARRANTY SHALL NOT APPLY TO COMPONENTS PURCHASED BY ARMSTRONG FROM OTHER MANUFACTURERS; IN LIEU OF PROVIDING WARRANTY ON SUCH COMPONENTS, ARMSTRONG WILL MAKE AVAILABLE TO CUSTOMER ANY WARRANTIES RECEIVED BY IT FROM SUCH MANUFACTURERS. OTHER THAN THE FOREGOING WARRANTY, ARMSTRONG MAKES NO REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESSED OR IMPLIED, WITH RESPECT TO ITS PRODUCTS, WHETHER AS TO MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER MATTER.
9. F.O.B. Point: Prices are f.o.b. our warehouse, unless otherwise stated. Where freight allowances are specifically offered, ARMSTRONG reserves the right to select carrier and routing. All deliveries and shipments will be at the customer's risk from the time of delivery to the carrier by ARMSTRONG., irrespective of whether the principal carrier shall have been designated in the shipping instructions of the customer. The Customer is required to inspect all inbound documents for accuracy. If there is any evidence of injury to or shortage of containers' contents, do not receipt to carrier "in good condition", but give receipt according to the facts. In case of damage, claim must be made on carrier without delay. Our assistance is available to secure adjustment. Any discrepancy must be reported in writing to ARMSTRONG Customer Service within 5 days of receipt.
10. Prior Sale: Goods in stock are offered subject to prior sales or shipment.
11. Shipments, Deliveries or Cancellations: ARMSTRONG shall not be liable for any charges or damages arising out of loss, damage, stoppage or delay and interruption with respect to shipments or to delivery schedules resulting from fire, storm, flood, war, explosion, accident, strike, lockout, labour disturbance, act of God or other causes beyond their reasonable control. If shipments are delayed or deferred by the customer more than one month beyond the original shipping date, payment for goods shall become due at the time and storage or warehousing charges of 2% per month may be charged. No order for assembled to order equipment may be cancelled, materially altered or terminated except upon payment to ARMSTRONG for loss, damage and expense arising from such cancellation, alteration or termination.
12. Consequential Damages: NOTWITHSTANDING ANYTHING TO THE CONTRARY HEREIN CONTAINED, ARMSTRONG SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, CONTINGENT OR INCIDENTAL DAMAGES WHATSOEVER.
13. Acceptance: Customer's acceptance of any goods supplied by ARMSTRONG or on ARMSTRONG's behalf shall without limitation constitute acceptance of all terms and conditions as stated above.

ARMSTRONG SUBMITTAL

Series 1050
1.5B
Custom In-Line Circulators

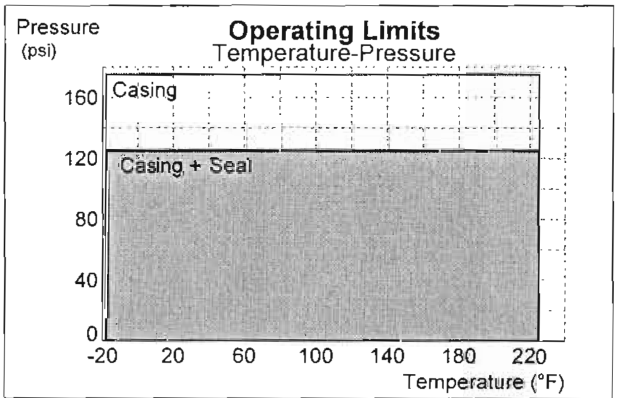
Project Number: 062306	**Representative:** Mechanical Solutions
Name: The Children's School	121 Commerce Way, South Windsor, CT
Reference:	Phone: 860-290-1564, Fax: 860-290-1825
Location:	**Order No:** **Date:**
Engineer:	**Submitted by:** Julie Kirk **Date:** 12/4/2006
Contractor: Eastern Mechanical	**Approved by:** **Date:** 12/4/2006

PUMP DESIGN DATA

Tag Num:	HWRP-1,2
Service:	
Location:	
No. of Pumps:	2
Capacity:	48 usgpm
Head:	18 ft
Piping:	Single
Suction Pressure:	0 ft
Liquid:	Water, sg= 1.00, 70 °F
Viscosity:	31 ssu
Branch Sizes:	Suction= 1.5 in, Discharge= 1.5 in

MATERIALS OF CONSTRUCTION

Construction	BF (Bronze Fitted)
Pump Body	Cast Iron (A48-30)
Impeller	Bronze-Cast
Bearings	Sleeve-Oil Lubricated
Shaft && Sleeve	Alloy Steel - Copper Sleeve
Seal	Mechanical
Stationary Seal Face	ARMSEAL Ceramic
Coupler	Flexible, Spacer Type

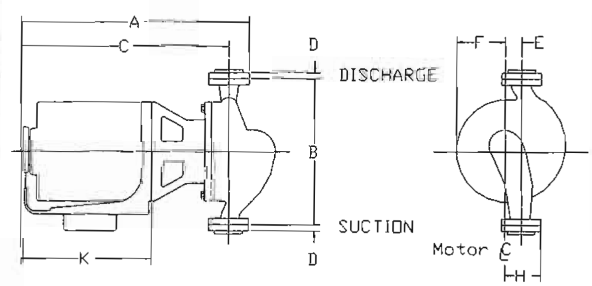


MOTOR DESIGN DATA

Motor Supplier:	Factory Choice
Motor Size:	0.5 hp @ 1800 rpm
Frame Size:	
Enclosure:	ODP
Cycle/Phase/Voltage:	60/3/208
Motor Eff:	Std
Insulation:	Class "B" Insulation (266.0 °F)
Starter Config:	DOL
Full Load/Starting (A)	4.0 / 33.2

MECHANICAL SEAL DESIGN DATA

Manufacturer	Armstrong
Manu. Code [Armseal]	(Circs)
Seal Type	Inside Unbalanced
Rotating Face	Carbon
Stationary Seat	Ceramic
Secondary Seal	BUNA-N
Springs	Stainless Steel
Rotating Hardware	Brass



DIMENSIONAL DATA (in, lbs, hp) NOT for CONSTRUCTION

Mount	A	C	K	TotWgt	Wgt.
Resilient	19.75	16	9.88	58	58

6/5/2007, 15:04:31, Julie Kirk, Mechanical Solutions, 860-290-1564, Fax: 860-290-1825

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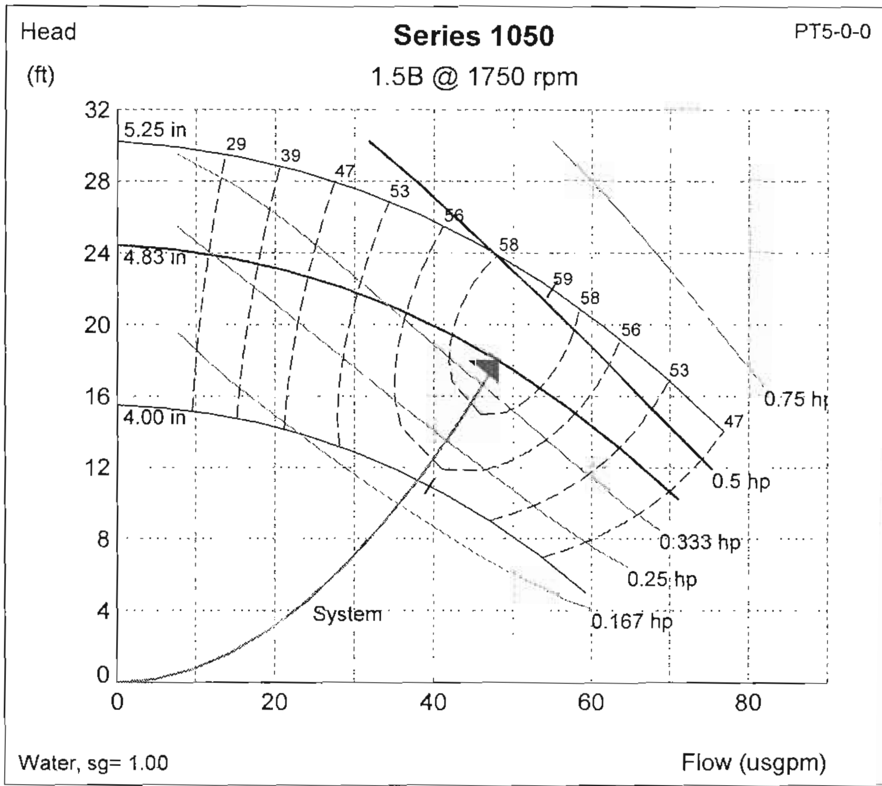
ARMSTRONG
SUBMITTAL

Series 1050
1.5B
Custom In-Line Circulators



--- Admin Data ---
Tag Num: HWRP-1,2
Service:
Location:

--- Motor Data ---
Motor Size: 0.5 hp
Motor Speed: 1800 rpm

--- Design Duty Point ---
Flow: 48 usgpm
Head: 18 ft
Impeller: 4.83 in

--- Performance Data ---
- NPSHR: 5.68 ft
- Eff. @ Design: 58.24 %
- BHP @ Design: 0.37 hp
- %Mtr Safety: 33.48%
- BEP @ Design Imp.: 58.26 % @ 49.5 usgpm
- Impeller Max BHP @ Flow: 0.40 hp @ 68.9 usgpm
- %max imp. range: 66.07 %
- Outlet Velocity: 7.56 ft/s

H WRP-1, 2

Circulator Parts **Model No.** 1050 1½B **ARMSTRONG**

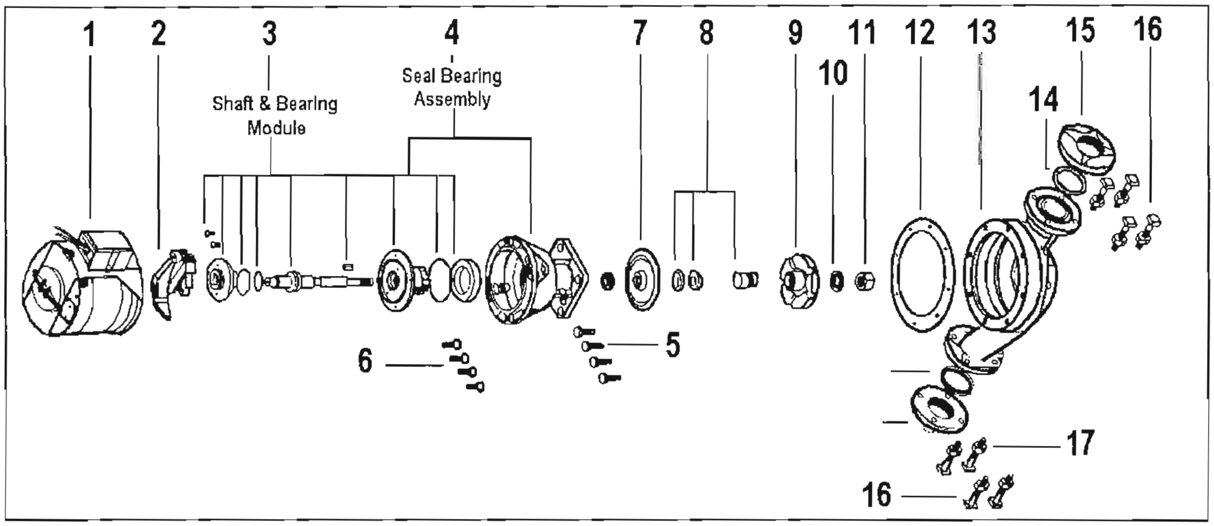
Material **Bronze Fitted**

Description: Custom serial number required **60 Hz** **Phase: 1**

Motor Assembly	1	call Armstrong	Impeller Washer	10	927411-700
Coupler Assembly	2	Call Armstrong	Impeller Nut	11	106076-000
Shaft & Sleeve Assembly	3	816999-041	Body Gasket	12	106158-000
Bearing Assembly	4	816032-000	Pump Body	13	816337-011
Bearing Cap Assy. Kit	5		Flange Gasket	14	805176-000
Coverplate Capscrews	6	3/8-16x7/8 911121-107	Flange	15	1 1/2" NPT 116009-011
Coverplate	7	174003-071	Flange Bolts	16	7/16-14x1-3/4 911123-111
Mech. Seal Assembly Kit	8	816706-001	Flange Nuts	17	7/16-14 JAM 913123-100
Impeller	9	Call Armstrong	Capscrews (Pump Body)	18	5/16-18x3/4 911119-106
Complete Bearing Assy. (includes seal kit & C.plate)	4				

If a part field is blank, then this model does not contain that part

Comments: Custom Circulator, trimmed impeller, consult Armstrong for duty point



Bell & Gossett Model No.

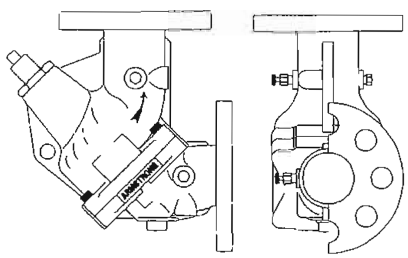
Grainger Model No.

ARMSTRONG®

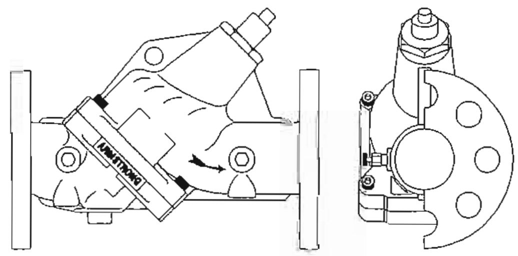
FILE NO.:	35.81
DATE:	November 20, 1998
SUPERSEDES:	NEW
DATE:	NEW

Installation and Operating Instructions and Parts List

Armstrong Model FTV Hard Flanged Flo-Trex Combination Valve



Angle Pattern Model FTV-AF



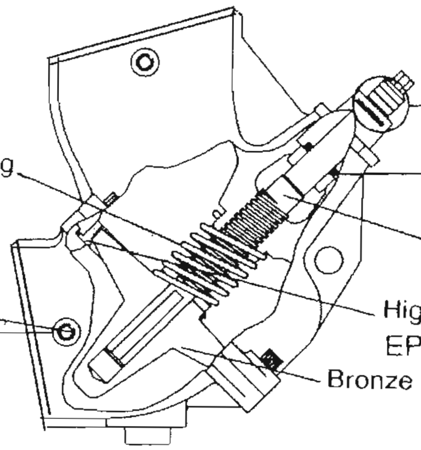
Straight Pattern Model FTV-SF

Table of Contents

1.0 INTRODUCTION

1.1 The Armstrong Model FTV Flo-Trex Combination Valves are designed for installation on the discharge side of centrifugal pumps. The Armstrong Combination Valve incorporates three functions in one valve:

- Drip-tight, shut-off valve ·
- Spring closure design. Non-slam check valve ·
- Flow throttling valve



Armstrong Model FTV-AF
Flo-Trex Combination Valve

2.0 INSTALLATION

2.1 The valve should be mounted to a spool piece on the discharge side of the pump. Spool piece required is based on a minimum recommended space of 12" for pump sizes 2 x 2 to 6 x 6 and 24" for pump sizes 8 x 8 to 12 X 12.

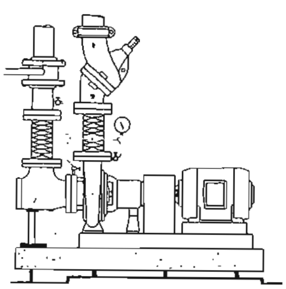
2.2 It is not recommended to mount a valve directly to the pump as this could cause undesirable noise in the system.

2.2 Sufficient clearance around the valve should be left for valve removal or repair.

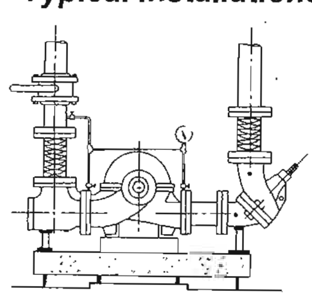
2.3 Install valve in the direction of the flow arrows on the valve body.

2.5 The valve body has been designed to handle the weight of the pump on vertical in-line installations. The body is not designed to support the piping weight. It is recommended that the piping be supported by hangers. Pipe supports should be provided under the valve and strainer bodies.

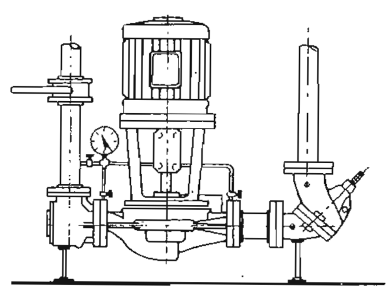
Typical Installations



Base-Mounted Single Suction



Base-Mounted Double Suction



Vertical In-Line

For additional information on Armstrong Model SG Suction Guides, request File 35.10.

3.0 FLANGE BOLT TIGHTENING

Valve Size	125 psi/150 psi Cast Iron	
	Bolt	
	No.	Size
2-1/2	4	5/8
3	4	5/8
4	8	5/8
5	8	3/4
6	8	3/4

Table 1

Recommended Bolt Tightening Procedure

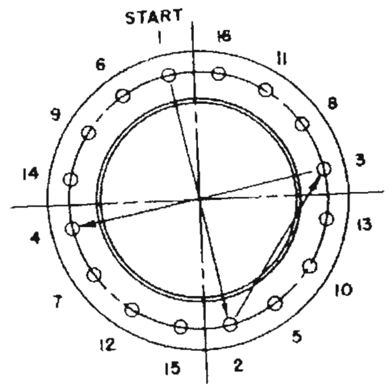
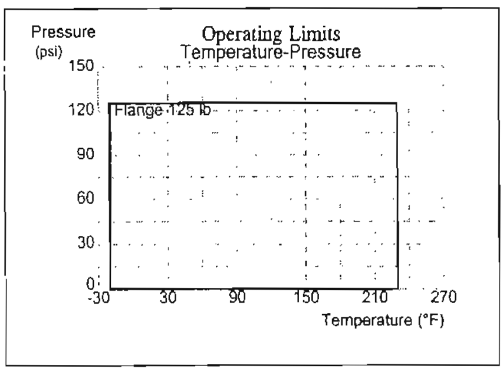


Fig. 1

3.1 Tighten nuts evenly, following bolting instructions (fig.1) so that the flange faces remain parallel. Flange bolts should be tightened to 70 ft/lbs. Torque minimum to assure firm metal-to-metal contact. When raised face flanges are used, there will be a gap between the faces of the outer diameter.

4.0 PRESSURE TEMPERATURE LIMITS



5.0 FIELD CONVERSION (Straight to Angle pattern valve)

5.1 Open valve at least one complete turn.

5.2 Remove the body bolts from valve body using Allen Key.

5.3 Rotate one half of the valve body 180° making sure the lower valve seat and "0' Ring stay in position. Inspect the "O" Ring for any cuts or nicks and replace if necessary.

5.4 Replace body bolts and torque evenly to 70 ft/lbs.

6.0 FLOW MEASUREMENT

6.1 Where approximate indication of flow is acceptable the Armstrong Flo-Trex valve can be used.

6.2 FLOW MEASUREMENT VALVE IN WIDE OPEN POSITION

6.22 Measure and record the differential pressure across the valve using an Armstrong CompuFlo with high pressure range transducer, or CBDM- 135/60 meter, or pressure gauges with PMP adapters.
Caution: Safety glasses should be used and the probe should not be left inserted into fittings for prolonged periods of time (overnight, etc), as leakage from the PMP may occur when probe is removed.

6.23 Refer to Flo-Trex Performance Curves with valve in full open position (Fig 2).

Locate Pressure Differential on left hand side of chart and extend line horizontally across to valve size being used. Drop line vertically down and read flow rate from bottom of chart.

6.3 DETERMINING FLOW RATE WITH VALVE IN THROTTLED POSITION

Flo-Trex Performance Curve with Valve in Full Position

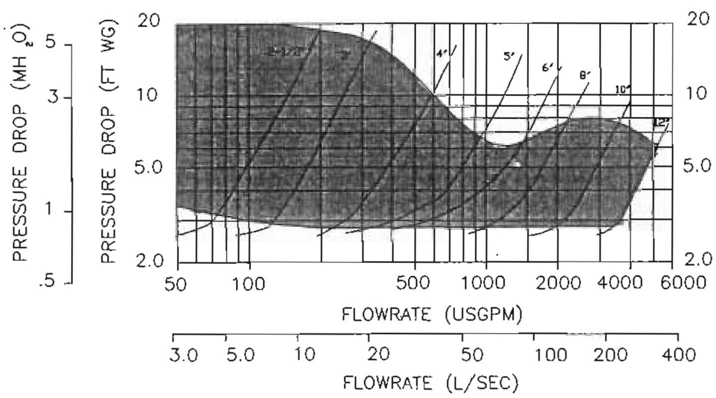


Fig. 2

Inherent Flow Characteristic Curve with Valve in Throttled Position

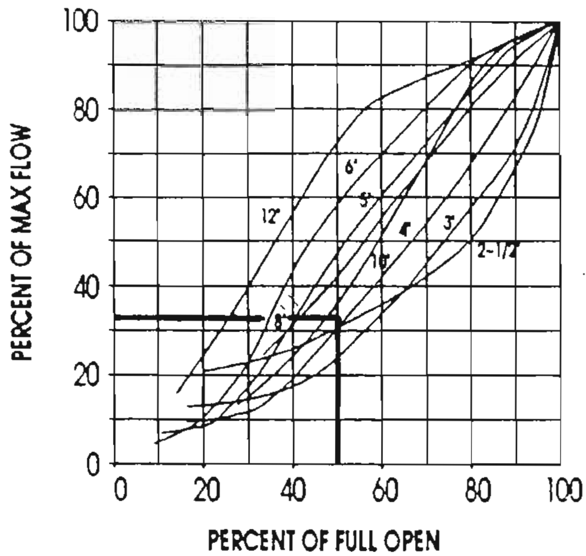


Fig. 3

6.31 Record the size of the valve and stem position using the Flow Indicator Scale (page 5). Calculate percentage of valve opening referring to table below:

Valve Size	2 1/2	3	4	5	6	8	10	12
Number of Rings (valve full open)	5	5	6	9	10	12	18	28

6.3.2 Measure and record the differential pressure across the valve in the throttled position.

6.3.3 Locate percentage of valve opening on the bottom scale of Flow Characteristic Curve (fig 3). Project line vertically up to intersect with the Valve Characteristic Curve and from this point project line horizontally across to the left of the chart and record the percentage of maximum flow rate.

6.3.4 On the Flo-Trex Performance Curve (fig. 2) locate the differential pressure obtained in Step 6.3.2 and project line horizontally across to intercept with Valve Performance Curve. Drop a line vertically down to read the flow rate at the bottom of the chart.

6.3.5 To calculate flow rate of valve in the throttled position, multiply the flow rate from Step 6.3.4 by the percentage flow rate from Step 6.32 divided by 100.

Example: Valve size 4 inch.
Differential Pressure is 5.4 ft. (1.65 m).
Number of rings open = 3. Therefore: 3 rings ÷ 6 rings x 100 = 50% throttled.
From the Flo-Trex Performance Curve (fig 2), a 4 inch, valve with 5.4 ft. pressure drop (1.65 m) represents a flow of 400 USgpm (25.2 l/s).
From Flow Characteristic Curve (fig 3), a 4 inch valve 50% open, represents 34% of maximum flow.
Approximate flow of a 4 inch valve, with a 5.4 ft. (1.65 m) pressure drop when 50% throttled is:

$\frac{400 \times 34}{100}$ = 136USgpm or in metric $\frac{25.2 \times 34}{100}$ = 8.57l/s

Note: To prevent premature valve failure it is not recommended that the valve operate in the throttled position with more than 25 ft. pressure differential. Instead the pump impeller should be trimmed or valves located elsewhere in the system be used to partially throttle the flow.

Flow Indicator Scale

The valve stem with its grooved rings and positioning sleeve indicates the throttled position of the valve. The quarter turn graduations on the sleeve, with the scribed line on the stem provides for approximate flow measurement.

Note: The valve is shipped in the closed position. The indicator on the plastic sleeve is aligned with the vertical scribed line on the stem.

7.0 OPERATION

7.1 To assure tight shut off the valve must be closed using a wrench with 25 to 30 ft/lbs. of torque.

7.2 To assure trouble-free check valve operation and shut off operation, the valve should be periodically opened and closed to keep valve seat and valve disc guide stem free of build up of system contaminants.

8.0 REPACKING OF FTV UNDER FULL SYSTEM PRESSURE

8.1 Should it be necessary, stem "O" Ring can be changed under full system pressure.
Caution: Safety glasses should be worn.

8.2 Record the valve setting.

8.3 Turn the valve stem counter-clockwise until the valve is fully open and will not turn any further. Torque to a maximum force of 45 ft/lbs. This will ensure good metal-to-metal contact and minimum leakage.

8.4 The valve bonnet may now be removed. There may be a slight leakage. As the metal-to-metal back seating does not provide a drip-tight seal.

8.5 Clean exposed portion of valve stem (Do not scratch).

8.6 Remove and replace the '0" Ring and gasket.

8.7 Install the valve bonnet.

8.8 Tightening valve bonnet is necessary to stop any leaks.

8.9 Open valve to balance set point as recorded in 8.2.

9.0 MAXIMUM NUMBER OF TURNS FULL OPEN VALVE

Note: On valve sizes 2-1/2" and 3", full open position of valve is 5 turns. However valve will open to 5-1/2 turns which is just back of seating of valve.

10.0 SEAT REPLACEMENT

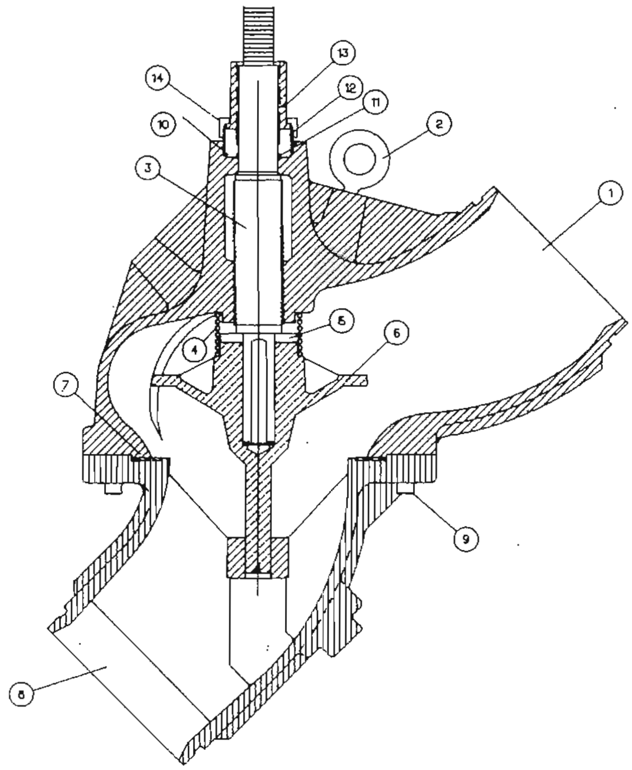
10.1 Drain system and remove valve from piping.

10.2 Remove the body bolts from the body using an Allen Key.

10.3 Remove seat and "O" Ring.

10.4 Inspect and clean 'O' Ring cavity and install new "0" Ring and seat. Valve disc stem also should be inspected and replaced if worn. Valve stem 'O' Ring should be replaced at this time. Refer to section 8.

Flo-Trex Valves
Replacement Parts List



11.0 Parts List

Part	Item No.	2-1/2" Straight or Angle	3" Straight or Angle	4" Straight or Angle	5" Straight or Angle	6" Straight or Angle
Shaft	3	570202-006	570202-006	570202-006	570202-007	570202-007
Spring	4	570203-002	570203-003	570203-004	570203-005	570203-006
Bushing	-	570223-001	570223-001	570223-002	570223-001	570223-002
Bonnet	13	570201-006	570201-006	570201-006	570201-006	570201-006
Eye Bolt	2	N/A	N/A	N/A	N/A	N/A
Cap-Sleeve	15	N/A	N/A	N/A	N/A	N/A
"O" Ring **	12	961131-210	961131-210	961131-210	961131-210	961131-210
Sleeve	14	570216-000	570216-000	570216-000	570216-000	570216-000
Spacer	5	570198-006	570198-006	570198-006	570198-006	570198-006
Disc	6	570232-041	570233-041	570234-041	570235-041	570236-041
Body Main	1	570518-611	570520-611	570522--611	570524-611	570526-611
Seat **	7	570196-000	570196-001	570196-002	570196-003	570196-004
"O" Ring Body **	8	961131-238	961131-242	961131-250	961131-259	961131-263
Body Suction	9	570500--611	570502-611	570504-611	570506-611	570508-611
Capscrew	10	911821-112	911821-112	911825-112	911829-114	911829-114
Performed Insulation (Straight)	-	570225-386	570225-387	570225-388	570225-389	570225-390
Performed Insulation (Angle)	-	570225-486	570225-487	570225-488	570225-498	570225-490

** Recommended Spare Parts

Common parts to all: Gasket - 570217-006; 14" Brass Pipe Plug - 935105-001; 14" Brass Metering Ports - 570148-001

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Fax: (416) 759-9101
Visit us at armstrongpumps.com

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Armstrong Pumps Inc.
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FCI STANDARD #89-1

Guide for the Selection, Installation and Maintenance of Pipe Line Strainers

Prepared by

PIPE LINE STRAINER SECTION
FLUID CONTROLS INSTITUTE, INC.

CONTENTS

PREFACE

Experience has proven the need for strainers in the protection of pumps, compressors, turbines, meters, automatic valves, sprinkler heads, burner nozzles, steam traps and other pipeline equipment.

This guide has been established as a technical reference for project engineers and managers responsible for specifying and using pipeline strainers. While strainers remain a relatively low cost item, when specified properly, the protection they provide is invaluable. It is the intent of this guide to provide the background and information necessary to make knowledgeable and sound engineering decisions in the specification of pipeline strainers.

The Pipe Line Strainer Section of the Fluid Controls Institute Inc. acknowledges and appreciates the assistance of those people who have made the creation and updating of this technical resource possible.

<u>CHAPTER 1</u>

Definition

A pipe line strainer is a device which provides a means of mechanically removing solids from a flowing fluid by utilizing a perforated, mesh or wedge wire straining element. The most common range of strainer particle retention is 1 inch to 40 micron (.00156 inch).

Purpose

Strainers are employed in pipe lines to protect downstream mechanical equipment such as condensers, heat exchangers, pumps, compressors, meters, spray nozzles, turbines, steam traps, etc. from the detrimental effect of sediment, rust, pipe scale or other extraneous debris.

Types of Strainers

Two frequently specified strainers are the "Y" strainer and the basket strainer. While there is primarily one type of "Y" strainer (Fig. 1A), there are several variations of basket strainers (Fig. 1B through 1E).

Vertical piping, frequently found at pump inlets,

Fig. 1A

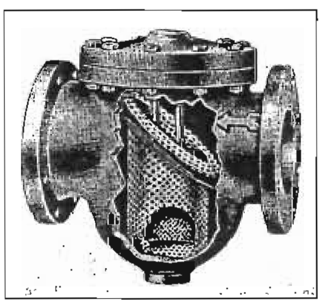

Fig. 1B

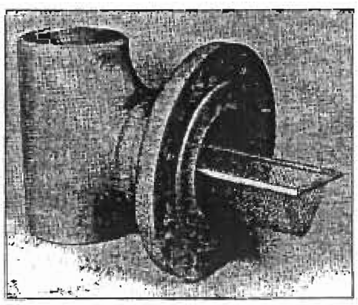

Fig. 1C

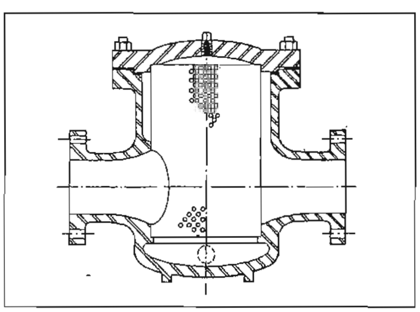

Fig. 1D

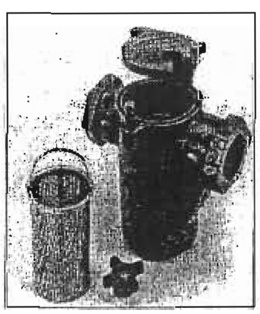

Fig. 1E

necessitates the use of a "Y" strainer or a tee type basket strainer. Most basket strainers are intended for horizontal or slightly inclined piping. "Y" strainers and tee type basket strainers, on the other hand, can be used in horizontal as well as vertical (downward) piping. Special attention must be given, however, to maintaining the position of the debris collection chamber and the drain (blowdown) connection in their lowest position (Fig. 2). A "Y" strainer in vertical piping must be placed with its screen in the downward position to trap the sediment in the debris collection chamber.

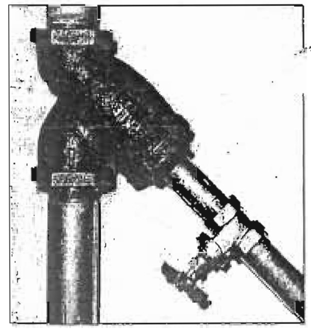

Fig. 2

Tee type strainers, suction diffusers and several variations of fabricated basket strainers can also be used in a right angle flow application (Fig. 3).

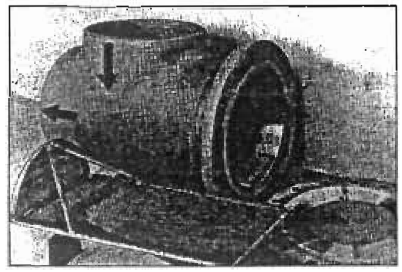

Fig. 3

"Y" strainers and most variations of basket strainers can be self-cleaning. With the addition of a blowdown valve and some modification of the straining element of a basket strainer, the element can be flushed out by opening and closing the blowdown valve . This can be done without flow shut down or disassembling any piping.

In sizes above 4", a single basket strainer will generally create less pressure drop than a "Y" type. Basket strainers are normally installed in a horizontal pipe with the cover over the basket at the top. Cleaning of the strainer is generally simple and no draining is required. Cover flanges for basket strainers are relatively easy to remove and servicing is simplified. Replacement of covers on "Y"-type strainers is facilitated by some manufacturers through the use of studs, rather than bolts, which help to align the cover during the replacement operation. Hinged covers and screen locking devices can also make servicing easier.

There seems to be a general misconception among engineers and contractors concerning "Y" strainers and basket strainers used in steam service. In many instances, basket and "Y" strainers will perform comparably in steam service. It is essential in ordering strainers for steam service that the manufacturer be so advised. As mentioned above, the housings may be furnished without a bottom, allowing the accumulated debris to be blown out by opening the blowdown valve (Fig. 4).

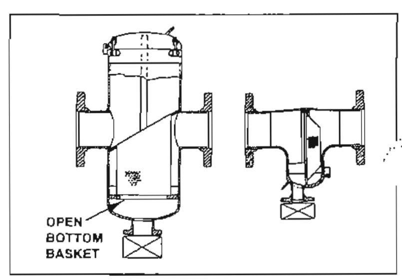

Fig. 4

While there are some high pressure

applications for basket strainers, (Fig. 5), due to the required thickness and subsequent high cost, basket strainers are not normally constructed for pressures above 1,500 psi. "Y" strainers, on the other hand, are readily available for working pressures up to 6,000 psi and higher. In addition to "Y" and basket types, other strainers are available such as duplex/twin, geometric, washdown/backflushing, automatic self cleaning, plate or expanded cross section type, scraper, and magnetic screen types. Descriptions of these as well as miscellaneous options available with them, follow.

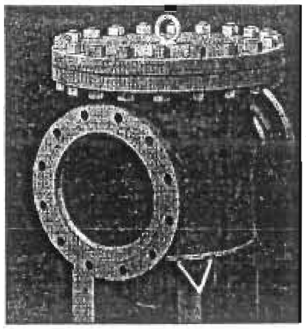

Fig. 5

Duplex/Twin Strainers

For applications where continuous operation is required and the line cannot be disassembled for cleanout, duplex or twin basket strainers can be used. Refer also to Automatic Strainers, Page 5, for continuous service applications. Examples are fuel oil strainers for industrial or marine oil burners, lubricating lines on board ships, cooling towers, continuously running chemical operations, and many industrial water intake and service lines.

When one basket becomes full, the flow is switched to the other basket. The first basket is removed, cleaned and replaced. For smaller sizes the "plug"-type duplex basket strainer (Fig. 6) is generally used since it is less costly to make and simpler to operate and maintain than other types. It is basically a plug valve with two integral basket wells into which flow can be diverted by rotating the plug. In larger sizes the plug design becomes unwieldy, and an individual valving arrangement is used (Fig. 7). Here, flow is shifted from one basket to the other by integral sliding gate valves. These strainers are frequently furnished with an interlocking chain-drive mechanism so the two valves work in unison (one basket compartment opens while the other is being valved off) . This prevents accidental shutoff of the line.

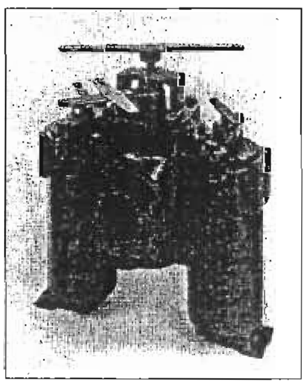

Fig. 6

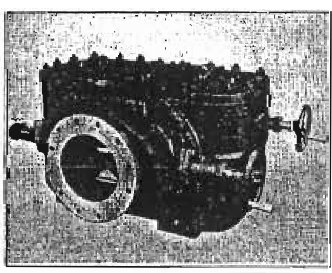

Fig. 7

This type strainer can be furnished with individual globe valves instead of gate valves. Globe valves give more positive shutoff, but since these strainers are not normally used for high pressures they are generally not needed. The globe- valve-type duplex strainer is usually more expensive than the gate-valve type.

Twin strainers, two single basket strainers connected in parallel with individual control valves are also available (Fig. 8). Where continuous operation is required, however, a duplex strainer is generally preferred. It occupies less space and is a "one-piece unit". However, because of the more circuitous path the liquid must take through a duplex strainer, pressure drop is higher than through the equivalent size single basket strainer.

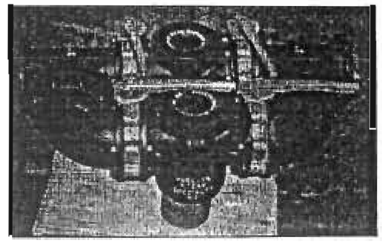

Fig. 8

Geometric (Temporary) Strainers (Fig. 9A through 9C)

Where cost is of prime importance, a geometric strainer may be installed between flanges in a pipe line. Variations of geometric strainers include cone (Fig. 9A), truncated cone (Fig. 9B) and flat geometries (Fig. 9C). The design considerations with these types of strainers are:

1) They have a lower net open area than basket strainers.

2) The pipe line must be disassembled to inspect, clean or remove these strainers.

3) Structural strength can be difficult to achieve, particularly in larger sizes, and in the case of wire mesh. While these strainers were once called temporary or startup strainers, more frequently than not, they are now left in the line during operation. As with all types of strainers, periodic maintenance must be carried out to ensure efficient operation.

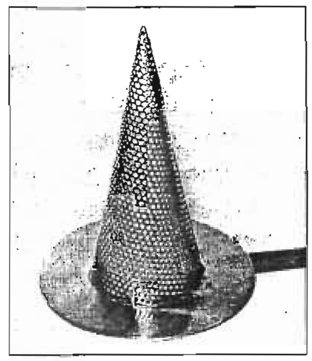

Fig. 9A

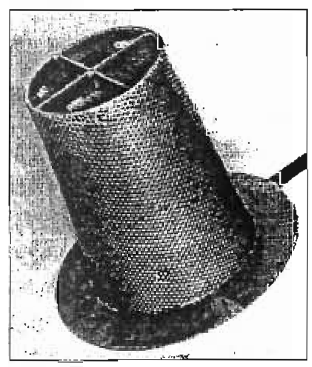

Fig. 9B

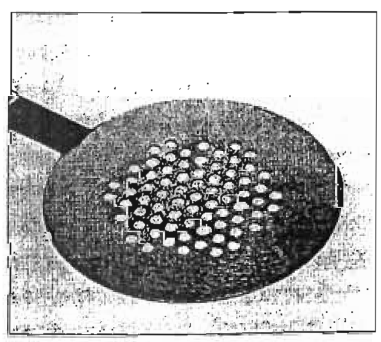

Fig. 9C

set strainer (Fig. 18) with a high inlet and low outlet will satisfy this need. Other designs may use a tee type basket strainer (Fig. 3) in an angle flow application.

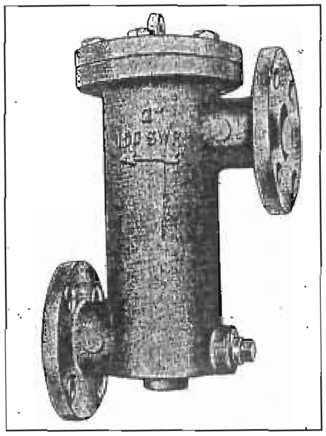

Fig. 18

Quite frequently line sizes are reduced following a strainer prior to temperature control valves or heating and cooling coils (Fig. 19). A reducing strainer can eliminate joints, reduce pressure loss, and still provide the same offset produced by the reducer. Of course, the reducer is also eliminated.

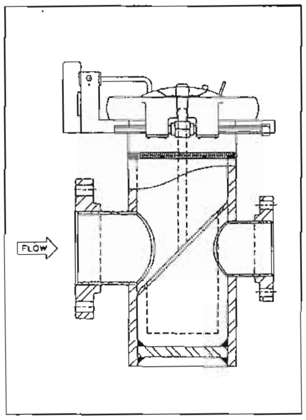

Fig. 19

Special processes may warrant special strainer housings. Steel or stainless steel strainers may be fitted with a fabricated or cast outer jacket with connections for the introduction of steam or other heating or cooling medium (Fig. 20). These find their application mainly in process piping where the liquid handled must be maintained at other than ambient temperatures.

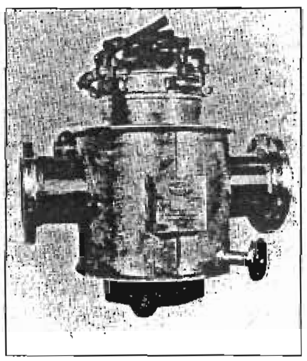

Fig. 20

In addition to special process needs, there may be special maintenance needs. Simplifying the handling of strainers during cleanings or inspections reduces maintenance costs. Strainers are available with many types of quick-opening covers to reduce the length of time and labor involved in cleaning operations (Fig. 21). Among these are swing eye bolts, yoke covers, pinwheel covers and "C" washers. The variety of closures are too numerous to mention, but consideration should be given to them where reduction of down time is important. Additionally, many of these closures can be operated without the use of tools, which enables operators to service the strainer where Union contracts require only maintenance personnel to use tools.

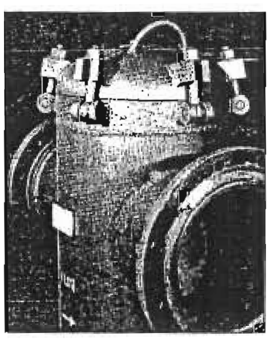

Fig. 21

CHAPTER 2

End Connections

Strainers are available in a variety of end connections. Iron strainers are most commonly furnished in either threaded or flanged ends. Steel, stainless steel and bronze are supplied in any of the types discussed below. The four most common groups of end connections are listed and described below.

Threaded

Usually a tapered female pipe thread, although male connections are also available.

Flanged

ANSI (American National Standards Institute) and MSS (Manufacturer's Standardization Society) standard flange ratings 25, 125, 150, 250, 300, 400, 600, 900, 1500 and 2500 pounds can be supplied. Ring-type joints (male and female), and tongue and groove joints are also available. The U.S. Navy also has some flange standards which are quite different from the commercial standards. Among these are B-176, B-177, and MIL-F-20042C.

Weld Ends

Butt weld end strainers are generally available in all sizes, and although many forms of end preparation can be used, the standard 37-1/2° beveled end is most common. ANSI B16.25 illustrates the various types of weld joint preparations available.

It is very important that the purchaser specify the bore of pipe being used so that the manufacturer can provide a matching bore in the strainer.

Socket weld end strainers are usually available in sizes through 3", and again, it is important to specify the bore of the pipe used. In ordering weld end strainers of any type, consider whether you desire a welded blowdown connection.

Special Ends

Grooved ends are available on many strainers, and a detail of this end should be supplied to the manufacturer. Other special ends such as "O" ring and union ends are also available on special order, and complete details should be furnished.

Most "Y"-type and certain other types of small strainers are designed according to the fitting standards for full pressure ratings and therefore can be subjected to higher working pressures at lower temperatures. It should be clearly understood, however, that most of the larger types and many of the smaller strainers are designed for the working pressure requested and should not be operated above that pressure without consulting the manufacturer. It is important to note that the flange rating is not necessarily the same as the pressure rating of the vessel. A fabricated carbon steel strainer, for example, may be operated at 40 psig at 500`F, designed for 100 psig at 650`F, and have 150-lb ANSI flanges. The maximum safe pressure at any temperature (650`F and below) for this vessel is 100 psig, even though the flange can be taken to 170 psig at 500`F.

It is important, at the time of initial design, to specify working pressure, working temperature, design pressure, design temperature, required flange rating and any operating conditions affecting vessel loading.

CHAPTER 3

Materials of Construction

Strainer components can include a body, flanges, cover, perforated plate, mesh, wedge wire, gasket and cover fasteners. Listed below are some materials of construction for these components.

A - Housing/Body

Description	ASTM Specification
Iron Castings	A 126, A 278
Ductile Iron Castings	A 395, A 536
Iron-Austenitic Castings	A 436
Carbon Steel Castings	A 216
Carbon Steel Castings	A 27
Carbon Steel Pipe	A 53, A 106
Carbon Steel Plate	A 20, A 285, A 515, A 516
Carbon Steel Forgings	A 105
Carbon Moly Castings	A 217, A 352
Chrome Moly Forgings	A 182
Stainless Steel Castings	A 743, A 744, A 351
Chrome Moly Plate	A 387
Chrome Moly Pipe	A 335
Stainless Steel Pipe	A 312
Stainless Steel Plate	A 240
Stainless Steel Forgings	A 182
Aluminum Castings	B 26
Bronze Castings	B 61, B 62
Monel	B 164, B 127
Nickel 200 Plate	B 160, B 162
Hastelloy B Castings	A 494
Hastelloy B Plate	B 333
Hastelloy C Plate	B 575
Hastelloy C Pipe	B 619
Titanium Pipe	B 337
Titanium Castings	B 367

B - Perf. Plate/Mesh/Wedge Wire

Carbon Steel	S.S. (Various Grades Available)
Monel	Hastelloy B
Hastelloy C	Alloy 20
Nickel	Brass
Copper	Galvanized Steel
Incoloy	Inconel
Titanium	Aluminum

C - Gaskets

Red Rubber	Compressed Nonasbestos
Teflon	Buna-N, O Ring
Neoprene	S.S. - Jacketed
Graphite	S.S. - Spiral Wound

D - Fasteners

Carbon Steel	Alloy Steel
Silicon Bronze	304 S.S.
316 S.S.	Monel

CHAPTER 4

Corrosion Resistance - Selection of Materials

Almost every strainer operating in a pipe line is subject to some degree of corrosion or erosion. It is therefore very important that corrosion/erosion resistance is considered when selecting materials and/or coatings. The selection of the material or coating used is also usually based on economic considerations and should be made by the customer and/or consulting engineer after some discussion with the strainer manufacturer.

It is important that the type of fluid, the pressure and temperature conditions, type of adjacent piping, desired service life, and the customer's prior experience with similar fluid conditions be known. Corrosion resistance charts offer some assistance in the selection of materials or coatings. (See Corrosion Data Survey - Metals Solution, 6th Edition, NACE).

Electrolytic corrosion is also a consideration in some services and the manufacturer should be advised. Sometimes the inclusion of magnesium or zinc- consumable bars in the body will retard this action.

Most types of strainers can be lined with various coatings to retard corrosion, and some of these are listed below:

Epoxy	Asphalt
Teflon	Vinyl
Kel-F	Rubber
Neoprene	Baked Phenolic

Penton (Plating: Zinc, Cadmium, Nickel, Galvanizing, etc.)

Perforations and Mesh Sizing

An extremely important consideration in the selection of a strainer is the size of the perforations, mesh or wedge wire opening used in the making of the straining element. A tendency exists to select smaller holes than those actually needed, leading to too-frequent cleaning, excessive pressure drops, and screens constructed of thinner metal which will withstand less pressure differential.

Generally, stainless steel perforated metal can only be obtained in a thickness which is one gage thickness less than the diameter of the punched holes. Carbon steel and brass can be obtained in approximately the same thickness as the hole diameter. These limitations are important considerations. For example, a strainer made with stainless steel plate perforated with 1/64″ diameter holes in a 16″ line would be impractical, as the plate would be about 17″ in diameter and only .014″ thick, and would have a very low maximum allowable differential pressure.

The most common way to accomplish fine straining in large strainers is by mesh lining a larger hole, heavier gage perforated plate.

The following table illustrates available perforations, mesh, and wedge wire and their respective straining capability. The main criteria for choosing hole and mesh size is the size and quantity of particles which can pass through downstream equipment without causing damage.

PERFORATED METAL**

Hole Diameter x Hole Spacing	Percent Open Area
.020″ x .043	20
.027 x .066	17
*.033 x .077	20
*.045 x .086	28
*.057 x .121	25
*.062 x 3/32	41
*.094 x 5/32	33
.100 x 5/32	37
*1/8 x 3/16	40
*5/32 x 3/16	63
3/16 x 1/4	51
*1/4 x 3/8	40
5/16 x 7/16	47
3/8 x 1/2	51
7/16 x 19/32	49
1/2 x 11/16	48
5/8 x 13/16	54
3/4 x 1	51
1 x 1-3/8	48

*These are standards as they appear in the Designers, Specifiers and Buyers Handbook for Perforated Metals published by The Industrial Perforators Association.

**Perforated plate listed is for staggered pattern only.

MESH

Mesh (Openings/In.)	Wire Diameter (In.)	Opening Inches	Opening Micron	Percent Open Area
2	.063	.437	11100	76.4
2	.092	.407	10360	66.6
3	.063	.270	6860	65.6
4	.047	.208	5160	65.9
4	.063	.187	4750	56.0
5	.041	.159	4040	63.2
6	.035	.132	3350	62.7
7	.035	.108	2740	57.2
8	.028	.097	2460	60.2
10	.025	.075	1910	56.3
11	.018	.073	1850	64.5
12	.023	.060	1520	51.8
14	.020	.051	1300	51.0
16	.018	.044	1130	50.7
18	.017	.038	980	48.3
20	.016	.034	872	46.2
30	.013	.020	513	37.1
40	.010	.015	384	36.0
50	.009	.011	282	30.3
60	.007	.009	231	33.9
80	.005	.0075	180	36.0
24 x 115		.0056		
100	.0045	.0055	141	30.3
120	.0037	.0046	118	30.1
30 x 160		.0046	118	
150	.0026	.0041	105	37.4
40 x 200		.0033	85	
170	.0024	.0035	79	35.1
30 x 260		.0029	75	
200	.0021	.0029	74	33.6
250	.0016	.0024	62	36.0
50 x 250	.0024	62		
28 x 480		.0023	59	
300	.0015	.0018	46	29.7
325	.0014	.0017	44	30.0
400	.0010	.0015	39	36.0
80 x 700		.0012	40	
125 x 600			30	
165 x 800			28	
165 x 1400			17	
200 x 1400			10	
250 x 1400			83	
25 x 2300			53	
75 x 2400			4	
400 x 2800			3	

WEDGE WIRE

Opening	Micron	% Open
.003″	75	
.005″	127	7.7
.010″	254	14.3
.015″	381	25
.020″	500	25
.031″	775	34
.034″	864	20
.062″	1550	51
.063″	1600	50
.094″	2350	44
.125″	3175	66
.156	3962	71

CHAPTER 6

Capacity

The capacity ratio, or open area ratio (OAR) of a strainer influences such operating characteristics as the length of time it can operate without cleaning and the created pressure loss. The ratio/OAR is the relationship between internal cross sectional area (flow area) of the pipe and the open flow area of the material which makes up the straining element.

A 100% OAR, or 1-to-1 ratio would give an unrestricted flow area equal to that of the pipe while the element was clean. As clogging occurs, however, flow would be inhibited. A 200% OAR, or 2-to-1 ratio would provide full flow, after the element became 50% clogged. A 250% OAR is a good standard for general heating and air conditioning service. However, larger OAR's or ratios would be appropriate for flow in which much debris is expected to be strained or where very viscous fluids are being handled.

When considering the OAR of a straining element, there are two accepted methods of analysis used by various specifying agencies and manufacturers. One method maintains a "line of sight" reasoning and uses the multiple of the open areas for elements in series. In this method, a 60% open area material in series with a 40% open area material has a resultant combined open area of 24% (i.e. as in accordance with military standards). An alternative method allows the open area of the more restrictive element in series to be used. This would be 40% for the example above (i.e. as in accordance with Underwriter Laboratory Standards). The method used influences the estimated operating pressure drop, as well as design decisions such as sizing.

As an example, fuel oils are generally strained to a fine degree to protect small orifices in burner nozzles. This requires a fine woven mesh be used in series with a reinforcing perforated plate. Due to the fact that the perforated plate may have a 50% open area and the mesh 30%, the resultant combined open area may be considered to be only 15% if there is no flow path other than line of sight through the two elements in series. This, of course, would mean that to have a OAR of 250%, a high capacity, large bodied strainer is required.

This same strainer using only the perforated plate would have a OAR more than three times as great. So, it may be seen that in any given strainer, the OAR may be varied by using various perforations or meshes having different open areas. Thus, it is essential to specify not only the OAR desired, but the straining element opening size and the method for calculating OAR.

CHAPTER 7

Pressure Loss

Because strainers are made with various dimensions and configurations, most reputable manufacturers have tested and published pressure drop results.

Most pump installations designed for reasonable velocities will permit approximately a 2-psi drop across the strainer. When a screen becomes clogged, the pressure drop varies with the clogging pattern experienced and the type of strainer being used. While some manufacturers speculate as to the change in head loss at different percentages of clogging, it should be recognized that this type of testing is very difficult to relate to actual line performance. This is because of differences in strainer clogging characteristics — a 1/4″ perforated basket two- thirds full of 1/2″ stones will be less affected than a small amount of fine leaves on a large 100-mesh basket. If large amounts of solids are expected, use a strainer with a high net open area as discussed in Chapter 6.

As a strainer becomes clogged to the point where the OAR of the strainer approaches the pipe area, the pressure drop across the strainer increases very rapidly and unpredictably. It is at this point, therefore, that it is recommended the strainer be cleaned. Otherwise, a large differential pressure will develop. The maximum differential pressure a strainer can withstand varies widely with strainer type, line size and material used. Always consult the manufacturer for maximum differential pressure a straining element can withstand.

From the foregoing discussion, it is obvious that periodic cleaning is essential in any strainer installation. Once the rate of clogging is established, a cleaning schedule can be set up. Pressure gauges on each side of the strainer can be valuable to determine when the strainer requires cleaning. Differential pressure switches can be set up to operate warning lights or alarms if so desired.

Some manufacturers have related their strainers' pressure drop to equivalent feet of pipe at various turbulent flow rates, and this can simplify the computation of head loss for an entire system. However, varying field conditions and fluid properties can affect the accuracy of general type pressure drop estimations. Further, operating viscous fluids under laminar flow conditions requires analysis different from that for fluids under turbulent conditions. Accordingly, the manufacturer should always be consulted for the most specific and accurate estimated pressure loss.

CHAPTER 8

Specifications and Manufacturer Testing

Needless to say, the more information provided to the manufacturer when ordering strainers, the better the chance of obtaining a strainer which is appropriately suited for a particular job. It is for this reason that considerable space is devoted to the preparation of specifications.

Specification

To allow the manufacturer to make selection or recommendations for a particular strainer, as much as possible of the following information should be provided:

A - Physical characteristics

1 - Pipe size and schedule.
2 - Strainer type required.
3 - End connections.
4 - Material (body, screen, studs, gaskets).
5 - Pressure rating (design/operating — including shock).
6 - Temperature rating (design, operating, minimum).
7 - Straining element opening size.
8 - Capacity:
  (a) Net effective open area required.
  (b) Method of net open area calculation.
9 - Special requirements (hinged cover, vent tapping, jacketed, etc.).
10 - Applicable specifications (military specifications, special nondestructive nondestructive tests or other QC Requirements).
11 - For automatic self-cleaning strainers, specify the following:
  (a) Voltage and frequency of power supply;
  (b) Air supply pressure if available;
  (c) Type of controls desired;
  (d) Type of motor, switch and control panel enclosure required.

B - Flow data.

1- Liquid:
  (a) Description of fluid.
  (b) Rate of flow - gallons per minute (gpm) or pounds per hour (lbs/hr).
  (c) Viscosity - SSU.
  (d) Specific gravity/density.
  (e) Temperature.
  (f) Concentration (if acid or other corrosive).

2 - Gas:
  (a) Description of Gas
  (b) Rate of flow - standard cubic feet per minute (scfm).
  - actual cubic feet per minute (cfm).
  (c) Specific gravity.
  (d) Temperature and pressure.
  (e) Molecular weight.

3 - Steam:
  (a) Flow-pounds per hour.
  (b) Temperature.
  (c) Pressure.
  (d) Density.
  (e) State of flow.

C - Solids to be removed:

Specify the nature and relative size of the sediment. Parts per million (ppm) or percent by volume or cubic inches per hour or percent by weight can also be specified.

NOTE: If strainer is to be steam jacketed, the following information for the heat transfer fluid or steam must be given:
(a) Type of fluid.
(b) Rate of flow.
(c) Temperature.
(d) Pressure.
(e) Type and size connections desired.
(f) Material for jacket construction.
(g) Whether strainer end flanges are oversized to match jacketed pipe.

D - Allowable pressure drop (psi):

1 - Clean.
2 - 50% clogged.

NOTE: Operating pressure drop is a function of operating conditions, fluid characteristics and strainer geometry. Consequently, if specifying a strainer type and geometry, a desired pressure drop may not be obtainable if fluid parameters are fixed. The "trade-off" relationship between fluid conditions, strainer geometry and operating pressure drop establishes what compromises must be made.

Available Types of Manufacturer Testing

A - Hydrostatic:

Most common test - usually 1-1/2 times working pressure to determine that a strainer body, cover gaskets, etc., are sound.

B - Radiographic examination:

To determine if the casting or welded joint has any slag or sand inclusions, gas pockets or subsurface defects. This type of test is quite expensive and usually specified only for high pressure strainers.

C - Magnetic Particle:

A reasonably low cost examination to reveal relatively shallow subsurface cracks, gas pockets, etc. Iron dust is sprinkled on the surface of the casting/weld and a magnetic force is induced electrically, causing the dust to align over defects and cracks showing their location and size. Can be used only on iron and steel.

D - Dye penetrant:

Equivalent to magnetic particle testing, except used mainly with nonmagnetic castings/welds to reveal surface defects, cracks, depressions, etc.

E - Air test:

Either under water or with part covered with soap solution. This is a more stringent test for porosity and gasket leakage than hydrostatic, and leaks often are more obvious. Sometimes not done, due to relative danger involved.

F - Hydrostatic burst test:

Sometimes done to establish manufacturer's maximum working pressure rating, or at the request of purchaser.

G - Shock:

Usually a government requirement where strainers will remain operative or intact in the event of a near-proximity explosion. Test normally conducted on a machine where weighted hammer strikes plate on which strainer is mounted.

H - Vibration:

Normally a government requirement where strainers must withstand a vibration test which involves a number of frequencies. This usually simulates shipboard vibrations, earthquake, etc..

I - Surge test:

- A strainer is pressurized with water and a quick-opening valve on the outlet flange is rapidly opened to determine that no damage is sustained by the basket. Normally, a military requirement.

J - Helium leak test:

A very stringent test where the strainer is pressurized with helium and leaks are checked with sensitive instruments. A maximum leak rate is usually specified. Used mostly for nuclear plants for radioactive water piping.

K - Ferroxyl:

A test to detect free iron in stainless steel strainers where the iron would contaminate the product.

NOTE: Many tests by their very nature can be more or less stringent. Acceptance standards should be included in any inquiry calling for such tests. Naturally, the more stringent the test requirements, the more costly the ultimate strainer becomes.

CHAPTER 9

Shock-Hydraulic and Thermal

Any liquid being transmitted in a pipe line possesses a certain amount of energy (weight times velocity). A rapid change in velocity results in a momentary shock wave. In the case of a quick-closing valve, the energy of the flowing fluid must be used up in some way, and the resulting shock, or "water hammer", is clearly audible. A pressure wave, in some cases, travels at over 3,000 feet per second and traverses the pipeline in one direction, then the other, until it dissipates. A theoretical figure of 54 psi for each foot per second that is stopped by the valve may be used. A 12 foot per second velocity could produce a shock wave having a peak of 648 psi; therefore, consideration should be given to the shock and non-shock rating of the strainer.

No attempt will be made here to go into the highly technical field of hydraulic shock, and it is covered briefly to point out that even if your system can produce only a specific head, if the possibility of shock is present, tremendous overpressures may result.

Commonly known is the phenomenon of pouring hot tea into a glass and watching the glass crack. This is an example of thermal shock. Rapid changes of temperature in piping systems can have the same effect, and in selecting strainers consideration must be given to this possibility.

In improperly trapped steam lines, condensate can collect in low points and subsequently become a slug of water traveling at high velocity down the line. Almost all strainers cause a change in direction of flow due to their configuration, and the result can be obvious if the strainer cannot absorb this type of shock. In considering this situation, it is important to remember that steam velocities of 4,000 to 20,000 feet per minute are quite common.

Conclusion

Strainers are no longer confined to a simple cast body with a wire mesh screen, but are a technical, highly refined, carefully designed piece of equipment.

Sometimes they operate at 1,500 degrees F and 10,000 psig or at cryogenic temperatures. They are modified with steam jackets, cover lifting davits, magnets, motorized cleaning devices and automatic vent valves. They are supplied with screwed, flanged, socket weld, butt weld, ring joint and silver brazing end connections.

Accordingly, the implementation of a strainer needs to be well thought out and engineered. While it is good practice to use a strainer to protect downstream equipment, it is very important to carefully consider the options available. Choosing the correct strainer can save money not only by protecting equipment, but also by keeping operations and maintenance costs at a minimum.

This guide for the selection, installation and maintenance of pipeline strainers has been created within the cooperation of the Fluid Controls Institute, Inc., Pipeline Strainer Section, and represents the collective knowledge and experience of its members.

R.P. Adams Company, Inc.
Armstrong International, Inc.
The Clarke-Reliance Corporation
Cleveland Gear, Hellan Strainer Division
Fabrotech Industries, Inc.
Hayward Industrial Products, Inc.
O.C. Keckley Co.
The Kraissl Co., Inc.
The Mack Iron Works Company
The Metraflex Company
Mueller Steam Specialty
Plenty Products, Inc.
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FCI STANDARD #89-1
GUIDE FOR THE SELECTION, INSTALLATION AND MAINTENANCE OF PIPE LINE STRAINERS

List of Figures

This guide was published by PLANT ENGINEERING magazine, a Cahners Publication

Metraflex®

Installation, Operation and Maintenance Instructions

METRAFLEX BUTTERFLY VALVE

(Standard Product with Elastomer Seat)

FLANGE AND PIPE COMPATIBILITY

The B series (BL, BW, BLA, BWA) valve is designed to mate between all types of ANSI 125 & 150 pound flat or raised face flanges. Gaskets are unnecessary as the seat face design eliminates their need. Heavy wall or lined pipe, or flanges must have minimum allowable inside diameter to clear disc sealing edge when opening the valve.

INSTALLATION INFORMATION

The Metraflex valve is non-directional (there is no upstream or downstream side). For the best results in slurry service regarding sedimentation, position the valve assembly to have the stem in the horizontal position and the lower disc edge to open in the down-stream direction. To install the value between existing ANSI flanges, the flanges must be spread sufficiently before placing the valve in position to prevent distortion and/or damage to the sealing face of the seat. IMPORTANT: DO NOT finish weld the flanges to the pipe with the valve bolted between the flanges as this will result in serious heat damage to the seat. Finish welding the flanges to the pipe and allow the flanges to cool completely.

INSTALLATION INSTRUCTIONS

With the disc in the nearly closed position and after spreading the pipe flanges, insert the valve between the flanges and assemble the valve body to the flanges with all flange bolts possible. Turn the disc to the fully open position. Next, while gradually removing the flange spreaders, center the valve body to the flanges and tighten the bolting hand tight. Slowly close the valve to check for adequate disc clearance. Return the disc to the fully open position and cross-tighten all bolting to the proper torque specification. Again,

check for adequate disc clearance. If the installation is satisfactory, the valve is ready for service after installing the valve operator or actuator.

MAINTENANCE

Routine maintenance or lubrication is not required.

REPAIRS

Contact factory for repair instructions manual and parts availability.

The Metraflex Company

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ARMSTRONG®

FILE NO.:	37.873
DATE:	Sept. 5, 2003
SUPERSEDES:	New
DATE:	New

INSTALLATION AND OPERATING INSTRUCTIONS

Vortex Air Separator
Models VA/VAS
Sizes: 2", 2.5" & 3" – Cast Iron

VESSEL DESCRIPTION

Armstrong **VA/VAS Vortex Air Separators** eliminate air quickly and efficiently from heating/cooling systems. Water enters and exits through unique "tangential" connections which promote a low velocity swirling effect in the centre of the unit. Centrifugal force moves the water to the outer edges of the unit and a vortex is formed. Entrained air migrates to the eye of the vortex (lower pressure point) and is evacuated at the top of the separator. The water exits the unit near the bottom of the unit, bubble free, protecting the system against the noise, corrosion and damage associated with entrained air.

VAS models are equipped with a stainless steel strainer.

CONSTRUCTION DETAILS

MATERIALS OF CONSTRUCTION	
Shell	Cast Iron
Strainer	Stainless Steel Mesh (¼" x ¾")
Gasket	Non-Asbestos

TECHNICAL DATA	
Max. Working Temperature	350°F (176°C)
Max. Working Pressure	160 psi (1105 kPa)
Connection Type	Threaded NPT

STEPS & PROCEDURE

- Visually inspect the air separator for damage, which may occur during transit.
- A manual drain can be added to help facilitate purging sediment from the air separator.
- VAS Models have a strainer that must be removed and cleaned after 24 hours of operation.

DISTANCE REQUIRED TO REMOVE STRAINER	
Size	Distance
2.0 VAS	7.0 in. (178 mm)
2.5 VAS	8.0 in. (203 mm)
3.0 VAS	8.0 in. (203 mm)

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ARMSTRONG®

FILE NO.:	37.870
DATE:	Sept. 5, 2003
SUPERSEDES:	New
DATE:	New

INSTALLATION AND OPERATING INSTRUCTIONS

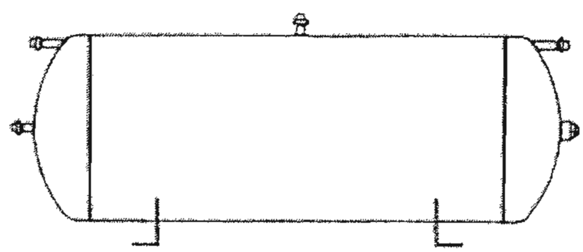
AX (Horizontal) and AX-V Series

ASME PRE-PRESSURIZED DIAPHRAGM EXPANSION TANKS FOR HEATING & COOLING SYSTEMS

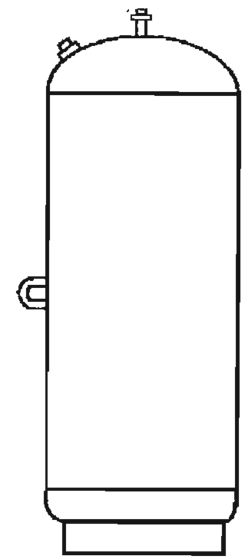
VESSEL DESCRIPTION

Armstrong AX Series Tanks are ASME constructed, pre-charged expansion tanks. They are designed to absorb the expansion forces and control the pressure in heating/cooling systems. The system's expanded water (is contained behind a heavy-duty diaphragm fully compatible with water/glycol mixtures) preventing tank corrosion and waterlogging problems.

The factory set pre-charge for these tanks is **12 psig (83 kPa).**



AX Series – Fixed Diaphragm



AX-V Series – Fixed Diaphragm

CONSTRUCTION DETAILS

MATERIALS OF CONSTRUCTION	
Shell	Carbon Steel
Diaphragm	Heavy Duty Butyl

MAXIMUM OPERATING CONDITIONS	
Working Temperature	240°F (115°C)
Working Pressure	125 psi (862 kPa)

STEPS & PROCEDURE

- Visually inspect tank for damage, which may occur during transit.
- Factory pre-charge pressure may not be correct for the installation. Tank MUST be pre-charged to system design fill pressure BEFORE placing into operation. Remove pipe plug covering the valve enclosure. Check and adjust the charge pressure by adding or releasing air for each application.
- If the system has been filled, the tank must be isolated from the system and the tank emptied before charging. This ensures all fluid has exited the diaphragm area and proper charging will occur.
- If the pre-charge adjustment is necessary, oil and water free compressed air or nitrogen gas may be used. Check the pre-charge using an accurate pressure gauge at the charging valve and adjust as required. Check air valve for leakage. If evident, replace the Schrader-type tire valve core. Do not depend on the valve cap to seal the leak. After making sure air charge is correct, replace pipe plug over the charging valve for protection.
- Set tank in place and pipe system connection to system. Be sure to include isolation valve(s) and drain.
- Purge air from system BEFORE placing tank into operation. All models have system water contained behind diaphragm.
- When filling the system with water, open valves to tank to ensure that any residual air in the tank is displaced by water.
- It is recommended that the pre-charge be checked annually to ensure proper system protection and long life for the vessel.

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AIR RELEASE VALVES

Operation, Installation and Maintenance

The Air Release Valves are fully automatic valves and require no regular maintenance.

The purpose of the "Air Release Valves" is to release air which accumulates in a pipeline during its operation.

OPERATION: The valve, as shipped, is a normally open valve. As the system is being filled, air is vented through the small orifice. When the fluid enters the valve, the float raises and shuts off the orifice, preventing any leakage. As air accumulates and enters the valve, displacing fluid, the float drops, allowing the venting orifice to open. This cycle is repeated as often as necessary during the pumping cycle.

INSTALLATION: Air Release Valves should be installed in a vertical position at high points on a piping system. A ball valve should be installed below each valve in the event servicing is required. A drain line is recommended, as the valve may "spit" a small amount of fluid during venting. To vent air quickly during initial start up, remove the 1/2-inch pipe plug in the cap of the air vent.

MAINTENANCE: No regular maintenance is necessary; however, periodic inspection for leakage and function can be performed. Close the inlet service valve and slowly remove the 1/2-inch pipe plug. Slowly open the service valve. If a volume of air larger than that contained in the air release valve body escapes, the valve may not be functioning properly, and the valve should be removed and inspected for wear and/or possible damage from foreign matter.

Replacement parts are available.

CUSTOMER ____	the Metraflex company CHICAGO ILLINOIS
PROJECT ____	
ENGINEER ____	DESCRIPTION: AIR RELEASE VALVES STYLE MV
ARCHITECT ____	DRAWN BY: DATE: DRAWING NO:

INSTALLATION AND OPERATING INSTRUCTIONS
PRESSURE REDUCING VALVES

Armstrong PUMPS

MODELS RD-11, RD-40, RD-50 & HRD-70

INSTALLATION:

The pressure reducing valve should be installed with the flow arrow on the body pointing in the direction of the flow. A shut-off valve should be installed on the city water side of the pressure reducing valve. If the pressure reducing valve is not equipped with a fast fill feature, a by-pass may be used. A three valve bypass around the pressure reducing valve will also serve as a fast fill option and is recommended for service.

CAUTION:

The use of teflon tape when installing a valve provides lubricity. Care should be taken to avoid over tightening, which may crack the valve body.

OPERATION:

Models RD-11, RD-40 and RD-50 are preset at 12 psi, and the HRD-70 is preset at 45 psi. Open the cold water fill valve and the system will be filled until the boiler gauge indicates the preset valve pressure has been obtained.

Model RD-11 is preset at 12 psi and is equipped with a fast fill feature. When filling the system as noted above, the fast fill thumbscrew should be manually turned in completely. This overides the pressure regulating function of the valve. The system should be filled until the boiler gauge indicates the preset pressure of the valve and then the fast fill thumbscrew should be backed off completely until it spins freely.

WARNING:

THE FAST FILL THUMBSCREW MUST NEVER BE LEFT IN THE DOWN POSITION AFTER THE SYSTEM HAS BEEN FILLED. THE THUMBSCREW MUST BE PLACED IN THE FREE POSITION TO AVOID OVER PRESSURIZATION AND UNNECESSARY RELIEF VALVE DISCHARGE.

ADJUSTMENT:

Allow system water to cool to ambient temperature. If necessary, adjust valve pressure setting as follows: pressure setting can be raised or lowered by loosening the jam nut and turning the slotted adjusting screw clockwise to increase the set pressure or counter-clockwise to lower the set pressure. This should be done slowly until the boiler pressure gauge indicates the required system pressure. A screw driver should be used to hold the adjusting stem stationary while the jam nut is secured.

SERVICE:

If the pressure reducing valve fails to maintain the set cold fill pressure, the sediment strainer may be clogged. To service the strainer, shut off city water supply and the isolation valve on the discharge of the pressure reducing valve. Remove and clean or replace the strainer, and replace the strainer gasket and nut. Open both the city water shut-off valve and the isolation valve to resume normal system operation.

ARMSTRONG PUMPS INC. • 93 East Avenue, North Tonawanda, N.Y. 14120
(716) 693-8813, FAX (716)693-8970

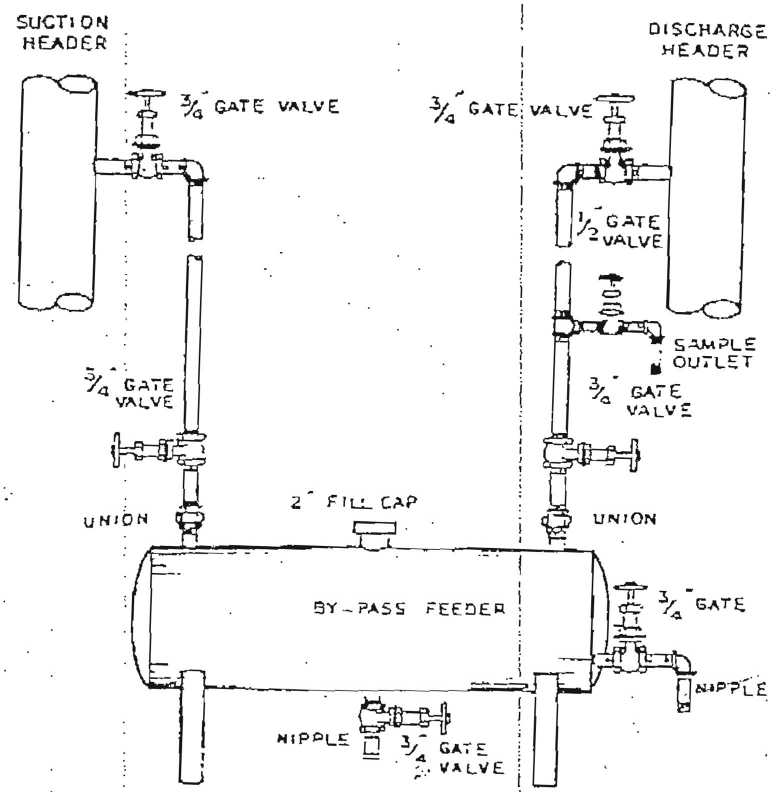
FORM NO.: 6943 PRINTED IN U.S.A.

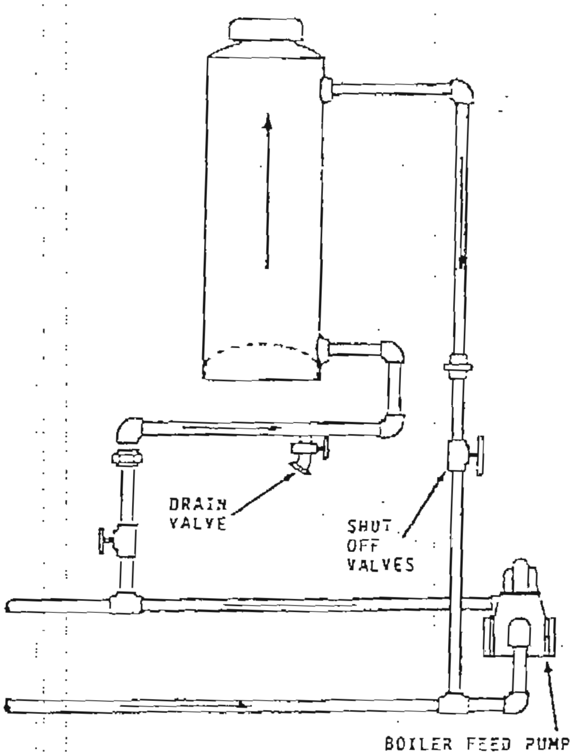
THE JOHN WOOD COMPANY

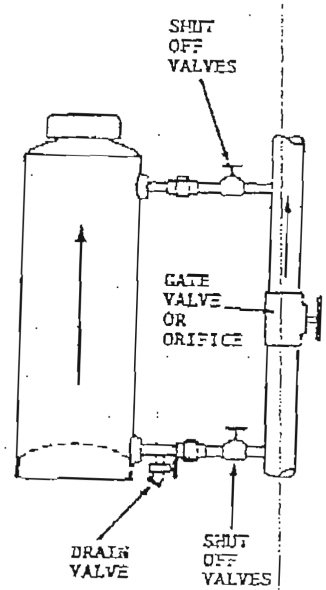
QUALITY PRODUCTS SINCE 1867

INSTALLATION INSTRUCTIONS

1. Pipe feeder to cause pressure drop across inlet and outlet resulting in flow through feeder.
2. Provide isolation and drain valves for servicing and draining.
3. Use with hot or cold water only. DO NOT USE FOR STEAM.
4. DO NOT OPEN UNDER PRESSURE- close isolation valves and bleed off pressure before opening.
5. CONTENTS MAY BE HOT.
6. Be certain gasket is positioned in groove under cap before replacing cap. (Replace gasket if cap does not seal by hand pressure.) Cap should seal with hand tightening pressure only. Do not strike cap with any tool to seal or unseal.
7. Open valves slowly when returning service.
8. DO NOT COMBINE CHEMICALS IN THIS DISPENSING DEVICE- without specific instructions from your chemical supplier.
9. READ AND FOLLOW LABEL DIRECTIONS FOR THE CHEMICAL IN USE
10. CONSULT YOUR CHEMICAL SUPPLIER FOR THE PROPER USE OF THIS TANK WITH THE CHEMICAL







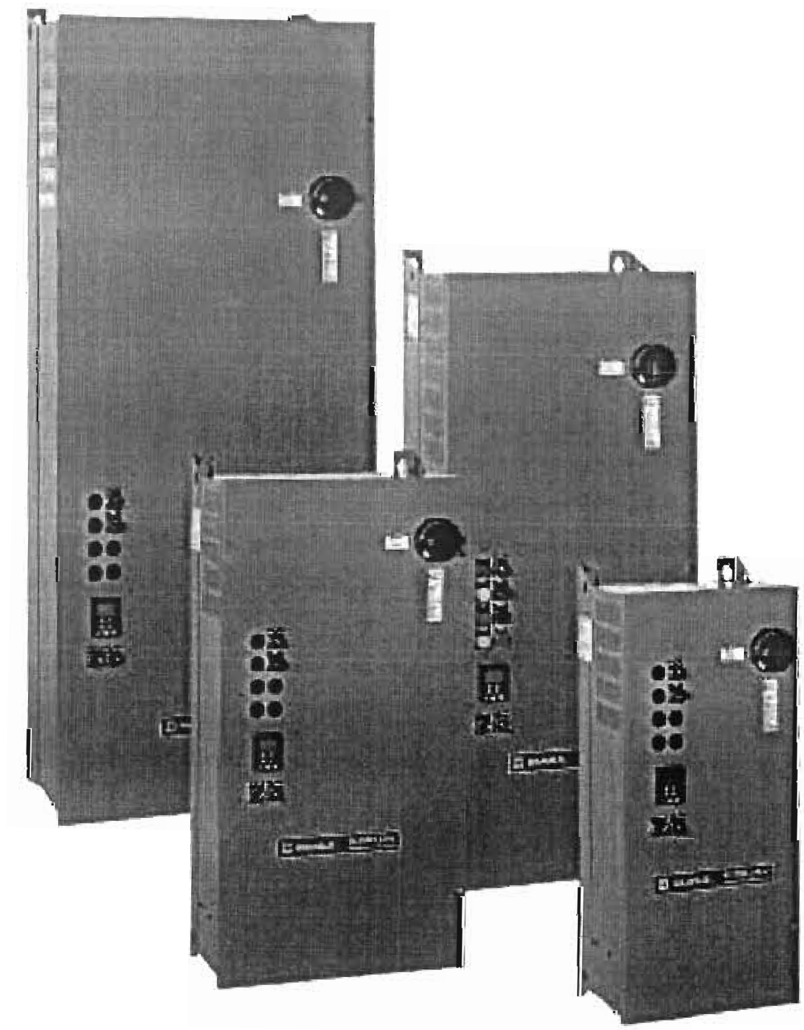
TYPICAL INSTALLATIONS OF STANDARD AND VERTICAL STYLE BY-PASS FEEDERS

ECONOFLEX™

Adjustable Speed Drive Controllers for HVAC and Pumping Applications 1–100 HP, 460 V and 1–50 HP, 208/230 V
Class 8839

Instruction Bulletin

Retain for future use.



a brand of Schneider Electric

SQUARE D

INTRODUCTION

The Class 8839 ECONOFLEX enclosed drive controllers are tailored for commercial market specifications in wall-mounted Type 1, Type 12K, or Type 3R enclosures. With a circuit breaker disconnect, these drive controllers may be configured with or without bypass.

This instruction bulletin covers receiving, installation, start-up, configuration, and troubleshooting of the 1 to 100 hp, 460 V and 1 to 50 hp, 208/230 V Class 8839 ECONOFLEX drive controllers.

REVISION LEVEL

This document replaces bulletin no. 30072-450-10G dated February 2002.

DOCUMENTATION REFERENCE

For further information, refer to the latest revision of the following instruction bulletins:

- Instruction bulletin VVDED397047US, *ALTIVAR® 58 Adjustable Speed Drive Controllers Keypad Display, VW3A58101.*
- Instruction bulletin 30072-200-50, *Handling, Installation, Operation, and Maintenance of Electrical Control Equipment.*
- Instruction bulletin VVDED397046US, *ALTIVAR 58 Adjustable Speed Drive Controllers Analog I/O Extension Card, VW3A58201U* (supplied with controller when analog card, MOD H09, is selected).
- Instruction bulletin VVDED300055US, *LONWORKS® to MODBUS® Module VW3A58312PU* (supplied with controller when LONWORKS, MOD L09, is selected).
- Instruction bulletin VVDED397054US, AL*TIVAR 58 Adjustable Speed Drive Controllers MODBUS/JBUS/UNITELWAY User's Guide, VW3A58303U* (supplied with controller when MODBUS, MOD M09 or LONWORKS L09,is selected).
- Instruction bulletin VVDED300028US, *ALTIVAR 58 Adjustable Speed Drive Controllers METASYS® N2 Communication Option VW3A58354U* (supplied with controller when METASYS N2, MOD P09, is selected).

TERMINOLOGY

The following terminology is used throughout this instruction bulletin in reference to the Class 8839 ECONOFLEX drive controller family. This distinction is made to minimize confusion when discussing installation and adjustment practices.

- When used as a component of the Class 8839 ECONOFLEX drive controller, part numbers beginning with FLEX58 are referred to in this instruction bulletin as *power converters.*
- The combination of the power converter, the enclosure, and the power and control circuits that constitute the Class 8839 ECONOFLEX product is referred to as the *drive controller, the controller, or the adjustable frequency controller (AFC).*

CONTROLLER CATALOG NUMBERS

The controller catalog number, located on the nameplate on the inside of the door, is coded to describe the configuration and options present. Use the following grid to translate the catalog number into a description of the drive controller.

Class	Type						Modifications: Control	Light	Misc.
8839	58E	•	•	•	V	•	•	•	•
	①	②	③	④	⑤	⑥	⑦	⑧	⑨

① Product

Code	Drive Type
58E	ECONOFLEX Controller

② Horsepower Code

Code	HP Rating	Code	HP Rating
C	1 hp	L	25
D	2 hp	M	30
E	3 hp	N	40
F	5 hp	P	50
G	7.5 hp	Q	60 (460 V only)
H	10 hp	R	75 (460 V only)
J	15 hp	S	100 (460 V only)
K	20 hp		

③ Enclosure Type

Code	Environment Rating
A	Type 12K
G	Type 1
H [5]	Type 3R

④ Voltage Rating

Code	Voltage
2	208 V
3	230 V
4	460 V

⑤ Application Type

Code	Applied Rating
V	Variable Torque

⑥ Device Type

Code	Power Circuit
W [6]	Without Bypass
Y [8]	Bypass

[1] Control option C07 (Start/Stop, Speed Potentiometer) is not compatible with Power Circuit Y (Bypass) or light cluster A08 or B08.
[2] Light cluster A08, B08, and C08 cannot be selected together. Select only one.
[3] Light cluster B08 is not compatible with Power Circuit W (Without Bypass).
[4] Light cluster C08 is not compatible with A07 (Hand/Off/Auto, Speed Potentiometer), or B07 (Hand/Off/Auto, Start/Stop, Speed Potentiometer).
[5] Line contactor B09 is not compatible with this option.
[6] Smoke purge E09 permits the motor to run at full speed.

⑦ Control Option

Code	AFC Controls
A07 [7]	Hand/Off/Auto, Speed Potentiometer
B07 [7]	Hand/Off/Auto, Start/Stop, Speed Potentiometer
C07 [1]	Start/Stop, Speed Potentiometer
N07	None

⑧ Light Option

Code	Light Cluster
A08 [2]	Red Power On
	Green AFC Run
	Yellow AFC Fault
	Yellow Auto
B08 [2], [3]	Red Power On
	Green AFC Run
	Yellow AFC Fault
	Yellow Bypass
C08 [2], [4]	Red Power On
	Green AFC Run
	Yellow AFC Fault

⑨ Misc. Options

Code	Feature
A09 [9]	Line Reactor (Included with 30–100 hp @ 460 V and 15–50 hp @ 208/230 V)
B09	Line Contactor
C09 [10]	3-15 PSI Transducer
D09 [13]	Omit Keypad
E09 [6]	Smoke Purge
G09	22 KAIC UL Coordinated Rating
H09 [11]	Analog Card, 0–20 mA, programmable for 4–20 mA output
J09 [12]	0–10 Vdc Auto Speed Reference
K09	cUL Listing
L09 [14]	LonWorks
M09 [14]	MODBUS
P09 [14]	METASYS N2

[7] Place the Hand-Off-Auto switch in the Off position for AFC fault reset.
[8] Includes AFC/Off/Bypass switch and Test/Normal switch.
[9] Line reactor A09 is an option for 1–25 hp @ 460 V and 1–10 hp @ 208/230 V.
[10] 3–15 PSI Transducer C09 is not compatible with Start/Stop, Speed Potentiometer C07, 0–10 V Auto Speed Reference J09, or Analog Card H09.
[11] Analog Card H09 is not compatible with 3–15 PSI Transducer C09 or serial communication L09, M09 or P09.
[12] 0–10 V Auto Speed Reference J09 is not compatible with C07 Start/Stop Potentiometer or C09 3–15 PSI Transducer.
[13] Omit the keypad D09. User must buy separate device to program the controller.
[14] Serial communication L09, M09 and P09 cannot be selected together. Select only one. Serial communication cannot be selected with H09 analog card.

CONTROLLER NAMEPLATE IDENTIFICATION

The nameplate for the Class 8839 ECONOFLEX drive controller is located on the inside of the door. This nameplate, described in Figure 1, identifies the controller class, type, and modification (options) listing. When identifying or describing Class 8839 ALTIVAR ECONOFLEX drive controllers, use the data from this nameplate.

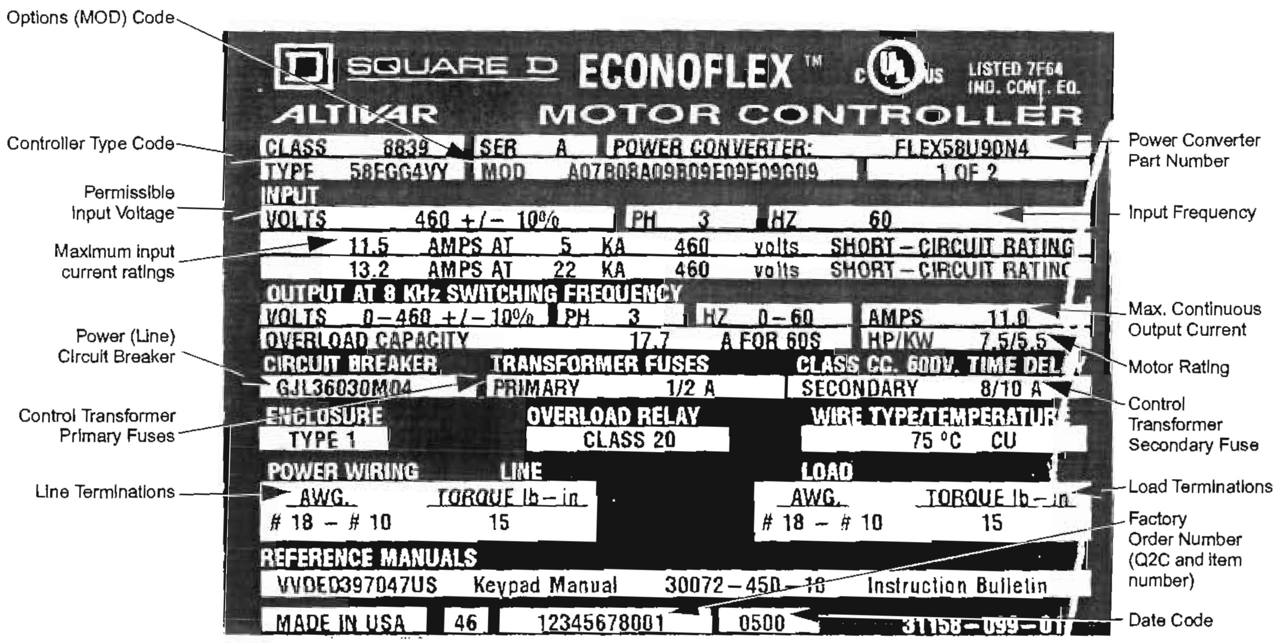


Figure 1: Information Provided by the Drive Controller Nameplate

COMPONENT LOCATIONS

NOTE: See pages 13 and 14 for components inside of the cabinet.

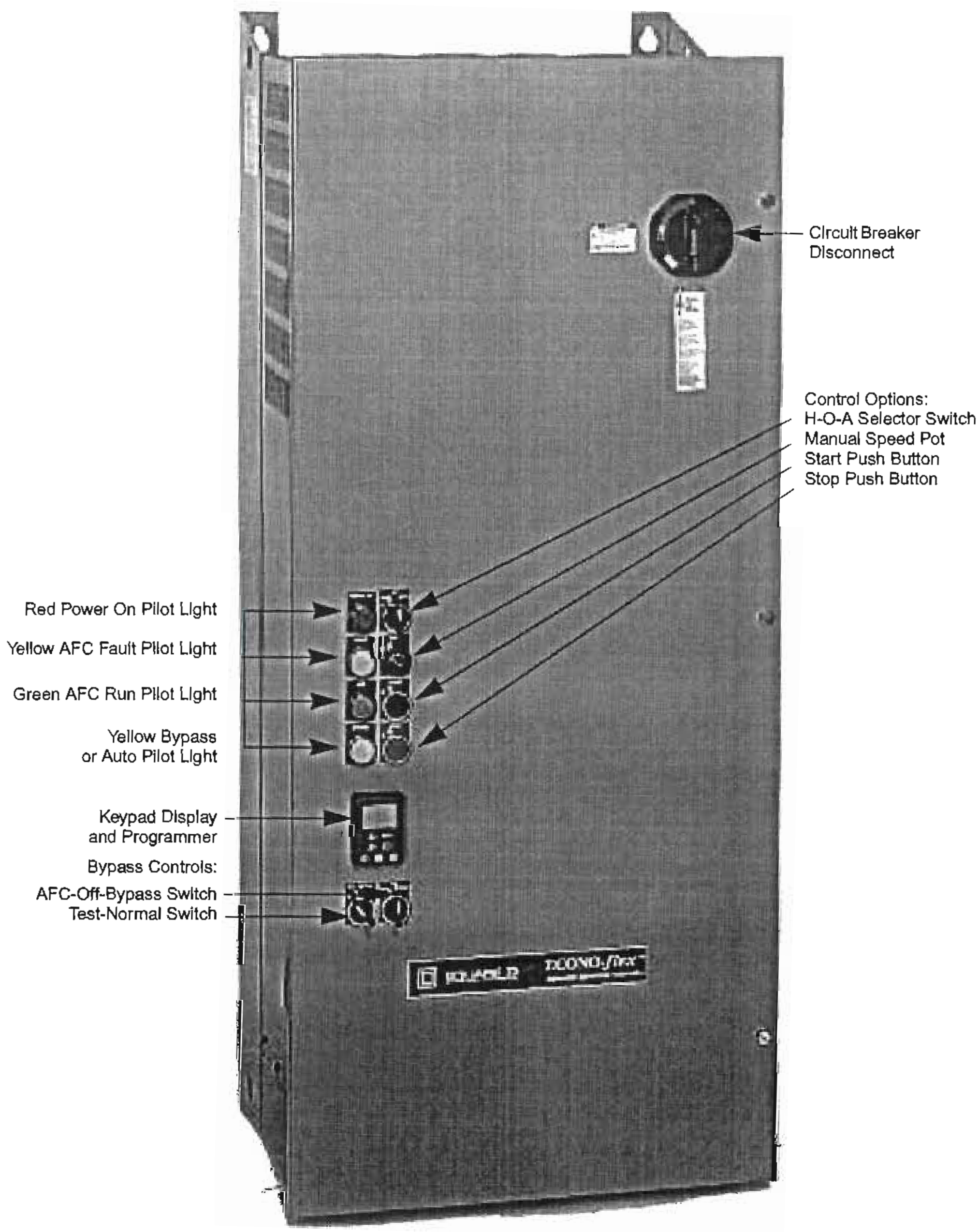


Figure 2: Front Component Locations for Controller: 1–100 HP @ 460 V and 1–50 HP @ 208/230 V (Class 8839, 58EPG4VY, MODS B07, B08, A09, B09, and E09 Shown)

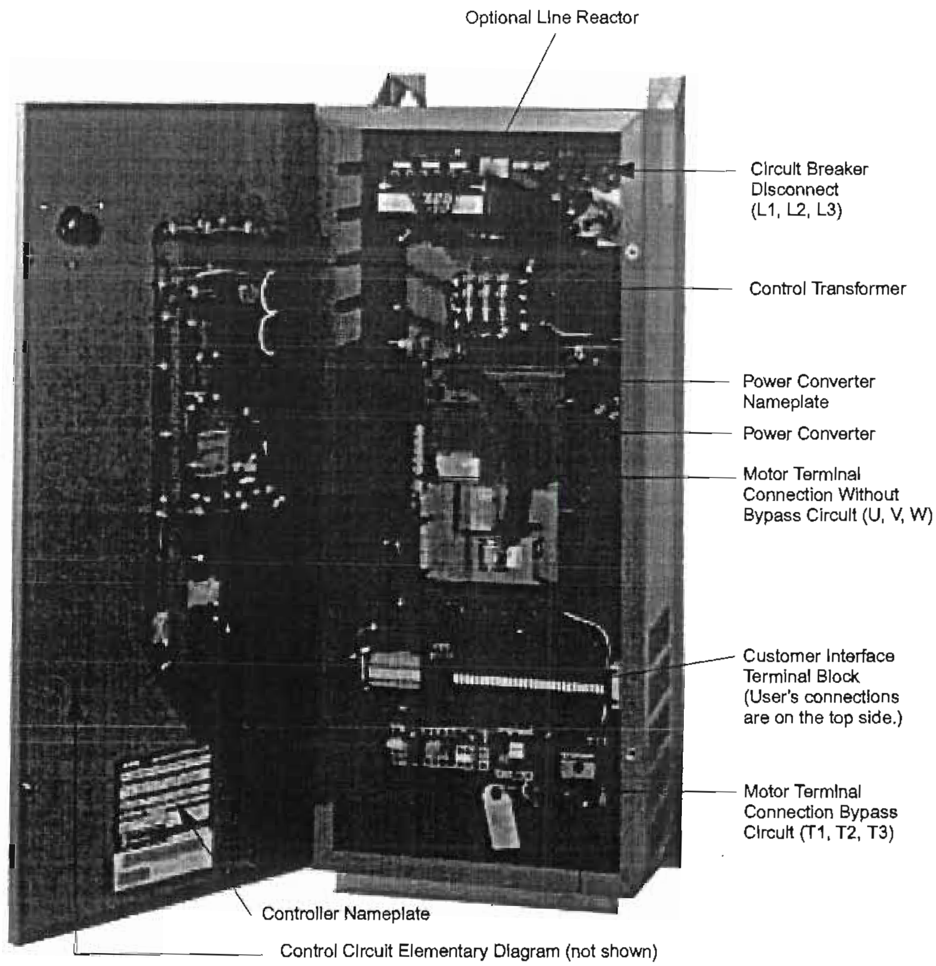


Figure 3: Inside Cabinet Component Locations for Controller: 1–25 HP @ 460 V and 1–10 HP @ 208/230 V (Class 8839, 58EGG4VY, MODS B07, B08, A09, B09, and E09 Shown)

Table 3: Class 8839 ECONOFLEX Drive Controller Ratings, 208 V

Drive Controller Catalog Number [1]	Motor Power [2] 208 V 60 Hz (HP)	Max. Continuous Output Current [3] (A)	Max. Transient Output Current (60 s) (A)	Power Converter Part Number
58EC•2V_	1	4.6	5.1	FLEX58U29M2
58ED•2V_	2	7.5	8.3	FLEX58U29M2
58EE•2V_	3	10.6	11.7	FLEX58U41M2
58EF•2V_	5	16.7	18.4	FLEX58U72M2
58EG•2V_	7.5	24.2	26.6	FLEX58U90M2
58EH•2V_	10	30.8	33.9	FLEX58D12M2
58EJ•2V_	15	46.2	50.8	FLEX58D16M2
58EK•2V_	20	59.4	65.3	FLEX58D16M2
58EL•2V_	25	74.8	82.3	FLEX58D23M2
58EM•2V_	30	88	96.8	FLEX58D28M2
58EN•2V_	40	114	125.4	FLEX58D33M2
58EP•2V_	50	143	157.3	FLEX58D46M2

Notes to Table 3:

[1] "•" can be "A", "G", or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes Type 3R enclosure "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.

[2] Power shown is for a carrier switching frequency of 8 kHz. For a switching frequency between 12 and 16 kHz, select the next largest size drive controller. If the duty cycle does not exceed 60% (36 s maximum for a 60 s cycle) this is not necessary.

[3] Continuous output current is based on NEC table 430-150. The ECONOFLEX controller nameplate rating is per the NEC table, not the current value listed in the keypad lookup table.

Input Current Ratings

All branch circuit components and equipment such as feeder cables, disconnect devices, and protective devices must be rated for the input current of the drive controller, not the motor full load current. The input current is stamped on the nameplate (see Figure 1 on page 11). The branch circuit feeder protection must be sized according to NEC Article 430-2.

Line reactors can be used to add reactance to the branch circuit, minimize drive controller input line current, reduce controller nuisance tripping due to transient overvoltage, reduce harmonic distortion, and improve phase-to-phase voltage imbalance. If line reactors are used:

- In systems that use bypass contactors, the line reactor should only be connected between the breaker load terminals in the controller and the power converter. A line reactor in a bypass motor starting circuit will reduce the ability of the motor to produce starting torque.
- The voltage tolerance at the input of the reactor will be different from that of the drive controller due to the voltage drop across the line reactor. Voltage tolerance measured at the input terminals of the drive controller will be as specified in this manual.

Specifications

Table 7: Specifications for Drive Controllers

Input voltage	460 V ±10%, 230 V ±10%, 208 V±10%
Displacement power factor	98% through speed range
Input frequency	60 Hz ± 5%
Output voltage	Three-phase output Maximum voltage equal to input voltage
Galvanic isolation	Galvanic isolation between power and control (inputs, outputs, and power supplies)
Frequency range of power converter	0.1 to 500 Hz (factory setting of 60 Hz maximum)
Current	110% of controller rated current for 60 s
Switching frequency	Selectable from 0.5 to 16 kHz [1] Factory setting: 8 kHz
Speed reference	AI1: 0 to +10 V, Impedance = 30 kΩ Speed potentiometer to AI1 AI2: FACTORY SETTING: 4 to 20 mA, Impedance = 100 Ω (reassignable, X–Y range with keypad display). FACTORY MODIFICATION J09 provides a controller interface 0–10 Vdc reference signal to the AI2 input using a 0–10 V / 4–20 mA converter with Z= 100 kΩ
Frequency resolution in analog reference	0.1 for 100 Hz (10 bits)
Speed regulation	V/f: determined by motor slip, typically 3% SLFV (sensorless flux vector): 1%
Efficiency	97% at full load typical
Reference sample time	5 ms
Acceleration and deceleration ramps	0.1 to 999.9 seconds (definition in 0.1 s increments)
Motor protection	Class 10 electronic overload protection Class 20 electromechanical overload protection with bypass [2]
Keypad display	Self diagnostics with fault messages in three languages; also refer to instruction bulletin VVDED397047US
Temperature	Storage for all enclosures: -13 to +149 °F (-25 to +65 °C) Operation for Type 1 and 12K: +14 to +104 °F (-10 to 40 °C) Operation for Type 3R: +14 to +122 °F (-10 to 50 °C)
Humidity	95% with no condensation or dripping water, conforming to IEC 60068-2-3.
Altitude	3,300 ft (1000 m) maximum without derating; derating of the current by 1% for each additional 330 ft (100 m)
Enclosure	Type 1, Type 12K (Type 12 with knockouts) or Type 3R
Pollution degree	Type 1 or Type 3R: Pollution degree 2 per NEMA ICS-1 Annex A and IEC 60664-1 Type 12K: Pollution degree 3 per NEMA ICS-1 and IEC 60664-1
Operational test vibration	Conforming to IEC 60721-3-3-3M3 amplitude 1.5 mm peak to peak from 3 to 13 Hz 1 g from 13 to 200 Hz
Transit test to shock	Conforming to National Safe Transit Association and International Safe Transit Association test for packages.
Operational shock	15 g, 11 ms
Codes and standards	UL Listed per UL508C under category NMMS. Conforms to applicable NEMA ICS, NFPA, and IEC Standards. Manufactured under ISO 9001 standards. Factory Modification K09 provides Canadian cUL Certification.

[1] Above 8 kHz, select the next largest size drive controller. If the duty cycle does not exceed 60% (36 s maximum for a 60 s cycle), this is not necessary.

[2] Class 10 electromechanical for 1 hp @ 460 V.

Short Circuit Ratings

Notes to Table 8:

[1] "•"can be "A", "G", or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.

Table 8: Short Circuit Ratings, 460 V

8839 Controller [1]	Power Circuit	HP	MOD G09	Power Converter (AFC) Path Short-Circuit Rating (Symm.)	Bypass Path Short-Circuit Rating (Symm.)
58EC•4VW_ to 58EP•4VW_	W (Without Bypass)	1–50	Not selected	5,000 A	N/A
58EC•4VY_ to 58EP•4VY_	Y (Bypass)			5,000 A	5,000 A
58EQ•4VW_ to 58ES•4VW_	W (Without Bypass)	60–100	Not selected	10,000 A	N/A
58EQ•4VY_ to 58ES•4VY_	Y (Bypass)			10,000 A	10,000 A
58EC•4VWG09_ to 58EP•4VWG09_	W (Without Bypass)	1–50	Selected	22,000 A	N/A
58EC•4VYG09_ to 58EP•4VYG09_	Y (Bypass)			22,000 A	22,000 A
58EQ•4VWG09_ to 58ES•4VWG09_	W (Without Bypass)	60–100	Selected	22,000 A	N/A
58EQ•4VYG09_ to 58ES•4VYG09_	Y (Bypass)			22,000 A	22,000 A

Notes to Table 9:

[1] "•"can be "A", "G", or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.

Table 9: Short Circuit Ratings, 230 V

8839 Controller [1]	Power Circuit	HP	MOD G09	Power Converter (AFC) Path Short-Circuit Rating (Symm.)	Bypass Path Short-Circuit Rating (Symm.)
58EC•3VW_ to 58EP•3VW_	W (Without Bypass)	1–50	Not selected	5,000 A	N/A
58EC•3VY_ to 58EP•3VY_	Y (Bypass)			5,000 A	5,000 A
58EC•3VWG09_ to 58EP•3VWG09_	W (Without Bypass)	1-50	Selected	22,000 A	N/A
58EC•3VYG09_ to 58EP•3VYG09_	Y (Bypass)			22,000 A	22,000 A

Notes to Table 10:

[1] "•" can be "A", "G", or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.

Table 10: Short Circuit Ratings, 208 V

8839 Controller [1]	Power Circuit	HP	MOD G09	Power Converter (AFC) Path Short-Circuit Rating (Symm.)	Bypass Path Short-Circuit Rating (Symm.)
58EC•2VW_ to 58EP•2VW_	W (Without Bypass)	1–50	Not selected	5,000 A	N/A
58EC•2VY_ to 58EP•2VY_	Y (Bypass)			5,000 A	5,000 A
58EC•2VWG09_ to 58EP•2VWG09_	W (Without Bypass)	1-50	Selected	22,000 A	N/A
58EC•2VYG09_ to 58EP•2VYG09_	Y (Bypass)			22,000 A	22,000 A

FACTORY MODIFICATIONS

Control Options

NOTE: Refer to the notes on page 10 for rules governing component selection.

Table 12: Control Options (Required Selection)

Control Option	Description	Parts List
A07	Hand-Off-Auto Selector Switch	ZB5AD3 Three-position selector switch ZB5AZ009 mounting collar ZBE203 Additional contact block (2 N.O.) (2) ZBE102 Additional contact block (1 N.C.) ZBZ32 Legend plate holder
	Speed Potentiometer	ZB5AD922 Potentiometer operetor ZBZ32 Legend plate holder
B07	Hand-Off-Auto Selector Switch	ZB5AD3 Three-position selector switch ZB5AZ009 mounting collar ZBE203 Additional contact block (2 N.O.) (2) ZBE102 Additional contact block (1 N.C.) ZBZ32 Legend plate holder
	Stop/Start Push Buttons	ZB5AA2 Black push button w/ mounting base ZB5AA4 Red push button w/ mounting base ZB5AZ101 Mounting collar w/ additional contact block (1 N.O.) ZB5AZ102 Mounting collar w/ additional contact block (1 N.C.) (2) ZBZ32 Legend plate holder
	Speed Potentiometer	ZB5AD922 Potentiometer operator ZBZ32 Legend plate holder
C07	Stop/Start Push Buttons	ZB5AA2 Black push button w/ mounting base ZB5AA4 Red push button w/ mounting base ZB5AZ101 Mounting collar w/ additional contact block (1 N.O.) ZB5AZ102 Mounting collar w/ additional contact block (1 N.C.) (2) ZBZ32 Legend plate holder
	Speed Potentiometer	ZB5AD922 Potentiometer operator ZBZ32 Legend plate holder
N07	None	No drive control options are supplied on the front door of the drive controller. For use in remote-mounted operator applications. Refer to chapter 3, Power Circuit Descriptions, for remote mounting information.

Light Options

NOTE: Refer to the notes on page 10 for rules governing component selection.

Table 13: Light Options (Optional Selection)

Light Option	Description	Parts List
A08 Pilot Light Option #1 Cluster	Red Power On	ZB5AV04 Red pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Green AFC Run	ZB5AV03 Green pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Yellow Fault	ZB5AV05 Amber pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Yellow Auto	ZB5AV05 Amber pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
B08 Pilot Light Option #2 Cluster	Red Power On	ZB5AV04 Red pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Green AFC Run	ZB5AV03 Green pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Yellow Fault	ZB5AV05 Amber pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Yellow Bypass	ZB5AV05 Amber pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
C08 Pilot Light Option # 3 Cluster	Red Power On	ZB5AV04 Red pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Green AFC Run	ZB5AV03 Green pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Yellow Fault	ZB5AV05 Amber pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder

Misc. Options

NOTE: Refer to the notes on page 10 for rules governing component selection.

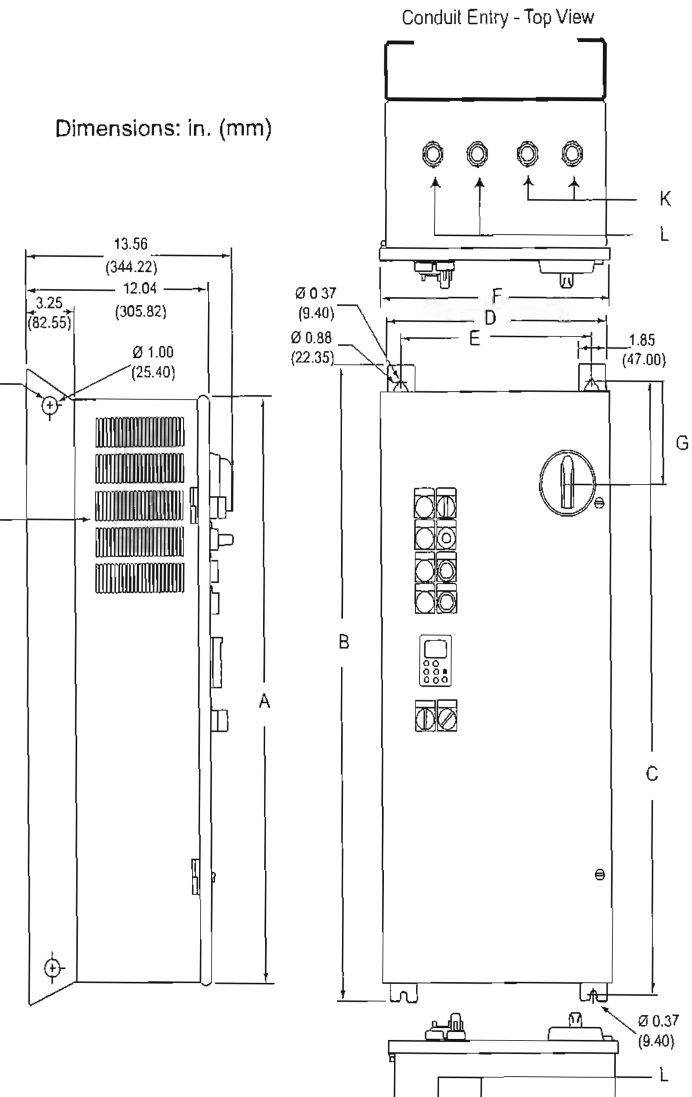
Table 14: Miscellaneous Options (Optional Selection)

Misc. Option	Name	Description
A09	Line Reactor	Factory-mounted line reactor within enclosure. Optional 1–25 hp, Included 30–100 hp @ 460 V Optional 1–10 hp, Included 15–50 hp @ 208/230 V
B09	Line Contactor	A line contactor can be added between the circuit breaker and the drive controller, (Type 1 and 12K only).
C09	3–15 PSI Transducer	Allows the controller to follow a user-supplied 3–15 PSI input.
D09	Omit Door-Mounted Keypad	The keypad is not supplied. The user must buy a keypad as a separate device to program the drive.
E09	Smoke Purge	Provides a smoke purge operating mode controlled by a user-supplied 120 Vac signal wired to customer's terminal block.
G09	22 KAIC UL Coordinated Rating	Provides a fully-coordinated 22 KAIC rating marked on enclosure nameplate (short circuit coordination to UL508C Power Conversion Equipment and NEMA ICS 7.1).
H09	Analog Card	0–20 mA analog output for customer use. Factory programmed for motor frequency. Includes analog card VW3A58201U and customer terminal block. Reassignable x–y range with keypad display.
J09	0–10 Vdc Auto Speed Reference	Provides a controller interface with differential input, 31158-297-50, for a 0–10 Vdc user-supplied auto speed reference signal to the AI2 input using a 0–10 V/4–20 mA converter with Z=40 kΩ.
K09	cUL Listing	Provides Canadian cUL certification when required by local code requirements.
L09	LONWORKS Serial Communication [1]	Provides factory installed LONWORKS to MODBUS Module VW3A58312PU, 24 Vdc power supply 8440PS24 and plug-in MODBUS card VW3A58303U. Serial Communication is factory installed for register monitoring.
M09	MODBUS Serial Communication [2]	Provides factory installed plug-in MODBUS card VW3A58303U and separate user termination to D-shell interface device, Square D part number 25410-00084. (Phoenix contact connector part #2761839.) Serial Communication is factory installed for register monitoring.
P09	METASYS® N2 Serial Communication	Provides factory installed plug-in METASYS N2 card VW3A58354U and separate user termination to D-shell interface device, Square D part number 25410-00084. (Phoenix contact connector part #2761839.) Serial Communication is factory installed for register monitoring.

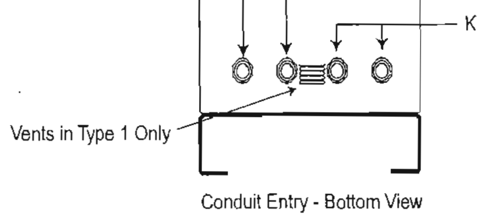
[1] For the most recent *.xif installation help files, refer to www.us.SquareD.com. The files are listed on the LONWORKS instruction bulletin page in the Product Technical Library. Refer to instruction bulletin VVDED300055US.

[2] The 9-pin to 15-pin connector cable that ships with the MODBUS® card when ordered from the distributor does not ship with an ECONOFLEX unit. ECONOFLEX units ship with a Phoenix connector for user terminations.

DIMENSIONS AND WEIGHTS FOR WALL MOUNTING



NOTE: Provide at least 3 in. of mounting clearance on each side of the drive controller and at least 6 in. of mounting clearance at the top and bottom of the drive controller.



Knockout Dimensions

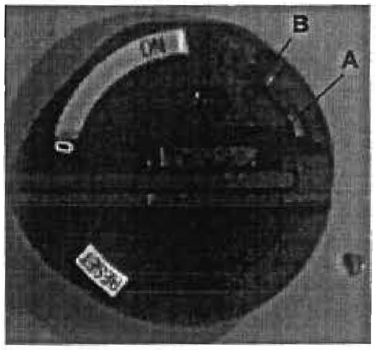
460 V	208/ 230 V	K	L
1–7.5 hp	1–5 hp	For 1/2" conduit	For 1/2" conduit
10–25 hp	7.5–10 hp	For 1/2", 3/4", and 1" conduit	For 1/2", 3/4", and 1" conduit

HP		Weight		Enclosure Dimensions													
				A		B		C		D		E		F		G	
460 V	208/ 230 V	lb	kg	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1–7.5	1–5	87	39.5	32.00	812.8	35.00	889.00	33.75	857.25	14.25	361.95	12.29	312.17	14.76	374.90	4.88	123.95
10–25	7.5–10	126	57.2	38.00	965.2	41.0	1041.40	39.75	1009.65	19.49	495.05	17.53	445.26	20.52	521.21	4.88	123.95

Figure 5: Mounting Information for Type 1 or Type 12K 1–25 HP Controllers @ 460 V and 1–10 HP Controllers @ 208/230 V

CHAPTER 2: RECEIVING, INSTALLATION, AND START-UP

PRELIMINARY INSPECTION



Circuit Breaker and Handle Assembly

⚠ CAUTION

DAMAGED EQUIPMENT

Do not operate any drive controller that appears damaged.

Failure to follow this instruction can result in injury or equipment damage.

The drive controller must be thoroughly inspected before it is stored or installed. Upon receipt:

a. Remove the drive controller from its packaging and visually inspect the exterior for shipping damage.
b. Ensure that the class, type, and MOD specified on the drive controller nameplate agree with the packaging slip and corresponding purchase order.
c. If you find any shipping damage, notify the carrier and your sales representative.
d. If you plan to store the drive controller after receipt, replace it in its original packaging material and observe storage temperature specifications in Table 7 on page 19.

⚠ CAUTION

DAMAGE TO INSULATED PARTS IN AIR DUCT

- Protect the air duct at the rear of the enclosure from entry of foreign material.
- Do not place loose objects on top of the enclosure.
- Do not block air flow from the duct.

Failure to follow these instructions can cause breaker trip, resulting in process shutdown or equipment damage.

Before installation:

1. Open the door of the drive controller. To open the door, turn the circuit breaker and handle assembly to the Off position as shown in the illustration at left. Pinch the handle (**A**) and handle latch (**B**) together and jiggle the assembly if necessary to open the door.
2. Visually verify that all internal mounting and terminal connection hardware is properly seated, securely fastened, and undamaged.
3. Visually verify that the control board on the power converter is properly seated, securely fastened, and undamaged. Verify that the internal wiring connections are tight. Inspect all connections for damage.
4. Close and secure the drive controller door.

HANDLING THE DRIVE CONTROLLER

> **⚠ WARNING**
>
> **HANDLING AND LIFTING HAZARD**
>
> Keep the area below any equipment being lifted clear of all personnel and property. Use the lifting method shown in Figure 8.
>
> **Failure to follow this instruction can result in death, serious injury, or equipment damage.**

Drive controllers are shipped on a pallet on their back. To avoid damage, do not stack drive controllers on top of each other. Store the drive controller in its original packaging until it is at the final installation site. The packaging protects the drive controller and prevents damage to its exterior.

Handle the drive controller carefully to avoid damage to the internal components, frame, or exterior. When handling a drive controller, balance it carefully to keep it from tipping. After removing packaging materials, drive controllers require some type of mechanical lifting.

When handling drive controllers:

- Always work with another person. The weight, size, and shape of the drive controller is such that two people are required to handle it.
- Use gloves.
- Attach a spreader bar to the two top lifting holes on the drive controller back panel (see Figure 5 on page 25 for location of lifting holes) and hoist the controller with chains or straps. See Figure 8 for the proper hoisting method.
- Raise the drive controller from a horizontal position (i.e., the back of the controller resting on a pallet).
- Place the drive controller in an upright position. Note: The bottom of the drive controller is on an angle.
- Mount the drive controller on a flat, solid, noncombustible vertical surface.
- Secure all four corners of the controller with hardware of a sufficient size and type for the controller weight.

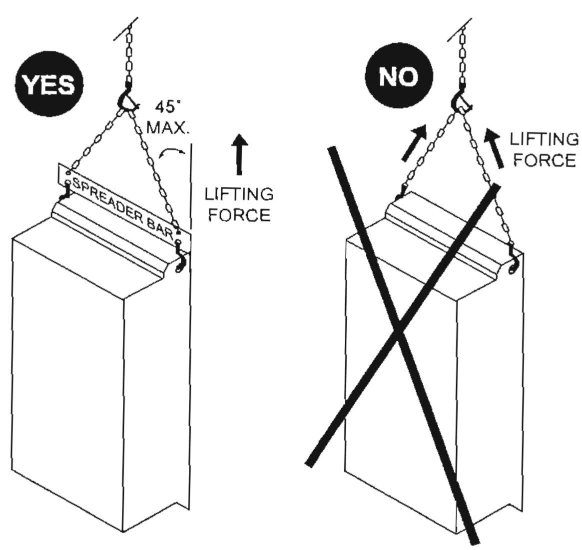


Figure 8: Hoisting Class 8839 ECONOFLEX Drive Controllers

INSTALLATION

Mechanical Installation

Refer to Table 7 on page 19 for Specifications.

- The Type 1 or 12K controller must be mounted vertically against a solid, flat surface to allow for proper ventilation.
- If drilling for conduit entry, exercise care to prevent metal chips from falling on parts and electronic printed wiring boards.
- See Figure 5 on page 25, Figure 6 on page 26, Figure 7 on page 27 for mounting dimensions, mounting clearances, conduit entry areas, and controller weights.
- Do not mount the drive controller on hot surfaces.
- Do not mount the Type 1 or 12K drive controllers in direct sunlight.

Electrical Installation

⚠ DANGER

HAZARDOUS VOLTAGE

Turn off all power (main and remote) before installing the equipment.

Failure to follow this instruction will result in death or serious injury.

General Wiring Practices

Before wiring, perform the bus voltage measurement procedure on page 40. Good wiring practice requires the separation of control circuit wiring from all power wiring. Power wiring to the motor must have the maximum possible separation from all other power wiring, whether from the same drive controller or other drive controllers. **Do not run power and/or control or multiple power wiring in the same conduit.** This separation reduces the possibility of coupling electrical transients from power circuits into control circuits or from motor power wiring into other power circuits.

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

Follow the wiring practices described in this document in addition to those already required by the National Electrical Code and local codes.

Failure to follow this instruction can result in injury or equipment damage.

Follow the practices below when wiring the Class 8839 ECONOFLEX drive controller:

- Use metallic conduit for all drive controller wiring. Do not run control and power wiring in the same conduit.
- Separate metallic conduits carrying power wiring or low-level control wiring by at least 3 inches (76 mm).
- Separate existing, non-metallic conduits or cable trays used to carry power wiring from metallic conduit carrying low-level control wiring by at least 12 inches (305 mm).
- Whenever power and control wiring cross, the metallic conduits and non-metallic conduits or trays must cross at right angles.
- Equip all inductive circuits near the controller (relays, contactors, solenoid valves) with noise suppressors or connect them to a separate circuit.

Input Power

The Class 8839 ECONOFLEX drive controller operates from a three-phase, 460 Vac ± 10%, 230 Vac ±10%, or 208 Vac ± 10% 60 Hz ± 5% supply connected to the input circuit breaker disconnect. The circuit breaker disconnect is coordinated and tested with the controller power circuit for a short circuit rating of 5 KAIC for 1–50 hp and 10 KAIC for 60–100 hp. When modification G09 is selected, the circuit breaker disconnect is coordinated and tested with the controller power circuit for a short circuit rating of 22 KAIC.

Branch Circuit Connections

All branch circuit components and equipment (such as feeder cables, disconnect devices, and protective devices) must be rated for the maximum input current of the Class 8839 ECONOFLEX drive controller, not the FLA of the motor. The drive controller input current is stamped on the nameplate. Refer to Tables 4, 5, and 6 on pages 17–18 for drive controller input currents.

Connect input power leads L1, L2, and L3 to the input of the circuit breaker. Refer to Figure 3 (page 13) or Figure 4 (page 14) or Figures 14–17 (pages 44–47) for location. Refer to Tables 22, 23, and 24 (pages 48–50) for lug data and wire size range for drive controller input terminals L1, L2 and L3.

⚠ WARNING

IMPROPER OVERCURRENT COORDINATION

- Protective devices must be properly coordinated.
- Do not connect the drive controller to a power feeder whose short circuit capacity exceeds the short circuit rating listed on the drive controller nameplate.

Failure to follow this instruction can result in death or serious injury.

⚠ CAUTION

IMPROPER WIRING

- Do not connect input power leads to the drive controller output terminals (T1, T2, T3 or U, V, W). This damages the controller and voids the warranty.
- Check the power connections before energizing the controller.

Failure to follow this instruction can result in injury or equipment damage.

Grounding

Ground the drive controller according to the National Electrical Code and all local codes. To ground the drive controller:

- Connect a copper wire from the ground bar terminal to the power system ground.
- Verify that the resistance to ground is 1 Ω or less. Improper grounding causes intermittent and unreliable operation.

⚠ DANGER

HAZARDOUS VOLTAGE

- Ground equipment using the provided ground connection point as shown in Figures 14–17 starting on page 44. The drive controller panel must be properly grounded before power is applied.
- Do not use metallic conduit as a ground conductor.

Failure to follow this instruction will result in death or serious injury.

Ground multiple drive controllers as shown in Figure 9. Use one grounding conductor per device. Do not loop ground conductors or install them in series.

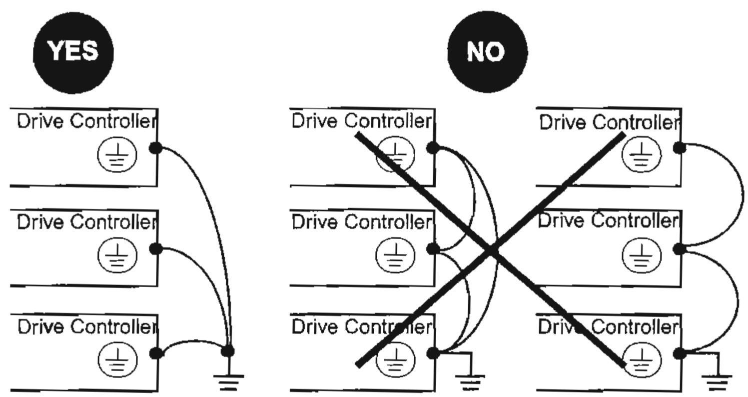


Figure 9: Grounding Multiple Drive Controllers

Output Wiring

The ampacity of motor power conductors should be sized according to the motor full load current, National Electrical Code, and applicable local codes.

Connect motor conductors to the lugs provided and connect the motor ground to the ground bar provided. Connect motor conductors to T1, T2, and T3 on the overload relay when the controller is supplied with a bypass circuit. Connect motor conductors to U, V, and W on the power converter when the controller is supplied without a bypass circuit. See Figure 3 (page 13) or Figure 4 (page 14) and Figures 14–17 starting on page 44 for location. See Tables 22, 23, and 24 (pages 48–50) for lug data and wire size range. Refer to the nameplate for torque requirements.

The drive controller is sensitive to the amount of capacitance (either phase-to-phase or phase-to-ground) present on the output power conductors. If excessive capacitance is present, the drive controller may trip on overcurrent.

Output Cable

Follow the guidelines below when selecting output cable:

- Cable type: the cable selected must have a low capacitance phase-to-phase and to ground. Do not use mineral-impregnated cable because it has a very high capacitance. Immersion of cables in water increases capacitance.
- Cable length: the longer the cable, the greater the capacitance. Cable lengths greater than 100 ft (30.5 m) may cause ground faults. For installation where cable capacitances may be a problem, a reactor can be installed between the drive controller and the motor.
- Proximity to other output cables: because of high frequency switching and increased capacitance, the drive controller may fault under some conditions.
- **Do not use lightning arrestors or power factor correction capacitors on the output of the drive controller.**

A minimum inductance is needed to protect the drive controller output from short circuits. Provide at least 20 in. (500 mm) of cable at the drive controller output (U, V, and W for a controller without bypass or T1, T2, and T3 for a controller with bypass).

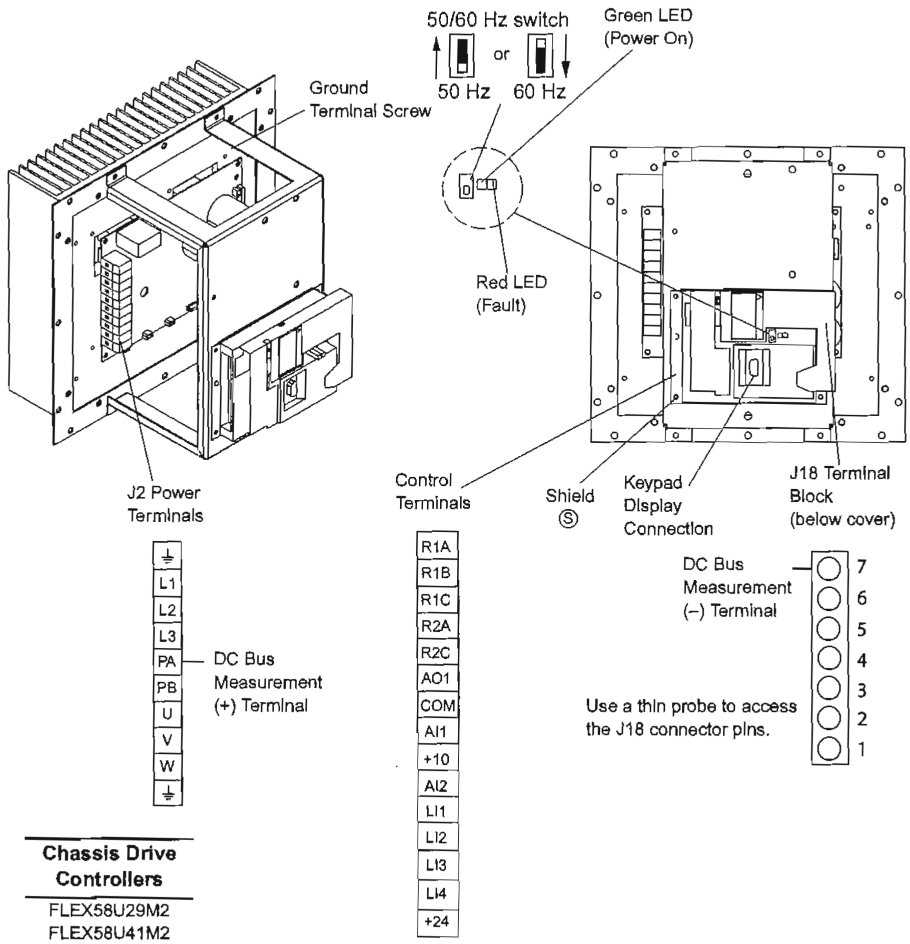
⚠ CAUTION

INSUFFICIENT OUTPUT INDUCTANCE

For proper drive controller short circuit protection, certain values of inductance may be required in the output power wiring. Inductance can be supplied by the power wiring or auxiliary inductors.

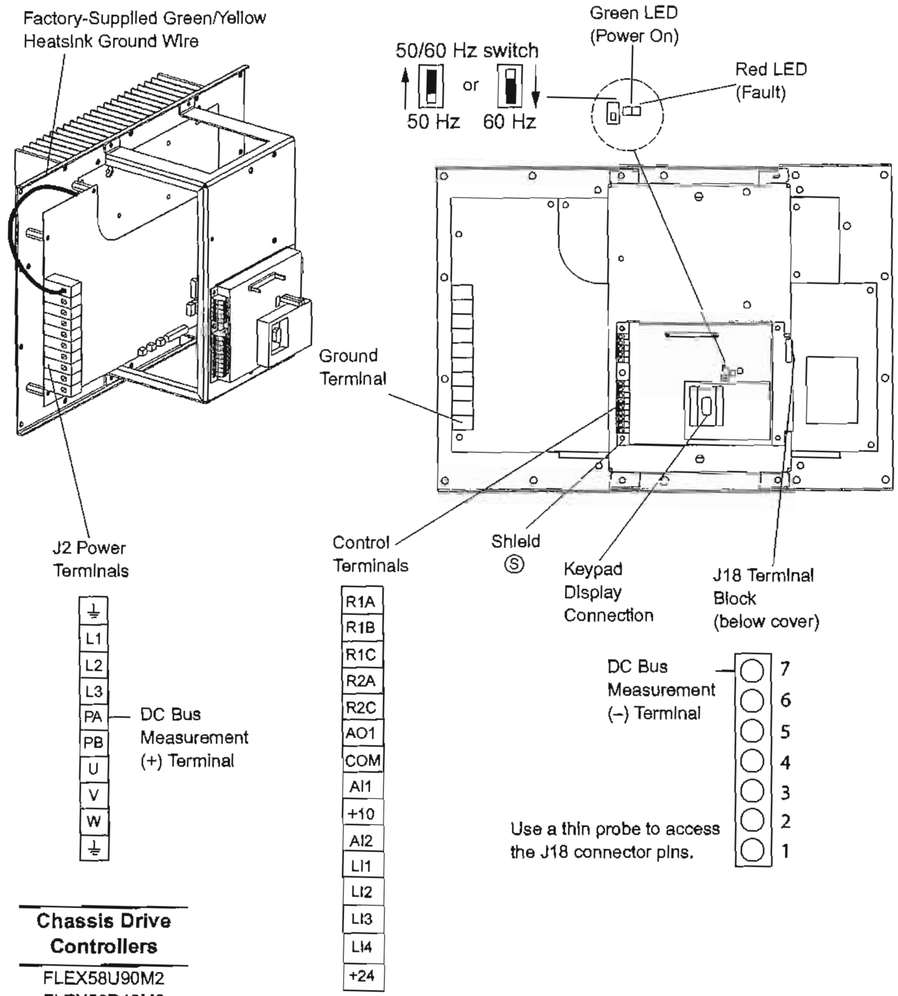
Failure to follow this instruction can result in injury or equipment damage.

DC Bus Voltage Measurement Terminal Locations



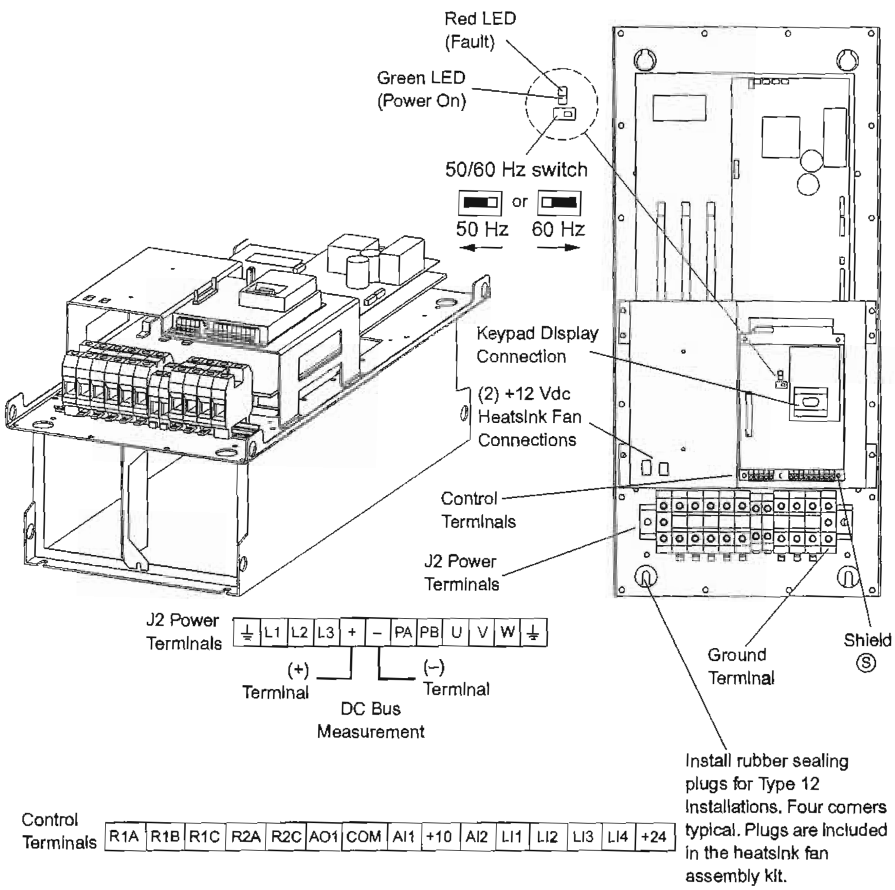
Chassis Drive Controllers
FLEX58U29M2
FLEX58U41M2
FLEX58U72M2
FLEX58KU18N4
FLEX58KU29N4
FLEX58KU41N4
FLEX58KU54N4
FLEX58KU72N4

Figure 10: FLEX58U29M2–U72M2 and FLEX58KU18N4–KU72N4



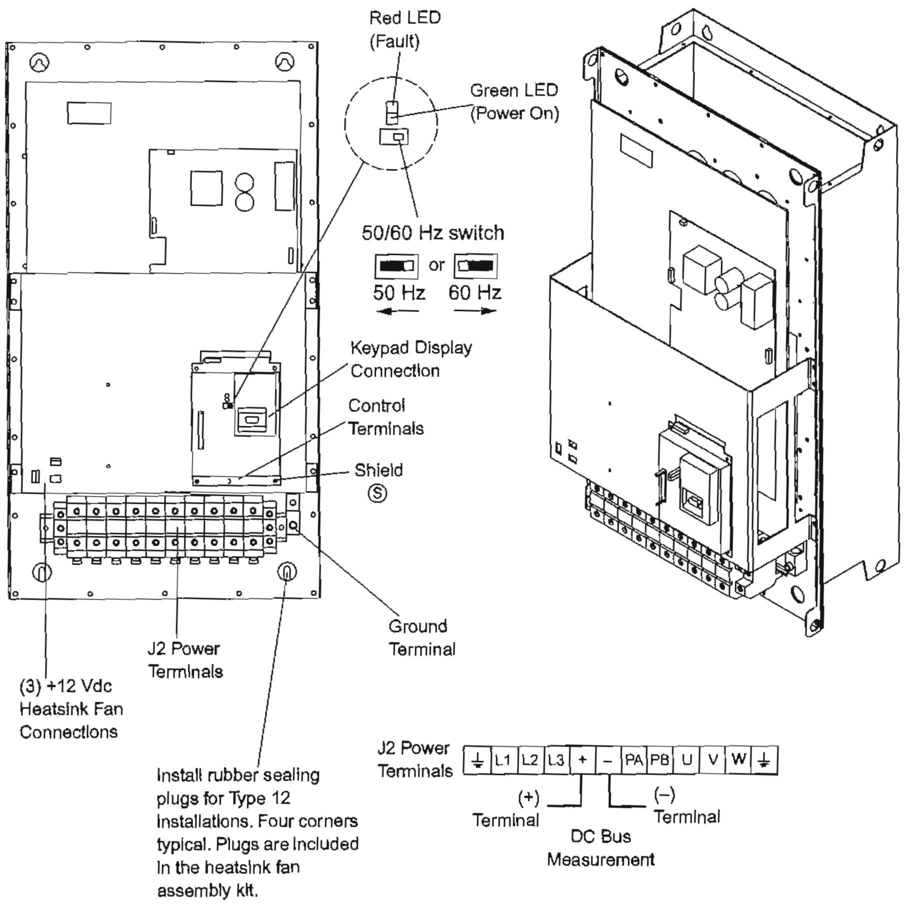
Chassis Drive Controllers
FLEX58U90M2
FLEX58D12M2
FLEX58KU90N4
FLEX58KD12N4
FLEX58KD16N4
FLEX58KD23N4

Figure 11: FLEX58U90M2, FLEX58D12M2, and FLEX58KU90N4–KD23N4



Chassis Drive Controllers
FLEX58D16M2
FLEX58D23M2
FLEX58KD28N4
FLEX58KD33N4
FLEX58KD46N4

Figure 12: FLEX58D16M2, FLEX58D23M2, and FLEX58KD28N4–KD46N4



Chassis Drive Controllers
FLEX58D28M2
FLEX58D33M2
FLEX58D46M2
FLEX58KD54N4
FLEX58KD64N4
FLEX58KD79N4

Control Terminals

R1A	R1B	R1C	R2A	R2C	AO1	COM	AI1	+10	AI2	LI1	LI2	LI3	LI4	+24

Figure 13: FLEX58D28M2–D46M2 and FLEX58KD54N4–KD79N4

DC Bus Voltage Measurement Procedure

⚠ DANGER

HAZARDOUS VOLTAGE

- Read and understand the Bus Voltage Measurement Procedure before performing the procedure. Measurement of bus capacitor voltage must be performed by qualified personnel.
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Failure to follow this instruction will result in death or serious injury.

The DC bus voltage level is determined by monitoring the (+) and (–) measurement points. Their location varies by power converter model number as listed in Table 18. The power converter model number is listed on its nameplate.

Table 18: (+) and (–) Measurement Points

FLEX58 Power Converter		Refer to Figure	(+) Measurement Point		(–) Measurement Point	
208/230 V	460 V		Terminal Block or Connector	Terminal Designation	Terminal Block or Connector	Terminal Designation
FLEX58U29M2 FLEX58U41M2 FLEX58U72M2	FLEX58KU18N4 FLEX58KU29N4 FLEX58KU41N4 FLEX58KU54N4 FLEX58KU72N4	10 on page 36	J2	PA	J18	7
FLEX58U90M2 FLEX58D12M2	FLEX58KU90N4 FLEX58KD12N4 FLEX58KD16N4 FLEX58KD23N4	11 on page 37				
FLEX58D16M2 FLEX58D23M2	FLEX58KD28N4 FLEX58KD33N4 FLEX58KD46N4	12 on page 38	J2	(+)	J2	(-)
FLEX58D28M2 FLEX58D33M2 FLEX58D46M2	FLEX58KD54N4 FLEX58KD64N4 FLEX58KD79N4	13 on page 39				

To measure the DC bus capacitor voltage:

1. Observe the lockout/tagout procedures as identified in OSHA Standard 29 CFR, Subpart J covering:
   — 1910.147: The control of hazardous energy (lockout/tagout).
   — 1910.147: App A, Typical minimal lockout procedures.
2. Open the disconnect between the input line and the drive controller. Lock the disconnect in the open position and install a "Do Not Turn On" sign. Open the circuit breaker disconnect located on the front of the drive controller. Also, be sure to remove all external control power that may be present such as on the control board and the option board terminals.
3. Wait three minutes for the DC bus capacitors to discharge.
4. Read the model number of the power converter from the nameplate, and identify the corresponding (+) and (–) measurement points from Table 18 and Figures 10 to 13 on pages 36 to 39.
5. Open the door of the power converter.

6. Set the voltmeter to the 1000 Vdc scale. Measure the voltage between the (+) and (–) measurement points identified in step 4.
7. Verify that the DC bus voltage has discharged below 45 V before servicing the drive controller. If the DC bus capacitors will not discharge below 45 V, contact your local Square D representative. **Do not operate the drive controller.**
8. After servicing the drive controller, close and secure door.

Wire Routing and Interconnection

Wire Class

The Wire Class describes the compatibility of the field wiring terminal with the conductor material and insulation system. When used in conjunction with the required conductor current rating and controller ambient temperature rating, the Wire Class forms the basis for selecting a conductor size that limits the temperature on the conductor insulation at the field wiring terminal to acceptable limits. Although it is permissible to use conductors with operating temperatures exceeding those given by the Wire Class, conductor **size** must fall within the Wire Class limits.

Noise Class

The Noise Class categorizes the electromagnetic properties of the voltages and currents present. The Noise Class is comprised of the six categories shown in Table 19.

Table 19: Noise Class Categories

Noise Class	Definition
Quiet Wiring 1 (QW1)	High susceptibility analog and digital control signals. Signals falling under this classification include digital communication/network circuits, controller analog I/O and analog process signals.
Quiet Wiring 2 (QW2)	Medium susceptibility, analog and digital control signals. Signals falling under this classification include 24 Vdc and Vac control circuits.
Standard Wiring 1 (SW1)	Low susceptibility control or power circuits rated less than 600 Vac (250 Vdc) and less than 15 A (voltage and current spectra are generally contained within 0.05–9 kHz). Signals falling under this classification include 120 Vac control circuits.
Standard Wiring 2 (SW2)	Power circuits rated greater than 15 A (voltage and current spectra are generally contained within 0.05–9 kHz). Signals falling under this classification include line power to controllers.
Standard Wiring 3 (SW3)	Reserved.
Pulse Wiring 1 (PW1)	Control or power circuits whose voltage or current spectra significantly exceed 9 kHz. Signals falling under this classification include motor and dynamic braking circuits fed from PWM power converters.

Voltage Class

The Voltage Class categorizes the voltages present into recognized conductor insulation categories (30, 150, 300, and 600 V) for selection of the conductor voltage rating and physical segregation purposes.

Wiring Methods

Based upon the Noise Class and Voltage Class of the conductors, apply the wiring methods in Table 20 to the drive system.

Table 20: Wire Routing and Interconnection

Wiring Methods and Considerations	Noise Class of Conductors				
	QW1	QW2	SW1	SW2	PW1
Conductor Grouping In Wireways/Conduits 1. All conductors of 1 or 3 phase AC power circuits must be bundled to minimize stray magnetic fields.			X	X	X
2. All conductors of a DC power circuit must be bundled to minimize stray magnetic fields.			X	X	X
3. When paralleled conductors must be run in separate wireways or conduit, bundle conductors into groups that minimize stray magnetic fields.				X	X
4. Maintain conductor runs as short and direct as practical.	X	X	X	X	X
Separation of Circuits 1. DO NOT run different Noise Class conductors in the same conduit.	X	X	X	X	X
2. DO NOT run different Voltage Class conductors in same conduit unless all conductors are insulated for the maximum Voltage Class present.	X	X	X	X	X
3. All PW conductor groups must be individually segregated using metallic conduit.					X
4. Segregate all conductors by Noise Class. Use the following circuit separation when conductors can run parallel for more than 12 in.					
• Metallic conduit: 3 in. between QW to SW/PW	X	X	X	X	X
• Metallic tray: 3 in. between SW to PW			X	X	X
• Metallic tray: 6 in. between QW to SW/PW	X	X	X	X	X
• Against continuous metal surface: 3 in. between SW to PW			X	X	X
• Against continuous metal surface: 6 in. between QW to SW/PW	X	X	X	X	X
• Metallic conduit housing QW: 12 in. to non-metallic conduit SW/PW	X	X	X	X	X
• Non-metallic conduit: 3 in. between SW to PW			X	X	X
• Non-metallic conduit: 24 in. between QW to SW/ PW	X	X	X	X	X
5. If QW and SW1 wiring must cross SW2 or PW1 wiring, the bundles must cross at right angles.	X	X	X	X	X
Common Mode Noise Issues 1. Provide adjacent signal returns using twisted pair cable.	X	X			
2. Galvanically isolate signal and associated signal return path when possible.	X	X			
Shielding 1. Use metallic conduit for all power and control circuits external to the controller enclosure.	X	X	X	X	X
2. Shields should be continuous and equipped with a drain wire.	X	X	X		
3. DO NOT group different Noise Class conductors within the same shield.	X	X	X	X	X
4. Minimize non-shielded portion of conductor at the ends of shielded cable.	X	X	X	X	X
5. When shielding AC or DC power conductors, group conductors to minimize magnetic field in shield.			X	X	X
Grounding 1. Ground shields only at the controller end.	X	X	X	X	X
2. Use separate ground wire for each shield ground.	X	X	X	X	X
3. Provide a ground wire with all conductor groups whether in tray or conduit.			X	X	X
4. When multiple grounds must be made to a shielded power cable, the shield must have the same short circuit withstand capability as the ground conductor in the power cable.			X	X	X
5. Terminate all power grounds and power shield grounds to the controller grounding point or bar.			X	X	X
6. Terminate all signal shield grounds to the terminals provided.	X	X			
7. Always supply a separate equipment grounding conductor with the controller power feed. DO NOT depend upon metallic conduit for ground connection.			X	X	X

Component Identification and Terminal Strip Locations

NOTE: Typical device shown with options. Type 3R ventilation fan and space heater not shown.

Figure 14 shows component identification and terminal strip locations for Class 8839 ECONOFLEX drive controllers 1–7.5 hp at 460 V and 1–5 hp at 208/230 V. Tables 22, 23, and 24 (pages 48–50) list wire size range and terminal torque requirements.

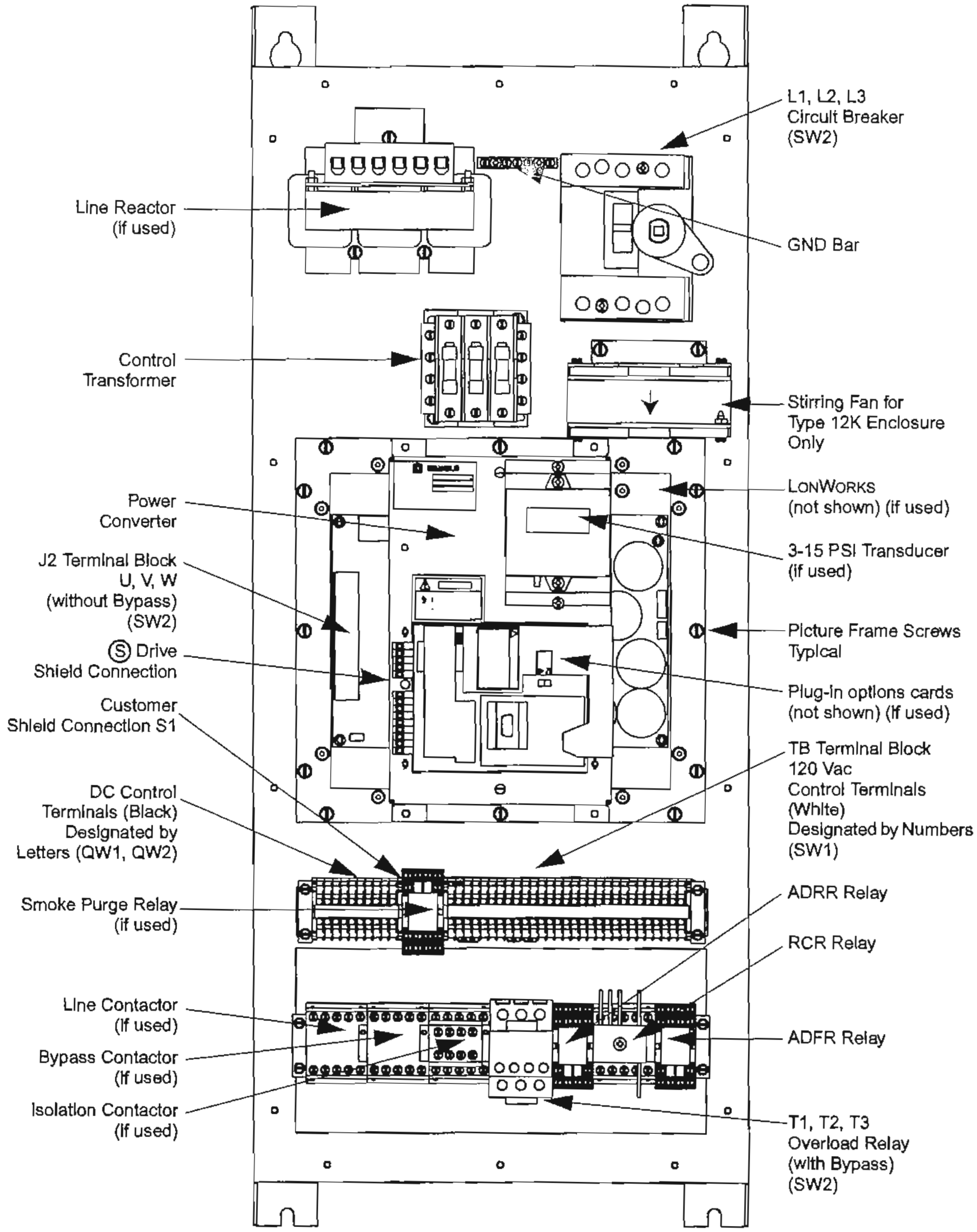


Figure 14: Component Identification and Terminal Strip Locations for 1–7.5 HP @ 460 V and 1–5 HP @ 208/230 V

Figure 15 shows component identification and terminal strip locations for Class 8839 ECONOFLEX drive controllers 10–25 hp at 460 V and 7.5–10 hp at 208/230 V. Tables 22, 23, and 24 (pages 48–50) list wire size range and terminal torque requirements.

NOTE: Typical device shown with options. Type 3R ventilation fan and space heater not shown.

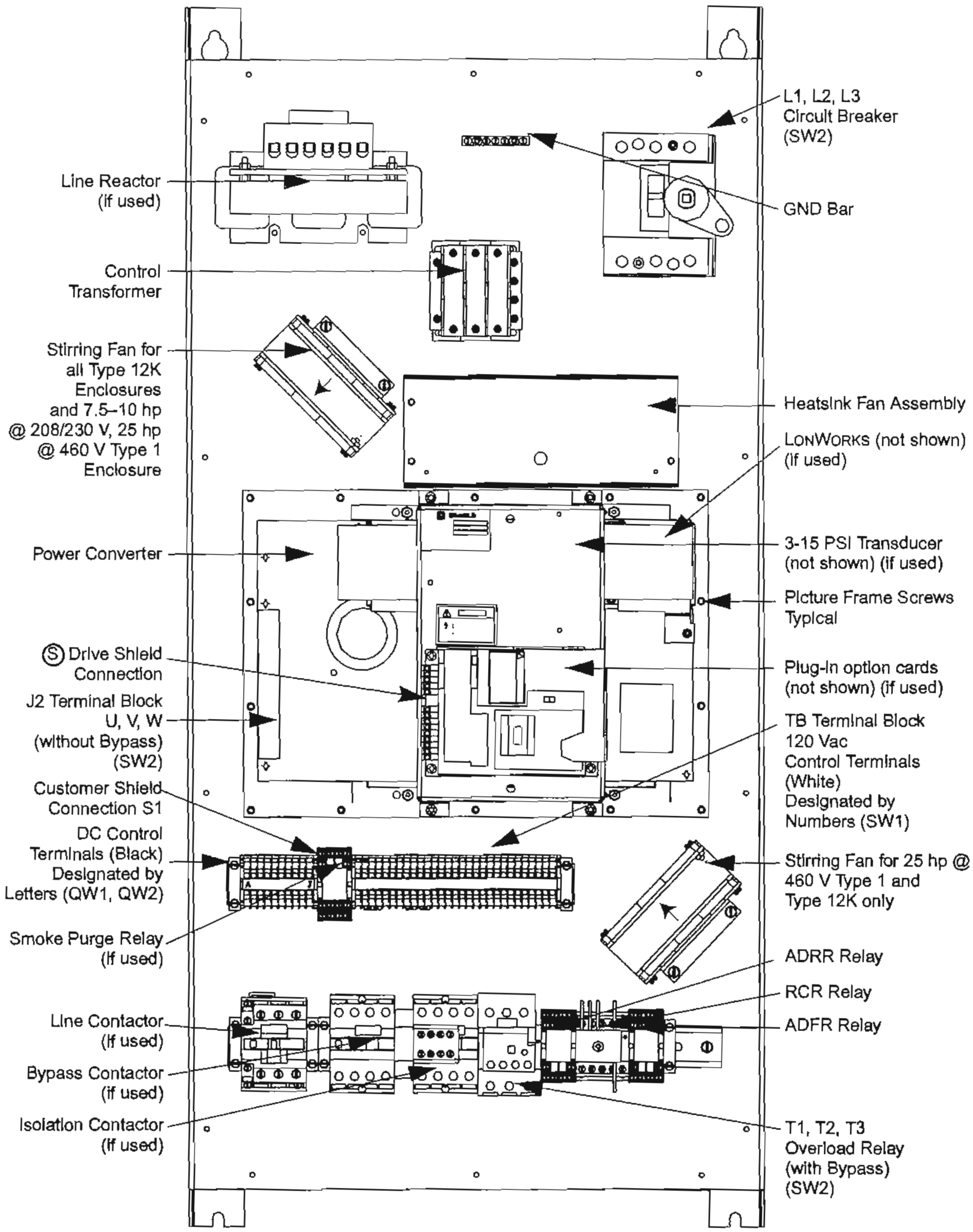


Figure 15: Component Identification and Terminal Strip Locations for 10–25 HP @ 460 V and 7.5–10 hp @ 208/230 V

Figure 16 shows component identification and terminal strip locations for Class 8839 ECONOFLEX drive controllers 30–50 hp at 460 V and 15–25 hp at 208/230 V. Tables 22, 23, and 24 (pages 48–50) list wire size range and terminal torque requirements.

NOTE: Typical device shown with options. Type 3R ventilation fan and space heater not shown.

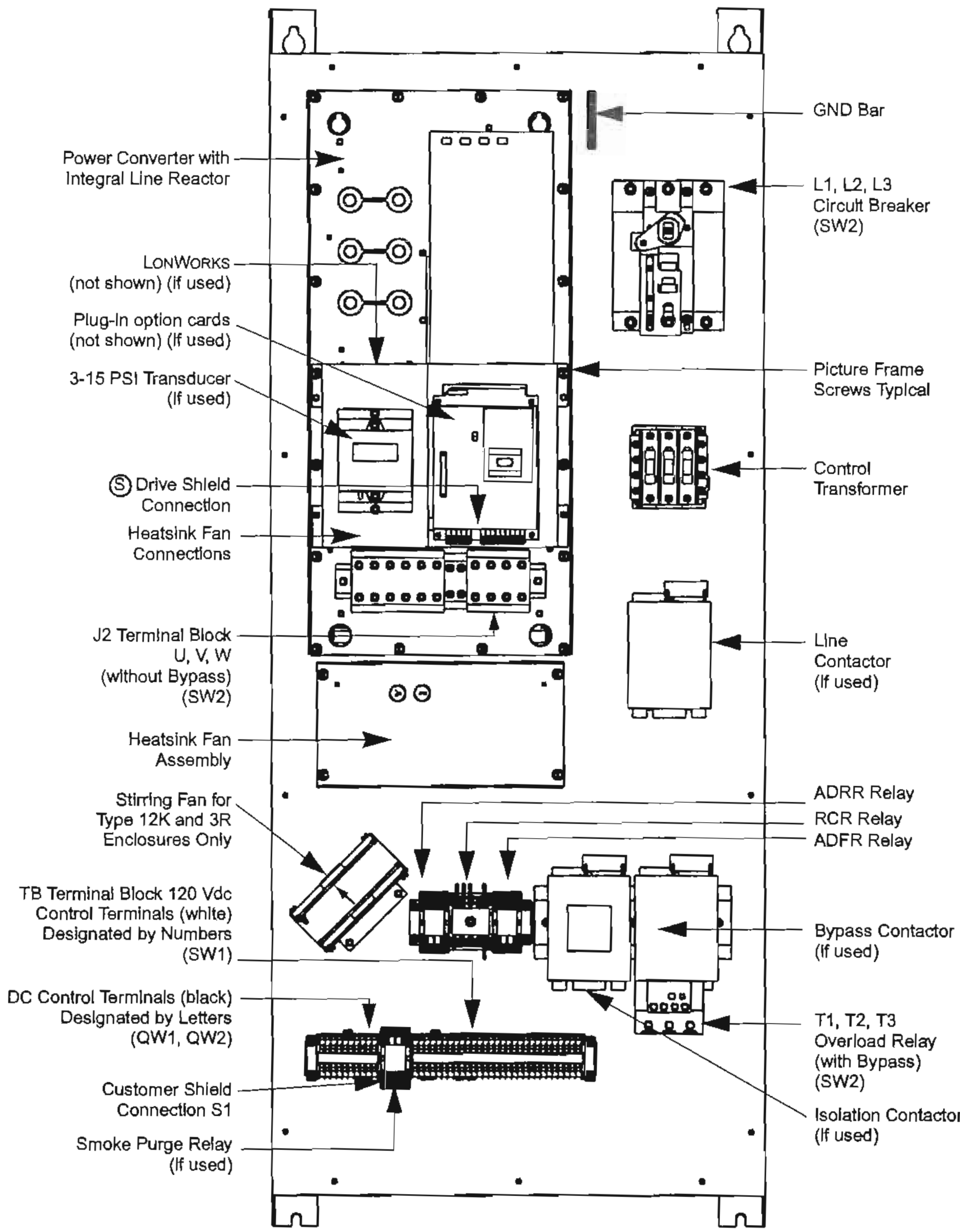


Figure 16: Component Identification and Terminal Strip Locations for 30–50 HP @ 460 V and 15–25 HP @ 208/230 V

Figure 17 shows component identification and terminal strip locations for Class 8839 ECONOFLEX drive controllers 60–100 hp at 460 V and 30–50 hp at 208/230 V. Tables 22, 23, and 24 (pages 48–50) list wire size range and terminal torque requirements.

NOTE: Typical device shown with options. Type 3R ventilation fan and space heater not shown.

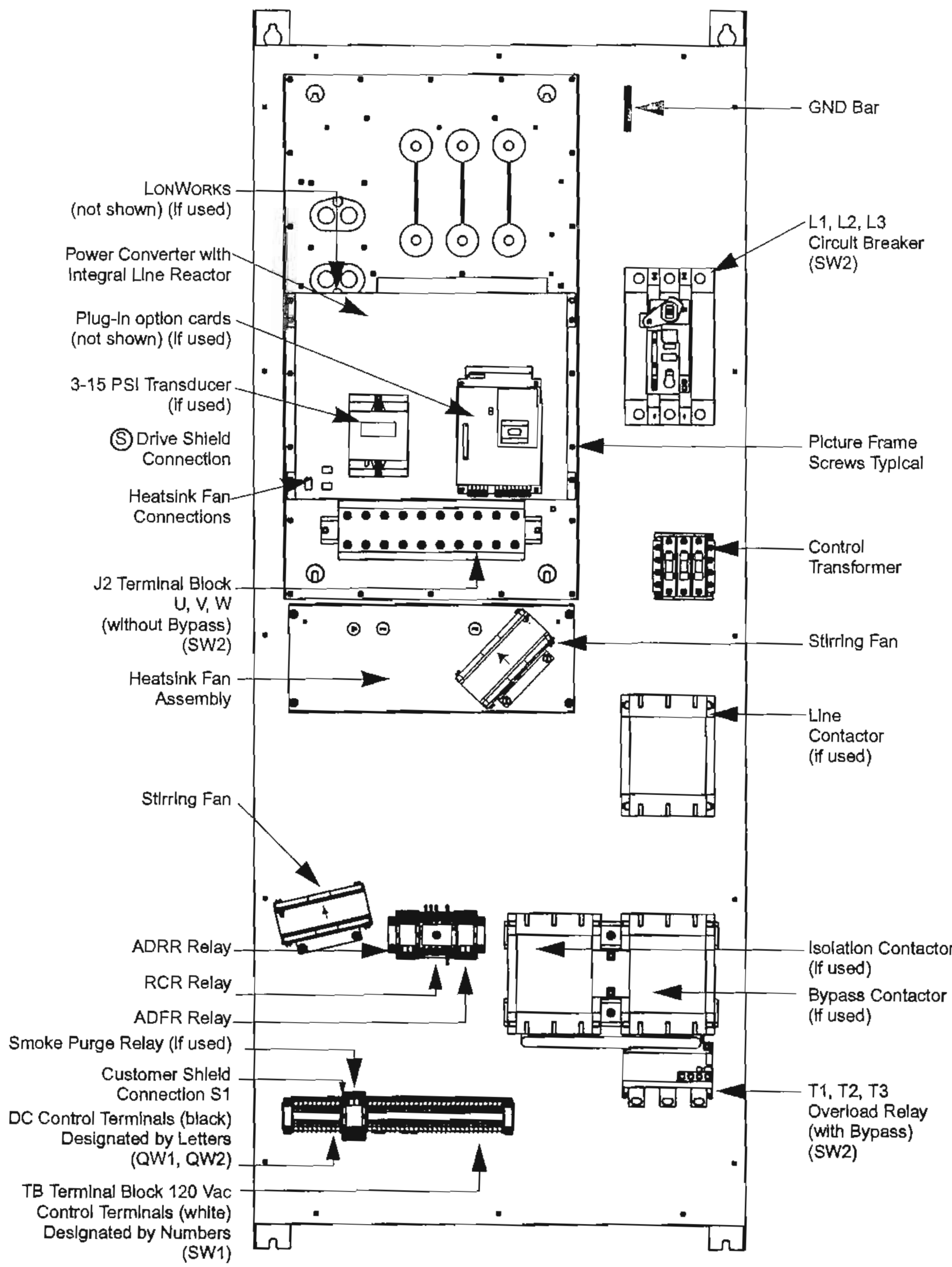


Figure 17: Component Identification and Terminal Strip Locations for 60–100 HP @ 460 V and 30–50 HP @ 208/230 V

Power Wiring

Table 21: Power Terminal Functions

Terminal	Function
GND	(Ground Bar)
L1 L2 L3	3-phase input power supply (at top of circuit breaker)
T1 T2 T3	Output connections to motor for controller with bypass (at bottom of overload relay)
U V W	Output connections to motor for controller without bypass (power converter output J2 terminal)

Table 22: Power Terminal Wire Range, 460 V

		Terminals					
		Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)
Power Circuit W (Without Bypass)[1]	HP	L1, L2, L3 (Line)		U, V, W (Load)		GND Bar	
58EC•4VW_	1	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58ED•4VW_	2	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EE•4VW_	3	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EF•4VW_	5	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EG•4VW_	7.5	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EH•4VW_	10	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EJ•4VW_	15	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EK•4VW_	20	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EL•4VW_	25	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EM•4VW_	30	1/0 (53.5)	50 (5.65)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EN•4VW_	40	1/0 (53.5)	80 (9.04)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EP•4VW_	50	1/0 (53.5)	80 (9.04)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EQ•4VW_	60	1/0 (53.5)	80 (9.04)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58ER•4VW_	75	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58ES•4VW_	100	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
Power Circuit Y (Bypass)[1]	HP	L1, L2, L3 (Line)		T1, T2, T3 (Load)		GND Bar	
58EC•4VY_	1	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58ED•4VY_	2	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EE•4VY_	3	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EF•4VY_	5	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EG•4VY_	7.5	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EH•4VY_	10	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EJ•4VY_	15	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EK•4VY_	20	1/0 (53.5)	50 (5.65)	6 (13.3)	15 (1.69)	4 (21.15)	20 (2.26)
58EL•4VY_	25	1/0 (53.5)	50 (5.65)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EM•4VY_	30	1/0 (53.5)	50 (5.65)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EN•4VY_	40	1/0 (53.5)	80 (9.04)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EP•4VY_	50	1/0 (53.5)	80 (9.04)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EQ•4VY_	60	1/0 (53.5)	80 (9.04)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58ER•4VY_	75	350 (177)	250 (28.25)	250 (127)	300 (33.9)	4 (21.15)	20 (2.26)
58ES•4VY_	100	350 (177)	250 (28.25)	250 (127)	300 (33.9)	4 (21.15)	20 (2.26)

[1] "•" can be "A","G" or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes a Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.
[2] 75 °C copper.

Notes to Table 23:

[1] "•" can be "A","G" or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes a Type 3R enclosure. "_" Indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.
[2] 75 °C copper.

Table 23: Power Terminal Wire Range, 230 V

		Terminals					
		Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)
Power Circuit W (Without Bypass)[1]	HP	L1, L2, L3 (Line)		U, V, W (Load)		GND Bar	
58EC•3VW_	1	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58ED•3VW_	2	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EE•3VW_	3	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EF•3VW_	5	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EG•3VW_	7.5	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EH•3VW_	10	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EJ•3VW_	15	1/0 (53.5)	50 (5.65)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EK•3VW_	20	1/0 (53.5)	50 (5.65)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EL•3VW_	25	1/0 (53.5)	80 (9.04)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EM•3VW_	30	1/0 (53.5)	80 (9.04)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58EN•3VW_	40	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58EP•3VW_	50	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
Power Circuit Y (Bypass)[1]	HP	L1, L2, L3 (Line)		T1, T2, T3 (Load)		GND Bar	
58EC•3VY_	1	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58ED•3VY_	2	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EE•3VY_	3	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EF•3VY_	5	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EG•3VY_	7.5	1/0 (53.5)	50 (5.65)	6 (13.3)	15 (1.69)	4 (21.15)	20 (2.26)
58EH•3VY_	10	1/0 (53.5)	50 (5.65)	6 (13.3)	15 (1.69)	4 (21.15)	20 (2.26)
58EJ•3VY_	15	1/0 (53.5)	50 (5.65)	6 (13.3)	75 (8.47)	4 (21.15)	20 (2.26)
58EK•3VY_	20	1/0 (53.5)	50 (5.65)	6 (13.3)	75 (8.47)	4 (21.15)	20 (2.26)
58EL•3VY_	25	1/0 (53.5)	80 (9.04)	6 (13.3)	75 (8.47)	4 (21.15)	20 (2.26)
58EM•3VY_	30	1/0 (53.5)	80 (9.04)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)
58EN•3VY_	40	350 (177)	250 (28.25)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)
58EP•3VY_	50	350 (177)	250 (28.25)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)

Notes to Table 24:

[1] "•" can be "A","G" or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes a Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.
[2] 75 °C copper.

Table 24: Power Terminal Wire Range, 208 V

		Terminals					
		Maximum Wire Size AWG (mm^2)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm^2)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm^2)[2]	Terminal Torque lb-in (N•m)
Power Circuit W (Without Bypass)[1]	HP	L1, L2, L3 (Line)		U, V, W (Load)		GND Bar	
58EC•2VW_	1	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58ED•2VW_	2	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EE•2VW_	3	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EF•2VW_	5	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EG•2VW_	7.5	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EH•2VW_	10	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EJ•2VW_	15	1/0 (53.5)	50 (5.65)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EK•2VW_	20	1/0 (53.5)	80 (9.04)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EL•2VW_	25	1/0 (53.5)	80 (9.04)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EM•2VW_	30	1/0 (53.5)	80 (9.04)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58EN•2VW_	40	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58EP•2VW_	50	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
Power Circuit Y (Bypass)[1]	HP	L1, L2, L3 (Line)		T1, T2, T3 (Load)		GND Bar	
58EC•2VY_	1	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58ED•2VY_	2	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EE•3VY_	3	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EF•2VY_	5	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EG•2VY_	7.5	1/0 (53.5)	50 (5.65)	6 (13.3)	15 (1.69)	4 (21.15)	20 (2.26)
58EH•2VY_	10	1/0 (53.5)	50 (5.65)	6 (13.3)	15 (1.69)	4 (21.15)	20 (2.26)
58EJ•2VY_	15	1/0 (53.5)	50 (5.65)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EK•2VY_	20	1/0 (53.5)	80 (9.04)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EL•2VY_	25	1/0 (53.5)	80 (9.04)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EM•2VY_	30	1/0 (53.5)	80 (9.04)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)
58EN•2VY_	40	350 (177)	250 (28.25)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)
58EP•2VY_	50	350 (177)	250 (28.25)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)

Notes to Table 25 and Table 26:

[1] See the Control Circuit Elementary Diagrams in chapter 5.
[2] All terminals are rated 600 V, 30 A (Class 9080 Type GM6). Max. wire size for all terminals:
10 AWG (2.5 mm^2). Tightening Torque: 7–8 lb-in (0.8–0.9 N•m).

Table 25: Analog Output (MOD H09)

Terminal[1][2]	Function	Characteristics
AO	Analog output programmed for motor frequency	0–20 mA Z=500 Ω Reassignable x–y range with keypad
COM	Common for analog output	0 V

Table 26: 0–10 V Auto Speed Reference (MOD J09), Signal Converter Board 31158-297-50

Terminal[1][2]	Function (Differential)	Characteristics
G1, S2+	AI2A+ Input	0–10 V, Z = 40 kΩ
G2, S2–	AI2B– Input	

Control Wiring

NOTE: Refer to Table 25 for characteristics of the analog output available with MOD H09.

Notes to Table 27:

[1] See the Control Circuit Elementary Diagrams in chapter 5.
[2] All terminals are rated 600 V, 30 A (Class 9080 Type GM6). Max. wire size for all terminals: 10 AWG (5.26 mm^2). Tightening Torque: 7–8 lb-in (0.8–0.9 N•m).
[3] Relay coil deenergizes on fault. Contacts are shown in fault mode.
[4] Contact state with drive controller deenergized.
[5] Total current of +24 V internal supply is 140 mA. If more current is required, an external supply must be used.
[6] 0–20 mA, X–Y programmable with keypad display.
[7] Available only when option is provided.
[8] Approximately 45 VA available when all mods selected except L09 LONWORKS. 26 VA when LONWORKS selected.
[9] Approximately 58 VA available when all mods selected except L09 LONWORKS. 38 VA when LONWORKS selected.

Table 27: Terminal Block Characteristics

Terminal[1] [2]	Function	Characteristics
A	+24 V (+24 V control supply)	Minimum: 20 V; Maximum: 30 V; I = 140 mA maximum[5]
B	LI3 (Logic Input 3) programmed for reference switching Auto/Manual	24 Vdc, 10 mA State 0: V<5 V; State 1: V>11 V; Z = 3.5 kΩ
C	LI4 (Logic Input 4) programmed for fault reset. Communication option programmed for forced local.	24 Vdc, 10 mA State 0: V<5 V; State 1: V>11 V; Z = 3.5 kΩ
D	LI2 (Logic Input 2) programmed for Freewheel Stop on bypass. Without bypass not assigned.	24 Vdc, 10 mA State 0: V<5 V; State 1: V>11 V; Z = 3.5 kΩ
E F	Line contactor auxiliary contact or jumper LI1 (Logic Input 1) Run Forward	24 Vdc, 10 mA State 0: V<5 V; State 1: V>11 V; Z = 3.5 kΩ
G1, S2+	AI2 (Analog Input 2: Speed Reference Current)	4-20 mA[6], Z = 100 Ω
G2, S2–	Factory jumpered to G1, S2+ terminal unless 0–10 V Auto speed reference option selected. See Table 26 on page 51.	
H	+10 V Reference Supply	10 V, I = 10 mA maximum
I	AI1 (Analog Input 1: Speed Reference Voltage)	0–10 V, Z = 30 kΩ
J, S3	COM (Speed Reference Common)	0 V
S1	Shield	
1 2	Fire/Freezestat Interlocks	Provision for user-supplied, N.C. fire/freezestat contact.
2	Control Transformer (Ungrounded)	115 Vac, 60 Hz, [100 VA Type 1, 12K[8] 350 VA Type 3R[9]]
2 3	Smoke Purge Relay Contact[7]	Normally-jumpered or N.C. SPR contact when option is supplied.
3 4	AFC Select[7]	Supplied with bypass circuit
3 5	Bypass Select[7]	Supplied with bypass circuit
6 7	Auto Enabled	User-supplied auto start contact (run permissive)
6A 8	Stop push button[7]	
6 8	Start push button and Interlock[7]	
9	AFC Fault Pilot Light[7]	
10A	Auto Pilot Light[7]	
10	AFC Run Pilot Light[7]	
11	Line Contactor Coil[7]	
12 13	Normal Contact of Test-Normal Switch[7]	
14 -15	Bypass Pilot Light[7]	
 16 17 18	AFC Run Contacts [4] Auxiliary N.C. Contact (AFC Run) COM Auxiliary N.O. Contact (AFC Run)	Minimum: 10 mA, 24 Vdc; Maximum: inductive load of: • 2.0 A @ 120 Vac; maximum 0.10 J/operation, 80 operations/minute • 1.0 A @ 220 Vac; maximum 0.25 J/operation, 25 operations/minute • 2.0 A @ 24 Vac; maximum 0.10 J/operation, 80 operations/minute

Notes to Table 27:

[1] See the Control Circuit Elementary Diagrams in chapter 5.
[2] All terminals are rated 600 V, 30 A (Class 9080 Type GM6). Max. wire size for all terminals: 10 AWG (5.26 mm^2). Tightening Torque: 7–8 lb-in (0.8–0.9 N•m).
[3] Relay coil deenergizes on fault. Contacts are shown in fault mode.
[4] Contact state with drive controller deenergized.
[5] Total current of +24 V internal supply is 140 mA. If more current is required, an external supply must be used.
[6] 0–20 mA, X–Y programmable with keypad display.
[7] Available only when option is provided.
[8] Approximately 45 VA available when all mods selected except L09 LONWORKS. 26 VA when LONWORKS selected.
[9] Approximately 58 VA available when all mods selected except L09 LONWORKS. 38 VA when LONWORKS selected.

Table 27: Terminal Block Characteristics (Continued)

Terminal[1] [2]	Function	Characteristics
 19 20 21	AFC Fault Contacts[3] Auxiliary N.C. Contact (AFC Fault) COM Auxiliary N.O. Contact (AFC Fault)	Minimum: 10 mA, 24 Vdc; Maximum: Inductive load of: • 2.0 A @ 120 Vac; maximum 0.10 J/operation, 80 operations/minute • 1.0 A @ 220 Vac; maximum 0.25 J/operation, 25 operations/minute • 2.0 A @ 24 Vac; maximum 0.10 J/operation, 80 operations/minute
22 23	120 Vac Smoke Purge Relay coil[7]	115–120 Vac/60 Hz supply (user supplied)
24	Control Transformer (Grounded)	115 Vac, 60 Hz

INITIAL START-UP PROCEDURE

⚠ DANGER

HAZARDOUS VOLTAGE

Before working on this equipment, turn off all power supplying it and perform the bus voltage measurement procedure on page 40.

Failure to follow this instruction will result in death or serious injury.

Locked (left)	Partial Unlock (center)	Total Unlock (right)
0	1	2

Keypad Access Switch

⚠ DANGER

HAZARDOUS VOLTAGE

- Properly ground the controller panel before applying power.
- Close and secure the enclosure door before applying power.
- Certain adjustments and test procedures require that power be applied to this controller. Extreme caution must be exercised as hazardous voltages exist. The enclosure door must be closed and secured while turning on power or starting and stopping this controller.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

ELECTRIC SHOCK, BURN, OR EXPLOSION

- This equipment must be installed and serviced only by qualified personnel.
- Qualified personnel performing diagnostics or troubleshooting requiring electrical conductors to be energized, must comply with NFPA 70 E - Standard for Electrical Safety Requirements for Employee Workplaces and OSHA Standards – 29 CFR Part 1910 Subpart S Electrical.

Failure to follow this instruction will result in death or serious injury.

The Class 8839 ECONOFLEX drive controller has been configured for the installed options and tested at the factory. Minor adjustments to complete the field installation may be required based upon the application requirements. This initial start-up procedure should be followed step by step. In case of difficulty, refer to Chapter 4, Troubleshooting and Maintenance, on page 74.

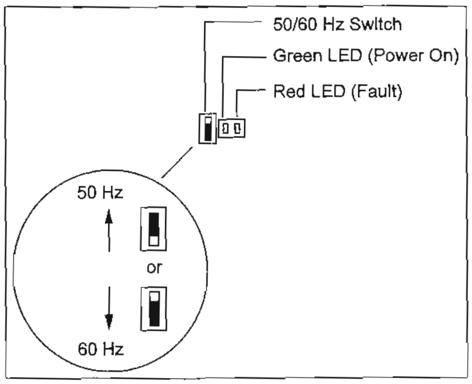
A door-mounted or remote-mounted keypad must be used to perform the initial start-up procedure. The keypad must be in the Total Unlock position to perform any drive controller programming. On Type 1 and 12K enclosures, the keypad access switch is accessible through the back of the enclosure door. Type 3R enclosures include a keypad cable and keypad located inside the enclosure. To set the keypad to Total Unlock, move the switch all the way to the right. To lock the keypad after programming, move the switch all the way to the left. Refer to the diagram at left for switch positions.

To perform any programming on the Type 3R Enclosure:

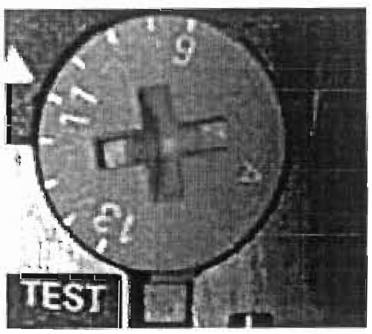
1. **Remove all power.**
2. Open the door of the drive controller. Refer to step 1 on page 30.
3. Remove the keypad and cable from the cloth bag.
4. Connect the keypad cable to the power converter and keypad. The 9-pin male D-shell plugs into the power converter, the female D-shell plugs into the keypad.
5. Place the keypad cable outside the enclosure by positioning the cable in the bottom left corner between the hinge and bottom of the door.
6. Close and secure the enclosure door.
7. Close the equipment disconnect means.
8. Perform programming on keypad.
9. When programming is completed. **Remove all power.**
10. Open enclosure door.
11. Remove keypad cable from power converter.
12. Place keypad and cable inside cloth bag.
13. Close and secure the enclosure door.

After replacing the power converter or installing any plug-in option card, the programming parameters must be set as listed in the elementary diagram that corresponds to the options ordered. See pages 90–94.

In addition, after installing any plug-in option card for the first time, previously-saved parameters downloaded from the keypad or PC software will not be correct because they do not include the additional parameters available with



50/60 Hz Switch
(See Figs. 10–13
for switch location)



Overload Relay Dial

The LR2-D1516 overload relay is shown. Your dial setting range may be different.

the card. The analog card parameters must be set as listed in the elementary diagram that corresponds to the options ordered. See pages 90–94.

With all incoming power removed, make the following equipment checks:

a. Verify that all equipment disconnects are open.
b. Set the Hand-Off-Auto selector switch (controller mounted or remote mounted) to Off and the AFC-Off-Bypass switch (if used) to Off.
c. Set the speed potentiometer (controller mounted or remote mounted) to its minimum setting (full counterclockwise position).
d. Open the enclosure door. Refer to Step 1 on page 30.
e. Check the wiring of the input power ground, motor ground, speed potentiometer (if remote mounted), and Hand-Off-Auto circuit connections (if remote mounted). See the control circuit elementary diagrams in chapter 5, and the power circuit descriptions starting on page 62, for wiring diagrams of the remote control operators.
f. When using the bypass circuit, check that the motor conductors are wired to the T1, T2, and T3 terminals of the overload relay. When using the power circuit *without* bypass, check the motor conductors wired to U, V, and W on the J2 terminal block of the power converter.
g. If the controller includes a bypass option for running the motor across the line, set the overload relay dial (on the load side of the bypass contactor) to the full load ampere rating on the nameplate of the connected motor. See example at left.
h. Using a voltmeter set at the 1000 Vac scale, verify that the incoming line voltage at the line side of the disconnecting means is within ± 10% of the input voltage rating on the controller nameplate.
i. The 50/60 Hz switch, on the power converter control board, is factory set to 60 Hz. Check the switch before operating the drive controller to ensure that it is set to 60 Hz. See the diagram at left.
j. Close and secure the enclosure door. Close the equipment disconnect means. The Power On pilot light (if used) illuminates.

⚠ CAUTION

MOTOR HEATING HAZARD

This drive controller does not provide direct thermal protection for the motor. Use of a thermal sensor in the motor may be required for protection at all speeds or load conditions. Consult the motor manufacturer for the thermal capability of motor when it is operated over desired speed range.

Failure to follow this instruction can result in injury or equipment damage.

k. Press the ESC key on the keypad. Scroll with the down arrow key to Menu 2–Adjust (SEt), press the ENT key, then scroll with the down key to ThermCurrent–A (ItH) and press ENT. Use the up/down arrow keys to enter the motor nameplate full load amperes, then press ENT and ESC. The controller is now calibrated to provide motor overload protection.

   Refer to instruction bulletin VVDED397047US, *ALTIVAR 58 Adjustable Speed Drive Controllers Keypad Display VW3A58101.*

NOTE: The settings listed in this procedure are suitable for most applications. If your application requires different operating characteristics, refer to instruction bulletin VVDED397047US, ALTIVAR 58 Adjustable Speed Drive Controllers Keypad Display VW3A58101 *for more information.*

⚠ WARNING

HAZARD OF MACHINE ENTANGLEMENT

Before starting the drive controller, ensure that the motor and its connected load are clear from personnel and are ready to run.

Failure to follow this instruction can result in death or serious injury.

l. Set the AFC-Off-Bypass selector switch (if used) to AFC, the Normal-Test selector switch (if used) to Normal, and Hand-Off-Auto selector switch to Hand (push Start if the Start/Stop push buttons are used). Slowly turn the speed potentiometer clockwise to accelerate the motor. Check the direction of motor rotation. If correct, proceed to step p. If incorrect, stop the drive. **Remove all power!**

⚠ DANGER

HAZARDOUS VOLTAGE

Turn off all power supplying this equipment and perform the bus voltage measurement procedure on page 40 before proceeding.

Failure to follow this instruction will result in death or serious injury.

m. Correct the direction of motor rotation by reversing any two motor leads located on terminals T1, T2, or T3 for a drive controller with bypass; or U, V, or W for a drive controller without bypass.

n. Reset the speed potentiometer to minimum speed (fully counterclockwise). Close and secure the enclosure door, then reapply power and restart the controller.

o. Slowly turn the speed potentiometer clockwise to accelerate the motor. Check the direction of motor rotation. If correct, this completes the controller mode, motor rotation check.

p. Set the AFC-Off-Bypass selector switch (if used) to Off, leaving the Hand-Off-Auto selector switch in the Hand position.

q. Momentarily set the AFC-Off-Bypass selector switch to Bypass to check the direction of motor rotation, then return it immediately to the Off position. If the direction of motor rotation is correct, proceed to step t. If incorrect, stop the drive controller. **Remove all power!**

Note: If the controller circuit breaker trips during this test, a higher trip setting may be required. Refer to "Circuit Breaker Trip Adjustment Procedure" on page 57.

⚠ DANGER

HAZARDOUS VOLTAGE

Turn off all power supplying this equipment and perform the bus voltage measurement procedure on page 40 before proceeding.

Failure to follow this instruction will result in death or serious injury.

r. Correct the direction of motor rotation by reversing any two incoming leads to the circuit breaker disconnect means marked L1, L2, or L3.

s. Momentarily set the AFC-Off-Bypass selector switch to Bypass to check the direction of motor rotation, then return it immediately to the Off position. If correct, this completes the bypass mode, motor rotation check.

t. Check the High Speed (HSP) setting (maximum motor speed setting). Press the ESC key on the keypad. Scroll with the down arrow key to Menu 2–Adjust (SEt), press the ENT key, then scroll with the down key to parameter High Speed–Hz and press ENT. Use the up/down arrow keys to enter the maximum output frequency required for the application (factory default is 60 Hz), then press ENT and ESC. The controller HSP setting is now complete.

   Refer to instruction bulletin VVDED397047US, *ALTIVAR 58 Adjustable Speed Drive Controllers Keypad Display VW3A58101.*

u. Check the Low Speed (LSP) setting (minimum motor speed setting). Press the ESC key on the keypad. Scroll with the down arrow key to Menu 2–Adjust (SEt), press the ENT key, then scroll with the down key to parameter Low Speed–Hz and press ENT. Use the up/down arrow keys to enter the minimum output frequency required for the application (factory default is 3 Hz), then press ENT and ESC. The controller LSP setting is now complete.

   Refer to instruction bulletin VVDED397047US, *ALTIVAR 58 Adjustable Speed Drive Controllers Keypad Display VW3A58101.*

v. The application may require changing the setting of acceleration (ACC) and deceleration (dEC) times. Factory default is 10 seconds. To change the setting, press the ESC key. Scroll with the down arrow to Menu 2–Adjust, press ENT, then scroll with the down key to parameter Acceleration-s and Deceleration-s. Use the up/down arrows to enter in seconds the time required for the application, then press ENT and ESC. The controller acceleration and deceleration time setting is now complete.

Circuit Breaker Trip Adjustment Procedure

Use the following equation to calculate the circuit breaker dial setting. For the Type GJL breakers see Tables 28–30.

$$\text{Dial Setting} = \frac{\text{Motor FLA} \times \text{Multiplication Factor}}{\text{Breaker Rating}}$$

Read the motor FLA from the motor nameplate and read the breaker rating from Tables 28–30. The multiplication factor is derived from NEC Table 430-152. For Type FAL and KAL circuit breakers, set the breaker dial according to the magnetic trip setting shown on the breaker nameplate. See Tables 31–33. For example, to calculate the dial factory setting of a 7.5 hp, 460 V motor:

$$4 = \frac{11 \times 11}{30}$$

In this example, the arrow on the circuit breaker dial should be turned to 4X.

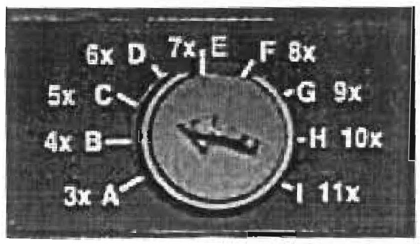


Figure 18: Circuit Breaker Trip Adjustment Dial

Notes to Tables:

[1] Factory setting is 11 times the motor FLA (multiplication factor = 11).
[2] Maximum trip setting is 13 times the motor FLA (multiplication factor = 13).

Table 28: 460 V GJL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Breaker Rating	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
1	GJL36007M02	007	3.3X	3.9X
2	GJL36007M02	007	5.3X	6.3X
3	GJL36015M03	015	3.5X	4.2X
5	GJL36030M04	030	3X	3.3X
7.5	GJL36030M04	030	4X	4.8X
10	GJL36030M04	030	5.1X	6.1X
15	GJL36050M05	050	4.6X	5.5X
20	GJL36050M05	050	6X	7.0X
25	GJL36075M06	075	5X	5.9X
30	GJL36075M06	075	5.9X	6.9X

Table 29: 230 V GJL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Breaker Rating	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
1	GJL36015M03	015	3.1X	3.7X
2	GJL36015M03	015	5X	5.9X
3	GJL36030M04	030	3.5X	4.2X
5	GJL36050M05	050	3.4X	4X
7.5	GJL36050M05	050	4.9X	5.7X
10	GJL36075M06	075	4.1X	4.9X
15	GJL36075M06	075	6.2X	7.3X
20	GJL36075M06	075	7.9X	9.4X

Notes to Tables:

[1] Factory setting is 11 times the motor FLA (multiplication factor = 11).
[2] Maximum trip setting is 13 times the motor FLA (multiplication factor = 13).

Table 30: 208 V GJL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Breaker Rating	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
1	GJL36015M03	015	3.4X	4X
2	GJL36030M04	030	3X	3.3X
3	GJL36030M04	030	3.9X	4.6X
5	GJL36050M05	050	3.7X	4.4X
7.5	GJL36050M05	050	5.3X	6.3X
10	GJL36075M06	075	4.5X	5.4X
15	GJL36075M06	075	6.8X	8X

Table 31: 460 V FAL and KAL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Max. Input Current	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
40	FAL36100-18M	54.5	600	709
50	FAL36100-18M	67	737	871
60	KAL36250-25M	82.8	911	1076
75	KAL36250-26M	100.5	1106	1307
100	KAL36250-29M	129.3	1422	1681

Table 32: 230 V FAL and KAL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Max. Input Current	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
25	FAL36100-18M	68	748	884
30	KAL36250-25M	80	880	1040
40	KAL36250-26M	104	1144	1352
50	KAL36250-29M	130	1430	1690

Table 33: 208 V FAL and KAL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Max. Input Current	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
20	FAL36100-18M	59.4	653	772
25	FAL36100-18M	74.8	823	972
30	KAL36250-25M	88	968	1144
40	KAL36250-26M	114	1254	1482
50	KAL36250-30M	143	1573	1859

CHAPTER 4: TROUBLESHOOTING AND MAINTENANCE

INTRODUCTION

A number of diagnostic and status codes are included on the power converter. The keypad display provides visual indication of controller operating and protective circuit functions and indicator lights to assist in maintenance and troubleshooting. If the controller trips while operating, the codes must be viewed before power is removed because removing power resets the fault code.

NOTE: For controllers equipped with optional line contactor (MOD B09) the power is removed via the line contactor upon power converter fault trips.

EXTERNAL SIGNS OF DAMAGE

The following are examples of external signs of damage:

- Cracked, charred, or damaged covers or enclosure parts
- Damage to the keypad such as scratches, punctures, burn marks, chemical burns, or moisture in the screen
- Oil or electrolyte on the bottom of the drive controller which might have leaked from the capacitors inside
- Excessive surface temperatures of enclosures and conduits
- Damage to power or control conductors
- Unusual noise or odors from any of the equipment
- Abnormal temperature, humidity, or vibration

If any of the above signs are found while the equipment is powered up, immediately inform operating personnel and assess the risk of leaving the drive system powered up. Before removing power from the equipment, always consult with the operating personnel responsible for the machinery and process.

If troubleshooting indicates the necessity of component replacement, refer to "Field Replacement of The Power Converter" on page 78.

PREVENTIVE MAINTENANCE

Type 1 controllers in the 1–7.5 hp range at 460 V and 1–5 hp range at 208/230 V use convection cooling. All Type 12K controllers and Type 1 controllers for 10 hp and above at 460 V and 7.5 hp and above at 208/230 V use forced air cooling. All Type 3R controllers use ventilation cooling. Inspect the interior fans (if used) and exterior fans of the controller for blockage and impeded rotation. To prevent overheating and to allow proper air flow, maintain clearances shown on the enclosure outline drawings in this instruction bulletin.

To maintain the environmental rating of Type 12K or 3R enclosures, periodically inspect the enclosure gaskets for damage.

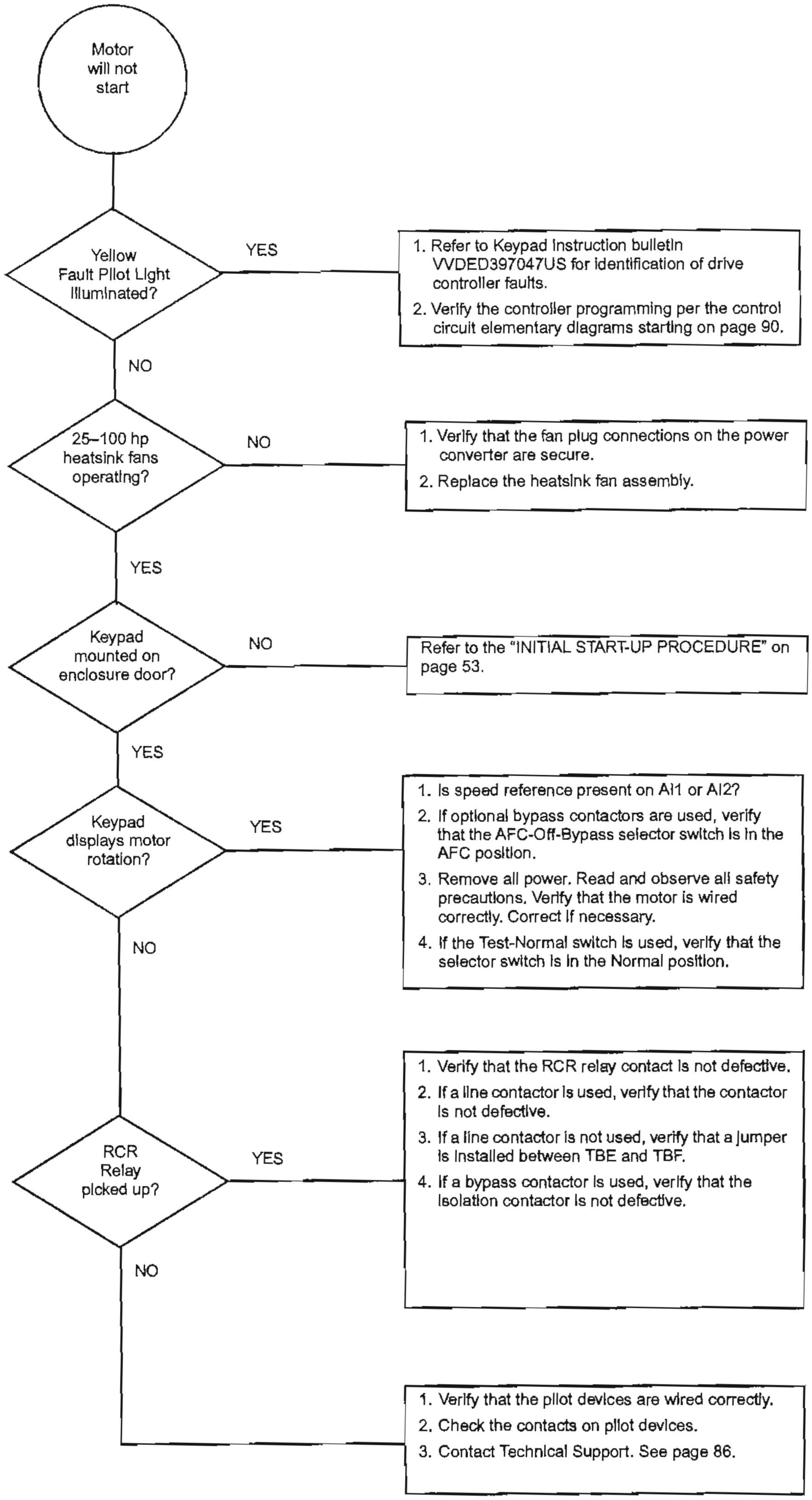
The keypad display is an integral part of the enclosure and must be installed on the door to maintain the environmental integrity of a Type 12K enclosure. It can be omitted when MOD D09 is selected and in that case a closing plate must be installed to maintain the Type 12K environmental rating.

TROUBLESHOOTING FLOW DIAGRAMS

The flow charts on pages 75 to 77 contain troubleshooting procedures for the following conditions:

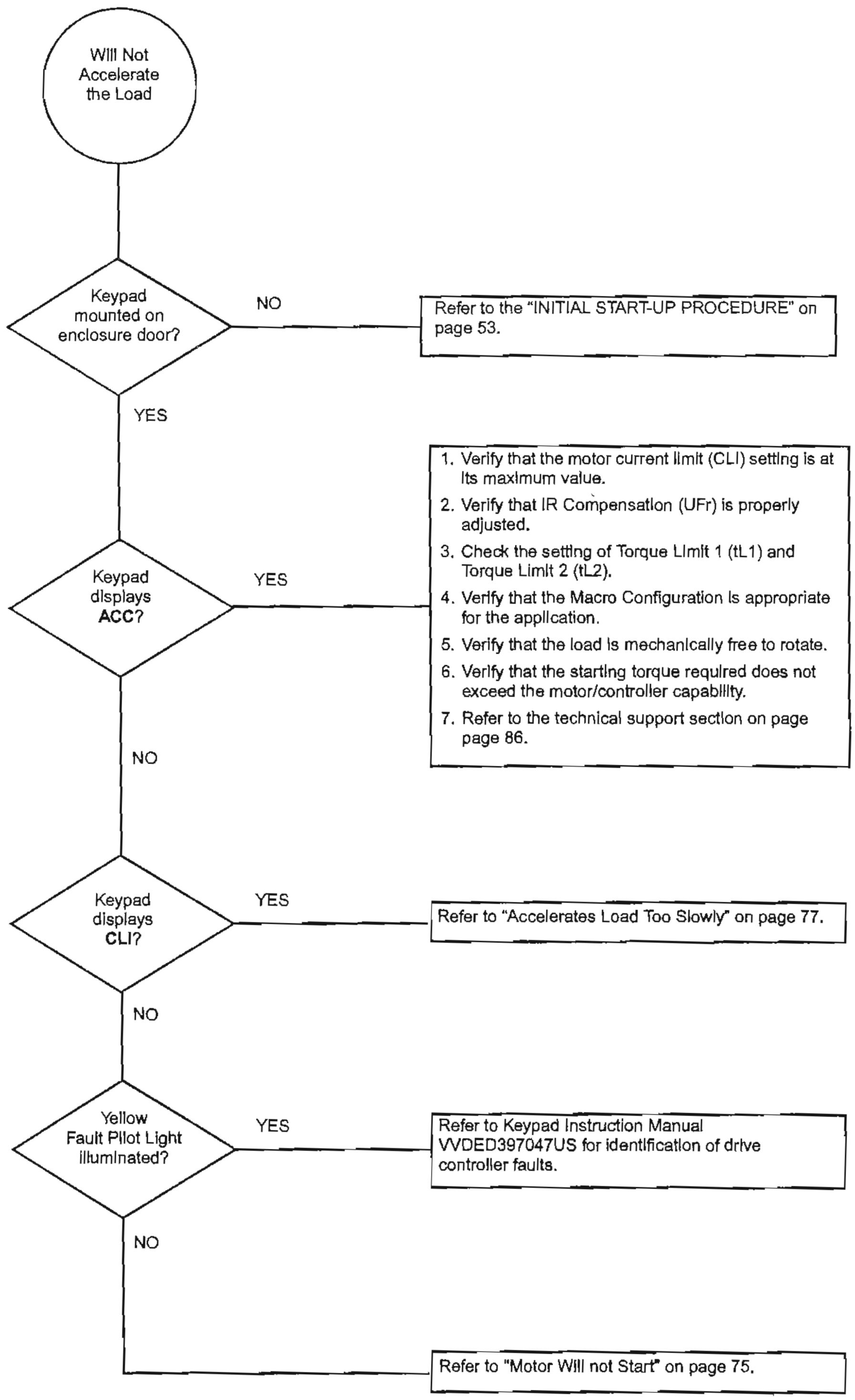
- Motor will not start (page 75)
- Will not accelerate the load (page 76)
- Accelerates the load too slowly (page 77)
- Excessive motor temperature (page 77)

Motor Will Not Start



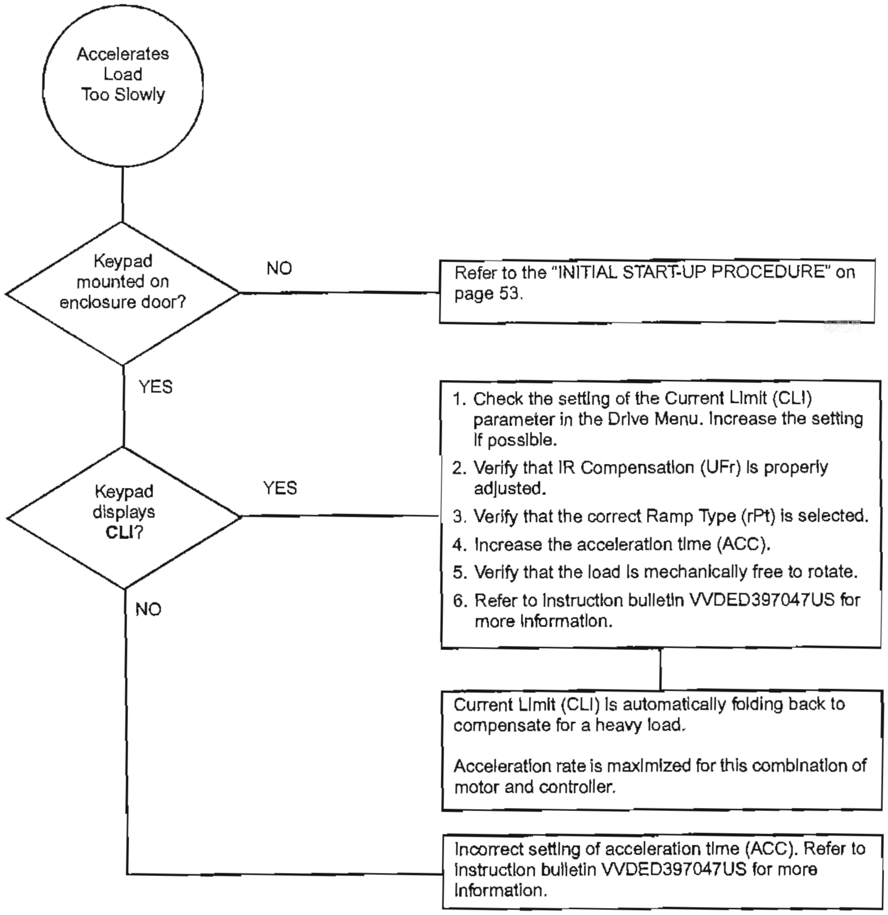
Will Not Accelerate The Load

NOTE: You must have a keypad for this procedure and the keypad must be in "Var. State". To set the keypad, press the ESC key, scroll up with the arrow to 1—Display menu (SUP), and press the ENT key. Then scroll up to Var. State (RDY) and press ENT.

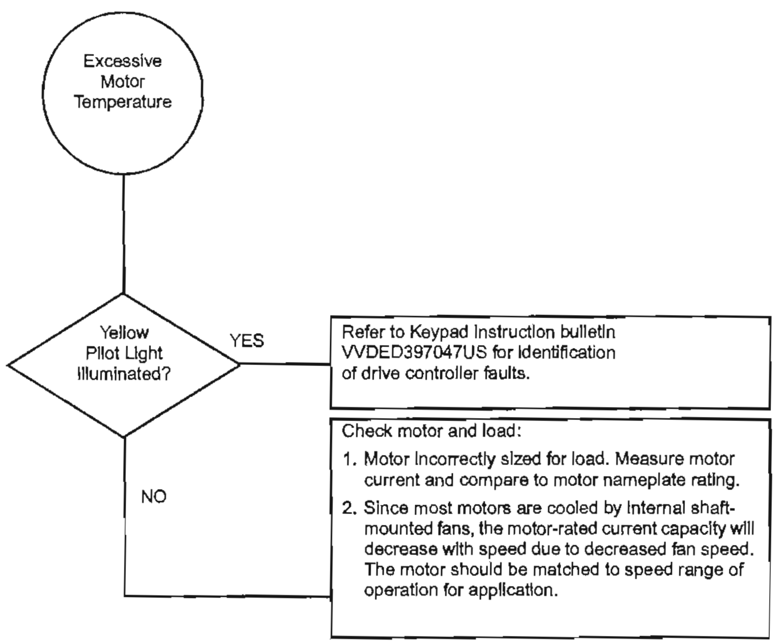


Accelerates The Load Too Slowly

NOTE: You must have a keypad for this procedure and the keypad must be in "Var. State". To set the keypad, press the ESC key, scroll up with the arrow to 1—Display menu (SUP), and press the ENT key. Then scroll up to Var. State (RDY) and press ENT.



Excessive Motor Temperature



FIELD REPLACEMENT OF THE POWER CONVERTER

If the power converter becomes inoperable in the ECONOFLEX controllers, it must be replaced. Refer to Table 34 for power converter weights.

Table 34: Power Converter Weights

HP		Weight	
460 V	208/230 V	lb	kg
1–7.5	1–5	20	9.1
10–25	7.5–10	30	13.6
30–50	15–25	70	31.7
60–100	30–50	122	55.3

Observe the lockout/tagout procedures as identified in OSHA Standard 29 CFR, Subpart J covering:

- 1910.147: The control of hazardous energy (lockout/tagout).
- 1910.147: App A, Typical minimal lockout procedures.

Removing the Power Converter Assembly

⚠ DANGER

HAZARDOUS VOLTAGE

- Disconnect all power.
- Place a "Do Not Turn On" label on the drive controller disconnect.
- Lock the disconnect in open position.
- Read and understand the bus voltage measurement procedure on page 40 before performing procedure. Measurement of bus capacitor voltage must be performed by qualified personnel.
- DO NOT short across DC bus capacitors or touch unshielded components or terminal strip screw connectors with voltage present.
- Many parts in the drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

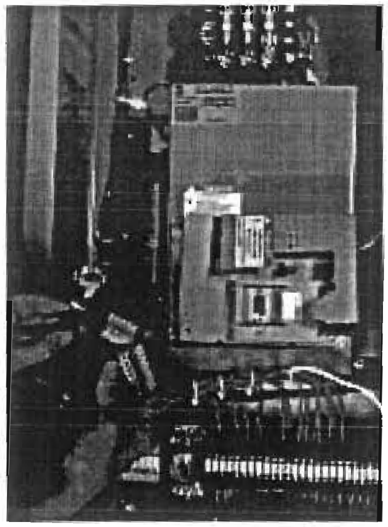
ELECTROSTATIC DISCHARGE

Do not subject this device to electrostatic discharge. This controller contains electronic components that are very susceptible to damage from electrostatic discharge.

Failure to follow this instruction can result in injury or equipment damage.

To replace the power converter, follow these steps:

1. Open the door of the drive controller. Refer to step 1 on page 30.
2. Measure the DC bus voltage as described on page 40 of this instruction bulletin.
3. Disconnect all power and control wiring from the power converter assembly. Identify each wire for ease of re-assembling the new power converter. See Figure 24.



Disconnect:

- The keypad cable
- Two MAC board plugs
- Six power wires
- The ground
- The shield
- The heatsink fan connections on 30–100 hp (460 V) or 15–50 hp (208/230 V)
- The analog card (if used)
- The Serial communication card (if used)
- The customer terminal block on the power converter (if used)
- The 3–15 PSI transducer (if used)
- The 0–10 V signal converter (if used)

Figure 24: Remove All Power and Control Wiring

4. For the 60-100 hp 460 V and 30-50 hp 208/230 V, it may be easier to remove the heatsink fan assembly before removing the power converter. Refer to the "FIELD REPLACEMENT OF HEATSINK FAN ASSEMBLY" on page 83 for directions.
5. Remove the outside hex-slot picture frame screws that secure the power converter to the enclosure back pan. Refer to Figures 14–17 starting on page 44 for screw locations. Refer to Table 35 for the number of screws on your controller. Keep the screws for the new power converter. See Figure 25.

Table 35: Number of Picture Frame Screws

HP		No. of Screws
460 V	208/230 V	
1–7.5	1–5	12
10–25	7.5–10	14
30–50	15–25	18
60–100	30–50	22

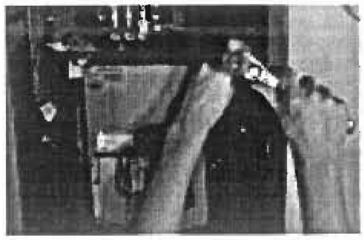


Figure 25: Remove Picture Frame Screws

6. Remove the power converter assembly from the enclosure. See Figure 26.

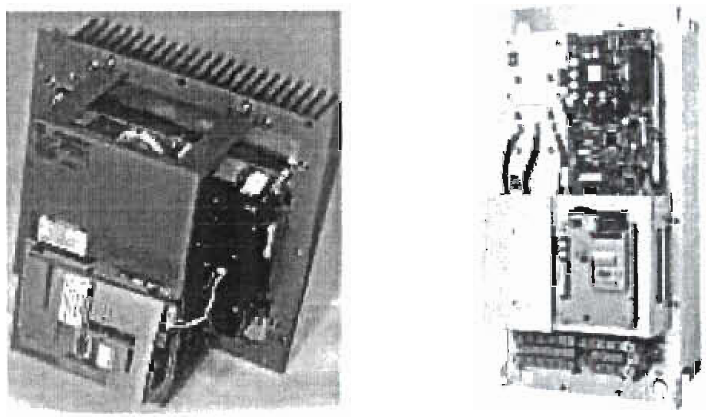
Figure 26: Remove Power Converter

7. Remove four 1/2" (33 mm) rubber sealing plugs from the corners of the Type 12K and 3R power converters (30–100 hp at 460 V and 15–50 hp at 208/230 V). Keep the plugs for the new power converter.

Installing the Power Converter Assembly

To install the new power converter, follow these steps:

1. Install the four 1/2" (13mm) rubber sealing plugs in the corners of the Type 12K and 3R power converters (30–100 hp at 460 V and 15–50 hp at 208/230 V). The plugs maintain the Type 12K enclosure rating.
2. Install the new power converter assembly in the enclosure. See Figures 26 and 27.



1–25 hp @ 460 V and 1–10 hp @ 208/230 V Typical

30–100 hp @ 460 V and 15–50 hp @ 208/230 V Typical

Figure 27: Install New Power Converter

3. Secure the power converter picture frame to the enclosure back pan with the picture frame screws from the removed power converter. Torque the screws to 15 ± 2 lb-in. (1.7 ± 0.2 N•m) See Figure 25 on page 80.
4. Install all power and control wiring to the power converter assembly terminal blocks. Install all other removed equipment. See Figure 24 on page 79. Tighten the hardware to the torque values given in the table below. Check all wiring connections for correct terminations and check the power wiring for grounds with an ohmmeter.

Terminal		Torque	
		lb-in	N•m
Ground (heatsink)		15	1.7
J2 Power Terminal Strip:			
460 V	58EC•4V_ to 58EG•4V_ (1–7.5 hp)	7.5	0.85
	58EH•4V_ to 58EL•4V_ (10–25 hp)	20	2.3
	58EM•4V_ to 58EP•4V_ (30–50 hp)	88	9.9
	58EQ•4V_ to 58ES•4V_ (60–100 hp)	170	19.2
230 V	58EC•3V_ to 58EF•3V_ (1–5 hp)	7.5	0.85
	58EG•3V_ to 58EH•3V_ (7.5–10 hp)	20	2.3
	58EJ•3V_ to 58EL•3V_ (15–25 hp)	88	9.9
	58EM•3V_ to 58EP•3V_ (30–50 hp)	170	19.2
208 V	58EC•2V_ to 58EF•2V_ (1–5 hp)	7.5	0.85
	58EG•2V_ to 58EH•2V_ (7.5–10 hp)	20	2.3
	58EJ•2V_ to 58EL•2V_ (15–25 hp)	88	9.9
	58EM•2V_ to 58EP•2V_ (30–50 hp)	170	19.2
S Shield Connection (power converter)		3.5	0.34
Analog output customer terminal block Din rail mounting screws (if used)		22	2.5

5. Shut the enclosure door, secure the door with door fasteners, and close the circuit breaker disconnect. See Figure 28.

Figure 28: Close and Secure the Door

⚠ DANGER

ELECTRIC SHOCK, BURN, OR EXPLOSION

- This equipment must be installed and serviced only by qualified personnel.
- Qualified personnel performing diagnostics or troubleshooting requiring electrical conductors to be energized, must comply with NFPA 70 E - Standard for Electrical Safety Requirements for Employee Workplaces and OSHA Standards – 29 CFR Part 1910 Subpart S Electrical.

Failure to follow this instruction will result in death or serious injury.

6. Program the drive controller according to the control circuit elementary diagrams in chapter 5. Follow the initial start-up procedure on page 53.

The drive controller is now ready to operate.

FIELD REPLACEMENT OF HEATSINK FAN ASSEMBLY

Removing the Heatsink Fan Assembly

NOTE: For the equipment required for this procedure, refer to the recommended spare parts list for the heatsink fan assembly part number.

If a heatsink fan becomes inoperable in the 10–100 hp 460 V or 7.5–50 hp 208/230 V controllers, the fan assembly must be replaced. Observe the lockout / tagout procedures as identified in OSHA Standard 29 CFR, Subpart J covering:

- 1910.147: The control of hazardous energy (lockout/tagout).
- 1910.147: App A, Typical minimal lockout procedures.

⚠ DANGER

HAZARDOUS VOLTAGE

- Disconnect all power.
- Place a "Do Not Turn On" label on the drive controller disconnect.
- Lock the disconnect in the open position.
- Read and understand the bus voltage measurement procedure on page 40 before performing procedure. Measurement of bus capacitor voltage must be performed by qualified personnel.
- DO NOT short across DC bus capacitors or touch unshielded components or terminal strip screw connectors with voltage present.
- Many parts in the drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

ELECTROSTATIC DISCHARGE

Do not subject this device to electrostatic discharge. This controller contains electronic components that are very susceptible to damage from electrostatic discharge.

Failure to follow this instruction can result in injury or equipment damage.

To replace the heatsink fan assembly, follow these steps:

1. Open the door of the drive controller. Refer to Step 1 on page 30.
2. Measure the DC bus voltage as described on page 40.
3. Locate the heatsink fan assembly above or below the power converter.

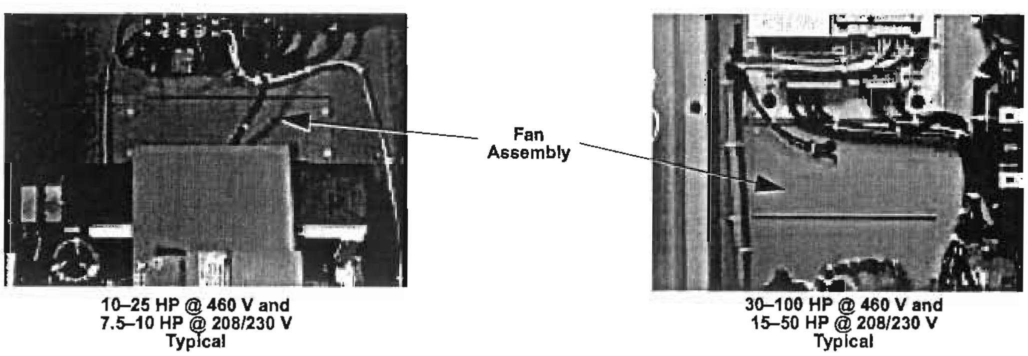
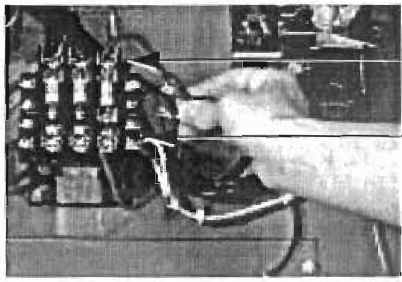
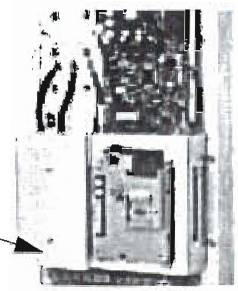


Figure 29: Heatsink Fan Assembly Location

4. For 10–25 hp controllers, disconnect the four fan wires connected to the control transformer. The 1/4" (6.35 mm) fast-on is connected to XF on the transformer fuse. The spade lug is connected to the X2 terminal on the transformer. See Figure 30. For 30–100 hp 460 V controllers and 20–50 hp 208/230 V controllers, disconnect the heatsink fan wire connectors.



10–25 HP @ 460 V and
7.5–10 HP @ 208/230 V
Typical



30–100 HP @ 460 V and
15–50 HP @ 208/230 V
Typical

Figure 30: Remove the Fan Wiring

5. Remove the four screws securing the heatsink fan assembly. Keep the four screws. See Figure 29.
6. Remove the heatsink fan assembly from the enclosure. For the 10–25 hp 460 V controllers and 7.5–10 hp 208/230 V controllers, lift the assembly up toward the top of the enclosure then pull it out. For 30 –100 hp 460 V controllers and 15–50 hp 208/230 V controllers, pull the assembly down toward the bottom of the enclosure then pull it out. See Figure 31.

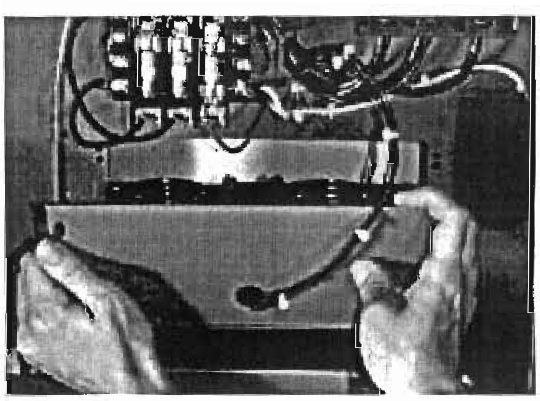


Figure 31: Remove the Heatsink Fan Assembly

Installing the Heatsink Fan Assembly

To install the new heatsink fan assembly, follow these steps:

1. Install the heatsink fan assembly. Secure the assembly with the four screws saved from step 5 above. Torque the screws to 15 lb-in (1.7 N•m). See Figure 29 and Figure 31.
2. For 10–25 hp 460 V controllers and 7.5–10 hp 208/230 V controllers, terminate the wire with the spade lug to X2 on the transformer. Torque the screw to 20–25 lb-in (2.3–2.8 N•m). Terminate the fast-on to XF on the transformer fuse. See Figure 30. Check all wiring connections for correct terminations. For 30 –100 hp controllers at 460 V and 15–50 hp controllers at 208/230 V, plug the DC fan connectors to the power converter.
3. Shut the enclosure door and secure it with door fasteners. Then close the circuit breaker disconnect.
4. The drive controller is now ready to operate.

NOTE: For 30–100 hp controllers at 460 V and 15–50 hp controllers at 208/230 V, when the heatsink fan connectors are not properly attached to the power converter, the power converter may cycle on and off or not function. If either of these occurs, check the heatsink fan connections.

FIELD REPLACEMENT OF THE STIRRING FANS

If a stirring fan inside the enclosure becomes inoperable in the ECONOFLEX controllers, the fan must be replaced.

Before removing the inoperable stirring fan, mark airflow direction to ensure proper installation of the replacement fan.

FIELD REPLACEMENT OF THE VENTILATION FAN ON TYPE 3R

If a Type 3R ventilation fan becomes inoperable in the ECONOFLEX controllers, the fan must be replaced.

Before removing the inoperable ventilation fan, mark airflow direction to ensure proper installation of the replacement fan.

FIELD REPLACEMENT OF THE SPACE HEATER ON TYPE 3R

If a Type 3R space heater becomes inoperable in the ECONOFLEX controllers, the space heater must be replaced. The thermostat is factory set at 60 °F (30 °C).

FIELD MAINTENANCE AND REPLACEMENT OF HOOD FILTERS ON TYPE 3R

The Type 3R ECONOFLEX filter material located on the bottom of the side hoods is washable. Remove, wash and install as required to maintain airflow.

The fan mounting bracket assembly must be removed first. This assembly is fastened to the hood by four screws. Then the fan can be removed from the bracket assembly by removing two mounting screws.

TECHNICAL SUPPORT

When troubleshooting the Class 8839 ECONOFLEX drive controller, discuss with operating personnel the symptoms of the reported problems. Ask them to describe the problem, when they first observed the problem, and where the problem was seen. Observe directly the drive system and process. Record the drive controller, motor and peripheral equipment nameplate data on the Class 8839 ECONOFLEX Trouble-shooting Sheet, a sample of which is shown on the next page. (You may copy this form as needed.)

For more information, call, fax, or write:

Square D AC Drives Technical Support Group
8001 Highway 64 East
Knightdale, NC 27545-9023

Telephone: 919-266-8600
Fax Line: 919-217-6508
E-mail: drivepsg@squared.com

INSTALLATION & OPERATION INSTRUCTIONS

GENERAL INFORMATION

1. Clean the lines of particles larger than 1/16" diameter (welding slag, pipe scale & other contaminants). Upstream installation of a 20 mesh strainer is recommended. Provisions should be made for keeping the water clean. See Maintenance section for more information.
2. For optimum operation, air entrapment in the fluid MUST be eliminated. The Manual Balancing valve must remain full of fluid during flow setting and system operation.
3. The operation of the valve is dependent on the characteristics of the flowing medium (fluid). Therefore it is important that when ordering a valve for a fluid other than 100% water, complete fluid specifications are included. See Fluids section for more information.

INSTALLATION

1. Manual Balancing Valves are factory assembled and marked with the Valve Cv on the body tag. ***The body tag is located on the handle.*** The Venturi is not field changeable.
2. Manual Balancing Valves are marked to show direction of flow. The union end is the inlet and the body end is the outlet. ***The flow arrow must point in the direction of flow for proper operation.***
3. Manual Balance Valve body size should match the pipe size it will be installed in. Valve Cv should be matched to the flow required. Reducing Fittings or bushings may be attached directly to control valve.
4. Griswold balancing valves may be installed in the pipe line either horizontally or vertically. Straight sections of pipe upstream and downstream of the valves are not necessary for proper operation (1/2"–2" Only).

THREADED CONNECTIONS

1. Threaded connections are tapped with NPT threads. Seal connections per industry standards using approved pipe sealant. Torque should not exceed 75 foot pounds.
2. When installing threaded union end fittings, the fitting and union nut must be removed from the valve body. Slide the union nut over the pipe, then tighten the fitting to the pipe.

SWEAT CONNECTIONS

1. Sweat end connections will accept standard copper tubing per ASTM B88-71. Follow general directions and recommendations of the sweat fitting and tubing manufacturers when installing the valves.
2. Manual Balancing Valves are designed for soft solder only. Excessive heat (over 500°F) may damage Teflon seals. Manual Balancing Valves are to be soldered in the full closed position.
3. For Sweat end body connections, use of a heat sink (heat absorbing putty, wet rag, etc.) is highly recommended. Do not apply flame (heat) directly to the center of valve body or to the test ports as excessive heat can damage internal seals and cause leaks.
4. When installing sweat union end fittings, the fitting and union nut must be removed from the valve body. Slide the union nut over the pipe, then sweat the fitting to the pipe. Allow to cool to touch before assembling the union to the body to prevent heat damage to the o-ring seal.

UNION CONNECTIONS

1. The Union Nut connection is sealed using an o-ring. In normal use no other sealant is required. Tighten the union nut hand tight, hold body with a wrench to prevent it from twisting body connection and then tighten approximately an additional quarter turn.
2. Using silicon oil or grease lubricant at assembly helps protect the O-ring from damage by abrasion, pinching, or cutting. Do not use aerosol products or petroleum based lubricants. The lubricant should not excessively soften or harden.

FLANGED CONNECTIONS *(2-1/2"–18" Only)*

1. Assemble and then tighten the field furnished flanges to the Griswold QuickSet Valve. Then align and place the assembly to the mating field piping. Tack weld the field furnished flanges to the pipe. **WARNING: Do not finish welding the flanges to the pipe with the valve bolted between the flanges. This will result in serious heat damage to the valve seat.**
2. Remove the flange bolting and valve from between the field furnished flanges. Finish welding the field furnished flanges to the field furnished

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pipe and allow the flanges to cool completely before proceeding.

3. Next, reinstall the Griswold valve using field furnished approved gaskets between the Griswold valve flange and the field furnished pipe flange. Before tightening any bolts, on butterfly type valves, turn the disk of the butterfly to full open position. Center the valve and hand tighten all bolts. Slowly close the disk to check for adequate disk clearance. When properly aligned, return the disk to full open position and evenly cross-tighten all bolts. Make sure the disk opens and closes correctly.

GROOVED END CONNECTIONS (2-1/2"–18" Only)

Metering Station

1. This style valve is joined together by housing clamps and rubber gaskets, which are field furnished and installed.
2. Clean the end of the valve and pipe past the grooved section. Grease the pipe ends, valve ends and rubber gasket lips with cup grease, graphite paste or similar grease recommended by the housing clamp manufacturer.
3. Slip the rubber gasket over the pipe end of each joint. **Note:** In 10" and larger valve connections, turn the gasket inside out and slip it over the pipe ends. Roll the gasket back after bringing the valve into position.
4. Position the grooved end valve between the pipe ends and slide the gasket back into central spanning position. Smear grease on the outside of the gasket.
5. Put housing clamps over gasket – insert bolts and nuts. Tighten nuts evenly, using socket or other wrench (The best speed of assembly is obtained with brace or T-handle wrenches). Tighten so the housing clamps come together evenly. This avoids gasket pinching. When housing clamps meet metal-to-metal, further tightening of bolts in not necessary or desirable.
6. Pre-assemble large diameter multi-segment housing clamps loosely, and install them as half-housings. Take up evenly from top to bottom on alternate bolts.

QuickSet Valve

1. The flanged-to-grooved connection furnished on the outboard side of the butterfly valve must be unbolted. The field furnished pipe with a grooved end is installed inside the unbolted flange-to-groove connection with a field-furnished gasket and grease in the same manner as described above in the Metering Station. The connection must then be rebolted.

WELD END CONNECTIONS (2-1/2"–18" Only)

Metering Station

1. Clean the end of the valve and pipe where the weld will be made. Make up the assembly butting the connections together.
2. Tack weld the assembly together and observe fit. If everything fits satisfactorily, the final complete welds can be made.

Quickset Valve

1. Clean the end of the valve and pipe where the weld will be made. Make up the assembly butting the connections together.
2. Tack weld the assembly together and observe fit **WARNING: Do not finish welding the flanges to the pipe with the butterfly valve bolted between the flanges. This will result in serious heat damage to the rubber gaskets and valve seat.**
3. Remove the bolting and flange from between the flanges. Finish welding the piping together and allow flanges to cool completely before reinstalling and bolting the butterfly valve in its original position.

OPERATION

1. Manual Balancing Valve(s) are ordered by line size and Valve Cv. The Cv is the flow coefficient of the Valve. Flow rates are set by adjusting the ball valve until the differential pressure reading across the Venturi corresponds to the required flow (GPM). Use the flow graphs (1/2"–2": Form #F-4040; 2-1/2"–18": Form #F-4090)
2. Once the Valve(s) has been installed and the system has been filled and purged, each valve loop must be set to the correct flow setting. Multiple passes are generally required to get the system in balance as the adjustment of each new valve affects the pressure drop (and flow) through the previously adjusted valves.
3. A meter kit can be purchased from Griswold Controls to take the differential pressure readings. The kit consists of either a 0-100" or 0-300" water column test gauge with the appropriate control

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valves, hoses and fittings. See Griswold Form F-4086B for more information on the Meter Kit.

4. Griswold offers a set of Transparent Overlays for use with a 6" test gauge (meter kit) scaled for 0-100" or 0-300" water column. These overlays allow the gauge to be read directly in GPM (gallons per minute) for each of the valves. See Griswold Form F-4045 for more information.
5. When all valves in the system have been correctly adjusted, the locking Memory Stop should be set to prevent changes in flow rate. To set the memory stop, loosen the handle hex bolt, rotate the memory stop against the valve body boss, and retighten the handle bolt.
6. The memory stop will allow the valve to be used for isolation (full closed) and then be reopened to the preset flow position.

FLUIDS

1. The operation of the Manual Balancing Valve is dependent on the characteristics of the flowing medium (fluid). Therefore it is important that when ordering and setting a valve for a fluid other than 100% water, complete fluid specifications are known. Flow rates must be corrected for the changes the fluid medium creates.

2. ***Specific Gravity***

   Specific gravity is the most important attribute of a liquid used in a Manual Balancing Valve. Correction will need to be made for any fluid with a specific gravity other than 1.0 (100% water). The specific gravities of fluids change as fluid temperature changes. Please consult Griswold for conversion.

3. ***Viscosity & Temperature***

   The viscosity of a fluid is mainly dependent on the fluid temperature. For fluids such as water, the viscosity change with temperature is negligible. In other fluids, such as petroleum oils, the change with temperature is quite noticeable. Both viscosity and operating temperature must be specified and known for proper setting of the corrected flow rate. Please consult Griswold for conversion.

MAINTENANCE

If the system experiences large amounts of pipe scale due to poor water conditions, as is sometimes found in older or retrofit systems, provision should be made to keep the system clean. Proper water treatment is also recommended by the use of a Griswold Separator. ***If a Griswold Separator is not used for system cleaning, the Manual Balancing Valve should be inspected annually.***

INSULATION

Griswold recommends that the Manual Balancing valve be insulated. However, insulation shall not block access to the memory stop and P/T taps.

LIMITED WARRANTY

When you purchase from Griswold Controls, you trust us to provide you with innovative, quality products that satisfy your need for profitable growth. We work hard to earn your business, not to give you a hassle. If you are not completely satisfied with something you have purchased or provided, just tell us. We will make it right by repairing or replacing the product. We want your business and we guarantee you: no hassle!

Claims under this warranty will only be honored if written notice is given to Griswold immediately upon discovery of the defect. A Product shall not be deemed defective unless it fails to perform in accordance with Griswold's written specifications. Customer shall pay freight charges for return. Griswold shall pay freight charges for return shipment to customer.

All requests for return of Products and the handling of credit or replacement shall be made in accordance with Griswold's return policy in effect at time of return. Griswold's obligation to repair or replace defective Products shall not apply to any Product that has been (1) subjected to misuse, neglect, or accident, or (2) altered or repaired (other than Griswold) in such a manner as to affect adversely its performance, stability or reliability.

The foregoing warranty is in lieu of all other warranties expressed or implied, in fact or at law, including implied warranties of merchantability and fitness for particular purpose.

This is Griswold's sole and entire liability to anyone for any claim in connection with the Product(s). In no event shall Griswold be liable for incidental, special or consequential damages, loss of profits, or damages in any amount exceeding the cost for any Product(s) even if Griswold has been told in advance of the possibility of such damages.

Replaces form F-4030C

12/05
F-4030D

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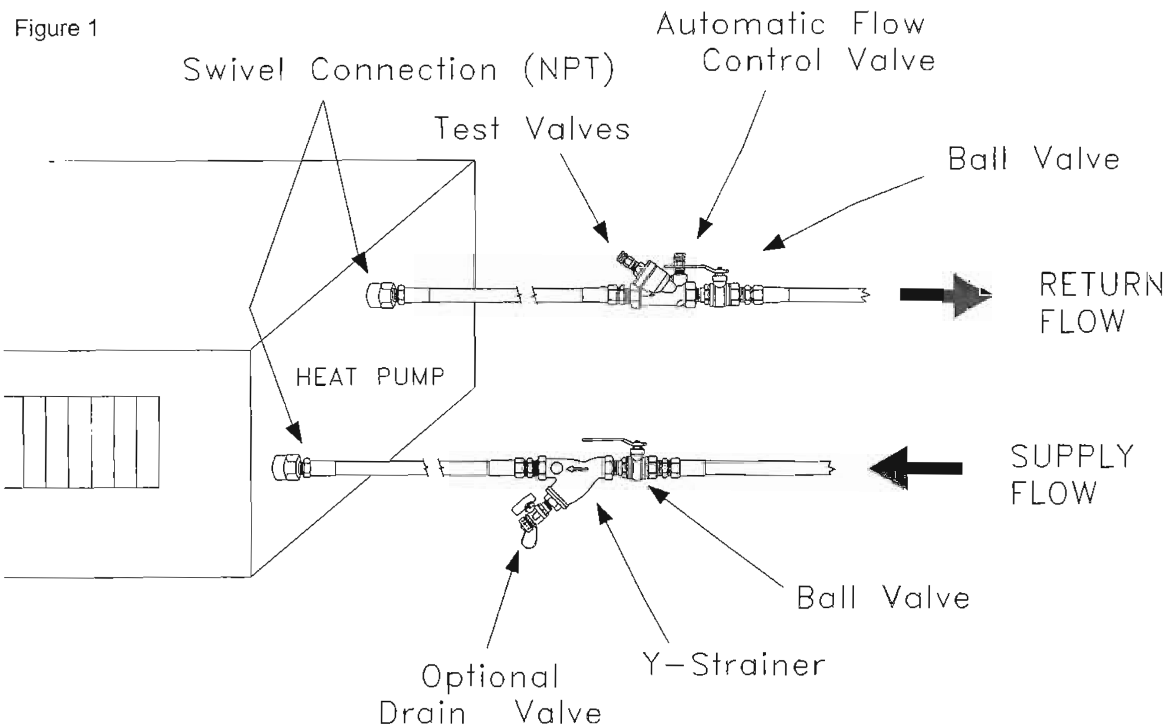
INSTALLATION & OPERATION INSTRUCTIONS

An Automatic Balancing Hose Kit is shown in Figure 1. It includes all the available components: a Flow Control Valve, two Flexible Hoses, a Y-Strainer, two Ball Valves, and a Pressure/Temperature test valve. The Ball Valve, Y-Strainer, and Pressure/Temperature Test Valve combination is installed on the supply side of the terminal unit, and the Flow Control Valve and Ball Valve combination is installed on the return side of the terminal unit.

Figure 1



CLEANING AND DRAINING THE SYSTEM

Prior to full system start-up, good installation practice requires that all lines be thoroughly cleaned to remove dirt and debris. To flush out the lines properly, Griswold Hose Kits can be modified (as shown in Figure 2) by "looping" the supply hose and return piping together, thus by-passing the terminal unit and Flow Control Valve. This simple procedure helps protect terminal units from contamination and insures you a smooth system operation right from the start.

PROCEDURE FOR "LOOPING" HOSES

1) Disassemble the return side Hose Kit assembly, but leave the Ball Valve assembled directly to the return pipe.

2) If you have a Y-Strainer, you may want to remove the internal screen from the strainer while flushing the system.

3) Loosen the supply side Hose Kit assembly from the terminal unit and "loop" it directly to the Ball Valve on the return side piping. (A coupling may be required depending on the ball valve connection type.)

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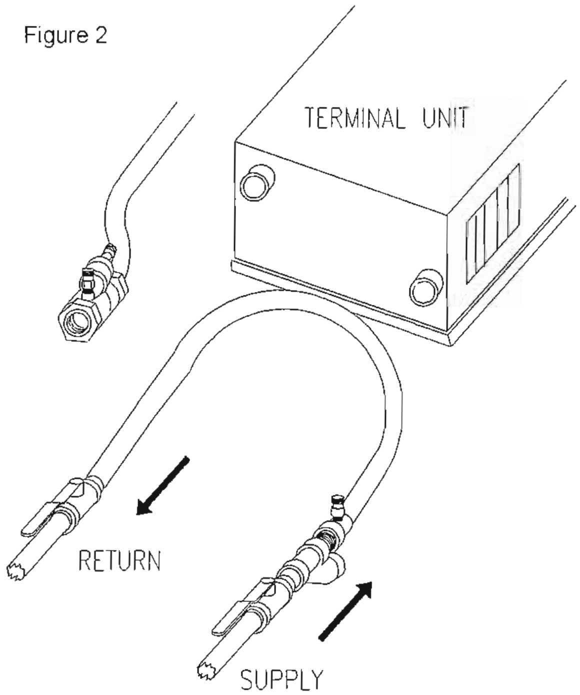
4) After all hoses have been "looped", start the pump to clean lines of particles larger than approximately 1/16" in diameter (i.e., weld splatter, mill scale, other contaminants) by flushing per equipment manufacturer's standards.

Figure 2



FINAL CONNECTIONS

1) Shut off both Ball Valves (handles should be at right angles to their bodies). If a Strainer and Drain Valve are installed, open the Drain Valve to remove water from the connecting hose.

2) Break the temporary "loop" and reinstall the Flow Control Valve and return side hose.

3) Connect both hoses to the terminal unit as shown in Figure #1. Swivel end connections are provided for ease of installation. Seal all connections with approved pipe compound or tape.

4) If a Strainer is used, reinstall the internal screen and rethread the cap securely.

5) Open both Ball Valves and re-fill the system with fluid.

6) Bleed any entrained air so that the Flow Control Valve will remain full of fluid during operation.

MAINTENANCE

If the system experiences large amounts of pipe scale due to poor water conditions (as sometimes found in older or retrofit projects), then installation of the optional Y-Strainer and an annual inspection of the system is recommended. Proper water treatment is also recommended.

PLEASE NOTE

The Griswold Automatic Flow Control Valves component of the Hose Kit is factory-assembled and individually calibrated. It is tamper-proof and does not require any field adjustments. Specified flow is within ±5% of design when properly installed.

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CARAVAN®

HOT WATER/OIL
APPLICATION GUIDE

WET-BASED CAST-IRON MODULAR BOILERS

Guidelines for the design, purchase and installation of Slant/Fin Caravan oil-fired and dual fuel hot water modular boiler systems.

CONTENTS

CODES AND STANDARDS

Oil-fired Caravan installations must comply to local codes or, in the absence of local codes, to the ANSI/NFPA 31, Installation of Oil Burning Equipment, latest edition.

In addition, where required by the authority having jurisdiction, the installation must conform to American Society of Mechanical Engineers Safety Codes for controls and safety devices for automatically fired boilers, No. CSD-1. The installation must also conform to the additional requirements of Slant/Fin Instruction Book publication no. L-40 latest edition.

All electrical wiring is to be done in accordance with the National Electrical Code ANSI/NFPA No. 70-latest edition and all local electrical codes. The unit must be electrically grounded if an external power source is used.

In Canada, the installation must be in accordance with standards CGA B149.1 and B149.2, installation codes for oil burning appliances and equipment and/or local codes. All electrical connections are to be made in accordance with Standard C.S.A. C22.1 Canadian Electrical Code Part 1 and/or local codes.

LOCAL CODE APPROVALS

New York City:

New York City Bar No. 51-58

Pennsylvania:

174-BT-S

INTRODUCTION OF FRESH WATER

Introduction of excessive amounts of fresh water into a system can cause scaling and leave deposits in the boiler and the surrounding pipes. This will lead to inefficient boiler operation and breakdown. Fresh water will enter the system as a result of hidden leaks such as may occur in underground piping. Relief valves should be piped to a location that shows visible signs of relief.

Process applications that use fresh water, require the use of heat exchangers. Any process application that results in introduction of fresh water into a boiler can cause scaling with deposits forming in the boiler and surrounding piping. This will damage the boiler. Introduction of fresh water from leaks will cause similar damage. Use of fresh water will void warranty.

In some areas it may be necessary to use a feed water treatment to control the corrosive makeup of the feed water. Check with the local authority, to determine if the feed water will need a conditioning treatment before being supplied to the boiler.

Slant/Fin®

Publication No. CG-10-HWO
Printed in the U.S.A. 1105
www.slantfin.com

INTRODUCTION

This Caravan application manual is intended to simplify the selection and application of Slant/Fin modular systems for a variety of space heating and domestic hot water requirements. Where any additional information is required, contract your local wholesaler, Slant/Fin sales representative, or the Slant/Fin factory.

A. Design flexibility - Caravan modular boiler systems are available in virtually any size capacity simply by adding modules.

B. Boiler room design, size and flexibility - since Caravan modules have the burner and controls mounted to the front, they can be installed with minimum clearances as per codes, thus saving a significant amount of floor space.

C. Faster, easier installation - modules are completely factory assembled, including individual jackets to save on-site labor. Optional easy to install supply and return headers with flexible quick connect fittings are available for hot water systems.

D. Safety - each module contains an individual high limit control and a flame safeguard control. ASME relief valve is provided separately for mounting directly on boiler.

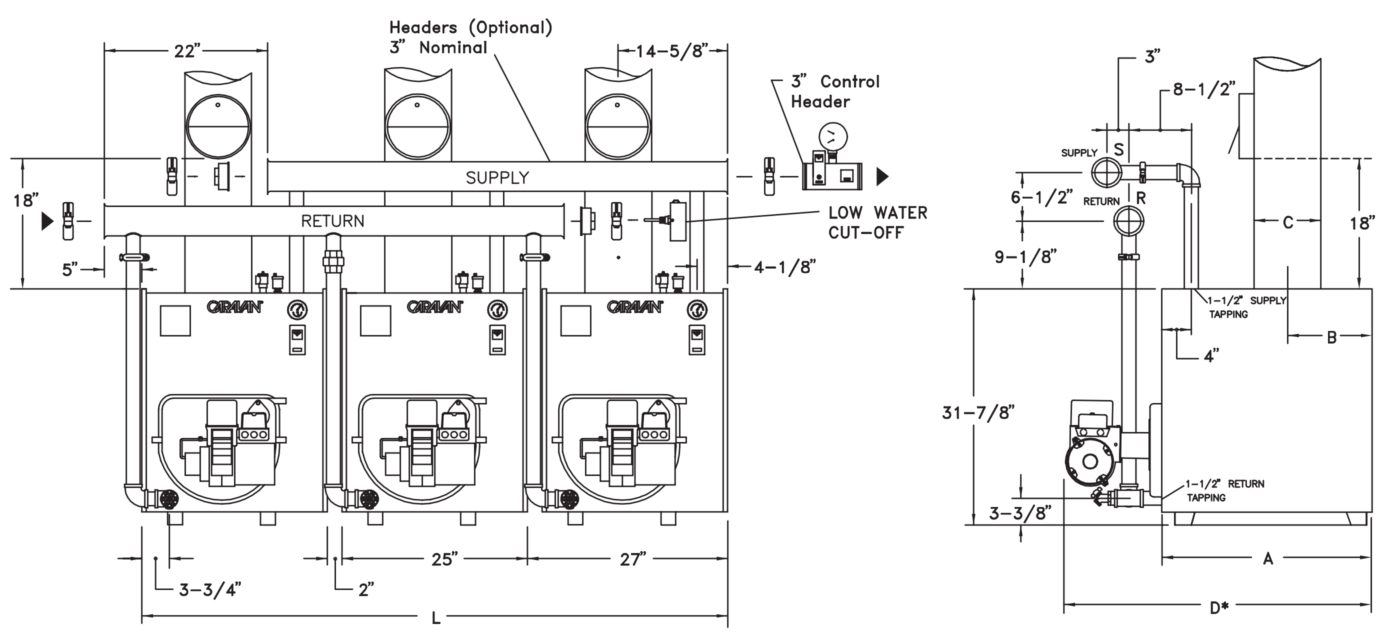
E. Fast domestic hot water recovery - Caravan offers an external heat exchanger of the positive circulating type.

Table 1: Oil Caravan ratings hot water models - LDWO Series (100 psi maximum working pressure)

Model No.	No. of Heating Modules	Firing Rate #2 Oil GPH*	Ratings (MBH) Input	Ratings (MBH) Gross Output	‡ EDR Water (Sq. Ft.)	I=B=R Net Ratings (MBH)†	Boiler Horsepower	Water Content (gal.)	Ship Wt.	Recommended Header Size§
LDWO-600-2-5	2	4.30	602	500	2900	435	14.9	31.0	1570	2"
LDWO-750-2-6	2	5.20	728	596	3453	518	17.8	35.6	1790	2"
LDWO-850-2-7	2	6.00	840	684	3967	595	20.4	45.2	2000	3"
LDWO-900-3-5	3	6.40	896	750	4347	652	22.4	46.5	2355	3"
LDWO-1100-3-6	3	7.80	1092	894	5180	777	26.7	53.4	2685	3"
LDWO-1300-3-7	3	9.00	1260	1026	5947	892	30.6	67.8	3000	3"
LDWO-1700-4-7	4	12.00	1680	1368	7933	1190	40.9	90.4	4000	3"
LDWO-2100-5-7	5	15.00	2100	1710	9913	1487	51.1	113.0	5000	3"
LDWO-2500-6-7	6	18.00	2520	2052	11893	1784	61.3	135.6	6000	3"
LDWO-2900-7-7	7	21.00	2940	2394	13880	2082	71.5	158.2	7000	4"
LDWO-3400-8-7	8	24.00	3360	2736	15860	2379	81.7	180.8	8000	4"

* Light oil, 140,000 Btuh per gallon.
† Net ratings are based on a piping and pick-up allowance of 1.15. Slant/Fin should be consulted before selecting a boiler for installation having unusual piping and pick-up requirements.
‡ Based on 150 Btuh per square foot E.D.R. at 170°F average water temperature.
§ Modules in excess of 8 are piped in parallel to first eight.

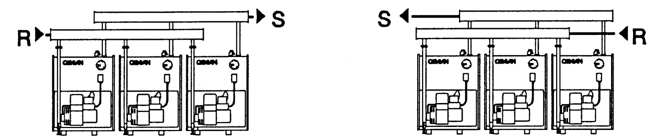
For larger sizes, use multiples of the above.



Model No. ‡	A	B	C	D †	L *
LDWO-600-2-5	21⅝	8 7/32	8	34⅜	4'4"
LDWO-750-2-6	25	9 29/32	8	37¾	4'4"
LDWO-850-2-7	28⅜	11 19/32	9	41⅛	4'4"
LDWO-900-3-5	21⅝	8 7/32	8	34⅜	6'7"
LDWO-1100-3-6	25	9 29/32	8	37¾	6'7"
LDWO-1300-3-7	28⅜	11 19/32	9	41⅛	6'7"
LDWO-1700-4-7	28⅜	11 19/32	9	41⅛	8'10"
LDWO-2100-5-7	28⅜	11 19/32	9	41⅛	11'1"
LDWO-2500-6-7	28⅜	11 19/32	9	41⅛	13'4"
LDWO-2900-7-7	28⅜	11 19/32	9	41⅛	15'7"
LDWO-3400-8-7	28⅜	11 19/32	9	41⅛	17'10"

Note: Standard boiler unit prefix is LDWO.

SYSTEM PIPING, CONNECTION DIAGRAMS



* 27" spacing between modules.
† Add 15¼" for dual fuel models.
‡ Dual fuel prefix is LWDF.

Figure 1. Oil Caravan dimensions and typical piping/hot water models

Design Data

Max. ASME Working Pressure: 100 psi
Power Requirements: 120 V/60 HZ,
Amp (s) per module:
For Carlin burners 6.0

Table 2. Dual Fuel Caravan Ratings Hot Water Models - LWDF Series (100 psi maximum working pressure)

Model No.	No. of Htg. Mod.	Fuel	Firing Rate CCFH GPH	Ratings: Input (MBH)	Ratings: Gross Output (MBH)	Ratings: ‡ EDR Water (Sq. Ft.)	Ratings: I=B=R Net (MBH)†	Ratings: Horse-power	Water Content (gal.)	Ship Wt.	Recom-mended Header Size§
LWDF-600-2-5	2	Gas Oil	620 4.30*	620 602	500	2900	435	14.9	31.0	1650	2"
LWDF-750-2-6	2	Gas Oil	750 5.20*	750 728	592	3433	515	17.7	35.6	1870	2"
LWDF-850-2-7	2	Gas Oil	798 6.00*	798 840	620 674	3607 3907	540 586	18.6 20.1	40.4	2080	3"
LWDF-900-3-5	3	Gas Oil	930 6.40*	930 896	750	4347	652	22.4	46.5	2475	3"
LWDF-1100-3-6	3	Gas Oil	1125 7.80*	1125 1092	888	5147	772	26.5	53.4	2805	3"
LWDF-1300-3-7	3	Gas Oil	1197 9.00*	1197 1260	930 1011	5407 5860	810 879	27.9 30.2	60.6	3120	3"
LWDF-1700-4-7	4	Gas Oil	1596 12.00*	1596 1680	1240 1348	7213 7813	1080 1172	37.2 40.3	80.8	4160	3"
LWDF-2100-5-7	5	Gas Oil	1995 15.00*	1995 2100	1550 1685	9013 9767	1350 1465	46.4 50.3	101.0	5200	3"
LWDF-2500-6-7	6	Gas Oil	2394 18.00	2394 2520	1860 2022	10820 11720	1620 1758	55.7 60.4	121.2	6240	3"
LWDF-2900-7-7	7	Gas Oil	2793 21.00*	2793 2940	2170 2359	12620 13673	1890 2051	65.0 70.5	141.4	7280	4"
LWDF-3400-8-7	8	Gas Oil	3192 24.00*	3192 3360	2480 2696	14420 15627	2160 2344	74.3 80.5	161.6	8320	4"

* Light oil, 140,000 Btuh per gallon.
† Net ratings are based on a piping and pick-up allowance of 1.15.
Slant/Fin should be consulted before selecting a boiler for installation having unusual piping and pick-up requirements.
‡ Based on 150 Btuh per square foot E.D.R. at 170°F average water temperature.
§ Modules in excess of 8 are piped in parallel to first eight.

For larger sizes, use multiples of the above.

Design Data

Max. ASME Working Pressure:100 psi
Power Requirements: 120 V/60 HZ,
8.0 amps per module

RECOMMENDED PIPING AND WATER FLOW

Good system design addresses flow rates through boilers. It is possible to have too little flow and too much flow. Most boiler system designs are based on a 20˚F to 30˚F temperature rise in the boiler when it is firing at full input.

When the flow rate is too high through a module the water flow tends to short circuit from the return tapping to the supply tapping of a module. When flow rate is too high the boiler efficiency may drop and there is excess electrical consumption by the circulator.

Recommended water flows and resultant pressure drops through Caravan modules are as follows. Flow rate is for 20 rise in water temperature and pressure drop is determined at recommended flow rate and includes 1-1/2” pipe that connects module to Slant/Fin header.

7-section modules are used in LDWO-850, LDWO-1300,

Module	Flow Rate/ Module GPM	Pressure Drop/Module PSI
7-section	34	0.30
6-section	30	0.30
5-section	25	0.30

LDWO-1700, LDWO-2100, LDWO-2500, LDWO-2900 and LDWO-3400.

6-section modules are used in LWO-750 and LWO-1100.

5-section modules are used in LWO-600 and LWO-900.

Operating Pressures

System static pressure should be at least 15 PSI cold in modules. When circulators are operating the pressure in the modules should be at least 15 PSI when the water is cold.

Optional Piping Method - Primary/Secondary

When applying oil-fired Caravan boilers to a low temperature water system care should be taken to maintain 130˚F return water temperature inside the Caravan boiler. One way to accomplish this is to design the boiler using primary/secondary piping.

Slant/Fin recommends a minimum of 15˚F system water temperature rise across modules that are firing. If the desired temperature rise is lower than a primary/secondary arrangement should be used, either for the whole modular boiler or using a multiple boiler system as described below. The 15˚F minimum temperature rise can be maintained in the modules without affecting the system water.

1. Primary/secondary piping may be applied to a Caravan modular boiler system as demonstrated on Figure 4. In this type of application the modular boiler is contained within the primary loop. However, this is still a modular boiler, if it has no valves between the modules.

2. Primary/secondary piping may also be used on each individual “module”, please see figure 5. In this arrangement the Caravan is no longer a “modular” boiler, it is now a “multiple” boiler system. In a multiple boiler system each module is actually a standalone boiler and each boiler should be equipped with a manual reset hi limit and low water cutoff. Certain local codes also require a minimum distance between each boiler.

Please remember to always follow code requirements applicable to the building that the boilers are being installed in.

Most Caravan systems are applied as a modular boiler, not as a multiple boiler. A modular boiler system is efficient, easy to maintain and very dependable. When a multiple boiler is used there are additional circulators, manual reset hi limits and low water cutoffs to install and maintain.

Some people believe a multiple boiler system is more efficient because water flows through only those units that are firing. They may think water flowing through modules not firing leads to energy loss in those modules. However, we must remember a boiler heat exchanger is designed to absorb heat from high temperature combustion and transfer it to low temperature water (certainly below 250˚F water). Boilers do not make good “convectors” and very little heat is passed through the venting of a module not firing. Oil-fired modules experience very low airflow through the heat exchanger when not firing.

In most applications we recommend a step or stage controller, that modulates system water temperature, be used on a Caravan system. These controls ensure the number of modules firing equals the actual demand for heat. Slant/Fin’s step controllers are the SC-3 and SC-9 model controls. Please see the Control section of this manual for more information on these controls.

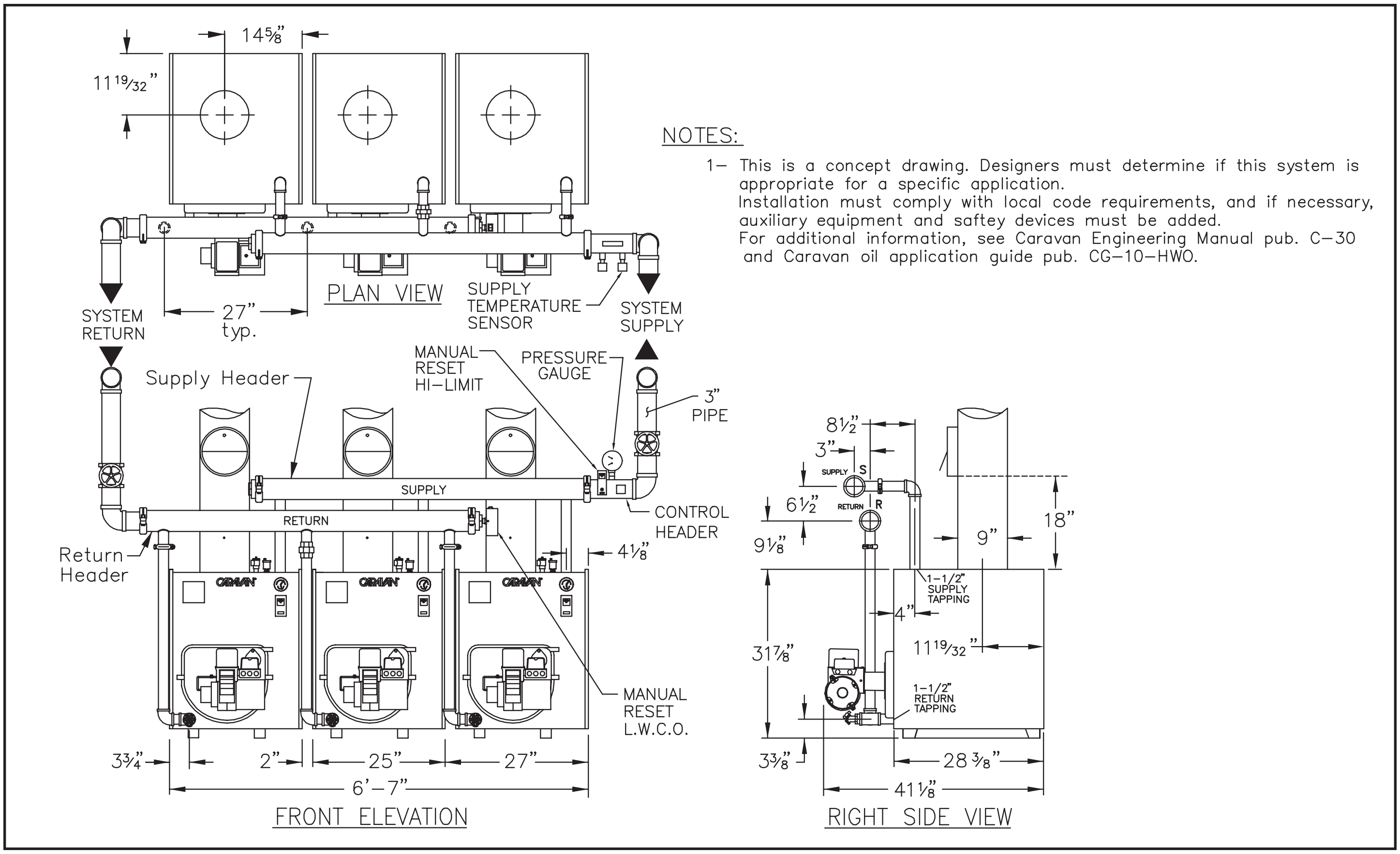


Figure 2. Typical space heat piping – For primary circulation only.

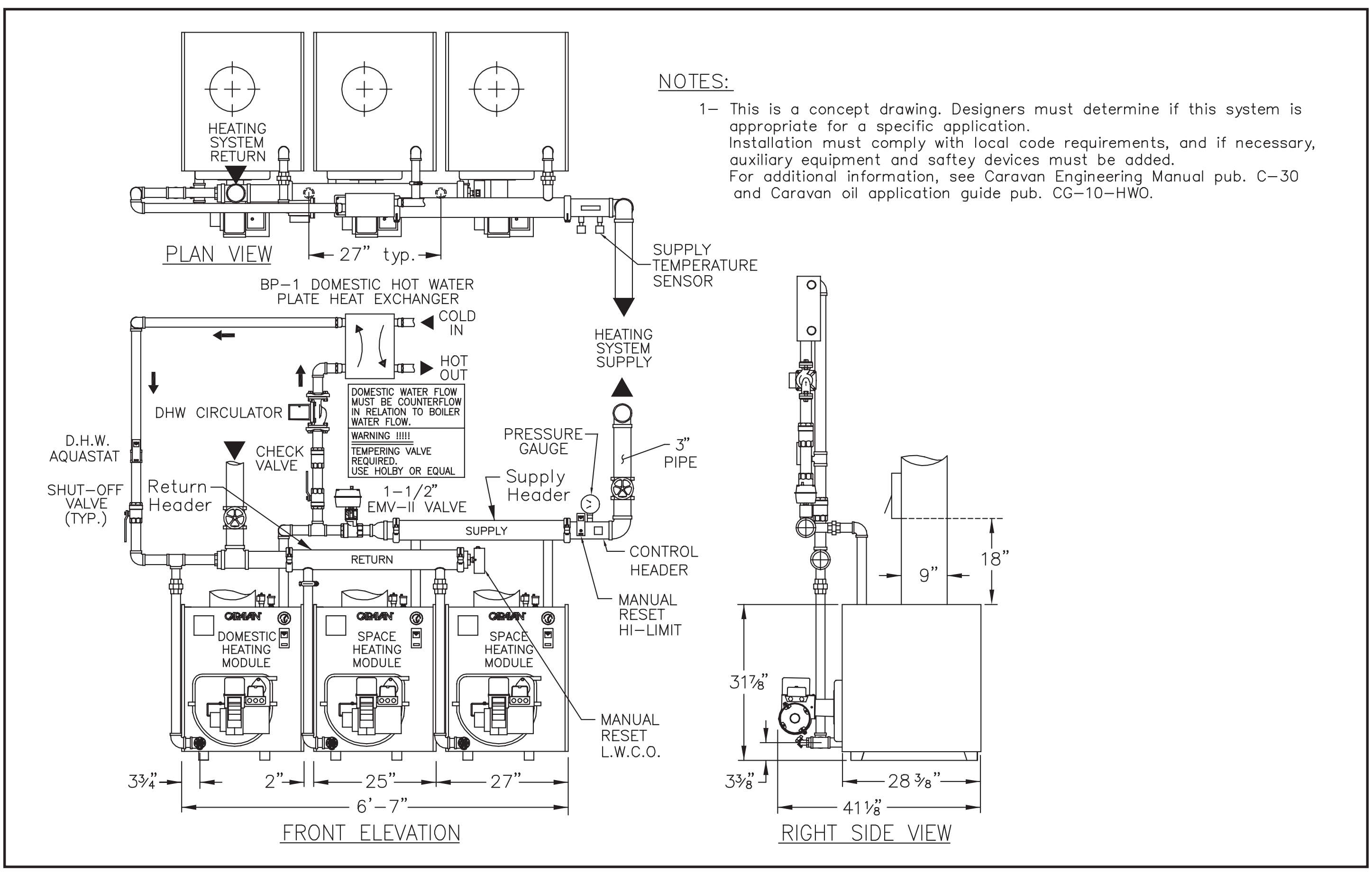


Figure 3. Typical space heat and domestic piping – For primary circulation only.

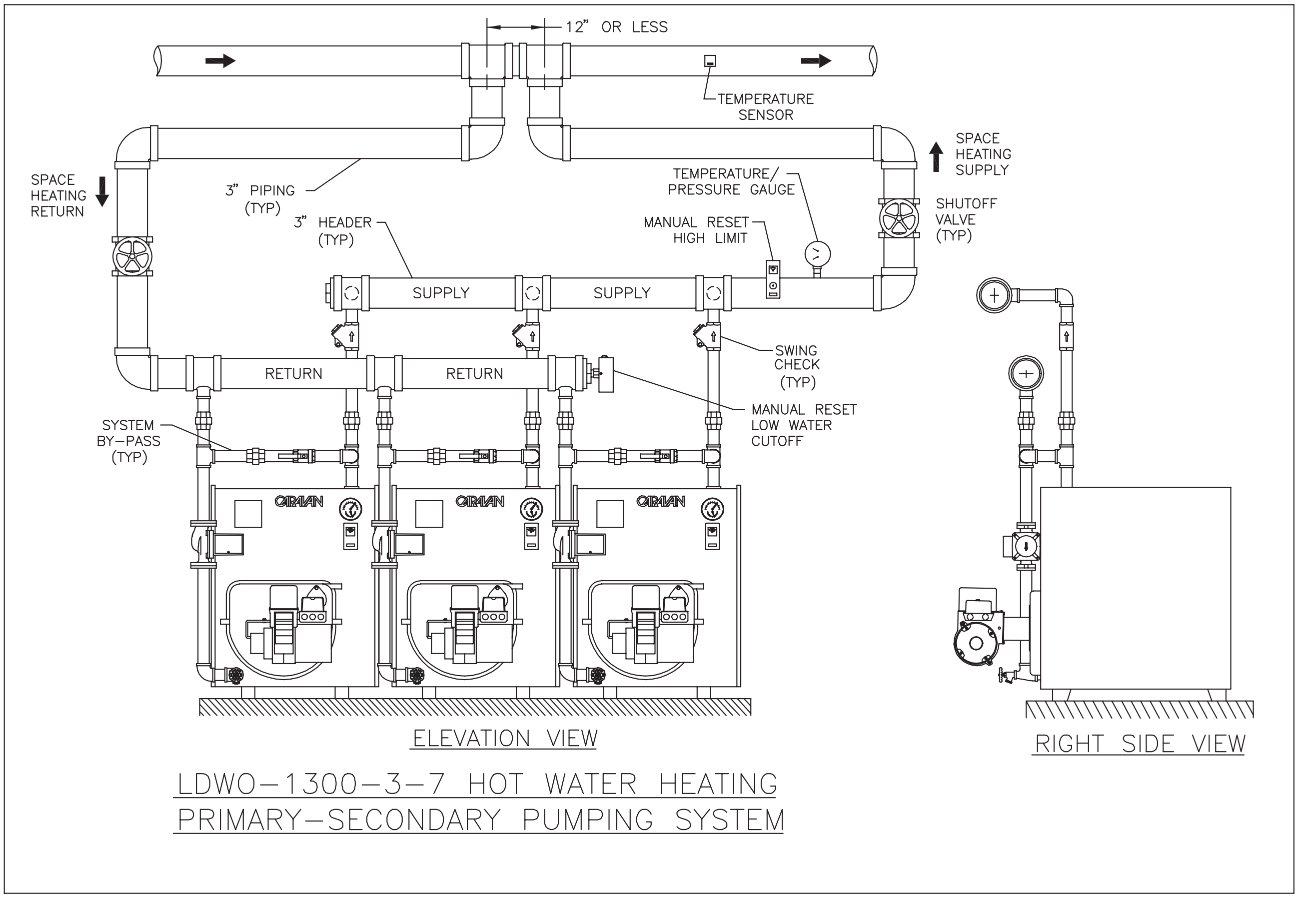


Figure 4. Primary/Secondary piping of modular boiler.

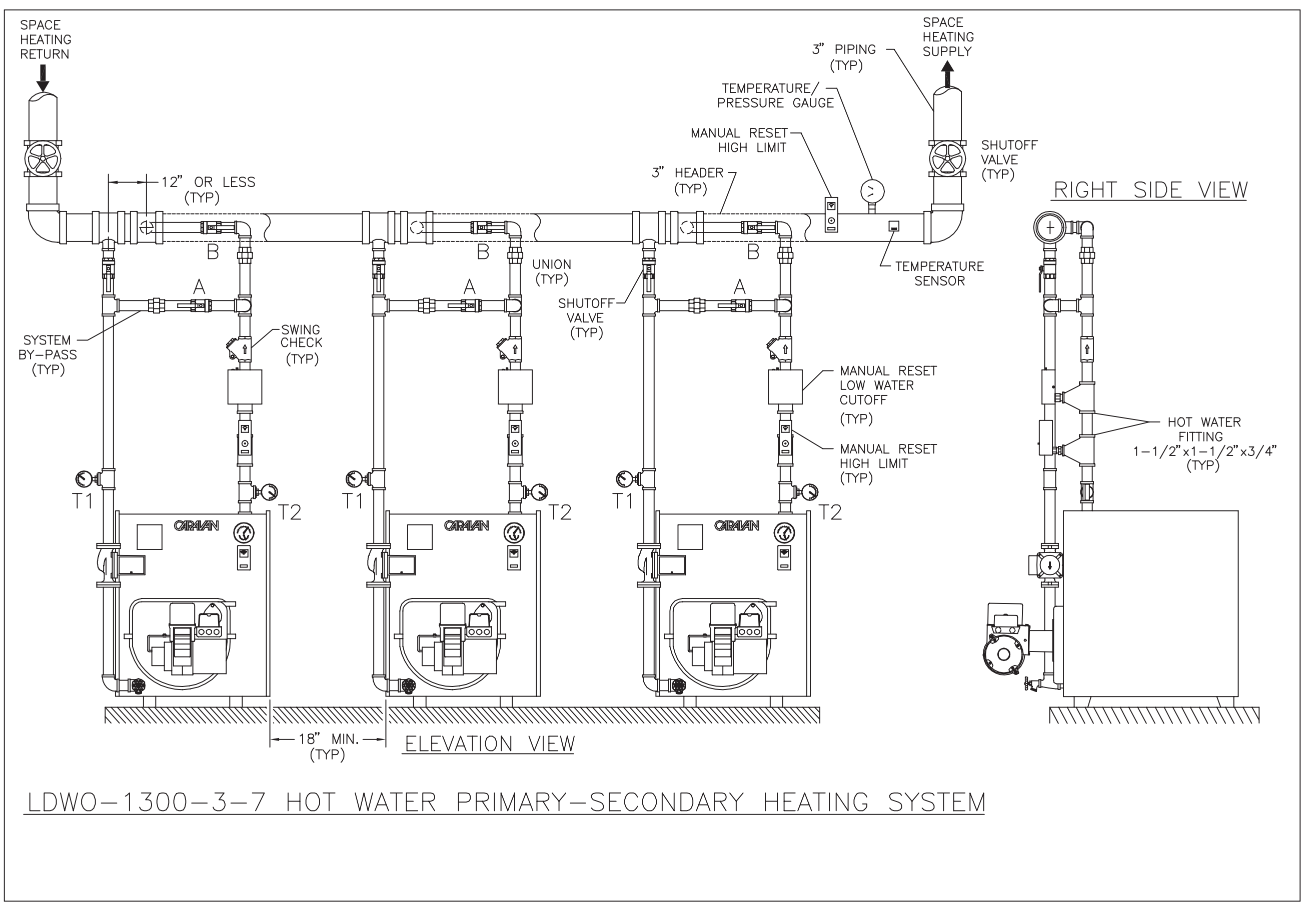
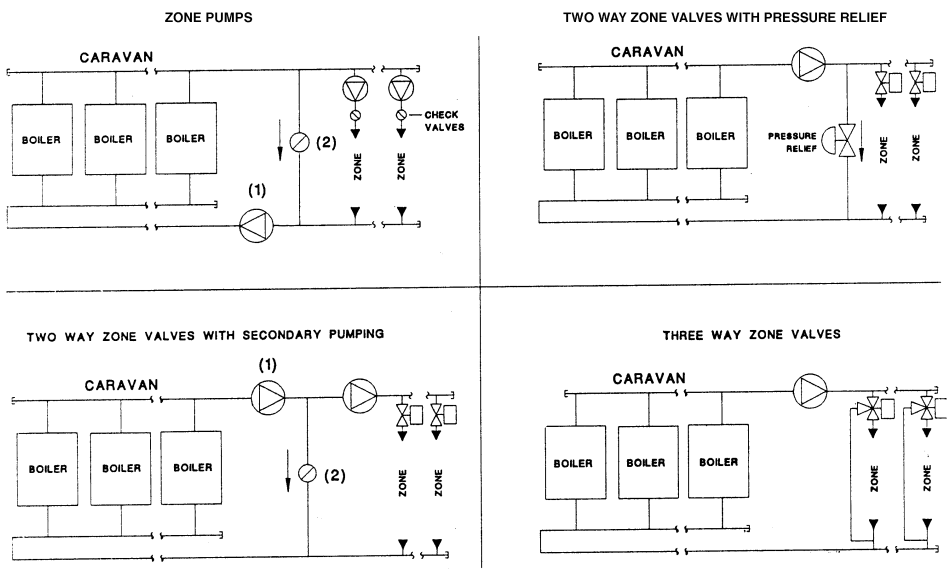


Figure 5. Primary/Secondary piping of multiple boiler.

RECOMMENDED SYSTEM PIPING AND WATER FLOW



(1) Pump capacity sized for full system GPM. Pump head sized to overcome pressure drop through boiler piping loop only.
(2) Check valve and bypass piping sized for minimum pressure drop. Three inch recommended.

Figure 6. Recommended boiler piping for variable volume zone circulation

Minimum flow rate formula:
Minimum flow rate through modules =

$$\frac{\text{Gross output (MBH)}}{20{,}000}$$

Note:	A water flow proving device is recommended on all Caravan systems.

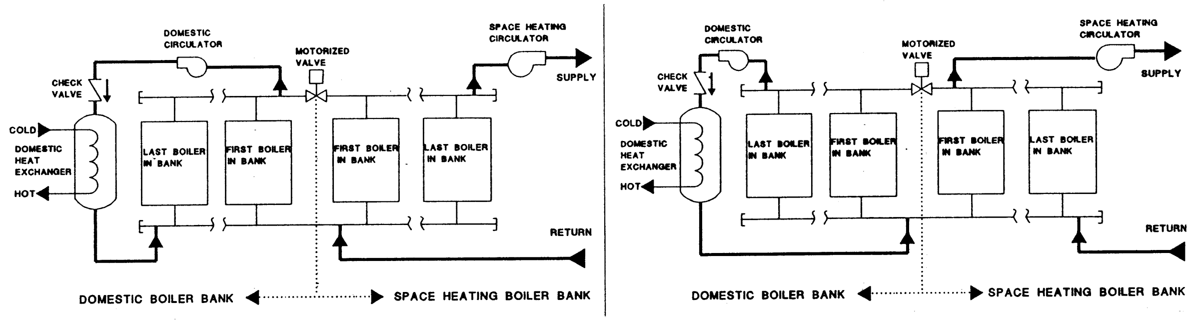


Figure 7. Supply and return piping locations for space heat with domestic hot water

SUGGESTED DOMESTIC HOT WATER PIPING

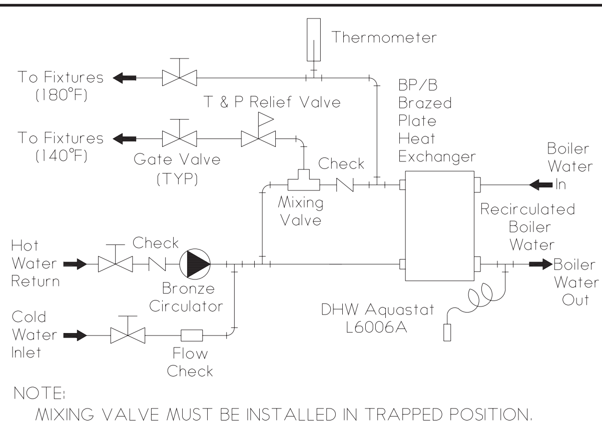


Figure 8: Instantaneous tankless coil— two temperature with recirculation

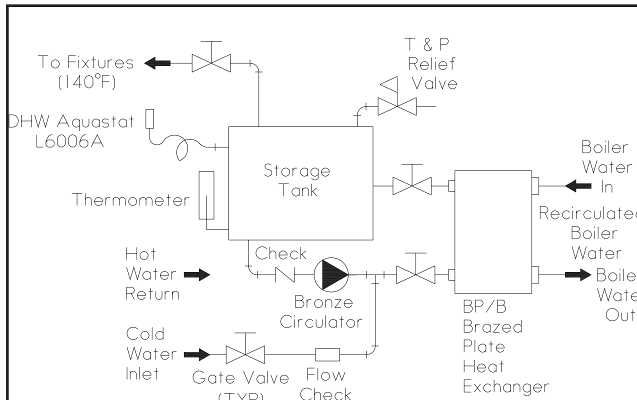


Figure 9: Storage tank from tankless coil with recirculation locations for space heat with domestic hot water

EQUIPMENT INCLUDED
LDWO SERIES — Hot Water Models

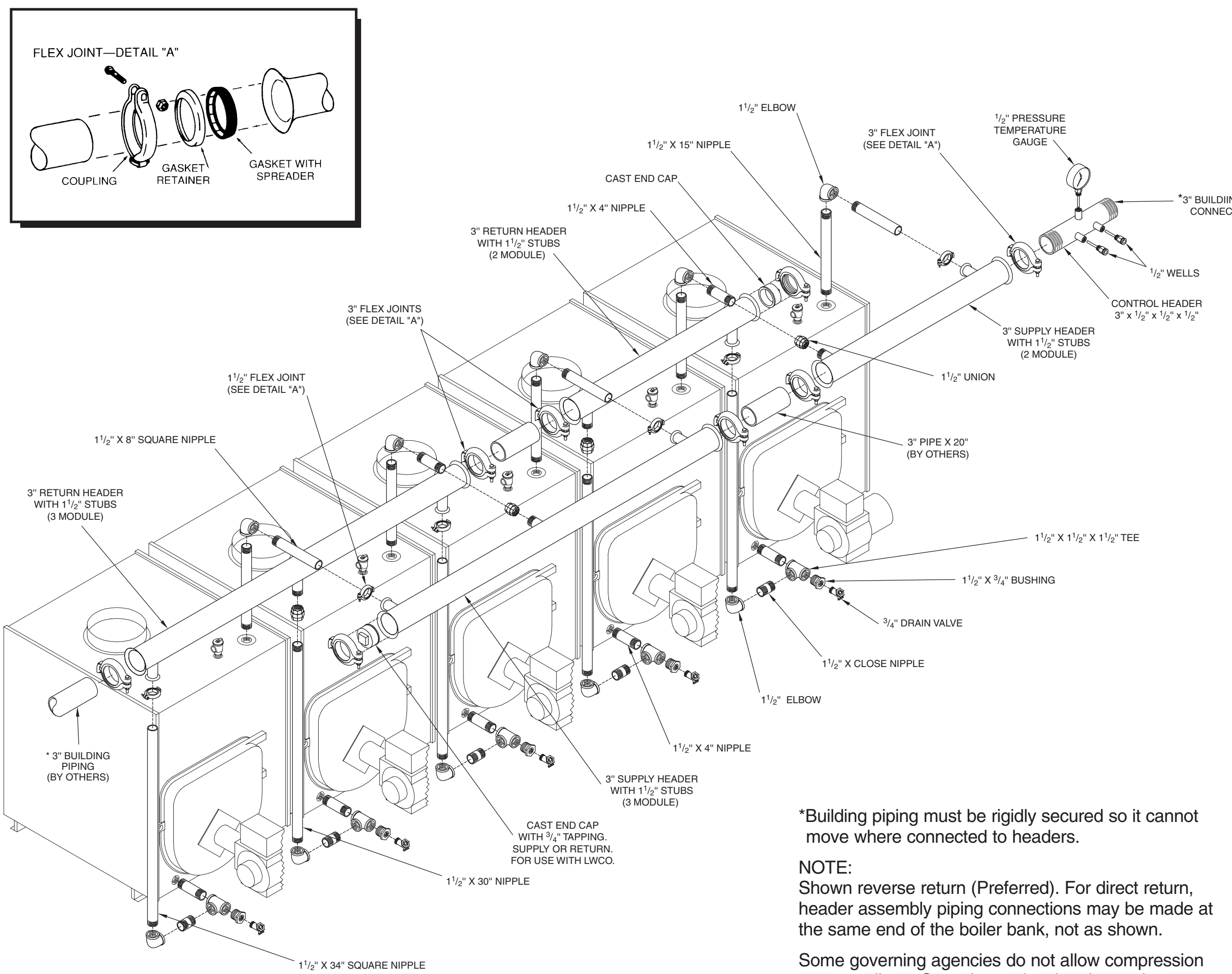
- Pre-assembled heat exchangers with built-in air separators
- Insulated baked enamel jacket.
- Flue collector.
- Draft regulator.
- Flame retention oil burner with nozzle and CAD cell.
- Primary burner control.
- Temperature limit.
- Flue brush.
- Module temperature and pressure gauge.
- System pressure and temperature gauge. (unmounted-1 per system).
- Pressure relief valve (unmounted-1 per module).
- Control header (unmounted-1 per system, up to 8 modules).

OPTIONAL EQUIPMENT

- Headers.
- Control System.

Pressure/Temp Rating for flex joint fittings

150 psi	275˚ F



*Building piping must be rigidly secured so it cannot move where connected to headers.

NOTE:
Shown reverse return (Preferred). For direct return, header assembly piping connections may be made at the same end of the boiler bank, not as shown.

Some governing agencies do not allow compression type couplings. Consult your local code requirements.

Figure 10. Oil Caravan—optional header assembly for all models LDWO and LWDF hot water Caravan systems.

BOILER ROOM DESIGN

Caravan modular boiler systems allow better utilization of floor space and permit future expansion with minimum cost. Caravan modules are hand truckable, fit through doorways and often may be installed around an existing inoperative boiler. They can be grouped in heating module batteries of single, multiple or angular rows. Oil-fired boiler systems consisting of 9 or more modules should be piped in parallel in two or more batteries. Illustrated below are typical boiler room layouts and dimensional data on the size requirements of oil-fired hot water boilers.

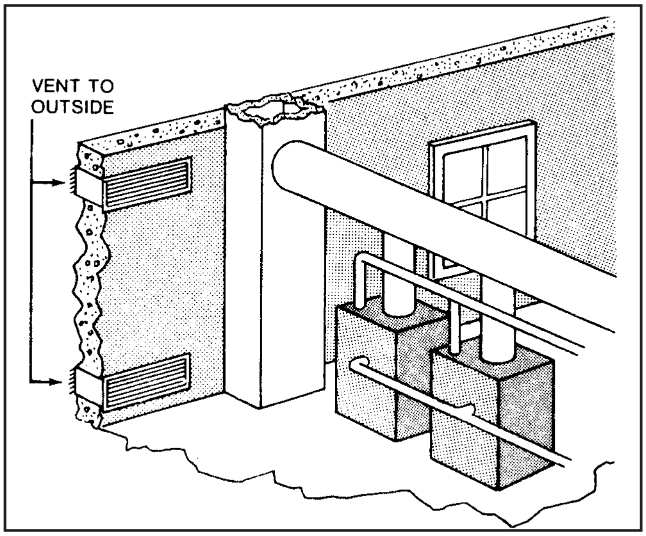


Figure 11. Correct location of combustion-air supply ducts

BOILER ROOM AIR SUPPLY

To ensure safe, efficient operation, the modular boiler system must be supplied with sufficient air to support complete combustion, replacing air entering draft dampers or draft hoods and ventilating the boiler room or areas. For additional information, not listed below, see ANSI,Z223.1, section 5.3.3.

INSTALLATION IN ENCLOSED BOILER ROOM REQUIRES TWO UNOBSTRUCTED OPENINGS FOR PASSAGE OF AIR INTO THE BOILER ROOM:

1. **Air drawn horizontally from outdoors DIRECTLY through an outside wall;** one louvered opening near the floor (below burner air inlet) and one louvered opening near the ceiling (above the highest draft regulator), each opening with a minimum FREE air passage area of **1 square inch per 4000 BTUH** of total system input.

2. **Air drawn horizontally from outdoors through HORIZONTAL DUCTS;** one opening near the floor (below burner inlet) and one opening near the ceiling (above the highest draft regulator), each opening with a minimum FREE air passage area of **1 square inch per 2000 BTUH** of total system input.

3. **Air drawn VERTICALLY from outdoors**; one opening at the floor and one opening at the ceiling, each opening with a minimum FREE air passage area of **1 square inch per 4000 BTUH** of total system input.

4. **Air drawn from inside the building;** one opening near the floor (below burner inlet) and one opening near the ceiling (above the highest draft regulator), each opening with a minimum FREE air passage area of **1 square inch per 1000 BTUH** of total system input.

IF BOILERS ARE INSTALLED ADJACENT TO OTHER FUEL BURNING EQUIPMENT, THE AREA OF FREE OPENINGS MUST BE APPROPRIATELY INCREASED TO ACCOMMODATE THE ADDITIONAL LOAD.

UNLESS PROPERLY CONTROLLED, AVOID THE USE OF FORCED VENTILATION, SINCE IT CAN CREATE AN UNDESIRABLE PRESSURE DIFFERENTIAL BETWEEN BOILER ROOM AND AIR SOURCE.

See Figure 1 for "L" dimension .

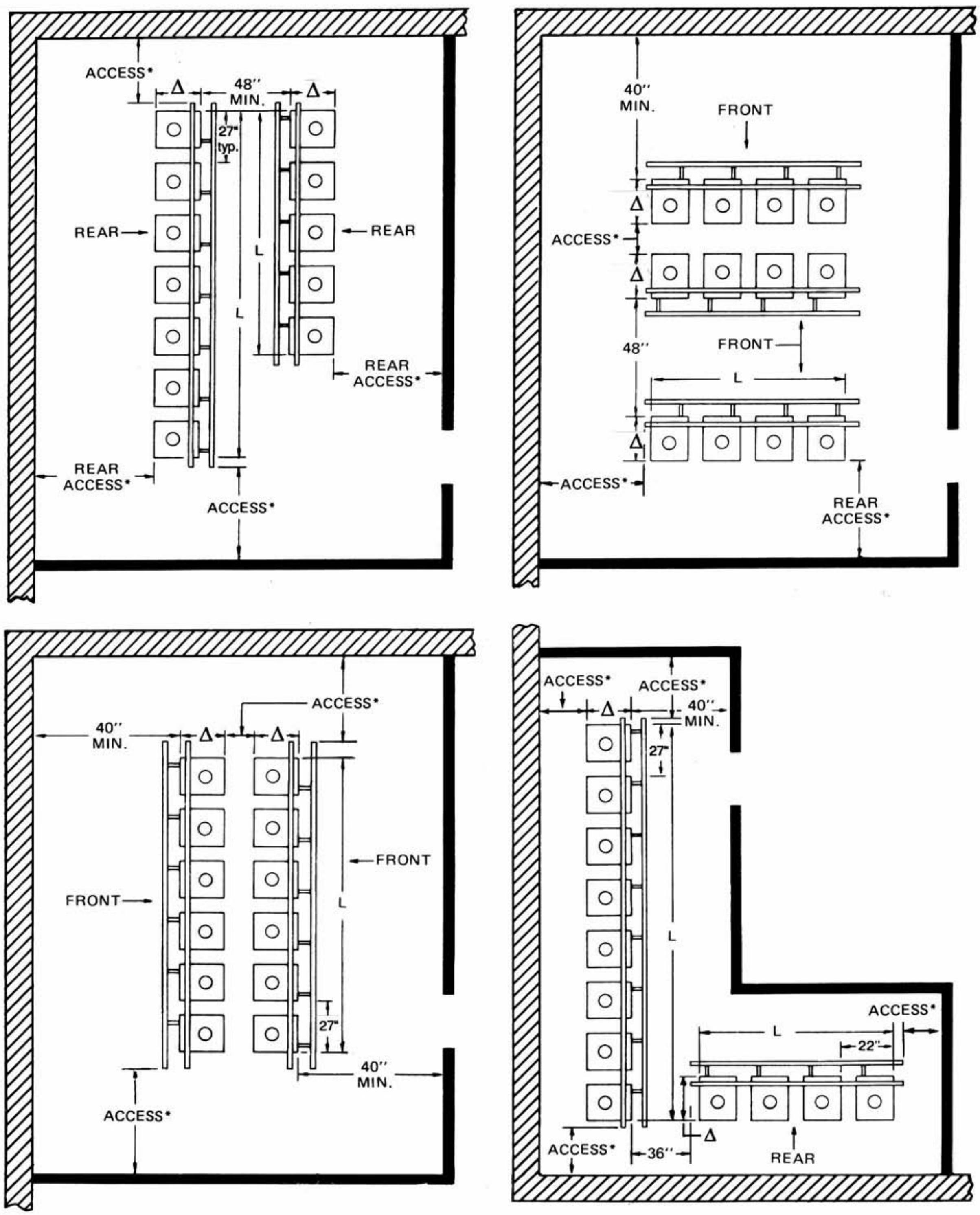


Figure 12. Typical layouts for oil-fired systems

* Caravan can be installed as close as 1" from the wall, local codes permitting. However, 24" is recommended for service inspection access.

Δ See Figure 1 dimensions A and D.

VENTING A OIL-FIRED SYSTEM

A boiler venting system provides draft and an escape path for the products of combustion. In a venting system for an oil-fired Caravan, there are three major components: a riser with draft regulator for each module, a breeching manifold, and a chimney.

Sometimes the venting system for a boiler plant has to be designed to compensate for inadequate chimney conditions. A mechanical draft inducer, properly sized and installed, can usually increase chimney capacity sufficiently to provide proper venting. Where a draft inducer is called for, consult local codes and the recommendations of the mechanical draft inducer manufacturer. Normally, a draft proving device is necessary to permit operation of the boilers only when adequate draft exists.

It is important to note that when considering a mechanical draft inducer, the boiler room air supply requirements must be increased. Consult the draft inducer manufacturer for this information.

Draft Regulator

The draft regulator compensates for excessive draft that can be caused by varying weather conditions. The regulator should be of the barometric-draft type. Once adjusted for a particular venting system, this type regulator automatically compensates for excessive draft to assure optimum operating efficiency.

Breeching

Breeching is a term used to describe a manifold(s) that connects individual boiler modules to a chimney. Breeching is usually constructed of sheet metal having a smooth interior surface with all joints made tight against leakage. The layout of a particular boiler room may require that the modules be arranged in "batteries" with rows either parallel or at right angles. Minimum breeching sizes are given in Table 3.

Table 3. Breeching dimensions for oil-fired systems — LDWO Series

Model No. *	No. of Modules	Breeching Diameter	Minimum Area (sq.in.)	Breechin g
LDWO-600-2-5	2	11"	84	4'8"
LDWO-750-2-6	2	12"	101	4'8"
LDWO-850-2-7	2	13"	115	4'8"
LDWO-900-3-5	3	13"	123	7'1"
LDWO-1100-3-6	3	14"	148	7'1"
LDWO-1300-3-7	3	15"	170	7'1"
LDWO-1700-4-7	4	16"	189	9'6"
LDWO-2100-5-7	5	18"	233	11'11"
LDWO-2500-6-7	6	19"	277	14'4"
LDWO-2900-7-7	7	21"	320	16'9"
LDWO-3400-8-7	8	22"	365	19'2"

* Dual fuel prefix = LWDF.

Notes:

1. For breeching and chimney sizing over 8 modules, consult factory.
2. Breeching length should be as short as possible. Measurement from the base of the vertical vent to the nearest connected appliance should be limited to 10' or 50% of the total vent height, whichever is greater.

To avoid creating turbulent air patterns in the breeching, it is suggested that individual boiler vent pipes be connected to the breeching as indicated in Figure 13.

The breeching manifold should extend into, but not beyond, the chimney liner. Round breeching is preferable to rectangular breeching.

Chimney

Caravan oil-fired modular boilers operate efficiently with masonry or prefabricated chimneys. This latter type of chimney construction is generally the least expensive.

Minimum chimney sizes and heights are given in Table 4. In addition, the chimney should be high enough to minimize the effects of turbulent winds and high pressure areas common near roof-top obstructions. The National Board of Fire Underwriters recommends that the chimney should extend 3 feet above the roof and be 2 feet higher than any obstruction within 10 feet (figure 13). The use of a vent cap where permitted by code gives additional protection against adverse wind conditions and precipitation.

Model No. *	No. of Modules	Chimney Liner Inside Dim. †		
		Dia. Inches	Rectangular L x W Inches	Minimum Height Feet
LDWO-600-2-5	2	11"	9¾" X 9¾"	20'
LDWO-750-2-6	2	12"	9½" X 13½"	20'
LDWO-850-2-7	2	13"	13¼" X 13¼"	20'
LDWO-900-3-5	3	13"	13¼" X 13¼"	20'
LDWO-1100-3-6	3	14"	13¼" X 13¼"	20'
LDWO-1300-3-7	3	15"	13" X 17"	20'
LDWO-1700-4-7	4	16"	13" X 17"	25'
LDWO-2100-5-7	5	18"	16¾" X 16¾"	25'
LDWO-2500-6-7	6	19"	16½" X 20½"	25'
LDWO-2900-7-7	7	21"	20¼" X 20¼"	25'
LDWO-3400-8-7	8	22"	20¼" X 20¼"	25'

* Dual fuel prefix = LWDF.

† Dimensions shown are from ASHRAE Guide Equipment Handbook. Also select inside liner dimensions to give area as great or greater than shown in this table. Chimney height is measured from the center line of the breeching to the top of the chimney. Chimney dimensions are approximate, with no manifold elbows or tees; and good vent construction practices. Field conditions vary. It is doubtful that the chimney dimensions shown here will be suitable for all applications. Consult the 2000 ASHRAE Equipment Handbook and Chimney Manufacturers Sizing Handbook.

Sizing Horizontal Breeching Connectors and Chimneys for Oil-Fired Systems

Horizontal breeching connectors shall be constant sized. The chimney and the horizontal breeching connector are sized using table 3.

When there are multiple banks of boilers, the horizontal breeching connector for each bank is sized using table 3. To size the common horizontal breeching connector, add up the total input and refer to table 3 to size.

The minimum chimney will be equal to the size of the largest horizonatl breeching section connected to it.

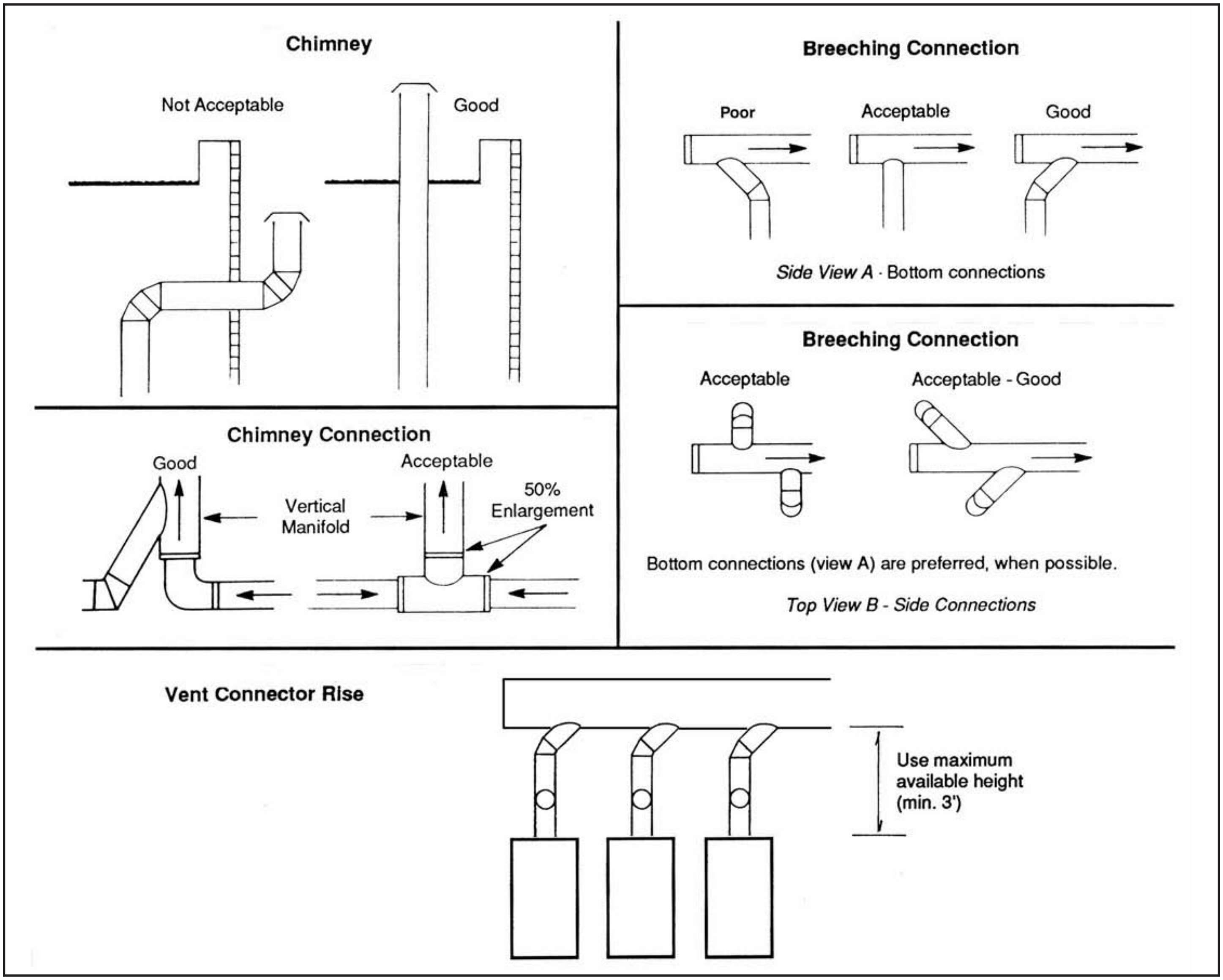


Figure 13. Suggested venting system constructions

FUEL OIL STORAGE FACILITIES

Local codes usually govern the installation of fuel oil storage facilities. However, for areas where no rules have been established, the following information can provide assistance to the system designer.

Storage tank sizing

When calculating minimum fuel oil storage capacity, several variables must be considered. These include: maximum fuel consumption rate, storage space limitations, availability, distance from source of supply, and method of delivery (truck or railroad tank car). Large storage tanks, of course, cost more than smaller ones but the cost is not proportional (e.g., a 10,000 gal. tank does not cost twice as much as a 5,000 gal. tank). And larger tank capacity allows oil purchases usually at lower per gallon rates.

Generally, the storage tank should hold enough oil to sustain continuous operation for 10 days (plus an additional 10% margin to allow for suction stub clearance).

To determine the <u>minimum</u> storage requirement, proceed as follows:

a) Refer to Table 1 to find the maximum hourly oil consumption (GPH) of the system being installed.

b) Multiply the maximum hourly consumption by the probable maximum daily hours of operation to achieve maximum daily consumption.

c) Multiply the maximum daily consumption by 10 (days) and add 10% to obtain the <u>MINIMUM</u> storage capacity.

Requirements for fuel oil storage tanks.

Data in this section is based on the use of steel storage tanks. Where no local codes apply, take the following data into consideration.

a) Inside tanks are usually located in the lowest part of the building. When supply and return lines are piped through the top of the tank, spillage is minimized in the event of leaks.

b) Unenclosed tanks should be at least 7 feet from any open flames or fires.

c) Most fire codes prohibit unenclosed inside tanks exceeding 275 gallons each. Where multiple tanks are installed, the total storage capacity should not exceed 550 gallons unless vaulted.

d) If inside tanks are properly enclosed, the maximum storage capacity can be increased to 5,000 gallons in non-fire-resistant buildings, and to 15,000 gallons in fire-resistant structures.

   NOTE: An enclosure shall consist of walls constructed of 6" reinforced concrete or 8-inch thick masonry with the space between tank and walls filled with sand. If floor above has a load-bearing capacity of 150 lbs./sq. inch or greater and is constructed of fire-resistant material, 1 foot of sand fill over the tank is sufficient. If not, a 5-inch concrete slab, or equivalent, must be employed. An alternative method is to pour a 6-inch thick concrete enclosure directly over the tank (no air spaces).

e) Underground tanks (Figure 14) are to be buried at least 2 feet below grade.

f) Tanks buried beneath buildings ALWAYS require 4-inch reinforced concrete slab covers that extend 1 foot beyond tank in all directions.

g) <u>Fiberglass and/or double-walled tanks may be required. Check your local codes</u>. Underground metal tanks should be painted with heavy asphaltum, rust-resistant paint or be of double walled construction (check local codes). ***DO NOT*** install tank in bed of cinders (cinders contain sulphur, which becomes corrosive when wet).

   NOTE: Before installing underground tanks, check local surface water conditions. Where potential problems exist, concrete anchors should be provided.

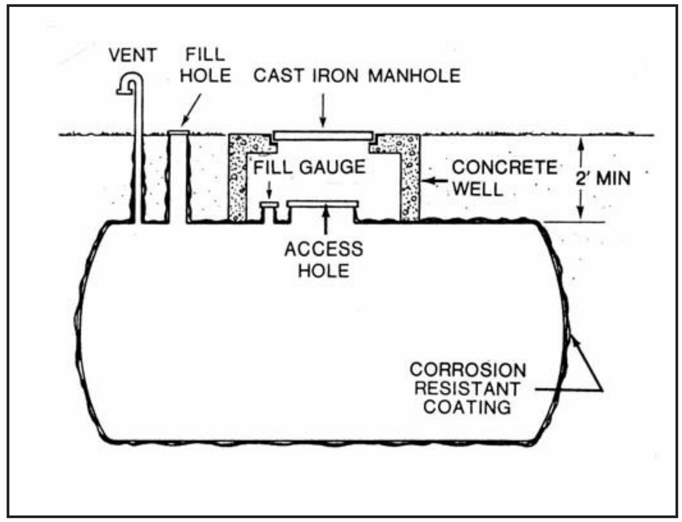


Figure 14. Typical example of properly installed underground fuel tank

FUEL OIL DELIVERY SYSTEMS FOR SINGLE FUEL BURNERS

General

Three methods for delivering oil to the individual burners are described herein. These methods are chosen to provide <u>tempered</u>, <u>filtered</u> and <u>air-free</u> oil to the individual burners. Consistent oil quality will optimize burner operation over longer periods.

There are variations to the methods described herein which, if applied properly, will result in acceptable operation. These methods are for reference only. Local codes vary. It is important to check all codes for compliance.

Information herein has been compiled using data from industry sources, including companies such as Mitco, Webster, Suntec and Tuthill. For additional information on these products, contact the representative in your area.

MFG data and safety codes vary with regard to maximum fuel unit inlet pressure. Pay particular attention to the gravity oil head. Be sure to add oil pressure reducing valves in the event that codes or MFG data will be exceeded. 5 psi is equivalent to approximately 12 feet in height. (See "H" dimension.)

Storage tank above burners *(Figure 15)*

A simple one pipe connection from the supply tank to each burner helps to eliminate air in the oil line and tempers the oil in the pipe as it travels slowly to the burners.

This method maintains consistent fuel oil quality to the individual burners and therefore decreases the frequency of maintenance and service. When a component breakdown occurs in a burner or in the supply system, the trouble is easily found and service is restored quickly.

Storage tank below burners and gravity tank above burners ***(Figure 16)***

Oil is automatically and constantly maintained in the supply tank at a level sufficient to meet all burner needs. As oil is used, the pressure drop is sensed by a pre-set automatic pressure switch, which signals the booster pump to restore proper level. There is no practical limit on the height or distance that the motorized pump can deliver oil to the supply tank.

The great advantage of the booster pump along with a gravity tank is that it accomplishes its purpose in the most simple and direct manner. This results in the most economical installation, with the shortest possible runs of pipe and wire. It also enables the installer to adapt with ease to almost any building configuration. A simple one pipe connection to each burner helps eliminate air in oil line with constant flow of fuel and tempers the oil.

Simplicity of operation of the individual burner decreases the chances that service will be needed. When a component breakdown occurs in a burner or in the supply system, the trouble is easily found and service is restored quickly.

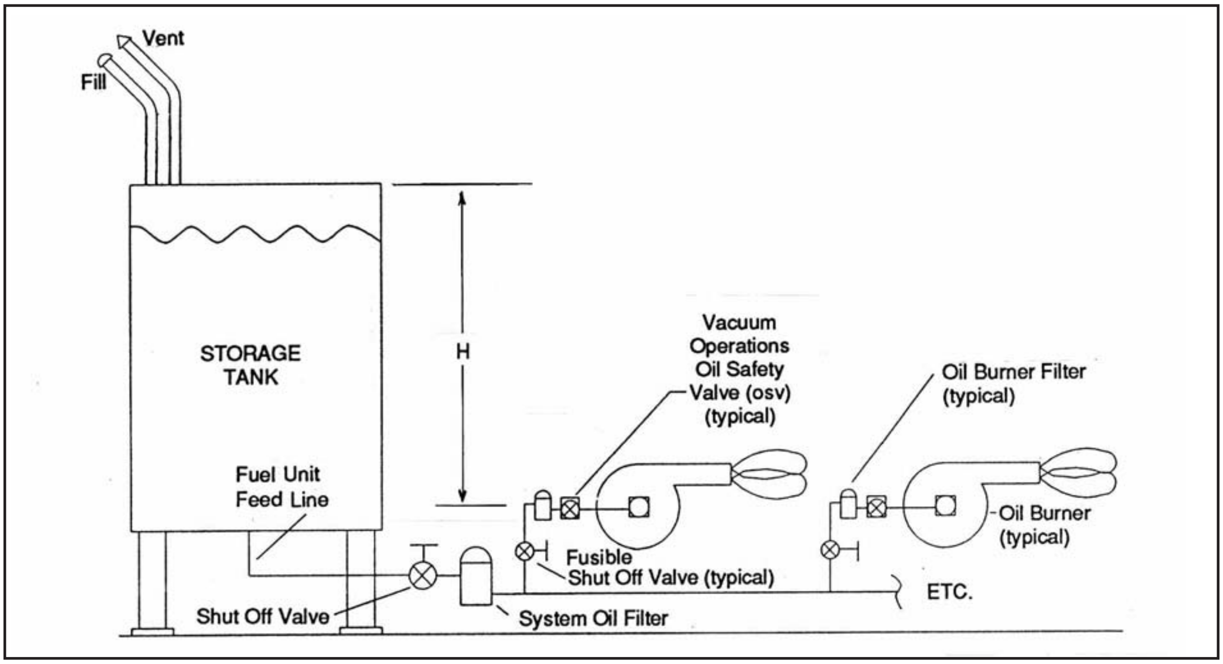


Figure 15. Storage tank above burners

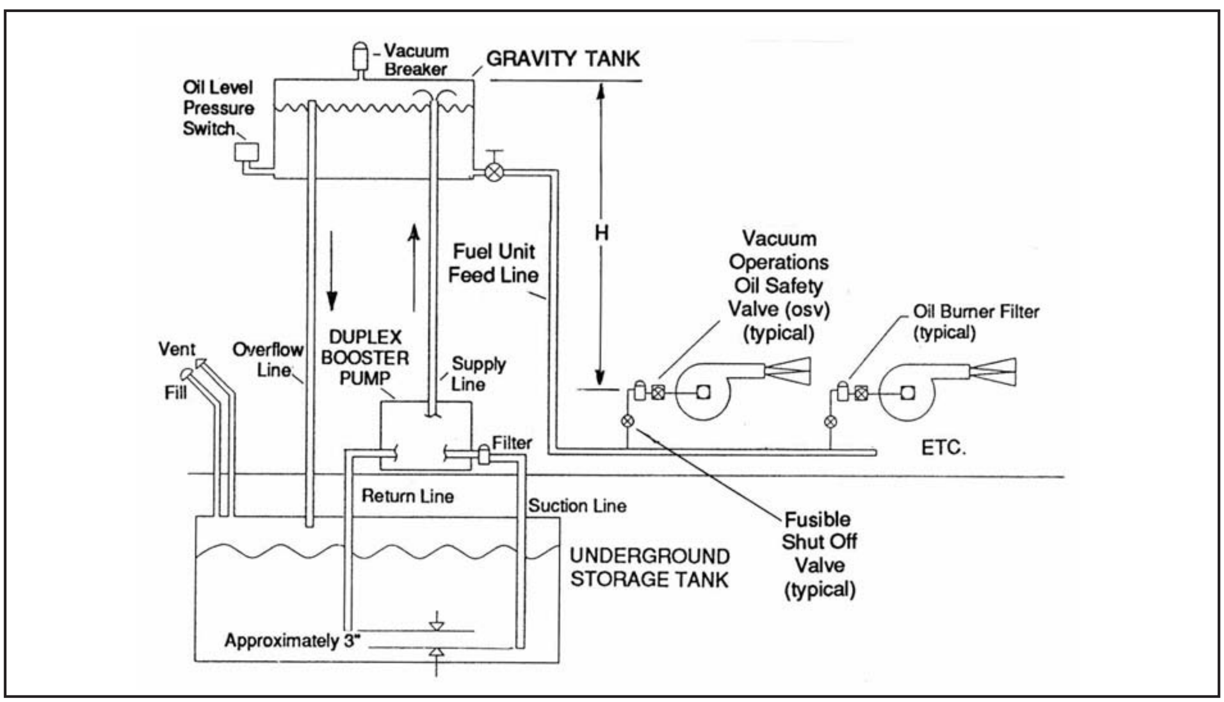
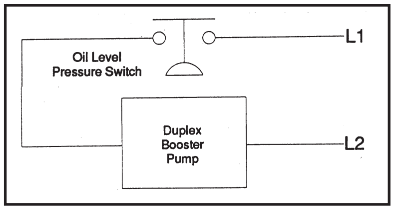


Figure 16. Storage tank below burners

Figure 17. Wiring diagram for gravity feed booster- pump operation



Components usually required are a motorized booster pump of sufficient capacity, gravity tank and mounting hardware, automatic oil level pressure switch, vacuum breaker and necessary check valves and fittings. Additional information can be obtained from Mitco Manufacturing, Hicksville, New York.

Duplex booster pumps are desirable to provide standby capability, in the event of booster pump failure.

Sizing booster pump
To determine the correct size of a booster pump:

a) Using Table 1, find maximum total firing rate of the boiler system being installed.
b) Find the vertical and horizontal dimensions of the booster pump's suction line.
c) Make sure the suction line lift and length are with capabilities of typical booster pumps. Refer to Table 5. (This data is based on Suntec models BH-1030M at 30 GPH, and BH-1050M at 50 GPH or equivalent.)

NOTE: If lift is excessive (max. 6" Hg one stage, 15" Hg two stage), contact pump manufacturer with exact requirements. If total length is too long, increase suction line diameter.

d) Using Table 6, find correct supply line size.

Table 5. Maximum booster pump suction line length (1)

Vertical Lift (2)	Maximum Total Suction Line Lengths (3) 1/2" O.D. copper tubing (4) — Firing Rates up to 30 GPH (5)	Firing Rates up to 50 GPH (6)
0 - 7'	100'	63'
8 - 10'	80'	53'
11 - 13'	63'	41'
14 - 15'	52'	34'

Table 6. Supply line sizes for high-volume fuel oil delivery systems (7)

Firing Rate	Maximum Total Supply Line Length (8)		
Up to 30 GPH (5)	300'	800'	2500'
Up to 50 GPH (6)	175'	350'	1500'
Supply Line Size	½" O.D. tube	½" pipe	¾" pipe

Table 7. Boiler feed line sizes (9)

Total Length Maximum	Firing Rates up to 30 GPH (5)	Firing Rates up to 50 GPH (6)
25'	½" O.D. tube	½" O.D. tube
75'	½" pipe	½" pipe
200'	¾" pipe	¾" pipe

(1) Defined as the connection distance between storage tank and inlet of booster pump.
(2) Height of booster pump inlet above bottom of storage tank. If higher lift is needed, contact booster pump manufacturer with exact requirements.
(3) Total suction length equals vertical lift plus horizontal distance between suction line connection at storage tank and inlet of booster pump.
(4) 5/8" tubing allows maximum horizontal distance between supply tank outlet and booster pump inlet to be safely increased by 250%.
(5) Maximum fuel oil consumption rate with Suntec BH-1030M pump.
(6) Maximum fuel oil consumption rate with Suntec BH-1050M pump.
(7) Supply line is defined as the connection between the outlet of the booster pump and the inlet of the supply tank.
(8) Total supply line length equals vertical lift plus horizontal distance between booster pump outlet and supply tank inlet.
(9) Boiler feed line is defined as the connection between the gravity feed tank and the furthest burner.

FUEL OIL DELIVERY SYSTEMS FOR DUAL FUEL BURNERS

GENERAL

Dual fuel burners are shipped separately and must be field mounted and wired. Connections to Slant/Fin control systems can be found in the control section of this manual.

Burner set-up and mounting instructions are shipped with each dual fuel burner. The installer must follow these instructions.

Dual fuel burners require specific types of fuel oil piping systems. The fuel oil pump is active during gas and oil operation. Since no oil flows to the burner during gas operation, a two pipe system keeps fuel oil in circulation, preventing pump overheating and thermal expansion.

Figures 18 and 19 illustrate two types of two pipe fuel oil delivery systems for dual fuel burners.

If the system is gravity feed, or if the lift is 12' or less, a single stage pump may be selected. If the lift is 18' or less, then a two stage fuel pump should be used. If the lift is more than 18', use a pseudo two pipe loop system (Figure 15).

TWO PIPE SYSTEM *(Figure 18)*
An important factor to consider in a two pipe system is the line size which depends on the maximum line length and the total oil volume. The gear capacity of the pump is normally quite high compared to the pump's marked capacity. For example, an "A" pump marked for 3 GPH could have a gear capacity of 17 GPH at 3450 RPM.

For a Caravan system, it is ideal to have individual supply and return fuel lines for each boiler. In practice, one can opt to have not more than 3 boilers on a single supply or suction line and a common return for 6 to 9 boilers. (Figure 18)

Table 8 is the calculated line lengths for two types of "B" pumps with different gear capacities. For example, if the lift is 10', the furthest boiler 150' and the fuel oil pump is two stage, of type B89 series, then the corresponding line length from the table is 161' for 5/8" tubing.

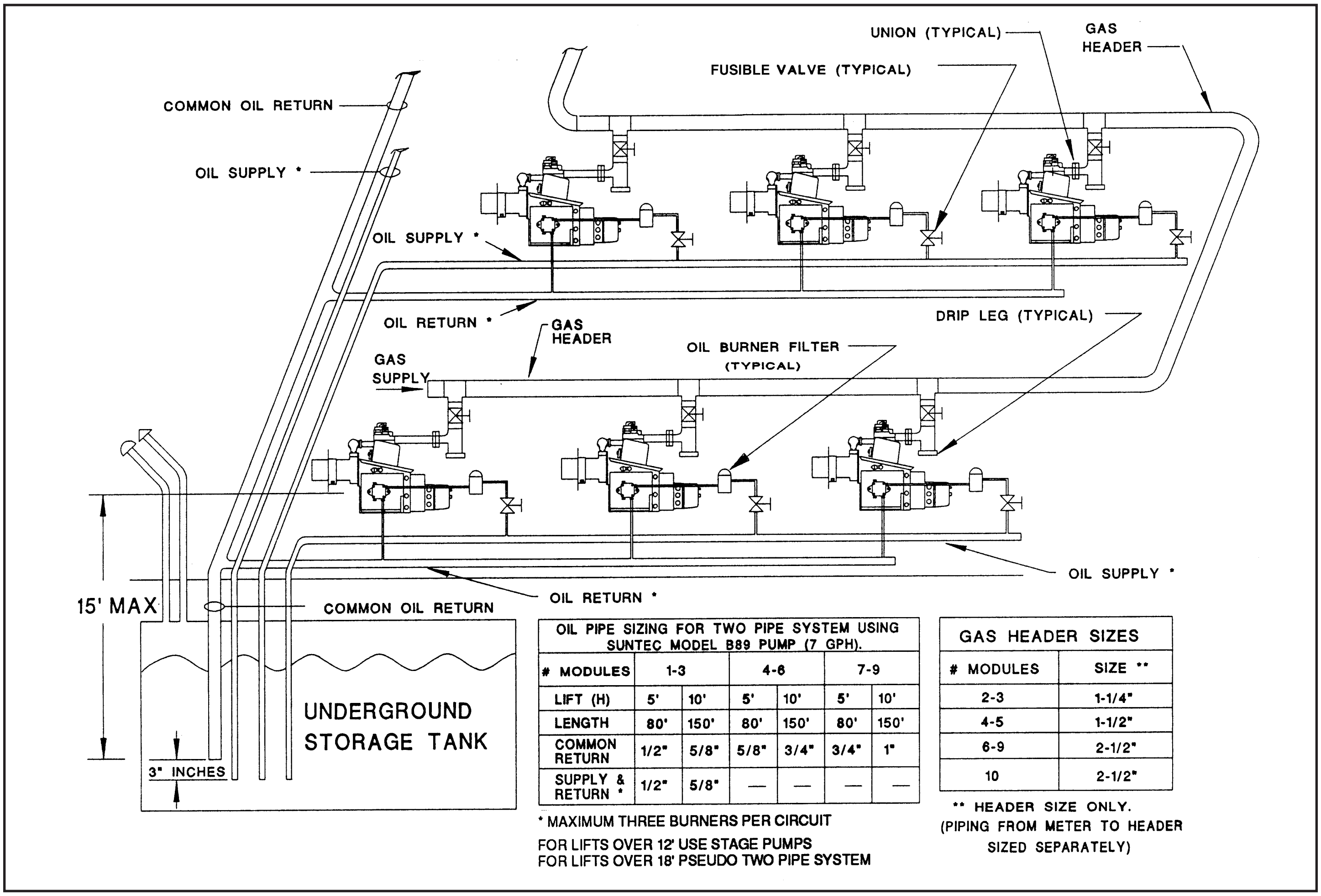
NOTE: NFPA requires that the pump inlet pressure not exceed 3 psi. Therefore, when oil is fed by gravity from above the pump, the height should not be more than 8' from the pump to the top of fuel oil supply. If it is more than 8', then one way to protect the pump is to have a vacuum operated safety valve (OSV) on each fuel unit.

PSEUDO TWO PIPE LOOP SYSTEM *(Figure 19)*
Another way to prevent overheating and thermal expansion of the oil while the unit is running on gas for extended periods, is to use a pseudo two pipe loop system (Figure 15). This system uses a booster pump to circulate the oil from the tank to a header that feeds the burners. Excess oil is fed back to the tank. Generally, a 1/2" fuel line should handle most installations within 200' when using a type "A" pump. A duplex pump-motor boost system should be wired to run for oil as well as for gas. Whenever a burner (regardless of fuel) is running, one of the duplex pump motors should be activated and another pump motor should serve as an automatic backup

Table 8. Line Length for Two-Stage Fuel Unit

Two Pipe Lift Ht.	1/2" O.D. Tubing A	1/2" O.D. Tubing B	5/8" O.D. Tubing A	5/8" O.D. Tubing B
1'	118	99	328	276
2'	113	95	313	263
3'	107	90	298	250
4'	102	86	283	237
5'	96	81	268	225
6'	91	76	253	212
7'	86	72	238	200
8'	80	67	222	187
9'	75	61	207	174
10'	69	58	192	161
11'	64	54	177	148
12'	58	49	162	136
13'	53	44	147	123
14'	47	40	131	110
15'	42	35	116	98

A = B82 Series Suntec Pump 63 GPH gear capacity.
B = B89 Series Suntec Pump 75 GPH gear capacity.



OIL PIPE SIZING FOR TWO PIPE SYSTEM USING SUNTEC MODEL B89 PUMP (7 GPH).

# MODULES	1-3		4-6		7-9	
LIFT (H)	5'	10'	5'	10'	5'	10'
LENGTH	80'	150'	80'	150'	80'	150'
COMMON RETURN	1/2"	5/8"	5/8"	3/4"	3/4"	1"
SUPPLY & RETURN *	1/2"	5/8"	—	—	—	—

* MAXIMUM THREE BURNERS PER CIRCUIT

FOR LIFTS OVER 12' USE STAGE PUMPS
FOR LIFTS OVER 18' PSEUDO TWO PIPE SYSTEM

GAS HEADER SIZES

# MODULES	SIZE **
2-3	1-1/4"
4-5	1-1/2"
6-9	2-1/2"
10	2-1/2"

** HEADER SIZE ONLY.
(PIPING FROM METER TO HEADER SIZED SEPARATELY)

Figure 18. Dual Fuel Piping Two Pipe

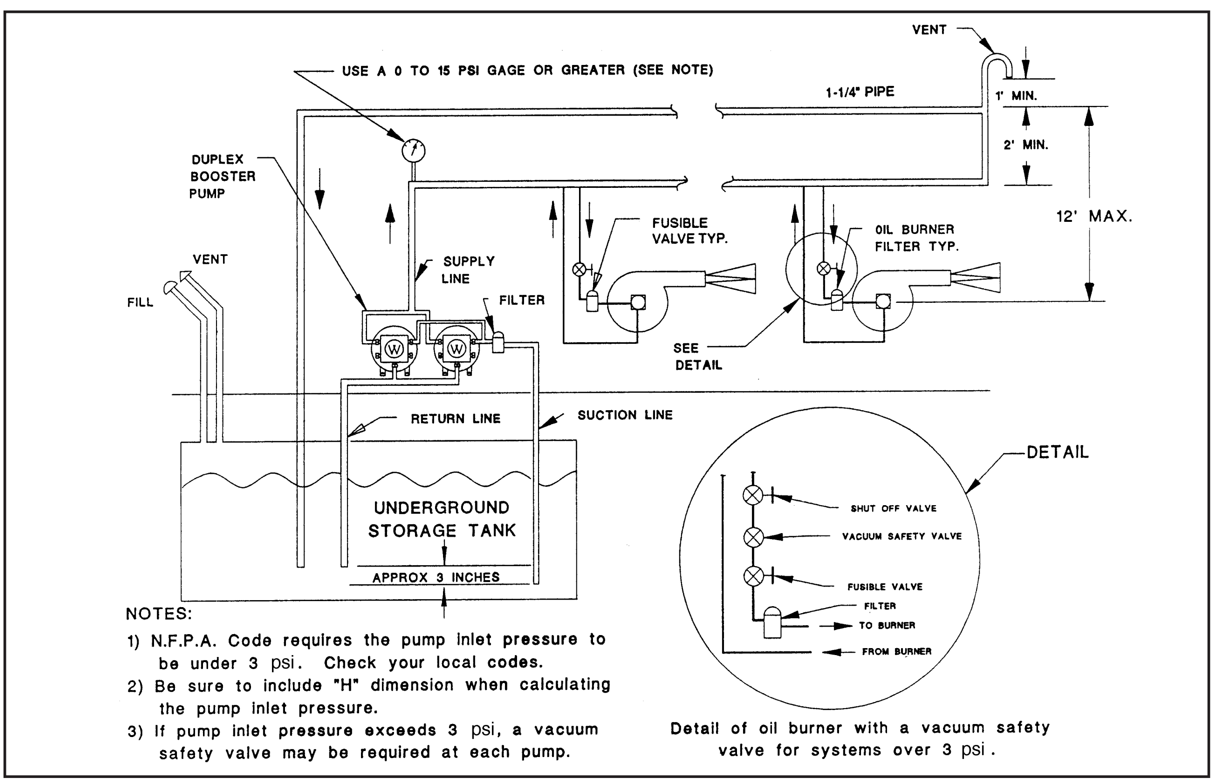


Figure 19. Pseudo Two-Pipe Loop System

CONTROLS

THE BOILER STAGING CONCEPT

The heart of the Caravan boiler plant is a temperature-actuated control system that automatically stages only those boiler modules needed to meet the heating demand in a given period, thereby conserving fuel.

In a staging control system, each stage ordinarily activates one boiler module. With appropriate wiring, multiple modules can be grouped within a stage.

During a fluctuation in heating requirements, a large central boiler cycles on and off to match heat output to building demand. A staged modular boiler system, on the other hand, will energize only as many modules as the system load requires. Only one stage cycles at a time. The other stages remain off or operate continuously, thereby performing at peak efficiency. For example, in a 10 module boiler system, with the heating load at 61% of capacity, six of the modules operate continuously at peak efficiency. Fractional heating requirements are supplied by the seventh "cycling" module, while the remaining three modules are "off." This is in contrast to a single large central boiler that simply cycles on and off, resulting in lower efficiency.

Over-sizing is a major factor in poor system efficiency. Most of the time a single central boiler is oversized. Historical data shows that many single central boilers are considerably over-sized even at the outdoor temperature for which they were designed. Modular boiler systems are not oversized by more than a portion of one module, regardless of the load.

The Caravan control system automatically compensates for seasonal temperature changes. It energizes more or fewer modules depending on changes of outside temperature, system water temperature, or both. Modules save energy by operating in long cycles at full-rated output and maximum efficiency.

CONTROL SYSTEM SELECTION

Slant/Fin offers two controls to step fire a hot water Caravan system. The SC-3 and SC-9 controls fulfill a wide range of applications. They control the boiler system and are not intended to be the sole building temperature control. They do not replace zoning the system or the thermostats that control these zones.

SC-3 Control

The SC-3 control allows up to 3 stages in a Caravan system. Generally each stage controls 1 module. However, it is possible to have more than 1 module activated with each stage.

Standard programmable features include: system activation or de-activation based on outdoor temperature; minimum target supply water temperature; adjustable design target supply water temperature; adjustable delay between stages; adjustable outdoor temperature and indoor design temperatures.

The view menu on the control includes error messages, actual outdoor air temperature, actual supply water temperature, target supply water temperature and running time for each stage.

This control can be programmed as follows:

1. **Outdoor reset:** The supply water temperature is automatically adjusted up or down based on outdoor temperature. The control automatically controls the number of modules required to maintain required supply water temperature.
2. **Setpoint temperature:** The control can be programmed to maintain a set supply water temperature. The control automatically controls the number of modules activated to maintain the setpoint temperature.

SC-9 Control

The SC-9 control allows up to 9 stages of operation for space heating, domestic water or combination, in a Caravan system. Generally each stage controls 1 module. However, it is possible to have more than one module activated with each stage.

Standard programmable features include: system activation or de-activation based on outdoor temperature; minimum target supply water temperature; adjustable design target supply water temperature; adjustable delay between stages; adjustable outdoor and indoor design temperatures; delay to allow combustion air damper to open; ability to provide equal run time rotation of boiler modules; fixed lead of a module when Caravan system activates; first on/last off or first on/first off for modules; control of primary circulator and periodic exercising of primary circulator when system is inactive.

The view menu on the control includes error messages, actual outdoor air temperature, actual supply water temperature, target water temperature, running time for each stage and the difference between supply water and return water temperatures.

The SC-9 can be programmed as follows:

1. **Outdoor reset:** The supply water temperature is automatically increased as outdoor temperature decreases and decreased as outdoor temperature increases. The control activates only the number of stages required to maintain the required supply water temperature.

2. **Setpoint temperature:** The control maintains a set supply water temperature. The control activates only the number of stages required to maintain the setpoint temperature. Setpoint temperature may be used for a Caravan system that is dedicated for use as volume water heating.

3. **Domestic hot water:** The domestic hot water controls override the SC-9 control for only those modules used to heat the domestic hot water. The modules for domestic hot water are isolated from space heating system until demand for domestic hot water is satisfied. The modules not used for domestic hot water heating remain under control of SC-9 control.

   Slant/Fin offers domestic hot water control packages and external tankless heaters as options for use with the SC-9 control.

BILL OF MATERIALS FOR SC SERIES CONTROLLERS

Material List for SC-3

- SC-3 modular boiler control (part# 435-084)
- 1 Outdoor sensor (part # 339-070)
- 1 Universal sensor to be used as supply water sensor (part # 339-071)
- 1 Plastic tie strap

Material List for SC-9

- 1 SC-9 modular boiler control (part # 435-085)
- 1 Outdoor sensor (part # 339-070)
- 2 Universal sensors (part # 339-071)
  - 1 to be used as supply water sensor
  - 1 can be used as return water sensor
- 2 Plastic tie straps

Other Options include:

- Immersion well for supply water sensor: to be installed in control header supplied with Caravan
- High Limit (manual reset) and Immersion Well: to be installed in control header supplied with Caravan
- Low Water Cut-Off (manual reset): to be installed in modular boiler headers above modules cast iron heat exchanger
- Domestic Hot Water Control Packages: components include EMV valve; setpoint aquastat L6006A with immersion well. This is to be used with external heat exchanger such as Caravan BP series brazed plate heat exchangers.

Circulators, switches, wiring and other relays are provided by contractor.

FIELD WIRING AT MODULES

Figure C1 OIL FIRIED BURNER WIRING

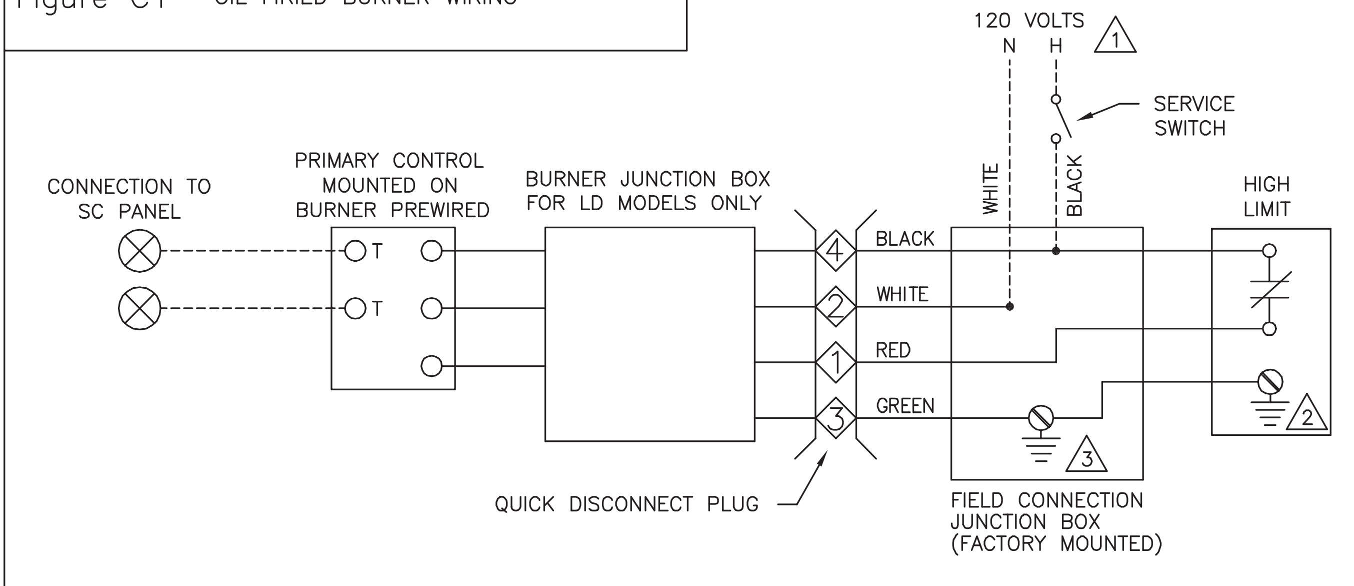


Figure C2 MULTIPLE MANUAL RESET HIGH LIMIT WIRING (IF USED)

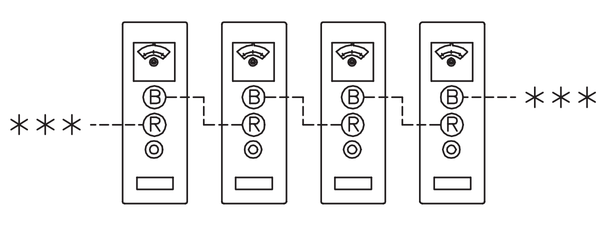


Figure C3 MULTIPLE HYDROLEVEL 550 L.W.C.O. WIRING (IF USED)

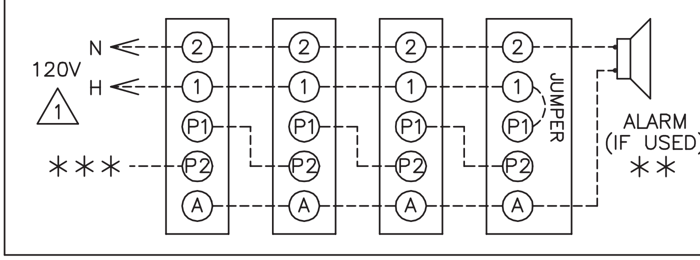


Figure C4 MM 750-MT-120 L.W.C.O. ALTERNATE WIRING (IF USED)

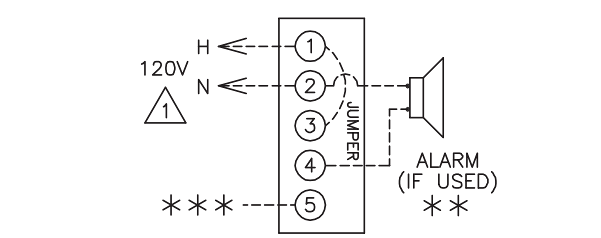
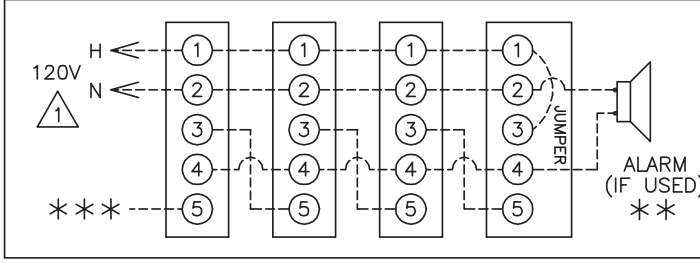


Figure C5 MULTIPLE MM 750-MT-120 L.W.C.O. WIRING (IF USED)



1 – PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED BY LOCAL CODE.

2 – CONTROL CASE MUST BE CONNECTED TO EARTH GROUND. USE GROUND SCREW PROVIDED.

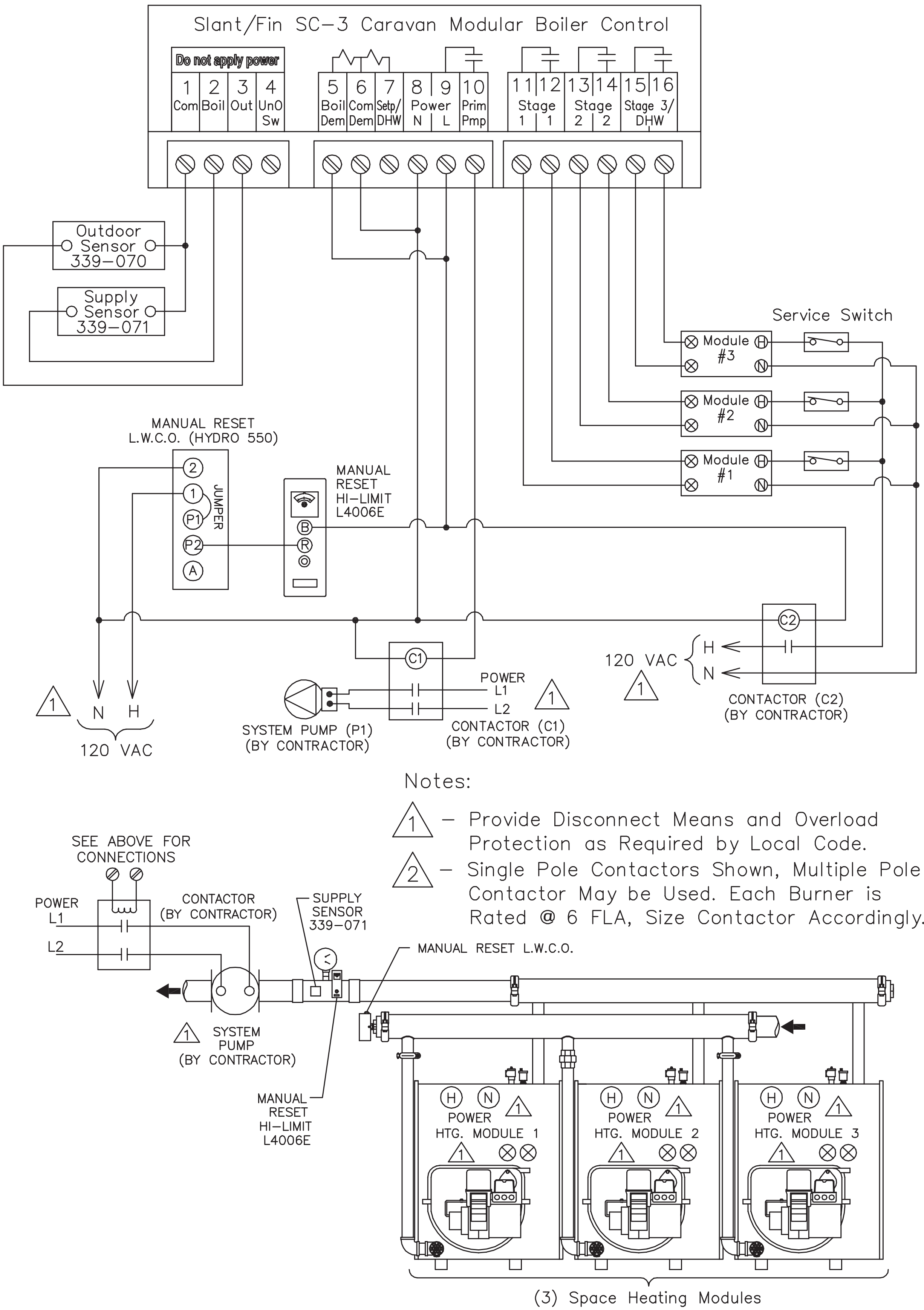
3 – GROUNDING CONDUCTOR: TWO GREEN GROUND WIRES ARE FACTORY CONNECTED TO THE GREEN GROUND SCREW IN THIS BOX. FIELD WIRE A GROUNDED CONDUCTOR TO THIS SCREW TOGETHER WITH THE TWO GREEN FACTORY CONNECTED GREEN GROUND WIRES.

** – OPTIONAL ALARM CIRCUIT BY CONTRACTOR.

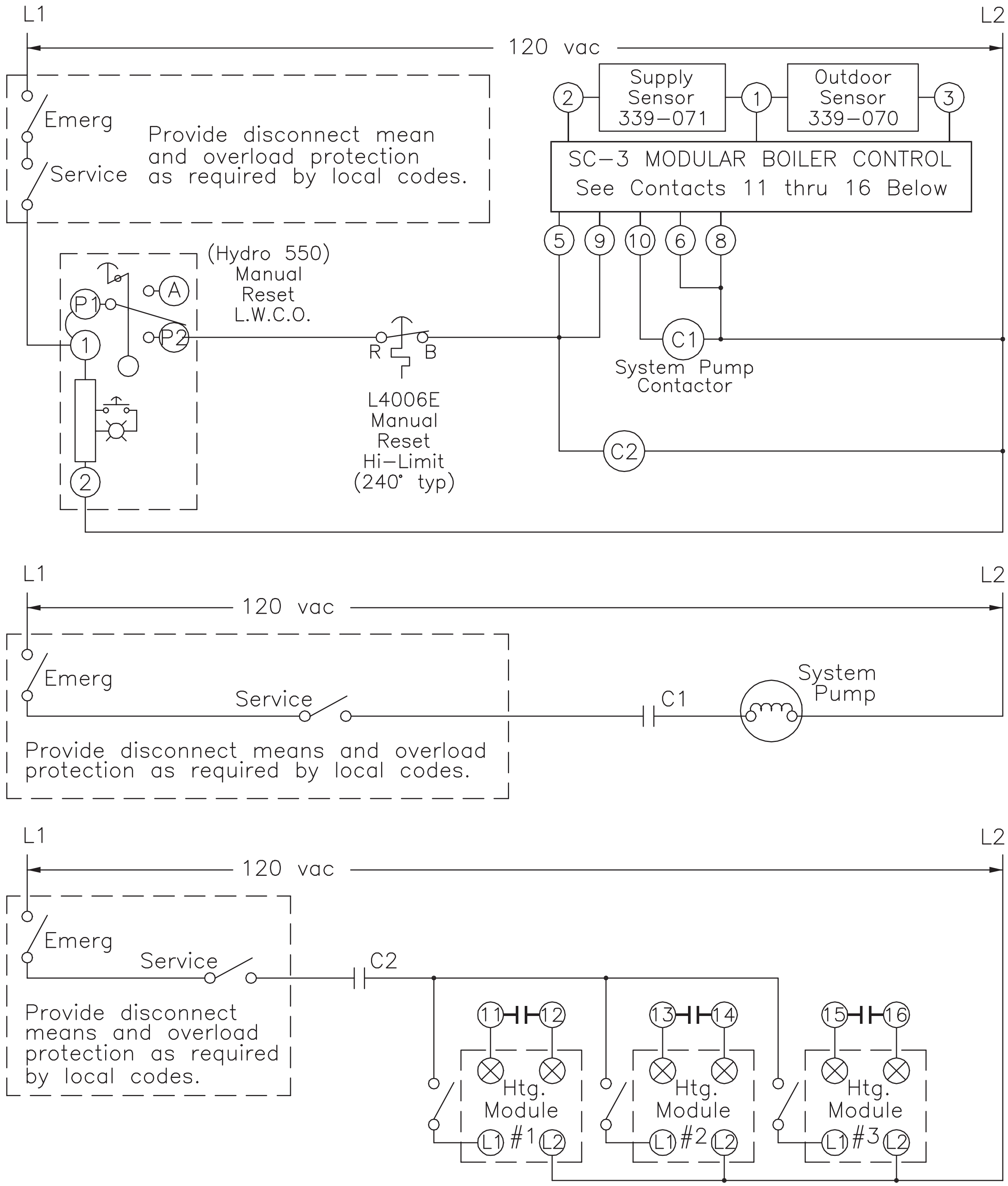
*** – REFER TO SC-3 OR SC-9 WIRING DIAGRAM FOR PROPER WIRE CONNECTION.

LEGEND:
------ FIELD WIRING
—— FACTORY WIRING

SC-3 SYSTEM WIRING DIAGRAM

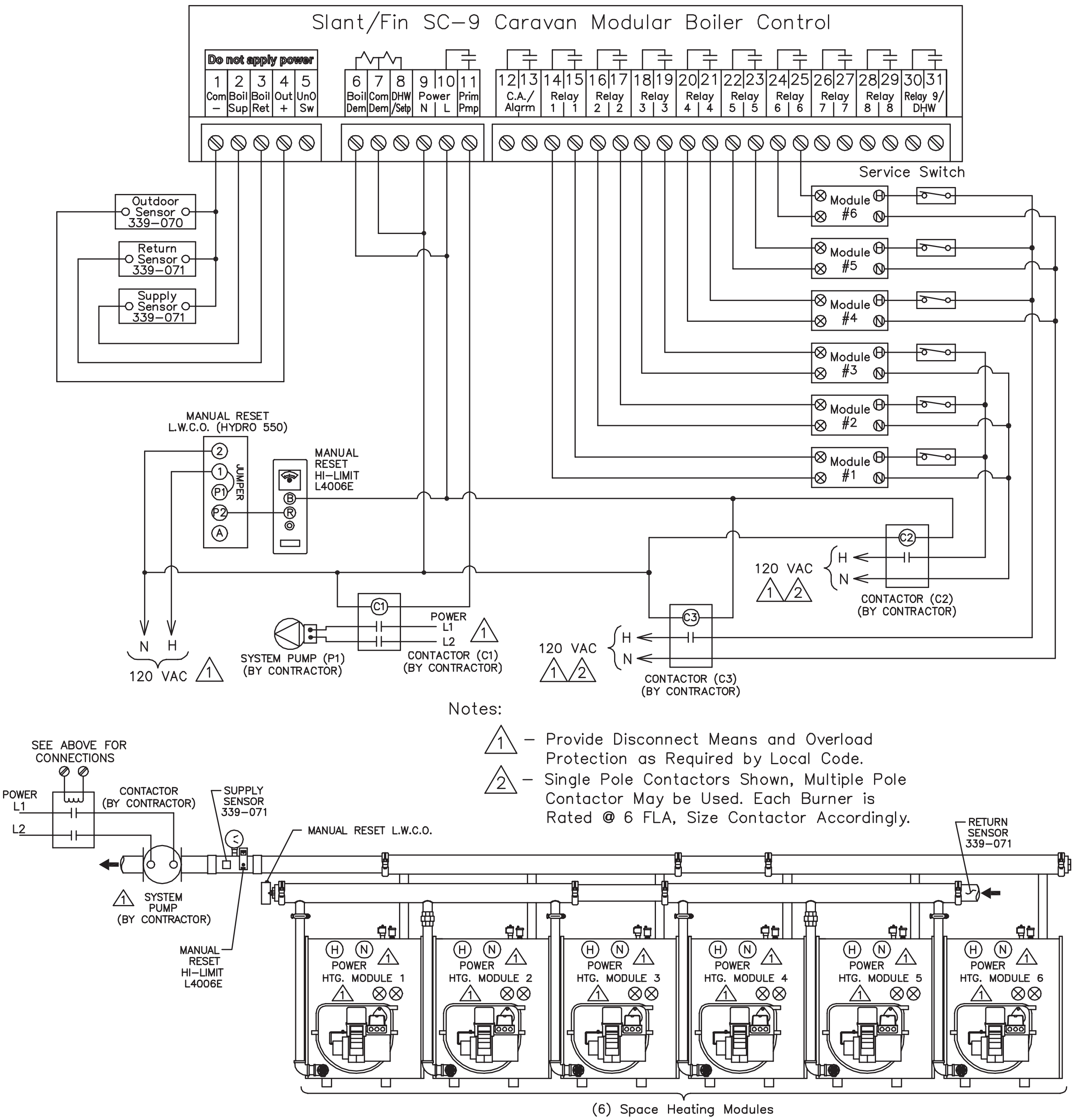


SC-3 LADDER WIRING DIAGRAM

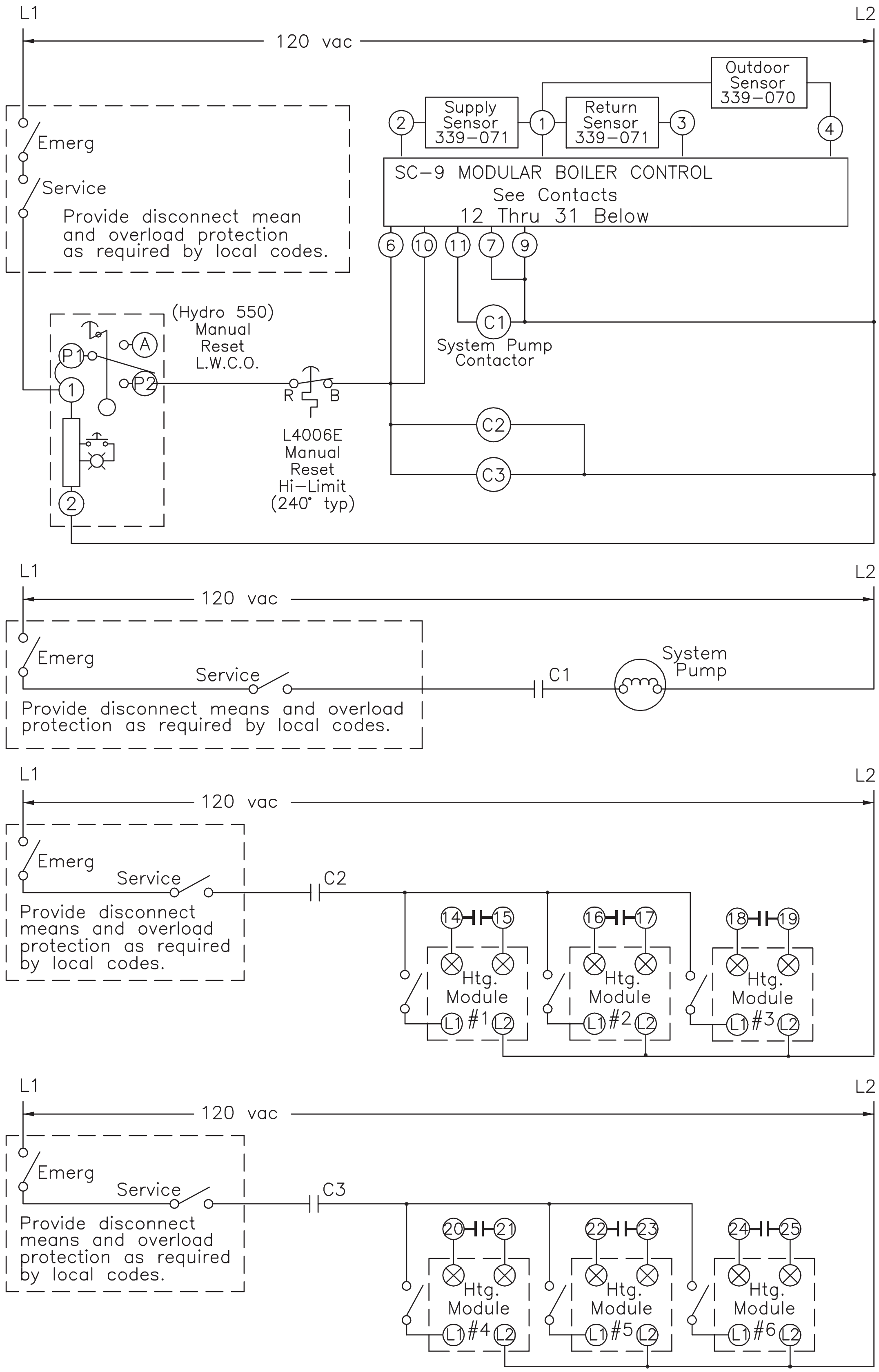


⊗ – SEE FIG. C1 FOR CONNECTION AT MODULE.

SC-9 SPACE HEATING WIRING DIAGRAM

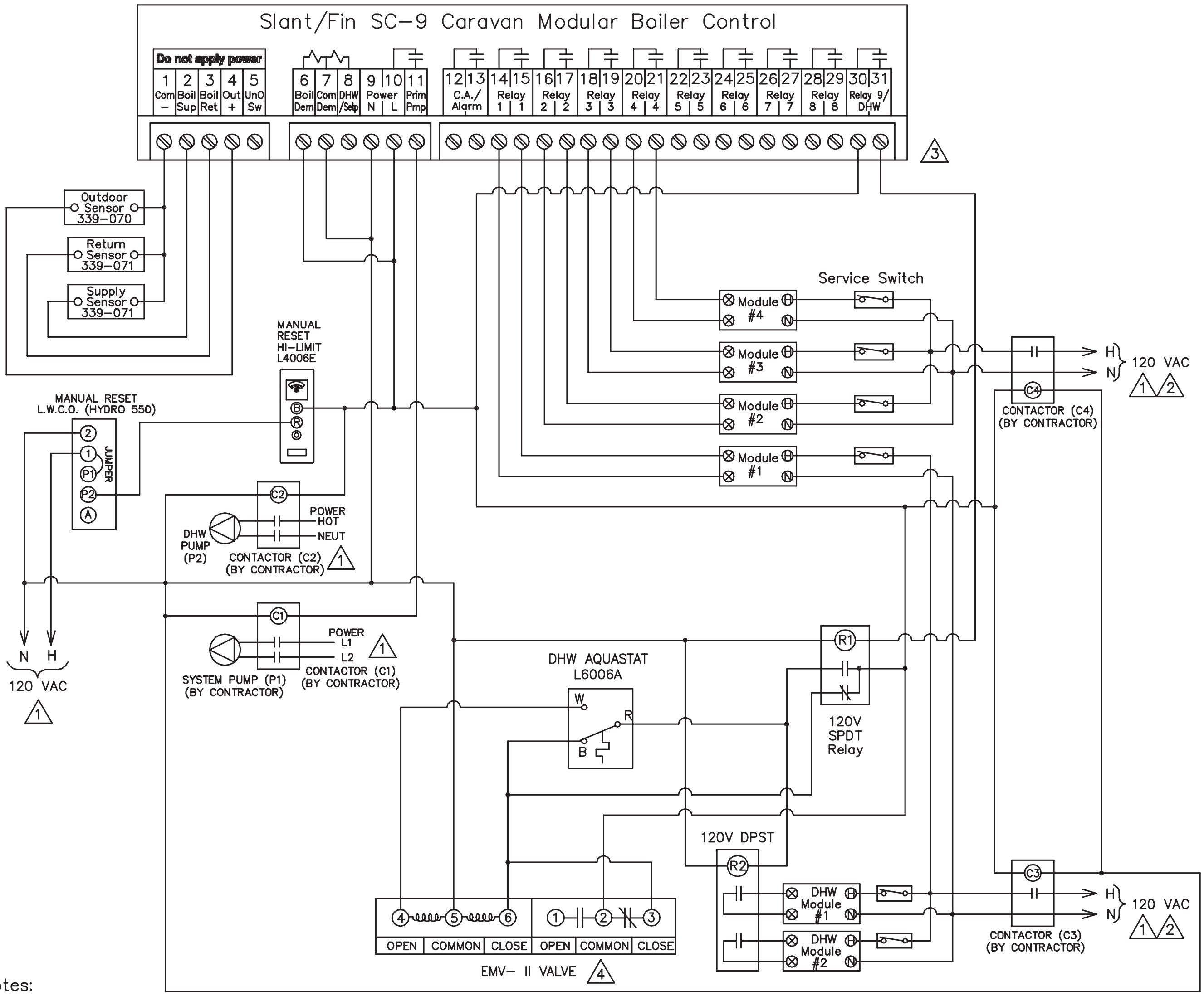


SC-9 SPACE HEATING LADDER WIRING DIAGRAM



⊗ – SEE FIG. C1 FOR CONNECTION AT MODULE.

SC-9 SPACE AND DOMESTIC HOT WATER WIRING DIAGRAM



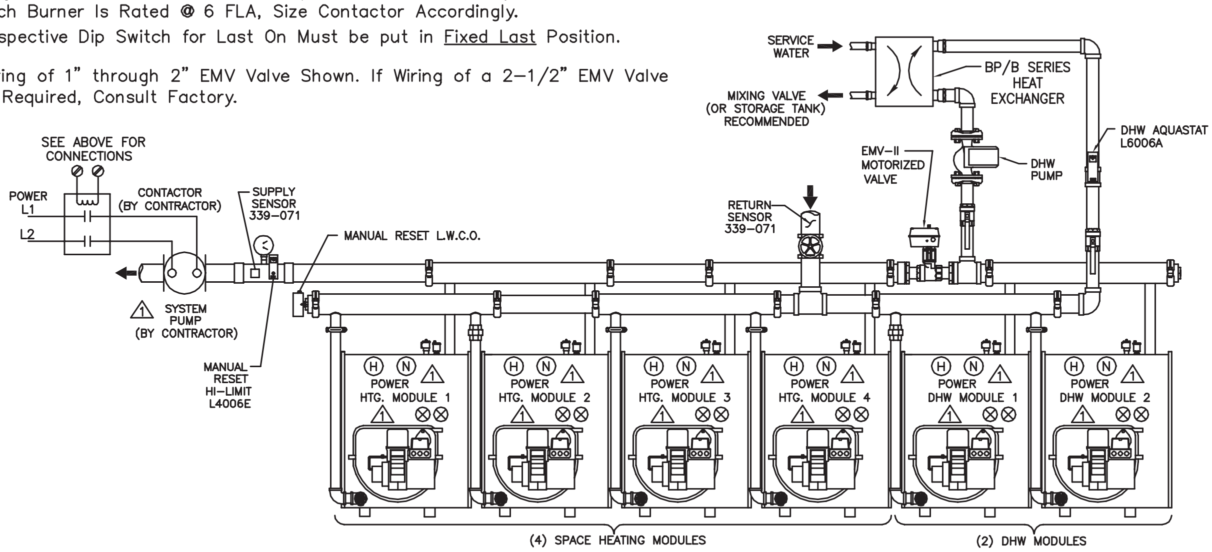
Notes:

1 – Provide Disconnect Means and Overload Protection As Required by Local Code.

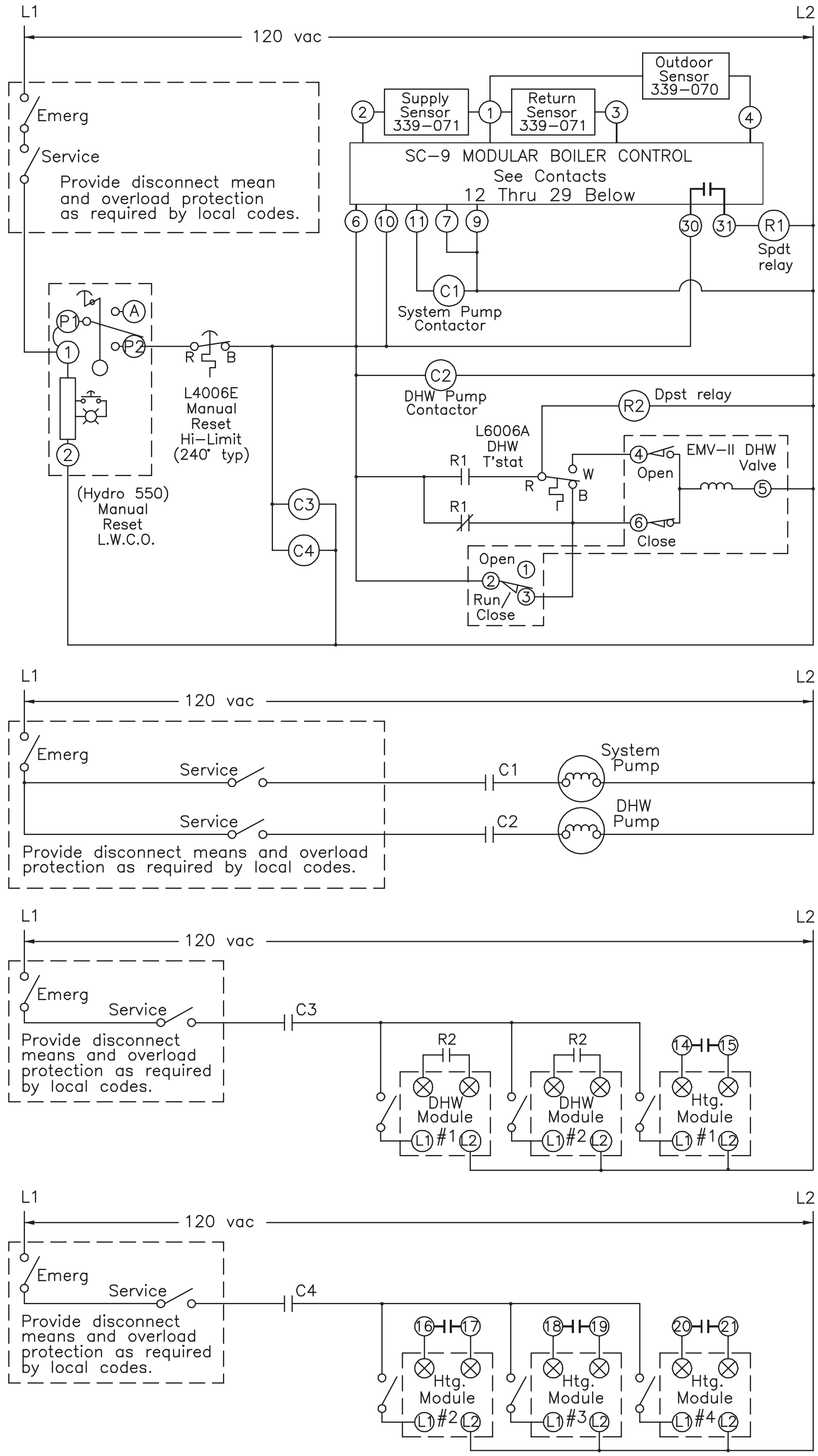
2 – Single Pole Contactors Shown, Multiple Pole Contactor May be Used. Each Burner Is Rated @ 6 FLA, Size Contactor Accordingly.

3 – Respective Dip Switch for Last On Must be put in Fixed Last Position.

4 – Wiring of 1" through 2" EMV Valve Shown. If Wiring of a 2-1/2" EMV Valve is Required, Consult Factory.



SC-9 SPACE AND DOMESTIC HOT WATER LADDER WIRING DIAGRAM



⊗ – SEE FIG. C1 FOR CONNECTION AT MODULE.

Slant/Fin
Limited Five-Year Warranty

for Caravan Modular and Individual Commercial Application Cast-iron Hot Water Boilers in Space Heating Applications.

WARRANTY INCLUDES:
FIRST YEAR: Repair or replacement in accordance with warranty service procedure, for a period of one year after original installation, of all parts found to be defectively manufactured.

WARRANTY INCLUDES:
SECOND THROUGH FIFTH YEAR: Repair or replacement for the second through fifth year after original installation, of cast iron heat exchanger found to be defectively manufactured, at no cost for the replacement part. The repaired or exchanged part will be warranted for only the unexpired portion of the original warranty.

This warranty extends only to boilers in space heating applications. See "Additional Warranty Terms" section for more details.

Warranty extends only to boilers which have been properly installed, operated and maintained in accordance with Slant/Fin installation instructions and all applicable codes. Warranty applies only if the boiler has remained at all times in the location at which it was originally installed. Slant/Fin makes no express warranties other than the warranties contained herein.

WARRANTY EXCLUDES:
All labor charges incurred by any person in connection with the examination, removal, and repair of parts claimed to be defective and the installation of replacement parts.

The part claimed to be defective shall be returned to Slant/Fin. The cost of shipment to Slant/Fin is borne by the consumer.

Damage caused by water that contains excessive lime, calcium, or other contaminants.

Boilers operated with combustion air that may be contaminated by chemicals or improper fuel additives.

Improper burner adjustments, control settings or maintenance procedures.

***NOTE**: Boilers are to be used in closed systems. Any application that causes significant quantities of fresh make up water to enter the system is not permitted. Such applications can be met with a heat exchanger that will maintain the boilers in a closed system.*

AFTER FIRST YEAR, WARRANTY EXCLUDES:
All boiler components other than a cast-iron heat exchanger, such as, sheet metal base, jacket, insulation, combustion chamber, tankless heater exhaust and air inlet piping, burner enclosure, mixing elbow, gas and air orifice, blower assembly, air filter and electrical and mechanical components furnished to Slant/Fin by other manufacturers, such as pumps, relays, controls, gauges, etc.

PROCEDURE FOR WARRANTY SERVICE:
For warranty service, provide the person who installed your Slant/Fin boiler with the following information: boiler model number and serial number (from the boiler rating plate) and the date of installation. That person will notify the Slant/Fin wholesaler from whom the boiler was purchased.

Part(s) claimed to be defective must be returned through trade channels and replacement part(s) will, if warranty conditions are met, be provided by Slant/Fin through the wholesaler.

If there are any questions about the coverage of this warranty, please contact Slant/Fin at the address shown below.

LIMITATIONS ON IMPLIED WARRANTIES AND DAMAGES:
Slant/Fin assumes no liability for damages or unsatisfactory performance of any kind which is a result of improper installation.

Slant/Fin's sole obligation in the event of a breach of any implied warranty (including, but not limited to, implied warranties of merchantability and fitness for a particular purpose) is limited to repair or replacement, and all such warranties are limited in duration to the period of time after the date of original installation as stated above.

This warranty does not cover claims for incidental or consequential damages resulting from a breach of any express or implied warranty or any other reason.

Some states do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of incidental or consequential damages. So the above limitation or exclusion may not apply to you.

THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.

Technical Service Department

Slant/Fin®

Slant/Fin Corporation, 100 Forest Drive at East Hills, Greenvale, N. Y. 11548 • (516) 484-2600

CARAVAN SYSTEM RATING PLATE

System rating plate format for Caravan modular boiler system.
System rating plates are available upon request using the form on the back cover.

Slant/Fin® CORP. GREENVALE, NEW YORK 11548

CARAVAN

OIL FIRED CAST IRON BOILER SYSTEM

CARAVAN SYSTEM SERIAL NO.:

CARAVAN MODEL NO.

CONSISTING OF MODEL BOILER MODULES

INDIVIDUAL BOILER MODULE SERIAL NUMBERS:

MODEL NO.	CARAVAN SYSTEM	INDIVIDUAL BOILER MODULE
I.B.R. BURNER CAPACITY LIGHT OIL GALS./HR.:		
I.B.R. GROSS OUTPUT BTU/HR.:		
D.O.E. CAPACITY BTU/HR.:		
NET I.B.R. WATER BTU/HR.:		
NET I.B.R. STEAM BTU/HR.:		
NET I.B.R. STEAM SQ. FT.:		

SAMPLE

CERTIFIED BY SLANT/FIN CORP.
MAXIMUM WORKING PRESSURE

SYSTEM	INDIVIDUAL BOILER MODULE
MAWP,WATER ____ PSI	MAWP,WATER ____ PSI
MAWP,STEAM ____ PSI	MAWP,STEAM ____ PSI
MAXIMUM WATER TEMP. ____ F	MAXIMUM WATER TEMP. ____ F
TOTAL SYSTEM MINIMUM RELIEF VALVE CAPACITY ____ LBS./HR.	MINIMUM RELIEF VALVE CAPACITY ____ LBS./HR.
SEE INDIVIDUAL BOILER MODULE CAPACITY	FOR INDIVIDUAL BOILER MODULES

0302.btw

Slant/Fin®

REQUEST FOR CARAVAN SYSTEM RATING PLATE

Each individual Caravan module is shipped with a rating plate bearing the model, serial number, capacities and certifications for that module. A modular boiler system is a single boiler. To meet local requirements, a system rating plate will be issued by Slant/Fin upon request. Just provide the information indicated on this page.

Slant/Fin Tech Service	FAX THIS REQUEST TO:	516-484-6958
	PHONE:	516-484-2600

Requested by: ______________________

____

____

Phone: ______________________
Required

Mail to: ______________________

____

____

Phone: ______________________
Required

NOTE:

INDICATE ACCURATELY
Some model numbers are similar, such as GGT-600 and GGT-600E etc.

PLEASE USE CARE TO MAKE SURE THE PROPER SYSTEM MODEL IS INDICATED COMPLETE WITH LETTER SUFFIX.

BE ACCURATE!
INCLUDE ALL LETTERS AND ZEROS, ENTER ALL INFORMATION ASKED FOR!

USE A SEPARATE FORM FOR EACH SYSTEM

Type of System:

- ☐ Gas
- ☐ Oil
- ☐ Water
- ☐ Steam
- ☐ Natural Gas
- ☐ Propane
- ☐ Dual Fuel

INDICATE SYSTEM MODEL NUMBER BELOW:

____

INDICATE SERIAL NUMBERS OF INDIVIDUAL MODULES (Please write legibly)

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

DO NOT WRITE BELOW THIS LINE
FOR SLANT/FIN USE ONLY

System serial number assigned ______________________ Done by ______________________

Eastern Mechanical Services, Inc.

64Triangle Street
PO Box 246
Danbury, CT 06813

Project Name: Children's School		Job number/loc: 1245 / Stamford		Testing Technician: Karl Burr
Date	Description	Model	Serial No.	Result
8/9/2007	Carlin 102CRP oil burner	Carlin	478093	

High fire vacuum reading at oil pump inlet	2" HG
Oil nozzle supply pressure	150PSI
Power supply	120volts/1ph/60Hz
GPH firing rate	250 with 70degree P nozzle
CO2	12.5
Bacharach scale smoke number	0
Overfire draft	"-.02"
Stack outlet test point draft	"-.04"
Net stack temperature	400 F net
Combustion efficiency	84%
Low water cut off worked properly	Yes
High water cut off worked properly	N/A
Flame safeguard control ignition failure	Yes
Flame safeguard control main flame failure	Yes
Burner air flow switch	N/A
Induced draft fan controls	N/A
Over fire draft controls	N/A
Fresh air damper switch	N/A
Barometric damper	Yes
Boiler room combustion air and ventilation provisions correct	Yes
Oil tank vent system checked	Yes
All oil lines checked for leaks	Yes
All gas lines checked for leaks	N/A
Gas lines and controls properly vented	N/A
Fuel Grade	#2 fuel oil
Signature:	

CT Licenses:
F1-10573, S1-303124, P1-277842, SM1-3935

Eastern Mechanical Services, Inc.

64Triangle Street
PO Box 246
Danbury, CT 06813

Project Name: Children's School		Job number/loc: 1245 / Stamford		Testing Technician: Karl Burr
Date	Description	Model	Serial No.	Result
8/9/2007	Carlin 102CRP oil burner	Carlin	478095	

High fire vacuum reading at oil pump inlet	2" HG
Oil nozzle supply pressure	150PSI
Power supply	120volts/1ph/60Hz
GPH firing rate	250 with 70degree P nozzle
CO2	12.5
Bacharach scale smoke number	0
Overfire draft	"-.02"
Stack outlet test point draft	"-.04"
Net stack temperature	400 F net
Combustion efficiency	84%
Low water cut off worked properly	Yes
High water cut off worked properly	N/A
Flame safeguard control ignition failure	Yes
Flame safeguard control main flame failure	Yes
Burner air flow switch	N/A
Induced draft fan controls	N/A
Over fire draft controls	N/A
Fresh air damper switch	N/A
Barometric damper	Yes
Boiler room combustion air and ventilation provisions correct	Yes
Oil tank vent system checked	Yes
All oil lines checked for leaks	Yes
All gas lines checked for leaks	N/A
Gas lines and controls properly vented	N/A
Fuel grade	#2 fuel oil
Signature:	

CT Licenses:
F1-10573, S1-303124, P1-277842, SM1-3935

Eastern Mechanical Services, Inc.

64Triangle Street
PO Box 246
Danbury, CT 06813

Project Name: Children's School		Job number/loc: 1245 / Stamford		Testing Technician: Karl Burr
Date	Description	Model	Serial No.	Result
8/9/2007	Carlin 102CRP oil burner	Carlin	478094	
			High fire vacuum reading at oil pump inlet	2" HG
			Oil nozzle supply pressure	150PSI
			Power supply	120volts/1ph/60Hz
			GPH firing rate	250 with 70degree P nozzle
			CO2	12.5
			Bacharach scale smoke number	0
			Overfire draft	"-.02"
			Stack outlet test point draft	"-.04"
			Net stack temperature	400 F net
			Combustion efficiency	84%
			Low water cut off worked properly	Yes
			High water cut off worked properly	N/A
			Flame safeguard control ignition failure	Yes
			Flame safeguard control main flame failure	Yes
			Burner air flow switch	N/A
			Induced draft fan controls	N/A
			Over fire draft controls	N/A
			Fresh air damper switch	N/A
			Barometric damper	Yes
			Boiler room combustion air and ventilation provisions correct	Yes
			Oil tank vent system checked	Yes
			All oil lines checked for leaks	Yes
			All gas lines checked for leaks	N/A
			Gas lines and controls properly vented	N/A
			Fuel grade	#2 fuel oil
		Signature:		

CT Licenses:
F1-10573, S1-303124, P1-277842, SM1-3935

ADVANCED TECHNOLOGY. TOTAL COMFORT.

Double Wall Safety Fuel Oil Storage Tanks

Installation Instructions

For single and Multiple Tank Applications

c UL us Listed under SU2258

Meets the requirements of NFPA 31 (2006) and CSA B-139-04

USA Contact Info:

Roth Industries
77 Circuit Drive
North Kingstown, RI 02852
Phone: 401.267.9044
Toll Free: 888.316.7684
Fax: 401.267.9048
E-mail: info@roth-usa.com
Web Site: www.roth-usa.com

Canadian Contact Info:

Roth Canada
1607 Rue de l'Industrie
Beloeil, QC J3G 4S5
Phone: 450.464.1329
Toll Free: 800.969.7684
Fax: 450.464.7950
E-mail: service@roth-canada.com
Web Site: www.roth-canada.com

Table of Contents

1. General Warnings

Please read and observe these warnings! Failure to comply may void the tank warranty!

- Roth Double Wall Safety Fuel Oil Storage Tanks must be installed by a person who has successfully completed Roth-certified DWT installation training and the tank(s) must be installed according to these instructions.

- *All Roth tanks (both inner and outer) are pressure tested at the factory according to UL® standards and do not require additional field testing*. If local codes require pressure testing of the piping, it should be done with the pipes disconnected from the tank. Further information is available in this manual.

- Do not stand on or store heavy objects on the top of these tanks.

- Do not install this tank if there is physical damage which may affect the integrity of either the inner tank or outer containment tank. Further information is available in this manual.

- Do not remove the Leak Detector from the tank.

- All tanks must be installed with an approved vent alarm (Roth Vent Alarm #335000999, or equivalent sized UL listed whistle vent) in order to maintain warranty requirements.

- Roth Suction Assemblies are an *optional* accessory and are not recommended for all installations. Further information on acceptable and unacceptable applications for the Suction Assembly is included in this manual.

- All tanks installed outside must have a Roth approved cover as specified in this manual.

- All multiple tanks must be installed with the Roth Expansion Kits or with separate fill lines for each tank as described in this manual. A field constructed manifold for the vent piping may be used on multiple tanks with separate fill lines if permitted by local codes.

- Multiple tank installations using the Roth Expansion Kits must have a tight-fitting connection for the delivery truck hose. These tanks must be “pressure filled” at 40-85 gpm (150-325 lpm) and 85 psi (586 kPa) maximum pressure. “Cascade” filling of multiple tanks is not permitted under any circumstances. If “pressure filling” systems are not available on either the delivery truck or the fill connection point all tanks must have separate fill lines.

- The warranty for the steel containment tank is reduced from ten (10) years to five (5) years for tanks installed outdoors within 300’ (92 m) of the high water level of a salt water body.

- The tank warranty is only valid if one copy of the warranty card is completed and returned to the manufacturer within ten (10) days of installation. The second copy must be left with the customer. If the warranty card is not registered as above, the warranty period will begin on the date of manufacture.

- The tank warranty applies to the original installation address only. Reinstallation of the tank at a new location will void the warranty.

- All Roth Safety Tanks should be inspected by the homeowner, a qualified service technician or the fuel oil supplier at the beginning and end of the heating season to verify that the entire system is free of leaks. This is a minimum requirement. Some locations may require the fuel delivery driver to check the system before and after each delivery. Check local codes for requirements.

2. Technical Installation Instructions

General Information

The Roth Double Wall Safety Fuel Oil Storage Tanks are UL® listed in the United States and Canada under SU2258 and approved under NFPA 31 (2001) and CSA B-139-04 as non-metallic fuel oil storage tanks. Other codes may be in effect in your area and may impose additional restrictions. If you have any questions regarding these requirements, please contact your local building or fire official for more information.

The Roth DWT's are available in fiver (5) sizes. Approximate dimensions and capacities are:

Tank Model	DWT 400L	DWT 620L	DWT 1000L	DWT 1000LH	DWT 1500L
Nom. Capacity US gal (liters)	110 (400)	165 (620)	275 (1000)	275 (1000)	400 (1500)
Length inches (cm)	29 (74)	29 (74)	43 (110)	51 (130)	64 (163)
Width inches (cm)	28 (72)	28 (72)	28 (72)	30 (76)	30 (77)
Height Inches (cm)	44 (112)	61 (155)	61 (155)	54 (137)	68 (173)
Min Height Req'd inches (cm)	49 (125)	66 (168)	66 (168)	60 (152)	76 (193)
Tank Weight lbs. (kg)	106 (48)	132 (60)	167 (76)	208 (94)	333 (151)
Shipping Weight lbs. (kg)	115 (52)	143 (65)	185 (84)	230 (104)	358 (162)

Approx. Footprint for Multiple DWT Installations

Tank Model	DWT 400L	DWT 620L	DWT 1000L	DWT 1000LH	DWT 1500L
2 Tanks (Side by Side)	29 x 60 (74 x 152)	29 x 60 (74 x 152)	43 x 60 (110 x 152)	51 x 63 (130 x 160)	64 x 63 (163 x 160)
3 Tanks (Side by Side)	29 x 92 (74 x 234)	29 x 92 (74 x 234)	43 x 92 (110 x 234)	51 x 96 (130 x 244)	64 x 96 (163 x 244)
4 Tanks (Side by Side)	29 x 124 (74 x 315)	29 x 124 (74 x 315)	43 x 124 (110 x 315)	51 x 129 (130 x 328)	N/A
5 Tanks (Side by Side)	29 x 156 (74 x 397)	29 x 156 (74 x 397)	43 x 156 (110 x 397)	51 x 162 (130 x 411)	N/A
2 Tanks (End to End)	N/A	N/A	28 x 90 (72 x 229)	N/A	N/A

Only technicians who have successfully completed an installation training course given by Roth representatives are permitted to install these tanks using the installation tools and guidelines described in this manual. Roth will maintain records of individuals who have successfully completed this training. Proper installation of each tank shall be acknowledged when one copy of the Warranty Certificate is completed and signed by the installing technician.

Inspection of Tank and Contents

Unpacking and Damage Evaluation

Do not remove any protective packaging until the DWT has been delivered to the installation location. After unpacking, each tank should be visually inspected for "unacceptable" damage of the base support, the containment tank, the primary (inner) tank, rolled metal seams, fittings and accessories. Unacceptable damage is defined as any material, component or product defects such as holes, cuts or permanent deformation of the structural or fluid confining parts which could cause leakage, excessive corrosion or other mechanical and fire safety hazards. Minor deformations and dents are acceptable except at the bottom of the dike.

Be sure to use care when you cut the shrink wrap and remove the base and Styrofoam. Properly dispose of all packing materials.

Supplied With All Tanks

All Roth UL Listed tanks are supplied with:

4 - # 1150000024 Cap Nut
3 - # 1150000025 2” Plastic Adapters
4 - # 1150000031 #3 Gaskets
4 - # Threaded Dust Plugs (Discard when ready to start installation if all connections are used)
4 - Bulkhead Nuts (Do not remove)
1 - Leak Indicator (Do not remove)
1 - #3350000025 2” Die Cast Adapter (installed in one of the tank connections)
Warranty Forms (2), Installation Instructions (under packing on top of the tank)

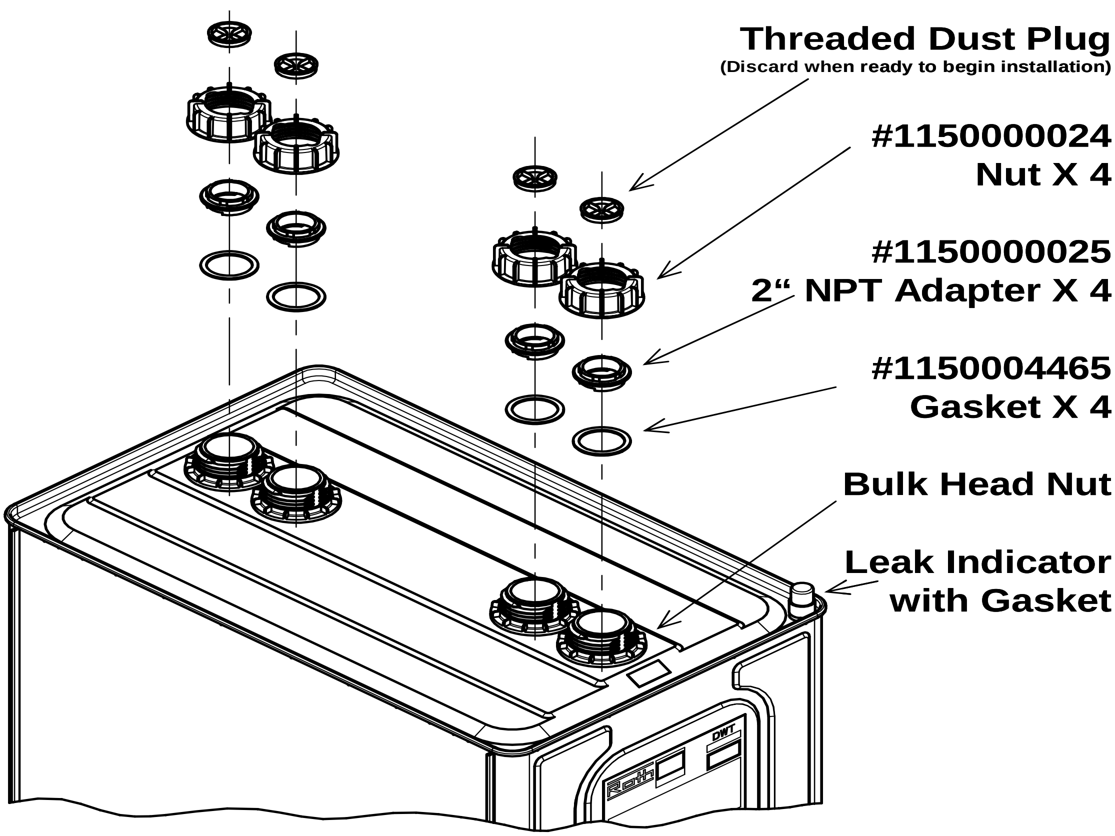


Figure 1

All parts shown in Figure 1 are preinstalled to prevent dirt from entering the tank during shipment. Be sure to inspect for damage and count all parts that come with the Roth DWT prior to installation.

General Installation Instructions

<u>Location Selection</u>
The tank shall be placed into service in accordance with local codes and the listed use (indoor or outdoor) on a flat, level and stable surface, away from heat sources, corrosive atmospheres or fluids, potential mechanical damage or rapid temperature changes. The final location must have the tank label visible after installation.

A minimum of 2” (50 mm) from all walls or obstructions is recommended for normal tank expansion and visual inspection. The integral base support shall not be removed and raising the tank height is not allowed except on a continuous concrete platform at least 6” (150 mm) wider than the tank base at all sides. All local fire code set-backs for fuel oil storage tanks must be observed.

Tanks installed indoors shall not be exposed to direct sunlight on any plastic parts. Tanks installed outdoors shall be assembled with the required cover (Roth #3335100749 for the 400L and 620L, Roth #3335100747 for the 1000L, #1135003721 for the 1000LH and Roth #1135002054 for the 1500L). These covers are purchased separately and are not included with the basic tank.

Piping Connections

Connect the fill, vent, burner fuel supply piping and other accessories in accordance with local codes using only the provided transition or blank fittings and accessories. Only vent alarms specified by the manufacturer (Roth Vent Alarm #335000999, or equivalent sized UL® listed vent whistle) shall be used in the tank before connection with the vent pipe. Care should be taken to ensure proper position of all gaskets and threaded connections to avoid damage or leakage. All pipe and fittings should be hand tightened and inspected for proper alignment prior to final tightening. Tighten the plastic fittings with the Roth Tank Fitting Wrench (#3335100191) or similar device. Plastic fittings should be tightened to approximately 18 ft-lb (2.5 kg-m) initially. You may use approximately 1.5x this torque, if needed. ***Pipe sealants or Teflon tape are not allowed on any of the threaded plastic connections***. Bending of the pipes beyond 15° during assembly, placing stress on the transition fittings or other distortion of fittings is not allowed. Metal threaded connections should be installed in the normal manner with thread sealant, pipe wrenches, etc. All fill, vent and fuel supply piping shall be secured and supported by fire resistant hangers to prevent stress loading of the tank or fittings. The vent and fill piping shall be inspected to verify there are no blockages and terminated outside the building with acceptable fittings and in a location allowed by local codes.

Tanks used in outdoor locations shall be assembled only with the required covers (#3335100749 for the 400L and 620L, #3335100757 for the 1000L, #1135003721 for the 1000LH and 1135002054 for the 1500L) with the fill, vent and fuel gauge located inside the cover. For connection to the burner fuel piping, open a knockout for the tubing to exit the cover and replace it only with a UL® listed outdoor rated bushing matching that tubing size to ensure a liquid-tight fit.

Testing & Approval for Commissioning

Both inner and outer tanks are pressure tested at the factory during assembly according to UL® standards and do not require further field testing. If local codes require a pressure test for the piping, this test should be performed with the piping disconnected from the tank(s). After the assembly is completed, the final connections at the tank may be air tested at 0.5 psi (3.5 kPa) using a leak detection solution on the fittings. It is not necessary to use pressures in excess of 0.5 psi (3.5 kPa) for this purpose. If leaks are found at the plastic connections you may use additional torque of up to approx. 27 ft-lbs (3.7 kg-m) to seal the leak. If the fitting does not seal or is defective it should be replaced. Following the check of the final connections, verify that the Leak Indicator is properly seated. A final visual inspection shall be done at this time including verification that all of the required labels are visible and instructions are available for the user. If all required installation items described above are accepted, the technician shall provide contact information (installing company’s name and phone number) on the owner’s copy of the Warranty Certificate, sign and date the manufacturer’s copy of the Warranty Certificate and then send the manufacturer’s copy to the office of the manufacturer. The manufacturer shall keep this copy on file as proof of proper installation.

Flood, Wind & Earthquake Protection

If tanks are installed in areas subject to earthquakes, high winds or floods, good engineering practices should be observed for tank location, piping support and connections. Local codes may require the installation of particular restraint devices, limit the placement of tanks or impose other installation requirements. You should contact your local building department for further information. We suggest the use of the Roth Tie Down Kit (#3335100749 for the 400L,#3335100222 for the 620L and 1000L, #3335400222 for the 1000LH and #3335400222 for the 1500L) in these areas. Earthquake bands may also be available from your local supply house. These bands secure the tank to a structural wall to limit movement during earthquakes or high winds. ***When using these bands it is important not to screw the band to the outer containment tank as this will destroy the containment tank integrity and possibly damage the inner tank and void the warranty!***

3. Single Tank Installation Instructions (see Figure 2)

Beginning Installation

Insure that all of the General Installation Instructions have been followed.

Set the base on the floor in the desired location. The location should provide a stable, level area capable of supporting the weight of the tank you will be using. Local codes may impose restrictions on the material and construction methods of the base material. Observe all clearances for building and fire code requirements for your area.

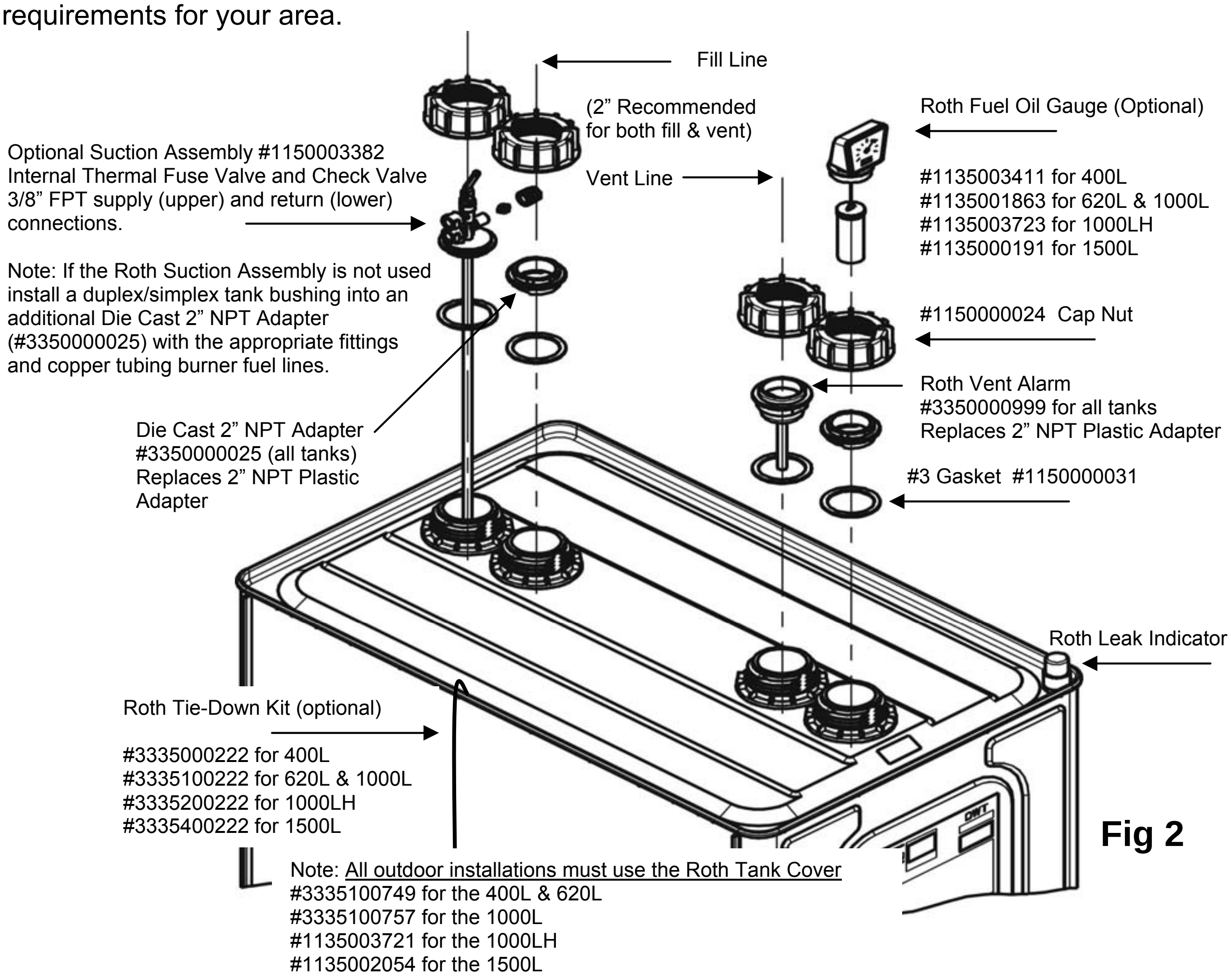


Fig 2

Determine which of the tank openings will be used for the fill, vent, fuel supply/suction assembly and gauge (if used) based on your installation requirements. Figure 2 is a suggested connection diagram only and other connection patterns may better suit your installation requirements. It is strongly suggested that if you use the optional fuel gauge that you install it at the opposite end of the tank from the fuel supply suction. This will ensure that the gauge float does not get tangled in the suction line.

Piping Connections

Remove dust plugs from the tank only when you are ready to use that connection. It is recommended that you assemble all fill and vent lines prior to connecting them to the tank. All piping must be properly supported and aligned with its connection point to the tank. Do not try to straighten the pipe by tightening the plastic cap nut. DO NOT USE THE TANK TO SUPPORT THE PIPE. The tank is not designed to support the weight of the piping and will not tolerate the torque of misaligned pipe.

All piping should be air pressure tested prior to final connection with the tank. Every tank is factory tested. Do not air test the Roth DWT in the field at pressures in excess of 0.5 psi (3.4 kPa) as this will void the tank warranty. If local codes require a piping pressure test higher than 0.5 psi (3.4 kPa), the test must be performed with the piping disconnected from the tank. After a successful piping pressure test make the final connections and perform a final air test on all the connections at no more than 0.5 psi (3.4 kPa) using a leak detection solution on all of the fittings. Do not use any pipe thread sealant or Teflon tape on any plastic threaded connections.

Fill Piping

Each fitting on the top of the tank is a swivel connection. **Do not use Teflon tape or pipe joint compound on any plastic threaded connection or on the gaskets**. Slide the large cap nut over the fill pipe connection and then tighten the 2” die cast adapter onto the end of the pipe. Place the #3 gasket on the sealing face of the adapter and place the adapter on the tank connection. Check the piping for proper alignment and length and adjust as needed prior to the final tightening. Be sure that the gasket is properly seated between the adapter and the tank and tighten the cap nut onto the tank. Firm hand tightening is all that should be needed for a good seal. An optional wrench (#1135002121) is also available. 18-27 ft-lbs (2.5 -3.7 kg-m) is the maximum required torque for this fitting.

Vent Piping

ALL TANKS MUST BE VENTED. <u>Unless another UL® approved system for fill level detection is used, all tanks must have a vent alarm (whistle) installed</u>. We require the use of our proprietary vent alarm (#3350000999) in each tank. This vent alarm also provides a 2” NPT adapter for easy connection of your vent piping to the tank. The Roth Vent Alarm is installed in place of one of the plastic adapters in the top of the tank. Use the cap nut and a #3 gasket to secure the vent alarm in the manner described above.

Vent lines must not be trapped in any way that could reduce the venting capacity of the line. Roth strongly recommends the use of a 2” vent line in all applications; however, local codes may allow some variation. You should contact your local building department or refer to the current edition adopted in your area of NFPA 31 (US) or CSA B-139 (Canada) if you have any questions.

Fuel Supply Piping

When replacing an existing fuel oil storage tank it is the installer’s responsibility to check the condition of the existing fuel lines to the burner and determine if they are serviceable or need to be replaced. Consult your local codes to determine the requirements for your area if the lines need to be replaced. Follow the normal piping practices for supplying oil from top feed storage tanks.

There are two (2) options for the fuel supply piping to the burner: the optional Roth Suction Assembly (#1150003382 for all tank sizes) or a conventional duplex or simplex tank bushing with copper tubing.

<u>Roth Suction Assembly</u>

The Roth Suction Assembly (#1150003382 for all tank sizes) is a combination assembly with burner supply and return connections (⅜" fem NPT), a flexible suction hose and built-in check valve and thermal fuse valve. This unit is easily installed in place of one of the plastic adapters in the top of the tank. It is secured with the Cap Nut and sealed with a #3 gasket. The cap nut is tightened in the manner described above. There is no need for an additional check valve in the burner supply line. Your local codes may require an additional thermal fuse valve at the burner. On 1-pipe systems (burner supply only) the Roth Suction Assembly will increase the vacuum on the line to 1.7" Hg. When using the Suction Assembly on 1-pipe systems we strongly recommend using an oil de-aerator such as a TigerLoop to ensure proper burner operation. Please note that the Suction Assembly will add additional line loss to the system. It is important not to exceed the burner fuel pump manufacturer's recommendations for maximum lift, distance to burner and tubing size. Exceeding these recommendations will cause nuisance burner outages due to lack of fuel. With this in mind, we recommend that burner fuel supply piping be routed only as high as necessary between the tank and the burner. Please refer to the pump installation manual for additional information. You can install a 2-pipe system (burner supply and return) to meet lift or distance requirements when using the Suction Assembly on single tank, indoor installations.

The Suction Assembly may be used in the following applications:

- Indoor installations of a single tank serving a single residential burner with a firing rate less than 3.0 gph (11.4 l/hr) and/or a residential water heater using either a 1-pipe or 2-pipe system
- Indoor installations of a multiple tank system serving a single residential burner with a firing rate of less than 3.0 gph (11.4 l/hr) using a 1-pipe system. ***Do not*** *use the Suction Assembly when using a 2-pipe system and multiple tanks.*

The Suction Assembly *should not* be used in the following applications:

- Supplying burners with firing rates greater than 3.0 gph (11.4 l/hr) – these are considered "commercial" burners
- Supplying any system in which the vacuum exceeds 2.9" Hg (-10 kPa)
- Systems using a transfer pump or pump supplying multiple burners with standpipes or day tanks
- Systems supplying emergency equipment, such as power generators, etc. (these are considered "commercial applications" and should be "hard-piped")
- Supplying multiple burners, except a residential heating appliance and water heater meeting the above criteria
- Outdoor installations where the temperature can be expected to be at or below +10°F (-12°C) for prolonged periods
- Areas where it is common to use tank treatments which contain naphtha. High concentrations of naphtha may cause damage to the suction hose. Oil additives added by the distributor in bulk (before loaded into the delivery truck) usually do not result in high enough concentrations of naphtha to cause problems.

<u>"Hard Pipe" Fuel Supply</u>

Fabricating your own fuel supply line of copper tubing and duplex/simplex tank bushings is always an option with the Roth DWT. This is done in a similar manner to piping any standard top connection fuel tank. Install the tank bushing with the appropriate fittings for the tubing using in a Die Cast Adapter (#3350000025). Please note that only one (1) Die Cast Adapter (for the fill piping) is included with each tank and you will need to purchase a second Die Cast Adapter for this application. Flare fittings are always recommended for all joints in fuel oil lines to ensure proper vacuum seal. Install the suction line to a level that is a minimum of 1" (2.5 cm) above the bottom of the tank to prevent drawing dirt into the fuel line. If a return line is used in your application it should be terminated as customary. If the return line is terminated above the lowest expected fuel level in the tank a check valve will be required to maintain prime during burner off cycles.

Local regulations and good piping practices may require the installation of accessory items in the supply line, such as fire valves, check valves filters, etc. It is the installer's responsibility to know of and comply with these regulations and practices.

“Hard Pipe” fuel lines should always be used in the following applications:

- Burners with firing rates greater than 3.0 gph (11.4 l/hr) in single or multiple tank applications (these are considered “commercial” burners and should always be hard-piped)
- Any system supplying emergency equipment such as generators, etc.
- Any system using transfer pumps supplying day tanks or standpipes
- When supplying multiple burners
- Any system with vacuum requirements exceeding 2.9” Hg (-10 kPa)
- Outdoor tank installations where the temperature can be expected to be at or below +10°F (-12°C) for prolonged periods
- Areas where tank treatments containing naphtha are commonly used
- Multiple tank installations where 2-pipe fuel supply systems are used, either indoor or outdoor

Fuel Level Gauge

Roth has an optional fuel level gauge that can be installed in the DWT. These are sealed gauges and have 2” threaded connections with “O” ring seals and cord style floats. Part #1135000191 fits the 1500L (400 gal) DWT, #1135001863 fits both the 1000L (275 gal) and 620L (165 gal) DWT and #1135003411 fits the 400L (110 gal) DWT. They are installed into one of the plastic adapters included with the tank. Remove the dust plug from one of the 2” plastic adapters and install the fuel gauge into the adapter. Hand tightening is all that is required because the gauge has an “O” ring seal for the threaded connection. Install a #3 gasket on the seating surface and place the unit into one of the tank connections. The cap nut is used to secure the unit to the tank and is tightened in the same manner as mentioned above. We recommend that the fuel gauge not be installed in a port adjacent to the fuel suction line to avoid tangling the float with the suction line.

Outside Installation (Single Tank)

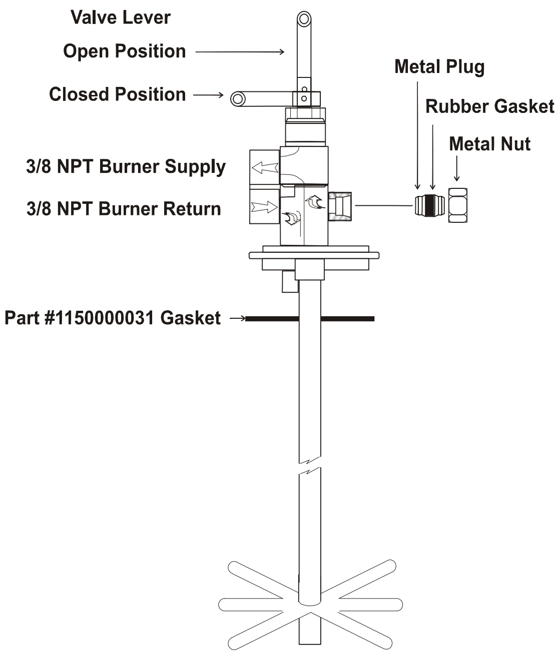
All conditions of the General Installations and Single Tank Installation Instructions apply. Be sure to comply with all local building and fire codes concerning location, clearances and setbacks. A proper cement pad must be provided for the tank base. This base should meet the requirements of the current edition adopted in your area of NFPA 31 (US) or CSA B-139 (Canada) and any other local codes. At a minimum, it should extend 6” (15 cm) beyond the edge of the tank, as described earlier. Consult your local building department if you have any questions regarding these requirements.

All tanks installed outside must use a Roth Approved Tank Cover. Part #1135002054 fits the 1500L (400 gal) DWT, #3335100757 fits the 1000L (275 gal) DWT and #3335100749 fits both the 620L (165 gal) and 400L (110 gal) tanks. The fill pipe, vent pipe and fuel level gauge (if used) are to be located inside the cover. *The Roth Suction Assembly (#1150003382) should not be used in outdoor tank installations if you can expect temperatures at or below +10°F (-12°C) for prolonged periods.* We recommend that outdoor installations have the fuel supply lines “hard piped” using a duplex/simplex tank bushing and copper tubing as described above. The fuel supply line (and return line, if used) must exit the cover through one of the knock-outs provided in the cover and a UL® approved, outdoor rated bushing installed to ensure a liquid-tight seal. All fuel piping to the burner must be properly supported and protected. Some areas also require the use of jacketed containment tubing for both above and below ground fuel lines. Be sure to comply with all local codes and observe good piping practices.

No tank cover is need if the DWT is installed in a garage or shed. A shed must provide protection from rain and snow and prevent water from standing on the top of the tank. Improper protection may allow water to enter the containment tank and freeze. This will damage the inner polyethylene tank and void the warranty.

4. Installation Accessories

Suction Assembly (Fuel Supply Valve) **Fig 3** #1150003382 for all tanks



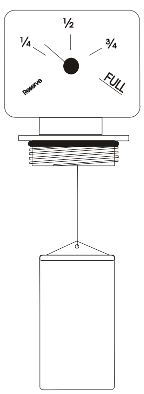
- Built in thermal fuse valve
- Built in check valve
- ⅜" Female IPS connections for burner supply and return (if used) piping
- Can be connected to a 2-pipe system if used with a single DWT
- Can be used with burners that have a firing rate up to 3.0 gph (11.4 l/hr)
- Flexible suction line is easy to install in low overhead clearance applications

Because this valve increases the vacuum to 1.7" (43 mm) Hg, we strongly recommend the use of an oil de-aerator, such as a Flow Control, at the burner when using a 1-pipe system. You can also use a 2-pipe system in single DWT applications.

The plugged port in the rear of the valve is for connecting multiple tanks (1-pipe system only) with the Roth Expansion Kits.

Note: This unit has an internal check valve. You cannot "blow back" on it to clear the line

Fuel Level Gauge



#1135003411 for the 400L
#1135001863 for the 620L & 1000L
#1135003723 for the 1000LH
#1135000191 for the 1500L

- 2" NPT connection has an O-ring seal and only requires hand tightening
- 30 psi pressure rating

Fig 4

Vent Alarm

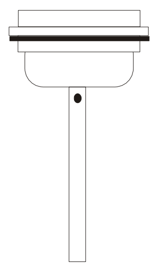
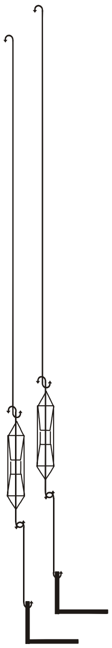


Fig 5

#33350000999 (all tank models)

- Specific for Roth DWT
- All metal construction
- 2" FPT adapter is built in for easy connection of the vent piping

Tie Down Kit
#335000222 for the 400L
#335100222 for the 620L & 1000L
#335200222 for the 1000LH
#335400222 for the 1500L



- Clips over top rim of tank
- Base bolts to floor/concrete
- Turnbuckles adjust tension
- 2 tie downs per kit
- Anchor/lag bolts supplied by installer
- Use one kit in low risk areas
- Use multiple kits in high risk areas

Note: Tighten each side evenly in an alternating pattern. Do not over tighten. Make sure that the tank remains level while tightening the tie downs

Fig 6

Roth Tank Covers
#3335100749 for the 400L & 620L
#3335100757 for the 1000L
#1135003721 for the 1000LH
#1135002054 for the 1500L

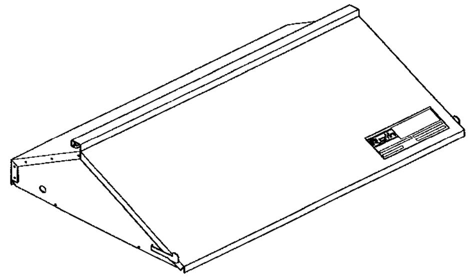
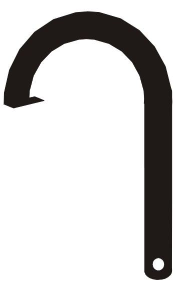


Fig 7

- Assembles and installs quickly with stainless steel screws provided
- Fastens to tank lip with self-tapping screws provided
- Knock-outs on both ends and back (total of 4) for fuel oil supply lines
- Required for outdoor tank installations
- May be used for multiple tank installations with separate fill and vent lines when fuel oil supply lines are manifolded outside the covers.



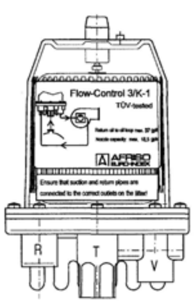
Tank Fitting Wrench
#335100191 (all tank models)

Optional tool for tightening the Cap Nut on all Roth DWT

- Durable painted steel
- Pre-drilled hanger hole

Fig 8

Roth Fuel Oil De-Aerator
#3335100191



Die Cast 2" NPT Tank Adapter
#3350000025 (all tank models)

Fig 9

- Provides 2" female NPT connection point
- One (1) adapter included with each tank
- For connecting the fill pipe to the tank in single tank or "separate fill & vent" multiple tank applications
- For connecting a duplex tank bushing when "hard piping" fuel supply lines *(this requires the purchase of a second adapter in many cases)*

5. Multiple Tank Installations

Initial Considerations

The same considerations for location, setbacks, clearances, etc. that apply to single tank installations also apply to multiple tank installations. In general, the maximum number of tanks that can be installed in a location is five (5) 400L, 620L or 1000L, 1000LH and three (3) 1500L tanks. Be sure to check your local codes to determine what is allowed in your area.

When installing multiple tanks in tandem, all tanks must be the same model, at the same height, level and plumb. You cannot manifold different models without a risk of unequal draining or filling.

Indoor Installations (see Fig 10)

Roth offers easy to install Expansion Kits to manifold multiple indoor tanks. All tanks can be installed in a side by side configuration as shown in Fig 10. Additionally, the 1000L DWT can be installed two (2) tanks end to end. *The end to end configuration is only available for two (2) 1000L tanks.* These kits provide a common vent, fill and fuel oil supply connection. *The Roth Expansion Kits may only be used with a 1-pipe fuel supply system and with a single burner firing less than 3.0 gph (11.4 l/hr) and/or a residential water heater when the Roth Suction Assembly is used.*

***Note*: When using the Roth Expansion Kits, the tanks must be pressure filled! A tight seal connection is required between the delivery truck hose and the fill fitting. The fill rate must be 40 to 85 gpm (150 to 325 lpm) at a pressure not to exceed 85 psi (586 kPa). Failure to fill the tanks within these parameters may result in an overfill of one or more tanks. If a pressure fill connection is not available the tanks must be piped with separate fill lines.**

The Roth Expansion Kits are available in the following configurations:

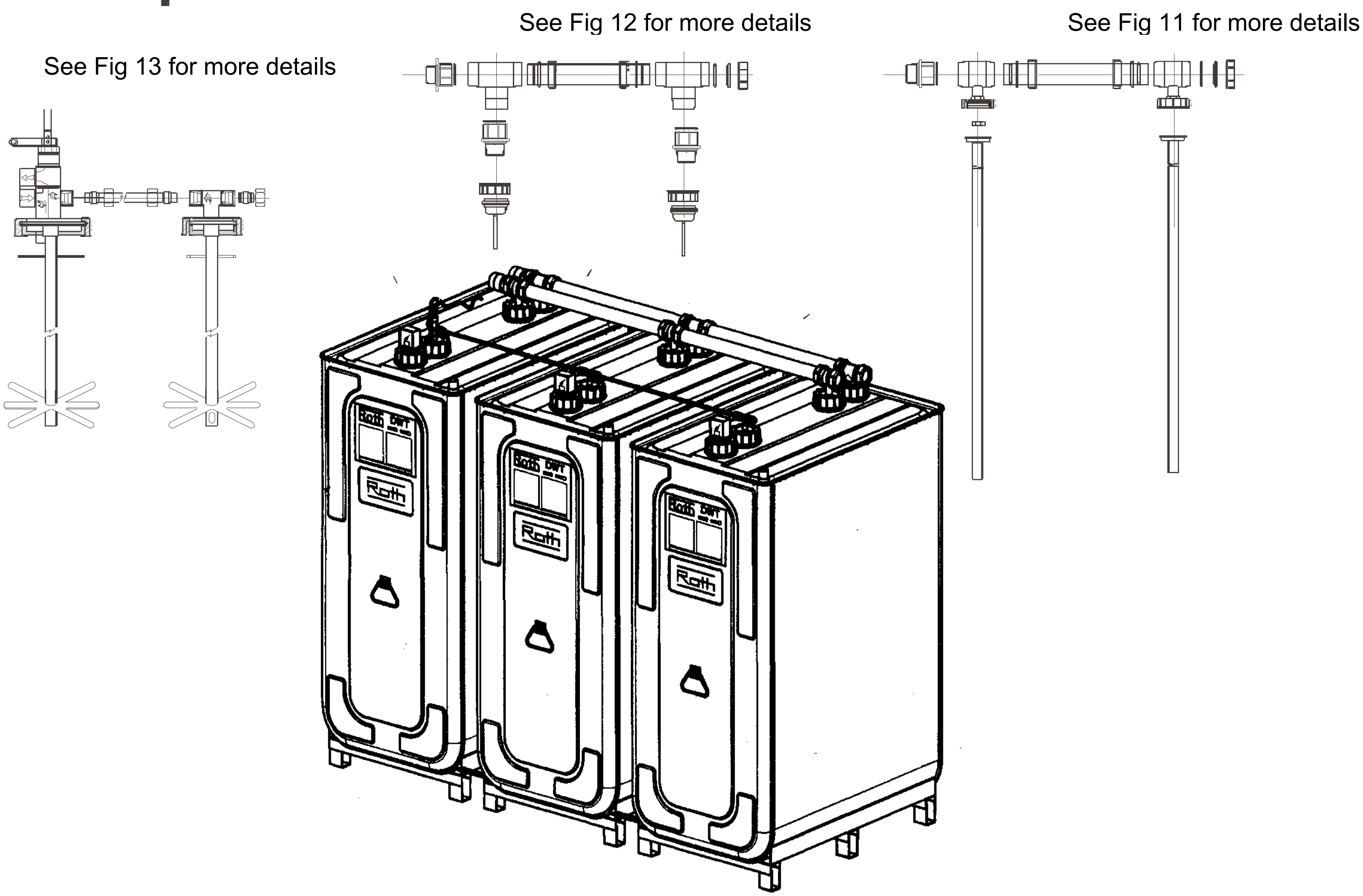
Kit #1 #115007012 For the first two 400L, 620L or 1000L tanks side by side [1]
Kit #2 #115007013 For the 3rd, 4th and 5th 400L, 620L or 1000L tanks side by side
Kit #3 #115005343 For two (2) 1000L tanks in end to end configuration [1]
Kit #4 #115006910 For the first two 1000LH and 1500L tanks side by side [2]
Kit #5 #115006911 For the 3rd 10000LH and 1500L tank in side by side configuration [2]

Notes: [1] The Roth Suction Assembly for the 1st tank (if used) is purchased separately
[2] ***The Roth Suction Assembly is not used with multiple 1500L tanks*. No fuel supply piping is included with Kits #4 or #5. Hard pipe fuel supply lines must be used with multiple 1500L tanks. 4th and 5th tanks are not permitted with the 1500L tank.**

Fill Piping (Important! Do not install tanks without reading this section!)

As noted above, when the Roth Expansion Kits are used to manifold the tanks with a single fill connection, the tanks must be pressure filled at between 40-85 gpm (150-325 lpm) and at no more than 85 psi (586 kPa). This requires a tight fitting connection between the delivery truck nozzle and the fill fitting. *If the proper fill connection or delivery truck hose connection is not available in your area you must use individual fill pipes*. Please see the note above. *Failure to pressure fill tanks using the Roth Expansion Kit fill piping will result in possible over-pressurization or overfill of one or more tanks. This condition will void the warranty*. Some areas do not allow common fill pipes and require individual fill pipes for each tank. Please check your local codes to determine the requirements for your area.

Multiple Tank Side by Side Installation



All multiple tanks must be the size and at the same height.
All tanks must be level and plumb for proper function.
All tanks using the Roth Expansion Kits must be filled at
40-85 gpm (150-325 lpm) at no more than 85 psi (586 kPa).

Fig 10

The fill piping for the Roth Expansion Kits (side by side configuration) #1, #2, #4 and #5 are installed according to Fig 11 (see below).

Multiple Tank Installation - Fill Pipe

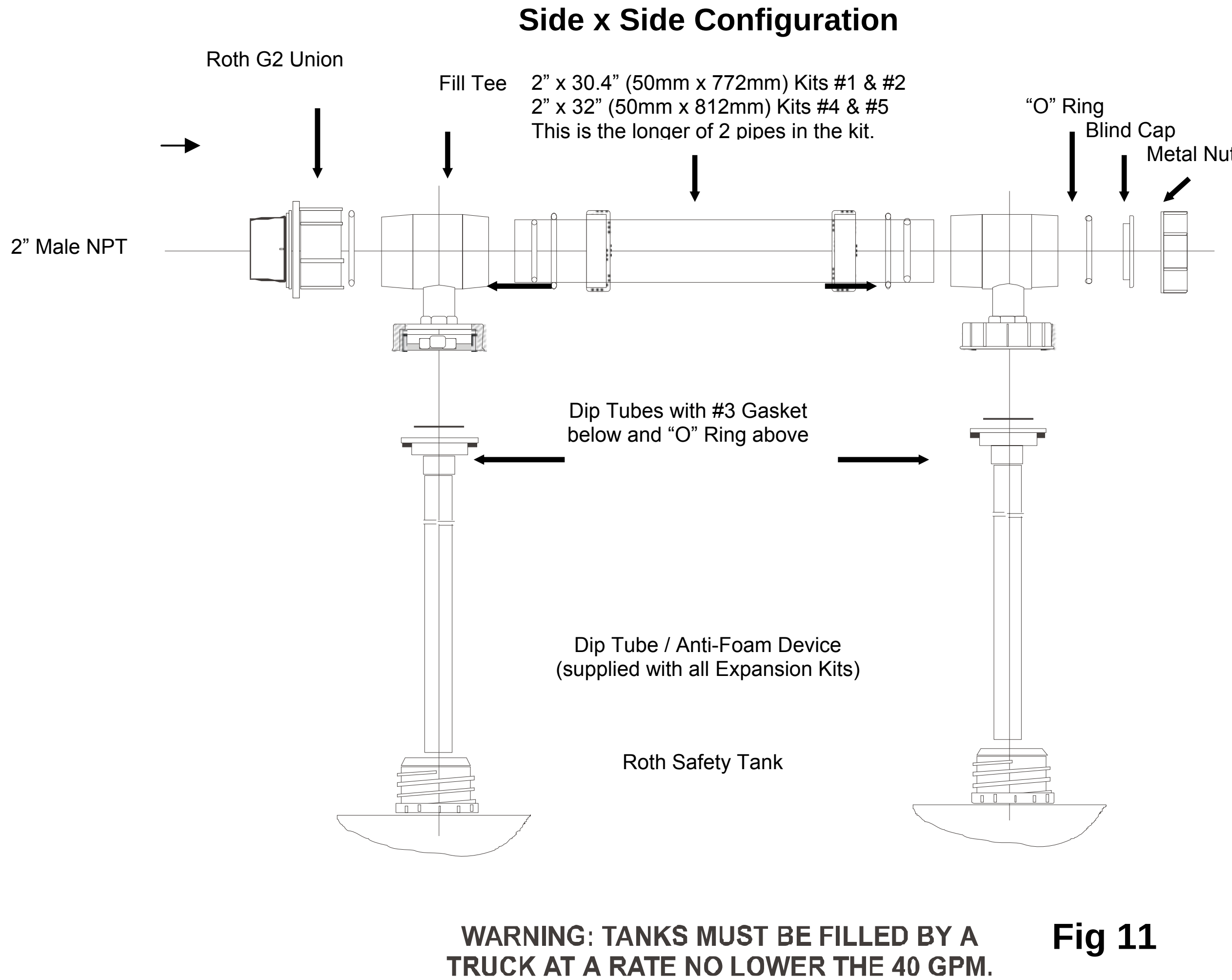


Fig 11

<u>if you are using separate fill pipes for each tank they are piped in the same manner as a single tank installation</u>.

Vent Piping

<u>Each tank in a multiple tank installation must have a separate Vent Alarm</u> (#3335000999) or an equivalent sized UL® listed vent whistle/device to detect the proper fill level of each tank. The Roth Vent Alarm has a built-in 2” NPT female adapter. You must use the G2 union included with the Expansion Kits to connect the Vent Alarm to the Vent Tee. *Do not connect the Vent Tee directly to the Vent Alarm.* This combination will not seal correctly and will result in nuisance oil odors or possible leaks. Most areas will allow a common vent pipe for multiple tanks even if they require separate fill pipes. Be sure to check your local codes to verify. The Roth Expansion Kit vent piping for side by side tanks is installed as shown in Fig 12 below.

Multiple Tank Installation - Vent Pipe

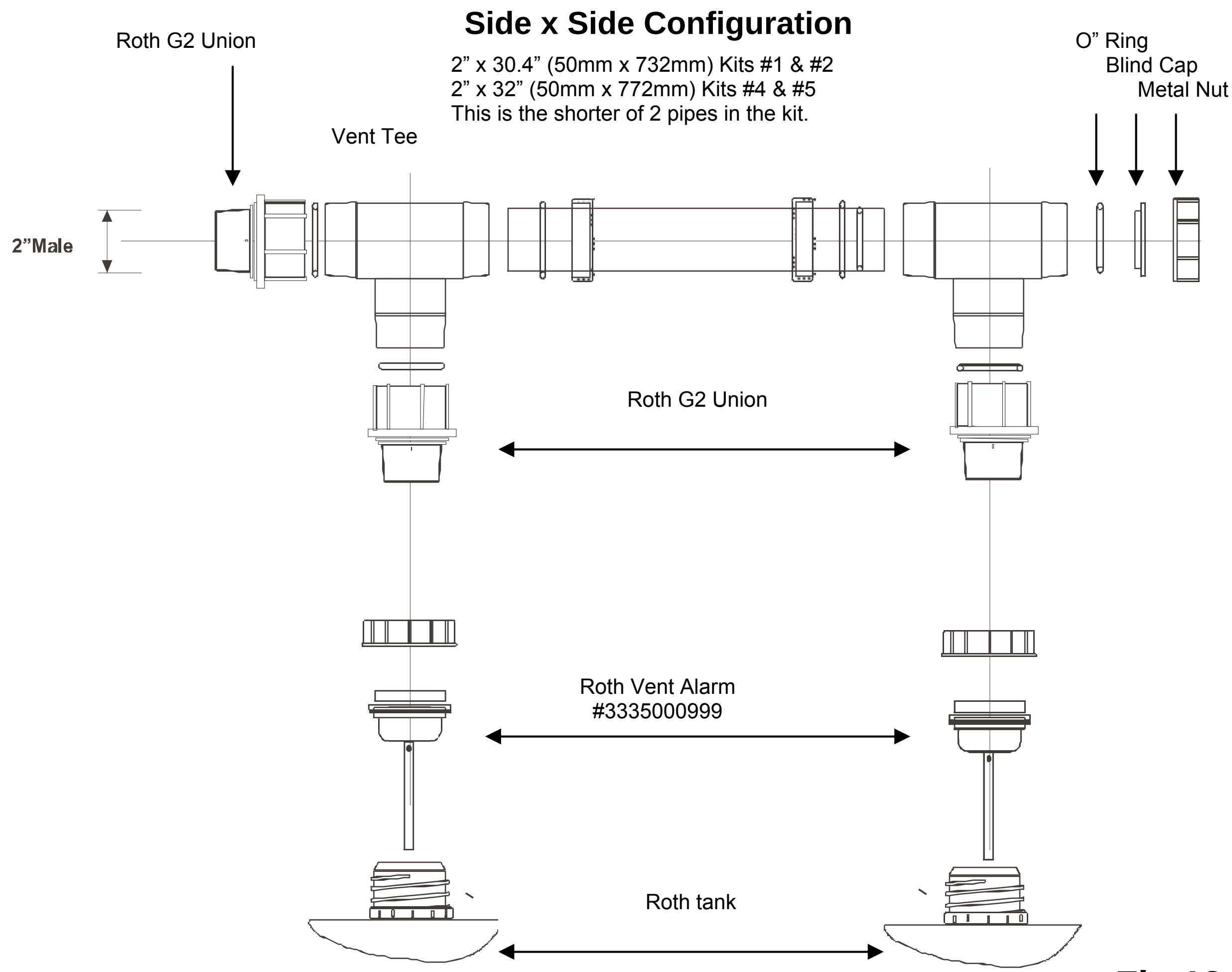


Fig 12

Fuel Supply Piping

There are two options for piping the fuel supply for your burner(s). Depending on the tank size and application you will use both the Roth Suction Assembly and the fuel supply parts included with the Expansion Kit(s) or "hard pipe" the fuel supply lines using tank bushings and copper tubing. The decision is based on the DWT model used and the application.

<u>Roth Suction Assembly and Fuel Supply Parts included with the Expansion Kits</u>
You may only use the Roth Suction Assembly and the fuel supply parts included with the Expansion Kits in the following application:

- Indoor multiple tank applications serving a single burner with a firing rate less than 3.0 gph (11.4 l/hr) and/or a residential size oil fired water heater using a 1-pipe fuel supply system. It is strongly recommended that an oil de-aerator be used on the burner(s) when using the Suction Assembly. The Suction Assembly for the 1st tank must be purchased separately. It is not included in the kits.

You should <u>not</u> use the Roth Suction Assembly and fuel supply parts in the following applications:

- Multiple tank installations serving a burner with a firing rate greater than 3.0 gph (11.4 l/hr)
- Multiple tank applications using a 2-pipe fuel supply system
- Outdoor installations where the temperature can be expected to be at or below +10°F (-12°C) for prolonged periods
- Multiple tanks serving a burner that can be expected to run for prolonged periods (such as a pool heater at the beginning of the season) that may not provide enough "burner off" time to allow for proper tank level equalization.

- Applications where the use of tank treatments containing naphtha are commonly used
- Any 1500L multiple tank installation

The Roth Expansion Kits include the fuel supply assemblies for the 2nd through 5th (depending on configuration and tank size) tanks only. A Roth Suction Assembly must be purchased separately for the 1st tank.

The Roth suction Assembly and fuel supply parts included with the Expansion Kits are installed as shown in Fig 13 below.

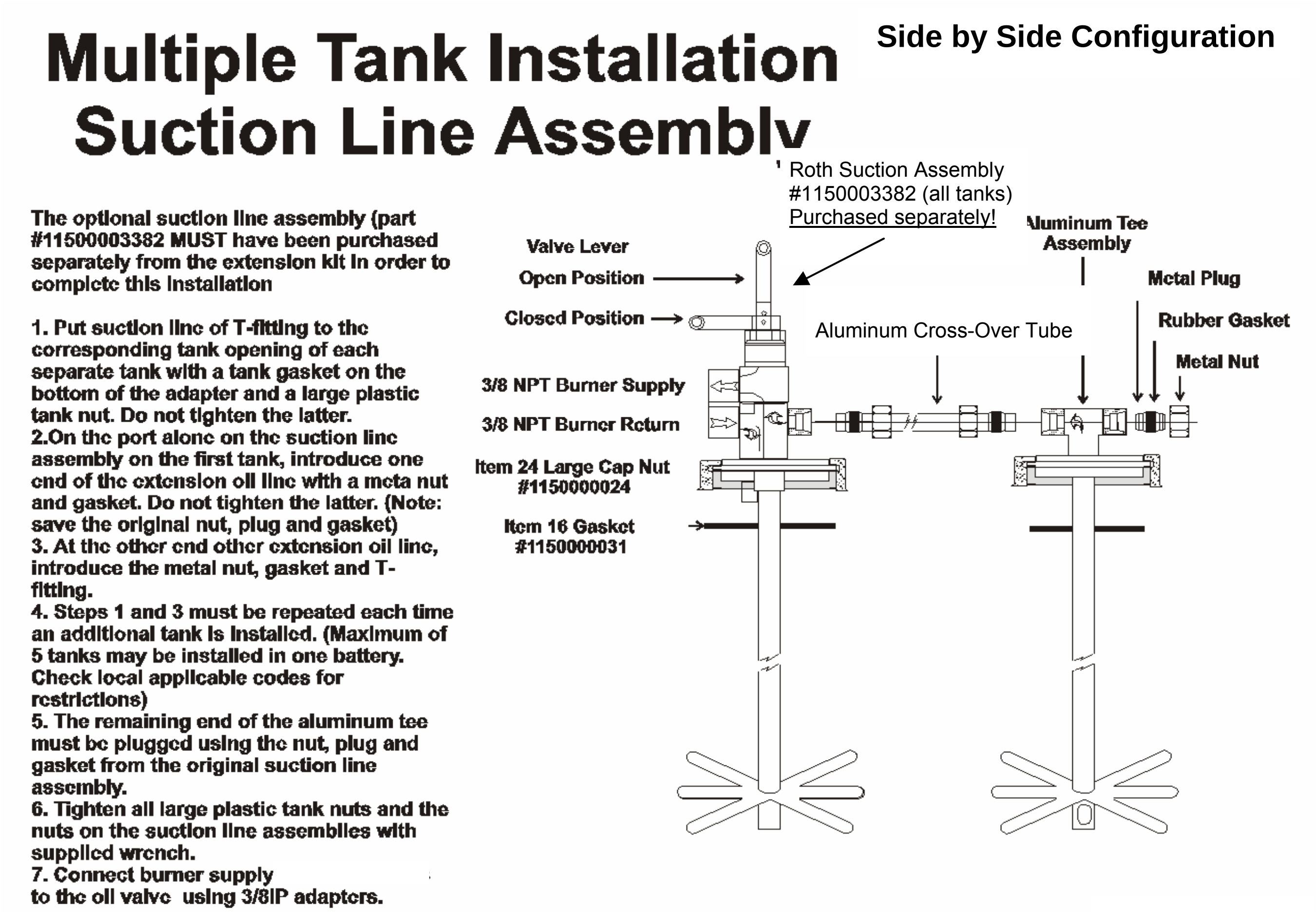
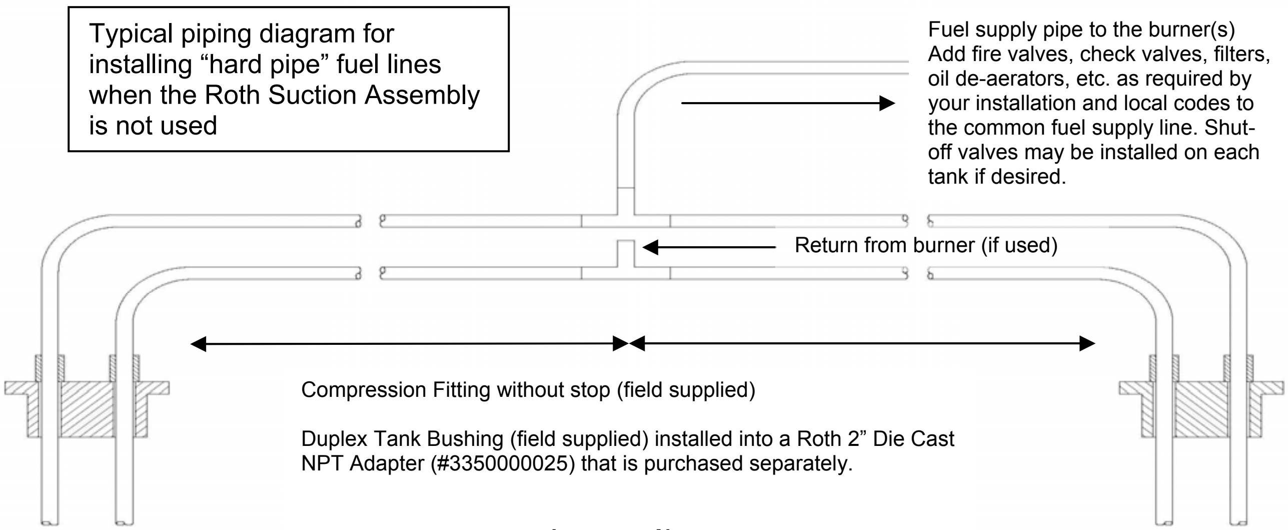


Fig 13

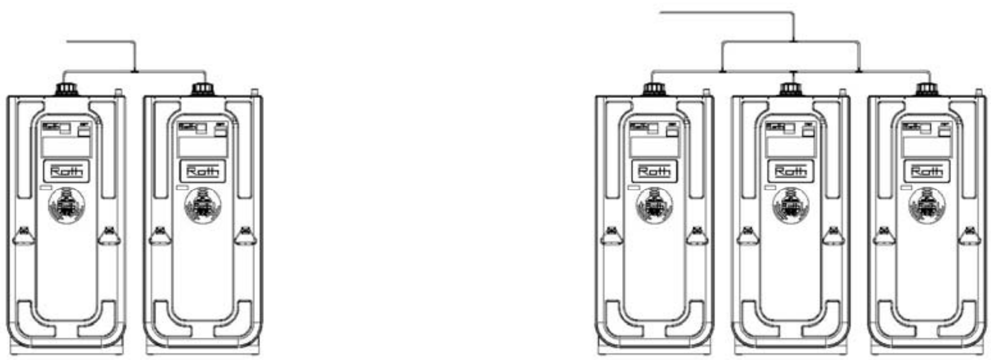
<u>"Hard Pipe" Fuel Supply Piping</u>

"Hard Piping" the fuel supply line(s) is allowed in all applications and configurations of any size Roth DWT. In applications where the Suction Assembly can not be used or is not used by choice, fuel supply piping is field fabricated using standard duplex/simplex 2" tank bushings with copper tubing (sized for the application) in an "Equal Manifold" configuration. This method applies to a 1-pipe or 2-pipe fuel system. The tanks return piping, if used, must also be an "equal manifold" configuration the same as the supply. It is important to make the manifold parts as close to equal as possible to ensure equal draw from all tanks (1-pipe systems) and equal return to all tanks (2-pipe systems). When connecting the fuel supply piping with a tank bushing and copper tubing and using the Roth Expansion Kits, use the Die Cast 2" NPT Adapter (#3350000025) included with each tank to install the tank bushing. This part is not needed to connect the fill pipe because the fill tee included with the kit connects directly to the tank. Fig 14 shows the basic assembly of the tank bushing and fuel supply piping with two tanks and also the manifold construction with up to five tanks.



Important Note:

Tees are to be installed as close as possible to the center of the pipe run between the two tanks to insure equal draw and return to all tanks.



The maximum lift available from the bottom of the tank to the highest point of the piping is determined by the performance of the burner fuel pump. Please refer to the pump manufacturer’s instructions for maximum available lift. *In most cases a 1-pipe system has 8’ (2.4m) max lift regardless of whether there is single stage or two-stage fuel pump.*

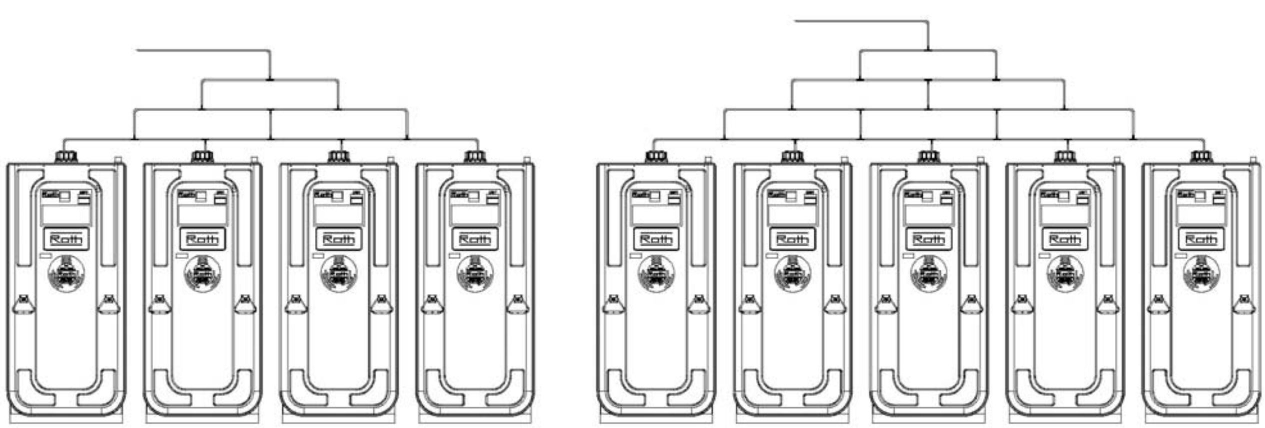


Fig 14

End to End Installations

Roth offers an Expansion Kit #3 (#115005343) for indoor installation of two (2) 1000L tanks. End to end kits are not available for any other model tank or for more than two (2) 1000L tanks. Installation is similar to the side by side kits. The following illustrations show the assembly of this kit.

End to End Multiple Tank Installation

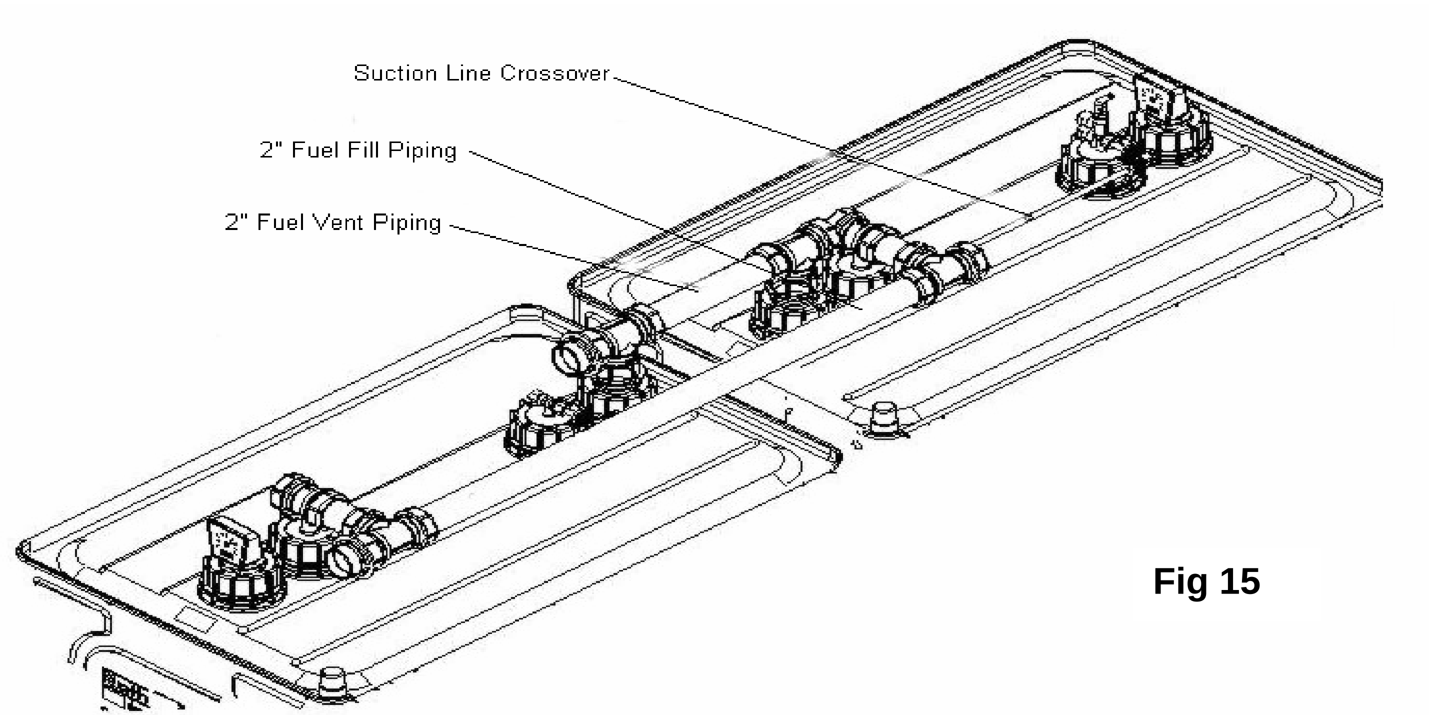


Fig 15

Note: All multiple tank installations using the Roth Expansion Kits <u>must</u> be filled at a rate of 40-85 gpm (150-325 lpm) at no more than 85 psi (586 kPa) with a tight fitting connection between the truck nozzle and fill fitting!

Multiple Tank Installation - End to End Suction Line Assembly

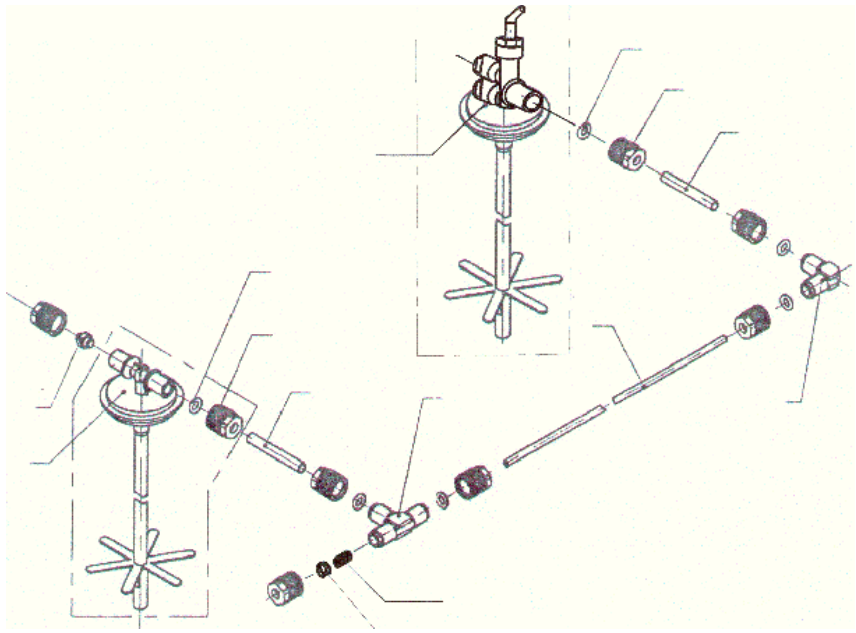


Fig 16

All conditions for multiple tank side by side installations must be observed for end to end multiple tanks installations. These include the acceptable uses for the Roth Suction Assembly, requirement for a Vent Alarm for each tank. use of the 2” NPT Transition Adapter between any NPT connection and the compression connection at the vent and fill tees, piping instructions for field assembled “hard pipe” fuel supply lines, etc.

Outdoor Installations of Multiple Tanks

The Roth Expansion Kits cannot be used with outdoor tank installations. The tanks are to be installed in the same manner as single tank outdoor installations. Each tank requires a separate fill pipe, vent pipe and Roth Vent Alarm (#3350000999) or equivalent sized UL® listed vent whistle for accurate indication of the fill level.

All outdoor tank installations require the use of the Roth Tank Cover for each tank (purchased separately). Roth Tank Cover #3335100749 fits the 400L & 620L, #3335100757 fits the 1000L, #1135003721 fits the 1000LH and #1135002054 fits the 1500L. The fill pipe, vent pipe and fuel gauge (if used) must be located under the cover. The fuel supply piping must exit the cover at one of the knock-outs and be sealed with a UL® listed outdoor rated bushing to provide a water-tight seal. Tanks located in a garage of fully-enclosed shed are not required to use the Tank Cover.

In most cases the Roth Suction Assembly will not be acceptable for these installations (refer to the conditions listed in Indoor Multiple Tank Installations, Fuel Supply Piping earlier in the instructions). The tanks will need to be hard piped as in Fig 14 with the manifold assembled on the outside of the cover. All conditions listed for multiple tank indoor installations using hard pipe fuel supply lines also apply to outdoor installations.

If you have any questions regarding any installation please contact the Roth office for your area at the numbers listed on the cover of these instructions.

6. Final Completion

Upon completion of any installation the tank installer shall verify that all conditions of the project are in compliance with these instructions and any local code requirements. The installer shall then complete one of the Warranty Certificates for each installed tank and leave this copy with the owner. Contact information for the installer is to be included on this form. The second copy of the Warranty Certificate is to be completed with date and location of the tank installation, customer contact information, name & address of the installing contractor and installer's signature. The installer's signature is verification that the installation conforms to all Roth instructions and meets the requirements of local codes. The form is then to be returned to the Roth office in your area for warranty registration. Upon receipt of the completed Warranty Certificate Roth will enter this information into its records for future reference. *This information is for warranty purposes only and will not be shared with any other company for reasons other than warranty maintenance.*

Notes

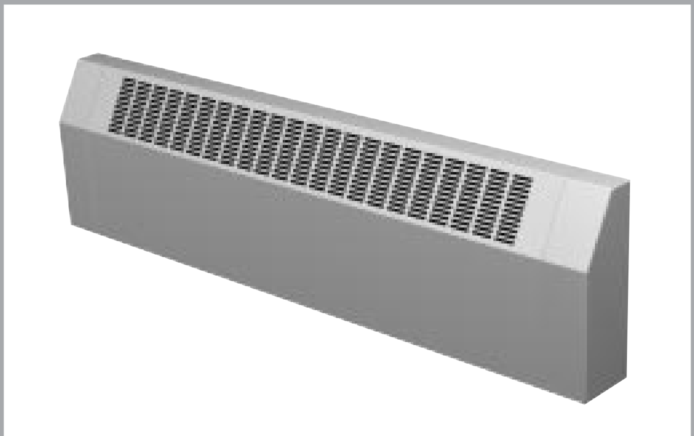
Notes

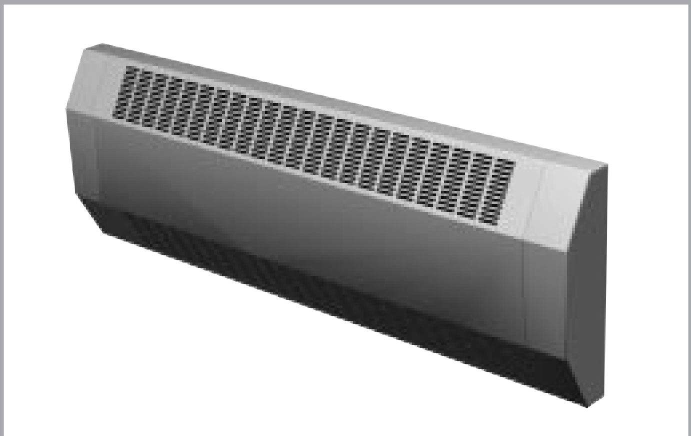
Hydro-Air Components Inc.
4950 Camp Road • Hamburg, New York 14075
Phone: 716-648-3801 • Fax: 716-648-3203
Toll-Free: 800-FIN-TUBE (800-346-8823)
E-mail: sales@rittling.com • www.Rittling.com

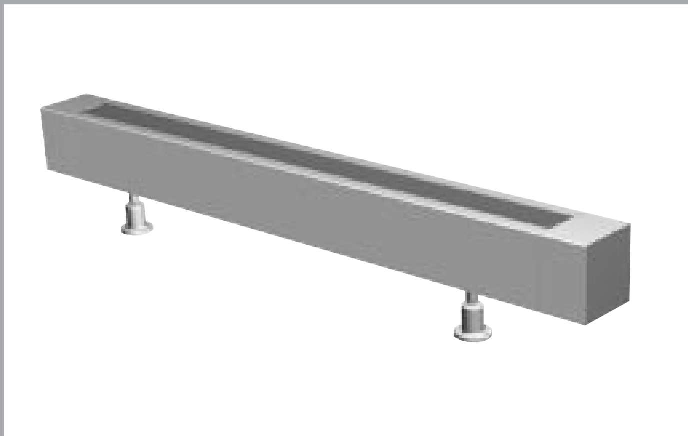
EIOM-1004-2.5M

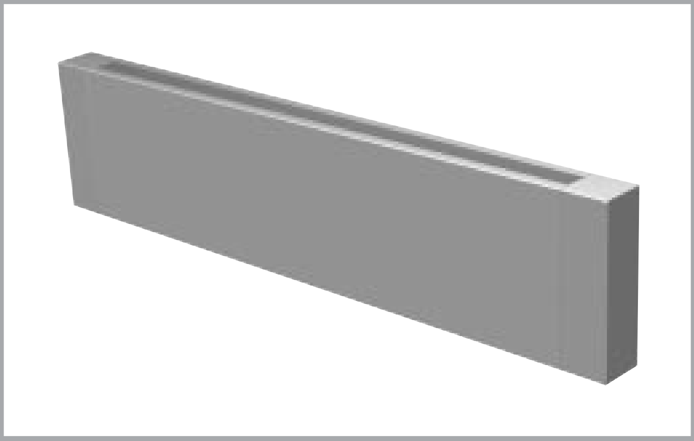
ENCLOSURE INSTALLATION & MAINTENANCE INSTRUCTIONS

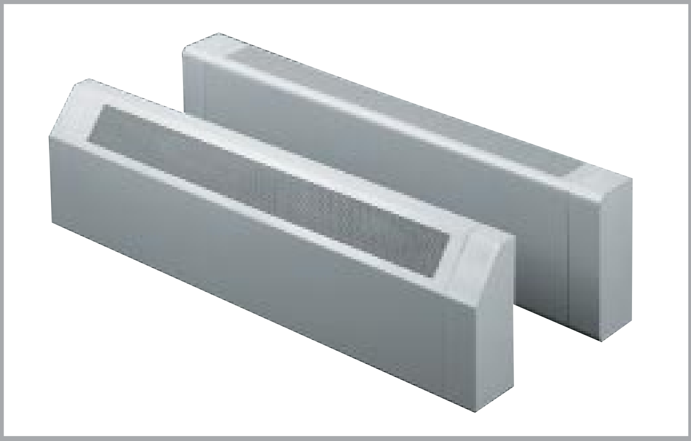
HYDRO-AIR COMPONENTS INC. PEDESTAL • WALL • FLOOR • SECURITY • HARDWARE











Enclosure Installation & Maintenance Instructions

Pedestal • Wall • Security • Hardware

Inspection

Inspect the entire shipment for damage, either readily visible or concealed. Remove shipping carton upon receipt and inspect for any damage that might have occurred in transit. Any damage should be noted on the freight bill by carrier's agent, a claim filed as soon as possible and your Rittling representative notified. See General Terms and Conditions of Sale for more detail. After inspection, return each enclosure to its carton until ready for installation.

Fin-Tube Radiation Maintenance

Regular maintenance of the fin-tube radiation units will help keep the unit running at optimum capacity. A regularly scheduled inspection and maintenance program should be implemented and followed.

(1) Cover:

Use a soft non-abrasive cloth with a standard household cleaner. Under no circumstances should an abrasive cleaner be used.

(2) Heating Element:

The heating element should be cleaned at least once every year. More frequent cleanings should occur if the heating element appears to have a build-up of contaminants. Remove any dirt by brushing or vacuuming the heating element. High-pressure air may be blown through the heating element to dislodge any built-up contaminants. In extreme cases, it may be necessary to remove the heating element and spray it with a mild alkaline cleaning solution, followed by a rinse.

Standard Rittling Pedestal Enclosure Installation Instructions

Installation

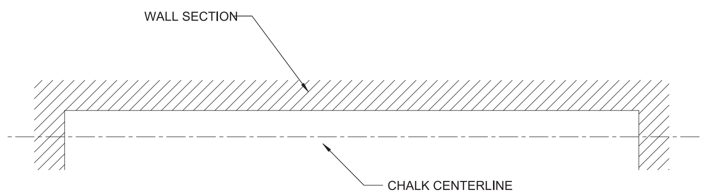


FIGURE P-1

(1) The floor should be continuous and level under each pedestal. Snap a chalk line on the floor along the centerline of the pedestals. The pedestal centerline should be 4" from the wall for one row pedestals, and 6-1/2" from the wall for two row pedestals. (FIGURE P-1)

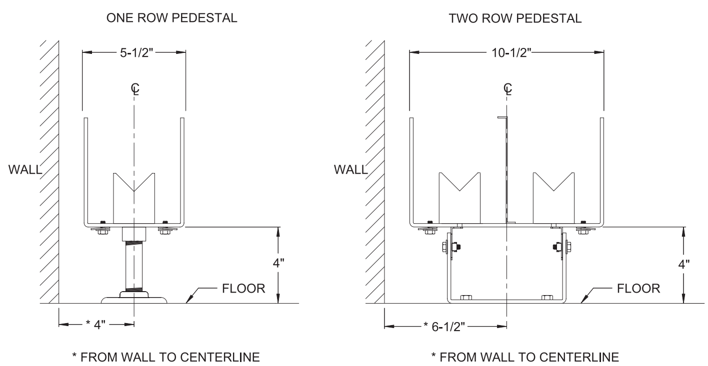


FIGURE P-2

(2a) Place the pedestals along the chalk line evenly. The pedestal should be installed a maximum of 3'-0" apart on center. Secure the pedestal using a fastener suitable for floor construction.

(2b) Adjust the pedestals to the desired height. The minimum recommended height of the pedestal from the floor is 4". (FIGURE P-2)

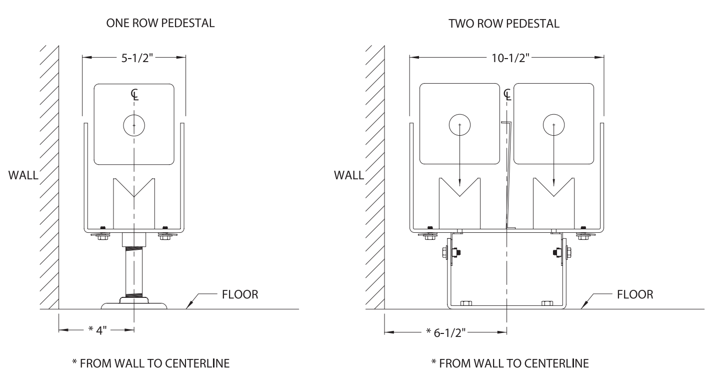


FIGURE P-3

(3) Place the heating element on the pedestal. Before connecting the piping to the system, be sure to purge the system to insure against heating element blockage. Care must also be taken to prevent debris from entering the system when making the piping connections. (FIGURE P-3)

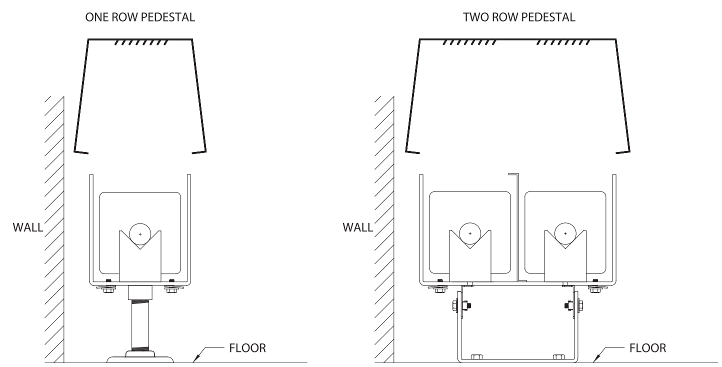
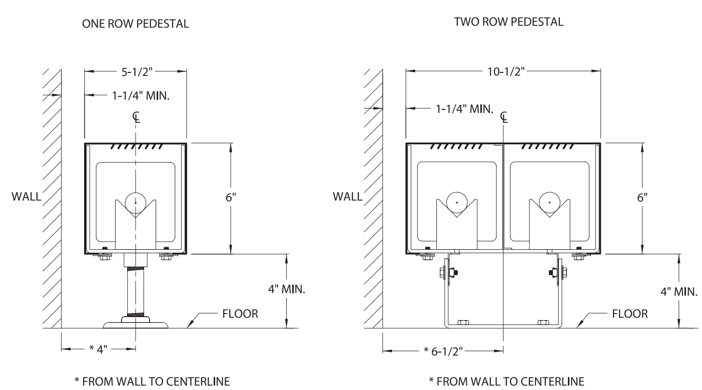


FIGURE P-4

(4) Install the enclosure over the pedestal bracket. (FIGURE P-4)



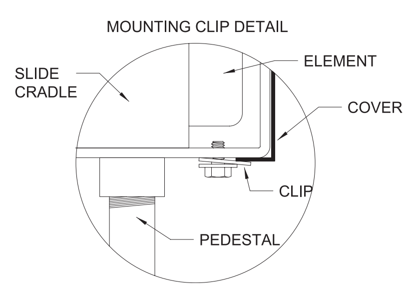


FIGURE P-5

(5) Once the cover is in place, secure the bottom of the enclosure by tightening the mounting clips on the bottom of the bracket. (FIGURE P-5)

Standard Rittling Wall Enclosure Installation Instructions

Installation
(Wall Channel or Full Backplate)

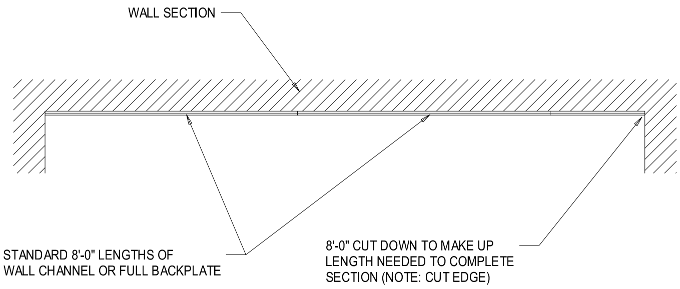


FIGURE W-1

(1a) Determine the distance needed for wall enclosure application. The snap mounting channel or snap full height backplate should be installed on the entire wall surface where the enclosure and accessories will be installed.

(1b) Cut the snap mounting channel or or snap full height backplate to the desired length. The channel and backplate are furnished in lengths of 4'-0" or 8'-0". Combine multiple lengths if needed. When joining two pieces, make sure that the cut end is at the end of the run. (FIGURE W-1)

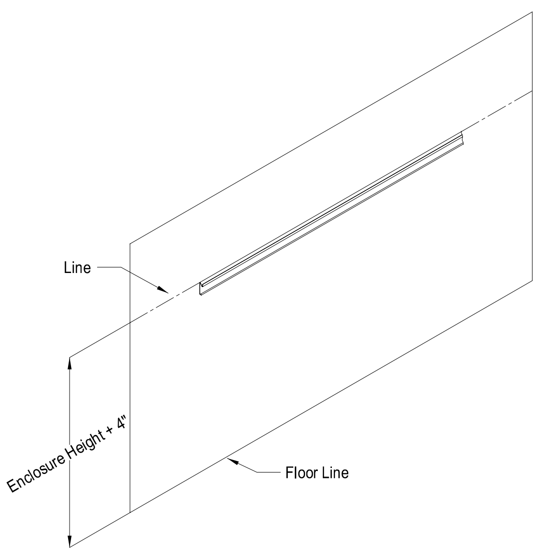


FIGURE W-2

(2) Find and mark the mounting height on the wall. (The standard mounting height is equal to the enclosure height plus 4".)

The snap mounting channel or full height backplate should be lined up flush with the marked mounting height. Attach the snap mounting channel or full height backplate using fasteners suitable for wall construction. (FIGURE W-2)

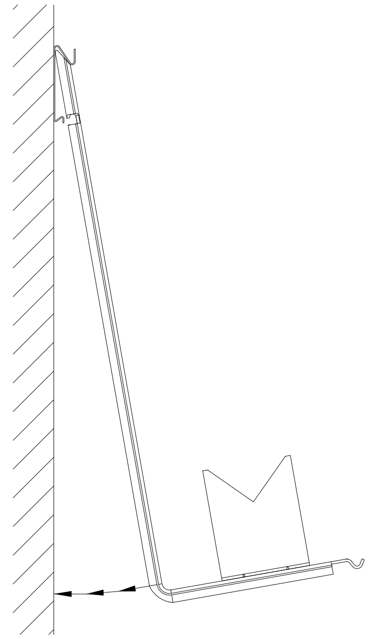


FIGURE W-3

(3) Slip the snap expansion bracket into the snap mounting channel or full height backplate, and snap into place. (FIGURE W-3)

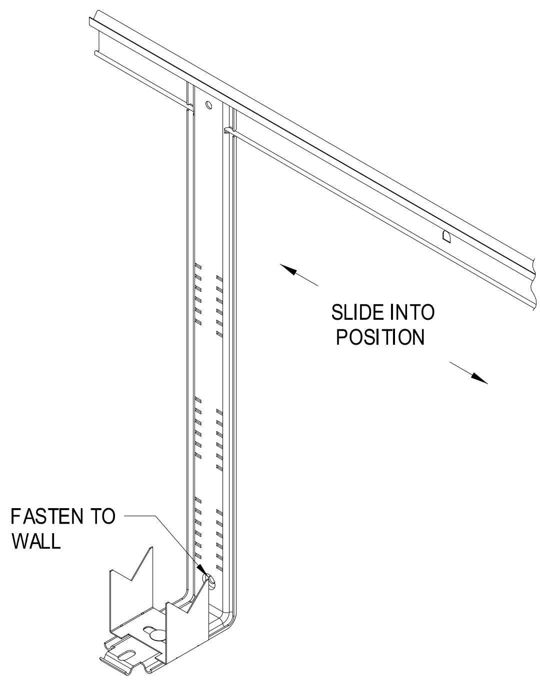


FIGURE W-4

(4) Slide the snap expansion bracket into place and fasten the bottom of the bracket. (The snap expansion brackets should be installed approximately 36" apart.) The snap expansion bracket is installed with a fastener using the recessed hole near the bottom of the bracket. (FIGURE W-4)

Standard Rittling Wall Enclosure Installation Instructions

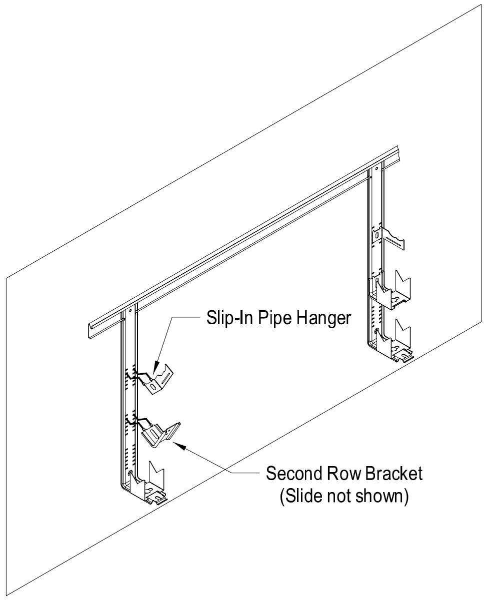


FIGURE W-5

(5) Install any additional mounting brackets to the snap expansion bracket by slipping them into the slots provided on the snap expansion bracket. (Not all mounting brackets are available on all units.) (FIGURE W-5)

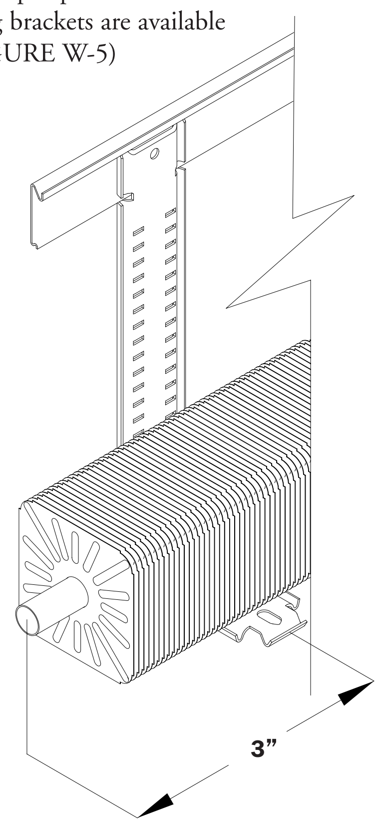


FIGURE W-6

(6) Install the heating element on the slide cradles located on the bracket. (The end of the heating element should be installed at least 3" from the snap expansion bracket.)

If installing additional rows of heating element or return piping, always install the bottom-most element first and work upward. (FIGURE W-6)

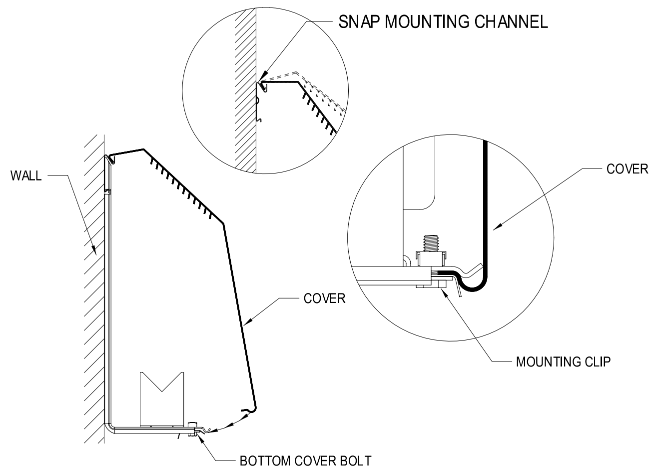


FIGURE W-7

(7) Install the cover as shown. (FIGURE W-7) Tighten the bottom bolt with the mounting clip to secure the cover in place.

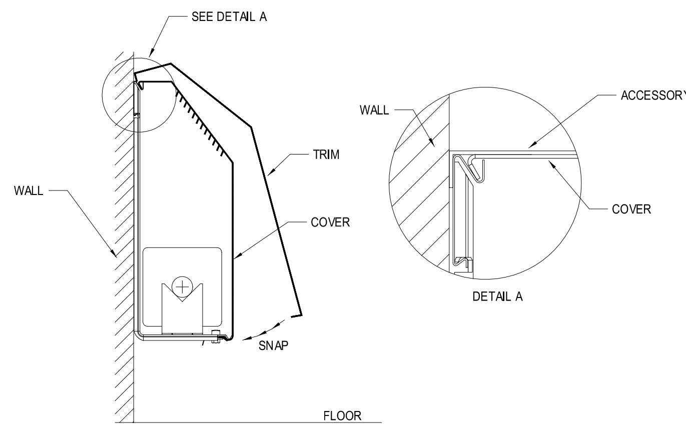


FIGURE W-8

(8) Install accessories between the wall and wall channel at the top and around the cover at the bottom. (FIGURE W-8)

Installation (Wall Channel or Full Backplate)

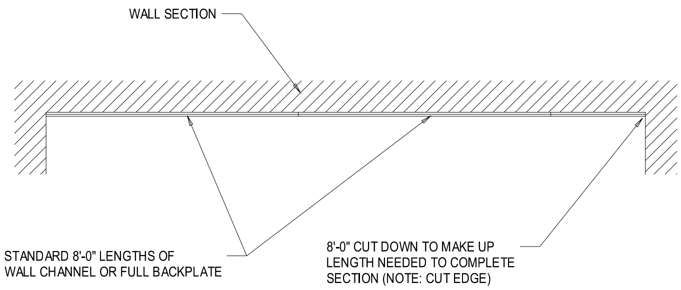


FIGURE VH-1

(1a) Determine the distance needed for wall enclosure application. The snap mounting channel or snap full height backplate should be installed on the entire wall surface where the enclosure and accessories will be installed.

(1b) Cut the snap mounting channel or or snap full height backplate to the desired length. The channel and backplate are furnished in lengths of 4'-0" or 8'-0". Combine multiple lengths if needed. When joining two pieces, make sure that the cut end is at the end of the run. (FIGURE VH-1)

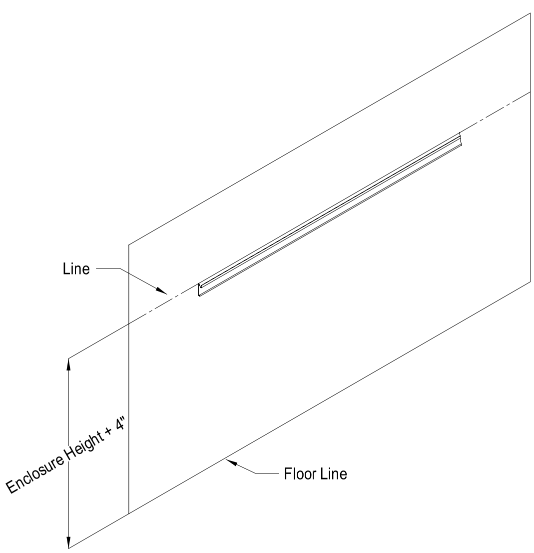


FIGURE VH-2

(2) Find and mark the mounting height on the wall. (The standard mounting height is equal to the enclosure height plus 4" for HL models and just the enclosure height for VL models.

The snap mounting channel or full height backplate should be lined up flush with the marked mounting height. Attach the snap mounting channel or full height backplate using fasteners suitable for wall construction. (FIGURE VH-2)

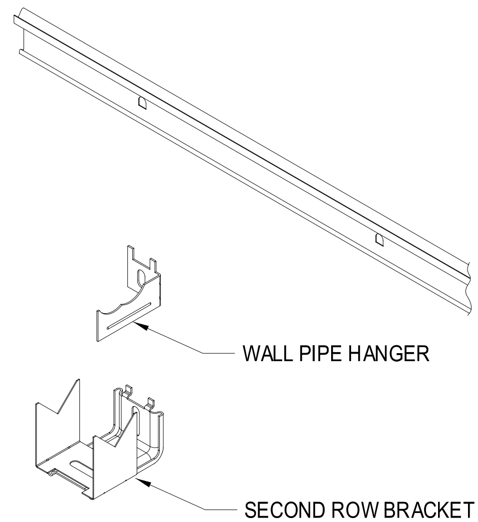


FIGURE VH-3

(3) On enclosed units, the second row brackets and wall pipe hangers will be mounted directly to the wall. (The brackets and pipe hangers should be installed approximately 36" apart.) Install the second row brackets and wall pipe hangers to the wall using fasteners suitable for wall construction. (FIGURE VH-3)

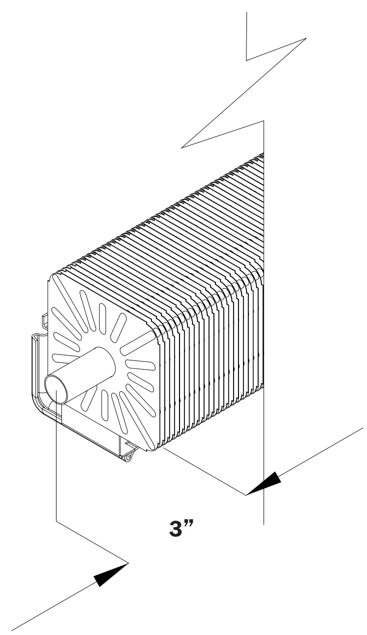


FIGURE VH-4

(4) Install the heating element on the slide cradles located on the second row bracket. (The end of the heating element should be installed at least 3" from the second row bracket.)

If installing additional rows of heating element or return piping, always install the bottom-most element first and work upward. (FIGURE VH-4)

Standard Rittling Fully Enclosed Enclosure Installation Instructions

Floor Mounted Enclosure Installation

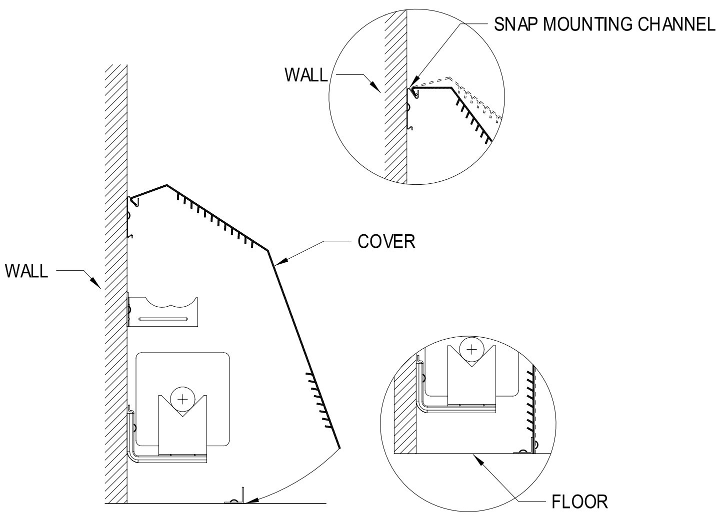


FIGURE V-5

(5) Install floor angle to floor using suitable fasteners. For 3-15/16" deep enclosure, the floor angle must be mounted 3-7/8" from the base at the wall. For 5-3/8" deep enclosure, the floor angle must be mounted 5-5/16" away from the base of the wall. (FIGURE V-5)

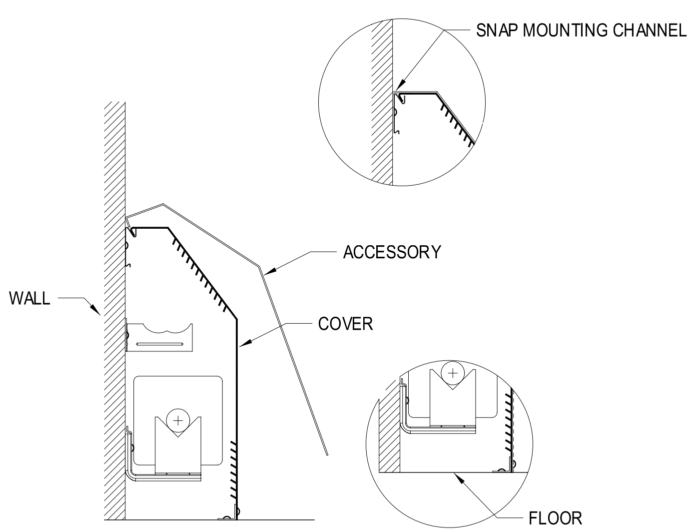


FIGURE V-6

(6) Install accessories between the wall and wall channel at the top and around the cover at the bottom. Secure cover to floor mounted angle using suitable fasteners. (FIGURE V-6)

Bottom Inlet Enclosure Installation

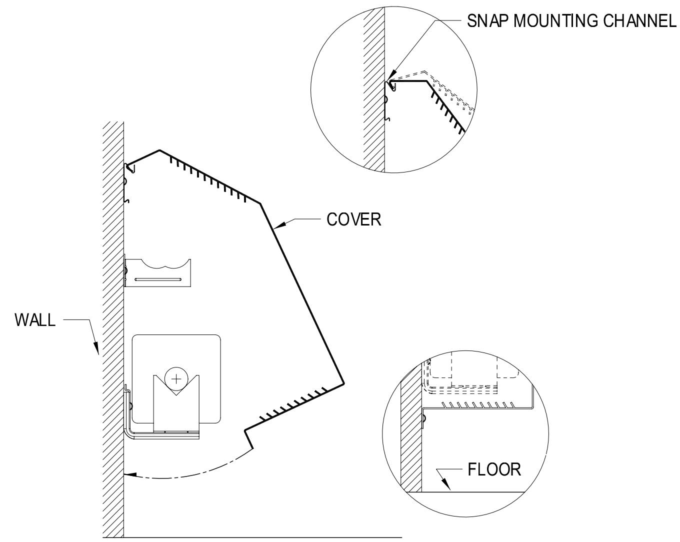


FIGURE H-5

(5) Install the cover as shown. Secure cover to wall using suitable fasteners. (FIGURE H-5)

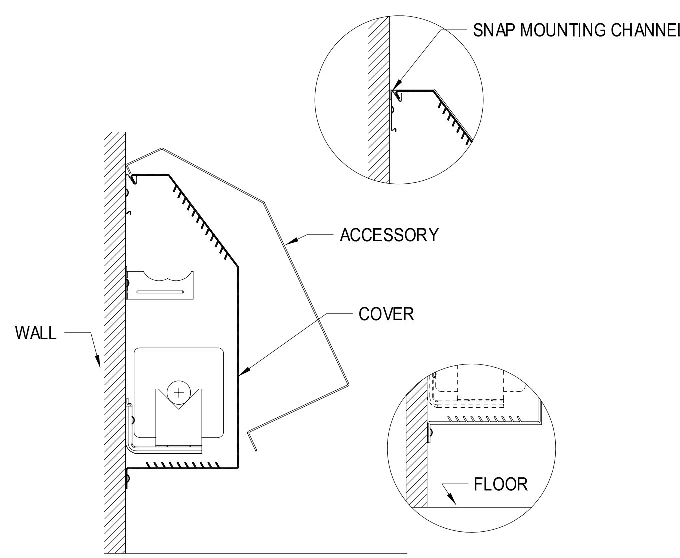


FIGURE H-6

(6) Install accessories between the wall and wall channel at the top and around the cover at the bottom. Secure accessory to wall using suitable fasteners. (FIGURE H-6)

Installation
(Offset Strip or Full Backplate):

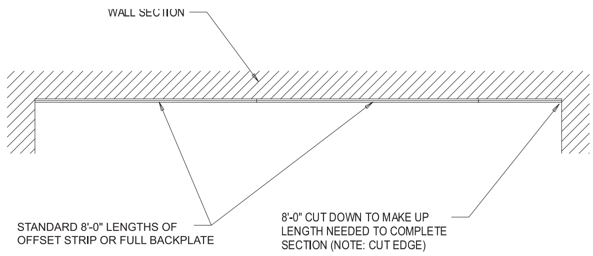


FIGURE S-1

(1a) Determine the distance needed for wall enclosure application. The offset channel or full height backplate should be installed on the entire wall surface where the enclosure and accessories will be installed.

(1b) Cut the offset channel or full height backplate to the length needed. The channel and backplate are furnished in lengths of 4'-0" or 8'-0". Combine multiple lengths if needed to complete the distance. When joining two pieces, make sure that the cut end is at the end of the run. (FIGURE S-1)

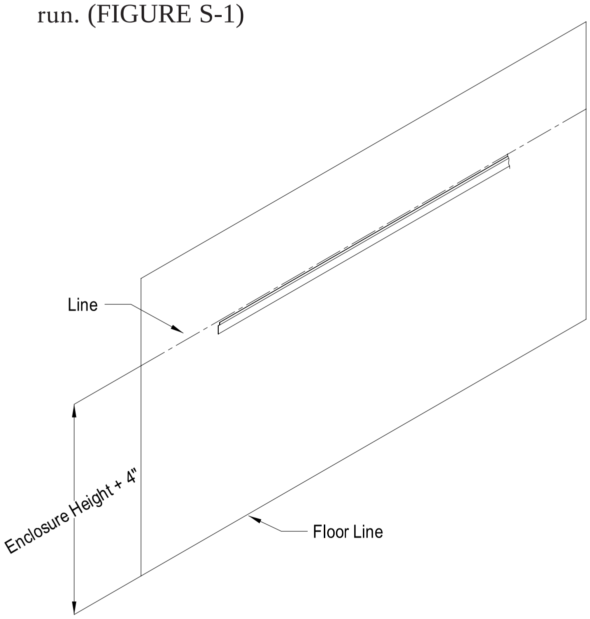


FIGURE S-2

(2) Find and mark the mounting height on the wall. (The standard mounting height is equal to the enclosure height plus 4".)

The offset channel or offset full height backplate should be lined up flush with the marked mounting height. Attach the offset channel or offset full height backplate using fasteners suitable for wall construction. (FIGURE S-2)

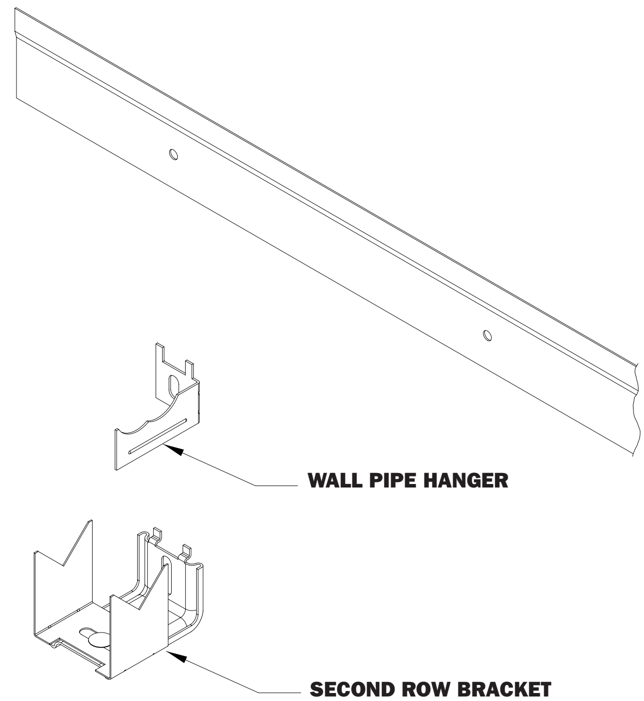


FIGURE S-3

(3) On security units the second row brackets and wall pipe hangers will be mounted directly to the wall. (The brackets and pipe hangers should be installed approximately 36" apart.) Install the second row brackets and wall pipe hangers to the wall using fasteners suitable for wall construction. (FIGURE S-3)

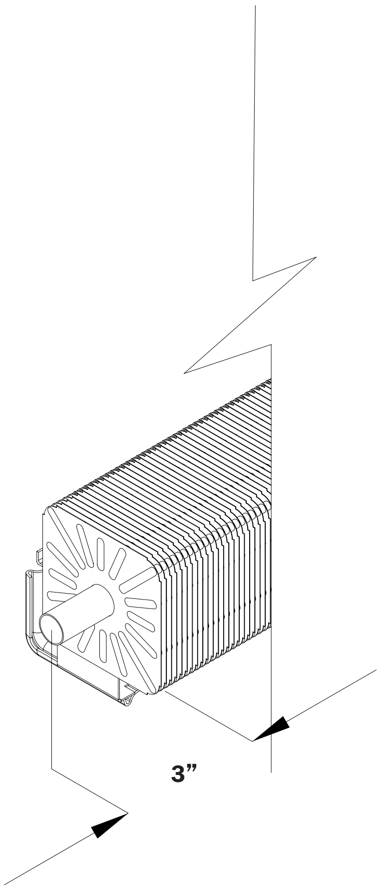


FIGURE S-4

(4) Install the heating element on the slide cradles located on the second row bracket. (The end of the heating element should be installed at least 3" from the second row bracket.)

If installing additional rows of heating element or return piping, always install the bottom-most element first and work upward. (FIGURE S-4)

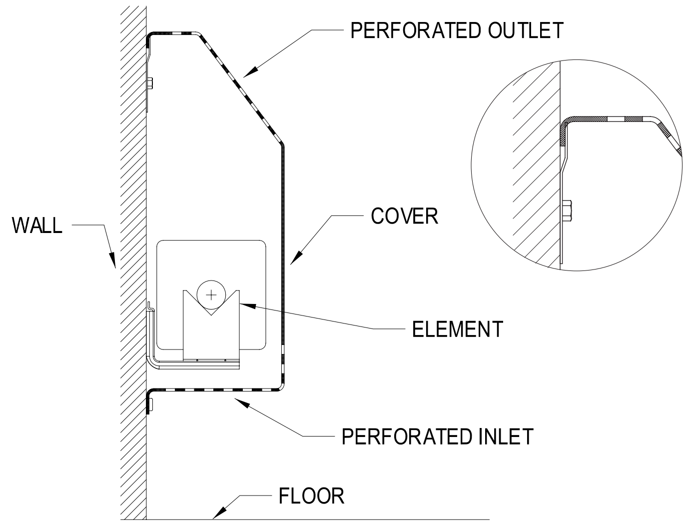


FIGURE S-5

(5a) Place the cover over the element and the offset strip and push the cover until it locks into the strip. (FIGURE S-5)

(5b) The trims and accessories will be attached in the same manner, overlapping the cover.

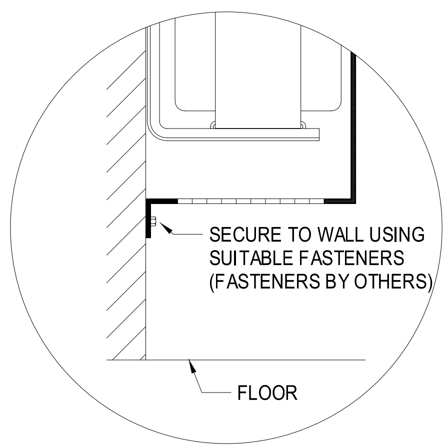
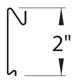


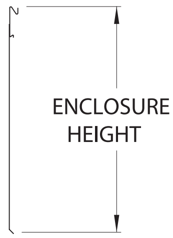
FIGURE S-6

(6) Once in place, the cover, trim, and accessories should all be secured to the wall. Use a fastener suitable for wall construction. (FIGURE S-6)

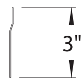
Standard Rittling Hardware



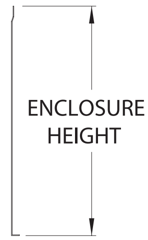
SNAP MOUNTING
CHANNEL



SNAP FULL
BACK PANEL

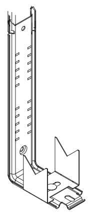


OFFSET
CHANNEL

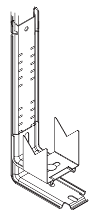


OFFSET FULL
BACK PANEL

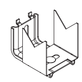
INTERNAL JOGGLE-JOINER



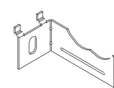
SNAP ENCLOSURE
EXPANSION BRACKET



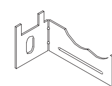
SNAP ENCLOSURE
STEAM BRACKET



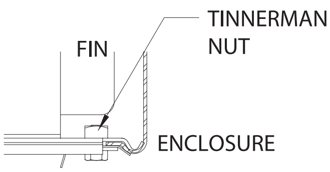
SLIP-IN SECOND
ROW BRACKET



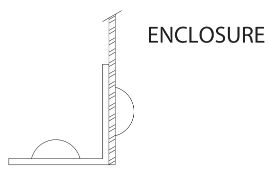
SLIP-IN PIPE
HANGER



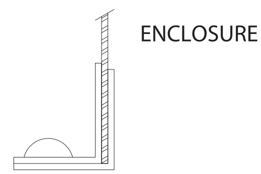
WALL
PIPE HANGER



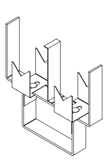
WALL ENCLOSURE
BOTTOM MOUNTING CLIP



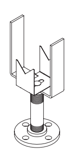
FLOOR MOUNTING
ANGLE



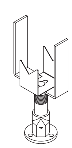
FLOOR MOUNTING
CHANNEL



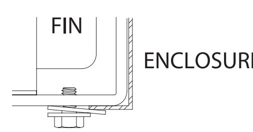
(2) ROW PEDESTAL
EXPANSION BRACKET



(1) ROW PEDESTAL
EXPANSION BRACKET
STEEL FLOOR FLANGE



(1) ROW PEDESTAL
EXPANSION BRACKET
ALUMINUM FLOOR FLANGE



PEDESTAL ENCLOSURE
BOTTOM MOUNTING CLIP

R.A. NOVIA & ASSOCIATES
355 HIGHLAND AVE.
CHESHIRE, CT. 06410
PH:(203) 271-0348 FX:(203) 272-1692

PROJECT:	THE CHILDREN'S SCHOOL
LOCATION:	STAMFORD, CT
ARCHITECT:	MARYANN THOMPSON ARCHITECTS
MECHANICAL CONTRACTOR:	EASTERN MECHANICAL SERVICES

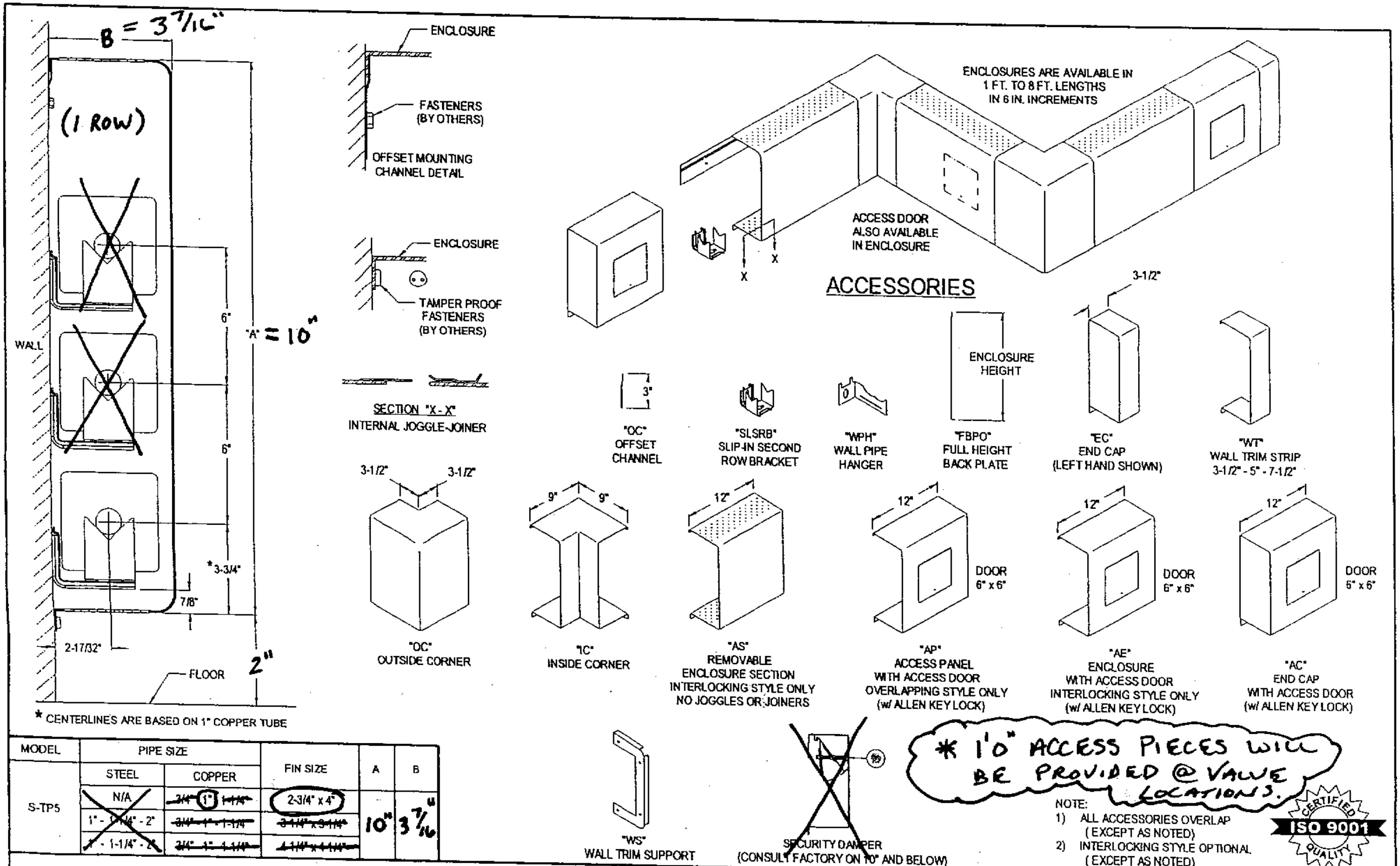
*** RE-SUBMITTAL DATA FOR ***

PRODUCT	MANUFACTURER
FIN TUBE RADIATION	RITTLING

AS SUBMITTED BY:

R.A. NOVIA & ASSOCIATES, LLC.
355 HIGHLAND AVE.
CHESHIRE, CT. 06410

CHRIS NOVIA
12/6/06



* 1'0" ACCESS PIECES WILL BE PROVIDED @ VALVE LOCATIONS.

NOTE:
1) ALL ACCESSORIES OVERLAP (EXCEPT AS NOTED)
2) INTERLOCKING STYLE OPTIONAL (EXCEPT AS NOTED)

ISO 9001 CERTIFIED QUALITY

MODEL	PIPE SIZE STEEL	PIPE SIZE COPPER	FIN SIZE	A	B
S-TP5	~~N/A~~	~~3/4"~~ 1" ~~1-1/4"~~	2-3/4" x 4"	10"	3 7/16"
	~~1" - 1-1/4" - 2"~~	~~3/4" - 1" - 1-1/4"~~	~~3-1/4" x 3-1/4"~~		
	~~1" - 1-1/4" - 2"~~	~~3/4" - 1" - 1-1/4"~~	~~4-1/4" x 4-1/4"~~		

CONTRACTOR EMS
ARCHITECT
ENGINEER
REPRESENTATIVE R.A. NOVIA + ASSOC.
LOCATION

ELEMENT 1"C - 2 3/4 x 4 - 40
RATING 592 BTU 180° A.W.T. 65° E.A.T.
BACKPLATE PARTIAL ~~FULL~~ PARTIAL
ENCL. GAUGE 14 MATERIAL CRS
COLOR STANDARD SELECTION BY ARCHITECT DAMPER NO

HYDRO-AIR COMPONENTS, INC.
4950 CAMP ROAD
HAMBURG, NEW YORK 14075
Rittling

JOB: THE CHILDRENS SCHOOL REV: A
ENCLOSURE MODEL: S-TP 3 7/16" x 10" HIGH
DATE: 06-17-03 DWG.NO. S-TP

Aquarion Company
600 Lindley Street
Bridgeport CT 06604-4995

Telephone
203 337 5968

AQUARION

Facsimile

To	VIKING CONST CO.	From	John Anderson
ATTN: EMIL CANAMN		Date	10-12-06
		Time	8:30 AM
Fax No.	203-353-0750	Telephone	203-337-5854
Number of pages including this sheet	2	Fax No.	203-337-5837

FLOW TEST
SCOFIELD TOWN RD.. STAMFORD

Aquarion Water Company Fire Flow Test

Date	Town Code	Town	Division	Time	Flow Hyd #	Ref #
10/11/2006	201	STAMFORD	WESTERN	10:35 AM	75	70-06

	Address	Location	DIA.	TYPE	PITO/	GPM
Hyd#1: 75		Location Flow Hydrant: SCOFIELDTOWN RD @ ROCK RIMMON RD	DIA. 1: 2.5	TYPE 1: B	PITO/ 1: 70	GPM 1: 1,373
Hyd #2:		Location of # 2 Hydrant:	DIA. 2: 0	TYPE 2:	PITO/ 2: 0	GPM 2: 0
Hyd #3:		Location Of # 3 Hydrant:	DIA. 3: 0	TYPE 3:	PITO/ 3: 0	GPM 3: 0

Total GPM: 1,373

Location of Residual Hydrant: SCOFIELDTOWN RD @ HANNAH'S RD

Residual Hyd #: 76

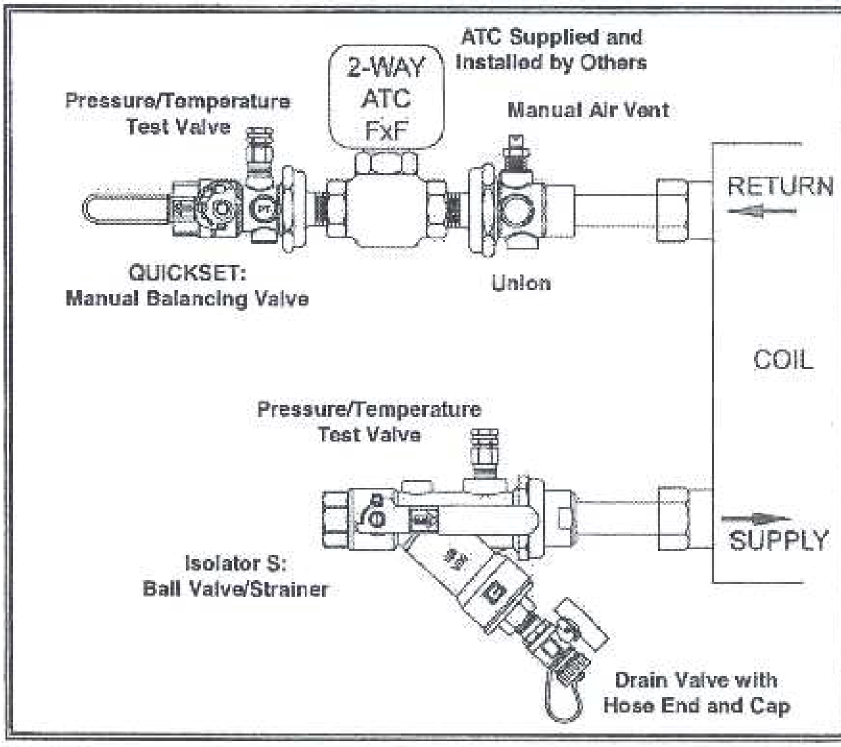
Static Before	H/ Factor For Actual Drop	PSI Drop	Yields	
122	6.49801917084988	32	1,373	G.P.M.

Residual During	H/ Factor for Possible Drop	Possible Psi Drop at 20	Yields	
90	12.1518973631836	102	2,567	G.P.M.

After: 122

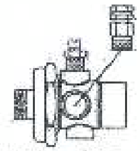
Employee 1: J ANDERSON Employee #2: J POREMBA Employee #3:

ALL END CONNECTIONS ARE FEMALE THREADED
CONNECTION TO ATC IS DOWN ONE SIZE



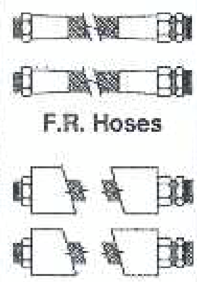
Size: ❐ 3/4", ❐ 1"
❐ 1" Large, ❐ 1-1/4", ❐ 1-1/2"
❐ 1-1/2" Large, ❐ 2"

Union Options:



+PT on Union
(See Model # Table)

Hoses:



F.R. Hoses

Insulated Hoses

ATC Handling:

- ❐ Supplied and Installed by Others
- ❐ Supplied and Installed by Griswold

Specifications

QuickSet: Forged brass (ASTM B283) manual balancing valve with brass venturi insert, polymer Optimizer flow insert, and graduated memory stop. Valve housing includes Teflon seals and Nickel plated full port ball. Valve includes one fixed end (FNPT) connection and one union (MNPT) connection. Union end includes union nut and EPDM o-ring. Valve body has two 1/4" tapped ports with two pressure/temperature test valves. Valve is fully assembled.
PSI/Temperature Rating: 400 PSI / 250°F.

Isolator S: Ball valve and integrated strainer. Valve housing is forged brass with Teflon seals and Nickel plated ball. Strainer is 20 mesh stainless steel and can be removed from housing without disturbing pipe connections for inspection or replacement. Valve includes one fixed end (FNPT) connection and one union (FNPT) connection. Union end includes union nut and EPDM o-ring. Body has one 1/4" tapped with one pressure/temperature test valve. Assembly includes drain valve with 3/4" hose connection with cap. Valve is fully assembled.
PSI/Temperature Rating: 400 PSI / 250°F.

Union: Forged brass (ASTM B283) union. Union includes one fixed end (FNPT) connection and one union (MNPT) connection. Union end includes union nut and EPDM o-ring. Union body has one 1/4" tap with one manual air vent.
PSI/Temperature Rating: 400 PSI / 250°F.

Drain Valve: Rated 275 PSI / 250°F. Brass housing, Nickel plated ball. 3/4" NPSH hose connection.

Pressure/Temperature Test Valve: Rated 1000 PSI / 350°F. Brass Housing, Nordel Seal.

Manual Air Vent: Rated 1000 PSI / 350°F. Brass Housing.

9/02
F-5031D

2803 Barranca Parkway, Irvine, CA 92606
(949) 559-6000 Fax (949) 559-6088
www.GriswoldControls.com

GRISWOLD CONTROLS

DOWNSIZED CPP-2QIS PACKAGES

Model Number Selection

Std. Model Number	Package Size	ATC Connection
4PCPP2QS3Q2010H	3/4"	1/2"
4PCPP2QS3Q3010I	1"	3/4"
4PCPP2QS3Q3010IL	1" Large	3/4"
4PCPP2QS3Q4010J	1-1/4"	1"
4PCPP2QS3Q5010S	1-1/2"	1-1/4"
4PCPP2QS3Q5010SL	1-1/2" Large	1-1/4"
4PCPP2QS3Q6010T	2"	1-1/2"

+PT Model Number	Package Size	ATC Connection	
4PCPP2QS21UPH	3/4"	1/2"	(4) VAV, (1) UH Coils
4PCPP2QS31UPI	1"	3/4"	(2) RH Coils
4PCPP2QS31UPIL	1" Large	3/4"	
4PCPP2QS41UPJ	1-1/4"	1"	
4PCPP2QS51UPS	1-1/2"	1-1/4"	
4PCPP2QS51UPSL	1-1/2" Large	1-1/4"	
4PCPP2QS61UPT	2"	1-1/2"	

All connections are line size.
Connections to ATC are down one size MNPT; all other connections are FNPT for female threaded.
List Pricing is shown for ATC supplied and installed by others.

Flow Rates (+/- 3%)

SIZE	MODEL NO.	FLOW GPM[3] AT 4 FT/SEC	Cv[4]	GPM RANGE FOR 5"-100" W.C. ΔP (SET W/100" GAUGE)	GPM RANGE FOR 5"-300" W.C. ΔP (SET W/300" GAUGE)
3/4"	3Q2	6.7	0.8	.3 - 1.4	.3 - 2.5
			1.7	.6 - 2.8	.6 - 4.9
			3.5	1.25 - 5.7	1.3 - 9.8
			7.5	2.5 - 11.4	2.5 - 19.7
1"	3Q3	10.8	1.6	.6 - 2.8	.6 - 4.9
			3.3	1.25 - 5.7	1.3 - 9.8
			7.0	2.5 - 11.4	2.5 - 19.7
			11.4	4.0 - 18.0	4.0 - 31.3
			9.0	3.4 - 15.0	3.4 - 26.3
1-1/4"	3Q4	18.7	19.8	6.8 - 30.4	6.8 - 52.6
1-1/2"	3Q5	25.4	19.2	6.8 - 30.4	6.8 - 52.6
			36.0	12.3 - 55.0	12.3 - 95.4
2"	3Q6	41.9	61.0	20.3 - 91.2	20.3 - 157.9

[1] *48 Hour Price* for standard packages with ATC supplied and installed by others.
[2] *Plus Price* for standard packages with ATC supplied by others and installed by Griswold Controls. Indicate ATC installation by adding "-A" to the model number.
[3] The generally accepted upper limit as recommended by ASHRAE to prevent pipe noise is 4 ft/sec.
[4] Cv's are used to calculate the permanent pressure drop. PSID=(Flow/Cv)^2 Use the Flow Curve for flow measurement.

9/02
F-5031D

2803 Barranca Parkway, Irvine, CA 92606
(949) 559-6000 Fax (949) 559-6088
www.GriswoldControls.com

GRISWOLD CONTROLS

Guarantee

AND LIMITED WARRANTY

10 YEAR WARRANTY

For our HeatLink® cross linked PEX pipe, we render the following warranty over and above our terms of delivery: Our cross linked pipe is manufactured from high quality, high heat stabilized Polyethylene. Within a period of 10 years from the date of manufacture, we offer compensation up to a limit of 5,000,000 US dollars in individual cases and up to a limit of 5,000,000 US dollars in the whole number of cases per year, covered by a production liability insurance.

a) for damage to property of third persons and the resulting damage therefrom, and / or
b) for expenses to third persons for removal, dismantling, or uncovering defective products and for installing, fixing , and laying of new products to be supplied by us
c) furthermore we guarantee compensation for a period not exceeding 10 years after liquidation.
d) for a period of 10 years from the date of manufacture, free replacement for the cross linked PEX pipe supplied by us in which defects arise, that can be proved to have arisen from manufacturing or material faults for which the manufacturer is responsible. This is subject to compliance with the guidelines as outlined in our installation manual.

EXTENDED 15 YEAR LIMITED WARRANTY

Limited Warranty: This limited warranty shall expire twenty-five (25) years after the date of manufacture for our HeatLink® and AquaLink® cross linked PEX pipes.

HeatLink USA Inc., HeatLink Ireland, and Polytech Products Inc. sole obligation hereunder shall be, at its option, to issue credit, repair or replace any article or part thereof which is proved to be other than as warranted. Further, no allowances shall be made to buyer for transportation, labour charges or part adjustments or repairs or any other work.

Additionally, any performance by buyer or its designee, of any repairs without the express written consent of HeatLink USA Inc., HeatLink Ireland, and Polytech Products Inc. , shall render this Warranty invalid.

GENERAL GUIDELINES FOR THE LAYING OF PEX PIPE:

1. The minimum bending radius is 6 times pipe diameter at an ambient temperature of +20°C, and 8 times pipe diameter by lower temperatures down to 0°C.
2. Fixing of the pipe must be made with suitable pipe clamps. Fixing with binding wire is not permissible.
3. Before enclosure of the PEX pipe, the pipe must be put under pressure by water or air, (if necessary antifreeze should be added). This test should be carried out at a pressure not less than 550 kPa (80 psi) and not more than 690 kPa (100 psi) and remain thus for 24 hours, after which all connections should be tightened. The pipe is to remain under pressure while the covering is being laid.
4. Storage of the PEX pipes which allows an exposure to sun light is not permissible (danger of UV rays).
5. In areas liable to frost, a suitable anti-freeze is to be used.
6. Kinking and buckling points are to be removed.

NO LIABILITY CAN BE ACCEPTED FOR FAULTS IN INSTALLATION OR LAYING OF THE PIPE. OUR GENERAL LAYING DIRECTIONS ARE A CONSTITUENT PART OF THIS WARRANTY. QUALITY CONTROL CHECKS ARE CARRIED OUT UNDER CONTRACT WITH THE MANUFACTURER. HEATLINK® DISCLAIMS ANY EXPRESS WARRANTY NOT PROVIDED HEREIN, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEATLINK® FURTHER DISCLAIMS ANY RESPONSIBILITY FOR LOSSES, EXPENSES, INCONVENIENCES, SPECIAL, INDIRECT, SECONDARY INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING FROM OWNERSHIP OR USE OF THE ARTICLES SOLD HEREUNDER. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FACE HEREOF.

MARYANN THOMPSON ARCHITECTS
14 Hillside Avenue Cambridge MA 02140 telephone: 617 491 4144 fax: 617 491 3844

TRANSMITTAL

DATE:
11.28.2006

PROJECT:
528 – The Children's School

TO:
Emil Canaan
Viking Construction
76 Progress Drive
Stamford, CT 06902

FROM:
Martha Foss

If enclosures are not as noted, please inform us immediately.

IF CHECKED BELOW, PLEASE:
(X) Acknowledge receipt of enclosures.
( ) Return enclosures to us.

WE TRANSMIT:
(X) herewith
( ) in accordance with your request
( ) under separate cover via
( ) For Building Permit

FOR YOUR:
( ) approval
( ) review and comment
( ) distribution to parties
( ) record
( )information
(X)use

THE FOLLOWING:
( ) Drawings
( ) Specifications
( ) Test Results
( ) Shop Drawing Prints
( ) Shop Drawing Reproducibles
( ) Change Order
(X) Product Data
( ) Photo Prints and Stats

COPIES	DATE	DESCRIPTION	ACTION CODE
2		Submittal 15500-71	A

ACTION CODE:
A: Action indicated in item transmitted
B: No action required
C: For Signature and return to this office
D: For signature and forwarding as noted
E: See REMARKS below

REMARKS:

Eastern Mechanical Services, Inc.
P.O. Box 246
64 Triangle Street Suite H2
Danbury, CT 06813-0246
Phone: 203.792.7668 Fax: 203.748.0385

SUBMITTALS MANUAL FOR:

The Children's School

Stamford, CT

MARYANN THOMPSON ARCHITECTS
14 Hillside Avenue Cambridge MA 02140
telephone: 617 491 4144 fax: 617 491 3844

[ ] No Exception Taken
[X] Make Corrections Noted
[ ] Revise and Resubmit Record Copy
[ ] Revise and Resubmit
[ ] Rejected
[ ] Not Reviewed
[ ]

Notations and / or comments on this submittal do not authorize any changes to the contract amount. Corrections and / or comments made on the shop drawings during this review do not relieve the contractor from compliance with the requirements of the drawings and specifications. This review is for general performance with the design concept of the project and information shown on the contract documents only.

Contractor is responsible for confirming, correlating and coordinating quantities, dimensions in the field for tolerance, clearances, fabrication, and installation processes, means and methods of construction, coordination of the work with other trades and performing work in a safe and satisfactory manner.

By MPJ Date 11/20/06

☐ FURNISH AS SUBMITTED ☐ REVISE AND RESUBMIT
☐ REJECTED ☐ SUBMIT SPECIFIED ITEM
☒ FURNISH AS CORRECTED

Corrections or comments made on the shop drawings duri[illegible] this review do not relieve contractor from compliance w[illegible] requirements of the drawings and specifications. This check [illegible] review of general conformance with the design conc[illegible] and general compliance with the information g[illegible] in the contract documents. The contractor is responsib[illegible] confirming and correlating all quantities and dimens[illegible] selecting fabrication process and techniques of construc[illegible] coordinating his work with that of all other trades; a[illegible] [illegible] work in a safe and satisfactory manner.

van ZELM, HEYWOOD & SHADFORD, INC.

Date 11/16/06 By AWS/BPCW

Jesus Christ paid the price for our sins

R.A. NOVIA & ASSOCIATES
355 HIGHLAND AVE.
CHESHIRE, CT. 06410
PH: (203) 271-0348 FX: (203) 272-1692

PROJECT:	THE CHILDREN'S SCHOOL
LOCATION:	STAMFORD, CT
MECHANICAL CONTRACTOR:	EASTERN MECHANICAL SERVICES

*** SUBMITTAL DATA FOR ***

PRODUCT	MANUFACTURER
UNIT HEATER	RITTLING
FIN TUBE RADIATION	RITTLING

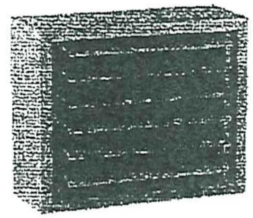
AS SUBMITTED BY:

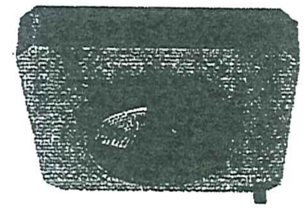
R.A. NOVIA & ASSOCIATES, LLC.
355 HIGHLAND AVE.
CHESHIRE, CT. 06410

CHRIS NOVIA
7/18/06

Rittling ISO 9001

UNIT HEATERS
FOR STEAM OR HOT WATER





GENERAL UNIT HEATER FEATURES

Coil
- Mechanically bonded copper/aluminum coil with 12 fins per inch with 1/2" nominal tubes (serpentine design for RH-18 through RH-86, steel header design for RH-108 through RH-340 and vertical model RV) between extra heavy steel pipe connections
- High BTU Capacity
- Fins are continuous along width and depth and are vertically oriented to resist collection of dirt and foreign particles.

Mounting Hardware
- Heavy duty threaded hardware allows unit to be mounted with threaded rod
- Optional pipe hanger kit available for mounting unit with threaded pipe

Formed Air Inlet/Outlet
- Die-formed venturi allows air to flow smoothly through unit for maximum airflow.

Fan
- Lightweight, dynamically balanced
- Designed to move air efficiently and quietly with minimum power requirement

HORIZONTAL UNIT HEATER FEATURES

Casing
- Rugged 18 gauge casing protects against impact & abuse
- Two piece enclosure allows for ease of maintenance
- Attractive gray, textured epoxy powder coating is standard and durable

Motor
- All motors are totally enclosed, permanently lubricated for extended, reliable motor life
- Low operating cost and quiet operation
- When teamed with variable speed control, fan speed adjustment is infinite
- Equipped with thermal overload protection

Louvers
- Adjustable horizontal louvers are standard for adjustment of air distribution
- Constructed of rigid 18 gauge steel
- Color matched to unit for consistent appearance

Piping Connection
- NPT threaded fittings permit quick and easy piping connections
- Mounted to casing for rigidity

Finger Proof Fan Guard
- Standard equipment
- Securely mounts motor to unit while absorbing vibration with rubber isolation mounts

Options
Explosion-proof motors are offered as well as various motor voltage configurations. Vertically oriented diffusers are offered to direct airflow. Numerous control options are offered in both unit mounted and wall mounted orientations.

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- Rugged 16 gauge casing protects against impact & abuse
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- Designed for easy motor removal, important for high ceiling applications
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Junction Box
- All unit wiring is contained in an electrical junction box that is integral to the unit heater casing.

Air Diffusion
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4950 Camp Road, Hamburg, NY 14075
Tel. 716.648.3801 Fax. 716.648.3203

Rittling ISO 9001 Certified Quality

UNIT HEATERS
FOR STEAM OR HOT WATER

E.W.T. -________T.D.-________STEAM________PSI

TAG	QTY	MODEL	MBH	E.A.T. °F	L.A.T. °F	CFM	GPM	PD	HP	RPM	MOTOR CODE	MOTOR AMPS	OPTIONS
	1	RH-86	61.9	60°	103°	710	6.2	0.7	1/10	1550	01	1.30	3, A

GENERAL UNIT HEATER DATA

Motor/Power Code	Description
01	115V, 60 HZ, 1PH
02	230V, 60HZ, 1PH
05	230V/460V, 60HZ, 3PH
06	115V/208-230V, 60 HZ, 1 PH, Explosion Proof

Field Installed Options (Horizontal & Vertical)[1,2]

Option	Description
9	Std. Wall Thermostat 22A @125V, 50° F to 90° F Range
10	Explosion-Proof Wall Thermostat 10.2 A @115V, 6.5 A@230V, 46 °F to 84 °F Range
11	Aquastat 100 °F to 240 °F Range
12	Wall Mounted Variable Speed Controller (Only on Model RH-18 through RH-258)
13	Locking Thermostat Guard w/ Plastic Cover
14	Pipe Hanger Kit
15	Wall Mounted Manual Starter
16	Wall Mounted Disconnect

1 115V 60 HZ 1 PH Motors Only
2 Not compatible with Explosion-Proof Motors

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Factory Mounted

Option	Description
1	Unit Mounted Disconnect
2	Variable Speed Controller (Only on Model RH-18 through RH-108)
3	Unit Mounted Thermostat
4	Unit Mounted Manual Starter
A	Diffuser Blades

Notes:

VERTICAL UNIT HEATER OPTIONS

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3	Unit Mounted Thermostat
4	Unit Mounted Manual Starter

Field Installed Air Outlet Options

Option	Description
C	Cone Jet
D	Truncone
E	One-Way Louver
F	Two-Way Louver
G	3-Cone Anemostat
H	4-Cone Anemostat

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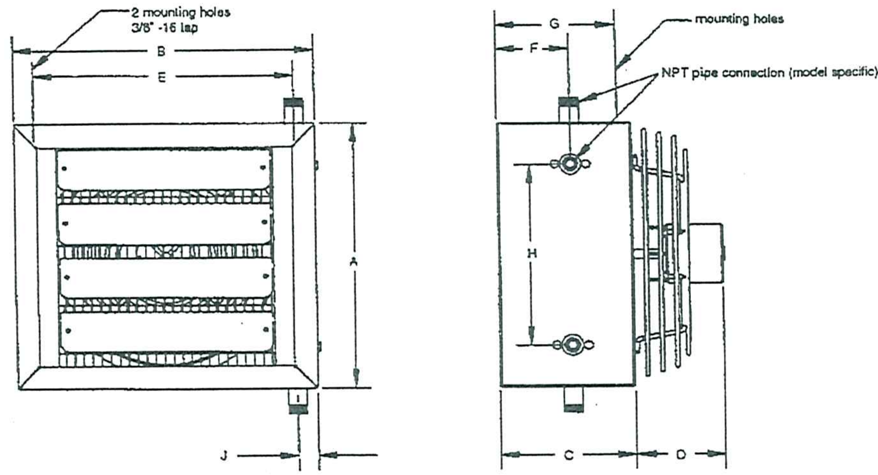
UNIT HEATERS
FOR STEAM OR HOT WATER

HORIZONTAL AIR DELIVERY UNIT HEATER DIMENSIONS & DATA

Motor Data		Voltage and Motor Type			
		115/60/1	230/60/1	230/460/60/3	115/208-230/60/1
		Totally Enclosed w/ Thermal Overload	Totally Enclosed w/ Thermal Overload	Totally Enclosed	Explosion Proof w/ Thermal Overload
Model No.	Motor HP	Full Load Amps	Full Load Amps	Full Load Amps	Full Load Amps
RH-18	1/30	0.70	0.35	N/A	4.8/2.3-2.4
RH-24	1/30	0.70	0.35	N/A	4.8/2.3-2.4
RH-33	1/15	0.72	0.40	N/A	4.8/2.3-2.4
RH-47	1/15	0.72	0.40	N/A	4.8/2.3-2.4
RH-63	1/10	1.30	0.80	1.4/0.7	4.8/2.3-2.4
RH-86	1/10	1.30	0.80	1.4/0.7	4.8/2.3-2.4
RH-108	1/8	1.58	0.90	2.2/1.1	6.8/3.1-3.4
RH-121	1/8	1.58	0.90	2.2/1.1	6.8/3.1-3.4
RH-165	1/4	2.70	1.40	2.2/1.1	6.8/3.1-3.4
RH-193	1/4	2.80	1.40	2.2/1.1	6.8/3.1-3.4
RH-258	1/3	3.60	1.90	2.2/1.1	7.8/3.6-3.9
RH-290	1/2	4.70	2.40	2.2/1.1	9.6/4.7-4.8
RH-340	1/2	4.70	2.40	2.2/1.1	9.6/4.7-4.8



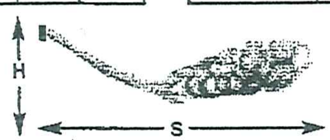
Maximum Mounting Heights

Performance Data for Standard Units at Standard Conditions of 200°F Entering Water and 60 °F Entering Air

Model No.	Height - Ft	
	H	S
RH-18	9	18
RH-24	10	20
RH-33	11	22
RH-47	13	26
RH-63	15	30
RH-86	16	31
RH-108	16	33
RH-121	17	36
RH-165	18	38
RH-193	19	40
RH-258	20	42
RH-290	21	46
RH-340	22	50

Performance Data for Standard Units at Standard Conditions of 2 psig Steam and 60 °F Entering Air

Model No.	Height - Ft	
	H	S
RH-18	9	17
RH-24	9	18
RH-33	10	20
RH-47	12	25
RH-63	14	29
RH-86	15	31
RH-108	15	32
RH-121	16	33
RH-165	17	34
RH-193	18	37
RH-258	19	40
RH-290	20	44
RH-340	20	46



Model RH Dimensions

Model	A	B	C	D	E	F	G	H	J	NPT Connections	Fan Diameter	Approx. Shipping Wt. (lbs)
RH-18	14 3/4	16 3/4	7 7/16	4 1/2	12 3/4	4 1/8	5 9/16	10	N/A	3/4	9	18
RH-24	14 3/4	16 3/4	7 7/16	4 1/2	12 3/4	4 1/8	5 9/16	10	N/A	3/4	9	19
RH-33	18 7/8	16 3/4	7 7/16	4 3/4	12 3/4	4 1/8	5 13/16	16	N/A	3/4	12	35
RH-47	18 7/8	16 3/4	7 7/16	4 3/4	12 3/4	4 1/8	5 13/16	16	N/A	3/4	12	36
RH-63	18 7/8	22 3/4	8 7/16	4 3/4	17 3/4	4 1/8	7	16	N/A	3/4	14	51
RH-86	18 7/8	22 3/4	8 7/16	4 3/4	17 3/4	4 1/8	7	16	N/A	3/4	14	52
RH-108	26 15/16	25 7/8	9 1/2	6 1/4	24 3/4	3 1/2	6 1/4	N/A	2	1 1/2	18	76
RH-121	26 15/16	25 7/8	9 1/2	6 1/4	24 3/4	3 1/2	6 1/4	N/A	2	1 1/2	18	77
RH-165	26 15/16	31 7/8	10	6 1/4	30 3/4	3 1/2	6 1/4	N/A	2	1 1/2	20	95
RH-193	26 15/16	31 7/8	10	6 1/4	30 3/4	3 1/2	6 1/4	N/A	2	1 1/2	20	96
RH-258	32 15/16	40 13/16	11	6 1/4	39 11/16	3 1/2	6 1/4	N/A	2	2	22	165
RH-290	32 15/16	40 13/16	11	6 1/4	39 11/16	3 1/2	6 1/4	N/A	2	2	22	167
RH-340	32 15/16	40 13/16	12	6 1/4	39 11/16	3 1/2	8 1/4	N/A	2	2	24	182

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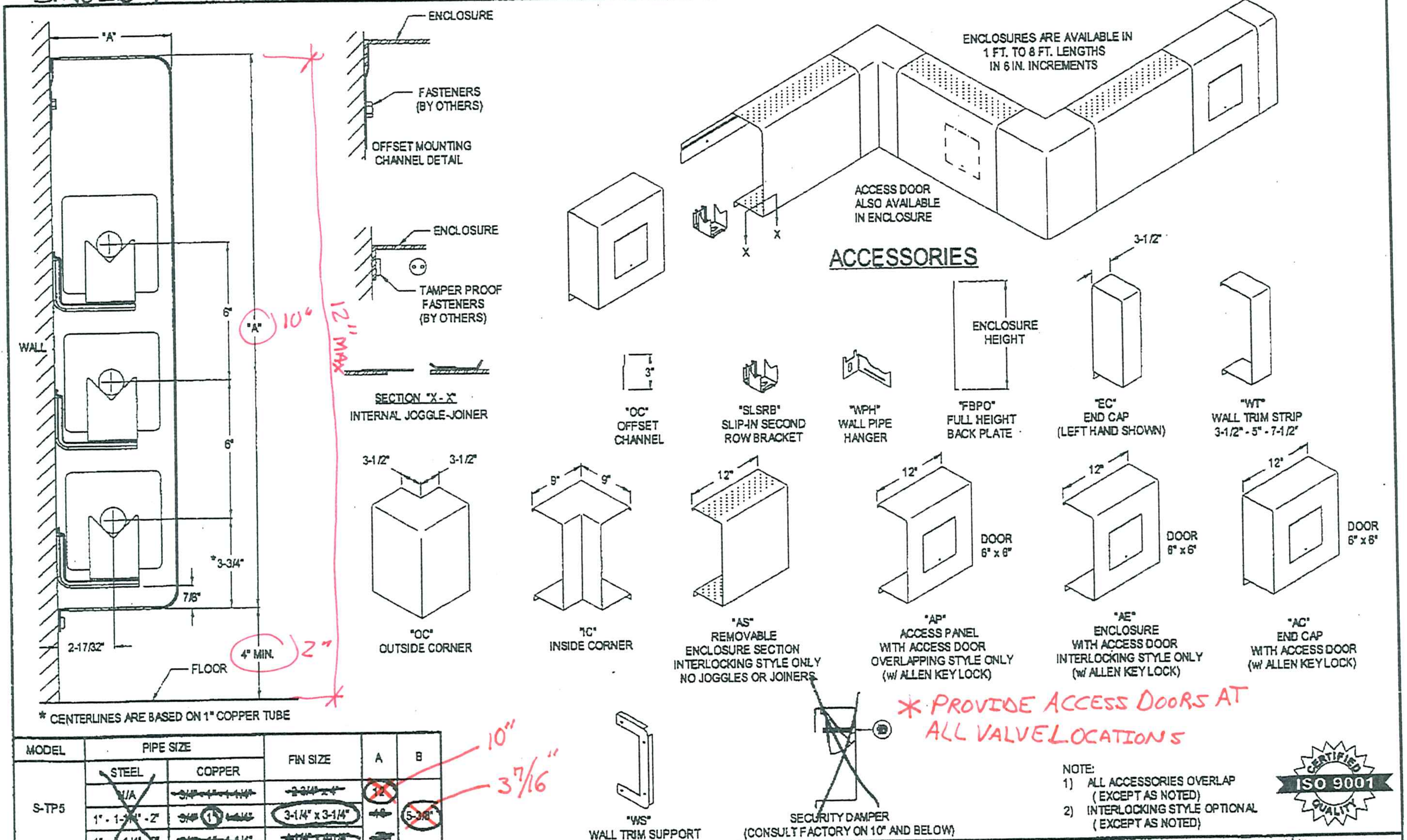
SINGLE ROW



* CENTERLINES ARE BASED ON 1" COPPER TUBE

* PROVIDE ACCESS DOORS AT ALL VALVE LOCATIONS

NOTE:
1) ALL ACCESSORIES OVERLAP (EXCEPT AS NOTED)
2) INTERLOCKING STYLE OPTIONAL (EXCEPT AS NOTED)

MODEL	PIPE SIZE STEEL	PIPE SIZE COPPER	FIN SIZE	A	B
S-TP5	~~N/A~~	~~3/4"-1"-1-1/4"~~	~~2-3/4" x 4"~~	~~12~~ 10"	
	~~1" - 1-1/4" - 2"~~	~~3/4"~~ 1" ~~1-1/4"~~	3-1/4" x 3-1/4"	~~10~~	~~5-3/8"~~ 3 7/16"
	~~1" - 1-1/4" - 2"~~	~~3/4"-1"-1-1/4"~~	~~4-1/4" x 4-1/4"~~	~~8~~	

CONTRACTOR EMS

ARCHITECT

ENGINEER

REPRESENTATIVE RA Novia + Assoc

LOCATION

ELEMENT 1"C - 3 1/4 x 3 1/4 - 40

RATING 740 BTU 180° A.W.T. 65° E.A.T.

BACKPLATE PARTIAL FULL PARTIAL

ENCL. GAUGE 14 MATERIAL CRS

COLOR STANDARD SELECTION BY ARCHITECT DAMPER NO

HYDRO-AIR COMPONENTS, INC.
4950 CAMP ROAD
HAMBURG, NEW YORK 14075

Rittling

ISO 9001 CERTIFIED QUALITY

JOB: THE CHILDRENS SCHOOL	REV. A
ENCLOSURE MODEL: S-TP5	
DATE: 06-17-03	DWG.NO. S-TP5

GUARANTEED RATINGS

S-TP5/PROD PERFORATED ENCLOSURE

In Btu/hr per active (finned) lineal foot of tube at entering air temperature of 65°F

I=B=R MEMBER

Finned Tube Model	Rows of Finned Tube (on 6" centers)	Enclosure Height (Inches)	Recommended Minimum Installed Height (Inches)	EDR† (ft²/ft)	STEAM HEAT 215° (Factor of 1.00)	HOT WATER HEAT 190° (Factor of 0.78)	180° (Factor of 0.69)	170° (Factor of 0.61)	160° (Factor of 0.53)
1C–Dia. 3¼ x 3¼ 32 Fin/Ft.	1	12	16	3.70	880	690	610	540	470
	1	18	22	3.90	930	730	640	570	490
	2	18	22	5.60	1360	1060	940	830	720
	1	24	28	4.00	990	770	680	600	520
	2	24	28	6.40	1540	1200	1060	940	820
	3	24	28	7.50	1790	1400	1240	1090	950
1C–Dia. 3¼ x 3¼ 40 Fin/Ft.	1	12	16	4.50	1070	830	740	650	570
	1	18	22	4.90	1170	910	810	710	620
	2	18	22	6.50	1560	1220	1080	950	830
	1	24	28	5.30	1280	1000	880	780	680
	2	24	28	7.30	1740	1360	1200	1060	920
	3	24	28	8.30	2000	1560	1380	1220	1060
1C–Dia. 3¼ x 3¼ 48 Fin/Ft.	1	12	16	4.90	1170	910	810	710	620
	1	18	22	5.60	1350	1050	930	820	720
	2	18	22	6.40	1540	1200	1060	940	820
	1	24	28	6.20	1490	1160	1030	910	790
	2	24	28	7.50	1810	1410	1250	1100	960
	3	24	28	8.70	2080	1620	1430	1270	1100
¾C–Dia. 4¼ x 4¼ 32 Fin/Ft.	1	12	16	5.40	1290	1010	890	790	680
	1	18	22	5.80	1390	1080	960	850	740
	2	18	22	8.50	2040	1590	1410	1240	1080
	1	24	28	6.10	1470	1150	1010	900	780
	2	24	28	9.50	2290	1790	1580	1400	1210
	3	24	28	11.00	2630	2050	1810	1600	1390
¾ C–Dia. 4¼ x 4¼ 40 Fin/Ft.	1	12	16	6.30	1510	1180	1040	920	800
	1	18	22	6.90	1640	1280	1130	1000	870
	2	18	22	9.20	2200	1720	1520	1340	1170
	1	24	28	7.30	1760	1370	1210	1070	930
	2	24	28	10.30	2470	1930	1700	1510	1310
	3	24	28	11.80	2840	2220	1960	1730	1510
¾ C–Dia. 4¼ x 4¼ 48 Fin/Ft.	1	12	16	6.60	1590	1240	1100	970	840
	1	18	22	7.60	1830	1430	1260	1120	970
	2	18	22	8.80	2120	1650	1460	1290	1120
	1	24	28	8.60	2060	1610	1420	1260	1090
	2	24	28	10.30	2470	1930	1700	1510	1310
	3	24	28	11.80	2830	2210	1950	1730	1500
1C–Dia. 4¼ x 4¼ 32 Fin/Ft.	1	12	16	5.30	1270	990	880	780	670
	1	18	22	5.70	1360	1060	940	830	720
	2	18	22	8.30	2000	1560	1380	1220	1060
	1	24	28	6.00	1440	1120	990	880	760
	2	24	28	9.40	2250	1760	1550	1370	1190
	3	24	28	10.80	2580	2010	1780	1570	1370
1C–Dia. 4¼ x 4¼ 40 Fin/Ft.	1	12	16	6.20	1480	1150	1020	900	780
	1	18	22	6.70	1610	1260	1110	980	850
	2	18	22	9.00	2160	1690	1490	1320	1150
	1	24	28	7.20	1730	1350	1190	1060	920
	2	24	28	10.10	2420	1890	1670	1480	1280
	3	24	28	11.60	2780	2170	1920	1700	1470

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7/18/06

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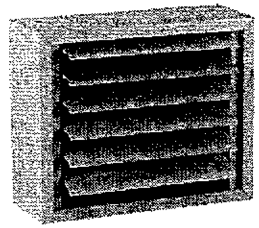

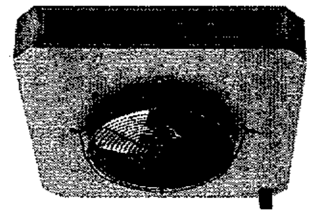

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Rittling

CERTIFIED ISO 9001 QUALITY

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FOR STEAM OR HOT WATER

E.W.T. -________ T.D.-________ STEAM________ PSI

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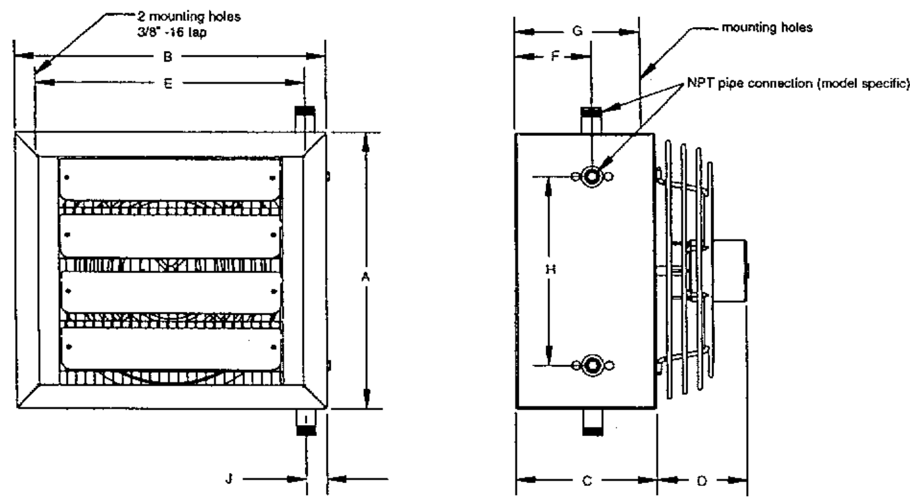
RH-33	1/15	0.72	0.40	N/A	4.8/2.3-2.4
RH-47	1/15	0.72	0.40	N/A	4.8/2.3-2.4
RH-63	1/10	1.30	0.80	1.4/0.7	4.8/2.3-2.4
RH-86	1/10	1.30	0.80	1.4/0.7	4.8/2.3-2.4
RH-108	1/8	1.58	0.90	2.2/1.1	6.8/3.1-3.4
RH-121	1/8	1.58	0.90	2.2/1.1	6.8/3.1-3.4
RH-165	1/4	2.70	1.40	2.2/1.1	6.8/3.1-3.4
RH-193	1/4	2.80	1.40	2.2/1.1	6.8/3.1-3.4
RH-258	1/3	3.60	1.90	2.2/1.1	7.8/3.6-3.9
RH-290	1/2	4.70	2.40	2.2/1.1	9.6/4.7-4.8
RH-340	1/2	4.70	2.40	2.2/1.1	9.6/4.7-4.8



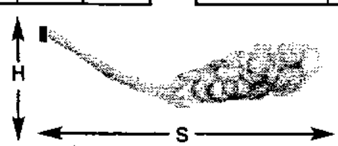
Maximum Mounting Heights

Performance Data for Standard Units at Standard Conditions of 200°F Entering Water and 60 °F Entering Air

Model No.	Height - Ft H	Height - Ft S
RH-18	9	18
RH-24	10	20
RH-33	11	22
RH-47	13	26
RH-63	15	30
RH-86	16	31
RH-108	16	33
RH-121	17	36
RH-165	18	38
RH-193	19	40
RH-258	20	42
RH-290	21	46
RH-340	22	50

Performance Data for Standard Units at Standard Conditions of 2 psig Steam and 60 °F Entering Air

Model No.	Height - Ft H	Height - Ft S
RH-18	9	17
RH-24	9	18
RH-33	10	20
RH-47	12	25
RH-63	14	29
RH-86	15	31
RH-108	15	32
RH-121	16	33
RH-165	17	34
RH-193	18	37
RH-258	19	40
RH-290	20	44
RH-340	20	46

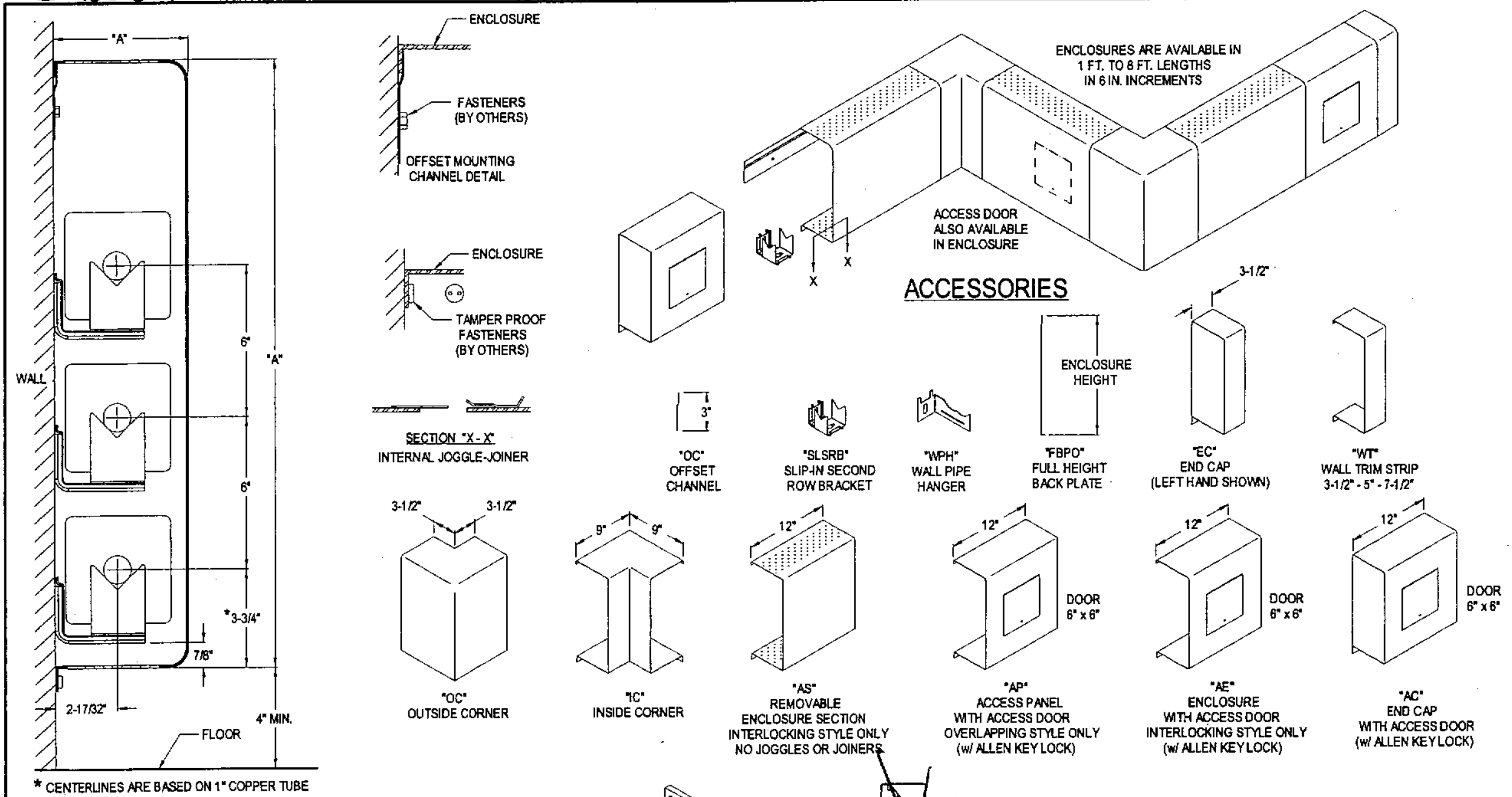


Model RH Dimensions

Model	A	B	C	D	E	F	G	H	J	NPT Connections	Fan Diameter	Approx. Shipping Wt. (lbs)
RH-18	14 3/4	16 3/4	7 7/16	4 1/2	12 3/4	4 1/8	5 9/16	10	N/A	3/4	9	18
RH-24	14 3/4	16 3/4	7 7/16	4 1/2	12 3/4	4 1/8	5 9/16	10	N/A	3/4	9	19
RH-33	18 7/8	16 3/4	7 7/16	4 3/4	12 3/4	4 1/8	5 13/16	16	N/A	3/4	12	35
RH-47	18 7/8	16 3/4	7 7/16	4 3/4	12 3/4	4 1/8	5 13/16	16	N/A	3/4	12	36
RH-63	18 7/8	22 3/4	8 7/16	4 3/4	17 3/4	4 1/8	7	16	N/A	3/4	14	51
RH-86	18 7/8	22 3/4	8 7/16	4 3/4	17 3/4	4 1/8	7	16	N/A	3/4	14	52
RH-108	26 15/16	25 7/8	9 1/2	6 1/4	24 3/4	3 1/2	6 1/4	N/A	2	1 1/2	18	76
RH-121	26 15/16	25 7/8	9 1/2	6 1/4	24 3/4	3 1/2	6 1/4	N/A	2	1 1/2	18	77
RH-165	26 15/16	31 7/8	10	6 1/4	30 3/4	3 1/2	6 1/4	N/A	2	1 1/2	20	95
RH-193	26 15/16	31 7/8	10	6 1/4	30 3/4	3 1/2	6 1/4	N/A	2	1 1/2	20	96
RH-258	32 15/16	40 13/16	11	6 1/4	39 11/16	3 1/2	6 1/4	N/A	2	2	22	165
RH-290	32 15/16	40 13/16	11	6 1/4	39 11/16	3 1/2	6 1/4	N/A	2	2	22	167
RH-340	32 15/16	40 13/16	12	6 1/4	39 11/16	3 1/2	8 1/4	N/A	2	2	24	182

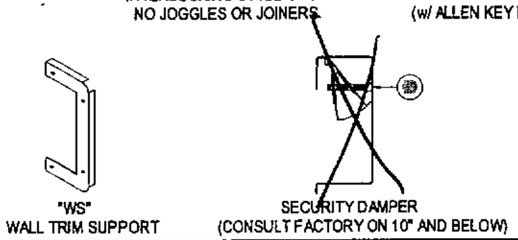
4950 Camp Road, Hamburg, NY 14075
Tel. 716.648.3801 Fax. 716.648.3203

SINGLE ROW



* CENTERLINES ARE BASED ON 1" COPPER TUBE

MODEL	PIPE SIZE		FIN SIZE	A	B
	STEEL	COPPER			
S-TP5	~~N/A~~	~~3/4" - 1" - 1-1/4"~~	~~2-3/4" x 4"~~	12	
	~~1" - 1-1/4" - 2"~~	~~3/4"~~ 1" ~~1-1/4"~~	3-1/4" x 3-1/4"	~~10~~	5-3/8"
	~~1" - 1-1/4" - 2"~~	~~3/4" - 1" - 1-1/4"~~	~~4-1/4" x 4-1/4"~~	~~[illegible]~~	



NOTE:
1) ALL ACCESSORIES OVERLAP (EXCEPT AS NOTED)
2) INTERLOCKING STYLE OPTIONAL (EXCEPT AS NOTED)

ISO 9001 CERTIFIED QUALITY

CONTRACTOR EMS
ARCHITECT
ENGINEER
REPRESENTATIVE RA Novia + Assoc.
LOCATION

ELEMENT 1"C - 3 1/4 x 3 1/4 - 40
RATING 740 BTU 180° A.W.T. 65° E.A.T.
BACKPLATE PARTIAL FULL PARTIAL X
ENCL. GAUGE 14 MATERIAL CRS
COLOR STANDARD SELECTION BY ARCHITECT DAMPER NO

HYDRO-AIR COMPONENTS, INC.
4950 CAMP ROAD
HAMBURG, NEW YORK 14075
Rittling

JOB: THE CHILDRENS SCHOOL | REV. A
ENCLOSURE MODEL: S-TP5
DATE: 06-17-03 | DWG.NO. S-TP5

GUARANTEED RATINGS

I=B=R MEMBER

S-TP5/PROD PERFORATED ENCLOSURE

In Btu/hr per active (finned) lineal foot of tube at entering air temperature of 65°F

Finned Tube Model	Rows of Finned Tube (on 6" centers)	Enclosure Height (inches)	Recommended Minimum Installed Height (inches)	EDR† (ft²/ft)	STEAM HEAT 215° (Factor of 1.00)	HOT WATER HEAT 190° (Factor of 0.78)	HOT WATER HEAT 180° (Factor of 0.69)	HOT WATER HEAT 170° (Factor of 0.61)	HOT WATER HEAT 160° (Factor of 0.53)
1C–Dia. 3¼ x 3¼ 32 Fin/Ft.	1	12	16	3.70	880	690	610	540	470
	1	18	22	3.90	930	730	640	570	490
	2	18	22	5.60	1360	1060	940	830	720
	1	24	28	4.00	990	770	680	600	520
	2	24	28	6.40	1540	1200	1060	940	820
	3	24	28	7.50	1790	1400	1240	1090	950
1C–Dia. 3¼ x 3¼ 40 Fin/Ft.	1	12	16	4.50	1070	830	740	650	570
	1	18	22	4.90	1170	910	810	710	620
	2	18	22	6.50	1560	1220	1080	950	830
	1	24	28	5.30	1280	1000	880	780	680
	2	24	28	7.30	1740	1360	1200	1060	920
	3	24	28	8.30	2000	1560	1380	1220	1060
1C–Dia. 3¼ x 3¼ 48 Fin/Ft.	1	12	16	4.90	1170	910	810	710	620
	1	18	22	5.60	1350	1050	930	820	720
	2	18	22	6.40	1540	1200	1060	940	820
	1	24	28	6.20	1490	1160	1030	910	790
	2	24	28	7.50	1810	1410	1250	1100	960
	3	24	28	8.70	2080	1620	1430	1270	1100
¾ C–Dia. 4¼ x 4¼ 32 Fin/Ft.	1	12	16	5.40	1290	1010	890	790	680
	1	18	22	5.80	1390	1080	960	850	740
	2	18	22	8.50	2040	1590	1410	1240	1080
	1	24	28	6.10	1470	1150	1010	900	780
	2	24	28	9.50	2290	1790	1580	1400	1210
	3	24	28	11.00	2630	2050	1810	1600	1390
¾ C–Dia. 4¼ x 4¼ 40 Fin/Ft.	1	12	16	6.30	1510	1180	1040	920	800
	1	18	22	6.90	1640	1280	1130	1000	870
	2	18	22	9.20	2200	1720	1520	1340	1170
	1	24	28	7.30	1760	1370	1210	1070	930
	2	24	28	10.30	2470	1930	1700	1510	1310
	3	24	28	11.80	2840	2220	1960	1730	1510
¾ C–Dia. 4¼ x 4¼ 48 Fin/Ft.	1	12	16	6.60	1590	1240	1100	970	840
	1	18	22	7.60	1830	1430	1260	1120	970
	2	18	22	8.80	2120	1650	1460	1290	1120
	1	24	28	8.60	2060	1610	1420	1260	1090
	2	24	28	10.30	2470	1930	1700	1510	1310
	3	24	28	11.80	2830	2210	1950	1730	1500
1C–Dia. 4¼ x 4¼ 32 Fin/Ft.	1	12	16	5.30	1270	990	880	780	670
	1	18	22	5.70	1360	1060	940	830	720
	2	18	22	8.30	2000	1560	1380	1220	1060
	1	24	28	6.00	1440	1120	990	880	760
	2	24	28	9.40	2250	1760	1550	1370	1190
	3	24	28	10.80	2580	2010	1780	1570	1370
1C–Dia. 4¼ x 4¼ 40 Fin/Ft.	1	12	16	6.20	1480	1150	1020	900	780
	1	18	22	6.70	1610	1260	1110	980	850
	2	18	22	9.00	2160	1690	1490	1320	1150
	1	24	28	7.20	1730	1350	1190	1060	920
	2	24	28	10.10	2420	1890	1670	1480	1280
	3	24	28	11.60	2780	2170	1920	1700	1470

The Children's School

Eastern Mechanical Services

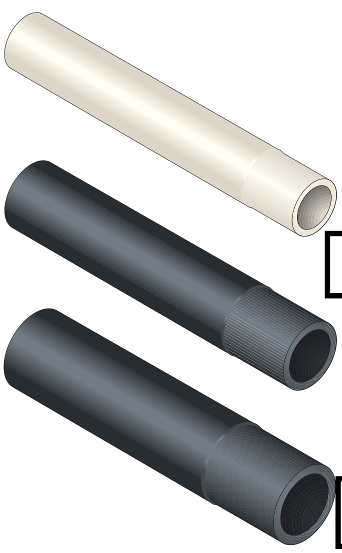
PEX Pipe with O_2 Barrier

High molecular cross-linked polyethylene (PEX) with minimum bending radii of 6 times the diameter at 68°F (20°C). Maximum operating temperature: 95°C @ 6 bar (203°F @ 90 PSI). Covered by a twenty-five year manufacturers warranty. Comes with oxygen diffusion barrier which prevents oxygen from entering the heating system through the pipe wall.

Pipe is manufactured to ASTM F-876/F-877 & CSA B137.5 and approved by: CSA & IAPMO. Oxygen Barrier is manufactured to DIN 4726/9.

PEX-A Pipe up to 4" ID (110 mm) is available by special order.

Minimum bending radius @ 68°F (20°C):
3/8" = 2-1/4" (57 mm)
1/2" = 3" (77 mm)
5/8" = 3-3/4" (95 mm)
3/4" = 4-1/2" (115 mm)
1" = 6" (153 mm)
1-1/4" = 9-1/2" (240 mm)
1-1/2" = 12" (300 mm)
2" = 15" (378mm)



Description	Stk. #	Length	Availability		UV stablized
			US	CA	
3/8" natural PEX-A pipe with O_2 barrier	94312	300'	✔	✔	✔
1/2" natural PEX pipe with O_2 barrier	98305	300'	✔		
	98105	1000'	✔		
1/2" natural PEX-A pipe with O_2 barrier	94205	250'	✔	✔	✔
	94305	300'	✔	✔	✔
	94505	500'	✔	✔	✔
	94105	1000'	✔	✔	✔
5/8" natural PEX pipe with O_2 barrier	98419	450'	✔		
	98119	1000'	✔		
5/8" natural PEX-A pipe with O_2 barrier	94419	450'	✔		✔
	94519	500'		✔	✔
	94119	1000'	✔	✔	✔
3/4" natural PEX pipe with O_2 barrier	98322	300'	✔		
	98522	500'	✔		
	98122	1000'	✔		
3/4" natural PEX-A pipe with O_2 barrier	94522	500'	✔	✔	✔
	94122	1000'	✔	✔	✔
1" natural PEX-A pipe with O_2 barrier	94128	100'	✔	✔	✔
	94528	500'	✔	✔	✔
1-1/4" ID (40x3.7mm) natural PEX-A pipe with O_2 barrier	94040	per ft	✔	✔	
1-1/2" ID (40x3.7mm) natural PEX-A pipe with O_2 barrier	94050	per ft	✔	✔	
2" ID (40x3.7mm) natural PEX-A pipe with O_2 barrier	94063	per ft	✔	✔	

TECHNICAL PROPERTIES

HDPE casing

This corrugated high density polyethylene casing provides the necessary mechanical protection and water sealant properties, and is shock-resistant, even at sub-zero temperatures.

Technical insulation properties		
	Standard	**Value**
Density	ISO 845	1.56 lbs/ft^3
Ultimate tensile strength	ISO 1926	34.8 lbs-force/in^2
Working temperature	-	-112° F to 230° F
Water take-up after 28 days	DIN 53428	< 1.7 % Vol.
Thermal conductivity	DIN 52612	50 ° F 0.0359 BTUH/ft 104° F 0.0379 BTUH/ft

Insulation properties

The insulation of Microflex pipes is composed of micro-cellular cross-linked polyethylene foam with a closed cellular structure, permitting low water vapour diffusion, good insulation and resistance to extreme temperatures.

The PEX-a pipe

Plastic pipes have more than proved their quality in recent years. They are flexible, heat and pressure-resistant, non-corrosive and lightweight. The MICROFLEX® pipe is supplied with one or more PEX-a pipes manufactured according to the Engel process, with a 92% cross-link density.

Mechanical and thermal properties of the PEX-a pipe

Properties	**Test specification**	**Unit**	**Value**
Density	DIN 53479	oz/in^3	0.53
Elasticity modulus (tensile) 68° F	DIN 53457	lbs-force/in^2	-87,022
Tensile stress 68°F 176° F	DIN 53455	lbs-force/in^2	≥ 2,465 > 1,015
Breaking strength 68° F 176° F 284° F	DIN 53455	lbs-force/in^2	> 3,480 2,610-2,900 232-290
Breaking expansion 68° F 176° F 284° F	DIN 53455	%	≥ 400 ≥ 400 ≥ 250
Notch toughness 68°F -4°F	DIN 53453	BTU/ft^2	no ruptures no ruptures
Thermal conductivity	DIN 52612	BTUH/ft	0.22(t_F+459.7)
Linear expansion coefficient 68° F 212 °F	DIN 42328	in	5.5 X 10^{-6} 7.8 X 10^{-6}
Oxygen permeability at 104°F	DIN 4726 DIN 4729	lbs/gal	≤ 0.8x10^{-6} per day
Pipe surface roughness k		in	0.2x10^{-3}

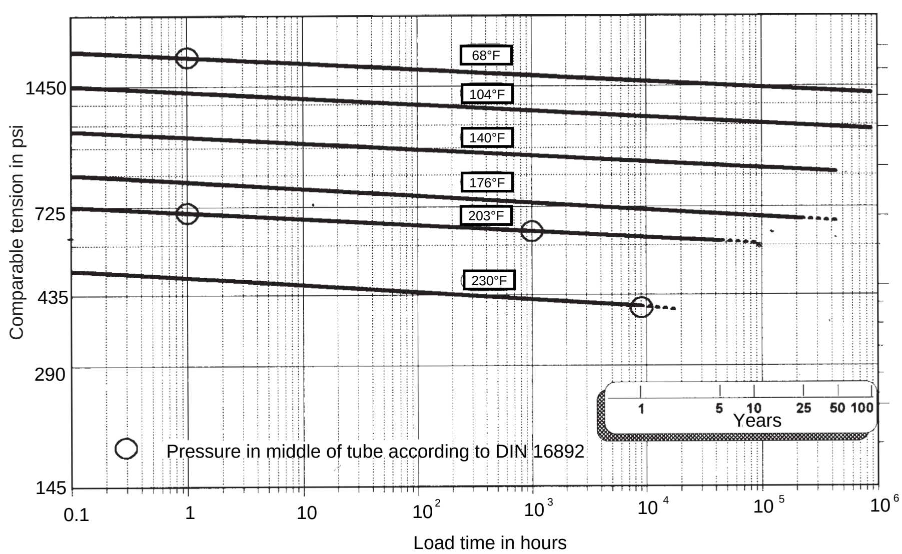
Life tests are used to test the strength of PEX-a pipes as a function of time and temperature.

The table opposite shows the linear changes at different temperatures.

The permitted load on the pipe and the safety factor can be calculated using the table opposite and the Kessel formula, according to the different applications options.

Feel free to ask for **specific** documentation!

Timespan - Internal compression strength of the PEX-a pipe



Guarantee

AND LIMITED WARRANTY

10 YEAR WARRANTY

For our HeatLink® cross linked PEX pipe, we render the following warranty over and above our terms of delivery: Our cross linked pipe is manufactured from high quality, high heat stabilized Polyethylene. Within a period of 10 years from the date of manufacture, we offer compensation up to a limit of 5,000,000 US dollars in individual cases and up to a limit of 5,000,000 US dollars in the whole number of cases per year, covered by a production liability insurance.

a) for damage to property of third persons and the resulting damage therefrom, and / or
b) for expenses to third persons for removal, dismantling, or uncovering defective products and for installing, fixing , and laying of new products to be supplied by us
c) furthermore we guarantee compensation for a period not exceeding 10 years after liquidation.
d) for a period of 10 years from the date of manufacture, free replacement for the cross linked PEX pipe supplied by us in which defects arise, that can be proved to have arisen from manufacturing or material faults for which the manufacturer is responsible. This is subject to compliance with the guidelines as outlined in our installation manual.

EXTENDED 15 YEAR LIMITED WARRANTY

Limited Warranty: This limited warranty shall expire twenty-five (25) years after the date of manufacture for our HeatLink® and AquaLink® cross linked PEX pipes.

HeatLink USA Inc., HeatLink Ireland, and Polytech Products Inc. sole obligation hereunder shall be, at its option, to issue credit, repair or replace any article or part thereof which is proved to be other than as warranted. Further, no allowances shall be made to buyer for transportation, labour charges or part adjustments or repairs or any other work.

Additionally, any performance by buyer or its designee, of any repairs without the express written consent of HeatLink USA Inc., HeatLink Ireland, and Polytech Products Inc. , shall render this Warranty invalid.

GENERAL GUIDELINES FOR THE LAYING OF PEX PIPE:

1. The minimum bending radius is 6 times pipe diameter at an ambient temperature of +20°C, and 8 times pipe diameter by lower temperatures down to 0°C.
2. Fixing of the pipe must be made with suitable pipe clamps. Fixing with binding wire is not permissible.
3. Before enclosure of the PEX pipe, the pipe must be put under pressure by water or air, (if necessary antifreeze should be added). This test should be carried out at a pressure not less than 550 kPa (80 psi) and not more than 690 kPa (100 psi) and remain thus for 24 hours, after which all connections should be tightened. The pipe is to remain under pressure while the covering is being laid.
4. Storage of the PEX pipes which allows an exposure to sun light is not permissible (danger of UV rays).
5. In areas liable to frost, a suitable anti-freeze is to be used.
6. Kinking and buckling points are to be removed.

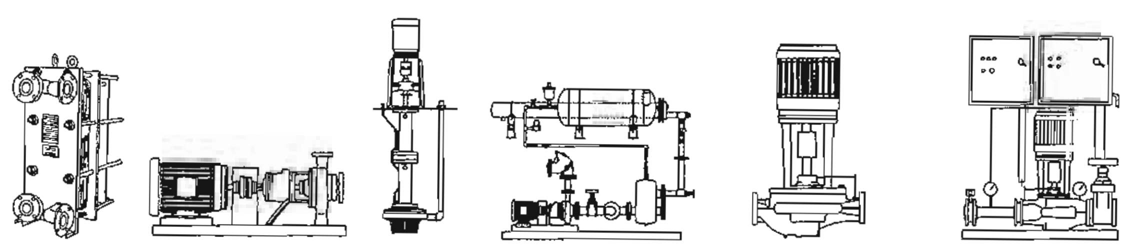
NO LIABILITY CAN BE ACCEPTED FOR FAULTS IN INSTALLATION OR LAYING OF THE PIPE. OUR GENERAL LAYING DIRECTIONS ARE A CONSTITUENT PART OF THIS WARRANTY. QUALITY CONTROL CHECKS ARE CARRIED OUT UNDER CONTRACT WITH THE MANUFACTURER. HEATLINK® DISCLAIMS ANY EXPRESS WARRANTY NOT PROVIDED HEREIN, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEATLINK® FURTHER DISCLAIMS ANY RESPONSIBILITY FOR LOSSES, EXPENSES, INCONVENIENCES, SPECIAL, INDIRECT, SECONDARY INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING FROM OWNERSHIP OR USE OF THE ARTICLES SOLD HEREUNDER. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FACE HEREOF.

Mechanical Solutions Inc.

121 Commerce Way
PO Box 790
South Windsor, CT 06074

phone 860-290-1564
fax 860-290-1825
jkirk@msipump.com

PROJECT:	**THE CHILDREN'S SCHOOL**
ENGINEER:	**VZH&S**
CONTRACTOR:	**EASTERN MECHANICAL**
SPECIFICATION SECTION:	**15500**
EQUIPMENT DESCRIPTION:	**Operation & Maintenance Manuals** **Refer To Attached Equipment List**



BILL OF MATERIAL

Item	Qty	Description	Weight
A	2	(PHWP-1,2) Armstrong Model 4380 2x2x6 Vertical In Line Pump rated for 77 gpm at 23' of head with a 1HP, ODP Standard Efficient Motor, 208V-3P and 1800RPM	140
	2	2-1/2" Armstrong Model FTV-2.5 Triple Duty Valve with Flanged Connections. #570200-376	39
	2	2-1/2" Metraflex Model TF Wye Strainer - Flanged. TF-2.5	36
	2	2.5" Metraflex Butterfly Valve, Lug Body, 10 Position Lever. 2.5-BVALVE	12
B	2	(SHWP-1,2) Armstrong Model 4380 2x2x8 Vertical In Line Pump rated for 77 gpm at 40' of head with a 2HP, ODP Standard Efficient Motor, 208V-3P and 1800RPM	172
	2	2-1/2" Armstrong Model FTV-2.5 Triple Duty Valve with Flanged Connections. #570200-376	39
	2	2-1/2" Metraflex Model TF Wye Strainer - Flanged. TF-2.5	36
	2	2.5" Metraflex Butterfly Valve, Lug Body, 10 Position Lever. 2.5-BVALVE	12
C	2	(HWRP-1) Armstrong Model 1050 1.5B Circulator rated for 48 gpm at 14' of head with 1/3HP, ODP Motor, 208V-3P and 1800RPM.	48
D	1	(AS-1) 3" Armstrong Model VAS-3 Vortex Air Separator with Stainless Steel Strainer.#570289-002	130
E	1	(ET-1) Armstrong Model AX-60V Vertical Diaphragm Type Expansion Tank, ASME, 34 Gallon Tank, 12.5 Gallon Acceptance. #572006-100	110
	1	3/4" Metraflex Model MV-15A High Capacity Air Vent.	10
	1	3/4" Armstrong Model HRD-70 Pressure Reducing Valve. #207936-300	20
F	1	John Woods Model JWVF-27-005 5 Gallon Shot Feeder	37
I	2	(VFD-SHWP-1,2) Square D Variable Frequency Drive to operate 2HP, 208V-3P motor with bypass.	150
		Griswold Valves	
A	1	(VAV-1)Griswold Model 4PCPP2QS22UPH Coil Package.	
B	1	(VAV-2) Griswold Model 4PCPP2QS22UPH Coil Package.	
C	1	(VAV-3) Griswold Model 4PCPP2QS22UPH Coil Package.	
D	1	(VAV-4) Griswold Model 4PCPP2QS22UPH Coil Package.	

E	1	(UH) Griswold Model 4PCPP2QS22UPH Coil Package.
F	1	(HWC-1) Griswold Model 4PCPP2QS32UPI Coil Package.
G	1	(HWC-2) Griswold Model 4PCPP2QS22UPH Coil Package.

ARMSTRONG

FILE NO.: 43.80
DATE: Feb. 16, 2008
SUPERSEDES: 43.80
DATE: Aug. 15, 1997

INSTALLATION AND OPERATING INSTRUCTIONS

COMMERCIAL PUMPS

Series 4300, 4360 & 4380 Vertical In-Line Pumps

INTRODUCTION

This document contains specific information regarding the safe installation, operating and maintenance of Vertical In-Line pumps and should be read and understood by installing, operating and maintenance personnel. The equipment supplied has been designed and constructed to be safe and without risk to health and safety when properly installed, operated and maintained. The instructions following must be strictly adhered to. If clarification is needed on any point please contact Armstrong quoting the equipment serial number.

WARNING SYMBOLS

Safety instruction where an electrical hazard is involved.

Safety instruction where non-compliance would affect safety risk.

Safety instruction relating to safe operation of the equipment. (ATTENTION)

INSTRUCTIONS FOR SAFE USE

No installation of this equipment should take place unless this document has been studied and understood. Handling, transportation and installation of this equipment should only undertaken by trained personnel with proper use of lifting equipment. See later diagrams for lifting advice. Refer to the pump nameplate for pump speed, pressure and temperature limitations. The limits stated must not be exceeded without written permission from Armstrong.

TEMPERATURE

Where under normal operating conditions the limit of 68°C/155°F (Restricted Zone) for normal touch, or 80°C/176°F (Unrestricted Zone) for unintentional touch, may be experienced, steps should be taken to minimize contact or warn operators/users that normal operating conditions will be exceeded. In certain cases where the temperature of the pumped liquid exceeds the above stated temperature levels, pump casing temperatures may exceed 100°C/212°F and not withstanding pump insulation techniques appropriate measures must be taken to minimize risk for operating personnel.

NOISE LEVELS

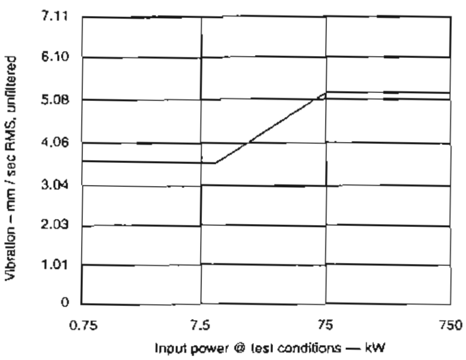
Estimated Pumping Unit Sound Power Level, Decibels, A-Weighted, at 1 m /3 ft. from unit.

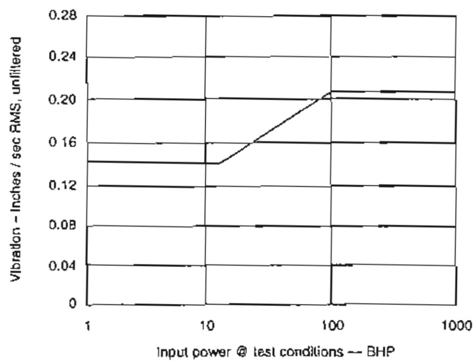
	1200 rpm				1800 rpm				3600 rpm			
Frame	ODP		TEFC		ODP		TEFC		ODP		TEFC	
Designation	hp	dB-A	hp	dB-A	hp	dB-A	hp	dB-A	hp	dB-A	hp	dB-A
140	0.75 - 1	65	0.75 - 1	64	1 - 3	70	1 - 2	70	1.5 - 3	76	1.5 - 2	85
180	1.5 - 2	67	1.5 - 2	67	3 - 5	72	3 - 5	74	5 - 7.5	80	3 - 5	88
210	3 - 5	72	3 - 5	71	7.5 - 10	76	7.5 - 10	79	10 - 15	82	7.5 - 10	91
250	7.5 - 10	76	7.5 - 10	75	15 - 20	80	15 - 20	84	20 - 25	84	15 - 20	94
280	15 - 20	81	15 - 20	80	25 - 30	80	25 - 30	88	30 - 40	86	25 - 30	95
320	25 - 30	83	25 - 30	83	40 - 50	84	40 - 50	89	50 - 60	89	40 - 50	100
360	40 - 50	86	40 - 50	86	60 - 75	86	60 - 75	95	75 - 100	94	60 - 75	101
400	60 - 75	88	60 - 75	90	100 - 125	89	100	98	125 - 150	98	100	102
440	100 - 125	91	100 - 125	94	150 - 200	93	125 - 150	102	200 - 250	101	125 - 150	104

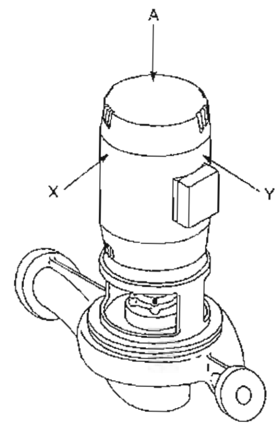
ARMSTRONG

VIBRATION LEVELS

Armstrong Vertical In-Line pumps are designed to meet vibration levels set by Hydraulic Institute Standard HI Pump Vibration 9.6.4. Standard levels are as detailed below:







Vertical In-Line

STORAGE

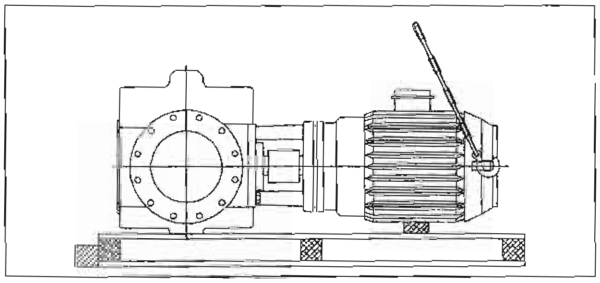
Pumps not immediately placed into service, or removed from service and stored, must be properly prepared to prevent excessive rusting. Pump port protection plates must not be removed until the pump is ready to connect to the piping.
Rotate the shaft periodically (At least monthly) to keep rotating element free and bearings fully functional.
For long term storage, the pump must be placed in a vertical position in a dry environment.
Internal rusting can be prevented by removing the plugs at the top and bottom of the casing and drain or air blow out all water to prevent rust buildup or the possibility of freezing. Be sure to reinstall the plugs when the unit is made operational. Rustproofing or packing the casing with moisture absorbing material and covering the flanges is acceptable. When returning to service be sure to remove the drying agent from the pump.

UNCRATING

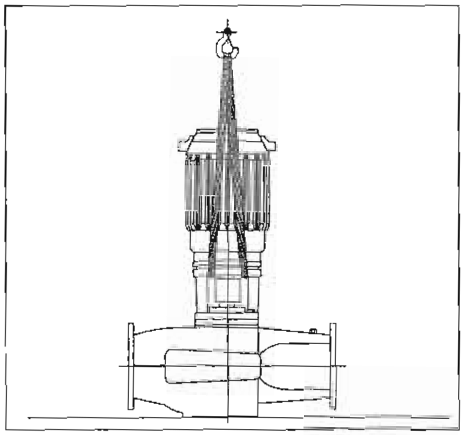
Armstrong Vertical In-Line pumps are thoroughly inspected before shipment to assure they meet with your order requirements. After removing the pump from the crate, make sure the equipment is in good order and that all components are received as called for on the packing list. Any shortages or damage should be reported immediately. Use extreme care in handling the unit, placing slings and hooks carefully so that stress will not be imposed on the pump. NEVER PLACE CABLE SLINGS AROUND THE PUMP SHAFT. The eye bolts or lifting lugs on the motor are intended for lifting only the motor and not the complete unit.

HANDLING LARGE VIL UNITS

One effective way of lifting a large Series 4300 unit from the shipment pallet following uncovering the unit is to place lifting hooks through the motor lifting rings or straps around the upper part of the motor and carefully lift sufficiently to stand the pump vertically. Lift only sufficiently to remove the pallet then lower onto a flat surface. The pump and motor unit will free-stand on the casing ribs. Remove the coupling guard and place (2) lifting straps through the pump/motor pedestal, one on each side of the motor shaft and secure to the lifting device. With the straps in place, using a spacer bar if necessary to protect the motor fan cover, the whole assembly can now be lifted securely and placed in position in the piping.



Secure pallet and lift pump vertical using motor eye-bolts lift only to clear pallet then sit on the flat surface



Remove coupling guard and place lifting straps on each side of coupling, use spacer bar if necessary to protect motor fan cover.

> **IMPORTANT:**
> Do not run the pump for any length of time under very low flow conditions or with the discharge valve closed. To do so could cause the water in the casing to reach super heated steam conditions and will cause premature failure and could cause serious and dramatic damage to the pump and surrounding area.

INSTALLATION

1. LOCATION

- In open systems, locate the unit as close as practical to the liquid being pumped, with a short, direct suction pipe. Ensure adequate space is left above and around the unit for operation, maintenance, service and inspection of parts.
- In closed systems, where possible, the pumps should be installed immediately downstream of the expansion tank / make-up connection. This is the point of zero pressure change and is necessary for effective pump operation. Do not install more than one expansion tank connection into any closed hydronic system.
- Electric motor driven pumps should not be located in damp or dusty location without special protection.
- Airflow into the motor and/or motor fan should not be obstructed.

2. INSTALLATION

- *When installing vertical in-line pumps, an important consideration to accrue full added-value from the pump design is to ensure that the pump is pipe-mounted and free to 'float' with any movement, expansion and contraction of the piping. Should any vertical in-line pump use supports to the structure it is imperative that no pipe strain is imposed on the pump flanges. Tell-tale pieces of equipment such as springs or 'waffle' style isolation pads that distort with pressure to indicate added piping weight, should be used under pump supports should the pump not be truly pipe mounted.*
- Recommended installation arrangements are:
  - 2.1. Piping supported at ceiling with additional floor mounted pipe-stools, isolated from the structure by 'waffle' isolation pads, under the Armstrong Suction Guide and Flo-Trex Valve. (Fig. 2.1a) The majority of Series 4300 pumps are installed in this manner. Should additional space saving be required the discharge spool piece and Flo-Trex valve may be replaced by a long-radius elbow and the Flo-Trex valve field converted to a straight-through valve and installed in the vertical discharge pipe. (Fig 2.1b)
  - 2.2. Supported from the ceiling by pipe hangers. (Fig. 2.2) This could be at sufficient height to use zero floor space.
  - 2.3. Floor mounted saddle supports. (Fig. 2.3) Typical for condenser water pumps where cooling tower base is at mechanical room elevation.

2.4. Where required, additional floor support may be used as shown in Fig. 2.4. Note that the pump should not be rigidly attached to the column. Leave a small gap between pump and column or install a 'waffle' isolation pad under the pump. It is critical that piping be installed in such a manner that the pump does not become a pipe support.
2.5. Flange mounted stanchion plates can be used on pump flanges. Fig. 2.5a indicates stanchion plates as pump legs that may be supplied for installation convenience. As with Fig. 2.4, 'waffle' style isolation pads must be used under the legs and pipe hangers adjusted to ensure the pump casing is not a piping support. Fig. 2.5b uses the stanchion plates along with seismically rated isolation pads or snubbers to restrain the pump during a seismic event. Again it must be stressed that pipe hangers carry the weight of the equipment as seismic components are designed only to restrain the equipment during a seismic event.
2.6. DO NOT support the unit by the motor eye bolts (Fig. 2.6) or by any other part of the motor.
2.7. DO NOT rigidly connect the pump to a permanent base (Fig. 2.7). This is similar to the notes under Fig. 2.4. Note that if the pump must be connected to a permanent base, the pump becomes a base-mounted unit and must be isolated from the piping by flexible connectors and the base isolated from the building structure on an inertia base.
2.8. Close coupled in-line units (Series 4360 & 4380) up to 15 hp / 11 kW may be installed with the shaft horizontal. (Fig. 2.8) For horizontal mounting of large units or Series 4300 Split-Coupled style consult the factory.
2.9. Many Vertical In-Line pumps are piped successfully into grooved piping systems. In-line pumps are supported well by grooved piping however flange adapter locking devices or a welded flange at the pump should be used to prevent the possibility of pipe mounted pumps from rotating in the piping. Armstrong offers grooved suction and discharge piping accessories with inherent locking devices to prevent this possibility. The Armstrong grooved piping accessories are versions of the suction guides (Diffusers) and Flo-Trex (Triple-Duty) valves detailed in the Pump Piping section below.

IMPORTANT:
All Series 4300 pumps contain a tapped hole in the motor bracket above the discharge flange (see Fig. 2.10) for draining the well. Pipe this drain hole to a floor drain to avoid overflow of the cavity caused by collecting chilled water condensate or from seal failure.

3. PUMP PIPING - GENERAL

- Never connect a pump to piping, unless extra care is taken to measure and align the piping flanges well. Always start piping from pump.
- Use as few bends as possible and preferably long radius elbows.
- Do not use flexible connectors on the suction or discharge of a vertical in-line pump, unless the pump is rigidly mounted to a foundation.
- Ensure piping exerts no strain on pump as this could distort the casing causing breakage or early failure due to pump misalignment.
- All conecting pipe flanges must be square to the pipework and parallel to the pump flanges.
- Suction and discharge pipes may be increased or decreased at pump nozzle to suit pump capacity and particular conditions of installation. Use eccentric reducers on suction connection with flat side uppermost.
- Layout the suction line with a continual rise towards the pump without high points, thus eliminating possibility of air pockets that may prevent the pump from operating effectively.
- A strainer of three or four times the area of the suction pipe, installed in the suction line, will prevent the entrance of foreign materials into the pump. 3/16" (5 mm) diameter perforations in the strainer is typical.
- In open systems, test suction line for air leaks before starting; this becomes essential with long suction line or static lift.
- Install, at the pump suction, a straight pipe of a length equivalent to 4 or 6 times its diameter; this becomes essential when handling liquids above 120°F (49°C). Armstrong suction guides may be used in place of the straight pipe run and in-line strainer.
- Install an isolation valve in both suction and discharge lines on flooded suction application; these valves are used primarily to isolate the pump for inspection or repair
- Install a non-slam non-return check valve in discharge line between pump and isolation valve to protect pump from excessive back pressure and to prevent water running back through the pump in case of driver failure on open systems. An Armstrong Flo-Trex valve may be used in place of non-return check valve and isolation valve on pump discharge.

A **CAUTION:**
The discharge valve only is to be used to throttle pump flow, not the suction valve. Care must be taken in the suction line layout and installation, as it is usually the major source of concern in centrifugal pump applications

4. ALIGNMENT

- Alignment is unnecessary on close-coupled pumps, Series 4360 & 4380, as there is no shaft coupling.
- Series 4300 units are accurately aligned at the factory prior to being shipped and do not need re-aligning when installed.
- Alignment on a Series 4300 unit may be verified by assuring an equal and parallel gap between coupling halves on both sides of the coupling.

OPERATION

5. STARTING PUMP

- Ensure that the pump turns freely by hand, or with some mechanical help such as a strap and lever on larger pumps. Ensure that all protective guarding is securely fixed in position.
- The pump must be fully primed on start up. Fill the pump casing with liquid and rotate the shaft by hand to remove any air trapped in the impeller. On Series 4300 any air trapped in the casing as the system is filled must be removed by the manual air vent in the seal flush line. Series 4360 & 4380 units are fitted with seal flush/vent lines piped to the pump suction area. When these units operate residual air is drawn out of the pump towards the suction piping.
- "Bump" or energize the motor momentarily and check that the rotation corresponds with the directional arrow on the pump casing.
- To reverse rotation of a three phase motor, interchange any two power leads.
- Start the pump with the discharge valve closed and the suction valve open, then gradually open the discharge valve when the motor is at operating speed. The discharge valve may be "cracked" or open slightly at start up to help eliminate trapped air.
- When stopping the pump: Close the discharge valve and de-energize the motor.
- DO NOT run the pump against a closed discharge valve for an extended period of time. (A few minutes maximum)
- Star-Delta motor starters should be fitted with electronic/mechanical interocks that have a timed period of no more than 40 mili-seconds before switching from star (Starting) to delta (Run) connection yet allow the motor to reach full star (Starting) speed before switching to delta (Run).
- Should the pump be noisy or vibrate on start-up a common reason is overstated system head. Check this by calculating the pump operating head by deducting the suction pressure gauge value from the discharge gauge reading. Convert the result into the units of the pump head as stated on the pump nameplate and compare the values. Should the actual pump operating head be significantly less than the nameplate head value it is typically permissable to throttle the discharge isolation valve until the actual operating head is equal to the nameplate value. Any noise or vibration usually disappears. The system designer or operator should be made aware of this soon as some adjustment may be required to the pump impeller diameter or drive settings, if applicable, to make the pump suitable for the system as installed.

CAUTION:
Check rotation arrow prior to operating the unit. The rotation of all Armstrong Vertical In-Line units is "clockwise" when viewed from the drive end. (Looking from on top of / behind the motor)

6. GENERAL CARE

- Vertical In-Line pumps are built to operate without periodic maintenance, other than motor lubrication on larger units. A systematic inspection made at regular intervals, will ensure years of trouble-free operation, giving special attention to the following:
  - Keep unit clean
  - Provide the motor with correctly sized overload protection
  - Keep moisture, refuse, dust or other loose particles away from the pump and ventilating openings of the motor.
  - Avoid operating the unit in overheated surroundings (Above 100°F/40°C).

WARNING:
Whenever any service work is to be performed on a pumping unit, disconnect the power source to the driver, LOCK it OFF and tag with the reason. Any possibility of the unit starting while being serviced must be eliminated.

- If mechanical seal environmental accessories are installed, ensure water is flowing through the sight flow indicator and that filter cartridges are replaced as recommended. (See Armstrong files 43.85 & 43.86 for seal environmental instructions).

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7. LUBRICATION

Pump
- Lubrication is not required. There are no bearings in the pump that need external lubrication service.
- Large Series 4300 units are installed with a shaft bushing located beneath the impeller that is lubricated from the pump discharge. This bearing is field removable for service on the 20x20x19 size without disturbing the motor or other major pump components.
- Service instructions for the lower bearing is to be found on File No: 43.805.

Motor
- Follow the lubrication procedures recommended by the motor manufacturer. Many small and medium sized motors are permanently lubricated and need no added lubrication. Generally if there are grease fittings evident the motor needs periodic lubrication. None if not.
- Check the lubrication instructions supplied with the motor for the particular frame size indicated on the motor nameplate.

Mechanical Seal
- Mechanical seals require no special attention. The mechanical seal is fitted with a flush line. The seal is flushed from discharge of the pump casing on Series 4300 pumps and is flushed/vented to the suction on close coupled pumps, Series 4360 & 4380.
- The Series 4300 pump is flushed from the pump discharge because the mechanical seal chamber is isolated from the liquid in the pump by a throttle bushing. Because the seal chamber is isolated, seal environmental controls such as filters and separators, when installed in the Series 4300 flush line are very effective, as only the seal chamber needs cleansing, and will prolong seal life in HVAC systems.
- Do not run the pump unless properly filled with water as the mechanical seals need a film of liquid between the faces for proper operation.
- Mechanical seals may 'weep' slightly at start-up. Allow the pump to continue operating for several hours and the mechanical seal to 'seat' properly prior to calling for service personnel.
- The following Armstrong files are available for mechanical seal replacement instructions:
  - Series 4360: File 6040.60
  - Series 4380: File 43.81
  - Series 4300: P-Base and TCZ Motor Frames – File 43.83
TC Motor Frame – File 43.88

8. SYSTEM CLEANLINESS
- Before starting the pump the system must be thoroughly cleaned, flushed and drained and replenished with clean liquid.
- Welding slag and other foreign materials, "Stop Leak" and cleaning compounds and improper or excessive water treatment are all detrimental to the pump internals and sealing arrangement.
- Proper operation cannot be guaranteed if the above conditions are not adhered to.

NOTE:
Particular care must be taken to check the following before the pump is put into operation:

A. Pump primed?
B. Rotation OK?
C. Lubrication OK?
D. Pipe work properly supported?
E. Voltage supply OK?
F. Overload protection OK?
G. Is the system clean?
H. Is the area around the pump clean?

WARRANTY
Does not cover any damages to the equipment resulting from failure to observe the above precautions. Refer to Armstrong General Terms and Warranty sheet. Contact your local Armstrong representative for full information.

ARMSTRONG

INSTALLATION LAYOUTS

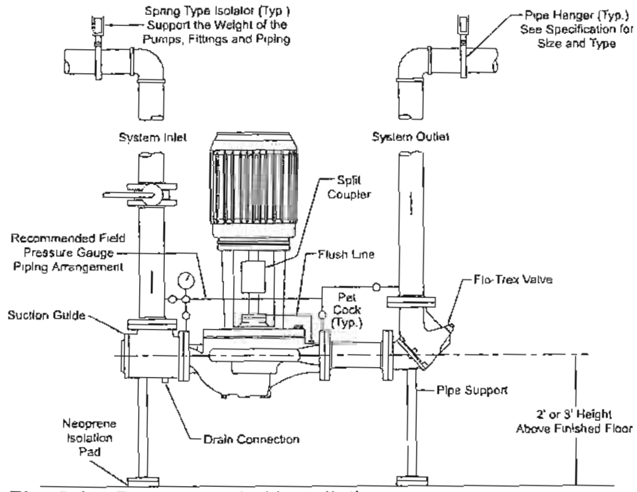

Fig. 2.1a Recommended Installation

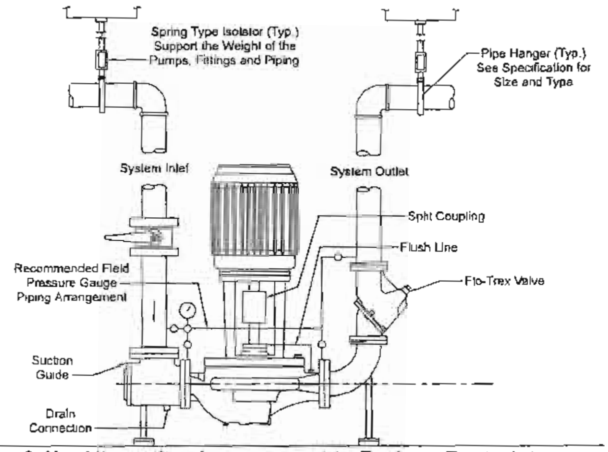

Fig. 2.1b Alternative Arrangement to Reduce Footprint

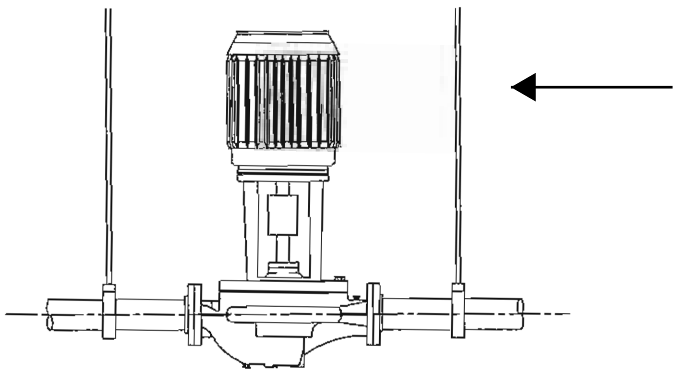

Fig. 2.2 Pipe Hanger Support

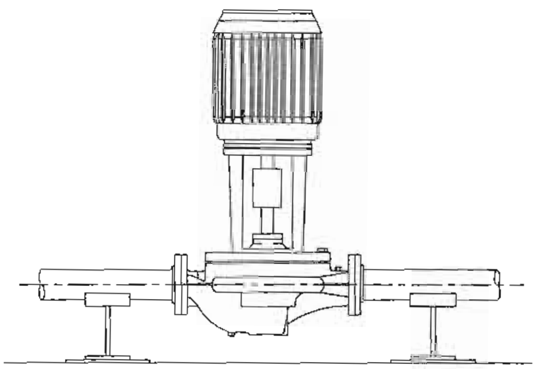

Fig. 2.3 Floor Saddle Support

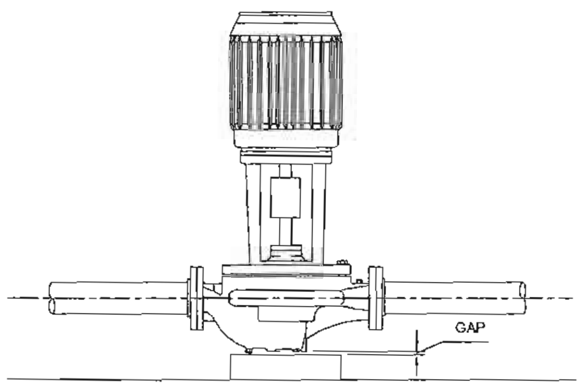

Fig. 2.4 Additional Floor Support

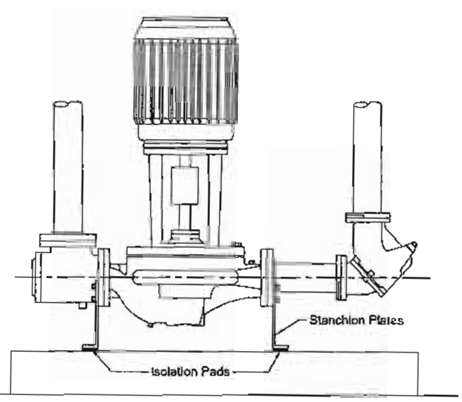

Fig. 2.5a Mounting VIL with Stanchion Plates

ARMSTRONG

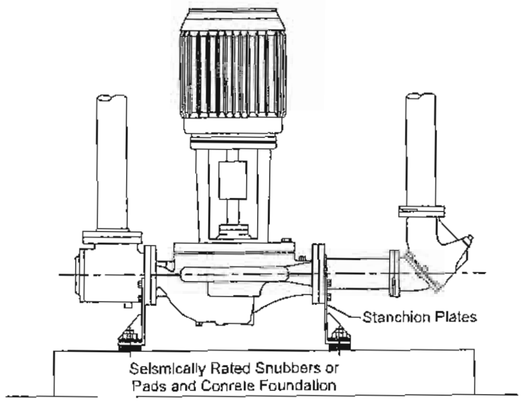

Fig. 2.5b Seismic Region Installation

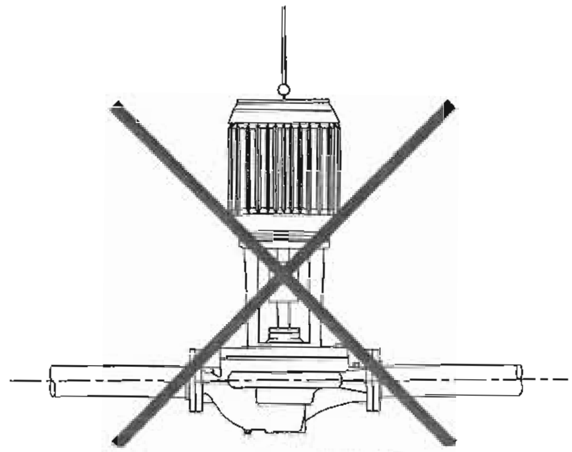

Fig. 2.6 Not Recommended – Hanging

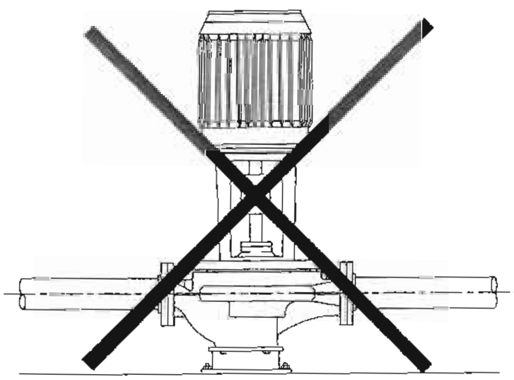

Fig. 2.7 Not Recommended – Rigid Base

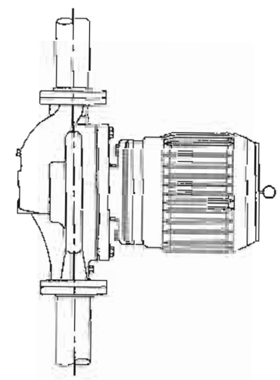

Fig. 2.8 Horizontal Mounting

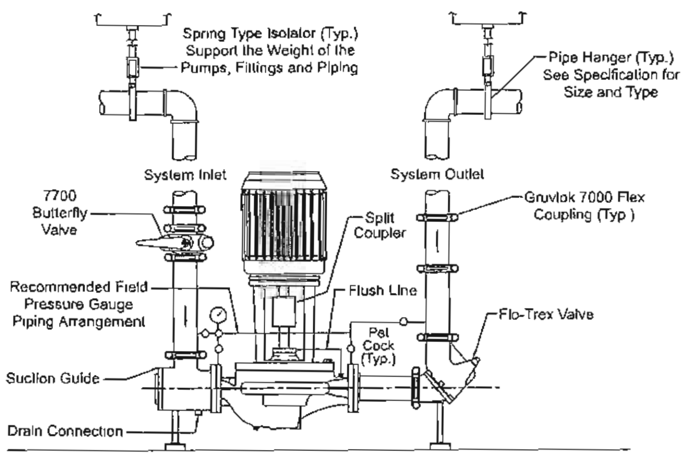

Fig. 2.9 Mounting in Grooved Pipe systems

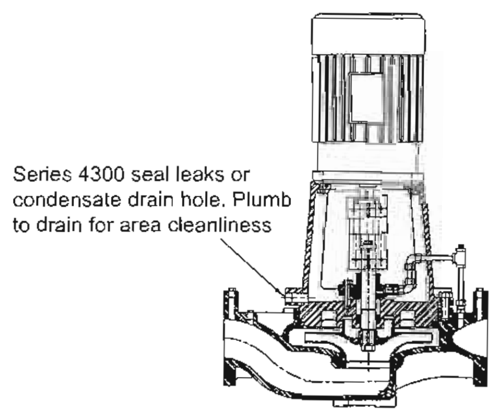

Fig. 2.10 Seal leaks or condensate drain hole. Plumb to drain for area cleanliness.

S. A. Armstrong Limited
23 Bertrand Avenue
Toronto, Ontario
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T: (416) 755-2291
F (Main): (416) 759-9101

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93 East Avenue
North Tonawanda, New York
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Armstrong Holden Brooke Pullen
Wenlock Way
Manchester
United Kingdom, M12 5JL
T: +44 (0) 161 223 2223
F: +44 (0) 161 220 9660

ARMSTRONG SUBMITTAL

Series 4380
2x2x6
Close Coupled Vertical In-Line Centrifugal Pump

Project Number: 062306	**Representative:** Mechanical Solutions
Name: The Children's School	121 Commerce Way, South Windsor, CT
Reference:	Phone: 860-290-1564, Fax: 860-290-1825
Location:	**Order No:** **Date:**
Engineer:	**Submitted by:** Julie Kirk **Date:** 12/4/2006
Contractor: Eastern Mechanical	**Approved by:** **Date:** 12/4/2006

PUMP DESIGN DATA

Tag Num:	PHWP-1,2
Service:	
Location:	
No. of Pumps:	2
Capacity:	77 usgpm
Head:	23 ft
Piping:	Single
Suction Pressure:	0 ft
Liquid:	Water, sg= 1.00, 70 °F
Viscosity:	31 ssu
Branch Sizes:	Suction= 2 in, Discharge= 2 in

MOTOR DESIGN DATA

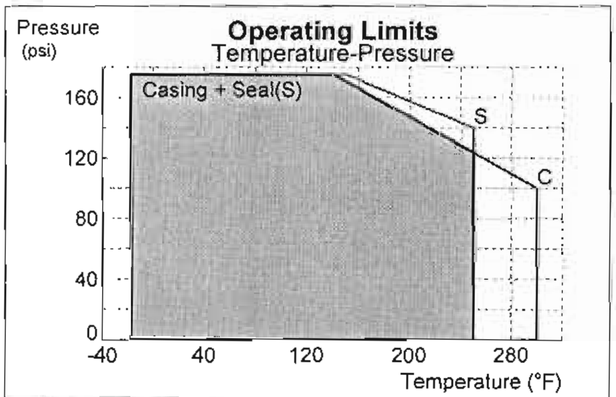
Motor Supplier:	Factory Choice
Motor Size:	1 hp @ 1800 rpm
Frame Size:	143JM
Enclosure:	ODP
Cycle/Phase/Voltage:	60/3/208 (Dedicated)
Motor Eff:	Std
Insulation:	Class "B" Insulation (266.0 °F)
Starter Config:	DOL
Full Load/Starting (A)	4.0 / 33.2

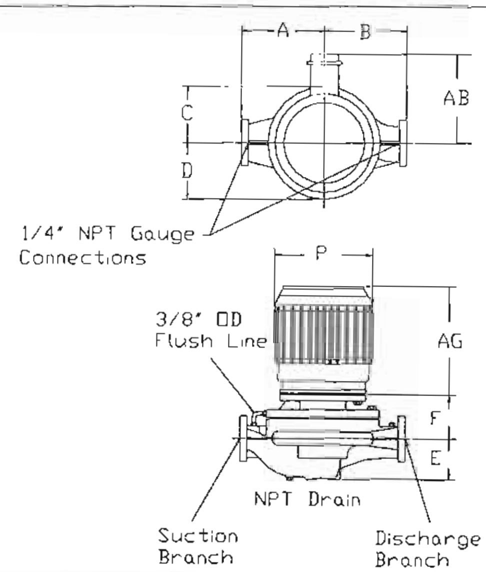
MATERIALS OF CONSTRUCTION

Construction	BF (Bronze Fitted)
ANSI Flange Rating	125 lb. (Cast Iron)
Volute	Cast Iron (A48-30)
Impeller	Bronze (B584-844)
Shaft Sleeve	Bronze (B584-844)
Flush Line	Bronze (B584-844)
Casing Gasket	Confined Non-Asbestos Fiber
Motor Shaft	Carbon Steel

MECHANICAL SEAL DESIGN DATA

Manufacturer	John Crane
Manu. Code [JC 21]	JC 21, OF171
Seal Type	Inside Unbalanced
Rotating Face	Carbon
Stationary Seal	Silicon Carbide
Secondary Seal	EPDM
Springs	Stainless Steel
Rotating Hardware	Stainless Steel



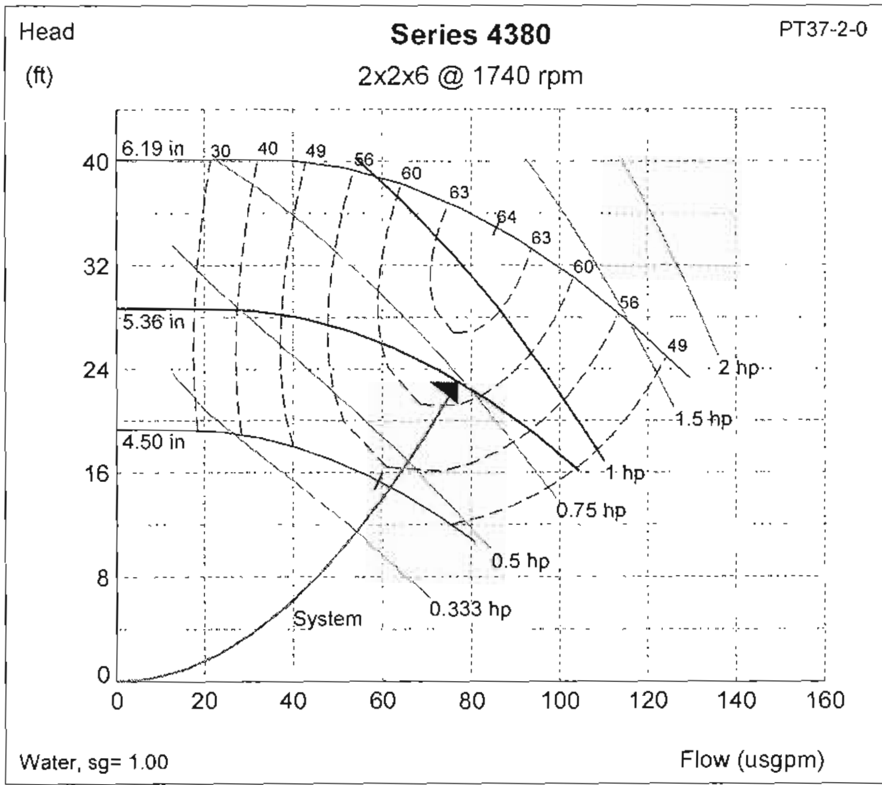


DIMENSIONAL DATA (in, lbs, hp) NOT for CONSTRUCTION

Suct	Disch.	A	B	C	D	E	Drain	P.Wgt	F	AG	P	AB	M.Wgt
2	2	8	7	4.88	4.88	4.88	0.25	110	3.75	11	7.5	6	30

ARMSTRONG SUBMITTAL

Series 4380
2x2x6
Close Coupled Vertical In-Line Centrifugal Pump



--- **Admin Data** ---
Tag Num: PHWP-1,2
Service:
Location:

--- **Motor Data** ---
Motor Size: 1 hp
Motor Speed: 1800 rpm

--- **Design Duty Point** ---
Flow: 77 usgpm
Head: 23 ft
Impeller: 5.36 in

--- **Performance Data** ---
- NPSHR: 6.216 ft
- Eff. @ Design: 60.86 %
- BHP @ Design: 0.73 hp
- %Mtr Safety: 36.09%
- BEP @ Design Imp.: 61.26 % @ 72.4 usgpm
- Impeller Max BHP @ Flow: 0.88 hp @ 104.3 usgpm
- %max imp. range: 50.85 %
- Outlet Velocity: 7.36 ft/s

OPTIONAL EQUIPMENT	
Motor	Dedicated Nameplate Voltage

PAWP-1,2

Pump Parts **Model No.** 4380 2x2x6 **ARMSTRONG**

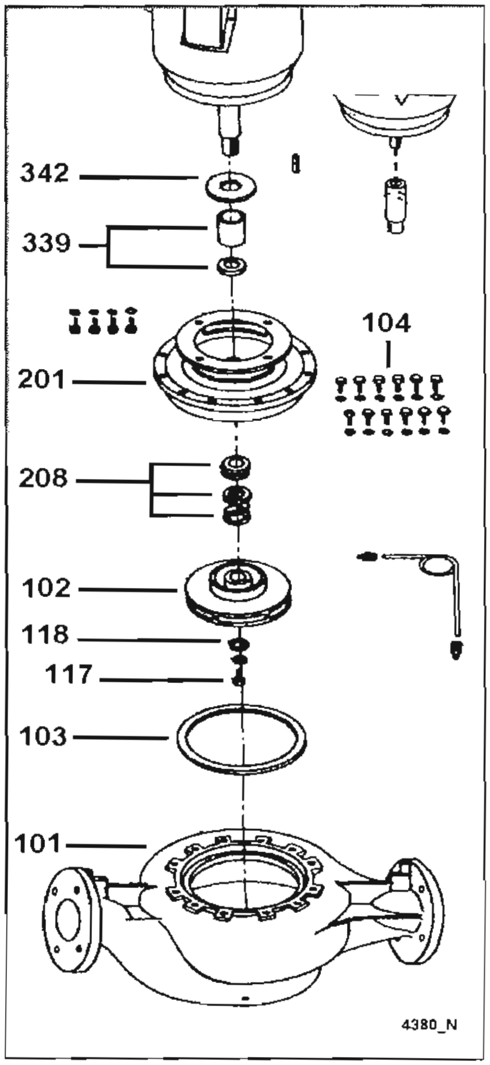
Frame S1 **Material** Bronze Fitted

Description New Style Vertical-In-Line, Split Coupler, Equal Suction & Discharge Size

Volute 250#	101	427038-031
Volute 125#	101	427037-011
Impeller	102	427109-041
Volute Gasket	103	426401-002
Volute Capscrews	104	1/2-13NCx1 1/4"
Impeller Capscrews	117	911900-114
Impeller Washer	118	426472-001
Combination M/P Brkt	201	426746-011
Coverplate	201	
Mech. Seal Assy.	208	9975000-991
Shaft or Shaft Sleeve Kit	339	810150-150

If a part field is blank, then this model does not contain that part

Comments: Small Frame = 7/8" impeller bore



ARMSTRONG SUBMITTAL

Series 4380
2x2x8
Close Coupled Vertical In-Line Centrifugal Pump

Project Number: 062306	**Representative:** Mechanical Solutions
Name: The Children's School	121 Commerce Way, South Windsor, CT
Reference:	Phone: 860-290-1564, Fax: 860-290-1825
Location:	**Order No:** **Date:**
Engineer:	**Submitted by:** Julie Kirk **Date:** 12/4/2006
Contractor: Eastern Mechanical	**Approved by:** **Date:** 12/4/2006

PUMP DESIGN DATA

Tag Num:	SHWP-1,2
Service:	
Location:	
No. of Pumps:	2
Capacity:	77 usgpm
Head:	40 ft
Piping:	Single
Suction Pressure:	0 ft
Liquid:	Water, sg= 1.00, 70 °F
Viscosity:	31 ssu
Branch Sizes:	Suction= 2 in, Discharge= 2 in

MOTOR DESIGN DATA

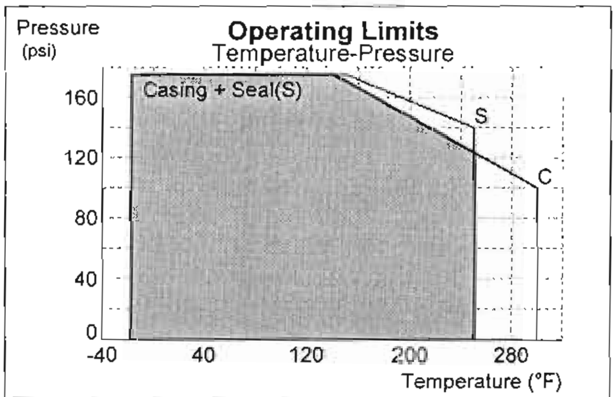
Motor Supplier:	Factory Choice
Motor Size:	2 hp @ 1800 rpm
Frame Size:	145JM
Enclosure:	ODP
Cycle/Phase/Voltage:	60/3/208
Motor Eff:	Std
Insulation:	Class "B" Insulation (266.0 °F)
Starter Config:	DOL
Full Load/Starting (A)	7.5 / 55.3

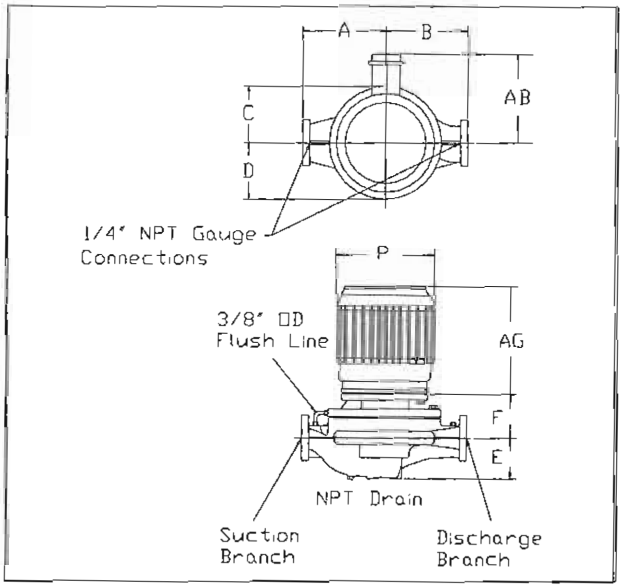
MATERIALS OF CONSTRUCTION

Construction	BF (Bronze Fitted)
ANSI Flange Rating	125 lb. (Cast Iron)
Volute	Cast Iron (A48-30)
Impeller	Bronze (B584-844)
Shaft Sleeve	Bronze (B584-844)
Flush Line	Bronze (B584-844)
Casing Gasket	Confined Non-Asbestos Fiber
Motor Shaft	Carbon Steel

MECHANICAL SEAL DESIGN DATA

Manufacturer	John Crane
Manu. Code [JC 21]	JC 21, OF171
Seal Type	Inside Unbalanced
Rotating Face	Carbon
Stationary Seat	Silicon Carbide
Secondary Seal	EPDM
Springs	Stainless Steel
Rotating Hardware	Stainless Steel



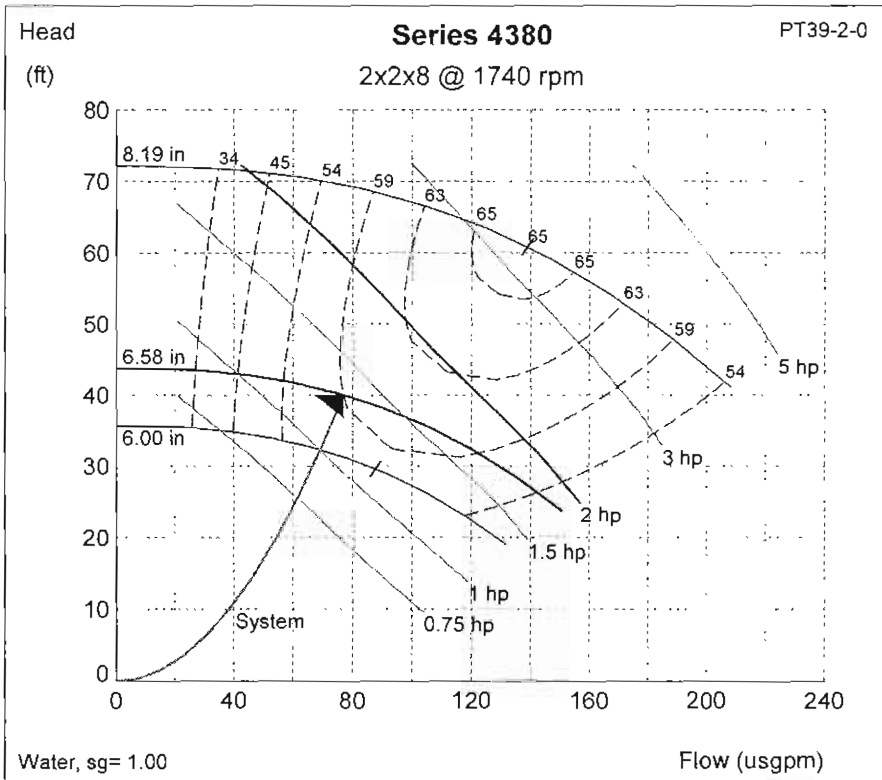


DIMENSIONAL DATA (in, lbs, hp) NOT for CONSTRUCTION

Suct.	Disch.	A	B	C	D	E	Drain	P.Wgt	F	AG	P	AB	M.Wgt
2	2	9.5	8.5	5.75	5.75	5.13	0.25	137	3.75	12	7.5	6	35

ARMSTRONG
SUBMITTAL

Series 4380
2x2x8
Close Coupled Vertical In-Line Centrifugal Pump



--- Admin Data ---
Tag Num: SHWP-1,2
Service:
Location:

--- Motor Data ---
Motor Size: 2 hp
Motor Speed: 1800 rpm

--- Design Duty Point ---
Flow: 77 usgpm
Head: 40 ft
Impeller: 6.58 in

--- Performance Data ---
- NPSHR: 4.034 ft
- Eff. @ Design: 58.97 %
- BHP @ Design: 1.32 hp
- %Mtr Safety: 51.65%
- BEP @ Design Imp.: 60.51 % @ 100.4 usgpm
- Impeller Max BHP @ Flow: 1.83 hp @ 150.5 usgpm
- %max imp. range: 26.58 %
- Outlet Velocity: 7.36 ft/s

SAWP 1, 2

Pump Parts **Model No.** 4380 2x2x8 **ARMSTRONG**

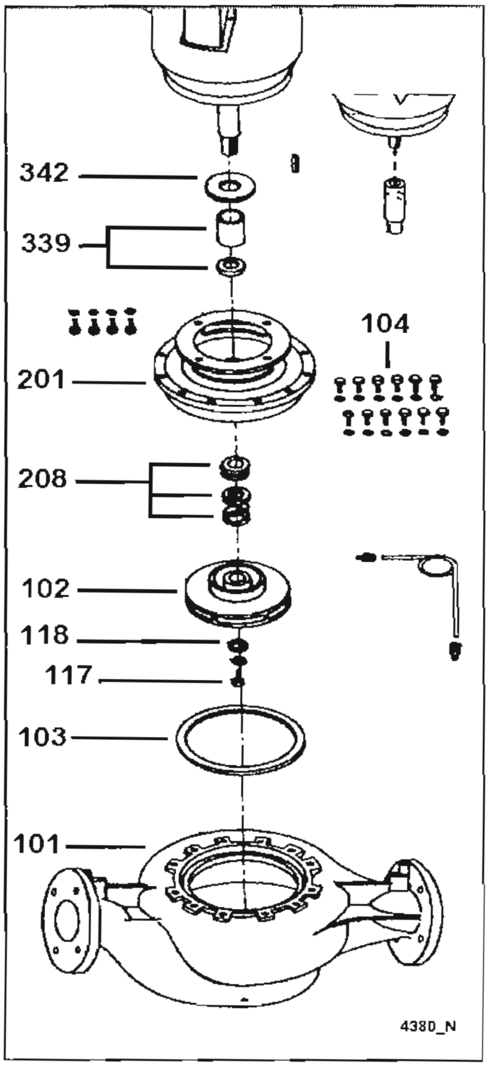
Frame S1 **Material** Bronze Fitted

Description New Style Vertical-In-Line, Split Coupler, Equal Suction & Discharge Size

Volute 250#	101	427048-031
Volute 125#	101	427047-011
Impeller	102	427121-041
Volute Gasket	103	426401-003
Volute Capscrews	104	5/8-11NCx1 1/2"
Impeller Capscrews	117	911900-114
Impeller Washer	118	426472-001
Combination M/P Brkt	201	426749-011
Coverplate	201	
Mech. Seal Assy.	208	9975000-991
Shaft or Shaft Sleeve Kit	339	810150-150

If a part field is blank, then this model does not contain that part

Comments: Small Frame = 7/8" impeller bore



ARMSTRONG

FILE NO.:	10.80
DATE:	June 15, 1991
SUPERSEDES:	5010.65 (U.S.A.)
DATE:	Sept 25, 1987
SUPERSEDES:	10.65 (CAN)
DATE:	Feb. 14, 1989

INSTALLATION AND OPERATING INSTRUCTIONS
IN LINE CIRCULATING PUMPS

MODELS S-25 to S-69, H-32 to H-68, and Series 1050 & 1060

CAUTION: ALWAYS DISCONNECT POWER SUPPLY FROM MOTOR BEFORE SERVICING.

INSTALLATION For convenience, Armstrong Circulators generally are Installed in vertical pipelines, but may be changed easily on the job for horizontal pipelines or for opposite flow directions. To make the change, remove the body capscrews, taking care body gasket is kept in position, and rotate body to desired direction at 90° or 180° from the original position.

With arrow on body pointing in direction of flow, insert body capscrews and tighten evenly. (On Models S-25 to S-57, H-32 to H-54 and Series 1050 (1B to 2B), a gap between bearing bracket and pump body (volute) is normal. Do no overtighten body capscrews!) Turn pump shaft manually at coupler to make sure shaft turns freely and impeller does not rub in body. Always install with motor shaft in a horizontal position with pump oil cups or oil well cover on top.

Models S-25 to S-46 and H-32 to H-41 are shipped for down-discharge. All other models are shipped for up-discharge as pumps of this size usually are installed to pump upward on hydronic systems, so the point of zero pressure change - namely, the compression tank connection - can be made easily to the system on the suction aide of the circulator

The pump should be installed in a position to permit proper lubrication and servicing. Motor and bearing bracket are to be kept free of insultation. Pump and motor unit are designed to be supported by the *inline piping only. Do not* support in any other manner. A height of approximately 4 feet above floor is recommended. When placing pump between flanges, tighten flange bolts evenly and do not tighten excessively.

Gate vales should be installed on discharge and auction side of pump to facilitate service. On larger pump sizes, a check valve should be located on discharge side of pump between pump body and gate valve to prevent damage due to water hammer

SYSTEM CLEANLINESS Before starting the pump, the system must be thoroughly cleaned, flushed and drained, then replenished with clean liquid. Welding slag and other foreign materials, "stopleak" and cleaning compounds, excessive or improper water treatment - all are detrimental to the pump internals. Guarantee will be void if any of these conditions are allowed is exist. (Refer to File No. 6090.645 - Design and Care of Closed Hydronic Systems.)

STARTING UP The pump must be fully primed on start-up. Fill system piping and pump body with liquid and vent complete system, turning pump by hand to dislodge air from body. Make sure fittings and drain valves are airtight, then add any additional fill required.

Check motor electrics against available supply, then start pump making sure rotation is correct. When viewed from motor end, rotation is counter-clockwise on Models S-25 to S-46 and H-32 to H-41. On all other models, rotation is clockwise. If pressure does not develop, stop pump, re-check, vent and fill. Never attempt to fill system when pump is running.

LUBRICATION

CAUTION: STOP MOTOR BEFORE LUBRICATION, DO NOT OVER-OIL OR SPILL ON RESILIENT MOTOR RINGS. DO NOT FORCE OIL INTO CUPS, AND STOP IF CUP FILLS BEFORE ADDITION OF SPECIFIED AMOUNT.

PUMP LUBRICATION Immediately after pump is installed and before running, slowly add the oil (SAE 30 non-detergent regular, supplied with pump) to pump oil cup, located on top of bearing bracket:

S-25 to S-57, H-32 to H-54 and Series 1050 (1B to 2B)	1/2 oz.
S-69, H-63 to H-58, Series 1050 (1-1/2D, 2D) and Series 1060 (3D)	3-3/4 oz.

At the start of each following heating season, lubricate with SAE 30 oil. For Models S-25 to S-57, H-32 to H-54 and Series 1050 (1B to 2B), add approximately 1/2 oz. (Lubricate every 6 months for high temperature or constant operation) On Models S-69, H-63 to H-68, Series 1050 (1-1/2D, 2D) and Series 1060 (3D), be sure oil is visible at the top and center of window on side of bracket and maintain this level at all times.

MOTOR LUBRICATION

CAUTION: STOP MOTOR BEFORE LUBRICATING. DO NOT OVER-OIL OR SPILL ON RESILIENT MOTOR RINGS.

This motor has been lubricated properly at the factory. At the start of each following heating season, however, *on motors with oil cups*, and 15 drops SAE 30 non-detergent oil to each motor cup

If motor is fitted with grease fittings, follow the motor manufacturer's recommended procedure. Motors without oil cups *or* grease fittings are custom-greased for several years operation and require little or no attention.

SEAL REPLACEMENT Remove pump bracket from body. Remove the impeller, damaged seal assembly, ceramic insert and rubber cup. Clean the recess in bearing bracket coverplate and install a new retainer cup and ceramic Check the condition of the shaft sleeve. If scored, replace the shaft assembly. Otherwise, clean shaft extension and polish sleeve with fine crocus cloth, using a rotating motion, if required.

Press against coupler end of shaft to take up and play while pressing new seal firmly against the stationary face. A slight amount of clean vaseline may be put on shaft sleeve to assist installation. Press down firmly and evenly, using 2 screwdrivers and pushing against the 4 ears of driving band (the metal ring around rubber bellows), or around top outer edge of driving band on Models S-25 to S-57, H-32 to H-54 and Series 1050 (1B to 2B).

Do no use spring washer on Models S-25, S-35 and H-32 current style circulators, where recess to locate spring is provided on impeller hub.

Continue pressing against coupler end of shaft, re-mount impeller and re-assemble the seal bearing assembly into body. If necessary, install a new body gasket and clean gasket surface of both volute and bracket.

CAUTION: Before operating pump, carefully check:

1. IS THE PUMP PRIMED?
2. IS ROTATION CORRECT?
3. IS PUMP PROPERLY LUBRICATED?
4. DOES THE POWER SUPPLY AGREE WITH DATA ON MOTOR NAMEPLATE?
5. IS OVERLOAD PROTECTION PROVIDED?
6. IS THE SYSTEM CLEAN?

FOR DOMESTIC WATER SYSTEMS USE BRONZE BODY PUMPS.

File No.: 9.10
Date: August 15, 1997
Supersedes: 9.10
Date: May 17, 1982

SCHEDULE G

TERMS OF SALE AND WARRANTY

ARMSTRONG PUMPS INC. (*"ARMSTRONG"*)

1. ARMSTRONG Terms: The following terms shall prevail over and cancel any other or different terms or conditions of Customer's purchase order. ARMSTRONG's acceptance of Customer's order shall not be construed as an acceptance of printed or inserted provisions on Customer's order form which are inconsistent with or additional to these terms and conditions, unless specifically accepted in writing by an authorized Officer of ARMSTRONG. No sales representative, agent, or employee of ARMSTRONG is authorized to alter, vary or waive any of these terms and conditions. Such changes require the written approval of an authorized Officer of ARMSTRONG.
2. Acceptance of Orders: All orders are subject to formal acceptance at Head Office by an authorized Officer of the Company.
3. Prices: *Federal, State, Municipal and Provincial taxes* [including without limitation Goods & Services tax] extra, if applicable, unless otherwise stated.

   Prices quoted are firm for 30 days from date of quotation.
   Prices will remain firm to time of shipment, provided:
   a) Delivery is accepted as goods are available.
   b) The customer will accept delivery six months or less from date of his order.
   c) Approval data is returned within 30 days from date of submission.
4. Terms: Net 30 days from date of invoice, unless otherwise stated. 2% per month interest (24% per annum) will be charged on all overdue accounts. These terms are subject to credit approval; otherwise, terms are cash with order or C.O.D.
5. Minimum Billing: Minimum billing of each customer order will be $150.00.
6. Confirmation of Telephone Orders: Orders are accepted by telephone for the convenience of the customer and must be promptly confirmed in writing. Such orders should be clearly marked as 'CONFIRMATION'; otherwise they may be duplicated.
7. Returned Goods: No goods may be returned without first obtaining a Returned Goods number from ARMSTRONG. Application must include invoice number and date of original shipment.
   a) All goods returned will be subject to a re-handling charge - minimum 25% of invoice amount. Minimum charge of $50.00 will apply.
   b) If, upon inspection, the goods are found to be in need of reconditioning or repair, an additional deduction will be made and the customer will be advised of the total re-handling charge that will apply.
   c) All goods approved for return must be clearly tagged with RG number and have transportation charges prepaid and will be accepted for credit on the basis of original invoiced prices, and must be received by Armstrong within 30 days of return approval.
   d) Goods which are assembled to order [this includes all pumps, systems, heat exchangers and replacement tube bundles], obsolete, used, non-stock, or over 18 months old (from date of shipment), are not returnable.
8. Warranty: ARMSTRONG warrants Armstrong-manufactured products to be free from defects in material and workmanship under normal use and service for a period of one year from date of shipment [except Circulators and Hydronic Specialties which are for a period of two years from date of shipment] when installed and used in accordance with our printed instructions [normal wear and tear excepted]. Note: All mechanical seal warranties are restricted to those failures at start-up and must be reported to the factory within 48 hours. Our obligations shall be limited to the repair of parts or replacement of any parts at our option, f.o.b. factory (or f.o.b. Authorized Armstrong Service facility located in user's territory where such facility is available and services the product in question) which may prove defective under normal use and service during the warranty period and which our examination shall disclose to be defective. This warranty shall not apply to any goods which have been subject to accident, alteration, abuse, misuse, tampering, negligence, damage by flood, fire or act of God or where the goods have been improperly installed, maintained or subjected to certain types and/or improperly applied water treatment or other system additives. ARMSTRONG shall not be liable for service, labour or transportation charges or for damages for delay caused by defective material or workmanship or for personal injuries or damage to property caused directly or indirectly by any Armstrong-manufactured product or by its use or operation experienced by the customer or any other person whatsoever. THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED. NO REPRESENTATIVE OR OTHER PERSON IS AUTHORIZED OR PERMITTED TO MAKE ANY WARRANTY OR ASSUME FOR US ANY LIABILITY NOT STRICTLY IN ACCORDANCE WITH THE FOREGOING. THE FOREGOING WARRANTY SHALL NOT APPLY TO COMPONENTS PURCHASED BY ARMSTRONG FROM OTHER MANUFACTURERS; IN LIEU OF PROVIDING WARRANTY ON SUCH COMPONENTS, ARMSTRONG WILL MAKE AVAILABLE TO CUSTOMER ANY WARRANTIES RECEIVED BY IT FROM SUCH MANUFACTURERS. OTHER THAN THE FOREGOING WARRANTY, ARMSTRONG MAKES NO REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESSED OR IMPLIED, WITH RESPECT TO ITS PRODUCTS, WHETHER AS TO MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER MATTER.
9. F.O.B. Point: Prices are f.o.b. our warehouse, unless otherwise stated. Where freight allowances are specifically offered, ARMSTRONG reserves the right to select carrier and routing. All deliveries and shipments will be at the customer's risk from the time of delivery to the carrier by ARMSTRONG., irrespective of whether the principal carrier shall have been designated in the shipping instructions of the customer. The Customer is required to inspect all inbound documents for accuracy. If there is any evidence of injury to or shortage of containers' contents, do not receipt to carrier "in good condition", but give receipt according to the facts. In case of damage, claim must be made on carrier without delay. Our assistance is available to secure adjustment. Any discrepancy must be reported in writing to ARMSTRONG Customer Service within 5 days of receipt.
10. Prior Sale: Goods in stock are offered subject to prior sales or shipment.
11. Shipments, Deliveries or Cancellations: ARMSTRONG shall not be liable for any charges or damages arising out of loss, damage, stoppage or delay and interruption with respect to shipments or to delivery schedules resulting from fire, storm, flood, war, explosion, accident, strike, lockout, labour disturbance, act of God or other causes beyond their reasonable control. If shipments are delayed or deferred by the customer more than one month beyond the original shipping date, payment for goods shall become due at the time and storage or warehousing charges of 2% per month may be charged. No order for assembled to order equipment may be cancelled, materially altered or terminated except upon payment to ARMSTRONG for loss, damage and expense arising from such cancellation, alteration or termination.
12. Consequential Damages: NOTWITHSTANDING ANYTHING TO THE CONTRARY HEREIN CONTAINED, ARMSTRONG SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, CONTINGENT OR INCIDENTAL DAMAGES WHATSOEVER.
13. Acceptance: Customer's acceptance of any goods supplied by ARMSTRONG or on ARMSTRONG's behalf shall without limitation constitute acceptance of all terms and conditions as stated above.

ARMSTRONG SUBMITTAL

Series 1050
1.5B
Custom In-Line Circulators

Project Number: 062306	**Representative:** Mechanical Solutions
Name: The Children's School	121 Commerce Way, South Windsor, CT
Reference:	Phone: 860-290-1564, Fax: 860-290-1825
Location:	**Order No:** **Date:**
Engineer:	**Submitted by:** Julie Kirk **Date:** 12/4/2006
Contractor: Eastern Mechanical	**Approved by:** **Date:** 12/4/2006

PUMP DESIGN DATA

Tag Num:	HWRP-1,2
Service:	
Location:	
No. of Pumps:	2
Capacity:	48 usgpm
Head:	18 ft
Piping:	Single
Suction Pressure:	0 ft
Liquid:	Water, sg= 1.00, 70 °F
Viscosity:	31 ssu
Branch Sizes:	Suction= 1.5 in, Discharge= 1.5 in

MOTOR DESIGN DATA

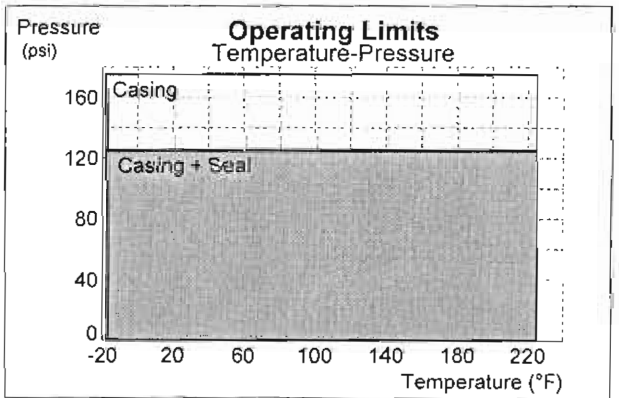
Motor Supplier:	Factory Choice
Motor Size:	0.5 hp @ 1800 rpm
Frame Size:	
Enclosure:	ODP
Cycle/Phase/Voltage:	60/3/208
Motor Eff:	Std
Insulation:	Class "B" Insulation (266.0 °F)
Starter Config:	DOL
Full Load/Starting (A)	4.0 / 33.2

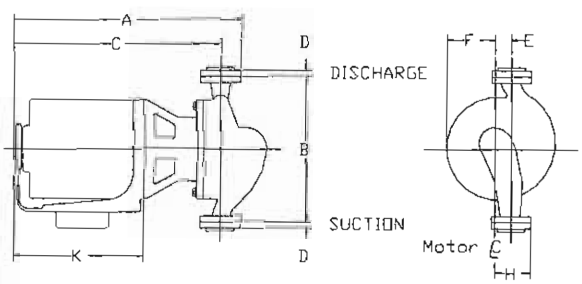
MATERIALS OF CONSTRUCTION

Construction	BF (Bronze Fitted)
Pump Body	Cast Iron (A48-30)
Impeller	Bronze-Cast
Bearings	Sleeve-Oil Lubricated
Shaft && Sleeve	Alloy Steel - Copper Sleeve
Seal	Mechanical
Stationary Seal Face	ARMSEAL Ceramic
Coupler	Flexible, Spacer Type

MECHANICAL SEAL DESIGN DATA

Manufacturer	Armstrong
Manu. Code [Armseal]	(Circs)
Seal Type	Inside Unbalanced
Rotating Face	Carbon
Stationary Seat	Ceramic
Secondary Seal	BUNA-N
Springs	Stainless Steel
Rotating Hardware	Brass





DIMENSIONAL DATA (in, lbs, hp) NOT for CONSTRUCTION

Mount	A	C	K	TotWgt	Wgt.
Resilient	19 75	16	9.88	58	58

6/5/2007, 15:04:31, Julie Kirk, Mechanical Solutions, 860-290-1564, Fax: 860-290-1825

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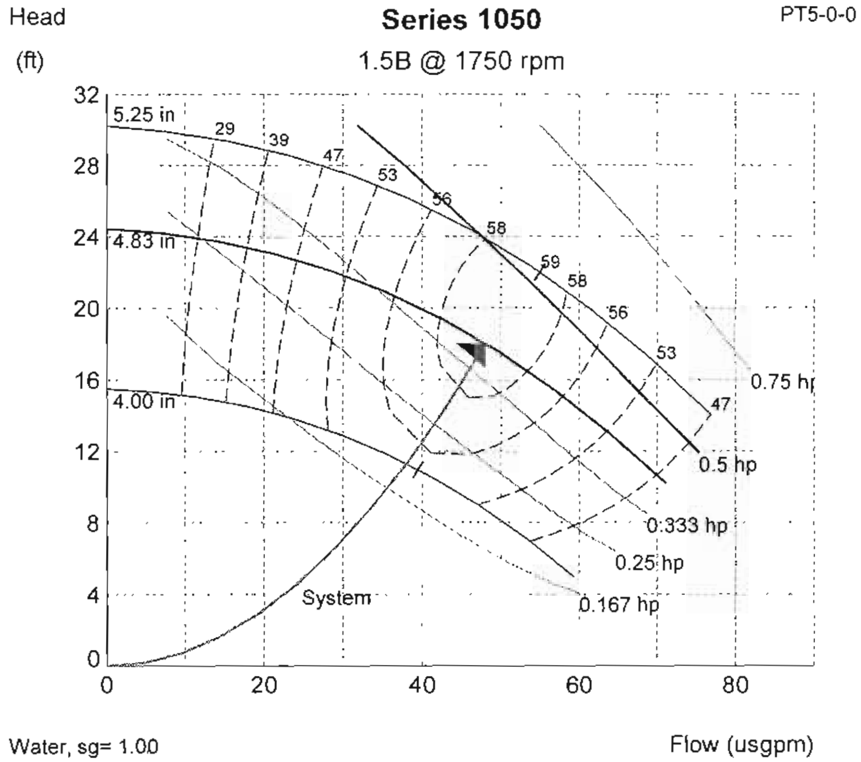
ARMSTRONG SUBMITTAL

Series 1050
1.5B
Custom In-Line Circulators



--- Admin Data ---
Tag Num: HWRP-1,2
Service:
Location:

--- Motor Data ---
Motor Size: 0.5 hp
Motor Speed: 1800 rpm

--- Design Duty Point ---
Flow: 48 usgpm
Head: 18 ft
Impeller: 4.83 in

--- Performance Data ---
- NPSHR: 5.68 ft
- Eff. @ Design: 58.24 %
- BHP @ Design: 0.37 hp
- %Mtr Safety: 33.48%
- BEP @ Design Imp.: 58.26 % @ 49.5 usgpm
- Impeller Max BHP @ Flow: 0.40 hp @ 68.9 usgpm
- %max imp. range: 66.07 %
- Outlet Velocity: 7.56 ft/s

H WRP-1,2

Circulator Parts **Model No.** 1050 1½B **ARMSTRONG**

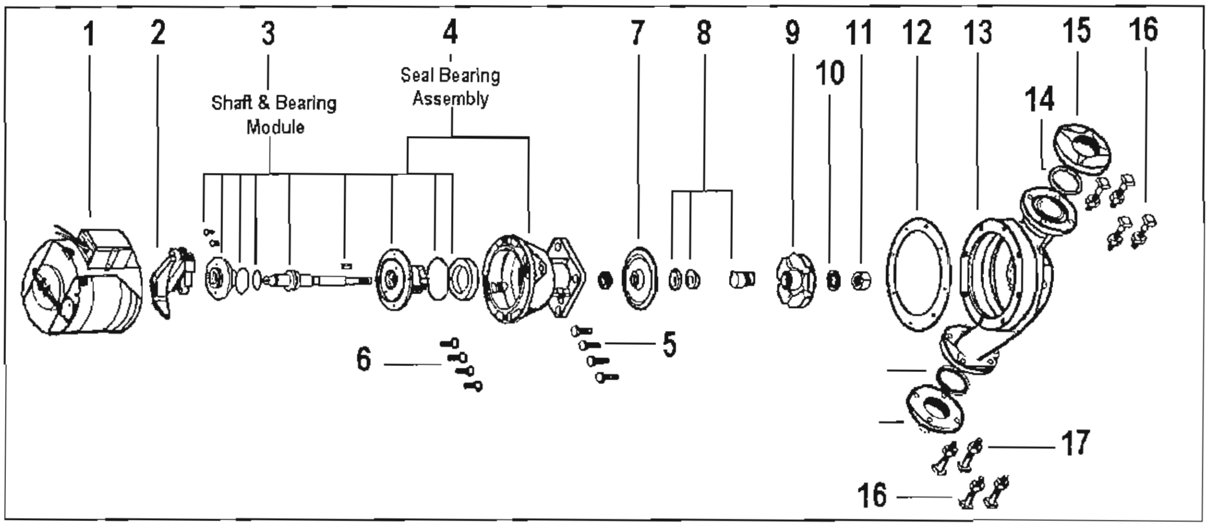
Material Bronze Fitted

Description: Custom serial number required **60 Hz** **Phase: 1**

Motor Assembly	1	call Armstrong	Impeller Washer	10	927411-700
Coupler Assembly	2	Call Armstrong	Impeller Nut	11	106076-000
Shaft & Sleeve Assembly	3	816999-041	Body Gasket	12	106158-000
Bearing Assembly	4	816032-000	Pump Body	13	816337-011
Bearing Cap Assy. Kit	5		Flange Gasket	14	805176-000
Coverplate Capscrews	6	3/8-16x7/8 911121-107	Flange	15	1 1/2" NPT 116009-011
Coverplate	7	174003-071	Flange Bolts	16	7/16-14x1-3/4 911123-111
Mech. Seal Assembly Kit	8	816706-001	Flange Nuts	17	7/16-14 JAM 913123-100
Impeller	9	Call Armstrong	Capscrews (Pump Body)	18	5/16-18x3/4 911119-106
Complete Bearing Assy. (includes seal kit & C.plate)	4				

If a part field is blank, then this model does not contain that part

Comments: Custom Circulator, trimmed impeller, consult Armstrong for duty point



Bell & Gossett Model No.

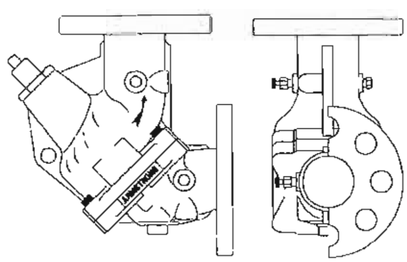
Grainger Model No.

ARMSTRONG®

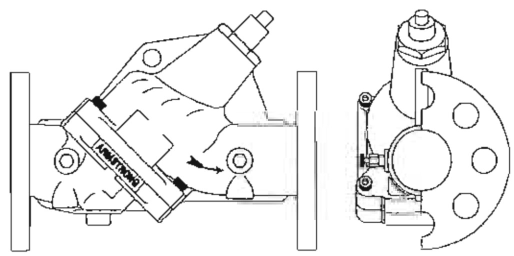
FILE NO.:	35.81
DATE:	November 20, 1998
SUPERSEDES:	NEW
DATE:	NEW

Installation and Operating Instructions and Parts List

Armstrong Model FTV Hard Flanged Flo-Trex Combination Valve



Angle Pattern Model FTV-AF



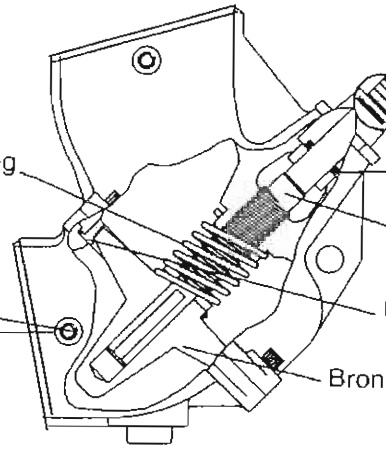
Straight Pattern Model FTV-SF

Table of Contents

1.0 INTRODUCTION

1.1 The Armstrong Model FTV Flo-Trex Combination Valves are designed for installation on the discharge side of centrifugal pumps. The Armstrong Combination Valve incorporates three functions in one valve:

- Drip-tight, shut-off valve ·
- Spring closure design. Non-slam check valve ·
- Flow throttling valve



Armstrong Model FTV-AF
Flo-Trex Combination Valve

2.0 INSTALLATION

2.1 The valve should be mounted to a spool piece on the discharge side of the pump. Spool piece required is based on a minimum recommended space of 12" for pump sizes 2 x 2 to 6 x 6 and 24" for pump sizes 8 x 8 to 12 X 12.

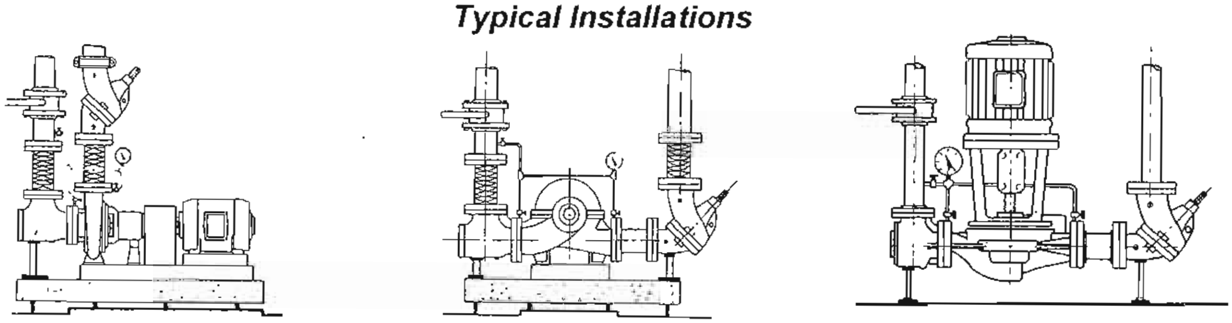
2.2 It is not recommended to mount a valve directly to the pump as this could cause undesirable noise in the system.

2.2 Sufficient clearance around the valve should be left for valve removal or repair.

2.3 Install valve in the direction of the flow arrows on the valve body.

2.5 The valve body has been designed to handle the weight of the pump on vertical in-line installations. The body is not designed to support the piping weight. It is recommended that the piping be supported by hangers. Pipe supports should be provided under the valve and strainer bodies.

Typical Installations



Base-Mounted Single Suction ***Base-Mounted Double Suction*** ***Vertical In-Line***

For additional information on Armstrong Model SG Suction Guides, request File 35.10.

3.0 FLANGE BOLT TIGHTENING

Recommended Bolt Tightening Procedure

Valve Size	125 psi/150 psi Cast Iron Bolt	
	No.	Size
2-1/2	4	5/8
3	4	5/8
4	8	5/8
5	8	3/4
6	8	3/4

Table 1

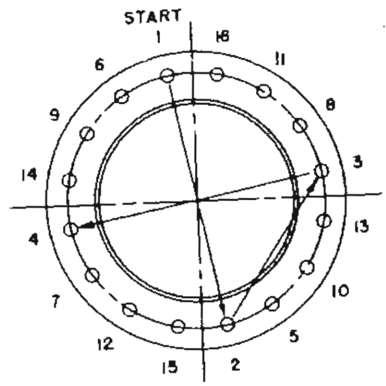
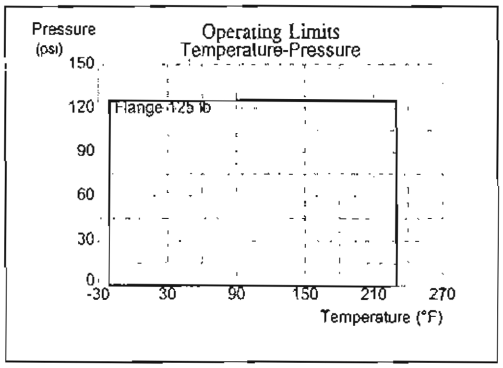


Fig. 1

3.1 Tighten nuts evenly, following bolting instructions (fig.1) so that the flange faces remain parallel. Flange bolts should be tightened to 70 ft/lbs. Torque minimum to assure firm metal-to-metal contact. When raised face flanges are used, there will be a gap between the faces of the outer diameter.

4.0 PRESSURE TEMPERATURE LIMITS



5.0 FIELD CONVERSION (Straight to Angle pattern valve)

5.1 Open valve at least one complete turn.

5.2 Remove the body bolts from valve body using Allen Key.

5.3 Rotate one half of the valve body 180° making sure the lower valve seat and "0' Ring stay in position. Inspect the "O" Ring for any cuts or nicks and replace if necessary.

5.4 Replace body bolts and torque evenly to 70 ft/lbs.

6.0 FLOW MEASUREMENT

6.1 Where approximate indication of flow is acceptable the Armstrong Flo-Trex valve can be used.

6.2 FLOW MEASUREMENT VALVE IN WIDE OPEN POSITION

6.22 Measure and record the differential pressure across the valve using an Armstrong CompuFlo with high pressure range transducer, or CBDM- 135/60 meter, or pressure gauges with PMP adapters.
Caution: Safety glasses should be used and the probe should not be left inserted into fittings for prolonged periods of time (overnight, etc), as leakage from the PMP may occur when probe is removed.

6.23 Refer to Flo-Trex Performance Curves with valve in full open position (Fig 2).

Locate Pressure Differential on left hand side of chart and extend line horizontally across to valve size being used. Drop line vertically down and read flow rate from bottom of chart.

6.3 DETERMINING FLOW RATE WITH VALVE IN THROTTLED POSITION

Flo-Trex Performance Curve with Valve in Full Position

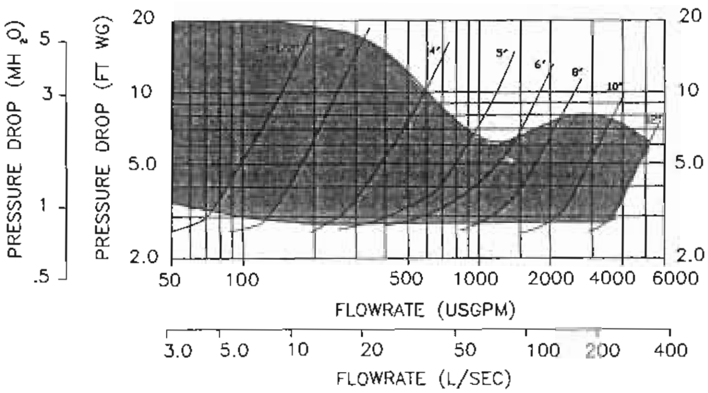


Fig. 2

Inherent Flow Characteristic Curve with Valve in Throttled Position

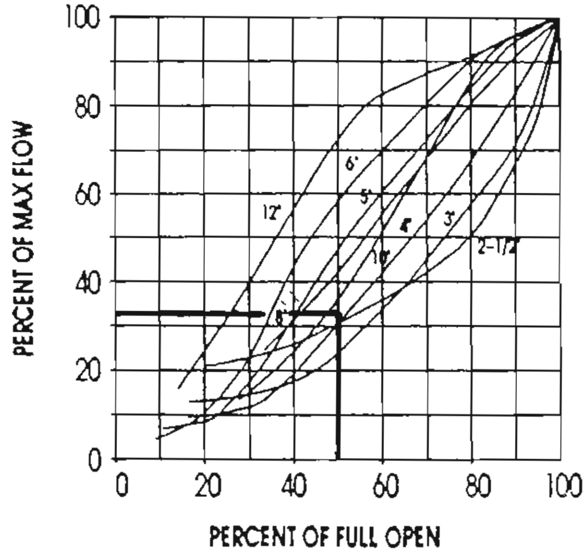


Fig. 3

6.31 Record the size of the valve and stem position using the Flow Indicator Scale (page 5). Calculate percentage of valve opening referring to table below:

Valve Size	2 1/2	3	4	5	6	8	10	12
Number of Rings (valve full open)	5	5	6	9	10	12	18	28

6.3.2 Measure and record the differential pressure across the valve in the throttled position.

6.3.3 Locate percentage of valve opening on the bottom scale of Flow Characteristic Curve (fig 3). Project line vertically up to intersect with the Valve Characteristic Curve and from this point project line horizontally across to the left of the chart and record the percentage of maximum flow rate.

6.3.4 On the Flo-Trex Performance Curve (fig. 2) locate the differential pressure obtained in Step 6.3.2 and project line horizontally across to intercept with Valve Performance Curve. Drop a line vertically down to read the flow rate at the bottom of the chart.

6.3.5 To calculate flow rate of valve in the throttled position, multiply the flow rate from Step 6.3.4 by the percentage flow rate from Step 6.32 divided by 100.

Example: Valve size 4 inch.
Differential Pressure is 5.4 ft. (1.65 m).
Number of rings open = 3. Therefore: 3 rings ÷ 6 rings x 100 = 50% throttled.
From the Flo-Trex Performance Curve (fig 2), a 4 inch, valve with 5.4 ft. pressure drop (1.65 m) represents a flow of 400 USgpm (25.2 l/s).
From Flow Characteristic Curve (fig 3), a 4 inch valve 50% open, represents 34% of maximum flow.
Approximate flow of a 4 inch valve, with a 5.4 ft. (1.65 m) pressure drop when 50% throttled is:

$\frac{400 \times 34}{100}$ = 136USgpm or in metric $\frac{25.2 \times 34}{100}$ = 8.57l/s

Note: To prevent premature valve failure it is not recommended that the valve operate in the throttled position with more than 25 ft. pressure differential. Instead the pump impeller should be trimmed or valves located elsewhere in the system be used to partially throttle the flow.

Flow Indicator Scale

The valve stem with its grooved rings and positioning sleeve indicates the throttled position of the valve. The quarter turn graduations on the sleeve, with the scribed line on the stem provides for approximate flow measurement.

Note: The valve is shipped in the closed position. The indicator on the plastic sleeve is aligned with the vertical scribed line on the stem.

7.0 OPERATION

7.1 To assure tight shut off the valve must be closed using a wrench with 25 to 30 ft/lbs. of torque.

7.2 To assure trouble-free check valve operation and shut off operation, the valve should be periodically opened and closed to keep valve seat and valve disc guide stem free of build up of system contaminants.

8.0 REPACKING OF FTV UNDER FULL SYSTEM PRESSURE

8.1 Should it be necessary, stem "O" Ring can be changed under full system pressure.
Caution: Safety glasses should be worn.

8.2 Record the valve setting.

8.3 Turn the valve stem counter-clockwise until the valve is fully open and will not turn any further. Torque to a maximum force of 45 ft/lbs. This will ensure good metal-to-metal contact and minimum leakage.

8.4 The valve bonnet may now be removed. There may be a slight leakage. As the metal-to-metal back seating does not provide a drip-tight seal.

8.5 Clean exposed portion of valve stem (Do not scratch).

8.6 Remove and replace the '0" Ring and gasket.

8.7 Install the valve bonnet.

8.8 Tightening valve bonnet is necessary to stop any leaks.

8.9 Open valve to balance set point as recorded in 8.2.

9.0 MAXIMUM NUMBER OF TURNS FULL OPEN VALVE

Note: On valve sizes 2-1/2" and 3", full open position of valve is 5 turns. However valve will open to 5-1/2 turns which is just back of seating of valve.

10.0 SEAT REPLACEMENT

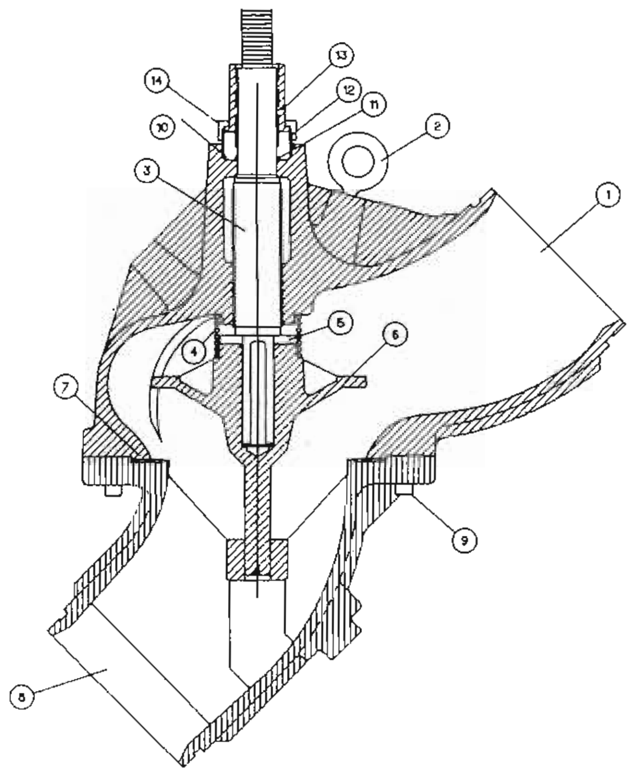
10.1 Drain system and remove valve from piping.

10.2 Remove the body bolts from the body using an Allen Key.

10.3 Remove seat and "O" Ring.

10.4 Inspect and clean 'O' Ring cavity and install new "0" Ring and seat. Valve disc stem also should be inspected and replaced if worn. Valve stem 'O' Ring should be replaced at this time. Refer to section 8.

Flo-Trex Valves
Replacement Parts List



11.0 Parts List

Part	Item No.	2-1/2" Straight or Angle	3" Straight or Angle	4" Straight or Angle	5" Straight or Angle	6" Straight or Angle
Shaft	3	570202-006	570202-006	570202-006	570202-007	570202-007
Spring	4	570203-002	570203-003	570203-004	570203-005	570203-006
Bushing	-	570223-001	570223-001	570223-002	570223-001	570223-002
Bonnet	13	570201-006	570201-006	570201-006	570201-006	570201-006
Eye Bolt	2	N/A	N/A	N/A	N/A	N/A
Cap-Sleeve	15	N/A	N/A	N/A	N/A	N/A
"O" Ring **	12	961131-210	961131-210	961131-210	961131-210	961131-210
Sleeve	14	570216-000	570216-000	570216-000	570216-000	570216-000
Spacer	5	570198-006	570198-006	570198-006	570198-006	570198-006
Disc	6	570232-041	570233-041	570234-041	570235-041	570236-041
Body Main	1	570518-611	570520-611	570522--611	570524-611	570526-611
Seat **	7	570196-000	570196-001	570196-002	570196-003	570196-004
"O" Ring Body **	8	961131-238	961131-242	961131-250	961131-259	961131-263
Body Suction	9	570500--611	570502-611	570504-611	570506-611	570508-611
Capscrew	10	911821-112	911821-112	911825-112	911829-114	911829-114
Performed Insulation (Straight)	-	570225-386	570225-387	570225-388	570225-389	570225-390
Performed Insulation (Angle)	-	570225-486	570225-487	570225-488	570225-498	570225-490

** Recommended Spare Parts
Common parts to all: Gasket - 570217-006; 14" Brass Pipe Plug - 935105-001; 14" Brass Metering Ports - 570148-001

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Fax: (416) 759-9101
Visit us at armstrongpumps.com

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Fax: 01206-760532

Armstrong Pumps Inc.
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Buffalo, New York
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Fax: (716) 693-8970

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FCI STANDARD #89-1

Guide for the Selection, Installation and Maintenance of Pipe Line Strainers

Prepared by

PIPE LINE STRAINER SECTION
FLUID CONTROLS INSTITUTE, INC.

CONTENTS

PREFACE

Experience has proven the need for strainers in the protection of pumps, compressors, turbines, meters, automatic valves, sprinkler heads, burner nozzles, steam traps and other pipeline equipment.

This guide has been established as a technical reference for project engineers and managers responsible for specifying and using pipeline strainers. While strainers remain a relatively low cost item, when specified properly, the protection they provide is invaluable. It is the intent of this guide to provide the background and information necessary to make knowledgeable and sound engineering decisions in the specification of pipeline strainers.

The Pipe Line Strainer Section of the Fluid Controls Institute Inc. acknowledges and appreciates the assistance of those people who have made the creation and updating of this technical resource possible.

CHAPTER 1

Definition

A pipe line strainer is a device which provides a means of mechanically removing solids from a flowing fluid by utilizing a perforated, mesh or wedge wire straining element. The most common range of strainer particle retention is 1 inch to 40 micron (.00156 inch).

Purpose

Strainers are employed in pipe lines to protect downstream mechanical equipment such as condensers, heat exchangers, pumps, compressors, meters, spray nozzles, turbines, steam traps, etc. from the detrimental effect of sediment, rust, pipe scale or other extraneous debris.

Types of Strainers

Two frequently specified strainers are the "Y" strainer and the basket strainer. While there is primarily one type of "Y" strainer (Fig. 1A), there are several variations of basket strainers (Fig. 1B through 1E).

Fig. 1A

Vertical piping, frequently found at pump inlets, necessitates the use of a "Y" strainer or a tee type basket strainer. Most basket strainers are intended for horizontal or slightly inclined piping. "Y" strainers and tee type basket strainers, on the other hand, can be used in horizontal as well as vertical (downward) piping. Special attention must be given, however, to maintaining the position of the debris collection chamber and the drain (blowdown) connection in their lowest position (Fig. 2). A "Y" strainer in vertical piping must be placed with its screen in the downward position to trap the sediment in the debris collection chamber.

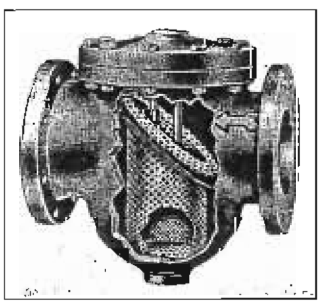

Fig. 1B

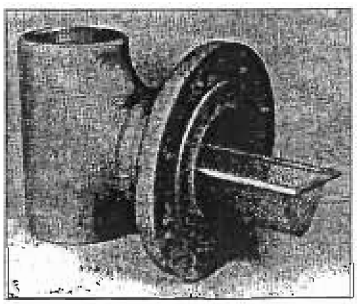

Fig. 1C

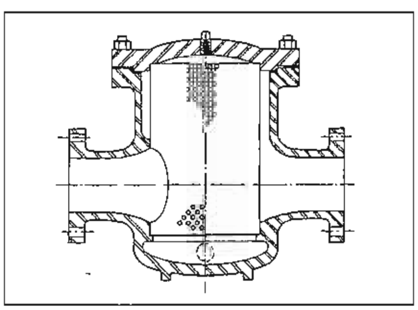

Fig. 1D

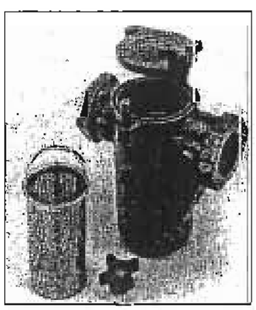

Fig. 1E

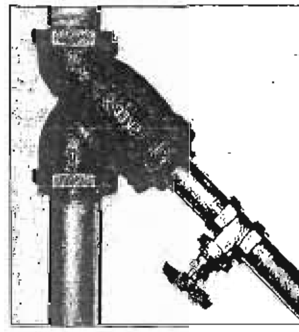

Fig. 2

Tee type strainers, suction diffusers and several variations of fabricated basket strainers can also be used in a right angle flow application (Fig. 3).

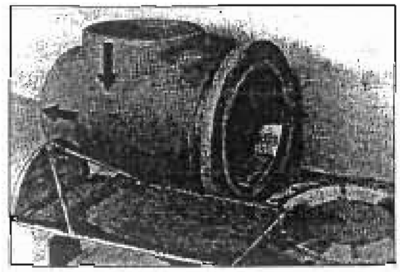

Fig. 3

"Y" strainers and most variations of basket strainers can be self-cleaning. With the addition of a blowdown valve and some modification of the straining element of a basket strainer, the element can be flushed out by opening and closing the blowdown valve . This can be done without flow shut down or disassembling any piping.

In sizes above 4", a single basket strainer will generally create less pressure drop than a "Y" type. Basket strainers are normally installed in a horizontal pipe with the cover over the basket at the top. Cleaning of the strainer is generally simple and no draining is required. Cover flanges for basket strainers are relatively easy to remove and servicing is simplified. Replacement of covers on "Y"-type strainers is facilitated by some manufacturers through the use of studs, rather than bolts, which help to align the cover during the replacement operation. Hinged covers and screen locking devices can also make servicing easier.

There seems to be a general misconception among engineers and contractors concerning "Y" strainers and basket strainers used in steam service. In many instances, basket and "Y" strainers will perform comparably in steam service. It is essential in ordering strainers for steam service that the manufacturer be so advised. As mentioned above, the housings may be furnished without a bottom, allowing the accumulated debris to be blown out by opening the blowdown valve (Fig. 4).

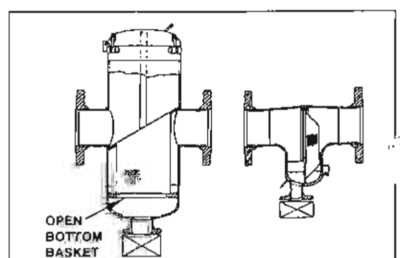

Fig. 4

While there are some high pressure

applications for basket strainers, (Fig. 5), due to the required thickness and subsequent high cost, basket strainers are not normally constructed for pressures above 1,500 psi. "Y" strainers, on the other hand, are readily available for working pressures up to 6,000 psi and higher. In addition to "Y" and basket types, other strainers are available such as duplex/twin, geometric, washdown/backflushing, automatic self cleaning, plate or expanded cross section type, scraper, and magnetic screen types. Descriptions of these as well as miscellaneous options available with them, follow.

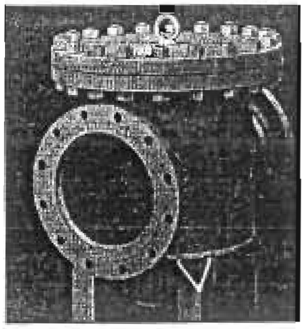

Fig. 5

Duplex/Twin Strainers

For applications where continuous operation is required and the line cannot be disassembled for cleanout, duplex or twin basket strainers can be used. Refer also to Automatic Strainers, Page 5, for continuous service applications. Examples are fuel oil strainers for industrial or marine oil burners, lubricating lines on board ships, cooling towers, continuously running chemical operations, and many industrial water intake and service lines.

When one basket becomes full, the flow is switched to the other basket. The first basket is removed, cleaned and replaced. For smaller sizes the "plug"-type duplex basket strainer (Fig. 6) is generally used since it is less costly to make and simpler to operate and maintain than other types. It is basically a plug valve with two integral basket wells into which flow can be diverted by rotating the plug. In larger sizes the plug design becomes unwieldy, and an individual valving arrangement is used (Fig. 7). Here, flow is shifted from one basket to the other by integral sliding gate valves. These strainers are frequently furnished with an interlocking chain-drive mechanism so the two valves work in unison (one basket compartment opens while the other is being valved off). This prevents accidental shutoff of the line.

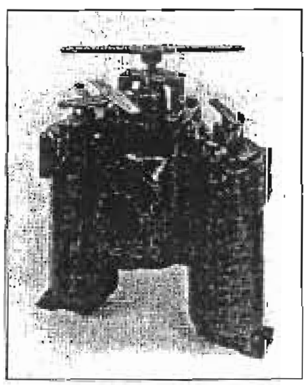

Fig. 6

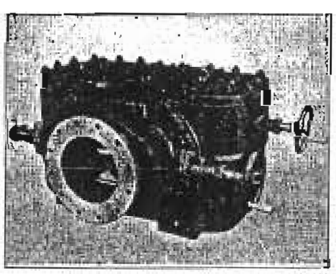

Fig. 7

This type strainer can be furnished with individual globe valves instead of gate valves. Globe valves give more positive shutoff, but since these strainers are not normally used for high pressures they are generally not needed. The globe- valve-type duplex strainer is usually more expensive than the gate-valve type.

Twin strainers, two single basket strainers connected in parallel with individual control valves are also available (Fig. 8). Where continuous operation is required, however, a duplex strainer is generally preferred. It occupies less space and is a "one-piece unit". However, because of the more circuitous path the liquid must take through a duplex strainer, pressure drop is higher than through the equivalent size single basket strainer.

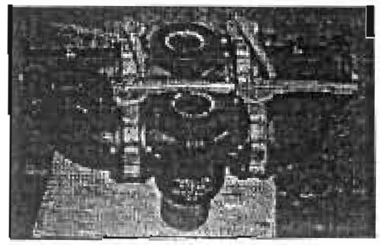

Fig. 8

Geometric (Temporary) Strainers (Fig. 9A through 9C)

Where cost is of prime importance, a geometric strainer may be installed between flanges in a pipe line. Variations of geometric strainers include cone (Fig. 9A), truncated cone (Fig. 9B) and flat geometries (Fig. 9C). The design considerations with these types of strainers are:

1) They have a lower net open area than basket strainers.

2) The pipe line must be disassembled to inspect, clean or remove these strainers.

3) Structural strength can be difficult to achieve, particularly in larger sizes, and in the case of wire mesh. While these strainers were once called temporary or startup strainers, more frequently than not, they are now left in the line during operation. As with all types of strainers, periodic maintenance must be carried out to ensure efficient operation.

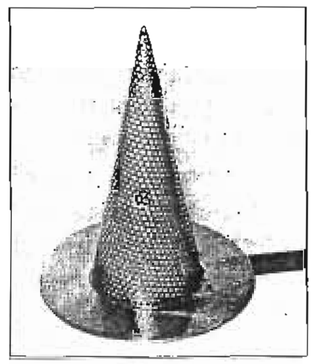

Fig. 9A

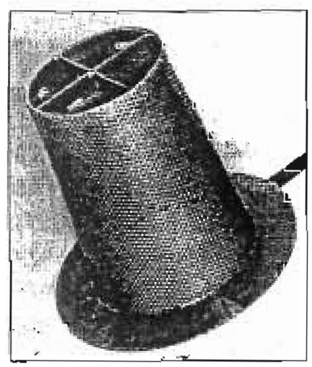

Fig. 9B

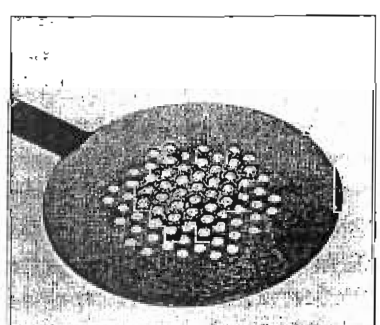

Fig. 9C

set strainer (Fig. 18) with a high inlet and low outlet will satisfy this need. Other designs may use a tee type basket strainer (Fig. 3) in an angle flow application.

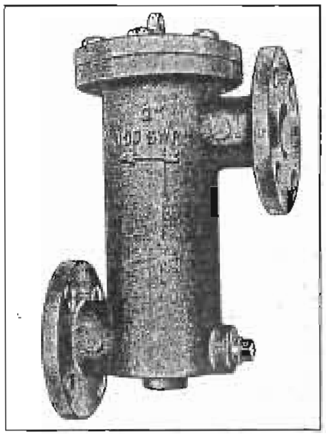

Fig. 18

Quite frequently line sizes are reduced following a strainer prior to temperature control valves or heating and cooling coils (Fig. 19). A reducing strainer can eliminate joints, reduce pressure loss, and still provide the same offset produced by the reducer. Of course, the reducer is also eliminated.

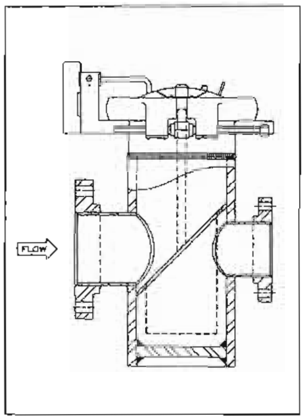

Fig. 19

Special processes may warrant special strainer housings. Steel or stainless steel strainers may be fitted with a fabricated or cast outer jacket with connections for the introduction of steam or other heating or cooling medium (Fig. 20). These find their application mainly in process piping where the liquid handled must be maintained at other than ambient temperatures.

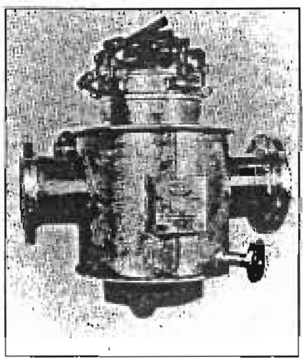

Fig. 20

In addition to special process needs, there may be special maintenance needs. Simplifying the handling of strainers during cleanings or inspections reduces maintenance costs. Strainers are available with many types of quick-opening covers to reduce the length of time and labor involved in cleaning operations (Fig. 21). Among these are swing eye bolts, yoke covers, pinwheel covers and "C" washers. The variety of closures are too numerous to mention, but consideration should be given to them where reduction of down time is important. Additionally, many of these closures can be operated without the use of tools, which enables operators to service the strainer where Union contracts require only maintenance personnel to use tools.

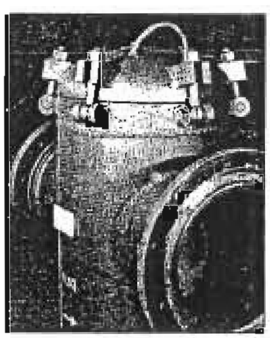

Fig. 21

CHAPTER 2

End Connections

Strainers are available in a variety of end connections. Iron strainers are most commonly furnished in either threaded or flanged ends. Steel, stainless steel and bronze are supplied in any of the types discussed below. The four most common groups of end connections are listed and described below.

Threaded

Usually a tapered female pipe thread, although male connections are also available.

Flanged

ANSI (American National Standards Institute) and MSS (Manufacturer's Standardization Society) standard flange ratings 25, 125, 150, 250, 300, 400, 600, 900, 1500 and 2500 pounds can be supplied. Ring-type joints (male and female), and tongue and groove joints are also available. The U.S. Navy also has some flange standards which are quite different from the commercial standards. Among these are B-176, B-177, and MIL-F-20042C.

Weld Ends

Butt weld end strainers are generally available in all sizes, and although many forms of end preparation can be used, the standard 37-1/2` beveled end is most common. ANSI B16.25 illustrates the various types of weld joint preparations available.

It is very important that the purchaser specify the bore of pipe being used so that the manufacturer can provide a matching bore in the strainer.

Socket weld end strainers are usually available in sizes through 3", and again, it is important to specify the bore of the pipe used. In ordering weld end strainers of any type, consider whether you desire a welded blowdown connection.

Special Ends

Grooved ends are available on many strainers, and a detail of this end should be supplied to the manufacturer. Other special ends such as "O" ring and union ends are also available on special order, and complete details should be furnished.

Most "Y"-type and certain other types of small strainers are designed according to the fitting standards for full pressure ratings and therefore can be subjected to higher working pressures at lower temperatures. It should be clearly understood, however, that most of the larger types and many of the smaller strainers are designed for the working pressure requested and should not be operated above that pressure without consulting the manufacturer. It is important to note that the flange rating is not necessarily the same as the pressure rating of the vessel. A fabricated carbon steel strainer, for example, may be operated at 40 psig at 500°F, designed for 100 psig at 650°F, and have 150-lb ANSI flanges. The maximum safe pressure at any temperature (650°F and below) for this vessel is 100 psig, even though the flange can be taken to 170 psig at 500°F.

It is important, at the time of initial design, to specify working pressure, working temperature, design pressure, design temperature, required flange rating and any operating conditions affecting vessel loading.

CHAPTER 3

Materials of Construction

Strainer components can include a body, flanges, cover, perforated plate, mesh, wedge wire, gasket and cover fasteners. Listed below are some materials of construction for these components.

A - Housing/Body

Description	ASTM Specification
Iron Castings	A 126, A 278
Ductile Iron Castings	A 395, A 536
Iron-Austenitic Castings	A 436
Carbon Steel Castings	A 216
Carbon Steel Castings	A 27
Carbon Steel Pipe	A 53, A 106
Carbon Steel Plate	A 20, A 285, A 515, A 516
Carbon Steel Forgings	A 105
Carbon Moly Castings	A 217, A 352
Chrome Moly Forgings	A 182
Stainless Steel Castings	A 743, A 744, A 351
Chrome Moly Plate	A 387
Chrome Moly Pipe	A 335
Stainless Steel Pipe	A 312
Stainless Steel Plate	A 240
Stainless Steel Forgings	A 182
Aluminum Castings	B 26
Bronze Castings	B 61, B 62
Monel	B 164, B 127
Nickel 200 Plate	B 160, B 162
Hastelloy B Castings	A 494
Hastelloy B Plate	B 333
Hastelloy C Plate	B 575
Hastelloy C Pipe	B 619
Titanium Pipe	B 337
Titanium Castings	B 367

B - Perf. Plate/Mesh/Wedge Wire

Carbon Steel	S.S. (Various Grades Available)
Monel	Hastelloy B
Hastelloy C	Alloy 20
Nickel	Brass
Copper	Galvanized Steel
Incoloy	Inconel
Titanium	Aluminum

C - Gaskets

Red Rubber	Compressed Nonasbestos
Teflon	Buna-N, O Ring
Neoprene	S.S. - Jacketed
Graphite	S.S. - Spiral Wound

D - Fasteners

Carbon Steel	Alloy Steel
Silicon Bronze	304 S.S.
316 S.S.	Monel

CHAPTER 4

Corrosion Resistance - Selection of Materials

Almost every strainer operating in a pipe line is subject to some degree of corrosion or erosion. It is therefore very important that corrosion/erosion resistance is considered when selecting materials and/or coatings. The selection of the material or coating used is also usually based on economic considerations and should be made by the customer and/or consulting engineer after some discussion with the strainer manufacturer.

It is important that the type of fluid, the pressure and temperature conditions, type of adjacent piping, desired service life, and the customer's prior experience with similar fluid conditions be known. Corrosion resistance charts offer some assistance in the selection of materials or coatings. (See Corrosion Data Survey - Metals Solution, 6th Edition, NACE).

Electrolytic corrosion is also a consideration in some services and the manufacturer should be advised. Sometimes the inclusion of magnesium or zinc- consumable bars in the body will retard this action.

Most types of strainers can be lined with various coatings to retard corrosion, and some of these are listed below:

Epoxy	Asphalt
Teflon	Vinyl
Kel-F	Rubber
Neoprene	Baked Phenolic

Penton (Plating: Zinc, Cadmium, Nickel, Galvanizing, etc.)

Perforations and Mesh Sizing

An extremely important consideration in the selection of a strainer is the size of the perforations, mesh or wedge wire opening used in the making of the straining element. A tendency exists to select smaller holes than those actually needed, leading to too-frequent cleaning, excessive pressure drops, and screens constructed of thinner metal which will withstand less pressure differential.

Generally, stainless steel perforated metal can only be obtained in a thickness which is one gage thickness less than the diameter of the punched holes. Carbon steel and brass can be obtained in approximately the same thickness as the hole diameter. These limitations are important considerations. For example, a strainer made with stainless steel plate perforated with 1/64" diameter holes in a 16" line would be impractical, as the plate would be about 17" in diameter and only .014" thick, and would have a very low maximum allowable differential pressure.

The most common way to accomplish fine straining in large strainers is by mesh lining a larger hole, heavier gage perforated plate.

The following table illustrates available perforations, mesh, and wedge wire and their respective straining capability. The main criteria for choosing hole and mesh size is the size and quantity of particles which can pass through downstream equipment without causing damage.

PERFORATED METAL**

Hole Diameter x Hole Spacing	Percent Open Area
.020" x .043	20
.027 x .066	17
*.033 x .077	20
*.045 x .086	28
*.057 x .121	25
*.062 x 3/32	41
*.094 x 5/32	33
.100 x 5/32	37
*1/8 x 3/16	40
*5/32 x 3/16	63
3/16 x 1/4	51
*1/4 x 3/8	40
5/16 x 7/16	47
3/8 x 1/2	51
7/16 x 19/32	49
1/2 x 11/16	48
5/8 x 13/16	54
3/4 x 1	51
1 x 1-3/8	48

*These are standards as they appear in the Designers, Specifiers and Buyers Handbook for Perforated Metals published by The Industrial Perforators Association.

**Perforated plate listed is for staggered pattern only.

MESH

Mesh (Openings/In.)	Wire Diameter (In.)	Opening Inches	Opening Micron	Percent Open Area
2	.063	.437	11100	76.4
2	.092	.407	10360	66.6
3	.063	.270	6860	65.6
4	.047	.208	5160	65.9
4	.063	.187	4750	56.0
5	.041	.159	4040	63.2
6	.035	.132	3350	62.7
7	.035	.108	2740	57.2
8	.028	.097	2460	60.2
10	.025	.075	1910	56.3
11	.018	.073	1850	64.5
12	.023	.060	1520	51.8
14	.020	.051	1300	51.0
16	.018	.044	1130	50.7
18	.017	.038	980	48.3
20	.016	.034	872	46.2
30	.013	.020	513	37.1
40	.010	.015	384	36.0
50	.009	.011	282	30.3
60	.007	.009	231	33.9
80	.005	.0075	180	36.0
24 x 115		.0056		
100	.0045	.0055	141	30.3
120	.0037	.0046	118	30.1
30 x 160		.0046	118	
150	.0026	.0041	105	37.4
40 x 200		.0033	85	
170	.0024	.0035	79	35.1
30 x 260		.0029	75	
200	.0021	.0029	74	33.6
250	.0016	.0024	62	36.0
50 x 250	.0024	62		
28 x 480		.0023	59	
300	.0015	.0018	46	29.7
325	.0014	.0017	44	30.0
400	.0010	.0015	39	36.0
80 x 700		.0012	40	
125 x 600			30	
165 x 800			28	
165 x 1400			17	
200 x 1400			10	
250 x 1400			83	
25 x 2300			53	
75 x 2400			4	
400 x 2800			3	

WEDGE WIRE

Opening	Micron	% Open
.003″	75	
.005″	127	7.7
.010″	254	14.3
.015″	381	25
.020″	500	25
.031″	775	34
.034″	864	20
.062″	1550	51
.063″	1600	50
.094″	2350	44
.125″	3175	66
.156	3962	71

CHAPTER 6

Capacity

The capacity ratio, or open area ratio (OAR) of a strainer influences such operating characteristics as the length of time it can operate without cleaning and the created pressure loss. The ratio/OAR is the relationship between internal cross sectional area (flow area) of the pipe and the open flow area of the material which makes up the straining element.

A 100% OAR, or 1-to-1 ratio would give an unrestricted flow area equal to that of the pipe while the element was clean. As clogging occurs, however, flow would be inhibited. A 200% OAR, or 2-to-1 ratio would provide full flow, after the element became 50% clogged. A 250% OAR is a good standard for general heating and air conditioning service. However, larger OAR's or ratios would be appropriate for flow in which much debris is expected to be strained or where very viscous fluids are being handled.

When considering the OAR of a straining element, there are two accepted methods of analysis used by various specifying agencies and manufacturers. One method maintains a "line of sight" reasoning and uses the multiple of the open areas for elements in series. In this method, a 60% open area material in series with a 40% open area material has a resultant combined open area of 24% (i.e. as in accordance with military standards). An alternative method allows the open area of the more restrictive element in series to be used. This would be 40% for the example above (i.e. as in accordance with Underwriter Laboratory Standards). The method used influences the estimated operating pressure drop, as well as design decisions such as sizing.

As an example, fuel oils are generally strained to a fine degree to protect small orifices in burner nozzles. This requires a fine woven mesh be used in series with a reinforcing perforated plate. Due to the fact that the perforated plate may have a 50% open area and the mesh 30%, the resultant combined open area may be considered to be only 15% if there is no flow path other than line of sight through the two elements in series. This, of course, would mean that to have a OAR of 250%, a high capacity, large bodied strainer is required.

This same strainer using only the perforated plate would have a OAR more than three times as great. So, it may be seen that in any given strainer, the OAR may be varied by using various perforations or meshes having different open areas. Thus, it is essential to specify not only the OAR desired, but the straining element opening size and the method for calculating OAR.

CHAPTER 7

Pressure Loss

Because strainers are made with various dimensions and configurations, most reputable manufacturers have tested and published pressure drop results.

Most pump installations designed for reasonable velocities will permit approximately a 2-psi drop across the strainer. When a screen becomes clogged, the pressure drop varies with the clogging pattern experienced and the type of strainer being used. While some manufacturers speculate as to the change in head loss at different percentages of clogging, it should be recognized that this type of testing is very difficult to relate to actual line performance. This is because of differences in strainer clogging characteristics — a 1/4″ perforated basket two- thirds full of 1/2″ stones will be less affected than a small amount of fine leaves on a large 100-mesh basket. If large amounts of solids are expected, use a strainer with a high net open area as discussed in Chapter 6.

As a strainer becomes clogged to the point where the OAR of the strainer approaches the pipe area, the pressure drop across the strainer increases very rapidly and unpredictably. It is at this point, therefore, that it is recommended the strainer be cleaned. Otherwise, a large differential pressure will develop. The maximum differential pressure a strainer can withstand varies widely with strainer type, line size and material used. Always consult the manufacturer for maximum differential pressure a straining element can withstand.

From the foregoing discussion, it is obvious that periodic cleaning is essential in any strainer installation. Once the rate of clogging is established, a cleaning schedule can be set up. Pressure gauges on each side of the strainer can be valuable to determine when the strainer requires cleaning. Differential pressure switches can be set up to operate warning lights or alarms if so desired.

Some manufacturers have related their strainers' pressure drop to equivalent feet of pipe at various turbulent flow rates, and this can simplify the computation of head loss for an entire system. However, varying field conditions and fluid properties can affect the accuracy of general type pressure drop estimations. Further, operating viscous fluids under laminar flow conditions requires analysis different from that for fluids under turbulent conditions. Accordingly, the manufacturer should always be consulted for the most specific and accurate estimated pressure loss.

CHAPTER 8

Specifications and Manufacturer Testing

Needless to say, the more information provided to the manufacturer when ordering strainers, the better the chance of obtaining a strainer which is appropriately suited for a particular job. It is for this reason that considerable space is devoted to the preparation of specifications.

Specification

To allow the manufacturer to make selection or recommendations for a particular strainer, as much as possible of the following information should be provided:

A - Physical characteristics

1 - Pipe size and schedule.
2 - Strainer type required.
3 - End connections.
4 - Material (body, screen, studs, gaskets).
5 - Pressure rating (design/operating — including shock).
6 - Temperature rating (design, operating, minimum).
7 - Straining element opening size.
8 - Capacity:
  (a) Net effective open area required.
  (b) Method of net open area calculation.
9 - Special requirements (hinged cover, vent tapping, jacketed, etc.).
10 - Applicable specifications (military specifications, special nondestructive nondestructive tests or other QC Requirements).
11 - For automatic self-cleaning strainers, specify the following:
  (a) Voltage and frequency of power supply;
  (b) Air supply pressure if available;
  (c) Type of controls desired;
  (d) Type of motor, switch and control panel enclosure required.

B - Flow data.

1 - Liquid:
  (a) Description of fluid.
  (b) Rate of flow - gallons per minute (gpm) or pounds per hour (lbs/hr).
  (c) Viscosity - SSU.
  (d) Specific gravity/density.
  (e) Temperature.
  (f) Concentration (if acid or other corrosive).

2 - Gas:
  (a) Description of Gas
  (b) Rate of flow - standard cubic feet per minute (scfm).
  - actual cubic feet per minute (cfm).
  (c) Specific gravity.
  (d) Temperature and pressure.
  (e) Molecular weight.

3 - Steam:
  (a) Flow-pounds per hour.
  (b) Temperature.
  (c) Pressure.
  (d) Density.
  (e) State of flow.

C - Solids to be removed:

Specify the nature and relative size of the sediment. Parts per million (ppm) or percent by volume or cubic inches per hour or percent by weight can also be specified.

NOTE: If strainer is to be steam jacketed, the following information for the heat transfer fluid or steam must be given:

(a) Type of fluid.
(b) Rate of flow.
(c) Temperature.
(d) Pressure.
(e) Type and size connections desired.
(f) Material for jacket construction.
(g) Whether strainer end flanges are oversized to match jacketed pipe.

D - Allowable pressure drop (psi):

1 - Clean.
2 - 50% clogged.

NOTE: Operating pressure drop is a function of operating conditions, fluid characteristics and strainer geometry. Consequently, if specifying a strainer type and geometry, a desired pressure drop may not be obtainable if fluid parameters are fixed. The "trade-off" relationship between fluid conditions, strainer geometry and operating pressure drop establishes what compromises must be made.

Available Types of Manufacturer Testing

A - Hydrostatic:

Most common test - usually 1-1/2 times working pressure to determine that a strainer body, cover gaskets, etc., are sound.

B - Radiographic examination:

To determine if the casting or welded joint has any slag or sand inclusions, gas pockets or subsurface defects. This type of test is quite expensive and usually specified only for high pressure strainers.

C - Magnetic Particle:

A reasonably low cost examination to reveal relatively shallow subsurface cracks, gas pockets, etc. Iron dust is sprinkled on the surface of the casting/weld and a magnetic force is induced electrically, causing the dust to align over defects and cracks showing their location and size. Can be used only on iron and steel.

D - Dye penetrant:

Equivalent to magnetic particle testing, except used mainly with nonmagnetic castings/welds to reveal surface defects, cracks, depressions, etc.

E - Air test:

Either under water or with part covered with soap solution. This is a more stringent test for porosity and gasket leakage than hydrostatic, and leaks often are more obvious. Sometimes not done, due to relative danger involved.

F - Hydrostatic burst test:

Sometimes done to establish manufacturer's maximum working pressure rating, or at the request of purchaser.

G - Shock:

Usually a government requirement where strainers will remain operative or intact in the event of a near-proximity explosion. Test normally conducted on a machine where weighted hammer strikes plate on which strainer is mounted.

H - Vibration:

Normally a government requirement where strainers must withstand a vibration test which involves a number of frequencies. This usually simulates shipboard vibrations, earthquake, etc..

I - Surge test:

- A strainer is pressurized with water and a quick-opening valve on the outlet flange is rapidly opened to determine that no damage is sustained by the basket. Normally, a military requirement.

J - Helium leak test:

A very stringent test where the strainer is pressurized with helium and leaks are checked with sensitive instruments. A maximum leak rate is usually specified. Used mostly for nuclear plants for radioactive water piping.

K - Ferroxyl:

A test to detect free iron in stainless steel strainers where the iron would contaminate the product.

NOTE: Many tests by their very nature can be more or less stringent. Acceptance standards should be included in any inquiry calling for such tests. Naturally, the more stringent the test requirements, the more costly the ultimate strainer becomes.

CHAPTER 9

Shock-Hydraulic and Thermal

Any liquid being transmitted in a pipe line possesses a certain amount of energy (weight times velocity). A rapid change in velocity results in a momentary shock wave. In the case of a quick-closing valve, the energy of the flowing fluid must be used up in some way, and the resulting shock, or "water hammer", is clearly audible. A pressure wave, in some cases, travels at over 3,000 feet per second and traverses the pipeline in one direction, then the other, until it dissipates. A theoretical figure of 54 psi for each foot per second that is stopped by the valve may be used. A 12 foot per second velocity could produce a shock wave having a peak of 648 psi; therefore, consideration should be given to the shock and non-shock rating of the strainer.

No attempt will be made here to go into the highly technical field of hydraulic shock, and it is covered briefly to point out that even if your system can produce only a specific head, if the possibility of shock is present, tremendous overpressures may result.

Commonly known is the phenomenon of pouring hot tea into a glass and watching the glass crack. This is an example of thermal shock. Rapid changes of temperature in piping systems can have the same effect, and in selecting strainers consideration must be given to this possibility.

In improperly trapped steam lines, condensate can collect in low points and subsequently become a slug of water traveling at high velocity down the line. Almost all strainers cause a change in direction of flow due to their configuration, and the result can be obvious if the strainer cannot absorb this type of shock. In considering this situation, it is important to remember that steam velocities of 4,000 to 20,000 feet per minute are quite common.

Conclusion

Straineres are no longer confined to a simple cast body with a wire mesh screen, but are a technical, highly refined, carefully designed piece of equipment.

Sometimes they operate at 1,500 degrees F and 10,000 psig or at cryogenic temperatures. They are modified with steam jackets, cover lifting davits, magnets, motorized cleaning devices and automatic vent valves. They are supplied with screwed, flanged, socket weld, butt weld, ring joint and silver brazing end connections.

Accordingly, the implementation of a strainer needs to be well thought out and engineered. While it is good practice to use a strainer to protect downstream equipment, it is very important to carefully consider the options available. Choosing the correct strainer can save money not only by protecting equipment, but also by keeping operations and maintenance costs at a minimum.

This guide for the selection, installation and maintenance of pipeline strainers has been created within the cooperation of the Fluid Controls Institute, Inc., Pipeline Strainer Section, and represents the collective knowledge and experience of its members.

R.P. Adams Company, Inc.
Armstrong International, Inc.
The Clarke-Reliance Corporation
Cleveland Gear, Hellan Strainer Division
Fabrotech Industries, Inc.
Hayward Industrial Products, Inc.
O.C. Keckley Co.
The Kraissl Co., Inc.
The Mack Iron Works Company
The Metraflex Company
Mueller Steam Specialty
Plenty Products, Inc.
Process Strainers, Inc.
Spirax Sarco, Inc.
William E. Williams Valve Corp.
Yarway Corporation

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FCI STANDARD #89-1
GUIDE FOR THE SELECTION,
INSTALLATION AND MAINTENANCE
OF PIPE LINE STRAINERS

List of Figures

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Metraflex

Installation, Operation and Maintenance Instructions

METRAFLEX BUTTERFLY VALVE

(Standard Product with Elastomer Seat)

FLANGE AND PIPE COMPATIBILITY

The B series (BL, BW, BLA, BWA) valve is designed to mate between all types of ANSI 125 & 150 pound flat or raised face flanges. Gaskets are unnecessary as the seat face design eliminates their need. Heavy wall or lined pipe, or flanges must have minimum allowable inside diameter to clear disc sealing edge when opening the valve.

INSTALLATION INFORMATION

The Metraflex valve is non-directional (there is no upstream or downstream side). For the best results in slurry service regarding sedimentation, position the valve assembly to have the stem in the horizontal position and the lower disc edge to open in the down-stream direction. To install the value between existing ANSI flanges, the flanges must be spread sufficiently before placing the valve in position to prevent distortion and/or damage to the sealing face of the seat. IMPORTANT: DO NOT finish weld the flanges to the pipe with the valve bolted between the flanges as this will result in serious heat damage to the seat. Finish welding the flanges to the pipe and allow the flanges to cool completely.

INSTALLATION INSTRUCTIONS

With the disc in the nearly closed position and after spreading the pipe flanges, insert the valve between the flanges and assemble the valve body to the flanges with all flange bolts possible. Turn the disc to the fully open position. Next, while gradually removing the flange spreaders, center the valve body to the flanges and tighten the bolting hand tight. Slowly close the valve to check for adequate disc clearance. Return the disc to the fully open position and cross-tighten all bolting to the proper torque specification. Again,

check for adequate disc clearance. If the installation is satisfactory, the valve is ready for service after installing the valve operator or actuator.

MAINTENANCE

Routine maintenance or lubrication is not required.

REPAIRS

Contact factory for repair instructions manual and parts availability.

The Metraflex Company

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ARMSTRONG®

FILE NO.:	37.873
DATE:	Sept. 5, 2003
SUPERSEDES:	New
DATE:	New

INSTALLATION AND OPERATING INSTRUCTIONS

Vortex Air Separator
Models VA/VAS
Sizes: 2", 2.5" & 3" – Cast Iron

VESSEL DESCRIPTION

Armstrong **VA/VAS Vortex Air Separators** eliminate air quickly and efficiently from heating/cooling systems. Water enters and exits through unique "tangential" connections which promote a low velocity swirling effect in the centre of the unit. Centrifugal force moves the water to the outer edges of the unit and a vortex is formed. Entrained air migrates to the eye of the vortex (lower pressure point) and is evacuated at the top of the separator. The water exits the unit near the bottom of the unit, bubble free, protecting the system against the noise, corrosion and damage associated with entrained air.

VAS models are equipped with a stainless steel strainer.

CONSTRUCTION DETAILS

MATERIALS OF CONSTRUCTION	
Shell	Cast Iron
Strainer	Stainless Steel Mesh (¼" x ¾")
Gasket	Non-Asbestos

TECHNICAL DATA	
Max. Working Temperature	350°F (176°C)
Max. Working Pressure	160 psi (1105 kPa)
Connection Type	Threaded NPT

STEPS & PROCEDURE

- Visually inspect the air separator for damage, which may occur during transit.
- A manual drain can be added to help facilitate purging sediment from the air separator.
- VAS Models have a strainer that must be removed and cleaned after 24 hours of operation.

DISTANCE REQUIRED TO REMOVE STRAINER	
Size	Distance
2.0 VAS	7.0 in. (178 mm)
2.5 VAS	8.0 in. (203 mm)
3.0 VAS	8.0 in. (203 mm)

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www.armstrongpumps.com

ARMSTRONG®

FILE NO.:	37.870
DATE:	Sept. 5, 2003
SUPERSEDES:	New
DATE:	New

INSTALLATION AND OPERATING INSTRUCTIONS

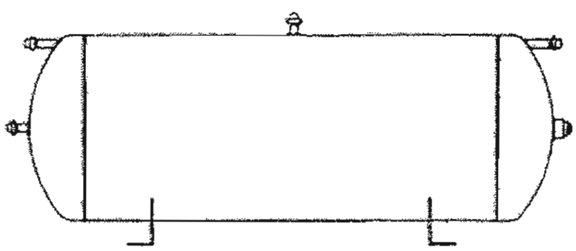
AX (Horizontal) and AX-V Series

ASME PRE-PRESSURIZED DIAPHRAGM EXPANSION TANKS FOR HEATING & COOLING SYSTEMS

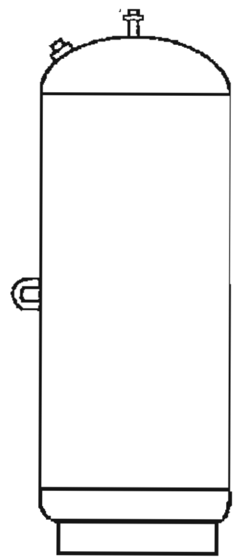
VESSEL DESCRIPTION

Armstrong AX Series Tanks are ASME constructed, pre-charged expansion tanks. They are designed to absorb the expansion forces and control the pressure in heating/cooling systems. The system's expanded water (is contained behind a heavy-duty diaphragm fully compatible with water/glycol mixtures) preventing tank corrosion and waterlogging problems.

The factory set pre-charge for these tanks is **12 psig (83 kPa).**



AX Series – Fixed Diaphragm



AX-V Series – Fixed Diaphragm

CONSTRUCTION DETAILS

MATERIALS OF CONSTRUCTION	
Shell	Carbon Steel
Diaphragm	Heavy Duty Butyl

MAXIMUM OPERATING CONDITIONS	
Working Temperature	240°F (115°C)
Working Pressure	125 psi (862 kPa)

STEPS & PROCEDURE

- Visually inspect tank for damage, which may occur during transit.
- Factory pre-charge pressure may not be correct for the installation. Tank MUST be pre-charged to system design fill pressure BEFORE placing into operation. Remove pipe plug covering the valve enclosure. Check and adjust the charge pressure by adding or releasing air for each application.
- If the system has been filled, the tank must be isolated from the system and the tank emptied before charging. This ensures all fluid has exited the diaphragm area and proper charging will occur.
- If the pre-charge adjustment is necessary, oil and water free compressed air or nitrogen gas may be used. Check the pre-charge using an accurate pressure gauge at the charging valve and adjust as required. Check air valve for leakage. If evident, replace the Schrader-type tire valve core. Do not depend on the valve cap to seal the leak. After making sure air charge is correct, replace pipe plug over the charging valve for protection.
- Set tank in place and pipe system connection to system. Be sure to include isolation valve(s) and drain.
- Purge air from system BEFORE placing tank into operation. All models have system water contained behind diaphragm.
- When filling the system with water, open valves to tank to ensure that any residual air in the tank is displaced by water.
- It is recommended that the pre-charge be checked annually to ensure proper system protection and long life for the vessel.

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AIR RELEASE VALVES

Operation, Installation and Maintenance

The Air Release Valves are fully automatic valves and require no regular maintenance.

The purpose of the "Air Release Valves" is to release air which accumulates in a pipeline during its operation.

OPERATION: The valve, as shipped, is a normally open valve. As the system is being filled, air is vented through the small orifice. When the fluid enters the valve, the float raises and shuts off the orifice, preventing any leakage. As air accumulates and enters the valve, displacing fluid, the float drops, allowing the venting orifice to open. This cycle is repeated as often as necessary during the pumping cycle.

INSTALLATION: Air Release Valves should be installed in a vertical position at high points on a piping system. A ball valve should be installed below each valve in the event servicing is required. A drain line is recommended, as the valve may "spit" a small amount of fluid during venting. To vent air quickly during initial start up, remove the 1/2-inch pipe plug in the cap of the air vent.

MAINTENANCE: No regular maintenance is necessary; however, periodic inspection for leakage and function can be performed. Close the inlet service valve and slowly remove the 1/2-inch pipe plug. Slowly open the service valve. If a volume of air larger than that contained in the air release valve body escapes, the valve may not be functioning properly, and the valve should be removed and inspected for wear and/or possible damage from foreign matter.

Replacement parts are available.

CUSTOMER ____________________

PROJECT ____________________

ENGINEER ____________________

ARCHITECT ____________________

the Metraflex *company*
CHICAGO ILLINOIS

DESCRIPTION:
AIR RELEASE VALVES
STYLE MV

DRAWN BY: DATE: DRAWING NO:

Armstrong PUMPS

INSTALLATION AND OPERATING INSTRUCTIONS
PRESSURE REDUCING VALVES

MODELS RD-11, RD-40, RD-50 & HRD-70

INSTALLATION:

The pressure reducing valve should be installed with the flow arrow on the body pointing in the direction of the flow. A shut-off valve should be installed on the city water side of the pressure reducing valve. If the pressure reducing valve is not equipped with a fast fill feature, a by-pass may be used. A three valve bypass around the pressure reducing valve will also serve as a fast fill option and is recommended for service.

CAUTION:

The use of teflon tape when installing a valve provides lubricity. Care should be taken to avoid over tightening, which may crack the valve body.

OPERATION:

Models RD-11, RD-40 and RD-50 are preset at 12 psi, and the HRD-70 is preset at 45 psi. Open the cold water fill valve and the system will be filled until the boiler gauge indicates the preset valve pressure has been obtained.

Model RD-11 is preset at 12 psi and is equipped with a fast fill feature. When filling the system as noted above, the fast fill thumbscrew should be manually turned in completely. This overides the pressure regulating function of the valve. The system should be filled until the boiler gauge indicates the preset pressure of the valve and then the fast fill thumbscrew should be backed off completely until it spins freely.

WARNING:

THE FAST FILL THUMBSCREW MUST NEVER BE LEFT IN THE DOWN POSITION AFTER THE SYSTEM HAS BEEN FILLED. THE THUMBSCREW MUST BE PLACED IN THE FREE POSITION TO AVOID OVER PRESSURIZATION AND UNNECESSARY RELIEF VALVE DISCHARGE.

ADJUSTMENT:

Allow system water to cool to ambient temperature. If necessary, adjust valve pressure setting as follows: pressure setting can be raised or lowered by loosening the jam nut and turning the slotted adjusting screw clockwise to increase the set pressure or counter-clockwise to lower the set pressure. This should be done slowly until the boiler pressure gauge indicates the required system pressure. A screw driver should be used to hold the adjusting stem stationary while the jam nut is secured.

SERVICE:

If the pressure reducing valve fails to maintain the set cold fill pressure, the sediment strainer may be clogged. To service the strainer, shut off city water supply and the isolation valve on the discharge of the pressure reducing valve. Remove and clean or replace the strainer, and replace the strainer gasket and nut. Open both the city water shut-off valve and the isolation valve to resume normal system operation.

ARMSTRONG PUMPS INC. • 93 East Avenue, North Tonawanda, N.Y. 14120
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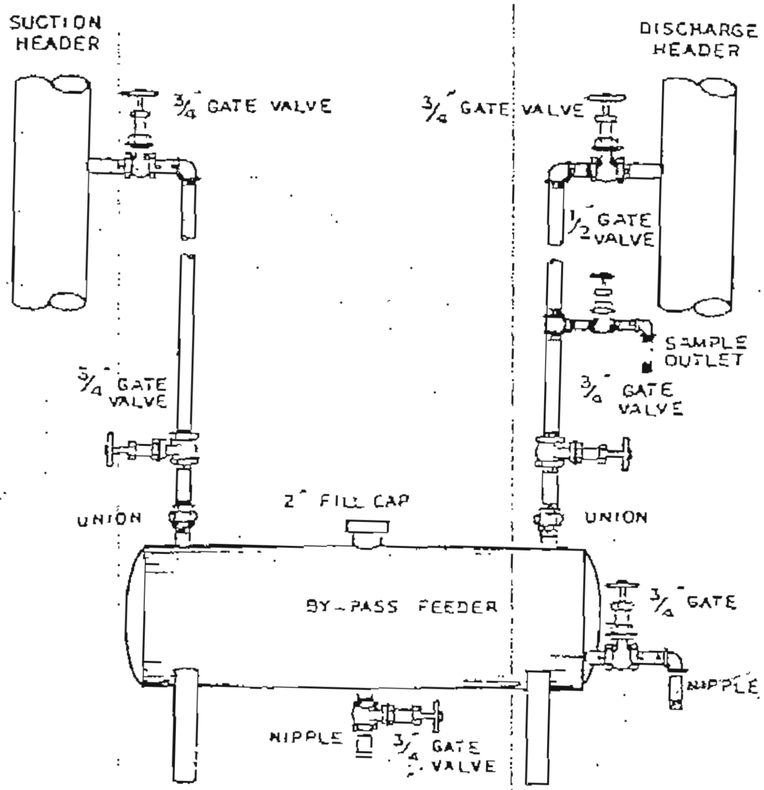
FORM NO.: 6943 PRINTED IN U.S.A.

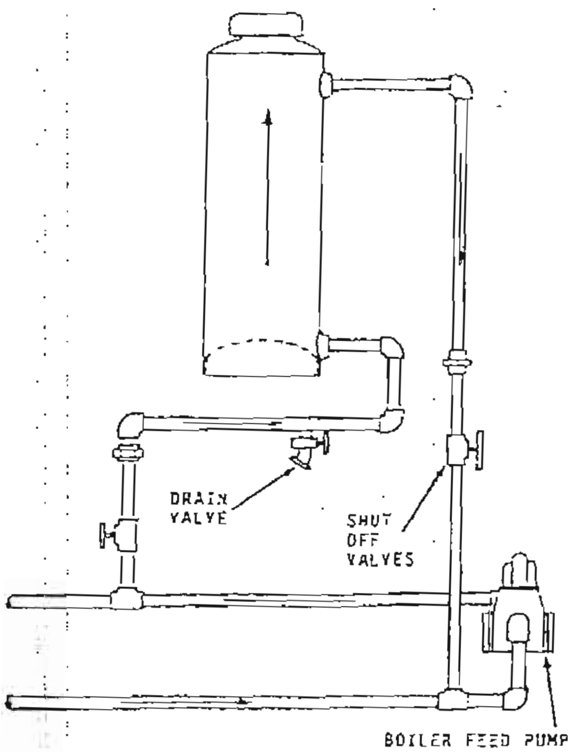
THE JOHN WOOD COMPANY

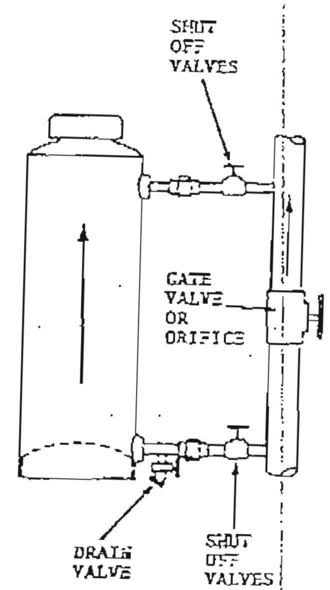
QUALITY PRODUCTS SINCE 1867

INSTALLATION INSTRUCTIONS

1. Pipe feeder to cause pressure drop across inlet and outlet resulting in flow through feeder.
2. Provide isolation and drain valves for servicing and draining.
3. Use with hot or cold water only. DO NOT USE FOR STEAM.
4. DO NOT OPEN UNDER PRESSURE- close isolation valves and bleed off pressure before opening.
5. CONTENTS MAY BE HOT.
6. Be certain gasket is positioned in groove under cap before replacing cap. (Replace gasket if cap does not seal by hand pressure.) Cap should seal with hand tightening pressure only. Do not strike cap with any tool to seal or unseal.
7. Open valves slowly when returning service.
8. DO NOT COMBINE CHEMICALS IN THIS DISPENSING DEVICE- without specific instructions from your chemical supplier.
9. READ AND FOLLOW LABEL DIRECTIONS FOR THE CHEMICAL IN USE.
10. CONSULT YOUR CHEMICAL SUPPLIER FOR THE PROPER USE OF THIS TANK WITH THE CHEMICAL.







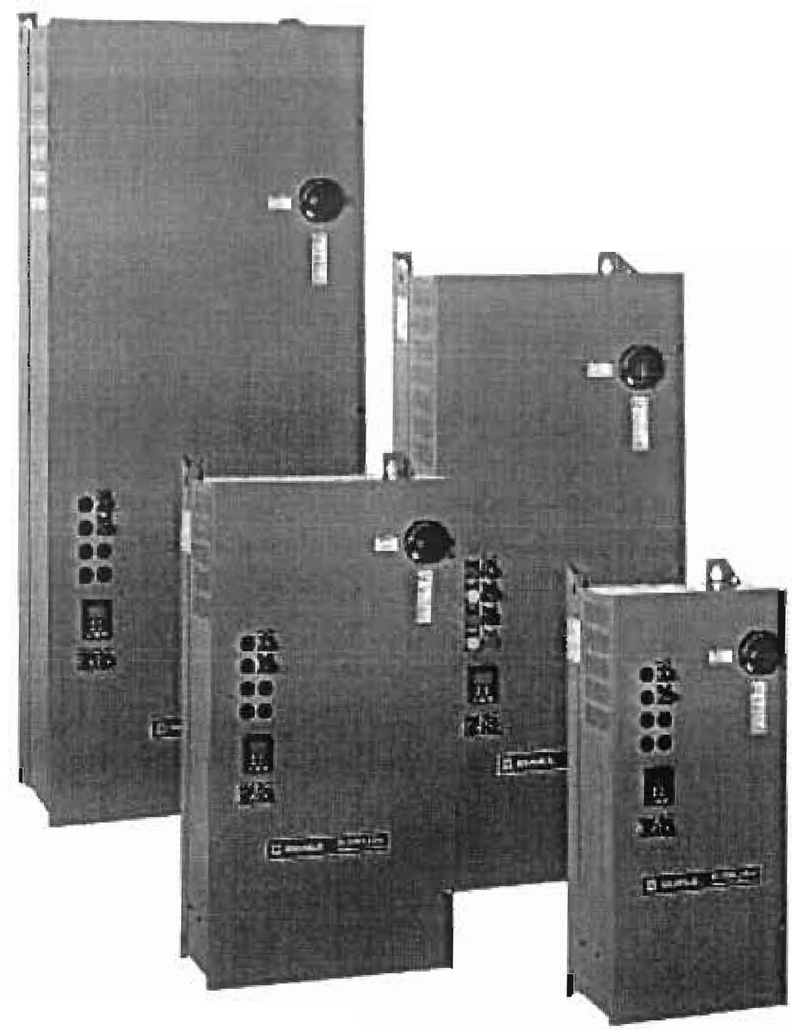
TYPICAL INSTALLATIONS OF STANDARD AND VERTICAL STYLE BY-PASS FEEDERS

ECONOFLEX™

Adjustable Speed Drive Controllers for HVAC and Pumping Applications
1–100 HP, 460 V and 1–50 HP, 208/230 V
Class 8839

Instruction Bulletin

Retain for future use.



a brand of Schneider Electric

SQUARE D

INTRODUCTION

The Class 8839 ECONOFLEX enclosed drive controllers are tailored for commercial market specifications in wall-mounted Type 1, Type 12K, or Type 3R enclosures. With a circuit breaker disconnect, these drive controllers may be configured with or without bypass.

This instruction bulletin covers receiving, installation, start-up, configuration, and troubleshooting of the 1 to 100 hp, 460 V and 1 to 50 hp, 208/230 V Class 8839 ECONOFLEX drive controllers.

REVISION LEVEL

This document replaces bulletin no. 30072-450-10G dated February 2002.

DOCUMENTATION REFERENCE

For further information, refer to the latest revision of the following instruction bulletins:

- Instruction bulletin VVDED397047US, *ALTIVAR® 58 Adjustable Speed Drive Controllers Keypad Display, VW3A58101.*
- Instruction bulletin 30072-200-50, *Handling, Installation, Operation, and Maintenance of Electrical Control Equipment.*
- Instruction bulletin VVDED397046US, *ALTIVAR 58 Adjustable Speed Drive Controllers Analog I/O Extension Card, VW3A58201U* (supplied with controller when analog card, MOD H09, is selected).
- Instruction bulletin VVDED300055US, *LONWORKS® to MODBUS® Module VW3A58312PU* (supplied with controller when LONWORKS, MOD L09, is selected).
- Instruction bulletin VVDED397054US, AL*TIVAR 58 Adjustable Speed Drive Controllers MODBUS/JBUS/UNITELWAY User's Guide, VW3A58303U* (supplied with controller when MODBUS, MOD M09 or LONWORKS L09,is selected).
- Instruction bulletin VVDED300028US, *ALTIVAR 58 Adjustable Speed Drive Controllers METASYS® N2 Communication Option VW3A58354U* (supplied with controller when METASYS N2, MOD P09, is selected).

TERMINOLOGY

The following terminology is used throughout this instruction bulletin in reference to the Class 8839 ECONOFLEX drive controller family. This distinction is made to minimize confusion when discussing installation and adjustment practices.

- When used as a component of the Class 8839 ECONOFLEX drive controller, part numbers beginning with FLEX58 are referred to in this instruction bulletin as *power converters.*
- The combination of the power converter, the enclosure, and the power and control circuits that constitute the Class 8839 ECONOFLEX product is referred to as the *drive controller, the controller, or the adjustable frequency controller (AFC).*

CONTROLLER CATALOG NUMBERS

The controller catalog number, located on the nameplate on the inside of the door, is coded to describe the configuration and options present. Use the following grid to translate the catalog number into a description of the drive controller.

Class	Type						Modifications: Control	Light	Misc.
8839	58E	•	•	•	V	•	•	•	•
	①	②	③	④	⑤	⑥	⑦	⑧	⑨

① Product

Code	Drive Type
58E	ECONOFLEX Controller

② Horsepower Code

Code	HP Rating	Code	HP Rating
C	1 hp	L	25
D	2 hp	M	30
E	3 hp	N	40
F	5 hp	P	50
G	7.5 hp	Q	60 (460 V only)
H	10 hp	R	75 (460 V only)
J	15 hp	S	100 (460 V only)
K	20 hp		

③ Enclosure Type

Code	Environment Rating
A	Type 12K
G	Type 1
H [5]	Type 3R

④ Voltage Rating

Code	Voltage
2	208 V
3	230 V
4	460 V

⑤ Application Type

Code	Applied Rating
V	Variable Torque

⑥ Device Type

Code	Power Circuit
W [6]	Without Bypass
Y [8]	Bypass

[1] Control option C07 (Start/Stop, Speed Potentiometer) is not compatible with Power Circuit Y (Bypass) or light cluster A08 or B08.

[2] Light cluster A08, B08, and C08 cannot be selected together. Select only one.

[3] Light cluster B08 is not compatible with Power Circuit W (Without Bypass).

[4] Light cluster C08 is not compatible with A07 (Hand/Off/Auto, Speed Potentiometer), or B07 (Hand/Off/Auto, Start/Stop, Speed Potentiometer).

[5] Line contactor B09 is not compatible with this option.

[6] Smoke purge E09 permits the motor to run at full speed.

⑦ Control Option

Code	AFC Controls
A07 [7]	Hand/Off/Auto, Speed Potentiometer
B07 [7]	Hand/Off/Auto, Start/Stop, Speed Potentiometer
C07 [1]	Start/Stop, Speed Potentiometer
N07	None

⑧ Light Option

Code	Light Cluster
A08 [2]	Red Power On
	Green AFC Run
	Yellow AFC Fault
	Yellow Auto
B08 [2], [3]	Red Power On
	Green AFC Run
	Yellow AFC Feult
	Yellow Bypass
C08 [2], [4]	Red Power On
	Green AFC Run
	Yellow AFC Fault

⑨ Misc. Options

Code	Feature
A09 [9]	Line Reactor (Included with 30–100 hp @ 460 V and 15–50 hp @ 208/230 V)
B09	Line Contactor
C09 [10]	3-15 PSI Transducer
D09 [13]	Omit Keypad
E09 [6]	Smoke Purge
G09	22 KAIC UL Coordinated Rating
H09 [11]	Analog Card, 0–20 mA, programmable for 4–20 mA output
J09 [12]	0–10 Vdc Auto Speed Reference
K09	cUL Listing
L09 [14]	LonWorks
M09 [14]	MODBUS
P09 [14]	METASYS N2

[7] Place the Hand-Off-Auto switch in the Off position for AFC fault reset.

[8] Includes AFC/Off/Bypass switch and Test/Normal switch.

[9] Line reactor A09 is an option for 1–25 hp @ 460 V and 1–10 hp @ 208/230 V.

[10] 3–15 PSI Transducer C09 is not compatible with Start/Stop, Speed Potentiometer C07, 0–10 V Auto Speed Reference J09, or Analog Card H09.

[11] Analog Card H09 is not compatible with 3–15 PSI Transducer C09 or serial communication L09, M09 or P09.

[12] 0–10 V Auto Speed Reference J09 is not compatible with C07 Start/Stop Potentiometer or C09 3–15 PSI Transducer.

[13] Omit the keypad D09. User must buy separate device to program the controller.

[14] Serial communication L09, M09 and P09 cannot be selected together. Select only one. Serial communication cannot be selected with H09 analog card.

CONTROLLER NAMEPLATE IDENTIFICATION

The nameplate for the Class 8839 ECONOFLEX drive controller is located on the inside of the door. This nameplate, described in Figure 1, identifies the controller class, type, and modification (options) listing. When identifying or describing Class 8839 ALTIVAR ECONOFLEX drive controllers, use the data from this nameplate.

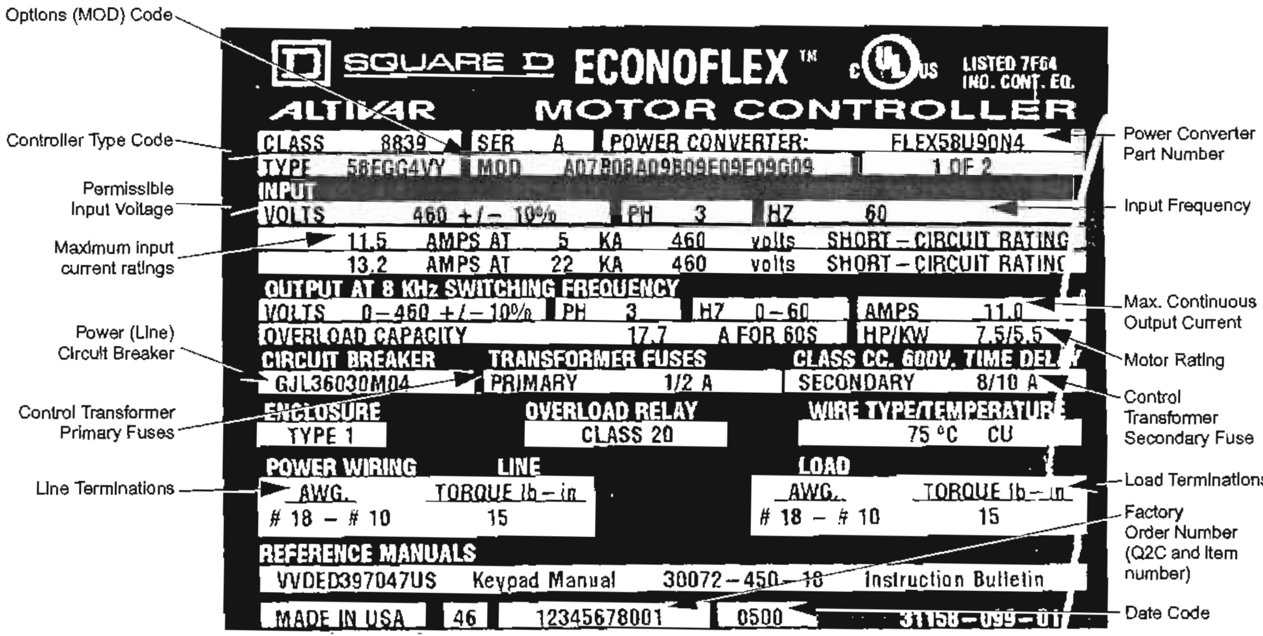


Figure 1: **Information Provided by the Drive Controller Nameplate**

COMPONENT LOCATIONS

NOTE: See pages 13 and 14 for components inside of the cabinet.

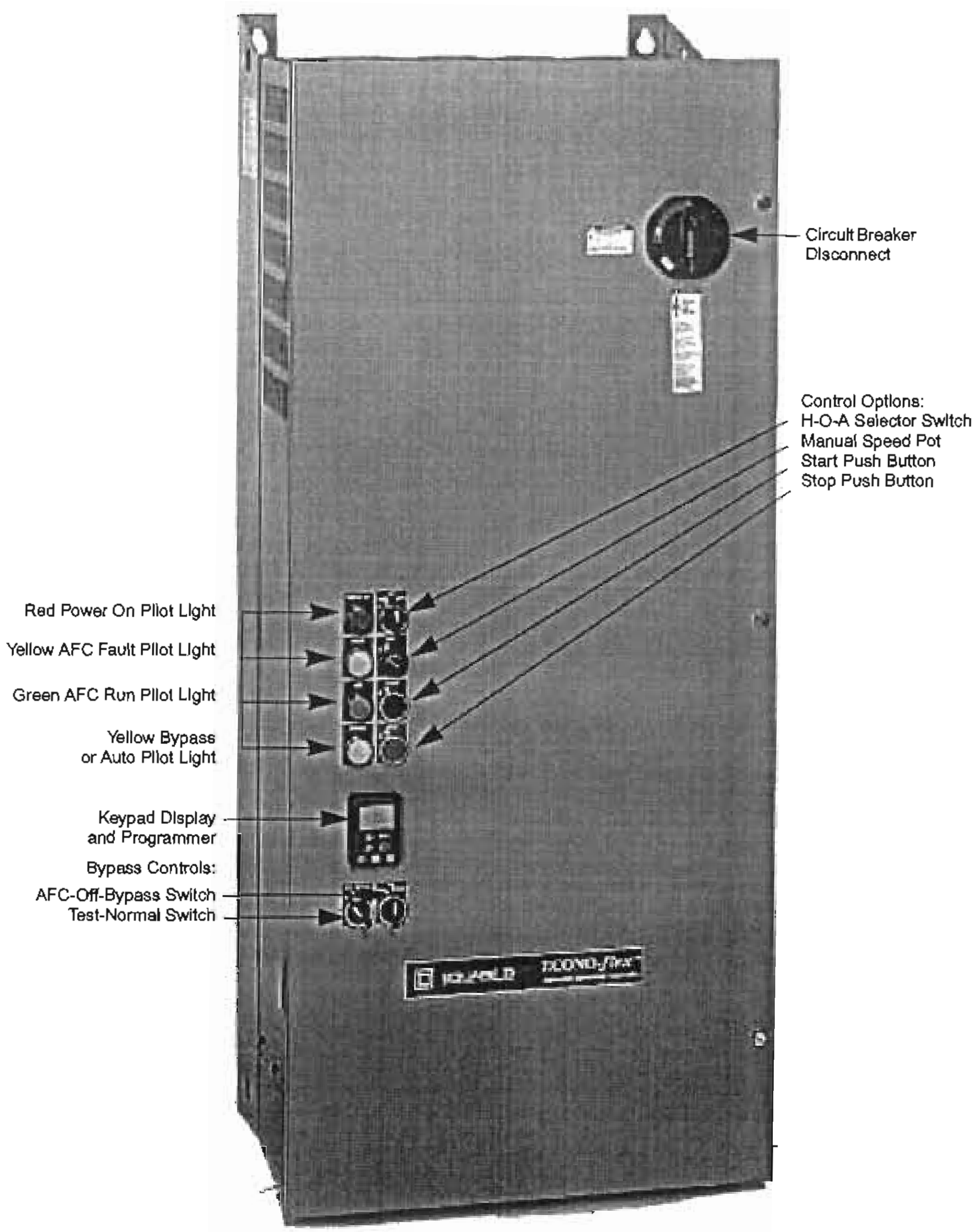


Figure 2: Front Component Locations for Controller: 1–100 HP @ 460 V and 1–50 HP @ 208/230 V (Class 8839, 58EPG4VY, MODS B07, B08, A09, B09, and E09 Shown)

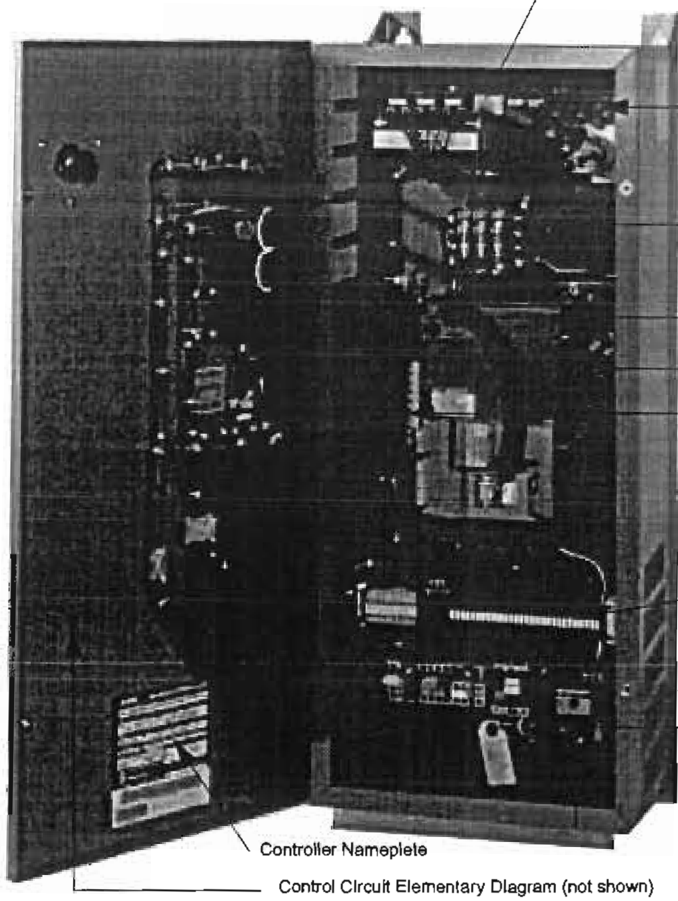


Figure 3: Inside Cabinet Component Locations for Controller: 1–25 HP @ 460 V and 1–10 HP @ 208/230 V (Class 8839, 58EGG4VY, MODS B07, B08, A09, B09, and E09 Shown)

Table 3: Class 8839 ECONOFLEX Drive Controller Ratings, 208 V

Drive Controller Catalog Number [1]	Motor Power [2] 208 V 60 Hz (HP)	Max. Continuous Output Current [3] (A)	Max. Transient Output Current (60 s) (A)	Power Converter Part Number
58EC•2V_	1	4.6	5.1	FLEX58U29M2
58ED•2V_	2	7.5	8.3	FLEX58U29M2
58EE•2V_	3	10.6	11.7	FLEX58U41M2
58EF•2V_	5	16.7	18.4	FLEX58U72M2
58EG•2V_	7.5	24.2	26.6	FLEX58U90M2
58EH•2V_	10	30.8	33.9	FLEX58D12M2
58EJ•2V_	15	46.2	50.8	FLEX58D16M2
58EK•2V_	20	59.4	65.3	FLEX58D16M2
58EL•2V_	25	74.8	82.3	FLEX58D23M2
58EM•2V_	30	88	96.8	FLEX58D28M2
58EN•2V_	40	114	125.4	FLEX58D33M2
58EP•2V_	50	143	157.3	FLEX58D46M2

Notes to Table 3:

[1] "•" can be "A", "G", or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes Type 3R enclosure "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.

[2] Power shown is for a carrier switching frequency of 8 kHz. For a switching frequency between 12 and 16 kHz, select the next largest size drive controller. If the duty cycle does not exceed 60% (36 s maximum for a 60 s cycle) this is not necessary.

[3] Continuous output current is based on NEC table 430-150. The ECONOFLEX controller nameplate rating is per the NEC table, not the current value listed in the keypad lookup table.

Input Current Ratings

All branch circuit components and equipment such as feeder cables, disconnect devices, and protective devices must be rated for the input current of the drive controller, not the motor full load current. The input current is stamped on the nameplate (see Figure 1 on page 11). The branch circuit feeder protection must be sized according to NEC Article 430-2.

Line reactors can be used to add reactance to the branch circuit, minimize drive controller input line current, reduce controller nuisance tripping due to transient overvoltage, reduce harmonic distortion, and improve phase-to-phase voltage imbalance. If line reactors are used:

- In systems that use bypass contactors, the line reactor should only be connected between the breaker load terminals in the controller and the power converter. A line reactor in a bypass motor starting circuit will reduce the ability of the motor to produce starting torque.
- The voltage tolerance at the input of the reactor will be different from that of the drive controller due to the voltage drop across the line reactor. Voltage tolerance measured at the input terminals of the drive controller will be as specified in this manual.

Specifications

Table 7: Specifications for Drive Controllers

Input voltage	460 V ±10%, 230 V ±10%, 208 V±10%
Displacement power factor	98% through speed range
Input frequency	60 Hz ± 5%
Output voltage	Three-phase output Maximum voltage equal to input voltage
Galvanic isolation	Galvanic isolation between power and control (inputs, outputs, and power supplies)
Frequency range of power converter	0.1 to 500 Hz (factory setting of 60 Hz maximum)
Current	110% of controller rated current for 60 s
Switching frequency	Selectable from 0.5 to 16 kHz [1] Factory setting: 8 kHz
Speed reference	AI1: 0 to +10 V, Impedance = 30 kΩ Speed potentiometer to AI1 AI2: FACTORY SETTING: 4 to 20 mA, Impedance = 100 Ω (reassignable, X–Y range with keypad display). FACTORY MODIFICATION J09 provides a controller interface 0–10 Vdc reference signal to the AI2 input using a 0–10 V / 4–20 mA converter with Z= 100 kΩ.
Frequency resolution in analog reference	0.1 for 100 Hz (10 bits)
Speed regulation	V/f: determined by motor slip, typically 3% SLFV (sensorless flux vector): 1%
Efficiency	97% at full load typical
Reference sample time	5 ms
Acceleration and deceleration ramps	0.1 to 999.9 seconds (definition in 0.1 s increments)
Motor protection	Class 10 electronic overload protection Class 20 electromechanical overload protection with bypass [2]
Keypad display	Self diagnostics with fault messages in three languages; also refer to instruction bulletin VVDED397047US
Temperature	Storage for all enclosures: -13 to +149 °F (-25 to +65 °C) Operation for Type 1 and 12K: +14 to +104 °F (-10 to 40 °C) Operation for Type 3R: +14 to +122 °F (-10 to 50 °C)
Humidity	95% with no condensation or dripping water, conforming to IEC 60068-2-3.
Altitude	3,300 ft (1000 m) maximum without derating; derating of the current by 1% for each additional 330 ft (100 m)
Enclosure	Type 1, Type 12K (Type 12 with knockouts) or Type 3R
Pollution degree	Type 1 or Type 3R: Pollution degree 2 per NEMA ICS-1 Annex A and IEC 60664-1 Type 12K: Pollution degree 3 per NEMA ICS-1 and IEC 60664-1
Operational test vibration	Conforming to IEC 60721-3-3-3M3 amplitude 1.5 mm peak to peak from 3 to 13 Hz 1 g from 13 to 200 Hz
Transit test to shock	Conforming to National Safe Transit Association and International Safe Transit Association test for packages.
Operational shock	15 g, 11 ms
Codes and standards	UL Listed per UL508C under category NMMS. Conforms to applicable NEMA ICS, NFPA, and IEC Standards. Manufactured under ISO 9001 standards. Factory Modification K09 provides Canadian cUL Certification.

[1] Above 8 kHz, select the next largest size drive controller. If the duty cycle does not exceed 60% (36 s maximum for a 60 s cycle), this is not necessary.
[2] Class 10 electromechanical for 1 hp @ 460 V.

Short Circuit Ratings

Notes to Table 8:

[1] "•"can be "A", "G", or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.

Table 8: Short Circuit Ratings, 460 V

8839 Controller [1]	Power Circuit	HP	MOD G09	Power Converter (AFC) Path Short-Circuit Rating (Symm.)	Bypass Path Short-Circuit Rating (Symm.)
58EC•4VW_ to 58EP•4VW_	W (Without Bypass)	1–50	Not selected	5,000 A	N/A
58EC•4VY_ to 58EP•4VY_	Y (Bypass)			5,000 A	5,000 A
58EQ•4VW_ to 58ES•4VW_	W (Without Bypass)	60–100	Not selected	10,000 A	N/A
58EQ•4VY_ to 58ES•4VY_	Y (Bypass)			10,000 A	10,000 A
58EC•4VWG09_ to 58EP•4VWG09_	W (Without Bypass)	1–50	Selected	22,000 A	N/A
58EC•4VYG09_ to 58EP•4VYG09_	Y (Bypass)			22,000 A	22,000 A
58EQ•4VWG09_ to 58ES•4VWG09_	W (Without Bypass)	60–100	Selected	22,000 A	N/A
58EQ•4VYG09_ to 58ES•4VYG09_	Y (Bypass)			22,000 A	22,000 A

Notes to Table 9:

[1] "•"can be "A", "G", or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.

Table 9: Short Circuit Ratings, 230 V

8839 Controller [1]	Power Circuit	HP	MOD G09	Power Converter (AFC) Path Short-Circuit Rating (Symm.)	Bypass Path Short-Circuit Rating (Symm.)
58EC•3VW_ to 58EP•3VW_	W (Without Bypass)	1–50	Not selected	5,000 A	N/A
58EC•3VY_ to 58EP•3VY_	Y (Bypass)			5,000 A	5,000 A
58EC•3VWG09_ to 58EP•3VWG09_	W (Without Bypass)	1-50	Selected	22,000 A	N/A
58EC•3VYG09_ to 58EP•3VYG09_	Y (Bypass)			22,000 A	22,000 A

Notes to Table 10:

[1] "•" can be "A", "G", or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.

Table 10: Short Circuit Ratings, 208 V

8839 Controller [1]	Power Circuit	HP	MOD G09	Power Converter (AFC) Path Short-Circuit Rating (Symm.)	Bypass Path Short-Circuit Rating (Symm.)
58EC•2VW_ to 58EP•2VW_	W (Without Bypass)	1–50	Not selected	5,000 A	N/A
58EC•2VY_ to 58EP•2VY_	Y (Bypass)			5,000 A	5,000 A
58EC•2VWG09_ to 58EP•2VWG09_	W (Without Bypass)	1-50	Selected	22,000 A	N/A
58EC•2VYG09_ to 58EP•2VYG09_	Y (Bypass)			22,000 A	22,000 A

FACTORY MODIFICATIONS

Control Options

NOTE: Refer to the notes on page 10 for rules governing component selection.

Table 12: Control Options (Required Selection)

Control Option	Description	Parts List
A07	Hand-Off-Auto Selector Switch	ZB5AD3 Three-position selector switch ZB5AZ009 mounting collar ZBE203 Additional contact block (2 N.O.) (2) ZBE102 Additional contact block (1 N.C.) ZBZ32 Legand plate holder
	Speed Potentiometer	ZB5AD922 Potentiometer operator ZBZ32 Legend plate holder
B07	Hand-Off-Auto Selector Switch	ZB5AD3 Three-position selector switch ZB5AZ009 mounting collar ZBE203 Additional contact block (2 N.O.) (2) ZBE102 Additional contact block (1 N.C.) ZBZ32 Legend plate holder
	Stop/Start Push Buttons	ZB5AA2 Black push button w/ mounting base ZB5AA4 Red push button w/ mounting base ZB5AZ101 Mounting collar w/ additional contact block (1 N.O.) ZB5AZ102 Mounting collar w/ additional contact block (1 N.C.) (2) ZBZ32 Legend plate holder
	Speed Potentiometer	ZB5AD922 Potentiometer operator ZBZ32 Legend plate holder
C07	Stop/Start Push Buttons	ZB5AA2 Black push button w/ mounting base ZB5AA4 Red push button w/ mounting base ZB5AZ101 Mounting collar w/ additional contact block (1 N.O.) ZB5AZ102 Mounting collar w/ additional contact block (1 N.C.) (2) ZBZ32 Legend plate holder
	Speed Potentiometer	ZB5AD922 Potentiometer operator ZBZ32 Legend plate holder
N07	None	No drive control options are supplied on the front door of the drive controller. For use in remote-mounted operator applications. Refer to chapter 3, Power Circuit Descriptions, for remote mounting information.

Light Options

NOTE: Refer to the notes on page 10 for rules governing component selection.

Table 13: Light Options (Optional Selection)

Light Option	Description	Parts List
A08 Pilot Light Option #1 Cluster	Red Power On	ZB5AV04 Red pilot light head ZB5AV6 Mounting coller with light module ZBZ32 Legend plate holder
	Green AFC Run	ZB5AV03 Green pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Yellow Fault	ZB5AV05 Amber pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Yellow Auto	ZB5AV05 Amber pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
B08 Pilot Light Option #2 Cluster	Red Power On	ZB5AV04 Red pilot light head ZB5AV5 Mounting collar with light module ZBZ32 Legend plate holder
	Green AFC Run	ZB5AV03 Green pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Yellow Fault	ZB5AV05 Amber pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Yellow Bypass	ZB5AV05 Amber pilot light head ZB5AV6 Mounting coller with light module ZBZ32 Legend plate holder
C08 Pilot Light Option # 3 Cluster	Red Power On	ZB5AV04 Red pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Green AFC Run	ZB5AV03 Green pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder
	Yellow Fault	ZB5AV05 Amber pilot light head ZB5AV6 Mounting collar with light module ZBZ32 Legend plate holder

Misc. Options

NOTE: Refer to the notes on page 10 for rules governing component selection.

Table 14: Miscellaneous Options (Optional Selection)

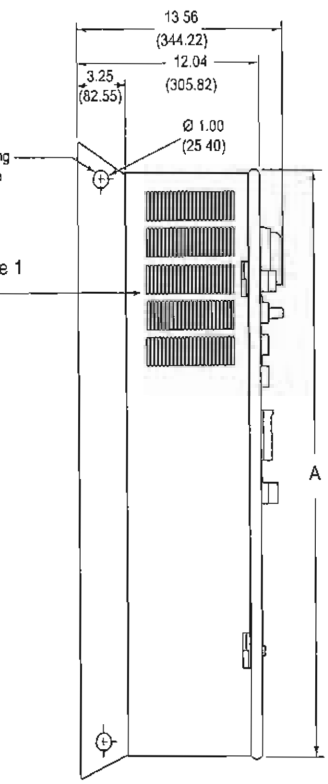
Misc. Option	Name	Description
A09	Line Reactor	Factory-mounted line reactor within enclosure. Optional 1–25 hp, included 30–100 hp @ 460 V Optional 1–10 hp, included 15–50 hp @ 208/230 V
B09	Line Contactor	A line contactor can be added between the circuit breaker and the drive controller, (Type 1 and 12K only).
C09	3–15 PSI Transducer	Allows the controller to follow a user-supplied 3–15 PSI input.
D09	Omit Door-Mounted Keypad	The keypad is not supplied. The user must buy a keypad as a separate device to program the drive.
E09	Smoke Purge	Provides a smoke purge operating mode controlled by a user-supplied 120 Vac signal wired to customer's terminal block.
G09	22 KAIC UL Coordinated Rating	Provides a fully-coordinated 22 KAIC rating marked on enclosure nameplate (short circuit coordination to UL508C Power Conversion Equipment and NEMA ICS 7.1).
H09	Analog Card	0–20 mA analog output for customer use. Factory programmed for motor frequency. Includes analog card VW3A58201U and customer terminal block. Reassignable x–y range with keypad display.
J09	0–10 Vdc Auto Speed Reference	Provides a controller interface with differential input, 31158-297-50, for a 0–10 Vdc user-supplied auto speed reference signal to the AI2 input using a 0–10 V/4–20 mA converter with Z=40 kΩ.
K09	cUL Listing	Provides Canadian cUL certification when required by local code requirements.
L09	LONWORKS Serial Communication [1]	Provides factory installed LONWORKS to MODBUS Module VW3A58312PU, 24 Vdc power supply 8440PS24 and plug-in MODBUS card VW3A58303U. Serial Communication is factory installed for register monitoring.
M09	MODBUS Serial Communication [2]	Provides factory installed plug-in MODBUS card VW3A58303U and separate user termination to D-shell interface device, Square D part number 25410-00084. (Phoenix contact connector part #2761839.) Serial Communication is factory installed for register monitoring.
P09	METASYS® N2 Serial Communication	Provides factory installed plug-in METASYS N2 card VW3A58354U and separate user termination to D-shell interface device, Square D part number 25410-00084. (Phoenix contact connector part #2761839.) Serial Communication is factory installed for register monitoring.

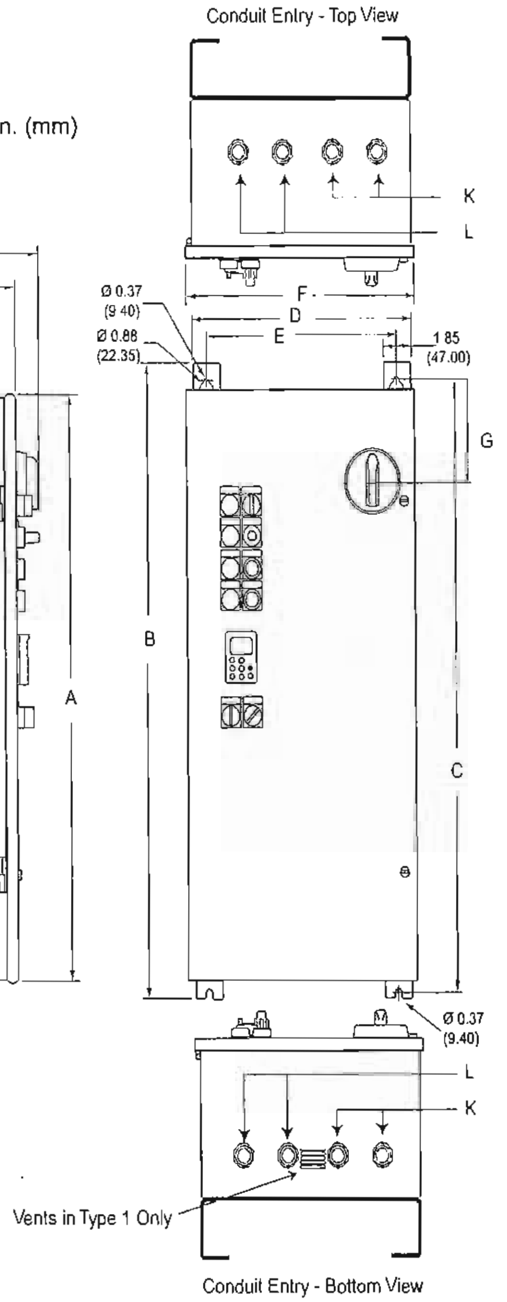
[1] For the most recent *.xif installation help files, refer to www.us.SquareD.com. The files are listed on the LONWORKS instruction bulletin page in the Product Technical Library. Refer to instruction bulletin VVDED300055US.

[2] The 9-pin to 15-pin connector cable that ships with the MODBUS® card when ordered from the distributor does not ship with an ECONOFLEX unit. ECONOFLEX units ship with a Phoenix connector for user terminations.

DIMENSIONS AND WEIGHTS FOR WALL MOUNTING

Dimensions: in. (mm)





NOTE: Provide at least 3 in. of mounting clearance on each side of the drive controller and at least 6 in. of mounting clearance at the top and bottom of the drive controller.

Knockout Dimensions

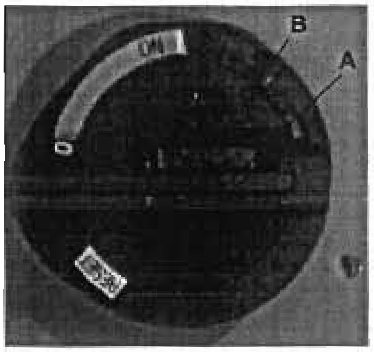
460 V	208/ 230 V	K	L
1–7.5 hp	1–5 hp	For 1/2" conduit	For 1/2" conduit
10–25 hp	7.5–10 hp	For 1/2", 3/4", and 1" conduit	For 1/2", 3/4", and 1" conduit

HP		Weight		Enclosure Dimensions													
				A		B		C		D		E		F		G	
460 V	208/ 230 V	lb	kg	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1–7.5	1–5	87	39.5	32.00	812.8	35.00	889.00	33.75	857.25	14.25	361.95	12.29	312.17	14.76	374.90	4.88	123.95
10–25	7.5–10	126	57.2	36.00	965.2	41.0	1041.40	39.75	1009.65	19.49	495.05	17.53	445.26	20.52	521.21	4.88	123.95

Figure 5: Mounting Information for Type 1 or Type 12K 1–25 HP Controllers @ 460 V and 1–10 HP Controllers @ 208/230 V

CHAPTER 2: RECEIVING, INSTALLATION, AND START-UP

PRELIMINARY INSPECTION



Circuit Breaker and Handle Assembly

> ### ⚠ CAUTION
> **DAMAGED EQUIPMENT**
>
> Do not operate any drive controller that appears damaged.
>
> **Failure to follow this instruction can result in injury or equipment damage.**

The drive controller must be thoroughly inspected before it is stored or installed. Upon receipt:

a. Remove the drive controller from its packaging and visually inspect the exterior for shipping damage.
b. Ensure that the class, type, and MOD specified on the drive controller nameplate agree with the packaging slip and corresponding purchase order.
c. If you find any shipping damage, notify the carrier and your sales representative.
d. If you plan to store the drive controller after receipt, replace it in its original packaging material and observe storage temperature specifications in Table 7 on page 19.

> ### ⚠ CAUTION
> **DAMAGE TO INSULATED PARTS IN AIR DUCT**
>
> - Protect the air duct at the rear of the enclosure from entry of foreign material.
> - Do not place loose objects on top of the enclosure.
> - Do not block air flow from the duct.
>
> **Failure to follow these instructions can cause breaker trip, resulting in process shutdown or equipment damage.**

Before installation:

1. Open the door of the drive controller. To open the door, turn the circuit breaker and handle assembly to the Off position as shown in the illustration at left. Pinch the handle (**A**) and handle latch (**B**) together and jiggle the assembly if necessary to open the door.
2. Visually verify that all internal mounting and terminal connection hardware is properly seated, securely fastened, and undamaged.
3. Visually verify that the control board on the power converter is properly seated, securely fastened, and undamaged. Verify that the internal wiring connections are tight. Inspect all connections for damage.
4. Close and secure the drive controller door.

HANDLING THE DRIVE CONTROLLER

⚠ WARNING

HANDLING AND LIFTING HAZARD

Keep the area below any equipment being lifted clear of all personnel and property. Use the lifting method shown in Figure 8.

Failure to follow this instruction can result in death, serious injury, or equipment damage.

Drive controllers are shipped on a pallet on their back. To avoid damage, do not stack drive controllers on top of each other. Store the drive controller in its original packaging until it is at the final installation site. The packaging protects the drive controller and prevents damage to its exterior.

Handle the drive controller carefully to avoid damage to the internal components, frame, or exterior. When handling a drive controller, balance it carefully to keep it from tipping. After removing packaging materials, drive controllers require some type of mechanical lifting.

When handling drive controllers:

- Always work with another person. The weight, size, and shape of the drive controller is such that two people are required to handle it.
- Use gloves.
- Attach a spreader bar to the two top lifting holes on the drive controller back panel (see Figure 5 on page 25 for location of lifting holes) and hoist the controller with chains or straps. See Figure 8 for the proper hoisting method.
- Raise the drive controller from a horizontal position (i.e., the back of the controller resting on a pallet).
- Place the drive controller in an upright position. Note: The bottom of the drive controller is on an angle.
- Mount the drive controller on a flat, solid, noncombustible vertical surface.
- Secure all four corners of the controller with hardware of a sufficient size and type for the controller weight.

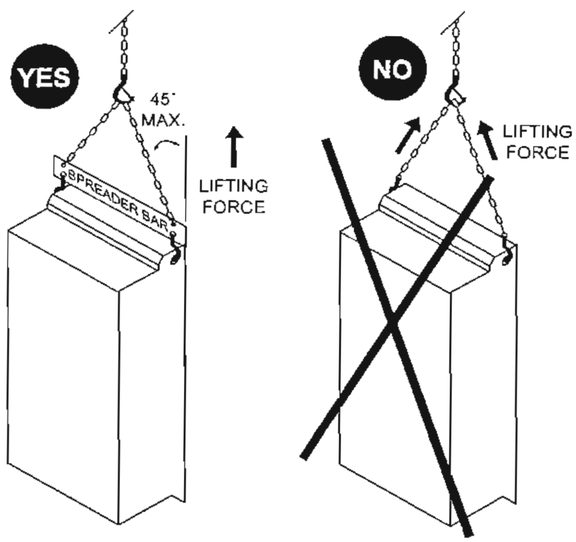


Figure 8: Hoisting Class 8839 ECONOFLEX Drive Controllers

INSTALLATION

Mechanical Installation

Refer to Table 7 on page 19 for Specifications.

- The Type 1 or 12K controller must be mounted vertically against a solid, flat surface to allow for proper ventilation.
- If drilling for conduit entry, exercise care to prevent metal chips from falling on parts and electronic printed wiring boards.
- See Figure 5 on page 25, Figure 6 on page 26, Figure 7 on page 27 for mounting dimensions, mounting clearances, conduit entry areas, and controller weights.
- Do not mount the drive controller on hot surfaces.
- Do not mount the Type 1 or 12K drive controllers in direct sunlight.

Electrical Installation

⚠ DANGER

HAZARDOUS VOLTAGE

Turn off all power (main and remote) before installing the equipment.

Failure to follow this instruction will result in death or serious injury.

General Wiring Practices

Before wiring, perform the bus voltage measurement procedure on page 40. Good wiring practice requires the separation of control circuit wiring from all power wiring. Power wiring to the motor must have the maximum possible separation from all other power wiring, whether from the same drive controller or other drive controllers. **Do not run power and/or control or multiple power wiring in the same conduit.** This separation reduces the possibility of coupling electrical transients from power circuits into control circuits or from motor power wiring into other power circuits.

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

Follow the wiring practices described in this document in addition to those already required by the National Electrical Code and local codes.

Failure to follow this instruction can result in injury or equipment damage.

Follow the practices below when wiring the Class 8839 ECONOFLEX drive controller:

- Use metallic conduit for all drive controller wiring. Do not run control and power wiring in the same conduit.
- Separate metallic conduits carrying power wiring or low-level control wiring by at least 3 inches (76 mm).
- Separate existing, non-metallic conduits or cable trays used to carry power wiring from metallic conduit carrying low-level control wiring by at least 12 inches (305 mm).
- Whenever power and control wiring cross, the metallic conduits and non-metallic conduits or trays must cross at right angles.
- Equip all inductive circuits near the controller (relays, contactors, solenoid valves) with noise suppressors or connect them to a separate circuit.

Input Power

The Class 8839 ECONOFLEX drive controller operates from a three-phase, 460 Vac ± 10%, 230 Vac ±10%, or 208 Vac ± 10% 60 Hz ± 5% supply connected to the input circuit breaker disconnect. The circuit breaker disconnect is coordinated and tested with the controller power circuit for a short circuit rating of 5 KAIC for 1–50 hp and 10 KAIC for 60–100 hp. When modification G09 is selected, the circuit breaker disconnect is coordinated and tested with the controller power circuit for a short circuit rating of 22 KAIC.

Branch Circuit Connections

All branch circuit components and equipment (such as feeder cables, disconnect devices, and protective devices) must be rated for the maximum input current of the Class 8839 ECONOFLEX drive controller, not the FLA of the motor. The drive controller input current is stamped on the nameplate. Refer to Tables 4, 5, and 6 on pages 17–18 for drive controller input currents.

Connect input power leads L1, L2, and L3 to the input of the circuit breaker. Refer to Figure 3 (page 13) or Figure 4 (page 14) or Figures 14–17 (pages 44–47) for location. Refer to Tables 22, 23, and 24 (pages 48–50) for lug data and wire size range for drive controller input terminals L1, L2 and L3.

⚠ WARNING

IMPROPER OVERCURRENT COORDINATION

- Protective devices must be properly coordinated.
- Do not connect the drive controller to a power feeder whose short circuit capacity exceeds the short circuit rating listed on the drive controller nameplate.

Failure to follow this instruction can result in death or serious injury.

⚠ CAUTION

IMPROPER WIRING

- Do not connect input power leads to the drive controller output terminals (T1, T2, T3 or U, V, W). This damages the controller and voids the warranty.
- Check the power connections before energizing the controller.

Failure to follow this instruction can result in injury or equipment damage.

Grounding

Ground the drive controller according to the National Electrical Code and all local codes. To ground the drive controller:

- Connect a copper wire from the ground bar terminal to the power system ground.
- Verify that the resistance to ground is 1 Ω or less. Improper grounding causes intermittent and unreliable operation.

⚠ DANGER

HAZARDOUS VOLTAGE

- Ground equipment using the provided ground connection point as shown in Figures 14–17 starting on page 44. The drive controller panel must be properly grounded before power is applied.
- Do not use metallic conduit as a ground conductor.

Failure to follow this instruction will result in death or serious injury.

Ground multiple drive controllers as shown in Figure 9. Use one grounding conductor per device. Do not loop ground conductors or install them in series.

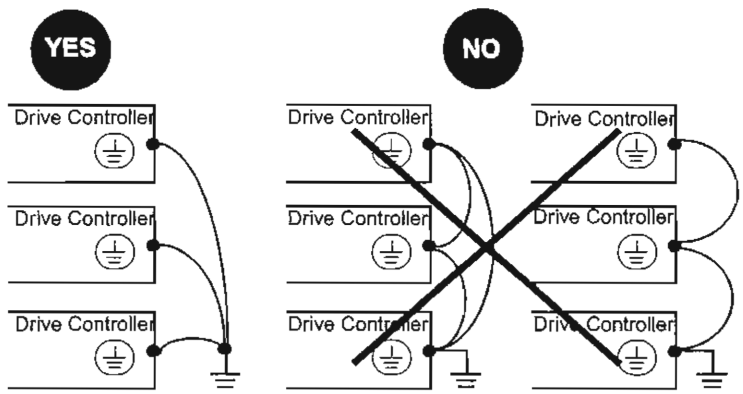


Figure 9: Grounding Multiple Drive Controllers

Output Wiring

The ampacity of motor power conductors should be sized according to the motor full load current, National Electrical Code, and applicable local codes.

Connect motor conductors to the lugs provided and connect the motor ground to the ground bar provided. Connect motor conductors to T1, T2, and T3 on the overload relay when the controller is supplied with a bypass circuit. Connect motor conductors to U, V, and W on the power converter when the controller is supplied without a bypass circuit. See Figure 3 (page 13) or Figure 4 (page 14) and Figures 14–17 starting on page 44 for location. See Tables 22, 23, and 24 (pages 48–50) for lug data and wire size range. Refer to the nameplate for torque requirements.

The drive controller is sensitive to the amount of capacitance (either phase-to-phase or phase-to-ground) present on the output power conductors. If excessive capacitance is present, the drive controller may trip on overcurrent.

Output Cable

Follow the guidelines below when selecting output cable:

- Cable type: the cable selected must have a low capacitance phase-to-phase and to ground. Do not use mineral-impregnated cable because it has a very high capacitance. Immersion of cables in water increases capacitance.
- Cable length: the longer the cable, the greater the capacitance. Cable lengths greater than 100 ft (30.5 m) may cause ground faults. For installation where cable capacitances may be a problem, a reactor can be installed between the drive controller and the motor.
- Proximity to other output cables: because of high frequency switching and increased capacitance, the drive controller may fault under some conditions.
- **Do not use lightning arrestors or power factor correction capacitors on the output of the drive controller.**

A minimum inductance is needed to protect the drive controller output from short circuits. Provide at least 20 in. (500 mm) of cable at the drive controller output (U, V, and W for a controller without bypass or T1, T2, and T3 for a controller with bypass).

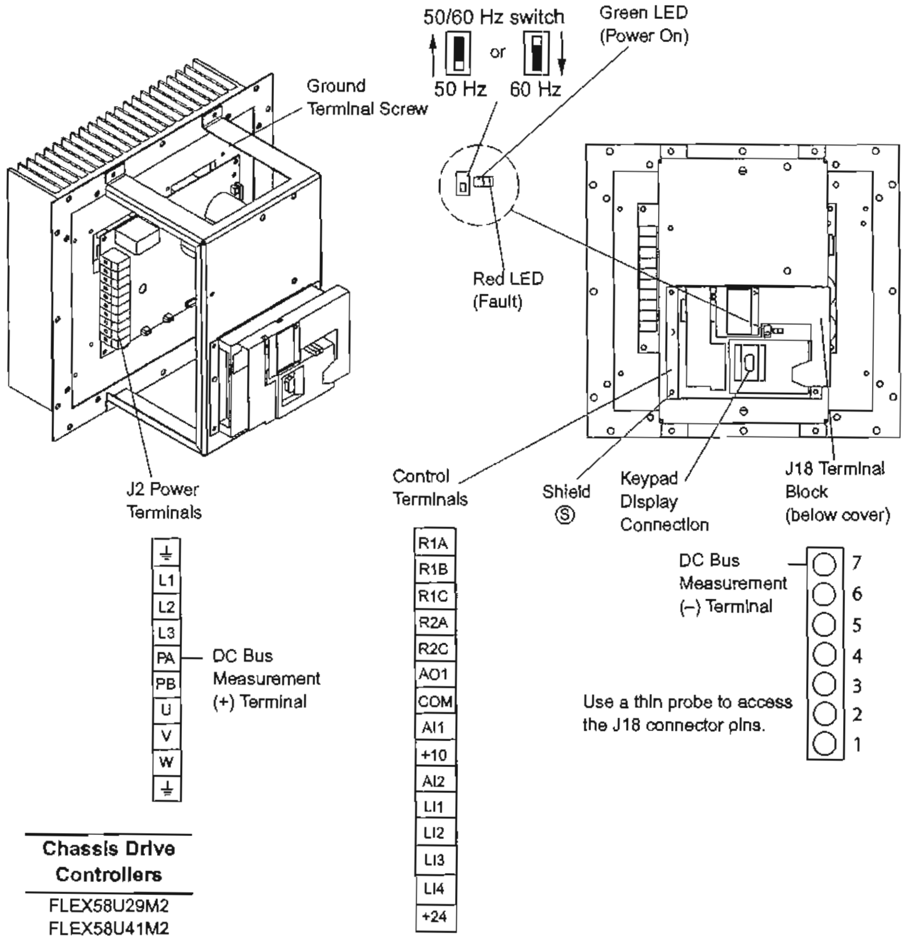
⚠ CAUTION

INSUFFICIENT OUTPUT INDUCTANCE

For proper drive controller short circuit protection, certain values of inductance may be required in the output power wiring. Inductance can be supplied by the power wiring or auxiliary inductors.

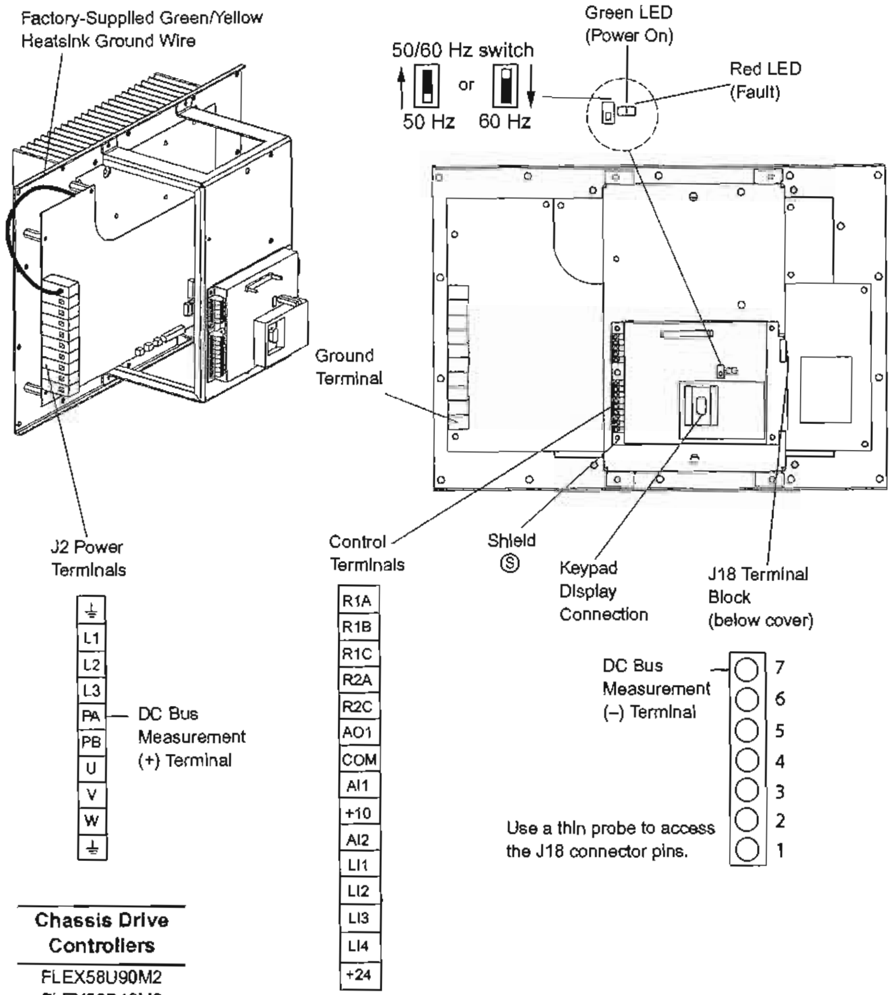
Failure to follow this instruction can result in injury or equipment damage.

DC Bus Voltage Measurement Terminal Locations



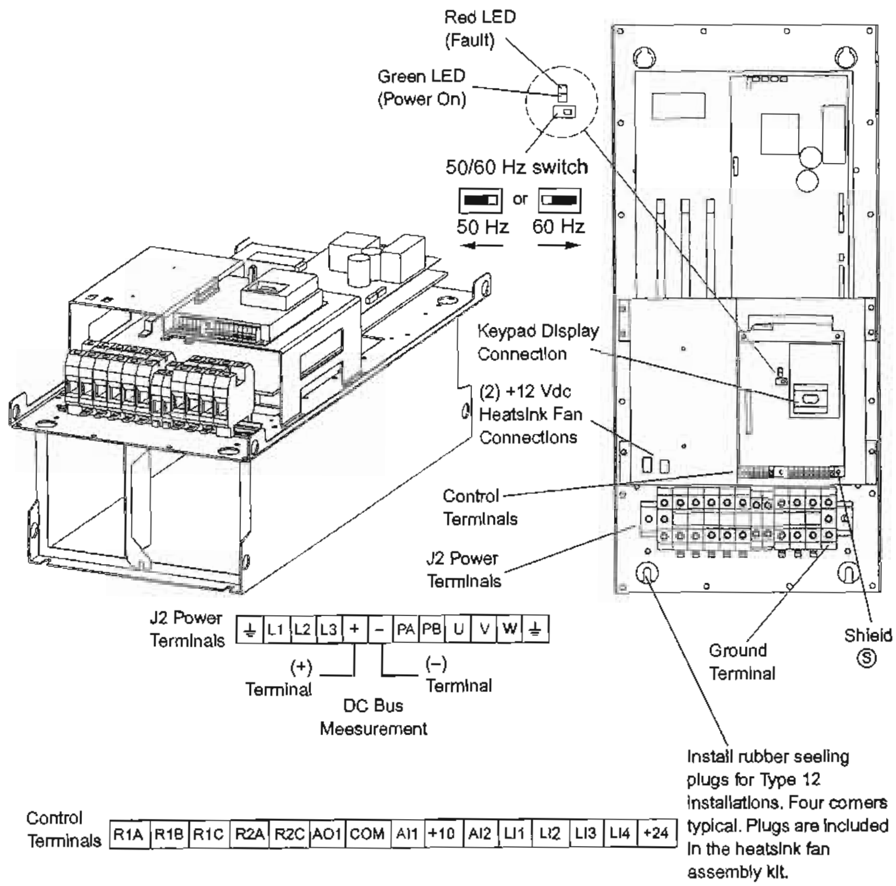
Chassis Drive Controllers
FLEX58U29M2
FLEX58U41M2
FLEX58U72M2
FLEX58KU18N4
FLEX58KU29N4
FLEX58KU41N4
FLEX58KU54N4
FLEX58KU72N4

Figure 10: FLEX58U29M2–U72M2 and FLEX58KU18N4–KU72N4



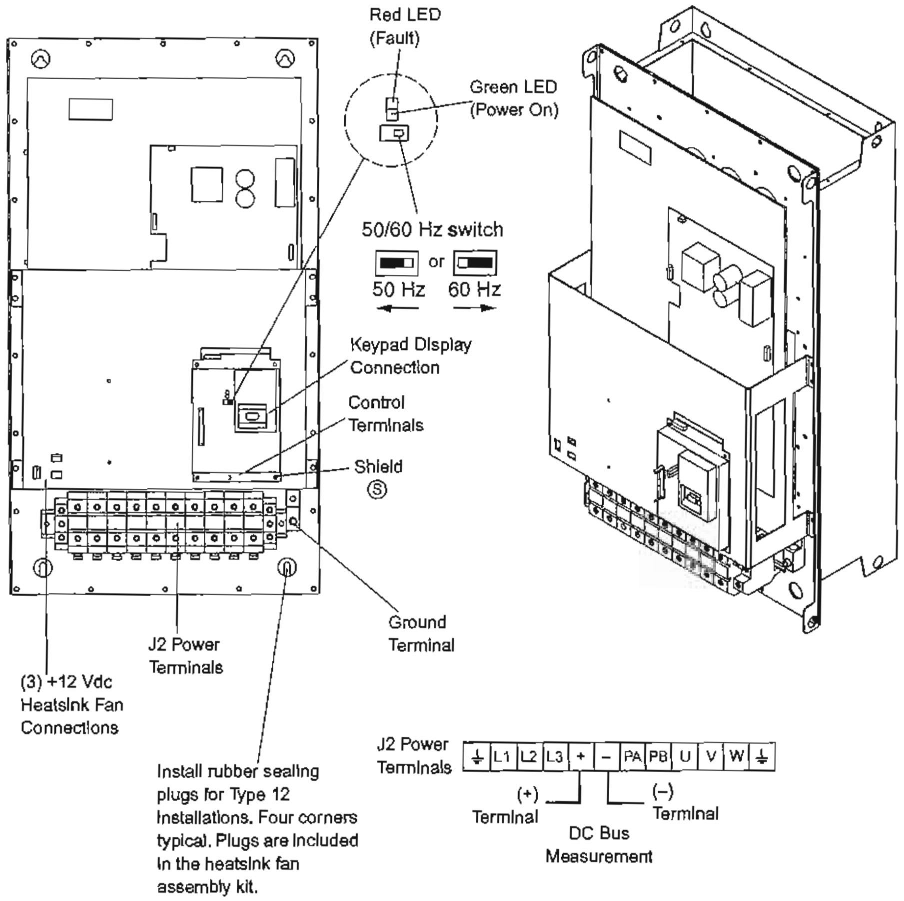
Chassis Drive Controllers
FLEX58U90M2
FLEX58D12M2
FLEX58KU90N4
FLEX58KD12N4
FLEX58KD16N4
FLEX58KD23N4

Figure 11: FLEX58U90M2, FLEX58D12M2, and FLEX58KU90N4–KD23N4



Chassis Drive Controllers
FLEX58D16M2
FLEX58D23M2
FLEX58KD28N4
FLEX58KD33N4
FLEX58KD46N4

Figure 12: FLEX58D16M2, FLEX58D23M2, and FLEX58KD28N4–KD46N4



Chassis Drive Controllers
FLEX58D28M2
FLEX58D33M2
FLEX58D46M2
FLEX58KD54N4
FLEX58KD64N4
FLEX58KD79N4

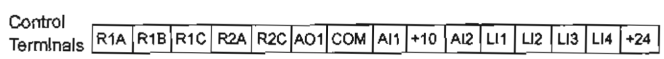


Figure 13: FLEX58D28M2–D46M2 and FLEX58KD54N4–KD79N4

DC Bus Voltage Measurement Procedure

⚠ DANGER

HAZARDOUS VOLTAGE

- Read and understand the Bus Voltage Measurement Procedure before performing the procedure. Measurement of bus capacitor voltage must be performed by qualified personnel.
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Failure to follow this instruction will result in death or serious injury.

The DC bus voltage level is determined by monitoring the (+) and (–) measurement points. Their location varies by power converter model number as listed in Table 18. The power converter model number is listed on its nameplate.

Table 18: (+) and (–) Measurement Points

FLEX58 Power Converter		Refer to Figure	(+) Measurement Point		(–) Measurement Point	
208/230 V	460 V		Terminal Block or Connector	Terminal Designation	Terminal Block or Connector	Terminal Designation
FLEX58U29M2 FLEX58U41M2 FLEX58U72M2	FLEX58KU18N4 FLEX58KU29N4 FLEX58KU41N4 FLEX58KU54N4 FLEX58KU72N4	10 on page 36	J2	PA	J18	7
FLEX58U90M2 FLEX58D12M2	FLEX58KU90N4 FLEX58KD12N4 FLEX58KD16N4 FLEX58KD23N4	11 on page 37				
FLEX58D16M2 FLEX58D23M2	FLEX58KD28N4 FLEX58KD33N4 FLEX58KD46N4	12 on page 38	J2	(+)	J2	(-)
FLEX58D28M2 FLEX58D33M2 FLEX58D46M2	FLEX58KD54N4 FLEX58KD64N4 FLEX58KD79N4	13 on page 39				

To measure the DC bus capacitor voltage:

1. Observe the lockout/tagout procedures as identified in OSHA Standard 29 CFR, Subpart J covering:
   — 1910.147: The control of hazardous energy (lockout/tagout).
   — 1910.147: App A, Typical minimal lockout procedures.
2. Open the disconnect between the input line and the drive controller. Lock the disconnect in the open position and install a "Do Not Turn On" sign. Open the circuit breaker disconnect located on the front of the drive controller. Also, be sure to remove all external control power that may be present such as on the control board and the option board terminals.
3. Wait three minutes for the DC bus capacitors to discharge.
4. Read the model number of the power converter from the nameplate, and identify the corresponding (+) and (–) measurement points from Table 18 and Figures 10 to 13 on pages 36 to 39.
5. Open the door of the power converter.

6. Set the voltmeter to the 1000 Vdc scale. Measure the voltage between the (+) and (–) measurement points identified in step 4.
7. Verify that the DC bus voltage has discharged below 45 V before servicing the drive controller. If the DC bus capacitors will not discharge below 45 V, contact your local Square D representative. **Do not operate the drive controller.**
8. After servicing the drive controller, close and secure door.

Wire Routing and Interconnection

Wire Class

The Wire Class describes the compatibility of the field wiring terminal with the conductor material and insulation system. When used in conjunction with the required conductor current rating and controller ambient temperature rating, the Wire Class forms the basis for selecting a conductor size that limits the temperature on the conductor insulation at the field wiring terminal to acceptable limits. Although it is permissible to use conductors with operating temperatures exceeding those given by the Wire Class, conductor **size** must fall within the Wire Class limits.

Noise Class

The Noise Class categorizes the electromagnetic properties of the voltages and currents present. The Noise Class is comprised of the six categories shown in Table 19.

Table 19: Noise Class Categories

Noise Class	Definition
Quiet Wiring 1 (QW1)	High susceptibility analog and digital control signals. Signals falling under this classification include digital communication/network circuits, controller analog I/O and analog process signals.
Quiet Wiring 2 (QW2)	Medium susceptibility, analog and digital control signals. Signals falling under this classification include 24 Vdc and Vac control circuits.
Standard Wiring 1 (SW1)	Low susceptibility control or power circuits rated less than 600 Vac (250 Vdc) and less than 15 A (voltage and current spectra are generally contained within 0.05–9 kHz). Signals falling under this classification include 120 Vac control circuits.
Standard Wiring 2 (SW2)	Power circuits rated greater than 15 A (voltage and current spectra are generally contained within 0.05–9 kHz). Signals falling under this classification include line power to controllers.
Standard Wiring 3 (SW3)	Reserved.
Pulse Wiring 1 (PW1)	Control or power circuits whose voltage or current spectra significantly exceed 9 kHz. Signals falling under this classification include motor and dynamic braking circuits fed from PWM power converters.

Voltage Class

The Voltage Class categorizes the voltages present into recognized conductor insulation categories (30, 150, 300, and 600 V) for selection of the conductor voltage rating and physical segregation purposes.

Wiring Methods

Based upon the Noise Class and Voltage Class of the conductors, apply the wiring methods in Table 20 to the drive system.

Table 20: Wire Routing and Interconnection

Wiring Methods and Considerations	Noise Class of Conductors				
	QW1	QW2	SW1	SW2	PW1
Conductor Grouping in Wireways/Conduits 1. All conductors of 1 or 3 phase AC power circuits must be bundled to minimize stray magnetic fields.			X	X	X
2. All conductors of a DC power circuit must be bundled to minimize stray magnetic fields.			X	X	X
3. When paralleled conductors must be run in separate wireways or conduit, bundle conductors into groups that minimize stray magnetic fields.				X	X
4. Maintain conductor runs as short and direct as practical.	X	X	X	X	X
Separation of Circuits 1. DO NOT run different Noise Class conductors in the same conduit.	X	X	X	X	X
2. DO NOT run different Voltage Class conductors in same conduit unless all conductors are insulated for the maximum Voltage Class present.	X	X	X	X	X
3. All PW conductor groups must be individually segregated using metallic conduit.					X
4. Segregate all conductors by Noise Class. Use the following circuit separation when conductors can run parallel for more than 12 in.					
• Metallic conduit: 3 in. between QW to SW/PW	X	X	X	X	X
• Metallic tray: 3 in. between SW to PW			X	X	X
• Metallic tray: 6 in. between QW to SW/PW	X	X	X	X	X
• Against continuous metal surface: 3 in. between SW to PW			X	X	X
• Against continuous metal surface: 6 in. between QW to SW/PW	X	X	X	X	X
• Metallic conduit housing QW: 12 in. to non-metallic conduit SW/PW	X	X	X	X	X
• Non-metallic conduit: 3 in. between SW to PW			X	X	X
• Non-metallic conduit: 24 in. between QW to SW/ PW	X	X	X	X	X
5. If QW and SW1 wiring must cross SW2 or PW1 wiring, the bundles must cross at right angles.	X	X	X	X	X
Common Mode Noise Issues 1. Provide adjacent signal returns using twisted pair cable.	X	X			
2. Galvanically isolate signal and associated signal return path when possible.	X	X			
Shielding 1. Use metallic conduit for all power and control circuits external to the controller enclosure.	X	X	X	X	X
2. Shields should be continuous and equipped with a drain wire.	X	X	X		
3. DO NOT group different Noise Class conductors within the same shield.	X	X	X	X	X
4. Minimize non-shielded portion of conductor at the ends of shielded cable.	X	X	X	X	X
5. When shielding AC or DC power conductors, group conductors to minimize magnetic field in shield.			X	X	X
Grounding 1. Ground shields only at the controller end.	X	X	X	X	X
2. Use separate ground wire for each shield ground.	X	X	X	X	X
3. Provide a ground wire with all conductor groups whether in tray or conduit.			X	X	X
4. When multiple grounds must be made to a shielded power cable, the shield must have the same short circuit withstand capability as the ground conductor in the power cable.			X	X	X
5. Terminate all power grounds and power shield grounds to the controller grounding point or bar.			X	X	X
6. Terminate all signal shield grounds to the terminals provided.	X	X			
7. Always supply a separate equipment grounding conductor with the controller power feed. DO NOT depend upon metallic conduit for ground connection.			X	X	X

Component Identification and Terminal Strip Locations

NOTE: Typical device shown with options. Type 3R ventilation fan and space heater not shown.

Figure 14 shows component identification and terminal strip locations for Class 8839 ECONOFLEX drive controllers 1–7.5 hp at 460 V and 1–5 hp at 208/230 V. Tables 22, 23, and 24 (pages 48–50) list wire size range and terminal torque requirements.

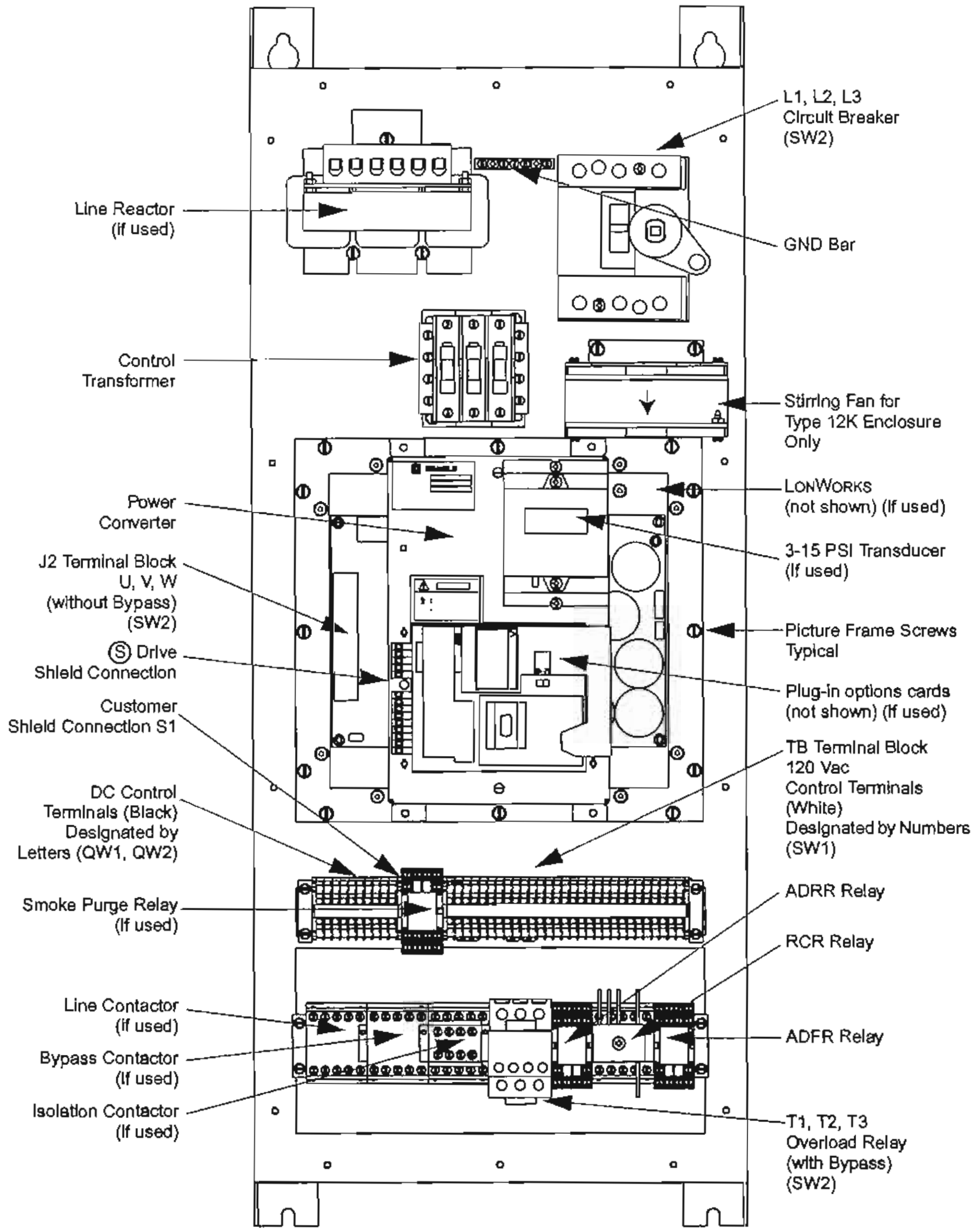


Figure 14: Component Identification and Terminal Strip Locations for 1–7.5 HP @ 460 V and 1–5 HP @ 208/230 V

Figure 15 shows component identification and terminal strip locations for Class 8839 ECONOFLEX drive controllers 10–25 hp at 460 V and 7.5–10 hp at 208/230 V. Tables 22, 23, and 24 (pages 48–50) list wire size range and terminal torque requirements.

NOTE: Typical device shown with options. Type 3R ventilation fan and space heater not shown.

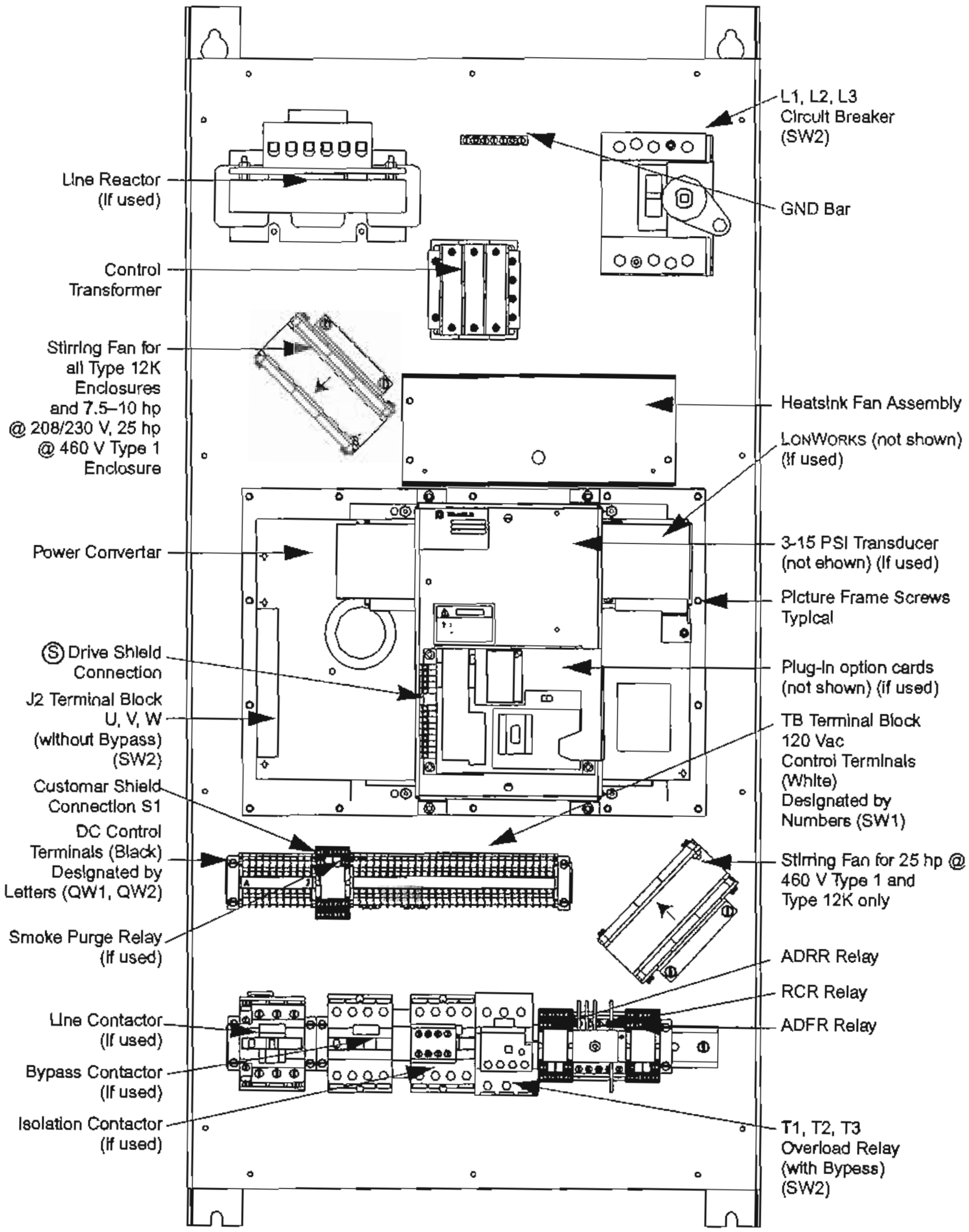


Figure 15: Component Identification and Terminal Strip Locations for 10–25 HP @ 460 V and 7.5–10 hp @ 208/230 V

Figure 16 shows component identification and terminal strip locations for Class 8839 ECONOFLEX drive controllers 30–50 hp at 460 V and 15–25 hp at 208/230 V. Tables 22, 23, and 24 (pages 48–50) list wire size range and terminal torque requirements.

NOTE: Typical device shown with options. Type 3R ventilation fan and space heater not shown.

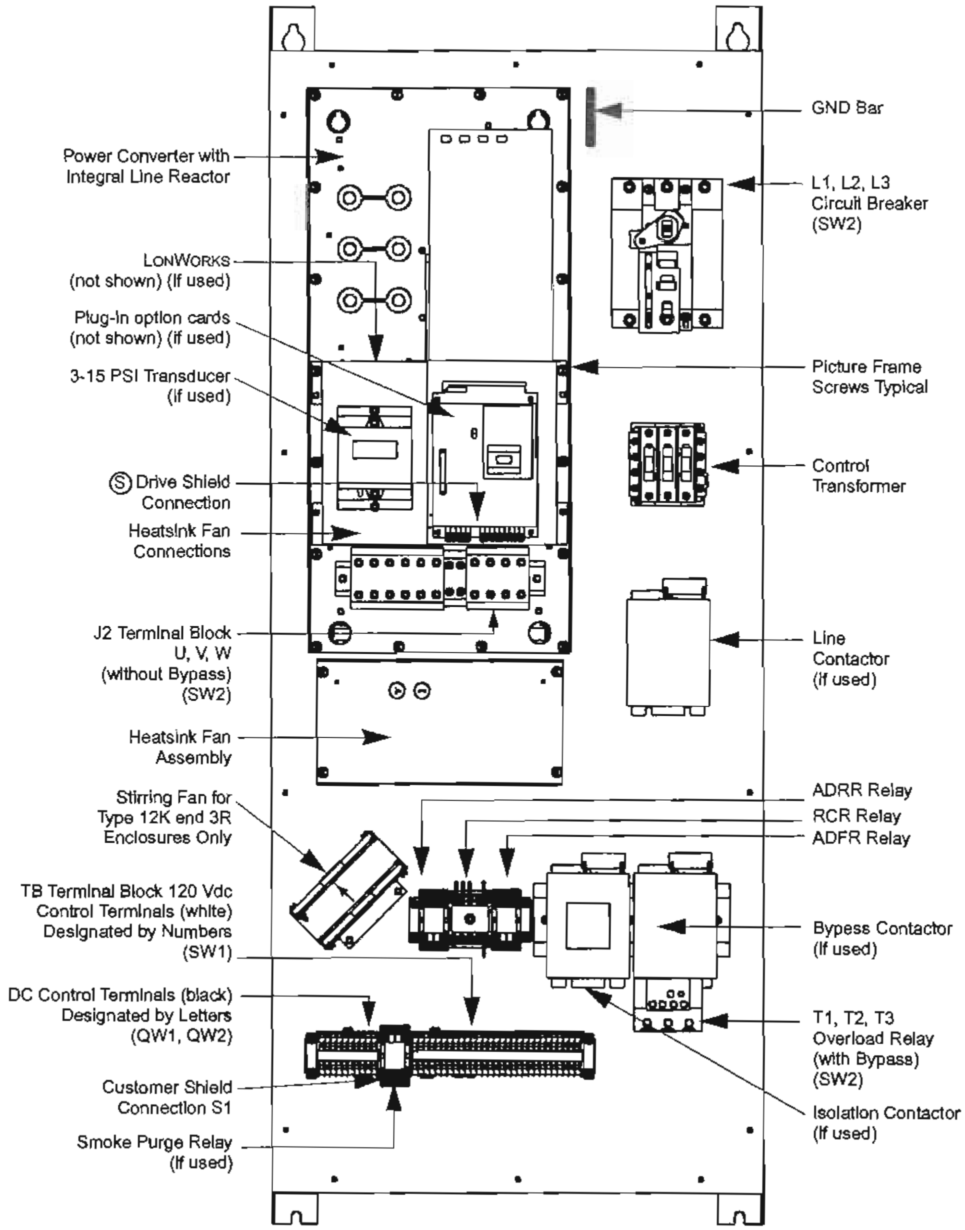


Figure 16: Component Identification and Terminal Strip Locations for 30–50 HP @ 460 V and 15–25 HP @ 208/230 V

Figure 17 shows component identification and terminal strip locations for Class 8839 ECONOFLEX drive controllers 60–100 hp at 460 V and 30–50 hp at 208/230 V. Tables 22, 23, and 24 (pages 48–50) list wire size range and terminal torque requirements.

NOTE: Typical device shown with options. Type 3R ventilation fan and space heater not shown.

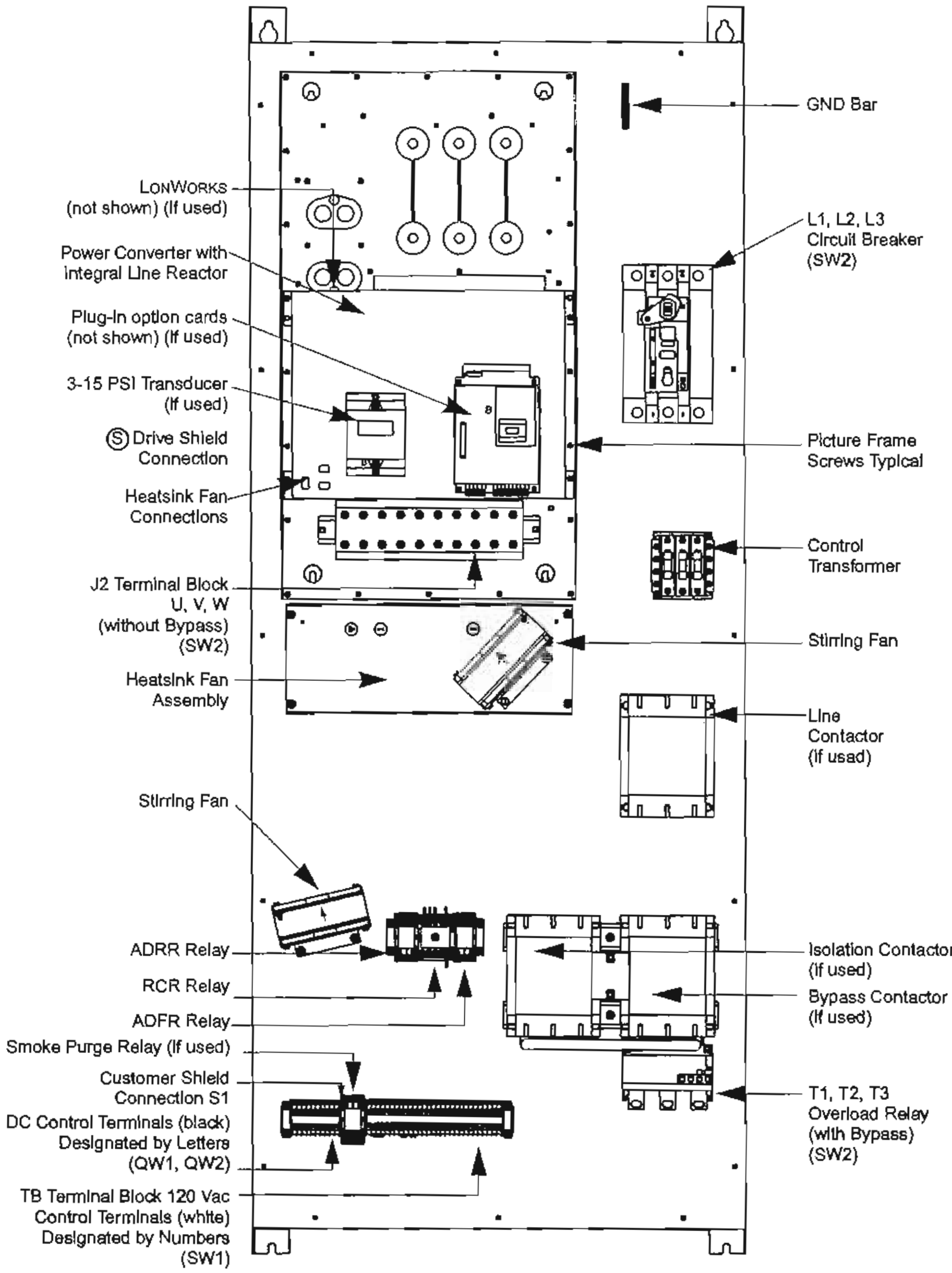


Figure 17: Component Identification and Terminal Strip Locations for 60–100 HP @ 460 V and 30–50 HP @ 208/230 V

Power Wiring

Table 21: Power Terminal Functions

Terminal	Function
GND	(Ground Bar)
L1 L2 L3	3-phase input power supply (at top of circuit breaker)
T1 T2 T3	Output connections to motor for controller with bypass (at bottom of overload relay)
U V W	Output connections to motor for controller without bypass (power converter output J2 terminal)

Table 22: Power Terminal Wire Range, 460 V

		Terminals					
		Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)
Power Circuit W (Without Bypass)[1]	HP	L1, L2, L3 (Line)		U, V, W (Load)		GND Bar	
58EC•4VW_	1	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58ED•4VW_	2	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EE•4VW_	3	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EF•4VW_	5	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EG•4VW_	7.5	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EH•4VW_	10	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EJ•4VW_	15	1/0 (53.5)	50 (5.65)	8 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EK•4VW_	20	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EL•4VW_	25	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EM•4VW_	30	1/0 (53.5)	50 (5.65)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EN•4VW_	40	1/0 (53.5)	80 (9.04)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EP•4VW_	50	1/0 (53.5)	80 (9.04)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EQ•4VW_	60	1/0 (53.5)	80 (9.04)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58ER•4VW_	75	350 (177)	250 (26.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58ES•4VW_	100	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
Power Circuit Y (Bypass)[1]	HP	L1, L2, L3 (Line)		T1, T2, T3 (Load)		GND Bar	
58EC•4VY_	1	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58ED•4VY_	2	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EE•4VY_	3	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EF•4VY_	5	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EG•4VY_	7.5	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EH•4VY_	10	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EJ•4VY_	15	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EK•4VY_	20	1/0 (53.5)	50 (5.65)	6 (13.3)	15 (1.69)	4 (21.15)	20 (2.26)
56EL•4VY_	25	1/0 (53.5)	50 (5.65)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EM•4VY_	30	1/0 (53.5)	50 (5.65)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
56EN•4VY_	40	1/0 (53.5)	80 (9.04)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EP•4VY_	50	1/0 (53.5)	80 (9.04)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EQ•4VY_	60	1/0 (53.5)	80 (9.04)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58ER•4VY_	75	350 (177)	250 (28.25)	250 (127)	300 (33.9)	4 (21.15)	20 (2.26)
58ES•4VY_	100	350 (177)	250 (26.25)	250 (127)	300 (33.9)	4 (21.15)	20 (2.26)

[1] "•" can be "A","G" or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes a Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.
[2] 75 °C copper.

Notes to Table 23:

[1] "•" can be "A","G" or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes a Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.

[2] 75 °C copper.

Table 23: Power Terminal Wire Range, 230 V

		Terminals					
		Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm²)[2]	Terminal Torque lb-in (N•m)
Power Circuit W (Without Bypass)[1]	HP	L1, L2, L3 (Line)		U, V, W (Load)		GND Bar	
58EC•3VW_	1	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58ED•3VW_	2	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EE•3VW_	3	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EF•3VW_	5	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EG•3VW_	7.5	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EH•3VW_	10	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EJ•3VW_	15	1/0 (53.5)	50 (5.65)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EK•3VW_	20	1/0 (53.5)	50 (5.65)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EL•3VW_	25	1/0 (53.5)	80 (9.04)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EM•3VW_	30	1/0 (53.5)	80 (9.04)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58EN•3VW_	40	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58EP•3VW_	50	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
Power Circuit Y (Bypass)[1]	HP	L1, L2, L3 (Line)		T1, T2, T3 (Load)		GND Bar	
58EC•3VY_	1	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58ED•3VY_	2	1/0 (53.5)	50 (5.85)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EE•3VY_	3	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EF•3VY_	5	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EG•3VY_	7.5	1/0 (53.5)	50 (5.65)	6 (13.3)	15 (1.69)	4 (21.15)	20 (2.26)
58EH•3VY_	10	1/0 (53.5)	50 (5.65)	6 (13.3)	15 (1.69)	4 (21.15)	20 (2.26)
58EJ•3VY_	15	1/0 (53.5)	50 (5.65)	8 (13.3)	75 (8.47)	4 (21.15)	20 (2.26)
58EK•3VY_	20	1/0 (53.5)	50 (5.65)	6 (13.3)	75 (8.47)	4 (21.15)	20 (2.26)
58EL•3VY_	25	1/0 (53.5)	80 (9.04)	6 (13.3)	75 (8.47)	4 (21.15)	20 (2.26)
58EM•3VY_	30	1/0 (53.5)	80 (9.04)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)
58EN•3VY_	40	350 (177)	250 (28.25)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)
58EP•3VY_	50	350 (177)	250 (28.25)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)

Notes to Table 24:

[1] "•" can be "A","G" or "H". "A" denotes a Type 12K enclosure; "G" denotes a Type 1 enclosure; "H" denotes a Type 3R enclosure. "_" indicates that the catalog number continues. See page 10 for a detailed description of catalog numbers.

[2] 75 °C copper.

Table 24: Power Terminal Wire Range, 208 V

		Terminals					
		Maximum Wire Size AWG (mm^2)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm^2)[2]	Terminal Torque lb-in (N•m)	Maximum Wire Size AWG (mm^2)[2]	Terminal Torque lb-in (N•m)
Power Circuit W (Without Bypass)[1]	HP	L1, L2, L3 (Line)		U, V, W (Load)		GND Bar	
58EC•2VW_	1	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58ED•2VW_	2	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EE•2VW_	3	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EF•2VW_	5	1/0 (53.5)	50 (5.65)	8 (8.37)	7.5 (0.85)	4 (21.15)	20 (2.26)
58EG•2VW_	7.5	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EH•2VW_	10	1/0 (53.5)	50 (5.65)	6 (13.3)	20 (2.26)	4 (21.15)	20 (2.26)
58EJ•2VW_	15	1/0 (53.5)	50 (5.65)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EK•2VW_	20	1/0 (53.5)	80 (9.04)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EL•2VW_	25	1/0 (53.5)	80 (9.04)	2/0 (67.4)	88 (9.94)	4 (21.15)	20 (2.26)
58EM•2VW_	30	1/0 (53.5)	80 (9.04)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58EN•2VW_	40	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
58EP•2VW_	50	350 (177)	250 (28.25)	4/0 (107.2)	170 (19.21)	4 (21.15)	20 (2.26)
Power Circuit Y (Bypass)[1]	HP	L1, L2, L3 (Line)		T1, T2, T3 (Load)		GND Bar	
58EC•2VY_	1	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58ED•2VY_	2	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EE•3VY_	3	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EF•2VY_	5	1/0 (53.5)	50 (5.65)	10 (5.26)	15 (1.69)	4 (21.15)	20 (2.26)
58EG•2VY_	7.5	1/0 (53.5)	50 (5.65)	6 (13.3)	15 (1.69)	4 (21.15)	20 (2.26)
58EH•2VY_	10	1/0 (53.5)	50 (5.65)	6 (13.3)	15 (1.69)	4 (21.15)	20 (2.26)
56EJ•2VY_	15	1/0 (53.5)	50 (5.65)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EK•2VY_	20	1/0 (53.5)	80 (9.04)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EL•2VY_	25	1/0 (53.5)	80 (9.04)	1/0 (53.5)	75 (8.47)	4 (21.15)	20 (2.26)
58EM•2VY_	30	1/0 (53.5)	80 (9.04)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)
58EN•2VY_	40	350 (177)	250 (28.25)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)
58EP•2VY_	50	350 (177)	250 (28.25)	3/0 (85)	200 (22.6)	4 (21.15)	20 (2.26)

Notes to Table 25 and Table 26:

[1] See the Control Circuit Elementary Diagrams in chapter 5.

[2] All terminals are rated 600 V, 30 A (Class 9080 Type GM6). Max. wire size for all terminals:
10 AWG (2.5 mm^2). Tightening Torque: 7–8 lb-in (0.8–0.9 N•m).

Table 25: Analog Output (MOD H09)

Terminal[1][2]	Function	Characteristics
AO	Analog output programmed for motor frequency	0–20 mA Z=500 Ω Reassignable x–y range with keypad
COM	Common for analog output	0 V

Table 26: 0–10 V Auto Speed Reference (MOD J09), Signal Converter Board 31158-297-50

Terminal[1][2]	Function (Differential)	Characteristics
G1, S2+	AI2A+ Input	0–10 V, Z = 40 kΩ
G2, S2–	AI2B– Input	

Control Wiring

NOTE: Refer to Table 25 for characteristics of the analog output available with MOD H09.

Table 27: Terminal Block Characteristics

Terminal[1] [2]	Function	Characteristics
A	+24 V (+24 V control supply)	Minimum: 20 V; Maximum: 30 V; I = 140 mA maximum[5]
B	LI3 (Logic Input 3) programmed for reference switching Auto/Manual	24 Vdc, 10 mA State 0: V<5 V; State 1: V>11 V; Z = 3.5 kΩ
C	LI4 (Logic Input 4) programmed for fault reset. Communication option programmed for forced local.	24 Vdc, 10 mA State 0: V<5 V; State 1: V>11 V; Z = 3.5 kΩ
D	LI2 (Logic Input 2) programmed for Freewheel Stop on bypass. Without bypass not assigned.	24 Vdc, 10 mA State 0: V<5 V; State 1: V>11 V; Z = 3.5 kΩ
E F	Line contactor auxiliary contact or jumper LI1 (Logic Input 1) Run Forward	24 Vdc, 10 mA State 0: V<5 V; State 1: V>11 V; Z = 3.5 kΩ
G1, S2+	AI2 (Analog Input 2: Speed Reference Current)	4-20 mA[6], Z = 100 Ω
G2, S2–	Factory jumpered to G1, S2+ terminal unless 0–10 V Auto speed reference option selected. See Table 26 on page 51.	
H	+10 V Reference Supply	10 V, I = 10 mA maximum
I	AI1 (Analog Input 1: Speed Reference Voltage)	0–10 V, Z = 30 kΩ
J, S3	COM (Speed Reference Common)	0 V
S1	Shield	
1 2	Fire/Freezestat Interlocks	Provision for user-supplied, N.C. fire/freezestat contact.
2	Control Transformer (Ungrounded)	115 Vac, 60 Hz, [100 VA Type 1, 12K[8] 350 VA Type 3R[9]]
2 3	Smoke Purge Relay Contact[7]	Normally-jumpered or N.C. SPR contact when option is supplied.
3 4	AFC Select[7]	Supplied with bypass circuit
3 5	Bypass Select[7]	Supplied with bypass circuit
6 7	Auto Enabled	User-supplied auto start contact (run permissive)
6A 8	Stop push button[7]	
6 8	Start push button and Interlock[7]	
9	AFC Fault Pilot Light[7]	
10A	Auto Pilot Light[7]	
10	AFC Run Pilot Light[7]	
11	Line Contactor Coil[7]	
12 13	Normal Contact of Test-Normal Switch[7]	
14 -15	Bypass Pilot Light[7]	
 16 17 18	AFC Run Contacts [4] Auxiliary N.C. Contact (AFC Run) COM Auxiliary N.O. Contact (AFC Run)	Minimum: 10 mA, 24 Vdc; Maximum: Inductive load of: • 2.0 A @ 120 Vac; maximum 0.10 J/operation, 80 operations/minute • 1.0 A @ 220 Vac; maximum 0.25 J/operation, 25 operations/minute • 2.0 A @ 24 Vac; maximum 0.10 J/operation, 80 operations/minute

Notes to Table 27:

[1] See the Control Circuit Elementary Diagrams in chapter 5.
[2] All terminals are rated 600 V, 30 A (Class 9080 Type GM6). Max. wire size for all terminals: 10 AWG (5.26 mm^2). Tightening Torque: 7–8 lb-in (0.8–0.9 N•m).
[3] Relay coil deenergizes on fault. Contacts are shown in fault mode.
[4] Contact state with drive controller deenergized.
[5] Total current of +24 V internal supply is 140 mA. If more current is required, an external supply must be used.
[6] 0–20 mA, X–Y programmable with keypad display.
[7] Available only when option is provided.
[8] Approximately 45 VA available when all mods selected except L09 LONWORKS. 26 VA when LONWORKS selected.
[9] Approximately 58 VA available when all mods selected except L09 LONWORKS. 38 VA when LONWORKS selected.

Table 27: Terminal Block Characteristics (Continued)

Terminal[1] [2]	Function	Characteristics
 19 20 21	AFC Fault Contacts[3] Auxiliary N.C. Contact (AFC Fault) COM Auxiliary N.O. Contact (AFC Fault)	Minimum: 10 mA, 24 Vdc; Maximum: Inductive load of: • 2.0 A @ 120 Vac; maximum 0.10 J/operation, 80 operations/minute • 1.0 A @ 220 Vac; maximum 0.25 J/operation, 25 operations/minute • 2.0 A @ 24 Vac; maximum 0.10 J/operation, 80 operations/minute
22 23	120 Vac Smoke Purge Relay coil[7]	115–120 Vac/60 Hz supply (user supplied)
24	Control Transformer (Grounded)	115 Vac, 60 Hz

Notes to Table 27:

[1] See the Control Circuit Elementary Diagrams in chapter 5.
[2] All terminals are rated 600 V, 30 A (Class 9080 Type GM6). Max. wire size for all terminals: 10 AWG (5.26 mm^2). Tightening Torque: 7–8 lb-in (0.8–0.9 N•m).
[3] Relay coil deenergizes on fault. Contacts are shown in fault mode.
[4] Contact state with drive controller deenergized.
[5] Total current of +24 V internal supply is 140 mA. If more current is required, an external supply must be used.
[6] 0–20 mA, X–Y programmable with keypad display.
[7] Available only when option is provided.
[8] Approximately 45 VA available when all mods selected except L09 LONWORKS. 26 VA when LONWORKS selected.
[9] Approximately 58 VA available when all mods selected except L09 LONWORKS. 38 VA when LONWORKS selected.

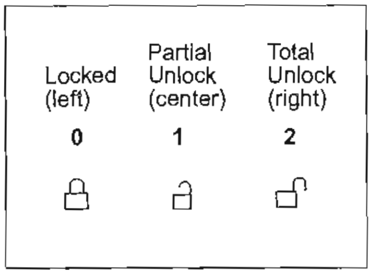
INITIAL START-UP PROCEDURE

⚠ DANGER

HAZARDOUS VOLTAGE

Before working on this equipment, turn off all power supplying it and perform the bus voltage measurement procedure on page 40.

Failure to follow this instruction will result in death or serious injury.



Keypad Access Switch

⚠ DANGER

HAZARDOUS VOLTAGE

- Properly ground the controller panel before applying power.
- Close and secure the enclosure door before applying power.
- Certain adjustments and test procedures require that power be applied to this controller. Extreme caution must be exercised as hazardous voltages exist. The enclosure door must be closed and secured while turning on power or starting and stopping this controller.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

ELECTRIC SHOCK, BURN, OR EXPLOSION

- This equipment must be installed and serviced only by qualified personnel.
- Qualified personnel performing diagnostics or troubleshooting requiring electrical conductors to be energized, must comply with NFPA 70 E - Standard for Electrical Safety Requirements for Employee Workplaces and OSHA Standards – 29 CFR Part 1910 Subpart S Electrical.

Failure to follow this instruction will result in death or serious injury.

The Class 8839 ECONOFLEX drive controller has been configured for the installed options and tested at the factory. Minor adjustments to complete the field installation may be required based upon the application requirements. This initial start-up procedure should be followed step by step. In case of difficulty, refer to Chapter 4, Troubleshooting and Maintenance, on page 74.

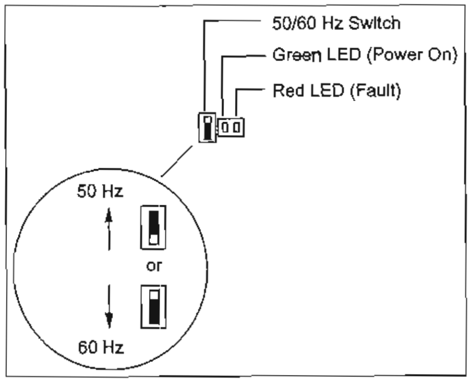
A door-mounted or remote-mounted keypad must be used to perform the initial start-up procedure. The keypad must be in the Total Unlock position to perform any drive controller programming. On Type 1 and 12K enclosures, the keypad access switch is accessible through the back of the enclosure door. Type 3R enclosures include a keypad cable and keypad located inside the enclosure. To set the keypad to Total Unlock, move the switch all the way to the right. To lock the keypad after programming, move the switch all the way to the left. Refer to the diagram at left for switch positions.

To perform any programming on the Type 3R Enclosure:

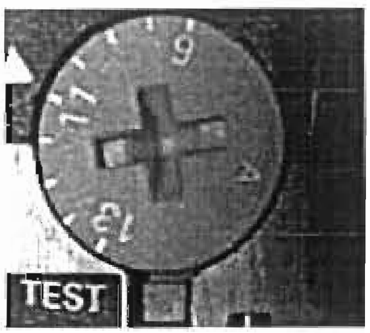
1. **Remove all power.**
2. Open the door of the drive controller. Refer to step 1 on page 30.
3. Remove the keypad and cable from the cloth bag.
4. Connect the keypad cable to the power converter and keypad. The 9-pin male D-shell plugs into the power converter, the female D-shell plugs into the keypad.
5. Place the keypad cable outside the enclosure by positioning the cable in the bottom left corner between the hinge and bottom of the door.
6. Close and secure the enclosure door.
7. Close the equipment disconnect means.
8. Perform programming on keypad.
9. When programming is completed. **Remove all power.**
10. Open enclosure door.
11. Remove keypad cable from power converter.
12. Place keypad and cable inside cloth bag.
13. Close and secure the enclosure door.

After replacing the power converter or installing any plug-in option card, the programming parameters must be set as listed in the elementary diagram that corresponds to the options ordered. See pages 90–94.

In addition, after installing any plug-in option card for the first time, previously-saved parameters downloaded from the keypad or PC software will not be correct because they do not include the additional parameters available with the card. The analog card parameters must be set as listed in the elementary diagram that corresponds to the options ordered. See pages 90–94.



50/60 Hz Switch
(See Figs. 10–13
for switch location)



Overload Relay Dial

The LR2-D1516 overload relay is shown. Your dial setting range may be different.

With all incoming power removed, make the following equipment checks:

a. Verify that all equipment disconnects are open.
b. Set the Hand-Off-Auto selector switch (controller mounted or remote mounted) to Off and the AFC-Off-Bypass switch (if used) to Off.
c. Set the speed potentiometer (controller mounted or remote mounted) to its minimum setting (full counterclockwise position).
d. Open the enclosure door. Refer to Step 1 on page 30.
e. Check the wiring of the input power ground, motor ground, speed potentiometer (if remote mounted), and Hand-Off-Auto circuit connections (if remote mounted). See the control circuit elementary diagrams in chapter 5, and the power circuit descriptions starting on page 62, for wiring diagrams of the remote control operators.
f. When using the bypass circuit, check that the motor conductors are wired to the T1, T2, and T3 terminals of the overload relay. When using the power circuit *without* bypass, check the motor conductors wired to U, V, and W on the J2 terminal block of the power converter.
g. If the controller includes a bypass option for running the motor across the line, set the overload relay dial (on the load side of the bypass contactor) to the full load ampere rating on the nameplate of the connected motor. See example at left.
h. Using a voltmeter set at the 1000 Vac scale, verify that the incoming line voltage at the line side of the disconnecting means is within ± 10% of the input voltage rating on the controller nameplate.
i. The 50/60 Hz switch, on the power converter control board, is factory set to 60 Hz. Check the switch before operating the drive controller to ensure that it is set to 60 Hz. See the diagram at left.
j. Close and secure the enclosure door. Close the equipment disconnect means. The Power On pilot light (if used) illuminates.

⚠ CAUTION

MOTOR HEATING HAZARD

This drive controller does not provide direct thermal protection for the motor. Use of a thermal sensor in the motor may be required for protection at all speeds or load conditions. Consult the motor manufacturer for the thermal capability of motor when it is operated over desired speed range.

Failure to follow this instruction can result in injury or equipment damage.

k. Press the ESC key on the keypad. Scroll with the down arrow key to Menu 2–Adjust (SEt), press the ENT key, then scroll with the down key to ThermCurrent–A (ItH) and press ENT. Use the up/down arrow keys to enter the motor nameplate full load amperes, then press ENT and ESC. The controller is now calibrated to provide motor overload protection.

   Refer to instruction bulletin VVDED397047US, *ALTIVAR 58 Adjustable Speed Drive Controllers Keypad Display VW3A58101.*

NOTE: The settings listed in this procedure are suitable for most applications. If your application requires different operating characteristics, refer to instruction bulletin VVDED397047US, ALTIVAR 58 Adjustable Speed Drive Controllers Keypad Display VW3A58101 *for more information.*

⚠ WARNING

HAZARD OF MACHINE ENTANGLEMENT

Before starting the drive controller, ensure that the motor and its connected load are clear from personnel and are ready to run.

Failure to follow this instruction can result in death or serious injury.

l. Set the AFC-Off-Bypass selector switch (if used) to AFC, the Normal-Test selector switch (if used) to Normal, and Hand-Off-Auto selector switch to Hand (push Start if the Start/Stop push buttons are used). Slowly turn the speed potentiometer clockwise to accelerate the motor. Check the direction of motor rotation. If correct, proceed to step p. If incorrect, stop the drive. **Remove all power!**

⚠ DANGER

HAZARDOUS VOLTAGE

Turn off all power supplying this equipment and perform the bus voltage measurement procedure on page 40 before proceeding.

Failure to follow this instruction will result in death or serious injury.

m. Correct the direction of motor rotation by reversing any two motor leads located on terminals T1, T2, or T3 for a drive controller with bypass; or U, V, or W for a drive controller without bypass.

n. Reset the speed potentiometer to minimum speed (fully counterclockwise). Close and secure the enclosure door, then reapply power and restart the controller.

o. Slowly turn the speed potentiometer clockwise to accelerate the motor. Check the direction of motor rotation. If correct, this completes the controller mode, motor rotation check.

p. Set the AFC-Off-Bypass selector switch (if used) to Off, leaving the Hand-Off-Auto selector switch in the Hand position.

q. Momentarily set the AFC-Off-Bypass selector switch to Bypass to check the direction of motor rotation, then return it immediately to the Off position. If the direction of motor rotation is correct, proceed to step t. If incorrect, stop the drive controller. **Remove all power!**

   Note: If the controller circuit breaker trips during this test, a higher trip setting may be required. Refer to "Circuit Breaker Trip Adjustment Procedure" on page 57.

⚠ DANGER

HAZARDOUS VOLTAGE

Turn off all power supplying this equipment and perform the bus voltage measurement procedure on page 40 before proceeding.

Failure to follow this instruction will result in death or serious injury.

r. Correct the direction of motor rotation by reversing any two incoming leads to the circuit breaker disconnect means marked L1, L2, or L3.

s. Momentarily set the AFC-Off-Bypass selector switch to Bypass to check the direction of motor rotation, then return it immediately to the Off position. If correct, this completes the bypass mode, motor rotation check.

t. Check the High Speed (HSP) setting (maximum motor speed setting). Press the ESC key on the keypad. Scroll with the down arrow key to Menu 2–Adjust (SEt), press the ENT key, then scroll with the down key to parameter High Speed–Hz and press ENT. Use the up/down arrow keys to enter the maximum output frequency required for the application (factory default is 60 Hz), then press ENT and ESC. The controller HSP setting is now complete.

   Refer to instruction bulletin VVDED397047US, *ALTIVAR 58 Adjustable Speed Drive Controllers Keypad Display VW3A58101*.

u. Check the Low Speed (LSP) setting (minimum motor speed setting). Press the ESC key on the keypad. Scroll with the down arrow key to Menu 2–Adjust (SEt), press the ENT key, then scroll with the down key to parameter Low Speed–Hz and press ENT. Use the up/down arrow keys to enter the minimum output frequency required for the application (factory default is 3 Hz), then press ENT and ESC. The controller LSP setting is now complete.

   Refer to instruction bulletin VVDED397047US, *ALTIVAR 58 Adjustable Speed Drive Controllers Keypad Display VW3A58101*.

v. The application may require changing the setting of acceleration (ACC) and deceleration (dEC) times. Factory default is 10 seconds. To change the setting, press the ESC key. Scroll with the down arrow to Menu 2–Adjust, press ENT, then scroll with the down key to parameter Acceleration-s and Deceleration-s. Use the up/down arrows to enter in seconds the time required for the application, then press ENT and ESC. The controller acceleration and deceleration time setting is now complete.

Circuit Breaker Trip Adjustment Procedure

Use the following equation to calculate the circuit breaker dial setting. For the Type GJL breakers see Tables 28–30.

$$\text{Dial Setting} = \frac{\text{Motor FLA} \times \text{Multiplication Factor}}{\text{Breaker Rating}}$$

Read the motor FLA from the motor nameplate and read the breaker rating from Tables 28–30. The multiplication factor is derived from NEC Table 430-152. For Type FAL and KAL circuit breakers, set the breaker dial according to the magnetic trip setting shown on the breaker nameplate. See Tables 31–33. For example, to calculate the dial factory setting of a 7.5 hp, 460 V motor:

$$4 = \frac{11 \times 11}{30}$$

In this example, the arrow on the circuit breaker dial should be turned to 4X.

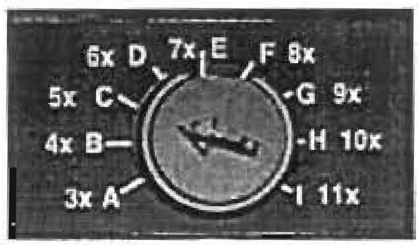


Figure 18: Circuit Breaker Trip Adjustment Dial

Notes to Tables:

[1] Factory setting is 11 times the motor FLA (multiplication factor = 11).
[2] Maximum trip setting is 13 times the motor FLA (multiplication factor = 13).

Table 28: 460 V GJL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Breaker Rating	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
1	GJL36007M02	007	3.3X	3.9X
2	GJL36007M02	007	5.3X	6.3X
3	GJL36015M03	015	3.5X	4.2X
5	GJL36030M04	030	3X	3.3X
7.5	GJL36030M04	030	4X	4.8X
10	GJL36030M04	030	5.1X	6.1X
15	GJL36050M05	050	4.6X	5.5X
20	GJL36050M05	050	6X	7.0X
25	GJL36075M06	075	5X	5.9X
30	GJL36075M06	075	5.9X	6.9X

Table 29: 230 V GJL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Breaker Rating	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
1	GJL36015M03	015	3.1X	3.7X
2	GJL36015M03	015	5X	5.9X
3	GJL36030M04	030	3.5X	4.2X
5	GJL36050M05	050	3.4X	4X
7.5	GJL36050M05	050	4.9X	5.7X
10	GJL36075M06	075	4.1X	4.9X
15	GJL36075M06	075	6.2X	7.3X
20	GJL36075M06	075	7.9X	9.4X

Notes to Tables:

[1] Factory setting is 11 times the motor FLA (multiplication factor = 11).
[2] Maximum trip setting is 13 times the motor FLA (multiplication factor = 13).

Table 30: 208 V GJL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Breaker Rating	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
1	GJL36015M03	015	3.4X	4X
2	GJL36030M04	030	3X	3.3X
3	GJL36030M04	030	3.9X	4.6X
5	GJL36050M05	050	3.7X	4.4X
7.5	GJL36050M05	050	5.3X	6.3X
10	GJL36075M06	075	4.5X	5.4X
15	GJL36075M06	075	6.8X	8X

Table 31: 460 V FAL and KAL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Max. Input Current	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
40	FAL36100-18M	54.5	600	709
50	FAL36100-18M	67	737	871
60	KAL36250-25M	82.8	911	1076
75	KAL36250-26M	100.5	1106	1307
100	KAL36250-29M	129.3	1422	1681

Table 32: 230 V FAL and KAL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Max. Input Current	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
25	FAL36100-18M	68	748	884
30	KAL36250-25M	80	880	1040
40	KAL36250-26M	104	1144	1352
50	KAL36250-29M	130	1430	1690

Table 33: 208 V FAL and KAL Circuit Breaker Trip Adjustment

HP	Circuit Breaker	Max. Input Current	Circuit Breaker Dial Setting	
			Factory[1]	Max.[2]
20	FAL36100-18M	59.4	653	772
25	FAL36100-18M	74.8	823	972
30	KAL36250-25M	88	968	1144
40	KAL36250-26M	114	1254	1482
50	KAL36250-30M	143	1573	1859

CHAPTER 4: TROUBLESHOOTING AND MAINTENANCE

INTRODUCTION

A number of diagnostic and status codes are included on the power converter. The keypad display provides visual indication of controller operating and protective circuit functions and indicator lights to assist in maintenance and troubleshooting. If the controller trips while operating, the codes must be viewed before power is removed because removing power resets the fault code.

NOTE: For controllers equipped with optional line contactor (MOD B09) the power is removed via the line contector upon power converter fault trips.

EXTERNAL SIGNS OF DAMAGE

The following are examples of external signs of damage:

- Cracked, charred, or damaged covers or enclosure parts
- Damage to the keypad such as scratches, punctures, burn marks, chemical burns, or moisture in the screen
- Oil or electrolyte on the bottom of the drive controller which might have leaked from the capacitors inside
- Excessive surface temperatures of enclosures and conduits
- Damage to power or control conductors
- Unusual noise or odors from any of the equipment
- Abnormal temperature, humidity, or vibration

If any of the above signs are found while the equipment is powered up, immediately inform operating personnel and assess the risk of leaving the drive system powered up. Before removing power from the equipment, always consult with the operating personnel responsible for the machinery and process.

If troubleshooting indicates the necessity of component replacement, refer to "Field Replacement of The Power Converter" on page 78.

PREVENTIVE MAINTENANCE

Type 1 controllers in the 1–7.5 hp range at 460 V and 1–5 hp range at 208/230 V use convection cooling. All Type 12K controllers and Type 1 controllers for 10 hp and above at 460 V and 7.5 hp and above at 208/230 V use forced air cooling. All Type 3R controllers use ventilation cooling. Inspect the interior fans (if used) and exterior fans of the controller for blockage and impeded rotation. To prevent overheating and to allow proper air flow, maintain clearances shown on the enclosure outline drawings in this instruction bulletin.

To maintain the environmental rating of Type 12K or 3R enclosures, periodically inspect the enclosure gaskets for damage.

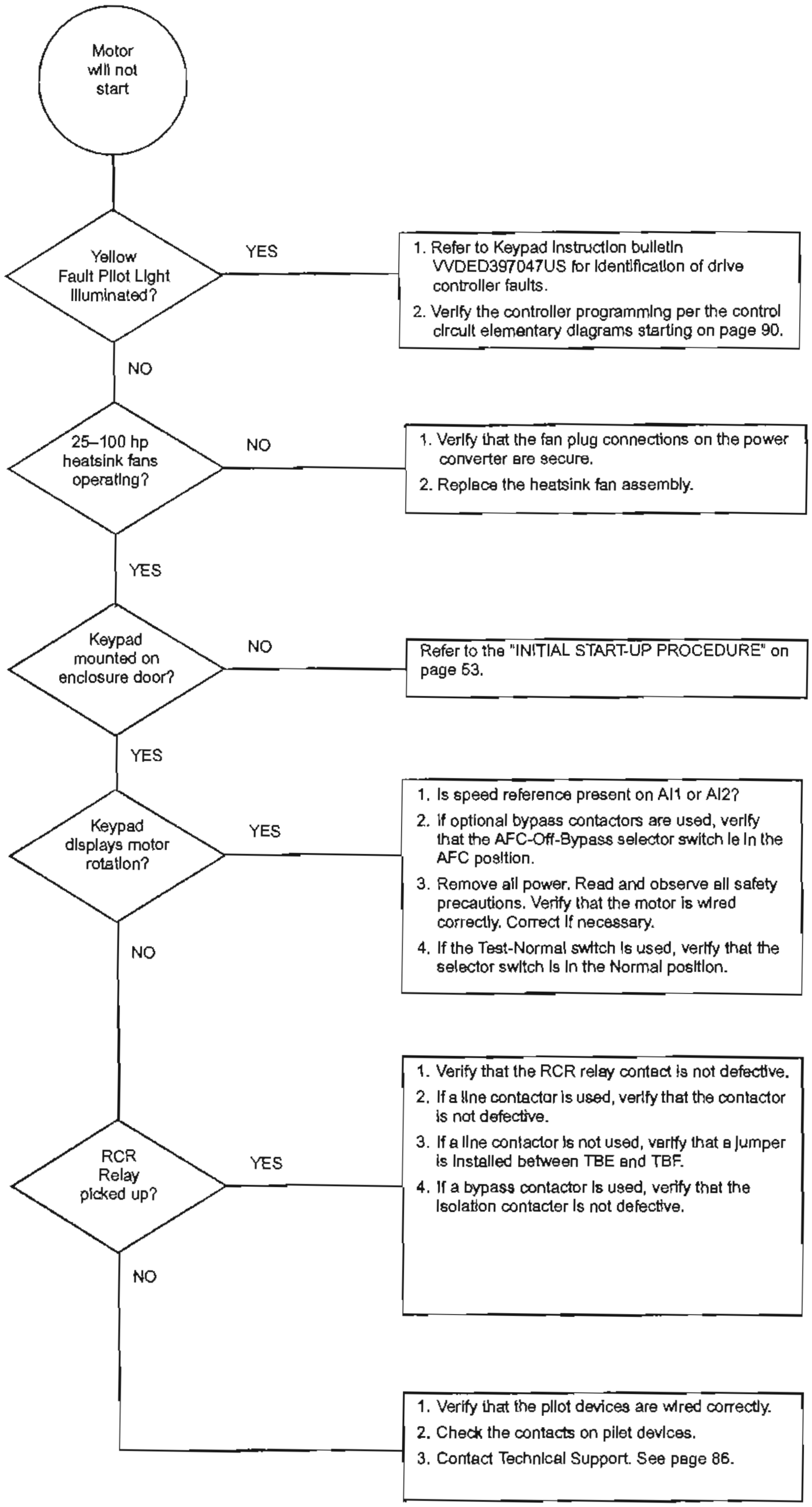
The keypad display is an integral part of the enclosure and must be installed on the door to maintain the environmental integrity of a Type 12K enclosure. It can be omitted when MOD D09 is selected and in that case a closing plate must be installed to maintain the Type 12K environmental rating.

TROUBLESHOOTING FLOW DIAGRAMS

The flow charts on pages 75 to 77 contain troubleshooting procedures for the following conditions:

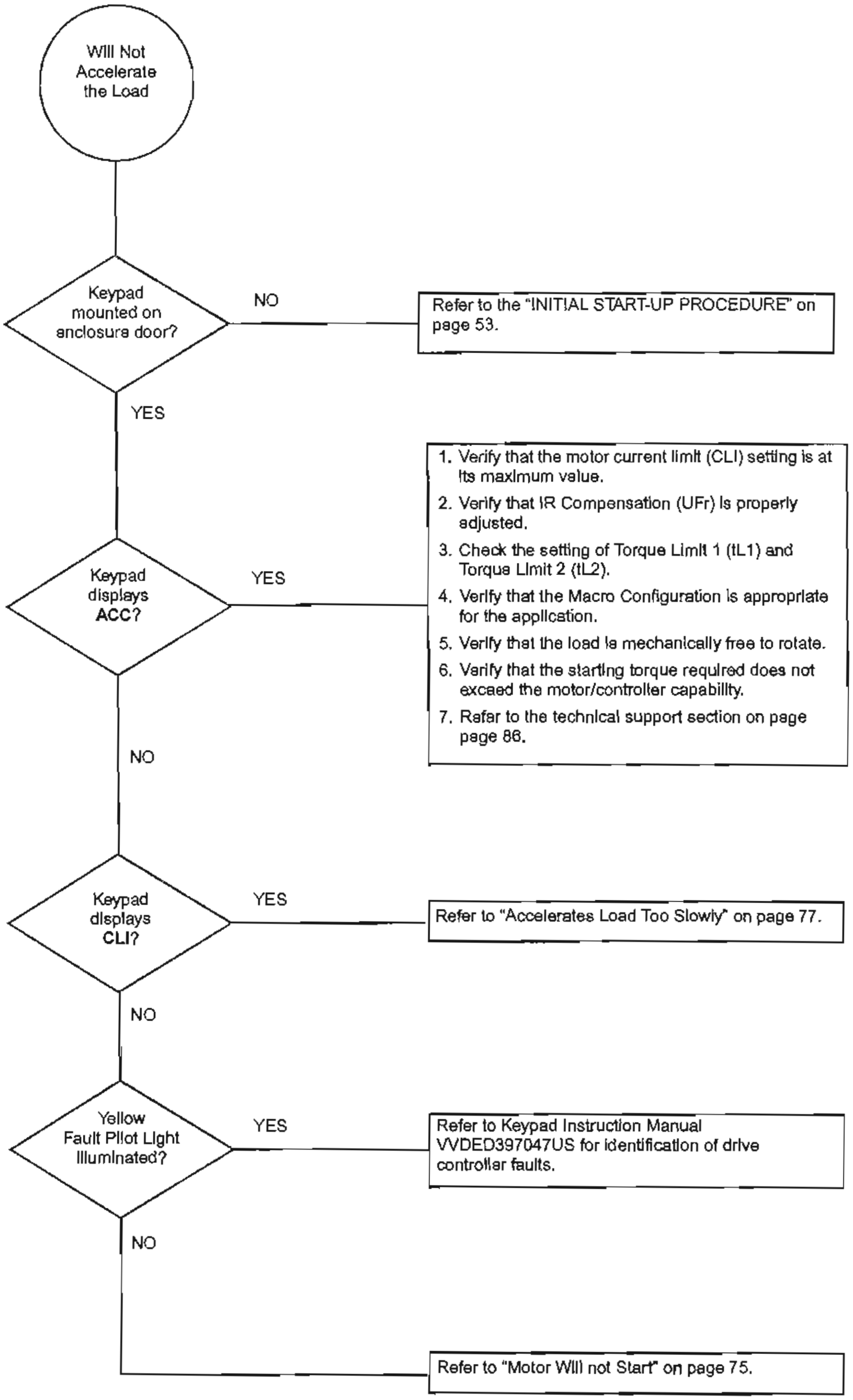
- Motor will not start (page 75)
- Will not accelerate the load (page 76)
- Accelerates the load too slowly (page 77)
- Excessive motor temperature (page 77)

Motor Will Not Start



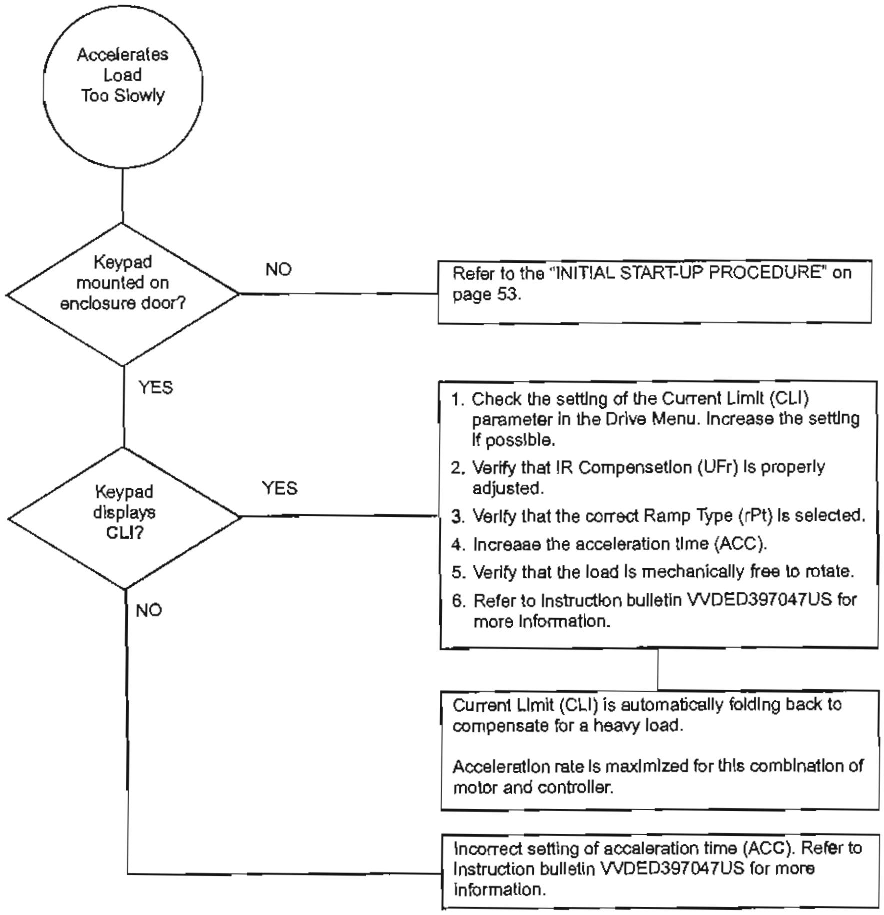
Will Not Accelerate The Load

NOTE: You must have a keypad for this procedure and the keypad must be in "Var. State". To set the keypad, press the ESC key, scroll up with the arrow to 1—Display menu (SUP), and press the ENT key. Then scroll up to Var. State (RDY) and press ENT.

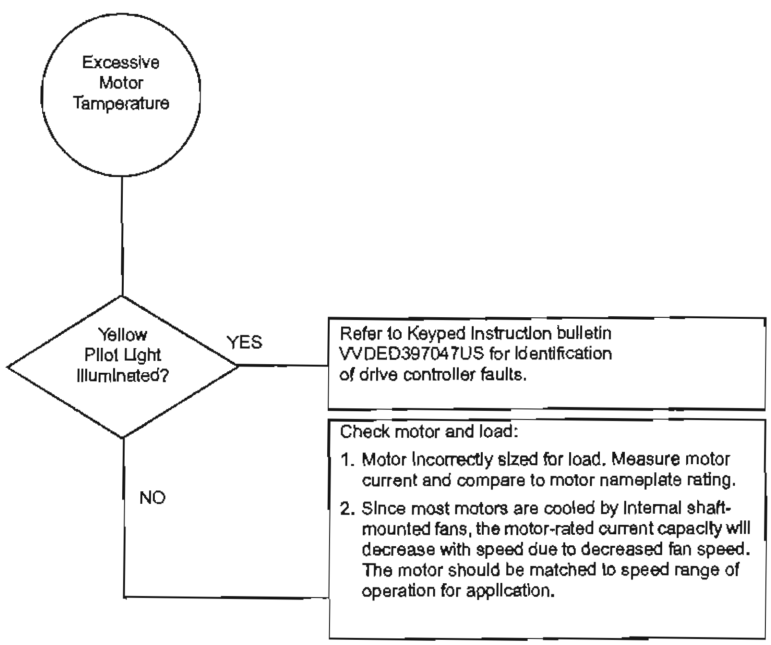


Accelerates The Load Too Slowly

NOTE: You must have a keypad for this procedure and the keypad must be in "Var. State". To set the keypad, press the ESC key, scroll up with the arrow to 1—Display menu (SUP), and press the ENT key. Then scroll up to Var. State (RDY) and press ENT.



Excessive Motor Temperature



FIELD REPLACEMENT OF THE POWER CONVERTER

If the power converter becomes inoperable in the ECONOFLEX controllers, it must be replaced. Refer to Table 34 for power converter weights.

Table 34: Power Converter Weights

HP		Weight	
460 V	**208/230 V**	**lb**	**kg**
1–7.5	1–5	20	9.1
10–25	7.5–10	30	13.6
30–50	15–25	70	31.7
60–100	30–50	122	55.3

Observe the lockout/tagout procedures as identified in OSHA Standard 29 CFR, Subpart J covering:

- 1910.147: The control of hazardous energy (lockout/tagout).
- 1910.147: App A, Typical minimal lockout procedures.

Removing the Power Converter Assembly

⚠ DANGER

HAZARDOUS VOLTAGE

- Disconnect all power.
- Place a "Do Not Turn On" label on the drive controller disconnect.
- Lock the disconnect in open position.
- Read and understand the bus voltage measurement procedure on page 40 before performing procedure. Measurement of bus capacitor voltage must be performed by qualified personnel.
- DO NOT short across DC bus capacitors or touch unshielded components or terminal strip screw connectors with voltage present.
- Many parts in the drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

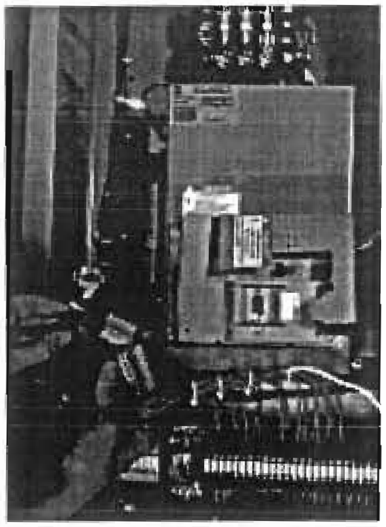
ELECTROSTATIC DISCHARGE

Do not subject this device to electrostatic discharge. This controller contains electronic components that are very susceptible to damage from electrostatic discharge.

Failure to follow this instruction can result in injury or equipment damage.

To replace the power converter, follow these steps:

1. Open the door of the drive controller. Refer to step 1 on page 30.
2. Measure the DC bus voltage as described on page 40 of this instruction bulletin.
3. Disconnect all power and control wiring from the power converter assembly. Identify each wire for ease of re-assembling the new power converter. See Figure 24.



Disconnect:

- The keypad cable
- Two MAC board plugs
- Six power wires
- The ground
- The shield
- The heatsink fan connections on 30–100 hp (460 V) or 15–50 hp (208/230 V)
- The analog card (if used)
- The Serial communication card (if used)
- The customer terminal block on the power converter (if used)
- The 3–15 PSI transducer (if used)
- The 0–10 V signal converter (if used)

Figure 24: Remove All Power and Control Wiring

4. For the 60-100 hp 460 V and 30-50 hp 208/230 V, it may be easier to remove the heatsink fan assembly before removing the power converter. Refer to the "FIELD REPLACEMENT OF HEATSINK FAN ASSEMBLY" on page 83 for directions.
5. Remove the outside hex-slot picture frame screws that secure the power converter to the enclosure back pan. Refer to Figures 14–17 starting on page 44 for screw locations. Refer to Table 35 for the number of screws on your controller. Keep the screws for the new power converter. See Figure 25.

Table 35: Number of Picture Frame Screws

HP		No. of Screws
460 V	208/230 V	
1–7.5	1–5	12
10–25	7.5–10	14
30–50	15–25	18
80–100	30–50	22

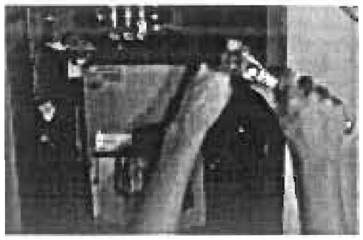


Figure 25: Remove Picture Frame Screws

6. Remove the power converter assembly from the enclosure. See Figure 26.

Figure 26: Remove Power Converter

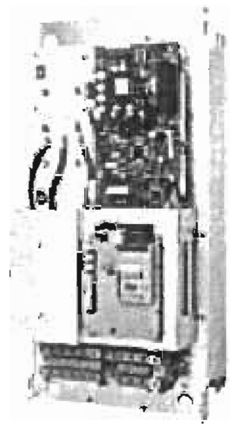
7. Remove four 1/2" (33 mm) rubber sealing plugs from the corners of the Type 12K and 3R power converters (30–100 hp at 460 V and 15–50 hp at 208/230 V). Keep the plugs for the new power converter.

Installing the Power Converter Assembly

To install the new power converter, follow these steps:

1. Install the four 1/2" (13mm) rubber sealing plugs in the corners of the Type 12K and 3R power converters (30–100 hp at 460 V and 15–50 hp at 208/230 V). The plugs maintain the Type 12K enclosure rating.
2. Install the new power converter assembly in the enclosure. See Figures 26 and 27.

1–25 hp @ 460 V and
1–10 hp @ 208/230 V
Typical



30–100 hp @ 460 V and
15–50 hp @ 208/230 V
Typical

Figure 27: Install New Power Converter

3. Secure the power converter picture frame to the enclosure back pan with the picture frame screws from the removed power converter. Torque the screws to 15 ± 2 lb-in. (1.7 ± 0.2 N•m) See Figure 25 on page 80.
4. Install all power and control wiring to the power converter assembly terminal blocks. Install all other removed equipment. See Figure 24 on page 79. Tighten the hardware to the torque values given in the table below. Check all wiring connections for correct terminations and check the power wiring for grounds with an ohmmeter.

Terminal		Torque	
		lb-in	N•m
Ground (heatsink)		15	1.7
J2 Power Terminal Strip:			
460 V	58EC•4V_ to 58EG•4V_ (1–7.5 hp)	7.5	0.85
	58EH•4V_ to 58EL•4V_ (10–25 hp)	20	2.3
	58EM•4V_ to 58EP•4V_ (30–50 hp)	88	9.9
	58EQ•4V_ to 58ES•4V_ (60–100 hp)	170	19.2
230 V	58EC•3V_ to 58EF•3V_ (1–5 hp)	7.5	0.85
	58EG•3V_ to 58EH•3V_ (7.5–10 hp)	20	2.3
	58EJ•3V_ to 58EL•3V_ (15–25 hp)	88	9.9
	58EM•3V_ to 58EP•3V_ (30–50 hp)	170	19.2
208 V	58EC•2V_ to 58EF•2V_ (1–5 hp)	7.5	0.85
	58EG•2V_ to 58EH•2V_ (7.5–10 hp)	20	2.3
	58EJ•2V_ to 58EL•2V_ (15–25 hp)	88	9.9
	58EM•2V_ to 58EP•2V_ (30–50 hp)	170	19.2
S Shield Connection (power converter)		3.5	0.34
Analog output customer terminal block Din rail mounting screws (if used)		22	2.5

5. Shut the enclosure door, secure the door with door fasteners, and close the circuit breaker disconnect. See Figure 28.

Figure 28: Close and Secure the Door

⚠ DANGER

ELECTRIC SHOCK, BURN, OR EXPLOSION

- This equipment must be installed and serviced only by qualified personnel.
- Qualified personnel performing diagnostics or troubleshooting requiring electrical conductors to be energized, must comply with NFPA 70 E - Standard for Electrical Safety Requirements for Employee Workplaces and OSHA Standards – 29 CFR Part 1910 Subpart S Electrical.

Failure to follow this instruction will result in death or serious injury.

6. Program the drive controller according to the control circuit elementary diagrams in chapter 5. Follow the Initial start-up procedure on page 53.

The drive controller is now ready to operate.

FIELD REPLACEMENT OF HEATSINK FAN ASSEMBLY

Removing the Heatsink Fan Assembly

NOTE: For the equipment required for this procedure, refer to the recommended spare parts list for the heatsink fan assembly part number.

If a heatsink fan becomes inoperable in the 10–100 hp 460 V or 7.5–50 hp 208/230 V controllers, the fan assembly must be replaced. Observe the lockout / tagout procedures as identified in OSHA Standard 29 CFR, Subpart J covering:

- 1910.147: The control of hazardous energy (lockout/tagout).
- 1910.147: App A, Typical minimal lockout procedures.

⚠ DANGER

HAZARDOUS VOLTAGE

- Disconnect all power.
- Place a "Do Not Turn On" label on the drive controller disconnect.
- Lock the disconnect in the open position.
- Read and understand the bus voltage measurement procedure on page 40 before performing procedure. Measurement of bus capacitor voltage must be performed by qualified personnel.
- DO NOT short across DC bus capacitors or touch unshielded components or terminal strip screw connectors with voltage present.
- Many parts in the drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

ELECTROSTATIC DISCHARGE

Do not subject this device to electrostatic discharge. This controller contains electronic components that are very susceptible to damage from electrostatic discharge.

Failure to follow this instruction can result in injury or equipment damage.

To replace the heatsink fan assembly, follow these steps:

1. Open the door of the drive controller. Refer to Step 1 on page 30.
2. Measure the DC bus voltage as described on page 40.
3. Locate the heatsink fan assembly above or below the power converter.

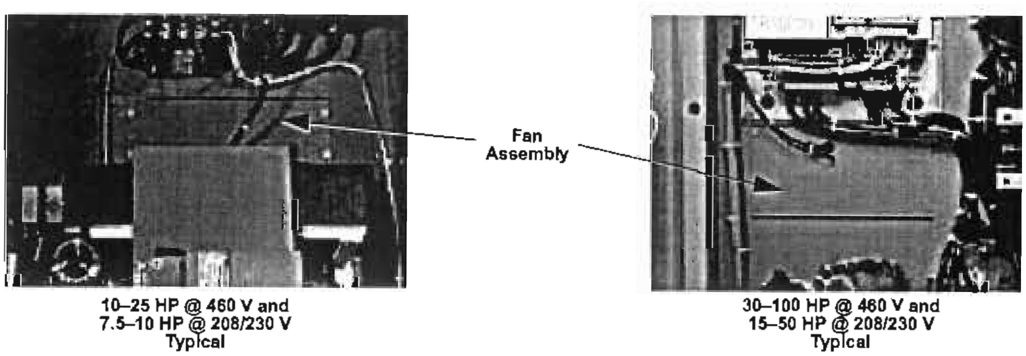
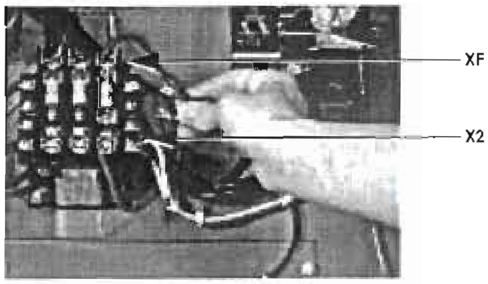
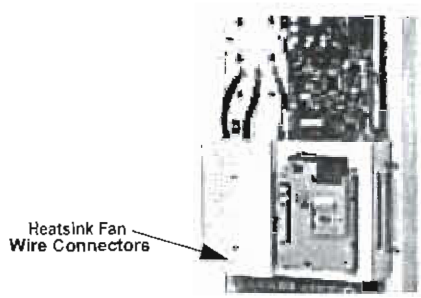


Figure 29: Heatsink Fan Assembly Location

4. For 10–25 hp controllers, disconnect the four fan wires connected to the control transformer. The 1/4" (6.35 mm) fast-on is connected to XF on the transformer fuse. The spade lug is connected to the X2 terminal on the transformer. See Figure 30. For 30–100 hp 460 V controllers and 20–50 hp 208/230 V controllers, disconnect the heatsink fan wire connectors.



10–25 HP @ 460 V and
7.5–10 HP @ 208/230 V
Typical



30–100 HP @ 460 V and
15–50 HP @ 208/230 V
Typical

Figure 30: Remove the Fan Wiring

5. Remove the four screws securing the heatsink fan assembly. Keep the four screws. See Figure 29.
6. Remove the heatsink fan assembly from the enclosure. For the 10–25 hp 460 V controllers and 7.5–10 hp 208/230 V controllers, lift the assembly up toward the top of the enclosure then pull it out. For 30–100 hp 460 V controllers and 15–50 hp 208/230 V controllers, pull the assembly down toward the bottom of the enclosure then pull it out. See Figure 31.

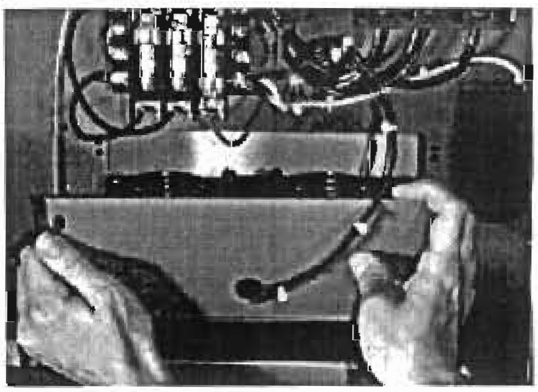


Figure 31: Remove the Heatsink Fan Assembly

Installing the Heatsink Fan Assembly

To install the new heatsink fan assembly, follow these steps:

1. Install the heatsink fan assembly. Secure the assembly with the four screws saved from step 5 above. Torque the screws to 15 lb-in (1.7 N•m). See Figure 29 and Figure 31.
2. For 10–25 hp 460 V controllers and 7.5–10 hp 208/230 V controllers, terminate the wire with the spade lug to X2 on the transformer. Torque the screw to 20–25 lb-in (2.3–2.8 N•m). Terminate the fast-on to XF on the transformer fuse. See Figure 30. Check all wiring connections for correct terminations. For 30 –100 hp controllers at 460 V and 15–50 hp controllers at 208/230 V, plug the DC fan connectors to the power converter.
3. Shut the enclosure door and secure it with door fasteners. Then close the circuit breaker disconnect.
4. The drive controller is now ready to operate.

NOTE: For 30–100 hp controllers at 460 V and 15–50 hp controllers at 208/230 V, when the heatsink fan connectors are not properly attached to the power converter, the power converter may cycle on and off or not function. If either of these occurs, check the heatsink fan connections.

FIELD REPLACEMENT OF THE STIRRING FANS

If a stirring fan inside the enclosure becomes inoperable in the ECONOFLEX controllers, the fan must be replaced.

Before removing the inoperable stirring fan, mark airflow direction to ensure proper installation of the replacement fan.

FIELD REPLACEMENT OF THE VENTILATION FAN ON TYPE 3R

If a Type 3R ventilation fan becomes inoperable in the ECONOFLEX controllers, the fan must be replaced.

Before removing the inoperable ventilation fan, mark airflow direction to ensure proper installation of the replacement fan.

FIELD REPLACEMENT OF THE SPACE HEATER ON TYPE 3R

If a Type 3R space heater becomes inoperable in the ECONOFLEX controllers, the space heater must be replaced. The thermostat is factory set at 60 °F (30 °C).

FIELD MAINTENANCE AND REPLACEMENT OF HOOD FILTERS ON TYPE 3R

The Type 3R ECONOFLEX filter material located on the bottom of the side hoods is washable. Remove, wash and install as required to maintain airflow.

The fan mounting bracket assembly must be removed first. This assembly is fastened to the hood by four screws. Then the fan can be removed from the bracket assembly by removing two mounting screws.

TECHNICAL SUPPORT

When troubleshooting the Class 8839 ECONOFLEX drive controller, discuss with operating personnel the symptoms of the reported problems. Ask them to describe the problem, when they first observed the problem, and where the problem was seen. Observe directly the drive system and process. Record the drive controller, motor and peripheral equipment nameplate data on the Class 8839 ECONOFLEX Trouble-shooting Sheet, a sample of which is shown on the next page. (You may copy this form as needed.)

For more information, call, fax, or write:

Square D AC Drives Technical Support Group
8001 Highway 64 East
Knightdale, NC 27545-9023

Telephone: 919-266-8600
Fax Line: 919-217-6508
E-mail: drivepsg@squared.com

INSTALLATION & OPERATION INSTRUCTIONS

GENERAL INFORMATION

1. Clean the lines of particles larger than 1/16" diameter (welding slag, pipe scale & other contaminants). Upstream installation of a 20 mesh strainer is recommended. Provisions should be made for keeping the water clean. See Maintenance section for more information.
2. For optimum operation, air entrapment in the fluid MUST be eliminated. The Manual Balancing valve must remain full of fluid during flow setting and system operation.
3. The operation of the valve is dependent on the characteristics of the flowing medium (fluid). Therefore it is important that when ordering a valve for a fluid other than 100% water, complete fluid specifications are included. See Fluids section for more information.

INSTALLATION

1. Manual Balancing Valves are factory assembled and marked with the Valve Cv on the body tag. ***The body tag is located on the handle.*** The Venturi is not field changeable.
2. Manual Balancing Valves are marked to show direction of flow. The union end is the inlet and the body end is the outlet. ***The flow arrow must point in the direction of flow for proper operation.***
3. Manual Balance Valve body size should match the pipe size it will be installed in. Valve Cv should be matched to the flow required. Reducing Fittings or bushings may be attached directly to control valve.
4. Griswold balancing valves may be installed in the pipe line either horizontally or vertically. Straight sections of pipe upstream and downstream of the valves are not necessary for proper operation (1/2"–2" Only).

THREADED CONNECTIONS

1. Threaded connections are tapped with NPT threads. Seal connections per industry standards using approved pipe sealant. Torque should not exceed 75 foot pounds.
2. When installing threaded union end fittings, the fitting and union nut must be removed from the valve body. Slide the union nut over the pipe, then tighten the fitting to the pipe.

SWEAT CONNECTIONS

1. Sweat end connections will accept standard copper tubing per ASTM B88-71. Follow general directions and recommendations of the sweat fitting and tubing manufacturers when installing the valves.
2. Manual Balancing Valves are designed for soft solder only. Excessive heat (over 500°F) may damage Teflon seals. Manual Balancing Valves are to be soldered in the full closed position.
3. For Sweat end body connections, use of a heat sink (heat absorbing putty, wet rag, etc.) is highly recommended. Do not apply flame (heat) directly to the center of valve body or to the test ports as excessive heat can damage internal seals and cause leaks.
4. When installing sweat union end fittings, the fitting and union nut must be removed from the valve body. Slide the union nut over the pipe, then sweat the fitting to the pipe. Allow to cool to touch before assembling the union to the body to prevent heat damage to the o-ring seal.

UNION CONNECTIONS

1. The Union Nut connection is sealed using an o-ring. In normal use no other sealant is required. Tighten the union nut hand tight, hold body with a wrench to prevent it from twisting body connection and then tighten approximately an additional quarter turn.
2. Using silicon oil or grease lubricant at assembly helps protect the O-ring from damage by abrasion, pinching, or cutting. Do not use aerosol products or petroleum based lubricants. The lubricant should not excessively soften or harden.

FLANGED CONNECTIONS (2-1/2"–18" Only)

1. Assemble and then tighten the field furnished flanges to the Griswold QuickSet Valve. Then align and place the assembly to the mating field piping. Tack weld the field furnished flanges to the pipe. **WARNING: Do not finish welding the flanges to the pipe with the valve bolted between the flanges. This will result in serious heat damage to the valve seat.**
2. Remove the flange bolting and valve from between the field furnished flanges. Finish welding the field furnished flanges to the field furnished

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pipe and allow the flanges to cool completely before proceeding.

3. Next, reinstall the Griswold valve using field furnished approved gaskets between the Griswold valve flange and the field furnished pipe flange. Before tightening any bolts, on butterfly type valves, turn the disk of the butterfly to full open position. Center the valve and hand tighten all bolts. Slowly close the disk to check for adequate disk clearance. When properly aligned, return the disk to full open position and evenly cross-tighten all bolts. Make sure the disk opens and closes correctly.

GROOVED END CONNECTIONS (2-1/2"–18" Only)

Metering Station

1. This style valve is joined together by housing clamps and rubber gaskets, which are field furnished and installed.
2. Clean the end of the valve and pipe past the grooved section. Grease the pipe ends, valve ends and rubber gasket lips with cup grease, graphite paste or similar grease recommended by the housing clamp manufacturer.
3. Slip the rubber gasket over the pipe end of each joint. **Note:** In 10" and larger valve connections, turn the gasket inside out and slip it over the pipe ends. Roll the gasket back after bringing the valve into position.
4. Position the grooved end valve between the pipe ends and slide the gasket back into central spanning position. Smear grease on the outside of the gasket.
5. Put housing clamps over gasket – insert bolts and nuts. Tighten nuts evenly, using socket or other wrench (The best speed of assembly is obtained with brace or T-handle wrenches). Tighten so the housing clamps come together evenly. This avoids gasket pinching. When housing clamps meet metal-to-metal, further tightening of bolts in not necessary or desirable.
6. Pre-assemble large diameter multi-segment housing clamps loosely, and install them as half-housings. Take up evenly from top to bottom on alternate bolts.

QuickSet Valve

1. The flanged-to-grooved connection furnished on the outboard side of the butterfly valve must be unbolted. The field furnished pipe with a grooved end is installed inside the unbolted flange-to-groove connection with a field-furnished gasket and grease in the same manner as described above in the Metering Station. The connection must then be rebolted.

WELD END CONNECTIONS(2-1/2"–18" Only)

Metering Station

1. Clean the end of the valve and pipe where the weld will be made. Make up the assembly butting the connections together.
2. Tack weld the assembly together and observe fit. If everything fits satisfactorily, the final complete welds can be made.

Quickset Valve

1. Clean the end of the valve and pipe where the weld will be made. Make up the assembly butting the connections together.
2. Tack weld the assembly together and observe fit **WARNING: Do not finish welding the flanges to the pipe with the butterfly valve bolted between the flanges. This will result in serious heat damage to the rubber gaskets and valve seat.**
3. Remove the bolting and flange from between the flanges. Finish welding the piping together and allow flanges to cool completely before reinstalling and bolting the butterfly valve in its original position.

OPERATION

1. Manual Balancing Valve(s) are ordered by line size and Valve Cv. The Cv is the flow coefficient of the Valve. Flow rates are set by adjusting the ball valve until the differential pressure reading across the Venturi corresponds to the required flow (GPM). Use the flow graphs (1/2"–2": Form #F-4040; 2-1/2"–18": Form #F-4090)
2. Once the Valve(s) has been installed and the system has been filled and purged, each valve loop must be set to the correct flow setting. Multiple passes are generally required to get the system in balance as the adjustment of each new valve affects the pressure drop (and flow) through the previously adjusted valves.
3. A meter kit can be purchased from Griswold Controls to take the differential pressure readings. The kit consists of either a 0-100" or 0-300" water column test gauge with the appropriate control

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valves, hoses and fittings. See Griswold Form F-4086B for more information on the Meter Kit.

4. Griswold offers a set of Transparent Overlays for use with a 6" test gauge (meter kit) scaled for 0-100" or 0-300" water column. These overlays allow the gauge to be read directly in GPM (gallons per minute) for each of the valves. See Griswold Form F-4045 for more information.
5. When all valves in the system have been correctly adjusted, the locking Memory Stop should be set to prevent changes in flow rate. To set the memory stop, loosen the handle hex bolt, rotate the memory stop against the valve body boss, and retighten the handle bolt.
6. The memory stop will allow the valve to be used for isolation (full closed) and then be reopened to the preset flow position.

FLUIDS

1. The operation of the Manual Balancing Valve is dependent on the characteristics of the flowing medium (fluid). Therefore it is important that when ordering and setting a valve for a fluid other than 100% water, complete fluid specifications are known. Flow rates must be corrected for the changes the fluid medium creates.
2. ***Specific Gravity***

   Specific gravity is the most important attribute of a liquid used in a Manual Balancing Valve. Correction will need to be made for any fluid with a specific gravity other than 1.0 (100% water). The specific gravities of fluids change as fluid temperature changes. Please consult Griswold for conversion.
3. ***Viscosity & Temperature***

   The viscosity of a fluid is mainly dependent on the fluid temperature. For fluids such as water, the viscosity change with temperature is negligible. In other fluids, such as petroleum oils, the change with temperature is quite noticeable. Both viscosity and operating temperature must be specified and known for proper setting of the corrected flow rate. Please consult Griswold for conversion.

MAINTENANCE

If the system experiences large amounts of pipe scale due to poor water conditions, as is sometimes found in older or retrofit systems, provision should be made to keep the system clean. Proper water treatment is also recommended by the use of a Griswold Separator. ***If a Griswold Separator is not used for system cleaning, the Manual Balancing Valve should be inspected annually.***

INSULATION

Griswold recommends that the Manual Balancing valve be insulated. However, insulation shall not block access to the memory stop and P/T taps.

LIMITED WARRANTY

When you purchase from Griswold Controls, you trust us to provide you with innovative, quality products that satisfy your need for profitable growth. We work hard to earn your business, not to give you a hassle. If you are not completely satisfied with something you have purchased or provided, just tell us. We will make it right by repairing or replacing the product. We want your business and we guarantee you: no hassle!

Claims under this warranty will only be honored if written notice is given to Griswold immediately upon discovery of the defect. A Product shall not be deemed defective unless it fails to perform in accordance with Griswold's written specifications. Customer shall pay freight charges for return. Griswold shall pay freight charges for return shipment to customer.

All requests for return of Products and the handling of credit or replacement shall be made in accordance with Griswold's return policy in effect at time of return. Griswold's obligation to repair or replace defective Products shall not apply to any Product that has been (1) subjected to misuse, neglect, or accident, or (2) altered or repaired (other than Griswold) in such a manner as to affect adversely its performance, stability or reliability.

The foregoing warranty is in lieu of all other warranties expressed or implied, in fact or at law, including implied warranties of merchantability and fitness for particular purpose.

This is Griswold's sole and entire liability to anyone for any claim in connection with the Product(s). In no event shall Griswold be liable for incidental, special or consequential damages, loss of profits, or damages in any amount exceeding the cost for any Product(s) even if Griswold has been told in advance of the possibility of such damages.

Replaces form F-4030C 12/05

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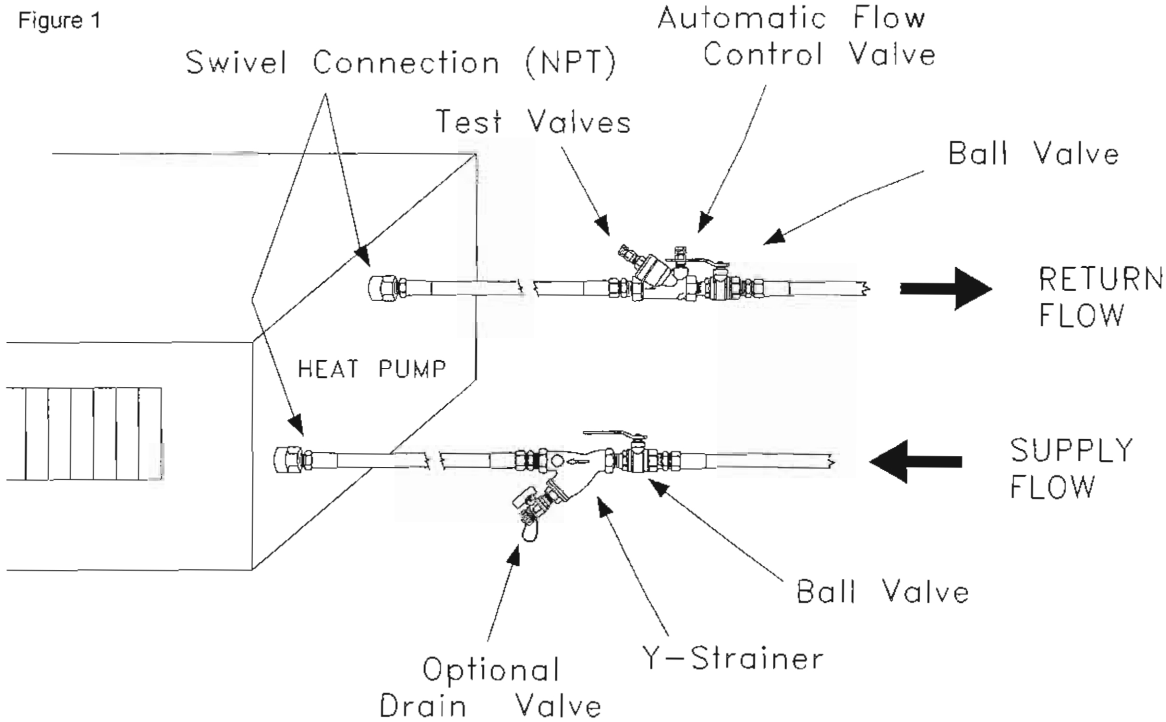
INSTALLATION & OPERATION INSTRUCTIONS

An Automatic Balancing Hose Kit is shown in Figure 1. It includes all the available components: a Flow Control Valve, two Flexible Hoses, a Y-Strainer, two Ball Valves, and a Pressure/Temperature test valve. The Ball Valve, Y-Strainer, and Pressure/Temperature Test Valve combination is installed on the supply side of the terminal unit, and the Flow Control Valve and Ball Valve combination is installed on the return side of the terminal unit.

Figure 1



CLEANING AND DRAINING THE SYSTEM

Prior to full system start-up, good installation practice requires that all lines be thoroughly cleaned to remove dirt and debris. To flush out the lines properly, Griswold Hose Kits can be modified (as shown in Figure 2) by "looping" the supply hose and return piping together, thus by-passing the terminal unit and Flow Control Valve. This simple procedure helps protect terminal units from contamination and insures you a smooth system operation right from the start.

PROCEDURE FOR "LOOPING" HOSES

1) Disassemble the return side Hose Kit assembly, but leave the Ball Valve assembled directly to the return pipe.

2) If you have a Y-Strainer, you may want to remove the internal screen from the strainer while flushing the system.

3) Loosen the supply side Hose Kit assembly from the terminal unit and "loop" it directly to the Ball Valve on the return side piping. (A coupling may be required depending on the ball valve connection type.)

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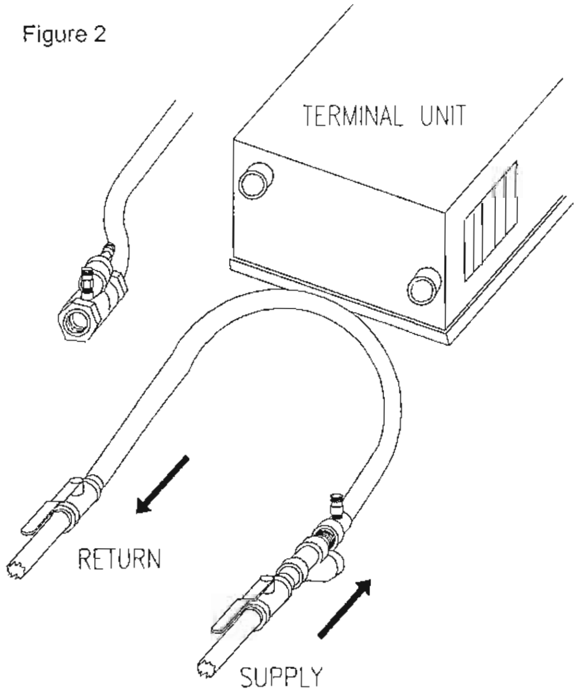
4) After all hoses have been "looped", start the pump to clean lines of particles larger than approximately 1/16" in diameter (i.e., weld splatter, mill scale, other contaminants) by flushing per equipment manufacturer's standards.

Figure 2



FINAL CONNECTIONS

1) Shut off both Ball Valves (handles should be at right angles to their bodies). If a Strainer and Drain Valve are installed, open the Drain Valve to remove water from the connecting hose.

2) Break the temporary "loop" and reinstall the Flow Control Valve and return side hose.

3) Connect both hoses to the terminal unit as shown in Figure #1. Swivel end connections are provided for ease of installation. Seal all connections with approved pipe compound or tape.

4) If a Strainer is used, reinstall the internal screen and rethread the cap securely.

5) Open both Ball Valves and re-fill the system with fluid.

6) Bleed any entrained air so that the Flow Control Valve will remain full of fluid during operation.

MAINTENANCE

If the system experiences large amounts of pipe scale due to poor water conditions (as sometimes found in older or retrofit projects), then installation of the optional Y-Strainer and an annual inspection of the system is recommended. Proper water treatment is also recommended.

PLEASE NOTE

The Griswold Automatic Flow Control Valves component of the Hose Kit is factory-assembled and individually calibrated. It is tamper-proof and does not require any field adjustments. Specified flow is within ±5% of design when properly installed.

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MANUFACTURERS REPRESENTATIVE
105 Woodmont Road Milford CT 06460
Area Code 203-877-7070/800-665-4737 FAX 203-783-9042

SUBMITTAL DATA & MATERIAL LIST

Project: The Children's School Stamford CT

Engineer: vZHS West Hartford CT

Contractor: Eastern Mechanical Danbury CT

Materials Submitted for Approval
Radiant Space Heating

Quantity	Model	Manufacturer	Description
12600'	98405	Heat-Link	Polyethylene Cross Linked (PEX-A) Radiant Floor Tubing with Oxygen Diffusion Barrier 1/2" nominal 300'/roll – 42 rolls – one/loop
One (1)	335-213	Terra Therma	Stainless Steel Manifold – Complete - 4 Loops Sound Isolation Wall Brackets, Loop Marking Labels Individual Loop Shutoff & Balance Valves Indivdual Loop Flow Indicators 1" Female Sweat Connections – Supply & Return Manual Air Vent, Drain Valve, ½" PEX Connectors M-1-1
Two (2)	335-214	Terra Therma	Stainless Steel Manifold – Complete – 5 Loops Trimmed as Above – M-2 & M-4
Two (2)	335-215	Terra Therma	Stainless Steel Manifold – Complete – 6 Loops Trimmed as Above – M-1-2 & M-6
One (1)	335-216	Terra Therma	Stainless Steel Manifold – Complete – 7 Loops Trimmed as Above – M-5
One (1)	335-218	Terra Therma	Stainless Steel Manifold – Complete – 9 Loops Trimmed as Above – M-3

Eighty-Four	86005	Heat Link	Conduit Ell - floor ½" PEX transitions
Two Thousand Feet (2000')	89000	Heat Link	Plastic Pipe Tracking for 3/8", ½", 5/8" PEX Tubing 5' sections with 3" Center positions
One (1)		Mechanical Marketing	Supervision of Installation & Startup

Prepared by: Michael Skoldberg **Dated:** June 21, 2006

<u>Note</u>- Tubing Layouts to be submitted for Engineer's approval when CAD backgrounds are available. Materials only submitted for Approval to avoid delay in having materials ready on site for installation.

	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
2	The Children's School					Prepared By:	Mike S.		Nearest City:	New York NY		20-Dec-05		HeatLink® Heatloss		
3	Room Name		Active Lrng	Hall 1	Learning A	Practical Life	Core	Entry	Library	Learning B	Art Science	Gallery				
4	Room Number		114	2	115	113	116	101	119	117	122	123				
5	Manifold Group Number															
6	Thermostat (Y-Yes)															
7	Thermostat / Zone Number															
9	Zone valve for Manifold(Y -Yes)															
10	Floor Finish		1	1	1	1	1	1	1	1	1	1				
11	Exp. Wall Height	11.0	14.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00				
12	Exposed Wall	perim. ft	106.00	16.00	32.00	62.00	68.00	20.00	37.00	97.00	83.00	40.00				
13	Rm Length	ft	34.00	25.00	24.00	31.00	47.00	28.00	43.00	43.00	39.00	8.00				
14	Rm Width	ft	23.00	8.00	40.00	24.00	31.00	10.00	23.00	23.00	32.00	32.00				
15	Gross Rm Area	sq ft	782	200	960	744	1,457	280	989	989	1,248	256				
16	Exposed Ceiling Area	sq ft	782	200	960	744	1,457	280	989	989	1,248	256				
17	Exposed Floor Area	sq ft	782	200	960	744	1,457	280	989	989	1,248	256				
18	Ceiling R Value	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0				
20	Wall R Value	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0				
20	Wall Factor		0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035				
22	Cold Floor Type		SOG	SOG	SOG	SOG	SOG	SOG	SOG	SOG	SOG	SOG	SOG	SOG	SOG	
24	Crawl Space R-Value	20.0														
25	Cement Floor R Value	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0				
27	Perimeter R Value (S.O.G	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0				
29	Buried Wall height															
30	Buried Wall R Value	8.0														
32	Glass Type	2.79	2.79	2.79	2.79	2.79	2.79			2.79	2.79	2.79				
33	Glass (fixed)	sq. ft.	393.00	49.00	124.75	86.00	434.00			494.50	140.50	265.00				
35	Glass Type	1.82	1.82		1.82				1.82		1.82	1.82				
36	Glass (hinged)	sq. ft.	56.00		10.50				57.50		30.00	14.00				
38	Door Type	1.40	1.40													
39	Door Entry (metal/wood) sq.ft.															
41	Door Type	1.04	1.04	1.04		1.04		1.04		1.04	1.04	1.04				
42	Door (glass/overhead) sq.ft.		21.00	42.00		42.00		84.00		42.00	63.00	21.00				
44	Skylight Type															
45	Skylight (fixed)	sq. ft.														
47	Infiltration factor (ACH)	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050				
48	Com. Airchange factor (ACH)		0.750	0.500	0.250	0.500	0.500	0.500	0.250	0.750	0.500	0.250				
49	No Heat	sq.ft.														
50	Room Temp	°F	70	70	70	70	70	70	70	70	70	70	70	70	70	
51	Net Area	sqft	782	200	960	744	1,457	280	989	989	1,248	256				
52	Heat Loss	BTU/H	37,250	8,313	19,722	21,427	40,665	11,631	19,239	40,158	35,677	13,434				

54	Construction Loss:	247,515	Gross Area:	7,905	Controls:	Inj. Mixing	Inside:	70°F	Supply Temp.:	140 °F	100 - 140 norm
55	Mech. Venti. Loss Res.:		Net Area:	7,905	StatLink:	No	Outside:		Water Temp. Drop:	20 °F	10 - 20 norm
56	TOTAL HEAT LOSS:	247,515	No Heat:		Setback:	No	Difference:	70°F	Base on Pipe Size:	1/2	3/8, 1/2, 5/8, 3/4
57			FLR. WARMING:	No	Indoor sensor:	No	Glycol %:	30			

			E	F	G	H	I	J	K	L	M	N	O	P	Q
59	Floor Heat?/Rad/Fan Coil	Y/N/R/FC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
60	Wet or Dry	(WC / WT / WS / D)	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT
61	Leader Length	ft	10	10	10	10	10	10	10	10	10	10	10	10	10
62	Cement abv pipe	inch	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
63	Sub Floor Thickness in.	7/8													
64	Max Floor Temp	°F	88 °F	88 °F	88 °F	88 °F	88 °F	88 °F	88 °F	88 °F	88 °F	88 °F	88 °F	88 °F	88 °F
65	Temp. Drop	D°F H2O	20 °F	20 °F	20 °F	20 °F	20 °F	20 °F	20 °F	20 °F	20 °F	20 °F	20 °F	20 °F	20 °F
66	Pipe Type (oxy / non oxy)		oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy
67	Pipe Size	in	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
69	Spacing	inches	9 in	9 in	9 in	9 in	9 in	9 in	9 in	9 in	9 in	9 in	9 in	9 in	9 in
70	Max. Length	ft	295	295	295	295	295	295	295	295	295	295	295	295	295
72	Border Zone	sq. ft													
73	Border Zone Spacing	in													
74	Max. Length	ft	185	185	185	185	185	185	185	185	185	185	185	185	185
75	Temp. Drop	D°F H2O	5	5	5	5	5	5	5	5	5	5	5	5	5
76	Max Floor Temp	°F	95°F	95°F	95°F	95°F	95°F	95°F	95°F	95°F	95°F	95°F	95°F	95°F	95°F

1	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
22	*The Children's School*					Prepared By:	Mike S.		New York NY		20-Dec-05		HeatLink® System Analysis			
23	Room Name		Active Lrng	Hall 1	Learning A	Practical Life	Core	Entry	Library	Learning B	Art Science	Gallery				
24	Room Number		114	2	115	113	116	101	119	117	122	123				
25	Do Floor Heat?	(Y/N)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y				
26	Type of heating		floor heat	floor heat	floor heat	floor heat	floor heat	floor heat	floor heat	floor heat	floor heat	floor heat	Y	Y	Y	
27	Wet or Dry (WC / WT / WS / D)		WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	floor heat	floor heat	floor heat	
29	Cement above pipe	inch	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	WT	WT	WT	
30	Floor Covering		Carpet	Carpet	Carpet	Carpet	Carpet	Carpet	Carpet	Carpet	Carpet	Carpet	2.50	2.50	2.50	
31	Gross Area	sq ft	782	200	960	744	1457	280	989	989	1248	256				
32	Net Area	sq ft	782	200	960	744	1457	280	989	989	1248	256				
41	Required output	Btu/h-sqft	54 Btu	47 Btu	23 Btu	32 Btu	31 Btu	47 Btu	22 Btu	46 Btu	32 Btu	59 Btu				
42	Actual output	Btu/h-sqft	37 Btu	37 Btu	23 Btu	32 Btu	31 Btu	37 Btu	22 Btu	37 Btu	32 Btu	37 Btu				
43	TOTAL BTU	Btuh	28,602	7,315	22,196	24,113	45,764	10,241	21,651	36,174	40,151	9,363				
44	*Non-floor heat*	Btuh														
45	**Short**	Btuh	*11,834*	*1,813*				*2,531*		*8,015*		*5,114*				
46	**BORDER ZONE LOOPS**															
48	Border Zone Area	sq ft														
53	Output	Btu/h-sqft														
55	Zone floor temp	°F														
59	Flow Rate/loop	gpm														
65	ΔP total	ft head														
66	Total Pipe in Border zone	ft														
68	Loops in Border Zone															
69	Manifold Group (Border)															
70	Room / Loop#															
71	Spacing	in														
72	Ave. Border Loop Leng	ft														
73	HeatLink® Setting															
75	**STANDARD ZONE LOOPS**															
76	Floor Temp	°F	86 °F	86 °F	80 °F	84 °F	84 °F	86 °F	80 °F	86 °F	84 °F	86 °F				
79	Flow Rate/loop	gpm	0.79	0.80	0.49	0.67	0.72	0.57	0.48	0.80	0.74	0.53				
85	ΔP (Loop + Manifold)	ft. hd.	7.7	8.2	3.3	5.5	7.0	3.3	3.2	8.0	7.2	2.6				
88	Thermostat / Zone Number															
89	Pipe type (oxy / non oxy)		oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	oxy	
90	Total Pipe in Room	ft	**1083 ft**	**277 ft**	**1330 ft**	**1032 ft**	**2013 ft**	**393 ft**	**1369 ft**	**1369 ft**	**1724 ft**	**361 ft**				
85	Loops in Room		**4**	**1**	**5**	**4**	**7**	**2**	**5**	**5**	**6**	**2**				
96	**Manifold Group**															
97	**Room / Loop#**		**114**	**2**	**115**	**113**	**116**	**101**	**119**	**117**	**122**	**123**				
98	**Spacing**	in	**9 in**	**9 in**	**9 in**	**9 in**	**9 in**	**9 in**	**9 in**	**9 in**	**9 in**	**9 in**	**9 in**	**9 in**	**9 in**	
99	**Average Loop Length**	ft	**271 ft**	**277 ft**	**266 ft**	**258 ft**	**288 ft**	**197 ft**	**274 ft**	**274 ft**	**287 ft**	**181 ft**				
100	**HeatLink® Setting**		**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**	**#N/A**				
102	Base Board Rad Length	ft														
104	B Board For Shortages	ft	22 ft	3 ft				5 ft		15 ft		10 ft				
105	**Design Temp.:**				**Total Circuits:**	**41**		*Floor Heat (BTU/h):*		***245,572***		*Non-floor heat areas:*				*(BtuH)*
106	**Supply Temp.:**		**140 °F**		**Total Pipe:**	**10,950 ft**			*Short:*	***29,306***		*TOTAL BOILER MAKE-UP:*			***274,878***	*(BtuH)*
107	**Total Flow USgal/min:**		**27.1**		**Total ft. hd.:**	**8.20**		**Glycol Vol.:**	**45.38gal**	**171.8 L**		*Mech. Ventilation Res.:*				*(BtuH)*
158	**SQ. FT. Dry system:**				**SQ. FT. Wet Tyrap:**				**SQ. FT. Tracking on Subfloor:**	**7,905**			**SQ. FT. Tracking on styrofoam:**		274,878	*Total BTU*

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MANUFACTURERS REPRESENTATIVE
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HeatLink PEX Tubing Loop Layout and Installation Instructions

Date: June 21, 2006

Project: The Children's School 12 Gary Street Stamford CT

Important Notes for PEX Installers:

1. The amount of loops and lengths of tubing supplied for this project has been calculated by HeatLink USA. The design is as specified by the consulting engineer, and should not be changed without the express consent and authorization of the specifiers.

2. The tubing should be stored in a dry weather protected area until ready for installation. Tubing stored at temperatures below 55F should be brought into a heated area for at least 24 hours before installation begins. PEX tubing gets more rigid as the temperature drops. Tubing should not be stored in direct sunlight or in areas where the temperature can exceed 125F.

3. The tubing loops should be laid out within the allocated areas and not extended in any way. When planning installation, the location of the manifold is paramount. Begin by installing the manifold on either permanent or temporary supports, at the final designed location. Manifolds cannot be moved once the tubing is installed.

4. Supply and Return connections of loops are interchangeable, as the tubing is bi-directional. However good practice is to make the supply, where the water is hottest, to the outside walls. PEX tubing has a shape memory. As tubing is removed from the rolls, unroll it. If the roll is simply expanded, there will be large loops that will make securing it difficult.

5. Refer to the materials chart included in the submittals for specific length/rolls to be used for each loop or room area. Where a roll is long enough, it can be used for more than one loop. Example: 3 loops of 330' each are required. A 1000-foot long roll supplied will be required. However excessive loop length will cause material shortage at the end of the project.

6. Tubing is marked at every 3 foot increment. While installing each loop, the length of the loop must be continually monitored. The distance required as a leader from the manifold to the heated area should be noted. This length is included in the maximum loop lengths designed. As the tubing is placed in serpentine paths back and forth, allow for the length of tubing required to return back to the manifold location. **There are no hiding loops that are too long or too short**. The tubing is marked and will be exposed at the manifold location. The balance valves within the manifold will allow balancing of flow between loops but they will not compensate for loops that are too long or where there is a great disparity in the loop lengths.

7. Tubing should be secured into tracking if provided or directly to webbing or reinforcing steel in wet pour installations. The tubing should be only secured with plastic tie wrap straps. Do NOT use wire or any other metal restraints.

8. If tubing is applied to steel within the concrete, be certain the mason supports the steel so that the tubing is at the proper depth for the design. Tubing too low in the mass will have poor response, and tubing too high in the mass will cause spalling or flaking on the surface of the concrete over time.

9. Where the tubing will pass through concrete expansion joints, each loop should be sleeved through a 12" piece of armaflex type soft installation to prevent damage from shearing afterwards. As well, tubing should always be run through a plastic conduit elbow, supplied with the system, where it enters and exits the concrete mass. Over time expansion will cause failure of the tube if not protected in this manner.

10. Tubing MUST be air pressure tested as outlined in the instructions and the specifications. Failure to test the system fully voids the warranty. It is not worth the shortcut to let the process continue until <u>your work has been tested and verified</u>. If testing with air, 60 psig maximum is recommended. Leave the tubing charged with the test pressure while the concrete is being poured. Monitor the tubing system at each manifold while the concrete is being poured. Any damage will show up immediately, and the pour must be stopped for repair.

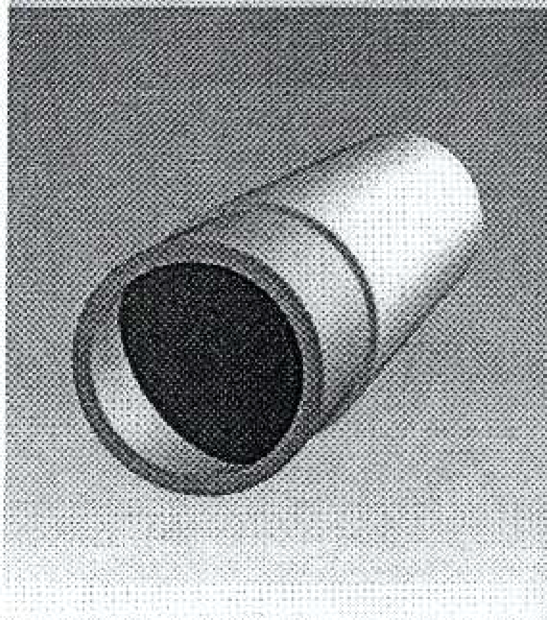
11. The manifold provides a shutoff valve and balancing valve for each individual loop. However, each manifold must have shutoff valves installed in the field on supply and return. It is also a good practice to install a hose bib for bleeding air on both supply and return lines. Sometimes it is necessary to purge in both direction to totally eliminate air within the tubing that will restrict flow. If multiple manifolds are being installed on the same system, balancing devices may be required. Check the specification to see what type of valve is to be used.

12. Tubing should <u>not</u> be installed within 6 inches of the edge of any system. Carpet strips, railing mountings, wall plates, and other devices that may be secured into the floor may damage tubing.

13. When cutting PEX tubing, use a plastic cutter, not a saw. Plastic filings must be cleaned off ends before being made up into the manifold brass connections. Filings that are not flushed out of the system before connection will lodge in the balance valve of the return manifold connection.

14. A chemical cleaner should be used to completely clean and then flush the system before adding glycol. For snow melt systems a minimum of 40% glycol should be installed. For space heating apllcaitons, a minimum of 20% glycol is recommended for corrosion and bacteria control.

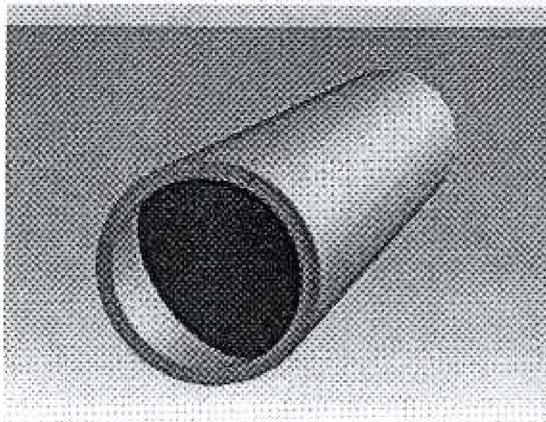
HeatLink® PEX Heating Pipe
Page 2



HeatLink® Blue PEX-C Heating Pipe
98000 Series

High molecular Cross-linked Polyethylene (PEX) extruded from BASF base, with minimum bending radii of 6 times the diameter at 68°, and 8 times pipe diameter at 32-68°. Maximum operating temperature 180°F @ 100 PSI. Covered by a twenty-five year manufacturers warranty. Conforms to ASTM F-876/77, NSF61, CSA B137.5 LM101713, DIN 4726/9, IAPMO-C, and ICBO ES ER-5258.

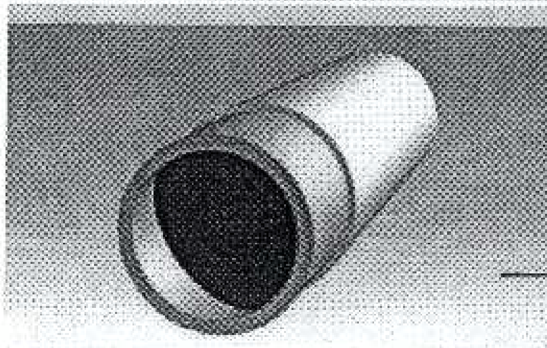
Description	Stk. #	Qty.
3/8" Blue PEX-C with O_2 Barrier	98312	300'
1/2" Blue PEX-C with O_2 Barrier	98305	300'
	98105	1000'
5/8" Blue PEX-C with O_2 Barrier	98419	450'
	98119	1000'
3/4" Blue PEX-C with O_2 Barrier	98322	300'
	98122	1000'



HeatLink® SnowMelt
96000 Series

Specified as above, without oxygen diffusion barrier. For use in nonferrous, or inhibited systems where protection from ultraviolet light is desired.

Description	Stk. #	Qty.
5/8" Black UV PEX-C without O_2 Barrier	96419	450'
	96119	1000'
3/4" Black UV PEX-C without O_2 Barrier	96322	300'
	96122	1000'



HeatLink® PEX-A Heating Pipe
94000 Series

Specified as above. Available with oxygen diffusion barrier only.

Description	Stk. #	Qty.
1/2" PEX-A with O_2 Barrier	94305	300'
	94105	1000'
5/8" PEX-A with O_2 Barrier	94419	450'
	94119	1000'

Technical Specifications

Mechanical Properties		PEX A (Engel/Peroxide)	PEX C (Irradiation)	Unit	Standard Tested
Density		938	940	kg/m^3	ASTM F 876
Tensile strength	(at 20°C)	20-26	23-26	N/mm^2	DIN 53455
	(at 100°C)	9-13	9-13	N/mm^2	
Modulus of elasticity E	(at 20°C)	1150	600-900	N/mm^2	DIN 53457
	(at 80°C)	560	400	N/mm^2	
Elongation on failure	(at 20°C)	300-450	500-700	%	DIN 53455
	(at 100°C)	500-700	750-900	%	
Impact strength	(at 20°C)	No failure	No failure	kJ/m^2	DIN 53453
	(at -140°C)	No failure	No failure*	kJ/m^2	
Moisture absorption	(at 22°C)	0.01	0.01	mg/4d	DIN 53472
Coefficient of friction on steel		0.08-0.1	0.08-0.1	-	
Surface energy		34×10^{-3}	34×10^{-3}	N/m	
Oxygen permeability	(at 20°C)	0.7×10^{-3}	0.7×10^{-3}	g/m^3 day	DIN 4726
	(at 55°C)	2.6×10^{-3}	2.6×10^{-3}	g/m^3 day	
ESCR (environmental cracking)		No failure	No failure		ASTM F 876
Degree of Crosslinking 65% to 75%					ASTM F 876

Thermal Properties		PEX A	PEX C	Unit	
Service temperature range		-100, +120	-100, +120	°C	
Coefficient of linear expansion	(at 20°C)	1.4×10^{-4}	1.4×10^{-4}	m/m°C	
Coefficient of linear expansion	(at 100°C)	2.05×10^{-4}	2.05×10^{-4}	m/m°C	
Softening temperature		+133	+133	°C	
Specific heat		2.3	2.3	kJ/kg°C	
Coefficient of thermal conductivity		0.38	0.38	W/m°C	

Electrical Properties		PEX A	PEX C	Unit	
Specific internal resistance	(at 20°C)	10^{15}	10^{15}	-m	
Dielectric constant	(at 20°C)	2.3	2.3		
Dielectric loss factor	(at 20°C/50 Hz	1×10^{-3}	1×10^{-3}	-	
Rupture voltage	(at 20°C)	60-90	60-90	kV/mm	

* tested at -80°C

* **Basic Standard DIN 16892/3**—Pipe properties such as: degree of cross-linking, dimensions and tolerances, long term pressure testing at 95°C @ 6 bar (203°F @ 90 PSI), ageing resistance in heat, and more, are tested according to DIN 16892/3 in frequencies exceeding DIN requirements. HeatLink® pipes meet all these standards and exceed these requirements in many cases.

* **Basic Standard ASTM F 876, for nominal Imperial sizes**—dimensions are marked in nominal sizes, long term pressure testing at 200°F @ 80 PSI. HeatLink® pipes meet all these standards and exceed these requirements in all cases.

HeatLink®'s PEX pipes are made of a unique high density Polyethylene and contains special additives to avoid thermic ageing at high heating water temperatures. Pipes for floor heating systems may be coated with an optional Oxygen diffusion barrier. Strict quality testing and control are routinely performed at the manufacturer's laboratories, in addition to elaborate on line monitoring. Independent testing agencies assure the high quality of the product and conformity to standard requirements.

Guarantee

AND LIMITED WARRANTY

10 YEAR WARRANTY

For our HeatLink® cross linked PEX pipe, we render the following warranty over and above our terms of delivery: Our cross linked pipe is manufactured from high quality, high heat stabilized Polyethylene. Within a period of 10 years from the date of manufacture, we offer compensation up to a limit of 5,000,000 US dollars in individual cases and up to a limit of 5,000,000 US dollars in the whole number of cases per year, covered by a production liability insurance.

a) for damage to property of third persons and the resulting damage therefrom, and / or
b) for expenses to third persons for removal, dismantling, or uncovering defective products and for installing, fixing , and laying of new products to be supplied by us
c) furthermore we guarantee compensation for a period not exceeding 10 years after liquidation.
d) for a period of 10 years from the date of manufacture, free replacement for the cross linked PEX pipe supplied by us in which defects arise, that can be proved to have arisen from manufacturing or material faults for which the manufacturer is responsible. This is subject to compliance with the guidelines as outlined in our installation manual.

EXTENDED 15 YEAR LIMITED WARRANTY

Limited Warranty: This limited warranty shall expire twenty-five (25) years after the date of manufacture for our HeatLink® and AquaLink® cross linked PEX pipes.

HeatLink USA Inc., HeatLink Ireland, and Polytech Products Inc. sole obligation hereunder shall be, at its option, to issue credit, repair or replace any article or part thereof which is proved to be other than as warranted. Further, no allowances shall be made to buyer for transportation, labour charges or part adjustments or repairs or any other work.

Additionally, any performance by buyer or its designee, of any repairs without the express written consent of HeatLink USA Inc., HeatLink Ireland, and Polytech Products Inc. , shall render this Warranty invalid.

GENERAL GUIDELINES FOR THE LAYING OF PEX PIPE:

1. The minimum bending radius is 6 times pipe diameter at an ambient temperature of +20°C, and 8 times pipe diameter by lower temperatures down to 0°C.
2. Fixing of the pipe must be made with suitable pipe clamps. Fixing with binding wire is not permissible.
3. Before enclosure of the PEX pipe, the pipe must be put under pressure by water or air, (if necessary antifreeze should be added). This test should be carried out at a pressure not less than 550 kPa (80 psi) and not more than 690 kPa (100 psi) and remain thus for 24 hours, after which all connections should be tightened. The pipe is to remain under pressure while the covering is being laid.
4. Storage of the PEX pipes which allows an exposure to sun light is not permissible (danger of UV rays).
5. In areas liable to frost, a suitable anti-freeze is to be used.
6. Kinking and buckling points are to be removed.

NO LIABILITY CAN BE ACCEPTED FOR FAULTS IN INSTALLATION OR LAYING OF THE PIPE. OUR GENERAL LAYING DIRECTIONS ARE A CONSTITUENT PART OF THIS WARRANTY. QUALITY CONTROL CHECKS ARE CARRIED OUT UNDER CONTRACT WITH THE MANUFACTURER. HEATLINK® DISCLAIMS ANY EXPRESS WARRANTY NOT PROVIDED HEREIN, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEATLINK® FURTHER DISCLAIMS ANY RESPONSIBILITY FOR LOSSES, EXPENSES, INCONVENIENCES, SPECIAL, INDIRECT, SECONDARY INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING FROM OWNERSHIP OR USE OF THE ARTICLES SOLD HEREUNDER. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FACE HEREOF.

POLYTECH PRODUCTS INC.
COMPONENTS & ELECTRONICS

WARRANTY

Limited Warranty: This limited warranty shall expire 18 MONTHS after the Polytech Products Inc. shipping date for all products as listed in the pricing catalog. These include all HeatLink® and AquaLink® brass compression fittings, 4-way mixing valves and actuating motors, distribution manifolds, plus all StatLink® and MultiZone electronics including all thermostats and zone drive motors.
Polytech Products Inc. sole obligation hereunder shall be, at its option, to issue credit, repair or replace any article or part thereof which is proved to be other than as warranted. Further, no allowances shall be made to buyer for transportation, labour charges or part adjustments or repairs or any other work. Additionally, any performance by buyer or its designee, of any repairs without the express written consent of Polytech Products Inc., shall render this Warranty invalid.

NO LIABILITY CAN BE ACCEPTED FOR FAULTS IN INSTALLATION OR ASSEMBLY OF THE VARIOUS COMPONENTS. OUR GENERAL INSTALLATION DIRECTIONS ARE A CONSTITUENT PART OF THIS WARRANTY. IN ADDITION, NO LIABILITY WILL BE ACCEPTED DUE TO DAMAGE CAUSED BY EXCESSIVE TEMPERATURES OR PRESSURES, EXPOSURE TO UNAUTHORIZED FLUIDS, CHEMICALS, ACIDS, SOLDER, FLUX, HIGHLY ALKALINE SOLUTIONS OR STRONG OXIDIZING AGENTS, WATER IMPURITIES AND WATER CONDITIONS WHICH MAY HAVE CAUSED UNUSUAL DEPOSITS OR SLUDGE FORMATION. QUALITY CONTROL CHECKS ARE CARRIED OUT UNDER CONTRACT WITH THE MANUFACTURER. POLYTECH PRODUCTS INC. DISCLAIMS ANY EXPRESS WARRANTY NOT PROVIDED HEREIN, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. POLYTECH PRODUCTS INC. FURTHER DISCLAIMS ANY RESPONSIBILITY FOR LOSSES, EXPENSES, INCONVENIENCES, SPECIAL, INDIRECT, SECONDARY INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING FROM OWNERSHIP OR USE OF THE ARTICLES SOLD HEREUNDER. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE FACE HEREOF.

UNIT HEATERS

FOR STEAM OR HOT WATER

Installation, Operation & Maintenance

HYDRO-AIR COMPONENTS INC.

CONTENTS

General Information

Installation and service instructions in this manual are applicable to the steam/hot water unit heaters which should be installed in their proper applications for their most effective function as overhead heating units. The copper coils are warranted for operation at steam or hot water pressures up to 180 psig, and or temperatures up to 360°F. Canadian Standards Association (CSA) requirements state that explosion-resistant designs may not be used with a fluid temperature in excess of 329°F (165°C) and still maintain their explosion-resistant rating, for National Electric Code (NEC) or Canadian Electric Code (CEC) ignition temperature rating T3B for grain dust.

DO NOT REMOVE OUTLET FAN GUARD FROM MODEL RV UNITS.

Inspection On Arrival

1. Inspect unit upon arrival. In case of damage, report immediately to transportation company and your local Rittling Sales Representative.
2. Check rating plate on unit and motor to verify that power input and motor specification meet available electric power at point of installation.
3. Inspect unit received for conformance with description of product ordered (including specifications where applicable).

INSTALLER'S RESPONSIBILITY
Installer Please Note: This equipment has been test fired and inspected. It has been shipped free from defects from our factory. However, during shipment and installation, problems such as loose wires, leaks, or loose fasteners may occur. **It is the Installer's responsibility to inspect and correct any problems that may be found.**

INSTALLATION

SPECIAL PRECAUTIONS

1. Disconnect power supply before making wiring connections to prevent electrical shock and equipment damage. All units must be wired strictly in accordance with wiring diagram furnished with unit.
2. Units should not be installed in atmospheres where corrosive fumes or sprays are present.
3. Units with power codes 01, 02, or 05 must not be installed in potentially explosive or flammable atmospheres.
4. Be sure no obstructions block air intake or air discharge of unit heater.
5. Do not install unit above recommended maximum mounting heights or below the minimum height of eight feet.

UNIT SUSPENSION

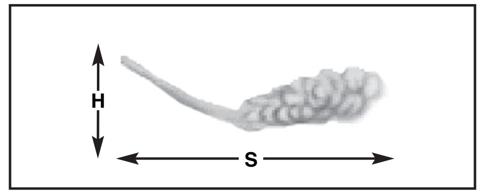
Horizontal Delivery Units, Model RH Series
All horizontal delivery units have two tapped holes (3/8"-16) in the top for unit suspension. Piping support hangers or clamps are recommended and should be placed as close to the unit heater as possible. For other models, independent suspension can be made with threaded rods, pipes, or ceiling hanger brackets.

Vertical Delivery Units, Model RV Series
Models RV-42 through RV-161 have 4 tapped holes (1/2"-13) on the top surface for unit suspension. Suspension can be made with threaded rods, pipes, or ceiling hanger brackets. Models RV-193 through RV-610 have angle-iron frame mounting brackets for heavy-duty installation with applicable hardware.

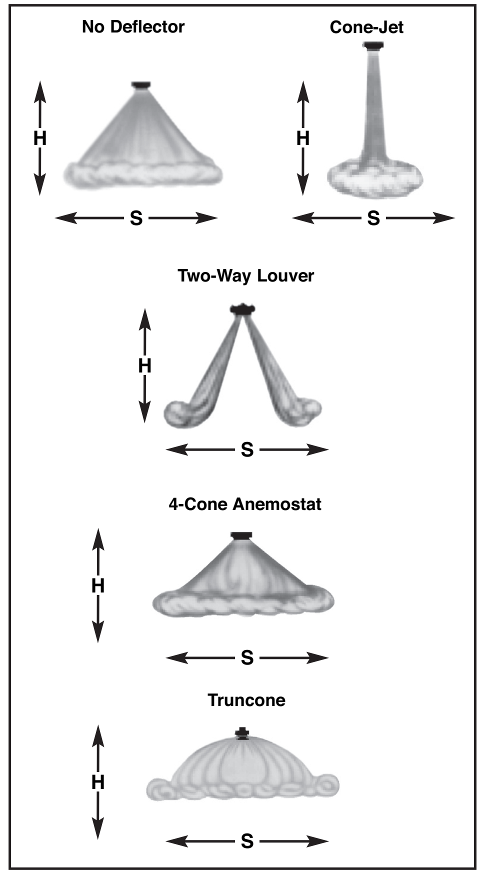
UNIT HEATER MOUNTING HEIGHT

Do not install unit above recommended maximum mounting heights or below the minimum height of eight feet. The height at which unit heaters are installed is critical. Maximum mounting heights for all units are listed below. Maximum mounting heights for Model RV is given for units with or without air diffusion accessories. Locate horizontal delivery unit heaters so air streams of individual units wipe the exposed walls of the building with either parallel or angular flow without blowing directly against the walls. Heaters should be spaced so the air stream from one supports the air stream from another heater. Locate vertical delivery unit heaters in the center area of the space to be heated, using horizontal delivery unit heaters along the walls where heat loss is usually greatest. *See Mounting Height.*

Horizontal Air Delivery



Vertical Air Delivery



MAXIMUM MOUNTING HEIGHTS

Horizontal Type			Vertical Type															
Model Number	Height-Ft.		Model Number	No Deflector Height-Ft.		Cone-Jet Height-Ft.		Truncone Height-Ft.		One-Way Louvers Height-Ft.		Two-Way Louvers Height-Ft.		3-Cone Anemostat Height-Ft.		4-Cone Anemostat Height-Ft.	
	H	S		H	S	H	S	H	S	H	S	H	S	H	S	H	S
RH-18	9	17	**RV-42**	11	17	15	11	8	19	13	11	8	22	8	22	8	28
RH-24	9	18	**RV-59**	13	20	18	13	9	25	16	14	10	28	9	28	8	35
RH-33	10	20	**RV-78**	14	22	19	14	11	26	17	15	11	30	11	30	8	30
RH-47	12	25	**RV-95**	16	24	21	16	11	26	17	15	11	30	11	30	8	30
RH-63	14	29	**RV-139**	18	27	24	18	13	32	21	18	13	36	13	36	9	45
RH-86	15	31	**RV-161**	21	31	28	21	14	35	23	20	14	40	14	40	10	50
RH-108	15	32	**RV-193**	23	34	31	23	16	39	25	22	15	44	16	44	12	55
RH-121	16	33	**RV-212**	25	37	33	25	16	39	25	22	15	44	16	44	12	55
RH-165	17	34	**RV-247**	26	39	34	26	17	46	30	26	18	52	17	52	13	65
RH-193	18	37	**RV-279**	30	45	37	30	18	53	35	30	21	60	18	60	13	75
RH-258	19	40	**RV-333**	30	45	37	30	17	53	35	30	21	60	17	60	13	75
RH-290	20	44	**RV-385**	30	45	36	30	17	53	35	30	21	60	17	60	13	75
RH-340	20	46	**RV-500**	37	56	44	37	19	65	42	37	26	74	19	74	13	93
			RV-610	36	54	43	36	19	63	41	41	25	72	-	-	-	-

NOTES: With hori ontal louvers open 30° from the vertical plane. Values are for heaters operating at standard conditions (2 psi. Steam and 60 °F entering air).
Listed heights for two-way louvers and cone jet are with deflectors in their fully-opened position.

INSTALLATION

Suggested Piping Arrangements

PIPING INSTALLATION

Horizontal and Vertical Unit Heaters
Note: Only make piping connections using two (2) pipe wrenches. One wrench is used as a "back-up" while the other wrench is used for applying force necessary to tighten the fitting.

The illustrations, on right, suggest four (4) different piping configurations. Refer to the ASHRAE Guide & Specialty Manufacturer for selection of filter, piping traps and other specialty sizing. Piping is typical for unit heaters.

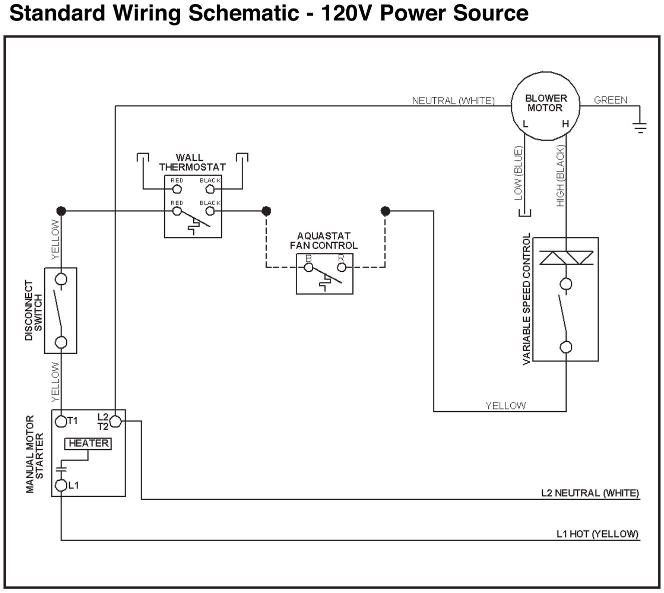
Wiring Instructions
Disconnect power supply before making wiring connections to prevent electrical shock and equipment damage. All units must be wired strictly in accordance with wiring diagram.

All wiring must be done in accordance with the National Electric Code and applicable local codes. In Canada, wiring must conform to the Canadian Electric Code. It is recommended that all wiring be adequately grounded.

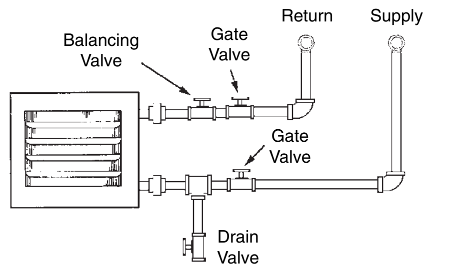
Electric wiring must be sized to carry the full load amp draw of the motor, starter, and any controls that are used with the unit heater. All units with power code 05 (polyphase motors) must be provided with suitable overcurrent protection in circuit supplying heater at installation. Overcurrent protectors should be sized based on motor current rating shown on the unit serial plate, and applicable national electric code procedures.

All units should be installed with an electrical junction box. Junction boxes are either integral to the motor or to be attached to the unit casing. Units with explosion-proof motors have an explosion-proof junction box attached to the motor. Any damage to or failure of Rittling units caused by incorrect wiring of the units is not covered by Rittling's standard warranty.

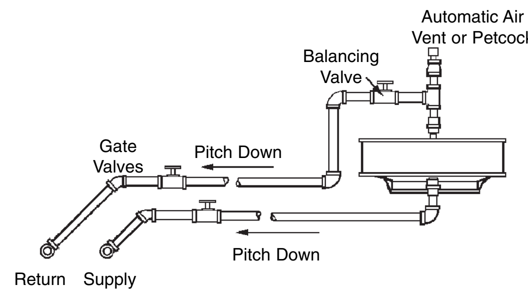
Standard Wiring Schematic - 120V Power Source



Hot Water Systems

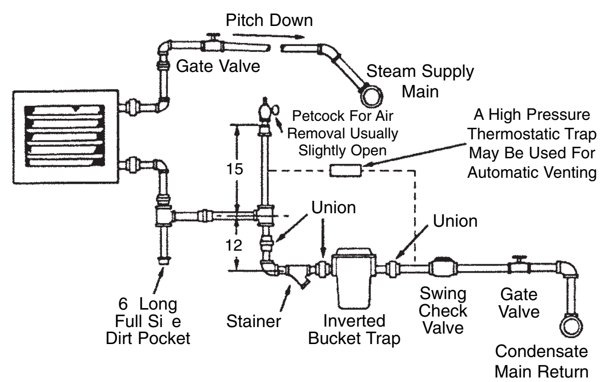


Horizontal Unit Heater Connected to Overhead Hot Water Mains

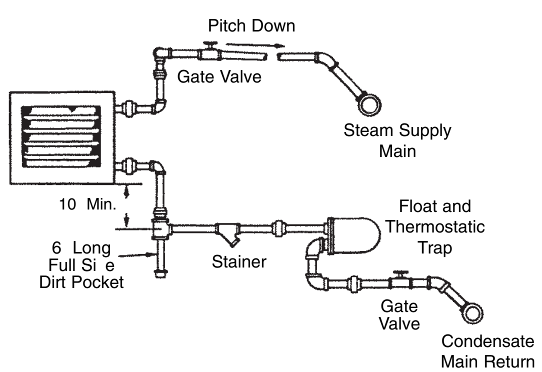


Vertical Unit Heater Connected to Lower Hot Water Mains

Steam Systems



Unit Heater Connection for High Pressure Steam



Unit Heater Connection for Low Pressure Steam - Open Gravity or Vacuum Return System

OPERATION

Prior to Operation

1. Check all electrical connections to assure they are secure.
2. Check rigidity of unit mounting. Tighten all fasteners, if necessary.
3. Inspect piping, strainers, traps, fittings, etc.

Initial Start-Up

1. Set thermostat to lowest position.
2. Turn on power supply to unit.
3. Open return gate valve, and then open supply gate valve to unit.
4. Raise thermostat setting to desired position.
5. Adjust louvers (if provided) for desired heat distribution.
6. To ensure proper sequence of operation, cycle unit on and off a few times by raising and lowering thermostat setting.
7. Check for proper rotation of fan. All fans must rotate in a counterclockwise direction when viewed from the back (RH) of the unit heater.

UNIT HEATER MAINTENANCE

Inspect Regularly

Under average conditions, it is recommended that unit heaters be inspected before every heating season — more often in locations where air is contaminated with corrosive fumes, dust, soot or oil spray. Check for dirty, clogged coils, excessive vibration and loose connections. Inspect piping, strainers, traps, fittings, etc.

Motors

A. Cleaning

Remove grease and dirt on motor during each inspection or lubrication. Open frame motors should be blown clean every heating season, or whenever coils are cleaned, whichever is sooner.

B. Lubrication

Motors do not have oil fittings. These motors are lubricated for long life and do not require further lubrication.

C. Overload Protection

A change in line voltage higher or lower than motor nameplate rating may cause overheating and serious motor damage. Check plant voltage conditions. A separate manual starter with thermal overload protection device is recommended for those units that do not have motors with built in overload protection.

Casings

A. Cleaning

Periodic cleaning of casings is recommended to remove dirt, grease and corrosive substances that may injure finish. Rusted or corroded spots should be cleaned and repainted.

B. General Inspection

Tighten fan guard and motor bracket. Check fan for proper clearance, free rotation and firm connection to shaft. When servicing is complete, tag unit to indicate date of inspection and cleaning.

Coils

A. Cleaning

Clean coil at least once a year, more often under unfavorable conditions. Unless coil is kept reasonably free of dirt, lint and grease, its original heating capacity will be reduced — possibly to a serious degree, and motor damage may result.
Two commonly used cleaning methods are:

1. Loosen dirt by brushing fins on side where air enters coil and then turn on fan to blow dirt from unit.
2. Use high-pressure air hose to loosen dirt by blowing from side where air leaves coil (side adjacent to louvers on blow-through units (RH); side adjacent to fan on draw-through units (RV)). For thorough cleaning of coil, remove motor and fan and spray a mild alkaline cleaning solution over the coil. After a few minutes, follow by a hot water rinse. (A steam gun can be used for spraying cleaning solution and hot water.) Coils subjected to corrosive fumes should be checked and cleaned frequently.

B. Internal Corrosion Safeguards

Provide controlled water treatment — don't use excess of boiler compounds. Contact your boiler compound supplier for proper usage or the services of a water treatment laboratory. Periodic internal flushing of the coils is recommended in areas where water supply is suspected of causing scale. Use an alkaline-chelant solution and introduce it at the main pump of the hydronic system. Flush thoroughly.

WARNING: USING INORGANIC OR MINERAL ACIDS SUCH AS MURIATIC (HYDROCHLORIC) ACID, EVEN THOUGH INHIBITED, MAY LEAD TO SEVERE DAMAGE, INCLUDING CORROSION AND LEAKAGE.

De-aerate boiler feed-water (particularly if large amount of new water is used). Ensure rapid continuous and adequate condensate drainage by properly sized and installed traps and piping. Check traps for sticking. Clean strainers ahead of traps. (When traps don't work, condensate accumulates in unit heater coil; water hammer results.) Adequately vent each unit. Use low-pressure steam when possible.

THE EQUIPMENT COVERED IN THIS MANUAL SHOULD BE INSTALLED, MAINTAINED AND SERVICED BY A QUALIFIED LICENSED TECHNICIAN. FOR SERVICE CONTACT YOUR LOCAL LICENSED QUALIFIED INSTALLATION AND SERVICE CONTRACTOR OR APPROPRIATE UTILITY COMPANY.

WARRANTY

Hydro-Air Components Inc. manufacturer of the Rittling product line, guarantees its products to be free from defects in material and workmanship for a period of one year from date of shipment from our Hamburg, NY factory.

Should there be any defects in the good(s), the purchaser should promptly notify Hydro-Air Components Inc. and upon receipt of written consent fromHydro-Air Components Inc. the purchaser shall return the defective good(s) to the factory for inspection with freight prepaid. If inspection shows the goods to be defective, Hydro-Air Components Inc. will at its discretion repair or replace the said item(s).

Defects arising from damage due to shipment, improper installation, negligence or misuse by others are not covered by this warranty.

This warranty is extended only to the original purchaser from Hydro-Air Components Inc.

Rittling HYDRONICS

Hydro-Air Components Inc.
4950 Camp Road Hamburg, New York 14075
Phone: 716-648-3801 Fax: 716-648-3203
Toll-Free: 800-FIN-TUBE (800-346-8823)
E-mail: sales@rittling.com www.Rittling.com

Valve Chart Children's School

1. Hot water boiler #1 supply header isolation
2. Hot water boiler #1 return header isolation
3. Hot water boiler #2 supply header isolation
4. Hot water boiler #2 return header isolation
5. Hot water boiler #3 supply header isolation
6. Hot water boiler #3 return header isolation
7. Air Separator lock shield valve to expansion tank
8. Air Separator drain valve
9. Chemical feeder supply
10. Chemical feeder return
11. Chemical feeder drain
12. PRV inlet isolation
13. PRV outlet isolation
14. PRV by-pass
15. Primary Hot Water circulation pump #2 shut off
16. Primary Hot Water circulation pump #2 Triple Duty Valve
17. Primary Hot Water circulation pump #1 shut off
18. Primary Hot Water circulation pump #1 Triple Duty Valve
19. Secondary Hot Water circulation pump #2 shut off
20. Secondary Hot Water circulation pump #2 Triple Duty Valve
21. Secondary Hot Water circulation pump #1 shut off
22. Secondary Hot Water circulation pump #1 Triple Duty Valve
23. Hot Water Radiant circulation pump # 2 shut off
24. Hot Water Radiant circulation pump # 2 circuit setter
25. Hot Water Radiant circulation pump # 1 shut off
26. Hot Water Radiant circulation pump # 1 circuit setter
27. Hot Water Radiant system three way valve
28. Hot Water Radiant return isolation
29. Hot Water Radiant main return shut off
30. Main system Hot Water return shut off
31. Primary Hot Water circulation pump #1 strainer blow down
32. Primary and Secondary Hot Water system riser drain
33. Primary Hot Water circulation pump #2 strainer blow down
34. Secondary Hot Water circulation pump #2 strainer blow down
35. Secondary Hot Water circulation pump #1 strainer blow down
36. Primary and Secondary Hot Water system main riser drain
37. Radiant system riser drain

38. Hot Water Radiant circulation pump #2 strainer blow down
39. Hot Water Radiant circulation pump #1 strainer blow down
40. VAV unit # 1 supply shut off
41. VAV unit # 1 return shut off
42. Supply shut off Radiation room 113
43. Return shut off Radiation room 113
44. Main supply shut off for VAV boxes 2,3,4
45. Main return shut off for VAV boxes 2,3,4
46. Supply shut off Radiation room 105
47. Return shut off Radiation room 105
48. Supply shut off AHU #1
49. Return shut off (circuit setter) AHU #1
50. Main by-pass return AHU #1
51. By-pass valve #1 AHU #1
52. By-pass valve #2 AHU #1
53. Supply shut off Unit Heater #1
54. Return shut off Unit Heater #1
55. Supply shut off Radiant system Zone 2 rooms 108-113
56. Return shut off Radiant system Zone 2 rooms 108-113

Items (including # 91 and #92) #1 through #56 are located in Boiler Room

57. Supply shut off Radiant system Zone 1 room 114
58. Return shut off (circuit setter) Radiant system Zone 1 room 114
59. Supply shut off Radiant system Zone 3 room 116
60. Return shut off (circuit setter) Radiant system Zone 3 room 116
61. Supply shut off Radiant system Zone 1 room 115
62. Return shut off (circuit setter) Radiant system Zone 1 room 115
63. Main supply shut off Radiant system Zones 4,5,6
64. Main return shut off Radiant system Zones 4,5,6
65. Supply shut off Radiation room 116 column 4-F
66. Return shut off Radiation room 116 column 4-F
67. Supply shut off Radiation room 114 column 1-F
68. Return shut off Radiation room 114 column 1-F
69. Supply shut off Radiation room 114 column 1-M
70. Return shut off Radiation room 114 column 1-M
71. Main supply shut off to Gym
72. Main return shut off to Gym
73. Main supply shut off Radiation rooms 117,118,122,123
74. Main return shut off Radiation rooms 117,118,122,123

Items #57 through #74 are located in basement storage room
Items 75 through 92 are identified but not tagged.

75. VAV unit # 2 supply shut off
76. VAV unit # 2 return shut off
77. VAV unit # 3 supply shut off
78. VAV unit # 3 return shut off
79. VAV unit # 4 supply shut off
80. VAV unit # 4 return shut off
81. Supply shut off Radiant system Zone 4-1 room 117
82. Return shut off (circuit setter) Radiant system Zone 4-1 room 117
83. Supply shut off Radiant system Zone 5-1 rooms 118,119,120,121,123
84. Return shut off (circuit setter) Radiant system Zone 5-1 rooms 118,119,120,121,123
85. Supply shut off Radiant system Zone 6-1 room 122
86. Return shut off (circuit setter)Radiant system Zone 6-1 room 122

Items 87 through 90 in Gym area

87. Supply shut off HWC #1
88. Return shut off HWC #1
89. Supply shut off HWC #2
90. Return shut off HWC #2

91. AHU #1 primary drain
92. AHU #1 strainer blow down
93. Main shut off for radiation first floor
94. Main shut off for radiation first floor

Children's School
Hydronic Pumps VFD Startup Report

VFD #1					VFD #2			
	Volts					Volts		
	L1	L2	L3			L1	L2	L3
	120.1	120.3	119.8			120.3	120.4	120.1
	Amps					Amps		
	L1	L2	L3			L1	L2	L3
60Hz Auto	3.34	3.36	3.36		60Hz Auto	3.23	3.27	3.3
Full BHP	3.7	3.8	3.6		Full BHP	3.47	3.5	3.52
Adjust Parameters		Drive			Control			
ACC	10s	UNS	230V		TCC	2 wire		
DEC	10s	FRS	60Hz		TCT	2 wire		
LSP	3Hz	NCR	6.9a		RIN	No		
HSP	10Hz	NSP	1748		BSP	No		
FLG	20%	COS	0.81		CRL	4.0 ma		
STA	20%	TUN	yes		CRH	20.0 ma		
ITH	6.9a	TFR	72Hz		AOL	0 ma		
TDC	.5s	NLD	yes		AOH	20 ma		
SDC	2.9a	FDB	No		LCC	No		
FPT	0	BRA	yes		PST	Yes		
JPF	0	FRT	0		ADD	0		
JF2	0	STT	Ramp		TBR	19200 BOD		
JF3	0	RPT	Linear		RPR	No		
USC	1	TL1	200					
LST	0	CL1	10.6					
		ADC	yes					
		SFT	Lt duty					
		SFR	8Hz					
		NRD	No					
I/O			Fault			Files		
L12		Free wheel stop	ATR		No	F1S	In use	
L13		Auto/manual	RST		Partial	F2S	Free	
L14		Fault reset	OPL		No	F3S	Free	
A12		Speed ref	THT		Vent. Motor	F4S	Free	
R2		Drive run	LFL		No	FOT	No	
A01		Motor frequency	FLR		Yes	COD	No	
			STP		No			
Motor Info								
Armstrong								
Model Number: HB 002 4FJA								
60Hz - 1725 RPM								
2HP - 208-230 Volts								
1.15 SP - 6.9 - 6.2 Amps								

CFM TEST & BALANCE CORPORATION

14 DEPOT SQUARE

BETHEL, CONNECTICUT 06801

(203) 778-1900

TESTING AND BALANCING SUBMITTAL

FOR

THE CHILDREN'S SCHOOL

12 GRAY ROAD

STAMFORD, CT

CFM Test & Balance Corporation
ASSOCIATED AIR BALANCE COUNCIL
AABC
TBE • 02-08-25
Robert J. Wade, III

JULY 26, 2007

CFM #4055

CFM TEST & BALANCE CORPORATION	THE CHILDREN'S SCHOOL 12 GARY ROAD STAMFORD, CT	DATA SHEET # 1
14 DEPOT SQUARE, BETHEL, CT 06801 TEL (203) 778-1900 FAX (203) 778-1710	DATE 7/26/07 BY RW	CFM 4055

PUMP NO.	HWRP-1		
MANUFACTURER	ARMSTRONG		
SIZE	1.5B 1050-001		
IMPELLER	4.75"		
SERVICE	RADIANT FLOOR		
TEST DATA	**GPM**	**FT. HD.**	**BHP**
DESIGN	32.7	20.0	.29
ACTUAL	34.0	19.9	.39
DISCHARGE	25.8		
SUCTION	17.2		
ΔP	8.6 X 2.31 = 19.9 FT. HD.		
BLOCK OFF			
DISCHARGE	28.3		
SUCTION	18.6		
ΔP	9.7 X 2.31 = 22.4 FT. HD.		
MOTOR MFG.	ARMSTRONG		
H.P.	1/2		
RPM	1725		
AMPS	2.1	ACT:	1.7/1.7/1.6
VOLTS	208	ACT:	208/207/205

PUMP NO.	HWRP-2		
MANUFACTURER	ARMSTRONG		
SIZE	1.5B 1050-001		
IMPELLER	4.75"		
SERVICE	RADIANT FLOOR		
TEST DATA	**GPM**	**FT. HD.**	**BHP**
DESIGN	32.7	20.0	.29
ACTUAL	31.8	20.3	.40
DISCHARGE	25.9		
SUCTION	17.1		
ΔP	8.8 X 2.31 = 20.3 FT. HD.		
BLOCK OFF			
DISCHARGE	28.4		
SUCTION	18.5		
ΔP	9.9 X 2.31 = 22.9 FT. HD.		
MOTOR MFG.	ARMSTRONG		
H.P.	1/2		
RPM	1725		
AMPS	2.1	ACT:	1.6/1.8/1.7
VOLTS	208	ACT:	207/206/205

CFM TEST & BALANCE CORPORATION
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TEL (203) 778-1900 FAX (203) 778-1710

THE CHILDREN'S SCHOOL
12 GARY ROAD
STAMFORD, CT

DATE 7/26/07 BY RW

DATA SHEET # 2
CFM 4055

PUMP NO.	SHWP-1
MANUFACTURER	ARMSTRONG
SIZE	2X2X8 4380
IMPELLER	6.5"
SERVICE	SECONDARY HOT WATER

TEST DATA	GPM	FT. HD.	BHP
DESIGN	77.0	40	1.25
ACTUAL	78.0	39.7	1.33
DISCHARGE	38.6		
SUCTION	21.4		
ΔP	17.2 X 2.31 = 39.7 FT. HD.		

BLOCK OFF	
DISCHARGE	42.1
SUCTION	23.5
ΔP	18.6 X 2.31 = 43.0 FT. HD.

MOTOR MFG.	ARMSTRONG		
H.P.	2		
RPM	1725		
AMPS	6.9	ACT:	4.6
VOLTS	208	ACT:	205

PUMP NO.	SHWP-2
MANUFACTURER	ARMSTRONG
SIZE	2X2X8 4380
IMPELLER	6.5"
SERVICE	SECONDARY HOT WATER

TEST DATA	GPM	FT. HD.	BHP
DESIGN	77.0	40	1.25
ACTUAL	79.0	39.5	1.36
DISCHARGE	38.7		
SUCTION	21.6		
ΔP	17.1 X 2.31 = 39.5 FT. HD.		

BLOCK OFF	
DISCHARGE	42.3
SUCTION	23.6
ΔP	18.7 X 2.31 = 43.2 FT. HD.

MOTOR MFG.	ARMSTRONG		
H.P.	2		
RPM	1725		
AMPS	6.9	ACT:	4.7
VOLTS	208	ACT:	206

CFM TEST & BALANCE CORPORATION 14 DEPOT SQUARE, BETHEL, CT 06801 TEL (203) 778-1900 FAX (203) 778-1710	THE CHILDREN'S SCHOOL 12 GARY ROAD STAMFORD, CT	DATA SHEET # 3
	DATE 7/26/07 BY RW	CFM 4055

PUMP NO.	PHWP-1		
MANUFACTURER	ARMSTRONG		
SIZE	2X2X6 4380		
IMPELLER	5.25"		
SERVICE	PRIMARY HOT WATER		
TEST DATA	**GPM**	**FT. HD.**	**BHP**
DESIGN	77.0	23	.70
ACTUAL	79.0	22.4	.96
DISCHARGE	27.3		
SUCTION	17.6		
ΔP	9.7 X 2.31 = 22.4 FT. HD.		
BLOCK OFF			
DISCHARGE	36.4		
SUCTION	24.1		
ΔP	12.3 X 2.31 = 28.4 FT. HD.		
MOTOR MFG.	BALDOR		
H.P.	1		
RPM	1725		
AMPS	4.0	ACT:	3.8/3.7/4.0
VOLTS	208	ACT:	208/205/207

PUMP NO.	PHWP-2		
MANUFACTURER	ARMSTRONG		
SIZE	2X2X6 4380		
IMPELLER	5.25"		
SERVICE	PRIMARY HOT WATER		
TEST DATA	**GPM**	**FT. HD.**	**BHP**
DESIGN	77.0	23	.70
ACTUAL	78.0	22.6	.97
DISCHARGE	27.1		
SUCTION	17.3		
ΔP	9.8 X 2.31 = 22.6 FT. HD.		
BLOCK OFF			
DISCHARGE	36.2		
SUCTION	24.0		
ΔP	12.2 X 2.31 = 28.2 FT. HD.		
MOTOR MFG.	BALDOR		
H.P.	1		
RPM	1725		
AMPS	6.9	ACT:	3.9/3.8/3.9
VOLTS	208	ACT:	207/205/206

CFM TEST & BALANCE CORPORATION 14 DEPOT SQUARE, BETHEL, CT 06801 TEL (203) 778-1900 FAX (203) 778-1710	THE CHILDREN'S SCHOOL 12 GARY ROAD STAMFORD, CT	DATA SHEET # 4
	DATE 7/26/07 BY RW	CFM 4055

CIRCUIT SETTERS

LOCATION		#	MODEL	SIZE	DESIGN GPM	VALVE SETTING	FINAL PD	FINAL GPM
SECONDARY HOT WATER SYSTEM								
AHU-1	001	1	B&G	1 1/2"	9.7	50°	19.0'	10.0
FT 11'	113	2	B&G	3/4"S	.62	38°	1.1'	.65
FT 34'	114	3	B&G	3/4"S	1.90	12°	1.3'	2.0
FT 25'	116	4	B&G	3/4"S	1.40	20°	1.4'	1.5
FT 23'	117	5	B&G	3/4"S	1.30	26°	1.9'	1.4
FT 23'	122	6	B&G	3/4"S	1.30	20°	1.2'	1.4
FT 29'	123	7	B&G	3/4"S	1.60	30°	3.5'	1.6
FT 12'	101	8	B&G	3/4"S	.67	42°	1.9'	.70
FT 8'	105	9	B&G	3/4"S	.45	50°	2.2'	.50
HWC-1	129	10	GRISWOLD	1"	8.3	80%	25"	8.5
HWC-2	127	11	GRISWOLD	1"	7.2	80%	50"	7.3
VAV-1	001	12	GRISWOLD	3/4"	.60	70%	20"	.65
VAV-2	105	13	GRISWOLD	3/4"	1.33	100%	200"	1.3
VAV-3	105	14	GRISWOLD	3/4"	.84	60%	40"	.86
VAV-4	107	15	GRISWOLD	3/4"	.84	60%	40"	.86
UH-1	001	16	GRISWOLD	3/4"	5.3	50%	25"	5.5
HWRP-1	001	17	B&G	1 1/2"	32.7	28°	33.2'	34.0

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THE CHILDREN'S SCHOOL
12 GARY ROAD
STAMFORD, CT

DATE 7/26/07 BY RW

DATA SHEET # 5

CFM 4055

CIRCUIT SETTERS

LOCATION		#	MODEL	SIZE	DESIGN GPM	VALVE SETTING	FINAL PD	FINAL GPM
RADIANT FLOOR HOT WATER SYSTEM								
HWRP-1	001	1	B&G	1 1/2"	32.7	28°	33.2'	34.0
HWRP-2	001	2	B&G	1 1/2"	32.7	28°	32.1'	31.8
ZONE 1-1	114	3	B&G	3/4"S	3.7	10°	4.4'	4.0
ZONE 1-2	115	4	B&G	3/4"S	4.0	10°	4.5'	4.1
ZONE 2-1	113	5	B&G	3/4"S	3.7	10°	4.0'	3.8
ZONE 3-1	116	6	B&G	3/4"S	7.2	0°	9.8'	7.1
ZONE 4-1	117	7	B&G	3/4"S	4.6	0°	4.5'	4.8
ZONE 5-1	119	8	B&G	3/4"S	4.0	10°	4.4'	4.0
ZONE 6-1	122	9	B&G	3/4"S	5.5	0°	6.0'	5.5