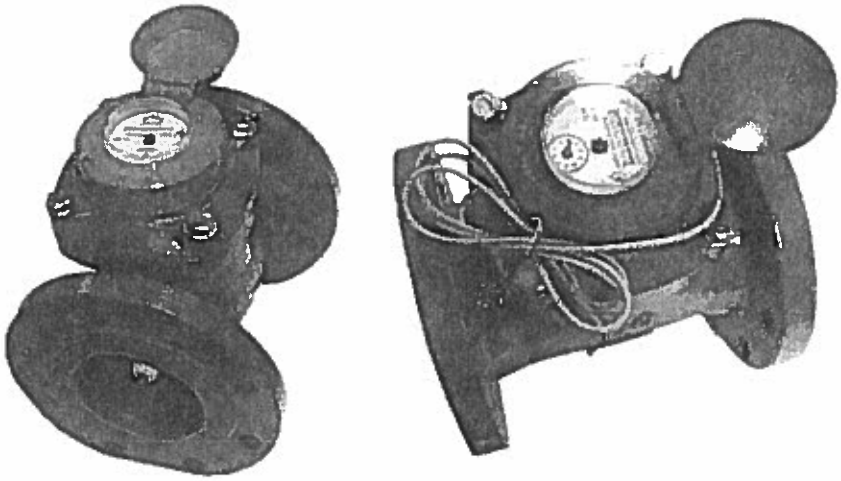
DLJ Epoxy Coated Cast Iron Turbine Meters

200T, 250T, 300T, 400T, 600T, 800T



Description

Operation DLJ Turbine Meters are horizontal Woltman type water meters designed for installation where occasional low and moderate to high sustained flows are demanded. Water flow drives a vertical impeller in direct proportion to the quantity of water passing through the meter. Impeller revolutions are transferred to the register assembly through a reduction gear and magnetic drive.

Compliance The DLJ Turbine Meters comply with AWWA C701 and ISO 4064 Class B standards.

Installation The meter must be installed in a clean pipeline, free of any foreign materials. Install the meter with direction of flow as indicated by the arrow cast into the meter body. You can install the meter vertically or horizontally and the registers are fully revolvable for ease of reading. It is recommended to strain the incoming water to prevent foreign debris damage and to reduce the effects of water turbulence.

Application The DLJ Cold Water Turbine Meters are for use only with cold water up to 120 degrees F (50 degrees C)

Construction The meter consists of a fully epoxy coated cast iron main case with the flow direction cast into it and a removable measuring element for easy maintenance.

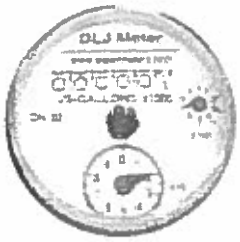
	Specifications					
Characteristics	**DLJ 200T 2"**	**DLJ 250T 2 1/2"**	**DLJ 300T 3"**	**DLJ 400T 4"**	**DLJ 600T 6"**	**DLJ 800T 8"**
Flow Rating (gpm)	325	395	495	1250	2500	3450
Continuous Flow (gpm)	250	300	375	1000	2000	2800
Low Flow (gpm)	4	5	6	9	32	38
Maximum Pressure (psi)	175	175	175	175	175	175
Maximum Temperature (°F)	120	120	120	120	120	120
Sweep Hand Registers (Gallons)	10/100	10/100	10/100	10/100	10/100	10/100
Register Capacity (Millions of Gallons)	1000	1000	1000	1000	1000	1000

DLJ Meter

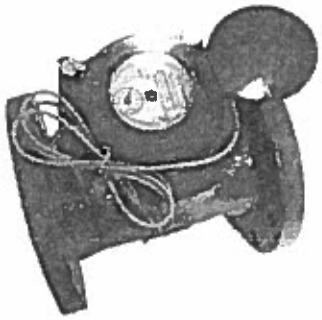
DLJ Epoxy Coated Cast Iron Turbine Meters

200T, 250T, 300T, 400T, 600T, 800T

Direct Read Register The register is contained in a hermetically sealed nylon casing with a 5mm tempered glass lens. The totalizer wheels are large and easy to read and the sweep hands are offset on seperate 10 gallon and 100 gallon register wheels. The large black spinning trickle indicator is excellent for leak detection. Each register clearly show's it's applicable meter size.



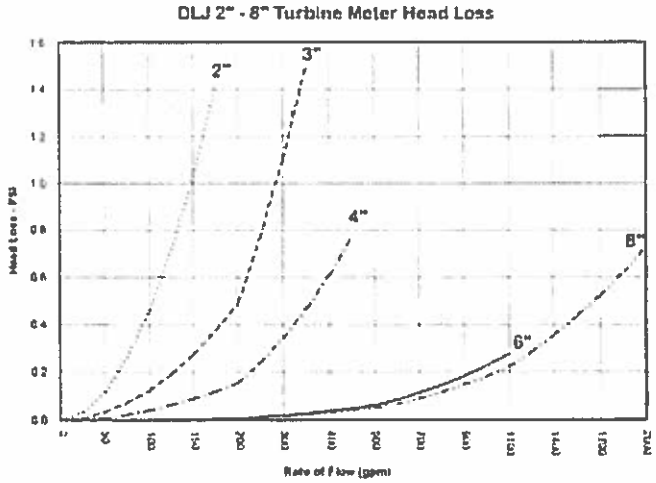
Pulse Output The DLJ line is available with a dry contact reed switch pulse output. This requires external DC power, 4 watts, 30VDC maximum. Contact closure is 1 pulse per 100 gallons on the 2 - 3" Turbines and 1 pulse per 1000 gallons on the 4 - 8" Turbines



Magnetic Drive The magnetic drive design eliminates all miscouplings associated with conventional right angle drives. Excess torque is eliminated in the encased undergear assembly, ensuring constant magnet coupling.

Maintenance The register/measuring assembly is easily removable and replaceable if needed, and doesn't require taking the meter off line.

Connections The DLJ Turbine Meters are available with standard Class 150lb ANSI flanges (4 bolt in 2, 2 1/2" and 3", 8 bolt in 4, 6 and 8"). Companion Flange sets in Cast Iron or PVC and Uni-Flanges are available for ease of connection.



Characteristics	Specifications					
	DLJ 200T 2"	DLJ 250T 2 1/2"	DLJ 300T 3"	DLJ 400T 4"	DLJ 600T 6"	DLJ 800T 8"
Length (Inches)	12	7.75	8.75	9.75	11.6	13.6
Weight (Pounds)	32	29	35	40	92	141
Crated Weight (Pounds)	43	40	47	50	110	150

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DLJ Meter

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Stacking Shipping Containers on Land for an Off-Axis Detector

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(May 29, 2003)

Introduction

Fig. 1 shows a typical International Standards Organization (ISO) Series 1 shipping container.

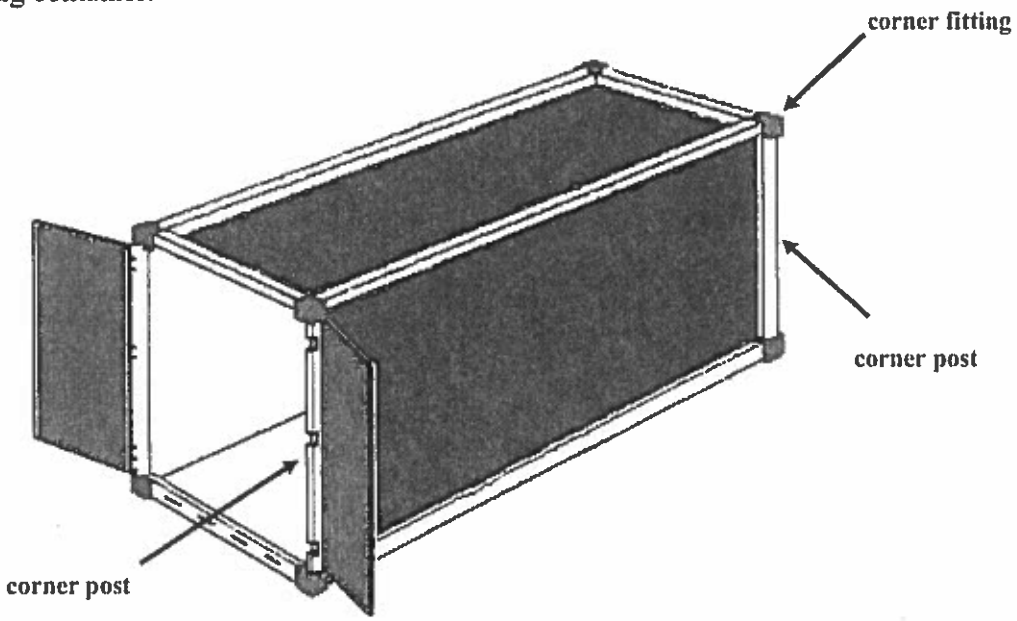


Figure 1. ISO Series 1 Shipping Container

These containers are designed to make vertical contact with each other through discrete corner fittings; when stacked, all vertical force is transferred through these fittings, in turn loading the corner posts, and not the walls, of the container. The number of containers which can be stacked on each other is determined by the strength of the corner posts.

ISO Standard 1496[1] states that the corner posts of ISO Series 1 containers should be tested to a load of 86,400 kg (190,480 lbs). This is the load applied to the posts of the bottom container in an 8-on-1 stack of 24,000 kg (gross weight) containers,

multiplied by a factor of 1.8. This extra factor is used to take into account "conditions aboard ship and the relative eccentricities between superimposed containers."[1] The "conditions aboard ship" were derived from a 1964 study of maximum acceleration values under the worst sea and wind conditions.[2]

Calculating the safe stacking height for loaded containers *on land* requires some understanding of the corner posts, their material properties, possible failure modes, and what constitutes an adequate factor of safety.

Corner Post Geometry and Compressive Load-Bearing Capacity

Corner post steels typically correspond to the specification ASTM A-572, with a yield stress of 47,000 psi, and an ultimate stress of 70,000 psi. This is a low alloy columbium or vanadium steel commonly used for high-strength steel weldments, such as bridges. The load-bearing characteristics of corners posts are complex, because in a walled container the posts receive substantial lateral stability, and compressive cross sectional area, from the participation of the walls and doors.

The corner post can fail in two ways: The first is collapse, or buckling. This occurs in a slender column when the compressive load reaches a critical load P_{cr} which is so large that the column can no longer recover from small lateral displacements along its length. The result is sudden and catastrophic loss of stiffness, and gross deformation of the column and its attached material.

A second type of failure can occur if the compressive load P_{comp} exceeds the value S_yA, where S_y is the yield stress of the material, and A is the cross sectional area of the post. Even a column which is stable against buckling failure can fail from compressive yielding. Failures of this type are rare for columns, since the yielding will tend to produce larger cross sectional area through plastic deformation, and eventually become self-limiting. This self-limit may not be reached before even a very short column becomes unstable, however, resulting in a type of collapse that is characterized by large amounts of plastic deformation.

The most likely failure mode, given the substantial lateral constraint offered by the walls, is probably a combination of collapse and gross yielding, a type of failure referred to as elastic/plastic collapse.

The calculation of collapse (buckling) loads for long, slender steel columns uses the Euler equation:

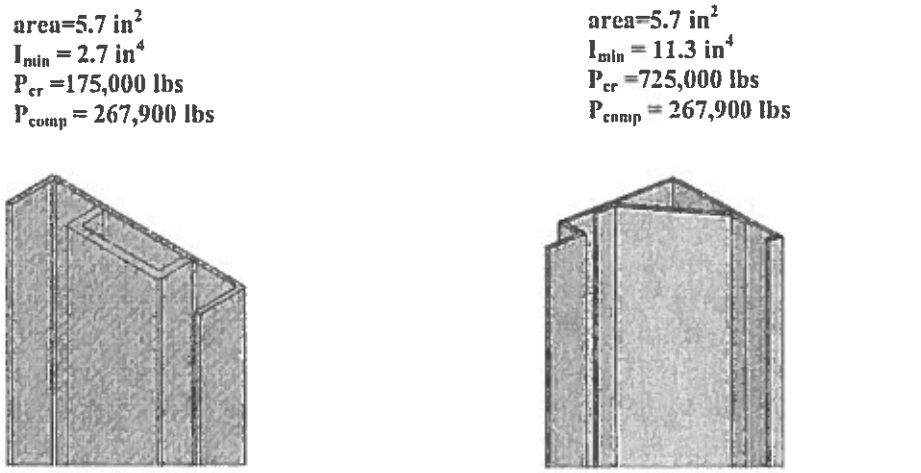
$$P_{cr} = k\pi^2 EI/L^2$$

where P_{cr} = critical (collapse) load
E = modulus of elasticity of steel = 30e6 psi
I = minimum moment of inertia of section
L = length of column
k = factor for end rotational restraint (theoretical range from 1-4)

For the corner posts, the degree of end rotational restraint is difficult to quantify. The top, bottom, and side rails will serve to provide substantial restraint, and even the corner fitting contact of the loading container above a corner post will tend to limit rotation. Therefore, a k factor of 2 is chosen for calculating the estimates of collapse load.[3] This is less than the complete rotational restraint (k = 4), but greater than free rotation (k = 1).

In addition to resisting collapse, the corner post must also work at a compressive stress that is below the yield of the material. Corner posts will yield at a stress of 47,000 psi. Therefore, the minimum cross sectional area for resisting the corner post loads is A = 190,840/47,000 = 4.05 in^2.

While the minimum performance of a corner post is standardized via ISO, the actual geometry of the post is not. Manufacturers have explored many different designs for many different types of containers, all of which will pass the ISO test load of 86,400 kg or 190,840 pounds. Figure 2 shows the most common corner post cross-sections at the door and walled ends of a Series 1 container. These posts are made of 6mm thick pressed steel shapes welded together along the length of the post. In the case of the door end post, a piece of hot rolled channel 113 x 40 x 10 mm is welded to the 6mm plate. Both posts in Figure 2 have adequate cross sectional area from the standpoint of compressive stress. However, the Door End post (a), has a collapse load which is less than the load required by the ISO standard, and therefore must rely on interaction with the walls and doors of the container to produce the necessary load-bearing capacity.



(a) Corner Post at Door End **(b) Corner Post at Walled End**

Figure 2. Corner Post Cross Sections -- Properties and Load Capacities without Wall/Door Participation

The effect of participation of the walls and doors is illustrated in Fig. 3 The profile of Fig. 2(a) has been used with a 3-inch wide strip of adjacent container sidewall (3.6 mm thick) and a 2-inch wide strip of door panel (2 mm thick), to form a column of considerably higher strength than the profile of Fig. 2(a) alone. The cross section shown, with walls, has a critical load of approximately 252,000 lbs, which is well above the 175,000 lbs of the corner post alone, and well above the 190,480 lbs required by the ISO Standard.

These calculations show that the door is an important part of the load path under stacking, providing additional cross-sectional area for compression and stability. The door also acts as a sheer wall, preventing the parallelogram deformation of the end referred to as "racking" or "sidesway." For these reasons, in commercial practice, the doors on a container within a stack are presumably never opened. This is not a constraint on the way the containers are used in commerce, since only one container at a time is loaded or unloaded at terminals, with stacking occurring only during transit.

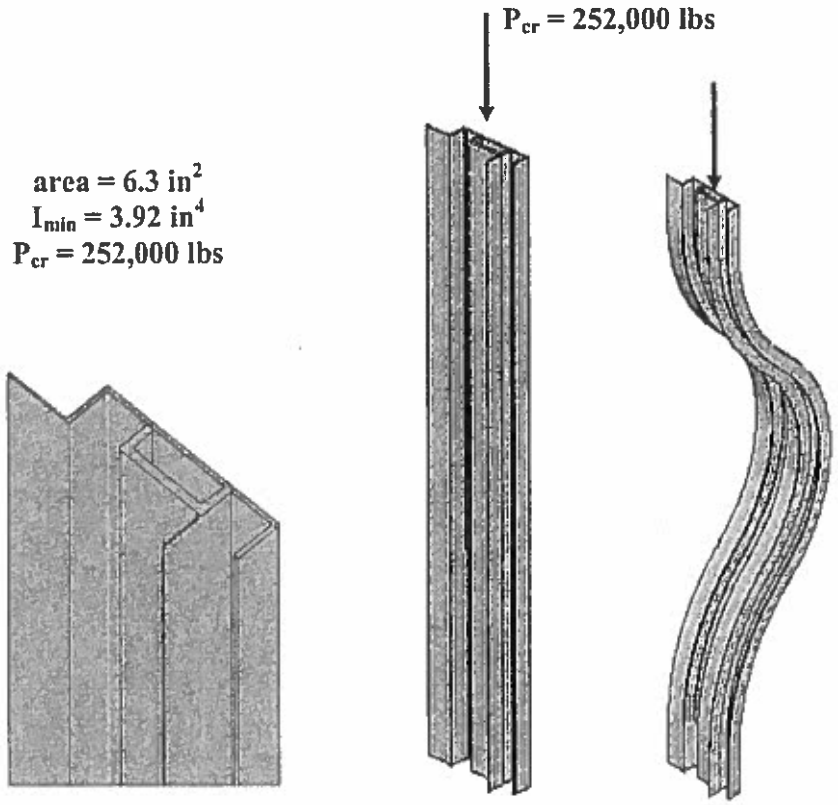


Figure 3. Corner Post from Fig. 2(a) showing increase in buckling strength due to participation of wall

Corner Fittings

The corner fittings shown in Figure 1 are an integral part of the load-bearing column in the container. ISO 1161-1984(E)[4] states "Corner fittings for Series 1 freight containers shall be capable of withstanding the loads calculated in accordance with the requirements of ISO 1496/1 for Series 1 containers." This means that the bottom corner fitting of the bottom container in a stack must withstand the weight of the containers stacked above it, plus the weight of the bottom container itself. The maximum load which a single corner fitting must take is then

$$P_{tot} = 190{,}480 + (52{,}800/4) = 203{,}680 \text{ lbs}$$

A typical corner fitting is shown in Fig. 4.. The cross sectional area of this fitting is shown in Fig. 5. The total cross sectional area available for compression is 10.15 in^2. This results in an average compressive stress under maximum load of 20,067 psi.

Corner fittings are typically cast and machined from A-216 steel, which has a minimum specified yield stress of 40,000 psi. Therefore, under maximum load, a corner fitting of the cross section shown below operates with a safety factor on yield of nearly 2.0

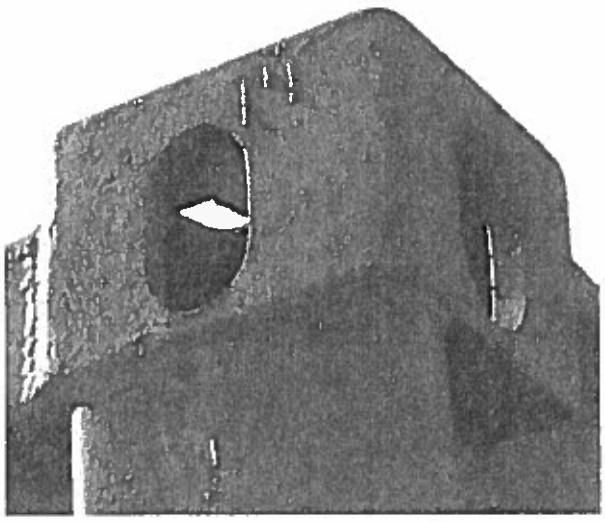


Figure 4. Corner Fitting

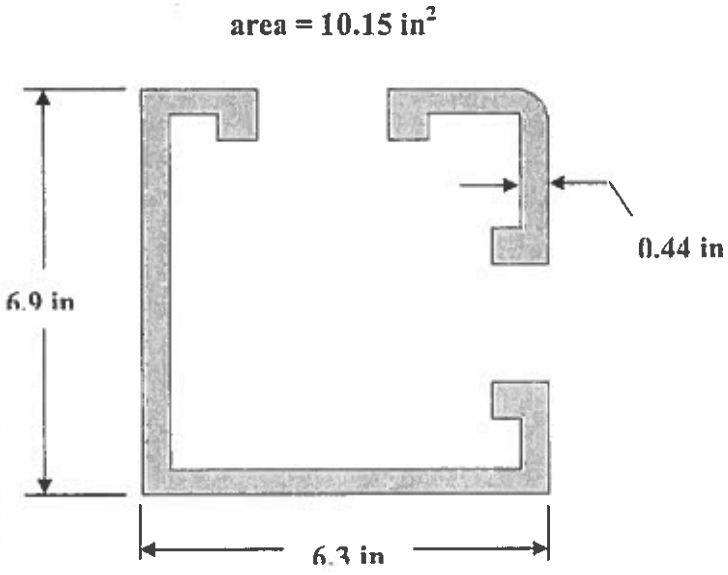


Figure 5. Fitting Cross Section

Safety Factor for Stacking Containers on Land

A safety factor for the corner posts in the bottom container of a stack can be defined as

$$SF = F_{cp\text{-}fail}/F_{cp\text{-}act}$$

where SF = safety factor
$F_{cp\text{-}act}$ = actual operating load on corner post
$F_{cp\text{-}fail}$ = failure load of corner post

The ISO Standard, however, does not define a force $F_{cp\text{-}fail}$; rather, it specifies the load that each corner post must withstand *without* failure. In this sense, the specified load is a *proof* load, F_{cp_proof}, which is simply a load which each corner post must be shown capable of resisting. For the purposes of calculating a safety factor, the specified test load can be thought of as an absolute lower limit on the failure load. Any safety factor calculated with $F_{cp\text{-}fail} = F_{cp\_proof}$ will be smaller than the actual safety factor, since F_{cp_proof} is always smaller than $F_{cp\text{-}fail}$.

Using the expression above, the safety factor of an 8-on-1 stack of containers on land is at least 1.8 . Safety factors in engineering commonly range from 1.25 to 2.0 or greater, depending on the amount of confidence the designer has in material performance and load characterization. The AISC Steel Construction Code[5], for example, uses a safety factor of 2 for column loading; however, conservative design in civil structures is necessary because there is typically no load-testing of the parts; they are designed, manufactured, and set in place with only the calculation and fabrication standards serving as proof of merit. Aircraft design, however, uses safety factors closer to 1.25, due to the great penalties incurred by excess weight. The extremely rigorous materials and testing programs common in the aviation industry justify these smaller safety factors.

Because the corner posts of all containers are known to have been tested to the load stipulated by ISO 1496 with no failures occurring at a load that is less than the test load, a safety factor of about 1.5 is adequate for a stack of containers on land. Table I shows the safety factor on the corner post loading of the bottom container in a stack, for stacks of various heights. This table is based on the application of the equation for safety factor, with $F_{cp\text{-}fail} = F_{cp\text{-}proof} = 190{,}480$ lbs, and containers of 52,910 lbs gross weight:

Table I. Safety Factors on Land for Various Stack Heights on Land with Container Corner Post Capacity of 190,480 lbs (86,400 kg)

Number of Containers Stacked on One	Total Height of Stack	Safety Factor on Corner Post Loading
8	9	1.80
9	10	1.60
10	11	1.44
11	12	1.31

The table shows that we can stack 9-on-1 on land, and maintain a safety factor of greater than 1.5.

Possible Modifications

For a final detector design, good engineering practice would require that the corner posts of several containers be loaded to failure to more precisely determine F_{cp_fail}, from which more accurate stacking safety factors could be calculated. Some advantage might be taken of the fact that while $F_{cp\text{-}fail}$ is not known, it is certainly higher than 190,480 lbs (86,400 kg). If the measured failure load is just 4% higher than the test (proof) load, the safety factor on a 10-on-1 stack becomes 1.5, and stacking to that height becomes defensible.

Some vendors advertise containers with a higher capacity[(6)] than the ISO Series 1 standard, and advantage could be taken of the greater payload, as well as the higher post strength, in configuring the detector array. The typical higher post rating quoted is 214,290 lbs (97,400 kg), allowing exactly 9 on 1 stacking of 52,910 lb (24,000 kg) containers at sea and therefore allowing 10 on 1 on land with a safety factor of (9/8)*(1.44) = 1.62.

Similarly, if the Off-Axis detector density is small enough that our standard gross weight container is less than 52,910 lbs (24,000 kg), then even higher stacks could be supported. Table II shows the stack heights possible when the higher strength containers are used. A container volume of 33.2 m^3 is assumed with a tare weight of 2,250 kg and four different detector gross weights of 22,150 kg, 24,000 kg, 26,000 kg and 30,480 kg. The 30,480 kg number is the vendor quoted maximum gross weight for the higher strength containers. Comparing Tables I and II shows that the higher strength posts lead to the same height stacks as the lower strength posts for containers of density 0.75 gm/cc vs. 0.66 gm/cc.

Table II. Stack Heights on Land forVarious Detector Densities with Container Corner Post Capacity of 214,290 lbs (97,400 kg)

Number of Containers Stacked on One	Total Height of Stack (m)	Safety Factor on Corner Post Loading			
		with payload density = **0.60 g/cc** (22,150 kg gross)	with payload density = **0.66 g/cc** (24,000 kg gross)	with payload density = **0.75 g/cc** (27,150 kg gross)	with payload density = **0.85 g/cc** (30,480 kg gross)
8 on 1	23.3	2.20	2.03	1.80	1.60
9 on 1	25.9	1.95	1.80	1.59	1.42
10 on 1	28.5	1.76	1.62	1.43	1.28
11 on 1	31.1	1.60	1.48	1.30	1.16

Conclusion

Stacking ISO containers 10 high on land is reasonable, and stacks as high as 12 may be possible depending on the type of container purchased and on the loading of the container with Off-Axis detector elements. For a final detector design, good engineering practice would require that the corner posts of the selected containers be loaded to failure to more accurately determine the safety factor of the stacked array.

References

1. ISO 1496-1:1990 *Series 1 freight containers – Specification and testing – Part 1: General cargo containers for general purposes*

2. ISO/TR 15070:1996(E) *Series 1 freight containers – Rationale for structural test criteria*

3. "Commentary on the Specification for the Design, Fabrication and Erection of Structural Steel for Buildings", Section 1.8, American Institute of Steel Construction, 1978

4. ISO 1161-1984(E) *Series 1 freight containers – Corner fittings – Specification*

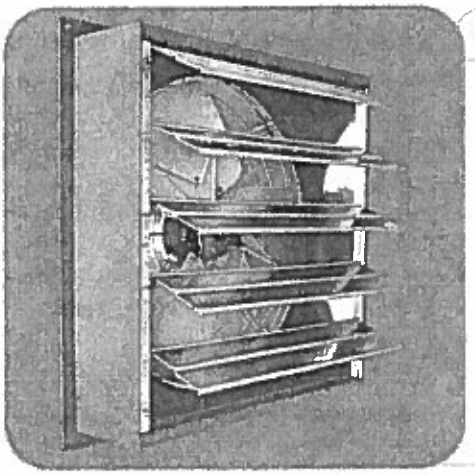
5. "Commentary on the Specification for the Design, Fabrication and Erection of Structural Steel for Buildings", Section 1.5.1.3, American Institute of Steel Construction, 1978

6. We have several specification documents from container vendors that stipulate a higher load capacity, but no details on just how this is accomplished by any container manufacturer via changes in the post configuration. We suspect that these vendors may just be taking advantage of a specification requiring a higher measured failure load as discussed in the preceding paragraph. After all, our post calculations for Figures 2(b) and Figure 3 indicate that these "standard" posts should easily pass a failure load test at 214,290 lbs vs. the original ISO test at 190,480 lbs.

STANDARD FANS

Efficient • Low Maintenance • Easy Installation

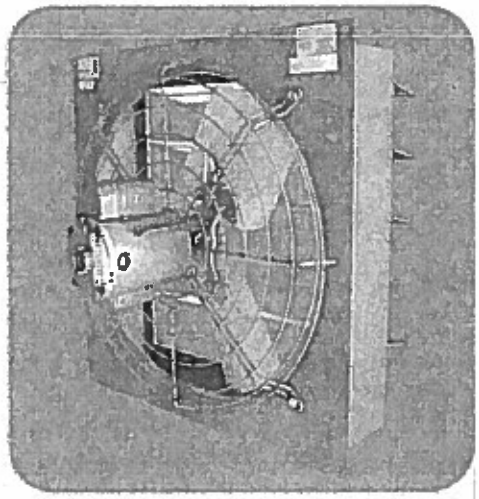
Canarm's Standard Fans follow a tradition of quality in design, materials and construction.



Features

- Available in 8" to 36" sizes.
- Single, two and variable speed models are available.
- All fans use a totally enclosed, ball bearing motor with thermal overload protection.
- The motor mount is manufactured with heavy welded rods and has a powder coated finish.
- The fan blades are well-balanced, heavy gauge aluminum.
- The rugged steel welded box housing has a durable powder coated finish.
- Aluminum louver shutters are supported by long life nylon bushings (30" and 36" have PVC louvers).
- All fans are shipped completely assembled.

General Information



Canarm's Standard Fans follow a tradition of quality in design, materials and construction. All our Standard Fans are developed to be efficient and economically priced. All variable speed Standard Fans use an energy efficient variable speed, dual voltage motor and blade combination.

To determine the proper Canarm Fan for your applications, use the following formula.

Number of cubic feet in room / Number of minutes per air change = Required C.F.M. Capacity

*****Example*****

A general office, (see chart) which requires an air change every ten minutes, would require the following fan capacity. If office is 100' x 40' x 10' = 40,000 cubic feet

40,000 cubic feet / 10 minutes per air change = 4000 Required C.F.M.

From the "Performance Data" section on the back of this page, you would select a fan that is rated at 4000 C.F.M. at 1/8" S.P. (Static Pressure)

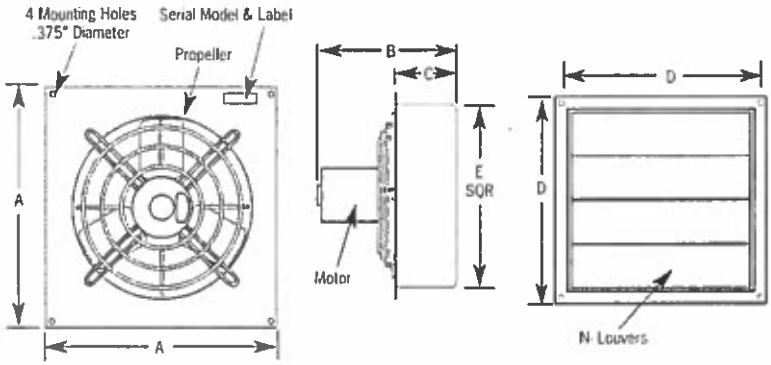
Fan Selection Chart

Application	Minutes per Air Change	Application	Minutes per Air Change	Application	Minutes per Air Change
Assembly Hall	7	Department Store	6	Plating Room	3
Auditorium	10	Dry Cleaning	5	Pressing Room	1
Bakery	3	Engine Room	6	Projection Booth	2
Barber Shop	6	Forge Room	3	Restaurant	6
Basement	8	Foundry	4	School	7
Battery Room	4	Garage	5	Summer Cooling	1
Boiler Room	1	General Office	10	Store	8
Bowling Alley	5	Gymnasium	8	Tavern	3
Church	15	Hospital	8	Toilet	3
Cocktail Bar	3	Kitchen	2	Transformer Room	1
Corridor	10	Laundry	2	Warehouse	12
Dairy	4	Locker Room	3	Welding Shop	2
		Machine Shop	8		

STANDARD FANS

Fan Dimensions

Fan Auto	A	B	C	D (c/c)	E	N
8"	13 1/4"	10"	4"	12"	10 3/4"	2
10"	15 1/4"	10"	4"	14"	12 3/4"	2
12"	17 1/4"	14"	6"	16"	14 3/4"	3
14"	19 1/4"	14"	6"	18"	16 3/4"	3
16"	21 1/4"	14"	6"	20"	18 3/4"	4
18"	23 1/4"	15"	6"	22"	20 3/4"	4
20"	25 1/4"	16"	6"	24"	22 3/4"	5
24"	29 1/4"	16"	6"	28"	26 3/4"	5
30"	35 1/4"	19"	6"	34"	32 3/4"	16
36"	41 1/4"	16"	6"	40"	38 3/4"	20



Performance Data & Specifications

Model Number	Fan Size	Motor HP	Operation Speed	Fan RPM	Current Load Amps @ 115V	Current Load Amps @230V	Input Watts	Airflow Capacity - CFM 0" S.P.	.10" S.P.	.125" S.P.	.25" S.P.	CFM Watts	Sound Level Decibel (A)	Framing Dimensions	Shipping Weight Lbs.
S8-B2	8"	1/20	Two	High 1550 Low 1300	0.95 0.45	- -	109	360 300	270 150	230 110	0 0	2.5	48 43	11" x 11"	12
S10-B2	10"	1/20	Two	High 1550 Low 1300	1.2 0.7	- -	125	690 580	590 460	570 390	0 0	4.72	56 50	13" x 13"	13
S12-E1	12"	1/4	Single	1750	3.5	-	245	1,640	1,540	1,510	1,390	6.00	63	15" x 15"	28
S12-E2			Two	High 1760 Low 1180	3.4 2.3	- -	230 132	1,650 1,090	1,550 950	1,520 930	1,390 -	6.74 7.31	64 50		32
SD12-EV			Variable	Max 1625 Min 600	2.2	1.1	205	1,650 560	1,540 440	1,510 420	1,390 -	7.50	60 -		32
S14-E1	14"	1/4	Single	1740	3.6	-	257	2,170	2,070	2,030	1,860	8.05	67	17" x 17"	30
S14-E2			Two	High 1740 Low 1170	3.8 2.2	- -	253 137	2,180 1,350	2,080 1,190	2,060 1,160	1,890 -	8.22 8.69	65 53		34
S16-E1	16"	1/4	Single	1740	3.7	-	274	2,370	2,270	2,210	2,060	8.28	68	19" x 19"	33
S16-E2			Two	High 1740 Low 1170	3.7 2.3	- -	270 152	2,380 1,640	2,280 1,490	2,230 1,430	2,070 -	8.44 9.80	69 55		36
SD16-EV			Variable	Max 1625 Min 450	2.6	1.3	248	2,370 610	2,270 580	2,210 570	2,063 -	9.15	63 -		36
S18-F1	18"	1/3	Single	1700	4.8	-	448	3,200	3,090	3,040	2,920	6.89	73	21" x 21"	37
S18-F2			Two	High 1700 Low 1140	5.7 3.1	- -	446 250	3,200 2,100	3,090 1,890	3,040 1,820	2,920 -	6.93 7.56	74 64		43
SD18-FV			Variable	Max 1625 Min 390	3..7	1.9	378	3,150 700	3,050 650	2,980 630	2,860 -	8.07	74 -		45
S20-F1	20"	1/3	Single	1735	4.8	-	322	3,420	3,220	3,170	2,920	10.00	77	23" x 23"	41
S20-F2			Two	High 1745 Low 1165	4.3 2.6	- -	315 190	3,440 2,300	3,240 2,000	3,180 1,950	2,930 -	10.20 10.52	77 67		45
SD24-F1	24"	1/3	Single	1075	4.3	-	370	5,000	4,500	4,300	3,600	12.80	70	27" x 27"	46
SD24-GV		1/2	Variable	Max 1100 Min 310	4.2	2.1	290	5,050 800	4,940 710	4,810 650	4,400 -	13.2	72 -		56
SD30-G1D	30"	1/2	Single	1075	4.6	2.3	600	8,000	7,000	6,000	5,000	11.5	82	33" x 33"	72
SD36-G1D	36"	1/2	Single	850	6.0	3.0	660	12,000	11,000	10,500	9,500	13.0	72	39" x 39"	88

NOTE: RPM Min (Minimum) is determined when louvers are opened one inch

Note: Wind has a significant effect on exhaust fans. A 10 mph wind creates a 0.05" pressure against the fan. A 20 mph wind creates 0.20" pressure and 30 mph a 0.45" pressure. These pressures are in addition to the static pressure in the building. Wind blocks or hoods should be included in all designs where fans will be subjected to winds above 10 mph.

Warranty

- 1 year on all components

CANARM LTD. - Corporate Office
2157 Parkedale Ave., Brockville, ON
Canada K6V 5V6
Tel: (613) 342-5424 Fax: 1-800-263-4598

CANARM LTD. - USA Warehouse
808 Commerce Park Drive
Ogdensburg, New York, USA 13669
Tel: 1-800-267-4427 Fax: 1-800-263-4598

Arthur Manufacturing Facility
#7686 Concession 16, RR 4 Arthur, ON
Canada N0G 1A0
Tel: (519) 848-3910 Fax: (519) 848-3948
Web Site: **www.bsmagri.com**
E-Mail: **sales@bsmagri.com**

Web Site: **www.canarm.com**
E-Mail: **agsales@canarm.ca**

Printed in Canada - 01/05

Code No. LIT-1927010
Issued February 1, 2009

A19 Series

Remote Bulb Control

Description

The A19 Series are single-stage temperature controls that incorporate environmentally friendly liquid-filled sensing elements.

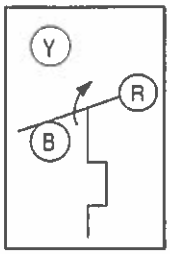
Features

- wide temperature ranges available
- constant differential throughout the entire range
- compact enclosure
- fixed or adjustable differential available
- variety of sensing element styles
- unaffected by cross-ambient conditions

Applications

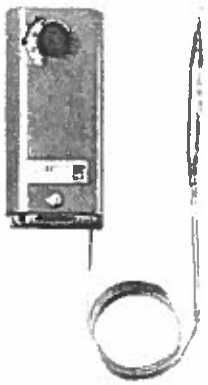
The A19 is suitable for temperature control in heating, ventilating, air conditioning, and refrigeration.

A19 Series



Action on increase of Temperature

A19 Series
Terminal Arrangement for SPDT



A19ABC-24

Selection Charts

A19 Series Remote Bulb Control[1]

Code Number	Switch Action	Range °F (°C)	Diff F° (C°)	Bulb and Capillary	Bulb Well No. (order separately)	Range Adjuster	Max. Bulb Temp. °F (°C)
Adjustable Differential (Wide Range)							
A19ABA-40C [2]	SPST Open Low	-30 to 100 (-34 to 38)	3 to 12 (1.7 to 6.7)	3/8 in. x 4 in., 6 ft. Cap.	WEL14A-602R	Screwdriver Slot	140 (60)
A19ABC-4C	SPDT	50 to 130 (10 to 55)	3 1/2 to 14 (1.9 to 8)	3/8 in. x 5 in., 8 ft. Cap.	WEL14A-603R	Knob	170 (77)
A19ABC-24C [3]	SPDT	-30 to 100 (-34 to 38)	3 to 12 (1.7 to 6.7)	3/8 in. x 4 in., 8 ft. Cap.	WEL14A-602R	Convertible	140 (60)
A19ABC-36C	SPDT	-30 to 100 (-34 to 38)	3 to 12 (1.7 to 6.7)	3/8 in. x 4 in., 20 ft. Cap.	WEL14A-602R	Convertible	140 (60)
A19ABC-37C	SPDT	-30 to 100 (-34 to 38)	3 to 12 (1.7 to 6.7)	3/8 in. x 4 in., 10 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
A19ABC-74C	SPDT	-30 to 100 (-34 to 38)	3 to 12 (1.7 to 6.7)	3/8 in. x 4 in., 6 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
Fixed Differential							
A19AAF-12C	SPDT	25 to 225 (-4 to 107)	3 1/2 (1.9)	3/8 in. x 3 in., 10 ft. Cap.	WEL14A-602R	Screwdriver slot	275 (135)
Fixed Differential (Case Compensated)							
A19AAC-4C	SPDT	0 to 80 (-18 to 27)	5 (2.8)	3/8 in. x 4 in., 6 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
A19AAD-12C	SPST Open Low	-30 to 50 (-34 to 10)	2 1/2 (1.4)	3/8 in. x 4 in., 7 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
Fixed Differential (Close)							
A19AAD-5C [4]	SPST Open Low	30 to 50 (-1 to 10) (Bulk Milk Cooler)	2 1/2 (1.4)	3/8 in. x 2 5/8 in., 6 ft. Cap.	WEL16A-601R	Screwdriver slot	190 (88)
A19AAF-20C	SPDT	-30 to 100 (-34 to 38)	2 1/2 (1.4)	3/8 in. x 4 in., 6 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
A19AAF-21C	SPDT	40 to 90 (4 to 32)	1 1/2 (0.8)	3/8 in. x 5 3/4 in., 6 ft. Cap.	WEL14A-603R	Screwdriver slot	140 (60)
Manual Reset							
A19ACA-14C	SPST Open Low	-30 to 100 (-34 to 38)	Manual Reset	3/8 in. x 4 in. 6 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
A19ACA-15C	SPST Open Low	-30 to 100 (-34 to 38)	Manual Reset	3/8 in. x 4 in. 10 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
A19ADB-1C	SPST Open High	100 to 240 (38 to 116)	Manual Reset	3/8 in. x 3 1/2 in. 6 ft. Cap.	WEL14A-602R	Knob	290 (143)
A19ADN-1C	SPST Open High	100 to 240 (38 to 116)	Manual Reset	3/8 in. x 4 in. 6 ft. Cap.	WEL14A-602R	Screwdriver slot	290 (143)

1. Specify the control model code number, packing nut code number (if required), and bulb well code number (if required).
2. Replaces White-Rodgers 1609-101
3. Replaces White-Rodgers 1609-12, -13, Ranco 010-1408, -1409, - 1410, -1490, 060-110, Honeywell L6018C-1006, L6021A-1005, T675A-1011, -1508, -1516, -1821, T4301A-1008, T6031A-1011, T6031A-1029
4. Case-Compensated

Remote Bulb Control (Continued)

Selection Charts (Continued)

Replacement Parts

Code Number	Description
CVR28A-617R	Concealed adjustment cover
CVR28A-618R	Visible scale cover
KNB20A-602R	Replacement Knob Kit

Accessories

A packing nut is available for closed tank application.
Specify the part number **FTG13A-600R**.

Bulb wells (WEL14A Series) are available for liquid immersion applications.
Refer to the selection chart or to *Bulb Wells Catalog Page, LIT-1922135.*

Technical Specifications

Electrical Ratings

Motor Ratings VAC	120	208	240
Wide Range – Adjustable Differential			
AC Full Load A	16.0	9.2	8.0
AC Locked Rotor A	96.0	55.2	48.0
Non-Inductive A [1]	22 A, 120 to 277 VAC		
Pilot Duty – 125 VA, 24 to 600 VAC			
Fixed Differential and Close Differential			
AC Full Load A	6.0	3.4	3.0
AC Locked Rotor A	36.0	20.4	18.0
Non-Inductive A	10 A, 24 to 277 VAC		
Pilot Duty – 125 VA, 24 to 277 VAC			
Case Compensated – Fixed Differential A19AAC-4			
AC Full Load A	16.0	9.2	8.0
AC Locked Rotor A	96.0	55.2	48.0
Non-Inductive A [1]	22 A, 120 to 277 VAC		
Pilot Duty – 125 VA, 24 to 600 VAC			
A19AAD-12			
AC Full Load A	6.0	3.4	3.0
AC Locked Rotor A	36.0	20.4	18.0
Non-Inductive A	10 A, 24 to 277 VAC		
Pilot Duty – 125 VA, 24 to 277 VAC			
Manual Reset			
AC Full Load A	16.0	9.2	8.0
AC Locked Rotor A	96.0	55.2	48.0
Non-Inductive A	16.0	9.2	8.0
Pilot Duty – 125 VA, 24 to 600 VAC			

1. SPST and N.O. contact of SPDT control.
SPDT N.C. contact- 16 amps 120 to 277 VAC

Features

The 460's universal range from 190-480VAC, 50/60 Hz provides the versatility needed to handle global applications.

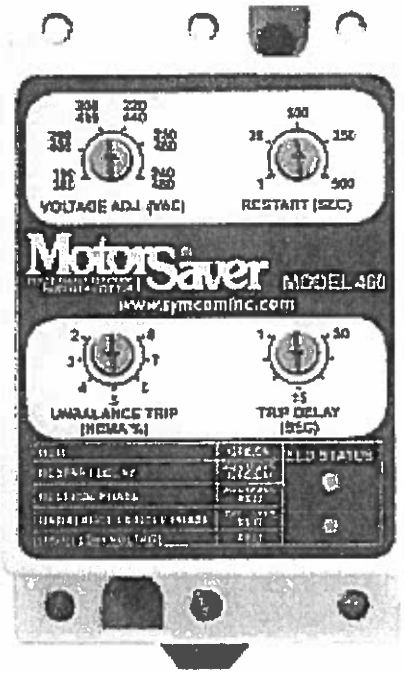
Four adjustment pots provide versatility for a variety of applications.

Diagnostic LEDs indicate trip status and provide simple troubleshooting.

Microcontroller-based circuitry provides better accuracy and higher reliability than analog designs.

Single-phase conditions are detected regardless of regenerated voltages.

Transient protection meets IEEE and IEC standards and permits operation under tough conditions.



MotorSaver
THREE-PHASE ELECTRONIC MOTOR PROTECTOR

Model 460

Three-Phase Voltage Monitor

•

Engineered Protection

•

Microcontroller Based

Protects 3-Phase Motors from:

- Loss of any phase
- Low voltage
- High voltage
- Voltage unbalance
- Phase reversal
- Rapid cycling

Additional Features:

- Compact design
- UL and cUL listed
- CE compliant
- Finger-safe terminals
- 5-year warranty
- Made in USA
- Standard surface or DIN rail mountable
- Standard 1-500 sec. variable restart delay
- Standard 2-8% variable voltage unbalance
- Standard 1-30 sec. variable trip delay
- One 10 amp general purpose Form C relay
- Optional manual reset

The **Model 460** is designed to protect 3-phase motors from damaging power conditions. The 460's wide operating range combined with UL and CE compliance enables quick access to domestic and global markets.

A unique microcontroller-based voltage and phase-sensing circuit constantly monitors the 3-phase voltages to detect harmful power line conditions. When a harmful condition is detected, the MotorSaver's output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to an acceptable level for a specified amount of time (restart delay). The trip delay prevents nuisance tripping due to rapidly fluctuating power line conditions.

The Model 460 automatically senses whether it is connected to a 190-240V, 60Hz system, a 440-480V, 60Hz system, or a 380-416V, 50Hz system. An adjustment is provided to set the nominal line voltage from 190-240 or 380-480VAC. Other adjustments include a 1-30 second trip delay, 1-500 second restart delay, and 2-8% voltage unbalance trip point.

SymCom Inc
Motor Protection & Controls Since 1974

2880 North Plaza Drive • Rapid City, SD 57702
(800) 843-8848 • (605) 348-5580 • FAX (605) 348-5685
www.symcominc.com • email: sales@symcominc.com

10/05

MotorSaver®
THREE-PHASE ELECTRIC MOTOR PROTECTOR

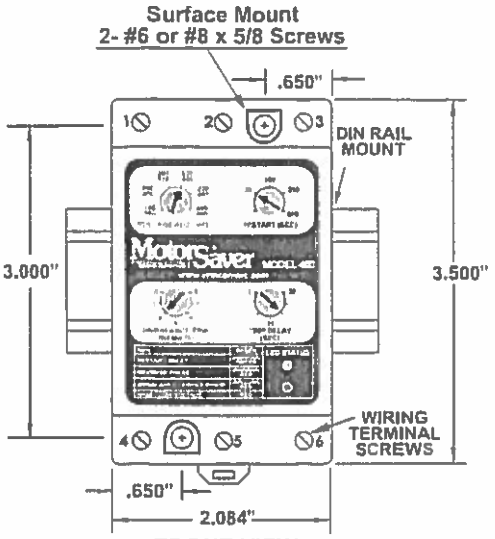
Specifications
•
Operating Points
•
Special Options

Model 460
Three-Phase Voltage Monitor

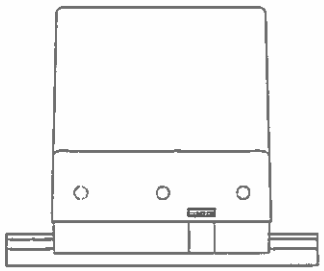
Specifications

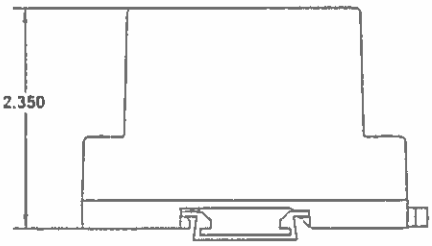
3-Phase Line Voltage	190-480VAC (475-600VAC optional) (95-120VAC optional)
Frequency	50*/60Hz
Low Voltage (% of setpoint)	
•Trip	90% ±1%
•Reset	93% ±1%
High Voltage (% of setpoint)	
•Trip	110% ±1%
•Reset	107% ±1%
Voltage Unbalance (NEMA)	
•Trip	2-8% adjustable
•Reset	Trip setting minus 1% (5 - 8%) Trip setting minus .5% (2 - 4%)
Trip Delay Time	
•Low, High and Unbalanced Voltage	1-30 seconds adjustable
•Single-Phasing Faults	1 second fixed
Restart Delay Time	
•After a Fault	1-500 seconds adjustable
•After a Complete Power Loss	1-500 seconds adjustable
Output Contact Rating	
•1-Form C	10A General Purpose @ 240VAC Pilot Duty 480VA @ 240VAC, B300
Power Consumption	6 Watts (max.)
Weight	14 oz
Enclosure	Polycarbonate
Terminal Torque	6 in.-lbs.
Wire Type	Stranded or solid 12-20 AWG, one per terminal
Safety Marks	
•UL	UL508
•CE	IEC 60947-6-2
Standards Passed	
•Electrostatic Discharge (ESD)	IEC 1000-4-2, Level 3, 6kV contact, 8kV air
•Radio Frequency Immunity, Radiated	150 MHz, 10V/m
•Fast Transient Burst	IEC 1000-4-4, Level 3, 3.5kV input power & controls
Surge	
•IEC	IEC 1000-4-5, Level 3, 4kV line-to-line, Level 4, 4kV line-to-ground
•ANSI/IEEE	C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line
•Hi-potential Test	Meets UL508 (2 x rated V +1000V for 1 minute)
Environmental	
Temperature Range	Ambient Operating: -20° to 70° C (-4° to 158°F) Ambient Storage: -40° to 80° C (-40° to 176°F)
Class of Protection	IP20, NEMA 1 (FINGER SAFE)
Relative Humidity	10-95%, non-condensing per IEC 68-2-3
Special Options	
Manual Reset	External momentary pushbutton required

*Note: 50 Hz will increase all delay timers by 20%

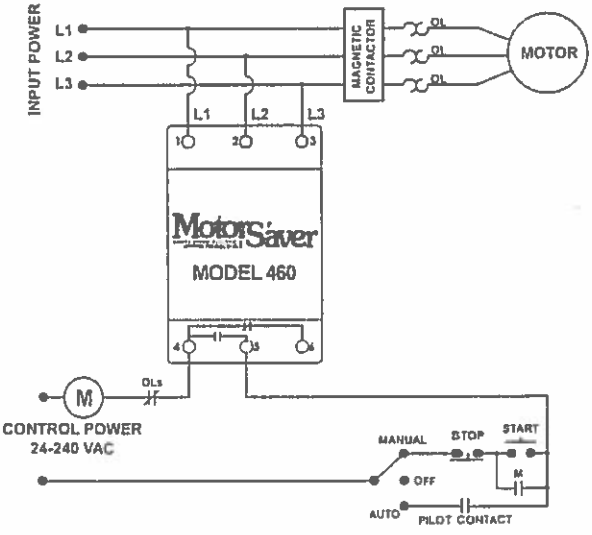


FRONT VIEW


BOTTOM VIEW



SIDE VIEW



TYPICAL WIRING DIAGRAM

SymCom Inc
Motor Protection & Controls Since 1974
2880 North Plaza Drive • Rapid City, SD 57702
(800) 843-8848 • (605) 348-5580 • FAX (605) 348-5685
www.symcominc.com • email: sales@symcominc.com

Manual Document List

PMProjNum **RTS151**

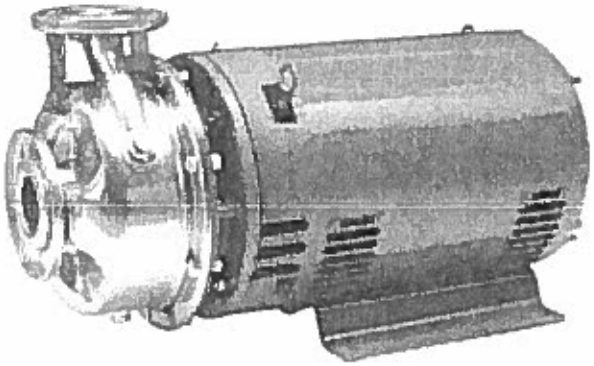
WTS, 150gpm, OWS-24, Carbon, 40' Container

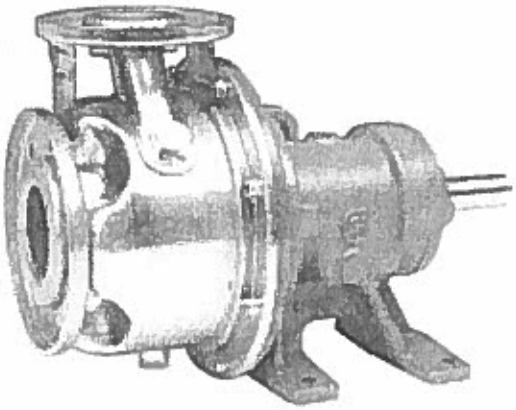
Tag	Part Number	Part Description		
Module:		*4900*		
P-4901	21028	Pump, Suction, Goulds, SSH Series, 4SH2K	Manucturer:	Goulds
			ManDoc:	#N:\Library\Goulds\Manuals\Goulds_Pu
Module:		*8200*		
8200	18396	Motor Saver, 460 w/Diagnostic 3ph	Manucturer:	Symcom
			ManDoc:	N:\Library\Symcom\Manuals\Motor Sav

G&L Pumps

Installation, Operation and Maintenance Instructions

Models SSH-C and SSH-F





Owner's Information

Please fill in data from your pump nameplate.
Warranty information is on page 28.

Pump Model: _____

Serial Number: _____

Dealer: _____

Dealer's Phone Number: _____

Date of Purchase: _____

Installation Date: _____

Table of Contents

Goulds Pumps

ITT Industries

SAFETY INSTRUCTIONS

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

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

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

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

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

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

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

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

⚠WARNING

UNIT NOT DESIGNED FOR USE WITH HAZARDOUS LIQUIDS OR FLAMMABLE GASES. THESE FLUIDS MAY BE PRESENT IN CONTAINMENT AREAS.

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

1. Important Instructions

1. Inspect unit for damage. Report damage to carrier immediately.
2. Electrical supply must be a separate branch circuit with fuses or circuit breakers, wire sizes, etc., per National and Local electrical codes. Install an all-leg disconnect switch near pump.

⚠WARNING

ALWAYS DISCONNECT ELECTRICAL POWER WHEN HANDLING PUMP OR CONTROLS.

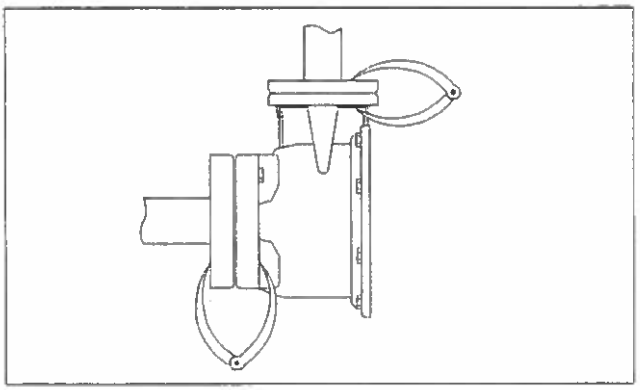
3. Motors must be wired for proper voltage (check nameplate). Wire size must limit maximum voltage drop to 10% of nameplate voltage at motor terminals, or motor life and pump performance will be lowered.
4. Single-Phase: Thermal protection for single-phase units is sometimes built-in (Check nameplate). If no built-in protection is provided, use a contactor with proper overload. Fusing is permissible if properly fused.
5. Three-Phase: Provide three-leg protection with proper size magnetic starter and thermal overloads.
6. Maximum Liquid Temperatures:
   212°F (100°C) with standard seal.
   250°F (120°C) with optional high-temperature seal.
7. Maximum allowable operating pressure: 230 PSI (15 bars).
8. Maximum number of starts per hour: 20, evenly distributed.
9. Regular Inspection and Maintenance will increase service life. Base schedule on operating time.

2. Installation

1. Close-coupled units may be installed inclined or vertical.

⚠ CAUTION DO NOT INSTALL WITH MOTOR BELOW PUMP. CONDENSATION WILL BUILD UP IN MOTOR.

2. Locate pump as near liquid source as possible (below level of liquid for automatic operation).
3. Protect from freezing or floods.
4. Allow adequate space for servicing and ventilation.
5. For close-coupled pumps, the foundation must be flat and substantial to eliminate strain when tightening bolts. Use rubber mounts to minimize noise and vibration. Tighten motor hold-down bolts before connecting piping to pump.
6. For frame-mounted pumps, permanent and solid foundation is required for smooth operation. Bedplate must be grouted to a foundation with solid footing.
7. Place unit in position on wedges located at four points (Two below approximate center of driver and two below approximate center of pump). Adjust wedges to level unit, bringing coupling halves into reasonable alignment. Level or plumb suction and discharge flanges.
8. Make sure bedplate is not distorted and final coupling alignment can be made within the limits of movement of motor and by shimming if necessary.
9. Tighten foundation bolts finger tight and build dam around foundation. Pour grout under bedplate making sure the areas under pump and motor feet are filled solid. Allow grout to harden 48 hours before further tightening foundation bolts.
10. All piping must be supported independently of the pump, and must "line-up" naturally. Never draw piping into place by forcing the pump suction and discharge connections!
11. Angular alignment of the flanges can best be accomplished using calipers at bolt locations (See illustration).



12. On frame-mounted units, tighten foundation, pump and driver hold-down bolts before connecting piping to pump.
13. Avoid unnecessary fittings. Select sizes to keep friction losses low.
14. After completing piping, rotate unit by hand to check for binding. **Note:** A screwdriver slot or flats are provided in end of motor shaft.

3. Alignment

1. No field alignment is necessary on close-coupled pumps.
2. Even though the pump-motor unit may have a factory alignment, in transit this alignment could be disturbed and must be checked prior to running.
3. Check the tightness of all hold-down bolts before checking the alignment.
4. If re-alignment is necessary, always move the motor. Shim as required.
5. Final alignment is achieved when parallel and angular requirements are achieved with both pump and motor hold down bolts tight.

⚠CAUTION ALWAYS RECHECK BOTH ALIGNMENTS AFTER MAKING ADJUSTMENTS.

6. Parallel misalignment exists when the shafts are not concentric. Place dial indicator on one hub and rotate this hub 360° while taking readings on the outside diameter of the other hub. Parallel alignment occurs when Total Indicator Reading is .005" or less.
7. Angular misalignment exists when the shafts are not parallel. Place dial indicator on one hub and rotate this hub 360° while taking readings on the face of the other hub. Angular alignment is achieved when Total Indicator Reading is .005" or less.

4. Suction Piping

1. Low static lift and short, direct suction piping is desired. For suction lift over 15 feet, consult pump performance curve for *Net Positive Suction Head Required.*
2. Suction pipe size must be at least equal to suction connection of pump.
3. If larger pipe is used, an eccentric pipe reducer (with straight side up) must be used at the pump.
4. Installation with pump below source of supply:
   4.1. Install isolation valve in piping for inspection and maintenance.
   4.2. Do not use suction isolation valve to throttle pump!
5. Installation with pump above source of supply:
   5.1. To avoid air pockets, no part of piping should be higher than pump suction connection. Slope piping upwards from liquid source.
   5.2. All joints must be airtight.
   5.3. Foot valve to be used only if necessary for priming, or to hold prime on intermittent service.
   5.4. Suction strainer open area must be at least triple the pipe area.
6. Size of inlet from liquid source, and minimum submergence over inlet, must be sufficient to prevent air entering pump.

5. Discharge Piping

1. Arrangement must include a check valve located between a gate valve and the pump. The gate valve is for regulation of capacity, or inspection of pump or check valve.
2. If reducer is required, place between check valve and pump.

6. Rotation

⚠WARNING

DO NOT PLACE HANDS IN PUMP WHILE CHECKING MOTOR ROTATION. TO DO SO WILL CAUSE SEVERE PERSONAL INJURY.

1. Pumps are right-hand rotation (Clockwise when viewed from the driver end). Switch power on and off. Observe shaft rotation. On frame-mounted units, check rotation before coupling pump to motor.
2. Single-Phase: Refer to wiring diagram on motor if rotation must be changed.
3. Three-Phase: Interchange any two power supply leads to change rotation.

7. Operation

1. Before starting, pump must be primed (free of air and suction pipe full of liquid) and discharge valve partially open.

⚠CAUTION PUMPED LIQUID PROVIDES LUBRICATION. IF PUMP IS RUN DRY, ROTATING PARTS WILL SEIZE AND MECHANICAL SEAL WILL BE DAMAGED.

2. Make complete check after unit is run under operating conditions and temperature has stabilized. Check for expansion of piping. Check coupling alignment.
3. Do not operate at or near zero flow. Energy imparted to the liquid is converted into heat. Liquid may flash to vapor. Rotating parts require liquid to prevent scoring or seizing.

8. Maintenance

⚠WARNING
Hazardous voltage

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY MAINTENANCE CAN CAUSE SHOCK, BURNS OR DEATH.

1. Bearings are located in and are part of the motor. For lubrication procedure, refer to manufacturer's instructions.
2. On frame-mounted units, regrease at 2,000 hours use or after 3 months. Use #2 Sodium or Lithium grease and fill until grease comes out of the relief fitting.

9. Disassembly

1. Always turn power off.
2. Drain system. Flush if necessary.
3. Remove motor hold-down bolts on close-coupled or disconnect coupling and remove spacer.
4. Remove casing bolts and pump hold-down bolts.
5. Remove motor and rotating element from casing.
6. Unscrew impeller bolt with a socket wrench. Do not insert screwdriver between impeller vanes to prevent rotation. It may be necessary to use a strap wrench around the impeller if impacting the socket wrench will not loosen the impeller bolt.
7. Remove impeller o-ring.
8. Insert two pry bars (180° apart) between impeller and seal housing. Pry off impeller.
9. Remove shaft sleeve, seal spring, cupwasher, seal rotary and impeller key.
10. Remove seal housing.
11. Place seal housing on flat surface. Press out stationary seal parts.
12. Remove deflector from shaft on frame-mounted units.
13. Remove bolts holding bearing cover to frame and remove bearing cover (frame-mount).
14. Remove lip seals from bearing frame and bearing cover (frame-mount).
15. Remove shaft and bearings from frame (frame-mount).
16. Remove bearing retaining ring (frame-mount).
17. Use bearing puller or arbor press to remove ball bearings (frame-mount).
18. Remove wear ring if excessively worn. Use pry bar and/or vicegrips.

10. Reassembly

1. All parts should be cleaned before assembly.
2. Refer to parts list to identify required replacement items.
3. Reassembly is the reverse of the disassembly procedure.
4. Replace lip seals if worn or damaged (frame-mount only).
5. Replace ball bearings if loose, rough or noisy when rotated (frame-mount only).
6. Check shaft for maximum runout of .005" TIR. Bearing seats and lip seal areas must be smooth and free of scratches or grooves. Replace if necessary (frame-mount only).
7. All mechanical seal components must be in good condition or leakage may result. Replacement of complete seal assembly, whenever seal has been removed, is good standard practice.
8. If wear ring is being replaced, do not use lubricants on the metal-to-metal fit when pressing in the replacement.
9. If the impeller is removed, as for example to effect a mechanical seal change, this procedure must be followed: Old impeller bolt and impeller o-ring cannot be reused.
10. Install the mechanical seal stationary seat in the seal housing, using soapy water as a lubricant to ease insertion.
11. S-Group – Install the mechanical seal spring retainer, spring and rotary assembly on the shaft sleeve using soapy water to lubricate. Slide the shaft sleeve over the pump shaft, be sure that a new shaft sleeve o-ring is used.

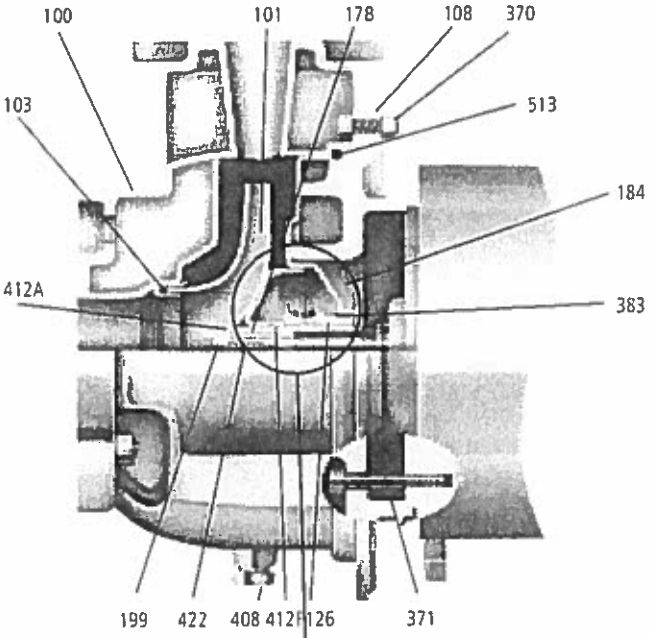
NOTE: THE SHAFT SLEEVE O-RING AND IMPELLER WASHER O-RING ARE ALMOST IDENTICAL IN DIAMETER. BE SURE TO USE THE SQUARE CROSS-SECTION O-RING IN THE IMPELLER WASHER. THE ROUND CROSS-SECTION O-RING IS USED IN THE SHAFT SLEEVE.

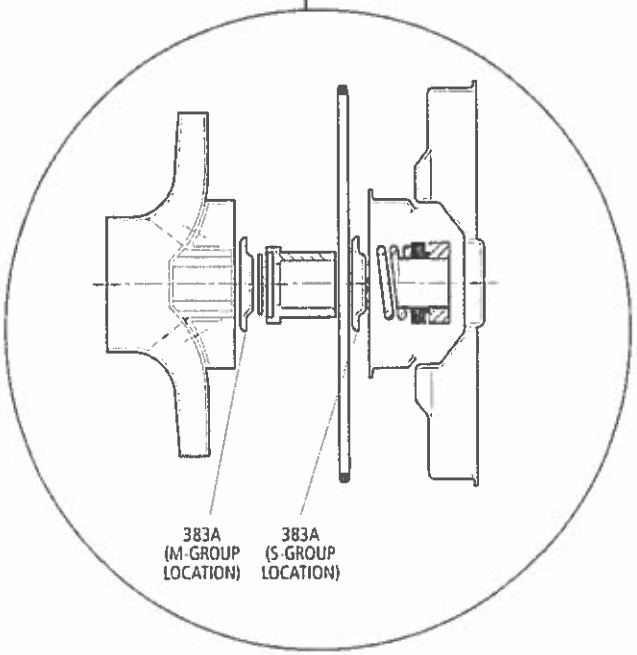
11. M-Group – Install the mechanical seal spring and rotary on the shaft sleeve using soapy water to lubricate. Slide the shaft sleeve over the pump shaft. Be sure that a new shaft sleeve o-ring is used. Place the mechanical seal spring retainer over the impeller hub.
12. Place the impeller key into the shaft keyway and slide the impeller in place. Install the impeller stud and impeller washer. Be sure that a new impeller o-ring is used. Tighten S-Group (⅜" thread) to 17 lb.ft. and M-Group (½" thread) to 38 lb.ft.

11. Troubleshooting

1. Motor does not start, and no noise or vibration occurs:
   1.1. Power supply not connected.
   1.2. Fuses or protection device tripped or defective.
   1.3. Loose or broken electrical connections.
2. Motor will not start, but generates noise and vibration:
   2.1. Motor not wired as directed on diagram.
   2.2. Shaft locked due to mechanical obstructions in motor or pump.
   2.3. Low voltage or phase loss on three phase supply.
3. Pump does not deliver rated capacity:
   3.1. Pump not filled and primed.
   3.2. Pump has lost prime due to leaks in suction line.
   3.3. Direction of rotation incorrect. See Rotation.
   3.4. Head required is higher than that originally specified. (Valve may be partially closed.)
   3.5. Foot valve clogged.
   3.6. Suction lift too high.
   3.7. Suction pipe diameter too small.
4. Protection trips as unit starts:
   4.1. Phase loss on three-phase supply.
   4.2. Protection device may be defective.
   4.3. Loose or broken electrical connections.
   4.4. Check motor resistance and insulation to ground.
5. Protection device trips too often:
   5.1. Protection may be set to a value lower than motor full load.
   5.2. Phase loss due to faulty contacts or supply cable.
   5.3. Liquid is viscous or its specific gravity is too high.
   5.4. Rubbing occurs between rotating and stationary parts.
6. Shaft spins with difficulty:
   6.1. Check for obstructions in the motor or the pump.
   6.2. Rubbing occurs between rotating and stationary parts.
   6.3. Check bearings for proper conditions.
7. Pump vibrates, runs noisily, and flow rate is uneven:
   7.1. Pump runs beyond rated capacity.
   7.2. Pump or piping not properly secured.
   7.3. Suction lift too high.
   7.4. Suction pipe diameter too small.
   7.5. Cavitation caused by insufficient liquid supply or excessive suction losses.
   7.6. Impeller blockage.
8. When stopped, unit turns slowly in the reverse direction:
   8.1. Leaks on air locks in suction pipe.
   8.2. Partial blockage in check valve.
9. In pressure boosting applications, the unit starts and stops too often:
   9.1. Pressure switch settings are incorrect.
   9.2. Tank size may be incorrect.
10. In pressure boosting applications, the unit does not stop:
    10.1. Pressure switch maximum setting is higher than was specified.
    10.2. Direction of rotation incorrect. See Rotation.

SSH-C Components





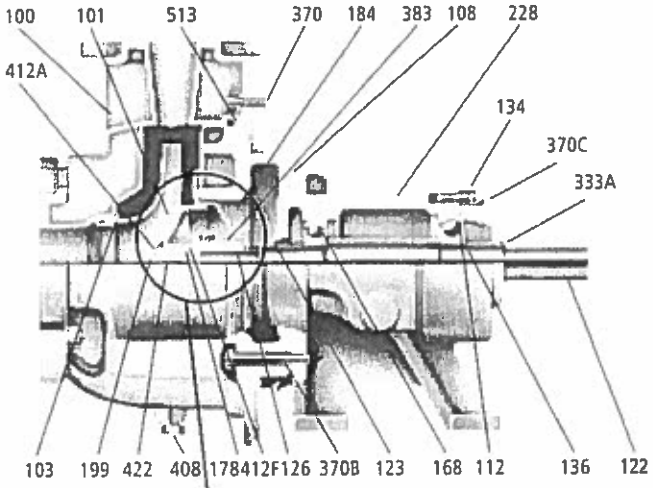
MATERIALS OF CONSTRUCTION

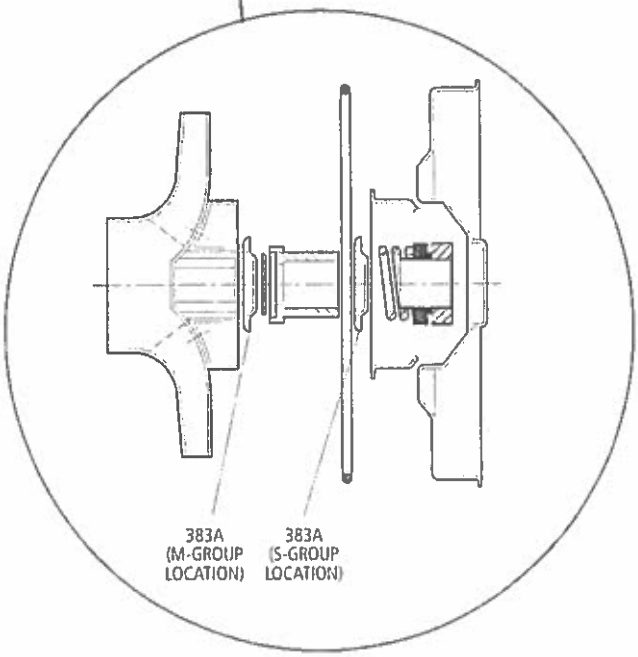
Item	Description	Material
100 101 103 184 370	Casing Impeller Wear Ring Seal Housing Socket Head Cap Screw (Casing to Adapter)	AISI TYPE 316L Stainless Steel
408	Drain Plug — ¾ NPT	AISI TYPE 316 SS
126	Shaft Sleeve	316 SS
178	Impeller Key	Steel
422	Impeller Stud	Steel
199	Impeller Washer	316 SS
108	Adapter	Cast Iron ASTM A48CL20
371	Hex Head Cap Screw (Adapter to Motor)	Steel
412A	O-ring, impeller	BUNA-N
412F	O-ring, shaft sleeve	BUNA-N
513	O-Ring	BUNA-N
383	Mechanical Seal Part No. 10K13	Carbon/Ceramic Buna Elastomers 316 SS Metal Parts
383A	Spring Retainer	AISI Type 316 SS

OPTIONAL MECHANICAL SEALS

John Crane Type 21 Mechanical Seals						
Item	Part No.	Rotary	Stationary	Elastomers	Metal Parts	Intended Duty
383 Options	10K19	Carbon	Ni-Resist	EPR	316 SS	Hi-Temperature
	10K25		Ni-Resist	Viton		Chemical
	10K27		Tungsten Carbide	EPR		Hi-Temperature Mild Abrasive

SSH-F Components





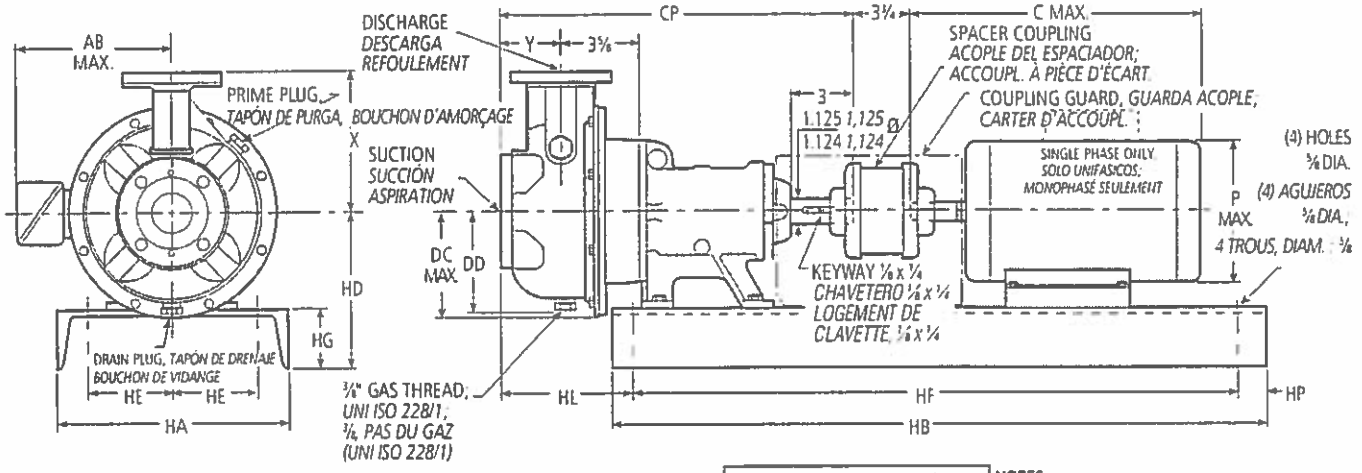
MATERIALS OF CONSTRUCTION

Item		Description	Material
Pump End Components	100 101 103 184 370	Casing Impeller Wear Ring Seal Housing Socket Head Cap Screw	AISI TYPE 316L Stainless Steel
	408	Drain plug – ¼ NPT	AISI TYPE 316 SS
	126	Shaft Sleeve	316 SS
	178	Impeller Key	Steel
	422	Impeller Stud	Steel
	199	Impeller Washer	316 SS
	412A	O-ring, impeller	BUNA-N
	412F	O-ring, shaft sleeve	BUNA-N
	513	O-Ring	BUNA-N
	383	Mechanical Seal Standard Part No. 10K13	Carbon/Ceramic BUNA-N Elastomers 316 SS Metal Parts
	383A	Spring Retainer	AISI Type 316SS
Power End Components	108 228 134	Adapter Bearing Frame Bearing Cover	Cast Iron ASTM A48 CL20
	122 168 112 136 370B 370C	Pump Shaft Ball Bearing (Inboard) Ball Bearing (Outboard) Retaining Ring Hex Head Cap Screw (Adapter to Bearing Frame) Hex Head Cap Screw (Bearing Frame to Cover)	Steel
	333A	Lip Seal	BUNA-N
	193	Grease Fitting	Steel
	123	V-Ring Deflector	BUNA-N

OPTIONAL MECHANICAL SEALS

John Crane Type 21 Mechanical Seals						
Item	Part No.	Rotary	Stationary	Elastomers	Metal Parts	Intended Duty
383 Options	10K19	Carbon	Ni-Resist	EPR	316 SS	Hi-Temperature
	10K25		Ni-Resist	Viton		Chemical
	10K27		Tungsten Carbide	EPR		Hi-Temperature Mild Abrasive

Channel Steel Bedplate, Clockwise Rotation Viewed from Drive End;
Fundación de Acero, Rotación en Dirección de las Agujas del Reloj Visto desde el Extremo del Motor;
Plaque de base profilée en U et rotation en sens horaire (vue de l'extrémité du moteur)



Dimensions and Weights – Determined by Pump,
Dimensiones y Pesos – Determinados por la Bomba;
Dimensions et poids – pompe

Pump, *Bomba, Pompe*		Suction ① *Succión ① Aspir.*	Discharge ① *Descarga ① Refoul.*	CP	DC Max., *DC Máx. DC max.*	DD	X	Y	Wt. (lbs.), *Peso (lib.) Poids*	Dimension "HL" Determined by Pump and Bedplate, *Dimensión "HL" determinada la bomba y el motor, Dimensions HL – pompe et plaque de base* Motor Frame Size, *Tamaño del bastidor del motor, Carcasse de moteur* 143/145	183/184	213/215	254/256	284/286
9SH	1 X 2–6	2	1	16⅜	5	4¼	6⅛	3¼	56	9⅛		7⅛		3⅛
10SH	1 X 2–8				5⅛	5⅛	7⅛		64					
11SH	1 X 2–10			17¼	6⅛	6⅛	8⅛		86	10		8½		4½
4SH	1½ X 2½–6	2½	1½	16½	5	4¼	6⅛	3¼	57	9¼		7¼		4
7SH	1½ X 2½–8			17¼	5⅛	5⅛	7⅛	4	66	10		8½		4¼
5SH	2 X 2½–6		2		5	4¼			57					
8SH	2 X 2½–8				6	5¼	7¹⁵⁄₁₆		68					
6SH	2½ X 3–6	3	2½						59					

① For use with ANSI class 150 mating flanges.
Para usar con bridas que casan ANSI clase 150.
À utiliser avec des contre-brides ANSI, classe 150.

NOTES:
1. All pumps shipped in vertical discharge position. May be rotated in 90° increments. Tighten ⅛ – 16 casing bolts to 12 ft./lbs. torque.
2. Dimensions in inches.
3. Motor dimensions may vary with motor manufacturer.
4. Not to be used for construction purposes.

NOTAS:
1. Todas las bombas transportadas en posición de descarga vertical. Pueden rotarse en aumentos de 90°. Apretar ⅛ – 16 tornillos de carcasa a 12 pies/libras potencia.
2. Las dimensiones en pulgadas.
3. Las dimensiones puede que varíen con los fabricantes.
4. No para propósitos de construcción.

NOTA :
1. L'orifice de refoulement est orienté vers le haut. On peut le tourner de 90° en 90°. Serrer les vis ⅛ - 16 du corps de pompe à 12 lbf pi.
2. Les dimensions sont en pouces, et le poids en livres.
3. Les dimensions et le poids du moteur peuvent varier selon le fabricant.
4. Ne pas utiliser les dimensions pour la construction si elles ne sont pas certifiées à cette effet.

Available Motor and Bedplate Dimensions and Weights,
Pesos y Dimensiones Disponibles de la Fundación y del Motor
Dimensions et poids – moteur et plaque de base

Motor Frame, *Armazón del Motor, Carcasse de moteur*	HP @ 3500 RPM, *HP a 3500 RPM, hp à 3 500 trimin*				HP @ 1750 RPM, *HP a 1750 RPM, hp à 1 750 trimin*				AB Max., *AB Máx., AB max.*	C Max., *C Máx., C max.*	P Max., *P Máx., P max.*	Wt. Max., *Peso Máx., Poids max.*	Bedplate Data, *Datos de la Fundación, Plaque de base*								
	Single Phase, *Monofásicos, 1 Ø*		Three Phase, *Trifásicas, 3 Ø*		Single Phase, *Monofásicos, 1 Ø*		Three Phase, *Trifásicas, 3 Ø*						HA	HB	HD*	HE	HF	HG	HP*	Wt. (lbs.), *Peso (libras), Poids*	Motor Shim, *Plancha de relleno del motor Cale de moteur*	Bearing Frame Shim *Plancha de relleno del bastidor del cojinete, Cale de palier*
	ODP	TEFC	ODP	TEFC	ODP	TEFC	ODP	TEFC														
143T					1	1	1	1	5¼	13⅜	6⅛	45	10	28	8	3¾	24	2¾	¼	48	1¼	–
145T	2	2	2 or ou 3	2	1½	1½	1½ or ou 2	1½ or ou 2		14½		53										
182T	3	3	5	3	2	2	3	3	5⅛	16⅛	7⅛	74										
184T	5	5	7½	5	3 or ou 5	3	5	3		18⅛		95										
213T			10	7½					7⅛	18	9⅛	116	12	31	8¼	4¼	29	3	1	65	–	–
215T			15	10						19¼		136										
254T			20	15					10⅛	21⅜	13	266	13	42	9¼	5¼	38½	4	1¼	110	–	1
256T			25	20						23¾		264										
284TS			30	25					12⅝	24¼	15	392	15	44	10½	5¾	40½	3½		124	–	1¾
286TS			40	30						26¼		432										

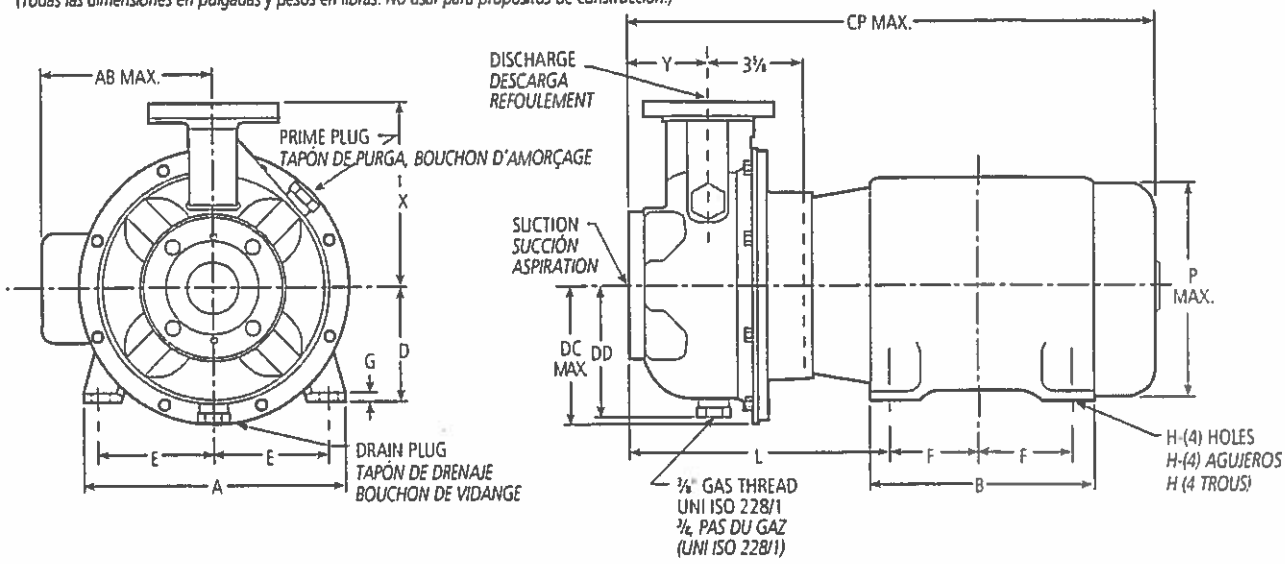
Dimensions and weights vary with manufacturers. Dimensions in inches and weights in lbs.
"HP" Dimensions at motor end only.
* "HD" Dimension for 254T/256T motor frame on 1 x 2-10 only is 11", A ¾" motor shim and a 1¼" bearing frame shim are required.

Dimensiones y pesos varían con los fabricantes. Dimensiones en pulgadas y pesos en libras.
Dimensiones "HP" sólo en el extremo del motor.
** La dimensión "HD" para el bastidor del motor 254T/256T de 1 x 2 - 10 es sólo 11", se requieren una cuña del motor de ¾" y una cuña del bastidor de apoyo de 1¼".*

ODP = carcasse abritée (à ouvertures de ventilation protégées) , TEFC = carcasse fermée autoventilée.
**Dimensions HP à l'extrémité du moteur seulement. La dimension HD pour la carcasse 254T ou 256T, version 1X2-10 seulement, est de 11 po ; une cale de moteur de ¾ po et une cale de palier de 1¼ po sont requises.*

SSH S-Group Close Coupled – Dimensions and Weights, *SSH Acople Cerrado – Dimensiones y Pesos, Dimensions et poids – SSH montée sur moteur, groupe S*

(All dimensions in inches and weights in lbs. Do not use for construction purposes.)
(Todas las dimensiones en pulgadas y pesos en libras. No usar para propósitos de construcción.)



Dimensions "L" Determined by Pump and Motor, *Dimensiones "L" Determinadas por la Bomba y el Motor, Dimensions L – pompe et moteur*													
Pump, *Bomba, Pompe*		150 lb. Flange, *Brida de 150 lib., Bride, 150 lbfpo²*		CP Max., *CP Máx., CP max.*	DC Max., *DC Máx., DC max.*	DD	X	Y	Motor Frame Size, *Tamaño del Armazón del Motor, Carcasse de moteur*				Wt. (lbs.), *Pesos (libras), Poids*
		Suct. ① *Succ. ① Aspir.*	Disch. ① *Desc. ① Refoul.*						143/145	182/184	213/215	254/256	
9SH	1 x 2 – 6	2	1	25¾	5	4¼	6⅜	3⅛	9⅛	10¼	11¼	—	24
10SH	1 x 2 – 8				5⅜	5⅛	7⅛						32
11SH	1 x 2 – 10			27⅛	6¼	6⅜	8⅛	4	10½	11⅛	12⅛	12⅜	54
4SH	1½ x 2½ – 6	2½	1½	25½	5	4¾	6⅛	3¼	9¼	10⅜	11⅜	—	25
7SH	1½ x 2½ – 8			27⅞	5⅜	5⅛	7⅛	4	10½	11⅛	12⅛	12¾	34
5SH	2 x 2½ – 6		2		5	4¼	6⅛						25
8SH	2 x 2½ – 8				6	4¾	7 15/16						36
6SH	2½ x 3 – 6	3	2½										27

① For use with ANSI class 150 mating flanges.
Para usar con bridas que casan ANSI clase 150.
À utiliser avec des contre-brides ANSI, classe 150.

NOTE:
1. Pumps shipped in vertical discharge as standard. For other orientations, remove casing bolts, rotate discharge to desired position, and tighten ¾ – 16 bolts to 12 ft./lbs., ⅞ – 14 bolts to 20 ft./lbs.
2. ALL dimensions in inches.
3. Motor dimensions may vary with motor manufacturer.
4. Not for construction purposes.

NOTA:
1. *Las bombas se transportarán en descarga vertical como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posicion deseada, y apretar ¾ – 16 tornillos a 12 pies/libras, ⅞ – 14 tornillos a 20 pies/libras.*
2. *TODAS las dimensiones en pulgadas.*
3. *Las dimensiones puede que varíen con los fabricantes.*
4. *No para propósitos de construcción.*

NOTA :
1. *L'orifice de refoulement est orienté vers le haut. Pour l'orienter autrement, enlever les vis de fixation du corps de pompe, placer l'orifice dans le sens voulu, puis reposer et serrer les vis ¾ - 16 à 12 lbf pi et ⅞ - 14 à 20 lbf pi.*
2. *Les dimensions sont en pouces, et le poids, en livres.*
3. *Les dimensions et le poids du moteur peuvent varier selon le fabricant.*
4. *Ne pas utiliser les dimensions pour la construction si elles ne sont pas certifiées à cette effet.*

Dimensions Determined by JM Motor Frame, *Dimensiones Determinadas por el Armazón del Motor JM, Dimensions – carcasse de moteur JM*

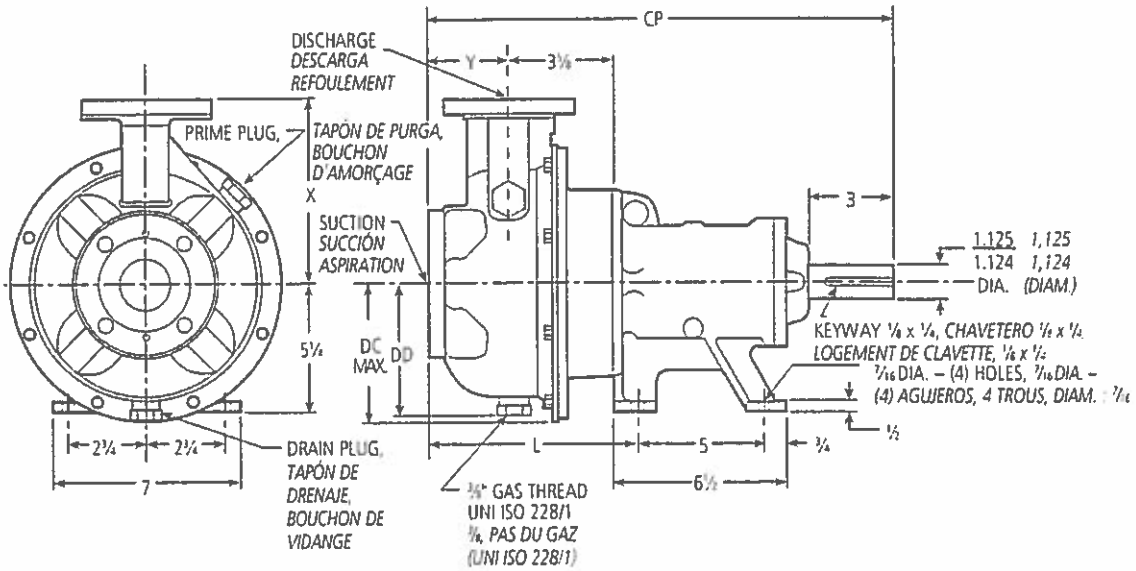
JM Frame, *JM Armazón, Carcasse*	A	AB	B	D	E	F	G	H Dia., *H Diám., H (diam.)*	P Max., *P Máx., P max.*	Motor Wt. (lbs.) *Peso Motor (lib.), Poids du moteur*
143JM	6½	5¼	6	3½	2¾	2	⅛	11/32	6⅝	41
145JM						2½				57
182JM	8½	5⅛	6½	4½	3¾	2¼	3/16	13/32	7⅛	77
184JM						2¼				97
213JM	9½	7⅛	8	5¼	4¼	2¼	7/32		9⅝	122
215JM						3½				155
254TCZ	11¼	9	9½	6¼	5	4⅛	¼	17/32	11½	265
256TCZ			11¼			5				320

Motor Frame Selections, *Selecciones del Armazón del Motor, Choix de carcasses de moteur*

Motor Frame, *Armazón del Motor, Carcasse*	Motor Horsepower, *Potencia del Motor, Puissance (hp)*							
	3500 RPM, *3500 RPM, 3 500 trimin*				1750 RPM, *1750 RPM, 1750 trimin*			
	1Ø, *Monofásicos 1 Ø*		3Ø, *Trifásicos 3 Ø*		1Ø, *Monofásicos 1 Ø*		3Ø, *Trifásicos 3 Ø*	
	ODP	TEFC	ODP	TEFC	ODP	TEFC	ODP	TEFC
143JM	–	–	–	–	–	–	1	1
145JM	2	2	2-3	2	1-1½	1-1½	1½-2	1½-2
182JM	3	3	5	3	2	2-3	3	3
184JM	5	5	7½	5	3	–	5	5
213JM	7½	–	10	7½	5	–	7½	7½
215JM	10	–	15	10-15	–	–	–	–
254TCZ	–	–	20	–	–	–	–	–
256TCZ	–	–	25	20-25	–	–	–	–

ODP = carcasse abritée (à ouvertures de ventilation protégées),
TEFC = carcasse fermée autoventilée.

SSH S-Group Frame-Mounted – Dimensions and Weights, *SSH Armazón Montado – Dimensiones y Pesos, Dimensions et poids – SSH montée sur palier, groupe S*



Dimensions and Weights – Bare Pump Only,
Dimensiones y Pesos – Solamente Bomba,
Dimensions et poids – pompe nue seulement

Pump, *Bomba, Pompe*		150 lb. Flange, *Brida de 150 lib., Bride, 150 lb/po²*		DC Max., *DC Máx., DC max.*	DD	CP Max., *CP Máx., CP max.*	L	X	Y	Wt. (lbs.), *Peso (libras), Poids*
		Suction ① *Succión ① Aspir.*	Discharge *Descarga ① Refoul.*							
9SH	1 x 2 – 6	2	1	5	4¾	16¾	7¾	6⅛	3¼	56
10SH	1 x 2 – 8			5⅛	5⅛			7⅛		64
11SH	1 x 2 – 10			6⅛	6⅛	17¼	8½	8⅛	4	86
4SH	1½ x 2½ – 6	2½	1½	5	4¾	16½	7¾	6⅛	3¼	56
7SH	1½ x 2½ – 8			5⅛	5⅛	16½	8½	7⅛	4	64
5SH	2 x 2½ – 6		2	5	4¾					57
8SH	2 x 2½ – 8			6	5¼			6⅛		66
6SH	2½ x 3 – 6	3	2½							57

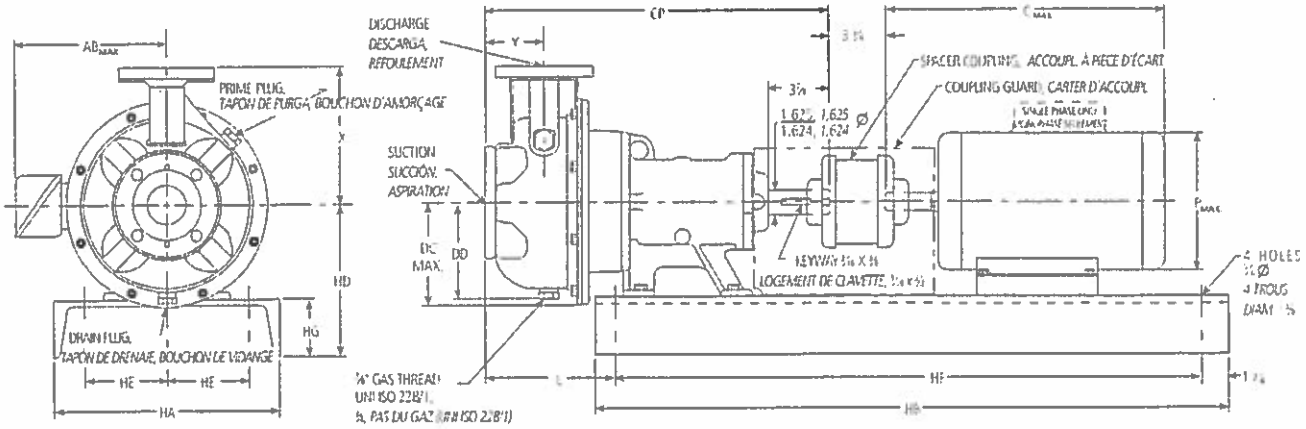
① For use with ANSI class 150 mating flanges.
Para usar con bridas que casan ANSI clase 150.
À utiliser avec des contre-brides ANSI, classe 150.

NOTE:
1. Pumps will be shipped with top vertical discharge as standard. For other orientations, remove casing bolts, rotate discharge to desired position, and tighten ⅜ –16 bolts to 12 ft./lbs., 7/16 – 14 bolts to 20 ft./lbs.
2. ALL dimensions in inches.
3. Not for construction purposes.

NOTA:
1. *Las bombas se transportarán con la descarga vertical superior como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posición deseada, y apretar ⅜ – 16 tornillos a 12 pies/libras, 7/16 – 14 tornillos a 20 pies/libras.*
2. *TODAS las dimensiones en pulgadas.*
3. *No para propósitos de construcción.*

NOTA :
1. *L'orifice de refoulement est orienté vers le haut. Pour l'orienter autrement, enlever les vis de fixation du corps de pompe, placer l'orifice dans le sens voulu, puis reposer et serrer les vis ⅜ – 16 à 12 lbf·pi et 7/16 – 14 à 20 lbf·pi.*
2. *Les dimensions sont en pouces, et le poids, en livres.*
3. *Ne pas utiliser les dimensions pour la construction si elles ne sont pas certifiées à cette effet.*

Channel Steel Bedplate, Clockwise Rotation Viewed from Drive End;
Fundación de Acero, Rotación en Dirección de las Agujas del Reloj Visto desde el Extremo del Motor;
Plaque de base profilée en U et rotation en sens horaire (vue de l'extrémité du moteur)



Dimensions and Weights – Determined by Pump,
Dimensiones y Pesos – Determinados por la Bomba,
Dimensions et poids – pompe

Pump, *Bomba, Pompe*	Pump Size, *Tamaño de la Bomba, Dimensions*	① Suction *Succión Aspir.*	① Discharge *Descarga Refoul.*	CP	DC Max., *DC Máx., DC max.*	DD	L	X	Y	Wt. (lbs.), *Peso (libras), Poids*
24SH	1½ x 2 ½-10	2½	1½	23	6⅞	6⅛	10⅛	8¹⁵⁄₁₆	4	125
25SH	2 x 2½-10		2							125
22SH	2½ x 3-8	3	2½		6⅛	5⅞				125
27SH	2½ x 3-10				6⅞	6⅛		9¹⁵⁄₁₆		134
23SH	3 x 4-8	4	3	24			11⅛		5	136
28SH	3 x 4-10				7⅝	7⅛		11⅛		148

① For use with ANSI class 150 mating flanges.
Para usar con bridas que casan ANSI clase 150.
À utiliser avec des contre-brides ANSI, classe 150.

NOTE:
1. Pumps will be shipped with top vertical discharge as standard. For other orientations, remove casing bolts, rotate discharge to desired position and tighten ⅜ – 16 bolts to 12 ft./lbs.
2. ALL dimensions in inches.
3. Not for construction purposes.

NOTA:
1. *Las bombas se transportarán con la descarga vertical superior como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posición deseada, y apretar ⅜ – 16 tornillos a 12 pies/libras.*
2. *TODAS las dimensiones en pulgadas.*
3. *No para propósitos de construcción.*

NOTA :
1. *L'orifice de refoulement est orienté vers le haut. Pour l'orienter autrement, enlever les vis de fixation du corps de pompe, placer l'orifice dans le sens voulu, puis reposer et serrer les vis ⅜ - 16 à 12 lbf·pi.*
2. *Les dimensions sont en pouces, et le poids, en livres.*
3. *Les dimensions et le poids du moteur peuvent varier selon le fabricant.*
4. *Ne pas utiliser les dimensions pour la construction si elles ne sont pas certifiées à cette effet.*

Available Motor and Bedplate Dimensions and Weights,
Pesos y Dimensiones Disponibles de la Fundación y del Motor,
Dimensions et poids – moteur et plaque de base

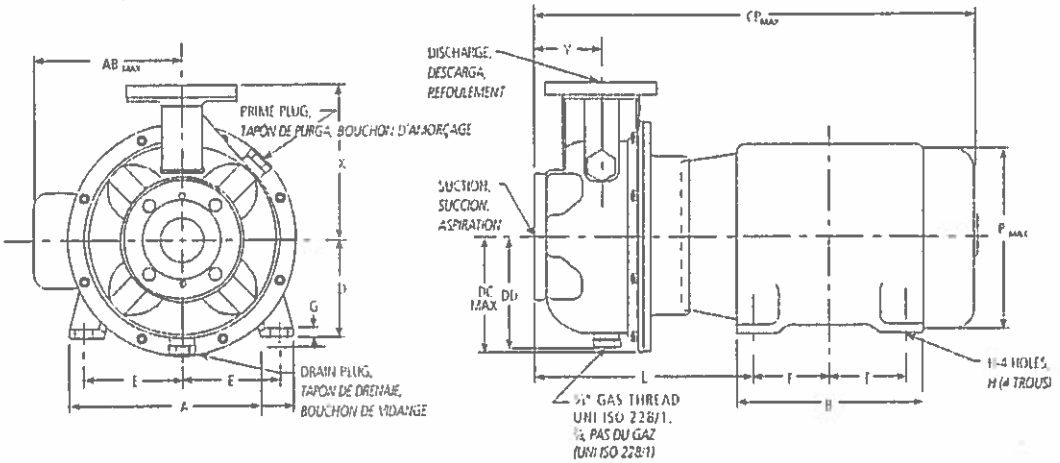
Motor Frame, *Armazón del Motor, Carcasse de moteur*	HP @ 3500 RPM, *hp à 3 500 tr/min*		HP @ 1750 RPM – T-Frame Only *hp à 1 750 tr/min – carc. T seulem.*				AB Max., *AB Máx., AB max.*	C Max., *C Máx., C max.*	P Max., *P Máx., P max.*	Wt. Max., *Peso Máx., Poids max.*	Bedplate Data, *Datos de la Fundación, Plaque de base*						
	Three Phase, *Trifásicos, 3 Ø*		Single Phase, *Monofásicos, 1 Ø*		Three Phase, *Trifásicos, 3 Ø*						HA	HB	HD	HE	HF	HG	Wt. (lbs.), *Peso (libras), Poids*
	ODP	TEFC	ODP	TEFC	ODP	TEFC											
184T			3 or ou 5	3	5	5	5⅞	18⅛	7⅛	95	13	42	10¼	5¼	38½	4	111
213T					7½	7½	7⅜	18	9⅝	116							
215T	15				10	10		19⅛		136							
254T	20	15			15	15	9½	21⅝	13	266							
256T	25	20			20	20		23⅜		264							
284TS/T	30	25			25	25	12⅝	24⅞	15	392	15	44	10½	5¾	40½	3½	124
286TS/T	40	30						26⅝		422							
324TS/T	50	40					14⅛	28¾	17⅜	592	18	48	12	7¼	44½	4	183
326TS/T	60	50						30¼		634							
364TS/T	75	60					15⅞	31⅝	18⅞	834			13				
365TS/T	100	75						32⅝		1000							
405TS/T		100					18	36¼	20½	1060	22	56	14	7¼	52½	4	214

Dimensions and weights vary with manufacturers. Dimensions in inches and weights in lbs
Dimensiones y pesos varían con los fabricantes. Dimensiones en pulgadas y pesos en libras.

ODP = carcasse abritée (à ouvertures de ventilation protégées) ; TEFC = carcasse fermée autoventilée.

SSH M-Group Close Coupled – Dimensions and Weights, *SSH Acople Cerrado – Dimensiones y Pesos, Dimensions et poids – SSH montée sur moteur, groupe M*

(All dimensions in inches and weights in lbs. Do not use for construction purposes.)
(Todas las dimensiones en pulgadas y pesos en libras. No usar para propósitos de construcción.)



Dimensions "L" Determined by Pump and Motor, *Dimensiones "L" Determinadas por la Bomba y el Motor, Dimensions L – pompe et moteur*																
Pump, *Bomba, Pompe*	Pump Size, *Tamaño de la Bomba, Dimensions*	① Suction *Succión Aspir.*	① Discharge *Descarga Refoul.*	CP Max., *CP Máx., CP max.*	DC Max., *DC Máx., DC max.*	DD	X	Y	Wt. (lbs.), *Peso (libras), Poids*	Motor Frame Size, *Tamaño del Armazón del Motor, Carcasse de moteur*						
										140	180	210	250	280	320	360
24SH	1½ x 2 ½-10	2½	1½	34½	6⅞	6⅝	8 15/16	4	75	10½	11⅛	12⅛	13⅜		14⅜	-
25SH	2 x 2½-10		2	36					75							15
22SH	2½ x 3-8	3	2½		6⅛	5⅞			72	-						
27SH	2½ x 3-10				6⅞	6⅝	9 15/16		84	-	-					
23SH	3 x 4-8	4	3	37				5	86	11½	12⅛	13⅜	14⅞		15⅜	16
28SH	3 x 4-10				7⅛	7⅜	11⅛		98	-	-					

① For use with ANSI class 150 mating flanges.
Para usar con bridas que casan ANSI clase 150.
À utiliser avec des contre-brides ANSI, classe 150.

NOTES:
1. Pumps shipped in vertical discharge as standard. For other orientations, remove casing bolts, rotate discharge to desired position, and tighten ⅜ – 16 bolts to 12 ft./lbs., ⅞ – 14 bolts to 20 ft./lbs., ½ – 13 bolts to 35 ft./lbs.
2. Motor dimensions may vary with motor manufacturer.
3. Not for construction purposes.

NOTAS:
1. *Las bombas se transportarán en descarga vertical como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posición deseada, y apretar ⅜ – 16 tornillos a 12 pies/libras, ⅞ – 14 tornillos a 20 pies/libras, ½ – 13 tornillos a 35 pies/libras.*
2. *TODAS las dimensiones en pulgadas.*
3. *No para propósitos de construcción.*

NOTA :
1. *L'orifice de refoulement est orienté vers le haut. Pour l'orienter autrement, enlever les vis de fixation du corps de pompe, placer l'orifice dans le sens voulu, puis reposer et serrer les vis ⅜ - 16 à 12 lbf·pi, ⅞ - 14 à 20 lbf·pi et ½ - 13 à 35 lbf·pi.*
2. *Les dimensions sont en pouces, et le poids, en livres.*
3. *Les dimensions et le poids du moteur peuvent varier selon le fabricant.*
4. *Ne pas utiliser les dimensions pour la construction si elles ne sont pas certifiées à cette effet.*

Dimensions Determined by JM Motor Frame, *Dimensiones Determinadas por el Armazón del Motor JM, Dimensions – carcasse de moteur JM*

Frame, *Armazón, Carcasse*	A	AB Max., *AB max.*	B	D	E	F	G	H	P Max., *P Máx., P max.*
145JM	6½	5¼	6	3½	2¼	2½	⅛	11/32	7 5/16
182JM	8½	5⅞	6½	4½	3¾	2¼	3/16	13/32	8½
184JM						2¾			
213JM	9½	7⅜	8	5¼	4¼	3½	7/32		10 3/16
215JM									
254JM	11¼	9	11¾	6¼	5	4⅛	¼	17/32	13¼
256JM						5			
284JM	12¼	12¼	12¼	7	5½	4¾			15
286JM						5½			
324JM	14	13¼	14	8	6¼	5½	5/16	21/32	16 5/16
326JM						5½			
364TCZ	17¾	15½	15½	9	7	5⅝	1		19
365TCZ						6⅛			

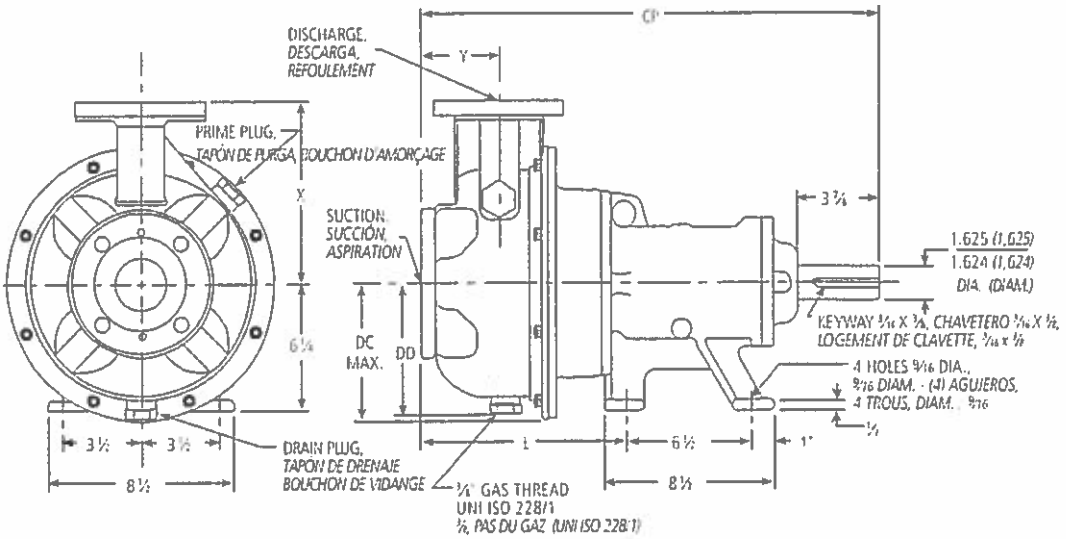
364TCZ and 365TCZ frames are built with 326JM shaft extensions.
Dimensions may vary with manufacturer.;
Los armazones 364TCZ y 365TCZ se construyen con extensiones del eje 326JM.
Las dimensiones puede que varíen con los fabricantes.;
Les carcasses 364TCZ et 365TCZ possèdent la rallonge d'arbre de la 326JM.

Motor Frame Selections, *Selecciones del Armazón del Motor, Choix de carcasses de moteur*

Frame, *Armazón, Carcasse*	Motor Horsepower, *Potencia del Motor, Puissance (hp)*						Wt. Max., *Peso Máx., Poids max.*
	3500 RPM, *3500 r/min*		1750 RPM, *1750 r/min*				
	3 PH, *Trifásicos, 3 Ø*		1 PH, *Monofásicos, 1 Ø*		3 PH, *Trifásicos, 3Ø*		
	ODP	TEFC	ODP	TEFC	ODP	TEFC	
145JM	–	–	–	–	2	2	57
182JM	–	–	2	2, 3	3	3	77
184JM	–	–	3	–	5	5	97
213JM	10	–	5	–	7½	7½	141
215JM	15	10	–	–	10	10	155
254JM	20	15	–	–	15	15	265
256JM	25	20	–	–	20	20	320
284JM	30	25	–	–	25	25	419
286JM	40	30	–	–	–	–	422
324JM	50	40	–	–	–	–	562
326JM	60	50	–	–	–	–	625
364TCZ	75	60	–	–	–	–	775
365TCZ	100	75, 100	–	–	–	–	905

364TCZ and 365TCZ frames are built with 326JM shaft extensions.
Los armazones 364TCZ y 365TCZ se construyen con extensiones del eje 326JM.
ODP = carcasse abritée (à ouvertures de ventilation protégées) ; TEFC = carcasse fermée autoventilée. Les carcasses 364TCZ et 365TCZ possèdent la rallonge d'arbre de la 326JM.

SSH M-Group Frame Mounted – Dimensions and Weights, *SSH Armazón Montado – Dimensiones y Pesos, Dimensions et poids – SSH montée sur palier, groupe M*



Dimensions and Weights – Bare Pump Only,
Dimensiones y Pesos – Solamente Bomba
Dimensions et poids – pompe nue seulement

Pump, *Bomba, Pompe*	Pump Size, *Tamaño de la Bomba, Dimensions*	① Suction *Succión Aspir.*	① Discharge *Descarga Refoul.*	CP	DC Max., *DC Máx., DC max.*	DD	L	X	Y	Wt. (lbs.), *Peso (libras), Poids*
24SH	1½ x 2 ½-10	2½	1½	23	6⅞	6⅝	10½	8 15/16	4	125
25SH	2 x 2½-10		2							125
22SH	2½ x 3-8	3	2½		6⅛	5⅞				125
27SH	2½ x 3-10									134
23SH	3 x 4-8	4	3	24	6⅜	6½	11½	9 15/16	5	136
28SH	3 x 4-10				7⅛	7⅜		11⅛		148

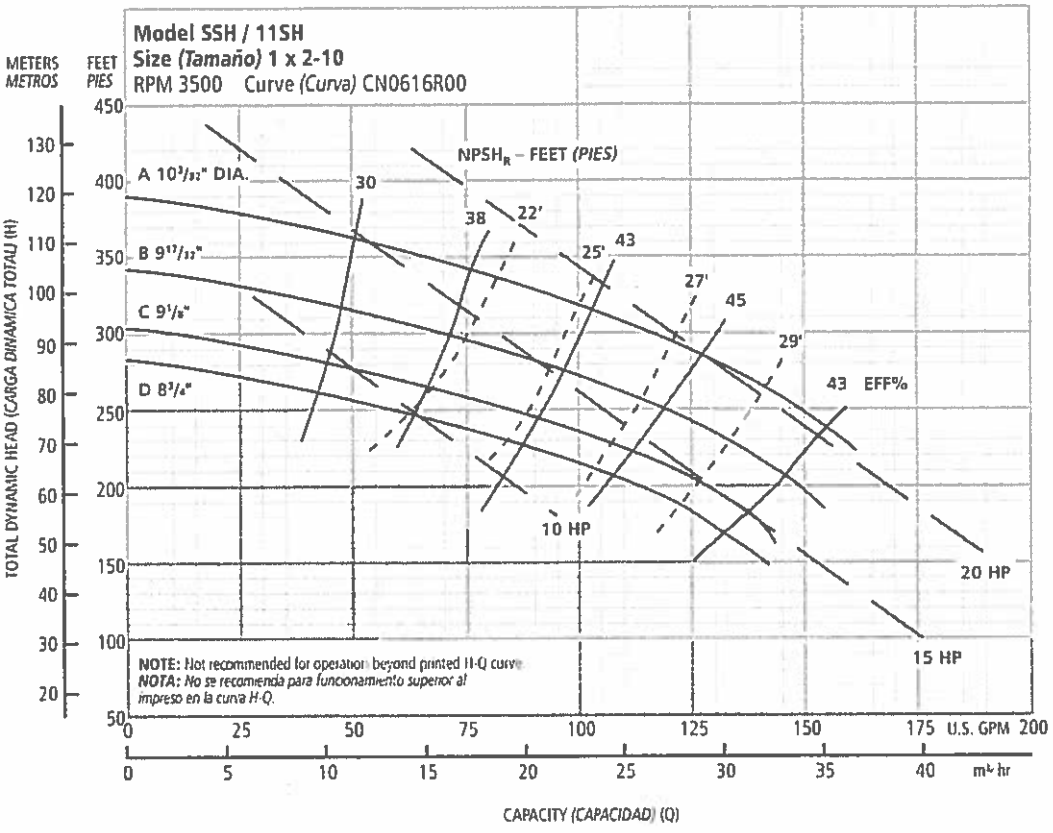
① For use with ANSI class 150 mating flanges.
Para usar con bridas que casan ANSI clase 150.
À utiliser avec des contre-brides ANSI, classe 150.

NOTES:
1. Pumps will be shipped with top vertical discharge as standard. For other orientations, remove casing bolts, rotate discharge to desired position, replace and tighten ⅜–16 bolts to 12 ft./lbs.
2. Motor dimensions may vary with motor manufacturer.
3. Not for construction purposes.

NOTAS:
1. *Las bombas se transportarán con la descarga vertical superior como estándar. Para otras orientaciones, retirar los tornillos de la carcasa, rotar la descarga a la posición deseada, y apretar ⅜ – 16 tornillos a 12 pies/libras.*
2. *TODAS las dimensiones en pulgadas.*
3. *No para propósitos de construcción.*

NOTA :
1. *L'orifice de refoulement est orienté vers le haut. Pour l'orienter autrement, enlever les vis de fixation du corps de pompe, placer l'orifice dans le sens voulu, puis reposer et serrer les vis ⅜ – 16 à 12 lbf pi.*
2. *Les dimensions sont en pouces, et le poids, en livres.*
3. *Les dimensions et le poids du moteur peuvent varier selon le fabricant.*
4. *Ne pas utiliser les dimensions pour la construction si elles ne sont pas certifiées à cette effet.*

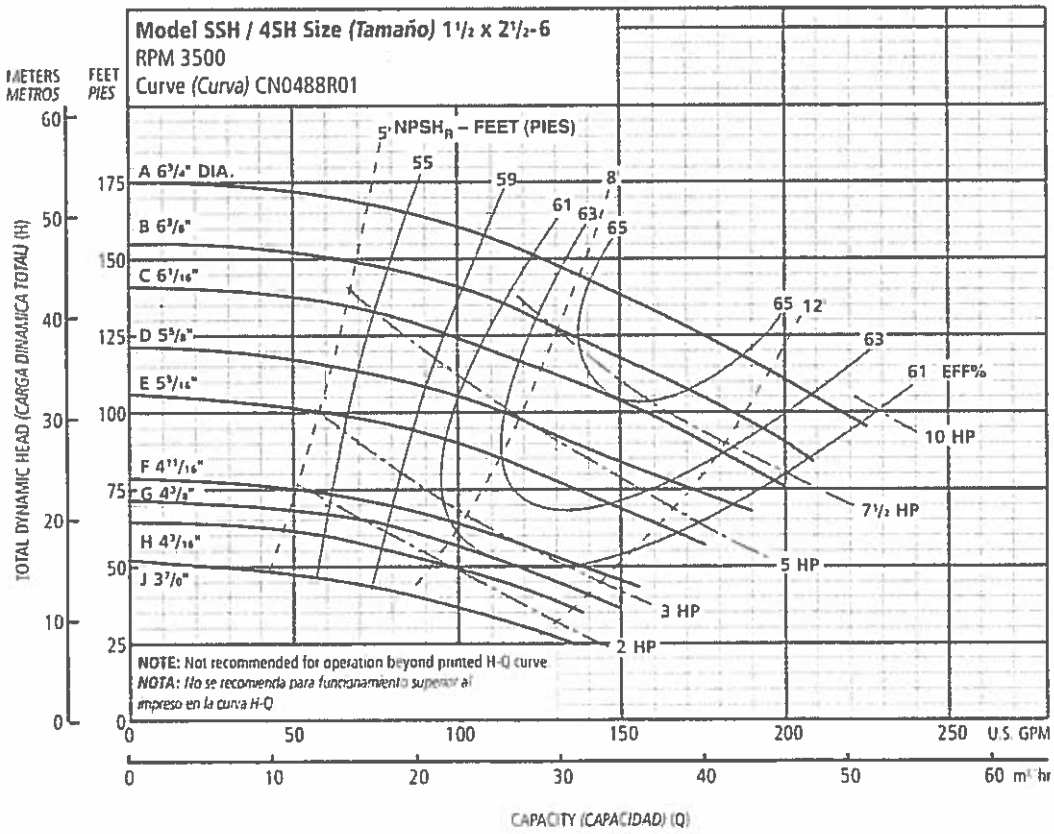
Performance Curves – 60 Hz, 3500 RPM
Curvas de Funcionamiento – 60 Hz, 3500 RPM



Optional Impeller, *Impulsor Opcional*		
Impeller Code, *Código del Impulsor*	Dia., *Diá.*	Standard HP Rating, *Estándar HP Potencia*
A	10 3/32"	20
B	9 17/32	15
C	9 1/8	15
D	8 3/4	15

NOTE: Pump will pass a sphere to 1/4" diameter.

NOTA: La bomba pasará una esfera a 1/4" diámetro.



Optional Impeller, *Impulsor Opcional*		
Impeller Code, *Código del Impulsor*	Dia., *Diá.*	Standard HP Rating, *Estándar HP Potencia*
A	6 3/4"	10
B	6 3/8	7 1/2
C	6 1/16	7 1/2
D	5 5/8	5
E	5 5/16	5
F	4 11/16	3
G	4 3/8	3
H	4 3/16	2
J	3 7/8	2

NOTE: Pump will pass a sphere to 3/16" diameter.

NOTA: La bomba pasará una esfera a 3/16" diámetro.

GOULDS PUMPS

Wastewater Pumps
Dewatering, Effluent and Sewage
Installation and Operation Manual

Owner's Information

Pump Model Number: _____

Pump Serial Number: _____

Control Model Number: _____

Dealer: _____

Dealer Phone No. _____

Date of Purchase: _____ Installation: _____

Current Readings at Startup:

1Ø	3Ø	L1-2	L2-3	L3-1
Amps: _____	Amps: _____	_____	_____	_____
Volts: _____	Volts: _____	_____	_____	_____

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Goulds Pumps

ITT Industries

SAFETY INSTRUCTIONS

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

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE PUMP.

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

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

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

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

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

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS PUMP.

MAINTAIN ALL SAFETY DECALS.

⚠ WARNING All electrical work must be performed by a qualified technician. Always follow the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial codes. Code questions should be directed to your local electrical inspector. Failure to follow electrical codes and OSHA safety standards may result in personal injury or equipment damage. Failure to follow manufacturer's installation instructions may result in electrical shock, fire hazard, personal injury or death, damaged equipment, provide unsatisfactory performance, and may void manufacturer's warranty.

⚠ WARNING Standard units are not designed for use in swimming pools, open bodies of water, hazardous liquids, or where flammable gases exist. These fluids and gases may be present in containment areas. Tank or wetwell must be vented per local codes.

Only pumps specifically Listed for Class 1, Division 1 are allowable in hazardous liquids and where flammable gases may exist. *See specific pump catalog bulletins or pump nameplate for all agency Listings.*

⚠ WARNING Disconnect and lockout electrical power before installing or servicing any electrical equipment. Many pumps are equipped with automatic thermal overload protection which may allow an overheated pump to restart unexpectedly.

⚠ CAUTION All three phase (3Ø) control panels for submersible pumps must provide Class 10, quick-trip, overload protection.

PRE-INSTALLATION CHECKS

Open all cartons and inspect for shipping damage. Report any damage to your supplier or shipping carrier immediately.

Important: Always verify that the pump nameplate Amps, Voltage, Phase, and HP ratings match your control panel and power supply.

Many of our sewage pumps are oil-filled. If there are any signs of oil leakage or if the unit has been stored for an extended period check the oil level in the motor dome and the seal housing, if so equipped.

Check the motor cover oil level through the pipe plug on top of the unit. The motor chamber oil should just cover the motor. Do not overfill, leave room for expansion!

To check the seal housing oil level, where used, lay the unit on its side with the fill plug at 12 o'clock. Remove the plug. The oil should be within ½" (13mm) of the top. If low, refill with an ASTM 150 turbine oil. Replace the plug.

Oil is available in 5 gallon cans through our distributors. You can also source oil locally at motor repair shops. Typical oil brands are: Shell Turbo 32, Sunoco Sunvis 932, Texaco Regal R&O 32, Exxon Nuto 32 and Mobil DTE Light.

Check the strain relief nut on power cable strain assemblies. Power cables should be torqued to 75 in. lbs. for #16 cables and 80 in. lbs. for all other cable assemblies. Seal/heat sensor cables, where used, should be torqued to 75 in. lbs.

Warranty does not cover damage caused by connecting pumps and controls to an incorrect power source (voltage/phase supply).

Record the model numbers and serial numbers from the pumps and control panel on the front of this instruction manual for future reference. Give it to the owner or affix it to the control panel when finished with the installation.

LIFTING OF PUMP

⚠ WARNING

DO NOT LIFT, CARRY OR HANG PUMP BY THE ELECTRICAL CABLES. DAMAGE TO THE ELECTRICAL CABLES CAN CAUSE SHOCK, BURNS OR DEATH.

Lift the pump with an adequately sized chain or cable attached to the lifting eye bolt. DO NOT damage electrical and sensor cables while raising and lowering unit.

OPTIONAL GUIDE RAIL OR LIFT-OUT SYSTEM

In many effluent and sewage basins or lift stations it is advisable to install the pump on a guide rail system or on a lift-out adapter to facilitate installation and removal for inspection and/or service. Most codes do not allow personnel to enter a wetwell without the correct protective equipment and training. Guide rails are designed to allow easy removal of the pump without the need for entry into the wetwell or need to disturb piping. The guide rail or lift-out adapter should locate the pump opposite the influent

opening preventing stagnate areas where solids can settle. The basin or pit must be capable of supporting the weight of the pump and guide rail. The pit floor must be flat.

NOTICE: FOLLOW THE INSTRUCTIONS THAT ARE PROVIDED WITH THE GUIDE RAIL ASSEMBLY.

PIPING

Discharge piping should be no smaller than the pump discharge diameter and kept as short as possible, avoiding unnecessary fittings to minimize friction losses.

Install an adequately sized check valve matched to the solids handling capability of the pump to prevent fluid backflow. Backflow can allow the pump to "turbine" backwards and may cause premature seal and/or bearing wear. If the pump is turning backwards when it is called on to start the increased torque may cause damage to the pump motor and/or motor shaft and some single-phase pumps may actually run backwards.

Install an adequately sized gate valve AFTER the check valve for pump, plumbing and check valve maintenance.

Important – Before pump installation. Drill a 3/16" (4.8mm) relief hole in the discharge pipe. It should be located within the wetwell, 2" (51mm) above the pump discharge but below the check valve. The relief hole allows any air to escape from the casing. Allowing liquid into the casing will insure that the pump can start when the liquid level rises. Unless a relief hole is provided, a bottom intake pump could "air lock" and will not pump water even though the impeller turns.

All piping must be adequately supported, so as not to impart any piping strain or loads on the pump.

The pit access cover must be of sufficient size to allow for inspection, maintenance and crane or hoist service.

WIRING AND GROUNDING

Important notice: Read Safety Instructions before proceeding with any wiring.

⚠ Use only stranded copper wire to pump/motor and ground. The ground wire must be at least as large as the power supply wires. Wires should be color coded for ease of maintenance and troubleshooting.

⚠ Install wire and ground according to the National Electrical Code (NEC), or the Canadian Electrical Code, as well as all local, state and provincial codes.

⚠ Install an all leg disconnect switch where required by code.

⚠ Disconnect and lockout electrical power before performing any service or installation.

⚠ The electrical supply voltage and phase must match all equipment requirements. Incorrect voltage or phase can cause fire, motor and control damage, and voids the warranty.

⚠ All splices must be waterproof. If using splice kits follow manufacturer's instructions.

⚠ WARNING Select the correct type and NEMA grade junction box for the application and location. The junction box must insure dry, safe wiring connections.

⚠ WARNING Seal all controls from gases present which may damage electrical components.

⚠ WARNING Hazardous voltage

FAILURE TO PERMANENTLY GROUND THE PUMP, MOTOR AND CONTROLS BEFORE CONNECTING TO POWER CAN CAUSE SHOCK, BURNS OR DEATH.

SELECTING AND WIRING PUMP CONTROL PANELS AND SWITCHES

FLOAT SWITCH TYPES

There are two basic float switch designs; single-action and wide-angle. Single-action switches operate over a range of 15° so they open and close quickly. Wide-angle floats operate over a 90° swing with the tether length between the float body and the pivot point controlling the On-Off range. The design determines how many floats are required with different systems or controls.

Floats may be normally open (NO) for pump down applications or to empty a tank. Normally closed (NC) switches are used to pump up or to fill a tank.

A single-action control switch may be used only with a control panel, never direct connected to a pump.

The wide-angle, pump down switches may be used as direct connected pump switches or as control switches.

SETTING THE FLOAT SWITCHES

There are no absolute rules for where to set the float switches, it varies from job to job.

Suggested Rules to Follow:
All floats should be set below the Inlet pipe!

Off Float: Best: set so the water level is always above the top of the pump (motor dome). **Next Best:** set so the water level is not more than 6" below the top of the pump.

On Float: set so the volume of water between the On and Off floats allows pumps of 1½ HP and under to operate for 1 minute minimum. Two (2) HP and larger pumps should run a minimum of 2 minutes. Basin literature states the gallons of storage per inch of basin height.

Lag/Alarm Float(s): should be staggered above the Off and On floats. Try to use most of the available storage provided by the basin, save some space for reserve storage capacity. *See Diagrams and Charts in Float Switch Chart Section.*

PANEL WIRING DIAGRAMS

Our control panels are shipped with instructions and wiring diagrams. Use those instructions in conjunction with this IOM. Electrical installation should be performed only by qualified technicians. Any problem or questions pertaining to another brand control must be referred to that control supplier or manufacturer. Our technical people have no technical schematics or trouble shooting information for other companies' controls.

ALARMS

We recommend the installation of an alarm on all Wastewater pump installations. Many standard control panels come equipped with alarm circuits. If a control panel is not used, a stand alone high liquid level alarm is available. The alarm alerts the owner of a high liquid level in the system so they can contact the appropriate service personnel to investigate the situation.

SINGLE PHASE PUMPS

Single phase (1Ø) pumps may be operated using a piggyback or hard wired float switch, a contactor, or a Simplex or Duplex control panel. *See Figures 1, 2 and 5.*

All 1/3 and 1/2 HP, 115 or 230 volt pumps, and some 3/4 and 1 HP pumps, are supplied with plug style power cords. They may be plugged into piggyback float switches for simple installations. It is allowable to remove the plugs in order to hardwire or connect to a Simplex or Duplex controller. Removing the plug neither voids the warranty nor violates the agency Listings. *See Figure 5.*

PLUG-CONNECTED UNITS MUST BE CONNECTED TO A PROPERLY GROUNDED, GROUNDING TYPE RECEPTACLE.

ON NON-PLUG UNITS, DO NOT REMOVE CORD AND STRAIN RELIEF. DO NOT CONNECT CONDUIT TO PUMP.

Pumps with bare lead power cords can be hard-wired to a float switch, wired to a 1Ø contactor, a Simplex controller or a Duplex controller. Always verify that the float switch is rated for the maximum run amperage, maximum starting amperage, and the HP rating on the pump. Single-phase wastewater pumps contain on-winding overloads, unless noted on the pump nameplate. *See Figures 1 and 2.*

THREE PHASE PUMPS:

As a Minimum a 3Ø pump requires a 3 pole circuit breaker/fused circuit, an across the line magnetic starter rated for the pump HP, and ambient compensated Quick Trip Class 10 overloads.

SINGLE AND THREE PHASE CONTROL PANELS:

Control panels are available as Simplex (controls 1 pump) or Duplex (controls 2 pumps). Our standard SES Series Panels are available with many standard features and can be built with our most popular options. We also custom build panels which offer many more design options than the SES panels. Custom control panels are available in many different configurations. Custom panel quote requests may be forwarded to Customer Service through any authorized distributor.

Our "SES" Duplex panels feature a solid-state printed circuit board design with standard high level alarm circuits. Other standard features are: an auxiliary dry alarm contact for signaling a remote alarm and float switch position indicator lights. Our 3Ø panels have built-in, adjustable, Class 10 overloads. The adjustable overloads on all our 3Ø panels mean less labor for the installer and no need to order specific overloads. Most SES panels are in stock for immediate delivery.

On pumps equipped with seal fail and/or heat (high temperature) sensors it is recommended that you use our control panel with the appropriate options. The pump sensors do not function without a seal fail relay or terminal connection in the control panel and a warning device such as a bell, horn or light.

Seal Failure Circuit - Some dual seal pumps are equipped with a standard, built-in seal failure circuit, which may also be called a moisture detection circuit. This circuit must be connected to a control panel with an optional seal fail relay. The panel must be special ordered with the seal fail relay and alarm. There are also stand alone seal fail panels such as the A4-3 or A4-4 available as standard items. The pumps can be identified by an extra control cable exiting the motor cover. The cable contains two wires, a black wire, connects to panel "terminal" going to "probe"; and a white wire, connects to the panel "terminal" going to the relay ground. Do not connect to the panel ground screw. Follow the wiring instructions supplied with the panel.

Heat Sensor and Seal Failure Circuit - Some pumps are equipped with a seal fail and normally closed, on-winding high temperature thermostats (heat sensors). The pumps have a control cable with four (4) leads, black (probe) and green (relay ground) for the seal fail circuit and red and white for the high temperature circuit. Connect the high temperature (heat sensor) circuit to the panel terminal strip as indicated on the panel drawing using the red and white wires. The high temperature panel circuit is also an optional item which you must specifically order when you order your control panel. The high temperature circuit is different from the Class 10 overloads which are always required on three phase pumps. *Follow the wiring instructions supplied with the panel.*

INSTALLATION

Connect the pump(s) to the guide rail pump adapters or to the discharge piping. Slide rail bases should be anchored to the wetwell floor.

Complete all wiring per the control panel wiring diagrams and NEC, Canadian, state, provincial and/or local codes. This a good time to check for proper rotation of the motors/impellers.

DO NOT PLACE HANDS IN PUMP SUCTION WHILE CHECKING MOTOR ROTATION. TO DO SO WILL CAUSE SEVERE PERSONAL INJURY.

Always verify correct rotation. Correct rotation is indicated on the pump casing. Three phase motors are reversible. It is allowable to bump or jog the motor for a few seconds to check impeller rotation. It is easier to check rotation before installing the pump. Switch any two power leads to reverse rotation.

Lower the pump(s) into the wetwell.

Check to insure that the floats will operate freely and not contact the piping.

OPERATION

Once the piping connections are made and checked you can run the pumps.

Piggyback Switch Operation – Plug the piggyback switch into a dedicated grounded outlet and then plug the pump into the switch. Test the pump by filling the wetwell until the pump goes On. If the pumps run but fail to pump, they are probably air locked, drill the relief holes per the instructions in the Piping Section.

Check the operating range to insure a minimum one minute run time and that the pump goes Off in the correct position.

Control Panel Operation – Fill the wetwell with clear water.

Use the pump H-O-A (Hand-Off-Automatic) switches in Hand to test the pumps. If they operate well in Hand proceed to test Automatic operation. If the pumps run but fail to pump, they are probably air locked, drill the relief holes per the instructions in the Piping Section.

Place Control Panel switch(es) in Automatic position and thoroughly test the operation of the ON, OFF, and Alarm floats by filling the wetwell with clear water. **Important:** Failure to provide a Neutral from the power supply to a 10, 230 volt Control Panel will not allow the panel control circuit to operate. The Neutral is necessary to complete the 115 volt control circuit.

Check voltage and amperage and record the data on the front of this manual for future reference. Compare the amperage readings to the pump nameplate maximum amperage. If higher than nameplate amperage investigate cause. Operating the pump off the curve, i.e. with too little head or with high or low voltage will increase amperage. The motor will operate properly with voltage not more than 10% above or below pump nameplate ratings. Performance within this range will not necessarily be the same as the published performance at the exact rated nameplate frequency and voltage. Correct the problem before proceeding. Three phase unbalance is also a possible cause. *See Three Phase Power Unbalance and follow the instructions.*

Reset the Alarm circuit, place pump switch(es) in the Automatic position and Control Switch in ON position. The system is now ready for automatic operation.

Explain the operation of the pumps, controls and alarms to the end user. Leave the paperwork with the owner or at the control panel if in a dry, secure location.

FLOAT SWITCH AND PANEL CHART

The purpose of this chart is to show the required switch quantities and the function of each switch in a typical wastewater system. The quantities required vary depending on the switch type, single-action or wide-angle. Switch quantities also vary by panel type: simplex with and without alarms, and duplex with alarms.

Duplex Panels using single-action switches:

Three Float Panel Wiring

SW1	Bottom	Pumps Off
SW2	Middle	1st Pump On
SW3	Top	2nd Pump & Alarm On

Four Float Panel Wiring ②

SW1	Bottom	Pumps Off
SW2	2nd	1st Pump On
SW3	3rd	2nd Pump On
SW4	Top	Alarm On

Duplex Panels using wide-angle switches:

Three Float Panel Wiring

SW1	Bottom	1st Pump On/Both Off
SW2	Top	2nd Pump & Alarm On

Four Float Panel Wiring

SW1	Bottom	1st Pump On/Both Off
SW2	Middle	2nd Pump On
SW3	Top	Alarm On

Simplex Panel using single-action switches:

Simplex Panel with Alarm ①

SW1	Bottom	Pump Off
SW2	Middle	Pump On
SW3	Top	Alarm On/Off

Simplex Panel with No Alarm

SW1	Bottom	Pump Off
SW2	Top	Pump On

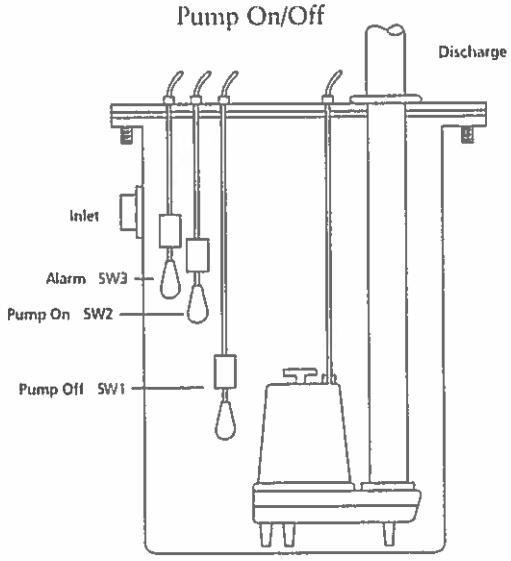
Simplex Panel using wide-angle switches:

Simplex Panel with Alarm

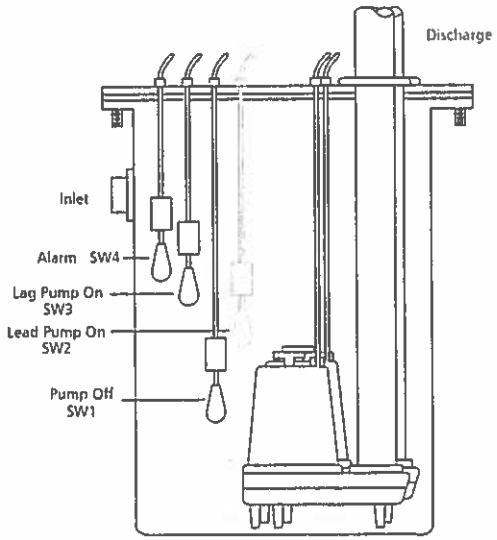
SW1	Bottom	Pump On/Off
SW2	Top	Alarm On/Off

Simplex Panel with No Alarm

SW1	Pump On/Off



Simplex ①



Duplex ②

THREE PHASE POWER UNBALANCE

A full three phase supply consisting of three individual transformers or one three phase transformer is recommended. "Open" delta or wye connections using only two transformers can be used, but are more likely to cause poor performance, overload tripping or early motor failure due to current unbalance.

Check the current in each of the three motor leads and calculate the current unbalance as explained below.

If the current unbalance is 2% or less, leave the leads as connected.

If the current unbalance is more than 2%, current readings should be checked on each leg using each of the three possible hook-ups. Roll the motor leads across the starter in the same direction to prevent motor reversal.

To calculate percent of current unbalance:

A. Add the three line amp values together.

B. Divide the sum by three, yielding average current.

C. Pick the amp value which is furthest from the average current (either high or low).

D. Determine the difference between this amp value (furthest from average) and the average.

E. Divide the difference by the average. Multiply the result by 100 to determine percent of unbalance.

Current unbalance should not exceed 5% at service factor load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg farthest from the average stays on the same power lead, most of the unbalance is coming from the power source.

Contact your local power company to resolve the imbalance.

	Hookup 1			Hookup 2			Hookup 3		
Starter Terminals	L1	L2	L3	L1	L2	L3	L1	L2	L3
	⊥ T	⊥ T	⊥ T	⊥ T	⊥ T	⊥ T	⊥ T	⊥ T	⊥ T
Motor Leads	R	B	W	W	R	B	B	W	R
	T3	T1	T2	T2	T3	T1	T1	T2	T3

Example:

T3-R = 51 amps	T2-W = 50 amps	T1-B = 50 amps
T1-B = 46 amps	T3-R = 48 amps	T2-W = 49 amps
T2-W = 53 amps	T1-B = 52 amps	T3-R = 51 amps
Total = 150 amps	Total = 150 amps	Total = 150 amps
÷ 3 = 50 amps	÷ 3 = 50 amps	÷ 3 = 50 amps
— 46 = 4 amps	— 48 = 2 amps	— 49 = 1 amps
4 ÷ 50 = .08 or 8%	2 ÷ 50 = .04 or 4%	1 ÷ 50 = .02 or 2%

INSULATION RESISTANCE READINGS

Normal Ohm and Megohm Values between all leads and ground

Condition of Motor and Leads	Ohm Value	Megohm Value
A new motor (without drop cable).	20,000,000 (or more)	20 (or more)
A used motor which can be reinstalled in well.	10,000,000 (or more)	10 (or more)
Motor in well. Readings are for drop cable plus motor.		
New motor.	2,000,000 (or more)	2 (or more)
Motor in good condition.	500,000 - 2,000,000	.5 - 2
Insulation damage, locate and repair.	Less than 500,000	Less than .5

Insulation resistance varies very little with rating. Motors of all HP, voltage and phase ratings have similar values of insulation resistance.

Insulation resistance values above are based on readings taken with a megohmmeter with a 500V DC output. Readings may vary using a lower voltage ohmmeter, consult factory if readings are in question.

This table was reprinted through the courtesy of Franklin Electric.

Engineering data for specific models may be found in your catalog and on our website (address is on the cover).

Control panel wiring diagrams are shipped with the control panels. Please use the control panel drawings in conjunction with this instruction manual to complete the wiring.

PUMP CONSTRUCTION	
Minimum Submergence	
Continuous Duty	Fully Submerged
Intermittent Duty	6" Below Top of Motor

Maximum Fluid Temperature	
Continuous Operation	104° F 40° C
Intermittent Operation	140° F 60° C

Pumpmaster and Pumpmaster Plus - Hard Wired

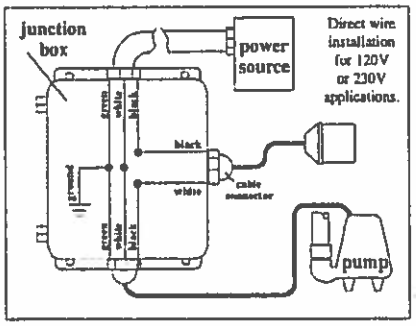


Fig. 1

Single-Action Float Switch "Typical" Installation

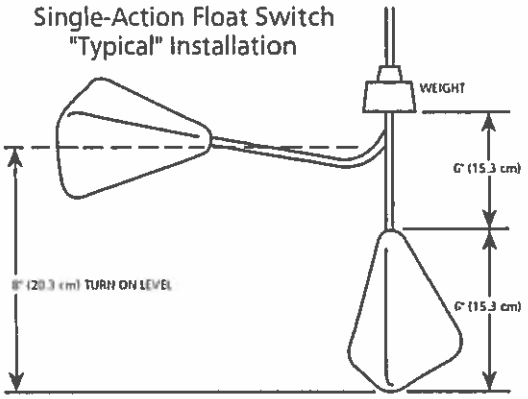


Fig. 4

Double Float - Hard Wired

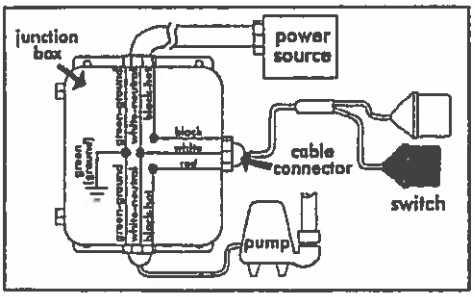


Fig. 2

Wide-Angle Float Switch

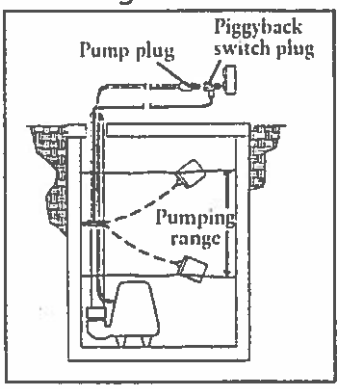


Fig. 5

Determining Pumping Range

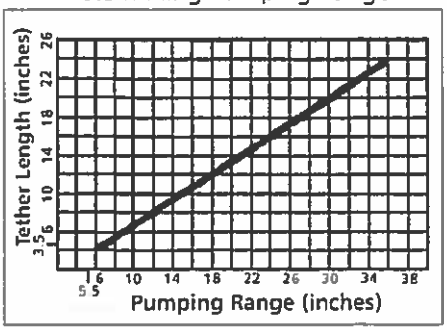


Fig. 3

Three Phase Connection Diagram

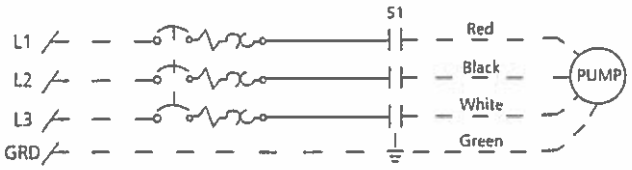
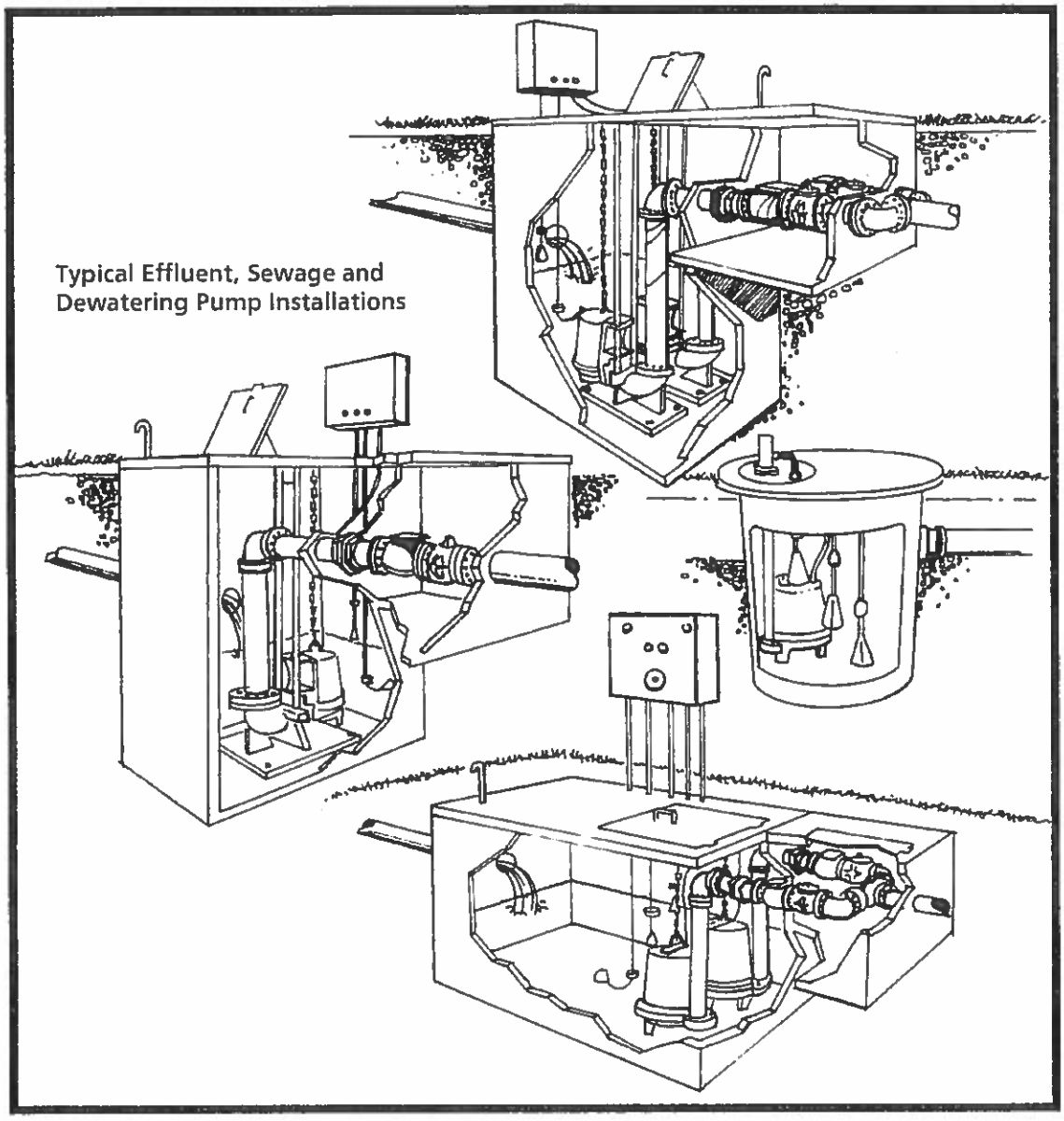


Fig. 6


Typical Effluent, Sewage and
Dewatering Pump Installations

⚠WARNING
Hazardous voltage

FAILURE TO DISCONNECT AND LOCKOUT ELECTRICAL POWER BEFORE ATTEMPTING ANY SERVICE CAN CAUSE SHOCK, BURNS OR DEATH.

SYMPTOM	PROBABLE CAUSE	RECOMMENDED ACTION
MOTOR NOT RUNNING NOTE: If circuit breaker "OPENS" repeatedly, DO NOT reset. Call qualified electrician.	Motor thermal protector tripped.	Allow motor to cool. Insure minimum pump submergence. Clear debris from casing and impeller.
	Open circuit breaker or blown fuse.	Determine cause, call a qualified electrician.
	Pump impeller binding or jammed.	Check motor amp draw. If two or more times higher than listed on pump nameplate, impeller is locked, motor bearings or shaft is damaged. Clear debris from casing and impeller, consult with dealer.
a) Manual operation	Power cable is damaged.	
	Inadequate electrical connection in control panel.	
b) Automatic operation	No neutral wire connected to control panel.	Resistance between power leads and ground should read infinity. If any reading is incorrect, call a qualified electrician.
	Inadequate electrical connection in control panel.	Inspect control panel wiring. Call a qualified electrician.
NOTE: Check the pump in manual mode first to confirm operation. If pump operates, the automatic control or wiring is at fault. If pump does not operate, see above.	Defective liquid level switch.	With switch disconnected, check continuity while activating liquid level switch. Replace switch, as required.
	Insufficient liquid level to activate controls.	Allow liquid level to rise 3" to 4" (76 mm - 101 mm) above turn-on level.
	Liquid level cords tangled.	Untangle cords and insure free operation.
PUMP WILL NOT TURN OFF	Liquid level cords tangled.	Untangle cords and insure free operation.
	Pump is air locked.	Shut off pump for approximately one minute, then restart. Repeat until air lock clears. If air locking persists in a system with a check valve, a 3/16" (4.8 mm) hole may be drilled in the discharge pipe approximately 2" (51 mm) above the discharge connection.
	Influent flow is matching pump's discharge capacity.	Larger pump may be required.
LITTLE OR NO LIQUID DELIVERED BY PUMP	Check valve installed backwards, plugged or stuck closed.	Check flow arrow on valve and check valve operation.
	Excessive system head.	Consult with dealer.
	Pump inlet plugged.	Inspect and clear as required.
	Improper voltage or wired incorrectly.	Check pump rotation, voltage and wiring. Consult with qualified electrician.
	Pump is air locked.	See recommended action, above.
	Impeller is worn or damaged.	Inspect impeller, replace as required.
	Liquid level controls defective or improperly positioned.	Inspect, readjust or replace as required.
PUMP CYCLES CONSTANTLY	Discharge check valve inoperative.	Inspect, repair or replace as required.
	Sewage containment area too small.	Consult with dealer.
	Liquid level controls defective or improperly positioned.	Inspect, readjust or replace as required.
	Influent excessive for this size pump.	Consult with dealer.

GOULDS PUMPS LIMITED WARRANTY

This warranty applies to all water systems pumps manufactured by Goulds Pumps.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twelve (12) months from date of installation or eighteen (18) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Goulds Pumps distributor from whom the pump was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Goulds Pumps Customer Service Department.

The warranty excludes:

(a) Labor, transportation and related costs incurred by the dealer;
(b) Reinstallation costs of repaired equipment;
(c) Reinstallation costs of replacement equipment;
(d) Consequential damages of any kind; and,
(e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:

(1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Goulds Pumps and the dealer in purchases, consignments or contracts for sale of the subject pumps.
(2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing pumps to customers.
(3) "Customer" means any entity who buys or leases the subject pumps from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

THIS WARRANTY EXTENDS TO THE DEALER ONLY.

Printed in U.S.A.

Goulds Pumps
ITT Industries

ITT

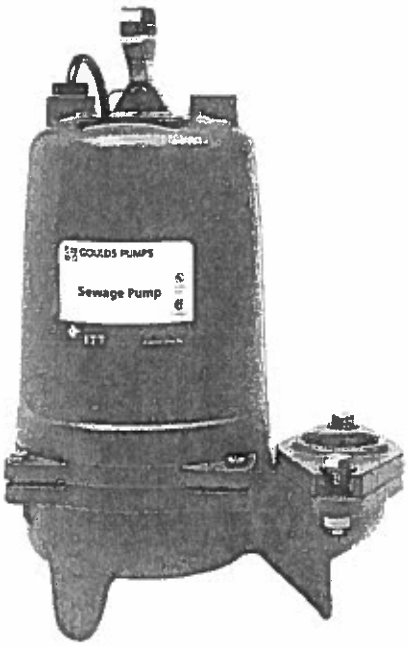
Wastewater

Goulds Pumps

WS_BHF Series Model 3887BHF

Submersible Sewage Pump

Prosurance available for residential applications.



FEATURES

- **Impeller:** Cast iron, enclosed, non-clog, dynamically balanced with pump out vanes for mechanical seal protection.
- **Casing:** Cast iron flanged volute type for maximum efficiency. Designed for easy installation on A10-20 slide rail or base elbow rail systems.
- **Mechanical Seal:** Silicon Carbide vs. Silicon Carbide sealing faces for superior abrasive resistance, stainless steel metal parts, BUNA-N elastomers.
- **Shaft:** Corrosion resistant, 300 series stainless steel. Threaded design. Locknut on all models to guard against component damage on accidental reverse rotation.
- **Fasteners:** 300 series stainless steel.
- Capable of running dry without damage to components.
- Designed for continuous operation, when fully submerged.

GOULDS PUMPS

AGENCY LISTINGS

Tested to UL 778 and CSA 22.2 108 Standards
By Canadian Standards Association — File #LR38549

Goulds Pumps is ISO 9001 Registered.

Goulds Pumps is a brand of ITT Corporation.

www.goulds.com

Engineered for life

APPLICATIONS

Specifically designed for the following uses:

- Homes
- Sewage systems
- Dewatering/Effluent
- Water transfer
- Light industrial
- Commercial applications

Anywhere waste or drainage must be disposed of quickly, quietly and efficiently.

SPECIFICATIONS

Pump

- Solids handling capabilities: 2" maximum.
- Capacities: up to 220 GPM.
- Total heads: up to 81 feet TDH.
- Discharge size: 2" NPT threaded companion flange as standard. 3" option available but must be ordered separately. (Order no. A1-3)
- Temperature: 104°F (40°C) continuous
  140°F (60°C) intermittent.

MOTORS

- Fully submerged in high grade turbine oil for lubrication and efficient heat transfer. All ratings are within the working limits of the motor.
- Class B insulation on ⅓-1½ HP models.
- Class F insulation on 2 HP models.

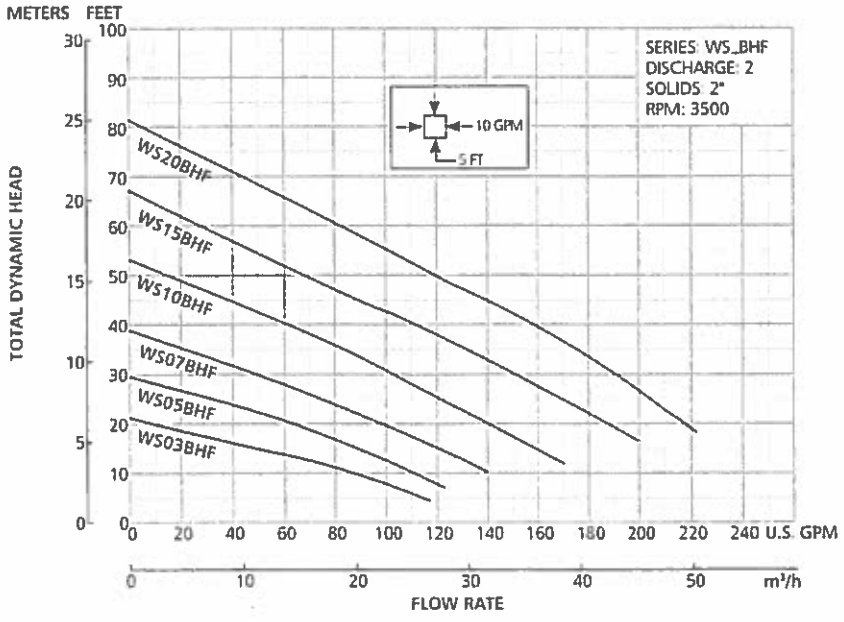
Single phase (60 Hz):

- Capacitor start motors for maximum starting torque.
- Built-in overload with automatic reset.
- SJTOW or STOW severe duty oil and water resistant power cords.
- ⅓ – 1 HP models have NEMA three prong grounding plugs.
- 1½ HP and larger units have bare lead cord ends.

Three phase (60 Hz):

- Class 10 overload protection must be provided in separately ordered starter unit.
- STOW power cords all have bare lead cord ends.

- **Designed for Continous Operation:** Pump ratings are within the motor manufacturer's recommended working limits, can be operated continuously without damage when fully submerged.
- **Bearings:** Upper and lower heavy duty ball bearing construction.
- **Power Cable:** Severe duty rated, oil and water resistant. Epoxy seal on motor end provides secondary moisture barrier in case of outer jacket damage and to prevent oil wicking. Standard cord is 20'. Optional lengths are available.
- **Motor Cover O-ring:** Assures positive sealing against contaminant and oil leakage.

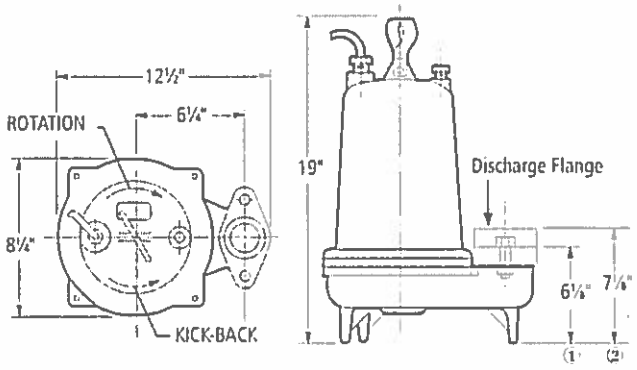


MOTOR AND MODEL INFORMATION

ORDER NUMBER	HP	PHASE	VOLTS	RPM	IMPELLER DIA. (IN.)	MAX. AMPS	LOCKED ROTOR AMPS	KVA CODE	FULL LOAD MOTOR EFF. %	RESISTANCE	
										START	LINE-LINE
WS0311BHF	0.33	1	115	3500	2.94	12.4	46.0	M	54	7.5	1.0
WS0318BHF	0.33	1	208			6.8	31.0	K	68	9.7	2.4
WS0312BHF	0.33	1	230			6.2	34.5	M	53	9.6	4.0
WS0511BHF	0.5	1	115		3.19	14.5	46.0	M	54	7.5	1.0
WS0518BHF	0.5	1	208			8.4	31.0	K	68	9.7	2.4
WS0512BHF	0.5	1	230			7.6	34.5	M	53	9.6	4.0
WS0538BHF	0.5	3	200			4.9	22.6	R	68	–	3.8
WS0532BHF	0.5	3	230			3.6	18.8	R	70	–	5.8
WS0534BHF	0.5	3	460			1.8	9.4	R	70	–	23.2
WS0537BHF	0.5	3	575			1.5	7.5	R	62	–	35.3
WS0718BHF	0.75	1	208		3.44	11.0	31.0	K	68	9.7	2.4
WS0712BHF	0.75	1	230			10.0	27.5	J	65	12.2	2.7
WS0738BHF	0.75	3	200			6.2	20.6	L	64	–	5.7
WS0732BHF	0.75	3	230			5.4	15.7	K	68	–	8.6
WS0734BHF	0.75	3	460			2.7	7.9	K	68	–	34.2
WS0737BHF	0.75	3	575			2.2	9.9	L	78	–	26.5
WS1018BHF	1	1	208		3.75	14.5	59.0	K	68	9.3	1.1
WS1012BHF	1	1	230			13.0	36.2	J	69	10.3	2.1
WS1038BHF	1	3	200			8.6	27.6	M	77	–	2.7
WS1032BHF	1	3	230			7.5	24.1	L	79	–	4.1
WS1034BHF	1	3	460			3.8	12.1	L	79	–	16.2
WS1037BHF	1	3	575			3.1	9.9	L	78	–	26.5
WS1512BHF	1.5	1	230		4.00	18.0	52.0	J	67	2.76	0.53
WS1538BHF	1.5	3	200			10.0	42.4	K	78	–	1.7
WS1532BHF	1.5	3	230			9.6	42.4	K	78	–	1.7
WS1534BHF	1.5	3	460			4.8	21.2	K	78	–	6.6
WS1537BHF	1.5	3	575			3.9	16.3	L	78	–	10.5
WS2012BHF	2	1	230		4.44	18.0	49.6	F	78	3.2	1.1
WS2038BHF	2	3	200			12.0	42.4	K	78	–	1.7
WS2032BHF	2	3	230			11.6	42.4	K	78	–	1.7
WS2034BHF	2	3	460			5.8	21.2	K	78	–	6.6
.WS2037BHF	2	3	575			4.7	16.3	L	78	–	10.5

DIMENSIONS

(All dimensions are in inches. Do not use for construction purposes.)



Discharge Flange:

① 2" NPT standard

② 3" NPT optional (order an A1-3)

ITT

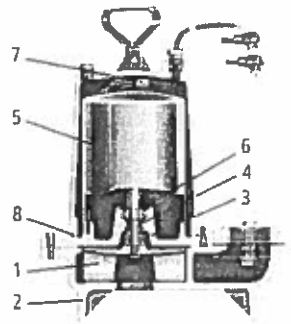
Wastewater

PERFORMANCE RATINGS (gallons per minute)

Order No.		WS03BHF	WS05BHF	WS07BHF	WS10BHF	WS15BHF	WS20BHF
HP ▶		1/3	1/2	3/4	1	1 1/2	2
RPM ▶		3500	3500	3500	3500	3500	3500
Total Head Feet of Water	10 ▶	86	110	140	–	–	–
	15	48	88	120	158	–	–
	20	–	62	98	139	186	217
	25	–	32	74	120	170	204
	30	–	–	49	101	150	190
	35	–	–	21	82	130	175
	40	–	–	–	60	110	159
	45	–	–	–	38	88	140
	50	–	–	–	–	67	120
	55	–	–	–	–	47	100
	60	–	–	–	–	29	80
	65	–	–	–	–	–	62
	70	–	–	–	–	–	43
	75	–	–	–	–	–	23

COMPONENTS *(for reference only)*

Item No.	Description
1	Impeller
2	Casing
3	Mechanical Seal
4	Motor Shaft
5	Motor
6	Ball Bearings
7	Power Cable
8	Casing O-Ring



** For repair parts, reference repair parts book.*

GOULDS PUMPS

B3887BHF April, 2007

Engineered for life

MotorSaver®
THREE-PHASE ELECTRIC MOTOR PROTECTOR

INSTALLATION INSTRUCTIONS FOR SYMCOM'S MOTORSAVER®
MODEL 460

DANGER!

HAZARDOUS VOLTAGES MAY BE PRESENT DURING INSTALLATION.
Electrical shock can cause death or serious injury.
Installation should be done by qualified personnel following all national, state and local electrical codes.

BE SURE POWER IS DISCONNECTED PRIOR TO INSALLATION!
FOLLOW NATIONAL, STATE, AND LOCAL CODES!
READ THESE INSTRUCTIONS ENTIRELY BEFORE INSTALLATION!

! WARNING !

UNEXPECTED OUTPUT ACTUATION CAN OCCUR.
Use hard-wired safety interlocks where personnel and/or equipment hazards exist.
Failure to follow this instruction can result in death, injury or equipment damage.

The Model 460 MotorSaver® is an auto ranging voltage monitor designed to protect three-phase motors regardless of size. The MotorSaver® is used on 190-480 VAC, 50 to 60 Hz motors to protect from damage caused by single phasing, low voltage, high voltage, phase reversal, and voltage unbalance.

CONNECTIONS

1. Mount the MotorSaver® in a convenient location in or near the motor control panel. If the location is wet or dusty, the MotorSaver® should be mounted in a NEMA 4 or 12 enclosure. The MotorSaver® can be mounted to a back panel using two #6 or #8 x 5/8 screws or can be snapped onto a DIN rail.
2. Connect L1, L2 and L3 on the MotorSaver's terminal strip to the LINE SIDE of the motor starter. (See Figure No. 1).
3. Connect the output relay to the circuitry to be controlled. For motor control, connect the normally open contact in series with the magnetic coil of the motor starter as shown in Figure No. 1. For alarm operation, connect the normally closed contact in series with the control circuit as shown in Figure No. 2.

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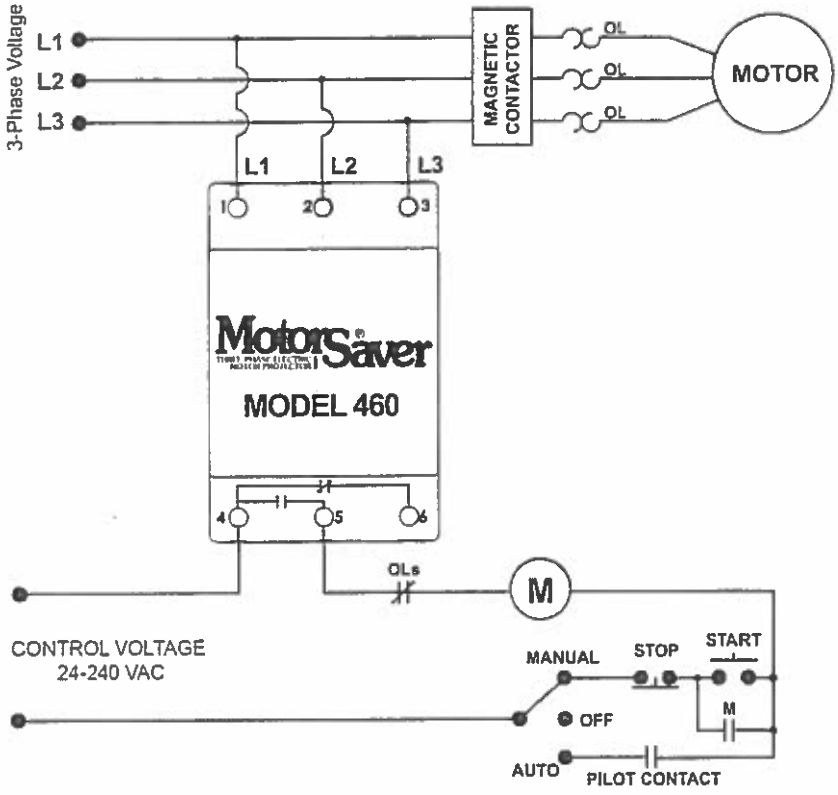


FIGURE NO. 1: CONTROL WIRING DIAGRAM

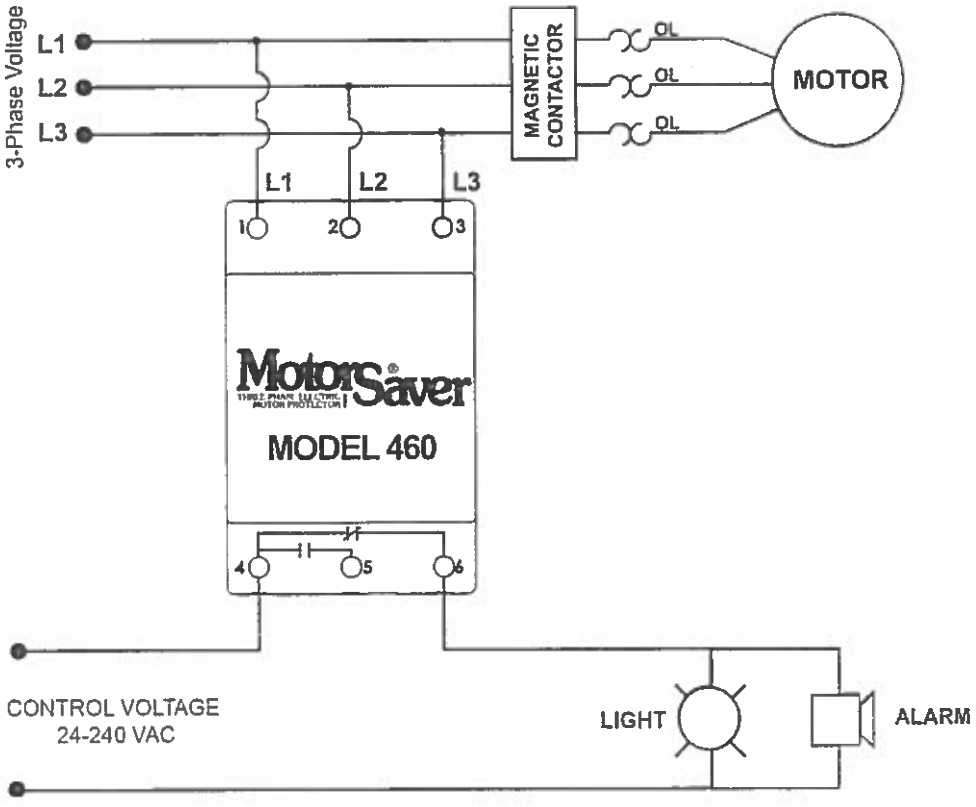
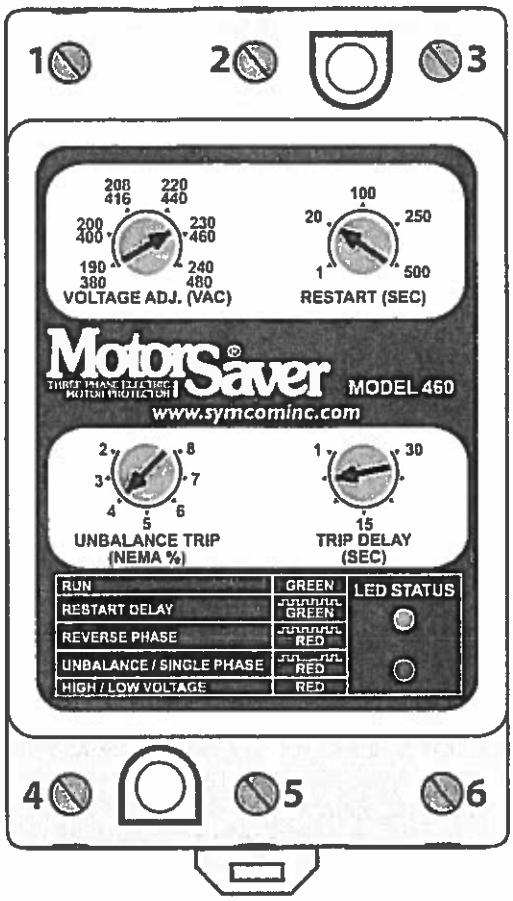


FIGURE NO. 2: ALARM WIRING DIAGRAM

SETTINGS



1. Line voltage adjustment: Rotate the **"VOLTAGE ADJ. (VAC)"** to the nominal three-phase line voltage feeding the motor to be protected.
2. Restart delay adjustment: Rotate the **"RESTART (SEC)"** adjustment to the desired position. The restart delay is the time between MotorSaver® seeing acceptable voltage and the MotorSaver® closing its output contacts. For compressor applications, the restart delay should be set for the approximate time it takes for the head pressure to bleed off of the compressor. For other applications, the restart delay is typically set between 2 and 10 seconds.
3. Trip delay adjustment: Rotate the **"TRIP DELAY (SEC)"** adjustment to the desired setting. This adjustment does not affect the trip delay on phasing faults. Typically, the trip delay adjustment is set between 1 and 5 seconds. In areas where voltage fluctuations are frequent, the trip delay adjustment may be set greater than 10 seconds.
4. Voltage unbalance adjustment: Rotate the **"UNBALANCE TRIP (NEMA%)"** adjustment to the desired unbalance trip level. The NEMA MG1 standard does not recommend operating a motor above 1% voltage unbalance without derating the motor. The NEMA MG1 standard also recommends against operating a motor above a 5% voltage unbalance under any circumstances. SymCom recommends consulting the motor manufacturer for specific tolerances.

$$\text{Percent Unbalance} = \frac{\text{Maximum Deviation from the Average}}{\text{Average}} \times 100$$

Example: The measured line-to-line voltages are 203, 210, and 212.

$$\text{Average} = \frac{203 + 210 + 212}{3} = 208.3$$

The maximum deviation from the average is the largest difference between the average voltage (208.3) and any one voltage reading.

208.3 - 203 = 5.3 210 - 208.3 = 1.7 212 - 208.3 = 3.7

The maximum deviation from the average is 5.3.

$$\frac{5.3}{208.3} \times 100 = 2.5\% \text{ Unbalance}$$

POWER-UP

Turn on the 3∅ power to the motor. The MotorSaver's green RUN light will blink during the RESTART delay. After the RESTART delay, the MotorSaver® will energize its output contacts and the green RUN light will illuminate. If the contacts do not energize and the RUN light does not illuminate, see the TROUBLESHOOTING section.

DIAGNOSTIC INDICATOR LIGHTS	
RUN	GREEN
RESTART DELAY	 GREEN
REVERSE PHASE	 RED
UNBALANCE / SINGLE PHASE	 RED
HIGH / LOW VOLTAGE	RED

CONGRATULATIONS!!
YOU HAVE JUST INSTALLED THE FINEST MOTOR PROTECTION AVAILABLE!!

TROUBLESHOOTING

SYMPTOM	LIGHT PATTERN	SOLUTION
No lights are on. The unit seems completely dead.	N / A	Measure the three line-to-line voltages. If any of the voltages are below 150 VAC, the MotorSaver® does not have enough power to operate its internal electronics. This may occur on a single-phased system. If the voltages are correct, call SymCom at 1-800-843-8848 or 1-605-348-5580.
Red light is blinking (on initial power up).	 RED	Turn off the three-phase power. Swap any two leads powering the MotorSaver® (L1, L2, or L3). There is a 50-50 chance of connecting L1, L2, and L3 correctly the first time. Re-apply the three-phase power.
Red light is blinking (after the motor has been previously running).	 RED	The incoming lines have been reverse phased. The MotorSaver® is preventing the motor from running backwards. Correct the phase sequence.
Red light is blinking in this pattern.	 RED	The voltage is unbalanced or single-phased. Measure the incoming line voltages and calculate the % unbalance. If the voltage unbalance does not exceed the % unbalance reset value, call SymCom at 1-800-843-8848 or 1-605-348-5580.
Red light is on steady.	RED	The voltage is out of tolerance. Measure the three line-to-line voltages. Calculate the average of the three voltages. If the average is 7% above or below the nominal voltage as selected by the LINE VOLTAGE ADJUST, the MotorSaver® is functioning properly. If the voltage is within ±7% of the selected line voltage, call SymCom at 1-800-843-8848 or 1-605-348-5580.
Green light blinks and motor is not running.	 GREEN	The MotorSaver® is in restart delay.
Green light is on steady, but motor does not start.	GREEN	The MotorSaver® is in run mode. Ensure other control devices are allowing the motor to start. Check control circuit for loose wires or malfunctioning switches.

Any questions or comments call SymCom at 1-800-843-8848 or 1-605-348-5580

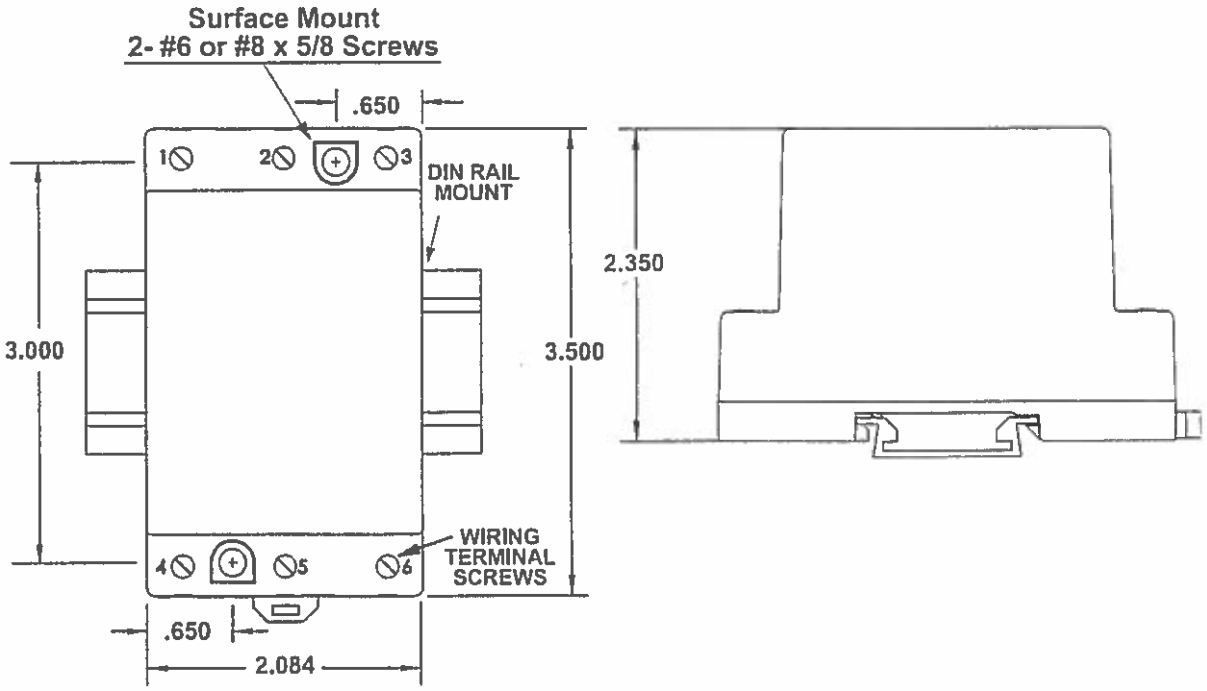
SPECIFICATIONS

3 - Phase Line Voltage	190 - 480 VAC
Frequency	50* - 60 Hz
Low Voltage (% of setpoint)	
Trip	90% ± 1%
Reset	93% ± 1%
High Voltage (% of setpoint)	
Trip	110% ±1%
Reset	107% ±1%
Voltage Unbalance (NEMA)	
Trip	2 - 8% Adjustable
Reset	Trip Setting minus 1% (5 - 8%)
	Trip Setting minus 0.5% (2 - 4%)
Trip Delay Time	
Low, High, and Unbalanced Voltage	1 - 30 Seconds Adjustable
Single-phasing faults (>25% UB)	1 Second Fixed
Restart Delay Time	
After a fault or complete power loss	1 - 500 Seconds Adjustable
Output Contact Rating - SPDT	
Pilot Duty	480 VA @ 240 VAC
General Purpose	10 A @ 240 VAC
Power Consumption	6 Watts (maximum)
Weight	14 oz
Enclosure	Polycarbonate
Terminal	
Torque	6 Inch-Pounds Max.
Wire AWG	12 - 20 AWG
Safety Marks	
UL	UL508 (File # E68520)
CE	IEC 60947-6-2
Standards Passed	
Electrostatic Discharge (ESD)	IEC 1000-4-2, Level 3, 6 kv contact, 8 kv air
Radio Frequency Immunity, Radiated	159 MHz, 10 V/m
Fast Transient Burst	IEC 1000-4-4, Level 3, 3.5 kv input power and controls

*NOTE: 50 Hz will increase all delay timers by 20%

Surge	
IEC	IEC 1000-4-5, Level 3, 4kv line-to-line; Level 4, 4kv line-to-ground
ANSI / IEEE	C62.41 Surge and Ring Wave Compliance to a level of 6kv line-to-line
Hi-potential Test	Meets UL508 (2 x rated V +1000V for 1 minute)
Environmental	
Temperature Range	Ambient Operating: -20° - 70° C (-4° - 158°F) Ambient Storage: -40° - 80° C (-40° - 176°F)
Class of Protection	IP20, NEMA 1 (Finger Safe)
Relative Humidity	10-95%, non-condensing per IEC 68-2-3

DIMENSIONS



SymCom warrants its microcontroller based products against defects in material or workmanship for a period of five (5) years* from the date of manufacture. All other products manufactured by SymCom shall be warranted against defects in material and workmanship for a period of two (2) years from the date of manufacture. For complete information on warranty, liability, terms, and conditions, please refer to the SymCom Terms and Conditions of Sale document.

Visit our website at www.symcominc.com for our complete catalog and new product listings!

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FAX: (605) 348-5685

Warning: This document does not replace the manufacturer's recommended maintenance schedules as referenced in the OM manual provided by the equipment manufacturer. It is provided as a quick guide to required OM activities for this project.

Section1: General Maintenance Activities
Section2: Cross Reference Maintenance Code to Parts
Section3: Maintenance Schedule by Hours

General Maintenance Activities

Daily

- Check the control panel for running status.
- Contact the system remotely to check system operation for:
  - Alarms
  - Operating Conditions

Weekly

- Check for Leaks.
- Check the volume of consumables. i.e. Chemicals, oil etc
- Check for excessive noise of various components.
- Check for Alarms.
- Check and record Flow Rates, Vacuums, Pressures, Temperatures, pH.
- Check for excessive moisture inside the control panels and transducer wiring boxes.
- Check for corrosion and grease the moving parts if required to reduce corrosion.

Monthly

- Test critical inputs for proper shutdown capacity.
- Test the operation of the overloads.
- Test building sump switch if it is present.

Yearly

- Test each input.
- Test alarm conditions.
- Test the operation of each output device.

Parts Listing per Maintenance Code

Fan

	Part		Qty	Module
F-7901	10329	Fan, Building, 24", 1/3hp, 1625rpm, 120/230V, 1ph, XPF	1	Building, Trailer or Skid
F-7903	M1072	Fan, Building, 12", 1/4hp, 1750rpm, 120V, 1ph, TEFC	1	Building, Trailer or Skid

Flow Meter (Liquid)

	Part		Qty	Module
FQI,FT-7001	15499	Meter, Water, 2", US Gal, w/ pulse, Turbine, DLJ	1	Liquid Phase Carbon

Gauge, Pressure

	Part		Qty	Module
PI-7001	16203	Gauge, Pressure, 0-60psi, Indumart, P16T2-FG-60	2	Liquid Phase Carbon
P-4901	16203	Gauge, Pressure, 0-60psi, Indumart, P16T2-FG-60	1	Oil/Water Separator

Oil Water Separator

	Part		Qty	Module
OWS-4901	16263	Oil Water Separator, OWS-24, Stainless	1	Oil/Water Separator

Pump, Discharge

	Part		Qty	Module
P-4901	21028	Pump, Suction, Goulds, SSH Series, 4SH2K52C0	1	Oil/Water Separator

Strainer

	Part		Qty	Module
P-4901	M1523	Strainer, Wye, Brass, 3"	1	Oil/Water Separator

Vertical Level Switch (Almeg)

	Part		Qty	Module
LSHH-5201	12351	Switch, Level, Almeg, Vertical, ATB3-48B	1	Product Storage Tank

EVERY 200 OPERATING HOURS

Strainer

Remove strainer basket. Inspect strainer and empty if necessary.

EVERY 800 OPERATING HOURS

Pump, Discharge

Close-Coupled Unit
Ball bearings are located in and are part of the motor. They are permanently lubricated. No greasing required.

Frame-Mounted Units
Regrease frame with a #2 sodium or lithium based grease. Fill until grease comes out of relief fittings, or lip seal. Then wipe off excess. Follow motor and coupling manufacturers' lubrication instructions.

Note: Alignment must be rechecked after any maintenance work involving any disturbance of the unit.

Fan

1) Check the fan outlet pressure.
2) Check to ensure nothing is obstructing the air intake.
3) Check the fan wheel for corrosion.
4) Check the fan wheel alignment and positioning.

Flow Meter (Liquid)

Test the operation of the flow meter. Disassemble and clean the internal components if dirt or particles are preventing the meter from working properly.

Vertical Level Switch (Almeg)

1) Test the operation of the switch.
2) Remove the switch and check for debris buildup that can potentially cause a failure of normal operation.

EVERY **4000** OPERATING HOURS

Gauge, Pressure

1) Check accuracy of gauges.
2) Zero gauge if required.

Oil Water Separator

After the first 6 months of operation, the inlet should be inspected and cleaned as follows:
1) Stop the flow of influent to the separator.
2) Remove separator cover.
3) Dispose of separated oil per regular procedures.
4) Remove water from separator through drain or hose. Measure and record the depth of the solids. Use this measurement as the timing basis for the next solids inspection and clean out. Consult OWS drawing for depth of sludge baffle. Solids should not exceed this depth.
5) The HD Q-PAC plates can be either cleaned in place or removed and cleaned.
6) Examine the tank interior for damage and repair any damage to internal coating.
7) To restart separator, install HD Q-PAC plate packs and polishing pack in original position. Make sure that both are securely in place so that they do not float when unit is operational.

WINTER OPERATION AND STORAGE IN COLD CLIMATES

GENERAL

Systems operating in climates where seasonal temperatures regularly fall below freezing may need to be winterized. Depending on the equipment in the system, different steps must be taken to prepare for winter operation.

If the system is going to be shut down and stored for the winter, additional measures should be taken above and beyond normal maintenance practices for an extended shut down.

SYSTEMS OPERATING THOUGH THE WINTER

- Confirm that the enclosure heater is working. This can be done by adjusting the set point on the low temperature switch (TSL) to a setting above the ambient temperature inside the enclosure. Verify that the heater has turned on before adjusting the setting on the low temperature switch to a point above 32℉. If the heater is controlled by a temperature transmitter (TT), the set point can be adjusted through the HMI.
- Confirm that the control panel heater is working by adjusting the thermostat inside the panel – follow the procedure above.
- If the enclosure has a sump with a high level switch, ensure the sump is free of water to prevent ice from forming and potentially disabling the switch.
- If the system has a heat exchanger or rotary screw compressor, provisions may be included to prevent cycling cold air through the system. Depending on the design of the system, the following options may be available for winter operation:
    - Systems where the heat exchanger/compressor is recessed from the wall or ceiling, by removing the hood and withdrawing the insert, the discharge port can be fully or partially boarded up to allow warm air to be re-circulated back into the enclosure. See Figure 1.
    - The hood provided on the exterior of the enclosure may have been designed to allow air to be re-circulated back into the container through a duct on the wall above the heat exchanger/compressor or through the roof. See Figure 2.

Note: Depending on the parameters of the system, the above mentioned options may need to be fine-tuned onsite to optimize performance of the system. While these methods are good for maintaining the temperature inside the enclosure above freezing, there are some situations where too much air is being re-circulated and the heat exchanger is not able to cool the process air sufficiently. This will cause the high temperature switch on the discharge of the heat exchanger to trip and send the system into alarm.

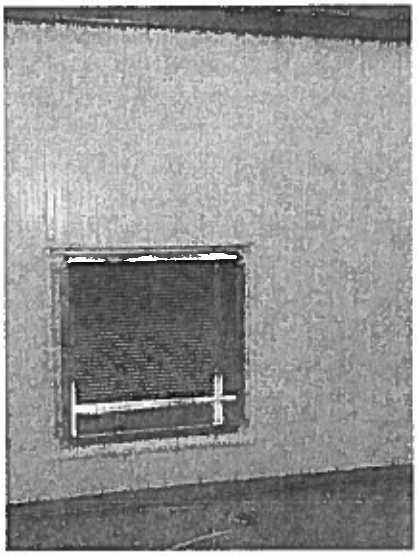

Figure 1: Recessed Heat Exchanger

Figure 2: Re-circulating Hood

SYSTEMS BEING STORED THROUGH THE WINTER

- All water must be drained from the system where possible.
- Valves should be left open to allow ice to expand in the event residual water was left in the system without damaging piping or equipment.
- Additional O&M as required for long-term system shutdowns.

WINTERIZING PROCEDURE

Progressive Cavity Pumps (Moyno)

- Remove bolts from pump end and ensure all water is removed.

Centrifugal Pumps (Goulds)

- Remove drain plug on the bottom of the outer steel body. Keep in mind water inside lines will also drain through these plugs depending on elevations.

Inlet Manifolds

- Drain all water from SVE and ground water extraction manifolds.

Vapor/Liquid Separators

- Drain all water from VLS.

Bag Filter Housings

- Drain all water and remove bag filter from housing.
- Pour antifreeze into bottom of housing ensuing drain valve is closed.

Oil/Water Separators

- Pour antifreeze in bottom of OWS, filling 1 to 2" from the bottom, ensuring drain lines are filled with antifreeze.

Air Strippers

- Sump should be drained and trays disassembled.
- Pour antifreeze in bottom of stripper and ensure drain lines are filled with antifreeze.

Air Compressors

- Drain receiver tank of any condensate.

Water Flow Meters (Paddlewheels and Rotameters)

- Remove via unions and drain. Store for the winter.

CAUTION

Freezing water poses a serious threat to the equipment in a system. Pipes, vessels and pumps can be severely damaged by freezing water.

Troubleshooting Chart

Symptom	Potential Cause	Possible Solution
Electrical Motor		
Motor will not start and there is no noise.	Motor may not be receiving the proper power.	Check fuses and power distribution between power lines to motor.
	Overload is tripped.	Reset overload.
	Main power may be off.	Check main power.
	Contactor may not be closing because motor is in manual position.	Switch motor to Auto position.
	Contactor may not be closing because PLC is not telling output to be on.	Check PLC operating sequence to determine if a start requirement is not met.
Motor will not start but makes a humming noise.	One of the phases of power is not getting to the Motor as a result of a blown fuse.	Change fuse.
	One of the phases of power is not getting to the Motor as a result of a poor wire connection.	Check wiring for a loose wire or a poor connection.
	The driven component (i.e. pump) will not spin and could be seized up.	Disassemble driven component, check clearances and clean internal components and replace any damaged components.
	Bearing on drive shaft of motor or driven component may be seized up.	Replace bearings.
Overloads trip immediately after startup.	Check for short circuit in motor windings.	Re-wind motor.
	One of the phases of power is not getting to the motor as a result of a blown fuse.	Change fuse.
	Motor power wires may be shorting out to ground.	Search for wiring short and replace wiring if required.
	Motor may have too much load or backpressure as a result of operating the driven component outside of its operating capabilities.	Check operating capabilities of driven component. I.e. Ensure positive displacement pump is not over pressured or that centrifugal pump is not operating at too high a flow rate.
Motors amps are above the allowable value on the nameplate.	Motor may be designed to operate on the upper limit.	Calculate maximum allowable amps. Name plate amps x safety factor.
	Driven component may have scale build up inside.	Clean internal components of driven component.

	Driven component may be rotating in the wrong direction.	Check direction of rotation and switch rotation of motor if it is incorrect.
	Check voltage of power. Low voltage results in high amps.	Adjust overloads for higher amps if the difference is only slight, otherwise change power or motor.
Centrifugal Pumps		
Pump does not produce sufficient pressure/vacuum.	Pump is not primed.	Prime pump.
	Pump is rotating in wrong direction.	Check and change rotation if required.
	Vacuum or pressure gauge is faulty.	Replace gauge.
	Pump is not operating at required RPM.	Check and replace motor if required.
	Pump has wrong sized impeller.	Check impeller and replace if required.
	Pump pressure or vacuum is lost due to an obstruction located between the pump and gauge.	Check for flow restrictions and clean strainers or piping if required.
	Pump is not turned on.	Turn pump on.
	Coupling between pump and motor is no longer connected preventing the pump from rotating with the motor.	Reconnect and realign motor and pump.
Pump is leaking.	Gaskets are worn or faulty.	Replace gaskets.
	Mechanical seal has been overheated. This is often a result of operating the pump without any water.	Replace mechanical seal.
	Fittings are leaking on or around pump.	Tighten fittings.
	Water may be coming from another location.	Check for leaks around pump.
Pump flow rate is too low.	Backpressure is too high for pump.	Reduce backpressure.
	Pump may not be sized correctly for process.	Replace pump.
	Pump impeller is too small.	Change pump impeller but watch power consumption on motor.
	Flow control valve is closed.	Open flow control valve.
	May have blocked line or filter.	Replace filter and clean line.

Pump is making excessive noise during operation.	Manually rotate pump impeller and listen for clearance problems.	Disassemble pump and fix clearance problems.
	Alignment of pump may be off causing the flexible coupling to degrade.	Check alignment and reset alignment if needed. Replace flexible coupling if it is degraded.
Liquid Ring Pump		
Pump does not produce enough vacuum.	Pump is not primed.	Prime pump and start under vacuum.
	Service fluid is to low in seal oil tank.	Add seal oil.
	No restriction on inlet of pump.	Close valves to create suction.
	Dilution valve is open.	Close dilution valve.
	Service fluid is not flowing into the pump.	Check for flow restrictions in service fluid lines. Check strainer.
	Pump is rotating in the wrong direction.	Check and change direction if required.
	Vacuum gauge is not working correctly.	Replace vacuum gauge.
	Pump seals may be allowing air into the pump.	Check for leaking and replace seals if required.
	Pump is too small for application.	Replace pump.
	Vacuum relief valve is set too low.	Replace or reset vacuum relief valve.
	Air may be leaking into vapor lines.	Check for air leaks in vapor lines.
	Pump internal components are damaged.	Disassemble pump and replace components if required.
Pump is making a growling noise.	Cavitation is occurring.	Decrease the vacuum.
	Insufficient seal fluid flow or excessive seal fluid flow.	Increase/decrease seal fluid flow rate.
Pump is leaking.	Gaskets are faulty.	Replace gaskets.
	Mechanical seal has been overheated or is faulty.	Replace mechanical seal.
	Oil may be leaking from 1/8" vacuum relief valves in pump housing.	Remove valves and install plugs.
Pump is running too hot.	Seal fluid strainer is plugged restricting seal fluid.	Clean out strainer.
	LRP is not providing enough suction to draw sufficient seal fluid.	Increase seal oil suction. Pipe seal fluid into a higher vacuum port of pump.

	Seal fluid flow rate is too low.	Open seal fluid control valve to allow more seal fluid to enter the pump.
	Seal fluid heat exchanger is not working properly.	Check heat exchanger.
Excessive discharge pressure built up in seal oil tank.	Demister filter is plugged and requires replacement.	Replace demister.
	Seal oil is not being drawn out of demister filter through scavenger line.	Increase vacuum of LRP to allow oil to be sucked through scavenger line. Ensure that scavenger line has sufficient vacuum to draw oil out of the demister filter.
Seal Oil Low Level Alarm	Seal oil temperature may be operating too high causing the oil to evaporate.	Check seal oil operating temperature and increase seal oil flow.
	Seal oil suction line may be plugged causing seal oil to collect in bottom of demister filter.	Check for plugging of seal oil return line and clean or replace if required.
Air to Air and Air to Fluid Heat Exchangers		
Heat exchanger fan is drawing too many amps.	See troubleshooting for motors.	
	Fan blade pitch and diameter may be wrong.	Change fan blade.
	Motor may be operating at wrong RPM for fan blade.	Replace motor or fan blade.
	Check clearance of fan blade.	Make adjustments if blade is making contact.
Phase Separator		
Water will not pump out of phase separator.	Base of separator may be plugged with sand.	Flush sand and debris out of separator.
Electric Solenoid Valve		
Valve will not completely shut.	May have dirt or rocks preventing it from shutting properly.	Disassemble and clean out internal components.
Valve will not open	Check for power to solenoid.	Trace power lines and determine why power is not going to valve.
	PLC may not be telling it to open.	Check start requirements in manual.
	Coil may be damaged or faulty.	Replace coil.
Level Switches		
Level switch is staying closed when water in tank drops below switch.	Level switch is upside down or on its side.	Check orientation of level switch. Level switch may be designed as normally closed and therefore will be upside down.

	Sight glass is plugged giving a false level in the tank.	Clean sight glass.
	Level switch has dirt or film causing it to stick up.	Remove level switch, clean and test for normal operation using a millimeter.
	Level switch may be damaged or faulty and failed closed regardless of the switch position.	Replace switch.
	Wiring to level switch may be shorting out to ground causing the switch to appear closed at all times.	Disconnect switch from system wiring and separate system wires so they are not in contact with each other or any metal. If the input is still on, the input wiring is being grounded somewhere. Find short and replace or fix wiring.
	IS barrier is shorted out internally.	Switch IS barrier with working barrier and if problem goes away then the barrier may be faulty and should be changed.
	Input wiring is loose in terminal strip.	Tighten terminal strip where field wiring is brought into panel.
	Level switch is wired incorrectly.	Consult input wiring diagram and inspect wiring of level switch. Change if required.
Level switch stays open when water in tank is above the switch.	Level switch is upside down or on its side.	Check orientation of level switch. Level switch may be designed as normally closed and therefore will be upside down.
	Sight glass is plugged giving a false level in the tank.	Clean sight glass.
	Level switch has dirt or film causing it to stick down.	Remove level switch, clean and test for normal operation using a millimeter.
	Level switch may be damaged or faulty and failed open regardless of the switch position.	Replace switch.
	IS barrier is blown preventing the level switch signal from crossing the barrier.	Switch IS barrier with working barrier and if problem goes away then the barrier may be blown. If barrier is blown, the input wire on the right side of the barrier will have 24 V DC and the wire on the opposite side will have 0V DC.
	Level switch is wired incorrectly.	Consult input wiring diagram and inspect wiring of level switch. Change if required.

Regenerative Blowers		
Blower does not produce sufficient pressure/vacuum.	Blower is not turned on.	Turn on blower.
	Wrong direction of rotation.	Check and change rotation if required.
	Vacuum or pressure gauge is faulty.	Replace gauge.
	Blower is not operating at required RPM.	Check and replace motor if required.
	Blower has wrong sized impeller.	Check impeller and replace if required.
	Pressure or vacuum is lost due to obstruction located between blower and gauge.	Check for flow restrictions and clean strainers or piping if required.
Blower is leaking.	Fittings are leaking on or around blower.	Tighten fittings.
Blower flow rate is too low.	Backpressure is too high for blower.	Reduce backpressure.
	Blower may not be sized correctly for process.	Replace blower.
	Blower impeller is too small.	Change blower impeller but watch power consumption on motor.
	Flow control valve is closed.	Open flow control valve.
	May have blocked line or filter.	Replace filter and clean line.
Air Stripper		
Stripper leaks.	Gaskets are leaking.	Apply silicon grease to gaskets and close up stripper. If they cannot be fixed the gaskets may need to be replaced.
Pressure or vacuum is building up in stripper.	Stripper is being fouled by mineral precipitates.	Clean stripper with acid to dissolve precipitates.
	Airflow rate through stripper has risen or is above the design value.	Decrease airflow rate.
Stripper is not cleaning contaminants sufficiently.	Inlet concentrations are higher than the design values.	Decrease water flow rate to obtain required stripping capacity.
	Flow rate of water through stripper is too high.	Decrease flow rate allowing longer residence time in stripper.
	Water temperature is lower than the design (below 60°F).	Increase water temperature or slow down water flow rate or increase airflow rate.
	Airflow rate is not high enough.	Increase airflow rate or decrease water flow rate.

	Products that are not easily strippable may be in higher concentrations than originally planned.	Consult manufacturer with test results of discharge contaminants.
	Stripper may have been shut down manually causing the contaminated water in the trays to fall into the sump without being cleaned.	Allow stripper to go through proper shutdown cycle when stopping the unit.
	Stripper may be setup wrong allowing the water to bypass trays.	Check orientation of trays to ensure water will flow through each tray properly.
	Some contaminants may be present that are affecting the ability to strip other contaminants.	Consult manufacturer with test results of intake and discharge contaminants.
	Increase in pressure causes a decrease in airflow resulting in a decrease of contaminant concentrations.	See pressure rise in stripper troubleshooting above.
Water is collecting in discharge piping of stripper.	Air leaving the stripper is very humid and will condense some water in the pipelines.	Install a knockout drum in discharge line before air is piped to another section of the process.
	The stripper causes foaming of the water which results in water collecting in the discharge lines.	Test for foaming contaminants such as soaps and install antifoaming dosing system to prevent foaming.
	Airflow rate is higher than the design value causing water to be carried over into the discharge lines.	Decrease flow rate to within design range.
Stripper often shuts down on a high stripper sump alarm.	Transfer pump is flowing faster than the discharge pump.	Slow transfer pump or speed up discharge pump.
	Discharge pump is not working properly.	Troubleshoot discharge pump.
Moyno Pumps		
Pump does not produce sufficient pressure/vacuum.	Pump is not primed.	Prime pump.
	Wrong direction of rotation.	Check and change rotation if required.
	Vacuum or pressure gauge is faulty.	Replace gauge.
	Pump is not operating at required RPM.	Check and replace motor if required.
	Pump has wrong sized impeller.	Check impeller and replace if required.
	Pump pressure or vacuum is lost due to obstruction located between pump and gauge.	Check for flow restrictions and clean strainers or piping if required.

	Pump is not turned on.	Turn pump on.
	Coupling between pump and motor is no longer connected preventing the pump from rotating with the motor.	Reconnect and realign motor and pump.
Pump is leaking.	Gaskets are worn or faulty.	Replace gaskets.
	Mechanical seal has been overheated. This is often a result of operating the pump without any water.	Replace mechanical seal.
	Fittings are leaking on or around pump.	Tighten fittings.
	Water may be coming from another location.	Check for leaks around pump.
	Pump was run in reverse allowing the rotor to spin off of the pump shaft.	Disassemble pump and screw rotor back onto shaft (See manufacturer's manual).
Pump flow rate is too low.	Backpressure is too high for pump.	Reduce backpressure.
	Pump may not be sized correctly for process.	Replace pump.
	Pump impeller is too small.	Change pump impeller but watch power consumption on motor.
	Flow control valve is closed.	Open flow control valve.
	May have blocked line or filter.	Replace filter and clean line.
Pump is making excessive noise during operation.	Manually rotate pump impeller and listen for clearance problems.	Disassemble pump and fix clearance problems.
	Alignment of pump may be off causing the flexible coupling to degrade.	Check alignment and reset alignment if needed. Replace flexible coupling if it is degraded.
Pressure Switch/Vacuum Switch		
Switch is not reacting at desired set point.	Switch is out of adjustment.	Change set point to desired value.
Switch is not working.	Switch may be faulty.	Remove input wires and test switch at desired pressure. If it does not trigger, it should be replaced.
Flow meter		
Flow meter is not rotating.	Dirt could have caused meter internals to jam up.	Disassemble flow meter and clean internal components.
Flow meter is rotating but pulse input is not working.	Switch on meter may be faulty.	Remove wiring and test contacts on meter to ensure that they are opening and closing. If not meter head needs to be replaced.

	Input wiring may be grounding out preventing the signal from opening and closing.	Test input wiring by isolating input wires and checking if input is on. If so you have a grounded input wire.
	Input to PLC is not working.	Simulate rotating meter by contacting input wires together and check for a detected flow rate and change in totalized flow.
Belt Driven Assemblies		
Squealing noise occurs on startup.	Belt is too loose.	Check tension of belt and tighten if required.
Excessive wear on bearings.	Belt is too tight.	Loosen belt tension.
Belt is wearing excessively.	Check orientation of blower and motor.	Adjust orientation if required.
Carbon Vessel		
Vessel is operating over pressure.	Silt may have collected in water phase vessel.	Remove lid and check for silt. Remove top layer of silt or replace vessel.
Vessel is breaking through earlier than expected.	Flow rate through vessel may be too high. Check design specifications.	Decrease flow rate.
	Air contaminant concentrations are higher than expected.	Test inlet concentrations.
	Check piping orientation to ensure that water is going in the top of water phase vessels and air is going in the bottom of air phase vessels.	Repipe vessel if piping is wrong.
	Ensure that there is not a large trapped air gap in the top of the water phase carbon vessel allowing the water to bypass a portion of the carbon.	Release air gap if present.
Bag Filter		
Vessel is operating over pressure.	Bag filter may be full of dirt and silt.	Remove cover and check for dirt buildup in the bag. Replace filter element if required.
	Equipment down stream of bag filter may be plugging.	Check for pressure buildup down stream of filter and fix pressure buildup downstream if found.
Water will not flow through filter fast enough.	Pump may not be able to supply enough pressure.	Check pressure output of pump with pump curve. Replace pump if needed.
Filters are plugging too fast	Filter element micron size may be too low.	Install larger micron filter element.

	Filter pressure switch setpoint may be too low.	Increase high pressure shutdown setpoint.
Oil Water Separator		
Water is collecting in product tank	Oil water separator may not be level causing water to spill into the skimmer tube.	Check level of oil water separator and adjust if necessary.
	Skimmer tube is not adjusted properly.	Check position of skimmer tube ensure that tube is rotated so the skimming slot allows at least 1-2" of oil to collect before spilling over into the oil tank.
	Skimmer tube is cracked or leaking.	Check that skimmer tube is not cracked, replace if necessary.
	Separator can be full of sludge on the bottom restricting water flow through to the clean water reservoir.	Check for dirt buildup in bottom. Drain and clean separator if necessary.
Oil is collecting on the clean water side	Oil water separator may be operating outside of design parameters.	Check that specific gravity of product and flow rate of separator match site-specific design print out for oil water separator. This can be found in the oil water separator section of your **newterra** manual or submittal package.
	Oil water separator was not primed with clean water on startup and large amounts of product were initially pumped into separator contaminating the clean water sections.	Drain separator, clean separator and media, and fill with clean water before proceeding.
	Silt can build up in the bottom of the separator restricting volume capacity and flow through media.	Inspect bottom of separator and inside of media. Drain and clean separator and clean or replace media if plugged or restricted.
	Inlet side of separator can have excessive amounts of oil on the top layer. This will reduce effective capacity of oil water separator.	Check level of oil collected in inlet side of separator. Adjust skimmer if required. Re-prime separator so only 1-2" of product remains on the top of the separator.
	Biological bacteria is suspending product in high-density mucus like collections that are passing through the separator.	Check for signs of bacteria in the inlet side of the separator. Contact **newterra** to discuss solutions to eliminating biological suspension.
	Product may be made up of two different components. The component breaking through may have a different density from what the separator was designed for.	Collect a sample of what is breaking through and confirm that it has the same properties as the product collecting on the inlet side.

	Oil storage tank may be full and high-level alarm not working properly. This will back the product up and fill the inlet side of the separator with product until the product passes under the lower weir and collects in the clean-water side.	Check product storage tank and ensure that level switch is working properly and that tank has not overfilled.
Oil and water is building up on inlet side but is not passing through separator and collecting in the clean water side.	Sludge and dirt may have built up on floor of separator preventing the water from passing by the lower weir.	Check for dirt buildup on bottom of separator. Drain and clean if necessary.
	Oil Water interface may be too low indicating that the separator has insufficient water to properly separate.	Fill the separator with clean water allowing water to collect in the inlet side forcing the oil water interface level to rise up too about 1" - 2" below the skimmer level.
	Only product is being pumped into inlet of separator.	If water is not present in sample entering the separator then it will not collect in the clean water side.
Water is in the oil outlet.	Skimmer opening is below the oil/water interface.	Adjust skimmer alignment to allow more oil to collect before skimming.
Oil is making its way to the outlet.	Water flow rate is too high.	Reduce flow rate through system.
	Filter media is plugged.	Replace or clean media.
	Oil discharge is plugged backing up OWS.	Drain oil down stream of skimmer.
Sand Filter		
Vessel is operating over pressure.	Sand filter may be full of dirt and silt.	Remove cover and check for dirt buildup on top of filter. Backwash filter.
	Equipment down stream of sand filter may be plugging.	Check for pressure buildup down stream of filter and fix pressure buildup downstream if found.
Water will not flow through filter fast enough.	Pump may not be able to supply enough pressure.	Check pressure output of pump with pump curve. Replace pump if required.
Filters are plugging too fast.	Filter was not backwashed properly.	Backwash filter vessel as per manufacturer's instructions.
	Filter pressure switch setpoint may be too low.	Increase high-pressure shutdown setpoint.
	Filter sand has solidified with calcification.	Replace sand in filter.

	Process water flow rate is operating above the design flow rate for the sand filter.	Check process flow rate and compare with design flow rate listed on manufacturer's literature or on the component sheet of the sand filter section of your **newterra** Manual.
Rotary Screw Compressor Package		
Compressor not starting.	Motor Overload.	Reset overload. Check compressor output pressure. Oil separator may be dirty, replace if needed. Check supply voltage.
	Stopped by compressed air temperature relay.	Oil level is too low. Not enough cooling air flow. Wrong compressor oil. Ambient temperature too high. Cooler dirty.
Insufficient air output.	Clogged intake filter.	Check condition of the filter and replace if needed.
	Clogged oil separator element.	Check condition of the oil separator element and replace if needed.
	Pressure switch is not working.	Check pressure switch adjustment. Repair or replace if switch is faulty.
	Receiver blow down valve open.	Disassemble and clean out internal components.
	Too high air consumption.	Check network for leaks and air powered devices.
	Drive belt slipping.	Check tension of belt and tighten if required. Replace belt if worn.
Compressor overheating.	Insufficient amount of oil.	Add more oil.
	Clogged oil filter.	Check condition of the filter and replace if needed.
	Cooler dirty.	Clean.
	Ambient temperature too high.	Check temperature and air circulation.
High oil consumption.	Oil return tube or its orifice is blocked.	Open and clean all internal components.
	Oil separator or sealing damaged or loosened.	Check seals and repair if needed.
	Oil separator dirty.	Replace.
	Wrong compressor oil.	Change oil. Use the correct oil as specified in the manufacturer's instructions.
	Output air temperature too high.	Check output temperature correct if it is too high.

	Faulty non-return valve of oil return pipe.	Check operation and replace valve if needed.
	Too much oil.	Drain extra oil out.
Network pressure rises over set valve.	Pressure switch is not working or damaged.	Check operation of switch.
	Output valve leaking.	Replace seal.
	Loose wire connections.	Check for loose wires and correct as needed.
Compressor doesn't restart automatically.	Pressure switch damaged.	Replace pressure switch.
	Output valve leaks.	Replace seals of output valve.
	Loose wires.	Check for loose wires and correct as needed.
Compressor doesn't stop automatically.	Output valve leaks.	Replace seals of output valve.
	Pressure Switch Damaged.	Replace pressure switch.
Refrigerated Dryer		
Water down stream of dryer.	Residual air in piping.	Blow out system with dry air.
	Air bypass system is open.	Check the bypass valve position.
	Inlet and Outlet conditions are reversed.	Check for correct connection.
	Air temperature on outlet of dryer may be too low.	Add heat trace to piping.
	Automatic drain mechanism is not working.	Replace drain mechanism.
	Dryer overloaded.	Check flow rate and inlet temperature.
High pressure drop across dryer.	Inlet air strainer clogged.	Clean inlet air strainer.
	Excessive air flow.	Check flow rate and reduce if needed.
	Separator filter clogged.	Replace filter sleeve.
	Freezing of moisture in evaporator.	Shut down dryer until system thaws.
Fault Alarm.	Dryer overloaded resulting in high air outlet temperature.	Check operating conditions.
	High outlet air temperature.	Correct high temperature.
	Thermostat switch is malfunctioning or not securely mounted.	Replace thermostat switch.
Refrigeration system not functioning properly in on position.	Power failure.	Check power.
	Line disconnect switch is open.	Check disconnect.

	Fuses blown, breaker blown.	Check fuses or breaker.
	Loose or faulty wiring.	Check wiring.
Refrigeration system cycles on and off.	High or low ambient conditions.	Check min/max temperature ranges.
	Air filter clogged.	Clean filter.
	Condenser fins clogged.	Clean fins.
	Fan motor or control switch not working.	Replace fan motor or switch.

Analog 4-20mA Transmitters		
Transmitter is sending a signal that is not accurate.	There may be water in the air sampling lines that is throwing off the readings.	Drain any moisture out of the air sampling lines.
	Transmitter may be out of calibration.	Refer to transmitter specification sheets on how to calibrate the transmitter. Note if transmitter is more than 10-25% out of calibration it will likely require factory recalibration.
Transmitter is sending 0-2 mA to the PLC input.	Transmitter may not be wired properly or one or more wire connections may be loose.	Check wiring with device specification sheet and newterra drawing. Check wiring for loose connections.
	Transmitter may be damaged or not working properly.	If you have a similar transmitter installed in another location on the system, switch them around to determine if the faulty transmitter works in another location. If the transmitter works you know the transmitter is not the problem. If the transmitter does not work in the other location then it is likely the transmitter. If the good transmitter does not work in the faulty location the problem is likely the wiring at that location or the input into the PLC.
Transmitter is sending over 20 mA to the PLC.	Transmitter is likely damaged.	Send back to manufacturer for re-calibration.
PLCs		
Power is on, Lights are on but PLC is not running the logic. Run light is not on.	PLC may not be in run mode. If the power has been off to the panel for an extended period of time, the PLC will switch out of run mode and stop running the logic.	Use external switch on PLC to switch from "term" to "run" then back to "term". This will force the PLC back into run mode. The run light should now indicate that the PLC is in run mode.
Power is on to panel but PLC lights are not on.	Fuse for PLC is pulled out or blown.	Test PLC fuse and replace if necessary. This is in the "PLC" fuse holder.

APPENDIX B –

OWS COMMISSIONING JOB HAZARD ANALYSIS (JHA)

Job Hazard Analysis Form

PROJECT/TASK: Commissioning Mobile OWS		CONTRACTOR: BIM				JOB No.:			
SUPERVISOR:		LOCATION:				DATE:			
JOB STEP Break the job into steps. Listing work which may be hazardous.	**HAZARDS** List the hazard or type of harm identified with each step.	**Inherent**			**CONTROL MEASURE** List the necessary control measures to be followed to eliminate/reduce the identified hazards.	**Residual**			**ACTION** Person who will ensure this happens
		Consequence	Likelihood	Risk Ranking		Consequence	Likelihood	Risk Ranking	
Opening Media canisters	Potential built up gases				Technicians will use appropriate PPE and wear Gas Tester alarm systems while opening GAC canisters and opening vent ports.				
Vacuum Media from OWS	Vacuum line inside OWS area				Operators/technician will open valve and ensure system is operating properly before working inside OWS canisters				
	Potential for inhalation of carcinogenic particulate being disturbed				Respirators will be worn while disturbing spent bentonite and GAC to avoid inhalation of particulate				
	Working from a ladder or raised platform				Work platform or ladder will be tested for stability before working with vacuum line to remove media				
Discharge or Vacuum to/from an open vessel	Working with pressurized hoses				When completing discharge, pressure is released, 3” opened, and the line will be vacuumed out.				
					Open end must always be controlled –				

					braced by operator, or in a bracket.				
	Potential for inhalation of carcinogenic particulate being disturbed				Respirators will be worn while disturbing spent bentonite and GAC to avoid inhalation of particulate				
Installing new media	Working from heights				Scaffolding will be present to ensure platform and railing to prevent falling.				
	Heavy lifting at heights				Telehandler will need to be used to remove pallets of media from Sea Cans and onto OWS roof so bags of media are within reach of the scaffolding and railing system				
	Potential for inhalation of carcinogenic particulate being disturbed				Respirators will need to be worn while pouring media through roof ports into canisters to prevent inhalation of particulate				
Commissioning new media	Working with pressurized hoses				A water truck operator will need to hook up line to tanks and fill through influent port in first media canister until fresh water comes out the effluent line into the berm.				

Job Hazard Analysis Attendees:

	Name	Signature	Date
Written by:			
Reviewed by:			

Score	*TABLE OF CONSEQUENCE*		
	People	**Plant**	**Environment**
5 – Very High/ Catastrophic	Multiple Fatalities.	Greater than $10 Million Loss	Catastrophe, destruction of sensitive environment, worldwide attention. Likely EPA prosecution. More than 30 days delay.
4 – High/ Major	Fatality or Permanent Disabilities.	$1 Million to $10 Million Loss	Disaster, high levels of media attention, high cost of clean up. Offsite environmental harm; more than 10 days delay.
3 – Moderate	Major Injuries – Incapacitations or requiring time of work.	$100 Thousand to $1 Million Loss	Major spills, onsite release, substantial environmental nuisance, more than 1day delay. (Leads to an additional resources call out i.e. SES).
2 – Low/ Minor	Significant Injuries – Medical Treatments, non-permanent injury.	$10 Thousand to $100 Thousand Loss	Significant spills. (Leads to a call out of Site Emergency Response Group).
1 – Very Low/ Insignificant	Minor Injuries – First Aid Treatments (cuts/bruises).	Less than $10 Thousand Loss	Low environmental impact. Minor Spills less than 80 Litres.

Score	*LIKELIHOOD*
5 – Almost Certain	The event is expected to occur in most circumstances. Likely to occur frequently - More than 1 per year.
4 – Likely/ Probable	The event will probably occur in most circumstances. Likely to occur several times – 1 per year.
3 – Moderate/ Occasional	The event should occur at some time. Likely to occur some time – 1 per 5 years.
2 – Remote/ Unlikely	The event could occur at some time. Unlikely but possible. 1 per 10 years.
1 – Rare/ Very Unlikely	The event may occur only in exceptional circumstances. Assumed it may not be experienced. 1 per 100 years.

Risk Rating = Consequence + Likelihood

Consequence	Risk Rating				
5	**6**	**7**	**8**	**9**	**10**
4	**5**	**6**	**7**	**8**	**9**
3	**4**	**5**	**6**	**7**	**8**
2	**3**	**4**	**5**	**6**	**7**
1	**2**	**3**	**4**	**5**	**6**
	1	**2**	**3**	**4**	**5**
	Likelihood				

Risk Rating - Definitions

Risk Rating	Definitions	*Action Required*
8 - 10	Intolerable	Task not to start till the risk is eliminated or reduced. Bring to the immediate attention of management. Formal assessment required. MUST reduce the risk as a matter of priority.
7	High	Bring to the immediate attention of management. Task not to start till the risk is eliminated or reduced. Further Assessment required. MUST reduce the risk as a matter of priority.
6	Significant Risk	Bring to the attention of supervision. Review risks and ensure that they are reduced to as low as reasonably practicable. To be dealt with as soon as possible, preferably before the task commences. Introduce some form of hardware to control risk.
5	Moderate Risk	Needs to be controlled but not necessarily immediately, an action plan to control the risk should be drawn up. Review effectiveness of controls. Ensure responsibilities for control are specified.
2-4	Low Risk	If practical reduce the risk. Ensure personnel are competent to do the task. Manage by routing procedure. Monitor for change

A JHA considers a variety of activities/tasks involved in a job scope and analyses the key hazards (sources of harm) and their consequences (types of harm) eg. Sources of harm – lifting a heavy pipe - manual handling. Types of harm – Back strain.