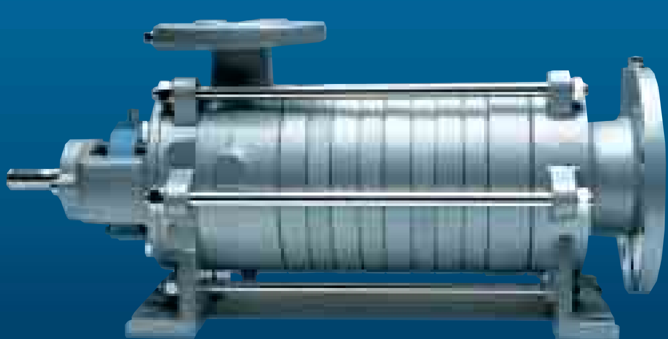
Corken Specialty Selection Guide

Selective Catalytic Reduction Systems



- Anhydrous Ammonia
- Aqueous Ammonia
- Urea

Solutions beyond products...

CORKEN®

IDEX

Corken, a tradition of excellence

As a unit of IDEX Corporation, Corken Inc. is a leader in specialized niche markets. To maintain our leadership in your industry requires continual Innovation, Diversity and Excellence.

With over 50 years of global experience in liquefied gas handling, Corken offers unparalleled experience in rapidly changing ammonia handling systems. Corken's exceptional reputation is built upon decades of maintaining the highest quality and customer service standards. Corken follows all of the guidelines set out by national agencies like the American National Standard Institute (ANSI) and the American Society of Mechanical Engineers (ASME) as they apply to our products.

Through intimate contact within your industry, Corken is committed to applying new product technology and streamlining product selection.

This specialized information packet is designed as a comprehensive guide to applying Corken products in your industry. It covers the capabilities, applications and guidelines for use of our compressors and pumps specifically for NH_3 transfer in selective catalyst reduction (SCR) systems.

SCR Definition and Overview

Selective Catalytic Reduction (SCR): a post-combustion NO_X reduction technology in which ammonia (NH_3) is added to the flue gas, which then passes through layers of a catalyst. The ammonia and NO_X react on the surface of the catalyst, forming harmless nitrogen (N_2) and water vapor.

New Environmental Protection Agency (EPA) regulations generate high demand for SCR systems to reduce NO_X emissions from many large fossil-fuel fired industrial boilers and electricity generating units. The emerging demand for SCR systems also creates market opportunities for Corken equipment. SCR systems can reduce NO_X levels by 90% or more. The SCR market is mainly driven by environmental regulations and environmental technologies.

SCR is well accepted by the industry as the best available technology, achieving the highest NO_X reduction level. Technologies are changing rapidly in the NO_X reduction SCR market and new alternative technologies keep coming to the market. Ammonia is currently considered the most effective NO_X reducing agent used with SCR systems. Ammonia-based SCR systems can use three different NO_X reducing agents: anhydrous ammonia, aqueous ammonia, and urea.

ANHYDROUS AMMONIA TECHNOLOGY

- Anhydrous ammonia is the most effective NO_X reducing agent used in SCR systems. However, due to its hazardous nature, this form of ammonia can incur high compliance costs and safety concerns related to transportation, storing, and handling.
- This technology has been in use in Europe since the 1980’s.
- Corken pumps and compressors are used in anhydrous ammonia SCR systems.

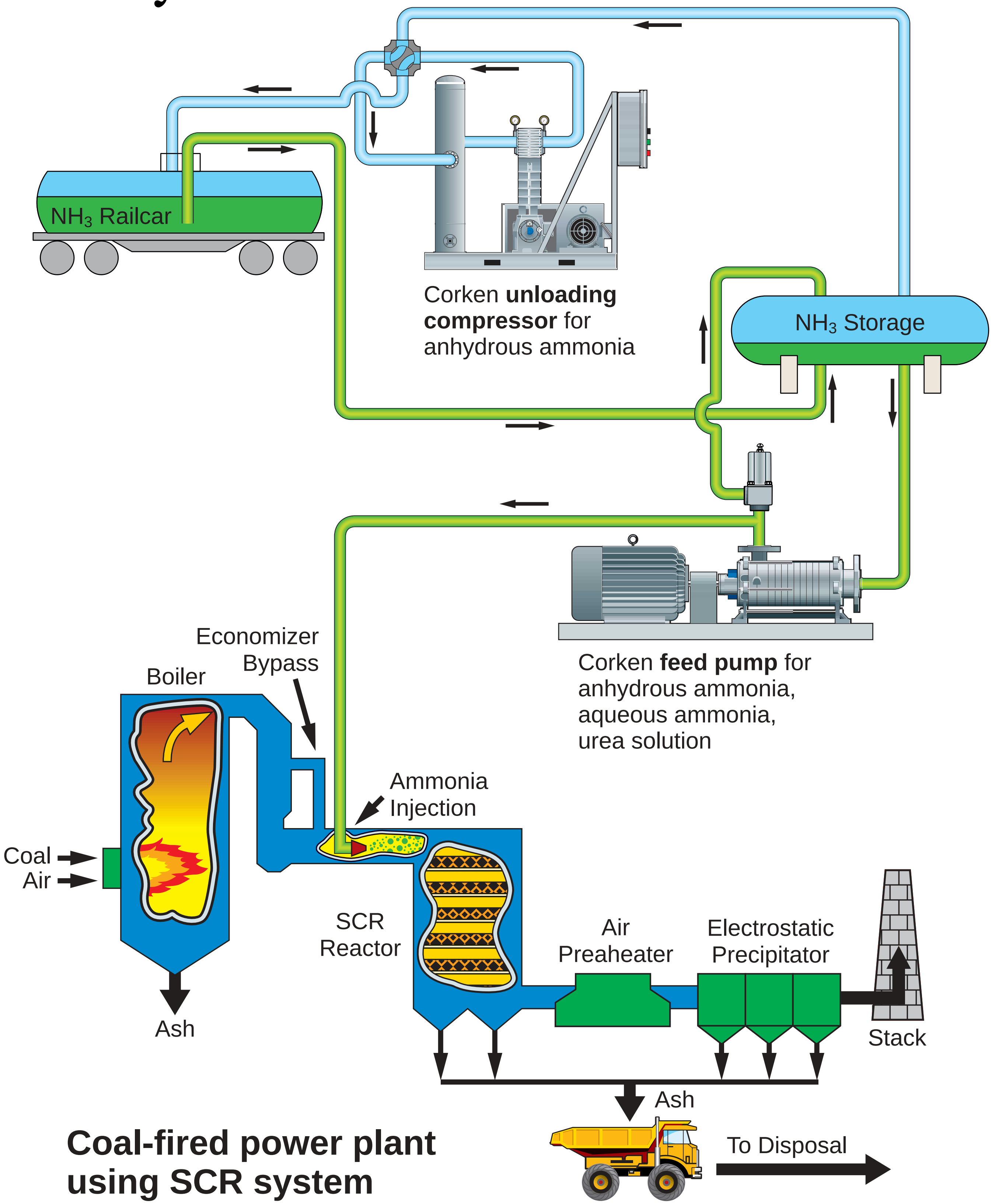
AQUEOUS AMMONIA TECHNOLOGY

- Aqueous ammonia is commonly used in concentrations of 19% and 29% in SCR systems. When diluted to 19% concentration, aqueous ammonia is not classified as a toxic chemical.
- Aqueous ammonia is generally considered safer than anhydrous ammonia because of its lower toxicity and lower storage pressure.
- Corken pumps are used as feed pumps in aqueous ammonia systems.

UREA BASED AMMONIA GENERATION TECHNOLOGY

- Non-toxic urea is transported as a granular solid. It is mixed with water on site and converted to ammonia to be used as a NO_X reducing agent in SCR systems.
- This technology has recently gained a lot of interest from end-users due to minimal safety concerns. This technology is in the growth stage of its product life cycle.
- Corken pumps are used in urea based SCR systems.

Where is Corken Equipment Applied in SCR Systems?



Coal-fired power plant using SCR system

Corken Industrial Pumps and Compressors Meet the Challenges of SCR Ammonia Transfer

COMPRESSORS FOR ANHYDROUS AMMONIA

Proven Reliability

Corken Industrial Compressors have been the standard in bulk ammonia transfer for 50 years. Our product and system experience in ammonia handling allows us to streamline your selection process.

Sealing / Environmental Control

Corken's proven double distance piece (t-style) offering is specifically designed for hazardous gases. Optional ANSI/DIN flanges provide increased environmental security.

One Stop Shopping

Corken compressor packages are engineered to customer specifications. No other company offers the range of Selective Catalytic Reduction (SCR) ammonia pump and compressor system capability.

PUMPS FOR ANHYDROUS AMMONIA, AQUEOUS AMMONIA AND UREA

Wide Ranging Flows and Pressures

Corken offers specialized pumping technologies where flows range from 1-400 gpm with differential pressures to 1,100 feet.

Low Net Positive Suction Head (NPSH)

No need to compromise system design or experience down time associated with vapor lock and cavitation. Corken's unique design exceeds expectations where NPSH is as low as 1 ft.

Continuous Duty Service

Corken offers a continuous rated design. Reduced operating speed and free-floating impellers (no metal-to-metal contact) provide years of trouble free service.

Sealing Integrity

Whether your application calls for mechanical sealing or sealless designs, Corken provides the widest range of options.

Commitment and Support

Corken products are backed by the strongest service commitment in your industry. We are pleased to provide you with our growing list of satisfied customers.

A Comprehensive Guide to SCR Systems

Why Use a Compressor to Transfer Highly Volatile Liquids?

Liquefied gases must be transferred from one container to another either with a liquid pump or a gas compressor, and there are very definite benefits from selecting either one. Because Corken has had many years of experience in manufacturing both pumps and compressors for volatile liquid service, it is possible for our personnel to analyze this problem objectively and present the following comparisons to assist you in making the proper choice.

LIQUID PUMPS

A liquid pump, such as the Corken Coro-Vane® has the advantage of producing higher differential pressures than the compressor to overcome high pressure losses caused by inadequate discharge piping, pumping into small, hard to fill tanks, and particularly through meters. A compressor cannot successfully discharge volatile liquid through a meter. However, the liquid pump does have certain limitations:

- Volatile liquids with their tendency to boil or "flash" readily whenever the pressure is reduced require particular attention to pump installation.
- To reduce this "flashing" effect, pump inlet piping-must be designed carefully with larger and more expensive valves, strainers and flexible piping arrangements to provide the pump's required NPSH (net positive suction head).
- Most tank cars have top outlets, necessitating a "siphon leg" which contributes to liquid flashing.
- The flashing liquid may cause pump "vapor lock", with the attendant loss of capacity and accelerated wear on the shaft seals and running parts.
- Tanks are seldom emptied entirely of liquid; uneven unloading sites and variations in the vehicle undercarriage increase this possibility.

None of the valuable residual vapors remaining in the unloaded tank may be recovered.

GAS COMPRESSORS

A gas compressor will overcome many of the obstacles associated with transferring liquid with a pump, such as poor piping conditions and top outlet tanks. The compressor will do everything the pump will do in low pressure liquid transfer, with the same horsepower requirement, and will recover the valuable residual vapors. The quantities of recoverable residual vapors are shown in Figure 1, page 16 for typical gases.

Transports have bottom openings and may be unloaded with a liquid pump successfully. The amount of valuable vapors remaining usually is not as great as in a tank car, and a transporter understandably is reluctant to leave his expensive equipment for an hour or so while the residual vapors are being recovered. Because of these factors, many "transport only" bulk plants utilize only liquid pumps. Yet it is reasonable to expect that the plant operator could recover vapors for the period of time the driver is performing his accounting chores, if a plant compressor were available. Figure 1, page 17, illustrates that a large percentage of the vapors may be recovered in the first 15 to 30 minutes. Actually, more equivalent pounds or gallons of vapor will be recovered during the first few minutes while the residual liquid is being vaporized than will be reclaimed during the same period of time later on. The vaporized liquid content is in addition to the values shown in Figure 1, page 17.

Even when gas ownership does not change hands, as in the case when a producer delivers to his own terminal, the vapor recovery compressor can develop an increased transporting capacity of about 3 percent! This means a fleet of 97 tank cars unloaded with vapor recovery can do the job of 100 when the vapor is not recovered!

Maintenance of a pump or a compressor is about the same if the equipment is not abused. The liquid pump can be damaged seriously if allowed to run dry, either from "vapor locking" or after the unloading tank is emptied, whereas the compressor is remarkably resistant to this kind of abuse. You must, however, take action to prevent liquid entering the compressor.

Safety of plant operation is a factor often not considered in compressor selection: a safety minded operator will use the versatile compressor to evacuate tanks and piping rather than "bleeding down". He will also find the purging of new tanks is more effectively done by first evacuating the air with the compressor.

Today, in the gas distribution business with the price of product increasing and competition more pressing, profits are more difficult to produce than ever before. The profit contribution of vapor recovery may very well make the difference in an acceptable profit margin; the discussion on the "Economics of Compressor Operation" indicates this clearly, and is a logical method you may use to justify your own decision.

Profits will continue to accrue whenever vapor recovery operations are performed.

Guide to Compressor Selection

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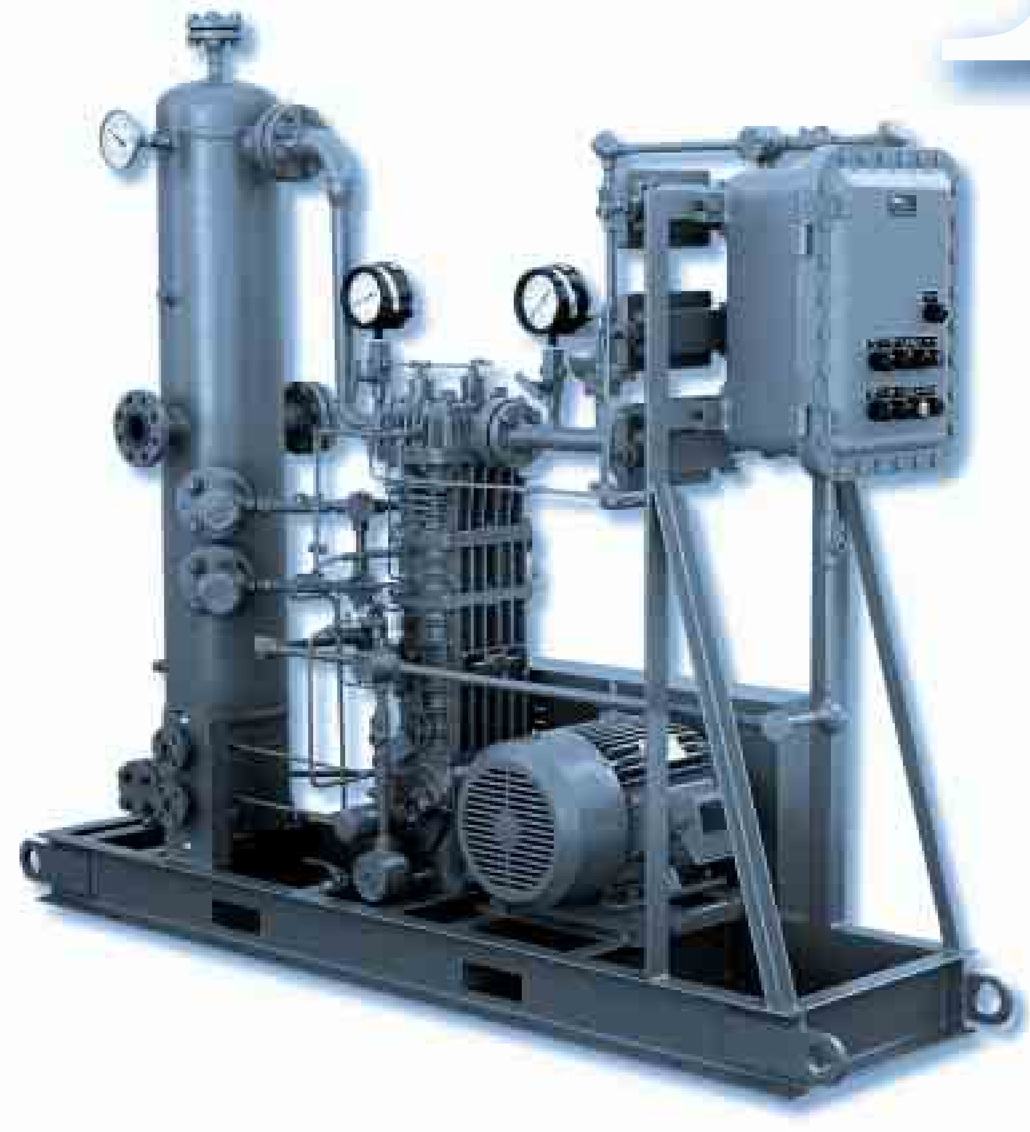


FEATURES

ANSI FLANGED HEAD is made from ductile iron and is ideal for most industrial applications. ANSI flanges eliminate the possibility of leaks from threaded connections.

PISTON ROD SEALS of glass-filled, self-lubricating Teflon® are spring loaded and adjustable to compensate for lateral rod movement, wear and temperature variations. The seals stop gas leakage into the crankcase and crankcase oil entry into the compression cylinders.

CROSSHEAD – PISTON ROD assemblies transmit the crankshaft motion into vertical, reciprocating piston motion. The vertical piston motion provides no side thrust, and thus the pistons require no rider rings. The crosshead and the hardened steel piston rod are assembled and machined as one piece to assure perfect alignment between the connecting rod wrist pin and the piston rod.

CRANKSHAFTS have integral, balanced counterweights for smoother operation. Bearing surfaces are extra large and the crankshaft is precision ground to size. The crankshafts are rifle drilled for positive oil distribution to the connecting rods and wrist pin bearings.

THE CRANKCASE is operated at atmospheric pressure, but is totally enclosed with an automatic breather valve to prevent entrance of dust or foreign matter. Since no oil is consumed in the compression process, the oil remains clean in the crankcase, and the major sources of crankcase wear are virtually eliminated. **The oil stays in the crankcase where it belongs!** The crankshaft running parts are pressure lubricated by filtered oil from an automatically reversible pump (reversing does not require disassembly). An easy-to-read, dial-type, oil pressure gauge indicates proper functioning of the lubrication system.

TAPERED ROLLER BEARINGS are mounted on each end of the crankshaft to absorb radial and thrust loads. These oversize bearings assure added years of service, and can be adjusted easily from the external position of the crankcase if required.

CUSHIONED VALVES are designed and lapped for long life. The valve bumpers have a gas cushion to prevent valve slamming and provide quiet operation. Each valve is easily removable for inspection.

OIL-FREE CYLINDER AND PISTON DESIGN permits these compressors to operate with no lubrication of any kind in the compression cylinders. A combination of self-lubricating, filled Teflon® piston rings, honed cylinder walls and low lift valves make this unique pumping system possible. The pistons are arranged not to contact the cylinder wall and are designed to be removable from the cylinder and piston rod without disturbing the cylinder.

INTERNAL PROTECTION DEVICES guard against liquid slugging. Volatile liquid transfer incurs risk of liquid entering or "slugging" the compressor. Reliable relieving devices are built into the cylinder head and suction valves to prevent damage from reasonable amounts of liquid. **An optional liquid trap** provides additional protection externally, and is recommended for all plant installations.

LARGE FLYWHEEL FAN provides maximum crankcase cooling and smooth operation.

DUCTILE IRON CONNECTING RODS provide great strength for heavy duty applications. The connecting rod bearing inserts are steel backed, babbit-lined, removable automotive type. The rod is constructed with a communicating lubrication port from the crank to the honed bronze wrist pin bearing for lubrication from the crankcase oil pump.

Teflon® is a registered trademark of DuPont.

FD491 COMPRESSOR

SPECIFICATIONS

MECHANICAL SPECIFICATIONS

SPECIFICATION	MODEL SIZE FD291	FD491	FD691
Number of Stages	1	1	1
Number of Cylinders	2	2	2
Bore of Cylinder, inches (cm)	3 (7.62)	4 (10.16)	4.5 (11.43)
Stroke, inches (cm)	2.5 (6.35)	3 (7.62)	4 (10.16)
Piston Displacement, cfm (m^2/hr)			
Minimum at 400 rpm	8 (18.6)	17 (28.9)	29 (49.3)
Maximum at 825 rpm	16 (27.2)	36 (61.2)	60 (102)
Maximum Discharge Pressure, psig (bars g)	335 (23.1)	335 (23.1)	335 (23.1)
Maximum Compression Ratio: Continuous Duty	5	5	5
Intermittent Duty	7	7	7
Maximum Allowable Driver Size, hp	15	20	30

COMPRESSOR SELECTION CHART

COMPRESSOR MODEL	MOTOR SIZE, HORSEPOWER[1]	APPROXIMATE CAPACITY FOR AMMONIA GPM (LIT/MIN)[2]
291	3	44 (166)
	5	77 (291)
	7-1/2	88 (333)
491	5	77 (291)
	7-1/2	110 (416)
	10	148 (560)
	15	198 (749)
691	10	132 (500)
	15	198 (749)
	20	265 (1,003)
	25	330 (1,249)

NOTES:
1. The driver horsepower shown is based upon recovering residual vapors in moderate climates.
2. The actual capacity will vary depending upon piping factors. The capacities shown are conservative and may be increased as much as 10% in well designed plants.

CHOOSE FROM A VARIETY OF MOUNTING ARRANGEMENTS TO SUIT YOUR PARTICULAR APPLICATION

There are a number of standard base mounted gas compressor units to fit most installations, but special mounting and piping arrangements can be designed and manufactured to fit your particular needs.

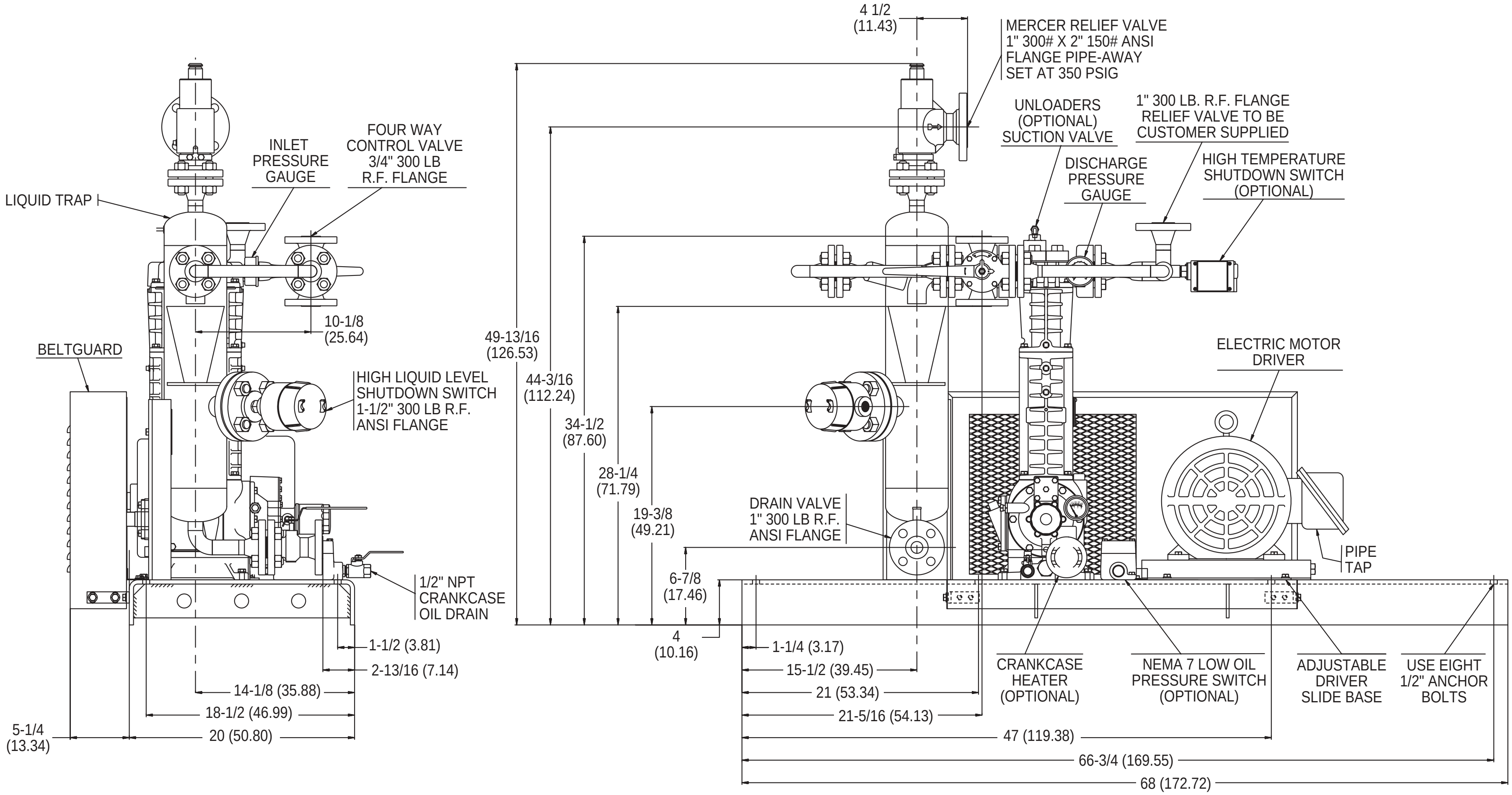
BARE
Gas compressor with flywheel.

STYLE – 103
Gas compressor unit with pressure gauges, steel baseplate, adjustable driver slide base, v-belt drive and enclosed belt guard – ready to receive an electric motor driver.

STYLE – 107F
Complete gas compressor bulk plant unit with ANSI flanged mounting includes pressure gauges / block valves, ASME code stamped ANSI flange inlet trap with one or two liquid level switches, flanged trap relief valve, manual tank drain, non-lube ANSI flanged four-way valve and flange welded interconnecting piping. Mounted on a steel base, v-belt drive and enclosed belt guard. Motor and flanged compressor not included.

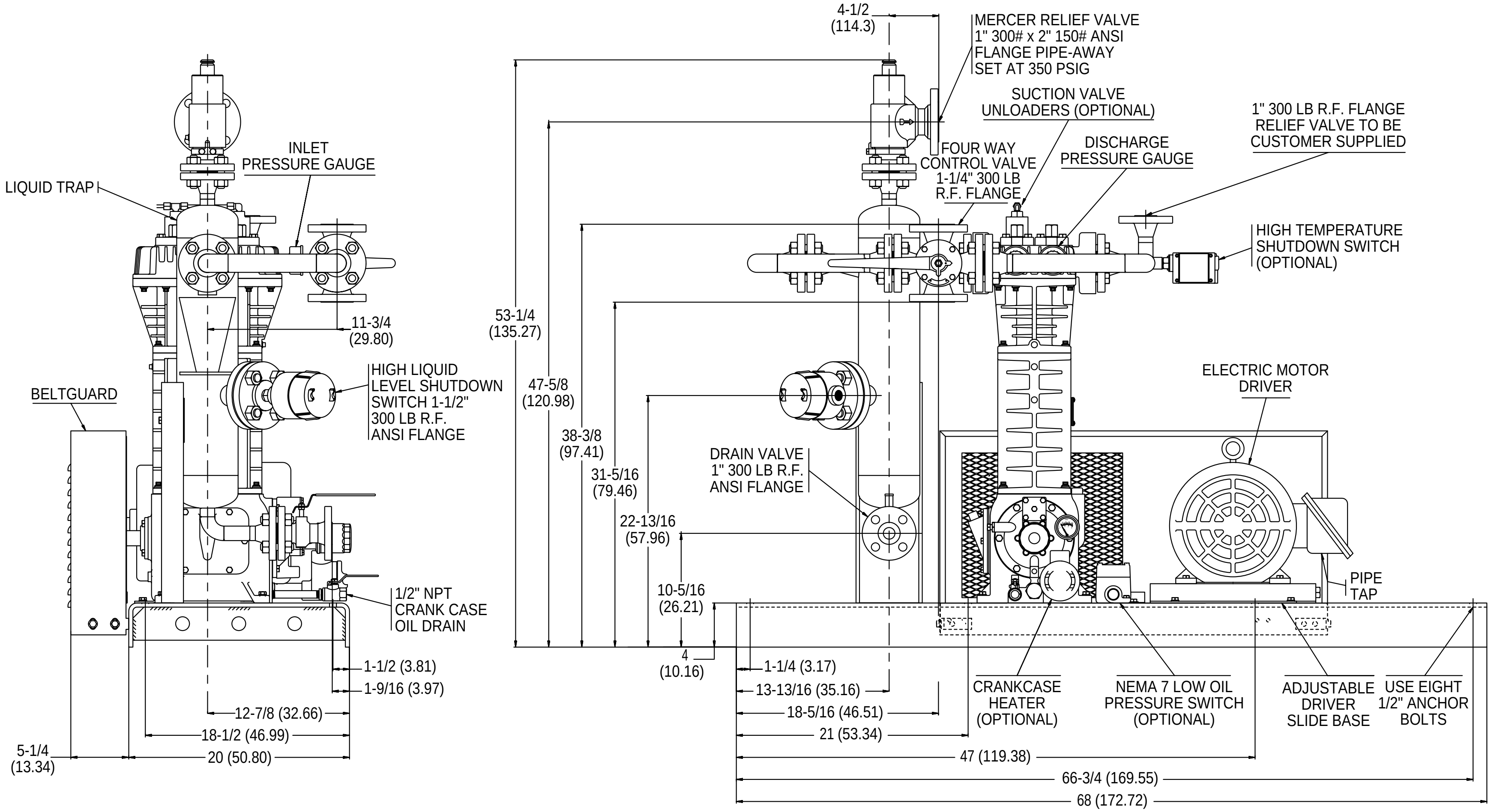
Style – 109F
Gas compressor unit with ANSI flanged mounting includes pressure gauges / block valves, ASME code stamped ANSI flange inlet trap with two liquid level switches, flanged trap relief valve and manual tank drain and flange welded interconnecting piping. Mounted on a steel base, v-belt drive and enclosed belt guard. Motor and flanged compressor not included.

OUTLINE DIMENSIONS – FD291-107F



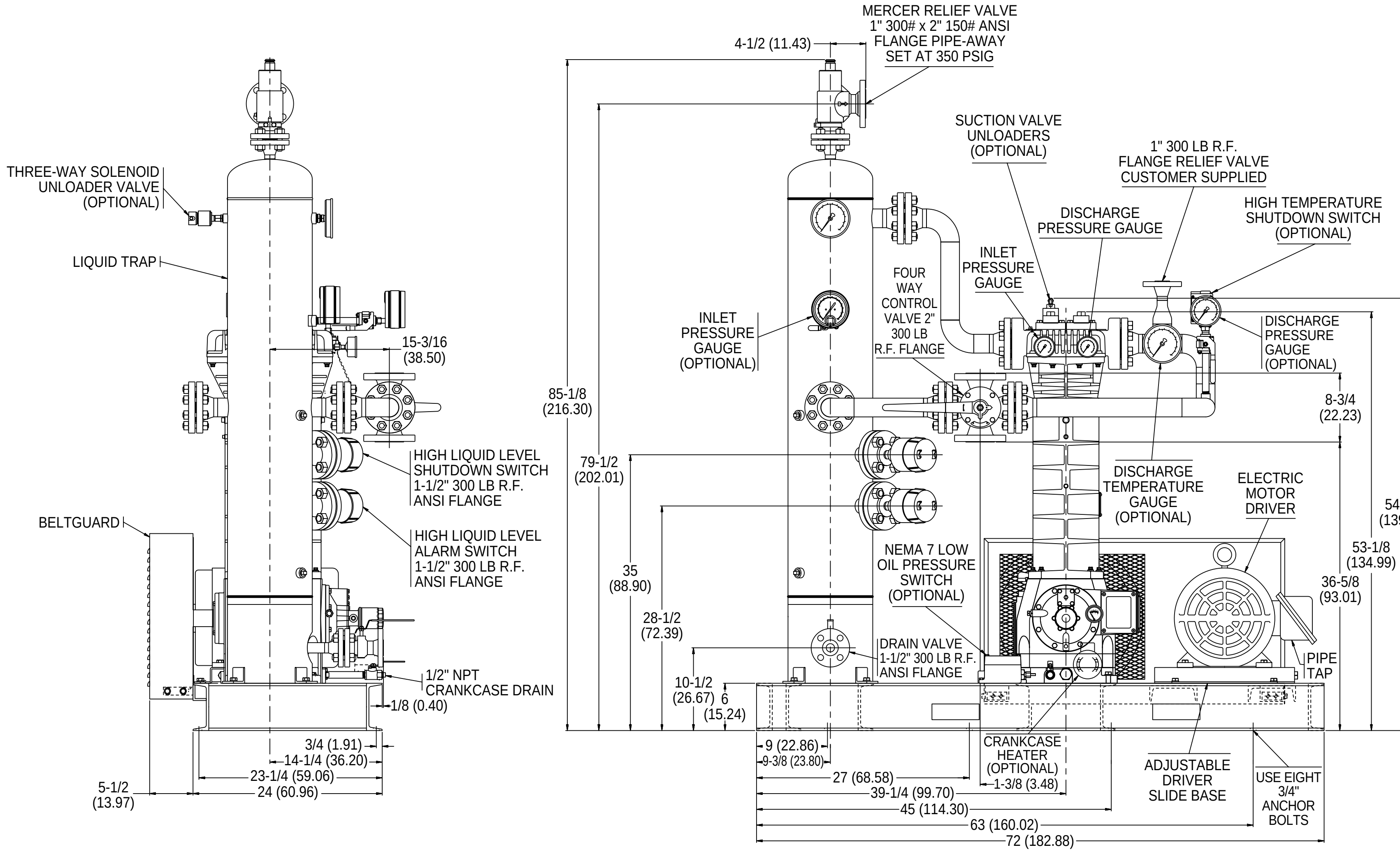
ALL DIMENSIONS IN INCHES(CM)

OUTLINE DIMENSIONS – FD491-107F



ALL DIMENSIONS IN INCHES(CM)

OUTLINE DIMENSIONS - FD691-107F



DIMENSIONS IN INCHES (CM)

MATERIAL SPECIFICATIONS

PART	STANDARD		OPTIONAL	
	SIZE	MATERIAL	SIZE	MATERIAL
HEAD, CYLINDER	91, 191, 291, 491, 691	DUCTILE IRON ASTM A536	492-692	DUCTILE IRON DIN 1693 666-40.3
DISTANCE PIECE, CROSSHEAD GUIDE CRANKCASE, FLYWHEEL BEARING CARRIER	ALL	GRAY IRON ASTM A48, CLASS 30		
FLANGE	691	DUCTILE IRON ASTM A536	690, 691, 690-4	STEEL WELDING
VALVE SEAT AND BUMPER	291	17-4 PH STAINLESS STEEL		
	391, 491, 491-3	DUCTILE IRON ASTM A536		
	691	STAINLESS STEEL		
VALVE PLATE	291	410 STAINLESS STEEL	291	PEEK
	491, 491-3	17-7 PH STAINLESS STEEL		
	691	STAINLESS STEEL	691	PEEK
VALVE SPRING	291, 691	17-7 STAINLESS STEEL		
	491, 491-3	INCONEL		
VALVE GASKETS	ALL	SOFT ALUMINUM	ALL	COPPER, IRON-LEAD
PISTON	291, 491, 691	GRAY IRON ASTM A48, CLASS 30		
PISTON ROD	ALL	C1050 STEEL, NITROTEC, ROCKWELL 60C	ALL D & T STYLE MODELS	CHROME OXIDE COATING
CROSSHEAD	ALL	GRAY IRON ASTM A48, CLASS 30		
PISTON RINGS	ALL	PTFE, GLASS AND MOLY FILLED OR ALLOY 50	ALL	SPECIAL ORDER MATERIALS AVAILABLE
PISTON RING EXPANDERS	ALL	302 STAINLESS STEEL		NONE
HEAD GASKET	291, 491, 691	O-RING (BUNA-N)	291, 491, 691	PTFE, VITON®, NEOPRENE®
ADAPTER PLATE, PACKING CARTRIDGE, CONNECTING ROD	ALL	DUCTILE IRON ASTM A536		
PACKING RINGS	ALL	PTFE, GLASS AND MOLY FILLED OR ALLOY 50		SPECIAL ORDER MATERIALS AVAILABLE
CRANKSHAFT	ALL	DUCTILE IRON ASTM A536		
CONNECTING ROD BEARING	ALL	BIMETAL D-2 BABBIT		
WRIST PIN	ALL	C1018 STEEL, ROCKWELL 62C		
WRIST PIN BUSHING	ALL	BRONZE SAE 660		
MAIN BEARING	ALL	TAPERED ROLLER		
INSPECTION PLATE	ALL	ALUMINUM		
O-RINGS	ALL	BUNA-N	ALL	PTFE, VITON®, NEOPRENE®
RETAINER RINGS	ALL	STEEL		
MISCELLANEOUS GASKETS	ALL	COROPRENE		

VITON® AND NEOPRENE® ARE REGISTERED TRADEMARKS OF DUPONT.

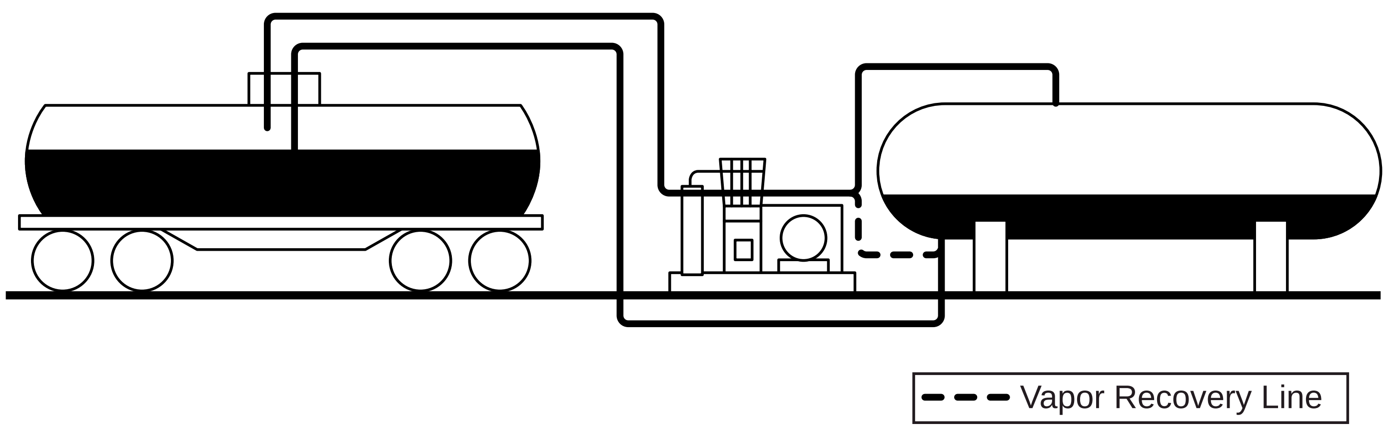
1 Guide to Compressor Selection

THE TRANSFER COMPRESSOR OPERATING PRINCIPLE

Most people are somewhat familiar with the operating principles of a liquid pump; the transfer compressor is another matter entirely. Visualize a tank car full of volatile liquid on a plant siding ready to be unloaded into storage tanks. Both tank car and storage tank are normally under approximately the same vapor pressure.

A piping connection is made between the tops of vapor sections of the tank car and the storage tank, and a similar connection is made between the liquid sections of the two tanks. As the connections are opened, the liquid will seek its own level and then flow will stop. However, by creating pressure in the tank car sufficient to overcome pipe friction and any static elevation difference between the tanks, all the liquid is forced into the storage tank quickly. The gas compressor does this job by drawing gas from the top of the storage tank. This procedure lowers the storage tank pressure slightly and increases the tank car pressure, normally 10 to 20 psig (0.7 to 1.4 bars), above vapor pressure.
After all possible liquid has been transferred in this manner, some liquid still remains, and the tank car is still full of valuable vapors. To remove the remaining liquid and the residual vapors, piping connections are reversed by means of the compressor four-way control valve, and the direction of flow through the compressor is reversed. After closing the connection between the liquid sections of the two tanks, the gas can now be drawn from the top of the tank car thereby vaporizing the remaining liquid. After all liquid has been vaporized, the compressor continues to draw gas from the tank car until the tank car pressure is reduced to an economical point.

The recovered vapors must be discharged into the storage tank liquid section where they will be condensed. If the recovered vapors are not condensed, the storage tank will develop an excessive pressure.



ECONOMICS OF USING A COMPRESSOR

Any claim of an equipment manufacturer should be supported by facts, including the economics or payout calculations. If the profitability of a piece of machinery cannot be proven, it probably should not be purchased. The "proof of profit" of an unloading compressor is quite simple, if certain conservative assumptions are agreed upon:

1 . Either a liquid pump or a compressor must be used to transfer the liquid product.

2. The liquid transfer capacity of either a pump or a compressor, horsepower for horsepower, is comparable. In the Corken line, a gas compressor requires the same horsepower for liquid transfer only as does a liquid pump.

3. Since a transfer compressor may recover residual vapors, and a liquid pump cannot, it is to be expected that the horsepower requirements for this cycle of operation are greater for a compressor.

4. Only the difference in cost between the compressor and its motor and that of a pump and its motor is to be considered in the payout since one or the other must be utilized to transfer the liquid.

5. The cost of operation of the compressor for the vapor recovery cycle is offset by the recovery of the vaporized liquid left in the tank after the transfer of all possible liquid is completed.

Example A:
How many tank cars of propane, 33,000 wg capacity, must be unloaded of vapor to pay for a $4,940 compressor? For the sake of simplicity, we shall be unloading cars with an average pressure of 125 psig, and a product cost, including freight, of $0.52 per gallon. A liquid pump of comparable capacity costs approximately $1,525. The recoverable vapors in equivalent gallons of liquid are shown in Figure 1 as 770 gallons.

$$\text{Number of Tank Cars} = \frac{\$4{,}940-\$1{,}525}{770 \text{ gal. x } \$0.52/\text{gal.}} = 8$$

Only eight tank cars to pay for a 15 hp compressor unit ... thereafter all vapors recovered are profit!!!

Example B:
How many tank cars of ammonia, 11000 wg capacity, must be unloaded of vapor to pay for a 90 gpm, 5 hp compressor, if the tank car pressures are approximately 150 psig, and the product value is $225 per ton, or $0.113 per pound? A 2-1/2” liquid pump of the same horsepower would remove the liquid as quickly as the compressor. The approximate difference in cost between the compressor and pump is $2,860. Figure 1 shows 1,490 equivalent lbs. of vapor remaining in a 33,000 wg car; since our example tank car is only 11,000 wg, the remaining equivalent vapor is approximately 500 lbs.

$$\text{Number of Tank Cars} = \frac{\$2{,}860}{500 \text{ lbs. x } \$0.113} = 50$$

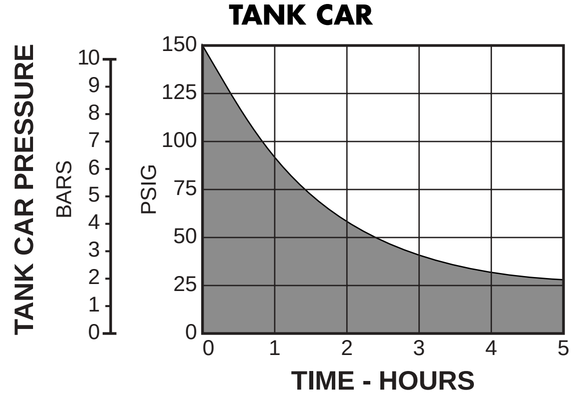
FIGURE 1

VAPOR LEFT IN A 33,000 WATER GALLON (124,905 LITER) CAPACITY TANK CAR EXPRESSED IN LIQUID CAPACITY

TANK CAR PRESSURE PSIG (BARS)[1]	GALLONS (LITERS) OF LP GAS[2]	POUNDS (KILOGRAMS) OF AMMONIA[2]
200 (13.79)	—	2,090 (948)
175 (12.06)	1,170 (4428)	1,790 (812)
150 (10.34)	970 (3671)	1,490 (676)
125 (8.61)	770 (2914)	1,190 (540)
100 (6.90)	570 (2157)	890 (404)
75 (5.17)	370 (1400)	590 (268)
50 (3.45)	170 (643)	290 (132)

NOTES:
1. This pressure is that of the tank car before vapor recovery operations are begun. Capacities are based upon recovering vapors to 25 psig (1.72 bars).
2. There are several different tank car and transport tank capacities. When the unloading tank is of different capacity than 33,000 gallons, the liquid recovery capacities shown here will be proportional. For example, if the tank car is only 11,000 water gallon capacity, the values shown here will be multiplied by 11,000 ÷ 33,000, or one third.

PROPANE EVACUATION TIME FOR 33,000 WATER GALLON (124,905 LITER) CAPACITY TANK CAR

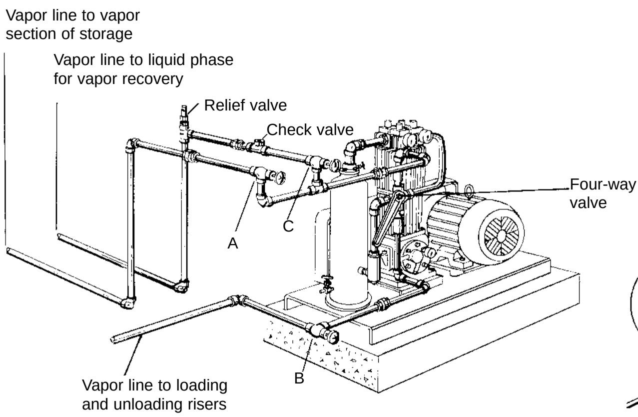


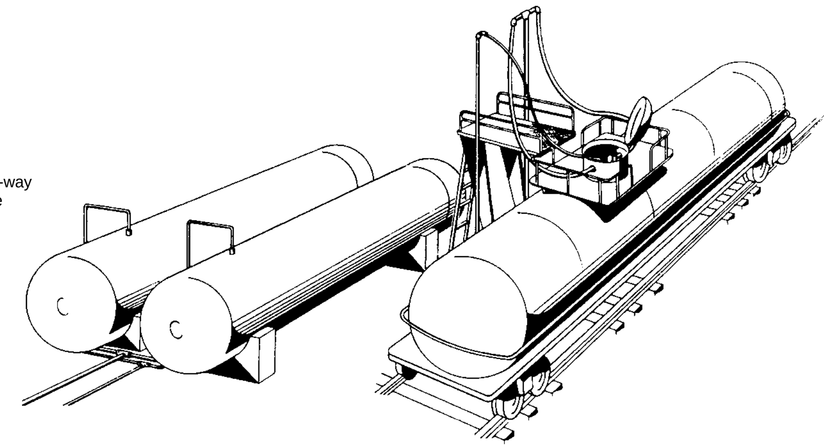
NOTES:
1. Economic recovery time is about three hours. More than half of economically recoverable vapor is removed in the first hour.
2. Vapor recovery is economic to about 25 percent of storage tank pressure.
3. Curve is based on the use of a 36 cfm (1,020 lit/min) displacement Corken dry-cylinder model 491 compressor recovering vapor through 1-1/2" vapor piping into 150 psig (10.34 bars) storage tank pressure.

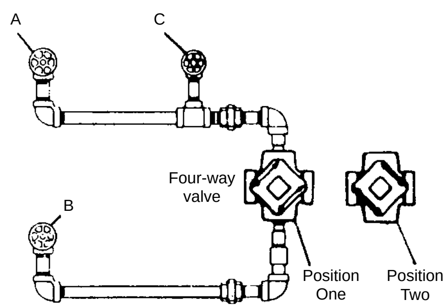
1 Guide to Compressor Selection

SIMPLIFIED BULK PLANT PIPING DETAILS

Installation piping details are available for the arrangement shown here or for larger and more complex operations.







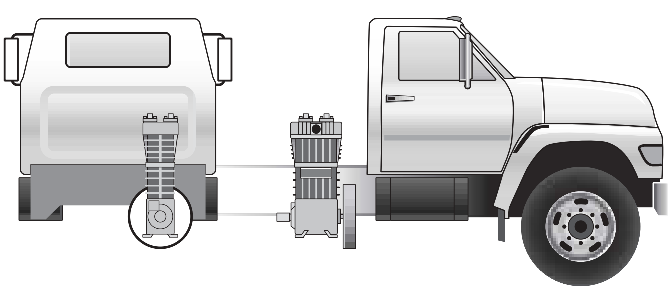
SERVICE TO PERFORM	VALVES			
	FOUR-WAY	A	B	C
1. Unload into Storage Tank	Position One	Open	Open	Close
2. Recover Vapors into Storage Tank	Position Two	Close	Open	Open
3. Load Out from Storage Tank	Position Two	Open	Open	Close

FIGURE 2

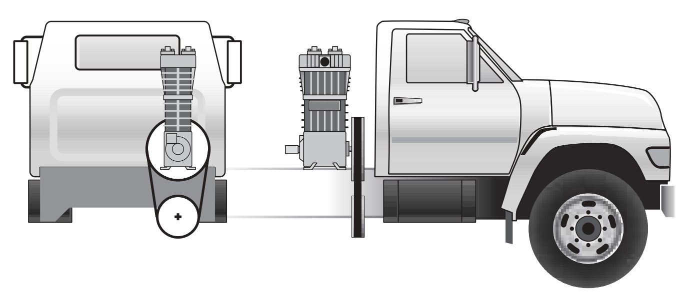
TYPICAL TRANSPORT MOUNTING ARRANGEMENT

Many companies increase their operating efficiency by equipping their transports with Corken compressors, enabling them to handle a greater variety of liquids with complete independence from the pumping facilities at the destination. The increased time savings in unloading pays for the compressor. Corken compressors often are mounted behind the tractor cab for direct drive from the truck power take off (PTO) or through a V-belt arrangement.

An engine driven compressor is used whenever it is impractical to use the truck engine, and it may be mounted anywhere on the cab or tanker.



DIRECT DRIVE MOUNTING: The compressor is hung inside the main truck frame in line with the PTO. Power is transmitted through a U-joint drive shaft directly to the compressor. Use extended crankshaft compressor models.



BELT DRIVE MOUNTING: The location of the fifth wheel and design of the tanks determine whether the compressor can be mounted behind the cab, above the frame, or outside the frame.

AMMONIA COMPRESSOR SELECTION TABLE

SERVICE	CAPACITY GPM (1)	DISPLACEMENT CFM	COMPRESSOR MODEL	COMPRESSOR RPM	DRIVER SHEAVE SIZE P.D. (2) 1750 RPM	DRIVER SHEAVE SIZE P.D. (2) 1450 RPM	DRIVER HORSEPOWER: LIQUID TRANSFER AND RESIDUAL VAPOR RECOVERY 100°F	DRIVER HORSEPOWER: LIQUID TRANSFER AND RESIDUAL VAPOR RECOVERY 80°F	DRIVER HORSEPOWER: LIQUID TRANSFER WITHOUT RESIDUAL VAPOR RECOVERY 100°F	DRIVER HORSEPOWER: LIQUID TRANSFER WITHOUT RESIDUAL VAPOR RECOVERY 80°F	PIPING SIZE (3) VAPOR	PIPING SIZE (3) LIQUID
UNLOADING SINGLE TANK CAR OR TRANSPORT	45	8	291	390	A 3.4	B 4.0	5	3	3	3	1	1-1/2
	50	9	291	435	A 3.8	B 4.6	5	5	3	3	1	1-1/2
	56	10	291	490	B 4.4	B 5.2	5	5	5	3	1	2
	62	11	291	535	B 4.8	B 5.8	7-1/2	5	5	5	1	2
	67	12	291	580	B 5.2	B 6.2	7-1/2	5	5	5	1	2
	72	13	291	625	B 5.6	B 6.6	7-1/2	5	5	5	1-1/4	2
	80	14	291	695	B 6.2	B 7.4	7-1/2	7-1/2	7-1/2	5	1-1/4	2
	85	15	291	735	B 6.6	B 8.0	10	7-1/2	7-1/2	7-1/2	1-1/4	2-1/2
	85	15	491	345	A 3.0	A 3.6	7-1/2	7-1/2	5	5	1-1/4	2-1/2
	90	16	291	780	B 7.0	B 8.6	10	7-1/2	7-1/2	7-1/2	1-1/4	2-1/2
	90	16	491	370	A 3.2	A 3.8	10	7-1/2	5	5	1-1/4	2-1/2
UNLOADING TWO OR MORE TANK CARS AT ONE TIME, OR LARGE TRANSPORT WITH EXCESS FLOW VALVES OF ADEQUATE CAPACITY	96	17	491	390	A 3.4	B 4.0	10	7-1/2	5	5	1-1/4	3
	102	18	491	415	A 3.6	B 4.4	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	107	19	491	435	A 3.8	B 4.6	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	110	20	491	445	B 4.0	B 4.8	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	115	21	491	470	B 4.2	B 5.0	10	7-1/2	7-1/2	7-1/2	1-1/4	3
	120	22	491	490	B 4.4	B 5.2	15	10	7-1/2	7-1/2	1-1/4	3
	126	23	491	515	B 4.6	B 5.6	15	10	7-1/2	7-1/2	1-1/4	3
	131	24	491	535	B 4.8	B 5.8	15	10	10	7-1/2	1-1/4	3
	138	25	491	560	B 5.0	B 6.0	15	10	10	7-1/2	1-1/4	3
	142	26	491	580	B 5.2	B 6.2	15	10	10	7-1/2	1-1/4	3
	148	27	491	605	B 5.4	B 6.4	15	10	10	10	1-1/4	3
	153	28	491	625	B 5.6	B 6.6	15	10	10	10	1-1/2	3
	160	29	491	650	B 5.8	B 7.0	15	15	10	10	1-1/2	3
	165	30	491	670	B 6.0		15	15	15	10	1-1/2	3
	165	30	691	400	B 4.4	B 5.2	15	15	10	10	1-1/2	3
	170	31	491	695	B 6.2	B 7.4	15	15	15	10	1-1/2	3
	173	31	691	420	B 4.6	B 5.6	15	15	10	10	1-1/2	3
	181	32	491	740	B 6.6	B 8.0	15	15	15	15	1-1/2	3
	180	32	691	440	B 4.8	B 5.8	15	15	10	10	1-1/2	3
	188	34	691	455	B 5.0	B 6.0	20	15	10	10	1-1/2	3
	195	35	691	475	B 5.2	B 6.2	20	15	10	10	1-1/2	3
	203	36	691	495	B 5.4	B 6.4	20	15	15	10	1-1/2	3
UNLOADING LARGE TANK CAR, MULTIPLE VESSELS, BARGES OR TERMINALS	211	38	691	510	B 5.6	B 6.8	20	15	15	10	1-1/2	4
	218	39	691	530	B 5.8	B 7.0	20	15	15	15	1-1/2	4
	226	41	691	550	B 6.0	A 7.0	20	15	15	15	1-1/2	4
	233	42	691	565	B 6.2	B 7.4	20	15	15	15	2	4
	240	43	691	585	B 6.4	A 7.4	20	20	15	15	2	4
	248	45	691	605	B 6.6	B 8.0	20	20	15	15	2	4
	255	45	691	620	B 6.8		25	20	15	15	2	4
	263	47	691	640	B 7.0	A 8.2	25	20	15	15	2	4
	278	48	691	675	B 7.4	B 8.6	25	20	15	15	2	4
	301	54	691	730	B 8.0	B 9.4	25	20	20	15	2	4
	323	58	691	785	B 8.6		30	25	20	20	2	4
	338	60	691	820	TB9.0	A 10.6	30	25	20	20	2	4
	459	82	D891	580	5V 7.1	5V 8.5	40	30	30	30	3	6
	630	113	D891	800	5V 9.75	5V 11.8		40	40	30	3	6

Consult factory for compressors for higher flows.

NOTES: 1. The capacities shown are based on 70°F, but will vary depending upon piping, fittings used, product being transferred and temperature. The factory can supply a detailed computer analysis if required.

2. Driver sheaves: 291, 491 - three belts; 691 - four belts

3. The piping sizes shown are considered minimum. If the length exceeds 100 ft., use the next larger size.

MOVING LIQUID WITH VAPOR

The most flexible method for moving liquid ammonia is with a compressor, a device designed to handle vapor and only vapor. How is this done? You will remember from the first chapter that creating a different pressure between two points may move any fluid, vapor or gas. A compressor may be used to create a pressure difference between the vapor spaces of two tanks. If the liquid spaces of the two tanks are connected, the pressure difference exerted by vapor will cause the liquid to begin flowing from the higher pressure tank to the lower pressure tank. Figure 2, page 18.

You will also remember that changes in internal pressure of an ammonia tank will result in condensation and boiling. Condensation and boiling will tend to negate the pressure difference created by the compressor. Liquid transfer using a compressor works because vapor may be moved more quickly than it boils off and condenses. The flow rate induced will equal the volume of gas discharged from the compressor if a large enough compressor is chosen to make the effect of boiling and condensation negligible. The pressure increase through the compressor will equal the pressure decrease due to friction in the liquid piping. Years of experience have shown that piping designed to create a pressure drop of 30 psi or less works best. Higher pressure drops result in more condensation and boiling and reduced flow rates due to reduced discharge volume.

Compressors may also be used to evacuate tanks. High pressure ammonia vapor in a large tank has substantial economic value that makes it worth recovering. Tanks that must be unloaded through a dip tube (such as most railroad tank cars) leave a small liquid puddle in the tank when liquid transfer is complete. A compressor can be used to reduce the pressure in the tank to boil the puddle into recoverable vapor. The vapor recondenses when it is fed into the liquid section of another ammonia tank (see Figure 3, Page 21).

Corken oil-free gas transfer compressors are the standard of the industry. Models FD291 / 491 are popular for truck unloading and unloading small railroad cars. The model FD691 is suitable for unloading large railroad tank cars.

LIQUID TRANSFER AND VAPOR RECOVERY

Compressor size and speed selection is a highly inexact process with complex interactions of a number of different variables such as ambient temperature, pressure drops in liquid line and vapor suction line, solar radiation, precipitation, size of the tanks and the surface area of the tank and piping. With this many variables, the exact performance of the compressor cannot be precisely calculated. Corken's Compressor Selection Table, on page 19, is a fast and easy method to make an approximate selection for ammonia compressors. The chart shows flows for different Corken compressors run at different speeds with a maximum tank temperature of 100°F and 80°F with a 30 psi pressure drop in the piping. In only the most extreme temperature conditions will tank temperatures exceed 100°F. A large tank heats up and cools down much more slowly than the surrounding atmosphere. Although temperatures may frequently exceed 100°F on hot summer afternoons, tank temperatures will seldom rise this high. Therefore, the horsepower values shown in the charts are very conservative and may be lowered for milder climates. Your local Corken distributor is usually the best source of information for ideal motor sizes for the climate in your region. Corken supplies a computer analysis showing the capacity and horsepower required for different tank temperatures.

If it is important that unloading operations must be complete in a certain amount of time, a more complex analysis is required. When such an analysis is required, contact Corken so a factory application engineer may thoroughly review the application. By inputting the tank size, pressure drops, model number, speed and gas into a special computer program, Corken's application engineers can determine how the machine will perform over a wide temperature range with reasonable accuracy. Such an analysis is shown in Figures 4 and 5, pages 23 and 24. This analysis is divided into three parts that clearly demonstrate how temperature affects flow rates and vapor recovery time.

The highest liquid flow rates are achieved on hot days. This is because the pressure drop in the piping remains relatively constant as the temperature changes while the vapor pressure swings over a wide pressure range. The vapor pressure of ammonia is 30 psia at 0°F and 247 psia at 110°F. The discharge pressure, P2, is the product vapor pressure plus the system differential pressure. In Figure 4, page 23, the 30 psi pressure drop is added to the vapor pressure (VP) to yield the discharge pressure shown in column P2. You will notice that the compression ratio (the absolute inlet vapor pressure divided by the absolute discharge pressure) rises as the temperature falls. As the compression ratio rises with falling temperature, the gas passing through the compressor is squeezed into a smaller and smaller discharge volume. As the volume at the discharge of the compressor is reduced, the amount of liquid displaced by the vapor is also reduced.

LIQUID TRANSFER AND VAPOR RECOVERY

FIGURE 2 LIQUID TRANSFER

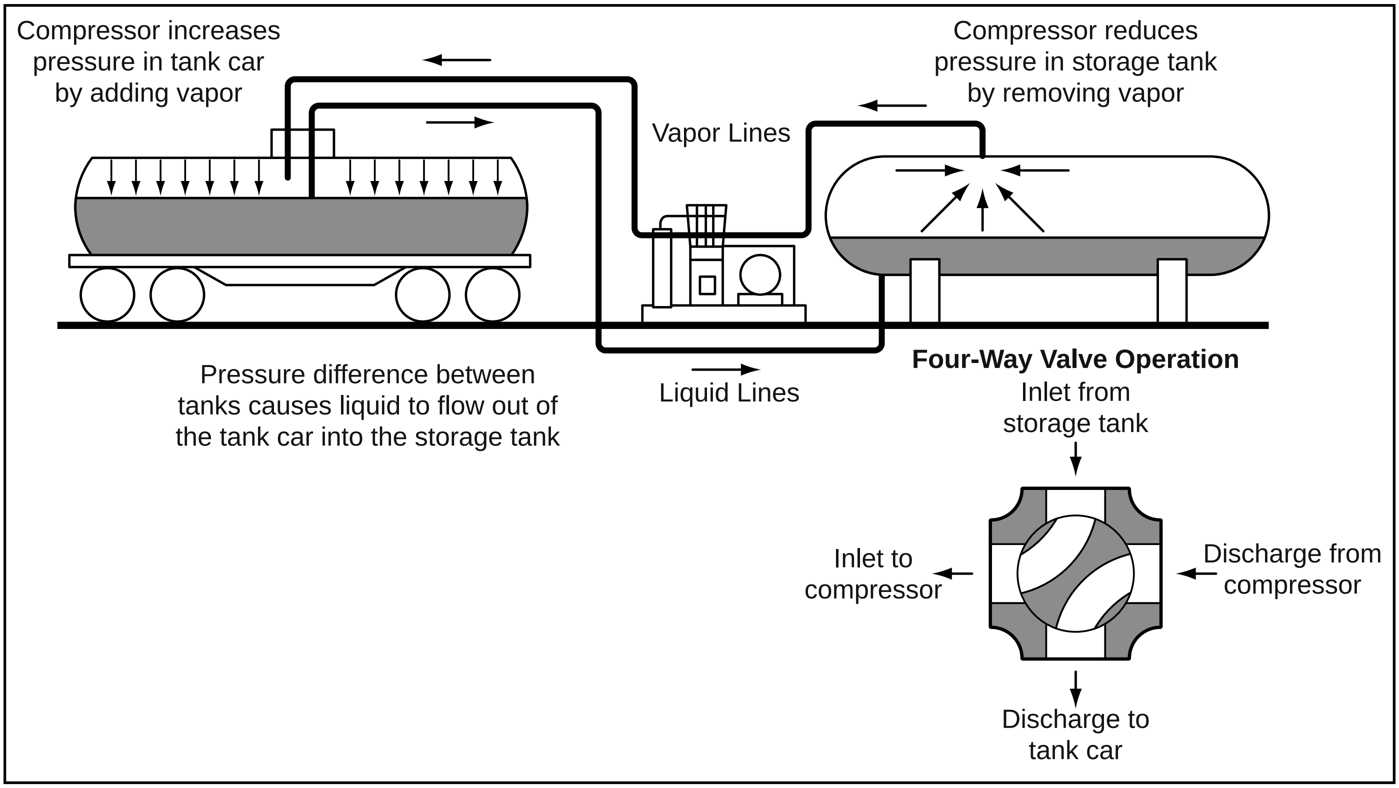
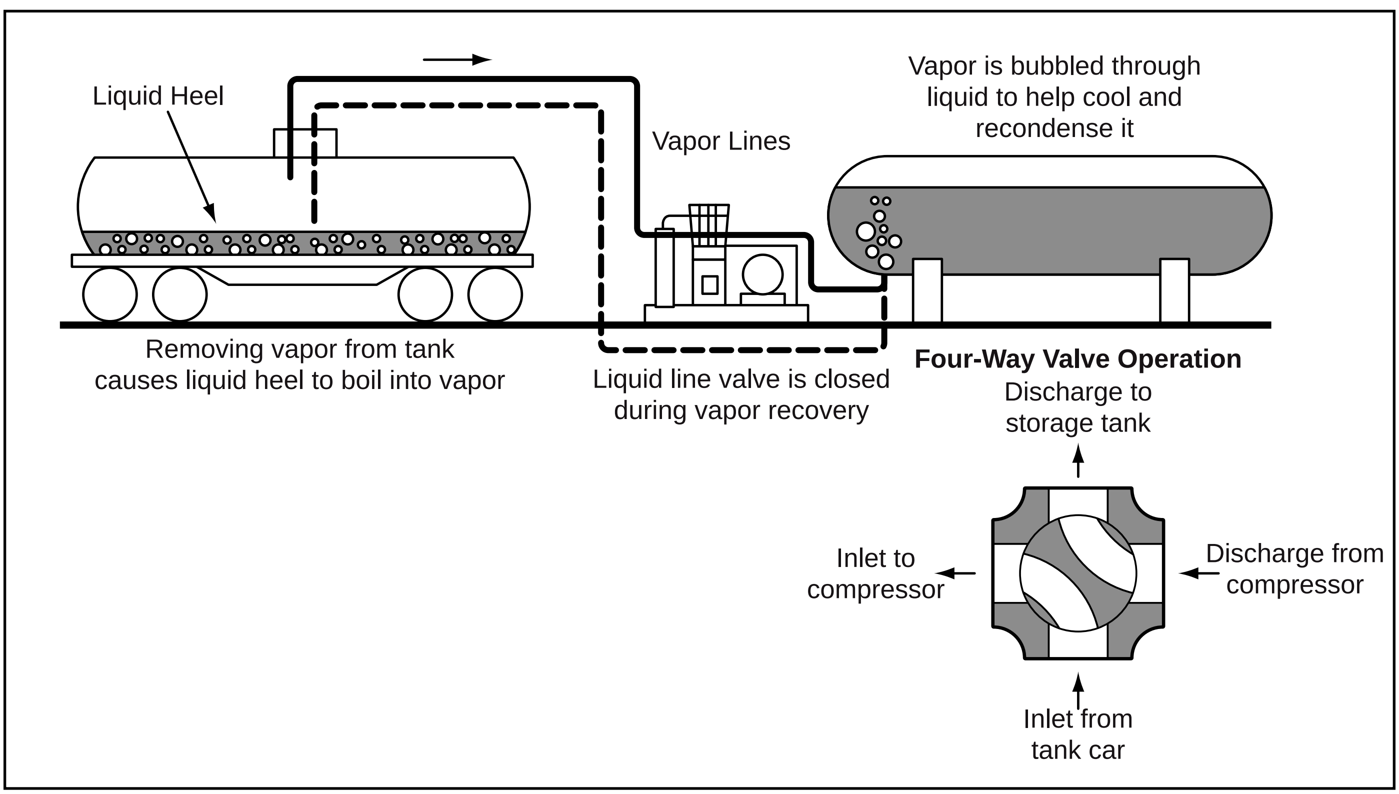


FIGURE 3 VAPOR RECOVERY



LIQUID TRANSFER AND VAPOR RECOVERY

When the liquid in a tank is unloaded through a dip tube, liquid transfer will cease when the liquid level falls beneath the bottom of this tube. The residual puddle is called a "liquid heel". By reversing the direction of vapor flow and blocking the liquid line as shown in Figure 3, page 18, this liquid may be recovered. By withdrawing vapor out of the tank, the liquid will begin to boil into vapor to replace the vapor being removed. This process is called "boil-out". Boil-out is completed most rapidly on hot days. The high vapor pressure on hot days gives the gas a higher density than on cold days. It takes a larger quantity of liquid to replace a cubic foot of high density vapor than low density vapor.

When boil-out is completed a substantial amount of gas is left in the tank in a vapor state. This vapor is equivalent to a substantial amount of liquid of significant economic value. As a rule of thumb in the industry, tank cars should be evacuated to 40 psia. Alternately, a final evacuation pressure of 25 to 30 percent of original tank car pressure is a good value for most any liquid gas. Evacuation pressures lower than this will not pay for the energy required to run the compressor and generally should not be considered unless factors other than economics are being considered. The vapor recovery procedure requires the most time on hot days because of the high initial vapor pressure in the tank. The recovered vapor should be bubbled up through the liquid section of the receiver tank to recondense the vapor to liquid. The maximum horsepower requirement for the compressor occurs when the tank has been evacuated to approximately 50 percent of full vapor pressure. Larger motors are required to do vapor recovery in hot climates.

FIGURE 4 – LIQUEFIED GAS TRANSFER COMPRESSOR WORKSHEET – MODEL 491

LIQUID TRANSFER PHASE													
T1 °F	VP psia	P2 psia	T2 °F	CR	VE %	Z In	Z Out	ACFM In	ACFM Out	Lb/Hr Liquid	GPM	BHP	Time Min.
0	30	60	82	2.0	88	.97	.97	27.0	13.5	31,317	101	5.7	276
10	39	69	78	1.8	90	.96	.96	27.4	15.5	35,930	116	6.2	241
20	48	78	78	1.6	91	.96	.95	27.6	17.0	39,481	127	6.6	219
30	60	90	79	1.5	91	.95	.95	27.9	18.6	43,111	139	7.0	201
40	73	103	82	1.4	92	.94	.94	28.0	19.9	46,087	149	7.4	188
50	89	119	86	1.3	92	.94	.93	28.1	21.1	48,852	157	7.9	177
60	108	138	91	1.3	92	.93	.92	28.2	22.1	51,296	165	8.4	169
70	129	159	97	1.2	93	.92	.91	28.3	23.0	53,312	172	8.9	162
80	153	183	103	1.2	93	.91	.90	28.4	23.7	55,042	177	9.5	157
90	181	211	110	1.2	93	.90	.89	28.4	24.4	56,554	182	10.1	153
100	212	242	118	1.1	93	.88	.88	28.4	24.9	57,813	186	10.8	150
110	247	277	126	1.1	93	.87	.87	28.5	25.4	58,888	190	11.5	147

RPM: 700

PD: 30.5

MAWP: 335 psia

Tank Volume: 33,000 Gallons and is 85 percent full

Gas: Anhydrous Ammonia (NH_3)

n: 1.31

Molecular weight: 17.03

Critical pressure: 1,636 psia

Critical temperature: 730° R

30 psi drop in liquid transfer system

Total liquid volume transferred = 27,885 gallons (84.5 of total tank volume)

Liquid heel: 165 gallons (0.5 percent of total tank volume)

35 psia desired evacuation pressure

8 psi drop in vapor recovery system

BOIL-OFF PHASE												
T1 °F	VP psia	P2 psia	T2 °F	CR	VE %	Z In	Z Out	Equiv. Vapor ACFM In	Liquid Rec. Vol Ft3	Rate GPM	BHP	Time Min.
0	30	38	26	1.3	93	.97	.97	28.5	7,994	1	3.8	281
10	39	47	31	1.2	94	.96	.96	28.6	6,242	1	4.1	218
20	48	56	38	1.2	94	.96	.96	28.6	5,150	1	4.3	180
30	60	68	45	1.1	94	.95	.95	28.7	4,174	1	4.7	146
40	73	81	52	1.1	94	.94	.94	28.7	3,475	1	5.0	121
50	89	97	60	1.1	94	.94	.93	28.7	2,882	2	5.4	100
60	108	116	69	1.1	94	.93	.93	28.7	2,397	2	5.8	83
70	129	137	78	1.1	94	.92	.92	28.7	2,024	2	6.2	70
80	153	161	87	1.1	94	.91	.91	28.7	1,719	3	6.8	60
90	181	189	96	1.0	94	.90	.89	28.7	1,461	3	7.3	51
100	212	220	105	1.0	94	.88	.88	28.7	1,253	4	8.0	44
110	247	255	114	1.0	94	.87	.87	28.7	1,079	4	8.6	38

VAPOR RECOVERY PROCESS												Equiv. Liquid (gal)					
T1 °F	VP psia	P2 psia	T2 °F	VE% Initial	VE% Final	ACFM Initial	ACFM Final	Z in Initial	Z in Final	P1 VE VE=0	P1 at Max VHP	Actual	Recovered	Claimable	BHP Max	Time Min.	Total Time Hrs.
10	39	47	31	94	94	28.6	28.6	.96	.96	2	39	116.6	22.7	109.7	4.1	33	8.2
20	48	56	64	94	92	28.6	28.1	.96	.97	3	39	141.4	49.1	133.3	5.1	46	7.4
30	60	68	97	94	90	28.7	27.5	.95	.97	3	40	174.4	81.7	164.7	6.1	79	7.1
40	73	81	132	94	88	28.7	26.8	.94	.97	4	40	209.5	118.3	198.3	7.1	110	7.0
50	89	97	169	94	85	28.7	26.1	.94	.97	5	40	252.6	162.0	239.4	8.1	142	7.0
60	108	116	207	94	83	28.7	25.2	.93	.97	6	49	303.7	213.3	288.2	9.3	174	7.1
70	129	137	247	94	80	28.7	24.3	.92	.98	7	59	359.6	270.1	341.6	10.5	206	7.3
80	153	161	287	94	76	28.7	23.3	.91	.98	8	70	423.4	334.5	402.6	12.0	238	7.6
90	181	189	358	94	68	28.7	20.9	.90	.98	10	83	498.2	421.7	474.3	13.7	272	7.9
100	212	220	399	94	64	28.7	19.6	.88	.98	11	99	580.9	503.5	553.6	15.6	307	8.3
110	247	255	440	94	60	28.7	18.3	.87	.98	13	116	674.9	596.0	643.6	17.7	344	8.8

Assumptions of Calculations:
1. Pressure drops remain constant.
2. Induced flow based on isothermal compression.
3. BHP and temperature are based on adiabatic compression.
4. Compressibility effects are considred in calculations.
5. Heat transfer is sufficient to maintain constant tank temperature during boil-out.

FIGURE 5 – LIQUEFIED GAS TRANSFER COMPRESSOR WORKSHEET – MODEL 691

RPM: 775

PD: 57.1

MAWP: 335 psia

Tank Volume: 33,000 Gallons and is 85 percent full

Gas: Anhydrous Ammonia (NH_3)

n: 1.31

Molecular weight: 17.03

Critical pressure: 1,636 psia

Critical temperature: 730° R

30 psi drop in liquid transfer system

Total liquid volume transferred = 27,885 gallons (84.5 of total tank volume)

Liquid heel: 165 gallons (0.5 percent of total tank volume)

35 psia desired evacuation pressure

8 psi drop in vapor recovery system

LIQUID TRANSFER PHASE

T1 °F	VP psia	P2 psia	T2 °F	CR	VE %	Z In	Z Out	ACFM In	ACFM Out	Lb/Hr Liquid	GPM	BHP	Time Min.
0	30	60	82	2.0	86	.97	.97	48.9	24.5	56,781	183	10.4	152
10	39	69	78	1.8	88	.96	.96	50.0	28.3	65,594	211	11.1	132
20	48	78	78	1.6	89	.96	.95	50.7	31.2	72,388	233	11.7	120
30	60	90	79	1.5	90	.95	.95	51.3	34.2	79,337	256	12.3	109
40	73	103	82	1.4	91	.94	.94	51.7	36.6	85,038	274	12.9	102
50	89	119	86	1.3	91	.94	.93	52.0	38.9	90,338	291	13.5	96
60	108	138	91	1.3	92	.93	.92	52.3	40.9	95,026	306	14.2	91
70	129	159	97	1.2	92	.92	.91	52.5	42.6	98,893	319	14.8	87
80	153	183	103	1.2	92	.91	.90	52.7	44.0	102,213	329	15.6	85
90	181	211	110	1.2	93	.90	.89	52.8	45.3	105,117	339	16.4	82
100	212	242	118	1.1	93	.88	.88	52.9	46.3	107,535	347	17.2	80
110	247	277	126	1.1	93	.87	.87	53.0	47.2	109,600	353	18.1	79

BOIL-OFF PHASE

T1 °F	VP psia	P2 psia	T2 °F	CR	VE %	Z In	Z Out	Equiv. Vapor ACFM In	Liquid Rec. Vol Ft3	Rate GPM	BHP	Time Min.
0	30	38	26	1.3	93	.97	.97	52.8	7,994	1	7.0	151
10	39	47	31	1.2	93	.96	.96	53.1	6,242	1	7.3	118
20	48	56	38	1.2	93	.96	.96	53.2	5,150	2	7.6	97
30	60	68	45	1.1	94	.95	.95	53.4	4,174	2	8.0	78
40	73	81	52	1.1	94	.94	.94	53.4	3,475	3	8.4	65
50	89	97	60	1.1	94	.94	.93	53.5	2,882	3	8.8	54
60	108	116	69	1.1	94	.93	.93	53.5	2,397	4	9.3	45
70	129	137	78	1.1	94	.92	.92	53.6	2,024	4	9.9	38
80	153	161	87	1.1	94	.91	.91	53.6	1,719	5	10.5	32
90	181	189	96	1.0	94	.90	.89	53.6	1,461	6	11.2	27
100	212	220	105	1.0	94	.88	.88	53.6	1,253	7	12.0	23
110	247	255	114	1.0	94	.87	.87	53.5	1,079	8	12.8	20

VAPOR RECOVERY PROCESS

T1 °F	VP psia	P2 psia	T2 °F	VE% Initial	VE% Final	ACFM Initial	ACFM Final	Z in Initial	Z in Final	P1 VE VE=0	P1 at Max VHP	Equiv. Liquid (gal) Actual	Equiv. Liquid (gal) Recovered	Equiv. Liquid (gal) Claimable	BHP Max	Time Min.	Total Time Hrs.
10	39	47	31	93	93	53.1	53.1	.96	.96	3	39	116.6	21.0	106.9	7.3	16	4.4
20	48	56	62	93	91	53.2	51.9	.96	.97	4	39	141.4	45.8	130.0	9.0	25	4.0
30	60	68	93	94	89	53.4	50.6	.95	.97	5	41	174.4	76.7	160.9	10.8	43	3.8
40	73	81	125	94	86	53.4	49.1	.94	.97	6	42	209.5	111.7	193.8	12.6	60	3.8
50	89	97	184	94	80	53.5	45.5	.94	.97	7	43	252.6	168.8	234.2	14.4	78	3.8
60	108	116	219	94	76	53.5	43.5	.93	.98	8	52	303.7	217.9	282.0	16.4	97	3.9
70	129	137	255	94	72	53.6	41.3	.92	.98	10	63	359.6	272.2	334.4	18.5	115	4.0
80	153	161	291	94	68	53.6	39.1	.91	.98	11	75	423.4	334.1	394.5	21.0	134	4.2
90	181	189	352	94	60	53.6	34.1	.90	.98	13	75	498.2	416.9	464.7	23.9	155	4.4
100	212	220	387	94	55	53.6	31.6	.88	.98	16	89	580.9	496.3	542.2	27.1	177	4.7
110	247	255	443	94	47	53.5	26.5	.87	.98	19	105	674.9	594.4	630.4	30.7	202	5.0

Assumptions of Calculations:

1. Pressure drops remain constant.
2. Induced flow based on isothermal compression.
3. BHP and temperature are based on adiabatic compression.
4. Compressibility effects are considred in calculations.
5. Heat transfer is sufficient to maintain constant tank temperature during boil-out.

COMPRESSOR FOUNDATION DESIGN

Corken vertical compressors are similar in many ways to the small vertical lubricated compressors that have been used for years. However, Corken oil-free compressors are, by design, much taller than most other compressor types. This also means that the vertical center of gravity is considerably higher. These factors amplify the magnitude of any vibration present, and must be considered when selecting a mounting location for your compressor.

Corken recommends securing the compressor on a concrete pad or sturdy structural steel mounting base.

Most Corken units do fine with the baseplate mounted directly to a solid reinforced concrete slab. Special attention should be given to the large vertical compressors (models 591, 691, 791, and 891). These units require very firm foundations due to their vertical height. The HG600 series is a horizontal balanced-opposed unit, but we suggest that the same foundation guidelines be followed.

Generally speaking, the larger the foundation, the less likely you are to have vibration or shaking problems.

Permanent anchor bolts or “J” bolts embedded in the foundation will usually provide excellent stability. Grouting the baseplate into your foundation and checking the mounting bolts for tightness at frequent intervals is highly recommended.

As a rule of thumb, when preparing the foundation, the mounting slab should be a minimum of eight inches thick, with the overall length and width four inches longer and wider on each side of the baseplate.

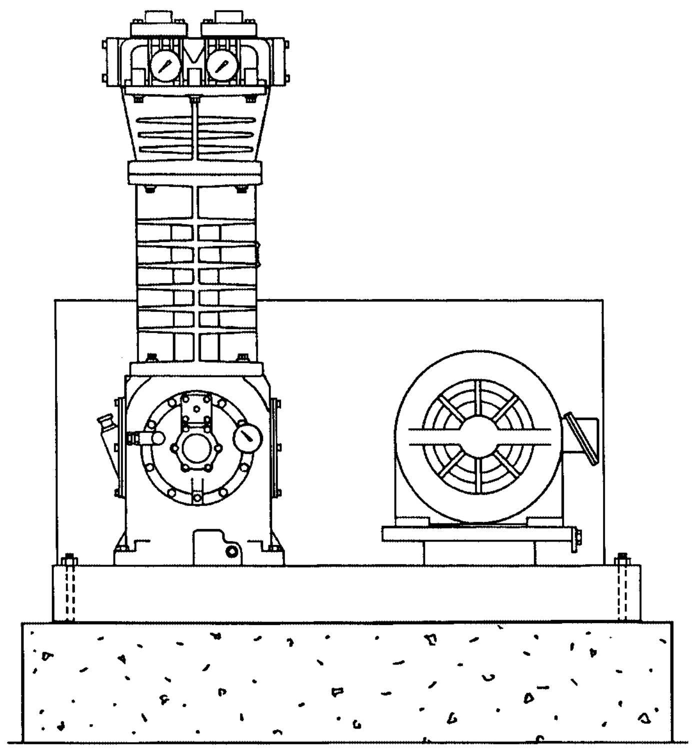
The following illustrations show some basic guidelines to follow. The mounting variations shown are guidelines only. A properly engineered foundation should be installed before putting your new compressors into service. A special baseplate is required on some of the illustrations.

IMPORTANT: Any proposed isolation mounting arrangement must be properly engineered. Failure to do so will most likely increase the severity of the problem.

The compressor must not support any significant piping weight, so the piping must be properly supported. The use of flexible connections at the compressor is highly recommended. Rigid, unsupported piping combined with a poor foundation will result in severe vibration problems.

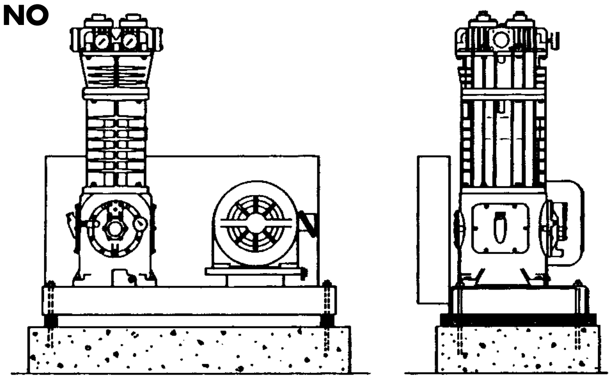
Corken baseplates come with anchor-bolt mounting holes. Use all mounting holes when installing baseplates.

If you have any questions about the compressor foundation for your installation, please feel free to contact Corken.



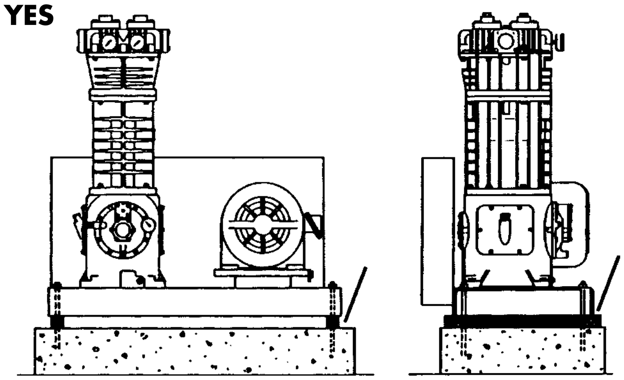
COMPRESSOR FOUNDATION DESIGN

1. NO



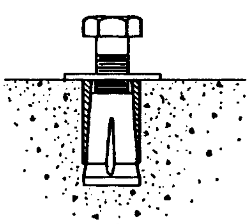
Do not suspend baseplate with spacers or shims allowing support only at the anchor bolts.

2. YES

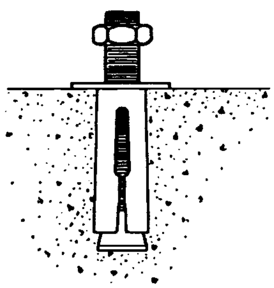


Support entire length of base to slab. Some shims may be required on an unlevel slab.

3. NO

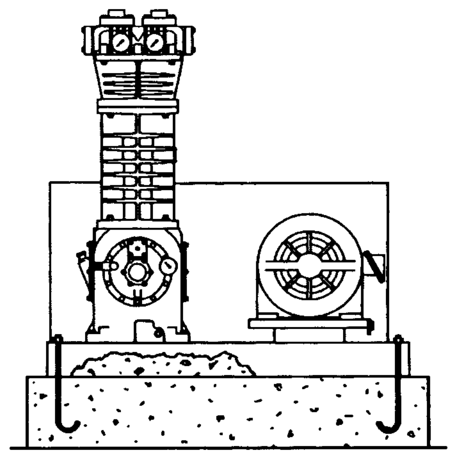


Lead anchors will not hold permanently.



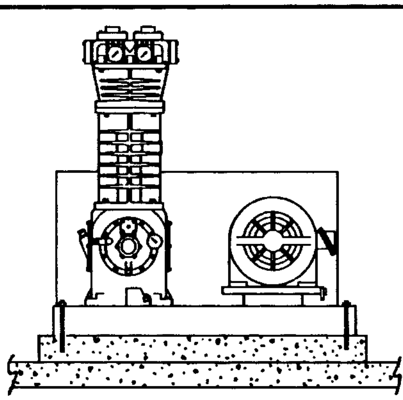
If anchors must be used, they should be the type with a steel stud and sleeve.

4. YES



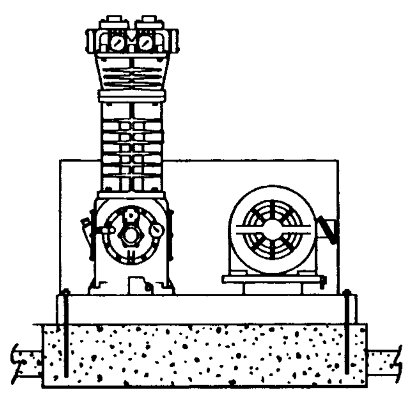
Permanent anchor bolts imbedded in the concrete slab is a very good installation method. Grouting the baseplate to the slab is highly recommended.

5. NO



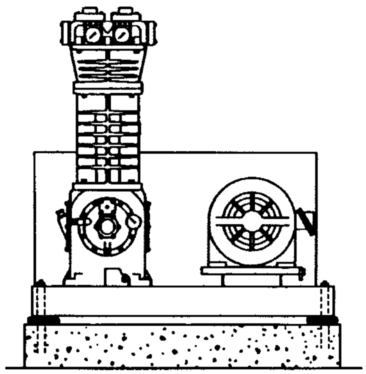
Anchors or lags with a shallow mounting will pull loose. Be sure the existing floor is solid (special consideration should be given to units on suspended floors).

6. YES



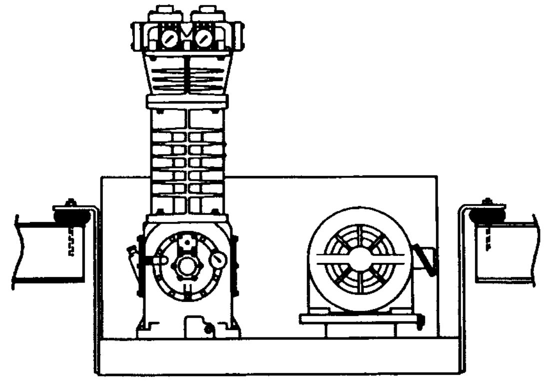
If the existing floor is too weak to support compressor mounting, cut out the existing floor and mount a separate foundation directly on the ground.

7. NO



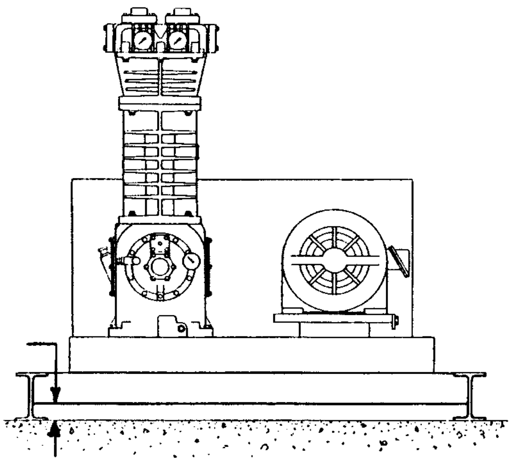
Rubber mounts or pads are generally not recommended.

8. YES



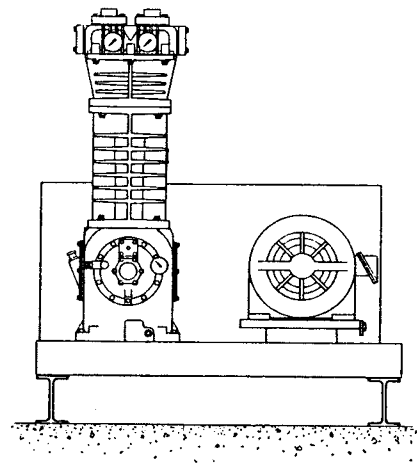
NOTE: A special rigid baseplate is required on this mounting. Installing mounts at the compressor's center of gravity is effective on smaller units (models 91 - 491).

9. NO



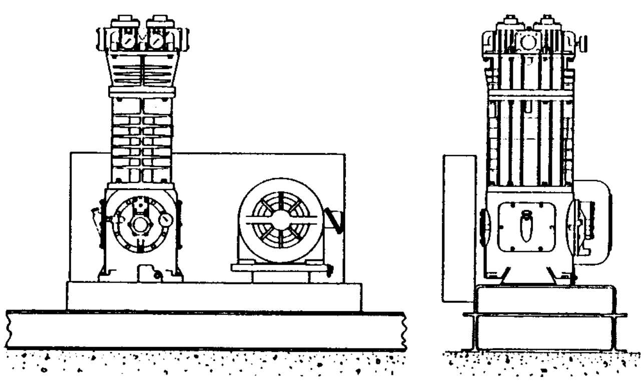
If skid mounting, do not mount the compressor assembly on shallow beams or angle iron.

10. NO



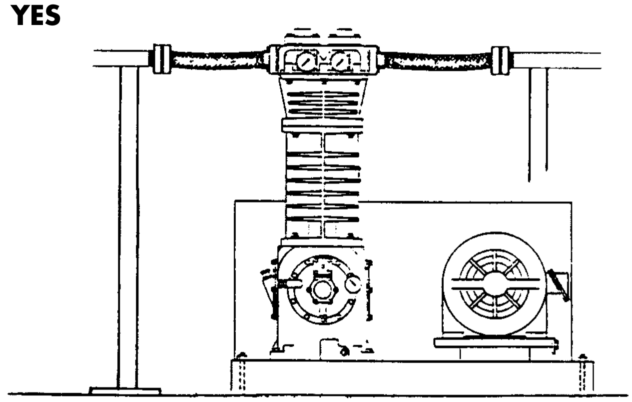
Do not mount the compressor assembly across beams without center support.

11. YES



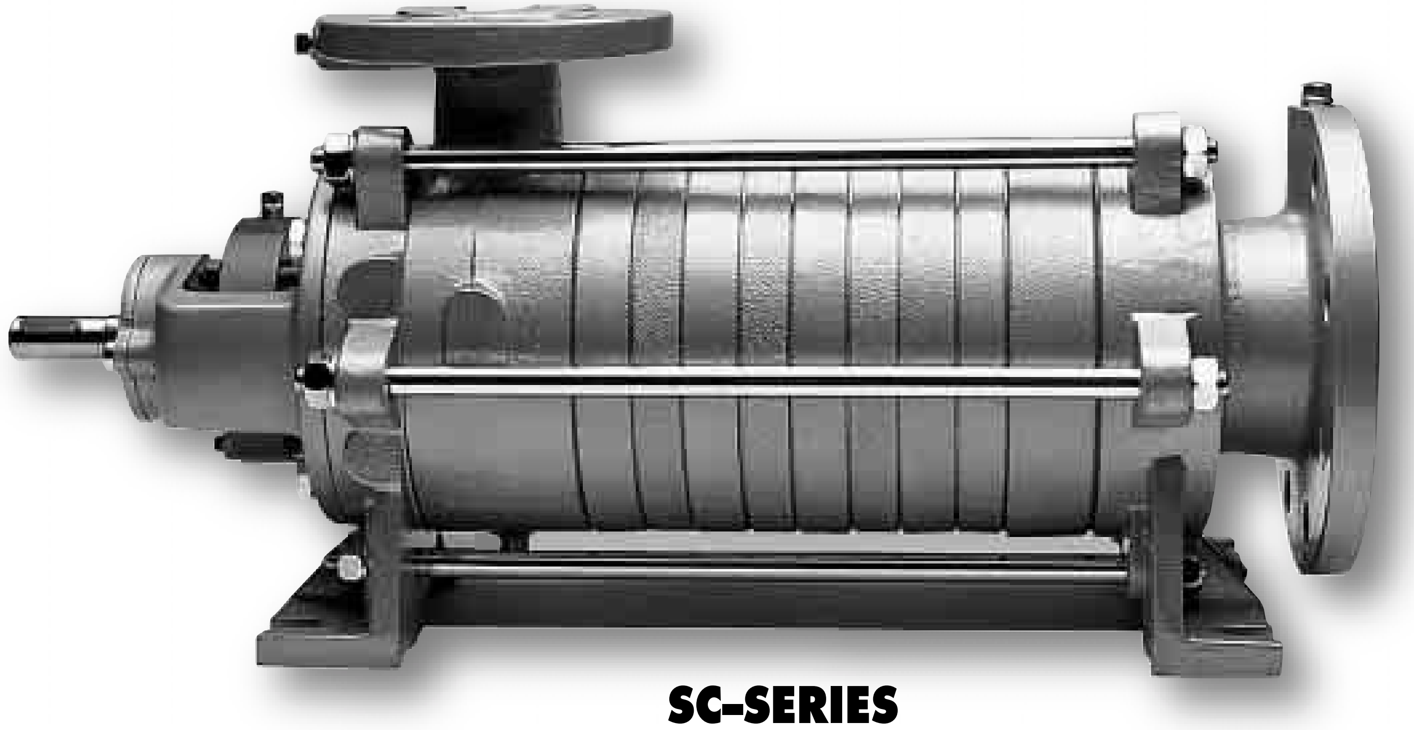
Mount the baseplate so that the beam or channel provides support along the entire length of the baseplate.
NOTE: Crossbeams should be full depth of main beams. The baseplate is normally welded to the skid directly over the vertical web of the support beam.

12. YES



The compressor must not support any significant piping weight, so the piping must be properly supported. The use of flexible connections at the compressor is highly recommended. Rigid, unsupported piping combined with a poor foundation will result in severe vibration problems.

Guide to Pump Selection 2



SC-SERIES

SC-SERIES SIDE CHANNEL PUMPS

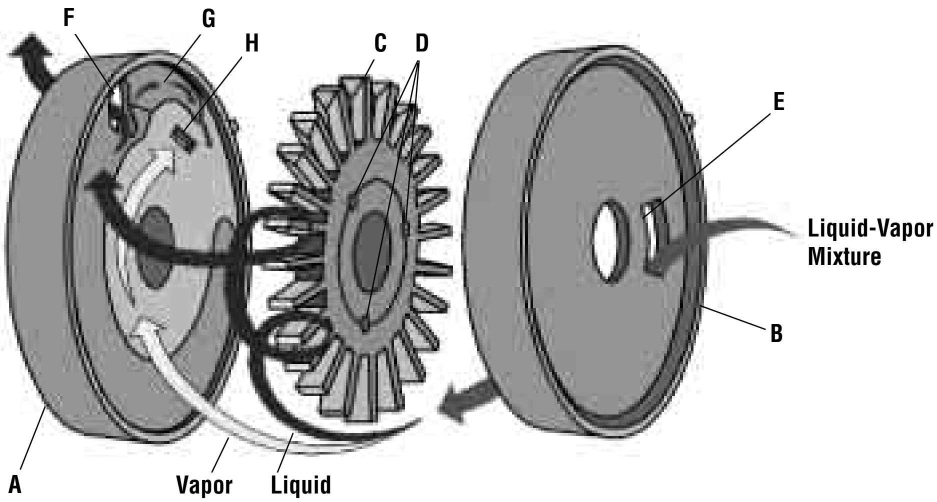
Corken's side channel (sc-series) product line is the optimal offering for ammonia transfer. This continuous duty pump, which operates at lower speeds than most impeller designs, will allow for a high percentage of entrained vapor (up to 50 percent) and is extremely forgiving when inlet conditions are questionable ($NPSH_r$ as low as 1 ft.).

In addition to being suitable for continuous duty operation, this pump is also capable of differential pressures up to 325 psi for anhydrous ammonia. While many pump designs will not offer a sealless option for liquefied gas applications, our side channel magnetic drive (scm) pump is not only suitable for liquefied gas transfer, it will also operate under the same extreme inlet conditions as the sealed model.

SPECIFICATIONS	MODEL					
	10	20	30	40	50	60
Number of Stages	1 to 8					
Inlet Flange inches (mm)	1-1/2 (40)	2-1/2 (65)	2-1/2 (65)	3 (80)	4 (100)	4 (100)
Outlet Flange inches (mm)	3/4 (20)	1-1/4 (32)	1-1/4 (32)	1-1/2 (40)	2 (50)	2-1/2 (65)
RPM-60 hz	1150/1750	1150/1750	1150/1750	1150/1750	1150/1750	1150/1750
RPM-50 hz	1450	1450	1450	1450	1450	1450
Maximum Working Pressure psig (bar)	580 (40)	580 (40)	580 (40)	580 (40)	580 (40)	580 (40)
Differential Pressure* Range psi (bar)	7 (.5) 200 (14)	7 (.5) 325 (21)	4 (.3) 240 (16)	7 (.5) 230 (16)	7 (.5) 230 (16)	7 (.5) 230 (16)
Min. Temp. °F (°C)	-40° (-40°)	-40° (-40°)	-40° (-40°)	-40° (-40°)	-40° (-40°)	-40° (-40°)
Max. Temp. °F (°C)	428° (220°)	428° (220°)	428° (220°)	428° (220°)	428° (220°)	428° (220°)
NPSH Range ft (m)	1.0 (.3)	1.3 (.4)	1.0 (.3)	1.0 (.3)	1.0 (.3)	1.0 (.3)
	13 (4)	3.3 (1)	6.6 (2)	8.2 (2.5)	8.2 (2.5)	8.2 (2.5)
Maximum Viscosity ssu (cst)	1050 (230)	1050 (230)	1050 (230)	1050 (230)	1050 (230)	1050 (230)
Maximum Proportion of Gas Allowable	50%	50%	50%	50%	50%	50%
ANSI Flange Option	**	Yes	Yes	Yes	Yes	Yes
DIN Flange Option	Yes	Yes	Yes	Yes	Yes	Yes
Casing Material Options	Ductile Iron, Cast Iron, Stainless Steel					
Impeller Material Options	Bronze, Steel, Stainless Steel					
O-Ring Material Options	Neoprene®, Viton®, Teflon®, Ethylene-Propylene, Kalrez®					
Double Seal Option	Yes	Yes	Yes	Yes	Yes	Yes
Magnetic Drive Option	Yes	Yes	Yes	Yes	Yes	No
High Temp. Option	Yes	Yes	Yes	Yes	Yes	Yes
Internal Relief Option	No	No	No	No	No	No

* Above differential pressures are based on a .65 specific gravity.
** Consult Factory
Neoprene®, Viton®, Kalrez® and Teflon® are registered trademarks of the DuPont Company.

PRINCIPLE OF SIDE CHANNEL OPERATION



Item	Description
A	Discharge Stage Casing
B	Suction Stage Casing
C	Impeller
D	Equalization Holes
E	Inlet Port
F	Outlet Port
G	Mini-Channel
H	Secondary Discharge Port

The design of the side-channel pump allows for the transfer of liquid-gas mixtures with up to 50 percent vapor; therefore eliminating possible air or vapor locking that can occur in other pump designs. A special suction impeller lowers the NPSH requirement for the pump.

The side-channel pump design is similar to a regenerative turbine in that the impeller makes regenerative passes through the liquid. However, the actual design of the impeller and casing as well as the principles of operation differ greatly. The side-channel pump has a channel only in the discharge stage casing (A) and a flat surface which is flush with the impeller on the suction stage casing (B). A star-shaped impeller (C) is keyed to the shaft and is axially balanced through equalization holes (D) in the hub of the impeller.

The liquid or liquid/vapor mixture enters each stage of the pump through the inlet port (E). Once the pump is initially filled with liquid, the pump will provide a siphoning effect at the inlet port. The effect is similar to what happens in water ring pumps. The water remaining in the pump casing forms a type of water ring with a free surface. A venturi effect is created by the rotation of the impeller and the free surface of the water, thus pulling the liquid into the casing.

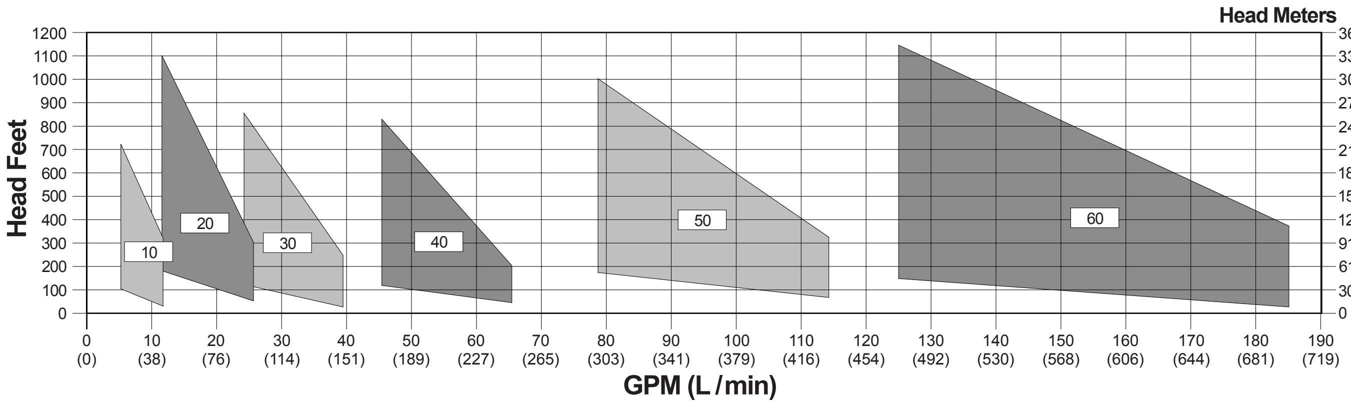
After the liquid is pulled through the inlet port, it is forced to the outer periphery of the impeller blade by centrifugal action. It is through this centrifugal action that the liquid is accelerated and forced into the side channel. The liquid then flows along the semicircular contour of the side channel from the outermost point to the innermost point until once again it is accelerated by the impeller blade. The liquid moves several times between the impeller and the side channel. Thus the rotating impeller makes several regenerative passes until the liquid reaches the outlet port. The speed of the impeller along with the centrifugal action impart energy to the liquid through the exchange of momentum, thus allowing the pump to build pressure.

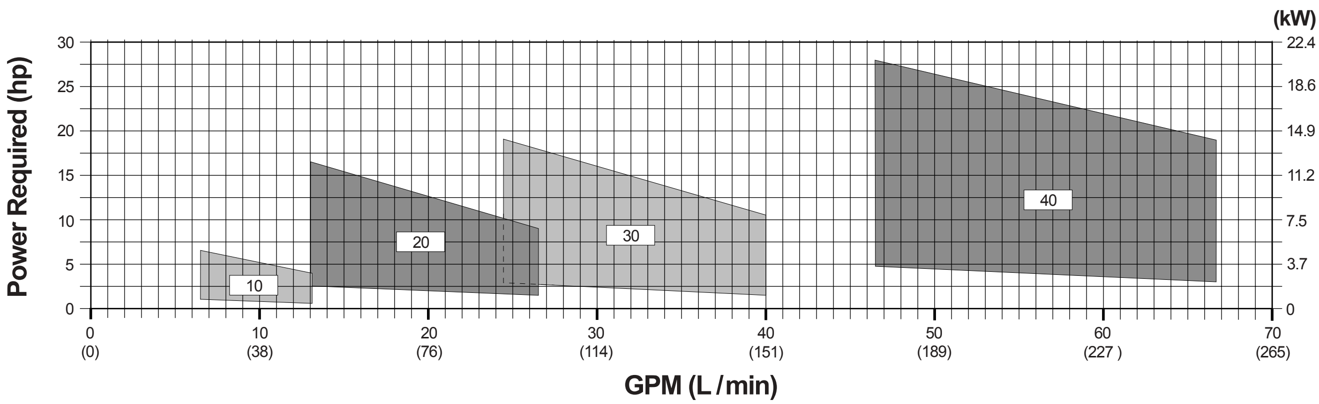
The side channel leads directly to the outlet port (F). At the outlet port, the main channel ends and a smaller minichannel (G) begins. At the point where the mini-channel ends, there is a small secondary discharge port (H) level with the base of the impeller blades.

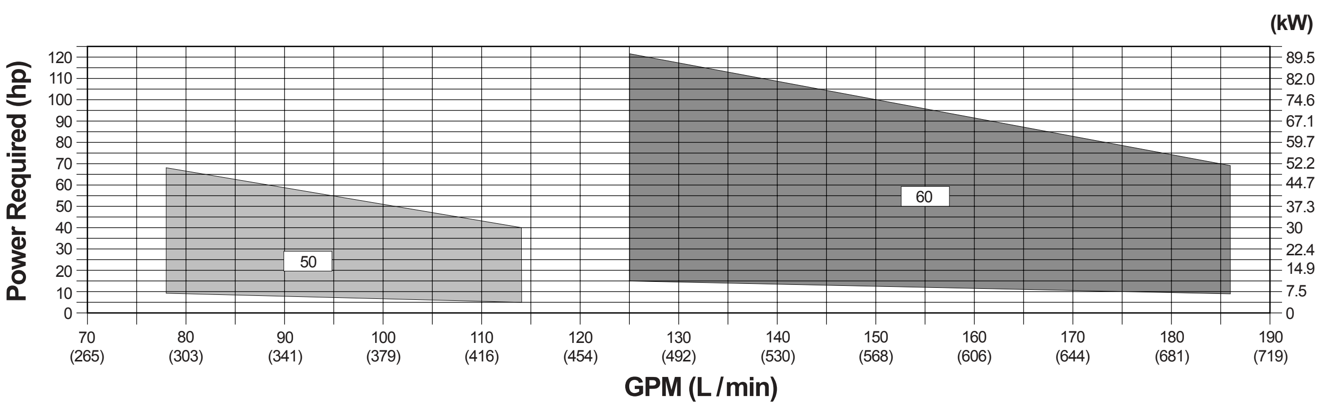
As the liquid is forced to the periphery through centrifugal action due to its density, the vapor within the liquid stream tends to remain at the base of the impeller blades since it has a much lower density. The main portion of liquid and possibly some vapor, depending on the mix, is discharged through the outlet port. A small portion of the liquid flow follows the mini-channel and eventually is forced into the area between the impeller blades. The remaining vapor which was not drawn through the outlet port resides at the base of the impeller blades. At the end of the mini-channel, as the liquid is forced into the area between the blades, the area between and around the impeller blade is reduced. The liquid between the blades displaces and thus compresses the remaining vapor at the base of the impeller blades. The compressed vapor is then forced through the secondary discharge port where it combines with the liquid discharged through the outlet port as it is pulled into the next stage or discharged from the pump. Thus entrained vapor is moved through each stage of the pump.

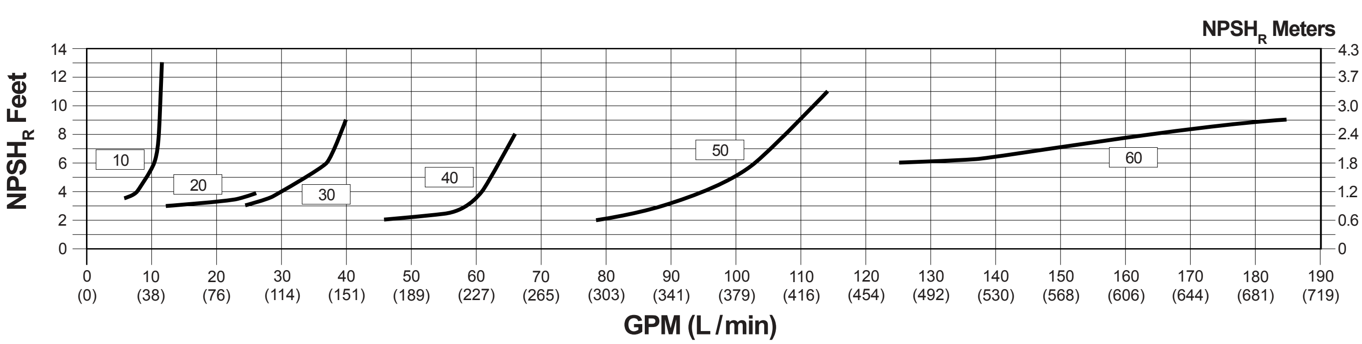
Each subsequent stage operates under the same principle. The number of stages can be varied to meet the required discharge head. When multiple stages are required, the relative positions of the stage outlet ports are radially staggered to balance shaft loads.

SC/SCM OVERVIEW GRAPH–1750 RPM

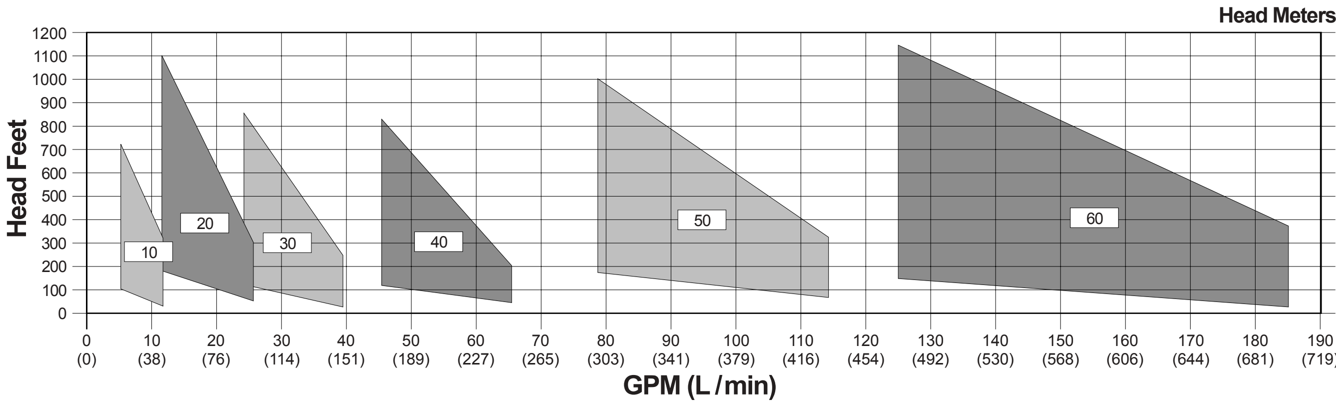


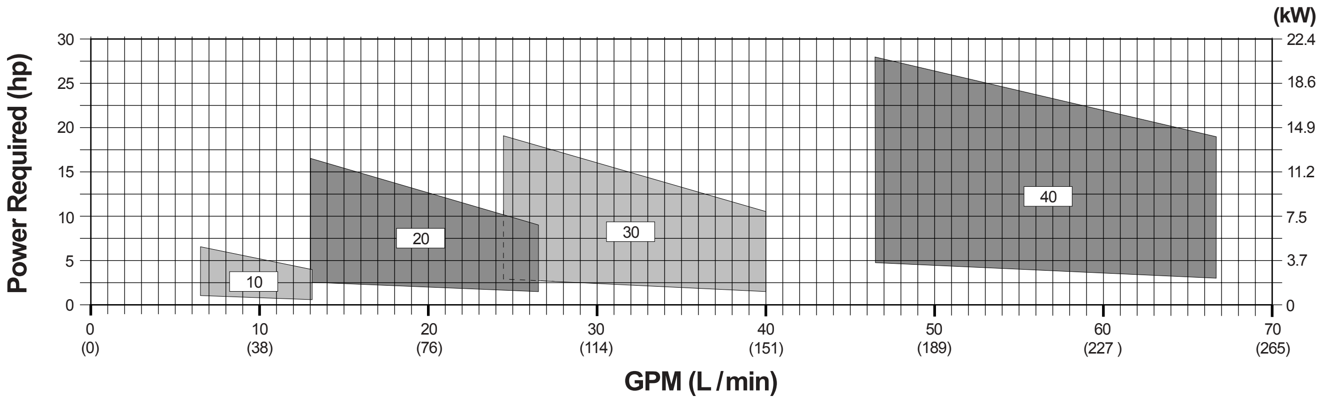


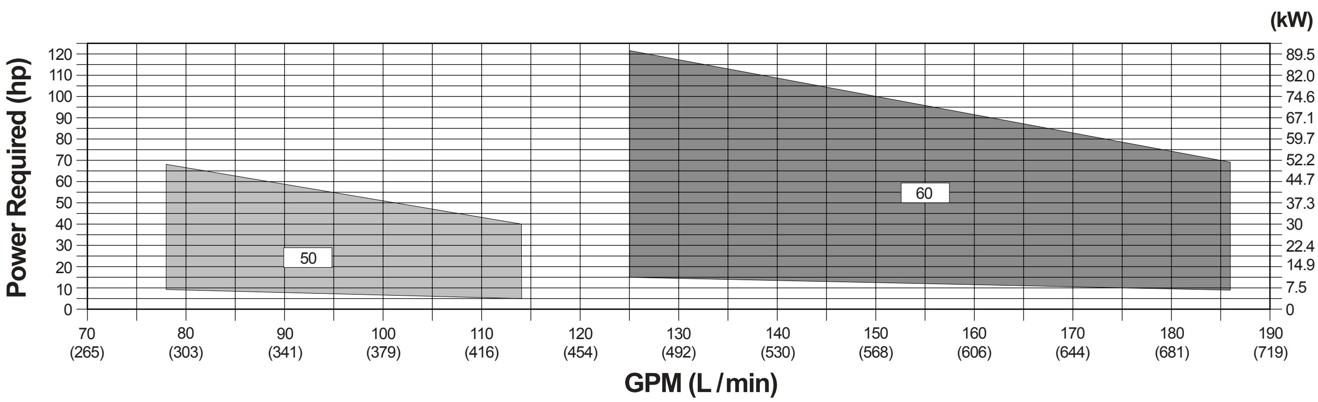


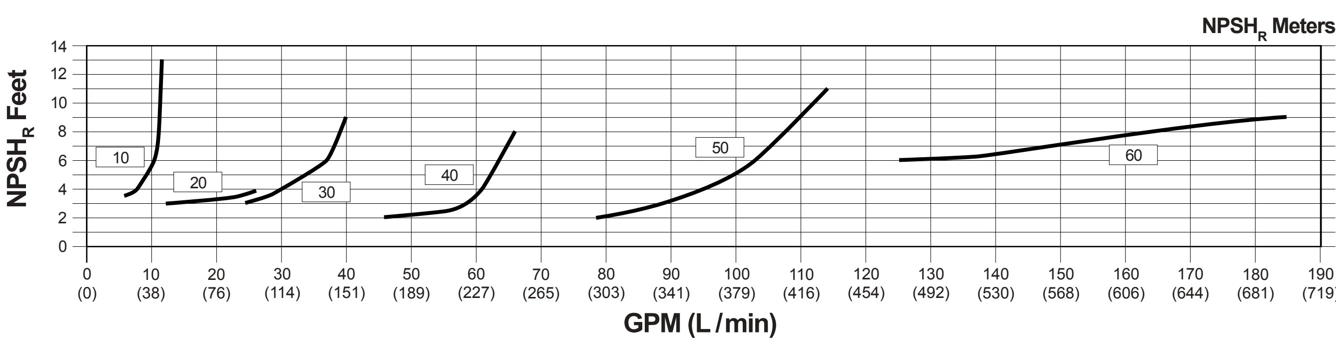


SC/SCM OVERVIEW GRAPH–1150 RPM









INSTRUCTIONS FOR SELECTION OF MECHANICAL SEAL MODEL

1. Turn to the performance curve page that corresponds with the pump series and speed that you noted from the overview on pages 31 & 32.

Series	1750 RPM	1150 RPM
10	page 36	page 37
20	page 38	page 39
30	page 40	page 41
40	page 42	page 43
50	page 44	page 45
60	page 46	page 47

2. Locate the differential head value (head feet = $\frac{\text{2.31 x psi (differential)}}{\text{specific gravity of liquid pumped}}$) on the left side of Graph 1.

   NOTE: Differential pressure = pump discharge pressure – pump inlet pressure.

3. From that point, move horizontally to the right until you intersect one of the eight diagonal lines. Move down vertically from the point of intersection to the bottom of the graph to determine if the flow rate at that point comes close to the desired flow rate. If it does not, continue horizontally from the current point of intersection until you reach the next diagonal line. Repeat until you determine which line most closely matches the desired flow at the required differential head. Make note of the number that corresponds with that particular line. This is the specific model that most closely meets your application.

4. From the point of intersection on Graph 1, move vertically down to Graph 2. Continue to move down until you intersect the diagonal line that corresponds with the specific model that you selected above.

5. From this point of intersection, move horizontally to the left side of the graph and note the horsepower value. Take this value and multiply it by the specific gravity of the liquid to be pumped. The value that you calculate is the brake horsepower required to operate this pump in the given application. You must select a motor with a horsepower greater than (or at a minimum equal to) this value.

6. Now proceed straight vertically down to Graph 3, the point on the NPSH line that corresponds with the flow rate that you determined the specific model would provide. Move horizontally to the left and note the value of NPSH required. This value must be less than the npsh available. If it is not, repeat procedures to try to locate a different model, or contact your distributor or Corken for assistance.

Guide to Pump Selection

INSTRUCTIONS FOR SELECTION OF MAGNETIC DRIVE MODEL

1. Turn to the performance curve page that corresponds with the pump series and speed that you noted from the overview on pages 31 & 32.

Series	1750 RPM	1150 RPM
10	page 36	page 37
20	page 38	page 39
30	page 40	page 41
40	page 42	page 43
50	page 44	page 45
60	page 46	page 47

2. Locate the differential head value on the left side of Graph 1.

3. From that point, move horizontally to the right until you intersect one of the eight diagonal lines. Move down vertically from the point of intersection to the bottom of the graph to determine if the flow rate at that point comes close to the desired flow rate. If it does not, continue horizontally from the current point of intersection until you reach the next diagonal line. Repeat until you determine which line most closely matches the desired flow at the required differential head. Make note of the number that corresponds with that particular line. This is the specific model that most closely meets your application.

4. From the point of intersection on Graph 1, move vertically down to Graph 2. Continue to move down until you intersect the diagonal line that corresponds with the specific model that you selected above.

5. From this point of intersection, move horizontally to the left side of the graph and note the horsepower value.

6. Multiply this value by the specific gravity of the liquid to be pumped to calculate the power demand of the pump.

7. Refer to the magnetic coupling selection table on page 34.

8. Find the row in table 1 listed as **MAXIMUM POWER DEMAND OF PUMP**. Proceed to the right until you locate a hp value **greater than** the power demand that you calculated in step 6.

9. Look at table 2 in the same column to see if there is a dot in the same row as the pump series that you have selected. If so, proceed to step 10. If not, repeat step 8 (continue to the right). Note: There are occasions when there is not a magnetic coupling with enough torque to handle a specific application. For this case, consider whether a sealed unit is acceptable or consult your distributor or the factory for advice.

10. Look at table 3 in the same column. Locate the maximum working pressure of the separation canister for the magnetic coupling at the temperature value that exceeds your operating temperature. This pressure value must be greater than the discharge pressure of your application. Note that the hastelloy canister at the bottom of table 3 offers higher pressure capabilities. When the discharge pressure of your application exceeds the maximum of the standard stainless canister.

11. Once you have located a magnetic coupling size that meets the above criteria, add the value in the **POWER LOSS** row (table 1) to your value calculated in step 6.

12. Select a motor size greater than the value just calculated, but no larger than the value in the row that is titled **MAXIMUM MOTOR SIZE**. Make note of the coupling size that you have selected.

13. Return to performance curve page, proceed straight down to graph 3. Find the point on the line that corresponds with the flow rate that you determined the specific model will provide. Move horizontally to the left and note the value of NPSH required. This value must be less than the NPSH available. If it is not, repeat procedures to try to locate a different model, or contact your distributor or Corken for assistance.

MAGNETIC COUPLING SELECTION TABLE

Table 1

Coupling Characteristics

Coupling Size	12	14	16	22	24	26	36	38
Maximum Power Demand of Pump (hp)	1.1	2.6	3.8	2.6	7.6	11.3	16.8	28.5
Power Loss in Magnet (hp)	0.2	0.3	0.3	0.3	0.6	0.9	1.2	1.5
Maximum Motor Size	1.5	3.0	5.0	5.0	10.0	15.0	25.0	30.0

Above Couplings can be used for pump models with check marks below in the same column.

Table 2

Pump Series

Coupling Size	12	14	16	22	24	26	36	38
SCM10	●	●	●					
SCM20/SCM30	●	●	●	●	●	●		
SCM40				●	●	●	●	●
SCM50				●	●	●	●	●

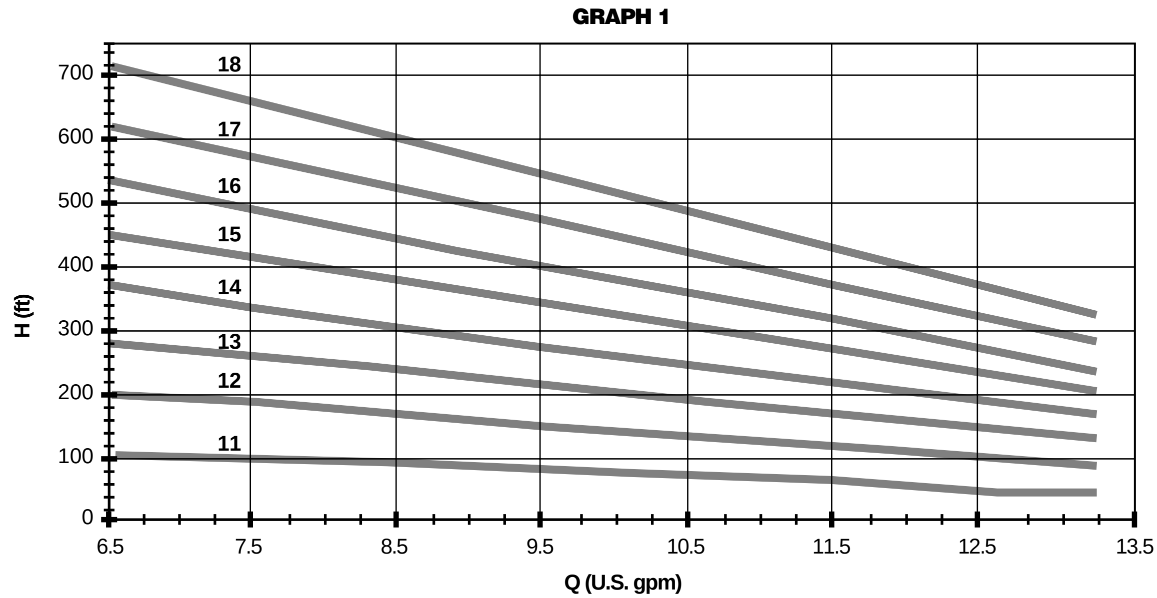
Table 3

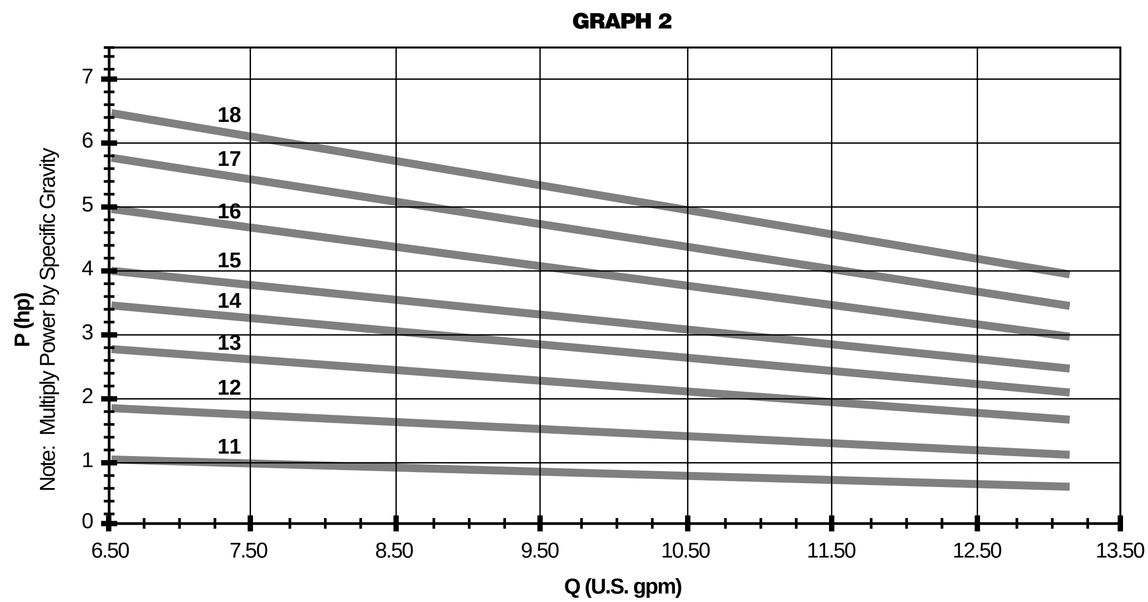
Separation Canisters

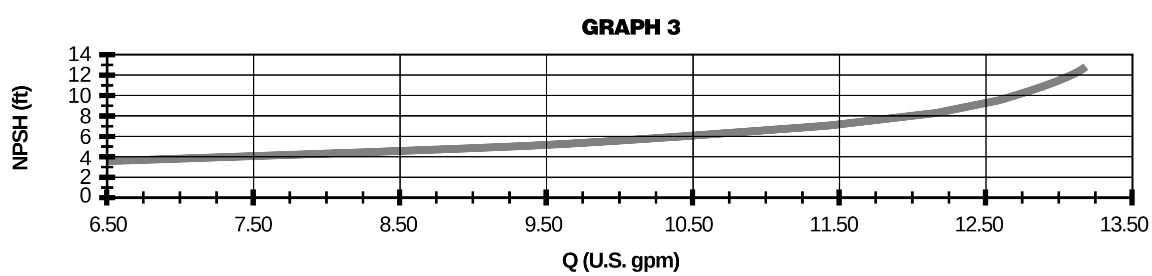
Coupling Size		12	14	16	22	24	26	36	38
Stainless Canister (Standard)	70°F/20°C	470	470	470	305	305	305	N/A	N/A
	210°F/100°C	430	430	430	275	275	275	N/A	N/A
	300°F/150°C	400	400	400	260	260	260	N/A	N/A
	390°F/200°C	375	375	375	240	240	240	N/A	N/A
Hastelloy Canister	70°F/20°C	580	580	580	420	420	420	420	420
	210°F/100°C	580	580	580	390	390	390	395	395
	300°F/150°C	575	575	575	370	370	370	380	380
	390°F/200°C	545	545	545	350	350	350	370	370

Maximum allowable working pressure (psig) for magnetic coupling at various temperatures.

SC/SCM10 SERIES - 1750 RPM

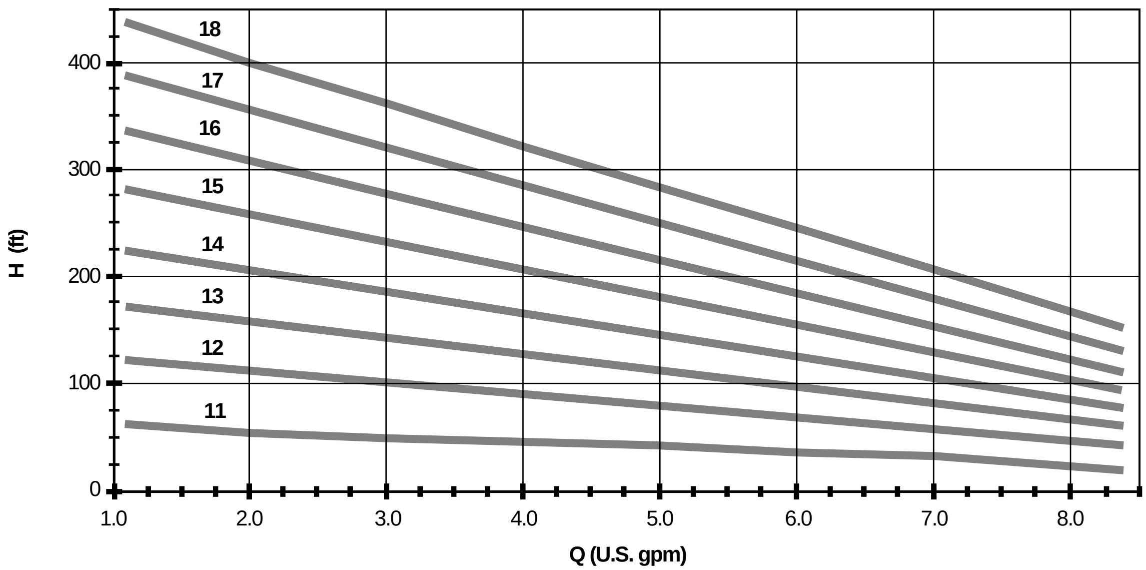




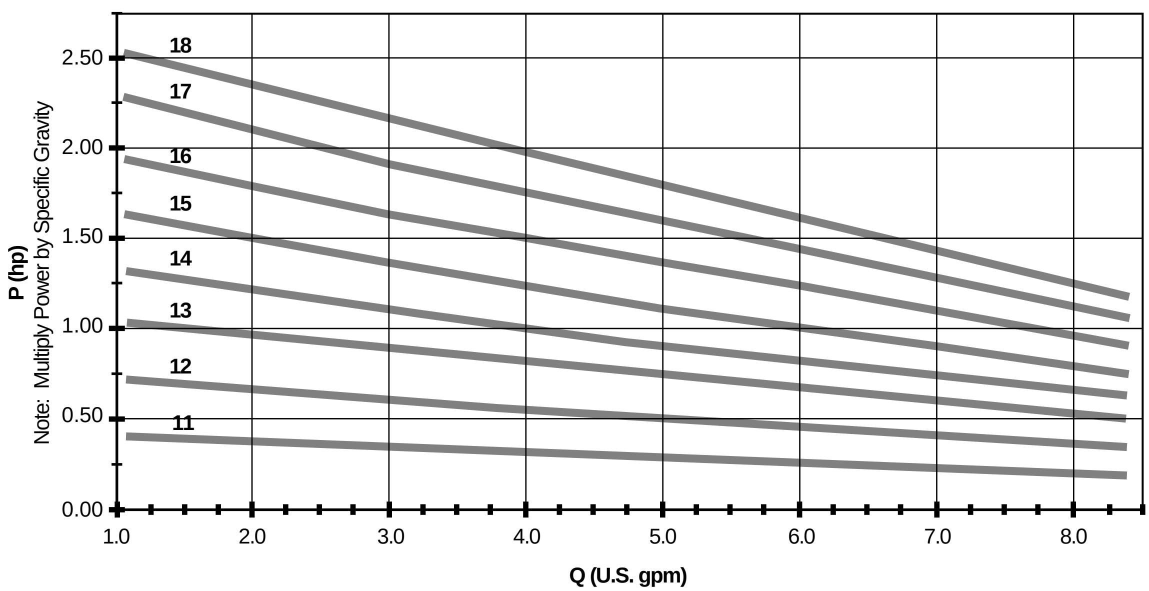


SC/SCM10 SERIES - 1150 RPM

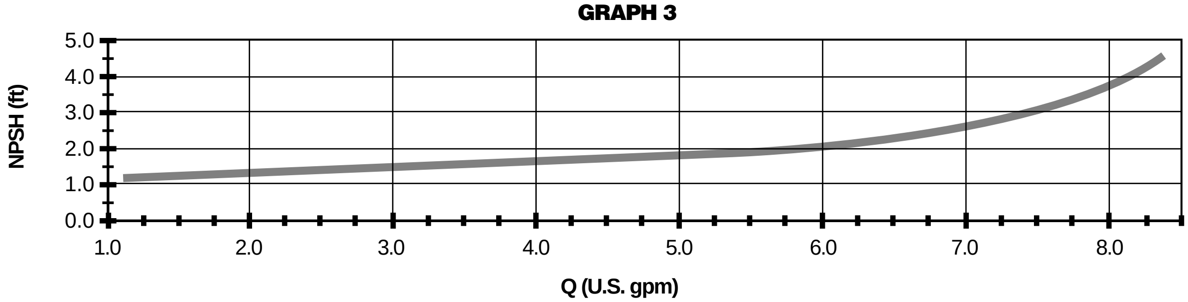
GRAPH 1



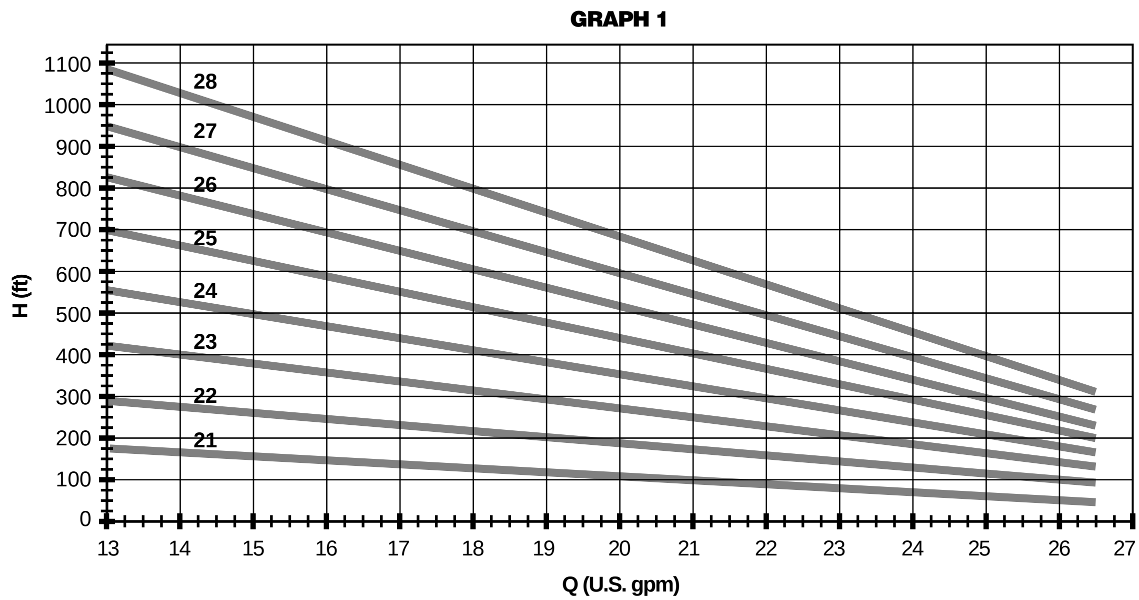
GRAPH 2

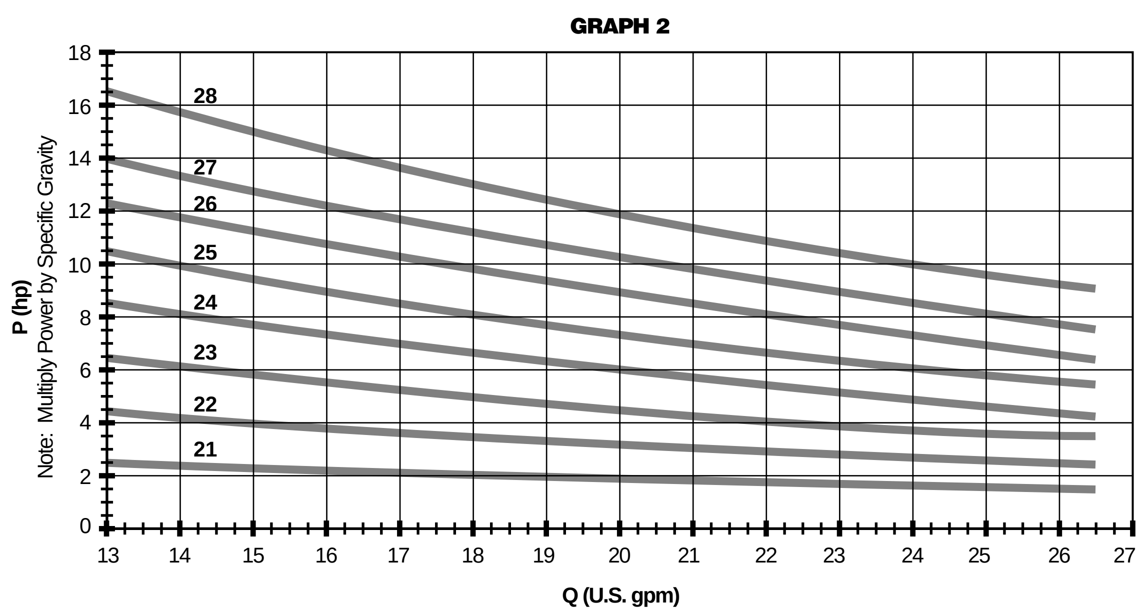


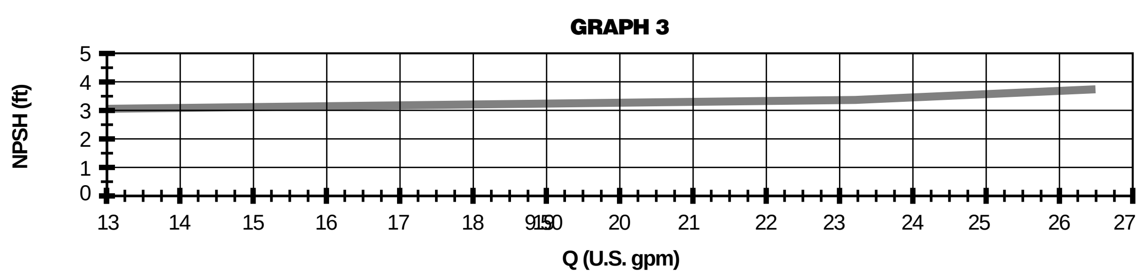
GRAPH 3



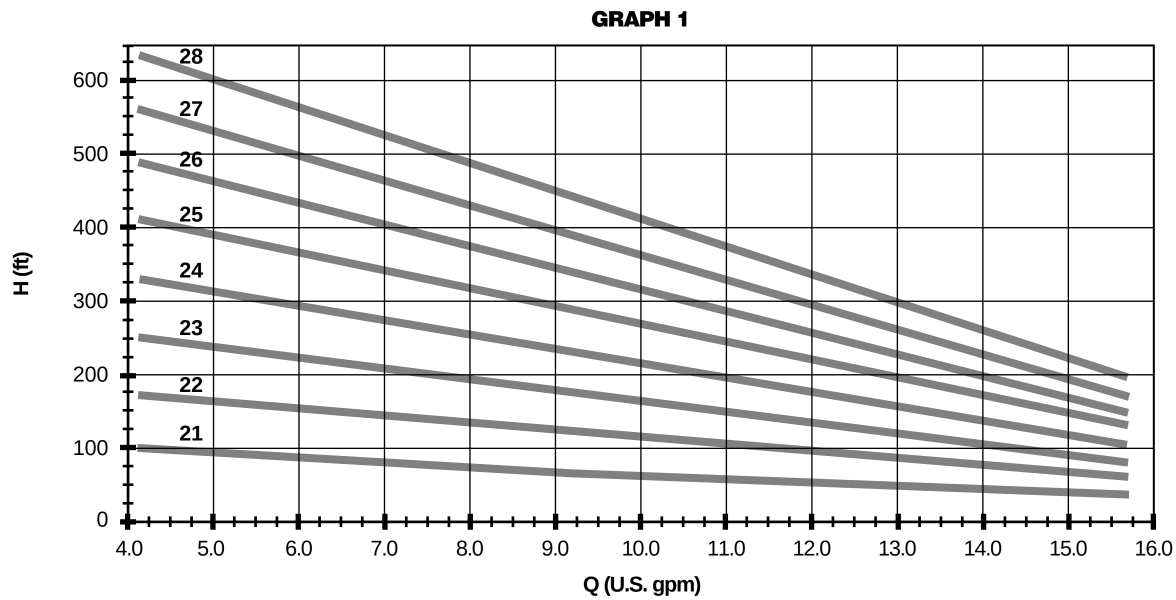
SC/SCM20 SERIES - 1750 RPM

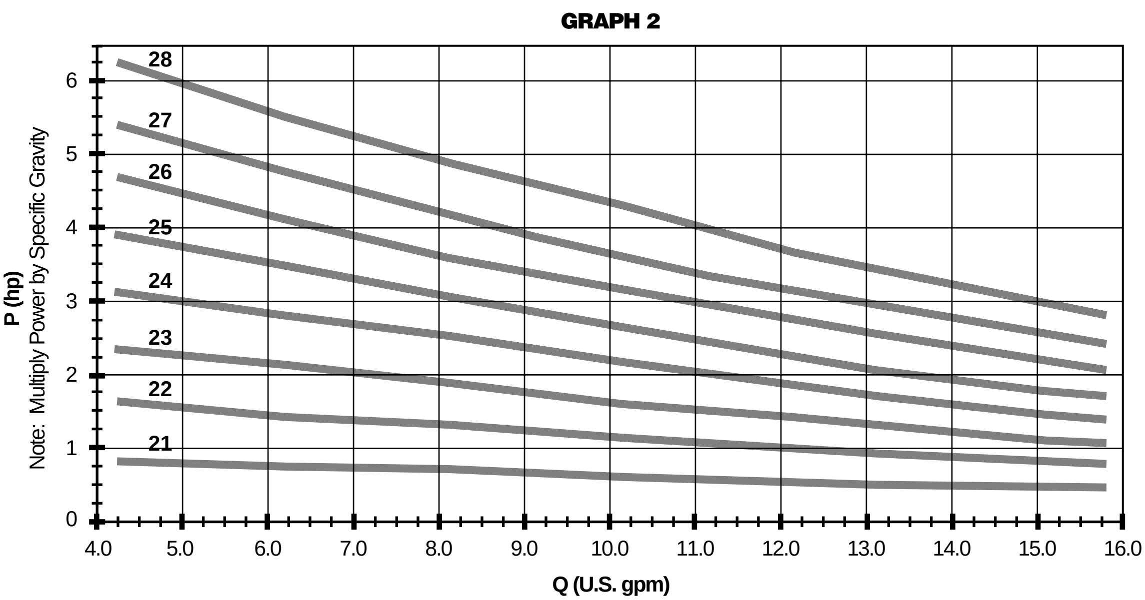


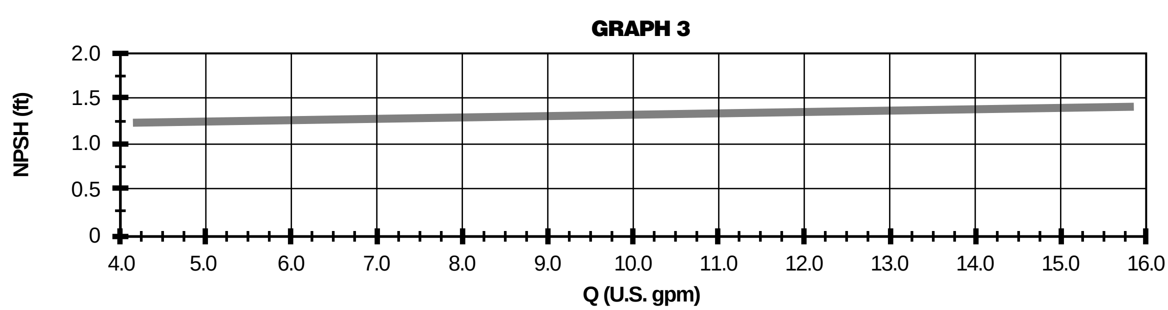




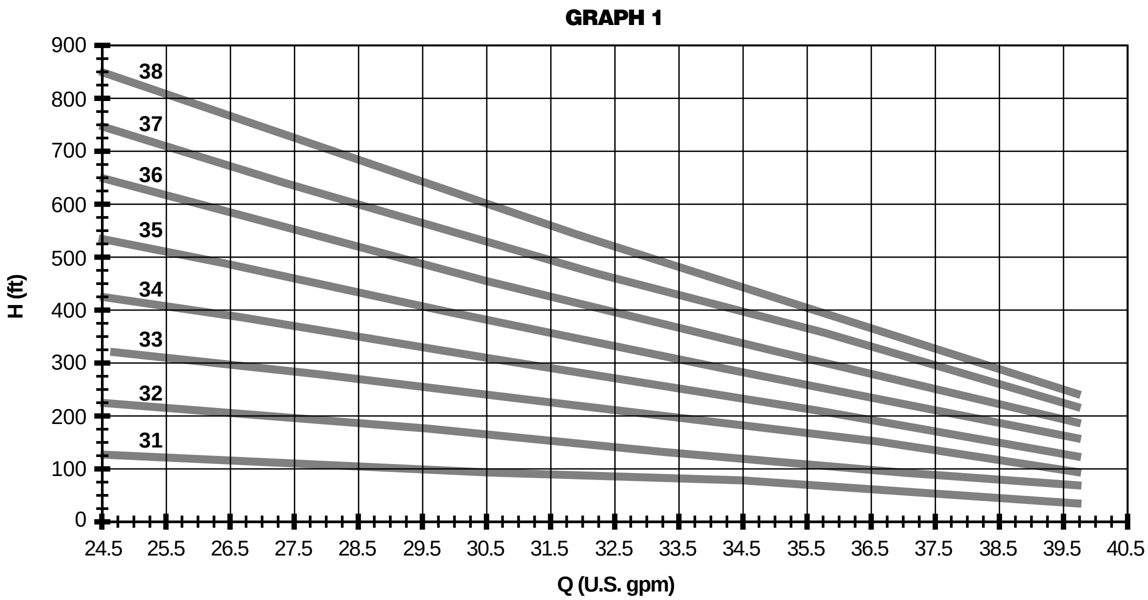
SC/SCM20 SERIES - 1150 RPM

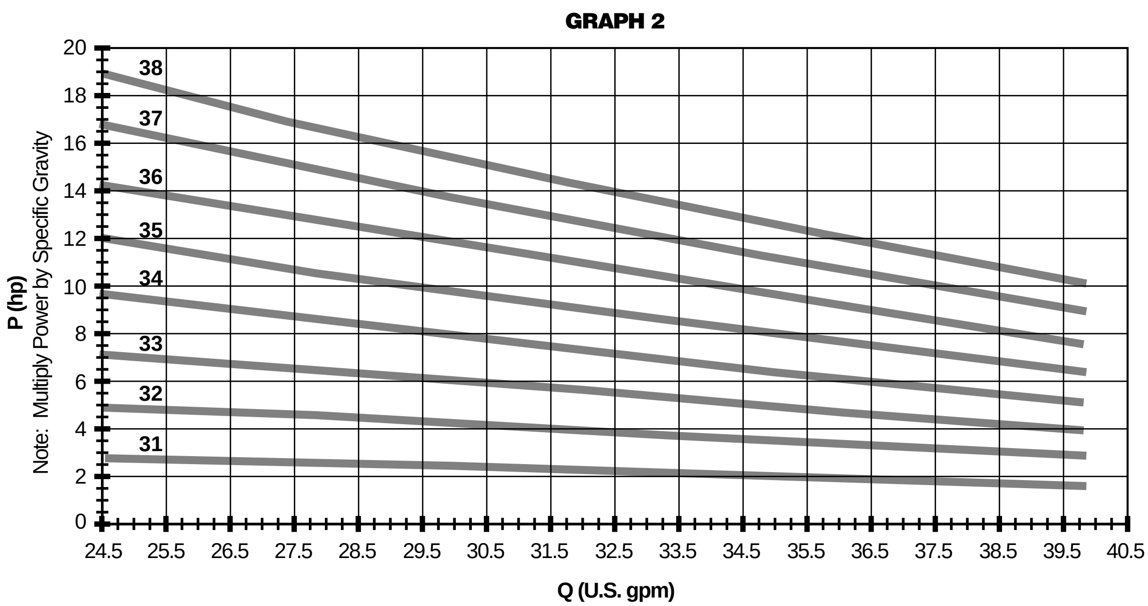


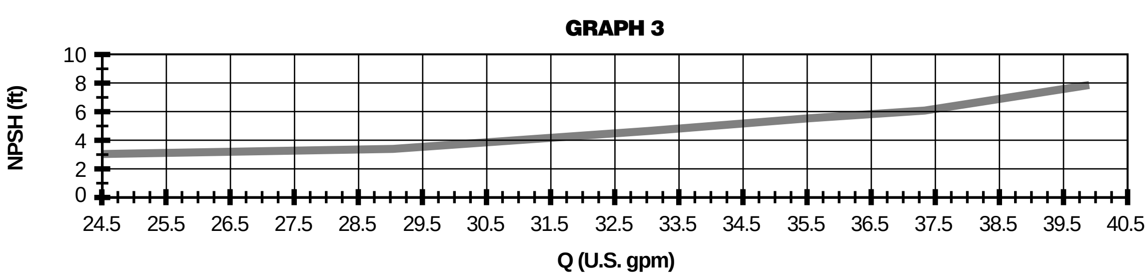




SC/SCM30 SERIES - 1750 RPM

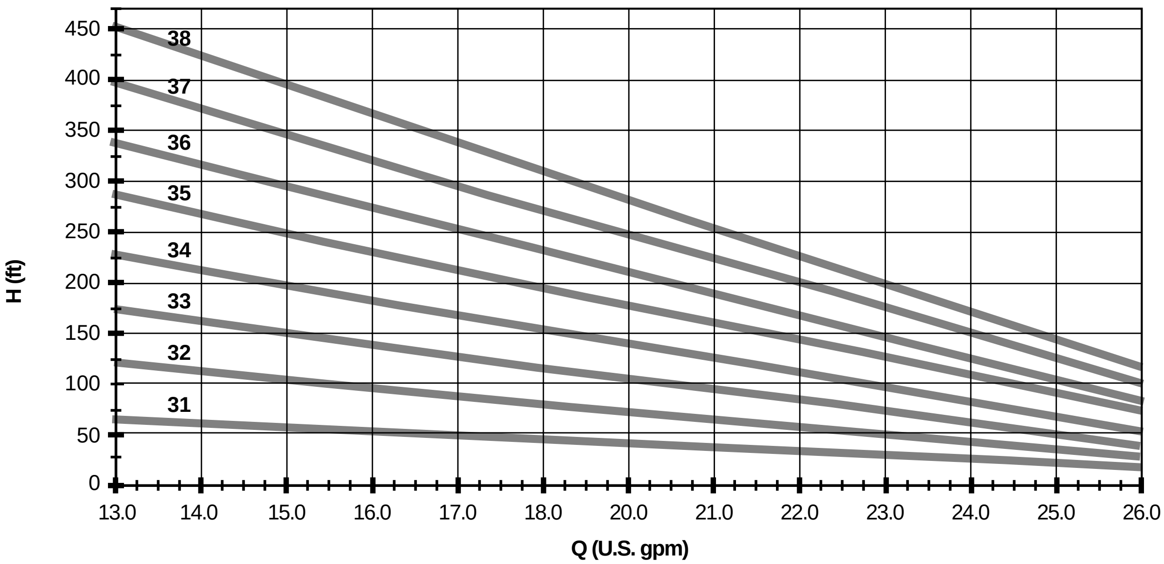




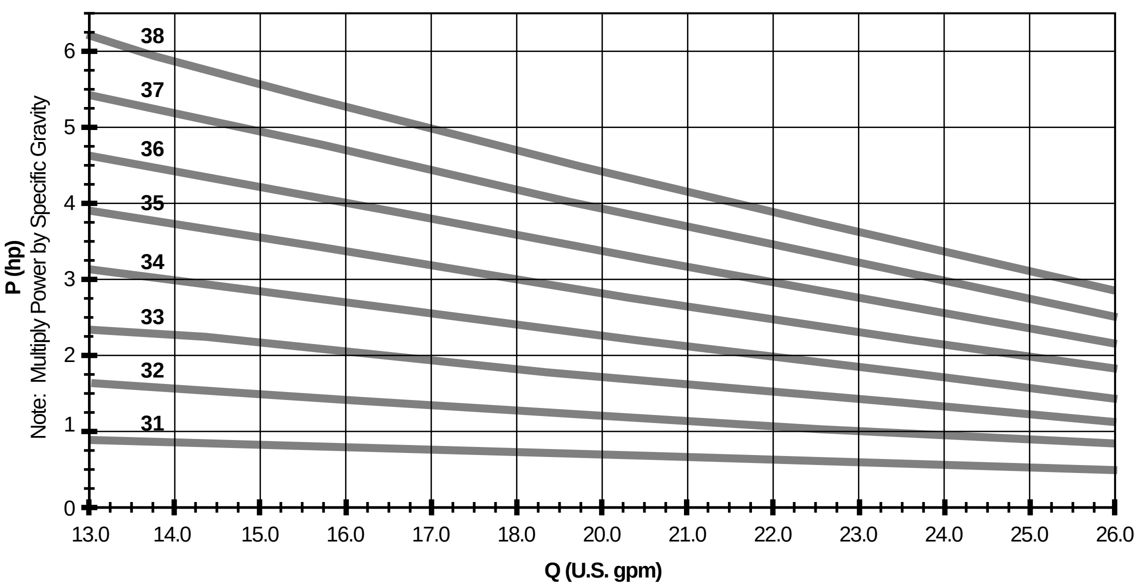


SC/SCM30 SERIES - 1150 RPM

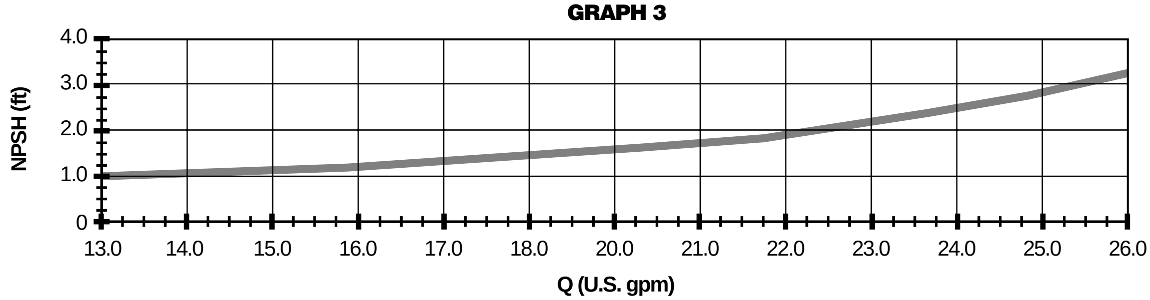
GRAPH 1



GRAPH 2

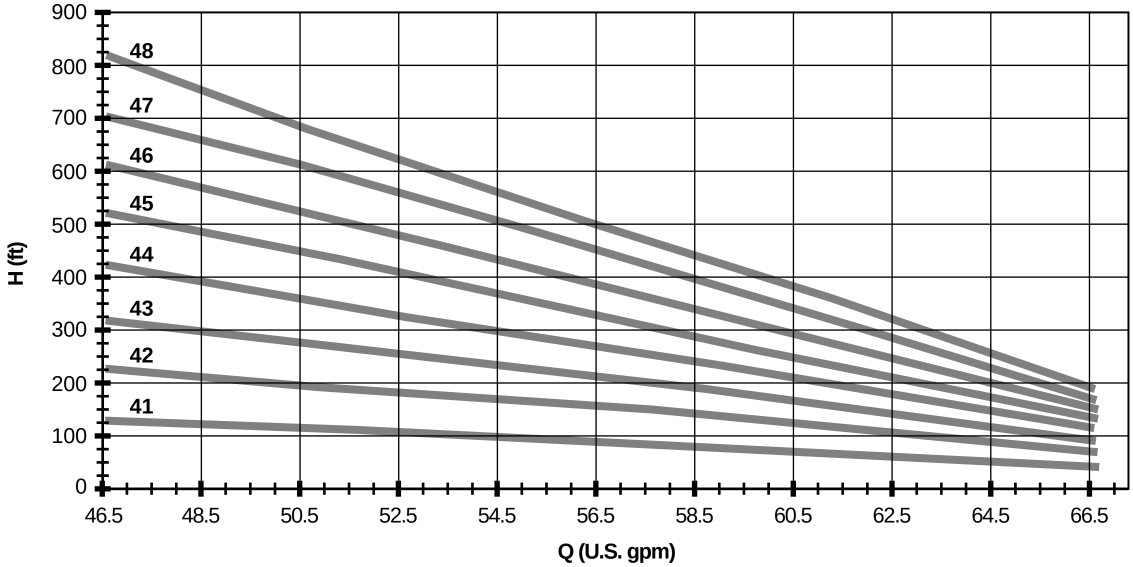


GRAPH 3



SC/SCM40 SERIES - 1750 RPM

GRAPH 1



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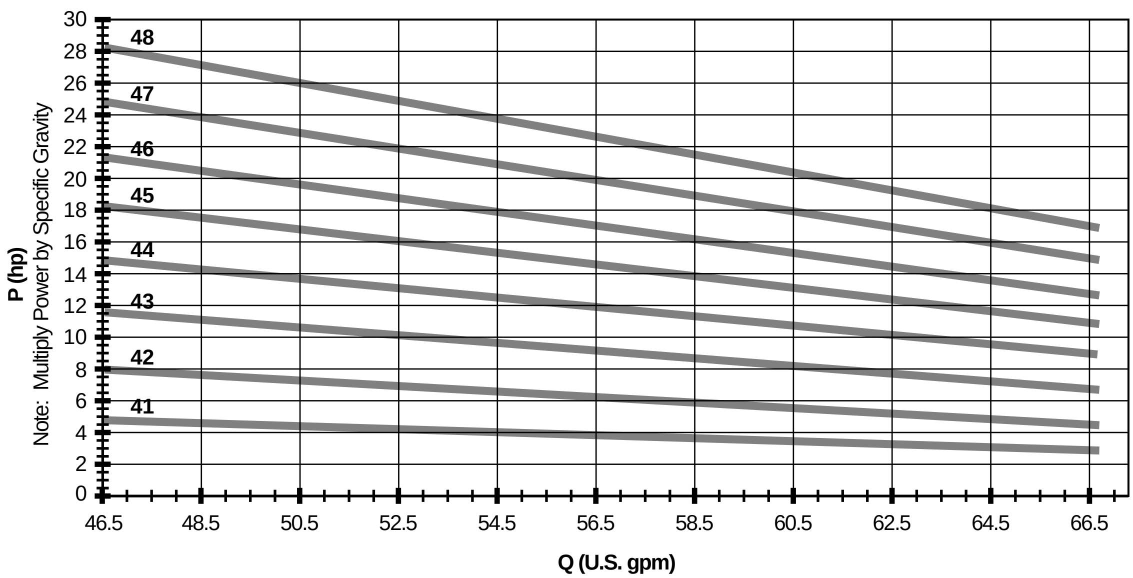

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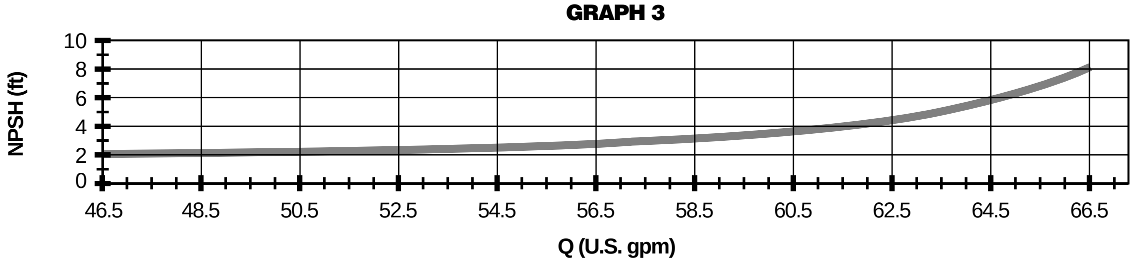
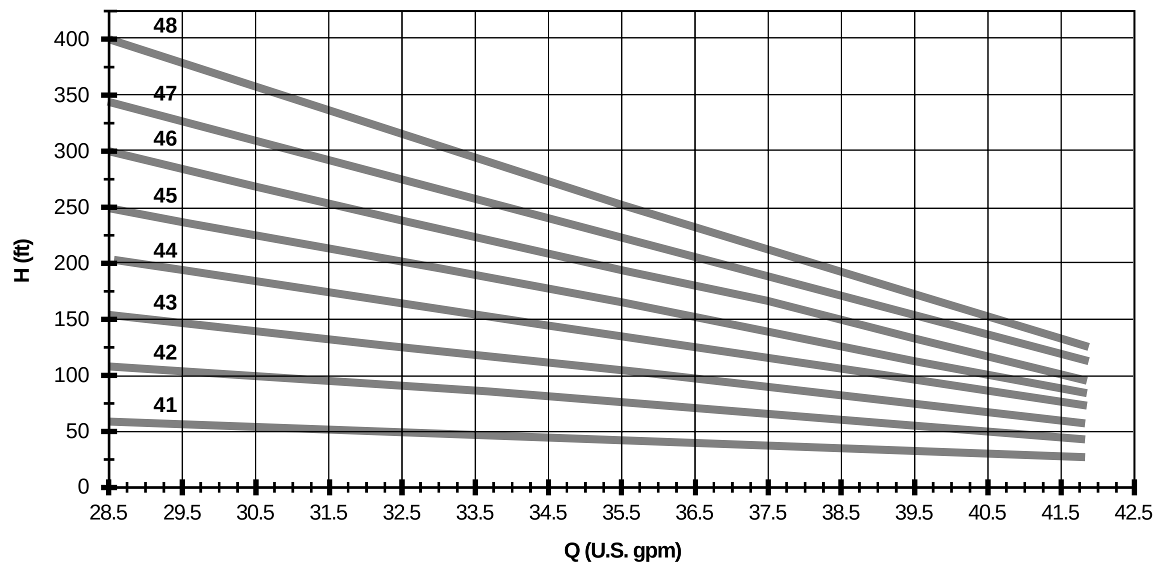
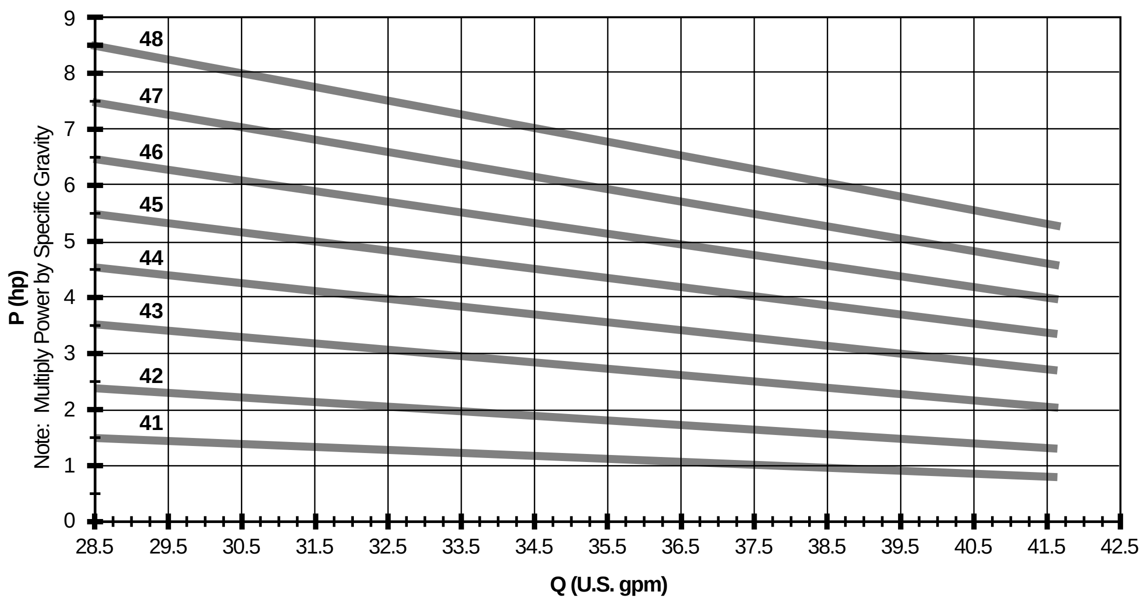


SC/SCM40 SERIES - 1150 RPM

GRAPH 1



GRAPH 2



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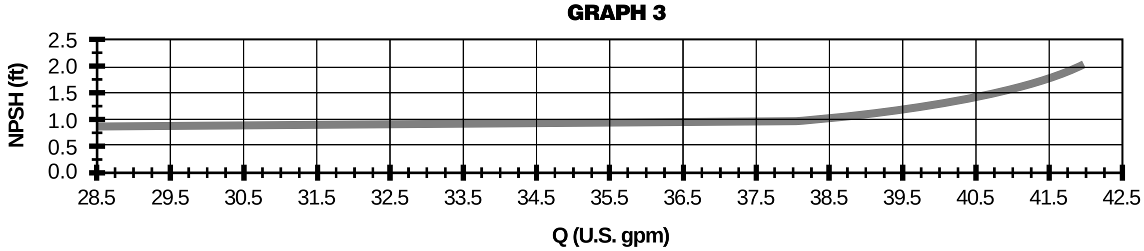
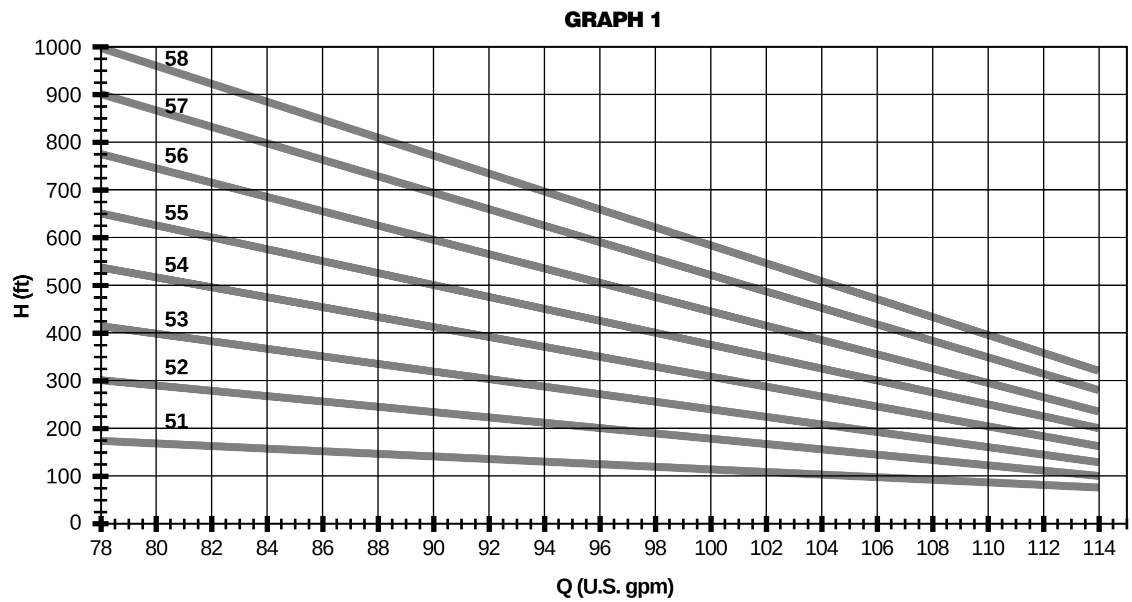
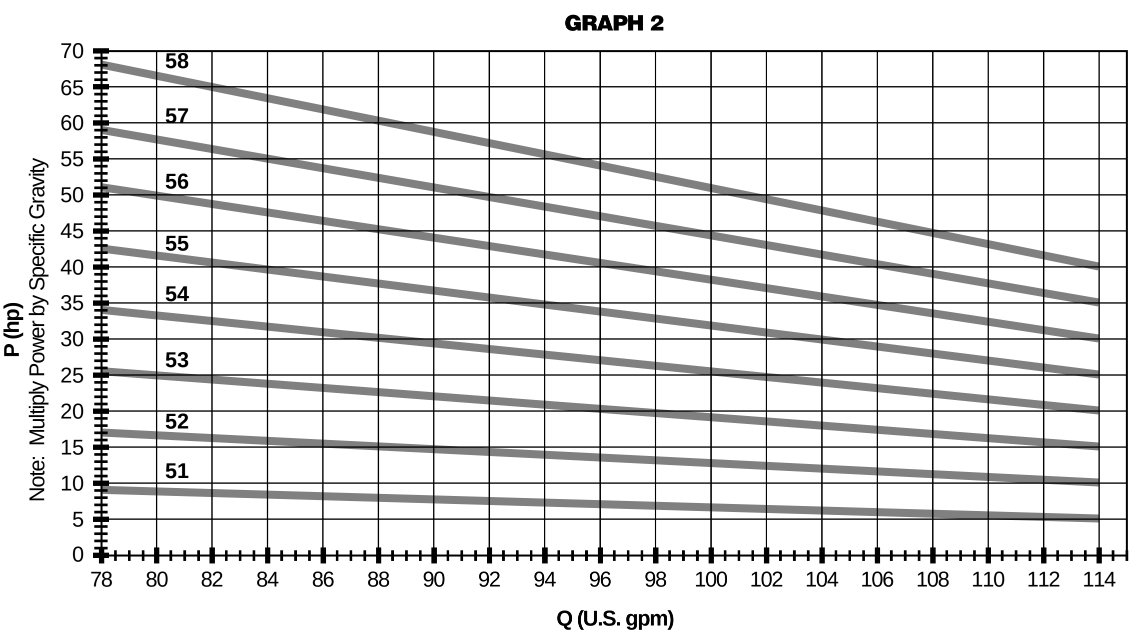
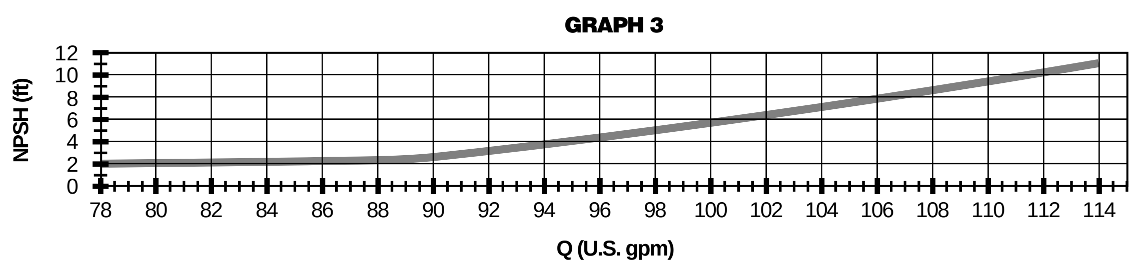


SC/SCM50 SERIES - 1750 RPM

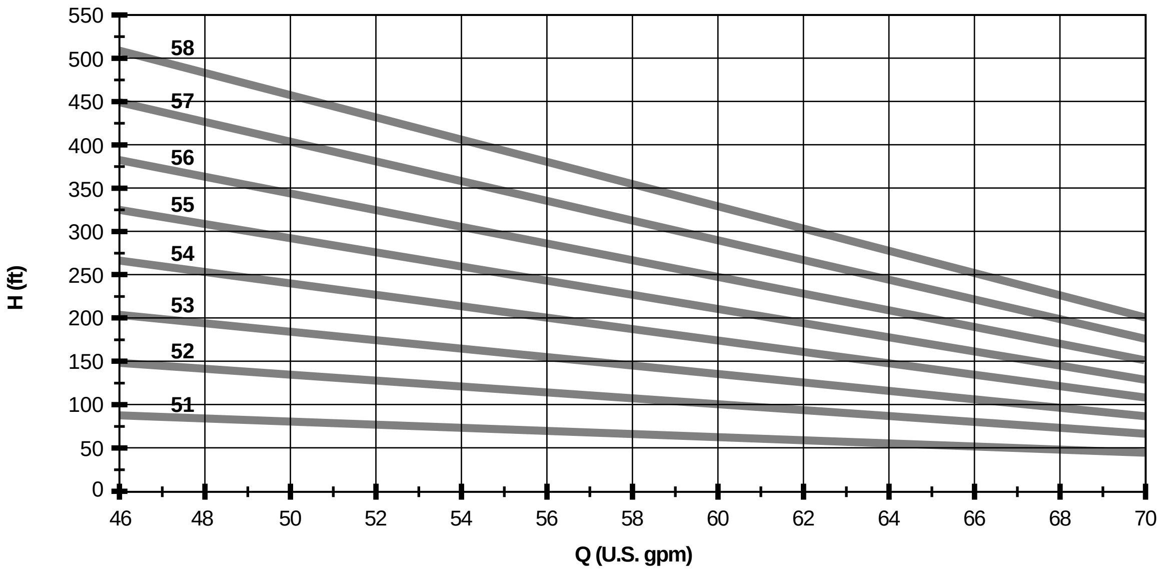




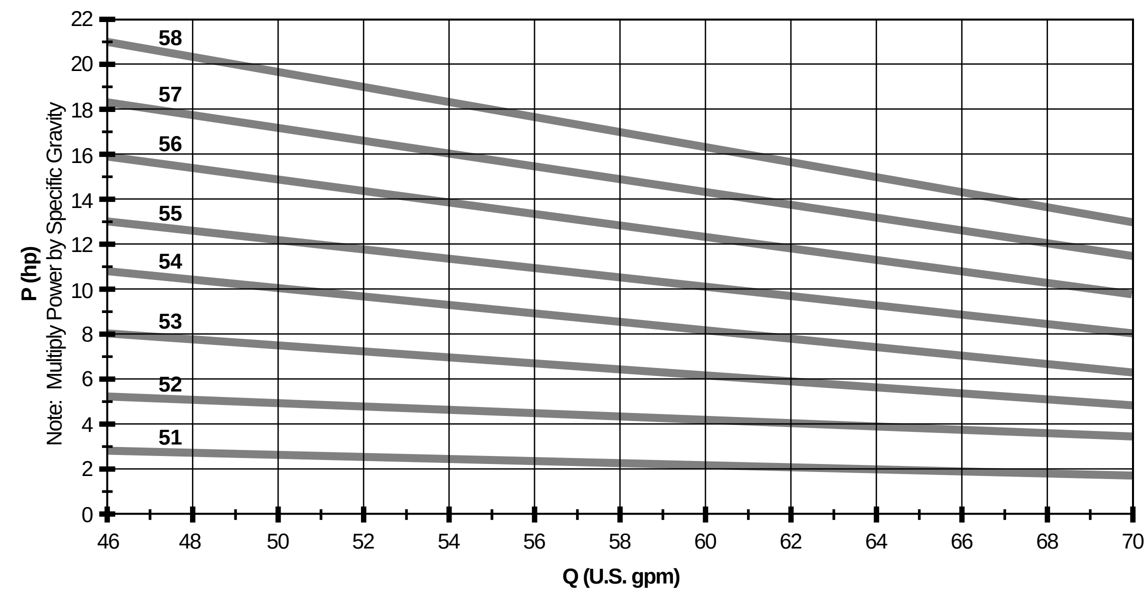


SC/SCM50 SERIES - 1150 RPM

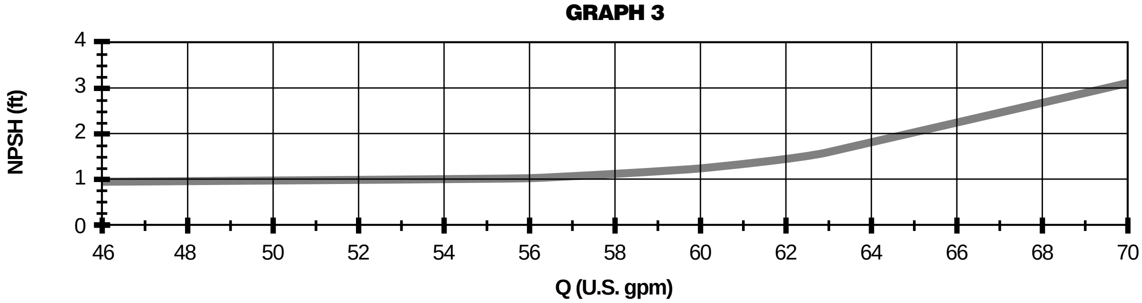
GRAPH 1



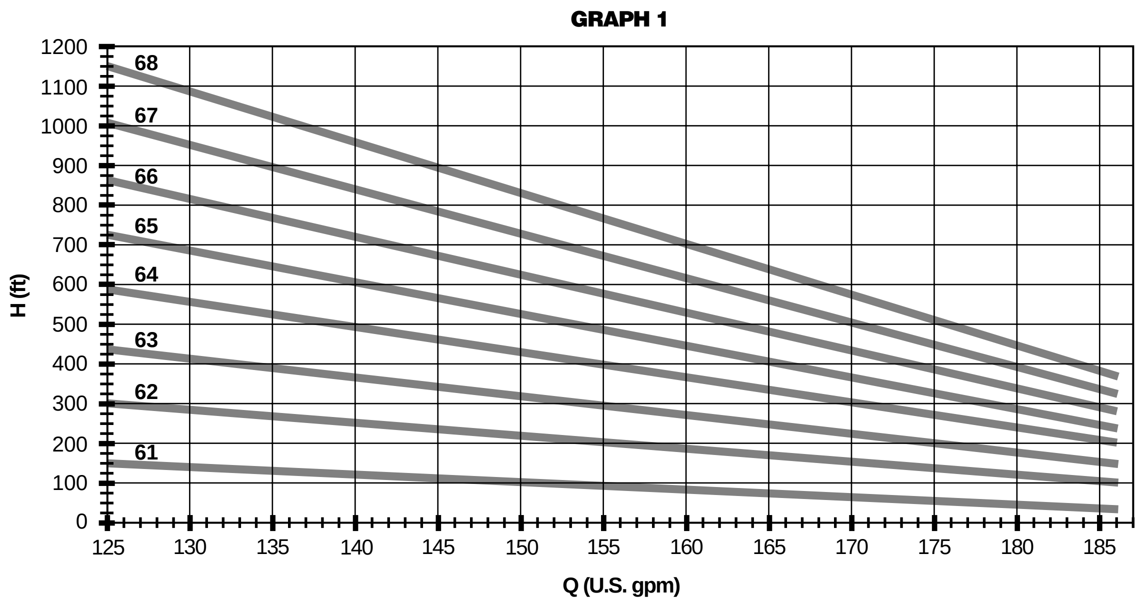
GRAPH 2

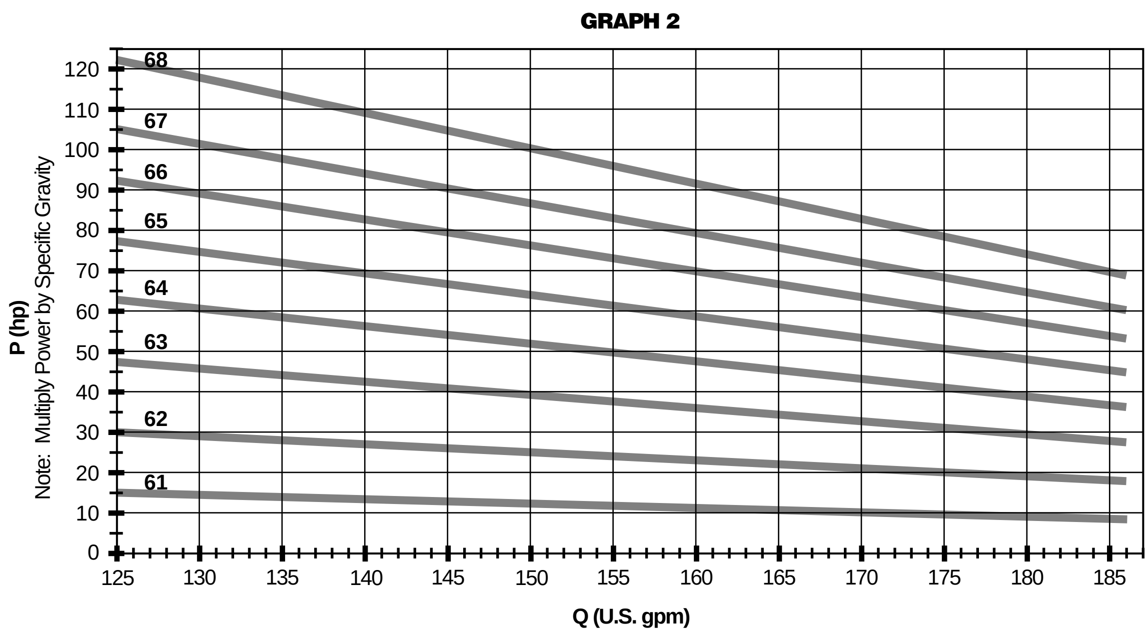


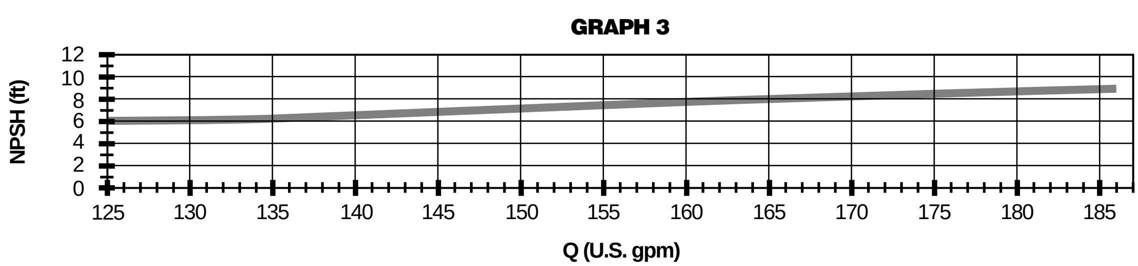
GRAPH 3



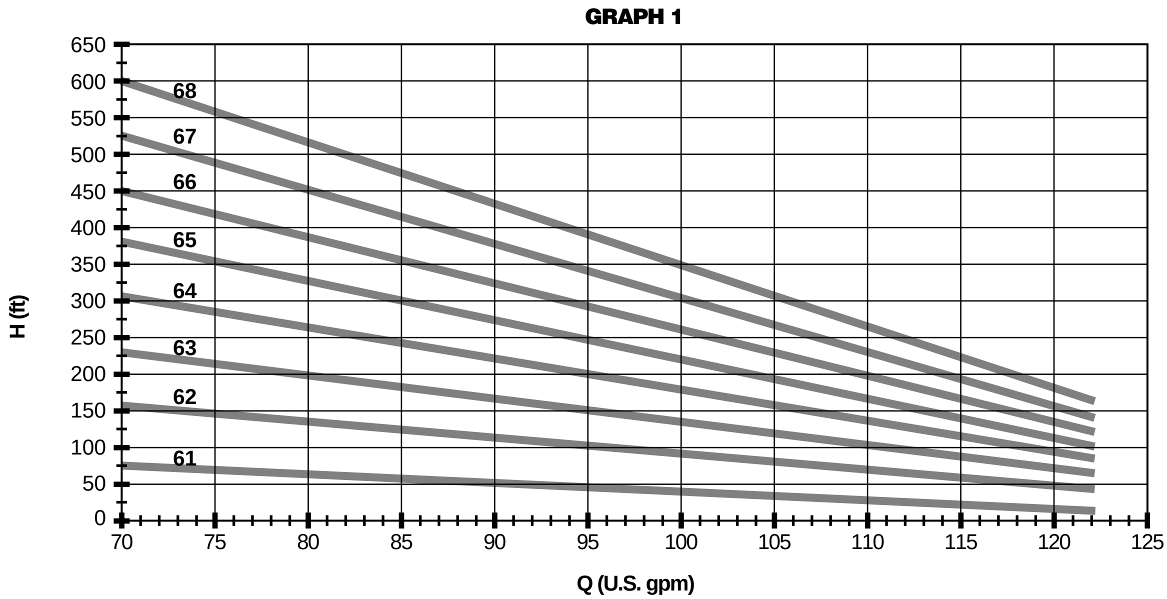
SC/SCM60 SERIES - 1750 RPM

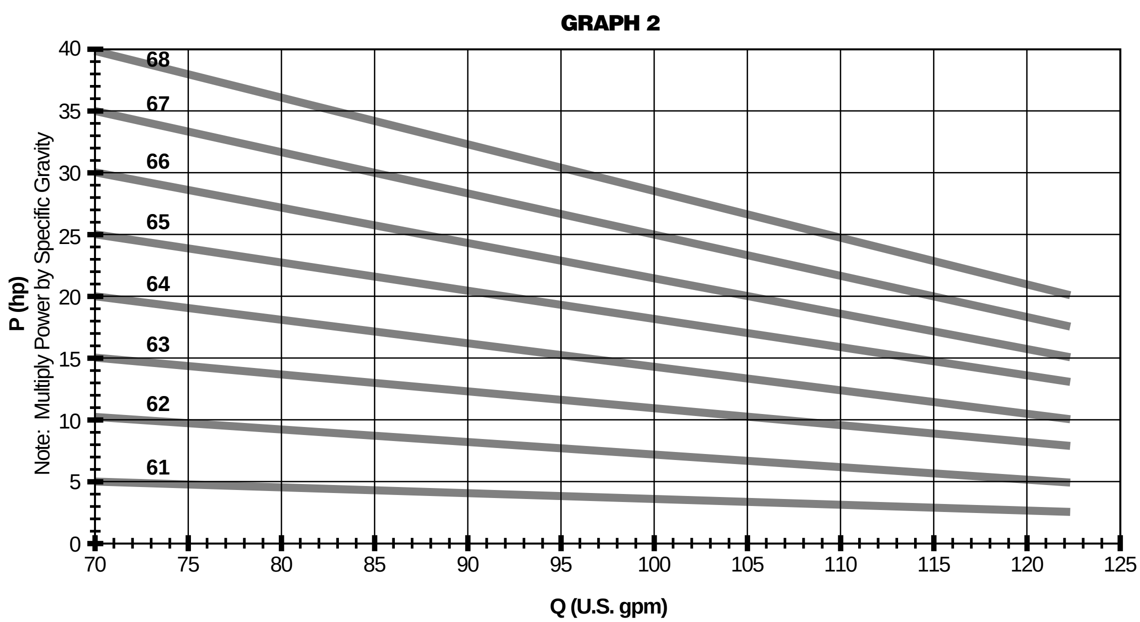


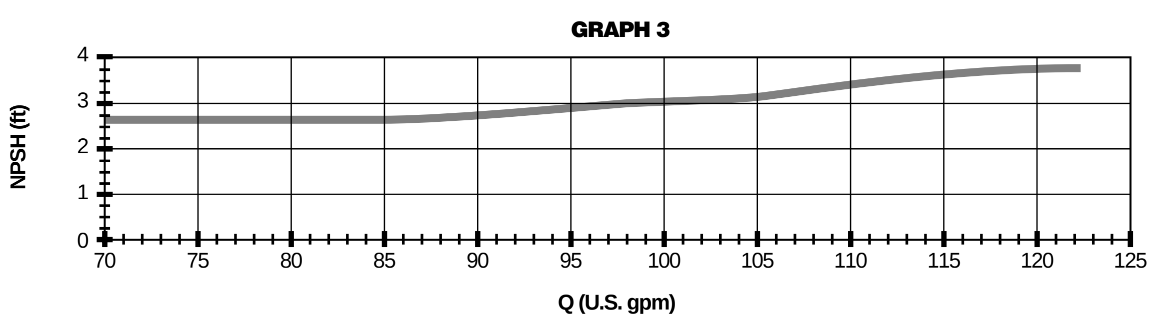




SC/SCM60 SERIES - 1150 RPM







Guide to Pump Selection

MATERIAL SPECIFICATIONS

The last number in your complete side channel model number is the material code. Please find material specification tables below according to these codes.

SC (Sealed) Model Part Description	**1**	**2**	**3**	**4**	**5**
Suction Casing	Ductile Iron	Ductile Iron	316 Stainless	Cast Iron	Cast Iron
Discharge Casing	Ductile Iron	Ductile Iron	316 Stainless	Cast Iron	Cast Iron
Stage Casing	Ductile Iron	Ductile Iron	316 Stainless	Cast Iron	Cast Iron
Side Channel Casing	Ductile Iron	Ductile Iron	316 Stainless	Cast Iron	Cast Iron
Foot	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron
Shaft	Steel	Steel	316 Stainless	Steel	Steel
Impeller	Bronze	Steel	316 Stainless	Bronze	Steel
Suction Impeller	Bronze	Steel	316 Stainless	Bronze	Steel
Bearing Housing	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Cast Iron
Gasket	Teflon	Teflon	Teflon	Teflon	Teflon
Sleeve Bearing	Bronze (Carbon Option)	Carbon	Carbon	Bronze (Carbon Option)	Carbon
Additional Parts for SCM (Mag Drive) Model					
Sleeve Bearing (Magnetic Coupling)	Stainless Reinforced SiC	Stainless Reinforced SiC	Stainless Reinforced SiC	Stainless Reinforced SiC	Stainless Reinforced SiC
Shaft Sleeve	SiC	SiC	SiC	SiC	SiC
Separation Canister	316 Stainless (Hastelloy Option)	316 Stainless (Hastelloy Option)	316 Stainless (Hastelloy Option)	316 Stainless (Hastelloy Option)	316 Stainless (Hastelloy Option)

SiC = Silicon Carbide

MODEL NUMBER SELECTION GUIDE FOR MECHANICAL SEAL MODEL

SC 25 A C 2 B D 2 4
(1) (2) (3) (4) (5) (6) (7) (8)

(1) **Basic Model**

This is the number at which you should have arrived through the sizing exercise.

(2) **Flange and Ports**

Options: A - 300 Lb. ANSI compatible flanges / NPT tapped gauge and drain ports. (available for all models except 10 series)
D- DIN flanges / straight thread gauge ports
W- DIN flange with weld neck compatible flanges included with the pump / NPT tapped gauge and drain ports (available for 10 series only)

(3) **Sleeve Bearing Material**

Options: B- Bronze (Available for all models except 60 series) (Only available in pumps with bronze impellers)
C- Carbon (All models)

(4) **Temperature Option**

Options 2- Standard for temperatures below 250°F (120°C).
3- Option for temperatures between 250°F (120°C) and 430°F (220°C). Also can be used as heating option for low temperature applications.
Note: This option requires cooling water be supplied to pump.

(5) **Seal Type (see page 3-36 for guidance)**

A- Single Unbalanced (Discharge pressure from pump must be less than 230 psig (16 bar))
B- Single Balanced (Good for pressures exceeding 230 psig (16 bar))
C- Double Unbalanced (Discharge pressure from pump must be less than 230 psig (16 bar))
D- Double Balanced (Good for pressures exceeding 230 psig (16 bar))
E- Quench Unbalanced (Discharge pressure from pump must be less than 230 psig (16 bar))
G- Quench Balanced (Good for pressures exceeding 230 psig (16 bar))

(6) **O-ring Material**

B- Neoprene
D- Viton
E- Teflon
G- Ethylene Propylene

(7) **Seal Face / Seal Seat**

1- Carbon Graphite / Aluminum Oxide (Standard for unbalanced single seals and all double seals)
2- Aluminum Oxide / Carbon Graphite (Standard for single balanced seals)
3- Silicon Carbide / Carbon Graphite (Standard for high temp option)
4- Silicon Carbide / Silicon Carbide
1L- Silicon Carbide / Carbon Graphite (Unbalanced single seal - LPG only) (Pressures below 230 psig (16 bar))
2L- Carbon Graphite / Silicon Carbide (Balanced single seal - LPG only) (Pressures below 580 psig)
3L- Carbon Graphite / Silicon Carbide (Balanced single seal - LPG only) (Pressures below 360 psig)

(8) **Material- Case / Impeller**

1- Ductile Iron / Bronze
2- Ductile Iron / Steel
3- Stainless Steel / Stainless Steel
4- Cast Iron / Bronze
5- Cast Iron / Steel

2 Guide to Pump Selection

MODEL NUMBER SELECTION GUIDE FOR MAGNETIC DRIVE MODEL

SCM	26	A	C	2	S2	G	V	24	3
	↑ ①	↑ ②	↑ ③	↑ ④	↑ ⑤	↑ ⑥	↑ ⑦	↑ ⑧	↑ ⑨

① **Basic Model**

This is the number at which you should have arrived through the sizing exercise.

② **Flange and Ports**

Options: A - 300 Lb. ANSI compatible flanges / NPT tapped gauge and drain ports. (available for all models except 10 series)
D- DIN flanges / straight thread gauge ports
W- DIN flange with weld neck compatible flanges included with the pump / NPT tapped gauge and drain ports (available for 10 series only)

③ **Sleeve Bearing Material**

Options: B- Bronze (Only available in pumps with bronze impellers)
C- Carbon (All models)

④ **Temperature Option**

Options 2- Standard for temperatures below 250°F (120°C).
3- Option for temperatures between 250°F (120°C) and 390°F (200°C). Also can be used as heating option for low temperature applications.

⑤ **Bearing Material (Magnetic Coupling)**

S2- Silicon Carbide (Pressureless Sintered)

⑥ **Ball Bearing Lubrication**

O- Oil
G- Grease (Std)

⑦ **Separation Canister Material**

V- Stainless Steel
H- Hastelloy

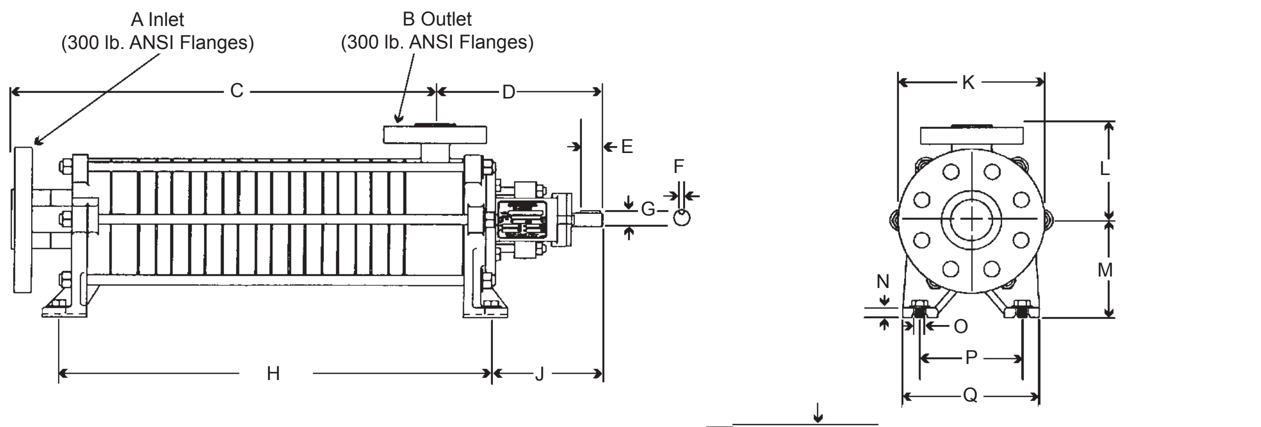
⑧ **Magnetic Coupling Size**

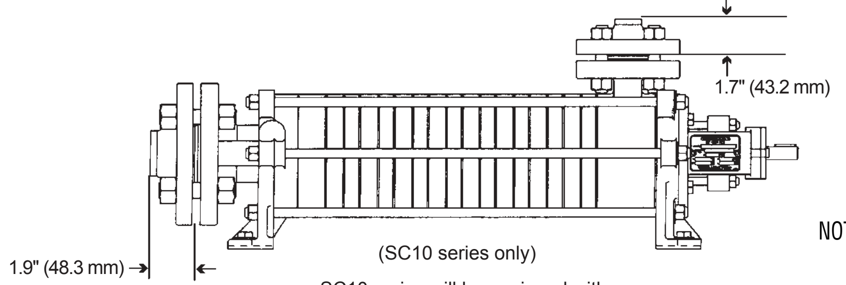
12- 1.1 Hp (10-30 Series)
14- 2.6 Hp (10-30 Series)
16- 3.8 Hp (10-30 Series)
22- 2.6 Hp (20-50 Series)
24- 7.6 Hp (20-50 Series)
26- 11.3 Hp (20-50 Series)
36- 16.8 Hp (40-50 Series)
38- 28.5 Hp (40-50 Series)

⑨ **Material- Case / Impeller**

1- Ductile Iron / Bronze
2- Ductile Iron / Steel
3- Stainless Steel / Stainless Steel
4- Cast Iron / Bronze
5- Cast Iron / Steel

SC–PUMP OUTLINE DIMENSIONS





(SC10 series only)

SC10 series will be equipped with
weld neck companion flanges on inlet and outlet.

NOTE: PUMP TURNS COUNTER-CLOCKWISE WHEN VIEWED FROM THE DRIVE END.

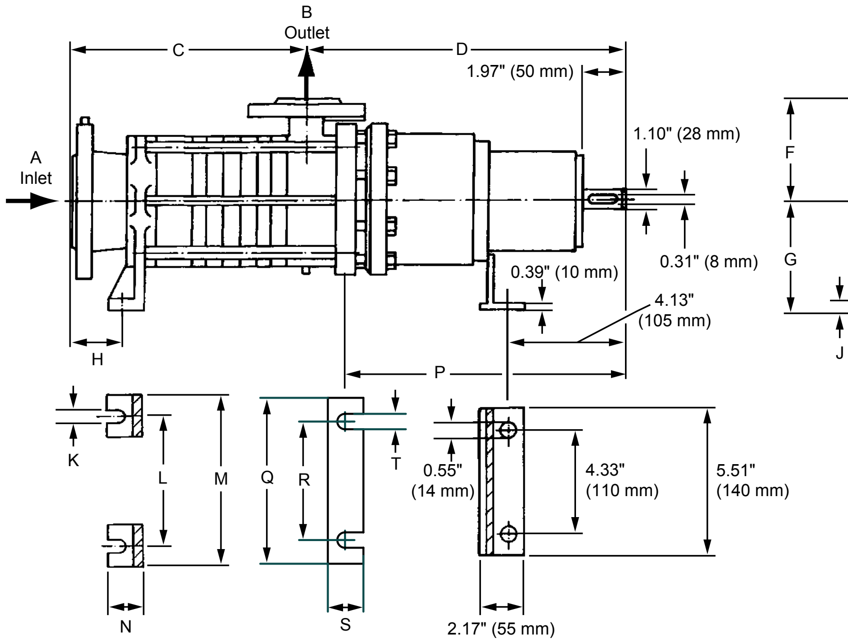
Series	Inlet A*	Outlet B*	D	E	F	G	J	K	L	M	N	O	P	Q
SC10	1-1/2	3/4	6.73	**	**	**	4.45	5.91	3.94	3.94	0.39	0.51	4.13	5.51
	40	20	171	25	5	14	113	150	100	100	10	13	105	140
SC20 and 30	2-1/2	1-1/4	7.91	**	**	**	5.28	7.28	5.20	4.41	0.51	0.55	5.31	6.69
	65	32	210	40	6	19	134	185	132	112	13	14	135	170
SC40	3	1-1/2	7.68	**	**	**	5.59	7.87	5.51	5.20	0.59	0.59	6.10	7.68
	80	40	195	45	8	24	142	200	140	132	15	15	155	195
SC50	4	2	9.33	**	**	**	6.26	9.25	6.50	6.30	0.71	0.59	6.69	8.46
	100	50	237	50	10	28	159	235	165	160	18	15	170	215
SC60	4	2-1/2	10.31	**	**	**	6.77	9.25	7.09	7.09	0.79	0.59	7.68	9.65
	100	65	262	65	10	32	172	235	180	180	20	15	195	245

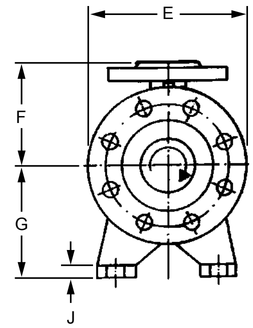
** Inlet and outlet flanges are per DIN spec (PN40 DIN 2501). Flanges can be drilled per ANSI for 300 lb. flanges, except for SC10 series.*
***These dimensions are available in metric only. U.S. couplings must be machined before use.*

	1 Stage		2 Stage		3 Stage		4 Stage		5 Stage		6 Stage		7 Stage		8 Stage	
Series	C	H	C	H	C	H	C	H	C	H	C	H	C	H	C	H
SC10	7.68	8.03	9.02	9.37	10.35	14.65	11.69	12.05	13.03	13.39	14.37	14.72	15.71	16.06	17.05	17.40
	195	204	229	238	263	372	297	306	331	340	365	374	399	408	433	442
SC20 and 30	8.39	8.94	9.96	10.51	11.54	12.09	13.11	13.66	14.69	15.24	16.26	16.81	17.83	18.39	19.41	19.96
	213	227	253	267	293	307	333	347	373	387	413	427	453	467	493	507
SC40	10.55	10.20	12.72	12.36	14.88	14.53	17.05	16.69	19.21	18.86	21.38	21.02	23.54	23.19	26.89	25.35
	268	259	323	314	378	369	433	424	488	479	543	534	598	589	653	644
SC50	12.01	12.32	14.96	15.28	17.91	18.23	20.87	21.18	23.82	24.13	26.77	27.09	29.72	30.04	32.68	32.99
	305	313	380	388	455	463	530	538	605	613	680	688	755	763	830	838
SC60	13.31	13.90	16.85	17.44	20.39	20.98	23.94	24.53	27.48	28.07	31.02	31.61	34.57	35.16	38.11	38.70
	338	353	428	443	518	533	608	623	698	713	788	803	878	893	968	983

Dimensions shown in grey area are millimeters while non-shaded areas are inches.

SCM–PUMP OUTLINE DIMENSIONS





NOTE: 1) SCM10 series will be equipped with weld neck companion flanges on inlet and outlet.
2) For pumps containing four to eight stages, a middle foot is required. For dimensions see the chart on page 34.

Series	Inlet A[1]	Inlet B[1]	D[2]	E	F	G	H	J	K	L	M	N	P[2]
SCM10	1.5	0.75	14.33	5.91	3.94	3.94	1.93	0.39	0.51	4.13	5.51	1.73	11.54
	40	20	364	150	100	100	49	10	13	105	140	44	293
SCM20 and 30	2.5	1.25	13.97 / 14.76	7.28	5.20	4.41	2.09	0.51	0.55	5.31	6.69	1.89	11.85 / 12.64
	65	32	355 / 375	185	132	112	53	13	14	135	170	48	301 / 321
SCM40	3	15	14.09 / 15.16	7.87	5.51	5.20	2.48	0.59	0.59	6.10	7.68	2.17	11.10 / 12.17
	80	40	358 / 385	200	140	132	63	15	15	155	195	55	282 / 309
SCM50	4	2	14.56 / 15.35	9.25	6.50	6.30	2.83	0.63	0.59	6.89	8.66	2.13	11.54 / 12.44
	100	50	370 / 390	235	165	160	72	16	15	175	220	54	296 / 316

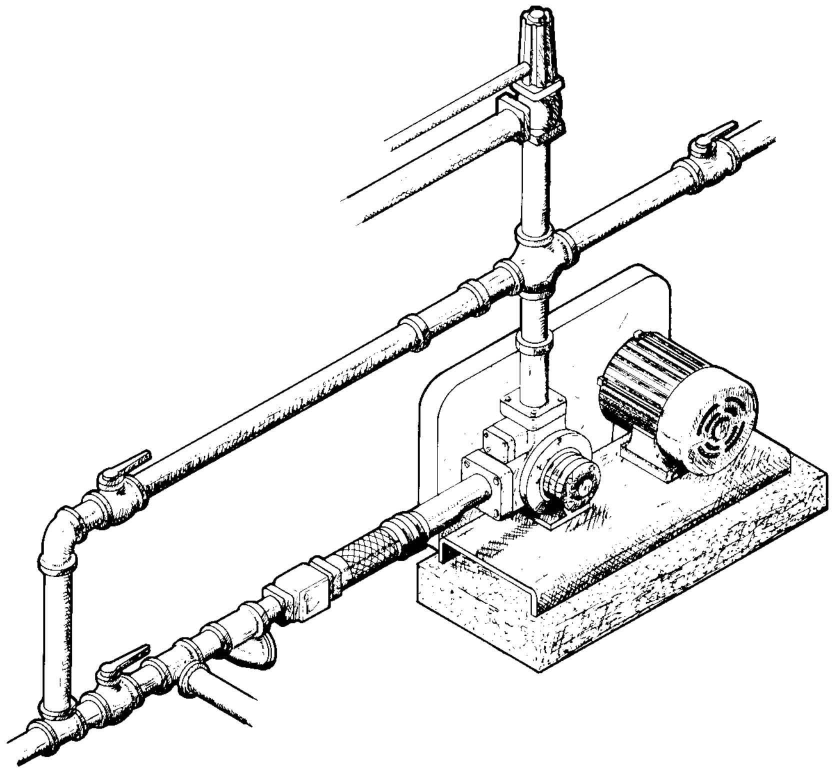
[1]Inlet and outlet flanges are per DIN spec (PN40 DIN 2501). Flanges can be drilled per ANSI for 300 lb flanges, except for SC10 series.
[2]Depends on the magnetic coupling selected.

Series	C Number of stages							
	1	2	3	4	5	6	7	8
SCM10	7.68	9.02	10.35	11.69	13.03	14.37	15.71	17.05
	195	229	263	297	331	365	399	433
SCM20 & 30	8.39	9.96	11.54	13.11	14.69	16.26	17.83	19.41
	213	253	293	333	373	413	453	493
SCM40	10.55	12.72	14.88	17.05	19.21	21.38	23.54	25.71
	268	323	378	433	488	543	598	653
SCM50	12.01	14.96	17.91	20.87	23.82	26.77	29.72	32.68
	305	380	455	530	605	680	755	830

Dimensions for Extra Foot on SCM Series Pumps (for stages 4-8 only)					
Pumps	SCM10	SCM20	SCM30	SCM40	SCM50
Coupling sizes / Dimension	12,14,16	12,14,16 22,24,26	12,14,16 22,24,26	22,24,26 36,38	22,24,26 36,38
Q	6.69	7.87	7.87	7.87	7.87
	170	200	200	200	200
R	5.51	6.69	6.69	6.69	6.69
	140	170	170	170	170
S	1.81	0.79	0.79	1.81	1.81
	30	20	20	30	30
T	0.51	0.51	0.51	0.59	0.59
	13	13	13	15	15

Dimensions shown in grey area are millimeters while non-shaded areas are inches.

PIPING RECOMMENDATIONS



THE APPLICATION OF PUMPS TO LIQUEFIED GAS TRANSFER

Of the many hundreds of pump manufacturers in the United States, only a handful recommend their equipment for transferring liquefied gases. There are various reasons for this, but the basic problem has to do with the nature of a liquefied gas. The specific peculiarity of a liquefied gas is that a liquefied gas is normally stored at its boiling point ... exactly at its boiling point! This means that any reduction in pressure, regardless of how slight, or any increase in temperature, no matter how small, causes the liquid to start to boil. If either of these things happen in the inlet piping coming to the pump, the pump performance is severely affected. Pump capacity can be drastically reduced, the pump can be subjected to severe wear and the mechanical seal and the pump may run completely dry, causing dangerous wear and leakage.

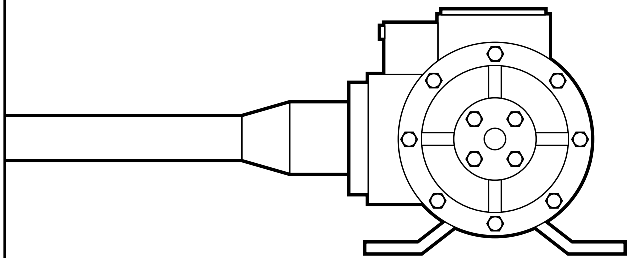
Although we cannot change the nature of the liquefied gas, there are many things we can and must do to design an acceptable liquefied gas pumping system.

Many of these design hints are incorporated in the accompanying illustrations. You will note that each drawing is over-simplified and illustrates just one principle. Normal fittings, strainers, unions, flex lines, valves, etc. have been ignored so that just that portion of the piping which applies to the problem is shown. Do not pipe a plant from these incomplete illustrations! You should also note that all of these rules can be violated to a degree and still have a workable pumping system. You may see several places where your plant is at variance from some of these. However, you should be aware that every violation is reducing your pumping efficiency and increasing your pump maintenance cost. The principles apply to all makes and styles of liquefied gas pumps ... rotary positive displacement, regenerative turbine or even centrifugal types.

This booklet is used in Corken Training Schools. Corken cooperates with gas marketers, trade associations and other groups to conduct complete training schools for persons involved in the transfer of liquefied gases. These presentations include product information, safety, plant design and servicing equipment. Other information is available in various sections of the Corken catalog.

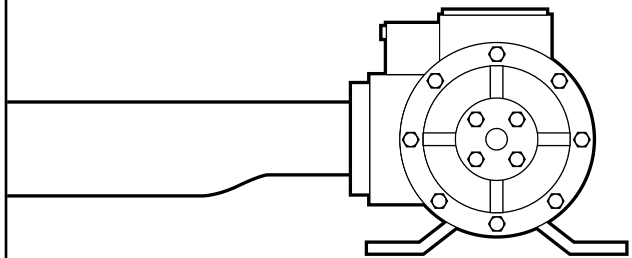
PIPING RECOMMENDATIONS

1 No!



Do not use restricted inlet line!

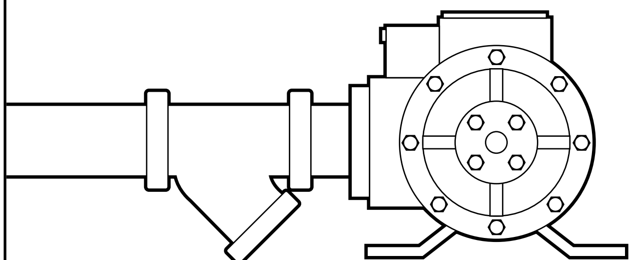
2 Yes!



Use inlet line larger than pump suction nozzle. Same size as nozzle OK on short runs.

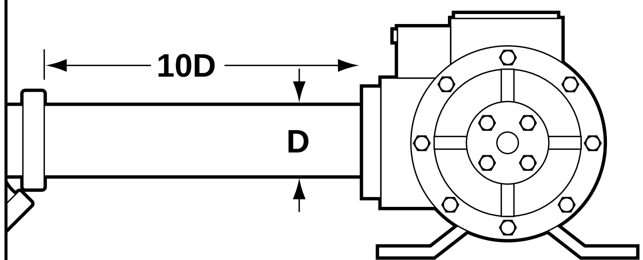
Pressure drop caused by restriction in suction line will cause vaporization and cavitation.

3 No!



Do not locate restrictive fittings or elbows close to pump inlet.

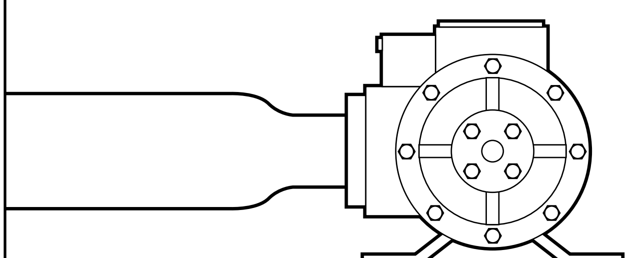
4 Yes!



Best rule is 10 pipe diameters straight pipe upstream from pump! (not always possible)

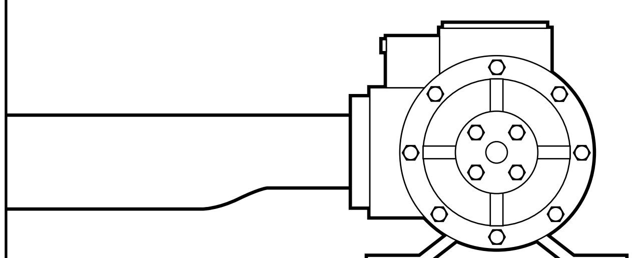
Turbulence caused by flow interference close to the pump accentuates incipiant cavitation.

5 No!



Concentric Reducer.

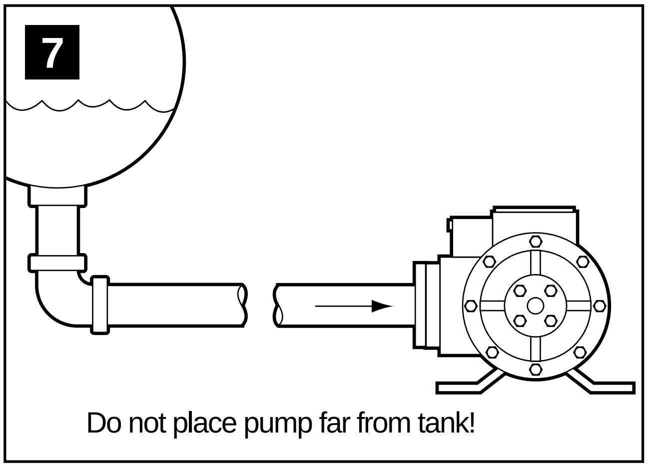
6 Yes!

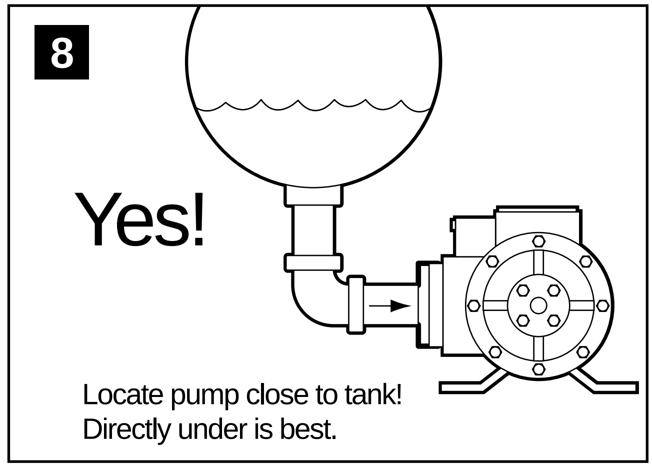


Eccentric Reducer.

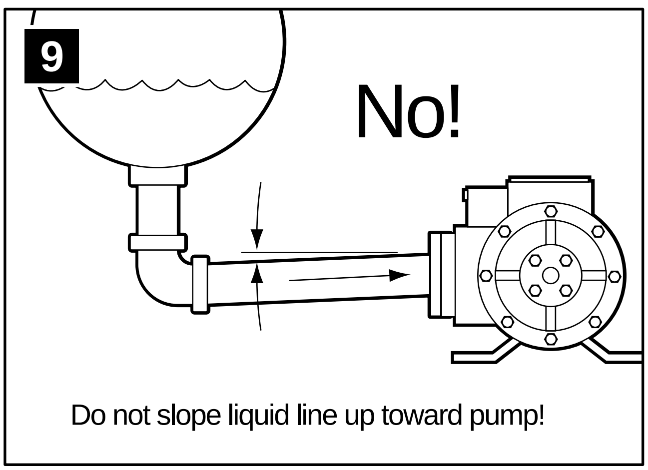
An eccentric reducer should always be used when reducing into any pump inlet where vapor might be encountered in the pumpage. The flat upper portion of the reducer prevents an accumulation of vapor that could interfere with pumping action.

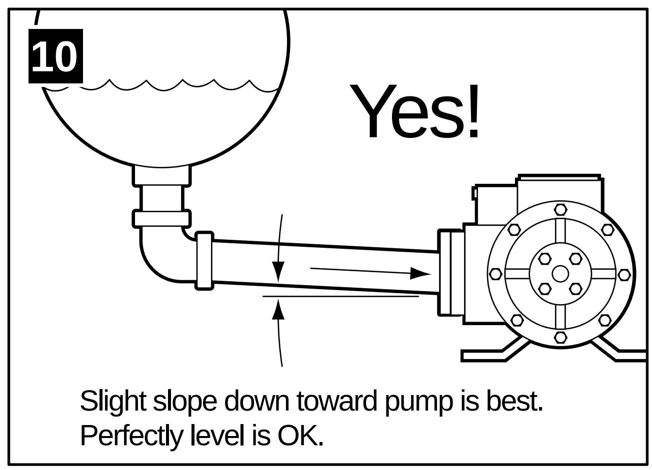
PIPING RECOMMENDATIONS



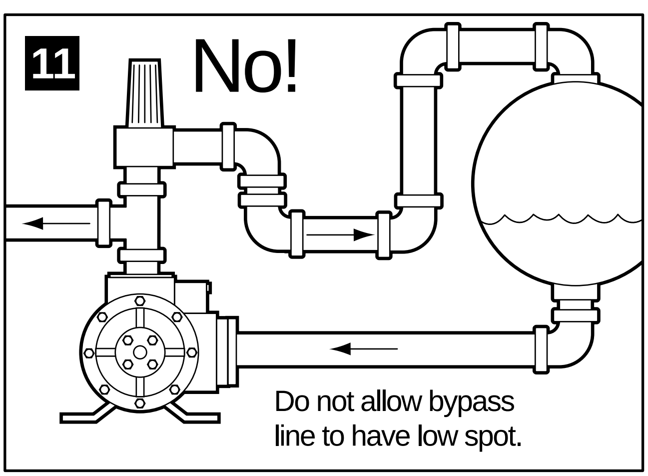


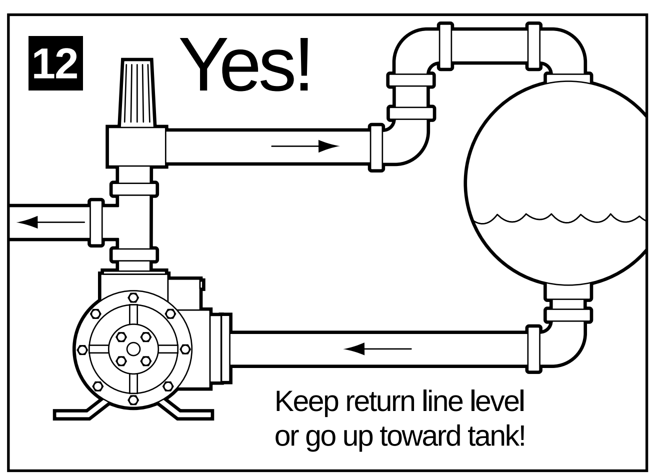
When possible, it is best to allow the pump to be fed by gravity flow to give stable, trouble-free operation.





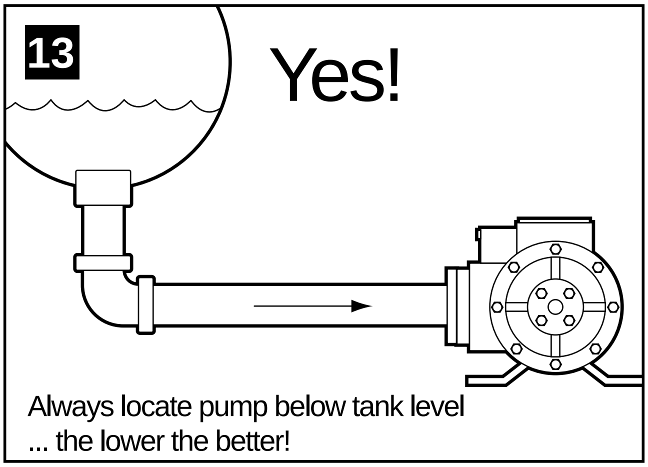
Vaporization in the pump inlet line can displace liquid in the pump so that pump may start up in a dry condtition. A slope back toward the tank of only an inch or two in a 10 foot run will allow vapor to gravitate back into the tank and be replaced with liquid.

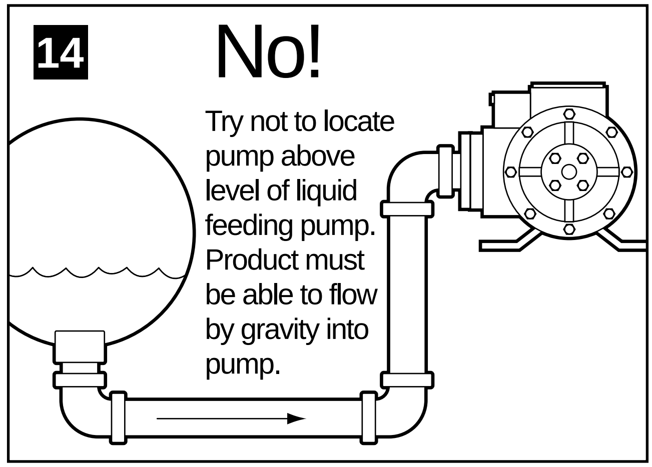




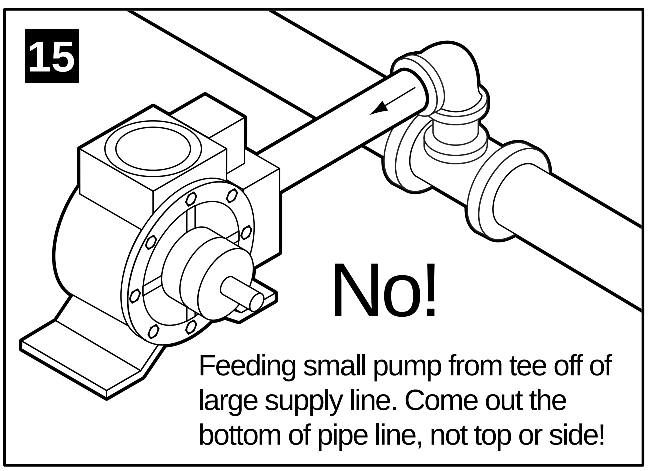
Low spots in bypass line can collect liquid which prevents normal vapor passage for priming purposes just like the P trap in the drain of a kitchen sink. This is not a problem for bypass lines where vapor elimination is not required.

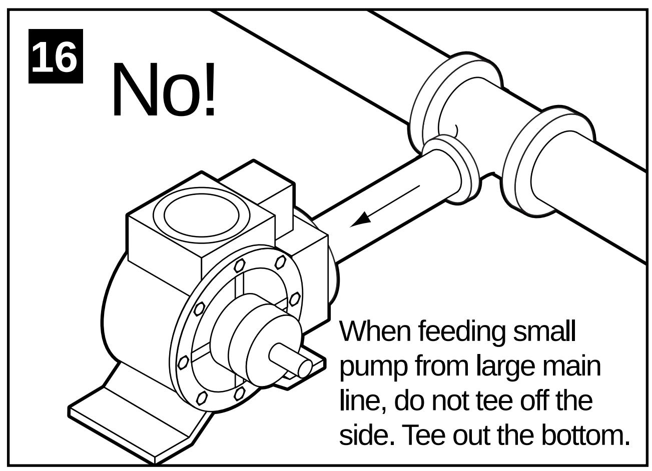
PIPING RECOMMENDATIONS



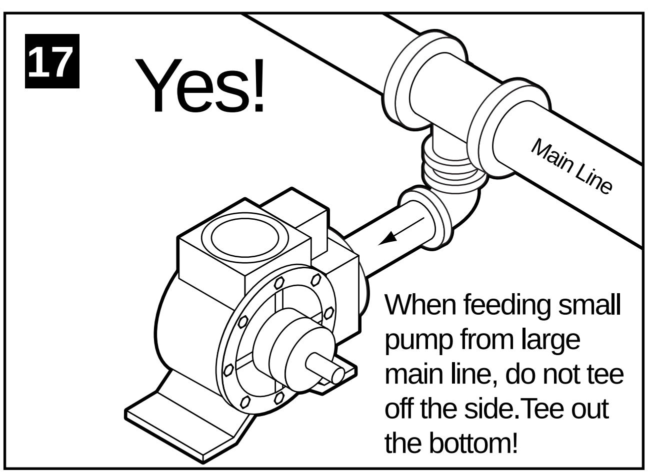


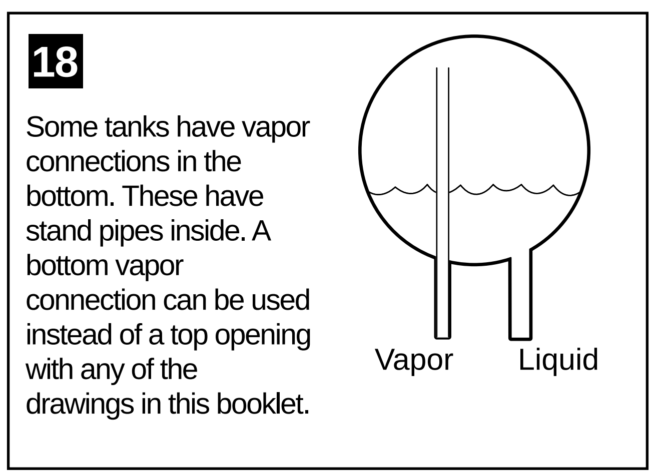
Since liquefied gases boil when drawn into a pump by its own suction, the pump must be fed by gravity flow to give stable, trouble-free operation.



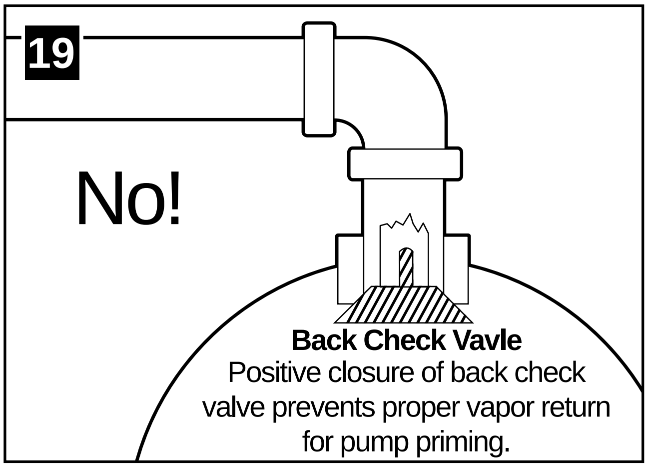


Low capacity flow through large lines often does not sweep out vapor. Flow occurs like liquid in a flume. Drawings 15 and 16 would allow vapor slugs to be drawn into the small pump causing erratic performance. Drawing 17 shows the best chance for stable feed into a small pump from a large line.

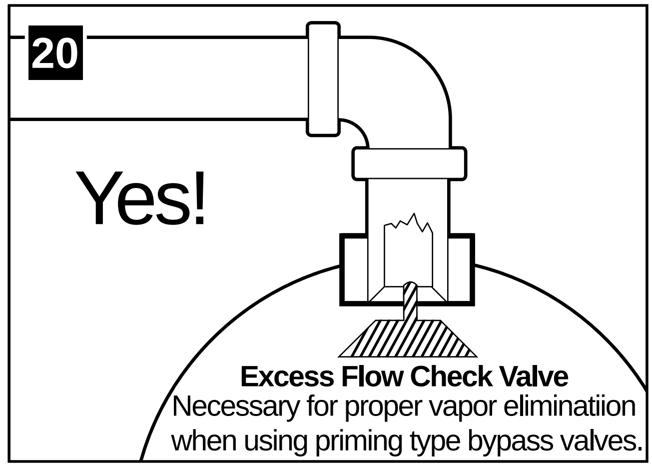




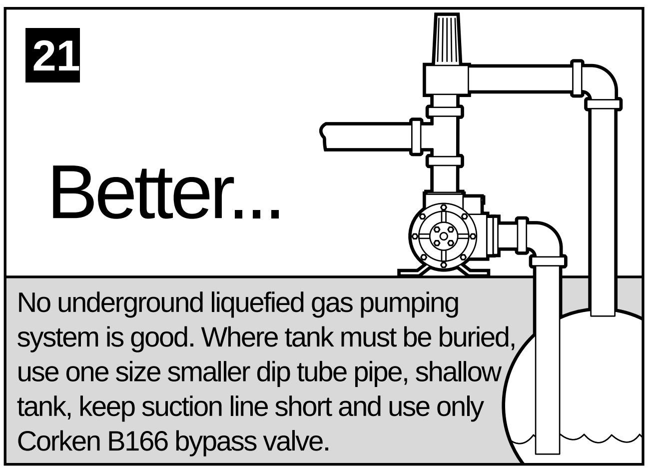
PIPING RECOMMENDATIONS



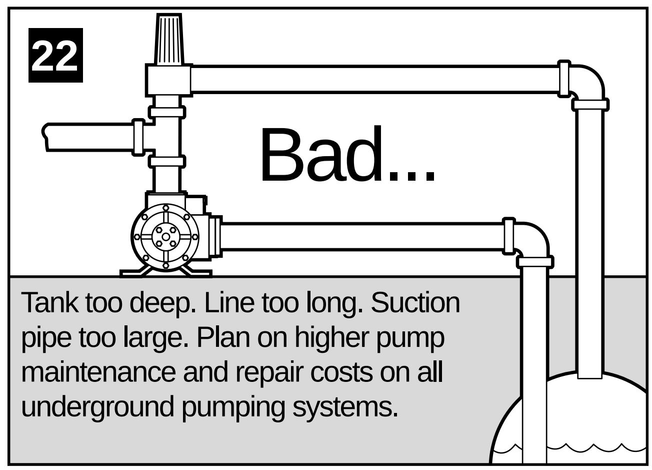
Positive closure of back check valve prevents proper vapor return for pump priming.



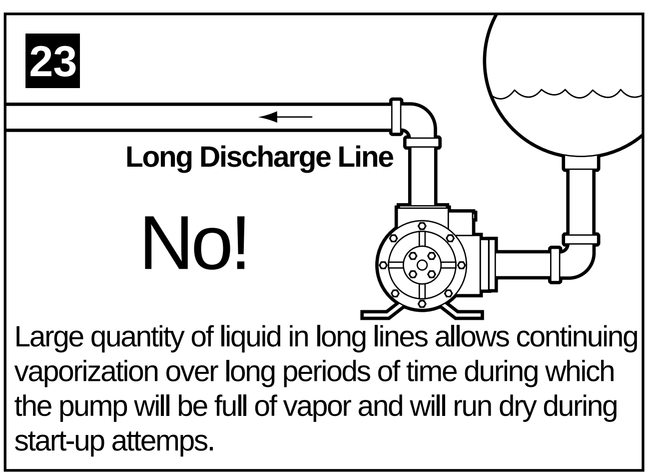
Necessary for proper vapor eliminatiion when using priming type bypass valves.



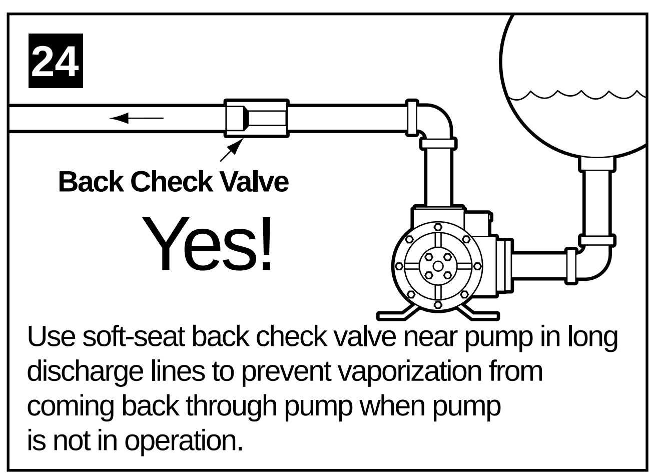
No underground liquefied gas pumping system is good. Where tank must be buried, use one size smaller dip tube pipe, shallow tank, keep suction line short and use only Corken B166 bypass valve.



Tank too deep. Line too long. Suction pipe too large. Plan on higher pump maintenance and repair costs on all underground pumping systems.



Large quantity of liquid in long lines allows continuing vaporization over long periods of time during which the pump will be full of vapor and will run dry during start-up attemps.

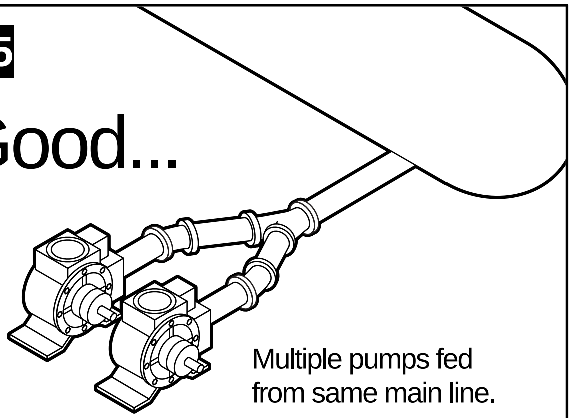


Use soft-seat back check valve near pump in long discharge lines to prevent vaporization from coming back through pump when pump is not in operation.

PIPING RECOMMENDATIONS

25

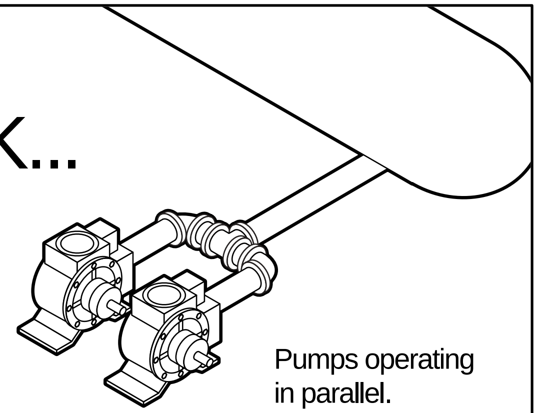
Good...



Multiple pumps fed from same main line.

26

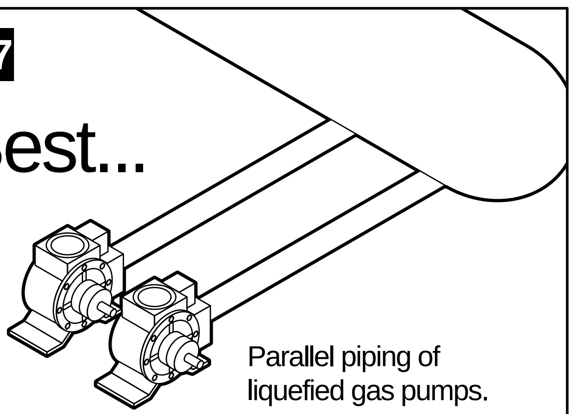
OK...



Pumps operating in parallel.

27

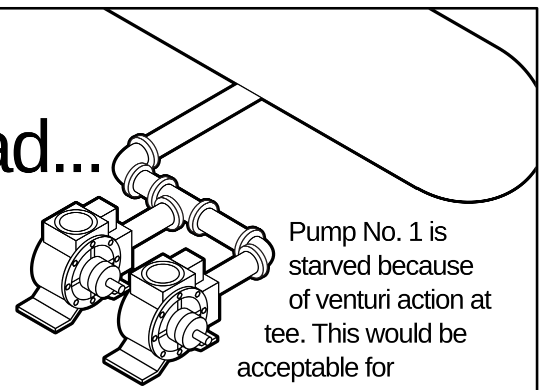
Best...



Parallel piping of liquefied gas pumps.

28

Bad...

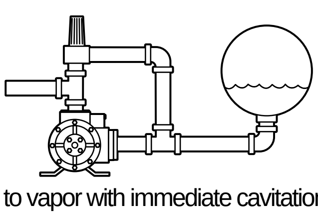


Pump No. 1 is starved because of venturi action at tee. This would be acceptable for installations where both pumps would never operate at the same time.

Inquire about Corken's Duplex-Series Pump Set.

29

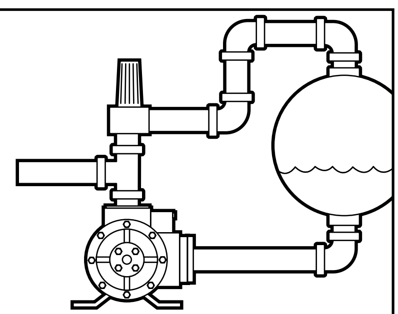
No!



Do not pipe bypass line back into suction piping! Heat buildup in recirculated products causes flashing of liquid to vapor with immediate cavitation and ultimate dry-running. This is why the bypass relief valves which are built into many positive displacement pumps should not be used for normal bypass action when handling liquefied gases. The internal valve should be considered to be a back-up safety relief in addition to a back-up safety relief in addition to a back-up safety relief in addition to a back-to-tank bypass valve and should be set to relieve at a pressure 10 to 20 psi higher than the working bypass. Some built-in bypass valves have the capability of being piped back-to-tank so check with the pump manufacturer.

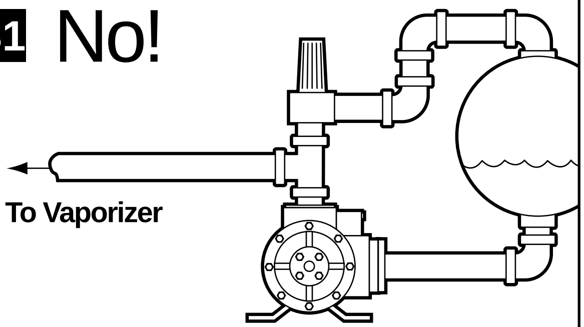
30

Yes!



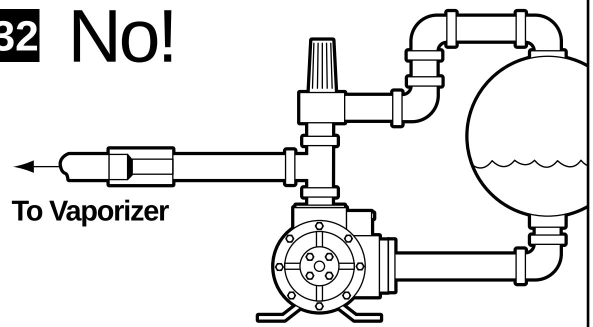
Always pipe bypass back to tank! Make sure bypass line is large enough to handle full pump flow without excessive pressure build-up. Note that bypass line must be capable of bypassing full pump capacity without excessive pressure build-up. High pressure rise can cause bypass valve to chatter and vibrate.

31 No!



Back check must be located to allow back-flow into tank from vaporizer.

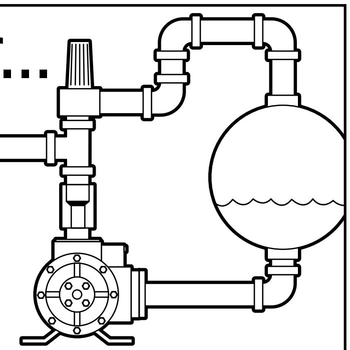
32 No!



Back check must be located to allow back-flow into tank from vaporizer.

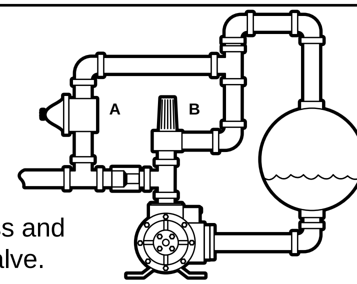
33 Better...

To Vaporizer



Back check valve protects pump but allows back flow through bypass valve into storage tank. Use back check without spring loaded valve to allow normal vapor elimination.

34 Best



Where A is a constant pressure bypass control valve and B is Corken B166 bypass and vapor elimination valve. Valve A is a fixed pressure bypass like the Fisher 98H which limits the feed pressure into the vaporizer to a specific value regardless of system vapor pressure. A differential difference in pressure exists between the pump discharge and the tank. Differential valve B must be set to the maximum acceptable differential of the pump while fixed pressure valve A is set for the vaporizer pressure requirement.

35

Corken B166 Bypass Valve Functions.

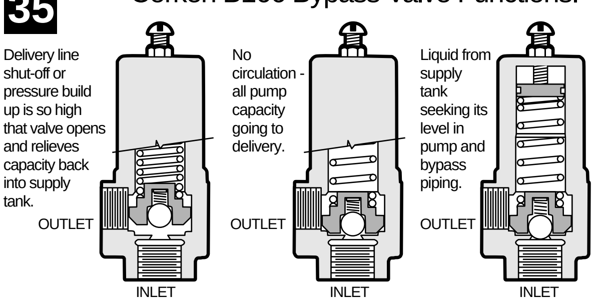
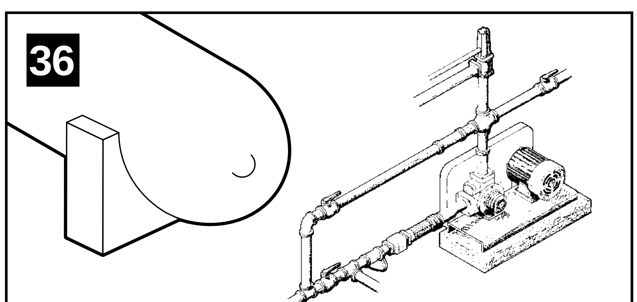


FIG. 1 Relieving Operation OPEN	FIG. 2 Pumping Operation CLOSED	FIG. 3 Priming Operation OPEN

For pump capacities under 100 GPM, use a bypass valve with built-in vapor elimination where possible. Like Corken's B166 or T166 valves.

36



Some bypass valves, like the Corken B177, require tank pressure sensing lines. Check instructions for your valve.

THE CORKEN B166 BYPASS VALVE

Your new Corken B166 valve (Figure 1) is a patented, dual purpose automatic priming and differential bypass valve especially designed for high pressure volatile liquid service, but it is suitable also as a bypass valve for handling stable liquids. The B166 valve was developed for use with the Corken Coro-Flo® turbine regenerative pumps to keep the pump primed at all times and to act as a differential bypass when needed. The B166 is also ideal for centrifugal and other pumps.

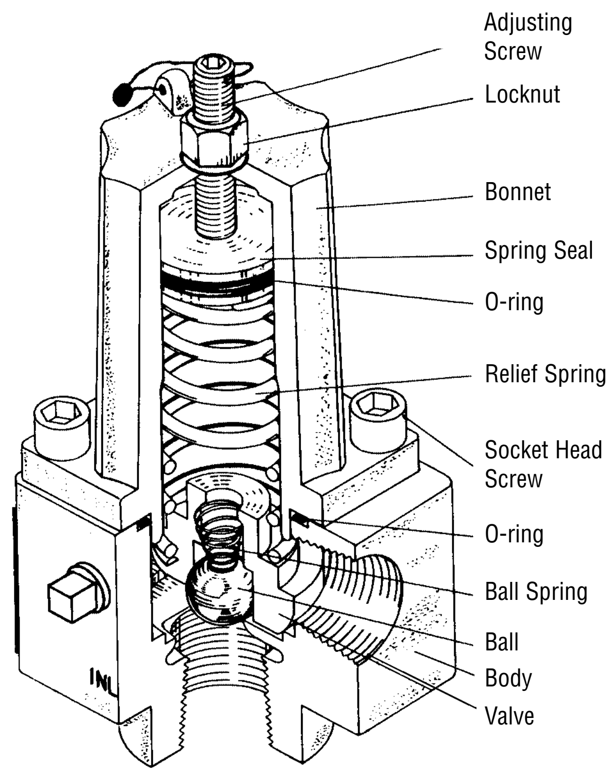


Figure 1

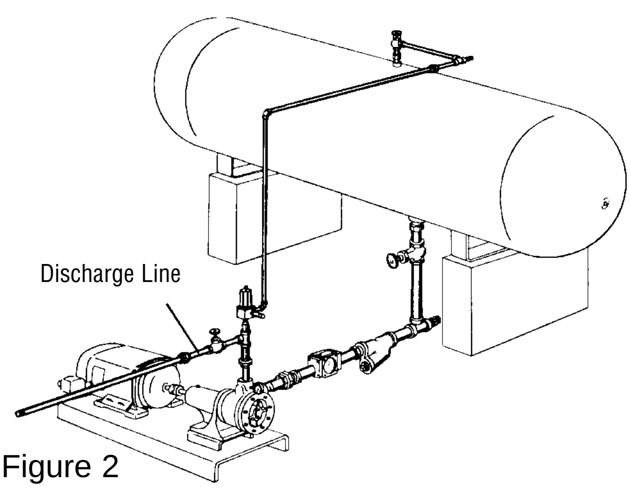


Figure 2

INSTALLATION OF B166 VALVE

Proper installation of the Corken B166 valve will ensure optimum performance of the pump as well as the valve. Install your B166 valve on the discharge side of the pump, either vertically or horizontally. All Corken Coro-Flo® turbine pumps have a 3/4" NPT opening in the discharge nozzle for piping this valve. For other pumps a tee in the discharge line must be provided. The discharge piping from the valve must go to the vapor section of the supply tank into an excess flow valve, not a back check valve. The typical installation is shown in Figure 2. The recommended valve discharge pipe line sizes are given in the table below. For distances of 50 ft. or more, the next larger pipe size should be used.

Recommended Valve Discharge Line Sizes

Flow Rate	B166 Valve Size	
GPM	3/4"	1"
Up to 20	3/4"	3/4"
Up to 40	1"	1"

ADJUSTMENT OF CORKEN B166 VALVE

The proper setting of the valve must be made at the time of installation. Start the pump and circulate liquid through the valve back to the tank. Turn the valve adjusting screw out (counterclockwise) to decrease the pressure and in (clockwise) to increase the pump discharge pressure.

Adjust the valve to open at the maximum pump pressure required to fill all containers.

Tighten the lock nut and permit the pump to circulate liquid through the valve. On stationary applications, if the motor overload protection device stops the motor, readjust the valve by turning the screw out another turn or two.

Once a satisfactory pressure adjustment has been made, attach the "tamper-proof" seal furnished with your valve to prevent unauthorized valve adjustment. On installations where the pump has an internal safety relief valve, the B166 bypass valve should be set at a pressure slightly lower than the pump internal safety relief valve.

THE CORKEN T166 BYPASS VALVE

Your new Corken T166 valve (Figure 3) has been especially designed for use with delivery truck pumps to control the pump discharge pressure and to bypass excess liquid back to the truck tank. It is also quite satisfactory for service with any positive displacement pump within its capacity range and has been used in many stationary installations.

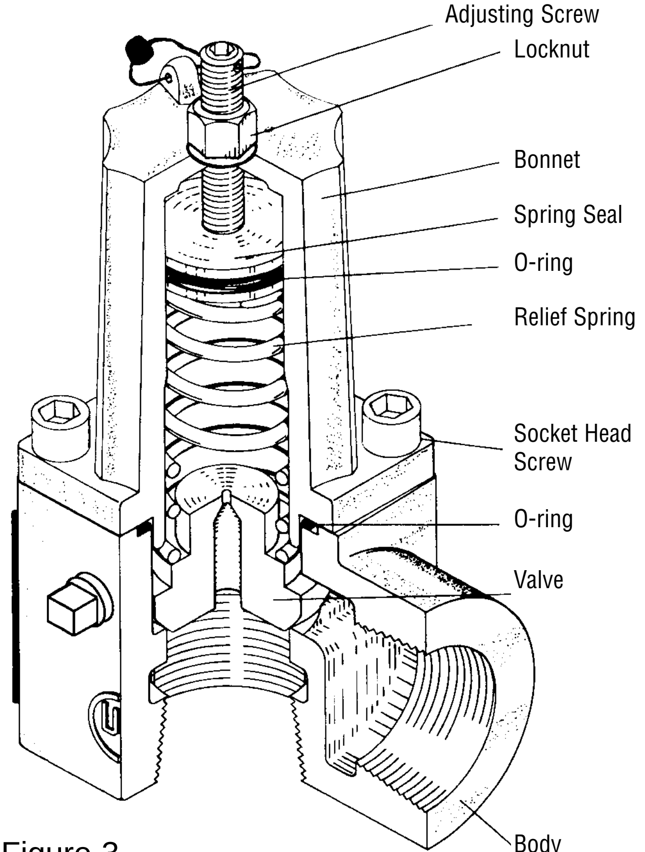


Figure 3

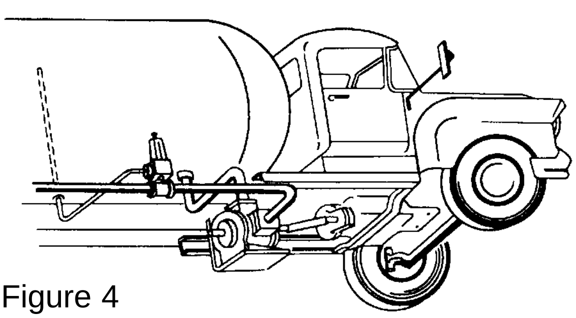


Figure 4

INSTALLATION OF T166 VALVE

Proper installation of the Corken T166 valve will ensure optimum performance of the pump as well as the valve. Install your T166 valve on the discharge side of the pump, either vertically or horizontally. The discharge piping from the valve should go to the vapor section of the truck tank into a filler type valve or a back check valve. A typical truck installation is shown in Figure 4. When the valve is being used for vapor venting on stationary applications using pumps with internal safety relief valves, the piping should be the same as that used for the Corken B166. The recommended valve discharge pipe line sizes are given in the table below. For distances of 50 ft. or more, the next larger pipe size should be used.

Recommended Valve Discharge Line Sizes

Flow Rate GPM	T166 Valve Size 1-1/4"	1-1/2"
Up to 40	1-1/2"	1-1/2"

ADJUSTMENT OF CORKEN T166 VALVE

The proper setting of the valve must be made at the time of installation. Start the pump and circulate liquid through the valve back to the tank. Turn the valve adjusting screw out (counterclockwise) to decrease the pressure and in (clockwise) to increase the pump discharge pressure.

Adjust the valve to open at the maximum pump pressure required to fill all containers. This is typically around 100 psi differential.

Tighten the lock nut and permit the pump to circulate liquid through the valve. On stationary applications, if the motor overload protection device stops the motor, readjust the valve by turning the screw out another turn or two.

Once a satisfactory pressure adjustment has been made, attach the "tamper-proof" seal furnished with your valve to prevent unauthorized valve adjustment. On installations where the pump has an internal safety relief valve, the T166 bypass valve should be set at a pressure slightly lower than the pump internal safety relief valve.

Warranty Information

ONE YEAR LIMITED WARRANTY

Corken, INC. warrants that its products will be free from defects in material and workmanship for a period of 12 months following date of purchase from Corken.

Corken products which fail within the warranty period due to defects in material or workmanship will be repaired or replaced at Corken's option, when returned, freight prepaid to Corken, INC., 3805 N.W. 36th St., Oklahoma City, Oklahoma 73112.

Parts subject to wear or abuse, such as mechanical seals, blades, piston rings, valves and packing, and other parts showing signs of abuse, neglect or failure to be properly maintained are not covered by this limited warranty. Also, equipment, parts and accessories not manufactured by Corken but furnished with Corken products are not covered by this limited warranty and the purchaser must look to the original manufacturer's warranty, if any. This limited warranty is void if the Corken product has been altered or repaired without the consent of Corken.

All implied warranties, including any implied warranty of merchantability or fitness for a particular purpose, are expressly negated to the extent permitted by law and shall in no event extend beyond the expressed warrantee period.

Corken DISCLAIMS ANY LIABILITY FOR CONSEQUENTIAL DAMAGES DUE TO BREACH OF ANY WRITTEN OR IMPLIED WARRANTY ON Corken PRODUCTS. Transfer of toxic, dangerous, flammable or explosive substances using Corken PRODUCTS is at the user's risk. Such substances should be handled by experienced, trained personnel in compliance with governmental and industrial safety standards

PRICES

All prices are f.o.b. factory at Oklahoma City U.S.A. Prices quoted are for acceptance within 30 days, but in the meantime may be changed upon proper notice. Prices of equipment for future delivery will be those in effect at time of shipment.

TERMS

Standard terms for all sales are net payment within thirty (30) days from the date of invoice unless it is the judgment of Corken that the financial condition of the purchaser warrants other terms. In the event the purchaser fails to make payment in accordance with the conditions specified, the purchaser shall pay interest on the amount due at the rate of 1.5 percent per month.

DESIGN

It is Corken's intention to continually improve the design and performance of its products as new ideas, new practices and new materials become available. Therefore, all published designs, specifications and prices are subject to minor modifications at the time of manufacture to coincide with this policy, without prior notice to the purchaser. If the equipment purchased is to be used in an existing installation to match previously purchased equipment, material will be furnished to be interchangeable as near as may be feasible, but Corken reserves the right to substitute materials and designs.

SHIPMENTS

The prices shown include standard crating or packaging for normal rail or commercial truck shipments within the borders of the continental United States, Canada and Mexico. Consult factory for export crating charges. All promises of shipment are estimates contingent upon strikes, fires, elements beyond our control or manufacturing difficulties, including the scheduled shipping dates of materials from our suppliers.

CANCELLATION CHARGES

There will be a minimum cancellation charge of 15 percent of the net price for any order which is cancelled after having been accepted and officially acknowledged by Corken. In the event there is material involved that is manufactured by others, and is being purchased by Corken for the sole purpose of becoming part of this canceled order, the cancellation charges assessed Corken by these other manufacturers shall be borne by the purchaser.

If shipment has already been made before notice of cancellation, the purchaser will be charged all the freight costs involved in the handling of the order, including the charges necessary to get the equipment back to the respective warehouses of Corken and its suppliers, in addition to the cancellation charge described above.

RETURNED MATERIAL

Material may be returned to the factory ONLY if there is prior written authorization from Corken and accompanied by a Corken CSC number and the freight is paid by the shipper.

Material that is authorized for return will be inspected when received, and if it is of current design, unused, and in first-class resalable condition, credit will be allowed on the basis of the original invoice value less restocking charges. Returned material that is found to be worn, or in damaged condition, will not be accepted. The customer will be notified of this, and return shipping instructions, or permission to scrap such items will be requested. If no instructions are received within sixty (60) days after such notice, the material will be scrapped. Outside purchased materials and equipment may be returned for credit ONLY by Corken's prior written authorization, and must be in new and undamaged resalable condition, and of current design. Such returned materials are subject to a MINIMUM restocking charge of 25 percent.

LITERATURE

Corken will furnish, upon request and without charge to the purchaser, six copies of paper prints of standard drawings, performance curves, and other current literature covering the pump or compressor and/or such other descriptive material that good judgment would consider necessary. Any additional material and/or special drawings will be charged for at appropriate rates determined by Corken. See Corken optional services in price pages for details.

FACTORY INSPECTION AND TESTS

Each article of Corken's manufacture passes a standard factory inspection and operating test prior to shipment. Special factory inspections, tests and/or certified test reports are all subject to a factory charge available upon request.

LIABILITY FROM USE OF PRODUCT

Corken has no control over the ultimate use of its products and specifically disclaims any liability damage, loss or fines which may arise from the use thereof. The user and purchaser shall hold Corken harmless from such damage, loss or fines. The user and purchaser shall determine the suitability of Corken products for the use intended and issue adequate safety instructions therefore.

Compliance with the Occupational Safety and Health Act and similar laws and regulations shall be the responsibility of the user of the product and not the responsibility of Corken.

MULTIPLY	BY	TO OBTAIN
Bar	33.456	Feet H_2O @ 39°F
Bar	29.530	In. Hg @ 32°F
Bar	1.0197	kg/cm^2
Bar	14.504	$Pounds/in^2$
Centimeters	0.3937	Inches
Centimeters	0.01	Meters
Centimeters	10	Millimeters
Centipoise	0.001	Pascal - second
Centipoise	0.01	Poise
Centistokes	0.01	Sq. cm / sec.
Centistokes	0.01	Stokes
Feet	30.48	Centimeters
Feet	0.166667	Fathoms
Feet	3.0480×10^{-4}	Kilometers
Feet	304.8	Millimeters
Feet	12	Inches
Feet	0.3048	Meters
Feet	1/3	Yards
Feet of water	0.0295	Atmospheres
Feet of water	0.8826	Inches of mercury
Feet of water	304.8	Kgs. / sq. meter
Feet of water	62.43	Lbs. / sq. ft.
Feet of water	0.4335	Lbs. / sq. inch
Gallons	3785	Cubic centimeters
Gallons	0.1337	Cubic feet
Gallons	231	Cubic inches
Gallons	3.785×10^{-3}	Cubic meters
Gallons	4.951×10^{-3}	Cubic yards
Gallons	3.785	Liters
Gallons	8	Pints (liq.)
Gallons	4	Quarts (liq.)
Gallons - Imperial	1.20095	U.S. gallons
Gallons - U.S.	0.83267	Imperial gallons
Gallons / min.	2.228×10^{-3}	Cubic feet / sec.

NOTE: Gallon - designates to the U.S. gallon. To convert into the Imperial gallon, multiply the U.S. gallon by 0.83267.

Product Application Form

Company Name and Location

Submitted By: Date:

Phone Number: FAX Number:

COMPRESSOR

Gas: (if mixture, provide % breakdown)

Inlet Pressure: psig Outlet Pressure: psig

Inlet Temperature: °F

Volume (flow rate) (scfm, acfm, nm_3/hr, m^3/hr, etc.)

Duty Cycle: ☐ Continuous ☐ Intermittent

Atmospheric Pressure: psia

Oil Free Compression Required? ☐ Yes ☐ No

PUMP

Liquid: Specific Gravity:

Discharge Pressure: psig Inlet Temperature: °F

Differential Pressure: psig Viscosity:

Flow Rate: m^3/hr, gal/ltr (per. minute) NPSHA:

Power Available: Phase Hz Voltage

APPLICATION SUMMARY

NOTES

End Use: End User:

Solutions beyond products...

CORKEN®

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CP370C

Printed in the U.S.A.
October 2002