HAYWARD®

FLOW CONTROL

Engineering Product Guide

define
design
deliver

Company History and Reputation

Hayward® Flow Control, a division of Hayward Industries, Inc., has been manufacturing industrial thermoplastic valves and process control products for more than 50 years. We have remained committed to producing the highest quality products while providing outstanding service that exceeds customer expectations. Hayward has earned an unsurpassed reputation for product design, manufacturing precision, quality assurance, experience and know-how and a total commitment to customer satisfaction and support.

Irving M. Hayward formed Hayward Industries in 1923. It was a small company, located in Brooklyn, NY, making specialty metal valves and industrial flow control products. When Mr. Hayward retired in 1964, its present management acquired the company. With that, a new period of growth and diversification began, one that continues to this day. Management realized an opportunity existed for thermoplastic, rather than metal, swimming pool filters and accessories and diversified into the swimming pool market. Rapid growth in the pool business resulted in the creation of Hayward Pool Products, Inc. At the same time, through a combination of acquisitions, modernization of the manufacturing facilities and product innovations, the industrial thermoplastic valve and pipeline strainer business grew as well—and became Hayward Flow Control.

Hayward's 2 Year Product Warranty

1. Hayward Flow Control (Hayward) guarantees its products against defective material and workmanship only. Hayward assumes no responsibility for property damage or personal injury resulting from improper installation, misapplication or abuse of any product.
2. Hayward assumes no responsibility for property damage or personal injury resulting from chemical incompatibility between its products and the process fluids to which they are exposed. Determining whether a particular PVC, CPVC or PP product is suitable for an application is the responsibility of the user. Chemical compatibility charts provided in Hayward literature are based on ambient temperatures of 70°F non-shock and are for reference only.
3. Hayward products are designed for use with non-compressible liquids.

   WARNING: *HAYWARD PVC AND CPVC PRODUCTS SHOULD NEVER BE USED OR TESTED WITH COMPRESSIBLE FLUIDS SUCH AS COMPRESSED AIR OR NITROGEN. USE OF PVC AND CPVC PRODUCTS IN COMPRESSIBLE FLUID APPLICATIONS MAY RESULT IN PRODUCT DAMAGE, PROPERTY DAMAGE, PERSONAL INJURY OR EVEN DEATH.*
4. The maximum recommended fluid velocity through any Hayward product is eight feet per second (8 ft/s). Higher fluid velocity can result in damage due to the water hammer effect.
5. Piping systems must be designed and supported to prevent excess mechanical loading on Hayward products due to system misalignment, weight, shock, vibration and the effects of thermal expansion and contraction.

6. The effect of temperature on plastic piping systems must be considered when the systems are initially designed. The pressure rating of plastic systems must be reduced with increasing temperature. Maximum operating pressure is dependent upon material selection as well as operating temperature. Before installing any Hayward product, consult Hayward product literature for pressure vs. temperature curves to determine any operating pressure or temperature limitations.
7. PVC and CPVC plastic products become brittle below 40°F. Use caution in their installation and operation below this temperature.

   WARNING: *HAYWARD PVC AND CPVC PRODUCTS SHOULD NOT BE USED IN SERVICES WITH OPERATING TEMPERATURE BELOW 34°F.*
8. Due to differential thermal expansion rates between metal and plastic, transmittal of pipe vibration and pipe loading forces, DIRECT INSTALLATION OF PLASTIC VALVES INTO METAL PIPING SYSTEMS IS NOT RECOMMENDED. Wherever installation of plastic valves into metal piping systems is necessary, it is recommended that at least 10 pipe diameters in length of plastic pipe be installed upstream and downstream of the plastic valve to compensate for the factors mentioned above.
9. Published operating torque requirements are based on testing of new valves using clean water at 70°F non-shock. Valve torque is affected by many factors including fluid chemistry, viscosity, flow rate and temperature. These should be considered when sizing electric or pneumatic actuators.
10. Systems should always be depressurized and drained prior to installing or maintaining any Hayward product.

BACKED BY HAYWARD FLOW CONTROL'S EXCLUSIVE TWO YEAR WARRANTY

The Benefits Of Hayward® Thermoplastic Flow Control Products

Since the introduction of PVC in the U.S. during the 1940s, thermoplastic valves, pipe and fittings have gained broad acceptance. Thermoplastic valves, pipes and fittings are often the material of choice for systems that were traditionally designed in metal. Unlike metal, thermoplastic valves and piping components have a high resistance to corrosion, will not scale or rust and will not contaminate sensitive fluids.

Hayward manufactures products from compounds of PVC, CPVC, natural PP, glass filled PP (GFPP), PVDF, Eastar® and Polyetherimide. These materials are nonconductors and, as such, are immune to electrolytic and galvanic corrosion. Equally important, they contain nothing to leach out and contaminate sensitive fluids. Benefits of Hayward thermoplastic valves and process control products include:

NONTOXIC

Hayward PVC and CPVC products are suitable for use with potable water and are consistent with National Sanitation Foundation (NSF) and Canadian Standards Association (CSA) requirements. Hayward products are made to ASTM and ANSI standards. See specific products in this catalog for NSF/ANSI 61 compliance.

CORROSION RESISTANCE

Hayward thermoplastic flow control products are immune to corrosion. They are dielectric, meaning they will not support a charge, and will remain free from the ionization and corrosion that occurs with metal valves.

EXTENDED SERVICE LIFE

Hayward thermoplastic valves will outlast most metal valves and are not affected by normal weather conditions. They will provide years of maintenance-free service.

LOW THERMAL CONDUCTIVITY

Hayward thermoplastic valves have much less thermal conductivity than metal valves so that heat gain or loss is greatly reduced. Pipe insulation is rarely required for thermoplastic piping systems.

IMPROVED FLOW RATES

Hayward thermoplastic valves have a high flow coefficient and, as compared to metal, will absolutely not pit, rust or corrode. Their interior walls are molded with an ultra-smooth finish that will remain smooth throughout the valve's service life—resulting in a more consistent flow rate over time.

HIGH TEMPERATURE SERVICE

Hayward process control products are capable of handling corrosive chemicals at elevated temperatures—up to 250°F with glass filled PP (GFPP).

EASY INSTALLATION

Hayward thermoplastic valves and process control products are generally 1/3 to 1/2 the weight of similar size and type metal valves. They are simple to install and result in reduced handling, labor and installation costs.

CONSERVATION

Hayward thermoplastic valves and flow controls are energy efficient. The use of natural resources or fuels to produce a Hayward thermoplastic valve is half that of a comparative size metal one.

ECONOMICS

When evaluating the economics of Hayward thermoplastic valves and flow control products over metal equals, consider not only the initial cost savings, but the reduced freight, lower installation and maintenance costs, and the extended service life of the valves. Hayward thermoplastic valves and flow controls are a cost-effective alternative to metal products.

NSF/ANSI Standard 61 is a standard defining the requirements for products that are destined for use in drinking water systems. In summary, the standard requires immersion testing of all products that will come into contact with drinking water for any elements (i.e., lead, mercury, cadmium, etc.) that may leach into the water that passes through the product. Many of Hayward's standard products underwent testing to this standard in 2007, and are now NSF listed products.

NSF/ANSI Standard 50 provides a comprehensive product evaluation for health effects safety, performance validation and safety for factors such as burst, sustained pressure, cyclic pressure, head loss, UV resistance, tensile strength, impact and load testing, turbidity reduction, filtration efficacy, bacterial disinfection efficacy, cyst inactivation, durability or life testing, chemical resistance, corrosion resistance and electrical safety.

This applies to various filter media diatomite and other pre-coat media filters, granular media filters, cartridge filters, skimmers, pumps, valves, suction fittings or other equipment that may be used in pools, spas and other recreational water facilities.

Hayward's products that are NSF 61 and NSF 50 listed can easily be found on the NSF website at www.NSF.org.

– Eastar is a registered trademark of Eastman.
– Hastelloy is a registered trademark of Haynes International, Inc.
– Monel is a registered trademark of Special Metals Corporation.
– Santoprene is a registered trademark of Advanced Elastomer Systems.

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Material Description

PVC (POLYVINYL CHLORIDE)
Type 1, Grade 1 PVC is the most frequently specified of all plastic valve materials. It has been successfully used for over 40 years in such areas as chemical processing, industrial plating, chilled water, deionized water lines, chemical drainage, DWV piping and irrigation systems. PVC is generally inert to most mineral acids, bases, salts and paraffinic hydrocarbon solutions. PVC is not recommended for use with chlorinated or aromatic hydrocarbons, esters or ketones. PVC possesses excellent fire performance properties. In particular, it will not burn once the source of heat or flame is removed. PVC has excellent weatherability. The PVC used in Hayward products conforms to ASTM D1784. The maximum recommended working temperature of PVC is 140°F. PVC products can be installed using solvent cement, threaded or flanged end connections.

CPVC (CHLORINATED POLYVINYL CHLORIDE)
CPVC is generally inert to most mineral acids, bases, salts and paraffinic hydrocarbon solutions. CPVC is not recommended for use with chlorinated or aromatic hydrocarbons, esters or ketones. The CPVC used in Hayward products conforms to ASTM D1784-23447B. The maximum working temperature for Hayward products made of CPVC is 190°F at 60 PSI. It has been proven an excellent material for hot corrosive liquids and hot and cold water distribution. CPVC products can be installed using solvent cement, threaded or flanged end connections.

GFPP (GLASS FILLED POLYPROPYLENE)
GFPP is a lightweight material with generally high resistance to chemical attack. It has the highest long-term temperature resistance of any material furnished by Hayward. It has been used successfully for years in such areas as chemical processing, industrial plating, chilled water, deionized water lines, chemical drainage, DWV piping and irrigation systems. GFPP is generally inert to most mineral acids, bases, salts and hydrocarbon solutions. The GFPP material used in Hayward products conforms to ASTM D4101. The maximum recommended working temperature of PP is 250°F. GFPP products can be installed using threaded or flanged end connections.

PP (POLYPROPYLENE)
PP is a member of the polyolefin family of pure hydrocarbon plastics. Even though PP has half the strength of PVC and CPVC, with a design stress of 1,000 PSI at 73°F, it has the most versatile chemical resistance of the thermoplastic materials. PP is superior for concentrated acetic acid or hydroxides. It is also very suitable for milder solutions of most acids, alkalis, salts and many organic chemicals, including solvents. However, PP is not compatible with strong oxidizers, such as the hypochlorites and higher concentrations of sulfuric, nitric and hydrofluoric acids. The PP used in Hayward products conforms to ASTM D4101. The maximum recommended working temperature of PP is 200°F. PP products can be installed using fusion weld, threaded or flanged joinery.

EASTAR®
Eastar is a clear polyester thermoplastic compound having excellent impact strength, chemical resistance and high clarity. It is used in a variety of applications such as chemical processing and ultra-pure industries.

PVDF (POLYVINYLIDENE FLUORIDE)
PVDF is a thermoplastic polymer with excellent corrosion, chemical and abrasion resistance. It has a good mechanical and thermal stability with a maximum operating temperature of 300°F. The material has a high impact resistance and excellent UV resistance. It is used in applications of high purity and chemical processing.

EPDM (ETHYLENE PROPYLENE DIENE MONOMER)
EPDM rubber is an elastomer prepared from ethylene and propylene compounds. It has been used continuously to a temperature of 300°F. The material is recommended for water, steam, dilute acids, dilute alkalis and alcohols. EPDM is not recommended for petroleum oils or diester lubricants.

FPM OR FKM (FLUOROCARBON RUBBER)
The fluorocarbon elastomers have a maximum service temperature of 400°F. Fluorocarbon materials are recommended for petroleum oils, diester base lubricants, silicate fluids and greases, halogenated hydrocarbons, acids and vacuum environments. Fluorocarbon materials are not recommended for ketones, amines, anhydrous ammonia, hot hydrofluoric or chlorosulfonic acids.

NITRILE OR BUNA-N
Nitrile, chemically, is a copolymer of butadiene and acrylonitrile. Nitrile maximum service temperature is 275°F. The material is recommended for petroleum oils and fluids, cold water, silicone greases and oils, diester base lubricants and ethylene glycol base fluids. Nitrile is not recommended for halogenated hydrocarbons, nitro hydrocarbons, phosphate ester hydraulic fluids, ketones, strong acids, ozone and automotive brake fluid.

PTFE (POLYTETRAFLUOROETHYLENE)
PTFE is chemically stable and virtually unaffected by chemicals, acids, bases and solvents. It has a maximum service temperature of 500°F. PTFE is used as a seat material in several lines of Hayward valves due to its low coefficient of friction and chemical stability.

ETFE (ETHYLENE TETRAFLUOROETHYLENE)
ETFE is a fluorocarbon based polymer. It has a very good resistance to solvents and chemicals as well as outdoor weathering. The material has a maximum service temperature of 300°F. It is widely used in the electronics, chemical processing and laboratory testing equipment industries.

Abbreviations

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BS	British Standards
CPVC	Chlorinated Polyvinyl Chloride
CRN	Canadian Registration Number
CSA	Canadian Standards Association
DIN	Deutsches Institut für Normung (German Institute for Standards)
DPDT	Double Pole, Double Throw
EN	European Standards
EPDM	Ethylene Propylene Diene Monomer
ETFE	Ethylene Tetrafluoroethylene
FM	Factory Mutual
FPM	Fluoro Polymer
GPM	Gallons per Minute
GFPP	Glass Filled Polypropylene
IAPMO	International Association of Plumbing and Mechanical Officials
I/P	Instrument Signal to Pressure
ISO	International Standards Organization
LED	Light Emitting Diode
NEMA	National Electrical Manufacturers Association
NPT	American National Standard Taper Pipe Thread
NSF	National Sanitation Foundation
PP	Polypropylene
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch Gauge Pressure
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl Chloride
PVDF	Polyvinylidene Fluoride
SPDT	Single Pole, Double Throw
SPST	Single Pole, Single Throw
UL	Underwriters Laboratories, Inc.

Conversion Factors

LIQUID MEASURE AND WEIGHT

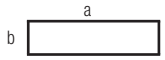
TO OBTAIN MULTIPLY BY	U.S. GALLON	IMPERIAL GALLON	U.S. POUND WATER	U.S. CUBIC FOOT	U.S. CUBIC INCH	LITER	CUBIC METER
U.S. GALLON	1	0.8327	8.337	0.13368	231.0	3.785	0.003785
IMPERIAL GALLON	1.2009	1	10.0	0.16054	277.78	4.546	0.004546
U.S. POUND WATER	0.11995	0.1	1	0.016035	27.708	0.45404	0.000454
U.S. CUBIC FOOT	7.4805	6.2288	62.365	1	1728.0	28.316	0.028314
U.S. CUBIC INCH	0.004329	0.00360	0.3609	0.000578	1	0.016387	0.0000164
LITER	0.26418	0.21997	2.202	0.035315	61.025	1	0.0010
CUBIC METER	264.2	219.99	2202.6	35.3183	61030.0	999.97	1

PRESSURE AND HEAD

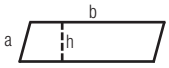
TO OBTAIN MULTIPLY BY	LB/SQ IN	LB/SQ FT	ATMO-SPHERE	KG/SQ CM	IN WATER	FT WATER	IN MERCURY	MM MERCURY	BAR
LB/SQ IN	1	144.0	0.068046	0.070307	27.7276	2.3106	2.0360	51.7150	0.06895
LB/SQ FT	0.006945	1	0.000473	0.000488	0.1926	0.01605	0.014139	0.35913	0.000479
ATMOSPHERE	14.696	2116.22	1	1.0332	407.484	33.9570	29.921	760.0	1.01325
KG/SQ CM	14.2233	2048.16	0.96784	1	394.27	32.864	28.959	735.558	0.9807
IN WATER	0.03607	5.194	0.002454	0.00254	1	0.08333	0.0734	1.865	0.00249
FT WATER	0.43278	62.3205	0.029449	0.03043	12.0	1	0.8811	22.381	0.02984
IN MERCURY	0.49115	70.726	0.033421	0.03453	13.617	1.1349	1	25.40	0.03386
MM MERCURY	0.019337	2.7845	0.0013158	0.0013595	0.5361	0.04468	0.03937	1	0.001333
BAR	14.5038	2088.55	0.98692	1.0197	402.1	33.51	29.53	750.0	1

PRESSURE AND HEAD

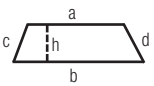
A = Area, S = Surface Area of Solid, V = Volume, C = Circumference, R = Radius of Circumscribed Circle



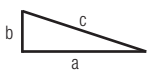
Rectangle
$A = ab$
$C = 2(a + b)$



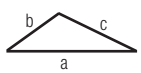
Parallelogram
$A = bh$
$C = 2(a + b)$



Trapezoid
$A = 0.5(a + b)\,h$
$C = a + b + c + d$

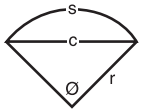


Right Triangle
$A = 0.5\,ab$
$R = 0.5\,c$

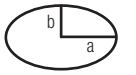


General Triangle
$A = \sqrt{s(s-a)(s-b)(s-c)}$
$R = abc/(0.25A)$

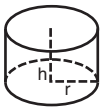
Circle
$A = 3.142r^2$
$C = 6.283r$



Sector of Circle
$S = r\,Ø$
$C = 2r\sin(Ø/2)$
$A\ (\text{sector}) = 0.5\,r\,s$
$A\ (\text{segment}) = 0.5r^2(Ø - \sin Ø)$



Ellipse
$A = 3.142ab$
$C = 6.284\sqrt{[a(a+b)\,b]/2}$



Cylinder
$C = 3.142\,r^2h$
$S = 6.284\,rh$

Cone
$V = 1.047r^2h$
$S = 3.142\,r\sqrt{r(r+h)\,h}$

Sphere
$A = 4.189r^3$
$S = 12.57r^2$

Frustrum of Right Circular Cone
$V = 1.047h[a(a+b)(b+a)b]$
$S = 3.142(a+b)\sqrt{(a-b)}$

Flow Coefficient Cv

Extensive experimentation has shown that, in general, for a given flow passage and completely turbulent flow, the relationship between fluid flow rate and pressure drop follows a power law.

Variable: ΔP = Pressure drop across flow passage (PSI)
Q = Volume flow rate of fluid through passage (GPM)
Cv = Flow coefficient [GPM/PSI$^{1/2}$]

The flow coefficient Cv is the necessary proportionality constant, and it is typically determined experimentally. Usually, flow coefficient is expressed as the flow rate in GPM for a pressure drop of 1 PSI across a flow passage. By definition:

$$Cv = \sqrt{\frac{1}{\Delta P}}$$

A standardized test procedure for finding Cv factors is presented in ISA S75.02. A form of the equation is:

$$\Delta P = \left[\frac{Q}{Cv}\right]^2$$

EXAMPLES

EXAMPLE ONE

A Hayward® 1/2" True Union Ball Valve has an experimentally-determined Cv rating of 8 for water. It is required to flow 20 GPM of water through this valve. The anticipated pressure drop across this valve may be calculated as follows:

$$\Delta P = \left[\frac{20}{8}\right]^2 = 6.3 \text{ PSI}$$

EXAMPLE TWO

If a 0.5 PSI pressure drop has been allotted for a Hayward 4" True Union Ball Valve, the associated flow rate may be calculated by:

$$Q = Cv\sqrt{\Delta P}$$

A Hayward 4" True Union Ball Valve has an experimentally-determined Cv rating of 600 for water. The approximate flow rate at a 0.5 PSI pressure drop is calculated by:

$$Q = 600\sqrt{0.5} = 420 \text{ GPM}$$

Water Hammer

A significant, nearly instantaneous pressure shock wave may be generated when a valve opens or closes too quickly, or when a pump starts with an empty discharge line or suddenly shuts down. This phenomenon is the result of the sudden change in velocity of the fluid flow in combination with the characteristics of the piping. This shock wave is manifested by a series of hammerblow-like sounds, called water hammer, which may have sufficient magnitude to cause catastrophic failure within the piping system.

TO AVOID WATER HAMMER CONDITIONS, CONSIDER THE FOLLOWING:

1. Fluid velocities in excess of five feet per second in plastic piping systems increase the hydraulic shock effect resulting from the starting and stopping of pumps and rapid opening and closing of valves. Fluid velocity not exceeding five feet per second is considered safe, and will minimize the effects of water hammer.
2. Install pressure relief valves to dampen the effects of water hammer and relieve excess pressure and flow.
3. Slow-closing actuated valves should be installed to control the speed at which valves open and close. They can be controlled electrically or pneumatically, eliminating the chances of human error.

The pressure rise created by water hammer is added to the nominal actual working pressure of the system.

In order to calculate this pressure rise, it is first necessary to come up with a combined modulus of elasticity for the pipe/liquid system as shown here:

$$E' = \frac{1}{\frac{1}{E_w} + \frac{d}{4\,t\,E_p}(5 - 4e)} = 37{,}531\text{PSI}$$

Where:
- E' = modulus of elasticity of liquid/pipe combination (PSI)
- d = inside pipe diameter (in)
- e = Poisson's ratio for thermoplastic pipe material, a value within the range from 0.38 to 0.42 may be used
- E_p = modulus of elasticity for pipe (PSI, from Table 1)
- E_w = modulus of elasticity of liquid, water = 300,000 PSI
- t = pipe wall thickness (in)

TABLE 1 – MODULUS OF ELASTICITY AT 73°F

MATERIAL	PVC	CPVC
MODULUS (PSI)	400,000	360,000

EXAMPLES

EXAMPLE ONE

For a 4" Schedule 80 PVC pipe (I.D. 3.786", wall thickness 0.337"), carrying water, the combined modulus of elasticity is calculated below:

$$E' = \frac{1}{\frac{1}{300{,}0000} + \frac{3.786}{4\,(.337)\,400{,}000}\,[5 - 4\,(.42)]} = 37{,}531\text{ PSI}$$

The pressure rise due to water hammer is:

$$\Delta P = \frac{V\sqrt{\frac{m}{G_c}\,E'}}{12}$$

Where:
- ΔP = pressure rise due to water hammer (PSI)
- m = density of liquid, water = 62.4 lbm ft^3
- G_c = dimensional constant = 32.2 lbm ft/(lbf sec^2)
- E' = modulus of elasticity of liquid/pipe combination (PSI)
- V = velocity reduction causing water hammer (ft/sec)

EXAMPLE TWO

Water is flowing at 250 gpm (6.5 ft/sec) at a line pressure of 40 PSI. If a valve in the line is closed suddenly, the resultant pressure rise is calculated by:

$$\Delta P = \frac{6.5\sqrt{\frac{62.4}{32.2}\,37{,}531}}{12} = 146\text{ PSI}$$

Total line pressure: $P_{total} = 40 + 146 = 186$ PSI

A 4" Schedule 80 PVC pipe is rated for 320 PSI at room temperature and is, therefore, acceptable for this application.

Note: Insure that all other system components are rated for this pressure.

For convenience, Table 2 lists "Wave Surge Constants" for common sizes of pipe carrying water at 73°F.

The wave surge constant may be used to quickly calculate pressure rise due to water hammer as illustrated to the right: $\Delta P = VC$

Where:
- P = pressure rise due to water hammer (PSI)
- C = wave surge constant from Table 2
- V = velocity reduction causing water hammer

TABLE 2 – WAVE SURGE CONSTANTS (FOR PIPE CARRYING WATER AT 73°F, E = 0.42)

SIZE	1/2"		3/4"		1"		1-1/2"		2"		3"		4"		6"		8"		10"		12"	
SCHEDULE	40	80	40	80	40	80	40	80	40	80	40	80	40	80	40	80	40	80	40	80	40	80
PVC	30.1	35.4	27.3	32.1	26.8	30.8	22.7	26.9	20.9	25.0	20.3	23.1	18.7	22.5	16.7	20.9	15.7	19.7	15.0	19.2	14.5	19.0
CPVC	28.9	34.1	26.1	30.8	25.2	29.6	21.7	25.7	19.9	23.9	19.4	22.1	17.8	21.4	15.9	19.9	14.9	18.8	14.2	18.3	13.8	18.1

Typical Minimum Physical Properties

PROPERTIES	ASTM TEST METHOD	POLYVINYL CHLORIDE	CHLORINATED POLYVINYL CHLORIDE	POLYPROPYLENE *UNFILLED (NATURAL)*	POLYPROPYLENE *30% GLASS FILLED*	PVC *30% GLASS FILLED*	POLYETHERIMIDE *40% GLASS FILLED*
MECHANICAL AT 73°F							
SPECIFIC GRAVITY	D792	1.41	1.52	1.33	1.13	1.53	1.61
TENSILE STRENGTH, PSI	D638	7000	8230	3650	12500	11500	27000
MODULUS ELASTICITY, PSI	D638	450000	400000	170000	170000	970000	1700000
COMPRESSIVE STRENGTH, PSI		9000	9000	5500	9500	9500	31800
FLEXURAL STRENGTH, PSI	D790	12930	14990	7000	18200	17900	36000
IZOD NOTCH IMPACT, FT LB/IN	D256	1.5	1.6	1.3	2.0	1.3	2.1
HARDNESS, ROCKWELL R	D785	112	117	95	M57	110	M114
THERMAL							
HEAT DISTORTION TEMPERATURE: 66 PSI 264 PSI		 165 164	 243 214	 225 185	 325 300	 169 167	 420 415
COEFFICIENT OF EXPANSION, IN/IN/°F		3.1×10^{-5}	3.8×10^{-5}	3.0×10^{-5}	2.1×10^{-5}	1.4×10^{-5}	0.8×10^{-5}
OTHER PROPERTIES							
WATER ABSORPTION, % 24 HR	D570	0.05	0.07	0.03	0.02	0.05	0.13
LIGHT TRANSMISSION	E308	Opaque	Opaque	Translucent	Opaque	Opaque	Opaque
LIGHT STABILITY		Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
EFFECT OF SUNLIGHT		Slight Darkening	Very Slight	Slight	Slight	Slight	Slight
COLOR		Dark Gray	Medium Gray	Clear	Black	Light Gray	Black
NSF APPROVED		Yes	Yes	Yes			

Notes:
1. Working pressure (non-shock) figures are the maximum recommended for the indicated temperatures.
2. It is recommended that the minimum process temperature for Hayward products not fail below 34°F (1°C).

Applicable Plastic Piping Standards

ASTM D1784 - 11 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

This specification covers rigid poly (vinyl chloride) (PVC) compounds and chlorinated poly (vinyl chloride) (CPVC) compounds for use in extruded or molded form like pipe and fitting applications. Classification requirements for identifying rigid PVC and CPVC shall be according to base resin, impact resistance under notch, tensile strength, modulus of elasticity in tension, deflection temperature under load and flammability. PVC and CPVC shall be in the form of cubes, granules, free-flowing powder blends or compacted powder blends, and shall be of uniform size and free of foreign matter. The material shall conform to the test requirements such as tensile strength and modulus of elasticity, conditioning, impact resistance, deflection temperature and flammability.

ASTM D2464 - 06 Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

This specification covers poly (vinyl chloride) (PVC) threaded Schedule 80 pipe fittings, which are PVC 12454, 13354, 11443 and 14333. The pipe fittings are intended for use with the distribution of pressurized liquids only, which are chemically compatible with the piping materials. The materials shall conform to the required dimensions and burst pressure limits.

ASTM D2467 - 06 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

This specification covers the requirements for materials, workmanship, dimensions and burst pressure of poly (vinyl chloride) plastic Schedule 80 pipe fittings, intended for use with the distribution of pressurized liquids that are chemically compatible with the piping materials. In-line fittings, such as couplings, unions, bushings, caps, nipples and the like, shall be molded or machined from extruded stock. The pipe fittings shall conform to the specified inside and outside diameter, minimum wall thickness, dimension and burst pressure strength requirements. The fittings shall be homogeneous throughout and free of cracks, holes, foreign inclusions or other defects and shall be as uniform as commercially practicable in color, opacity, density and other physical properties.

ASTM D4101 - 11 Standard Specification for Polypropylene Injection and Extrusion Materials

This specification covers polypropylene materials, suitable for injection molding and extrusion, that include unreinforced polypropylene with natural color only, unfilled and unreinforced polypropylene, calcium carbonate filled polypropylene, glass reinforced polypropylene, polypropylene copolymers and talc filled polypropylene. Polymers consist of homopolymer, copolymers and elastomer compounded with or without the addition of impact modifiers (ethylene-propylene rubber, polyisobutylene rubber and butyl rubber), colorants, stabilizers, lubricants or reinforcements. Tests shall be conducted on each of the specimens to determine the required physical and mechanical properties of the materials. The specimens for the various materials shall conform to the following requirements: nominal flow rate; test specimen dimensions; tensile stress at yield; flexural modulus; Izod impact resistance; deflection temperature and multiaxial impact ductile-brittle transition temperature.

ASTM F437 - 09 Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

This specification covers material requirements, workmanship, dimensions and burst pressure for threaded schedule 80 chlorinated poly (vinyl chloride) (CPVC) plastic pipe fittings. Fittings fabricated by backwelding are not included in this specification. Fittings shall be homogeneous and free from defects. Dimensions of elbows, tees, crosses, couplings, plugs and caps shall conform to the requirements of this specification. Requirements for test specimen conditioning, sampling, thread, burst pressure and marking are included.

ASTM F439 - 12 Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

This specification covers chlorinated poly (vinyl chloride) (CPVC) Schedule 80 pipe fittings intended for use with Iron Pipe Size (IPS) outside-diameter plastic pipe. Materials shall be tested and shall conform to the requirements for materials, workmanship, dimensions and burst pressure.

ANSI/ASME B1.20.1 Pipe Threads, General Purpose, Inch

This standard covers dimensions and gaging of pipe threads for general purpose applications.

B1.20.1 is a revision and redesignation of ANSI B2.1-1968.

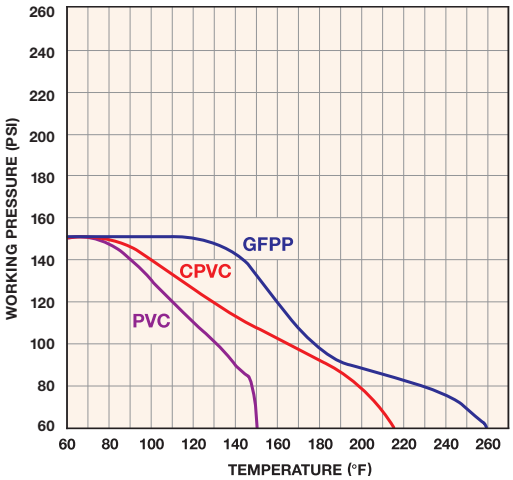
ANSI/ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

This standard covers pressure-temperature ratings, materials, dimensions, tolerances, marking, testing and methods of designating openings for pipe flanges and flanged fittings. Included are: flanges with rating class designations 150, 300, 400, 600, 900 and 1500 in sizes NPS 1/2 through NPS 24 and flanges with rating class designation 2500 in sizes NPS 1/2 through NPS 12, with requirements given in both metric and U.S. Customary units with diameter of bolts and flange bolt holes expressed in inch units; flanged fittings with rating class designation 150 and 300 in sizes NPS 1/2 through NPS 24, with requirements given in both metric and U.S. Customary units with diameter of bolts and flange bolt holes expressed in inch units; and flanged fittings with rating class designation 400, 600, 900 and 1500 in sizes NPS 1/2 through NPS 24 and flanged fittings with rating class designation 2500 in sizes NPS 1/2 through NPS 12 that are acknowledged in Non-Mandatory Appendix E in which only U.S. Customary units are provided.

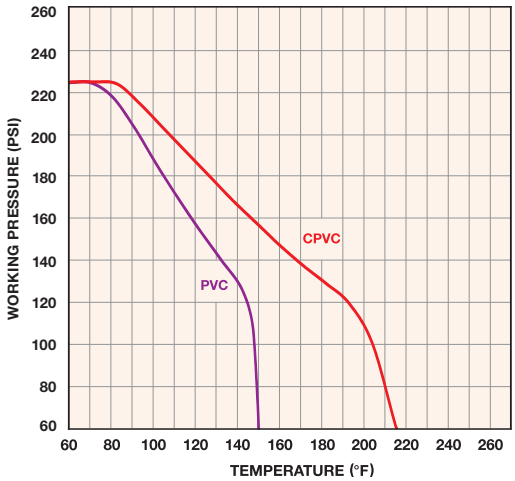
Operating Temperature Charts

Operating Temperature/Pressure for 150 PSI Rated Products

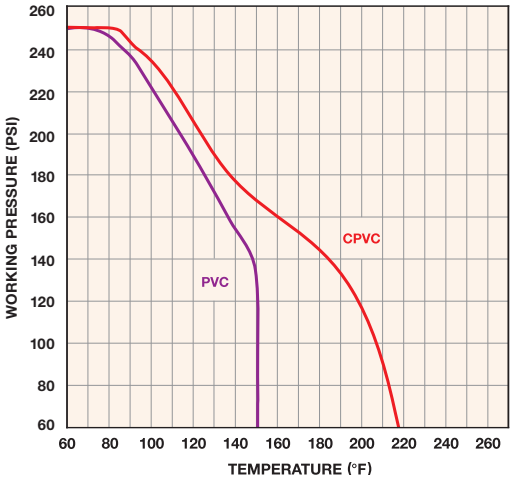
(EXCEPT FILTER HOUSINGS)



Operating Temperature/Pressure for 235 PSI Rated Products



Operating Temperature/Pressure for 250 PSI Rated Products



Nomenclature

a	Area (in^2)	g	Gravitational acceleration, 386 in/sec^2	r	Inside radius (in)
A	Area (ft^2)	G	Gravitational acceleration, 32.2 ft/sec^2	R	Outside radius (in)
C	Wave surge constant (PSI sec/ft)	G_c	Dimension constant, 32.2 lbm ft/(lbf sec^2)	t	Thickness (in)
C_d	Discharge coefficient (dimensionless)	h	Height	T	Temperature (°F)
C_v	Flow coefficient ($gpm/PSI^{1/2}$)	L	Length (ft)	V	Velocity (ft/sec)
d_{orf}	Orifice diameter (in)	L_a	Length of expansion loop along run (ft)	$\propto$	Coefficient of thermal expansion (in/in/°F)
d	Inside diameter (in)	L_o	Length of expansion loop offset (ft)	ΔH	Head loss through pipe (ft)
D	Outside diameter	m	Mass density of liquid (lbm/ft^3)	ΔL	Change in length (in)
e	Poisson's ratio (dimensionless)	M	Mass density (lbm/ft^3)	ΔP	Change in pressure (PSI)
f	Friction factor (dimensionless)	P	Pressure (PSI)	Δt	Time duration (sec)
E	Modulus of elasticity	P_{total}	Total line pressure (PSI)	θ	Half angle of conical tank (°)
E_w	Modulus of elasticity for liquid (PSI)	q	Volume flow rate (in^3/sec)	S_d	Design stress (PSI)
E_p	Modulus of elasticity for pipe (PSI)	Q	Volume flow rate (gpm)	μ	Absolute velocity [lbm/(ft sec)]
E'	Combined modulus of elasticity of liquid and pipe (PSI)	Re	Reynolds number based on inside diameter of pipe (dimensionless)	*	Used to indicate multiplication

THERMAL EFFECTS OF PIPE, VALVES AND FITTINGS

Temperature effects on plastic piping systems should always be considered when the system is initially designed. As with all piping systems, the pipe changes length with changes in temperature. When a piping system is designed without enough directional changes to compensate for expansion or contraction, the movement can affect the performance of the system valves and, in many cases, generate external loads that can cause damage. Generally the system will have many bends in the pipe, minimizing the effects of temperature changes. Plastic piping should be installed in such a way as to minimize the stress induced by temperature changes by hanging the pipe on rollers or pipe hangers – rather than fixing it in position. With long lengths of straight pipe with expected large temperature changes, either from time of installation or in operating conditions, expansion joints should be considered. When an expansion loop or expansion joint is installed, the pipe should be anchored in such a way as to direct the axial movement into the compensating configuration. The total pipe length change can be calculated from the following: $\Delta L = L * (T2 - T1) * \propto * 12$

Where: ΔL = pipe length change (in)
$\propto$ = coefficient of thermal expansion (in/in/°F), from Table 1
T1 = ambient temperature (°F)
T2 = maximum process temperature
L = length of pipe run (ft)

TABLE 1 – COEFFICIENT OF THERMAL EXPANSION

MATERIAL	PVC	CPVC	PP
A (IN/IN/°F)	0.000031	0.000038	0.000021

EXAMPLES

EXAMPLE ONE

A 200-ft 4-in CPVC straight pipe run is to be constructed. During installation the ambient temperature is 60°F. The anticipated operating temperature for the system is 100°F. The total change in length of the pipe run is:

$$\Delta L = 200 * (100 - 60) * 0.000038 * 12 = 3.6 \text{ in}$$

The length of the offset leg of an expansion loop can be calculated by:

$$L_o = \frac{\sqrt{\frac{3 * E}{S_d} * D * \Delta L}}{12}$$

Where: L_o = length of offset leg (ft)
D = nominal outside pipe diameter (in)
E = modulus of elasticity at the maximum temperature (PSI)
S_d = design stress of the pipe at design condition (PSI)

EXAMPLE TWO

The design stress for the system is 1,600 PSI and the modulus of elasticity for CPVC is 360,000 PSI. The length of the offset leg required to accommodate expansion during operation is given by:

$$L_o = \frac{\sqrt{\frac{3 * 360{,}000}{1{,}600} * 4.5 * 3.6}}{12} = 8.7 \text{ ft}$$

The length of the expansion loop along the run of the pipe is:

$$L_a = \frac{L_o}{2}$$

EXAMPLE THREE

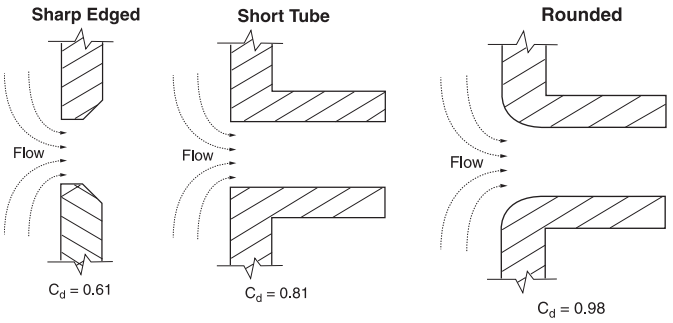
The length of the expansion loop along the run is:

$$L_a = \frac{8.7}{2} = 4.4 \text{ ft}$$

Calculating the Time Required to Empty a Vessel

The following formulas are based on turbulent flow of a Newtonian fluid through an outlet (orifice) in a tank. The discharge coefficient C_d depends on the configuration of the outlet. Some typical values for discharge coefficient are shown at right.

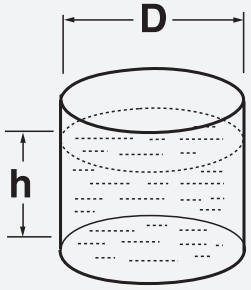
Variables:
- h = elevation of tank
- D = diameter of tank
- A = orifice area (ft^2)
- G = gravitational acceleration = 32.2 ft/sec^2
- Δt = time required to empty tank (sec)



EXAMPLES

EXAMPLE ONE
VERTICAL CYLINDRICAL TANK

$$\Delta t = \frac{\pi D^2}{C_d A}\sqrt{\frac{h}{8G}}$$



A vertical cylindrical tank 12' in diameter is fitted with a 2" Hayward bulkhead fitting (comparable to a short tube outlet). The area of the outlet is:

$$\Delta t = \frac{\pi D_{orf}^2}{4\,(144)} = \frac{\pi\, 2^2}{4\,(144)} = 0.0218\ ft^2$$

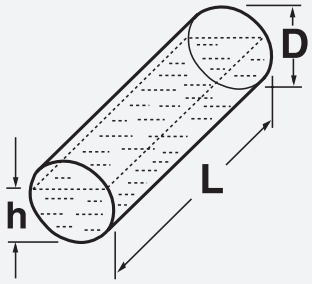
If the tank is filled with water to a height of 20', and we assume turbulent flow, the approximate time to empty the tank is given by:

$$\Delta t = \frac{\pi\, 12^2}{0.81\,(0.0218)}\sqrt{\frac{20}{8\,(32.2)}} = 7{,}139\ sec$$

The tank should be empty in about 2 hours.

EXAMPLE TWO
HORIZONTAL CYLINDRICAL TANK

$$\Delta t = \frac{L\{D^{3/2} - (D-h)^{3/2}\}}{3\,C_d A}\sqrt{\frac{8}{G}}$$



A 7' diameter by 9' long horizontal cylindrical tank has a 4" diameter sharp edged orifice outlet. The area of the outlet is:

$$\Delta t = \frac{\pi D_{orf}^2}{4\,(144)} = \frac{\pi\, 4^2}{4\,(144)} = 0.0873\ ft^2$$

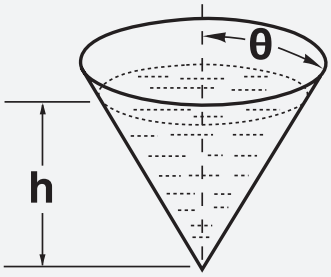
If the tank is filled with water to a height of 5', and we assume turbulent flow, the approximate time to empty the tank is given by:

$$\Delta t = \frac{9\{7^{3/2} - (7-5)^{3/2}\}}{3\,(0.61)\,0.0873}\sqrt{\frac{8}{(32.2)}} = 440\ sec$$

The tank should be empty in about 7 minutes.

EXAMPLE THREE
CONICAL TANK

$$\Delta t = \frac{\pi h^{5/2}\tan^2\theta}{5\,C_d A}\sqrt{\frac{8}{G}}$$



A conical tank with a taper angle of 25° is fitted with a 2" diameter short tube type outlet. The area of the outlet is:

$$\Delta t = \frac{\pi D_{orf}^2}{4\,(144)} = \frac{\pi\, 2^2}{4\,(144)} = 0.0218\ ft^2$$

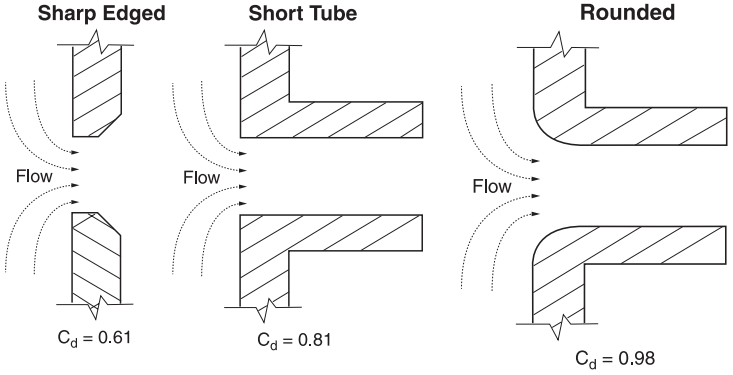
If the tank is filled with water to a height of 28', and we assume turbulent flow, the approximate time to empty the tank is given by:

$$\Delta t = \frac{\pi\,(28^{5/2})\tan^2 25°}{5\,(0.81)\,0.0128}\sqrt{\frac{2}{32.2}} = 8{,}000\ sec$$

The tank should be empty in about 2-1/4 hours.

Formulas for Calculating Flow Rate From a Vessel

The following formulas are for calculating the rate at which a fluid will flow from a tank when the fluid level is maintained constant (h is constant). The discharge coefficient C_d depends on the configuration of the outlet. Some typical values for discharge coefficient are shown below.

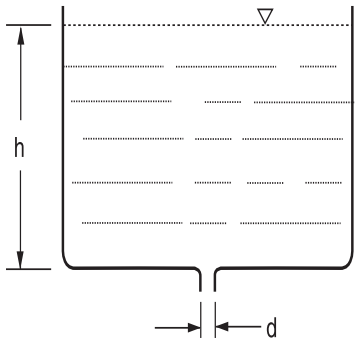


Variables:

- h = Elevation of tank
- d = Diameter of tank
- a = Orifice area (ft^2)
- g = Gravitational acceleration = 32.2 ft/sec^2
- q = Volume flow rate of fluid through opening (in^3/sec)
- C_d = Discharge coefficient

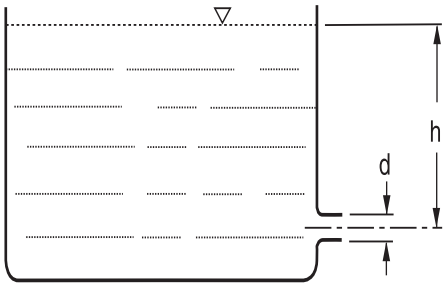
Bottom Opening

$$q = C_d (a)\sqrt{2gh}$$



Side Opening

$$q = C_d (a)\sqrt{2gh}$$



EXAMPLES

EXAMPLE ONE

An open tank is continuously fed with water such that the height from the water surface to the outlet is maintained at 60". The outlet has a 1" diameter bulkhead fitting (comparable to a short tube outlet). The outlet area is calculated by:

$$a = \frac{\pi d^2}{4} = \frac{\pi (1^2)}{4} = 0.7854 \text{ in}^2$$

The flow of water through the outlet is given by:

$$q = 0.81\ (0.7854)\sqrt{2\ (386)\ 60} = 137 \text{ in}^3/\text{sec}$$

This flow rate is equivalent to about 36 gpm.

THREADING

Hayward® threaded valves have NPT (American standard) tapered pipe threads that are molded or cut to the dimensions and tolerances for tapered pipe threads consistent with ANSI B1.20.1 standards.

When installing threaded plastic pipe into Hayward valves, it is important to use a thread sealant such as PTFE tape. Do not use oil-based joint compound or PTFE paste. They may contain substances that could cause stress cracking of the plastic.

Facing the threaded end of the pipe, begin wrapping the tape in a clockwise direction, starting with the second thread nearest the end of the pipe. Overlap each wrap by one-half the width of the PTFE tape. Pipe sizes 2" and larger may benefit with two wraps due to the greater depth of the thread.

Carefully screw the end connectors onto the end of the pipe and hand tighten. Using a strap wrench only (never use a Stilson type wrench or "channel lock" type plier), tighten the end connector 1 to 1-1/2 turns beyond hand tight. Avoid distorting or cracking the end connector by over-tightening.

FLANGE JOINTS

Hayward valves with flanged end connectors are recommended for applications where frequent dismantling is required, or when the system piping is other than plastic (steel, fiberglass, metal-lined pipe, etc.). All Hayward flanged valves have flanges with a bolt hole pattern that meets ANSI 150 lb dimensions.

Elastomeric gaskets between the flanges must be used and should be a minimum 1/8" thick full face gasket with a hardness between 50 to 70 durometers. Bolts, nuts and washers should be well lubricated.

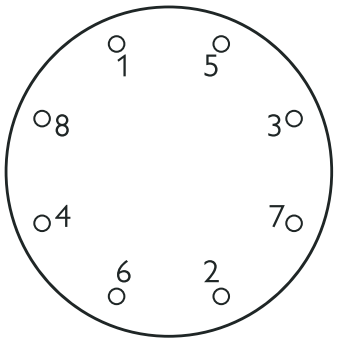
Begin making the flanged joint by making sure that the bolt holes of the mating pipe flanges line up. Insert the bolts and make certain that the distance between the flanges is not excessive prior to bolting down the flanges. Using a torque wrench, tighten each bolt in sequence as detailed in the flange bolt tightening sketch.

Tighten the bolts to the recommended torque values as listed in Table 1.

TABLE 1 – RECOMMENDED BOLT TORQUE

FLANGE SIZE	RECOMMENDED TORQUE
1/2" TO 1-1/2"	10 – 15 ft/lb
2" TO 4"	15 – 25 ft/lb
6" TO 8"	25 – 45 ft/lb
10"	53 – 75 ft/lb
12"	80 – 110 ft/lb

THE FOLLOWING BOLT TIGHTENING PATTERN IS SUGGESTED FOR THE FLANGE



Flow of Water Through Schedule 80 Plastic Pipe

DISCHARGE		VELOCITY IN SCHEDULE 80 PLASTIC PIPE FOR WATER @ 60°F VELOCITY							
GALLONS/MINUTE	CUBIC FEET/SECOND	FEET/SECOND	FEET/SECOND	FEET/SECOND	FEET/SECOND	FEET/SECOND	FEET/SECOND	FEET/SECOND	FEET/SECOND
			1/4"	3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"
0.2	0.000446	—	0.824	—	—	—	—	—	—
0.3	0.000668	—	1.237	0.651	0.392	—	—	—	—
0.4	0.000891	—	1.646	0.867	0.529	—	—	—	—
0.5	0.00111	—	2.061	1.083	0.653	0.359	—	—	—
0.6	0.00134	—	2.476	1.303	0.782	0.431	—	—	—
0.8	0.00178	—	3.295	1.728	1.043	0.574	—	—	—
1	0.00223	—	4.122	2.167	1.311	0.718	0.435	—	—
2	0.00446	—	8.245	4.335	2.609	1.432	0.871	0.525	—
3	0.00668	—	12.381	6.502	3.919	2.161	1.306	0.788	0.538
4	0.00891	2"	16.502	8.671	5.218	2.876	1.747	1.051	0.717
5	0.01114	—	—	10.837	6.528	3.592	2.181	1.313	0.896
6	0.01337	0.65	2-1/2"	13.005	7.827	4.308	2.614	1.579	1.076
8	0.01782	0.86	—	—	10.448	5.741	3.482	2.105	1.434
10	0.02228	1.08	0.752	3"	13.057	7.185	4.351	2.632	1.798
15	0.03342	1.61	1.134	—	—	10.778	6.531	3.941	2.697
20	0.04456	2.15	1.505	0.986	—	—	8.712	5.252	3.596
25	0.0557	2.69	1.886	1.238	—	4"	10.881	6.574	4.484
30	0.06684	3.23	2.256	1.476	—	—	13.062	7.884	5.383
35	0.07798	3.78	2.638	1.726	—	0.973	15.232	9.193	6.282
40	0.08912	4.32	3.009	1.976	—	1.114	17.413	10.515	7.171
45	0.1003	4.84	3.391	2.215	—	1.247	—	11.838	8.069
50	0.1114	5.39	3.761	2.465	—	1.391	—	13.147	8.969
60	0.1337	6.47	4.513	2.953	—	1.665	—	15.779	10.778
70	0.156	7.55	5.266	3.453	—	1.942	—	—	12.577
80	0.1782	8.62	6.018	3.942	—	2.228	—	6"	14.36
90	0.2005	9.69	6.771	4.442	—	2.504	—	—	16.162
100	0.2228	10.77	7.523	4.931	—	2.781	—	1.225	17.96
125	0.2785	13.48	9.409	6.168	—	3.475	—	1.534	22.445
150	0.3342	16.18	11.284	7.395	—	4.171	—	1.893	—
175	0.3899	18.87	13.171	8.633	—	4.865	—	2.141	8"
200	0.4456	21.56	15.068	9.861	—	5.561	—	2.451	—
225	0.5013	—	16.943	11.098	—	6.255	—	2.759	1.577
250	0.557	—	—	12.325	—	6.951	—	3.069	1.752
275	0.6127	—	—	13.563	—	7.645	—	3.367	1.927
300	0.6684	—	—	14.768	—	8.341	—	3.675	2.102
325	0.7241	—	—	16.041	—	9.035	—	3.985	2.277
350	0.7798	—	—	—	—	9.731	—	4.294	2.453
375	0.8355	—	—	—	—	10.425	—	4.592	2.628
400	0.8912	—	—	—	—	11.121	—	4.901	2.803
425	0.9469	10"	—	—	—	11.815	—	5.211	2.989
450	1.003	—	—	—	—	12.511	—	5.519	3.164
475	1.059	2.199	—	—	—	13.205	—	5.817	3.329
500	1.114	2.229	—	—	—	13.901	—	6.126	3.515
550	1.225	2.459	—	—	—	15.279	—	6.744	3.865
600	1.337	2.679	12"	—	—	16.681	—	7.352	4.215
650	1.225	2.899	—	—	—	—	—	7.971	4.566
700	1.56	3.129	2.205	—	—	—	—	8.588	4.916
750	1.671	3.349	2.359	—	—	—	—	9.195	5.267
800	1.56	3.569	2.513	—	—	—	—	9.802	5.617
850	1.782	3.799	2.677	—	—	—	—	10.421	5.968
900	2.005	4.019	2.831	—	—	—	—	11.028	6.318
950	2.117	4.239	2.984	—	—	—	—	11.646	6.668
1000	2.228	4.469	3.149	—	—	—	—	12.253	7.019
1100	2.451	4.919	3.458	—	—	—	—	13.489	7.719
1200	2.674	5.359	3.775	—	—	—	—	14.715	8.431
1300	2.896	5.809	4.093	—	—	—	—	15.929	9.121
1400	3.119	6.259	4.401	—	—	—	—	17.165	9.833
1500	3.342	6.698	4.718	—	—	—	—	18.391	10.534
1600	3.565	7.148	5.037	—	—	—	—	19.611	11.235
1800	4.01	8.038	5.662	—	—	—	—	22.067	12.636
2000	4.456	8.938	6.228	—	—	—	—	24.517	14.038
2500	5.57	11.168	7.868	—	—	—	—	—	17.552
3000	6.684	13.396	9.437	—	—	—	—	—	21.068
3500	7.798	15.637	11.006	—	—	—	—	—	24.572
4000	8.912	17.866	12.587	—	—	—	—	—	28.08
4500	10.13	20.106	14.156	—	—	—	—	—	31.613
5000	11.14								
6000	13.37								
7000	15.6								
8000	17.82								
9000	20.05								
10000	22.28								
12000	26.74								

The following wave surge constants may be used to quickly calculate pressure rise due to water hammer where: "C"= the wave surge constant from the table below multiplied by "V" the line velocity in feet per second. The resultant number is then added to the line pressure to determine the resulting wave surge (Water Hammer Effect).

Pipe Size	1/4"	1/2"	3/4"	1"	1-1/2"	2"	3"	4"	6"	8"	10"	12"
Constant	40	35	32	31	27	25	23	23	21	20	19	19

Maximum recommended fluid velocity is 8 feet per second (solenoid valves 5 feet per second)

How to Select a Basket Strainer

SELECTION CRITERIA

The first consideration when selecting a Hayward® basket strainer is the amount of free open area. This is the ratio of the open area through the strainer basket to the cross sectional area of the pipe. A well-designed basket strainer should have an open area ratio of at least 4 to 1. Anything less may cause excessive pressure drop. The area is calculated with a clean basket – and as the basket begins to clog, the ratio will drop. Unless there is a wide safety margin, the area through the basket may quickly become smaller than the pipe area. This will reduce flow through the strainer and necessitate very frequent cleaning. A small open area ratio also means the holding capacity of the basket is small (an important consideration if there is a lot of solid material to be removed.)

Second, is ease of basket removal. Since a basket strainer is used where cleaning may occur often, it stands to reason that the basket should be able to be removed and replaced as simply as possible. Hayward Simplex and Duplex strainers feature hand removable, threaded covers which can be quickly loosened or tightened by hand without the use of tools.

Another item to look for in selecting a strainer is compactness of design. Is the strainer unnecessarily bulky or tall? In many industrial areas, space is at a premium and the less room a strainer takes the better.

Lastly, a wide variety of basket perforation sizes should be available. This is necessary to cope with the great range of particle sizes which the strainer may be called upon to remove.

SELECTION AND SIZING

Selecting the proper size basket strainer for a particular application is extremely important for optimum performance of the strainer. Factors such as viscosity, specific gravity, and mesh lining size all influence pressure drop of flow through the strainer. As a general rule of thumb, a pressure of greater than 2 PSI through a clean strainer usually indicates the strainer selected is too small for the intended application.

In some cases, the strainer size may not always be the same size as the pipe diameter. For example, the pressure drop of highly viscous liquids passing through a mesh basket can cut flow considerably making it necessary to use a strainer several times larger than pipeline to ensure adequate flow. Likewise, if an unusually large amount of material needs to be taken out of the process flows, a larger strainer or multiple strainer should be specified. By using two strainers in series, the first with large openings designed to catch larger particles and the second with a fine mesh lining to trap smaller material, the load is spread over two strainers and time between maintenance for cleaning is also extended.

PROPER BASKET SELECTION

The question of which perforation or mesh lining size to use comes up regularly. Here again, the basic rule is to use the coarsest size which will strain out the product to be removed. Using a finer mesh than needed will only result in premature clogging. When in doubt about which of two basket screens to use, it is best to choose the larger. As a rule of thumb, size the baskets for one half the particle size to be removed.

BASKET SIZES OFFERED FOR HAYWARD SIMPLEX AND DUPLEX PLASTIC BASKET STRAINERS

Pressure Drop Correction Factors for Various Size Basket Screens

PLASTIC		STAINLESS STEEL		STAINLESS STEEL	
PERFORATION	CORRECTION FACTOR	PERFORATION	CORRECTION FACTOR	MESH	CORRECTION FACTOR
1/32"	1.05	1/32"	0.82	20	0.79
1/16"	1.00	3/64"	0.63	40	1.01
1/8"	0.58	1/16"	0.74	60	1.20
3/16"	0.46	5/64"	0.50	80	1.16
		7/64"	0.51	100	1.20
		1/8"	0.58	200	1.09
		5/32"	0.37	325	1.22
		3/16"	0.46		
		1/4"	0.58		
		3/8"	0.45		
		1/2"	0.48		

Comparative Particle Size

MESH	INCHES	MICRONS	MESH	INCHES	MICRONS	MESH	INCHES	MICRONS
3,250	0.0002	6	130	0.0043	110	24	0.028	718
1,600	0.0005	14	120	0.0046	118	20	0.034	872
750	0.0010	25	110	0.0051	131	18	0.039	1,000
325	0.0016	40	100	0.0055	149	16	0.045	1,154
250	0.0024	62	90	0.0061	156	14	0.051	1,308
200	0.0029	74	80	0.0070	179	12	0.060	1,538
180	0.0033	85	70	0.0078	200	10	0.075	1,923
170	0.0035	90	60	0.0092	238	8	0.097	2,488
160	0.0038	97	50	0.0117	300	6	0.132	3,385
150	0.0041	100	40	0.015	385	5	0.159	4,077
140	0.0042	108	30	0.020	513	4	0.203	5,205

Note: To calculate pressure drop through vessels using other than 1/16" perforated baskets, first calculate the pressure drop using the listed Cv, and then multiply the result by the correction factor in the Correction Factors chart above. See page 102 for the applicable pressure drop calculation.

How to Select Filter Bags

HOW TO SELECT A PART NUMBER

MATERIAL		MICRON RATING		FINISH		BAG SIZE		BAG STYLE*		OPTIONS	
Polypropylene Needle Felt Glazed	PO	1 Micron	001	Needle Felt Glazed	G	16"	1	PP Ring	PR	Sewn with Handle	SH
Polypropylene Monofilament Mesh	PMO	5 Microns	005	Needle Felt Singed	S	32"	2	PP Flange	PF	Welded with Flange	WF
Polyester Needle Felt Singed	PE	10 Microns	010	Monofilament Mesh	M						
Nylon Monofilament Mesh	NMO	25 Microns	025								
		50 Microns	050								
		100 Microns	100								
		150 Microns	150								
		200 Microns	200								
		400 Microns	400								
		600 Microns	600								
		800 Microns	800								
To find your part number, please select your Material, Micron Rating, Finish, etc., and place the corresponding identifier (PO, 001, G, etc.) in the boxes below.											
EXAMPLE	**PO**		**100**		**G**		**1**		**PR**		**SH**

* Carbon Steel and Stainless Steel rings are available upon request – consult factory for information

STANDARD FIBER AND MICRON RATINGS

FIBER CONSTRUCTION	MATERIAL	AVAILABLE MICRON RATINGS										
		1	*5*	*10*	*25*	*50*	*100*	*150*	*200*	*400*	*600*	*800*
Needle Felts	Polypropylene	●	●	●	●	●	●		●			
	Polyester	●	●	●	●	●	●		●			
Monofilament Meshes	Polypropylene							●		●	●	●
	Nylon							●		●	●	●

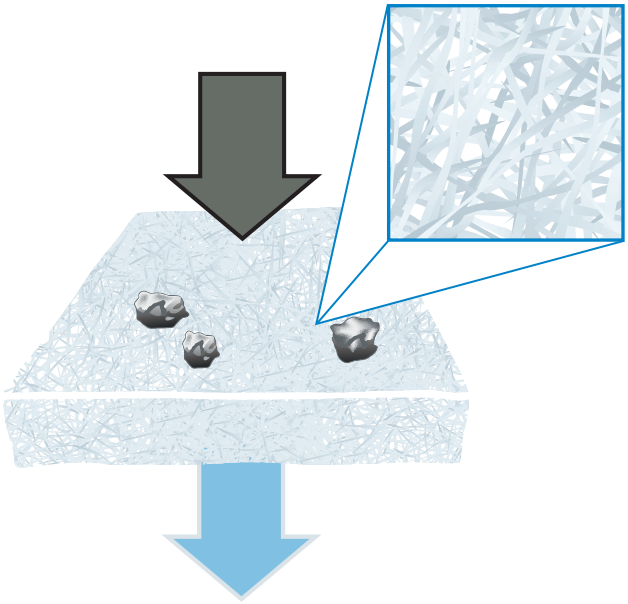
COMPATIBILITY AND TEMPERATURE LIMITS

FIBER	COMPATIBLE WITH							
	Organic Solvent	*Animal, Vegetable and Petro Oils*	*Microorganisms*	*Alkalies*	*Organic Agents*	*Oxidizing Agents*	*Mineral Acids*	*Temperature Limits (Max °F)*
Polyester	A	A	A	B	B	B	B	300
Polypropylene	A	A	A	A	A	C	C	200
Nylon	A	A	A	B	C	D	D	325

A Excellent B Good C Fair D Poor

POLYPROPYLENE AND POLYESTER NEEDLED FELT FILTER BAGS:

Felt material offers particle filtration by a depth process. Particles larger than the felt openings are trapped against the surface as particles that are smaller are forced into the material and trapped by the fibrous web. This three-dimensional media filtration is effective at removing both solid and gelatinous particles and is available in silicone-free polypropylene and polyester materials. Bags are available in 1 to 100 and 200 microns.



KEY FEATURES

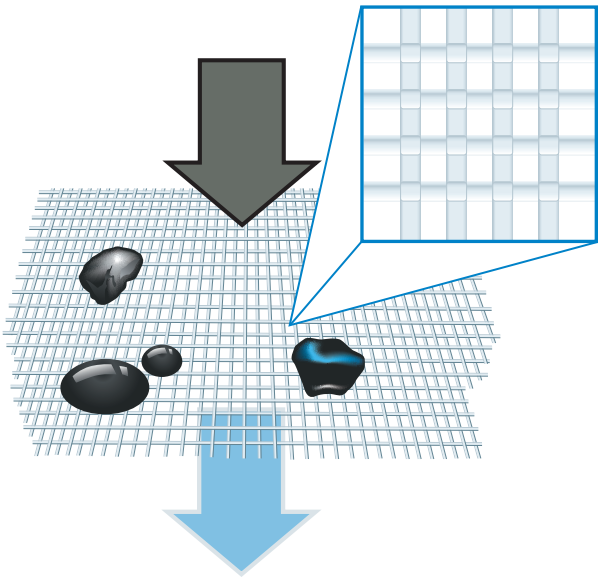
- Needled Felt Structure
- Silicone-Free Material
- Suitable to Lower Viscosity Fluid
- Stable Filtration with High-Flow Velocity
- No Chemical or Fiber Release
- Temperature for Polypropylene: up to 200°F
- Temperature for Polyester: up to 300°F
- Chemical Resistance: Water, Aromatics, Weak Acids, Alkali

SPECIFIC APPLICATIONS

- Prefiltration in Water Treatment
- Amine Filtration in Petroleum Industries
- Electrophoretic Paint Filtration in Automotive Industries
- Syrup Filtration
- Raw Medicine Filtration
- Recycled Water Filtration in Electronics Industries

POLYPROPYLENE AND NYLON MONOFILAMENT MESH FILTER BAGS:

Monofilament mesh offers particle filtration on the surface of a single interwoven fiber. All the holes are uniform providing the same filtration from top to bottom and are fusion welded for strength. Filtration is available at 150 microns and 400 to 800 microns.



KEY FEATURES

- Monofilament Mesh Structure
- Silicone-Free Material
- Fixed Aperture
- Good Stretch-Proof Performance
- Suitable to Intercept Rigid Impurity and High Viscosity Fluid
- Easy to Clean
- Temperature for Polypropylene: up to 200°F
- Temperature for Nylon: up to 325°F
- Chemical Resistance: Water, Aromatics, Aliphatic, Alkali

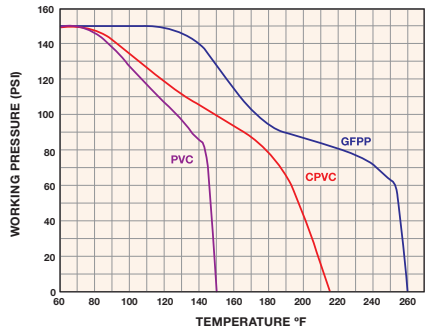
SPECIFIC APPLICATIONS

- Prefiltration in Metallurgy Industries
- Degreasing in Automotive Industries
- Raw Water Filtration in Water Treatment Industries
- Coolant Filtration in Paint Industries
- Cutting Fluid Filtration in Machine Industries
- Coarse Filtration in Chemical Industries
- Recycled Water Filtration in Paper Mills

How to Select a Bag Filter

1. CHECK THE TEMPERATURE AND PRESSURE RATING OF A VESSEL

To make sure that the temperature/pressure of the application falls within the OK range, see the chart below.



2. DETERMINE THE FLOW RATE

In GPM, of the system into which the bag filter is to be installed. Hayward® single and double length bag filters work with flows of up to 150 GPM. If the system's flow rate is greater, consider using two or more filters manifolded together in parallel. For example, if the system flow rate is 150 GPM or higher, using two manifolded filters would reduce the flow to a manageable 75 GPM through each. Constantly running the flow through the vessels at their maximum rating limit is not recommended.

3. SELECT THE BAG

Hayward bags are available from 1 to 800 microns. The bags are made from several types of materials and are either of a sewn or welded construction. All bags are sold in Carton Quantities. A single length bag has a surface area of 2.0 sq ft and a double length of 4.1 sq ft.

4. CONSIDER STARTUP PRESSURE LOSS

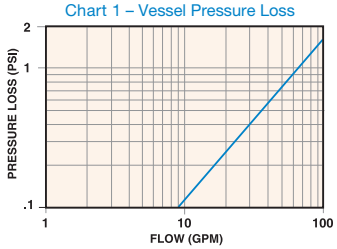
Bag filters are typically sized so that there is a 2 PSI or less pressure loss across them with a clean bag installed. Keep in mind that this is just a guide. The time between bag change outs for a double length filter is more than twice that of a single length filter in the same application.

5. CALCULATE STARTUP PRESSURE LOSS

To figure the total pressure loss across the filter with a clean bag requires making two pressure loss calculations and adding them together: The loss across the filter vessel without a bag and the bag loss.

First: Use the system flow rate and Chart 1 to determine the loss across the filter without a bag (single and double length filter vessels have virtually the same pressure loss without a bag).

Chart 1 – Vessel Pressure Loss



Example: A flow rate of 30 GPM results in a 0.4 PSI pressure loss. If the process media is water or has a viscosity less than 200 CPS, that's it. If the viscosity is greater, select the correction factor that matches the process media viscosity in CPS units from Table Number One. Multiply the pressure drop by this factor.

Table 1 – Vessel Viscosity Correction

VISCOSITY IN CPS	200	400	600	800
CORRECTION FACTOR	1.10	1.20	1.40	1.50

Second: Single and double length filter bags have different pressure losses. Use Chart 2A and 2B to determine the pressure loss per square foot of bag surface. Example: with a system flow rate of 30 GPM, a 5 or 10 micron bag would have a 0.2 PSI loss per square foot. This loss is divided by 2.0 for a single length bag or 4.1 for a double length bag. These factors are the respective surface areas of the bags in square feet. The loss for a single bag would be 0.1 PSI (0.2 ÷ 2.0) and 0.05 for a double length bag (0.2 ÷ 4.1). For fluids with viscosities other than water, select the correction factor from Table 2 and multiply the pressure drop by it. Example: If the fluid viscosity were 800 CPS, the pressure loss for a single length bag would be 5.0 (0.1 x 50.0).

Chart 2A – Bag Pressure Loss

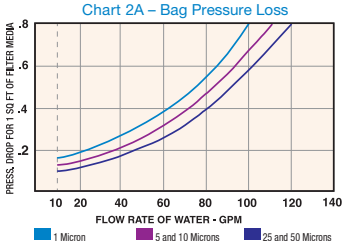
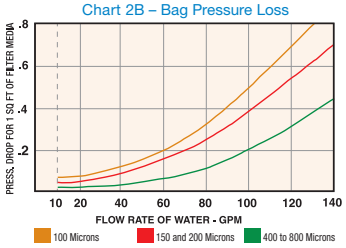


Chart 2B – Bag Pressure Loss



Last: Add the pressure loss of the vessel and the bag together to get the pressure loss across the filter with the bag installed.

Table 2 – Bag Viscosity Correction

VISCOSITY IN CPS	Water 1	50	100	200	400	600	800
CORRECTION FACTOR	1.00	4.50	8.50	16.60	27.70	38.90	50.00

Strainer Basket Opening Equivalents

MESH	INCHES	MM	MICRONS	PERF	INCHES	MM	MICRONS
400	0.0015	0.0381	38	1/32	0.033	0.838	838
300	0.0018	0.0457	45	3/64	0.045	1.143	1143
250	0.0024	0.0609	60	1/16	0.070	1.778	1776
200	0.0027	0.0686	68	3/32	0.094	2.387	2387
150	0.0041	0.1041	104	1/8	0.125	3.175	3175
100	0.0065	0.1651	165	5/32	0.150	3.810	3810
80	0.007	0.1778	177	3/16	0.1875	4.762	4762
60	0.009	0.2286	228	1/4	0.250	6.350	6350
40	0.015	0.8636	380	3/8	0.375	9.525	9525
20	0.034	0.8636	862	1/2	0.500	12.700	12700

Stem Extensions for Butterfly Valves

1-1/2" TO 24" SIZES

At left: 3" butterfly valve with supported aluminum stem extension.
At right: 6" butterfly valve with unsupported stem extension.

SPECIAL FEATURES AND OPTIONS

Hayward® Butterfly Valves are used for throttling or quick quarter-turn on-off control. They are simple, lightweight and compact – and are ideal for use where either space is limited or service and maintenance must be performed quickly. Because they require only 90° to fully open or close, Hayward Butterfly Valves are easily automated and are widely used as efficient throttling or flow regulating valves. Additionally, they are excellent for handling abrasive or slurry-type fluids.

CORROSION RESISTANT, NO CONTAMINATION

Hayward plastic butterfly valves are installed for many reasons, including: resistance to corrosion and/or freedom from contamination. Hayward plastic butterfly valves do not have any metal in contact with the process media. There is none of the rusting or corrosion associated with metal valves, even those made from so-called "higher" alloys. PVC, CPVC and polypropylene are electrically non-conductive. Therefore, galvanic corrosion is completely unknown in Hayward plastic butterfly valves.

Equally important, there is nothing to leach out and contaminate the most sensitive liquids. Such difficult fluids as de-ionized water and delicate chemical solutions cannot pick up traces of metal or other foreign matter from a Hayward Butterfly Valve. The all-plastic construction makes them entirely inert. Hayward Butterfly Valves will outperform metal butterfly valves in many places. The applications are limited only by the imagination of the user.

OTHER FEATURES AND OPTIONS

HAYWARD MODULAR DESIGN

Hayward Modular Series Butterfly Valves have been specifically designed as a rugged component-matched system. They offer a versatile range of operators, including hand levers, gear operators, electric and pneumatic actuators.

The unique modular mounting design takes the difficulty and guesswork out of installation or service. The valves can be installed or removed in minutes – regardless of which valve trim or accessories are used.

The rugged one-piece body incorporates fully supported flange bolt holes. This prevents stressing of the mating pipe flanges, ensuring long service life and enhanced system integrity. Additionally, all sizes meet industry face-to-face standards – allowing simple retrofit to replace most metal butterfly valves

UNIQUE LINER ASSURES POSITIVE SEAL

The tough, abrasion resistant, elastomeric liner incorporates a unique retention design which assures positive sealing of the liner to the valve body. Thus, liner replacements can be made simply and quickly. Further, each liner has an integrally molded face seal which provides positive sealing against any mating flange without the use of additional gaskets.

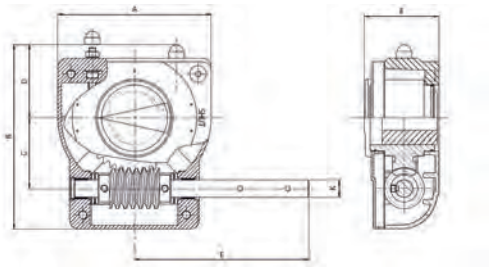
The primary seal between the disc and liner is factory tested to bubble-tight shutoff. This seal is self adjusting and will remain tight even beyond the design working pressure of the valve. The design provides for uniform wear on all contact surfaces for extended service life. The stainless steel shaft is completely sealed from the process media, is positively secured, and is blowout proof.

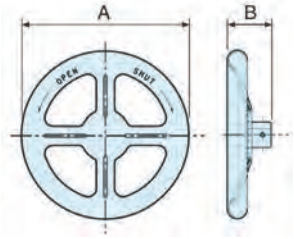
TROUBLE-FREE SERVICE

Designed for both the quality and cost conscious user, the Hayward Modular Series Plastic Butterfly Valves provide trouble-free service for highly corrosive or high purity liquids at elevated temperatures. They will neither corrode nor contaminate the fluids passing through them.

Gear Operators

1-1/2" TO 12" SIZES





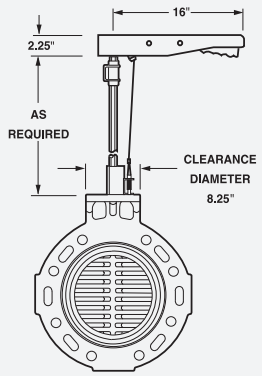
DIMENSIONS

VALVE SERIES	VALVE SIZE	GEARBOX							HANDWHEEL	
		A	B	C	D	E	F	K	A	B
BY	1-1/2"– 12"	5.75	6.84	2.36	3.13	7.87	3.11	0.59	8.00	2.00
BYC	2" – 4"	3.15	4.49	1.67	1.89	6.10	2.32	0.47	8.00	2.00
	5" – 8"	3.94	5.16	1.98	2.21	6.69	2.64	0.47	8.00	2.00

* Consult Hayward for dimensions for BYB 14" – 24" Gear Operators

OPTIONS

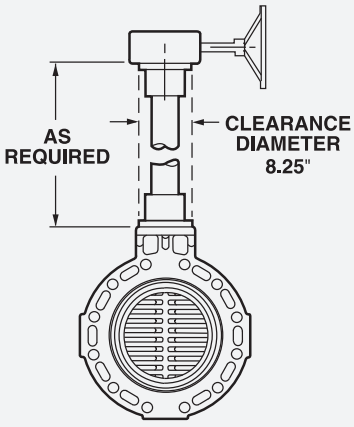
1-1/2" TO 8" LEVER OPERATED BUTTERFLY VALVE STEM EXTENSION



Standard lengths available from 24" to 120" in 6 increments only. Other lengths available as special order.

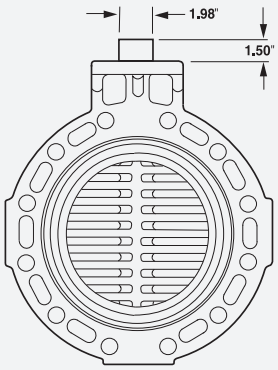
Recommended for extension lengths:
36" to 60" One Bearing Support Bracket
60" to 96" Two Bearing Support Brackets
96" to 120" Three Bearing Support Brackets

1-1/2" TO 12"* GEAR OPERATED BUTTERFLY VALVE STEM EXTENSION WITH PVC HOUSING

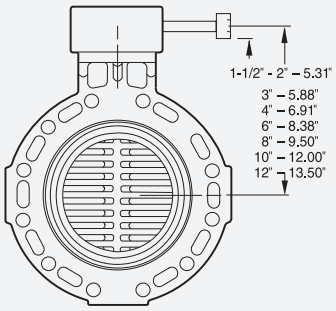


Standard lengths available from 24" to 120" in 6" increments only. Other lengths available as special order.

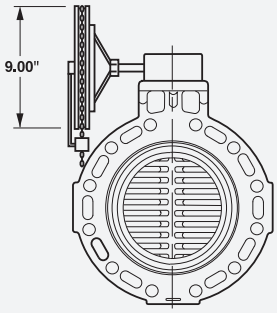
1-1/2" TO 8" BUTTERFLY VALVE WITH NON-LOCKING 2" SQUARE OPERATING NUT



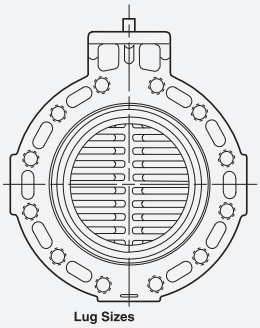
1-1/2" TO 12"* GEAR OPERATED BUTTERFLY VALVE WITH 2" SQUARE OPERATING NUT



1-1/2" TO 12"* CHAIN OPERATED BUTTERFLY VALVE



1-1/2" TO 12"* BUTTERFLY VALVE WITH LUG MOUNTS



Lug Sizes
3", 4" – 5/8" 11 NC
6", 8" – 3/4" 10 NC
10", 12" – 7/8" 9 NC

* Consult factory for option drawings for 14" to 24" size butterfly valves

Operational Torques for Hayward® Valves*

SERIES	SIZE	TORQUE (in lbs.)
TB Series True Union Ball Valves	1/2"	40
	3/4"	50
	1"	60
	1-1/4"	70
	1-1/2"	70
	2"	80
	2-1/2"	140
	3"	140
	4"	170
	6"	170
TW Series 3 Way Ball Valves	1/2"	40
	3/4"	50
	1"	60
	1-1/4"	70
	1-1/2"	70
	2"	80
	2-1/2"	140
	3"	140
	4"	170
	6"	170
LA Series Lateral Ball Valves	1/2"	40
	3/4"	50
	1"	60
	1-1/4"	70
	1-1/2"	70
	2"	80
	2-1/2"	140
	3"	140
	4"	170
	6"	170
BY Series Butterfly Valves	2"	80
	3"	200
	4"	300
	6"	450
	8"	900
	10"	1800
	12"	2500

* Bench torque for a clean valve. Actuators should be up-sized.

EPZ Series On/Off Electric Actuators

FOR BALL VALVES UP TO 2"

OVERVIEW

The EPZ Series is a compact and robust actuator designed for small space areas that can deliver up to 135 in-lbs. The line features NEMA 4/4x environmental rating, comes standard with an ISO5211 F03/F05 mounting pattern and a 14mm double-square female drive shaft making this an ideal actuator for small valve applications.
The unit is available in 24 VAC, 120 VAC and 230 VAC supply voltages.

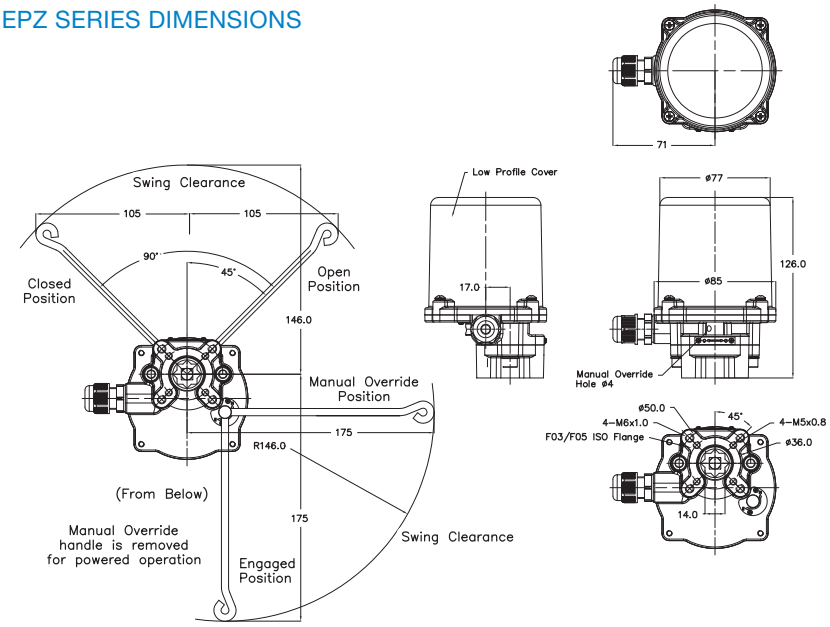
FEATURES

- Ideal for Limited Space Applications
- Available in Two Sizes EPZ 6 and EPZ 15
- Superior Gear Design
- Lightweight Design
- On/Off Jog Control Capabilities
- ISO 5211 F03/F05 Mounting Pattern
- Drive Socket – 14 mm Female
- Non-Spring Return
- Thermal Class F Motor Protection
- NEMA 4X/IP67 Rating
- Manual Override Including Lock-Out Functionality
- Override Tool Included

OPTIONS

- Power Supply Flexibility – 24 VAC, 120 VAC and 230 VAC

EPZ SERIES DIMENSIONS



ACTUATOR SPECIFICATIONS

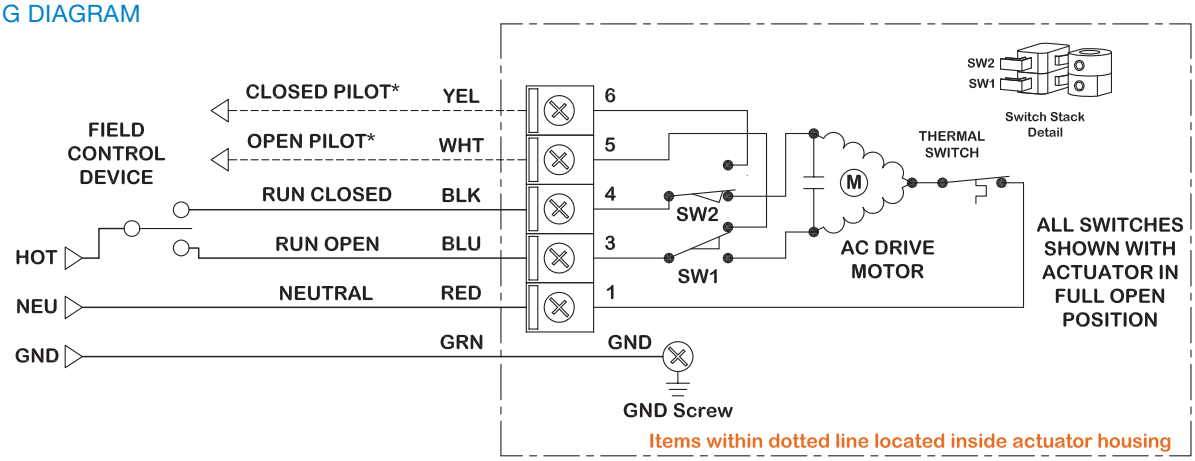
	EPZ 6	EPZ 15
Torque Output (in. lb/Nm)	55/6	135/15
Supply Voltage	24 VAC 120 VAC 230 VAC	24 VAC 120 VAC 230 VAC
Duty Cycle	24V, 120V and 230V 30%	24V, 120V and 230V 30%
Thermal Overload	Standard	Standard
Cycle Time – Seconds @ 90º	17 @ 60 Hz/20 @ 50 Hz	17 @ 60 Hz/20 @ 50 Hz
Conduit Entry	1/4" PF Gland w/ 1 meter Pre-Wired Cable	1/4" PF Gland w/ 1 meter Pre-Wired Cable
Enclosure	NEMA 4/4X/IP67	NEMA 4/4X/IP67
Enclosure Material	Aluminum Alloy	Aluminum Alloy
Maximum Inrush Current	5.0A @ 24 VAC 1.0A @ 120 VAC 0.6A @ 230 VAC	5.0A @ 24 VAC 1.0A @ 120 VAC 0.6A @ 230 VAC
Running Current	1.5A @ 24 VAC 0.3A @ 120 VAC 0.2A @ 230 VAC	1.5A @ 24 VAC 0.3A @ 120 VAC 0.2A @ 230 VAC
Weight (lbs/kg)	3/2	3/2

BALL VALVE SELECTION CHART*

SIZE in/DN	TRUE UNION BALL VALVE	THREE-WAY BALL VALVE
1/2 – 1/15 – 25	EPZ 6/EPZ 15	EPZ 6/EPZ 15
1-1/4 – 2/32 – 50	EPZ 15	EPZ 15

* Actuator size selections based on clean water at 70°F

WIRING DIAGRAM



EPM Series Reversing Electric Actuators

OVERVIEW

The EPM Series features both on/off and Proportional Control models, designed for use with all ball and butterfly valves up to 24" in size and torque outputs from 300-13,500 in. lb, all on/off and proportional control models feature a Modular Design and Superior Gear Design as standard.

FEATURES

Modular Design

All EPM Series actuators utilize modular PC boards designed and manufactured in North America. By eliminating 90% of the internal wiring found in most actuation products, we're producing a higher quality, more reliable product that is easier to install, operate and maintain.

Superior Gear Design

All EPM Series actuators employ an epicyclic gear design to provide tough, dependable torque transmission in a compact, quiet, smooth package.

Data Logging and Diagnostics

Our Proportional Control Actuators respond to a variety of control signals which are user-selectable through a simple joystick/menu interface. The microprocessor-based control monitors and records operating parameters that can be used for process diagnostics, advanced alarming functions or maintenance scheduling.

Proportional Control Models

All EPM Series Proportional Control Models feature added Data Logging and Diagnostics capabilities not found on the basic EPM on/off models.

FEATURES

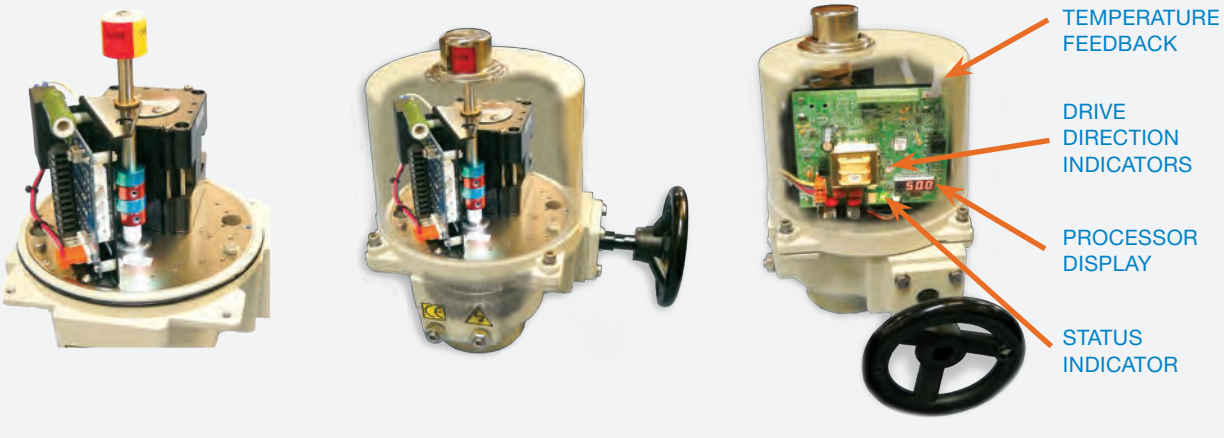
- Four Limit Switches (Two Auxiliary)
- Internal Low Power Heater
- NEMA 4/4X Enclosure
- Position Indicator
- Clutchless Manual Override
- Self-Locking Drive
- Permanently Lubricated
- Thermal Overload Protection
- CE/CSA/UL Approved
- ISO 5211 Mounting Base
- Choice of Voltages: 12 VAC/DC, 24VAC/DC, 120 VAC, 230 VAC

OPTIONS*

- Positioners
- Extended Duty Motors
- 0-90°-180°/0-45°-90°
- Feedback Potentiometer
- Two Additional Auxiliary Switches
- Local Control Station
- Power Supply Flexibility– 3 Phase w/230 VAC, 380 VAC or 460 VAC

* Not available on all models

CUTAWAY DIAGRAMS



EPM Series Product Specifications

ACTUATOR SPECIFICATIONS

	EPM2*	EPM3	EPM4	EPM6	EPM8
Torque Output (in. lb/Nm)	135/15	300/35	445/50	600/67	800/90
Supply Voltage	12 VDC 24 VDC 120 VAC 230 VAC	12 VAC/DC 24 VAC/DC 120 VAC 230 VAC		24 VAC/DC 120 VAC 230 VAC	12 VAC/DC 24 VAC/DC 120 VAC 230 VAC
Duty Cycle	12 V and 24 V – 75% 120 V and 230 V – 25% to 50%	12 V and 24 V – 75% 120 V and 230 V – 25% to 50% Proportional Control – 75%		24 V – 75% 120 V and 230 V – 25% to 50% Proportional Control – 75%	25% to 50% On/Off Control, Proportional Control 100% Managed
Thermal Overload	Standard				
Cycle Time – Secs.@ 90º	8	12	20	15	15
Auxiliary Limit Switch Rating	3A @ 250 V			10A @ 250 V	10A @ 250 V
Conduit Entry (2)	1/2" NPT			3/4" NPT	3/4" NPT
Enclosure	NEMA 4/4X				
Enclosure Material	Aluminum Alloy Dry Powder Coated				
Maximum Inrush Current	3.0A @ 12 VAC/DC 0.8A @ 24 VAC/DC 1.5A @ 120 VAC 1.0A @ 230 VAC		3.0A @ 12 VAC/DC 8.0A @ 24 VAC/DC 1.5A @ 120 VAC/DC 1.0A @ 230 VAC/DC	— 5.0A @ 24 VAC/DC 3.0A @ 120 VAC 1.5A @ 230 VAC	5.0A @ 12 VAC/DC 5.0A @ 24 VAC/DC 3.0A @ 120 VAC 1.5A @ 230 VAC
Running Current	0.5A @ 12 VAC/DC 0.6A @ 24 VAC/DC 0.5A @ 120 VAC 0.3A @ 230 VAC		0.5A @ 12 VAC/DC 0.7A @ 24 VAC/DC 0.5A @ 120 VAC/DC 0.3A @ 230 VAC/DC	— 3.0A @ 24 VAC/DC 1.0A @ 120 VAC 0.5A @ 230 VAC	3.4A @ 12 VAC/DC 3.0A @ 24 VAC/DC 1.0A @ 120 VAC 0.5A @ 230 VAC
Weight (lb/kg)	5/2	5/2	8/3.6	25/11	25/11

* On/Off Only

BALL VALVE SELECTION CHART*

SIZE	TRUE UNION BALL VALVE	THREE-WAY BALL VALVE
1/2" – 2"	EPM2/EPM3/EPM4	EPM2/EPM3/EPM4
2-1/2" – 3"	EPM3/EPM4/EPM6	EPM3/EPM4/EPM6
4" – 6"	EPM3/EPM4/EPM6	EPM4/EPM6/EPM8

* Actuator size selections based on clean water at 70°F

ACTUATOR SPECIFICATIONS

	EPM11	EPM13	EPM22	EPM35	EPM130
Torque Output (in. lb/Nm)	1150/130	1300/150	2200/248	3500/400	13500/1500
Supply Voltage	24 VAC/DC 120 VAC 230 VAC	12 VAC/DC 24 VAC/DC 120 VAC 230 VAC	24 VAC/DC 120 VAC 230 VAC	12 VAC 24 VAC 120 VAC 230 VAC	24 VAC/DC 120 VAC 230 VAC —
Duty Cycle	24 V – 75% 120 V and 230 V – 25% to 50% Proportional Control – 75%	25% to 50% On/Off Control, Proportional Control 100% Managed	24 V – 75% 120 V and 230 V – 25% to 50% Proportional Control – 75%	24 V – 75% 25% to 50% On/Off Control, Proportional Control 100% Managed	
Thermal Overload	Standard				
Cycle Time – Secs.@ 90°	22	22	16	16	46
Auxiliary Limit Switch Rating	10A @ 250 V				
Conduit Entry (2)	3/4" NPT				
Enclosure	NEMA 4/4X				
Enclosure Material	Aluminum Alloy Dry Powder Coated				
Maximum Inrush Current	— 5.0A @ 24 VAC/DC 3.0A @ 120 VAC 1.5A @ 230 VAC	5.0A @ 12 VAC/DC 5.0A @ 24 VAC/DC 3.0A @ 120 VAC 1.5A @ 230 VAC	— 8.0A @ 24 VAC/DC 3.1A @ 120 VAC 1.5A @ 230 VAC	8.5A @ 12 VAC 8.0A @ 24 VAC 3.1A @ 120 VAC 1.5A @ 230 VAC	— 14.0A @ 120 VAC 3.6A @ 230 VAC —
Running Current	— 3.0A @ 24 VAC/DC 1.0A @ 120 VAC 0.5A @ 230 VAC	3.4A @ 12 VAC/DC 3.0A @ 24 VAC/DC 1.0A @ 120 VAC 0.5A @ 230 VAC	— 6.0A @ 24 VAC/DC 3.0A @ 120 VAC 0.6A @ 230 VAC	12.0A @ 12 VAC 6.0A @ 24 VAC 1.3A @ 120 VAC 0.6A @ 230 VAC	— 4.0A @ 120 VAC 2.0A @ 230 VAC —
Weight (lb/kg)	25/11	25/11	49/22	49/22	80/36

* On/Off Only

BUTTERFLY VALVE SELECTION CHART*

SIZE	BUTTERFLY VALVE
1-1/2", 2" and 3"	EPM3/EPM4
4"	EPM4/EPM6
6"	EPM6/EPM8
8"	EPM8
10" and 12"	EPM22/EPM35
14" – 24"	EPM130

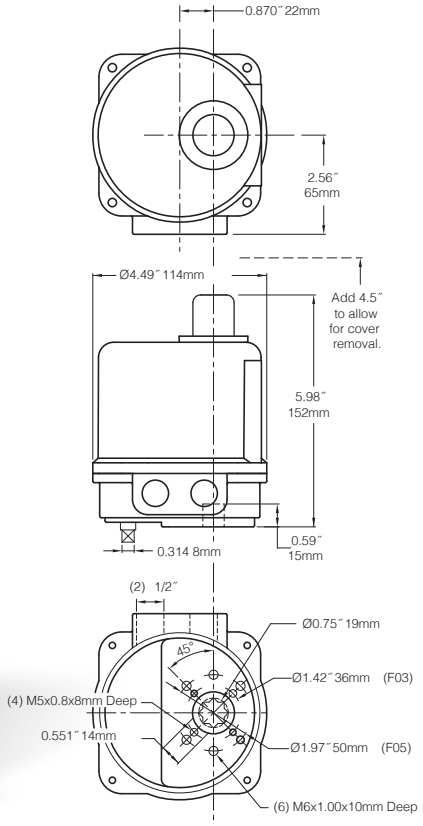
* Actuator size selections based on clean water at 70°F

Please Note: All EPM, EPS, and EPL Series Reversing Electric Actuators are considerably heavier than those typically used with plastic ball and butterfly valves, and they must be supported independently of the valves on which they are mounted. The weight must not be borne by the valve or piping. Please consult the factory if you need help with your particular application.

EPM2

FOR BALL VALVES 1/2" TO 2"

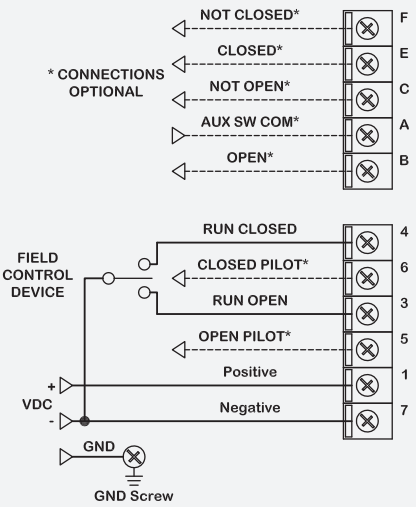
EPM2 SERIES DIMENSIONS



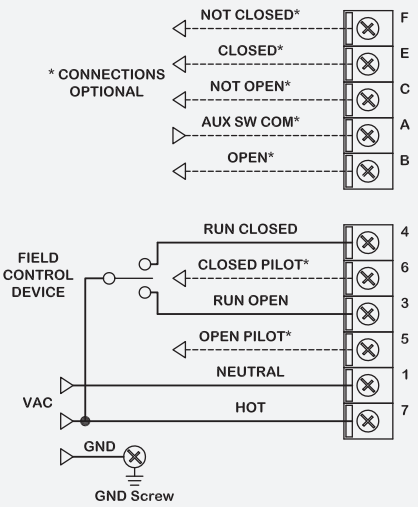
WIRE DIAGRAMS

ON/OFF CONTROL

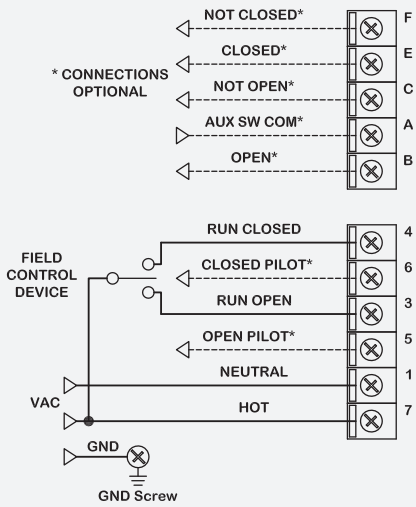
12/24 VDC



12/24 VAC



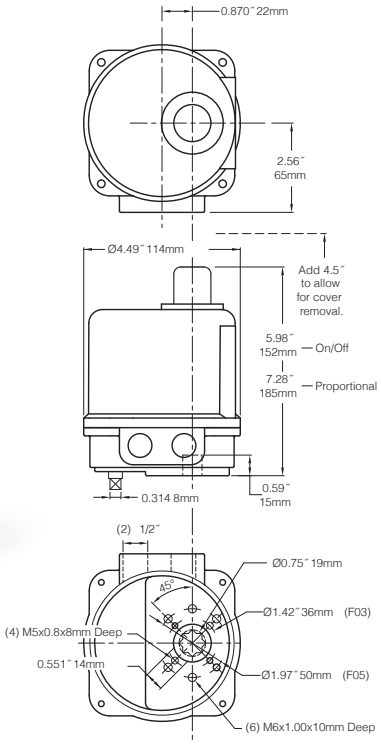
120/230 VDC



EPM3

FOR BALL VALVES 1/2" TO 3",
TRUE UNION BALL VALVES ONLY 4" TO 6"
AND BUTTERFLY VALVES 1-1/2" TO 3"

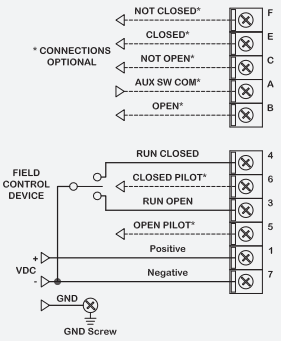
EPM3 SERIES DIMENSIONS



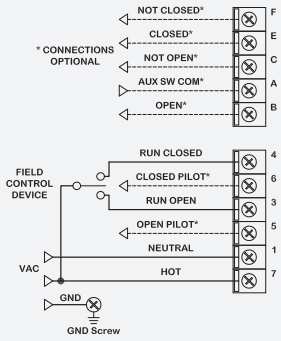
WIRE DIAGRAMS

ON/OFF CONTROL

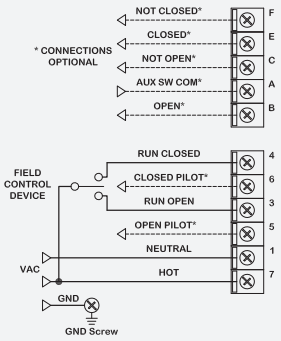
12/24 VDC



12/24 VAC

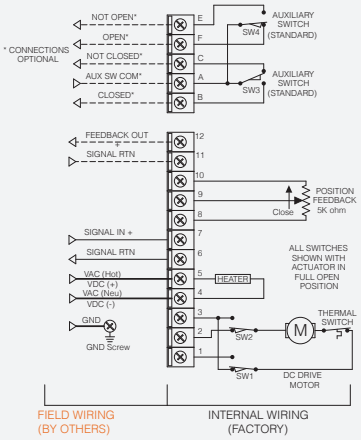


120/230 VDC



PROPORTIONAL CONTROL

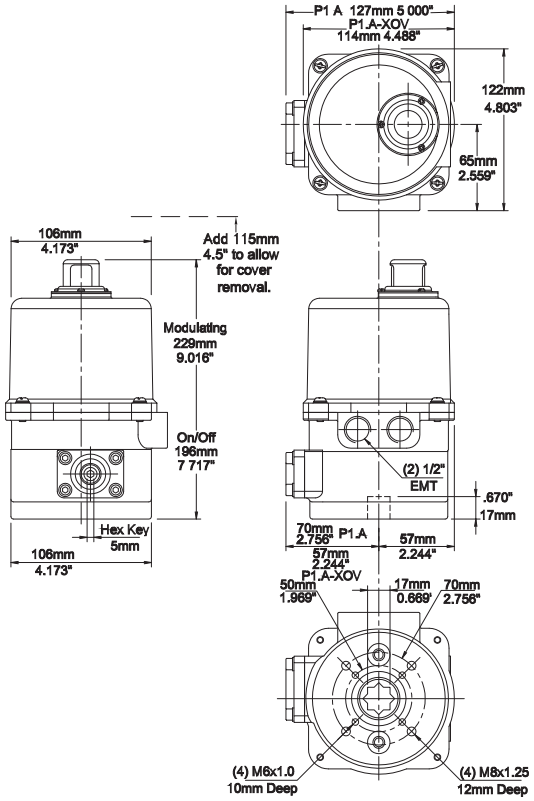
12/24 VDC AND 12/24/120/230 VAC



EPM4

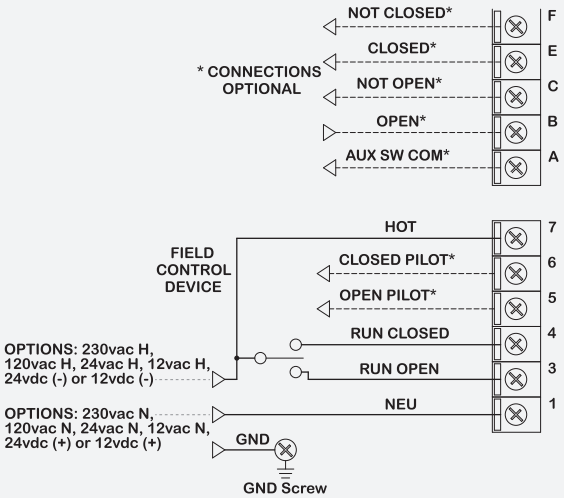
FOR BALL VALVES 1/2" TO 6" AND BUTTERFLY VALVES 1-1/2" TO 4"

EPM4 SERIES DIMENSIONS

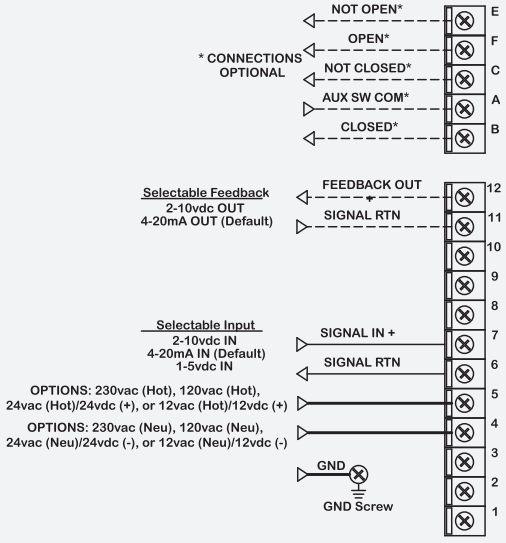


WIRE DIAGRAMS

ON/OFF JOG CONTROL



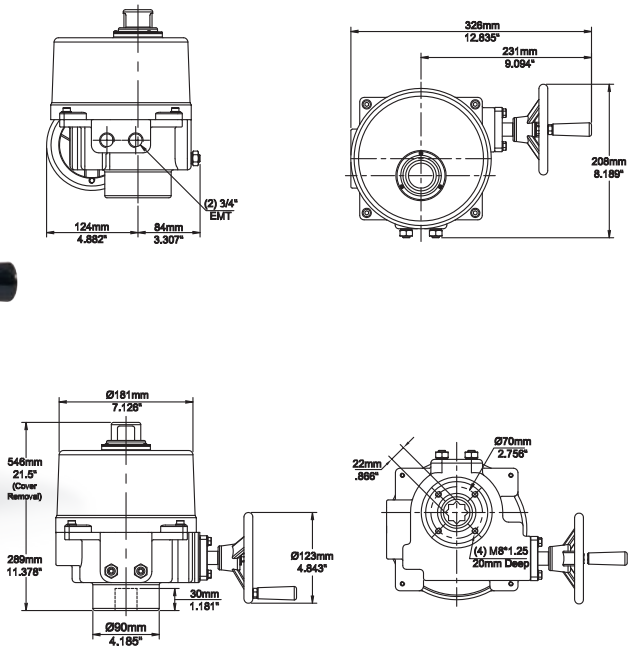
MODULATING CONTROL



EPM6

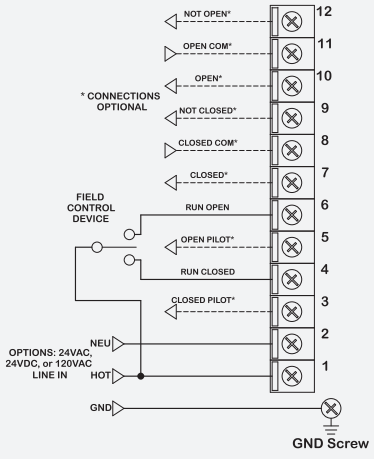
FOR BALL VALVES 1/2" TO 6" AND
BUTTERFLY VALVES 1-1/2" TO 6"

EPM6 SERIES DIMENSIONS

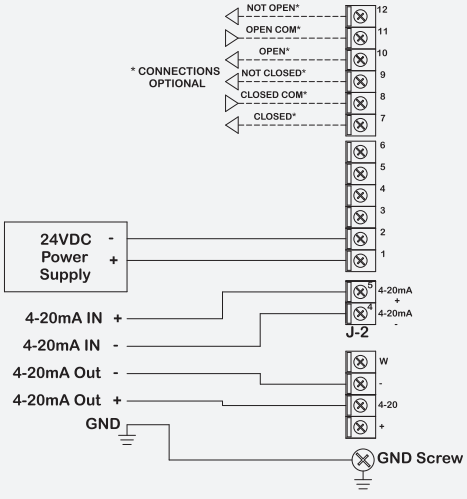


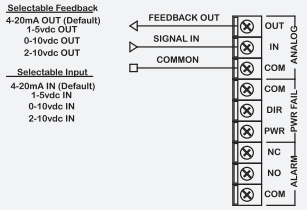
WIRE DIAGRAMS

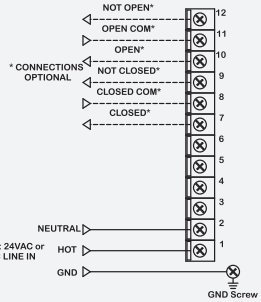
ON/OFF CONTROL



PROPORTIONAL CONTROL





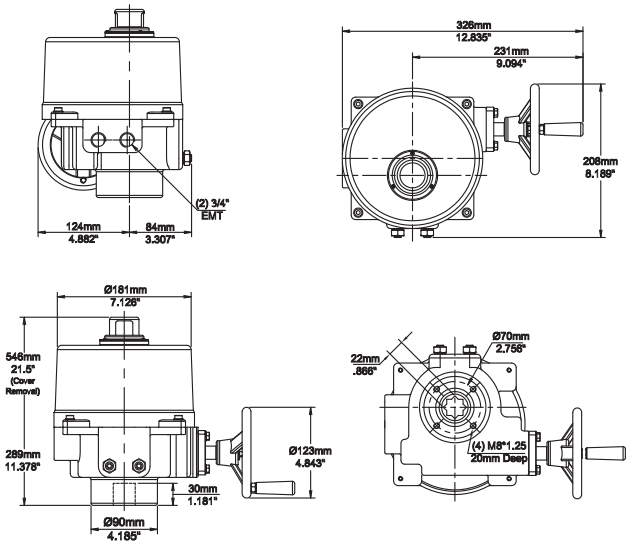


Please Note: For 24VDC Negative connects to terminal 2 and Positive to terminal 1.

EPM8

FOR THREE-WAY BALL VALVES AND BUTTERFLY VALVES 4" TO 6"

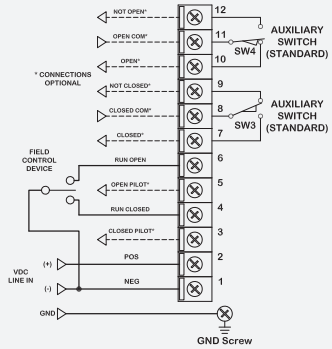
EPM8 SERIES DIMENSIONS



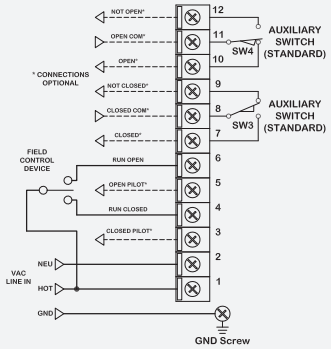
WIRE DIAGRAMS

ON/OFF CONTROL

12/24 VDC

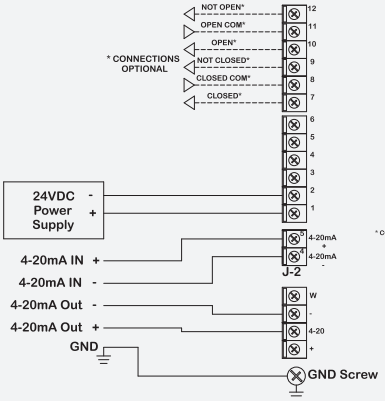


12/24/120/230 VAC

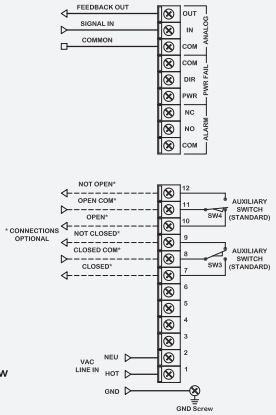


PROPORTIONAL CONTROL

24 VDC



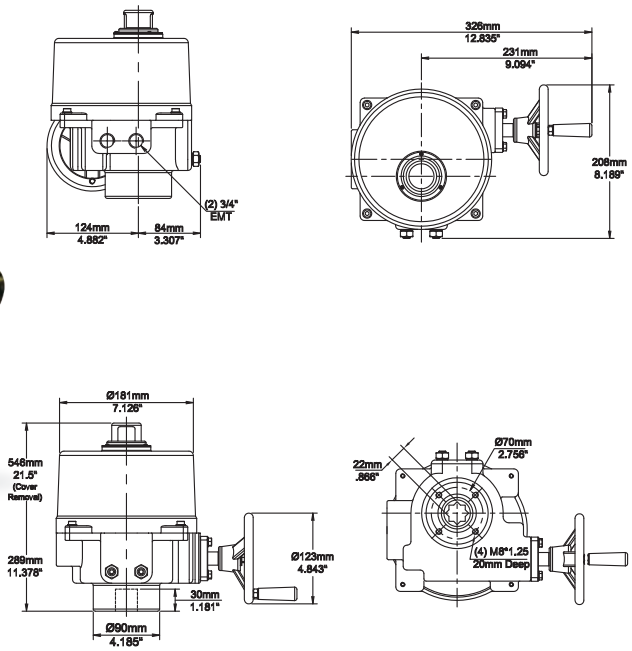
24/120/230 VAC



EPM11

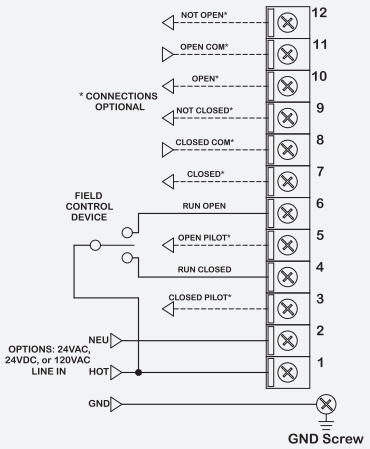
FOR BUTTERFLY VALVES 1-1/2" TO 8"

EPM11 SERIES DIMENSIONS

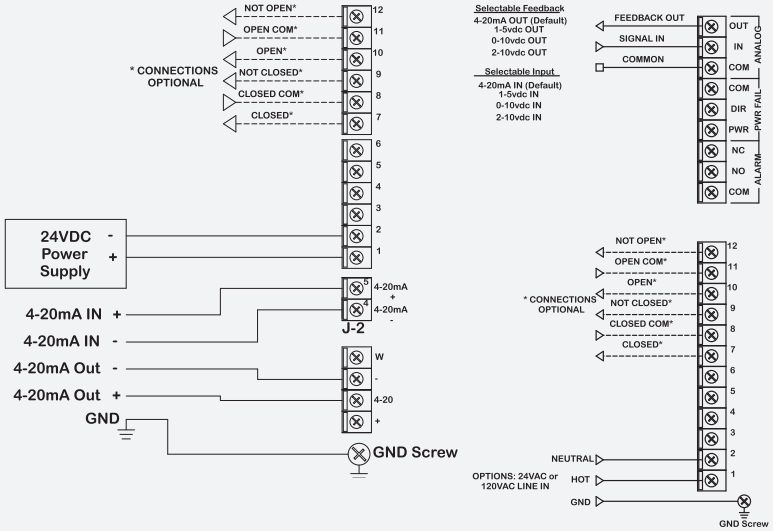


WIRE DIAGRAMS

ON/OFF CONTROL



PROPORTIONAL CONTROL

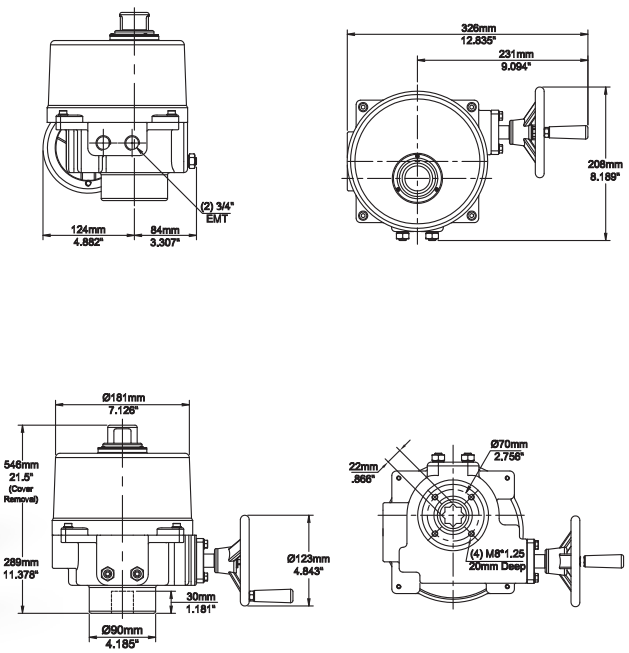


Please Note: For 24VDC Negative connects to terminal 2 and Positive to terminal 1.

EPM13

FOR BUTTERFLY VALVES 8"

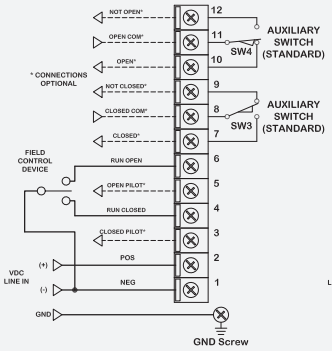
EPM13 SERIES DIMENSIONS



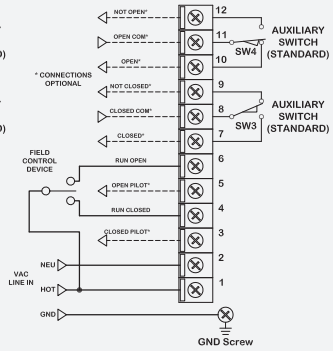
WIRE DIAGRAMS

ON/OFF CONTROL

12/24 VDC

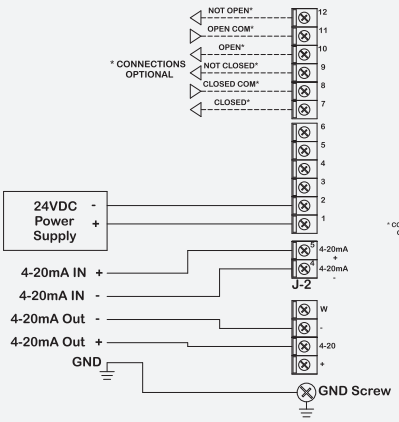


12/24/120/230 VAC

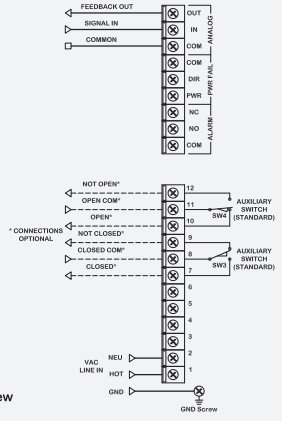


PROPORTIONAL CONTROL

24 VDC



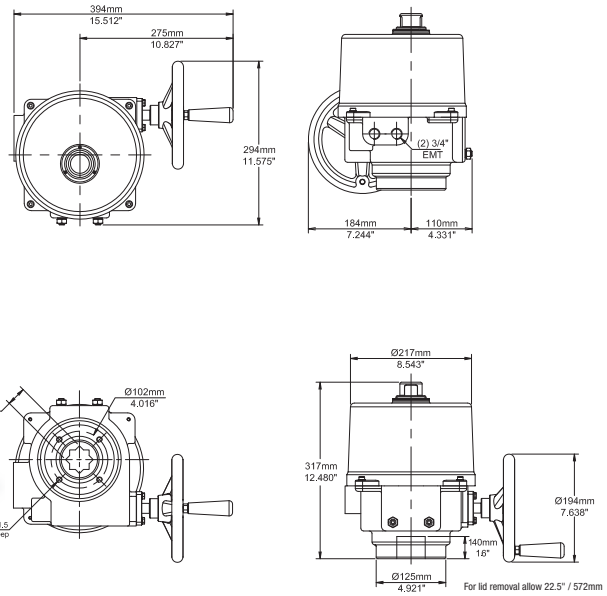
24/120/230 VAC



EPM22

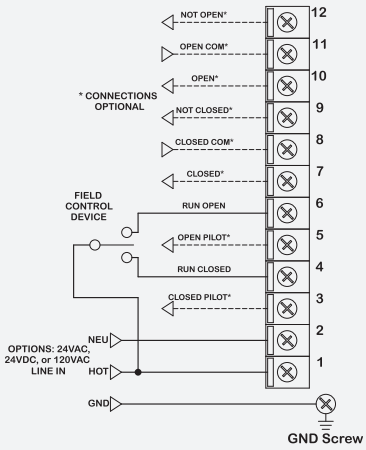
FOR BUTTERFLY VALVES 6" TO 10"

EPM22 SERIES DIMENSIONS

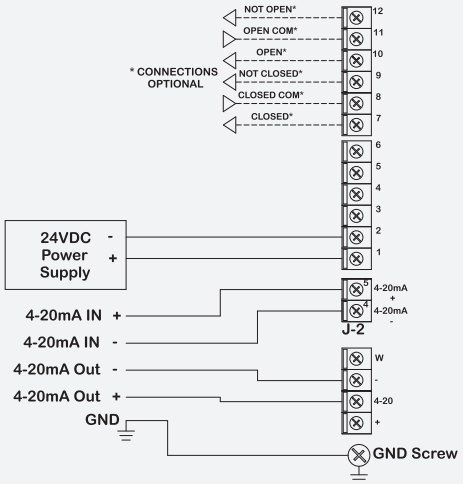


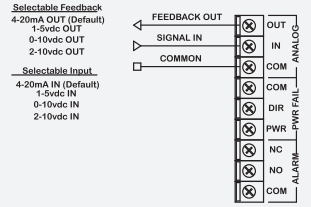
WIRE DIAGRAMS

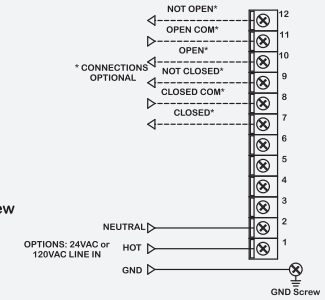
ON/OFF CONTROL



PROPORTIONAL CONTROL





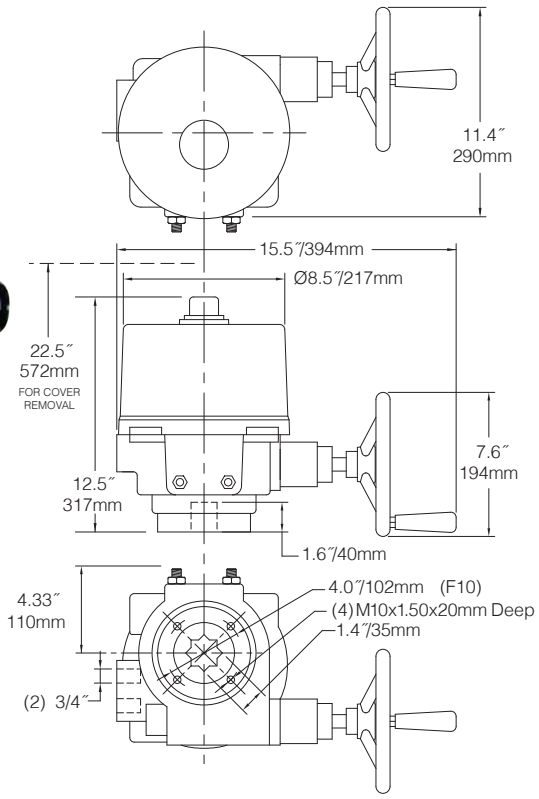


Please Note: For 24VDC Negative connects to terminal 2 and Positive to terminal 1.

EPM35

FOR BUTTERFLY VALVES 10" TO 12"

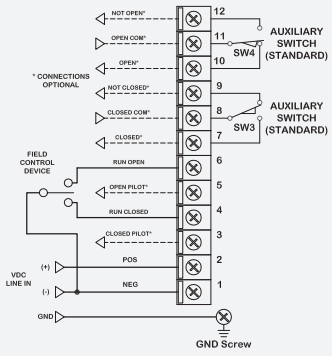
EPM35 SERIES DIMENSIONS



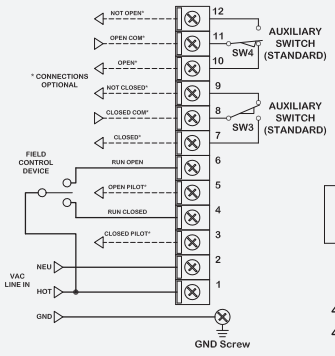
WIRE DIAGRAMS

ON/OFF CONTROL

12/24 VDC

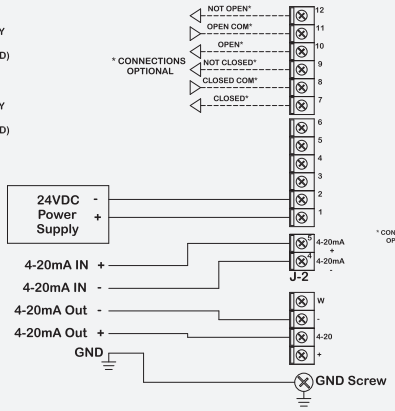


12/24/120/230 VAC

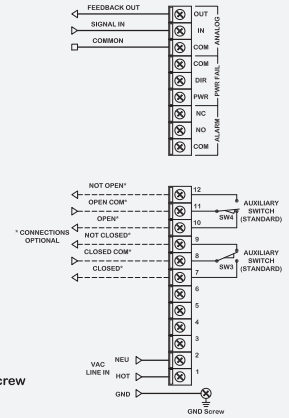


PROPORTIONAL CONTROL

24 VDC



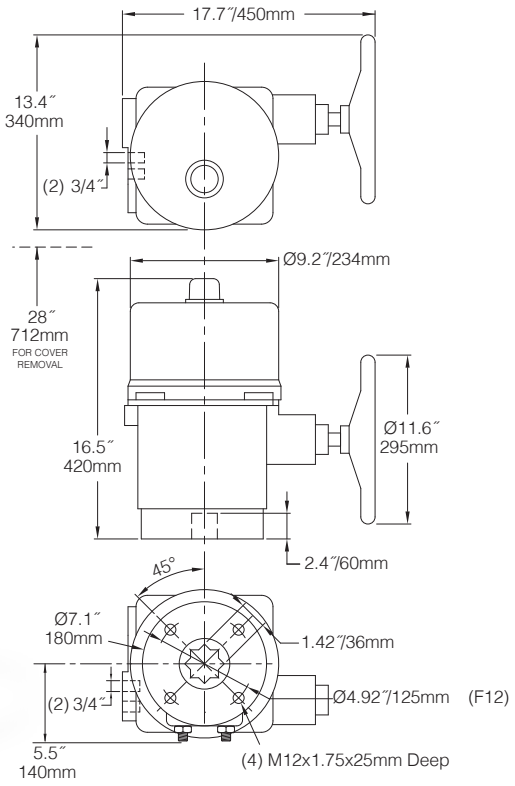
24/120/230 VAC



EPM130

FOR BUTTERFLY VALVES 14" TO 24"

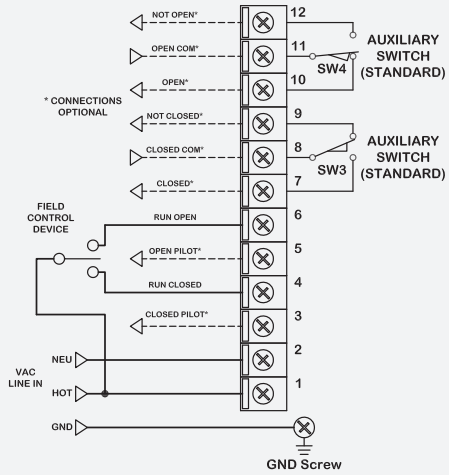
EPM130 SERIES DIMENSIONS



WIRE DIAGRAMS*

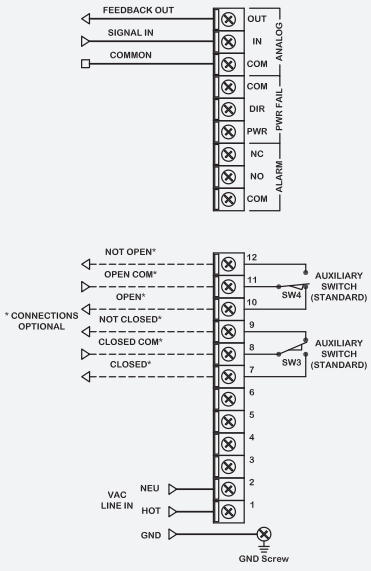
ON/OFF CONTROL

120/230 VAC



PROPORTIONAL CONTROL

120/230 VAC



* Also available for 24 VAC/DC On/Off and Proportional Control. Consult factory for wiring diagrams.

EPS Series Reversing Spring Return Electric Actuators

OVERVIEW

Cost effective, rugged, spring return actuator is designed for use with all ball valves and butterfly valves up to 8" in size with torque outputs from 450 to 2,300 in. lb. Ideal for a wide range of applications without costly options, the actuator is available with a clockwise or counterclockwise spring return depending upon application requirements.

FEATURES

- Four Limit Switches (Two Auxiliary)
- Internal Low Power Heater
- NEMA 4/4X Enclosure
- Position Indicator
- Rack and Pinion Spring Pack Design
- Permanently Lubricated Gear Train
- Thermal Overload Protection
- CE and CSA Pending
- ISO 5211 Mounting Base
- Choice of Voltages: 24 VAC/DC, 120 VAC, 230 VAC

OPTIONS*

- Positioners
- Two Additional Auxiliary Switches
- Local Control Station
- Clutchless Manual Override

* Not available on all models

Please Note: All EPM, EPS, and EPL Series Reversing Electric Actuators are considerably heavier than those typically used with plastic ball and butterfly valves, and they must be supported independently of the valves on which they are mounted. The weight must not be borne by the valve or piping. Please consult the factory if you need help with your particular application.

TECHNICAL INFORMATION



ACTUATOR SPECIFICATIONS

	EPS5	EPS12	EPS18
Torque Output (in. lb/Nm)	450/50	1150/130	1750/200
Supply Voltage	24 VAC/DC 120 VAC 230 VAC		
Duty Cycle	24 V – 50% 120 V and 230 V – 50% Proportional Control – 25%		
Thermal Overload	Standard		
Cycle Time			
secs @ 90° 24 V/120 – 230 V	7.0/7.0	8.0/7.0	11.0/11.0
secs @ 90° Spring 24 V/120 – 230 V	3.0/3.0	3.0/8.0	3.0/12.0
Auxiliary Limit Switch Ratings	3A @ 250 VAC		
Conduit Entry	3/4" NPT		
Enclosure	NEMA 4/4X		
Enclosure Material	Aluminum Alloy, Dry Powder Coated		
Maximum Inrush Current	4.0A @ 24 VAC/DC 2.8A @ 120 VAC 1.3A @ 230 VAC	19.0A @ 24 VAC/DC 11.0A @ 120 VAC 5.6A @ 230 VAC	
Running Current	3.0A @ 24 VAC/DC 1.5A @ 120 VDC 0.7A @ 230 VAC	9.0A @ 24 VAC/DC 3.8A @ 120 VAC 2.1A @ 230 VAC	
Weight (lb/kg)	82/37	163/74	297/135

BALL VALVE SELECTION CHART*

SIZE	TRUE UNION BALL VALVE	THREE-WAY BALL VALVE
1/2" – 3"	EPS5	EPS5
4" and 6"	EPS5	EPS12

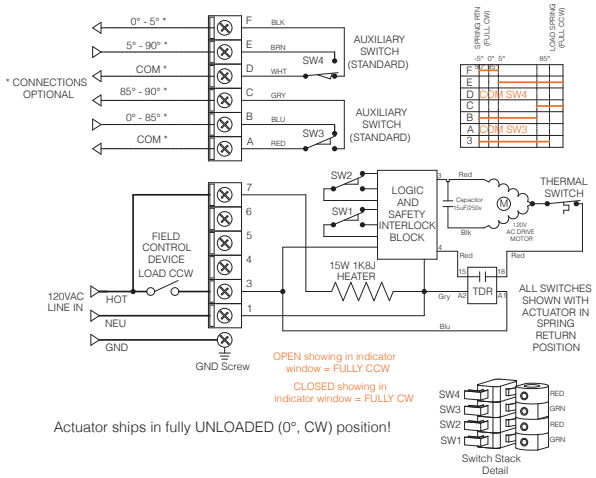
* Actuator size selections based on clean water at 70°F

BUTTERFLY VALVE SELECTION CHART*

SIZE	BUTTERFLY VALVE
1-1/2", 2" and 3"	EPS5
4" and 6"	EPS12
8"	EPS18

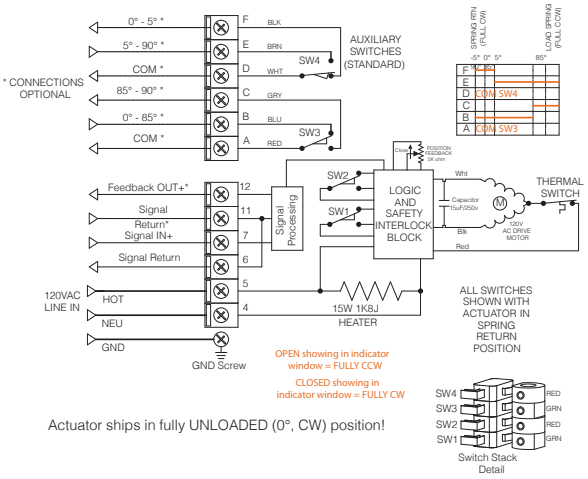
* Actuator size selections based on clean water at 70°F

ON/OFF CONTROL



Actuator ships in fully UNLOADED (0°, CW) position!

PROPORTIONAL CONTROL

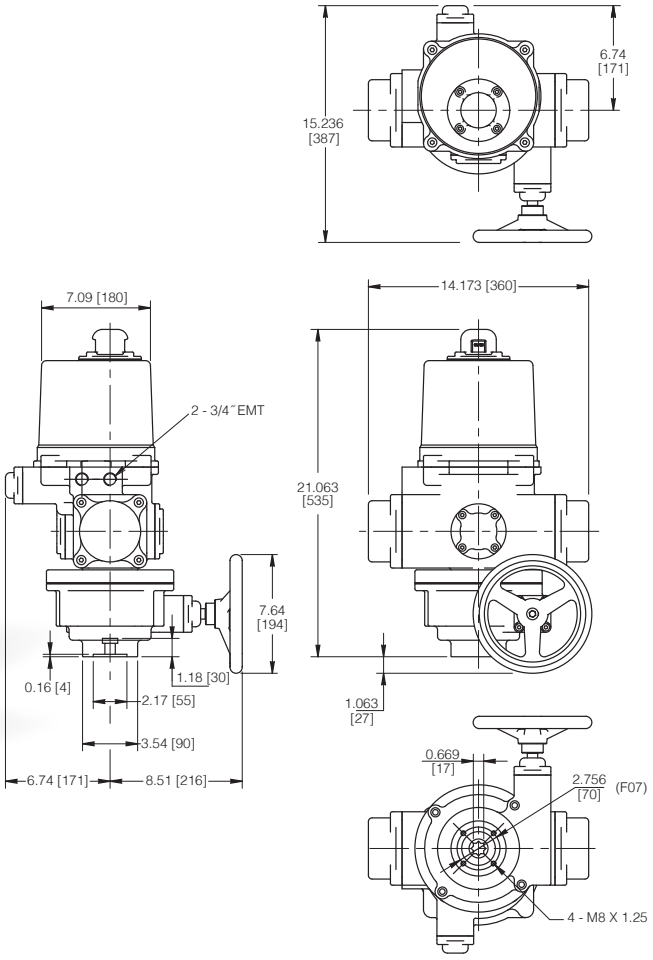


Actuator ships in fully UNLOADED (0°, CW) position!

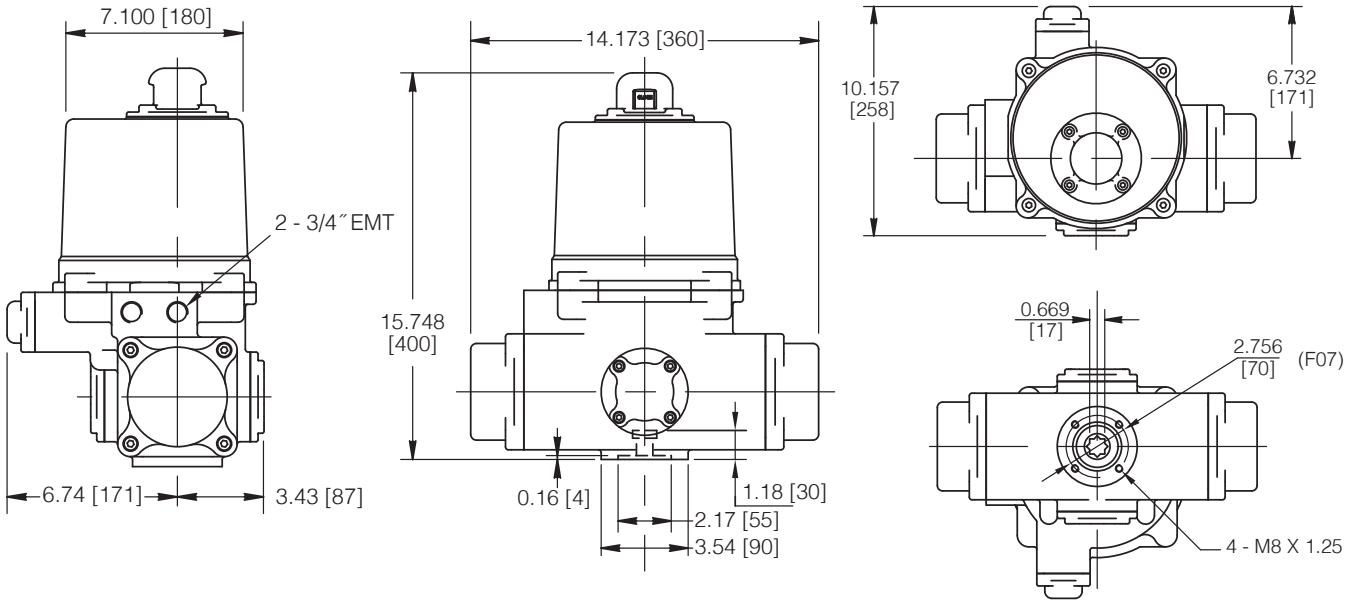
EPS5

FOR BALL VALVES 1/2" TO 3", TRUE UNION BALL VALVES ONLY 4" TO 6"
AND BUTTERFLY VALVES 1-1/2" TO 3"

EPS5 DIMENSIONS WITH MANUAL OVERRIDE



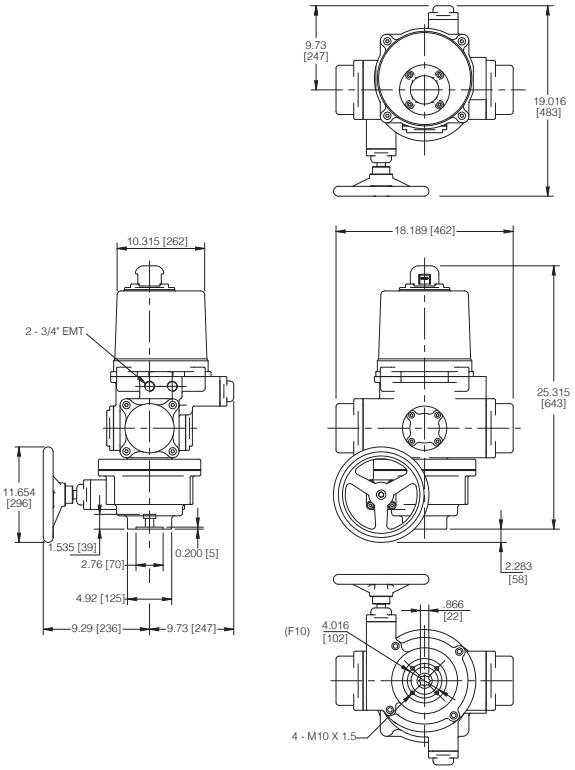
EPS5 DIMENSIONS WITHOUT MANUAL OVERRIDE



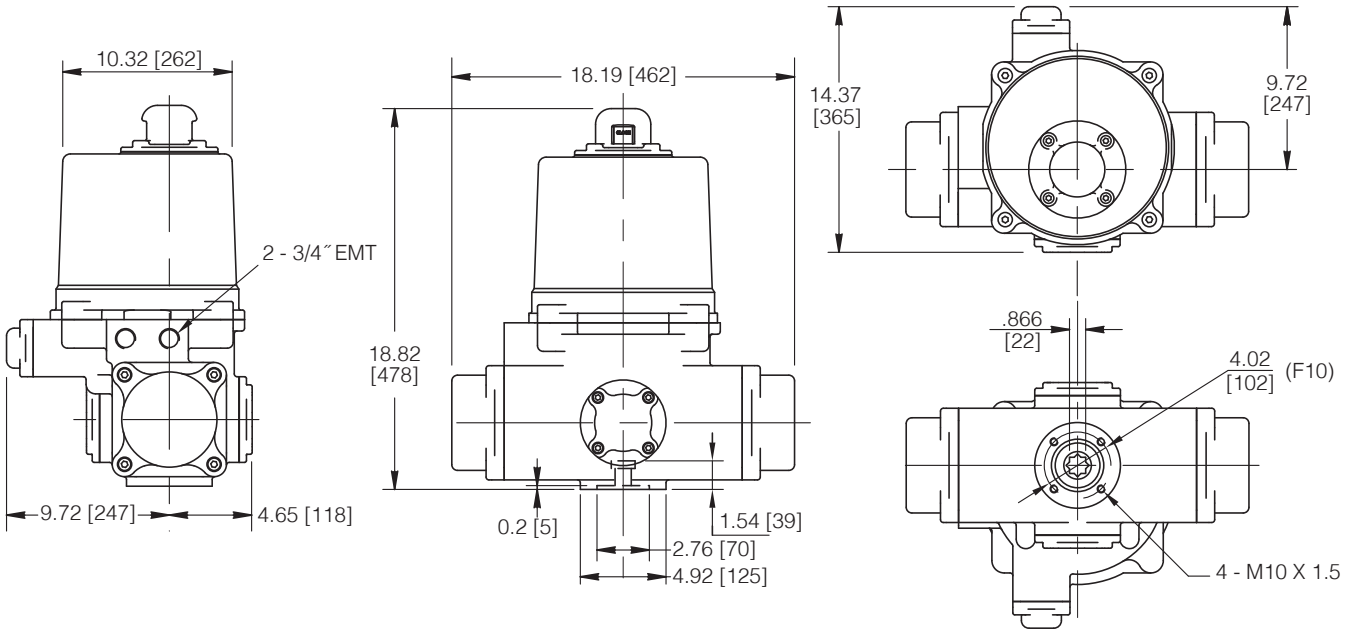
EPS12

FOR THREE-WAY BALL VALVES AND BUTTERFLY VALVES 4" TO 6"

EPS12 DIMENSIONS WITH MANUAL OVERRIDE



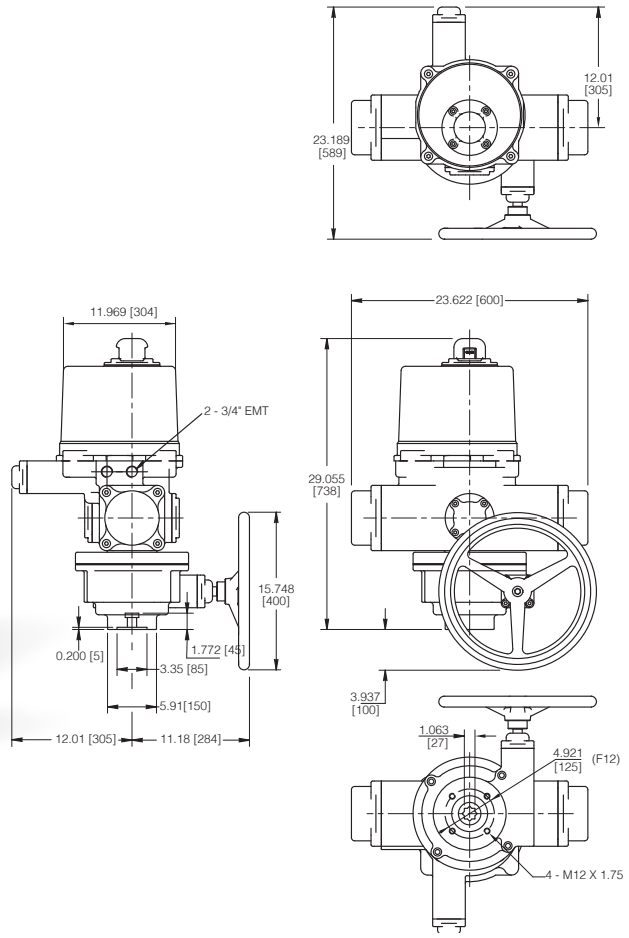
EPS12 DIMENSIONS WITHOUT MANUAL OVERRIDE



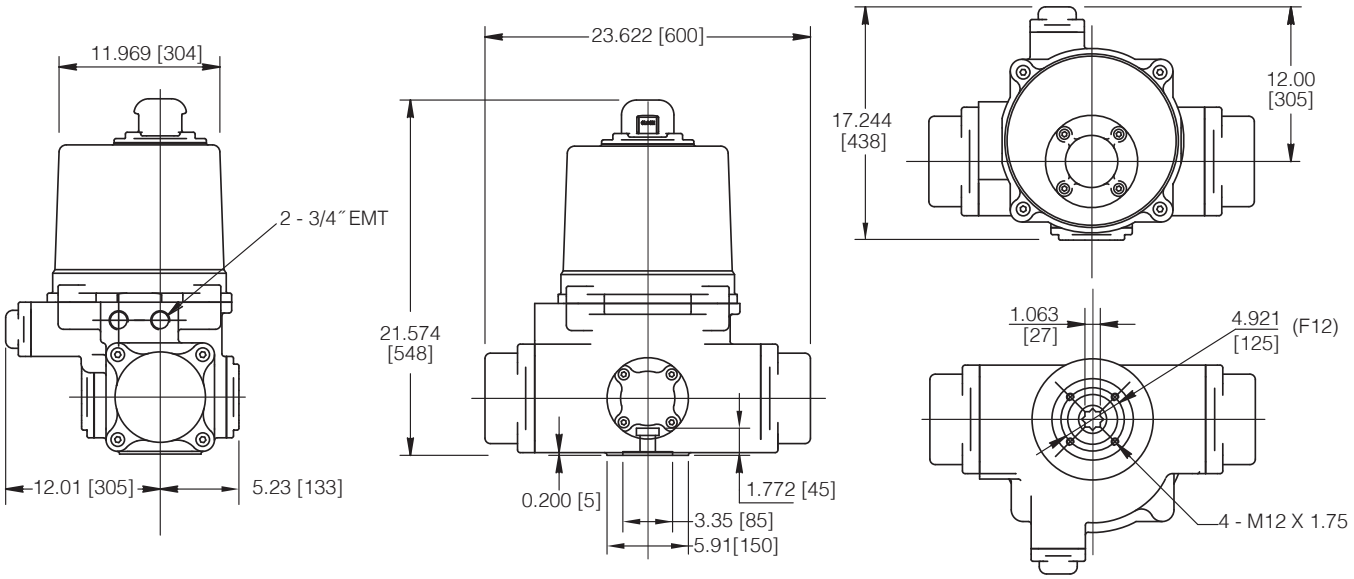
EPS18

FOR BUTTERFLY VALVES 8"

EPS18 DIMENSIONS WITH MANUAL OVERRIDE



EPS18 DIMENSIONS WITHOUT MANUAL OVERRIDE



EPD Series Spring Return Electric Actuators

OVERVIEW

Compact, rugged, spring return actuator is designed for use with damper frames and valve top works, and provides torque outputs from 90 to 450 in. lb. Ideal for industrial applications without costly options, the actuator features field adjustable speed control and field adjustable spring return along with auto-switching power supplies that are ready to connect to 24V to 230V AC or DC power sources.

FEATURES

- Maintenance Free
- Field Adjustable Speed Control
- Field Adjustable Spring Return Speed*
- Auto-Switching Power Supplies
- Hex Key Override and Mounting Screws
- Internal Low Power Heater
- NEMA 4 Enclosure
- Manual Override
- CE and CSA Pending (NEMA 4/IP66 Certified)
- Mechanical 12 mm Double-Square Drive Shaft Connection
- Thermal Overload Protection
- Choice of Voltages: Units Can Operate on Any Voltage from 24 VAC/VDC to 230 VAC/VDC

* Some Models

OPTIONS

- Two Internal End-of-Travel Nonadjustable Switches
- Externally Mounted Switch Pack with 2 Additional Adjustable Switches
- EMT Enclosure
- Manual Override Handwheel
- Mounting Kit

EPD Series Spring Return Electric Actuators, *CONTINUED*

ACTUATOR SPECIFICATIONS

MODEL	EPD2	EPD3	EPD4	EPD5
Torque Output (in.-lb/Nm)	90/10	133/15	266/30	450/50
Supply Voltage	24 to 230 VAC/DC, +15%/-20% AC: 50/60 Hz			
Amp Draw	Max 4.7A @ 3 Sec Mode, 120 VAC		Max 2.0A @ 40 Sec Mode, 120 VAC	
Duty Cycle Mode	> 14 Sec Mode: 100%		All Modes: 100%	
	3 Sec Mode: 10%; One Power/Spring Cycle per Minute Max.		N/A	
Thermal Overload	Standard			
Runtime (Power) Selectable	3/15/30/60/120 @ 90° (Field Selectable)		40/60/90/120/150 @ 90° (Field Selectable)	
Runtime (Spring)	3 or 10 seconds @ 90° (Field Selectable)		20 seconds @ 90° (Fixed)	
3 Sec Mode (Spring)	3-4 seconds @ 90° (Load Dependant)		N/A	N/A
Response Time (Spring)	Up to 1 Second After Power Failure			
Auxiliary Limit Switch Rating	230 VAC @ 250 mA and 24 VAC/DC @ 3A Max			
Electrical Connections	1m Cable, Multiconductor (Optional EMT)			
Enclosure	NEMA 4 (IP66)			
Enclosure Material	Aluminum Die Casting			
Drive Configuration	12 mm Double Square, 100% Overload Proof Self-Locking up to 133 in. lb/15 Nm		16 mm Double Square, 100% Overload Proof Self-Locking up to 445 in. lb/50 Nm	
Manual Override	Supplied Hex Key (Optional Handwheel)			
Weight (lbs/kg)	7.8/3.5 (No Installed Options)		20.9/9.5 (No Installed Options)	

TRUE UNION BALL VALVE SELECTION CHART*

SIZE in/DN	ACTUATOR
1/2 – 1/15 – 25	EPD2
1-1/4 – 2/32 – 50	EPD3
2-1/2 – 6/63 – 150	EPD4

* Actuator size selections based on clean water at 70°F

BUTTERFLY VALVE SELECTION CHART*

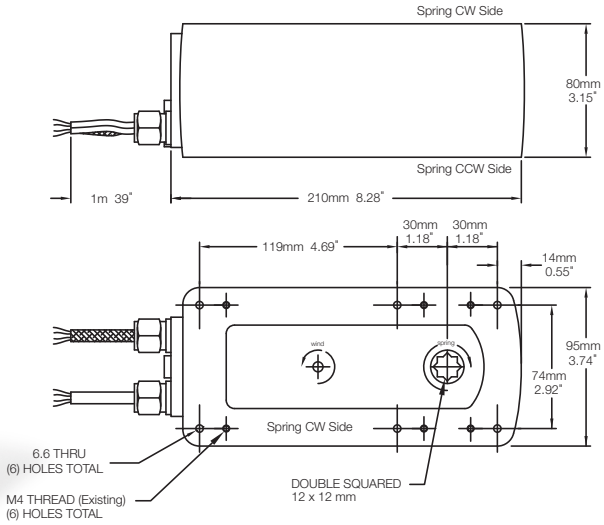
SIZE in/DN	ACTUATOR
1-1/2 – 4/40 – 100	EPD5

* Actuator size selections based on clean water at 70°F

EPD 2/3

FOR BALL VALVES 1/2" TO 2"

WITH SUPPLIED HEX KEY



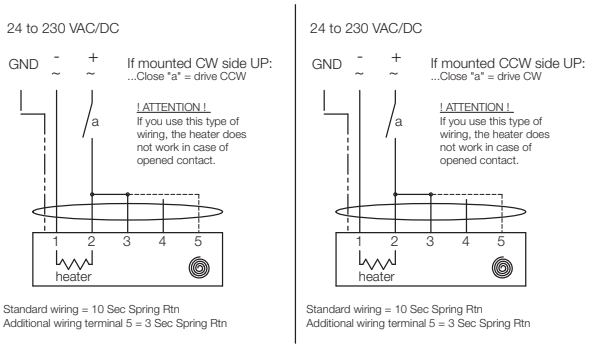
Notes: Do NOT operate the spring return actuator in 3 second mode without a MINIMUM LOAD of 27 in. lb (3 Nm)

If using the 3 second spring return mode, do NOT exceed more than one complete drive/spring return cycle per minute

Actuator will NOT activate until the internal temperature reaches at least -8°F (-20°C). All functions are disabled until after this heat-up period

EPD 2/3 ON/OFF CONTROL

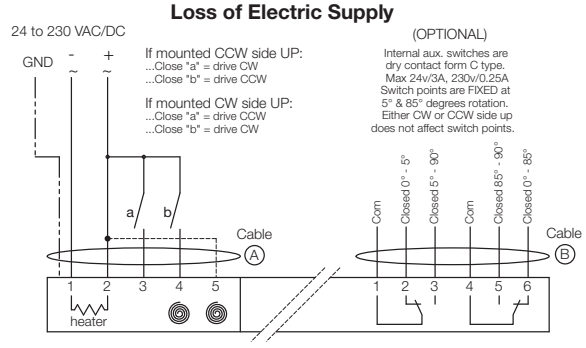
Drive Open or Closed/Spring Opposite



Standard wiring = 10 Sec Spring Rtn
Additional wiring terminal 5 = 3 Sec Spring Rtn

Standard wiring = 10 Sec Spring Rtn
Additional wiring terminal 5 = 3 Sec Spring Rtn

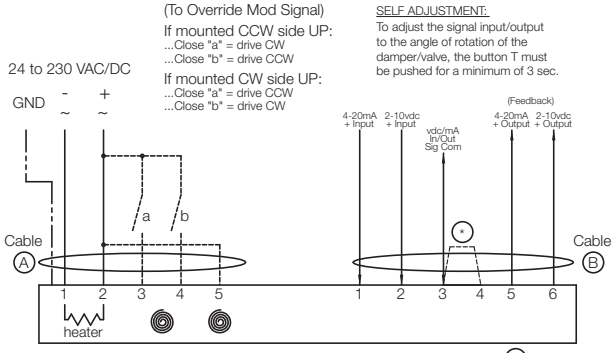
Drive Open/Closed; Spring Engaged Upon Loss of Electric Supply



Standard wiring = 10 Sec Spring Rtn.
Additional wiring terminal 5 = 3 Sec Spring Rtn.

Additional wiring of the integral aux. switches.

EPD 2/3 PROPORTIONAL CONTROL



SECTION OF RUNNING TIME FOR SPRING RETURN:
Standard wiring = spring return in 10 sec.
Additional wiring terminal 5 = spring return in 3 sec.

FUNCTION OF SWITCH a AND b:
Closing switch a or b overrides the proportional control of the actuator.
Direction of rotation is a function of which side (CW or CCW) of actuator is UP.

REVERSE FUNCTION:
Add jumper between 3 & 4 for REVERSE acting control. This affects both INPUT and FEEDBACK signal processing.

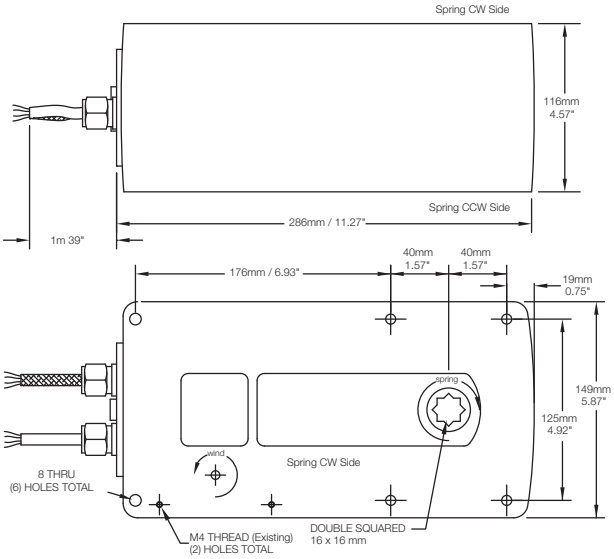
Proportional Control

Input: 4-20 mA or 0-10 VDC
Feedback: 4-20 mA or 0-10 VDC

EPD 4/5

FOR BALL VALVES 2-1/2" TO 6" AND BUTTERFLY VALVES 1-1/2" TO 4"

WITH SUPPLIED HEX KEY

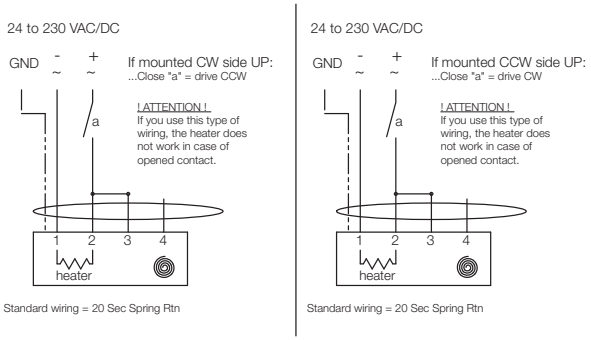


Notes: Do NOT operate the spring return actuator without a MINIMUM LOAD of at least 90 in. lb (3 Nm)

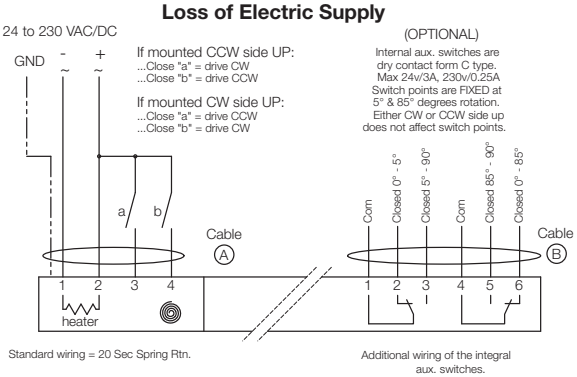
Actuator will NOT activate until the internal temperature reaches at least -8°F (-20°C). All functions are disabled until after this heat-up period

EPD 4/5 ON/OFF CONTROL

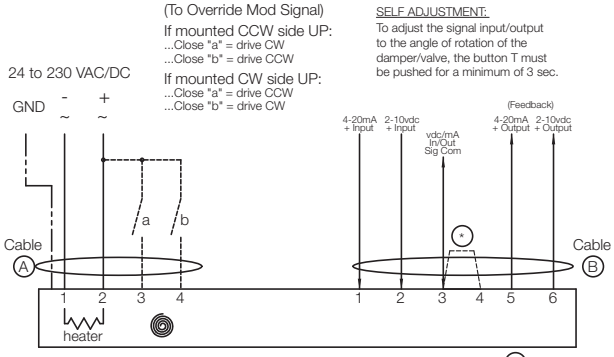
Drive Open or Closed/Spring Opposite



Drive Open/Closed; Spring Engaged Upon Loss of Electric Supply



EPD 4/5 PROPORTIONAL CONTROL



SELF ADJUSTMENT:
To adjust the signal input/output to the angle of rotation of the damper/valve, the button T must be pushed for a minimum of 3 sec.

SECTION OF RUNNING TIME FOR SPRING RETURN:
Standard wiring = spring return in 20 sec.

REVERSE FUNCTION:
Add jumper between 3 & 4 for REVERSE acting control. This affects both INPUT and FEEDBACK signal processing.

FUNCTION OF SWITCH a AND b:
Closing switch a or b overrides the proportional control of the actuator. Direction of rotation is a function of which side (CW or CCW) of actuator is UP.

Proportional Control

Input: 4-20 mA or 0-10 VDC
Feedback: 4-20 mA or 0-10 VDC

EPL Series Linear Drive Actuators

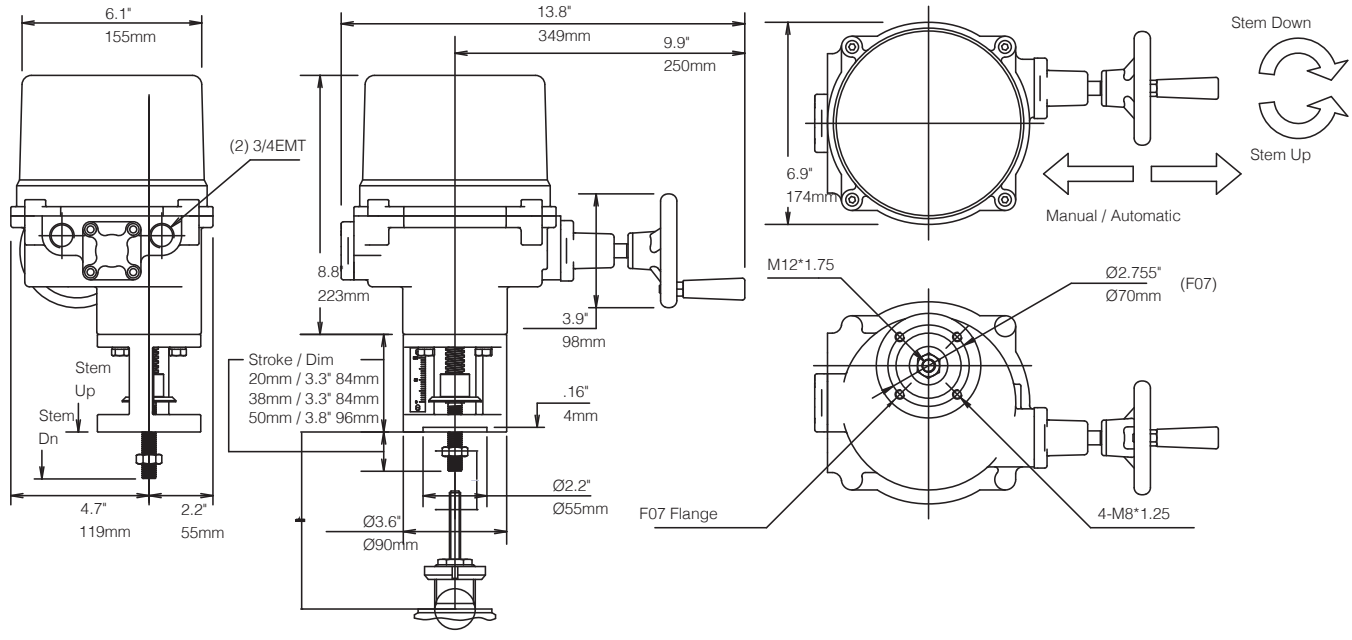
OVERVIEW

Rugged, linear drive, non-spring return, easily adapts to most rising stem designs and provides up to 4400 lb. down/up force and up to 100 mm (4") stem travel for diaphragm valves. Ideal for applications that require a more closely matched actuator/valve combination without overdriving the valve or exceeding its capabilities

FEATURES

- Modular Design
- Four Different Output Forces
- Internal Low Power Heater
- NEMA 4/4X Enclosure
- External Stem Area Position Indicator
- Manual Override
- Self-Locking Drive
- Permanently Lubricated
- Thermal Overload Protection
- CE and CSA Pending
- Universal Bonnet Mounting
- Choice of Voltages: 24 VAC/DC, 120 VAC and 230 VAC

EPL SERIES DIMENSIONS



EPL Series Linear Drive Actuators, *CONTINUED*

LINEAR DRIVE SPECIFICATIONS

ACTUATOR MODEL	FORCE *(DN AND UP)* lb/kg	STROKE LENGTH in/mm	24 VAC/DVC			120/1/60			230/1/60			MOTOR POWER	WEIGHT lb/kg
			FULL TRAVEL TIME (SEC)	*RUN AMPS*	*IN-RUSH AMPS*	*FULL TRAVEL TIME (SEC)*	*RUN AMPS*	*IN-RUSH AMPS*	*FULL TRAVEL TIME (SEC)*	*RUN AMPS*	*IN-RUSH AMPS*		
EPL550-20	550/250	0.79/20	34	0.7	0.9	34	0.5	0.7	34	0.4	0.5	15W	18/8
EPL550-38	550/250	1.50/38	64	0.7	0.9	64	0.5	0.7	64	0.4	0.5	15W	18/8
EPL1100-38	1100/500	1.50/38	64	0.7	0.9	64	0.5	0.7	64	0.4	0.5	15W	18/8
EPL1100-50	1100/500	1.97/50	84	0.7	0.9	84	0.5	0.7	84	0.4	0.5	15W	18/8
EPL2200-38	2200/1000	1.50/38	76	1.3	2.2	76	0.5	0.6	76	0.3	0.3	25W	50/22.5
EPL2200-50	2200/1000	1.97/50	100	1.3	2.2	100	0.5	0.6	100	0.3	0.3	25W	50/22.5
EPL2200-75	2200/1000	2.95/75	150	1.3	2.2	150	0.5	0.6	150	0.3	0.3	25W	50/22.5
EPL2200-100	2200/1000	3.94/100	200	1.3	2.2	200	0.5	0.6	200	0.3	0.3	25W	50/22.5
EPL4400-50	4400/2000	1.97/50	100	0.7	3.0	100	0.4	0.6	100	0.3	1.3	35W	50/22.5
EPL4400-75	4400/2000	2.95/75	150	0.7	3.0	150	0.4	0.6	150	0.3	1.3	35W	50/22.5
EPL4400-100	4400/2000	3.94/100	200	0.7	3.0	200	0.4	0.6	200	0.3	1.3	35W	50/22.5

DIAPHRAGM VALVE SELECTION CHART* (WITH EPL SERIES LINEAR ACTUATOR)

VALVE SIZE in/DN	ACTUATOR SIZE FOR LISTED OPERATING LINE PRESSURE			TOTAL TRAVEL in/mm
	< 50 PSI	*> 50 TO 100 PSI*	*> 100 TO 150 PSI*	
1/2/15	EPL550-20	EPL550-20	EPL550-20	.49/12.4
3/4/20	EPL550-20	EPL550-20	EPL550-20	.58/14.7
1/25	EPL550-20	EPL550-20	EPL550-20	.62/15.7
1-1/4/32	EPL550-20	EPL550-20	EPL550-20	.62/15.7
1-1/2/40	EPL550-38	EPL1100-38	EPL1100-38	.75/19.1
2/50	EPL550-38	EPL1100-38	EPL2200-38	1.25/31.8
2-1/2/63	EPL1100-50	EPL2200-50	EPL4400-50	1.38/35.1
3/80	EPL2200-50	EPL4400-50	EPL4400-50	1.38/35.1
4/100	EPL2200-75	EPL4400-75	—	1.85/47.0

VALVE SIZE in/DN	ACTUATOR SIZE FOR LISTED OPERATING LINE PRESSURE			TOTAL TRAVEL in/mm
	< 20 PSI	*> 20 TO 40 PSI*	*> 40 TO 75 PSI*	
6/150	EPL2200-100	EPL4400-100	—	2.91/73.9
8/200	EPL2200-100	EPL4400-100	—	3.86/98.0
10/250	—	—	—	4.79/121.7

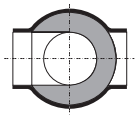
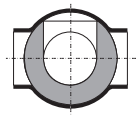
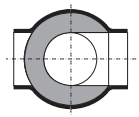
* Linear Drive Selections based on clean water at 70°F. Consult factory for Linear actuator model recommendation.

Please Note: All EPM, EPS, and EPL Series Reversing Electric Actuators are considerably heavier than those typically used with plastic ball and butterfly valves, and they must be supported independently of the valves on which they are mounted. The weight must not be borne by the valve or piping. Please consult the factory if you need help with your particular application.

EP Series Options

COLD WEATHER PACKAGE, SUFFIX CWP

Optional cold weather kit for EP series actuators. A bi-metal disc thermostat turns on an 85W or 88W resistance heater when the internal temperature falls below 32°F. The heater is turned off when the internal temperature rises above 50°F to prevent overheating. NOTE: For 120 vac applications this option will increase the actuator amp draw by 2-3Amps (1-2Amp for 230v and 3-4Amp for 24V applications); appropriate review of the power supply, wire size and length of run is recommended.

FLOW AT	TW BALL *Available "HCTW" Prefix*		
0°	Port A		Port B
90° *Center-Off*	Port A		Port B
180°	Port A		Port B

180° CENTER-OFF, SUFFIX D

180 degree center off is used with three-way valves. A 2-hole ball (TW) is installed in the valve to provide an OFF position. The actuator moves the ball 180 degrees in 90 degree increments.

This feature is also useful when used with true union blocked end valves for two-stage shut-off or dribble control.

Consult factory if this feature is used on actuators with auxiliary limit switches, Suffix S, S2 and S3. Not available on LA Series.

EXTENDED DUTY CYCLE MOTORS, SUFFIX E

Extended Duty Motor option provides a motor package with a duty cycle rating of 75% minimum. Extended duty motors allow more frequent periods of operation without overheating and should be considered for applications that require severe cycling of the valve, or for pulse signal modulation control systems. All 24VDC powered actuators come standard with the extended duty motor kit.

FEEDBACK POTENTIOMETER, SUFFIX F

A potentiometer provides continuous, remote status indication of the position of the valve to the control panel, building automation system or other monitoring equipment. The potentiometer is driven by hardened steel gears connected via steel shaft directly to gear train. The standard usage is 0 to 1000 ohms, but other resistive values (5K or 10K ohm) can be supplied.

- Use 90°, 0 to 1000 ohms for two-way valves–Suffix P
- Use no-stop, 0 to 1000 ohms for three-way valves–Suffix P2
- Use dual, 0 to 1000 ohms for applications requiring two distinct feedback signals–Suffix P3

4-20 MA FEEDBACK KIT (120VAC ONLY), SUFFIX F2

Factory installed option 4-20mA position feedback generator. NOTE: ONLY FOR INSTALLATION IN OPEN/CLOSE Actuators (ALL PROPORTIONAL CONTROL ACTUATORS INCLUDE POSITION FEEDBACK AS STANDARD) Used in EPM Series actuators on/off, Jogging or Pulse Signal Control systems requiring intermediate position feedback via a 4-20mA signal. An external (LCS) enclosure is used to house additional components for EPM-2 through EPM-4; For EPM-6 and larger all components are installed internally in the actuator.

HANDWHEEL MANUAL OVERRIDE, SUFFIX M

EPM2, 3 or 4 offer a socket operated manual operated override system STANDARD. EPM6 and larger models offer a Clutch Free/Lever Free Hand wheel manual operated override system STANDARD. EPD series actuators offer a socket operated manual operated override system STANDARD, this option will provide a field installable hand wheel override. Offers flexible mounting and ease of operation. EPS series actuators when ordered with this option include a electrical and mechanical interlocked manual override hand wheel to provide the ultimate in protection and safety.

PROPORTIONAL CONTROL, SUFFIX P1 AND 2

Factory installed proportional control conversion kit for 120v/230v EPM series quarter-turn actuators. Modular kit readily installs in on/off actuators to provide modulating control of the actuator using 4-20mA, 2-10vdc, 0-10vdc or 1-5vdc. Controller also provides analog signal for closed-loop position feedback as a STANDARD FEATURE.

RELAY CLOSED KIT, SUFFIX RC

Factory installed relay interface to allow single-wire control of an EPM Series actuator. The RC option dictates the actuator is normally OPEN, and a control line activates the internal relay to drive the actuator CLOSED. When the control line is de-energized, the actuator returns to its fully OPEN position. These cannot be stopped in mid-travel unless power is removed. This function is NOT an equivalent to a spring return or fail safe actuator.
This option is voltage specific and matches that of the actuator.

RELAY OPEN KIT, SUFFIX RO

Factory installed relay interface to allow single-wire control of an EPM Series actuator. The RO option dictates the actuator is normally CLOSED, and a control line activates the internal relay to drive the actuator OPEN. When the control line is de-energized, the actuator returns to its fully CLOSED position. These cannot be stopped in mid-travel unless power is removed. This function is NOT an equivalent to a spring return or fail safe actuator.
This option is voltage specific and matches that of the actuator.

AUXILIARY LIMIT SWITCHES, SUFFIX S, S2 AND S3

Standard equipment on all EPM series actuators. Provides two sets of dry-contacts (voltage-free, Form C {com/NO/NC}) for use by field devices (3A @ 250V MAX) to control fans, pumps, status to PLC, etc. These are factory set to trip just ahead of the end of travel setpoints controlling the movement of the actuator. Trip-points can be field adjusted without affecting the end of travel limit settings.

5TH AND 6TH AUXILLARY LIMIT SWITCH, SUFFIX S5

Factory installed option (AT TIME OF ACTUATOR ORDER) on EPM6 and larger model actuators. Provides two ADDITIONAL sets of dry-contacts (voltage-free, Form C {com/NO/NC}) for use by field devices (5A @ 250V MAX) to control fans, pumps, status to PLC, etc. These are factory set to trip 3 degrees ahead of the end of travel setpoints controlling the movement of the actuator. Trip-points can be field adjusted without affecting the end of travel limit settings.

THERMOSTAT, SUFFIX T

A thermostat is added to the standard heater element circuit to activate the internal heater when temperatures fall below 32°F, and to disconnect the heater when temperature reaches 50°F. This option should be considered for extreme of higher ambient temperature environments.

TIMER KIT 115 VAC INPUT, SUFFIX TK

The timer board is a solid state device that allows the user to program actuators to automatically control valves in repetitive on/off functions. The controller offers two dial switches for programming; one switch controls the frequency and the second switch controls the duration of cycle. These are both adjustable from 1 second to 100 hours. Please contact technical support or regional sales manager for application assistance.

316 STAINLESS STEEL TAGS, SUFFIX YSS2

Factory installed tags for corrosive environments.

OPTIONAL MOTOR VOLTAGES–SEE BELOW FOR RESPECTIVE SUFFIX, (OPTIONS VARY BY EP MODEL)

12D–For 12vdc applications (on/off ONLY)

24D– For 24vdc applications (on/off ONLY)

24A – For 24vac applications

220A– For 220/230vac single or three phase applications (specify on order)

Also available upon request depending on model, 380V 3ph and 460V 3ph.

WHAT IS THE RELATIONSHIP BETWEEN VOLTAGE AND AMPERAGE?

Voltage, V indicates the electrical potential difference between two points. Voltage is measured in Volts.

Electric current, I, refers to the flow of electric charge through a conductive medium. Current is measured in Ampere or Amps, and indicates the magnitude of current.

Electrical resistance, R, is the opposition of the flow of current through a component, or element of an electrical system. Resistance is measured in Ohms. Electrical resistance, R, of an object is also defined as the ratio of voltage, V, across it to the current, I, through it. Stated as an equation: R=V/I.

The relationship between Voltage (V), Current (I) and Resistance (R) can also be stated as: V=I*R.

Power, P, is the rate at which energy is used, or transferred, or a measure of the change in energy with respect to time. Power is measured in Watts (or Joules per second) or HP (Horsepower). In electrical terms, Power, P, is defined as Voltage, V, multiplied by Current, I. Stated as an equation: P = V*I.

PMD/PMS Series Corrosion Resistant Pneumatic Actuators

FOR 1/4" TO 4" BALL VALVES

OVERVIEW

The PMD/PMS Series of thermoplastic actuators are designed to withstand the most arduous environments. Available in three sizes, double acting or spring return, ideal for your applications that require plastic housings and corrosion resistance up to 500 in-lbs of torque (PMD). The PMD/PMS Series are specified into the food and beverage, chemical and pharmaceutical industries. An excellent alternative to stainless steel actuators, this series exhibits superior resistance to hydrocarbons, organic solvents and fuels.

FEATURES

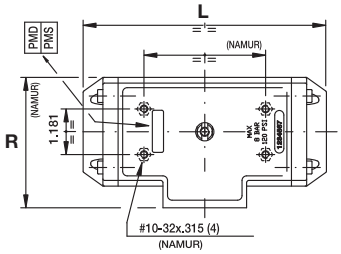
- Corrosion-Resistant Thermoplastic Housing
- Two-Piston Rack and Pinion Design
- Manual Override
- Position Indicator
- Permanent Lubrication
- Lightweight
- Namur-Style Solenoid Mounting
- ISO 5211 Mounting Base

OPTIONS

- Double Acting Air-to-Open and Close
- Solenoid Valves with Optional Voltages
- Auxiliary Limit Switch
- Speed Controls

EXPLODED VIEW

TOP



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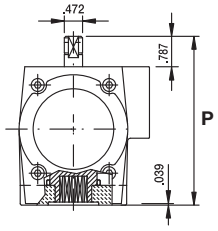

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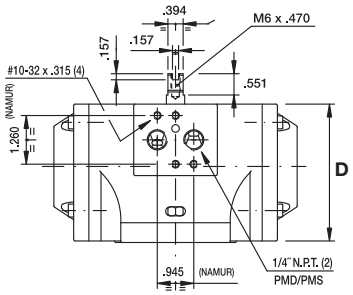

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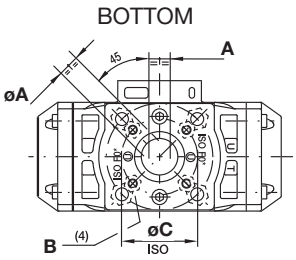


PMD/PMS Series Corrosion Resistant Pneumatic Actuators, *CONTINUED*

FOR 1/4" TO 4" BALL VALVES

DIMENSIONS

MODEL	øA in/mm	B in/mm	C in/mm	L in/mm	P in/mm	R in/mm
PMD/PMS10	.43/11	10-32 x .32	ø1.65/42	4.69/119	3.58/91	2.64/67
PMD/PMS15	.55/14	10-32 x .32	ø1.969/50	6.30/160	4.37/111	3.39/86
PMD/PMS19	.70/18	10-32 x .32	ø2.76/70	6.89/271	5.22/132	3.98/101

Dimensions are subject to change without notice – consult factory for installation information

ACTUATOR SPECIFICATIONS

MODEL	PMD10	PMD15	PMD19	PMS10	PMS15	PMS19
Torque Output (in-lbs) @ 80 PSI	125	275	500	81	168	316
Position 2 (Start/End)	NA	NA	NA	66/44	150/107	245/184
Enclosure Material	Polyamide					
Output Shaft	Carbon Steel					
Air Port Connections	1/4" NPT					
Air Consumption (cu. in.)	13.5	22.0	40.6	8.0	10.8	17.5
Air Transfer	Internal					
Stroke Time (seconds)	.5	.5	.5	.5	.5	.5
Cycle Time	1/2 second					
Minimum Air Pressure	80 PSI					
Maximum Air Pressure	120 PSI					
Operation	Rack and Pinion					
Weight (lbs/kg)	1.15/.52	2.25/1.02	3.55/1.61	1.44/.65	3.1/1.4	5.16/2.34
ISO5211 Mount	F04	F05	F07	F04	F05	F07

VALVE SELECTION CHART

SIZE in/DN	TRUE UNION BALL VALVE	THREE-WAY BALL VALVE
1/4 – 1/2/8 – 15	PMD10/PMS15	PMD10/PMS15
3/4/20	PMD10/PMS15	PMD10/PMS15
1/25	PMD10/PMS15	PMD10/PMS15
1-1/4 – 2/32 – 50	PMD10/PMS15	PMD10/PMS15
1/25	PMD10/PMS15	PMD10/PMS15
1-1/4/32	PMD10/PMS15	PMD10/PMS15
1-1/2/40	PMD10/PMS15	PMD10/PMS15
2/50	PMD10/PMS15	PMD10/PMS19
2-1/2/63	PMD15/PMS19	PMD15/PMS19
3/80	PMD15/PMS19	PMD15/PMS19
4/100	PMD15/PMS19	PMD15/PMS19
6/150	PMD15/PMS19	PMD15/PMS19

PCD/PCS Series Pneumatic Actuators

FOR BALL AND BUTTERFLY VALVES UP TO 24"

OVERVIEW

The superiority of the PCD/PCS Series actuators vs. single and double rack and pinion actuator designs, results from the four pistons that generate torque around a centrally located pinion, thereby giving more than double the torque achieved by other designs. The increased number of pistons in the actuator allows their diameters to be reduced while maintaining their high torque. This in turn allows the overall sizes of the actuators to be reduced and become more compact and space saving! Additionally, the bodies of the PCD/PCS Series are anodized internally and externally providing protection against ingress of corrosive atmosphere. An external epoxy base layer and a second coat of polyurethane provide further protection against aggressive elements.

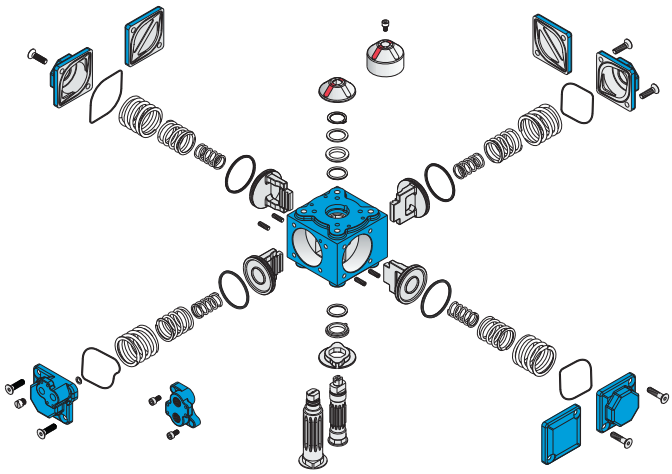
FEATURES

- For All Sizes of Ball and Butterfly Valves
- Double Acting or Spring Return Design
- Four-Piston Rack and Pinion Design
- Superior Corrosion Resistance
- Manual Override
- Compact, Lightweight
- Position Indicator
- Namur-Style Solenoid Mounting (Inlet/Outlet)
- Adjustable Travel Stops
- ISO 5211 Mounting Base

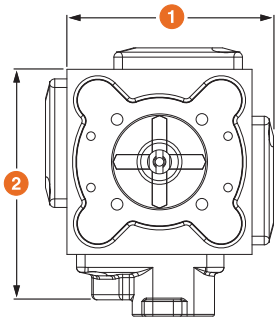
OPTIONS

- Double Acting Air-to-Open and Close
- Solenoid Valves with Optional Voltages
- Positioners
- Auxiliary Limit Switches
- Cycle Speed Controls

EXPLODED VIEW



TOP



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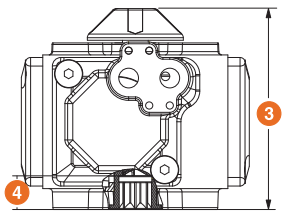
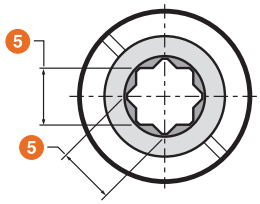


OUTPUT SHAFT



MODEL	1-PCD in/mm	1-PCS in/mm	2-PCD in/mm	2-PCS in/mm	3 in/mm	4 in/mm	5 in/mm
PCD/PCS15	3.39/86	4.31/109	3.85/98	4.31/109	3.50/89	.53/13	.35/9
PCD/PCS20	4.03/102	5.17/131	4.60/117	5.17/131	3.96/101	.59/15	.43/11
PCD/PCS25	5.24/133	6.34/161	5.79/147	6.34/161	4.61/117	.77/20	.55/14
PCD/PCS30	5.94/150	7.33/186	6.64/169	7.33/186	5.37/136	.87/22	.67/17
PCD/PCS35	7.15/182	8.74/222	7.94/202	8.74/222	6.10/155	1.02/26	.87/22
PCD/PCS45	8.70/220	10.59/269	9.65/245	10.59/269	7.64/194	1.30/33	1.06/27
PCD/PCS60	11.22/285	14.17/360	N/A	14.17/360	9.76/248	1.69/43	1.42/36
PCD/PCS70	13.46/342	17.20/437	N/A	17.20/437	11.81/300	1.69/43	1.42/36

PCD/PCS Series
Pneumatic Actuators, *CONTINUED*
FOR BALL AND BUTTERFLY VALVES UP TO 24"

ACTUATOR SPECIFICATIONS

MODEL	PCD15	PCD20	PCD25	PCD30	PCD35	PCD45	PCD60	PCD75
Torque Output (in-lbs) @ 80 PSI	172	311	639	1,052	1,848	3,622	2,857	5,166
Enclosure Material	Epoxy-Coated Aluminum							
Output Shaft	Plated Steel							
Air Port Connections	1/4" NPT							
Air Consumption (cu. in.)	3	6	13	25	49	81	195	351
Air Transfer	Internal							
Stroke Time (seconds)	.5	.5	.7	.8	.5	1.5	2.5	4.0
Cycle Time	Under 1 Second Typical-Depends on Solenoid							
Minimum Air Pressure	80 PSI							
Maximum Air Pressure	120 PSI							
Operation	Rack and Pinion							
Weight (lbs/kg)	1.5/.7	2/.9	4.3/2	6.8/3.1	16/7.3	22/10	57/26	112/51

MODEL	PCS15	PCS20	PCS25	PCS30	PCS35	PCS45	PCS60	PCS75
Torque Output (in-lbs) @ 80 PSI	61	109	217	345	607	1,218	2,857	5,166
Enclosure Material	Epoxy-Coated Aluminum							
Output Shaft	Plated Steel							
Air Port Connections	1/4" NPT							
Air Consumption (cu. in.)	3	9.2	13	25	41	81	195	351
Air Transfer	Internal							
Stroke Time (seconds)	.5	.4	.7	.8	.8	1.5	1.5	1.5
Cycle Time	Under 1 Second Typical-Depends on Solenoid							
Minimum Air Pressure	80 PSI							
Maximum Air Pressure	120 PSI							
Operation	Rack and Pinion							
Weight (lbs/kg)	1.8/.8	4/1.9	5.7/2.6	9.2/4.2	17.4/7.9	27.5/12.5	27.5/12.5	27.5/12.5
ISO 5211 Mount	F05	F05	F07	F07	F10	F12	F14	F16

VALVE SELECTION CHART

SIZE* in/DN	TRUE UNION BALL VALVE	THREE-WAY BALL VALVE	BUTTERFLY VALVE
1/4 – 1/8 – 25	PCS15	PCS15	N/A
1-1/4 – 2/32 – 50	PCD15/PCS20	PCD20/PCS20	PCD20/PCS25
2-1/2/63	PCD20/PCS25	PCD20/PCS25	PCD20/PCS25
3/80	PCD20/PCS25	PCD20/PCS25	PCD20/PCS25
4/100	PCD20/PCS25	PCD20/PCS30	PCD25/PCS30
6/150	PCD20/PCS25	PCD20/PCS30	PCD25/PCS35
8/200	N/A	N/A	PCD35/PCS45
10 – 12/250 – 300	N/A	N/A	PCD45/PCS60
14 – 16/350 – 400	N/A	N/A	POA
18, 20 and 24/450, 500 and 600	N/A	N/A	POA

* Actuator size selections based on clean water at 70°F

Pneumatic Actuator Specifications and Accessories

ACTUATOR FEATURES AND GENERAL SPECIFICATIONS

		DOUBLE ACTING		SPRING RETURN	
STANDARD ACTUATOR FEATURES		PMD	PCD	PMS	PCS
Design Type		R & P	R & P	R & P	R & P
Number of Pistons/Vanes		2	4	2	4
Piston Sealing Material		Nitrile	Nitrile	Nitrile	Nitrile
Enclosure Materials		Polyarylamide	Aluminum	Polyarylamide	Aluminum
Exterior Finish		N/A	Epoxy	N/A	Epoxy
Manual Override		Standard	Standard	Standard	Standard
Position Indication		Standard	Standard	Standard	Standard
End of Travel Stops (Adjustable)		N/A	Standard	N/A	Standard
External Hardware		SSTL	SSTL	SSTL	SSTL
Integral Solenoid Mounting		Standard	Standard	Standard	Standard
Uniform Bearing Load Distribution		Standard	Standard	Standard	Standard
Maximum Operating Pressure – PSI		100	100	100	100
Shaft Rotation for "Fail Closed"		—	—	CW	CW
Spring Configuration – Quantity/Type		—	—	1/Clock	1/Clock
High Ambient Limit – °F/Low Ambient Limit – °F		176/0	176/0	176/0	176/0
Mounting Position		Any	Any	Any	Any
OPTIONAL ACTUATOR ACCESSORIES	SUFFIX	PMD	PCD	PMS	PCS
Solenoid Valves – Integral (Namur) 4-Way, A/A, 115 VAC	A8	Opt	Opt	Opt	Opt
Solenoid Valves – Integral (Namur) 3-Way, A/S, 115 VAC	A9	Opt	Opt	Opt	Opt
Solenoid Valves – Integral (Namur) 4-Way, A/A, 115 VAC	AA8	—	Opt	—	Opt
Solenoid Valves – Integral (Namur) 3-Way, A/S, 115 VAC	AA9	—	Opt	—	Opt
12 VAC	12A	Opt	Opt	Opt	Opt
24 VAC	24A	Opt	Opt	Opt	Opt
12 VDC	12D	Opt	Opt	Opt	Opt
24 VDC	24D	Opt	Opt	Opt	Opt
220 VAC	220A	Opt	Opt	Opt	Opt
Speed Controls, Air/Spring	T3	Opt	Opt	Opt	Opt
Speed Controls, Air/Air	T4	Opt	Opt	Opt	Opt
Positioners, 3-15 PSI Input, Ryton, A/A and A/S	C	—	Opt	—	Opt
Positioners, Electro/Pneumatic 4-20 mA Input, Ryton, A/A and A/S	C2	—	Opt	—	Opt
POSITIONER OPTIONS	SUFFIX	PMD	PCD	PMS	PCS
Positioner Indicator – Beacon w/ color	R2	—	Opt	—	Opt
Position Transmitter, 4-20 mA Output	R5	—	Opt	—	Opt
Top-Mounted Limit Switches, Eastar® – Flat Cover, 2 SPDT, 15 Amps	S2	Opt	Opt	Opt	Opt
Top-Mounted Limit Switches, Eastar® – Beacon, 2 SPDT, 15 Amps	S4	Opt	Opt	Opt	Opt
Top-Mounted Limit Switches, Aluminum – Flat Cover, 2 SPDT, 15 Amps	SA2	Opt	Opt	Opt	Opt
Top-Mounted Limit Switches, Aluminum – Beacon, 2 SPDT, 15 Amps	SA4	Opt	Opt	Opt	Opt
316 Stainless Steel Tags	YSS2	Opt	Opt	—	—

Eastar® is a registered trademark of Eastman

Important Note: The valve and actuator combinations shown in this catalog have been tested and approved compatible by Hayward Flow Control Systems when installed into compatible process systems. Should actuators, accessories or mounting hardware other than those supplied by Hayward be used for the operation of these valves, the installer assumes all responsibility for the performance of those valves.

Pneumatic Actuator Accessories

EXTENDED DESCRIPTIONS

SOLENOID VALVES

A solenoid valve is used to control the inflow and outflow of compressed air using an electrical signal to operate a pneumatic actuator.

SUFFIX A8/A9
Solenoid Valve for PCD/PCS and PMD/PMS Actuators

INTEGRAL, NEMA 4X, FOUR-WAY AIR/AIR

SUFFIX A8

(For all PCS and PMS actuators)

FEATURES

- P-port or high pressure air inlet port is 1/8" NPT
- 100% duty cycle
- Standard input voltage is 115 VAC/60 Hz, other voltages available
- 1/2" conduit connection (rotatable 180º)
- Non-locking manual override
- Aluminum die cast body with corrosion resistant coating
- Maximum operating pressure 120 PSI
- Integral speed controls for opening and closing cycle
- Namur style mount
- C_v of 0.15
- Weight is 1 lb

INTEGRAL, NEMA 4X, THREE-WAY AIR/SPRING

SUFFIX A9

FEATURES

- P-port or high pressure air inlet port is 1/8" NPT
- 100% duty cycle
- Standard input voltage is 115 VAC/60 Hz, other voltages available
- 1/2" conduit connection (rotatable 180º)
- Non-locking manual override
- Zinc die cast body with corrosion resistant coating
- Maximum operating pressure 100 PSI
- Tool adjustable needle valves for speed controls for opening cycle only
- C_v of 0.2
- Weight is 1 lb

SUFFIX AA8/AA9
Solenoid Valve for PCD/PCS and PMD/PMS Actuators

INTEGRAL, NEMA 7, FOUR-WAY AIR/AIR

SUFFIX AA8

(For all PCD actuators)

FEATURES

- P-port or high pressure air inlet port is 1/4" NPT
- 100% duty cycle
- Standard input voltage is 115 VAC/60 Hz, other voltages available
- 1/2" conduit connection (rotatable 180º)
- Non-locking manual override
- Aluminum die cast body with corrosion resistant coating
- Maximum operating pressure 120 PSI
- Namur style mount
- C_v of 0.2
- Weight is 1 lb

INTEGRAL, NEMA 7, THREE-WAY AIR/SPRING

SUFFIX AA9

(For all PCS and PMS actuators)

FEATURES

- P-port or high pressure air inlet port is 1/4" NPT
- 100% duty cycle
- Standard input voltage is 115 VAC/60 Hz, other voltages available
- 1/2" conduit connection (rotatable 180º)
- Non-locking manual override
- Aluminum die cast body with corrosion resistant coating
- Maximum operating pressure 120 PSI
- Namur style mount
- C_v of 0.2
- Weight is 1 lb

Pneumatic Actuator Accessories, *CONTINUED*

EXTENDED DESCRIPTIONS

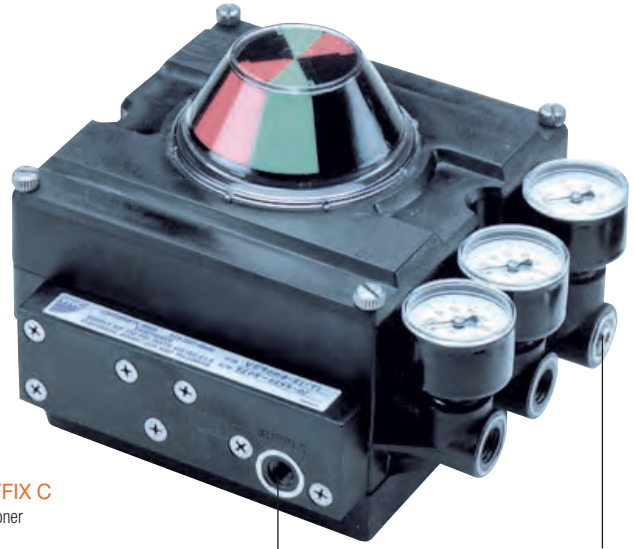
SUFFIX A10
Pneumatic Filter-Regulator with Gauge

PNEUMATIC FILTER-REGULATOR, WITH GAUGE

SUFFIX A10

(For all pneumatic actuators)

Pneumatic Filter-Regulator with bracket and gauge mounts to the actuator. For removal of moisture and miniscule debris such as scale from compressed air lines. Eliminates buildup of corrosion that can affect actuator and solenoid operation. Features include: 1/4" NPT inlet connection, piston operated, 25 micron sintered brass filter, 0-160 PSI gauge, and 1-2 oz. clear polycarbonate collection bowl. Maximum operating pressure 100 PSI (optimum 80 PSI). Weight 0.79 lb.



SUFFIX C
Positioner

Signal Air

Supply Air

PNEUMATIC POSITIONER (RYTON®)

SUFFIX C
3-15 PSI INPUT, AIR/AIR AND AIR/SPRING

(For PCD and PCS series actuators)

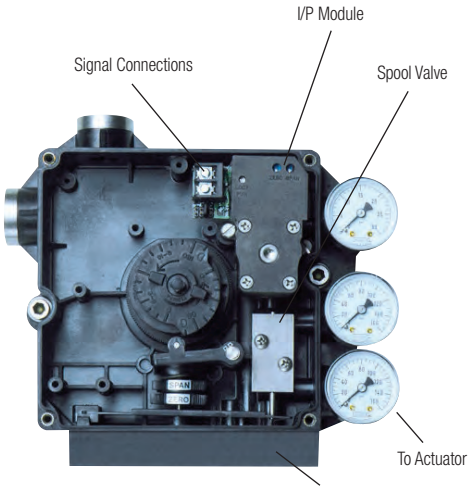
This pneumatic positioner is mounted on the top of either the double acting or spring return pneumatic actuator, with low profile mounting hardware specifically designed to minimize hysteresis.

Features of this positioner include: precise performance for economical operation, standard flat lens position indicator for 90° and 0° – 180° indication, color coded proportional sections to improve interpretation over single-color indicators. Both the flat lens and beacon lens indicators are field adjustable. Indicator colors are red and green, beacon lenses are clear Lexan®, NEMA 4, 4X, dust-tight, corrosion resistant in hostile process and outdoor environments, high strength, (pps) polyphenylene sulfide-(Ryton) enclosure with 300 stainless captive hardware, NASA rated for fire safety, single and double acting, direct and reverse acting, full and split ranges, 0° to 90° and 0° to 180° rotation. Advanced balanced port spool valve for vibration and corrosion resistance, reliability, and low air consumption. Gauge block with 3 gauges, 2-1/2" conduit entries, supply connection 1/8" NPT, air consumption 0.25 scfm @ 80 PSI. Weight 2 lbs.

This positioner also offers extensive options such as: Integral position indicator with color lenses; stainless steel gauges, (1) 0-30 PSI and (2) 0-160 PSI; integral position transmitter, 4-20 mA or resistive outputs; integral limit switches, mechanical and proximity.

Note: All NPT air ports must be sealed with PTFE paste, non-hardening type. Never use PTFE tape. Maximum applied torque to air fittings is 12 ft-lbs for 1/4" NPT and 6 ft-lbs for 1/8" NPT.

Lexan® is a registered trademark of General Electric
Ryton® is a registered trademark of Chevron Phillips Chemicals



SUFFIX C2

ELECTRO/PNEUMATIC POSITIONER (RYTON®)

SUFFIX C2

4-20 MA INPUT, AIR/AIR AND AIR/SPRING

(For PCD and PCS series actuators)

Conversion of the pneumatic positioner to an electro/pneumatic positioner requires only the simple addition of a single module inside the positioner enclosure using (2) captive mounting screws. Features of this electro/pneumatic positioner include: continuously adjustable split ranging, red LED loop power indication, reversible and de-pluggable current loop connections, selectable speed control, I/P final air supply filtration-30 micron-replaceable, automatic compensation for supply air pressure, atmospheric pressure and ambient temperature changes, radio frequency interference (RFI) and transient protection, vibration resistant construction, linear speed control.

SUFFIX R2

INTEGRAL POSITION INDICATOR, BEACON WITH COLOR

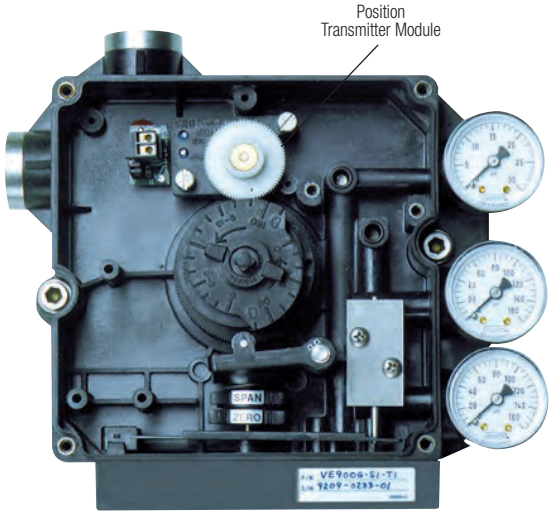
SUFFIX R2

(For C and C2 positioners only)

The standard flat lens position indicator on top of the positioner can be changed to a beacon type. This, like the flat lens, is color coded and proportionally sectional to improve interpretation over single color indicators. Features include: wide angle visibility, NEMA 4, 4X, 0° to 90° indication, high impact corrosion resistant and UV stabilized, high visibility fluorescent red and green rotor and contrasting black lens, on/off and proportional indication.

Pneumatic Actuator Accessories, *CONTINUED*

EXTENDED DESCRIPTIONS



SUFFIX R5

SUFFIX S2

SUFFIX S4

Zytel® is a registered trademark of DuPont

INTEGRAL POSITION TRANSMITTER

SUFFIX R5, R9 AND R10
4-20 MA OUTPUT
(For C and C2 positioners only)

The integral position transmitter is mounted inside the positioner enclosure with position pickup directly from the positioner shaft. Easily mounted with captive stainless steel screws, direct driven, polarity reversible 2-wire connections, environmentally sealed, potentiometer type zero and span adjustments, red-LED power loop indicator, de-pluggable terminal block and jumper selectable for reverse output. The position transmitter must be specified by the output signal desired.

Position Transmitter, 4-20 mA Output..... add suffix R5

Integral Limit Switches, Mechanical, 2 SPDT ..... add suffix R9

Integral Limit Switches, Proximity, 2 SPST ..... add suffix R10

TOP MOUNTED LIMIT SWITCHES ZYTEL® ENCLOSURE

SUFFIX S2 AND S4
NEMA 4X, FLAT COVER, 2 SPDT, 15 AMPS
NEMA 4X, BEACON, 2 SPDT, 15 AMPS
(For PCD, PCS, PMD and PMS series actuators)

This top mounted limit switch is designed to survive corrosive environments. High performance polyamide resin offers a viable alternative to metal enclosures. The “supertough” glass reinforced enclosure combines chemical resistance with high impact strength and immunity to weathering.

TOP MOUNTED LIMIT SWITCHES ALUMINUM/EPOXY ENCLOSURE

SUFFIX SA2 AND SA4
NEMA 4 AND 7, FLAT COVER, 2 SPDT, 15 AMPS
NEMA 4 AND 7, BEACON, 2 SPDT, 15 AMPS
(For PCD and PCS series actuators)

Hayward® Flow Control Automated Valve Questionnaire

VALVE TYPE

- ☐ Ball Valve
- ☐ Butterfly Valve
- ☐ Diaphragm Valve
- ☐ Three-Way Valve, Ball Configuration *(NT, TW or TP)*
- ☐ Lateral Three-Way Valve, Ball Configuration *(NT or 90)*

VALVE MATERIAL

- ☐ PVC
- ☐ CPVC
- ☐ PP
- ☐ PVDF *(BYB Series or DAB only)*

O-RING MATERIAL

- ☐ EPDM
- ☐ FPM

CONNECTION

- ☐ Socket
- ☐ Threaded
- ☐ Flanged
- ☐ Lugged Flange *(BY valves only)*

ELECTRIC ACTUATOR

Voltage _____ AC or DC

Options
- ☐ Timer Board
- ☐ Cycle Time Regulator
- ☐ Positioner *(4-20 mA)*
- ☐ Feedback Potentiometer
- ☐ Handwheel
- ☐ Battery Backup
- ☐ Auxiliary Limit Switches
- ☐ Heater/Thermostat
- ☐ Explosion-Proof Housing
- ☐ I.D. Tag

VALVE SIZE

_____

DISC MATERIAL *(BY VALVE ONLY)*

- ☐ PVC
- ☐ CPVC
- ☐ PP
- ☐ PVDF

DIAPHRAGM MATERIAL *(DAB VALVES ONLY)*

- ☐ EPDM
- ☐ EPM
- ☐ PTFE

VALVE OPERATION

- ☐ On/Off
- ☐ Throttling *(modulating, 4-20 mA)*

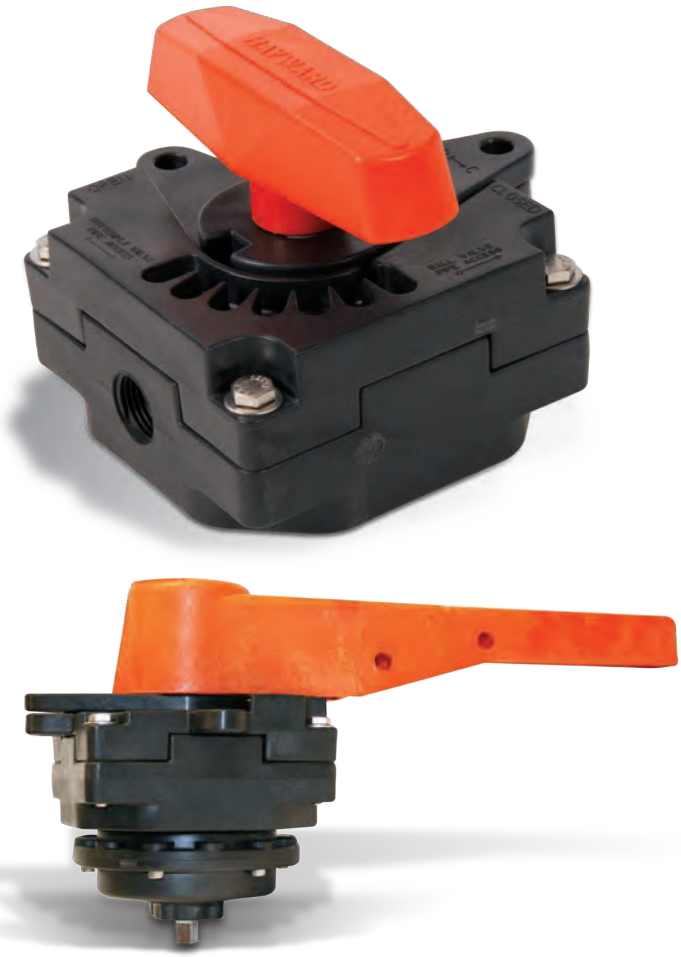
INSTALLATION

- ☐ Indoors
- ☐ Outdoors *(for outdoors, use electric actuator with heater)*

PNEUMATIC ACTUATOR *(80 PSI)*

- ☐ Double-Acting
- ☐ Spring Return

Options
- ☐ Solenoid *(AC or DC)*
- ☐ Air Filter/Regulator
- ☐ Positioner *(4-20 mA)*
- ☐ Auxiliary Limit Switches
- ☐ I.D. Tag



LHB Series Manual Limit Switches

FOR BALL VALVES UP TO 6" AND BUTTERFLY VALVES UP TO 8"

OVERVIEW

Manual Limit Switches are available for two-way and three-way ball valves up to 6" in size and butterfly valves up to 8" in size. Typical top works components include a lever handle, fail-safe spring return and mechanical limit switches. The limit switches are available with a variety of features and in various materials of construction.

FEATURES

- Available with "Dead-Man" Spring Return Handle or Handlever
- Remote Monitoring of Critical Services
- Retrofits to Existing Valves
- Robust GFPP Body, Cover and Plate
- 304 Stainless Steel Stem and FPM Seals
- Fits All Hayward® Ball and Butterfly Valves up to 8"
- Temperature Range 20°F (-7°C) to 200°F (93°C)
- Two Adjustable SPDT 10 Amp @ 120 VAC Switches (Open/Close Position)
- Integral Lockout
- 1/2" Conduit Port
- Terminal Blocks for Ease of Wiring
- Meets ISO5211, F05, F07 and F10 Patterns
- NEMA 4X
- Switches CSA Listed
- Patent Pending Design

OPTIONS

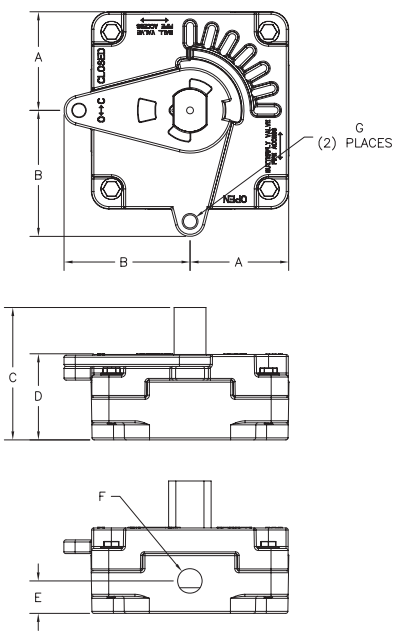
- Additional Two Switches
- Potentiometer Available (LHB1/LHB2)
- Optional Handles – Handlever or T-Handle
- LED for Open/Close Indication (LHB1/LHB2)

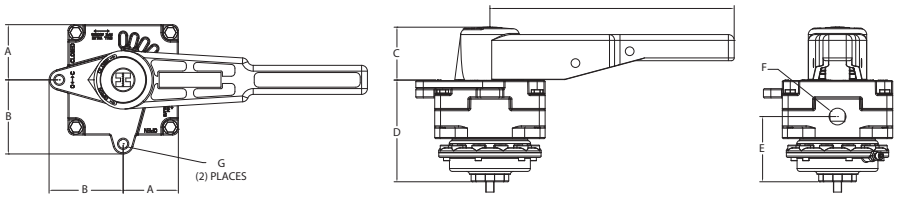
MATERIALS

- GFPP Per ASTM D4101 Cell Class 85580
- Heavy Duty FPM O-Ring Seals

DIMENSIONS – INCHES/MILLIMETERS

MANUAL LIMIT SWITCH MODEL	VALVE SIZE/ SERIES	A in/mm	B in/mm	C in/mm	D in/mm	E in/mm	F in/mm	G in/mm
LHB-1	1/2" – 2" TB 1-1/2" – 4" BY	2.38/61	3.19/81	3.88/99	2.52/64	.95/24	1/2" NPT	.38/10
LHB-2	2-1/2" – 6" TB 6" and 8" BY	2.89/73	3.69/94	3.88/99	2.52/64	.95/24	1/2" NPT	.38/10
LHB1-SR	1/2" – 2" TB 1-1/2" – 4" BY	2.38/61	3.19/81	2.28/60	4.38/112	2.81/71	1/2" NPT	.38/10
LHB2-SR	2-1/2" – 6" TB 6" and 8" BY	2.89/73	3.69/94	2.28/60	2.52/64	112/71	1/2" NPT	.38/10





LHB Series Manual Limit Switches, *CONTINUED*

WHERE TO USE THE LHB

- Tank Isolation
- Process Flow Verification
- Remote, Visual Indication of Valve Status
- Critical Services and Applications – Allows Lock-Out and Continuous Monitoring in Applications Such as Acids, Caustics, Flammables, etc.
- All Safety Concern Valve Applications:
  - ✓ Unmanned Storage Sites – Switches can Trigger Auto-Dialer if Valve State Changes
  - ✓ Excellent Complement to the Sand Filter Sets for Simplex/Duplex Status – Tie Switches into Indicator Lights
  - ✓ Electric Signal Providing Flow Identification on Three-Way 90° Travel Ball Valves
  - ✓ Pump Operation Safety (Valve Must be Open) Before Pump Will Engage
  - ✓ Where Inadvertent Operation of the Valve Can Result in Personal Injury, Property Damage, Environmental Impact or Loss of Life

HOW TO USE THE LHB

- Integrated into Building Automation Systems for Valve State Confirmation – Open/Closed/Mid-Position
- Integrated in Building Automation Systems for Process Sequencing – When Monitored Valve is Opened or Closed, Switches can Trigger Other Actions in System BAS
- Direct Alarm Applications (Independent from any BAS)
- Integrated Alarm Applications (Tied into BAS Control)

LHB SIZING CHART

VALVE TYPE	SIZE	MANUAL LIMIT SWITCH MODEL			
	in/DN	LHB1	LHB2	LHB1SR	LHB2SR
TB Series Ball Valves	1/2/15	●		●	
	3/4/20	●		●	
	1/25	●		●	
	1-1/4/32	●		●	
	1-1/2/40	●		●	
	2/50	●		●	
	2-1/2 – 3/63 – 80		●		●
	4 – 6/100 – 150		●		●
TW/LA Series Three Way Valves	1/2/15	●		●	
	3/4/20	●		●	
	1/25	●		●	
	1-1/2/40	●		●	
	2/50	●		●	
	3/80		●		●
	4 – 6/100 – 150		●		●
BY Series Butterfly Valves	2 – 3/50 – 80	●		●	
	4/100		●		●
	6/150		●		●
	8/200		●		●

Performance Curves

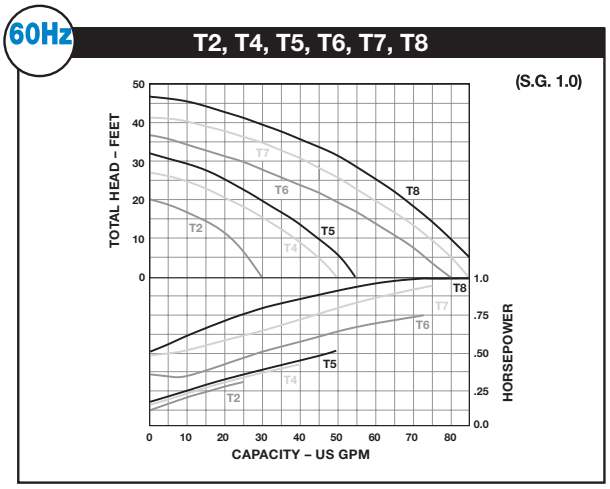
WATER AT AMBIENT TEMPERATURE

T, S, R, D AND C SERIES

T SERIES

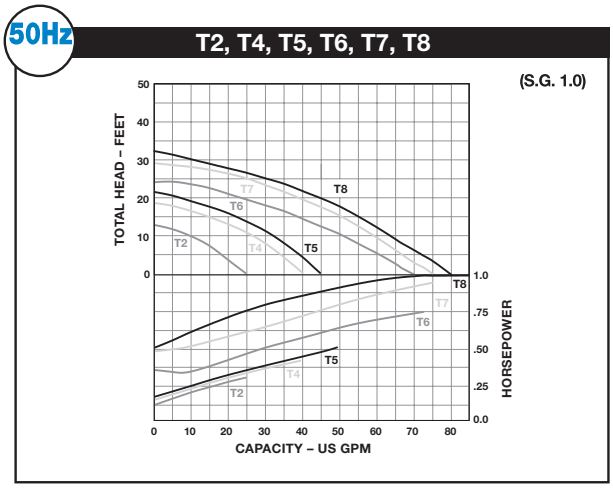
60Hz

T2, T4, T5, T6, T7, T8



50Hz

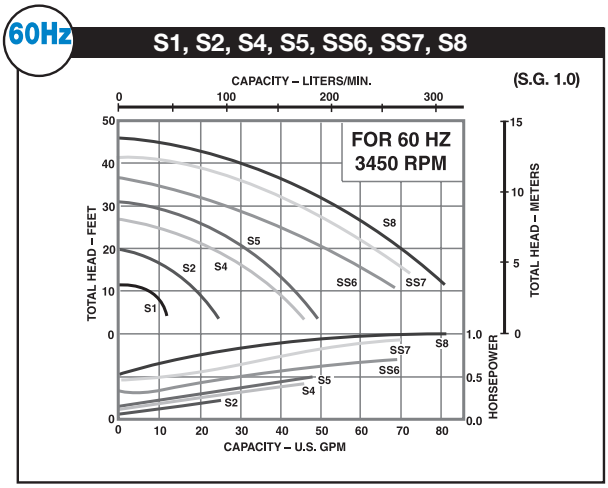
T2, T4, T5, T6, T7, T8



S SERIES

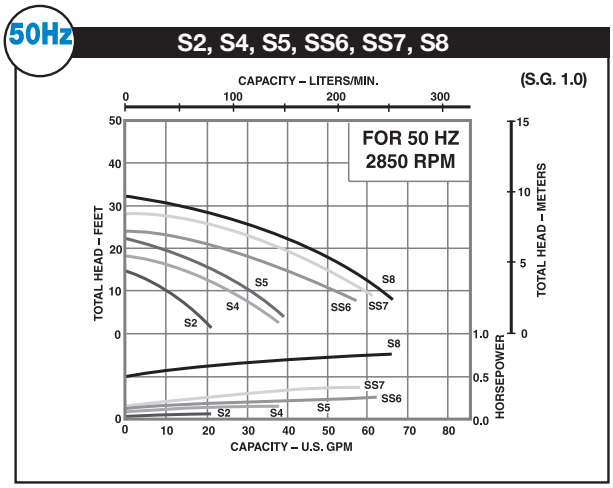
60Hz

S1, S2, S4, S5, SS6, SS7, S8



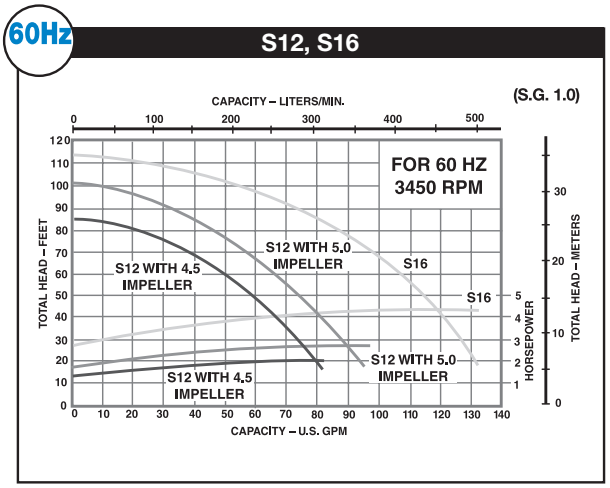
50Hz

S2, S4, S5, SS6, SS7, S8



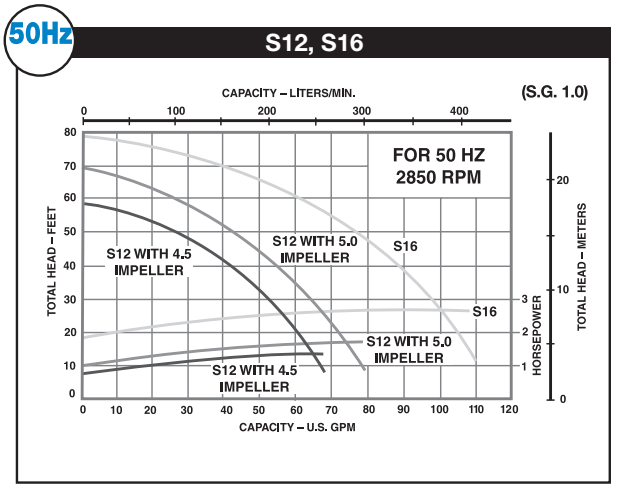
60Hz

S12, S16



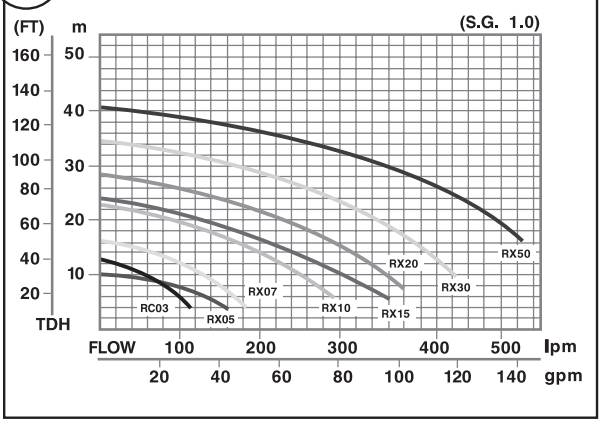
50Hz

S12, S16

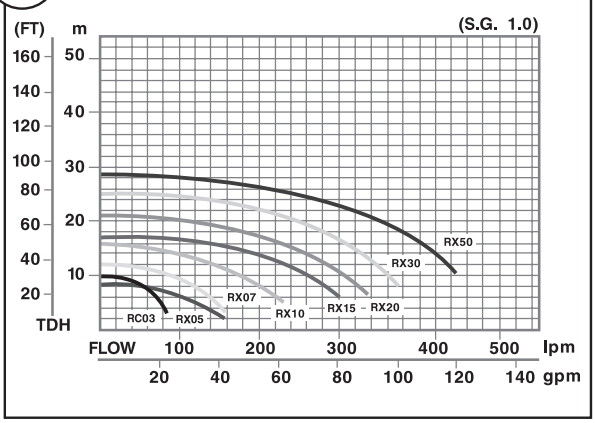


R SERIES

60Hz RC03, RX05, RX07, RX10, RX15, RX20, RX30, RX50

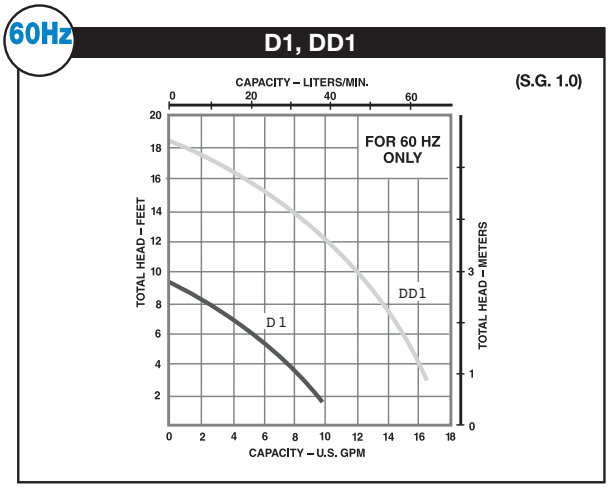


50Hz RC03, RX05, RX07, RX10, RX15, RX20, RX30, RX50

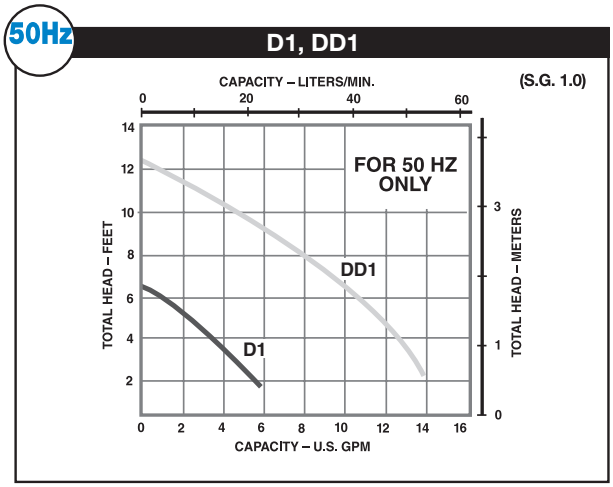


D SERIES

60Hz D1, DD1

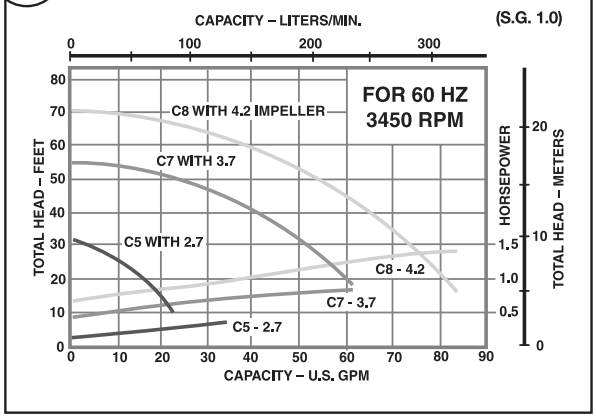


50Hz D1, DD1

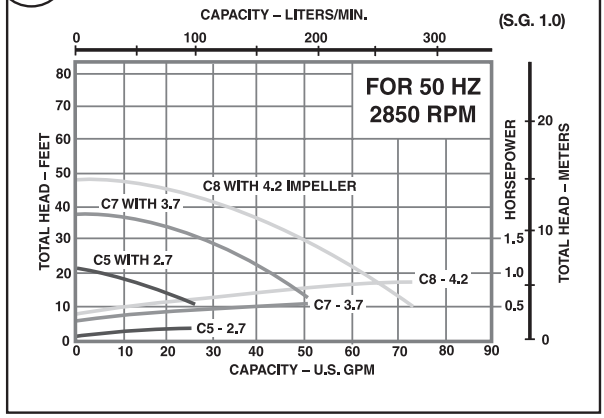


C SERIES

60Hz C5, C7, C8



50Hz C5, C7, C8



Pump Options

575V MOTORS
575V 3 phase is being used in Canada.

EXPLOSION PROOF MOTORS
Explosion proof motors are a class of electric motors that are constructed to both contain an explosion if it occurs within the motor as well as prevent the release of explosive gases or vapors to the surrounding environment. To be classified as explosion proof, the motors must be manufactured to the requirements of Underwriters Laboratories (UL) and the National Electrical Code (NEC) in "class, group and temperature code restrictions."

IMPELLER TRIM VARIATIONS
Trimming reduces the impeller's tip speed which, in turn, reduces the amount of energy imparted to the pumped fluid; as a result, the pump's flow rate and pressure both decrease. A smaller or trimmed impeller can thus be used efficiently in applications in which the current impeller is producing excessive head.

IN-TANK FILTRATION
Compact, easy to install filter system with a choice of single or double string wound filter cartridges.

OPTIONAL INLET SCREEN
Inlet screens are available to be placed inside inlet port.

S-J TYPE ELECTRICAL CORD
The S-J Type cord has a voltage rating of 300 volts. The portable cord has excellent resistance to oil and moisture, good tensile strength, high flexibility and excellent abrasion resistance.

WASH-DOWN MOTORS
Wash-Down motors are designed for use in applications where motors are routinely exposed to wash-down, certain chemicals, moisture and humidity. Wash-Down motors provide durability and flexibility to help maximize uptime and reduce overall operating costs.

Pump Definitions

CENTRIFUGAL PUMP
A pump that moves liquid with centrifugal force. Available in circular and volute configurations.

HEAD
The head is the equivalent height of the liquid. Water is used, as the standard where 10 meters (33.9 ft.) of water equals one atmosphere (14.7 PSI or 1 bar). The term head is used instead of pressure in the centrifugal pump business.

IMPELLER SHROUD
The shroud is the plate located on one or both sides of the impeller vanes. It prevents solids from penetrating behind the vanes.

MAGNETIC DRIVE
Magnetic drive is a type of seal-less pump that is most often limited to pumping clean lubricating liquids. Similar in concept to a canned pump.

PRIME
Prime is a charge of liquid required beginning the pumping action of centrifugal pumps when the liquid source is lower than the pump.

STAINLESS STEEL
Stainless steel is an alloy steel containing a high percentage of chromium.

SYSTEM CURVE
System curve is a description of what the pump is required to perform. The pump will pump where the system curve intersects the pump curve.

TOTAL DYNAMIC HEAD
Total Dynamic Head is the total equivalent height that a fluid is to be pumped, taking into account friction losses in the pipe. Pump curves in feet of head can be converted to PSI by $p=0.434\ h\ SG$.

Hayward® Industrial Pump Selection Worksheet

NOTE: ALL PUMPS REQUIRE FLOODED SUCTION FOR OPTIMUM PERFORMANCE.

MAXIMUM FLOW REQUIRED

_____ GPM

HEAD PRESSURE REQUIRED

_____ PSI or _____ Feet of Head

LIQUID TYPE & CONCENTRATION

_____

LIQUID TEMPERATURE

_____ F or C

ELASTOMER (SEAL) REQUIRED

☐ FPM ☐ EPDM

ADDITIONAL INFORMATION

LIQUID SPECIFIC GRAVITY

_____ SG

LIQUID VISCOSITY

_____ cST or _____ SSU

MOTOR VOLTAGE & PHASE

_____ Volts _____ PHASE

SPECIALTY MOTOR REQUIRED?

☐ Wash-down ☐ Explosion-proof

DRAWING OR SCHEMATIC (IF APPLICABLE)

Chemical Resistance Guide

The data in the following tables was obtained from numerous sources in the industry. The information is based primarily on the immersion of unstressed strips in the chemicals at ambient temperature and, to a lesser degree, on field experience. The end user should be aware of the fact that actual service conditions will affect the chemical resistance. It should be noted in the following charts that the "A" rating does not mean or imply that material will perform within original specification. The chemical resistance table should be used for reference only. It is the ultimate responsibility of the end user to determine the compatibility of the chemical being used in his or her particular application. Contact Hayward for information on Eastar® products.

CHEMICALS	CPVC	PP	PTFE	PVC	PVC-GF (Fibertoc™)	PVDF	Ultem® (GF 40%)	EPDM	FPM	Nitrile (Buna N)	Hastelloy® C	Monel®	18-8 SS	316 SS	416 SS	Titanium
Acetal Benzene			A				A	X	X							
Acetal Oxide			A				B	X	C							
Acetaldehyde	X	B	A	X	X	C	B	X	X				A	A	A	
Acetaldehyde, Aq.	X	A	A	X	X	X	A	A	B		A	A	A	A		A
Acetamide		A	A				A	A	C	A	A			A	A	
Acetate Solv., Crude	X	X		X	X	A					A		A	A	B	
Acetate Solv., Pure	X	X	A	X	X	A		C	X	X	A		A	A	A	
Acetic Acid 10%	A	A	A	A	A	A	A	B	X	B				A	A	B
Acetic Acid 20%	B	A	A	A	A	A	A	B	C	B				A	B	A
Acetic Acid 30%	B		A	A	A		A	A	C	B						
Acetic Acid 5%	A		A	A			A	A	A	B						
Acetic Acid 50%	B	A	A	A	A	A	A	B	C	A				A	C	
Acetic Acid 60%	B	B	A	A	A	A	A	C	C					A	X	
Acetic Acid 80%	B	C	A	B	C	A	A	B	C	C				A	X	
Acetic Acid, Glacial	X	B	A	X	C	B	C	B	X	X				A	X	B
Acetic Aldehyde			A					A	X	X						
Acetic Anhydride	C	B	A	X	X	B		C	X	C	A		AB	A	X	B
Acetic Ester			A					B	X	X						
Acetic Ether			A					B	X	X						
Acetol			A													
Acetone	X	B	A	X	X	X	C	A	X	C	A		A	A	AB	A
Acetonitrile		B	A	X	X	A	C	A	C	C			A	A	AB	
Acetophenone	X	A	A	X		A		A	X	C			A	A	X	
Acetyl Acetone	X		A	X	X	X		A	X	X			A		AB	
Acetyl Bromide			A			A										
Acetyl Chloride	X	A	A	X	X	A		X	C	C			BC	AC	AB	
Acetyl Propane			A					B	X	X						
Acetylene Dichl.			A						A					X		
Acetylene Tetrachl.			A					X	A	X	A		A	A	A	
Acetylene	C	A	A	C	C	A		A	A	A	A		A	A	A	
Acid Mine Water	A	B	A	A	A	A			A							
Acrylic Acid	X		A	X	X	A								A		

CHEMICALS	CPVC	PP	PTFE	PVC	PVC-GF (Fibertoc™)	PVDF	Ultem® (GF 40%)	EPDM	FPM	Nitrile (Buna N)	Hastelloy® C	Monel®	18-8 SS	316 SS	416 SS	Titanium
Acrylic Emulsions		X														
Acrylonitrile	X	B	A	X	X	A		X	X	C	AB	A	A	A	A	A
Adipic Acid, Aq.	A	A	A	A	A	A		A	A	A	A	AB	A	A	A	A
Air	A	A	A	A	A	A	A	A	A	A						
Alcohol	C		A					A	B	A	A	A	A	A	AC	AB
Aldehyde			A					A	X	X						
Alkanes			A					X	A	A						
Alkazene			A					X	B	X						
Allyl Alcohol	X	A	A	X	C	A		A	B	A	A	A	A	A	A	
Allyl Aldehyde			A						A	B						
Allyl Bromide			A						B	X						
Allyl Chloride	X		B	X	X	A		X	B	X	A			AB		A
Allyl Trichloride			A						A	X						
Alum	A	A	A	A	A	A		A	A	A	A	AB	AC	AB	X	A
Aluminum Acetate	A		A					A	C	B	A	AC	A	AB	AC	A
Aluminum Bromide			A					A	A	A						
Aluminum Chloride	A	A	A	A	A	A	A	A	A	A	A		X	X	X	AB
Aluminum Fluoride	A			A	C	A		A	A	A	AB	A	X	C	X	A
Aluminum Formate			A						X	X						
Aluminum Salts		A	A	A	A	A		A	A	A				X	X	
Aluminum Sulfate	A	A	A	A	A	A		A	A	A				B	X	A
Amber Acid	A	A	A	A	A	A		A	A							
Amines	X		A	C	C	B			X	X	AB	A	A	A	A	AB
Ammon. Metaphosph.	A	A	A	A	A	A		A	A	A						
Ammonia 10%	X	A	A	A	A				A	X				A	A	A
Ammonia, Anhydrous	X	A	A	X	X	B		A	X	C	A	AB		A	A	AB
Ammonia, Aq. 25%	A	A		A	A	A									B	
Ammonia, Dry Gas	A	A	A	A	A			A	X	A			A		A	A
Ammonia, Liquid	X	A	A	X	X	A	C	A	X	B	A	A	AB	A	A	AB
Ammonia. Nitrate	B	A		B	C	A		A	A	B				A	A	
Ammonium Acetate	A	A	A	A	A			A	A	A	A	A		A		X
Ammonium Alum	X	A	A	X	C	A		A	A	B	A	BC	A	A	A	

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Chemical Resistance Guide, *CONTINUED*

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Ammonium Bichrom.			A				A		A							
Ammonium Bifluoride	A	A	A	A	A	A	A	A	B	A	B	X	X		X	
Ammonium Bisulfide				A	A	A										
Ammonium Carbonate	A	A	A	A	A	A	A	A	C	AB	AB	AB	AB	B	A	
Ammonium Casenite													A			
Ammonium Chloride	A	A	A	A	A	A	A	A	B	AB	A	X	AB	X	A	
Ammonium Dichromate	A		A	A	A		A		A							
Ammonium Fluoride 20%	A	A	A	A	C	A	A	A								
Ammonium Fluoride	A		A	A					B	A			X		BC	
Ammonium Hydroxide	X	A	A	A	A	A	X	A	B	B	A	X	AC	A	A	A
Ammonium Nitrate	B	A		B	A	A		A	A	A	AB	C	A	A	B	A
Ammonium Oxalate										A	A	A	A	A	A	
Ammonium Persulfate	A	C	A	A	A	A		B	C	C	B	X	AC	A	AC	A
Ammonium Ph. Di Basic	A	A	A	A	A			A	A	A	AB	AB	BC	A	AC	A
Ammonium Ph. Mono	A	A	A	A	A			A	A	A	A	B	C	A	A	A
Ammonium Ph.Tri.	A	A	A	A	A			A	A	A	A	AB	AB	A	AB	A
Ammonium Phosphate	A	A	A	A	A	A	A	A	A	A					A	
Ammonium Salts		A	A	A	A	A		A	C	A				X		
Ammonium Sulfate	A	A	A	A	A	A	A	A	C	B	A	AB	AB	A	B	A
Ammonium Sulfide	A	A	A	A	A	A		A	C	A	A		BC	A	C	
Ammonium Thiocyanate	A	A	A	A	A			A	A	A	A			A		
Ammonium Thiosulfate			A					A	A	A			AB	A	C	A
Ammonium, Fluoride 10%	A	A	A	A	C	A		A	A							
Ammonium, Fluoride 25%	A	A		X	X	A										
Amyl Acetate	X	X	A	X	X	C		A	X	C	A	A	AB	A	AB	A
Amyl Alcohol	B	A	A	C	C	A		A	A	A	A	A	AB	A	A	AB
Amyl Borate			A			A		X	A	A						
Amyl Bromide			A					X	B	X						
Amyl Chloride	X	X	A	X	X	A		X	A	X	A	A	AB	A	AC	X
Aniline Chlorohydrate				X	X											
Aniline Hydrochloride	X	A	A	X	X	A		B	B	C					X	
Aniline	X	A	A	X	X	C		B	B	X	A	B	AB	A	B	AC
Anthraquinone Sulf. Ac.	A	A		A	A	A			A							
Antichlor			A					A	A	A						
Anti-Freeze		A	A	A	A		C	A	A	A	A			A		
Antimony Chloride		A	A			A			A	X						
Antimony Pentachloride			A							X						
Antimony Trichloride	A	A	A	A		A		A	A	A	A	AB	X	A	X	AB

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Aqua Regia	X	X	A	X		A		C	C	C	X	X	X	X	X	A
Argon	X		A	X				A	A	C		A	A	A	A	
Arochlor									A	X	A	A		B		A
Aromatic Hydrocarbons	X			X	X			X	A	X				A		
Arsenic Acid	A	A	A	A	A	A		A	A	B	AB	A	AB	AB	B	AB
Arsenous Acid																
Aryl Supfonic Acid	X	X		X		X										
Asphalt	X	A	A	X	X	A		X	A	B	A	A	A	A	AB	A
Aviation Fuel			A								A	A	A	A	A	
Aviation Turbine Fuel			A								A	A	A	A	A	A
Baking Soda			A					A	A	A					A	
Barium Carbonate	A	A	A	A	A	A		A	A	A	B	AB	AB	B	AB	A
Barium Chloride	A	A	A	A	A	A		A	A	A	A	AB	A	AB	BC	A
Barium Cyanide									A	C	A		A	A	C	
Barium Hydrate			A					A	A	A	A	A	A	A	A	
Barium Hydroxide	A	A	A	A	A	A		A	A	A	B	A	AB	AB	AB	A
Barium Nitrate	A	A	A	A	A				A	A		X	AB	B	B	A
Barium Salts		A	A	A	A	A		A	A	A				A		
Barium Sulfate	A	A	A	A	A	A			A	A	A	AB	AB	AB	C	AB
Barium Sulfide	A	A	A	A	A	A		A	A	A		A	A	AB	A	A
Beer	A	A	A	A	A	A		A	A	C	A	A	A	A	A	A
Beet Sugar Liquid	A	A	A	A	A			A	A	A				A	A	
Beet Sugar Liquor	A	A	A	A	A	A		A	A	A	A	A	A	A	B	A
Benzaldehyde	X	C		X	X	C		C	C	X	A	B	A	A	C	A
Benzalkonium Chl.				A												
Benzene Sulf Ac .	X	X	A	X	X	B		X	A	C	B	B	A	AB		AB
Benzene Sulf. Ac. 10%	X	X	A	X	X	B			A							
Benzene	X	C	A	X	X	B	C	X	B	C	AB	A	A	AB	A	A
Benzoic Acid	A	A	A	A	A	A		B	A	X				B	B	A
Benzyl Alcohol	X	A	A	X	X	A	X	C	A	X		A	C	AB	A	A
Benzyl Benzoate			A					C	A	X			C	AB	C	
Benzyl Chloride	X	A	A					X	A	X	B		C	AB	C	
Bismuth Carbonate	A	A	A	A	A	A		A	A	A						
Black Liquor	A	A	A	A	A	A		B	A	A	AC		A	A	AC	
Borax	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A
Boric Acid	A	A	A	A	A	A		A	A	B	A	AC	B	B	BC	A
Brake Fluid			A				C	A	X	C	A	A	A	A	A	
Brewery Slop									A	A				A		
Brine Acid	A	A	A	A	A	A		A	A	A						

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Brine Acid	A	A	A	A	A	A		A	A	A						
Brine	A	A	A	A	A	A		A	A	A	A	A	A		A	
Bromic Acid	A	X	A	A	A	A		B	A		A			X		
Bromine Gas		X	A	C	C	A		X	A	X	A	X	X	X	X	A
Bromine Dry			A					X	A	X	A	A	X	X	X	AB
Bromine Liquid, Br	X	X	A	X	X	A		X	A	X	A	A	X	X	X	X
Bromine Water	C	C	A	X	X	A		X	A	C	A	X	X	X	X	A
Bromobenzene	X		A	X	X			X	A	C						
Bromotoluene	X	X		X	X											
Butadiene Gas	A	A	A	B	C	A		X	A	X	AC	A	A	A	A	
Butane	A	A	A	A	A	A		X	A	A	A	A	A	A	A	A
Butanediol	B			A	A	A		X	A							
Butter			A						A	A			A	A		
Buttermilk			A						A	A			A	A		
Butyl Acetate	X	C	A	X	X	B	C	B	X	C	A	A	A	A	A	A
Butyl Acrylate Pure	X	X	A	X	X	A		A	X							
Butyl Acrylate Satur.								A	X							
Butyl Alcohol (Butanol)	A	A	A	C	C	A		A	A	A	A	A	A	A	A	A
Butyl Amine	X	X	A	X	X	B		X	X	C	AB			A	A	AB
Butyl Benzoate			A					A	A	X						
Butyl Bromide			A			A			B	X						
Butyl Butyrate			A					B	C	X						
Butyl Carbitol	X		A					A	A	C						
Butyl Cellosolve	X		A	A	A	A		B	X	C	A	A	C	A	AC	AB
Butyl Chloride			A			A			A	X	A	A	A	A		A
Butyl Diol	A	A	A	B	C	A		A	A							
Butyl Ether	X	X	A	X	X	A		X	X	B			A	A	A	
Butyl Formate			A							X						
Butyl Hydrate			A					B	A	A						
Butyl Hydride			A					X	A	A						
Butyl Hydroxide			A					B	A	A						
Butyl Mercaptan			A	X	X	A										
Butyl Phenol	A	A		C	C	A					A			A	A	
Butyl Phthalate	X	A	A	X	X	A		B	C	X	AB	AB	AB	AB	A	A
Butyl Stearate			A			A		B	A	B			C	A	AC	
Butylbenzene			A						A	X						
Butylene	A	X	A	A	A	A		X	A	B	A	A	A	A	A	
Butyraldehyde			A					B	X	X	A					

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Butyric Acid	B	A	A	X		A		B	B	X	A	A	AC	AB	X	A
Cadmium Cyanide	A			A	A				A							
Cadmium Salts		A	A			A			A							
Caffeine Citrate			A	A		A										
Calamine			A					A	B							
Calcium Acetate	A	A	A	A	A	A		A	X	B		AB	C	AB	C	
Calcium Bisulfate	A	A	A	A	A	A		X	A	A			C	X	X	
Calcium Bisulfide	A	A	A	A	A	A		X	A	A	A			AB		A
Calcium Carbonate	A	A	A	A	A	A		A	A	A	B	AB	A	AB	A	AB
Calcium Chlorate	A	A	A	A	A	A		A	A	A	AB	AC	A	B	C	A
Calcium Chloride	A	A	A	A	A	A		A	A	A	A	AC	X	B	X	A
Calcium Cyanide			A					A		A						
Calcium Hydroxide	A	A	A	A	A	A	A	A	A	A	A	AB	AB	A	A	
Calcium Hypochloride			A					A	A	X						
Calcium Hypochlorite	A	B	A	A	A	A	A	A	A	B	A	X	X	AB	X	A
Calcium Nitrate	A	A	A	A	A	A		A	A	B	AB	A		AB		AB
Calcium Oxide	A	A	A	A	A	A		A	A	A	A	A	A	A		A
Calcium Phosphate			A					A	A	A	AB		C	AB	C	AB
Calcium Sulfate	A	A	A	A	A	A		A	A	A	AB	A		A	AB	A
Calcium Sulfide	A	A	A	A	A	A		A	A	A		AB	A	AB	BC	
Calcium Thiosulfate			A					A	A	B						
Calgon		C	A			A			A	A			A	A	A	
Cane Sugar Liquors	A	A	A	A	A	A		A	A	A		A	A	A	B	
Caprylic Acid			A			A				C						
Carbinol			A					A	X	A						
Carbolic Acid	A	A								C	A	B	A	A	AB	AB
Carbon Bisulfide	X	X	A	X	X	A			A	X				C		
Carbon Dioxide	A	A	A	A	A	A		B	A	A	A	A	A	A	A	A
Carbon Disulfide	X	X	A	X	X	A		X	A	C	A	B	A	A	AC	AB
Carbon Monoxide	A	A	A	A	A			A	A	A	A	A	A	A	A	
Carbon Tetrachloride	X	X	A	X	X	A	A	X	B	C	A	A	AB	AB	A	A
Carbonic Acid	A	A	A	A	A	A		A	A	B	A	A	AB	A	AC	AB
Casein			A			A		A	A	A						
Castor Oil	C	A	A	A	A	A		B	A	A	A	A	A	A	A	A
Catsup	A	A		A	A				A	A	A			A	A	
Caustic Lime	(See Calcium Hydroxide)															
Caustic Potash	(See Potassium Hydroxide)															
Caustic Soda	(See Sodium Hydroxide)															

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Cellosolve	X	A	A	B		A	C	B	C	C	A	A	C	C	AC	AB
Chloral Hydrate	A	A		A	A	A			A	C						
Chloric Acid 20%	A	X		A	A	A										
Chloric Acid	A		A	A		A				X	AB	X	X	X	X	
Chlorinated Glue								B	A	C				A		
Chlorine Dioxide	A	C	A	A	A	A		X	A		A	X	X	X	X	AB
Chlorine Gas, Dry	X	X	A	X	X	A	A	X	B	C	A	AB	B	B	BC	X
Chlorine Gas, Wet	X	X	A	X	X	A	C	X	C	C	A	C	X	X	X	A
Chlorine Water	A	C	A	A	A	A		B	A	C	A	C	X	X	X	A
Chlorine, Dry	X		A					B	C	X				A		X
Chlorine, Liquid	X	X	C	X	X	A				C						
Chloroacetic Acid		X	A	A				B	X	X	A	B	X	X	X	A
Chlorohydr. Alum			A													
Chlorosulfonic,Acid	X	X	A	X	X	C		X	X	X	A	AC	X	X	X	A
Chocolate Syrup		A							A	A	AB	AB	A	A	A	
Chresylic Acid 50%				A		B			A	X				A		
Chrome Alum	A	A		A	A				A	A						
Chrome Alum	A	A		A	A	A			A	A						
Chromic Acid 10%	A	B	A	A	A	A	A	B	A	X						A
Chromic Acid 20%	A	X	A	B	C	A		B	B	C						A
Chromic Acid 30%	A	X	A	B	C	A			A	X						A
Chromic Acid 5%	A	X		A	A		A	A	A	X				A		A
Chromic Acid 50%	X	X	A	X	X	A	C	B	A	X				X		A
Chromium Alum	A	A	A	A	A	A		A	A							
Citric Acid	A	A	A	A	A	A	A	A	A	B	A	AB	AB	B	BC	A
Citric Oils	X	A	A					B	A	A	A			A		
Cobalt Chloride			A					A	A	A						
Coconut Oil	A	A	A	A	A	A		B	A	A	A	BC		A	AC	
Cod Liver Oil			A					A	A	B	A	A	A	A	A	
Coffee	A	A						A	A	A	A	AC	A	A	A	A
Coke Oven Gas	A	A	A	X	X	A		A	A	X			A	A	A	
Cola Concentrates		A														
Copper Acetate	A	A	A	A	A	A		A	X	B	A	X	A	A	AB	
Copper Borofluoride	A	A	A	A	A	A		A	A							
Copper Carbonate	A	A	A	A	A	A		A	A	X	A	X	A	A	BC	A
Copper Chloride	A	A	A	A	A	A		A	A	A	A	X	X	X	BC	A
Copper Cyanide	A	A	A	A	A	A		A	A	B	A	X	A	B	AB	A
Copper Fluoborate			A	A	A				A	B	B	C		X		

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Copper Fluoride	A	A	A	A	A	A		A	A			C		A			
Copper Nitrate	A	A	A	A	A	A		A	A	A	A	X	AB	A	B	A	
Copper Salts	A	A	A	A	A	A		A	A	A							
Copper Sulfate 5%	A	A	A	A	A				A	A				A	B	A	
Copper Sulfate	A	A	A	A	A	A		A	B	B	A	AB	AB	A	AB	A	
Corn Oil	A	A	A	A	A			B	A	A	A	A	A	A	A		
Corn Syrup	A	A	A	A	A	A		B	A	A				A			
Cottonseed Oil	A	A	A	A	A	A		B	A	B	A	A	AB	A	A	A	
Cream	A	A							A	A				A			
Creosol	X	C	A	X	X	C		X	A	X			A	A			
Creosote	X		A	X	X			X	A	B	A	A	A	A	AB	A	
Cresols	X	C	A	X	X	A		X	A	X	AB			A	A	AB	
Cresylic Acid	C	A	A	C		A		X	A	X	A	A	A	A	A	A	
Croton Aldehyde	X	A	A	X	X	C		B	A								
Crude Oil	A	A	A	A	A	A		X	A	X	A	AB	A	A	A	A	
Cryolite	B	A	A	B		A		A	A	B							
Cupric Fluoride	A	A	A	A	A	A		A	A								
Cupric Nitrate			A					A	A	A							
Cupric Salts		A	A	A	A	A		A	A					X			
Cupric Sulfate	A	A	A	A	A	A		A	A	A							
Cutting Oil			A					X	A	A			A	A	A		
Cyanic Acid			A					A		A		B		A			
Cyclohexane	X	X	A	X	X	A	A	X	A	C	AB	A	AC	A	AC	A	
Cyclohexanol	X	A	A	X	X	C		B	A	B	A		C	A	AC		
Cyclohexanone	X	B	A	X	X	C		C	X	C	A	BC	C	A	BC		
Decalin	X	A	A	X	X	A		X	A	X							
Decanal			A						X	X							
Decane			A			A		X	A	B							
Detergents	B	B	A	A	A	A		A	A	A	AB	A		A	A	A	
Detergents, Heavy Duty	A	A		A	A	A											
Developers			A						A	A	AB	A	A	A	A	A	
Dextrin	A	A	A	A	A	A		A	A				A	A			
Dextrose	A	A	A	A	A	A		A	A	A	A	A		A	A	A	
Diacetone Alcohol	X	C	A	X	X	B		A	X	C	A	A	A	A	A	A	
Diallyl Phthalate																	
Diazo Salts	A	A		A	A	A											
Dibenzyl Ether			A			A		C					A	A	A		
Dibutyl Amine			A			A		X	C	C							

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Chemical Resistance Guide, *CONTINUED*

CHEMICALS	CPVC	PP	PTFE	PVC	PVC-GF (Fiberloc™)	PVDF	Ultem® (GF 40%)	EPDM	FPM	Nitrile (Buna N)	Hastelloy® C	Monel®	18-8 SS	316 SS	416 SS	Titanium
Dibutyl Ether			A			A		C	C	C			A	A	A	
Dibutyl Phthalate	X	B	A	X	X	A		A	B	X	AB			AB	A	
Dibutyl Sebacate			A	B		A		B	C							
Dichlorobenzene	X		A	X	X	A	X	X	B	X	A		A	A	A	
Dichloroethane			A	X	X		X		C		A	A	A	A	A	AB
Dichloroethylene	X	X	A	X	X	A		X	A	X	AB	A		BC		
Dichloroisopropyl Ether						A										
Dichloromethane			A				X	X	B	X						
Diemethyl Phthalate											A		AB	A		
Diesel Fuel	A	B	A	A	A	A	A	X	A	A	A	A	A	A	A	A
Diethanolamine											A	A	A	A	A	A
Diethyl Cellosolve						A		X								
Diethyl Ether	X	B	A	X	X	A		C	C	X	A	B	AB	A	AB	A
Diethyl Ketone			A					B	X	X						
Diethyl Oxide			A					X	X	B						
Diethylamine	X	A	A	X	X	C		B	X	B		BC	A	A	A	X
Diethylbenzene			A					X	A	X						
Diethylene Glycol	A	A	A				A		A	A	B	AB	A	A	A	A
Diethylenetriamine			A			A				B						
Diglycolic Acid	A	A	A	A	A	A		A	A							
Diisobutyl Ketone						A		X	X							
Diisobutylene			A			A		X	A					A		
Diisooctyl Phthalate			A				A	B	B							
Diisopropyl Ketone			A			B		B	X			C	A	A	A	
Dimethyl Amine	X	A	A	X	X	B		C	X	B						
Dimethyl Benzene			A					X	A	X						
Dimethyl Ether			A					B	B	B	C	C	C	C	C	A
Dimethyl Formamide	X	A	A	X	X	A	X	B	C	B	A	A		A		
Dimethyl Ketone			A					A	X	X						
Dimethyl Phthalate			A			B		B	B	X	A			A		
Dimethylamine	X	A		X	X	X		X	X							
Dioctyl Phthalate	X	X	A	X	X	A		B	A	X	A		A	A	A	
Dioxane	X	B	A	X	X	X	X	B	X	X	X	A	A	AB		
Dioxolane						X		X	X							
Diphenyl Ether											A			A		
Diphenyl Oxide								X	A	X						
Diphenyl			A					X	A	X	B	AB	B	B	A	A
Dipropylene Glycol			A						A	A						

CHEMICALS	CPVC	PP	PTFE	PVC	PVC-GF (Fiberloc™)	PVDF	Ultem® (GF 40%)	EPDM	FPM	Nitrile (Buna N)	Hastelloy® C	Monel®	18-8 SS	316 SS	416 SS	Titanium
Disodium Phosphate	A	A	A	A	A	A		A		A	A			A		
Distilled Water	A	A		A	A	A										
Divinylbenzene	X	X		X	X	X										
Dolomite			A					B	A	A						
Dowtherm											A	A	A	A	A	A
Dry Cleaning Solvents			A		X			X	A	A			A	A	A	
Epichlorohydrin	X	A	A	X		A		X	X		A		A		A	A
Epsom Salt		A	A	A	A	A		A	A	A	A	A	A	AB	AB	A
Esters	X	C	A	X	X	A										
Ethane			A					X	A	A			A	A	A	A
Ethanol	B	A	A	A	A	A	A	A	B	A				A	B	A
Ethanolamine	X	X	A	X	X	X		A	X	B	AB	A	A	A	A	A
Ether Alcohol			A					A	B	C						
Ethers	X	C	A	X	X			C	C	X	A	A	A	A	A	A
Ethyl Acetate	X	C	A	X	X	A	C	B	X	X	A	A	AB	A	A	A
Ethyl Acetoacetate	X		A	X	X	A		A	X	X						
Ethyl Acrylate	X	X	A	X	X	A	C	B	X	X	A	A	A	A	A	BC
Ethyl Alcohol	A	A	A	A	A	A	A	A	B	A	A	A	A	A	A	A
Ethyl Benzene	X		A		A			X	A	X	A	A	A	A	A	
Ethyl Bromide		X											A	A	A	
Ethyl Chloride	X	X	A	X	X	A		A	A	B	B	AB	A	A	A	A
Ethyl Ether	X	B	A	X	X	A	A	X	C	X	A	B	AB	AB	AB	A
Ethyl Formate			A					B	B	X			A	A	A	
Ethyl Hexanol			A			A		A	A	B						
Ethyl Sulfate			A						X	C	A	A	C	X	A	
Ethylene Bromide	X	C	A	X	X	A		C	B	X	AB			AB	B	BC
Ethylene Chloride	X	C	A	X	X	A		C	A	X	A	AB	A	A	A	AB
Ethylene Chlorohydrin	X	A	A	X	X	A		A	A	X	B			AB		BC
Ethylene Diamine	X	A	A	X	X	C	X	A	X	A	AC		A	A	A	A
Ethylene Dichloride	X	C	A	X	X	A		X	A	X	A	AB	A	A	A	AB
Ethylene Glycol	C	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ethylene Oxide	X	X	A	X	X	A		X	X	X	A	A	A	AB	A	
Extrin	A	A	A	A		A		A	A							
Fatty Acids	B	A	A	A	A	A		X	A	B	A	A	A	A	B	A
Ferric Acetate			A	B	B				X	X						
Ferric Chl. Anhydrous	A	A	A	A	A	A		A	A	B				X	X	A
Ferric Hydroxide	A	A	A	A	A			A	C							
Ferric Nitrate	A	A	A	A	A	A		A	A	A	AB	X	A	B	B	A

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Ferric Sulfate	A	A		A	A	A		A	A	B	A	B	A	B	B	A
Ferrous Chloride	A	A	A	A	A	A		A	A	B	AB	X	X	X	X	A
Ferrous Nitrate	A	A	A	A	A	A		B	A	A						
Ferrous Sulfate	A	A	A	A	A	A		A	A	A	A	AB	A	C	B	A
Fish Solubles	A	B		A	A											
Fluoboric Acid	A	A		A	A	A	B	A	A	B	A	A		B		X
Fluorine Gas (Wet)	A	B	A	A	C	A		A	A	X	A	A				
Fluorine Liquid		X	B	C	X	A		C	B	X				X		X
Fluosilicic Acid 25%	A	A	A	A		A		A	A	A	B	A	X	B	C	X
Formaldehyde 35%	A	A	A	A	A	A		A	A						B	
Formaldehyde 50%	A	A	A	A	A	A		X	B							
Formaldehyde	A	A	A	X	B	A	A	B	B	B	B	A	A	A	B	A
Formic Acid	A	A	A	A	A	A	B	A	X	C	A	AB	B	B	B	C
Freon 11	A	A	A	X	X	A		X	B	B	A	A	A	A	A	
Freon 113	B	X	A	B	C	A		X	B	A	A	A	A	A	A	
Freon 114			A	A	A	A		C	A	A			A			
Freon 12 (Wet)		A	A	B	C			B	A	A				X	A	
Freon 12	A	A	A	C	C	A		A	B	B	A	AB	A	A	A	
Freon 22	X	A	A	X	X	A		B	X	X			A	A	A	
Freon TF	(See Freon 113)															
Fructose	A	A	A	A	A	A		A	A	A	A	A	A	A		
Fruit Juice	A	A	A	A	A	A			A	A	A	A	A	A		
Fruit Pulp	A	A		A	A	A			A							
Fuel Oil		B	A	B	C	A		X	A	A	A	A	A	A		A
Fumaric Acid			A						A	A			A			
Furan			A					X	X		B					
Furfural (Ant Oil)	X	C	A	X	X	B		B	X	X	AB	B	AB	A	A	
Furfuryl Alcohol			A			B		C	X				A			
Gallic Acid	A	A	A	A	A	A		A	A	A	B	B	A	A	B	
Gas, Natural	A	A		A	A	A		X	A	A	A	A				
Gasoline, Leaded	X	X	A	A	A	A	A	X	B	A	A	A	A	A	A	X
Gasoline, Sour	B	X	A	A	A	A		X	A	A	A	X	A	A	A	X
Gasoline, Unleaded	X	X	A	C	C	A	A	X	B	A	A	A	A	A	A	X
Gelatin	A	A	A	A	A	A		A	A	A	A	A	A	A	A	
Gin	A	A	A	A	A	A		A	A							
Glucose	A	A	A	A	A	A		A	A	A	A	A	A	A	A	
Glue	A	A	A	A	A	A		B	A	A	A	A	A	A	A	A
Glycerine	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A

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Glycerol	A	A	A	A	A	A		A	A	A				A		
Glycolic Acid	A	A	A	A	A	A		A	A	A	A					
Glycols	A	A	A	A	A	A		A	A	A		AB				
Glyoxal									A							
Gold Monocyanide									A	A				A		
Grape Juice	A			A	A				A	A				A		
Grape Sugar	A	A	A	A	A	A		A	A	A						
Grease		A	A	A	A	A		X	A	B	A	A	A	A		
Green Liquor	A	A	A	A	A	A		A	A	B		A				
Helium			A					A	A	A			A			
Heptane	A	B	A	A	A	A		X	A	A	A	A	A	A		
Hexane	A	B	A	X	X	A	A	X	A	A	A	A	A	A		
Hexene			A					X	A	A						
Hexyl Alcohol	A	A	A	A	A	A		B	A	A	A	A	A	A		A
Honey		A	A	A	A	A			A	A	A			A		
Hydraulic Oil (Synth.)		X			C				A	C	A	A	A	A		
Hydraulic Oil			A				A	X	A	A	A	A	A			
Hydrazine	X	X	A	X	X	X		A	X	C			A	A		
Hydrobromic Acid 20%	A	A	A	A	A	A		A	A	X				X	X	A
Hydrobromic Acid 50%	A	B	A	A	A	A		A	A	X			X	C	X	X
Hydrobromic Acid	A	B	A	A	A	A		A	A	X	A	X	X	X	X	A
Hydrochloric Acid 10%	A	A	A	A	A	A	A	A	A	B			X		X	C
Hydrochloric Acid 20%	A	A	A	A	A	A	A	A	A	B			X	X	X	C
Hydrochloric Acid 25%	A	A	A	A	A	A	A	A	A	C			X		X	
Hydrochloric Acid 37%	A	A	A	A	A	A	A	C	A	C			X	X	X	C
Hydrochloric Acid	A		A	A			A	A			B	X	X	A		
Hydrocyanic Acid 10%	A	A	A	A	A	A		A	A	B				X	X	
Hydrocyanic Acid	A	A	A	A	A	A		A	A	B	A	AB	A	A	B	A
Hydrofluoric Acid 10%	A	A	A	A	C	A		A	A	B			X		X	
Hydrofluoric Acid 20%	A	A	A	A	C			A	A	X			X	X	X	X
Hydrofluoric Acid 30%	A	A	A	A	C	A		A	A				X		X	
Hydrofluoric Acid 40%	C	A	A	B	C	A		A	A				X		X	
Hydrofluoric Acid 50%	C	A	A	X	X	B	A	A	A	C				X	X	X
Hydrofluoric Acid 65%	C		A					B	A	X			X		X	
Hydrofluoric Acid 75%	C	A	A	X	X	A		X	A	X	A	A	X	X	X	
Hydrofluosilic Acid	A	A	A	A	A	A		A	A	A	B	A	X	X	X	A
Hydrofluosilicic Acid 20%	A	A	A	A	A			A	A	B				X	X	X
Hydrogen Chl. Gas Dry		A				A					A	A	A		X	

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Hydrogen Cyanide	A	A	A	A	A	A		A	A	B	A	B	A		C	
Hydrogen Fluoride	X	A		X	X	A					B	AB	AB		C	
Hydrogen Peroxide 10%	A	A	A	A	A	A				A				C	B	C
Hydrogen Peroxide 30%	A	C	A	A	A		A	B	A	X				B	B	B
Hydrogen Peroxide 5%	A	A	A	A	A	A		A	A						B	
Hydrogen Peroxide 50%	A	A	A	B	C	A		C	A	X					C	
Hydrogen Peroxide 90%	X	X	A	X	C	A		C	B	X					X	
Hydrogen Peroxide		A	A	A	A	A		B	A	C	A	AB	AB	B	B	B
Hydrogen Phosphide	A	A		X	C	A				C						
Hydrogen Sulf. (Aq. Sol.)	A	A	A	A	A			A	C	C				A	C	A
Hydrogen Sulfide (Dry)	A	A	A	A	A	A		A	A	A	A	B	C	A	C	
Hydrogen Sulfide	A	A	A	A	A	A		A	A		A	BC	AB		C	
Hydrogen	A	A	A	A	A	A		A	A	A	A	A	A	A	A	
Hydroquinone	A	A	A	A	A	A		A	A	X	B	A	C			
Hydroxide Alum	A	A	A	A	C	A	A	A	C	A				A	A	A
Hydroxyacetic Acid 70%	A			A	A			A	A	A						B
Hydroxyacetic Acid	A								A	A						A
Hydroxylamine Sutfate	A	A		A	A	A		A								
Hypochlorous Acid	A	A	A	A	A	A		B	B	X	A		X	X		
Ink		A				A				A	A	AC	A	A		
Iodine Solution	A	C	A	X	X	A	A	A	A	C	A	A	B	X	X	A
Isobutyl Alcohol			A			A	A	A	A	B	A	A		A		A
Isooctane	A	A	A	A	A	A		X	A	A	A	A	A			
Isophorone	X			X	X			X	X		A					
Isopropyl Acetate			A					B	X	X	B	AB		B		
Isopropyl Alcohol	A	A	A	A	A	B		A	A	B	A	AB	AB	A		A
Isopropyl Ether	X	C	A	X	X	A		X	X	B	A	A		A		
Jet Fuel JP-3		A	A					X	A	A	A	A	A	A	A	
Jet Fuel JP-4	A	C	A	A	A	A		X	A	B	A	A	A	A	A	
Jet Fuel JP-5	A	C	A	A	A	A	A	X	A	A	A	A	A	A	A	
Kerosene	A	A	A	A	A	A	A	X	A	A	A	A	A	A	A	A
Ketones	X	A	A	X	X	A		C	X	X	A	A	A	A		A
Kraft Liquor	A	A		A	A	A										
Lacquer Thinner		B	A	C	C			A		X	A	A	A	A		A
Lacquer		A	A					X	X	X	A	A	A	A		
Lactic Acid	A	A	A	A	A	A	A	B	B	B	A	AB	A	A	C	B
Lard Oil	A	A	A	A	A	A		C	A							
Lard	A	A	A	A	A	A	A	C	A	A	A	AC	A	A	A	

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Latex		A	A				B	A	B	A			A	A		
Lauric Acid	A	A	A	A	A	A										
Lauryl Chloride	A	A	A	A	A	A										
Lead Acetate	A	A	A	A	A	A		A	C	B	AB	A	B	B	B	A
Lead Chloride	A	A	A	A	A	A		A	A							
Lead Nitrate	A	A	A	A	A			A	A	A	B	B	C		B	
Lead Sulfate	A	A	A	A	A	A		A	A	A						
Lemon Oil	A	X	X	A	A	A						A				
Ligroin	X	C		X	X	A		C	A	A	A	A	A	A		
Lime - Sulfur Solution	A	A		A	A	A				X					B	
Lime	(See Calcium Oxide)															
Linoleic Acid	A	A	A	B	C	A		X	B	B	A	A	A		A	
Linseed Oil	A	A	A	A	A	A		B	A	A	A	A	A		A	
Lithium Bromide			A	A	A	A			A	A	AB	AB				
Lithium Chloride	A				A						AB	A	A		X	
LPG			A								A	A	A			
Lubricants		A	A	A	A				A	A				A	A	A
Lubricating Oil	A	A	A	A	A	A			A		A	A	A		A	
Lye Solution											A	A	A			
Machine Oil	A	A	A	A	A	A			A							
Magnesium Acetate			A						X	X						
Magnesium Carbonate	A	A	A	A	A	A		B	A	A	AB	A	AB	A	A	
Magnesium Chloride	A	A	A	A	A	A		A	A	A	A	A	X	B	B	A
Magnesium Citrate	A	A	A	A	A	A		A	A							
Magnesium Hydroxide	A	A	A	A	A	A		A	A		A	A	A			
Magnesium Nitrate	A	A	A	A	A	A		B	A	A	A	B	AB	A	A	A
Magnesium Oxide	A		A					A	A	A	A	AB		A	B	
Magnesium Sulfate (Epsom Salts)	A	A	A	A	A	A		C	A	A	A	A	A	A	A	A
Maleic Acid	A	A	A	A	A	A		C	A	X	A	AC	B	A	A	A
Maleic Anhydride									A	X	A					
Malic Acid	A	A	A	A	A	A		X	A	A	A	A	A	B	A	
Manganese Sulfate	A	A	A	A	A			A	A	A	A	A				
Mash										A	A	A		A		
Mayonnaise		A	A					A	A	A	AC	A	A			
Melamine										C				X		
Mercuric Chloride	A	A	A	A	A	A		A	A	A	AB	X	X	X	X	A
Mercuric Cyanide	A	A	A	A	A	A		B	A	A	A	X	A	A	X	A
Mercuric Nitrate	A		A					A	A		A				A	

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Mercuric Sulfate	A	A	A	A	A	A		A	A	A						
Mercurous Nitrate	A	A	A	A	A	A		A	A			X	A			
Mercury	A	A	A	A	A	A		A	A	A	A	B	A	A	A	B
Methacrylic Ac.Glacial				X												
Methane Sulfonic Ac.			A			A										
Methane	A	A	A	A	A	A		C	A	A	A	A	A		A	
Methanol (Methyl Alcohol)	X	A	A	A	A	A	A	A	X	A	A	A	AB	A		A
Methoxyethyl Oleate				A	A											
Methyl Cellosolve	X	A		X	X	A		B	X	X	A	A	AC			
Methyl Acetate	X	B	A	X	X	A		B	X	X		AB	A	A		
Methyl Acetone			A						X	X		AB	A	A		
Methyl Acrylate			A			A		B	X	X		AB	A	A		
Methyl Alcohol	X	A	A	A	A	A		A	X	A				A		A
Methyl Benzene	(See Toluene)															
Methyl Bromide	X	X	A	X	X	A		C	A	X	AB		A			
Methyl Butanol			A						B	A						
Methyl Butyl Ketone			A					B	X	X				A		
Methyl Chloride	X	X	A	X	X	A		C	C	C	A	A	A	A	B	A
Methyl Chloroform	X	C	A	X	X	A		X	B		A	C				
Methyl Ether			A					C	C	B	C	C	C			
Methyl Ethyl Ketone	X	C	A	X	X	X	C	A	X	X	A	A	A	A		A
Methyl Formate	X							A	X		AB		A			
Methyl Isobutyl Alcohol										X						
Methyl Isopropyl Ketone	X	B	A	X	X	A		C	X	X			A	A		
Methyl Isobutyl Carbinol			A					A	A							
Methyl Isobutyl Ketone	X	C	A	X	X	A		B	X	X				A		A
Methyl Methacrylate	X		A	A			C	X	X	X			C			
Methyl Propanol			A					B	A	A						
Methyl Salicylate	A	A		A	A	A										
Methyl Sulfate	A	A		B	C	A										
Methylamine	X	X	A	X	X	C		A		B				A		
Methylene Bromide				X	X	X										
Methylene Chloride	X	X	A	X	X	C		X	B	X	A	A	AC	A	B	A
Methylene Iodine			A	X	X	C			A							
Methylhexane			A					X	A	A						
Methylisobutyl Carb.	A	A		A	A	A		A	A							
Methylmethacrylate			A			A		X	X							
Methylsulfuric Acid	A	A	A	A	A	A										

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Milk	A	A	A	A	A	A	B	A	A	A	A	BC	A	A	A	
Mineral Oil	A	A	A	B	A	A	A	X	A	A	A	A	A		A	
Molasses	A	A	A	A	A			C	A	A	A	A	A	A	A	
Monochlorobenzene		B	A			A		X	A		A	A	AB			
Monochlorocetic Acid	A	B	A	A	A	A		C	B		A	B			X	
Monoethanolamine	X		A	X	X	X		A	A	A	AB	A	A		A	
Morpholine			A								A			A		
Motor Oil	A	C	A	A	A	A	A	X	A	A	A	A				
Mustard	A	A		A	A				A	B	A	BC	A	A		
Naphtha	A	A	A	A	A	A	A	X	A	B	A	A	A	A	A	A
Naphthalene	X	B	A	X	X	A		X	B	X	A	A	B	B	A	A
Natural Gas	A	A		A	A	A		X	A	A	A	A	A			
Neon			A					A	A	A			A			
Nickel Acetate	A	A	A	A	A	A		A	X	B		A	C			
Nickel Chloride	A	A	A	A	A	A		A	A	B	A	AB	AC	B	X	A
Nickel Cyanide	A			A	A											
Nickel Nitrate	A	A	A	A	A	A		B	A	A	B	B	A		B	
Nickel Sulfate	A	A	A	A	A	A		A	A	A	AB	AB	A	C	B	
Nickel	A	A	A	A	A			A	A	A						
Nicotine Acid	A	A	A	A	A	A		A								
Nicotine	A	X	A	A	A	C										
Nitrate Alum	A	A	A	A	A	A		A	B	A					A	
Nitric Acid 10%	A	A	A	A	A	A	A	B	A	X	B	X	A	A	B	A
Nitric Acid 20%	A	A	A	A	A		A	X	A	X	B	X	A		B	
Nitric Acid 30%	A	A	A	A	A	B	A	B	A	X	B	X	A		B	
Nitric Acid 40%	A	C		A	A	B	A	X	A	X	B	X	A		C	
Nitric Acid 50%	A	C	A	A	A	B		X	A	X	B	X	A		X	
Nitric Acid 70%	A	X	A	X	X	X	A	X	C	X	B	X	A		X	
Nitric Acid Concentr.	A	X	A	X	X	X		X	C	X	B	X	A		C	
Nitric Acid Fuming	X	X		X	X	X									C	
Nitrobenzene	X	C	A	X	X	A	C	C	C	C	A	AB	B	B	B	A
Nitroethane			A			A		A	X				A			
Nitrogen Dioxide			A			A										
Nitrogen			A					A	A	A	A	A	A		A	
Nitroglycerine				X				A			A	A	A			
Nitromethane			A			A		B			A		A			
Nitrous Oxide	A	A	A	A	A	A		A	A	A	A	X	C			
Ocenol	A	X		A	A	A										

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Chemical Resistance Guide, *CONTINUED*

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Octane			A			A		X	A							
Octyl Acid			A			A				C						
Octyl Alcohol									A	B	A		A	A		A
Octylamine			A						X	C						
Oils, Crude Sour	X														C	
Oils	X	A		A	A	A										
Oils, Aniline		A	A	X	X			B	A	X				A		A
Oils, Anise													A			
Oils, Bay									A				A			
Oils, Bone									A	A			A			
Oils, Castor				A				B	A	A			A			
Oils, Cinnamon				A					A				A			
Oils, Citric		A							A	A			A			
Oils, Clove		B								A			A			
Oils, Coconut		A						A	A	A			A			
Oils, Cod Liver		A						A	A	A			A			
Oils, Corn	X	A						C	A	A			A			
Oils, Cotton Seed	X	A	A	A	A			C	A	A			A			
Oils, Creosote		X			X			X	A	B			A			
Oils, Diesel Fuel		A			A			X	A	A			A			
Oils, Fuel			A	A	A			X	A	B			A			A
Oils, Linseed	X	A		A	A			X	A	A			A			
Oils, Mineral		A		A	A			X	A	A	A	A	A	A	A	
Oils, Olive	X	A	A	A	A			B	A	A	A	A	A	A	A	
Oils, Pine	X		A	A	A			X	A	C		A	A	A		
Oils, Silicone		A			A				A	A			A			
Oils, Vegetable	X	A		A	A	A			A	A	A	A	A		A	
Oleic Acid	B	A	A	A	A	A	A	C	B	B	A	A	A	A	B	
Oleum	X	X	A	X	X	X		X	X	X				A		
Orange Extract		A	A			A										
Oxalic Acid	A	A	A	A	A	A		A	A	B	A	B	A	B	C	C
Oxychloride Alum	A	A		A	A	A			X							
Oxygen Gas	A	A	A	A	A	A		A	A	C	A	A	A			
Ozone	B	C		B	B	A		A	A	X	A	A	A			
Palmitic Acid 10%	A	A	A	A	A	A		B	A	A						
Palmitic Acid 70%	A	A	A	X				B	A	A						
Paraffin	A	A	A	A	A	A		X	B	A	A	A	A	A	A	
Pentane			A					X	A	A	A	A	A	C		

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Peracetic Acid 40%	X	X	A	X	X	A		B	A							
Perchlorlc Acid 10%	A	A	A	A	A	A		B	A	X					B	
Perchlorlc Acid 70%	X	A	A	X	X	A	X	A	A	X					X	
Perchloroethylene	X	C	A	X	X	A		X	A	X	A	A	AB	A		
Perphosphate	A	A	A	A	A			A	A							
Petrolatum	A	A	A	A	A	A		C	A	A	A	A	A	A		
Petroleum (Sour)				A	A			X	A	A					C	
Petroleum Oils	A	B	A	A	A	A		X	A	A					A	
Phenols 100%	A	A	A	X	X	A	X	C	B	X	A	B	A	A		C
Phenylacetate			A					B	X	X						
Phenylhydrazine Hydrochl	A	X		X	X	A										
Phenylhydrazine	X	X	A	X	X	A		C	C	X						
Phosgene Gas	X	C		X	X	A		A	X	X						
Phosgene Liquid	X	X		X	X	C		A	X	X						
Phosphate Alum			A					A	A	A						
Phosphoric Acid 10%	A	A	A	A	A	A	A	A	A	C	A		A	A		B
Phosphoric Acid 100%	A	A	A	A	A			B	A	X	A		A	B		B
Phosphoric Acid 20%	A	A	A	A	A	A	A	A	A	C	A		A			
Phosphoric Acid 40%	A	A	A	A	A		A	B	A	X	A		A	A		A
Phosphoric Acid 50%	A	A	A	A	A	A	A	A	A	C	A		A	B		B
Phosphoric Acid 80%	A	A	A	A	A	A	A	A	A		A		AB			
Phosphoric Acid 85%	A	A	A	A	A	B	A	A	A	C	A		AB	B		C
Phosphoric Acid Crude			A					B	A	C				C		C
Phosphorous Oxychloride			A										X			
Phosphorous Red	A	A	A	A	A	A										
Phosphorous Trichloride	X	C	A	X	X	A		C	C	X	A	A	A	A		
Phosphorous Yellow	A	A	A	A	A	A										
Photographic Developer	A	A		A	A	A			A	A	A	A	C	A		A
Photographic Solutions	A	A	A	A	A	A			A	A	AB	AC	C			
Phthalic Acid	X	X	A	X	X	A		A	A		A	X	C		B	
Phthalic Anhydride	X	X	A	X	X			A	A	C	A	A	B	B	A	
Pickle Brine	A	A		A	A	A										
Pickling Solutions	A	A	A	A	A	A		C	B	X						
Picric Acid	C	A	A	X	X	A		C	A	B	B	X	AB	A	B	
Plating Solutions, Antimony	A	A	A	A	A				A	A	A	A		A		A
Plating Solutions, Arsenic	A	A		A	A				A	A	A			A		A
Plating Solutions, Brass	A	A	A	A	A	A		A	A	A	A			A		A
Plating Solutions, Bronze	A	A	A	A	A				A	A	A			A		A

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Plating Solutions, Cadmium	A	C	A	A	A	A		A	A	A	A			A		A
Plating Solutions, Chrome	A	C	A	A	A	A		B	C	X	X	C		C	A	A
Plating Solutions, Copper	A	A	A	A	A	A		A	A	A	A			X		A
Plating Solutions, Gold	A	C	A	A	A	A		A	A	A	A			C		A
Plating Solutions, Iron	A	C	A	X	X				A	A	A			C		A
Plating Solutions, Lead	A	A	A	A	A	A		A	A	B	A	A		C		X
Plating Solutions, Indium	A	A	A	A	A				A	A				C		A
Plating Solutions, Nickel	A	A	A	A	A	A		A	A	A	A			C		A
Plating Solutions, Rhodium	A	A	A	A	A	A		A	A	A				X		X
Plating Solutions, Silver	A	A	A	A	A	A		A	A	A	A			A		A
Plating Solutions, Tin	A	A	A	A	A	A		A	A	B	A	A		C		X
Plating Solutions, Zinc	A	A	A	A	A	A		A	A	A	A			X		A
Polyethylene Glycol	A	A	A	A	A	A		A	A	A						
Polyvinyl Acetate Emul			A			A		A	A							
Polyvinyl Alcohol	X	A	A	A	A	A		A	A							
Potash	A	A	A	A	A	A		B	C	C				A		
Potassium Acetate	A	A	A	A	A	A		A	X	B		A	C			
Potassium Alum	A	A	A	A	A	A		A	A	A					X	
Potassium Bichromate	A	A	A	A	A	A		A	A	A		AC	AB		B	
Potassium Bisulfate	A	A	A	A	A	A		A	A	A	A					
Potassium Bromate	A	A	A	A	A	A		A	A	A		A				
Potassium Bromide	A	A	A	A	A	A		A	A	A	A	A	AC	B	B	A
Potassium Carbonate	A	A	A	A	A	A	A	A	A	B	AB	A	AB	A	B	A
Potassium Chlorate	A	A	A	A	A	A		A	A	A	AC		AB	A	B	A
Potassium Chloride	A	A	A	A	A	A		A	A	A	A	AB	C	A	B	A
Potassium Chromate	A	A	A	A	A	A		A	A	A	A	A	C	B	B	
Potassium Coppercyanide	A	A	A	A	A	A		A	A							
Potassium Cyanide	A	A	A	A	A	A		A	B	A	B	B	AC	B	B	A
Potassium Dichromate	A	A	A	A	A	A		A	A	A				A	B	A
Potassium Ferricyanide	A	A	A	A	A	A		A	A	A	A	BC	AC		A	
Potassium Ferrocyanide	A	A	A	A	A	A		A	A	C	B	AC	B		A	
Potassium Fluoride	A	A	A	A	A	A		A	A	A		A				
Potassium Hydroxide 25%	A				A						A	A	A			
Potassium Hydroxide 50%	A	A		A	A	B					A	A	A			
Potassium Hydroxide	A	A	A	A	A	A	A	B	C	C	AB	A	A	C	B	C
Potassium Hypochlorite	A	A	A	A	A	A		A	A	X	B	X	X		X	
Potassium Iodide	A	A	A	A	A	A		A	A	A	A	AB	A		A	
Potassium Nitrate	A	A	A	A	A	A		A	B	A	AB		A	B	B	A

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Potassium Perborate	A	A	A	A	A	A										
Potassium Perchlorate	A	A	A	A	A			A								
Potassium Permanganate	A	B	A	A	A	A		A	B	C	B	AC	AC	B	B	B
Potassium Persulfate	A	A	A	A	A	A		A			A	X				
Potassium Phosphate	A									A						
Potassium Salts		A	A			A		A	A							
Potassium Sulfate	A	A	A	A	A	A		A	A	A	A	A	AB	B	B	A
Potassium Sulfide	A		A	A	A			A	A	A	AB		A		B	
Potassium Thiosulfate			A						A	A						
Potossium Bicarbonate	A	A	A	A	A	A		A	A	A				B	B	A
Propane	A	B	A	A	A	A		X	A	A	A	A	A	A	A	
Propargyl Alcohol	A	A		A	A	A										
Propyl Acetate			A			A		B	X	X		A				
Propyl Alcohol (Propanol)	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A
Propylene Dichloride	X	C	A	X	X	A		X	B	X		A	C			
Propylene Glycol	C		A				A	A	A	A	B	B	AB	A		
Propylene			A					X	A	X			A			
Pyridine	X	C	B	X	X	C	X	C	X	X	A	A	B	C	B	
Pyrogallic Acid			A	B	C	X			A	A	AB	AB	AB	A	B	
Rayon Coagulating Bath	A	A		A	A	A										
Rhodan Salts	A	A	A	A	A	A		A	A							
Rosins		A	A						A	A				A	B	
Rum		A	A	A	A			A	B	A						
Rust Inhibitors		A							A	A				A		
Salad Dressings		A		A	A				A	A				A		
Salicylaldehyde			A	X	X	C	X	A	A							
Salicylic Acid			A	A	A	A	A	A	A	C	A	AB	A		B	
Saline Solutions	A	A		A	A	A										
Salt Brine	A	A	A	A	A	A		A	A	A	A	A				
Sea Water	A	A	A	A	A	A		A	A	A	A	B	AB	C	C	A
Selenic Acid	A	A		A	A	A										
Sewage	A	A	A	A	A	A		A	A	A	A	A	A			
Shellac Orange		A	A						A							
Shellac Bleached		A	A						A					A	A	
Silicic Acid	A	A	A	A	A	A		A	A							
Silicone Oil	A	A	A	A	A			A	A	A	A	A	A	A		
Silver Bromide											A	B	X	C	X	
Silver Cyanide	A	A	A	A	A	A		A	A		A	AB	A		A	

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Silver Nitrate	A	A	A	A	A	A		C	A	C	AB	X	B	B	B	A
Silver Salts		A	A	A	A	A		A	A				A			
Silver Sulfate	A	A	A	A	A	A		A	A	C						A
Soap Solutions	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A
Soda Ash			A					A	A	A						
Sodium Acetate	A	A	A	A	A	A		A	C	C	A	A	AB	B	B	A
Sodium Aluminate	A	A	A	A	A	A		A	A	A	AB	AB	AB	A	C	B
Sodium Benzoate	A	A	A	A	A	A					A	AB				
Sodium Bicarbonate	A	A	A	A	A	A		A	A	A	A	A	A	A	A	A
Sodium Bichromate	A	A	A	A	A	A		A	A		B		AC		B	
Sodium Bisulfate	A	A	A	A	A	A		A	A	B	B	AB	X	A	A	A
Sodium Bisulfite	A	A	A	A	A	A		A	A	A	B	B	C	A	C	A
Sodium Borate	A	A	A	C	C	A		A	A	A	A	AB	A		A	
Sodium Bromide	A	A	A	A	A	A		A	A		AB	AC	A		C	
Sodium Carbonate	A	A	A	A	A	A		A	A	A	A	A	A	A		A
Sodium Chlorate	A	A	A	A	A	A		A	A	C	A	X	BC	B	B	A
Sodium Chloride	A	A	A	A	A	A		A	A	A	A	A	A	C	B	A
Sodium Chlorite	X	X	B	X	X			X	X							
Sodium Chromate	A	A	A						B	A	A	AB	AC	A	B	
Sodium Cyanide	A	A	A	A	A	A		A	A	A	A	X	A	A	A	A
Sodium Dichromate	A	A	A	A	A	A		A	A							
Sodium Ferricyanide	A	A	A	A	A	A		A	A		A	AC	C		B	
Sodium Ferrocyanide	A	A	A	A	A	A		A	A		A	A				
Sodium Fluoride	A	A	A	A	A	A		A	B	C	A	A	B		C	A
Sodium Hydrosulfide											A	A				
Sodium Hydrosulfite			A	C					A		A	A				
Sodium Hydroxide 15%	A	A	A	A	A	A	A	A	C	A	A			B	B	A
Sodium Hydroxide 20%	A	A	A	A	A	A		A	C	A	A			B	B	A
Sodium Hydroxide 30%	A	A	A	A	A	A		A	C		A			B	B	
Sodium Hydroxide 50%	A	A	A	A	A	A		A	C	X	A			B	C	A
Sodium Hydroxide 70%	A	B	A	A	A	B		A	X	X	A				X	A
Sodium Hydroxide Conc	A	A	A	A	A	A		A	B	X	A	AB	A		C	
Sodium Hypochlorite 20%	A	C	A	A	A	A		X	A	C	A			C		A
Sodium Hypochlorite 5% (Bleach)	A	C	A	A	A	A	A	B	A	X	AB	X	X	B	X	AC
Sodium Hypochlorite	A	C	A	A	A	A	A	X	X	X	AB	X	X		X	
Sodium Hyposulfate			A											A		
Sodium Metaphosphate	A	C	A	A	A	A		A	A	A		A	A	A		
Sodium Metasilicate	A	A	A	A	A	A		A	A	A	A	A	A	A	A	

CHEMICALS	CPVC	PP	PTFE	PVC	PVC-GF (Fiberloc™)	PVDF	Ultem® (GF 40%)	EPDM	FPM	Nitrile (Buna N)	Hastelloy® C	Monel®	18-8 SS	316 SS	416 SS	Titanium
Sodium Nitrate	A	A	A	A	A	A		A	B	C	AB	B	A	B	B	A
Sodium Nitrite	A	A	A	A	A	A		A	A		AC	BC	A	B		
Sodium Palmitrate	A	A	A	A	A	A										
Sodium Perborate	A	A	A	A	A	A		A	A	C	A	A	AB	C	B	
Sodium Perchlorate	A	A	A	A	A	A					B	A				
Sodium Peroxide	A	A	A	A	A	A		B	A	C	AB	AC	A	A	A	
Sodium Phosphate Acid	A	A	A	A	A	A		A	A	A	A	A	B			
Sodium Phosphate Alkaline	A	A	A	A	A	A		A	A	A	A	A	A			
Sodium Phosphate Neutral	A	A	A	A	A	A		A	A	A	A	AB	AC			
Sodium Polyphosphate			A					A	A	B				A		A
Sodium Silicate	A	A		A	A	A		A	A	A	A	A	AB	B	B	A
Sodium Sulfate	A	A	A	A	A	A		A	A	A	A	A	A	B	B	A
Sodium Sulfide	A	A	A	A	A	A		A	A	C	A	AB	AC	B	X	A
Sodium Sulfite	A	A	A	A	A	A		A	A	A	A	B	A	C	B	A
Sodium Tetraborate				A					A	A	A	AB	A	A	A	
Sodium Thiocyanate	A	A	A	A	A	A		A	A							
Sodium Thiosulfate	A	A	A	A	A	A		A	A	B	A	AB	A	A	A	
Sodium	A	A	A	A	A	A		A	A							
Sorghum									A	A				A		
Soy Sauce									A	A				A		
Soybean Oil	A	A	A	A	A	A		A	A		A	AB	A			
Stannic Chloride	A	A	A	A	A	A		A	A	A	AB	X	X	A	X	A
Stannic Salts		A	A	A	A	A		A	A							
Stannous Chloride	A	A	A	A	A	A		B	B	C	B	C	X	C	C	A
Starch	A	A	A	A	A			A	A	A		A	AB	A		
Stearic Acid	A	B	A	A	A	A		C	A	B	A	A	A	B	B	A
Stoddard Solvent	X	C	A	X	X	A		X	A	B	A	A	A	A		A
Styrene			A			A		X	C	X		AC	A	A		
Succinic Acid	A	A	A	A	A	A		A	A		A	AC	B			
Sugar Solutions	A	A	A						A	A				A	A	
Sulfamic Acid	X	X		X	X	X					B					
Sulfate Liquors	A	A		A	A	A		A	A	A	A	B	X	C	A	
Sulfated Detergents	A	A		A	A	A										
Sulfite Liquor	A	A	A	A	A	A		A	A	B	A	C	C		X	
Sulfur 10%	A	A	A	A	A			X	A	C	A		A	C		A
Sulfur Chloride	A	C	A	A	A	A		X	A	X	A	C	X	X	C	
Sulfur Dioxide Dry	A	A	A	A	A	A		A	A	X	B		A	B	B	
Sulfur Dioxide Wet	A	A	A	X	X	A		A	A	X	AC	X	A		B	

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Chemical Resistance Guide, *CONTINUED*

CHEMICALS	CPVC	PP	PTFE	PVC	PVC-GF Fiberloc™	PVDF	Ultem® (GF 40%)	EPDM	FPM	Nitrile (Buna N)	Hastelloy® C	Monel®	18-8 SS	316 SS	416 SS	Titanium
Sulfur Dioxide		X	A	X	C			A	C	X			A		A	
Sulfur Slurries	A	A		A	A	A										
Sulfur Trioxide Dry	C	X	B	C	C	X		C	C	C		AB	A	C	B	
Sulfur	A	X	A	A	A	A		C	A	C	A		BC		A	
Sulfuric Acid 10%	A	A	A	A	A	A	A	B	A	C				C	X	A
Sulfuric Acid 100%	A	X	B	X	X	C		X	C	X				C	C	X
Sulfuric Acid 30%	A	A	A	A	A	A		A	A	C				X	X	C
Sulfuric Acid 50%	A	A	A	A	A	A		B	A	C				X	X	C
Sulfuric Acid 60%	A	A	A	A	A	B		B	A	X				X	X	C
Sulfuric Acid 70%	A	C	A	A	A	A		A	A	C				X	X	C
Sulfuric Acid 80%	A	A	A	X	X	A		A	A	C				X	X	X
Sulfuric Acid 90%	A	C	A	X	X	A		A	A	C				X	X	X
Sulfuric Acid 95%	A	X	A	X	X	A	X	X	A	X				X	X	X
Sulfuric Acid 98%	A	X	B	X	X	A		X	X					X	X	
Sulfurous Acid	A	A	A	A	A	A		C	A	X	B	X	BC	B	C	A
Sulfuryl Chloride			A	A												
Syrup		A	A	A	A				A	A				A		
Tall Oil	A	A	A	A	A	A		X	A	A	A	A	C		X	
Tallow		A	A			A		A	A	A		B	A	A		
Tannic Acid	A	A	A	A	A	A		B	A	C	A	A	AC	C	B	A
Tanning Liquors	A	A	A	A	A	A		B	A	C	A			A		A
Tar	X	B	A	X	X	A		X	A	C	A	A	A		B	
Tartaric Acid	A	A	A	A	A	A		B	A	C	A	A	A	B	B	A
Tertiary Butyl Alcohol	A	A	A	A	A	A		B	A							
Tetrachlorethane		A	A	X	X			X	A	X	A	A	AB	A		A
Tetrachloroethane			A		X	A		X	A		A	A	A			
Tetraethyl Lead	A	A	A	B	C	A		X	B	C		A				
Tetrahydrofuron	X	B	A	X	X	B	X	X	X	X	A	B		A		
Tetralin	X	X	A	X	X	A		X	A	X						
Thionylchloride	X	X	A	X	X	X										
Thread Cutting Oils	A	A		A	A	A		X			A		A			
Titanium Tetrachloride	X	X	A	X	X	X		X	A	C	A	B	A			
Titanous Sulfate	A	A	A	A	A	A										
Toluene (Toluol)	X	C	A	X	X	B	C	X	C	X	A	A	A	A	A	A
Tomato Juice	A	C	A	A	A	A		A		A	A	AB	A	A	C	
Toxaphene-Xylene	X	X		X	X	A										
Transformer Oil	A	A	A	A	A	A		X	A	A	A	A	A			
Tributyl Phosphate	X	C	A	X	X	A		A	X	X						

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Trichloroacetic Acid	A	C	A	A	A	A		X	X	X	A	BC	X	X	X	
Trichloroethane			A		X		X	X	A	X	A	C		A		A
Trichloroethylene	X	B	A	X	X	A	X	X	A	C	A	B	A	A	A	B
Trichloropropane			A		X				A	A	A	A	A	A	A	
Tricresyl Phosphate			A	X	X			A	B	X	A		A	A		B
Triethanolamine		C		B	C	C		A	X		A	A	A			
Triethyl Phosphate	A	A	A	A	A	A	C	A	A					A		
Triethylamine	A	X		A	A	C	A		A	A		A	A			
Trimethylpropane	A	A	A	A	A	A										
Trisodium Phosphate	A	A	A	A	A	A		A	A	A				A	B	
Turbine Oil	A	B	A	A	A			X	A	B			A			
Turpentine	A	B	A	X		A	A	C	A	C	A	AB	AB	A	B	
Urea	A	A	A	A	A	A	A	A	A	C	A					
Urine	A	A	A	A	A	A		A	A	A		A		A		
Vanilla Extract		A	A		A											
Varnish		A	A			A		X	A	B	A	A	A	A	A	
Vaseline	A	A	A	X	X	A		X	A	A	A	A	A			
Vegetable Oil	C	A	A	A	A	A		A	A	A	A	A	A	A		
Vinegar	A	A	A	A	A	A	A	A	A	C	A	A	A	A	A	A
Vinyl Acetate	X		A	X	X	A	X	B	X	X	A		AC			
Vinyl Chloride			A				C	A	X	A	B	B		A		
Vinyl Ether			A					X	B							
Water Potable	A	A	A	A	A	A		A	A	A	A	A	A	A	A	
Water Salt	A	A	A	A	A	A		A	A	A	A	B	AB	A	C	
Water Sewage	A	A	A	A	A	A		A	A	A						
Water, Acid Mine	A	A	A	A	A	A		A	A	A	A			A	C	
Water, Deionized	A	A	A	A	A	A		A	B	A	A	A	A	A		
Water, Demineralized	A	A		A	A	A		A	A	A	A	A	A			
Water, Distilled	A	A	A	A	A	A		A	A	A	A	A	A	A	A	
Weed Killers									A	B				A		
Whey									A	A				A		
Whiskey	A	A	A	A	A	A		A	A	A	A	AB	A	A		
White Acid			A			A										
White Liquor	A	A	A	A	A	A		A	A	B	A	A		A		
Wines	A	A	A	A	A	A		A	A	A	A	AB	A	A	C	
Xenon			A					A	A	A			A			
Xylene	X	X	A	X	X	A	X	X	B	X	A	A	A	A		
Xylol	X	X	A	X	X	A		X	A	C						

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Yeast		A	A			A		A	A							
Zeolite			A					A	A	B						
Zinc Acetate	A	A	A	A	A	A		A	C	B		A				
Zinc Carbonate	A		A						A	A	B	B	C		B	
Zinc Chloride	A	A	A	A	A	A	A	A	A	A	A	B	X	B	C	A
Zinc Chromate			A													
Zinc Nitrate	A	A	A	A	A	A		A	A							
Zinc Salts		A	A		A	A		A	A	A						
Zinc Sulfate	A	A	A	A	A	A		A	A	A	A	A	B	A	A	A
Zirilite			A					A	C	B						

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Engineering Terminology

ABRASION RESISTANCE
Ability to withstand the repeated action of rubbing, scratching, wearing, etc.

ADHESIVE
A substance capable of holding two or more objects together by attaching to their surfaces.

AGING
The effect of exposing plastic to a specific environment for an extended period of time.

ANNEAL
A procedure for preventing or removing stresses within a material through the use of controlled heating and subsequent cooling of the material.

BOND
To attach two or more objects by means of an adhesive.

BURST STRENGTH
The hydraulic pressure required to cause a pipe; fitting or vessel to fail. This value is typically dependent on the rate at which the pressure is applied as well as the pressure duration.

CALENDERING
A process by which sheet material (esp. rubber or plastic) is passed between sets of rollers to produce a specific thickness or finish. In certain applications this process may be used to combine two or more dissimilar sheet materials (e.g., cloth and rubber) to produce a single multi-layered sheet.

CEMENT
Any of a variety of solutions commonly used in the plastics industry for bonding objects. The solution either dissolves or softens the common surfaces of the objects such that they may be fused together.

CHEMICAL RESISTANCE
The degree to which a given plastic will resist degradation due to contact with certain chemicals. This characteristic will usually vary with chemical concentration and temperature.

COLD FLOW
The deformation of a material attributed to forces or pressures acting at ambient temperatures.

COMPLETE TURBULENT FLOW
Pipe fluid flow characterized by a constant friction factor for increasing Reynolds Number.

COMPRESSION SET
Unrecoverable deformation (strain) that remains in a material after compressive loading has been removed.

CREEP
The elongation a material undergoes when subjected to a force or pressure loading. This elongation is in addition to the initial elastic elongation and will increase over time provided the loading is maintained.

CRITICAL FLOW
Fluid flow characterized by a Reynolds Number typically between 2000 and 4000. Flow in this region is neither laminar nor turbulent.

DEFLECTION TEMPERATURE
The temperature at which a plastic structure will deflect a specific distance for a given loading. Standardized conditions for this test may be found in ASTM D648.

DELAMINATION
Separation in the layers of material.

DEGRADATION
A deleterious change in the chemical composition, appearance, physical or mechanical properties of a plastic.

DENSITY
The mass per unit volume of a substance. For solids and liquids, typically, temperature would also be provided with density. For gasses, both temperature and pressure should be given with the density.

DIMENSIONAL STABILITY
The ability of a part to retain its size and proportion over time.

DUROMETER
A numerical scale for measuring the hardness of rubber or plastic based on the depth of penetration of an indenter point on the surface of a test specimen.

ELASTICITY
The property that describes the tendency of a plastic material to return to its original dimensions after undergoing a deformation.

ELASTOMER
A material that exhibits almost complete recovery to its original size after undergoing dramatic strain levels (as high as 100% and sometimes more).

ENVIRONMENTAL STRESS CRACKING
The tendency of a material to craze and/or crack due to the combination of residual or applied stress in the material and chemical, thermal or electromagnetic environments.

FILLER
A substance added to plastic to alter its properties.

Engineering Terminology, *CONTINUED*

FRICTION FACTOR
A quantity that relates the head loss to the fluid velocity for a fluid flowing through a specific diameter and length of pipe.

FUSE
To join two or more plastic parts by the action of heat or solvents.

FULL PORT VALVE
A valve in which the resistance to flow, in the fully open position, is comparable to the equivalent length of pipe.

GASKET
A device installed within the gap of a joint for the purpose of retaining a fluid.

HEAD
A unit of measure representing the relative energy of a flowing fluid. Commonly recorded in "feet" of fluid, it provides a convenient means of combining the pressure, velocity and elevation energy portions of a flowing fluid.

HEAD LOSS
Energy loss in a fluid as it passes through a flow passage. The loss is due to friction between fluid particles and can be expressed as a linear change in the height of a column of fluid.

HOOP STRESS
The circumferential stress in a cylindrical shell due to internal or external pressure.

HOT STAMP
Process for marking plastic by applying roll leaf to the surface through the use of hot metal dies.

IMPACT STRENGTH
The degree to which a plastic will withstand the sudden application of a load.

IMPERMEABLE
Describes a material that prevents the passage of a substance into or through it.

LAMINATE
Object composed of two or more sheets or shells of material unitized by means of a bonding agent.

LAMINAR FLOW
Fluid flow characterized by a Reynolds Number typically less than 2000.

LIGHT STABILITY
Degree to which a plastic will resist degradation due to light exposure (especially ultraviolet).

MODULUS OF ELASTICITY
The ratio of applied stress to the associated strain developed within a material that has been elastically deformed.

NEWTONIAN FLUID
A fluid for which the ratio of the shear stress to the shear rate is equivalent to the absolute viscosity.

NOZZLE
A fluid flow passage characterized by a rapid transition from a large cross sectional area to a small cross sectional area.

OPERATING PRESSURE RANGE
The range of pressures for which the component will perform normally.

PLASTIC DEFORMATION
Unrecoverable deformation due to stresses beyond the yield strength of the material.

POISE
Unit of measure for absolute viscosity with dimensions of gram per centimeter per second. A one poise fluid would require a force of one dyne to move a one square centimeter layer at a velocity of one centimeter per second relative to a second parallel layer one centimeter away.

POROSITY
The presence of voids within an object.

PRESSURE DROP
Energy loss in a fluid as it passes through a flow passage. The loss is due to friction between fluid particles and can be measured as a decrease in pressure in the direction of flow.

RELATIVE ROUGHNESS
The ratio between the experimentally determined roughness to the pipe I.D.

REYNOLDS NUMBER
A dimensionless ratio of inertial to viscous forces for a fluid flowing through a conduit.

ROUGHNESS
An experimentally determined length that characterizes the degree to which the surface finish of a pipe tends to resist the motion of a fluid.

RUBBER
Polymers that can endure dramatic strain levels and still be able to return to their original form.

SOLVENT
A substance that is capable of dissolving another material.

SCHEDULE
A system of pipe sizes that provides for standardized outside diameters and wall thicknesses.

SPECIFIC GRAVITY
The ratio of the weight density of a substance (solid or liquid) at a specific temperature and the weight density of water at 600°F. For solids and liquids the effect of pressure on the weight density of a substance is typically negligible, however, temperature usually has a more significant effect.

SPRING RATE
The force per unit deflection for a given object (especially a spring).

STRESS
The internal force per unit area that resists deformation due to applied external forces.

STRESS CRACKS
Cracks that form on the inside or outside of an object and are attributable to tensile stresses below the short term mechanical strength of the material.

STRAIN
The ratio of the change in dimension of an object, due to external loading and the original undeformed dimension.

THERMOPLASTIC
Material which when heated becomes sufficiently pliable that it can be formed into a variety of shapes and then quickly hardened by cooling.

TRANSITIONAL FLOW
Fluid flow region between critical flow and complete turbulent flow.

TURBULENT FLOW
Fluid flow region that encompasses transitional flow and complete turbulent flow. Typically it begins at a Reynolds Number greater than 4000.

VENTURI
A fluid flow passage characterized by smooth transitions from a large cross sectional area to a small cross sectional area, and back to a large cross sectional area.

VIRGIN MATERIAL
Plastic material that has not undergone any processing other than that required to prepare it for manufacturing parts.

VISCOSITY
The property of a fluid that describes its resistance to flow. It is due to shear stresses that result from friction between fluid particles.

WATER HAMMER
A phenomenon whereby a pressure shock wave is generated due to a sudden change in fluid velocity within a piping system. The resulting pressure pulses can be significantly higher than the nominal working pressure of the system.

WEEPING
A very low leakage rate evidenced by the appearance of fluid at a pipe joint or fitting.

WEIGHT DENSITY
The weight per unit volume at a substance. For solids and liquids, typically, temperature would also be provided with density. For gasses, both temperature and pressure should be given with the density.

Glossary of Actuation Terms

AUTOMATIC RESET
(Electric) A component of the thermal overload device that permits it to automatically engage when the temperature falls to an acceptable level.

AMPERAGE RATING AUXILIARY LIMIT SWITCH
The maximum current carrying capacity of the extra limit switches contained within the actuator housing.

CONDUIT ENTRY, SIZE NPT
The electrical entrance into the housing of the actuator through which the operating wires are connected. The exterior of the entrance hole is usually tapped with an NPT thread (National Pipe Thread).

CONSTANT TORQUE OUTPUT
(Pneumatic) The torque in inch pounds developed by a double acting pneumatic rack and pinion or vane type actuator as measured at the beginning and end of a stroke or at any point in between.

CYCLE TIME
The time required for an actuator to rotate one complete cycle (typically 90° or 180°), expressed in seconds.

DESIGN TYPE
The basic design type of the actuator in terms of the method used to deliver rotational torque to the output shaft.

DIRECT MOUNTING
A method used to attach a valve to an actuator, being coupled without the use of separate bracketry or special mounting hardware.

DISCRETE MOUNTING BRACKET
A method used to attach a valve to an actuator, being a separate part from either the valve, actuator or both.

DPDT
Double Pole, Double Throw.

DUTY CYCLE
(Electric) The ratio of actual motor run time as compared to 100%. (Example: an actuator with a 20% duty cycle, having a required run time of 5 seconds to rotate 90°, would require an off time of 25 seconds before it can be cycled another 90°.)

EMF
Electro-Magnetic Force.

ENCLOSURE MATERIALS (TOP AND BOTTOM)
Material of construction of the actuator base (bottom) and cover (top).

END OF STROKE TRAVEL STOPS (ADJUSTABLE)
A mechanical component on the actuator that can be adjusted to position the valve either open or closed.

EXTERIOR FINISH
The exterior coating or finish used to protect the actuator housing from corrosion.

EXTERNAL HARDWARE
The materials of construction of the fasteners and/or other hardware used to assemble the actuator components.

FEMALE OUTPUT SHAFT
The output drive of the actuator having a recessed opening into which the valve stem or coupling shaft fits.

HIGH AMBIENT LIMIT
The maximum operating temperature of the actuator, as designated by the actuator manufacturer.

HYSTERESIS
The cumulative rotational twist resulting from the “take-up” of clearances between the fitting dimensions of the ball, stem, coupling and actuator mechanism.

INTEGRAL MOUNTING BRACKET
A method used to attach a valve to an actuator, being a part of either the valve, actuator or both.

INTERNAL AIR PORTING
The high pressure (100 PSI) air passages contained within the actuator that shuttle the air pressure to either side of the torque producing components.

LOW AMBIENT LIMIT (°F)
The minimum operating temperature of the actuator as set by the actuator’s manufacturer, expressed in degrees Fahrenheit.

LOW AMBIENT LIMIT W/OUT “T” (HEATER AND THERMOSTAT)
The minimum operating temperature of the actuator, as designated by the actuator manufacturer without the use of a heater and thermostat.

MALE OUTPUT SHAFT
The output drive of the actuator consisting of an externally protruding shaft.

MANUAL OVERRIDE (DE-CLUTCHING)
(Electric) An actuator component that allows mechanical turning of the valve, while simultaneously disengaging the gear train.

MANUAL OVERRIDE
An actuator component that allows mechanical turning of the valve.

MAXIMUM OPERATING PRESSURE (PSI)
(Pneumatic) The pressure limitation established as the maximum safe operating pressure.

MOTOR BRAKE/MECHANICAL BRAKE (STANDARD ON BUTTERFLY VALVES)
(Electric) A mechanical device that is designed to apply a force to a motor shaft to prevent back drive of the actuator geartrain resulting from hydraulic pressure transfer of the process fluid through the valve.

MIN/MAX WIRE SIZE
The minimum and maximum wire size that the actuator requires or that will fit into the actuator's terminal connections.

MODULATING SERVICE
The ability of the actuator to be used in systems that require continuous control, typically with a positioner.

MOTOR DRIVE ROTATION
(Electric) The rotation of the actuator output shaft in either one direction (uni-directional) or two directions (reversing).

MOTOR SWITCHES (SPDT)
(Electric) The switches that control the motor's starting and stopping. (SPDT means Single Pole Double Throw.)

MOTOR THERMAL PROTECTOR
(Electric) A device that protects the motor against overheating and subsequent burn-out due to (typically a 120 VAC 25% duty cycle motor is protected at 100°C) heat buildup resulting from excessive starting, stopping or continuous running.

MOUNTING POSITION
The ability of the valve/actuator to be physically mounted in the piping system.

NEMA RATING (AVAILABLE)
1, 4, 4X, 7, 9 National Electrical Manufacturers Association Rating.

NUMBER OF PISTONS
(Pneumatic) The number of torque producing surfaces within the actuator.

PERMANENT LUBRICATION
A type of lubrication sealed within the actuator to prolong cycle life.

PISTON SEALING MATERIAL
(Pneumatic) The type of elastomer used to maintain an airtight seal between the piston and the cylinder.

POSITION INDICATOR WITH LED
Light emitting diodes which, when illuminated, indicate visual confirmation of the valve's position in terms of open or closed.

POSITION INDICATOR
A mechanical or electrical device that allows visual confirmation of the valve's position in terms of open or closed (e.g., Red = "closed" or Green = "open").

PREWIRED TO TERMINAL STRIP
Internal component wire leads or printed circuit board connector pins which terminate at a terminal strip to which field wiring can be attached.

REVERSING
The output shaft of the actuator rotates in both CW and CCW directions.

SELF-LOCKING GEAR TRAIN
(Electric) Design of an actuator gear train that locks the actuator output shaft, thus preventing valve rotation.

SPDT
Single Pole, Double Throw.

SPRING CONFIGURATION (QTY/TYPE)
(Pneumatic) The quantity and design configuration of the springs used within a pneumatic actuator that affect the spring return (fail-safe) function.

STANDARD VOLTAGE (AC)
Unless otherwise specified, the voltage of all electrical devices in this catalog will be considered to be 115/120 VAC/60 Hz. All ratings, performance or specifications are based on standard voltage.

START/FINISH TORQUE
(Pneumatic) The torque in inch pounds, as measured at the actuator output shaft of a pneumatic actuator containing a spring return feature. The torque developed at the beginning of the stroke when the spring is fully compressed (START) and the torque at the end of the stroke (FINISH) when the spring has dissipated its stored energy.

START/STALL TORQUE
(Electric) The torque in inch pounds, as measured at the actuator output shaft at the instant of the start of rotation, and at maximum stall when the motor is restricted from rotation while energized.

TWO STAGE SHUT-OFF (DRIBBLE CONTROL)
The closing of the valve in two, or more, distinct motions. The first movement, partially closing such that the remaining flow is small. The second movement, fully closing the valve.

UNI-DIRECTIONAL
The output shaft of the actuator rotates in only CW direction, as viewed from the top of the actuator.

UNIFORM BEARING LOAD DISTRIBUTION
The design of the torque producing components to be supported by bearing surfaces that allow high cycle life.

VOLTAGE VARIATIONS
The variations of optional voltages available for all products offered.

Sample Specifications

TB SERIES:

All thermoplastic ball valves shall be manufactured with PVC Type 1, Grade 1 (ASTM D1784, Cell Classification 12454), CPVC (ASTM D1784, Cell Classification 23447), or glass filled Polypropylene (ASTM D4101, Cell Classification 85580). All O-rings shall be EPDM or FPM. Seats shall be PTFE as standard. Seats for 1/2" – 2" valves shall be reversible to allow field rebuild. All sizes of ball valves shall be of true union design. Balls must be full-port design for 1/2" – 4" sizes. Stem shall contain double O-rings, and shall be blowout-proof design. Body shall contain an integral mounting pad to facilitate actuation if required.

All 1/2" – 2" ball valves shall be pressure-rated for 250 PSI at 70°F non-shock, and 2-1/2" – 4" ball valves shall be pressure-rated for 235 PSI at 70°F non-shock. All sizes of ANSI 150 lb flanged ball valves shall be pressure-rated for 150 PSI at 70°F non-shock.

All PVC and CPVC ball valves (1/2" – 4") shall be NSF 61 certified. All ball valves shall carry a two-year warranty, and shall be manufactured by Hayward® Flow Control products.

TBZ SERIES:

All VENTED thermoplastic ball valves for sodium hypochlorite service shall be manufactured with PVC Type 1, Grade 1 (ASTM D1784, Cell Classification 12454), or CPVC (ASTM D1784, Cell Classification 23447). All O-rings shall be FPM. Balls must be full-port design for 1/2" – 4" sizes. Balls shall have one 3/16"-diameter hole drilled into one side to VENT in the upstream direction. A black handle shall be used for these VENTED ball valves to identify them in the field. Seats shall be PTFE as standard. Seats for 1/2" – 2" valves shall be reversible to allow field rebuild. All sizes of ball valves shall be of true union design. All valve stems shall contain double O-rings, and shall be blowout-proof design. Body shall contain an integral mounting pad to facilitate actuation if required.

All 1/2" – 2" ball valves shall be pressure-rated for 250 PSI at 70°F non-shock, and 2-1/2" – 4" ball valves shall be pressure-rated for 235 PSI at 70°F non-shock. All sizes of ANSI 150 lb flanged ball valves shall be pressure-rated for 150 PSI at 70°F non-shock.

All PVC and CPVC ball valves (1/2" – 4") shall be NSF 61 certified. All ball valves shall carry a two-year warranty, and shall be manufactured by Hayward Flow Control products.

TC SERIES:

All thermoplastic ball check valves shall be manufactured with PVC Type 1, Grade 1 (ASTM D1784, Cell Classification 12454), CPVC (ASTM D1784, Cell Classification 23447), or Polypropylene (ASTM D4101, Cell Classification 85580). All O-rings shall be EPDM or FPM. Primary seat shall be square-cut design to ensure proper ball seating. All sizes of ball check valves shall be of true union design.

All 1/2" – 6" ball check valves shall be pressure-rated for 150 PSI at 70°F non-shock, including ANSI 150 lb flanged ball check valves.

All PVC and CPVC ball check valves (1/2" – 4") shall be NSF 61 certified. All ball valves shall carry a two-year warranty, and shall be manufactured by Hayward Flow Control products.

YC SERIES:

All thermoplastic y-check valves shall be manufactured from PVC Type 1, Grade 1 (ASTM D1784, Cell Classification 12454), or CPVC (ASTM D1784, Cell Classification 23447). All O-rings and seals shall be EPDM or FPM for chemical service required. Valve shall be piston-type design with a PVC or CPVC coil/compression spring to assist in piston closure. Standard body connections shall be female NPT, but a true union-style shall be available if needed. A removable hex cap shall be threaded into the body, allowing removal of the cap when needed for valve cleanout or valve drainage.

All 1/2" – 4" y-check valves shall be pressure-rated for 150 PSI at 70°F non-shock.

All y-check valves shall carry a two-year warranty, and shall be manufactured by Hayward Flow Control products.

WCV SERIES:

All thermoplastic wafer check valves shall be manufactured with PVC Type 1, Grade 1 (ASTM D1784, Cell Classification 12454), CPVC (ASTM D1784, Cell Classification 23447), or glass filled Polypropylene (ASTM D4101, Cell Classification 85580). All O-rings and seals shall be EPDM or FPM. Body shall be full pattern design with integral spacer. Body shall contain contoured inlet to ensure self-cleaning capabilities. Body shall contain integral eyelets/external tabs to assist with installation. Disc shall be one-piece, teardrop design. Seat shall be tilted-disc design for better seating characteristics. For spring-assisted discs, spring material shall be 316 stainless steel, or Hastelloy® as required.

All 2" – 8" wafer check valves shall be pressure-rated for 150 PSI at 70°F non-shock.

All wafer check valves shall carry a two-year warranty, and shall be manufactured by Hayward Flow Control products.

SW SERIES:

All thermoplastic swing check valves shall be manufactured from PVC Type 1, Grade 1 (ASTM D1784, Cell Classification 12454), CPVC (ASTM D1784, Cell Classification 23447) or glass filled Polypropylene (ASTM D4101, Cell Classification 85580). All O-rings and seals shall be EPDM or FPM for chemical service required. Design shall be two-body (assembled) design with pivoting swing arm/disc clapper assembly. The two-body design allows "seat" replacement if needed. Seats of bodies shall be tilted-disc design for better seating characteristics. Each body shall contain an integral ANSI 150 lb flanged end (along with an EPDM or FPM O-ring seal) to facilitate flanged inlet and outlet connections. Each body shall contain a drain port with plug. For the close-assist option, an external counterweight design shall be used. If position indication feedback (open/close) is required, an "external limit switch" option shall be available.

All 3" – 8" swing check valves shall be pressure-rated for 150 PSI at 70°F non-shock.

All swing check valves shall carry a two-year warranty, and shall be manufactured by Hayward Flow Control products.

BY SERIES:
All thermoplastic, wafer-style butterfly valves shall be manufactured with PVC Type 1, Grade 1 (ASTM D1784, Cell Classification 12454), CPVC (ASTM D1784, Cell Classification 23447), or glass filled Polypropylene (ASTM D4101, Cell Classification 85580). All O-rings and liner shall be EPDM, FPM or Nitrile. Liner shall be FULL BOOT design, and shall firmly lock into the body via v-notch engagement. Liner shall serve as master disc seal and face seals for body mating flanges. Stem shall be 316 stainless steel, non-wetted and provide full engagement over length of disc. Stem shall be blowout-proof design. Body shall contain fully-supported flange bolt holes, and shall meet ANSI B16.10 face-to-face dimensions. Lever handle shall be trigger-style, allowing handle to LOCK into body notches every fifteen degrees for throttling applications. Trigger shall contain hole for padlock to lockout valve if needed. For larger valves, 8" – 12", a gear operator will be used in place of the lever. If LUGGED butterfly valves are required, lugs shall be self-tapping type, 316 stainless steel. All sizes of butterfly valves shall be actuator-ready.

All 1-1/2" through 12" butterfly valves shall be pressure-rated for 150 PSI at 70°F non-shock.

All PVC/EPDM and CPVC/EPDM butterfly valves (1-1/2" – 12") shall be NSF 61 certified. All butterfly valves shall carry a two-year warranty, and shall be manufactured by Hayward Flow Control products.

SB SERIES:
All thermoplastic basket strainers shall be manufactured with PVC Type 1, Grade 1 (ASTM D1784, Cell Classification 12454), CPVC (ASTM D1784, Cell Classification 23447), or glass filled Polypropylene (ASTM D4101, Cell Classification 85580). All O-rings shall be EPDM or FPM. Sizes 1/2" – 4" shall be one-piece molded body, true union type design. 6" and 8" sizes shall be fabricated design, and shall be flanged. Bodies shall contain (3) ports to accommodate in-line or loop-style flow patterns. Bodies shall contain interrupted external cover thread for safety purposes. Each body shall have an integral mounting base. Covers shall contain a vent plug, and bodies shall contain a drain plug. Both plugs shall be hand-removable. Covers shall have an integral liquid-displacing dome on the underside of each cover. Strainer baskets shall be 1/32" perforation (20-mesh) for 1/2" – 1" sizes, and 1/8" perforation for 1-1/2" – 8" sizes. Alternative basket perforation sizes and materials shall be available to meet the installation requirements.

All 1/2" through 8" basket strainers shall be pressure-rated for 150 PSI at 70°F non-shock.

All PVC and CPVC basket strainers (1/2" – 8") shall be NSF 61 certified. All basket strainers shall carry a two-year warranty, and shall be manufactured by Hayward® Flow Control products.

YS SERIES:
All thermoplastic y-strainers shall be manufactured from PVC Type 1, Grade 1 (ASTM D1784, Cell Classification 12454), Clear PVC, or CPVC (ASTM D1784, Cell Classification 23447). All O-rings shall be EPDM or FPM for chemical service required. Standard body connections shall be female NPT, but a true union-style shall be available if needed. A removable hex cap shall be threaded into the body, allowing removal of the cap when needed for screen cleanout or valve drainage. Standard y-strainer screen shall be 1/32" perforation (20-mesh equivalent), made of PVC or CPVC. Other screen materials, such as stainless steel, shall be available (assuming chemical compatibility is not an issue) in different mesh sizes to meet particular straining requirements.

All 1/2" – 4" y-strainers shall be pressure-rated for 150 PSI at 70°F non-shock.

All y-strainers shall carry a two-year warranty, and shall be manufactured by Hayward Flow Control products.

FLV SERIES:
All thermoplastic filter vessels shall be manufactured with glass filled Polypropylene conforming to ASTM D4101, Cell Classification 85580. All O-rings shall be EPDM or FPM. Both single-length and double-length models shall be one-piece molded body, true union type design. Bodies shall contain (4) ports to accommodate in-line or loop-style flow patterns. Various end connection sizes and materials shall be available to accommodate installation requirements. Bodies shall contain interrupted external cover thread for safety purposes. Each body shall have an integral mounting base. Covers shall contain vent valve which is protected by raised handles. Covers shall have an integral liquid-displacing dome on the underside of each cover. Cover-to-Body seal will be a face-seal, NOT a piston-type seal. Internal basket, for bag filtration, shall be split-type (hinged) to ease bag removal. Filter vessels shall accommodate both bag filtration and cartridge filtration.

All filter vessels shall be pressure-rated for 150 PSI at 70°F non-shock.

All filter vessels shall carry a two-year warranty, and shall be manufactured by Hayward Flow Control products.

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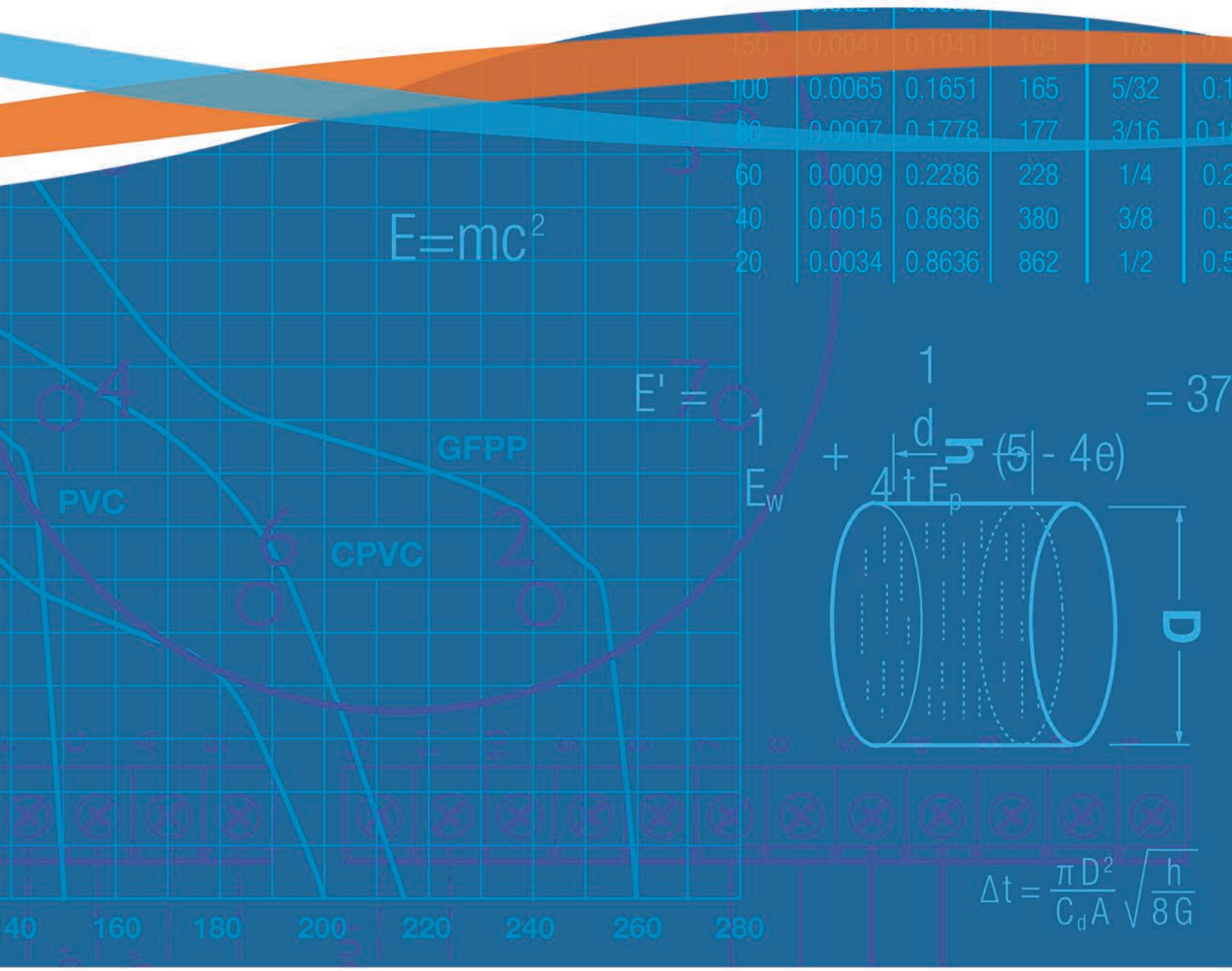

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