Appendix C

Interim Leachate Management Plan Processing Equipment

SCHRADER ENVIRONMENTAL SERVICES, INC.
212 S Pine River
Ithaca, MI 48847
Office (989) 875-6500
Fax (989) 875-8880
SALES@SCHRADERENVIRO.COM

PROPOSAL

PROPOSAL NUMBER JM022313-4

ATTN: SEAN TORREY | **DATE:** February 23, 2013

TO: Republic Services
13570 St. Charles Rock Road
Bridgeton, MO 63044

PHONE: 314-744-8165
CELL: 615-238-5813
FAX: 314-739-2588
E-MAIL: Storrey@republicservices.com

RE: 20,000 lb. Vapor Phase Carbon Vessel Rental
SITE: Republic Services Landfill, Bridgeton, MO

Item:	Description:	Quantity:	Item cost:	Total:
1	**SES Model VP-8208, 20,000 lb. Capacity Vapor Phase Carbon Filtration Vessels** Includes: - Carbon steel construction VPC filtration units - Dimensions: 8'-0" wide X 20'-0" long X 8'-9" high - 24 5/8" inlet and 25" x 16" outlet on each unit - 64" maximum bed depth for filtration media - Sky Blue Painted Exterior - 304 stainless steel mesh over 1½" steel grating to support carbon bed - 850 cubic feet of filtration media capacity for each unit - Units can be operated in up flow configuration - Magnehelic pressure gauge - Sample ports - Designed for up to 20,000 lbs of Vapor Phase Carbon	1	$1,800.00 Per Month Based On (3) Month Minimum Rental Agreement	$5,400.00
2	**(1) Centrifugal Blower Max. 13,000 CFM @ 15" WC** Includes: - 50 Hp. 460V 3 phase TEFC motor - Electrical Control Panel - Fused Electrical Disconnect - Variable Frequency Drive (VFD)	1	$2,200.00 Per Month Based On (3) Month Minimum Rental Agreement	$6,600.00
3	**STEP/DROP DECK TRAILER RENTAL** * Trailer rental transportation costs from Rental Company to S.E.S. factory are NOT included * Additional rental charges will be added to invoice at $.06/mile	1	$1,095.00 Per Month Based On (3) Month Minimum Rental Agreement	$3,285.00

Item:	Description:	Quantity:	Item cost:	Total:
4	**S.E.S. INSTALLATION LABOR & MATERIALS** *to assemble vapor vessel, fan & fan outlet transition assembly onto rental trailer at S.E.S. facility in Ovid, MI*			$1,860.00
5	**Purchase of Vapor Phase Carbon** - 4 x 10 Reactivated Vapor Phase Carbon	20,000 lbs.	$0.98/lb.	$19,600.00
6	**LABOR TO REMOVE SPENT (NON-HAZ) CARBON** - after return of rental equipment.	1		$1,495.00
7	**REACTIVATION OF SPENT CARBON** - Only Non-Hazardous spent carbon accepted. - Additional charges will apply for Hazardous spent carbon.	20,000 lbs.	$0.32/lb.	$6,400.00
8	**Mobilization of Vapor Phase Carbon Vessel & G.A.C.** - to Bridgeton, MO	1	$2,672.00	$2,672.00
9	**De-Mobilization of Vapor Phase Carbon Vessel & G.A.C.** - to Bridgeton, MO	1	$2,672.00	$2,672.00
			SUB-TOTAL.....	**$49,984.00**

ON SITE CUSTOMER RESPONSIBILITIES:

*- Power **480/3/60 VAC** and Field Connection By Others*
- Field Assembly of Ductwork, Stack & Controls By Others
- Operation of the Systems is By others
- Permits By Others
- Sound insulation to lower operating dBa level By Others
- Installation of G.A.C. into Vapor Phase Vessels By Others
- Fan Inlet Ductwork and Exhast Stack is NOT included at this time

ESTIMATED EQUIPMENT WEIGHTS:

Vapor Bin with 20,000 Lbs of Carbon = 27,000 Pounds/Unit
Blower Skid with Controls = 4500 Pounds/Skid

DELIVERY: Estimated at 1-3 days from placement of order, subject to availability.

RENTAL TERMS: First and last months rent due with order plus shipping and a signed rental contract.
Monthly rent due 1st of each month.
1½% per month finance charge will apply to any invoices over 30 days.
The above pricing does not include any applicable sales tax.

MODIFICATION OF RENTAL EQUIPMENT: Any modification (removal or replacement) either mechanical or electrical for site specific applications that require SES re-work before or after the rental period will be added to final invoice.

ACCEPTANCE:

Accepted by: ____________________ Company: ____________________

Printed Name & Title: ____________________

Purchase Order #: ____________________ Date: ____________________

Sincerely,
Schrader Environmental Services, Inc.

John Mulholland
Project Manager

Rain for Rent

Model DV-100c

Size 6" X 4"

Standard Features

- Hot Dip Galvanized Trailers and Skids
  - Radiator Enclosure
  - Battery Box
  - Wheels
- Zinc Plated Jacks
- Emissions Certified Engines
  - Perkins and John Deere
- DOT LED lights (optional)
- Electric Brakes with Safety breakaway
- Locking Battery Box

Pump Features

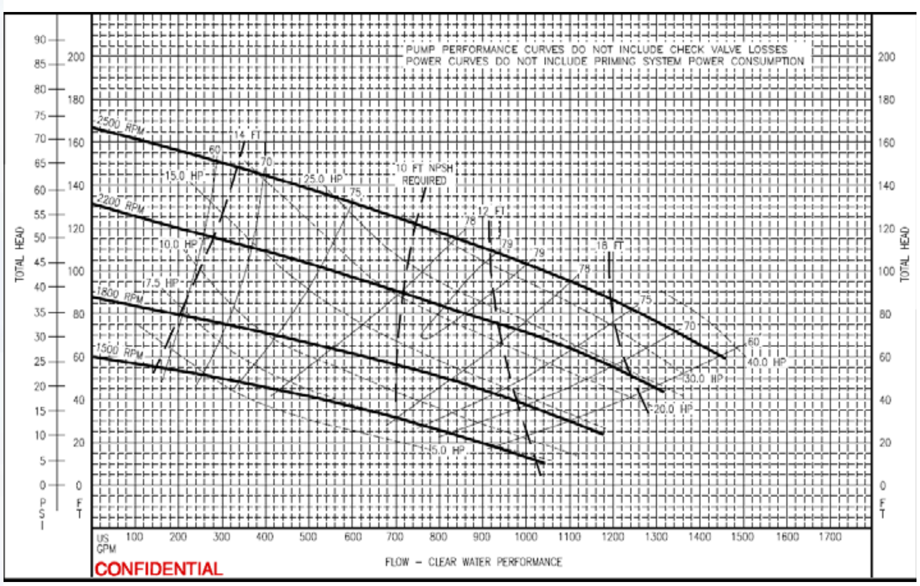
- Solids-handling capabilities to 3" diameter maximum
- Continuous self-priming
- Runs dry unattended
- Suction lift up to 28 ft.
- Skid- or trailer-mounted
- Auto-start-capable control panel

Technical

- SAE-mounted
- 12 volt, electric start with control panel
- Skid- or trailer-mounted with optional lifting bale
- 24-hour minimum capacity fuel tank
- Compressor/Venturi automatic priming system
- Electric drive option available
- Sound attenuated option available

Material Specifications

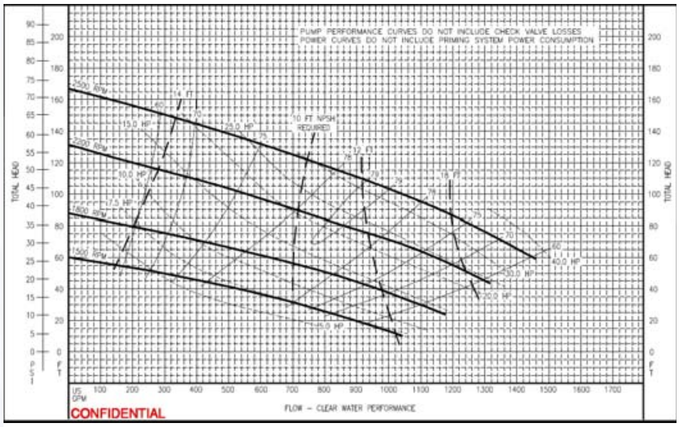
- Standard Build – ASTM A48 CLASS 30 Gray Iron volute Enclosed 2 vane non-clog impeller and replaceable wear rings
- Pump Shaft
  LaSalle 1144 stress proof steel
- Mechanical Seal
  Tungsten carbide vs. silicon carbide mating faces
  Oil-bath lubrication for dry running
- Suction / discharge flanges ANSI 150# FF



Rain for Rent
P.O. Box 2248
Bakersfield CA 93303
800-742-7246
661-393-1542
FAX 661-393-1542
www.rainforrent.com
info@rainforrent.com

DV-100c Technical Specifications

Production Curve



Performance Specs

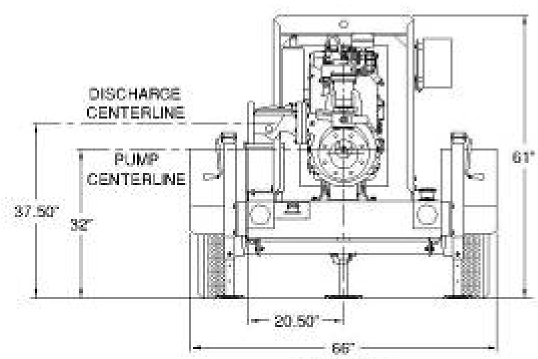
2 VANE NON-CLOG IMPELLER	
Minimum Operating Speed:	1800 rpm
Maximum Operating Speed:	2500 rpm
Maximum Head:	165 ft.
Maximum Flow:	1450 gpm

Design Details

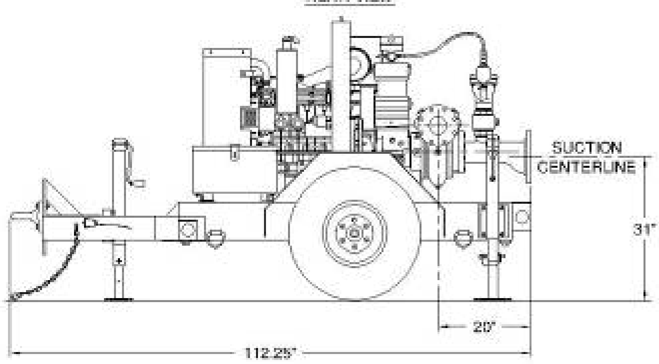
Pump Designation:	DV-100c
Pump Description:	Centrifugal end suction pump, single stage, volute type, 2 vane non-clog impeller
Solid Handling Size:	Up to 3 inches (76.2mm)
Operating Temperature	MIN: -4ºF (-20ºC) - MAX: +212ºF (+100ºC)

Rain for Rent
P.O. Box 2248
Bakersfield CA 93303
800-742-7246
661-399-9124
FAX 661-393-1542
www.rainforrent.com
info@rainforrent.com

Dimensions



REAR VIEW



SIDE VIEW

GORMAN-RUPP PUMPS Mansfield Division

PA Series® (Prime Aire)

Prime Aire® pumps feature Gorman-Rupp's patented priming system. The system uses a venturi and compressor, eliminating the leaks associated with traditional vacuum-assisted pumps. An oversized, oil-lubricated mechanical seal allows the pump to run dry continuously without damage. For positive, reliable priming time after time, Gorman-Rupp Prime Aire pumps are the ones you can count on.

Specifications

Size	4" (100 mm), 6" (150 mm), 8" (200 mm), 10" (250 mm), 12" (300 mm), 14" (350 mm)
Min Capacity	40 GPM (3 lps)
Max Capacity	6320 GPM (399 lps)
Min Head	20' (6 m)
Max Head	420' (128 m)
Max Solids	3" (76 mm)
Max Temperature	160 F(71 C)
Materials of Construction	Cast Iron, Ductile Iron

Features

Dry Run Capability

A dry run capability is designed into the Prime Aire® system. An oversized, oil-lubricated mechanical seal allows the pump to run dry continuously without damage. For positive, reliable priming time after time, Gorman-Rupp Prime Aire pumps are the ones you can count on.

Dual-Suction Side Capability

Model PA6C features a removable cover plate and adjustable/replaceable wearplate.

Compressor-Over-Pump

Several popular Prime Aire® models are available in a "Compressor-Over-Pump" arrangement. This innovative configuration offers a compact, flexible design while allowing ease of operation and servicing when needed.

Abrasive Handling Seal

Prime Aire® pumps are equipped with oversized, mechanical, oil-lubricated, double-floating, self-aligning seals with silicon carbide rotating and stationary faces that are designed to take the wear and tear of pumping solids, slurries and other abrasives.

Standard Auto-Start Controls

Auto-Start control starts and stops the pump in response to a liquid level. The pump only starts when there is water to pump and turns itself off when the water reaches the desired level. There is never any need to waste fuel and add to costly engine overhauls.

Specifications are subject to change. Please contact your Gorman-Rupp Distributor for more details.

The Gorman-Rupp Company
Mansfield Division
P.O. Box 1217
Mansfield, Ohio 144901-1217, USA
Tel: 419-755-1011
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The Gorman-Rupp International Company
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Gorman-Rupp of Canada, Ltd.
70 Burwell Road
St. Thomas, Ontario, N5P 3R7, Canada
Tel: 519-631-2870
Fax: 519-631-4624
E-mail: grcanada@grcanada.com

GRpumps.com

PIONEER PRIME SERIES

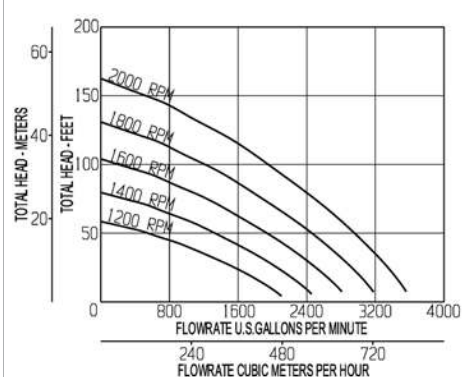
PP66S12

OTHER VIEWS: < 1 2 3 4 5 6 >

TECHNICAL SPECIFICATIONS

Pump Size	6" x 6"
Max Flow	3,400 GPM
Max Head	200 FT
Solids Handling Capability	3.0"
Construction Materials	Ductile Iron, 316 Stainless Steel, CD4MCu, Hardened Metals

PERFORMANCE CURVE



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FEATURES

- Superior Lift Capability
- Extreme Flow Technology
- Large Solids Handling
- Heavy Duty Construction
- High Efficiency Design
- Run-dry Seal
- Indefinate Run Dry Capability
- 50 CFM Vacuum System
- Variable Speed
- Location Flexability
- Premium Hydraulic Efficiency
- Unmanned Operation
- 24 Hour Run Time

OPTIONS

- Engine Driven Open Unit
- Sound Attenuated Unit
- Electric Driven
- Direct Coupled Electric
- Horizontal V-Belt Drive
- Vertical V-Belt Drive
- VFD
- Controls
- Off Road Trailer
- DOT Trailer Mounted
- Skid Mounted
- SAE Engine Drive
- Hardened Steel
- 316 SS
- CD4MCU
- Drag Skid
- Various Metallurgies

PIONEER QUICK LINKS

Pump Selector

Quickly find the Pioneer pump that meets your needs using this powerful tool.

Request a Quote

Easily request a quote using this handy online form.

(503) 266-4115

CANBY, OREGON USA

PDF DOWNLOADS

PRODUCT OPTIONS

PP66S12L71-H SPEC SHEET

PP66S12L72-H SPEC SHEET

PP66S12-BH8.5 07790A BS DRAWING

PP66S12-SAE-3 A531A

PP66S12-SAE-4 A6274A

PP66S12-12.0-VS-A6156HQ_V2

PP66S12-11.0-VS-A928HQ

PACKAGE OPTIONS

PP66S12L71 4045TF290 PACKAGE SPEC

PACKAGE OPTIONS

PP66S12L2_D914L04 PACKAGE SPEC

PACKAGE OPTIONS

PP66S12L71-D914L04_PKG SPEC

XQ100 RENTAL

Picture shown with optional trailer

STANDBY 100 kW
PRIME 90 kW
60 Hz

Voltage	Standby kW (kVA)	Prime kW (kVA)
208/120V	100 (125)	90 (112.5)
480/277V	100 (125)	90 (112.5)
240/139V	100 (125)	90 (112.5)

FEATURES

EPA TIER 3 AND CARB CERTIFIED FOR NON-ROAD MOBILE APPLICATIONS

SOUND ATTENUATED ENCLOSURE

- The fully weatherproof enclosure incorporates an internally mounted exhaust silencer and is of extremely rugged construction in order to withstand the rough handling common on many construction sites.
- Highly corrosion resistant construction.
  - Body made from sheet steel components pretreated with zinc phosphate prior to polyester powder coating at 200° C (392° F)
  - Black stainless steel padlockable latches.
  - Zinc die cast hinges/grab handles.
- Excellent access for maintenance.
  - Two large doors on each side. Rear door for distribution/control panel.
  - Front panel for air discharge box access.
  - Lube oil and cooling water drains piped to exterior of the enclosure.
- Security and safety.
  - Safety glass control panel viewing window in a lockable access door.
  - Cooling fan and battery charging alternator fully guarded.
  - Fuel fill and battery can only be reached through lockable access doors.
- Transportability.
  - Tested and certified single point lifting eye.
  - Lifting points on baseframe.

ROBUST DESIGN FOR RENTAL ENVIRONMENT

- Packages designed to survive in a rugged environment.

MULTI-VOLTAGE DISTRIBUTION PANEL

- Simultaneous 3-phase voltage output: 480/277 volt, 208/120 volt and adjustable for 3-phase 240 volt output.*

REAR CUSTOMER ACCESS

- Separate control panel and distribution panel access doors.
- Hinged door over main bus connectors.
- Emergency stop on panel.
- Remote start/stop contacts.

ENVIRONMENTALLY FRIENDLY DESIGN

- EPA Tier 3 off-highway compliant engine.
- UL double walled fuel tank base with 24 hour minimum fuel supply.
- Sound attenuated enclosure for low noise.

ELECTRONIC GOVERNING

- Isochronous.
- Fully adjustable.

OPTIONS

- AH1L – Anti-condensation heater 110-120 volt AC.
- WHL – Coolant heater 110-120 volt AC.
- PBC3UL – UL Listed battery charger.
- Tandem Axle Trailers with hydraulic or electric brakes.

* Refer to distribution panel specifications for details.

STANDARD FEATURES

1. ENGINE
Heavy duty industrial EPA Tier 3 diesel engine.

1.1 Governor

Electronic, compliant with BS5514, Class G2.

1.2 Electrical System

12 volt DC. Energized to run shutdown solenoid. Oil pressure and coolant temperature/level shutdown switches and gauge senders.

1.3 Derates

Genset power derates will be required in accordance with engine manufacturers above 39° C (102° F).

2. COOLING RADIATOR
Radiator and cooling fan complete with protection guards, designed to cool the engine in ambient temperatures up to 43° C (110° F) without derate.

3. ENGINE FILTRATION SYSTEM
Cartridge type dry air filters with restriction indicator. Dry, 2 stage cyclonic paper element. Cartridge type fuel filters and full flow lube oil filters. All filters have replaceable elements.

4. EXHAUST SYSTEM
Critical silencer with flexible connector. All internal pipework lagged.

5. ELECTRICAL SYSTEM
12 volt system with 65A battery charging alternator and starter motor on engine, battery rack mounted on the generator set baseframe. Includes a 12V (880 CCA) Cat® brand maintenance free battery. Optional battery charger mounted on control panel.

6. GENERATOR
Screen protected and drip-proof, self exciting, self-regulating brushless generator with fully interconnected damper windings, IC06 cooling system and sealed-for-life bearings. Simultaneous multi-voltage output.

6.1 Insulation System

The insulation system is Class H. Windings are impregnated in a triple dip thermo-setting moisture, oil and acid resisting polyester varnish. Heavy coat of anti-tracking varnish for additional protection against moisture or condensation.

6.2 Electrical Characteristics

Electrical design in accordance with BS5000 Part 99, IEC60034-1, EN61000-6, NEMA MG-1.22.

6.3 Automatic Voltage Regulator (AVR)

The fully sealed automatic voltage regulator maintains the voltage within the limits of ± 0.5% at steady state from no load to full load. Nominal adjustment is by means of a trimmer incorporated in the AVR. The panel door incorporates an additional voltage adjustment potentiometer.

6.3.1 Permanent Magnet Generator

Providing 350% short circuit capabilities, enhanced motor starting and non-linear loading performance.

6.4 Waveform Distortion, THF and TIF Factors

The total distortion of the voltage waveform with open circuit between phases or phase and neutral is in the order of 1.8. On a 3-phase balanced harmonic-free load the total distortion is < 4%. Machines are designed to have a THF less than 2% and a TIF less than 50. A 2/3 pitch factor is standard on all stator windings.

6.5 Radio Interference

Suppression is in line with the provisions of EN61000-6.

7. MOUNTING ARRANGEMENT

7.1 Baseframe

The complete generator set is mounted on a heavy duty fabricated steel baseframe. The baseframe includes a UL listed dual wall closed top fuel tank and incorporates specially designed lifting points.

7.2 Coupling

The engine and generator are directly coupled by means of an SAE flange so that there is no possibility of misalignment after prolonged use. The engine flywheel is flexibly coupled to the generator rotor and a full torsional analysis has been carried out to guarantee no harmful vibration will occur in the assembly.

7.3 Anti-Vibration Mounting Pads

Captive anti-vibration pads are affixed between engine/generator feet and the baseframe ensuring complete vibration isolation of the rotating assemblies.

7.4 Safety Guards

The fan, fan drive and optional battery charging alternator drive are fully guarded for personnel protection. Heat guards protect personnel from the exhaust pipe. All guards are to OSHA standards.-

8. FUEL SYSTEM
Fuel feed and return lines to the engine are terminated at the baseframe mounted 24 hour extended capacity fuel tank. 3-way valves allow connection of auxiliary fuel tank.

8.1 Primary Fuel Filters

Primary fuel filters in addition to cartridge type fuel filters.

9. CONTROL SYSTEM

9.1 Control Panel

EMCP 4.2 in a vibration isolated NEMA 1 sheet steel enclosure with a hinged lockable door.

9.2 DC and AC Wiring Harnesses

DC and AC wiring harnesses utilizing industrial type multi-pin connectors to permit fast fault finding.

10. DISTRIBUTION PANEL

10.1 Dual Bus Connections

NEMA 1 enclosure with hinged lockable door and main bus connection studs enclosed with hinged transparent cover for easy access and operator safety.

10.2 Circuit Breakers, Two

3-pole UL/CSA listed molded case circuit breaker with solid neutral (4 wire) and integral trip unit.

10.3 Multiple power receptacles

Receptacles accept industry standard male plugs. Each receptacle is protected by a circuit breaker which also acts as an on/off switch.

11. DOCUMENTATION
A full set of operation and maintenance manuals, circuit wiring diagrams, and instruction leaflets is provided.

12. SOUND ATTENUATED ENCLOSURES
A noise reducing enclosure surrounds the entire generator set. Combined with a critical engine silencer this provides an overall noise reduction from 65 to 68 dBA at 23 feet through the range.

13. FACTORY TESTS
The generator set is load tested before dispatch. All protective devices, control functions and site load conditions are simulated; the generator and its systems checked, proved and then passed for dispatch.

14. EQUIPMENT FINISH
All sheet metal components including the enclosure and the base tank are fully degreased, phosphated and chromated for anti-corrosive protection prior to painting with polyester powder.
The powder is cured at a temperature of 200° C (392° F) to ensure maximum scuff resistance and durability. All fasteners are electroplated.

15. STANDARDS
The equipment meets the following standards: BS4999, BS5000, BS5514, IEC60034, EN61000-6, NEMA MG-1.22.

16. WARRANTY
Full manufacturer's warranty.

XQ100

Materials and specifications are subject to change without notice.

Generator Set Technical Data – 1800 rpm/60 Hz			Standby		Prime	
Power Rating	kW	(kVA)	100	(125)	90	(112.5)
Lubricating System						
Type: full pressure						
Oil filter: spin-on, full flow						
Oil cooler: water cooled						
Oil type required: API CF-4						
Total oil capacity	L	(U.S. gal)	8.0	(2.1)	8.0	(2.1)
Oil pan	L	(U.S. gal)	7.0	(1.8)	7.0	(1.8)
Fuel System						
Generator set fuel consumption						
100% load	L/hr	(gal/hr)	29.1	(7.7)	26.9	(7.1)
75% load	L/hr	(gal/hr)	23.5	(6.2)	21.8	(5.8)
50% load	L/hr	(gal/hr)	17.6	(4.6)	16.4	(4.3)
Fuel tank capacity	L	(U.S. gal)	634	(167)	634	(167)
Running Time @ 75%	hours		27		29	
Cooling System						
Radiator system capacity including engine	L	(U.S. gal)	17.1	(4.49)	17.1	(4.49)
Air Requirements						
Combustion air flow	m^3/min	(cfm)	8.4	(297)	8.5	(300)
Maximum air cleaner restriction	kPa	(in H_2O)	8.0	(32.2)	8.0	(32.2)
Radiator cooling air (within enclosure)	m^3/min	(cfm)	230	(8,135)	230	(8,135)
Generator cooling air	m^3/min	(cfm)	26.4	(933)	26.4	(933)
Exhaust System						
Exhaust flow at rated kW	m^3/min	(cfm)	17.5	(618)	16	(572)
Exhaust temperature at rated kW – dry exhaust	°C	(°F)	522	(972)	524	(975)
Generator Set Noise Rating* [with enclosure at 7 meters (23 feet)]	dBA		68.2		68.0	

*dBA levels are for guidance only

SPECIFICATIONS

GENERATOR

Voltage regulation .... ± 0.5% at steady state from no load to full load
Frequency regulation......... ± 0.25% for constant load from no load to 100% load
Waveform distortion .... THD < 4%
Radio interference .... Compliance with EN61000-6
Telephone interference................... TIF < 50, THF < 2%
Overspeed limit .... 2250 rpm
Insulation.. Class H
Temperature rise .... Within Class H limits
Available voltages..... Simultaneous 3-phase voltage output: 480/277 volt, 208/120 volt and adjustable for 3-phase 240 volt output
Deration .... Consult factory for available outputs
Ratings..................... At 30° C (86° F), 152.4 m (500 ft) 60% humidity, 0.8 pf

ENGINE

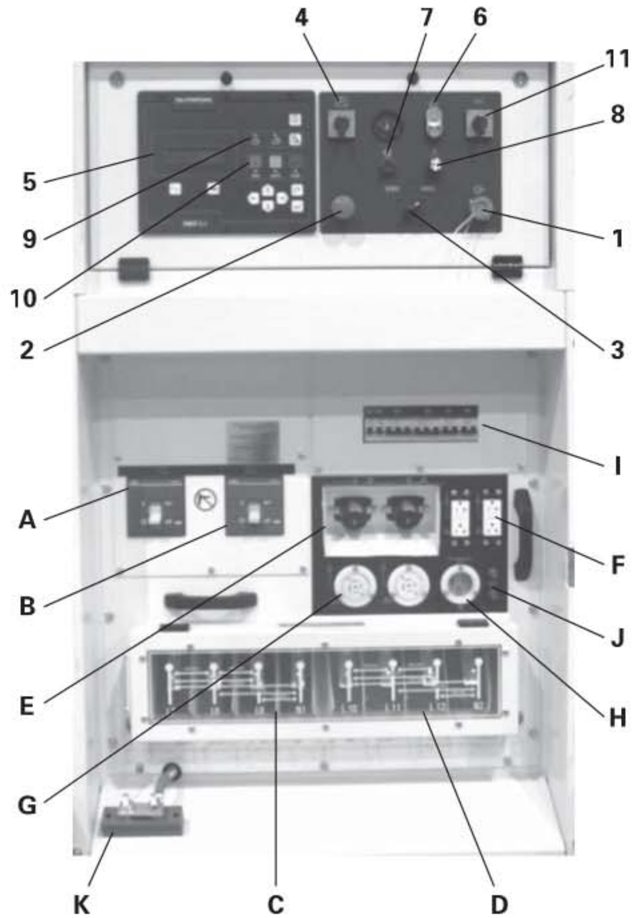
Manufacturer .... Caterpillar
Model.. C 4.4
Type 4-cycle
Aspiration.................................. Turbocharged
Cylinder configuration............................. In-line 4
Displacement – L (cu in)............................ 4.4 (269)
Bore – mm (in) 105 (4.13)
Stroke – mm (in)................................ 127.0 (5.0)
Compression ratio 18.3:1
Governor
  Type .... Fully Electronic
  Class .... ISO 8528-5 G2
Piston speed – m/sec (ft/sec)...................... 7.62 (25.0)
Engine speed – rpm 1800
Maximum power at rated rpm – kW (hp)
  Standby 117.0 (156.0)
  Prime 106.0 (142.0)
BMEP – kPa (psi)
  Standby 1612 (233)
  Prime.. 1771 (257)
Regenerative power – kW (hp) 13.8 (18.5)

CONTROL PANEL – EMCP 4.2

1 Electronic Service Tool Link.
2 Red emergency stop push button.
3 AC sensing selector switch.
4 Panel on/off switch.
5 Digital display for AC/DC metering.
6 EMCP Disconnect Switch.
7 Fuel View Switch.
8 Voltage adjust potentiometer.
9 Shutdowns: high coolant temperature/low coolant level, low oil pressure, overcrank, overspeed.
10 Run/auto/stop pushbuttons.
11 Panel light on/off switch.

DISTRIBUTION PANEL

A 400 amp main circuit breaker for 208/120 volt bus connections.
B 250 amp main circuit breaker for 480/227 volt bus connections.
C Separate bus connection studs for 480/277 volt and 208/120 volt, 3-phase simultaneous output.*
D 240/139 volt, 3-phase available from 208/120 volt bus bar connections with voltage adjustment.**
E 2 – single phase – California style Twistlocks, 50 amps @ 208 volt phase to phase, 120 volt phase to neutral or 240 volt phase to phase, 139 volt phase to neutral.
F 2 – single phase – GFCI Duplex receptacles, 20 amps @ 120 volts.***
G 2 – three phase – NEMA locking receptacles, 20 amps @ 208/120 volts.***
H 1 – single phase – NEMA locking inlet receptacle for 125 volt, 30 amp rated auxiliary supply.
I Individual circuit breaker protection for receptacles. Also act as on/off switches.
J Two wire remote start connection terminals.
K Neutral ground connection.



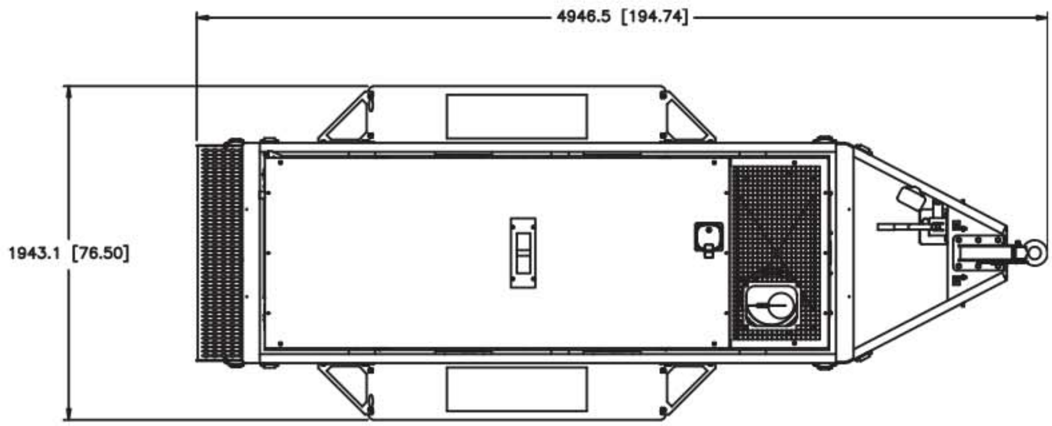
* Either set of bus bars is capable of supplying up to full rating. Total load from bus bars and receptacles cannot exceed rating of generator set. Generator is wye connected in all cases.
** High voltage bus connections not useable with low voltage adjusted to 240 volts.
*** Receptacles not for use with low voltage adjusted to 240 volts.

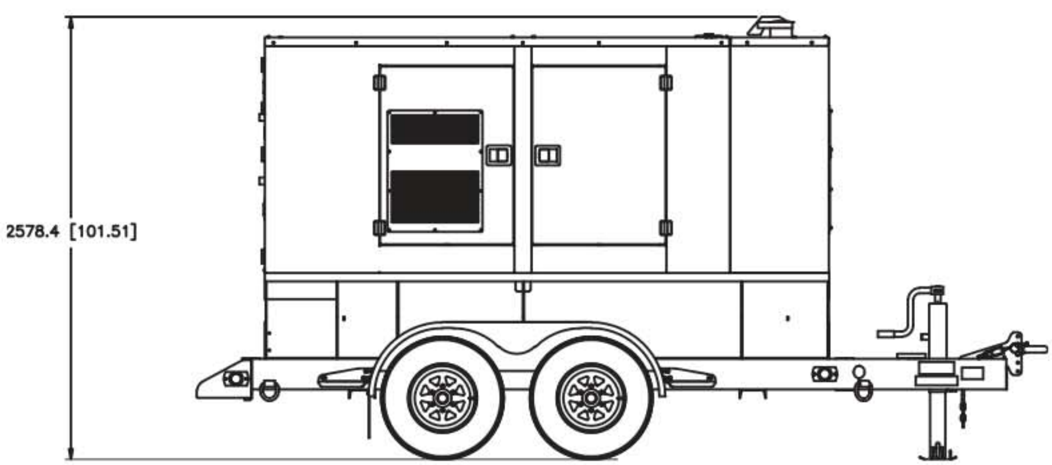
Model	Length mm (in)	Width mm (in)	Height mm (in)	Weight With Lube Oil and Coolant kg (lb)	Weight With Fuel, Lube Oil and Coolant kg (lb)
XQ100	3280 (129.1)	1130 (44.5)	1870 (73.6)	2495 (5,501)	3032 (6,684)
XQ100 w/trailer	4946.5 (194.74)	1943.1 (76.5)	2578.4 (101.5)	3214 (7,086)	3751 (8,269)

RATING DEFINITIONS

Standby – Applicable for supplying continuous electrical power (at variable load) in the event of a utility power failure. No overload is permitted on these ratings. The generator on the generator set is peak prime rated (as defined in ISO8528-3) at 30° C (86° F).

Prime – Applicable for supplying continuous electrical power (at variable load) in lieu of commercially purchased power. There is no limitation to the annual hours of operation and the generator set can supply 10% overload power for 1 hour in 12 hours.





XQ175 RENTAL

CATERPILLAR

Picture shown with optional trailer

STANDBY 175 kW
PRIME 157.5 kW
60 Hz

Voltage	Standby kW (kVA)	Prime kW (kVA)
208/120V 3 phase	175 (218.8)	157.5 (196.9)
480/277V 3 phase	175 (218.8)	157.5 (196.9)

FEATURES

EPA TIER 3 AND CARB CERTIFIED FOR NON-ROAD MOBILE APPLICATIONS

SOUND ATTENUATED ENCLOSURE
- The fully weatherproof enclosure incorporates an internally mounted exhaust silencer and is of extremely rugged construction in order to withstand the rough handling common with rental applications.
- Highly corrosion resistant construction.
  - Body made from sheet steel components pretreated with zinc phosphate prior to polyester powder coating at 200° C (392° F)
  - Black stainless steel padlockable latches.
  - Zinc die cast hinges/grab handles.
- Excellent access for maintenance.
  - Two large doors on each side. Two rear doors for distribution/control panel.
  - Hinged front door for air discharge box access.
  - Lube oil and cooling water drains piped to exterior of the enclosure.
  - Doorkeepers on all doors.
- Security and safety.
  - Safety glass control panel viewing window in a lockable access door.
  - Cooling fan and battery charging alternator fully guarded.
  - Fuel fill and battery can only be reached through lockable access doors.
- Transportability.
  - Tested and certified single point lifting eye.
  - Lifting points on baseframe.

ROBUST DESIGN FOR RENTAL ENVIRONMENT
- Packages designed to survive in rugged environments.
- Dual wall UL142 fuel tank base with 24 hour fuel supply.

DISTRIBUTION PANEL
- Switchable voltage from 480/277V 3-phase to 240/139V 3-phase (can be adjusted down to 208/120V 3-phase).

REAR CUSTOMER ACCESS
- Separate control panel and distribution panel access doors.
- Hinged door over main bus connectors.
- Emergency stop on panel.
- Remote start/stop contacts.

ENVIRONMENTALLY FRIENDLY DESIGN
- EPA Tier 3 off-highway compliant C6.6 engine.
- 110% Spill containment for all fluids.
- Sound attenuated to 73 dBA for low noise.

RENTAL READY FEATURES
- Anti-condensation heater 110-120 volt AC.
- Coolant heater 110-120 volt AC.
- UL Listed 10A Battery charger.
- Cam lock distribution system.

OPTIONS
- Tandem axle trailers with hydraulic or electric brakes.
- CSA Certification.

CATERPILLAR®

FACTORY INSTALLED STANDARD AND OPTIONAL FEATURES

System	Standard Features
Air Inlet	• Air cleaner, two stage cyclonic/paper with dust cup and service indicator • Turbocharger and Air-to-air aftercooler
Charging System	• 12V – 100A charging alternator with integral regulator and fully guarded • 10A battery charger (panel mounted) with meter
Control Panel	• Analog auto-start control panel in a vibration isolated enclosure with hinged lockable door and clear plexi-glass viewing window • Panel light switches, emergency stop pushbutton • Voltage/Amperage selection switch and voltage adjust poteniometer • Fault indicators for: Low coolant level shutdown, high coolant temp shutdown, low fuel level/leak alarm, low oil pressure shutdown, over-speed and emergency stop shutdown • Gauges for: oil pressure, engine temperature, engine hours, voltage, amperage, frequency, fuel level, battery voltage
Cooling System	• Radiator package mounted with vertical discharge designed for 43° C ambient capability • 50% coolant antifreeze with corrosion inhibitor • Blower fan, fan drive, and belts complete with protection guards • 120V AC coolant heater, fuse protected, thermostatically controlled, automatically disconnected on start-up • Coolant drain lines with valves piped to base-frame
Distribution Panel	• NEMA 1 steel enclosure with separate, hinged lockable door for load section • Main bus connections with hinged load cover with clear plexiglass window which must be closed during operation • 3-pole 800A 100% rated UL circuit breaker with 12 VDC shunt trip wired to load door safety switch • Multiple duplex and twistlock output receptacles with individual circuit breakers • Two wire start/stop connection terminals and 120V AC shore power connection for rapid emergency starting • CamLock distribution system
Enclosure	• Sound attenuating, 12-gauge steel enclosure of modular panel construction limits overall noise 73 dBA at 7 m (23 feet) • Black stainless steel pad-lockable latches, doorkeepers on all doors and Zinc die-cast hinges/grab handles • Hinged, lockable access door for easy radiator maintenance • All components are pretreated for anti-corrosive protection prior to painting with polyester powder at 200° C
Engine	• Heavy duty industrial Tier 3 compliant Caterpillar C6.6 with electronic governor compliant with BS5514, Class A1 • 12V DC energized to shutdown solenoid. • Oil pressure and coolant temperature/level shutdowns switches and gauge senders • High gloss polyurethane paint for durability and scuff resistance
Exhaust System	• Critical exhaust silencer with flexible connector and vertical discharge • Heat guards provide protection from the exhaust pipe
Fuel System	• Integral UL142 dual wall fuel tank in base-frame with 264 gallon capacity (provides 24 hours of operation at 75% of prime rating) • Cartridge type, replaceable element fuel filter with integrated manual priming pump • Fuel cooler, fuel/water separator and primary fuel filter • Interconnected, 3-way valve for switching fuel supply between remote and integral fuel
Generator	• Screen protected and drip proof, self regulating, brushless generator with fully interconnected damper windings, IC06 cooling system and sealed for life bearings • Class H Insulation with coastal insulation protection. Windings are impregnated in a triple dip, thermo-setting moisture, oil and acid resisting polyester varnish. Heavy coat of anti-tracking varnish for additional protection against moisture and condensation. • Permanent magnet provides 350% short circuit, enhanced motor starting, and non-linear load performance • Fully sealed, R448 automatic voltage regulator maintains the voltage within ± 0.5% at steady state from no load to full load • 120 VAC anti-condensation heater, automatically disconnected on start-up • Reconnectable voltage output
Lube System	• Cartridge type full flow lube oil filters (spin-on) and dipstick • Lubricating oil, oil cooler, crankcase breather with collection assembly • Oil drain lines with valve
Mounting System	• Engine-generator are directly coupled using SAE flange prohibiting misalignment and the engine flywheel is flexibly coupled to the generator rotor • Generator set soft mounted to the heavy duty, fabricated steel base-frame using captive anti-vibration pads between generator set and base-frame to ensure complete isolation of the rotating assemblies • Base-frame includes integral fuel tank and provides 110% spill containment
Starting System	• Single, 12V starting motor on engine • Dual 12V (950 CCA) Cat brand maintenance free batteries with disconnect switch, battery rack, cables, installed on the base. • Glow plugs fitted on the engine
General	• Full manufacturer's warranty • Factory testing • Caterpillar yellow paint on engine and generator, black on base, lifting arch, and radiator, white enclosure • Complete O&M manuals • The equipment meets the following quality standards: BS49999, BS5000, BS5514, IEC60034, EN6100-6, NEMA MG1-22.
System	**Optional Features**
Mounting	• 5000 lb, tandem axle trailers with torflex suspension and either hydraulic or electric brakes

XQ175

Materials and specifications are subject to change without notice.

Generator Set Technical Data – 1,800 rpm/60 Hz			Standby		Prime	
Power Rating	kW	(kVA)	175	(218.8)	157.5	(196.9)
Lubricating System						
Oil type required: API CH-4						
Total oil capacity	L	(U.S. gal)	16.5	(4.4)	16.5	(4.4)
Oil pan	L	(U.S. gal)	15.5	(4.1)	15.5	(4.1)
Fuel System						
Recommended fuel: #2 diesel						
Generator set fuel consumption						
100% load	L/hr	(gal/hr)	52.7	(13.9)	49.4	(13.1)
75% load	L/hr	(gal/hr)	41.4	(10.9)	40.5	(10.7)
50% load	L/hr	(gal/hr)	34.4	(9.1)	33.0	(8.7)
Fuel tank capacity	L	(U.S. gal)	988	(264)	988	(264)
Cooling System						
Radiator system capacity including engine	L	(U.S. gal)	21	(5.5)	21	(5.5)
Air Requirements						
Combustion air flow	m^3/min	(cfm)	12.6	(445)	12.6	(445)
Maximum air cleaner restriction	kPa	(in H_2O)	8.0	(32.1)	8.0	(32.1)
Radiator cooling air	m^3/min	(cfm)	302.4	(10,686)	302.4	(10,686)
Generator cooling air	m^3/min	(cfm)	30.6	(1,081)	30.6	(1,081)
Exhaust System						
Exhaust flow at rated kW	m^3/min	(cfm)	29.7	(1,049)	28.6	(1010)
Exhaust temperature at rated kW – dry exhaust	°C	(°F)	677	(1,251)	666	(1231)
Generator Set Noise Rating [with enclosure at 7 meters (23 feet)]	dBA		73		73	

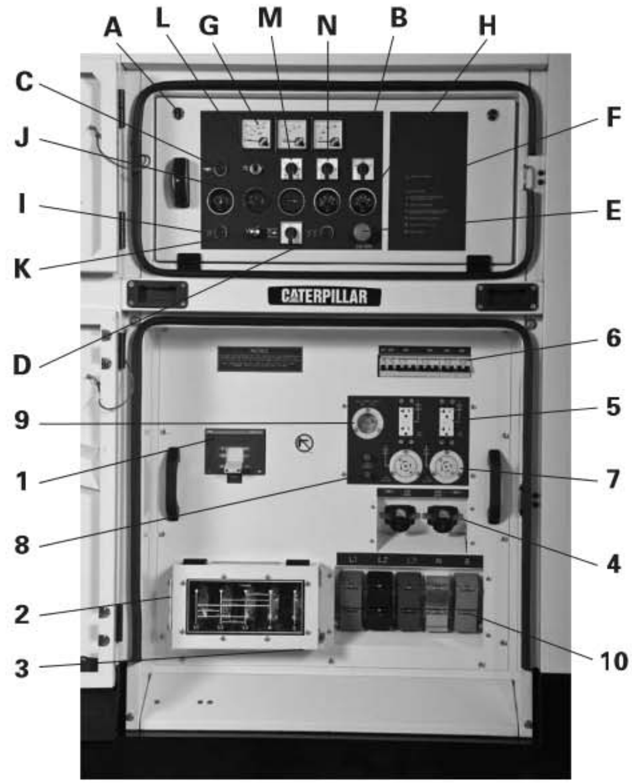
SPECIFICATIONS

GENERATOR

Voltage regulation .... ± 0.5% at steady state from no load to full load
Frequency .... ± 0.25% for constant load from no load to 100% load
Waveform distortion .... THD < 4%, at no load
Radio interference .... Compliance with EN61000-6
Telephone interference.................. TIF < 50, THF < 2%
Overspeed limit .... 2,250 rpm
Insulation.. Class H
Temperature rise .... Within Class H limits
Available voltages .... Reconnectable voltage output: 480/277 volt, 208/120 volt, 240/139 volt 3-phase
Deration .... Consult factory for available outputs
Ratings..................... At 30° C (86° F), 152.4 m (500 ft) 60% humidity, 0.8 pf

ENGINE

Manufacturer .... Caterpillar
Model C6.6
Type 4-cycle
Aspiration .... ATAAC
Cylinder configuration.............................. In-line 6
Displacement – L (cu in)............................ 6.6 (403)
Bore – mm (in) 105 (4.13)
Stroke – mm (in) 127 (5.00)
Compression ratio 16.2:1
Governor
Type .... Electronic
Class G2
Piston speed – m/sec (ft/sec) 7.62 (25.0)
Engine speed – rpm.................................. 1,800
Maximum power at rated rpm – kW (hp)
Standby 204.3 (273.9)
Prime 185.7 (249)
BMEP – kPa (psi)
Standby...................................... 1103 (160.0)
Prime 1003 (145.5)



CONTROL PANEL

A Steel enclosure with hinged lockable door with viewing window.
B Manual run/off.
C Panel light ON/OFF switch.
D Pre-heat pushbutton.
E Red emergency stop pushbutton.
F Lamp test/reset pushbutton.
G AC instrumentation: 1-voltmeter, 1-ammeter, 1-frequency meter.
H Engine gauges for: oil pressure, coolant temperature, battery volts, fuel level.
I Fuel level display with momentary activation pushbutton.
J Hours run meter.
K Voltage adjust potentiometer.
L Frequency adjust potentiometer.
M 1 — 7 Position voltmeter phase selector switch.
N 1 — 4 Position ammeter phase selector switch.

OTHER FEATURES

- Shutdowns: high coolant temperature/low coolant level, low oil pressure, overcrank, overspeed.
- Low fuel level/fuel tank leak alarm.
- Solid state control logic.
- Autostart standard.
- Cycle cranking with 3 adjustable time crank/rest periods.
- Battery charger, 10 Amp constant voltage, UL listed.

DISTRIBUTION PANEL

1 1 — 3 Pole MCCB with solid neutral (4 Wire). UL/CSA listed with shunt trip. Integral trip unit for thermal and magnetic overload protection on MCCB.
2 Main bus connection studs enclosed with hinged transparent cover for easy access and operator safety.
3 Cover for bus studs includes safety lockout feature to keep unit from operating with door open.
4 2 — Single phase — California style Twistlocks, 50 Amps @ 208 Volt phase to phase, 120 Volt phase to neutral (adjustable to 240/139).
5 2 — Single phase — GFCI Duplex receptacles, 20 Amps @ 120 Volts.***
6 Individual circuit breaker protection for receptacles. Also act as on/off switches.
7 2 — 3-phase NEMA locking receptacles, 20 Amps at 208/120V
8 Two wire remote start connection terminals.
9 1 — 30A, 125V single phase NEMA locking inlet receptacle
10 Camlock Connections

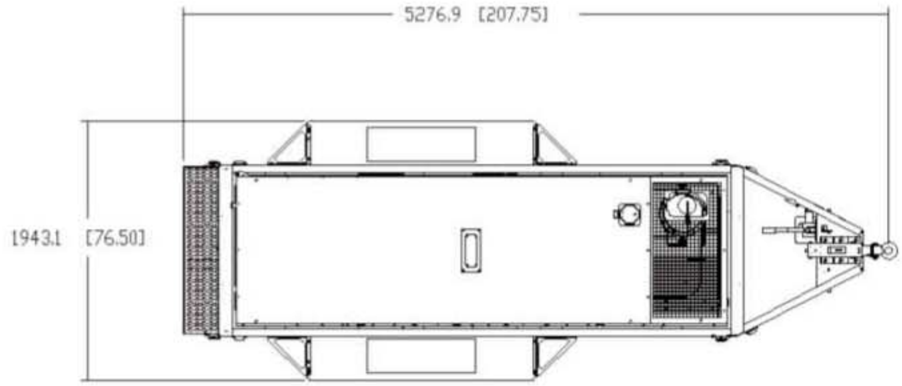
*** Receptacles not for use with unit operating at 480/277V or 240/139V 3 phase.

Model	Length mm (in)	Width mm (in)	Height mm (in)	Weight: With Lube Oil and Coolant kg (lb)	Weight: With Fuel, Lube Oil and Coolant kg (lb)
XQ175	3722.5 (146.55)	1157 (44.55)	2159.8 (85.03)	3145 (6,934)	4015 (8,852)
XQ175 with trailer	5276.9 (207.75)	1943.1 (76.5)	2528.4 (99.54)	3940.5 (8,687)	4810.5 (10,605)

RATING DEFINITIONS

Standby – Applicable for supplying continuous electrical power (at variable load) in the event of a utility power failure. No overload is permitted on these ratings. The generator on the generator set is peak prime rated (as defined in ISO8528-3) at 30° C (86° F).

Prime – Applicable for supplying continuous electrical power (at variable load) in lieu of commercially purchased power. There is no limitation to the annual hours of operation and the generator set can supply 10% overload power for 1 hour in 12 hours.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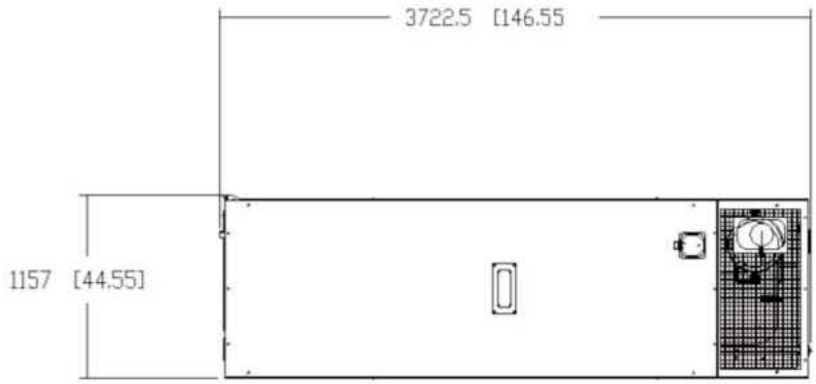
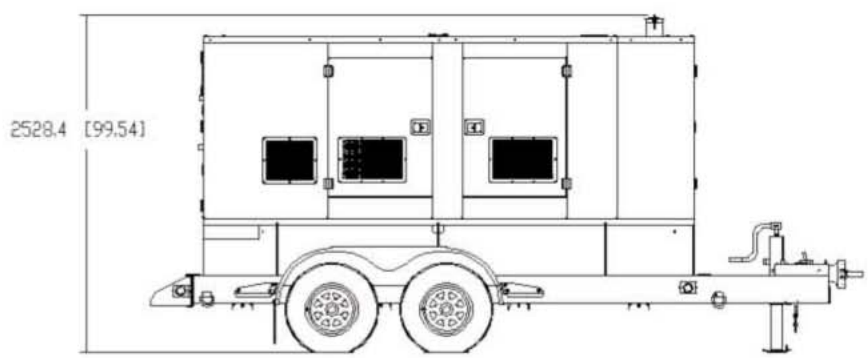
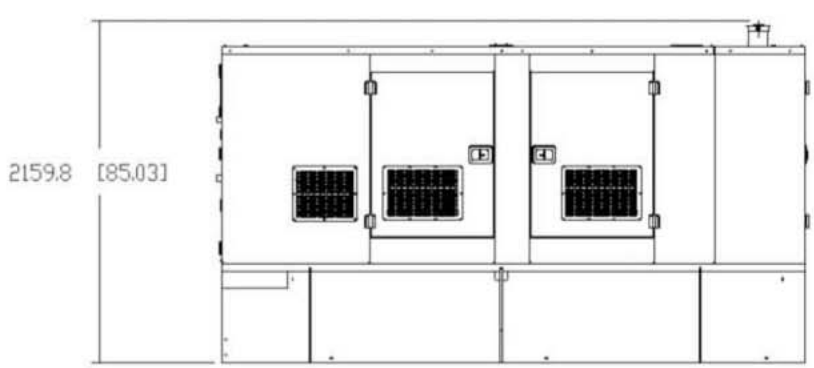
1943.1 [76.50]


3722.5 [146.55
1157 [44.55]


2528.4 [99.54]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375 cfm: Single axle, oil-injected, rotary screw portable compressors, 250 – 375 cfm (100-200 psi)

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XA(T,V)S 375 JD
The options you need for all your specific applications. These portable compressors are workhorses. Featuring Atlas Copco's new C111 element for improved compression efficiency, the XAS 375 JD6, XATS 375 JD6 and the XAVS 375 JD6 are ideal for demanding applications, including sandblasting and plumbing. The XC 2002 control module with LCD display puts integrated engine electronics for performance and diagnostics at your fingertips.
XAS 300 and XATS 250 JDU
This compressor is designed for cross mounting on service vehicles used for maintenance, road stripping and related activities. For easy mounting and dismounting from the carrier, the XAS 300 and XATS 250 feature two sets of forklifts slots, one on each end, as well as a lifting bail.

Customer benefits

- Extremely reliable John Deere engine
- Tier 3 exhaust emission compliance
- Operates under widely varying climatic conditions, water-cooler engine, large capacity oil cooling system, high efficiency heavy-duty two-stage intake filters (with cartridge replacement indicators)
- Highly efficient oil extraction system means low oil consumption
- Large capacity fuel tank placed low for good road handling and easy filling
- Gull wing doors for easy access to engine and components
- Few moving parts, minimum mechanical wear
- Rugged and reliable, needing little maintenance

Leaflet XA (T,V) S 375 JD6 T3 (1208kB, Pdf document) - Download
Leaflet XAS300 XATS 250 JDU7 (465kB, Pdf document) - Download

Technical data

Units: Metric Imperial

Technical Specifications	
Normal effective working pressure	100 - 200 psi
Engine	John Deere
Weight	2190 - 3920 lbs
Length	84 - 145 inch
Width	34 - 72 inch
Height	55 - 71 inch
Air flow (FAD)	250 - 375 cfm

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OEM and Industrial Air Handling Specialist

HDBI

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cincinnati fan

A Company That Stands Behind Its Product

Since the founding of **Cincinnati Fan** in 1956, the company's mission has been to provide quality products at competitive prices, backed by dependable service.

This mission is carried out by specializing in the market for industrial air handling products up to 125 HP. But specialization does not mean the product line is small. **Cincinnati Fan** offers a wide variety of standard and customized products, production flexibility, and customer responsiveness.

Cincinnati Fan has over 170 experienced sales engineers across the U.S. and Canada ready to serve your air handling needs.

Cincinnati Fan can provide:

- Technical evaluation for correct performance conditions.
- Review of air stream and ambient conditions that require special attention.
- Selection of proper components to meet required design specifications.
- Selection of proper accessories.
- System analysis for proper fan design.

Cincinnati Fan operates in a modern facility specifically designed for world class manufacturing enabling us to build standard products to order, including accessories, and ship within 10 to 15 working days.

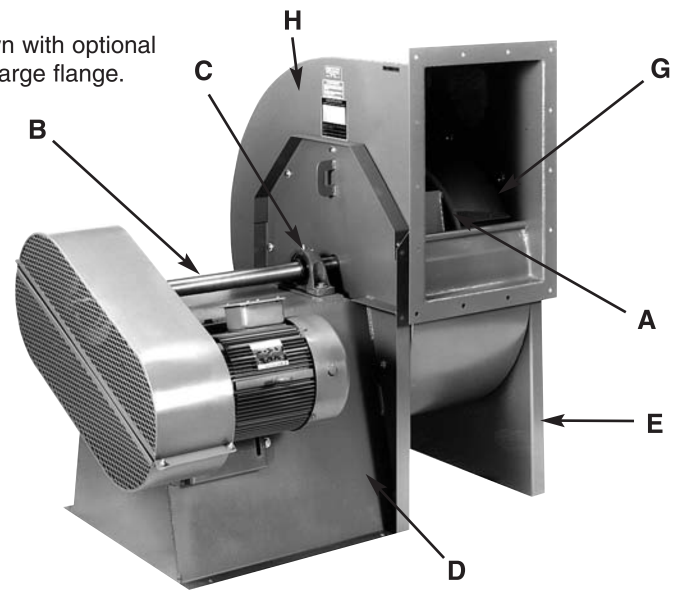
With support like this, you can be sure your **Cincinnati Fan** product will be well-built and will provide maximum dependability and longevity.

Visit us at www.cincinnatifan.com for more information.

HDBI FEATURES

A) Backward inclined blades are fabricated of heavy-gauge, high-strength steel to assure long lasting, efficient operation.
B) Turned, ground and polished shafting assures smooth operation. A rust preventive coating is applied prior to shipment.
C) Heavy-duty, self-aligning, relubricatable, ball bearings in cast-iron pillow blocks. Bearings are selected for optimal performance depending on fan size and class.
D) Bearing base is heavy steel construction with internal supports to maximize rigidity and assure long equipment life. Arrangement #1 fans can be converted to arrangement #9 with the addition of the motor slide base.
E) Inlet side support is used to assure a vibration-free, stable housing.
F) Slip collar inlet (not shown) is used for duct work connection. Flanged inlet optional.
G) Inlet bell is designed for smooth air entrance into the wheel inlet for maximum efficiency.
H) Reversible housing provides increased configuration flexibility. Removable side plates allow the wheel to be removed from the motor or inlet side of the housing. Housings are rotatable in 45 degree increments. Wheels are not reversible. See note at right.

Shown with optional discharge flange.



NOTE: HDBI-330 and HDBI-360 housings are not rotatable or reversible.

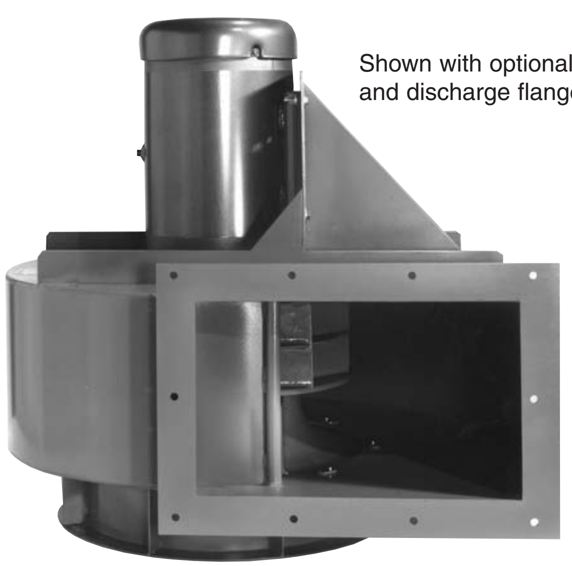
ADVANTAGES OF DIRECT DRIVE ARRANGEMENT #4 & #4HM

All sizes available with 2 wheel diameters in 100% to 50% widths in 5% increments

Shown with optional inlet and discharge flanges.

ADVANTAGES

- Compact - requires less space.
- Weighs Less - requires less supporting structure.
- Less Maintenance - no belts or fan bearings to replace.
- Less Expensive - above features result in lower first cost and lower maintenance cost.
- More Ratings - the combination of several motor speeds, two wheel diameters and eleven fan widths results in a vast selection of direct drive ratings.
- Temperature - good up to 200˚F. (93°C.)



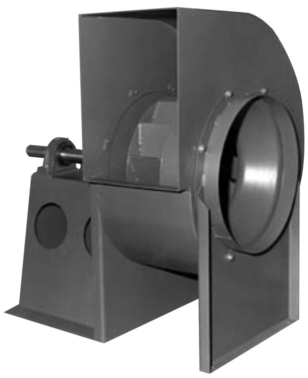
Shown with optional inlet and discharge flanges.

OPTIONAL ARRANGEMENT 4HM HORIZONTAL MOUNTING

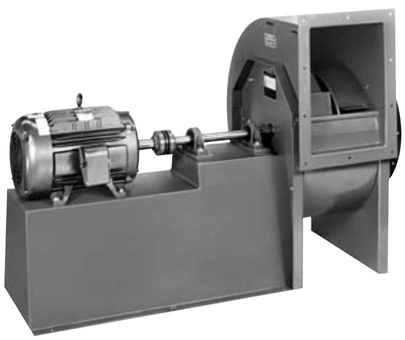
Ideal for bag house or other equipment requiring the simplicity of a horizontally mounted fan. Motors are limited to frame 365T maximum.

This mounting is available on all sizes. All horizontal mount housings are non-reversible. Inlet flange is optional and must be added if required. Supporting equipment must be adequate to support weights shown on page 26 plus motor weight.

SIX STANDARD ARRANGEMENTS

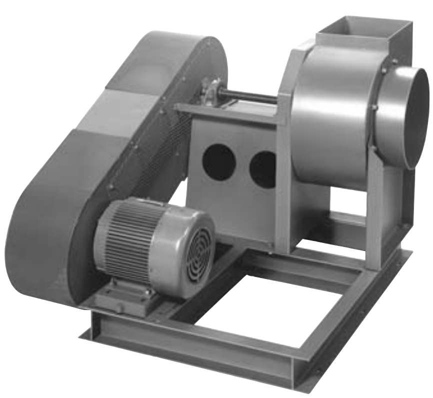


ARRANGEMENT 1 (V-BELT DRIVE)
- Motor not mounted on bearing base.
- Wheel mounted on fan shaft with two pillow block bearings.
- Maximum temperature of standard design: 300°F. (149°C.); high temperature designs up to 750°F. (398°C.)



(Shown with shaft/coupling guard removed and optional discharge flange.)

ARRANGEMENT 8 (DIRECT DRIVE)
- Motor mounted on motor base extending beyond the bearing base. Shaft/coupling guard is standard.
- Wheel mounted on fan shaft with two pillow block bearings.
- Maximum temperature of standard design: 300°F. (149°C.); high temperature designs up to 750°F. (398°C.)



ARRANGEMENT 9CB (V-BELT DRIVE)
- Same as Arrangement 9 except motor and fan are mounted on a common channel base.
- Maximum temperature of standard design: 300°F. (149°C.); high temperature designs up to 750°F. (398°C.)

(Shown with optional discharge flange.)

ARRANGEMENT 4 (DIRECT DRIVE)
- Motor mounted on motor base.
- Wheel mounted on motor shaft.
- Maximum temperature of standard design: 200°F (93°C.); high temperature design not available.

(Shown with optional discharge flange.)

ARRANGEMENT 9 (V-BELT DRIVE)
- Motor mounted on an adjustable slide base on the side of the bearing base.
- Wheel mounted on fan shaft with two pillow block bearings.
- Maximum temperature of standard design: 300°F. (149°C.) high temperature designs up to 750°F. (398°C.)

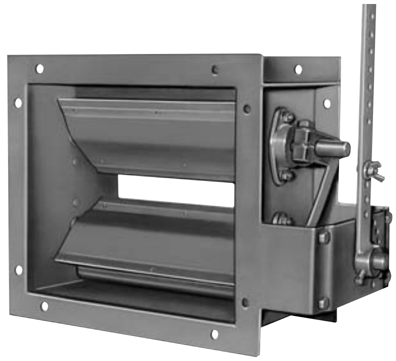
(Shown with weather cover removed)

ARRANGEMENT 10 (V-BELT DRIVE)
- Motor mounted on adjustable base under the fan shaft.
- Wheel mounted on fan shaft with two pillow block bearings.
- Maximum temperature of standard design: 300°F. (149°C.); high temperature design not available.

OPTIONAL ACCESSORIES

Shaft Seal

Teflon shaft seal good to 400°F. (204°C.) Ceramic fiber gasket material with steel cover plate above 400°F. (205°C.)

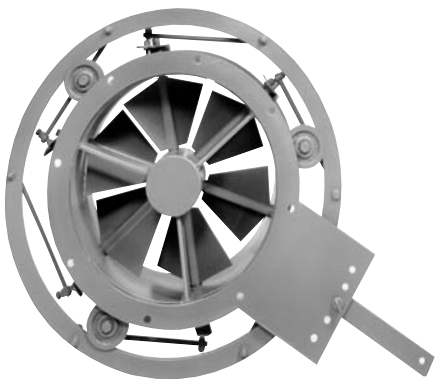


Outlet Damper

All dampers are 1 or 2 blade. All dampers 10" deep flange to flange. Opposed blade construction is standard.

Belt Guard

Belt guard standard on Arrangement 9 and 9CB only. **Painted safety yellow.**



Inlet Vane Control

Linkage assembly is external on smaller sizes, internal on larger sizes. Inlet vane depth varies with inlet diameter. Contact your local Cincinnati Fan sales representative for dimensions.

Inspection Door

Bolted or quick-release doors positioned as specified on scroll. Rubber gasket standard up to 250°F. (121°C.) Ceramic fiber gasket standard at temperatures above 250°F (122°C.).

Drain Connection

3/4" pipe coupling welded to lowest point of housing. Not required on BH discharge position.

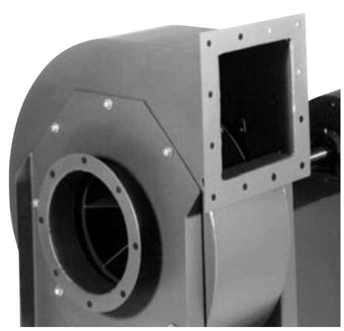
Shaft and/or Heat Slinger Guard

Guard available on Arrangement 1, 9 and 9CB. Covers bearings and shaft between fan housing and belt guard. Has extended lube lines. Standard on high temperature fans above 301°F. (150°C). **Painted safety yellow.**

⚠ DANGER

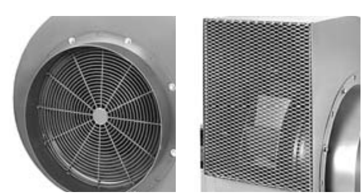
All fans & blowers shown have rotating parts and pinch points. Severe personal injury can result if operated without guards. Stay away from rotating equipment unless it is disconnected from its power source.

Read operating instructions.



Inlet & Outlet Flanges

Flanges on inlet and outlet available where installation requires tight duct connections. Standard hole pattern furnished. Outlet flange not available on some discharge positions. Outlet flange standard on all sizes 270 through 360. See page 31 for dimensions.



Inlet & Outlet Guards

Ring guard on inlet and expanded metal on discharge. Meet OSHA approval.

SPARK-RESISTANT CONSTRUCTION

Type A: All parts in contact with airstream are of nonferrous material. (***Contact your local Cincinnati Fan sales representative***).

Type B: Fabricated aluminum wheel and aluminum rubbing ring on motor shaft or fan shaft. **Maximum Temperature 200°F. (93°C.) all arrangements.**

Type C: Consists of aluminum inlet bell and aluminum plate on drive side of the fan. Maximum Temperature is the same as for high temperature construction below for each arrangement.

⚠ WARNING

The use of aluminum or aluminum alloys in the presence of steel which has been allowed to rust requires special consideration. Research by the U.S. Bureau of Mines and others has shown that aluminum impellers rubbing on rusty steel may cause high intensity sparking.

The use of the above Standard in no way implies a guarantee of safety for any level of spark resistance. Spark-resistant construction also does not protect against ignition of explosive gases caused by catastrophic failure or from any airstream material that may be present in a system.

Maximum RPM for Aluminum Wheels*	
Size	Max. RPM
120	5400
130	4999
150	4712
160	4285
180	3885
200	3574
220	3550
240	2837
270	2476
300	2300
330	2300
360	1950

* Up to 200˚F. (93°C.) Consult your local Cincinnati Fan sales representative for higher temperatures and/or higher RPMs.

HIGH TEMPERATURE CONSTRUCTION

Standard Construction: Arrangements 1, 8, 9, 9CB and 10 suitable to 300° F. (149° C.)
Arrangements 4 and 4HM suitable to 200° F. (93° C.)

201°- 400° F. (94° - 204° C.) Construction: Standard fan with heat slinger, slinger guard, teflon shaft seal and extended hub on wheel. Arrangements 4 and 4HM only.

301°- 400° F. (150° - 204° C.) Construction: Standard fan with heat slinger, fan shaft and slinger guard and teflon shaft seal. Arrangements 1, 8, 9 and 9CB.

401°- 600° F. (205° - 316° C.) Construction: Standard fan with heat slinger, fan shaft and slinger guard, high temp shaft seal, gaskets and paint. Arrangements 1, 8, 9 and 9CB.

601°- 750° F. (317° - 398° C.) Construction: Standard fan with high temp bearings, heat slinger, fan shaft and slinger guard, high temp shaft seal, gaskets and paint. Arrangements 1, 8, 9 and 9CB

TEMPERATURE RANGE	MAXIMUM RPM REDUCTION FACTOR†
Up to 175˚F.	0%
176˚-200˚	2%
201˚-300˚	4%
301˚-400˚	7%
401˚-500˚	11%
501˚-600˚	15%
601˚-700˚	20%
701˚-750˚	30%

† Steel wheels only.

TEMPERATURE - ALTITUDE CONVERSIONS

AIR TEMP. F°	AIR TEMP. C°	ALTITUDE IN FEET ABOVE SEA LEVEL										
		0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
0°	-18°	.87	.91	.94	.98	1.01	1.05	1.09	1.13	1.17	1.22	1.26
40°	4°	.94	.98	1.02	1.06	1.10	1.14	1.19	1 23	1.28	1.32	1.36
70°	21°	1.00	1.04	1.08	1.12	1.16	1.20	1.25	1.30	1.35	1.40	1.45
80°	27°	1.02	1.06	1.10	1.14	1.19	1.23	1.28	1.33	1.38	1.43	1.48
100°	38°	1.06	1.10	1.14	1.19	1.23	1.28	1.33	1.38	1.43	1.48	1.54
120°	49°	1.09	1.14	1.18	1.23	1.28	1.32	1.38	1.43	1.48	1.53	1.58
140°	60°	1.13	1.18	1.22	1.27	1.32	1.37	1.42	1.48	1.54	1.58	1.65
160°	71°	1.17	1.22	1.26	1.31	1.36	1.42	1.47	1.53	1.59	1.64	1.70
180°	82°	1.21	1.26	1.30	1.36	1.41	1.46	1.52	1.58	1.64	1.70	1.75
200°	93°	1.25	1.29	1.34	1.40	1.45	1.51	1.57	1.63	1.69	1.75	1.81
250°	121°	1.34	1.39	1.45	1.50	1.56	1.62	1.68	1.74	1.82	1.88	1.94
300°	149°	1.43	1.49	1.55	1.61	1.67	1.74	1.80	1.87	1.94	2.00	2.08
350°	177°	1.53	1.59	1.65	1.72	1.78	1.85	1.92	2.00	2.07	2.14	2.22
400°	205°	1.62	1.69	1.75	1.82	1.89	1.96	2.04	2.12	2.20	2.27	2.35
450°	232°	1.72	1.79	1.86	1.93	2.00	2.08	2.16	2.24	2.33	2.41	2.50
500°	260°	1.81	1.88	1.96	2.03	2.11	2.19	2.28	2.36	2.46	2.54	2.62
550°	288°	1.91	1.98	2.06	2.14	2.22	2.30	2.40	2.49	2.58	2.68	2.77
600°	315°	2.00	2.08	2.16	2.24	2.33	2.42	2.50	2.61	2.71	2.80	2.90
650°	343°	2.10	2.18	2.26	2.35	2.44	2.54	2.63	2.74	2.84	2.94	3.04
700°	371°	2.19	2.27	2.36	2.46	2.55	2.65	2.75	2.86	2.97	3.06	3.18
750°	398°	2.28	2.37	2.47	2.56	2.66	2.76	2.87	2.98	3.10	3.19	3.31

Fan performance tables are developed using standard air which is 70°F., 29.92" barometric pressure and .075 lbs. per cubic foot. Density changes resulting from temperature or barometric pressure variations (such as higher altitudes) must be corrected to standard conditions before selecting a fan based on standard performance data. Temperature and/or altitude conversion factors are used in making corrections to standard conditions.

EXAMPLE:

Select a belt driven HDBI-300 to deliver 8327 CFM at .50" SP at 200°F. (93°C.), and 7000' altitude.

STEP 1. From the table, conversion factor is 1.63.

STEP 2. Correct static pressure is: 1.63 x .50" SP = .81" SP at standard conditions.

STEP 3. Check HDBI catalog for 8327 CFM at .81" SP. We select a belt driven HDBI-300 and interpolation gives 660 RPM and 1.83 BHP.

STEP 4. Correct the BHP for the lighter air: 1.83 ÷ 1.63 = 1.12 BHP. A 1.5 HP motor will suffice at 200°F., and 7000' but not at standard conditions. Special motor insulation may be required due to altitude.

DIRECT DRIVE RATING TABLES

CFM and BHP at Static Pressure Shown • Ratings at 70˚F., .075 Density, Sea Level

MODEL	RPM	0" SP CFM	0" SP BHP	1" SP CFM	1" SP BHP	2" SP CFM	2" SP BHP	3" SP CFM	3" SP BHP	4" SP CFM	4" SP BHP	5" SP CFM	5" SP BHP
HDBI-120	1150	1170 †	.09										
	1750	1780 †	.32	1375 †	.39								
	3500	3560 †	2.54	3370 †	2.82	3180 †	2.98	2975	3.08	2750	3.15	2490	3.16
HDBI-130	1150	1540 †	.16										
	1750	2344 †	.56	1828 †	.62	1086 †	.59						
	3500	4688	4.50	4457	4.68	4227	4.86	3946	4.93	3656	4.99	3353	5.01
HDBI-150	1150	2100 †	.23	1175 †	.28								
	1750	3195 †	.82	2700 †	.96	2070 †	1.00						
	3500	6385	6.59	6155	6.96	5930	7.28	5690	7.57	5405	7.71	5115	7.83
HDBI-160	1150	2795 †	.38	1875 †	.46								
	1750	4250 †	1.33	3730	1.53	3080	1.61	2170	1.55				
	3500	8500	10.62	8250	11.12	8000	11.55	7750	11.98	7460	12.26	7140	12.44
HDBI-180	1150	3780 †	.69	2800 †	.82								
	1750	5750	2.40	5195	2.68	4495	2.83	3685	2.87				
	3500	11500	17.58	11225	18.28	10945	18.86	10670	19.44	10395	20.02	10055	20.32
HDBI-200	1150	4975 †	.99	3935 †	1.17	2140 †	1.10						
	1750	7570	3.47	6960	3.88	6235	4.09	5435	4.23	4390	4.14		
	3500	15140	27.79	14830	28.74	14530	29.50	14225	30.27	13920	31.03	13620	31.80
HDBI-220	1150	6915	1.65	5955	1.99	4720	2.11						
	1750	10520	5.80	9900	6.41	9270	6.89	8610	7.26	7755	7.39	6820	7.42
HDBI-240	1150	9230	2.67	8185	3.15	6945	3.39	4880	3.26				
	1750	14045	9.39	13365	10.22	12680	10.92	11960	11.44	11185	11.85	10205	11.97
HDBI-270	1150	12885	4.68	11780	5.34	10550	5.79	9010	5.93				
	1750	19605	16.49	18885	17.62	18155	18.53	17405	19.37	16575	20.00	15745	20.63
HDBI-300	1150	17670	7.92	16450	8.85	15130	9.54	13630	9.98	11525	9.89		
	1750	26890	27.92	26095	29.54	25290	30.79	24480	32.04	23605	33.06	22680	33.92
HDBI-330	1150	23521	12.76	22173	13.95	20784	15.04	19242	15.79	17420	16.13	14835	15.81
	1750	35793	44.97	34907	46.77	34022	48.58	33136	50.38	32251	52.19	31254	53.42
HDBI-360	1150	30536	19.72	29067	21.26	27597	22.80	25940	23.84	24238	24.79	22104	24.96
	1750	46469	69.47	45503	71.82	44537	74.16	43571	76.51	42605	78.85	41629	81.13

MODEL	RPM	6" SP CFM	6" SP BHP	7" SP CFM	7" SP BHP	8" SP CFM	8" SP BHP	9" SP CFM	9" SP BHP	10" SP CFM	10" SP BHP	11" SP CFM	11" SP BHP
HDBI-120	3500	2170	3.09	1580	2.76								
HDBI-130	3500	2996	4.96	2595	4.85	2172	4.71						
HDBI-150	3500	4810	7.94	4510	8.06	4140	8.02	3700	7.87	3200	7.66		
HDBI-160	3500	6820	12.61	6490	12.76	6160	12.90	5825	13.04	5360	12.86	4870	12.64
HDBI-180	3500	9705	20.56	9350	20.80	8990	21.01	8620	21.20	8255	21.40	7885	21.59
HDBI-200	3500	13240	32.13	12850	32.44	12465	32.75	12075	33.04	11675	33.30	11270	33.56
HDBI-240	1750	9175	12.02										
HDBI-270	1750	14730	20.81	13625	20.87	11950	20.29						
HDBI-300	1750	21760	34.77	20685	35.19	19515	35.34	18025	35.05				
HDBI-330	1750	30240	54.56	29226	55.71	28133	56.57	26846	56.77	25560	56.98	23764	56.34
HDBI-360	1150	19092	24.39										
	1750	40522	82.61	39416	84.10	38309	85.58	37203	87.06	35851	87.53	34448	87.80

MODEL	RPM	12" SP CFM	12" SP BHP	13" SP CFM	13" SP BHP	14" SP CFM	14" SP BHP	15" SP CFM	15" SP BHP	16" SP CFM	16" SP BHP	17" SP CFM	17" SP BHP
HDBI-160	3500	4335	12.39										
HDBI-180	3500	7375	21.34	6865	21.08	6265	20.74						
HDBI-200	3500	10870	33.83	10465	34.09	9935	33.87	9375	33.54	8775	33.15	8130	32.70
HDBI-330	1750	21713	55.28										
HDBI-360	1750	33046	88.06	31056	87.17	28817	85.80						

Performance certified is for installation type B-Free inlet, Ducted Outlet.
Performance ratings do not include the effects of appurtenances (accessories).

† See pages 25 or 26 for minimum motor frame sizes regardless of BHP.

amca CERTIFIED RATINGS AIR PERFORMANCE AIR MOVEMENT AND CONTROL ASSOCIATION, INC.

Cincinnati Fan & Ventilator Company certifies that the HDBI Heavy Duty Backward Inclined Fans shown on this page and on pages 12 through 23 are licensed to bear the AMCA seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and comply with the requirements of the AMCA Certified Ratings Program.

Fans are capable of operating to the maximum safe speeds shown on each performance table. These speeds permit obtaining the minimum SP/OV limits established as follows:

CLASS II - 8.5" SP at 3000 FPM to 4.25" SP at 4175 FPM.
CLASS III - 13.5" SP at 3780 FPM to 6.75" SP at 5260 FPM.
CLASS IV - 20" SP at 4600 FPM to 10" SP at 6400 FPM.

DIRECT DRIVE RATING TABLES
for partial width fans with two wheel types

The partial width fan ratings shown on this page and on Pages 9,10 and 11 were derived from tests performed in accordance with AMCA Publication 211 and fan laws were applied to arrive at the data shown for partial width fans. However, none of the partial width fans or fans with SQBI wheels are licensed to bear the AMCA seal. All 100% width fans with HDBI wheels are licensed to bear the AMCA seal as shown on pages 7 and 12 through 23.

MODEL NUMBER	RPM	WHEEL TYPE	FAN WIDTH	1" SP		2" SP		3" SP		4" SP		5" SP		6" SP	
				CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
HDBI-120	1750	SQBI	1/2	813 †	.26	600 †	.26								
	1750	SQBI	3/4	1220 †	.39	900 †	.40								
	1750	HDBI	FULL	1375 †	.39										
	1750	SQBI	FULL	1627 †	.52	1201 †	.53								
	3500	HDBI	1/2	1685 †	1.41	1590 †	1.49	1488 †	1.54	1375 †	1.58	1245 †	1.58	1085 †	1.55
	3500	SQBI	1/2	1858 †	1.87	1789 †	1.96	1712 †	2.03	1627 †	2.08	1539 †	2.13	1437 †	2.14
	3500	HDBI	3/4	2527 †	2.10	2385 †	2.20	2231 †	2.30	2063 †	2.36	1868 †	2.37	1628 †	2.30
	3500	SQBI	3/4	2788 †	2.80	2683 †	2.93	2568	3.04	2441	3.12	2309	3.19	2155	3.21
	3500	HDBI	FULL	3370 †	2.82	3180 †	2.98	2975	3.08	2750	3.15	2490	3.16	2170	3.09
	3500	SQBI	FULL	3717	3.73	3578	3.91	3424	4.05	3255	4.16	3079	4.26	2874	4.28
HDBI-130	1750	SQBI	1/2	1127 †	.41	919 †	.44	799 †	.46						
	1750	SQBI	3/4	1690 †	.62	1378 †	.65	1199 †	.70						
	1750	HDBI	FULL	1828 †	.62	1086 †	.59								
	1750	SQBI	FULL	2254 †	.83	1838 †	.87	1599 †	.93						
	3500	HDBI	1/2	2278 †	2.27	2175 †	2.39	2065	2.46	1953 †	2.53	1820 †	2.56	1678 †	2.57
	3500	SQBI	1/2	2500	3.00	2423	3.12	2346	3.24	2254	3.31	2161	3.39	2065	3.45
	3500	HDBI	3/4	3416	3.41	3263	3.58	3098	3.69	2929	3.80	2730	3.84	2516	3.86
	3500	SQBI	3/4	3750	4.50	3635	4.68	3520	4.86	3381	4.97	3241	5.08	3097	5.18
	3500	HDBI	FULL	4457	4.68	4227	4.86	3946	4.93	3656	4.99	3353	5.01	2996	4.96
	3500	SQBI	FULL	5000	6.00	4846	6.24	4693	6.48	4508	6.63	4322	6.77	4130	6.90
HDBI-150	1750	SQBI	1/2	1535 †	.66	1321 †	.71	1040 †	.70						
	1750	SQBI	3/4	2303 †	1.00	1982 †	1.06	1560 †	1.05						
	1750	HDBI	FULL	2700 †	.96	2070 †	1.00								
	1750	SQBI	FULL	3071 †	1.33	2643 †	1.41	2080 †	1.41						
	3500	HDBI	1/2	3078	3.48	2965	3.64	2845	3.79	2703	3.86	2558	3.92	2405	3.97
	3500	SQBI	1/2	3355	4.82	3261	4.99	3166	5.15	3071	5.30	2967	5.40	2862	5.50
	3500	HDBI	3/4	4616	5.22	4448	5.46	4268	5.68	4054	5.78	3836	5.87	3608	5.96
	3500	SQBI	3/4	5033	7.24	4891	7.48	4750	7.72	4607	7.96	4451	8.11	4294	8.26
	3500	HDBI	FULL	6155	6.96	5930	7.28	5690	7.57	5405	7.71	5115	7.83	4810	7.94
	3500	SQBI	FULL	6710	9.65	6522	9.97	6333	10.30	6143	10.61	5934	10.81	5725	11.01
HDBI-160	1750	SQBI	1/2	2090 †	1.05	1873 †	1.13	1613 †	1.16	1183 †	1.08				
	1750	SQBI	3/4	3136	1.58	2809	1.69	2420	1.73	1775	1.61				
	1750	HDBI	FULL	3730	1.53	3080	1.61	2170	1.55						
	1750	SQBI	FULL	4181	2.11	3746	2.26	3227	2.31	2366	2.15				
	3500	HDBI	1/2	4125	5.56	4000	5.78	3875	5.99	3730	6.13	3570	6.22	3410	6.31
	3500	SQBI	1/2	4495	7.79	4390	8.03	4285	8.24	4181	8.44	4076	8.62	3969	8.77
	3500	HDBI	3/4	6188	8.34	6000	8.66	5813	8.99	5595	9.20	5355	9.33	5115	9.46
	3500	SQBI	3/4	6742	11.68	6584	12.04	6428	12.37	6271	12.66	6113	12.92	5953	13.16
	3500	HDBI	FULL	8250	11.12	8000	11.55	7750	11.98	7460	12.26	7140	12.44	6820	12.61
	3500	SQBI	FULL	8990	15.58	8779	16.06	8571	16.49	8362	16.88	8151	17.23	7937	17.54
HDBI-180	1750	SQBI	1/2	2871	1.71	2637	1.82	2378	1.89	2057	1.90	1489	1.73		
	1750	HDBI	3/4	3896	1.88	3371	1.97	2764	2.00						
	1750	SQBI	3/4	4307	2.56	3955	2.73	3567	2.84	3086	2.85	2233	2.59		
	1750	HDBI	FULL	5195	2.68	4495	2.83	3685	2.87						
	1750	SQBI	FULL	5743	3.42	5273	3.65	4756	3.78	4114	3.80	2978	3.45		
	3500	HDBI	1/2	5613	9.14	5473	9.43	5335	9.72	5198	10.01	5028	10.16	4853	10.28
	3500	SQBI	1/2	6091	12.76	5974	13.09	5858	13.39	5743	13.67	5627	13.93	5511	14.17
	3500	HDBI	3/4	8419	13.71	8209	14.15	8003	14.58	7796	15.02	7541	15.24	7279	15.42
	3500	SQBI	3/4	91.36	19.14	8961	19.63	8787	20.09	8614	20.51	8441	20.90	8267	21.25
	3500	HDBI	FULL	11225	18.28	10945	18.86	10670	19.44	10395	20.02	10055	20.32	9705	20.56
	3500	SQBI	FULL	12181	25.52	11947	26.18	11716	26.79	11486	27.35	11255	27.87	11022	28.34
HDBI-200	1750	SQBI	1/2	3934	2.85	3658	3.02	3371	3.16	3045	3.18	2612	3.09	1722	2.51
	1750	HDBI	3/4	5220	2.91	4676	3.07	4076	3.17	3293	3.11				
	1750	SQBI	3/4	5901	4.27	5487	4.53	5057	4.74	4568	4.77	3918	4.63	2583	3.77
	1750	HDBI	FULL	6960	3.88	6235	4.09	5435	4.23	4390	4.14				
	1750	SQBI	FULL	7868	5.69	7317	6.05	6743	6.33	6091	6.36	5224	6.18	3444	5.03
	3500	HDBI	1/2	7415	14.37	7265	14.75	7113	15.14	6960	15.52	6810	15.90	6620	16.07
	3500	SQBI	1/2	8268	21.53	8135	21.94	8001	22.35	7867	22.76	7734	23.17	7600	23.58
	3500	HDBI	3/4	11123	21.56	10898	22.13	10669	22.70	10440	23.27	10215	23.85	9930	24.10
	3500	SQBI	3/4	12403	32.29	12202	32.91	12002	33.52	11801	34.14	11601	34.76	11401	35.37
	3500	HDBI	FULL	14830	28.74	14530	29.50	14225	30.27	13920	31.03	13620	31.80	13240	32.13
	3500	SQBI	FULL	16537	43.05	16270	43.88	16003	44.70	15735	45.52	15468	46.34	15201	47.16

Performance shown is for installation type B-Free inlet,ducted outlet. Performance ratings do not include the effects of appurtenances (accessories).

CFM and BHP at Static Pressure Shown
Ratings at 70°F., .075 Density, Sea Level

7" SP		8" SP		9" SP		10" SP		11" SP		12" SP		13" SP		14" SP	
CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
1330 †	2.15	1201 †	2.11	1021	1.95										
1996	3.22	1801	3.16	1532	2.93										
1580 †	2.76														
2661	4.29	2402	4.21	2043	3.90										
1951	3.47	1838	3.48	1705	3.45	1559	3.39	1347	3.14						
2927	5.20	2758	5.22	2558	5.18	2339	5.08	2021	4.71						
2595	4.85	2172	4.71												
3903	6.93	3677	6.97	3411	6.91	3119	6.78	2695	6.28						
2255	4.03	2070	4.01												
2758	5.60	2643	5.66	2527	5.71	2406	5.74	2244	5.68	2081	5.62	1817	5.35	1086	4.39
3383	6.05	3105	6.02												
4137	8.41	3965	8.48	3791	8.56	3610	8.61	3367	8.52	3121	8.43	2725	8.02	1629	6.58
4510	8.06	4140	8.02	3700	7.87	3200	7.66								
5516	11.21	5287	11.31	5055	11.41	4813	11.49	4489	11.37	4162	11.24	3634	10.69	2173	8.77
3245	6.38	3080	6.45	2913	6.52	2680	6.43								
3859	8.91	3746	9.03	3628	9.12	3503	9.20	3370	9.24	3227	9.25	3067	9.22	2885	9.14
4868	9.57	4620	9.68	4369	9.78	4020	9.65								
5788	13.36	5618	13.54	5441	13.68	5255	13.79	5056	13.86	4840	13.88	4601	13.83	4327	13.70
6490	12.76	6160	12.90	5825	13.04	5360	12.86	4870	12.64	4335	12.39				
7718	17.82	7491	18.05	7255	18.25	7006	18.39	6741	18.48	6453	18.51	6134	18.45	5769	18.27
4675	10.40	4495	10.51	4310	10.60	4128	10.70	3943	10.80						
5393	14.39	5273	14.59	5150	14.75	5024	14.90	4893	15.03	4756	15.13	4612	15.20	4459	15.24
7013	15.60	6743	15.76	6465	15.90	6191	16.05	5914	16.19						
8090	21.58	7910	21.87	7726	22.13	7536	22.36	7339	22.55	7134	22.70	6918	22.80	6689	22.86
9350	20.80	8990	21.01	8620	21.20	8255	21.40	7885	21.59	7375	21.34	6865	21.08	6265	20.74
10786	28.77	10547	29.16	10301	29.51	10048	29.81	9786	30.06	9512	30.26	9224	30.40	8918	30.48
6425	16.22	6323	16.38	6038	16.52	5838	16.65	5635	16.78	5425	16.92	5233	17.05	4968	16.94
7458	23.88	7317	24.18	7175	24.48	7033	24.78	6891	25.08	6743	25.30	6580	25.34	6417	25.38
9638	24.33	9349	24.56	9056	24.78	8756	24.98	8453	25.17	8153	25.37	7849	25.57	7451	25.40
11188	35.82	10975	36.27	10762	36.72	10550	37.17	10337	37.62	10115	37.95	9870	38.01	9626	38.07
12850	32.44	12465	32.75	12075	33.04	11675	33.30	11270	33.56	10870	33.83	10465	34.09	9935	33.87
14917	47.76	14364	48.36	14350	48.96	14066	49.56	13783	50.16	13487	50.60	13160	50.68	12834	50.76

† Requires a 143T frame or larger even though BHP is available in a 56 frame. See pages 25 or 26.

See additional HDBI-160 ratings at bottom of page 10.

See additional HDBI-180 ratings at bottom of page 10.

See additional HDBI-200 ratings at bottom of pages 10 & 11.

DIRECT DRIVE RATING TABLES (cont'd)

The partial width fan ratings shown on this page and on Pages 8, 9 and 11 were derived from tests performed in accordance with AMCA Publication 211 and fan laws were applied to arrive at the data shown for partial width fans. However, none of the partial width fans or fans with SQBI wheels are licensed to bear the AMCA seal. All 100% width fans with HDBI wheels are licensed to bear the AMCA seal as shown on pages 7 and 12 through 23.

MODEL NUMBER	RPM	WHEEL TYPE	FAN WIDTH	1" SP		2" SP		3" SP		4" SP		5" SP		6" SP	
				CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
HDBI-220	1750	HDBI	1/2	4950	3.21	4635	3.45	4305	3.63	3878	3.70				
	1750	SQBI	1/2	5375	4.43	5104	4.69	4777	4.83	4443	4.97	4092	5.07	3655	5.08
	1750	HDBI	3/4	7425	4.81	6953	5.17	6548	5.45	5816	5.54				
	1750	SQBI	3/4	8063	6.65	7656	7.03	7166	7.25	6664	7.45	6138	7.60	5483	7.62
	1750	HDBI	FULL	9900	6.41	9270	6.89	8610	7.26	7755	7.39	6820	7.42		
	1750	SQBI	FULL	10750	8.87	10209	9.37	9555	9.67	8886	9.93	8184	10.13	7311	10.16
	3500	HDBI	1/2	10364	23.77	10209	24.34	10054	24.91	9899	25.48	9744	26.05	9589	26.62
	3500	HDBI	3/4	15547	35.66	15314	36.51	15081	37.37	14849	38.22	14616	39.08	14383	39.94
	3500	HDBI	FULL	20729	47.54	20419	48.68	20109	49.82	19799	50.97	19488	52.11	19178	53.25
HDBI-240	1750	HDBI	1/2	6683	5.11	6340	5.46	5980	5.72	5593	5.93	5103	5.99		
	1750	SQBI	1/2	7250	7.12	6955	7.47	6618	7.72	6258	7.92	5884	8.08	5497	8.21
	1750	HDBI	3/4	10024	7.67	9510	8.19	8970	8.58	8389	8.89	7654	8.98		
	1750	SQBI	3/4	10875	10.68	10433	11.20	9928	11.58	9388	11.87	8826	12.12	8246	12.32
	1750	HDBI	FULL	13365	10.22	12680	10.92	11960	11.44	11185	11.85	10205	11.97	9175	12.02
	1750	SQBI	FULL	14500	14.25	13911	14.93	13237	15.43	12517	15.83	11769	16.16	10995	16.43
HDBI-270	1750	HDBI	1/2	9443	8.81	9078	9.27	8703	9.69	8288	10.00	7873	10.32	7365	10.42
	1750	SQBI	1/2	9764	11.46	9440	11.92	9106	12.36	8709	12.62	8312	12.89	7898	13.10
	1750	HDBI	3/4	14161	13.22	13616	13.90	13054	14.53	12431	15.00	11803	15.47	11048	15.61
	1750	SQBI	3/4	14647	17.20	14161	17.89	13659	18.53	13064	18.93	12469	19.33	11848	19.65
	1750	HDBI	FULL	18885	17.62	18155	18.53	17405	19.37	16575	20.00	15745	20.63	14730	20.81
	1750	SQBI	FULL	19529	22.93	18881	23.85	18212	24.71	17418	25.24	16625	25.78	15797	26.21
HDBI-300	1750	HDBI	1/2	13048	14.77	12645	15.40	12240	16.02	11803	16.53	11340	16.96	10880	17.39
	1750	SQBI	1/2	13496	19.30	13136	19.94	12775	20.57	12377	21.08	11936	21.44	11495	21.81
	1750	HDBI	3/4	19571	22.16	18968	23.09	18360	24.03	17704	24.80	17010	25.44	16320	26.08
	1750	SQBI	3/4	20244	28.96	19704	29.91	19163	30.86	18565	31.61	17904	32.16	17242	32.71
	1750	HDBI	FULL	26095	29.54	25290	30.79	24480	32.04	23605	33.06	22680	33.92	21760	34.77
	1750	SQBI	FULL	26992	38.61	26272	39.87	25551	41.14	24754	42.15	23872	42.88	22990	43.61
HDBI-330	1750	HDBI	1/2	17453	23.38	17011	24.28	16568	25.19	16125	26.09	15627	26.71	15120	27.28
	1750	SQBI	1/2	19051	34.49	18555	35.13	18059	35.77	17538	36.25	16985	36.53	16432	36.81
	1750	HDBI	3/4	26180	35.07	25516	36.43	24852	37.78	24188	39.14	23441	40.07	22680	40.92
	1750	SQBI	3/4	28576	51.73	27832	52.69	27088	53.65	26307	54.38	25478	54.79	24648	55.21
	1750	HDBI	FULL	34907	46.77	34022	48.58	33136	50.38	32251	52.19	31254	53.42	30240	54.56
	1750	SQBI	FULL	38102	68.98	37110	70.26	36118	71.54	35076	72.50	33970	73.06	32864	73.62
HDBI-360	1750	HDBI	1/2	22751	35.91	22268	37.08	21785	38.25	21302	39.43	20814	40.57	20261	41.31
	1750	SQBI	1/2	25982	57.19	25433	58.06	24884	58.93	24336	59.79	23747	60.35	23134	60.73
	1750	HDBI	3/4	34127	53.86	33402	55.62	32678	57.38	31954	59.13	31221	60.85	30391	61.96
	1750	SQBI	3/4	38973	85.79	38150	87.09	37327	88.39	36504	89.69	35620	90.53	34702	91.10
	1750	HDBI	FULL	45503	71.82	44537	74.16	43571	76.51	42605	78.85	41629	81.13	40522	82.61

MODEL NUMBER	RPM	WHEEL TYPE	FAN WIDTH	15" SP		16" SP		17" SP		18" SP		19" SP		20" SP	
				CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
HDBI-160	3500	SQBI	1/2	2664	8.96	2366	8.61								
	3500	SQBI	3/4	3996	13.44	3549	12.92								
	3500	SQBI	FULL	5328	17.92	4732	17.22								
HDBI-180	3500	SQBI	1/2	4295	15.24	4114	15.18								
	3500	SQBI	3/4	6442	22.86	6171	22.78								
	3500	SQBI	FULL	8589	30.47	8229	30.37								
HDBI-200	3500	SQBI	1/2	6254	25.42	6091	25.46	5922	25.47	5690	25.21	5457	24.96	5224	24.70
	3500	SQBI	3/4	9381	38.13	9137	38.18	8884	38.20	8535	37.82	8185	37.44	7836	37.06
	3500	SQBI	FULL	12508	50.83	12182	50.91	11845	50.94	11380	50.43	10914	49.92	10449	49.41
HDBI-220	3500	HDBI	1/2	7975	29.46	7753	29.55	7531	29.64	7309	29.73	7066	29.72	6822	29.70
	3500	HDBI	3/4	11963	44.19	11630	44.33	11297	44.46	10964	44.59	10600	44.58	10233	44.54
	3500	HDBI	FULL	15951	58.93	15507	59.10	15063	59.28	14619	59.46	14133	59.43	13644	59.39
HDBI-330	1750	SQBI	1/2	8235	31.96										
	1750	SQBI	3/4	12352	47.95										
	1750	SQBI	FULL	16470	63.93										
HDBI-360	1750	SQBI	1/2	16331	60.33	15064	59.99	13619	59.67	11878	55.24				
	1750	SQBI	3/4	24497	90.49	22597	89.99	20429	89.50	17817	82.87				

Performance shown is for installation type B-Free inlet,ducted outlet. Performance ratings do not include the effects of appurtenances (accessories).

CFM and BHP at Static Pressure Shown
Ratings at 70°F., .075 Density, Sea Level

7" SP		8" SP		9" SP		10" SP		11" SP		12" SP		13" SP		14" SP	
CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
3061	4.96														
4591	7.43														
6122	9.91														
9434	27.19	9269	27.56	9105	27.93	8940	28.31	8776	28.68	8611	29.05	8420	29.29	8198	29.37
14151	40.79	13904	41.35	13657	41.90	13411	42.46	13164	43.02	12917	43.57	12630	43.93	12297	44.06
18868	54.39	18539	55.13	18210	55.87	17881	56.61	17552	57.35	17223	58.10	16840	58.57	16396	58.75
5045	8.27	4464	8.17	3641	7.81										
7567	12.40	6696	12.25	5462	11.71										
10090	16.53	8929	16.34	7283	15.61										
7472	13.28	7046	13.46	6437	13.37	5731	13.16	4756	12.55						
11208	19.92	10569	20.19	9655	20.05	8597	19.74	7134	18.83						
13625	20.87	11950	20.29												
14945	26.56	14092	26.92	12874	26.73	11463	26.32	9512	25.10						
10343	17.60														
11044	22.13	10570	22.38	10097	22.62	9607	22.84	8923	22.70	8198	22.50	7281	22.03	5851	20.43
15514	26.39														
16566	33.20	15856	33.57	15145	33.93	14411	34.26	13385	34.05	12297	33.75	10922	33.05	8776	30.65
20685	35.19	19515	35.34	18025	35.05										
22089	44.27	21141	44.76	20194	45.25	19215	45.68	17847	45.39	16396	45.00	14562	44.06	11702	40.86
14613	27.85	14066	28.28	13423	28.38	12780	28.48	11882	28.16	10856	27.64				
15875	37.07	15208	37.00	14542	36.92	13866	36.83	13046	36.57	12225	36.32	11166	36.07	9860	35.83
21920	41.77	21100	42.42	20135	42.58	19170	42.73	17823	42.25	16285	41.45				
23812	55.61	22812	55.50	21813	55.38	20799	55.24	19569	54.86	18338	54.47	16749	54.10	14791	53.74
29226	55.71	28133	56.57	26846	56.77	25560	56.98	23764	56.34	21713	55.28				
31750	74.15	30417	73.99	29084	73.84	27732	73.66	26092	73.15	24451	72.63	22332	72.14	19721	71.66
19708	42.05	19154	42.78	18601	43.53	17925	43.76	17224	43.89	16523	44.03	15528	43.58	14408	42.89
22522	61.11	21909	61.49	21239	61.65	20501	61.54	19763	61.43	19025	61.33	18148	61.02	17240	60.68
29562	63.07	28732	64.18	27902	65.29	26888	65.64	25836	65.84	24784	66.04	23292	65.37	21613	64.37
33783	91.67	32864	92.24	31858	92.47	30752	92.31	29645	92.15	28538	91.99	27223	91.54	25860	91.01
39416	84.10	38309	85.58	37203	87.06	35851	87.53	34448	87.80	33046	88.06	31056	87.17	28817	85.80

See additional HDBI-220 ratings at bottom of page 10 and this page.

See additional HDBI-330 and HDBI-360 ratings at bottom of page 10.

21" SP		22" SP		23" SP		24" SP		25" SP		26" SP		27" SP		28" SP	
CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP	CFM	BHP
4950	24.32	4616	23.74	4282	23.16	3444	20.10	2845	17.59						
7426	36.48	6924	35.60	6423	34.73	5166	30.15	4267	26.39						
9901	48.63	9233	47.47	8564	46.31	6888	40.20	5690	35.18						
6577	29.68	6072	29.04	5522	28.29										
9865	44.51	9108	43.56	8283	42.44										
13154	59.35	12144	58.07	11044	56.58										

HDBI-120

BELT DRIVE RATING TABLES

Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. - 12.25"

OUTLET O.D.
Size - 9.38" x 13.69"
Area - .85 Sq. Ft. I.D.

INLET O.D.
Size - 13.25"
Area - .93 Sq.Ft. I.D.

SEE PAGE 24 FOR MAX. WHEEL RPM & WR².

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face

VOLUME	O.V.	0" SP		1/4" SP		1/2" SP		3/4" SP		1" SP		1 1/2" SP		2" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
600	705	589	.01	812	.04	995	.07	1164	.11	1324	.15				
750	882	737	.02	920	.06	1084	.09	1227	.13	1366	.18	1624	.28	1850	.39
900	1058	884	.04	1045	.08	1185	.12	1316	.17	1437	.21	1666	.32	1883	.44
1050	1235	1032	.07	1173	.11	1294	.16	1415	.21	1526	.26	1730	.37	1928	.50
1200	1411	1179	.10	1305	.15	1416	.20	1522	.26	1625	.32	1818	.44	1990	.57
1350	1588	1326	.14	1440	.20	1543	.26	1636	.32	1731	.38	1909	.51	2078	.65
1500	1764	1474	.19	1578	.26	1672	.33	1760	.39	1841	.46	2011	.60	2168	.75
1650	1941	1621	.25	1717	.33	1803	.41	1887	.48	1964	.55	2118	.70	2265	.86
1800	2117	1768	.33	1857	.41	1938	.50	2015	.57	2089	.65	2227	.81	2370	.98
1950	2294	1916	.42	1998	.51	2074	.60	2146	.69	2217	.77	2347	.94	2478	1.12
2100	2470	2063	.52	2140	.62	2211	.71	2279	.81	2346	.90	2471	1.08	2587	1.27
2250	2647	2211	.64	2282	.74	2350	.85	2414	.95	2477	1.06	2597	1.25	2709	1.44
2400	2823	2358	.78	2425	.89	2490	1.00	2551	1.11	2609	1.23	2725	1.43	2833	1.63
2550	3000	2505	.93	2569	1.05	2630	1.16	2688	1.28	2744	1.41	2854	1.63	2958	1.85
2700	3176	2653	1.11	2713	1.23	2771	1.35	2827	1.48	2880	1.61	2985	1.85	3086	2.08
2850	3352	2800	1.30	2857	1.43	2913	1.56	2966	1.69	3017	1.83	3116	2.09	3214	2.33

VOLUME	O.V.	2 1/2" SP		3" SP		4" SP		5" SP		6" SP		7" SP		8" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
1050	1235	2116	.64	2295	.78	2614	1.09								
1200	1411	2165	.71	2329	.86	2647	1.20	2928	1.55						
1350	1588	2230	.80	2386	.96	2681	1.30	2961	1.68	3215	2.07				
1500	1764	2317	.90	2455	1.06	2732	1.42	2995	1.81	3249	2.23	3482	2.66	3699	3.11
1650	1941	2407	1.02	2543	1.19	2792	1.56	3044	1.96	3283	2.39	3516	2.84	3733	3.32
1800	2117	2501	1.15	2632	1.34	2874	1.72	3103	2.12	3331	2.57	3550	3.03	3767	3.53
1950	2294	2606	1.30	2725	1.49	2963	1.89	3177	2.31	3391	2.76	3601	3.24	3801	3.74
2100	2470	2713	1.47	2829	1.67	3053	2.09	3265	2.52	3459	2.98	3660	3.47	3855	3.99
2250	2647	2821	1.65	2935	1.86	3145	2.29	3354	2.76	3546	3.23	3726	3.72	3915	4.25
2400	2823	2934	1.85	3043	2.07	3250	2.53	3445	3.00	3635	3.50	3813	4.01	3980	4.53
2550	3000	3057	2.07	3153	2.30	3355	2.78	3540	3.27	3726	3.79	3901	4.32	4067	4.86
2700	3176	3181	2.31	3272	2.55	3463	3.05	3645	3.56	3817	4.10	3991	4.65	4155	5.21
2850	3352	3307	2.58	3395	2.83	3571	3.34	3751	3.88	3918	4.43	4082	5.00	**4245**	**5.59**
3000	3529	3434	2.87	3520	3.13	3682	3.66	3858	4.22	4022	4.79	4177	5.37	**4336**	**5.98**
3150	3705	3562	3.18	3646	3.45	3804	4.00	3966	4.58	4128	5.17	**4281**	**5.78**	**4427**	**6.40**
3300	3882	3692	3.52	3773	3.80	3928	4.38	4076	4.96	**4236**	**5.58**	**4387**	**6.21**	**4530**	**6.85**
3450	4058	3822	3.89	3902	4.18	4053	4.78	**4194**	**5.38**	**4344**	**6.01**	**4493**	**6.67**	**4635**	**7.33**
3600	4235	3953	4.29	4031	4.59	4178	5.20	**4317**	**5.83**	**4454**	**6.48**	**4601**	**7.15**	**4741**	**7.83**
3750	4411	4086	4.71	4161	5.02	**4305**	**5.66**	**4442**	**6.31**	**4571**	**6.97**	**4710**	**7.66**	**4848**	**8.37**
3900	4588	**4220**	**5.15**	**4293**	**5.49**	**4433**	**6.15**	**4567**	**6.82**	**4694**	**7.50**	**4820**	**8.20**	**4956**	**8.93**
4050	4764	**4355**	**5.62**	**4425**	**5.99**	**4562**	**6.67**	**4693**	**7.37**	**4817**	**8.07**	**4937**	**8.78**		
4200	4941	**4491**	**6.11**	**4558**	**6.52**	**4692**	**7.23**	**4820**	**7.94**	**4942**	**8.67**				

VOLUME	O.V.	9" SP		10" SP		11" SP		12" SP		13" SP		14" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
1800	2117	3971	4.03	4164	4.56	**4347**	**5.09**						
1950	2294	4004	4.27	**4197**	**4.82**	**4381**	**5.37**	**4556**	**5.95**	**4724**	**6.53**		
2100	2470	4039	4.52	**4231**	**5.08**	**4414**	**5.66**	**4590**	**6.26**	**4758**	**6.86**	**4920**	**7.48**
2250	2647	4098	4.80	**4272**	**5.37**	**4448**	**5.96**	**4623**	**6.57**	**4791**	**7.20**	**4953**	**7.84**
2400	2823	4157	5.10	**4331**	**5.68**	**4496**	**6.28**	**4658**	**6.90**	**4825**	**7.55**		
2550	3000	**4224**	**5.42**	**4390**	**6.01**	**4555**	**6.64**	**4713**	**7.27**	**4865**	**7.91**		
2700	3176	**4311**	**5.79**	**4459**	**6.38**	**4615**	**7.00**	**4772**	**7.66**	**4924**	**8.32**		
2850	3352	**4399**	**6.18**	**4546**	**6.79**	**4687**	**7.41**	**4832**	**8.06**	**4983**	**8.75**		
3000	3529	**4489**	**6.60**	**4635**	**7.23**	**4775**	**7.87**	**4909**	**8.52**				
3150	3705	**4579**	**7.04**	**4724**	**7.69**	**4863**	**8.35**						
3300	3882	**4671**	**7.50**	**4815**	**8.18**	**4952**	**8.86**						
3450	4058	**4770**	**8.00**	**4906**	**8.69**								

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-130

BELT DRIVE RATING TABLES

Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. - 13.50"

OUTLET O.D.
Size - 10.38" x 15.19"
Area - 1.05 Sq. Ft. I.D.

INLET O.D.
Size - 14.63"
Area - 1.14 Sq.Ft. I.D.

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

SEE PAGE 24 FOR MAX. WHEEL RPM & WR².

VOLUME	O.V.	0" SP		¼" SP		½" SP		¾" SP		1" SP		1½" SP		2" SP		2½" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
900	857	672	.03	867	.08	1027	.13	1167	.18	1290	.24	1500	.37	1706	.51	1892	.67
1100	1047	821	.06	986	.11	1129	.17	1257	.23	1372	.30	1579	.44	1756	.60	1921	.76
1300	1238	971	.10	1111	.16	1242	.22	1356	.29	1465	.37	1661	.52	1835	.69	1990	.87
1500	1428	1120	.15	1241	.22	1361	.29	1468	.37	1565	.45	1751	.62	1918	.81	2071	1.00
1700	1619	1269	.21	1378	.29	1484	.37	1583	.46	1677	.55	1847	.73	2007	.93	2153	1.14
1900	1809	1419	.30	1518	.39	1611	.48	1705	.57	1792	.67	1952	.87	2102	1.08	2243	1.30
2100	2000	1568	.40	1658	.50	1741	.60	1829	.70	1911	.81	2064	1.02	2202	1.25	2339	1.49
2300	2190	1717	.53	1801	.64	1877	.74	1956	.85	2034	.97	2179	1.20	2313	1.44	2436	1.69
2500	2380	1866	.68	1944	.79	2016	.91	2084	1.03	2159	1.15	2297	1.40	2426	1.66	2546	1.93
2700	2571	2016	.86	2088	.98	2155	1.10	2219	1.23	2286	1.36	2419	1.63	2541	1.91	2658	2.19
2900	2761	2165	1.06	2232	1.20	2296	1.33	2356	1.46	2415	1.60	2543	1.89	2660	2.18	2772	2.48
3100	2952	2314	1.30	2378	1.44	2438	1.58	2495	1.72	2550	1.87	2669	2.17	2782	2.48	2889	2.80
3300	3142	2464	1.57	2523	1.72	2580	1.87	2635	2.02	2687	2.17	2796	2.49	2906	2.82	3009	3.15
3500	3333	2613	1.87	2669	2.03	2723	2.19	2775	2.35	2826	2.51	2925	2.84	3031	3.19	3132	3.54
3700	3523	2762	2.21	2816	2.38	2867	2.54	2917	2.71	2965	2.89	3057	3.23	2158	3.59	3255	3.96
3900	3714	2912	2.59	2962	2.76	3012	2.94	3059	3.12	3105	3.30	3194	3.66	3286	4.04	3381	4.42
4100	3904	3061	3.01	3109	3.19	3156	3.38	3202	3.56	3246	3.75	3332	4.13	3415	4.52	3507	4.92
4300	4095	3210	3.47	3257	3.66	3301	3.86	3345	4.05	3388	4.25	3470	4.65	3549	5.05	3635	5.47
4500	4285	3360	3.98	3404	4.18	3447	4.38	3489	4.59	3530	4.79	3609	5.21	3686	5.63	3764	6.06
4700	4476	3509	4.53	3551	4.74	3593	4.95	3633	5.17	3673	5.38	3749	5.82	3823	6.25	**3895**	**6.69**

VOLUME	O.V.	3" SP		4" SP		5" SP		6" SP		7" SP		8" SP		9" SP		10" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
1500	1428	2211	1.20	2461	1.63	2708	2.10	2946	2.60	3165	3.12	3368	3.65	3560	4.21	3741	4.79
1700	1619	2292	1.36	2540	1.82	2760	2.31	2975	2.83	3193	3.38	3397	3.95	3588	4.54	3769	5.15
1900	1809	2375	1.54	2620	2.03	2839	2.54	3039	3.08	3223	3.65	3426	4.25	3617	4.88	3798	5.52
2100	2000	2466	1.73	2703	2.25	2920	2.80	3118	3.37	3301	3.96	3472	4.58	3646	5.22	3827	5.90
2300	2190	2562	1.95	2789	2.50	3002	3.08	3198	3.68	3380	4.30	3550	4.95	3711	5.61	**3863**	**6.29**
2500	2380	2659	2.20	2883	2.78	3086	3.38	3281	4.01	3461	4.67	3630	5.34	3790	6.03	**3941**	**6.75**
2700	2571	2767	2.48	2979	3.08	3178	3.71	3364	4.37	3543	5.06	3711	5.76	**3870**	**6.49**	**4021**	**7.23**
2900	2761	2879	2.78	3077	3.41	3274	4.07	3454	4.76	3627	5.47	3793	6.21	**3951**	**6.96**	**4101**	**7.74**
3100	2952	2993	3.12	3186	3.78	3370	4.46	3549	5.18	3716	5.92	**3877**	**6.68**	**4034**	**7.47**	**4183**	**8.27**
3300	3142	3108	3.49	3297	4.18	3471	4.89	3645	5.64	3811	6.41	**3966**	**7.20**	**4117**	**8.01**	**4265**	**8.84**
3500	3333	3227	3.89	3410	4.62	3581	5.36	3743	6.13	**3906**	**6.93**	**4060**	**7.75**	**4207**	**8.59**	**4349**	**9.44**
3700	3523	3348	4.33	3525	5.09	3692	5.87	**3849**	**6.66**	**4004**	**7.49**	**4156**	**8.34**	**4301**	**9.21**	**4439**	**10.09**
3900	3714	3471	4.81	3641	5.60	3806	6.42	**3959**	**7.24**	**4104**	**8.08**	**4253**	**8.97**	**4396**	**9.87**	**4533**	**10.79**
4100	3904	3595	5.33	3761	6.16	**3920**	**7.00**	**4071**	**7.86**	**4214**	**8.74**	**4351**	**9.63**	**4493**	**10.57**	**4629**	**11.52**
4300	4095	3721	5.89	**3883**	**6.76**	**4036**	**7.63**	**4185**	**8.53**	**4325**	**9.44**	**4459**	**10.36**	**4591**	**11.31**	**4726**	**12.29**
4500	4285	**3847**	**6.50**	**4006**	**7.40**	**4155**	**8.31**	**4299**	**9.24**	**4438**	**10.18**	**4570**	**11.14**	**4696**	**12.11**	*4823*	*13.11*
4700	4476	**3975**	**7.15**	**4130**	**8.09**	**4276**	**9.03**	**4415**	**9.99**	**4552**	**10.97**	**4682**	**11.96**	*4806*	*12.96*	*4926*	*13.98*
4900	4666	**4104**	**7.86**	**4255**	**8.82**	**4398**	**9.80**	**4534**	**10.80**	**1667**	**11.81**	*4795*	*12.83*	*4918*	*13.87*		
5100	4857	**4234**	**8.61**	**4382**	**9.61**	**4522**	**10.63**	**4654**	**11.66**	*4783*	*12.70*	*4909*	*13.76*				

VOLUME	O.V.	11" SP		12" SP		13" SP		14" SP		15" SP		16" SP		17" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
1900	1809	**3970**	**6.18**	**4134**	**6.85**	**4292**	**7.54**	**4444**	**8.25**	**4590**	**8.97**	**4732**	**9.70**		
2100	2000	**3999**	**6.59**	**4163**	**7.30**	**4320**	**8.02**	**4472**	**8.76**	**4619**	**9.51**	**4760**	**10.28**	*4898*	*11.06*
2300	2190	**4027**	**7.01**	**4192**	**7.75**	**4349**	**8.51**	**4501**	**9.28**	**4647**	**10.06**	**4789**	**10.86**	*4926*	*11.67*
2500	2380	**4086**	**7.47**	**4224**	**8.22**	**4378**	**9.00**	**4530**	**9.81**	**4676**	**10.63**	*4818*	*11.46*	*4955*	*12.30*
2700	2571	**4164**	**7.99**	**4302**	**8.76**	**4435**	**9.55**	**4563**	**10.36**	**4705**	**11.20**	*4847*	*12.07*	*4984*	*12.95*
2900	2761	**4244**	**8.53**	**4381**	**9.33**	**4513**	**10.15**	**4641**	**10.99**	*4764*	*11.84*	*4883*	*12.70*		
3100	2952	**4325**	**9.09**	**4461**	**9.93**	**4593**	**10.78**	**4719**	**11.65**	*4842*	*12.53*	*4961*	*13.42*		
3300	3142	**4407**	**9.70**	**4543**	**10.56**	**4673**	**11.44**	*4799*	*12.34*	*4921*	*13.25*				
3500	3333	**4490**	**10.33**	**4625**	**11.23**	*4755*	*12.14*	*4880*	*13.07*						
3700	3523	**4574**	**11.00**	**4708**	**11.93**	*4837*	*12.87*	*4962*	*13.83*						
3900	3714	**4665**	**11.72**	*4792*	*12.66*	*4921*	*13.64*								
4100	3904	*4759*	*12.48*	*4885*	*13.46*										

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-150

BELT DRIVE RATING TABLES

Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. - 15.00"

OUTLET O.D.
Size - 11.38" x 16.75"
Area - 1.28 Sq. Ft. I.D.

INLET O.D.
Size - 16.13"
Area - 1.39 Sq.Ft. I.D.

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

SEE PAGE 24 FOR MAX. WHEEL RPM & WR^2.

VOLUME	O.V.	0" SP		1/4" SP		1/2" SP		3/4" SP		1" SP		1 1/2" SP		2" SP		2 1/2" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
1750	1367	959	.14	1062	.21	1165	.29	1258	.37	1341	.45	1502	.63	1651	.83	1789	1.04
2000	1562	1096	.20	1188	.29	1278	.37	1364	.46	1444	.56	1585	.75	1728	.96	1858	1.18
2250	1757	1233	.29	1316	.38	1394	.48	1475	.58	1550	.68	1686	.89	1809	1.12	1936	1.35
2500	1953	1370	.40	1446	.50	1514	.61	1589	.72	1659	83	1789	1.06	1907	1.30	2017	1.55
2750	2148	1507	.53	1576	.64	1640	.76	1705	.88	1772	1.00	1895	1.25	2009	1.50	2114	1.77
3000	2343	1644	.68	1708	.81	1768	.93	1824	1.07	1887	1.20	2005	1.46	2114	1.74	2216	2.02
3250	2539	1781	.87	1840	1.00	1896	1.14	1949	1.28	2003	1.42	2117	1.71	2221	2.00	2320	2.30
3500	2734	1918	1.09	1973	1.23	2026	1.38	2076	1.53	2124	1.68	2230	1.98	2331	2.30	2425	2.61
3750	2929	2055	1.33	2107	1.49	2156	1.65	2204	1.81	2249	1.97	2346	2.29	2443	2.62	2534	2.96
4000	3125	2192	1.62	2241	1.78	2288	1.95	2333	2.12	2376	2.29	2463	2.64	2557	2.99	2645	3.35
4250	3320	2329	1.94	2375	2.12	2419	2.29	2462	2.47	2504	2.66	2583	3.02	2672	3.39	2757	3.77
4500	3515	2466	2.31	2510	2.49	2552	2.68	2593	2.87	2632	3.06	2708	3.45	2788	3.84	2871	4.23
4750	3710	2603	2.71	2644	2.91	2685	3.10	2724	3.30	2761	3.50	2834	3.91	2906	4.33	2986	4.74
5000	3906	2740	3.16	2779	3.37	2818	3.58	2855	3.79	2891	4.00	2962	4.42	3029	4.86	3103	5.29
5250	4101	2877	3.66	2915	3.88	2951	4.09	2987	4.31	3022	4.53	3089	4.98	3154	5.44	3220	5.89
5500	4296	3014	4.21	3050	4.44	3085	4.66	3119	4.89	3153	5.12	3218	5.59	3281	6.06	3341	6.54
5750	4492	3151	4.81	3185	5.05	3219	5.28	3252	5.52	3284	5.76	3347	6.25	3408	6.74	3466	7.24
6000	4687	3288	5.47	3321	5.71	3353	5.96	3385	6.21	3416	6.46	3477	6.97	**3535**	**7.48**	**3592**	**8.00**
6250	4882	3425	6.18	3457	6.43	3488	6.69	**3518**	**6.95**	**3548**	**7.21**	**3607**	**7.74**	**3664**	**8.27**	**3719**	**8.81**
6500	5078	**3562**	**6.95**	**3593**	**7.21**	**3623**	**7.48**	**3652**	**7.75**	**3681**	**8.02**	**3738**	**8.57**	**3793**	**9.12**	**3846**	**9.68**

VOLUME	O.V.	3" SP		4" SP		5" SP		6" SP		7" SP		8" SP		9" SP		10" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
1750	1367	1917	1.26	2175	1.77	2403	2.33										
2000	1562	1982	1.42	2210	1.92	2438	2.51	2644	3.14								
2250	1757	2053	1.60	2273	2.13	2473	2.70	2679	3.35	2868	4.04	3045	4.76				
2500	1953	2132	1.81	2342	2.36	2536	2.96	2714	3.58	2903	4.30	3079	5.05	3245	5.83	3402	6.63
2750	2148	2213	2.05	2418	2.63	2606	3.25	2782	3.90	2944	4.58	3115	5.34	3280	6.15	3437	6.99
3000	2343	2310	2.31	2499	2.93	2680	3.57	2851	4.25	3013	4.96	3164	5.70	3315	6.49	3472	7.36
3250	2539	2412	2.61	2582	3.25	2760	3.93	2924	4.63	3083	5.37	3233	6.14	3374	6.93	3509	7.75
3500	2734	2516	2.94	2682	3.62	2841	4.32	3004	5.06	3155	5.81	3303	6.61	3443	7.44	**3577**	**8.28**
3750	2929	2621	3.31	2784	4.02	2934	4.75	3085	5.52	3235	6.31	3376	7.12	**3514**	**7.97**	**3647**	**8.85**
4000	3125	2728	3.71	2888	4.45	3034	5.22	3171	6.01	3315	6.84	3455	7.69	**3588**	**8.55**	**3717**	**9.45**
4250	3320	2838	4.15	2993	4.93	3136	5.73	3270	6.56	3397	7.41	**3536**	**8.29**	**3667**	**9.19**	**3792**	**10.11**
4500	3515	2950	4.63	3099	5.45	3240	6.29	3372	7.15	3496	8.03	**3618**	**8.93**	**3748**	**9.87**	**3872**	**10.83**
4750	3710	3063	5.16	3208	6.01	3345	6.89	3475	7.78	**3597**	**8.70**	**3713**	**9.63**	**3829**	**10.59**	**3953**	**11.58**
5000	3906	3177	5.73	3319	6.62	3452	7.53	3579	8.46	**3699**	**9.41**	**3814**	**10.38**	**3923**	**11.37**	**4034**	**12.38**
5250	4101	3293	6.35	3431	7.28	**3560**	**8.22**	**3684**	**9.19**	**3803**	**10.18**	**3916**	**11.18**	**4024**	**12.21**	**4127**	**13.24**
5500	4296	3409	7.02	**3544**	**7.99**	**3670**	**8.97**	**3791**	**9.97**	**3907**	**10.99**	**4018**	**12.04**	**4125**	**13.09**	**4228**	**14.17**
5750	4492	**3527**	**7.74**	**3658**	**8.75**	**3782**	**9.77**	**3899**	**10.80**	**4013**	**11.86**	**4123**	**12.94**	**4228**	**14.03**	**4329**	**15.14**
6000	4687	**3648**	**8.52**	**3774**	**9.56**	**3894**	**10.62**	**4009**	**11.69**	**4120**	**12.79**	**4228**	**13.90**	**4331**	**15.03**	*4431*	*16.18*
6250	4882	**3773**	**9.35**	**3890**	**10.44**	**4008**	**11.53**	**4121**	**12.65**	**4229**	**13.77**	**4334**	**14.92**	*4436*	*16.09*	*4535*	*17.27*
6500	5078	**3899**	**10.24**	**4007**	**11.37**	**4123**	**12.51**	**4233**	**13.66**	**4339**	**14.82**	*4441*	*16.00*	*4542*	*17.20*	*4639*	*18.42*

VOLUME	O.V.	11" SP		12" SP		13" SP		14" SP		15" SP		16" SP		17" SP		18" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
3000	2343	**3621**	**8.25**	**3763**	**9.17**	**3899**	**10.11**	**4031**	**11.07**								
3250	2539	**3656**	**8.66**	**3798**	**9.61**	**3934**	**10.58**	**4066**	**11.57**	**4192**	**12.58**	**4315**	**13.62**	*4434*	*14.68*		
3500	2734	**3705**	**9.15**	**3833**	**10.06**	**3970**	**11.06**	**4101**	**12.08**	**4227**	**13.13**	**4350**	**14.19**	*4469*	*15.28*	*4584*	*16.39*
3750	2929	**3774**	**9.75**	**3896**	**10.67**	**4013**	**11.60**	**4136**	**12.61**	**4263**	**13.69**	*4385*	*14.78*	*4504*	*15.90*	*4619*	*17.04*
4000	3125	**3843**	**10.39**	**3965**	**11.34**	**4081**	**12.30**	**4194**	**13.29**	**4303**	**14.29**	*4420*	*15.39*	*4539*	*16.53*	*4654*	*17.70*
4250	3320	**3914**	**11.05**	**4035**	**12.04**	**4151**	**13.04**	**4263**	**14.06**	*4371*	*15.10*	*4476*	*16.15*	*4579*	*17.21*	*4690*	*18.38*
4500	3515	**3991**	**11.80**	**4105**	**12.78**	**4221**	**13.82**	**4332**	**14.87**	*4440*	*15.94*	*4545*	*17.02*	*4647*	*18.12*		
4750	3710	**4071**	**12.59**	**4184**	**13.61**	**4294**	**14.64**	*4403*	*15.72*	*4510*	*16.82*	*4615*	*17.94*				
5000	3906	**4151**	**13.43**	**4264**	**14.48**	*4373*	*15.55*	*4478*	*16.64*	*4581*	*17.74*	*4685*	*18.89*				
5250	4101	**4233**	**14.31**	**4345**	**15.40**	*4453*	*16.51*	*4558*	*17.63*	*4659*	*18.76*						
5500	4296	**4326**	**15.25**	*4427*	*16.37*	*4534*	*17.51*	*4638*	*18.67*								
5750	4492	*4426*	*16.27*	*4521*	*17.40*	*4616*	*18.56*										
6000	4684	*4528*	*17.33*	*4621*	*18.51*	*4712*	*19.70*										

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-160

BELT DRIVE RATING TABLES
Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. - 16.50"

OUTLET O.D.
Size - 12.50" x 18.38"
Area - 1.54 Sq. Ft. I.D.

INLET O.D.
Size - 18.00"
Area - 1.73 Sq.Ft. I.D.

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

SEE PAGE 24 FOR MAX. WHEEL RPM & WR².

VOLUME CFM	O.V. FPM	0" SP RPM	0" SP BHP	½" SP RPM	½" SP BHP	1" SP RPM	1" SP BHP	1½" SP RPM	1½" SP BHP	2" SP RPM	2" SP BHP	2½" SP RPM	2½" SP BHP	3" SP RPM	3" SP BHP	4" SP RPM	4" SP BHP
2100	1363	865	.16	1054	.34	1214	.54	1361	.76	1498	.99	1622	1.24	1740	1.51	1975	2.14
2400	1558	988	.24	1155	.44	1306	.66	1435	.90	1566	1.15	1685	1.42	1798	1.70	2007	2.31
2700	1753	1112	.34	1259	.57	1401	.81	1526	1.07	1639	1.34	1755	1.62	1861	1.92	2061	2.55
3000	1948	1235	.47	1367	.72	1500	.99	1619	1.26	1726	1.55	1828	1.85	1932	2.17	2124	2.83
3300	2142	1359	.62	1481	.90	1601	1.19	1714	1.49	1818	1.80	1913	2.12	2005	2.45	2192	3.15
3600	2337	1482	.81	1596	1.11	1705	1.42	1812	1.74	1912	2.07	2005	2.41	2091	2.77	2264	3.50
3900	2532	1606	1.03	1711	1.35	1810	1.69	1913	2.03	2008	2.38	2098	2.75	2183	3.12	2338	3.89
4200	2727	1729	1.28	1828	1.63	1918	1.99	2016	2.36	2107	2.73	2194	3.12	2276	3.51	2428	4.32
4500	2922	1853	1.58	1946	1.95	2031	2.34	2120	2.73	2208	3.12	2291	3.53	2371	3.94	2519	4.80
4800	3116	1976	1.91	2064	2.31	2145	2.72	2225	3.14	2310	3.56	2391	3.98	2467	4.42	2613	5.32
5100	3311	2100	2.29	2183	2.72	2260	3.15	2332	3.59	2414	4.04	2492	4.49	2566	4.94	2707	5.88
5400	3506	2223	2.72	2302	3.17	2376	3.63	2445	4.09	2519	4.56	2595	5.03	2667	5.51	2803	6.49
5700	3701	2347	3.20	2422	3.67	2492	4.15	2559	4.64	2625	5.14	2698	5.64	2768	6.14	2900	7.16
6000	3896	2471	3.73	2542	4.23	2609	4.73	2673	5.25	2735	5.77	2803	6.29	2871	6.81	3000	7.88
6300	4090	2594	4.32	2662	4.84	2727	5.37	2788	5.91	2848	6.45	2909	7.00	2975	7.55	3101	8.66
6600	4285	2718	4.97	2783	5.51	2845	6.07	2904	6.63	2962	7.19	3017	7.77	3080	8.34	**3203**	**9.50**
6900	4480	2841	5.68	2903	6.25	2963	6.82	3021	7.41	3076	8.00	3130	8.60	3186	9.20	**3306**	**10.40**
7200	4675	2965	6.45	3024	7.04	3082	7.64	3137	8.25	3191	8.87	**3243**	**9.19**	**3294**	**10.12**	**3410**	**11.37**
7500	4870	3088	7.29	3146	7.91	**3201**	**8.53**	**3255**	**9.17**	**3307**	**9.80**	**3357**	**10.45**	**3406**	**11.10**	**3514**	**12.41**

VOLUME CFM	O.V. FPM	5" SP RPM	5" SP BHP	6" SP RPM	6" SP BHP	7" SP RPM	7" SP BHP	8" SP RPM	8" SP BHP	9" SP RPM	9" SP BHP	10" SP RPM	10" SP BHP	11" SP RPM	11" SP BHP	12" SP RPM	12" SP BHP
2100	1363	2183	2.81														
2400	1558	2214	3.02	2401	3.78												
2700	1753	2246	3.25	2433	4.04	2605	4.87	2765	5.73								
3000	1948	2301	3.55	2465	4.31	2637	5.17	2797	6.08	2947	7.02	3090	7.99				
3300	2142	2363	3.89	2523	4.68	2671	5.50	2828	6.43	2979	7.41	3121	8.42	**3257**	**9.45**	**3386**	**10.52**
3600	2337	2429	4.28	2586	5.10	2733	5.96	2870	6.85	3011	7.81	3153	8.86	**3288**	**9.93**	**3418**	**11.04**
3900	2532	2501	4.71	2651	5.55	2795	6.44	2932	7.37	3061	8.33	3185	9.31	**3320**	**10.42**	**3449**	**11.56**
4200	2727	2574	5.17	2722	6.06	2860	6.97	2995	7.93	3123	8.93	**3245**	**9.95**	**3361**	**10.99**	**3481**	**12.11**
4500	2922	2656	5.68	2795	6.60	2932	7.56	3060	8.54	3186	9.56	**3307**	**10.62**	**3423**	**11.71**	**3534**	**12.81**
4800	3116	2746	6.24	2870	7.19	3004	8.19	3132	9.21	**3252**	**10.25**	**3371**	**11.34**	**3486**	**12.46**	**3596**	**13.61**
5100	3311	2838	6.85	2960	7.84	3078	8.86	**3204**	**9.93**	**3324**	**11.01**	**3438**	**12.12**	**3549**	**13.26**	**3659**	**14.45**
5400	3506	2931	7.51	3052	8.54	3165	9.60	**3278**	**10.69**	**3396**	**11.82**	**3509**	**12.97**	**3618**	**14.13**	**3723**	**15.33**
5700	3701	3026	8.21	3144	9.29	**3256**	**10.40**	**3361**	**11.52**	**3470**	**12.68**	**3582**	**13.87**	**3689**	**15.08**	**3793**	**16.31**
6000	3896	3122	8.98	**3238**	**10.10**	**3347**	**11.24**	**3452**	**12.41**	**3552**	**13.60**	**3655**	**14.82**	**3762**	**16.07**	**3865**	**17.35**
6300	4090	**3219**	**9.80**	**3333**	**10.96**	**3441**	**12.15**	**3543**	**13.36**	**3642**	**14.59**	**3737**	**15.84**	**3835**	**17.12**	**3937**	**18.44**
6600	4285	**3318**	**10.68**	**3429**	**11.89**	**3535**	**13.12**	**3636**	**14.37**	**3733**	**15.64**	**3827**	**16.93**	**3917**	**18.24**	*4011*	*19.59*
6900	4480	**3419**	**11.63**	**3525**	**12.87**	**3630**	**14.15**	**3730**	**15.45**	**3826**	**16.76**	**3918**	**18.09**	*4007*	*19.45*	*4093*	*20.82*
7200	4675	**3520**	**12.64**	**3625**	**13.93**	**3726**	**15.25**	**3824**	**16.59**	**3919**	**17.94**	*4010*	*19.32*	*4098*	*20.71*	*4183*	*22.13*
7500	4870	**3622**	**13.72**	**3725**	**15.06**	**3824**	**16.41**	**3920**	**17.79**	*4013*	*19.20*	*4103*	*20.62*	*4190*	*22.05*	*4274*	*23.51*

VOLUME CFM	O.V. FPM	13" SP RPM	13" SP BHP	14" SP RPM	14" SP BHP	15" SP RPM	15" SP BHP	16" SP RPM	16" SP BHP	17" SP RPM	17" SP BHP	18" SP RPM	18" SP BHP	19" SP RPM	19" SP BHP
3600	2337	**3542**	**12.17**	**3661**	**13.33**										
3900	2532	**3573**	**12.73**	**3693**	**13.93**	**3808**	**15.15**	**3919**	**16.40**	*4027*	*17.68*				
4200	2727	**3605**	**13.31**	**3724**	**14.55**	**3839**	**15.81**	**3951**	**17.09**	*4059*	*18.40*	*4164*	*19.74*	*4266*	*21.09*
4500	2922	**3640**	**13.94**	**3756**	**15.18**	**3871**	**16.47**	*3982*	*17.80*	*4090*	*19.14*	*4195*	*20.51*		
4800	3116	**3702**	**14.77**	**3804**	**15.96**	**3904**	**17.17**	*4014*	*18.52*	*4122*	*19.90*	*4227*	*21.31*		
5100	3311	**3764**	**15.65**	**3866**	**16.88**	*3965*	*18.13*	*4061*	*19.39*	*4154*	*20.68*	*4259*	*22.12*		
5400	3506	**3828**	**16.58**	**3929**	**17.84**	*4027*	*19.13*	*4123*	*20.44*	*4215*	*21.76*				
5700	3701	**3892**	**17.55**	*3993*	*18.85*	*4090*	*20.18*	*4185*	*21.53*	*4277*	*22.89*				
6000	3896	*3964*	*18.63*	*4059*	*19.94*	*4154*	*21.28*	*4248*	*22.67*						
6300	4090	*4036*	*19.77*	*4131*	*21.12*	*4223*	*22.48*								
6600	4285	*4109*	*20.97*	*4203*	*22.36*										
6900	4480	*4182*	*22.22*	*4276*	*23.65*										

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-180

BELT DRIVE RATING TABLES

Ratings at 70°F., .075 Density, Sea Level

WHEEL
Dia. - 18.25"

OUTLET O.D.
Size - 13.88" x 20.38"
Area - 1.90 Sq. Ft. I.D.

INLET O.D.
Size - 20.00"
Area - 2.13 Sq.Ft. I.D.

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

SEE PAGE 24 FOR MAX. WHEEL RPM & WR^2.

VOLUME CFM	O.V. FPM	0" SP RPM	0" SP BHP	1/2" SP RPM	1/2" SP BHP	1" SP RPM	1" SP BHP	1 1/2" SP RPM	1 1/2" SP BHP	2" SP RPM	2" SP BHP	2 1/2" SP RPM	2 1/2" SP BHP	3" SP RPM	3" SP BHP	4" SP RPM	4" SP BHP
2800	1473	852	.28	1010	.54	1150	.82	1272	1.12	1392	1.46	1502	1.82	1605	2.18	1804	3.00
3200	1684	974	.42	1112	.70	1243	1.02	1356	1.35	1463	1.70	1568	2.09	1667	2.50	1848	3.33
3600	1894	1095	.60	1217	.91	1339	1.27	1447	1.62	1545	1.99	1640	2.39	1735	2.83	1910	3.74
4000	2105	1217	.82	1328	1.16	1439	1.55	1541	1.95	1635	2.35	1722	2.76	1806	3.20	1975	4.19
4400	2315	1339	1.09	1441	1.47	1540	1.88	1638	2.32	1728	2.76	1812	3.20	1890	3.65	2046	4.65
4800	2526	1461	1.42	1556	1.83	1644	2.26	1737	2.73	1823	3.22	1904	3.69	1980	4.17	2120	5.17
5200	2736	1582	1.80	1671	2.25	1751	2.70	1838	3.21	1920	3.73	1998	4.25	2072	4.76	2209	5.81
5600	2947	1704	2.25	1787	2.73	1863	3.22	1941	3.74	2020	4.29	2094	4.86	2166	5.42	2300	6.53
6000	3157	1826	2.77	1903	3.28	1975	3.80	2045	4.34	2121	4.93	2193	5.53	2261	6.14	2392	7.32
6400	3368	1947	3.36	2021	3.90	2089	4.46	2153	5.02	2224	5.63	2294	6.27	2360	6.91	2485	8.19
6800	3578	2069	4.03	2138	4.60	2203	5.19	2265	5.79	2328	6.42	2395	7.08	2459	7.76	2580	9.13
7200	3789	2191	4.78	2256	5.39	2318	6.01	2377	6.64	2434	7.28	2498	7.98	2560	8.69	2678	10.14
7600	4000	2313	5.62	2375	6.27	2434	6.92	2490	7.58	2545	8.25	2602	8.96	2662	9.70	2777	11.22
8000	4210	2434	6.56	2494	7.23	2550	7.92	2604	8.62	2657	9.32	2707	10.03	2766	10.81	2877	12.39
8400	4421	2556	7.59	2613	8.30	2667	9.02	2719	9.75	2769	10.49	2818	11.23	2870	12.01	**2978**	**13.66**
8800	4631	2678	8.73	2732	9.47	2784	10.22	2834	10.99	2883	11.75	**2930**	**12.53**	**2975**	**13.31**	**3080**	**15.03**
9200	4842	2800	9.98	2851	10.75	2901	11.54	**2950**	**12.33**	**2997**	**13.13**	**3042**	**13.94**	**3086**	**14.75**	**3184**	**16.50**

NOTE: See pages 27, 29 or 30 for minimum

VOLUME CFM	O.V. FPM	5" SP RPM	5" SP BHP	6" SP RPM	6" SP BHP	7" SP RPM	7" SP BHP	8" SP RPM	8" SP BHP	9" SP RPM	9" SP BHP	10" SP RPM	10" SP BHP	11" SP RPM	11" SP BHP	12" SP RPM	12" SP BHP
3200	1684	2022	4.26	2192	5.28	2347	6.36										
3600	1894	2069	4.68	2223	5.69	2378	6.83	2523	8.01	2659	9.23						
4000	2105	2131	5.20	2275	6.23	2410	7.31	2554	8.55	2690	9.83	2819	11.15	**2942**	**12.51**	**3059**	**13.91**
4400	2315	2196	5.75	2337	6.86	2470	8.00	2594	9.17	2722	10.45	2850	11.82	**2973**	**13.24**	**3090**	**14.69**
4800	2526	2266	6.32	2402	7.53	2532	8.74	2655	9.97	2772	11.23	2882	12.52	**3004**	**13.99**	**3121**	**15.50**
5200	2736	2339	6.94	2472	8.20	2597	9.51	2717	10.83	2833	12.15	**2943**	**13.51**	**3048**	**14.89**	**3152**	**16.33**
5600	2947	2422	7.68	2544	8.93	2668	10.30	2783	11.71	2896	13.13	**3005**	**14.55**	**3109**	**15.99**	**3209**	**17.46**
6000	3157	2512	8.53	2623	9.77	2739	11.15	2854	12.62	**2963**	**14.13**	**3067**	**15.65**	**3171**	**17.16**	**3271**	**18.69**
6400	3368	2603	9.46	2713	10.76	2816	12.09	**2926**	**13.59**	**3034**	**15.15**	**3136**	**16.75**	**3235**	**18.39**	**3333**	**19.99**
6800	3578	2695	10.47	2803	11.84	**2905**	**13.23**	**3001**	**14.65**	**3106**	**16.25**	**3207**	**17.91**	**3305**	**19.60**	**3399**	**21.33**
7200	3789	2789	11.57	2895	13.00	**2995**	**14.45**	**3090**	**15.93**	**3180**	**17.43**	**3279**	**19.13**	**3376**	**20.88**	**3469**	**22.67**
7600	4000	2884	12.76	**2988**	**14.25**	**3086**	**15.76**	**3179**	**17.31**	**3269**	**18.87**	**3355**	**20.46**	**3448**	**22.24**	**3541**	**24.08**
8000	4210	**2982**	**14.01**	**3082**	**15.60**	**3178**	**17.18**	**3270**	**18.78**	**3358**	**20.41**	**3443**	**22.05**	**3525**	**23.73**	*3613*	*25.57*
8400	4421	**3081**	**15.34**	**3177**	**17.05**	**3272**	**18.69**	**3363**	**20.36**	**3449**	**22.05**	**3533**	**23.76**	*3613*	*25.49*	*3691*	*27.24*
8800	4631	**3180**	**16.77**	**3275**	**18.55**	**3367**	**20.31**	**3456**	**22.04**	**3541**	**23.79**	*3623*	*25.57*	*3703*	*27.36*	*3780*	*29.17*
9200	4842	**3281**	**18.31**	**3374**	**20.16**	**3463**	**22.03**	**3550**	**23.84**	*3634*	*25.65*	*3715*	*27.49*	*3794*	*29.34*	*3870*	*31.22*

VOLUME CFM	O.V. FPM	13" SP RPM	13" SP BHP	14" SP RPM	14" SP BHP	15" SP RPM	15" SP BHP	16" SP RPM	16" SP BHP	17" SP RPM	17" SP BHP	18" SP RPM	18" SP BHP	19" SP RPM	19" SP BHP
4400	2315	**3202**	**16.19**	**3310**	**17.71**										
4800	2526	**3233**	**17.05**	**3341**	**18.63**	**3445**	**20.24**	**3546**	**21.89**	*3644*	*23.57*				
5200	2736	**3264**	**17.93**	**3372**	**19.57**	**3476**	**21.24**	**3577**	**22.94**	*3674*	*24.67*	*3769*	*26.44*	*3862*	*28.23*
5600	2947	**3306**	**18.96**	**3403**	**20.54**	**3507**	**22.26**	*3608*	*24.02*	*3706*	*25.81*	*3800*	*27.63*		
6000	3157	**3367**	**20.25**	**3459**	**21.84**	**3548**	**23.45**	*3639*	*25.13*	*3737*	*26.98*	*3832*	*28.85*		
6400	3368	**3428**	**21.62**	**3520**	**23.26**	*3609*	*24.93*	*3696*	*26.62*	*3780*	*28.34*	*3863*	*30.11*		
6800	3578	**3491**	**23.05**	**3583**	**24.76**	*3671*	*26.49*	*3757*	*28.25*	*3840*	*30.02*				
7200	3789	**3559**	**24.48**	*3646*	*26.33*	*3734*	*28.13*	*3819*	*29.95*						
7600	4000	*3630*	*25.96*	*3716*	*27.86*	*3799*	*29.79*	*3882*	*31.73*						
8000	4210	*3701*	*27.51*	*3787*	*29.47*	*3870*	*31.47*								
8400	4421	*3774*	*29.14*	*3859*	*31.17*										
8800	4631	*3855*	*31.01*												

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-200

BELT DRIVE RATING TABLES
Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. - 20.00"

OUTLET O.D.
Size - 15.25" x 22.38"
Area - 2.30 Sq. Ft. I.D.

INLET O.D.
Size - .22"
Area - 2.58 Sq.Ft. I.D.

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

SEE PAGE 24 FOR MAX. WHEEL RPM & WR².

VOLUME	O.V.	0" SP		1/2" SP		1" SP		1 1/2" SP		2" SP		2 1/2" SP		3" SP		4" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
4200	1826	971	.59	1085	.95	1199	1.32	1299	1.71	1389	2.12	1479	2.56	1566	3.01	1728	3.97
4600	2000	1064	.78	1169	1.17	1274	1.57	1370	1.99	1457	2.43	1537	2.88	1620	3.36	1775	4.35
5000	2173	1156	1.00	1254	1.42	1350	1.86	1442	2.31	1526	2.77	1604	3.25	1677	3.75	1829	4.80
5400	2347	1249	1.26	1340	1.71	1428	2.18	1516	2.66	1597	3.16	1673	3.67	1744	4.19	1883	5.28
5800	2521	1341	1.56	1427	2.05	1507	2.55	1592	3.06	1670	3.58	1744	4.12	1813	4.67	1941	5.81
6200	2695	1433	1.91	1515	2.43	1588	2.96	1669	3.50	1744	4.05	1815	4.62	1883	5.20	2008	6.40
6600	2869	1526	2.30	1603	2.85	1673	3.42	1746	3.99	1819	4.57	1888	5.17	1954	5.78	2077	7.03
7000	3043	1618	2.75	1691	3.33	1758	3.93	1825	4.53	1896	5.15	1963	5.77	2026	6.41	2146	7.72
7400	3217	1711	3.25	1780	3.86	1844	4.49	1905	5.13	1973	5.77	2038	6.43	2100	7.09	2217	8.46
7800	3391	1803	3.80	1869	4.45	1931	5.11	1989	5.78	2052	6.46	2115	7.14	2175	7.84	2288	9.26
8200	3565	1896	4.42	1959	5.09	2018	5.79	2074	6.49	2131	7.21	2192	7.92	2251	8.64	2361	10.12
8600	3739	1988	5.09	2048	5.80	2105	6.53	2159	7.26	2211	8.01	2270	8.76	2327	9.51	2435	11.05
9000	3913	2081	5.84	2138	6.58	2193	7.34	2245	8.10	2295	8.89	2349	9.67	2405	10.45	2510	12.05
9400	4086	2173	6.65	2229	7.43	2281	8.21	2331	9.01	2380	9.83	2428	10.65	2483	11.46	2586	13.12
9800	4260	2266	7.54	2319	8.34	2370	9.16	2418	10.00	2465	10.84	2511	11.69	2561	12.54	**2662**	**14.26**
10200	4434	2358	8.50	2409	9.34	2458	10.19	2505	11.05	2551	11.93	2595	12.81	2641	13.70	**2739**	**15.48**
10600	4608	2451	9.54	2500	10.41	2547	11.29	2593	12.19	2637	13.09	**2680**	**14.01**	**2722**	**14.94**	**2817**	**16.78**
11000	4782	2543	10.66	2591	11.56	2637	12.48	**2681**	**13.41**	**2724**	**14.34**	**2765**	**15.29**	**2806**	**16.25**	**2895**	**18.16**
11400	4956	2636	11.87	**2682**	**12.80**	**2726**	**13.75**	**2769**	**14.71**	**2811**	**15.68**	**2851**	**16.65**	**2891**	**17.64**	**2974**	**19.63**

NOTE: See pages 27, 29 or 30 for minimum motor frame sizes regardless of BHP.

VOLUME	O.V.	5" SP		6" SP		7" SP		8" SP		9" SP		10" SP		11" SP		12" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
4200	1826	1874	4.99	2021	6.14	2163	7.39	2295	8.69	2420	10.05						
4600	2000	1921	5.43	2053	6.56	2187	7.81	2319	9.16	2443	10.56	2560	12.01	**2672**	**13.51**		
5000	2173	1968	5.91	2099	7.09	2221	8.31	2343	9.64	2467	11.09	2584	12.59	**2696**	**14.13**	**2803**	**15.72**
5400	2347	2019	6.44	2146	7.65	2267	8.93	2381	10.25	2490	11.63	2608	13.18	**2719**	**14.77**	**2826**	**16.41**
5800	2521	2073	7.02	2196	8.27	2315	9.59	2427	10.96	2533	12.37	2634	13.82	**2743**	**15.43**	**2850**	**17.12**
6200	2695	2128	7.64	2250	8.95	2364	10.29	2474	11.71	2580	13.18	**2680**	**14.68**	**2776**	**16.21**	**2874**	**17.84**
6600	2869	2189	8.32	2304	9.68	2417	11.08	2523	12.51	2627	14.03	**2727**	**15.58**	**2823**	**17.17**	**2914**	**18.79**
7000	3043	2257	9.07	2360	10.46	2471	11.92	2577	13.41	**2676**	**14.93**	**2774**	**16.53**	**2869**	**18.17**	**2960**	**19.85**
7400	3217	2325	9.87	2427	11.31	2526	12.81	2631	14.36	**2729**	**15.94**	**2824**	**17.55**	**2917**	**19.23**	**3007**	**20.96**
7800	3391	2395	10.73	2495	12.23	2588	13.77	**2685**	**15.36**	**2784**	**17.00**	**2877**	**18.67**	**2967**	**20.36**	**3055**	**22.12**
8200	3565	2465	11.65	2563	13.21	2656	14.80	**2744**	**16.43**	**2838**	**18.12**	**2931**	**19.84**	**3020**	**21.59**	**3106**	**23.37**
8600	3739	2537	12.63	2633	14.25	**2724**	**15.90**	**2811**	**17.58**	**2894**	**19.30**	**2986**	**21.08**	**3074**	**22.89**	**3159**	**24.73**
9000	3913	2609	13.68	**2704**	**15.36**	**2794**	**17.07**	**2879**	**18.81**	**2961**	**20.58**	**3041**	**22.38**	**3129**	**24.25**	**3213**	**26.15**
9400	4086	**2682**	**14.81**	**2775**	**16.54**	**2864**	**18.31**	**2948**	**20.10**	**3029**	**21.93**	**3107**	**23.78**	**3184**	**25.68**	**3268**	**27.63**
9800	4260	**2757**	**16.01**	**2847**	**17.79**	**2934**	**19.62**	**3018**	**21.47**	**3098**	**23.36**	**3174**	**25.27**	**3248**	**27.21**	*3323*	*29.19*
10200	4434	**2832**	**17.29**	**2920**	**19.13**	**3006**	**21.01**	**3088**	**22.92**	**3167**	**24.86**	**3243**	**26.83**	*3316*	*28.82*	*3387*	*30.85*
10600	4608	**2908**	**18.65**	**2994**	**20.54**	**3078**	**22.48**	**3159**	**24.45**	**3237**	**26.45**	*3312*	*28.47*	*3384*	*30.52*	*3454*	*32.60*
11000	4782	**2985**	**20.09**	**3070**	**22.05**	**3151**	**24.03**	**3230**	**26.06**	*3307*	*28.12*	*3381*	*30.20*	*3453*	*32.31*	*3523*	*34.44*
11400	4956	**3062**	**21.62**	**3145**	**23.64**	**3225**	**25.68**	*3303*	*27.76*	*3379*	*29.87*	*3452*	*32.01*	*3523*	*34.18*	*3591*	*36.37*

VOLUME	O.V.	13" SP		14" SP		15" SP		16" SP		17" SP		18" SP		19" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
5400	2347	**2928**	**18.09**	**3027**	**19.81**	**3122**	**21.57**								
5800	2521	**2952**	**18.84**	**3051**	**20.61**	**3146**	**22.42**	**3238**	**24.27**	*3327*	*26.15*				
6200	2695	**2976**	**19.62**	**3074**	**21.43**	**3169**	**23.29**	**3261**	**25.18**	*3350*	*27.11*	*3437*	*29.08*	*3521*	*31.08*
6600	2869	**3002**	**20.44**	**3098**	**22.28**	**3193**	**24.18**	**3285**	**26.12**	*3374*	*28.10*	*3460*	*30.11*	*3545*	*32.16*
7000	3043	**3048**	**21.56**	**3133**	**23.29**	**3217**	**25.09**	*3309*	*27.08*	*3398*	*29.11*	*3484*	*31.17*	*3568*	*33.26*
7400	3217	**3095**	**22.72**	**3179**	**24.51**	**3260**	**26.33**	*3339*	*28.17*	*3421*	*30.14*	*3508*	*32.25*		
7800	3391	**3142**	**23.93**	**3226**	**25.78**	*3307*	*27.65*	*3385*	*29.55*	*3462*	*31.48*	*3536*	*33.43*		
8200	3565	**3189**	**25.20**	**3273**	**27.10**	*3354*	*29.03*	*3432*	*30.99*	*3508*	*32.97*				
8600	3739	**3241**	**26.59**	*3321*	*28.48*	*3401*	*30.47*	*3479*	*32.48*	*3555*	*34.51*				
9000	3913	*3295*	*28.07*	*3374*	*30.01*	*3450*	*31.98*	*3527*	*34.03*						
9400	4086	*3349*	*29.61*	*3427*	*31.61*	*3503*	*33.64*								
9800	4260	*3404*	*31.22*	*3482*	*33.28*	*3557*	*35.37*								

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-220

BELT DRIVE RATING TABLES

Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. - 22.25"

OUTLET O.D.
Size - 16.88" x 24.88"
Area - 2.84 Sq. Ft. I.D.

INLET O.D.
Size - 24.63"
Area - 3.24 Sq.Ft. I.D.

SEE PAGE 24 FOR MAX. WHEEL RPM & WR^2.

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

VOLUME	O.V.	0" SP		1/2" SP		1" SP		1 1/2" SP		2" SP		2 1/2" SP		3" SP		4" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
4600	1619	765	.48	870	.85	962	1.22	1054	1.62	1137	2.04	1214	2.48	1299	2.99	1460	4.10
5200	1830	865	.70	959	1.11	1042	1.52	1125	1.96	1204	2.41	1277	2.89	1347	3.38	1494	4.52
5800	2042	965	.97	1051	1.43	1128	1.88	1199	2.35	1275	2.85	1345	3.36	1411	3.89	1534	4.99
6400	2253	1065	1.31	1144	1.80	1215	2.31	1281	2.82	1348	3.35	1415	3.90	1479	4.47	1597	5.64
7000	2464	1164	1.71	1237	2.25	1303	2.82	1366	3.36	1424	3.92	1488	4.51	1549	5.12	1662	6.37
7600	2676	1264	2.19	1332	2.77	1394	3.39	1453	3.98	1509	4.58	1561	5.19	1621	5.84	1732	7.17
8200	2887	1364	2.75	1427	3.38	1486	4.03	1541	4.69	1594	5.33	1645	5.98	1695	6.65	1803	8.06
8800	3098	1464	3.39	1523	4.07	1578	4.77	1630	5.48	1681	6.17	1730	6.86	1776	7.56	1875	9.03
9400	3309	1564	4.14	1619	4.86	1672	5.60	1721	6.36	1769	7.10	1816	7.83	1861	8.58	1949	10.11
10000	3521	1663	4.98	1716	5.75	1766	6.53	1813	7.34	1858	8.15	1903	8.92	1947	9.70	2029	11.30
10600	3732	1763	5.93	1813	6.75	1860	7.57	1906	8.42	1949	9.28	1991	10.12	2033	10.94	2113	12.61
11200	3943	1863	7.00	1910	7.85	1956	8.73	1999	9.62	2040	10.52	2080	11.43	2121	12.29	2198	14.05
11800	4154	1963	8.19	2008	9.09	2051	10.01	2092	10.94	2132	11.88	2171	12.84	2209	13.78	2284	15.61
12400	4366	2063	9.50	2106	10.44	2147	11.41	2187	12.38	2225	13.37	2262	14.37	2298	15.39	**2371**	**17.30**
13000	4577	2163	10.94	2204	11.93	2243	12.95	2281	13.96	**2318**	**15.00**	**2354**	**16.04**	**2389**	**17.10**	**2459**	**19.14**
13600	4788	2262	12.53	2302	13.57	**2340**	**14.62**	**2376**	**15.68**	**2412**	**16.76**	**2447**	**17.85**	**2481**	**18.95**	**2547**	**21.12**

NOTE: See pages 27, 29 or 30 for minimum motor frame sizes regardless of BHP.

VOLUME	O.V.	5" SP		6" SP		7" SP		8" SP		9" SP		10" SP		11" SP		12" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
4600	1619	1629	5.38	1782	6.74	1922	8.17										
5200	1830	1635	5.78	1785	7.20	1926	8.70	2056	10.27	2179	11.90	2296	13.58				
5800	2042	1669	6.30	1797	7.70	1929	9.24	2060	10.88	2183	12.58	2299	14.34	**2410**	**16.15**	**2515**	**18.01**
6400	2253	1706	6.87	1831	8.33	1948	9.87	2064	11.49	2186	13.27	2303	15.10	**2413**	**16.98**	**2519**	**18.91**
7000	2464	1769	7.67	1868	9.02	1983	10.61	2092	12.28	2195	13.99	**2306**	**15.86**	**2417**	**17.82**	**2522**	**19.83**
7600	2676	1833	8.54	1930	9.97	2021	11.43	2127	13.14	2229	14.93	**2326**	**16.76**	**2420**	**18.66**	**2526**	**20.74**
8200	2887	1902	9.51	1994	11.00	2084	12.54	2169	14.12	2264	15.91	**2360**	**17.82**	**2453**	**19.78**	**2541**	**21.78**
8800	3098	1972	10.56	2062	12.13	2148	13.75	2232	15.40	**2311**	**17.09**	**2395**	**18.92**	**2487**	**20.96**	**2575**	**23.03**
9400	3309	2044	11.72	2132	13.36	2215	15.05	2296	16.78	**2374**	**18.54**	**2449**	**20.34**	**2522**	**22.19**	**2610**	**24.34**
10000	3521	2116	12.97	2203	14.70	2285	16.46	**2362**	**18.26**	**2438**	**20.10**	**2512**	**21.97**	**2583**	**23.87**	**2652**	**25.81**
10600	3732	2190	14.34	2275	16.15	**2356**	**17.99**	**2432**	**19.86**	**2505**	**21.77**	**2576**	**23.71**	**2647**	**25.70**	**2714**	**27.70**
11200	3943	2271	15.84	**2348**	**17.71**	**2427**	**19.63**	**2503**	**21.58**	**2575**	**23.57**	**2644**	**25.58**	**2711**	**27.63**	**2778**	**29.72**
11800	4154	**2355**	**17.48**	**2422**	**19.39**	**2500**	**21.39**	**2574**	**23.42**	**2645**	**25.49**	**2713**	**27.58**	**2779**	**29.70**	*2843*	*31.86*
12400	4366	**2440**	**19.25**	**2506**	**21.24**	**2574**	**23.28**	**2646**	**25.40**	**2716**	**27.54**	**2784**	**29.71**	*2848*	*31.91*	*2911*	*34.14*
13000	4577	**2526**	**21.17**	**2590**	**23.23**	**2652**	**25.33**	**2720**	**27.50**	**2789**	**29.73**	*2855*	*31.98*	*2919*	*34.26*	*2981*	*36.56*
13600	4788	**2613**	**23.23**	**2675**	**25.37**	**2735**	**27.54**	**2794**	**29.75**	*2862*	*32.06*	*2927*	*34.39*	*2990*	*36.75*	*3051*	*39.13*

VOLUME	O.V.	13" SP		14" SP		15" SP		16" SP		17" SP		18" SP		19" SP		20" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
6400	2253	**2620**	**20.90**	**2718**	**22.93**	**2812**	**25.01**										
7000	2464	**2624**	**21.88**	**2721**	**23.99**	**2815**	**26.14**	*2906*	*28.33*	*2994*	*30.57*	*3080*	*32.85*				
7600	2676	**2627**	**22.88**	**2725**	**25.05**	**2819**	**27.28**	*2910*	*29.55*	*2998*	*31.86*	*3084*	*34.21*	*3167*	*36.60*	*3248*	*39.03*
8200	2887	**2631**	**23.87**	**2728**	**26.13**	**2822**	**28.42**	*2913*	*30.76*	*3001*	*33.15*	*3087*	*35.57*	*3170*	*38.04*	*3251*	*40.54*
8800	3098	**2660**	**25.15**	**2741**	**27.31**	*2826*	*29.57*	*2917*	*31.99*	*3005*	*34.45*	*3091*	*36.94*	*3174*	*39.48*	*3255*	*42.06*
9400	3309	**2694**	**26.53**	**2775**	**28.76**	*2854*	*31.03*	*2930*	*33.34*	*3008*	*35.75*	*3094*	*38.32*	*3177*	*40.93*	*3258*	*43.59*
10000	3521	**2729**	**27.97**	**2810**	**30.28**	*2888*	*32.62*	*2964*	*35.00*	*3038*	*37.42*	*3109*	*39.88*	*3181*	*42.39*	*3262*	*45.12*
10600	3732	**2780**	**29.74**	*2845*	*31.85*	*2923*	*34.27*	*2999*	*36.72*	*3072*	*39.22*	*3144*	*41.75*	*3213*	*44.31*	*3281*	*46.90*
11200	3943	*2843*	*31.83*	*2906*	*33.98*	*2967*	*36.14*	*3034*	*38.51*	*3107*	*41.08*	*3178*	*43.68*	*3248*	*46.32*	*3315*	*48.99*
11800	4154	*2907*	*34.05*	*2969*	*36.27*	*3029*	*38.51*	*3088*	*40.78*	*3145*	*43.07*	*3213*	*45.68*	*3282*	*48.39*	*3350*	*51.14*
12400	4366	*2972*	*36.40*	*3033*	*38.69*	*3093*	*41.01*	*3151*	*43.36*	*3208*	*45.73*	*3263*	*48.12*	*3318*	*50.54*	*3385*	*53.36*
13000	4577	*3041*	*38.90*	*3099*	*41.25*	*3157*	*43.65*	*3215*	*46.07*	*3271*	*48.51*	*3326*	*50.98*	*3380*	*53.48*	*3433*	*55.99*
13600	4788	*3110*	*41.54*	*3168*	*43.98*	*3224*	*46.44*	*3280*	*48.92*	*3335*	*51.45*	*3390*	*53.99*	*3443*	*56.56*		

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-240

BELT DRIVE RATING TABLES

Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. - 24.50"

OUTLET O.D.
Size - 18.56" x 27.38"
Area - 3.45 Sq. Ft. I.D.

INLET O.D.
Size - 27.00"
Area - 3.90 Sq.Ft. I.D.

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

SEE PAGE 24 FOR MAX. WHEEL RPM & WR².

VOLUME	O.V.	0" SP		1/4" SP		1/2" SP		3/4" SP		1" SP		1 1/2" SP		2" SP		2 1/2" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
5000	1449	623	.42	678	.62	727	.82	772	1.02	821	1.23	908	1.68	987	2.16	1073	2.71
5800	1681	723	.66	771	.89	814	1.12	856	1.34	894	1.58	977	2.08	1051	2.60	1120	3.15
6600	1913	822	.97	865	1.23	905	1.49	942	1.75	978	2.01	1049	2.56	1120	3.13	1184	3.73
7400	2144	922	1.37	961	1.66	997	1.95	1030	2.25	1064	2.54	1125	3.12	1191	3.75	1254	4.40
8200	2376	1022	1.87	1057	2.18	1090	2.51	1121	2.83	1152	3.16	1210	3.80	1264	4.46	1325	5.16
9000	2608	1121	2.47	1154	2.81	1184	3.17	1213	3.52	1241	3.89	1296	4.59	1347	5.30	1398	6.04
9800	2840	1221	3.19	1251	3.56	1279	3.95	1307	4.33	1333	4.73	1384	5.50	1433	6.27	1479	7.05
10600	3072	1321	4.04	1348	4.44	1375	4.85	1400	5.27	1425	5.69	1472	6.55	1519	7.37	1563	8.20
11400	3304	1420	5.02	1446	5.45	1471	5.90	1495	6.34	1518	6.79	1563	7.71	1607	8.61	1649	9.50
12200	3536	1520	6.15	1544	6.62	1568	7.09	1590	7.56	1612	8.04	1655	9.02	1696	10.01	1737	10.95
13000	3768	1620	7.45	1642	7.94	1665	8.44	1686	8.95	1707	9.45	1748	10.49	1786	11.54	1825	12.57
13800	4000	1719	8.91	1741	9.43	1762	9.96	1782	10.50	1802	11.04	1841	12.13	1878	13.23	1914	14.36
14600	4231	1819	10.55	1839	11.10	1859	11.66	1879	12.22	1898	12.79	1935	13.94	1970	15.11	2005	16.29
15400	4463	1919	12.38	1938	12.96	1957	13.55	1975	14.15	1994	14.74	2029	15.95	2063	17.18	2096	18.41
16200	4695	2019	14.41	2037	15.02	2055	15.64	2072	16.26	2090	16.89	2124	18.16	**2157**	**19.44**	**2189**	**20.75**

NOTE: See pages 27, 29 or 30 for minimum motor frame sizes regardless of BHP.

VOLUME	O.V.	3" SP		4" SP		5" SP		6" SP		7" SP		8" SP		9" SP		10" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
5000	1449	1155	3.32	1317	4.60												
5800	1681	1190	3.75	1335	5.12	1475	6.59	1608	8.13								
6600	1913	1246	4.34	1369	5.70	1497	7.26	1620	8.91	1742	10.62	1855	12.39				
7400	2144	1312	5.06	1422	6.44	1532	7.98	1648	9.72	1754	11.54	1867	13.43	1974	15.36	2074	17.35
8200	2376	1381	5.88	1486	7.36	1584	8.91	1682	10.59	1788	12.51	1888	14.49	1986	16.54	2086	18.64
9000	2608	1453	6.81	1554	8.39	1648	10.03	1736	11.74	1823	13.54	1922	15.62	2015	17.76	2103	19.96
9800	2840	1526	7.85	1625	9.54	1715	11.29	1800	13.09	1882	14.94	1958	16.83	2050	19.06	**2138**	**21.36**
10600	3072	1606	9.05	1696	10.83	1785	12.68	1867	14.57	1945	16.52	2021	18.52	2093	20.56	**2172**	**22.82**
11400	3304	1690	10.40	1770	12.25	1856	14.20	1936	16.20	2012	18.25	2085	20.35	**2156**	**22.49**	**2224**	**24.67**
12200	3536	1776	11.90	1850	13.84	1929	15.88	2007	17.99	2082	20.14	**2152**	**22.33**	**2220**	**24.57**	**2288**	**26.85**
13000	3768	1862	13.57	1934	15.62	2002	17.72	2079	19.94	**2152**	**22.19**	**2222**	**24.49**	**2288**	**26.82**	**2352**	**29.20**
13800	4000	1950	15.42	2020	17.58	2085	19.77	**2153**	**22.05**	**2224**	**24.41**	**2292**	**26.82**	**2357**	**29.25**	**2420**	**31.73**
14600	4231	2039	17.46	2106	19.72	**2169**	**22.02**	**2230**	**24.37**	**2297**	**26.82**	**2364**	**29.33**	**2428**	**31.87**	**2490**	**34.45**
15400	4463	2129	19.67	**2193**	**22.06**	**2255**	**24.47**	**2314**	**26.92**	**2371**	**29.41**	**2436**	**32.03**	**2500**	**34.68**	**2560**	**37.37**
16200	4695	**2220**	**22.05**	**2281**	**24.62**	**2341**	**27.13**	**2398**	**29.68**	**2454**	**32.28**	**2510**	**34.94**	*2572*	*37.70*	*2632*	*40.49*

VOLUME	O.V.	11" SP		12" SP		13"SP		14"SP		15" SP		16" SP		17" SP		18" SP	
CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
8200	2376	**2182**	**20.79**	**2274**	**22.99**	**2361**	**25.23**										
9000	2608	**2194**	**22.23**	**2286**	**24.54**	**2374**	**26.90**	**2458**	**29.29**	**2539**	**31.73**	*2618*	*34.21*				
9800	2840	**2221**	**23.71**	**2302**	**26.12**	**2386**	**28.59**	**2470**	**31.10**	**2552**	**33.66**	*2630*	*36.25*	*2707*	*38.88*	*2781*	*41.54*
10600	3072	**2256**	**25.28**	**2336**	**27.78**	**2413**	**30.34**	**2487**	**32.95**	**2564**	**35.62**	*2643*	*38.32*	*2719*	*41.07*	*2793*	*43.85*
11400	3304	**2291**	**26.91**	**2370**	**29.52**	**2447**	**32.18**	**2521**	**34.89**	*2592*	*37.65*	*2661*	*40.45*	*2731*	*43.30*	*2805*	*46.19*
12200	3536	**2352**	**29.17**	**2414**	**31.53**	**2482**	**34.10**	**2555**	**36.91**	*2627*	*39.77*	*2695*	*42.66*	*2762*	*45.61*	*2827*	*48.59*
13000	3768	**2416**	**31.62**	**2477**	**34.08**	**2536**	**36.57**	*2594*	*39.10*	*2661*	*41.97*	*2730*	*44.97*	*2797*	*48.01*		
13800	4000	**2480**	**34.24**	**2541**	**36.80**	*2599*	*39.40*	*2656*	*42.02*	*2711*	*44.68*	*2765*	*47.37*	*2831*	*50.51*		
14600	4231	**2549**	**37.07**	*2606*	*39.72*	*2664*	*42.41*	*2720*	*45.14*	*2774*	*47.90*	*2828*	*50.69*				

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-270

BELT DRIVE RATING TABLES

Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. - 27.00"

OUTLET O.D.
Size - 20.44" x 30.13"
Area - 4.19 Sq. Ft. I.D.

INLET O.D.
Size - 30.00"
Area - 4.83 Sq.Ft. I.D.

SEE PAGE 24 FOR MAX. WHEEL RPM & WR^2.

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

VOLUME CFM	O.V. FPM	0"SP RPM	0"SP BHP	1/4" SP RPM	1/4" SP BHP	1/2" SP RPM	1/2" SP BHP	3/4" SP RPM	3/4" SP BHP	1" SP RPM	1" SP BHP	1 1/2" SP RPM	1 1/2" SP BHP	2" SP RPM	2" SP BHP
5600	1336	500	.38	551	.59	599	.81	644	1.04	688	1.27	777	1.80		
6400	1527	571	.57	617	.81	660	1.06	700	1.31	739	1.57	814	2.11	894	2.73
7200	1718	643	.82	684	1.08	722	1.36	760	1.63	794	1.92	865	2.51	932	3.14
8000	1909	714	1.12	752	1.41	786	1.72	821	2.02	853	2.33	916	2.98	978	3.64
8800	2100	786	1.49	820	1.81	852	2.14	883	2.48	914	2.82	971	3.51	1029	4.23
9600	2291	857	1.94	889	2.29	919	2.64	947	3.01	975	3.38	1030	4.12	1082	4.90
10400	2482	928	2.46	958	2.84	986	3.23	1012	3.62	1038	4.02	1091	4.82	1139	5.64
11200	2673	1000	3.07	1027	3.48	1054	3.89	1079	4.32	1103	4.75	1152	5.60	1198	6.48
12000	2863	1071	3.78	1097	4.22	1122	4.66	1145	5.11	1168	5.56	1213	6.48	1259	7.41
12800	3054	1143	4.59	1167	5.05	1190	5.52	1213	6.00	1234	6.48	1276	7.47	1320	8.44
13600	3245	1214	5.50	1237	5.99	1259	6.49	1280	7.00	1301	7.51	1341	8.55	1381	9.59
14400	3436	1285	6.53	1307	7.05	1328	7.58	1348	8.11	1368	8.65	1406	9.75	1444	10.85
15200	3627	1357	7.68	1377	8.23	1397	8.79	1417	9.35	1436	9.92	1472	11.06	1507	12.24
16000	3818	1428	8.96	1448	9.54	1467	10.12	1485	10.71	1504	11.31	1539	12.51	1572	13.74
16800	4009	1500	10.38	1518	10.98	1537	11.59	1554	12.21	1572	12.83	1605	14.09	1638	15.37
17600	4200	1571	11.93	1589	12.56	1606	13.20	1623	13.85	1640	14.50	1673	15.81	1704	17.15
18400	4391	1642	13.63	1660	14.28	1676	14.96	1693	15.63	1709	16.31	1740	17.68	1770	19.07
19200	4582	1714	15.49	1730	16.17	1746	16.87	1762	17.58	1778	18.28	1808	19.71	1837	21.15
20000	4773	1785	17.50	1801	18.21	1816	18.95	1832	19.68	1847	20.41	**1876**	**21.89**	**1904**	**23.39**

NOTE: See pages 27, 29 or 30 for minimum motor frame sizes regardless of BHP.

VOLUME CFM	O.V. FPM	2 1/2" SP RPM	2 1/2" SP BHP	3" SP RPM	3" SP BHP	4" SP RPM	4" SP BHP	5" SP RPM	5" SP BHP	6" SP RPM	6" SP BHP	7" SP RPM	7" SP BHP	8" SP RPM	8" SP BHP
8000	1909	1039	4.36	1103	5.14										
8800	2100	1085	4.97	1140	5.76	1253	7.50								
9600	2291	1136	5.69	1186	6.49	1290	8.28	1390	10.20						
10400	2482	1187	6.48	1237	7.34	1328	9.12	1427	11.15	1518	13.25				
11200	2673	1242	7.37	1288	8.28	1376	10.15	1464	12.17	1554	14.37	1638	16.64		
12000	2863	1301	8.35	1341	9.32	1427	11.29	1506	13.32	1591	15.58	1674	17.95	1752	20.38
12800	3054	1361	9.44	1400	10.46	1479	12.54	1557	14.67	1629	16.86	1711	19.34	1789	21.87
13600	3245	1421	10.64	1459	11.70	1531	13.89	1607	16.13	1678	18.41	1749	20.82	1826	23.46
14400	3436	1482	11.95	1519	13.07	1588	15.36	1659	17.70	1729	20.09	1795	22.53	**1863**	**25.13**
15200	3627	1544	13.39	1580	14.56	1647	16.95	1712	19.40	1780	21.89	1845	24.43	**1907**	**27.02**
16000	3818	1606	14.96	1641	16.18	1707	18.67	1769	21.22	1832	23.83	**1896**	**26.47**	**1957**	**29.16**
16800	4009	1669	16.67	1703	17.95	1767	20.54	1827	23.19	**1885**	**25.90**	**1948**	**28.64**	**2008**	**31.43**
17600	4200	1734	18.50	1765	19.85	1828	22.55	**1887**	**25.30**	**1943**	**28.11**	**2000**	**30.96**	**2059**	**33.86**
18400	4391	1800	20.48	1828	21.90	**1889**	**24.71**	**1947**	**27.56**	**2002**	**30.47**	**2054**	**33.43**	**2111**	**36.43**
19200	4582	**1866**	**22.61**	**1893**	**24.09**	**1951**	**27.03**	**2007**	**29.99**	**2061**	**33.00**	**2112**	**36.06**	**2163**	**39.16**
20000	4773	**1932**	**24.91**	**1959**	**26.44**	**2013**	**29.51**	**2068**	**32.57**	**2121**	**35.69**	**2171**	**38.85**	**2220**	**42.06**

VOLUME CFM	O.V. FPM	9" SP RPM	9" SP BHP	10" SP RPM	10" SP BHP	11" SP RPM	11" SP BHP	12" SP RPM	12" SP BHP	13" SP RPM	13" SP BHP	14" SP RPM	14" SP BHP	15" SP RPM	15" SP BHP
12800	3054	**1862**	**24.46**												
13600	3245	**1898**	**26.15**	**1967**	**28.90**										
14400	3436	**1935**	**27.93**	**2004**	**30.78**	**2070**	**33.69**								
15200	3627	**1973**	**29.81**	**2041**	**32.77**	**2106**	**35.77**	**2169**	**38.83**	**2229**	**41.93**				
16000	3818	**2015**	**31.89**	**2078**	**34.85**	**2143**	**37.97**	**2206**	**41.13**	*2266*	*44.33*	*2324*	*47.58*		
16800	4009	**2065**	**34.27**	**2120**	**37.14**	**2181**	**40.27**	**2243**	**43.53**	*2302*	*46.84*	*2360*	*50.19*	*2416*	*53.59*
17600	4200	**2115**	**36.79**	**2170**	**39.77**	**2222**	**42.78**	*2280*	*46.05*	*2339*	*49.47*	*2397*	*52.93*	*2453*	*56.42*
18400	4391	**2167**	**39.47**	**2220**	**42.54**	*2272*	*45.66*	*2322*	*48.81*	*2377*	*52.21*	*2434*	*55.78*		
19200	4582	**2218**	**42.31**	*2271*	*45.48*	*2322*	*48.70*	*2372*	*51.95*	*2420*	*55.24*	*2472*	*58.75*		
20000	4773	*2271*	*45.31*	*2323*	*48.59*	*2373*	*51.91*	*2422*	*55.26*	*2470*	*58.65*				

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-300

BELT DRIVE RATING TABLES

Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. - 30.00"

OUTLET O.D.
Size - 22.75" x 33.56"
Area - 5.20 Sq. Ft. I.D.

INLET O.D.
Size - 33.50"
Area - 6.12 Sq.Ft. I.D.

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

SEE PAGE 24 FOR MAX. WHEEL RPM & WR².

VOLUME CFM	O.V. FPM	0" SP RPM	0" SP BHP	1/4" SP RPM	1/4" SP BHP	1/2" SP RPM	1/2" SP BHP	3/4" SP RPM	3/4" SP BHP	1" SP RPM	1" SP BHP	1 1/2" SP RPM	1 1/2" SP BHP	2" SP RPM	2" SP BHP
8000	1538	521	.74	561	1.03	599	1.34	635	1.65	670	1.97	737	2.65	808	3.42
9000	1730	586	1.05	622	1.38	656	1.72	690	2.07	721	2.42	783	3.16	842	3.94
10000	1923	651	1.44	684	1.80	715	2.18	745	2.56	775	2.95	830	3.75	886	4.58
11000	2115	716	1.91	747	2.31	775	2.73	802	3.15	830	3.57	881	4.43	933	5.33
12000	2307	781	2.48	809	2.92	836	3.36	861	3.82	886	4.28	935	5.21	981	6.17
13000	2500	846	3.15	872	3.63	897	4.11	921	4.60	943	5.10	990	6.10	1034	7.12
14000	2692	911	3.94	936	4.45	959	4.96	981	5.49	1003	6.03	1046	7.10	1088	8.18
15000	2884	976	4.85	999	5.39	1021	5.94	1042	6.50	1062	7.07	1103	8.22	1143	9.37
16000	3076	1041	5.88	1063	6.46	1084	7.05	1104	7.64	1123	8.25	1160	9.48	1199	10.69
17000	3269	1106	7.05	1127	7.67	1146	8.29	1165	8.92	1184	9.56	1219	10.86	1255	12.16
18000	3461	1171	8.37	1191	9.02	1209	9.68	1227	10.35	1245	11.02	1279	12.38	1312	13.77
19000	3653	1236	9.85	1255	10.53	1272	11.22	1290	11.93	1307	12.63	1339	14.07	1370	15.53
20000	3846	1302	11.49	1319	12.20	1336	12.94	1352	13.67	1368	14.41	1400	15.91	1430	17.44
21000	4038	1367	13.30	1383	14.05	1399	14.82	1415	15.58	1431	16.36	1461	17.93	1490	19.53
22000	4230	1432	15.29	1448	16.07	1463	16.88	1478	17.68	1493	18.49	1522	20.14	1550	21.80
23000	4423	1497	17.47	1512	18.29	1527	19.13	1541	19.97	1556	20.82	1584	22.53	1611	24.26
24000	4615	1562	19.85	1576	20.69	1591	21.58	1605	22.46	1618	23.34	1645	25.12	1672	26.92
25000	4807	1627	22.43	1641	23.33	1655	24.23	1668	25.15	**1681**	**26.07**	**1707**	**27.92**	**1733**	**29.78**

NOTE: See pages 27, 29 or 30 for minimum motor frame sizes regardless of BHP.

VOLUME CFM	O.V. FPM	2 1/2" SP RPM	2 1/2" SP BHP	3" SP RPM	3" SP BHP	4" SP RPM	4" SP BHP	5" SP RPM	5" SP BHP	6" SP RPM	6" SP BHP	7" SP RPM	7" SP BHP	8" SP RPM	8" SP BHP
10000	1923	939	5.46	997	6.44										
11000	2115	982	6.25	1031	7.22	1133	9.38								
12000	2307	1029	7.16	1074	8.17	1166	10.37	1256	12.76						
13000	2500	1076	8.17	1120	9.24	1201	11.45	1290	13.96	1371	16.58				
14000	2692	1127	9.30	1167	10.44	1247	12.77	1324	15.26	1405	18.00	1480	20.82		
15000	2884	1181	10.55	1217	11.75	1293	14.21	1364	16.75	1439	19.52	1513	22.47	1583	25.50
16000	3076	1235	11.93	1270	13.20	1340	15.79	1410	18.45	1475	21.19	1547	24.23	1616	27.39
17000	3269	1290	13.46	1324	14.79	1388	17.51	1456	20.30	1520	23.16	1581	26.10	1650	29.39
18000	3461	1346	15.14	1379	16.53	1441	19.38	1504	22.30	1566	25.28	1625	28.33	**1684**	**31.51**
19000	3653	1403	16.97	1435	18.43	1495	21.40	1552	24.45	1613	27.57	1671	30.74	**1727**	**33.97**
20000	3846	1460	18.98	1491	20.50	1549	23.60	1605	26.78	1661	30.02	**1718**	**33.32**	**1772**	**36.68**
21000	4038	1518	21.15	1547	22.75	1604	25.98	1658	29.28	**1710**	**32.65**	**1765**	**36.08**	**1819**	**39.56**
22000	4230	1577	23.49	1604	25.18	1660	28.54	**1713**	**31.97**	**1763**	**35.46**	**1813**	**39.02**	**1866**	**42.64**
23000	4423	1637	26.01	1662	27.79	**1716**	**31.29**	**1767**	**34.85**	**1817**	**38.48**	**1863**	**42.16**	**1913**	**45.90**
24000	4615	**1697**	**28.74**	**1722**	**30.58**	**1772**	**34.25**	**1823**	**37.94**	**1871**	**41.69**	**1917**	**45.50**	**1961**	**49.37**
25000	4807	**1757**	**31.68**	**1781**	**33.59**	**1829**	**37.42**	**1878**	**41.24**	**1925**	**45.12**	**1971**	**49.06**	**2014**	**53.05**

VOLUME CFM	O.V. FPM	9" SP RPM	9" SP BHP	10" SP RPM	10" SP BHP	11" SP RPM	11" SP BHP	12" SP RPM	12" SP BHP	13" SP RPM	13" SP BHP
15000	2884	**1693**	**29.09**								
16000	3076	**1682**	**30.61**								
17000	3269	**1715**	**32.75**	**1778**	**36.17**						
18000	3461	**1749**	**35.00**	**1811**	**38.55**	**1870**	**42.16**				
19000	3653	**1783**	**37.37**	**1845**	**41.06**	**1903**	**44.80**	**1960**	**48.60**	**2014**	**52.46**
20000	3846	**1824**	**40.09**	**1879**	**43.70**	**1937**	**47.57**	**1993**	**51.51**	**2047**	**55.49**
21000	4038	**1870**	**43.10**	**1919**	**46.68**	**1971**	**50.48**	**2027**	**54.55**	*2081*	*58.67*
22000	4230	**1916**	**46.30**	**1965**	**50.01**	**2012**	**53.77**	**2061**	**57.74**	*2115*	*61.99*
23000	4423	**1963**	**49.69**	**2011**	**53.53**	**2057**	**57.42**	*2102*	*61.35*	*2149*	*65.46*
24000	4615	**2010**	**53.29**	**2058**	**57.26**	*2104*	*61.27*	*2148*	*65.33*	*2191*	*69.43*
25000	4807	**2058**	**57.11**	*2105*	*61.20*	*2150*	*65.34*	*2194*	*69.53*	*2237*	*73.75*

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-330

BELT DRIVE RATING TABLES

Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. -33.00"

OUTLET O.D.
Size - 24.88" x 36.88"
Area - 6.2 Sq. Ft. I.D.

INLET O.D.
Size - 36.75"
Area - 7.20 Sq.Ft. I.D.

SEE PAGE 24 FOR MAX. WHEEL RPM & WR².

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

VOLUME CFM	O.V. FPM	0" SP RPM	0" SP BHP	1" SP RPM	1" SP BHP	2" SP RPM	2" SP BHP	3" SP RPM	3" SP BHP	4" SP RPM	4" SP BHP	5" SP RPM	5" SP BHP	6" SP RPM	6" SP BHP
12000	1935	587	1.69	700	3.51	812	5.67	911	7.94						
13000	2096	636	2.15	742	4.11	843	6.34	943	8.92	1025	11.19				
14000	2258	684	2.69	784	4.79	875	7.06	973	9.78	1057	12.40	1130	14.87		
15000	2419	733	3.31	826	5.56	910	7.91	1004	10.72	1088	13.72	1161	16.33		
16000	2580	782	4.02	869	6.41	951	8.89	1035	11.72	1118	14.86	1192	17.89	1258	20.69
17000	2741	831	4.82	914	7.35	991	9.97	1067	12.81	1149	16.09	1224	19.50	1289	22.51
18000	2903	880	5.72	959	8.39	1033	11.15	1100	14.01	1180	17.40	1254	20.94	1321	24.45
19000	3064	929	6.73	1004	9.54	1074	12.45	1140	15.43	1212	18.79	1284	22.47	1352	26.27
20000	3225	978	7.84	1050	10.80	1117	13.85	1181	16.97	1243	20.28	1315	24.10	1382	28.03
21000	3387	1027	9.08	1096	12.17	1159	15.38	1222	18.62	1279	21.97	1347	25.83	1413	29.90
22000	3548	1076	10.44	1142	13.67	1202	17.03	1263	20.41	1319	23.88	1379	27.66	1444	31.87
23000	3709	1125	11.93	1188	15.30	1246	18.81	1305	22.32	1360	25.92	1411	29.61	1475	33.94
24000	3870	1173	13.56	1235	17.07	1291	20.71	1347	24.38	1400	28.10	1451	31.92	**1507**	**36.14**
25000	4032	1222	15.32	1281	18.97	1336	22.75	1389	26.58	1442	30.43	1491	34.38	**1539**	**38.45**
26000	4193	1271	17.23	1328	21.03	1381	24.94	1432	28.93	1483	32.92	**1532**	**36.99**	**1578**	**41.14**
27000	4354	1320	19.30	1375	23.23	1426	27.29	1475	31.44	**1525**	**35.55**	**1573**	**39.75**	**1618**	**44.03**
28000	4516	1369	21.53	1422	25.60	1472	29.79	**1519**	**34.09**	**1567**	**38.35**	**1614**	**42.68**	**1658**	**47.09**
29000	4677	1418	23.92	1469	28.13	**1518**	**32.46**	**1563**	**36.89**	**1610**	**41.32**	**1655**	**45.78**	**1699**	**50.31**
30000	4838	1467	26.48	**1517**	**30.84**	**1564**	**35.30**	**1608**	**39.87**	**1652**	**44.47**	**1697**	**49.05**	**1740**	**53.72**
31000	5000	**1516**	**29.21**	**1564**	**33.71**	**1610**	**38.32**	**1653**	**43.02**	**1695**	**47.79**	**1739**	**52.51**	**1781**	**57.30**
32000	5161	**1565**	**32.13**	**1612**	**36.77**	**1656**	**41.52**	**1698**	**46.36**	**1739**	**51.28**	**1782**	**56.15**	**1823**	**61.07**
33000	5322	**1613**	**35.24**	**1659**	**40.02**	**1702**	**44.91**	**1744**	**49.88**	**1783**	**54.95**	**1824**	**59.99**	**1865**	**65.04**
34000	5483	**1662**	**38.54**	**1707**	**43.47**	**1749**	**48.49**	**1789**	**53.60**	**18.28**	**58.80**	**1867**	**64.02**	**1907**	**69.20**

NOTE: See pages 28 and 30 for minimum motor frame sizes regardless of BHP.

VOLUME CFM	O.V. FPM	7" SP RPM	7" SP BHP	8" SP RPM	8" SP BHP	9" SP RPM	9" SP BHP	10" SP RPM	10" SP BHP	11" SP RPM	11" SP BHP	12" SP RPM	12" SP BHP	13" SP RPM	13" SP BHP
17000	2741	1350	25.50												
18000	2903	1381	27.58	1438	30.76										
19000	3064	1413	29.79	1469	33.10	**1522**	**36.47**								
20000	3225	1445	32.07	1500	35.59	**1553**	**39.09**	**1604**	**42.63**						
21000	3387	1475	34.07	**1532**	**38.22**	**1585**	**41.86**	**1635**	**45.54**	**1683**	**49.26**				
22000	3548	**1505**	**36.17**	**1563**	**40.58**	**1617**	**44.78**	**1666**	**48.60**	**1714**	**52.45**	**1760**	**56.35**		
23000	3709	**1536**	**38.39**	**1593**	**42.93**	**1648**	**47.57**	**1698**	**51.82**	**1745**	**55.81**	**1791**	**59.84**	**1835**	**63.92**
24000	3870	**1567**	**40.72**	**1624**	**45.40**	**1678**	**50.17**	**1729**	**55.03**	**1777**	**59.34**	**1822**	**63.51**	**1866**	**67.72**
25000	4032	**1598**	**43.17**	**1655**	**47.98**	**1708**	**52.89**	**1759**	**57.88**	**1809**	**62.96**	**1854**	**67.35**	*1897*	*71.69*
26000	4193	**1630**	**45.74**	**1686**	**50.69**	**1739**	**55.73**	**1790**	**60.86**	**1839**	**66.08**	*1886*	*71.37*	*1929*	*75.85*
27000	4354	**1662**	**48.44**	**1717**	**53.53**	**1770**	**58.71**	**1821**	**63.97**	**1869**	**69.32**	*1916*	*74.75*	*1961*	*80.20*
28000	4516	**1701**	**51.57**	**1749**	**56.50**	**1801**	**61.82**	**1852**	**67.22**	*1900*	*72.70*	*1946*	*78.26*	*1991*	*83.90*
29000	4677	**1741**	**54.92**	**1781**	**59.61**	**1833**	**65.07**	*1883*	*70.61*	*1930*	*76.22*	*1977*	*81.92*	*2021*	*87.69*
30000	4838	**1781**	**58.45**	**1821**	**63.25**	**1865**	**68.46**	*1914*	*74.14*	*1962*	*79.89*	*2007*	*85.72*	*2052*	*91.63*
31000	5000	**1822**	**62.16**	**1861**	**67.09**	*1899*	*72.08*	*1946*	*77.82*	*1993*	*83.71*	*2038*	*89.68*	*2082*	*95.72*
32000	5161	**1863**	**66.06**	*1901*	*71.11*	*1939*	*76.24*	*1978*	*81.65*	*2025*	*87.68*	*2070*	*93.78*	*2113*	*99.96*
33000	5322	*1904*	*70.15*	*1942*	*75.34*	*1979*	*80.58*	*2014*	*85.89*	*2057*	*91.81*	*2101*	*98.05*	*2145*	*104.36*
34000	5483	*1946*	*74.45*	*1983*	*79.76*	*2019*	*85.13*	*2054*	*90.57*	*2089*	*96.09*	*2133*	*102.48*	*2176*	*108.93*

VOLUME CFM	O.V. FPM	14" SP RPM	14" SP BHP	15" SP RPM	15" SP BHP	16" SP RPM	16" SP BHP	17" SP RPM	17" SP BHP	18" SP RPM	18" SP BHP	19" SP RPM	19" SP BHP
24000	3870	*1908*	*71.96*										
25000	4032	*1939*	*76.07*	*1980*	*80.49*	*2020*	*84.94*						
26000	4193	*1971*	*80.37*	*2011*	*84.92*	*2050*	*89.50*	*2089*	*94.13*				
27000	4354	*2002*	*84.85*	*2042*	*89.54*	*2082*	*94.26*	*2120*	*99.02*	*2157*	*103.81*		
28000	4516	*2034*	*89.53*	*2074*	*94.36*	*2113*	*99.22*	*2151*	*104.11*	*2188*	*109.04*	*2224*	*113.99*
29000	4677	*2064*	*93.54*	*2106*	*99.38*	*2145*	*104.38*	*2182*	*109.41*	*2219*	*114.47*	*2255*	*119.56*
30000	4838	*2095*	*97.61*	*2136*	*103.66*	*2177*	*109.75*	*2214*	*114.92*	*2251*	*120.12*	*2286*	*125.35*
31000	5000	*2125*	*101.83*	*2166*	*108.02*	*2207*	*114.27*	*2246*	*120.60*	*2283*	*125.99*		
32000	5161	*2156*	*106.21*	*2197*	*112.53*	*2237*	*118.92*	*2276*	*125.38*				
33000	5322	*2187*	*110.75*	*2228*	*117.20*	*2267*	*123.73*						
34000	5483	*2218*	*115.45*	*2259*	*122.04*	*2298*	*128.70*						

NOTE: HDBI-330 HAS A FIXED HOUSING AND IS THEREFORE NOT ROTATABLE IN THE FIELD.

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

HDBI-360

BELT DRIVE RATING TABLES
Ratings at 70˚F., .075 Density, Sea Level

WHEEL
Dia. -36.00"

OUTLET O.D.
Size - 27.25" x 40.25"
Area - 7.50 Sq. Ft. I.D.

INLET O.D.
Size - 40"
Area - 8.10 Sq.Ft. I.D.

All wheels are HDBI type
Class II = light face above Class III
Class III = bold face
Class IV = italic face below Class III

SEE PAGE 24 FOR MAX. WHEEL RPM & WR².

VOLUME CFM	O.V. FPM	0" SP RPM	0" SP BHP	1" SP RPM	1" SP BHP	2" SP RPM	2" SP BHP	3" SP RPM	3" SP BHP	4" SP RPM	4" SP BHP	5" SP RPM	5" SP BHP	6" SP RPM	6" SP BHP
24000	3200	904	9.57	969	13.11	1030	16.78	1089	20.51	1143	24.37	1201	28.32	1254	32.38
25000	3333	941	10.82	1005	14.50	1063	18.32	1120	22.18	1173	26.16	1228	30.25	1281	34.43
26000	3466	979	12.17	1040	15.99	1096	19.96	1152	23.95	1204	28.06	1255	32.28	1307	36.58
27000	3600	1017	13.63	1076	17.59	1130	21.71	1184	25.83	1235	30.07	1283	34.42	1335	38.85
28000	3733	1054	15.20	1112	19.30	1164	23.55	1216	27.84	1266	32.20	1313	36.67	1362	41.24
29000	3866	1092	16.89	1148	21.13	1198	25.52	1249	29.95	1298	34.45	1343	39.04	**1389**	**43.74**
30000	4000	1130	18.69	1184	23.08	1233	27.61	1281	32.20	1329	36.82	1375	41.54	**1417**	**46.37**
31000	4133	1167	20.63	1220	25.15	1268	29.82	1314	34.57	1361	39.32	**1406**	**44.17**	**1448**	**49.12**
32000	4266	1205	22.69	1256	27.35	1303	32.16	1347	37.07	**1394**	**41.95**	**1437**	**46.93**	**1479**	**52.01**
33000	4400	1243	24.88	1292	29.69	1338	34.63	**1381**	**39.70**	**1426**	**44.72**	**1469**	**49.83**	**1510**	**55.03**
34000	4533	1280	27.21	1328	32.16	1373	37.24	**1415**	**42.44**	**1459**	**47.63**	**1501**	**52.87**	**1541**	**58.20**
35000	4666	1318	29.68	1365	34.77	**1408**	**39.99**	**1450**	**45.33**	**1491**	**50.69**	**1533**	**56.05**	**1573**	**61.51**
36000	4800	1356	32.30	**1401**	**37.53**	**1444**	**42.89**	**1484**	**48.36**	**1524**	**53.89**	**1565**	**59.39**	**1605**	**64.97**
37000	4933	**1393**	**35.07**	**1438**	**40.44**	**1479**	**45.94**	**1519**	**51.55**	**1557**	**57.24**	**1598**	**62.87**	**1636**	**68.59**
38000	5066	**1431**	**37.99**	**1474**	**43.50**	**1515**	**49.14**	**1554**	**54.89**	**1591**	**60.74**	**1630**	**66.52**	**1668**	**72.36**
39000	5200	**1469**	**41.07**	**1511**	**46.73**	**1551**	**52.50**	**1589**	**58.39**	**1625**	**64.37**	**1663**	**70.32**	**1701**	**76.30**
40000	5333	**1506**	**44.31**	**1548**	**50.11**	**1587**	**56.02**	**1624**	**62.04**	**1660**	**68.17**	**1696**	**74.29**	**1733**	**80.40**
41000	5466	**1544**	**47.72**	**1584**	**53.65**	**1623**	**59.72**	**1659**	**65.87**	**1694**	**72.13**	**1729**	**78.43**	*1766*	*84.67*

NOTE: See pages 28 and 30 for minimum motor frame sizes regardless of BHP.

VOLUME CFM	O.V. FPM	7" SP RPM	7" SP BHP	8" SP RPM	8" SP BHP	9" SP RPM	9" SP BHP	10" SP RPM	10" SP BHP	11" SP RPM	11" SP BHP	12" SP RPM	12" SP BHP	13" SP RPM	13" SP BHP
24000	3200	1308	36.67	1366	41.34	**1420**	**46.11**	**1472**	**50.98**						
25000	3333	1330	38.70	**1385**	**43.40**	**1440**	**48.31**	**1491**	**53.30**	**1541**	**58.38**				
26000	3466	1357	40.98	**1405**	**45.55**	**1459**	**50.58**	**1511**	**55.71**	**1560**	**60.92**	**1607**	**66.22**		
27000	3600	**1383**	**43.38**	**1429**	**47.98**	**1479**	**52.94**	**1530**	**58.20**	**1579**	**63.55**	**1626**	**68.98**	**1672**	**74.49**
28000	3733	**1410**	**45.89**	**1456**	**50.62**	**1499**	**55.43**	**1550**	**60.79**	**1599**	**66.26**	**1646**	**71.82**	**1691**	**77.46**
29000	3866	**1437**	**48.52**	**1482**	**53.38**	**1526**	**58.31**	**1570**	**63.47**	**1618**	**69.08**	**1665**	**74.77**	**1710**	**80.54**
30000	4000	**1464**	**51.28**	**1509**	**56.26**	**1552**	**61.32**	**1593**	**66.45**	**1638**	**71.98**	**1685**	**77.81**	**1729**	**83.71**
31000	4133	**1492**	**54.16**	**1536**	**59.27**	**1579**	**64.46**	**1619**	**69.72**	**1659**	**75.05**	**1704**	**80.95**	*1749*	*86.98*
32000	4266	**1519**	**57.17**	**1563**	**62.42**	**1606**	**67.73**	**1646**	**73.12**	**1685**	**78.57**	**1724**	**84.19**	*1769*	*90.36*
33000	4400	**1549**	**60.32**	**1591**	**65.70**	**1633**	**71.14**	**1673**	**76.66**	**1711**	**82.24**	*1749*	*87.88*	*1788*	*93.84*
34000	4533	**1580**	**63.62**	**1619**	**69.12**	**1660**	**74.69**	**1700**	**80.33**	*1738*	*86.04*	*1775*	*91.81*	*1811*	*97.65*
35000	4666	**1611**	**67.05**	**1648**	**72.68**	**1687**	**78.39**	**1727**	**84.16**	*1765*	*89.99*	*1802*	*95.89*	*1837*	*101.85*
36000	4800	**1642**	**70.64**	**1678**	**76.40**	**1715**	**82.23**	*1754*	*88.13*	*1792*	*94.09*	*1828*	*100.12*	*1864*	*106.20*
37000	4933	**1673**	**74.39**	**1709**	**80.27**	*1744*	*86.23*	*1782*	*92.26*	*1819*	*98.35*	*1855*	*104.50*	*1890*	*110.71*
38000	5066	**1705**	**78.29**	*1740*	*84.29*	*1774*	*90.38*	*1809*	*96.54*	*1846*	*102.76*	*1882*	*109.04*	*1917*	*115.38*
39000	5200	*1737*	*82.35*	*1772*	*88.49*	*1805*	*94.70*	*1838*	*100.98*	*1874*	*107.34*	*1910*	*113.75*	*1944*	*120.22*
40000	5333	*1769*	*86.58*	*1803*	*92.84*	*1836*	*99.18*	*1869*	*105.59*	*1902*	*112.08*	*1937*	*118.62*	*1971*	*125.22*
41000	5466	*1801*	*90.99*	*1835*	*97.38*	*1868*	*103.84*	*1900*	*110.37*	*1931*	*116.98*	*1965*	*123.66*	*1999*	*130.39*

VOLUME CFM	O.V. FPM	14" SP RPM	14" SP BHP	15" SP RPM	15" SP BHP	16" SP RPM	16" SP BHP	17" SP RPM	17" SP BHP
28000	3733	**1734**	**83.18**						
29000	3866	*1754*	*86.39*	*1796*	*92.31*				
30000	4000	*1773*	*89.69*	*1815*	*95.74*	*1855*	*101.87*		
31000	4133	*1792*	*93.09*	*1834*	*99.28*	*1875*	*105.54*	*1914*	*111.86*
32000	4266	*1812*	*96.60*	*1853*	*102.92*	*1894*	*109.30*	*1933*	*115.76*
33000	4400	*1831*	*100.22*	*1873*	*106.66*	*1913*	*113.18*	*1952*	*119.77*
34000	4533	*1851*	*103.94*	*1892*	*110.52*	*1933*	*117.17*	*1972*	*123.89*
35000	4666	*1872*	*107.87*	*1912*	*114.49*	*1952*	*121.28*	*1991*	*128.13*
36000	4800	*1898*	*112.36*	*1932*	*118.58*	*1972*	*125.50*	*2011*	*132.48*

**NOTE:
HDBI-360
HAS A FIXED
HOUSING AND
IS THEREFORE
NOT ROTATABLE
IN THE FIELD.**

Performance certified is for installation type B - Free inlet, Ducted Outlet. Performance ratings do not include the effects of appurtenances (accessories). Power rating (BHP) does not include transmission losses.

DESIGN SPECIFICATIONS

Maximum Shaft and Bearing Speeds for Belt Driven Fans
Maximum Wheel Speeds & WR² (Lb.-Ft.²) for Direct Driven Fans

FAN SIZE	Maximum Shaft and Bearing Speeds			HDBI Steel Wheels ①						SQBI Steel Wheels ①				Aluminum Wheels ②	
				CLASS II		CLASS III		CLASS IV		CLASS II		CLASS III			
	CLASS II	CLASS III	CLASS IV	WHEEL WR^2	MAX. RPM	WHEEL WR^2	MAX. RPM	WHEEL WR^2	MAX. RPM	WHEEL WR^2	MAX. RPM	WHEEL WR^2	MAX. RPM	WHEEL WR^2	MAX. RPM
120	4189	4985	–	2.8	4380	2.8	5400	–	–	3.9	4065	4.1	5000	1.2	5400
130	3834	4738	4999	4.2	3900	–	–	4.2	4999	5.3	3750	5.7	4700	1.7	4999
150	3513	4357	4712	5.9	3513	–	–	5.9	4712	8.1	3050	8.3	4117	2.5	4712
160	3195	3961	4285	9.0	3195	–	–	9.9	4285	11.7	3042	12.4	3724	4.2	4285
180	2903	3591	3885	13.9	2903	–	–	15.0	3885	16.2	2593	17.1	3600	6.7	3885
200	2661	3285	3574	19.0	2661	–	–	20.8	3574	24.6	2380	26.5	3550	9.8	3574
220	2304	2824	3447	26.1	2304	–	–	29.1	3550	36.3	2115	39.6	3160	14.7	3550
240	2132	2565	2837	54.6	2132	–	–	58.2	2837	–	–	63.3	2740	26.5	2837
270	1854	2262	2476	–	–	–	–	89.9	2476	–	–	108.3	2493	45.9	2476
300	1680	2075	2300	–	–	–	–	130.2	2300	–	–	165.0	2243	64.3	2300
330	1500	1880	2300	–	–	–	–	193.6	2300	–	–	244.2	1935	130.0	2300
360	1380	1735	1950	–	–	–	–	255.8	1950	–	–	349.6	1750	176.0	1950

① For steel wheels up to 175˚F. (80°C.)
② For aluminum wheels up to 200˚F. (93°C.) All aluminum wheels are HDBI type, Class IV construction.

Approximate Shipping Weights Less Motor

SIZE	ARR#1			ARR#4			ARR#8			ARR#9			ARR#9CB			ARR#10		
	CL.II	CL.III	CL.IV	CL.II	CL.III	CL.IV	CL.II	CL.III	CL.IV	CL.II	CL.III	CL.IV	CL.II	CL.III	CL.IV	CL.II	CL.III	CL.IV
120	160	165	170	120	125	130	180	185	190	190	195	200	260	265	270	180	185	190
130	190	195	200	150	155	160	210	215	220	210	215	220	300	305	310	200	205	210
150	220	230	240	170	180	190	250	260	270	250	260	270	340	350	360	250	260	270
160	270	280	290	230	240	255	290	310	320	300	310	320	390	400	410	300	310	320
180	350	360	370	300	310	325	380	390	400	380	390	400	500	510	520	390	400	410
200	390	410	420	350	360	380	430	450	460	430	450	460	560	580	590	430	450	460
220	470	500	510	430	440	460	520	540	550	530	550	560	660	680	690	530	550	560
240	610	620	630	550	555	560	670	690	700	660	670	680	800	810	820	620	630	640
270	740	750	760	690	695	700	820	840	850	800	810	820	960	970	980	760	770	780
300	910	945	950	840	845	850	1000	1000	1040	970	1005	1010	1130	1165	1170	900	930	940
330	1200	1320	1510	1090	1090	1176	–	–	–	1260	1380	1570	1420	1560	1760	–	–	–
360	1410	1600	1720	1390	1430	1430	–	–	–	1470	1660	1780	1650	1840	1910	–	–	–

DIMENSIONS and SPECIFICATIONS

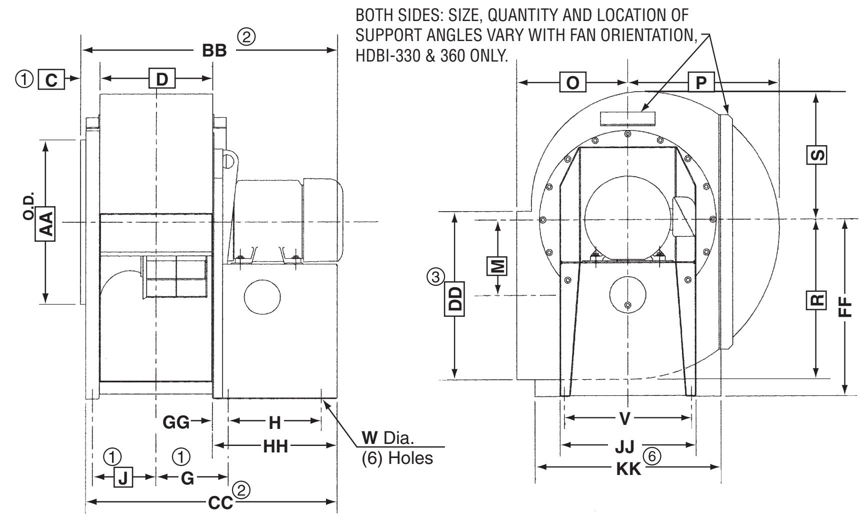
NOTE: The table below contains blower housing dimensions common to all arrangements on pages 25 and 27 through 29.

MODEL	C①	D②	J	M	O	P	R	S	AA	DD③
HDBI-120	4 1/16	9 3/8	5 3/4	6 3/16	9 15/16	12 3/8	13	10 3/8	13 1/4	13 3/4
HDBI-130	4 1/16	10 3/8	6 1/4	6 13/16	10 13/16	13 3/4	14 7/16	11 9/16	14 5/8	15 1/4
HDBI-150	4 1/16	11 3/8	6 3/4	7 9/16	11 3/4	15 3/16	15 15/16	12 3/4	16 1/8	16 13/16
HDBI-160	4 1/16	12 1/2	7 5/16	8 5/16	12 11/16	16 11/16	17 1/2	14	18	18 7/16
HDBI-180	4 1/16	13 7/8	8	9 1/4	13 13/16	18 7/16	19 7/16	15 1/2	20	20 3/8
HDBI-200	4 1/16	15 1/4	8 11/16	10 1/16	14 15/16	20 1/4	21 1/4	17	22	22 3/8
HDBI-220	4 1/16	16 7/8	9 1/2	11 3/16	16 3/8	22 1/2	23 5/8	18 7/8	24 5/8	24 7/8
HDBI-240	6 1/16	18 9/16	10 3/8	12 5/16	18 13/16	24 3/4	26	20 3/4	27	27 3/8
HDBI-270	6 1/16	20 7/16	11 5/16	13 9/16	20 5/8	27 1/4	28 5/8	22 7/8	30	30 1/16
HDBI-300	6 1/16	22 3/4	12 7/16	15 1/8	22 5/8	30 3/8	31 7/8	25 1/2	33 1/2	33 9/16
★ HDBI-330	3 1/4	24 7/8	14 1/2	16 9/16	24 11/16	33 3/8	35	28	36 3/4	36 7/8
★ HDBI-360	3 1/4	27 1/4	15 11/16	18 1/8	27 3/16	36 1/2	38 1/4	30 1/2	40	40 1/4

① Add 1/8" for AMCA “C” Construction fans and/or Downblast discharge position.
② Dimensions shown are for 100% width housings. For partial width housings, contact your local Cincinnati Fan sales representative.
③ Discharge flange is standard on Models HDBI-270 through HDBI-360. See page 31 for dimension.
★ HDBI-330 & 360 have fixed housings and are therefore not rotatable in the field.

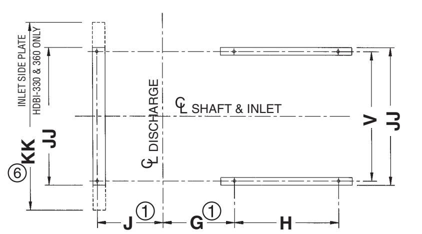
DIMENSIONS and SPECIFICATIONS

Arrangement #4, Direct Drive



For horizontal mount (arrangement 4HM), see Page 26.

CW-BH
(Clockwise-Bottom Horizontal)



FOUNDATION PLAN

① Add 1/8" for AMCA "C" Construction fans and/or Downblast discharge position.

② Add 1/4" for AMCA "C" Construction fans and/or Downblast discharge position.

③ Discharge flange (not shown above) is standard on Models HDBI-270 through HDBI-360. See page 31 for dimensions.

⑥ Inlet side plate width for HDBI-330 & 360. Inlet side plate for HDBI-120 to HDBI-300 is same width as "JJ" dimension.

NOTE: HDBI-120 to 300 are reversible and rotatable in 45˚ increments but wheels are not reversible. **HDBI-330 AND 360 ARE NOT ROTATABLE OR REVERSIBLE.**

DIMENSIONS IN INCHES ± 1/8"

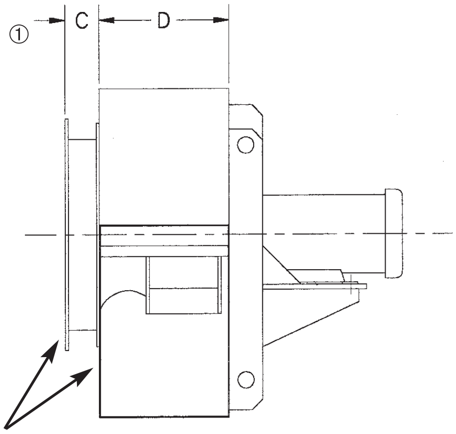
NOTE: For common boxed blower housing dimensions, see Page 24.

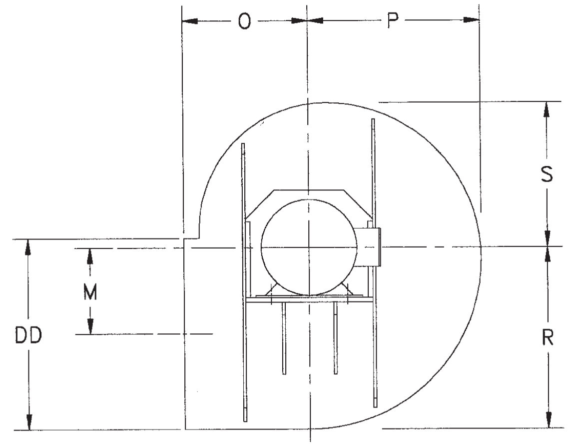
MODEL NO.	MOTOR FRAME	G①	H	V	W	BB②	CC②	FF	GG	HH	JJ	KK⑥
HDBI-120	143T-184T	7 11/16	5 1/2	14	9/16	24 15/16	22 15/16	15 1/2	3	11 1/2	16	—
HDBI-130	143T-215T	8 3/16	7 5/8	15 3/4	9/16	28 1/16	26 1/16	16 5/8	3	13 5/8	17 3/4	—
HDBI-150	143T-215T	8 11/16	7 5/8	17 1/4	9/16	29 1/16	27 1/16	18 1/8	3	13 5/8	19 1/4	—
	254T-256T		16			37 7/16	35 7/16			22		
HDBI-160	143T-184T	9 1/4	7 5/8	19 1/8	9/16	30 3/16	28 3/16	19 3/4	3	13 5/8	21 1/8	—
	213T-256T		17			39 9/16	37 9/16			23		
HDBI-180	143T-215T	9 15/16	8 3/8	21 1/2	9/16	32 5/16	30 5/16	22 3/4	3	14 3/8	23 1/2	—
	254T-286T		18 1/2			42 7/16	40 7/16			24 1/2		
	324T-326T		21			44 15/16	42 15/16			27		
HDBI-200	182T-256T	10 5/8	11 1/2	23 1/2	9/16	36 13/16	34 13/16	23 1/2	3	17 1/2	25 1/2	—
	284T-286T		18 1/2			43 13/16	41 13/16			24 1/2		
	324T-326T		21			46 5/16	44 5/16			27		
HDBI-220	182T-256T	11 7/16	11 1/2	26 1/8	9/16	38 7/16	36 7/16	26 1/4	3	17 1/2	28 1/8	—
	284T-326T		21			47 15/16	45 15/16			27		
HDBI-240	213T-256T	12 5/16	11 1/2	28 1/4	9/16	42 1/8	38 1/8	28 1/2	3	17 1/2	30 3/4	—
	284T-326T		21			51 5/8	47 5/8			27		
HDBI-270	213T-256T	13 1/4	11 1/2	31	9/16	44	40	31 1/4	3	17 1/2	33 3/4	—
	284T-326T		21			53 1/2	49 1/2			27		
HDBI-300	213T-256T	14 3/8	11 1/2	34 1/4	9/16	46 5/16	42 5/16	34 1/2	3	17 1/2	37 1/4	—
	284T-326T		21			55 13/16	51 13/16			27		
HDBI-330	284T-326T	15 15/16	20	28	3/4	55 1/8	54 15/16	38 3/4	3 1/2	27	30	41 3/4
	364T-405T		25			60 1/8	59 15/16			32		
	444T		29			64 1/8	63 15/16			36		
HDBI-360	284T-326T	17 1/8	20	31	3/4	57 1/2	57 5/16	42	3 1/2	27	33	45
	364T-405T		25			62 1/2	62 5/16			32		
	444T		29			66 1/2	66 5/16			36		

DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

DIMENSIONS and SPECIFICATIONS

Arrangement #4HM, Direct Drive





NOTE: Dimensions shown below are for 100% width housings. For partial width housings, contact your local Cincinnati Fan sales representative.

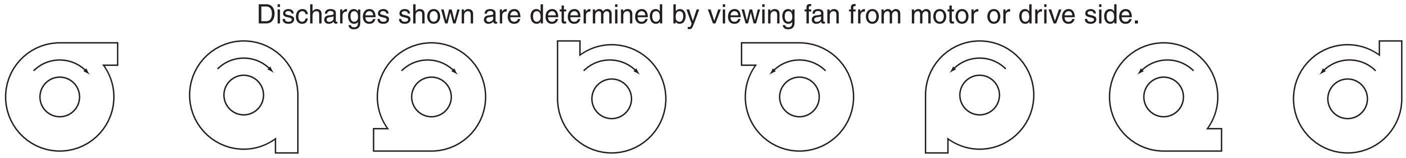
① Add 1/8" for AMCA “C” Construction.
② Optional inlet flange may be added to assist in fan installation. See page 31 for flange dimensions.
③ Discharge flange is optional on Models HDBI-120 through HDBI-240 and is standard on Models HDBI-270 and HDBI-300. See page 31 for flange dimensions.

DIMENSIONS IN INCHES ± 1/8"

MODEL NO.	MOTOR FRAME	① C	D	M	O	P	R	S	③ DD	SHIP WT. LESS MOTOR
HDBI-120	143T-184T	4 1/4	9 3/8	6 3/16	9 15/16	12 3/8	13	10 3/8	13 3/4	150
HDBI-130	143T-215T	4 1/4	10 3/8	6 13/16	10 13/16	13 3/4	14 7/16	11 9/16	15 1/4	170
HDBI-150	143T-215T	4 1/4	11 3/8	7 9/16	11 3/4	15 3/16	15 15/16	12 3/4	16 13/16	190
HDBI-160	143T-256T	4 1/4	12 1/2	8 5/16	12 11/16	16 11/16	17 1/2	14	18 7/16	210
HDBI-180	143T-326T	4 1/4	13 7/8	9 1/4	13 13/16	18 7/16	19 7/16	15 1/2	20 3/8	270
HDBI-200	182T-326T	4 1/4	15 1/4	10 1/16	14 15/16	20 1/4	21 1/4	17	22 3/8	320
HDBI-220	182T-326T	4 1/4	16 7/8	11 3/16	16 3/8	22 1/2	23 5/8	18 7/8	24 7/8	390
HDBI-240	213T-326T	6 1/4	18 9/16	12 5/16	18 13/16	24 3/4	26	20 3/4	27 3/8	450
HDBI-270	213T-326T	6 1/4	20 7/16	13 9/16	20 5/8	27 1/4	28 5/8	22 7/8	30 1/16	550
HDBI-300	213T-326T	6 1/4	22 3/4	15 1/8	22 5/8	30 3/8	31 7/8	25 1/2	33 9/16	640
HDBI-330	284T-365T	6 1/8	24 7/8	16 9/16	24 11/16	33 3/8	35	28	36 7/8	940
HDBI-360	284T-365T	6 1/8	27 1/4	18 1/8	27 3/16	36 1/2	38 1/4	30 1/2	40 1/4	1100

DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

16 DISCHARGE POSITIONS AVAILABLE. 45° DISCHARGE POSITIONS NOT SHOWN.*
Discharges shown are determined by viewing fan from motor or drive side.



CW-TH Clockwise Top Horizontal Discharge

CW-DB Clockwise Down-Blast Discharge ★

CW-BH Clockwise Bottom Horizontal Discharge

CW-UB Clockwise Up-Blast Discharge

CCW-TH Counter-Clockwise Top Horizontal Discharge

CCW-DB Counter-Clockwise Down-Blast Discharge ★

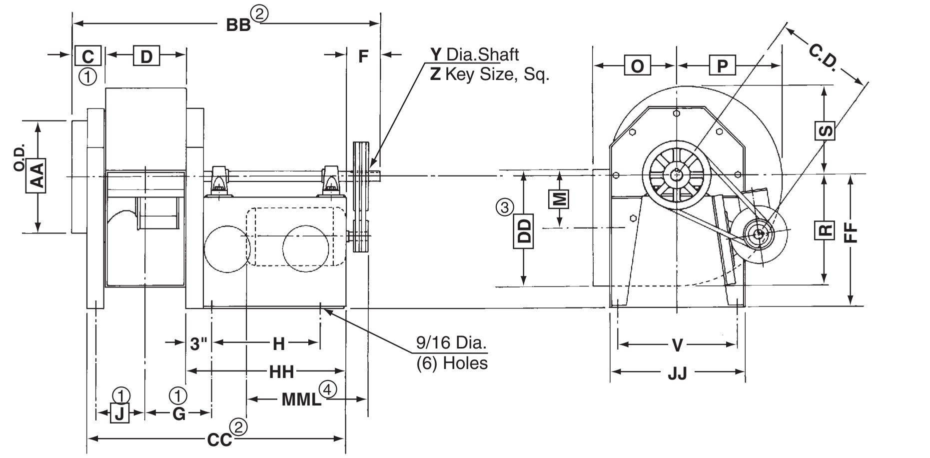
CCW-BH Counter-Clockwise Bottom Horizontal Discharge

CCW-UB Counter-Clockwise Up-Blast Discharge

★ Not available on models HDBI-270 through HDBI-360 or any other models with discharge flange option without special discharge extension. For arrangement 9CB units, contact your local Cincinnati Fan sales representative.
* See (*) on page 31.

DIMENSIONS and SPECIFICATIONS

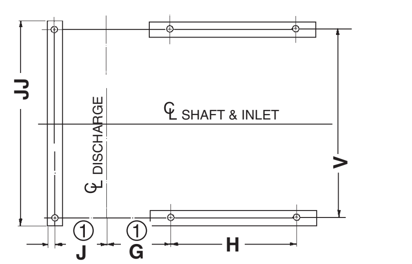
Arrangement #1 and #9, Belt Drive (specify 9R or 9L.)



CW-BH
(Clockwise-Bottom Horizontal)

For channel base dimensions, see page 30.

Unit shown is arrangement 9R (motor on right side). For motor on left side, specify arrangement 9L.



FOUNDATION PLAN

① Add 1/8" for AMCA “C” Construction fans and/or Downblast discharge position.

② Add 1/4" for AMCA “C” Construction fans and/or Downblast discharge position.

③ Discharge flange (not shown above) is standard on Models HDBI-270 and HDBI-300. See page 31 for dimensions.

④ MML IS MAXIMUM MOTOR LENGTH ON CUSTOMER SUPPLIED MOTOR. MOTOR MANUFACTURERS “C” DIMENSION CANNOT EXCEED “MML” WITHOUT A SPECIAL BASE.

NOTE: Housings are reversible and rotatable in 45° increments. Wheels are not reversible.

DIMENSIONS IN INCHES ± 1/8"

NOTE: For common boxed blower housing dimensions, see Page 24

MODEL NO.	MOTOR FRAME	F	① G	H	V	Y CL.II	Y CL.III	Y CL.IV	Z CL.II	Z CL.III	Z CL.IV	② BB	② CC	FF	HH	JJ	④ MML
HDBI-120	56-215T	4	7 11/16	12 3/4	14	1 3/16	1 3/16	—	1/4	1/4	—	36 3/16	30 3/16	15 1/2	18 3/4	16	19 3/8
HDBI-130	56-256T	4	8 3/16	17	15 3/4	1 3/16	1 7/16	1 7/16	1/4	3/8	3/8	41 7/16	35 7/16	16 5/8	23	17 3/4	24 1/4
HDBI-150	56-256T	4	8 11/16	17	17 1/4	1 7/16	1 11/16	1 11/16	3/8	3/8	3/8	42 7/16	36 7/16	18 1/8	23	19 1/4	24 1/4
HDBI-160	56-256T	4	9 1/4	17	19 1/8	1 7/16	1 11/16	1 15/16	3/8	3/8	1/2	43 9/16	37 9/16	19 3/4	23	21 1/8	24 1/4
HDBI-180	145T-286T	4	9 15/16	18 1/2	21 1/2	1 7/16	1 11/16	1 15/16	3/8	3/8	1/2	46 7/16	40 7/16	22 3/4	24 1/2	23 1/2	26 3/8
HDBI-200	145T-286T	4	10 5/8	18 1/2	23 1/2	1 7/16	1 15/16	2 3/16	3/8	1/2	1/2	47 13/16	41 13/16	23 1/2	24 1/2	25 1/2	26 3/8
HDBI-220	145T-324T	5	11 7/16	21	26 1/8	1 7/16	1 15/16	2 3/16	3/8	1/2	1/2	52 15/16	45 15/16	26 1/4	27	28 1/8	29 1/2
HDBI-240	145T-324T	6	12 5/16	21	28 1/4	1 11/16	2 3/16	2 3/16	3/8	1/2	1/2	57 5/8	47 5/8	28 1/2	27	30 3/4	29 1/2
HDBI-270	182T-324T	6	13 1/4	21	31	1 11/16	2 3/16	2 7/16	3/8	1/2	5/8	59 1/2	49 1/2	31 1/4	27	33 3/4	29 1/2
HDBI-300	182T-364T	6	14 3/8	24 3/4	34 1/4	1 15/16	2 7/16	2 7/16	1/2	5/8	5/8	65 9/16	55 9/16	34 1/2	30 3/4	37 1/4	33 1/4

FOR HDBI-330 & 360 DIMENSIONS, SEE PAGE 28.

DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

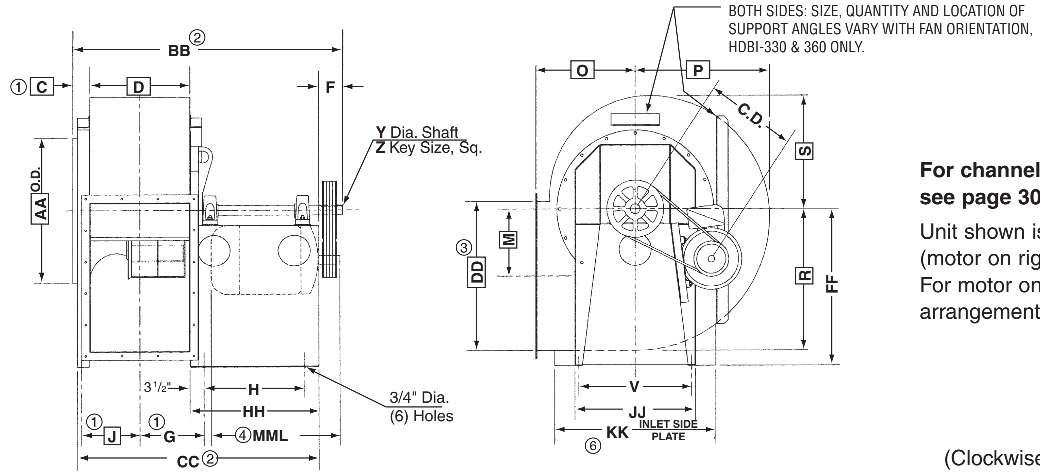
C.D. BELT CENTER DISTANCE

DIMENSIONS IN INCHES

MODEL	56-145T MIN.	56-145T MAX.	182T-184T MIN.	182T-184T MAX.	213T-215T MIN.	213T-215T MAX.	254T-256T MIN.	254T-256T MAX.	284T-286T MIN.	284T-286T MAX.	324T-326T MIN.	324T-326T MAX.	364T MIN.	364T MAX.
HDBI-120	11 3/16	12 3/4	12 1/8	13 1/2	12 5/16	13 11/16								
HDBI-130	11 1/8	12 11/16	12 13/16	14 3/8	13 1/8	14 11/16	13 7/16	14 13/16						
HDBI-150	11 5/8	13 3/16	13 7/16	14 15/16	13 7/8	15 5/8	14 5/16	16						
HDBI-160	12 3/16	13 11/16	14	15 1/2	15 1/8	17 3/16	15 11/16	17 5/8						
HDBI-180	12 7/8	14 3/8	14 9/16	16 1/16	15 13/16	17 11/16	17 1/2	19 11/16	17 13/16	19 3/16				
HDBI-200	12 5/8	14 1/4	14 1/4	15 7/8	15 5/8	17 1/2	17 1/4	19 9/16	18 1/8	20 13/16				
HDBI-220	13 9/16	15 1/16	15 3/16	16 5/8	16 7/16	18 3/16	18 1/8	20 1/4	19 1/4	21 3/4	20 3/4	22 9/16		
HDBI-240	13 11/16	15 3/16	15 7/16	16 15/16	16 11/16	18 9/16	18 1/2	20 11/16	19 7/16	22	21 5/16	24 3/8		
HDBI-270			16	17 1/2	17 5/16	19 3/16	19	21 1/4	20 1/16	22 11/16	21 15/16	25 1/16		
HDBI-300			15 15/16	17 5/16	17 15/16	19 3/4	19 9/16	21 11/16	20 5/8	23 1/8	22 7/16	25 1/2	23 15/16	27 3/8

DIMENSIONS and SPECIFICATIONS

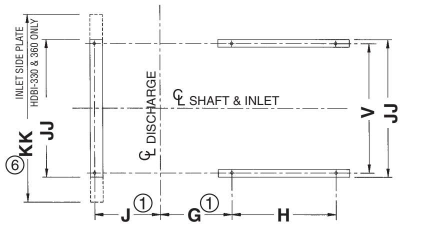
HDBI-330 & 360, Arrangement #1 and #9, Belt Drive (specify 9R or 9L)



For channel base dimensions, see page 30.

Unit shown is arrangement 9R (motor on right side).
For motor on left side, specify arrangement 9L.

CW-BH
(Clockwise-Bottom Horizontal)



FOUNDATION PLAN

NOTE: HDBI-330 AND 360 are not rotatable or reversible.

① Add 1/8" for AMCA "C" Construction fans and/or Downblast discharge position.
② Add 1/4" for AMCA "C" Construction fans and/or Downblast discharge position.
③ Discharge flange is standard on Models HDBI-330 and HDBI-360. See page 31 for dimensions.
④ MML IS MAXIMUM MOTOR LENGTH ON CUSTOMER SUPPLIED MOTOR. MOTOR MANUFACTURERS "C" DIMENSION CANNOT EXCEED "MML" WITHOUT A SPECIAL BASE.
⑥ Inlet side plate width for HDBI-330 & 360.

DIMENSIONS IN INCHES ± 1/8"

DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

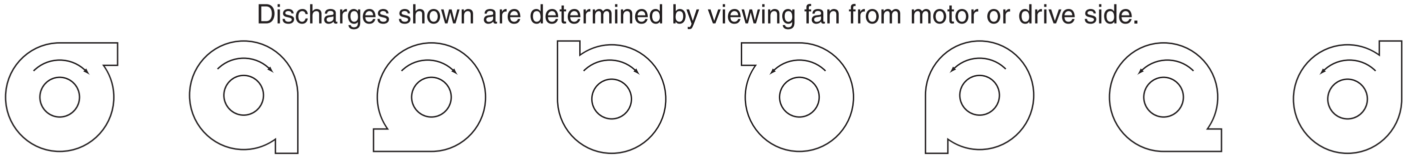
MODEL	MOTOR FRAME	F	① G	H	V	Y			Z			② BB	② CC	FF	HH	JJ	⑥ KK	④ MML
						CL.II	CL.III	CL.IV	CL.II	CL.III	CL.IV							
HDBI-330	182T-365T	6	15 15/16	25	28	2 3/16	2 7/16	2 11/16	1/2	5/8	5/8	66 1/8	59 15/16	38 3/4	32	30	41 3/4	33
HDBI-360	182T-365T	6	17 1/8	25	31	2 7/16	2 11/16	2 15/16	5/8	5/8	3/4	68 1/2	62 5/16	42	32	33	45	33

Note: For common boxed blower housing dimensions, see Page 24.

C.D. BELT CENTER DISTANCE

MOTOR FRAME	CLASS II & III		CLASS IV	
	MIN.	MAX.	MIN.	MAX.
182T-184T	17 9/16	18 5/8	17 7/8	19 3/16
213T-215T	18 7/8	20 5/16	19 3/16	20 7/8
254T-256T	20 9/16	22 5/16	21 1/16	22 7/8
184T-286T	21 9/16	23 11/16	22 1/8	24 5/16
324T-326T	23 1/2	26 1/16	24	26 11/16
364T-365T	24 15/16	28	25 3/8	28 5/8

16 DISCHARGE POSITIONS AVAILABLE. 45° DISCHARGE POSITIONS NOT SHOWN.*
Discharges shown are determined by viewing fan from motor or drive side.



CW-TH Clockwise Top Horizontal Discharge

CW-DB Clockwise Down-Blast Discharge ★

CW-BH Clockwise Bottom Horizontal Discharge

CW-UB Clockwise Up-Blast Discharge

CCW-TH Counter-Clockwise Top Horizontal Discharge

CCW-DB Counter-Clockwise Down-Blast Discharge ★

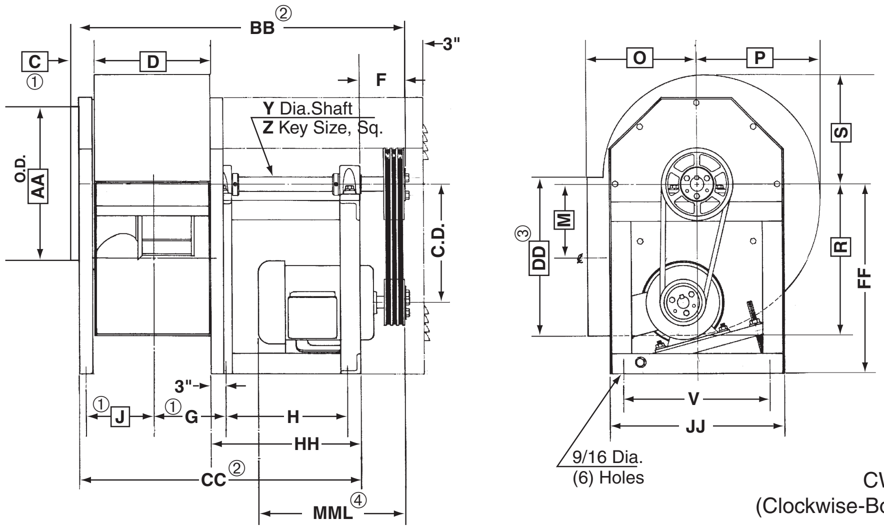
CCW-BH Counter-Clockwise Bottom Horizontal Discharge

CCW-UB Counter-Clockwise Up-Blast Discharge

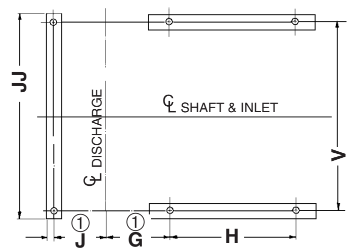
★ Not available on models HDBI-270 through HDBI-360 or any other models with discharge flange option without special discharge extension. For arrangement 9CB units, contact your local Cincinnati Fan sales representative.
* See (*) on page 31.

DIMENSIONS and SPECIFICATIONS

Arrangement #10, Belt Drive



CW-BH
(Clockwise-Bottom Horizontal)



FOUNDATION PLAN

① Add 1/8" for AMCA "C" Construction fans and/or Downblast discharge position.

② Add 1/4" for AMCA "C" Construction fans and/or Downblast discharge position.

③ Discharge flange (not shown above) is standard on Models HDBI-270 and HDBI-300. See page 31 for dimensions.

④ MML IS MAXIMUM MOTOR LENGTH ON CUSTOMER SUPPLIED MOTOR. MOTOR MANUFACTURERS "C" DIMENSION CANNOT EXCEED "MML" WITHOUT A SPECIAL BASE.

NOTE: Housings are reversible and rotatable in 45° increments. Wheels are not reversible.

DIMENSIONS IN INCHES ± 1/8"

NOTE: For common boxed blower housing dimensions, see Page 24.

MODEL NO.	MOTOR FRAME	F	① G	H	V	Y			Z			② BB	② CC	FF	HH	JJ	④ MML
						CL.II	CL.III	CL.IV	CL.II	CL.III	CL.IV						
HDBI-120	56-184T	4 1/8	7 11/16	12 3/4	14	1 3/16	1 3/16	—	1/4	1/4	—	36 3/16	30 3/16	15 1/2	18 5/8	16	18 7/8
HDBI-130	56-184T	4 1/8	8 3/16	17	15 3/4	1 3/16	1 7/16	1 7/16	1/4	3/8	3/8	41 7/16	35 5/16	16 5/8	22 7/8	17 3/4	23 1/8
HDBI-150	56-215T	4 1/8	8 11/16	17	17 1/4	1 7/16	1 11/16	1 11/16	3/8	3/8	3/8	42 7/16	36 5/16	18 1/8	22 7/8	19 1/4	24 1/4
HDBI-160	56-215T	4 1/8	9 1/4	17	19 1/8	1 7/16	1 11/16	1 15/16	3/8	3/8	1/2	43 9/16	37 7/16	19 3/4	22 7/8	21 1/8	24 1/4
HDBI-180	56-256T	4 1/8	9 15/16	18 1/2	21 1/2	1 7/16	1 11/16	1 15/16	3/8	3/8	1/2	46 7/16	40 5/16	22 3/4	24 3/8	23 1/2	26 5/8
HDBI-200	56-256T	4 1/8	10 5/8	18 1/2	23 1/2	1 7/16	1 15/16	2 3/16	3/8	1/2	1/2	47 13/16	41 11/16	23 1/2	24 3/8	25 1/2	26 5/8
HDBI-220	145T-286T	5 1/8	11 7/16	21	26 1/8	1 7/16	1 15/16	2 3/16	3/8	1/2	1/2	52 15/16	45 13/16	26 1/4	26 7/8	28 1/8	29 3/4
HDBI-240	145T-324T	6 3/16	12 5/16	21	28 1/4	1 11/16	2 3/16	2 3/16	3/8	1/2	1/2	57 5/8	47 7/16	28 1/2	26 15/16	30 3/4	29 5/8
HDBI-270	182T-324T	6 3/16	13 1/4	21	31	1 11/16	2 3/16	2 7/16	3/8	1/2	5/8	59 1/2	49 5/16	31 1/4	26 15/16	33 3/4	29 5/8
HDBI-300	182T-324T	6 3/16	14 3/8	24 3/4	34 1/4	1 15/16	2 7/16	2 7/16	1/2	5/8	5/8	65 9/16	65 9/16	34 1/2	30 9/16	37 1/4	33 3/8

HDBI-330 and HDBI-360 are not available in Arrangement 10.

DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

C.D. BELT CENTER DISTANCE

DIMENSIONS IN INCHES

MODEL	56		143T-145T		182T-184T		213T-215T		254T-256T		284T-186T		324T	
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
HDBI-120	8 1/8	10	8 1/8	10	7 1/2	9								
HDBI-130	9 1/4	11 1/8	9 1/4	11 1/8	8 3/8	10 1/8								
HDBI-150	10	12 1/8	10	12 1/8	9 1/8	11 1/8	8 3/8	10 3/8						
HDBI-160	11 5/8	13 5/8	11 5/8	13 5/8	10 5/8	12 5/8	10	11 7/8						
HDBI-180	14	16 1/8	14	16 1/8	12 3/4	15 1/8	12	14 3/8	11 1/8	13 3/8				
HDBI-200	14 3/4	16 7/8	14 3/4	16 7/8	13 1/2	15 7/8	12 3/4	15 1/8	11	13				
HDBI-220			17	19 3/4	16 1/8	18 5/8	15 3/8	17 7/8	14 3/8	16 7/8	13 3/4	16 1/4		
HDBI-240			19 1/4	22	18 1/4	21	17 5/8	20 1/8	16 5/8	19 1/8	15 7/8	18 3/8	14 7/8	17 3/8
HDBI-270					21	23 3/4	20 3/8	22 7/8	19 3/8	21 7/8	18 5/8	21 1/8	17 5/8	20 1/8
HDBI-300					24 1/4	26 7/8	23 1/2	26 1/8	22 1/2	25 1/8	21 7/8	24 3/8	20 7/8	23 3/8

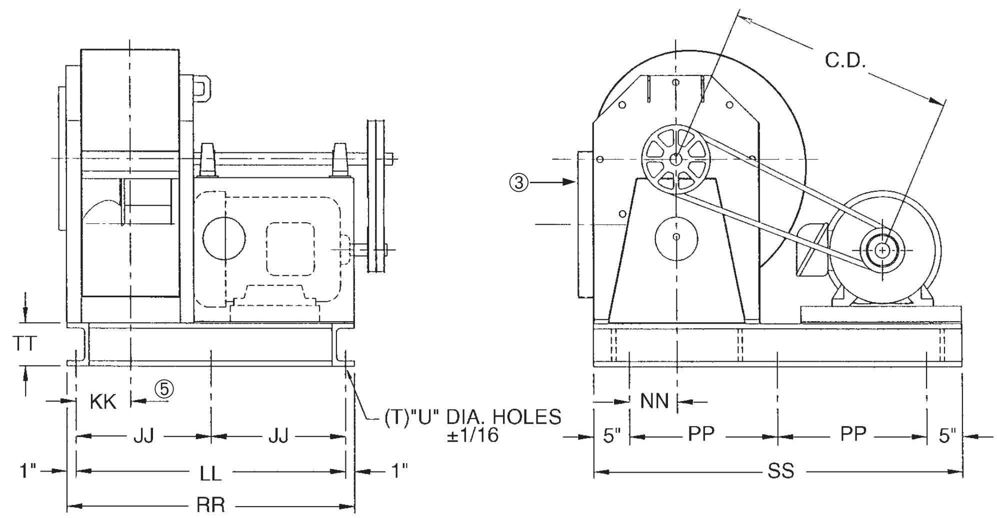
⚠ DANGER

All fans & blowers shown have rotating parts and pinch points. Severe personal injury can result if operated without guards. Stay away from rotating equipment unless it is disconnected from its power source.

Read operating instructions.

DIMENSIONS and SPECIFICATIONS

HDBI-120 to 360, Arrangement #9RCB or #9LCB Channel Base, Belt Drive



Unit shown is arrangement 9RCB (motor on right side). For motor on left side, specify arrangement 9LCB.
Channel base arrangements not available in down blast or 45˚ bottom angular down discharge positions.

DIMENSIONS IN INCHES ± 1/8"

MODEL	MOTOR FRAME	T	U	⑤ KK	JJ	LL	NN	PP	RR	SS	TT	Ship wt. less motor CL.II	CL.III	CL.IV
HDBI-120	184T-215T	6	9/16	5 3/4	—	28 3/16	3	13 15/32	30 3/16	36 15/16	4	260	265	—
HDBI-130	184T-256T	6	9/16	6 1/4	—	33 7/16	3 7/8	15 13/16	35 7/16	41 5/8	4	300	305	310
HDBI-150	184T-284T	6	9/16	6 3/4	—	34 7/16	4 5/8	17 3/4	36 7/16	45 1/2	4	340	350	360
HDBI-160	184T-286T	6	9/16	7 5/16	—	35 9/16	5 9/16	18 11/16	37 9/16	47 3/8	4	390	400	410
HDBI-180	184T-324T	6	9/16	8	—	38 7/16	6 3/4	21 3/16	40 7/16	52 3/8	6	500	510	520
HDBI-200	254T-324T	6	9/16	8 11/16	—	39 13/16	7 3/4	22 3/16	41 13/16	54 3/8	6	560	580	590
HDBI-220	254T-364T	6	9/16	9 1/2	—	43 15/16	9 1/16	26 11/16	45 15/16	63 3/8	6	660	680	690
HDBI-240	254T-364T	6	9/16	10 11/32	—	48 1/8	10 3/8	28	50 1/8	66	6	800	810	820
HDBI-270	254T-364T	6	9/16	11 9/32	—	50	11 7/8	29 1/2	52	69	6	960	970	980
HDBI-300	254T-405T	6	9/16	12 7/16	—	56 1/16	13 5/8	31 1/4	58 1/16	72 1/2	6	1130	1165	1170
HDBI-330	254T-444T	8	3/4	14 1/2	30 7/32	60 7/16	10	32 11/16	62 7/16	75 3/8	6	1420	1560	1760
HDBI-360	254T-444T	8	3/4	15 11/16	31 13/32	62 13/16	11 1/2	32 11/16	64 13/16	75 3/8	6	1650	1840	1910

③ Discharge flange (not shown above) is standard on Models HDBI-270 through HDBI-360. See page 31 for dimensions.
⑤ Subtract 1/8" for AMCA "C" Construction.
Dimensions subject to change without notice.

C.D. BELT CENTER DISTANCE

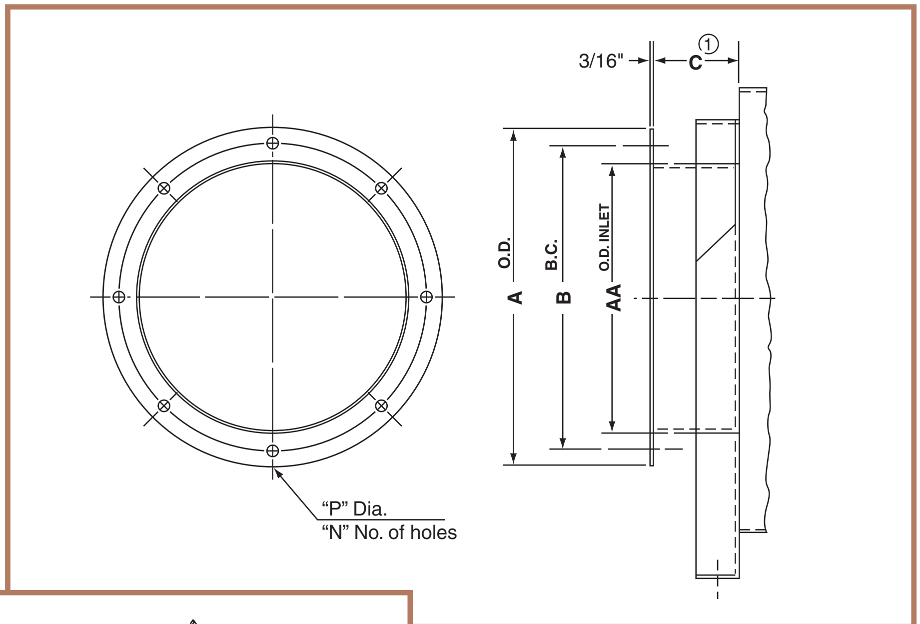
DIMENSIONS IN INCHES

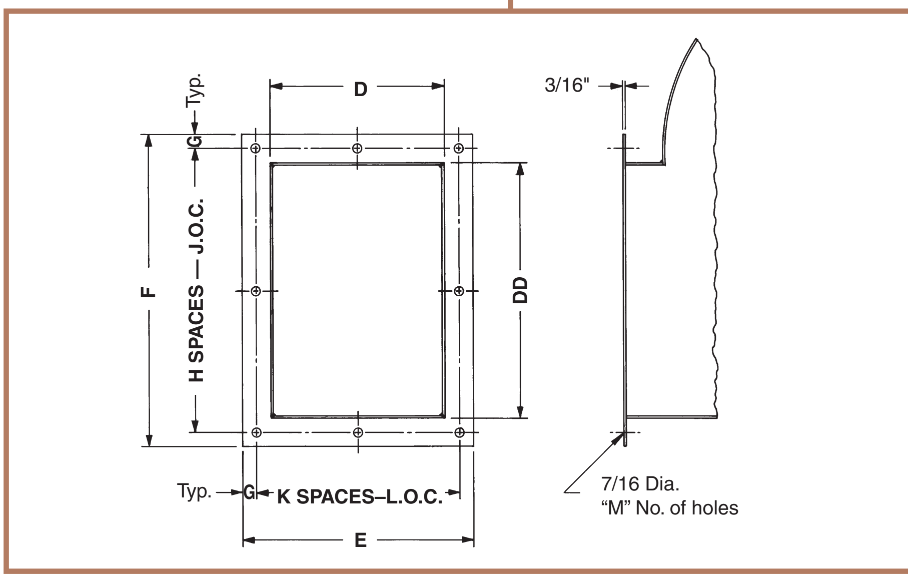
MODEL	MOTOR FRAME SIZE 184T MIN.	184T MAX.	213T-215T MIN.	213T-215T MAX.	254T-256T MIN.	254T-256T MAX.	284T-286T MIN.	284T-286T MAX.	324T-326T MIN.	324T-326T MAX.	364T-365T MIN.	364T-365T MAX.	404T-405T MIN.	404T-405T MAX.	444T MIN.	444T MAX.
HDBI-120	23 5/8	25 7/8	21 15/16	24 11/16												
HDBI-130	27 1/2	29 5/8	25 7/8	28 5/8	23 15/16	27 3/16										
HDBI-150	31	33	29 5/16	32 1/8	27 3/8	30 5/8	25 15/16	29 11/16								
HDBI-160	32 5/8	34 13/16	30 7/8	33 9/16	28 7/8	32 1/16	27 7/16	31 1/16								
HDBI-180	37 1/4	39 1/4	35 5/8	38 1/4	33 5/8	36 11/16	32 1/8	35 3/4	29 13/16	34 1/8						
HDBI-200					34 13/16	37 15/16	33 3/8	36 15/16	31 1/16	35 5/16						
HDBI-220					42 15/16	46 1/16	41 1/2	45 1/8	39 3/16	43 1/2	37 3/16	42 3/16				
HDBI-240					45 1/8	48 3/16	43 11/16	47 3/16	41 5/16	45 9/16	39 5/16	44 1/4				
HDBI-270					47 3/4	50 3/4	46 1/4	49 3/4	43 15/16	48 1/16	41 15/16	46 3/4				
HDBI-300					50 7/8	53 13/16	49 7/16	52 13/16	47 1/16	51 1/8	45 1/16	49 3/4	42 7/16	47 13/16		
HDBI-330					58 5/8	61 9/16	57 3/16	60 1/2	54 13/16	58 13/16	52 13/16	57 7/16	53 1/8	58 13/16	51 9/16	57 11/16
HDBI-360					59 3/16	62	57 3/4	60 15/16	55 5/16	59 3/16	53 5/16	57 13/16	53 1/2	59	51 7/8	57 13/16

DIMENSIONS and SPECIFICATIONS

INLET AND OUTLET FLANGES

INLET





OUTLET*

* **Not available on: down blast, top angular down, or bottom angular down outlet positions for any models without discharge transition. Outlet flange standard on all HDBI-270 to HDBI-360. Dimensions shown below are for 100% width housings. For partial width housings, contact your local Cincinnati Fan sales representative.**

NOTE: Flanges will be drilled unless otherwise specified.

DIMENSIONS IN INCHES ± 1/16" **

DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

MODEL	A	B	C①**	D**	E	F	G	H	J	K	L	M	N	P	AA**	DD**
HDBI-120	16	14 3/8	4 1/16	9 3/8	13 3/8	17 11/16	1	2	7 27/32	2	5 11/16	8	8	7/16	13 1/4	13 3/4
HDBI-130	17 3/4	15 15/16	4 1/16	10 3/8	14 3/8	19 3/16	1	2	8 19/32	2	6 3/16	8	8	7/16	14 5/8	15 1/4
HDBI-150	19 1/4	17 1/2	4 1/16	11 3/8	15 3/8	20 3/4	1	3	6 1/4	2	6 11/16	10	8	7/16	16 1/8	16 13/16
HDBI-160	21 1/8	19 3/8	4 1/16	12 1/2	16 1/2	22 7/16	1	3	6 13/16	2	7 1/4	10	8	7/16	18	18 7/16
HDBI-180	23 1/2	21 1/2	4 1/16	13 7/8	17 7/8	24 1/2	1	3	7 1/2	2	7 15/16	10	12	7/16	20	20 3/8
HDBI-200	25 1/2	23 1/2	4 1/16	15 1/4	19 1/4	26 3/8	1	3	8 1/8	3	5 3/4	12	12	7/16	22	22 3/8
HDBI-220	28 1/8	26 1/8	4 1/16	16 7/8	20 15/16	28 7/8	1	4	6 23/32	3	6 5/16	14	12	7/16	24 5/8	24 7/8
HDBI-240	30 3/4	28 3/4	6 1/16	18 9/16	22 5/8	31 3/8	1	4	7 11/32	3	6 7/8	14	16	7/16	27	27 3/8
HDBI-270	33 3/4	31 5/8	6 1/16	20 7/16	24 1/2	34 1/8	1	4	8 1/32	3	7 1/2	14	16	7/16	30	30 1/16
HDBI-300	37 1/4	35 1/4	6 1/16	22 3/4	26 3/4	37 5/8	1	5	7 1/8	3	8 1/4	16	16	7/16	33 1/2	33 9/16
★HDBI-330	40 3/8	38 3/4	6 1/16	24 7/8	28 7/8	40 7/8	1	7	5 9/16	5	5 3/8	24	16	1/2	36 3/4	36 7/8
★HDBI-360	43 5/8	42	6 1/16	27 1/4	31 1/4	44 1/4	1	7	6 1/32	5	5 27/32	24	16	1/2	40	40 1/4

① Add 1/8" for AMCA "C" Construction fans and/or Downblast discharge position.

★ **HDBI-330 & 360 HAVE FIXED HOUSINGS AND ARE THEREFORE NOT ROTATABLE IN THE FIELD.**

****NOTE: Dimensions C, D, AA and DD are ± 1/8".**

AMACS PROCESS TOWER INTERNALS

14211 Industry Street
Houston, Texas
77053
www.amacs.com

FRI Member
Fractionation Trays and Tray Hardware
Vane and Mesh Mist Eliminators
Packed Column Internals

MIST ELIMINATOR DATA SHEET (Vapor / Liquid Mist Separation)

Customer :		Date :	
Address :		AMACS Quote :	
		Item No. :	
Contact Name :			
Phone No. :		Inquiry / P.O. No.	
Fax No. :		Service :	
E Mail Address :		Tag No... :	

PROCESS DATA*

Property Data	**Unit / Case –Tag**	**Average**	**Max**	**Min**
Vapor				
Operating Temperature	° F (Fahrenheit)	120	140	100
Operating Pressure	Psia (Lbs/Sq. Inch)	14.7		
Compressibility Factor	Z	1		
Density of Gas	Lbs / cu. Ft.	.068		
Viscosity	Cp	1.316x10^-5	Dynamic vis. Lbm/ft/s	
Flow Rate Norm/Max./Min.	Lbs. / Hr.	1632.32	3264	
Liquid				
Density of Liquid	Lbs / cu. Ft.	61.7		
Viscosity	Cp	1.168x10^5	Dynamic vis. Lb-s/ft2	
Surface Tension	Dynes/cm	.0047 lb/ft		
Flow rate	Lbs. / Hr.	122.3	244.6	
Solids / Foulants	Yes / No	yes		

Vessel Details **New / Existing ?**

Column ID	Inch			
Material of construction				
Vessel Orientation	Horizontal/ Vertical			
Mist Eliminator material				

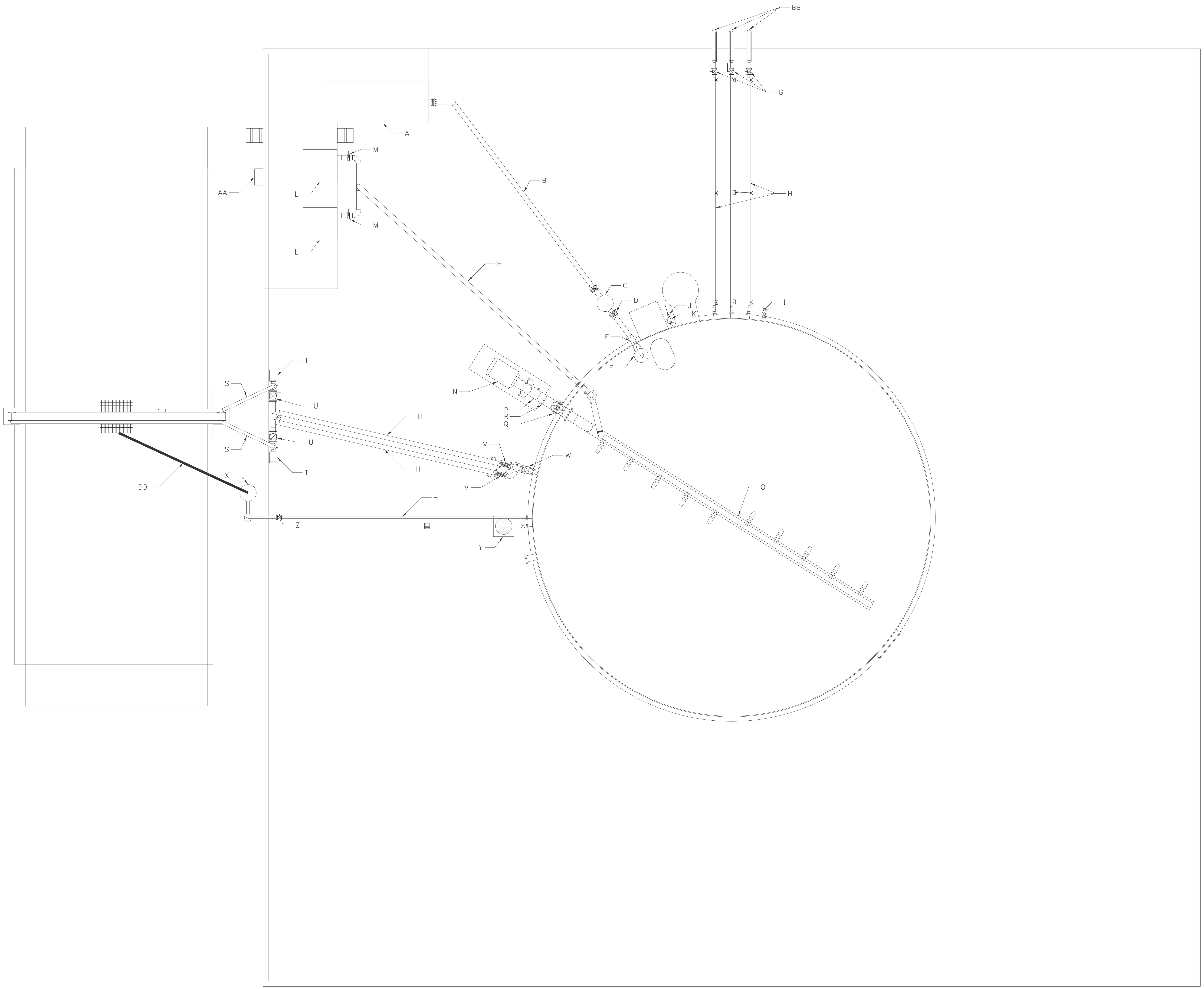
Supports	☐ Full Ring top & bottom		Width (Inch)		Thickness (Inch)	
	☐ Between body flange					
	☐ Clips (Angle)		Length / Width / Thickness		/ / (Inch)	
Beams	☐ Yes	☐ No	Size		(If required)	

Installation through tower manway	☐ Yes	☐ No

Pressure Drop (gas side)	Allowable		Inch WC /	Estimated		Inch WC

REMARKS / SPECIAL INSTRUCTIONS : Please attach sketch of your requirement & layout.

* AMACS can work from any units. Please write your own units if it is different from the one shown here.



Tag	Description
A	Pure Air PBS
B	PVC Duct Piping
C	Knock-Out Sump
D	10" Del Tech Butterfly Valve
E	Dwyer 2302 Magnehelic Gauge
F	Enardo 550 PVRV
G	3" Actuated SS Ball Valve
H	304SS A312 Piping & A403 Fittings
I	4" SS Ball Valve
J	Dwyer 681-42 Sanitary Pressure Transmitter
K	2" SS Thrd Ball Valve
L	Kaeser Blowers
M	4" Del Tech Butterfly Valve
N	Sulzer APT43-12 Pump
O	FRP Fiberglass Piping
P	12" Neoprene Single Sphere Expansion Joint
Q	14" Davis SS Knife Gate Valve
R	Trerice 700LFSS Pressure Gauge
S	4" SS Check Valve
T	Summit ANSI 2196 Pump
U	6" SS Actuated Ball Valve
V	6" SS Braided Pump Connector
W	6" SS Ball Valve
X	24" x 96" Fiberglass Dual Contained Sump
Y	24" x 72" Fiberglass Dual Contained Sump
Z	2" SS Ball Valve
AA	Tank Farm Control Panel
BB	HDPE Piping

PREPARED FOR
BRIDGETON LANDFILL, LLC

PLUMBING DETAILS
BRIDGETON LANDFILL
BRIDGETON, ST. LOUIS COUNTY, MISSOURI

REVISION DESCRIPTION
DATE
No.

WEAVER BOOS CONSULTANTS

2021 TIMBERBROOK LN
SPRINGFIELD, ILLINOIS
(217) 787-0290

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DENVER, CO — FORT WORTH, TX
GRAND RAPIDS, MI — GRIFFITH, IN
NAPERVILLE, IL — SOUTH BEND, IN
SPRINGFIELD, IL — EVANSVILLE, IN

www.weaverboos.com

DRAWN BY: AWS
DESIGNED BY: MEM
REVIEWED BY: JB
DATE: 03/28/2013
FILE: 0120-122-25
CAD: BL000007 AB.2013-3-28.DWG

SHEET 1 OF 1

Table of Contents

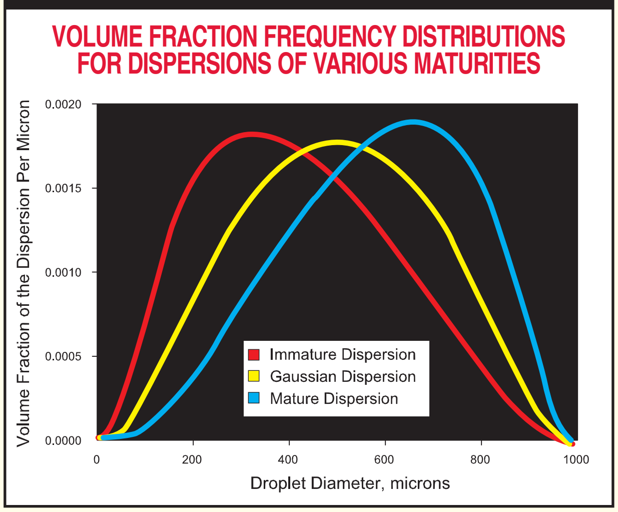
The Engineered Mist Eliminator

Mist elimination, or the removal of entrained liquid droplets from a vapor stream, is one of the most commonly encountered processes regardless of unit operation. Unfortunately, mist eliminators are often considered commodity items and are specified without attention to available technologies and design approaches. The engineered mist eliminator may reduce liquid carryover by a factor of one hundred or more relative to a standard unit, drop head losses by 50% or more, or increase capacity by factors of three or four. This manual summarizes input practical approaches to reducing absorbent losses, product contamination and entrainment carry over, extending equipment life and maintenance cycles - using proven and cost effective technologies and techniques.

Droplet Formation and Size Distributions

Entrained liquid does not consist of same-sized droplets, but as a broad range of droplet sizes that may be characterized with a Normal or Bell Distribution centered about some mean or average. The average droplet size depends very much on the mechanism by which they are generated. Sizing equations are expressed in terms of the probability of removing a droplet of a given diameter, and mist eliminator performance is the integration or cumulative sum of individual removal efficiencies. It is therefore critical to know the approximate droplet size distribution in order to properly design a mist elimination system. Figure 1 shows some typical size distribution curves from different sources.

FIGURE 1



In practice, designers or engineers do not quantify or measure droplet size distributions, rather they are assumed based on empirical data or experience. Fortunately, an experienced engineer can assume an approximate distribution based on the means or mechanism by which the droplets are generated. Typical examples from common mist sources are given to illustrate these concepts.

Fine droplet distributions, often called *fogs* (<3 μm diameter particles with an average typically in the submicron range), occur in high speed metal stamping in which cycles of extreme frictional heating and shock condensation of lubricating oils form droplets in the submicron range, so-called "blue smoke". This smoke is removed to comply with health and environmental regulations.

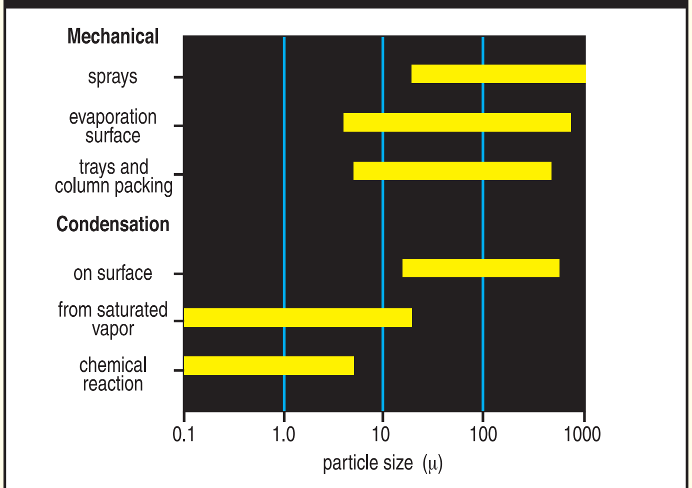
Fog is also produced when gas phase reactions form a liquid product as in the case of vapor phase SO_3 and water yielding H_2SO_4. Downstream equipment corrodes rapidly without the removal of this liquid. Similar concerns are found in ammonia prill towers, many chlorine applications, as well as phosphoric and nitric acid plants.

A *mist* consists of droplets in the range of 3µm and greater, though distributions with average diameters of 20 µm and greater are termed *Sprays*. Mist coming off the top of packing or trays, or generated by surface evaporation, are typically in the broad range of 5-800 µm. In towers used in glycol dehydration and amine sweetening in which mists are a major source of costly solvent losses, removal of droplets down to 5 µm is recommended.

Hydraulic spray nozzles generate particles with diameters greater than 50 µm and pneumatic nozzles generate particles with diameters greater than 10 µm, with upper limits reaching 1000 µm.

The first step in engineering a mist eliminator is to determine the mechanism by which the droplets are generated and assume an average droplet size. Figure 2 summarizes typical particle size distributions caused by various mechanisms:

FIGURE 2

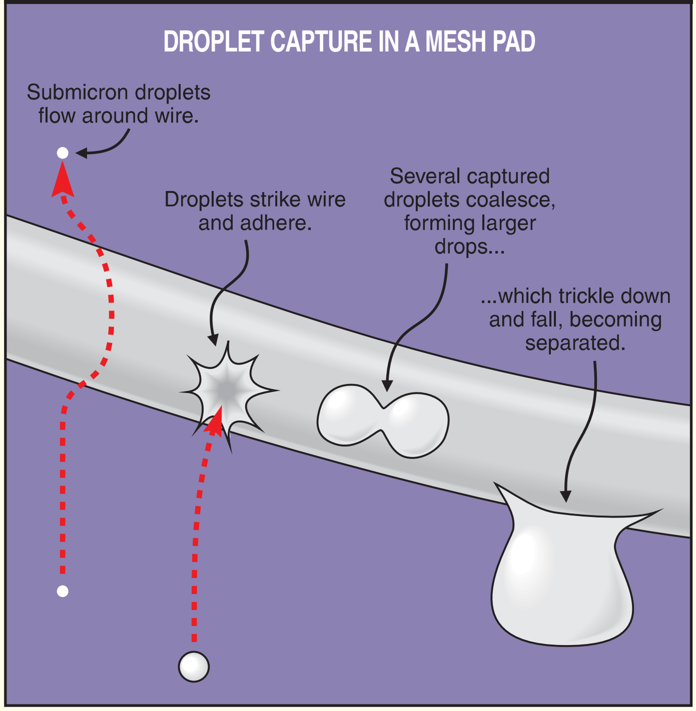


This manual contains basic design concepts used by engineers to remove droplets greater than 3 µm in diameter, so called mists and sprays.

Mechanisms of Droplet Removal

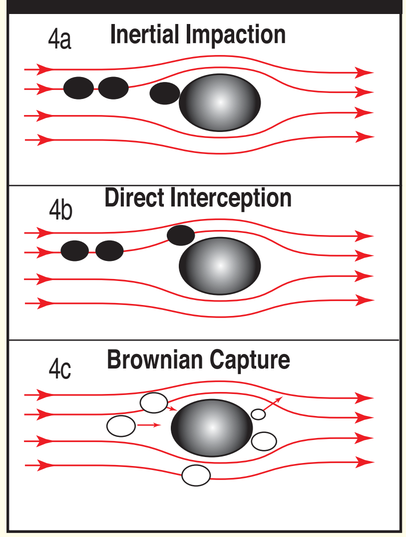
Droplets are removed from a vapor stream through a series of three stages: collision & adherence to a target, coalescence into larger droplets, and drainage from the impingement element. Knowing the size distributions as explained above is important because empirical evidence shows that the target size - important in the first step of removal - must be in the order of magnitude as the particles to be removed. These steps are shown schematically in Figure 3 for mist elimination using a wire mesh mist eliminator.

FIGURE 3



For fogs in which the bulk of the droplets are characterized with submicron diameters, the energy to bring about the collision with the target is derived from Brownian Diffusion, the random motion of fine liquid particles as they are pushed about by molecular action as shown in Figure 4a. Fog elimination with so-called fiberbed technology is beyond the scope of this manual.

FIGURE 4



For particles in the mist region between 3-20 µm, knitted wire mesh is the most common type of mist eliminator used and interception is the primary mechanism.

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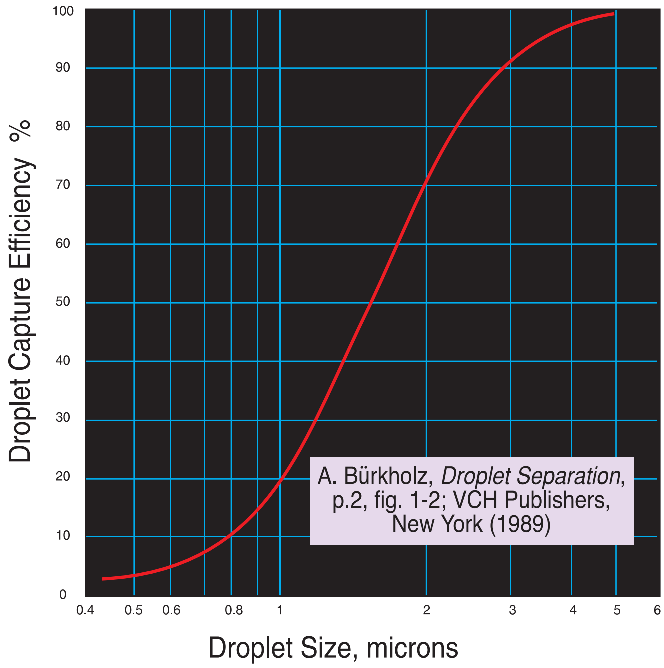
Consider a droplet approaching a mesh filament of much larger diameter as shown in Figure 4b. The more dense the droplet relative to the gas, the larger the droplet relative to the filament, and the higher the gas velocity, the more likely it is that the droplet will strike the filament. If the velocity is too low, or the droplet too small or too light compared to the gas, the droplet will simply flow around the filament with the gas. If the velocity is too high, liquid clinging to the filaments will be re-entrained, mostly as larger droplets, and carried away by the gas. Re-entrainment is also promoted by low relative liquid density (making it easier for the gas to pick up a droplet) and low liquid surface tension (as less energy is required to break up a film or droplet). The engineered wire mesh mist eliminator may remove 99.9% of particles 2 µm and greater diameter. Figure 5 shows a typical removal efficiency vs droplet size distribution for a wire mesh mist eliminator.

FIGURE 5

SEPARATION EFFICIENCY FOR VARIOUS DROPLET SIZES IN A TYPICAL WIRE MESH MIST ELIMINATOR



Droplets ~20 µm and greater are primarily collected by means of Inertial Impaction whereby the target is directly in the path of the streamline, as shown in Figure 4c. Figure 6 depicts a profile of the ACS Plate-Pak™ vane. The entrained droplets, due to their momentum, tend to move in straight lines. By studying this figure, it is easy to understand why in the design equations to follow the removal efficiency is directly proportional to the difference in densities of the liquid droplet and carrying gas. With each change in direction of the gas, some droplets collide with the surface and adhere, eventually coalescing into larger droplets which then drain by gravity. Properly designed vane mist eliminators can remove 99% of particles as low as 10 µm in diameter, especially at lower pressures.

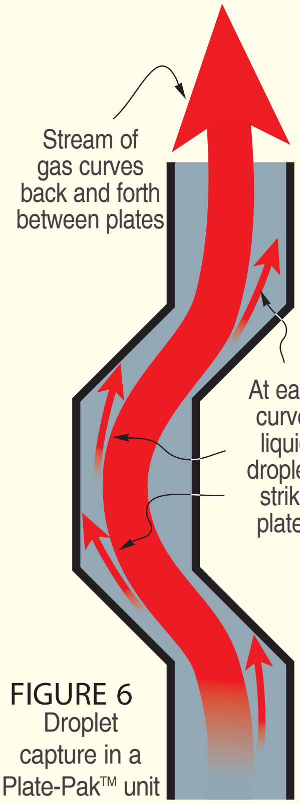


FIGURE 6
Droplet capture in a Plate-Pak™ unit

Figure 7 illustrates typical wire mesh and Plate-Pak™ vane mist eliminators, and Figure 8 shows some typical performance curves for both mesh and vane mist eliminators.

FIGURE 7

Typical AMACS Mist Eliminators

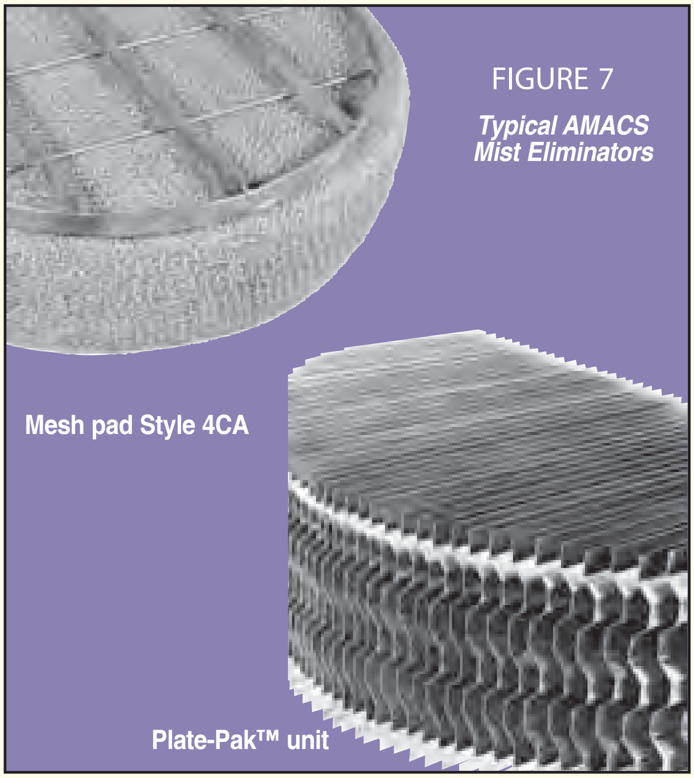


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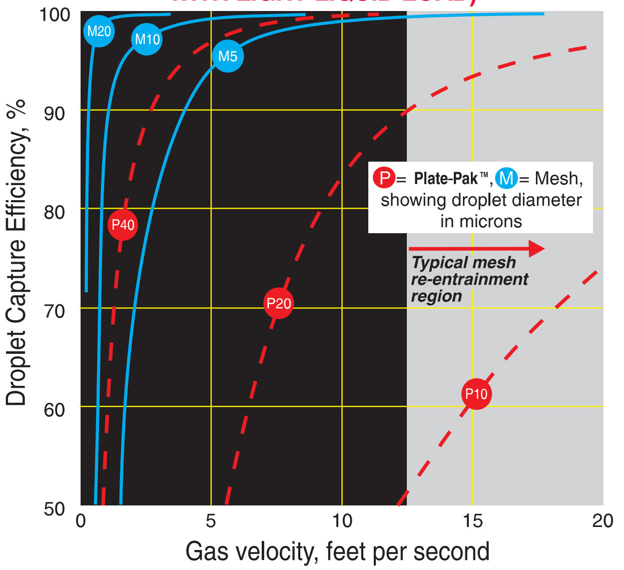
FIGURE 8

THEORETICAL EFFICIENCY VS. VELOCITY FOR VARIOUS DROPLET SIZES (WATER IN AIR AT AMBIENT CONDITIONS FOR TYPICAL MESH PADS AND PLATE-PAK™ UNITS WITH LIGHT LIQUID LOAD)



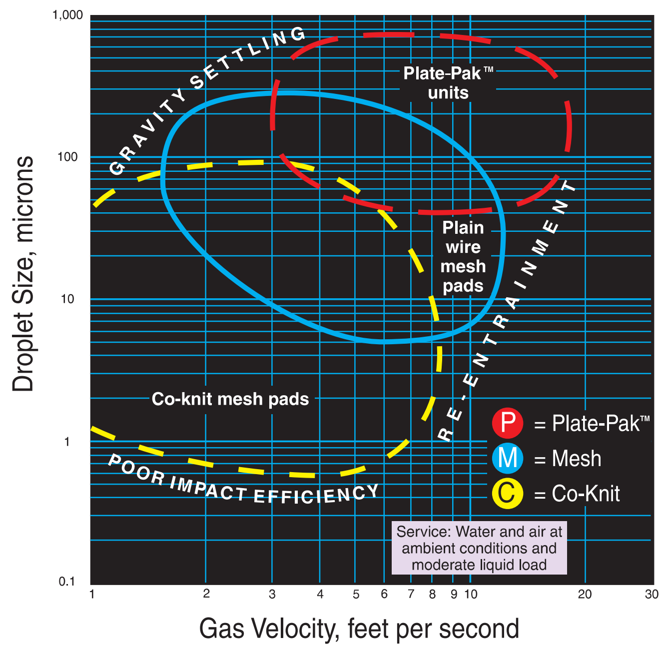
It is worthwhile to discuss Fig. 8 and mist eliminator performance. The dotted curves correspond to different styles of vanes and the solid to wire mesh styles. Note first of all that vanes can be engineered to operate at higher gas velocities and flow rates relative to mesh, but that mesh mist eliminators can approach 100% removal efficiency at smaller droplet sizes. This agrees with the discussions above on Interception and Inertial Impaction removal mechanisms. Note the drastic efficiency drop off at low velocities, in which droplets drift around the filaments or vane blades without striking them. This phenomenon defines the lower operating range of a mist eliminator. The other extreme is when the velocity is too high. In this case, the droplets are captured but the velocity of the gas provides sufficient energy to tear-off and re-entrain droplets. It is in the context of re-entrainment that the design equations which follow show that the removal efficiency is directly proportional to the surface tension of the liquid. As the surface tension increases, so it requires greater kinetic energy (i.e. gas velocity) to break the bond between droplet and target, and the droplets collect and coalesce until drainage by gravity. Re-entrainment defines the upper capacity limit of a mist eliminator.

Operating range is also affected by the liquid loading (proportion of liquid) of the gas. If too great, the mist eliminator becomes choked with liquid, a condition called flooding. Flooding is often noticed by high pressure drops or massive carryover of liquids. Typical wire mesh mist eliminators accommodate liquid loads up to about one US GPM per square foot and vanes twice as much.

The key operating ranges and suitability of mesh and vane mist eliminators are summarized in Figure 9. It emphasizes that vanes are more effective at higher velocities and greater droplet sizes while mesh is more suitable for removing smaller particles at lower velocities. Gravity settling alone is sufficient for very large particles, and co-knit mesh pads, discussed below, for particles in the range of sizes from 2-8 µm. Finally, fiberbed technology is used for submicron fogs.

FIGURE 9

APPROXIMATE OPERATING RANGES OF MIST ELIMINATORS



Types of Mist Eliminator Mesh Styles & Materials

Most designers believe that all wire mesh mist eliminators behave basically the same in terms of capacity and removal efficiency. It is true that for meshes of same filament diameter, the denser mesh offers superior removal efficiency. For meshes with differing filament diameters, a lighter (less dense) mesh may offer considerably better removal efficiency. The key is that the working part of the mesh is the target density, not

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the mass density. For example, the most common 9-lb density mesh, AMACS style 4CA, exhibits ~85 sq-ft/cu-ft of surface area. Compare this to the co-knit of a metal with fiberglass (AMACS style 6BE) which also exhibits 9-lb mass density but exhibits a specific surface area approaching 3,700 sq-ft/cu-ft, some 40X greater targets per unit volume.

Table 1 shows a few of the more common mesh styles available, together with mesh density and void fraction, and most importantly, the diameter and specific surface area (i.e. the target density) of filaments used.

TABLE 1 • Wire and Plastic Mesh Styles

Mesh Style	Density lbs/ft^3	Diameter D, inches	Surface, S, ft^2/ft^3	Percent Voids, ε
Metal mesh				
7CA	5.0	0.011	45	99.0
5CA	7.0	0.011	65	98.6
4CA	9.0	0.011	85	98.2
4BA	12.0	0.011	115	97.6
3BF	7.2	0.006	120	98.6
3BA	12.0	0.006	200	97.6
Plastic mesh				
8P	4.0	0.011	130	92.0
8K	4.0	0.011	160	96.3
8T	4.0	0.011	130	97.0

Mesh Style	Density lbs/ft^3	Diameter D, inches	Surface, S, ft^2/ft^3	Percent Voids, ε
Metal mesh				
8D	9	0.0008	615	99.0
8TMW11	12	0.0008	1170	99.0
6BE	9	0.00036	3725	99.0
Plastic mesh				
8PP	3	0.001	480	99.0
8TT	5	0.0008	1240	99.0

It is the amount of targets per unit volume which influences removal efficiency, not the density of mesh (the greater the number of targets the greater the probability of a successful collision).

In a co-knit such as a metal alloy and fiberglass, the alloy provides a skeleton for structural support and prevents the high specific surface media from collapsing on itself.

As far back as the 1950's researchers (C. LeRoy Carpenter et al) determined that specific surface area and target or filament diameter play a great role in removal efficiency. Target or filament diameter must be on the order of magnitude as the smallest droplets to be removed. Due to limitations in metal wire ductility and corrosion considerations, co-knits provide finer targets and hence remove finer droplets. Figures 10 and 11 are enlarged images of crimped wire mesh and a co-knit with fiberglass respectively.

FIGURE 10

CRIMPED WIRE MESH

FIGURE 11

CO-KNIT MESH WITH FIBERGLASS YARN

In summary, it is important to report mesh styles in terms of the specific surface area - a measure of the target density, and filament diameter -a measure of the smallest droplet size that can be removed with high efficiency. The mass density is only relevant insofar that a metal mesh of density 12-lb exhibits a greater specific surface area than one of density 7-lb provided the wire diameter remains constant.

Selecting the material of mesh style(s) is also important. Corrosion rates as low as 0.005"/year is not serious in vessel walls but will quickly destroy 0.006" or 0.011" wire mesh. Table 2 gives preliminary guidelines, but AMACS draws wire and knits mesh with any ductile metal for special applications.

When applying non-metal materials operating temperature limits must be considered.

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TABLE 2
Mesh Corrosion & Temp. Considerations

Material	Spec. Grav.	Max. Op. Temp., °F	Typical Surface
304 SS	1.00	---	Petroleum, aqueous
304L	1.00	---	Petroleum, aqueous
316L	1.00	---	Sulfuric acid
410 SS	1.00	---	Mild chemicals
Monel®	1.12	---	Corrosive chemicals
Nickel	1.13	---	Caustic evaporators
Alloy 20	1.00	---	Sulfuric acid
Glass	2.52	---	Mild aqueous chemicals
Hastelloy®	1.14	---	Hydrochloric & other acids
Dacron®	1.38	350	Co-knit applications
Kynar®	1.75	300	Acid, alkali
Polypropylene	0.90	160	Water, acid, alkali
Teflon®	2.15	400	Hot sulfuric acid up tp 300˚F
Tefzel®	1.70	380	Acid, alkali

Design Equations

To determine mist eliminator cross-sectional area (and hence vessel size) and predict performance in terms of removal efficiency, the optimum design gas velocity is determined first. The Souders-Brown equation is used to determine this velocity based on the physical properties of the liquid droplets and carrying vapor:

$$V_d = k(\rho L-\rho G/\rho G)^{1/2} \quad (1)$$

where V_d **= design gas velocity (ft/sec)**
k **= Capacity Factor (ft/sec)**
ρL **= Liquid Density (lbs/ft³)**
ρG **= Vapor Density (lbs/ft³)**

The capacity factor is determined through experience and for each application, and is influenced by type and style of mesh or vane targets used, the geometry of the targets (vertical or horizontal relative to the vapor flow), as well as by properties such as operating pressure, fluid viscosities, and liquid surface tension.

The design velocity V_d for a given application is the value that produces the best performance in terms of capturing droplets and avoiding re-entrainment. Referring to Figure 8, this ideal velocity for a given class of mist eliminators would be somewhere toward the upper end of the range: about 10 fps for plain wire mesh pads, about 8.5 fps for co-knits, and 14 fps for Plate-Pak™ elements. As discussed, effectiveness drops off at lower velocities as the droplets have sufficiently low momentum to negotiate paths through the targets, and at higher velocities because the vapor carried sufficient kinetic energy to re-entrain droplets. For typical designs, acceptable velocities range between 25% to 125% of the ideal value.

The Capacity Factor may be thought of as an indication of ability of a mist eliminator to drain liquids and avoid re-entrainment under various conditions. See Table 3 for some typical baseline values.

TABLE 3
Standard Souders-Brown Coefficients
(k factors) for mesh and Plate-Pak™ Units

Pad Arrangement	k, ft/sec
1. Horizontal Style 4CA pad	0.35
2. Style 4CA MisterMesh® Pad	0.42
3. Horizontal Plate-Pak™ Unit *With or without MisterMesh® Pad below*	0.50
4. Vertical Plate-Pak™ Unit *With or without wire mesh ahead*	0.65

NOTE: Water and air, room temperature, pressure below 100 psia

Note that Souders-Brown equation provides correction for only gas and liquid densities. Should any conditions exist which affect drainage or re-entrainment, the Capacity Factor must be pro-rated as appropriate.

After selecting the appropriate Capacity Factor and calculating the ideal vapor velocity, the cross-sectional area of mist eliminator is readily determined by dividing the volumetric flow rate by the velocity.

Having established this design velocity for the application, you can now predict the efficiency of a mesh pad for droplets of a particular size. This procedure is laborious and therefore well suited for a computer.

First, calculate the inertial parameter K as follows, using consistent units of measurement:

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$$K = [(\rho L - \rho G)Vd^2] / 9\mu D \qquad (2)$$

Where K = dimensionless inertial parameter
V = gas velocity in fps
d = Liquid droplet diameter in ft
μ = Gas viscosity in lb/ft sec
D = Wire or filament diameter in ft

Use this calculated K value with Figure 12 to find the corresponding value of the impaction efficiency fraction E. From Table 1, find S, the specific surface area for the mesh style of interest.

Subsequently determine SO of the mist eliminator perpendicular to vapor flow and with a correction factor of 0.67 to remove that portion of the knitted wire not perpendicular to the gas flow:

SO = Specific Surface Area x 1/π x Thickness (ft) x 0.67
Using these values and T, the thickness of the pad, calculate the capture efficiency:

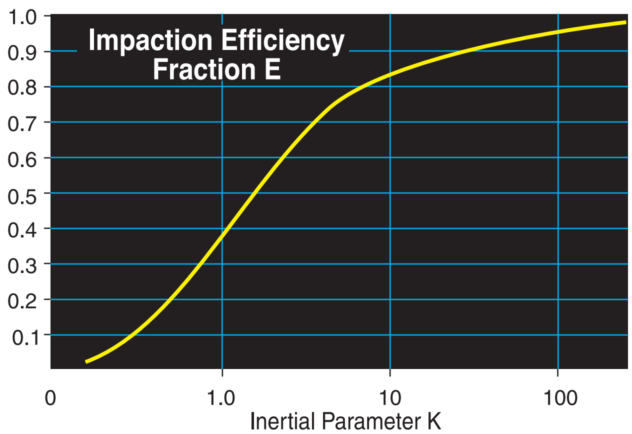
Efficiency % = 100 - (100/e^{ESO})

Where SO = Corrected Pad Specific Surface Area, ft²/ft³
E = Impaction efficiency fraction

This efficiency is the percent of all incoming droplets of the given diameter which will be captured rather than passing through the mist eliminator. The percentage will be higher for larger droplets and lower for smaller.

FIGURE 12

DETERMINING IMPACTION EFFICIENCY FRACTION E USING INERTIAL PARAMETER K



Predicting Pressure Drop

Although the operating pressure differential across a properly sized mesh pad or vane is never more than a few inches of water, pressure drop is an important design consideration in certain applications, particularly vacuum systems or larger columns requiring the movement of great quantities of gas. It has been shown that each inch of head loss requires some 0.16 hp/scfm. A simple correlation has been developed to describe the pressure drop through a dry mist eliminator (no mist):

$$\Delta P_{dry} = 0.4VD^2 \rho_G ST/g_c\, \varepsilon\, \rho_w \qquad (3)$$

Where V = Gas Superficial velocity = Ft / Sec
ρ_G = Gas Density lbs / ft³
S = Specific surface area of mesh ft²/ft³
T = Mesh Pad Thickness - Ft
Gc = gravitational constant, 32.2 ft / sec²
ε = Mesh Void Fraction
ρ_w = Ambient Density of water — lbs / ft³

Note: Applicable for wire diameter 0.0045" to 0.015".

The overall pressure drop is the sum of the head loss incurred as the gas travels through the mesh, as well as that due to the resistance to captured liquids. Liquid accumulates as a pool in the bottom of the mist eliminator. If the liquid loading and velocity are such that a 2" deep pool accumulates in the bottom of the mesh pad, this amount must be added to that calculated using Equation 3. Figure 13 summarizes pressure drop and velocity test data collected on the AMACS pilot plant for light and medium liquid loading.

With due consideration given to the mist eliminator itself, the flow of fluid to and from it requires the same attention.

Inlet Diffusers

At high flow rates, primary removal of bulk liquids upstream of the mist eliminator is very important to prevent flooding. This is typically done in a cost effective manner by using a simple inlet diverter as shown in Fig. 15.

With this design, liquids impinge upon the diverters, the flow is forced to flow laterally to allow bulk liquids to escape by gravity and eliminate the countercurrent momentum of the gas.

The *Force of Inertia*, expressed as $\rho\upsilon^2$, is typically used to quantify the flow entering a vessel to determine whether a simple baffle will suffice. AMACS recommends inlet diverters to a Force of Inertia up to 2,500 lb/ft s². Above this, more sophisticated distributors are recommended.

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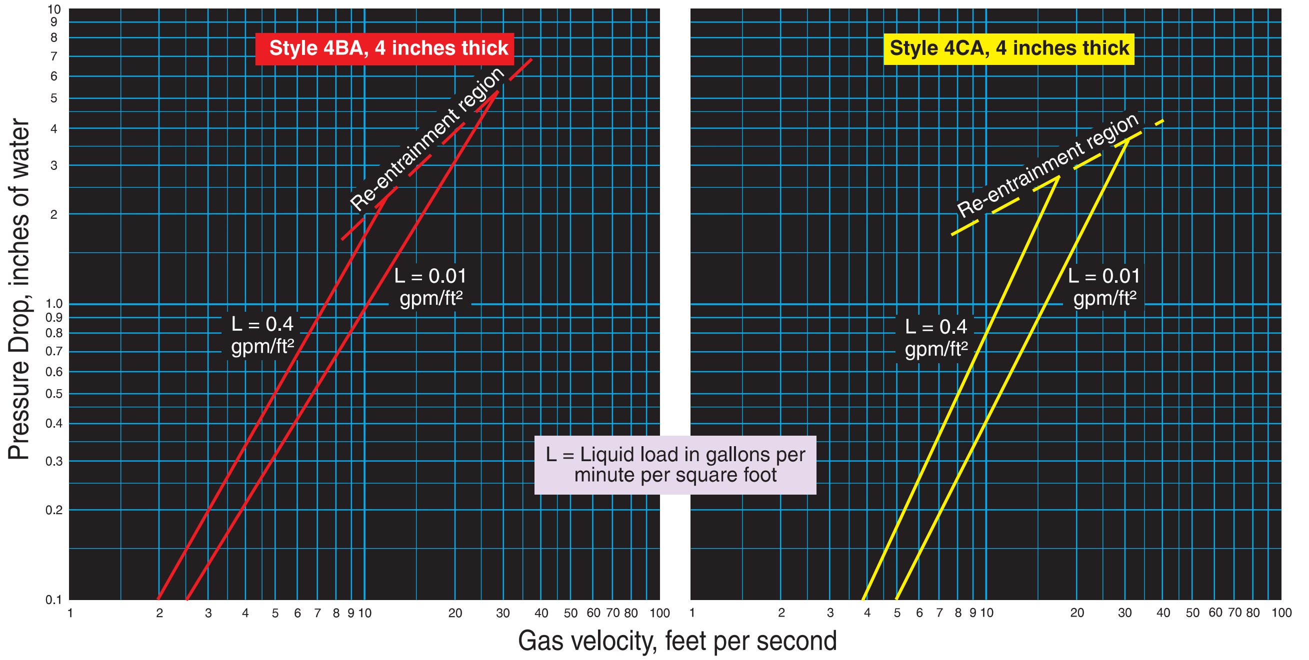
FIGURE 13

ACTUAL PRESSURE DROP VERSUS VELOCITY FOR TYPICAL AMACS MESH PADS AT LIGHT AND MEDIUM LOADS



Decades ago, Dutch Shell Chemical Company introduced Schoepentoeter® style bladed designs (Fig. 14). As the fluid flows axially towards the shell opposite of the inlet nozzle, liquids are captured by specially placed blades. This design is superior because it allows the escape of liquids over a much greater region of the vessel. A simple inlet diverter (Fig. 15) would simply shear bulk liquids into smaller droplets at great flow rates:

FIGURE 14

FIGURE 15

AMACS AccuFlow™ Inlet Diffuser (Fig. 16) is a similiar style of the bladed design in which the body of the diffuser maintains its shape, the restriction of flow which allows the escape of liquids over the diameter of the vessel is accomplished using internal blades of concentric and decreasing cross-sectional areas.

FIGURE 16

Vessel Configuration

Several factors must be considered when deciding on the configuration of vessel internals. The first step is to determine the cross-sectional area needed. Then a tentative geometry and shape appropriate for both the vessel and plant location is selected. Figure 17 shows the most typical, but by no means complete, configurations. Mist eliminators can be of virtually any size or shape to accommodate all factors.

The performance of the mist eliminator depends strongly on an even velocity distribution over the cross-sectional area. As a general rule, a distance of either half the vessel diameter or 72", which ever is smaller, is sufficient spacing both upstream and downstream of the element. Representations for specific cases are illustrated in Figure 18.

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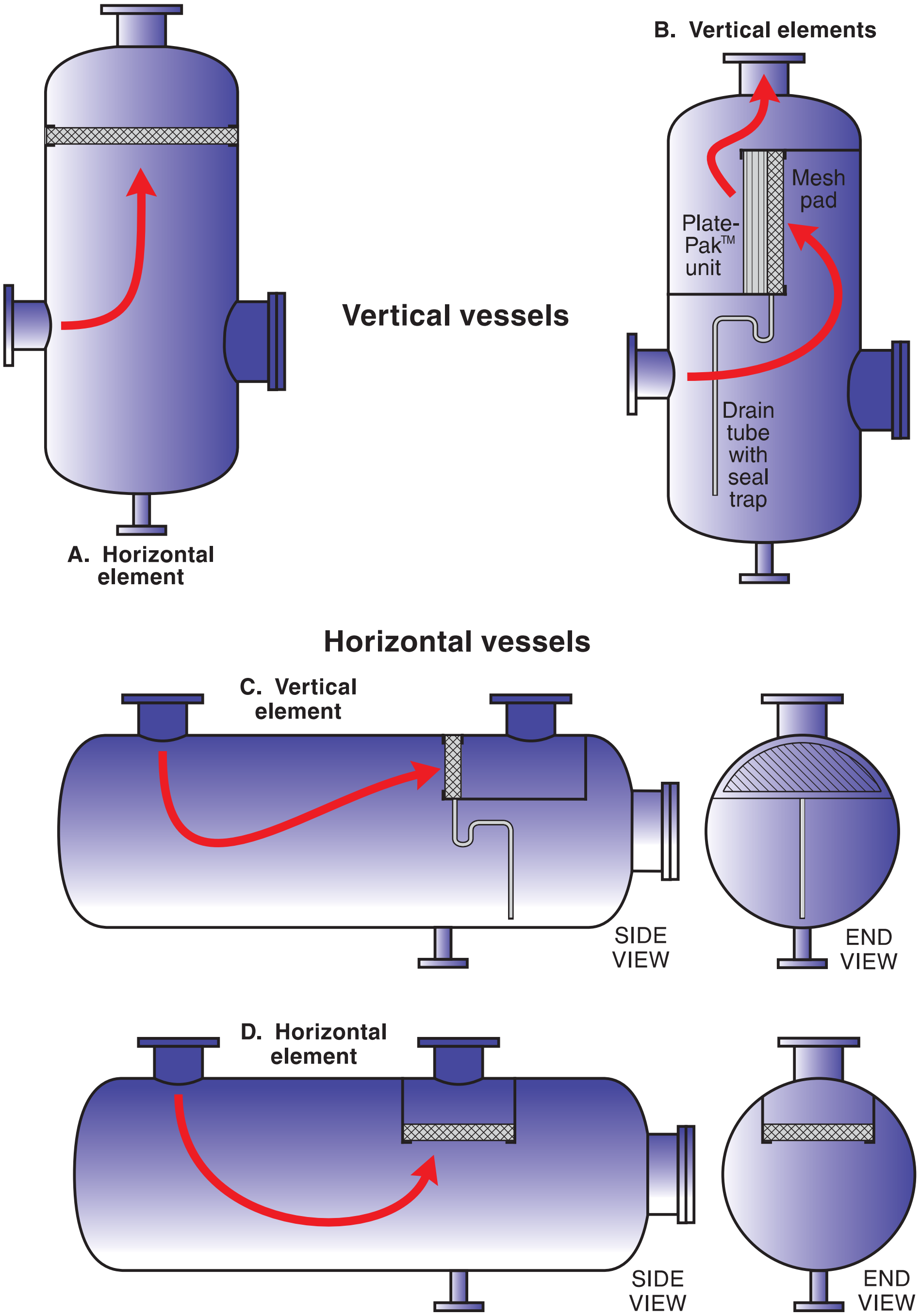
FIGURE 17

SIMPLIFIED VIEWS OF TYPICAL MIST ELIMINATOR CONFIGURATIONS IN SEPARATOR VESSELS



Small velocity differences across the surface are acceptable, but should be minimized at the design stage. Otherwise, some regions of the mist eliminator may be subjected to heavy loading leading to re-entrainment while other regions are unused.

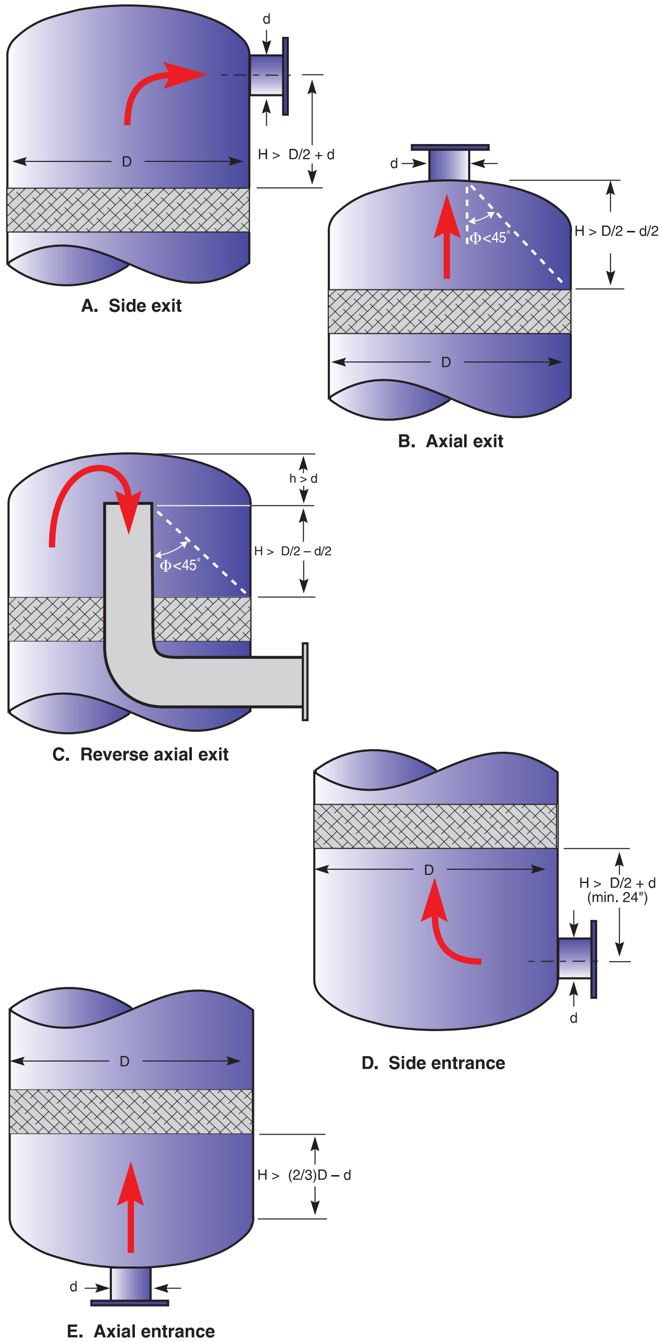
Most often, the mist eliminator is located just upstream of the outlet nozzle with insufficient disengagement space. Vapor tends to channel through the pad in the region closest to the outlet nozzle and peripheral regions of the pad remain unused. To rectify this, AMACS engineers apply an *Integral Flow Distributor* which is welded to region(s) of the downstream face of the pad. This technique allows the engineer to selectively increase the pressure drop through regions of the pad likely to suffer from channeling, and is cost effective.

Advanced Mist Eliminator Designs

There are several modifications to mesh pads and vanes to dramatically enhance performance.

FIGURE 18

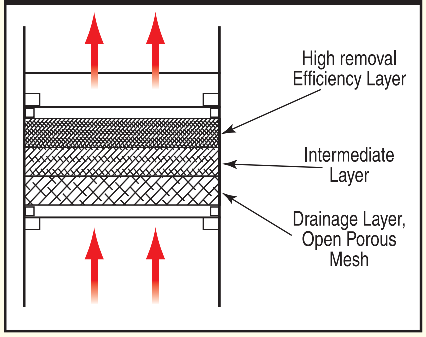
Guidelines for maintaining even flow distribution across mesh pads or vane units with axial flow in cylindrical vessels. Height of vessel head is assumed to be 1/4 of vessel diameter. Flow distribution devices can minimize required disengagement space above mesh pads. Contact AMACS for assistance.



Drainage & Collection Layering

Recall the discussion on pressure drop through a mist eliminator in which liquid tends to pool in the lower layers of mesh. The simplest technique to promote drainage is to use a few inches of open, porous mesh such as AMACS style 7CA (5-lb density with specific surface area as low as 45 sq-ft/cu-ft) in the upstream position. As drainage occurs through the interstitial regions of the mesh, opening the knit enhances liquid drainage.

FIGURE 19



An extension of this approach is to use higher specific surface area mesh in downstream positions to enhance separation efficiency, with intermediate mesh between the collection and drainage zones. Figure 19 illustrates a multilayer mist eliminator.

MisterMesh® Drainage Coils

A second technique used by AMACS to enhance liquid drainage, and often in conjunction with multi-layering, is to append drainage coils to the upstream face of a horizontal mist eliminator as shown in Figure 20. The coils are also made of mesh and "fill" with liquid.

FIGURE 20

Once filled, liquid from the pad above is drawn by gravity and The Coanda Effect to the coils, thereby establishing distinct regions for liquid drainage and liquid collection in the upstream layers. Figure 21 compares the pressure drop and flooding point of both conventional and MisterMesh® Mist Eliminators.

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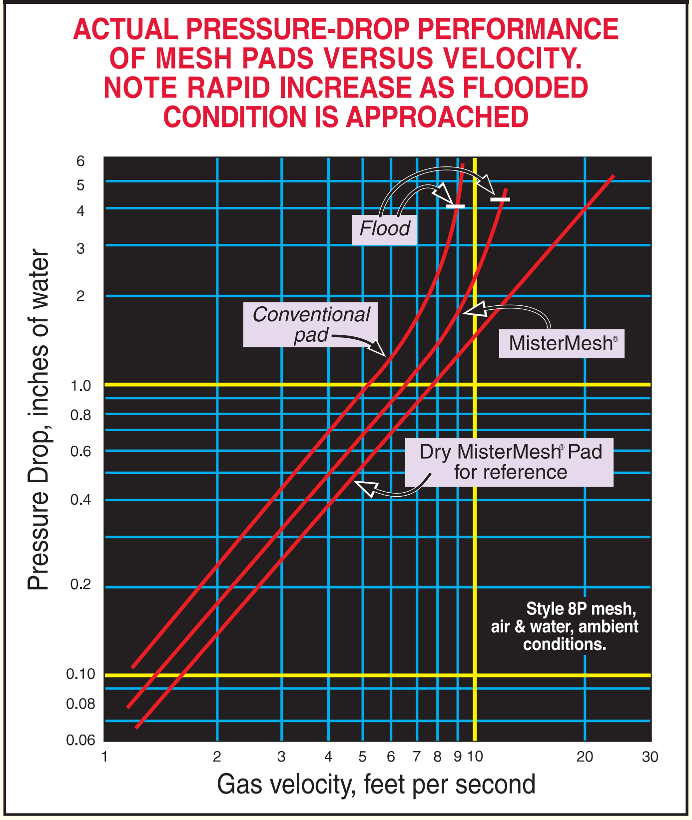
Mesh-Vane Assemblies

In grass root design of larger vessels and retrofit of existing ones to accommodate greater flow rates, mesh-vane assemblies are often used. In an assembly, mesh is placed upstream of the vane and acts as a flooded agglomerator. The capacity factor used corresponds to the downstream vane element. This approach combines the efficiency of mesh with the capacity of vanes and has been used by AMACS engineers with tremendous success over the past two decades.

FIGURE 21

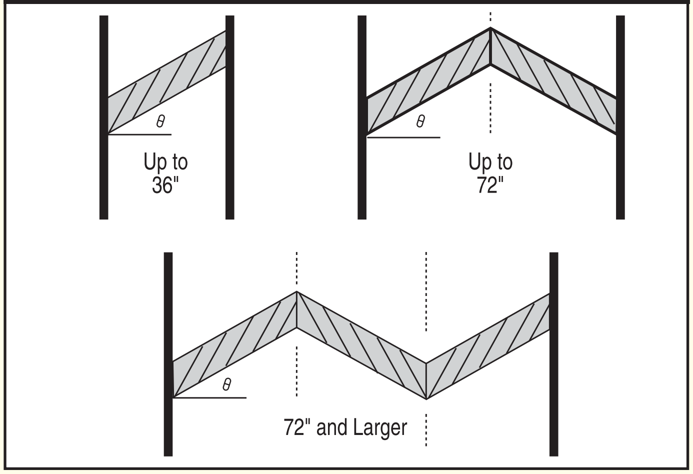


Throughout the industry there is ongoing debate as to whether the mesh should be positioned up- or downstream of the vane element. Engineers at AMACS have performed exhaustive comparative testing on pilot plants and have much field data proving that the mesh is indeed affective upstream of the vane, unless the vane element is used as a pre-filter to protect a downstream mesh pad.

Use of Geometry

Another approach used in the industry when the size of the vessel is limited is to arrange the mist eliminator at an angle. The capacity increase is equal to the sine of the angle though it should not exceed 45˚. This is shown in Figure 22 for smaller and larger diameters. An AMACS engineer should be consulted for such designs.

FIGURE 22



MultiPocket® Vanes

The capacity of vertical vanes (with horizontal vapor flow) can also be increased by enhancing liquid drainage. As discussed, captured liquids are re-entrained when the velocity of vapor exceeds the ideal. To prevent liquid re-entrainment, the serpentine path offered by the vane is augmented with obstructions to allow for the pooling of liquid with protection from the passing vapor stream. This design increases the capacity of the vane by as much as 25%. In vertical gas compressor knock-out drums, in which the vessel size is dictated by the capacity of the mist eliminator, MultiPocket® Vanes considerably reduce the Foot-print and cost of skids.

FIGURE 23

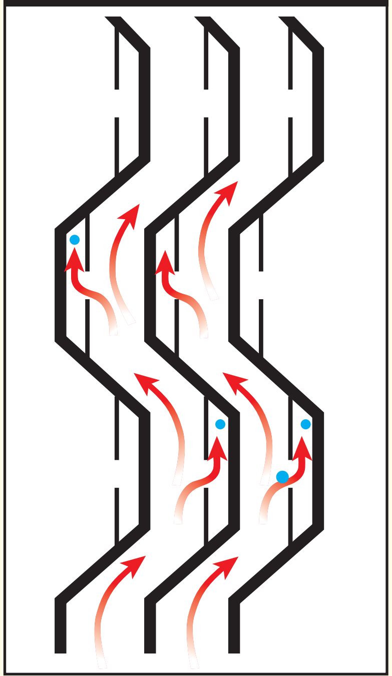


Figure 23 summarizes the approaches used by AMACS and the reduction in vessel dimensions possible using these advanced designs.

The MultiPocket® Vane has been patented by AMACS.

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Pockets Improve This Mist Eliminator's Efficiency

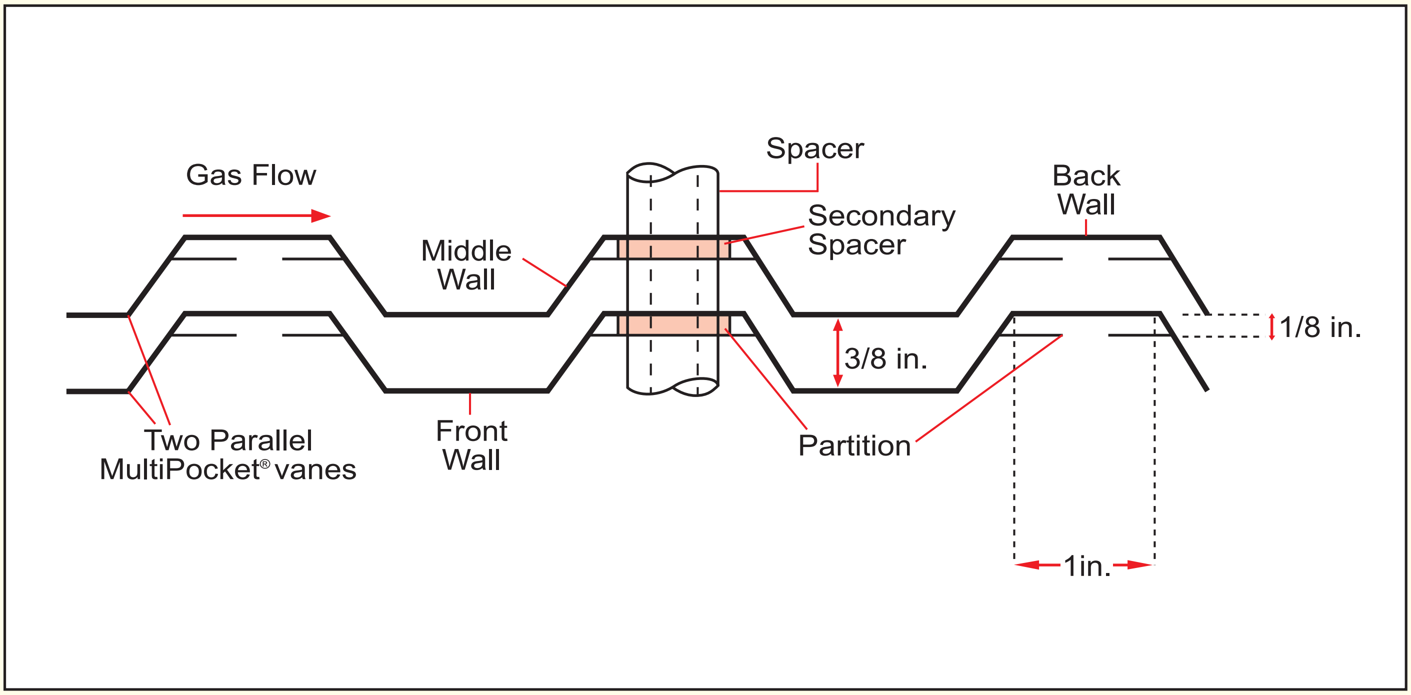
ACS Industries, Inc (Now AMACS Process Tower Internals) was awarded US Patent #6,852,146 for a vane-type mist eliminator that removes entrained liquid droplets from high-velocity gas streams. Available commercially as the MultiPocket® vane assembly (Figure), it comprises a sheet fabricated from one piece of metal and featuring parallel rows of serpentine-like vanes. These sheets are held in their arrangement by bolts and spacers, not welds, as used in conventional designs. "This design prevents corrosion caused by internal welding and tights radius bends common in other high performance vane designs," says Kanti Patel, ACS engineering manager.

The vane blades are configured in such a way as to create pockets that allow droplets entrained in a gas stream to impinge and cling to the vane, and then drain, without being re-entrained. With horizontal flow, the separated liquid drains perpendicularly to the gas stream, thereby preventing gas-liquid traffic below the Plate-Pak™ vanes. This feature allows higher flows. Third party testing shows that the MultiPocket® vanes exhibited a 3.4 — 14.1% capacity increase before breakthrough (liquid carryover) occurs downstream.

For any given installation thickness of the vanes, the number of pockets, spacing of the vanes, and other parameters can be varied to achieve the desired separation. The prefabricated unit comes in either a single piece ready for installation, or in smaller sections that can be installed through a vessel manway. To complete the installation a fabricated housing and a liquid drain are added, followed by welding or bolting of the entire unit in the vessel.

Gaston Rodriguez, process equipment proposals manager at the Hanover Co. (Houston, TX; www.hanover-co.com) provided the following case data in support of the MultiPocket® vane. A recent application for this product was in a vertical 2-phase scrubber handling 125 million ft^3/d of natural gas at an operating pressure of 350 psig and 90˚F. Using the MultiPocket® vane allowed for the reduction of the vessel diameter from 60 inches to 54 inches. The material, labor and installation savings was $6,500.

In other applications where pressure drop is critical, such as gas pipeline and utility contracts, the MultiPocket® vane provides the minimum pressure drop at the highest mist elimination efficiency. Tests has shown that for an inlet water spray loading of 2 gpm/ft^2 and air velocities of 10–25 ft/s, the pressure drop for a horizontal orientation is about 15% less than with the conventional vane.



The MultiPocket® vane is a thin sheet that is formed into hills and valleys. The gas stream enters one side and takes a zig-zag path to reach the other side. Pockets formed by partitions allow droplets entrained in a gas stream to impinge and cling to the vane, and then drain, without being re-entrained.

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MistFix® Insertion Mist Eliminators

MistFix® U.S. Patent #5985004

The patented AMACS MistFix® can solve carryover problems in vessels without a mist eliminator, as well as in vessels with a less efficient or damaged mist eliminator.

In existing vessels that do not have a manway, the MistFix® Insertion Mist Eliminator is an ideal choice. It is suitable for any vessel having an 8" or larger gas outlet nozzle at the top. It also eliminates the need for hazardous entry permits. Since there is no need to enter the vessel, this drastically reduces downtime, resulting in quicker turnarounds, reduced maintenance cost and production gains.

MistFix® also eliminates the need for modifications to vessels. For new vessels MistFix® may eliminate the need for a manway and reduce vessel cost. It also makes future maintenance easier and simpler.

AMACS MistFix® can easily be installed and replaced from the outside. Existing vessels require no modifications to accommodate the MistFix.®

Advantages:

- **No Cutting of existing vessel**
- **No Welding**
- **No Hazardous Entry**
- **No ASME re-certification**
- **No Scaffolding**
- **Minimal Downtime**

Figure 3. MistFix ™ insertion mist eliminator

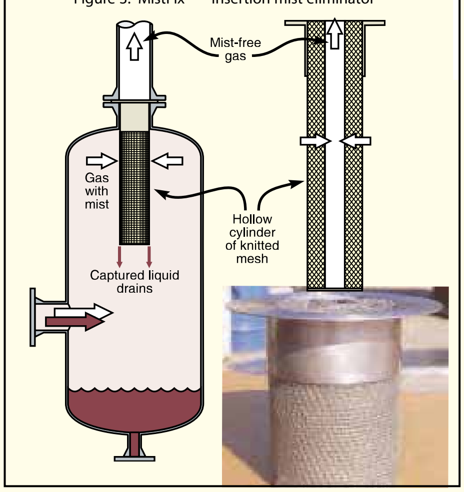

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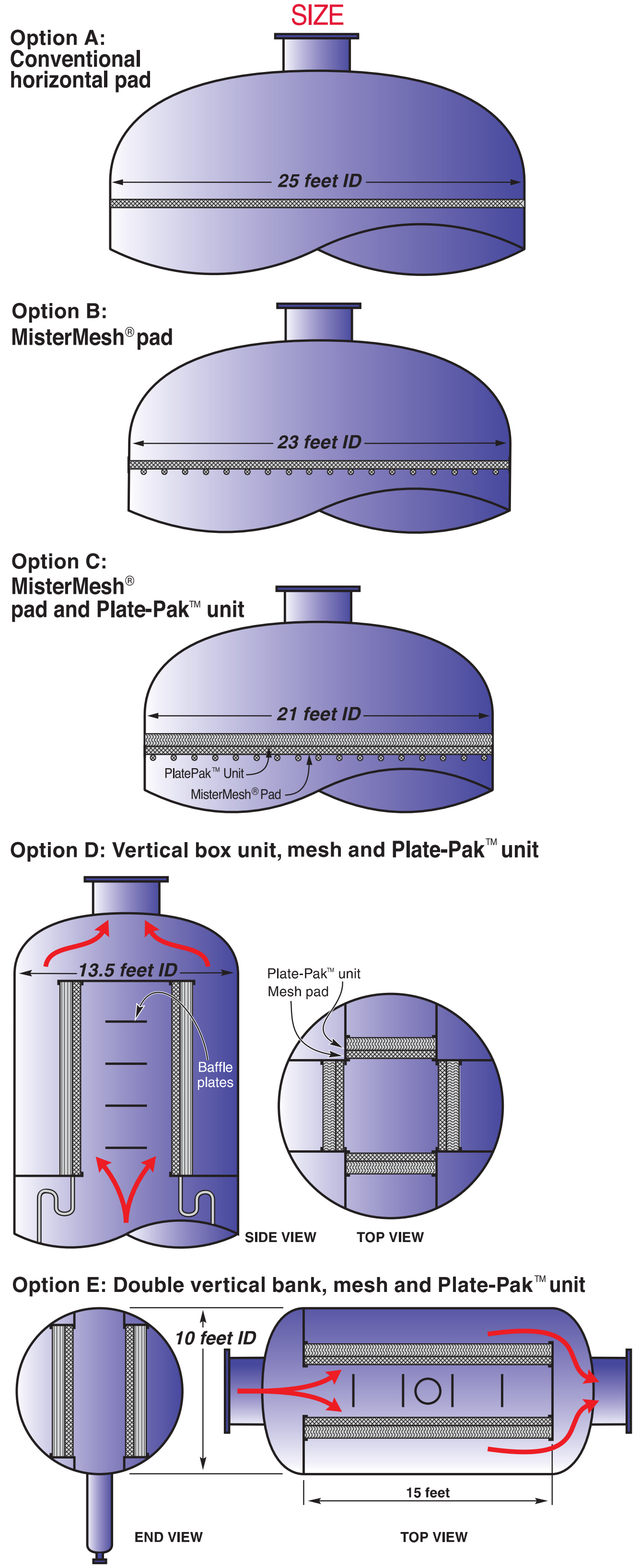
FIGURE 24

APPLYING COMBINATIONS OF AMACS MESH PADS AND PLATE-PAK™ VANE UNITS TO MINIMIZE VESSEL SIZE



CASE STUDIES & EXAMPLES

Case Study Number 1

Problem: In an HCl scrubber, an air stream of 60 acfs is coming off a bed of random packing and contains droplets of a weak acid. The unit operates at 122 psia at 82˚F. Determine the size of mist eliminator required to remove this mist and the removal efficiency possible.

Solution: Since the acid is dilute we assume the density and viscosity of water at the operating pressure and temperature:

$$\rho_L = 62.4 \text{ lb/ft}^3$$
$$\rho_G = 0.60 \text{ lb/ft}^3$$
$$P = 122 \text{ lb/ft}^2$$
$$T = 82^\circ F$$
$$F = 60 \text{ ft}^3\text{/sec}$$

The first step is to select the mist eliminator type and mesh style. As shown in Figure 24, mist coming to the mesh pad is typically comprised of droplets ranging in size from as small as 5 µm, so we select a mesh style mist eliminator to achieve this level of performance. From experience, the capacity factor for poly mesh at moderate liquid loading and lower pressures is ~.27 fps. Using the Souders-Brown equation the ideal velocity is calculated:

$$V_{ideal} = k\,[(\rho L - \rho G) / \rho G]^{1/2}$$
$$V_{ideal} = 0.27[(62.4-0.60)/0.60]^{1/2}$$
$$V_{ideal} = 2.74 \text{ fps}$$

The cross-sectional area of mist eliminator is determined by dividing the volumetric flow rate by the ideal velocity:

$$\text{Area}_{\text{Mist Eliminator}} = \text{Volumetric Flow Rate/Superficial Vapor Velocity}$$

$$\text{Area}_{\text{Mist Eliminator}} = [60 \text{ ft}^3\text{/sec}]/2.74 \text{ fps}$$

$$\text{Area}_{\text{Mist Eliminator}} = 21.9 \text{ ft2}$$

The corresponding diameter is 63.4", rounded up to a standard 66" scrubber vessel. Note that performing the same calculations using a vane (and a capacity factor of 0.50) yields an ideal vessel diameter of 46.7", rounded up to a standard 48" ID vessel. To calculate the removal efficiency at 5 µm, several parameters must be identified to use equation 2 to determine the inertial parameter K:

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$$K = [(\rho L - \rho G)Vd^2]/9\mu D$$

$$K = 0.32 \text{ fps}$$

From Figure 12, the corresponding Impaction Efficiency Fraction E is ~0.08. In the Removal Efficiency Equation there is a term for the corrected specific surface area SO:

$$SO = \text{Specific Surface Area} \times 1/\pi \times \text{Thickness (ft)} \times 0.67$$

For ACS style 8P, the specific surface area is (185 + 36) = 221 ft^2/ft^3, we will try both 4" and 6" thick mist eliminator thicknesses (1/3 and 1/2ft):

$$SO = 221 \times 1/3.14 \times 1/3 \times 0.67$$

$$SO_{4\text{"thick}} = 15.7 \text{ and } SO_{6\text{"thick}} = 23.6$$

And Removal Efficiency E at 5 µm is:

$$\text{Efficiency} = 100 - 100/e^{ESO}$$

$$\text{Efficiency} = 100 - 100/e(0.08)(15.7)$$

$$\text{Efficiency} = 71.5\%$$

For the 6" thick element, the removal efficiency is 84.8%. By using a composite pad containing a 2" layer of regular monofilament polypropylene, style 8P, upstream of a 2" thick layer of 8PP, mono- and multi-filament co-knit, the removal efficiency is 99.9% .

CASE STUDY #2

Traditionally, trays are used to bring about contact between glycol and natural gas in dehydration contactors. In recent years, the industry moved towards smaller diameter columns by exploiting the higher capacities achieved with structured packing. However, the lower capital investment associated with a smaller diameter packed tower is often offset by dramatically increased glycol losses.

Consider a mid-western sour gas plant operating a 96" glycol contactor and processing 1,310,000 lb/hr of gas at 116˚F and 1214 psia. The gas and liquid specific densities were 4.4 and 68 lb/cu-ft respectively. The plant was experiencing 0.13 US gal of carryover per mmscf, amounting to some 65 gal/day of lost triethylene glycol, several hundred dollars worth per day. A 10" thick wire mesh mist eliminator of 12-lb mass density was installed above the packing.

From experience, AMACS engineers knew that the droplet size distribution for glycol coming off the top of a packed dehydrator extends down to diameters of 5 µm and greater. Also, if the diameter of the packed column was sized in accordance with the hydraulic requirements of the packing, the wire mesh mist eliminator would be undersized.

The capacity factor for 12-lb density mesh in this service is ~0.23 – 0.27, having been de-rated for the high liquid viscosity of 18 cP (which retards liquid drainage) and relatively high operating pressure. Using the gas density, volumetric flow rate and cross-sectional area of the mist eliminator, the actual superficial velocity is readily calculated. Next, using known densities of the gas and glycol, the actual or operating Capacity Factor k is determined:

$$V_{actual} = k_{actual}\,[(\rho L - \rho G) / \rho G]^{1/2}$$

Re-arranging for

$$k_{actual} = V_{actual} / [(\rho L - \rho G) / \rho G]^{1/2}$$

$$= 0.44 \text{ fps}$$

A Capacity Factor of 0.44 fps is almost twice as high as the optimum, and is in the range of that of an AMACS Plate-Pak™ Vane mist eliminator. However, the vane will not remove particles down to 5 µm, so a mesh-vane assembly was proposed. The assembly has a multiple layers of mesh. The first layer is composed of highly porous mesh (AMACS style 7CA), followed by a layer of the high specific surface area (AMACS style 8DT) co-knit mesh of stainless and Dacron® Fibers. MisterMesh® drainage coils were appended to the bottom face of the mist eliminator. Downstream of the mesh was placed a Plate-Pak™ vane. The total thickness was 12" and was accommodated using the same supports as the mist eliminator it replaced.

Carryover from a glycol contactor occurs through two mechanisms, evaporative losses and mechanical (carryover losses). In this example, simulations showed evaporative glycol losses of 0.0054 gal/mmscfd. The total losses after the revamp were less than 0.008 gal/mmscfd, and carryover losses had been reduced from 0.13 gal/mmscfd, a 94% reduction!

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Website: www.amacs.com

TECHNICAL DATA SHEET • MIST ELIMINATOR

COMPANY INFORMATION

Company:	Contact (Name/Title):
Address:	TEL: ( ) FAX: ( ) E-mail:

STATE YOUR MIST ELIMINATOR APPLICTION

PROCESS CONDITIONS (Provide appropriate units)

Operating Temperature: deg F / deg C		Operating Pressure: psia (psig)	
Gas Type:	Flow Rate: MAX.:	MIN.:	lb/hr/(acfm)
Vapor Density or SG or Mol. Wt.:		Compressibility Factor:	Viscosity: cp
Liquid Type:	Qty.: gpm	Density or SG:	Viscosity: cp
Solids/Foulants: Yes No	If Yes, Explain:		

VESSEL DETAILS NEW EXISTING

Dia:	Ht./Length:
Manway Size:	Horiz.: Vert.
Material:	Housing Required? YES NO

DESIRED SEPARATION

____________________% removal of_________________µm Droplets

____

____________________ wt% / vol% / ppm in exit gas

MIST ELIMINATOR

Preferred Type: Wire Mesh Vane
Materials:
Remarks:

SKETCH

Notes


HIGH CAPACITY MIST ELIMINATORS
OUT PERFORM CONVENTIONAL TECHNOLOGY!
PLATE-PAK™
MIST ELIMINATOR
MISTER MESH®
MIST ELIMINATOR
WITH DRAINAGE ROLLS
ADVANCED TECHNOLOGY FOR DEBOTTLENECKING!
Our MisterMesh® Mist Eliminator out performs conventional pads. The drainage rolls accelerate liquid removal thus increasing capacity and reducing pressure drop. Used in conjunction with our Plate-Pak™ vane, the MisterMesh® drain rolls can increase capacity by over 200% while separating droplets down to 3 microns.
AMACS
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APPENDIX

2

PROPERTY TABLES AND CHARTS (ENGLISH UNITS)

TABLE A–1E

Molar mass, gas constant, and ideal-gas specific heats of some substances

Substance	Molar Mass, M, lbm/lbmol	Gas Constant R* Btu/lbm·R	Gas Constant R* psia·ft³/lbm·R	Specific Heat Data at 77°F c_p, Btu/lbm·R	Specific Heat Data at 77°F c_v, Btu/lbm·R	$k = c_p/c_v$
Air	28.97	0.06855	0.3704	0.2400	0.1715	1.400
Ammonia, NH_3	17.03	0.1166	0.6301	0.4999	0.3834	1.304
Argon, Ar	39.95	0.04970	0.2686	0.1243	0.07457	1.667
Bromine, Br_2	159.81	0.01242	0.06714	0.0538	0.04137	1.300
Isobutane, C_4H_{10}	58.12	0.03415	0.1846	0.3972	0.3631	1.094
n-Butane, C_4H_{10}	58.12	0.03415	0.1846	0.4046	0.3705	1.092
Carbon dioxide, CO_2	44.01	0.04512	0.2438	0.2016	0.1564	1.288
Carbon monoxide, CO	28.01	0.07089	0.3831	0.2482	0.1772	1.400
Chlorine, Cl_2	70.905	0.02802	0.1514	0.1142	0.08618	1.325
Chlorodifiuoromethane (R-22), $CHClF_2$	86.47	0.02297	0.1241	0.1552	0.1322	1.174
Ethane, C_2H_6	30.070	0.06604	0.3569	0.4166	0.3506	1.188
Ethylene, C_2H_4	28.054	0.07079	0.3826	0.3647	0.2940	1.241
Fluorine, F_2	38.00	0.05224	0.2823	0.1967	0.1445	1.362
Helium, He	4.003	0.4961	2.681	1.2403	0.7442	1.667
n-Heptane, C_7H_{16}	100.20	0.01982	0.1071	0.3939	0.3740	1.053
n-Hexane, C_6H_{14}	86.18	0.02304	0.1245	0.3951	0.3721	1.062
Hydrogen, H2	2.016	0.9850	5.323	3.416	2.431	1.405
Krypton, Kr	83.80	0.02370	0.1281	0.05923	0.03554	1.667
Methane, CH_4	16.04	0.1238	0.6688	0.5317	0.4080	1.303
Neon, Ne	20.183	0.09838	0.5316	0.2460	0.1476	1.667
Nitrogen, N_2	28.01	0.07089	0.3831	0.2484	0.1774	1.400
Nitric oxide. NO	30.006	0.06618	0.3577	0.2387	0.1725	1.384
Nitrogen dioxide, NO_2	46.006	0.04512	0.2438	0.1925	0.1474	1.306
Oxygen, O_2	32.00	0.06205	0.3353	0.2193	0.1572	1.395
n-Pentane, C_5H_{12}	72.15	0.02752	0.1487	0.3974	0.3700	1.074
Propane, C_3H_8	44.097	0.04502	0.2433	0.3986	0.3535	1.127
Propylene, C_3H_6	42.08	0.04720	0.2550	0.3657	0.3184	1.148
Steam, H_2O	18.015	0.1102	0.5957	0.4455	0.3351	1.329
Sulfur dioxide, SO_2	64.06	0.03100	0.1675	0.1488	0.1178	1.263
Tetrachloromethane, CCl_4	153.82	0.01291	0.06976	0.1293	0.1164	1.111
Tetrafluoroethane (R-134a), $C_2H_2F_4$	102.03	0.01946	0.1052	0.1991	0.1796	1.108
Trifluoroethane (R-143a), $C_2H_3F_3$	84.04	0.02363	0.1277	0.2219	0.1983	1.119
Xenon, Xe	131.30	0.01512	0.08173	0.03781	0.02269	1.667

*The gas constant is calculated from $R = R_u/M$, where R_u = 1.9859 Btu/lbmol·R = 10.732 psia·ft³/lbmol·R is the universal gas constant and M is the molar mass.

Source: Specific heat values are mostly obtained from the property routines prepared by The National Institute of Standards and Technology (NIST), Gaithersburg, MD.

TABLE A–2E

Boiling and freezing point properties

Substance	Boiling Data at 1 atm: Normal Boiling Point, °F	Boiling Data at 1 atm: Latent Heat of Vaporization h_{fg}, Btu/lbm	Freezing Data: Freezing Point, °F	Freezing Data: Latent Heat of Fusion h_{if}, Btu/lbm	Liquid Properties: Temperature, °F	Liquid Properties: Density ρ, lbm/ft^3	Liquid Properties: Specific Heat c_p, Btu/lbm·R
Ammonia	−27.9	24.54	−107.9	138.6	−27.9	42.6	1.06
					0	41.3	1.083
					40	39.5	1.103
					80	37.5	1.135
Argon	−302.6	69.5	−308.7	12.0	−302.6	87.0	0.272
Benzene	176.4	169.4	41.9	54.2	68	54.9	0.411
Brine (20% sodium chloride by mass)	219.0	—	0.7	—	68	71.8	0.743
n-Butane	31.1	165.6	−217.3	34.5	31.1	37.5	0.552
Carbon dioxide	−109.2*	99.6 (at 32°F)	−69.8	—	32	57.8	0.583
Ethanol	172.8	360.5	−173.6	46.9	77	48.9	0.588
Ethyl alcohol	173.5	368	−248.8	46.4	68	49.3	0.678
Ethylene glycol	388.6	344.0	12.6	77.9	68	69.2	0.678
Glycerine	355.8	419	66.0	86.3	68	78.7	0.554
Helium	−452.1	9.80	—	—	−452.1	9.13	5.45
Hydrogen	−423.0	191.7	−434.5	25.6	−423.0	4.41	2.39
Isobutane	10.9	157.8	−255.5	45.5	10.9	37.1	0.545
Kerosene	399–559	108	−12.8	—	68	51.2	0.478
Mercury	674.1	126.7	−38.0	4.90	77	847	0.033
Methane	−258.7	219.6	296.0	25.1	−258.7	26.4	0.834
					−160	20.0	1.074
Methanol	148.1	473	−143.9	42.7	77	49.1	0.609
Nitrogen	−320.4	85.4	−346.0	10.9	−320.4	50.5	0.492
					−260	38.2	0.643
Octane	256.6	131.7	−71.5	77.9	68	43.9	0.502
Oil (light)	—	—			77	56.8	0.430
Oxygen	−297.3	91.5	−361.8	5.9	−297.3	71.2	0.408
Petroleum	—	99–165			68	40.0	0.478
Propane	−43.7	184.0	−305.8	34.4	−43.7	36.3	0.538
					32	33.0	0.604
					100	29.4	0.673
Refrigerant-134a	−15.0	93.2	−141.9	—	−40	88.5	0.283
					−15	86.0	0.294
					32	80.9	0.318
					90	73.6	0.348
Water	212	970.5	32	143.5	32	62.4	1.01
					90	62.1	1.00
					150	61.2	1.00
					212	59.8	1.01

*Sublimation temperature. (At pressures below the triple-point pressure of 75.1 psia, carbon dioxide exists as a solid or gas. Also, the freezing-point temperature of carbon dioxide is the triple-point temperature of −69.8°F.)

TABLE A–3E

Properties of solid metals

	Melting	Properties at 540 R				Properties at Various Temperatures (R), k (Btu/h·ft·R)/c_p(Btu/lbm·R)					
Composition	Point, R	ρ lbm/ft^3	c_p (Btu/lbm·R)	k (Btu/h·ft·R)	$\alpha \times 10^6$ ft^2/s	180	360	720	1080	1440	1800
Aluminum	1679	168	0.216	137	1045	174.5	137	138.6	133.4	126	
Pure						0.115	0.191	0.226	0.246	0.273	
Alloy 2024-T6	1395	173	0.209	102.3	785.8	37.6	94.2	107.5	107.5		
(4.5% Cu, 1.5% Mg, 0.6% Mn)						0.113	0.188	0.22	0.249		
Alloy 195, cast (4.5% Cu)		174.2	0.211	97	734		100.5	106.9			
Beryllium	2790	115.5	0.436	115.6	637.2	572	174	93	72.8	61.3	52.5
						0.048	0.266	0.523	0.621	0.624	0.72
Bismuth	981	610.5	0.029	4.6	71	9.5	5.6	4.06			
						0.026	0.028	0.03			
Boron	4631	156	0.264	15.6	105	109.7	32.06	9.7	6.1	5.5	5.7
						0.03	0.143	0.349	0.451	0.515	0.558
Cadmium	1069	540	0.055	55.6	521	117.3	57.4	54.7			
						0.047	0.053	0.057			
Chromium	3812	447	0.107	54.1	313.2	91.9	64.1	52.5	46.6	41.2	37.8
						0.045	0.091	0.115	0.129	0.138	0.147
Cobalt	3184	553.2	0.101	57.3	286.3	96.5	70.5	49.3	39	33.6	80.1
						0.056	0.09	0.107	0.12	0.131	0.145
Copper	2445	559	0.092	231.7	1259.3	278.5	238.6	227.07	219	212	203.4
Pure						0.06	0.085	0.094	0.01	0.103	0.107
Commercial bronze	2328	550	0.1	30	150.7	24.3	30	34			
(90% Cu, 10% Al)							0.187	0.109	0.130		
Phosphor gear bronze	1987	548.1	0.084	31.2	183	23.7	37.6	42.8			
(89% Cu, 11% Sn)							—	—	—		
Cartridge brass	2139	532.5	0.09	63.6	364.9	43.3	54.9	79.2	86.0		
(70% Cu, 30% Zn)							0.09	0.09	0.101		
Constantan	2687	557	0.092	13.3	72.3	9.8	1.1				
(55% Cu, 45% Ni)						0.06	0.09				
Germanium	2180	334.6	0.08	34.6	373.5	134	56	25	15.7	11.4	10.05
						0.045	0.069	0.08	0.083	0.085	0.089
Gold	2405	1205	0.03	183.2	1367	189	186.6	179.7	172.2	164.09	156
						0.026	0.029	0.031	0.032	0.033	0.034
Iridium	4896	1404.6	0.031	85	541.4	99.4	88.4	83.2	79.7	76.3	72.8
						0.021	0.029	0.031	0.032	0.034	0.036
Iron:	3258	491.3	0.106	46.4	248.6	77.4	54.3	40.2	31.6	25.01	19
Pure						0.051	0.091	0.117	0.137	0.162	0.232
Armco		491.3	0.106	42	222.8	55.2	46.6	38	30.7	24.4	18.7
(99.75% pure)						0.051	0.091	0.117	0.137	0.162	0.233
Carbon steels		490.3	0.103	35	190.6			32.8	27.7	22.7	17.4
Plain carbon (Mn $\leq$ 1%, Si $\leq$ 0.1%)								0.116	0.113	0.163	0.279
AISI 1010		489	0.103	37	202.4			33.9	28.2	22.7	18
								0.116	0.133	0.163	0.278
Carbon-silicon		488	0.106	30	160.4			28.8	25.4	21.6	17
(Mn $\leq$ 1%, 0.1% < Si $\leq$ 0.6%)								0.119	0.139	0.166	0.231
Carbon-manganese-silicon		508	0.104	23.7	125			24.4	23	20.2	16
(1% < Mn $\leq$ 1.65%,								0.116	0.133	0.163	0.260
0.1% < Si $\leq$ 0.6%)											
Chromium (low) steels:		488.3	0.106	21.8	117.4			22	21.2	19.3	15.6
$\frac{1}{2}$ Cr–$\frac{1}{4}$ Mo–Si								0.117	0.137	0.164	0.23
(0.18% C, 0.65% Cr, 0.23% Mo, 0.6% Si)1											
1 Cr–$\frac{1}{2}$ Mo (0.16% C,		490.6	0.106	24.5	131.3			24.3	22.6	20	15.8
1% Cr, 0.54% Mo, 0.39% Si)								0.117	0.137	0.164	0.231
1 Cr–V		489.2	0.106	28.3	151.8			27.0	24.3	21	16.3
(0.2% C, 1.02% Cr, 0.15% V)								0.117	0.137	0.164	0.231

TABLE A–3E

Properties of solid metals *(Concluded)*

Composition	Melting Point, R	*Properties at 540 R*				*Properties at Various Temperatures* (R), k (Btu/h·ft·R)/c_p(Btu/lbm·R)					
		ρ lbm/ft^3	c_p(Btu/lbm·R)	k (Btu/h·ft·R)	$\alpha \times 10^6$ ft^2/s	180	360	720	1080	1440	1800
Stainless steels:		503	0.114	8.7	42			10	11.6	13.2	14.7
AISI 302								0.122	0.133	0.140	0.144
AISI 304	3006	493.2	0.114	8.6	42.5	5.31	7.3	9.6	11.5	13	14.7
						0.064	0.096	0.123	0.133	0.139	0.145
AISI 316		514.3	0.111	7.8	37.5			8.8	10.6	12.3	14
						0.12	0.131	0.137	0.143		
AISI 347		498	0.114	8.2	40			9.1	1.1	12.7	14.3
								0.122	0.133	0.14	0.144
Lead	1082	708	0.03	20.4	259.4	23	21.2	19.7	18.1		
						0.028	0.029	0.031	0.034		
Magnesium	1661	109	0.245	90.2	943	87.9	91.9	88.4	86.0	84.4	
						0.155	0.223	0.256	0.279	0.302	
Molybdenum	5209	639.3	0.06	79.7	578	1034	82.6	77.4	72.8	68.2	64.7
						0.038	0.053	0.062	0.065	0.068	0.070
Nickel:	3110	555.6	0.106	52.4	247.6	94.8	61.8	46.3	37.9	39	41.4
Pure						0.055	0.091	0.115	0.141	0.126	0.134
Nichrome	3010	524.4	0.1	6.9	36.6			8.0	9.3	12.2	
(80% Ni, 20% Cr)							0.114	0.125	0.130		
Inconel X-750	2997	531.3	0.104	6.8	33.4	5	5.9	7.8	9.8	11.8	13.9
(73% Ni, 15% Cr,											
6.7% Fe)						—	0.088	0.112	0.121	0.13	0.149
Niobium	4934	535	0.063	31	254	31.9	30.4	32	33.6	35.4	32.2
						0.044	0.059	0.065	0.067	0.069	0.071
Palladium	3289	750.4	0.058	41.5	263.7	44.2	41.4	42.5	46	50	54.4
						0.04	0.054	0.059	0.062	0.064	0.067
Platinum:	3681	1339	0.031	41.4	270	44.7	42	41.5	42.3	43.7	45.5
Pure						0.024	0.03	0.032	0.034	0.035	0.036
Alloy 60Pt-40Rh	3240	1038.2	0.038	27.2	187.3			30	34	37.5	40
(60% Pt, 40% Rh)								—	—	—	
Rhenium	6215	1317.2	0.032	27.7	180	34	30	26.6	25.5	25.4	25.8
						0.023	0.03	0.033	0.034	0.036	0.037
Rhodium	4025	777.2	0.058	86.7	534	107.5	89	84.3	78.5	73.4	70
						0.035	0.052	0.06	0.065	0.069	0.074
Silicon	3033	145.5	0.17	85.5	960.2	510.8	152.5	57.2	35.8	24.4	18.0
						0.061	0.132	0.189	0.207	0.218	0.226
Silver	2223	656	0.056	248	1873	257	248.4	245.5	238	228.8	219
						0.044	0.053	0.057	0.059	0.062	0.066
Tantalum	5884	1036.3	0.033	33.2	266	34.2	33.2	33.4	34	34.3	34.8
						0.026	0.031	0.034	0.035	0.036	0.036
Thorium	3641	730.4	0.028	31.2	420.9	34.6	31.5	31.4	32.2	32.9	32.9
						0.024	0.027	0.029	0.032	0.035	0.037
Tin	909	456.3	0.054	38.5	431.6	49.2	42.4	35.9			
						0.044	0.051	0.058			
Titanium	3515	281	0.013	12.7	100.3	17.6	14.2	11.8	11.2	11.4	12
						0.071	0.111	0.131	0.141	0.151	0.161
Tungsten	6588	1204.9	0.031	100.5	735.2	120.2	107.5	92	79.2	72.2	68.2
						0.020	0.029	0.032	0.033	0.034	0.035
Uranium	2531	1190.5	0.027	16	134.5	12.5	14.5	17.1	19.6	22.4	25.4
						0.022	0.026	0.029	0.035	0.042	0.043
Vanadium	3946	381	0.117	17.7	110.9	20.7	18	18	19.3	20.6	22.0
						0.061	0.102	0.123	0.128	0.134	0.142
Zinc	1247	445.7	0.093	67	450	67.6	68.2	64.1	59.5		
						0.07	0.087	0.096	0.104		
Zirconium	3825	410.2	0.067	13.1	133.5	19.2	14.6	12.5	12	12.5	13.7
						0.049	0.063	0.072	0.77	0.082	0.087

Source: Tables A–3E and A–4E are obtained from the respective tables in SI units in Appendix 1 using proper conversion factors.

TABLE A–4E

Properties of solid nonmentals

Composition	Melting Point, R	Properties at 540 R: ρ lbm/ft^3	c_p(Btu/lbm·R)	k (Btu/h·ft·R)	$\alpha \times 10^6$ ft^2/s	Properties at Various Temperatures (R), k (Btu/h·ft·R)/c_p(Btu/lbm·R): 180	360	720	1080	1440	1800
Aluminum oxide,	4181	247.8	0.182	26.6	162.5	260	47.4	18.7	11	7.5	6
sapphire						—	—	0.224	0.265	0.281	0.293
Aluminum oxide	4181	247.8	0.182	20.8	128	76.8	31.7	15.3	9.3	6	4.5
polycrystalline								0.244	0.265	0.281	0.293
Beryilium oxide	4905	187.3	0.246	157.2	947.3			113.2	64.2	40.4	27.2
								0.322	0.40	0.44	0.459
Boron	4631	156	0.264	16	107.5	109.8	30.3	10.8	6.5	4.6	3.6
								0.355	0.445	0.509	0.561
Boron fiber epoxy	1062	130									
(30% vol.) composite											
k, ∥ to fibers				1.3		1.2	1.3	1.31			
k, ⊥ to fibers				0.34		0.21	0.28	0.34			
c_p			0.268			0.086	0.18	0.34			
Carbon	2700	121.7	—	0.92	—	0.38	0.68	1.09	1.26	1.36	1.46
Amorphous Diamond,											
type IIa	—	219	0.121	1329	—	5778	2311.2	889.8			
insulator							0.005	0.046	0.203		
Graphite, pyrolytic	4091	138									
k, ∥ to layers				1126.7		2871.6	1866.3	803.2	515.4	385.4	308.5
k, ⊥ to layers				3.3		9.7	5.3	2.4	1.5	1.16	0.92
c_p			0.169			0.32	0.098	0.236	0.335	0.394	0.428
Graphite fiber epoxy	810	87.4									
(25% vol.) composite											
k, heat flow ∥ to fibers				6.4		3.3	5.0	7.5			
k, heat flow ⊥ to fibers				0.5	5	0.4	0.63				
c_p			0.223			0.08	0.153	0.29			
Pyroceram, Corning 9606	2921	162.3	0.193	2.3	20.3	3.0	2.3	2.1	1.9	1.7	1.7
Silicon carbide,	5580	197.3	0.161	283.1	2475.7			—	—	—	50.3
								0.210	0.25	0.27	0.285
Silicon dioxide,											
crystalline (quartz)	3389	165.4									
k, ∥ to c-axis				6		22.5	9.5	4.4	2.9	2.4	
k, ⊥ to c-axis				3.6		12.0	5.9	2.7	2	1.8	
c_p			0.177					0.211	0.256	0.298	
Silicon dioxide,	3389	138.6	0.177	0.79	9	0.4	0.65	0.87	1.01	1.25	1.65
polycrystalline (fused silica)						—	—	0.216	0.248	0.264	0.276
Silicon nitride	3911	150	0.165	9.2	104	—	—	8.0	6.5	5.7	5.0
						—	0.138	0.185	0.223	0.253	0.275
Sulfur	706	130	0.169	0.1	1.51	0.095	0.1				
						0.962	0.144				
Thorium dioxide	6431	568.7	0.561	7.5	65.7			5.9	3.8	2.7	2.12
								0.609	0.654	0.680	0.704
Titanium dioxide,	3840	259.5	0.170	4.9	30.1			4.0	2.9	2.3	2
polycrystalline								0.192	0.210	0.217	0.222

TABLE A–5E

Properties of building materials
(at a mean temperature of 75°F)

Material	Thickness, L in	Density, ρ lbm/ft^3	Thermal Conductivity, k Btu-in/h·ft^2·°F	Specific Heat, c_p Btu/lbm·R	R-value (for listed thickness, L/k), °F·h·ft^2/Btu
Building Boards					
Asbestos–cement board	¼ in.	120	—	0.24	0.06
Gypsum of plaster board	⅜ in.	50	—	0.26	0.32
	½ in.	50	—	—	0.45
Plywood (Douglas fir)	—	34	0.80	0.29	—
	¼ in.	34	—	0.29	0.31
	⅜ in.	34	—	0.29	0.47
	½ in.	34	—	0.29	0.62
	¾ in.	34	—	0.29	0.93
Insulated board and sheating	½ in.	18	—	0.31	1.32
(regular density)	25⁄32 in.	18	—	0.31	2.06
Hardboard (high density, standard tempered)	—	63	1.00	0.32	—
Particle board					
Medium density	—	50	0.94	0.31	—
Underlayment	⅝ in.	40	—	0.29	0.82
Wood subfloor	¾ in.	—	—	0.33	0.94
Building Membranes					
Vapor-permeable felt	—	—	—	—	0.06
Vapor-seal (2 layers of mopped 17.3 lbm/ft^2 felt)	—	—	—	—	0.12
Flooring Materials					
Carpet and fibrous pad	—	—	—	0.34	2.08
Carpet and rubber pad	—	—	—	0.33	1.23
Tile (asphalt, linoleum, vinyl)	—	—	—	0.30	0.05
Masonry Materials					
Masonry units:					
Brick, common		120	5.0	—	—
Brick, face		130	9.0	—	—
Brick, fire clay		150	9.3	—	—
		120	6.2	0.19	—
		70	2.8	—	—
Concrete blocks (3 oval cores, sand and gravel aggregate)	4 in.	—	5.34	—	0.71
	8 in.	—	6.94	—	1.11
	12 in.	—	9.02	—	1.28
Concretes					
Lightweight aggregates		120	5.2	—	—
(including expanded shale,		100	3.6	0.2	—
clay, or slate, expanded slags,		80	2.5	0.2	—
cinders; pumice; and scoria)		60	1.7	—	—
		40	1.15	—	—
Cement/lime, mortar, and stucco		120	9.7	—	—
		80	4.5		
Stucco		116	5.0		

TABLE A–5E

Properties of building materials *(Concluded)*
(at a mean temperature of 75°F)

Material	Thickness, L in	Density, ρ lbm/ft^3	Thermal Conductivity, k Btu-in/h·ft^2·°F	Specific Heat, c_p Btu/lbm·R	R-value (for listed thickness, L/k), °F·h·ft^2/Btu
Roofing					
Asbestos-cement shingles		120	—	0.24	0.21
Asphalt roll roofing		70	—	0.36	0.15
Asphalt shingles		70	—	0.30	0.44
Built-in roofing	3/8 in.	70	—	0.35	0.33
Slate	1/2 in.	—	—	0.30	0.05
Wood shingles (plain and plastic film faced)		—	—	0.31	0.94
Plastering Materials					
Cement plaster, sand aggregate	3/4 in.	1.16	5.0	0.20	0.15
Gypsum plaster					
Lightweight aggregate	1/2 in.	45	—	—	0.32
Sand aggregate	1/2 in.	105	5.6	0.20	0.09
Perlite aggregate	—	45	1.5	0.32	—
Siding Material (on flat surfaces)					
Asbestos-cement shingles	—	120	—	—	0.21
Hardboard siding	7/16 in.	—	—	0.28	0.67
Wood (drop) siding	1 in.	—	—	0.31	0.79
Wood (plywood) siding, lapped	3/8 in.	—	—	0.29	0.59
Aluminum or steel siding (over sheeting):					
Hollow backed	3/8 in.	—	—	0.29	0.61
Insulating-board backed	3/8 in.	—	—	0.32	1.82
Architectural glass	—	158	6.9	0.21	0.10
Woods					
Hardwoods (maple, oak etc.)	—	45	1.10	0.30	—
Softwoods (fir, pine, etc.)	—	32	0.80	0.33	—
Metals					
Aluminum (1100)	—	171	1536	0.214	—
Steel, mild	—	489	314	0.120	—
Steel Stainless,	—	494	108	0.109	—

Source: Tables A-5E and A-6E are adapted from *ASHRAE, Handbook of Fundamentals* (Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, 1993), Chap. 22, Table 4. Used with permission.

TABLE A–6E

Properties of insulating materials
(at a mean temperature of 75°F)

Material	Thickness, L in	Density, ρ lbm/ft^3	Thermal Conductivity, k Btu-in/h·ft^2·°F	Specific Heat, c_p Btu/lbm·R	R-value (for listed thickness, L/k) °F·h·ft^2/Btu
Blanket and Batt					
Mineral fiber (fibrous form	~2 to 2¾ in	0.3–2.0	—	0.17–0.23	7
processed from rock, slag,	~3 to 3½ in	0.3–2.0	—	0.17–0.23	11
or glass)	~5¼ to 6½ in	0.3–2.0	—	0.17–0.23	19
Board and Slab					
Cellular glass		8.5	0.38	0.24	—
Glass fiber (organic bonded)		4–9	0.25	0.23	—
Expanded polystyrene (molded beads)		1.0	0.28	0.29	—
Expanded polyurethane (R-11 expanded)		1.5	0.16	0.38	—
Expanded perlite (organic bonded)		1.0	0.36	0.30	—
Expanded rubber (rigid)		4.5	0.22	0.40	—
Mineral fiber with resin binder		15	0.29	0.17	—
Cork		7.5	0.27	0.43	—
Sprayed or Formed in Place					
Polyurethane foam		1.5–2.5	0.16–0.18	—	—
Glass fiber		3.5–4.5	0.26–0.27	—	—
Urethane, two-part mixture (rigid foam)		4.4	0.18	0.25	—
Mineral wool granules with asbestos/inorganic binders (sprayed)		12	0.32	—	—
Loose Fill					
Mineral fiber (rock, slag,	~3.75 to 5 in	0.6–0.20	—	0.17	11
or glass)	~6.5 to 8.75 in	0.6–0.20	—	0.17	19
	~7.5 to 10 in	—	—	0.17	22
	~7.25 in	—	—	0.17	30
Silica aerogel		7.6	0.17	—	—
Vermiculite (expanded)		7–8	0.47	—	—
Perlite, expanded		2–4.1	0.27–0.31	—	—
Sawdust or shavings		8–15	0.45	—	—
Cellulosic insulation (milled paper or wood pulp)		0.3–3.2	0.27–0.32	—	—
Cork, granulated		10	0.31	—	—
Roof Insulation					
Cellular glass	—	9	0.4	0.24	—
Preformed, for use above deck	½ in	—	—	0.24	1.39
	1 in	—	—	0.50	2.78
	2 in	—	—	0.94	5.56
Reflective Insulation					
Silica powder (evacuated)		10	0.0118	—	—
Aluminum foil separating fluffy glass mats; 10–12 layers (evacuated); for cryogenic applications (270 R)		2.5	0.0011	—	—
Aluminum foil and glass paper laminate; 75–150 layers (evacuated); for cryogenic applications (270 R)		7.5	0.00012	—	—

TABLE A–7E

Properties of common foods
(*a*) Specific heats and freezing-point properties

Food	Water Content,[a] % (mass)	Freezing Point,[a] °F	*Specific Heat*,[b] Btu/lbm·°F Above Freezing	*Specific Heat*,[b] Btu/lbm·°F Below Freezing	Latent Heat of Fusion[c] Btu/lbm
Vegetables					
Artichokes	84	30	0.873	0.453	121
Asparagus	93	31	0.945	0.481	134
Beans, snap	89	31	0.913	0.468	128
Broccoli	90	31	0.921	0.471	129
Cabbage	92	30	0.937	0.478	132
Carrots	88	29	0.905	0.465	126
Cauliflower	92	31	0.937	0.478	132
Celery	94	31	0.953	0.484	135
Corn, sweet	74	31	0.793	0.423	106
Cucumbers	96	31	0.969	0.490	138
Eggplant	93	31	0.945	0.481	134
Horseradish	75	29	0.801	0.426	108
Leeks	85	31	0.881	0.456	122
Lettuce	95	32	0.961	0.487	136
Mushrooms	91	30	0.929	0.474	131
Okra	90	29	0.921	0.471	129
Onions, green	89	30	0.913	0.468	128
Onions, dry	88	31	0.905	0.465	126
Parsley	85	30	0.881	0.456	122
Peas, green	74	31	0.793	0.423	106
Peppers, sweet	92	31	0.937	0.478	132
Potatoes	78	31	0.825	0.435	112
Pumpkins	91	31	0.929	0.474	131
Spinach	93	31	0.945	0.481	134
Tomatos, ripe	94	31	0.953	0.484	135
Tumips	92	30	0.937	0.478	132
Fruits					
Apples	84	30	0.873	0.453	121
Apricots	85	30	0.881	0.456	122
Avocados	65	31	0.721	0.396	93
Bananas	75	31	0.801	0.426	108
Blueberries	82	29	0.857	0.447	118
Cantaloupes	92	30	0.937	0.478	132
Cherries, sour	84	29	0.873	0.453	121
Cherries, sweet	80	29	0.841	0.441	115
Figs, dried	23	—	—	0.270	33
Figs, fresh	78	28	0.825	0.435	112
Grapefruit	89	30	0.913	0.468	128
Grapes	82	29	0.857	0.447	118
Lemons	89	29	0.913	0.468	128
Olives	75	29	0.801	0.426	108
Oranges	87	31	0.897	0.462	125
Peaches	89	30	0.913	0.468	128
Pears	83	29	0.865	0.450	119
Pineapples	85	30	0.881	0.456	122
Plums	86	31	0.889	0.459	124
Quinces	85	28	0.881	0.456	122
Raisins	18	—	—	0.255	26
Strawberries	90	31	0.921	0.471	129
Tangerines	87	30	0.897	0.462	125
Watermelon	93	31	0.945	0.481	134
Fish/Seafood					
Cod, whole	78	28	0.825	0.435	112
Halibut, whole	75	28	0.801	0.426	108
Lobster	79	28	0.833	0.438	113
Mackerel	57	28	0.657	0.372	82
Salmon, whole	64	28	0.713	0.393	92
Shrimp	83	28	0.865	0.450	119
Meats					
Beef carcass	49	29	0.593	0.348	70
Liver	70	29	0.761	0.411	101
Round, beef	67	—	0.737	0.402	96
Sirloin, beef	56	—	0.649	0.369	80
Chicken	74	27	0.793	0.423	106
Lamb leg	65	—	0.721	0.396	93
Pork carcass	37	—	0.497	0.312	53
Ham	56	29	0.649	0.369	80
Pork sausage	38	—	0.505	0.315	55
Turkey	64	—	0.713	0.393	92
Other					
Almonds	5	—	—	0.216	7
Butter	16	—	—	0.249	23
Cheese, cheddar	37	9	0.497	0.312	53
Cheese, Swiss	39	14	0.513	0.318	56
Chocolate, milk	1	—	—	0.204	1
Eggs, whole	74	31	0.793	0.423	106
Honey	17	—	—	0.252	24
Ice cream	63	22	0.705	0.390	90
Milk, whole	88	31	0.905	0.465	126
Peanuts	6	—	—	0.219	9
Peanuts, roasted	2	—	—	0.207	3
Pecans	3	—	—	0.210	4
Walnuts	4	—	—	0.213	6

Source: [a]Water content and freezing point data are from ASHRAE, *Handbook of Fundamentals*, I-P version (Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1993), Chap. 30, Table 1. Used with permission. Freezing point is the temperature at which freezing starts for fruits and vegetables, and the average freezing temperature for other foods.

[b]Specific heat data are based on the specific heat values of water and ice at 32°F and are determined from Siebel's formulas: $c_{p,\ fresh} = 0.800 \times (\text{Water content}) + 0.200$, above freezing, and $c_{p,\ frozen} = 0.300 \times (\text{Water content}) + 0.200$, below freezing.

[c]The latent heat of fusion is determined by multiplying the heat of fusion of water (143 Btu/lbm) by the water content of the food.

TABLE A–7E

Properties of common foods *(Concluded)*
(*b*) Other properties

Food	Water Content, %(mass)	Temperature, T °F	Density, ρ lbm/ft^3	Thermal Conductivity, k Btu/h·ft·°F	Thermal Diffusivity, α ft^2/s	Specific Heat, c_p Btu/lbm·R
Fruits/Vegetables						
Apple juice	87	68	62.4	0.323	1.51×10^{-6}	0.922
Apples	85	32–86	52.4	0.242	1.47×10^{-6}	0.910
Apples, dried	41.6	73	53.4	0.127	1.03×10^{-6}	0.650
Apricots, dried	43.6	73	82.4	0.217	1.22×10^{-6}	0.662
Bananas, fresh	76	41	61.2	0.278	1.51×10^{-6}	0.856
Broccoli	—	21	35.0	0.223	—	—
Cherries, fresh	92	32–86	65.5	0.315	1.42×10^{-6}	0.952
Figs	40.4	73	77.5	0.179	1.03×10^{-6}	0.642
Grape juice	89	68	62.4	0.328	1.51×10^{-6}	0.934
Peaches	36–90	2–32	59.9	0.304	1.51×10^{-6}	0.934
Plums	—	3	38.1	0.143	–	—
Potatoes	32–158	0–70	65.7	0.288	1.40×10^{-6}	0.868
Raisins	32	73	86.2	0.217	1.18×10^{-6}	0.592
Meats						
Beef, ground	67	43	59.3	0.235	1.40×10^{-6}	0.802
Beef, lean	74	37	68.0	0.272	1.40×10^{-6}	0.844
Beef fat	0	95	50.5	0.110	—	—
Beef liver	72	95	—	0.259	—	0.832
Cat food	39.7	73	71.2	0.188	1.18×10^{-6}	0.638
Chicken breast	75	32	65.5	0.275	1.40×10^{-6}	0.850
Dog food	30.6	73	77.4	0.184	1.18×10^{-6}	0.584
Fish, cod	81	37	73.7	0.309	1.29×10^{-6}	0.886
Fish, salmon	67	37	—	0.307	—	0.802
Ham	71.8	72	64.3	0.277	1.51×10^{-6}	0.831
Lamb	72	72	64.3	0.263	1.40×10^{-6}	0.832
Pork, lean	72	39	64.3	0.263	1.40×10^{-6}	0.832
Turkey breast	74	37	65.5	0.287	1.40×10^{-6}	0.844
Veal	75	72	66.2	0.272	1.40×10^{-6}	0.850
Other						
Butter	16	39	—	0.114	—	0.496
Chocolate cake	31.9	73	21.2	0.061	1.29×10^{-6}	0.591
Margarine	16	40	62.4	0.135	1.18×10^{-6}	0.496
Milk, skimmed	91	72	—	0.327	—	0.946
Milk, whole	88	82	—	0.335	—	0.928
Olive oil	0	90	56.8	0.097	—	—
Peanut oil	0	39	57.4	0.097	—	—
Water	100	0	62.4	0.329	1.51×10^{-6}	1.000
	100	30	59.6	0.357	1.61×10^{-6}	1.000
White cake	32.3	73	28.1	0.047	1.08×10^{-6}	0.594

Source: Data obtained primarily from ASHRAE, *Handbook of Fundamentals*, I-P version (Atlanta, GA: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1993), Chap. 30, Tables 7 and 9. Used with permission.

Most specific heats are calculated from $c_p = 0.4 + 0.6 \times$ (Water content), which is a good approximation in the temperature range of 40 to 90°F. Most thermal diffusivities are calculated from $\alpha = k/\rho c_p$. Property values given above are valid for the specified water content.

TABLE A–8E

Properties of miscellaneous materials
(values are at 540 R unless indicated otherwise)

Material	Density, ρ lbm/ft^3	Thermal Conductivity, k Btu/h·ft·R	Specific Heat, c_p Btu/lbm·R
Asphalt	132.0	0.036	0.220
Bakelite	81.2	0.81	0.350
Brick, refractory			
Chrome brick			
851 R	187.9	1.33	0.199
1481 R	—	1.44	—
2111 R	—	1.16	—
Fire clay, burnt 2880 R			
1391 R	128.0	0.58	0.229
1931 R	—	0.64	—
2471 R	—	0.64	—
Fire clay, burnt 3105 R			
1391 R	145.1	0.75	0.229
1931 R	—	0.81	—
2471 R	—	0.81	—
Fire clay brick			
860 R	165.1	0.58	0.229
1660 R	—	0.87	—
2660 R	—	1.04	—
Magnesite			
860 R	—	2.20	0.270
1660 R	—	1.62	—
2660 R	—	1.10	—
Chicken meat, white (74.4% water content)			
356 R	—	0.92	—
419 R	—	0.86	—
455 R	—	0.78	—
492 R	—	0.28	—
527 R	—	0.28	—
Clay, dry	96.8	0.54	—
Clay, wet	93.3	0.97	—
Coal, anthracite	84.3	0.15	0.301
Concrete (stone mix)	143.6	0.81	0.210
Cork	5.37	0.028	0.485
Cotton	5.0	0.035	0.311
Fat	—	0.10	—
Glass			
Window	174.8	0.40	0.179
Pyrex	138.9	0.6–0.8	0.199
Crown	156.1	0.61	—
Lead	212.2	0.49	—

Material	Density, ρ lbm/ft^3	Thermal Conductivity, k Btu/h·ft·R	Specific Heat, c_p Btu/lbm·R
Ice			
492 R	57.4	1.09	0.487
455 R	57.6	1.17	0.465
311 R	57.9	2.02	0.349
Leather, sole	62.3	0.092	—
Linoleum	33.4	0.047	—
	73.7	0.11	—
Mica	181.0	0.30	—
Paper	58.1	0.10	0.320
Plastics			
Plexiglass	74.3	0.11	0.350
Teflon			
540 R	137.3	0.20	0.251
720 R	—	0.26	—
Lexan	74.9	0.11	0.301
Nylon	71.5	0.17	—
Polypropylene	56.8	0.069	0.388
Polyester	87.1	0.087	0.279
PVC, vinyl	91.8	0.058	0.201
Porcelain	143.6	0.87	—
Rubber, natural	71.8	0.16	—
Rubber, vulcanized			
Soft	68.7	0.075	0.480
Hard	74.3	0.092	—
Sand	94.6	0.1–0.6	0.191
Snow, fresh	6.24	0.35	—
Snow 492 R	31.2	1.27	—
Soil, dry	93.6	0.58	0.454
Soil, wet	118.6	1.16	0.525
Sugar	99.9	0.34	—
Tissue, human			
Skin	—	0.21	—
Fat layer	—	0.12	—
Muscle	—	0.24	—
Vaseline	—	0.098	—
Wood, cross-grain			
Balsa	8.74	0.032	—
Fir	25.9	0.064	0.650
Oak	34.0	0.098	0.570
White pine	27.2	0.064	—
Yellow pine	40.0	0.087	0.670
Wood, radial			
Oak	34.0	0.11	0.570
Fir	26.2	0.081	0.650
Wool, ship	9.05	0.029	—

TABLE A–9E

Properties of saturated water

Temp. T, °F	Saturation Pressure P_{sat}, psia	Density ρ, lbm/ft^3 Liquid	Density Vapor	Enthalpy of Vaporization h_{fg}, Btu/lbm	Specific Heat c_p, Btu/lbm·R Liquid	Specific Heat Vapor	Thermal Conductivity k, Btu/h·ft·R Liquid	Thermal Conductivity Vapor	Dynamic Viscosity μ, lbm/ft·s Liquid	Dynamic Viscosity Vapor	Prandtl Number Pr Liquid	Prandtl Number Vapor	Volume Expansion Coefficient β, 1/R Liquid
32.02	0.0887	62.41	0.00030	1075	1.010	0.446	0.324	0.0099	1.204×10^{-3}	6.194×10^{-6}	13.5	1.00	-0.038×10^{-3}
40	0.1217	62.42	0.00034	1071	1.004	0.447	0.329	0.0100	1.308×10^{-3}	6.278×10^{-6}	11.4	1.01	A0.003 $\times 10^{-3}$
50	0.1780	62.41	0.00059	1065	1.000	0.448	0.335	0.0102	8.781×10^{-4}	6.361×10^{-6}	9.44	1.01	0.047×10^{-3}
60	0.2563	62.36	0.00083	1060	0.999	0.449	0.341	0.0104	7.536×10^{-4}	6.444×10^{-6}	7.95	1.00	0.080×10^{-3}
70	0.3632	62.30	0.00115	1054	0.999	0.450	0.347	0.0106	6.556×10^{-4}	6.556×10^{-6}	6.79	1.00	0.115×10^{-3}
80	0.5073	62.22	0.00158	1048	0.999	0.451	0.352	0.0108	5.764×10^{-4}	6.667×10^{-6}	5.89	1.00	0.145×10^{-3}
90	0.6988	62.12	0.00214	1043	0.999	0.453	0.358	0.0110	5.117×10^{-4}	6.778×10^{-6}	5.14	1.00	0.174×10^{-3}
100	0.9503	62.00	0.00286	1037	0.999	0.454	0.363	0.0112	4.578×10^{-4}	6.889×10^{-6}	4.54	1.01	0.200×10^{-3}
110	1.2763	61.86	0.00377	1031	0.999	0.456	0.367	0.0115	4.128×10^{-4}	7.000×10^{-6}	4.05	1.00	0.224×10^{-3}
120	1.6945	61.71	0.00493	1026	0.999	0.458	0.371	0.0117	3.744×10^{-4}	7.111×10^{-6}	3.63	1.00	0246×10^{-3}
130	2.225	61.55	0.00636	1020	0.999	0.460	0.375	0.0120	3.417×10^{-4}	7.222×10^{-6}	3.28	1.00	0.267×10^{-3}
140	2.892	61.38	0.00814	1014	0.999	0.463	0.378	0.0122	3.136×10^{-4}	7.333×10^{-6}	2.98	1.00	0.287×10^{-3}
150	3.722	61.19	0.0103	1008	1.000	0.465	0.381	0.0125	2.889×10^{-4}	7.472×10^{-6}	2.73	1.00	0.306×10^{-3}
160	4.745	60.99	0.0129	1002	1.000	0.468	0.384	0.0128	2.675×10^{-4}	7.583×10^{-6}	2.51	1.00	0.325×10^{-3}
170	5.996	60.79	0.0161	996	1.001	0.472	0.386	0.0131	2.483×10^{-4}	7.722×10^{-6}	2.90	1.00	0.346×10^{-3}
180	7.515	60.57	0.0199	990	1.002	0.475	0.388	0.0134	2.317×10^{-4}	7.833×10^{-6}	2.15	1.00	0.367×10^{-3}
190	9.343	60.35	0.0244	984	1.004	0.479	0.390	0.0137	2.169×10^{-4}	7.972×10^{-6}	2.01	1.00	0.382×10^{-3}
200	11.53	60.12	0.0297	978	1.005	0.483	0.391	0.0141	2.036×10^{-4}	8.083×10^{-6}	1.88	1.00	0.395×10^{-3}
210	14.125	59.87	0.0359	972	1.007	0.487	0.392	0.0144	1.917×10^{-4}	8.222×10^{-6}	1.77	1.00	0.412×10^{-3}
212	14.698	59.82	0.0373	970	1.007	0.488	0.392	0.0145	1.894×10^{-4}	8.250×10^{-6}	1.75	1.00	0.417×10^{-3}
220	17.19	59.62	0.0432	965	1.009	0.492	0.393	0.0148	1808×10^{-4}	8.333×10^{-6}	1.67	1.00	0.429×10^{-3}
230	20.78	59.36	0.0516	959	1.011	0.497	0.394	0.0152	1.711×10^{-4}	8.472×10^{-6}	1.58	1.00	0.443×10^{-3}
240	24.97	59.09	0.0612	952	1.013	0.503	0.394	0.0156	1.625×10^{-4}	8.611×10^{-6}	1.50	1.00	0.462×10^{-3}
250	29.82	58.82	0.0723	946	1.015	0.509	0.395	0.0160	1.544×10^{-4}	8.611×10^{-6}	1.43	1.00	0.480×10^{-3}
260	35.42	58.53	0.0850	939	1.018	0.516	0.395	0.0164	1.472×10^{-4}	8.861×10^{-6}	1.37	1.00	0.497×10^{-3}
270	41.85	58.24	0.0993	932	1.020	0.523	0.395	0.0168	1.406×10^{-4}	9.000×10^{-6}	1.31	1.01	0.514×10^{-3}
280	49.18	57.94	0.1156	926	1.023	0.530	0.395	0.0172	1.344×10^{-4}	9.111×10^{-6}	1.25	1.01	0.532×10^{-3}
290	57–53	57.63	0.3390	918	1.026	0.538	0.395	0.0177	1.289×10^{-4}	9.250×10^{-6}	1.21	1.01	0.549×10^{-3}
300	66.98	57.31	0.1545	910	1.029	0.547	0.394	0.0182	1.236×10^{-4}	9.389×10^{-6}	1.16	1.02	0.566×10^{-3}
320	89.60	56.65	0.2033	895	1.036	0.567	0.393	0.0191	1.144×10^{-4}	9.639×10^{-6}	1.09	1.03	0.636×10^{-3}
340	117.93	55.95	0.2637	880	1.044	0.590	0.391	0.0202	1.063×10^{-4}	9.889×10^{-6}	1.02	1.04	0.656×10^{-3}
360	152.92	56.22	0.3377	863	1.054	0.617	0.389	0.0213	9.972×10^{-5}	1.013×10^{-5}	0.973	1.06	0.681×10^{-3}
380	195.60	54.46	0.4275	845	1.065	0.647	0.385	0.0224	9.361×10^{-5}	1.041×10^{-5}	0.932	1.08	0.720×10^{-3}
400	241.1	53.65	0.5359	827	1.078	0.683	0.382	0.0237	8.833×10^{-5}	1.066×10^{-5}	0.893	1.11	0.771×10^{-3}
450	422.1	51.46	0.9082	775	1.121	0.799	0.370	0.0271	7.722×10^{-5}	1.130×10^{-5}	0.842	1.20	0.912×10^{-3}
500	680.0	48.95	1.479	715	1.188	0.972	0.352	0.0312	6.833×10^{-5}	1.200×10^{-5}	0.830	1.35	1.111×10^{-3}
550	1046.7	45.96	4.268	641	1.298	1.247	0.329	0.0368	6.083×10^{-5}	1.280×10^{-5}	0.864	1.56	1.445×10^{-3}
600	1541	42.32	3.736	550	1.509	1.759	0.299	0.0461	5.389×10^{-5}	1.380×10^{-5}	0.979	1.90	1.883×10^{-3}
650	2210	37.31	6.152	422	2.086	3.103	0.267	0.0677	4.639×10^{-5}	1.542×10^{-5}	1.30	2.54	
700	3090	27.28	13.44	168	13.80	25.90	0.254	0.1964	3.417×10^{-5}	2.044×10^{-5}	6.68	9.71	
705.44	3204	19.79	19.79	0	∞	∞	∞	∞	2.897×10^{-5}	2.897×10^{-5}			

Note 1: Kinematic viscosity ν and thermal diffusivity α can be calculated from their definitions, $\nu = \mu/\rho$ and $\alpha = k/\rho c_p = \nu/\text{Pr}$. The temperatures 32.02°F, 212°F, and 705.44°F are the triple-, boiling-, and critical-point temperatures of water, respectively. All properties listed above (except the vapor density) can be used at any pressures with negligible error except at temperatures near the critical-point value.

Note 2: The unit Btu/lbm·°F for specific heat is equivalent to Btu/lbm·R, and the unit Btu/h·ft·°F for thermal conductivity is equivalent to Btu/h·ft·R.

Source: Viscosity and thermal conductivity data are from J. V. Sengers and J. T. T. Watson, *Journal of Physical and Chemical Reference Data* 15 (1986), pp. 1291–1322. Other data are obtained from various sources or calculated.

TABLE A–10E

Properties of saturated refrigerant–134a

Temp. T, °F	Saturation Pressure P_{sat}, psia	Density ρ, lbm/ft³ Liquid	Density ρ, lbm/ft³ Vapor	Enthalpy of Vaporization h_{fg}, Btu/lbm	Specific Heat c_p, Btu/lbm·R Liquid	Specific Heat c_p, Btu/lbm·R Vapor	Thermal Conductivity k, Btu/h·ft·R Liquid	Thermal Conductivity k, Btu/h·ft·R Vapor	Dynamic Viscosity μ, lbm/ft·s Liquid	Dynamic Viscosity μ, lbm/ft·s Vapor	Prandtl Number Pr Liquid	Prandtl Number Pr Vapor	Volume Expansion Coefficient β, 1/R Liquid	Surface Tension lbf/ft
−40	7.4	88.51	0.1731	97.1	0.2996	0.1788	0.0636	0.00466	3.278×10^{-4}	1.714×10^{-6}	5.558	0.237	0.00114	0.001206
−30	9.9	87.5	0.2258	95.6	0.3021	0.1829	0.0626	0.00497	3.004×10^{-4}	2.053×10^{-6}	5.226	0.272	0.00117	0.001146
−20	12.9	86.48	0.2905	94.1	0.3046	0.1872	0.0613	0.00529	2.762×10^{-4}	2.433×10^{-6}	4.937	0.310	0.00120	0.001087
−10	16.6	85.44	0.3691	92.5	0.3074	0.1918	0.0602	0.00559	2.546×10^{-4}	2.856×10^{-6}	4.684	0.352	0.00124	0.001029
0	21.2	84.38	0.4635	90.9	0.3103	0.1966	0.0589	0.00589	2.345×10^{-4}	3.314×10^{-6}	4.463	0.398	0.00128	0.000972
10	26.6	83.31	0.5761	89.3	0.3134	0.2017	0.0576	0.00619	2.181×10^{-4}	3.811×10^{-4}	4.269	0.447	0.00132	0.000915
20	33.1	82.2	0.7094	87.5	0.3167	0.2070	0.0563	0.00648	2.024×10^{-4}	4.342×10^{-6}	4.098	0.500	0.00132	0.000859
30	40.8	81.08	0.866	85.8	0.3203	0.2127	0.0550	0.00676	1.883×10^{-4}	4.906×10^{-6}	3.947	0.555	0.00142	0.000803
40	49.8	79.92	1.049	83.9	0.3240	0.2188	0.0536	0.00704	1.752×10^{-4}	5.494×10^{-6}	3.814	0.614	0.00149	0.000749
50	60.2	78.73	1.262	82.0	0.3281	0.2253	0.0522	0.00732	1.633×10^{-4}	6.103×10^{-6}	3.697	0.677	0.00156	0.000695
60	72.2	77.51	1.509	80.0	0.3325	0.2323	0.0507	0.00758	1.522×10^{-4}	6.725×10^{-6}	3.594	0.742	0.00163	0.000642
70	85.9	76.25	1.794	78.0	0.3372	0.2398	0.0492	0.00785	1.420×10^{-4}	7.356×10^{-6}	3.504	0.810	0.00173	0.000590
80	101.4	74.94	2.122	75.8	0.3424	0.2481	0.0476	0.00810	1.324×10^{-4}	7.986×10^{-6}	3.425	0.880	0.00183	0.000538
90	119.1	73.59	2.5	73.5	0.3481	0.2572	0.0460	0.00835	1.234×10^{-4}	8.611×10^{-6}	3.357	0.955	0.00195	0.000488
100	138.9	72.17	2.935	71.1	0.3548	0.2674	0.0444	0.00860	1.149×10^{-4}	9.222×10^{-6}	3.303	1.032	0.00210	0.000439
110	161.2	70.69	3.435	68.5	0.3627	0.2790	0.0427	0.00884	1.068×10^{-4}	9.814×10^{-6}	3.262	1.115	0.00227	0.000391
120	186.0	69.13	4.012	65.8	0.3719	0.2925	0.0410	0.00908	9.911×10^{-5}	1.038×10^{-5}	3.235	1.204	0.00248	0.000344
130	213.5	67.48	4.679	62.9	0.3829	0.3083	0.0392	0.00931	9.175×10^{-5}	1.092×10^{-5}	3.223	1.303	0.00275	0.000299
140	244.1	65.72	5.455	59.8	0.3963	0.3276	0.0374	0.00954	8.464×10^{-5}	1.144×10^{-5}	3.229	1.416	0.00308	0.000255
150	277.8	63.83	6.367	56.4	0.4131	0.3520	0.0355	0.00976	7.778×10^{-5}	1.195×10^{-5}	3.259	1.551	0.00351	0.000212
160	314.9	61.76	7.45	52.7	0.4352	0.3839	0.0335	0.00998	7.108×10^{-5}	1.245×10^{-5}	3.324	1.725	0.00411	0.000171
170	355.8	59.47	8.762	48.5	0.4659	0.4286	0.0314	0.01020	6.450×10^{-5}	1.298×10^{-5}	3.443	1.963	0.00498	0.000132
180	400.7	56.85	10.4	43.7	0.5123	0.4960	0.0292	0.01041	5.792×10^{-5}	1.366×10^{-5}	3.661	2.327	0.00637	0.000095
190	449.9	53.75	12.53	38.0	0.5929	0.6112	0.0267	0.01063	5.119×10^{-5}	1.431×10^{-5}	4.090	2.964	0.00891	0.000061
200	504.0	49.75	15.57	30.7	0.7717	0.8544	0.0239	0.01085	4.397×10^{-5}	1.544×10^{-5}	5.119	4.376	0.01490	0.000031
210	563.8	43.19	21.18	18.9	1.4786	1.6683	0.0199	0.01110	3.483×10^{-5}	1.787×10^{-5}	9.311	9.669	0.04021	0.000006

Note 1: KInematic viscosity ν and thermal diffusivity α can be calculated from their definitions, $\nu = \mu/\rho$ and $\alpha = k/\rho c_p = \nu/\text{Pr}$. The properties listed here (except the vapor density) can be used at any pressures with negligible error except at temperatures near the critical-point value.

Note 2: The unit Btu/lbm . °F for specific heat is equivalent to Btu/lbm·R, and the unit Btu/h·ft·°F for thermal conductivity is equivalent to Btu/h·ft·R.

Source: Data generated from the EES software developed by S. A. Klein and F. L. Alvarado. Original sources: R. Tilner-Roth and H. D. Baehr, "An International Standard Formulation for the Thermodynamic Properties of 1,1,1,2-Tetrafluorethane (HFC-134a) for Temperatures from 170 K to 455 K and Pressures up to 70 Mpa," *J. Phys. Chem. Ref. Data*, Vol. 23, No.5, 1994: M. J. Assael, N. K. Dalaouti, A. A. Griva, and J. H. Dymond, "Viscosity and Thermal Conductivity of Halogenated Methane and Ethane Refrigerants," *IJR*, Vol. 22, pp. 525–535, 1999: NIST REPROP 6 program (M. O. McLinden, S. A. Klein, E. W. Lemmon, and A. P. Peskin, Physicial and Chemical Properties Division, National Institute of Standards and Technology, Boulder, CO 80303. 1995).

TABLE A–11E

Properties of saturated ammonia

Temp. T, °F	Saturation Pressure P_{sat}, psia	Density ρ, lbm/ft^3 Liquid	Density Vapor	Enthalpy of Vaporization h_{fg}, Btu/lbm	Specific Heat c_p, Btu/lbm·R Liquid	Specific Heat Vapor	Thermal Conductivity k, Btu/h·ft·R Liquid	Thermal Conductivity Vapor	Dynamic Viscosity μ, lbm/ft·s Liquid	Dynamic Viscosity Vapor	Prandtl Number Pr Liquid	Prandtl Number Vapor	Volume Expansion Coefficient β, 1/R Liquid	Surface Tension lbf/ft
−40	10.4	43.08	0.0402	597.0	1.0542	0.5354	–	0.01026	1.966×10^{-4}	5.342×10^{-6}	–	1.003	0.00098	0.002443
−30	13.9	42.66	0.0527	590.2	1.0610	0.5457	–	0.01057	1.853×10^{-4}	5.472×10^{-6}	–	1.017	0.00101	0.002357
−20	18.3	42.33	0.0681	583.2	1.0677	0.5571	0.3501	0.01089	1.746×10^{-4}	5.600×10^{-6}	1.917	1.031	0.00103	0.002272
−10	23.7	41.79	0.0869	575.9	1.0742	0.5698	0.3426	0.01121	1.645×10^{-4}	5.731×10^{-6}	1.856	1.048	0.00106	0.002187
0	30–4	41.34	0.1097	568.4	1.0807	0.5838	0.3352	0.01154	1.549×10^{-4}	5.861×10^{-6}	1.797	1.068	0.00109	0.002103
10	38.5	40.89	0.1370	560.7	1.0873	0.5992	0.3278	0.01187	1.458×10^{-4}	5.994×10^{-6}	1.740	1.089	0.00112	0.002018
20	48.2	40.43	0.1694	552.6	1.0941	0.6160	0.3203	0.01220	1.371×10^{-4}	6.125×10^{-6}	1.686	1.113	0.00116	0.001934
30	59.8	39.96	0.2075	544.4	1.1012	0.6344	0.3129	0.01254	1290×10^{-4}	6.256×10^{-6}	1.634	1.140	0.00119	0.001850
40	73.4	39.48	0.2521	535.8	1.1087	0.6544	0.3055	0.01288	1.213×10^{-4}	6.389×10^{-6}	1.585	1.168	0.00123	0.001767
50	89.2	38.99	0.3040	526.9	1.1168	0.6762	0.2980	0.01323	1.140×10^{-4}	6.522×10^{-6}	1.539	1.200	0.00128	0.001684
60	107.7	38.50	0.3641	517.7	1.1256	0.6999	0.2906	0.01358	1.072×10^{-4}	6.656×10^{-6}	1.495	1.234	0.00132	0.001601
70	128.9	37.99	0.4332	508.1	1.1353	0.7257	0.2832	0.01394	1.008×10^{-4}	6.786×10^{-6}	1.456	1.272	0.00137	0.001518
80	153.2	37.47	0.5124	498.2	1.1461	0.7539	0.2757	0.01431	9.486×10^{-5}	6.922×10^{-6}	1.419	1.313	0.00143	0.001436
90	180.8	36.94	0.6029	487.8	1.1582	0.7846	0.2683	0.01468	8.922×10^{-5}	7.056×10^{-6}	1.387	1.358	0.00149	0.001354
100	212.0	36.40	0.7060	477.0	1.1719	0.8183	0.2609	0.01505	8.397×10^{-5}	7.189×10^{-6}	1.358	1.407	0.00156	0.001273
110	247.2	35.83	0.8233	465.8	1.1875	0.8554	0.2535	0.01543	7.903×10^{-5}	7.325×10^{-6}	1.333	1.461	0.00164	0.001192
120	286.5	35.26	0.9564	454.1	1.2054	0.8965	0.2460	0.01582	7.444×10^{-5}	7.458×10^{-6}	1.313	1.522	0.00174	0.001111
130	330.4	34.66	1.1074	441.7	1.2261	0.9425	0.2386	0.01621	7.017×10^{-5}	7.594×10^{-6}	1.298	1.589	0.00184	0.001031
140	379.4	34.04	1.2786	428.8	1.2502	0.9943	0.2312	0.01661	6.617×10^{-5}	7.731×10^{-6}	1.288	1.666	0.00196	0.000951
150	433.2	33.39	1.4730	415.2	1.2785	1.0533	0.2237	0.01702	6.244×10^{-5}	7.867×10^{-4}	1.285	1.753	0.00211	0.000872
160	492.7	32.72	1.6940	400.8	1.3120	1.1214	0.2163	0.01744	5.900×10^{-5}	8.006×10^{-6}	1.288	1.853	0.00228	0.000794
170	558.2	32.01	1.9460	385.4	1.3523	1.2012	0.2089	0.01786	5.578×10^{-5}	8.142×10^{-6}	1.300	1.971	0.00249	0.000716
180	630.1	31.26	2.2346	369.1	1.4015	1.2965	0.2014	0.01829	5.278×10^{-5}	8.281×10^{-6}	1.322	2.113	0.00274	0.000638
190	708.5	30.47	2.5670	351.6	1.4624	1.4128	0.1940	0.01874	5.000×10^{-5}	8.419×10^{-6}	1.357	2.286	0.00306	0.000562
200	794.4	29.62	2.9527	332.7	1.5397	1.5586	0.1866	0.01919	4.742×10^{-5}	8.561×10^{-6}	1.409	2.503	0.00348	0.000486
210	887.9	28.70	3.4053	312.0	1.6411	1.7473	0.1791	0.01966	4500×10^{-5}	8.703×10^{-6}	1.484	2.784	0.00403	0.000411
220	989.5	27.69	3.9440	289.2	1.7798	2.0022	0.1717	0.02015	4.275×10^{-5}	8.844×10^{-6}	1.595	3.164	0.00480	0.000338
230	1099.0	25.57	4.5987	263.5	1.9824	2.3659	0.1643	0.02065	4.064×10^{-5}	8.989×10^{-6}	1.765	3.707	0.00594	0.000265
240	1219.4	25.28	5.4197	234.0	2.3100	2.9264	0.1568	0.02119	3.864×10^{-5}	9.136×10^{-6}	2.049	4.542	0.00784	0.000194

Note 1: Kinematic viscosity ν and thermal diffusivity α can be calculated from their definitions, $\nu = \mu/p$ and $\alpha = k/\rho c_p = \nu/\mathrm{Pr}$. The properties listed here (except the vapor density) can be used at any pressures with negligible error except at temperatures near the critical-point value.

Note 2: The unit Btu/lbm·°F for specific heat is equivalent to Btu/lbm·R, and the unit Btu/h·ft·°F for thermal conductivity is equivalent to Btu/h·ft·R.

Source: Data generated from the EES software developed by S. A. Klein and F. L. Alvarado. Orginal sources: Tillner-Roth, Harms-Watzenterg, and Baehr, "Eine neue Fundamentalgleichung fur Ammoniak," *DKV-Tagungsbericht* 20: 167–181, 1993; Liley and Desai, "Thermophysical Properties of Refrigerants," *ASHRAE*, 1993, ISBN 1-1883413-10-9.

TABLE A–12E

Properties of saturated propane

Temp. T, °F	Saturation Pressure P_{sat}, psia	Density ρ, lbm/ft^3 Liquid	Density Vapor	Enthalpy of Vaporization h_{fg}, Btu/lbm	Specific Heat c_p, Btu/lbm·R Liquid	Specific Heat Vapor	Thermal Conductivity k, Btu/h·ft·R Liquid	Thermal Conductivity Vapor	Dynamic Viscosity μ, lbm/ft·s Liquid	Dynamic Viscosity Vapor	Prandtl Number Pr Liquid	Prandtl Number Vapor	Volume Expansion Coefficient β, 1/R Liquid	Surface Tension lbf/ft
−200	0.0201	42.06	0.0003	217.7	0.4750	0.2595	0.1073	0.00313	5.012×10^{-4}	2.789×10^{-6}	7.991	0.833	0.00083	0.001890
−180	0.0752	41.36	0.0011	213.4	0.4793	0.2680	0.1033	0.00347	3.941×10^{-4}	2.975×10^{-6}	6.582	0.826	0.00086	0.001780
−160	0.2307	40.65	0.0032	209.1	0.4845	0.2769	0.0992	0.00384	3.199×10^{-4}	3.164×10^{-6}	5.626	0.821	0.00088	0.001671
−140	0.6037	39.93	0.0078	204.8	0.4907	0.2866	0.0949	0.00423	2.660×10^{-4}	3.358×10^{-6}	4.951	0.818	0.00091	0.001563
−120	1.389	39.20	0.0170	200.5	0.4982	0.2971	0.0906	0.00465	2.252×10^{-4}	3.556×10^{-6}	4.457	0.817	0.00094	0.001455
−100	2.878	38.46	0.0334	196.1	0.5069	0.3087	0.0863	0.00511	1.934×10^{-4}	3.756×10^{-6}	4.087	0.817	0.00097	0.001349
−90	4.006	38.08	0.0453	193.9	0.5117	0.3150	0.0842	0.00534	1.799×10^{-4}	3.858×10^{-6}	3.936	0.819	0.00099	0.001297
−80	5.467	37.70	0.0605	191.6	0.5169	0.3215	0.0821	0.00559	1.678×10^{-4}	3.961×10^{-6}	3.803	0.820	0.00101	0.001244
−70	7.327	37.32	0.0793	189.3	0.5224	0.3284	0.0800	0.00585	1.569×10^{-4}	4.067×10^{-6}	3.686	0.822	0.00104	0.001192
−60	9.657	36.93	0.1024	186.9	0.5283	0.3357	0.0780	0.00611	1.469×10^{-4}	4.172×10^{-6}	3.582	0.825	0.00106	0.001140
−50	12.54	36.54	0.1305	184.4	0.5345	0.3433	0.0760	0.00639	1.378×10^{-4}	4.278×10^{-6}	3.490	0.828	0.00109	0.001089
−40	16.05	36.13	0.1641	181.9	0.5392	0.3513	0.0740	0.00568	1.294×10^{-4}	4.386×10^{-6}	3.395	0.831	0.00112	0.001038
−30	20.29	35.73	0.2041	179.3	0.5460	0.3596	0.0721	0.00697	1.217×10^{-4}	4.497×10^{-6}	3.320	0.835	0.00115	0.000987
−20	25.34	35.31	0.2512	176.6	0.5531	0.3684	0.0702	0.00728	1.146×10^{-4}	4.611×10^{-6}	3.253	0.840	0.00119	0.000937
−10	31.3	34.89	0.3063	173.8	0.5607	0.3776	0.0683	0.00761	1.079×10^{-4}	4.725×10^{-6}	3.192	0.845	0.00123	0.000887
0	38.28	34.46	0.3703	170.9	0.5689	0.3874	0.0665	0.00794	1.018×10^{-4}	4.842×10^{-6}	3.137	0.850	0.00127	0.000838
10	46.38	34.02	0.4441	167.9	0.5775	0.3976	0.0647	0.00829	9.606×10^{-5}	4.961×10^{-6}	3.088	0.857	0.00132	0.000789
20	55.7	33.56	0.5289	164.8	0.5867	0.4084	0.0629	0.00865	9.067×10^{-5}	5.086×10^{-6}	3.043	0.864	0.00138	0.000740
30	66.35	33.10	0.6259	161.6	0.5966	0.4199	0.0512	0.00903	8.561×10^{-5}	5.211×10^{-6}	3.003	0.873	0.00144	0.000692
40	78.45	32.62	0.7365	158.1	0.6072	0.4321	0.0595	0.00942	8.081×10^{-5}	5.342×10^{-6}	2.967	0.882	0.00151	0.000644
50	92.12	32.13	0.8621	154.6	0.6187	0.4452	0.0579	0.00983	7.631×10^{-5}	5.478×10^{-6}	2.935	0.893	0.00159	0.000597
60	107.5	31.63	1.0046	150.8	0.6311	0.4593	0.0563	0.01025	7.200×10^{-5}	5.617×10^{-6}	2.906	0.906	0.00168	0.000551
70	124.6	31.11	1.1659	146.8	0.6447	0.4746	0.0547	0.01070	6.794×10^{-5}	5.764×10^{-6}	2.881	0.921	0.00179	0.000505
80	143.7	30.56	1.3484	142.7	0.6596	0.4915	0.0532	0.01116	6.406×10^{-5}	5.919×10^{-6}	2.860	0.938	0.00191	0.000460
90	164.8	30.00	1.5549	138.2	0.6762	0.5103	0.0517	0.01165	6.033×10^{-5}	6.081×10^{-6}	2.843	0.959	0.00205	0.000416
100	188.1	29.41	1.7887	133.6	0.6947	0.5315	0.0501	0.01217	5.675×10^{-5}	6.256×10^{-6}	2.831	0.984	0.00222	0.000372
120	241.8	28.13	2.3562	123.2	0.7403	0.5844	0.0472	0.01328	5.000×10^{-6}	6.644×10^{-6}	2.825	1.052	0.00267	0.000288
140	306.1	26.69	3.1003	111.1	0.7841	0.6613	0.0442	0.01454	4.358×10^{-5}	7.111×10^{-6}	2.784	1.164	0.00338	0.000208
160	382.4	24.98	4.1145	96.4	0.8696	0.7911	0.0411	0.01603	3.733×10^{-5}	7.719×10^{-6}	2.845	1.371	0.00459	0.000133
180	472.9	22.79	5.6265	77.1	1.1436	1.0813	0.0376	0.01793	3.083×10^{-5}	8.617×10^{-6}	3.380	1.870	0.00791	0.000065

Note 1: Kinematic viscosity ν and thermal diffusivity α can be calculated from their definitions, $\nu = \mu/\rho$ and $\alpha = k/\rho c_p = \nu/\text{Pr}$. The properties listed here (except the vapor density) can be used at any pressures with negligible error at temperatures near the critical-point value.

Note 2: The unit Btu/lbm·°F for specific heat is equivalent to Btu/lbm·R, and the unit Btu/h·ft·°F for thermal conductivity is equivalent to Btu/h·ft·R.

Source: Data generated from the EES software developed by S. A. Klein and F. L. Alvarado. Original sources: Reiner Tillner-Roth, "Fundamental Equations of State," Shaker, Verlag, Aachan, 1998; B. A. Younglove and J. F. Ely. "Thermophysical Properties of Fluids. II Methane, Ethane, Propane, Isobutane, and Normal Butane," *J. Phys. Chem. Ref. Data*, Vol. 16, No. 4, 1987; G. R. Somayajulu, "A Generalized Equation for Surface Tension from the Triple-Point to the Critical-Point," *International Journal of Thermophysics*, Vol. 9, No. 4, 1988.

TABLE A–13E

Properties of liquids

Temp. T, °F	Density ρ, lbm/ft³	Specific Heat c_p, Btu/lbm·R	Thermal Conductivity k, Btu/h·ft·R	Thermal Diffusivity α, ft²/s	Dynamic Viscosity μ, lbm/ft·s	Kinematic Viscosity ν, ft²/s	Prandtl Number Pr	Volume Expansion Coeff. β, 1/R
				Methane (CH_4)				
−280	27.41	0.8152	0.1205	1.497×10^{-6}	1.057×10^{-4}	3.857×10^{-6}	2.575	0.00175
−260	26.43	0.8301	0.1097	1.389×10^{-6}	8.014×10^{-5}	3.032×10^{-6}	2.183	0.00192
−240	25.39	0.8523	0.0994	1.276×10^{-6}	6.303×10^{-5}	2.482×10^{-6}	1.945	0.00215
−220	24.27	0.8838	0.0896	1.159×10^{-6}	5.075×10^{-5}	2.091×10^{-6}	1.803	0.00247
−200	23.04	0.9314	0.0801	1.036×10^{-6}	4.142×10^{-5}	1.798×10^{-6}	1.734	0.00295
−180	21.64	1.010	0.0709	9.008×10^{-7}	3.394×10^{-5}	1.568×10^{-6}	1.741	0.00374
−160	19.99	1.158	0.0616	7.397×10^{-7}	2.758×10^{-5}	1.379×10^{-6}	1.865	0.00526
−140	17.84	1.542	0.0518	5.234×10^{-7}	2.168×10^{-5}	1.215×10^{-6}	2.322	0.00943
				Methanol [$CH_3(OH)$]				
70	49.15	0.6024	0.1148	1.076×10^{-6}	3.872×10^{-4}	7.879×10^{-6}	7.317	0.000656
90	48.50	0.6189	0.1143	1.057×10^{-6}	3.317×10^{-4}	6.840×10^{-6}	6.468	0.000671
110	47.85	0.6373	0.1138	1.036×10^{-6}	2.872×10^{-4}	6.005×10^{-6}	5.793	0.000691
130	47.18	0.6576	0.1133	1.014×10^{-6}	2.513×10^{-4}	5.326×10^{-6}	5.250	0.000716
150	46.50	0.6796	0.1128	9.918×10^{-7}	2.218×10^{-4}	4.769×10^{-6}	4.808	0.000749
170	45.80	0.7035	0.1124	9.687×10^{-7}	1.973×10^{-4}	4.308×10^{-6}	4.447	0.000789
				Isobutane (R600a)				
−150	42.75	0.4483	0.0799	1.157×10^{-6}	6.417×10^{-4}	1.500×10^{-5}	12.96	0.000785
−100	41.06	0.4721	0.0782	1.120×10^{-6}	3.669×10^{-4}	8.939×10^{-6}	7.977	0.000836
−50	39.31	0.4986	0.0731	1.036×10^{-6}	2.376×10^{-4}	6.043×10^{-6}	5.830	0.000908
0	37.48	0.5289	0.0664	9.299×10^{-7}	1.651×10^{-4}	4.406×10^{-6}	4.738	0.001012
50	35.52	0.5643	0.0591	8.187×10^{-7}	1.196×10^{-4}	3.368×10^{-6}	4.114	0.001169
100	33.35	0.6075	0.0521	7.139×10^{-7}	8.847×10^{-5}	2.653×10^{-6}	3.716	0.001421
150	30.84	0.6656	0.0457	6.188×10^{-7}	6.558×10^{-5}	2.127×10^{-6}	3.437	0.001883
200	27.73	0.7635	0.0400	5.249×10^{-7}	4.750×10^{-5}	1.713×10^{-6}	3.264	0.002970
				Glycerin				
32	79.65	0.5402	0.163	1.052×10^{-6}	7.047	0.08847	84101	
40	79.49	0.5458	0.1637	1.048×10^{-6}	4.803	0.06042	57655	
50	79.28	0.5541	0.1645	1.040×10^{-6}	2.850	0.03594	34561	
60	79.07	0.5632	0.1651	1.029×10^{-6}	1.547	0.01956	18995	
70	78.86	0.5715	0.1652	1.018×10^{-6}	0.9422	0.01195	11730	
80	78.66	0.5794	0.1652	1.007×10^{-6}	0.5497	0.00699	6941	
90	78.45	0.5878	0.1652	9.955×10^{-7}	0.3756	0.004787	4809	
100	78.24	0.5964	0.1653	9.841×10^{-7}	0.2277	0.00291	2957	
				Engine Oil (unused)				
32	56.12	0.4291	0.0849	9.792×10^{-7}	2.563	4.566×10^{-2}	46636	0.000389
50	55.79	0.4395	0.08338	9.448×10^{-7}	1.210	2.169×10^{-2}	22963	0.000389
75	55.3	0.4531	0.08378	9.288×10^{-7}	0.4286	7.751×10^{-3}	8345	0.000389
100	54.77	0.4669	0.08367	9.089×10^{-7}	0.1630	2.977×10^{-3}	3275	0.000389
125	54.24	0.4809	0.08207	8.740×10^{-7}	7.617×10^{-2}	1.404×10^{-3}	1607	0.000389
150	53.73	0.4946	0.08046	8.411×10^{-7}	3.833×10^{-2}	7.135×10^{-4}	848.3	0.000389
200	52.68	0.5231	0.07936	7.999×10^{-7}	1.405×10^{-2}	2.668×10^{-4}	333.6	0.000389
250	51.71	0.5523	0.07776	7.563×10^{-7}	6.744×10^{-3}	1.304×10^{-4}	172.5	0.000389
300	50.63	0.5818	0.07673	7.236×10^{-7}	3.661×10^{-3}	7.232×10^{-5}	99.94	0.000389

Source: Data generated from the EES software developed by S. A. Klein and F. L. Alvarado. Originally based on various sources.

TABLE A–14E

Properties of liquid metals

Temp. T, °F	Density ρ, lbm/ft^3	Specific Heat c_p, Btu/lbm·R	Thermal Conductivity k, Btu/h·ft·R	Thermal Diffusivity α, ft^2/s	Dynamic Viscosity μ, lbm/ft·s	Kinematic Viscosity ν, ft^2/s	Prandtl Number Pr	Volume Expansion Coeff. β, 1/R
				Mercury (Hg) Melting Point: −38°F				
32	848.7	0.03353	4.727	4.614×10^{-5}	1.133×10^{-3}	1.335×10^{-6}	0.02895	1.005×10^{-4}
50	847.2	0.03344	4.805	4.712×10^{-5}	1.092×10^{-3}	1.289×10^{-6}	0.02737	1.005×10^{-4}
100	842.9	0.03319	5.015	4.980×10^{-5}	9.919×10^{-4}	1.176×10^{-6}	0.02363	1.005×10^{-4}
150	838.7	0.03298	5.221	5.244×10^{-5}	9.122×10^{-4}	1.087×10^{-6}	0.02074	1.005×10^{-4}
200	834.5	0.03279	5.422	5.504×10^{-5}	8.492×10^{-4}	1.017×10^{-6}	0.01849	1.005×10^{-4}
300	826.2	0.03252	5.815	6.013×10^{-5}	7.583×10^{-4}	9.180×10^{-7}	0.01527	1.005×10^{-4}
400	817.9	0.03236	6.184	6.491×10^{-5}	6.972×10^{-4}	8.524×10^{-7}	0.01313	1.008×10^{-4}
500	809.6	0.03230	6.518	6.924×10^{-5}	6.525×10^{-4}	8.061×10^{-7}	0.01164	1.018×10^{-4}
600	801.3	0.03235	6.839	7.329×10^{-5}	6.186×10^{-4}	7.719×10^{-7}	0.01053	1.035×10^{-4}
				Bismuth (Bi) Melting Point: 520°F				
700	620.7	0.03509	9.361	1.193×10^{-4}	1.001×10^{-3}	1.614×10^{-6}	0.01352	
800	616.5	0.03569	9.245	1.167×10^{-4}	9.142×10^{-4}	1.482×10^{-6}	0.01271	
900	612.2	0.0363	9.129	1.141×10^{-4}	8.267×10^{-4}	1.350×10^{-6}	0.01183	
1000	608.0	0.0369	9.014	1.116×10^{-4}	7.392×10^{-4}	1.215×10^{-6}	0.0109	
1100	603.7	0.0375	9.014	1.105×10^{-4}	6.872×10^{-4}	1.138×10^{-6}	0.01029	
				Lead (Pb) Melting Point: 621°F				
700	658	0.03797	9.302	1.034×10^{-4}	1.612×10^{-3}	2.450×10^{-6}	0.02369	
800	654	0.03750	9.157	1.037×10^{-4}	1.453×10^{-3}	2.223×10^{-6}	0.02143	
900	650	0.03702	9.013	1.040×10^{-4}	1.296×10^{-3}	1.994×10^{-6}	0.01917	
1000	645.7	0.03702	8.912	1.035×10^{-4}	1.202×10^{-3}	1.862×10^{-6}	0.01798	
1100	641.5	0.03702	8.810	1.030×10^{-4}	1.108×10^{-3}	1.727×10^{-6}	0.01676	
1200	637.2	0.03702	8.709	1.025×10^{-4}	1.013×10^{-3}	1.590×10^{-6}	0.01551	
				Sodium (Na) Melting Point: 208°F				
300	57.13	0.3258	48.19	7.192×10^{-4}	4.136×10^{-4}	7.239×10^{-6}	0.01007	
400	56.28	0.3219	46.58	7.142×10^{-4}	3.572×10^{-4}	6.350×10^{-6}	0.008891	
500	55.42	0.3181	44.98	7.087×10^{-4}	3.011×10^{-4}	5.433×10^{-6}	0.007667	
600	54.56	0.3143	43.37	7.026×10^{-4}	2.448×10^{-4}	4.488×10^{-6}	0.006387	
800	52.85	0.3089	40.55	6.901×10^{-4}	1.772×10^{-4}	3.354×10^{-6}	0.004860	
1000	51.14	0.3057	38.12	6.773×10^{-4}	1.541×10^{-4}	3.014×10^{-6}	0.004449	
				Potassium (K) Melting Point: 147°F				
300	50.40	0.1911	26.00	7.500×10^{-4}	2.486×10^{-4}	4.933×10^{-6}	0.006577	
400	49.58	0.1887	25.37	7.532×10^{-4}	2.231×10^{-4}	4.500×10^{-6}	0.005975	
500	48.76	0.1863	24.73	7.562×10^{-4}	1.976×10^{-4}	4.052×10^{-6}	0.005359	
600	47.94	0.1839	24.09	7.591×10^{-4}	1.721×10^{-4}	3.589×10^{-6}	0.004728	
800	46.31	0.1791	22.82	7.643×10^{-4}	1.210×10^{-4}	2.614×10^{-6}	0.003420	
1000	44.62	0.1791	21.34	7.417×10^{-4}	1.075×10^{-4}	2.409×10^{-6}	0.003248	
				Sodium-Potassium (%22Na-%78K) Melting Point: 12°F				
200	52.99	0.2259	14.79	3.432×10^{-4}	3.886×10^{-4}	7.331×10^{-6}	0.02136	
300	52.16	0.2230	14.99	3.580×10^{-4}	3.467×10^{-4}	6.647×10^{-6}	0.01857	
400	51.32	0.2201	15.19	3.735×10^{-4}	3.050×10^{-4}	5.940×10^{-6}	0.0159	
600	49.65	0.2143	15.59	4.070×10^{-4}	2.213×10^{-4}	4.456×10^{-6}	0.01095	
800	47.99	0.2100	15.95	4.396×10^{-4}	1.539×10^{-4}	3.207×10^{-6}	0.007296	
1000	46.36	0.2103	16.20	4.615×10^{-4}	1.353×10^{-4}	2.919×10^{-6}	0.006324	

Source: Data generated from the EES software developed by S. A. Klein and F. L. Alvarado. Originally based on various sources.

TABLE A–15E

Properties of air at 1 atm pressure

Temp. T, °F	Density ρ, lbm/ft^3	Specific Heat c_p, Btu/lbm·R	Thermal Conductivity k, Btu/h·ft·R	Thermal Diffusivity α, ft^2/s	Dynamic Viscosity μ, lbm/ft·s	Kinematic Viscosity ν, ft^2/s	Prandtl Number Pr
−300	0.24844	0.5072	0.00508	1.119×10^{-5}	4.039×10^{-6}	1.625×10^{-5}	1.4501
−200	0.15276	0.2247	0.00778	6.294×10^{-5}	6.772×10^{-6}	4.433×10^{-5}	0.7042
−100	0.11029	0.2360	0.01037	1.106×10^{-4}	9.042×10^{-6}	8.197×10^{-5}	0.7404
−50	0.09683	0.2389	0.01164	1.397×10^{-4}	1.006×10^{-5}	1.039×10^{-4}	0.7439
0	0.08630	0.2401	0.01288	1.726×10^{-4}	1.102×10^{-5}	1.278×10^{-4}	0.7403
10	0.08446	0.2402	0.01312	1.797×10^{-4}	1.121×10^{-5}	1.328×10^{-4}	0.7391
20	0.08270	0.2403	0.01336	1.868×10^{-4}	1.140×10^{-5}	1.379×10^{-4}	0.7378
30	0.08101	0.2403	0.01361	1.942×10^{-4}	1.158×10^{-5}	1.430×10^{-4}	0.7365
40	0.07939	0.2404	0.01385	2.016×10^{-4}	1.176×10^{-5}	1.482×10^{-4}	0.7350
50	0.07783	0.2404	0.01409	2.092×10^{-4}	1.194×10^{-5}	1.535×10^{-4}	0.7336
60	0.07633	0.2404	0.01433	2.169×10^{-4}	1.212×10^{-5}	1.588×10^{-4}	0.7321
70	0.07489	0.2404	0.01457	2.248×10^{-4}	1.230×10^{-5}	1.643×10^{-4}	0.7306
80	0.07350	0.2404	0.01481	2.328×10^{-4}	1.247×10^{-5}	1.697×10^{-4}	0.7290
90	0.07217	0.2404	0.01505	2.409×10^{-4}	1.265×10^{-5}	1.753×10^{-4}	0.7275
100	0.07088	0.2405	0.01529	2.491×10^{-4}	1.281×10^{-5}	1.809×10^{-4}	0.7260
110	0.06963	0.2405	0.01552	2.575×10^{-4}	1.299×10^{-5}	1.866×10^{-4}	0.7245
120	0.06843	0.2405	0.01576	2.660×10^{-4}	1.316×10^{-5}	1.923×10^{-4}	0.7230
130	0.06727	0.2405	0.01599	2.746×10^{-4}	1.332×10^{-5}	1.981×10^{-4}	0.7216
140	0.06615	0.2406	0.01623	2.833×10^{-4}	1.349×10^{-5}	2.040×10^{-4}	0.7202
150	0.06507	0.2406	0.01646	2.921×10^{-4}	1.365×10^{-5}	2.099×10^{-4}	0.7188
160	0.06402	0.2406	0.01669	3.010×10^{-4}	1.382×10^{-5}	2.159×10^{-4}	0.7174
170	0.06300	0.2407	0.01692	3.100×10^{-4}	1.398×10^{-5}	2.220×10^{-4}	0.7161
180	0.06201	0.2408	0.01715	3.191×10^{-4}	1.414×10^{-5}	2.281×10^{-4}	0.7148
190	0.06106	0.2408	0.01738	3.284×10^{-4}	1.430×10^{-5}	2.343×10^{-4}	0.7136
200	0.06013	0.2409	0.01761	3.377×10^{-4}	1.446×10^{-5}	2.406×10^{-4}	0.7124
250	0.05590	0.2415	0.01874	3.857×10^{-4}	1.524×10^{-5}	2.727×10^{-4}	0.7071
300	0.05222	0.2423	0.01985	4.358×10^{-4}	1.599×10^{-5}	3.063×10^{-4}	0.7028
350	0.04899	0.2433	0.02094	4.879×10^{-4}	1.672×10^{-5}	3.413×10^{-4}	0.6995
400	0.04614	0.2445	0.02200	5.419×10^{-4}	1.743×10^{-5}	3.777×10^{-4}	0.6971
450	0.04361	0.2458	0.02305	5.974×10^{-4}	1.812×10^{-5}	4.154×10^{-4}	0.6953
500	0.04134	0.2472	0.02408	6.546×10^{-4}	1.878×10^{-5}	4.544×10^{-4}	0.6942
600	0.03743	0.2503	0.02608	7.732×10^{-4}	2.007×10^{-5}	5.361×10^{-4}	0.6934
700	0.03421	0.2535	0.02800	8.970×10^{-4}	2.129×10^{-5}	6.225×10^{-4}	0.6940
800	0.03149	0.2568	0.02986	1.025×10^{-3}	2.247×10^{-5}	7.134×10^{-4}	0.6956
900	0.02917	0.2599	0.03164	1.158×10^{-3}	2.359×10^{-5}	8.087×10^{-4}	0.6978
1000	0.02718	0.2630	0.03336	1.296×10^{-3}	2.467×10^{-5}	9.080×10^{-4}	0.7004
1500	0.02024	0.2761	0.04106	2.041×10^{-3}	2.957×10^{-5}	1.460×10^{-3}	0.7158
2000	0.01613	0.2855	0.04752	2.867×10^{-3}	3.379×10^{-5}	2.095×10^{-3}	0.7308
2500	0.01340	0.2922	0.05309	3.765×10^{-3}	3.750×10^{-5}	2.798×10^{-3}	0.7432
3000	0.01147	0.2972	0.05811	4.737×10^{-3}	4.082×10^{-5}	3.560×10^{-3}	0.7516
3500	0.01002	0.3010	0.06293	5.797×10^{-3}	4.381×10^{-5}	4.373×10^{-3}	0.7543
4000	0.00889	0.3040	0.06789	6.975×10^{-3}	4.651×10^{-5}	5.229×10^{-3}	0.7497

Note: For ideal gases, the properties c_p, k, μ, and Pr are independent of pressure. The properties ρ, ν, and α at a pressure P (in atm) other than 1 atm are determined by multiplying the values of ρ at the given temperature by P and by dividing ν and α by P.

Source: Data generated from the EES software developed by S. A. Klein and F. L. Alvarado. Original sources: Keenan, Chao, Keyes, Gas Tables, Wiley, 1984; and *Thermophysical Properties of Matter*, Vol. 3: *Thermal Conductivity*, Y. S. Touloukian, P. E. Liley, S. C. Saxena, Vol. 11: *Viscosity*, Y. S. Touloukian, S. C. Saxena, and P. Hestermans, IFI/Plenun, NY, 1970, ISBN 0-306067020-8.

TABLE A–16E

Properties of gases at 1 atm pressure

Temp. T, °F	Density ρ, lbm/ft^3	Specific Heat c_p, Btu/lbm·R	Thermal Conductivity k, Btu/h·ft·R	Thermal Diffusivity α, ft^2/s	Dynamic Viscosity μ, lbm/ft·s	Kinematic Viscosity ν, ft^2/s	Prandtl Number Pr
			Carbon Dioxide, CO_2				
−50	0.14712	0.1797	0.00628	6.600×10^{-5}	7.739×10^{-6}	5.261×10^{-5}	0.7970
0	0.13111	0.1885	0.00758	8.522×10^{-5}	8.661×10^{-6}	6.606×10^{-5}	0.7751
50	0.11825	0.1965	0.00888	1.061×10^{-4}	9.564×10^{-6}	8.086×10^{-5}	0.7621
100	0.10769	0.2039	0.01017	1.286×10^{-4}	1.045×10^{-5}	9.703×10^{-5}	0.7543
200	0.09136	0.2171	0.01273	1.784×10^{-4}	1.217×10^{-5}	1.332×10^{-4}	0.7469
300	0.07934	0.2284	0.01528	2.341×10^{-4}	1.382×10^{-5}	1.743×10^{-4}	0.7445
500	0.06280	0.2473	0.02027	3.626×10^{-4}	1.696×10^{-5}	2.700×10^{-4}	0.7446
1000	0.04129	0.2796	0.03213	7.733×10^{-4}	2.381×10^{-5}	5.767×10^{-4}	0.7458
1500	0.03075	0.2995	0.04281	1.290×10^{-3}	2.956×10^{-5}	9.610×10^{-4}	0.7445
2000	0.02450	0.3124	0.05193	1.885×10^{-3}	3.451×10^{-5}	1.408×10^{-3}	0.7474
			Carbon Monoxide, CO				
−50	0.09363	0.2571	0.01118	1.290×10^{-4}	9.419×10^{-6}	1.005×10^{-4}	0.7798
0	0.08345	0.2523	0.01240	1.636×10^{-4}	1.036×10^{-5}	1.242×10^{-4}	0.7593
50	0.07526	0.2496	0.01359	2.009×10^{-4}	1.127×10^{-5}	1.498×10^{-4}	0.7454
100	0.06854	0.2484	0.01476	2.408×10^{-4}	1.214×10^{-5}	1.772×10^{-4}	0.7359
200	0.05815	0.2485	0.01702	3.273×10^{-4}	1.379×10^{-5}	2.372×10^{-4}	0.7247
300	0.05049	0.2505	0.01920	4.217×10^{-4}	1.531×10^{-5}	3.032×10^{-4}	0.7191
500	0.03997	0.2567	0.02331	6.311×10^{-4}	1.802×10^{-5}	4.508×10^{-4}	0.7143
1000	0.02628	0.2732	0.03243	1.254×10^{-3}	2.334×10^{-5}	8.881×10^{-4}	0.7078
1500	0.01957	0.2862	0.04049	2.008×10^{-3}	2.766×10^{-5}	1.413×10^{-3}	0.7038
2000	0.01559	0.2958	0.04822	2.903×10^{-3}	3.231×10^{-5}	2.072×10^{-3}	0.7136
			Methane, CH_4				
−50	0.05363	0.5335	0.01401	1.360×10^{-4}	5.861×10^{-6}	1.092×10^{-4}	0.8033
0	0.04779	0.5277	0.01616	1.780×10^{-4}	6.506×10^{-6}	1.361×10^{-4}	0.7649
50	0.04311	0.5320	0.01839	2.228×10^{-4}	7.133×10^{-6}	1.655×10^{-4}	0.7428
100	0.03925	0.5433	0.02071	2.698×10^{-4}	7.742×10^{-6}	1.972×10^{-4}	0.7311
200	0.03330	0.5784	0.02559	3.690×10^{-4}	8.906×10^{-6}	2.674×10^{-4}	0.7245
300	0.02892	0.6226	0.03077	4.748×10^{-4}	1.000×10^{-5}	3.457×10^{-4}	0.7283
500	0.02289	0.7194	0.04195	7.075×10^{-4}	1.200×10^{-5}	5.244×10^{-4}	0.7412
1000	0.01505	0.9438	0.07346	1.436×10^{-3}	1.620×10^{-5}	1.076×10^{-3}	0.7491
1500	0.01121	1.1162	0.10766	2.390×10^{-3}	1.974×10^{-5}	1.760×10^{-3}	0.7366
2000	0.00893	1.2419	0.14151	3.544×10^{-3}	2.327×10^{-5}	2.605×10^{-3}	0.7353
			Hydrogen, H_2				
−50	0.00674	3.0603	0.08246	1.110×10^{-3}	4.969×10^{-6}	7.373×10^{-4}	0.6638
0	0.00601	3.2508	0.09049	1.287×10^{-3}	5.381×10^{-6}	8.960×10^{-4}	0.6960
50	0.00542	3.3553	0.09818	1.500×10^{-3}	5.781×10^{-6}	1.067×10^{-3}	0.7112
100	0.00493	3.4118	0.10555	1.742×10^{-3}	6.167×10^{-6}	1.250×10^{-3}	0.7177
200	0.00419	3.4549	0.11946	2.295×10^{-3}	6.911×10^{-6}	1.652×10^{-3}	0.7197
300	0.00363	3.4613	0.13241	2.924×10^{-3}	7.622×10^{-6}	2.098×10^{-3}	0.7174
500	0.00288	3.4572	0.15620	4.363×10^{-3}	8.967×10^{-6}	3.117×10^{-3}	0.7146
1000	0.00189	3.5127	0.20989	8.776×10^{-3}	1.201×10^{-5}	6.354×10^{-3}	0.7241
1500	0.00141	3.6317	0.26381	1.432×10^{-2}	1.477×10^{-5}	1.048×10^{-2}	0.7323
2000	0.00112	3.7656	0.31923	2.098×10^{-2}	1.734×10^{-5}	1.544×10^{-2}	0.7362
			Nitrogen, N_2				
−50	0.09364	0.2320	0.01176	1.504×10^{-4}	9.500×10^{-6}	1.014×10^{-4}	0.6746
0	0.08346	0.2441	0.01300	1.773×10^{-4}	1.043×10^{-5}	1.251×10^{-4}	0.7056
50	0.07527	0.2480	0.01420	2.113×10^{-4}	1.134×10^{-5}	1.507×10^{-4}	0.7133

TABLE A–16E

Properties of gases at 1 atm pressure *(Concluded)*

Temp. T, °F	Density ρ, lbm/ft^3	Specific Heat c_p, Btu/lbm·R	Thermal Conductivity k, Btu/h·ft·R	Thermal Diffusivity α, ft^2/s	Dynamic Viscosity μ, lbm/ft·s	Kinematic Viscosity ν, ft^2/s	Prandtl Number Pr
100	0.06854	0.2489	0.01537	2.502×10^{-4}	1.221×10^{-5}	1.783×10^{-4}	0.7126
200	0.05815	0.2487	0.01760	3.379×10^{-4}	1.388×10^{-5}	2.387×10^{-4}	0.7062
300	0.05050	0.2492	0.01970	4.349×10^{-4}	1.543×10^{-5}	3.055×10^{-4}	0.7025
500	0.03997	0.2535	0.02359	6.466×10^{-4}	1.823×10^{-5}	4.559×10^{-4}	0.7051
1000	0.02628	0.2697	0.03204	1.255×10^{-3}	2.387×10^{-5}	9.083×10^{-4}	0.7232
1500	0.01958	0.2831	0.04002	2.006×10^{-3}	2.829×10^{-5}	1.445×10^{-3}	0.7202
2000	0.01560	0.2927	0.04918	2.992×10^{-3}	3.212×10^{-5}	2.059×10^{-3}	0.6882
				Oxygen, O_2			
−50	0.10697	0.2331	0.01216	1.355×10^{-4}	1.104×10^{-5}	1.032×10^{-4}	0.7622
0	0.09533	0.2245	0.01346	1.747×10^{-4}	1.218×10^{-5}	1.277×10^{-4}	0.7312
50	0.08598	0.2209	0.01475	2.157×10^{-4}	1.326×10^{-5}	1.543×10^{-4}	0.7152
100	0.07830	0.2200	0.01601	2.582×10^{-4}	1.429×10^{-5}	1.826×10^{-4}	0.7072
200	0.06643	0.2221	0.01851	3.484×10^{-4}	1.625×10^{-5}	2.446×10^{-4}	0.7020
300	0.05768	0.2262	0.02096	4.463×10^{-4}	1.806×10^{-5}	3.132×10^{-4}	0.7018
500	0.04566	0.2352	0.02577	6.665×10^{-4}	2.139×10^{-5}	4.685×10^{-4}	0.7029
1000	0.03002	0.2520	0.03698	1.357×10^{-3}	2.855×10^{-5}	9.509×10^{-4}	0.7005
1500	0.02236	0.2626	0.04701	2.224×10^{-3}	3.474×10^{-5}	1.553×10^{-3}	0.6985
2000	0.01782	0.2701	0.05614	3.241×10^{-3}	4.035×10^{-5}	2.265×10^{-3}	0.6988
				Water Vapor, H_2O			
−50	0.06022	0.4512	0.00797	8.153×10^{-5}	4.933×10^{-6}	8.192×10^{-5}	1.0050
0	0.05367	0.4484	0.00898	1.036×10^{-4}	5.592×10^{-6}	1.041×10^{-4}	1.0049
50	0.04841	0.4472	0.01006	1.291×10^{-4}	6.261×10^{-6}	1.293×10^{-4}	1.0018
100	0.04408	0.4473	0.01121	1.579×10^{-4}	6.942×10^{-6}	1.574×10^{-4}	0.9969
200	0.03740	0.4503	0.01372	2.263×10^{-4}	8.333×10^{-6}	2.228×10^{-4}	0.9845
300	0.03248	0.4557	0.01648	3.093×10^{-4}	9.756×10^{-6}	3.004×10^{-4}	0.9713
500	0.02571	0.4707	0.02267	5.204×10^{-4}	1.267×10^{-5}	4.931×10^{-4}	0.9475
1000	0.01690	0.5167	0.04134	1.314×10^{-3}	2.014×10^{-5}	1.191×10^{-3}	0.9063
1500	0.01259	0.5625	0.06315	2.477×10^{-3}	2.742×10^{-5}	2.178×10^{-3}	0.8793
2000	0.01003	0.6034	0.08681	3.984×10^{-3}	3.422×10^{-5}	3.411×10^{-3}	0.8563

Note: For ideal gases, the properties c_p, k, μ, and Pr are independent of pressure. The properties ρ, ν, and α at a pressure P (in atm) other than 1 atm are determined by multiplying the values of ρ at the given temperature by P and by dividing ν and α by P.

Source: Data generated from the EES software developed by S. A. Klein and F. L. Alvarado. Originally based on various sources.

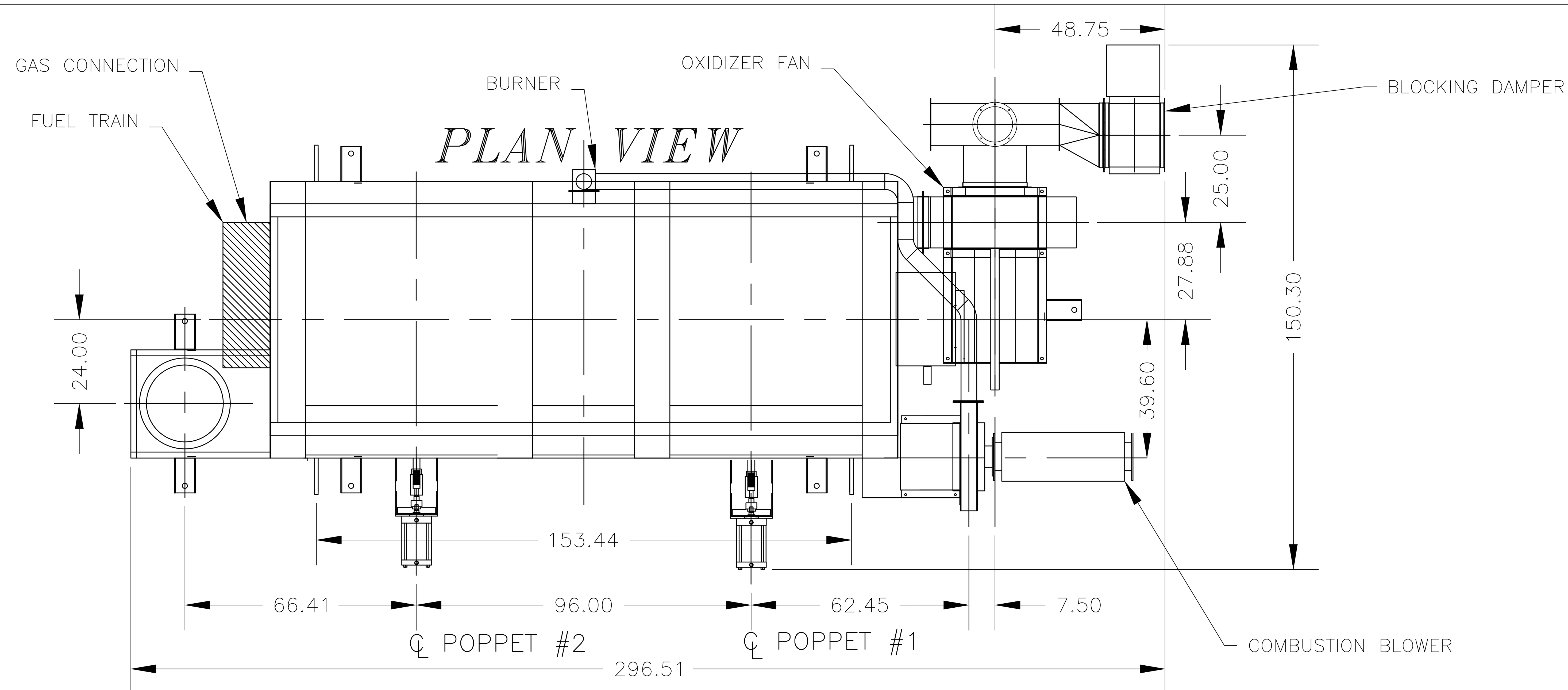
TABLE A–17E

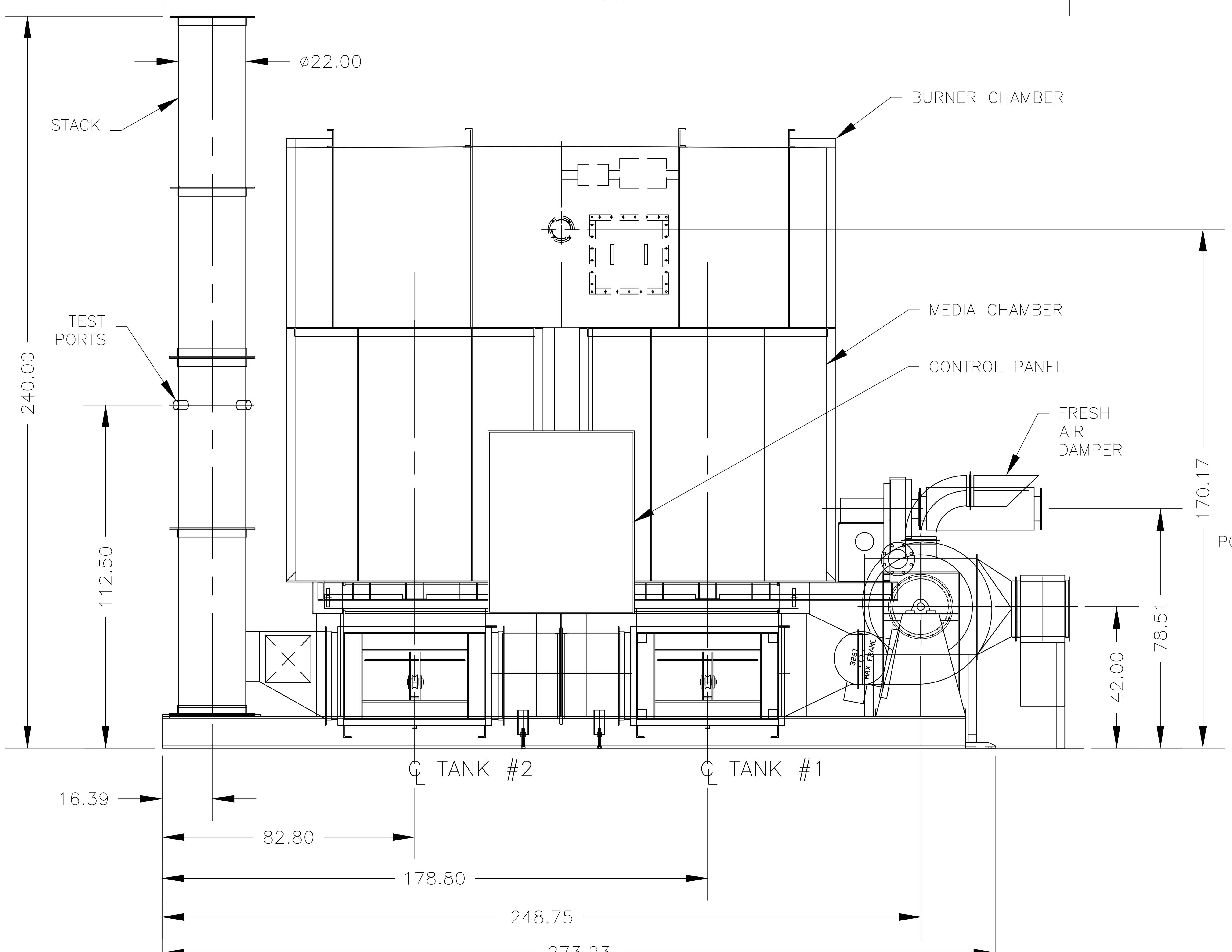
Properties of the atmosphere at high altitude

Altitude, z, ft	Temperature T, °F	Pressure, P, psia	Gravity g, ft/s^2	Speed of Sound c, ft/s	Density ρ, lbm/ft^3	Viscosity μ, lbm/ft·s	Thermal Conductivity, k, Btu/h·ft·R
0	59.00	14.7	32.174	1116	0.07647	1.202×10^{-5}	0.0146
500	57.22	14.4	32.173	1115	0.07536	1.199×10^{-5}	0.0146
1000	55.43	14.2	32.171	1113	0.07426	1.196×10^{-5}	0.0146
1500	53.65	13.9	32.169	1111	0.07317	1.193×10^{-5}	0.0145
2000	51.87	13.7	32.168	1109	0.07210	1.190×10^{-5}	0.0145
2500	50.09	13.4	32.166	1107	0.07104	1.186×10^{-5}	0.0144
3000	48.30	13.2	32.165	1105	0.06998	1.183×10^{-5}	0.0144
3500	46.52	12.9	32.163	1103	0.06985	1.180×10^{-5}	0.0143
4000	44.74	12.7	32.162	1101	0.06792	1.177×10^{-5}	0.0143
4500	42.96	12.5	32.160	1099	0.06690	1.173×10^{-5}	0.0142
5000	41.17	12.2	32.159	1097	0.06590	1.170×10^{-5}	0.0142
5500	39.39	12.0	32.157	1095	0.06491	1.167×10^{-5}	0.0141
6000	37.61	11.8	32.156	1093	0.06393	1.164×10^{-5}	0.0141
6500	35.83	11.6	32.154	1091	0.06296	1.160×10^{-5}	0.0141
7000	34.05	11.3	32.152	1089	0.06200	1.157×10^{-5}	0.0140
7500	32.26	11.1	32.151	1087	0.06105	1.154×10^{-5}	0.0140
8000	30.48	10.9	32.149	1085	0.06012	1.150×10^{-5}	0.0139
8500	28.70	10.7	32.148	1083	0.05919	1.147×10^{-5}	0.0139
9000	26.92	10.5	32.146	1081	0.05828	1.144×10^{-5}	0.0138
9500	25.14	10.3	32.145	1079	0.05738	1.140×10^{-5}	0.0138
10,000	23.36	10.1	32.145	1077	0.05648	1.137×10^{-5}	0.0137
11,000	19.79	9.72	32.140	1073	0.05473	1.130×10^{-5}	0.0136
12,000	16.23	9.34	32.137	1069	0.05302	1.124×10^{-5}	0.0136
13,000	12.67	8.99	32.134	1065	0.05135	1.117×10^{-5}	0.0135
14,000	9.12	8.63	32.131	1061	0.04973	1.110×10^{-5}	0.0134
15,000	5.55	8.29	32.128	1057	0.04814	1.104×10^{-5}	0.0133
16,000	+1.99	7.97	32.125	1053	0.04659	1.097×10^{-5}	0.0132
17,000	−1.58	7.65	32.122	1049	0.04508	1.090×10^{-5}	0.0132
18,000	−5.14	7.34	32.119	1045	0.04361	1.083×10^{-5}	0.0130
19,000	−8.70	7.05	32.115	1041	0.04217	1.076×10^{-5}	0.0129
20,000	−12.2	6.76	32.112	1037	0.04077	1.070×10^{-5}	0.0128
22,000	−19.4	6.21	32.106	1029	0.03808	1.056×10^{-5}	0.0126
24,000	−26.5	5.70	32.100	1020	0.03553	1.042×10^{-5}	0.0124
26,000	−33.6	5.22	32.094	1012	0.03311	1.028×10^{-5}	0.0122
28,000	−40.7	4.78	32.088	1003	0.03082	1.014×10^{-5}	0.0121
30,000	−47.8	4.37	32.082	995	0.02866	1.000×10^{-5}	0.0119
32,000	−54.9	3.99	32.08	987	0.02661	0.986×10^{-5}	0.0117
34,000	−62.0	3.63	32.07	978	0.02468	0.971×10^{-5}	0.0115
36,000	−69.2	3.30	32.06	969	0.02285	0.956×10^{-5}	0.0113
38,000	−69.7	3.05	32.06	968	0.02079	0.955×10^{-5}	0.0113
40,000	−69.7	2.73	32.05	968	0.01890	0.955×10^{-5}	0.0113
45,000	−69.7	2.148	32.04	968	0.01487	0.955×10^{-5}	0.0113
50,000	−69.7	1.691	32.02	968	0.01171	0.955×10^{-5}	0.0113
55.000	−69.7	1.332	32.00	968	0.00922	0.955×10^{-5}	0.0113
60,000	−69.7	1.048	31.99	968	0.00726	0.955×10^{-5}	0.0113

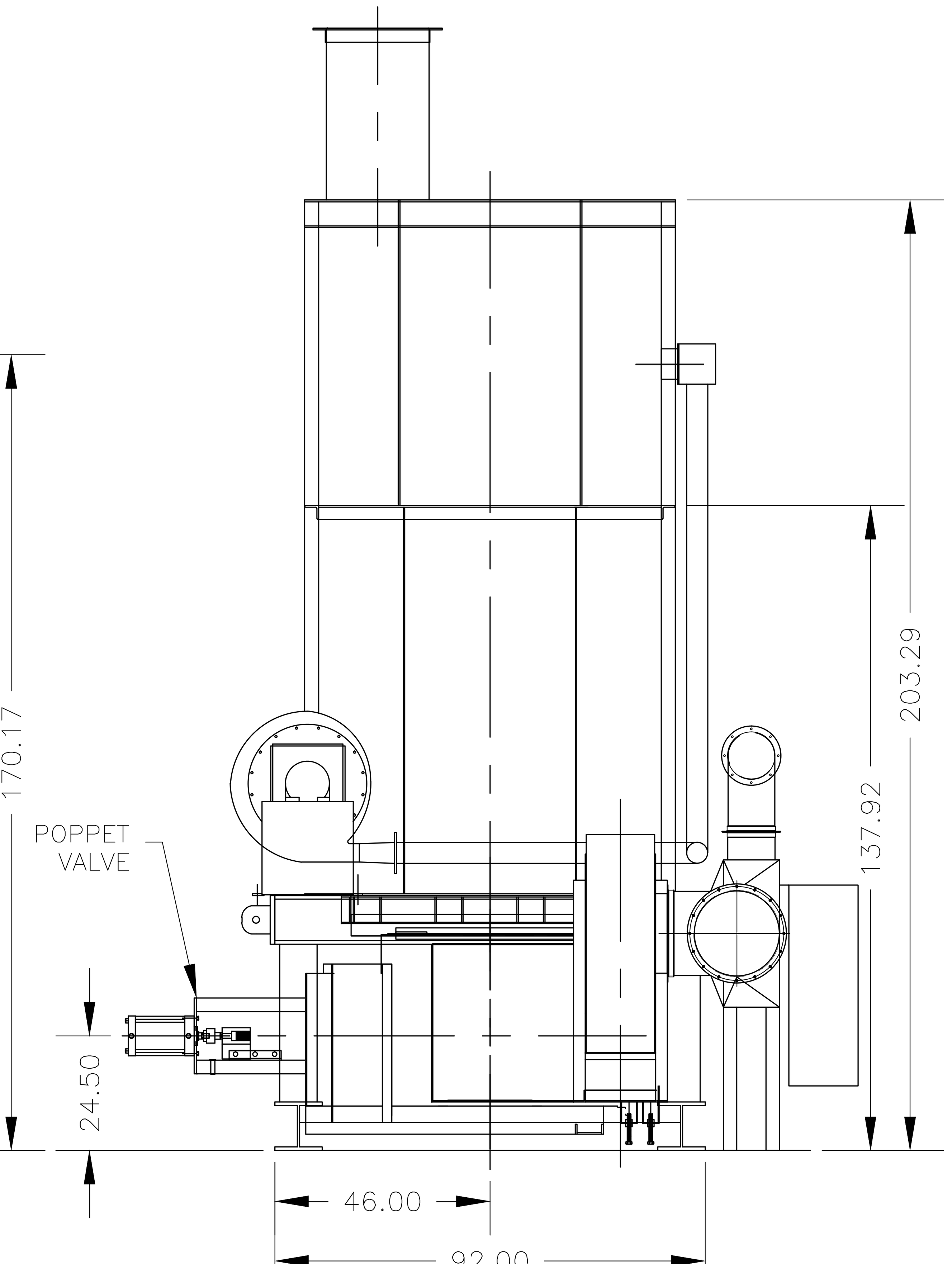
Source: U. S. Standard Atmosphere Supplements, U.S. Government Printing Office, 1966. Based on year-round mean conditions at 45° latitude and varies with the time of the year and the weather patterns. The conditions at sea level (z = D) are taken to be P = 14.696 psia, T = 59 °F, ρ = 0.076474 lbm/ft^3, g = 32.1741 ft^2/s.

Rev	Date	By	Description
.			





FRONT ELEVATION



SIDE ELEVATION

SUPPLIED BY CYCLETHERM:

(2) ENERGY RECOVERY CHAMBERS
(1) BURNER CHAMBER (CROSSOVER)
(2) TWO CYCLE POPPET VALVE
(1) RTO BURNER
(1) OXIDIZER FAN
(1) RTO GAS TRAIN
(1) FRESH AIR INTAKE/PURGE DAMPER
(1) BLOCKING DAMPER
(1) COMPRESSED AIR RESERVIOR
(1) ELECTRICAL CONTROL PANEL
(1) COMBUSTION BLOWER
(2) TEST PORTS ON STACK
(1) COMBUSTION AIR PIPING
(1) STACK ø22.00 X 20' TALL

WEIGHTS: (ESTIMATES)
ASSEMBLED UNIT – 40,000 LBS.
BASE UNIT – 20,000 LBS
CROSSOVER – 6000 LBS

OXIDIZER UTILITIES:
GAS:
TYPE – NATURAL
MAXIMUM FLOW – 600 CFH RTO
INLET PRESSURE : 5.0 PSIG AT GAS TRAIN
GAS SUPPLY CONNECTION – 1.0 NPT

ELECTRICAL: (SEE ELEC. PRINTS FOR COMPLETE DETAILS)
VOLTS – 460, HERTZ – 60, PHASE – 3

COMPRESSED AIR:
AIR PRESSURE : 70–100 PSIG
DEWPOINT : –40°F
FLOW : 18 CFH

SUPPLIED BY CUSTOMER:
1. ANY PERMITS TO OPERATE, CONSTRUCT OR INSTALL.
2. SUPPLY ELECTRICAL POWER TO RTO CONTROL PANEL.
3. ALL ROOF PENETRATIONS, ROOF JACKS AND FLASHINGS.
4. SUPPLY NATURAL GAS TO OXIDIZER LOCATION.
5. SUPPLY COMPRESSED AIR TO OXIDIZER LOCATION.
6. DUCTWORK FROM PROCESS TO BLOCKING DAMPER.

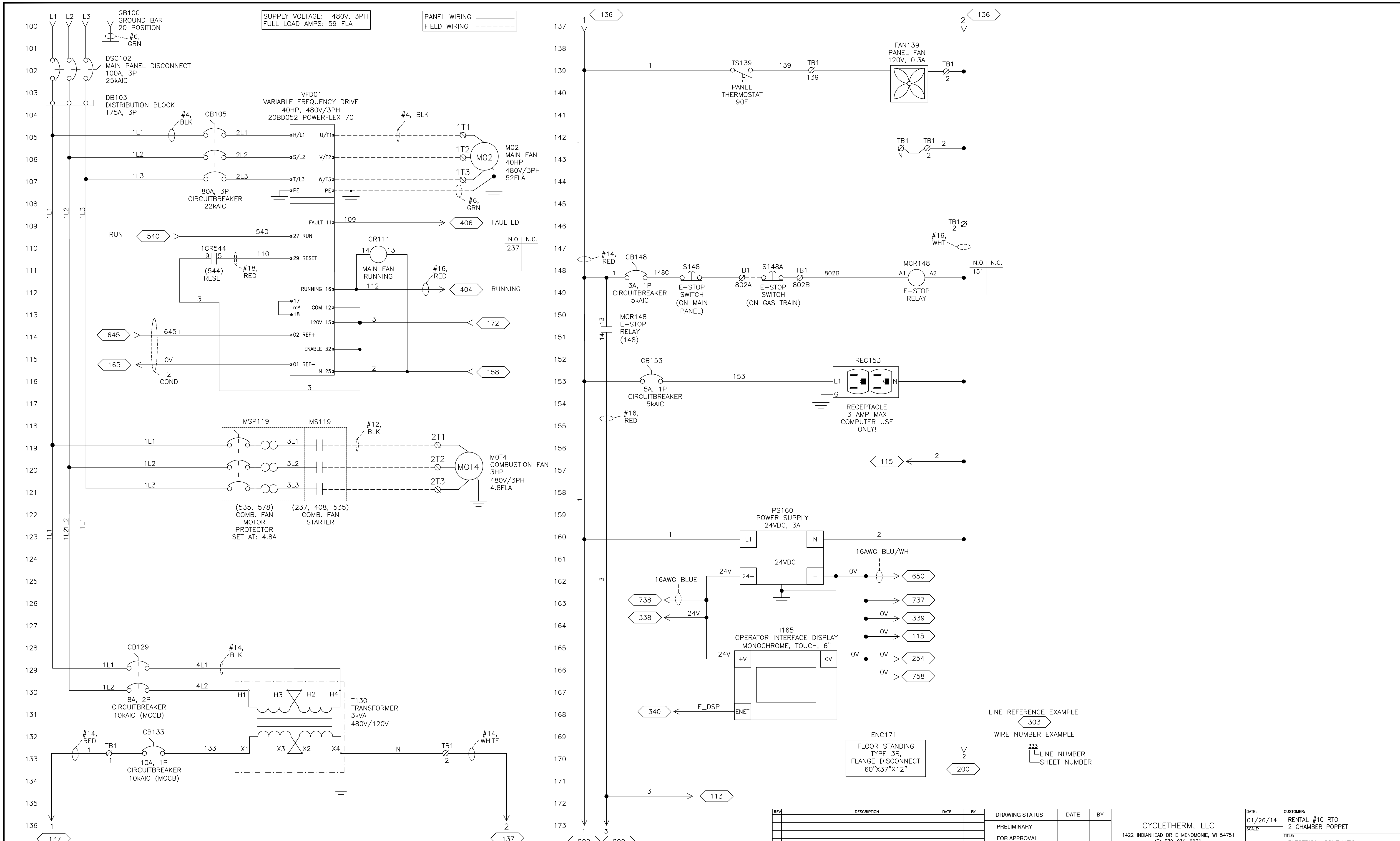
Cycle Therm
1422 Indianhead Drive East
Menomonie, WI 54751

CONFIDENTIAL

Title: GENERAL ARRANGEMENT MODEL 592 RTO

CEC, INC — REFERENCE 1139-06-100

Dwn By: SAL	Date: 1/31/14	Dwg No.: CT-N-14-1488-002	
Ch'd By: JS	Date: 1/31/14		
Ref:	Dwg Scale: NTS		
Filename: –	Plot Scale:	SHEET 1 OF 1	0



REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

	DRAWING STATUS	DATE	BY
	PRELIMINARY		
	FOR APPROVAL		
.	APPROVED FOR FAB	01/26/14	MEE
X	AS BUILT	01/31/14	MFK
	AS FIELD MODIFIED		

CYCLETHERM, LLC
1422 INDIANHEAD DR E MENOMONIE, WI 54751
(T) 570-839-8836
(F) 570-839-8837

MATERIAL: SEE BOM

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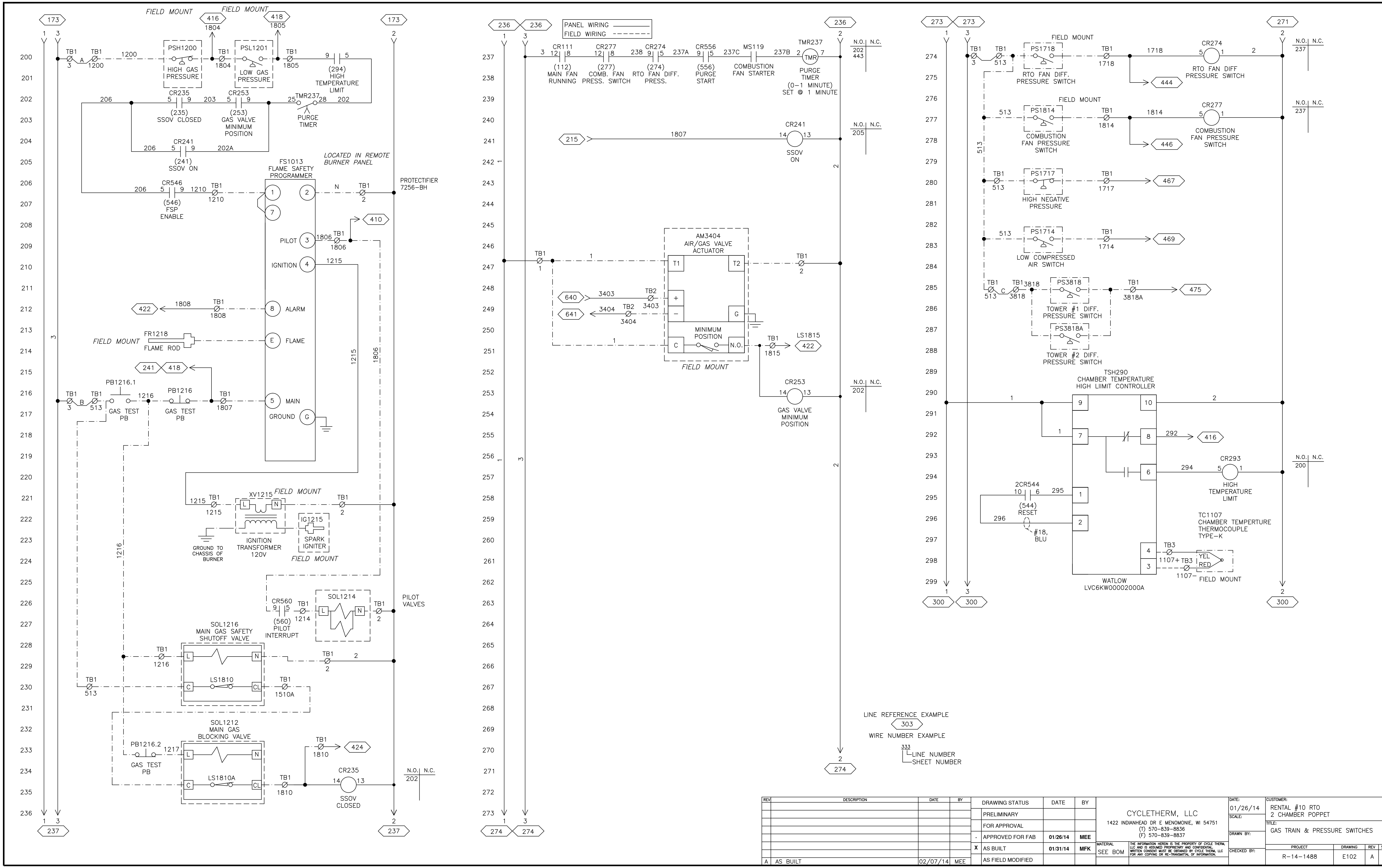
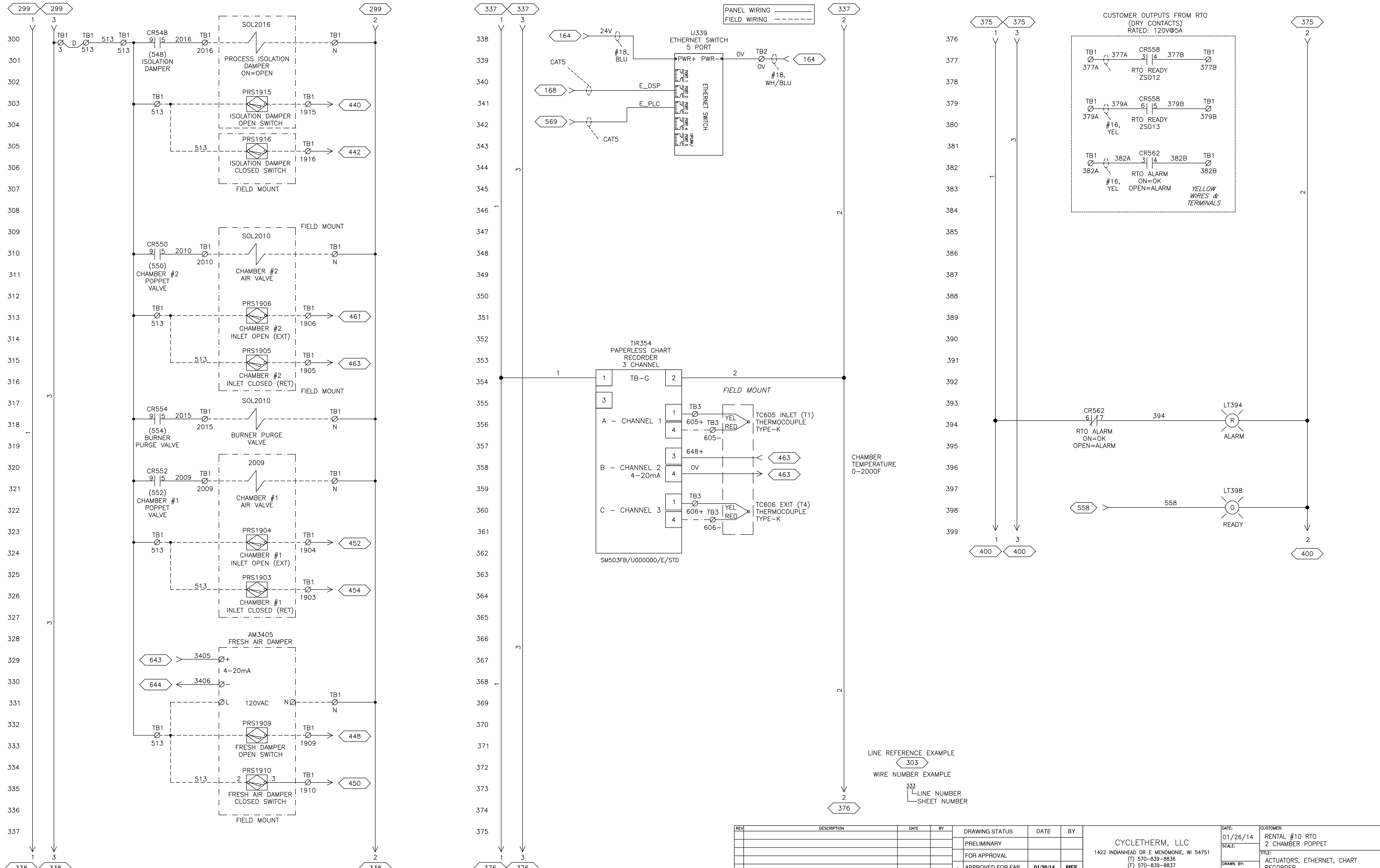
DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:

CUSTOMER: RENTAL #10 RTO 2 CHAMBER POPPET

TITLE: ELECTRICAL SCHEMATIC POWER, MOTOR, CONTROL POWER

PROJECT	DRAWING	REV	SIZE
R-14-1488	E101	A	B


FIELD MOUNT
PSH1200
HIGH GAS PRESSURE
PSL1201
LOW GAS PRESSURE
(294) HIGH TEMPERATURE LIMIT
CR235
(235) SSOV CLOSED
CR253
(253) GAS VALVE MINIMUM POSITION
TMR237
PURGE TIMER
CR241
(241) SSOV ON
LOCATED IN REMOTE BURNER PANEL
FS1013
FLAME SAFETY PROGRAMMER
PROTECTIFIER 7256-BH
CR546
(546) FSP ENABLE
PILOT
IGNITION
ALARM
FR1218
FLAME ROD
FLAME
PB1216.1
GAS TEST PB
PB1216
MAIN
GROUND
XV1215
IGNITION TRANSFORMER 120V
GROUND TO CHASSIS OF BURNER
IG1215
SPARK IGNITER
CR560
(560) PILOT INTERRUPT
SOL1214
PILOT VALVES
SOL1216
MAIN GAS SAFETY SHUTOFF VALVE
LS1810
SOL1212
MAIN GAS BLOCKING VALVE
PB1216.2
LS1810A
SSOV CLOSED
PANEL WIRING
FIELD WIRING
CR111
(112) MAIN FAN RUNNING
CR277
(277) COMB. FAN PRESS. SWITCH
CR274
(274) RTO FAN DIFF. PRESS.
CR556
(556) PURGE START
MS119
COMBUSTION FAN STARTER
TMR237
PURGE TIMER (0-1 MINUTE) SET @ 1 MINUTE
CR241
SSOV ON
AM3404
AIR/GAS VALVE ACTUATOR
MINIMUM POSITION
LS1815
CR253
GAS VALVE MINIMUM POSITION
PS1718
RTO FAN DIFF. PRESSURE SWITCH
CR274
RTO FAN DIFF PRESSURE SWITCH
PS1814
COMBUSTION FAN PRESSURE SWITCH
CR277
COMBUSTION FAN PRESSURE SWITCH
PS1717
HIGH NEGATIVE PRESSURE
PS1714
LOW COMPRESSED AIR SWITCH
PS3818
TOWER #1 DIFF. PRESSURE SWITCH
PS3818A
TOWER #2 DIFF. PRESSURE SWITCH
TSH290
CHAMBER TEMPERATURE HIGH LIIMIT CONTROLLER
2CR544
(544) RESET
#18, BLU
CR293
HIGH TEMPERATURE LIMIT
TC1107
CHAMBER TEMPERTURE THERMOCOUPLE TYPE-K
YEL
RED
WATLOW
LVC6KW00002000A
LINE REFERENCE EXAMPLE
303
WIRE NUMBER EXAMPLE
333
LINE NUMBER
SHEET NUMBER
REV
DESCRIPTION
DATE
BY
A
AS BUILT
02/07/14
MEE
DRAWING STATUS
PRELIMINARY
FOR APPROVAL
APPROVED FOR FAB 01/26/14 MEE
X AS BUILT 01/31/14 MFK
AS FIELD MODIFIED
CYCLETHERM, LLC
1422 INDIANHEAD DR E MENOMONIE, WI 54751
(T) 570-839-8836
(F) 570-839-8837
MATERIAL SEE BOM
DATE: 01/26/14
CUSTOMER: RENTAL #10 RTO 2 CHAMBER POPPET
TITLE: GAS TRAIN & PRESSURE SWITCHES
PROJECT R-14-1488
DRAWING E102
REV A
SIZE B



REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

DRAWING STATUS	DATE	BY
PRELIMINARY		
FOR APPROVAL		
APPROVED FOR FAB	01/26/14	MEE
X AS BUILT	01/31/14	MFK
AS FIELD MODIFIED		

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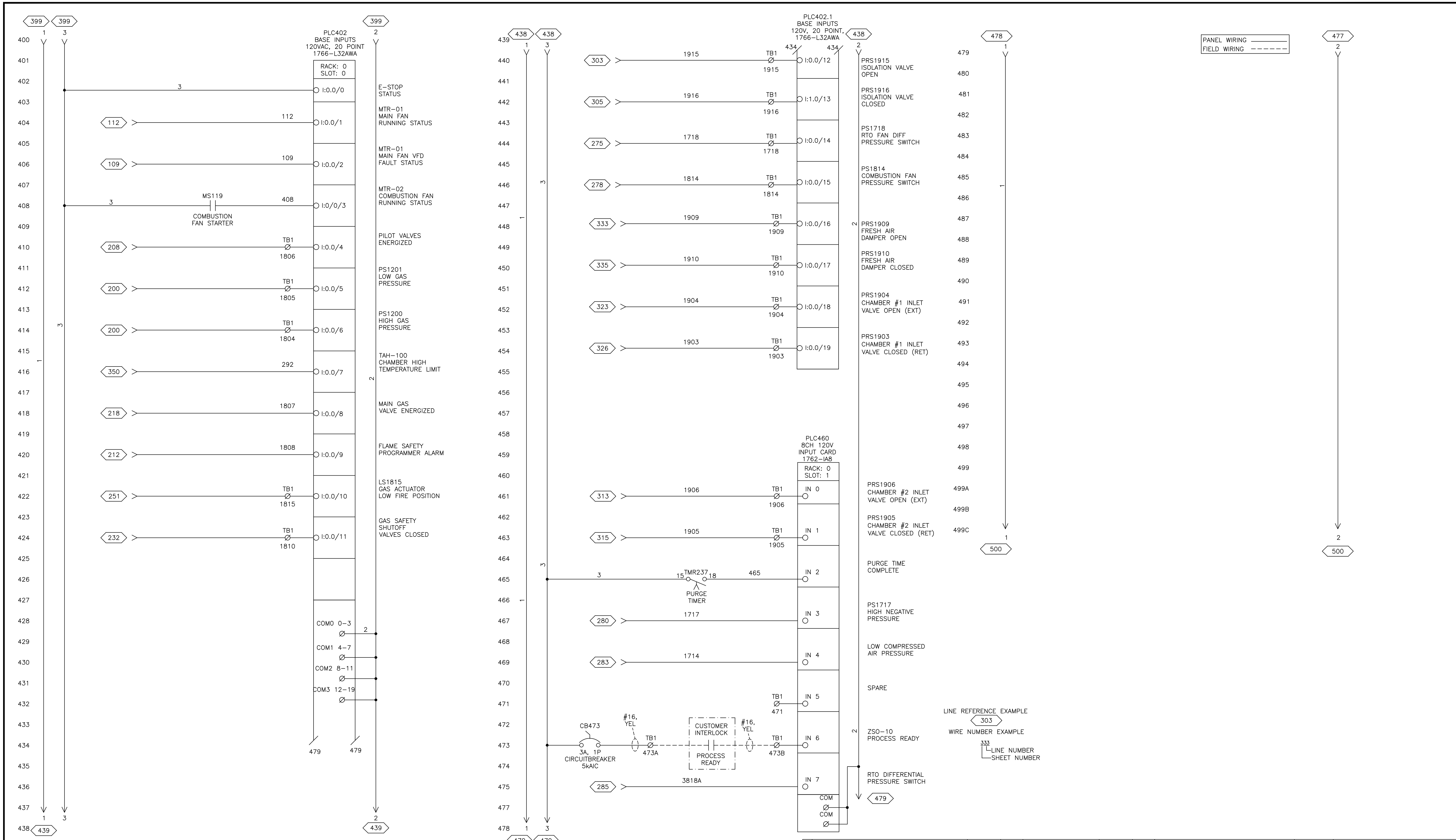
MATERIAL: SEE BOM

DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:

CUSTOMER: RENTAL #10 RTO 2 CHAMBER POPPET

TITLE: ACTUATORS, ETHERNET, CHART RECORDER

PROJECT	DRAWING	REV	SIZE
R-14-1488	E103	A	B



REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

	DRAWING STATUS	DATE	BY
	PRELIMINARY		
	FOR APPROVAL		
.	APPROVED FOR FAB	01/26/14	MEE
X	AS BUILT	01/31/14	MFK
	AS FIELD MODIFIED		

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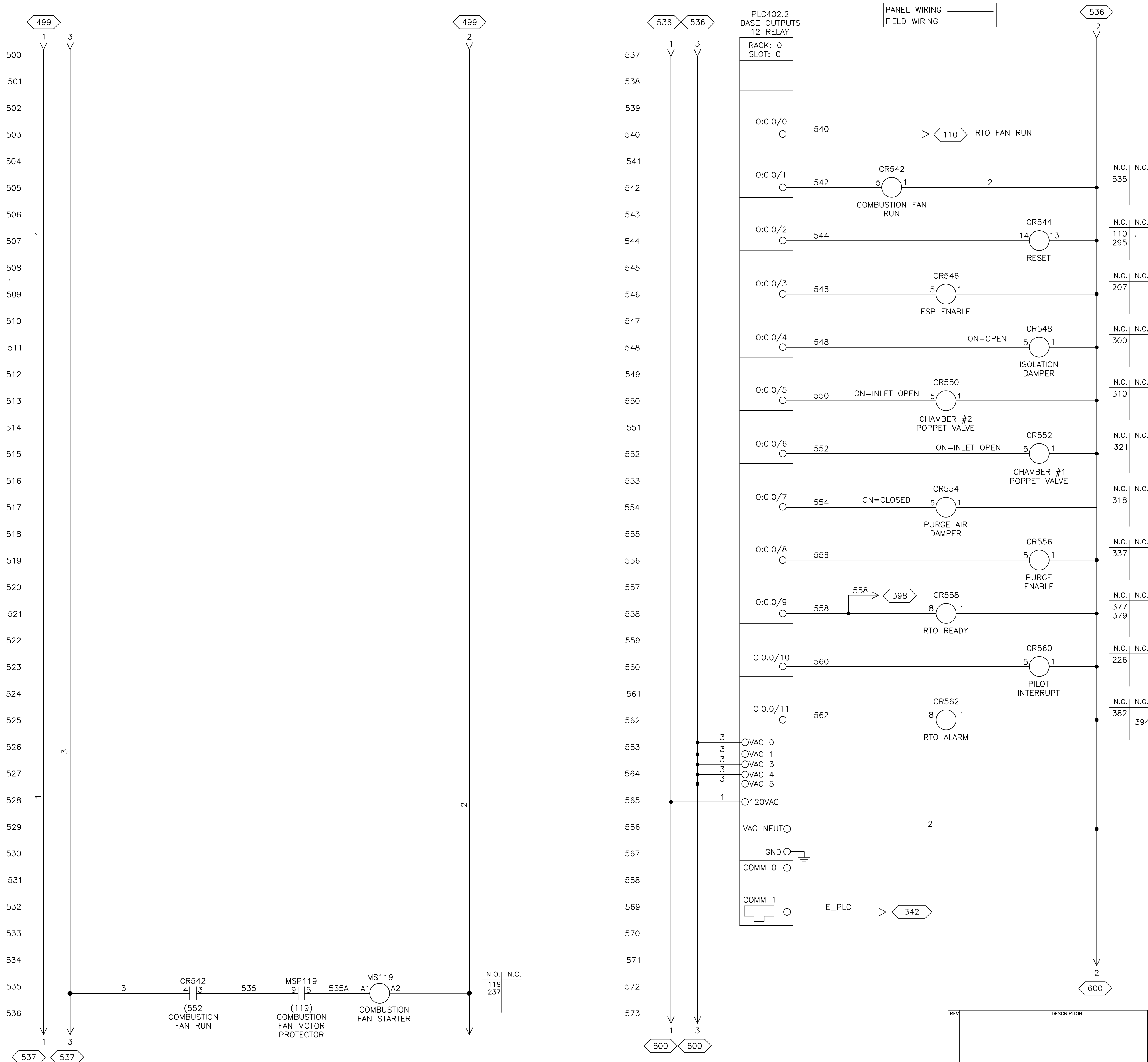
MATERIAL: SEE BOM

DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:
CUSTOMER: RENTAL #10 RTO 2 CHAMBER POPPET
TITLE: PLC DISCRETE INPUTS

PROJECT	DRAWING	REV	SIZE
R–14–1488	E104	A	B



LINE REFERENCE EXAMPLE

303

WIRE NUMBER EXAMPLE

333
LINE NUMBER
SHEET NUMBER

REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

DRAWING STATUS	DATE	BY
PRELIMINARY		
FOR APPROVAL		
APPROVED FOR FAB	01/26/14	MEE
X AS BUILT	01/31/14	MFK
AS FIELD MODIFIED		

CYCLETHERM, LLC
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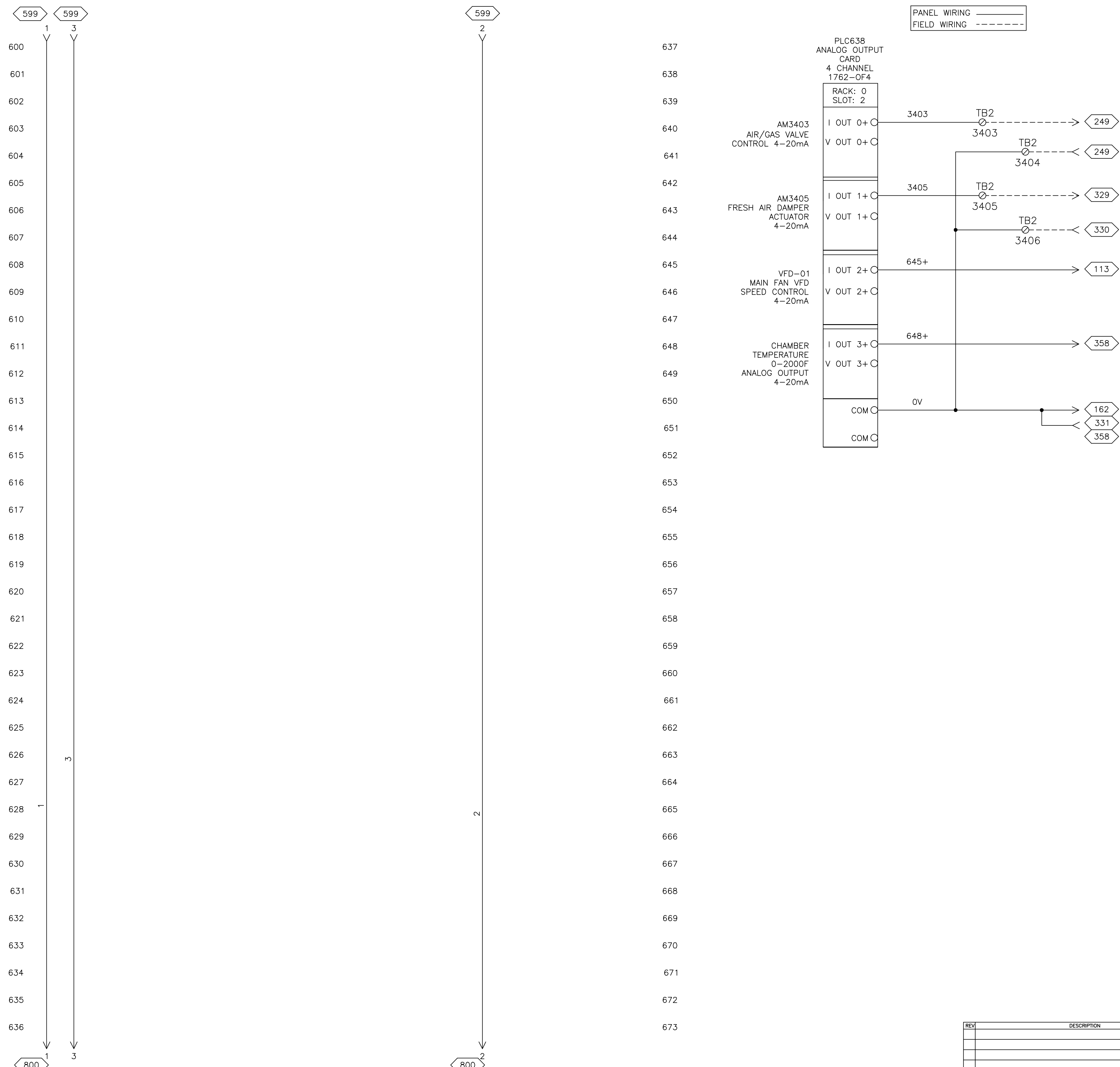
MATERIAL: SEE BOM

DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:

CUSTOMER: RENTAL #10 RTO 2 CHAMBER POPPET
TITLE: PLC DISCRETE OUTPUTS

PROJECT	DRAWING	REV	SIZE
R-14-1488	E105	A	B



REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

	DRAWING STATUS	DATE	BY
	PRELIMINARY		
	FOR APPROVAL		
.	APPROVED FOR FAB	01/26/14	MEE
X	AS BUILT	01/31/14	MFK
	AS FIELD MODIFIED		

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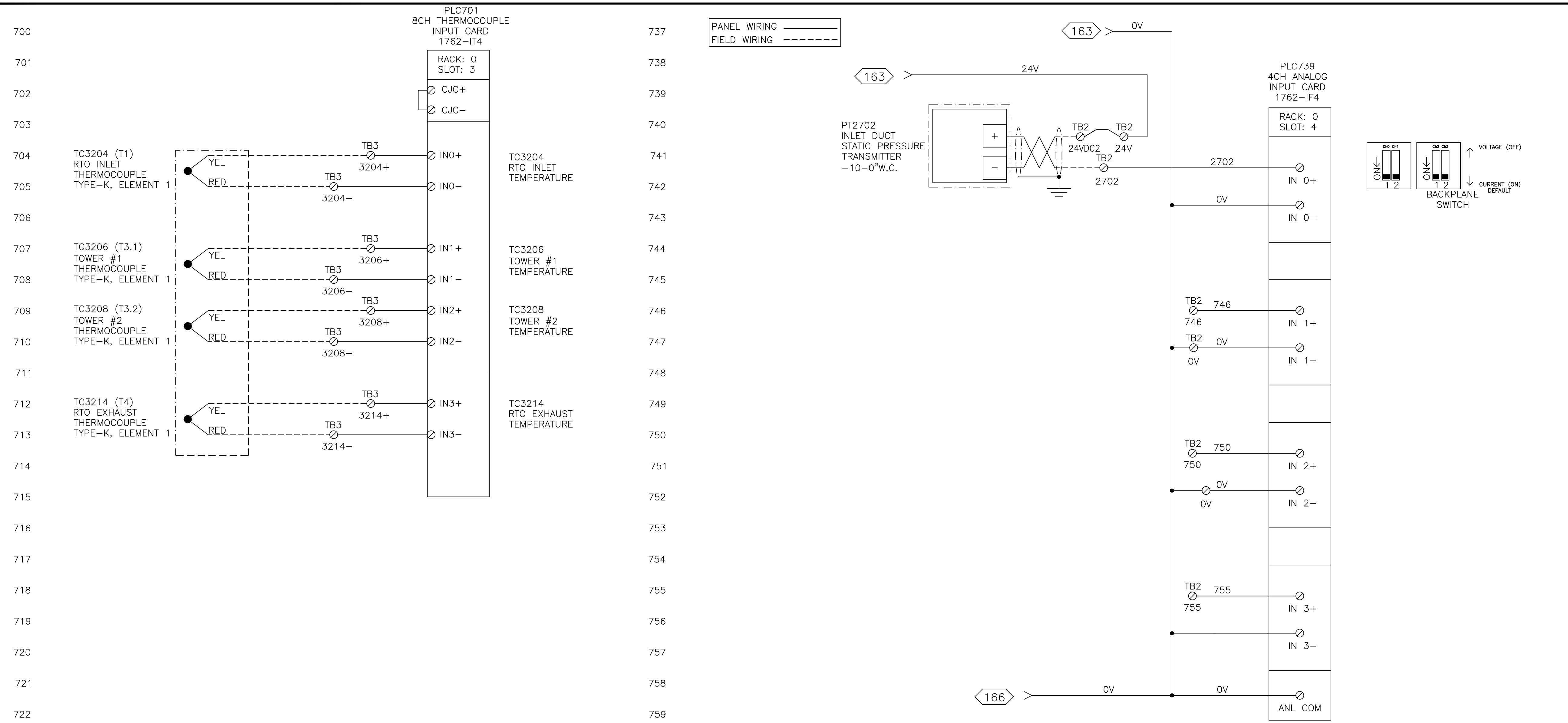
DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:

CUSTOMER: RENTAL #10 RTO
2 CHAMBER POPPET

TITLE: PLC ANALOG OUTPUTS

PROJECT	DRAWING	REV	SIZE
R-14-1488	E106	A	B



REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

	DRAWING STATUS	DATE	BY
	PRELIMINARY		
	FOR APPROVAL		
·	APPROVED FOR FAB	01/26/14	MEE
X	AS BUILT	01/31/14	MFK
	AS FIELD MODIFIED		

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(F) 570–839–8837

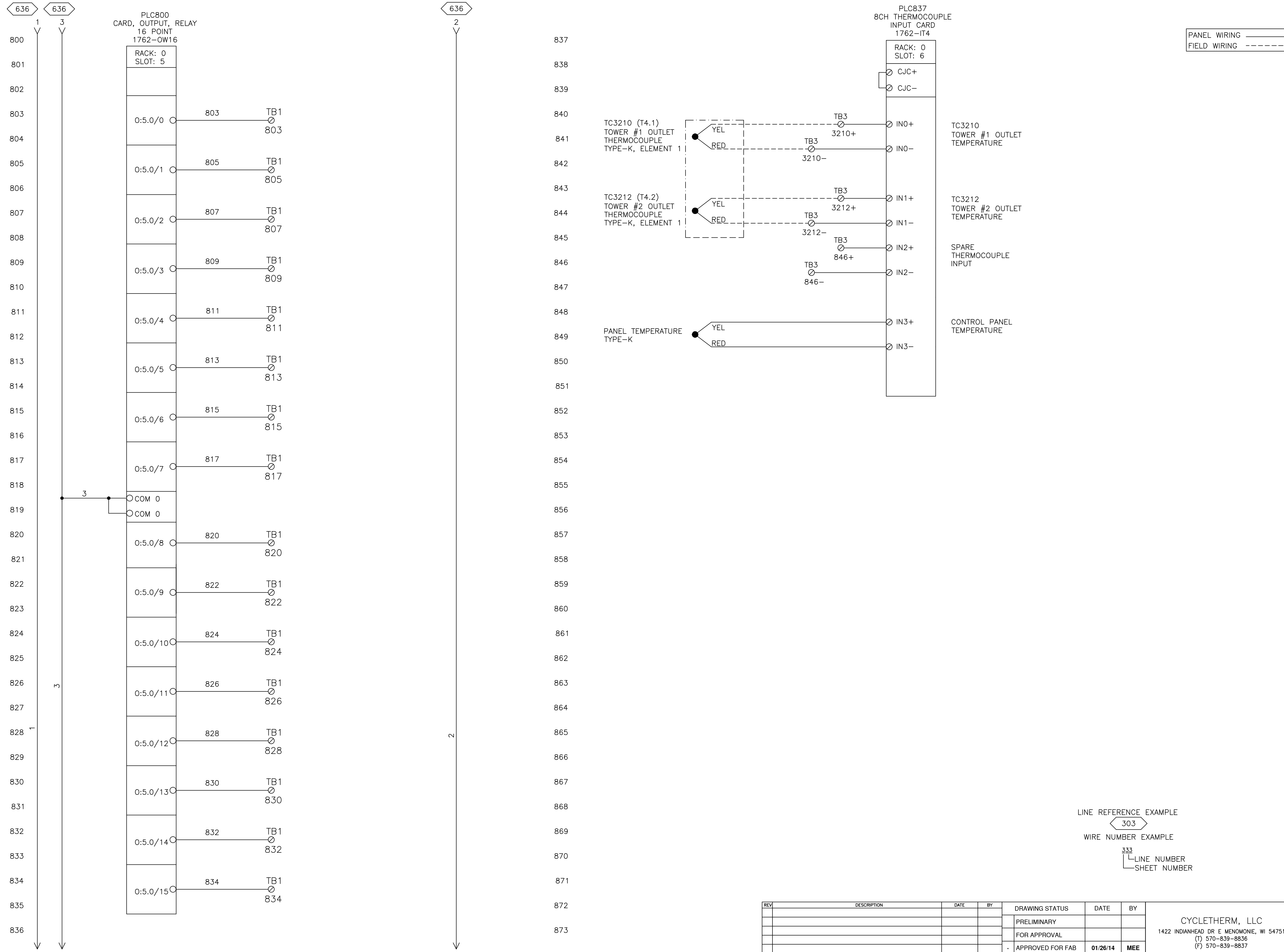
MATERIAL: SEE BOM

DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:

CUSTOMER: RENTAL #10 RTO
2 CHAMBER POPPET

TITLE: PLC THERMOCOUPLE & ANALOG INPUTS

PROJECT	DRAWING	REV	SIZE
R–14–1488	E107	A	B



REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

	DRAWING STATUS	DATE	BY
	PRELIMINARY		
	FOR APPROVAL		
.	APPROVED FOR FAB	01/26/14	MEE
X	AS BUILT	01/31/14	MFK
	AS FIELD MODIFIED		

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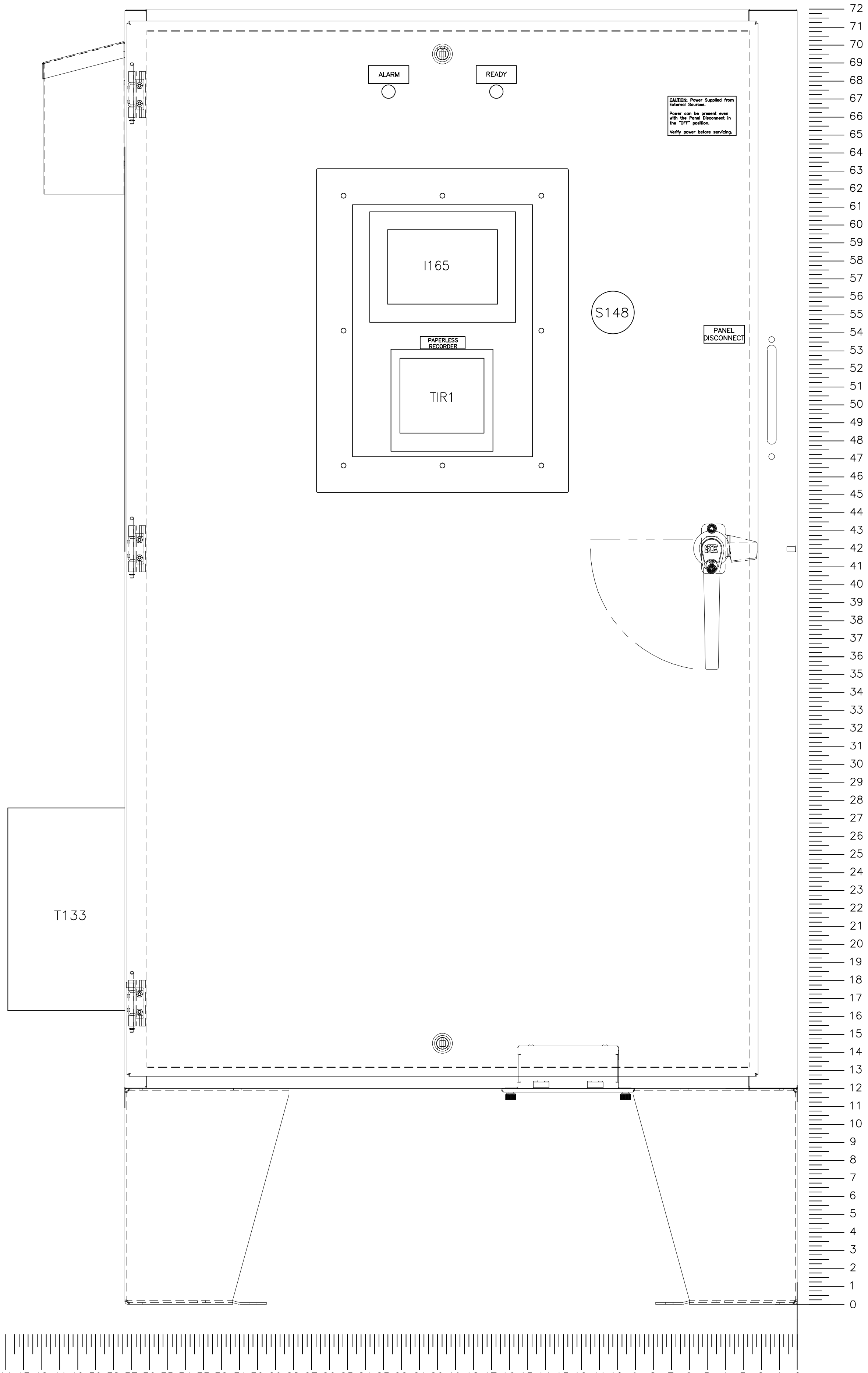
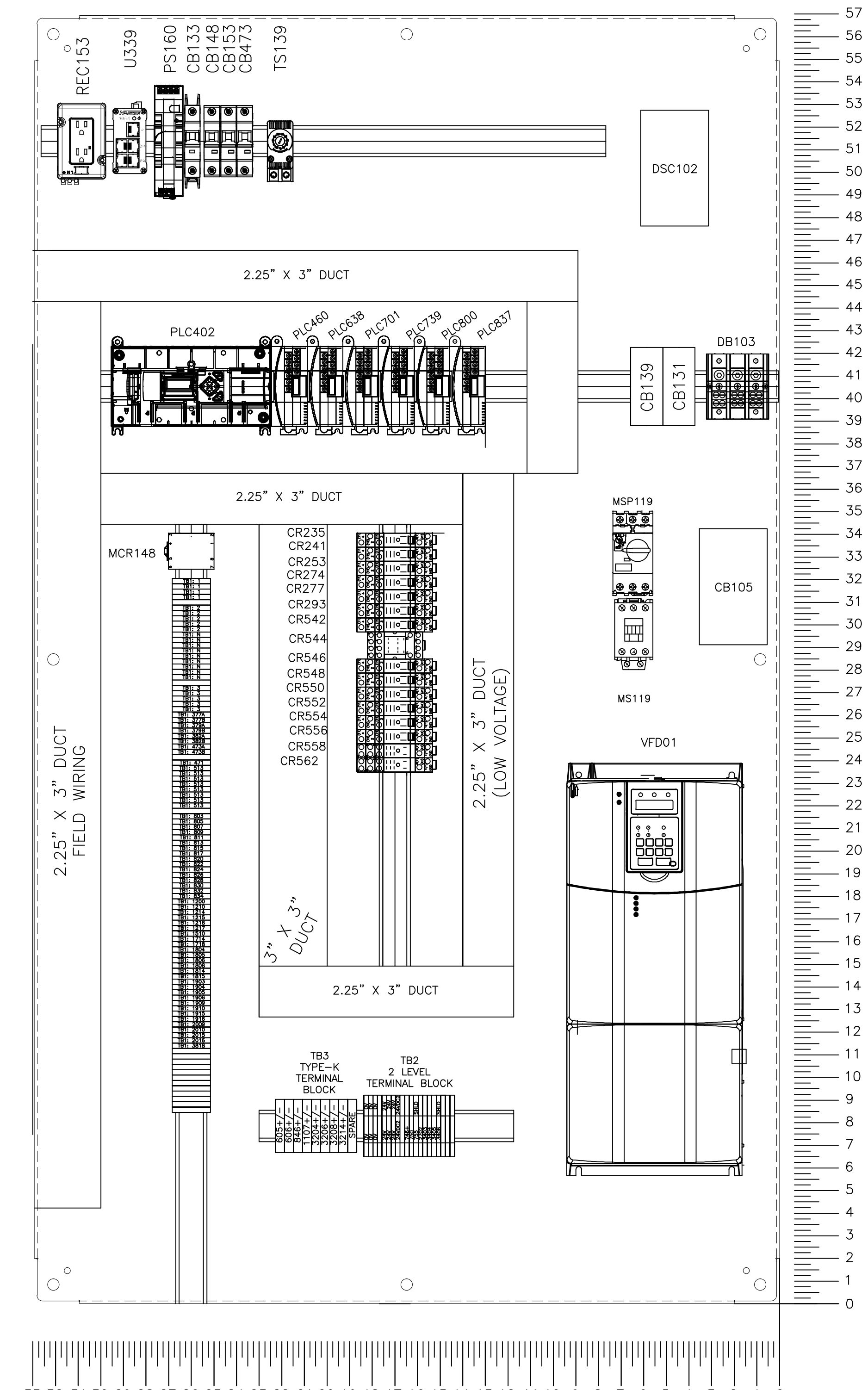
DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:

CUSTOMER: RENTAL #10 RTO
2 CHAMBER POPPET

TITLE: PLC DISCRETE OUTPUTS &
THERMOCOUPE INPUTS

PROJECT	DRAWING	REV	SIZE
R-14-1488	E108	A	B





- SIZE: 60"H X 37"W X 12"D
- TYPE: NEMA 3R
- FLOOR STANDING

REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

	DRAWING STATUS	DATE	BY
	PRELIMINARY		
	FOR APPROVAL		
·	APPROVED FOR FAB	01/26/14	MEE
X	AS BUILT	01/31/14	MFK
	AS FIELD MODIFIED		

CYCLETHERM, LLC
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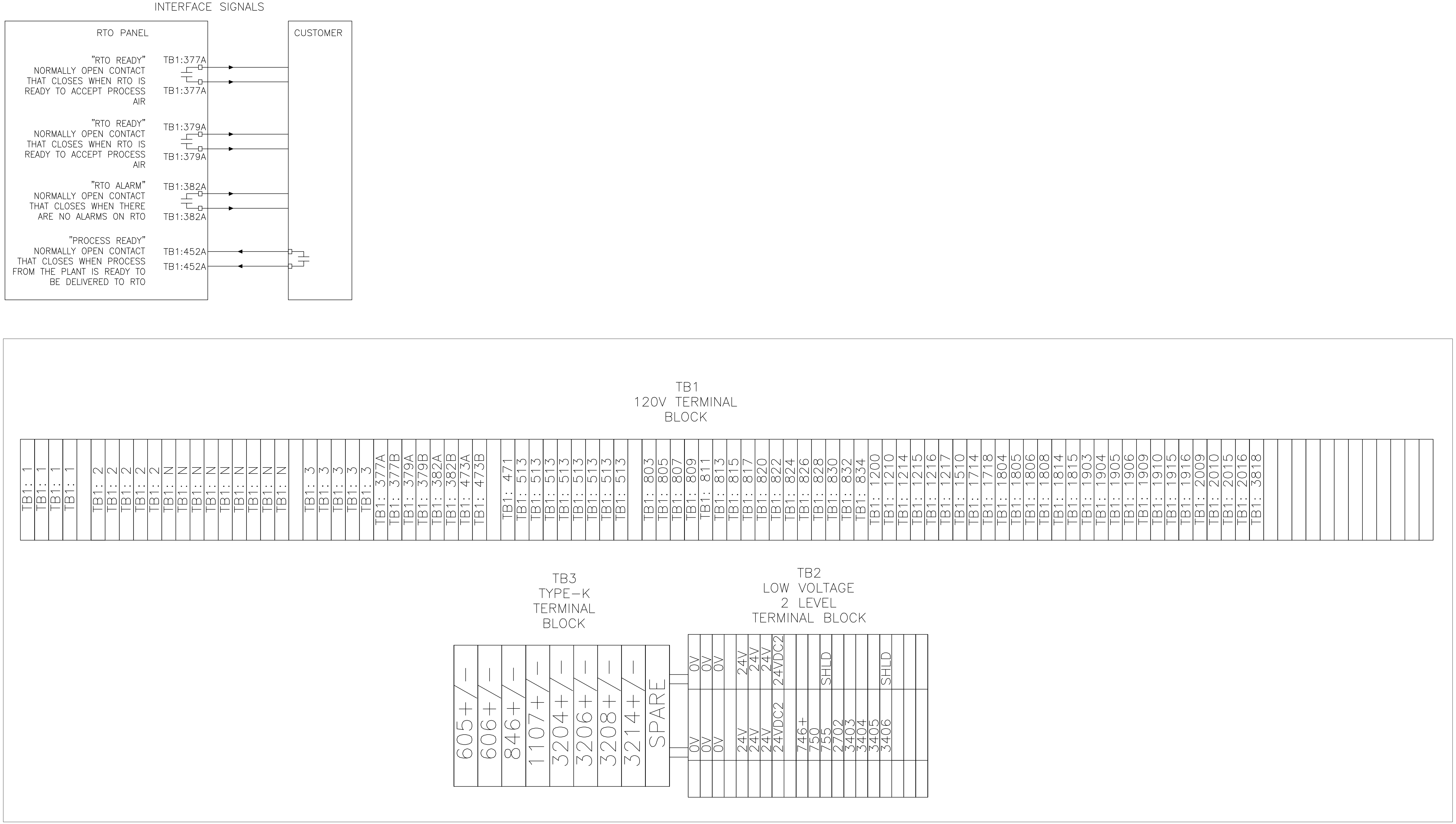
MATERIAL: SEE BOM

DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:

CUSTOMER: RENTAL #10 RTO 2 CHAMBER POPPET

TITLE: PANEL LAYOUT

PROJECT	DRAWING	REV	SIZE
R-14-1488	E109	A	B



REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

DRAWING STATUS	DATE	BY
PRELIMINARY		
FOR APPROVAL		
APPROVED FOR FAB	01/26/14	MEE
X AS BUILT	01/31/14	MFK
AS FIELD MODIFIED		

CYCLETHERM, LLC
1422 INDIANHEAD DR E MENOMONIE, WI 54751
(T) 570-839-8836
(F) 570-839-8837

MATERIAL: SEE BOM

DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:

CUSTOMER: RENTAL #10 RTO 2 CHAMBER POPPET
TITLE: INTERFACE & TERMINAL BLOCK LAYOUT

PROJECT	DRAWING	REV	SIZE
R-14-1488	E110	A	B

RTO FAN CONDUIT				
From	**TO**	**Wire#**	**Wire Color/Type**	**Note**
MCP	RTO Fan	1T1	Black/THHN	size wire for 40hp @ 52A
MCP	RTO Fan	1T2	Black/THHN	size wire for 40hp @ 52A
MCP	RTO Fan	1T3	Black/THHN	size wire for 40hp @ 52A
MCP	RTO Fan	ground	Green/THHN	Circuitbreaker size: 80A

COMBUSTION FAN CONDUIT				
MCP	Comb. Fan	2T1	Black/THHN	size wire for 3hp @ 4.8A
MCP	Comb. Fan	2T2	Black/THHN	size wire for 3hp @ 4.8A
MCP	Comb. Fan	2T3	Black/THHN	size wire for 3hp @ 4.8A
MCP	Comb. Fan	ground	Green/THHN	Circuitbreaker size: 15A

LOW VOLTAGE CONDUIT				
MCP	JB	24VDC2 2702	Belden: Shielded, Twisted, Pair, #18	1 cable
MCP	JB	3403 3404	Belden: Shielded, Twisted, Pair, #18	1 cable
MCP	JB	3405 3406	Belden: Shielded, Twisted, Pair, #18	1 cable
MCP	JB	3406	spares	2 spare cables

THERMOCOUPLE CONDUIT				
MCP	JB	1107+ 1107-	K-type extension wire, #20	1 cable
MCP	JB	3204+ 3204-	K-type extension wire, #20	1 cable
MCP	JB	3206+ 3206-	K-type extension wire, #20	1 cable
MCP	JB	3208+ 3208-	K-type extension wire, #20	1 cable
MCP	JB	3214+ 3214-	K-type extension wire, #20	1 cable
MCP	JB	spares	K-type extension wire, #20	2 spare cables

120VAC CONDUIT				
MCP	JB	1200	Red/THHN/#14	
MCP	JB	1210	Red/THHN/#14	
MCP	JB	1214	Red/THHN/#14	
MCP	JB	1215	Red/THHN/#14	
MCP	JB	1216	Red/THHN/#14	
MCP	JB	1217	Red/THHN/#14	
MCP	JB	1714	Red/THHN/#14	
MCP	JB	1717	Red/THHN/#14	
MCP	JB	1718	Red/THHN/#14	
MCP	JB	1804	Red/THHN/#14	
MCP	JB	1805	Red/THHN/#14	
MCP	JB	1806	Red/THHN/#14	
MCP	JB	1808	Red/THHN/#14	
MCP	JB	1814	Red/THHN/#14	
MCP	JB	1815	Red/THHN/#14	
MCP	JB	1903	Red/THHN/#14	
MCP	JB	1904	Red/THHN/#14	
MCP	JB	1905	Red/THHN/#14	
MCP	JB	1906	Red/THHN/#14	
MCP	JB	1909	Red/THHN/#14	
MCP	JB	1910	Red/THHN/#14	
MCP	JB	1915	Red/THHN/#14	
MCP	JB	1916	Red/THHN/#14	
MCP	JB	2009	Red/THHN/#14	
MCP	JB	2010	Red/THHN/#14	
MCP	JB	2015	Red/THHN/#14	
MCP	JB	2016	Red/THHN/#14	
MCP	JB	3818	Red/THHN/#14	
MCP	JB	1510A	Red/THHN/#14	
MCP	JB	N	White/THHN/#12	
MCP	JB	spares	Red/THHN/#14	10 spare wires

REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

	DRAWING STATUS	DATE	BY
	PRELIMINARY		
	FOR APPROVAL		
·	APPROVED FOR FAB	01/26/14	MEE
X	AS BUILT	01/31/14	MFK
	AS FIELD MODIFIED		

CYCLETHERM, LLC
1422 INDIANHEAD DR E MENOMONIE, WI 54751
(T) 570-839-8836
(F) 570-839-8837

MATERIAL: SEE BOM

DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:

CUSTOMER: RENTAL #10 RTO
2 CHAMBER POPPET

TITLE: MCP TO JUNCTION BOX WIRE SCHEDULE

PROJECT	DRAWING	REV	SIZE
R-14-1488	E111	A	B

Qty	Ref.	Description	Manufacturer	Manufacturer Part No.
1	CB105	Circuit Breaker, 80A, 3P, 22kAIC	Allen Bradley	140U-G2C3-C80
1	CB129	Circuit Breaker, 8A, 2P, UL489, MCCB, D trip	Eaton	WMZT2D08
1	CB133	Circuit Breaker, 10A, 1P, UL489, MCCB, D trip	Eaton	WMZT1D10
1	CB148	Circuit breaker, 3A, 1P, Suppl, D curve	Eaton	WMZS1D03
1	CB153	Circuit breaker, 5A, 1P, Suppl, D curve	Eaton	WMZS1D05
1	CB473	Circuit breaker, 3A, 1P, Suppl, D curve	Eaton	WMZS1D03
1	CR235	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR235	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR241	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR241	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR253	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR253	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR274	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR274	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR277	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR277	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR293	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR293	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR542	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR542	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR544	Relay, 4PDT, 120V coil, HC serires, 5A contact	Allen Bradley	700-HC14A1
1	CR544	Base, 4PDT, HC series	Allen Bradley	700-HN128
1	CR546	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR546	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR548	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR548	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR550	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR550	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR552	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR552	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR554	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR554	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR556	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR556	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR558	Relay, DPDT, 120V coil, HK serires, 8A contact	Allen Bradley	700-HK32A1
1	CR558	Base, DPDT, HK series	Allen Bradley	700-HN122
1	CR560	Relay, SPDT, 120V coil, HK serires, 16A contact	Allen Bradley	700-HK36A1
1	CR560	Base, SPDT, HK series	Allen Bradley	700-HN121
1	CR562	Relay, DPDT, 120V coil, HK serires, 8A contact	Allen Bradley	700-HK32A1
1	CR562	Base, DPDT, HK series	Allen Bradley	700-HN122
1	DB103	Distribution Block, 175A, 3P, 1 in 2/0kcmil-#14, 6 out #4-#14	Allen Bradley	1492-PD3141
1	DB103	Distribution Block Cover	Allen Bradley	1492-PBC1
1	DSC102	Circuit Breaker, 100A, 3P, 25kAIC, H-frame	Allen Bradley	140U-H2C3-D10
1	DSC102	Operator, Mechanism, Circuit breaker mount, w/ flange handle and 36" cable, NEMA 4	Allen Bradley	140U-H-FCX03
1	ENC197	Enclosure, 60"x37"x18", NEMA 4, Gray, Flanged Disconnect, Floor Standing, 2 Door	Saginaw Control	SCE-60XEL3712LP
1	ENC197	Panel, Mounting, 60"x37" (56"x33"), White, Heavy steel	Saginaw Control	SCE-60P36
1	ENC197	Louver, 4"x4", Gray	Saginaw Control	SCE-AVK44
1	ENC197	Kit, Window, Hinged, 18"x14"	Saginaw Control	SCE-HWK1814
2	ENC197	Knob, Mini, 1/4 turn	Saginaw Control	SCE- MINQLB
1	ENC197	Hood, Rain, Gray, 6"	Saginaw Control	SCE-RH66
1	ENC197	Kit, Floor, Standing, Gray, 12"x12"	Saginaw Control	SCE-FK1212
1	FAN139	Fan, Cooling, 4", 120V, Type 1	Saginaw Control & Engineering	SCE-FA
1	FS1013	Programmer, Flame Safety, 120V, Flame Rod, Protectifier series	Protection Controls	7256BH
1	GB100	Lug, Ground, 20 Position	Cutler-Hammer	GBK21
1	I165	Display, Operator interface, 6", Monochrome, Touch, 24VDC, STN, Ethernet, USB, Compact Flash	AUD	EA7-S6M
1	LT394	Pilot Light, Red, 120V, LED, 22mm	Allen Bradley	800FD-P4N5
1	LT398	Pilot Light, Green, 120V, LED, 22mm	Allen Bradley	800FD-P3N5
1	MCR148	Relay, DPDT, 120V coil, 15A contact, HB Series	Allen Bradley	700-HB32A1
1	MCR148	Base, Relay, DPDT, HA/HB	Allen Bradley	700-HN154
1	MS119	Contactor, 9A, 120V coil, 3ph	Fuji	SC-E02-110VAC
1	MS119	Contact, Auxiliary, 2 N.O., Front mount	Fuji	SZ-A20T
1	MSP119	Manual Motor Start protector, 4-6.3A, 45mm	Fuji	BM3RHB-6P3
1	MSP119	Contact, Auxiliary, 2 normally open, Side mount	Fuji	BZ0WUAAL
1	PLC402	Controller, Micrologix, 20 inputs-120VAC, 12 Outputs-Relay, 4 Analog inputs: 0-10V, 2 Analog outputs: 0-10V, Ethernet, 120 VAC Power	Allen Bradley	1766-L32AWA
1	PLC460	Card, Input, 8 Point, 120VAC	Allen Bradley	1762-IA8
1	PLC638	Card, Output, Analog, 4 channel Voltage or Current, Non-isolated	Allen Bradley	1762-OF4
1	PLC701	Card, Input, 4 channel, Thermocouple	Allen Bradley	1762-IT4
1	PLC739	Card, Input, Analog, 4 channel Voltage or Current, Non-isolated	Allen Bradley	1762-IF4
1	PLC800	Card, Output, 16 channel, Relay	Allen Bradley	1762-OW16
1	PLC837	Card, Input, 4 channel, Thermocouple	Allen Bradley	1762-IT4
1	PS160	Power supply, 85-264VAC - 24VDC, 3A@24V, DIN rail mount	Acme	
1	REC153	Receptacle, 15A, DIN Mount, 1 position	ABB	1SNA892461R1500
1	S148	Switch, E-Stop, Mushroomhead, Red, Twist to Release, NEMA 4, 22mm, 1 N.C. contact	Allen Bradley	800FD-MT44X01
1	S148	Legend, E-stop, Yellow w/ black text	Allen Bradley	800F15YSE112
1	T130	Transformer, 3kVA, 480V-120V, NEMA 3R	Hammond	C1F003LES
1	TIR354	Chart Recorder, Paperless, 3 Channel, 120VAC, USB, uL	ABB	SM503FB/U000000/E/STD
1	TMR237	Relay, Timer, 120V, 0-60 hours	Allen Bradley	700-FSA4UU23
1	TS139	Thermostat, Cooling, DIN mount	Saginaw Control & Engineering	SCE-TEMNO
1	TSH100	Controller, Limit, 120V, 1/4 DIN, Type-K input, Output #1 relay, Remote Reset, FM approved	Watlow	LVC6KW00002000A
1	U339	Ethernet Switch, 5 port, 24VDC, DIN mount	Ntron	105TX
1	VFD01	VFD, 40hp, 380-480V, P1000 series, NEMA 1	Allen Bradley	20BD052

REV	DESCRIPTION	DATE	BY
A	AS BUILT	02/07/14	MEE

	DRAWING STATUS	DATE	BY
	PRELIMINARY		
	FOR APPROVAL		
-	APPROVED FOR FAB	01/26/14	MEE
X	AS BUILT	01/31/14	MFK
	AS FIELD MODIFIED		

CYCLETHERM, LLC
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(T) 570-839-8836
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MATERIAL: SEE BOM

DATE: 01/26/14
SCALE:
DRAWN BY:
CHECKED BY:

CUSTOMER: RENTAL #10 RTO 2 CHAMBER POPPET

TITLE: PANEL BILL OF MATERIALS

PROJECT	DRAWING	REV	SIZE
R-14-1488	E112	A	B

RTO Operation Instructions
02/07/14

Overview

The regenerative thermal oxidizer (RTO) operates in a series of modes that allow the system to perform at optimum levels of efficiency. The RTO takes the volatile organic compound (VOC) laden air from the plant, destroys the VOC's in the burner chamber, and exhausts them to atmosphere.

System Modes

Offline Mode: RTO motors and burner offline and waiting to be started. Poppet valves are closed to the inlet to prevent drafting through the RTO.

Start Mode: system has started – fresh air damper opening to full open position.

Purge Mode: main fan (at fixed speed) & combustion fan start and purge the RTO on fresh air for a "soft" purge time.

Pre-Heat Mode: the burner sequence has been initiated. The RTO will systematically ramp to the chamber set point temperature and then stabilize on that temperature for pre-determined amount of time.

Run Mode (without Process Ready signal from plant): the RTO is ready (sends "RTO Ready" signal to plant) to accept process air from the plant, but is waiting for the "process ready" signal **from** the plant (indicating there are vapors to process). The RTO will run at a fixed air flow and maintain normal chamber operating temperatures.

Run Mode (with Process Ready signal): The RTO opens the Process Isolation Damper and releases the main fan to control the pressure in the main duct trunk. This is normal operation.

Non-Critical Alarm: The RTO has a non-critical alarm and will continue to function normal. Alarm should be addressed as soon as possible.

General Alarm: The RTO has an alarm that can cause system damage if normal operation continues. The RTO will go into an alarm shutdown and cool down. Alarm must be cleared before system can be re-started.

Critical Alarm: The RTO has an alarm that could cause immediate system damage if operation continues. All blowers and burner go offline immediately, and dampers go to there default safe positions. Alarm must be cleared before system can perform a normal start-up from the operator interface display.

Normal Shutdown Mode: The RTO has been placed in a Normal Shutdown by pressing the “Stop” button. The burner will ramp down until the “burner cool down set point” is reached. The fans will continue to run until the “system cool down” temperature is reached. The system can be re-started during a Normal Shutdown by pressing the “Run” button on the display or the system will automatically go into the Offline Mode when the “system cool down” set point is reached.

Alarm Shutdown Mode: The RTO has a General Alarm condition and is shutting down. The RTO can be re-started if the alarm condition is cleared and the “Reset” button is pressed on the display. The RTO will cool down to the “system cool down” set point, and then automatically go into the Offline Mode. All runtime alarms will be displayed in the alarm history and/or in the alarm status display.

START the RTO

Clear alarms if present then Press the “RUN” button on the display. No further operator action required.

If the RTO is in a normal shutdown, the RTO can be immediately re-started by pressing the “RUN” button on the display. The unit will go into the Pre-Heat mode again.

STOP the RTO

Press the “STOP” button on the operator interface. The “Are You Sure You Want to Shutdown the RTO” screen will appear. Press “YES” and the RTO will perform a normal shutdown with a cool down.

RESET Alarms

In the event of an alarm condition, clear the alarm condition and press the “RESET” button on the display. If the system is in an alarm shutdown and the RESET button is pressed on the display, the alarm condition will be reset and the RTO will immediately go into the Purge mode without completing the shutdown.

Run Sequence

1) Clear all alarms on RTO
2) Press the "RUN" button on the operator interface
3) Wait for fresh air damper to open
4) Runtime alarms are enabled
5) Tower flow dampers begin cycling at predetermined intervals (in seconds)
6) Main fan & combustion fan proven running, start hard wired purge timer
7) Hardwired purge timer complete, enable flame safety programmer
    a. enable pilot valve interrupt
8) Burner enabled
    a. pilot valves energized
    b. spark igniter energized
    c. flame established
    d. delay 5 seconds
    e. disable pilot valves
    f. main flame established
9) Ramp burner to set point temperature
10) Chamber set point temperature attained
11) Stabilize on chamber set point temperature for predetermined time (in seconds)
12) Stabilization complete. Deliver "RTO Ready" signal to upstream equipment
13) RTO remains at set point temperature running on fresh air
14) RTO receives "Process Ready" signal from upstream equipment
15) Isolation damper opens, Fresh air damper closes and main fan VFD modulates to maintain pressure at the RTO inlet duct.
16) Normal operation.

System Alarm List
Note: these values may upon since start-up

	Alarm	P&ID Reference	Electrical Schematic Line#	Alarm Type	Set Point	Notes
1	E-Stop Engaged		148	critical	n/a	E-Stop button pressed on front of RTO main control panel
2	Remote E-Stop Engaged		148	critical	n/a	E-Stop button pressed on junction box
3	RTO Inlet High Temperature	TC3204	704	general	250°F	10 second delay
4	RTO Exhaust High Temperature	TC3244	712	critical	450°F	10 second delay
5	Chamber High Temperature Limit	TC1107	298	general	1800°F	0.5 second delay
6	Chamber Thermocouple Fail Tower #2	TC3208	709	non-critical	n/a	0.05 second delay
7	Chamber Thermocouple Fail Tower #1	TC3206	707	non-critical	n/a	0.05 second delay
8	Both Chamber Thermocouples Failed	TC3206 & TC3208	707 & 709	general	n/a	
9	RTO Inlet Thermocouple Fail	TC3204	704	general	n/a	0.05 second delay
10	RTO Exhaust Thermocouple Fail	TC3244	712	critical	n/a	0.05 second delay
11	RTO Inlet High Negative Pressure	PS1714	285	critical	-10.0"w.c.	5 second delay
12	RTO Fan Low Differential Pressure	PS1718	274	critical	X"w.c.	20.00 second delay, when burner lit: 0 second delay
13	Combustion Air Fan Low Differential Pressure Alarm	PS1814	277	critical	X"w.c.	20.00 second delay, when burner lit: 0 second delay
14	Low Compressed Air Pressure	PS1714	283	critical	X"w.c.	10.00 second delay
15	RTO High Differential Pressure	PS3818 & PS3818A	285	non-critical	X"w.c.	20.00 second delay
16	Low Gas Pressure	PSL1201	200	general	X"w.c.	0.005 second delay
17	High Gas Pressure	PSH1200	200	general	X"w.c.	0.001 second delay
18	Tower #2 Poppet Valve Failed to Close to Inlet	PRS1905	315	critical		5.00 second delay
19	Tower #2 Poppet Valve Failed to Open to Inlet	PRS1906	313	critical		5.00 second delay
20	Tower #1 Poppet Valve Failed to Close to Inlet	PRS1903	326	critical		5.00 second delay
21	Tower #1 Poppet Valve Failed to Open to Inlet	PRS1904	323	critical		5.00 second delay
22	Isolation Damper Failed to Close	PRS1916	305	critical		70.00 second delay
23	Isolation Damper Failed to Open	PRS1915	303	general		70.00 second delay
24	Main Gas Valves Not Closed	LS1810 & LS1810A	230/235	general		10.00 second delay
25	Flame Safety Programmer Alarm – Possible Flame Failure	-	212	general		0.20 second delay
26	RTO Fan VFD Fault	VFD01	109	critical		0.01 second delay
27	Combustion Fan Motor Overload	MOT4	119	critical		2.00 second delay
28	Power Failure	-	-	critical		0.00 second delay
29	Burner Failed to Maintain Set Point Temperature	TC3206 & TC3208		general		1800 second delay (30 minute)

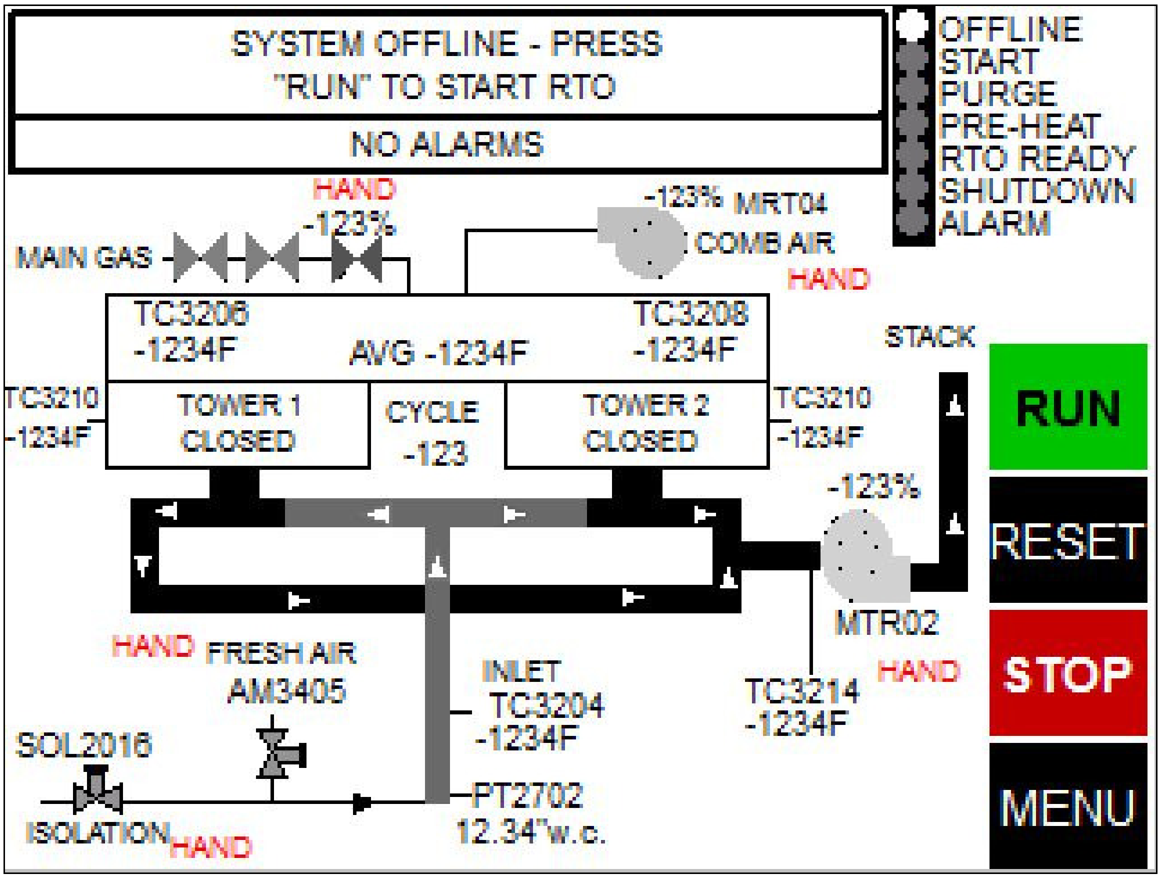
	Alarm	P&ID Reference	Electrical Schematic Line#	Alarm Type	Set Point	Notes
30	Fresh Air Damper Failed to Open	PRS1909	333	critical		35.00 second delay
31	Fresh Air Damper Failed to Close	PRS1910	335	non-critical		35.00 second delay
32	Main Control Panel Thermocouple Fail	--	849	non-critical		0.00 second delay
33	Main Control Panel High Temperature	--	849	non-critical	115°F	0.00 second delay
34	Gas Modulating Valve Not Closed	LS1815	250	general		45.00 second delay

SET POINTS

	Description	P&ID Reference	Electrical Schematic Line#		Set Point	Notes
1	Chamber/Burner Set Point Control	TC3206 & TC3208	707 & 709		1450 F	PID Settings Gain: 19.0 Reset (I): 6.5 Rate (d): 0.01 E-SP-PV
2	Burner Ramp Rate Deg/Minute	n/a	n/a		40F/min	
3	Burner Cool down Temperature	n/a	n/a		1400 F	burner shuts off but fans continue to run
4	System Cool down Temperature	n/a	n/a		250 F	
5	Stabilize On Set Point Temperature Time	n/a	n/a		60 seconds	
6	Valve Cycle Time	n/a	n/a		85 seconds	
7	Valve Switch Temperature	TC3244	712		425F	
8	Tower #1 Minimum Valve Switch Time	n/a	n/a		60 seconds	
9	Tower #2 Minimum Valve Switch Time	n/a	n/a		60 seconds	
10	Inlet Pressure Control Set Point	PT01	727		-2.0"w.c.	PID Settings Gain: 50 Reset (I): 5.2 Rate (d): 0.01 E=SP-PV
11	Minimum Fan Speed-Main Fan	n/a	n/a		60%	
12	Maximum Fan Speed-Main Fan	n/a	n/a		70%	
13	Purge/PreHeat Speed-Main Fan	n/a	n/a		40%	
14	Soft Purge Time	n/a	n/a		30 seconds	
15	Low Gas Pressure Switch				XX" w.c	
16	High Gas Pressure Switch				XX" w.c	
17	Inlet Gas Pressure After Regulator				XX " w.c	

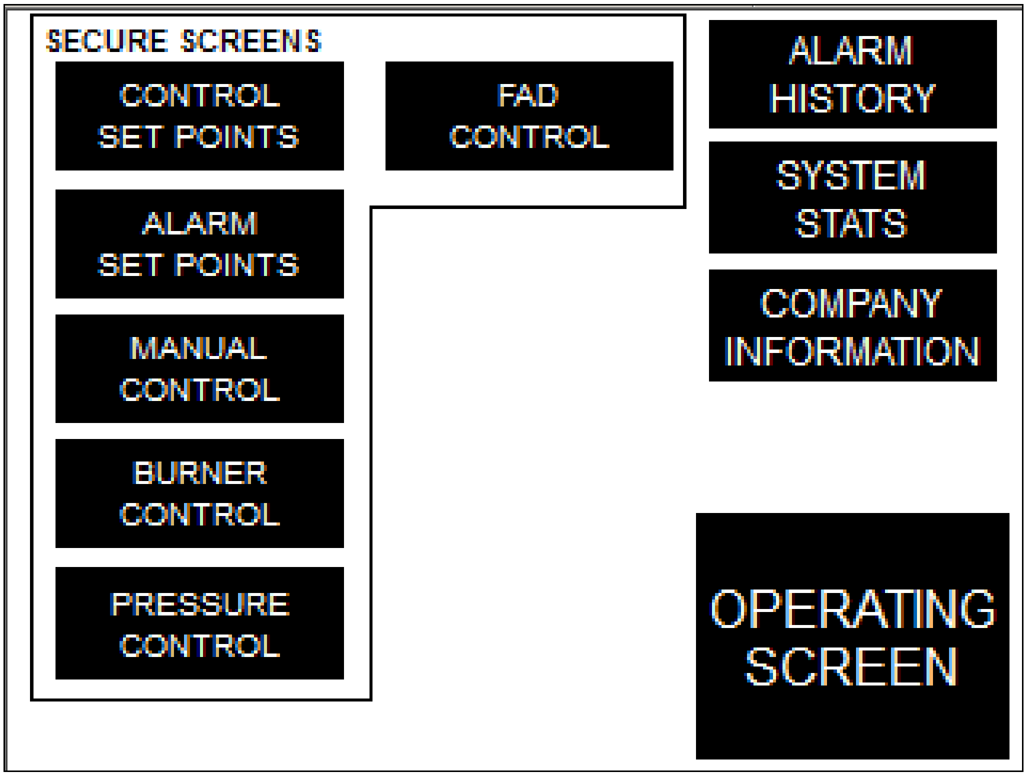
Operating Screen

The Operating Screen allows the user to Start, Stop, & Reset the RTO system. This screen also instructs the user of the status of system, temperatures, pressures, alarm conditions, and valve positions. This is the only screen the user can start, stop, and reset the system.



Menu Screen

The Menu Screen allows the operator to navigate to other screens within the operator interface display. Any screens that are located in the "secure screens" area require a password to enter.



System Statistics Screen

The System Statistics Screen allows the operator to view system operating hours & cycles. This can be helpful to determine when maintenance should be performed.

SYSTEM STATISTICS SCREEN

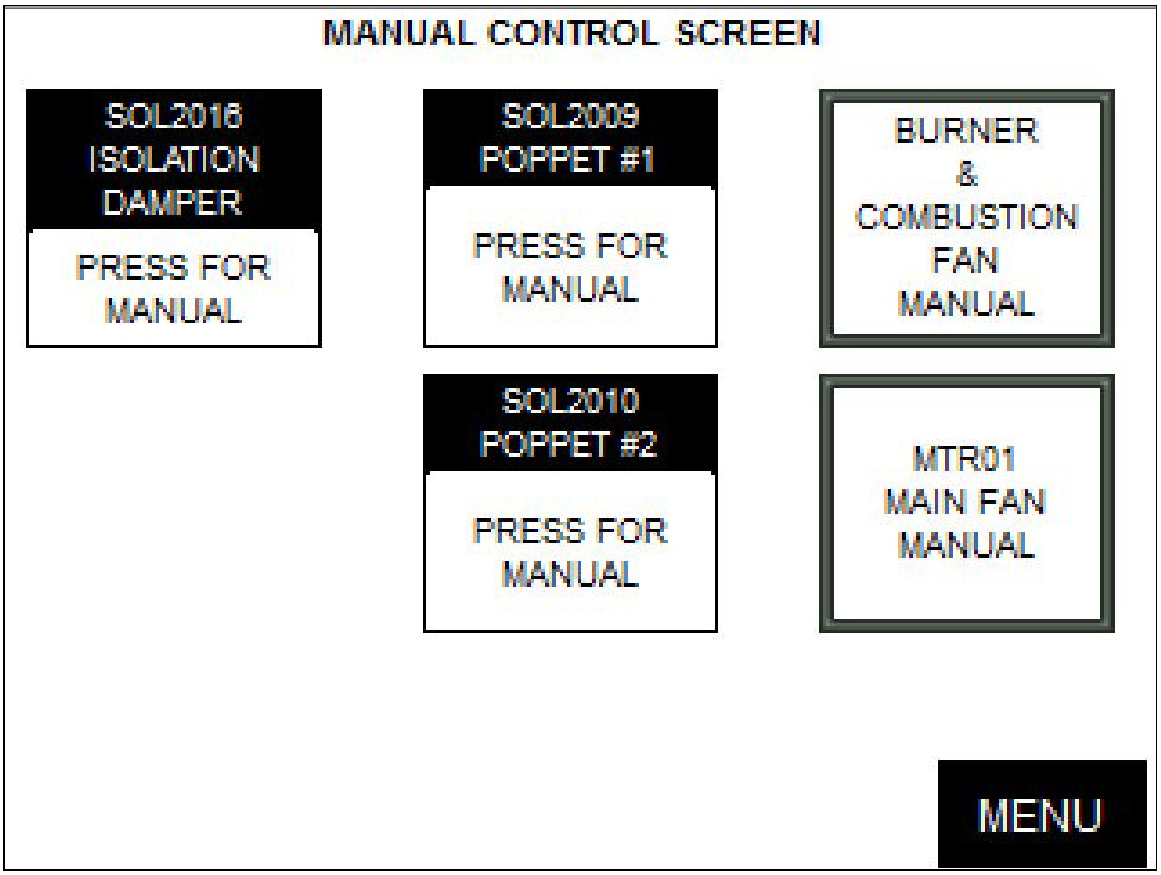
	HOURS	CYCLES
MAIN FAN	1234512	1234512
COMBUSTION FAN	1234512	1234512
BURNER	1234512	1234512
VALVE CYCLES	-	1234512
PROCESSING VAPORS	1234512	-

TOWER 1 CLOSE TIME: -12.34 SEC'S
TOWER 1 OPEN TIME: -12.34 SEC'S
TOWER 2 CLOSE TIME: -12.34 SEC'S
TOWER 2 OPEN TIME: -12.34 SEC'S

MENU

Manual Control Screen

The Manual Control Screen allows the operator to manually control system components when the system is completely offline. This can be helpful for troubleshooting purposes.



<u>Poppet #1:</u> pressing energizes the Tower #1 poppet valve open to the inlet

<u>Poppet #2:</u> pressing energizes the Tower #2 poppet valve open to the inlet

<u>Isolation:</u> pressing energizes the Isolation Damper to the “open to process” position.

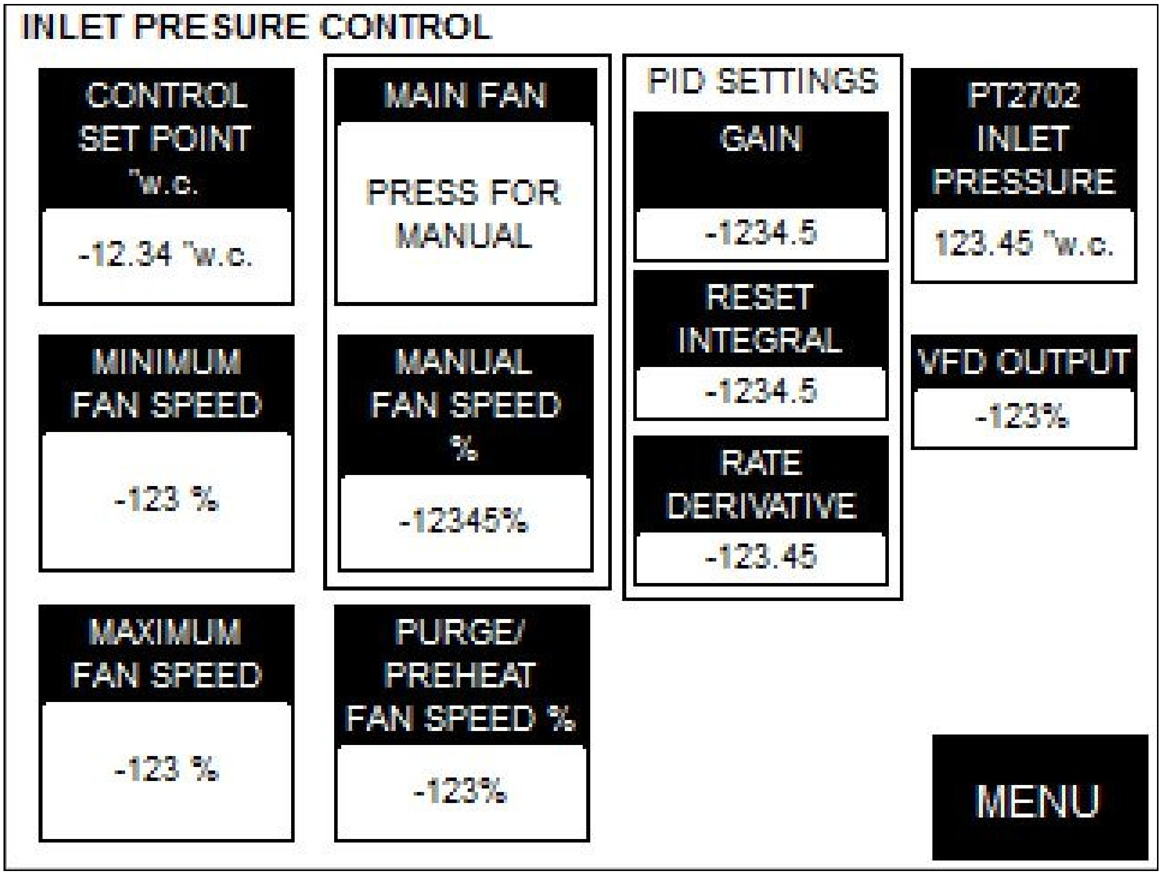
<u>Main Fan:</u> changes to the “Inlet Pressure” screen

<u>Burner:</u> changes to the “Burner Control” screen

Inlet Pressure Control Screen

The Inlet Pressure Control Screen allows the operator to adjust the parameters that are associated with the main fan.

<u>NOTE:</u> Incorrect settings can cause permanent system damage. Consult manufacturer prior to adjusting.



<u>Inlet Pressure Set Point:</u>	inlet duct pressure that main fan will modulate to maintain when processing vapors.
<u>Purge/Pre-Heat Fan:</u>	speed main fan runs during any non-processing vapors condition (purge, pre-heat, shutdown)
<u>Main Fan Hand:</u>	while RTO is offline, main fan runs at the “manual output %” value NOTE: when main fan is energized manually, the fresh air damper is automatically opened and the tower poppet valves automatically cycle.
<u>Maximum Fan Speed:</u>	value the main fan is not allowed to exceed while processing vapors.

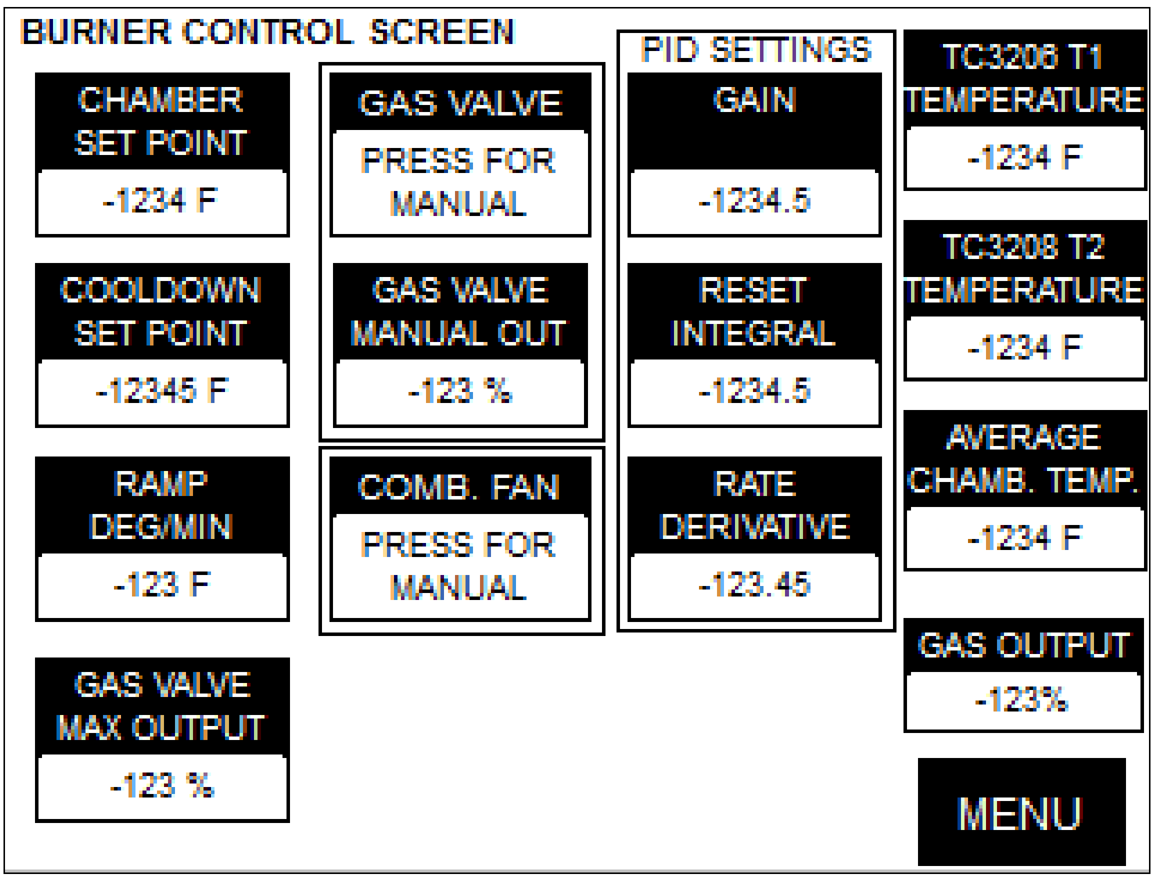
Minimum Fan Speed: value the main fan is not allowed to go below during processing vapors.

PID Settings: determine the aggressiveness of the main fan control loop.

Burner Control Screen

The Burner Control Screen allows the operator to adjust parameters that affect how the chamber temperature is controlled. These parameters adjust the air-to-gas flow to the burner.

<u>NOTE:</u> Incorrect settings can cause permanent system damage. Consult manufacturer prior to adjusting.



<u>Chamber Set Point:</u> temperature of the combustion chamber that burner will maintain.

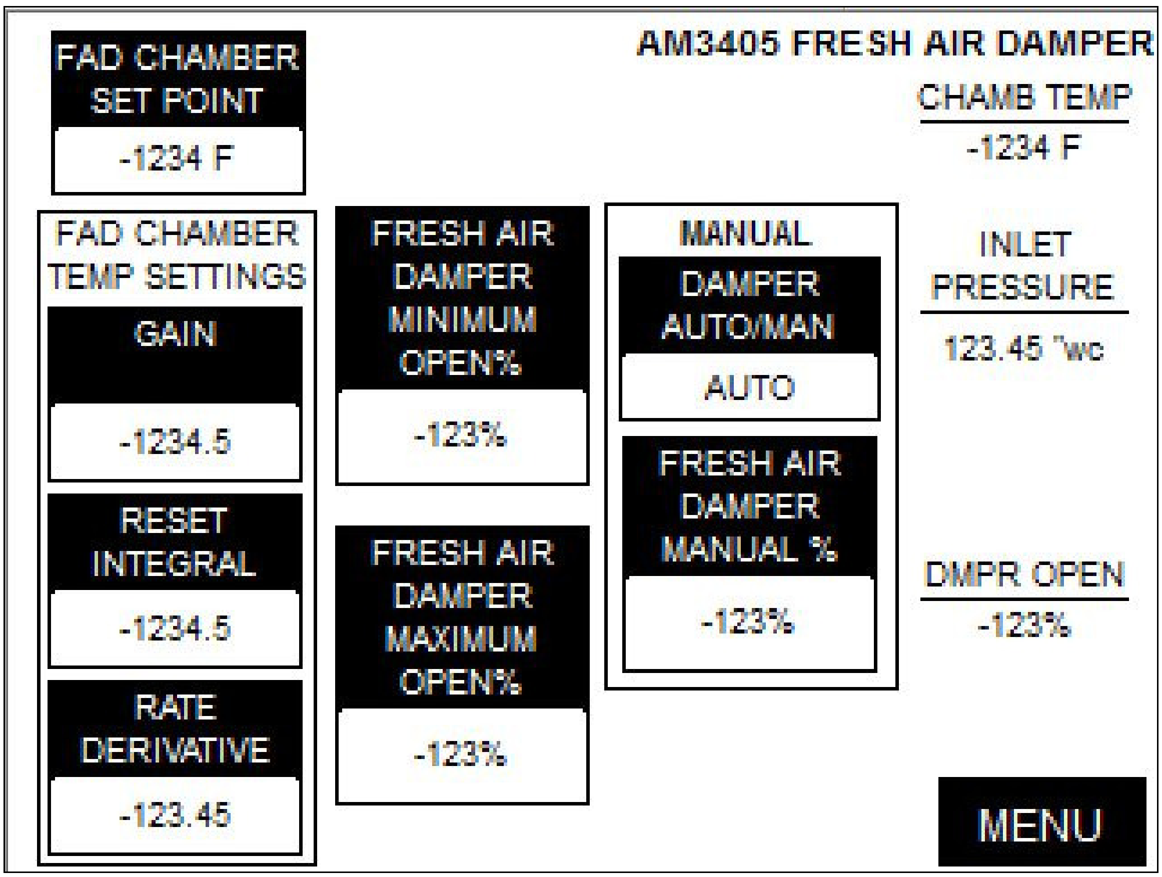
<u>Cool Down Set Point:</u> chamber temperature where fans and dampers assume offline positions after a normal shutdown.

Ramp Deg/Min:	burner ramps chamber temperature at this rate during pre-heat and normal shutdown conditions.
Gas Valve Hand:	during offline mode, enables the burner valve to move to the “gas valve manual output%” value.
Gas Valve Min Position:	minimum gas valve position during pre-heat, run mode, processing vapors mode, and normal shutdown.
PID Settings:	controls the aggressiveness of the burner to maintain the “chamber set point temperature”.
Combustion Air Fan Hand:	during offline mode energizes the combustion fan motor

FAD Control Screen

The FAD Control Screen allows the operator to adjust parameters that affect how the chamber temperature is controlled when the temperature is exceeding the set point value. These parameters adjust the of the modulating fresh air damper.

NOTE: Incorrect settings can cause permanent system damage. Consult manufacturer prior to adjusting.



Chamber Set Point: temperature of the combustion chamber that burner will maintain.

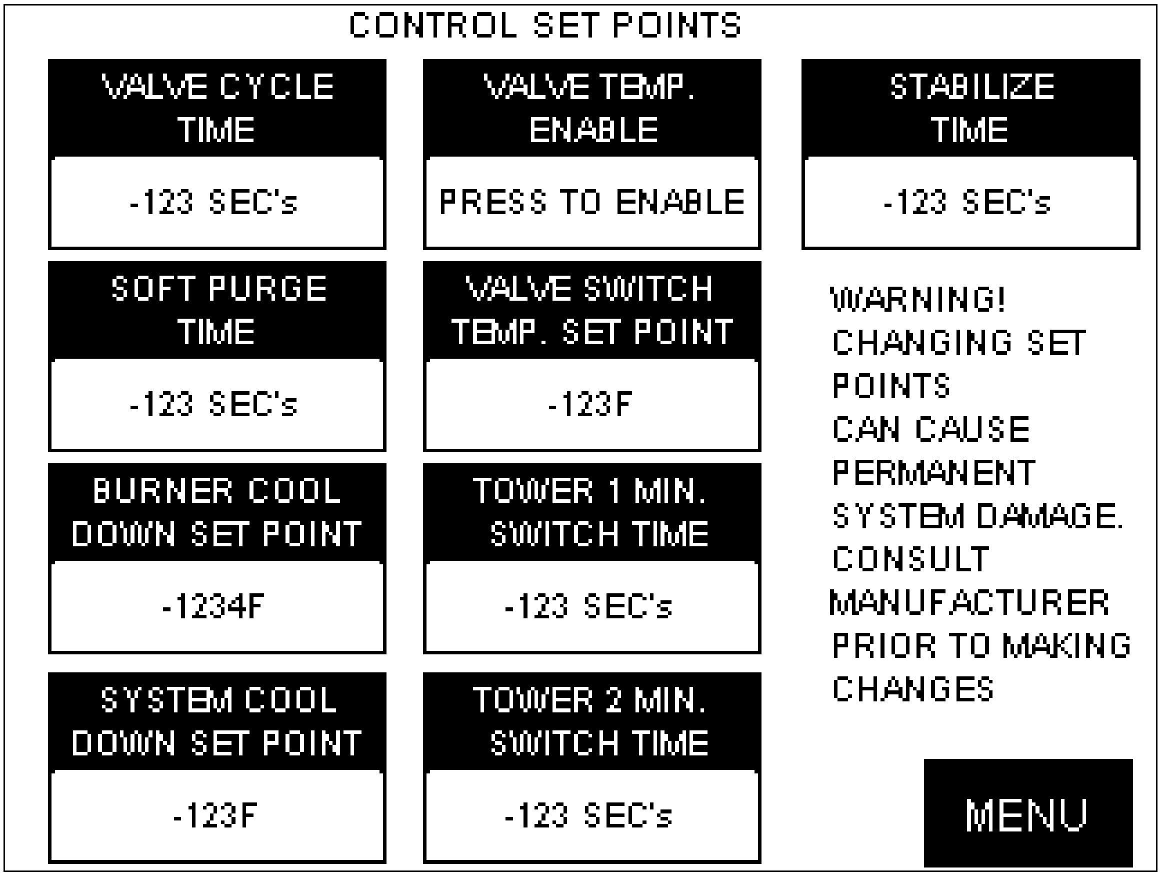
FAD Hand: during offline mode, enables the fresh air damper to move to the “fresh air damper manual output %” value.

FAD Min Position:	minimum FAD position during pre-heat, run mode, processing vapors mode, and normal shutdown.
FAD Max Position:	maximum FAD position during pre-heat, run mode, processing vapors mode, and normal shutdown.
PID Settings:	controls the aggressiveness of the burner to maintain the “chamber set point temperature”.

Control Set Points Screen

The Valve Control Screen allows the operator to adjust the valve switching times and temperatures.

NOTE: Incorrect settings can cause permanent system damage. Consult manufacturer prior to adjusting.



Valve Cycle Time: time between valves switches (inlet to outlet)

Valve Temp. Switching Enable: allows tower poppet valves to switch based on RTO outlet temperature in addition to the Valve Cycle time.

Valve Switch Temp. Set Point: RTO outlet temperature where tower poppet valves are allowed to switch

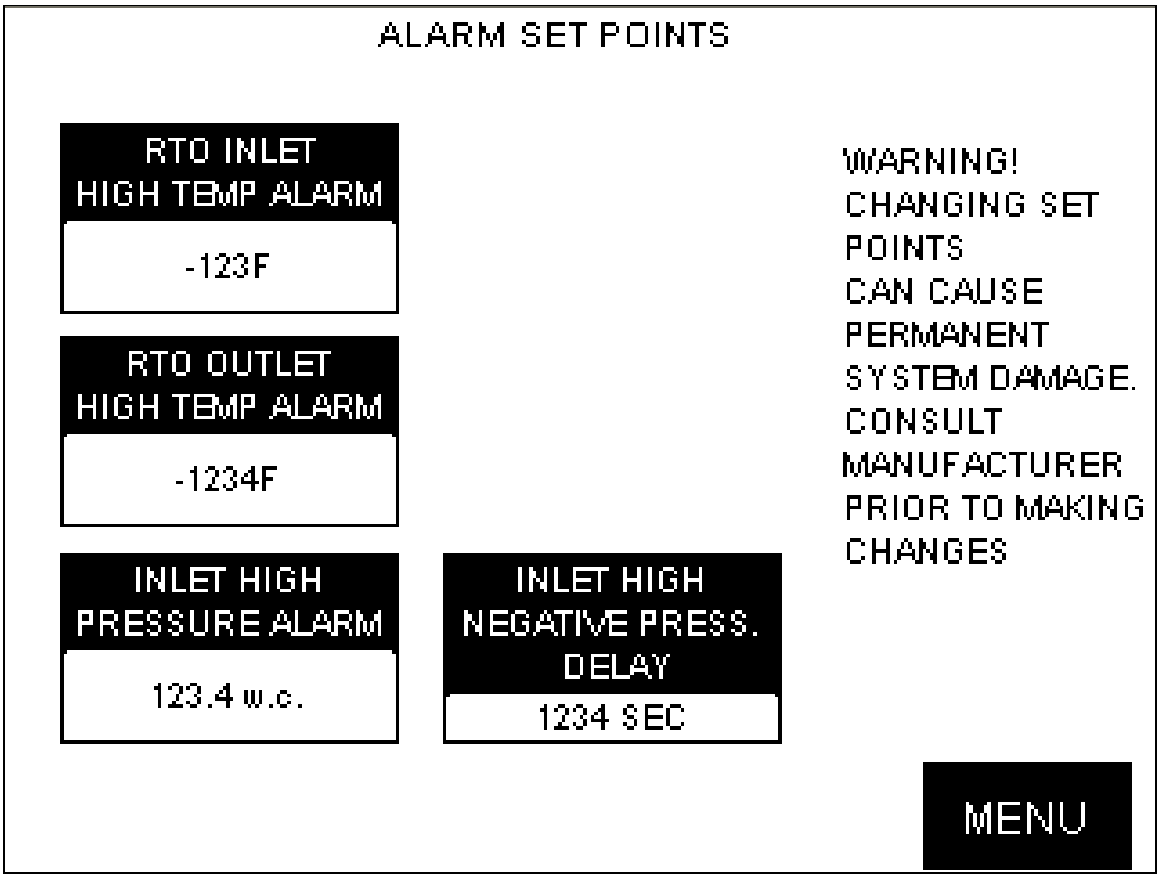
Tower 1 & Tower #2 MIN Switch Time: when the Valve Temp. Enable is on, this is the minimum amount of time the valves must stay in the current position before being allowed to switch (Tower #1). If this time has elapsed from the valve switch and the RTO outlet temperature has reached the “Valve Switch Temp. Set Point” and the “Valve Cycle Time” has not expired, the valves will switch to the next state.

<u>Soft Purge Time:</u>	How long the RTO purges on fresh air before enabling the burner sequence.
<u>Burner Cool down Set Point:</u>	chamber temperature where burner is disabled during normal shutdown. Fans continue to run and valves continue to cycle.
<u>System Cool Down Set Point:</u>	chamber temperature where fans and dampers assume offline positions after a normal shutdown.
<u>Stabilize Time:</u>	this is how long the RTO will stay at set point temperature after pre-heating before allowing the RTO to transition to process.

Alarm Set Points Screen

The Alarm Set Points Screen allows the operator to adjust the alarm set points for the system.

NOTE: Incorrect settings can cause permanent system damage. Consult manufacturer prior to adjusting.



RTO Inlet High Temperature: Temperature coming into the RTO from the process is too hot.

RTO Outlet High Temperature: the air coming out of the exhaust poppet valves is too hot.

Inlet High Pressure Alarm : prevents the inlet from becoming too negative that could adversely affect process or may indicate a blockage in air flow.

Inlet High Negative Press. Delay: how long the inlet pressure will remain below the "inlet high pressure alarm" set point before triggering the alarm.

INSTALLATION

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluid, before installation-

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Before installing the valve, inspect the valve body port and associated equipment for any damage that may have occurred and for any foreign matter that may have collected in shipping or storage. Make certain the body interior is clean.

2. Before installing the valve, inspect the pipe line and mating flanges, making sure the pipe is free of foreign material and the flanges are clean and have no burrs or pits that could cause leakage.

3. Due to stainless steel castings, machining tolerances, and flange thickness, the body tapped hole depth may vary slightly from valve to valve. It is, therefore, recommended that all knife gates be installed with a stainless steel ASTM A-304-B8 stud or an ASTM A-316-B-8M stud. The use of a carbon steel B-7 stud may also be considered. We further recommend the use of a teflon thread compound. It should be pointed out that the use of cap screws or bolts may harm the chest in the knife gate by bottoming out and should never be used on this area of the knife gate valve.

4. The Davis Knife Gate is manufactured with ANSI B 16.5 – 150# raised face flange dimensions. The use of a suitable gasket between the body and the pipe line flanges shall be selected by the customer. We would recommend the use of a PTFE gasket.

5. Carefully place the valve between the flanges and loosely assemble the valve by putting in the bottom two or three studs, then carefully insert the gaskets into place. The bottom studs will help locate the gasket and hold it in position.

6. Carefully insert the balance of the studs into place and tighten all of them evenly – <u>not in rotation</u> – but by the cross over method. <u>CAUTION:</u> Do not over tighten chest cavity studs.

7. The Davis Knife Gate Valve may be installed in any orientation in the pipe line, however, the normal method is with the handwheel vertical above the valve body. Other positions are acceptable, however, they may result in uneven valve wear.

8. The resilient seat knife gate is a bi-directional valve and will operate with the flow in either direction. Care must be taken with the metal-seated valve as it is a unidirectional valve (or a one-flow-direction valve). Make sure that the metal-seated valve is oriented so that the pipe line flow is in the same direction as the arrow on the side of the valve body. This will insure that the valve seat is on the downstream side of the gate.

9. All Resilient-Seated Knife Gate Valves require the resilient seat to be lubricated before stroking, regardless of type of actuator. The fit pressure of the gate against the resilient seat, on the sides of the valve up thru the packing gland, is such that stroking the valve dry (with no lubrication of any kind) will cause the resilient seat to cold flow beyond safe limits and will damage the seat with just a few strokes. CRC or WD40, sprayed on the seat, up in the chest area, both sides, will normally provide sufficient lubrication. This should be repeated every 2 or 3 strokes. This is CRITICAL to the life and performance of the seat. In operation, the process product normally supplies adequate lubrication.

OPERATION

1. After the valve has been installed, cycle the valve once completely. Open the valve by turning the handwheel counter clockwise, reverse the operation for closing. (Note: This will detect if any damage has been incurred either due to shipping or installation processes.) After installing Resilient Seat Valves (Lug Type), be sure to determine that bonnet nut and lock nut are secure. If either lock or bonnet nut are loose, adjust as follows:

    1. Back lock nut in counterclockwise rotation 2 turns.
    2. Back bonnet nut in counterclockwise rotation 2 turns.
    3. Turn handwheel in clockwise motion until gate bottoms out, then turn handwheel at that point ¼ turn more.
    4. Tighten bonnet nut down to stop-out against stem nut.
    5. Secure lock nut down on bonnet nut to hold in position.

After cycling the gate valve, turn the handwheel counterclockwise several turns allowing partial opening for preparation to fill system.

2. Open upstream valve slowly, building system pressure gradually, allowing installation personnel to detect any excessive packing gland leakage, making adjustments necessary.

3. After the system has come to a full pressure, open the knife gate fully by turning the handwheel counterclockwise, then close the valve fully by turning the handwheel clockwise. In resilient seat knife gate valves, this process will result in "seating in the valve." This step may be eliminated with the metal-seated valve.

4. You may now use the valve for its intended purpose, keeping in mind that a gate valve should be used in a full open or a full closed position. Gate valves should not be used for throttling unless specifically designed for such a use.

MAINTENANCE

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of the service conditions. This section includes instructions for packing adjustments, repacking, seat replacement, and seating adjustment.

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluids, before installation –

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Normal maintenance of the Davis Knife Gate Valve may only include a periodic tightening of the packing gland. Should a leak occur at the packing gland, simply tighten the packing gland bolt closest to the leak. This may require tightening two or three bolts on larger valves. After the leak has stopped, tighten all packing gland bolts ¼ turn. Do not over tighten. The only other normal maintenance required would be to grease the valve stem by using a grease gun at the grease fitting located on the valve yoke.

2. From time to time, it may be necessary to repack the valve completely. This can be done following the warning procedure listed above. Standard repacking kits are available through Davis Valve. Packing kits include necessary packing and a top wiper seal gasket which insures a tight seal. When ordering be sure to specify valve model number,

indicating type of seat and type of valve. Repacking the valve includes the following steps:

1. Remove packing gland nuts and lock washers.

2. Raise blade to the full open position.

3. Pull up the packing gland to the top of the blade and secure it to the top of the blade.

4. Using a packing hook, remove all of the old packing.

5. Carefully clean the stuffing box. If oil, grease, wax, or graphite impregnated packings were used, it might be necessary to use a solvent to clean the stuffing box.

6. Purchase precut packing kits from Davis Valve or carefully cut each ring by wrapping a length of packing around the blade snugly, but without tension. Cut each ring individually, making a square cut with a clean, sharp knife.

7. Insert rings one at a time into stuffing box. Tamp each ring lightly in place using a flat packing iron. Packing joints may be located 90° apart, on metal-seated valves, to minimize leakage. Successive layers are installed in the same manner.

8. Pull the packing gland down and tighten using only the two end studs until the packing gland almost bottoms out.

9. Remove the packing gland as previously described.

10. Insert the wiper seal gasket.

11. Pull down packing gland using lock washers and nuts and tighten using alternate method. Do not over tighten.

12. Bring the valve up to pressure and tighten the packing gland following the procedures listed under the maintenance instructions.

VALVE THRUST AND TORQUE VALUES

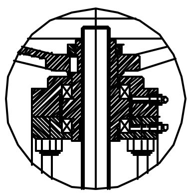
	Size	Valve Thrust lbs	Valve Torque ft lbs	Flow Coefficient Gal. per min. at a pressure drop of 1 psi
MODEL 60	2	648	9	285
	3	898	12	760
	4	1253	17	1420
	5	---	---	2890
	6	2077	37	3300
	8	3590	63	5800
	10	5469	97	11000
	12	7299	141	16500
	14	8573	166	20500
	16	10959	230	27000
	18	14409	302	36000
	20	17189	409	45000
	24	23801	592	60000
	30	---	---	95000
	36	---	---	138000
MODEL 61	2			285
	3			760
	4			1420
	5			2890
	6			3300
	8			5800
	10			11000
	12			16500
	14			20500
	16			27000
	18			36000
	20			45000
	24			60000
	30			95000
	36			138000
MODEL 70	2	565	8	285
	3	774	11	760
	4	1094	15	1420
	6	1958	27	3300
	8	3582	63	5800
	10	5541	98	11000
	12	7379	130	16500
	14	9551	185	20500
	16	12058	233	27000
	18	15353	322	36000
	20	18528	389	45000
	24	25880	616	60000

Davis Valve

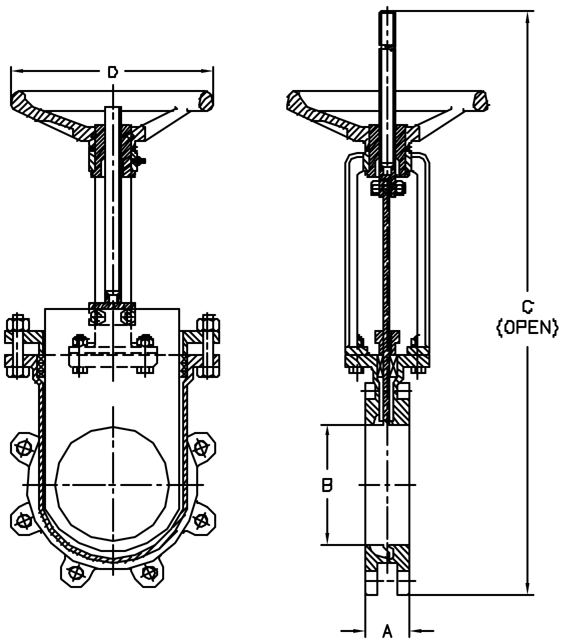
Memphis, Tennessee

Stainless Steel Knife Gate

TOPWORKS DETAIL
16" TO 48"



Model 60C - CF8 (304SS)
Model 60F - CF8M (316SS)
Model 60G - CG8M (317SS)



PART NAME	MATERIALS A 351-CF8	MATERIALS A 351-CF8M	MATERIALS A 351-CG8M
BODY	A 351-CF8	A 351-CF8M	A 351-CG8M
GATE	SS 304	SS 316	SS 317
YOKE	A 351-CF8	A 351-CF8	A 351-CF8
STEM	SS 304	SS 304	SS 304
GLAND	A 351-CF8	A 351-CF8M	A 351-CG8M
GLAND PACKING	PTFE	PTFE	PTFE
STEM NUT	AL BRONZE	AL BRONZE	AL BRONZE
HAND WHEEL	A 216-WCB	A 216-WCB	A 216-WCB

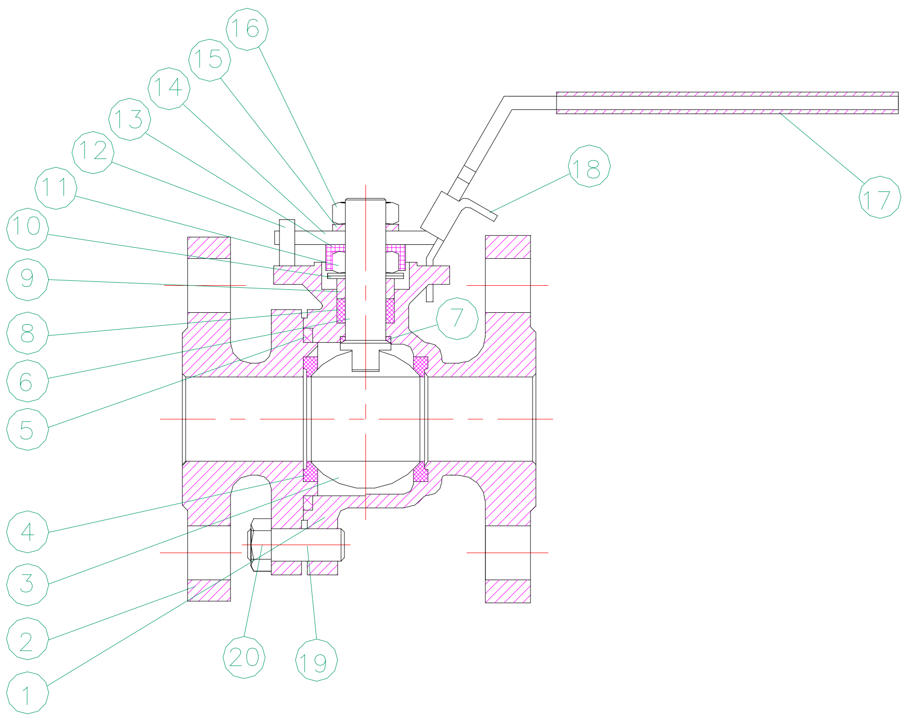
SIZE	INCH	2	2½	3	4	5	6	8	10	12	14	16	18	20	24	30	36
	MM	50	65	80	100	127	150	200	250	300	350	400	450	500	600	762	915
A	INCH	1.88	2.0	2.0	2.0	2.25	2.25	2.75	2.75	3.0	3.0	3.5	3.5	4.5	4.5	5.4	6.3
	MM	47.8	50.8	50.8	50.8	57.2	57.2	69.9	69.9	76.2	76.2	88.9	88.9	114.3	114.3	137.1	160.0
B	INCH	2.0	2.5	3.0	4.0	5.0	6.0	8.0	10.0	12.0	13.25	15.25	17.25	19.25	23.25	29.25	35.25
	MM	50.8	63.5	76.2	101.6	127.0	152.4	203.2	254.0	304.8	336.5	387.3	438.1	488.9	590.5	742.9	895.3
C	INCH	15.5	19.3	19.3	23.0	26.2	29.25	36.25	44.0	51.0	57.0	66.0	73.0	79.5	93.0	131.9	151.9
	MM	393.7	490.2	490.2	584.2	665.4	743.0	920.8	1117.6	1295.4	1447.8	1676.0	1854.0	2019.3	2362.2	3350.4	3858.2
D	INCH	8.0	8.0	8.0	10.0	10.0	12.0	14.0	16.0	16.7	18.9	18.9	20.9	20.9	24.8	36.7	36.7
	MM	203.0	203.0	203.0	254.0	254.0	304.8	355.6	406.4	424.1	480.0	480.0	530.8	530.8	630.0	932.1	932.1
WGT	LBS	22		31	38	47	59	84	124	170	201	294	372	503	671	1810	2252
	KGS	10		14	18	22	27	38	56	77	91	133	168	228	305	820	1020

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes ½" – 4" , Classes 150, 300, and 600

ITEM	DESCRIPTION
1	BODY
2	END CONNECTOR
3	BALL
4	SEAT
5	BODY GASKET
6	STEM
7	THRUST BEARING
8	STEM PACKING
9	GLAND PACKING
10	BELLVILLE WASHER
11	STEM NUT
12	STOPPER
13	LOCK TAB
14	HANDLE
15	HANDLE WASHER
16	HANDLE NUT
17	SLEEVE
18	LOCKING DEVICE
19	STUD
20	NUT



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150, 300, or 600.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the adjusting nut 1/4 turn. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle and travel stop plate.

3. Remove stem nut locking tab, stem nut, belleville springs, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a "rolling" motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

7. Take out other seat.

8. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Install one seat in the body cavity with the spherical curvature facing the ball.

2. Install thrust bearing on stem and slide the stem up through the body.

3. Install new stem seals, gland ring, and belleville springs. Install stem nut and tighten to the torque values given in Table 1. Install stem nut locking tab or cap. Tighten stem nut slightly if necessary to align nut with locking device surfaces.

4. Install travel stop (if supplied) and handle. Make sure handle aligns with flow bore through ball. Install hand retainer nut (or capscrew).

5. Turn the handle to the CLOSED position. Line up the ball slot with the stem tang and the ball into position on the stem tang. Turn the handle to the OPEN position to hold the ball in place.

6. Install the remaining seat into body end.

7. Place new body seal into counterbore in valve body.

8. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

9. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

10. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

11. Pressure test valve, if possible, before reinstalling in pipeline.

Table 1 - Stem Nut Torques

Valve Size	Torque (lb-ft)
½”	5.5
¾”	5.5
1”	6
1-1/2” – 4”	22

Table 2 – Body Bolting Torques (lb-ft)

Valve Size	Class 150	Class 300	Class 600
½”	5	10	15
¾”	5	10	20
1”	5	20	35
1-1/2”	15	35	80
2”	20	40	140
3”	20	60	155
4”	25	95	215

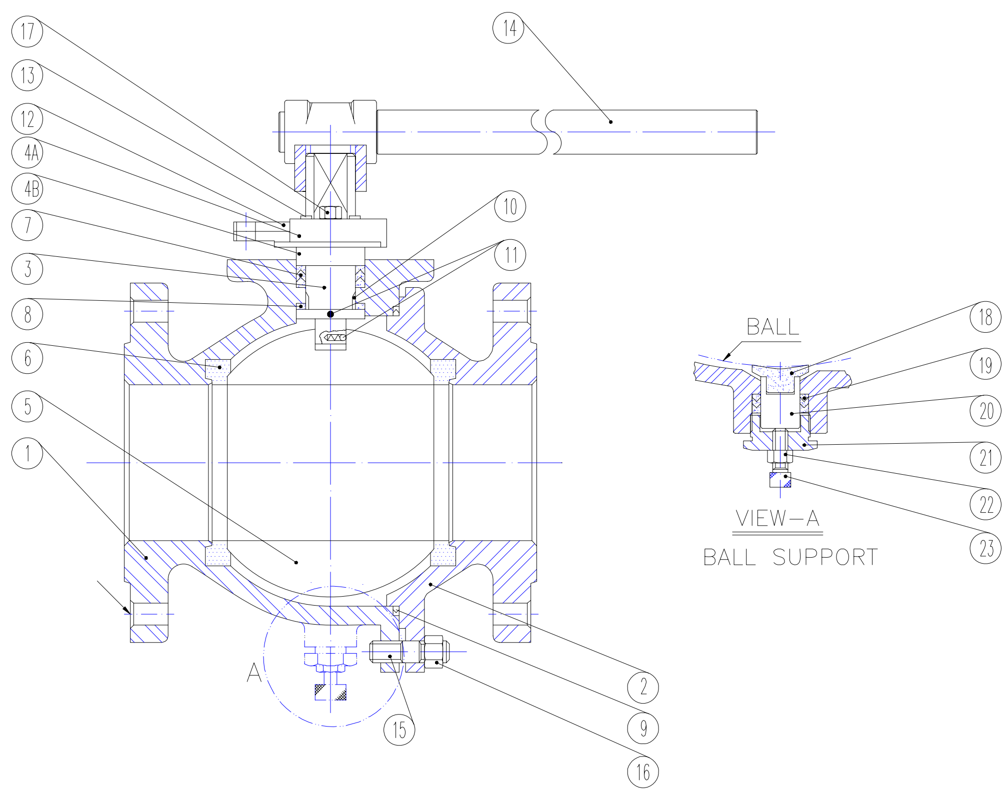
Note: Torque values are for TFE/RTFE or flexible graphite gaskets and seals. For other materials contact Sharpe Valves.

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes 6" - 12" , Classes 150 & 300

NO.	PART NAME
1	BODY
2	CAP
3	STEM
4A	GLAND
4B	GLAND RING
5	BALL
6	SEAT
7	PACKING
8	THRUST WASHER
9	GASKET
10	STEM BEARING
11	ANTI–STATIC
12	TRAVEL STOPPER
13	SNAP RING
14	HANDLE
15	STUD
16	NUT
17	GLAND BOLT
18	PIN SEAT
19	PIN PACKING
20	SUPPORT PIN
21	SUPPORT NUT
22	SET NUT
23	TUNING SCREW



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools. Ball support supplied for 10" and 12" Class 150 valves, and 6" through 12" Class 300 valves.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150 or Class 300.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the gland bolts 1/4 turn, each. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle, snap ring, and travel stop plate.

3. Remove gland bolts, gland, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. **<u>For 10" and 12" valves only</u>**: Ball support must be backed off to remove ball. Loosen support nut, set nut and back out tuning screw on bottom of valve to release the ball support. The weight of the ball will cause the ball support to come down.

7. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a "rolling" motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

8. Take out other seat.

9. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing and stem bushing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Set the valve body on a clean work suface, resting on the end flange.

2. Install one seat in the body cavity with the spherical curvature facing the ball (upwards).

3. Cut new stem bushing on one side at approx. 30° - 60° angle and wrap around stem above shoulder.

4. Install thrust bearing on stem and holding stem bushing in place, slide the stem up through stem bore from inside body.

5. Install new stem seals, gland ring, and gland. Install gland bolts and tighten hand tight.

6. Install travel stop, and snap ring.

7. Turn the stem to the CLOSED position (bottom stem tan parallel to flow passage). Line up the ball slot with the stem tang and roll and lower the ball into position on the stem tang, letting the ball rest in the seat. Turn the stem and ball to the OPEN position to hold the ball in place.

8. **For 10” and 12” Valves Only:** Re-set the ball support by turning the tuning screw inwards until the support pin seat firmly contacts the ball. Do not cause the ball to move. Holding the tuning screw in place, tighten the support nut and then the set nut.

9. Install the remaining seat into body end.

10. Place new body seal into counterbore in valve body.

11. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

12. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

13. Tighten the gland bolts to the torques specified in Table 1.

14. Install handle, making sure that the handle aligns with the flow passage through the ball.

15. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

16. Pressure test valve, if possible, before reinstalling in pipeline.

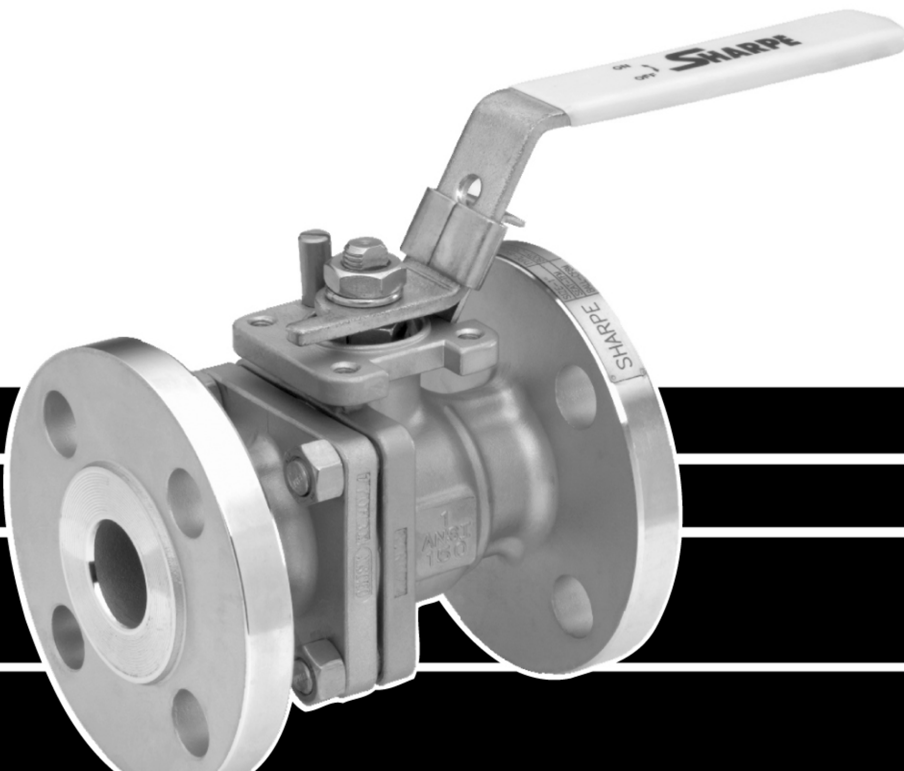
Table 1 – Gland Bolt Torques

SIZE	Tightening Torque (lb-ft) Max
6” – 8”	42 (1/2-13UNC)
10” - 12”	83 (5/8-11UNC)

Table 2 – Body Bolting Torques

SIZE	THREAD	Tightening Torque (lb-ft) Max
6”,8” (Class 150) / 3”~6”(Class 300)	5/8-11UNC	83
10”,12” (Class 150) / 8”(Class 300)	3/4-10UNC	120
10”(Class 300)	7/8-9UNC	190
12”(Class 300)	1-8UNC	260

SHARPE® VALVES

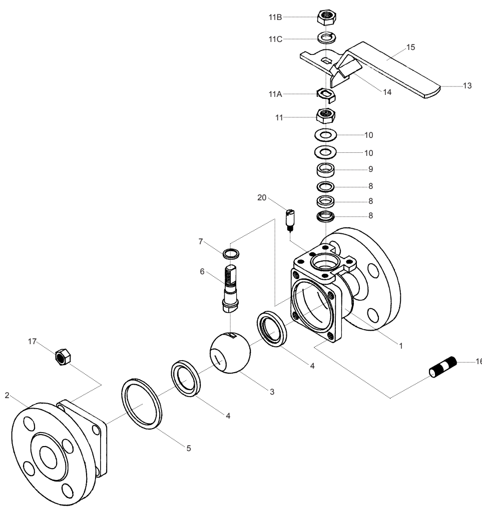


FLANGED FULL PORT
BALL VALVE
SERIES 50 / CLASS 150

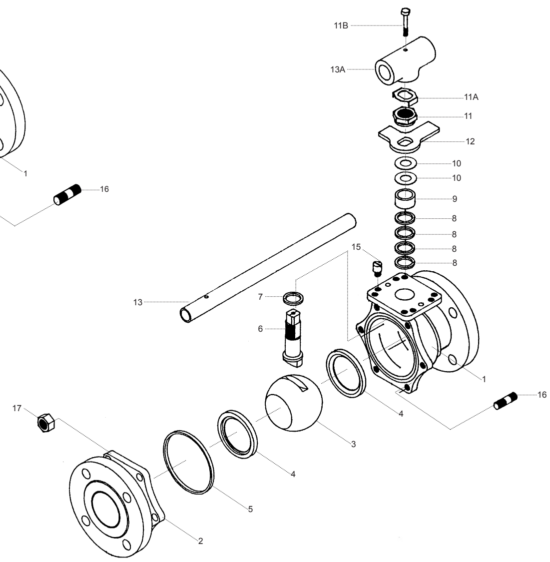
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

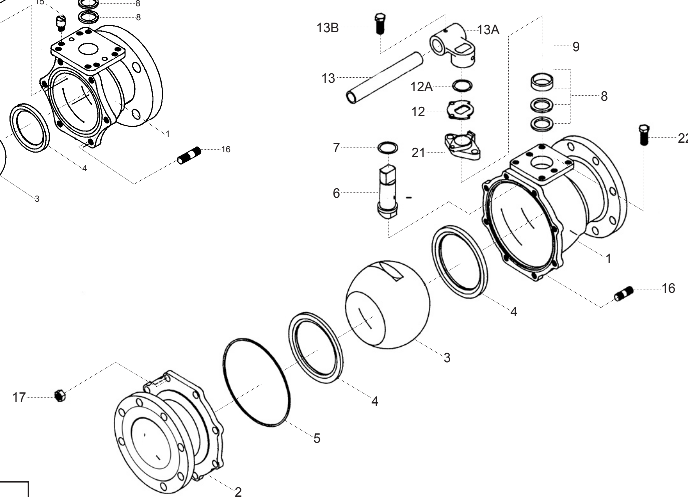
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2” - 2”



2-1/2” - 4”



6” - 8”

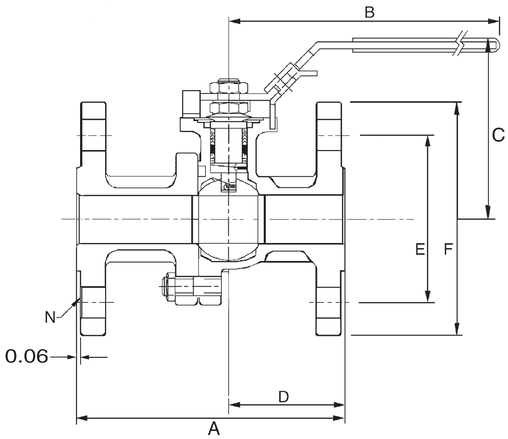
PART NO.	PART	QTY.	MATERIAL	
1	Body	1	316 Stainless Steel Alloy 20 Carbon Steel Hastelloy C Monel	ASTM A351 CF8M ASTM A351 CN7M ASTM A216 WCB ASTM A494 GR CW-12MW ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel Alloy 20 Carbon Steel Hastelloy C Monel	ASTM A351 CF8M ASTM A351 CN7M ASTM A216 WCB ASTM A494 GR CW-12MW ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel	Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) NOVA	TFE Reinforced TFE PEEK
5	Body Seal	1	TFE	
6	Stem	1	316 Stainless Steel 17-4PH (Option)	Alloy 20 Hastelloy C
7	Thrust Bearing	2	Reinforced TFE	
8	Stem Packing	3/4	Reinforced TFE	
9	Gland Packing	1	304 Stainless Steel	
10	Belleville Washer (1/2”-4”)	2/4	304 Stainless Steel	
11	Packing Nut (1/2”-4”)	1	304 Stainless Steel	
11A	Lock Tab	1	Stainless Steel	
11B	Handle Nut	1	304 Stainless Steel	
11C	Lock Washer	1	304 Stainless Steel (1/2”-2”)	

*See Dimensions

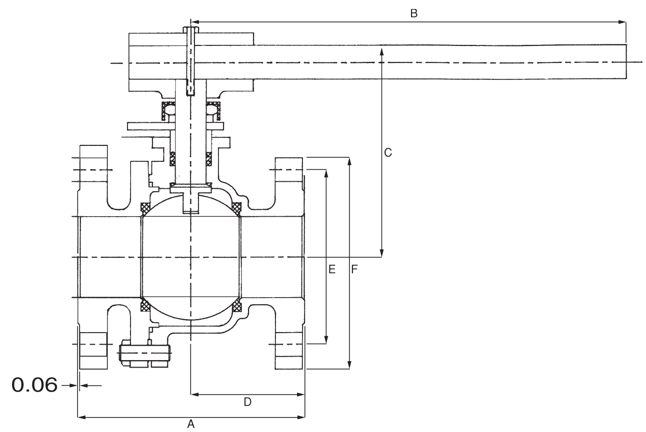
PART NO.	PART	QTY.	MATERIAL	
12	Stopper	1	304 Stainless Steel	
12A	Snap Ring	1	Stainless Steel (6”-8”)	
13	Handle	1	304 Stainless Steel (1/2”-2”) Galvanized Steel (2-1/2”-4”) Ductile Iron (6”-8”)	
13A	Wrench Block	1	Stainless Steel	
13B	Hex Head Bolt	1	304 Stainless Steel	
14	Locking Device (1/2”-2”)	1	304 Stainless Steel	
15	Sleeve	1	Vinyl	
16	Body Stud	SEE* N	A193 A193	B8 (SST) B7 (CS)
17	Nut	SEE* N	A194 A194	8 (SST) 2H (CS)
20	Stop Pin (1/2”-2”) (2-1/2”-4”)	1 2	304 Stainless Steel 304 Stainless Steel	
21	Gland Flange (6”-8”)	1	304 Stainless Steel	
22	Gland Bolts (6”-8”)	2	304 Stainless Steel	

SERIES 50
DIMENSIONS

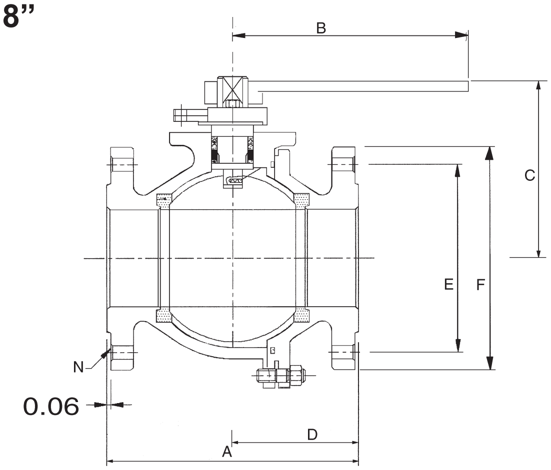
1/2" - 2"



2-1/2" - 4"



6" - 8"



CV DATA

1/2"	26
3/4"	50
1"	94
1-1/2"	260
2"	480
2-1/2"	750
3"	1300
4"	2300
6"	5400
8"	10000

PORT

1/2"	0.59
3/4"	0.78
1"	1.00
1-1/2"	1.50
2"	2.00
2-1/2"	2.55
3"	3.00
4"	4.00
6"	6.00
8"	7.88

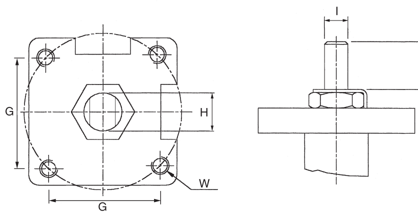
WEIGHT (lbs.)

1/2"	4
3/4"	6
1"	8
1-1/2"	15
2"	20
2-1/2"	36
3"	45
4"	75
6"	135
8"	290

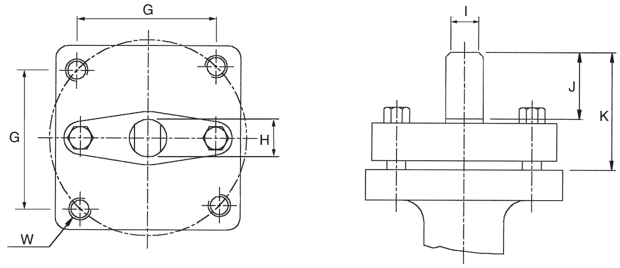
SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2"	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4"	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1"	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2"	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2"	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2"	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3"	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4"	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6"	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8"	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

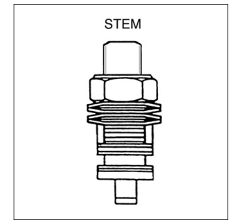
The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.

1/2" - 4"



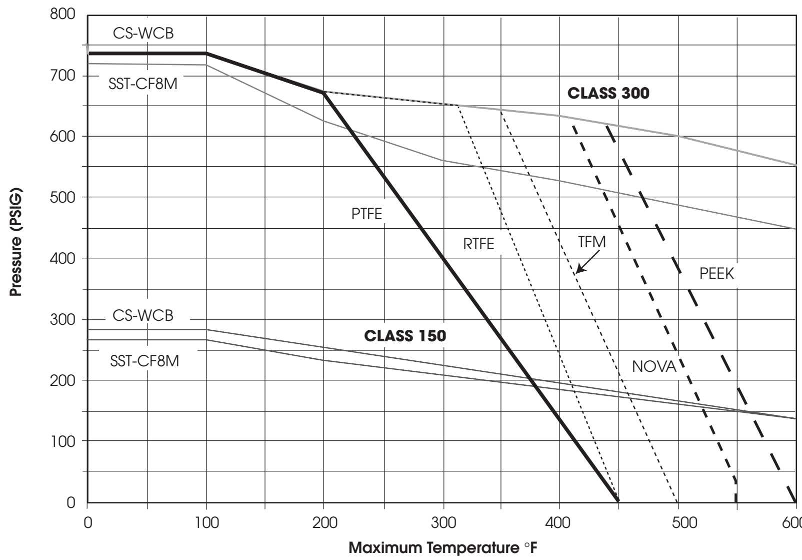
6" - 8"





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2"	50	150# = 11	2 = Alloy 20	T = TFE	X = Oxygen Service
3/4"			4 = Carbon Steel	R = RTFE	OH = Oval Handle
1"			6 = Stainless Steel	N = NOVA	F = Fugitive Emissions Certified ANSI 593.00.01
1-1/2"			5 = Hastelloy C	P = Peek	E = Extended Stem
2"			3 = Monel	M = TFM™	L = Lockable Extended Stem
2-1/2"					D = Leak detection Stem
3"					GO = Gear Operator
4"					7 = 17- 4PH Stem
6"					A = Nace
8"					

3/4" 50 11 6 T X

SHARPE® VALVES

A Division of Smith-Cooper International, LLC

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(877) 774-2773
Fax: (708) 562-9250
E-Mail: info@sharpevalves.com
www.sharpevalves.com
1260 Garnet Drive
Northlake, Illinois 60164 U.S.A.

INSTALLATION

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluid, before installation-

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Before installing the valve, inspect the valve body port and associated equipment for any damage that may have occurred and for any foreign matter that may have collected in shipping or storage. Make certain the body interior is clean.

2. Before installing the valve, inspect the pipe line and mating flanges, making sure the pipe is free of foreign material and the flanges are clean and have no burrs or pits that could cause leakage.

3. Due to stainless steel castings, machining tolerances, and flange thickness, the body tapped hole depth may vary slightly from valve to valve. It is, therefore, recommended that all knife gates be installed with a stainless steel ASTM A-304-B8 stud or an ASTM A-316-B-8M stud. The use of a carbon steel B-7 stud may also be considered. We further recommend the use of a teflon thread compound. It should be pointed out that the use of cap screws or bolts may harm the chest in the knife gate by bottoming out and should never be used on this area of the knife gate valve.

4. The Davis Knife Gate is manufactured with ANSI B 16.5 – 150# raised face flange dimensions. The use of a suitable gasket between the body and the pipe line flanges shall be selected by the customer. We would recommend the use of a PTFE gasket.

5. Carefully place the valve between the flanges and loosely assemble the valve by putting in the bottom two or three studs, then carefully insert the gaskets into place. The bottom studs will help locate the gasket and hold it in position.

6. Carefully insert the balance of the studs into place and tighten all of them evenly – <u>not in rotation</u> – but by the cross over method. <u>CAUTION:</u> Do not over tighten chest cavity studs.

7. The Davis Knife Gate Valve may be installed in any orientation in the pipe line, however, the normal method is with the handwheel vertical above the valve body. Other positions are acceptable, however, they may result in uneven valve wear.

8. The resilient seat knife gate is a bi-directional valve and will operate with the flow in either direction. Care must be taken with the metal-seated valve as it is a unidirectional valve (or a one-flow-direction valve). Make sure that the metal-seated valve is oriented so that the pipe line flow is in the same direction as the arrow on the side of the valve body. This will insure that the valve seat is on the downstream side of the gate.

9. All Resilient-Seated Knife Gate Valves require the resilient seat to be lubricated before stroking, regardless of type of actuator. The fit pressure of the gate against the resilient seat, on the sides of the valve up thru the packing gland, is such that stroking the valve dry (with no lubrication of any kind) will cause the resilient seat to cold flow beyond safe limits and will damage the seat with just a few strokes. CRC or WD40, sprayed on the seat, up in the chest area, both sides, will normally provide sufficient lubrication. This should be repeated every 2 or 3 strokes. This is CRITICAL to the life and performance of the seat. In operation, the process product normally supplies adequate lubrication.

OPERATION

1. After the valve has been installed, cycle the valve once completely. Open the valve by turning the handwheel counter clockwise, reverse the operation for closing. (Note: This will detect if any damage has been incurred either due to shipping or installation processes.) After installing Resilient Seat Valves (Lug Type), be sure to determine that bonnet nut and lock nut are secure. If either lock or bonnet nut are loose, adjust as follows:

    1. Back lock nut in counterclockwise rotation 2 turns.
    2. Back bonnet nut in counterclockwise rotation 2 turns.
    3. Turn handwheel in clockwise motion until gate bottoms out, then turn handwheel at that point ¼ turn more.
    4. Tighten bonnet nut down to stop-out against stem nut.
    5. Secure lock nut down on bonnet nut to hold in position.

After cycling the gate valve, turn the handwheel counterclockwise several turns allowing partial opening for preparation to fill system.

2. Open upstream valve slowly, building system pressure gradually, allowing installation personnel to detect any excessive packing gland leakage, making adjustments necessary.

3. After the system has come to a full pressure, open the knife gate fully by turning the handwheel counterclockwise, then close the valve fully by turning the handwheel clockwise. In resilient seat knife gate valves, this process will result in "seating in the valve." This step may be eliminated with the metal-seated valve.

4. You may now use the valve for its intended purpose, keeping in mind that a gate valve should be used in a full open or a full closed position. Gate valves should not be used for throttling unless specifically designed for such a use.

MAINTENANCE

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of the service conditions. This section includes instructions for packing adjustments, repacking, seat replacement, and seating adjustment.

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluids, before installation –

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Normal maintenance of the Davis Knife Gate Valve may only include a periodic tightening of the packing gland. Should a leak occur at the packing gland, simply tighten the packing gland bolt closest to the leak. This may require tightening two or three bolts on larger valves. After the leak has stopped, tighten all packing gland bolts ¼ turn. Do not over tighten. The only other normal maintenance required would be to grease the valve stem by using a grease gun at the grease fitting located on the valve yoke.

2. From time to time, it may be necessary to repack the valve completely. This can be done following the warning procedure listed above. Standard repacking kits are available through Davis Valve. Packing kits include necessary packing and a top wiper seal gasket which insures a tight seal. When ordering be sure to specify valve model number,

indicating type of seat and type of valve. Repacking the valve includes the following steps:

1. Remove packing gland nuts and lock washers.

2. Raise blade to the full open position.

3. Pull up the packing gland to the top of the blade and secure it to the top of the blade.

4. Using a packing hook, remove all of the old packing.

5. Carefully clean the stuffing box. If oil, grease, wax, or graphite impregnated packings were used, it might be necessary to use a solvent to clean the stuffing box.

6. Purchase precut packing kits from Davis Valve or carefully cut each ring by wrapping a length of packing around the blade snugly, but without tension. Cut each ring individually, making a square cut with a clean, sharp knife.

7. Insert rings one at a time into stuffing box. Tamp each ring lightly in place using a flat packing iron. Packing joints may be located 90° apart, on metal-seated valves, to minimize leakage. Successive layers are installed in the same manner.

8. Pull the packing gland down and tighten using only the two end studs until the packing gland almost bottoms out.

9. Remove the packing gland as previously described.

10. Insert the wiper seal gasket.

11. Pull down packing gland using lock washers and nuts and tighten using alternate method. Do not over tighten.

12. Bring the valve up to pressure and tighten the packing gland following the procedures listed under the maintenance instructions.

VALVE THRUST AND TORQUE VALUES

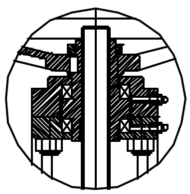
	Size	Valve Thrust lbs	Valve Torque ft lbs	Flow Coefficient Gal. per min. at a pressure drop of 1 psi
MODEL 60	2	648	9	285
	3	898	12	760
	4	1253	17	1420
	5	---	---	2890
	6	2077	37	3300
	8	3590	63	5800
	10	5469	97	11000
	12	7299	141	16500
	14	8573	166	20500
	16	10959	230	27000
	18	14409	302	36000
	20	17189	409	45000
	24	23801	592	60000
	30	---	---	95000
	36	---	---	138000
MODEL 61	2			285
	3			760
	4			1420
	5			2890
	6			3300
	8			5800
	10			11000
	12			16500
	14			20500
	16			27000
	18			36000
	20			45000
	24			60000
	30			95000
	36			138000
MODEL 70	2	565	8	285
	3	774	11	760
	4	1094	15	1420
	6	1958	27	3300
	8	3582	63	5800
	10	5541	98	11000
	12	7379	130	16500
	14	9551	185	20500
	16	12058	233	27000
	18	15353	322	36000
	20	18528	389	45000
	24	25880	616	60000

Davis Valve

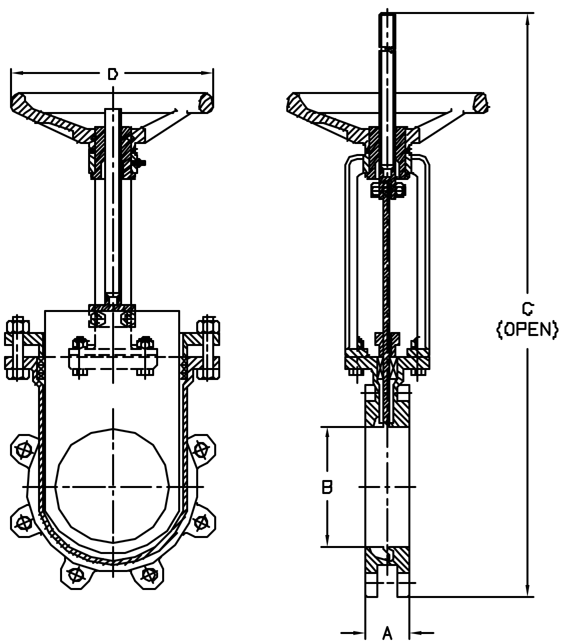
Memphis, Tennessee

Stainless Steel Knife Gate

TOPWORKS DETAIL
16" TO 48"



Model 60C - CF8 (304SS)
Model 60F - CF8M (316SS)
Model 60G - CG8M (317SS)



PART NAME	MATERIALS A 351-CF8	MATERIALS A 351-CF8M	MATERIALS A 351-CG8M
BODY	A 351-CF8	A 351-CF8M	A 351-CG8M
GATE	SS 304	SS 316	SS 317
YOKE	A 351-CF8	A 351-CF8	A 351-CF8
STEM	SS 304	SS 304	SS 304
GLAND	A 351-CF8	A 351-CF8M	A 351-CG8M
GLAND PACKING	PTFE	PTFE	PTFE
STEM NUT	AL BRONZE	AL BRONZE	AL BRONZE
HAND WHEEL	A 216-WCB	A 216-WCB	A 216-WCB

SIZE	INCH	2	2½	3	4	5	6	8	10	12	14	16	18	20	24	30	36
	MM	50	65	80	100	127	150	200	250	300	350	400	450	500	600	762	915
A	INCH	1.88	2.0	2.0	2.0	2.25	2.25	2.75	2.75	3.0	3.0	3.5	3.5	4.5	4.5	5.4	6.3
	MM	47.8	50.8	50.8	50.8	57.2	57.2	69.9	69.9	76.2	76.2	88.9	88.9	114.3	114.3	137.1	160.0
B	INCH	2.0	2.5	3.0	4.0	5.0	6.0	8.0	10.0	12.0	13.25	15.25	17.25	19.25	23.25	29.25	35.25
	MM	50.8	63.5	76.2	101.6	127.0	152.4	203.2	254.0	304.8	336.5	387.3	438.1	488.9	590.5	742.9	895.3
C	INCH	15.5	19.3	19.3	23.0	26.2	29.25	36.25	44.0	51.0	57.0	66.0	73.0	79.5	93.0	131.9	151.9
	MM	393.7	490.2	490.2	584.2	665.4	743.0	920.8	1117.6	1295.4	1447.8	1676.0	1854.0	2019.3	2362.2	3350.4	3858.2
D	INCH	8.0	8.0	8.0	10.0	10.0	12.0	14.0	16.0	16.7	18.9	18.9	20.9	20.9	24.8	36.7	36.7
	MM	203.0	203.0	203.0	254.0	254.0	304.8	355.6	406.4	424.1	480.0	480.0	530.8	530.8	630.0	932.1	932.1
WGT	LBS	22		31	38	47	59	84	124	170	201	294	372	503	671	1810	2252
	KGS	10		14	18	22	27	38	56	77	91	133	168	228	305	820	1020

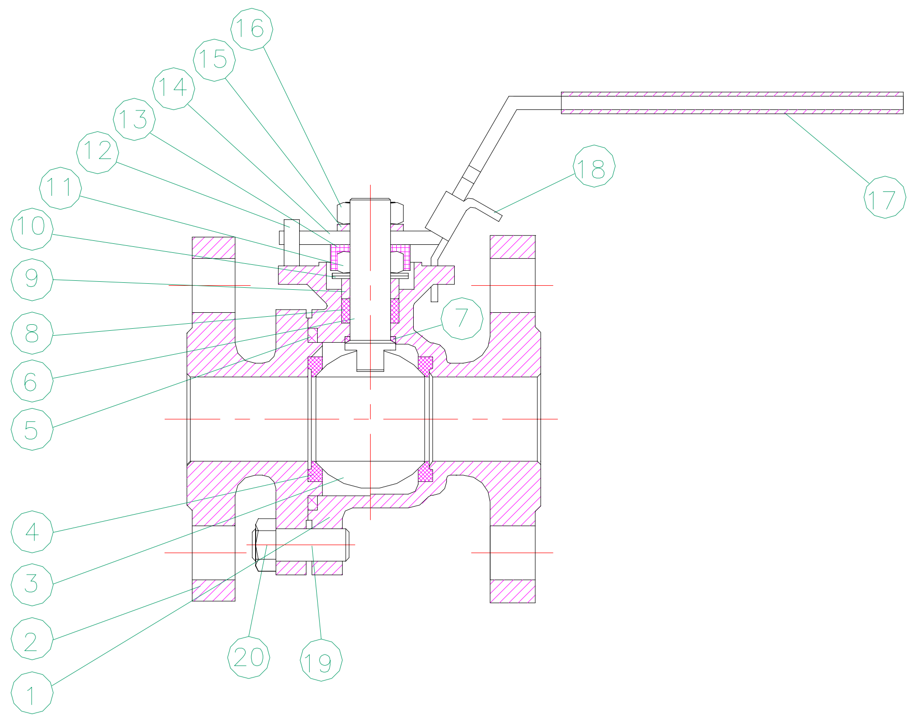
Davis Valve

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes ½" – 4" , Classes 150, 300, and 600

ITEM	DESCRIPTION
1	BODY
2	END CONNECTOR
3	BALL
4	SEAT
5	BODY GASKET
6	STEM
7	THRUST BEARING
8	STEM PACKING
9	GLAND PACKING
10	BELLVILLE WASHER
11	STEM NUT
12	STOPPER
13	LOCK TAB
14	HANDLE
15	HANDLE WASHER
16	HANDLE NUT
17	SLEEVE
18	LOCKING DEVICE
19	STUD
20	NUT



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150, 300, or 600.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the adjusting nut 1/4 turn. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle and travel stop plate.

3. Remove stem nut locking tab, stem nut, belleville springs, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

7. Take out other seat.

8. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Install one seat in the body cavity with the spherical curvature facing the ball.

2. Install thrust bearing on stem and slide the stem up through the body.

3. Install new stem seals, gland ring, and belleville springs. Install stem nut and tighten to the torque values given in Table 1. Install stem nut locking tab or cap. Tighten stem nut slightly if necessary to align nut with locking device surfaces.

4. Install travel stop (if supplied) and handle. Make sure handle aligns with flow bore through ball. Install hand retainer nut (or capscrew).

5. Turn the handle to the CLOSED position. Line up the ball slot with the stem tang and the ball into position on the stem tang. Turn the handle to the OPEN position to hold the ball in place.

6. Install the remaining seat into body end.

7. Place new body seal into counterbore in valve body.

8. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

9. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

10. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

11. Pressure test valve, if possible, before reinstalling in pipeline.

Table 1 - Stem Nut Torques

Valve Size	Torque (lb-ft)
½”	5.5
¾”	5.5
1”	6
1-1/2” – 4”	22

Table 2 – Body Bolting Torques (lb-ft)

Valve Size	Class 150	Class 300	Class 600
½”	5	10	15
¾”	5	10	20
1”	5	20	35
1-1/2”	15	35	80
2”	20	40	140
3”	20	60	155
4”	25	95	215

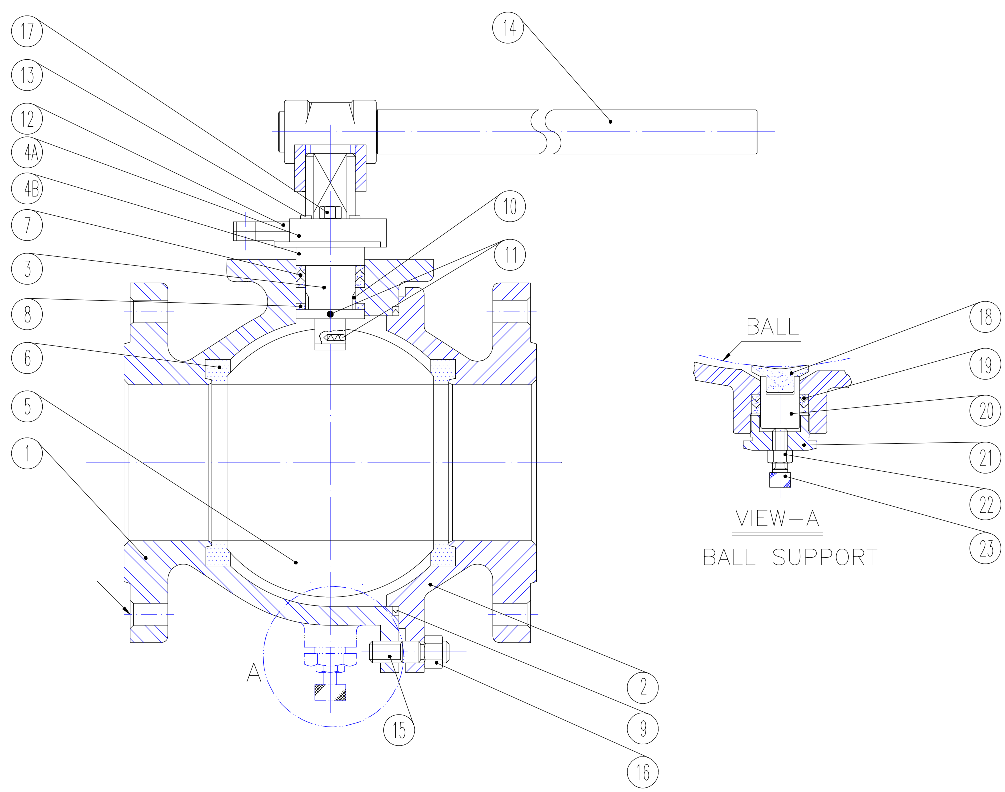
Note: Torque values are for TFE/RTFE or flexible graphite gaskets and seals. For other materials contact Sharpe Valves.

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes 6” - 12” , Classes 150 & 300

NO.	PART NAME
1	BODY
2	CAP
3	STEM
4A	GLAND
4B	GLAND RING
5	BALL
6	SEAT
7	PACKING
8	THRUST WASHER
9	GASKET
10	STEM BEARING
11	ANTI–STATIC
12	TRAVEL STOPPER
13	SNAP RING
14	HANDLE
15	STUD
16	NUT
17	GLAND BOLT
18	PIN SEAT
19	PIN PACKING
20	SUPPORT PIN
21	SUPPORT NUT
22	SET NUT
23	TUNING SCREW



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools. Ball support supplied for 10” and 12” Class 150 valves, and 6” through 12” Class 300 valves.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150 or Class 300.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the gland bolts 1/4 turn, each. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle, snap ring, and travel stop plate.

3. Remove gland bolts, gland, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. **<u>For 10” and 12” valves only</u>**: Ball support must be backed off to remove ball. Loosen support nut, set nut and back out tuning screw on bottom of valve to release the ball support. The weight of the ball will cause the ball support to come down.

7. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

8. Take out other seat.

9. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing and stem bushing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Set the valve body on a clean work suface, resting on the end flange.

2. Install one seat in the body cavity with the spherical curvature facing the ball (upwards).

3. Cut new stem bushing on one side at approx. 30° - 60° angle and wrap around stem above shoulder.

4. Install thrust bearing on stem and holding stem bushing in place, slide the stem up through stem bore from inside body.

5. Install new stem seals, gland ring, and gland. Install gland bolts and tighten hand tight.

6. Install travel stop, and snap ring.

7. Turn the stem to the CLOSED position (bottom stem tan parallel to flow passage). Line up the ball slot with the stem tang and roll and lower the ball into position on the stem tang, letting the ball rest in the seat. Turn the stem and ball to the OPEN position to hold the ball in place.

8. **For 10" and 12" Valves Only:** Re-set the ball support by turning the tuning screw inwards until the support pin seat firmly contacts the ball. Do not cause the ball to move. Holding the tuning screw in place, tighten the support nut and then the set nut.

9. Install the remaining seat into body end.

10. Place new body seal into counterbore in valve body.

11. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

12. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

13. Tighten the gland bolts to the torques specified in Table 1.

14. Install handle, making sure that the handle aligns with the flow passage through the ball.

15. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

16. Pressure test valve, if possible, before reinstalling in pipeline.

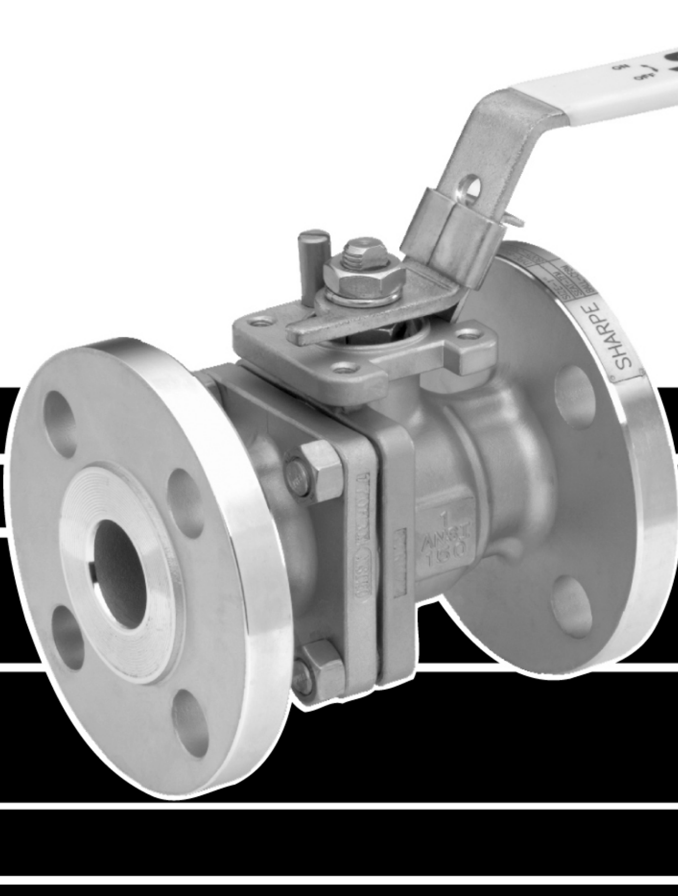
Table 1 – Gland Bolt Torques

SIZE	Tightening Torque (lb-ft) Max
6" – 8"	42 (1/2-13UNC)
10" - 12"	83 (5/8-11UNC)

Table 2 – Body Bolting Torques

SIZE	THREAD	Tightening Torque (lb-ft) Max
6”,8” (Class 150) / 3”~6”(Class 300)	5/8-11UNC	83
10”,12” (Class 150) / 8”(Class 300)	3/4-10UNC	120
10”(Class 300)	7/8-9UNC	190
12”(Class 300)	1-8UNC	260

SHARPE® VALVES

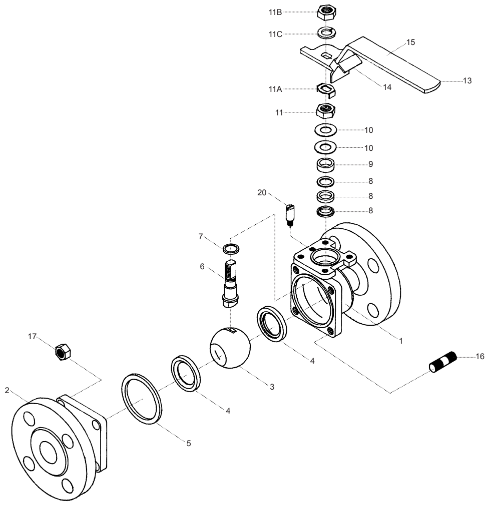


FLANGED FULL PORT BALL VALVE
SERIES 50 / CLASS 150

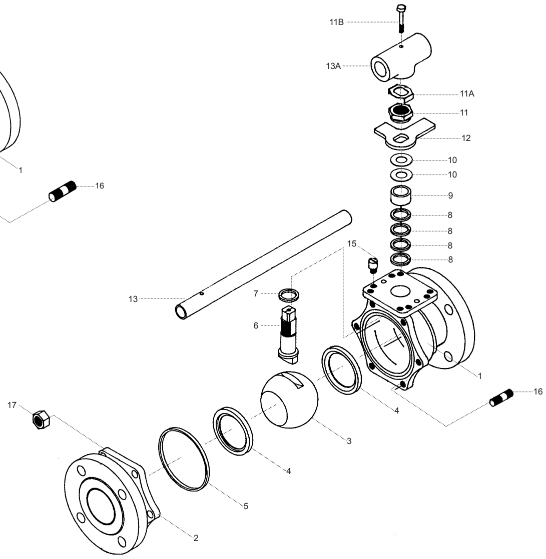
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

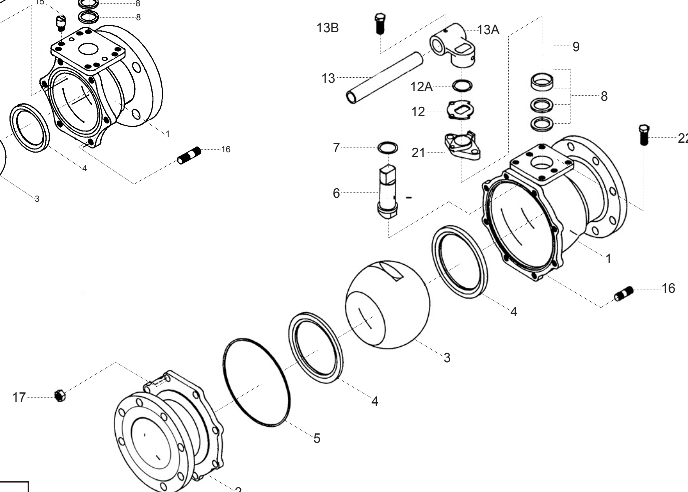
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2" - 2"



2-1/2" - 4"



6" - 8"

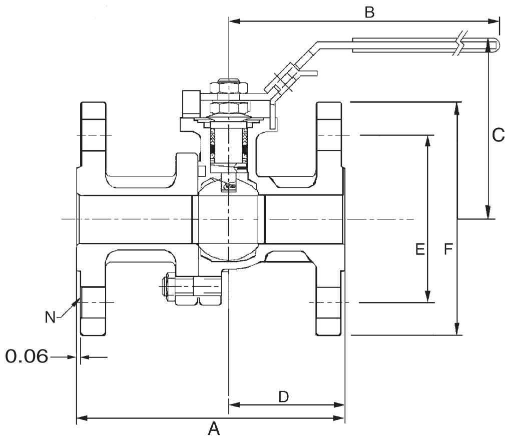
PART NO.	PART	QTY.	MATERIAL
1	Body	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) TFE Reinforced TFE NOVA PEEK
5	Body Seal	1	TFE
6	Stem	1	316 Stainless Steel Alloy 20 Hastelloy C 17-4PH (Option)
7	Thrust Bearing	2	Reinforced TFE
8	Stem Packing	3/4	Reinforced TFE
9	Gland Packing	1	304 Stainless Steel
10	Belleville Washer (1/2"-4")	2/4	304 Stainless Steel
11	Packing Nut (1/2"-4")	1	304 Stainless Steel
11A	Lock Tab	1	Stainless Steel
11B	Handle Nut	1	304 Stainless Steel
11C	Lock Washer	1	304 Stainless Steel (1/2"-2")

*See Dimensions

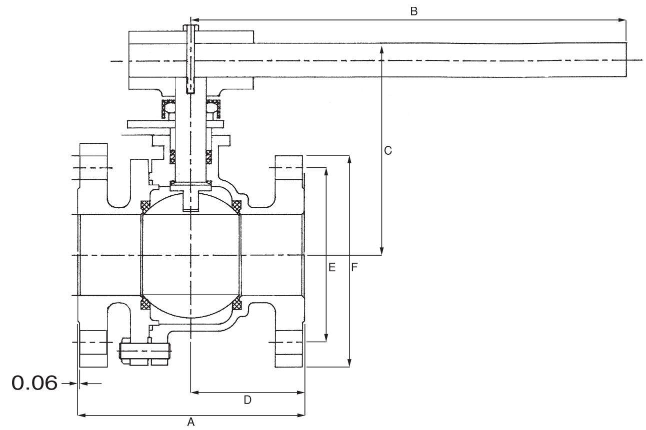
PART NO.	PART	QTY.	MATERIAL
12	Stopper	1	304 Stainless Steel
12A	Snap Ring	1	Stainless Steel (6"-8")
13	Handle	1	304 Stainless Steel (1/2"-2") Galvanized Steel (2-1/2"-4") Ductile Iron (6"-8")
13A	Wrench Block	1	Stainless Steel
13B	Hex Head Bolt	1	304 Stainless Steel
14	Locking Device (1/2"-2")	1	304 Stainless Steel
15	Sleeve	1	Vinyl
16	Body Stud	SEE* N	A193 B8 (SST) A193 B7 (CS)
17	Nut	SEE* N	A194 8 (SST) A194 2H (CS)
20	Stop Pin (1/2"-2") (2-1/2"-4")	1 2	304 Stainless Steel 304 Stainless Steel
21	Gland Flange (6"-8")	1	304 Stainless Steel
22	Gland Bolts (6"-8")	2	304 Stainless Steel

SERIES 50
DIMENSIONS

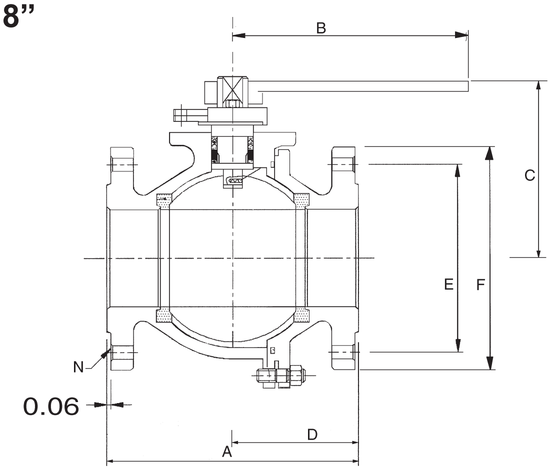
1/2" - 2"



2-1/2" - 4"



6" - 8"



CV DATA

1/2"	26
3/4"	50
1"	94
1-1/2"	260
2"	480
2-1/2"	750
3"	1300
4"	2300
6"	5400
8"	10000

PORT

1/2"	0.59
3/4"	0.78
1"	1.00
1-1/2"	1.50
2"	2.00
2-1/2"	2.55
3"	3.00
4"	4.00
6"	6.00
8"	7.88

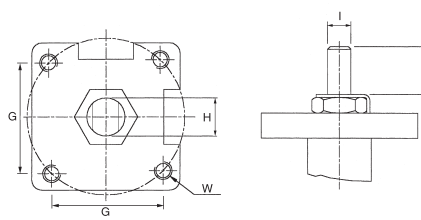
WEIGHT (lbs.)

1/2"	4
3/4"	6
1"	8
1-1/2"	15
2"	20
2-1/2"	36
3"	45
4"	75
6"	135
8"	290

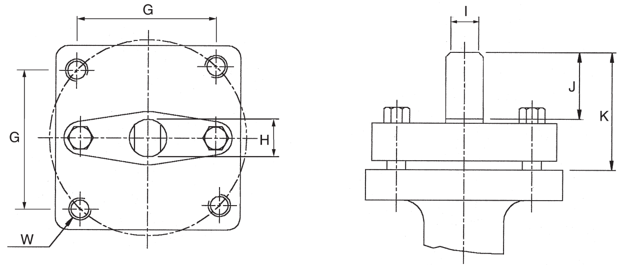
SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2"	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4"	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1"	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2"	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2"	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2"	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3"	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4"	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6"	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8"	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

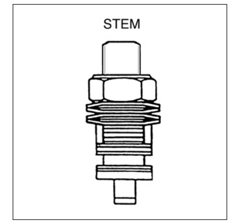
The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.

1/2" - 4"



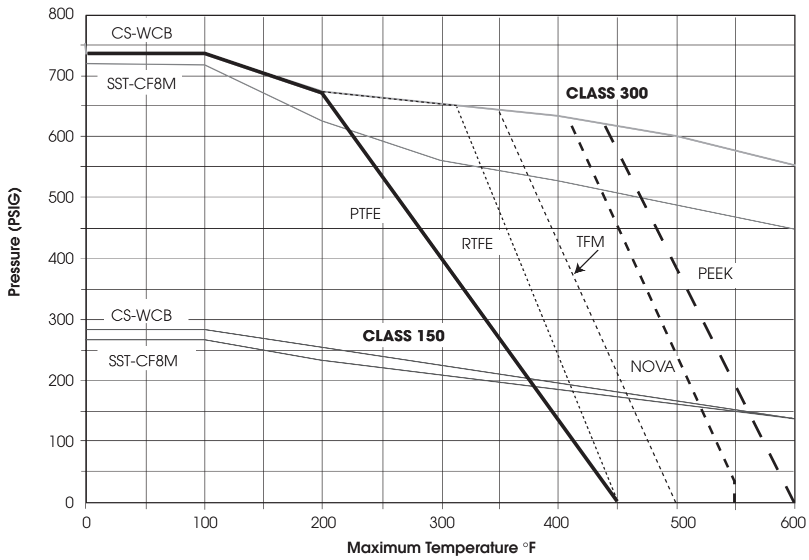
6" - 8"





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2″	50	150# = 11	2 = Alloy 20	T = TFE	X = Oxygen Service
3/4″			4 = Carbon Steel	R = RTFE	OH = Oval Handle
1″			6 = Stainless Steel	N = NOVA	F = Fugitive Emissions Certified ANSI 593.00.01
1-1/2″			5 = Hastelloy C	P = Peek	E = Extended Stem
2″			3 = Monel	M = TFM™	L = Lockable Extended Stem
2-1/2″					D = Leak detection Stem
3″					GO = Gear Operator
4″					7 = 17- 4PH Stem
6″					A = Nace
8″					

3/4" 50 11 6 T X

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(877) 774-2773
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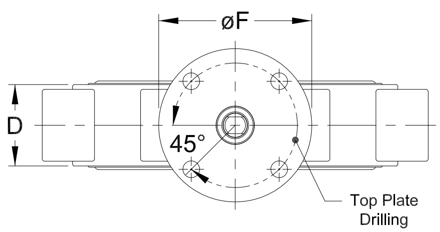
E-Mail: info@sharpevalves.com
www.sharpevalves.com
1260 Garnet Drive
Northlake, Illinois 60164 U.S.A.

SHARPE® VALVES

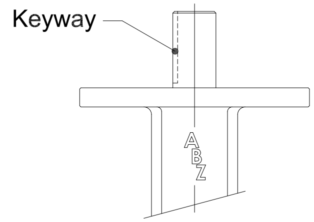
A Division of Smith-Cooper International, LLC

Rev. 1/09

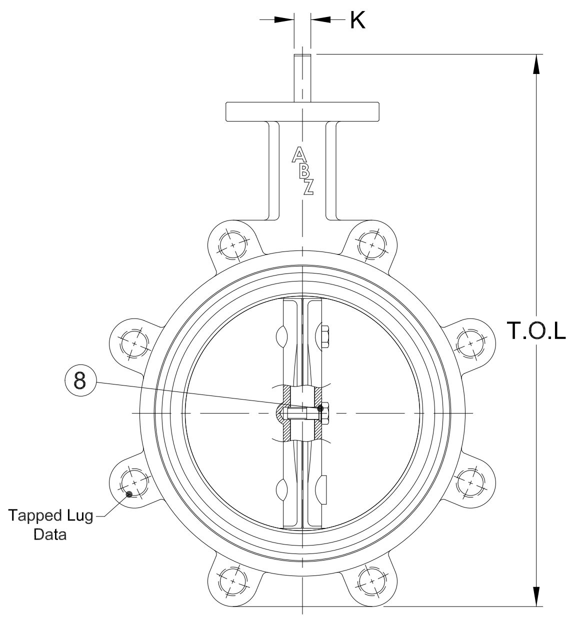
Valve Parts			
Item No.	Name	Material	No. Req'd
1	Lug Body	-	1
2	Disc	-	1
3	Stem	-	1
4	Seat	-	1
5	Bushing	-	1
6	Seal	-	1
7	Screw	-	1 Set
8	"O-Rings"	-	1 Set



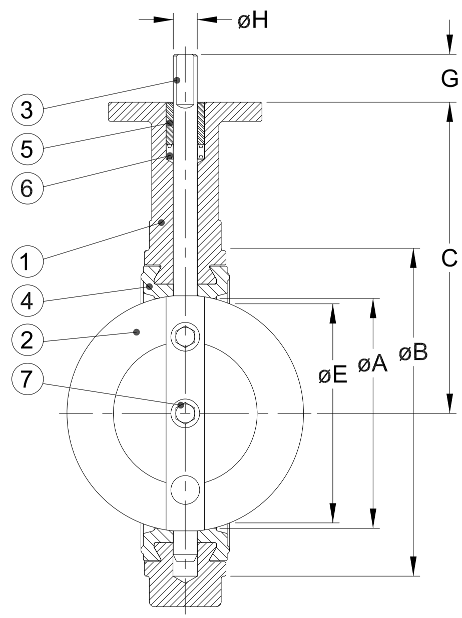
Top View



12" Stem



Flow View



Section View

Notes:
1. The Figure 102 valve can not be used on a pipe or flange with an inside diameter less than the "E" dimension.
2. Installation Direction: Bi-directional (175 psi) and Dead End Service (85 psi).
3. Undercut disc are rated for 50 psi bi-directional service and 25 psi dead end service.
4. Preferred direction is with disc bolts on downstream side of disc.

Valve Dimensions

Valve Size	øA	øB	C	D	øE	øF	G	øH	K	Keyway	T.O.L	Weight	Top Plate Drilling			Tapped Lug Data		
													Bolt Circle	No. of Holes	Hole Dia.	Bolt Circle	No. of Holes	Tap
2"	2 1/8	4 1/8	5 1/2	1 5/8	1 11/16	4	1 1/4	9/16	3/8	——	9.31	7 lbs	3 1/4	4	7/16	4 3/4	4	5/8"-11unc
2 1/2"	2 9/16	4 7/8	6	1 3/4	2 3 /16	4	1 1/4	9/16	3/8	——	10.06	10 lbs	3 1/4	4	7/16	5 1/2	4	5/8"-11unc
3"	3 1/8	5 3/8	6 1/4	1 3/4	2 7/8	4	1 1/4	9/16	3/8	——	10.56	10 lbs	3 1/4	4	7/16	6	4	5/8"-11unc
4"	4 1/8	6 7/8	7	2	3 7/8	4	1 1/4	5/8	7/16	——	12.56	18 lbs	3 1/4	4	7/16	7 1/2	8	5/8"-11unc
5"	5 3/16	7 5/8	7 1/2	2 1/8	5	4	1 1/4	5/8	7/16	——	13.31	22 lbs	3 1/4	4	7/16	8 1/2	8	3/4"-10unc
6"	6 1/8	8 3/4	8	2 1/8	6	4	1 1/4	5/8	7/16	——	14.50	24 lbs	3 1/4	4	7/16	9 1/2	8	3/4"-10unc
8"	8 1/8	11	9 1/2	2 1/2	8	6	1 1/4	3/4	1/2	——	17.19	44 lbs	5	4	9/16	11 3/4	8	3/4"-10unc
10"	10 1/8	13 3/8	10 3/4	2 1/2	10 1/16	6	1 1/4	7/8	5/8	——	19.56	62 lbs	5	4	9/16	14 1/4	12	7/8"-9unc
12"	12 1/8	16 1/8	12 1/4	3	11 15/16	6	2	1 1/8	——	1/4x1/4	23.19	93 lbs	5	4	9/16	17	12	7/8"-9unc

Design Standard	CWP Rating	Flange Connection	Test Standard
API 609 Cat. A	175 PSI	B16.1 / B16.5	API 598

FORUM™ ENERGY TECHNOLOGIES

Valve Solutions
ABZ Valves & Controls

ABZ VALVE

Title:
Resilient Seated Butterfly Valve
Series 102 - Lug Type

Scale: N/A

Projection

DWG No.: 2"-12" 102-Bare Stem

Unit: inch

Date	Drawn	Checked		Revision
09-22-11	BC	Tp	Dimensions are subject to change without notice.	0

Resilient Seated Butterfly Valves

ABZ VALVE

A GFT COMPANY

Figures 101/108/102

Sizes
2" - 12"
Rated Up To 175 PSI

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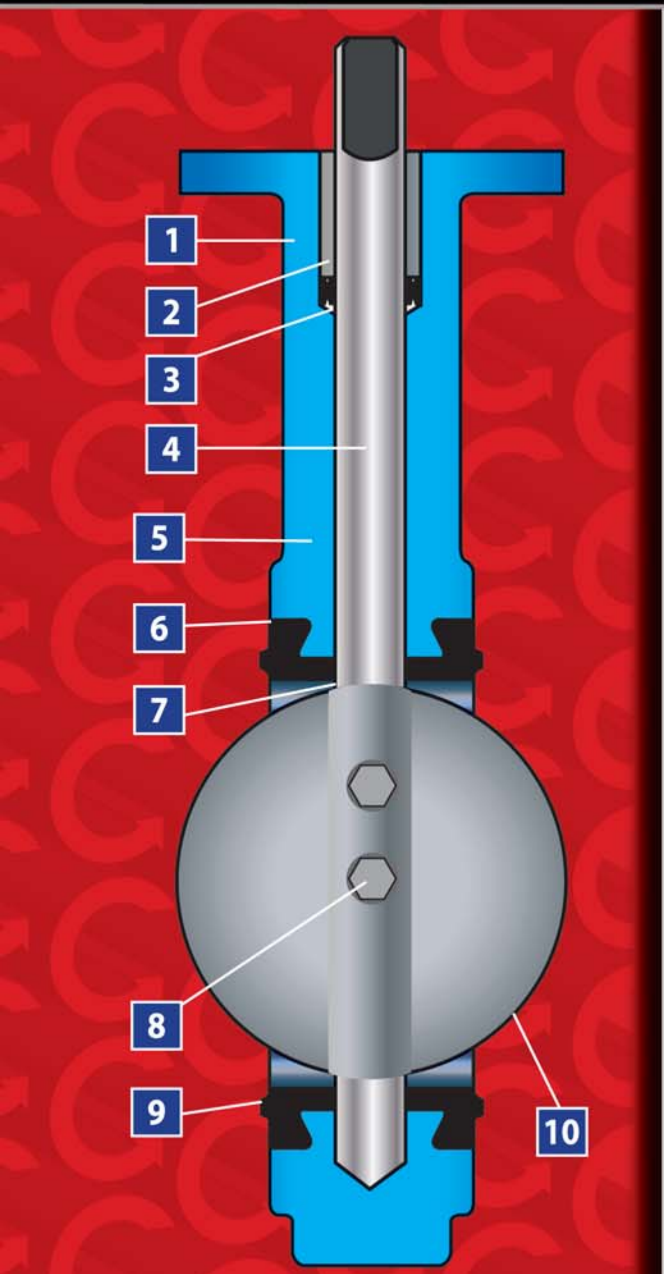
620-437-2440 • FAX 620-437-2435
www.abzvalve.com • info@abzvalve.com

ABZ Precision Built Butterfly Valves

Resil-O-Seat™ Seated Valves for Chemical and Abrasion Resistance Applications.

The figures 101/102/108 provide excellent flexibility with a variety of trim materials. These are available for a wide selection of applications.



1 Body machined to high tolerances. Guaranteed standard dimensions for interchangeability of parts and actuators.

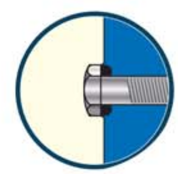
2 Top bushings protect the stem from side thrust of operators. They are made of impact and corrosion resistant materials.

3 Special double-V-shape of stem seal self-adjusts to protect the stem area for either vacuum or pressure use.

4 Stem extends through disc and aligns with socket in body. Stem end has standard dimensions for operator interchangeability.

5 Long neck allows for insulation requirements.

6 The special snap-in Resil-O-Seat™ design fixes seat in place without bonding. The Resil-O-Seat™ is 100% field replaceable - no special tools required.



7 Stem and body are isolated from the line media by the interference fit of the primary seal created between the disc and seat.

8 Stainless steel cap screws securely hold disc to stem. O-ring seal prevents leakage into the stem area and creates a positive connection.

9 Resil-O-SeatTM forms a seal against all standard ANSI 125/150 flanges. Gasketing requirements are eliminated.

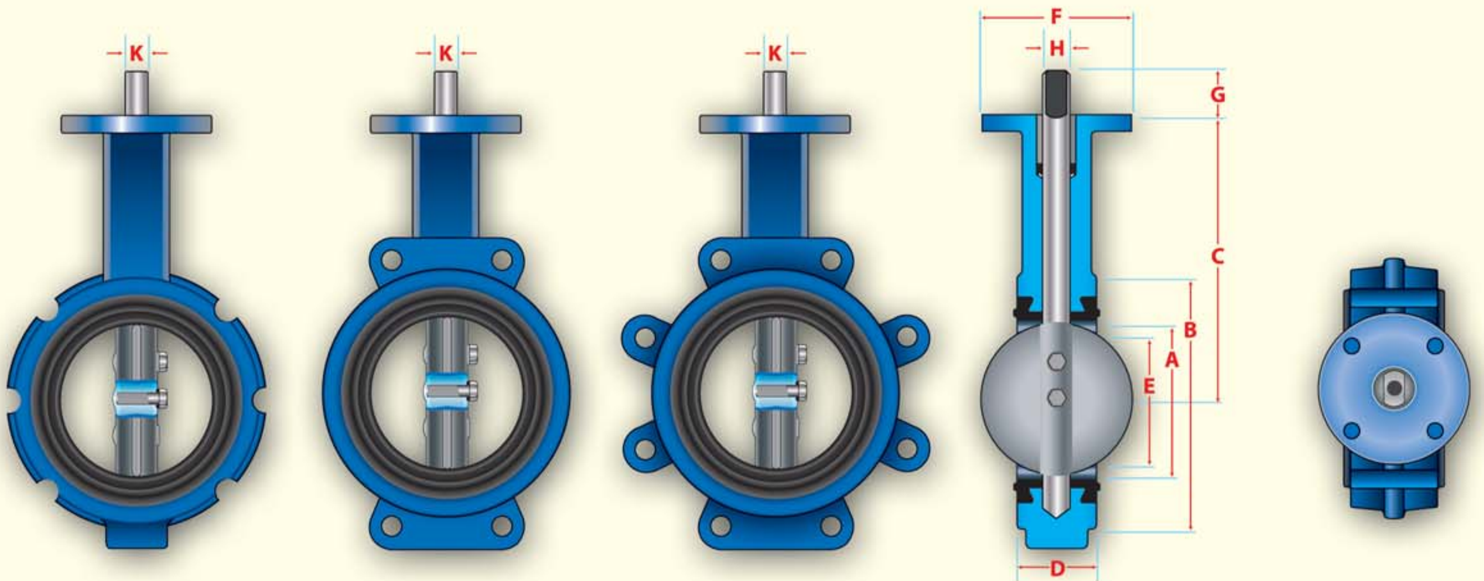
10 Disc edge is individually processed through machining and hand buffing for a smooth edge, providing a bubble tight shutoff and maximum seat life.

101 is a wafer style body
108 is semi-lug style body
102 is a full lug style body

ABZ VALVE
A GFT COMPANY

FIGURES 101/108/102

Valve Dimensions



All standard seats are Food Grade with the exception of Viton

Valve Size	DIMENSIONS									TOP PLATE DRILLING			TAPPED LUG DATA				WEIGHT (POUNDS)		
	A	B	C	D	E	F	G	H	K	Bolt Circle	No. Holes	Hole Dia.	Bolt Circle	No. Holes 102	No. Holes 108	Tap	101	108	102
2	2 1/8	4 1/8	5 1/2	1 5/8	1 11/16	4	1 1/4	9/16	3/8	3 1/4	4	7/16	4 3/4	4	4	5/8-11 UNC	7	8	8
2 1/2	2 9/16	4 7/8	6	1 3/4	2 3/16	4	1 1/4	9/16	3/8	3 1/4	4	7/16	5 1/2	4	4	5/8-11 UNC	8	9	9
3	3 1/8	5 3/8	6 1/4	1 3/4	2 7/8	4	1 1/4	9/16	3/8	3 1/4	4	7/16	6	4	4	5/8-11 UNC	9	10	10
4	4 1/8	6 7/8	7	2	3 7/8	4	1 1/4	5/8	7/16	3 1/4	4	7/16	7 1/2	8	4	5/8-11 UNC	13	17	20
5	5 3/16	7 5/8	7 1/2	2 1/8	5	4	1 1/4	5/8	7/16	3 1/4	4	7/16	8 1/2	8	4	3/4-10 UNC	19	20	23
6	6 1/8	8 3/4	8	2 1/8	6	4	1 1/4	5/8	7/16	3 1/4	4	7/16	9 1/2	8	4	3/4-10 UNC	20	24	27
8	8 1/8	11	9 1/2	2 1/2	8	6	1 1/4	3/4	1/2	5	4	9/16	11 3/4	8	4	3/4-10 UNC	36	38	43
10	10 1/8	13 3/8	10 3/4	2 1/2	10 1/16	6	1 1/4	7/8	5/8	5	4	9/16	14 1/4	12	4	7/8-9 UNC	49	55	63
12	12 1/8	16 1/8	12 1/4	3	11 15/16	6	2	1 1/8	1/4	5	4	9/16	17	12	4	7/8-9 UNC	70	82	90

STANDARD CONSTRUCTION SPECIFICATIONS:

Body: Cast Iron, Ductile Iron (Lug) and Aluminum (Wafer)

Disc: 316 Stainless Steel, Aluminum Bronze, Ductile Iron, Epoxy Coated Ductile Iron

Stem: 316 Stainless Steel, 416 Stainless Steel, Carbon Steel

Resilient Seat: EPDM, Buna-N, Viton, Natural Rubber, White Buna, White Neoprene.

Stem Bushing: Teflon® – Graphite Impregnated

Stem Packing: Buna-N and Viton

Additional materials are available for a wide selection of applications.

NOTES:

1. Dimension "K" not applicable to 12" size. The 12" stem is round with ¼" Key.
2. The figures 101, 102 and 108 cannot be used on pipe or flange with an inside diameter less than the "E" dimension.
3. Valves are rated up to 175 PSI bi-directional service and 85 PSI end of line rating. Undercut disc is rated up to 50 PSI bi-directional service and 25 PSI end of line rating. Preferred direction is with disc bolts on downstream side of disc.
4. Designed in accordance with sections of API 609 Catagory A, ASME 16.1/16.5, ASME 16.34 and MSS SP67. Design tested in accordance with API 598.
5. Compatible with ANSI Class 125/150 flange standards.

Rated Flow Coefficient (Cv) - Figure 101/108/102

Valve Size	ANGLE OF DISC OPENING								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
2	1.67	7.7	17	29	48	74	115	145	195
2 1/2	2.50	11.0	25	44	69	109	174	237	307
3	3.33	15.7	37	64	105	165	276	377	487
4	5.00	27.7	63	110	177	278	472	671	827
5	8.33	43.7	99	177	276	443	752	1,083	1,325
6	13.33	58.7	136	242	385	616	1,075	1,521	1,883
8	20.00	107.3	247	434	687	1,094	1,821	2,671	3,239
10	31.67	174.0	394	696	1,092	1,770	2,983	4,288	5,210
12	47.0	251.7	578	1,002	1,665	2,654	4,398	6,466	8,026

Cv is defined as the volume of water in U.S.G.P.M. that will flow through a given restriction or valve opening with a pressure drop of one (1) p.s.i. at room temperature. Recommended control angles are between 25°-70° open.

Torque Chart - Figure 101/108/102

Valve Size	NORMAL CONDITIONS					SEVERE CONDITIONS				
	Δ P=0	Δ P=50	Δ P=100	Δ P=150	Δ P=175	Δ P=0	Δ P=50	Δ P=100	Δ P=150	Δ P=175
2	221	230	240	250	254	373	384	400	406	410
2 1/2	269	283	288	302	311	454	464	475	486	497
3	322	341	365	379	392	540	568	589	611	634
4	480	514	542	576	590	816	848	886	918	936
5	653	706	754	806	854	1,102	1,162	1,220	1,274	1,301
6	907	1,008	1,109	1,210	1,260	1,529	1,642	1,756	1,868	1,926
8	1,512	1,714	1,915	2,112	2,215	2,549	2,776	3,002	3,229	3,343
10	2,318	2,621	2,900	3,224	3,372	3,910	4,250	4,590	4,931	5,101
12	3,125	3,629	4,138	4,637	6,112	5,270	5,838	6,404	6,971	7,258

Undercut disc available.

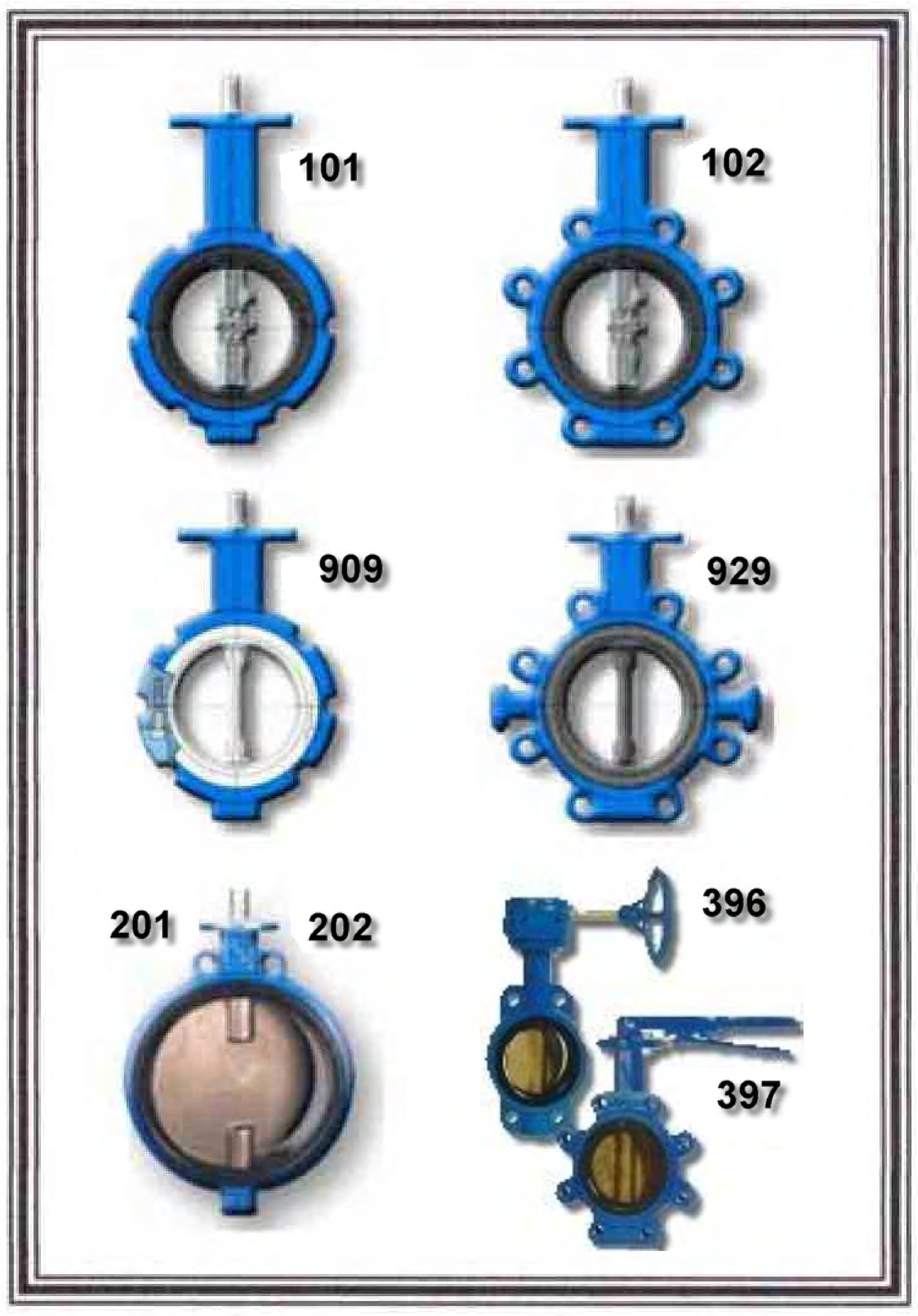
All torques shown in inch lbs. 20% Safety factor already included.

ABZ VALVES & CONTROLS, INC.
A Global Flow Technologies Company
P.O. Box 157 • 113 West Main • Madison, KS 66860
PHONE: 620-437-2440 • FAX: 620-437-2435
www.abzvalve.com • www.globalflowtech.com
info@abzvalve.com

Certified System ISO 9001-2008

ABZ VALVES & CONTROLS

BUTTERFLY VALVES



INSTALLATION AND MAINTENANCE MANUAL

ABZ VALVES & CONTROLS

Butterfly Valve
Installation Instructions

Table of Contents

Flange Requirements:

ABZ's resilient seated (RS) valves are designed for installation between ANSI Class 125/150 flat or raised faced flanges. Gaskets are not required. Lined pipe, heavy wall pipe or flanges must have a minimum allowable inside diameter at the centered body face to clear the disc sealing edge when opening the valve.

Storage:

The valves should be stored on a pallet or "skid" in a clean, dry warehouse. If the valves must be stored outside, the following apply:

1. Valves must be kept off the ground high enough to avoid standing water.

2. Cover the valves with a water repellant cover (not included with valve).

Service Locations:

For service or technical information, please contact us: (620) 437-2440, e-mail: abzvalve@madtel.net or at our website www.abzvalve.com

Maintenance:

Routine maintenance or lubrication is not required.

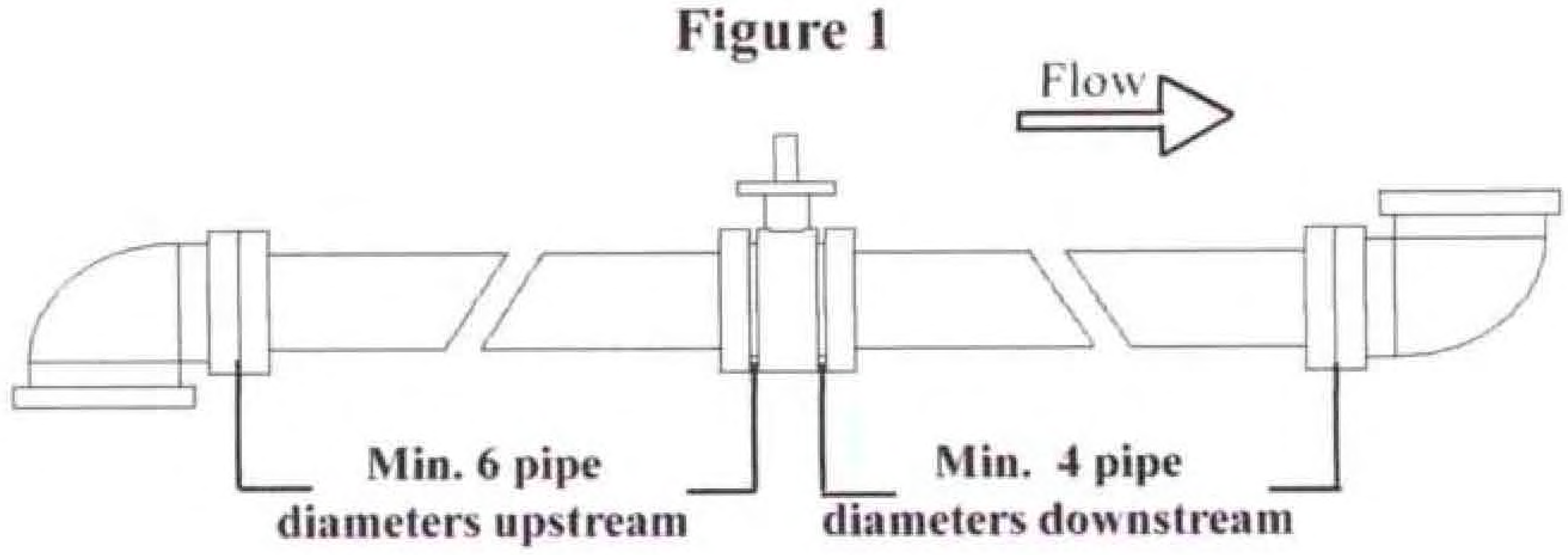
Installation Instructions:

ABZ's resilient seated (RS) valves are bidirectional and will control flow equally well in either direction. For the best results in slurry service regarding sedimentation, position the valve assembly so that the valve stem is in the horizontal position and the lower disc edge opens downstream. This will create a self-flushing effect, thereby extending the service life of the valve. (See Figure 3 on Page 5).

Installation Instructions cont.

Consideration should be given to the location of the valves in the piping system. The valve should not be placed too close to other valves, elbows, etc. as its performance may be affected. It is recommended that the valve have a minimum of six pipe diameters upstream (see Figure 1) and four pipe diameters downstream between it and other valves, elbows, etc. in the piping system. (See Figures 4 - 10 on pages 5 - 8 for pump applications, elbows, pipe reduction and other special applications).

Figure 1



Installation Between Pre-Existing ANSI Flanges:

(See Figures 11-13 on Pages 7 & 8 for illustrations)

1. Observe that the disc sealing edge is in line with the parallel flats (or keyway) on the stem. Rotate the stem clockwise to position the disc within the body at least 3/8" away from the body face.

2. Spread the flanges to exceed the valve's face-to-face dimension by 3/16" before placing the valve in position to prevent distortion and/or damage to the seating face of the seat.

3. Center the valve body between the flanges and span the valve body with all flange bolts possible. Turn the disk to the fully open position.

4. While gradually removing the flange spreaders, center the valve body to the flanges and tighten the bolting hand tight. Slowly close the valve to check for adequate disc clearance.

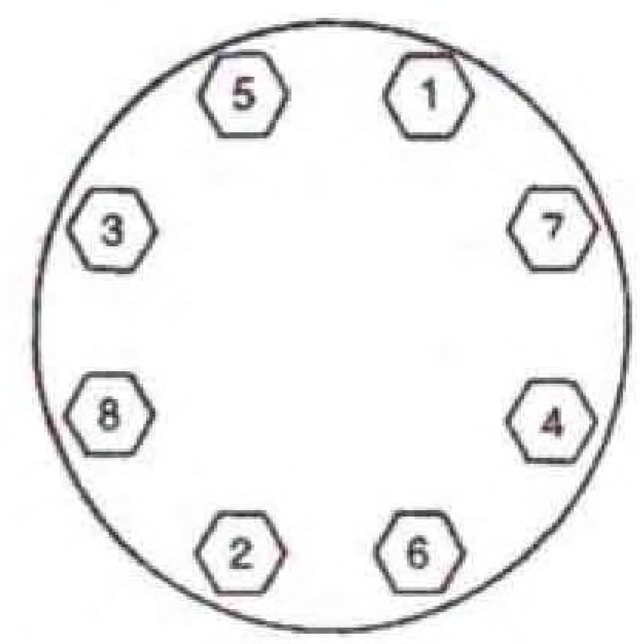
Installation Between Pre-Existing ANSI Flanges cont.:

5. Return the disc to the fully open position and cross-tighten all bolting to the proper torque specification:

Table 1. Bolt Torques: Resilient Seated Butterflies with Cap Screws on Metal Flanges

Flange Size	Recommended Min. Bolt Torque	Flange Size	Recommended Min. Bolt Torque
2"-4"	20 - 30 ft. lbs.	18"-20"	150 - 210 ft. lbs.
5"-8"	33 - 50 ft. lbs.	24"-30"	215 - 300 ft. lbs.
10"	53 - 75 ft. lbs.	36"	300 - 375 ft. lbs.
12"	80 - 110 ft. lbs.	42"-48"	350 - 425 ft. lbs.
14"-16"	140 - 200 ft. lbs.		

Figure 2.
Bolt Tightening Sequence



6. Again, check for adequate disc clearance. If the installation is satisfactory, the valve is ready for service and/or installing the valve actuator.

Installation in New Construction Using ANSI Welding Type Flange:

1. With the disc in the nearly closed position, align and center the companion flange bolt holes to the body lug holes.

2. Assemble the body and flanges with the flange bolting and mate-up the bolting using the flange-body-flange assembly for fit-up and centering to the pipe.

3. Tack weld the flanges to the pipe.

4. Remove the flange bolting and valve assembly from between the flanges.

Note: Do not finish weld the flanges to the pipe with the valve bolted between the flanges as this will result in serious heat damage to the valve seat.

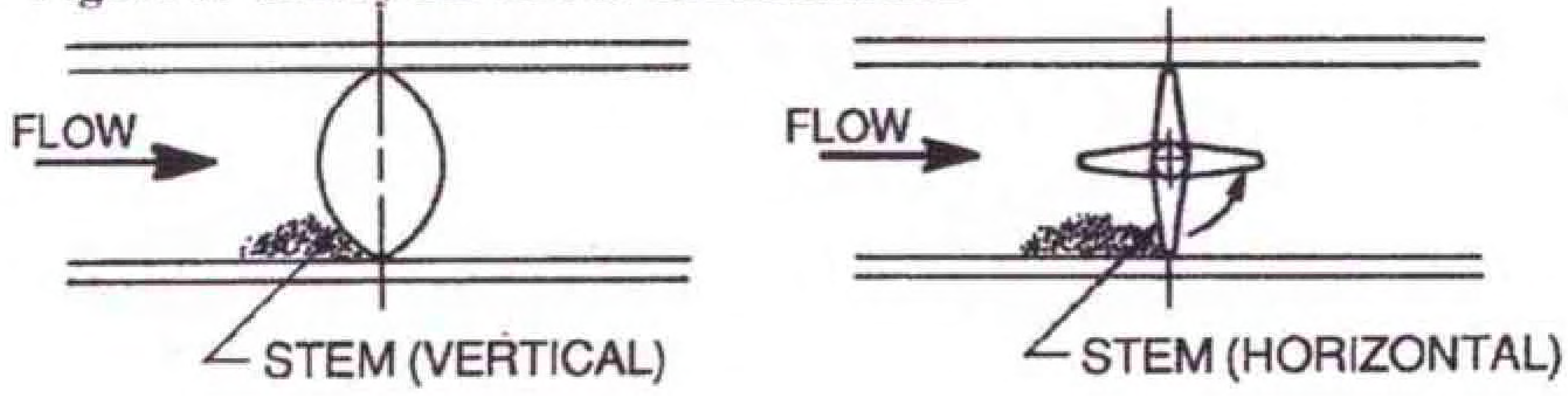
5. Finish welding the flanges to the pipe and allow the flanges to cool completely before proceeding.

6. Follow steps 1 through 5 of "Installation Between Pre-Existing ANSI Flanges."

Troubleshooting:

Symptom	Probable Cause	Solution
Excessively High Torque	1. Pinched Seats: A. Flange bolts are not evenly torqued. B. Over-torqued bolts.	1. Loosen the Flange Bolts around valve. Manually spin disc through butterfly valve a couple of times to attempt to reshape the seat. Tighten the Flange Bolts in the proper sequence (see Page 3) to correct torque per ANSI requirements. Note: If valve face seal has been damaged, or if the valve has been installed incorrectly for an extended period of time and this does not help, the valve may need to be replaced.
	2. Valve installed too close to an elbow, strainer, pipe reduction or other obstruction.	2. Either change piping, change the location of the valve or upgrade the torque on actuator.
	3. Valve oriented in incorrect position for the application.	3. See Page 8. Reinstall valve to the correct position.
	4. Obstruction in the pipeline.	4. Remove valve from pipeline and remove obstruction.
	5. Valve stem or disc bent.	5. Return valve to factory for disc/stem replacement (check for water hammer or freezing of line material).
	6. Scale build-up on stem or seat.	6. Open and close the valve several times. Operate the valve at least once a month. Check the valve seat for deterioration. Flush system periodically and ensure proper chemical treatemnt program is implemented on a consistent basis. Excessive addition of system chemicals at one time may coat the surface of valve seat and disc. (Yearly water treatment)
	7. Improper pipe supports.	7. Add pipe supports.
	8. Improperly welded flanges (NOT perpendicular).	8. Re-weld flange properly.
Leakage in the Closed Position (Leakage in the Pipeline)	The Disc is not closing fully: 1. Actuator is not adjusted properly.	1. Refer to Actuator Adjustment procedures in RE Troubleshooting Guide.
	2. Line pressure exceeds control valve's rated close-off pressure.	2. Reduce line pressure to control valve's rated close-off pressure or upgrade actuator.
	3. Excessively high torque.	3. See Excessively High Torque above.
Leakage Past the Flange Face	1. Flange bolts are not evenly torqued.	1. Loosen the Flange Bolts and tighten the Flange Bolts to correct torque per ANSI requirements. (See Page 3)
	2. Improper Flanged.	2. Refer to "Flange Requirements" on Page 1
Valve opens only a few degrees and stops (it will not open to the full angle desired)	1. Improper Installation. The valve is improperly aligned.	1. Loosen the flange bolts, realign the valve with flanges and retighten the flange bolts to correct torque per ANSI requirements. (See Page 3)
Water Hammer	1. The valve is closing too quickly.	1. Adjust the actuator speed if possible, or change control signal.

Figure 3. Slurry Service or Sedimentation

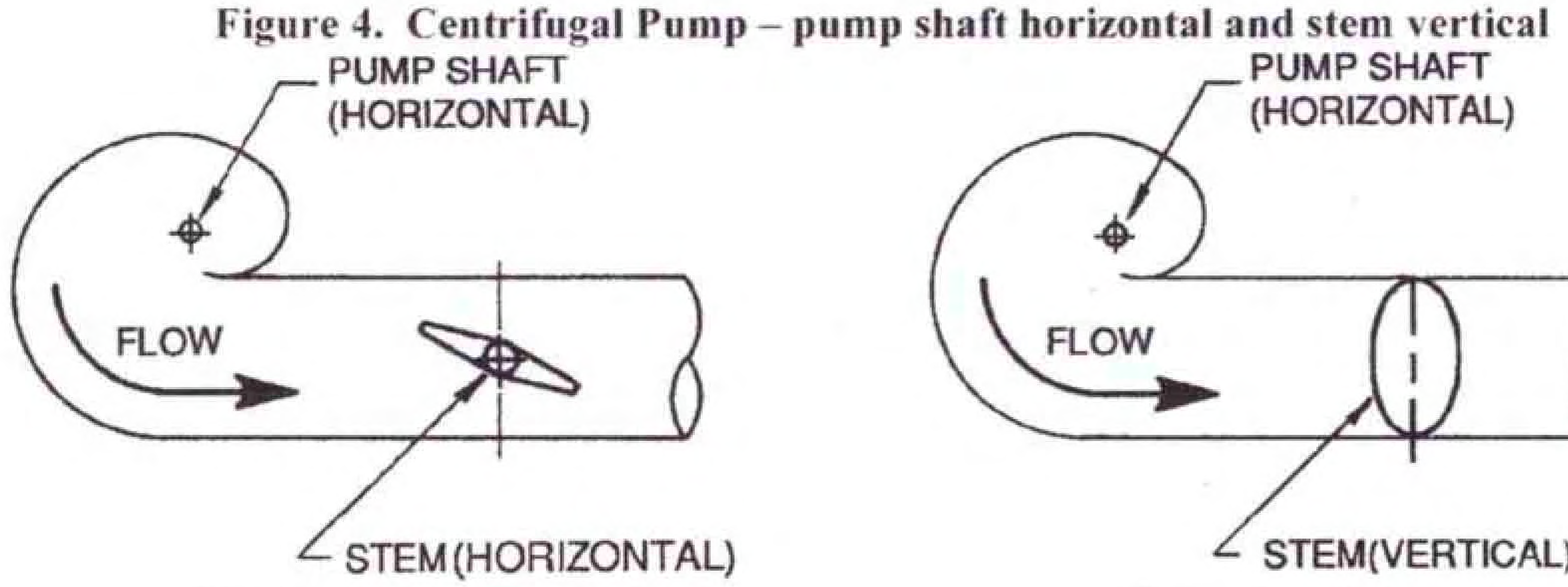


Incorrect Installation *Correct Installation*

Butterfly Valves Located at the Discharge of a Pump

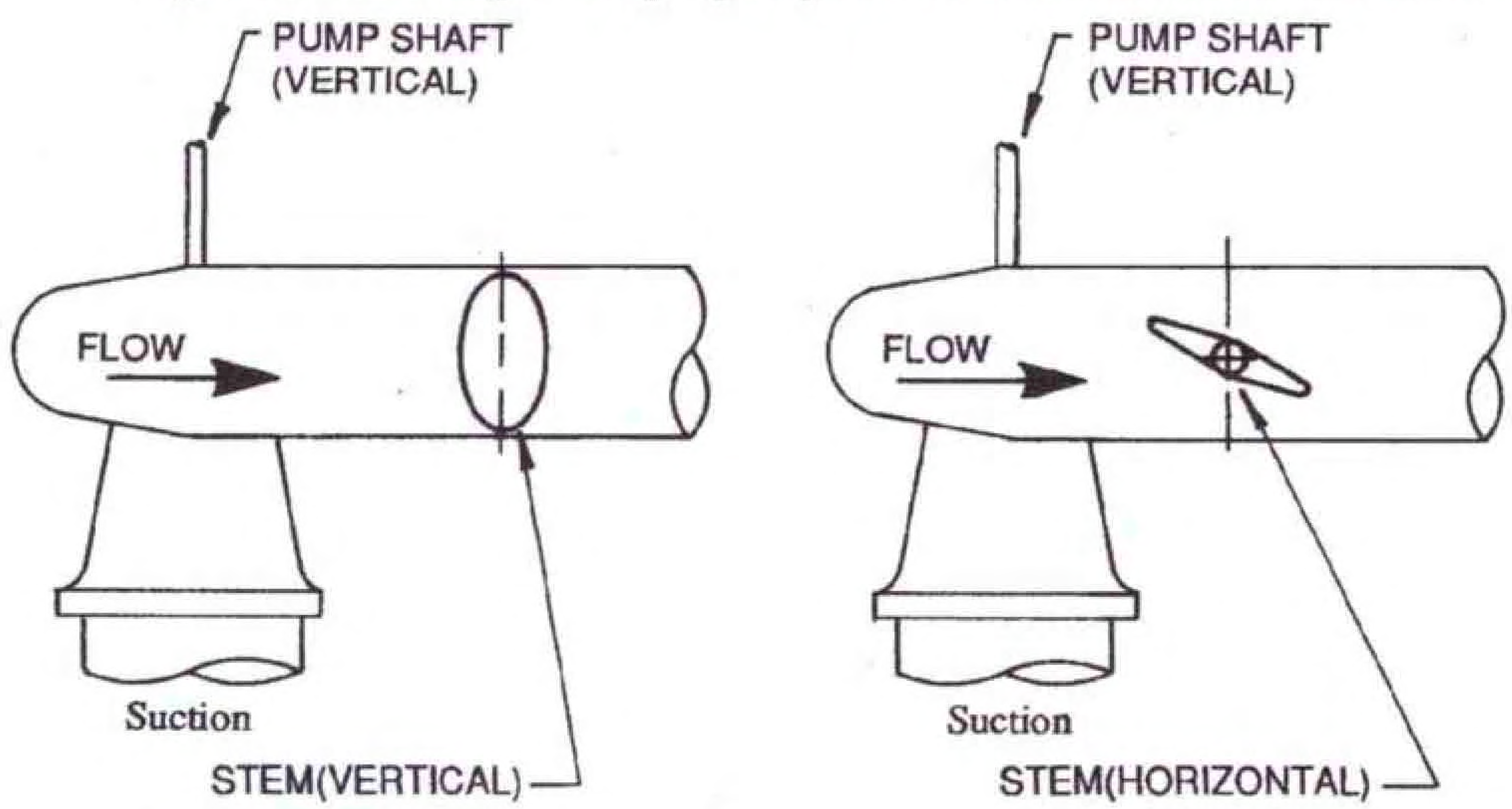
(See Page 2 for distance between pump and valve)

Figure 4. Centrifugal Pump – pump shaft horizontal and stem vertical



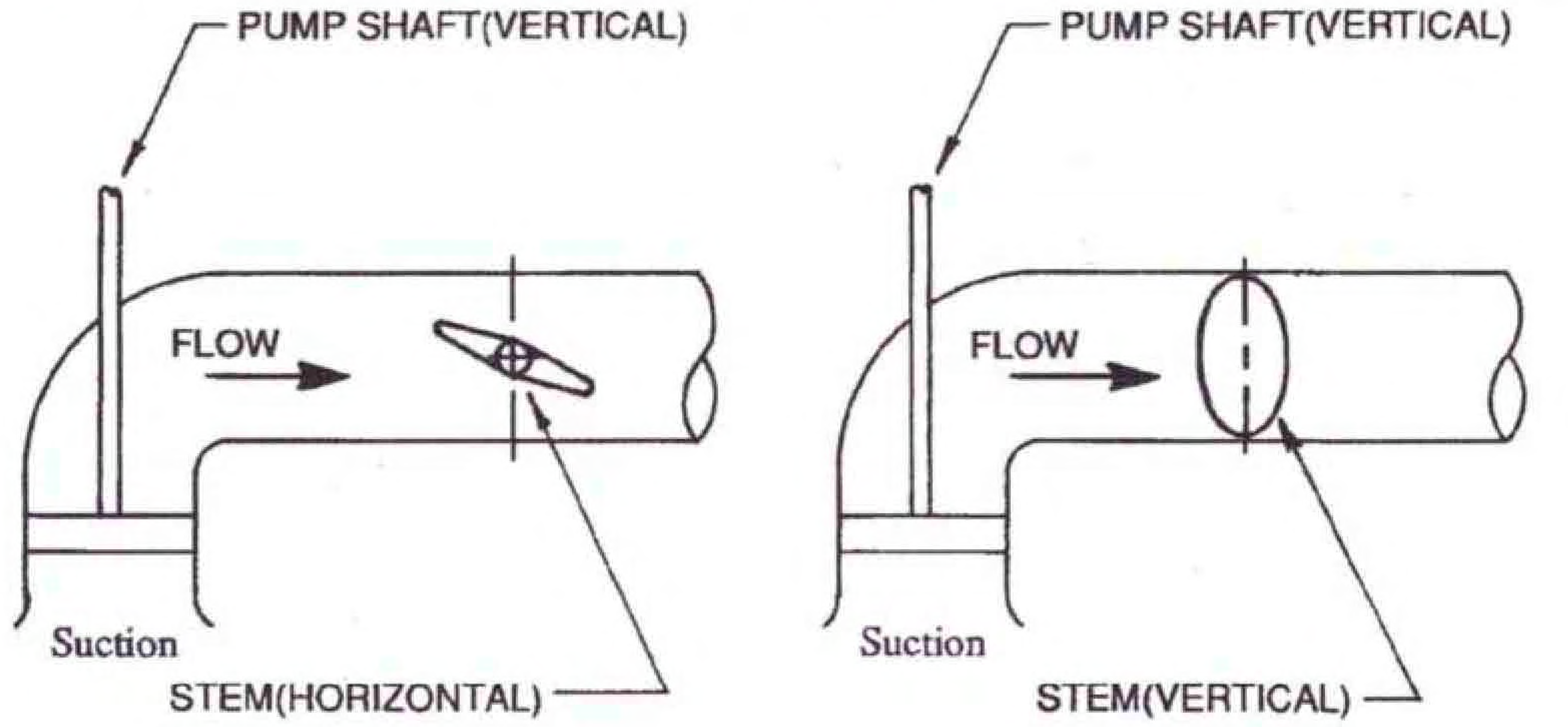
Incorrect Installation *Correct Installation*

Figure 5. Centrifugal Pump – pump shaft vertical and stem horizontal



Incorrect Installation *Correct Installation*

Figure 6. Axial Pump – pump shaft vertical and stem vertical



Incorrect Installation *Correct Installation*

Butterfly Valves Located Downstream of a Bend or Pipe Reducer

(See Page 2 for distance between bend/tee and valve)

Incorrect Installation *Correct Installation*

Figure 7. Bend

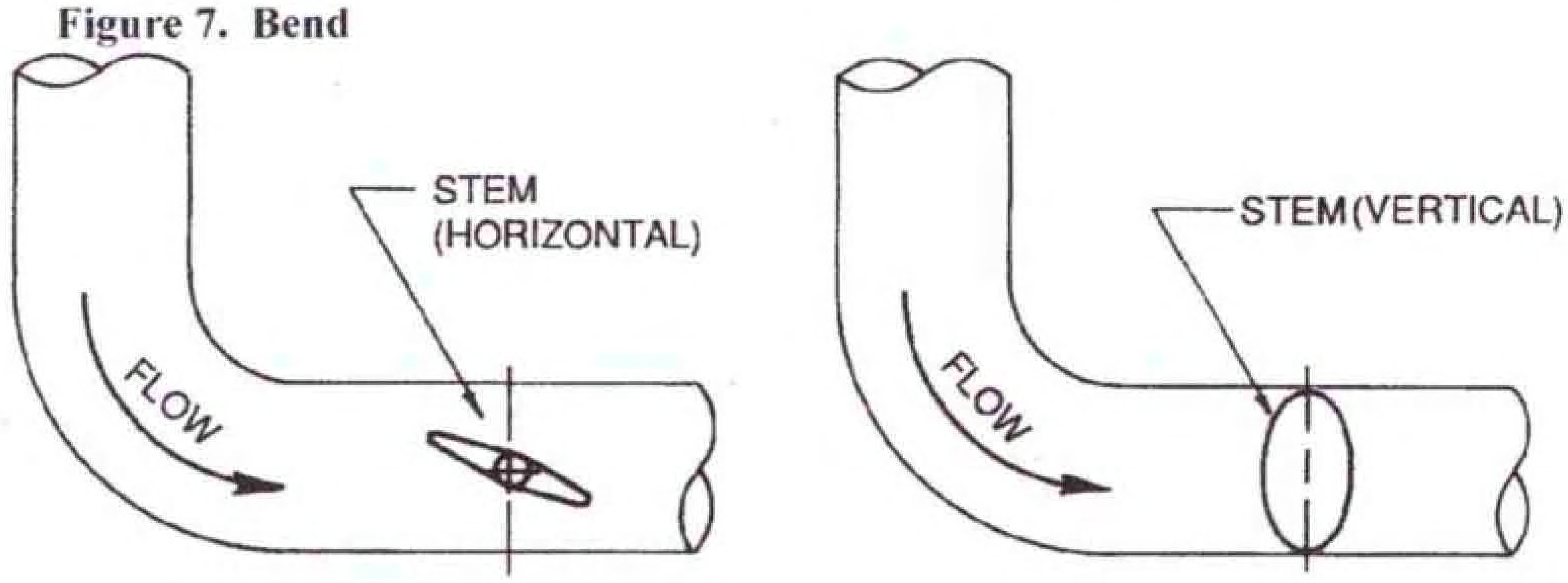


Figure 8. Tee

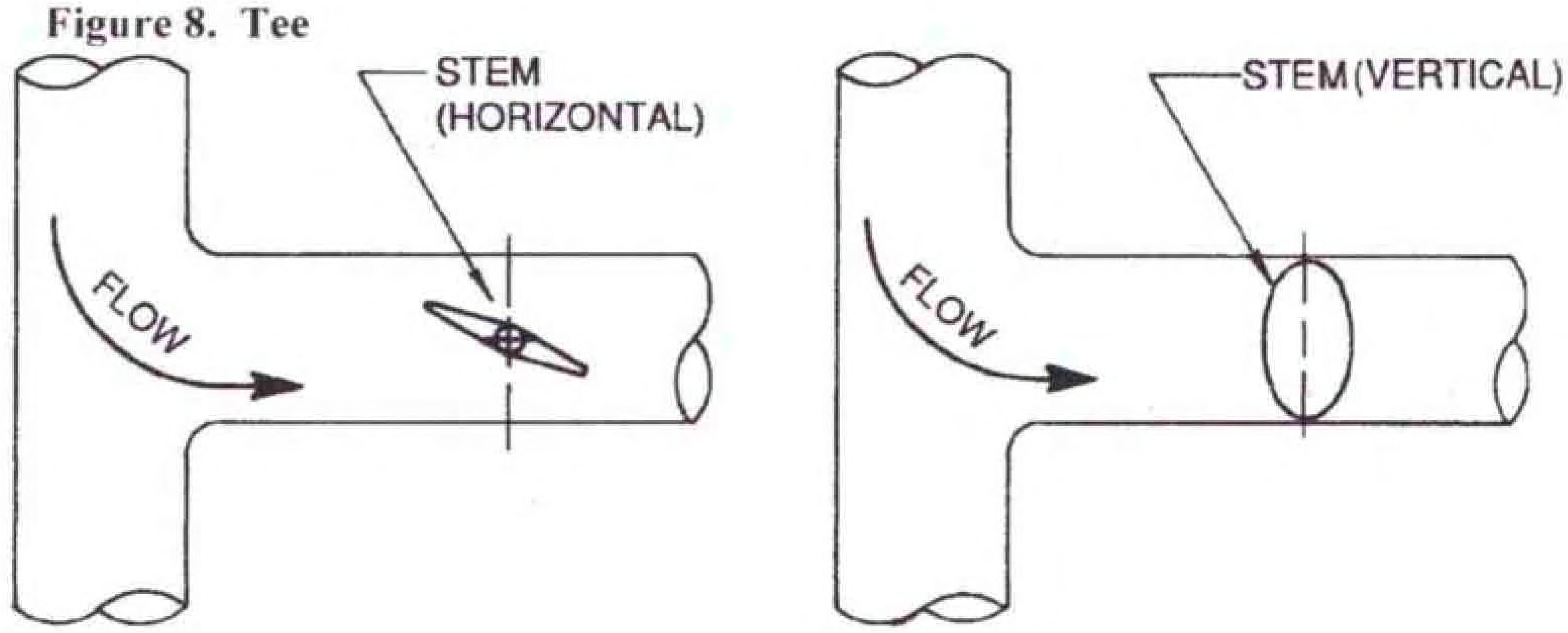
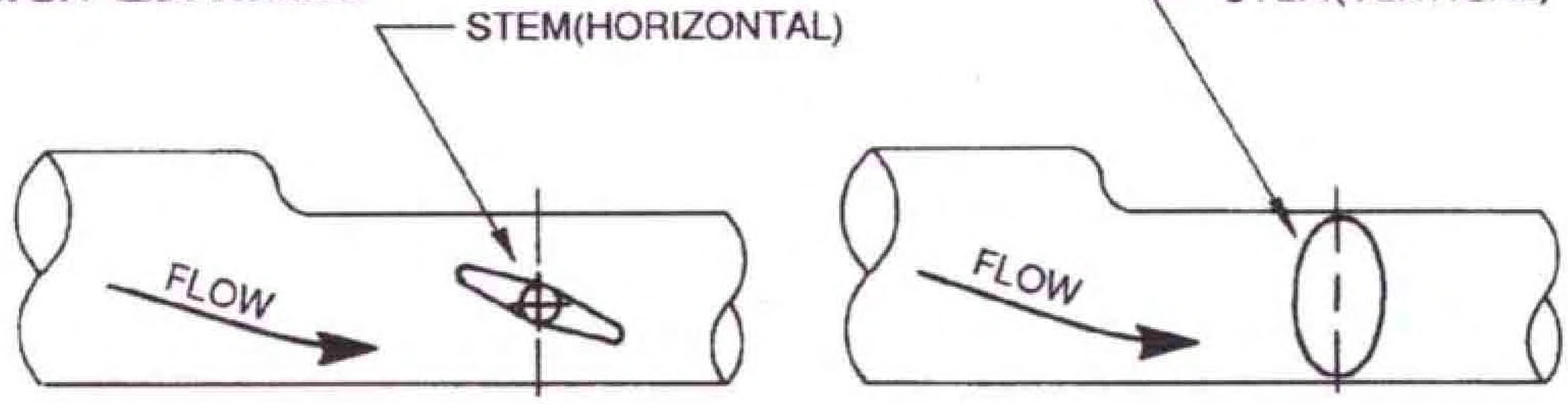


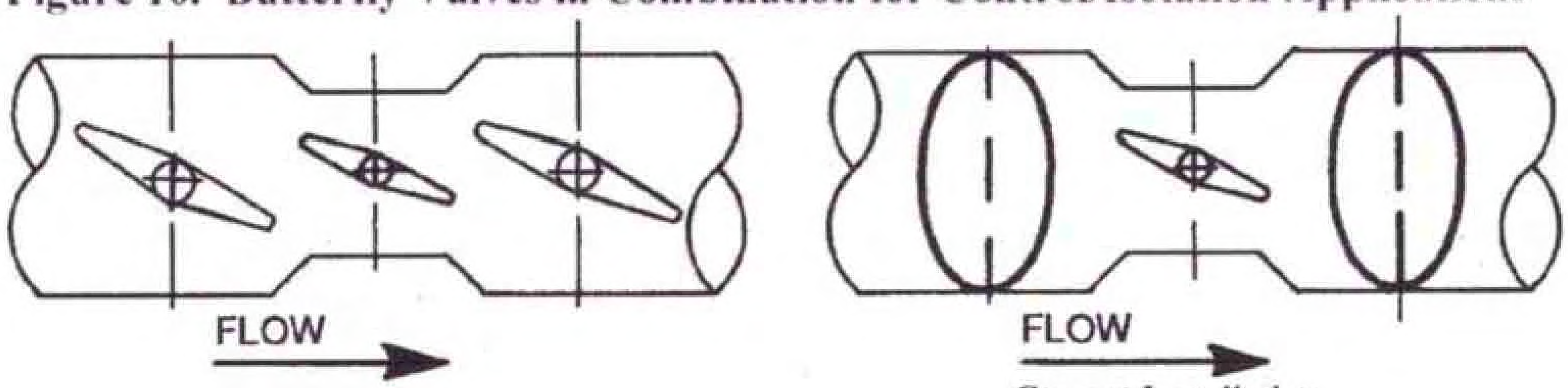
Figure 9. Pipe Reducer



Incorrect Installation

Correct Installation

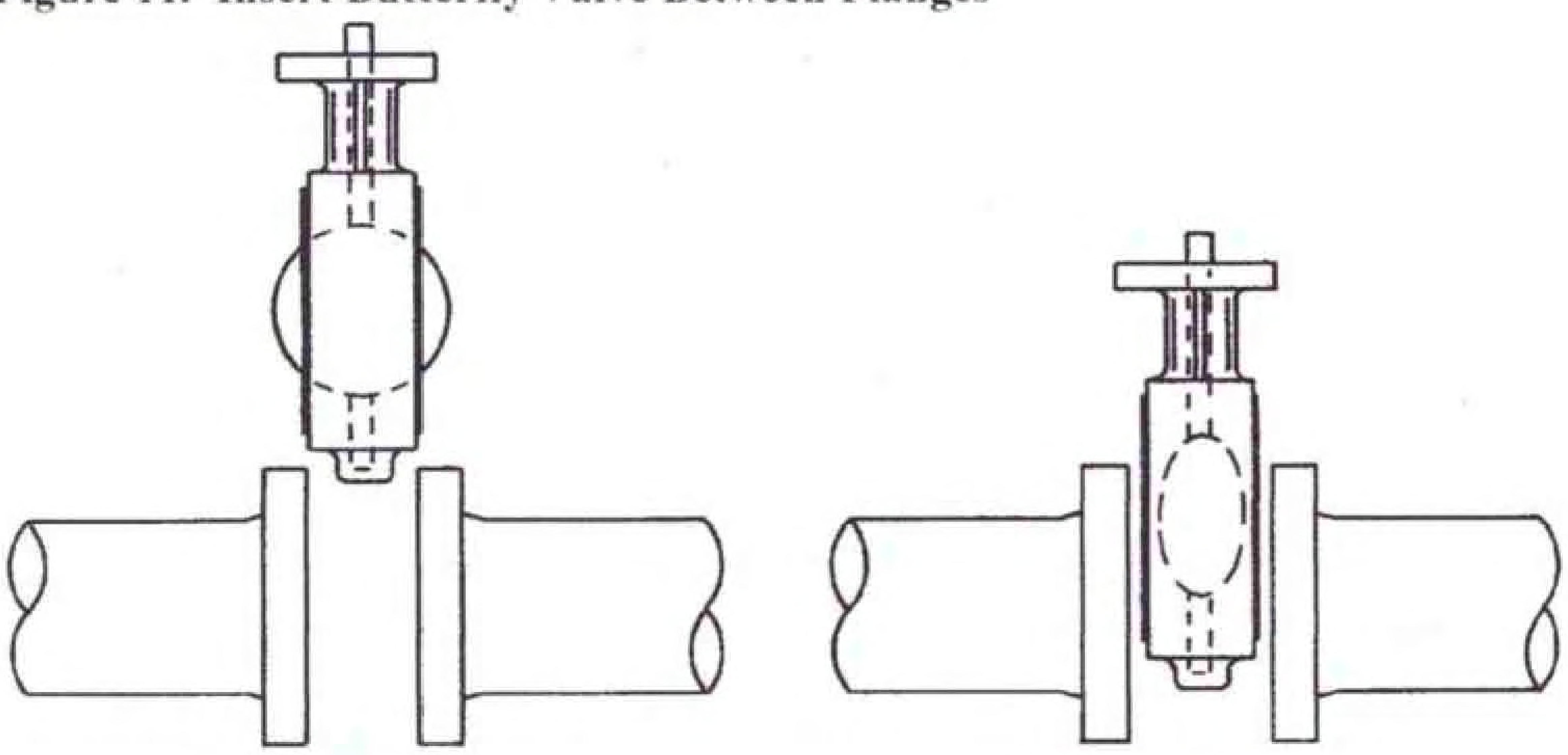
Figure 10. Butterfly Valves in Combination for Control/Isolation Applications



Incorrect Installation
Combination with all valve stems in the same direction accelerates possible noise, vibration, & erosion problems.

Correct Installation
Combination with the stem of the control valve at right angle to those of other valves tends to cancel the drift of the fluid, and reduces noises, vibration, and erosion.

Figure 11. Insert Butterfly Valve Between Flanges

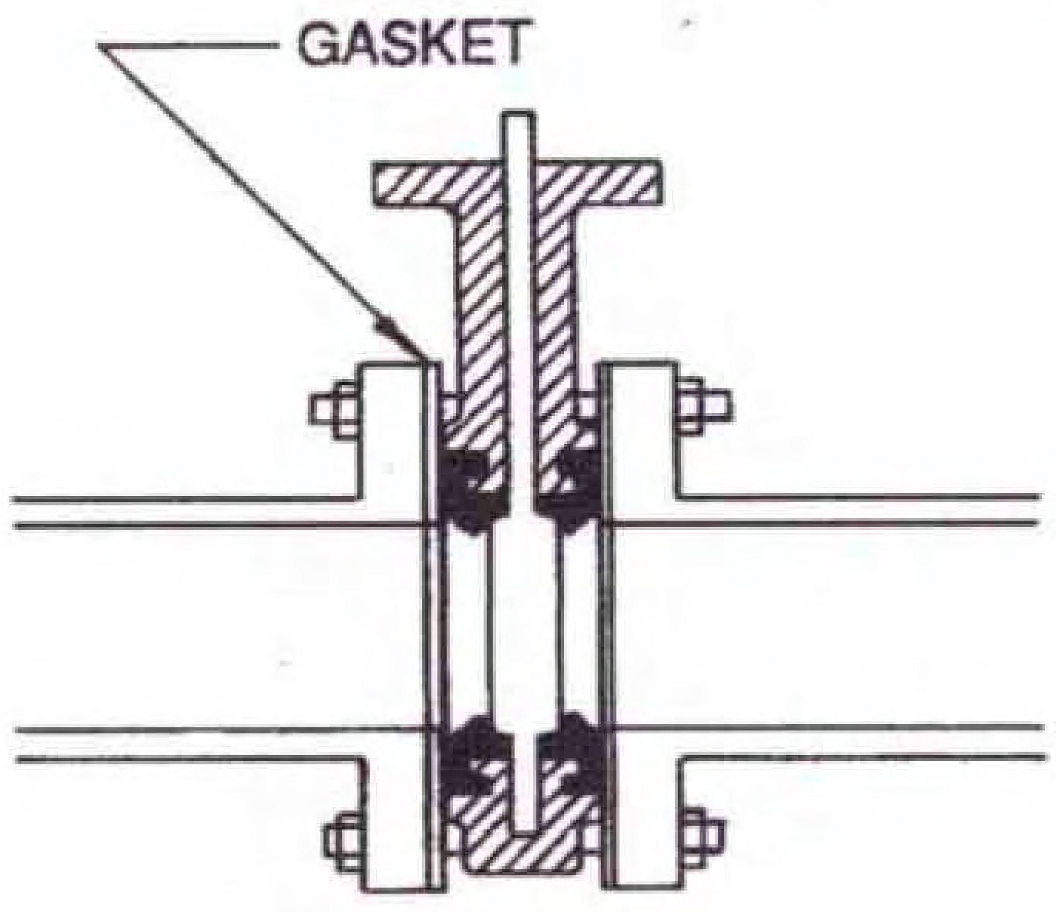


Incorrect Installation
Pipe not spread, disc opened beyond valve body face; Results: Disc edge damaged when it hits pipe flange.

Correct Installation
Pipe spread & aligned, disc rotated; Results: No undesirable beginning seating/unseating torque, disc edge protected.

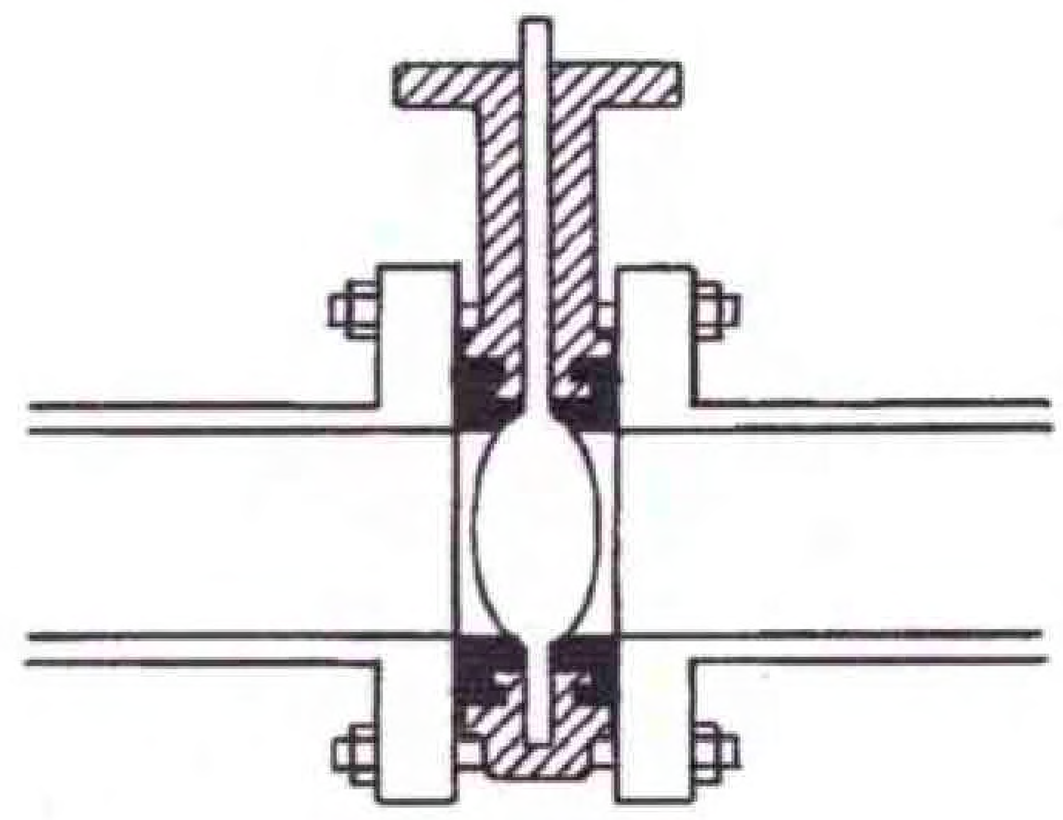
ABZ VALVES & CONTROLS

Figure 12. Initial Centering & Flanging of Valve



Incorrect Installation

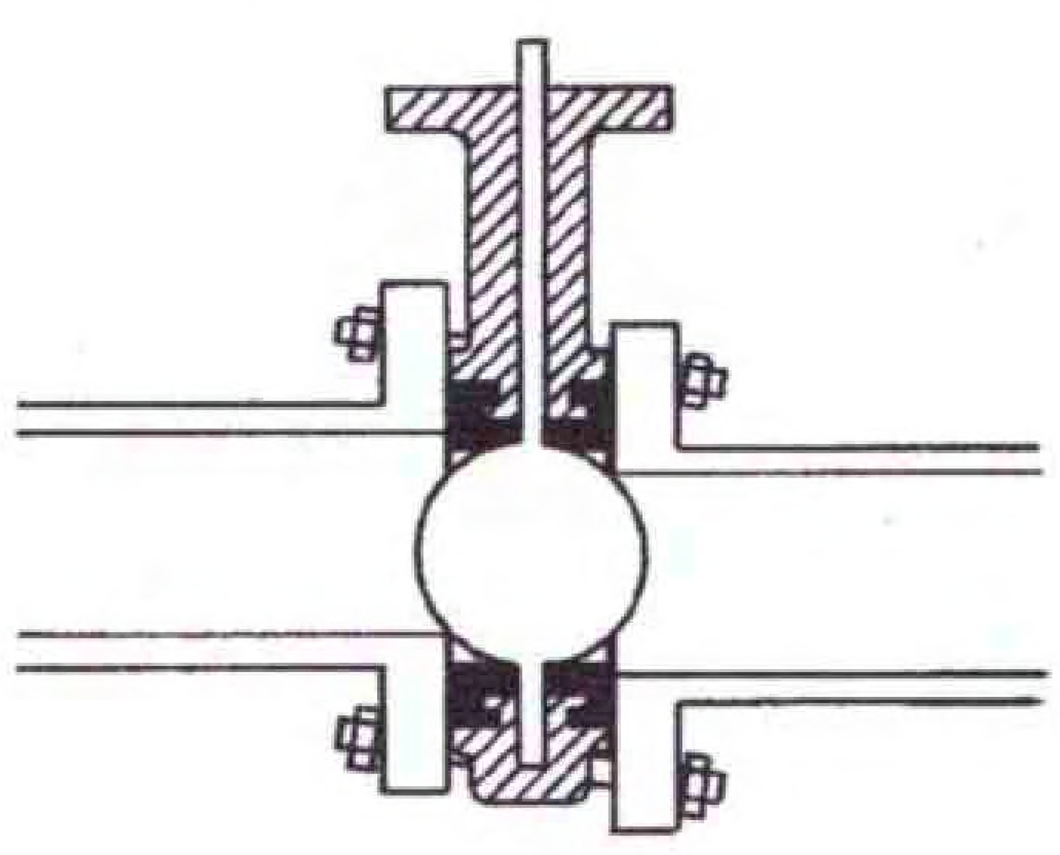
Disc in closed position; gaskets used; Results: Seat distorted and over-compressed causing high initial unseating torque problems.



Correct Installation

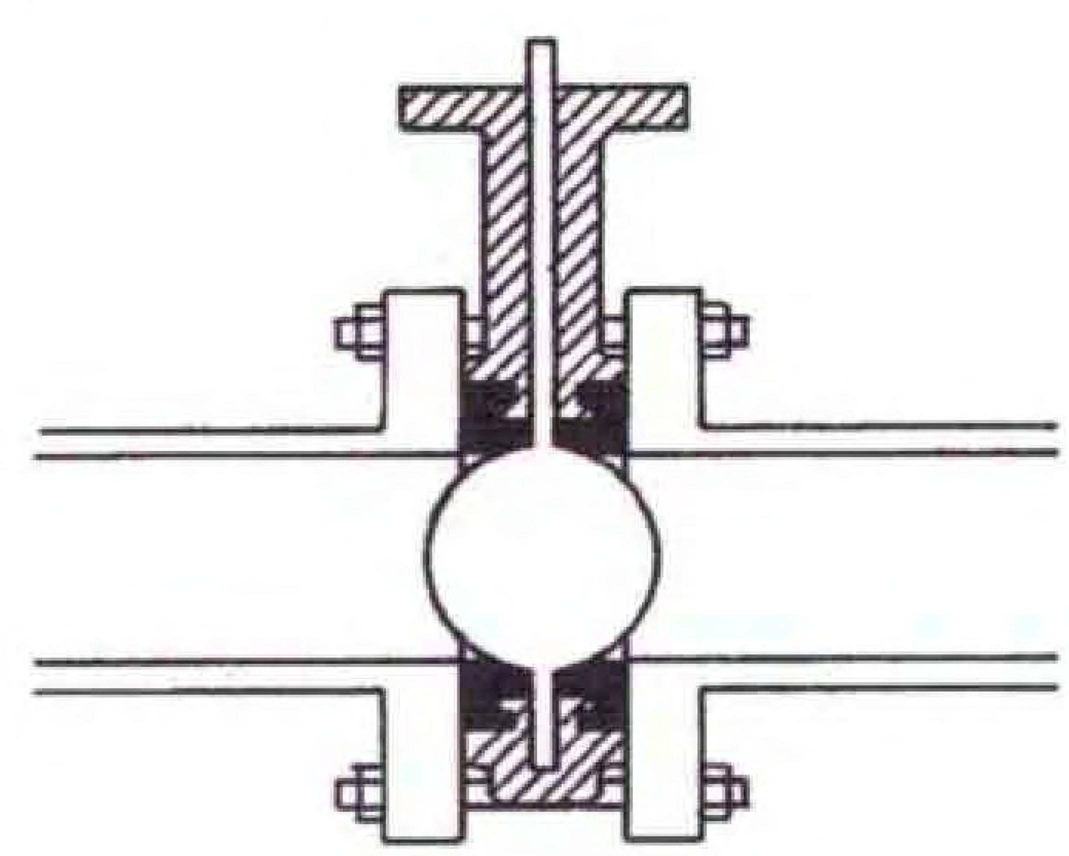
Bolts spanned, disc edge within body face-to-face, no flange gaskets; Results: No disc edge damage, proper sealing allowed.

Figure 13. Final Aligning & Tightening of Flange Bolts



Incorrect Installation

Piping misaligned; Results: Disc O.D. strikes pipe I.D. causing disc edge damage, increased torque and leakage. Seat face o-rings seal improperly without engagement.

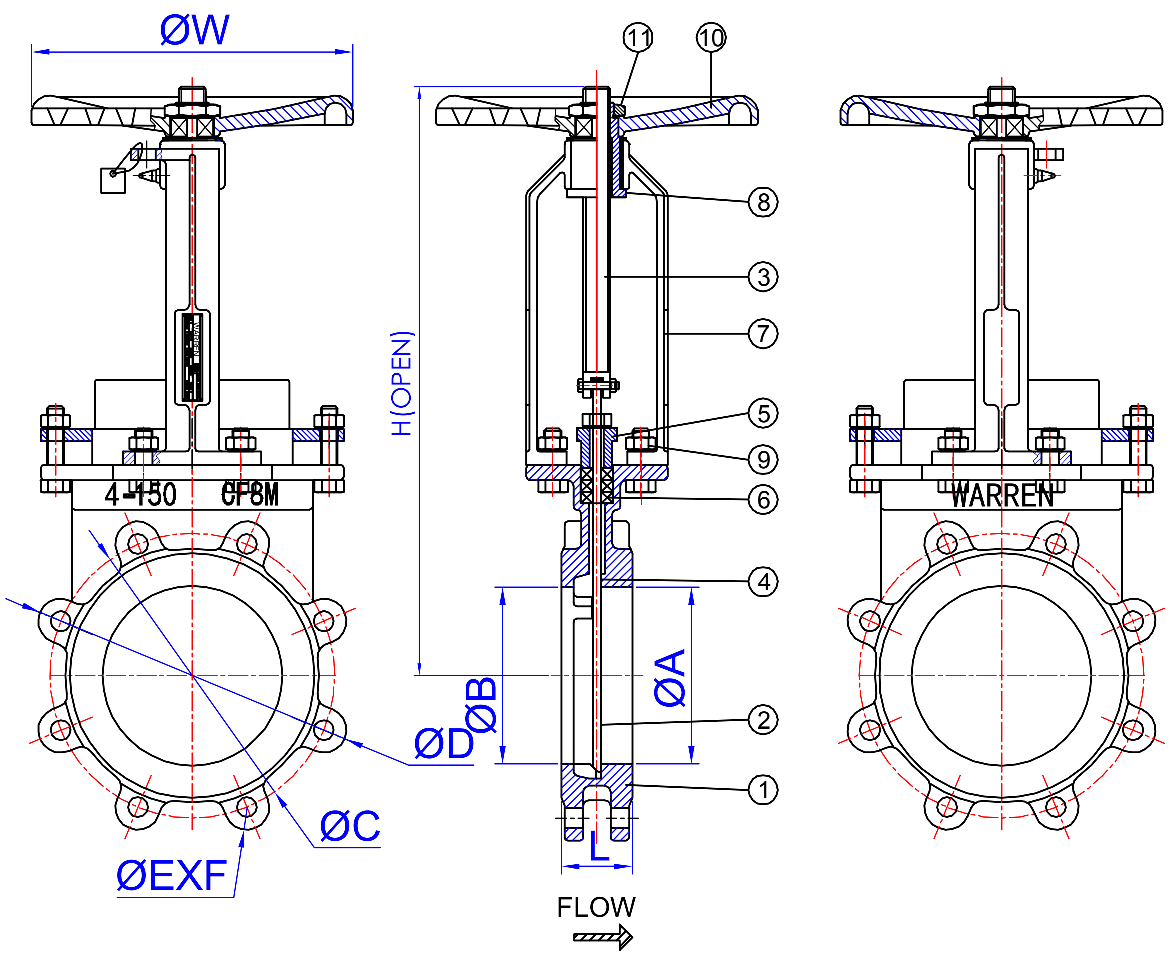


Correct Installation

Piping aligned properly when bolts tightened, disc in full open position; Results: disc clears adjacent pipe I.D., seat face seals properly, no excessive initial torque.

Fig No:WARREN -4156

NPS	L	A	B	øC	øD	øW	H	E"unc	F	N.W LB	CV gallon/min	Torque in–lb
2"	1.88	2.0	2.0	4.75	5.98	7.5	13.1	5/8"	4	17	298	35.72
2-1/2"	2.0	2.5	2.5	5.50	7.01	7.5	15.2	5/8"	4	19	466	44.65
3"	2.0	3.0	3.0	6.00	7.48	7.5	16.1	5/8"	4	21	694	44.65
4"	2.0	4.0	4.0	7.50	9.02	8.7	20.0	5/8"	8	29	1234	62.51
5"	2.25	4.7	4.7	8.50	10.0	11.4	23.0	3/4"	8	38	2053	71.44
6"	2.25	6.0	6.0	9.50	10.98	11.4	26.7	3/4"	8	52	2873	89.3
8"	2.75	8.0	8.0	11.75	13.50	13.8	33.4	3/4"	8	78	5109	133.95
10"	2.75	10.0	10.0	14.25	15.98	13.8	41.6	7/8"	12	118	8622	196.46
12"	3.0	12.0	12.0	17.00	19.02	15.7	47.2	7/8"	12	164	12416	205.39
14"	3.0	13.25	13.25	18.7	20.98	15.7	48.4	1"	12	222	17651	250.04
16"	3.5	15.25	15.25	21.2	23.50	19.7	55.9	1"	16	337	23055	285.76
18"	3.5	16.9	16.9	22.7	25.0	19.7	63.0	1-1/8"	16	440	30603	357.2
20"	4.5	18.9	18.9	25	27.48	19.7	67.0	1-1/8"	20	594	37782	482.22
24"	4.5	22.6	22.6	29.5	28.63	19.7	77.6	1-1/4"	20	836	57349	660.82



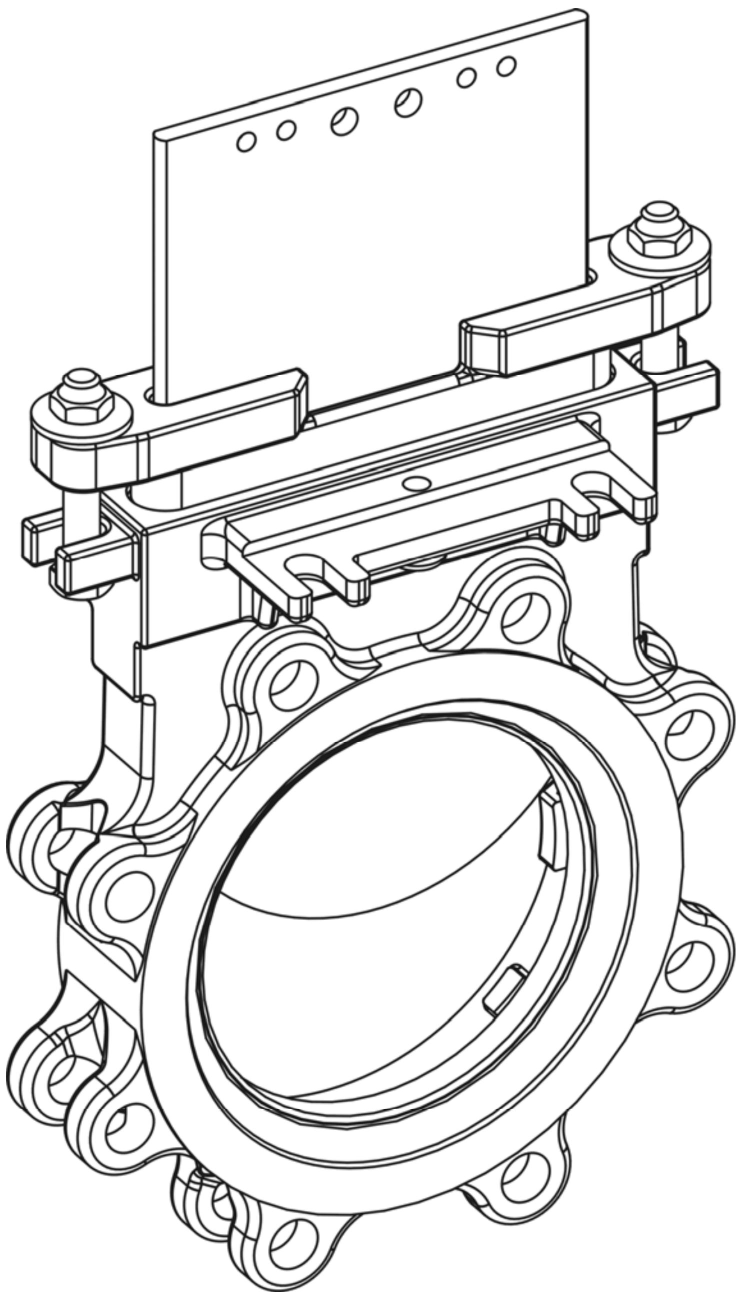
MSS-SP81 TEST STANDARD:
BODY TEST : 156PSI (WATER)
SEAT TEST : 40PSI (WATER)
LEAKAGE : 40 cc/in.min.

NO.	SUBJECT	MATERIAL	QTY
11	NUT	SS41+Zn	01
10	HAND WHEEL	CAST IRON	01
9	BOLT NUT	SUS304	04
8	YOKE SLEEVE	BRONZE	01
7	YOKE	ASTM A351-CF8	01
6	GLAND PACKING	TEFLON	01SET
5	GLAND	ASTM A351-CF8	01
4	SEAT	ASTM A351-CF8M	01
3	STEM	A276-304	01
2	PLATE	AISI 316	01
1	BODY	ASTM A351-CF8M	01

warren Valve

	APPROVED BY.	CHECK BY.	DRAWN BY.	DRAWING NO.		MATERIAL	UNIT	DESCRIPTION
SIGN	C.C.M	W.S.L	H.Y.S	WARREN-4156		CF8M	inch	MANUAL TYPE KNIFE GATE VALVE CLASS 150LB
DATE	10.19.11	10.19.11	10.18.11	REVISION	1	SCALE	FREE	

2-24” KGC Knife Gate Valves



Instruction D10411
September 2011

Instructions

These instructions are intended for personnel who are responsible for the installation, operation and maintenance of your KGC knife gate valve.

Safety Messages

All safety messages in the instructions are flagged with the word Caution, Warning or Danger. These messages must be followed exactly to avoid equipment damage, personal injury or death.

Safety label(s) on the product indicate hazards that can cause equipment damage, personal injury or death. If a safety label becomes difficult to see, or if a label has been removed, please contact DeZURIK for replacement.

WARNING
Personnel involved in the installation or maintenance of valves should be constantly alert to potential emission of process material and take appropriate safety precautions. Always wear suitable protection when dealing with hazardous process materials. Handle valves which have been removed from service with the assumption of process material within the valve.

Inspection

Your KGC knife gate valve has been packaged to provide protection during shipment. Carefully inspect the unit for damage upon arrival and file a claim with the carrier if damage is apparent.

Parts

Recommended spare parts are listed on the assembly drawing. These parts should be stocked to minimize downtime.

Order parts from your DeZURIK sales representative, or directly from DeZURIK. When ordering parts, please include the 7-digit part number and 4-digit revision number (example: **9999999R000**) located on the data plate attached to the valve assembly. Also include the part name, the assembly drawing number, the balloon number and the quantity stated on the assembly drawing.

DeZURIK Service

DeZURIK Service personnel are available to install, maintain and repair all DeZURIK products. DeZURIK also offers customized training programs and consultation services. For more information, contact your local DeZURIK representative or visit our website at www.dezurik.com.

Table of Contents

Description

KGC knife gate valves have a stainless steel body and gate, and an all-metal or resilient-faced seat. The KGC knife gate valve is available in 2-36" sizes with 150 CWP. A choice of several actuators and accessories is available.

Installation

Install the valve between ANSI Class 125 or Class 150 pipeline flanges. Flange gaskets are required. Before installation, remove foreign material such as weld spatter, oil, grease, and dirt from the valve and pipeline.

Install the valve so that the side marked "SEAT" is on the lower pressure side of the valve when the valve is closed; the pipeline pressure will then help seal the valve in the closed position.

Observe the following points to prevent distortion of the valve body and gate when the flange bolts are tightened:

- Align the mating pipeline flanges.
- Select the length of the flange bolts so that the bolts used in the blind holes near the chest area of the valve do not bottom out when tightened. We recommend using studs with nuts in the blind holes.
- Tighten the flange bolts evenly, in a crisscross pattern. Refer to Table A for recommended flange bolt/stud torques.

Note: Torque ranges are based on ASME Pressure Vessel Code Calculations and lab test data. These torques are only for the listed gasket types. For other gasket types listed in ASME, consult DeZURIK.

After installing the valve, pressurize pipeline and ensure the packing is not leaking. If the packing leaks, adjust the packing as described on the next page.

Table A: Recommended Flange Bolt/Stud Torque Range in ft-lbs (non-lubricated)

Valve Size	ASME Gasket Types	
	Rubber with Soft Fabric Filler, and 1/8" Thick Hard	**Soft Elastomer Gasket Shore Durometer < 75A**
2	26 - 29	8 - 9
3	37 - 41	14 - 16
4	26 - 29	11 - 12
6	41 - 45	22 - 24
8	55 - 61	35 - 39
10	56 - 62	40 - 44
12	80 - 88	59 - 65
14	107 - 118	81 - 89
16	103 - 114	79 - 87
18	128 - 141	102 - 112
20	123 - 136	99 - 109
24	188 - 207	155 - 171

Operation

The gate in the valve is positioned by the valve actuator. The actuator moves the gate over the valve port in the closed position, and withdraws the gate from the seat in the open position. Refer to the Actuator Instructions for adjustment and maintenance requirements for the actuator.

Lubrication

The valve does not require lubrication. Refer to the Actuator Instructions for lubrication requirements for the actuator.

Packing

The gate packing is contained and compressed by the packing gland. See Figure 1 for component identification (Page 6).

Note: The packing gland is slightly loosened prior to shipping. This is done to increase the life of the packing during extended storage.

Adjustment

If packing leaks, tighten the adjustment nuts on top of the packing gland. Tighten the nuts evenly and gently -just enough to stop the leak. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Drawings

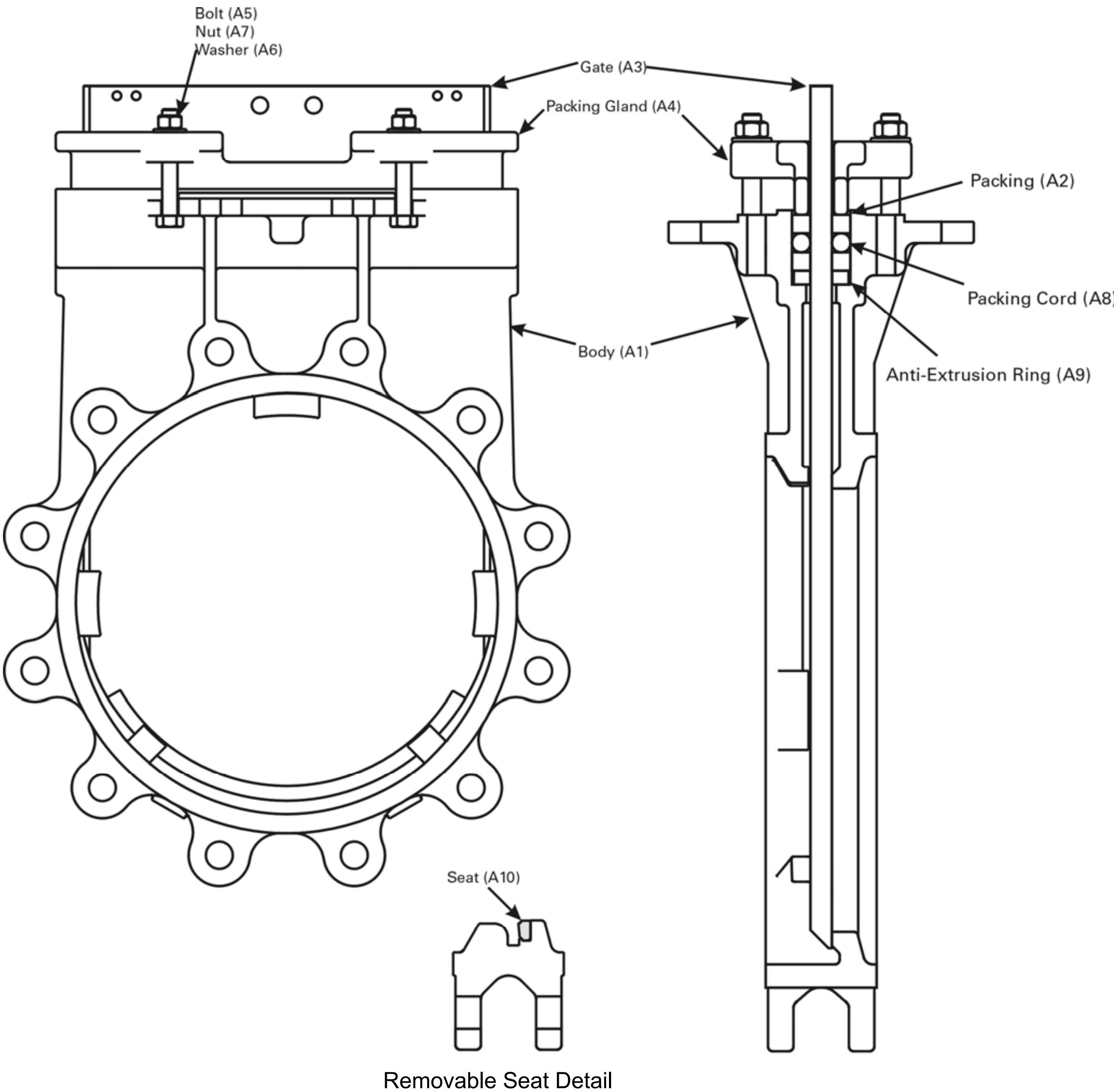


Figure 1—Component Identification

Packing Replacement

Removing the Old Packing

WARNING!
Pipeline pressure can cause personal injury or equipment damage. Relieve pipeline pressure before removing gate stem and packing gland nuts.

1. Relieve the pressure in the pipeline and close the valve.

WARNING!
Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. If the actuator is powered, disconnect and lock out power to prevent accidental operation of the actuator.

3. Remove the two screws and nuts near the top of the gate and disengage the stem from the gate by stroking the actuator (not the valve) to the open position.

4. Remove the gland nuts (A7), bolts (A5) and packing gland (A4).

5. Remove the used packing (A2) and anti-extrusion plates (A8) from the packing chamber.

Installing the New Packing

Packing (A2) strip length and quantity are shown in Table B. Ensure the inside and outside edges of each ring are packed against the gate and packing chamber, so that each strip is compressed flat and evenly.

Do not compress the packing any more than needed to stop leaks.

1. Ensure the gate (A3) is fully closed and centered in the body before packing.

2. If used, place the anti-extrusion ring (A9) or scraper ring in the bottom of the packing chamber.

Note: Ensure that the anti-extrusion ring fits tightly around the gate and that there is approximately *1/32-1/16"* clearance around the packing chamber.

3. Assemble and pack the rings one at a time, with the ends together, but not overlapped

Note: Stagger the joints, on the long side of the packing chamber. For packing rings, we recommend using a square-ended wood or plastic tool, driven by a hammer or mallet. Do not use a sharp tool to pack the rings.

4. For packing systems with the packing cord (A8), assemble and pack one row of packing (A2) and then insert the packing cord (A8). Assemble and pack the last row of packing. See detail below:

Table B: Packing Ring and Packing Cord Length and Quantity

Valve Size	Square Size	Length, inches	Quantity	Qty Cord
2		7.50		
3		9.50	4 w/o anti -ext ring or cord	
4		11.50		
5	3/8”	13.50		
6		15.50		
8		20.00		
10		25.00		1
12	1/2”	29.00	3 w/o cord	
14		32.00		
16		36.75		
18		41.25		
20	5/8”	45.25	2 with cord	
24		53.50		

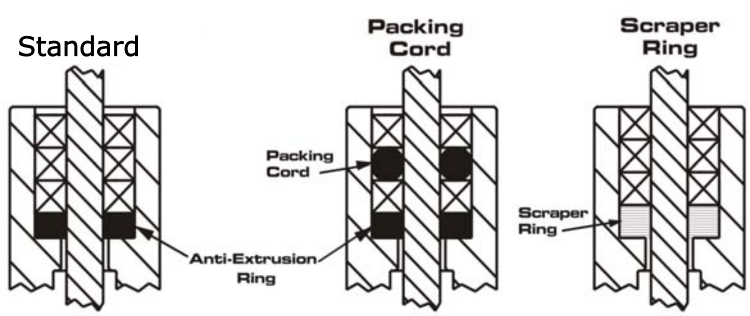


Figure 2—Packing Ring Detail

For all packing types, push excess packing toward the side opposite the seat.

Reassembling Valve

1. Replace the packing gland (A4), bolts (A5) and nuts (A6). Tighten the nuts evenly and finger tight, plus 1/2 turn.
2. Reconnect the stem to the gate with the two screws and nuts.
3. If the actuator is a powered actuator, reconnect power to the actuator.
4. Pressurize the pipeline and inspect packing for leakage.
5. If packing leaks, tighten the adjustment nuts on top of the packing gland. Tighten the nuts evenly and gently - just enough to stop the leak. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Replacing the Seat

See Figure 1 for component identification.

WARNING!
Pipeline pressure can cause personal injury or equipment damage. Relieve pipeline pressure before removing gate stem and packing gland nuts.

1. Relieve the pressure in the pipeline and close the valve.

WARNING!
Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. If the actuator is powered, disconnect and lock out power to prevent accidental operation of the actuator.
3. Remove the two screws and nuts near the top of the gate and disengage the stem from the gate.
4. Remove the pipeline flange bolts and flange from the side of the valve body opposite the word "seat". As an alternative, remove both flanges, and remove the valve from the pipeline.
5. Remove the actuator yoke and actuator from the valve.
6. Remove the gland nuts (A7), washers (A6), and packing gland (A4).
7. Remove the gate (A3) from the body.
8. Remove the packing (A2) from the packing chamber.
9. Remove the seat. Push the top of the removable seat (A10) toward the center of the valve, and remove the seat through the packing chamber.
10. Install the new replaceable seat:
    a. Note the gate side and body side of the seat as shown in Figure 3.
    b. Insert the new seat (A10) through the packing chamber.
    c. Place the seat behind the lug at the 5 and 7 o'clock positions in the body. Then push the top of the seat into position.

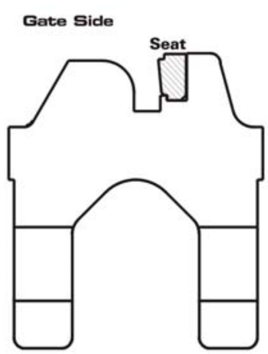


Figure 3—Seat

Seat Replacement ***Continued***

Reassembling the Valve

1. Reassemble the gate (A3) in the body, with the beveled edge facing away from the resilient seat. See Figure 3.
2. Place the gate in the fully closed position.
3. Reassemble the packing, as described in “Installing New Packing”.
4. Reassemble the packing gland (A4), washers (A6), nuts (A7) and bolts (A5). Tighten the nuts evenly and finger tight, plus 1/2 turn.
5. Reassemble the yoke and actuator on the valve.
6. Reconnect the stem to the gate with the two screws and locknuts.
7. Reassemble the pipeline flange and flange bolts, or reassemble the valve in the pipeline if the valve was removed. Refer to the requirements in the “Installation” section.
8. If the actuator is a powered actuator, reconnect power to the actuator.
9. Pressurize the pipeline and inspect the valve for leaks.
10. If the packing leaks, tighten the adjustment nuts (A7) on top of the packing gland. Tighten the nuts evenly and slowly, just enough to stop the leakage. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Replacing the Gate

See Figure 1 for component identification (Page 5).

WARNING!
Pipeline pressure can cause personal injury or equipment damage. Relieve pipeline pressure before removing gate stem and packing gland nuts.

1. Relieve the pressure in the pipeline and close the valve.

WARNING!
Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. If the actuator is powered, disconnect and lock out power to prevent accidental operation of the actuator.
3. Remove the pipeline flange bolts, and remove the valve from the pipeline.
4. Remove the actuator, actuator yoke, packing gland (A4), and packing (A2) from the valve.
5. Remove and inspect the gate (A3). If the gate appears to be scratched or galled due to too-long flange bolts in the chest area of the body, check for body damage in the tapped flange holes and within the chest cavity. Carefully check the seat for damage. Repair or replace the body, as appropriate.

Gate Replacement ***Continued***

8. Remove and inspect the seat components.
9. Replace or reinstall the seat components as described in step 10 in the “Seat Replacement “ section.
10. Place the new gate (A3) in the body, in the fully closed position.
11. Replace or reinstall the packing (A2) as described in “Installing New Packing”.
12. Replace the yoke and actuator on the valve.
13. Adjust the actuator, yoke, and packing gland so that the valve actuates smoothly full stroke in both directions, and so that there is no evidence of binding or scratching on the gate when the gate is visible in the fully open position.
14. Reinstall the valve in the pipe line —see “Installation” section.
15. If the actuator is a powered actuator, reconnect power to the actuator.
16. Pressurize the pipeline and inspect the valve for leaks.
17. If the packing leaks, tighten the adjustment nuts (A7) on top of the packing gland.

Note: Tighten the nuts evenly and slowly, just enough to stop the leakage. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Purge Port Option

When purge port options are ordered as illustrated, the intent is that the installer will connect purge lines.

WARNING!
If pipeline is under pressure with purge port plugs in place, release line pressure before removing plugs. Serious or fatal injury may occur if not complied with.

Installation:
1. Remove all purge plugs after valve has been installed in line and before line is pressurized.
2. Connect proper purge line to the ports.
3. Pressurize purge lines and check for leaks.
4. Pressurize pipe line.

See Figure 4 for Purge Port sizes and locations.

Purge Port Options

VALVE SIZE		
INCH	MM	A
2	50	1/4
3	80	1/4
4	100	1/4
5	125	1/4
6	150	3/8
8	200	3/8
10	250	3/8
12	300	3/8
14	350	1/2
16	400	1/2
18	450	3/4
20	500	3/4
24	600	3/4

NOTE:

1. VALVE TO HAVE PURGE CONNECTIONS IN THIS AREA WHEN ORDERED BY CATALOG CHARACTERISTIC PCA OR PSC
2. VALVE TO HAVE PURGE CONNECTIONS IN THIS AREA WHEN ORDERED BY CATALOG CHARACTERISTIC PSA OR PSC

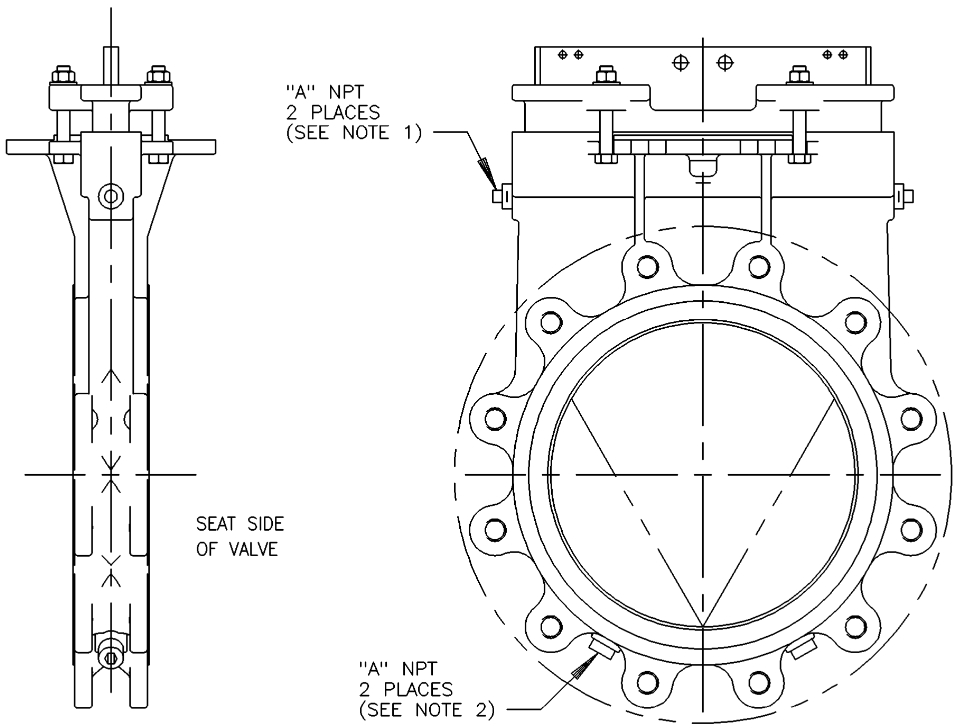


Figure 4—Purge Port Sizes and Locations

Troubleshooting

Condition	Possible Causes	Corrective Action
Packing leaks, with no evidence of galling on gate	Packing is loose	Adjust packing gland
	Packing is worn or torn	Replace packing
Packing leaks and gate is galled	Packing is worn or torn	Replace packing and gate, check seat for damage
Valve leaks when fully closed, with no evidence of galling on gate	Seat is worn or torn	Replace seat
Valve leaks when fully closed and gate is galled	Seat is worn or torn	Replace gate and seat

Guarantee

Products, auxiliaries and parts thereof of DeZURIK Canada, Inc. manufacture are warranted to the original purchaser for a period of twenty-four (24) months from date of shipment from factory, against defective workmanship and material, but only if properly installed, operated and serviced in accordance with DeZURIK Canada, Inc. recommendations. Repair or replacement, at our option, for items of DeZURIK Canada, Inc. manufacture will be made free of charge, (FOB) our facility with removal, transportation and installation at your cost, if proved to be defective within such time, and this is your sole remedy with respect to such products. Equipment or parts manufactured by others but furnished by DeZURIK Canada, Inc. will be repaired or replaced, but only to the extent provided in and honored by the original manufacturers warranty to DeZURIK Canada, Inc., in each case subject to the limitations contained therein. No claim for transportation, labor or special or consequential damages or any other loss, cost or damage shall be allowed. You shall be solely responsible for determining suitability for use and in no event shall DeZURIK Canada, Inc. be liable in this respect. DeZURIK Canada, Inc. does not guarantee resistance to corrosion, erosion, abrasion or other sources of failure, nor does DeZURIK Canada, Inc. guarantee a minimum length of service. Your failure to give written notice to us of any alleged defect under this warranty within twenty (20) days of its discovery, or attempts by someone other than DeZURIK Canada, Inc. or its authorized representatives to remedy the alleged defects therein, or failure to return product or parts for repair or replacement as herein provided, or failure to install and operate said products and parts according to instructions furnished by DeZURIK Canada, Inc., or misuse, modification, abuse or alteration of such product, accident, fire, flood or other Act of God, or failure to pay entire contract price when due shall be a waiver by you of all rights under this warranty.

The foregoing guarantee shall be null and void if, after shipment from our factory, the item is modified in any way or a component of another manufacturer, such as but not limited to, an actuator is attached to the item by anyone other than DeZURIK Canada, Inc. Factory Service personnel. All orders accepted shall be deemed accepted subject to this limited warranty, which shall be exclusive of any other or previous Warranty, and this shall be the only effective guarantee or warranty binding on DeZURIK Canada, Inc., despite anything to the contrary contained in the purchase order or represented by any agent or employee of DeZURIK Canada, Inc., in writing or otherwise, notwithstanding, including but not limited to implied warranties.

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Sales and Service

For information about our worldwide locations, approvals, certifications and local representative:
Web site: www.dezurik.com E-Mail: info@dezurik.com

DeZURIK

385 Franklin Blvd., Cambridge, ON CANADA N1R 5V5 ● Phone: 519-621-8980 ● Fax: 519-621-9521

DeZURIK Canada, Inc. reserves the right to incorporate our latest design and material changes without notice or obligation. Design features, materials of construction and dimensional data, as described in this manual, are provided for your information only and should not be relied upon unless confirmed in writing by DeZURIK Canada, Inc. Certified drawings are available upon request.

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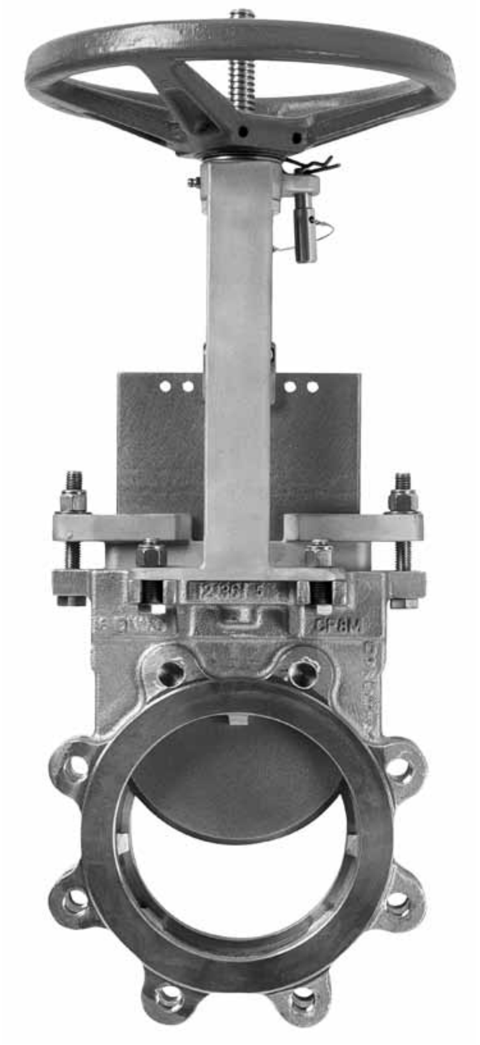
MAY 2013

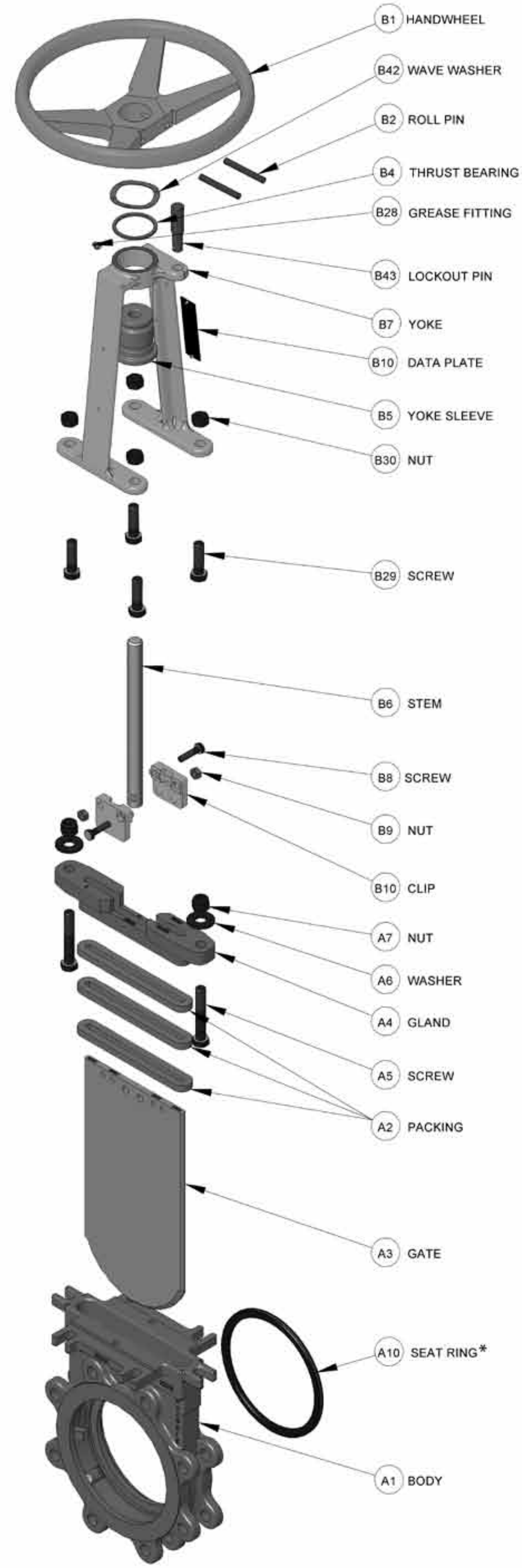
APCO | HILTON

DeZURIK KGC-HD HEAVY DUTY CAST STAINLESS STEEL KNIFE GATE VALVES TECHNICAL SPECIFICATIONS



Materials of Construction

Item	Description	Material
A1	Body	304 Stainless Steel, ASTM A351 CF8
		316 Stainless Steel, ASTM A351 CF8M
		317 Stainless Steel, ASTM A351 CG8M
		254-SMO Stainless Steel, ASTM A351 CK3MCuN
		2205 Duplex Stainless Steel, ASTM A890 CD3MN
		Hastelloy C 276, ASTM A494 CW12MW
A2	Packing	SMP - PTFE Braided Packing to 500°F (260°C) (pH Range 0-14)
		TDP - Dry Service, Dry PTFE Braided Packing with Solid PTFE Cord to 500°F (260°C) (pH Range: 0-14)
		HTP - High Temperature Braided Packing to 650°F (343°C) (pH Range: 1-12)
		HMP - High Temperature Braided Packing with Metal Scraper Ring to 1000°F (540°C) (pH Range: 3-10)
		FGP - Food Grade Service to 450°F (232°C) (pH Range: 3-11)
A3	Gate	304 Stainless Steel, ASTM A240
		316 Stainless Steel, ASTM A240
		317 Stainless Steel, ASTM A240
		17-4 Stainless Steel H900 Heat Treated, ASTM A564
		254 - SMO Stainless Steel, ASTM A240
		2205 Duplex Stainless Steel, ASTM A276
		Hastelloy C 276, ASTM B574
		410 Stainless Steel, ASTM A240
A4	Gland	Matches Body Material
A5	Screw	304 Stainless Steel
A6	Washer	304 Stainless Steel
A7	Nut	304 Stainless Steel
A10	Seat Ring*	CR - Chloroprene to 180°F (83°C)
		NBR - Acrylonitrile-Butadiene to 180°F (83°C)
		EPDM - Terpolymer of Ethylene, Propylene and a Diene to 250°F (122°C)
		FKM - Fluoro Rubber to 400°F (204°C)
		17-4 PH Stainless Steel H900 Heat Treated
		CRW - Chloroprene, Off White to 140°F (60°C)
		PTFE - Polytetrafluoroethylene, white to 450°F (230°C)
		Reinforced PTFE - Polytetrafluoroethylene, to 500°F (260°C)
B1	Handwheel	Painted, Cast Iron
B2	Roll Pin	Carbon Steel or 420 Stainless Steel
B4	Thrust Bearing	Oil Impregnated Bronze
B5	Yoke Sleeve	Aluminum Bronze
B6	Stem	304 Stainless Steel
B7	Yoke	Cast Steel or 304 Stainless Steel
B8	Screw	Zinc Plated Steel or 18-8 Stainless Steel
B9	Nut	Zinc Plated Steel or 18-8 Stainless Steel
B10	Clip	304 Stainless Steel
B23	Data Plate	316 Stainless Steel
B28	Grease Fitting	Zinc Plated Steel
B29	Screw	Zinc Plated Steel or 18-8 Stainless Steel
B30	Nut	Zinc Plated Steel or 18-8 Stainless Steel
B42	Wave Washer	304 Stainless Steel
B43	Lockout Pin	304 Stainless Steel



*The replaceable Seat Ring is standard on resilient-seated valves and optional on metal-seated valves.The standard integral metal seat matches the body material.

Valve Selection

Shut-Off Capabilities

Resilient Seats	Leak tight/drip tight
Metal Seats	Meet MSS SP-81 and TAPPI TIS 405-8

Pressure Ratings

2-48" (50-1200mm)	150 psi C.W.P. (1030 kPa)
Optional 30 & 36" (750 & 900mm)	100 psi C.W.P (690 kPa)

Notes:
Valve can handle Full Reverse Pressure without damage.

Valves with Chloroprene, off white seats are limited to 50 psi (350 kPa). Contact DeZURIK with service conditions.

Flow Parameters

Round Port

Valve Size	Cv* / Kv* 100% Open	K** (resistance)	Port Area (in²/cm²)
2" 50mm	300 260	0.16	3.1 20
3" 80mm	675 584	0.16	7.1 46
4" 100mm	1200 1040	0.16	12.6 81
5" 125mm	1900 1640	0.16	19.6 126
6" 150mm	2700 2340	0.16	28.3 183
8" 200mm	4800 4200	0.16	50.3 325
10" 250mm	7500 6500	0.16	78.5 506
12" 300mm	10800 9300	0.16	113 729
14" 350mm	13200 11400	0.16	138 890
16" 400mm	17400 15100	0.16	183 1180
18" 450mm	22300 19300	0.16	234 1510
20" 500mm	27800 24000	0.16	291 1880
22" 550mm	34000 29400	0.16	355 2290
24" 600mm	40500 35000	0.16	425 2740
26" 650mm	47800 41300	0.16	501 3230
28" 700mm	55600 48100	0.16	583 3760
30" 750mm	64000 55400	0.16	672 4340
32" 800mm	73000 63100	0.16	767 4950
36" 900mm	93000 80400	0.16	976 6300
42" 1050mm	126000 109000	0.16	1336 8620
48" 1200mm	165000 142700	0.16	1750 11290

*Cv = Flow in GPM of water at 1 psi pressure drop.
Kv = Flow in m3/hr. of water at 100 kPa pressure drop.
** K = The resistance coefficient of the valve. The constant (K) can be used to determine the equivalent length of pipe.

$L = \frac{KxD}{f}$ Where L = Equivalent length of pipe in feet
K = Resistance coefficient
D = Pipe diameter in feet
f = Friction factor, related to type of pipe

Applicable Standards

DeZURIK KGC-HD Knife Gate Valves are designed and/or tested to meet the following standards:	
MSS SP-81	Metal Seated Valves, Stainless Steel, Bonnetless, Flanged Knife Gate Valves
ANSI B16.5 2-24" (50-600mm)	Flanges and Flanged Fittings, ANSI 150 Conforms to related drilling dimensions
ANSI 16.47 26-48" (650-1200mm)	Large diameter Steel Flanges. Series A. Conforms to related dimensions
International Standards	Conforms to flanged bolt guides — JIS 10; DIN 10 and DIN 16; ISO 7005-1/PN10 and 7005-2/PN16; BS 4504/PN10 and BS 4504/PN16; and AS 2129 Tables D and E; SANS 1123-1000 and SANS 1123-1600
TAPPI TIS 405-8	Recommendations for Stainless Steel, Bonnetless, Flanged, Wafer Knife Gate Valves. Revoked by TAPPI, Same as MSS SP-81

Flow Parameters

V-port 60 Degrees

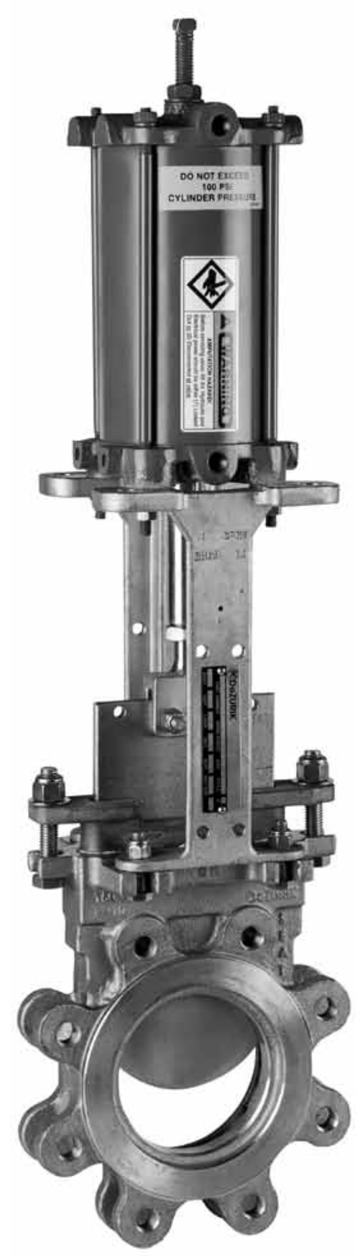
Valve Size	Cv* / Kv* 100% Open	K** (resistance)	Port Area (in²/cm²)
2" 50mm	89 77	1.80	1.9 12
3" 80mm	210 584	1.63	4.3 28
4" 100mm	386 330	1.53	7.7 50
5" 125mm	665 580	1.27	11.5 74
6" 150mm	900 780	1.42	17.2 111
8" 200mm	1660 1400	1.32	30.6 197
10" 250mm	2320 2000	1.65	42.0 271
12" 300mm	3490 3000	1.52	61.9 399
14" 350mm	4650 4000	1.27	80.8 521
16" 400mm	6110 5300	1.29	106 680
18" 450mm	8000 6900	1.23	138 890
20" 500mm	10100 8700	1.20	170 1100
22" 550mm	11900 10300	1.28	213 1370
24" 600mm	15100 13100	1.14	250 1610
26" 650mm	16800 14500	1.28	300 1940
28" 700mm	19500 16900	1.29	350 2260
30" 750mm	23900 20700	1.14	389 2510
32" 800mm	25600 22100	1.30	460 2970
36" 900mm	35200 30400	1.11	568 3660
42" 1050mm	44100 38100	1.32	800 5160
48" 1200mm	57800 50000	1.33	1050 6770

Valve Selection

Valve and Actuator Weights

Pounds
Kilograms

Valve Size	Basic Valve	With Lever	With Handwheel	With Chainwheel	With Bevel Gear Handwheel*	With Cylinder Size	lbs.	Kg.
2" 50mm	10 4.5	20 9	20 9	32 14.5	—	4" (100mm)	29	13
3" 80mm	16 7	37 17	27 12	39 18	88 40	4" (100mm)	37	17
4" 100mm	24 11	48 22	36 16	48 22	96 43.5	4" (100mm)	45	20
						6" (150mm)	63	29
5" 125mm	32 14.5	60 27	51 23	66 30	108 49	4" (100mm)	58	26
						6" (150mm)	76	35
						8" (200mm)	88	40
6" 150mm	38 17	66 30	57 26	75 34	113 51	4" (100mm)	63	29
						6" (150mm)	81	37
						8" (200mm)	93	42
8" 200mm	65 30	98 44.5	86 39	101 46	144 65	6" (150mm)	112	51
						8" (200mm)	124	56
10" 250mm	103 47	157 71	141 85	179 81	191 87	8" (200mm)	174	79
						10" (250mm)	220	100
						12" (300mm)	257	117
12" 300mm	148 67	213 97	187 85	227 103	241 109	8" (200mm)	225	102
						10" (250mm)	270	122
						12" (300mm)	309	140
14" 350mm	199 90	N/A	265 120	284 129	303 137	10" (250mm)	332	151
						12" (300mm)	372	169
16" 400mm	272 123	N/A	341 155	358 162	380 172	10" (250mm)	409	186
						12" (300mm)	449	204
						14" (350mm)	495	225
18" 450mm	361 164	N/A	433 197	449 204	473 215	12" (300mm)	551	250
						14" (350mm)	602	273
						16" (400mm)	813	369
20" 500mm	518 235	N/A	593 269	653 296	637 289	12" (300mm)	712	323
						14" (350mm)	760	345
						16" (400mm)	982	445
22" 550mm	622 282	N/A	698 317	N/A	760 345	12" (300mm)	830	377
						14" (350mm)	881	400
						16" (400mm)	1101	500
						18" (450mm)	1144	519
24" 600mm	725 329	N/A	803 364	N/A	882 400	12" (300mm)	947	430
						14" (350mm)	1001	454
						16" (400mm)	1219	553
						18" (450mm)	1262	572
26" 650mm	918 417	N/A	N/A	N/A	1104 501	12" (300mm)	1200	544
						14" (350mm)	1251	568
						16" (400mm)	1524	692
						18" (450mm)	1578	716
						20" (500mm)	1711	777
28" 700mm	1111 503	N/A	N/A	N/A	1325 601	12" (300mm)	1417	643
						14" (350mm)	1467	666
						16" (400mm)	1648	748
						18" (450mm)	1830	830
						20" (500mm)	1963	891
30" 750mm	1446 656	N/A	N/A	N/A	1594 723	12" (300mm)	1718	780
						14" (350mm)	1768	802
						16" (400mm)	1985	900
						18" (450mm)	2205	1000
						20" (500mm)	2365	1073
32" 800mm	1700 772	N/A	N/A	N/A	1825 828	12" (300mm)	1901	862
						14" (350mm)	1951	886
						16" (400mm)	2121	963
						18" (450mm)	2300	1044
						20" (500mm)	2426	1101
36" 900mm	2204 1000	N/A	N/A	N/A	2366 1073	14" (350mm)	2541	1153
						16" (400mm)	2755	1250
						18" (450mm)	2987	1355
						20" (500mm)	3150	1428
42" 1050mm	3600 1634	N/A	N/A	N/A	3908 1774	On Application		
48" 1200mm	4997 2266	N/A	N/A	N/A	5450 2474	On Application		



Note: Weights are approximate and do not include crating.

* For Bevel Gear with Chainwheel, add the following weight to the bevel gear with handwheel weight:
2-18" add 7 lbs. (3kg)
20-24" add 26 lbs. (12kg)
30" add 74 lbs. (34kg)
36" add 68 lbs. (31kg)

Ordering

To order, simply complete the valve order code from information shown. An ordering example is shown for your reference.

Valve Style
Give valve style code as follows:

KGC = Cast Stainless Steel Knife Gate Valve

Valve Size
Give valve size code as follows:

2	=	2"	(50mm)	20	=	20"	(500mm)
3	=	3"	(80mm)	22	=	22"	(550mm)
4	=	4"	(100mm)	24	=	24"	(600mm)
5	=	5"	(125mm)	26	=	26"	(650mm)
6	=	6"	(150mm)	28	=	28"	(700mm)
8	=	8"	(200mm)	30	=	30"	(750mm)
10	=	10"	(250mm)	32	=	32"	(800mm)
12	=	12"	(300mm)	36	=	36"	(900mm)
14	=	14"	(350mm)	42	=	42"	(1050mm)
16	=	16"	(400mm)	48	=	48"	(1200mm)
18	=	18"	(450mm)				

Body Style
Give body style code as follows:

HD = Heavy Duty

End Connection
Give end connection code as follows:

F1 = ANSI 150 UNC Tapping for Threads
F110 = ISO 7005/PN10 Drilling
F116 = ISO 7005/PN16 Drilling
F1DA = AS2129 Table D Drilling
F1EA = AS2129 Table E Drilling
F1UN(1) = ANSI 150 UN-8 Tapping for Threads
F1S10 = SANS1123-1000
F1S16 = SANS1123-1600

Optional End Connections

F1T = ANSI 150 Through Bolting

On Application

F1J1 = JIS 10 Drilling

Body Material
Give body material code as follows:

Standard

S1 = 304 Stainless Steel
S2 = 316 Stainless Steel
S3 = 317 Stainless Steel

On Application

HC = Hastelloy C
S6 = 254 Stainless Steel
S10 = 2205 Duplex Stainless Steel

Packing Material
Give packing material code as follows:

Standard Packing

SMP = PTFE Braided Packing to 500°F (260°C) (pH Range 0-14)

Optional Packing

TDP = Dry Service, Dry PTFE Braided Packing with Solid PTFE Cord to 500°F (260°C) (pH Range: 0-14)
HTP = High Temperature Braided Packing to 650°F (343°C) (pH Range: 1-12)
HMP = High Temperature Braided Packing with Metal Scraper Ring to 1000°F (540°C) (pH Range: 3-10)
FGP = Food Grade Service to 450°F (232°C) (pH Range: 3-11)

Gate Material (3)
Give gate material code as follows:

Standard Gate Materials

S1 = 304 Stainless Steel (Standard for S1 body material)
S2 = 316 Stainless Steel (Standard for S2 body material)
S3 = 317 Stainless Steel (Standard for S3 body material)

Optional Gate Materials

S5 = 17-4 Stainless Steel H900 Heat Treated (Used with S1, S2, & S3 body materials)

On Application

S6 = 254-SMO Stainless Steel (Used with S6 body material)
S8 = 410 Stainless Steel (Used with S1, S2 & S3 body materials)
S10 = 2205 Duplex Stainless Steel (Used with S2, S3 OR S10 body materials)
HC = Hastelloy C (Used with HC body materials)

Seat Material (2)
Give seat material code as follows:

Standard Seat Materials

M = Metal
V = V-Orifice All Metal
CR = Chloroprene to 180°F (83°C)
NBR = Acrylonitrile-Butadiene to 180°F (83°C)
EPDM = Terpolymer of Ethylene, Propylene and a Diene to 250°F (122°C)

Optional Seat Materials

FKM = Fluoro Rubber to 400°F (204°C)
S5D = 17-4 PH Stainless Steel H900 Heat Treated

On Application

CRW = Chloroprene, Off White to 140°F (60°C)
PTFE or RTFE

Standard Options
Give option code as follows:

ARRA = ARRA Compliant
PSA = Purge Ports in Seat Area
PCA = Purge Ports in Chest Area
PSC = Purge Ports in Seat and Chest Area
CMC = Certificate of Material Conformance
CRT = Certified Physical and Chemical Test Reports
— = Optional Coating
— = DeZURIK Standard Test Certification
P100 = 30" and 36" (750 and 900mm) valves with 100 psi (690 kPa) rating

Notes:
(1) Applies to valves 18" (450mm) and larger. Flange bolt hole threads are 8 threads per inch in accordance with ANSI, API and MSS standards.
(2) The limiting factor in valve selection is the lowest temperature of the packing or seat.
(3) Gate material limitations by body style in parentheses.

Ordering Example:

KGC,6,HD,F1,S2,SMP,S2-CR*Actuator

Manual Actuators

Lever Actuators

Lever actuators can be furnished on 2-12" (50-300mm) valves for applications where rapid valve operation is required or where space prevents use of a standard handwheel or bevel gear actuator. Maximum pressure differential required for valves with lever actuators should not exceed the limits listed. Maximums are based on the operating force for each valve size. Lever actuators are carbon steel only. SMP packing recommended with MN-LV.

To order, add the lever actuator code to the basic valve order code.

Ordering Example:
KGC,6,HD,F1,S2,SMP,S2-M*MN-LV-CS

Lever Actuator

Valve Size	Order Code Carbon Steel (CS) Yoke	Maximum Pressure Differential psi/kPa
2-4" 50-100mm	MN-LV-CS	75 / 520
5-6" 125-150mm	MN-LV-CS	45 / 310
8" 200mm	MN-LV-CS	25 / 170
10" 250mm	MN-LV-CS	20 / 140
12" 300mm	MN-LV-CS	14 / 100

Handwheel and Chainwheel Actuators

All 2-24" (50-600mm) valves can be furnished with handwheel actuators, and 2-20" (50-500mm) with chainwheel actuators. To order handwheel or chainwheel actuators, add the appropriate order code to the basic valve order code. Refer to information on bevel gear actuators for use on dry solids, paper stock, slurries or when pressure exceeds limits shown. Order chain for chainwheel actuators as a separate item.

Handwheel Actuator

Valve Size	Order Code Carbon Steel (CS) Yoke	Order Code 304 SST (S1) Yoke	Maximum Pressure Differential psi/kPa
2-4" 50-100mm	MN-HD8-CS	MN-HD8-S1	150 / 1030
5-8" 125-200mm	MN-HD12-CS	MN-HD12-S1	150 / 1030
10-12" 250-300mm	MN-HD16-CS	MN-HD16-S1	150 / 1030
14" 350mm	MN-HD20-CS*	MN-HD20-S1*	125 / 860
16" 400mm	MN-HD20-CS*	MN-HD20-S1*	100 / 680
18" 450mm	MN-HD20-CS*	MN-HD20-S1*	75 / 515
20" 500mm	MN-HD20-CS*	MN-HD20-S1*	50 / 340
22" 550mm	MN-HD20-CS*	MN-HD20-S1*	25 / 170
24" 600mm	MN-HD20-CS*	MN-HD20-S1*	25 / 170

*Bevel gear actuators recommended for dry solids, paper stocks, slurries, or when pressure exceeds limits shown.

Ordering Example:
KGC,6,HD,F1,S2,SMP,S2-M*MN-HD12-CS

Chainwheel Actuator

Valve Size	Order Code Carbon Steel (CS) Yoke	Order Code 304 SST (S1) Yoke	Maximum Pressure Differential psi/kPa
2-4" 50-100mm	MN-CW8-CS	MN-CW8-S1	150 / 1030
5-8" 125-200mm	MN-CW12-CS	MN-CW12-S1	150 / 1030
10-12" 250-300mm	MN-CW20-CS	MN-CW20-S1	150 / 1030
14" 350mm	MN-CW20-CS*	MN-CW20-S1*	125 / 860
16" 400mm	MN-CW20-CS*	MN-CW20-S1*	100 / 680
18" 450mm	MN-CW20-CS*	MN-CW20-S1*	75 / 515
20" 500mm	MN-CW20-CS*	MN-CW20-S1*	50 / 340

*Bevel gear actuators recommended for dry solids, paper stocks, slurries, or when pressure exceeds limits shown.

Ordering Example:
KGC,4,HD,F1,S2,SMP,S2-CR*MN-CW8-S1

Manual Actuators

Bevel Gear Actuators

Bevel gear actuators are available on 3-48" (80-1200mm) valves with handwheel or chainwheel actuators. Bevel gear actuators provide vertical mounting of the handwheel or chainwheel, or can be used where space limitations prohibit the use of a standard handwheel or chainwheel. A mechanical advantage makes large valve operation easier and faster.

Bevel Gear Handwheel Actuators

Valve Size	Order Code Carbon Steel (CS) Yoke	Order Code 304 SST (S1) Yoke	Maximum Pressure Differential psi/kPa
3-18" 80-450mm	MNB-HD12-CS	MNB-HD12-S1	150 1030
20-24" 500-600mm	MNB-HD16-CS	MNB-HD16-S1	150 1030
30-42" 750-1050mm	MNB-HD30-CS	MNB-HD30-S1	150* 1030*
48" 1200mm	MNB-HD36-CS	MNB-HD36-S1	150 1030

Ordering Example:
KGC,14,HD,F1,S2,SMP,S2-CR*MNB-HD12-CS

Bevel Gear Chainwheel Acutators

Valve Size	Order Code Carbon Steel (CS) Yoke	Order Code 304 SST (S1) Yoke	Maximum Pressure Differential psi/kPa
3-18" 80-450mm	MNB-CW12-CS	MNB-CW12-S1	150 1030
20-24" 500-600mm	MNB-CW20-CS	MNB-CW20-S1	150 1030
30-42" 750-1050mm	MNB-CW30-CS	MNB-CW30-S1	150* 1030*
48" 1200mm	MNB-CW36-CS	MNB-CW36-S1	150 1030

Ordering Example:
KCG,14,HD,F1,S2,SMP,S2-CR*MNB-CW12-CS-90
Actuator mounted at 90 degrees

Note:
For alternate mounting of bevel gear actuators, add -90, -180 or -270 after the actuator code and as 2nd line information on the order.
* Maximum pressure of 30" (750mm) and 36" (900mm) valves with P100 option is 100psi.

Manual Actuator Accessories

Chain for Chainwheel Actuators

Order as a separate item by giving the correct code and specify required length of chain as second line information. One closing link is supplied with the Chainwheel Actuator.

Order Code	Description
ACC*CN102	Steel, Zinc Plated 3/16
ACC*CN103	Galvanized 3/16
ACC*CN106	316 Stainless Steel 3/16

Ordering Example:
ACC*CN102
Chain 12 feet long (366cm)

Extension for Handwheel or 2" Nut Extension

Provides extension of the handwheel or nut to allow remote operation – normally from above. The extension includes fittings and extension pipe with handwheel or nut mounted. To order, specify description and extension length from center line of valve to handwheel or nut.

Order Code	Description
ENHD	Extension for Handwheel
ENTS	Extension for Nut

Ordering Example:
Handwheel: KGC,14,HD,F1,S2,SMP,S2-CR*MN-HD20-CS,ENHD
Nut: KGC,14,HD,F1,S2,SMP,S2-CR*MN-N-CS,ENTS
Center line of valve to handwheel nut 72 inches (1829mm).

Lockout Device

Available on all sizes of handwheel, bevel gear handwheel and cylinder actuated valves. To order, add a comma and the order code "LK" after the actuator code.

Ordering Example:
KGC,14,HD,F1,S2,SMP,S2-CR*MNB-HD12-CS,LK

Floorstand

A floorstand for handwheel actuated valves allows operation from above. Includes floorstand with gate position indicator, handwheel, fittings and extension. To order, specify length from center line of valve to base of floorstand. This dimension must be at least twice the dimension from center line to handwheel. For non-rising stems only. Floor stands for use with rising stems are available on application.

Ordering Example:
KGC,14,HD,F1,S2,SMP,S2-CR*MN-HD20-CS
Except with floorstand. Center line of valve to base of floorstand 72 inches (1829mm).

Deflection Cones

To prolong valve life in particularly demanding services, deflection cones are available in 316 stainless steel or abrasion resistant cast iron per ASTM A532 with Brinell Hardness of at least 500 BHN. Order as a separate line item by giving the correct code and valve size.

Order Code	Description
DCS23 - Valve Size	316 Stainless Steel
DCNH23 - Valve Size	Abrasion Resistant Cast Iron

Ordering Example:
ACC*DCS23-12 316SST Cone for 12" valve

Cylinder Actuators

On-Off Cylinder Actuators

DeZURIK cylinder actuators are available with double-acting pneumatic or hydraulic cylinders for on/off or positioning services. Supply pressure is 60 or 80 psi (410 or 550 kPa). To order, add the proper code from the on/off column of the table to the valve order code. Specify hydraulic media if other than oil.

Positioning Cylinder Actuators

DeZURIK cylinder actuators are available with pneumatic or electronic positioners for throttling control. Positioners are enclosed and mounted on the superstructure.

Actuator Sizing

60 psi (410 kPa) Air Supply

Valve Size	Order Code	Order Code	Maximum Pressure Differential psi/kPa			
			On/Off		Positioning	
	Carbon Steel (CS) Yoke	304 SST (S1) Yoke	Dry Solids, Slurries, Paper Stock	Liquids & Gases	Dry Solids, Slurries, Paper Stock	Liquids & Gases
2 & 3" / 50 & 80mm	CY-PC4-CS	CY-PC4-S1	150/1030	150/1030	150/1030	150/1030
4" / 100mm	CY-PC4-CS	CY-PC4-S1	100/690	150/1030	75/515	75/515
	CY-PC6-CS	CY-PC6-S1	150/1030	N/R	150/1030	150/1030
5 & 6" / 125 & 150mm	CY-PC4-CS	CY-PC4-S1	N/A	50/340	N/A	N/A
	CY-PC6-CS	CY-PC6-S1	125/860	150/1030	75/515	100/690
	CY-PC8-CS	CY-PC8-S1	150/1030	N/R	150/1030	150/1030
8" / 200mm	CY-PC6-CS	CY-PC6-S1	75/515	125/860	50/340	50/340
	CY-PC8-CS	CY-PC8-S1	150/1030	150/1030	125/860	125/860
10" / 250mm	CY-PC8-CS	CY-PC8-S1	100/690	150/1030	75/515	100/690
	CY-PC10-CS	CY-PC10-S1	150/1030	N/R	125/860	150/1030
	CY-PC12-CS	CY-PC12-S1	N/R	N/R	150/1030	N/R
12" / 300mm	CY-PC8-CS	CY-PC8-S1	75/515	125/860	50/340	50/340
	CY-PC10-CS	CY-PC10-S1	125/860	150/1030	100/690	125/860
	CY-PC12-CS	CY-PC12-S1	150/1030	N/R	150/1030	150/1030
14" / 350mm	CY-PC8-CS	CY-PC8-S1	50/340	75/515	25/170	50/340
	CY-PC10-CS	CY-PC10-S1	100/690	150/1030	75/515	75/515
	CY-PC12-CS	CY-PC12-S1	150/1030	N/R	100/690	125/860
16" / 400mm	CY-PC10-CS	CY-PC10-S1	75/515	125/860	50/340	50/340
	CY-PC12-CS	CY-PC12-S1	125/860	150/1030	75/515	100/690
	CY-PC14-CS	CY-PC14-S1	150/1030	N/R	125/860	150/1030
18" / 450mm	CY-PC12-CS	CY-PC12-S1	100/690	150/1030	50/340	75/515
	CY-PC14-CS	CY-PC14-S1	150/1030	N/R	100/690	125/860
	CY-PC16-CS	CY-PC16-S1	N/R	N/R	150/1030	150/1030
20" / 500mm	CY-PC12-CS	CY-PC12-S1	50/340	125/860	25/170	50/340
	CY-PC14-CS	CY-PC14-S1	125/860	150/1030	75/515	100/690
	CY-PC16-CS	CY-PC16-S1	150/1030	N/R	125/860	150/1030
22" / 550mm	CY-PC12-CS	CY-PC12-S1	50/340	100/690	N/A	25/170
	CY-PC14-CS	CY-PC14-S1	100/690	150/1030	50/340	75/515
	CY-PC16-CS	CY-PC16-S1	150/1030	N/R	100/690	125/860
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	150/1030	150/1030

N/R = Not required. Use next smaller actuator.
N/A = Not available. Use larger actuator or contact DeZURIK.

Cylinder Actuators

Actuator Sizing

60 psi (410 kPa) Air Supply

Valve Size	Order Code	Order Code	Maximum Pressure Differential psi/kPa			
			On/Off		Positioning	
	Carbon Steel (CS) Yoke	304 SST (S1) Yoke	Dry Solids, Slurries, Paper Stock	Liquids & Gases	Dry Solids, Slurries, Paper Stock	Liquids & Gases
24" 600mm	CY-PC12-CS	CY-PC12-S1	25/170	75/515	N/A	N/A
	CY-PC14-CS	CY-PC14-S1	75/515	150/1030	50/340	50/340
	CY-PC16-CS	CY-PC16-S1	150/1030	N/R	75/515	100/690
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	150/1030	150/1030
26" 650mm	CY-PC12-CS	CY-PC12-S1	N/A	75/515	N/A	N/R
	CY-PC14-CS	CY-PC14-S1	50/340	125/860	25/170	50/340
	CY-PC16-CS	CY-PC16-S1	125/860	150/1030	75/515	75/515
	CY-PC18-CS	CY-PC18-S1	150/1030	N/R	100/690	150/1030
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	150/1030	N/R
28" 700mm	CY-PC12-CS	CY-PC12-S1	N/A	50/340	N/A	N/A
	CY-PC14-CS	CY-PC14-S1	50/340	100/690	N/A	25/170
	CY-PC16-CS	CY-PC16-S1	75/515	150/1030	50/340	75/515
	CY-PC18-CS	CY-PC18-S1	150/1030	N/R	75/515	125/860
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	150/1030	150/1030
30" 750mm 100 CWP (P100)	CY-PC14-CS	CY-PC14-S1	25/170	75/515	N/A	N/A
	CY-PC16-CS	CY-PC16-S1	75/515	100/690	25/170	50/340
	CY-PC18-CS	CY-PC18-S1	100/690	N/R	75/515	75/515
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	100/690	100/690
30" 750mm 150 CWP	CY-PC14-CS	CY-PC14-S1	25/170	75/515	N/A	N/A
	CY-PC16-CS	CY-PC16-S1	75/515	150/1030	25/170	50/340
	CY-PC18-CS	CY-PC18-S1	125/860	N/R	75/515	75/515
	CY-PC20-CS	CY-PC20-S1	150/1030	N/R	125/860	150/1030
32" 800mm	CY-PC14-CS	CY-PC14-S1	25/170	75/515	N/A	N/A
	CY-PC16-CS	CY-PC16-S1	50/340	125/860	25/170	25/170
	CY-PC18-CS	CY-PC18-S1	100/690	150/1030	50/340	75/515
	CY-PC20-CS	CY-PC20-S1	150/1030	N/R	75/515	125/860
36" 900mm 100 CWP (P100)	CY-PC14-CS	CY-PC14-S1	N/A	50/340	N/A	N/A
	CY-PC16-CS	CY-PC16-S1	25/170	75/515	N/A	N/A
	CY-PC18-CS	CY-PC18-S1	75/515	100/690	25/170	50/340
	CY-PC20-CS	CY-PC20-S1	100/690	N/R	50/340	75/515
36" 900mm 150 CWP	CY-PC14-CS	CY-PC14-S1	N/A	50/340	N/A	N/A
	CY-PC16-CS	CY-PC16-S1	25/170	75/515	N/A	N/A
	CY-PC18-CS	CY-PC18-S1	75/515	150/1030	25/170	50/340
	CY-PC20-CS	CY-PC20-S1	100/690	N/R	50/340	75/515
42 & 48" 1050 & 1200mm	Contact DeZURIK for cylinder actuator sizing.					

N/R = Not required. Use next smaller actuator.
N/A = Not available. Use larger actuator or contact DeZURIK.

Cylinder Actuators

Actuator Sizing

80 psi (550 kPa) Air Supply

Valve Size	Order Code	Order Code	Maximum Pressure Differential psi/kPa			
			On/Off		Positioning	
	Carbon Steel (CS) Yoke	304 SST (S1) Yoke	Dry Solids, Slurries, Paper Stock	Liquids & Gases	Dry Solids, Slurries, Paper Stock	Liquids & Gases
2 & 3" / 50 & 80mm	CY-PC4-CS	CY-PC4-S1	150 / 1030	150 / 1030	150 / 1030	150 / 1030
4" / 100mm	CY-PC4-CS	CY-PC4-S1	150 / 1030	150 / 1030	100 / 690	150 / 1030
	CY-PC6-CS	CY-PC6-S1	N/R	N/R	150 / 1030	N/R
5 & 6" / 125 & 150mm	CY-PC4-CS	CY-PC4-S1	50 / 340	75 / 515	25 / 170	25 / 170
	CY-PC6-CS	CY-PC6-S1	150 / 1030	150 / 1030	125 / 860	150 / 1030
	CY-PC8-CS	CY-PC8-S1	N/R	N/R	150 / 1030	N/R
8" / 200mm	CY-PC6-CS	CY-PC6-S1	100 / 690	150 / 1030	75 / 515	75 / 515
	CY-PC8-CS	CY-PC8-S1	150 / 1030	N/R	150 / 1030	150 / 1030
10" / 250mm	CY-PC8-CS	CY-PC8-S1	150 / 1030	150 / 1030	100 / 690	125 / 860
	CY-PC10-CS	CY-PC10-S1	N/R	N/R	150 / 1030	150 / 1030
12" / 300mm	CY-PC8-CS	CY-PC8-S1	100 / 690	150 / 1030	75 / 515	100 / 690
	CY-PC10-CS	CY-PC10-S1	150 / 1030	N/R	150 / 1030	150 / 1030
14" / 350mm	CY-PC10-CS	CY-PC10-S1	125 / 860	150 / 1030	100 / 690	125 / 860
	CY-PC12-CS	CY-PC12-S1	150 / 1030	N/R	150 / 1030	150 / 1030
16" / 400mm	CY-PC10-CS	CY-PC10-S1	100 / 690	150 / 1030	75 / 515	100 / 690
	CY-PC12-CS	CY-PC12-S1	150 / 1030	N/R	125 / 860	150 / 1030
	CY-PC14-CS	CY-PC14-S1	N/R	N/R	150 / 1030	N/R
18" / 450mm	CY-PC12-CS	CY-PC12-S1	150 / 1030	150 / 1030	100 / 690	125 / 860
	CY-PC14-CS	CY-PC14-S1	N/R	N/R	150 / 1030	150 / 1030
20" / 500mm	CY-PC12-CS	CY-PC12-S1	125 / 860	150 / 1030	75 / 515	75 / 515
	CY-PC14-CS	CY-PC14-S1	150 / 1030	N/R	125 / 860	150 / 1030
	CY-PC16-CS	CY-PC16-S1	N/R	N/R	150 / 1030	N/R
22" / 550mm	CY-PC12-CS	CY-PC12-S1	100 / 690	150 / 1030	50 / 340	75 / 515
	CY-PC14-CS	CY-PC14-S1	150 / 1030	N/R	100 / 690	125 / 860
	CY-PC16-CS	CY-PC16-S1	N/R	N/R	150 / 1030	150 / 1030
24" / 600mm	CY-PC12-CS	CY-PC12-S1	75 / 515	150 / 1030	25 / 170	50 / 340
	CY-PC14-CS	CY-PC14-S1	150 / 1030	N/R	100 / 690	125 / 860
	CY-PC16-CS	CY-PC16-S1	N/R	N/R	150 / 1030	150 / 1030
26" / 650mm	CY-PC12-CS	CY-PC12-S1	50 / 340	125 / 860	25 / 170	25 / 170
	CY-PC14-CS	CY-PC14-S1	125 / 860	150 / 1030	75 / 515	75 / 515
	CY-PC16-CS	CY-PC16-S1	150 / 1030	N/R	125 / 860	150 / 1030
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	750 / 1030	N/R
28" / 700mm	CY-PC12-CS	CY-PC12-S1	50 / 340	100 / 690	N/A	25 / 170
	CY-PC14-CS	CY-PC14-S1	100 / 690	150 / 1030	50 / 340	75 / 515
	CY-PC16-CS	CY-PC16-S1	150 / 1030	N/R	100 / 690	125 / 860
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	150 / 1030	150 / 1030

N/R = Not required. Use next smaller actuator.
N/A = Not available. Use larger actuator or contact DeZURIK.

Cylinder Actuators

Actuator Sizing

80 psi (550 kPa) Air Supply

Valve Size	Order Code	Order Code	Maximum Pressure Differential psi/kPa			
			On/Off		Positioning	
	Carbon Steel (CS) Yoke	304 SST (S1) Yoke	Dry Solids, Slurries, Paper Stock	Liquids & Gases	Dry Solids, Slurries, Paper Stock	Liquids & Gases
30" 750mm 100 CWP (P100)	CY-PC12-CS	CY-PC12-S1	25 170	75 515	N/A	N/A
	CY-PC14-CS	CY-PC14-S1	75 515	100 690	50 340	50 340
	CY-PC16-CS	CY-PC16-S1	100 690	N/R	75 515	100 690
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	100 690	N/R
30" 750mm 150 CWP	CY-PC12-CS	CY-PC12-S1	25 170	75 515	N/A	N/A
	CY-PC14-CS	CY-PC14-S1	75 515	150 1030	50 340	50 340
	CY-PC16-CS	CY-PC16-S1	150 1030	N/R	75 515	100 690
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	125 860	150 1030
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	150 1030	N/R
32" 800mm	CY-PC12-CS	CY-PC12-S1	25 170	50 340	N/A	N/A
	CY-PC14-CS	CY-PC14-S1	50 340	125 860	25 170	50 340
	CY-PC16-CS	CY-PC16-S1	100 690	150 1030	50 340	75 515
	CY-PC18-CS	CY-PC18-S1	150 1030	N/R	100 690	150 1030
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	150 1030	N/R
36" 900mm 100 CWP (P100)	CY-PC14-CS	CY-PC14-S1	25 170	75 515	N/A	25 170
	CY-PC16-CS	CY-PC16-S1	75 515	100 690	50 340	50 340
	CY-PC18-CS	CY-PC18-S1	100 690	N/R	75 515	100 690
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	100 690	N/R
36" 900mm 150 CWP	CY-PC14-CS	CY-PC14-S1	25 170	75 515	N/A	25 170
	CY-PC16-CS	CY-PC16-S1	75 515	150 1030	50 340	50 340
	CY-PC18-CS	CY-PC18-S1	125 860	N/R	75 515	100 690
	CY-PC20-CS	CY-PC20-S1	150 1030	N/R	125 860	150 1030
42 & 48" 1050 & 1200mm	Contact DeZURIK for cylinder actuator sizing.					

N/R = Not required. Use next smaller actuator.
N/A = Not available. Use larger actuator or contact DeZURIK.

Cylinder Actuator Accessories

Positioners

DeZURIK cylinder actuators are available with pneumatic, electro-pneumatic or digital positioners for throttling control.

Air Filter Regulator

The DeZURIK Air Filter Regulator is designed to provide clean, accurate air pressure to actuators and positioners.

Four-Way Solenoid Valves

Solenoid valves may be ordered mounted and piped as part of a complete valve/actuator assembly or as a separate item.

Speed Control Valves

Speed Control Valves are available for controlling valve opening or closing speed with pneumatic actuators. The speed of operation is adjustable. To order mounted, add the appropriate code to the valve and actuator order code.

Speed Control	Order Code
Two speed controls	SP
One control to close	SPC
One control to open	SPO

Ordering Example:
KGC,4,HD,F1,S1,SMP,S1-M*CY-PC6-CS,SP

Cylinder Actuator Accessories
Position Indicating Switches
Position Indicating Switches are available for use on double-acting cylinder actuators. Order as part of a complete valve/actuator assembly by adding the appropriate code from the table below to the valve and actuator order code. Two switches will automatically be set to indicate full open and full closed positions.

Two Switches - Open/Closed

Quantity/ Description	Switch Type	Rating	Manufacturer	Order Code
2 SPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA1A-1A	SE649
2 DPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA2B-1A	SE524
2 SPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA3K-1A	SEH95
2 DPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA4L-1A	SEH96
2 SPDT, SST Housing	Proximity	CSA/FM Class 1, Division 1, Explosion Proof	GO 73-13526-A2	SEHK4
2 SPDT, SST Housing	Proximity	CSA Class I, Div 2, Hazardous Locations, (Groups A,B,C,D), Class II, (Groups E,F,G), Class III	GO 11-11124-A2	SEH94
2 SPDT, SST Housing	Proximity	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Stonel HK3077SG and HK3077SR	SEHK3

One Switch - Open

Quantity/ Description	Switch Type	Rating	Manufacturer	Order Code
1 SPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA1A-1A	SEJ40
1 DPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA2B-1A	SEJ42
1 SPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA3K-1A	SEJ46
1 DPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA4L-1A	SEJ44
1 SPDT, SST Housing	Proximity	CSA/FM Class 1, Division 1, Explosion Proof	GO 73-13526-A2	SEHK5
1 SPDT, SST Housing	Proximity	CSA Class I, Div 2, Hazardous Locations, (Groups A,B,C,D), Class II, (Groups E,F,G), Class III	GO 11-11124-A2	SEJ38
1 SPDT, SST Housing	Proximity	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Stonel HK3077SG	SEK37

One Switch - Closed

Quantity/ Description	Switch Type	Rating	Manufacturer	Order Code
1 SPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA1A-1A	SEJ41
1 DPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA2B-1A	SEJ43
1 SPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA3K-1A	SEJ47
1 DPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA4L-1A	SEJ45
1 SPDT, SST Housing	Proximity	CSA/FM Class 1, Division 1, Explosion Proof	GO 73-13526-A2	SEHK6
1 SPDT, SST Housing	Proximity	CSA Class I, Div 2, Hazardous Locations, (Groups A,B,C,D), Class II, (Groups E,F,G), Class III	GO 11-11124-A2	SEJ39
1 SPDT, SST Housing	Proximity	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Stonel HK3077SR	SEK87

Electric Motor Actuators
DeZURIK Knife Gate Valves can be furnished with electric motor actuators including Limitorque, Auma, Rotork, E.I.M. and others.

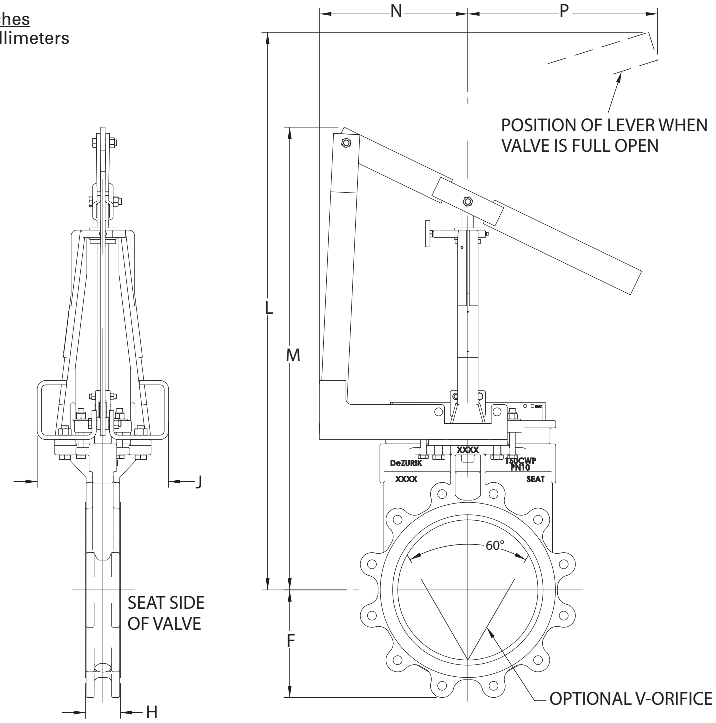
When ordering electric motor actuators, specify valve order code, shutoff pressure, service conditions (flowing media and installation direction); type of application (on/off or throttling); speed of operation; NEMA rating (4, 7, submersible, etc.); electrical characteristics (voltage and phase); actuator accessories and controls as per specification requirements.

Dimensions

Basic Valve with Lever Actuator

Valve Size	Dimensions						
	F	H	J	L	M	N	P
2" 50mm	3.0 76	1.88 48	5.75 146	15.96 405	14.78 375	4.38 111	8.00 203
3" 80mm	3.75 95	2.00 51	7.75 197	21.78 553	17.75 451	5.38 137	17.88 454
4" 100mm	4.50 114	2.00 51	7.88 200	29.40 747	19.87 505	6.12 155	24.12 613
5" 125mm	5.00 127	2.25 57	8.62 219	37.50 953	22.76 578	7.38 187	19.81 503
6" 150mm	5.50 140	2.25 57	8.62 219	42.00 1067	23.32 592	7.38 187	16.81 427
8" 200mm	6.75 171	2.75 70	9.38 238	58.12 1476	27.68 703	7.88 200	21.12 536
10" 250mm	8.00 203	2.75 70	11.25 286	68.19 1732	35.13 892	10.62 270	21.53 699
12" 300mm	9.50 241	3.00 76	11.25 286	76.03 1931	39.47 1003	12.69 322	33.44 849

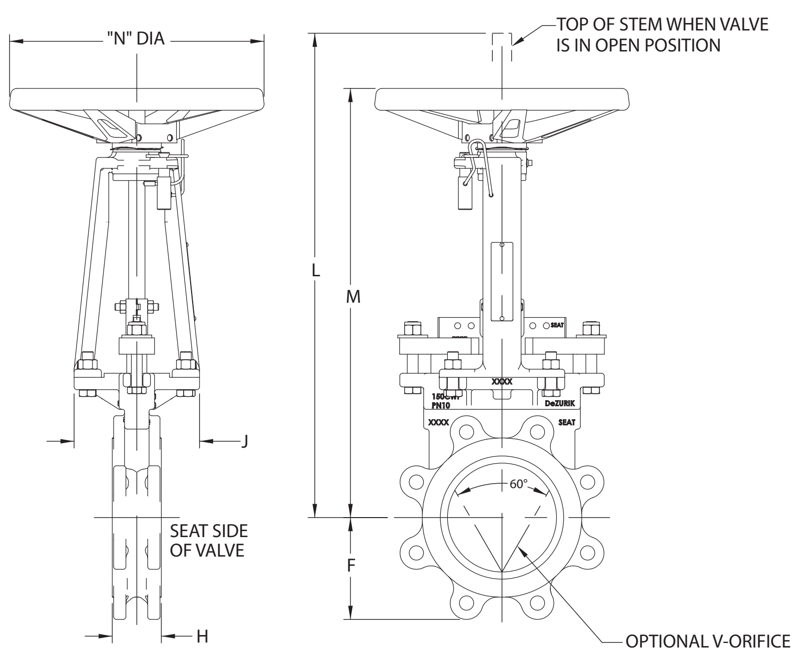
Inches
Millimeters



Basic Valve with Handwheel Actuator

Valve Size	Dimensions					
	F	H	J	L	M	N
2" 50mm	3.00 76	1.88 48	4.00 102	14.93 379	12.90 328	8.00 203
3" 80mm	3.75 95	2.00 51	4.75 121	16.65 423	14.62 371	8.00 203
4" 100mm	4.50 114	2.00 51	5.00 127	19.93 506	16.90 429	8.00 203
5" 125mm	5.00 127	2.25 57	5.75 146	24.30 618	19.56 497	12.00 305
6" 150mm	5.50 140	2.25 57	5.75 146	25.88 657	21.07 535	12.00 305
8" 200mm	6.75 171	2.75 70	6.38 162	31.43 798	24.65 626	12.00 305
10" 250mm	8.00 203	2.75 70	8.25 210	39.13 994	30.00 762	16.00 406
12" 300mm	9.50 241	3.00 76	8.25 210	44.75 1137	33.63 854	16.00 406
14" 350mm	10.50 267	3.00 76	8.25 210	54.75 1391	40.82 1037	20.00 508
16" 400mm	11.75 298	3.50 89	8.69 221	58.44 1484	42.38 1076	20.00 508
18" 450mm	12.50 318	3.50 89	9.06 230	67.75 1721	49.69 1262	20.00 508
20" 500mm	13.75 349	4.50 114	9.19 233	71.31 1811	51.25 1302	20.00 508
22" 550mm	15.5 394	4.50 114	9.19 233	77.22 1961	55.36 1406	20.00 508
24" 600mm	16.00 406	4.50 114	9.19 233	83.29 2116	59.22 1504	20.00 508

Inches
Millimeters



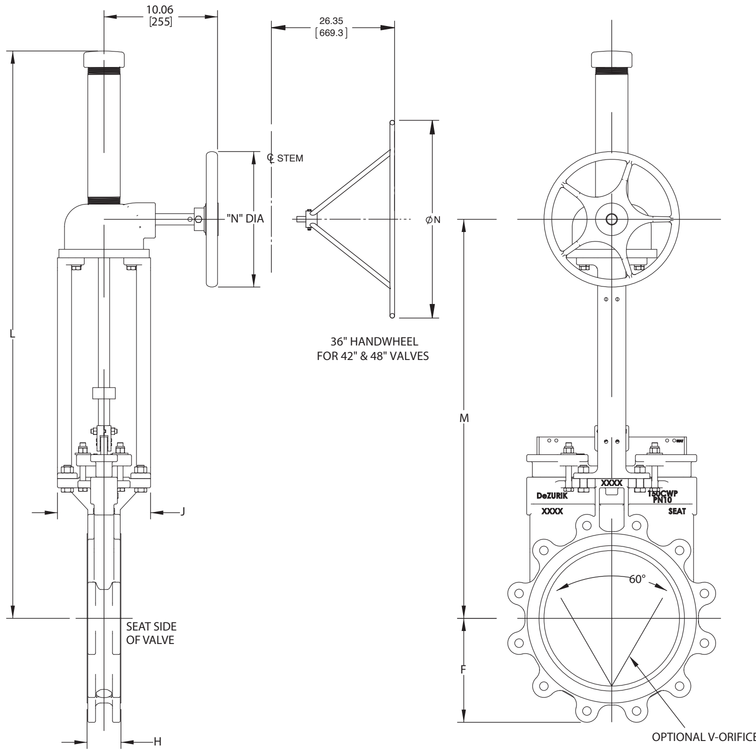
Dimensions

Bevel Gear Handwheel Actuator

Inches
Millimeters

Valve Size	F	H	J	L	M	N
3" 80mm	3.75 95	2.00 51	4.75 121	22.00 559	16.09 409	12.00 305
4" 100mm	4.50 114	2.00 51	5.00 127	24.30 617	18.37 467	12.00 305
5" 125mm	5.00 127	2.25 57	5.75 146	28.70 729	20.76 527	12.00 305
6" 150mm	5.50 140	2.25 57	5.75 146	30.30 769	22.29 566	12.00 305
8" 200mm	6.75 171	2.75 70	6.38 162	35.80 910	25.84 656	12.00 305
10" 250mm	8.00 203	2.75 70	8.25 210	46.50 1181	31.54 801	12.00 305
12" 300mm	9.50 241	3.00 76	8.25 210	50.20 1275	35.16 893	12.00 305
14" 350mm	10.50 267	3.00 76	8.25 210	56.70 1440	37.78 960	12.00 305
16" 400mm	11.75 298	3.50 89	8.69 221	60.40 1534	41.47 1053	12.00 305
18" 450mm	12.50 318	3.50 89	9.06 230	69.90 1775	47.08 1195	12.00 305
20" 500mm	13.75 349	4.50 114	9.19 233	73.50 1867	50.59 1285	16.00 406
24" 600mm	16.00 406	4.50 114	9.19 233	81.50 2070	58.57 1488	16.00 406
26" 650mm	17.13 435	4.63 117	9.50 241	100.95 2564	64.49 1638	30.00 762
28" 700mm	18.25 464	5.00 127	10.69 271	104.83 2663	68.37 1737	30.00 762
30"* 750mm	19.38 492	5.50 140	11.25 286	105.03 2668	73.09 1856	30.00 762
32" 800mm	20.88 530	6.00 152	11.25 286	113.20 2875	76.74 1949	30.00 762
36"* 900mm	23.00 584	6.00 152	11.25 286	122.53 3112	84.59 2149	30.00 762
42" 1050mm	26.50 673	6.50 165	13.50 343	146.28 3716	96.91 2462	36.00 914
48" 1200mm	29.75 756	7.00 178	18.50 470	194.87 4950	116.85 2968	36.00 914

* 100 psi, face-to-face (H dimension) on 30" and 36" (750 and 900mm) is 4.62" (117mm)



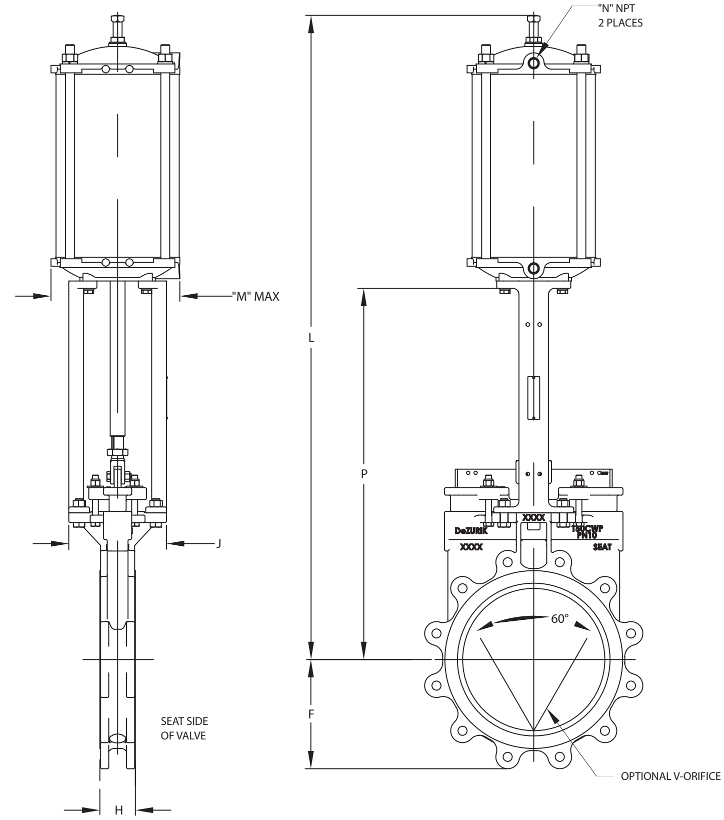
Dimensions

Basic Valve with Cylinder Actuator

Valve Size	Dimensions F	H	J
2" 50mm	3.00 76	1.88 48	4.00 102
3" 80mm	3.75 95	2.00 51	4.75 121
4" 100mm	4.50 114	2.00 51	5.00 127
5" 125mm	5.00 127	2.25 57	5.75 146
6" 150mm	5.50 140	2.25 57	5.75 146
8" 200mm	6.75 171	2.75 70	6.38 162
10" 250mm	8.00 203	2.75 70	8.25 210
12" 300mm	9.50 241	3.00 76	8.25 210
14" 350mm	10.50 267	3.00 76	8.25 210
16" 400mm	11.75 298	3.50 89	8.69 221
18" 450mm	12.50 318	3.50 89	9.06 230
20" 500mm	13.75 349	4.50 114	9.19 233
22" 550mm	15.50 394	4.50 114	9.19 233
24" 600mm	16.00 406	4.50 114	9.19 233
26" 650mm	17.13 435	4.63 117	9.50 241
28" 700mm	18.25 464	5.00 127	10.69 271
30"* 750mm	19.38 492	5.50 140	11.25 286
32" 800mm	20.88 530	6.00 152	11.25 286
36"* 900mm	23.00 584	6.00 152	11.25 286
42" 1050mm	26.50 673	6.50 165	13.50 343
48" 1200mm	Contact DeZURIK		

* 100 psi, face-to-face (H dimension) on 30" and 36" (750 and 900mm) is 4.62" (117mm)

Inches
Millimeters



2-16" (50-400mm) Valves

Actuator Number	L 2" 50mm	3" 80mm	4" 100mm	5" 125mm	6" 150mm	8" 200mm	10" 250mm	12" 300mm	14" 350mm	16" 400mm	M	N
CY-PC4	22.26 565	23.98 609	26.26 667	30.64 778	32.18 817	—	—	—	—	—	5.38 137	1/4
CY-PC6	—	—	27.61 701	32.00 813	33.56 852	39.11 993	47.13 1197	None	—	—	7.88 200	1/4
CY-PC8	—	—	—	32.38 822	33.94 862	39.49 1003	49.57 1259	53.19 1351	59.06 1500	62.74 1594	10.50 267	1/2
CY-PC10	—	—	—	—	—	—	50.97 1295	54.59 1387	60.35 1533	64.03 1626	13.00 330	1/2
CY-PC12	—	—	—	—	—	—	50.94 1294	54.56 1386	60.70 1542	64.38 1635	15.00 381	1/2
CY-PC14	—	—	—	—	—	—	—	—	—	63.68 1617	17.00 432	1/2

Inches
Millimeters

18-48" (450-1200mm) Valves

Actuator Number	L 18" 450mm	20" 500mm	22" 550mm	24" 600mm	26" 650mm	28" 700mm	30" 750mm	32" 800mm	36" 900mm	42" 1050mm	48" 1200mm	M	N
CY-PC10	73.59 1869	77.16 1960	—	—	—	—	—	—	—	—	—	13.00 330	1/2
CY-PC12	73.935 1878	77.495 1968	85.52 2172	89.475 2273	—	—	—	—	—	—		15.00 381	1/2
CY-PC14	73.24 1860	76.81 1951	85.52 2172	88.78 2255	95.38 2423	101.44 2577	108.19 2748	—	—	—		17.00* 432	1/2
CY-PC16	70.25 1784	75.94 1929	82.00 2083	87.91 2233	95.50 2426	101.56 2580	108.31 2751	113.94 2894	125.81 3196	—	Contact DeZURIK	17.00 432	1/2
CY-PC18	—	—	—	88.16 2239	95.75 2432	101.81 2585	108.56 2757	114.19 2900	126.06 3202	143.19 3637		19.00 483	3/4
CY-PC20	—	—	—	—	—	102.06 2592	109.81 2789	115.44 2932	126.31 3208	143.44 3643		21.00 533	3/4

* M dimension on 26-30" (650-750mm) is 14.75" (375mm)

Inches
Millimeters

Sales and Service

For information about our worldwide locations, approvals, certifications and local representative:
Web Site: www.dezurik.com E-Mail: info@dezurik.com

250 Riverside Ave. N. Sartell, Minnesota 56377 • Phone: 320-259-2000 • Fax: 320-259-2227

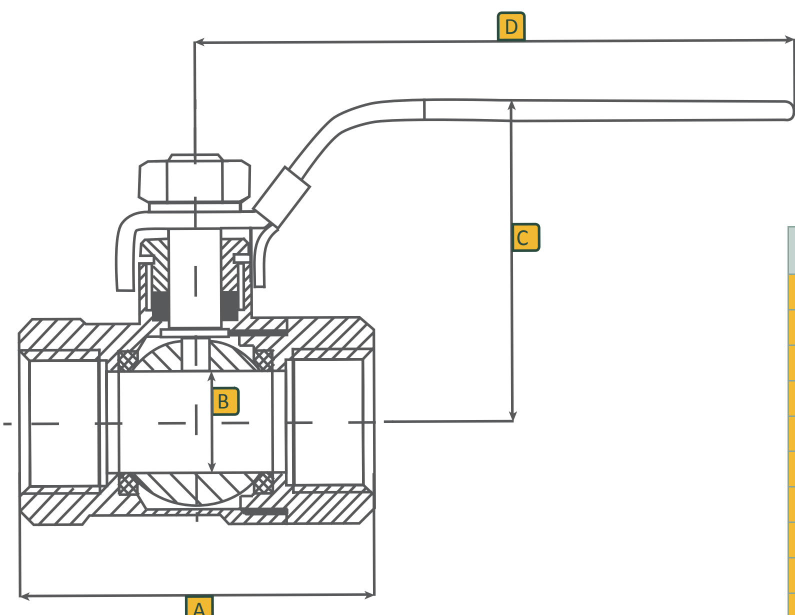
Series 50M76
2-Piece Ball Valve

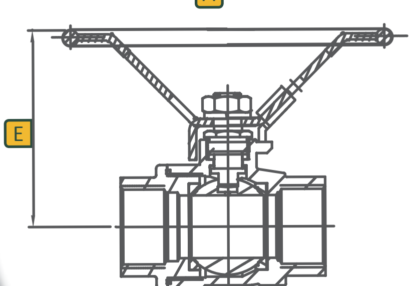
SHARPE®
Valves, Automation & Controls

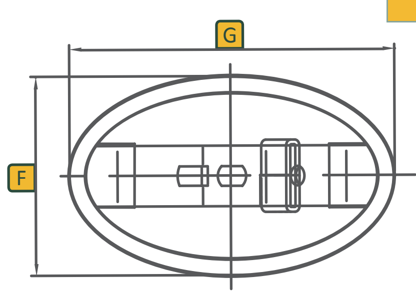
Features

- Full port
- 1000 WOG
- 316 Stainless Steel
- Locking device
- Blow-out proof stem
- Oval handle available

Dimensions







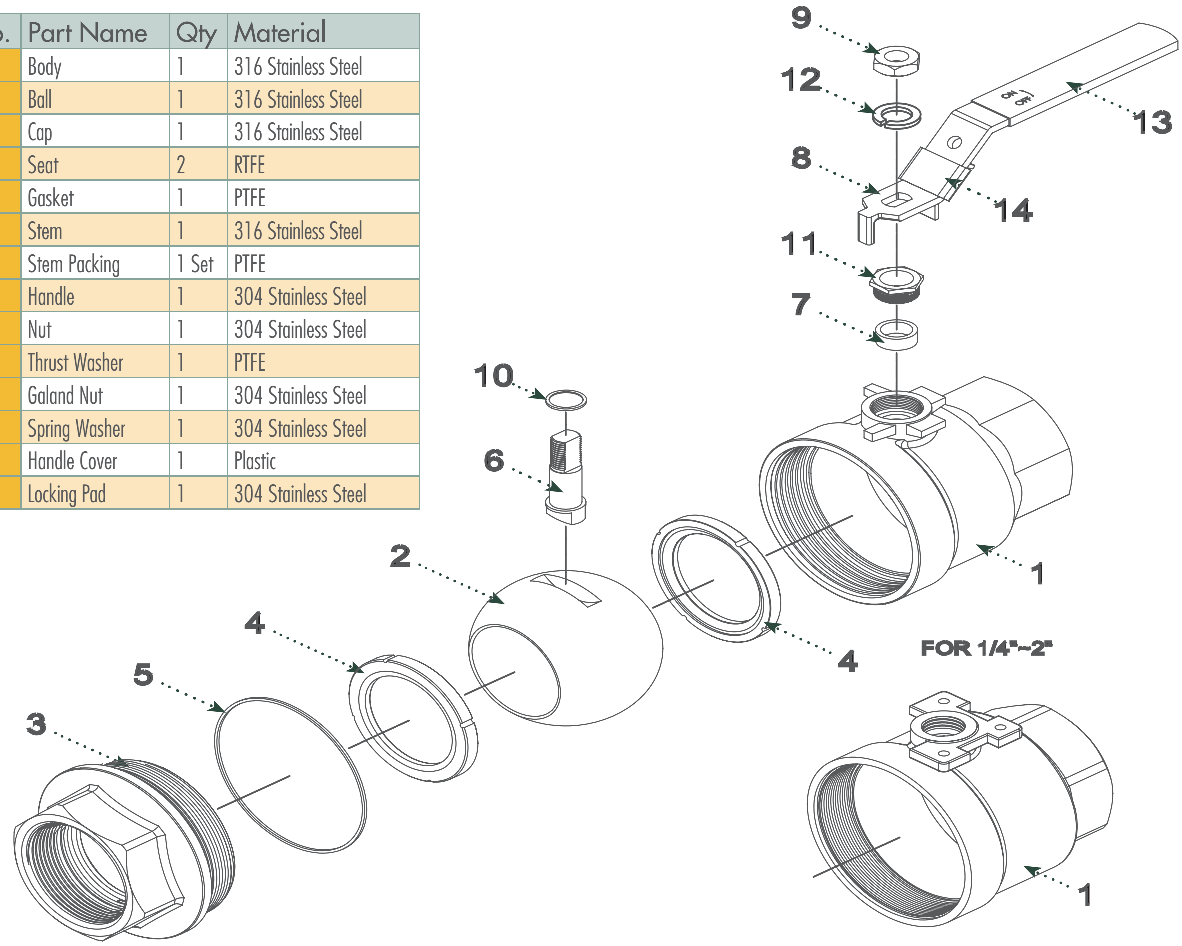
Dimensions (Inches)

Size	A	B	C	D	E	F	G
1/4	2.00	0.43	1.81	4.00	1.06	2.16	3.39
3/8	2.00	0.43	1.81	4.00	1.06	2.16	3.39
1/2	2.36	0.50	1.89	4.00	1.06	2.16	3.39
3/4	2.75	0.80	2.04	5.00	1.34	2.76	4.33
1	3.25	1.00	2.44	5.75	1.53	3.18	5.26
1-1/4	3.80	1.25	2.56	5.75	1.53	3.18	5.26
1-1/2	4.33	1.50	2.96	7.50	1.97	4.13	6.30
2	5.27	2.00	3.25	7.50	1.97	4.13	6.30
2-1/2	6.58	2.50	5.00	9.73	-	-	-
3	7.55	3.00	5.40	9.73	-	-	-

Toll Free (877) 774-2773 | Local (708) 562-9221 | Fax (708) 562-0890 | www.sharpevalves.com

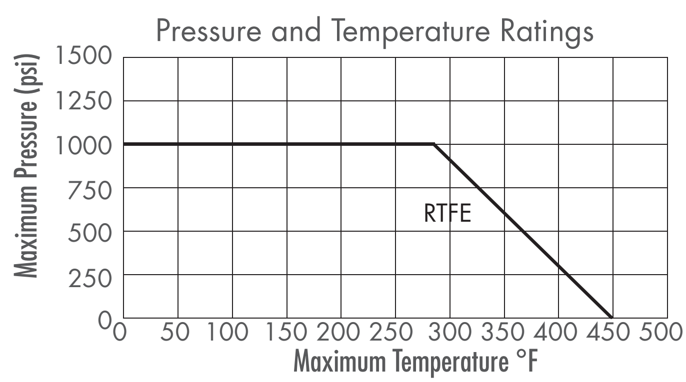
Parts & Materials

No.	Part Name	Qty	Material
1	Body	1	316 Stainless Steel
2	Ball	1	316 Stainless Steel
3	Cap	1	316 Stainless Steel
4	Seat	2	RTFE
5	Gasket	1	PTFE
6	Stem	1	316 Stainless Steel
7	Stem Packing	1 Set	PTFE
8	Handle	1	304 Stainless Steel
9	Nut	1	304 Stainless Steel
10	Thrust Washer	1	PTFE
11	Galand Nut	1	304 Stainless Steel
12	Spring Washer	1	304 Stainless Steel
13	Handle Cover	1	Plastic
14	Locking Pad	1	304 Stainless Steel



Technical Information

Size	Cv	Weight-Lbs
1/4	6	0.5
3/8	6	0.5
1/2	24	0.7
3/4	35	1.1
1	47	2.0
1-1/4	81	3.0
1-1/2	105	4.8
2	241	8.0
2-1/2	319	14.0
3	580	20.0



Ordering

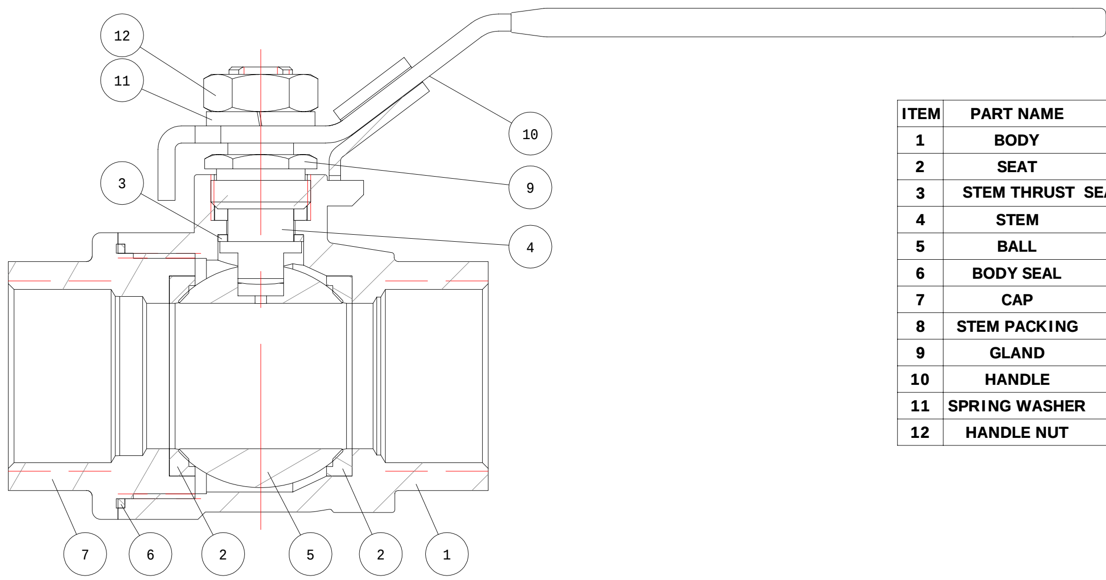
Fig: 1/2 - 50M76
Description: 1/2" - Series 50M76

Size		Series	Options	
1/4 3/8 1/2 3/4 1	1-1/4 1-1/2 2 2-1/2 3	50M76	OH	Oval Handle

Due to continuous development of our product range, we reserve the right to change the dimensions and information for this product as required.

SHARPE VALVES
A Division of Smith-Cooper International, LLC

FULL PORT BALL VALVE – MODEL 50M76
INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS



ITEM	PART NAME
1	BODY
2	SEAT
3	STEM THRUST SEAL
4	STEM
5	BALL
6	BODY SEAL
7	CAP
8	STEM PACKING
9	GLAND
10	HANDLE
11	SPRING WASHER
12	HANDLE NUT

INSTALLATION:

These valves may be installed in the pipeline in any orientation or position, using good piping practice. For threaded end valves, use a suitable joint compound or TFE tape on pipe threads for ease of fit-up.

OPERATION:

These are quarter-turn (90° rotation) ball valves, and are normal fitted with a latching lever handle for manual operation. The handles also contain travel stop tabs at the open and closed positions. To open the valve, lift the latch/lock slider up, and turn the handle counterclockwise. To close the valve, lift the latch/lock and turn the handle clockwise.

MAINTENANCE:

----WARNING----
Do not attempt to perform maintenance on valves in pressurized lines.

Stem Seal Adjustment:

If leakage is evident from the stem packing area, tighten the gland nut 1/8 turn. If the leakage persists, repeat tightening. When leakage cannot be corrected by tightening the stem nut, replacement of the valve will be necessary.

SHARPE VALVES
A Division of Smith-Cooper International, LLC
1260 Garnet Drive, Northlake, Illinois 60164-1028 Phone (877) 774-2773 Fax: (708) 562-0890 www.sharpevalves.com

INSTALLATION

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluid, before installation-

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Before installing the valve, inspect the valve body port and associated equipment for any damage that may have occurred and for any foreign matter that may have collected in shipping or storage. Make certain the body interior is clean.

2. Before installing the valve, inspect the pipe line and mating flanges, making sure the pipe is free of foreign material and the flanges are clean and have no burrs or pits that could cause leakage.

3. Due to stainless steel castings, machining tolerances, and flange thickness, the body tapped hole depth may vary slightly from valve to valve. It is, therefore, recommended that all knife gates be installed with a stainless steel ASTM A-304-B8 stud or an ASTM A-316-B-8M stud. The use of a carbon steel B-7 stud may also be considered. We further recommend the use of a teflon thread compound. It should be pointed out that the use of cap screws or bolts may harm the chest in the knife gate by bottoming out and should never be used on this area of the knife gate valve.

4. The Davis Knife Gate is manufactured with ANSI B 16.5 – 150# raised face flange dimensions. The use of a suitable gasket between the body and the pipe line flanges shall be selected by the customer. We would recommend the use of a PTFE gasket.

5. Carefully place the valve between the flanges and loosely assemble the valve by putting in the bottom two or three studs, then carefully insert the gaskets into place. The bottom studs will help locate the gasket and hold it in position.

6. Carefully insert the balance of the studs into place and tighten all of them evenly – <u>not in rotation</u> – but by the cross over method. <u>CAUTION:</u> Do not over tighten chest cavity studs.

7. The Davis Knife Gate Valve may be installed in any orientation in the pipe line, however, the normal method is with the handwheel vertical above the valve body. Other positions are acceptable, however, they may result in uneven valve wear.

8. The resilient seat knife gate is a bi-directional valve and will operate with the flow in either direction. Care must be taken with the metal-seated valve as it is a unidirectional valve (or a one-flow-direction valve). Make sure that the metal-seated valve is oriented so that the pipe line flow is in the same direction as the arrow on the side of the valve body. This will insure that the valve seat is on the downstream side of the gate.

9. All Resilient-Seated Knife Gate Valves require the resilient seat to be lubricated before stroking, regardless of type of actuator. The fit pressure of the gate against the resilient seat, on the sides of the valve up thru the packing gland, is such that stroking the valve dry (with no lubrication of any kind) will cause the resilient seat to cold flow beyond safe limits and will damage the seat with just a few strokes. CRC or WD40, sprayed on the seat, up in the chest area, both sides, will normally provide sufficient lubrication. This should be repeated every 2 or 3 strokes. This is CRITICAL to the life and performance of the seat. In operation, the process product normally supplies adequate lubrication.

OPERATION

1. After the valve has been installed, cycle the valve once completely. Open the valve by turning the handwheel counter clockwise, reverse the operation for closing. (Note: This will detect if any damage has been incurred either due to shipping or installation processes.) After installing Resilient Seat Valves (Lug Type), be sure to determine that bonnet nut and lock nut are secure. If either lock or bonnet nut are loose, adjust as follows:

    1. Back lock nut in counterclockwise rotation 2 turns.
    2. Back bonnet nut in counterclockwise rotation 2 turns.
    3. Turn handwheel in clockwise motion until gate bottoms out, then turn handwheel at that point ¼ turn more.
    4. Tighten bonnet nut down to stop-out against stem nut.
    5. Secure lock nut down on bonnet nut to hold in position.

After cycling the gate valve, turn the handwheel counterclockwise several turns allowing partial opening for preparation to fill system.

2. Open upstream valve slowly, building system pressure gradually, allowing installation personnel to detect any excessive packing gland leakage, making adjustments necessary.

3. After the system has come to a full pressure, open the knife gate fully by turning the handwheel counterclockwise, then close the valve fully by turning the handwheel clockwise. In resilient seat knife gate valves, this process will result in "seating in the valve." This step may be eliminated with the metal-seated valve.

4. You may now use the valve for its intended purpose, keeping in mind that a gate valve should be used in a full open or a full closed position. Gate valves should not be used for throttling unless specifically designed for such a use.

MAINTENANCE

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of the service conditions. This section includes instructions for packing adjustments, repacking, seat replacement, and seating adjustment.

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluids, before installation –

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Normal maintenance of the Davis Knife Gate Valve may only include a periodic tightening of the packing gland. Should a leak occur at the packing gland, simply tighten the packing gland bolt closest to the leak. This may require tightening two or three bolts on larger valves. After the leak has stopped, tighten all packing gland bolts ¼ turn. Do not over tighten. The only other normal maintenance required would be to grease the valve stem by using a grease gun at the grease fitting located on the valve yoke.

2. From time to time, it may be necessary to repack the valve completely. This can be done following the warning procedure listed above. Standard repacking kits are available through Davis Valve. Packing kits include necessary packing and a top wiper seal gasket which insures a tight seal. When ordering be sure to specify valve model number,

indicating type of seat and type of valve. Repacking the valve includes the following steps:

1. Remove packing gland nuts and lock washers.

2. Raise blade to the full open position.

3. Pull up the packing gland to the top of the blade and secure it to the top of the blade.

4. Using a packing hook, remove all of the old packing.

5. Carefully clean the stuffing box. If oil, grease, wax, or graphite impregnated packings were used, it might be necessary to use a solvent to clean the stuffing box.

6. Purchase precut packing kits from Davis Valve or carefully cut each ring by wrapping a length of packing around the blade snugly, but without tension. Cut each ring individually, making a square cut with a clean, sharp knife.

7. Insert rings one at a time into stuffing box. Tamp each ring lightly in place using a flat packing iron. Packing joints may be located 90° apart, on metal-seated valves, to minimize leakage. Successive layers are installed in the same manner.

8. Pull the packing gland down and tighten using only the two end studs until the packing gland almost bottoms out.

9. Remove the packing gland as previously described.

10. Insert the wiper seal gasket.

11. Pull down packing gland using lock washers and nuts and tighten using alternate method. Do not over tighten.

12. Bring the valve up to pressure and tighten the packing gland following the procedures listed under the maintenance instructions.

VALVE THRUST AND TORQUE VALUES

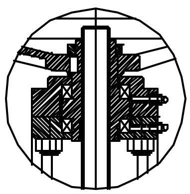
	Size	Valve Thrust lbs	Valve Torque ft lbs	Flow Coefficient Gal. per min. at a pressure drop of 1 psi
MODEL 60	2	648	9	285
	3	898	12	760
	4	1253	17	1420
	5	---	---	2890
	6	2077	37	3300
	8	3590	63	5800
	10	5469	97	11000
	12	7299	141	16500
	14	8573	166	20500
	16	10959	230	27000
	18	14409	302	36000
	20	17189	409	45000
	24	23801	592	60000
	30	---	---	95000
	36	---	---	138000
MODEL 61	2			285
	3			760
	4			1420
	5			2890
	6			3300
	8			5800
	10			11000
	12			16500
	14			20500
	16			27000
	18			36000
	20			45000
	24			60000
	30			95000
	36			138000
MODEL 70	2	565	8	285
	3	774	11	760
	4	1094	15	1420
	6	1958	27	3300
	8	3582	63	5800
	10	5541	98	11000
	12	7379	130	16500
	14	9551	185	20500
	16	12058	233	27000
	18	15353	322	36000
	20	18528	389	45000
	24	25880	616	60000

Davis Valve

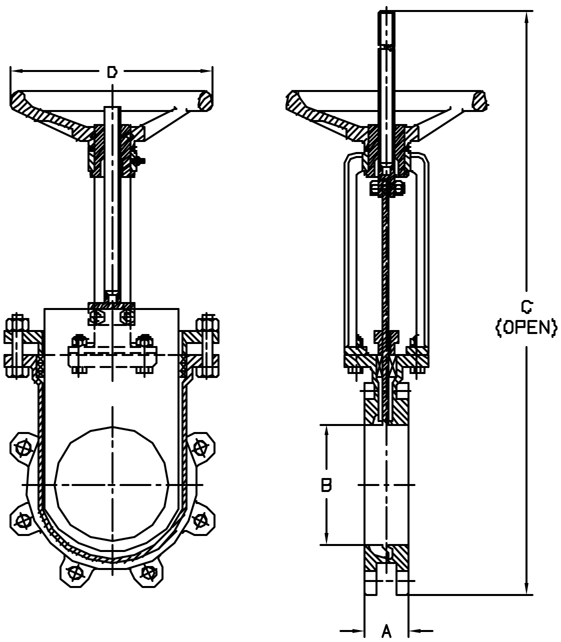
Memphis, Tennessee

Stainless Steel Knife Gate

TOPWORKS DETAIL
16" TO 48"



Model 60C - CF8 (304SS)
Model 60F - CF8M (316SS)
Model 60G - CG8M (317SS)



PART NAME	MATERIALS A 351-CF8	MATERIALS A 351-CF8M	MATERIALS A 351-CG8M
BODY	A 351-CF8	A 351-CF8M	A 351-CG8M
GATE	SS 304	SS 316	SS 317
YOKE	A 351-CF8	A 351-CF8	A 351-CF8
STEM	SS 304	SS 304	SS 304
GLAND	A 351-CF8	A 351-CF8M	A 351-CG8M
GLAND PACKING	PTFE	PTFE	PTFE
STEM NUT	AL BRONZE	AL BRONZE	AL BRONZE
HAND WHEEL	A 216-WCB	A 216-WCB	A 216-WCB

SIZE	INCH	2	2½	3	4	5	6	8	10	12	14	16	18	20	24	30	36
	MM	50	65	80	100	127	150	200	250	300	350	400	450	500	600	762	915
A	INCH	1.88	2.0	2.0	2.0	2.25	2.25	2.75	2.75	3.0	3.0	3.5	3.5	4.5	4.5	5.4	6.3
	MM	47.8	50.8	50.8	50.8	57.2	57.2	69.9	69.9	76.2	76.2	88.9	88.9	114.3	114.3	137.1	160.0
B	INCH	2.0	2.5	3.0	4.0	5.0	6.0	8.0	10.0	12.0	13.25	15.25	17.25	19.25	23.25	29.25	35.25
	MM	50.8	63.5	76.2	101.6	127.0	152.4	203.2	254.0	304.8	336.5	387.3	438.1	488.9	590.5	742.9	895.3
C	INCH	15.5	19.3	19.3	23.0	26.2	29.25	36.25	44.0	51.0	57.0	66.0	73.0	79.5	93.0	131.9	151.9
	MM	393.7	490.2	490.2	584.2	665.4	743.0	920.8	1117.6	1295.4	1447.8	1676.0	1854.0	2019.3	2362.2	3350.4	3858.2
D	INCH	8.0	8.0	8.0	10.0	10.0	12.0	14.0	16.0	16.7	18.9	18.9	20.9	20.9	24.8	36.7	36.7
	MM	203.0	203.0	203.0	254.0	254.0	304.8	355.6	406.4	424.1	480.0	480.0	530.8	530.8	630.0	932.1	932.1
WGT	LBS	22		31	38	47	59	84	124	170	201	294	372	503	671	1810	2252
	KGS	10		14	18	22	27	38	56	77	91	133	168	228	305	820	1020

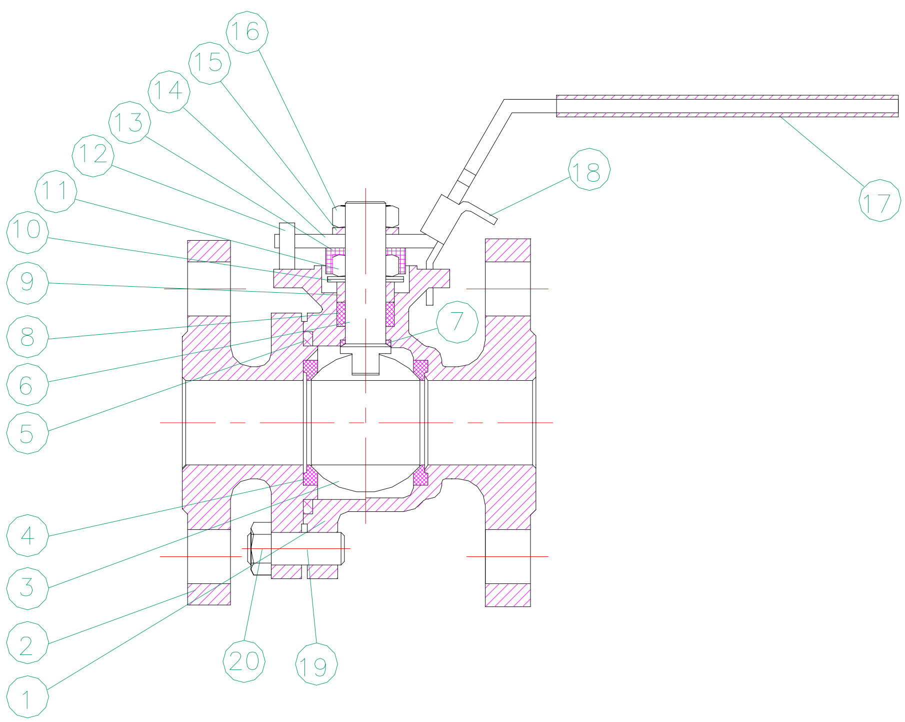
Davis Valve

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes ½” – 4” , Classes 150, 300, and 600

ITEM	DESCRIPTION
1	BODY
2	END CONNECTOR
3	BALL
4	SEAT
5	BODY GASKET
6	STEM
7	THRUST BEARING
8	STEM PACKING
9	GLAND PACKING
10	BELLVILLE WASHER
11	STEM NUT
12	STOPPER
13	LOCK TAB
14	HANDLE
15	HANDLE WASHER
16	HANDLE NUT
17	SLEEVE
18	LOCKING DEVICE
19	STUD
20	NUT



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150, 300, or 600.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the adjusting nut 1/4 turn. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle and travel stop plate.

3. Remove stem nut locking tab, stem nut, belleville springs, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

7. Take out other seat.

8. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Install one seat in the body cavity with the spherical curvature facing the ball.

2. Install thrust bearing on stem and slide the stem up through the body.

3. Install new stem seals, gland ring, and belleville springs. Install stem nut and tighten to the torque values given in Table 1. Install stem nut locking tab or cap. Tighten stem nut slightly if necessary to align nut with locking device surfaces.

4. Install travel stop (if supplied) and handle. Make sure handle aligns with flow bore through ball. Install hand retainer nut (or capscrew).

5. Turn the handle to the CLOSED position. Line up the ball slot with the stem tang and the ball into position on the stem tang. Turn the handle to the OPEN position to hold the ball in place.

6. Install the remaining seat into body end.

7. Place new body seal into counterbore in valve body.

8. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

9. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

10. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

11. Pressure test valve, if possible, before reinstalling in pipeline.

Table 1 - Stem Nut Torques

Valve Size	Torque (lb-ft)
½"	5.5
¾"	5.5
1"	6
1-1/2" – 4"	22

Table 2 – Body Bolting Torques (lb-ft)

Valve Size	Class 150	Class 300	Class 600
½"	5	10	15
¾"	5	10	20
1"	5	20	35
1-1/2"	15	35	80
2"	20	40	140
3"	20	60	155
4"	25	95	215

Note: Torque values are for TFE/RTFE or flexible graphite gaskets and seals. For other materials contact Sharpe Valves.

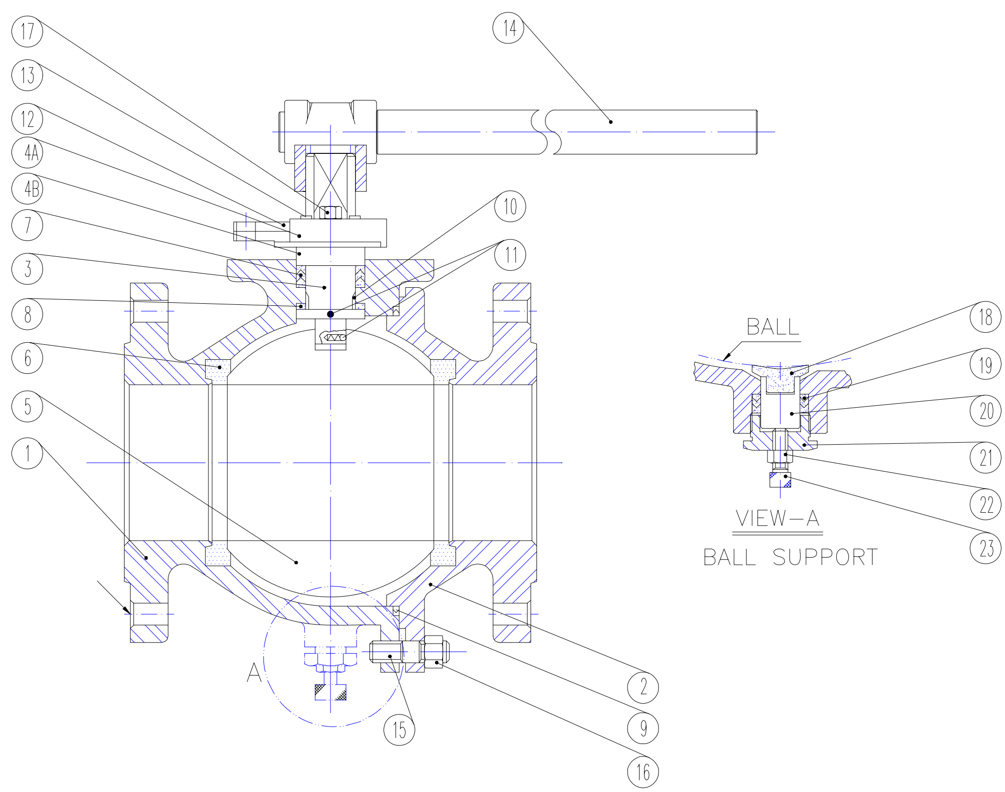
SHARPE VALVES
A Division of Smith-Cooper International, LLC

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes 6” - 12” , Classes 150 & 300

NO.	PART NAME
1	BODY
2	CAP
3	STEM
4A	GLAND
4B	GLAND RING
5	BALL
6	SEAT
7	PACKING
8	THRUST WASHER
9	GASKET
10	STEM BEARING
11	ANTI–STATIC
12	TRAVEL STOPPER
13	SNAP RING
14	HANDLE
15	STUD
16	NUT
17	GLAND BOLT
18	PIN SEAT
19	PIN PACKING
20	SUPPORT PIN
21	SUPPORT NUT
22	SET NUT
23	TUNING SCREW



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools. Ball support supplied for 10” and 12” Class 150 valves, and 6” through 12” Class 300 valves.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150 or Class 300.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the gland bolts 1/4 turn, each. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle, snap ring, and travel stop plate.

3. Remove gland bolts, gland, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. **<u>For 10” and 12” valves only</u>**: Ball support must be backed off to remove ball. Loosen support nut, set nut and back out tuning screw on bottom of valve to release the ball support. The weight of the ball will cause the ball support to come down.

7. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

8. Take out other seat.

9. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing and stem bushing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Set the valve body on a clean work suface, resting on the end flange.

2. Install one seat in the body cavity with the spherical curvature facing the ball (upwards).

3. Cut new stem bushing on one side at approx. 30° - 60° angle and wrap around stem above shoulder.

4. Install thrust bearing on stem and holding stem bushing in place, slide the stem up through stem bore from inside body.

5. Install new stem seals, gland ring, and gland. Install gland bolts and tighten hand tight.

6. Install travel stop, and snap ring.

7. Turn the stem to the CLOSED position (bottom stem tan parallel to flow passage). Line up the ball slot with the stem tang and roll and lower the ball into position on the stem tang, letting the ball rest in the seat. Turn the stem and ball to the OPEN position to hold the ball in place.

8. **For 10” and 12” Valves Only:** Re-set the ball support by turning the tuning screw inwards until the support pin seat firmly contacts the ball. Do not cause the ball to move. Holding the tuning screw in place, tighten the support nut and then the set nut.

9. Install the remaining seat into body end.

10. Place new body seal into counterbore in valve body.

11. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

12. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

13. Tighten the gland bolts to the torques specified in Table 1.

14. Install handle, making sure that the handle aligns with the flow passage through the ball.

15. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

16. Pressure test valve, if possible, before reinstalling in pipeline.

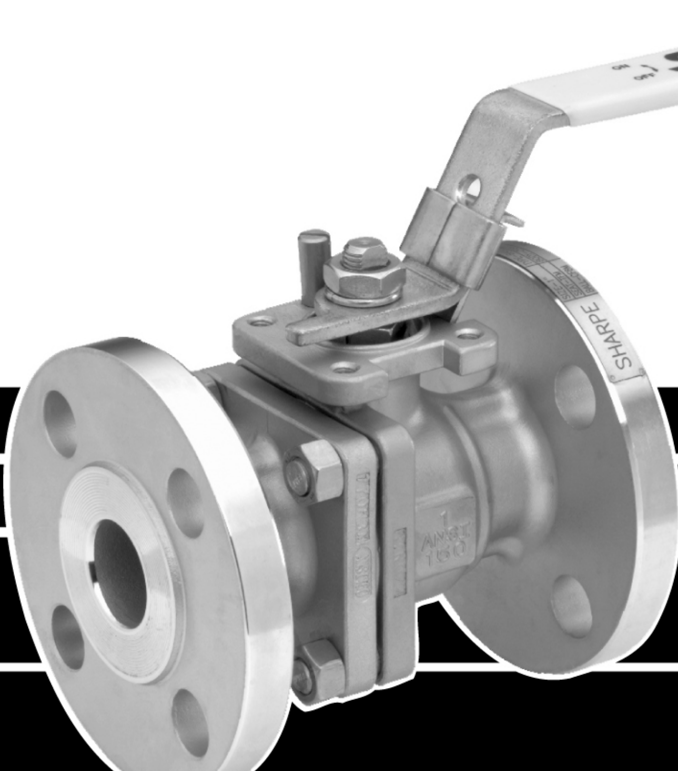
Table 1 – Gland Bolt Torques

SIZE	Tightening Torque (lb-ft) Max
6” – 8”	42 (1/2-13UNC)
10” - 12”	83 (5/8-11UNC)

Table 2 – Body Bolting Torques

SIZE	THREAD	Tightening Torque (lb-ft) Max
6”,8” (Class 150) / 3”~6”(Class 300)	5/8-11UNC	83
10”,12” (Class 150) / 8”(Class 300)	3/4-10UNC	120
10”(Class 300)	7/8-9UNC	190
12”(Class 300)	1-8UNC	260

SHARPE® VALVES

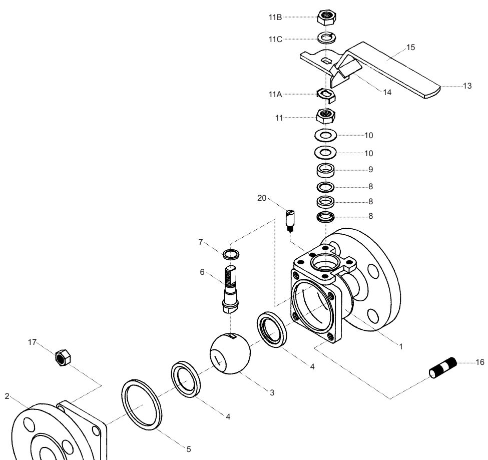


FLANGED FULL PORT BALL VALVE SERIES 50 / CLASS 150

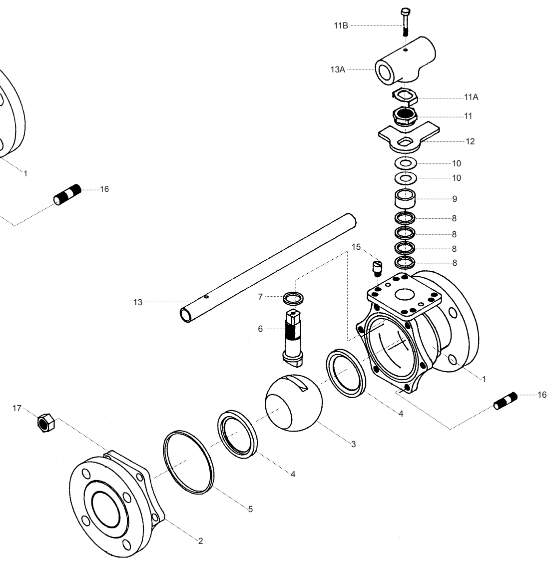
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

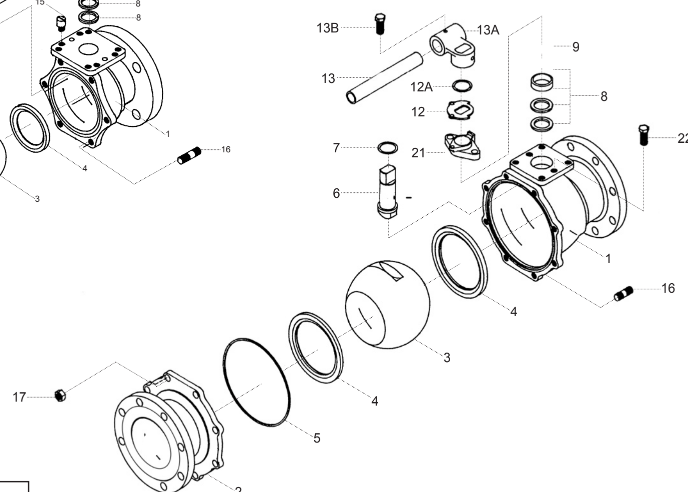
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2” - 2”



2-1/2” - 4”



6” - 8”

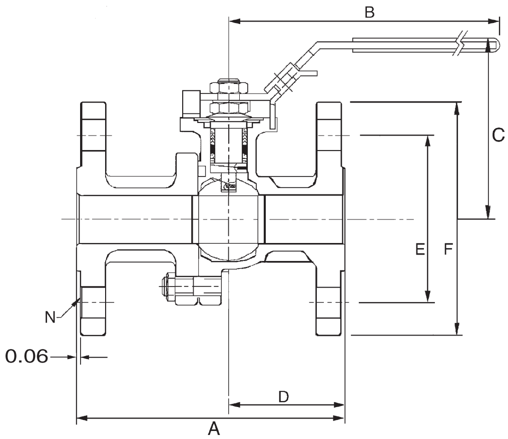
PART NO.	PART	QTY.	MATERIAL
1	Body	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) TFE Reinforced TFE NOVA PEEK
5	Body Seal	1	TFE
6	Stem	1	316 Stainless Steel Alloy 20 Hastelloy C 17-4PH (Option)
7	Thrust Bearing	2	Reinforced TFE
8	Stem Packing	3/4	Reinforced TFE
9	Gland Packing	1	304 Stainless Steel
10	Belleville Washer (1/2”-4”)	2/4	304 Stainless Steel
11	Packing Nut (1/2”-4”)	1	304 Stainless Steel
11A	Lock Tab	1	Stainless Steel
11B	Handle Nut	1	304 Stainless Steel
11C	Lock Washer	1	304 Stainless Steel (1/2”-2”)

*See Dimensions

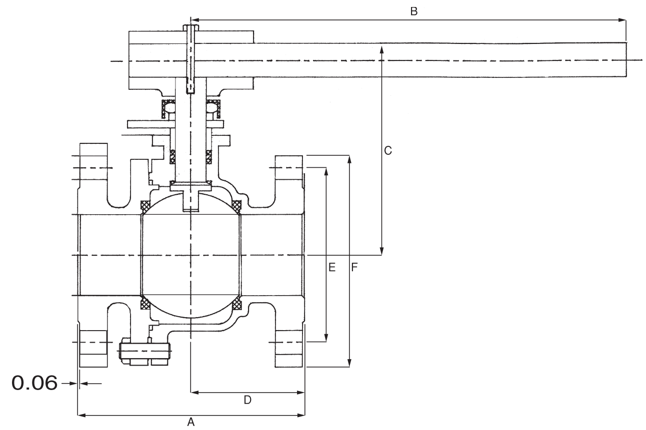
PART NO.	PART	QTY.	MATERIAL
12	Stopper	1	304 Stainless Steel
12A	Snap Ring	1	Stainless Steel (6”-8”)
13	Handle	1	304 Stainless Steel (1/2”-2”) Galvanized Steel (2-1/2”-4”) Ductile Iron (6”-8”)
13A	Wrench Block	1	Stainless Steel
13B	Hex Head Bolt	1	304 Stainless Steel
14	Locking Device (1/2”-2”)	1	304 Stainless Steel
15	Sleeve	1	Vinyl
16	Body Stud	SEE* N	A193 B8 (SST) A193 B7 (CS)
17	Nut	SEE* N	A194 8 (SST) A194 2H (CS)
20	Stop Pin (1/2”-2”) (2-1/2”-4”)	1 2	304 Stainless Steel 304 Stainless Steel
21	Gland Flange (6”-8”)	1	304 Stainless Steel
22	Gland Bolts (6”-8”)	2	304 Stainless Steel

SERIES 50
DIMENSIONS

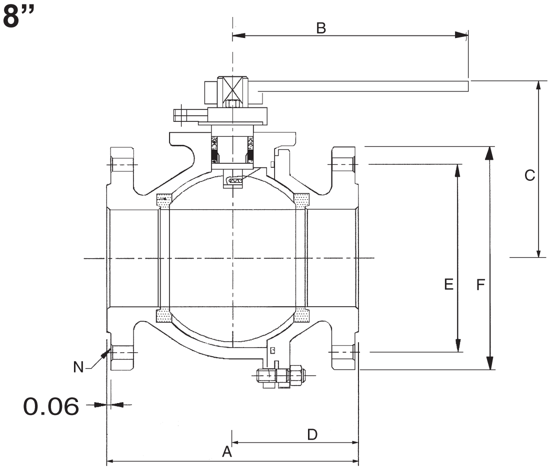
1/2" - 2"



2-1/2" - 4"



6" - 8"



CV DATA

1/2"	26
3/4"	50
1"	94
1-1/2"	260
2"	480
2-1/2"	750
3"	1300
4"	2300
6"	5400
8"	10000

PORT

1/2"	0.59
3/4"	0.78
1"	1.00
1-1/2"	1.50
2"	2.00
2-1/2"	2.55
3"	3.00
4"	4.00
6"	6.00
8"	7.88

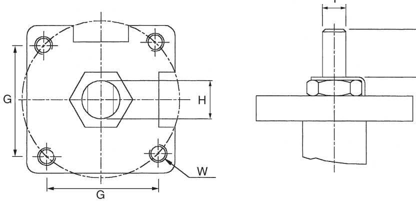
WEIGHT (lbs.)

1/2"	4
3/4"	6
1"	8
1-1/2"	15
2"	20
2-1/2"	36
3"	45
4"	75
6"	135
8"	290

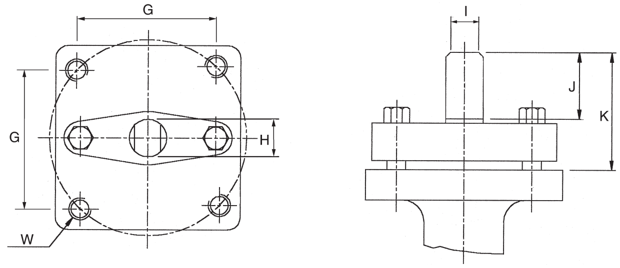
SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2"	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4"	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1"	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2"	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2"	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2"	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3"	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4"	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6"	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8"	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

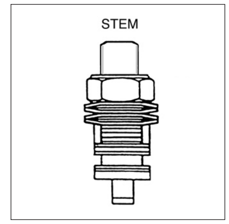
The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.

1/2" - 4"



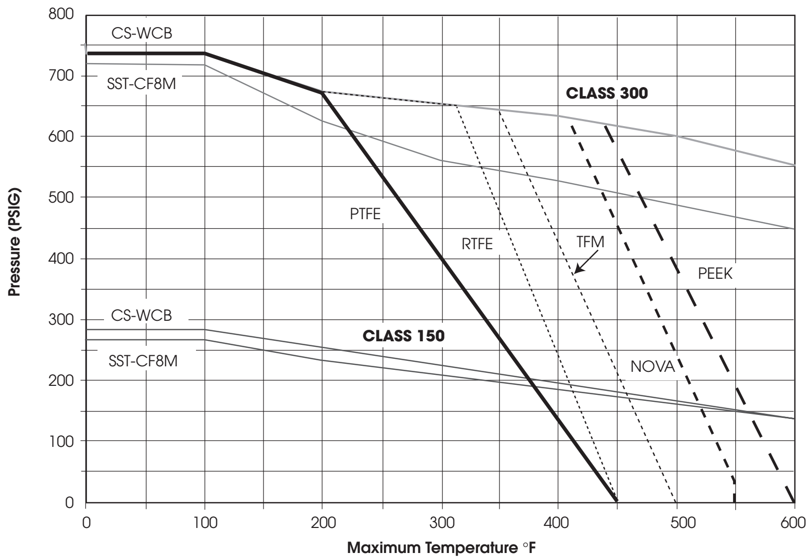
6" - 8"





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2″	50	150# = 11	2 = Alloy 20	T = TFE	X = Oxygen Service
3/4″			4 = Carbon Steel	R = RTFE	OH = Oval Handle
1″			6 = Stainless Steel	N = NOVA	F = Fugitive Emissions Certified ANSI 593.00.01
1-1/2″			5 = Hastelloy C	P = Peek	E = Extended Stem
2″			3 = Monel	M = TFM™	L = Lockable Extended Stem
2-1/2″					D = Leak detection Stem
3″					GO = Gear Operator
4″					7 = 17- 4PH Stem
6″					A = Nace
8″					

3/4" 50 11 6 T X

Toll-Free 1-877-7SHARPE
(877) 774-2773
Fax: (708) 562-9250
E-Mail: info@sharpevalves.com
www.sharpevalves.com
1260 Garnet Drive
Northlake, Illinois 60164 U.S.A.

SHARPE® VALVES
A Division of Smith-Cooper International, LLC

INSTALLATION

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluid, before installation-

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Before installing the valve, inspect the valve body port and associated equipment for any damage that may have occurred and for any foreign matter that may have collected in shipping or storage. Make certain the body interior is clean.

2. Before installing the valve, inspect the pipe line and mating flanges, making sure the pipe is free of foreign material and the flanges are clean and have no burrs or pits that could cause leakage.

3. Due to stainless steel castings, machining tolerances, and flange thickness, the body tapped hole depth may vary slightly from valve to valve. It is, therefore, recommended that all knife gates be installed with a stainless steel ASTM A-304-B8 stud or an ASTM A-316-B-8M stud. The use of a carbon steel B-7 stud may also be considered. We further recommend the use of a teflon thread compound. It should be pointed out that the use of cap screws or bolts may harm the chest in the knife gate by bottoming out and should never be used on this area of the knife gate valve.

4. The Davis Knife Gate is manufactured with ANSI B 16.5 – 150# raised face flange dimensions. The use of a suitable gasket between the body and the pipe line flanges shall be selected by the customer. We would recommend the use of a PTFE gasket.

5. Carefully place the valve between the flanges and loosely assemble the valve by putting in the bottom two or three studs, then carefully insert the gaskets into place. The bottom studs will help locate the gasket and hold it in position.

6. Carefully insert the balance of the studs into place and tighten all of them evenly – <u>not in rotation</u> – but by the cross over method. <u>CAUTION:</u> Do not over tighten chest cavity studs.

7. The Davis Knife Gate Valve may be installed in any orientation in the pipe line, however, the normal method is with the handwheel vertical above the valve body. Other positions are acceptable, however, they may result in uneven valve wear.

8. The resilient seat knife gate is a bi-directional valve and will operate with the flow in either direction. Care must be taken with the metal-seated valve as it is a unidirectional valve (or a one-flow-direction valve). Make sure that the metal-seated valve is oriented so that the pipe line flow is in the same direction as the arrow on the side of the valve body. This will insure that the valve seat is on the downstream side of the gate.

9. All Resilient-Seated Knife Gate Valves require the resilient seat to be lubricated before stroking, regardless of type of actuator. The fit pressure of the gate against the resilient seat, on the sides of the valve up thru the packing gland, is such that stroking the valve dry (with no lubrication of any kind) will cause the resilient seat to cold flow beyond safe limits and will damage the seat with just a few strokes. CRC or WD40, sprayed on the seat, up in the chest area, both sides, will normally provide sufficient lubrication. This should be repeated every 2 or 3 strokes. This is CRITICAL to the life and performance of the seat. In operation, the process product normally supplies adequate lubrication.

OPERATION

1. After the valve has been installed, cycle the valve once completely. Open the valve by turning the handwheel counter clockwise, reverse the operation for closing. (Note: This will detect if any damage has been incurred either due to shipping or installation processes.) After installing Resilient Seat Valves (Lug Type), be sure to determine that bonnet nut and lock nut are secure. If either lock or bonnet nut are loose, adjust as follows:

   1. Back lock nut in counterclockwise rotation 2 turns.
   2. Back bonnet nut in counterclockwise rotation 2 turns.
   3. Turn handwheel in clockwise motion until gate bottoms out, then turn handwheel at that point ¼ turn more.
   4. Tighten bonnet nut down to stop-out against stem nut.
   5. Secure lock nut down on bonnet nut to hold in position.

After cycling the gate valve, turn the handwheel counterclockwise several turns allowing partial opening for preparation to fill system.

2. Open upstream valve slowly, building system pressure gradually, allowing installation personnel to detect any excessive packing gland leakage, making adjustments necessary.

3. After the system has come to a full pressure, open the knife gate fully by turning the handwheel counterclockwise, then close the valve fully by turning the handwheel clockwise. In resilient seat knife gate valves, this process will result in "seating in the valve." This step may be eliminated with the metal-seated valve.

4. You may now use the valve for its intended purpose, keeping in mind that a gate valve should be used in a full open or a full closed position. Gate valves should not be used for throttling unless specifically designed for such a use.

MAINTENANCE

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of the service conditions. This section includes instructions for packing adjustments, repacking, seat replacement, and seating adjustment.

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluids, before installation –

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Normal maintenance of the Davis Knife Gate Valve may only include a periodic tightening of the packing gland. Should a leak occur at the packing gland, simply tighten the packing gland bolt closest to the leak. This may require tightening two or three bolts on larger valves. After the leak has stopped, tighten all packing gland bolts ¼ turn. Do not over tighten. The only other normal maintenance required would be to grease the valve stem by using a grease gun at the grease fitting located on the valve yoke.

2. From time to time, it may be necessary to repack the valve completely. This can be done following the warning procedure listed above. Standard repacking kits are available through Davis Valve. Packing kits include necessary packing and a top wiper seal gasket which insures a tight seal. When ordering be sure to specify valve model number,

indicating type of seat and type of valve. Repacking the valve includes the following steps:

1. Remove packing gland nuts and lock washers.

2. Raise blade to the full open position.

3. Pull up the packing gland to the top of the blade and secure it to the top of the blade.

4. Using a packing hook, remove all of the old packing.

5. Carefully clean the stuffing box. If oil, grease, wax, or graphite impregnated packings were used, it might be necessary to use a solvent to clean the stuffing box.

6. Purchase precut packing kits from Davis Valve or carefully cut each ring by wrapping a length of packing around the blade snugly, but without tension. Cut each ring individually, making a square cut with a clean, sharp knife.

7. Insert rings one at a time into stuffing box. Tamp each ring lightly in place using a flat packing iron. Packing joints may be located 90° apart, on metal-seated valves, to minimize leakage. Successive layers are installed in the same manner.

8. Pull the packing gland down and tighten using only the two end studs until the packing gland almost bottoms out.

9. Remove the packing gland as previously described.

10. Insert the wiper seal gasket.

11. Pull down packing gland using lock washers and nuts and tighten using alternate method. Do not over tighten.

12. Bring the valve up to pressure and tighten the packing gland following the procedures listed under the maintenance instructions.

VALVE THRUST AND TORQUE VALUES

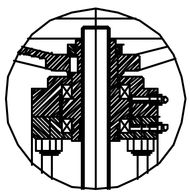
	Size	Valve Thrust lbs	Valve Torque ft lbs	Flow Coefficient Gal. per min. at a pressure drop of 1 psi
MODEL 60	2	648	9	285
	3	898	12	760
	4	1253	17	1420
	5	---	---	2890
	6	2077	37	3300
	8	3590	63	5800
	10	5469	97	11000
	12	7299	141	16500
	14	8573	166	20500
	16	10959	230	27000
	18	14409	302	36000
	20	17189	409	45000
	24	23801	592	60000
	30	---	---	95000
	36	---	---	138000
MODEL 61	2			285
	3			760
	4			1420
	5			2890
	6			3300
	8			5800
	10			11000
	12			16500
	14			20500
	16			27000
	18			36000
	20			45000
	24			60000
	30			95000
	36			138000
MODEL 70	2	565	8	285
	3	774	11	760
	4	1094	15	1420
	6	1958	27	3300
	8	3582	63	5800
	10	5541	98	11000
	12	7379	130	16500
	14	9551	185	20500
	16	12058	233	27000
	18	15353	322	36000
	20	18528	389	45000
	24	25880	616	60000

Davis Valve

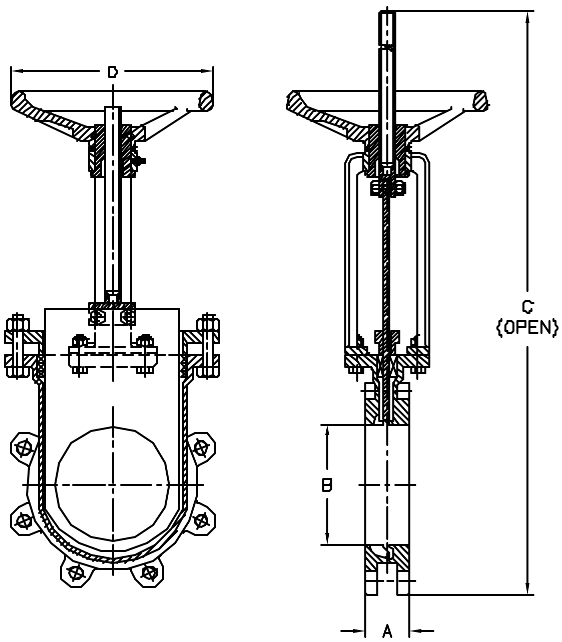
Memphis, Tennessee

Stainless Steel Knife Gate

TOPWORKS DETAIL
16" TO 48"



Model 60C - CF8 (304SS)
Model 60F - CF8M (316SS)
Model 60G - CG8M (317SS)



PART NAME	MATERIALS A 351-CF8	MATERIALS A 351-CF8M	MATERIALS A 351-CG8M
BODY	A 351-CF8	A 351-CF8M	A 351-CG8M
GATE	SS 304	SS 316	SS 317
YOKE	A 351-CF8	A 351-CF8	A 351-CF8
STEM	SS 304	SS 304	SS 304
GLAND	A 351-CF8	A 351-CF8M	A 351-CG8M
GLAND PACKING	PTFE	PTFE	PTFE
STEM NUT	AL BRONZE	AL BRONZE	AL BRONZE
HAND WHEEL	A 216-WCB	A 216-WCB	A 216-WCB

SIZE	INCH	2	2½	3	4	5	6	8	10	12	14	16	18	20	24	30	36
	MM	50	65	80	100	127	150	200	250	300	350	400	450	500	600	762	915
A	INCH	1.88	2.0	2.0	2.0	2.25	2.25	2.75	2.75	3.0	3.0	3.5	3.5	4.5	4.5	5.4	6.3
	MM	47.8	50.8	50.8	50.8	57.2	57.2	69.9	69.9	76.2	76.2	88.9	88.9	114.3	114.3	137.1	160.0
B	INCH	2.0	2.5	3.0	4.0	5.0	6.0	8.0	10.0	12.0	13.25	15.25	17.25	19.25	23.25	29.25	35.25
	MM	50.8	63.5	76.2	101.6	127.0	152.4	203.2	254.0	304.8	336.5	387.3	438.1	488.9	590.5	742.9	895.3
C	INCH	15.5	19.3	19.3	23.0	26.2	29.25	36.25	44.0	51.0	57.0	66.0	73.0	79.5	93.0	131.9	151.9
	MM	393.7	490.2	490.2	584.2	665.4	743.0	920.8	1117.6	1295.4	1447.8	1676.0	1854.0	2019.3	2362.2	3350.4	3858.2
D	INCH	8.0	8.0	8.0	10.0	10.0	12.0	14.0	16.0	16.7	18.9	18.9	20.9	20.9	24.8	36.7	36.7
	MM	203.0	203.0	203.0	254.0	254.0	304.8	355.6	406.4	424.1	480.0	480.0	530.8	530.8	630.0	932.1	932.1
WGT	LBS	22		31	38	47	59	84	124	170	201	294	372	503	671	1810	2252
	KGS	10		14	18	22	27	38	56	77	91	133	168	228	305	820	1020

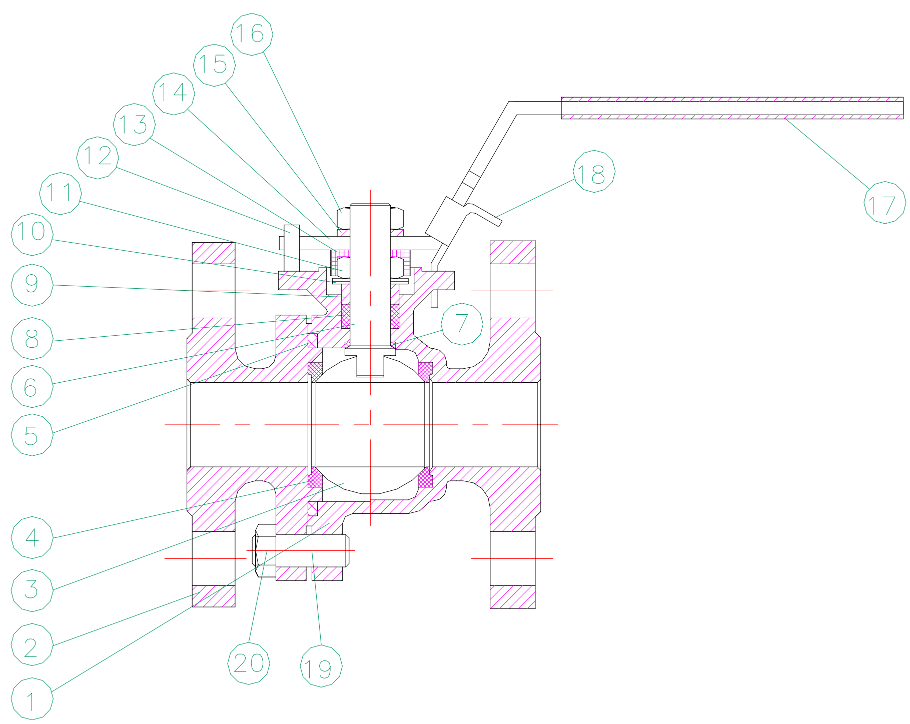
Davis Valve

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes ½" – 4" , Classes 150, 300, and 600

ITEM	DESCRIPTION
1	BODY
2	END CONNECTOR
3	BALL
4	SEAT
5	BODY GASKET
6	STEM
7	THRUST BEARING
8	STEM PACKING
9	GLAND PACKING
10	BELLVILLE WASHER
11	STEM NUT
12	STOPPER
13	LOCK TAB
14	HANDLE
15	HANDLE WASHER
16	HANDLE NUT
17	SLEEVE
18	LOCKING DEVICE
19	STUD
20	NUT



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150, 300, or 600.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the adjusting nut 1/4 turn. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle and travel stop plate.

3. Remove stem nut locking tab, stem nut, belleville springs, and gland ring from stem.
4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.
5. Remove body seal.
6. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.
7. Take out other seat.
8. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.
2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Install one seat in the body cavity with the spherical curvature facing the ball.
2. Install thrust bearing on stem and slide the stem up through the body.
3. Install new stem seals, gland ring, and belleville springs. Install stem nut and tighten to the torque values given in Table 1. Install stem nut locking tab or cap. Tighten stem nut slightly if necessary to align nut with locking device surfaces.
4. Install travel stop (if supplied) and handle. Make sure handle aligns with flow bore through ball. Install hand retainer nut (or capscrew).

5. Turn the handle to the CLOSED position. Line up the ball slot with the stem tang and the ball into position on the stem tang. Turn the handle to the OPEN position to hold the ball in place.

6. Install the remaining seat into body end.

7. Place new body seal into counterbore in valve body.

8. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

9. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

10. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

11. Pressure test valve, if possible, before reinstalling in pipeline.

Table 1 - Stem Nut Torques

Valve Size	Torque (lb-ft)
½”	5.5
¾”	5.5
1”	6
1-1/2” – 4”	22

Table 2 – Body Bolting Torques (lb-ft)

Valve Size	Class 150	Class 300	Class 600
½”	5	10	15
¾”	5	10	20
1”	5	20	35
1-1/2”	15	35	80
2”	20	40	140
3”	20	60	155
4”	25	95	215

Note: Torque values are for TFE/RTFE or flexible graphite gaskets and seals. For other materials contact Sharpe Valves.

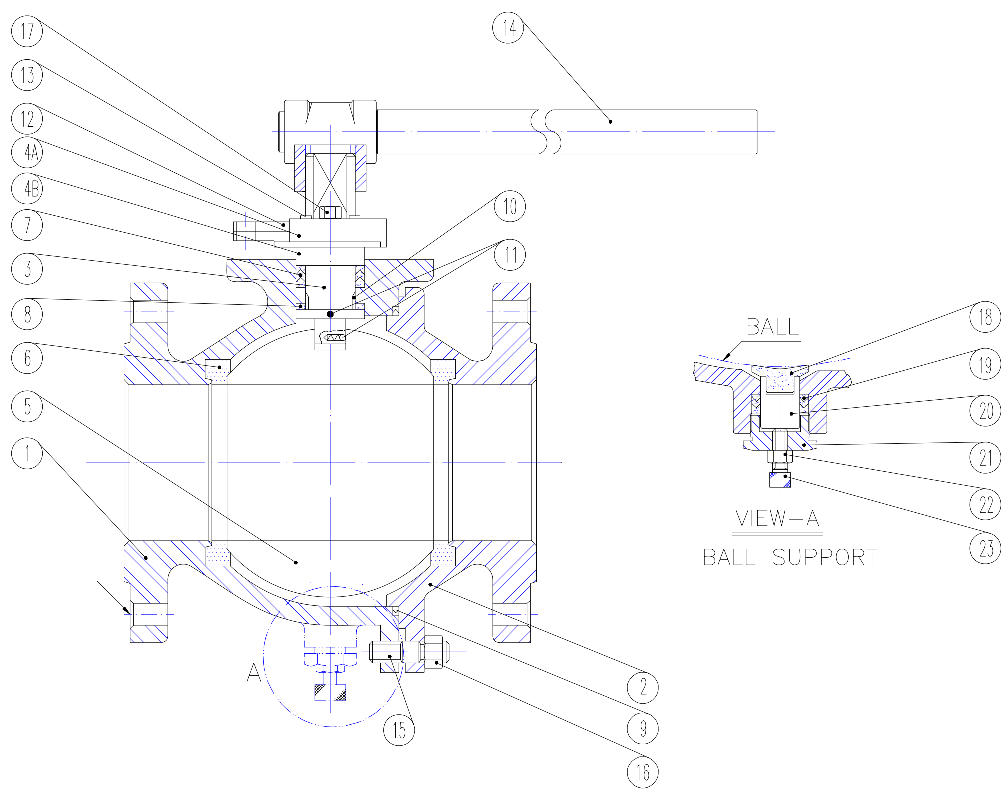
SHARPE VALVES
A Division of Smith-Cooper International, LLC

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes 6” - 12” , Classes 150 & 300

NO.	PART NAME
1	BODY
2	CAP
3	STEM
4A	GLAND
4B	GLAND RING
5	BALL
6	SEAT
7	PACKING
8	THRUST WASHER
9	GASKET
10	STEM BEARING
11	ANTI–STATIC
12	TRAVEL STOPPER
13	SNAP RING
14	HANDLE
15	STUD
16	NUT
17	GLAND BOLT
18	PIN SEAT
19	PIN PACKING
20	SUPPORT PIN
21	SUPPORT NUT
22	SET NUT
23	TUNING SCREW



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools. Ball support supplied for 10” and 12” Class 150 valves, and 6” through 12” Class 300 valves.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150 or Class 300.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the gland bolts 1/4 turn, each. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle, snap ring, and travel stop plate.

3. Remove gland bolts, gland, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. **<u>For 10" and 12" valves only</u>**: Ball support must be backed off to remove ball. Loosen support nut, set nut and back out tuning screw on bottom of valve to release the ball support. The weight of the ball will cause the ball support to come down.

7. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a "rolling" motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

8. Take out other seat.

9. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing and stem bushing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Set the valve body on a clean work suface, resting on the end flange.

2. Install one seat in the body cavity with the spherical curvature facing the ball (upwards).

3. Cut new stem bushing on one side at approx. 30° - 60° angle and wrap around stem above shoulder.

4. Install thrust bearing on stem and holding stem bushing in place, slide the stem up through stem bore from inside body.

5. Install new stem seals, gland ring, and gland. Install gland bolts and tighten hand tight.

6. Install travel stop, and snap ring.

7. Turn the stem to the CLOSED position (bottom stem tan parallel to flow passage). Line up the ball slot with the stem tang and roll and lower the ball into position on the stem tang, letting the ball rest in the seat. Turn the stem and ball to the OPEN position to hold the ball in place.

8. **For 10" and 12" Valves Only:** Re-set the ball support by turning the tuning screw inwards until the support pin seat firmly contacts the ball. Do not cause the ball to move. Holding the tuning screw in place, tighten the support nut and then the set nut.

9. Install the remaining seat into body end.

10. Place new body seal into counterbore in valve body.

11. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

12. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

13. Tighten the gland bolts to the torques specified in Table 1.

14. Install handle, making sure that the handle aligns with the flow passage through the ball.

15. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

16. Pressure test valve, if possible, before reinstalling in pipeline.

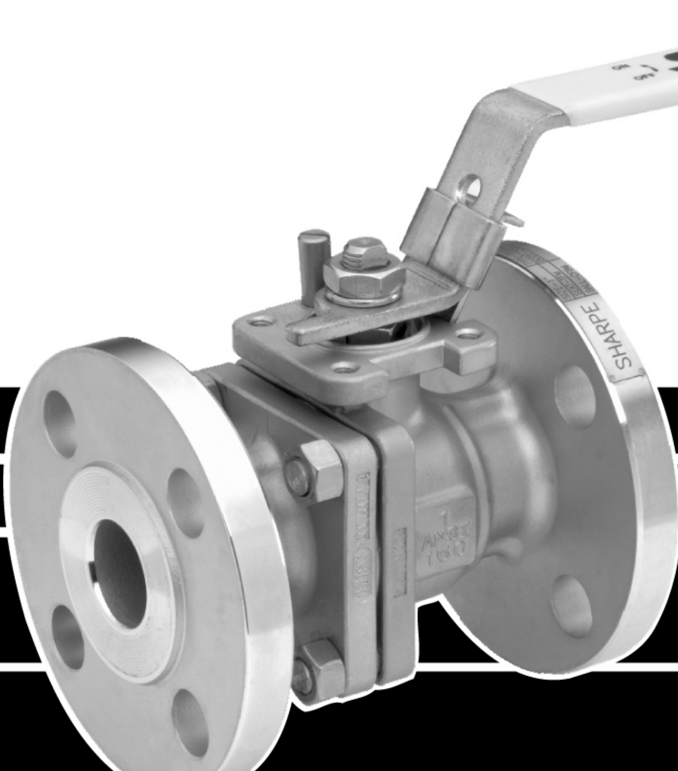
Table 1 – Gland Bolt Torques

SIZE	Tightening Torque (lb-ft) Max
6" – 8"	42 (1/2-13UNC)
10" - 12"	83 (5/8-11UNC)

Table 2 – Body Bolting Torques

SIZE	THREAD	Tightening Torque (lb-ft) Max
6”,8” (Class 150) / 3”~6”(Class 300)	5/8-11UNC	83
10”,12” (Class 150) / 8”(Class 300)	3/4-10UNC	120
10”(Class 300)	7/8-9UNC	190
12”(Class 300)	1-8UNC	260

SHARPE® VALVES

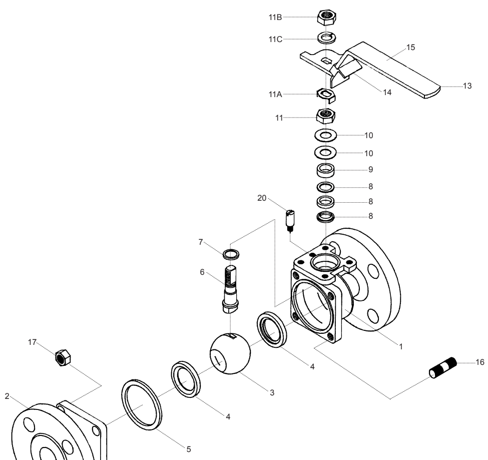


FLANGED FULL PORT
BALL VALVE
SERIES 50 / CLASS 150

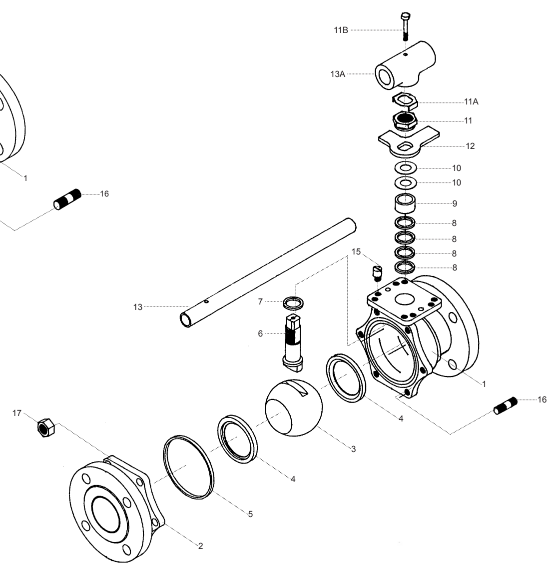
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

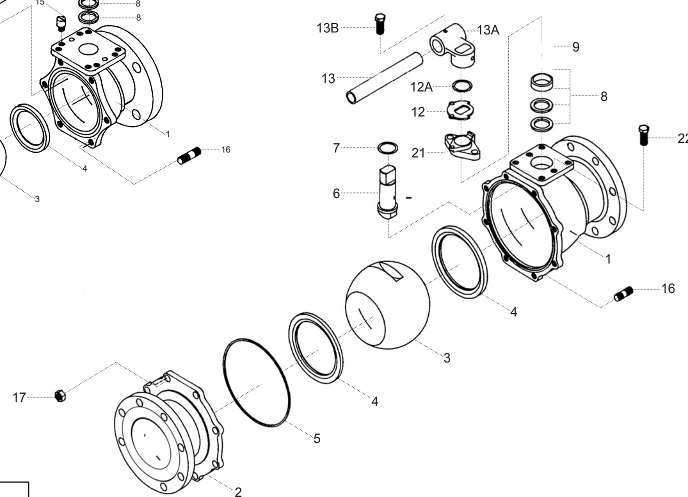
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2" - 2"



2-1/2" - 4"



6" - 8"

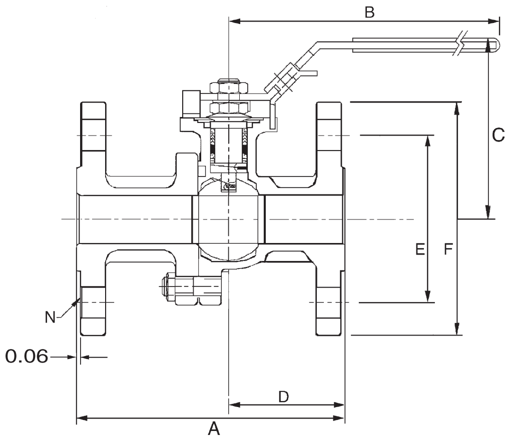
PART NO.	PART	QTY.	MATERIAL
1	Body	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) TFE Reinforced TFE NOVA PEEK
5	Body Seal	1	TFE
6	Stem	1	316 Stainless Steel Alloy 20 Hastelloy C 17-4PH (Option)
7	Thrust Bearing	2	Reinforced TFE
8	Stem Packing	3/4	Reinforced TFE
9	Gland Packing	1	304 Stainless Steel
10	Belleville Washer (1/2"-4")	2/4	304 Stainless Steel
11	Packing Nut (1/2"-4")	1	304 Stainless Steel
11A	Lock Tab	1	Stainless Steel
11B	Handle Nut	1	304 Stainless Steel
11C	Lock Washer	1	304 Stainless Steel (1/2"-2")

*See Dimensions

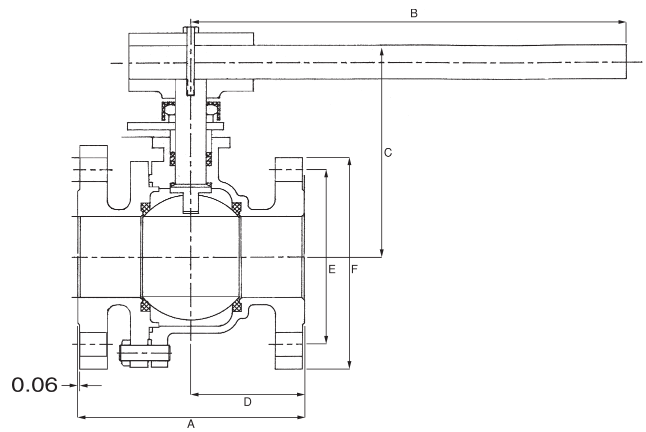
PART NO.	PART	QTY.	MATERIAL
12	Stopper	1	304 Stainless Steel
12A	Snap Ring	1	Stainless Steel (6"-8")
13	Handle	1	304 Stainless Steel (1/2"-2") Galvanized Steel (2-1/2"-4") Ductile Iron (6"-8")
13A	Wrench Block	1	Stainless Steel
13B	Hex Head Bolt	1	304 Stainless Steel
14	Locking Device (1/2"-2")	1	304 Stainless Steel
15	Sleeve	1	Vinyl
16	Body Stud	SEE* N	A193 B8 (SST) A193 B7 (CS)
17	Nut	SEE* N	A194 8 (SST) A194 2H (CS)
20	Stop Pin (1/2"-2") (2-1/2"-4")	1 2	304 Stainless Steel 304 Stainless Steel
21	Gland Flange (6"-8")	1	304 Stainless Steel
22	Gland Bolts (6"-8")	2	304 Stainless Steel

SERIES 50 DIMENSIONS

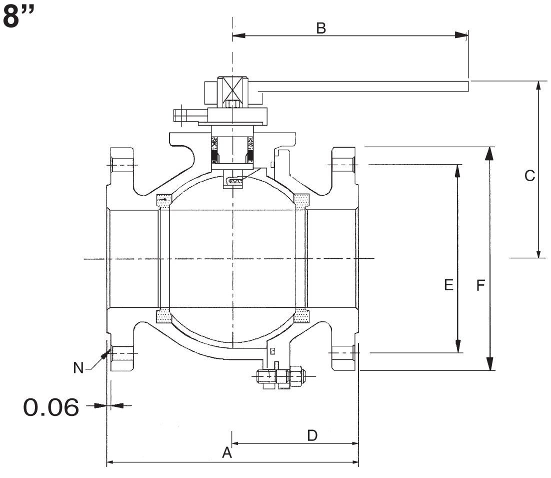
1/2" - 2"



2-1/2" - 4"



6" - 8"



CV DATA

1/2"	26
3/4"	50
1"	94
1-1/2"	260
2"	480
2-1/2"	750
3"	1300
4"	2300
6"	5400
8"	10000

PORT

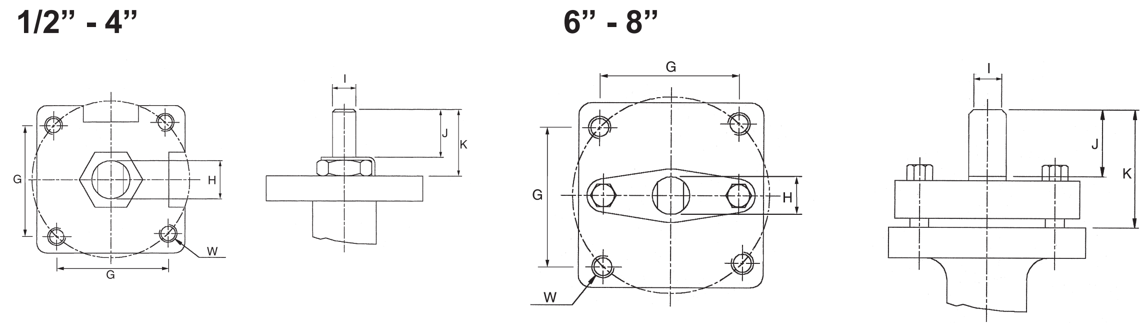
1/2"	0.59
3/4"	0.78
1"	1.00
1-1/2"	1.50
2"	2.00
2-1/2"	2.55
3"	3.00
4"	4.00
6"	6.00
8"	7.88

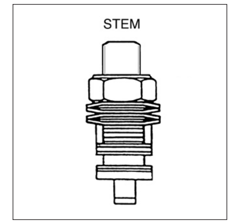
WEIGHT (lbs.)

1/2"	4
3/4"	6
1"	8
1-1/2"	15
2"	20
2-1/2"	36
3"	45
4"	75
6"	135
8"	290

SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2"	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4"	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1"	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2"	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2"	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2"	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3"	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4"	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6"	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8"	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

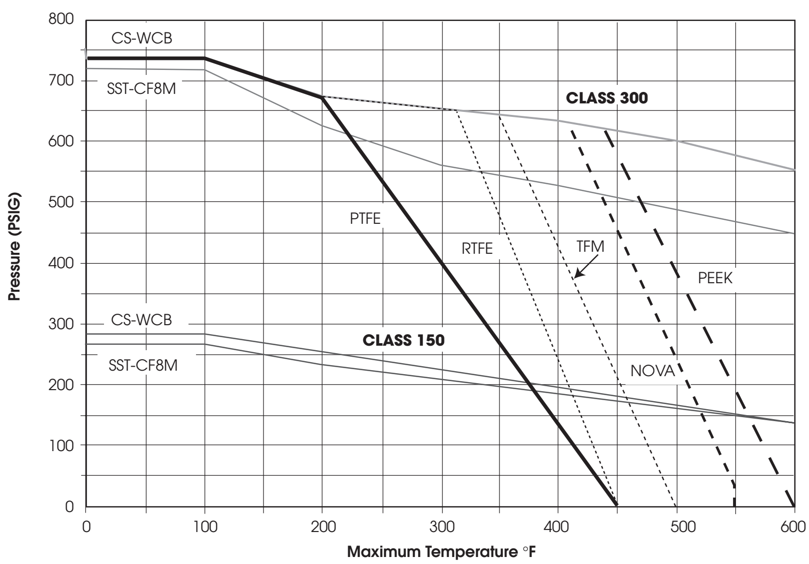
The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2″	50	150# = 11	2 = Alloy 20	T = TFE	X = Oxygen Service
3/4″			4 = Carbon Steel	R = RTFE	OH = Oval Handle
1″			6 = Stainless Steel	N = NOVA	F = Fugitive Emissions Certified ANSI 593.00.01
1-1/2″			5 = Hastelloy C	P = Peek	E = Extended Stem
2″			3 = Monel	M = TFM™	L = Lockable Extended Stem
2-1/2″					D = Leak detection Stem
3″					GO = Gear Operator
4″					7 = 17- 4PH Stem
6″					A = Nace
8″					

3/4" 50 11 6 T X

SHARPE® VALVES
A Division of Smith-Cooper International, LLC

Toll-Free 1-877-7SHARPE
(877) 774-2773
Fax: (708) 562-9250
E-Mail: info@sharpevalves.com
www.sharpevalves.com
1260 Garnet Drive
Northlake, Illinois 60164 U.S.A.

Rev. 1/09

INSTALLATION

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluid, before installation-

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Before installing the valve, inspect the valve body port and associated equipment for any damage that may have occurred and for any foreign matter that may have collected in shipping or storage. Make certain the body interior is clean.

2. Before installing the valve, inspect the pipe line and mating flanges, making sure the pipe is free of foreign material and the flanges are clean and have no burrs or pits that could cause leakage.

3. Due to stainless steel castings, machining tolerances, and flange thickness, the body tapped hole depth may vary slightly from valve to valve. It is, therefore, recommended that all knife gates be installed with a stainless steel ASTM A-304-B8 stud or an ASTM A-316-B-8M stud. The use of a carbon steel B-7 stud may also be considered. We further recommend the use of a teflon thread compound. It should be pointed out that the use of cap screws or bolts may harm the chest in the knife gate by bottoming out and should never be used on this area of the knife gate valve.

4. The Davis Knife Gate is manufactured with ANSI B 16.5 – 150# raised face flange dimensions. The use of a suitable gasket between the body and the pipe line flanges shall be selected by the customer. We would recommend the use of a PTFE gasket.

5. Carefully place the valve between the flanges and loosely assemble the valve by putting in the bottom two or three studs, then carefully insert the gaskets into place. The bottom studs will help locate the gasket and hold it in position.

6. Carefully insert the balance of the studs into place and tighten all of them evenly – <u>not in rotation</u> – but by the cross over method. <u>CAUTION:</u> Do not over tighten chest cavity studs.

7. The Davis Knife Gate Valve may be installed in any orientation in the pipe line, however, the normal method is with the handwheel vertical above the valve body. Other positions are acceptable, however, they may result in uneven valve wear.

8. The resilient seat knife gate is a bi-directional valve and will operate with the flow in either direction. Care must be taken with the metal-seated valve as it is a unidirectional valve (or a one-flow-direction valve). Make sure that the metal-seated valve is oriented so that the pipe line flow is in the same direction as the arrow on the side of the valve body. This will insure that the valve seat is on the downstream side of the gate.

9. All Resilient-Seated Knife Gate Valves require the resilient seat to be lubricated before stroking, regardless of type of actuator. The fit pressure of the gate against the resilient seat, on the sides of the valve up thru the packing gland, is such that stroking the valve dry (with no lubrication of any kind) will cause the resilient seat to cold flow beyond safe limits and will damage the seat with just a few strokes. CRC or WD40, sprayed on the seat, up in the chest area, both sides, will normally provide sufficient lubrication. This should be repeated every 2 or 3 strokes. This is CRITICAL to the life and performance of the seat. In operation, the process product normally supplies adequate lubrication.

OPERATION

1. After the valve has been installed, cycle the valve once completely. Open the valve by turning the handwheel counter clockwise, reverse the operation for closing. (Note: This will detect if any damage has been incurred either due to shipping or installation processes.) After installing Resilient Seat Valves (Lug Type), be sure to determine that bonnet nut and lock nut are secure. If either lock or bonnet nut are loose, adjust as follows:

    1. Back lock nut in counterclockwise rotation 2 turns.
    2. Back bonnet nut in counterclockwise rotation 2 turns.
    3. Turn handwheel in clockwise motion until gate bottoms out, then turn handwheel at that point ¼ turn more.
    4. Tighten bonnet nut down to stop-out against stem nut.
    5. Secure lock nut down on bonnet nut to hold in position.

After cycling the gate valve, turn the handwheel counterclockwise several turns allowing partial opening for preparation to fill system.

2. Open upstream valve slowly, building system pressure gradually, allowing installation personnel to detect any excessive packing gland leakage, making adjustments necessary.

3. After the system has come to a full pressure, open the knife gate fully by turning the handwheel counterclockwise, then close the valve fully by turning the handwheel clockwise. In resilient seat knife gate valves, this process will result in "seating in the valve." This step may be eliminated with the metal-seated valve.

4. You may now use the valve for its intended purpose, keeping in mind that a gate valve should be used in a full open or a full closed position. Gate valves should not be used for throttling unless specifically designed for such a use.

MAINTENANCE

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of the service conditions. This section includes instructions for packing adjustments, repacking, seat replacement, and seating adjustment.

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluids, before installation –

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Normal maintenance of the Davis Knife Gate Valve may only include a periodic tightening of the packing gland. Should a leak occur at the packing gland, simply tighten the packing gland bolt closest to the leak. This may require tightening two or three bolts on larger valves. After the leak has stopped, tighten all packing gland bolts ¼ turn. Do not over tighten. The only other normal maintenance required would be to grease the valve stem by using a grease gun at the grease fitting located on the valve yoke.

2. From time to time, it may be necessary to repack the valve completely. This can be done following the warning procedure listed above. Standard repacking kits are available through Davis Valve. Packing kits include necessary packing and a top wiper seal gasket which insures a tight seal. When ordering be sure to specify valve model number,

indicating type of seat and type of valve. Repacking the valve includes the following steps:

1. Remove packing gland nuts and lock washers.

2. Raise blade to the full open position.

3. Pull up the packing gland to the top of the blade and secure it to the top of the blade.

4. Using a packing hook, remove all of the old packing.

5. Carefully clean the stuffing box. If oil, grease, wax, or graphite impregnated packings were used, it might be necessary to use a solvent to clean the stuffing box.

6. Purchase precut packing kits from Davis Valve or carefully cut each ring by wrapping a length of packing around the blade snugly, but without tension. Cut each ring individually, making a square cut with a clean, sharp knife.

7. Insert rings one at a time into stuffing box. Tamp each ring lightly in place using a flat packing iron. Packing joints may be located 90° apart, on metal-seated valves, to minimize leakage. Successive layers are installed in the same manner.

8. Pull the packing gland down and tighten using only the two end studs until the packing gland almost bottoms out.

9. Remove the packing gland as previously described.

10. Insert the wiper seal gasket.

11. Pull down packing gland using lock washers and nuts and tighten using alternate method. Do not over tighten.

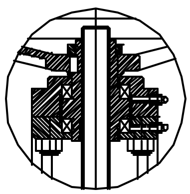
12. Bring the valve up to pressure and tighten the packing gland following the procedures listed under the maintenance instructions.

VALVE THRUST AND TORQUE VALUES

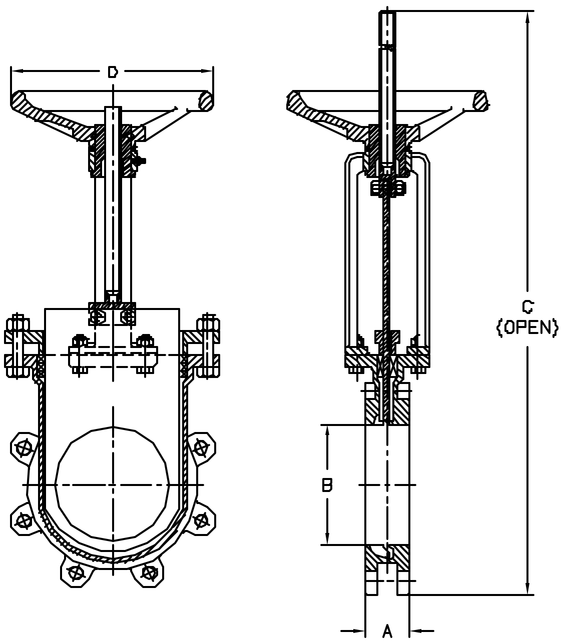
	Size	Valve Thrust lbs	Valve Torque ft lbs	Flow Coefficient Gal. per min. at a pressure drop of 1 psi
MODEL 60	2	648	9	285
	3	898	12	760
	4	1253	17	1420
	5	---	---	2890
	6	2077	37	3300
	8	3590	63	5800
	10	5469	97	11000
	12	7299	141	16500
	14	8573	166	20500
	16	10959	230	27000
	18	14409	302	36000
	20	17189	409	45000
	24	23801	592	60000
	30	---	---	95000
	36	---	---	138000
MODEL 61	2			285
	3			760
	4			1420
	5			2890
	6			3300
	8			5800
	10			11000
	12			16500
	14			20500
	16			27000
	18			36000
	20			45000
	24			60000
	30			95000
	36			138000
MODEL 70	2	565	8	285
	3	774	11	760
	4	1094	15	1420
	6	1958	27	3300
	8	3582	63	5800
	10	5541	98	11000
	12	7379	130	16500
	14	9551	185	20500
	16	12058	233	27000
	18	15353	322	36000
	20	18528	389	45000
	24	25880	616	60000

Stainless Steel Knife Gate

TOPWORKS DETAIL
16" TO 48"



Model 60C - CF8 (304SS)
Model 60F - CF8M (316SS)
Model 60G - CG8M (317SS)



PART NAME	MATERIALS A 351-CF8	MATERIALS A 351-CF8M	MATERIALS A 351-CG8M
BODY	A 351-CF8	A 351-CF8M	A 351-CG8M
GATE	SS 304	SS 316	SS 317
YOKE	A 351-CF8	A 351-CF8	A 351-CF8
STEM	SS 304	SS 304	SS 304
GLAND	A 351-CF8	A 351-CF8M	A 351-CG8M
GLAND PACKING	PTFE	PTFE	PTFE
STEM NUT	AL BRONZE	AL BRONZE	AL BRONZE
HAND WHEEL	A 216-WCB	A 216-WCB	A 216-WCB

SIZE	INCH	2	2½	3	4	5	6	8	10	12	14	16	18	20	24	30	36
	MM	50	65	80	100	127	150	200	250	300	350	400	450	500	600	762	915
A	INCH	1.88	2.0	2.0	2.0	2.25	2.25	2.75	2.75	3.0	3.0	3.5	3.5	4.5	4.5	5.4	6.3
	MM	47.8	50.8	50.8	50.8	57.2	57.2	69.9	69.9	76.2	76.2	88.9	88.9	114.3	114.3	137.1	160.0
B	INCH	2.0	2.5	3.0	4.0	5.0	6.0	8.0	10.0	12.0	13.25	15.25	17.25	19.25	23.25	29.25	35.25
	MM	50.8	63.5	76.2	101.6	127.0	152.4	203.2	254.0	304.8	336.5	387.3	438.1	488.9	590.5	742.9	895.3
C	INCH	15.5	19.3	19.3	23.0	26.2	29.25	36.25	44.0	51.0	57.0	66.0	73.0	79.5	93.0	131.9	151.9
	MM	393.7	490.2	490.2	584.2	665.4	743.0	920.8	1117.6	1295.4	1447.8	1676.0	1854.0	2019.3	2362.2	3350.4	3858.2
D	INCH	8.0	8.0	8.0	10.0	10.0	12.0	14.0	16.0	16.7	18.9	18.9	20.9	20.9	24.8	36.7	36.7
	MM	203.0	203.0	203.0	254.0	254.0	304.8	355.6	406.4	424.1	480.0	480.0	530.8	530.8	630.0	932.1	932.1
WGT	LBS	22		31	38	47	59	84	124	170	201	294	372	503	671	1810	2252
	KGS	10		14	18	22	27	38	56	77	91	133	168	228	305	820	1020

Davis Valve

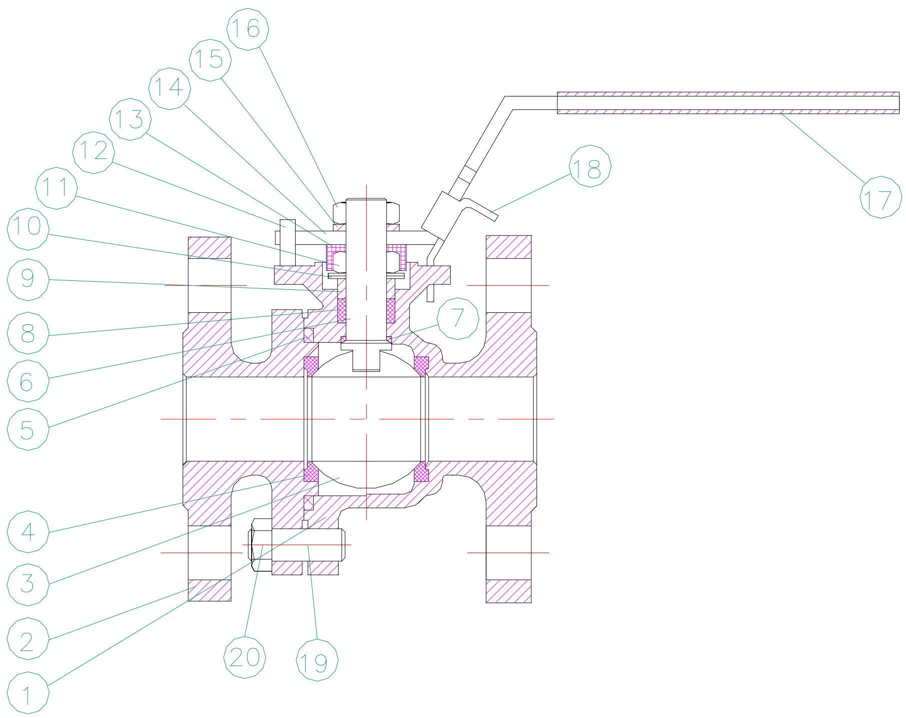
A Division of Smith-Cooper International, LLC

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes ½” – 4” , Classes 150, 300, and 600

ITEM	DESCRIPTION
1	BODY
2	END CONNECTOR
3	BALL
4	SEAT
5	BODY GASKET
6	STEM
7	THRUST BEARING
8	STEM PACKING
9	GLAND PACKING
10	BELLVILLE WASHER
11	STEM NUT
12	STOPPER
13	LOCK TAB
14	HANDLE
15	HANDLE WASHER
16	HANDLE NUT
17	SLEEVE
18	LOCKING DEVICE
19	STUD
20	NUT



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150, 300, or 600.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the adjusting nut 1/4 turn. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle and travel stop plate.

3. Remove stem nut locking tab, stem nut, belleville springs, and gland ring from stem.
4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.
5. Remove body seal.
6. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a "rolling" motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.
7. Take out other seat.
8. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.
2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Install one seat in the body cavity with the spherical curvature facing the ball.
2. Install thrust bearing on stem and slide the stem up through the body.
3. Install new stem seals, gland ring, and belleville springs. Install stem nut and tighten to the torque values given in Table 1. Install stem nut locking tab or cap. Tighten stem nut slightly if necessary to align nut with locking device surfaces.
4. Install travel stop (if supplied) and handle. Make sure handle aligns with flow bore through ball. Install hand retainer nut (or capscrew).

5. Turn the handle to the CLOSED position. Line up the ball slot with the stem tang and the ball into position on the stem tang. Turn the handle to the OPEN position to hold the ball in place.

6. Install the remaining seat into body end.

7. Place new body seal into counterbore in valve body.

8. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

9. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

10. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

11. Pressure test valve, if possible, before reinstalling in pipeline.

Table 1 - Stem Nut Torques

Valve Size	Torque (lb-ft)
½"	5.5
¾"	5.5
1"	6
1-1/2" – 4"	22

Table 2 – Body Bolting Torques (lb-ft)

Valve Size	Class 150	Class 300	Class 600
½"	5	10	15
¾"	5	10	20
1"	5	20	35
1-1/2"	15	35	80
2"	20	40	140
3"	20	60	155
4"	25	95	215

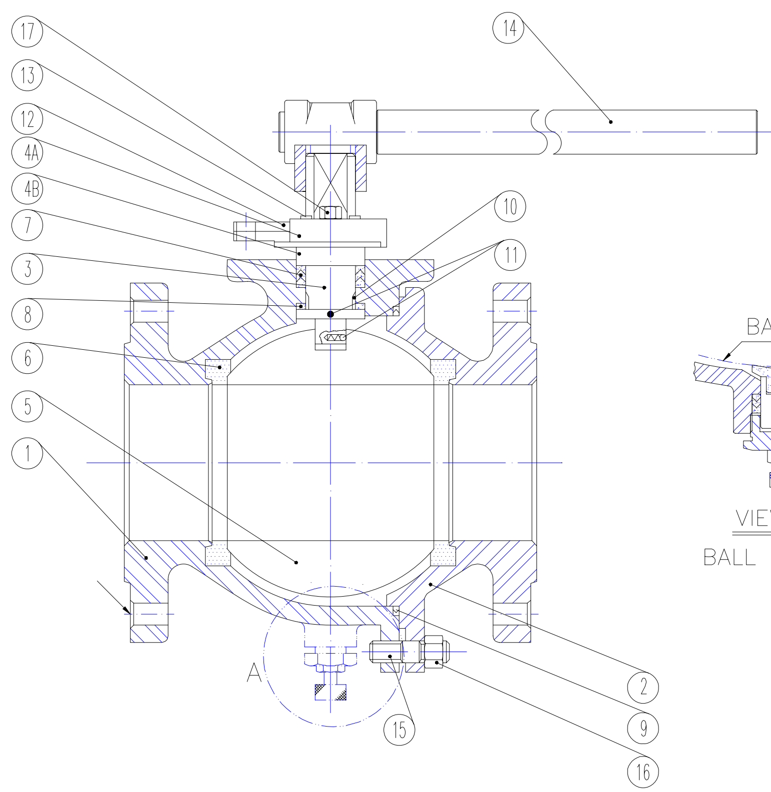
Note: Torque values are for TFE/RTFE or flexible graphite gaskets and seals. For other materials contact Sharpe Valves.

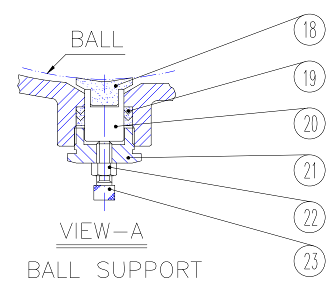
Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes 6" - 12" , Classes 150 & 300

NO.	PART NAME
1	BODY
2	CAP
3	STEM
4A	GLAND
4B	GLAND RING
5	BALL
6	SEAT
7	PACKING
8	THRUST WASHER
9	GASKET
10	STEM BEARING
11	ANTI–STATIC
12	TRAVEL STOPPER
13	SNAP RING
14	HANDLE
15	STUD
16	NUT
17	GLAND BOLT
18	PIN SEAT
19	PIN PACKING
20	SUPPORT PIN
21	SUPPORT NUT
22	SET NUT
23	TUNING SCREW





DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools. Ball support supplied for 10" and 12" Class 150 valves, and 6" through 12" Class 300 valves.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150 or Class 300.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the gland bolts 1/4 turn, each. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle, snap ring, and travel stop plate.

3. Remove gland bolts, gland, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. **<u>For 10” and 12” valves only</u>**: Ball support must be backed off to remove ball. Loosen support nut, set nut and back out tuning screw on bottom of valve to release the ball support. The weight of the ball will cause the ball support to come down.

7. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

8. Take out other seat.

9. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing and stem bushing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Set the valve body on a clean work suface, resting on the end flange.

2. Install one seat in the body cavity with the spherical curvature facing the ball (upwards).

3. Cut new stem bushing on one side at approx. 30° - 60° angle and wrap around stem above shoulder.

4. Install thrust bearing on stem and holding stem bushing in place, slide the stem up through stem bore from inside body.

5. Install new stem seals, gland ring, and gland. Install gland bolts and tighten hand tight.

6. Install travel stop, and snap ring.

7. Turn the stem to the CLOSED position (bottom stem tan parallel to flow passage). Line up the ball slot with the stem tang and roll and lower the ball into position on the stem tang, letting the ball rest in the seat. Turn the stem and ball to the OPEN position to hold the ball in place.

8. **For 10” and 12” Valves Only:** Re-set the ball support by turning the tuning screw inwards until the support pin seat firmly contacts the ball. Do not cause the ball to move. Holding the tuning screw in place, tighten the support nut and then the set nut.

9. Install the remaining seat into body end.

10. Place new body seal into counterbore in valve body.

11. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

12. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

13. Tighten the gland bolts to the torques specified in Table 1.

14. Install handle, making sure that the handle aligns with the flow passage through the ball.

15. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

16. Pressure test valve, if possible, before reinstalling in pipeline.

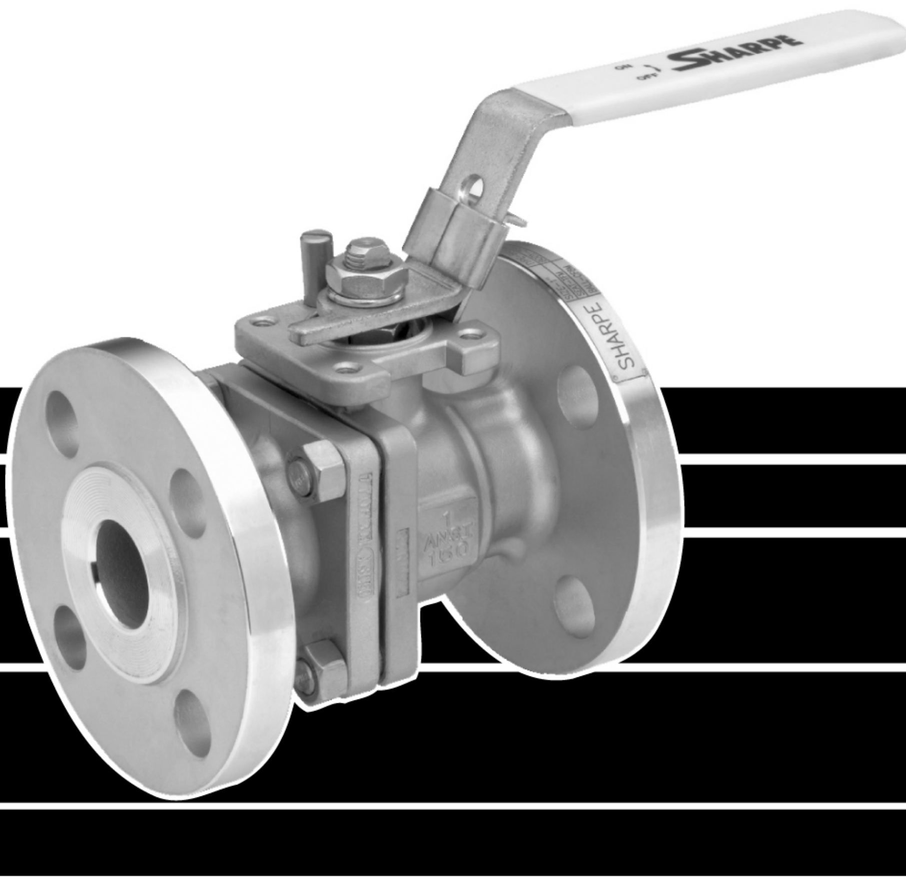
Table 1 – Gland Bolt Torques

SIZE	Tightening Torque (lb-ft) Max
6” – 8”	42 (1/2-13UNC)
10” - 12”	83 (5/8-11UNC)

Table 2 – Body Bolting Torques

SIZE	THREAD	Tightening Torque (lb-ft) Max
6”,8” (Class 150) / 3”~6”(Class 300)	5/8-11UNC	83
10”,12” (Class 150) / 8”(Class 300)	3/4-10UNC	120
10”(Class 300)	7/8-9UNC	190
12”(Class 300)	1-8UNC	260

SHARPE® VALVES

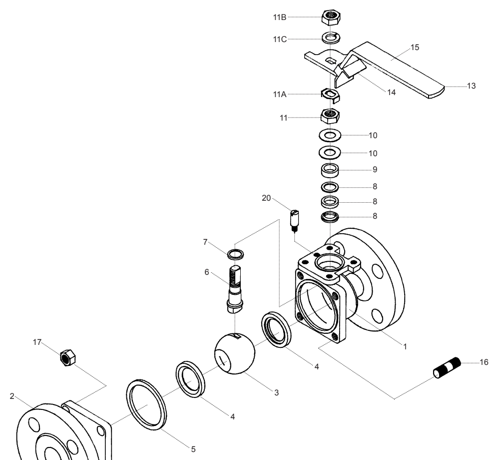


FLANGED FULL PORT BALL VALVE
SERIES 50 / CLASS 150

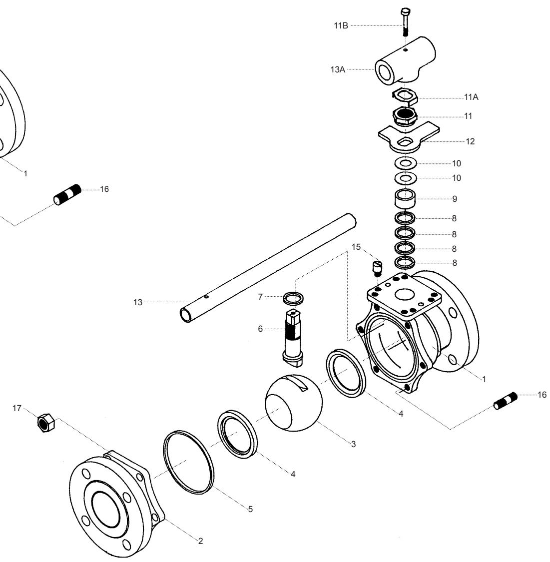
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

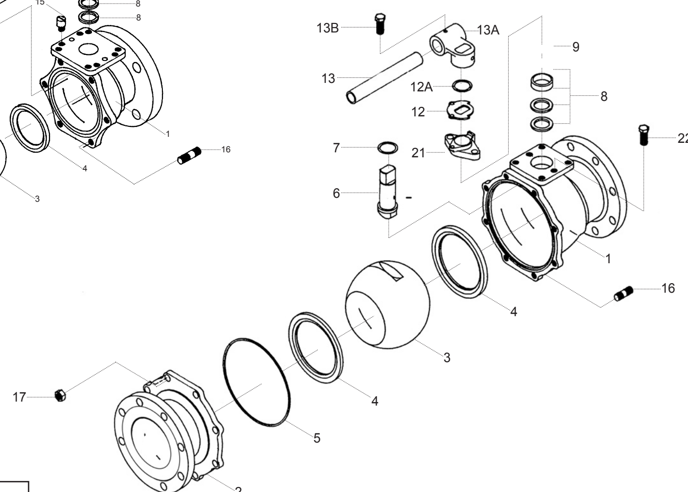
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2" - 2"



2-1/2" - 4"



6" - 8"

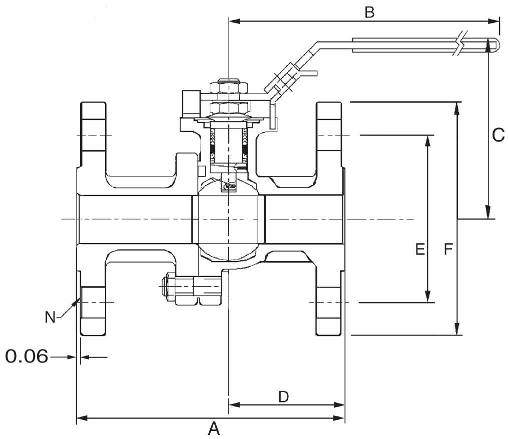
PART NO.	PART	QTY.	MATERIAL
1	Body	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) TFE Reinforced TFE NOVA PEEK
5	Body Seal	1	TFE
6	Stem	1	316 Stainless Steel Alloy 20 Hastelloy C 17-4PH (Option)
7	Thrust Bearing	2	Reinforced TFE
8	Stem Packing	3/4	Reinforced TFE
9	Gland Packing	1	304 Stainless Steel
10	Belleville Washer (1/2"-4")	2/4	304 Stainless Steel
11	Packing Nut (1/2"-4")	1	304 Stainless Steel
11A	Lock Tab	1	Stainless Steel
11B	Handle Nut	1	304 Stainless Steel
11C	Lock Washer	1	304 Stainless Steel (1/2"-2")

*See Dimensions

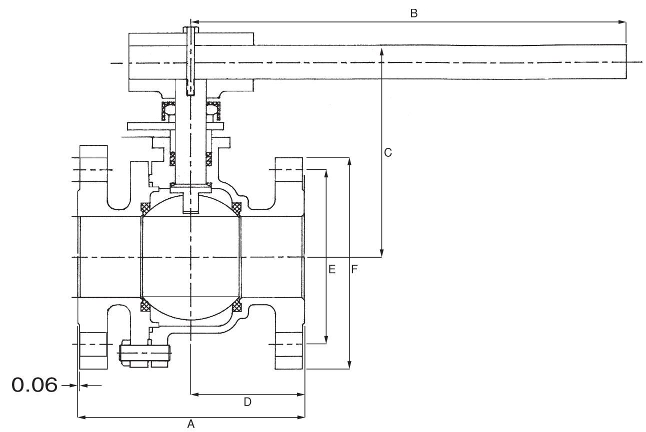
PART NO.	PART	QTY.	MATERIAL
12	Stopper	1	304 Stainless Steel
12A	Snap Ring	1	Stainless Steel (6"-8")
13	Handle	1	304 Stainless Steel (1/2"-2") Galvanized Steel (2-1/2"-4") Ductile Iron (6"-8")
13A	Wrench Block	1	Stainless Steel
13B	Hex Head Bolt	1	304 Stainless Steel
14	Locking Device (1/2"-2")	1	304 Stainless Steel
15	Sleeve	1	Vinyl
16	Body Stud	SEE* N	A193 B8 (SST) A193 B7 (CS)
17	Nut	SEE* N	A194 8 (SST) A194 2H (CS)
20	Stop Pin (1/2"-2") (2-1/2"-4")	1 2	304 Stainless Steel 304 Stainless Steel
21	Gland Flange (6"-8")	1	304 Stainless Steel
22	Gland Bolts (6"-8")	2	304 Stainless Steel

SERIES 50 DIMENSIONS

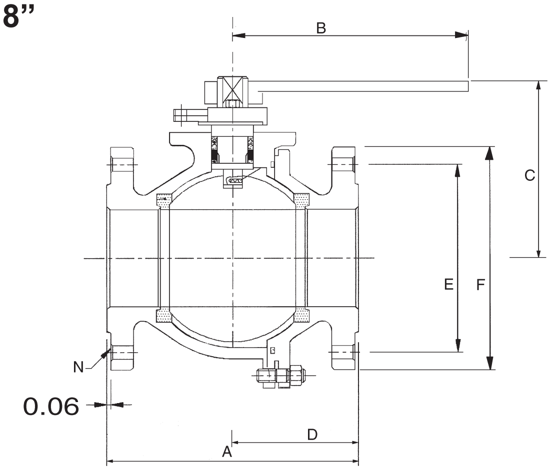
1/2” - 2”



2-1/2” - 4”



6” - 8”



CV DATA

1/2”	26
3/4”	50
1”	94
1-1/2”	260
2”	480
2-1/2”	750
3”	1300
4”	2300
6”	5400
8”	10000

PORT

1/2”	0.59
3/4”	0.78
1”	1.00
1-1/2”	1.50
2”	2.00
2-1/2”	2.55
3”	3.00
4”	4.00
6”	6.00
8”	7.88

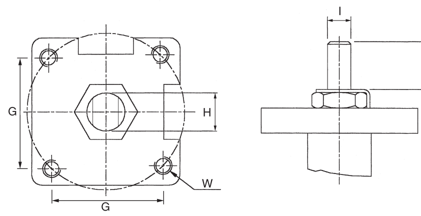
WEIGHT (lbs.)

1/2”	4
3/4”	6
1”	8
1-1/2”	15
2”	20
2-1/2”	36
3”	45
4”	75
6”	135
8”	290

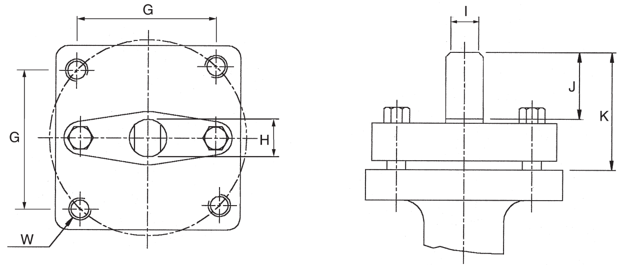
SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2”	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4”	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1”	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2”	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2”	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2”	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3”	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4”	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6”	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8”	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

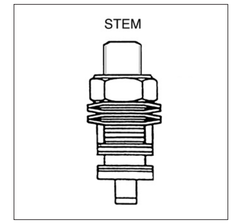
The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.

1/2" - 4"



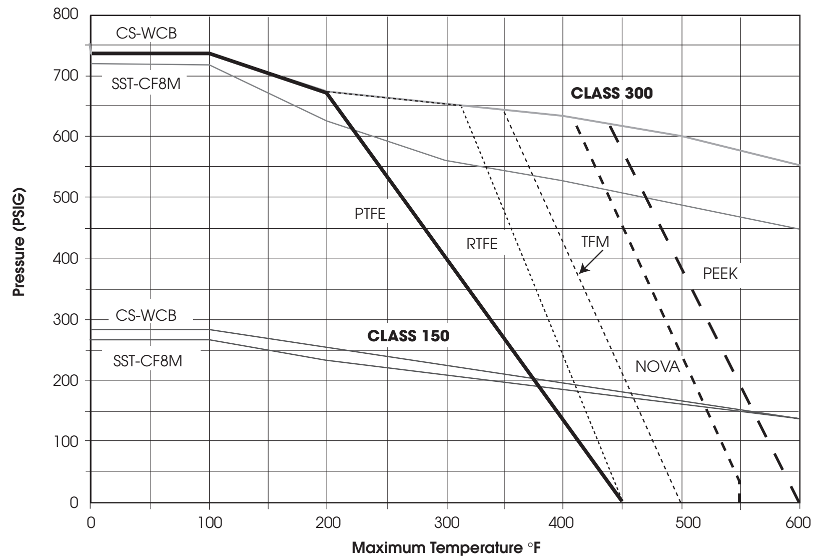
6" - 8"





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2″ 3/4″ 1″ 1-1/2″ 2″ 2-1/2″ 3″ 4″ 6″ 8″	50	150# = 11	2 = Alloy 20 4 = Carbon Steel 6 = Stainless Steel 5 = Hastelloy C 3 = Monel	T = TFE R = RTFE N = NOVA P = Peek M = TFM™	X = Oxygen Service OH = Oval Handle F = Fugitive Emissions Certified ANSI 593.00.01 E = Extended Stem L = Lockable Extended Stem D = Leak detection Stem GO = Gear Operator 7 = 17- 4PH Stem A = Nace

3/4" 50 11 6 T X

SHARPE® VALVES

A Division of Smith-Cooper International, LLC

Toll-Free 1-877-7SHARPE
(877) 774-2773
Fax: (708) 562-9250
E-Mail: info@sharpevalves.com
www.sharpevalves.com
1260 Garnet Drive
Northlake, Illinois 60164 U.S.A.

INSTALLATION

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluid, before installation-

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Before installing the valve, inspect the valve body port and associated equipment for any damage that may have occurred and for any foreign matter that may have collected in shipping or storage. Make certain the body interior is clean.

2. Before installing the valve, inspect the pipe line and mating flanges, making sure the pipe is free of foreign material and the flanges are clean and have no burrs or pits that could cause leakage.

3. Due to stainless steel castings, machining tolerances, and flange thickness, the body tapped hole depth may vary slightly from valve to valve. It is, therefore, recommended that all knife gates be installed with a stainless steel ASTM A-304-B8 stud or an ASTM A-316-B-8M stud. The use of a carbon steel B-7 stud may also be considered. We further recommend the use of a teflon thread compound. It should be pointed out that the use of cap screws or bolts may harm the chest in the knife gate by bottoming out and should never be used on this area of the knife gate valve.

4. The Davis Knife Gate is manufactured with ANSI B 16.5 – 150# raised face flange dimensions. The use of a suitable gasket between the body and the pipe line flanges shall be selected by the customer. We would recommend the use of a PTFE gasket.

5. Carefully place the valve between the flanges and loosely assemble the valve by putting in the bottom two or three studs, then carefully insert the gaskets into place. The bottom studs will help locate the gasket and hold it in position.

6. Carefully insert the balance of the studs into place and tighten all of them evenly – <u>not in rotation</u> – but by the cross over method. <u>CAUTION:</u> Do not over tighten chest cavity studs.

7. The Davis Knife Gate Valve may be installed in any orientation in the pipe line, however, the normal method is with the handwheel vertical above the valve body. Other positions are acceptable, however, they may result in uneven valve wear.

8. The resilient seat knife gate is a bi-directional valve and will operate with the flow in either direction. Care must be taken with the metal-seated valve as it is a unidirectional valve (or a one-flow-direction valve). Make sure that the metal-seated valve is oriented so that the pipe line flow is in the same direction as the arrow on the side of the valve body. This will insure that the valve seat is on the downstream side of the gate.

9. All Resilient-Seated Knife Gate Valves require the resilient seat to be lubricated before stroking, regardless of type of actuator. The fit pressure of the gate against the resilient seat, on the sides of the valve up thru the packing gland, is such that stroking the valve dry (with no lubrication of any kind) will cause the resilient seat to cold flow beyond safe limits and will damage the seat with just a few strokes. CRC or WD40, sprayed on the seat, up in the chest area, both sides, will normally provide sufficient lubrication. This should be repeated every 2 or 3 strokes. This is CRITICAL to the life and performance of the seat. In operation, the process product normally supplies adequate lubrication.

OPERATION

1. After the valve has been installed, cycle the valve once completely. Open the valve by turning the handwheel counter clockwise, reverse the operation for closing. (Note: This will detect if any damage has been incurred either due to shipping or installation processes.) After installing Resilient Seat Valves (Lug Type), be sure to determine that bonnet nut and lock nut are secure. If either lock or bonnet nut are loose, adjust as follows:

    1. Back lock nut in counterclockwise rotation 2 turns.
    2. Back bonnet nut in counterclockwise rotation 2 turns.
    3. Turn handwheel in clockwise motion until gate bottoms out, then turn handwheel at that point ¼ turn more.
    4. Tighten bonnet nut down to stop-out against stem nut.
    5. Secure lock nut down on bonnet nut to hold in position.

After cycling the gate valve, turn the handwheel counterclockwise several turns allowing partial opening for preparation to fill system.

2. Open upstream valve slowly, building system pressure gradually, allowing installation personnel to detect any excessive packing gland leakage, making adjustments necessary.

3. After the system has come to a full pressure, open the knife gate fully by turning the handwheel counterclockwise, then close the valve fully by turning the handwheel clockwise. In resilient seat knife gate valves, this process will result in "seating in the valve." This step may be eliminated with the metal-seated valve.

4. You may now use the valve for its intended purpose, keeping in mind that a gate valve should be used in a full open or a full closed position. Gate valves should not be used for throttling unless specifically designed for such a use.

MAINTENANCE

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of the service conditions. This section includes instructions for packing adjustments, repacking, seat replacement, and seating adjustment.

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluids, before installation –

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Normal maintenance of the Davis Knife Gate Valve may only include a periodic tightening of the packing gland. Should a leak occur at the packing gland, simply tighten the packing gland bolt closest to the leak. This may require tightening two or three bolts on larger valves. After the leak has stopped, tighten all packing gland bolts ¼ turn. Do not over tighten. The only other normal maintenance required would be to grease the valve stem by using a grease gun at the grease fitting located on the valve yoke.

2. From time to time, it may be necessary to repack the valve completely. This can be done following the warning procedure listed above. Standard repacking kits are available through Davis Valve. Packing kits include necessary packing and a top wiper seal gasket which insures a tight seal. When ordering be sure to specify valve model number,

indicating type of seat and type of valve. Repacking the valve includes the following steps:

1. Remove packing gland nuts and lock washers.

2. Raise blade to the full open position.

3. Pull up the packing gland to the top of the blade and secure it to the top of the blade.

4. Using a packing hook, remove all of the old packing.

5. Carefully clean the stuffing box. If oil, grease, wax, or graphite impregnated packings were used, it might be necessary to use a solvent to clean the stuffing box.

6. Purchase precut packing kits from Davis Valve or carefully cut each ring by wrapping a length of packing around the blade snugly, but without tension. Cut each ring individually, making a square cut with a clean, sharp knife.

7. Insert rings one at a time into stuffing box. Tamp each ring lightly in place using a flat packing iron. Packing joints may be located 90° apart, on metal-seated valves, to minimize leakage. Successive layers are installed in the same manner.

8. Pull the packing gland down and tighten using only the two end studs until the packing gland almost bottoms out.

9. Remove the packing gland as previously described.

10. Insert the wiper seal gasket.

11. Pull down packing gland using lock washers and nuts and tighten using alternate method. Do not over tighten.

12. Bring the valve up to pressure and tighten the packing gland following the procedures listed under the maintenance instructions.

VALVE THRUST AND TORQUE VALUES

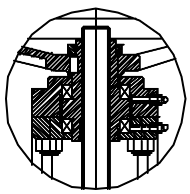
	Size	Valve Thrust lbs	Valve Torque ft lbs	Flow Coefficient Gal. per min. at a pressure drop of 1 psi
MODEL 60	2	648	9	285
	3	898	12	760
	4	1253	17	1420
	5	---	---	2890
	6	2077	37	3300
	8	3590	63	5800
	10	5469	97	11000
	12	7299	141	16500
	14	8573	166	20500
	16	10959	230	27000
	18	14409	302	36000
	20	17189	409	45000
	24	23801	592	60000
	30	---	---	95000
	36	---	---	138000
MODEL 61	2			285
	3			760
	4			1420
	5			2890
	6			3300
	8			5800
	10			11000
	12			16500
	14			20500
	16			27000
	18			36000
	20			45000
	24			60000
	30			95000
	36			138000
MODEL 70	2	565	8	285
	3	774	11	760
	4	1094	15	1420
	6	1958	27	3300
	8	3582	63	5800
	10	5541	98	11000
	12	7379	130	16500
	14	9551	185	20500
	16	12058	233	27000
	18	15353	322	36000
	20	18528	389	45000
	24	25880	616	60000

Davis Valve

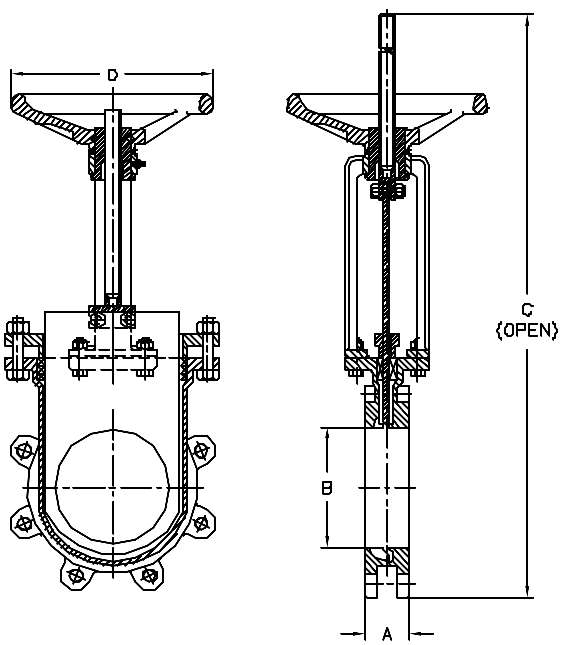
Memphis, Tennessee

Stainless Steel Knife Gate

TOPWORKS DETAIL
16" TO 48"



Model 60C - CF8 (304SS)
Model 60F - CF8M (316SS)
Model 60G - CG8M (317SS)



PART NAME	MATERIALS A 351-CF8	MATERIALS A 351-CF8M	MATERIALS A 351-CG8M
BODY	A 351-CF8	A 351-CF8M	A 351-CG8M
GATE	SS 304	SS 316	SS 317
YOKE	A 351-CF8	A 351-CF8	A 351-CF8
STEM	SS 304	SS 304	SS 304
GLAND	A 351-CF8	A 351-CF8M	A 351-CG8M
GLAND PACKING	PTFE	PTFE	PTFE
STEM NUT	AL BRONZE	AL BRONZE	AL BRONZE
HAND WHEEL	A 216-WCB	A 216-WCB	A 216-WCB

SIZE	INCH	2	2½	3	4	5	6	8	10	12	14	16	18	20	24	30	36
	MM	50	65	80	100	127	150	200	250	300	350	400	450	500	600	762	915
A	INCH	1.88	2.0	2.0	2.0	2.25	2.25	2.75	2.75	3.0	3.0	3.5	3.5	4.5	4.5	5.4	6.3
	MM	47.8	50.8	50.8	50.8	57.2	57.2	69.9	69.9	76.2	76.2	88.9	88.9	114.3	114.3	137.1	160.0
B	INCH	2.0	2.5	3.0	4.0	5.0	6.0	8.0	10.0	12.0	13.25	15.25	17.25	19.25	23.25	29.25	35.25
	MM	50.8	63.5	76.2	101.6	127.0	152.4	203.2	254.0	304.8	336.5	387.3	438.1	488.9	590.5	742.9	895.3
C	INCH	15.5	19.3	19.3	23.0	26.2	29.25	36.25	44.0	51.0	57.0	66.0	73.0	79.5	93.0	131.9	151.9
	MM	393.7	490.2	490.2	584.2	665.4	743.0	920.8	1117.6	1295.4	1447.8	1676.0	1854.0	2019.3	2362.2	3350.4	3858.2
D	INCH	8.0	8.0	8.0	10.0	10.0	12.0	14.0	16.0	16.7	18.9	18.9	20.9	20.9	24.8	36.7	36.7
	MM	203.0	203.0	203.0	254.0	254.0	304.8	355.6	406.4	424.1	480.0	480.0	530.8	530.8	630.0	932.1	932.1
WGT	LBS	22		31	38	47	59	84	124	170	201	294	372	503	671	1810	2252
	KGS	10		14	18	22	27	38	56	77	91	133	168	228	305	820	1020

Davis Valve

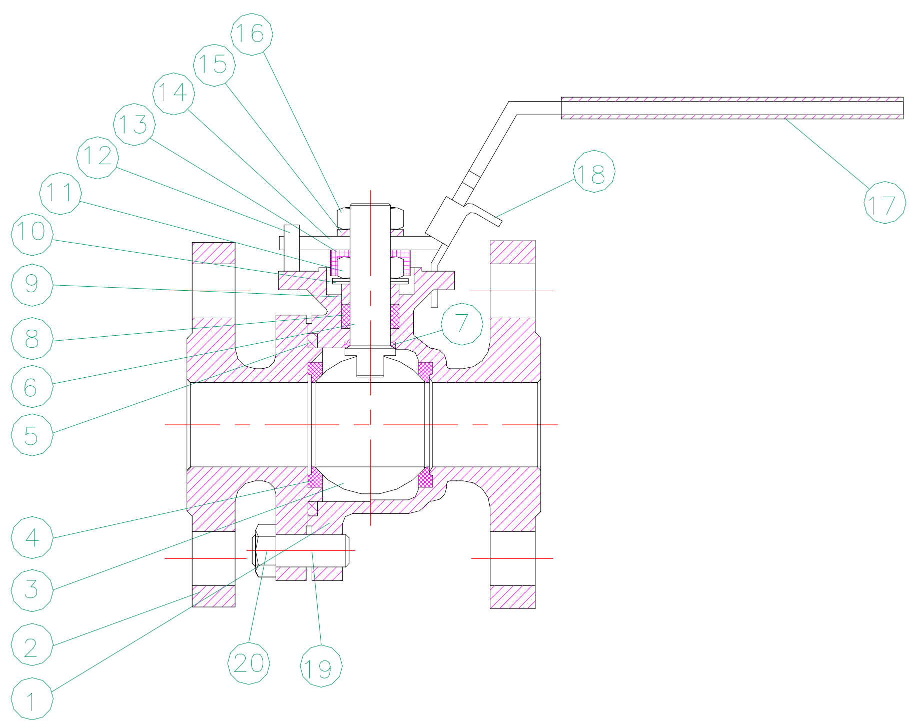
SHARPE® VALVES
A Division of Smith-Cooper International, LLC

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes ½" – 4" , Classes 150, 300, and 600

ITEM	DESCRIPTION
1	BODY
2	END CONNECTOR
3	BALL
4	SEAT
5	BODY GASKET
6	STEM
7	THRUST BEARING
8	STEM PACKING
9	GLAND PACKING
10	BELLVILLE WASHER
11	STEM NUT
12	STOPPER
13	LOCK TAB
14	HANDLE
15	HANDLE WASHER
16	HANDLE NUT
17	SLEEVE
18	LOCKING DEVICE
19	STUD
20	NUT



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150, 300, or 600.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the adjusting nut 1/4 turn. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle and travel stop plate.

3. Remove stem nut locking tab, stem nut, belleville springs, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

7. Take out other seat.

8. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Install one seat in the body cavity with the spherical curvature facing the ball.

2. Install thrust bearing on stem and slide the stem up through the body.

3. Install new stem seals, gland ring, and belleville springs. Install stem nut and tighten to the torque values given in Table 1. Install stem nut locking tab or cap. Tighten stem nut slightly if necessary to align nut with locking device surfaces.

4. Install travel stop (if supplied) and handle. Make sure handle aligns with flow bore through ball. Install hand retainer nut (or capscrew).

5. Turn the handle to the CLOSED position. Line up the ball slot with the stem tang and the ball into position on the stem tang. Turn the handle to the OPEN position to hold the ball in place.

6. Install the remaining seat into body end.

7. Place new body seal into counterbore in valve body.

8. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

9. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

10. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

11. Pressure test valve, if possible, before reinstalling in pipeline.

Table 1 - Stem Nut Torques

Valve Size	Torque (lb-ft)
½”	5.5
¾”	5.5
1”	6
1-1/2” – 4”	22

Table 2 – Body Bolting Torques (lb-ft)

Valve Size	Class 150	Class 300	Class 600
½”	5	10	15
¾”	5	10	20
1”	5	20	35
1-1/2”	15	35	80
2”	20	40	140
3”	20	60	155
4”	25	95	215

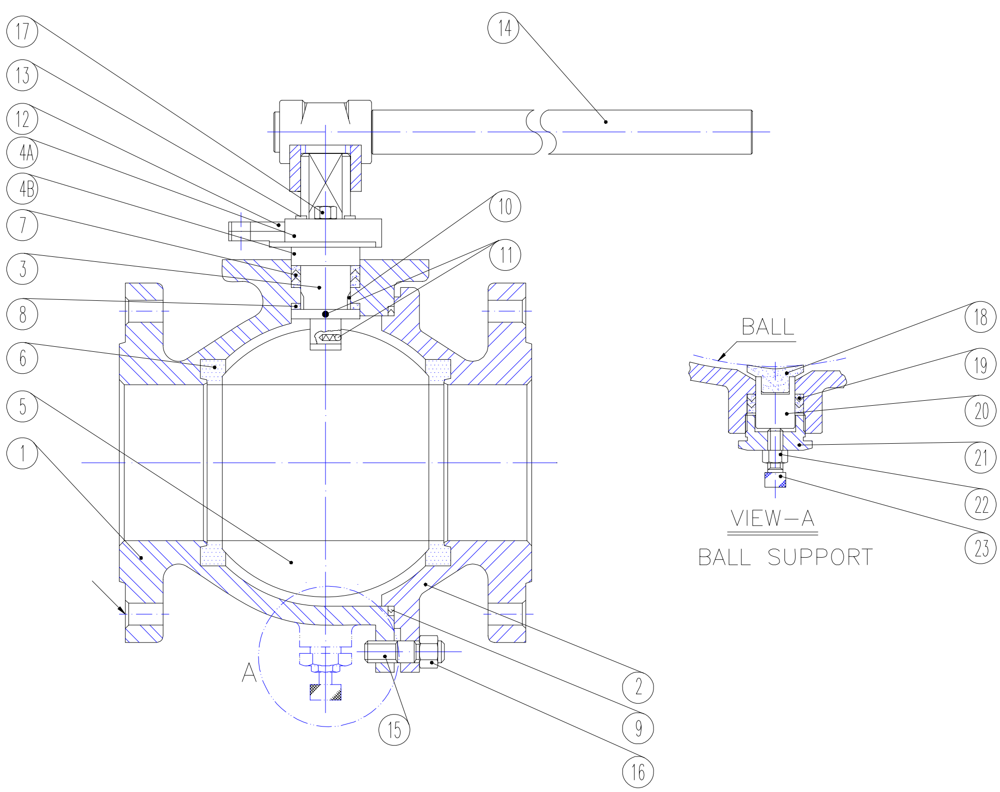
Note: Torque values are for TFE/RTFE or flexible graphite gaskets and seals. For other materials contact Sharpe Valves.

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes 6" - 12" , Classes 150 & 300

NO.	PART NAME
1	BODY
2	CAP
3	STEM
4A	GLAND
4B	GLAND RING
5	BALL
6	SEAT
7	PACKING
8	THRUST WASHER
9	GASKET
10	STEM BEARING
11	ANTI–STATIC
12	TRAVEL STOPPER
13	SNAP RING
14	HANDLE
15	STUD
16	NUT
17	GLAND BOLT
18	PIN SEAT
19	PIN PACKING
20	SUPPORT PIN
21	SUPPORT NUT
22	SET NUT
23	TUNING SCREW



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools. Ball support supplied for 10" and 12" Class 150 valves, and 6" through 12" Class 300 valves.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150 or Class 300.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the gland bolts 1/4 turn, each. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle, snap ring, and travel stop plate.

3. Remove gland bolts, gland, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. **<u>For 10” and 12” valves only</u>**: Ball support must be backed off to remove ball. Loosen support nut, set nut and back out tuning screw on bottom of valve to release the ball support. The weight of the ball will cause the ball support to come down.

7. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

8. Take out other seat.

9. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing and stem bushing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Set the valve body on a clean work suface, resting on the end flange.

2. Install one seat in the body cavity with the spherical curvature facing the ball (upwards).

3. Cut new stem bushing on one side at approx. 30° - 60° angle and wrap around stem above shoulder.

4. Install thrust bearing on stem and holding stem bushing in place, slide the stem up through stem bore from inside body.

5. Install new stem seals, gland ring, and gland. Install gland bolts and tighten hand tight.

6. Install travel stop, and snap ring.

7. Turn the stem to the CLOSED position (bottom stem tan parallel to flow passage). Line up the ball slot with the stem tang and roll and lower the ball into position on the stem tang, letting the ball rest in the seat. Turn the stem and ball to the OPEN position to hold the ball in place.

8. **For 10" and 12" Valves Only:** Re-set the ball support by turning the tuning screw inwards until the support pin seat firmly contacts the ball. Do not cause the ball to move. Holding the tuning screw in place, tighten the support nut and then the set nut.

9. Install the remaining seat into body end.

10. Place new body seal into counterbore in valve body.

11. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

12. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

13. Tighten the gland bolts to the torques specified in Table 1.

14. Install handle, making sure that the handle aligns with the flow passage through the ball.

15. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

16. Pressure test valve, if possible, before reinstalling in pipeline.

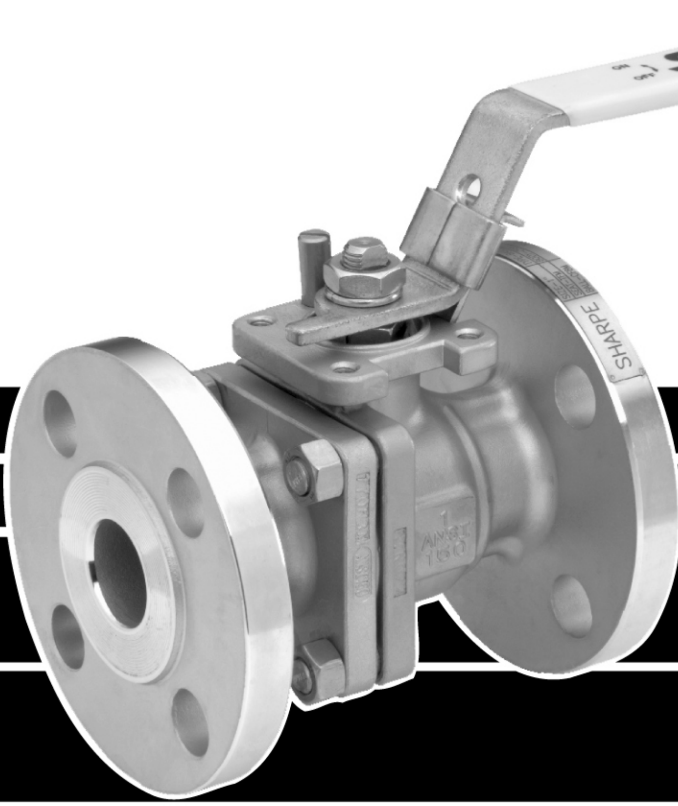
Table 1 – Gland Bolt Torques

SIZE	Tightening Torque (lb-ft) Max
6" – 8"	42 (1/2-13UNC)
10" - 12"	83 (5/8-11UNC)

Table 2 – Body Bolting Torques

SIZE	THREAD	Tightening Torque (lb-ft) Max
6”,8” (Class 150) / 3”~6”(Class 300)	5/8-11UNC	83
10”,12” (Class 150) / 8”(Class 300)	3/4-10UNC	120
10”(Class 300)	7/8-9UNC	190
12”(Class 300)	1-8UNC	260

SHARPE® VALVES

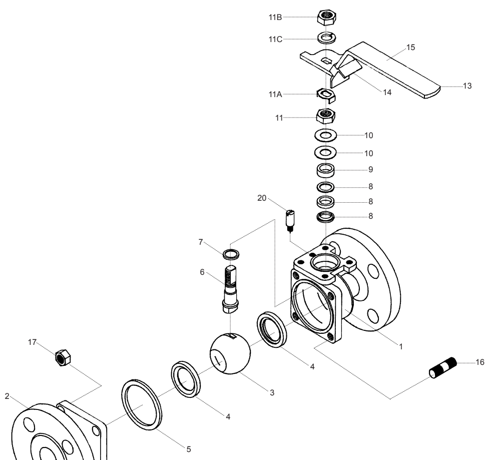


FLANGED FULL PORT BALL VALVE SERIES 50 / CLASS 150

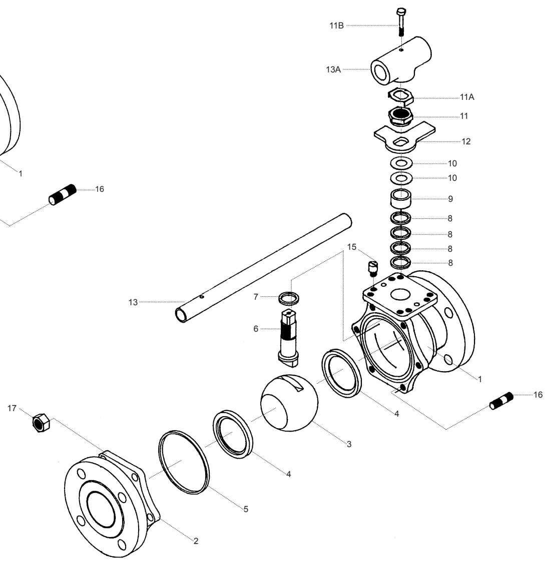
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

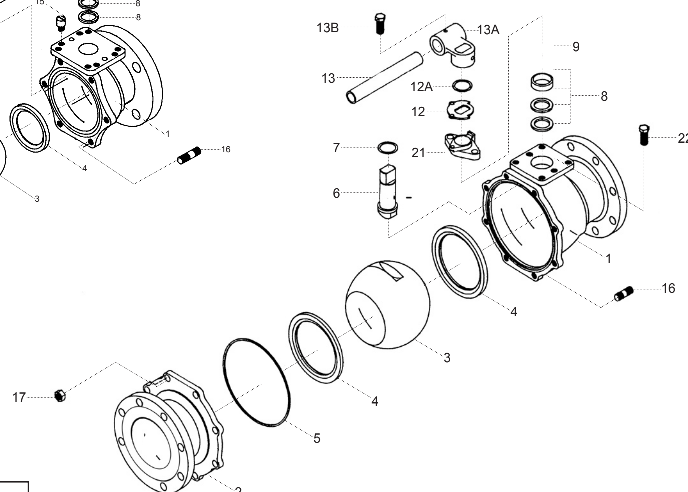
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2” - 2”



2-1/2” - 4”



6” - 8”

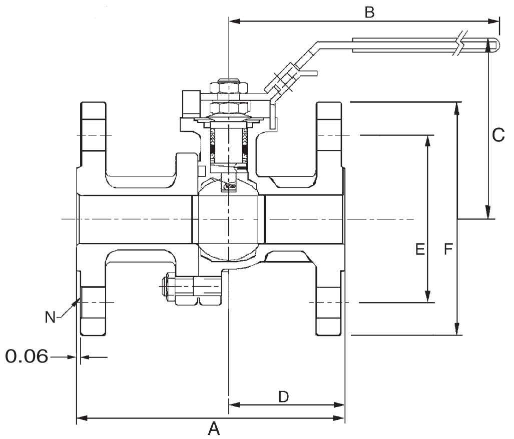
PART NO.	PART	QTY.	MATERIAL
1	Body	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) TFE Reinforced TFE NOVA PEEK
5	Body Seal	1	TFE
6	Stem	1	316 Stainless Steel Alloy 20 Hastelloy C 17-4PH (Option)
7	Thrust Bearing	2	Reinforced TFE
8	Stem Packing	3/4	Reinforced TFE
9	Gland Packing	1	304 Stainless Steel
10	Belleville Washer (1/2”-4”)	2/4	304 Stainless Steel
11	Packing Nut (1/2”-4”)	1	304 Stainless Steel
11A	Lock Tab	1	Stainless Steel
11B	Handle Nut	1	304 Stainless Steel
11C	Lock Washer	1	304 Stainless Steel (1/2”-2”)

*See Dimensions

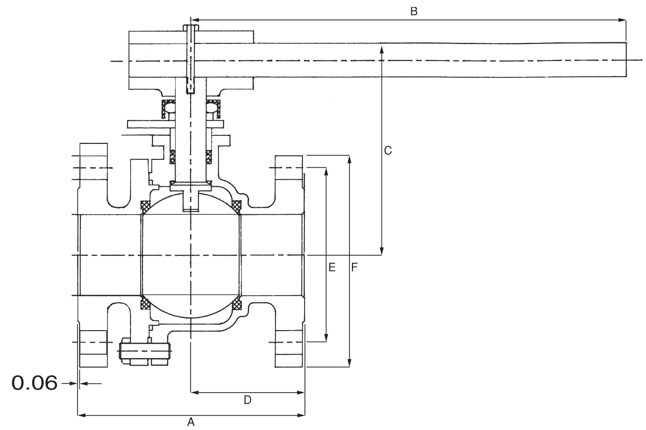
PART NO.	PART	QTY.	MATERIAL
12	Stopper	1	304 Stainless Steel
12A	Snap Ring	1	Stainless Steel (6”-8”)
13	Handle	1	304 Stainless Steel (1/2”-2”) Galvanized Steel (2-1/2”-4”) Ductile Iron (6”-8”)
13A	Wrench Block	1	Stainless Steel
13B	Hex Head Bolt	1	304 Stainless Steel
14	Locking Device (1/2”-2”)	1	304 Stainless Steel
15	Sleeve	1	Vinyl
16	Body Stud	SEE* N	A193 B8 (SST) A193 B7 (CS)
17	Nut	SEE* N	A194 8 (SST) A194 2H (CS)
20	Stop Pin (1/2”-2”) (2-1/2”-4”)	1 2	304 Stainless Steel 304 Stainless Steel
21	Gland Flange (6”-8”)	1	304 Stainless Steel
22	Gland Bolts (6”-8”)	2	304 Stainless Steel

SERIES 50
DIMENSIONS

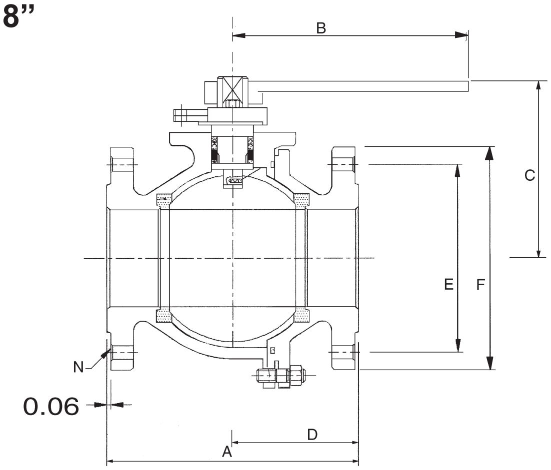
1/2" - 2"



2-1/2" - 4"



6" - 8"



CV DATA

1/2"	26
3/4"	50
1"	94
1-1/2"	260
2"	480
2-1/2"	750
3"	1300
4"	2300
6"	5400
8"	10000

PORT

1/2"	0.59
3/4"	0.78
1"	1.00
1-1/2"	1.50
2"	2.00
2-1/2"	2.55
3"	3.00
4"	4.00
6"	6.00
8"	7.88

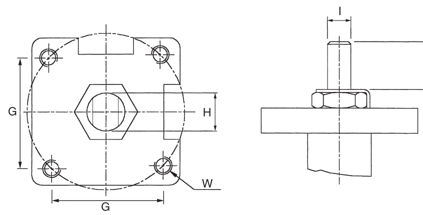
WEIGHT (lbs.)

1/2"	4
3/4"	6
1"	8
1-1/2"	15
2"	20
2-1/2"	36
3"	45
4"	75
6"	135
8"	290

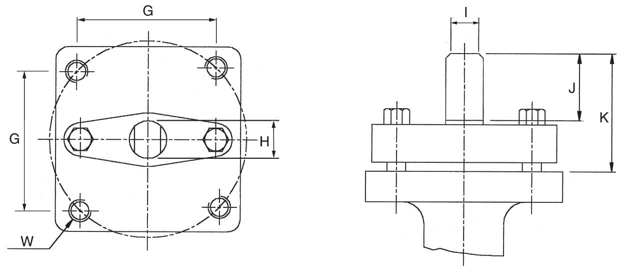
SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2"	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4"	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1"	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2"	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2"	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2"	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3"	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4"	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6"	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8"	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

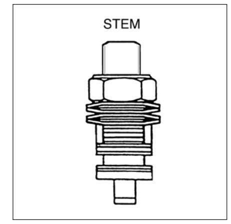
The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.

1/2" - 4"



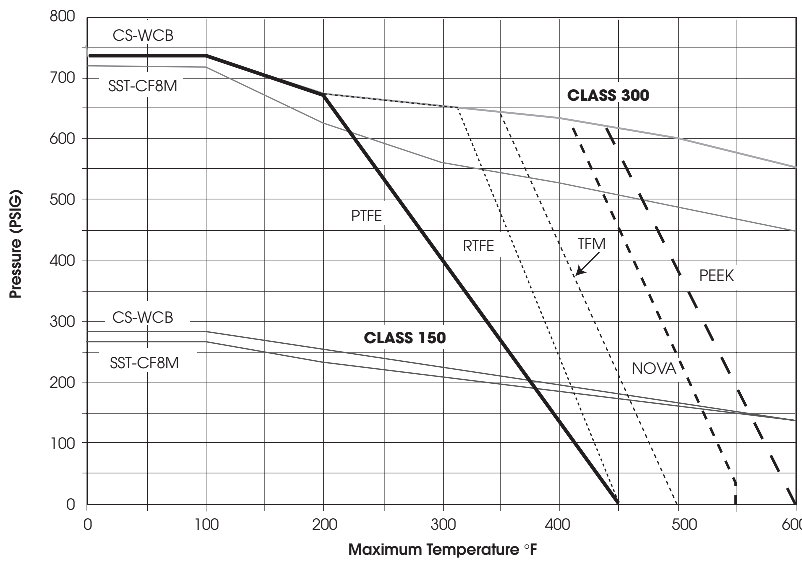
6" - 8"





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2"	50	150# = 11	2 = Alloy 20	T = TFE	X = Oxygen Service
3/4"			4 = Carbon Steel	R = RTFE	OH = Oval Handle
1"			6 = Stainless Steel	N = NOVA	F = Fugitive Emissions Certified ANSI 593.00.01
1-1/2"			5 = Hastelloy C	P = Peek	E = Extended Stem
2"			3 = Monel	M = TFM™	L = Lockable Extended Stem
2-1/2"					D = Leak detection Stem
3"					GO = Gear Operator
4"					7 = 17- 4PH Stem
6"					A = Nace
8"					

3/4" 50 11 6 T X

SHARPE® VALVES

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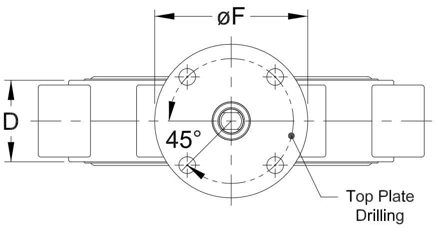
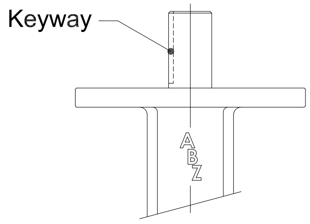
Fax: (708) 562-9250
E-Mail: info@sharpevalves.com
www.sharpevalves.com
1260 Garnet Drive
Northlake, Illinois 60164 U.S.A.

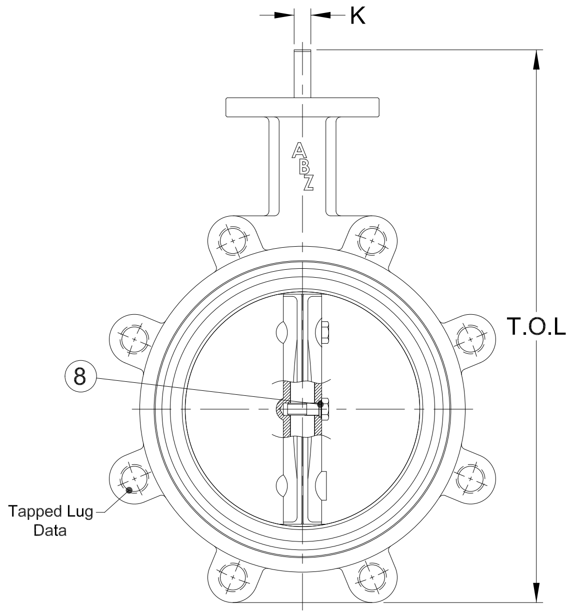


Top View

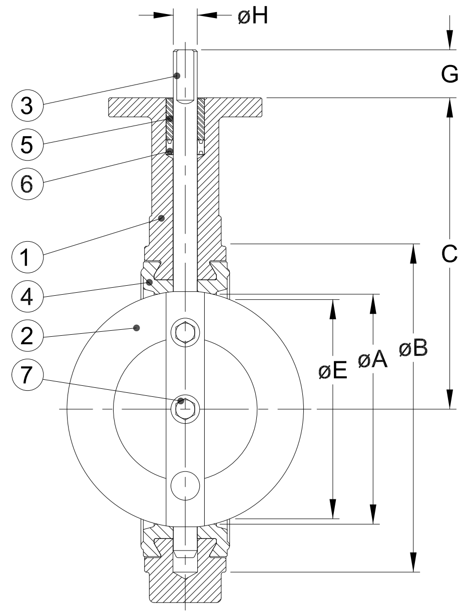


12" Stem

Valve Parts			
Item No.	Name	Material	No. Req'd
1	Lug Body	-	1
2	Disc	-	1
3	Stem	-	1
4	Seat	-	1
5	Bushing	-	1
6	Seal	-	1
7	Screw	-	1 Set
8	"O-Rings"	-	1 Set



Flow View



Section View

Notes:

1. The Figure 102 valve can not be used on a pipe or flange with an inside diameter less than the "E" dimension.
2. Installation Direction: Bi-directional (175 psi) and Dead End Service (85 psi).
3. Undercut disc are rated for 50 psi bi-directional service and 25 psi dead end service.
4. Preferred direction is with disc bolts on downstream side of disc.

Valve Dimensions

Valve Size	øA	øB	C	D	øE	øF	G	øH	K	Keyway	T.O.L	Weight	Top Plate Drilling			Tapped Lug Data		
													Bolt Circle	No. of Holes	Hole Dia.	Bolt Circle	No. of Holes	Tap
2"	2 1/8	4 1/8	5 1/2	1 5/8	1 11/16	4	1 1/4	9/16	3/8	—	9.31	7 lbs	3 1/4	4	7/16	4 3/4	4	5/8"-11unc
2 1/2"	2 9/16	4 7/8	6	1 3/4	2 3 /16	4	1 1/4	9/16	3/8	—	10.06	10 lbs	3 1/4	4	7/16	5 1/2	4	5/8"-11unc
3"	3 1/8	5 3/8	6 1/4	1 3/4	2 7/8	4	1 1/4	9/16	3/8	—	10.56	10 lbs	3 1/4	4	7/16	6	4	5/8"-11unc
4"	4 1/8	6 7/8	7	2	3 7/8	4	1 1/4	5/8	7/16	—	12.56	18 lbs	3 1/4	4	7/16	7 1/2	8	5/8"-11unc
5"	5 3/16	7 5/8	7 1/2	2 1/8	5	4	1 1/4	5/8	7/16	—	13.31	22 lbs	3 1/4	4	7/16	8 1/2	8	3/4"-10unc
6"	6 1/8	8 3/4	8	2 1/8	6	4	1 1/4	5/8	7/16	—	14.50	24 lbs	3 1/4	4	7/16	9 1/2	8	3/4"-10unc
8"	8 1/8	11	9 1/2	2 1/2	8	6	1 1/4	3/4	1/2	—	17.19	44 lbs	5	4	9/16	11 3/4	8	3/4"-10unc
10"	10 1/8	13 3/8	10 3/4	2 1/2	10 1/16	6	1 1/4	7/8	5/8	—	19.56	62 lbs	5	4	9/16	14 1/4	12	7/8"-9unc
12"	12 1/8	16 1/8	12 1/4	3	11 15/16	6	2	1 1/8	—	1/4x1/4	23.19	93 lbs	5	4	9/16	17	12	7/8"-9unc

Design Standard	CWP Rating	Flange Connection	Test Standard
API 609 Cat. A	175 PSI	B16.1 / B16.5	API 598

FORUM™ ENERGY TECHNOLOGIES

Valve Solutions
ABZ Valves & Controls

ABZ VALVE

Title: Resilient Seated Butterfly Valve Series 102 - Lug Type			Scale N/A Projection
DWG No. 2"-12" 102-Bare Stem			Unit inch
Date 09-22-11	Drawn BC	Checked Tp	Dimensions are subject to change without notice.	Revision 0

Resilient Seated Butterfly Valves

A GFT COMPANY

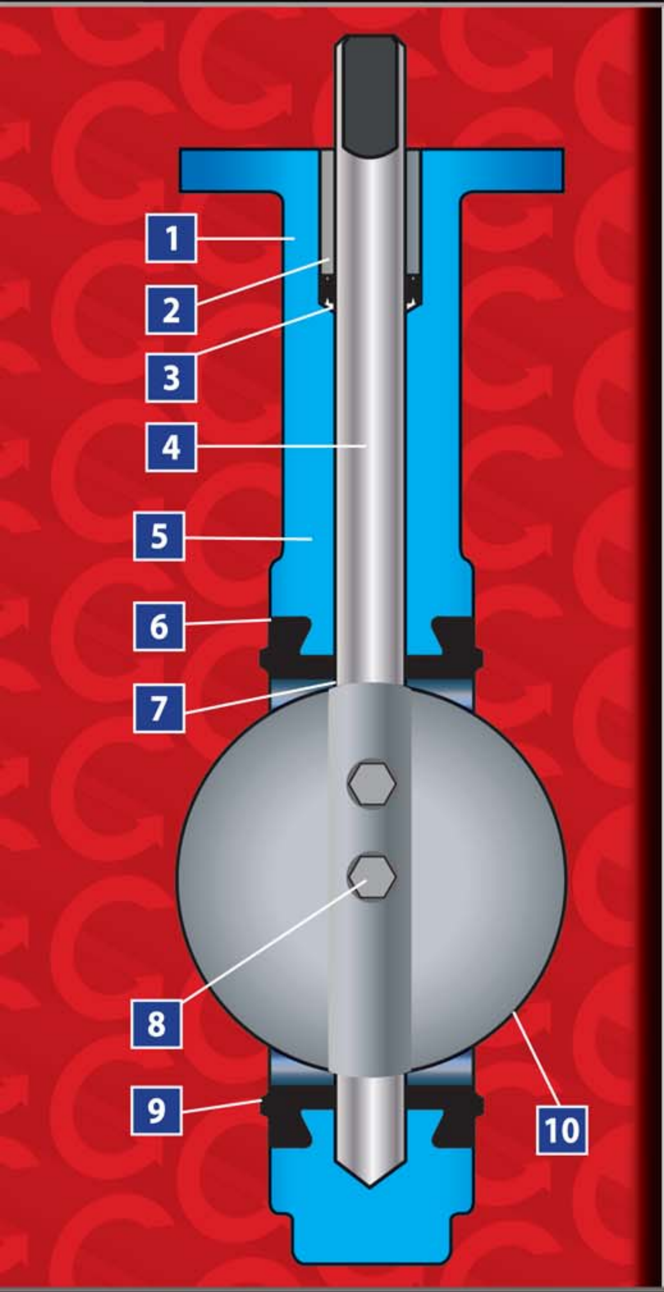
Figures 101/108/102

ABZ VALVES & CONTROLS
PO Box 157 • 113 W. Main • Madison, KS 66860
620-437-2440 • FAX 620-437-2435
www.abzvalve.com • info@abzvalve.com

ABZ Precision Built Butterfly Valves

Resil-O-Seat™ Seated Valves for Chemical and Abrasion Resistance Applications.

The figures 101/102/108 provide excellent flexibility with a variety of trim materials. These are available for a wide selection of applications.



1 Body machined to high tolerances. Guaranteed standard dimensions for interchangeability of parts and actuators.

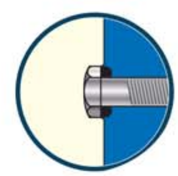
2 Top bushings protect the stem from side thrust of operators. They are made of impact and corrosion resistant materials.

3 Special double-V-shape of stem seal self-adjusts to protect the stem area for either vacuum or pressure use.

4 Stem extends through disc and aligns with socket in body. Stem end has standard dimensions for operator interchangeability.

5 Long neck allows for insulation requirements.

6 The special snap-in Resil-O-Seat™ design fixes seat in place without bonding. The Resil-O-Seat™ is 100% field replaceable - no special tools required.



7 Stem and body are isolated from the line media by the interference fit of the primary seal created between the disc and seat.

8 Stainless steel cap screws securely hold disc to stem. O-ring seal prevents leakage into the stem area and creates a positive connection.

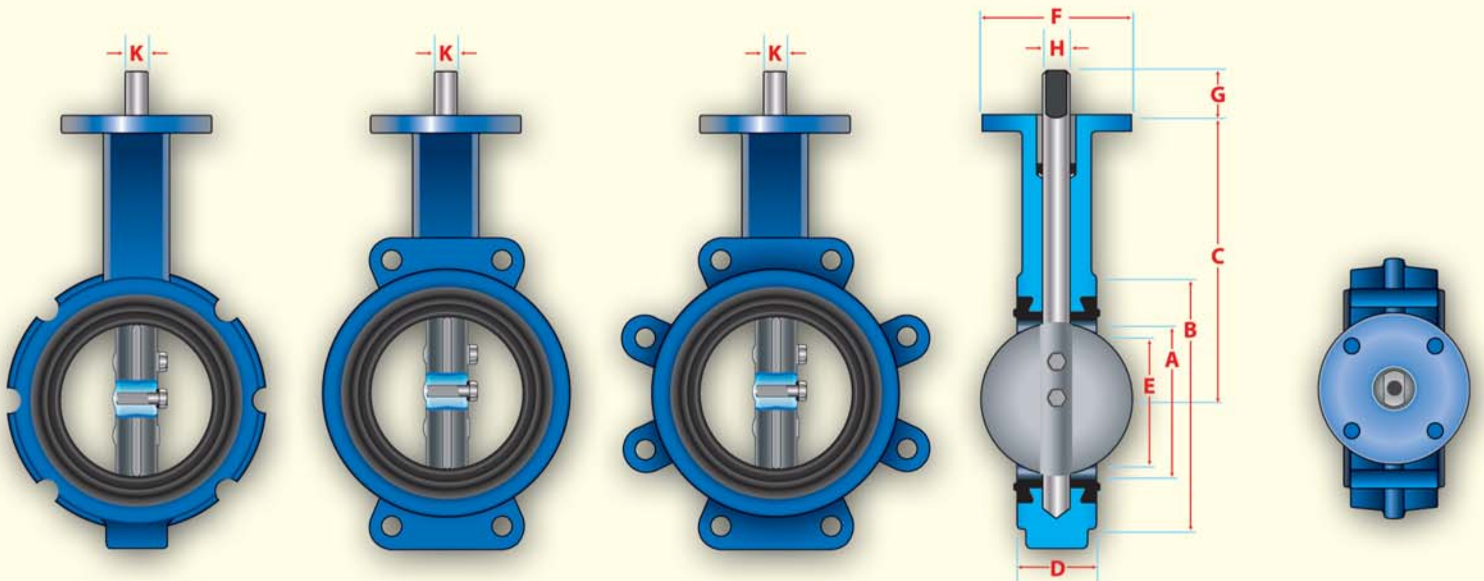
9 Resil-O-SeatTM forms a seal against all standard ANSI 125/150 flanges. Gasketing requirements are eliminated.

10 Disc edge is individually processed through machining and hand buffing for a smooth edge, providing a bubble tight shutoff and maximum seat life.

101 is a wafer style body
108 is semi-lug style body
102 is a full lug style body

FIGURES 101/108/102

Valve Dimensions



All standard seats are Food Grade with the exception of Viton

Valve Size	DIMENSIONS									TOP PLATE DRILLING			TAPPED LUG DATA				WEIGHT (POUNDS)		
	A	B	C	D	E	F	G	H	K	Bolt Circle	No. Holes	Hole Dia.	Bolt Circle	No. Holes 102	No. Holes 108	Tap	101	108	102
2	2 1/8	4 1/8	5 1/2	1 5/8	1 11/16	4	1 1/4	9/16	3/8	3 1/4	4	7/16	4 3/4	4	4	5/8-11 UNC	7	8	8
2 1/2	2 9/16	4 7/8	6	1 3/4	2 3/16	4	1 1/4	9/16	3/8	3 1/4	4	7/16	5 1/2	4	4	5/8-11 UNC	8	9	9
3	3 1/8	5 3/8	6 1/4	1 3/4	2 7/8	4	1 1/4	9/16	3/8	3 1/4	4	7/16	6	4	4	5/8-11 UNC	9	10	10
4	4 1/8	6 7/8	7	2	3 7/8	4	1 1/4	5/8	7/16	3 1/4	4	7/16	7 1/2	8	4	5/8-11 UNC	13	17	20
5	5 3/16	7 5/8	7 1/2	2 1/8	5	4	1 1/4	5/8	7/16	3 1/4	4	7/16	8 1/2	8	4	3/4-10 UNC	19	20	23
6	6 1/8	8 3/4	8	2 1/8	6	4	1 1/4	5/8	7/16	3 1/4	4	7/16	9 1/2	8	4	3/4-10 UNC	20	24	27
8	8 1/8	11	9 1/2	2 1/2	8	6	1 1/4	3/4	1/2	5	4	9/16	11 3/4	8	4	3/4-10 UNC	36	38	43
10	10 1/8	13 3/8	10 3/4	2 1/2	10 1/16	6	1 1/4	7/8	5/8	5	4	9/16	14 1/4	12	4	7/8-9 UNC	49	55	63
12	12 1/8	16 1/8	12 1/4	3	11 15/16	6	2	1 1/8	1/4	5	4	9/16	17	12	4	7/8-9 UNC	70	82	90

STANDARD CONSTRUCTION SPECIFICATIONS:

Body: Cast Iron, Ductile Iron (Lug) and Aluminum (Wafer)

Disc: 316 Stainless Steel, Aluminum Bronze, Ductile Iron, Epoxy Coated Ductile Iron

Stem: 316 Stainless Steel, 416 Stainless Steel, Carbon Steel

Resilient Seat: EPDM, Buna-N, Viton, Natural Rubber, White Buna, White Neoprene.

Stem Bushing: Teflon® – Graphite Impregnated

Stem Packing: Buna-N and Viton

Additional materials are available for a wide selection of applications.

NOTES:

1. Dimension "K" not applicable to 12" size. The 12" stem is round with ¼" Key.
2. The figures 101, 102 and 108 cannot be used on pipe or flange with an inside diameter less than the "E" dimension.
3. Valves are rated up to 175 PSI bi-directional service and 85 PSI end of line rating. Undercut disc is rated up to 50 PSI bi-directional service and 25 PSI end of line rating. Preferred direction is with disc bolts on downstream side of disc.
4. Designed in accordance with sections of API 609 Catagory A, ASME 16.1/16.5, ASME 16.34 and MSS SP67. Design tested in accordance with API 598.
5. Compatible with ANSI Class 125/150 flange standards.

Rated Flow Coefficient (Cv) - Figure 101/108/102

Valve Size	ANGLE OF DISC OPENING								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
2	1.67	7.7	17	29	48	74	115	145	195
2 1/2	2.50	11.0	25	44	69	109	174	237	307
3	3.33	15.7	37	64	105	165	276	377	487
4	5.00	27.7	63	110	177	278	472	671	827
5	8.33	43.7	99	177	276	443	752	1,083	1,325
6	13.33	58.7	136	242	385	616	1,075	1,521	1,883
8	20.00	107.3	247	434	687	1,094	1,821	2,671	3,239
10	31.67	174.0	394	696	1,092	1,770	2,983	4,288	5,210
12	47.0	251.7	578	1,002	1,665	2,654	4,398	6,466	8,026

Cv is defined as the volume of water in U.S.G.P.M. that will flow through a given restriction or valve opening with a pressure drop of one (1) p.s.i. at room temperature. Recommended control angles are between 25°-70° open.

Torque Chart - Figure 101/108/102

Valve Size	NORMAL CONDITIONS					SEVERE CONDITIONS				
	Δ P=0	Δ P=50	Δ P=100	Δ P=150	Δ P=175	Δ P=0	Δ P=50	Δ P=100	Δ P=150	Δ P=175
2	221	230	240	250	254	373	384	400	406	410
2 1/2	269	283	288	302	311	454	464	475	486	497
3	322	341	365	379	392	540	568	589	611	634
4	480	514	542	576	590	816	848	886	918	936
5	653	706	754	806	854	1,102	1,162	1,220	1,274	1,301
6	907	1,008	1,109	1,210	1,260	1,529	1,642	1,756	1,868	1,926
8	1,512	1,714	1,915	2,112	2,215	2,549	2,776	3,002	3,229	3,343
10	2,318	2,621	2,900	3,224	3,372	3,910	4,250	4,590	4,931	5,101
12	3,125	3,629	4,138	4,637	6,112	5,270	5,838	6,404	6,971	7,258

Undercut disc available.

All torques shown in inch lbs. 20% Safety factor already included.

ABZ VALVES & CONTROLS, INC.
A Global Flow Technologies Company
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PHONE: 620-437-2440 • FAX: 620-437-2435
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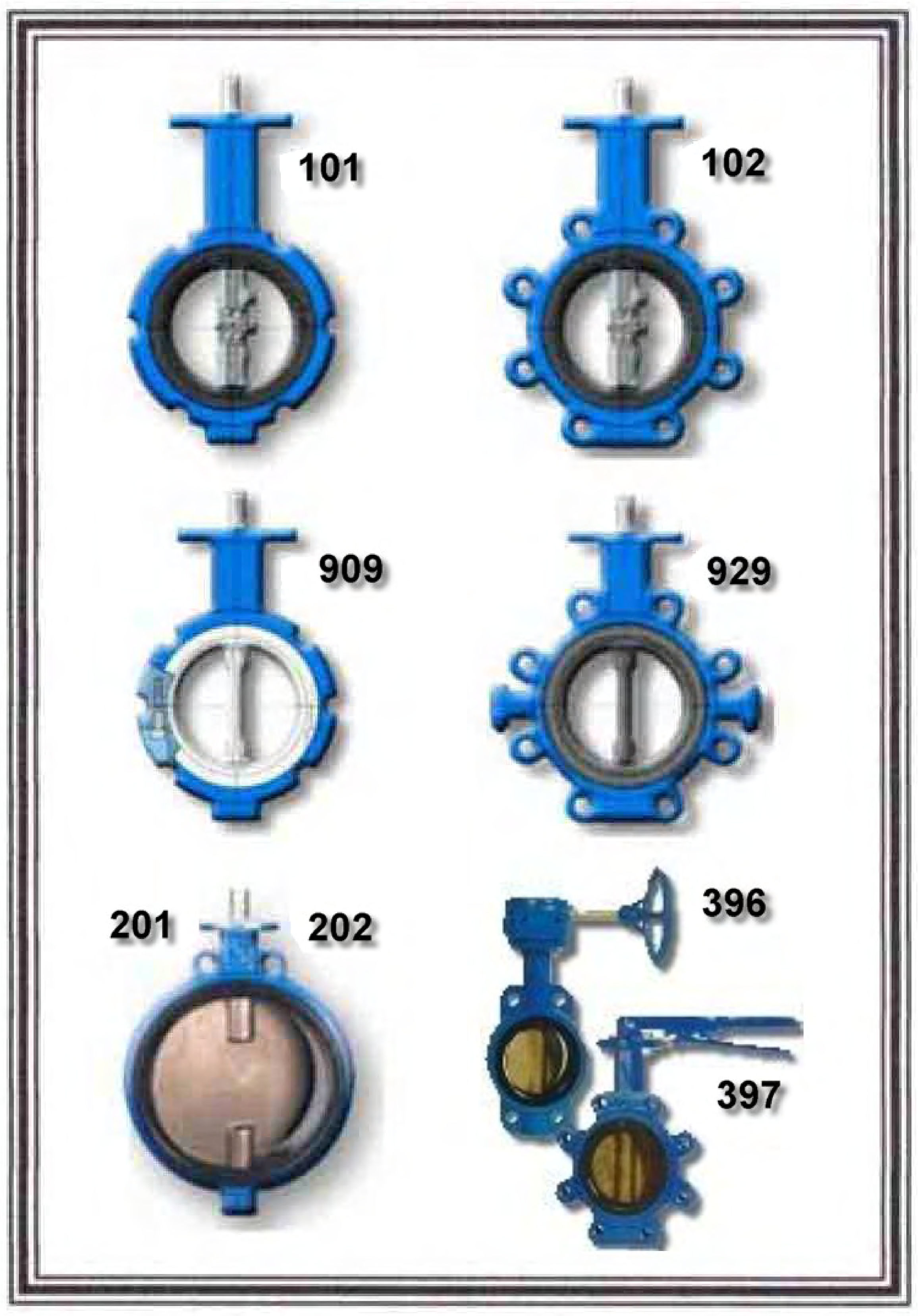
Certified System ISO 9001-2008

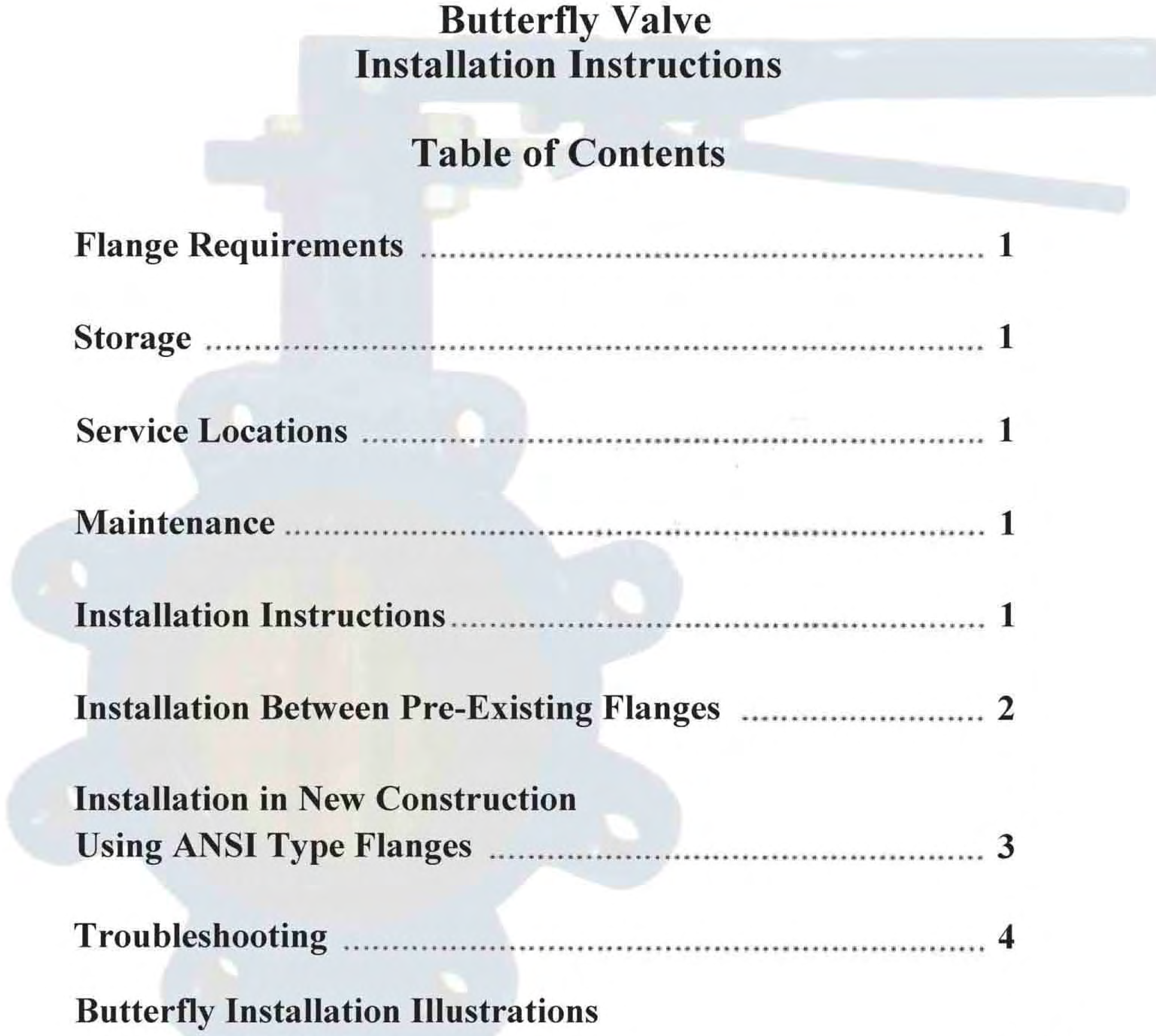
ABZ VALVES & CONTROLS

BUTTERFLY VALVES



INSTALLATION AND MAINTENANCE MANUAL

ABZ VALVES & CONTROLS



Butterfly Valve
Installation Instructions

Table of Contents

ABZ VALVES & CONTROLS

Flange Requirements:

ABZ's resilient seated (RS) valves are designed for installation between ANSI Class 125/150 flat or raised faced flanges. Gaskets are not required. Lined pipe, heavy wall pipe or flanges must have a minimum allowable inside diameter at the centered body face to clear the disc sealing edge when opening the valve.

Storage:

The valves should be stored on a pallet or "skid" in a clean, dry warehouse. If the valves must be stored outside, the following apply:

1. Valves must be kept off the ground high enough to avoid standing water.

2. Cover the valves with a water repellant cover (not included with valve).

Service Locations:

For service or technical information, please contact us: (620) 437-2440, e-mail: abzvalve@madtel.net or at our website www.abzvalve.com

Maintenance:

Routine maintenance or lubrication is not required.

Installation Instructions:

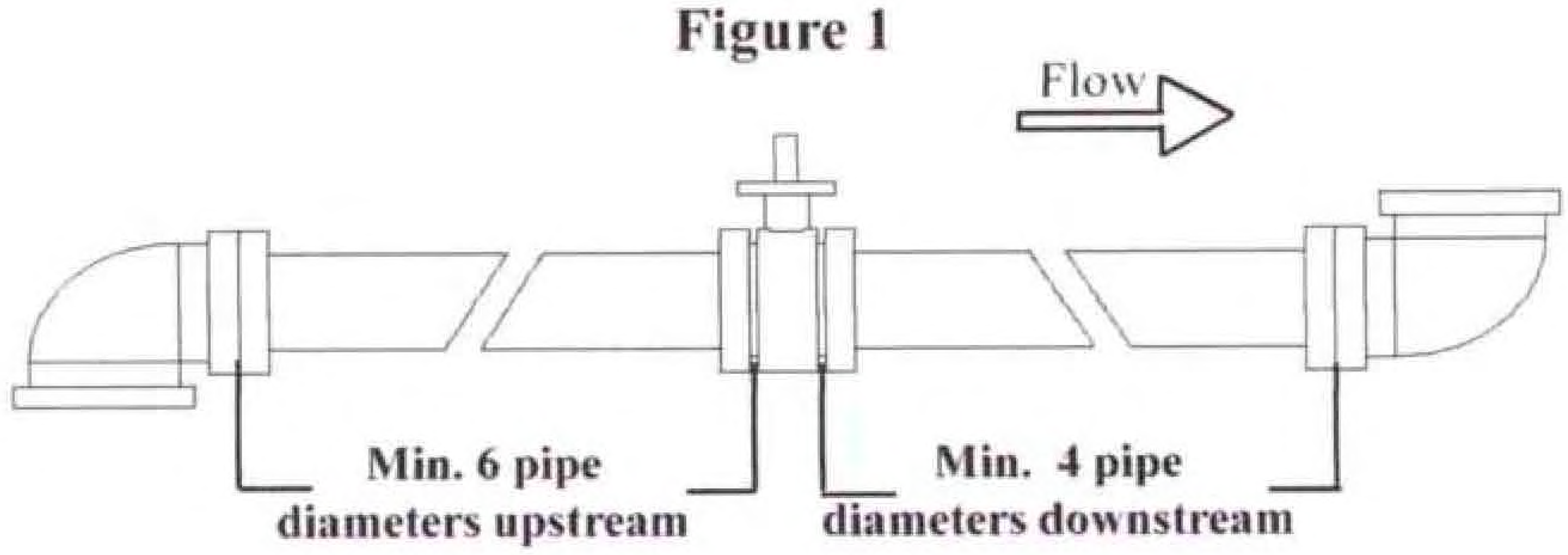
ABZ's resilient seated (RS) valves are bidirectional and will control flow equally well in either direction. For the best results in slurry service regarding sedimentation, position the valve assembly so that the valve stem is in the horizontal position and the lower disc edge opens downstream. This will create a self-flushing effect, thereby extending the service life of the valve. (See Figure 3 on Page 5).

ABZ VALVES & CONTROLS

Installation Instructions cont.

Consideration should be given to the location of the valves in the piping system. The valve should not be placed too close to other valves, elbows, etc. as its performance may be affected. It is recommended that the valve have a minimum of six pipe diameters upstream (see Figure 1) and four pipe diameters downstream between it and other valves, elbows, etc. in the piping system. (See Figures 4 - 10 on pages 5 - 8 for pump applications, elbows, pipe reduction and other special applications).

Figure 1



Installation Between Pre-Existing ANSI Flanges:

(See Figures 11-13 on Pages 7 & 8 for illustrations)

1. Observe that the disc sealing edge is in line with the parallel flats (or keyway) on the stem. Rotate the stem clockwise to position the disc within the body at least 3/8" away from the body face.

2. Spread the flanges to exceed the valve's face-to-face dimension by 3/16" before placing the valve in position to prevent distortion and/or damage to the seating face of the seat.

3. Center the valve body between the flanges and span the valve body with all flange bolts possible. Turn the disk to the fully open position.

4. While gradually removing the flange spreaders, center the valve body to the flanges and tighten the bolting hand tight. Slowly close the valve to check for adequate disc clearance.

ABZ VALVES & CONTROLS

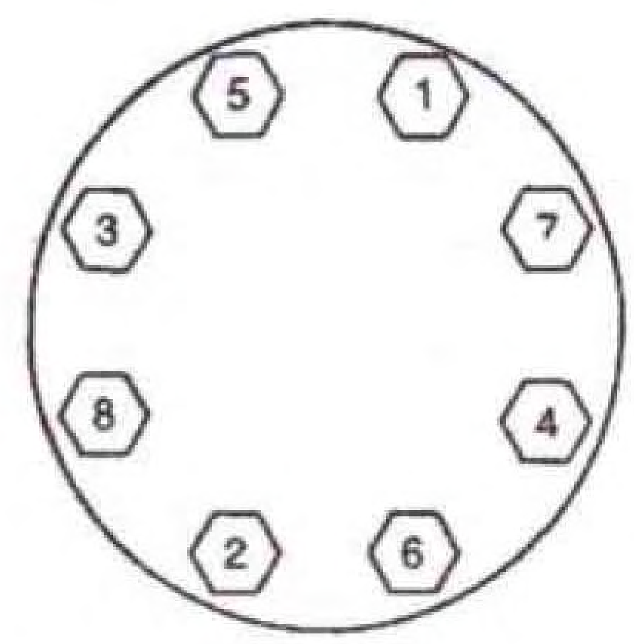
Installation Between Pre-Existing ANSI Flanges cont.:

5. Return the disc to the fully open position and cross-tighten all bolting to the proper torque specification:

Table 1. Bolt Torques: Resilient Seated Butterflies with Cap Screws on Metal Flanges

Flange Size	Recommended Min. Bolt Torque	Flange Size	Recommended Min. Bolt Torque
2"-4"	20 - 30 ft. lbs.	18"-20"	150 - 210 ft. lbs.
5"-8"	33 - 50 ft. lbs.	24"-30"	215 - 300 ft. lbs.
10"	53 - 75 ft. lbs.	36"	300 - 375 ft. lbs.
12"	80 - 110 ft. lbs.	42"-48"	350 - 425 ft. lbs.
14"-16"	140 - 200 ft. lbs.		

Figure 2.
Bolt Tightening Sequence



6. Again, check for adequate disc clearance. If the installation is satisfactory, the valve is ready for service and/or installing the valve actuator.

Installation in New Construction Using ANSI Welding Type Flange:

1. With the disc in the nearly closed position, align and center the companion flange bolt holes to the body lug holes.

2. Assemble the body and flanges with the flange bolting and mate-up the bolting using the flange-body-flange assembly for fit-up and centering to the pipe.

3. Tack weld the flanges to the pipe.

4. Remove the flange bolting and valve assembly from between the flanges.

Note: Do not finish weld the flanges to the pipe with the valve bolted between the flanges as this will result in serious heat damage to the valve seat.

5. Finish welding the flanges to the pipe and allow the flanges to cool completely before proceeding.

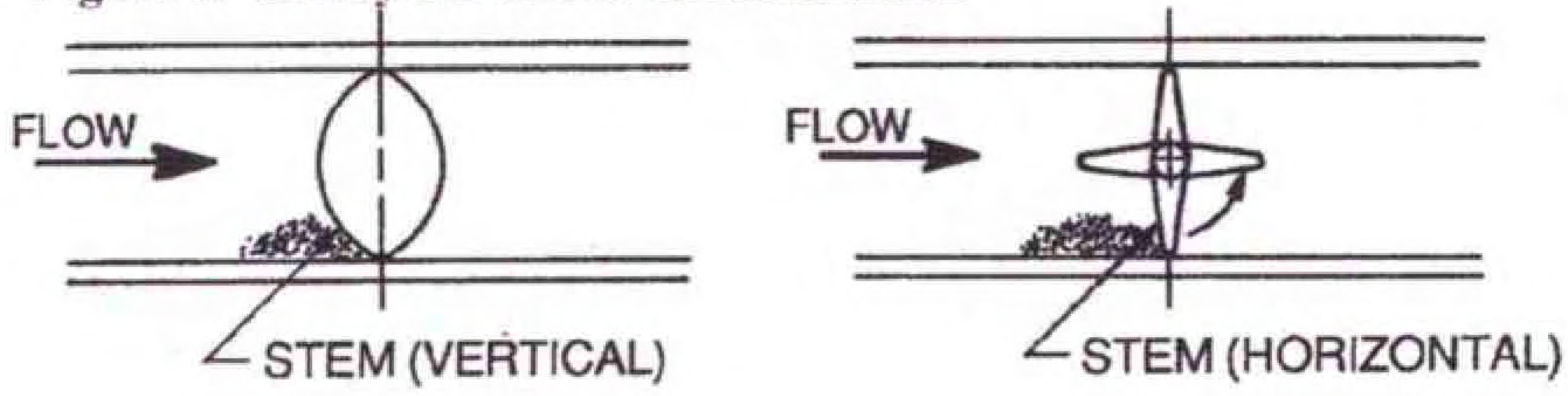
6. Follow steps 1 through 5 of "Installation Between Pre-Existing ANSI Flanges."

ABZ VALVES & CONTROLS

Troubleshooting:

Symptom	Probable Cause	Solution
Excessively High Torque	1. Pinched Seats: A. Flange bolts are not evenly torqued. B. Over-torqued bolts.	1. Loosen the Flange Bolts around valve. Manually spin disc through butterfly valve a couple of times to attempt to reshape the seat. Tighten the Flange Bolts in the proper sequence (see Page 3) to correct torque per ANSI requirements. Note: If valve face seal has been damaged, or if the valve has been installed incorrectly for an extended period of time and this does not help, the valve may need to be replaced.
	2. Valve installed too close to an elbow, strainer, pipe reduction or other obstruction.	2. Either change piping, change the location of the valve or upgrade the torque on actuator.
	3. Valve oriented in incorrect position for the application.	3. See Page 8. Reinstall valve to the correct position.
	4. Obstruction in the pipeline.	4. Remove valve from pipeline and remove obstruction.
	5. Valve stem or disc bent.	5. Return valve to factory for disc/stem replacement (check for water hammer or freezing of line material).
	6. Scale build-up on stem or seat.	6. Open and close the valve several times. Operate the valve at least once a month. Check the valve seat for deterioration. Flush system periodically and ensure proper chemical treatemnt program is implemented on a consistent basis. Excessive addition of system chemicals at one time may coat the surface of valve seat and disc. (Yearly water treatment)
	7. Improper pipe supports.	7. Add pipe supports.
	8. Improperly welded flanges (NOT perpendicular).	8. Re-weld flange properly.
Leakage in the Closed Position (Leakage in the Pipeline)	The Disc is not closing fully: 1. Actuator is not adjusted properly.	1. Refer to Actuator Adjustment procedures in RE Troubleshooting Guide.
	2. Line pressure exceeds control valve's rated close-off pressure.	2. Reduce line pressure to control valve's rated close-off pressure or upgrade actuator.
	3. Excessively high torque.	3. See Excessively High Torque above.
Leakage Past the Flange Face	1. Flange bolts are not evenly torqued.	1. Loosen the Flange Bolts and tighten the Flange Bolts to correct torque per ANSI requirements. (See Page 3)
	2. Improper Flanged.	2. Refer to "Flange Requirements" on Page 1
Valve opens only a few degrees and stops (it will not open to the full angle desired)	1. Improper Installation. The valve is improperly aligned.	1. Loosen the flange bolts, realign the valve with flanges and retighten the flange bolts to correct torque per ANSI requirements. (See Page 3)
Water Hammer	1. The valve is closing too quickly.	1. Adjust the actuator speed if possible, or change control signal.

Figure 3. Slurry Service or Sedimentation

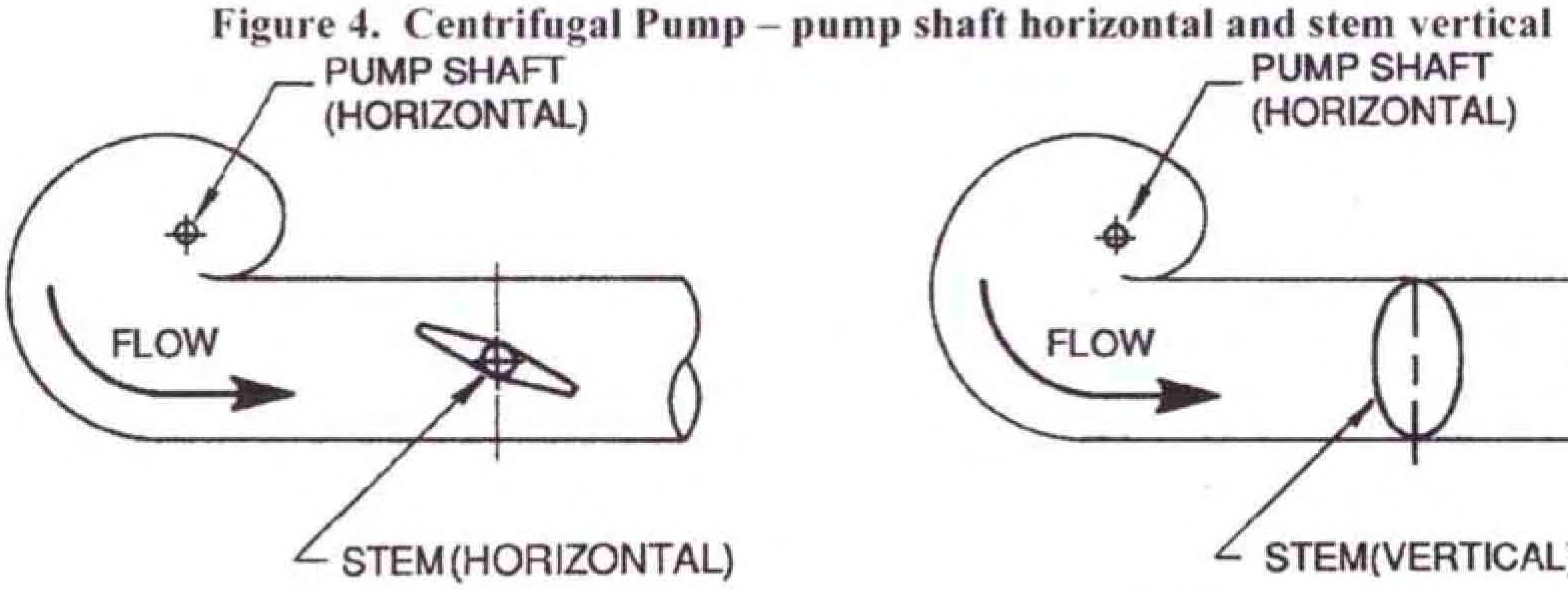


Incorrect Installation *Correct Installation*

Butterfly Valves Located at the Discharge of a Pump

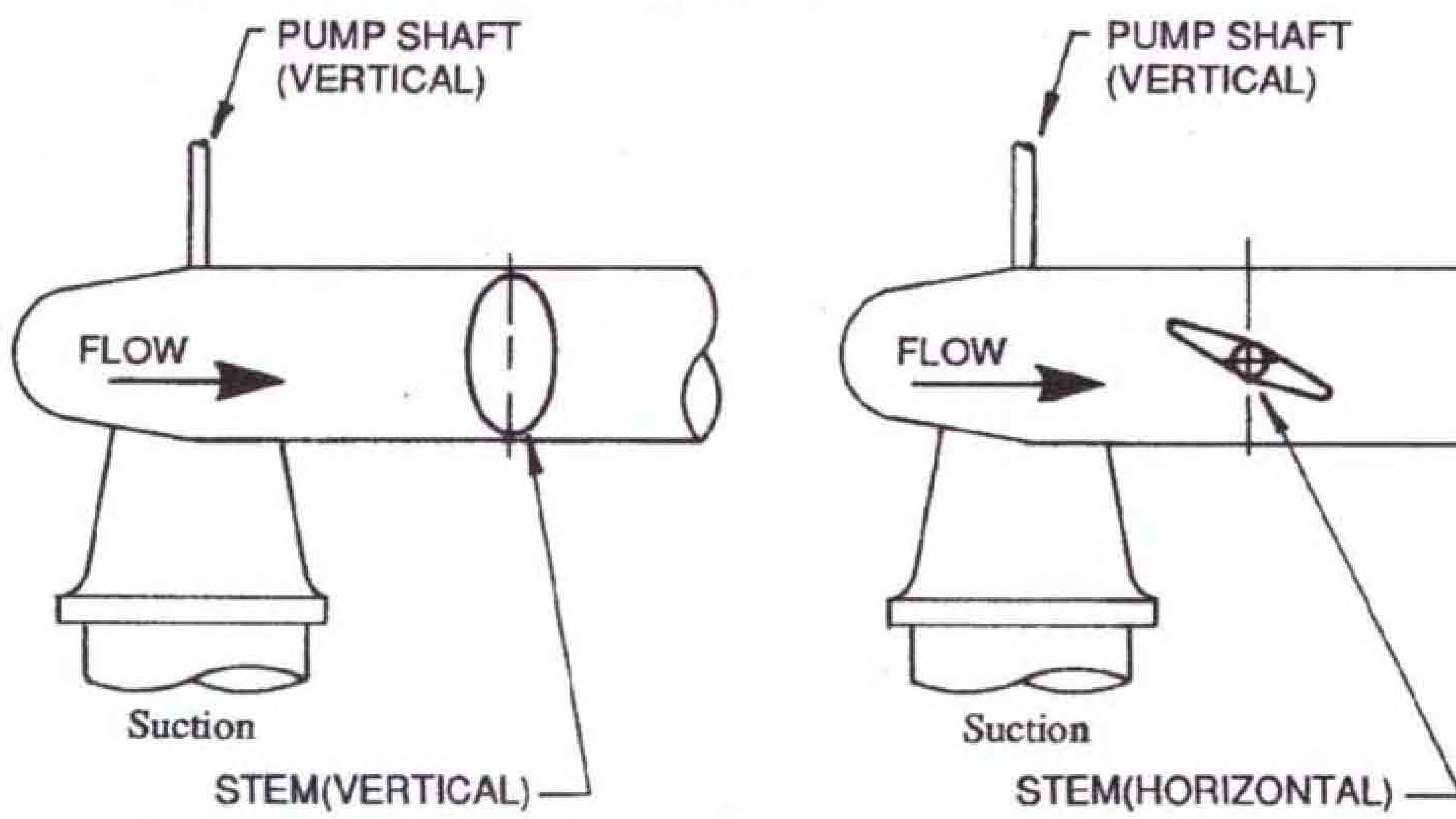
(See Page 2 for distance between pump and valve)

Figure 4. Centrifugal Pump – pump shaft horizontal and stem vertical



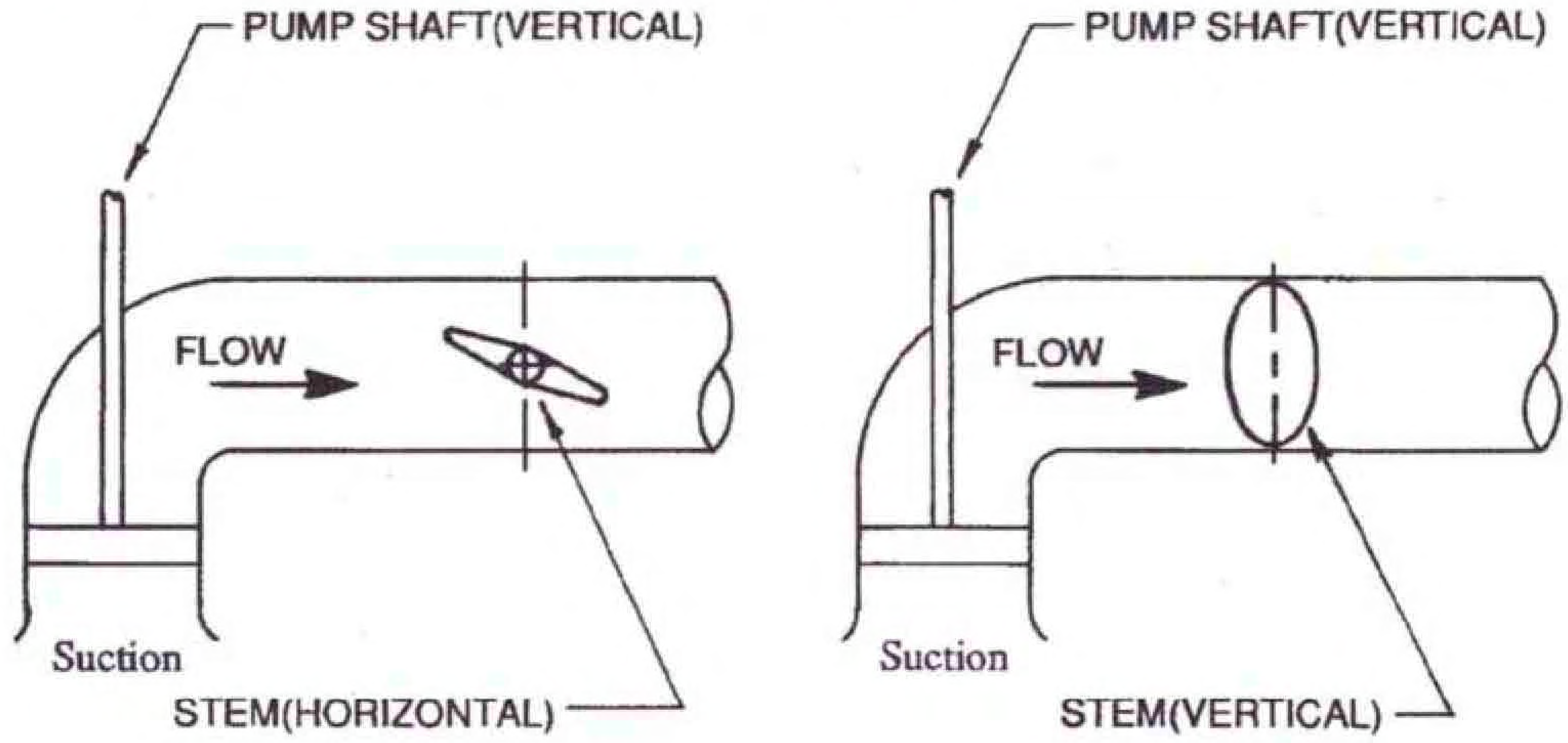
Incorrect Installation *Correct Installation*

Figure 5. Centrifugal Pump – pump shaft vertical and stem horizontal



Incorrect Installation *Correct Installation*

Figure 6. Axial Pump – pump shaft vertical and stem vertical



Incorrect Installation *Correct Installation*

Butterfly Valves Located Downstream of a Bend or Pipe Reducer

(See Page 2 for distance between bend/tee and valve)

Incorrect Installation *Correct Installation*

Figure 7. Bend

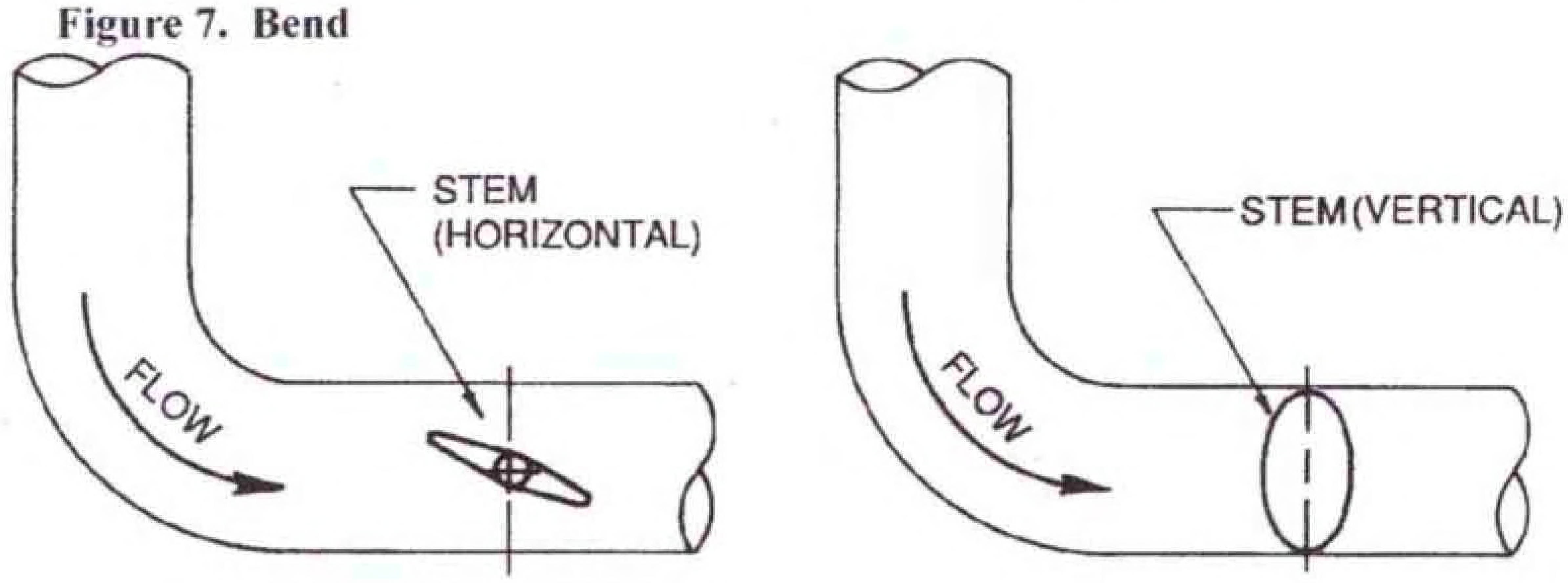


Figure 8. Tee

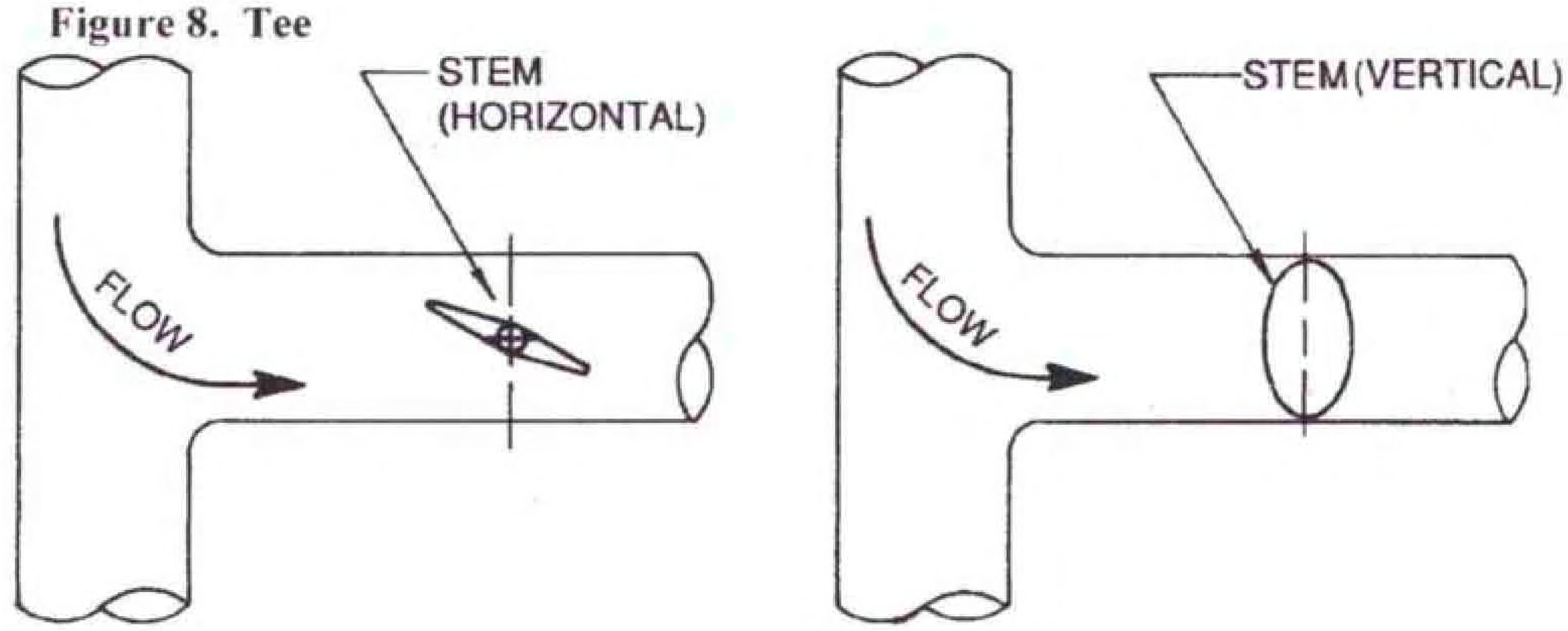
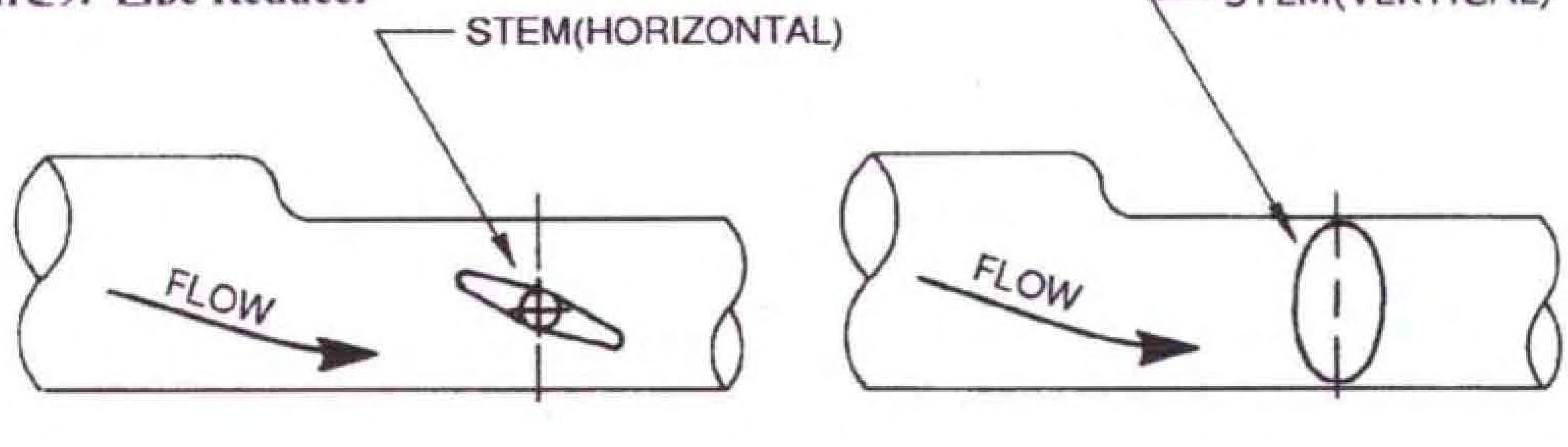


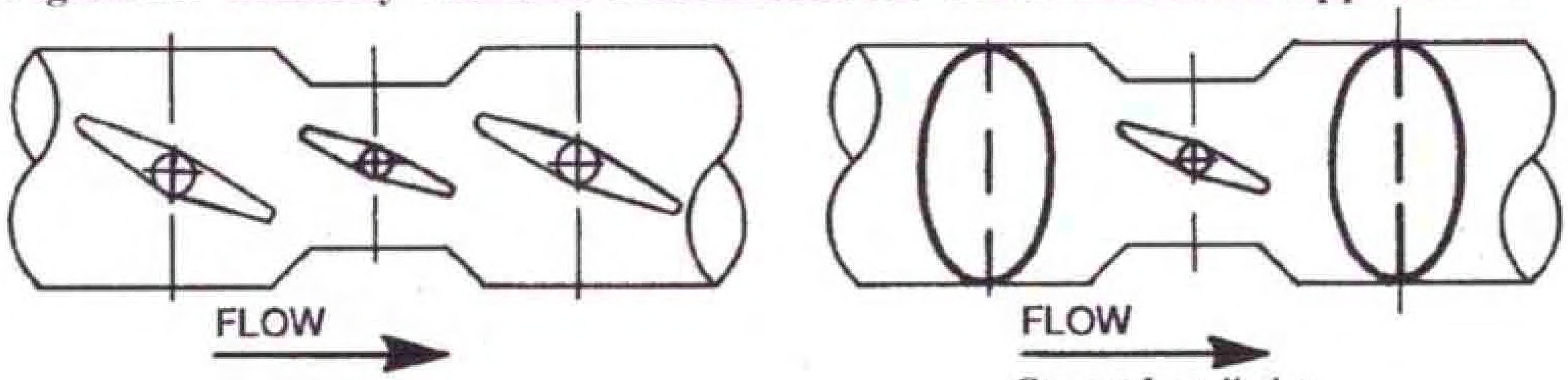
Figure 9. Pipe Reducer



Incorrect Installation

Correct Installation

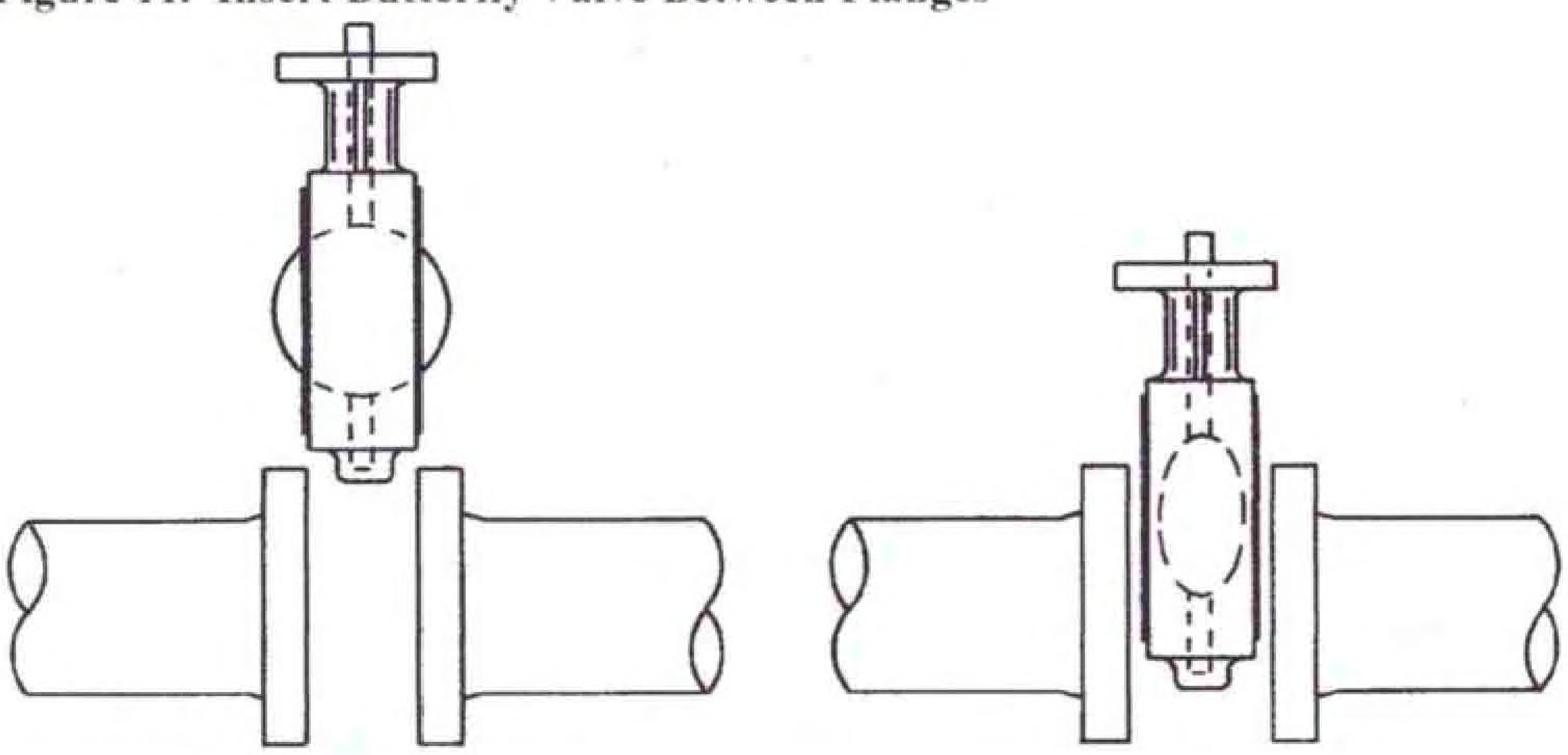
Figure 10. Butterfly Valves in Combination for Control/Isolation Applications



Incorrect Installation
Combination with all valve stems in the same direction accelerates possible noise, vibration, & erosion problems.

Correct Installation
Combination with the stem of the control valve at right angle to those of other valves tends to cancel the drift of the fluid, and reduces noises, vibration, and erosion.

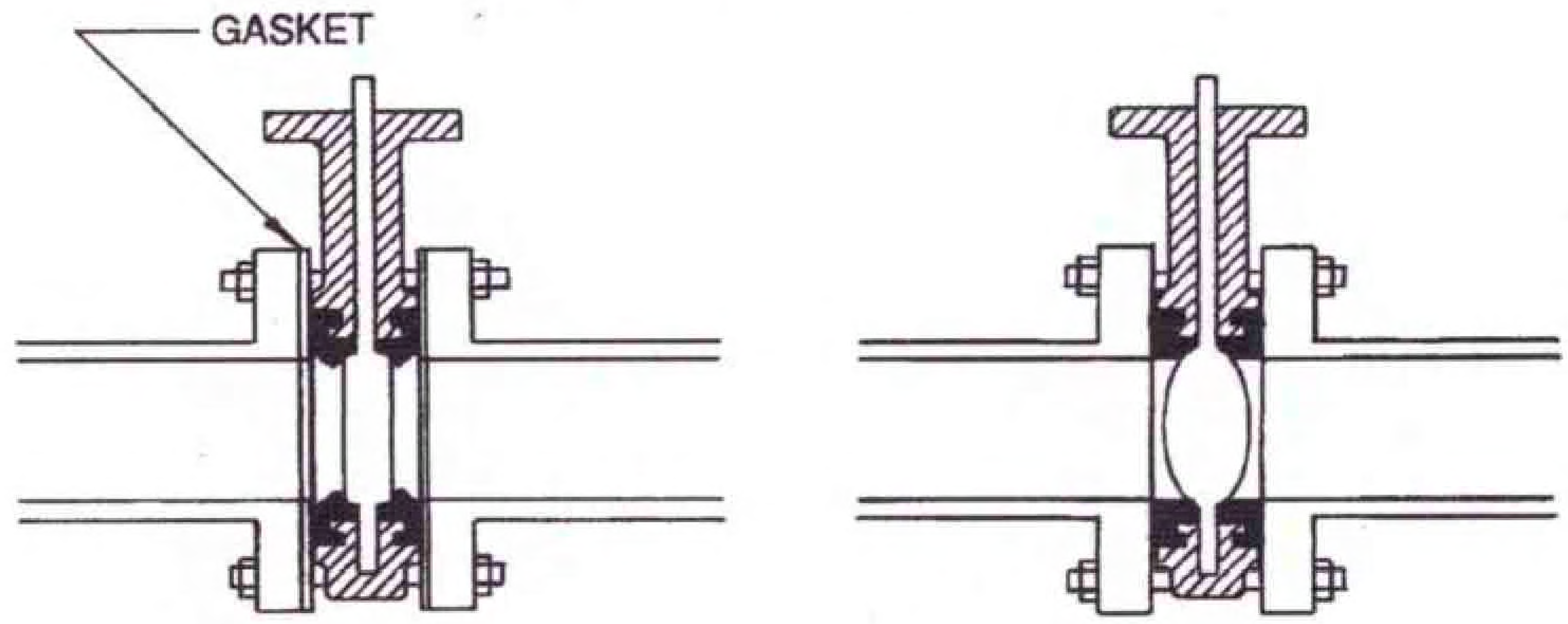
Figure 11. Insert Butterfly Valve Between Flanges



Incorrect Installation
Pipe not spread, disc opened beyond valve body face; Results: Disc edge damaged when it hits pipe flange.

Correct Installation
Pipe spread & aligned, disc rotated; Results: No undesirable beginning seating/unseating torque, disc edge protected.

Figure 12. Initial Centering & Flanging of Valve



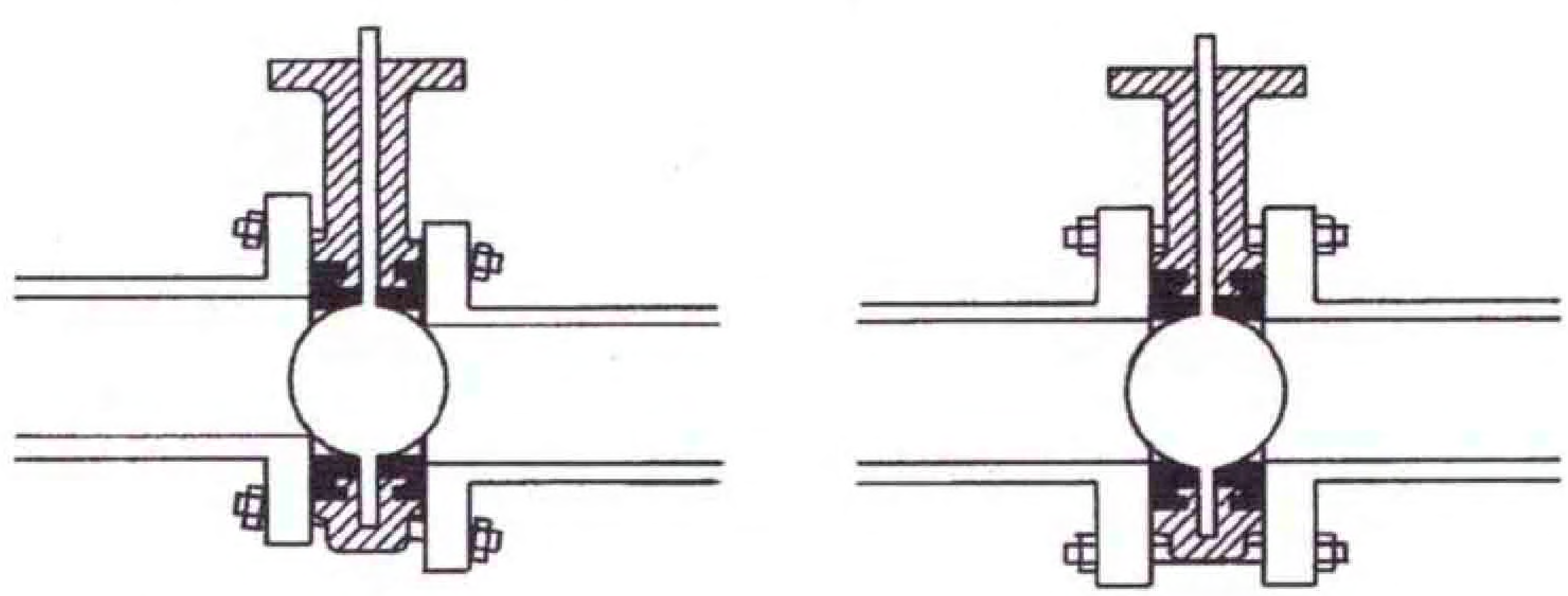
Incorrect Installation

Disc in closed position; gaskets used; Results: Seat distorted and over-compressed causing high initial unseating torque problems.

Correct Installation

Bolts spanned, disc edge within body face-to-face, no flange gaskets; Results: No disc edge damage, proper sealing allowed.

Figure 13. Final Aligning & Tightening of Flange Bolts



Incorrect Installation

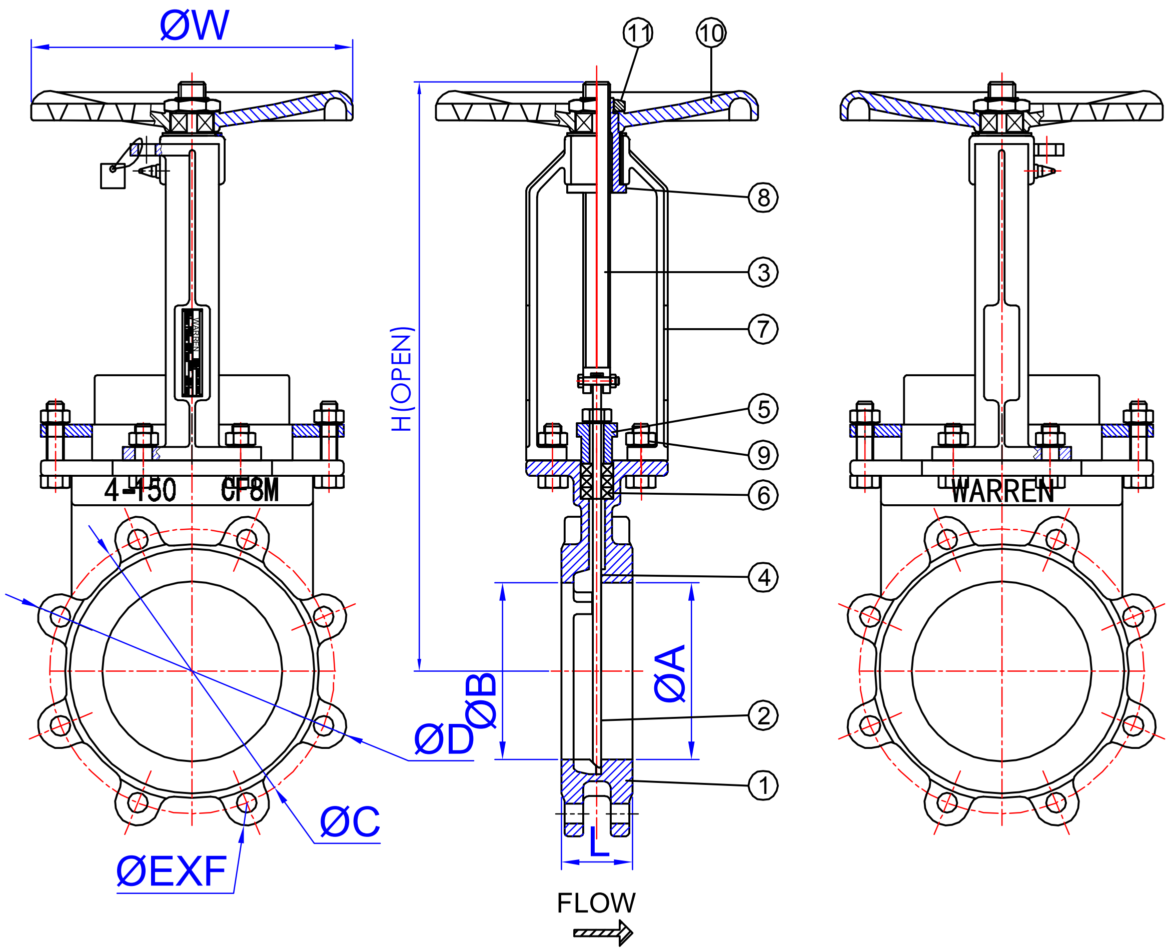
Piping misaligned; Results: Disc O.D. strikes pipe I.D. causing disc edge damage, increased torque and leakage. Seat face o-rings seal improperly without engagement.

Correct Installation

Piping aligned properly when bolts tightened, disc in full open position; Results: disc clears adjacent pipe I.D., seat face seals properly, no excessive initial torque.

Fig No:WARREN -4156

NPS	L	A	B	øC	øD	øW	H	E"unc	F	N.W LB	CV gallon/min	Torque in-lb
2"	1.88	2.0	2.0	4.75	5.98	7.5	13.1	5/8"	4	17	298	35.72
2-1/2"	2.0	2.5	2.5	5.50	7.01	7.5	15.2	5/8"	4	19	466	44.65
3"	2.0	3.0	3.0	6.00	7.48	7.5	16.1	5/8"	4	21	694	44.65
4"	2.0	4.0	4.0	7.50	9.02	8.7	20.0	5/8"	8	29	1234	62.51
5"	2.25	4.7	4.7	8.50	10.0	11.4	23.0	3/4"	8	38	2053	71.44
6"	2.25	6.0	6.0	9.50	10.98	11.4	26.7	3/4"	8	52	2873	89.3
8"	2.75	8.0	8.0	11.75	13.50	13.8	33.4	3/4"	8	78	5109	133.95
10"	2.75	10.0	10.0	14.25	15.98	13.8	41.6	7/8"	12	118	8622	196.46
12"	3.0	12.0	12.0	17.00	19.02	15.7	47.2	7/8"	12	164	12416	205.39
14"	3.0	13.25	13.25	18.7	20.98	15.7	48.4	1"	12	222	17651	250.04
16"	3.5	15.25	15.25	21.2	23.50	19.7	55.9	1"	16	337	23055	285.76
18"	3.5	16.9	16.9	22.7	25.0	19.7	63.0	1-1/8"	16	440	30603	357.2
20"	4.5	18.9	18.9	25	27.48	19.7	67.0	1-1/8"	20	594	37782	482.22
24"	4.5	22.6	22.6	29.5	28.63	19.7	77.6	1-1/4"	20	836	57349	660.82



MSS-SP81 TEST STANDARD:
BODY TEST : 156PSI (WATER)
SEAT TEST : 40PSI (WATER)
LEAKAGE : 40 cc/in.min.

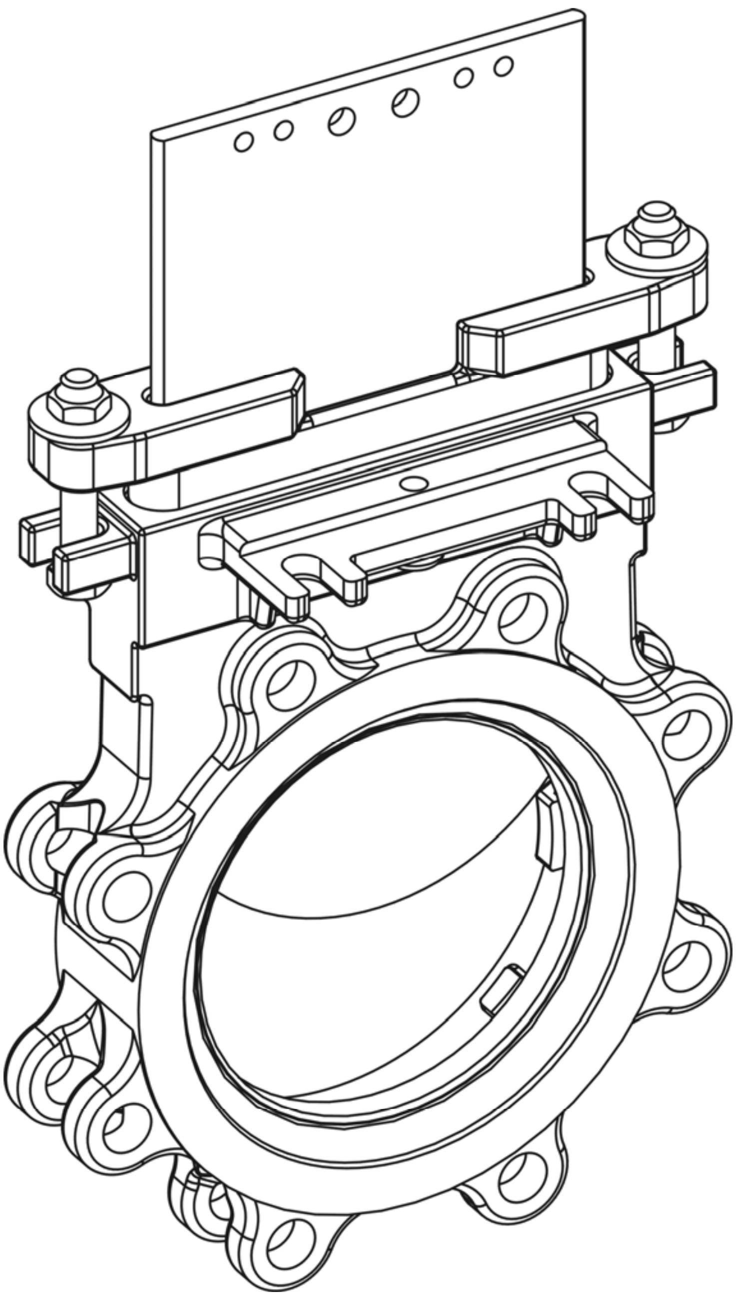
11	NUT	SS41+Zn	01
10	HAND WHEEL	CAST IRON	01
9	BOLT NUT	SUS304	04
8	YOKE SLEEVE	BRONZE	01
7	YOKE	ASTM A351-CF8	01
6	GLAND PACKING	TEFLON	01SET
5	GLAND	ASTM A351-CF8	01
4	SEAT	ASTM A351-CF8M	01
3	STEM	A276-304	01
2	PLATE	AISI 316	01
1	BODY	ASTM A351-CF8M	01
NO.	SUBJECT	MATERIAL	QTY

warren Valve

	APPROVED BY.	CHECK BY.	DRAWN BY.	DRAWING NO.	MATERIAL	UNIT	DESCRIPTION
SIGN	C.C.M	W.S.L	H.Y.S	WARREN-4156	CF8M	inch	MANUAL TYPE KNIFE GATE VALVE CLASS 150LB
DATE	10.19.11	10.19.11	10.18.11	REVISION 1	SCALE	FREE	

DeZURIK

2-24” KGC Knife Gate Valves



Instruction D10411
September 2011

Instructions

These instructions are intended for personnel who are responsible for the installation, operation and maintenance of your KGC knife gate valve.

Safety Messages

All safety messages in the instructions are flagged with the word Caution, Warning or Danger. These messages must be followed exactly to avoid equipment damage, personal injury or death.

Safety label(s) on the product indicate hazards that can cause equipment damage, personal injury or death. If a safety label becomes difficult to see, or if a label has been removed, please contact DeZURIK for replacement.

WARNING
Personnel involved in the installation or maintenance of valves should be constantly alert to potential emission of process material and take appropriate safety precautions. Always wear suitable protection when dealing with hazardous process materials. Handle valves which have been removed from service with the assumption of process material within the valve.

Inspection

Your KGC knife gate valve has been packaged to provide protection during shipment. Carefully inspect the unit for damage upon arrival and file a claim with the carrier if damage is apparent.

Parts

Recommended spare parts are listed on the assembly drawing. These parts should be stocked to minimize downtime.

Order parts from your DeZURIK sales representative, or directly from DeZURIK. When ordering parts, please include the 7-digit part number and 4-digit revision number (example: **9999999R000**) located on the data plate attached to the valve assembly. Also include the part name, the assembly drawing number, the balloon number and the quantity stated on the assembly drawing.

DeZURIK Service

DeZURIK Service personnel are available to install, maintain and repair all DeZURIK products. DeZURIK also offers customized training programs and consultation services. For more information, contact your local DeZURIK representative or visit our website at www.dezurik.com.

Table of Contents

Description

KGC knife gate valves have a stainless steel body and gate, and an all-metal or resilient-faced seat. The KGC knife gate valve is available in 2-36" sizes with 150 CWP. A choice of several actuators and accessories is available.

Installation

Install the valve between ANSI Class 125 or Class 150 pipeline flanges. Flange gaskets are required. Before installation, remove foreign material such as weld spatter, oil, grease, and dirt from the valve and pipeline.

Install the valve so that the side marked "SEAT" is on the lower pressure side of the valve when the valve is closed; the pipeline pressure will then help seal the valve in the closed position.

Observe the following points to prevent distortion of the valve body and gate when the flange bolts are tightened:

- Align the mating pipeline flanges.
- Select the length of the flange bolts so that the bolts used in the blind holes near the chest area of the valve do not bottom out when tightened. We recommend using studs with nuts in the blind holes.
- Tighten the flange bolts evenly, in a crisscross pattern. Refer to Table A for recommended flange bolt/stud torques.

Note: Torque ranges are based on ASME Pressure Vessel Code Calculations and lab test data. These torques are only for the listed gasket types. For other gasket types listed in ASME, consult DeZURIK.

After installing the valve, pressurize pipeline and ensure the packing is not leaking. If the packing leaks, adjust the packing as described on the next page.

Table A: Recommended Flange Bolt/Stud Torque Range in ft-lbs (non-lubricated)

Valve Size	ASME Gasket Types	
	Rubber with Soft Fabric Filler, and 1/8" Thick Hard	Soft Elastomer Gasket Shore Durometer < 75A
2	26 - 29	8 - 9
3	37 - 41	14 - 16
4	26 - 29	11 - 12
6	41 - 45	22 - 24
8	55 - 61	35 - 39
10	56 - 62	40 - 44
12	80 - 88	59 - 65
14	107 - 118	81 - 89
16	103 - 114	79 - 87
18	128 - 141	102 - 112
20	123 - 136	99 - 109
24	188 - 207	155 - 171

Operation

The gate in the valve is positioned by the valve actuator. The actuator moves the gate over the valve port in the closed position, and withdraws the gate from the seat in the open position. Refer to the Actuator Instructions for adjustment and maintenance requirements for the actuator.

Lubrication

The valve does not require lubrication. Refer to the Actuator Instructions for lubrication requirements for the actuator.

Packing

The gate packing is contained and compressed by the packing gland. See Figure 1 for component identification (Page 6).

Note: The packing gland is slightly loosened prior to shipping. This is done to increase the life of the packing during extended storage.

Adjustment

If packing leaks, tighten the adjustment nuts on top of the packing gland. Tighten the nuts evenly and gently -just enough to stop the leak. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Drawings

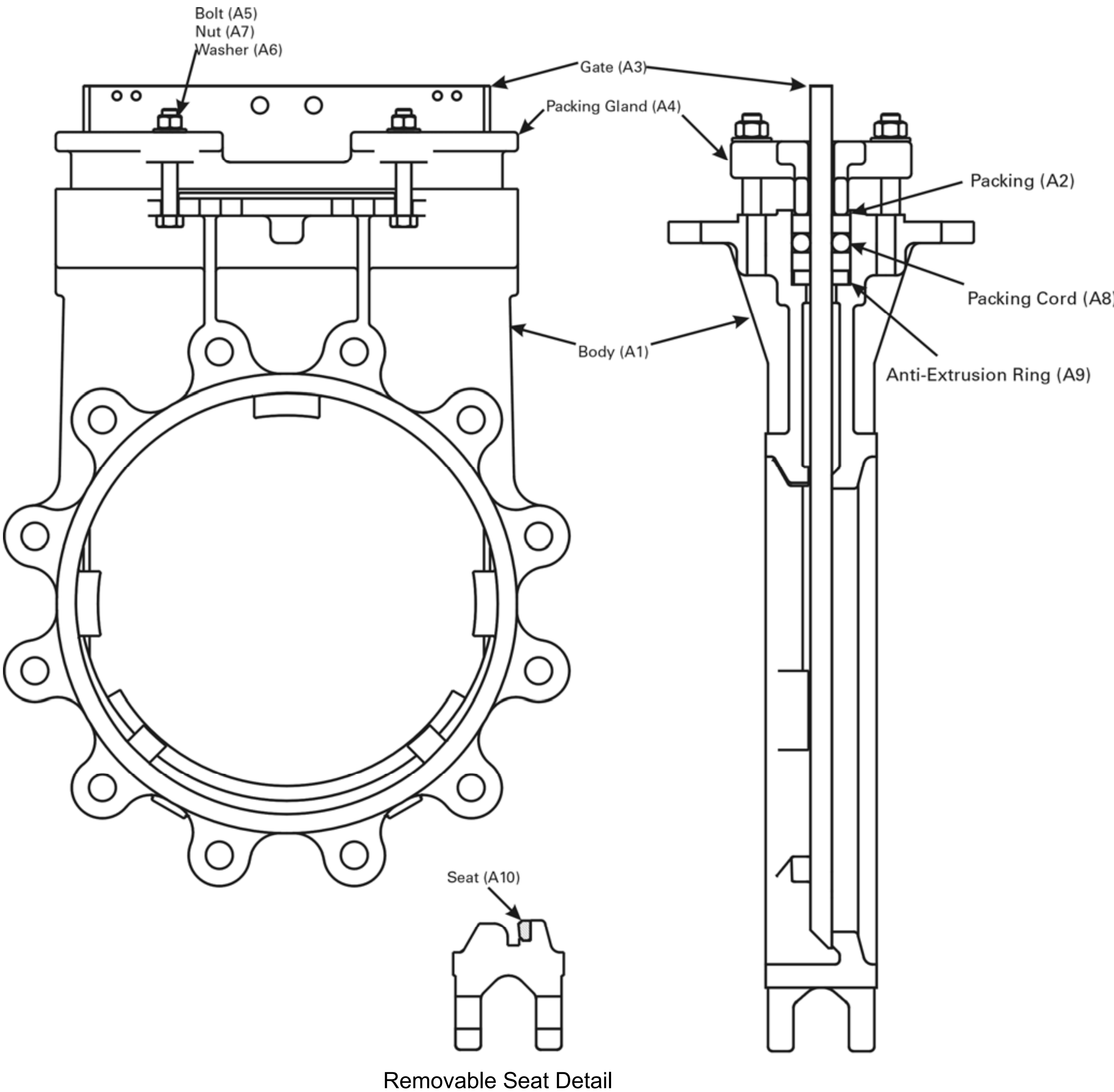


Figure 1—Component Identification

Packing Replacement

Removing the Old Packing

WARNING!
Pipeline pressure can cause personal injury or equipment damage. Relieve pipeline pressure before removing gate stem and packing gland nuts.

1. Relieve the pressure in the pipeline and close the valve.

WARNING!
Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. If the actuator is powered, disconnect and lock out power to prevent accidental operation of the actuator.
3. Remove the two screws and nuts near the top of the gate and disengage the stem from the gate by stroking the actuator (not the valve) to the open position.
4. Remove the gland nuts (A7), bolts (A5) and packing gland (A4).
5. Remove the used packing (A2) and anti-extrusion plates (A8) from the packing chamber.

Installing the New Packing

Packing (A2) strip length and quantity are shown in Table B. Ensure the inside and outside edges of each ring are packed against the gate and packing chamber, so that each strip is compressed flat and evenly.

Do not compress the packing any more than needed to stop leaks.

1. Ensure the gate (A3) is fully closed and centered in the body before packing.

2. If used, place the anti-extrusion ring (A9) or scraper ring in the bottom of the packing chamber.

Note: Ensure that the anti-extrusion ring fits tightly around the gate and that there is approximately *1/32-1/16"* clearance around the packing chamber.

3. Assemble and pack the rings one at a time, with the ends together, but not overlapped

Note: Stagger the joints, on the long side of the packing chamber. For packing rings, we recommend using a square-ended wood or plastic tool, driven by a hammer or mallet. Do not use a sharp tool to pack the rings.

4. For packing systems with the packing cord (A8), assemble and pack one row of packing (A2) and then insert the packing cord (A8). Assemble and pack the last row of packing. See detail below:

Table B: Packing Ring and Packing Cord Length and Quantity

Valve Size	Square Size	Length, inches	Quantity	Qty Cord
2	3/8”	7.50	4 w/o anti -ext ring or cord	1
3		9.50		
4		11.50		
5		13.50		
6		15.50		
8		20.00		
10	1/2”	25.00	3 w/o cord	
12		29.00		
14		32.00		
16		36.75		
18	5/8”	41.25	2 with cord	
20		45.25		
24		53.50		

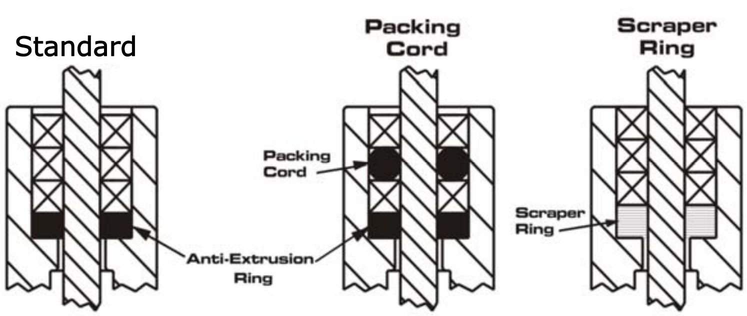


Figure 2—Packing Ring Detail

For all packing types, push excess packing toward the side opposite the seat.

Reassembling Valve

1. Replace the packing gland (A4), bolts (A5) and nuts (A6). Tighten the nuts evenly and finger tight, plus 1/2 turn.
2. Reconnect the stem to the gate with the two screws and nuts.
3. If the actuator is a powered actuator, reconnect power to the actuator.
4. Pressurize the pipeline and inspect packing for leakage.
5. If packing leaks, tighten the adjustment nuts on top of the packing gland. Tighten the nuts evenly and gently - just enough to stop the leak. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Replacing the Seat

See Figure 1 for component identification.

WARNING!
Pipeline pressure can cause personal injury or equipment damage. Relieve pipeline pressure before removing gate stem and packing gland nuts.

1. Relieve the pressure in the pipeline and close the valve.

WARNING!
Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. If the actuator is powered, disconnect and lock out power to prevent accidental operation of the actuator.
3. Remove the two screws and nuts near the top of the gate and disengage the stem from the gate.
4. Remove the pipeline flange bolts and flange from the side of the valve body opposite the word “seat”. As an alternative, remove both flanges, and remove the valve from the pipeline.
5. Remove the actuator yoke and actuator from the valve.
6. Remove the gland nuts (A7), washers (A6), and packing gland (A4).
7. Remove the gate (A3) from the body.
8. Remove the packing (A2) from the packing chamber.

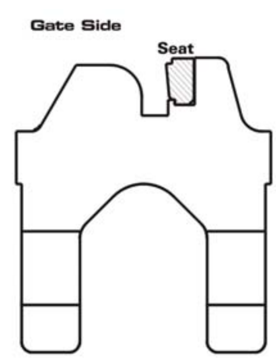


Figure 3—Seat

9. Remove the seat. Push the top of the removable seat (A10) toward the center of the valve, and remove the seat through the packing chamber.
10. Install the new replaceable seat:
    a. Note the gate side and body side of the seat as shown in Figure 3.
    b. Insert the new seat (A10) through the packing chamber.
    c. Place the seat behind the lug at the 5 and 7 o‘clock positions in the body. Then push the top of the seat into position.

Seat Replacement ***Continued***

Reassembling the Valve

1. Reassemble the gate (A3) in the body, with the beveled edge facing away from the resilient seat. See Figure 3.
2. Place the gate in the fully closed position.
3. Reassemble the packing, as described in “Installing New Packing”.
4. Reassemble the packing gland (A4), washers (A6), nuts (A7) and bolts (A5). Tighten the nuts evenly and finger tight, plus 1/2 turn.
5. Reassemble the yoke and actuator on the valve.
6. Reconnect the stem to the gate with the two screws and locknuts.
7. Reassemble the pipeline flange and flange bolts, or reassemble the valve in the pipeline if the valve was removed. Refer to the requirements in the “Installation” section.
8. If the actuator is a powered actuator, reconnect power to the actuator.
9. Pressurize the pipeline and inspect the valve for leaks.
10. If the packing leaks, tighten the adjustment nuts (A7) on top of the packing gland. Tighten the nuts evenly and slowly, just enough to stop the leakage. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Replacing the Gate

See Figure 1 for component identification (Page 5).

WARNING!
Pipeline pressure can cause personal injury or equipment damage. Relieve pipeline pressure before removing gate stem and packing gland nuts.

1. Relieve the pressure in the pipeline and close the valve.

WARNING!
Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. If the actuator is powered, disconnect and lock out power to prevent accidental operation of the actuator.
3. Remove the pipeline flange bolts, and remove the valve from the pipeline.
4. Remove the actuator, actuator yoke, packing gland (A4), and packing (A2) from the valve.
5. Remove and inspect the gate (A3). If the gate appears to be scratched or galled due to too-long flange bolts in the chest area of the body, check for body damage in the tapped flange holes and within the chest cavity. Carefully check the seat for damage. Repair or replace the body, as appropriate.

Gate Replacement ***Continued***

8. Remove and inspect the seat components.
9. Replace or reinstall the seat components as described in step 10 in the "Seat Replacement " section.
10. Place the new gate (A3) in the body, in the fully closed position.
11. Replace or reinstall the packing (A2) as described in "Installing New Packing".
12. Replace the yoke and actuator on the valve.
13. Adjust the actuator, yoke, and packing gland so that the valve actuates smoothly full stroke in both directions, and so that there is no evidence of binding or scratching on the gate when the gate is visible in the fully open position.
14. Reinstall the valve in the pipe line —see "Installation" section.
15. If the actuator is a powered actuator, reconnect power to the actuator.
16. Pressurize the pipeline and inspect the valve for leaks.
17. If the packing leaks, tighten the adjustment nuts (A7) on top of the packing gland.

Note: Tighten the nuts evenly and slowly, just enough to stop the leakage. Over tightening will cause excessive operating forces, and will decrease the life of the packing.

Purge Port Option

When purge port options are ordered as illustrated, the intent is that the installer will connect purge lines.

WARNING!
If pipeline is under pressure with purge port plugs in place, release line pressure before removing plugs. Serious or fatal injury may occur if not complied with.

Installation:
1. Remove all purge plugs after valve has been installed in line and before line is pressurized.
2. Connect proper purge line to the ports.
3. Pressurize purge lines and check for leaks.
4. Pressurize pipe line.

See Figure 4 for Purge Port sizes and locations.

Purge Port Options

VALVE SIZE INCH	VALVE SIZE MM	A
2	50	1/4
3	80	1/4
4	100	1/4
5	125	1/4
6	150	3/8
8	200	3/8
10	250	3/8
12	300	3/8
14	350	1/2
16	400	1/2
18	450	3/4
20	500	3/4
24	600	3/4

NOTE:

1. VALVE TO HAVE PURGE CONNECTIONS IN THIS AREA WHEN ORDERED BY CATALOG CHARACTERISTIC PCA OR PSC
2. VALVE TO HAVE PURGE CONNECTIONS IN THIS AREA WHEN ORDERED BY CATALOG CHARACTERISTIC PSA OR PSC

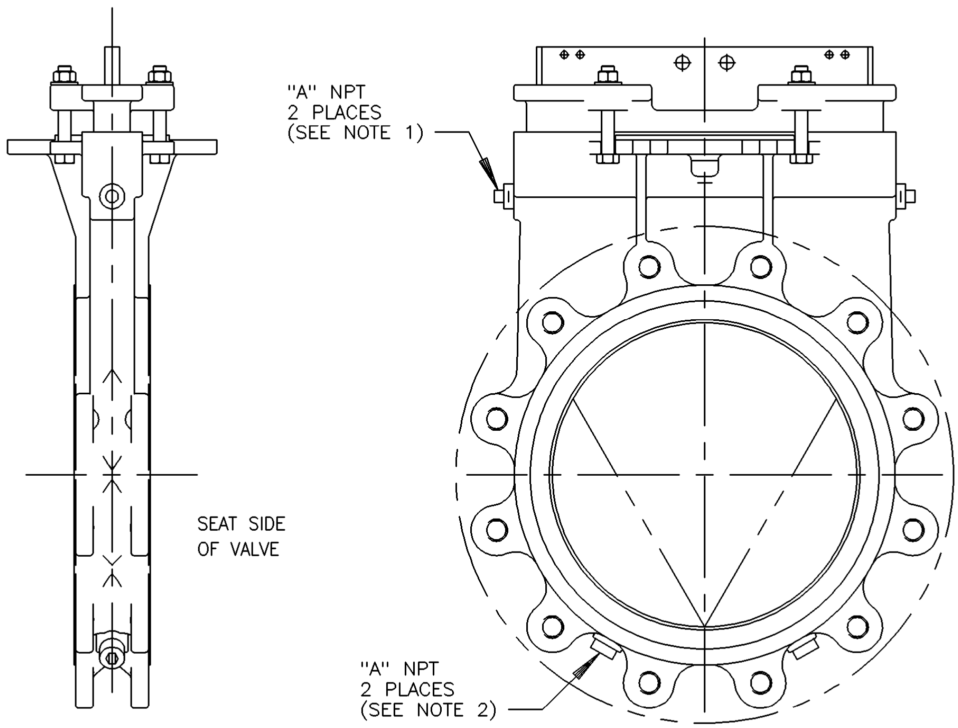


Figure 4—Purge Port Sizes and Locations

Troubleshooting

Condition	Possible Causes	Corrective Action
Packing leaks, with no evidence of galling on gate	Packing is loose	Adjust packing gland
	Packing is worn or torn	Replace packing
Packing leaks and gate is galled	Packing is worn or torn	Replace packing and gate, check seat for damage
Valve leaks when fully closed, with no evidence of galling on gate	Seat is worn or torn	Replace seat
Valve leaks when fully closed and gate is galled	Seat is worn or torn	Replace gate and seat

Guarantee

Products, auxiliaries and parts thereof of DeZURIK Canada, Inc. manufacture are warranted to the original purchaser for a period of twenty-four (24) months from date of shipment from factory, against defective workmanship and material, but only if properly installed, operated and serviced in accordance with DeZURIK Canada, Inc. recommendations. Repair or replacement, at our option, for items of DeZURIK Canada, Inc. manufacture will be made free of charge, (FOB) our facility with removal, transportation and installation at your cost, if proved to be defective within such time, and this is your sole remedy with respect to such products. Equipment or parts manufactured by others but furnished by DeZURIK Canada, Inc. will be repaired or replaced, but only to the extent provided in and honored by the original manufacturers warranty to DeZURIK Canada, Inc., in each case subject to the limitations contained therein. No claim for transportation, labor or special or consequential damages or any other loss, cost or damage shall be allowed. You shall be solely responsible for determining suitability for use and in no event shall DeZURIK Canada, Inc. be liable in this respect. DeZURIK Canada, Inc. does not guarantee resistance to corrosion, erosion, abrasion or other sources of failure, nor does DeZURIK Canada, Inc. guarantee a minimum length of service. Your failure to give written notice to us of any alleged defect under this warranty within twenty (20) days of its discovery, or attempts by someone other than DeZURIK Canada, Inc. or its authorized representatives to remedy the alleged defects therein, or failure to return product or parts for repair or replacement as herein provided, or failure to install and operate said products and parts according to instructions furnished by DeZURIK Canada, Inc., or misuse, modification, abuse or alteration of such product, accident, fire, flood or other Act of God, or failure to pay entire contract price when due shall be a waiver by you of all rights under this warranty.

The foregoing guarantee shall be null and void if, after shipment from our factory, the item is modified in any way or a component of another manufacturer, such as but not limited to, an actuator is attached to the item by anyone other than DeZURIK Canada, Inc. Factory Service personnel. All orders accepted shall be deemed accepted subject to this limited warranty, which shall be exclusive of any other or previous Warranty, and this shall be the only effective guarantee or warranty binding on DeZURIK Canada, Inc., despite anything to the contrary contained in the purchase order or represented by any agent or employee of DeZURIK Canada, Inc., in writing or otherwise, notwithstanding, including but not limited to implied warranties.

THE FOREGOING REPAIR AND REPLACEMENT OBLIGATIONS ARE IN LIEU OF ALL OTHER WARRANTIES, OBLIGATIONS AND LIABILITIES, INCLUDING ALL WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR OF MERCHANTABILITY OR OTHERWISE, EXPRESSED OR IMPLIED IN FACT OR BY LAW, AND STATE DEZURIK CANADA, INC.'S ENTIRE AND EXCLUSIVE LIABILITY AND YOUR EXCLUSIVE REMEDY FOR ANY CLAIM IN CONNECTION WITH THE SALE AND FURNISHING OF SERVICES, GOODS OR PARTS, THEIR DESIGN, SUITABILITY FOR USE, INSTALLATION OR OPERATIONS.

Limitation of liability

LIMITATION OF LIABILITY: IN NO EVENT SHALL DEZURIK CANADA, INC. BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES WHATSOEVER, AND DEZURIK CANADA, INC.'S LIABILITY, UNDER NO CIRCUMSTANCES, WILL EXCEED THE CONTRACT PRICE FOR THE GOODS AND/OR SERVICES FOR WHICH LIABILITY IS CLAIMED. ANY ACTION BY YOU FOR BREACH OF CONTRACT MUST BE COMMENCED WITHIN 12 MONTHS AFTER THE DATE OF SALE.

Sales and Service

For information about our worldwide locations, approvals, certifications and local representative:
Web site: www.dezurik.com E-Mail: info@dezurik.com

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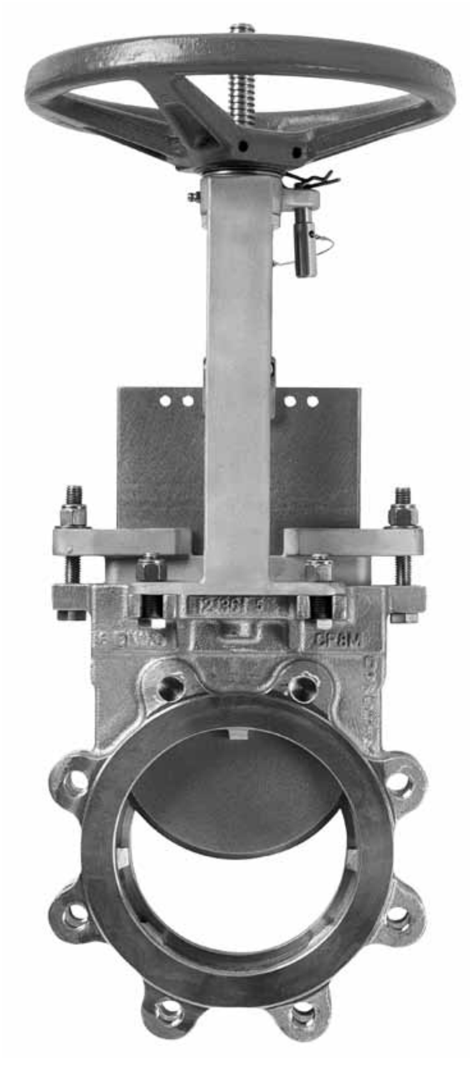
Printed in CANADA

BULLETIN 35.00-1B
MAY 2013

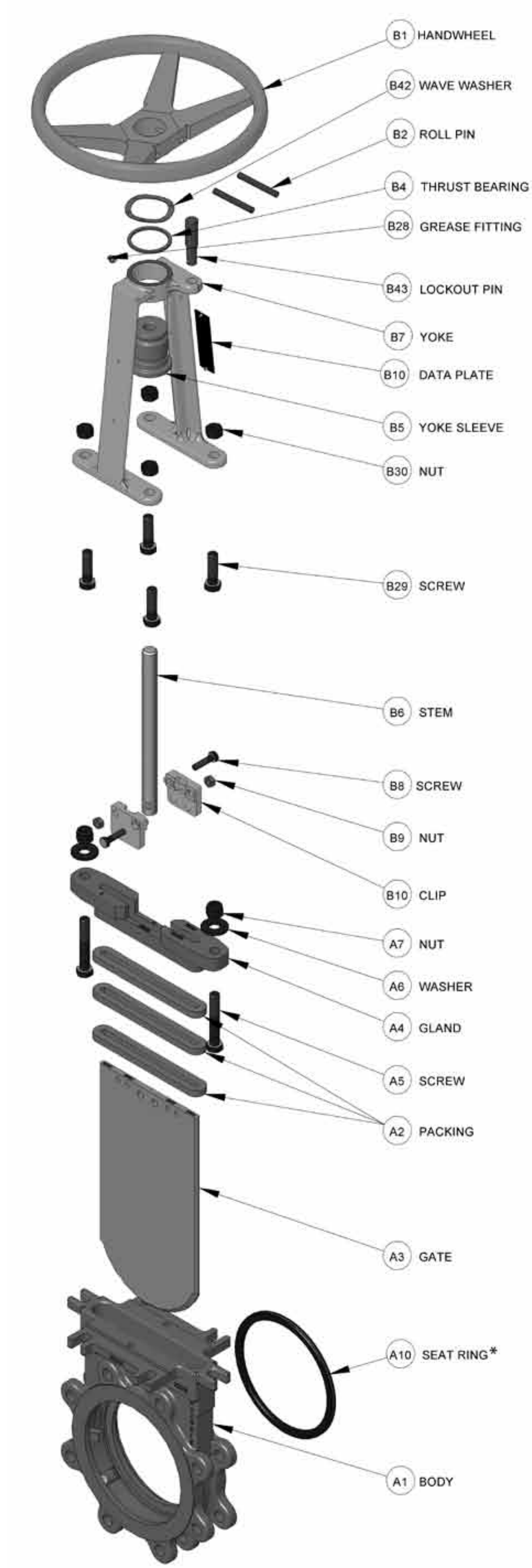
DeZURIK
APCO | HILTON

DeZURIK KGC-HD HEAVY DUTY CAST STAINLESS STEEL KNIFE GATE VALVES TECHNICAL SPECIFICATIONS



Materials of Construction

Item	Description	Material
A1	Body	304 Stainless Steel, ASTM A351 CF8
		316 Stainless Steel, ASTM A351 CF8M
		317 Stainless Steel, ASTM A351 CG8M
		254-SMO Stainless Steel, ASTM A351 CK3MCuN
		2205 Duplex Stainless Steel, ASTM A890 CD3MN
		Hastelloy C 276, ASTM A494 CW12MW
A2	Packing	SMP - PTFE Braided Packing to 500°F (260°C) (pH Range 0-14)
		TDP - Dry Service, Dry PTFE Braided Packing with Solid PTFE Cord to 500°F (260°C) (pH Range: 0-14)
		HTP - High Temperature Braided Packing to 650°F (343°C) (pH Range: 1-12)
		HMP - High Temperature Braided Packing with Metal Scraper Ring to 1000°F (540°C) (pH Range: 3-10)
		FGP - Food Grade Service to 450°F (232°C) (pH Range: 3-11)
A3	Gate	304 Stainless Steel, ASTM A240
		316 Stainless Steel, ASTM A240
		317 Stainless Steel, ASTM A240
		17-4 Stainless Steel H900 Heat Treated, ASTM A564
		254 - SMO Stainless Steel, ASTM A240
		2205 Duplex Stainless Steel, ASTM A276
		Hastelloy C 276, ASTM B574
		410 Stainless Steel, ASTM A240
A4	Gland	Matches Body Material
A5	Screw	304 Stainless Steel
A6	Washer	304 Stainless Steel
A7	Nut	304 Stainless Steel
A10	Seat Ring*	CR - Chloroprene to 180°F (83°C)
		NBR - Acrylonitrile-Butadiene to 180°F (83°C)
		EPDM - Terpolymer of Ethylene, Propylene and a Diene to 250°F (122°C)
		FKM - Fluoro Rubber to 400°F (204°C)
		17-4 PH Stainless Steel H900 Heat Treated
		CRW - Chloroprene, Off White to 140°F (60°C)
		PTFE - Polytetrafluoroethylene, white to 450°F (230°C)
		Reinforced PTFE - Polytetrafluoroethylene, to 500°F (260°C)
B1	Handwheel	Painted, Cast Iron
B2	Roll Pin	Carbon Steel or 420 Stainless Steel
B4	Thrust Bearing	Oil Impregnated Bronze
B5	Yoke Sleeve	Aluminum Bronze
B6	Stem	304 Stainless Steel
B7	Yoke	Cast Steel or 304 Stainless Steel
B8	Screw	Zinc Plated Steel or 18-8 Stainless Steel
B9	Nut	Zinc Plated Steel or 18-8 Stainless Steel
B10	Clip	304 Stainless Steel
B23	Data Plate	316 Stainless Steel
B28	Grease Fitting	Zinc Plated Steel
B29	Screw	Zinc Plated Steel or 18-8 Stainless Steel
B30	Nut	Zinc Plated Steel or 18-8 Stainless Steel
B42	Wave Washer	304 Stainless Steel
B43	Lockout Pin	304 Stainless Steel



*The replaceable Seat Ring is standard on resilient-seated valves and optional on metal-seated valves.The standard integral metal seat matches the body material.

Valve Selection
Shut-Off Capabilities

Resilient Seats	Leak tight/drip tight
Metal Seats	Meet MSS SP-81 and TAPPI TIS 405-8

Pressure Ratings

2-48" (50-1200mm)	150 psi C.W.P. (1030 kPa)
Optional 30 & 36" (750 & 900mm)	100 psi C.W.P (690 kPa)

Notes:
Valve can handle Full Reverse Pressure without damage.

Valves with Chloroprene, off white seats are limited to 50 psi (350 kPa). Contact DeZURIK with service conditions.

Flow Parameters
Round Port

Valve Size	Cv* Kv* 100% Open	K** (resistance)	Port Area (in^2/cm^2)
2" 50mm	300 260	0.16	3.1 20
3" 80mm	675 584	0.16	7.1 46
4" 100mm	1200 1040	0.16	12.6 81
5" 125mm	1900 1640	0.16	19.6 126
6" 150mm	2700 2340	0.16	28.3 183
8" 200mm	4800 4200	0.16	50.3 325
10" 250mm	7500 6500	0.16	78.5 506
12" 300mm	10800 9300	0.16	113 729
14" 350mm	13200 11400	0.16	138 890
16" 400mm	17400 15100	0.16	183 1180
18" 450mm	22300 19300	0.16	234 1510
20" 500mm	27800 24000	0.16	291 1880
22" 550mm	34000 29400	0.16	355 2290
24" 600mm	40500 35000	0.16	425 2740
26" 650mm	47800 41300	0.16	501 3230
28" 700mm	55600 48100	0.16	583 3760
30" 750mm	64000 55400	0.16	672 4340
32" 800mm	73000 63100	0.16	767 4950
36" 900mm	93000 80400	0.16	976 6300
42" 1050mm	126000 109000	0.16	1336 8620
48" 1200mm	165000 142700	0.16	1750 11290

*Cv = Flow in GPM of water at 1 psi pressure drop.
Kv = Flow in m3/hr. of water at 100 kPa pressure drop.
** K = The resistance coefficient of the valve. The constant (K) can be used to determine the equivalent length of pipe.

$L = \frac{KxD}{f}$ Where
L = Equivalent length of pipe in feet
K = Resistance coefficient
D = Pipe diameter in feet
f = Friction factor, related to type of pipe

Applicable Standards

DeZURIK KGC-HD Knife Gate Valves are designed and/or tested to meet the following standards:	
MSS SP-81	Metal Seated Valves, Stainless Steel, Bonnetless, Flanged Knife Gate Valves
ANSI B16.5 2-24" (50-600mm)	Flanges and Flanged Fittings, ANSI 150 Conforms to related drilling dimensions
ANSI 16.47 26-48" (650-1200mm)	Large diameter Steel Flanges. Series A. Conforms to related dimensions
International Standards	Conforms to flanged bolt guides — JIS 10; DIN 10 and DIN 16; ISO 7005-1/PN10 and 7005-2/PN16; BS 4504/PN10 and BS 4504/PN16; and AS 2129 Tables D and E; SANS 1123-1000 and SANS 1123-1600
TAPPI TIS 405-8	Recommendations for Stainless Steel, Bonnetless, Flanged, Wafer Knife Gate Valves. Revoked by TAPPI, Same as MSS SP-81

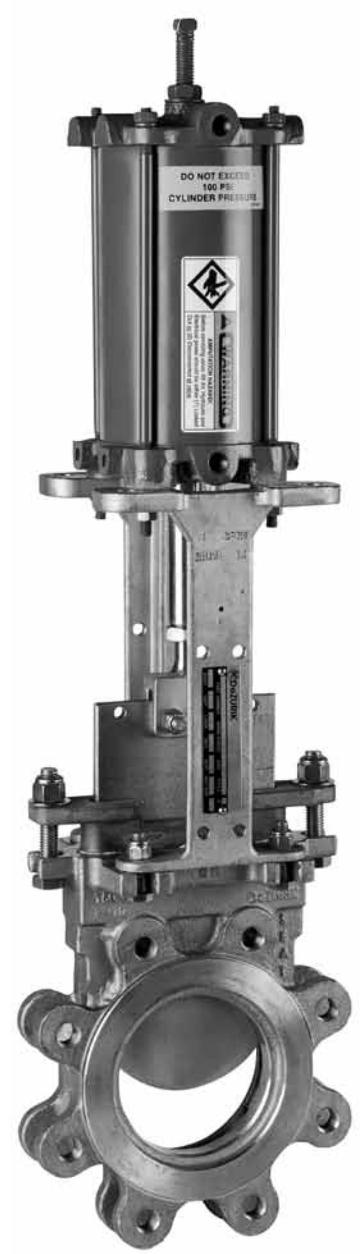
Flow Parameters
V-port 60 Degrees

Valve Size	Cv* Kv* 100% Open	K** (resistance)	Port Area (in^2/cm^2)
2" 50mm	89 77	1.80	1.9 12
3" 80mm	210 584	1.63	4.3 28
4" 100mm	386 330	1.53	7.7 50
5" 125mm	665 580	1.27	11.5 74
6" 150mm	900 780	1.42	17.2 111
8" 200mm	1660 1400	1.32	30.6 197
10" 250mm	2320 2000	1.65	42.0 271
12" 300mm	3490 3000	1.52	61.9 399
14" 350mm	4650 4000	1.27	80.8 521
16" 400mm	6110 5300	1.29	106 680
18" 450mm	8000 6900	1.23	138 890
20" 500mm	10100 8700	1.20	170 1100
22" 550mm	11900 10300	1.28	213 1370
24" 600mm	15100 13100	1.14	250 1610
26" 650mm	16800 14500	1.28	300 1940
28" 700mm	19500 16900	1.29	350 2260
30" 750mm	23900 20700	1.14	389 2510
32" 800mm	25600 22100	1.30	460 2970
36" 900mm	35200 30400	1.11	568 3660
42" 1050mm	44100 38100	1.32	800 5160
48" 1200mm	57800 50000	1.33	1050 6770

Valve Selection
Valve and Actuator Weights

Pounds
Kilograms

Valve Size	Basic Valve	With Lever	With Handwheel	With Chainwheel	With Bevel Gear Handwheel*	With Cylinder		
						Size	lbs.	Kg.
2" 50mm	10 4.5	20 9	20 9	32 14.5	—	4" (100mm)	29	13
3" 80mm	16 7	37 17	27 12	39 18	88 40	4" (100mm)	37	17
4" 100mm	24 11	48 22	36 16	48 22	96 43.5	4" (100mm)	45	20
						6" (150mm)	63	29
5" 125mm	32 14.5	60 27	51 23	66 30	108 49	4" (100mm)	58	26
						6" (150mm)	76	35
						8" (200mm)	88	40
6" 150mm	38 17	66 30	57 26	75 34	113 51	4" (100mm)	63	29
						6" (150mm)	81	37
						8" (200mm)	93	42
8" 200mm	65 30	98 44.5	86 39	101 46	144 65	6" (150mm)	112	51
						8" (200mm)	124	56
10" 250mm	103 47	157 71	141 85	179 81	191 87	8" (200mm)	174	79
						10" (250mm)	220	100
						12" (300mm)	257	117
12" 300mm	148 67	213 97	187 85	227 103	241 109	8" (200mm)	225	102
						10" (250mm)	270	122
						12" (300mm)	309	140
14" 350mm	199 90	N/A	265 120	284 129	303 137	10" (250mm)	332	151
						12" (300mm)	372	169
16" 400mm	272 123	N/A	341 155	358 162	380 172	10" (250mm)	409	186
						12" (300mm)	449	204
						14" (350mm)	495	225
18" 450mm	361 164	N/A	433 197	449 204	473 215	12" (300mm)	551	250
						14" (350mm)	602	273
						16" (400mm)	813	369
20" 500mm	518 235	N/A	593 269	653 296	637 289	12" (300mm)	712	323
						14" (350mm)	760	345
						16" (400mm)	982	445
22" 550mm	622 282	N/A	698 317	N/A	760 345	12" (300mm)	830	377
						14" (350mm)	881	400
						16" (400mm)	1101	500
						18" (450mm)	1144	519
24" 600mm	725 329	N/A	803 364	N/A	882 400	12" (300mm)	947	430
						14" (350mm)	1001	454
						16" (400mm)	1219	553
						18" (450mm)	1262	572
26" 650mm	918 417	N/A	N/A	N/A	1104 501	12" (300mm)	1200	544
						14" (350mm)	1251	568
						16" (400mm)	1524	692
						18" (450mm)	1578	716
						20" (500mm)	1711	777
28" 700mm	1111 503	N/A	N/A	N/A	1325 601	12" (300mm)	1417	643
						14" (350mm)	1467	666
						16" (400mm)	1648	748
						18" (450mm)	1830	830
						20" (500mm)	1963	891
30" 750mm	1446 656	N/A	N/A	N/A	1594 723	12" (300mm)	1718	780
						14" (350mm)	1768	802
						16" (400mm)	1985	900
						18" (450mm)	2205	1000
						20" (500mm)	2365	1073
32" 800mm	1700 772	N/A	N/A	N/A	1825 828	12" (300mm)	1901	862
						14" (350mm)	1951	886
						16" (400mm)	2121	963
						18" (450mm)	2300	1044
						20" (500mm)	2426	1101
36" 900mm	2204 1000	N/A	N/A	N/A	2366 1073	14" (350mm)	2541	1153
						16" (400mm)	2755	1250
						18" (450mm)	2987	1355
						20" (500mm)	3150	1428
42" 1050mm	3600 1634	N/A	N/A	N/A	3908 1774	On Application		
48" 1200mm	4997 2266	N/A	N/A	N/A	5450 2474	On Application		



Note: Weights are approximate and do not include crating.

* For Bevel Gear with Chainwheel, add the following weight to the bevel gear with handwheel weight:
2-18" add 7 lbs. (3kg)
20-24" add 26 lbs. (12kg)
30" add 74 lbs. (34kg)
36" add 68 lbs. (31kg)

Ordering

To order, simply complete the valve order code from information shown. An ordering example is shown for your reference.

Valve Style
Give valve style code as follows:

KGC = Cast Stainless Steel Knife Gate Valve

Valve Size
Give valve size code as follows:

2	=	2"	(50mm)	20	=	20"	(500mm)
3	=	3"	(80mm)	22	=	22"	(550mm)
4	=	4"	(100mm)	24	=	24"	(600mm)
5	=	5"	(125mm)	26	=	26"	(650mm)
6	=	6"	(150mm)	28	=	28"	(700mm)
8	=	8"	(200mm)	30	=	30"	(750mm)
10	=	10"	(250mm)	32	=	32"	(800mm)
12	=	12"	(300mm)	36	=	36"	(900mm)
14	=	14"	(350mm)	42	=	42"	(1050mm)
16	=	16"	(400mm)	48	=	48"	(1200mm)
18	=	18"	(450mm)				

Body Style
Give body style code as follows:

HD = Heavy Duty

End Connection
Give end connection code as follows:

F1 = ANSI 150 UNC Tapping for Threads
F110 = ISO 7005/PN10 Drilling
F116 = ISO 7005/PN16 Drilling
F1DA = AS2129 Table D Drilling
F1EA = AS2129 Table E Drilling
F1UN(1) = ANSI 150 UN-8 Tapping for Threads
F1S10 = SANS1123-1000
F1S16 = SANS1123-1600

Optional End Connections

F1T = ANSI 150 Through Bolting

On Application

F1J1 = JIS 10 Drilling

Body Material
Give body material code as follows:

Standard

S1 = 304 Stainless Steel
S2 = 316 Stainless Steel
S3 = 317 Stainless Steel

On Application

HC = Hastelloy C
S6 = 254 Stainless Steel
S10 = 2205 Duplex Stainless Steel

Packing Material
Give packing material code as follows:

Standard Packing

SMP = PTFE Braided Packing to 500°F (260°C) (pH Range 0-14)

Optional Packing

TDP = Dry Service, Dry PTFE Braided Packing with Solid PTFE Cord to 500°F (260°C) (pH Range: 0-14)
HTP = High Temperature Braided Packing to 650°F (343°C) (pH Range: 1-12)
HMP = High Temperature Braided Packing with Metal Scraper Ring to 1000°F (540°C) (pH Range: 3-10)
FGP = Food Grade Service to 450°F (232°C) (pH Range: 3-11)

Gate Material (3)
Give gate material code as follows:

Standard Gate Materials

S1 = 304 Stainless Steel (Standard for S1 body material)
S2 = 316 Stainless Steel (Standard for S2 body material)
S3 = 317 Stainless Steel (Standard for S3 body material)

Optional Gate Materials

S5 = 17-4 Stainless Steel H900 Heat Treated (Used with S1, S2, & S3 body materials)

On Application

S6 = 254-SMO Stainless Steel (Used with S6 body material)
S8 = 410 Stainless Steel (Used with S1, S2 & S3 body materials)
S10 = 2205 Duplex Stainless Steel (Used with S2, S3 OR S10 body materials)
HC = Hastelloy C (Used with HC body materials)

Seat Material (2)
Give seat material code as follows:

Standard Seat Materials

M = Metal
V = V-Orifice All Metal
CR = Chloroprene to 180°F (83°C)
NBR = Acrylonitrile-Butadiene to 180°F (83°C)
EPDM = Terpolymer of Ethylene, Propylene and a Diene to 250°F (122°C)

Optional Seat Materials

FKM = Fluoro Rubber to 400°F (204°C)
S5D = 17-4 PH Stainless Steel H900 Heat Treated

On Application

CRW = Chloroprene, Off White to 140°F (60°C)
PTFE or RTFE

Standard Options
Give option code as follows:

ARRA = ARRA Compliant
PSA = Purge Ports in Seat Area
PCA = Purge Ports in Chest Area
PSC = Purge Ports in Seat and Chest Area
CMC = Certificate of Material Conformance
CRT = Certified Physical and Chemical Test Reports
— = Optional Coating
— = DeZURIK Standard Test Certification
P100 = 30" and 36" (750 and 900mm) valves with 100 psi (690 kPa) rating

Notes:
(1) Applies to valves 18" (450mm) and larger. Flange bolt hole threads are 8 threads per inch in accordance with ANSI, API and MSS standards.
(2) The limiting factor in valve selection is the lowest temperature of the packing or seat.
(3) Gate material limitations by body style in parentheses.

Ordering Example:

KGC,6,HD,F1,S2,SMP,S2-CR*Actuator

Manual Actuators

Lever Actuators

Lever actuators can be furnished on 2-12" (50-300mm) valves for applications where rapid valve operation is required or where space prevents use of a standard handwheel or bevel gear actuator. Maximum pressure differential required for valves with lever actuators should not exceed the limits listed. Maximums are based on the operating force for each valve size. Lever actuators are carbon steel only. SMP packing recommended with MN-LV.

To order, add the lever actuator code to the basic valve order code.

Ordering Example:
KGC,6,HD,F1,S2,SMP,S2-M*MN-LV-CS

Lever Actuator

Valve Size	Order Code Carbon Steel (CS) Yoke	Maximum Pressure Differential psi/kPa
2-4" 50-100mm	MN-LV-CS	75 520
5-6" 125-150mm	MN-LV-CS	45 310
8" 200mm	MN-LV-CS	25 170
10" 250mm	MN-LV-CS	20 140
12" 300mm	MN-LV-CS	14 100

Handwheel and Chainwheel Actuators

All 2-24" (50-600mm) valves can be furnished with handwheel actuators, and 2-20" (50-500mm) with chainwheel actuators. To order handwheel or chainwheel actuators, add the appropriate order code to the basic valve order code. Refer to information on bevel gear actuators for use on dry solids, paper stock, slurries or when pressure exceeds limits shown. Order chain for chainwheel actuators as a separate item.

Handwheel Actuator

Valve Size	Order Code Carbon Steel (CS) Yoke	Order Code 304 SST (S1) Yoke	Maximum Pressure Differential psi/kPa
2-4" 50-100mm	MN-HD8-CS	MN-HD8-S1	150 1030
5-8" 125-200mm	MN-HD12-CS	MN-HD12-S1	150 1030
10-12" 250-300mm	MN-HD16-CS	MN-HD16-S1	150 1030
14" 350mm	MN-HD20-CS*	MN-HD20-S1*	125 860
16" 400mm	MN-HD20-CS*	MN-HD20-S1*	100 680
18" 450mm	MN-HD20-CS*	MN-HD20-S1*	75 515
20" 500mm	MN-HD20-CS*	MN-HD20-S1*	50 340
22" 550mm	MN-HD20-CS*	MN-HD20-S1*	25 170
24" 600mm	MN-HD20-CS*	MN-HD20-S1*	25 170

*Bevel gear actuators recommended for dry solids, paper stocks, slurries, or when pressure exceeds limits shown.

Ordering Example:
KGC,6,HD,F1,S2,SMP,S2-M*MN-HD12-CS

Chainwheel Actuator

Valve Size	Order Code Carbon Steel (CS) Yoke	Order Code 304 SST (S1) Yoke	Maximum Pressure Differential psi/kPa
2-4" 50-100mm	MN-CW8-CS	MN-CW8-S1	150 1030
5-8" 125-200mm	MN-CW12-CS	MN-CW12-S1	150 1030
10-12" 250-300mm	MN-CW20-CS	MN-CW20-S1	150 1030
14" 350mm	MN-CW20-CS*	MN-CW20-S1*	125 860
16" 400mm	MN-CW20-CS*	MN-CW20-S1*	100 680
18" 450mm	MN-CW20-CS*	MN-CW20-S1*	75 515
20" 500mm	MN-CW20-CS*	MN-CW20-S1*	50 340

*Bevel gear actuators recommended for dry solids, paper stocks, slurries, or when pressure exceeds limits shown.

Ordering Example:
KGC,4,HD,F1,S2,SMP,S2-CR*MN-CW8-S1

Manual Actuators

Bevel Gear Actuators

Bevel gear actuators are available on 3-48" (80-1200mm) valves with handwheel or chainwheel actuators. Bevel gear actuators provide vertical mounting of the handwheel or chainwheel, or can be used where space limitations prohibit the use of a standard handwheel or chainwheel. A mechanical advantage makes large valve operation easier and faster.

Bevel Gear Handwheel Actuators

Valve Size	Order Code Carbon Steel (CS) Yoke	Order Code 304 SST (S1) Yoke	Maximum Pressure Differential psi/kPa
3-18" 80-450mm	MNB-HD12-CS	MNB-HD12-S1	150 1030
20-24" 500-600mm	MNB-HD16-CS	MNB-HD16-S1	150 1030
30-42" 750-1050mm	MNB-HD30-CS	MNB-HD30-S1	150* 1030*
48" 1200mm	MNB-HD36-CS	MNB-HD36-S1	150 1030

Ordering Example:
KGC,14,HD,F1,S2,SMP,S2-CR*MNB-HD12-CS

Bevel Gear Chainwheel Acutators

Valve Size	Order Code Carbon Steel (CS) Yoke	Order Code 304 SST (S1) Yoke	Maximum Pressure Differential psi/kPa
3-18" 80-450mm	MNB-CW12-CS	MNB-CW12-S1	150 1030
20-24" 500-600mm	MNB-CW20-CS	MNB-CW20-S1	150 1030
30-42" 750-1050mm	MNB-CW30-CS	MNB-CW30-S1	150* 1030*
48" 1200mm	MNB-CW36-CS	MNB-CW36-S1	150 1030

Ordering Example:
KCG,14,HD,F1,S2,SMP,S2-CR*MNB-CW12-CS-90
Actuator mounted at 90 degrees

Note:
For alternate mounting of bevel gear actuators, add -90, -180 or -270 after the actuator code and as 2nd line information on the order.
* Maximum pressure of 30" (750mm) and 36" (900mm) valves with P100 option is 100psi.

Manual Actuator Accessories

Chain for Chainwheel Actuators

Order as a separate item by giving the correct code and specify required length of chain as second line information. One closing link is supplied with the Chainwheel Actuator.

Order Code	Description
ACC*CN102	Steel, Zinc Plated 3/16
ACC*CN103	Galvanized 3/16
ACC*CN106	316 Stainless Steel 3/16

Ordering Example:
ACC*CN102
Chain 12 feet long (366cm)

Extension for Handwheel or 2" Nut Extension

Provides extension of the handwheel or nut to allow remote operation – normally from above. The extension includes fittings and extension pipe with handwheel or nut mounted. To order, specify description and extension length from center line of valve to handwheel or nut.

Order Code	Description
ENHD	Extension for Handwheel
ENTS	Extension for Nut

Ordering Example:
Handwheel: KGC,14,HD,F1,S2,SMP,S2-CR*MN-HD20-CS,ENHD
Nut: KGC,14,HD,F1,S2,SMP,S2-CR*MN-N-CS,ENTS
Center line of valve to handwheel nut 72 inches (1829mm).

Lockout Device

Available on all sizes of handwheel, bevel gear handwheel and cylinder actuated valves. To order, add a comma and the order code "LK" after the actuator code.

Ordering Example:
KGC,14,HD,F1,S2,SMP,S2-CR*MNB-HD12-CS,LK

Floorstand

A floorstand for handwheel actuated valves allows operation from above. Includes floorstand with gate position indicator, handwheel, fittings and extension. To order, specify length from center line of valve to base of floorstand. This dimension must be at least twice the dimension from center line to handwheel. For non-rising stems only. Floor stands for use with rising stems are available on application.

Ordering Example:
KGC,14,HD,F1,S2,SMP,S2-CR*MN-HD20-CS
Except with floorstand. Center line of valve to base of floorstand 72 inches (1829mm).

Deflection Cones

To prolong valve life in particularly demanding services, deflection cones are available in 316 stainless steel or abrasion resistant cast iron per ASTM A532 with Brinell Hardness of at least 500 BHN. Order as a separate line item by giving the correct code and valve size.

Order Code	Description
DCS23 - Valve Size	316 Stainless Steel
DCNH23 - Valve Size	Abrasion Resistant Cast Iron

Ordering Example:
ACC*DCS23-12 316SST Cone for 12" valve

Cylinder Actuators

On-Off Cylinder Actuators

DeZURIK cylinder actuators are available with double-acting pneumatic or hydraulic cylinders for on/off or positioning services. Supply pressure is 60 or 80 psi (410 or 550 kPa). To order, add the proper code from the on/off column of the table to the valve order code. Specify hydraulic media if other than oil.

Positioning Cylinder Actuators

DeZURIK cylinder actuators are available with pneumatic or electronic positioners for throttling control. Positioners are enclosed and mounted on the superstructure.

Actuator Sizing

60 psi (410 kPa) Air Supply

Valve Size	Order Code	Order Code	Maximum Pressure Differential psi/kPa			
			On/Off		Positioning	
	Carbon Steel (CS) Yoke	304 SST (S1) Yoke	Dry Solids, Slurries, Paper Stock	Liquids & Gases	Dry Solids, Slurries, Paper Stock	Liquids & Gases
2 & 3" 50 & 80mm	CY-PC4-CS	CY-PC4-S1	150/1030	150/1030	150/1030	150/1030
4" 100mm	CY-PC4-CS	CY-PC4-S1	100/690	150/1030	75/515	75/515
	CY-PC6-CS	CY-PC6-S1	150/1030	N/R	150/1030	150/1030
5 & 6" 125 & 150mm	CY-PC4-CS	CY-PC4-S1	N/A	50/340	N/A	N/A
	CY-PC6-CS	CY-PC6-S1	125/860	150/1030	75/515	100/690
	CY-PC8-CS	CY-PC8-S1	150/1030	N/R	150/1030	150/1030
8" 200mm	CY-PC6-CS	CY-PC6-S1	75/515	125/860	50/340	50/340
	CY-PC8-CS	CY-PC8-S1	150/1030	150/1030	125/860	125/860
10" 250mm	CY-PC8-CS	CY-PC8-S1	100/690	150/1030	75/515	100/690
	CY-PC10-CS	CY-PC10-S1	150/1030	N/R	125/860	150/1030
	CY-PC12-CS	CY-PC12-S1	N/R	N/R	150/1030	N/R
12" 300mm	CY-PC8-CS	CY-PC8-S1	75/515	125/860	50/340	50/340
	CY-PC10-CS	CY-PC10-S1	125/860	150/1030	100/690	125/860
	CY-PC12-CS	CY-PC12-S1	150/1030	N/R	150/1030	150/1030
14" 350mm	CY-PC8-CS	CY-PC8-S1	50/340	75/515	25/170	50/340
	CY-PC10-CS	CY-PC10-S1	100/690	150/1030	75/515	75/515
	CY-PC12-CS	CY-PC12-S1	150/1030	N/R	100/690	125/860
16" 400mm	CY-PC10-CS	CY-PC10-S1	75/515	125/860	50/340	50/340
	CY-PC12-CS	CY-PC12-S1	125/860	150/1030	75/515	100/690
	CY-PC14-CS	CY-PC14-S1	150/1030	N/R	125/860	150/1030
18" 450mm	CY-PC12-CS	CY-PC12-S1	100/690	150/1030	50/340	75/515
	CY-PC14-CS	CY-PC14-S1	150/1030	N/R	100/690	125/860
	CY-PC16-CS	CY-PC16-S1	N/R	N/R	150/1030	150/1030
20" 500mm	CY-PC12-CS	CY-PC12-S1	50/340	125/860	25/170	50/340
	CY-PC14-CS	CY-PC14-S1	125/860	150/1030	75/515	100/690
	CY-PC16-CS	CY-PC16-S1	150/1030	N/R	125/860	150/1030
22" 550mm	CY-PC12-CS	CY-PC12-S1	50/340	100/690	N/A	25/170
	CY-PC14-CS	CY-PC14-S1	100/690	150/1030	50/340	75/515
	CY-PC16-CS	CY-PC16-S1	150/1030	N/R	100/690	125/860
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	150/1030	150/1030

N/R = Not required. Use next smaller actuator.
N/A = Not available. Use larger actuator or contact DeZURIK.

Cylinder Actuators

Actuator Sizing

60 psi (410 kPa) Air Supply

Valve Size	Order Code	Order Code	Maximum Pressure Differential psi/kPa			
			On/Off		Positioning	
	Carbon Steel (CS) Yoke	304 SST (S1) Yoke	Dry Solids, Slurries, Paper Stock	Liquids & Gases	Dry Solids, Slurries, Paper Stock	Liquids & Gases
24" 600mm	CY-PC12-CS	CY-PC12-S1	25/170	75/515	N/A	N/A
	CY-PC14-CS	CY-PC14-S1	75/515	150/1030	50/340	50/340
	CY-PC16-CS	CY-PC16-S1	150/1030	N/R	75/515	100/690
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	150/1030	150/1030
26" 650mm	CY-PC12-CS	CY-PC12-S1	N/A	75/515	N/A	N/R
	CY-PC14-CS	CY-PC14-S1	50/340	125/860	25/170	50/340
	CY-PC16-CS	CY-PC16-S1	125/860	150/1030	75/515	75/515
	CY-PC18-CS	CY-PC18-S1	150/1030	N/R	100/690	150/1030
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	150/1030	N/R
28" 700mm	CY-PC12-CS	CY-PC12-S1	N/A	50/340	N/A	N/A
	CY-PC14-CS	CY-PC14-S1	50/340	100/690	N/A	25/170
	CY-PC16-CS	CY-PC16-S1	75/515	150/1030	50/340	75/515
	CY-PC18-CS	CY-PC18-S1	150/1030	N/R	75/515	125/860
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	150/1030	150/1030
30" 750mm 100 CWP (P100)	CY-PC14-CS	CY-PC14-S1	25/170	75/515	N/A	N/A
	CY-PC16-CS	CY-PC16-S1	75/515	100/690	25/170	50/340
	CY-PC18-CS	CY-PC18-S1	100/690	N/R	75/515	75/515
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	100/690	100/690
30" 750mm 150 CWP	CY-PC14-CS	CY-PC14-S1	25/170	75/515	N/A	N/A
	CY-PC16-CS	CY-PC16-S1	75/515	150/1030	25/170	50/340
	CY-PC18-CS	CY-PC18-S1	125/860	N/R	75/515	75/515
	CY-PC20-CS	CY-PC20-S1	150/1030	N/R	125/860	150/1030
32" 800mm	CY-PC14-CS	CY-PC14-S1	25/170	75/515	N/A	N/A
	CY-PC16-CS	CY-PC16-S1	50/340	125/860	25/170	25/170
	CY-PC18-CS	CY-PC18-S1	100/690	150/1030	50/340	75/515
	CY-PC20-CS	CY-PC20-S1	150/1030	N/R	75/515	125/860
36" 900mm 100 CWP (P100)	CY-PC14-CS	CY-PC14-S1	N/A	50/340	N/A	N/A
	CY-PC16-CS	CY-PC16-S1	25/170	75/515	N/A	N/A
	CY-PC18-CS	CY-PC18-S1	75/515	100/690	25/170	50/340
	CY-PC20-CS	CY-PC20-S1	100/690	N/R	50/340	75/515
36" 900mm 150 CWP	CY-PC14-CS	CY-PC14-S1	N/A	50/340	N/A	N/A
	CY-PC16-CS	CY-PC16-S1	25/170	75/515	N/A	N/A
	CY-PC18-CS	CY-PC18-S1	75/515	150/1030	25/170	50/340
	CY-PC20-CS	CY-PC20-S1	100/690	N/R	50/340	75/515
42 & 48" 1050 & 1200mm	Contact DeZURIK for cylinder actuator sizing.					

N/R = Not required. Use next smaller actuator.
N/A = Not available. Use larger actuator or contact DeZURIK.

Cylinder Actuators

Actuator Sizing

80 psi (550 kPa) Air Supply

Valve Size	Order Code	Order Code	Maximum Pressure Differential psi/kPa			
			On/Off		Positioning	
	Carbon Steel (CS) Yoke	304 SST (S1) Yoke	Dry Solids, Slurries, Paper Stock	Liquids & Gases	Dry Solids, Slurries, Paper Stock	Liquids & Gases
2 & 3" / 50 & 80mm	CY-PC4-CS	CY-PC4-S1	150/1030	150/1030	150/1030	150/1030
4" / 100mm	CY-PC4-CS	CY-PC4-S1	150/1030	150/1030	100/690	150/1030
	CY-PC6-CS	CY-PC6-S1	N/R	N/R	150/1030	N/R
5 & 6" / 125 & 150mm	CY-PC4-CS	CY-PC4-S1	50/340	75/515	25/170	25/170
	CY-PC6-CS	CY-PC6-S1	150/1030	150/1030	125/860	150/1030
	CY-PC8-CS	CY-PC8-S1	N/R	N/R	150/1030	N/R
8" / 200mm	CY-PC6-CS	CY-PC6-S1	100/690	150/1030	75/515	75/515
	CY-PC8-CS	CY-PC8-S1	150/1030	N/R	150/1030	150/1030
10" / 250mm	CY-PC8-CS	CY-PC8-S1	150/1030	150/1030	100/690	125/860
	CY-PC10-CS	CY-PC10-S1	N/R	N/R	150/1030	150/1030
12" / 300mm	CY-PC8-CS	CY-PC8-S1	100/690	150/1030	75/515	100/690
	CY-PC10-CS	CY-PC10-S1	150/1030	N/R	150/1030	150/1030
14" / 350mm	CY-PC10-CS	CY-PC10-S1	125/860	150/1030	100/690	125/860
	CY-PC12-CS	CY-PC12-S1	150/1030	N/R	150/1030	150/1030
16" / 400mm	CY-PC10-CS	CY-PC10-S1	100/690	150/1030	75/515	100/690
	CY-PC12-CS	CY-PC12-S1	150/1030	N/R	125/860	150/1030
	CY-PC14-CS	CY-PC14-S1	N/R	N/R	150/1030	N/R
18" / 450mm	CY-PC12-CS	CY-PC12-S1	150/1030	150/1030	100/690	125/860
	CY-PC14-CS	CY-PC14-S1	N/R	N/R	150/1030	150/1030
20" / 500mm	CY-PC12-CS	CY-PC12-S1	125/860	150/1030	75/515	75/515
	CY-PC14-CS	CY-PC14-S1	150/1030	N/R	125/860	150/1030
	CY-PC16-CS	CY-PC16-S1	N/R	N/R	150/1030	N/R
22" / 550mm	CY-PC12-CS	CY-PC12-S1	100/690	150/1030	50/340	75/515
	CY-PC14-CS	CY-PC14-S1	150/1030	N/R	100/690	125/860
	CY-PC16-CS	CY-PC16-S1	N/R	N/R	150/1030	150/1030
24" / 600mm	CY-PC12-CS	CY-PC12-S1	75/515	150/1030	25/170	50/340
	CY-PC14-CS	CY-PC14-S1	150/1030	N/R	100/690	125/860
	CY-PC16-CS	CY-PC16-S1	N/R	N/R	150/1030	150/1030
26" / 650mm	CY-PC12-CS	CY-PC12-S1	50/340	125/860	25/170	25/170
	CY-PC14-CS	CY-PC14-S1	125/860	150/1030	75/515	75/515
	CY-PC16-CS	CY-PC16-S1	150/1030	N/R	125/860	150/1030
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	750/1030	N/R
28" / 700mm	CY-PC12-CS	CY-PC12-S1	50/340	100/690	N/A	25/170
	CY-PC14-CS	CY-PC14-S1	100/690	150/1030	50/340	75/515
	CY-PC16-CS	CY-PC16-S1	150/1030	N/R	100/690	125/860
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	150/1030	150/1030

N/R = Not required. Use next smaller actuator.
N/A = Not available. Use larger actuator or contact DeZURIK.

Cylinder Actuators

Actuator Sizing

80 psi (550 kPa) Air Supply

Valve Size	Order Code	Order Code	Maximum Pressure Differential psi/kPa			
			On/Off		Positioning	
	Carbon Steel (CS) Yoke	304 SST (S1) Yoke	Dry Solids, Slurries, Paper Stock	Liquids & Gases	Dry Solids, Slurries, Paper Stock	Liquids & Gases
30" 750mm 100 CWP (P100)	CY-PC12-CS	CY-PC12-S1	25/170	75/515	N/A	N/A
	CY-PC14-CS	CY-PC14-S1	75/515	100/690	50/340	50/340
	CY-PC16-CS	CY-PC16-S1	100/690	N/R	75/515	100/690
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	100/690	N/R
30" 750mm 150 CWP	CY-PC12-CS	CY-PC12-S1	25/170	75/515	N/A	N/A
	CY-PC14-CS	CY-PC14-S1	75/515	150/1030	50/340	50/340
	CY-PC16-CS	CY-PC16-S1	150/1030	N/R	75/515	100/690
	CY-PC18-CS	CY-PC18-S1	N/R	N/R	125/860	150/1030
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	150/1030	N/R
32" 800mm	CY-PC12-CS	CY-PC12-S1	25/170	50/340	N/A	N/A
	CY-PC14-CS	CY-PC14-S1	50/340	125/860	25/170	50/340
	CY-PC16-CS	CY-PC16-S1	100/690	150/1030	50/340	75/515
	CY-PC18-CS	CY-PC18-S1	150/1030	N/R	100/690	150/1030
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	150/1030	N/R
36" 900mm 100 CWP (P100)	CY-PC14-CS	CY-PC14-S1	25/170	75/515	N/A	25/170
	CY-PC16-CS	CY-PC16-S1	75/515	100/690	50/340	50/340
	CY-PC18-CS	CY-PC18-S1	100/690	N/R	75/515	100/690
	CY-PC20-CS	CY-PC20-S1	N/R	N/R	100/690	N/R
36" 900mm 150 CWP	CY-PC14-CS	CY-PC14-S1	25/170	75/515	N/A	25/170
	CY-PC16-CS	CY-PC16-S1	75/515	150/1030	50/340	50/340
	CY-PC18-CS	CY-PC18-S1	125/860	N/R	75/515	100/690
	CY-PC20-CS	CY-PC20-S1	150/1030	N/R	125/860	150/1030
42 & 48" 1050 & 1200mm	Contact DeZURIK for cylinder actuator sizing.					

N/R = Not required. Use next smaller actuator.
N/A = Not available. Use larger actuator or contact DeZURIK.

Cylinder Actuator Accessories

Positioners

DeZURIK cylinder actuators are available with pneumatic, electro-pneumatic or digital positioners for throttling control.

Air Filter Regulator

The DeZURIK Air Filter Regulator is designed to provide clean, accurate air pressure to actuators and positioners.

Four-Way Solenoid Valves

Solenoid valves may be ordered mounted and piped as part of a complete valve/actuator assembly or as a separate item.

Speed Control Valves

Speed Control Valves are available for controlling valve opening or closing speed with pneumatic actuators. The speed of operation is adjustable. To order mounted, add the appropriate code to the valve and actuator order code.

Speed Control	Order Code
Two speed controls	SP
One control to close	SPC
One control to open	SPO

Ordering Example:
KGC,4,HD,F1,S1,SMP,S1-M*CY-PC6-CS,SP

Cylinder Actuator Accessories
Position Indicating Switches
Position Indicating Switches are available for use on double-acting cylinder actuators. Order as part of a complete valve/actuator assembly by adding the appropriate code from the table below to the valve and actuator order code. Two switches will automatically be set to indicate full open and full closed positions.

Two Switches - Open/Closed

Quantity/ Description	Switch Type	Rating	Manufacturer	Order Code
2 SPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA1A-1A	SE649
2 DPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA2B-1A	SE524
2 SPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA3K-1A	SEH95
2 DPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA4L-1A	SEH96
2 SPDT, SST Housing	Proximity	CSA/FM Class 1, Division 1, Explosion Proof	GO 73-13526-A2	SEHK4
2 SPDT, SST Housing	Proximity	CSA Class I, Div 2, Hazardous Locations, (Groups A,B,C,D), Class II, (Groups E,F,G), Class III	GO 11-11124-A2	SEH94
2 SPDT, SST Housing	Proximity	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Stonel HK3077SG and HK3077SR	SEHK3

One Switch - Open

Quantity/ Description	Switch Type	Rating	Manufacturer	Order Code
1 SPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA1A-1A	SEJ40
1 DPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA2B-1A	SEJ42
1 SPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA3K-1A	SEJ46
1 DPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA4L-1A	SEJ44
1 SPDT, SST Housing	Proximity	CSA/FM Class 1, Division 1, Explosion Proof	GO 73-13526-A2	SEHK5
1 SPDT, SST Housing	Proximity	CSA Class I, Div 2, Hazardous Locations, (Groups A,B,C,D), Class II, (Groups E,F,G), Class III	GO 11-11124-A2	SEJ38
1 SPDT, SST Housing	Proximity	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Stonel HK3077SG	SEK37

One Switch - Closed

Quantity/ Description	Switch Type	Rating	Manufacturer	Order Code
1 SPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA1A-1A	SEJ41
1 DPDT	Mechanical	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Honeywell LSA2B-1A	SEJ43
1 SPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA3K-1A	SEJ47
1 DPDT	Mechanical	Nema 1, 3, 4, 6, 7 (Class 1, Division 1, Groups B, C, D), 9 (Class 2, Division 1, Groups E, F, G), 13	Honeywell LSXA4L-1A	SEJ45
1 SPDT, SST Housing	Proximity	CSA/FM Class 1, Division 1, Explosion Proof	GO 73-13526-A2	SEHK6
1 SPDT, SST Housing	Proximity	CSA Class I, Div 2, Hazardous Locations, (Groups A,B,C,D), Class II, (Groups E,F,G), Class III	GO 11-11124-A2	SEJ39
1 SPDT, SST Housing	Proximity	Nema 1, 3, 4, 4X, 6, 6P, 12 and 13	Stonel HK3077SR	SEK87

Electric Motor Actuators
DeZURIK Knife Gate Valves can be furnished with electric motor actuators including Limitorque, Auma, Rotork, E.I.M. and others.

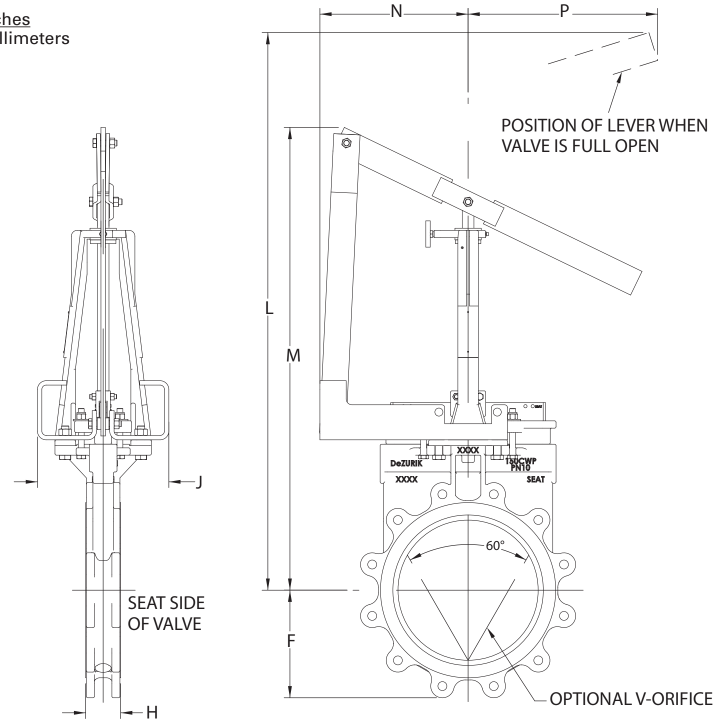
When ordering electric motor actuators, specify valve order code, shutoff pressure, service conditions (flowing media and installation direction); type of application (on/off or throttling); speed of operation; NEMA rating (4, 7, submersible, etc.); electrical characteristics (voltage and phase); actuator accessories and controls as per specification requirements.

Dimensions

Basic Valve with Lever Actuator

Valve Size	Dimensions						
	F	H	J	L	M	N	P
2" 50mm	3.0 76	1.88 48	5.75 146	15.96 405	14.78 375	4.38 111	8.00 203
3" 80mm	3.75 95	2.00 51	7.75 197	21.78 553	17.75 451	5.38 137	17.88 454
4" 100mm	4.50 114	2.00 51	7.88 200	29.40 747	19.87 505	6.12 155	24.12 613
5" 125mm	5.00 127	2.25 57	8.62 219	37.50 953	22.76 578	7.38 187	19.81 503
6" 150mm	5.50 140	2.25 57	8.62 219	42.00 1067	23.32 592	7.38 187	16.81 427
8" 200mm	6.75 171	2.75 70	9.38 238	58.12 1476	27.68 703	7.88 200	21.12 536
10" 250mm	8.00 203	2.75 70	11.25 286	68.19 1732	35.13 892	10.62 270	21.53 699
12" 300mm	9.50 241	3.00 76	11.25 286	76.03 1931	39.47 1003	12.69 322	33.44 849

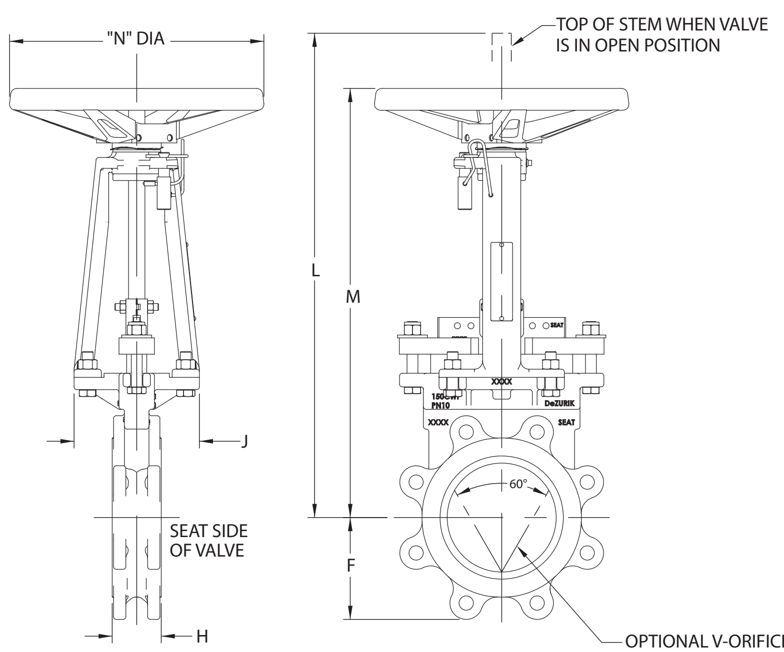
Inches
Millimeters



Basic Valve with Handwheel Actuator

Valve Size	Dimensions					
	F	H	J	L	M	N
2" 50mm	3.00 76	1.88 48	4.00 102	14.93 379	12.90 328	8.00 203
3" 80mm	3.75 95	2.00 51	4.75 121	16.65 423	14.62 371	8.00 203
4" 100mm	4.50 114	2.00 51	5.00 127	19.93 506	16.90 429	8.00 203
5" 125mm	5.00 127	2.25 57	5.75 146	24.30 618	19.56 497	12.00 305
6" 150mm	5.50 140	2.25 57	5.75 146	25.88 657	21.07 535	12.00 305
8" 200mm	6.75 171	2.75 70	6.38 162	31.43 798	24.65 626	12.00 305
10" 250mm	8.00 203	2.75 70	8.25 210	39.13 994	30.00 762	16.00 406
12" 300mm	9.50 241	3.00 76	8.25 210	44.75 1137	33.63 854	16.00 406
14" 350mm	10.50 267	3.00 76	8.25 210	54.75 1391	40.82 1037	20.00 508
16" 400mm	11.75 298	3.50 89	8.69 221	58.44 1484	42.38 1076	20.00 508
18" 450mm	12.50 318	3.50 89	9.06 230	67.75 1721	49.69 1262	20.00 508
20" 500mm	13.75 349	4.50 114	9.19 233	71.31 1811	51.25 1302	20.00 508
22" 550mm	15.5 394	4.50 114	9.19 233	77.22 1961	55.36 1406	20.00 508
24" 600mm	16.00 406	4.50 114	9.19 233	83.29 2116	59.22 1504	20.00 508

Inches
Millimeters



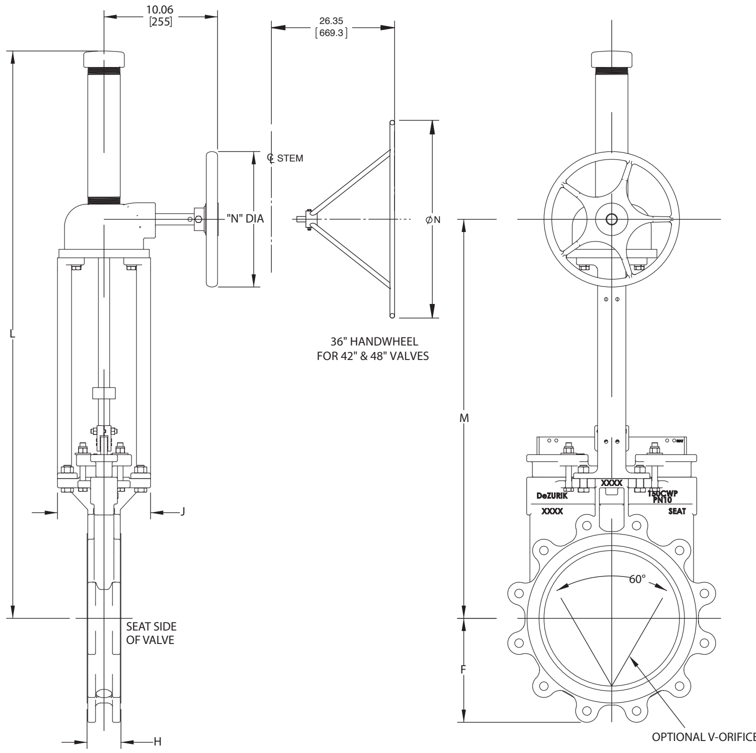
Dimensions

Bevel Gear Handwheel Actuator

Valve Size	Dimensions					
	F	H	J	L	M	N
3"	3.75	2.00	4.75	22.00	16.09	12.00
80mm	95	51	121	559	409	305
4"	4.50	2.00	5.00	24.30	18.37	12.00
100mm	114	51	127	617	467	305
5"	5.00	2.25	5.75	28.70	20.76	12.00
125mm	127	57	146	729	527	305
6"	5.50	2.25	5.75	30.30	22.29	12.00
150mm	140	57	146	769	566	305
8"	6.75	2.75	6.38	35.80	25.84	12.00
200mm	171	70	162	910	656	305
10"	8.00	2.75	8.25	46.50	31.54	12.00
250mm	203	70	210	1181	801	305
12"	9.50	3.00	8.25	50.20	35.16	12.00
300mm	241	76	210	1275	893	305
14"	10.50	3.00	8.25	56.70	37.78	12.00
350mm	267	76	210	1440	960	305
16"	11.75	3.50	8.69	60.40	41.47	12.00
400mm	298	89	221	1534	1053	305
18"	12.50	3.50	9.06	69.90	47.08	12.00
450mm	318	89	230	1775	1195	305
20"	13.75	4.50	9.19	73.50	50.59	16.00
500mm	349	114	233	1867	1285	406
24"	16.00	4.50	9.19	81.50	58.57	16.00
600mm	406	114	233	2070	1488	406
26"	17.13	4.63	9.50	100.95	64.49	30.00
650mm	435	117	241	2564	1638	762
28"	18.25	5.00	10.69	104.83	68.37	30.00
700mm	464	127	271	2663	1737	762
30"*	19.38	5.50	11.25	105.03	73.09	30.00
750mm	492	140	286	2668	1856	762
32"	20.88	6.00	11.25	113.20	76.74	30.00
800mm	530	152	286	2875	1949	762
36"*	23.00	6.00	11.25	122.53	84.59	30.00
900mm	584	152	286	3112	2149	762
42"	26.50	6.50	13.50	146.28	96.91	36.00
1050mm	673	165	343	3716	2462	914
48"	29.75	7.00	18.50	194.87	116.85	36.00
1200mm	756	178	470	4950	2968	914

* 100 psi, face-to-face (H dimension) on 30" and 36" (750 and 900mm) is 4.62" (117mm)

Inches
Millimeters



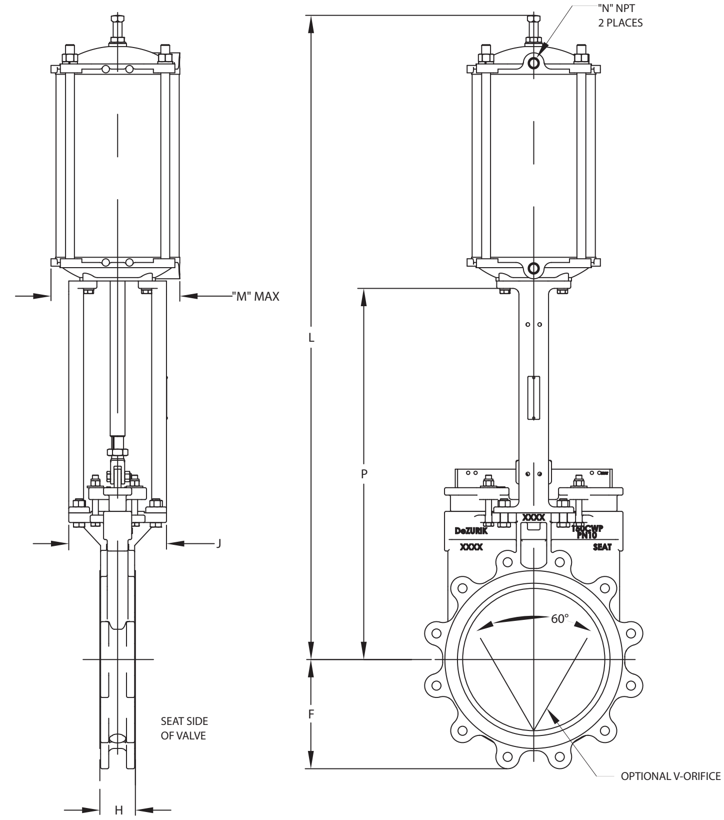
Dimensions

Basic Valve with Cylinder Actuator

Valve Size	Dimensions F	H	J
2" 50mm	3.00 76	1.88 48	4.00 102
3" 80mm	3.75 95	2.00 51	4.75 121
4" 100mm	4.50 114	2.00 51	5.00 127
5" 125mm	5.00 127	2.25 57	5.75 146
6" 150mm	5.50 140	2.25 57	5.75 146
8" 200mm	6.75 171	2.75 70	6.38 162
10" 250mm	8.00 203	2.75 70	8.25 210
12" 300mm	9.50 241	3.00 76	8.25 210
14" 350mm	10.50 267	3.00 76	8.25 210
16" 400mm	11.75 298	3.50 89	8.69 221
18" 450mm	12.50 318	3.50 89	9.06 230
20" 500mm	13.75 349	4.50 114	9.19 233
22" 550mm	15.50 394	4.50 114	9.19 233
24" 600mm	16.00 406	4.50 114	9.19 233
26" 650mm	17.13 435	4.63 117	9.50 241
28" 700mm	18.25 464	5.00 127	10.69 271
30"* 750mm	19.38 492	5.50 140	11.25 286
32" 800mm	20.88 530	6.00 152	11.25 286
36"* 900mm	23.00 584	6.00 152	11.25 286
42" 1050mm	26.50 673	6.50 165	13.50 343
48" 1200mm	Contact DeZURIK		

* 100 psi, face-to-face (H dimension) on 30" and 36" (750 and 900mm) is 4.62" (117mm)

Inches
Millimeters



2-16" (50-400mm) Valves

Actuator Number	Dimensions L 2" 50mm	3" 80mm	4" 100mm	5" 125mm	6" 150mm	8" 200mm	10" 250mm	12" 300mm	14" 350mm	16" 400mm	M	N
CY-PC4	22.26 565	23.98 609	26.26 667	30.64 778	32.18 817	—	—	—	—	—	5.38 137	1/4
CY-PC6	—	—	27.61 701	32.00 813	33.56 852	39.11 993	47.13 1197	None	—	—	7.88 200	1/4
CY-PC8	—	—	—	32.38 822	33.94 862	39.49 1003	49.57 1259	53.19 1351	59.06 1500	62.74 1594	10.50 267	1/2
CY-PC10	—	—	—	—	—	—	50.97 1295	54.59 1387	60.35 1533	64.03 1626	13.00 330	1/2
CY-PC12	—	—	—	—	—	—	50.94 1294	54.56 1386	60.70 1542	64.38 1635	15.00 381	1/2
CY-PC14	—	—	—	—	—	—	—	—	—	63.68 1617	17.00 432	1/2

Inches
Millimeters

18-48" (450-1200mm) Valves

Actuator Number	Dimensions L 18" 450mm	20" 500mm	22" 550mm	24" 600mm	26" 650mm	28" 700mm	30" 750mm	32" 800mm	36" 900mm	42" 1050mm	48" 1200mm	M	N
CY-PC10	73.59 1869	77.16 1960	—	—	—	—	—	—	—	—	—	13.00 330	1/2
CY-PC12	73.935 1878	77.495 1968	85.52 2172	89.475 2273	—	—	—	—	—	—		15.00 381	1/2
CY-PC14	73.24 1860	76.81 1951	85.52 2172	88.78 2255	95.38 2423	101.44 2577	108.19 2748	—	—	—		17.00* 432	1/2
CY-PC16	70.25 1784	75.94 1929	82.00 2083	87.91 2233	95.50 2426	101.56 2580	108.31 2751	113.94 2894	125.81 3196	—	Contact DeZURIK	17.00 432	1/2
CY-PC18	—	—	—	88.16 2239	95.75 2432	101.81 2585	108.56 2757	114.19 2900	126.06 3202	143.19 3637		19.00 483	3/4
CY-PC20	—	—	—	—	—	102.06 2592	109.81 2789	115.44 2932	126.31 3208	143.44 3643		21.00 533	3/4

* M dimension on 26-30" (650-750mm) is 14.75" (375mm)

Inches
Millimeters

Sales and Service

For information about our worldwide locations, approvals, certifications and local representative:
Web Site: www.dezurik.com E-Mail: info@dezurik.com

250 Riverside Ave. N. Sartell, Minnesota 56377 • Phone: 320-259-2000 • Fax: 320-259-2227

DeZURIK, Inc. reserves the right to incorporate our latest design and material changes without notice or obligation. Design features, materials of construction and dimensional data, as described in this bulletin, are provided for your information only and should not be relied upon unless confirmed in writing by DeZURIK, Inc. Certified drawings are available upon request.

Printed in the U.S.A.

INSTALLATION

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluid, before installation-

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Before installing the valve, inspect the valve body port and associated equipment for any damage that may have occurred and for any foreign matter that may have collected in shipping or storage. Make certain the body interior is clean.

2. Before installing the valve, inspect the pipe line and mating flanges, making sure the pipe is free of foreign material and the flanges are clean and have no burrs or pits that could cause leakage.

3. Due to stainless steel castings, machining tolerances, and flange thickness, the body tapped hole depth may vary slightly from valve to valve. It is, therefore, recommended that all knife gates be installed with a stainless steel ASTM A-304-B8 stud or an ASTM A-316-B-8M stud. The use of a carbon steel B-7 stud may also be considered. We further recommend the use of a teflon thread compound. It should be pointed out that the use of cap screws or bolts may harm the chest in the knife gate by bottoming out and should never be used on this area of the knife gate valve.

4. The Davis Knife Gate is manufactured with ANSI B 16.5 – 150# raised face flange dimensions. The use of a suitable gasket between the body and the pipe line flanges shall be selected by the customer. We would recommend the use of a PTFE gasket.

5. Carefully place the valve between the flanges and loosely assemble the valve by putting in the bottom two or three studs, then carefully insert the gaskets into place. The bottom studs will help locate the gasket and hold it in position.

6. Carefully insert the balance of the studs into place and tighten all of them evenly – <u>not in rotation</u> – but by the cross over method. <u>CAUTION:</u> Do not over tighten chest cavity studs.

7. The Davis Knife Gate Valve may be installed in any orientation in the pipe line, however, the normal method is with the handwheel vertical above the valve body. Other positions are acceptable, however, they may result in uneven valve wear.

8. The resilient seat knife gate is a bi-directional valve and will operate with the flow in either direction. Care must be taken with the metal-seated valve as it is a unidirectional valve (or a one-flow-direction valve). Make sure that the metal-seated valve is oriented so that the pipe line flow is in the same direction as the arrow on the side of the valve body. This will insure that the valve seat is on the downstream side of the gate.

9. <u>All</u> Resilient-Seated Knife Gate Valves require the resilient seat to be lubricated before stroking, regardless of type of actuator. The fit pressure of the gate against the resilient seat, on the sides of the valve up thru the packing gland, is such that stroking the valve dry (with no lubrication of any kind) will cause the resilient seat to cold flow beyond safe limits and will damage the seat with just a few strokes. CRC or WD40, sprayed on the seat, up in the chest area, both sides, will normally provide sufficient lubrication. This should be repeated every 2 or 3 strokes. This is <u>CRITICAL</u> to the life and performance of the seat. In operation, the process product normally supplies adequate lubrication.

OPERATION

1. After the valve has been installed, cycle the valve once completely. Open the valve by turning the handwheel counter clockwise, reverse the operation for closing. (Note: This will detect if any damage has been incurred either due to shipping or installation processes.) After installing Resilient Seat Valves (Lug Type), <u>be sure to determine that bonnet nut and lock nut are secure</u>. If either lock or bonnet nut are loose, adjust as follows:

    1. Back lock nut in counterclockwise rotation 2 turns.
    2. Back bonnet nut in counterclockwise rotation 2 turns.
    3. Turn handwheel in clockwise motion until gate bottoms out, then turn handwheel at that point ¼ turn more.
    4. Tighten bonnet nut down to stop-out against stem nut.
    5. Secure lock nut down on bonnet nut to hold in position.

After cycling the gate valve, turn the handwheel counterclockwise several turns allowing partial opening for preparation to fill system.

2. Open upstream valve slowly, building system pressure gradually, allowing installation personnel to detect any excessive packing gland leakage, making adjustments necessary.

3. After the system has come to a full pressure, open the knife gate fully by turning the handwheel counterclockwise, then close the valve fully by turning the handwheel clockwise. In resilient seat knife gate valves, this process will result in "seating in the valve." This step may be eliminated with the metal-seated valve.

4. You may now use the valve for its intended purpose, keeping in mind that a gate valve should be used in a full open or a full closed position. Gate valves <u>should not</u> be used for throttling unless specifically designed for such a use.

MAINTENANCE

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of the service conditions. This section includes instructions for packing adjustments, repacking, seat replacement, and seating adjustment.

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluids, before installation –

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Normal maintenance of the Davis Knife Gate Valve may only include a periodic tightening of the packing gland. Should a leak occur at the packing gland, simply tighten the packing gland bolt closest to the leak. This may require tightening two or three bolts on larger valves. After the leak has stopped, tighten all packing gland bolts ¼ turn. Do not over tighten. The only other normal maintenance required would be to grease the valve stem by using a grease gun at the grease fitting located on the valve yoke.

2. From time to time, it may be necessary to repack the valve completely. This can be done following the warning procedure listed above. Standard repacking kits are available through Davis Valve. Packing kits include necessary packing and a top wiper seal gasket which insures a tight seal. When ordering be sure to specify valve model number,

indicating type of seat and type of valve. Repacking the valve includes the following steps:

1. Remove packing gland nuts and lock washers.
2. Raise blade to the full open position.
3. Pull up the packing gland to the top of the blade and secure it to the top of the blade.
4. Using a packing hook, remove all of the old packing.
5. Carefully clean the stuffing box. If oil, grease, wax, or graphite impregnated packings were used, it might be necessary to use a solvent to clean the stuffing box.
6. Purchase precut packing kits from Davis Valve or carefully cut each ring by wrapping a length of packing around the blade snugly, but without tension. Cut each ring individually, making a square cut with a clean, sharp knife.
7. Insert rings one at a time into stuffing box. Tamp each ring lightly in place using a flat packing iron. Packing joints may be located 90° apart, on metal-seated valves, to minimize leakage. Successive layers are installed in the same manner.
8. Pull the packing gland down and tighten using only the two end studs until the packing gland almost bottoms out.
9. Remove the packing gland as previously described.
10. Insert the wiper seal gasket.
11. Pull down packing gland using lock washers and nuts and tighten using alternate method. Do not over tighten.
12. Bring the valve up to pressure and tighten the packing gland following the procedures listed under the maintenance instructions.

VALVE THRUST AND TORQUE VALUES

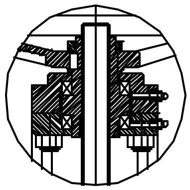
	Size	Valve Thrust lbs	Valve Torque ft lbs	Flow Coefficient Gal. per min. at a pressure drop of 1 psi
MODEL 60	2	648	9	285
	3	898	12	760
	4	1253	17	1420
	5	---	---	2890
	6	2077	37	3300
	8	3590	63	5800
	10	5469	97	11000
	12	7299	141	16500
	14	8573	166	20500
	16	10959	230	27000
	18	14409	302	36000
	20	17189	409	45000
	24	23801	592	60000
	30	---	---	95000
	36	---	---	138000
MODEL 61	2			285
	3			760
	4			1420
	5			2890
	6			3300
	8			5800
	10			11000
	12			16500
	14			20500
	16			27000
	18			36000
	20			45000
	24			60000
	30			95000
	36			138000
MODEL 70	2	565	8	285
	3	774	11	760
	4	1094	15	1420
	6	1958	27	3300
	8	3582	63	5800
	10	5541	98	11000
	12	7379	130	16500
	14	9551	185	20500
	16	12058	233	27000
	18	15353	322	36000
	20	18528	389	45000
	24	25880	616	60000

DV

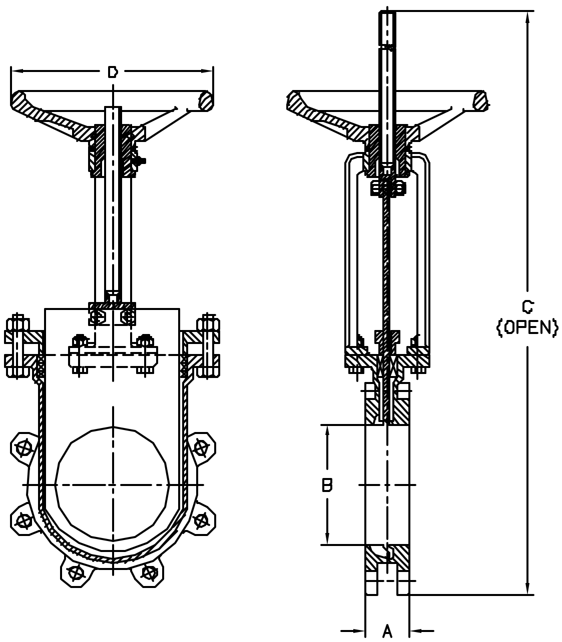
Davis Valve

Memphis, Tennessee

Stainless Steel Knife Gate



Model 60C - CF8 (304SS)
Model 60F - CF8M (316SS)
Model 60G - CG8M (317SS)



PART NAME	MATERIALS A 351-CF8	MATERIALS A 351-CF8M	MATERIALS A 351-CG8M
BODY	A 351-CF8	A 351-CF8M	A 351-CG8M
GATE	SS 304	SS 316	SS 317
YOKE	A 351-CF8	A 351-CF8	A 351-CF8
STEM	SS 304	SS 304	SS 304
GLAND	A 351-CF8	A 351-CF8M	A 351-CG8M
GLAND PACKING	PTFE	PTFE	PTFE
STEM NUT	AL BRONZE	AL BRONZE	AL BRONZE
HAND WHEEL	A 216-WCB	A 216-WCB	A 216-WCB

SIZE	INCH	2	2½	3	4	5	6	8	10	12	14	16	18	20	24	30	36
	MM	50	65	80	100	127	150	200	250	300	350	400	450	500	600	762	915
A	INCH	1.88	2.0	2.0	2.0	2.25	2.25	2.75	2.75	3.0	3.0	3.5	3.5	4.5	4.5	5.4	6.3
	MM	47.8	50.8	50.8	50.8	57.2	57.2	69.9	69.9	76.2	76.2	88.9	88.9	114.3	114.3	137.1	160.0
B	INCH	2.0	2.5	3.0	4.0	5.0	6.0	8.0	10.0	12.0	13.25	15.25	17.25	19.25	23.25	29.25	35.25
	MM	50.8	63.5	76.2	101.6	127.0	152.4	203.2	254.0	304.8	336.5	387.3	438.1	488.9	590.5	742.9	895.3
C	INCH	15.5	19.3	19.3	23.0	26.2	29.25	36.25	44.0	51.0	57.0	66.0	73.0	79.5	93.0	131.9	151.9
	MM	393.7	490.2	490.2	584.2	665.4	743.0	920.8	1117.6	1295.4	1447.8	1676.0	1854.0	2019.3	2362.2	3350.4	3858.2
D	INCH	8.0	8.0	8.0	10.0	10.0	12.0	14.0	16.0	16.7	18.9	18.9	20.9	20.9	24.8	36.7	36.7
	MM	203.0	203.0	203.0	254.0	254.0	304.8	355.6	406.4	424.1	480.0	480.0	530.8	530.8	630.0	932.1	932.1
WGT	LBS	22		31	38	47	59	84	124	170	201	294	372	503	671	1810	2252
	KGS	10		14	18	22	27	38	56	77	91	133	168	228	305	820	1020

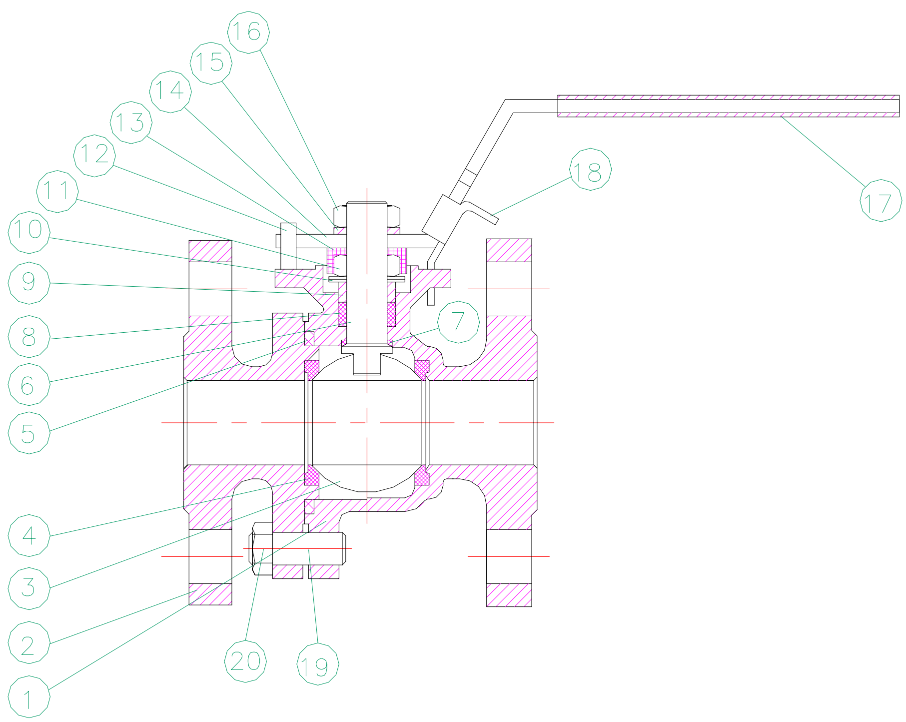
Davis Valve

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes ½" – 4" , Classes 150, 300, and 600

ITEM	DESCRIPTION
1	BODY
2	END CONNECTOR
3	BALL
4	SEAT
5	BODY GASKET
6	STEM
7	THRUST BEARING
8	STEM PACKING
9	GLAND PACKING
10	BELLVILLE WASHER
11	STEM NUT
12	STOPPER
13	LOCK TAB
14	HANDLE
15	HANDLE WASHER
16	HANDLE NUT
17	SLEEVE
18	LOCKING DEVICE
19	STUD
20	NUT



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150, 300, or 600.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the adjusting nut 1/4 turn. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle and travel stop plate.

3. Remove stem nut locking tab, stem nut, belleville springs, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

7. Take out other seat.

8. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Install one seat in the body cavity with the spherical curvature facing the ball.

2. Install thrust bearing on stem and slide the stem up through the body.

3. Install new stem seals, gland ring, and belleville springs. Install stem nut and tighten to the torque values given in Table 1. Install stem nut locking tab or cap. Tighten stem nut slightly if necessary to align nut with locking device surfaces.

4. Install travel stop (if supplied) and handle. Make sure handle aligns with flow bore through ball. Install hand retainer nut (or capscrew).

5. Turn the handle to the CLOSED position. Line up the ball slot with the stem tang and the ball into position on the stem tang. Turn the handle to the OPEN position to hold the ball in place.

6. Install the remaining seat into body end.

7. Place new body seal into counterbore in valve body.

8. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

9. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

10. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

11. Pressure test valve, if possible, before reinstalling in pipeline.

Table 1 - Stem Nut Torques

Valve Size	Torque (lb-ft)
½”	5.5
¾”	5.5
1”	6
1-1/2” – 4”	22

Table 2 – Body Bolting Torques (lb-ft)

Valve Size	Class 150	Class 300	Class 600
½”	5	10	15
¾”	5	10	20
1”	5	20	35
1-1/2”	15	35	80
2”	20	40	140
3”	20	60	155
4”	25	95	215

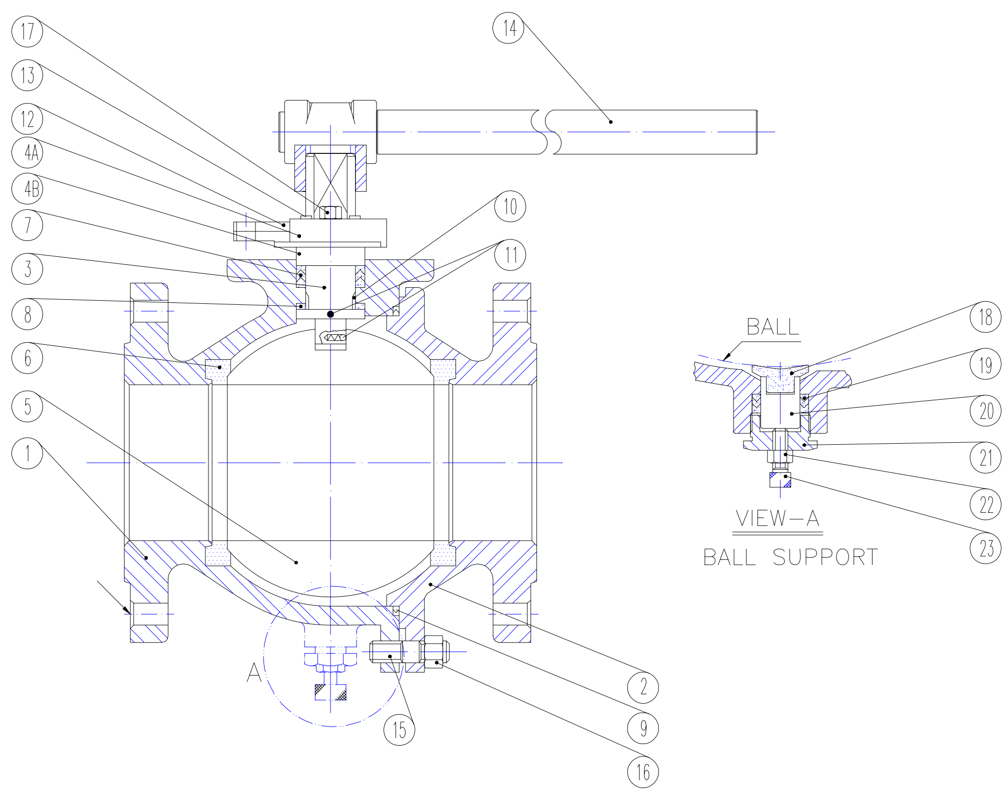
Note: Torque values are for TFE/RTFE or flexible graphite gaskets and seals. For other materials contact Sharpe Valves.

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes 6” - 12” , Classes 150 & 300

NO.	PART NAME
1	BODY
2	CAP
3	STEM
4A	GLAND
4B	GLAND RING
5	BALL
6	SEAT
7	PACKING
8	THRUST WASHER
9	GASKET
10	STEM BEARING
11	ANTI–STATIC
12	TRAVEL STOPPER
13	SNAP RING
14	HANDLE
15	STUD
16	NUT
17	GLAND BOLT
18	PIN SEAT
19	PIN PACKING
20	SUPPORT PIN
21	SUPPORT NUT
22	SET NUT
23	TUNING SCREW



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools. Ball support supplied for 10” and 12” Class 150 valves, and 6” through 12” Class 300 valves.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150 or Class 300.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the gland bolts 1/4 turn, each. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle, snap ring, and travel stop plate.

3. Remove gland bolts, gland, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. **<u>For 10” and 12” valves only</u>**: Ball support must be backed off to remove ball. Loosen support nut, set nut and back out tuning screw on bottom of valve to release the ball support. The weight of the ball will cause the ball support to come down.

7. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

8. Take out other seat.

9. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing and stem bushing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Set the valve body on a clean work suface, resting on the end flange.

2. Install one seat in the body cavity with the spherical curvature facing the ball (upwards).

3. Cut new stem bushing on one side at approx. 30° - 60° angle and wrap around stem above shoulder.

4. Install thrust bearing on stem and holding stem bushing in place, slide the stem up through stem bore from inside body.

5. Install new stem seals, gland ring, and gland. Install gland bolts and tighten hand tight.

6. Install travel stop, and snap ring.

7. Turn the stem to the CLOSED position (bottom stem tan parallel to flow passage). Line up the ball slot with the stem tang and roll and lower the ball into position on the stem tang, letting the ball rest in the seat. Turn the stem and ball to the OPEN position to hold the ball in place.

8. **For 10” and 12” Valves Only:** Re-set the ball support by turning the tuning screw inwards until the support pin seat firmly contacts the ball. Do not cause the ball to move. Holding the tuning screw in place, tighten the support nut and then the set nut.

9. Install the remaining seat into body end.

10. Place new body seal into counterbore in valve body.

11. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

12. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

13. Tighten the gland bolts to the torques specified in Table 1.

14. Install handle, making sure that the handle aligns with the flow passage through the ball.

15. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

16. Pressure test valve, if possible, before reinstalling in pipeline.

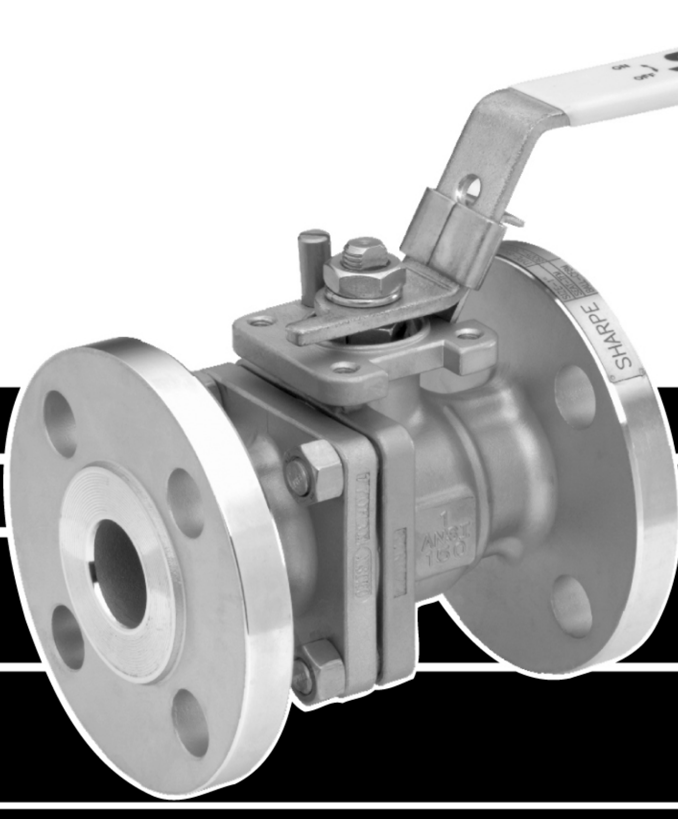
Table 1 – Gland Bolt Torques

SIZE	Tightening Torque (lb-ft) Max
6” – 8”	42 (1/2-13UNC)
10” - 12”	83 (5/8-11UNC)

Table 2 – Body Bolting Torques

SIZE	THREAD	Tightening Torque (lb-ft) Max
6”,8” (Class 150) / 3”~6”(Class 300)	5/8-11UNC	83
10”,12” (Class 150) / 8”(Class 300)	3/4-10UNC	120
10”(Class 300)	7/8-9UNC	190
12”(Class 300)	1-8UNC	260

SHARPE® VALVES

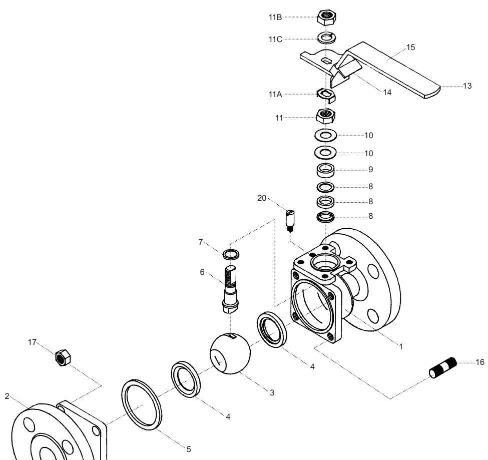


FLANGED FULL PORT
BALL VALVE
SERIES 50 / CLASS 150

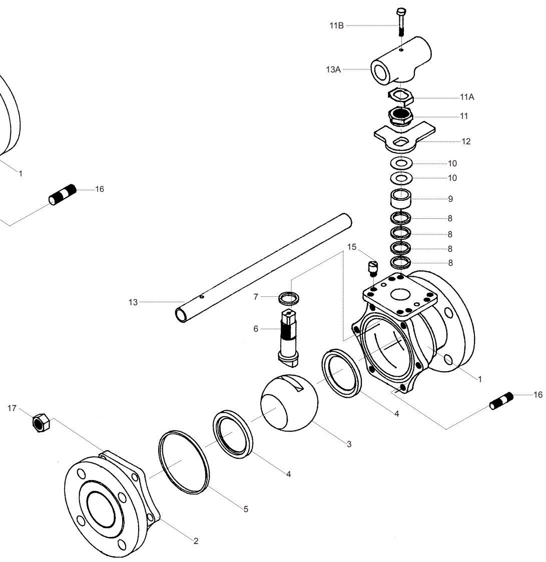
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

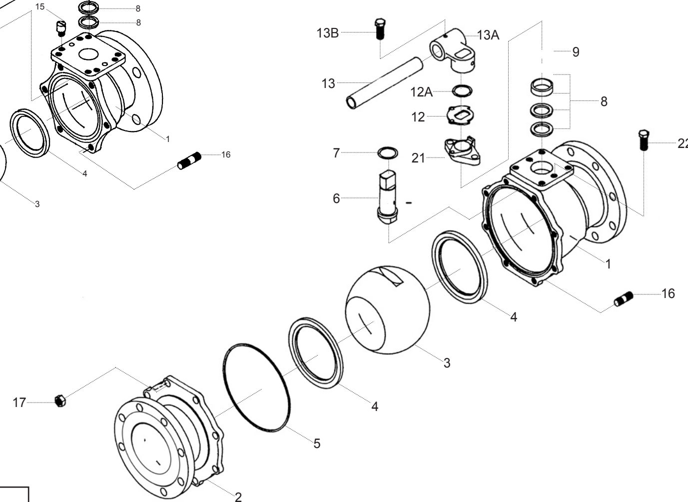
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2” - 2”



2-1/2” - 4”



6” - 8”

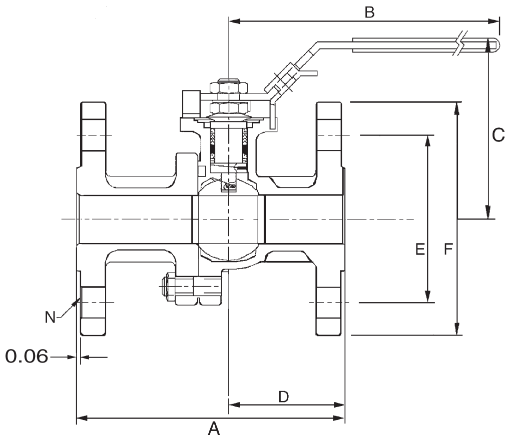
PART NO.	PART	QTY.	MATERIAL
1	Body	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) TFE Reinforced TFE NOVA PEEK
5	Body Seal	1	TFE
6	Stem	1	316 Stainless Steel Alloy 20 Hastelloy C 17-4PH (Option)
7	Thrust Bearing	2	Reinforced TFE
8	Stem Packing	3/4	Reinforced TFE
9	Gland Packing	1	304 Stainless Steel
10	Belleville Washer (1/2”-4”)	2/4	304 Stainless Steel
11	Packing Nut (1/2”-4”)	1	304 Stainless Steel
11A	Lock Tab	1	Stainless Steel
11B	Handle Nut	1	304 Stainless Steel
11C	Lock Washer	1	304 Stainless Steel (1/2”-2”)

*See Dimensions

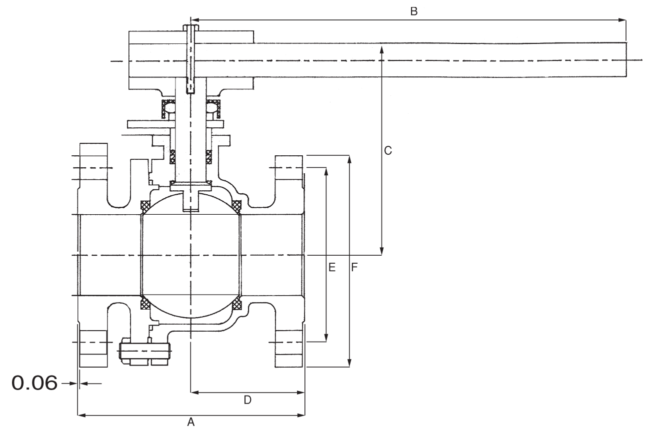
PART NO.	PART	QTY.	MATERIAL
12	Stopper	1	304 Stainless Steel
12A	Snap Ring	1	Stainless Steel (6”-8”)
13	Handle	1	304 Stainless Steel (1/2”-2”) Galvanized Steel (2-1/2”-4”) Ductile Iron (6”-8”)
13A	Wrench Block	1	Stainless Steel
13B	Hex Head Bolt	1	304 Stainless Steel
14	Locking Device (1/2”-2”)	1	304 Stainless Steel
15	Sleeve	1	Vinyl
16	Body Stud	SEE* N	A193 B8 (SST) A193 B7 (CS)
17	Nut	SEE* N	A194 8 (SST) A194 2H (CS)
20	Stop Pin (1/2”-2”) (2-1/2”-4”)	1 2	304 Stainless Steel 304 Stainless Steel
21	Gland Flange (6”-8”)	1	304 Stainless Steel
22	Gland Bolts (6”-8”)	2	304 Stainless Steel

SERIES 50 DIMENSIONS

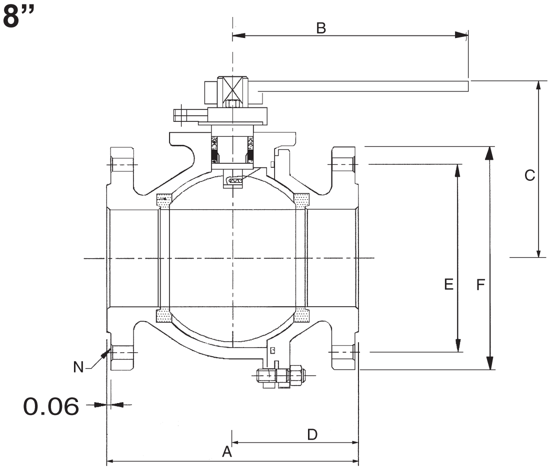
1/2" - 2"



2-1/2" - 4"



6" - 8"



CV DATA

1/2"	26
3/4"	50
1"	94
1-1/2"	260
2"	480
2-1/2"	750
3"	1300
4"	2300
6"	5400
8"	10000

PORT

1/2"	0.59
3/4"	0.78
1"	1.00
1-1/2"	1.50
2"	2.00
2-1/2"	2.55
3"	3.00
4"	4.00
6"	6.00
8"	7.88

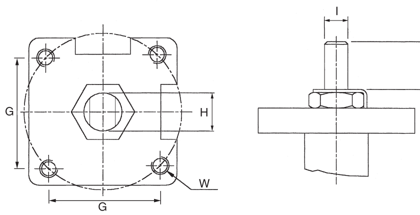
WEIGHT (lbs.)

1/2"	4
3/4"	6
1"	8
1-1/2"	15
2"	20
2-1/2"	36
3"	45
4"	75
6"	135
8"	290

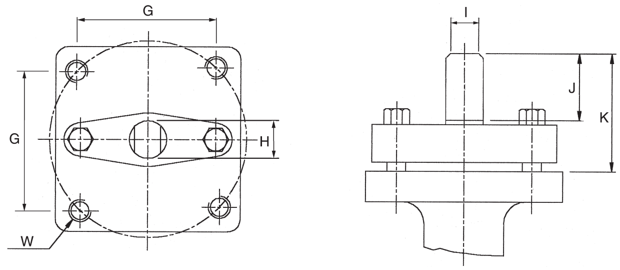
SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2"	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4"	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1"	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2"	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2"	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2"	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3"	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4"	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6"	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8"	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

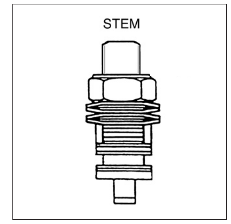
The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.

1/2" - 4"



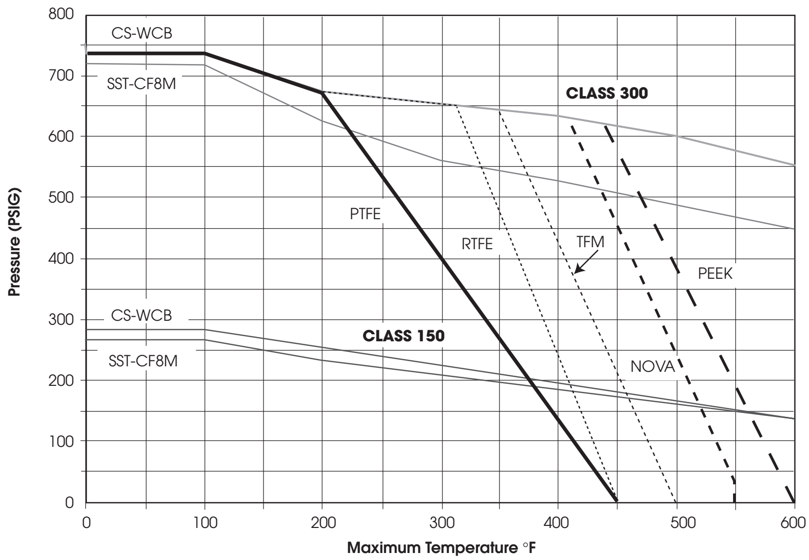
6" - 8"





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2"	50	150# = 11	2 = Alloy 20	T = TFE	X = Oxygen Service
3/4"			4 = Carbon Steel	R = RTFE	OH = Oval Handle
1"			6 = Stainless Steel	N = NOVA	F = Fugitive Emissions Certified ANSI 593.00.01
1-1/2"			5 = Hastelloy C	P = Peek	E = Extended Stem
2"			3 = Monel	M = TFM™	L = Lockable Extended Stem
2-1/2"					D = Leak detection Stem
3"					GO = Gear Operator
4"					7 = 17- 4PH Stem
6"					A = Nace
8"					

3/4" 50 11 6 T X

SHARPE® VALVES

A Division of Smith-Cooper International, LLC

Toll-Free 1-877-7SHARPE
(877) 774-2773
Fax: (708) 562-9250
E-Mail: info@sharpevalves.com
www.sharpevalves.com
1260 Garnet Drive
Northlake, Illinois 60164 U.S.A.

INSTALLATION

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluid, before installation-

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Before installing the valve, inspect the valve body port and associated equipment for any damage that may have occurred and for any foreign matter that may have collected in shipping or storage. Make certain the body interior is clean.

2. Before installing the valve, inspect the pipe line and mating flanges, making sure the pipe is free of foreign material and the flanges are clean and have no burrs or pits that could cause leakage.

3. Due to stainless steel castings, machining tolerances, and flange thickness, the body tapped hole depth may vary slightly from valve to valve. It is, therefore, recommended that all knife gates be installed with a stainless steel ASTM A-304-B8 stud or an ASTM A-316-B-8M stud. The use of a carbon steel B-7 stud may also be considered. We further recommend the use of a teflon thread compound. It should be pointed out that the use of cap screws or bolts may harm the chest in the knife gate by bottoming out and should never be used on this area of the knife gate valve.

4. The Davis Knife Gate is manufactured with ANSI B 16.5 – 150# raised face flange dimensions. The use of a suitable gasket between the body and the pipe line flanges shall be selected by the customer. We would recommend the use of a PTFE gasket.

5. Carefully place the valve between the flanges and loosely assemble the valve by putting in the bottom two or three studs, then carefully insert the gaskets into place. The bottom studs will help locate the gasket and hold it in position.

6. Carefully insert the balance of the studs into place and tighten all of them evenly – <u>not in rotation</u> – but by the cross over method. <u>CAUTION:</u> Do not over tighten chest cavity studs.

7. The Davis Knife Gate Valve may be installed in any orientation in the pipe line, however, the normal method is with the handwheel vertical above the valve body. Other positions are acceptable, however, they may result in uneven valve wear.

8. The resilient seat knife gate is a bi-directional valve and will operate with the flow in either direction. Care must be taken with the metal-seated valve as it is a unidirectional valve (or a one-flow-direction valve). Make sure that the metal-seated valve is oriented so that the pipe line flow is in the same direction as the arrow on the side of the valve body. This will insure that the valve seat is on the downstream side of the gate.

9. All Resilient-Seated Knife Gate Valves require the resilient seat to be lubricated before stroking, regardless of type of actuator. The fit pressure of the gate against the resilient seat, on the sides of the valve up thru the packing gland, is such that stroking the valve dry (with no lubrication of any kind) will cause the resilient seat to cold flow beyond safe limits and will damage the seat with just a few strokes. CRC or WD40, sprayed on the seat, up in the chest area, both sides, will normally provide sufficient lubrication. This should be repeated every 2 or 3 strokes. This is CRITICAL to the life and performance of the seat. In operation, the process product normally supplies adequate lubrication.

OPERATION

1. After the valve has been installed, cycle the valve once completely. Open the valve by turning the handwheel counter clockwise, reverse the operation for closing. (Note: This will detect if any damage has been incurred either due to shipping or installation processes.) After installing Resilient Seat Valves (Lug Type), be sure to determine that bonnet nut and lock nut are secure. If either lock or bonnet nut are loose, adjust as follows:

    1. Back lock nut in counterclockwise rotation 2 turns.
    2. Back bonnet nut in counterclockwise rotation 2 turns.
    3. Turn handwheel in clockwise motion until gate bottoms out, then turn handwheel at that point ¼ turn more.
    4. Tighten bonnet nut down to stop-out against stem nut.
    5. Secure lock nut down on bonnet nut to hold in position.

After cycling the gate valve, turn the handwheel counterclockwise several turns allowing partial opening for preparation to fill system.

2. Open upstream valve slowly, building system pressure gradually, allowing installation personnel to detect any excessive packing gland leakage, making adjustments necessary.

3. After the system has come to a full pressure, open the knife gate fully by turning the handwheel counterclockwise, then close the valve fully by turning the handwheel clockwise. In resilient seat knife gate valves, this process will result in "seating in the valve." This step may be eliminated with the metal-seated valve.

4. You may now use the valve for its intended purpose, keeping in mind that a gate valve should be used in a full open or a full closed position. Gate valves should not be used for throttling unless specifically designed for such a use.

MAINTENANCE

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of the service conditions. This section includes instructions for packing adjustments, repacking, seat replacement, and seating adjustment.

WARNING

To avoid personal injury to yourself or your fellow workers or damage to property from release of the process fluids, before installation –

1. Shut off all operating lines to the valve.
2. Isolate the valve completely from the process.
3. Release process pressure.
4. Drain the process fluid from the valve.

1. Normal maintenance of the Davis Knife Gate Valve may only include a periodic tightening of the packing gland. Should a leak occur at the packing gland, simply tighten the packing gland bolt closest to the leak. This may require tightening two or three bolts on larger valves. After the leak has stopped, tighten all packing gland bolts ¼ turn. Do not over tighten. The only other normal maintenance required would be to grease the valve stem by using a grease gun at the grease fitting located on the valve yoke.

2. From time to time, it may be necessary to repack the valve completely. This can be done following the warning procedure listed above. Standard repacking kits are available through Davis Valve. Packing kits include necessary packing and a top wiper seal gasket which insures a tight seal. When ordering be sure to specify valve model number,

indicating type of seat and type of valve. Repacking the valve includes the following steps:

1. Remove packing gland nuts and lock washers.

2. Raise blade to the full open position.

3. Pull up the packing gland to the top of the blade and secure it to the top of the blade.

4. Using a packing hook, remove all of the old packing.

5. Carefully clean the stuffing box. If oil, grease, wax, or graphite impregnated packings were used, it might be necessary to use a solvent to clean the stuffing box.

6. Purchase precut packing kits from Davis Valve or carefully cut each ring by wrapping a length of packing around the blade snugly, but without tension. Cut each ring individually, making a square cut with a clean, sharp knife.

7. Insert rings one at a time into stuffing box. Tamp each ring lightly in place using a flat packing iron. Packing joints may be located 90° apart, on metal-seated valves, to minimize leakage. Successive layers are installed in the same manner.

8. Pull the packing gland down and tighten using only the two end studs until the packing gland almost bottoms out.

9. Remove the packing gland as previously described.

10. Insert the wiper seal gasket.

11. Pull down packing gland using lock washers and nuts and tighten using alternate method. Do not over tighten.

12. Bring the valve up to pressure and tighten the packing gland following the procedures listed under the maintenance instructions.

VALVE THRUST AND TORQUE VALUES

	Size	Valve Thrust lbs	Valve Torque ft lbs	Flow Coefficient Gal. per min. at a pressure drop of 1 psi
MODEL 60	2	648	9	285
	3	898	12	760
	4	1253	17	1420
	5	---	---	2890
	6	2077	37	3300
	8	3590	63	5800
	10	5469	97	11000
	12	7299	141	16500
	14	8573	166	20500
	16	10959	230	27000
	18	14409	302	36000
	20	17189	409	45000
	24	23801	592	60000
	30	---	---	95000
	36	---	---	138000
MODEL 61	2			285
	3			760
	4			1420
	5			2890
	6			3300
	8			5800
	10			11000
	12			16500
	14			20500
	16			27000
	18			36000
	20			45000
	24			60000
	30			95000
	36			138000
MODEL 70	2	565	8	285
	3	774	11	760
	4	1094	15	1420
	6	1958	27	3300
	8	3582	63	5800
	10	5541	98	11000
	12	7379	130	16500
	14	9551	185	20500
	16	12058	233	27000
	18	15353	322	36000
	20	18528	389	45000
	24	25880	616	60000

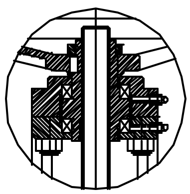
DV

Davis Valve

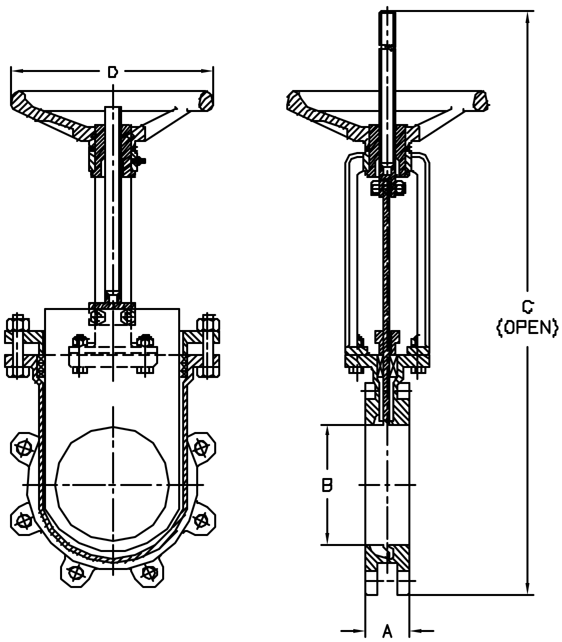
Memphis, Tennessee

Stainless Steel Knife Gate

TOPWORKS DETAIL
16" TO 48"



Model 60C - CF8 (304SS)
Model 60F - CF8M (316SS)
Model 60G - CG8M (317SS)



PART NAME	MATERIALS A 351-CF8	MATERIALS A 351-CF8M	MATERIALS A 351-CG8M
BODY	A 351-CF8	A 351-CF8M	A 351-CG8M
GATE	SS 304	SS 316	SS 317
YOKE	A 351-CF8	A 351-CF8	A 351-CF8
STEM	SS 304	SS 304	SS 304
GLAND	A 351-CF8	A 351-CF8M	A 351-CG8M
GLAND PACKING	PTFE	PTFE	PTFE
STEM NUT	AL BRONZE	AL BRONZE	AL BRONZE
HAND WHEEL	A 216-WCB	A 216-WCB	A 216-WCB

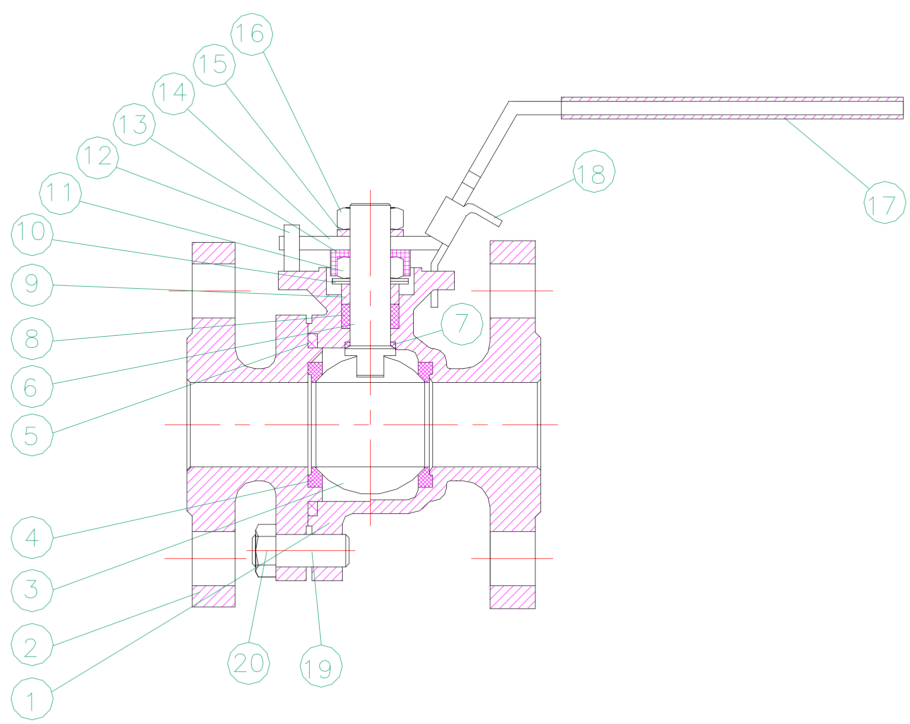
SIZE	INCH	2	2½	3	4	5	6	8	10	12	14	16	18	20	24	30	36
	MM	50	65	80	100	127	150	200	250	300	350	400	450	500	600	762	915
A	INCH	1.88	2.0	2.0	2.0	2.25	2.25	2.75	2.75	3.0	3.0	3.5	3.5	4.5	4.5	5.4	6.3
	MM	47.8	50.8	50.8	50.8	57.2	57.2	69.9	69.9	76.2	76.2	88.9	88.9	114.3	114.3	137.1	160.0
B	INCH	2.0	2.5	3.0	4.0	5.0	6.0	8.0	10.0	12.0	13.25	15.25	17.25	19.25	23.25	29.25	35.25
	MM	50.8	63.5	76.2	101.6	127.0	152.4	203.2	254.0	304.8	336.5	387.3	438.1	488.9	590.5	742.9	895.3
C	INCH	15.5	19.3	19.3	23.0	26.2	29.25	36.25	44.0	51.0	57.0	66.0	73.0	79.5	93.0	131.9	151.9
	MM	393.7	490.2	490.2	584.2	665.4	743.0	920.8	1117.6	1295.4	1447.8	1676.0	1854.0	2019.3	2362.2	3350.4	3858.2
D	INCH	8.0	8.0	8.0	10.0	10.0	12.0	14.0	16.0	16.7	18.9	18.9	20.9	20.9	24.8	36.7	36.7
	MM	203.0	203.0	203.0	254.0	254.0	304.8	355.6	406.4	424.1	480.0	480.0	530.8	530.8	630.0	932.1	932.1
WGT	LBS	22		31	38	47	59	84	124	170	201	294	372	503	671	1810	2252
	KGS	10		14	18	22	27	38	56	77	91	133	168	228	305	820	1020

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes ½” – 4” , Classes 150, 300, and 600

ITEM	DESCRIPTION
1	BODY
2	END CONNECTOR
3	BALL
4	SEAT
5	BODY GASKET
6	STEM
7	THRUST BEARING
8	STEM PACKING
9	GLAND PACKING
10	BELLVILLE WASHER
11	STEM NUT
12	STOPPER
13	LOCK TAB
14	HANDLE
15	HANDLE WASHER
16	HANDLE NUT
17	SLEEVE
18	LOCKING DEVICE
19	STUD
20	NUT



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150, 300, or 600.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the adjusting nut 1/4 turn. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle and travel stop plate.

3. Remove stem nut locking tab, stem nut, belleville springs, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a "rolling" motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

7. Take out other seat.

8. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Install one seat in the body cavity with the spherical curvature facing the ball.

2. Install thrust bearing on stem and slide the stem up through the body.

3. Install new stem seals, gland ring, and belleville springs. Install stem nut and tighten to the torque values given in Table 1. Install stem nut locking tab or cap. Tighten stem nut slightly if necessary to align nut with locking device surfaces.

4. Install travel stop (if supplied) and handle. Make sure handle aligns with flow bore through ball. Install hand retainer nut (or capscrew).

5. Turn the handle to the CLOSED position. Line up the ball slot with the stem tang and the ball into position on the stem tang. Turn the handle to the OPEN position to hold the ball in place.

6. Install the remaining seat into body end.

7. Place new body seal into counterbore in valve body.

8. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

9. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

10. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

11. Pressure test valve, if possible, before reinstalling in pipeline.

Table 1 - Stem Nut Torques

Valve Size	Torque (lb-ft)
½”	5.5
¾”	5.5
1”	6
1-1/2” – 4”	22

Table 2 – Body Bolting Torques (lb-ft)

Valve Size	Class 150	Class 300	Class 600
½”	5	10	15
¾”	5	10	20
1”	5	20	35
1-1/2”	15	35	80
2”	20	40	140
3”	20	60	155
4”	25	95	215

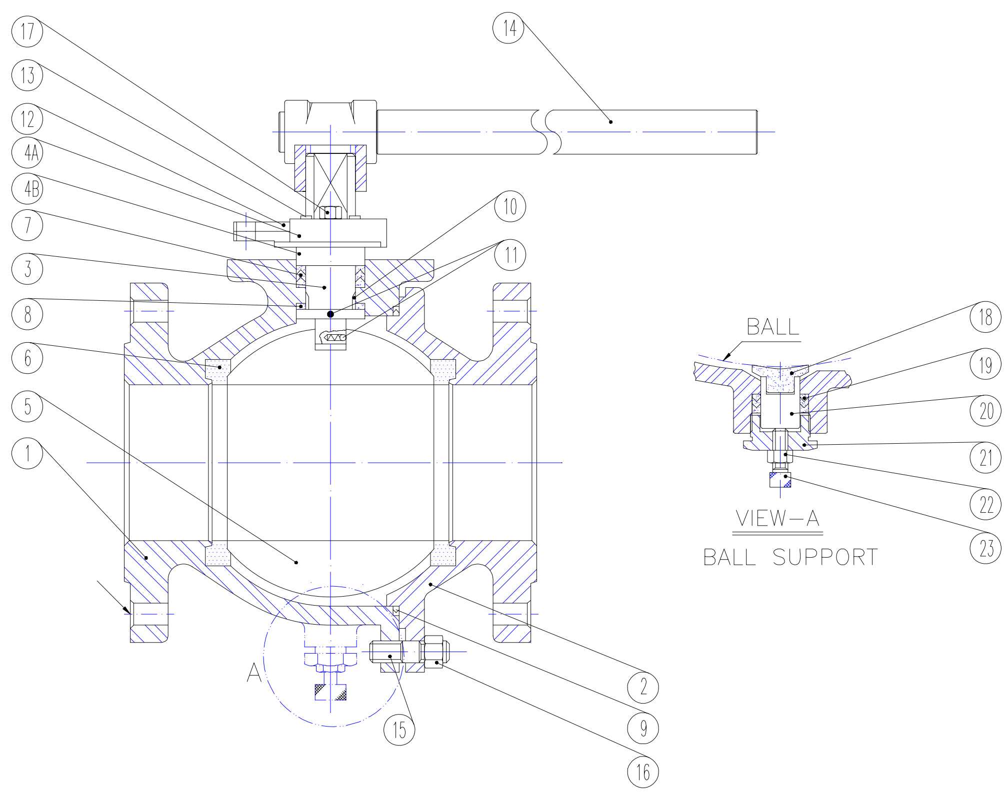
Note: Torque values are for TFE/RTFE or flexible graphite gaskets and seals. For other materials contact Sharpe Valves.

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes 6" - 12" , Classes 150 & 300

NO.	PART NAME
1	BODY
2	CAP
3	STEM
4A	GLAND
4B	GLAND RING
5	BALL
6	SEAT
7	PACKING
8	THRUST WASHER
9	GASKET
10	STEM BEARING
11	ANTI–STATIC
12	TRAVEL STOPPER
13	SNAP RING
14	HANDLE
15	STUD
16	NUT
17	GLAND BOLT
18	PIN SEAT
19	PIN PACKING
20	SUPPORT PIN
21	SUPPORT NUT
22	SET NUT
23	TUNING SCREW



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools. Ball support supplied for 10" and 12" Class 150 valves, and 6" through 12" Class 300 valves.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150 or Class 300.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the gland bolts 1/4 turn, each. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle, snap ring, and travel stop plate.

3. Remove gland bolts, gland, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. **<u>For 10” and 12” valves only</u>**: Ball support must be backed off to remove ball. Loosen support nut, set nut and back out tuning screw on bottom of valve to release the ball support. The weight of the ball will cause the ball support to come down.

7. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

8. Take out other seat.

9. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing and stem bushing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Set the valve body on a clean work suface, resting on the end flange.

2. Install one seat in the body cavity with the spherical curvature facing the ball (upwards).

3. Cut new stem bushing on one side at approx. 30° - 60° angle and wrap around stem above shoulder.

4. Install thrust bearing on stem and holding stem bushing in place, slide the stem up through stem bore from inside body.

5. Install new stem seals, gland ring, and gland. Install gland bolts and tighten hand tight.

6. Install travel stop, and snap ring.

7. Turn the stem to the CLOSED position (bottom stem tan parallel to flow passage). Line up the ball slot with the stem tang and roll and lower the ball into position on the stem tang, letting the ball rest in the seat. Turn the stem and ball to the OPEN position to hold the ball in place.

8. **For 10” and 12” Valves Only:** Re-set the ball support by turning the tuning screw inwards until the support pin seat firmly contacts the ball. Do not cause the ball to move. Holding the tuning screw in place, tighten the support nut and then the set nut.

9. Install the remaining seat into body end.

10. Place new body seal into counterbore in valve body.

11. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

12. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

13. Tighten the gland bolts to the torques specified in Table 1.

14. Install handle, making sure that the handle aligns with the flow passage through the ball.

15. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

16. Pressure test valve, if possible, before reinstalling in pipeline.

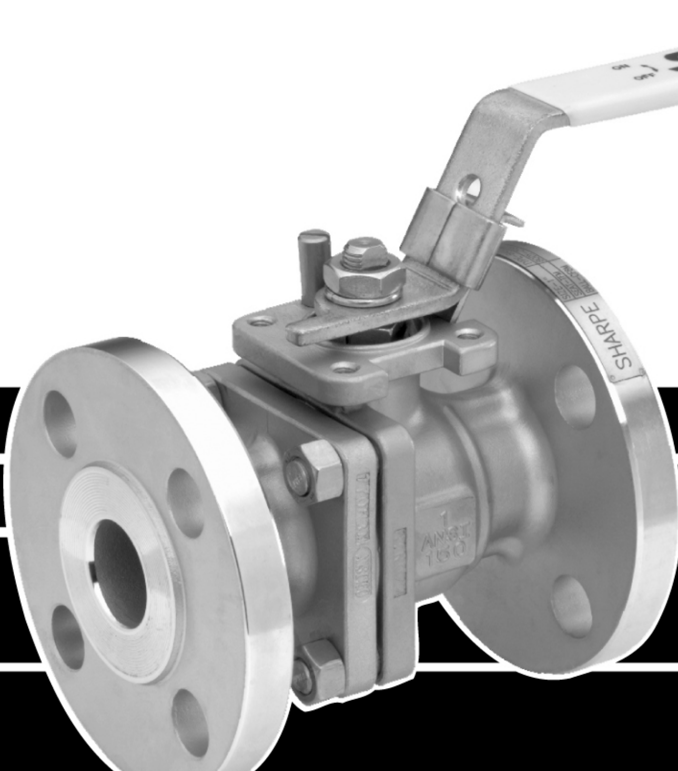
Table 1 – Gland Bolt Torques

SIZE	Tightening Torque (lb-ft) Max
6” – 8”	42 (1/2-13UNC)
10” - 12”	83 (5/8-11UNC)

Table 2 – Body Bolting Torques

SIZE	THREAD	Tightening Torque (lb-ft) Max
6”,8” (Class 150) / 3”~6”(Class 300)	5/8-11UNC	83
10”,12” (Class 150) / 8”(Class 300)	3/4-10UNC	120
10”(Class 300)	7/8-9UNC	190
12”(Class 300)	1-8UNC	260

SHARPE® VALVES

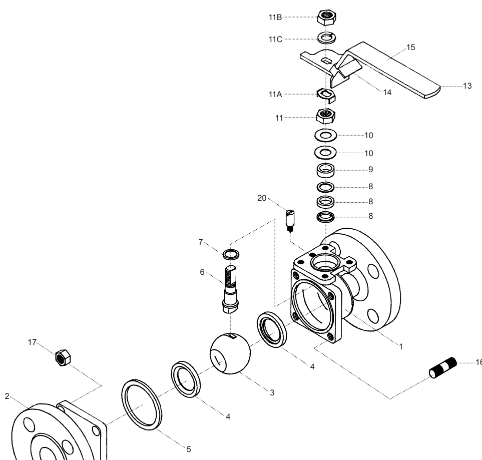


FLANGED FULL PORT BALL VALVE
SERIES 50 / CLASS 150

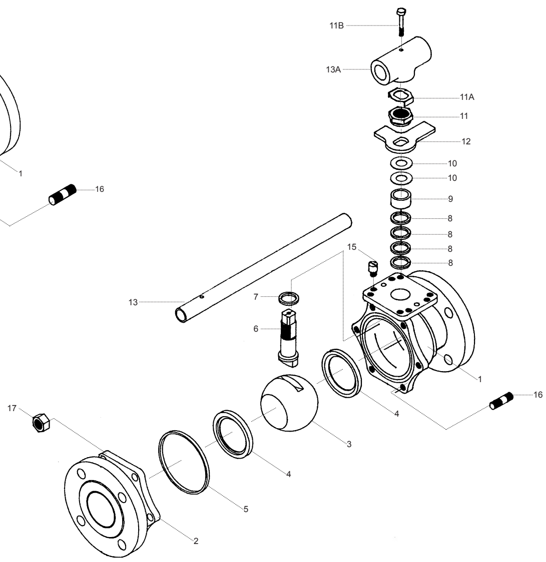
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

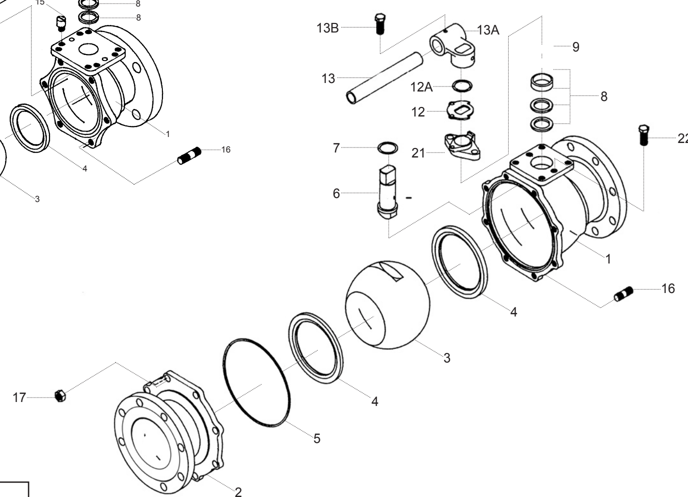
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2” - 2”



2-1/2” - 4”



6” - 8”

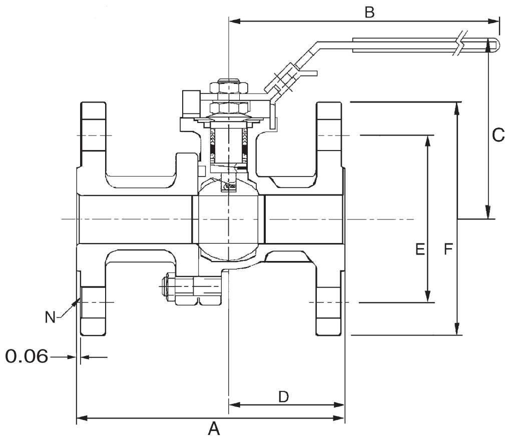
PART NO.	PART	QTY.	MATERIAL
1	Body	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) TFE Reinforced TFE NOVA PEEK
5	Body Seal	1	TFE
6	Stem	1	316 Stainless Steel Alloy 20 Hastelloy C 17-4PH (Option)
7	Thrust Bearing	2	Reinforced TFE
8	Stem Packing	3/4	Reinforced TFE
9	Gland Packing	1	304 Stainless Steel
10	Belleville Washer (1/2”-4”)	2/4	304 Stainless Steel
11	Packing Nut (1/2”-4”)	1	304 Stainless Steel
11A	Lock Tab	1	Stainless Steel
11B	Handle Nut	1	304 Stainless Steel
11C	Lock Washer	1	304 Stainless Steel (1/2”-2”)

*See Dimensions

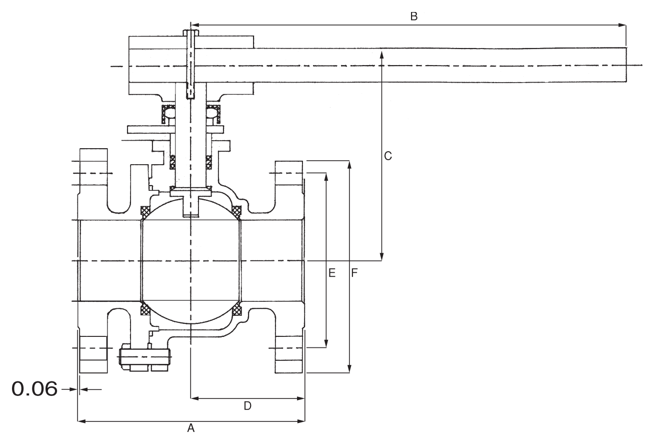
PART NO.	PART	QTY.	MATERIAL
12	Stopper	1	304 Stainless Steel
12A	Snap Ring	1	Stainless Steel (6”-8”)
13	Handle	1	304 Stainless Steel (1/2”-2”) Galvanized Steel (2-1/2”-4”) Ductile Iron (6”-8”)
13A	Wrench Block	1	Stainless Steel
13B	Hex Head Bolt	1	304 Stainless Steel
14	Locking Device (1/2”-2”)	1	304 Stainless Steel
15	Sleeve	1	Vinyl
16	Body Stud	SEE* N	A193 B8 (SST) A193 B7 (CS)
17	Nut	SEE* N	A194 8 (SST) A194 2H (CS)
20	Stop Pin (1/2”-2”) (2-1/2”-4”)	1 2	304 Stainless Steel 304 Stainless Steel
21	Gland Flange (6”-8”)	1	304 Stainless Steel
22	Gland Bolts (6”-8”)	2	304 Stainless Steel

SERIES 50
DIMENSIONS

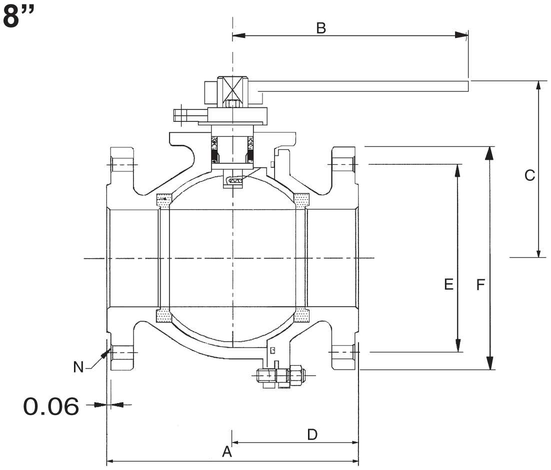
1/2" - 2"



2-1/2" - 4"



6" - 8"



CV DATA

1/2"	26
3/4"	50
1"	94
1-1/2"	260
2"	480
2-1/2"	750
3"	1300
4"	2300
6"	5400
8"	10000

PORT

1/2"	0.59
3/4"	0.78
1"	1.00
1-1/2"	1.50
2"	2.00
2-1/2"	2.55
3"	3.00
4"	4.00
6"	6.00
8"	7.88

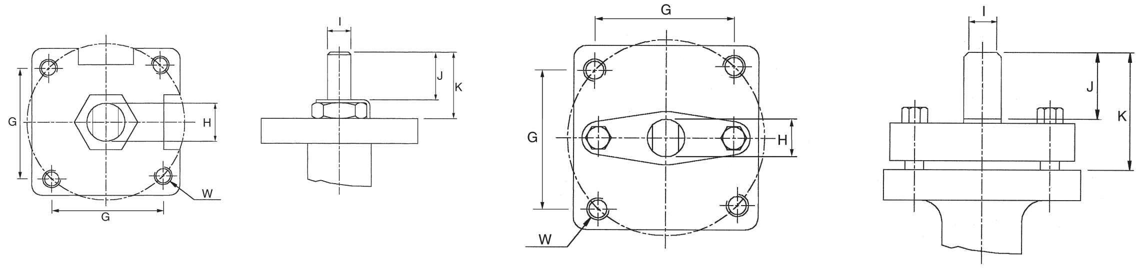
WEIGHT (lbs.)

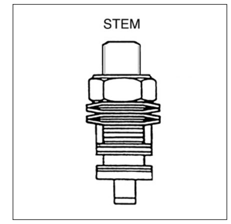
1/2"	4
3/4"	6
1"	8
1-1/2"	15
2"	20
2-1/2"	36
3"	45
4"	75
6"	135
8"	290

SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2"	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4"	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1"	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2"	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2"	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2"	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3"	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4"	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6"	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8"	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.

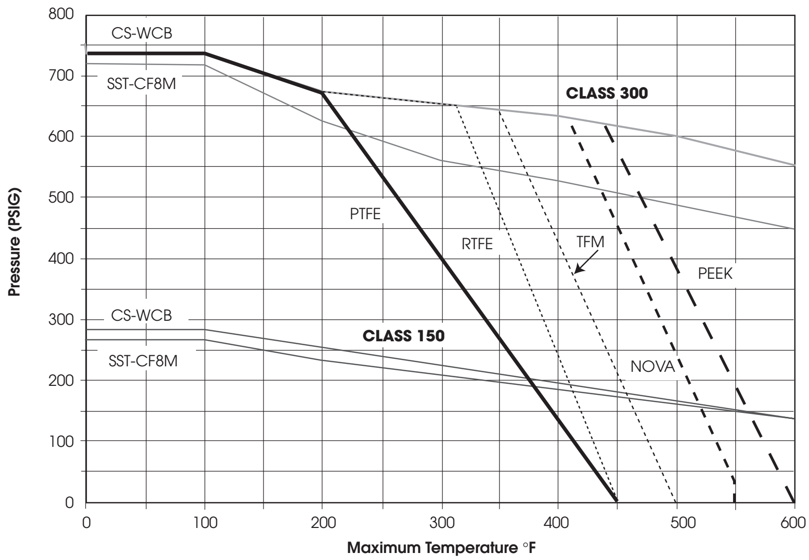
1/2" - 4"   6" - 8"





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



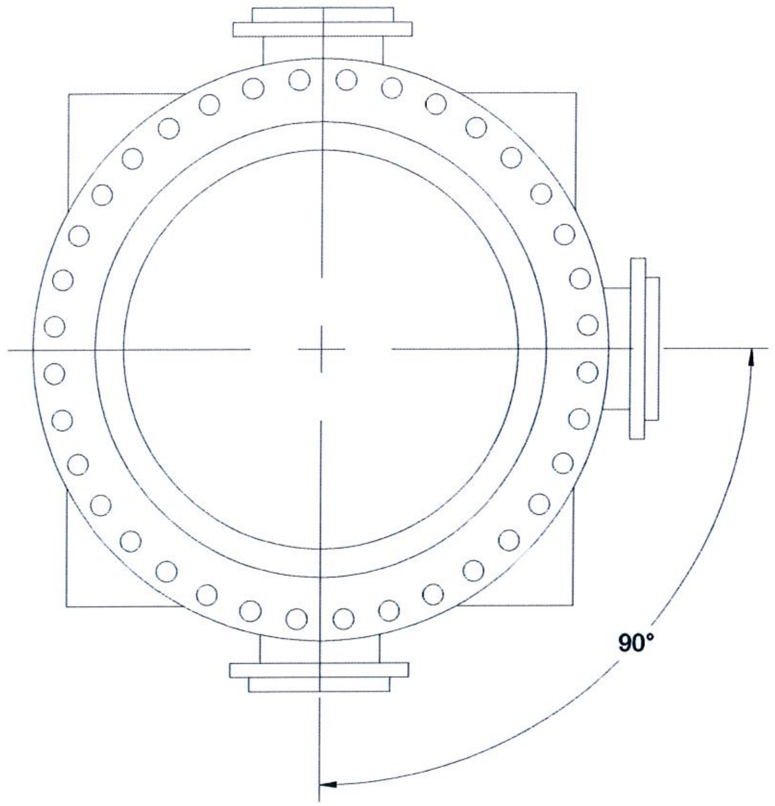
HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2″	50	150# = 11	2 = Alloy 20	T = TFE	X = Oxygen Service
3/4″			4 = Carbon Steel	R = RTFE	OH = Oval Handle
1″			6 = Stainless Steel	N = NOVA	F = Fugitive Emissions Certified ANSI 593.00.01
1-1/2″			5 = Hastelloy C	P = Peek	E = Extended Stem
2″			3 = Monel	M = TFM™	L = Lockable Extended Stem
2-1/2″					D = Leak detection Stem
3″					GO = Gear Operator
4″					7 = 17- 4PH Stem
6″					A = Nace
8″					

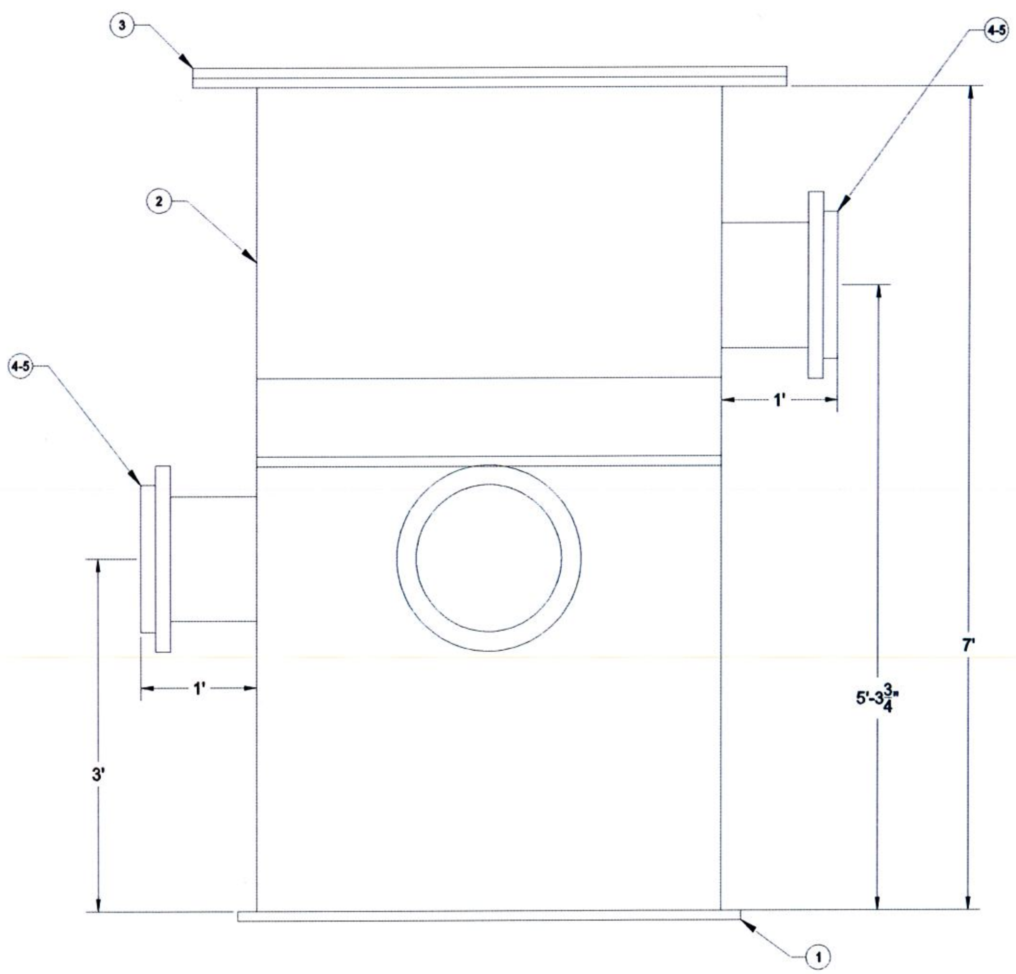
3/4"   50   11   6   T   X

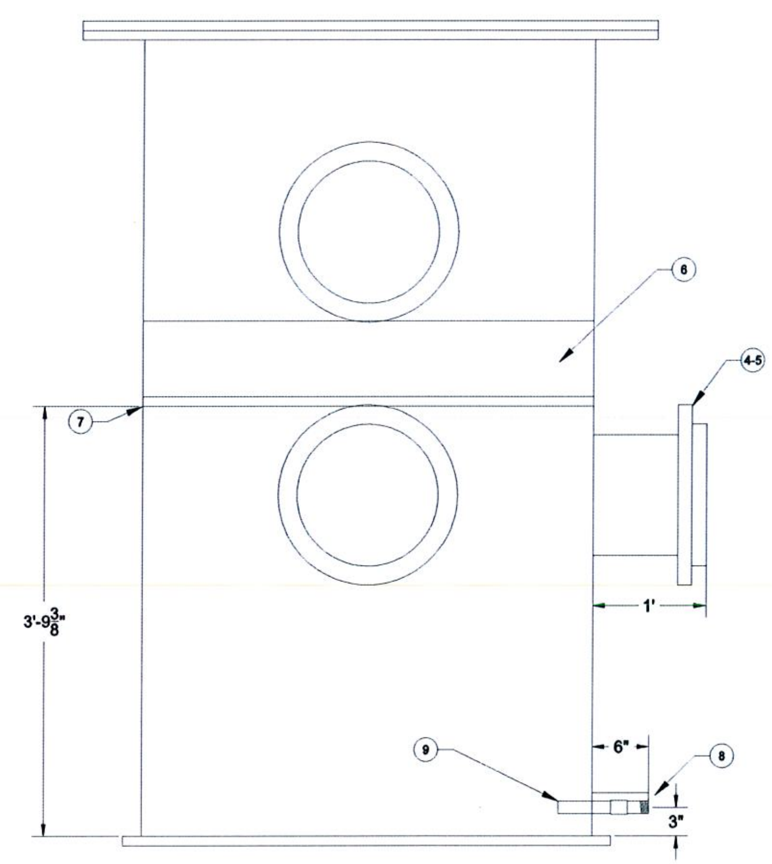
SHARPE® VALVES
A Division of Smith-Cooper International, LLC

Toll-Free 1-877-7SHARPE
(877) 774-2773
Fax: (708) 562-9250
E-Mail: info@sharpevalves.com
www.sharpevalves.com
1260 Garnet Drive
Northlake, Illinois 60164 U.S.A.



PARTS LIST		
ITEM	QTY	DESCRIPTION
1	1	54" X 54" X 1" HDPE SHEET STOCK BASE PLATE
2	5.5 FT	48' SDR 32.5 HDPE PIPE
3	1	48" FLANGE SET W/ NEOPRENE GASKET AND BOLTPACK
4	1	12" SDR 17 FLANGE ADAPTER
5	1	12" DI BACKING RING
6	1	DEMISTER PAD 8" OVERALL THICKNESS
7	1	HDPE SUPPORT RING FROM 1" SHEET 2" WIDE
8	1	1" HDPE SDR 11 SS MALE TRANSITION
9	1	1" HDPE SDR11 PIPE





PURE_AIR
KNOCK-OUT

Landmarc Environmental Systems, LLC

DRAWN BY: AWS	DATE: 12/19/2013	FILE: KNOCK-OUT
REVIEWED BY: MEM	CAD: KNOCK-OUT	SHEET # 1

Multi-Turn Bevel Gear (BG Type)
Installation & Operation Instructions

Installation Tips:
All DYNATORQUE™ operators & accessories have been designed to transmit the rated output torque of the operator with a safety factor. When designing mounting kits, torque transmission devices, or specifying mounting hardware the operator rating should be considered. DYNATORQUE recommends using grade 5 and higher bolts with lock washers for mounting operators to valve operator flanges and valve adaptation kits. DYNATORQUE components should not be installed in areas where those components will be subjected to high temperatures, corrosive atmospheres, or high pressures without prior knowledge by DYNATORQUE or unless originally designed for that purpose. Doing so may affect the product warranty.

Installation:
Before assembly is begun please insure that mounting bolt patterns have been machined correctly for the application.
The following steps should be taken to install the DYNATORQUE BG manual multi-turn operator. DYNATORQUE recommends operator mounting while on the test stand with the valve in the closed position.

Yoke Nut Driver Installation:
1. Move the valve in the closed position and insure valve seal has been attained.
2. Install the Yoke Nut Driver on the bottom of the bevel gear using the bolt pattern supplied.
3. Before installing the operator, liberally grease the Yoke Nut and the Yoke Nut Driver. This will reduce the possibility of corrosion between the two components.
4. Align the operator with the Yoke Nut and lower the operator into position on the valve flange or mounting kit.
5. Install and tighten the valve to operator mounting bolts.
6. Rotate the operator handwheel counterclockwise moving the valve from the closed to the open position checking to make sure the operator turns smoothly through the complete cycle. Visually verify that the open position has been achieved.
7. Rotate the valve from closed to open several times to insure proper operation.

Threaded Stem Nut Installation:
1. Move the valve in the closed position and insure valve seal has been attained.
2. Install the Threaded Stem Nut on the bottom of the bevel gear using the bolt pattern supplied.
3. Before installing the operator, liberally grease the Valve Stem and the Threaded Stem Nut. This will reduce the possibility of corrosion between the two components.
4. Position the Stem Nuts threaded hole over the valve stem. As you lower the operator, turn the input shaft. This rotation should engage the male with the female threads in the nut. Continue to rotate the input shaft until the unit comes into contact with the mounting adapter or valve operator-mounting flange.
5. Align the mounting holes by rotating the operator while allowing the input shaft to rotate freely. (If the operator-input shaft is held the valve position may move off the seat.)
6. Install and tighten the valve to operator mounting bolts.
7. Rotate the operator handwheel counterclockwise moving the valve from the closed to the open position checking to make sure the operator turns smoothly through the complete cycle. Visually verify that the open position has been achieved.
8. Rotate the valve from closed to open several times to insure proper operation.

Safety:
DYNATORQUE operators have been designed and manufactured to the highest quality standards. In most cases, operator and handwheel packages have been sized to produce rated torque with a maximum of 80 lbs. of handwheel rim effort. The use of larger handwheels, cheater bars, etc. will void the override warranty and may cause damage to the operator, valve stem, drive shafts, or other torque transmitting devises as well as being dangerous to the user. Additionally, the use of chainwheels on operators that are not recommended for those applications will result voiding operator warranty.

Operation:
Once the valve assembly has been installed, operation of multi-turn manual gear operators is very simple. Assuming a clockwise to close valve as in the assembly instructions, rotating the handwheel clockwise will result in clockwise output rotation or clockwise to close. Reversing rotation of the handwheel, counterclockwise, will result in counterclockwise rotation of the output or counterclockwise to open.

Please Note:

When assembling DYNATORQUE products to a valve or to an automated valve package, standard engineering practices must be utilized to assure proper mounting orientation, configuration, and distribution of weights and forces. Failure to do so could cause product damage and/or malfunction, ***and void warranty consideration***. If there are any questions please contact the factory.

FLOW CONTROL
2076 Northwoods Dr.
Muskegon, MI 49442
Tel 231.788.7025, Fax 231.788.7030
Info-DYT@c-a-m.com, www.c-a-m.com

CAMERON

CAMERON

Specifications For Multi-Turn Bevel Gear Operators: **Series BG**

Definition

DYNATORQUE™ Bevel geared operators are suited for applications where valve thrust and torque have been accurately calculated. All units have been designed to withstand loads far in excess of the rated thrusts and torques. Actuators in this category are totally enclosed, weather-proof, and permanently lubricated. Units are suitable for use in all handwheel and chainwheel applications.

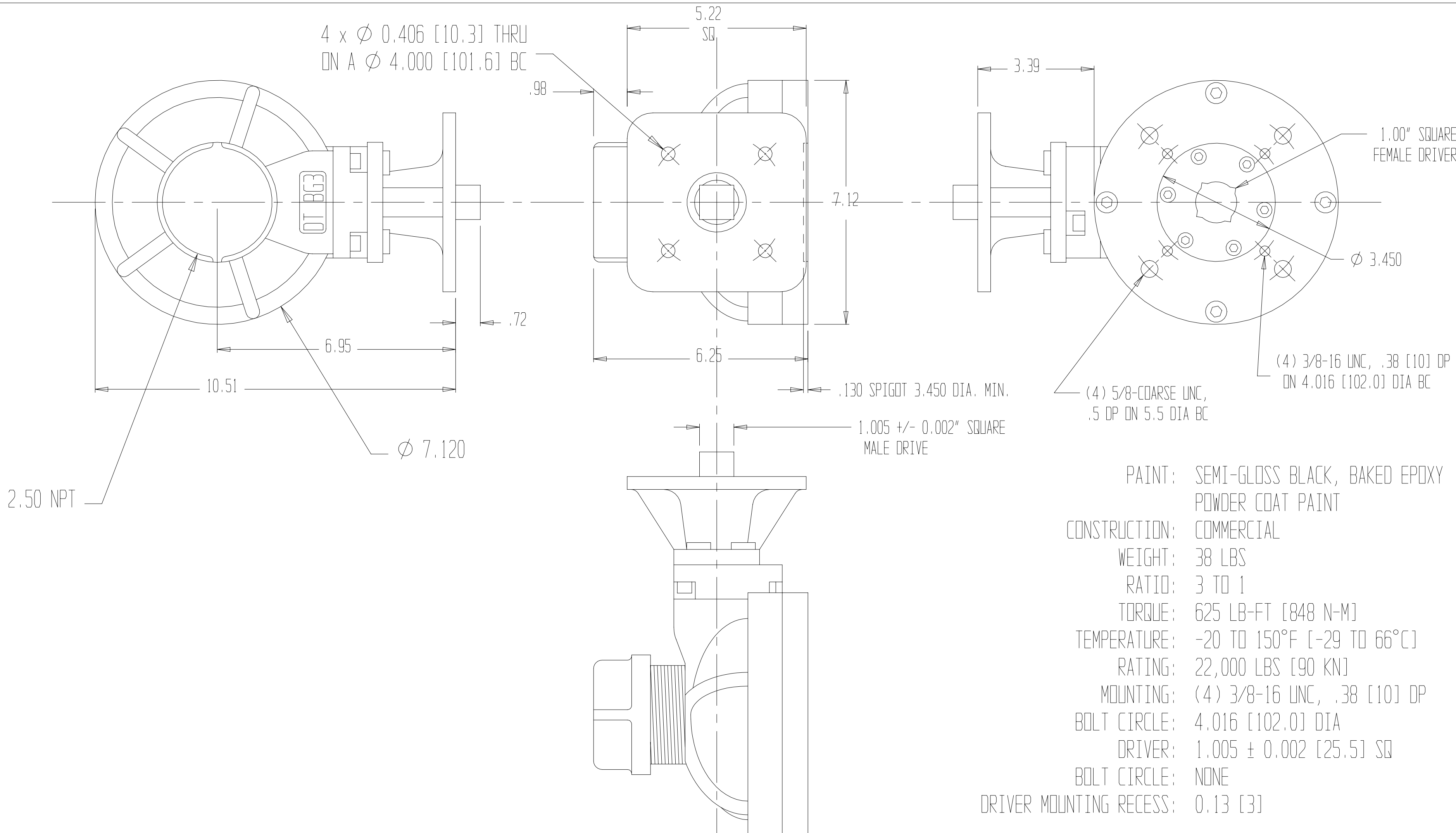
Construction

Unit housings, retainers, bevel gears and pinions are cast ductile iron (exception BG-4, bevel gear and pinion are 8620 steel); input shafts are carbon steel with yellow zinc coating, seals are Buna-N rubber, gaskets are impregnated styrene butadiene.

Model	Unit Wgt. Lbs.	Max. Output Torque Lb.-Ft.	Max. Thrust Lbs.	Gear Ratio	Mech. Adv.	Mounting Bolt Size and Qty.	Std. Mtg. Bolt Circle	Optional Mounting Bolt Circles
BG3	26	625	22,000	3:1	2.55	(4)5/8-11	5.512	3/8-16(4.016)-5/8-11(6.000)
BG34	60	625	22,000	12:1	8.16	(4)5/8-11	5.512	3/8-16(4.016)-5/8-11(6.000)
BG4	83	1,600	30,000	4:1	3.4	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG42	83	1,600	30,000	8:1	6.12	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG44	115	1,600	30,000	16:1	10.88	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG46	119	1,600	30,000	24:1	16.32	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG424	117	1,600	30,000	32:1	19.58	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG426	117	1,600	30,000	48:1	29.38	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG4GT	83	2,300	80,000	4:1	3.4	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG42GT	83	2,300	80,000	8:1	6.12	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG44GT	115	2,300	80,000	16:1	10.88	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG46GT	119	2,300	80,000	24:1	16.32	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG424GT	117	2,300	80,000	32:1	19.58	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG426GT	117	2,300	80,000	48:1	29.38	(8)1/2-13	7.625	3/8-16(6.875)-5/8-11(10.180)
BG6	210	3,500	150,000	6:1	5.1	(8)3/4-10	11.732	5/8-11(10.00)-1 1/8-7(14.02)
BG62	212	3,500	150,000	12:1	9.18	(8)3/4-10	11.732	5/8-11(10.00)-1 1/8-7(14.02)
BG64	242	3,500	150,000	24:1	16.32	(8)3/4-10	11.732	5/8-11(10.00)-1 1/8-7(14.02)
BG66	242	3,500	150,000	36:1	24.48	(8)3/4-10	11.732	5/8-11(10.00)-1 1/8-7(14.02)
BG624	245	3,500	150,000	48:1	29.38	(8)3/4-10	11.732	5/8-11(10.00)-1 1/8-7(14.02)
BG626	245	3,500	150,000	72:1	44.11	(8)3/4-10	11.732	5/8-11(10.00)-1 1/8-7(14.02)

Model	Output Drive Bolt Size and Qty.	Output Drive Bolt Circle	Stem Clearance Through Unit	Max. Stem in Style C Nut	Min. Stem in Style C Nut
BG3 Series	(6)5/16-18	2.844"	2.00"	1.75"	.500"
BG4 Series	(8)1/2-13	4.500"	3.11"	2.50"	.750"
BG6 Series	(16)1/2-13	6.960"	5.31"	4.38"	2.00"

FLOW CONTROL
2076 Northwoods Dr.
Muskegon, MI 49442
Tel 231.788.7025, Fax 231.788.7030
Info-DYT@c-a-m.com, www.c-a-m.com



PAINT:	SEMI-GLOSS BLACK, BAKED EPOXY POWDER COAT PAINT
CONSTRUCTION:	COMMERCIAL
WEIGHT:	38 LBS
RATIO:	3 TO 1
TORQUE:	625 LB-FT [848 N-M]
TEMPERATURE:	-20 TO 150°F [-29 TO 66°C]
RATING:	22,000 LBS [90 KN]
MOUNTING:	(4) 3/8-16 UNC, .38 [10] DP
BOLT CIRCLE:	4.016 [102.0] DIA
DRIVER:	1.005 ± 0.002 [25.5] SQ
BOLT CIRCLE:	NONE
DRIVER MOUNTING RECESS:	0.13 [3]

REV	DATE	DESCRIPTION	ENG
A	05 AUG 96	CHANGED FROM TEMP P# 100381DA	mlb

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES

TOLERANCES:

DECIMAL	
0.X	+-0.020
0.XX	+-0.010
0.XXX	+-0.005
FRACTIONAL	+-1/64
ANGULAR	+-30'

VALVCON

P.O. Box 901
Pine Valley Mill Bldg., Elm Street
Milford, New Hampshire 03055
Phone: 603-654-6111

MATERIAL

TITLE

TORQUE MAXIMIZER

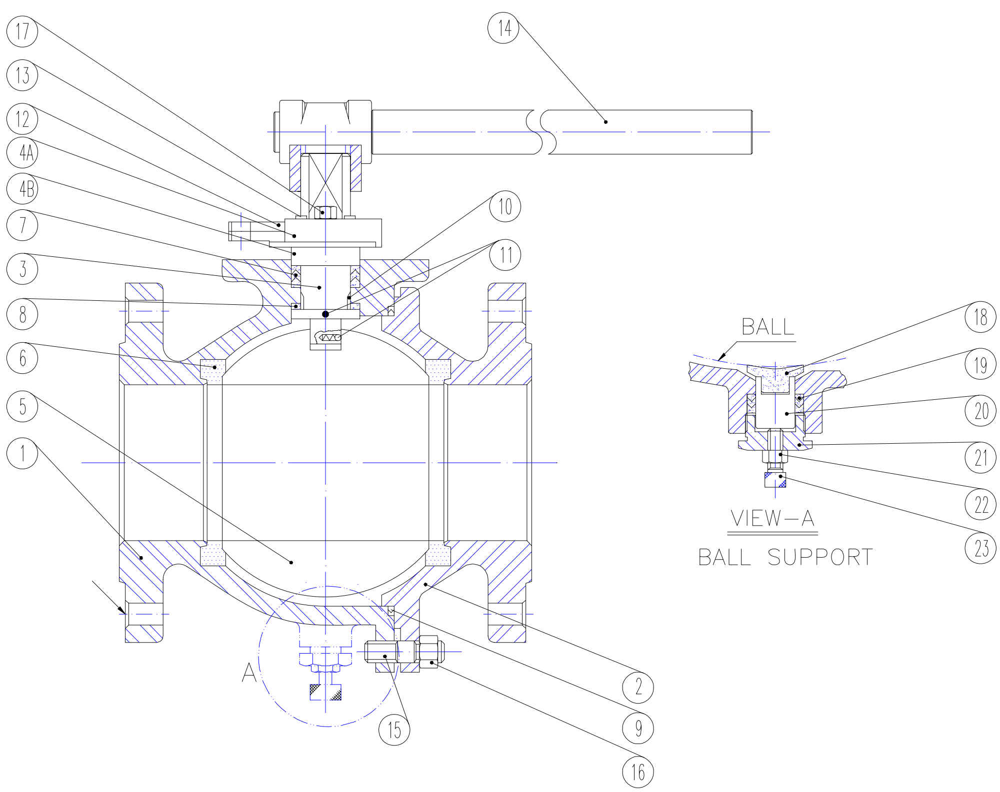
DRAWN	mlb
DATE	02 JUL 96
SCALE	NOT TO SCALE — A
SHEET	1 OF 1
DWG	1577
REV	B

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes 6” - 12” , Classes 150 & 300

NO.	PART NAME
1	BODY
2	CAP
3	STEM
4A	GLAND
4B	GLAND RING
5	BALL
6	SEAT
7	PACKING
8	THRUST WASHER
9	GASKET
10	STEM BEARING
11	ANTI–STATIC
12	TRAVEL STOPPER
13	SNAP RING
14	HANDLE
15	STUD
16	NUT
17	GLAND BOLT
18	PIN SEAT
19	PIN PACKING
20	SUPPORT PIN
21	SUPPORT NUT
22	SET NUT
23	TUNING SCREW



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools. Ball support supplied for 10” and 12” Class 150 valves, and 6” through 12” Class 300 valves.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150 or Class 300.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the gland bolts 1/4 turn, each. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle, snap ring, and travel stop plate.

3. Remove gland bolts, gland, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. **<u>For 10” and 12” valves only</u>**: Ball support must be backed off to remove ball. Loosen support nut, set nut and back out tuning screw on bottom of valve to release the ball support. The weight of the ball will cause the ball support to come down.

7. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

8. Take out other seat.

9. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing and stem bushing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Set the valve body on a clean work suface, resting on the end flange.

2. Install one seat in the body cavity with the spherical curvature facing the ball (upwards).

3. Cut new stem bushing on one side at approx. 30° - 60° angle and wrap around stem above shoulder.

4. Install thrust bearing on stem and holding stem bushing in place, slide the stem up through stem bore from inside body.

5. Install new stem seals, gland ring, and gland. Install gland bolts and tighten hand tight.

6. Install travel stop, and snap ring.

7. Turn the stem to the CLOSED position (bottom stem tan parallel to flow passage). Line up the ball slot with the stem tang and roll and lower the ball into position on the stem tang, letting the ball rest in the seat. Turn the stem and ball to the OPEN position to hold the ball in place.

8. **For 10” and 12” Valves Only:** Re-set the ball support by turning the tuning screw inwards until the support pin seat firmly contacts the ball. Do not cause the ball to move. Holding the tuning screw in place, tighten the support nut and then the set nut.

9. Install the remaining seat into body end.

10. Place new body seal into counterbore in valve body.

11. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

12. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

13. Tighten the gland bolts to the torques specified in Table 1.

14. Install handle, making sure that the handle aligns with the flow passage through the ball.

15. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

16. Pressure test valve, if possible, before reinstalling in pipeline.

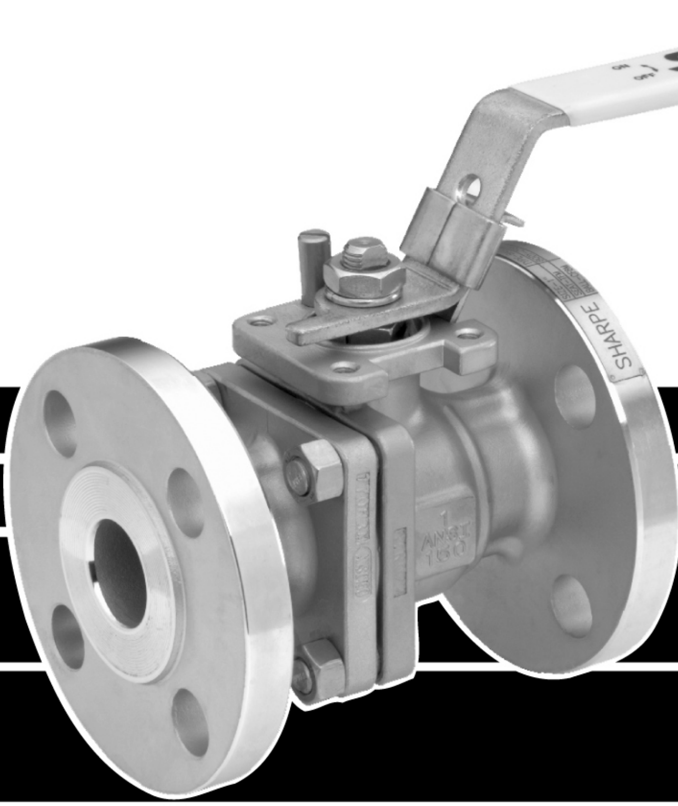
Table 1 – Gland Bolt Torques

SIZE	Tightening Torque (lb-ft) Max
6” – 8”	42 (1/2-13UNC)
10” - 12”	83 (5/8-11UNC)

Table 2 – Body Bolting Torques

SIZE	THREAD	Tightening Torque (lb-ft) Max
6”,8” (Class 150) / 3”~6”(Class 300)	5/8-11UNC	83
10”,12” (Class 150) / 8”(Class 300)	3/4-10UNC	120
10”(Class 300)	7/8-9UNC	190
12”(Class 300)	1-8UNC	260

SHARPE® VALVES

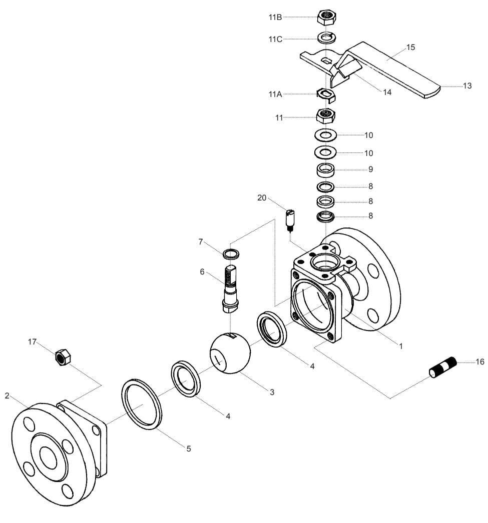


FLANGED FULL PORT BALL VALVE SERIES 50 / CLASS 150

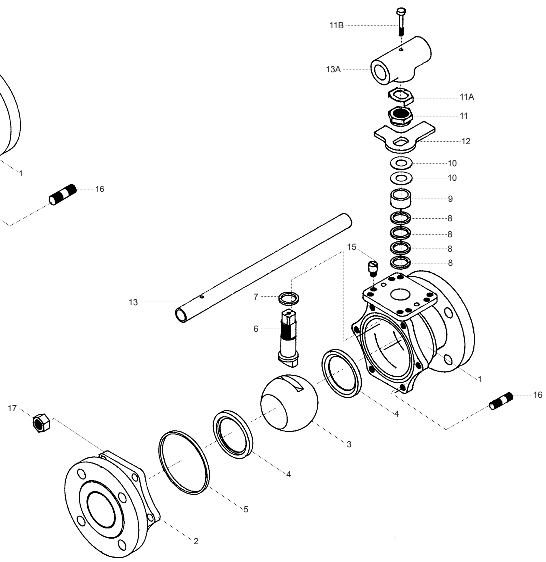
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

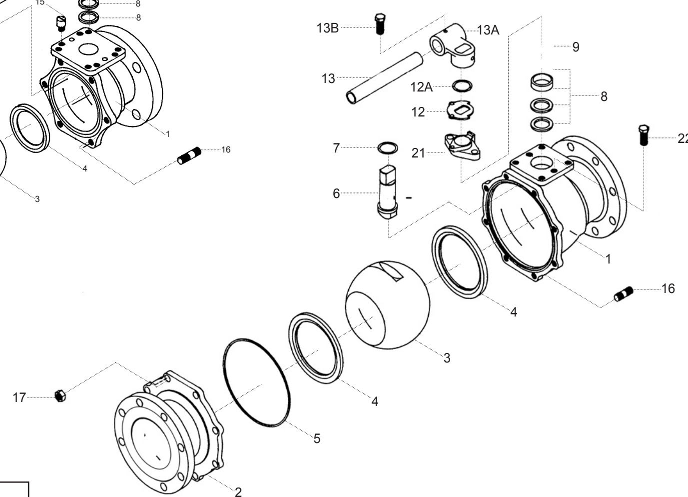
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2" - 2"



2-1/2" - 4"



6" - 8"

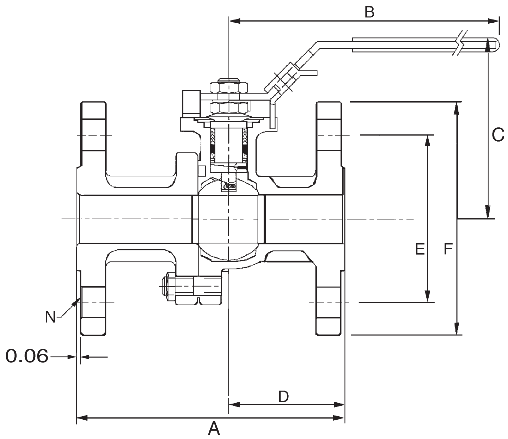
PART NO.	PART	QTY.	MATERIAL
1	Body	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) TFE Reinforced TFE NOVA PEEK
5	Body Seal	1	TFE
6	Stem	1	316 Stainless Steel Alloy 20 Hastelloy C 17-4PH (Option)
7	Thrust Bearing	2	Reinforced TFE
8	Stem Packing	3/4	Reinforced TFE
9	Gland Packing	1	304 Stainless Steel
10	Belleville Washer (1/2"-4")	2/4	304 Stainless Steel
11	Packing Nut (1/2"-4")	1	304 Stainless Steel
11A	Lock Tab	1	Stainless Steel
11B	Handle Nut	1	304 Stainless Steel
11C	Lock Washer	1	304 Stainless Steel (1/2"-2")

*See Dimensions

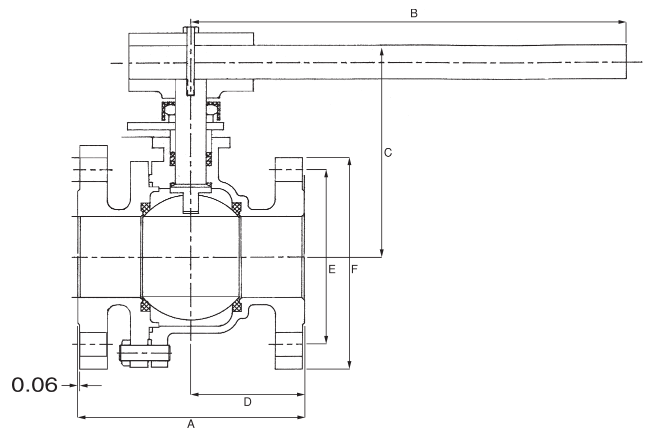
PART NO.	PART	QTY.	MATERIAL
12	Stopper	1	304 Stainless Steel
12A	Snap Ring	1	Stainless Steel (6"-8")
13	Handle	1	304 Stainless Steel (1/2"-2") Galvanized Steel (2-1/2"-4") Ductile Iron (6"-8")
13A	Wrench Block	1	Stainless Steel
13B	Hex Head Bolt	1	304 Stainless Steel
14	Locking Device (1/2"-2")	1	304 Stainless Steel
15	Sleeve	1	Vinyl
16	Body Stud	SEE* N	A193 B8 (SST) A193 B7 (CS)
17	Nut	SEE* N	A194 8 (SST) A194 2H (CS)
20	Stop Pin (1/2"-2") (2-1/2"-4")	1 2	304 Stainless Steel 304 Stainless Steel
21	Gland Flange (6"-8")	1	304 Stainless Steel
22	Gland Bolts (6"-8")	2	304 Stainless Steel

SERIES 50
DIMENSIONS

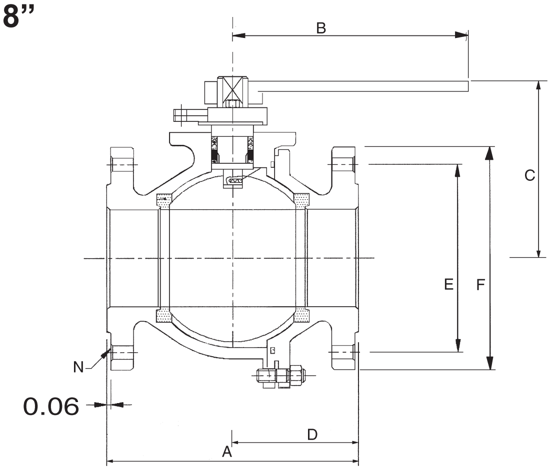
1/2" - 2"



2-1/2" - 4"



6" - 8"



CV DATA

1/2"	26
3/4"	50
1"	94
1-1/2"	260
2"	480
2-1/2"	750
3"	1300
4"	2300
6"	5400
8"	10000

PORT

1/2"	0.59
3/4"	0.78
1"	1.00
1-1/2"	1.50
2"	2.00
2-1/2"	2.55
3"	3.00
4"	4.00
6"	6.00
8"	7.88

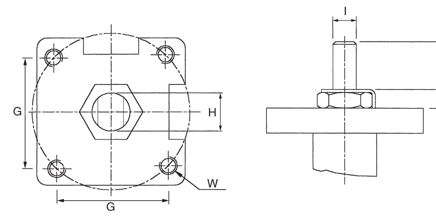
WEIGHT (lbs.)

1/2"	4
3/4"	6
1"	8
1-1/2"	15
2"	20
2-1/2"	36
3"	45
4"	75
6"	135
8"	290

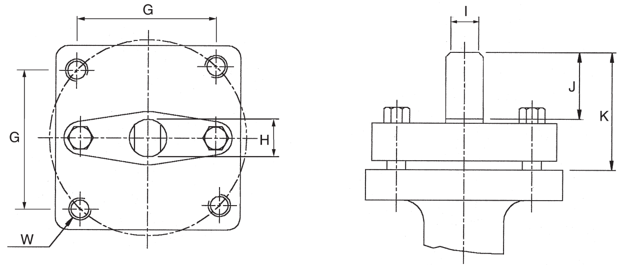
SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2"	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4"	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1"	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2"	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2"	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2"	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3"	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4"	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6"	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8"	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

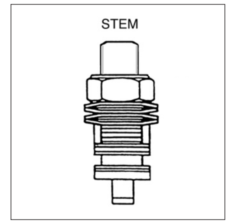
The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.

1/2" - 4"



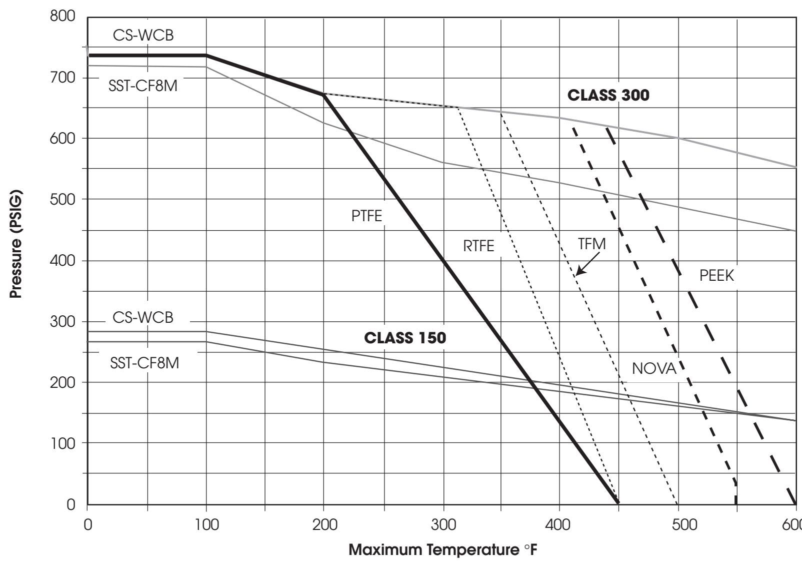
6" - 8"





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2"	50	150# = 11	2 = Alloy 20	T = TFE	X = Oxygen Service
3/4"			4 = Carbon Steel	R = RTFE	OH = Oval Handle
1"			6 = Stainless Steel	N = NOVA	F = Fugitive Emissions Certified ANSI 593.00.01
1-1/2"			5 = Hastelloy C	P = Peek	E = Extended Stem
2"			3 = Monel	M = TFM™	L = Lockable Extended Stem
2-1/2"					D = Leak detection Stem
3"					GO = Gear Operator
4"					7 = 17- 4PH Stem
6"					A = Nace
8"					

3/4" 50 11 6 T X

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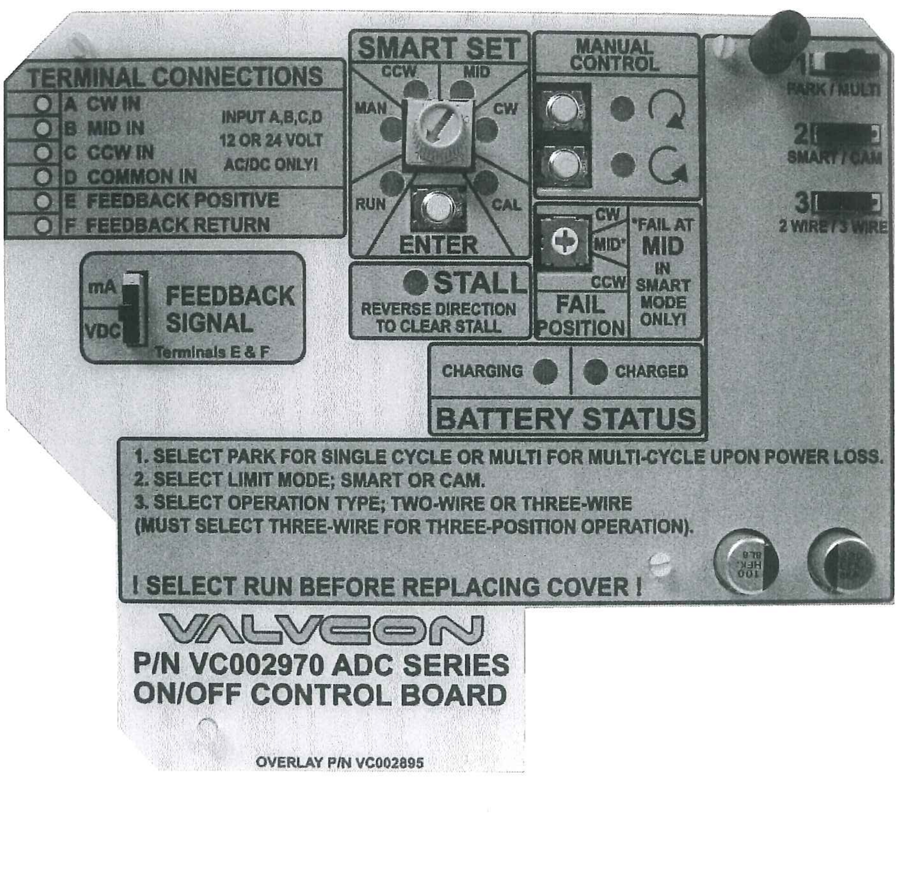
metso

VALVCON
ADC-Series
CONTINUOUS DUTY ON/OFF ELECTRIC ACTUATORS With R2, R3, L2, L3, L4 & L5 Options With "N" In The Model Number

Installation, Maintenance and Operating Instructions



metso
Expect results

IMO-I4500 • 1/2014

Table of Contents

READ THESE INSTRUCTIONS FIRST!

This instruction manual contains important information regarding the installation, operation, and troubleshooting of ADC-Series Continuous Duty On/Off Electric Actuators With R2, R3, L2, L3, L4 & L5 Options With "N" In The Model Number. Please read these instructions carefully and save them for future reference.

SAVE THESE INSTRUCTIONS!

Subject to change without notice.

1 GENERAL

1.1 ADC-Series On/Off Actuators (with Optional Battery Back-up)

The On/Off actuators are based on the ADC and LADC platform and provide an optional internal battery pack to power the actuator in the event of a loss of external power. ADC designates sizes from 150 to 600 in-lbs. LADC designates sizes from 1000 to 3000 in-lbs **(see Figure 10)**.

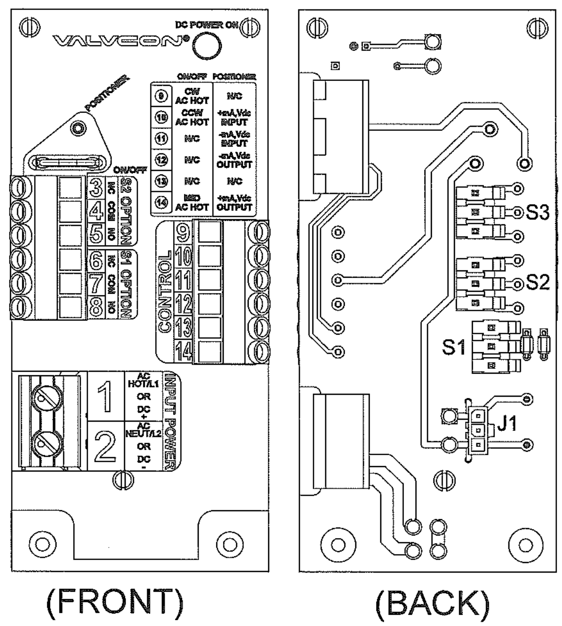
The electronic package consists of three separate boards; **P/N VC002360** Power Board and the **P/N VC002970** On/Off Control Board, and either a switching power supply or a DC isolator board. On/Off actuators are identified by the code "R2" or "R3" in the model number. On/Off actuators with battery back-up are identified by the code "L2", "L3", "L4" or "L5" (L2 & L4 are applicable in ADC-Series and L3 & L5 are applicable in LADC-Series) in the model number. (**Note:** The L4 and L5 options are factory-set for 180° operation with the MID position set at 90°.)

The On/Off control actuators covered in this manual are identified by the code "R2", "R3","L2", "L3", "L4" or "L5" and the letter **N** in the model number (do not confuse with "CL2" or CL3", which indicates a separate modulating control option).

1.2 Power Board P/N VC002360

The **P/N VC002360** Power Board provides terminals for input and output wiring to the actuator as well as plug-in connectors for ADC-Series options and accessories.

IMPORTANT! To use terminal 2 AC Neut/L2 as a COMMON connection for CW AC HOT and CCW AC HOT, set jumper to "ON/OFF" (horizontal). However, when using an AC control signal that is not COMMON to the actuator power supply, this jumper must be set to "POSITIONER" (45°) and a separate AC COMMON connection must be made to terminal 11 for CW AC HOT, CCW AC HOT and MID AC HOT signals.



S1 MOTOR / MOTOR JUMPER
S2 OPTIONAL ADDITIONAL LIMIT SWITCH CW
S3 OPTIONAL ADDITIONAL LIMIT SWITCH CCW
W1-W2 LIMIT SWITCH CW (BOTTOM)
W3-W4 LIMIT SWITCH CCW (2ND FROM THE BOTTOM)
W5-W6 AC POWER TO POWER MODULE
W7-W8 DC POWER RETURN FROM POWER MODULE

Figure 1

1.3 On/Off Control Board P/N VC002970

The **P/N VC002970** On/Off Control Board connects to the **P/N VC002360** Power Board via two plug-in connectors and a bracket, and hardware anchors it to the motor/gearbox. The On/Off Control Board allows the actuator to drive to either the full open or full closed position in response to applied control voltages. The **P/N VC002970** On/Off Control Board can be configured for either "Two-Wire" or "Three-Wire" control, (driving to mid-travel

positions can be achieved by removing the control voltage in "Three-Wire" mode). The On/Off Control option features include a choice of 115VAC, 230VAC, 12VDC, 24VDC or 24VAC input power as well as independent 115VAC, 230VAC, 12VDC, 24VDC or 24VAC control signals. Additional features include optional internal Battery Back-Up, Three-Position operation, analog position output signal (not present if using "Cam" Limit Type), manual push button control, single or multi cycling upon loss of line power, switch select power "Fail" position, locked rotor stall protection, on-board battery status indicators, and simple digital **Smart Set** functionality for entering and saving precise end of travel positions. (**Note**: Some of the above features are only applicable with the optional Back-Up battery installed.)

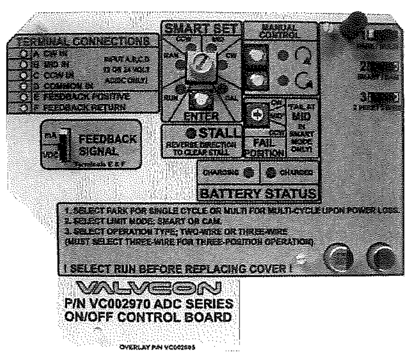


Figure 2
P/N VC002970 Battery Back-Up On/Off Control Board

1.4 LED Indicators

Visible on the **P/N VC002360** Power Board **(see Figure 1)**:

DC POWER ON – This green LED indicator shows that the user-supplied power is present and has been converted to DC (power conversion not applicable to DC input voltages) to drive the motor.

Visible on the **P/N VC002970** L2 &L3 Board **(see Figure 2)**:

POWER – A continuous green LED indicates that external or battery power is present.

STALL – A flashing red LED indicates a stall condition exists and that the actuator has been prevented from reaching the position commanded by the control signal. A STALL of more than several seconds will cause power to be automatically removed from the motor circuit, placing the actuator in a safe mode. A reverse signal or **Smart Set** mode change is required to clear the STALL LED alarm. A STALL alarm can be initiated in a few ways; by a blockage in the valve or damper, cam limit settings that are inside of the electronically saved travel stop positions, attempting to drive an actuator that is off-line due to thermal overload or some other increase in the torque load on the actuator.

CLOCKWISE – A continuous yellow LED indicates that the actuator is driving in the CW direction.

COUNTER-CLOCKWISE – A continuous yellow LED indicates the actuator is driving in the CCW direction.

CHARGING – A continuous yellow LED indicates that the battery is charging and is not fully charged.

CHARGED - A continuous green LED indicates that the battery is fully charged. A flashing green LED indicates the actuator is running on battery power.

RUN – A continuous green LED indicates that the normal operating mode has been selected.

MAN – A continuous yellow LED indicates that MANUAL mode has been selected. The actuator will not respond to external control signals and the CW and CCW push buttons are enabled for manually driving the actuator in either direction. The manual push buttons are also enabled in SPAN, MID, ZERO and CAL modes.

CCW – A continuous yellow LED indicates that the CCW **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the CCW LED is illuminated will cause the CCW LED to flash. Pressing **[ENTER]** while the CCW LED is flashing will save the current position as the CCW travel limit.

MID – A continuous yellow LED indicates that the MID **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the MID LED is illuminated will cause the MID LED to flash. Pressing **[ENTER]** while the MID LED is flashing will save the current position as the MID travel stop position.

CW – A continuous yellow LED indicates that the CW **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the CW LED is illuminated will cause the CW LED to flash. Pressing **[ENTER]** while the CW LED is flashing will save the current position as the CW travel stop limit.

CAL – A continuous yellow LED indicates that the CAL (calibration) mode has been selected. Pressing **[ENTER]** for two seconds while the CAL LED is illuminated may cause the CAL LED to flash indicating that further calibration of the position Feedback Potentiometer is required. **See Page 9 For Feedback Potentiometer Calibration Procedures.** If the CAL LED remains on continuously, no further calibration is required. Press **[ENTER]** to confirm the calibration setting and return to **RUN** mode.

At any point during Set-Up you may exit a "Smart Set" mode without changing the stored data, by simply selecting a different "Smart Set" mode.

2 OPERATION

> Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.

2.1 Wiring

The identification label on each actuator specifies the model number, serial number, input power voltage and current requirements for the actuator. It is important to verify the correct input voltage prior to wiring the actuator.

There are three basic wiring schemes designed to operate the ADC-Series On/Off Control Board options. These include:

Two Wire – On/Off Operation
Three Wire – Open/Stop/Close
Three Position – CW/MID/CCW

2.1.1 "Two-Wire" – On/Off Operation

(SEE FIGURE 3)

MAIN POWER – Terminals 1&2 - For "Two-Wire" control, the mode select slide switch must be in the LEFT, "Two-Wire" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - To control the actuator with a high voltage signal (115VAC or 230VAC) connect AC HOT to terminal 10 on the **P/N VC002360** Power Board. When terminal 10 is energized, the actuator will drive counter-clockwise. When terminal 10 is de-energized, the actuator will drive clockwise.

CONTROL SIGNALS – Low Voltage - To control the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the positive or hot lead to terminal C and connect the common or negative lead to terminal D on the **P/N VC002970** ON/OFF Control Board. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When terminal C and terminal D are de-energized, the actuator will drive clockwise.

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 on the **P/N VC002360** Power Board and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns, the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 3)**. Installing the optional heater and thermostat is a plug connection and requires no additional wiring.

2.1.2 "Three-Wire" – Open/Stop/ Close Operation

(SEE FIGURE 4)

MAIN POWER – Terminals 1&2 - For "Three-Wire" control, the mode select slide switch must be in the RIGHT, "Three -Wire" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - For "Three-Wire" control of the actuator with a high voltage signal (115VAC or 230VAC) connect the AC HOT CW lead to terminal 9. Connect the AC HOT CCW lead to terminal 10. When terminal 9 is energized, the actuator will drive clockwise. When terminal 10 is energized, the actuator will drive counter-clockwise. When neither 9 nor 10 are energized, the actuator will remain in position, (unless main power to 1 and 2 is interrupted).

CONTROL SIGNALS – Low Voltage - For "Three-Wire" control of the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the CW positive or hot lead to terminal A. Connect the CCW positive or hot lead to terminal C. Connect the common or negative lead to terminal D on the **P/N VC002970** board. When terminal A and terminal D are energized the actuator will drive clockwise. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When neither terminal A nor terminal C is energized, the actuator will remain in position, (unless power to 1 and 2 is interrupted).

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 4)**. Installing the optional heater and thermostat is a plug connection and requires no additional input power wiring.

2.1.3 "Three-Position" – CW/MID/CCW Operation

(SEE FIGURE 5)

MAIN POWER – Terminals 1&2 - For "Three-Position" control, the mode select slide switch must be in the RIGHT, "Three-Wire" position and the Limit Type select slide switch must be in the LEFT, "Smart" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - For "Three-Position" control of the actuator with a high voltage signal (115VAC or 230VAC) connect the AC HOT CW lead to terminal 9. Connect the AC HOT CCW lead to terminal 10. Connect the AC HOT MID (mid-position) lead to terminal 14. When terminal 9 is energized the actuator will drive clockwise. When terminal 14 is energized, the actuator will drive to the MID position. When terminal 10 is energized, the actuator will drive counter-clockwise. When neither terminals 9, 10, nor 14 are energized, the actuator will remain in position, unless power to 1 and 2 is interrupted.

CONTROL SIGNALS – Low Voltage - For "Three-Position" control of the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the CW positive or hot lead to terminal A. Connect the CCW positive or hot lead to terminal C. Connect the MID (mid-position) positive or hot lead to terminal B. Connect the common or negative lead to terminal D on the **P/N VC002970** board. When terminal A and terminal D are energized the actuator will drive clockwise. When terminal B and terminal D are energized, the actuator will drive to the MID position. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When neither terminals A, B, or C are energized, the actuator will remain in position, (unless power to 1 and 2 is interrupted).

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 5)**. Installing the optional heater and thermostat is a plug connection and requires no additional input power wiring.

Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.

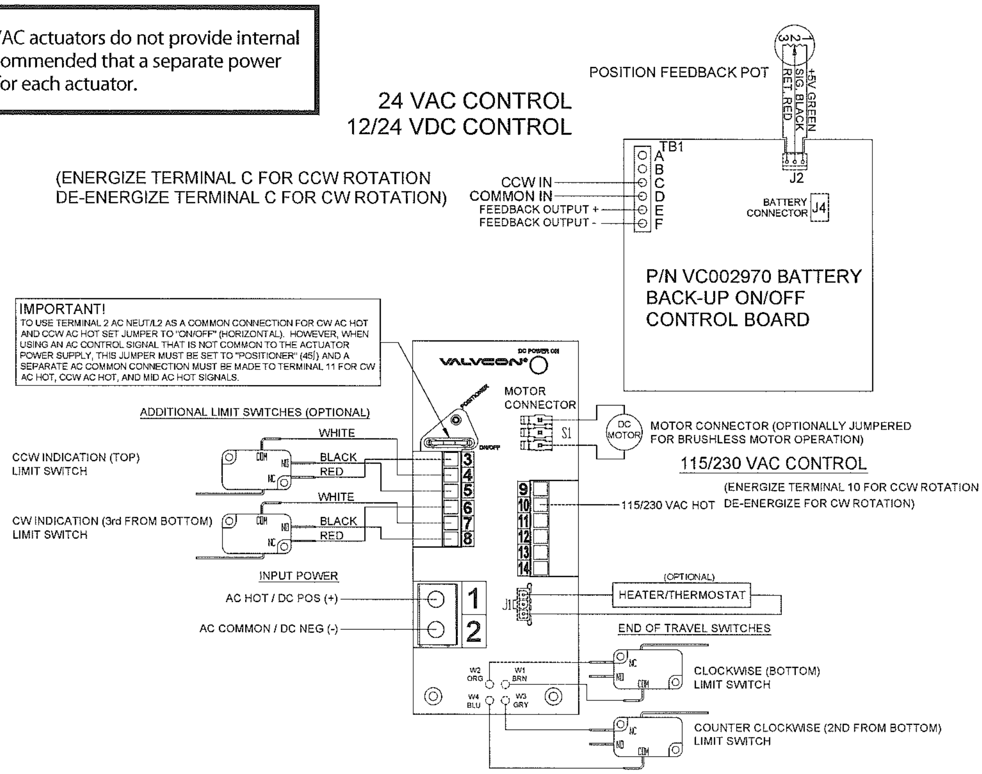
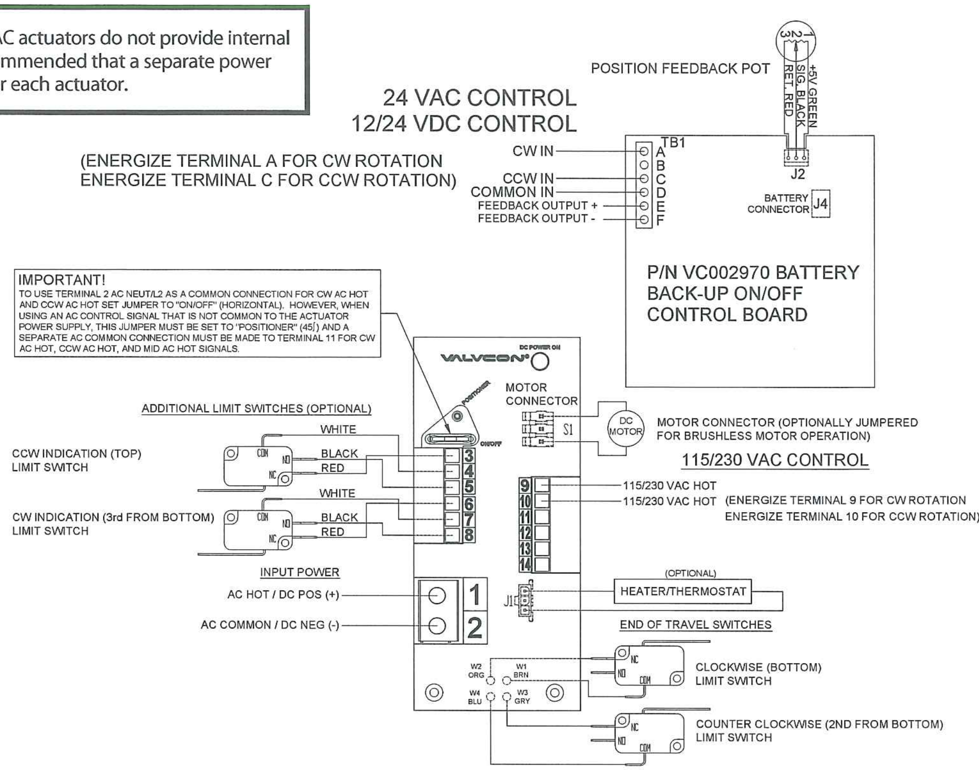


Figure 3

"Two-Wire" Wiring

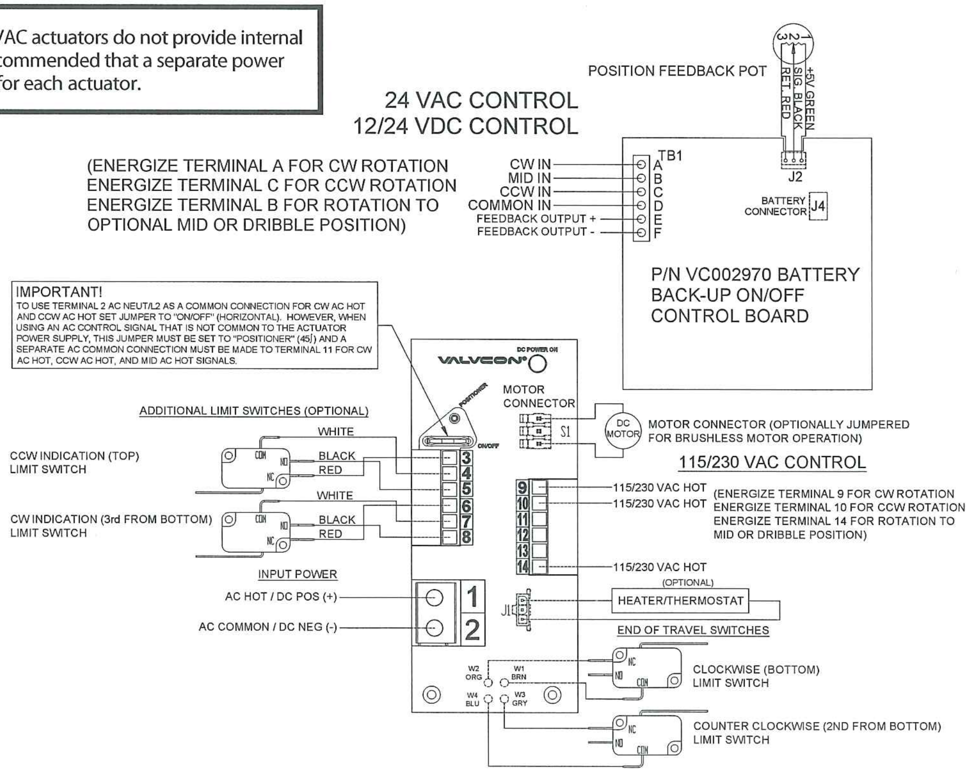
Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.



"Three-Wire" Wiring

Figure 4

Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.



"Three-Position" Wiring

Figure 5

2.2 ADC R2, R3, L2, L3, L4 & L5 Travel Limit Options

Travel limits, also referred to as "end of travel stops", are the precise positions to which the actuator will drive. The ADC-Series R2, R3, L2, L3, L4 & L5 options provide a number of choices for setting the travel limits. For "Two-Position" On/Off operation, travel limits are set at the full clockwise (CW) and full counter-clockwise (CCW) ends of travel. For "Three-Position" operation, an optional midway position (MID) may be set at any point between the CW and CCW settings.

CAUTION:
Dangerous Voltages Inside Actuator

Use extreme caution when working on the actuator with the cover removed.

2.2.1 Limit Types

To simplify the process of setting the precise travel limit positions, the ADC-Series R2, R3, L2, L3, L4 & L5 options provide two travel limit types. CW, CCW and MID may be set electronically via the **Smart Set** utility or CW and CCW may be set mechanically by selecting the "CAM Set" limit type.

2.2.2 CAM Set

When CAM Set is selected as the limit type, two limit switches operated by the stainless steel cams on the output shaft extension are used to determine the exact positions where the actuator will stop at each end of CW and CCW travel. The bottom limit switch determines the clockwise stop position. The next limit switch up from the bottom determines the counter-clockwise stop position.

The "end of travel limit" switches can be adjusted to provide from 5 to 320 degrees of actuator rotation.

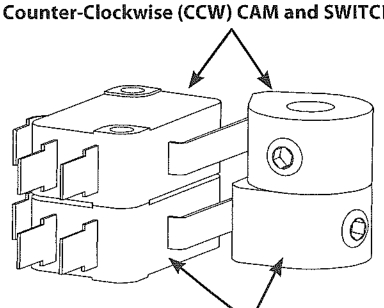


Figure 6

For "Three-Position" operation, limits must be entered and saved using the "Smart" Limit Type, only! **See Section 3** for detailed instructions.

2.2.3 Smart Set

When **Smart Set** is selected as the limit type, the micro processor stores the exact positions where the actuator will stop at each end of travel or mid position. Setting the **Smart Set** positions for the clockwise, counter-clockwise and midway positions is done with the selector knob and **[ENTER]** button in the **Smart Set** field of the **P/N VC002970** board. To use the **Smart Set** feature, the Feedback Potentiometer must be installed, connected and calibrated and the travel stop cams must be set to trip the switches beyond the desired electronic stop positions for CW, CCW.

The end of travel limits on standard ADC actuators can be entered and saved between 0° and 94° of travel. For rotation up to 270° of travel optional Feedback Potentiometer gears are available **(see Section 7; ADC-Series Standard Options)**.

For "Three-Position" operation, limits must be entered and saved using the "Smart" Limit Type, only! **See Section 2.1.3** for detailed instructions.

3 SET UP AND CALIBRATION

3.1 Initial Set Up

1. Remove actuator cover.
2. Select **Limit** type – **"SMART" or "CAM"** – Slide the **[SMART/CAM]** to the right to select **CAM** or to the left to select **SMART**. Selecting **SMART** will enable other features on the board such as Position Feedback and "Three-Position" operation. Selecting **CAM** will allow the actuator to drive between the end-of-travel limit switch settings. (Actuator is set up in **SMART** mode at factory; **SMART** set up is also recommended for field replacement.)
3. Select Operation **Limit** type – **"TWO-WIRE"** or **"THREE-WIRE"** – Slide the **[TWO-WIRE/THREE-WIRE]** to the right to select **THREE-WIRE** or to the left to select **TWO-WIRE**. In **TWO-WIRE** mode the actuator will drive **CCW** when the control terminal is energized and **CW** when the control terminal is de-energized. In **THREE-WIRE** mode separate terminals must be energized for **CW** or **CCW** movement; if using the **THREE-POSITION** feature the actuator must be set in **THREE-WIRE** mode.
4. Select Battery Mode On Power Fail – **"PARK AT FAIL" or "MULTI-CYCLE"** – Slide the **[PARK AT FAIL/MULTI-CYCLE]** to the right to select **MULTI-CYLCE** or to the left to select **PARK AT FAIL**. Selecting **PARK AT FAIL** will drive the actuator to the selected

Power Loss position upon loss of input power and the system will go to "sleep" until input power is restored. If **MULTI-CYLCE** is selected, the actuator will continue to respond to changes in control signal for up to ten cycles; the battery monitoring circuit will drive to the Power Loss position when it detects that the battery should be charged. Upon reaching the Power Loss position, the system will go to "sleep" until input power is restored.

5. Select **Power Loss Position – "CW", "MID" or "CCW"** – Turn the **[CW/MID/CCW]** to the clockwise to select **MID** or **CCW** or counterclockwise to select **MID** or **CW**. Selecting **CW** will drive the actuator to the clockwise position upon loss of input power. Selecting **CCW** will drive the actuator to the counterclockwise position upon loss of input power. Selecting **MID** will drive the actuator to the **MID** or **"THIRD"** position upon loss of input power; this setting is used in **THREE-WIRE** mode only.
6. Select **Output Feedback Signal** type – **"mA"** or **"VDC"** (current or voltage), the actuator will provide a 4-20mA or 2-10VDC feedback signal. Slide the **[OUTPUT SIGNAL]** switch up to select **mA** or down to select **VDC**.

3.2 Potentiometer Calibration

Field installation of the On/Off Control Board option or replacement of the position tracking potentiometer requires calibration of the position tracking potentiometer prior to setting positions and values for CW, MID and CCW. On/Off Control Board options installed at the factory are fully calibrated at the factory and should not require further calibration.

To confirm proper potentiometer calibration:

1. Turn the Mode Selector Dial to **[CAL]** and press **[ENTER]** for 2 seconds.
2. Using the **CW** push button, drive the actuator to the full clockwise position.
   - If the **[CAL]** LED is flashing, potentiometer calibration is required; proceed to step 3 below.
   - If the **[CAL]** LED remains on, calibration is not required; proceed to **Setting CW, MID and CCW Positions section below.**
3. Loosen the set screw in the larger Nylon gear with a 1/16" hex wrench.
4. Rotate the gear until the LED remains on constantly; hold the gear in place and tighten the set screw. Ensure that the LED remains on after the set screw is tightened. **Note**: The LED assists the user in locating the proper calibration window; it will flash faster as you approach the calibration window and slower as you move away from it.
5. Press the **[ENTER]** button to save the potentiometer setting.

3.3 Setting CW, MID and CCW Positions

Setting CW, MID and CCW Positions - Once calibration has been confirmed, set the desired "end of travel" positions. ***Make certain that the limit switch cams are set to operate the switches beyond the desired range for the CW and CCW positions.*** CW and CCW may be set at any position between 0° and 94° of travel (or 184° with "R3", "L4" or "L5" option).

3.3.1 Set CW:

1. Turn the Mode Selector Dial to **[CW]** and press **[ENTER]** for 2 seconds. The **[CW]** LED will begin to flash.
2. Drive the actuator to desired clockwise position using the **CW** or **CCW** push button. If the **"STALL"** LED begins to flash; check to see if the limit switch cam is preventing actuator from reaching desired **CW** end-of-travel. If necessary back the cam off so that it will trip the switch slightly beyond the desired end-of-travel.
3. Press the **[ENTER]** button to save the **CW** setting.

3.3.2 Set MID: (if applicable)

1. Turn the Mode Selector Dial to **[MID]** and press **[ENTER]** for 2 seconds. The **[MID]** LED will begin to flash.
2. Drive the actuator to desired **MID** or "THIRD" position using the **CW** or **CCW** push button.
3. Press the **[ENTER]** button to save the **MID** setting.

3.3.3 Set CCW:

1. Turn the Mode Selector Dial to **[CCW]** and press **[ENTER]** for 2 seconds. The **[CCW]** LED will begin to flash.
2. Drive the actuator to desired counterclockwise position using the **CW** or **CCW** push button. If the **"STALL"** LED begins to flash; check to see if the limit switch cam is preventing actuator from reaching desired "end of travel". If necessary back the cam off so that it will trip the switch slightly beyond the desired end-of-travel.
3. Press the **[ENTER]** button to save the **CCW** setting.

3.3.4 Verify End-Of-Travel Settings:

1. Turn the Mode Selector Dial to **[RUN]**.
2. Apply various control signals to verify operation.
3. Replace actuator cover.

4 POWER LOSS & BATTERY MODE OPTIONS

4.1 Battery Mode Selection – PARK AT FAIL or MULTI-CYCLE

The ADC-Series On/Off Control Board is designed to provide continuing service in the event of loss of line power. Upon power loss the ADC-Series actuator, equipped with the optional Battery Back-Up, can be configured to drive the actuator and PARK immediately at the designated power loss (Fail Position), or to continue to MULTI-CYCLE on battery power while a control signal and adequate battery power remain available. When MULTI-CYCLE is selected, the actuator will cycle until a low battery power condition is detected then automatically drive to and remain at the designated power loss (Fail Position). A fully charged battery will provide a minimum of ten complete 90 degree cycles.

To configure the actuator to immediately drive and park at the designated "Fail" position upon loss of line power, move the "Battery Mode On Fail" slide switch to the LEFT, PARK AT FAIL, position.

To configure the actuator to continue to cycle while adequate battery power is available upon loss of line power, move the "Battery Mode On Fail" slide switch to the RIGHT, Multi-Cycle position.

4.2 Power Loss – FAIL Position Selection

The ADC-Series On/Off Control Board is designed to be easily configured to drive to either the CW, CCW or MID position upon loss of line power (applicable with optional Battery Back-Up). This is the power loss or "Fail" position. In the "Fail Position" field, the power loss position is set with a miniature blade screw driver by moving the selector dial to the desired position. When designating MID as the power loss or "Fail" position, the limit type must be set at SMART and the MID position must have been entered and saved in the "**Smart Set**" field.

To confirm the power loss or "Fail" position, select RUN in the "**Smart Set**" field and select PARK AT FAIL in the "Battery Mode On Fail" field. De-energize terminal 1 and terminal 2 on the **P/N VC002360** Power Board. The actuator will drive to the designated power loss or "Fail" position.

4.3 Sleep and Wake Function – Manually Drive the Actuator During Power Outage

(PARK AT FAIL MODE, ONLY) After the battery drives the actuator to the Power Loss Position, the **P/N VC002970** board powers down and remains in **"Sleep"** mode until external power returns to terminals 1 & 2 on the **P/N VC002360** Power Board. To **"Wake"** the actuator, enabling the **CW** or **CCW** push buttons, push the button located below the battery connector (J4) on the upper left, back side of the **P/N VC002970** board. This will "Wake" the electronics and the actuator can be manually operated via the **CW** or **CCW** push buttons until low battery power level is detected. (**Note**: After using the **WAKE** Power Override function the actuator will not revert back to **SLEEP** mode. Disconnect the battery to preserve battery power if line power has not been restored.)

5 BATTERY PACK INFORMATION

The optional Battery Pack is capable of supplying sufficient power to ensure operation of the actuator during power outages. The battery voltage of a fully charged battery should read 13.6 volts as measured at the battery connector, (with the battery disconnected). This voltage will vary with temperature; see "Battery Charging Circuit" below.

Replacement battery packs should be stored only after a full charge and at less than 80°F. Temperature can affect battery shelf life. Generally lower temperatures will increase shelf life while higher temperatures will decrease shelf life.

When recharging battery packs, they should only be recharged from the **P/N VC002970** ADC-Series On/Off Control Board charging circuit, which is calibrated to provide the proper voltage and current for maximum battery pack life.

5.1 Battery Charging Circuit

The battery charging voltage has been designed for optimum battery performance. When charging, the yellow **CHARGING** LED will light. After reaching full charge, the green **CHARGED** LED will light.

The voltage on the battery terminals, connector "J4", will be between 10.5 and 12 volts, when external power is off, and the battery is connected to the 2970 On/Off Control Board. Fully charged, the battery voltage will reach approximately 13.6 volts. This voltage is designed to vary with temperature, and could be as high as 14.4 volts if in a very cold environment, or as low as 12.8 volts if in a very warm environment. This is normal operation.

A battery case that is swollen or cracked must be replaced. Please consult the factory for replacement. If the battery does not reach full charge (the green **CHARGED** LED remaining on and the yellow **CHARGING** LED turning off) within 48 hours, consult the factory or your local representative.

5.2 Battery Replacement

The only suggested maintenance is to examine, and if necessary, replace the batteries every two years. Battery life can vary with temperature. Cooler environments will generally prolong battery life and under ideal conditions ADC batteries will last in excess of five years.

To change the batteries, perform the following:

SMALL ENCLOSURE (150-600 in-lbs)

4. Remove power to the actuator.
5. Disconnect battery connection at the daughter board.
6. Pry back the battery retaining tab on the battery bracket.
7. Remove the battery.
8. Install new battery.
9. Slide battery into bracket so that the retaining tab secures the battery in place.
10. Plug battery connector into the connector on the back of the **P/N VC002970** board, and re-apply power.

LARGE ENCLOSURE (1000-3000 in-lbs)

1. Remove power to the actuator.
2. Unplug the battery wire from the daughter board.
3. Remove battery hold-down bracket.
4. Unplug the wires from the battery tabs.
5. Remove and replace the battery. Re-install the wires on the battery tabs, Black wire to Black terminal and Red wire to Red terminal.
6. Re-install the hold-down bracket.
7. Plug the battery connector into the daughter board, and re-apply power.

6 OUTPUT/POSITION FEEDBACK SIGNAL

Terminal E and terminal F on the **P/N VC002970** On/Off Control Board provide an analog position feedback signal. To enable the output feedback signal the Feedback Potentiometer must be installed, connected to the **P/N VC002970** board and properly calibrated. **See Section 3 for Set Up and Calibration instructions.**

To select a 4-20 mA output signal, move the slide switch to the **UP** position in the Output Signal field. To select a 2-10 VDC output signal, move the slide switch to the **DOWN** position in the Output Signal field.

7 ADC-SERIES STANDARD OPTIONS

All ADC-Series options are designed to be easily installed in the field. Options for all standard ADC-Series actuators are universal and completely interchangeable with each enclosure size. Voltage is not field changeable.

7.1 Option "H" – Tropical Heater and Thermostat P/N VC099035, P/N VC099036, P/N VC099037, P/N VC099038

The tropical heater and thermostat option is a self-adhesive, resistant heater strip which is applied to primary gear-box. It installs with a plug-in connector and is recommended in high-humidity applications. The tropical heater option is also recommended installations that experience wide temperature swings in order to evaporate any condensation. Thermostat is pre-set to active at or below 90°F and deactivate at or above 110°F. The tropical heater draws 15 watts @ 115 VAC, 12 VDC and 24V; 40 watts at 230 VAC. This option can be installed in the field; for 115 VAC applications, order kit **P/N VC099035**; for 230 VAC applications, order kit **P/N VC099036**; for 12 VDC applications, order kit **P/N VC099037** and for 24 V applications, order kit **P/N VC099038 (see Figure 7).**

Option "H" Tropical Heater and Thermostat
Option "T" Standard Heater and Thermostat

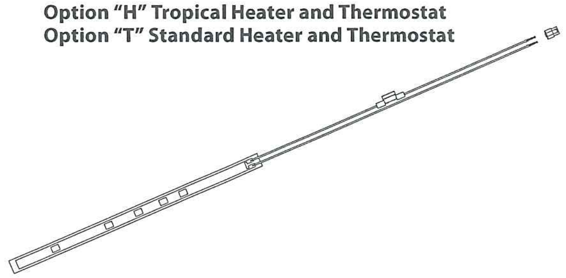


Figure 7

7.2 Option "I" – ISO 5211 Output

150 – 600 in-lbs models are supplied with a 3/4" female square output coupling; when the "I" option is selected they are supplied with a 14mm female square.

1000 – 3000 in-lbs models are supplied with a 1" female square output coupling; when the "I" option is selected, 1000 in-lbs models are supplied with a 19mm female square and 1500 – 3000 in-lbs models are supplied with a 22mm female square.

This option is factory installed only.

7.3 Option "S2" – Two Auxiliary Limit Switches P/N VC099900

The extra switches and stainless steel cams provide dry contacts and are fully adjustable to trip at any position. They are often used for position indication or to interlock other devices (such as in sequencing operations). The switches are single pole, double throw switches rated for 1/2 HP, 15 amps @250 VAC, CSA certified. Auxiliary switch kit **P/N VC099900** is universal to all standard ADC-Series actuators **(see Figure 8).**

Option "S2" – Two Auxiliary Limit Switches

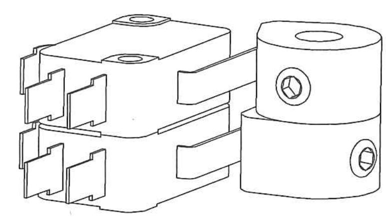


Figure 8

7.4 Option "T" – Heater and Thermostat P/N VC099015, P/N VC099016, P/N VC099017, P/N VC099018

The heater and thermostat option is a self-adhesive, resistance heater strip which is applied to the primary gearbox. It installs with a plug-in connector and is required in installations where the ambient temperatures drop below 32˚F. The heater option is also recommended in installations that experience wide temperature swings in order to evaporate any condensation. The thermostat is pre-set to activate at or below 40˚F and deactivate at or above 60˚F. The heater draws 15 watt @115 VAC, 12 VDC and 24 V; 40 watts @ 230 VAC. This option can be installed in the field; for 115 VAC order kit **P/N VC099015**; for 230 VAC applications, order kit **P/N VC099016**; for 12 VDC applications, order kit **P/N VC099017** and 24 V applications, order kit **P/N VC099018 (see Figure 7).**

7.5 Option "Y" - Keyed Output

150 – 600 in-lb actuators are supplied with a 3/4" female square output coupling; when the "Y" option is selected they are supplied with a 15mm female keyed output.

1000 – 3000 in-lb models are supplied with a 1" female square output coupling; when the "Y" option is selected they are supplied with a 20mm female keyed output.

This option is factory installed only.

7.6 Option "Z" – Handwheel Override P/N VC009097, P/N VC009098

Standard ADC-Series actuators are supplied with a plugged cover. Note that this not recommended for ADC-Series actuators equipped the optional internal battery back-up. If the handwheel override option is selected at the time of order a declutchable shaft and six-inch handwheel are provided for manual positioning. This option can be replaced in the field; for 150 – 600 in-lbs models, order kit **P/N VC009097** and for 1000 – 3000 in-lbs models, order kit **P/N VC009098**.

7.7 CSA Certification

CSA Certification is standard on all standard ADC-Series actuators for applications in either Hazardous (WX) or non-Hazardous (W) locations. CSA certified actuators are identified by the CSA logo on the product label.

7.8 Voltage

115 VAC, 230 VAC, 24 VAC, 12 VDC and 24 VDC. ADC-Series actuators are rated for full torque at +/- 10% of the nominal voltage at 50Hz or 60 Hz. ADC-Series positioning actuators are rated continuous duty. (**Note**: At 50Hz the cycle time will increase by approximately 20%.)

8 GENERAL OPERATING INFORMATION

For enclosure specifications and dimensions, **see Table 2 and Figure 10.**

8.1 NEMA Ratings and CSA Certification

Metso manufactures two styles of Valvcon enclosures: the "W" enclosure is weathertight and designed to NEMA 4/4X standards the "WX" enclosure is "explosionproof" and designed to NEMA 4/4X/7&9 (Class 1, Division 1, Groups C and D, and Class 2, Division 1, Groups E, F and G) standards.

Actuators are certified by CSA to meet Canadian and U.S. standards for applications in both Hazardous and Non-Hazardous locations. The "WX" option must specified at the time of ordering and can only be installed at the factory. Ensure that the actuator's ratings are appropriate for the application environment prior to installation. Use extreme care when removing the cover. Scratches or nicks on the flanges may cause the enclosure not to meet NEMA specifications.

8.2 Duty Cycle and Motor Protection

ADC-Series on/off actuators are equipped with a brushless DC motor and can operate continuously; they are rated for 100% duty cycle operation up to 104°F and for a maximum of 30 starts per minute. Higher temperature applications decrease the available duty cycle.

8.3 Operating Temperature Limits

ADC-Series actuators are designed to operate in ambient environments between 32˚F, (0˚C) and 130˚F, (55˚C). If the ambient temperature may drop below 32˚F, (0˚C), the heater and thermostat option must be installed. The actuator is rated to operate at -40˚F, (-40˚C) with the heater and thermostat option installed. In outdoor applications where ambient temperatures exceed 80˚F, (27˚C), actuators should be shielded from direct sunlight. In applications with high media temperatures, insulating blankets, heat shields and/or extended mounting shafts should be used to keep temperatures within normal operating limits.

Heaters and thermostats are required for all outdoor applications and may also be used to dry condensation in high humidity environments.

8.4 Actuator Mounting

The actuator may be mounted in any position including upside-down. It must be firmly secured to a direct mount flange or sturdy mounting bracket. A minimum of four bolts with lock washers should be used to secure the actuator to the bracket. Flexibility in the bracket is not allowed, and backlash, or "play", in the coupling should be minimized. The actuator output shaft must be in line (centered) with the valve shaft to avoid side-loading the shaft.

For output drive dimensions and mounting hardware specifications, **see Figure 10.**

8.5 Lubrication

All rotating power train components are permanently lubricated with multi-purpose Lithium grease suitable for the operating temperature range of the actuator. Additional lubrication is not required in normal operation.

8.6 Problem Prevention

Most actuator problems result from improper installation.

- **Incorrect Wiring and Set Up** Make certain the actuator is wired correctly and travel stops are properly set before power is applied.
- **Coupling, Alignment, and Mounting** Do not add extra torque! Make certain that the mounting arrangement is sturdy, centered, properly aligned, and that all mounting hardware is secure and properly tightened.
- **Moisture** Replace the cover tightly and make certain conduit entry holes are sealed properly to prevent moisture infiltration.

8.7 Warranty

All ADC-Series actuators are backed by a 2 year warranty that covers materials and workmanship.

8.8 Technical Assistance, Replacement Parts, Options and Repairs

All replacement parts, plug-in options, accessories, and repair services for ADC-Series actuators are available through a network of qualified Metso Stocking Representatives. For further technical information or to locate the Metso Stocking Representative closest to you, contact **www.metso.com/automation/valvcon**.

9 SPECIFICATIONS & TECHNICAL INFORMATION

TABLE 1 - TORQUE & VA RATINGS

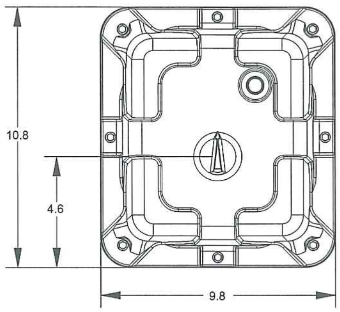
Torque (in-lbs)	Duty Cycle	12 VDC		24 VDC		24 VAC		115 VAC		230 VAC	
		Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)
150	100%	11	2.2	13	1.2	8	1.8	9	0.4	9	0.4
300	100%	17	2.5	13	1.4	12	2.1	13	0.5	13	0.4
600	100%	17	2.8	13	1.7	13	2.5	14	0.6	14	0.5
1000	100%	21	4	14	2.4	15	3.5	15	0.9	15	0.6
1500	100%	40	4	24	2.4	27	3.5	29	0.9	29	0.6
2000	100%	40	4.3	33	2.4	28	3.5	29	0.9	29	0.6
2500	100%	55	3.3	40	2	38	3.1	39	0.8	39	0.6
3000	100%	60	3.7	42	2.2	40	3.5	42	0.8	43	0.6

TABLE 2 - SPECIFICATIONS

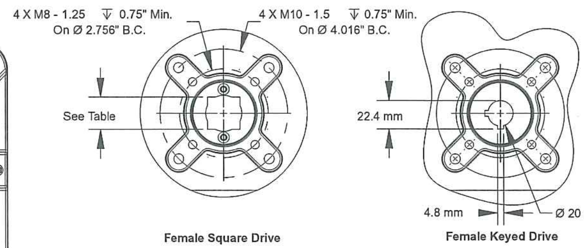
Temperature Range	32°F to 130°F (0˚C to 55˚C) (without heater and thermostat) -40°F to 130°F (-40˚C to 55˚C) (with heater and thermostat)
Conduit Connections	(2) 3/4" NPT in sizes up to 600 in-lbs (3/4" to 1/2" reducing bushings included) (2) 3/4" NPT in sizes 1000 in-lbs and above (3/4" to 1/2" reducing bushings included)
Output	150 to 600 in-lbs: ISO 5211 F05 and F07 bolt circles, 3/4" female square (14mm female square w/ "I" Option; 15mm female keyed output w/ "Y" Option). 1000 to 3000 in-lbs: ISO 5211 F07 and F10 bolt circles, 1" female square (1000 in-lbs: 19mm female square w/ "I" Option; 1500 - 3000 in-lbs: 22mm female square w/ "I" Option; 1000 to 3000 in-lbs: 20mm female keyed output w/ "Y" Option)
Voltage	12VDC: 10.8 to 13.2VAC 24VDC: 21.6 to 26.4VDC 24VAC: 21.6 to 26.4VAC, 50 or 60 Hz 115VAC: 103.5 to 126.5VAC, 50 or 60 Hz 230VAC: 207 to 253VAC, 50 or 60 Hz
Limit Switches	(2) Single pole, double throw switches rated for 1/2 HP, 11 amps @ 250VAC, CSA certified, fuse protected
Motor	Brushed DC motor with Class B or better insulation; sub-fractional horsepower
Lubrication	Permanently lubricated gear train and bearings
Gear Train	Hardened steel spur gears
Approximate Weight	17 lbs for sizes up to 600 in-lbs 31 lbs for sizes 1000 in-lbs and above
Enclosure	Die cast aluminum

9.1 Dimensions

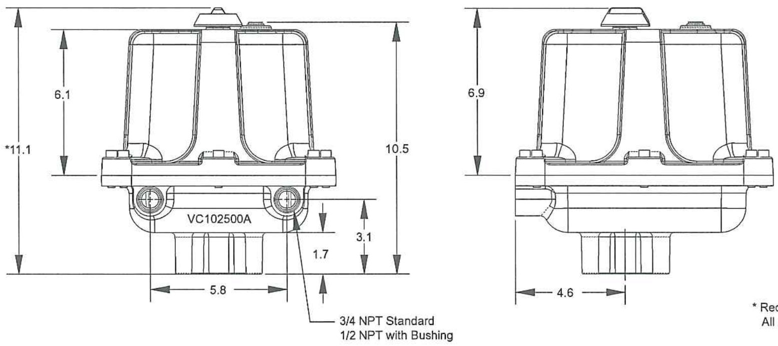
LADC-SERIES ENCLOSURE



Mounting Flange, ISO 5211
F07/F10

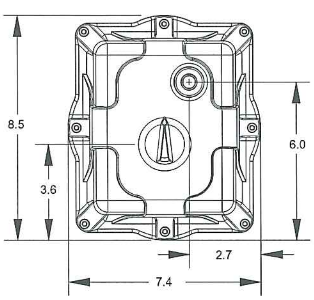


Actuator Size	Drive Option	Drive Type	Drive Size	Depth
1000-3000 lb-in	Standard	Square	1.000 (25mm)	1.20 (30.5mm)
1000 lb-in	Option "I"	Square	0.748 (19mm)	1.20 (30.5mm)
1500-3000 lb-in	Option "I"	Square	0.866 (22mm)	1.20 (30.5mm)
1000-3000 lb-in	Option "Y"	Keyed	0.787 (20mm)	1.50 (38.1mm)

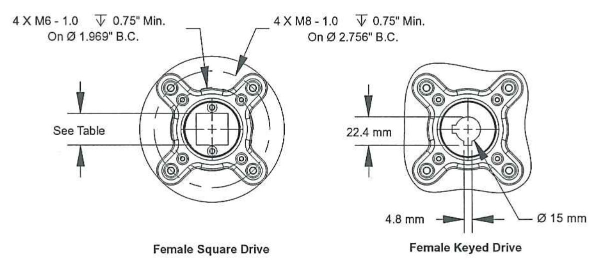


* Requires an additional 5.75" to remove cover
All dimensions in inches unless otherwise stated

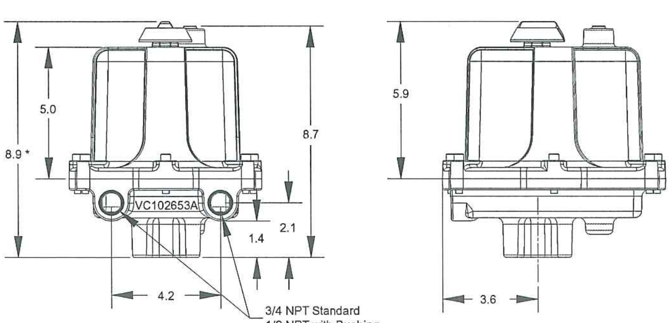
ADC-SERIES ENCLOSURE



Mounting Flange, ISO 5211
F05/F07



Actuator Size	Drive Option	Drive Type	Drive Size	Depth
150-600 lb-in	Standard	Square	0.750 (19mm)	0.90 (22.9mm)
150-600 lb-in	Option "I"	Square	0.551 (14mm)	0.90 (22.9mm)
150-600 lb-in	Option "Y"	Keyed	0.591 (15mm)	1.40 (35.6mm)



Approximate Weight	17 lb

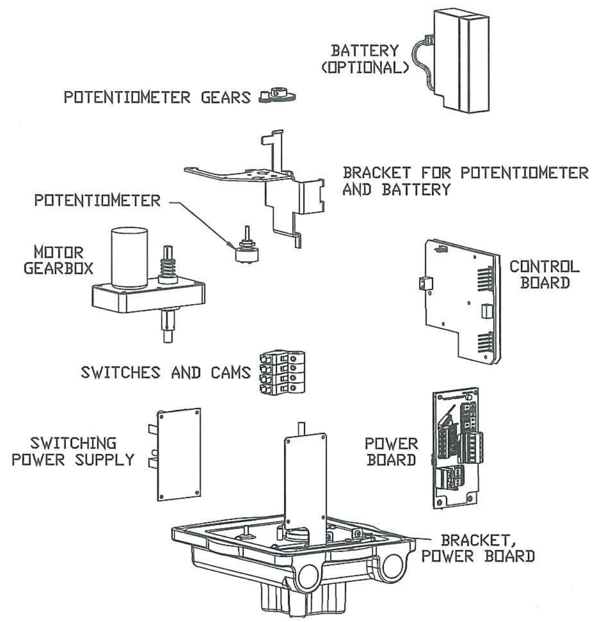
* Requires an additional 4.75" to remove cover
All dimensions in inches unless otherwise stated

Figure 10

9.2 Exploded View

ADC-Series Spare Parts

PART	DESCRIPTION
	Cover with Position Indicator (not shown)
VC009304	ADC - Small enclosure (150–600 in-lbs)
VC009307	LADC - Large enclosure (1000–3000 in-lbs)
	Cover Screw (8 required)
VC091340	ADC - Small NEMA 4/4X enclosure (150–600 in-lbs)
VC091336	ADC - Small NEMA 4/4X/7/9 enclosure (150–600 in-lbs)
VC091564	LADC - Large enclosure (1000–3000 in-lbs)
	Motor Gearbox
VC006229	ADC (150–600 in-lbs)
VC006144	LADC (1000–2000 in-lbs)
VC006230	LADC (2500–3000 in-lbs)
	Potentiometer and Switches
VC092067	Potentiometer with Gears (90° Operation)
VC099900	Two Auxiliary Switch Kit w/Cams
VC001020	Limit Switch - Replacement
	Brackets with Hardware
VC092665	Bracket, Power Board ADC (150–600 in-lbs)
VC092670	Bracket, Power Board LADC (1000–3000 in-lbs)
VC092450	Bracket, Batter & Potentiometer ADC
VC092445	Bracket, Potentiometer LADC
VC091760	Bracket, Battery LADC
	Power Board Kit Includes Switching Power Supply or Isolator Board (decided by voltage)
VC092361	ADC 115/230VAC
VC092362	LADC 115/230VAC
VC092363	ADC/LADC 12/24VDC
VC092364	ADC/LADC 24VDC
	Tropical Heater and Thermostat Kits
VC099035	Tropical Heater Thermostat 115VAC
VC099036	Tropical Heater Thermostat 230VAC
VC099037	Tropical Heater Thermostat 12VDC
VC099038	Tropical Heater Thermostat 24VAC or 24VDC



	Heater and Thermostat Kits
VC099015	Heater Thermostat 115VAC
VC099016	Heater Thermostat 230VAC
VC099017	Heater Thermostat 12VDC
VC099018	Heater Thermostat 24VAC or 24VDC
	Control Board Kits
VC099050	ADC On/Off Control Board Kit with Battery Back-Up
VC099055	LADC On/Off Control Board Kit with Battery Back-Up
VC099080	ADC On/Off Control Board Kit (without Battery Back-Up)
VC099085	LADC On/Off Control Board Kit (without Battery Back-Up)
	Replacement Battery
VC001573	ADC Battery
VC002509	LADC Battery

NOTES:

Brake – Holding Brake Is Standard On all ADC/LADC-Series Actuators.

Manual Override Is Not A Standard Feature On ADC/LADC-Series Actuators.

Figure 11

10 ENCLOSURE

Table 3

How To Order - ADC-Series Electric Actuators

Series	Enclosure Type		Torque		Board Options[1]		Other Options		Operating Voltage	
	Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
ADC	W	Weathertight	150	150 in•lb	C	Modulating	H[2]	Tropical Heater/Thermostat	N115AC	115 VAC
		NEMA 4/4X	300	300 in•lb	CL2	Modulating Battery Back-Up	I[3a]	ISO 5211 Output	N230AC	230 VAC
			600	600 in•lb	L2	On/off Battery Back-Up	S2	Two Auxiliary Limit Switches	N24AC	24 VAC
	WX	Weathertight & Explosionproof			L4	On/off Battery Back-Up – 3 Position	T[4]	Heater/Thermostat	N12DC	12 VDC
		NEMA 4/4X/7&9			R2	On/Off Isolated Control	Y[5a]	Keyed Output	N24DC	24 VDC
					R3	On/Off Board – 3 Position	Z[6]	Handwheel		
LADC	W	Weathertight	1000	1000 in•lb	C	Modulating	H[2]	Tropical Heater/Thermostat	N115AC	115 VAC
		NEMA 4/4X	1500	1500 in•lb	CL3	Modulating Battery Back-Up	I[3b]	ISO 5211 Output	N230AC	230 VAC
			2000	2000 in•lb	L3	On/off Battery Back-Up	S2	Two Auxiliary Limit Switches	N24AC	24 VAC
	WX	Weathertight & Explosionproof	2500	2500 in•lb	L5	On/off Battery Back-Up – 3 Position	T[4]	Heater/Thermostat	N12DC	12 VDC
		NEMA 4/4X/7&9	3000	3000 in•lb	R2	On/Off Isolated Control	Y[5b]	Keyed Output	N24DC	24 VDC
					R3	On/Off Board – 3 Position	Z[6]	Handwheel		

Notes:
1. Select only one board option; all of these board options include a holding Brake feature
2. This heater option activates at or below 90°F and deactivates at 110°F; it is recommended in high-humidity applications.
3a. 150 - 600 lb-in models with I option are supplied with a 14mm female square (note that without option I the female square is 3/4")
3b. 1000 lb-in models with I option are supplied with a 19mm female square and 1500 - 3000 lb-in models are supplied with a 22mm female square (note that without option I the female square is 1")
4. This heater option activates at or below 40°F and deactivates at 60°F; it is recommended in applications where the temperature may drop below 32°F.
5a. 150 - 600 lb-in models with Y option are supplied with a 15mm female keyed output.
5b. 1000 - 3000 lb-in models with Y option are supplied with a 20mm female keyed output.
6. Handwheel option not recommended with Back-Up Powered options.

- **Enclosure "W"** (weather-tight) is certified by CSA to meet specifications for NEMA 4/4X for weather-tight and dust-tight, environments. It is intended for non-hazardous locations in indoor or outdoor use and provides a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation. It is not designed to be submersible.
- **Enclosure "WX"** (explosion-proof & weather-tight) is certified by CSA to meet specifications for NEMA 7&9, explosion-proof environments as well as to meet NEMA 4/4X specifications. Explosion-proof means that an internal explosion will be contained, with no sparking that could ignite external atmospheric gases. The enclosure is rated for the following environments:
    - NEMA Class I, Division 1, Group C (Ethyl-ether vapors, ethylene or cyclopropane)
    - NEMA Class I, Division 1, Group D (Gasoline, hexane, naptha, benzene, butane, propane, alcohol, acetone, benzol, lacquer, solvent, vapors or natural gas)
    - NEMA Class II, Division 1, Group E (Metal dust, including aluminum, magnesium, their commercial alloys, and other metals of similarly hazardous characteristics)
    - NEMA Class II, Division 1, Group F (Carbon black, coal or coke dust)
    - NEMA Class II, Division 1, Group G (Flour, starch or grain dust)
    - NEMA Class III

Sample Model Code: ADCW150CL2IS2N24AC

Actuator Series	ADC
Enclosure Type	W
Torque	150
Board Option	CL2
Other Options	I
(if applicable)	S2
Operating Voltage	N24AC

For enclosure specifications and dimensions, **see Table 2 and Figure 10.**

- Torque = Breakaway Torque ADC-Series actuators are rated at breakaway torque; the amount of torque the actuator will provide from a fully loaded stop upon immediate power-up. With running momentum and inertia, the amount of torque supplied by the actuator at full speed (running torque) or upon entering a stall condition (stall torque) always exceeds the minimum rated breakaway torque. Since valves require most torque at breakaway, only breakaway torque should be considered when sizing actuators.

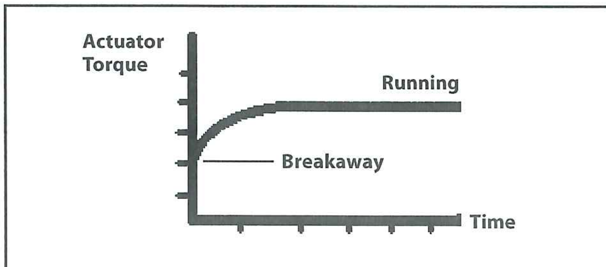


Figure 9

11 ADDITIONAL ACTUATOR PRODUCTS AND ACCESSORIES FROM METSO

V-Series

- Up to 3000 inch pounds for On/Off, Modulating or Automatic Cycling applications
- 75% Duty Cycle
- 115VAC and 230VAC voltages
- NEMA 4/4X and NEMA 4/4X/7&9 enclosures
- CSA Certified (Canadian & U.S. Standards)
- Options include Modulating Control Board, Speed Control/TimerBoard, Iso/Readback Board, extra limit switches, heater/thermostats, motor brake, feedback potentiometer and handwheel override

ESR-Series

- Up to 600 inch pounds for True "Two-Wire" On/Off applications
- 80% Duty Cycle
- 115VAC and 230VAC voltages
- Options include extra limit switches and heater/thermostats

QX-Series

- Up to 3000 inch pounds for On/Off applications
- Economical NEMA 4/4X/7&9 solution
- 12VDC & 24VDC voltages
- 80% Duty Cycle
- CSA (C US) Certification

LC Series

- Up to 600 inch pounds
- Economical actuators for Reversing or Unidirectional applications
- 25% duty cycle
- NEMA 4/4X enclosures
- 115VAC, 230VAC, 24VAC, 12 VDC and 24VDC voltages
- Options include extra limit switches and heater/thermostats
- Male output (standard) or female output (optional)

I-Series Network Capable

- Modbus®
- AS-Interface
- DeviceNet™
- Foundation Fieldbus
- Other fieldbus protocols (consult factory)

Q6-Series for Remote Solar Applications

- 600 inch pounds
- 12VDC
- Low current draw

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www.metso.com/valvcon

metso

VALVCON BACK-UP POWERED ELECTRIC ACTUATOR ADC SERIES

Metso is a leading designer and provider of Valvcon compact, reliable, electronically controlled electric actuators for valves and dampers. We offer a complete line of electric actuators for accurate positioning of dampers and valves in the aerospace, automotive, consumer services, discrete manufacturing, energy, environmental, oil/pipeline, petrochemical, power/utilities, process, recreation, transportation, and water/wastewater industries.

We have developed and introduced the industry's most innovative Metso Valvcon electric actuator products, including simple "set and go" calibration, intelligent processor-based digital electronics, "Plug-in" accessory boards, Back-Up Power actuators, as well as electric actuators designed for remote control, solar-powered applications and two-wire network applications.

The quarter-turn electric actuator will comply with Part 15, Class A of the FCC regulations for emissions and conducted radiation for industrial devices. It will also be designed to meet NEMA standards for use in weathertight or weathertight and hazardous locations. The actuator will be a single, complete unit composed of a compact cast aluminum housing, motor, gearing, limit switches controlled by metal cams for end of travel control, mechanical position indicator, and an optional internal back-up power source to drive to a pre-set position in the event of an external power loss. Actuator mounting flanges shall comply with ISO 5211 standards incorporating a female drive for direct output coupling. The actuator shall be capable of operating in ambient environments of -40° F to 130° F; optional internal heaters are required at temperatures below 32° F.

FEATURES AND BENEFITS

Isolation and Electrical

Internal electronic control boards shall have clearly marked and different size connection terminals for Power and Control Signals to prevent incorrect wiring and shall provide CW and CCW push buttons for local manual control. The actuator control electronics shall be electrically isolated to allow multiple actuators to be wired in parallel. Electronic control boards shall be protected on the outward side with insulating overlays providing operating instructions and additional safety. Additionally, electronic control boards shall include a simple user-interface, including slide switches and selection knob for mode selection, calibration and set up. The electronic control boards will also supply a mA or voltage position feedback signal and include a holding brake feature to prevent back-driving. All internal connections, (motor leads, limit switch leads, option connectors, etc.) shall be coded, using different style connectors for each function, to prevent incorrect wiring. All connections will plug-in to simplify field repairs and upgrades. In AC applications a highly reliable switching power supply will provide power conversion to drive the internal DC motor; DC applications will utilize an equally reliable DC to DC regulator. Other than periodic battery replacement; no maintenance will be required.

Motor

The internal electric motor will be of a brushless DC type, capable of running continuously at full torque at ambient temperature at or below 104° F.

metso
Expect results

Lubrication

All rotating power train components will be coated with a multi-purpose grease. Lubricants will be suitable for ambient conditions of -40° F to 130° F. For operation in temperatures between 32° F and -40° F an optional heater and thermostat assembly must be included.

Gearing

The powertrain will be comprised of hardened steel, machine cut spur gears. Non-metallic, aluminum, cast or stamped gearing will not be permitted.

Limit Switches

Actuators will have two standard end-of-travel switches, single pole double throw, rated at 15 amps at 250 VAC. Under normal operation the end of travel limit switches will not be activated; activating the limit switches will interrupt actuator travel. Up to two additional limit switches, adjustable to operate at any position as required by the process application, may be added to the actuator for end of travel indication.

On/Off Control (Open/Close Operation) with Optional Battery Back-Up

Open/Close actuators require separate Power and Control signals. The Power signal must be constantly maintained; immediately upon loss of the Power signal, the internal back-up power source will drive the actuator to the Power Loss Position. The Control signal consists of one to three maintained AC or DC contacts and the actuator can be set to operate in Two-wire, Three-wire or Three-position modes. In Two-wire mode a signal is maintained to drive the actuator to the CCW position and removed to drive to the CW position. In Three-wire mode separate Control signals are applied to drive the actuator to the CW and CCW positions and may be removed at any point in mid-stroke to position the valve or damper. In Three-position mode separate Control signals are applied to drive the actuator to the CW, "MID" or CCW positions and may be removed at any point in mid-stroke to position the valve or damper. The Power Loss Position may be either the full CW, the full CCW or "MID" position and is determined by the fail position selection switch.

Proportional Control (Modulating Operation) with Optional Battery Back-Up

Modulating control actuators will accept a variable, proportional 4-20 mA or 0-10VDC valve position signal and respond by positioning the valve linearly with an accuracy of 1%. Normally, the actuator will drive clockwise in response to a decreasing control signal; however, the actuator will be capable of "reverse acting" operation (driving counter-clockwise in response to a decreasing control signal) without internal wiring changes. The actuator will also provide the ability to adjust the sensitivity to control signal changes. Slide switches will enable the user to set the actuator response to a loss of control signal, select the "fail" position upon loss of Power and select either the single cycle or multi-cycle loss of power mode. Locked rotor, stall protection will detect whenever the actuator is unable to achieve the position commanded by the control signal, and will terminate power to the motor in order to prevent damage due to repeated stall conditions.

The Back-Up Powered Electric Actuators from Metso

Metso offers several product lines that are designed to drive a valve or damper to a pre-determined position in the event of a power loss. Under normal power conditions, they provide accurate positioning in response to the powered control signals.

Optional Internal Battery Back-Up

Metso Valvcon ADC Series can be equipped with an optional internal battery pack. The actuator is driven by an external power source under normal conditions. When power is lost, the internal battery pack can be set up to either drive immediately to the pre-set position, or continue to respond to a maintained control signal. The ADC Series is an excellent choice for continuous duty modulating applications, or any application where an inexpensive alternative to mechanical spring back-up is desired.

Break-away Torque

Designed for efficiency and reliability, all Metso Valvcon actuators deliver the power you need when and where it is needed. With efficient gear trains and motors these actuators are rated at breakaway torque. Immediately upon power up, the actuator supplies the rated torque — when it is needed to break the valve away from its seat. Other manufacturer's actuators may be rated at running torque, but actually deliver significantly less breakaway torque.

FEATURES AT A GLANCE!

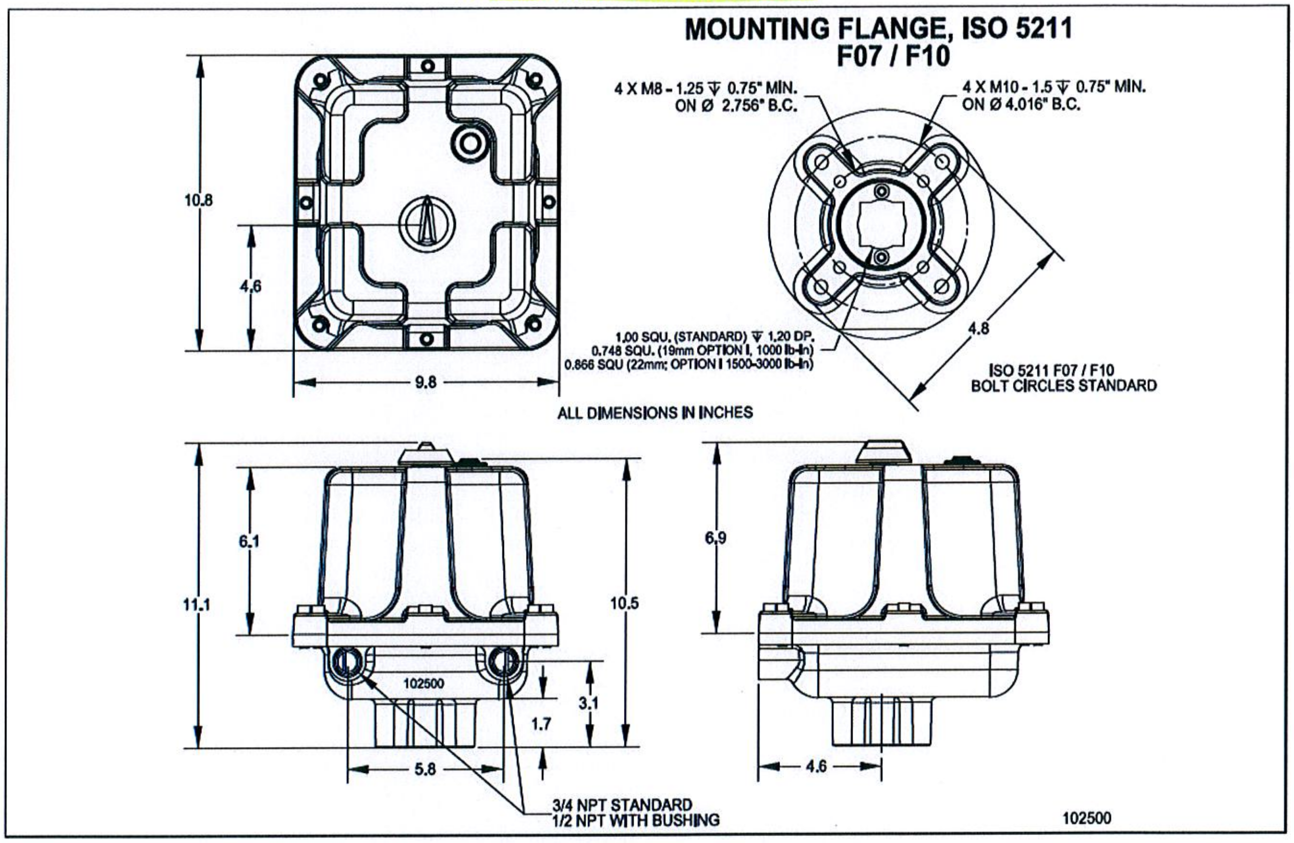
ADC Series

- ☐ Optional internal battery packs allow for continued modulation during power outages, provided the control signal remains.
- ☐ Field-settable for "fail clockwise" or "fail counter-clockwise."

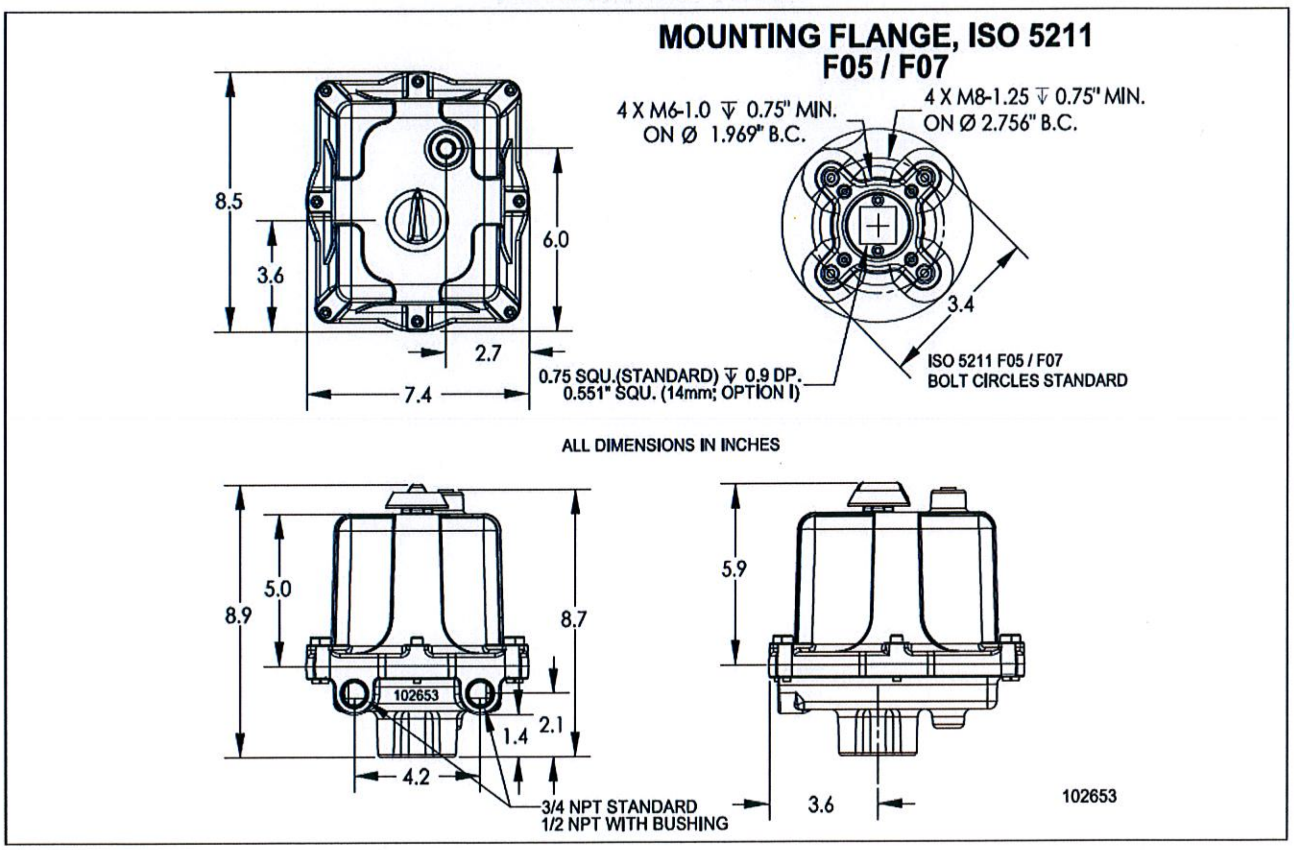
Valvcon Back-up Powered Actuators:

- ☐ Patented technology provides back-up capabilities within the standard size actuator enclosures!
- ☐ Dual conduit openings make wiring easier, and keep power and control wiring separate.
- ☐ Two year warranty.

LADC-SERIES ENCLOSURE



ADC-SERIES ENCLOSURE



ALL DIMENSIONS IN INCHES

ADC SPECIFICATIONS

Battery Back-up Power

Metso Valvcon ADC Series electric actuators, equipped with internal battery power, allow you to shut down your system in the event of an external power loss. Engineered to supply dependable valve actuation, they can provide up to 10 complete cycles under their own internal power.

The electronic back-up powered feature incorporates a rechargeable battery pack on a plug-in, modular PC board under the actuator cover. Upon power loss or a signal from an external sensor, the battery pack is automatically activated as the main power supply. The battery is compact and fits easily into the standard enclosures for an easy, space-saving upgrade. No hard-wiring or other complex operations are required.

Metso Valvcon battery back-up actuators are available in on/off (two position) or continuous duty modulating models.

- Internal batteries allow for continued cycling during power outages, enabling an orderly shut-down of critical processes.
- A built-in trickle charger, with over-charge protection, ensures the batteries always have enough power when called upon
- Batteries can be easily replaced in the field.

MODULATING DATA

Torque (in-lbs)	Duty Cycle	12VDC		24VDC		24VAC		115VAC		230VAC	
		Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)
150	100%	11	2.2	13	1.2	8	1.8	9	0.4	9	0.4
300	100%	17	2.5	13	1.4	12	2.1	13	0.5	13	0.4
600	100%	17	2.8	13	1.7	13	2.5	14	0.6	14	0.5
1000	100%	21	4	14	2.4	15	3.5	15	0.9	15	0.6
1500	100%	40	4	24	2.4	27	3.5	29	0.9	29	0.6
2000	100%	40	4.3	33	2.4	28	3.5	29	0.9	29	0.6
2500	100%	55	3.3	40	2	38	3.1	39	0.8	39	0.6
3000	100%	60	3.7	42	2.2	40	3.5	42	0.8	43	0.6

ON/OFF DATA

Torque (in lbs.)	Speed (per 90° rotation, in seconds)		Duty Cycle**	Normal Operating Current Draw (in Amps)				
		24VDC only		12VDC	24VDC	24VAC	115VAC	230VAC
150	5	3	Continuous**	1.9	2.4	1.5	.2	.1
300	10	5	Continuous**	1.9	2.4	1.5	.2	.1
600	15	8	Continuous**	1.9	2.4	1.5	.2	.1
1000	15	15	Continuous**	3.5	3.5	2.0	.4	.2
1500	20	20	Continuous**	3.5	3.5	2.0	.4	.2
2000	25	25	Continuous**	4.8	4.8	2.0	.4	.2
2500	30	30	Continuous**	4.8	4.8	2.0	.4	.2
3000	35	35	Continuous**	4.8	4.8	2.0	.4	.2

**Continuous for 1 hour after which duty cycle is reduced to 80%.

BACK-UP POWERED ELECTRIC ACTUATORS OPTIONS

Tropical Heater/Thermostat

(Order Code H)

Recommended in all high humidity applications where condensation may accumulate inside the actuator. For 115VAC applications the heater consumes 15 watts, for 230VAC applications the heater consumes 40 watts.

ISO 5211 Output

(Order I)

ISO 5211 Standard mounting configuration and output coupling.

150-600 in-lb models with "I" options are supplied with a 14mm female square. (note: without option "I" the female square is 3/4 inch).

1000 in-lb models with "I" options are supplied with a 19mm female square and 1500-3000 in-lb models are supplied with a 22 mm female square. (note: without option "I" the female square is 1inch).

Additional Limit Switches

(Order Code S2)

Up to two additional limit switches may be added for position indication or as dry contacts to operate other devices. Single pole, double throw switches rated for 1/2 HP, 15 amps @ 250VAC, CSA certified.

Heater/Thermostat

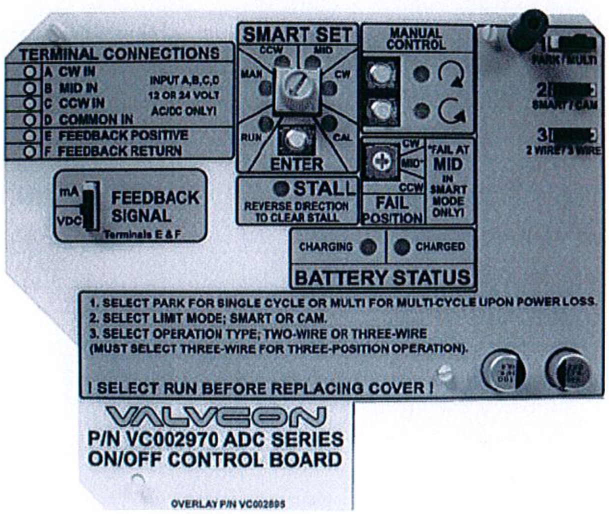
(Order Code T)

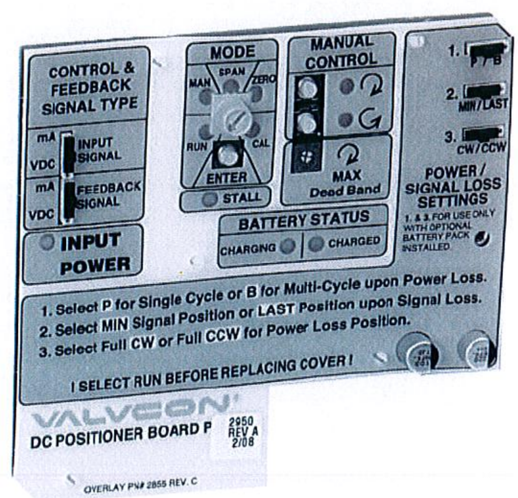
Required in all applications where the temperature may drop below 32°F. For 115VAC applications the heater consumes 15 watts, for 230VAC applications the heater consumes 40 watts.

Hazardous Location Enclosures

(ADCWX and LADCWX)

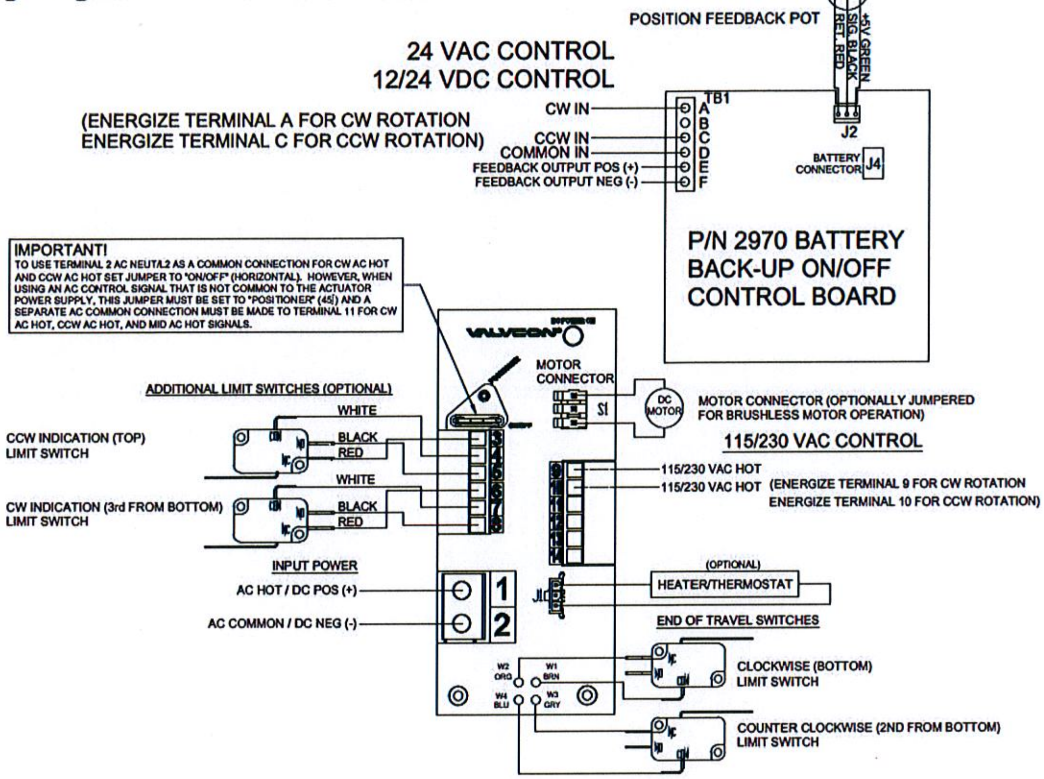
The standard enclosures (W) are rated for NEMA 4/4X (weather tight and corrosion resistant). The Hazardous Location enclosures (WX) are rated for NEMA 4/4X/7 & 9, Class I, Div 1, Groups C&D; Class II, Div. 1, Groups E, F, & G; Class III.





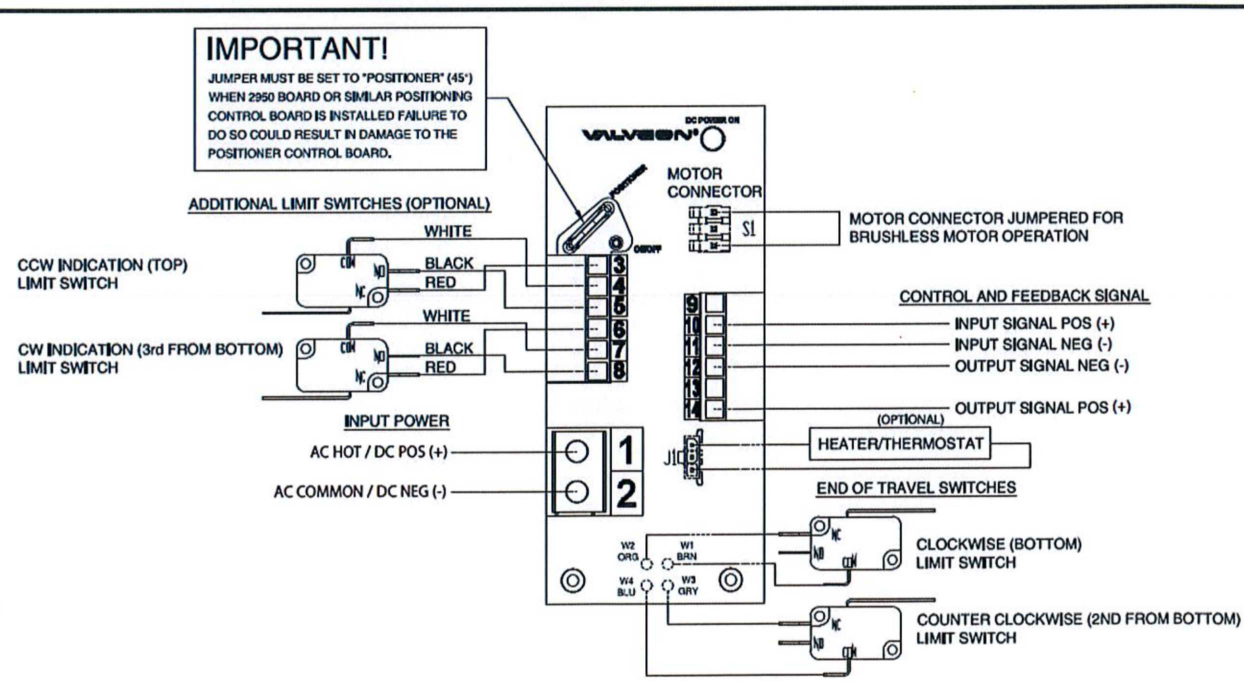
ADC/LADC ON/OFF APPLICATIONS

Wiring Diagram – "Three Wire" Control



Note: "Three Wire" control shown for other configurations see IMO.

ADC/LADC MODULATING APPLICATIONS



HOW TO ORDER – ADC SERIES ACTUATORS

Example: Sample model code: ADCW150CL2IS2N24AC

1	2	3	4	5	6
ADC	W	150	CL2	I S2	N24AC

1	Series
ADC	ADC

2	Enclosure
W	Weathertight (NEMA 4/4X)
WX	Weathertight & Explosion proof (NEMA 4/4X/7 & 9)

3	Torque (in lbs)
150	150
300	300
600	600

4	Options [1] (Must Select One)
C	Modulating
CL2	Modulating Battery Back-Up
L2	On/Off Battery Back-Up
L4	ON/Off Battery Back-Up - 3 Position
R2	ON/Off Isolated Control
R3	ON/Off Board - 3 Position

5	Other Options
—	No entry if standard
H[2]	Tropical Heater/Thermostat
I[3a]	ISO 5211 Output
S2	Two Auxiliary Limit Switches
T[4]	Heater/Thermostat
Z[5]	Handwheel

6	Operating Voltage
N115AC	115VAC
N230AC	230VAC
N24AC	24VAC
N12DC	12VDC
N24DC	24VDC

HOW TO ORDER – LADC SERIES ACTUATORS

Example: Sample model code: LADCW1500CL3IS2N24AC

1	2	3	4	5	6
LADC	W	1500	CL3	I S2	N24AC

1	Series
LADC	LADC

2	Enclosure
W	Weathertight (NEMA 4/4X)
WX	Weathertight & Explosion proof (NEMA 4/4X/7 & 9)

3	Torque (in lbs)
1000	1000
1500	1500
2000	2000
2500	2500
3000	3000

4	Options [1] (Must Select One)
C	Modulating
CL3	Modulating Battery Back-Up
L3	On/Off Battery Back-Up
L5	ON/Off Battery Back-Up - 3 Position
R2	ON/Off Isolated Control
R3	ON/Off Board - 3 Position

5	Other Options
—	No entry if standard
H[2]	Tropical Heater/Thermostat
I[3b]	ISO 5211 Output
S2	Two Auxiliary Limit Switches
T[4]	Heater/Thermostat
Z[5]	Handwheel

6	Operating Voltage
N115AC	115VAC
N230AC	230VAC
N24AC	24VAC
N12DC	12VDC
N24DC	24VDC

Notes:

1. Must select only one board option; all of these board options include 4-20mA or 0-10VDC position feedback, (2-10VDC on On/Off option boards) and a holding brake feature.
2. This heater option activates at or below 90°F and deactivates at 110°F; it is recommended in high-humidity applications.

3a. 150 - 600 lb-in models with I option are supplied with a 14mm female square (note that without option I the female square is 3/4").

3b. 1000 lb-in models with I option are supplied with a 19mm female square and 1500 - 3000 lb-in models are supplied with a 22mm female square (note that without option I the female square is 1").

4. This heater option activates at or below 40°F and deactivates at 60°F; it is recommended in applications where the temperature may drop below 32°F.
5. Handwheel option not recommended with Back-Up Powered options.

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Metso worldwide web site:
www.metso.com/automation/valvcon, provides 24 hour a day access to all technical support material—from sales brochures to instruction manuals to installation and troubleshooting tips. For local support, Our network of trained stocking distributors/representatives are industry leading experts in valve automation. Contact the Metso, Valvcon product web site to locate the nearest stocking distributor/representative.

Timely Technical Support

Metso Express Services is on call to answer your engineering or application questions, and to quickly repair or upgrade your actuators. These highly trained support engineers offer a broad range of expertise, with the combined experience to assist specifying engineers and contractors with information on feasibility and special applications. Find Metso Express at **www.metso.com/automation/valvcon**.

A Tradition of Quality

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Multi-Turn Bevel Gear (BG Type)
Installation & Operation Instructions

Installation Tips:
All DYNATORQUE™ operators & accessories have been designed to transmit the rated output torque of the operator with a safety factor. When designing mounting kits, torque transmission devices, or specifying mounting hardware the operator rating should be considered. DYNATORQUE recommends using grade 5 and higher bolts with lock washers for mounting operators to valve operator flanges and valve adaptation kits. DYNATORQUE components should not be installed in areas where those components will be subjected to high temperatures, corrosive atmospheres, or high pressures without prior knowledge by DYNATORQUE or unless originally designed for that purpose. Doing so may affect the product warranty.

Installation:
Before assembly is begun please insure that mounting bolt patterns have been machined correctly for the application.
The following steps should be taken to install the DYNATORQUE BG manual multi-turn operator. DYNATORQUE recommends operator mounting while on the test stand with the valve in the closed position.

Yoke Nut Driver Installation:
1. Move the valve in the closed position and insure valve seal has been attained.
2. Install the Yoke Nut Driver on the bottom of the bevel gear using the bolt pattern supplied.
3. Before installing the operator, liberally grease the Yoke Nut and the Yoke Nut Driver. This will reduce the possibility of corrosion between the two components.
4. Align the operator with the Yoke Nut and lower the operator into position on the valve flange or mounting kit.
5. Install and tighten the valve to operator mounting bolts.
6. Rotate the operator handwheel counterclockwise moving the valve from the closed to the open position checking to make sure the operator turns smoothly through the complete cycle. Visually verify that the open position has been achieved.
7. Rotate the valve from closed to open several times to insure proper operation.

Threaded Stem Nut Installation:
1. Move the valve in the closed position and insure valve seal has been attained.
2. Install the Threaded Stem Nut on the bottom of the bevel gear using the bolt pattern supplied.
3. Before installing the operator, liberally grease the Valve Stem and the Threaded Stem Nut. This will reduce the possibility of corrosion between the two components.
4. Position the Stem Nuts threaded hole over the valve stem. As you lower the operator, turn the input shaft. This rotation should engage the male with the female threads in the nut. Continue to rotate the input shaft until the unit comes into contact with the mounting adapter or valve operator-mounting flange.
5. Align the mounting holes by rotating the operator while allowing the input shaft to rotate freely. (If the operator-input shaft is held the valve position may move off the seat.)
6. Install and tighten the valve to operator mounting bolts.
7. Rotate the operator handwheel counterclockwise moving the valve from the closed to the open position checking to make sure the operator turns smoothly through the complete cycle. Visually verify that the open position has been achieved.
8. Rotate the valve from closed to open several times to insure proper operation.

Safety:
DYNATORQUE operators have been designed and manufactured to the highest quality standards. In most cases, operator and handwheel packages have been sized to produce rated torque with a maximum of 80 lbs. of handwheel rim effort. The use of larger handwheels, cheater bars, etc. will void the override warranty and may cause damage to the operator, valve stem, drive shafts, or other torque transmitting devises as well as being dangerous to the user. Additionally, the use of chainwheels on operators that are not recommended for those applications will result voiding operator warranty.

Operation:
Once the valve assembly has been installed, operation of multi-turn manual gear operators is very simple. Assuming a clockwise to close valve as in the assembly instructions, rotating the handwheel clockwise will result in clockwise output rotation or clockwise to close. Reversing rotation of the handwheel, counterclockwise, will result in counterclockwise rotation of the output or counterclockwise to open.

Please Note:

When assembling DYNATORQUE products to a valve or to an automated valve package, standard engineering practices must be utilized to assure proper mounting orientation, configuration, and distribution of weights and forces. Failure to do so could cause product damage and/or malfunction, ***and void warranty consideration***. If there are any questions please contact the factory.

FLOW CONTROL
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Muskegon, MI 49442
Tel 231.788.7025, Fax 231.788.7030
Info-DYT@c-a-m.com, www.c-a-m.com

VALVCON BACK-UP POWERED ELECTRIC ACTUATOR ADC SERIES

Metso is a leading designer and provider of Valvcon compact, reliable, electronically controlled electric actuators for valves and dampers. We offer a complete line of electric actuators for accurate positioning of dampers and valves in the aerospace, automotive, consumer services, discrete manufacturing, energy, environmental, oil/pipeline, petrochemical, power/utilities, process, recreation, transportation, and water/wastewater industries.

We have developed and introduced the industry's most innovative Metso Valvcon electric actuator products, including simple "set and go" calibration, intelligent processor-based digital electronics, "Plug-in" accessory boards, Back-Up Power actuators, as well as electric actuators designed for remote control, solar-powered applications and two-wire network applications.

The quarter-turn electric actuator will comply with Part 15, Class A of the FCC regulations for emissions and conducted radiation for industrial devices. It will also be designed to meet NEMA standards for use in weathertight or weathertight and hazardous locations. The actuator will be a single, complete unit composed of a compact cast aluminum housing, motor, gearing, limit switches controlled by metal cams for end of travel control, mechanical position indicator, and an optional internal back-up power source to drive to a pre-set position in the event of an external power loss. Actuator mounting flanges shall comply with ISO 5211 standards incorporating a female drive for direct output coupling. The actuator shall be capable of operating in ambient environments of -40° F to 130° F; optional internal heaters are required at temperatures below 32° F.

FEATURES AND BENEFITS

Isolation and Electrical

Internal electronic control boards shall have clearly marked and different size connection terminals for Power and Control Signals to prevent incorrect wiring and shall provide CW and CCW push buttons for local manual control. The actuator control electronics shall be electrically isolated to allow multiple actuators to be wired in parallel. Electronic control boards shall be protected on the outward side with insulating overlays providing operating instructions and additional safety. Additionally, electronic control boards shall include a simple user-interface, including slide switches and selection knob for mode selection, calibration and set up. The electronic control boards will also supply a mA or voltage position feedback signal and include a holding brake feature to prevent back-driving. All internal connections, (motor leads, limit switch leads, option connectors, etc.) shall be coded, using different style connectors for each function, to prevent incorrect wiring. All connections will plug-in to simplify field repairs and upgrades. In AC applications a highly reliable switching power supply will provide power conversion to drive the internal DC motor; DC applications will utilize an equally reliable DC to DC regulator. Other than periodic battery replacement; no maintenance will be required.

Motor

The internal electric motor will be of a brushless DC type, capable of running continuously at full torque at ambient temperature at or below 104° F.

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Lubrication

All rotating power train components will be coated with a multi-purpose grease. Lubricants will be suitable for ambient conditions of -40° F to 130° F. For operation in temperatures between 32° F and -40° F an optional heater and thermostat assembly must be included.

Gearing

The powertrain will be comprised of hardened steel, machine cut spur gears. Non-metallic, aluminum, cast or stamped gearing will not be permitted.

Limit Switches

Actuators will have two standard end-of-travel switches, single pole double throw, rated at 15 amps at 250 VAC. Under normal operation the end of travel limit switches will not be activated; activating the limit switches will interrupt actuator travel. Up to two additional limit switches, adjustable to operate at any position as required by the process application, may be added to the actuator for end of travel indication.

On/Off Control (Open/Close Operation) with Optional Battery Back-Up

Open/Close actuators require separate Power and Control signals. The Power signal must be constantly maintained; immediately upon loss of the Power signal, the internal back-up power source will drive the actuator to the Power Loss Position. The Control signal consists of one to three maintained AC or DC contacts and the actuator can be set to operate in Two-wire, Three-wire or Three-position modes. In Two-wire mode a signal is maintained to drive the actuator to the CCW position and removed to drive to the CW position. In Three-wire mode separate Control signals are applied to drive the actuator to the CW and CCW positions and may be removed at any point in mid-stroke to position the valve or damper. In Three-position mode separate Control signals are applied to drive the actuator to the CW, "MID" or CCW positions and may be removed at any point in mid-stroke to position the valve or damper. The Power Loss Position may be either the full CW, the full CCW or "MID" position and is determined by the fail position selection switch.

Proportional Control (Modulating Operation) with Optional Battery Back-Up

Modulating control actuators will accept a variable, proportional 4-20 mA or 0-10VDC valve position signal and respond by positioning the valve linearly with an accuracy of 1%. Normally, the actuator will drive clockwise in response to a decreasing control signal; however, the actuator will be capable of "reverse acting" operation (driving counter-clockwise in response to a decreasing control signal) without internal wiring changes. The actuator will also provide the ability to adjust the sensitivity to control signal changes. Slide switches will enable the user to set the actuator response to a loss of control signal, select the "fail" position upon loss of Power and select either the single cycle or multi-cycle loss of power mode. Locked rotor, stall protection will detect whenever the actuator is unable to achieve the position commanded by the control signal, and will terminate power to the motor in order to prevent damage due to repeated stall conditions.

The Back-Up Powered Electric Actuators from Metso

Metso offers several product lines that are designed to drive a valve or damper to a pre-determined position in the event of a power loss. Under normal power conditions, they provide accurate positioning in response to the powered control signals.

Optional Internal Battery Back-Up

Metso Valvcon ADC Series can be equipped with an optional internal battery pack. The actuator is driven by an external power source under normal conditions. When power is lost, the internal battery pack can be set up to either drive immediately to the pre-set position, or continue to respond to a maintained control signal. The ADC Series is an excellent choice for continuous duty modulating applications, or any application where an inexpensive alternative to mechanical spring back-up is desired.

Break-away Torque

Designed for efficiency and reliability, all Metso Valvcon actuators deliver the power you need when and where it is needed. With efficient gear trains and motors these actuators are rated at breakaway torque. Immediately upon power up, the actuator supplies the rated torque — when it is needed to break the valve away from its seat. Other manufacturer's actuators may be rated at running torque, but actually deliver significantly less breakaway torque.

FEATURES AT A GLANCE!

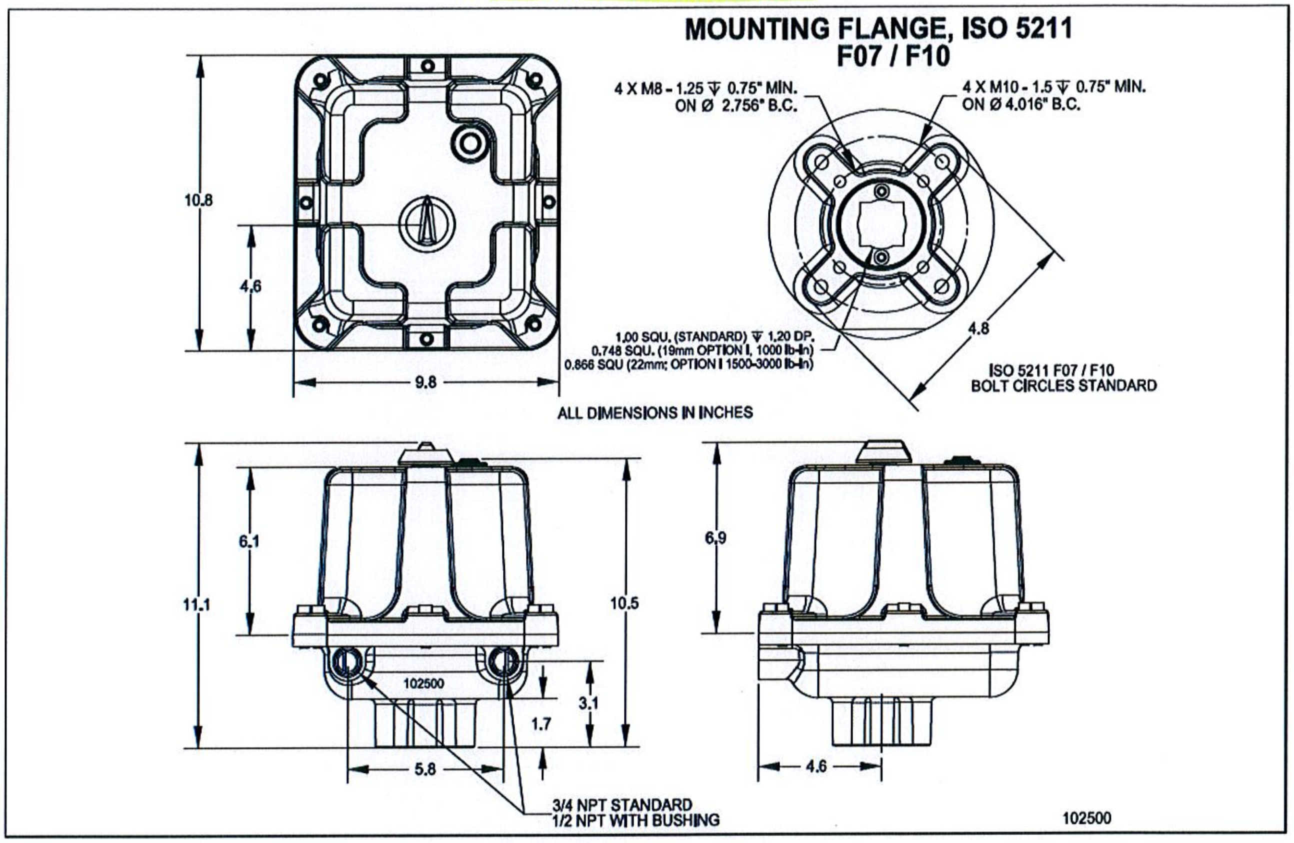
ADC Series

- Optional internal battery packs allow for continued modulation during power outages, provided the control signal remains.
- Field-settable for "fail clockwise" or "fail counter-clockwise."

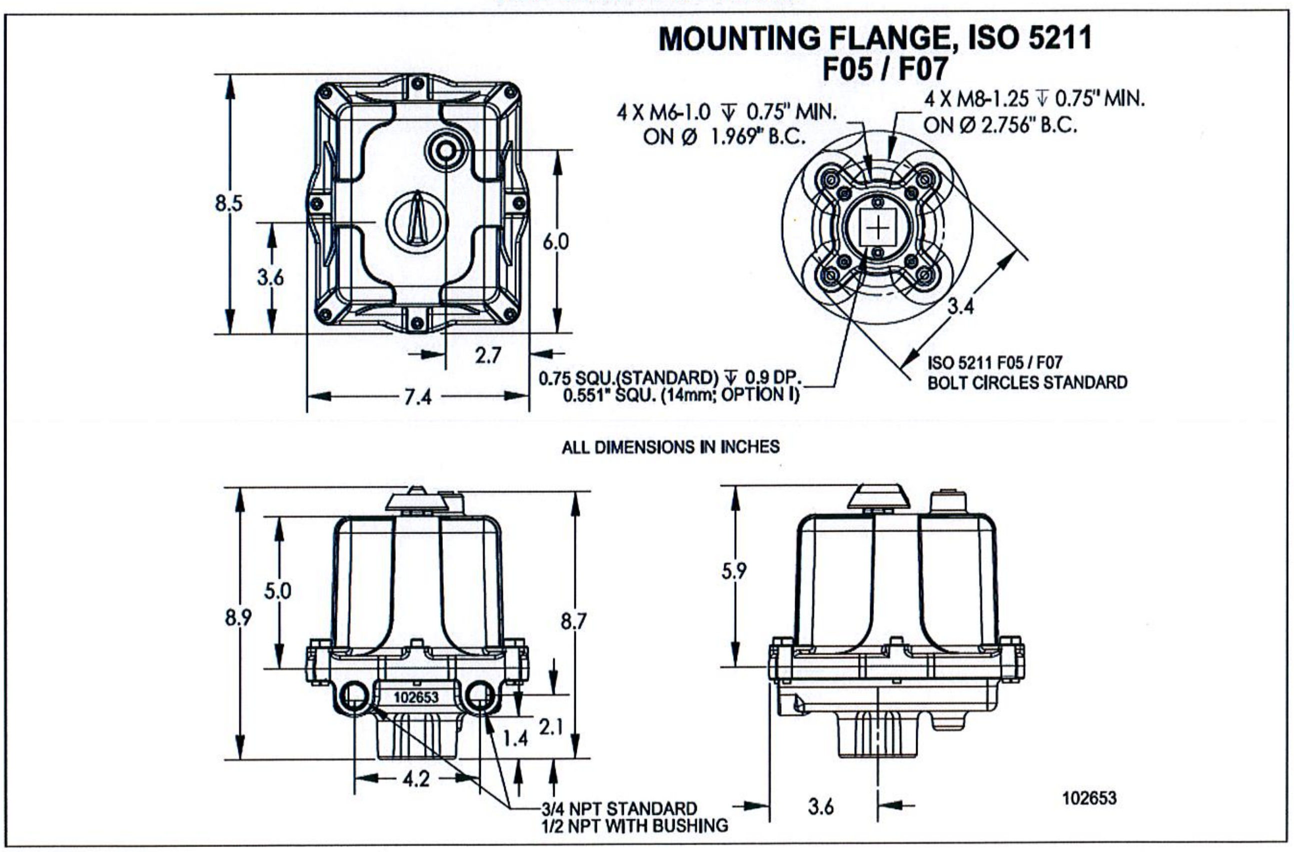
Valvcon Back-up Powered Actuators:

- Patented technology provides back-up capabilities within the standard size actuator enclosures!
- Dual conduit openings make wiring easier, and keep power and control wiring separate.
- Two year warranty.

LADC-SERIES ENCLOSURE



ADC-SERIES ENCLOSURE



ALL DIMENSIONS IN INCHES

ADC SPECIFICATIONS

Battery Back-up Power

Metso Valvcon ADC Series electric actuators, equipped with internal battery power, allow you to shut down your system in the event of an external power loss. Engineered to supply dependable valve actuation, they can provide up to 10 complete cycles under their own internal power.

The electronic back-up powered feature incorporates a rechargeable battery pack on a plug-in, modular PC board under the actuator cover. Upon power loss or a signal from an external sensor, the battery pack is automatically activated as the main power supply. The battery is compact and fits easily into the standard enclosures for an easy, space-saving upgrade. No hard-wiring or other complex operations are required.

Metso Valvcon battery back-up actuators are available in on/off (two position) or continuous duty modulating models.

- Internal batteries allow for continued cycling during power outages, enabling an orderly shut-down of critical processes.
- A built-in trickle charger, with over-charge protection, ensures the batteries always have enough power when called upon
- Batteries can be easily replaced in the field.

MODULATING DATA

Torque (in-lbs)	Duty Cycle	12VDC		24VDC		24VAC		115VAC		230VAC	
		Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)
150	100%	11	2.2	13	1.2	8	1.8	9	0.4	9	0.4
300	100%	17	2.5	13	1.4	12	2.1	13	0.5	13	0.4
600	100%	17	2.8	13	1.7	13	2.5	14	0.6	14	0.5
1000	100%	21	4	14	2.4	15	3.5	15	0.9	15	0.6
1500	100%	40	4	24	2.4	27	3.5	29	0.9	29	0.6
2000	100%	40	4.3	33	2.4	28	3.5	29	0.9	29	0.6
2500	100%	55	3.3	40	2	38	3.1	39	0.8	39	0.6
3000	100%	60	3.7	42	2.2	40	3.5	42	0.8	43	0.6

ON/OFF DATA

Torque (in lbs.)	Speed (per 90° rotation, in seconds)		Duty Cycle**	Normal Operating Current Draw (in Amps)				
		24VDC only		12VDC	24VDC	24VAC	115VAC	230VAC
150	5	3	Continuous**	1.9	2.4	1.5	.2	.1
300	10	5	Continuous**	1.9	2.4	1.5	.2	.1
600	15	8	Continuous**	1.9	2.4	1.5	.2	.1
1000	15	15	Continuous**	3.5	3.5	2.0	.4	.2
1500	20	20	Continuous**	3.5	3.5	2.0	.4	.2
2000	25	25	Continuous**	4.8	4.8	2.0	.4	.2
2500	30	30	Continuous**	4.8	4.8	2.0	.4	.2
3000	35	35	Continuous**	4.8	4.8	2.0	.4	.2

**Continuous for 1 hour after which duty cycle is reduced to 80%.

BACK-UP POWERED ELECTRIC ACTUATORS OPTIONS

Tropical Heater/Thermostat

(Order Code H)

Recommended in all high humidity applications where condensation may accumulate inside the actuator. For 115VAC applications the heater consumes 15 watts, for 230VAC applications the heater consumes 40 watts.

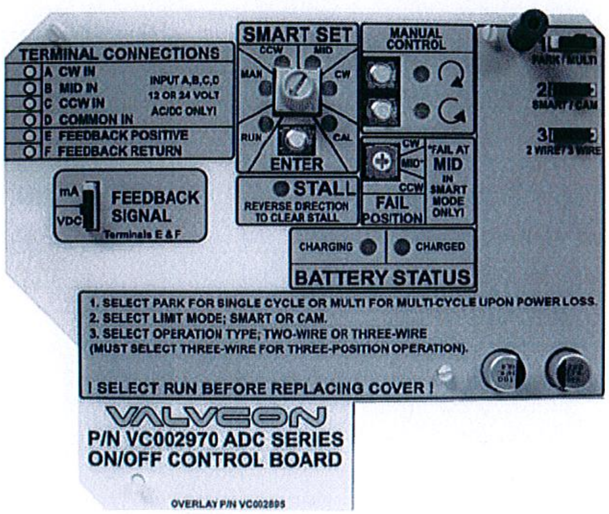
ISO 5211 Output

(Order I)

ISO 5211 Standard mounting configuration and output coupling.

150-600 in-lb models with "I" options are supplied with a 14mm female square. (note: without option "I" the female square is 3/4 inch).

1000 in-lb models with "I" options are supplied with a 19mm female square and 1500-3000 in-lb models are supplied with a 22 mm female square. (note: without option "I" the female square is 1inch).



Additional Limit Switches

(Order Code S2)

Up to two additional limit switches may be added for position indication or as dry contacts to operate other devices. Single pole, double throw switches rated for 1/2 HP, 15 amps @ 250VAC, CSA certified.

Heater/Thermostat

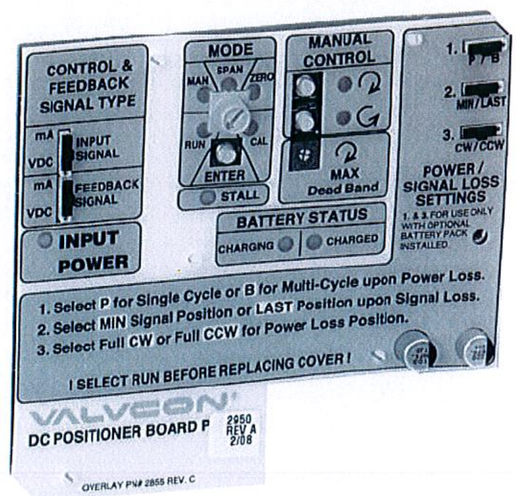
(Order Code T)

Required in all applications where the temperature may drop below 32°F. For 115VAC applications the heater consumes 15 watts, for 230VAC applications the heater consumes 40 watts.

Hazardous Location Enclosures

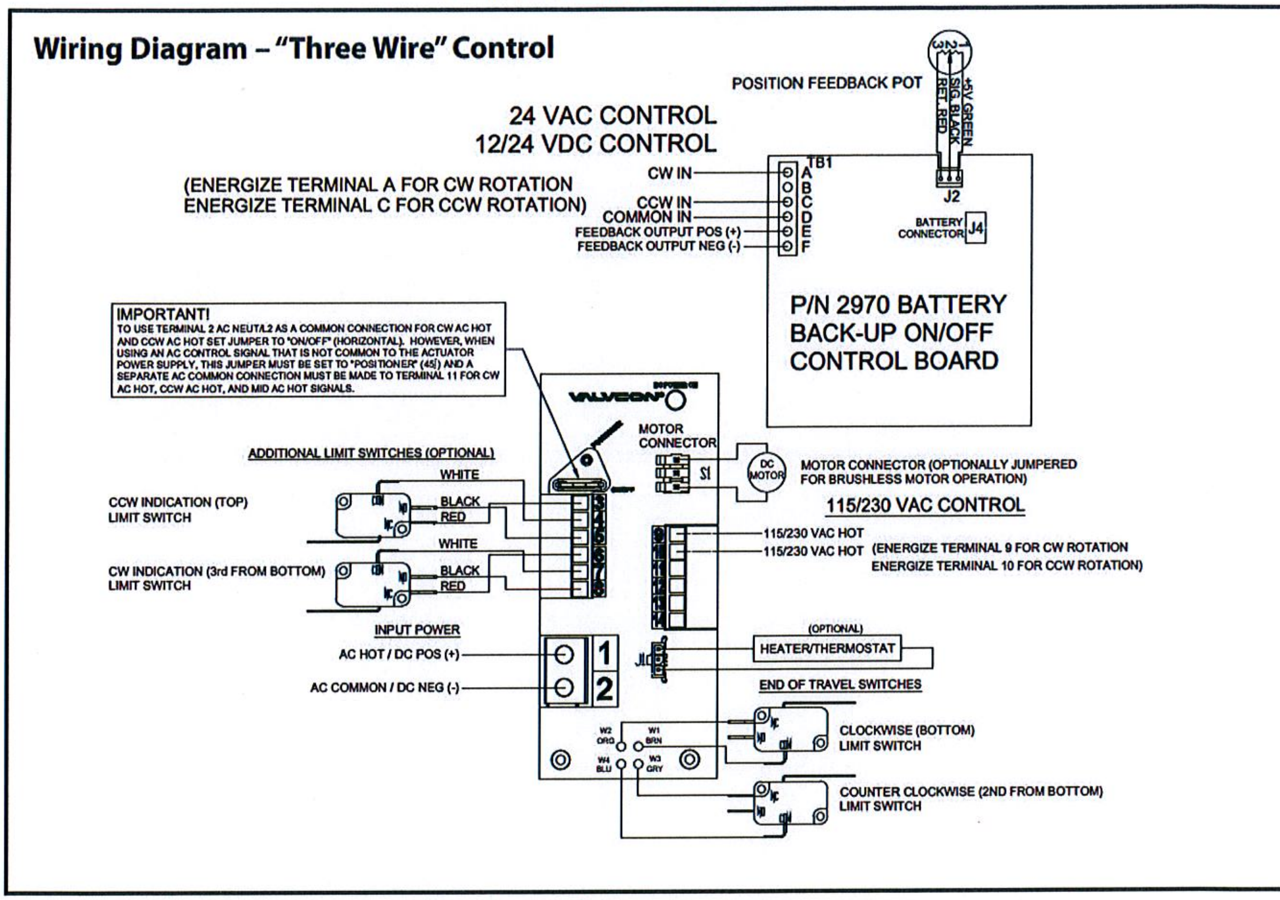
(ADCWX and LADCWX)

The standard enclosures (W) are rated for NEMA 4/4X (weather tight and corrosion resistant). The Hazardous Location enclosures (WX) are rated for NEMA 4/4X/7 & 9, Class I, Div 1, Groups C&D; Class II, Div. 1, Groups E, F, & G; Class III.



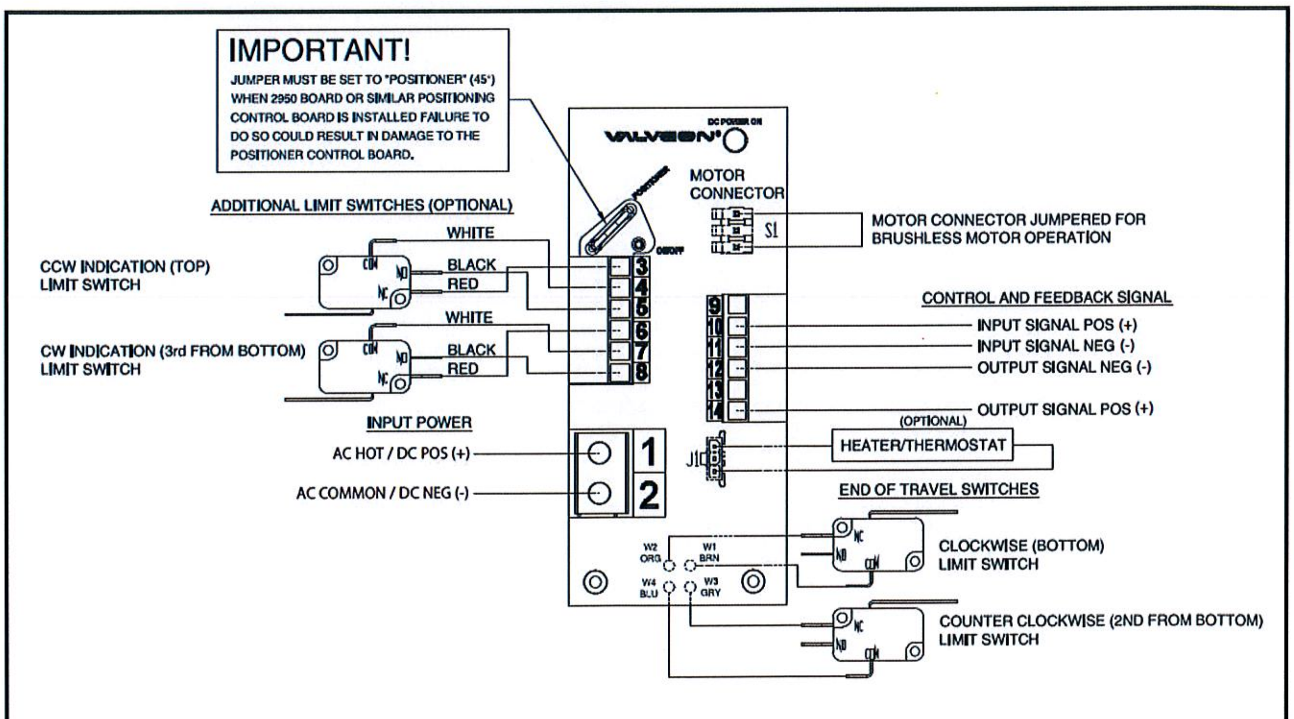
ADC/LADC ON/OFF APPLICATIONS

Wiring Diagram – "Three Wire" Control



Note: "Three Wire" control shown for other configurations see IMO.

ADC/LADC MODULATING APPLICATIONS



HOW TO ORDER – ADC SERIES ACTUATORS

Example: Sample model code: ADCW150CL2IS2N24AC

1	2	3	4	5	6
ADC	W	150	CL2	I S2	N24AC

1	Series
ADC	ADC

2	Enclosure
W	Weathertight (NEMA 4/4X)
WX	Weathertight & Explosion proof (NEMA 4/4X/7 & 9)

3	Torque (in lbs)
150	150
300	300
600	600

4	Options [1] (Must Select One)
C	Modulating
CL2	Modulating Battery Back-Up
L2	On/Off Battery Back-Up
L4	ON/Off Battery Back-Up - 3 Position
R2	ON/Off Isolated Control
R3	ON/Off Board - 3 Position

5	Other Options
—	No entry if standard
H[2]	Tropical Heater/Thermostat
I[3a]	ISO 5211 Output
S2	Two Auxiliary Limit Switches
T[4]	Heater/Thermostat
Z[5]	Handwheel

6	Operating Voltage
N115AC	115VAC
N230AC	230VAC
N24AC	24VAC
N12DC	12VDC
N24DC	24VDC

HOW TO ORDER – LADC SERIES ACTUATORS

Example: Sample model code: LADCW1500CL3IS2N24AC

1	2	3	4	5	6
LADC	W	1500	CL3	I S2	N24AC

1	Series
LADC	LADC

2	Enclosure
W	Weathertight (NEMA 4/4X)
WX	Weathertight & Explosion proof (NEMA 4/4X/7 & 9)

3	Torque (in lbs)
1000	1000
1500	1500
2000	2000
2500	2500
3000	3000

4	Options [1] (Must Select One)
C	Modulating
CL3	Modulating Battery Back-Up
L3	On/Off Battery Back-Up
L5	ON/Off Battery Back-Up - 3 Position
R2	ON/Off Isolated Control
R3	ON/Off Board - 3 Position

5	Other Options
—	No entry if standard
H[2]	Tropical Heater/Thermostat
I[3b]	ISO 5211 Output
S2	Two Auxiliary Limit Switches
T[4]	Heater/Thermostat
Z[5]	Handwheel

6	Operating Voltage
N115AC	115VAC
N230AC	230VAC
N24AC	24VAC
N12DC	12VDC
N24DC	24VDC

Notes:

1. Must select only one board option; all of these board options include 4-20mA or 0-10VDC position feedback, (2-10VDC on On/Off option boards) and a holding brake feature.
2. This heater option activates at or below 90°F and deactivates at 110°F; it is recommended in high-humidity applications.

3a. 150 - 600 lb-in models with I option are supplied with a 14mm female square (note that without option I the female square is 3/4").

3b. 1000 lb-in models with I option are supplied with a 19mm female square and 1500 - 3000 lb-in models are supplied with a 22mm female square (note that without option I the female square is 1").

4. This heater option activates at or below 40°F and deactivates at 60°F; it is recommended in applications where the temperature may drop below 32°F.
5. Handwheel option not recommended with Back-Up Powered options.

Committed to Customer Service

Metso worldwide web site:
www.metso.com/automation/valvcon, provides 24 hour a day access to all technical support material—from sales brochures to instruction manuals to installation and troubleshooting tips. For local support, Our network of trained stocking distributors/representatives are industry leading experts in valve automation. Contact the Metso, Valvcon product web site to locate the nearest stocking distributor/representative.

Timely Technical Support

Metso Express Services is on call to answer your engineering or application questions, and to quickly repair or upgrade your actuators. These highly trained support engineers offer a broad range of expertise, with the combined experience to assist specifying engineers and contractors with information on feasibility and special applications. Find Metso Express at **www.metso.com/automation/valvcon**.

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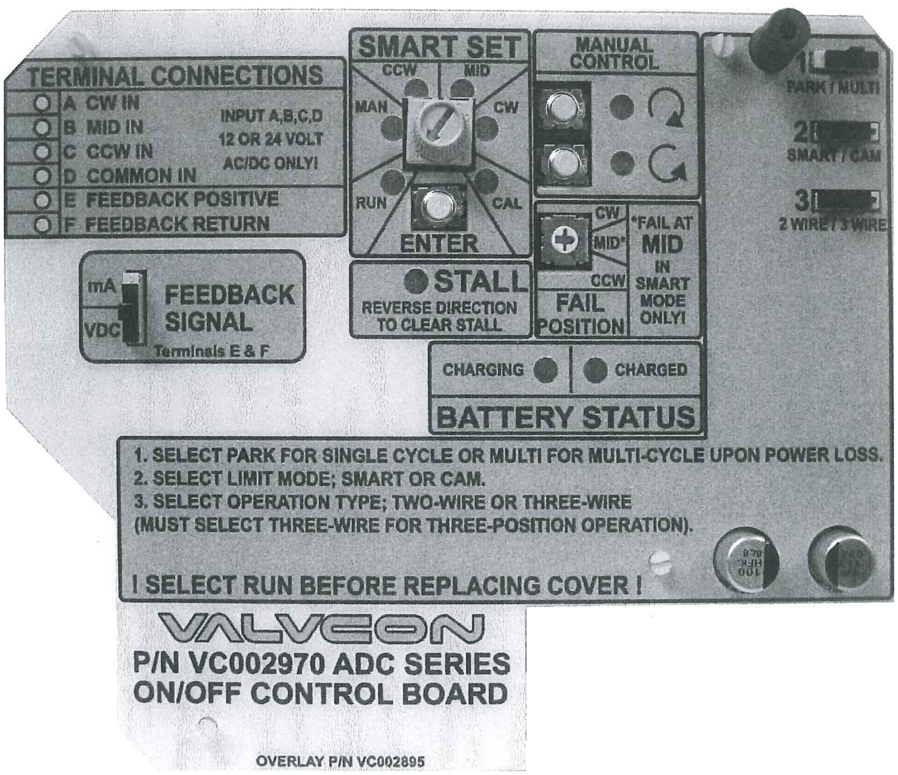
VALVCON
ADC-Series
CONTINUOUS DUTY
ON/OFF ELECTRIC ACTUATORS
With R2, R3, L2, L3, L4 & L5 Options
With "N" In The Model Number

Installation, Maintenance and
Operating Instructions



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IMO-I4500 • 1/2014

Table of Contents

> Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.

READ THESE INSTRUCTIONS FIRST!

This instruction manual contains important information regarding the installation, operation, and troubleshooting of ADC-Series Continuous Duty On/Off Electric Actuators With R2, R3, L2, L3, L4 & L5 Options With "N" In The Model Number. Please read these instructions carefully and save them for future reference.

SAVE THESE INSTRUCTIONS!

Subject to change without notice.

1 GENERAL

1.1 ADC-Series On/Off Actuators (with Optional Battery Back-up)

The On/Off actuators are based on the ADC and LADC platform and provide an optional internal battery pack to power the actuator in the event of a loss of external power. ADC designates sizes from 150 to 600 in-lbs. LADC designates sizes from 1000 to 3000 in-lbs **(see Figure 10)**.

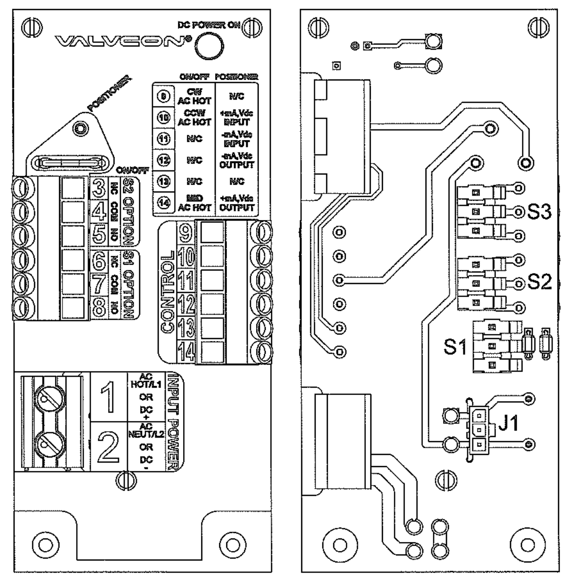
The electronic package consists of three separate boards; **P/N VC002360** Power Board and the **P/N VC002970** On/Off Control Board, and either a switching power supply or a DC isolator board. On/Off actuators are identified by the code "R2" or "R3" in the model number. On/Off actuators with battery back-up are identified by the code "L2", "L3", "L4" or "L5" (L2 & L4 are applicable in ADC-Series and L3 & L5 are applicable in LADC-Series) in the model number. (**Note:** The L4 and L5 options are factory-set for 180° operation with the MID position set at 90°.)

The On/Off control actuators covered in this manual are identified by the code "R2", "R3","L2", "L3", "L4" or "L5" and the letter **N** in the model number (do not confuse with "CL2" or CL3", which indicates a separate modulating control option).

1.2 Power Board P/N VC002360

The **P/N VC002360** Power Board provides terminals for input and output wiring to the actuator as well as plug-in connectors for ADC-Series options and accessories.

IMPORTANT! To use terminal 2 AC Neut/L2 as a COMMON connection for CW AC HOT and CCW AC HOT, set jumper to "ON/OFF" (horizontal). However, when using an AC control signal that is not COMMON to the actuator power supply, this jumper must be set to "POSITIONER" (45°) and a separate AC COMMON connection must be made to terminal 11 for CW AC HOT, CCW AC HOT and MID AC HOT signals.



(FRONT) (BACK)

S1 MOTOR / MOTOR JUMPER
S2 OPTIONAL ADDITIONAL LIMIT SWITCH CW
S3 OPTIONAL ADDITIONAL LIMIT SWITCH CCW
W1-W2 LIMIT SWITCH CW (BOTTOM)
W3-W4 LIMIT SWITCH CCW (2ND FROM THE BOTTOM)
W5-W6 AC POWER TO POWER MODULE
W7-W8 DC POWER RETURN FROM POWER MODULE

Figure 1

1.3 On/Off Control Board P/N VC002970

The **P/N VC002970** On/Off Control Board connects to the **P/N VC002360** Power Board via two plug-in connectors and a bracket, and hardware anchors it to the motor/gearbox. The On/Off Control Board allows the actuator to drive to either the full open or full closed position in response to applied control voltages. The **P/N VC002970** On/Off Control Board can be configured for either "Two-Wire" or "Three-Wire" control, (driving to mid-travel

positions can be achieved by removing the control voltage in "Three-Wire" mode). The On/Off Control option features include a choice of 115VAC, 230VAC, 12VDC, 24VDC or 24VAC input power as well as independent 115VAC, 230VAC, 12VDC, 24VDC or 24VAC control signals. Additional features include optional internal Battery Back-Up, Three-Position operation, analog position output signal (not present if using "Cam" Limit Type), manual push button control, single or multi cycling upon loss of line power, switch select power "Fail" position, locked rotor stall protection, on-board battery status indicators, and simple digital **Smart Set** functionality for entering and saving precise end of travel positions. (**Note**: Some of the above features are only applicable with the optional Back-Up battery installed.)

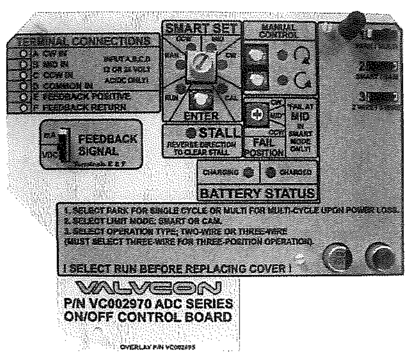


Figure 2

P/N VC002970 Battery Back-Up On/Off Control Board

1.4 LED Indicators

Visible on the **P/N VC002360** Power Board **(see Figure 1)**:

DC POWER ON – This green LED indicator shows that the user-supplied power is present and has been converted to DC (power conversion not applicable to DC input voltages) to drive the motor.

Visible on the **P/N VC002970** L2 &L3 Board **(see Figure 2)**:

POWER – A continuous green LED indicates that external or battery power is present.

STALL – A flashing red LED indicates a stall condition exists and that the actuator has been prevented from reaching the position commanded by the control signal. A STALL of more than several seconds will cause power to be automatically removed from the motor circuit, placing the actuator in a safe mode. A reverse signal or **Smart Set** mode change is required to clear the STALL LED alarm. A STALL alarm can be initiated in a few ways; by a blockage in the valve or damper, cam limit settings that are inside of the electronically saved travel stop positions, attempting to drive an actuator that is off-line due to thermal overload or some other increase in the torque load on the actuator.

CLOCKWISE – A continuous yellow LED indicates that the actuator is driving in the CW direction.

COUNTER-CLOCKWISE – A continuous yellow LED indicates the actuator is driving in the CCW direction.

CHARGING – A continuous yellow LED indicates that the battery is charging and is not fully charged.

CHARGED - A continuous green LED indicates that the battery is fully charged. A flashing green LED indicates the actuator is running on battery power.

RUN – A continuous green LED indicates that the normal operating mode has been selected.

MAN – A continuous yellow LED indicates that MANUAL mode has been selected. The actuator will not respond to external control signals and the CW and CCW push buttons are enabled for manually driving the actuator in either direction. The manual push buttons are also enabled in SPAN, MID, ZERO and CAL modes.

CCW – A continuous yellow LED indicates that the CCW **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the CCW LED is illuminated will cause the CCW LED to flash. Pressing **[ENTER]** while the CCW LED is flashing will save the current position as the CCW travel limit.

MID – A continuous yellow LED indicates that the MID **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the MID LED is illuminated will cause the MID LED to flash. Pressing **[ENTER]** while the MID LED is flashing will save the current position as the MID travel stop position.

CW – A continuous yellow LED indicates that the CW **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the CW LED is illuminated will cause the CW LED to flash. Pressing **[ENTER]** while the CW LED is flashing will save the current position as the CW travel stop limit.

CAL – A continuous yellow LED indicates that the CAL (calibration) mode has been selected. Pressing **[ENTER]** for two seconds while the CAL LED is illuminated may cause the CAL LED to flash indicating that further calibration of the position Feedback Potentiometer is required. **See Page 9 For Feedback Potentiometer Calibration Procedures.** If the CAL LED remains on continuously, no further calibration is required. Press **[ENTER]** to confirm the calibration setting and return to **RUN** mode.

At any point during Set-Up you may exit a "Smart Set" mode without changing the stored data, by simply selecting a different "Smart Set" mode.

2 OPERATION

Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.

2.1 Wiring

The identification label on each actuator specifies the model number, serial number, input power voltage and current requirements for the actuator. It is important to verify the correct input voltage prior to wiring the actuator.

There are three basic wiring schemes designed to operate the ADC-Series On/Off Control Board options. These include:

Two Wire – On/Off Operation
Three Wire – Open/Stop/Close
Three Position – CW/MID/CCW

2.1.1 "Two-Wire" – On/Off Operation

(SEE FIGURE 3)

MAIN POWER – Terminals 1&2 - For "Two-Wire" control, the mode select slide switch must be in the LEFT, "Two-Wire" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - To control the actuator with a high voltage signal (115VAC or 230VAC) connect AC HOT to terminal 10 on the **P/N VC002360** Power Board. When terminal 10 is energized, the actuator will drive counter-clockwise. When terminal 10 is de-energized, the actuator will drive clockwise.

CONTROL SIGNALS – Low Voltage - To control the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the positive or hot lead to terminal C and connect the common or negative lead to terminal D on the **P/N VC002970** ON/OFF Control Board. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When terminal C and terminal D are de-energized, the actuator will drive clockwise.

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 on the **P/N VC002360** Power Board and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns, the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 3)**. Installing the optional heater and thermostat is a plug connection and requires no additional wiring.

2.1.2 "Three-Wire" – Open/Stop/ Close Operation

(SEE FIGURE 4)

MAIN POWER – Terminals 1&2 - For "Three-Wire" control, the mode select slide switch must be in the RIGHT, "Three -Wire" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - For "Three-Wire" control of the actuator with a high voltage signal (115VAC or 230VAC) connect the AC HOT CW lead to terminal 9. Connect the AC HOT CCW lead to terminal 10. When terminal 9 is energized, the actuator will drive clockwise. When terminal 10 is energized, the actuator will drive counter-clockwise. When neither 9 nor 10 are energized, the actuator will remain in position, (unless main power to 1 and 2 is interrupted).

CONTROL SIGNALS – Low Voltage - For "Three-Wire" control of the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the CW positive or hot lead to terminal A. Connect the CCW positive or hot lead to terminal C. Connect the common or negative lead to terminal D on the **P/N VC002970** board. When terminal A and terminal D are energized the actuator will drive clockwise. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When neither terminal A nor terminal C is energized, the actuator will remain in position, (unless power to 1 and 2 is interrupted).

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 4)**. Installing the optional heater and thermostat is a plug connection and requires no additional input power wiring.

2.1.3 "Three-Position" – CW/MID/CCW Operation

(SEE FIGURE 5)

MAIN POWER – Terminals 1&2 - For "Three-Position" control, the mode select slide switch must be in the RIGHT, "Three-Wire" position and the Limit Type select slide switch must be in the LEFT, "Smart" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – **High Voltage** - For "Three-Position" control of the actuator with a high voltage signal (115VAC or 230VAC) connect the AC HOT CW lead to terminal 9. Connect the AC HOT CCW lead to terminal 10. Connect the AC HOT MID (mid-position) lead to terminal 14. When terminal 9 is energized the actuator will drive clockwise. When terminal 14 is energized, the actuator will drive to the MID position. When terminal 10 is energized, the actuator will drive counter-clockwise. When neither terminals 9, 10, nor 14 are energized, the actuator will remain in position, unless power to 1 and 2 is interrupted.

CONTROL SIGNALS – **Low Voltage** - For "Three-Position" control of the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the CW positive or hot lead to terminal A. Connect the CCW positive or hot lead to terminal C. Connect the MID (mid-position) positive or hot lead to terminal B. Connect the common or negative lead to terminal D on the **P/N VC002970** board. When terminal A and terminal D are energized the actuator will drive clockwise. When terminal B and terminal D are energized, the actuator will drive to the MID position. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When neither terminals A, B, or C are energized, the actuator will remain in position, (unless power to 1 and 2 is interrupted).

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 5)**. Installing the optional heater and thermostat is a plug connection and requires no additional input power wiring.

Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.

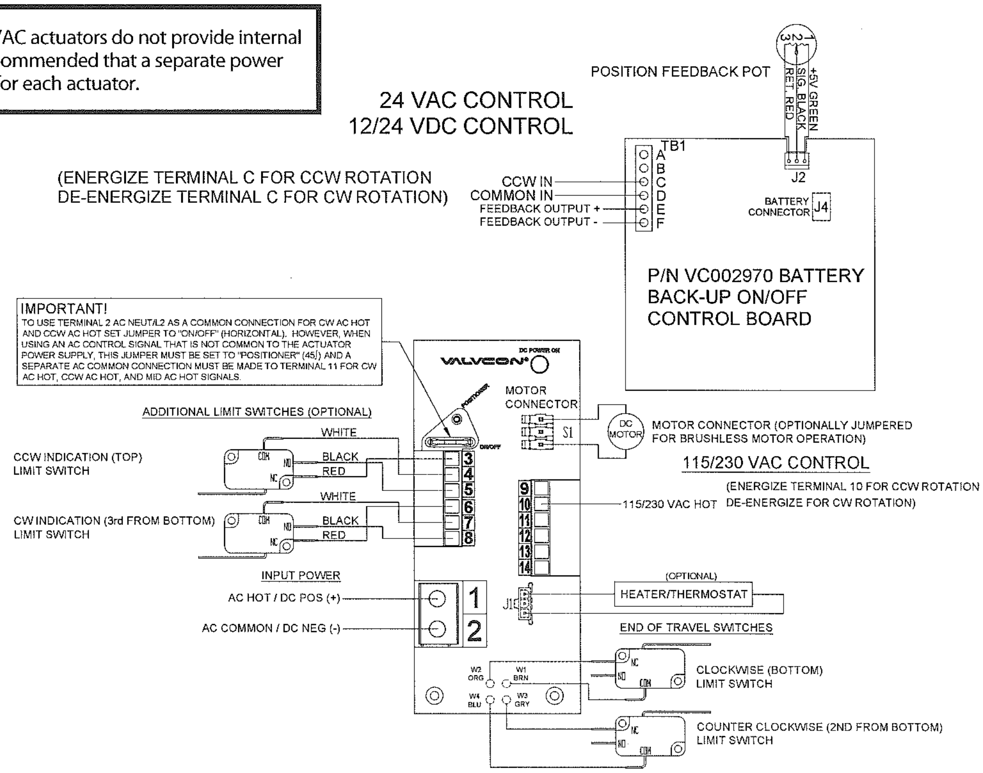
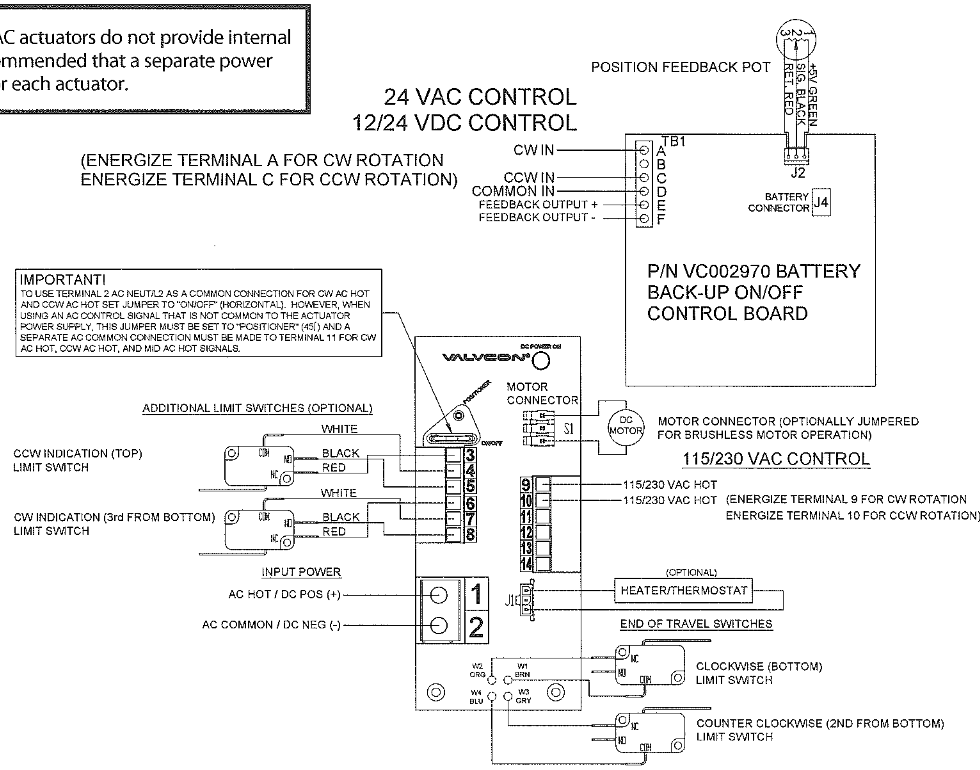


Figure 3

"Two-Wire" Wiring

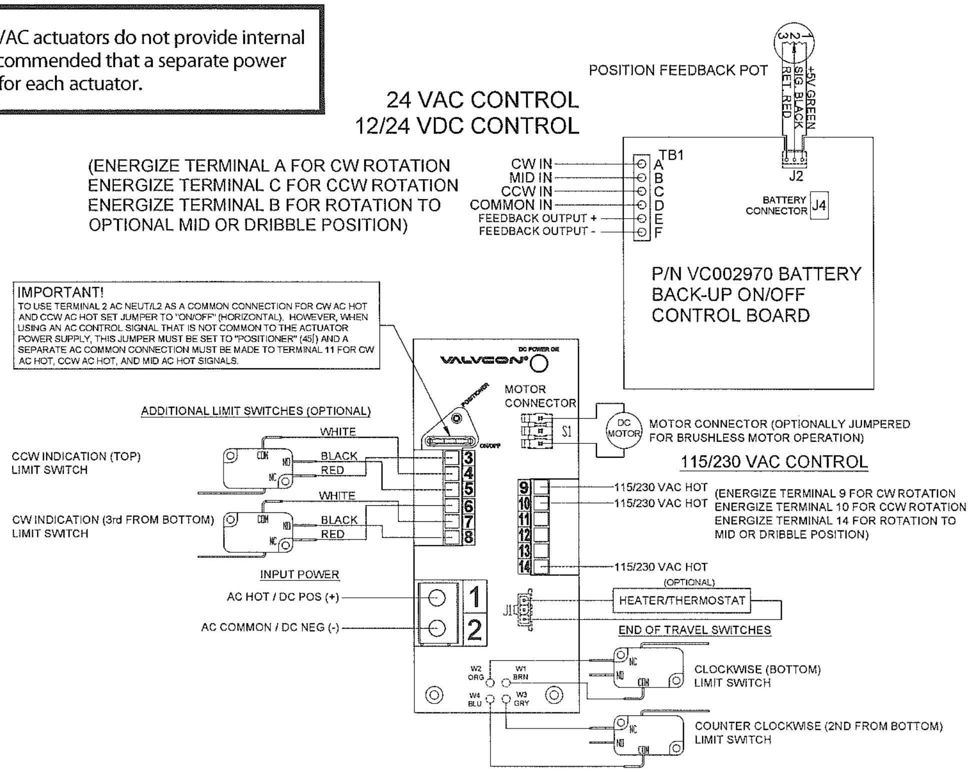
Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.



"Three-Wire" Wiring

Figure 4

Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.



"Three-Position" Wiring

Figure 5

2.2 ADC R2, R3, L2, L3, L4 & L5 Travel Limit Options

Travel limits, also referred to as "end of travel stops", are the precise positions to which the actuator will drive. The ADC-Series R2, R3, L2, L3, L4 & L5 options provide a number of choices for setting the travel limits. For "Two-Position" On/Off operation, travel limits are set at the full clockwise (CW) and full counter-clockwise (CCW) ends of travel. For "Three-Position" operation, an optional midway position (MID) may be set at any point between the CW and CCW settings.

> **CAUTION:**
> **Dangerous Voltages Inside Actuator**
>
> Use extreme caution when working on the actuator with the cover removed.

2.2.1 Limit Types

To simplify the process of setting the precise travel limit positions, the ADC-Series R2, R3, L2, L3, L4 & L5 options provide two travel limit types. CW, CCW and MID may be set electronically via the **Smart Set** utility or CW and CCW may be set mechanically by selecting the "CAM Set" limit type.

2.2.2 CAM Set

When CAM Set is selected as the limit type, two limit switches operated by the stainless steel cams on the output shaft extension are used to determine the exact positions where the actuator will stop at each end of CW and CCW travel. The bottom limit switch determines the clockwise stop position. The next limit switch up from the bottom determines the counter-clockwise stop position.

The "end of travel limit" switches can be adjusted to provide from 5 to 320 degrees of actuator rotation.

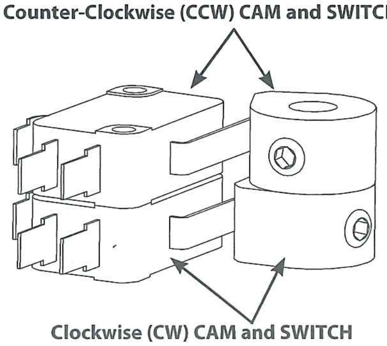


Figure 6

For "Three-Position" operation, limits must be entered and saved using the "Smart" Limit Type, only! **See Section 3** for detailed instructions.

2.2.3 Smart Set

When **Smart Set** is selected as the limit type, the micro processor stores the exact positions where the actuator will stop at each end of travel or mid position. Setting the **Smart Set** positions for the clockwise, counter-clockwise and midway positions is done with the selector knob and **[ENTER]** button in the **Smart Set** field of the **P/N VC002970** board. To use the **Smart Set** feature, the Feedback Potentiometer must be installed, connected and calibrated and the travel stop cams must be set to trip the switches beyond the desired electronic stop positions for CW, CCW.

The end of travel limits on standard ADC actuators can be entered and saved between 0° and 94° of travel. For rotation up to 270° of travel optional Feedback Potentiometer gears are available **(see Section 7; ADC-Series Standard Options).**

For "Three-Position" operation, limits must be entered and saved using the "Smart" Limit Type, only! **See Section 2.1.3** for detailed instructions.

3 SET UP AND CALIBRATION

3.1 Initial Set Up

1. Remove actuator cover.
2. Select **Limit** type – **"SMART" or "CAM"** – Slide the **[SMART/CAM]** to the right to select **CAM** or to the left to select **SMART**. Selecting **SMART** will enable other features on the board such as Position Feedback and "Three-Position" operation. Selecting **CAM** will allow the actuator to drive between the end-of-travel limit switch settings. (Actuator is set up in **SMART** mode at factory; **SMART** set up is also recommended for field replacement.)
3. Select Operation **Limit** type – **"TWO-WIRE"** or **"THREE-WIRE"** – Slide the **[TWO-WIRE/THREE-WIRE]** to the right to select **THREE-WIRE** or to the left to select **TWO-WIRE**. In **TWO-WIRE** mode the actuator will drive **CCW** when the control terminal is energized and **CW** when the control terminal is de-energized. In **THREE-WIRE** mode separate terminals must be energized for **CW** or **CCW** movement; if using the **THREE-POSITION** feature the actuator must be set in **THREE-WIRE** mode.
4. Select Battery Mode On Power Fail – **"PARK AT FAIL" or "MULTI-CYCLE"** – Slide the **[PARK AT FAIL/MULTI-CYCLE]** to the right to select **MULTI-CYLCE** or to the left to select **PARK AT FAIL**. Selecting **PARK AT FAIL** will drive the actuator to the selected

Power Loss position upon loss of input power and the system will go to "sleep" until input power is restored. If **MULTI-CYLCE** is selected, the actuator will continue to respond to changes in control signal for up to ten cycles; the battery monitoring circuit will drive to the Power Loss position when it detects that the battery should be charged. Upon reaching the Power Loss position, the system will go to "sleep" until input power is restored.

5. Select **Power Loss Position – "CW", "MID" or "CCW"** – Turn the **[CW/MID/CCW]** to the clockwise to select **MID** or **CCW** or counterclockwise to select **MID** or **CW**. Selecting **CW** will drive the actuator to the clockwise position upon loss of input power. Selecting **CCW** will drive the actuator to the counterclockwise position upon loss of input power. Selecting **MID** will drive the actuator to the **MID** or **"THIRD"** position upon loss of input power; this setting is used in **THREE-WIRE** mode only.
6. Select **Output Feedback Signal** type – **"mA"** or **"VDC"** (current or voltage), the actuator will provide a 4-20mA or 2-10VDC feedback signal. Slide the **[OUTPUT SIGNAL]** switch up to select **mA** or down to select **VDC**.

3.2 Potentiometer Calibration

Field installation of the On/Off Control Board option or replacement of the position tracking potentiometer requires calibration of the position tracking potentiometer prior to setting positions and values for CW, MID and CCW. On/Off Control Board options installed at the factory are fully calibrated at the factory and should not require further calibration.

To confirm proper potentiometer calibration:

1. Turn the Mode Selector Dial to **[CAL]** and press **[ENTER]** for 2 seconds.
2. Using the **CW** push button, drive the actuator to the full clockwise position.
   - If the **[CAL]** LED is flashing, potentiometer calibration is required; proceed to step 3 below.
   - If the **[CAL]** LED remains on, calibration is not required; proceed to **Setting CW, MID and CCW Positions section below**.
3. Loosen the set screw in the larger Nylon gear with a 1/16" hex wrench.
4. Rotate the gear until the LED remains on constantly; hold the gear in place and tighten the set screw. Ensure that the LED remains on after the set screw is tightened. **Note**: The LED assists the user in locating the proper calibration window; it will flash faster as you approach the calibration window and slower as you move away from it.
5. Press the **[ENTER]** button to save the potentiometer setting.

3.3 Setting CW, MID and CCW Positions

Setting CW, MID and CCW Positions - Once calibration has been confirmed, set the desired "end of travel" positions. ***Make certain that the limit switch cams are set to operate the switches beyond the desired range for the CW and CCW positions.*** CW and CCW may be set at any position between 0° and 94° of travel (or 184° with "R3", "L4" or "L5" option).

3.3.1 Set CW:

1. Turn the Mode Selector Dial to **[CW]** and press **[ENTER]** for 2 seconds. The **[CW]** LED will begin to flash.
2. Drive the actuator to desired clockwise position using the **CW** or **CCW** push button. If the **"STALL"** LED begins to flash; check to see if the limit switch cam is preventing actuator from reaching desired **CW** end-of-travel. If necessary back the cam off so that it will trip the switch slightly beyond the desired end-of-travel.
3. Press the **[ENTER]** button to save the **CW** setting.

3.3.2 Set MID: (if applicable)

1. Turn the Mode Selector Dial to **[MID]** and press **[ENTER]** for 2 seconds. The **[MID]** LED will begin to flash.
2. Drive the actuator to desired **MID** or "THIRD" position using the **CW** or **CCW** push button.
3. Press the **[ENTER]** button to save the **MID** setting.

3.3.3 Set CCW:

1. Turn the Mode Selector Dial to **[CCW]** and press **[ENTER]** for 2 seconds. The **[CCW]** LED will begin to flash.
2. Drive the actuator to desired counterclockwise position using the **CW** or **CCW** push button. If the **"STALL"** LED begins to flash; check to see if the limit switch cam is preventing actuator from reaching desired "end of travel". If necessary back the cam off so that it will trip the switch slightly beyond the desired end-of-travel.
3. Press the **[ENTER]** button to save the **CCW** setting.

3.3.4 Verify End-Of-Travel Settings:

1. Turn the Mode Selector Dial to **[RUN]**.
2. Apply various control signals to verify operation.
3. Replace actuator cover.

4 POWER LOSS & BATTERY MODE OPTIONS

4.1 Battery Mode Selection – PARK AT FAIL or MULTI-CYCLE

The ADC-Series On/Off Control Board is designed to provide continuing service in the event of loss of line power. Upon power loss the ADC-Series actuator, equipped with the optional Battery Back-Up, can be configured to drive the actuator and PARK immediately at the designated power loss (Fail Position), or to continue to MULTI-CYCLE on battery power while a control signal and adequate battery power remain available. When MULTI-CYCLE is selected, the actuator will cycle until a low battery power condition is detected then automatically drive to and remain at the designated power loss (Fail Position). A fully charged battery will provide a minimum of ten complete 90 degree cycles.

To configure the actuator to immediately drive and park at the designated "Fail" position upon loss of line power, move the "Battery Mode On Fail" slide switch to the LEFT, PARK AT FAIL, position.

To configure the actuator to continue to cycle while adequate battery power is available upon loss of line power, move the "Battery Mode On Fail" slide switch to the RIGHT, Multi-Cycle position.

4.2 Power Loss – FAIL Position Selection

The ADC-Series On/Off Control Board is designed to be easily configured to drive to either the CW, CCW or MID position upon loss of line power (applicable with optional Battery Back-Up). This is the power loss or "Fail" position. In the "Fail Position" field, the power loss position is set with a miniature blade screw driver by moving the selector dial to the desired position. When designating MID as the power loss or "Fail" position, the limit type must be set at SMART and the MID position must have been entered and saved in the "**Smart Set**" field.

To confirm the power loss or "Fail" position, select RUN in the "**Smart Set**" field and select PARK AT FAIL in the "Battery Mode On Fail" field. De-energize terminal 1 and terminal 2 on the **P/N VC002360** Power Board. The actuator will drive to the designated power loss or "Fail" position.

4.3 Sleep and Wake Function – Manually Drive the Actuator During Power Outage

(PARK AT FAIL MODE, ONLY) After the battery drives the actuator to the Power Loss Position, the **P/N VC002970** board powers down and remains in **"Sleep"** mode until external power returns to terminals 1 & 2 on the **P/N VC002360** Power Board. To **"Wake"** the actuator, enabling the **CW** or **CCW** push buttons, push the button located below the battery connector (J4) on the upper left, back side of the **P/N VC002970** board. This will "Wake" the electronics and the actuator can be manually operated via the **CW** or **CCW** push buttons until low battery power level is detected. (**Note**: After using the **WAKE** Power Override function the actuator will not revert back to **SLEEP** mode. Disconnect the battery to preserve battery power if line power has not been restored.)

5 BATTERY PACK INFORMATION

The optional Battery Pack is capable of supplying sufficient power to ensure operation of the actuator during power outages. The battery voltage of a fully charged battery should read 13.6 volts as measured at the battery connector, (with the battery disconnected). This voltage will vary with temperature; see "Battery Charging Circuit" below.

Replacement battery packs should be stored only after a full charge and at less than 80°F. Temperature can affect battery shelf life. Generally lower temperatures will increase shelf life while higher temperatures will decrease shelf life.

When recharging battery packs, they should only be recharged from the **P/N VC002970** ADC-Series On/Off Control Board charging circuit, which is calibrated to provide the proper voltage and current for maximum battery pack life.

5.1 Battery Charging Circuit

The battery charging voltage has been designed for optimum battery performance. When charging, the yellow **CHARGING** LED will light. After reaching full charge, the green **CHARGED** LED will light.

The voltage on the battery terminals, connector "J4", will be between 10.5 and 12 volts, when external power is off, and the battery is connected to the 2970 On/Off Control Board. Fully charged, the battery voltage will reach approximately 13.6 volts. This voltage is designed to vary with temperature, and could be as high as 14.4 volts if in a very cold environment, or as low as 12.8 volts if in a very warm environment. This is normal operation.

A battery case that is swollen or cracked must be replaced. Please consult the factory for replacement. If the battery does not reach full charge (the green **CHARGED** LED remaining on and the yellow **CHARGING** LED turning off) within 48 hours, consult the factory or your local representative.

5.2 Battery Replacement

The only suggested maintenance is to examine, and if necessary, replace the batteries every two years. Battery life can vary with temperature. Cooler environments will generally prolong battery life and under ideal conditions ADC batteries will last in excess of five years.

To change the batteries, perform the following:

SMALL ENCLOSURE (150-600 in-lbs)

4. Remove power to the actuator.
5. Disconnect battery connection at the daughter board.
6. Pry back the battery retaining tab on the battery bracket.
7. Remove the battery.
8. Install new battery.
9. Slide battery into bracket so that the retaining tab secures the battery in place.
10. Plug battery connector into the connector on the back of the **P/N VC002970** board, and re-apply power.

LARGE ENCLOSURE (1000-3000 in-lbs)

1. Remove power to the actuator.
2. Unplug the battery wire from the daughter board.
3. Remove battery hold-down bracket.
4. Unplug the wires from the battery tabs.
5. Remove and replace the battery. Re-install the wires on the battery tabs, Black wire to Black terminal and Red wire to Red terminal.
6. Re-install the hold-down bracket.
7. Plug the battery connector into the daughter board, and re-apply power.

6 OUTPUT/POSITION FEEDBACK SIGNAL

Terminal E and terminal F on the **P/N VC002970** On/Off Control Board provide an analog position feedback signal. To enable the output feedback signal the Feedback Potentiometer must be installed, connected to the **P/N VC002970** board and properly calibrated. **See Section 3 for Set Up and Calibration instructions.**

To select a 4-20 mA output signal, move the slide switch to the **UP** position in the Output Signal field. To select a 2-10 VDC output signal, move the slide switch to the **DOWN** position in the Output Signal field.

7 ADC-SERIES STANDARD OPTIONS

All ADC-Series options are designed to be easily installed in the field. Options for all standard ADC-Series actuators are universal and completely interchangeable with each enclosure size. Voltage is not field changeable.

7.1 Option "H" – Tropical Heater and Thermostat P/N VC099035, P/N VC099036, P/N VC099037, P/N VC099038

The tropical heater and thermostat option is a self-adhesive, resistant heater strip which is applied to primary gear-box. It installs with a plug-in connector and is recommended in high-humidity applications. The tropical heater option is also recommended installations that experience wide temperature swings in order to evaporate any condensation. Thermostat is pre-set to active at or below 90°F and deactivate at or above 110°F. The tropical heater draws 15 watts @ 115 VAC, 12 VDC and 24V; 40 watts at 230 VAC. This option can be installed in the field; for 115 VAC applications, order kit **P/N VC099035**; for 230 VAC applications, order kit **P/N VC099036**; for 12 VDC applications, order kit **P/N VC099037** and for 24 V applications, order kit **P/N VC099038 (see Figure 7)**.

Option "H" Tropical Heater and Thermostat
Option "T" Standard Heater and Thermostat

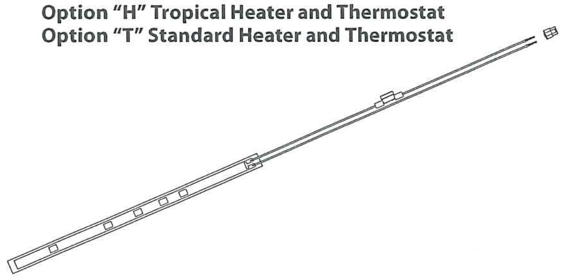


Figure 7

7.2 Option "I" – ISO 5211 Output

150 – 600 in-lbs models are supplied with a 3/4" female square output coupling; when the "I" option is selected they are supplied with a 14mm female square.

1000 – 3000 in-lbs models are supplied with a 1" female square output coupling; when the "I" option is selected, 1000 in-lbs models are supplied with a 19mm female square and 1500 – 3000 in-lbs models are supplied with a 22mm female square.

This option is factory installed only.

7.3 Option "S2" – Two Auxiliary Limit Switches P/N VC099900

The extra switches and stainless steel cams provide dry contacts and are fully adjustable to trip at any position. They are often used for position indication or to interlock other devices (such as in sequencing operations). The switches are single pole, double throw switches rated for 1/2 HP, 15 amps @250 VAC, CSA certified. Auxiliary switch kit **P/N VC099900** is universal to all standard ADC-Series actuators **(see Figure 8)**.

Option "S2" – Two Auxiliary Limit Switches

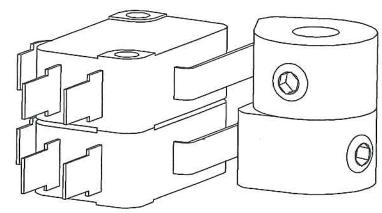


Figure 8

7.4 Option "T" – Heater and Thermostat P/N VC099015, P/N VC099016, P/N VC099017, P/N VC099018

The heater and thermostat option is a self-adhesive, resistance heater strip which is applied to the primary gearbox. It installs with a plug-in connector and is required in installations where the ambient temperatures drop below 32˚F. The heater option is also recommended in installations that experience wide temperature swings in order to evaporate any condensation. The thermostat is pre-set to activate at or below 40˚F and deactivate at or above 60˚F. The heater draws 15 watt @115 VAC, 12 VDC and 24 V; 40 watts @ 230 VAC. This option can be installed in the field; for 115 VAC order kit **P/N VC099015**; for 230 VAC applications, order kit **P/N VC099016**; for 12 VDC applications, order kit **P/N VC099017** and 24 V applications, order kit **P/N VC099018 (see Figure 7)**.

7.5 Option "Y" - Keyed Output

150 – 600 in-lb actuators are supplied with a 3/4" female square output coupling; when the "Y" option is selected they are supplied with a 15mm female keyed output.

1000 – 3000 in-lb models are supplied with a 1" female square output coupling; when the "Y" option is selected they are supplied with a 20mm female keyed output.

This option is factory installed only.

7.6 Option "Z" – Handwheel Override P/N VC009097, P/N VC009098

Standard ADC-Series actuators are supplied with a plugged cover. Note that this not recommended for ADC-Series actuators equipped the optional internal battery back-up. If the handwheel override option is selected at the time of order a declutchable shaft and six-inch handwheel are provided for manual positioning. This option can be replaced in the field; for 150 – 600 in-lbs models, order kit **P/N VC009097** and for 1000 – 3000 in-lbs models, order kit **P/N VC009098**.

7.7 CSA Certification

CSA Certification is standard on all standard ADC-Series actuators for applications in either Hazardous (WX) or non-Hazardous (W) locations. CSA certified actuators are identified by the CSA logo on the product label.

7.8 Voltage

115 VAC, 230 VAC, 24 VAC, 12 VDC and 24 VDC. ADC-Series actuators are rated for full torque at +/- 10% of the nominal voltage at 50Hz or 60 Hz. ADC-Series positioning actuators are rated continuous duty. (**Note**: At 50Hz the cycle time will increase by approximately 20%.)

8 GENERAL OPERATING INFORMATION

For enclosure specifications and dimensions, **see Table 2 and Figure 10.**

8.1 NEMA Ratings and CSA Certification

Metso manufactures two styles of Valvcon enclosures: the "W" enclosure is weathertight and designed to NEMA 4/4X standards the "WX" enclosure is "explosionproof" and designed to NEMA 4/4X/7&9 (Class 1, Division 1, Groups C and D, and Class 2, Division 1, Groups E, F and G) standards.

Actuators are certified by CSA to meet Canadian and U.S. standards for applications in both Hazardous and Non-Hazardous locations. The "WX" option must specified at the time of ordering and can only be installed at the factory. Ensure that the actuator's ratings are appropriate for the application environment prior to installation. Use extreme care when removing the cover. Scratches or nicks on the flanges may cause the enclosure not to meet NEMA specifications.

8.2 Duty Cycle and Motor Protection

ADC-Series on/off actuators are equipped with a brushless DC motor and can operate continuously; they are rated for 100% duty cycle operation up to 104°F and for a maximum of 30 starts per minute. Higher temperature applications decrease the available duty cycle.

8.3 Operating Temperature Limits

ADC-Series actuators are designed to operate in ambient environments between 32°F, (0°C) and 130°F, (55°C). If the ambient temperature may drop below 32°F, (0°C), the heater and thermostat option must be installed. The actuator is rated to operate at -40°F, (-40°C) with the heater and thermostat option installed. In outdoor applications where ambient temperatures exceed 80°F, (27°C), actuators should be shielded from direct sunlight. In applications with high media temperatures, insulating blankets, heat shields and/or extended mounting shafts should be used to keep temperatures within normal operating limits.

Heaters and thermostats are required for all outdoor applications and may also be used to dry condensation in high humidity environments.

8.4 Actuator Mounting

The actuator may be mounted in any position including upside-down. It must be firmly secured to a direct mount flange or sturdy mounting bracket. A minimum of four bolts with lock washers should be used to secure the actuator to the bracket. Flexibility in the bracket is not allowed, and backlash, or "play", in the coupling should be minimized. The actuator output shaft must be in line (centered) with the valve shaft to avoid side-loading the shaft.

For output drive dimensions and mounting hardware specifications, **see Figure 10.**

8.5 Lubrication

All rotating power train components are permanently lubricated with multi-purpose Lithium grease suitable for the operating temperature range of the actuator. Additional lubrication is not required in normal operation.

8.6 Problem Prevention

Most actuator problems result from improper installation.

- **Incorrect Wiring and Set Up** Make certain the actuator is wired correctly and travel stops are properly set before power is applied.
- **Coupling, Alignment, and Mounting** Do not add extra torque! Make certain that the mounting arrangement is sturdy, centered, properly aligned, and that all mounting hardware is secure and properly tightened.
- **Moisture** Replace the cover tightly and make certain conduit entry holes are sealed properly to prevent moisture infiltration.

8.7 Warranty

All ADC-Series actuators are backed by a 2 year warranty that covers materials and workmanship.

8.8 Technical Assistance, Replacement Parts, Options and Repairs

All replacement parts, plug-in options, accessories, and repair services for ADC-Series actuators are available through a network of qualified Metso Stocking Representatives. For further technical information or to locate the Metso Stocking Representative closest to you, contact **www.metso.com/automation/valvcon**.

9 SPECIFICATIONS & TECHNICAL INFORMATION

TABLE 1 - TORQUE & VA RATINGS

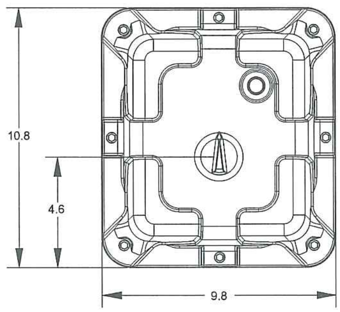
Torque (in-lbs)	Duty Cycle	12 VDC		24 VDC		24 VAC		115 VAC		230 VAC	
		Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)
150	100%	11	2.2	13	1.2	8	1.8	9	0.4	9	0.4
300	100%	17	2.5	13	1.4	12	2.1	13	0.5	13	0.4
600	100%	17	2.8	13	1.7	13	2.5	14	0.6	14	0.5
1000	100%	21	4	14	2.4	15	3.5	15	0.9	15	0.6
1500	100%	40	4	24	2.4	27	3.5	29	0.9	29	0.6
2000	100%	40	4.3	33	2.4	28	3.5	29	0.9	29	0.6
2500	100%	55	3.3	40	2	38	3.1	39	0.8	39	0.6
3000	100%	60	3.7	42	2.2	40	3.5	42	0.8	43	0.6

TABLE 2 - SPECIFICATIONS

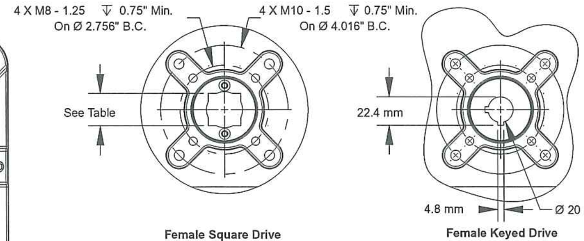
Temperature Range	32°F to 130°F (0°C to 55°C) (without heater and thermostat) -40°F to 130°F (-40°C to 55°C) (with heater and thermostat)
Conduit Connections	(2) 3/4" NPT in sizes up to 600 in-lbs (3/4" to 1/2" reducing bushings included) (2) 3/4" NPT in sizes 1000 in-lbs and above (3/4" to 1/2" reducing bushings included)
Output	150 to 600 in-lbs: ISO 5211 F05 and F07 bolt circles, 3/4" female square (14mm female square w/ "I" Option; 15mm female keyed output w/ "Y" Option). 1000 to 3000 in-lbs: ISO 5211 F07 and F10 bolt circles, 1" female square (1000 in-lbs: 19mm female square w/ "I" Option; 1500 - 3000 in-lbs: 22mm female square w/ "I" Option; 1000 to 3000 in-lbs: 20mm female keyed output w/ "Y" Option)
Voltage	12VDC: 10.8 to 13.2VAC 24VDC: 21.6 to 26.4VDC 24VAC: 21.6 to 26.4VAC, 50 or 60 Hz 115VAC: 103.5 to 126.5VAC, 50 or 60 Hz 230VAC: 207 to 253VAC, 50 or 60 Hz
Limit Switches	(2) Single pole, double throw switches rated for 1/2 HP, 11 amps @ 250VAC, CSA certified, fuse protected
Motor	Brushed DC motor with Class B or better insulation; sub-fractional horsepower
Lubrication	Permanently lubricated gear train and bearings
Gear Train	Hardened steel spur gears
Approximate Weight	17 lbs for sizes up to 600 in-lbs 31 lbs for sizes 1000 in-lbs and above
Enclosure	Die cast aluminum

9.1 Dimensions

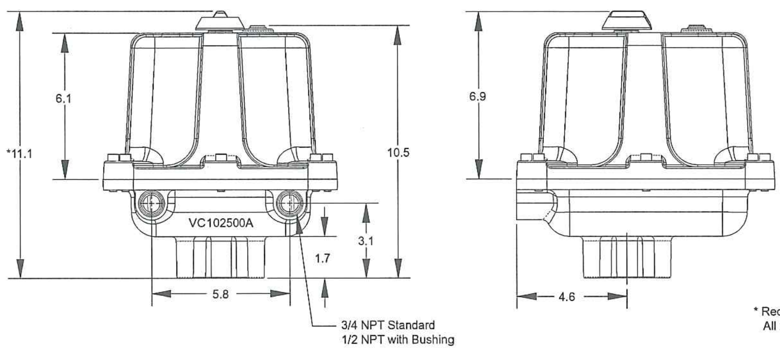
LADC-SERIES ENCLOSURE



Mounting Flange, ISO 5211
F07/F10

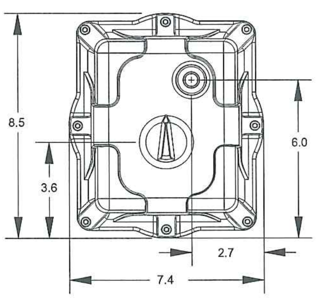


Actuator Size	Drive Option	Drive Type	Drive Size	Depth
1000-3000 lb-in	Standard	Square	1.000 (25mm)	1.20 (30.5mm)
1000 lb-in	Option "I"	Square	0.748 (19mm)	1.20 (30.5mm)
1500-3000 lb-in	Option "I"	Square	0.866 (22mm)	1.20 (30.5mm)
1000-3000 lb-in	Option "Y"	Keyed	0.787 (20mm)	1.50 (38.1mm)

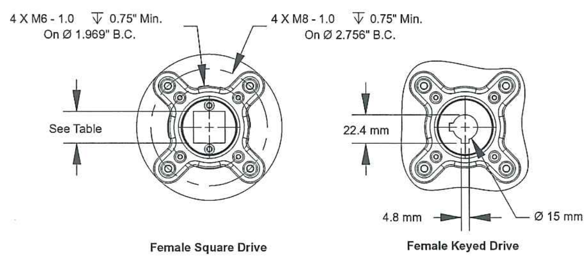


* Requires an additional 5.75" to remove cover
All dimensions in inches unless otherwise stated

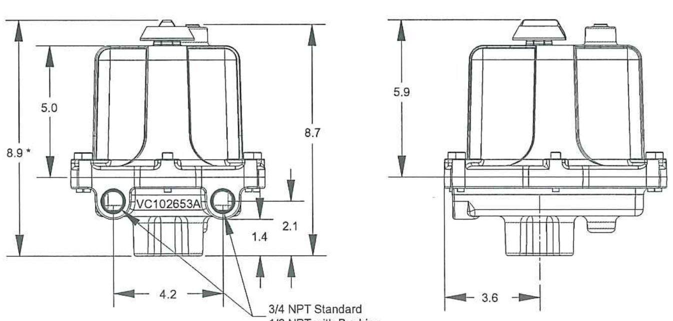
ADC-SERIES ENCLOSURE



Mounting Flange, ISO 5211
F05/F07



Actuator Size	Drive Option	Drive Type	Drive Size	Depth
150-600 lb-in	Standard	Square	0.750 (19mm)	0.90 (22.9mm)
150-600 lb-in	Option "I"	Square	0.551 (14mm)	0.90 (22.9mm)
150-600 lb-in	Option "Y"	Keyed	0.591 (15mm)	1.40 (35.6mm)



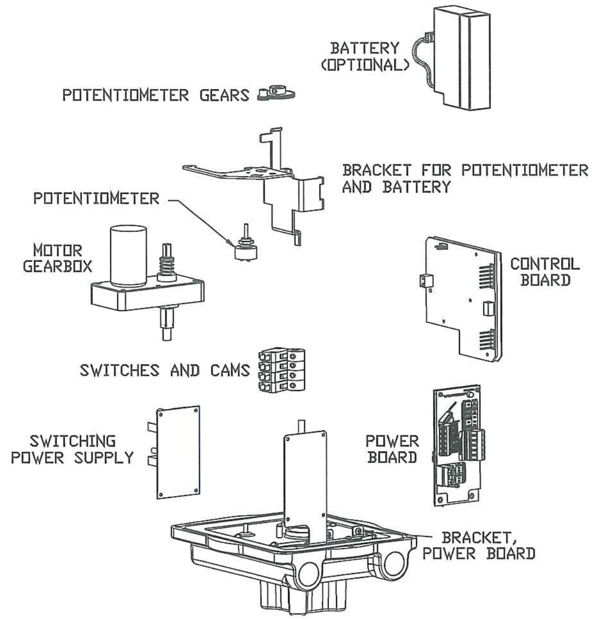
Approximate Weight	17 lb

* Requires an additional 4.75" to remove cover
All dimensions in inches unless otherwise stated

Figure 10

9.2 Exploded View

ADC-Series Spare Parts



PART	DESCRIPTION
	Cover with Position Indicator (not shown)
VC009304	ADC - Small enclosure (150–600 in-lbs)
VC009307	LADC - Large enclosure (1000–3000 in-lbs)
	Cover Screw (8 required)
VC091340	ADC - Small NEMA 4/4X enclosure (150–600 in-lbs)
VC091336	ADC - Small NEMA 4/4X/7/9 enclosure (150–600 in-lbs)
VC091564	LADC - Large enclosure (1000–3000 in-lbs)
	Motor Gearbox
VC006229	ADC (150–600 in-lbs)
VC006144	LADC (1000–2000 in-lbs)
VC006230	LADC (2500–3000 in-lbs)
	Potentiometer and Switches
VC092067	Potentiometer with Gears (90° Operation)
VC099900	Two Auxiliary Switch Kit w/Cams
VC001020	Limit Switch - Replacement
	Brackets with Hardware
VC092665	Bracket, Power Board ADC (150–600 in-lbs)
VC092670	Bracket, Power Board LADC (1000–3000 in-lbs)
VC092450	Bracket, Batter & Potentiometer ADC
VC092445	Bracket, Potentiometer LADC
VC091760	Bracket, Battery LADC
	Power Board Kit Includes Switching Power Supply or Isolator Board (decided by voltage)
VC092361	ADC 115/230VAC
VC092362	LADC 115/230VAC
VC092363	ADC/LADC 12/24VDC
VC092364	ADC/LADC 24VDC
	Tropical Heater and Thermostat Kits
VC099035	Tropical Heater Thermostat 115VAC
VC099036	Tropical Heater Thermostat 230VAC
VC099037	Tropical Heater Thermostat 12VDC
VC099038	Tropical Heater Thermostat 24VAC or 24VDC

	Heater and Thermostat Kits
VC099015	Heater Thermostat 115VAC
VC099016	Heater Thermostat 230VAC
VC099017	Heater Thermostat 12VDC
VC099018	Heater Thermostat 24VAC or 24VDC
	Control Board Kits
VC099050	ADC On/Off Control Board Kit with Battery Back-Up
VC099055	LADC On/Off Control Board Kit with Battery Back-Up
VC099080	ADC On/Off Control Board Kit (without Battery Back-Up)
VC099085	LADC On/Off Control Board Kit (without Battery Back-Up)
	Replacement Battery
VC001573	ADC Battery
VC002509	LADC Battery

NOTES:

Brake – Holding Brake Is Standard On all ADC/LADC-Series Actuators.

Manual Override Is Not A Standard Feature On ADC/LADC-Series Actuators.

Figure 11

10 ENCLOSURE

Table 3

How To Order - ADC-Series Electric Actuators

Series	Enclosure Type		Torque		Board Options[1]		Other Options		Operating Voltage	
	Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
ADC	W	Weathertight	150	150 in•lb	C	Modulating	H[2]	Tropical Heater/Thermostat	N115AC	115 VAC
		NEMA 4/4X	300	300 in•lb	CL2	Modulating Battery Back-Up	I[3a]	ISO 5211 Output	N230AC	230 VAC
			600	600 in•lb	L2	On/off Battery Back-Up	S2	Two Auxiliary Limit Switches	N24AC	24 VAC
	WX	Weathertight & Explosionproof			L4	On/off Battery Back-Up – 3 Position	T[4]	Heater/Thermostat	N12DC	12 VDC
		NEMA 4/4X/7&9			R2	On/Off Isolated Control	Y[5a]	Keyed Output	N24DC	24 VDC
					R3	On/Off Board – 3 Position	Z[6]	Handwheel		
LADC	W	Weathertight	1000	1000 in•lb	C	Modulating	H[2]	Tropical Heater/Thermostat	N115AC	115 VAC
		NEMA 4/4X	1500	1500 in•lb	CL3	Modulating Battery Back-Up	I[3b]	ISO 5211 Output	N230AC	230 VAC
			2000	2000 in•lb	L3	On/off Battery Back-Up	S2	Two Auxiliary Limit Switches	N24AC	24 VAC
	WX	Weathertight & Explosionproof	2500	2500 in•lb	L5	On/off Battery Back-Up – 3 Position	T[4]	Heater/Thermostat	N12DC	12 VDC
		NEMA 4/4X/7&9	3000	3000 in•lb	R2	On/Off Isolated Control	Y[5b]	Keyed Output	N24DC	24 VDC
					R3	On/Off Board – 3 Position	Z[6]	Handwheel		

Notes:
1. Select only one board option; all of these board options include a holding Brake feature
2. This heater option activates at or below 90°F and deactivates at 110°F; it is recommended in high-humidity applications.
3a. 150 - 600 lb-in models with I option are supplied with a 14mm female square (note that without option I the female square is 3/4")
3b. 1000 lb-in models with I option are supplied with a 19mm female square and 1500 - 3000 lb-in models are supplied with a 22mm female square (note that without option I the female square is 1")
4. This heater option activates at or below 40°F and deactivates at 60°F; it is recommended in applications where the temperature may drop below 32°F.
5a. 150 - 600 lb-in models with Y option are supplied with a 15mm female keyed output.
5b. 1000 - 3000 lb-in models with Y option are supplied with a 20mm female keyed output.
6. Handwheel option not recommended with Back-Up Powered options.

- **Enclosure "W"** (weather-tight) is certified by CSA to meet specifications for NEMA 4/4X for weather-tight and dust-tight, environments. It is intended for non-hazardous locations in indoor or outdoor use and provides a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation. It is not designed to be submersible.
- **Enclosure "WX"** (explosion-proof & weather-tight) is certified by CSA to meet specifications for NEMA 7&9, explosion-proof environments as well as to meet NEMA 4/4X specifications. Explosion-proof means that an internal explosion will be contained, with no sparking that could ignite external atmospheric gases. The enclosure is rated for the following environments:
  - NEMA Class I, Division 1, Group C (Ethyl-ether vapors, ethylene or cyclopropane)
  - NEMA Class I, Division 1, Group D (Gasoline, hexane, naptha, benzene, butane, propane, alcohol, acetone, benzol, lacquer, solvent, vapors or natural gas)
  - NEMA Class II, Division 1, Group E (Metal dust, including aluminum, magnesium, their commercial alloys, and other metals of similarly hazardous characteristics)
  - NEMA Class II, Division 1, Group F (Carbon black, coal or coke dust)
  - NEMA Class II, Division 1, Group G (Flour, starch or grain dust)
  - NEMA Class III

Sample Model Code: ADCW150CL2IS2N24AC

Actuator Series	ADC
Enclosure Type	W
Torque	150
Board Option	CL2
Other Options (if applicable)	I S2
Operating Voltage	N24AC

For enclosure specifications and dimensions, **see Table 2 and Figure 10.**

- Torque = Breakaway Torque ADC-Series actuators are rated at breakaway torque; the amount of torque the actuator will provide from a fully loaded stop upon immediate power-up. With running momentum and inertia, the amount of torque supplied by the actuator at full speed (running torque) or upon entering a stall condition (stall torque) always exceeds the minimum rated breakaway torque. Since valves require most torque at breakaway, only breakaway torque should be considered when sizing actuators.

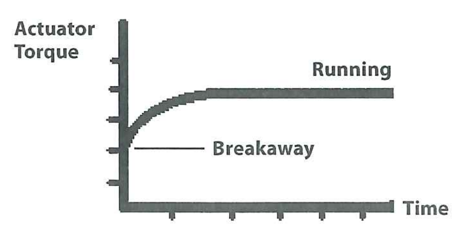


Figure 9

11 ADDITIONAL ACTUATOR PRODUCTS AND ACCESSORIES FROM METSO

V-Series

- Up to 3000 inch pounds for On/Off, Modulating or Automatic Cycling applications
- 75% Duty Cycle
- 115VAC and 230VAC voltages
- NEMA 4/4X and NEMA 4/4X/7&9 enclosures
- CSA Certified (Canadian & U.S. Standards)
- Options include Modulating Control Board, Speed Control/TimerBoard, Iso/Readback Board, extra limit switches, heater/thermostats, motor brake, feedback potentiometer and handwheel override

ESR-Series

- Up to 600 inch pounds for True "Two-Wire" On/Off applications
- 80% Duty Cycle
- 115VAC and 230VAC voltages
- Options include extra limit switches and heater/thermostats

QX-Series

- Up to 3000 inch pounds for On/Off applications
- Economical NEMA 4/4X/7&9 solution
- 12VDC & 24VDC voltages
- 80% Duty Cycle
- CSA (C US) Certification

LC Series

- Up to 600 inch pounds
- Economical actuators for Reversing or Unidirectional applications
- 25% duty cycle
- NEMA 4/4X enclosures
- 115VAC, 230VAC, 24VAC, 12 VDC and 24VDC voltages
- Options include extra limit switches and heater/thermostats
- Male output (standard) or female output (optional)

I-Series Network Capable

- Modbus®
- AS-Interface
- DeviceNet™
- Foundation Fieldbus
- Other fieldbus protocols (consult factory)

Q6-Series for Remote Solar Applications

- 600 inch pounds
- 12VDC
- Low current draw

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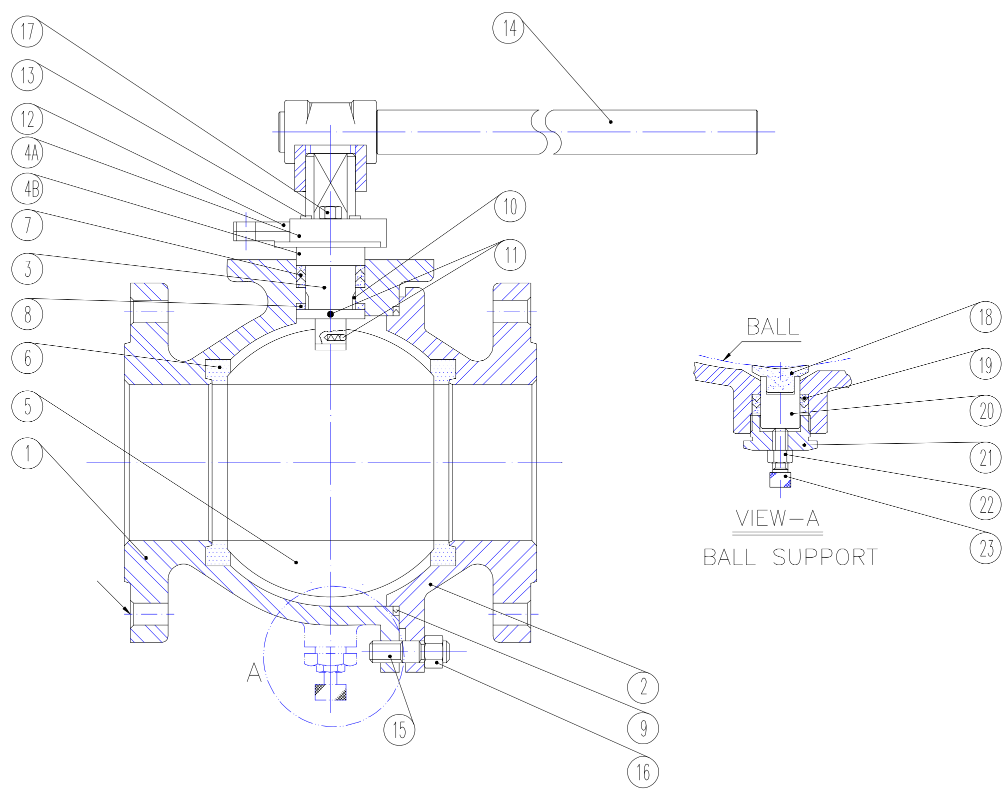
www.metso.com/valvcon

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes 6” - 12” , Classes 150 & 300

NO.	PART NAME
1	BODY
2	CAP
3	STEM
4A	GLAND
4B	GLAND RING
5	BALL
6	SEAT
7	PACKING
8	THRUST WASHER
9	GASKET
10	STEM BEARING
11	ANTI–STATIC
12	TRAVEL STOPPER
13	SNAP RING
14	HANDLE
15	STUD
16	NUT
17	GLAND BOLT
18	PIN SEAT
19	PIN PACKING
20	SUPPORT PIN
21	SUPPORT NUT
22	SET NUT
23	TUNING SCREW



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools. Ball support supplied for 10” and 12” Class 150 valves, and 6” through 12” Class 300 valves.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150 or Class 300.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the gland bolts 1/4 turn, each. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle, snap ring, and travel stop plate.

3. Remove gland bolts, gland, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. **For 10” and 12” valves only**: Ball support must be backed off to remove ball. Loosen support nut, set nut and back out tuning screw on bottom of valve to release the ball support. The weight of the ball will cause the ball support to come down.

7. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

8. Take out other seat.

9. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing and stem bushing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Set the valve body on a clean work suface, resting on the end flange.

2. Install one seat in the body cavity with the spherical curvature facing the ball (upwards).

3. Cut new stem bushing on one side at approx. 30° - 60° angle and wrap around stem above shoulder.

4. Install thrust bearing on stem and holding stem bushing in place, slide the stem up through stem bore from inside body.

5. Install new stem seals, gland ring, and gland. Install gland bolts and tighten hand tight.

6. Install travel stop, and snap ring.

7. Turn the stem to the CLOSED position (bottom stem tan parallel to flow passage). Line up the ball slot with the stem tang and roll and lower the ball into position on the stem tang, letting the ball rest in the seat. Turn the stem and ball to the OPEN position to hold the ball in place.

8. **<u>For 10" and 12" Valves Only:</u>** Re-set the ball support by turning the tuning screw inwards until the support pin seat firmly contacts the ball. Do not cause the ball to move. Holding the tuning screw in place, tighten the support nut and then the set nut.

9. Install the remaining seat into body end.

10. Place new body seal into counterbore in valve body.

11. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

12. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

13. Tighten the gland bolts to the torques specified in Table 1.

14. Install handle, making sure that the handle aligns with the flow passage through the ball.

15. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

16. Pressure test valve, if possible, before reinstalling in pipeline.

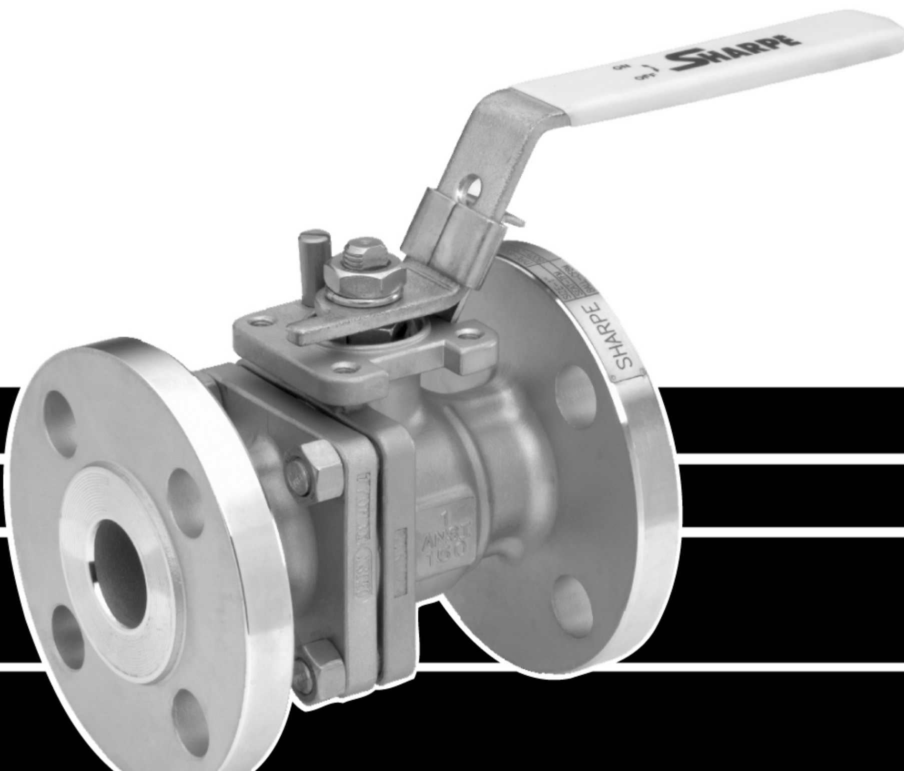
<u>Table 1 – Gland Bolt Torques</u>

SIZE	Tightening Torque (lb-ft) Max
6" – 8"	42 (1/2-13UNC)
10" - 12"	83 (5/8-11UNC)

Table 2 – Body Bolting Torques

SIZE	THREAD	Tightening Torque (lb-ft) Max
6”,8” (Class 150) / 3”~6”(Class 300)	5/8-11UNC	83
10”,12” (Class 150) / 8”(Class 300)	3/4-10UNC	120
10”(Class 300)	7/8-9UNC	190
12”(Class 300)	1-8UNC	260

SHARPE® VALVES

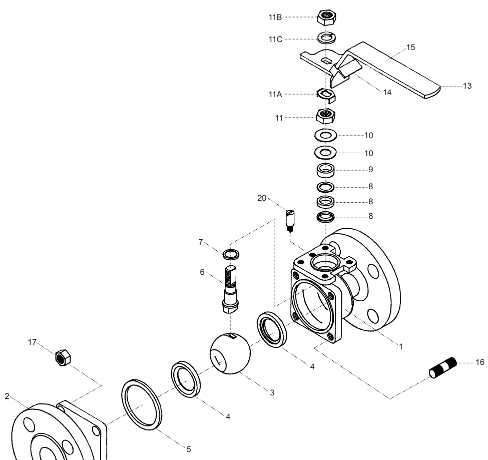


FLANGED FULL PORT BALL VALVE
SERIES 50 / CLASS 150

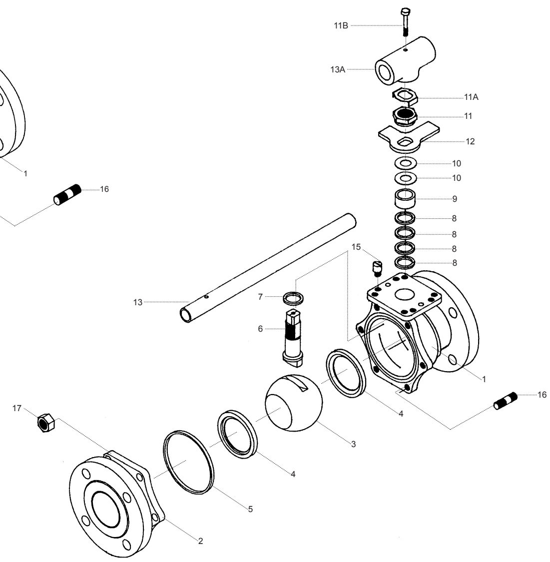
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

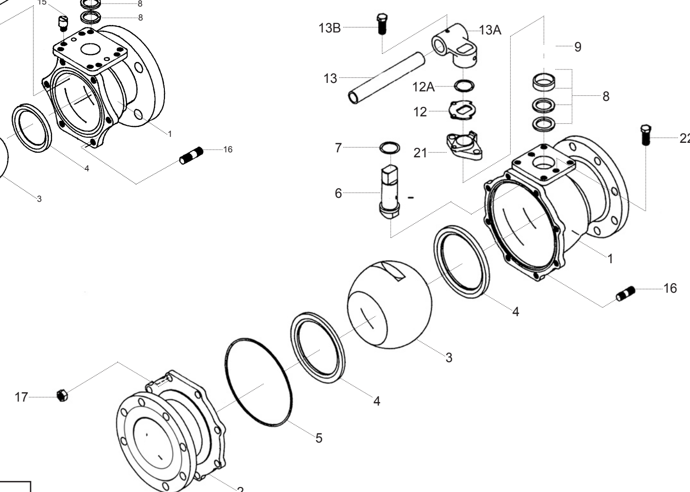
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2” - 2”



2-1/2” - 4”



6” - 8”

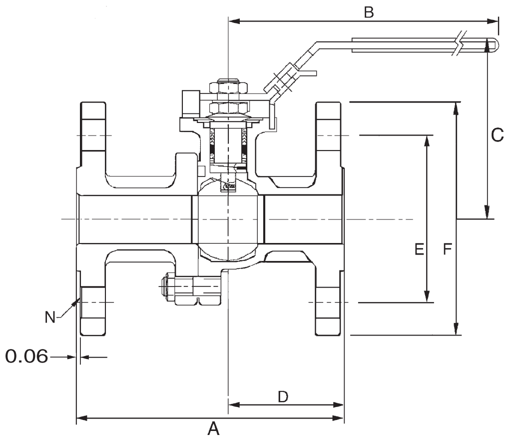
PART NO.	PART	QTY.	MATERIAL
1	Body	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) TFE Reinforced TFE NOVA PEEK
5	Body Seal	1	TFE
6	Stem	1	316 Stainless Steel Alloy 20 Hastelloy C 17-4PH (Option)
7	Thrust Bearing	2	Reinforced TFE
8	Stem Packing	3/4	Reinforced TFE
9	Gland Packing	1	304 Stainless Steel
10	Belleville Washer (1/2”-4”)	2/4	304 Stainless Steel
11	Packing Nut (1/2”-4”)	1	304 Stainless Steel
11A	Lock Tab	1	Stainless Steel
11B	Handle Nut	1	304 Stainless Steel
11C	Lock Washer	1	304 Stainless Steel (1/2”-2”)

*See Dimensions

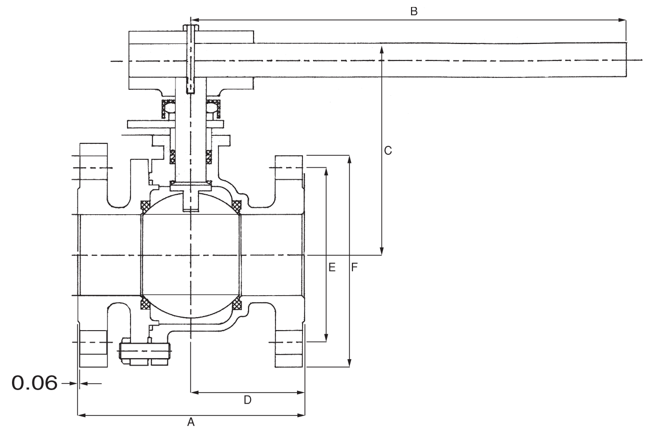
PART NO.	PART	QTY.	MATERIAL
12	Stopper	1	304 Stainless Steel
12A	Snap Ring	1	Stainless Steel (6”-8”)
13	Handle	1	304 Stainless Steel (1/2”-2”) Galvanized Steel (2-1/2”-4”) Ductile Iron (6”-8”)
13A	Wrench Block	1	Stainless Steel
13B	Hex Head Bolt	1	304 Stainless Steel
14	Locking Device (1/2”-2”)	1	304 Stainless Steel
15	Sleeve	1	Vinyl
16	Body Stud	SEE* N	A193 B8 (SST) A193 B7 (CS)
17	Nut	SEE* N	A194 8 (SST) A194 2H (CS)
20	Stop Pin (1/2”-2”) (2-1/2”-4”)	1 2	304 Stainless Steel 304 Stainless Steel
21	Gland Flange (6”-8”)	1	304 Stainless Steel
22	Gland Bolts (6”-8”)	2	304 Stainless Steel

SERIES 50
DIMENSIONS

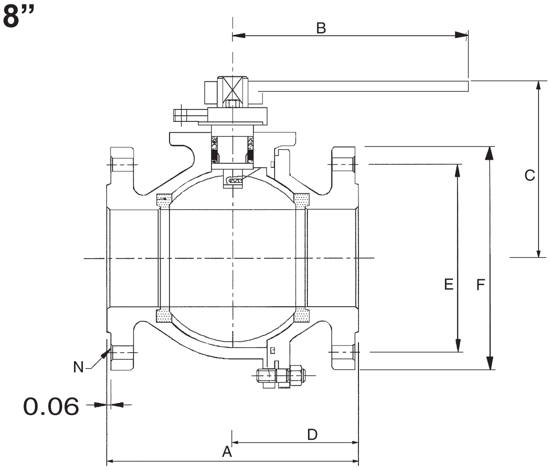
1/2" - 2"



2-1/2" - 4"



6" - 8"



CV DATA

1/2"	26
3/4"	50
1"	94
1-1/2"	260
2"	480
2-1/2"	750
3"	1300
4"	2300
6"	5400
8"	10000

PORT

1/2"	0.59
3/4"	0.78
1"	1.00
1-1/2"	1.50
2"	2.00
2-1/2"	2.55
3"	3.00
4"	4.00
6"	6.00
8"	7.88

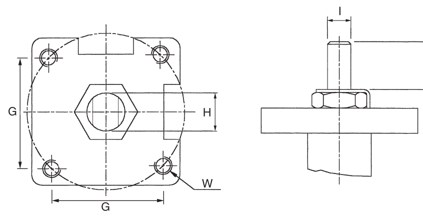
WEIGHT (lbs.)

1/2"	4
3/4"	6
1"	8
1-1/2"	15
2"	20
2-1/2"	36
3"	45
4"	75
6"	135
8"	290

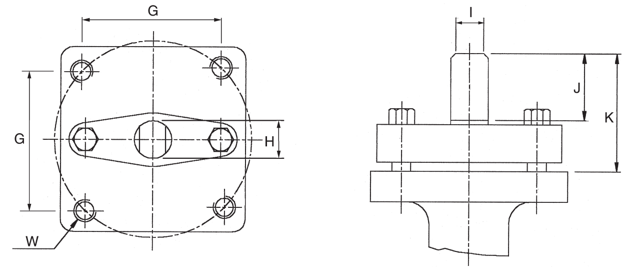
SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2"	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4"	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1"	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2"	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2"	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2"	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3"	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4"	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6"	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8"	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

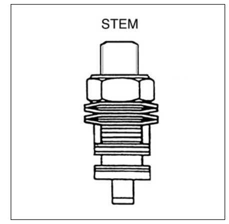
The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.

1/2" - 4"



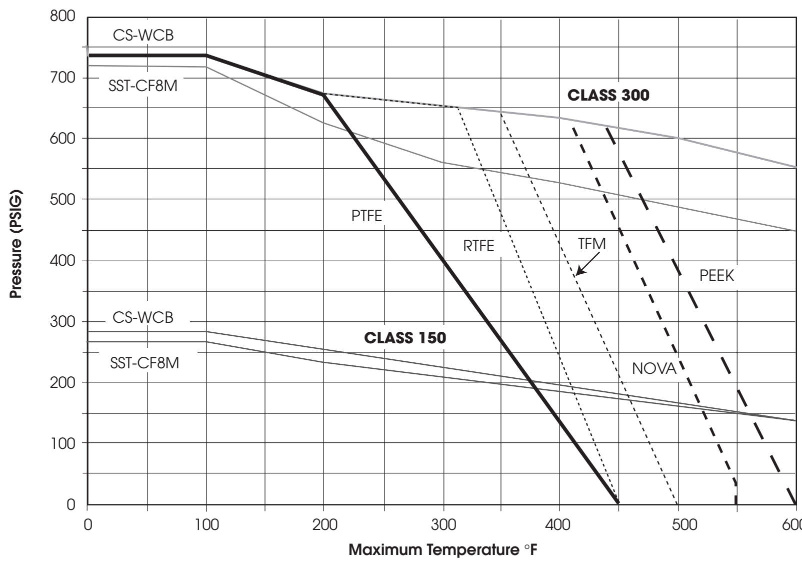
6" - 8"





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2"	50	150# = 11	2 = Alloy 20	T = TFE	X = Oxygen Service
3/4"			4 = Carbon Steel	R = RTFE	OH = Oval Handle
1"			6 = Stainless Steel	N = NOVA	F = Fugitive Emissions Certified ANSI 593.00.01
1-1/2"			5 = Hastelloy C	P = Peek	E = Extended Stem
2"			3 = Monel	M = TFM™	L = Lockable Extended Stem
2-1/2"					D = Leak detection Stem
3"					GO = Gear Operator
4"					7 = 17- 4PH Stem
6"					A = Nace
8"					

3/4" 50 11 6 T X

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(877) 774-2773
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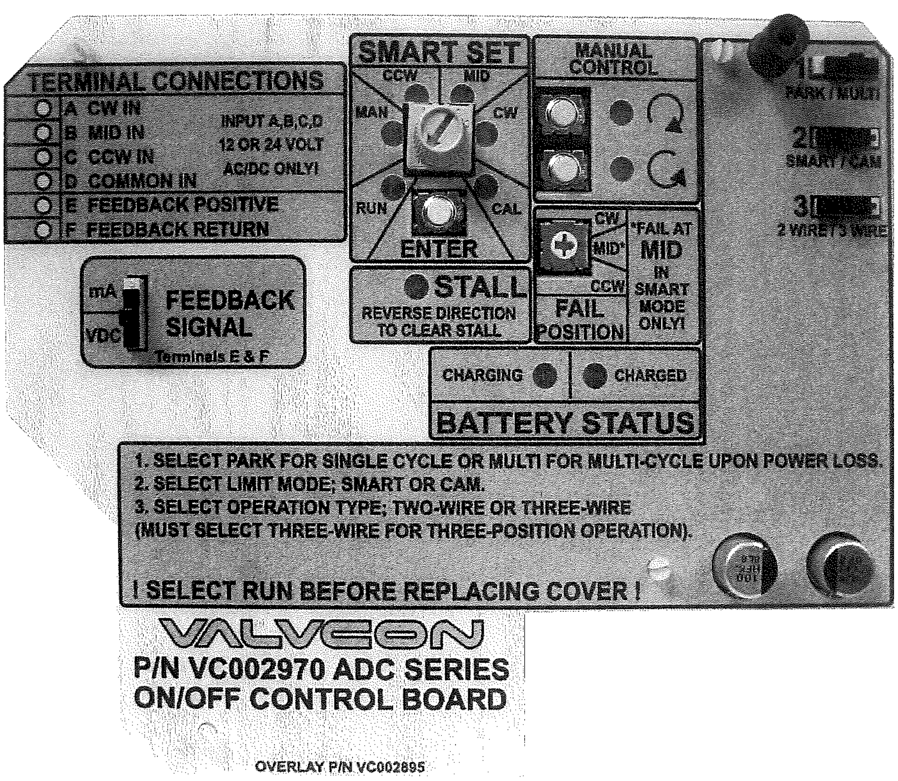
E-Mail: info@sharpevalves.com
www.sharpevalves.com
1260 Garnet Drive
Northlake, Illinois 60164 U.S.A.

metso

VALVCON
ADC-Series
CONTINUOUS DUTY
ON/OFF ELECTRIC ACTUATORS
With R2, R3, L2, L3, L4 & L5 Options
With "N" In The Model Number

Installation, Maintenance and
Operating Instructions



metso
Expect results

IMO-I4500 • 1/2014

Table of Contents

READ THESE INSTRUCTIONS FIRST!

This instruction manual contains important information regarding the installation, operation, and troubleshooting of ADC-Series Continuous Duty On/Off Electric Actuators With R2, R3, L2, L3, L4 & L5 Options With "N" In The Model Number. Please read these instructions carefully and save them for future reference.

SAVE THESE INSTRUCTIONS!

Subject to change without notice.

1 GENERAL

1.1 ADC-Series On/Off Actuators (with Optional Battery Back-up)

The On/Off actuators are based on the ADC and LADC platform and provide an optional internal battery pack to power the actuator in the event of a loss of external power. ADC designates sizes from 150 to 600 in-lbs. LADC designates sizes from 1000 to 3000 in-lbs **(see Figure 10)**.

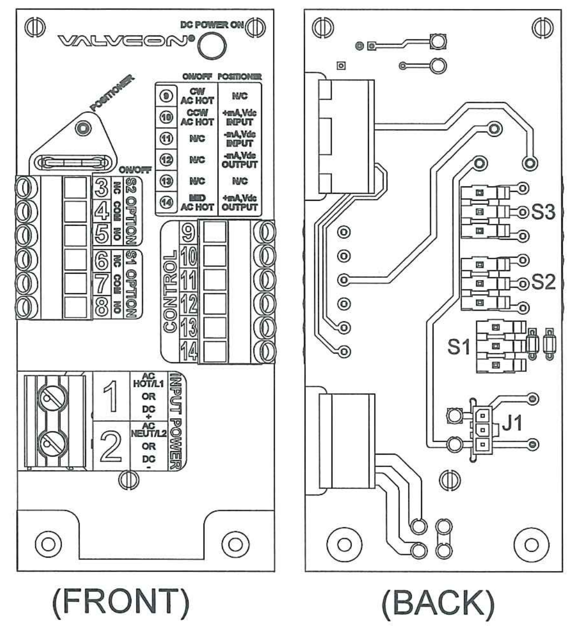
The electronic package consists of three separate boards; **P/N VC002360** Power Board and the **P/N VC002970** On/Off Control Board, and either a switching power supply or a DC isolator board. On/Off actuators are identified by the code "R2" or "R3" in the model number. On/Off actuators with battery back-up are identified by the code "L2", "L3", "L4" or "L5" (L2 & L4 are applicable in ADC-Series and L3 & L5 are applicable in LADC-Series) in the model number. (**Note:** The L4 and L5 options are factory-set for 180° operation with the MID position set at 90°.)

The On/Off control actuators covered in this manual are identified by the code "R2", "R3","L2", "L3", "L4" or "L5" and the letter **N** in the model number (do not confuse with "CL2" or CL3", which indicates a separate modulating control option).

1.2 Power Board P/N VC002360

The **P/N VC002360** Power Board provides terminals for input and output wiring to the actuator as well as plug-in connectors for ADC-Series options and accessories.

IMPORTANT! To use terminal 2 AC Neut/L2 as a COMMON connection for CW AC HOT and CCW AC HOT, set jumper to "ON/OFF" (horizontal). However, when using an AC control signal that is not COMMON to the actuator power supply, this jumper must be set to "POSITIONER" (45°) and a separate AC COMMON connection must be made to terminal 11 for CW AC HOT, CCW AC HOT and MID AC HOT signals.



S1 MOTOR / MOTOR JUMPER
S2 OPTIONAL ADDITIONAL LIMIT SWITCH CW
S3 OPTIONAL ADDITIONAL LIMIT SWITCH CCW
W1-W2 LIMIT SWITCH CW (BOTTOM)
W3-W4 LIMIT SWITCH CCW (2ND FROM THE BOTTOM)
W5-W6 AC POWER TO POWER MODULE
W7-W8 DC POWER RETURN FROM POWER MODULE

Figure 1

1.3 On/Off Control Board P/N VC002970

The **P/N VC002970** On/Off Control Board connects to the **P/N VC002360** Power Board via two plug-in connectors and a bracket, and hardware anchors it to the motor/gearbox. The On/Off Control Board allows the actuator to drive to either the full open or full closed position in response to applied control voltages. The **P/N VC002970** On/Off Control Board can be configured for either "Two-Wire" or "Three-Wire" control, (driving to mid-travel

positions can be achieved by removing the control voltage in "Three-Wire" mode). The On/Off Control option features include a choice of 115VAC, 230VAC, 12VDC, 24VDC or 24VAC input power as well as independent 115VAC, 230VAC, 12VDC, 24VDC or 24VAC control signals. Additional features include optional internal Battery Back-Up, Three-Position operation, analog position output signal (not present if using "Cam" Limit Type), manual push button control, single or multi cycling upon loss of line power, switch select power "Fail" position, locked rotor stall protection, on-board battery status indicators, and simple digital **Smart Set** functionality for entering and saving precise end of travel positions. (**Note**: Some of the above features are only applicable with the optional Back-Up battery installed.)

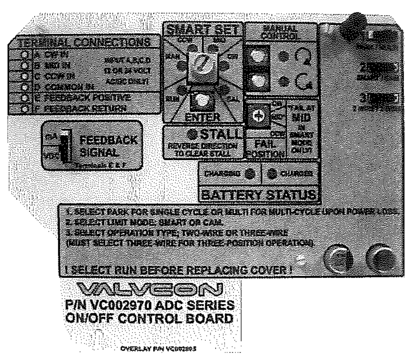


Figure 2

P/N VC002970 Battery Back-Up On/Off Control Board

1.4 LED Indicators

Visible on the **P/N VC002360** Power Board **(see Figure 1)**:

DC POWER ON – This green LED indicator shows that the user-supplied power is present and has been converted to DC (power conversion not applicable to DC input voltages) to drive the motor.

Visible on the **P/N VC002970** L2 &L3 Board **(see Figure 2)**:

POWER – A continuous green LED indicates that external or battery power is present.

STALL – A flashing red LED indicates a stall condition exists and that the actuator has been prevented from reaching the position commanded by the control signal. A STALL of more than several seconds will cause power to be automatically removed from the motor circuit, placing the actuator in a safe mode. A reverse signal or **Smart Set** mode change is required to clear the STALL LED alarm. A STALL alarm can be initiated in a few ways; by a blockage in the valve or damper, cam limit settings that are inside of the electronically saved travel stop positions, attempting to drive an actuator that is off-line due to thermal overload or some other increase in the torque load on the actuator.

CLOCKWISE – A continuous yellow LED indicates that the actuator is driving in the CW direction.

COUNTER-CLOCKWISE – A continuous yellow LED indicates the actuator is driving in the CCW direction.

CHARGING – A continuous yellow LED indicates that the battery is charging and is not fully charged.

CHARGED - A continuous green LED indicates that the battery is fully charged. A flashing green LED indicates the actuator is running on battery power.

RUN – A continuous green LED indicates that the normal operating mode has been selected.

MAN – A continuous yellow LED indicates that MANUAL mode has been selected. The actuator will not respond to external control signals and the CW and CCW push buttons are enabled for manually driving the actuator in either direction. The manual push buttons are also enabled in SPAN, MID, ZERO and CAL modes.

CCW – A continuous yellow LED indicates that the CCW **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the CCW LED is illuminated will cause the CCW LED to flash. Pressing **[ENTER]** while the CCW LED is flashing will save the current position as the CCW travel limit.

MID – A continuous yellow LED indicates that the MID **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the MID LED is illuminated will cause the MID LED to flash. Pressing **[ENTER]** while the MID LED is flashing will save the current position as the MID travel stop position.

CW – A continuous yellow LED indicates that the CW **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the CW LED is illuminated will cause the CW LED to flash. Pressing **[ENTER]** while the CW LED is flashing will save the current position as the CW travel stop limit.

CAL – A continuous yellow LED indicates that the CAL (calibration) mode has been selected. Pressing **[ENTER]** for two seconds while the CAL LED is illuminated may cause the CAL LED to flash indicating that further calibration of the position Feedback Potentiometer is required. **See Page 9 For Feedback Potentiometer Calibration Procedures.** If the CAL LED remains on continuously, no further calibration is required. Press **[ENTER]** to confirm the calibration setting and return to **RUN** mode.

At any point during Set-Up you may exit a "Smart Set" mode without changing the stored data, by simply selecting a different "Smart Set" mode.

2 OPERATION

> Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.

2.1 Wiring

The identification label on each actuator specifies the model number, serial number, input power voltage and current requirements for the actuator. It is important to verify the correct input voltage prior to wiring the actuator.

There are three basic wiring schemes designed to operate the ADC-Series On/Off Control Board options. These include:

Two Wire – On/Off Operation
Three Wire – Open/Stop/Close
Three Position – CW/MID/CCW

2.1.1 "Two-Wire" – On/Off Operation

(SEE FIGURE 3)

MAIN POWER – Terminals 1&2 - For "Two-Wire" control, the mode select slide switch must be in the LEFT, "Two-Wire" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - To control the actuator with a high voltage signal (115VAC or 230VAC) connect AC HOT to terminal 10 on the **P/N VC002360** Power Board. When terminal 10 is energized, the actuator will drive counter-clockwise. When terminal 10 is de-energized, the actuator will drive clockwise.

CONTROL SIGNALS – Low Voltage - To control the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the positive or hot lead to terminal C and connect the common or negative lead to terminal D on the **P/N VC002970** ON/OFF Control Board. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When terminal C and terminal D are de-energized, the actuator will drive clockwise.

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 on the **P/N VC002360** Power Board and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns, the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 3)**. Installing the optional heater and thermostat is a plug connection and requires no additional wiring.

2.1.2 "Three-Wire" – Open/Stop/ Close Operation

(SEE FIGURE 4)

MAIN POWER – Terminals 1&2 - For "Three-Wire" control, the mode select slide switch must be in the RIGHT, "Three -Wire" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - For "Three-Wire" control of the actuator with a high voltage signal (115VAC or 230VAC) connect the AC HOT CW lead to terminal 9. Connect the AC HOT CCW lead to terminal 10. When terminal 9 is energized, the actuator will drive clockwise. When terminal 10 is energized, the actuator will drive counter-clockwise. When neither 9 nor 10 are energized, the actuator will remain in position, (unless main power to 1 and 2 is interrupted).

CONTROL SIGNALS – Low Voltage - For "Three-Wire" control of the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the CW positive or hot lead to terminal A. Connect the CCW positive or hot lead to terminal C. Connect the common or negative lead to terminal D on the **P/N VC002970** board. When terminal A and terminal D are energized the actuator will drive clockwise. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When neither terminal A nor terminal C is energized, the actuator will remain in position, (unless power to 1 and 2 is interrupted).

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 4)**. Installing the optional heater and thermostat is a plug connection and requires no additional input power wiring.

2.1.3 "Three-Position" – CW/MID/CCW Operation

(SEE FIGURE 5)

MAIN POWER – Terminals 1&2 - For "Three-Position" control, the mode select slide switch must be in the RIGHT, "Three-Wire" position and the Limit Type select slide switch must be in the LEFT, "Smart" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - For "Three-Position" control of the actuator with a high voltage signal (115VAC or 230VAC) connect the AC HOT CW lead to terminal 9. Connect the AC HOT CCW lead to terminal 10. Connect the AC HOT MID (mid-position) lead to terminal 14. When terminal 9 is energized the actuator will drive clockwise. When terminal 14 is energized, the actuator will drive to the MID position. When terminal 10 is energized, the actuator will drive counter-clockwise. When neither terminals 9, 10, nor 14 are energized, the actuator will remain in position, unless power to 1 and 2 is interrupted.

CONTROL SIGNALS – Low Voltage - For "Three-Position" control of the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the CW positive or hot lead to terminal A. Connect the CCW positive or hot lead to terminal C. Connect the MID (mid-position) positive or hot lead to terminal B. Connect the common or negative lead to terminal D on the **P/N VC002970** board. When terminal A and terminal D are energized the actuator will drive clockwise. When terminal B and terminal D are energized, the actuator will drive to the MID position. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When neither terminals A, B, or C are energized, the actuator will remain in position, (unless power to 1 and 2 is interrupted).

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 5)**. Installing the optional heater and thermostat is a plug connection and requires no additional input power wiring.

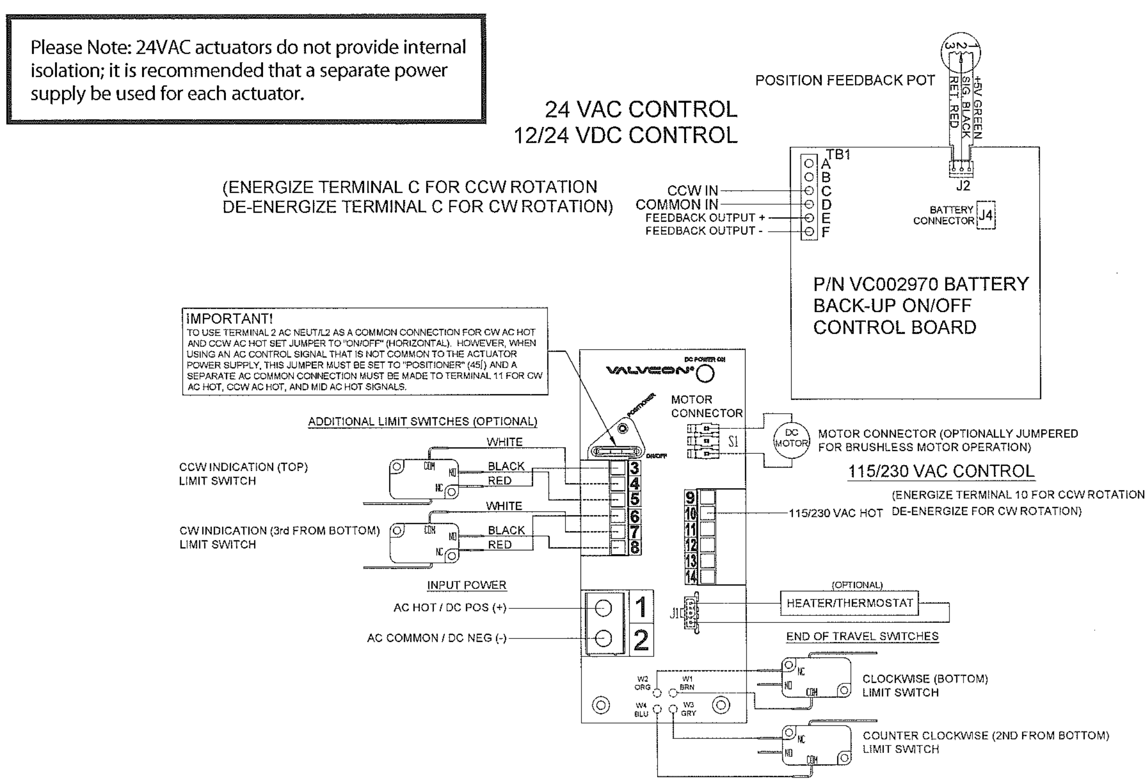
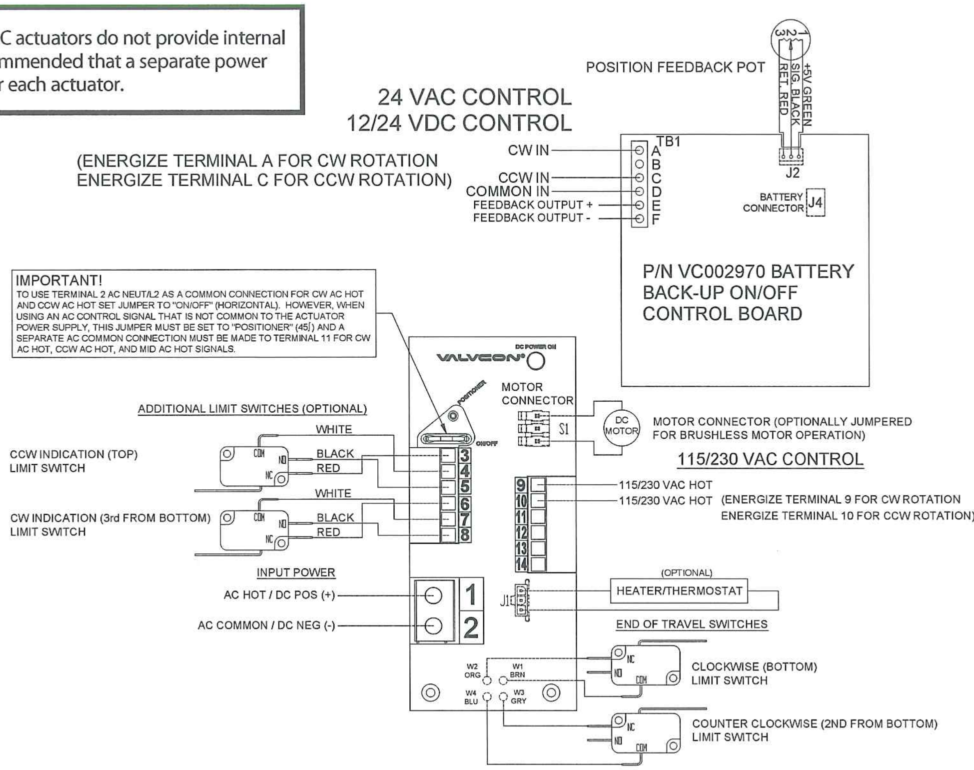


Figure 3

"Two-Wire" Wiring

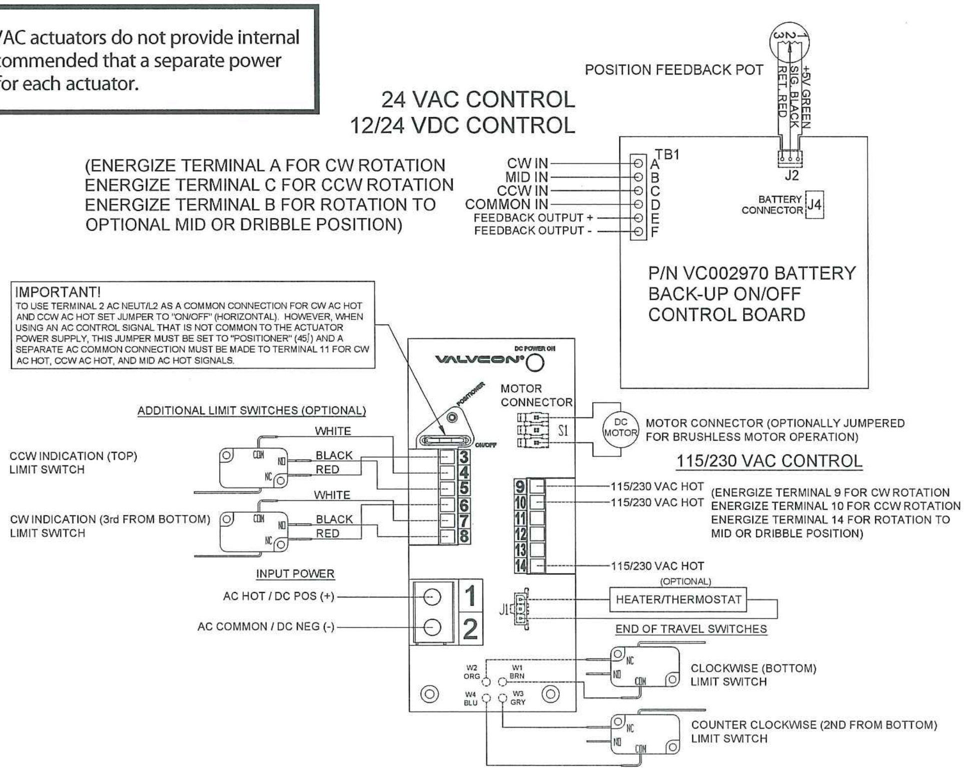
Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.



"Three-Wire" Wiring

Figure 4

Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.



"Three-Position" Wiring

Figure 5

2.2 ADC R2, R3, L2, L3, L4 & L5 Travel Limit Options

Travel limits, also referred to as "end of travel stops", are the precise positions to which the actuator will drive. The ADC-Series R2, R3, L2, L3, L4 & L5 options provide a number of choices for setting the travel limits. For "Two-Position" On/Off operation, travel limits are set at the full clockwise (CW) and full counter-clockwise (CCW) ends of travel. For "Three-Position" operation, an optional midway position (MID) may be set at any point between the CW and CCW settings.

CAUTION:
Dangerous Voltages Inside Actuator

Use extreme caution when working on the actuator with the cover removed.

2.2.1 Limit Types

To simplify the process of setting the precise travel limit positions, the ADC-Series R2, R3, L2, L3, L4 & L5 options provide two travel limit types. CW, CCW and MID may be set electronically via the **Smart Set** utility or CW and CCW may be set mechanically by selecting the "CAM Set" limit type.

2.2.2 CAM Set

When CAM Set is selected as the limit type, two limit switches operated by the stainless steel cams on the output shaft extension are used to determine the exact positions where the actuator will stop at each end of CW and CCW travel. The bottom limit switch determines the clockwise stop position. The next limit switch up from the bottom determines the counter-clockwise stop position.

The "end of travel limit" switches can be adjusted to provide from 5 to 320 degrees of actuator rotation.

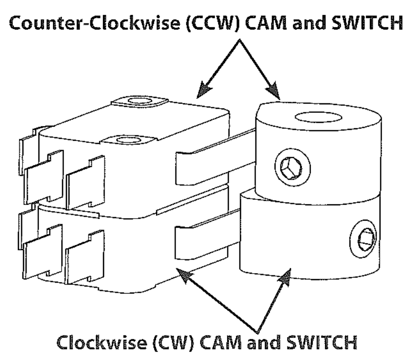


Figure 6

For "Three-Position" operation, limits must be entered and saved using the "Smart" Limit Type, only! **See Section 3** for detailed instructions.

2.2.3 Smart Set

When **Smart Set** is selected as the limit type, the micro processor stores the exact positions where the actuator will stop at each end of travel or mid position. Setting the **Smart Set** positions for the clockwise, counter-clockwise and midway positions is done with the selector knob and **[ENTER]** button in the **Smart Set** field of the **P/N VC002970** board. To use the **Smart Set** feature, the Feedback Potentiometer must be installed, connected and calibrated and the travel stop cams must be set to trip the switches beyond the desired electronic stop positions for CW, CCW.

The end of travel limits on standard ADC actuators can be entered and saved between 0° and 94° of travel. For rotation up to 270° of travel optional Feedback Potentiometer gears are available **(see Section 7; ADC-Series Standard Options)**.

For "Three-Position" operation, limits must be entered and saved using the "Smart" Limit Type, only! **See Section 2.1.3** for detailed instructions.

3 SET UP AND CALIBRATION

3.1 Initial Set Up

1. Remove actuator cover.
2. Select **Limit** type – **"SMART" or "CAM"** – Slide the **[SMART/CAM]** to the right to select **CAM** or to the left to select **SMART**. Selecting **SMART** will enable other features on the board such as Position Feedback and "Three-Position" operation. Selecting **CAM** will allow the actuator to drive between the end-of-travel limit switch settings. (Actuator is set up in **SMART** mode at factory; **SMART** set up is also recommended for field replacement.)
3. Select Operation **Limit** type – **"TWO-WIRE"** or **"THREE-WIRE"** – Slide the **[TWO-WIRE/THREE-WIRE]** to the right to select **THREE-WIRE** or to the left to select **TWO-WIRE**. In **TWO-WIRE** mode the actuator will drive **CCW** when the control terminal is energized and **CW** when the control terminal is de-energized. In **THREE-WIRE** mode separate terminals must be energized for **CW** or **CCW** movement; if using the **THREE-POSITION** feature the actuator must be set in **THREE-WIRE** mode.
4. Select Battery Mode On Power Fail – **"PARK AT FAIL" or "MULTI-CYCLE"** – Slide the **[PARK AT FAIL/ MULTI-CYCLE]** to the right to select **MULTI-CYLCE** or to the left to select **PARK AT FAIL**. Selecting **PARK AT FAIL** will drive the actuator to the selected

Power Loss position upon loss of input power and the system will go to "sleep" until input power is restored. If **MULTI-CYLCE** is selected, the actuator will continue to respond to changes in control signal for up to ten cycles; the battery monitoring circuit will drive to the Power Loss position when it detects that the battery should be charged. Upon reaching the Power Loss position, the system will go to "sleep" until input power is restored.

5. Select **Power Loss Position – "CW", "MID" or "CCW"** – Turn the **[CW/MID/CCW]** to the clockwise to select **MID** or **CCW** or counterclockwise to select **MID** or **CW**. Selecting **CW** will drive the actuator to the clockwise position upon loss of input power. Selecting **CCW** will drive the actuator to the counterclockwise position upon loss of input power. Selecting **MID** will drive the actuator to the **MID** or **"THIRD"** position upon loss of input power; this setting is used in **THREE-WIRE** mode only.
6. Select **Output Feedback Signal** type – **"mA"** or **"VDC"** (current or voltage), the actuator will provide a 4-20mA or 2-10VDC feedback signal. Slide the **[OUTPUT SIGNAL]** switch up to select **mA** or down to select **VDC**.

3.2 Potentiometer Calibration

Field installation of the On/Off Control Board option or replacement of the position tracking potentiometer requires calibration of the position tracking potentiometer prior to setting positions and values for CW, MID and CCW. On/Off Control Board options installed at the factory are fully calibrated at the factory and should not require further calibration.

To confirm proper potentiometer calibration:

1. Turn the Mode Selector Dial to **[CAL]** and press **[ENTER]** for 2 seconds.
2. Using the **CW** push button, drive the actuator to the full clockwise position.
   - If the **[CAL]** LED is flashing, potentiometer calibration is required; proceed to step 3 below.
   - If the **[CAL]** LED remains on, calibration is not required; proceed to **Setting CW, MID and CCW Positions section below**.
3. Loosen the set screw in the larger Nylon gear with a 1/16" hex wrench.
4. Rotate the gear until the LED remains on constantly; hold the gear in place and tighten the set screw. Ensure that the LED remains on after the set screw is tightened. **Note**: The LED assists the user in locating the proper calibration window; it will flash faster as you approach the calibration window and slower as you move away from it.
5. Press the **[ENTER]** button to save the potentiometer setting.

3.3 Setting CW, MID and CCW Positions

Setting CW, MID and CCW Positions - Once calibration has been confirmed, set the desired "end of travel" positions. ***Make certain that the limit switch cams are set to operate the switches beyond the desired range for the CW and CCW positions.*** CW and CCW may be set at any position between 0° and 94° of travel (or 184° with "R3", "L4" or "L5" option).

3.3.1 Set CW:

1. Turn the Mode Selector Dial to **[CW]** and press **[ENTER]** for 2 seconds. The **[CW]** LED will begin to flash.
2. Drive the actuator to desired clockwise position using the **CW** or **CCW** push button. If the **"STALL"** LED begins to flash; check to see if the limit switch cam is preventing actuator from reaching desired **CW** end-of-travel. If necessary back the cam off so that it will trip the switch slightly beyond the desired end-of-travel.
3. Press the **[ENTER]** button to save the **CW** setting.

3.3.2 Set MID: (if applicable)

1. Turn the Mode Selector Dial to **[MID]** and press **[ENTER]** for 2 seconds. The **[MID]** LED will begin to flash.
2. Drive the actuator to desired **MID** or "THIRD" position using the **CW** or **CCW** push button.
3. Press the **[ENTER]** button to save the **MID** setting.

3.3.3 Set CCW:

1. Turn the Mode Selector Dial to **[CCW]** and press **[ENTER]** for 2 seconds. The **[CCW]** LED will begin to flash.
2. Drive the actuator to desired counterclockwise position using the **CW** or **CCW** push button. If the **"STALL"** LED begins to flash; check to see if the limit switch cam is preventing actuator from reaching desired "end of travel". If necessary back the cam off so that it will trip the switch slightly beyond the desired end-of-travel.
3. Press the **[ENTER]** button to save the **CCW** setting.

3.3.4 Verify End-Of-Travel Settings:

1. Turn the Mode Selector Dial to **[RUN]**.
2. Apply various control signals to verify operation.
3. Replace actuator cover.

4 POWER LOSS & BATTERY MODE OPTIONS

4.1 Battery Mode Selection – PARK AT FAIL or MULTI-CYCLE

The ADC-Series On/Off Control Board is designed to provide continuing service in the event of loss of line power. Upon power loss the ADC-Series actuator, equipped with the optional Battery Back-Up, can be configured to drive the actuator and PARK immediately at the designated power loss (Fail Position), or to continue to MULTI-CYCLE on battery power while a control signal and adequate battery power remain available. When MULTI-CYCLE is selected, the actuator will cycle until a low battery power condition is detected then automatically drive to and remain at the designated power loss (Fail Position). A fully charged battery will provide a minimum of ten complete 90 degree cycles.

To configure the actuator to immediately drive and park at the designated "Fail" position upon loss of line power, move the "Battery Mode On Fail" slide switch to the LEFT, PARK AT FAIL, position.

To configure the actuator to continue to cycle while adequate battery power is available upon loss of line power, move the "Battery Mode On Fail" slide switch to the RIGHT, Multi-Cycle position.

4.2 Power Loss – FAIL Position Selection

The ADC-Series On/Off Control Board is designed to be easily configured to drive to either the CW, CCW or MID position upon loss of line power (applicable with optional Battery Back-Up). This is the power loss or "Fail" position. In the "Fail Position" field, the power loss position is set with a miniature blade screw driver by moving the selector dial to the desired position. When designating MID as the power loss or "Fail" position, the limit type must be set at SMART and the MID position must have been entered and saved in the "**Smart Set**" field.

To confirm the power loss or "Fail" position, select RUN in the "**Smart Set**" field and select PARK AT FAIL in the "Battery Mode On Fail" field. De-energize terminal 1 and terminal 2 on the **P/N VC002360** Power Board. The actuator will drive to the designated power loss or "Fail" position.

4.3 Sleep and Wake Function – Manually Drive the Actuator During Power Outage

(PARK AT FAIL MODE, ONLY) After the battery drives the actuator to the Power Loss Position, the **P/N VC002970** board powers down and remains in **"Sleep"** mode until external power returns to terminals 1 & 2 on the **P/N VC002360** Power Board. To **"Wake"** the actuator, enabling the **CW** or **CCW** push buttons, push the button located below the battery connector (J4) on the upper left, back side of the **P/N VC002970** board. This will "Wake" the electronics and the actuator can be manually operated via the **CW** or **CCW** push buttons until low battery power level is detected. (**Note**: After using the **WAKE** Power Override function the actuator will not revert back to **SLEEP** mode. Disconnect the battery to preserve battery power if line power has not been restored.)

5 BATTERY PACK INFORMATION

The optional Battery Pack is capable of supplying sufficient power to ensure operation of the actuator during power outages. The battery voltage of a fully charged battery should read 13.6 volts as measured at the battery connector, (with the battery disconnected). This voltage will vary with temperature; see "Battery Charging Circuit" below.

Replacement battery packs should be stored only after a full charge and at less than 80°F. Temperature can affect battery shelf life. Generally lower temperatures will increase shelf life while higher temperatures will decrease shelf life.

When recharging battery packs, they should only be recharged from the **P/N VC002970** ADC-Series On/Off Control Board charging circuit, which is calibrated to provide the proper voltage and current for maximum battery pack life.

5.1 Battery Charging Circuit

The battery charging voltage has been designed for optimum battery performance. When charging, the yellow **CHARGING** LED will light. After reaching full charge, the green **CHARGED** LED will light.

The voltage on the battery terminals, connector "J4", will be between 10.5 and 12 volts, when external power is off, and the battery is connected to the 2970 On/Off Control Board. Fully charged, the battery voltage will reach approximately 13.6 volts. This voltage is designed to vary with temperature, and could be as high as 14.4 volts if in a very cold environment, or as low as 12.8 volts if in a very warm environment. This is normal operation.

A battery case that is swollen or cracked must be replaced. Please consult the factory for replacement. If the battery does not reach full charge (the green **CHARGED** LED remaining on and the yellow **CHARGING** LED turning off) within 48 hours, consult the factory or your local representative.

5.2 Battery Replacement

The only suggested maintenance is to examine, and if necessary, replace the batteries every two years. Battery life can vary with temperature. Cooler environments will generally prolong battery life and under ideal conditions ADC batteries will last in excess of five years.

To change the batteries, perform the following:

SMALL ENCLOSURE (150-600 in-lbs)

4. Remove power to the actuator.
5. Disconnect battery connection at the daughter board.
6. Pry back the battery retaining tab on the battery bracket.
7. Remove the battery.
8. Install new battery.
9. Slide battery into bracket so that the retaining tab secures the battery in place.
10. Plug battery connector into the connector on the back of the **P/N VC002970** board, and re-apply power.

LARGE ENCLOSURE (1000-3000 in-lbs)

1. Remove power to the actuator.
2. Unplug the battery wire from the daughter board.
3. Remove battery hold-down bracket.
4. Unplug the wires from the battery tabs.
5. Remove and replace the battery. Re-install the wires on the battery tabs, Black wire to Black terminal and Red wire to Red terminal.
6. Re-install the hold-down bracket.
7. Plug the battery connector into the daughter board, and re-apply power.

6 OUTPUT/POSITION FEEDBACK SIGNAL

Terminal E and terminal F on the **P/N VC002970** On/Off Control Board provide an analog position feedback signal. To enable the output feedback signal the Feedback Potentiometer must be installed, connected to the **P/N VC002970** board and properly calibrated. **See Section 3 for Set Up and Calibration instructions.**

To select a 4-20 mA output signal, move the slide switch to the **UP** position in the Output Signal field. To select a 2-10 VDC output signal, move the slide switch to the **DOWN** position in the Output Signal field.

7 ADC-SERIES STANDARD OPTIONS

All ADC-Series options are designed to be easily installed in the field. Options for all standard ADC-Series actuators are universal and completely interchangeable with each enclosure size. Voltage is not field changeable.

7.1 Option "H" – Tropical Heater and Thermostat P/N VC099035, P/N VC099036, P/N VC099037, P/N VC099038

The tropical heater and thermostat option is a self-adhesive, resistant heater strip which is applied to primary gear-box. It installs with a plug-in connector and is recommended in high-humidity applications. The tropical heater option is also recommended installations that experience wide temperature swings in order to evaporate any condensation. Thermostat is pre-set to active at or below 90°F and deactivate at or above 110°F. The tropical heater draws 15 watts @ 115 VAC, 12 VDC and 24V; 40 watts at 230 VAC. This option can be installed in the field; for 115 VAC applications, order kit **P/N VC099035**; for 230 VAC applications, order kit **P/N VC099036**; for 12 VDC applications, order kit **P/N VC099037** and for 24 V applications, order kit **P/N VC099038 (see Figure 7)**.

Option "H" Tropical Heater and Thermostat
Option "T" Standard Heater and Thermostat

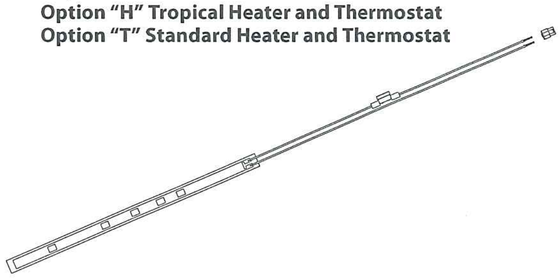


Figure 7

7.2 Option "I" – ISO 5211 Output

150 – 600 in-lbs models are supplied with a 3/4" female square output coupling; when the "I" option is selected they are supplied with a 14mm female square.

1000 – 3000 in-lbs models are supplied with a 1" female square output coupling; when the "I" option is selected, 1000 in-lbs models are supplied with a 19mm female square and 1500 – 3000 in-lbs models are supplied with a 22mm female square.

This option is factory installed only.

7.3 Option "S2" – Two Auxiliary Limit Switches P/N VC099900

The extra switches and stainless steel cams provide dry contacts and are fully adjustable to trip at any position. They are often used for position indication or to interlock other devices (such as in sequencing operations). The switches are single pole, double throw switches rated for 1/2 HP, 15 amps @250 VAC, CSA certified. Auxiliary switch kit **P/N VC099900** is universal to all standard ADC-Series actuators **(see Figure 8)**.

Option "S2" – Two Auxiliary Limit Switches

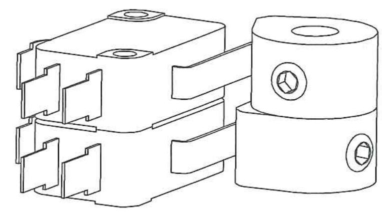


Figure 8

7.4 Option "T" – Heater and Thermostat P/N VC099015, P/N VC099016, P/N VC099017, P/N VC099018

The heater and thermostat option is a self-adhesive, resistance heater strip which is applied to the primary gearbox. It installs with a plug-in connector and is required in installations where the ambient temperatures drop below 32˚F. The heater option is also recommended in installations that experience wide temperature swings in order to evaporate any condensation. The thermostat is pre-set to activate at or below 40˚F and deactivate at or above 60˚F. The heater draws 15 watt @115 VAC, 12 VDC and 24 V; 40 watts @ 230 VAC. This option can be installed in the field; for 115 VAC order kit **P/N VC099015**; for 230 VAC applications, order kit **P/N VC099016**; for 12 VDC applications, order kit **P/N VC099017** and 24 V applications, order kit **P/N VC099018 (see Figure 7)**.

7.5 Option "Y" - Keyed Output

150 – 600 in-lb actuators are supplied with a 3/4" female square output coupling; when the "Y" option is selected they are supplied with a 15mm female keyed output.

1000 – 3000 in-lb models are supplied with a 1" female square output coupling; when the "Y" option is selected they are supplied with a 20mm female keyed output.

This option is factory installed only.

7.6 Option "Z" – Handwheel Override P/N VC009097, P/N VC009098

Standard ADC-Series actuators are supplied with a plugged cover. Note that this not recommended for ADC-Series actuators equipped the optional internal battery back-up. If the handwheel override option is selected at the time of order a declutchable shaft and six-inch handwheel are provided for manual positioning. This option can be replaced in the field; for 150 – 600 in-lbs models, order kit **P/N VC009097** and for 1000 – 3000 in-lbs models, order kit **P/N VC009098**.

7.7 CSA Certification

CSA Certification is standard on all standard ADC-Series actuators for applications in either Hazardous (WX) or non-Hazardous (W) locations. CSA certified actuators are identified by the CSA logo on the product label.

7.8 Voltage

115 VAC, 230 VAC, 24 VAC, 12 VDC and 24 VDC. ADC-Series actuators are rated for full torque at +/- 10% of the nominal voltage at 50Hz or 60 Hz. ADC-Series positioning actuators are rated continuous duty. (**Note**: At 50Hz the cycle time will increase by approximately 20%.)

8 GENERAL OPERATING INFORMATION

For enclosure specifications and dimensions, **see Table 2 and Figure 10**.

8.1 NEMA Ratings and CSA Certification

Metso manufactures two styles of Valvcon enclosures: the "W" enclosure is weathertight and designed to NEMA 4/4X standards the "WX" enclosure is "explosionproof" and designed to NEMA 4/4X/7&9 (Class 1, Division 1, Groups C and D, and Class 2, Division 1, Groups E, F and G) standards.

Actuators are certified by CSA to meet Canadian and U.S. standards for applications in both Hazardous and Non-Hazardous locations. The "WX" option must specified at the time of ordering and can only be installed at the factory. Ensure that the actuator's ratings are appropriate for the application environment prior to installation. Use extreme care when removing the cover. Scratches or nicks on the flanges may cause the enclosure not to meet NEMA specifications.

8.2 Duty Cycle and Motor Protection

ADC-Series on/off actuators are equipped with a brushless DC motor and can operate continuously; they are rated for 100% duty cycle operation up to 104°F and for a maximum of 30 starts per minute. Higher temperature applications decrease the available duty cycle.

8.3 Operating Temperature Limits

ADC-Series actuators are designed to operate in ambient environments between 32˚F, (0˚C) and 130˚F, (55˚C). If the ambient temperature may drop below 32˚F, (0˚C), the heater and thermostat option must be installed. The actuator is rated to operate at -40˚F, (-40˚C) with the heater and thermostat option installed. In outdoor applications where ambient temperatures exceed 80˚F, (27˚C), actuators should be shielded from direct sunlight. In applications with high media temperatures, insulating blankets, heat shields and/or extended mounting shafts should be used to keep temperatures within normal operating limits.

Heaters and thermostats are required for all outdoor applications and may also be used to dry condensation in high humidity environments.

8.4 Actuator Mounting

The actuator may be mounted in any position including upside-down. It must be firmly secured to a direct mount flange or sturdy mounting bracket. A minimum of four bolts with lock washers should be used to secure the actuator to the bracket. Flexibility in the bracket is not allowed, and backlash, or "play", in the coupling should be minimized. The actuator output shaft must be in line (centered) with the valve shaft to avoid side-loading the shaft.

For output drive dimensions and mounting hardware specifications, **see Figure 10**.

8.5 Lubrication

All rotating power train components are permanently lubricated with multi-purpose Lithium grease suitable for the operating temperature range of the actuator. Additional lubrication is not required in normal operation.

8.6 Problem Prevention

Most actuator problems result from improper installation.

- **Incorrect Wiring and Set Up** Make certain the actuator is wired correctly and travel stops are properly set before power is applied.
- **Coupling, Alignment, and Mounting** Do not add extra torque! Make certain that the mounting arrangement is sturdy, centered, properly aligned, and that all mounting hardware is secure and properly tightened.
- **Moisture** Replace the cover tightly and make certain conduit entry holes are sealed properly to prevent moisture infiltration.

8.7 Warranty

All ADC-Series actuators are backed by a 2 year warranty that covers materials and workmanship.

8.8 Technical Assistance, Replacement Parts, Options and Repairs

All replacement parts, plug-in options, accessories, and repair services for ADC-Series actuators are available through a network of qualified Metso Stocking Representatives. For further technical information or to locate the Metso Stocking Representative closest to you, contact **www.metso.com/automation/valvcon**.

9 SPECIFICATIONS & TECHNICAL INFORMATION

TABLE 1 - TORQUE & VA RATINGS

Torque (in-lbs)	Duty Cycle	12 VDC		24 VDC		24 VAC		115 VAC		230 VAC	
		Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)
150	100%	11	2.2	13	1.2	8	1.8	9	0.4	9	0.4
300	100%	17	2.5	13	1.4	12	2.1	13	0.5	13	0.4
600	100%	17	2.8	13	1.7	13	2.5	14	0.6	14	0.5
1000	100%	21	4	14	2.4	15	3.5	15	0.9	15	0.6
1500	100%	40	4	24	2.4	27	3.5	29	0.9	29	0.6
2000	100%	40	4.3	33	2.4	28	3.5	29	0.9	29	0.6
2500	100%	55	3.3	40	2	38	3.1	39	0.8	39	0.6
3000	100%	60	3.7	42	2.2	40	3.5	42	0.8	43	0.6

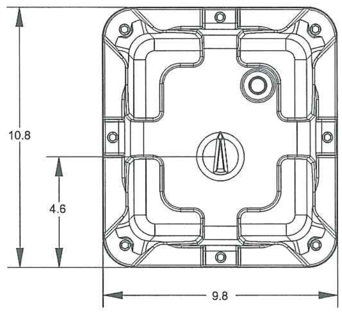
TABLE 2 - SPECIFICATIONS

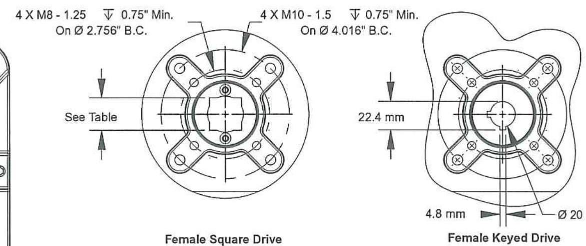
Temperature Range	32°F to 130°F (0°C to 55°C) (without heater and thermostat) -40°F to 130°F (-40°C to 55°C) (with heater and thermostat)
Conduit Connections	(2) 3/4" NPT in sizes up to 600 in-lbs (3/4" to 1/2" reducing bushings included) (2) 3/4" NPT in sizes 1000 in-lbs and above (3/4" to 1/2" reducing bushings included)
Output	150 to 600 in-lbs: ISO 5211 F05 and F07 bolt circles, 3/4" female square (14mm female square w/ "I" Option; 15mm female keyed output w/ "Y" Option). 1000 to 3000 in-lbs: ISO 5211 F07 and F10 bolt circles, 1" female square (1000 in-lbs: 19mm female square w/ "I" Option; 1500 - 3000 in-lbs: 22mm female square w/ "I" Option; 1000 to 3000 in-lbs: 20mm female keyed output w/ "Y" Option)
Voltage	12VDC: 10.8 to 13.2VAC 24VDC: 21.6 to 26.4VDC 24VAC: 21.6 to 26.4VAC, 50 or 60 Hz 115VAC: 103.5 to 126.5VAC, 50 or 60 Hz 230VAC: 207 to 253VAC, 50 or 60 Hz
Limit Switches	(2) Single pole, double throw switches rated for 1/2 HP, 11 amps @ 250VAC, CSA certified, fuse protected
Motor	Brushed DC motor with Class B or better insulation; sub-fractional horsepower
Lubrication	Permanently lubricated gear train and bearings
Gear Train	Hardened steel spur gears
Approximate Weight	17 lbs for sizes up to 600 in-lbs 31 lbs for sizes 1000 in-lbs and above
Enclosure	Die cast aluminum

9.1 Dimensions

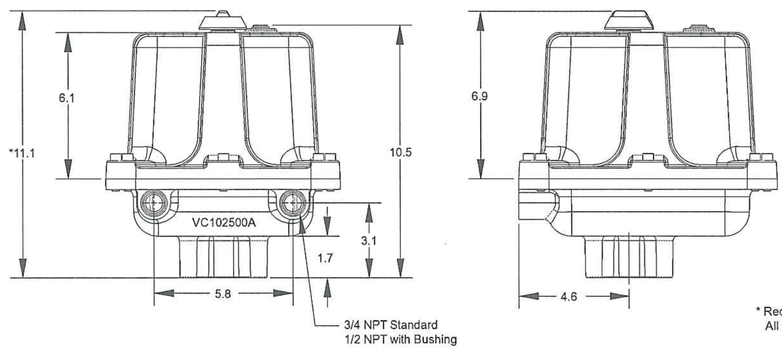
LADC-SERIES ENCLOSURE

Mounting Flange, ISO 5211
F07/F10





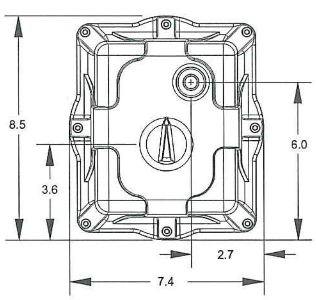
Actuator Size	Drive Option	Drive Type	Drive Size	Depth
1000-3000 lb-in	Standard	Square	1.000 (25mm)	1.20 (30.5mm)
1000 lb-in	Option "I"	Square	0.748 (19mm)	1.20 (30.5mm)
1500-3000 lb-in	Option "I"	Square	0.866 (22mm)	1.20 (30.5mm)
1000-3000 lb-in	Option "Y"	Keyed	0.787 (20mm)	1.50 (38.1mm)

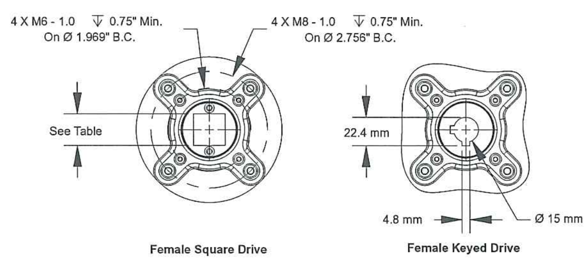


* Requires an additional 5.75" to remove cover
All dimensions in inches unless otherwise stated

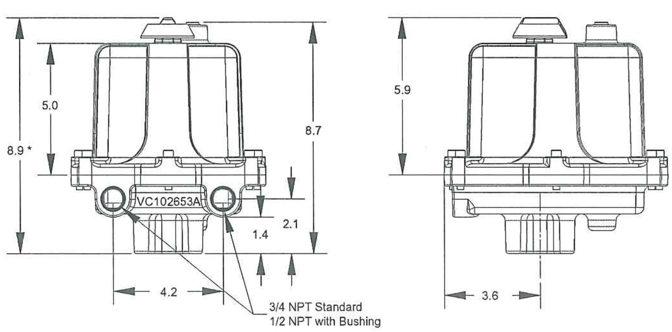
ADC-SERIES ENCLOSURE

Mounting Flange, ISO 5211
F05/F07





Actuator Size	Drive Option	Drive Type	Drive Size	Depth
150-600 lb-in	Standard	Square	0.750 (19mm)	0.90 (22.9mm)
150-600 lb-in	Option "I"	Square	0.551 (14mm)	0.90 (22.9mm)
150-600 lb-in	Option "Y"	Keyed	0.591 (15mm)	1.40 (35.6mm)



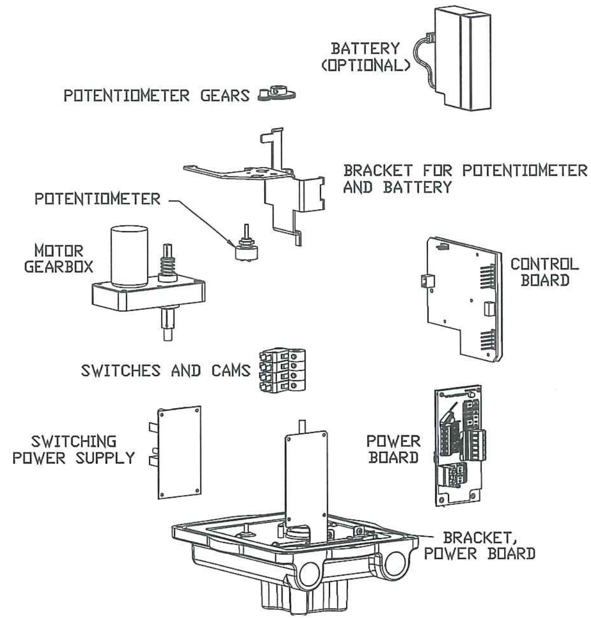
Approximate Weight	17 lb

* Requires an additional 4.75" to remove cover
All dimensions in inches unless otherwise stated

Figure 10

9.2 Exploded View

ADC-Series Spare Parts



PART	DESCRIPTION
	Cover with Position Indicator (not shown)
VC009304	ADC - Small enclosure (150–600 in-lbs)
VC009307	LADC - Large enclosure (1000–3000 in-lbs)
	Cover Screw (8 required)
VC091340	ADC - Small NEMA 4/4X enclosure (150–600 in-lbs)
VC091336	ADC - Small NEMA 4/4X/7/9 enclosure (150–600 in-lbs)
VC091564	LADC - Large enclosure (1000–3000 in-lbs)
	Motor Gearbox
VC006229	ADC (150–600 in-lbs)
VC006144	LADC (1000–2000 in-lbs)
VC006230	LADC (2500–3000 in-lbs)
	Potentiometer and Switches
VC092067	Potentiometer with Gears (90° Operation)
VC099900	Two Auxiliary Switch Kit w/Cams
VC001020	Limit Switch - Replacement
	Brackets with Hardware
VC092665	Bracket, Power Board ADC (150–600 in-lbs)
VC092670	Bracket, Power Board LADC (1000–3000 in-lbs)
VC092450	Bracket, Batter & Potentiometer ADC
VC092445	Bracket, Potentiometer LADC
VC091760	Bracket, Battery LADC
	Power Board Kit Includes Switching Power Supply or Isolator Board (decided by voltage)
VC092361	ADC 115/230VAC
VC092362	LADC 115/230VAC
VC092363	ADC/LADC 12/24VDC
VC092364	ADC/LADC 24VDC
	Tropical Heater and Thermostat Kits
VC099035	Tropical Heater Thermostat 115VAC
VC099036	Tropical Heater Thermostat 230VAC
VC099037	Tropical Heater Thermostat 12VDC
VC099038	Tropical Heater Thermostat 24VAC or 24VDC

	Heater and Thermostat Kits
VC099015	Heater Thermostat 115VAC
VC099016	Heater Thermostat 230VAC
VC099017	Heater Thermostat 12VDC
VC099018	Heater Thermostat 24VAC or 24VDC
	Control Board Kits
VC099050	ADC On/Off Control Board Kit with Battery Back-Up
VC099055	LADC On/Off Control Board Kit with Battery Back-Up
VC099080	ADC On/Off Control Board Kit (without Battery Back-Up)
VC099085	LADC On/Off Control Board Kit (without Battery Back-Up)
	Replacement Battery
VC001573	ADC Battery
VC002509	LADC Battery

NOTES:

Brake – Holding Brake Is Standard On all ADC/LADC-Series Actuators.

Manual Override Is Not A Standard Feature On ADC/LADC-Series Actuators.

Figure 11

10 ENCLOSURE

Table 3

How To Order - ADC-Series Electric Actuators

Series	Enclosure Type		Torque		Board Options[1]		Other Options		Operating Voltage	
	Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
ADC	W	Weathertight	150	150 in•lb	C	Modulating	H[2]	Tropical Heater/Thermostat	N115AC	115 VAC
		NEMA 4/4X	300	300 in•lb	CL2	Modulating Battery Back-Up	I[3a]	ISO 5211 Output	N230AC	230 VAC
			600	600 in•lb	L2	On/off Battery Back-Up	S2	Two Auxiliary Limit Switches	N24AC	24 VAC
	WX	Weathertight & Explosionproof			L4	On/off Battery Back-Up – 3 Position	T[4]	Heater/Thermostat	N12DC	12 VDC
		NEMA 4/4X/7&9			R2	On/Off Isolated Control	Y[5a]	Keyed Output	N24DC	24 VDC
					R3	On/Off Board – 3 Position	Z[6]	Handwheel		
LADC	W	Weathertight	1000	1000 in•lb	C	Modulating	H[2]	Tropical Heater/Thermostat	N115AC	115 VAC
		NEMA 4/4X	1500	1500 in•lb	CL3	Modulating Battery Back-Up	I[3b]	ISO 5211 Output	N230AC	230 VAC
			2000	2000 in•lb	L3	On/off Battery Back-Up	S2	Two Auxiliary Limit Switches	N24AC	24 VAC
	WX	Weathertight & Explosionproof	2500	2500 in•lb	L5	On/off Battery Back-Up – 3 Position	T[4]	Heater/Thermostat	N12DC	12 VDC
		NEMA 4/4X/7&9	3000	3000 in•lb	R2	On/Off Isolated Control	Y[5b]	Keyed Output	N24DC	24 VDC
					R3	On/Off Board – 3 Position	Z[6]	Handwheel		

Notes: 1. Select only one board option; all of these board options include a holding Brake feature
2. This heater option activates at or below 90°F and deactivates at 110°F; it is recommended in high-humidity applications.
3a. 150 - 600 lb-in models with I option are supplied with a 14mm female square (note that without option I the female square is 3/4")
3b. 1000 lb-in models with I option are supplied with a 19mm female square and 1500 - 3000 lb-in models are supplied with a 22mm female square (note that without option I the female square is 1")
4. This heater option activates at or below 40°F and deactivates at 60°F; it is recommended in applications where the temperature may drop below 32°F.
5a. 150 - 600 lb-in models with Y option are supplied with a 15mm female keyed output.
5b. 1000 - 3000 lb-in models with Y option are supplied with a 20mm female keyed output.
6. Handwheel option not recommended with Back-Up Powered options.

- **Enclosure "W"** (weather-tight) is certified by CSA to meet specifications for NEMA 4/4X for weather-tight and dust-tight, environments. It is intended for non-hazardous locations in indoor or outdoor use and provides a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation. It is not designed to be submersible.
- **Enclosure "WX"** (explosion-proof & weather-tight) is certified by CSA to meet specifications for NEMA 7&9, explosion-proof environments as well as to meet NEMA 4/4X specifications. Explosion-proof means that an internal explosion will be contained, with no sparking that could ignite external atmospheric gases. The enclosure is rated for the following environments:
  - NEMA Class I, Division 1, Group C (Ethyl-ether vapors, ethylene or cyclopropane)
  - NEMA Class I, Division 1, Group D (Gasoline, hexane, naptha, benzene, butane, propane, alcohol, acetone, benzol, lacquer, solvent, vapors or natural gas)
  - NEMA Class II, Division 1, Group E (Metal dust, including aluminum, magnesium, their commercial alloys, and other metals of similarly hazardous characteristics)
  - NEMA Class II, Division 1, Group F (Carbon black, coal or coke dust)
  - NEMA Class II, Division 1, Group G (Flour, starch or grain dust)
  - NEMA Class III

Sample Model Code: ADCW150CL2IS2N24AC

Actuator Series	ADC
Enclosure Type	W
Torque	150
Board Option	CL2
Other Options	I
(if applicable)	S2
Operating Voltage	N24AC

For enclosure specifications and dimensions, **see Table 2 and Figure 10.**

- Torque = Breakaway Torque ADC-Series actuators are rated at breakaway torque; the amount of torque the actuator will provide from a fully loaded stop upon immediate power-up. With running momentum and inertia, the amount of torque supplied by the actuator at full speed (running torque) or upon entering a stall condition (stall torque) always exceeds the minimum rated breakaway torque. Since valves require most torque at breakaway, only breakaway torque should be considered when sizing actuators.

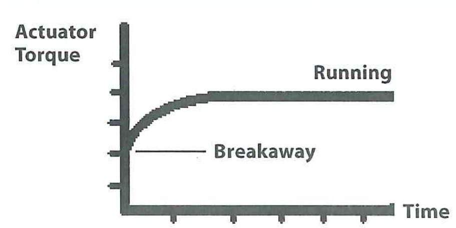


Figure 9

11 ADDITIONAL ACTUATOR PRODUCTS AND ACCESSORIES FROM METSO

V-Series

- Up to 3000 inch pounds for On/Off, Modulating or Automatic Cycling applications
- 75% Duty Cycle
- 115VAC and 230VAC voltages
- NEMA 4/4X and NEMA 4/4X/7&9 enclosures
- CSA Certified (Canadian & U.S. Standards)
- Options include Modulating Control Board, Speed Control/TimerBoard, Iso/Readback Board, extra limit switches, heater/thermostats, motor brake, feedback potentiometer and handwheel override

ESR-Series

- Up to 600 inch pounds for True "Two-Wire" On/Off applications
- 80% Duty Cycle
- 115VAC and 230VAC voltages
- Options include extra limit switches and heater/ thermostats

QX-Series

- Up to 3000 inch pounds for On/Off applications
- Economical NEMA 4/4X/7&9 solution
- 12VDC & 24VDC voltages
- 80% Duty Cycle
- CSA (C US) Certification

LC Series

- Up to 600 inch pounds
- Economical actuators for Reversing or Unidirectional applications
- 25% duty cycle
- NEMA 4/4X enclosures
- 115VAC, 230VAC, 24VAC, 12 VDC and 24VDC voltages
- Options include extra limit switches and heater/thermostats
- Male output (standard) or female output (optional)

I-Series Network Capable

- Modbus®
- AS-Interface
- DeviceNet™
- Foundation Fieldbus
- Other fieldbus protocols (consult factory)

Q6-Series for Remote Solar Applications

- 600 inch pounds
- 12VDC
- Low current draw

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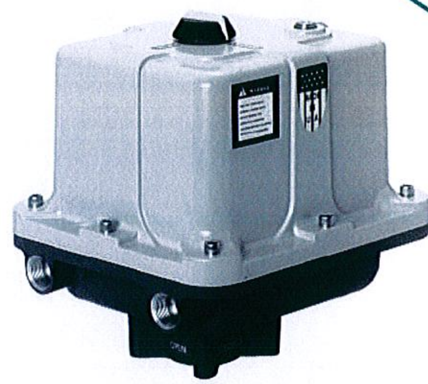
VALVCON BACK-UP POWERED ELECTRIC ACTUATOR ADC SERIES

Metso is a leading designer and provider of Valvcon compact, reliable, electronically controlled electric actuators for valves and dampers. We offer a complete line of electric actuators for accurate positioning of dampers and valves in the aerospace, automotive, consumer services, discrete manufacturing, energy, environmental, oil/pipeline, petrochemical, power/utilities, process, recreation, transportation, and water/wastewater industries.

We have developed and introduced the industry's most innovative Metso Valvcon electric actuator products, including simple "set and go" calibration, intelligent processor-based digital electronics, "Plug-in" accessory boards, Back-Up Power actuators, as well as electric actuators designed for remote control, solar-powered applications and two-wire network applications.

The quarter-turn electric actuator will comply with Part 15, Class A of the FCC regulations for emissions and conducted radiation for industrial devices. It will also be designed to meet NEMA standards for use in weathertight or weathertight and hazardous locations. The actuator will be a single, complete unit composed of a compact cast aluminum housing, motor, gearing, limit switches controlled by metal cams for end of travel control, mechanical position indicator, and an optional internal back-up power source to drive to a pre-set position in the event of an external power loss. Actuator mounting flanges shall comply with ISO 5211 standards incorporating a female drive for direct output coupling. The actuator shall be capable of operating in ambient environments of -40° F to 130° F; optional internal heaters are required at temperatures below 32° F.



FEATURES AND BENEFITS

Isolation and Electrical

Internal electronic control boards shall have clearly marked and different size connection terminals for Power and Control Signals to prevent incorrect wiring and shall provide CW and CCW push buttons for local manual control. The actuator control electronics shall be electrically isolated to allow multiple actuators to be wired in parallel. Electronic control boards shall be protected on the outward side with insulating overlays providing operating instructions and additional safety. Additionally, electronic control boards shall include a simple user-interface, including slide switches and selection knob for mode selection, calibration and set up. The electronic control boards will also supply a mA or voltage position feedback signal and include a holding brake feature to prevent back-driving. All internal connections, (motor leads, limit switch leads, option connectors, etc.) shall be coded, using different style connectors for each function, to prevent incorrect wiring. All connections will plug-in to simplify field repairs and upgrades. In AC applications a highly reliable switching power supply will provide power conversion to drive the internal DC motor; DC applications will utilize an equally reliable DC to DC regulator. Other than periodic battery replacement; no maintenance will be required.

Motor

The internal electric motor will be of a brushless DC type, capable of running continuously at full torque at ambient temperature at or below 104° F.

metso
Expect results

Lubrication

All rotating power train components will be coated with a multi-purpose grease. Lubricants will be suitable for ambient conditions of -40° F to 130° F. For operation in temperatures between 32° F and -40° F an optional heater and thermostat assembly must be included.

Gearing

The powertrain will be comprised of hardened steel, machine cut spur gears. Non-metallic, aluminum, cast or stamped gearing will not be permitted.

Limit Switches

Actuators will have two standard end-of-travel switches, single pole double throw, rated at 15 amps at 250 VAC. Under normal operation the end of travel limit switches will not be activated; activating the limit switches will interrupt actuator travel. Up to two additional limit switches, adjustable to operate at any position as required by the process application, may be added to the actuator for end of travel indication.

On/Off Control (Open/Close Operation) with Optional Battery Back-Up

Open/Close actuators require separate Power and Control signals. The Power signal must be constantly maintained; immediately upon loss of the Power signal, the internal back-up power source will drive the actuator to the Power Loss Position. The Control signal consists of one to three maintained AC or DC contacts and the actuator can be set to operate in Two-wire, Three-wire or Three-position modes. In Two-wire mode a signal is maintained to drive the actuator to the CCW position and removed to drive to the CW position. In Three-wire mode separate Control signals are applied to drive the actuator to the CW and CCW positions and may be removed at any point in mid-stroke to position the valve or damper. In Three-position mode separate Control signals are applied to drive the actuator to the CW, "MID" or CCW positions and may be removed at any point in mid-stroke to position the valve or damper. The Power Loss Position may be either the full CW, the full CCW or "MID" position and is determined by the fail position selection switch.

Proportional Control (Modulating Operation) with Optional Battery Back-Up

Modulating control actuators will accept a variable, proportional 4-20 mA or 0-10VDC valve position signal and respond by positioning the valve linearly with an accuracy of 1%. Normally, the actuator will drive clockwise in response to a decreasing control signal; however, the actuator will be capable of "reverse acting" operation (driving counter-clockwise in response to a decreasing control signal) without internal wiring changes. The actuator will also provide the ability to adjust the sensitivity to control signal changes. Slide switches will enable the user to set the actuator response to a loss of control signal, select the "fail" position upon loss of Power and select either the single cycle or multi-cycle loss of power mode. Locked rotor, stall protection will detect whenever the actuator is unable to achieve the position commanded by the control signal, and will terminate power to the motor in order to prevent damage due to repeated stall conditions.

The Back-Up Powered Electric Actuators from Metso

Metso offers several product lines that are designed to drive a valve or damper to a pre-determined position in the event of a power loss. Under normal power conditions, they provide accurate positioning in response to the powered control signals.

Optional Internal Battery Back-Up

Metso Valvcon ADC Series can be equipped with an optional internal battery pack. The actuator is driven by an external power source under normal conditions. When power is lost, the internal battery pack can be set up to either drive immediately to the pre-set position, or continue to respond to a maintained control signal. The ADC Series is an excellent choice for continuous duty modulating applications, or any application where an inexpensive alternative to mechanical spring back-up is desired.

Break-away Torque

Designed for efficiency and reliability, all Metso Valvcon actuators deliver the power you need when and where it is needed. With efficient gear trains and motors these actuators are rated at breakaway torque. Immediately upon power up, the actuator supplies the rated torque — when it is needed to break the valve away from its seat. Other manufacturer's actuators may be rated at running torque, but actually deliver significantly less breakaway torque.

FEATURES AT A GLANCE!

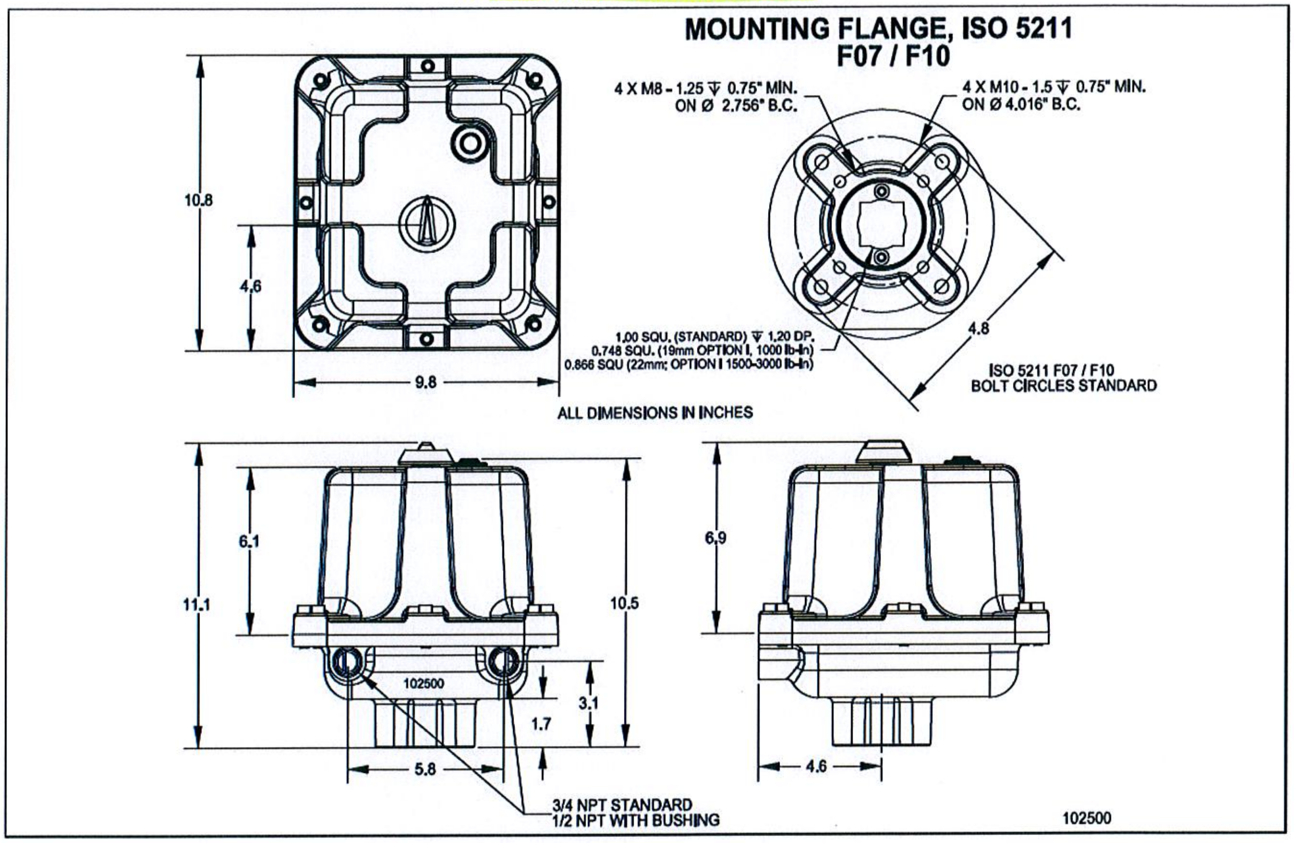
ADC Series

- ☐ Optional internal battery packs allow for continued modulation during power outages, provided the control signal remains.
- ☐ Field-settable for "fail clockwise" or "fail counter-clockwise."

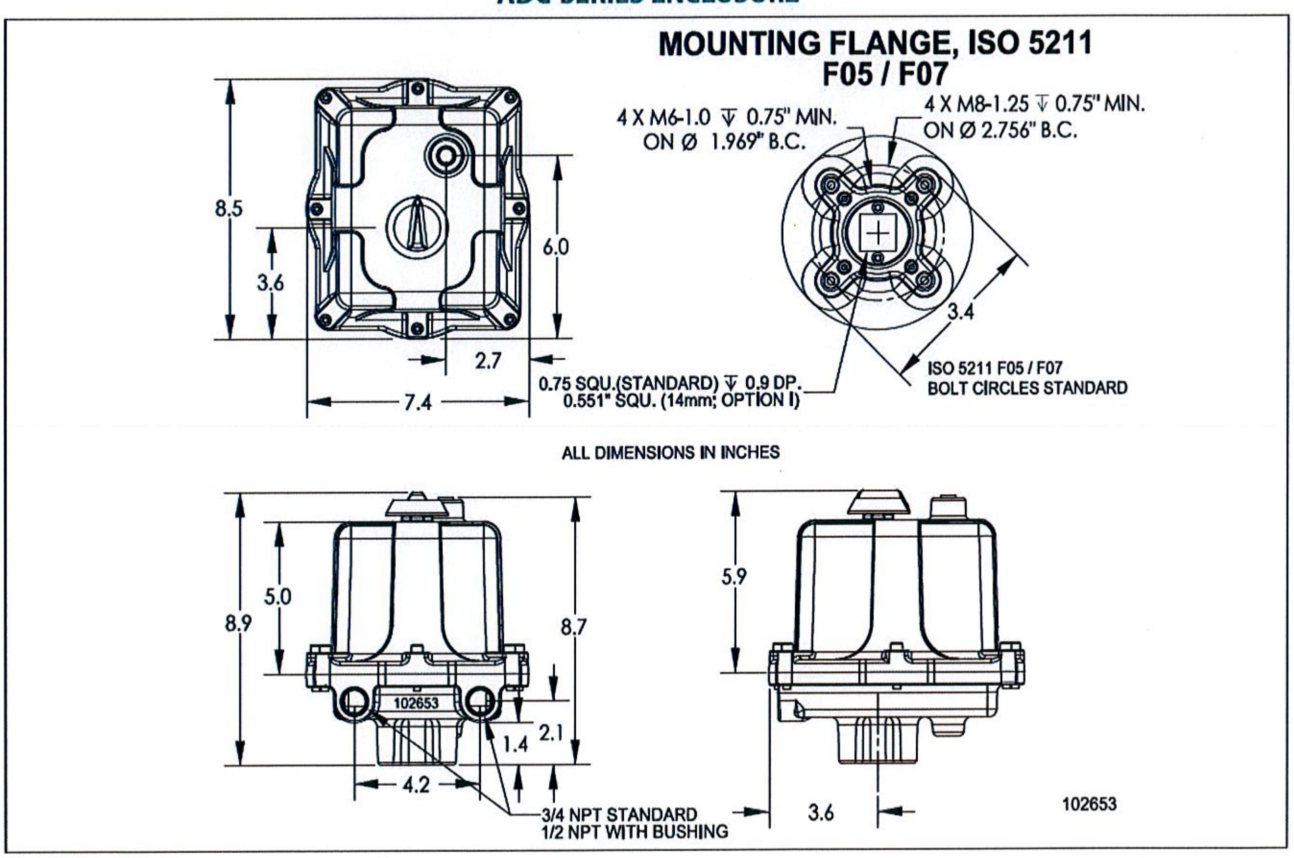
Valvcon Back-up Powered Actuators:

- ☐ Patented technology provides back-up capabilities within the standard size actuator enclosures!
- ☐ Dual conduit openings make wiring easier, and keep power and control wiring separate.
- ☐ Two year warranty.

LADC-SERIES ENCLOSURE



ADC-SERIES ENCLOSURE



ALL DIMENSIONS IN INCHES

ADC SPECIFICATIONS

Battery Back-up Power

Metso Valvcon ADC Series electric actuators, equipped with internal battery power, allow you to shut down your system in the event of an external power loss. Engineered to supply dependable valve actuation, they can provide up to 10 complete cycles under their own internal power.

The electronic back-up powered feature incorporates a rechargeable battery pack on a plug-in, modular PC board under the actuator cover. Upon power loss or a signal from an external sensor, the battery pack is automatically activated as the main power supply. The battery is compact and fits easily into the standard enclosures for an easy, space-saving upgrade. No hard-wiring or other complex operations are required.

Metso Valvcon battery back-up actuators are available in on/off (two position) or continuous duty modulating models.

- Internal batteries allow for continued cycling during power outages, enabling an orderly shut-down of critical processes.
- A built-in trickle charger, with over-charge protection, ensures the batteries always have enough power when called upon
- Batteries can be easily replaced in the field.

MODULATING DATA

Torque (in-lbs)	Duty Cycle	12VDC		24VDC		24VAC		115VAC		230VAC	
		Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)
150	100%	11	2.2	13	1.2	8	1.8	9	0.4	9	0.4
300	100%	17	2.5	13	1.4	12	2.1	13	0.5	13	0.4
600	100%	17	2.8	13	1.7	13	2.5	14	0.6	14	0.5
1000	100%	21	4	14	2.4	15	3.5	15	0.9	15	0.6
1500	100%	40	4	24	2.4	27	3.5	29	0.9	29	0.6
2000	100%	40	4.3	33	2.4	28	3.5	29	0.9	29	0.6
2500	100%	55	3.3	40	2	38	3.1	39	0.8	39	0.6
3000	100%	60	3.7	42	2.2	40	3.5	42	0.8	43	0.6

ON/OFF DATA

Torque (in lbs.)	Speed (per 90° rotation, in seconds)		Duty Cycle**	Normal Operating Current Draw (in Amps)				
		24VDC only		12VDC	24VDC	24VAC	115VAC	230VAC
150	5	3	Continuous**	1.9	2.4	1.5	.2	.1
300	10	5	Continuous**	1.9	2.4	1.5	.2	.1
600	15	8	Continuous**	1.9	2.4	1.5	.2	.1
1000	15	15	Continuous**	3.5	3.5	2.0	.4	.2
1500	20	20	Continuous**	3.5	3.5	2.0	.4	.2
2000	25	25	Continuous**	4.8	4.8	2.0	.4	.2
2500	30	30	Continuous**	4.8	4.8	2.0	.4	.2
3000	35	35	Continuous**	4.8	4.8	2.0	.4	.2

**Continuous for 1 hour after which duty cycle is reduced to 80%.

BACK-UP POWERED ELECTRIC ACTUATORS OPTIONS

Tropical Heater/Thermostat

(Order Code H)

Recommended in all high humidity applications where condensation may accumulate inside the actuator. For 115VAC applications the heater consumes 15 watts, for 230VAC applications the heater consumes 40 watts.

ISO 5211 Output

(Order I)

ISO 5211 Standard mounting configuration and output coupling.

150-600 in-lb models with "I" options are supplied with a 14mm female square. (note: without option "I" the female square is 3/4 inch).

1000 in-lb models with "I" options are supplied with a 19mm female square and 1500-3000 in-lb models are supplied with a 22 mm female square. (note: without option "I" the female square is 1inch).

Additional Limit Switches

(Order Code S2)

Up to two additional limit switches may be added for position indication or as dry contacts to operate other devices. Single pole, double throw switches rated for 1/2 HP, 15 amps @ 250VAC, CSA certified.

Heater/Thermostat

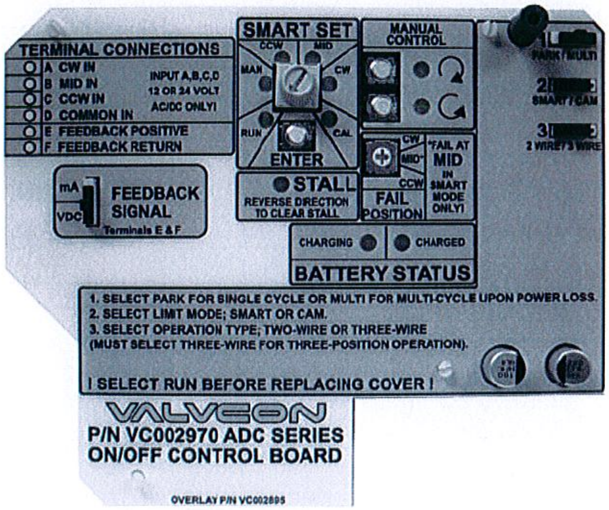
(Order Code T)

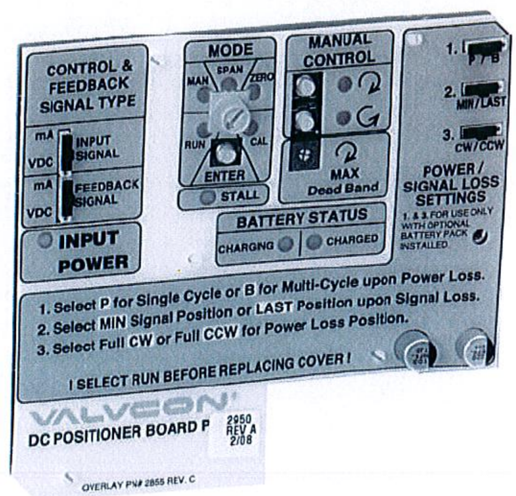
Required in all applications where the temperature may drop below 32°F. For 115VAC applications the heater consumes 15 watts, for 230VAC applications the heater consumes 40 watts.

Hazardous Location Enclosures

(ADCWX and LADCWX)

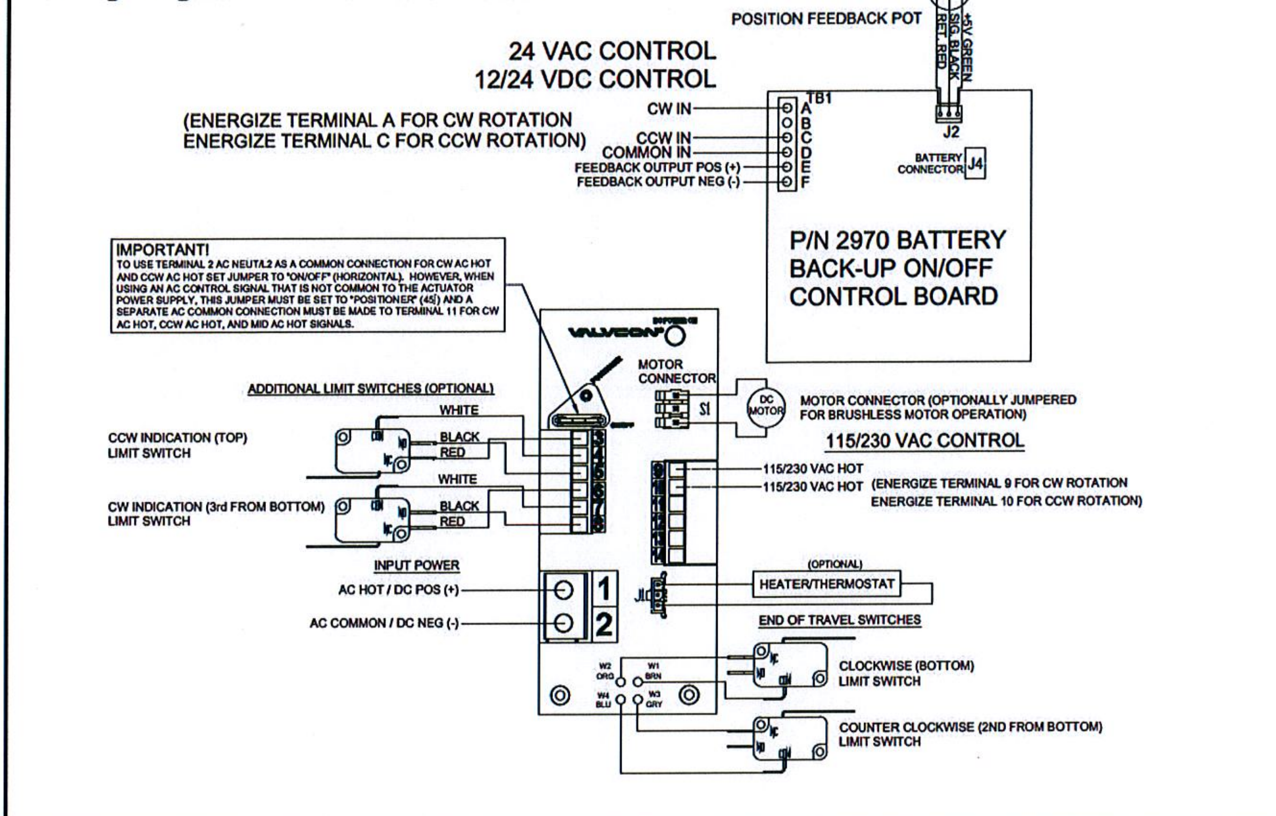
The standard enclosures (W) are rated for NEMA 4/4X (weather tight and corrosion resistant). The Hazardous Location enclosures (WX) are rated for NEMA 4/4X/7 & 9, Class I, Div 1, Groups C&D; Class II, Div. 1, Groups E, F, & G; Class III.





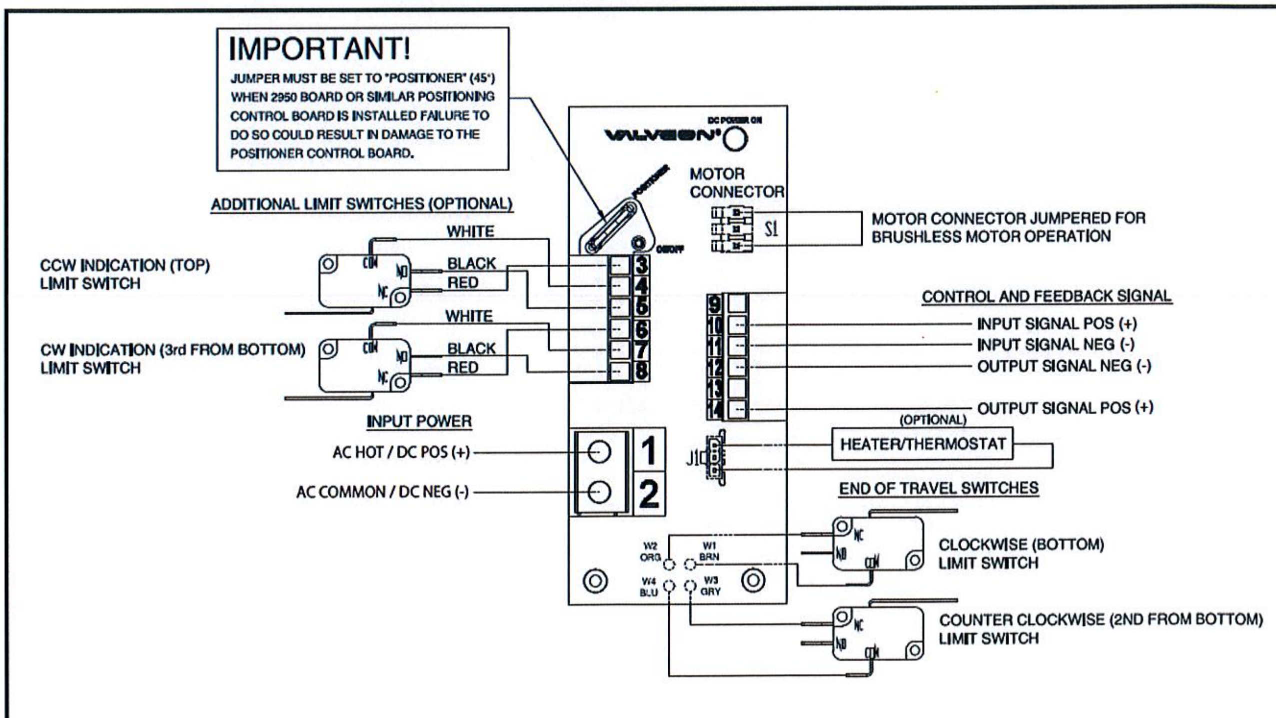
ADC/LADC ON/OFF APPLICATIONS

Wiring Diagram – "Three Wire" Control



Note: "Three Wire" control shown for other configurations see IMO.

ADC/LADC MODULATING APPLICATIONS



HOW TO ORDER – ADC SERIES ACTUATORS

Example: Sample model code: ADCW150CL2IS2N24AC

1	2	3	4	5	6
ADC	W	150	CL2	I S2	N24AC

1	Series
ADC	ADC

2	Enclosure
W	Weathertight (NEMA 4/4X)
WX	Weathertight & Explosion proof (NEMA 4/4X/7 & 9)

3	Torque (in lbs)
150	150
300	300
600	600

4	Options [1] (Must Select One)
C	Modulating
CL2	Modulating Battery Back-Up
L2	On/Off Battery Back-Up
L4	ON/Off Battery Back-Up - 3 Position
R2	ON/Off Isolated Control
R3	ON/Off Board - 3 Position

5	Other Options
—	No entry if standard
H[2]	Tropical Heater/Thermostat
I[3a]	ISO 5211 Output
S2	Two Auxiliary Limit Switches
T[4]	Heater/Thermostat
Z[5]	Handwheel

6	Operating Voltage
N115AC	115VAC
N230AC	230VAC
N24AC	24VAC
N12DC	12VDC
N24DC	24VDC

HOW TO ORDER – LADC SERIES ACTUATORS

Example: Sample model code: LADCW1500CL3IS2N24AC

1	2	3	4	5	6
LADC	W	1500	CL3	I S2	N24AC

1	Series
LADC	LADC

2	Enclosure
W	Weathertight (NEMA 4/4X)
WX	Weathertight & Explosion proof (NEMA 4/4X/7 & 9)

3	Torque (in lbs)
1000	1000
1500	1500
2000	2000
2500	2500
3000	3000

4	Options [1] (Must Select One)
C	Modulating
CL3	Modulating Battery Back-Up
L3	On/Off Battery Back-Up
L5	ON/Off Battery Back-Up - 3 Position
R2	ON/Off Isolated Control
R3	ON/Off Board - 3 Position

5	Other Options
—	No entry if standard
H[2]	Tropical Heater/Thermostat
I[3b]	ISO 5211 Output
S2	Two Auxiliary Limit Switches
T[4]	Heater/Thermostat
Z[5]	Handwheel

6	Operating Voltage
N115AC	115VAC
N230AC	230VAC
N24AC	24VAC
N12DC	12VDC
N24DC	24VDC

Notes:

1. Must select only one board option; all of these board options include 4-20mA or 0-10VDC position feedback, (2-10VDC on On/Off option boards) and a holding brake feature.
2. This heater option activates at or below 90°F and deactivates at 110°F; it is recommended in high-humidity applications.

3a. 150 - 600 lb-in models with I option are supplied with a 14mm female square (note that without option I the female square is 3/4").

3b. 1000 lb-in models with I option are supplied with a 19mm female square and 1500 - 3000 lb-in models are supplied with a 22mm female square (note that without option I the female square is 1").

4. This heater option activates at or below 40°F and deactivates at 60°F; it is recommended in applications where the temperature may drop below 32°F.
5. Handwheel option not recommended with Back-Up Powered options.

Committed to Customer Service

Metso worldwide web site:
www.metso.com/automation/valvcon, provides 24 hour a day access to all technical support material—from sales brochures to instruction manuals to installation and troubleshooting tips. For local support, Our network of trained stocking distributors/representatives are industry leading experts in valve automation. Contact the Metso, Valvcon product web site to locate the nearest stocking distributor/representative.

Timely Technical Support

Metso Express Services is on call to answer your engineering or application questions, and to quickly repair or upgrade your actuators. These highly trained support engineers offer a broad range of expertise, with the combined experience to assist specifying engineers and contractors with information on feasibility and special applications. Find Metso Express at **www.metso.com/automation/valvcon**.

A Tradition of Quality

Metso is dedicated to producing superior-quality products that are second to none. Our development laboratory and manufacturing facilities exemplify our total commitment to producing quality products.

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metso

Multi-Turn Bevel Gear (BG Type)
Installation & Operation Instructions

Installation Tips:
All DYNATORQUE™ operators & accessories have been designed to transmit the rated output torque of the operator with a safety factor. When designing mounting kits, torque transmission devices, or specifying mounting hardware the operator rating should be considered. DYNATORQUE recommends using grade 5 and higher bolts with lock washers for mounting operators to valve operator flanges and valve adaptation kits. DYNATORQUE components should not be installed in areas where those components will be subjected to high temperatures, corrosive atmospheres, or high pressures without prior knowledge by DYNATORQUE or unless originally designed for that purpose. Doing so may affect the product warranty.

Installation:
Before assembly is begun please insure that mounting bolt patterns have been machined correctly for the application.
The following steps should be taken to install the DYNATORQUE BG manual multi-turn operator. DYNATORQUE recommends operator mounting while on the test stand with the valve in the closed position.

Yoke Nut Driver Installation:
1. Move the valve in the closed position and insure valve seal has been attained.
2. Install the Yoke Nut Driver on the bottom of the bevel gear using the bolt pattern supplied.
3. Before installing the operator, liberally grease the Yoke Nut and the Yoke Nut Driver. This will reduce the possibility of corrosion between the two components.
4. Align the operator with the Yoke Nut and lower the operator into position on the valve flange or mounting kit.
5. Install and tighten the valve to operator mounting bolts.
6. Rotate the operator handwheel counterclockwise moving the valve from the closed to the open position checking to make sure the operator turns smoothly through the complete cycle. Visually verify that the open position has been achieved.
7. Rotate the valve from closed to open several times to insure proper operation.

Threaded Stem Nut Installation:
1. Move the valve in the closed position and insure valve seal has been attained.
2. Install the Threaded Stem Nut on the bottom of the bevel gear using the bolt pattern supplied.
3. Before installing the operator, liberally grease the Valve Stem and the Threaded Stem Nut. This will reduce the possibility of corrosion between the two components.
4. Position the Stem Nuts threaded hole over the valve stem. As you lower the operator, turn the input shaft. This rotation should engage the male with the female threads in the nut. Continue to rotate the input shaft until the unit comes into contact with the mounting adapter or valve operator-mounting flange.
5. Align the mounting holes by rotating the operator while allowing the input shaft to rotate freely. (If the operator-input shaft is held the valve position may move off the seat.)
6. Install and tighten the valve to operator mounting bolts.
7. Rotate the operator handwheel counterclockwise moving the valve from the closed to the open position checking to make sure the operator turns smoothly through the complete cycle. Visually verify that the open position has been achieved.
8. Rotate the valve from closed to open several times to insure proper operation.

Safety:
DYNATORQUE operators have been designed and manufactured to the highest quality standards. In most cases, operator and handwheel packages have been sized to produce rated torque with a maximum of 80 lbs. of handwheel rim effort. The use of larger handwheels, cheater bars, etc. will void the override warranty and may cause damage to the operator, valve stem, drive shafts, or other torque transmitting devises as well as being dangerous to the user. Additionally, the use of chainwheels on operators that are not recommended for those applications will result voiding operator warranty.

Operation:
Once the valve assembly has been installed, operation of multi-turn manual gear operators is very simple. Assuming a clockwise to close valve as in the assembly instructions, rotating the handwheel clockwise will result in clockwise output rotation or clockwise to close. Reversing rotation of the handwheel, counterclockwise, will result in counterclockwise rotation of the output or counterclockwise to open.

Please Note:

When assembling DYNATORQUE products to a valve or to an automated valve package, standard engineering practices must be utilized to assure proper mounting orientation, configuration, and distribution of weights and forces. Failure to do so could cause product damage and/or malfunction, ***and void warranty consideration***. If there are any questions please contact the factory.

FLOW CONTROL
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Muskegon, MI 49442
Tel 231.788.7025, Fax 231.788.7030
Info-DYT@c-a-m.com, www.c-a-m.com

VALVCON BACK-UP POWERED ELECTRIC ACTUATOR ADC SERIES

Metso is a leading designer and provider of Valvcon compact, reliable, electronically controlled electric actuators for valves and dampers. We offer a complete line of electric actuators for accurate positioning of dampers and valves in the aerospace, automotive, consumer services, discrete manufacturing, energy, environmental, oil/pipeline, petrochemical, power/utilities, process, recreation, transportation, and water/wastewater industries.

We have developed and introduced the industry's most innovative Metso Valvcon electric actuator products, including simple "set and go" calibration, intelligent processor-based digital electronics, "Plug-in" accessory boards, Back-Up Power actuators, as well as electric actuators designed for remote control, solar-powered applications and two-wire network applications.

The quarter-turn electric actuator will comply with Part 15, Class A of the FCC regulations for emissions and conducted radiation for industrial devices. It will also be designed to meet NEMA standards for use in weathertight or weathertight and hazardous locations. The actuator will be a single, complete unit composed of a compact cast aluminum housing, motor, gearing, limit switches controlled by metal cams for end of travel control, mechanical position indicator, and an optional internal back-up power source to drive to a pre-set position in the event of an external power loss. Actuator mounting flanges shall comply with ISO 5211 standards incorporating a female drive for direct output coupling. The actuator shall be capable of operating in ambient environments of -40° F to 130° F; optional internal heaters are required at temperatures below 32° F.

FEATURES AND BENEFITS

Isolation and Electrical

Internal electronic control boards shall have clearly marked and different size connection terminals for Power and Control Signals to prevent incorrect wiring and shall provide CW and CCW push buttons for local manual control. The actuator control electronics shall be electrically isolated to allow multiple actuators to be wired in parallel. Electronic control boards shall be protected on the outward side with insulating overlays providing operating instructions and additional safety. Additionally, electronic control boards shall include a simple user-interface, including slide switches and selection knob for mode selection, calibration and set up. The electronic control boards will also supply a mA or voltage position feedback signal and include a holding brake feature to prevent back-driving. All internal connections, (motor leads, limit switch leads, option connectors, etc.) shall be coded, using different style connectors for each function, to prevent incorrect wiring. All connections will plug-in to simplify field repairs and upgrades. In AC applications a highly reliable switching power supply will provide power conversion to drive the internal DC motor; DC applications will utilize an equally reliable DC to DC regulator. Other than periodic battery replacement; no maintenance will be required.

Motor

The internal electric motor will be of a brushless DC type, capable of running continuously at full torque at ambient temperature at or below 104° F.

Lubrication

All rotating power train components will be coated with a multi-purpose grease. Lubricants will be suitable for ambient conditions of -40° F to 130° F. For operation in temperatures between 32° F and -40° F an optional heater and thermostat assembly must be included.

Gearing

The powertrain will be comprised of hardened steel, machine cut spur gears. Non-metallic, aluminum, cast or stamped gearing will not be permitted.

Limit Switches

Actuators will have two standard end-of-travel switches, single pole double throw, rated at 15 amps at 250 VAC. Under normal operation the end of travel limit switches will not be activated; activating the limit switches will interrupt actuator travel. Up to two additional limit switches, adjustable to operate at any position as required by the process application, may be added to the actuator for end of travel indication.

On/Off Control (Open/Close Operation) with Optional Battery Back-Up

Open/Close actuators require separate Power and Control signals. The Power signal must be constantly maintained; immediately upon loss of the Power signal, the internal back-up power source will drive the actuator to the Power Loss Position. The Control signal consists of one to three maintained AC or DC contacts and the actuator can be set to operate in Two-wire, Three-wire or Three-position modes. In Two-wire mode a signal is maintained to drive the actuator to the CCW position and removed to drive to the CW position. In Three-wire mode separate Control signals are applied to drive the actuator to the CW and CCW positions and may be removed at any point in mid-stroke to position the valve or damper. In Three-position mode separate Control signals are applied to drive the actuator to the CW, "MID" or CCW positions and may be removed at any point in mid-stroke to position the valve or damper. The Power Loss Position may be either the full CW, the full CCW or "MID" position and is determined by the fail position selection switch.

Proportional Control (Modulating Operation) with Optional Battery Back-Up

Modulating control actuators will accept a variable, proportional 4-20 mA or 0-10VDC valve position signal and respond by positioning the valve linearly with an accuracy of 1%. Normally, the actuator will drive clockwise in response to a decreasing control signal; however, the actuator will be capable of "reverse acting" operation (driving counter-clockwise in response to a decreasing control signal) without internal wiring changes. The actuator will also provide the ability to adjust the sensitivity to control signal changes. Slide switches will enable the user to set the actuator response to a loss of control signal, select the "fail" position upon loss of Power and select either the single cycle or multi-cycle loss of power mode. Locked rotor, stall protection will detect whenever the actuator is unable to achieve the position commanded by the control signal, and will terminate power to the motor in order to prevent damage due to repeated stall conditions.

The Back-Up Powered Electric Actuators from Metso

Metso offers several product lines that are designed to drive a valve or damper to a pre-determined position in the event of a power loss. Under normal power conditions, they provide accurate positioning in response to the powered control signals.

Optional Internal Battery Back-Up

Metso Valvcon ADC Series can be equipped with an optional internal battery pack. The actuator is driven by an external power source under normal conditions. When power is lost, the internal battery pack can be set up to either drive immediately to the pre-set position, or continue to respond to a maintained control signal. The ADC Series is an excellent choice for continuous duty modulating applications, or any application where an inexpensive alternative to mechanical spring back-up is desired.

Break-away Torque

Designed for efficiency and reliability, all Metso Valvcon actuators deliver the power you need when and where it is needed. With efficient gear trains and motors these actuators are rated at breakaway torque. Immediately upon power up, the actuator supplies the rated torque — when it is needed to break the valve away from its seat. Other manufacturer's actuators may be rated at running torque, but actually deliver significantly less breakaway torque.

FEATURES AT A GLANCE!

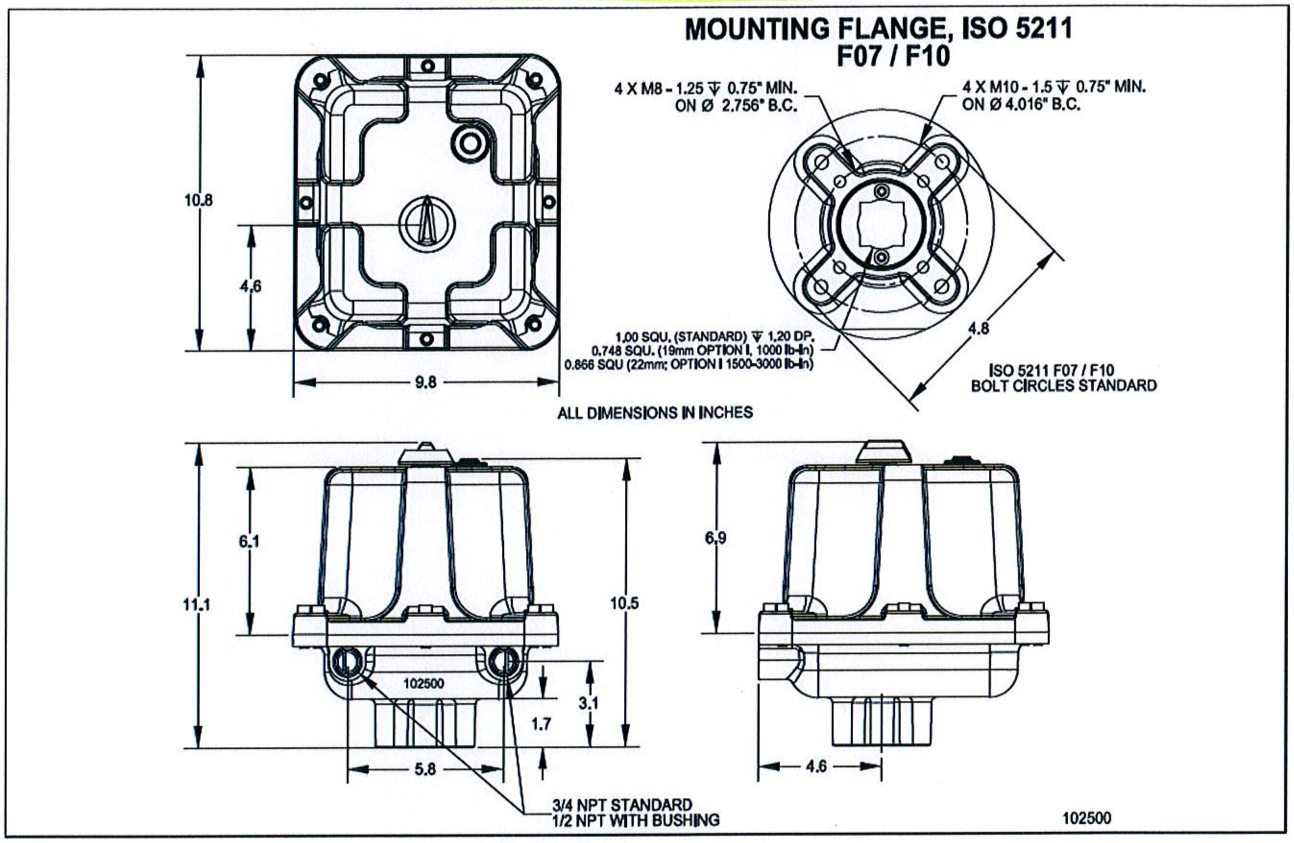
ADC Series

- ☐ Optional internal battery packs allow for continued modulation during power outages, provided the control signal remains.
- ☐ Field-settable for "fail clockwise" or "fail counter-clockwise."

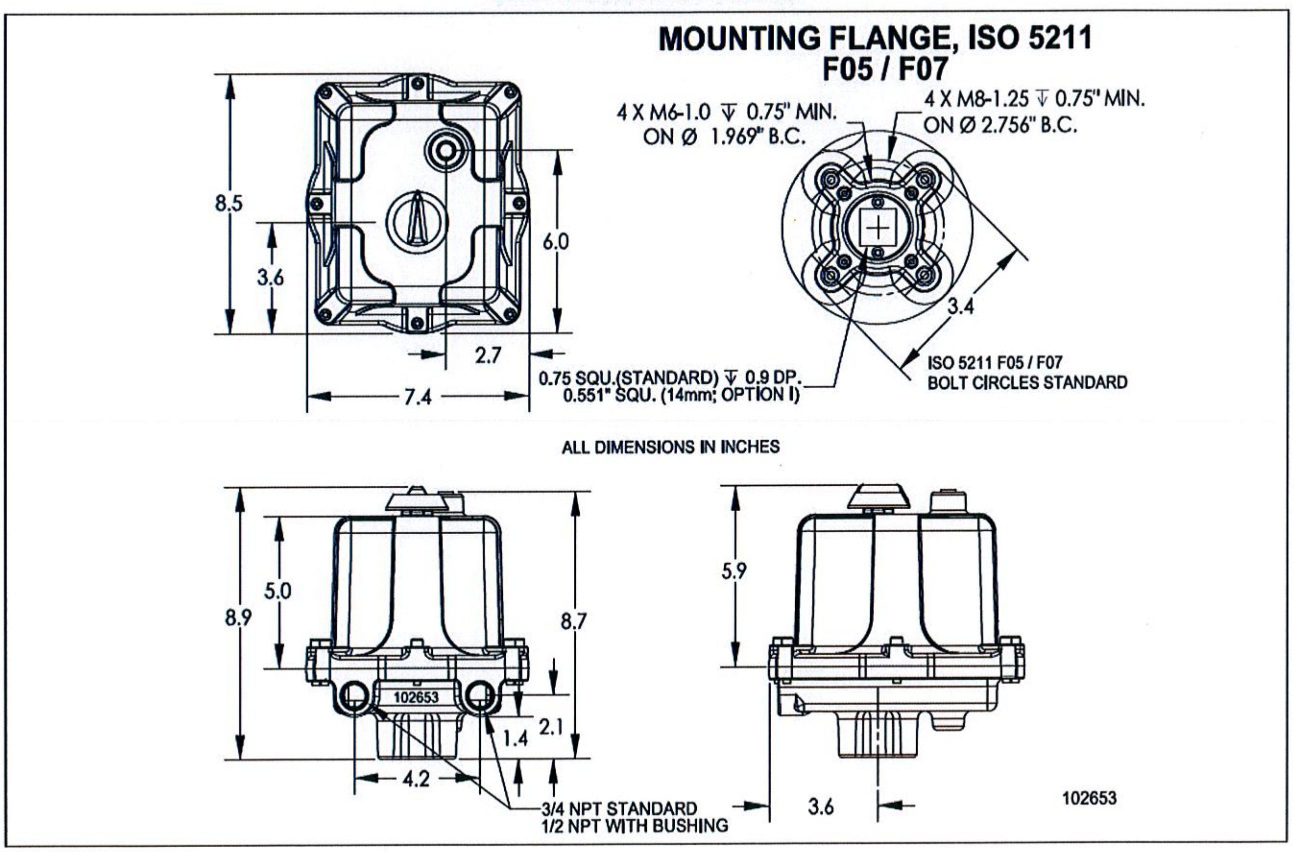
Valvcon Back-up Powered Actuators:

- ☐ Patented technology provides back-up capabilities within the standard size actuator enclosures!
- ☐ Dual conduit openings make wiring easier, and keep power and control wiring separate.
- ☐ Two year warranty.

LADC-SERIES ENCLOSURE



ADC-SERIES ENCLOSURE



ALL DIMENSIONS IN INCHES

ADC SPECIFICATIONS

Battery Back-up Power

Metso Valvcon ADC Series electric actuators, equipped with internal battery power, allow you to shut down your system in the event of an external power loss. Engineered to supply dependable valve actuation, they can provide up to 10 complete cycles under their own internal power.

The electronic back-up powered feature incorporates a rechargeable battery pack on a plug-in, modular PC board under the actuator cover. Upon power loss or a signal from an external sensor, the battery pack is automatically activated as the main power supply. The battery is compact and fits easily into the standard enclosures for an easy, space-saving upgrade. No hard-wiring or other complex operations are required.

Metso Valvcon battery back-up actuators are available in on/off (two position) or continuous duty modulating models.

- Internal batteries allow for continued cycling during power outages, enabling an orderly shut-down of critical processes.
- A built-in trickle charger, with over-charge protection, ensures the batteries always have enough power when called upon
- Batteries can be easily replaced in the field.

MODULATING DATA

Torque (in-lbs)	Duty Cycle	12VDC		24VDC		24VAC		115VAC		230VAC	
		Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)
150	100%	11	2.2	13	1.2	8	1.8	9	0.4	9	0.4
300	100%	17	2.5	13	1.4	12	2.1	13	0.5	13	0.4
600	100%	17	2.8	13	1.7	13	2.5	14	0.6	14	0.5
1000	100%	21	4	14	2.4	15	3.5	15	0.9	15	0.6
1500	100%	40	4	24	2.4	27	3.5	29	0.9	29	0.6
2000	100%	40	4.3	33	2.4	28	3.5	29	0.9	29	0.6
2500	100%	55	3.3	40	2	38	3.1	39	0.8	39	0.6
3000	100%	60	3.7	42	2.2	40	3.5	42	0.8	43	0.6

ON/OFF DATA

Torque (in lbs.)	Speed (per 90° rotation, in seconds)		Duty Cycle**	Normal Operating Current Draw (in Amps)				
		24VDC only		12VDC	24VDC	24VAC	115VAC	230VAC
150	5	3	Continuous**	1.9	2.4	1.5	.2	.1
300	10	5	Continuous**	1.9	2.4	1.5	.2	.1
600	15	8	Continuous**	1.9	2.4	1.5	.2	.1
1000	15	15	Continuous**	3.5	3.5	2.0	.4	.2
1500	20	20	Continuous**	3.5	3.5	2.0	.4	.2
2000	25	25	Continuous**	4.8	4.8	2.0	.4	.2
2500	30	30	Continuous**	4.8	4.8	2.0	.4	.2
3000	35	35	Continuous**	4.8	4.8	2.0	.4	.2

**Continuous for 1 hour after which duty cycle is reduced to 80%.

BACK-UP POWERED ELECTRIC ACTUATORS OPTIONS

Tropical Heater/Thermostat

(Order Code H)

Recommended in all high humidity applications where condensation may accumulate inside the actuator. For 115VAC applications the heater consumes 15 watts, for 230VAC applications the heater consumes 40 watts.

ISO 5211 Output

(Order I)

ISO 5211 Standard mounting configuration and output coupling.

150-600 in-lb models with "I" options are supplied with a 14mm female square. (note: without option "I" the female square is 3/4 inch).

1000 in-lb models with "I" options are supplied with a 19mm female square and 1500-3000 in-lb models are supplied with a 22 mm female square. (note: without option "I" the female square is 1inch).

Additional Limit Switches

(Order Code S2)

Up to two additional limit switches may be added for position indication or as dry contacts to operate other devices. Single pole, double throw switches rated for 1/2 HP, 15 amps @ 250VAC, CSA certified.

Heater/Thermostat

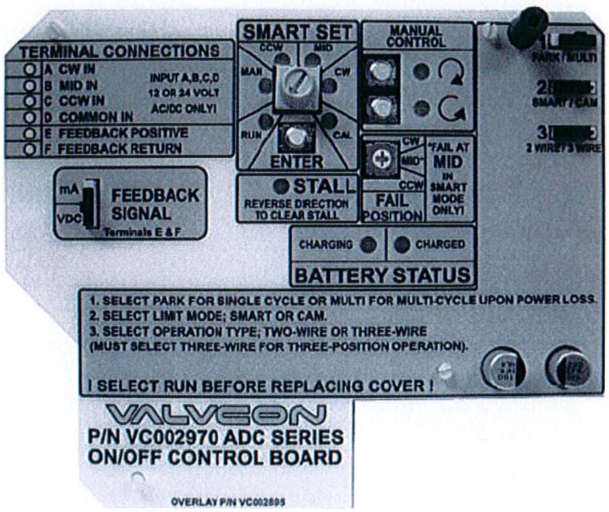
(Order Code T)

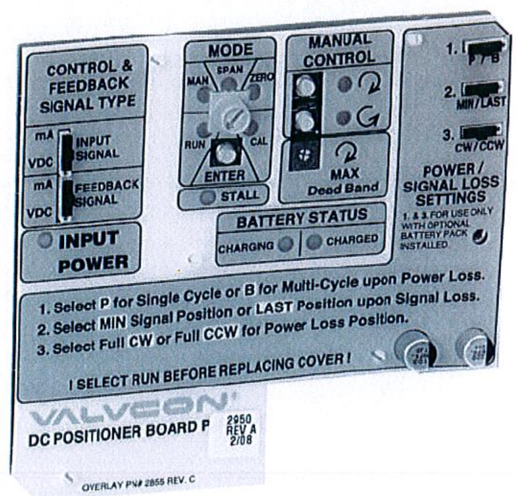
Required in all applications where the temperature may drop below 32°F. For 115VAC applications the heater consumes 15 watts, for 230VAC applications the heater consumes 40 watts.

Hazardous Location Enclosures

(ADCWX and LADCWX)

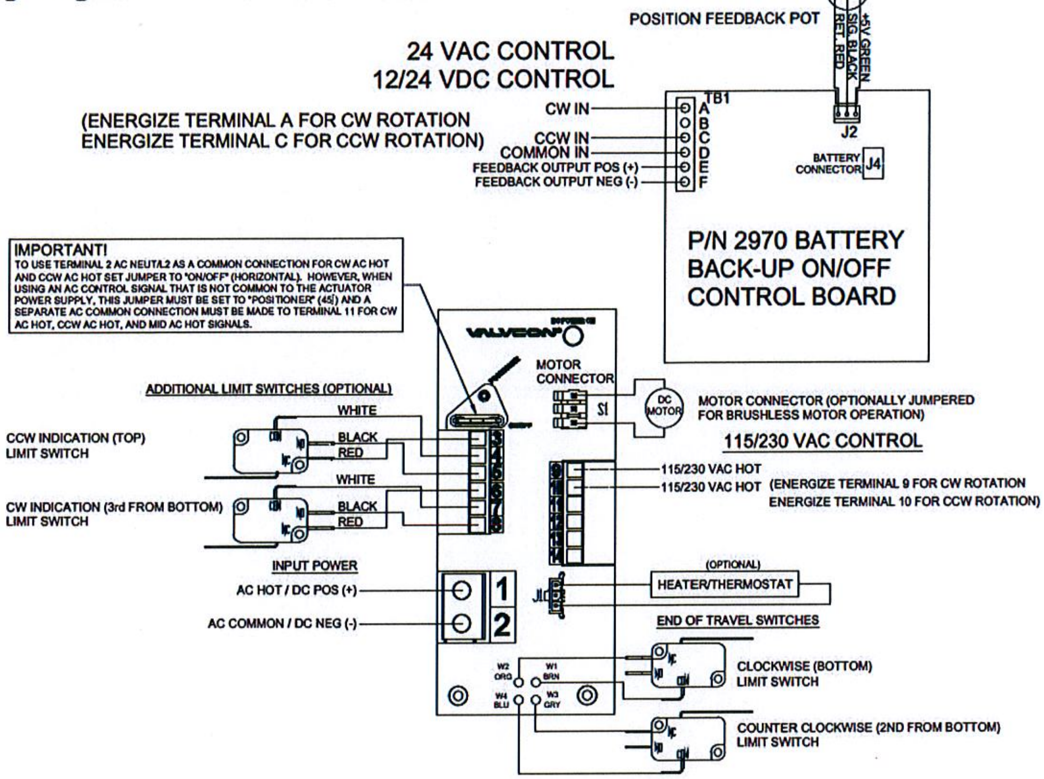
The standard enclosures (W) are rated for NEMA 4/4X (weather tight and corrosion resistant). The Hazardous Location enclosures (WX) are rated for NEMA 4/4X/7 & 9, Class I, Div 1, Groups C&D; Class II, Div. 1, Groups E, F, & G; Class III.





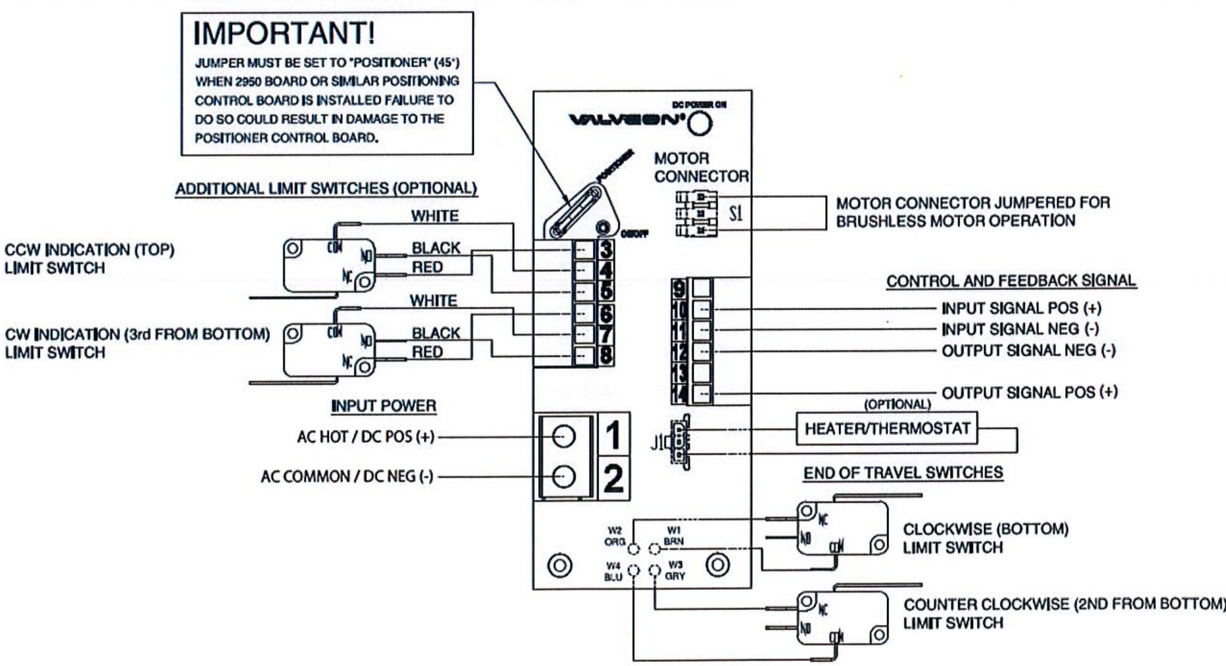
ADC/LADC ON/OFF APPLICATIONS

Wiring Diagram – "Three Wire" Control



Note: "Three Wire" control shown for other configurations see IMO.

ADC/LADC MODULATING APPLICATIONS



HOW TO ORDER – ADC SERIES ACTUATORS

Example: Sample model code: ADCW150CL2IS2N24AC

1	2	3	4	5	6
ADC	W	150	CL2	I S2	N24AC

1	Series
ADC	ADC

2	Enclosure
W	Weathertight (NEMA 4/4X)
WX	Weathertight & Explosion proof (NEMA 4/4X/7 & 9)

3	Torque (in lbs)
150	150
300	300
600	600

4	Options [1] (Must Select One)
C	Modulating
CL2	Modulating Battery Back-Up
L2	On/Off Battery Back-Up
L4	ON/Off Battery Back-Up - 3 Position
R2	ON/Off Isolated Control
R3	ON/Off Board - 3 Position

5	Other Options
—	No entry if standard
H[2]	Tropical Heater/Thermostat
I[3a]	ISO 5211 Output
S2	Two Auxiliary Limit Switches
T[4]	Heater/Thermostat
Z[5]	Handwheel

6	Operating Voltage
N115AC	115VAC
N230AC	230VAC
N24AC	24VAC
N12DC	12VDC
N24DC	24VDC

HOW TO ORDER – LADC SERIES ACTUATORS

Example: Sample model code: LADCW1500CL3IS2N24AC

1	2	3	4	5	6
LADC	W	1500	CL3	I S2	N24AC

1	Series
LADC	LADC

2	Enclosure
W	Weathertight (NEMA 4/4X)
WX	Weathertight & Explosion proof (NEMA 4/4X/7 & 9)

3	Torque (in lbs)
1000	1000
1500	1500
2000	2000
2500	2500
3000	3000

4	Options [1] (Must Select One)
C	Modulating
CL3	Modulating Battery Back-Up
L3	On/Off Battery Back-Up
L5	ON/Off Battery Back-Up - 3 Position
R2	ON/Off Isolated Control
R3	ON/Off Board - 3 Position

5	Other Options
—	No entry if standard
H[2]	Tropical Heater/Thermostat
I[3b]	ISO 5211 Output
S2	Two Auxiliary Limit Switches
T[4]	Heater/Thermostat
Z[5]	Handwheel

6	Operating Voltage
N115AC	115VAC
N230AC	230VAC
N24AC	24VAC
N12DC	12VDC
N24DC	24VDC

Notes:

1. Must select only one board option; all of these board options include 4-20mA or 0-10VDC position feedback, (2-10VDC on On/Off option boards) and a holding brake feature.
2. This heater option activates at or below 90°F and deactivates at 110°F; it is recommended in high-humidity applications.

3a. 150 - 600 lb-in models with I option are supplied with a 14mm female square (note that without option I the female square is 3/4").

3b. 1000 lb-in models with I option are supplied with a 19mm female square and 1500 - 3000 lb-in models are supplied with a 22mm female square (note that without option I the female square is 1").

4. This heater option activates at or below 40°F and deactivates at 60°F; it is recommended in applications where the temperature may drop below 32°F.
5. Handwheel option not recommended with Back-Up Powered options.

Committed to Customer Service

Metso worldwide web site:
www.metso.com/automation/valvcon, provides 24 hour a day access to all technical support material—from sales brochures to instruction manuals to installation and troubleshooting tips. For local support, Our network of trained stocking distributors/representatives are industry leading experts in valve automation. Contact the Metso, Valvcon product web site to locate the nearest stocking distributor/representative.

Timely Technical Support

Metso Express Services is on call to answer your engineering or application questions, and to quickly repair or upgrade your actuators. These highly trained support engineers offer a broad range of expertise, with the combined experience to assist specifying engineers and contractors with information on feasibility and special applications. Find Metso Express at **www.metso.com/automation/valvcon**.

A Tradition of Quality

Metso is dedicated to producing superior-quality products that are second to none. Our development laboratory and manufacturing facilities exemplify our total commitment to producing quality products.

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VALVCON

ADC-Series

CONTINUOUS DUTY
ON/OFF ELECTRIC ACTUATORS
With R2, R3, L2, L3, L4 & L5 Options
With "N" In The Model Number

Installation, Maintenance and
Operating Instructions

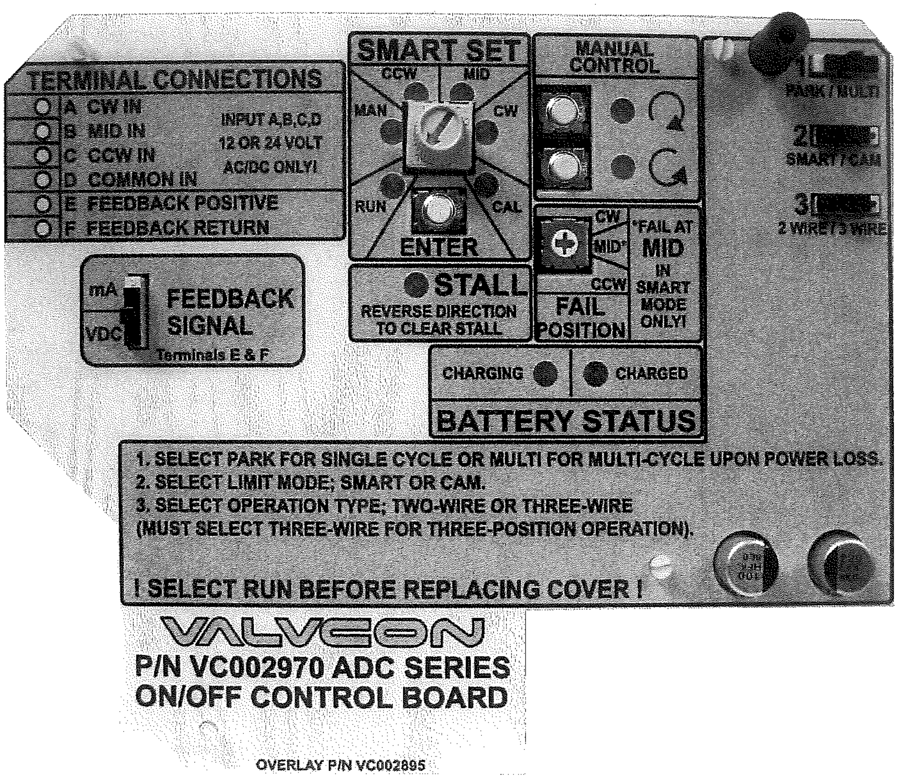

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Table of Contents

> Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.

READ THESE INSTRUCTIONS FIRST!

This instruction manual contains important information regarding the installation, operation, and troubleshooting of ADC-Series Continuous Duty On/Off Electric Actuators With R2, R3, L2, L3, L4 & L5 Options With "N" In The Model Number. Please read these instructions carefully and save them for future reference.

SAVE THESE INSTRUCTIONS!

Subject to change without notice.

1 GENERAL

1.1 ADC-Series On/Off Actuators (with Optional Battery Back-up)

The On/Off actuators are based on the ADC and LADC platform and provide an optional internal battery pack to power the actuator in the event of a loss of external power. ADC designates sizes from 150 to 600 in-lbs. LADC designates sizes from 1000 to 3000 in-lbs **(see Figure 10)**.

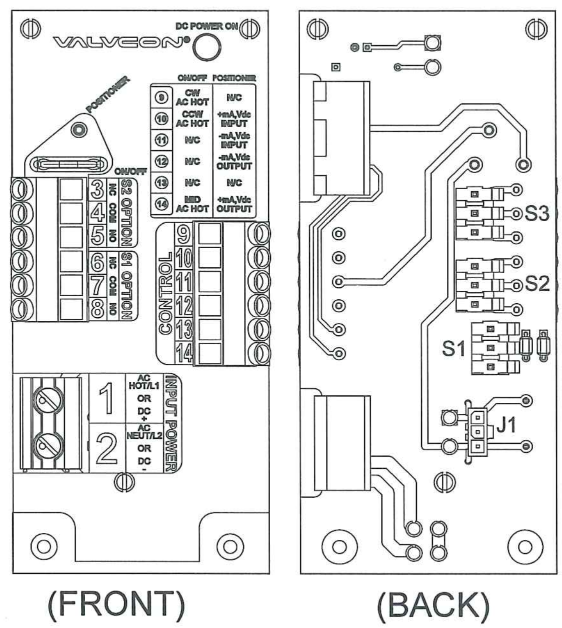
The electronic package consists of three separate boards; **P/N VC002360** Power Board and the **P/N VC002970** On/Off Control Board, and either a switching power supply or a DC isolator board. On/Off actuators are identified by the code "R2" or "R3" in the model number. On/Off actuators with battery back-up are identified by the code "L2", "L3", "L4" or "L5" (L2 & L4 are applicable in ADC-Series and L3 & L5 are applicable in LADC-Series) in the model number. (**Note:** The L4 and L5 options are factory-set for 180° operation with the MID position set at 90°.)

The On/Off control actuators covered in this manual are identified by the code "R2", "R3","L2", "L3", "L4" or "L5" and the letter **N** in the model number (do not confuse with "CL2" or CL3", which indicates a separate modulating control option).

1.2 Power Board P/N VC002360

The **P/N VC002360** Power Board provides terminals for input and output wiring to the actuator as well as plug-in connectors for ADC-Series options and accessories.

IMPORTANT! To use terminal 2 AC Neut/L2 as a COMMON connection for CW AC HOT and CCW AC HOT, set jumper to "ON/OFF" (horizontal). However, when using an AC control signal that is not COMMON to the actuator power supply, this jumper must be set to "POSITIONER" (45°) and a separate AC COMMON connection must be made to terminal 11 for CW AC HOT, CCW AC HOT and MID AC HOT signals.



S1 MOTOR / MOTOR JUMPER
S2 OPTIONAL ADDITIONAL LIMIT SWITCH CW
S3 OPTIONAL ADDITIONAL LIMIT SWITCH CCW
W1-W2 LIMIT SWITCH CW (BOTTOM)
W3-W4 LIMIT SWITCH CCW (2ND FROM THE BOTTOM)
W5-W6 AC POWER TO POWER MODULE
W7-W8 DC POWER RETURN FROM POWER MODULE

Figure 1

1.3 On/Off Control Board P/N VC002970

The **P/N VC002970** On/Off Control Board connects to the **P/N VC002360** Power Board via two plug-in connectors and a bracket, and hardware anchors it to the motor/gearbox. The On/Off Control Board allows the actuator to drive to either the full open or full closed position in response to applied control voltages. The **P/N VC002970** On/Off Control Board can be configured for either "Two-Wire" or "Three-Wire" control, (driving to mid-travel

positions can be achieved by removing the control voltage in "Three-Wire" mode). The On/Off Control option features include a choice of 115VAC, 230VAC, 12VDC, 24VDC or 24VAC input power as well as independent 115VAC, 230VAC, 12VDC, 24VDC or 24VAC control signals. Additional features include optional internal Battery Back-Up, Three-Position operation, analog position output signal (not present if using "Cam" Limit Type), manual push button control, single or multi cycling upon loss of line power, switch select power "Fail" position, locked rotor stall protection, on-board battery status indicators, and simple digital **Smart Set** functionality for entering and saving precise end of travel positions. (**Note**: Some of the above features are only applicable with the optional Back-Up battery installed.)

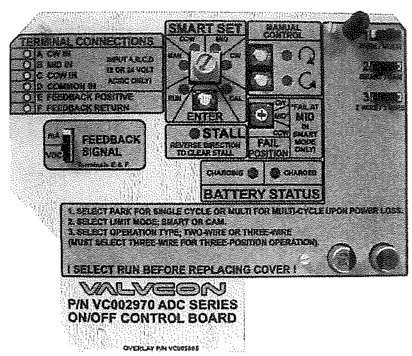


Figure 2
P/N VC002970 Battery Back-Up On/Off Control Board

1.4 LED Indicators

Visible on the **P/N VC002360** Power Board **(see Figure 1)**:

DC POWER ON – This green LED indicator shows that the user-supplied power is present and has been converted to DC (power conversion not applicable to DC input voltages) to drive the motor.

Visible on the **P/N VC002970** L2 &L3 Board **(see Figure 2)**:

POWER – A continuous green LED indicates that external or battery power is present.

STALL – A flashing red LED indicates a stall condition exists and that the actuator has been prevented from reaching the position commanded by the control signal. A STALL of more than several seconds will cause power to be automatically removed from the motor circuit, placing the actuator in a safe mode. A reverse signal or **Smart Set** mode change is required to clear the STALL LED alarm. A STALL alarm can be initiated in a few ways; by a blockage in the valve or damper, cam limit settings that are inside of the electronically saved travel stop positions, attempting to drive an actuator that is off-line due to thermal overload or some other increase in the torque load on the actuator.

CLOCKWISE – A continuous yellow LED indicates that the actuator is driving in the CW direction.

COUNTER-CLOCKWISE – A continuous yellow LED indicates the actuator is driving in the CCW direction.

CHARGING – A continuous yellow LED indicates that the battery is charging and is not fully charged.

CHARGED - A continuous green LED indicates that the battery is fully charged. A flashing green LED indicates the actuator is running on battery power.

RUN – A continuous green LED indicates that the normal operating mode has been selected.

MAN – A continuous yellow LED indicates that MANUAL mode has been selected. The actuator will not respond to external control signals and the CW and CCW push buttons are enabled for manually driving the actuator in either direction. The manual push buttons are also enabled in SPAN, MID, ZERO and CAL modes.

CCW – A continuous yellow LED indicates that the CCW **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the CCW LED is illuminated will cause the CCW LED to flash. Pressing **[ENTER]** while the CCW LED is flashing will save the current position as the CCW travel limit.

MID – A continuous yellow LED indicates that the MID **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the MID LED is illuminated will cause the MID LED to flash. Pressing **[ENTER]** while the MID LED is flashing will save the current position as the MID travel stop position.

CW – A continuous yellow LED indicates that the CW **Smart Set** mode has been selected. Pressing **[ENTER]** for two seconds while the CW LED is illuminated will cause the CW LED to flash. Pressing **[ENTER]** while the CW LED is flashing will save the current position as the CW travel stop limit.

CAL – A continuous yellow LED indicates that the CAL (calibration) mode has been selected. Pressing **[ENTER]** for two seconds while the CAL LED is illuminated may cause the CAL LED to flash indicating that further calibration of the position Feedback Potentiometer is required. **See Page 9 For Feedback Potentiometer Calibration Procedures.** If the CAL LED remains on continuously, no further calibration is required. Press **[ENTER]** to confirm the calibration setting and return to **RUN** mode.

At any point during Set-Up you may exit a "Smart Set" mode without changing the stored data, by simply selecting a different "Smart Set" mode.

2 OPERATION

> Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.

2.1 Wiring

The identification label on each actuator specifies the model number, serial number, input power voltage and current requirements for the actuator. It is important to verify the correct input voltage prior to wiring the actuator.

There are three basic wiring schemes designed to operate the ADC-Series On/Off Control Board options. These include:

Two Wire – On/Off Operation
Three Wire – Open/Stop/Close
Three Position – CW/MID/CCW

2.1.1 "Two-Wire" – On/Off Operation

(SEE FIGURE 3)

MAIN POWER – Terminals 1&2 - For "Two-Wire" control, the mode select slide switch must be in the LEFT, "Two-Wire" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - To control the actuator with a high voltage signal (115VAC or 230VAC) connect AC HOT to terminal 10 on the **P/N VC002360** Power Board. When terminal 10 is energized, the actuator will drive counter-clockwise. When terminal 10 is de-energized, the actuator will drive clockwise.

CONTROL SIGNALS – Low Voltage - To control the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the positive or hot lead to terminal C and connect the common or negative lead to terminal D on the **P/N VC002970** ON/OFF Control Board. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When terminal C and terminal D are de-energized, the actuator will drive clockwise.

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 on the **P/N VC002360** Power Board and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns, the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 3)**. Installing the optional heater and thermostat is a plug connection and requires no additional wiring.

2.1.2 "Three-Wire" – Open/Stop/ Close Operation

(SEE FIGURE 4)

MAIN POWER – Terminals 1&2 - For "Three-Wire" control, the mode select slide switch must be in the RIGHT, "Three -Wire" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - For "Three-Wire" control of the actuator with a high voltage signal (115VAC or 230VAC) connect the AC HOT CW lead to terminal 9. Connect the AC HOT CCW lead to terminal 10. When terminal 9 is energized, the actuator will drive clockwise. When terminal 10 is energized, the actuator will drive counter-clockwise. When neither 9 nor 10 are energized, the actuator will remain in position, (unless main power to 1 and 2 is interrupted).

CONTROL SIGNALS – Low Voltage - For "Three-Wire" control of the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the CW positive or hot lead to terminal A. Connect the CCW positive or hot lead to terminal C. Connect the common or negative lead to terminal D on the **P/N VC002970** board. When terminal A and terminal D are energized the actuator will drive clockwise. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When neither terminal A nor terminal C is energized, the actuator will remain in position, (unless power to 1 and 2 is interrupted).

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 4)**. Installing the optional heater and thermostat is a plug connection and requires no additional input power wiring.

2.1.3 "Three-Position" – CW/MID/CCW Operation

(SEE FIGURE 5)

MAIN POWER – Terminals 1&2 - For "Three-Position" control, the mode select slide switch must be in the RIGHT, "Three-Wire" position and the Limit Type select slide switch must be in the LEFT, "Smart" position. Main power must be supplied constantly to terminal 1 (AC Hot or DC Positive) and terminal 2 (AC Common or DC Negative) on the **P/N VC002360** Power Board.

CONTROL SIGNALS – High Voltage - For "Three-Position" control of the actuator with a high voltage signal (115VAC or 230VAC) connect the AC HOT CW lead to terminal 9. Connect the AC HOT CCW lead to terminal 10. Connect the AC HOT MID (mid-position) lead to terminal 14. When terminal 9 is energized the actuator will drive clockwise. When terminal 14 is energized, the actuator will drive to the MID position. When terminal 10 is energized, the actuator will drive counter-clockwise. When neither terminals 9, 10, nor 14 are energized, the actuator will remain in position, unless power to 1 and 2 is interrupted.

CONTROL SIGNALS – Low Voltage - For "Three-Position" control of the actuator with a low voltage signal (12VDC, 24VDC, 24VAC) connect the CW positive or hot lead to terminal A. Connect the CCW positive or hot lead to terminal C. Connect the MID (mid-position) positive or hot lead to terminal B. Connect the common or negative lead to terminal D on the **P/N VC002970** board. When terminal A and terminal D are energized the actuator will drive clockwise. When terminal B and terminal D are energized, the actuator will drive to the MID position. When terminal C and terminal D are energized, the actuator will drive counter-clockwise. When neither terminals A, B, or C are energized, the actuator will remain in position, (unless power to 1 and 2 is interrupted).

With the L2 & L3 option installed, the actuator will sense the loss of power to terminals 1 and 2 and immediately switch to internal battery power. **See Section 4** for Battery Mode options upon loss of line power. When line power returns the actuator will automatically resume normal operation.

Connections to terminals 3 through 8 are used only for optional, additional limit switches **(see Figure 5)**. Installing the optional heater and thermostat is a plug connection and requires no additional input power wiring.

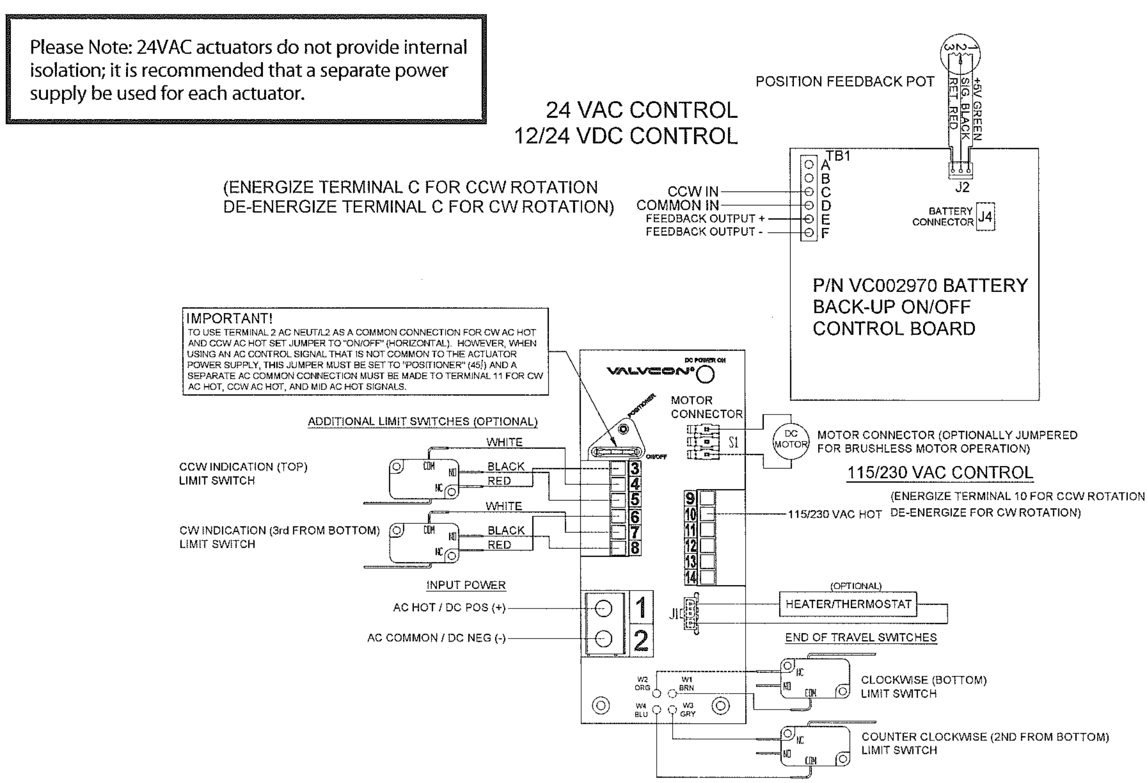
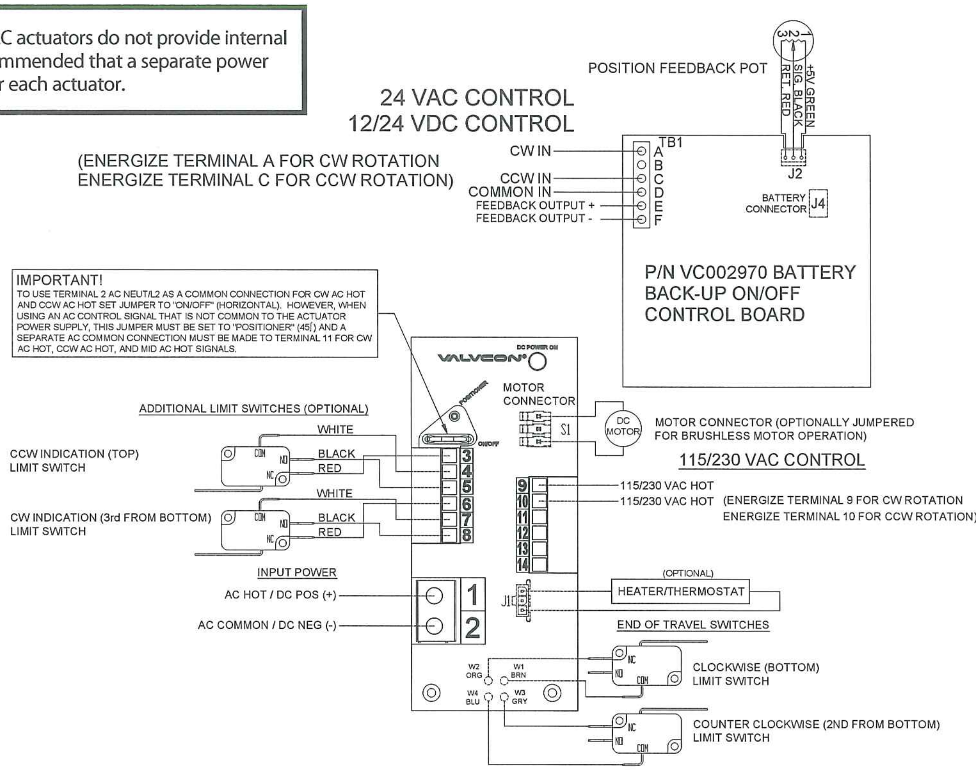


Figure 3

"Two-Wire" Wiring

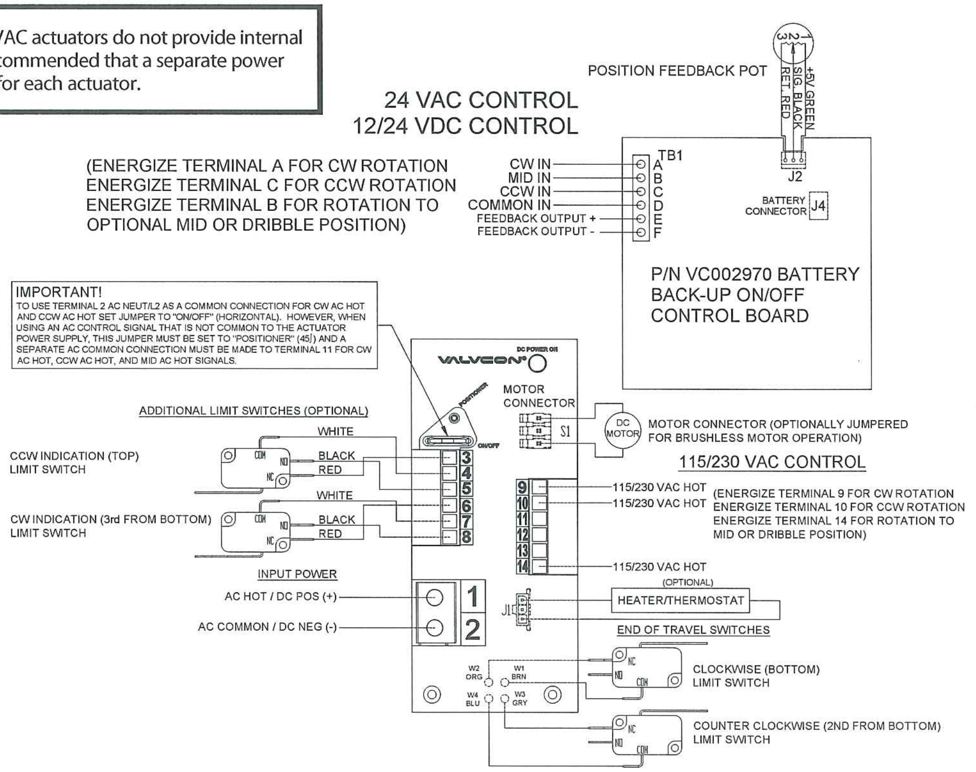
Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.



"Three-Wire" Wiring

Figure 4

Please Note: 24VAC actuators do not provide internal isolation; it is recommended that a separate power supply be used for each actuator.



"Three-Position" Wiring

Figure 5

2.2 ADC R2, R3, L2, L3, L4 & L5 Travel Limit Options

Travel limits, also referred to as "end of travel stops", are the precise positions to which the actuator will drive. The ADC-Series R2, R3, L2, L3, L4 & L5 options provide a number of choices for setting the travel limits. For "Two-Position" On/Off operation, travel limits are set at the full clockwise (CW) and full counter-clockwise (CCW) ends of travel. For "Three-Position" operation, an optional midway position (MID) may be set at any point between the CW and CCW settings.

CAUTION:
Dangerous Voltages Inside Actuator

Use extreme caution when working on the actuator with the cover removed.

2.2.1 Limit Types

To simplify the process of setting the precise travel limit positions, the ADC-Series R2, R3, L2, L3, L4 & L5 options provide two travel limit types. CW, CCW and MID may be set electronically via the **Smart Set** utility or CW and CCW may be set mechanically by selecting the "CAM Set" limit type.

2.2.2 CAM Set

When CAM Set is selected as the limit type, two limit switches operated by the stainless steel cams on the output shaft extension are used to determine the exact positions where the actuator will stop at each end of CW and CCW travel. The bottom limit switch determines the clockwise stop position. The next limit switch up from the bottom determines the counter-clockwise stop position.

The "end of travel limit" switches can be adjusted to provide from 5 to 320 degrees of actuator rotation.

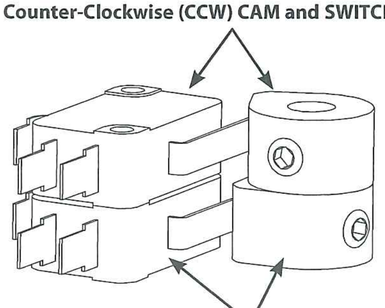


Figure 6

For "Three-Position" operation, limits must be entered and saved using the "Smart" Limit Type, only! **See Section 3** for detailed instructions.

2.2.3 Smart Set

When **Smart Set** is selected as the limit type, the micro processor stores the exact positions where the actuator will stop at each end of travel or mid position. Setting the **Smart Set** positions for the clockwise, counter-clockwise and midway positions is done with the selector knob and **[ENTER]** button in the **Smart Set** field of the **P/N VC002970** board. To use the **Smart Set** feature, the Feedback Potentiometer must be installed, connected and calibrated and the travel stop cams must be set to trip the switches beyond the desired electronic stop positions for CW, CCW.

The end of travel limits on standard ADC actuators can be entered and saved between 0° and 94° of travel. For rotation up to 270° of travel optional Feedback Potentiometer gears are available **(see Section 7; ADC-Series Standard Options)**.

For "Three-Position" operation, limits must be entered and saved using the "Smart" Limit Type, only! **See Section 2.1.3** for detailed instructions.

3 SET UP AND CALIBRATION

3.1 Initial Set Up

1. Remove actuator cover.
2. Select **Limit** type – **"SMART" or "CAM"** – Slide the **[SMART/CAM]** to the right to select **CAM** or to the left to select **SMART**. Selecting **SMART** will enable other features on the board such as Position Feedback and "Three-Position" operation. Selecting **CAM** will allow the actuator to drive between the end-of-travel limit switch settings. (Actuator is set up in **SMART** mode at factory; **SMART** set up is also recommended for field replacement.)
3. Select Operation **Limit** type – **"TWO-WIRE"** or **"THREE-WIRE"** – Slide the **[TWO-WIRE/THREE-WIRE]** to the right to select **THREE-WIRE** or to the left to select **TWO-WIRE**. In **TWO-WIRE** mode the actuator will drive **CCW** when the control terminal is energized and **CW** when the control terminal is de-energized. In **THREE-WIRE** mode separate terminals must be energized for **CW** or **CCW** movement; if using the **THREE-POSITION** feature the actuator must be set in **THREE-WIRE** mode.
4. Select Battery Mode On Power Fail – **"PARK AT FAIL" or "MULTI-CYCLE"** – Slide the **[PARK AT FAIL/MULTI-CYCLE]** to the right to select **MULTI-CYLCE** or to the left to select **PARK AT FAIL**. Selecting **PARK AT FAIL** will drive the actuator to the selected

Power Loss position upon loss of input power and the system will go to "sleep" until input power is restored. If **MULTI-CYLCE** is selected, the actuator will continue to respond to changes in control signal for up to ten cycles; the battery monitoring circuit will drive to the Power Loss position when it detects that the battery should be charged. Upon reaching the Power Loss position, the system will go to "sleep" until input power is restored.

5. Select **Power Loss Position – "CW", "MID" or "CCW"** – Turn the **[CW/MID/CCW]** to the clockwise to select **MID** or **CCW** or counterclockwise to select **MID** or **CW**. Selecting **CW** will drive the actuator to the clockwise position upon loss of input power. Selecting **CCW** will drive the actuator to the counterclockwise position upon loss of input power. Selecting **MID** will drive the actuator to the **MID** or **"THIRD"** position upon loss of input power; this setting is used in **THREE-WIRE** mode only.
6. Select **Output Feedback Signal** type – **"mA"** or **"VDC"** (current or voltage), the actuator will provide a 4-20mA or 2-10VDC feedback signal. Slide the **[OUTPUT SIGNAL]** switch up to select **mA** or down to select **VDC**.

3.2 Potentiometer Calibration

Field installation of the On/Off Control Board option or replacement of the position tracking potentiometer requires calibration of the position tracking potentiometer prior to setting positions and values for CW, MID and CCW. On/Off Control Board options installed at the factory are fully calibrated at the factory and should not require further calibration.

To confirm proper potentiometer calibration:

1. Turn the Mode Selector Dial to **[CAL]** and press **[ENTER]** for 2 seconds.
2. Using the **CW** push button, drive the actuator to the full clockwise position.
   - If the **[CAL]** LED is flashing, potentiometer calibration is required; proceed to step 3 below.
   - If the **[CAL]** LED remains on, calibration is not required; proceed to **Setting CW, MID and CCW Positions section below**.
3. Loosen the set screw in the larger Nylon gear with a 1/16" hex wrench.
4. Rotate the gear until the LED remains on constantly; hold the gear in place and tighten the set screw. Ensure that the LED remains on after the set screw is tightened. **Note**: The LED assists the user in locating the proper calibration window; it will flash faster as you approach the calibration window and slower as you move away from it.
5. Press the **[ENTER]** button to save the potentiometer setting.

3.3 Setting CW, MID and CCW Positions

Setting CW, MID and CCW Positions - Once calibration has been confirmed, set the desired "end of travel" positions. ***Make certain that the limit switch cams are set to operate the switches beyond the desired range for the CW and CCW positions.*** CW and CCW may be set at any position between 0° and 94° of travel (or 184° with "R3", "L4" or "L5" option).

3.3.1 Set CW:

1. Turn the Mode Selector Dial to **[CW]** and press **[ENTER]** for 2 seconds. The **[CW]** LED will begin to flash.
2. Drive the actuator to desired clockwise position using the **CW** or **CCW** push button. If the **"STALL"** LED begins to flash; check to see if the limit switch cam is preventing actuator from reaching desired **CW** end-of-travel. If necessary back the cam off so that it will trip the switch slightly beyond the desired end-of-travel.
3. Press the **[ENTER]** button to save the **CW** setting.

3.3.2 Set MID: (if applicable)

1. Turn the Mode Selector Dial to **[MID]** and press **[ENTER]** for 2 seconds. The **[MID]** LED will begin to flash.
2. Drive the actuator to desired **MID** or "THIRD" position using the **CW** or **CCW** push button.
3. Press the **[ENTER]** button to save the **MID** setting.

3.3.3 Set CCW:

1. Turn the Mode Selector Dial to **[CCW]** and press **[ENTER]** for 2 seconds. The **[CCW]** LED will begin to flash.
2. Drive the actuator to desired counterclockwise position using the **CW** or **CCW** push button. If the **"STALL"** LED begins to flash; check to see if the limit switch cam is preventing actuator from reaching desired "end of travel". If necessary back the cam off so that it will trip the switch slightly beyond the desired end-of-travel.
3. Press the **[ENTER]** button to save the **CCW** setting.

3.3.4 Verify End-Of-Travel Settings:

1. Turn the Mode Selector Dial to **[RUN]**.
2. Apply various control signals to verify operation.
3. Replace actuator cover.

4 POWER LOSS & BATTERY MODE OPTIONS

4.1 Battery Mode Selection – PARK AT FAIL or MULTI-CYCLE

The ADC-Series On/Off Control Board is designed to provide continuing service in the event of loss of line power. Upon power loss the ADC-Series actuator, equipped with the optional Battery Back-Up, can be configured to drive the actuator and PARK immediately at the designated power loss (Fail Position), or to continue to MULTI-CYCLE on battery power while a control signal and adequate battery power remain available. When MULTI-CYCLE is selected, the actuator will cycle until a low battery power condition is detected then automatically drive to and remain at the designated power loss (Fail Position). A fully charged battery will provide a minimum of ten complete 90 degree cycles.

To configure the actuator to immediately drive and park at the designated "Fail" position upon loss of line power, move the "Battery Mode On Fail" slide switch to the LEFT, PARK AT FAIL, position.

To configure the actuator to continue to cycle while adequate battery power is available upon loss of line power, move the "Battery Mode On Fail" slide switch to the RIGHT, Multi-Cycle position.

4.2 Power Loss – FAIL Position Selection

The ADC-Series On/Off Control Board is designed to be easily configured to drive to either the CW, CCW or MID position upon loss of line power (applicable with optional Battery Back-Up). This is the power loss or "Fail" position. In the "Fail Position" field, the power loss position is set with a miniature blade screw driver by moving the selector dial to the desired position. When designating MID as the power loss or "Fail" position, the limit type must be set at SMART and the MID position must have been entered and saved in the "**Smart Set**" field.

To confirm the power loss or "Fail" position, select RUN in the "**Smart Set**" field and select PARK AT FAIL in the "Battery Mode On Fail" field. De-energize terminal 1 and terminal 2 on the **P/N VC002360** Power Board. The actuator will drive to the designated power loss or "Fail" position.

4.3 Sleep and Wake Function – Manually Drive the Actuator During Power Outage

(PARK AT FAIL MODE, ONLY) After the battery drives the actuator to the Power Loss Position, the **P/N VC002970** board powers down and remains in **"Sleep"** mode until external power returns to terminals 1 & 2 on the **P/N VC002360** Power Board. To **"Wake"** the actuator, enabling the **CW** or **CCW** push buttons, push the button located below the battery connector (J4) on the upper left, back side of the **P/N VC002970** board. This will "Wake" the electronics and the actuator can be manually operated via the **CW** or **CCW** push buttons until low battery power level is detected. (**Note**: After using the **WAKE** Power Override function the actuator will not revert back to **SLEEP** mode. Disconnect the battery to preserve battery power if line power has not been restored.)

5 BATTERY PACK INFORMATION

The optional Battery Pack is capable of supplying sufficient power to ensure operation of the actuator during power outages. The battery voltage of a fully charged battery should read 13.6 volts as measured at the battery connector, (with the battery disconnected). This voltage will vary with temperature; see "Battery Charging Circuit" below.

Replacement battery packs should be stored only after a full charge and at less than 80°F. Temperature can affect battery shelf life. Generally lower temperatures will increase shelf life while higher temperatures will decrease shelf life.

When recharging battery packs, they should only be recharged from the **P/N VC002970** ADC-Series On/Off Control Board charging circuit, which is calibrated to provide the proper voltage and current for maximum battery pack life.

5.1 Battery Charging Circuit

The battery charging voltage has been designed for optimum battery performance. When charging, the yellow **CHARGING** LED will light. After reaching full charge, the green **CHARGED** LED will light.

The voltage on the battery terminals, connector "J4", will be between 10.5 and 12 volts, when external power is off, and the battery is connected to the 2970 On/Off Control Board. Fully charged, the battery voltage will reach approximately 13.6 volts. This voltage is designed to vary with temperature, and could be as high as 14.4 volts if in a very cold environment, or as low as 12.8 volts if in a very warm environment. This is normal operation.

A battery case that is swollen or cracked must be replaced. Please consult the factory for replacement. If the battery does not reach full charge (the green **CHARGED** LED remaining on and the yellow **CHARGING** LED turning off) within 48 hours, consult the factory or your local representative.

5.2 Battery Replacement

The only suggested maintenance is to examine, and if necessary, replace the batteries every two years. Battery life can vary with temperature. Cooler environments will generally prolong battery life and under ideal conditions ADC batteries will last in excess of five years.

To change the batteries, perform the following:

SMALL ENCLOSURE (150-600 in-lbs)

4. Remove power to the actuator.
5. Disconnect battery connection at the daughter board.
6. Pry back the battery retaining tab on the battery bracket.
7. Remove the battery.
8. Install new battery.
9. Slide battery into bracket so that the retaining tab secures the battery in place.
10. Plug battery connector into the connector on the back of the **P/N VC002970** board, and re-apply power.

LARGE ENCLOSURE (1000-3000 in-lbs)

1. Remove power to the actuator.
2. Unplug the battery wire from the daughter board.
3. Remove battery hold-down bracket.
4. Unplug the wires from the battery tabs.
5. Remove and replace the battery. Re-install the wires on the battery tabs, Black wire to Black terminal and Red wire to Red terminal.
6. Re-install the hold-down bracket.
7. Plug the battery connector into the daughter board, and re-apply power.

6 OUTPUT/POSITION FEEDBACK SIGNAL

Terminal E and terminal F on the **P/N VC002970** On/Off Control Board provide an analog position feedback signal. To enable the output feedback signal the Feedback Potentiometer must be installed, connected to the **P/N VC002970** board and properly calibrated. **See Section 3 for Set Up and Calibration instructions.**

To select a 4-20 mA output signal, move the slide switch to the **UP** position in the Output Signal field. To select a 2-10 VDC output signal, move the slide switch to the **DOWN** position in the Output Signal field.

7 ADC-SERIES STANDARD OPTIONS

All ADC-Series options are designed to be easily installed in the field. Options for all standard ADC-Series actuators are universal and completely interchangeable with each enclosure size. Voltage is not field changeable.

7.1 Option "H" – Tropical Heater and Thermostat P/N VC099035, P/N VC099036, P/N VC099037, P/N VC099038

The tropical heater and thermostat option is a self-adhesive, resistant heater strip which is applied to primary gear-box. It installs with a plug-in connector and is recommended in high-humidity applications. The tropical heater option is also recommended installations that experience wide temperature swings in order to evaporate any condensation. Thermostat is pre-set to active at or below 90°F and deactivate at or above 110°F. The tropical heater draws 15 watts @ 115 VAC, 12 VDC and 24V; 40 watts at 230 VAC. This option can be installed in the field; for 115 VAC applications, order kit **P/N VC099035**; for 230 VAC applications, order kit **P/N VC099036**; for 12 VDC applications, order kit **P/N VC099037** and for 24 V applications, order kit **P/N VC099038 (see Figure 7).**

Option "H" Tropical Heater and Thermostat
Option "T" Standard Heater and Thermostat

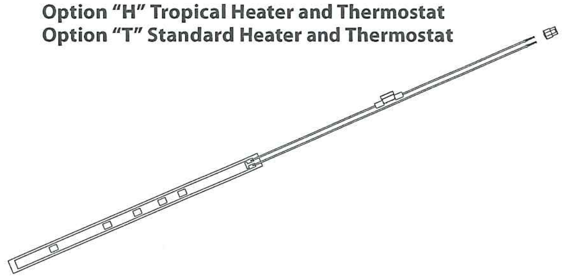


Figure 7

7.2 Option "I" – ISO 5211 Output

150 – 600 in-lbs models are supplied with a 3/4" female square output coupling; when the "I" option is selected they are supplied with a 14mm female square.

1000 – 3000 in-lbs models are supplied with a 1" female square output coupling; when the "I" option is selected, 1000 in-lbs models are supplied with a 19mm female square and 1500 – 3000 in-lbs models are supplied with a 22mm female square.

This option is factory installed only.

7.3 Option "S2" – Two Auxiliary Limit Switches P/N VC099900

The extra switches and stainless steel cams provide dry contacts and are fully adjustable to trip at any position. They are often used for position indication or to interlock other devices (such as in sequencing operations). The switches are single pole, double throw switches rated for 1/2 HP, 15 amps @250 VAC, CSA certified. Auxiliary switch kit **P/N VC099900** is universal to all standard ADC-Series actuators **(see Figure 8).**

Option "S2" – Two Auxiliary Limit Switches

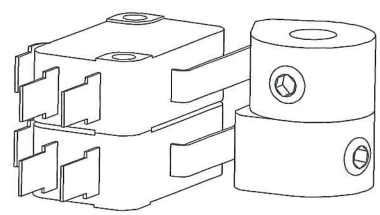


Figure 8

7.4 Option "T" – Heater and Thermostat P/N VC099015, P/N VC099016, P/N VC099017, P/N VC099018

The heater and thermostat option is a self-adhesive, resistance heater strip which is applied to the primary gearbox. It installs with a plug-in connector and is required in installations where the ambient temperatures drop below 32˚F. The heater option is also recommended in installations that experience wide temperature swings in order to evaporate any condensation. The thermostat is pre-set to activate at or below 40˚F and deactivate at or above 60˚F. The heater draws 15 watt @115 VAC, 12 VDC and 24 V; 40 watts @ 230 VAC. This option can be installed in the field; for 115 VAC order kit **P/N VC099015**; for 230 VAC applications, order kit **P/N VC099016**; for 12 VDC applications, order kit **P/N VC099017** and 24 V applications, order kit **P/N VC099018 (see Figure 7).**

7.5 Option "Y" - Keyed Output

150 – 600 in-lb actuators are supplied with a 3/4" female square output coupling; when the "Y" option is selected they are supplied with a 15mm female keyed output.

1000 – 3000 in-lb models are supplied with a 1" female square output coupling; when the "Y" option is selected they are supplied with a 20mm female keyed output.

This option is factory installed only.

7.6 Option "Z" – Handwheel Override P/N VC009097, P/N VC009098

Standard ADC-Series actuators are supplied with a plugged cover. Note that this not recommended for ADC-Series actuators equipped the optional internal battery back-up. If the handwheel override option is selected at the time of order a declutchable shaft and six-inch handwheel are provided for manual positioning. This option can be replaced in the field; for 150 – 600 in-lbs models, order kit **P/N VC009097** and for 1000 – 3000 in-lbs models, order kit **P/N VC009098**.

7.7 CSA Certification

CSA Certification is standard on all standard ADC-Series actuators for applications in either Hazardous (WX) or non-Hazardous (W) locations. CSA certified actuators are identified by the CSA logo on the product label.

7.8 Voltage

115 VAC, 230 VAC, 24 VAC, 12 VDC and 24 VDC. ADC-Series actuators are rated for full torque at +/- 10% of the nominal voltage at 50Hz or 60 Hz. ADC-Series positioning actuators are rated continuous duty. (**Note**: At 50Hz the cycle time will increase by approximately 20%.)

8 GENERAL OPERATING INFORMATION

For enclosure specifications and dimensions, **see Table 2 and Figure 10.**

8.1 NEMA Ratings and CSA Certification

Metso manufactures two styles of Valvcon enclosures: the "W" enclosure is weathertight and designed to NEMA 4/4X standards the "WX" enclosure is "explosionproof" and designed to NEMA 4/4X/7&9 (Class 1, Division 1, Groups C and D, and Class 2, Division 1, Groups E, F and G) standards.

Actuators are certified by CSA to meet Canadian and U.S. standards for applications in both Hazardous and Non-Hazardous locations. The "WX" option must specified at the time of ordering and can only be installed at the factory. Ensure that the actuator's ratings are appropriate for the application environment prior to installation. Use extreme care when removing the cover. Scratches or nicks on the flanges may cause the enclosure not to meet NEMA specifications.

8.2 Duty Cycle and Motor Protection

ADC-Series on/off actuators are equipped with a brushless DC motor and can operate continuously; they are rated for 100% duty cycle operation up to 104°F and for a maximum of 30 starts per minute. Higher temperature applications decrease the available duty cycle.

8.3 Operating Temperature Limits

ADC-Series actuators are designed to operate in ambient environments between 32°F, (0°C) and 130°F, (55°C). If the ambient temperature may drop below 32°F, (0°C), the heater and thermostat option must be installed. The actuator is rated to operate at -40°F, (-40°C) with the heater and thermostat option installed. In outdoor applications where ambient temperatures exceed 80°F, (27°C), actuators should be shielded from direct sunlight. In applications with high media temperatures, insulating blankets, heat shields and/or extended mounting shafts should be used to keep temperatures within normal operating limits.

Heaters and thermostats are required for all outdoor applications and may also be used to dry condensation in high humidity environments.

8.4 Actuator Mounting

The actuator may be mounted in any position including upside-down. It must be firmly secured to a direct mount flange or sturdy mounting bracket. A minimum of four bolts with lock washers should be used to secure the actuator to the bracket. Flexibility in the bracket is not allowed, and backlash, or "play", in the coupling should be minimized. The actuator output shaft must be in line (centered) with the valve shaft to avoid side-loading the shaft.

For output drive dimensions and mounting hardware specifications, **see Figure 10.**

8.5 Lubrication

All rotating power train components are permanently lubricated with multi-purpose Lithium grease suitable for the operating temperature range of the actuator. Additional lubrication is not required in normal operation.

8.6 Problem Prevention

Most actuator problems result from improper installation.

- **Incorrect Wiring and Set Up** Make certain the actuator is wired correctly and travel stops are properly set before power is applied.
- **Coupling, Alignment, and Mounting** Do not add extra torque! Make certain that the mounting arrangement is sturdy, centered, properly aligned, and that all mounting hardware is secure and properly tightened.
- **Moisture** Replace the cover tightly and make certain conduit entry holes are sealed properly to prevent moisture infiltration.

8.7 Warranty

All ADC-Series actuators are backed by a 2 year warranty that covers materials and workmanship.

8.8 Technical Assistance, Replacement Parts, Options and Repairs

All replacement parts, plug-in options, accessories, and repair services for ADC-Series actuators are available through a network of qualified Metso Stocking Representatives. For further technical information or to locate the Metso Stocking Representative closest to you, contact **www.metso.com/automation/valvcon**.

9 SPECIFICATIONS & TECHNICAL INFORMATION

TABLE 1 - TORQUE & VA RATINGS

Torque (in-lbs)	Duty Cycle	12 VDC		24 VDC		24 VAC		115 VAC		230 VAC	
		Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)	Cycle Time (sec/90°)	Current Draw (Amps)
150	100%	11	2.2	13	1.2	8	1.8	9	0.4	9	0.4
300	100%	17	2.5	13	1.4	12	2.1	13	0.5	13	0.4
600	100%	17	2.8	13	1.7	13	2.5	14	0.6	14	0.5
1000	100%	21	4	14	2.4	15	3.5	15	0.9	15	0.6
1500	100%	40	4	24	2.4	27	3.5	29	0.9	29	0.6
2000	100%	40	4.3	33	2.4	28	3.5	29	0.9	29	0.6
2500	100%	55	3.3	40	2	38	3.1	39	0.8	39	0.6
3000	100%	60	3.7	42	2.2	40	3.5	42	0.8	43	0.6

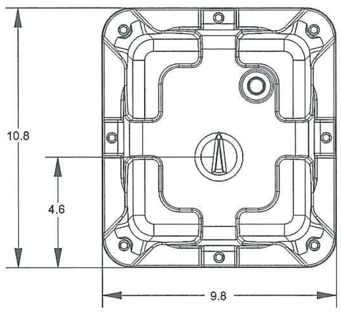
TABLE 2 - SPECIFICATIONS

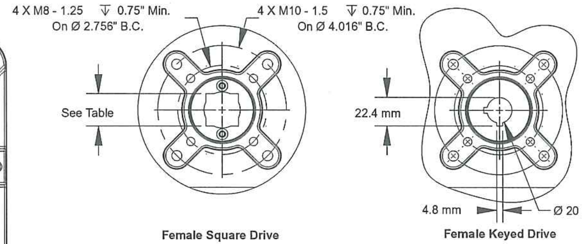
Temperature Range	32°F to 130°F (0˚C to 55˚C) (without heater and thermostat) -40°F to 130°F (-40˚C to 55˚C) (with heater and thermostat)
Conduit Connections	(2) 3/4" NPT in sizes up to 600 in-lbs (3/4" to 1/2" reducing bushings included) (2) 3/4" NPT in sizes 1000 in-lbs and above (3/4" to 1/2" reducing bushings included)
Output	150 to 600 in-lbs: ISO 5211 F05 and F07 bolt circles, 3/4" female square (14mm female square w/ "I" Option; 15mm female keyed output w/ "Y" Option). 1000 to 3000 in-lbs: ISO 5211 F07 and F10 bolt circles, 1" female square (1000 in-lbs: 19mm female square w/ "I" Option; 1500 - 3000 in-lbs: 22mm female square w/ "I" Option; 1000 to 3000 in-lbs: 20mm female keyed output w/ "Y" Option)
Voltage	12VDC: 10.8 to 13.2VAC 24VDC: 21.6 to 26.4VDC 24VAC: 21.6 to 26.4VAC, 50 or 60 Hz 115VAC: 103.5 to 126.5VAC, 50 or 60 Hz 230VAC: 207 to 253VAC, 50 or 60 Hz
Limit Switches	(2) Single pole, double throw switches rated for 1/2 HP, 11 amps @ 250VAC, CSA certified, fuse protected
Motor	Brushed DC motor with Class B or better insulation; sub-fractional horsepower
Lubrication	Permanently lubricated gear train and bearings
Gear Train	Hardened steel spur gears
Approximate Weight	17 lbs for sizes up to 600 in-lbs 31 lbs for sizes 1000 in-lbs and above
Enclosure	Die cast aluminum

9.1 Dimensions

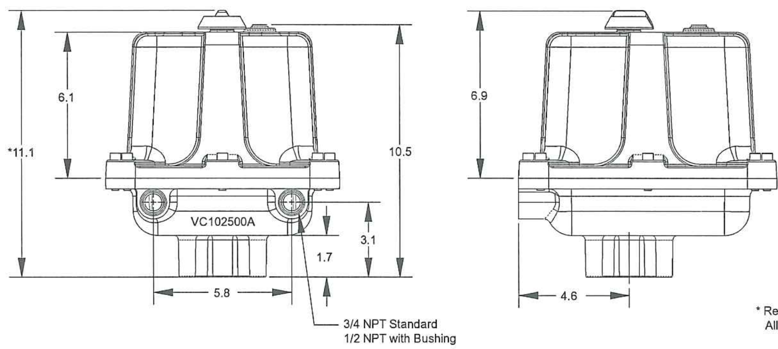
LADC-SERIES ENCLOSURE

Mounting Flange, ISO 5211
F07/F10





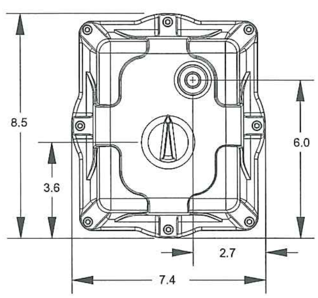
Actuator Size	Drive Option	Drive Type	Drive Size	Depth
1000-3000 lb-in	Standard	Square	1.000 (25mm)	1.20 (30.5mm)
1000 lb-in	Option "I"	Square	0.748 (19mm)	1.20 (30.5mm)
1500-3000 lb-in	Option "I"	Square	0.866 (22mm)	1.20 (30.5mm)
1000-3000 lb-in	Option "Y"	Keyed	0.787 (20mm)	1.50 (38.1mm)

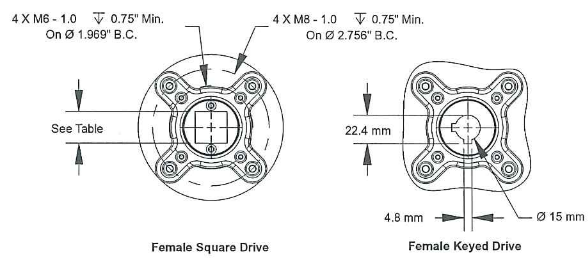


* Requires an additional 5.75" to remove cover
All dimensions in inches unless otherwise stated

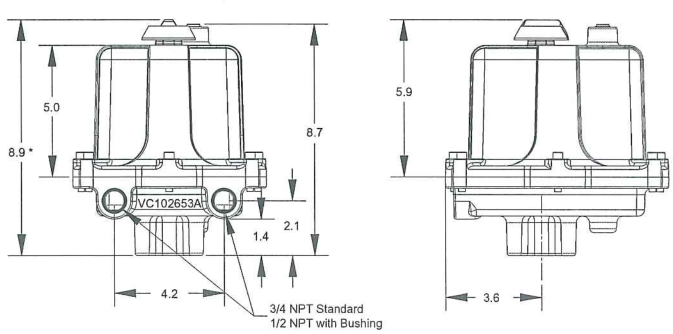
ADC-SERIES ENCLOSURE

Mounting Flange, ISO 5211
F05/F07





Actuator Size	Drive Option	Drive Type	Drive Size	Depth
150-600 lb-in	Standard	Square	0.750 (19mm)	0.90 (22.9mm)
150-600 lb-in	Option "I"	Square	0.551 (14mm)	0.90 (22.9mm)
150-600 lb-in	Option "Y"	Keyed	0.591 (15mm)	1.40 (35.6mm)



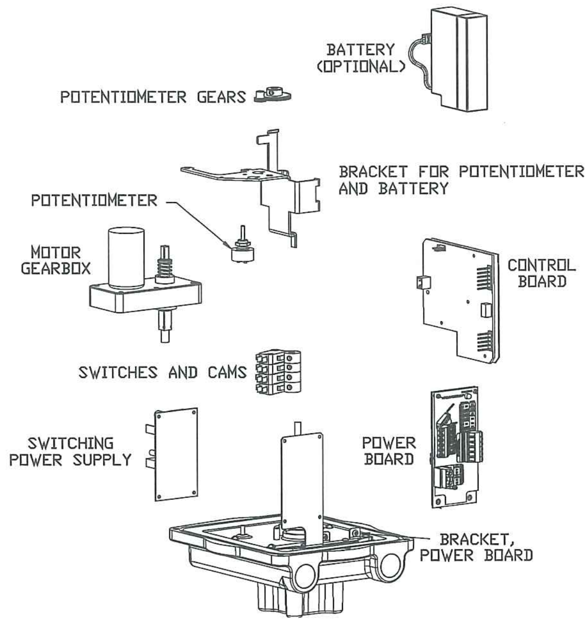
Approximate Weight	17 lb

* Requires an additional 4.75" to remove cover
All dimensions in inches unless otherwise stated

Figure 10

9.2 Exploded View

ADC-Series Spare Parts



PART	DESCRIPTION
	Cover with Position Indicator (not shown)
VC009304	ADC - Small enclosure (150–600 in-lbs)
VC009307	LADC - Large enclosure (1000–3000 in-lbs)
	Cover Screw (8 required)
VC091340	ADC - Small NEMA 4/4X enclosure (150–600 in-lbs)
VC091336	ADC - Small NEMA 4/4X/7/9 enclosure (150–600 in-lbs)
VC091564	LADC - Large enclosure (1000–3000 in-lbs)
	Motor Gearbox
VC006229	ADC (150–600 in-lbs)
VC006144	LADC (1000–2000 in-lbs)
VC006230	LADC (2500–3000 in-lbs)
	Potentiometer and Switches
VC092067	Potentiometer with Gears (90° Operation)
VC099900	Two Auxiliary Switch Kit w/Cams
VC001020	Limit Switch - Replacement
	Brackets with Hardware
VC092665	Bracket, Power Board ADC (150–600 in-lbs)
VC092670	Bracket, Power Board LADC (1000–3000 in-lbs)
VC092450	Bracket, Batter & Potentiometer ADC
VC092445	Bracket, Potentiometer LADC
VC091760	Bracket, Battery LADC
	Power Board Kit Includes Switching Power Supply or Isolator Board (decided by voltage)
VC092361	ADC 115/230VAC
VC092362	LADC 115/230VAC
VC092363	ADC/LADC 12/24VDC
VC092364	ADC/LADC 24VDC
	Tropical Heater and Thermostat Kits
VC099035	Tropical Heater Thermostat 115VAC
VC099036	Tropical Heater Thermostat 230VAC
VC099037	Tropical Heater Thermostat 12VDC
VC099038	Tropical Heater Thermostat 24VAC or 24VDC

	Heater and Thermostat Kits
VC099015	Heater Thermostat 115VAC
VC099016	Heater Thermostat 230VAC
VC099017	Heater Thermostat 12VDC
VC099018	Heater Thermostat 24VAC or 24VDC
	Control Board Kits
VC099050	ADC On/Off Control Board Kit with Battery Back-Up
VC099055	LADC On/Off Control Board Kit with Battery Back-Up
VC099080	ADC On/Off Control Board Kit (without Battery Back-Up)
VC099085	LADC On/Off Control Board Kit (without Battery Back-Up)
	Replacement Battery
VC001573	ADC Battery
VC002509	LADC Battery

NOTES:

Brake – Holding Brake Is Standard On all ADC/LADC-Series Actuators.

Manual Override Is Not A Standard Feature On ADC/LADC-Series Actuators.

Figure 11

10 ENCLOSURE

Table 3

How To Order - ADC-Series Electric Actuators

Series	Enclosure Type		Torque		Board Options[1]		Other Options		Operating Voltage	
	Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
ADC	W	Weathertight	150	150 in•lb	C	Modulating	H[2]	Tropical Heater/Thermostat	N115AC	115 VAC
		NEMA 4/4X	300	300 in•lb	CL2	Modulating Battery Back-Up	I[3a]	ISO 5211 Output	N230AC	230 VAC
			600	600 in•lb	L2	On/off Battery Back-Up	S2	Two Auxiliary Limit Switches	N24AC	24 VAC
	WX	Weathertight & Explosionproof			L4	On/off Battery Back-Up – 3 Position	T[4]	Heater/Thermostat	N12DC	12 VDC
		NEMA 4/4X/7&9			R2	On/Off Isolated Control	Y[5a]	Keyed Output	N24DC	24 VDC
					R3	On/Off Board – 3 Position	Z[6]	Handwheel		
LADC	W	Weathertight	1000	1000 in•lb	C	Modulating	H[2]	Tropical Heater/Thermostat	N115AC	115 VAC
		NEMA 4/4X	1500	1500 in•lb	CL3	Modulating Battery Back-Up	I[3b]	ISO 5211 Output	N230AC	230 VAC
			2000	2000 in•lb	L3	On/off Battery Back-Up	S2	Two Auxiliary Limit Switches	N24AC	24 VAC
	WX	Weathertight & Explosionproof	2500	2500 in•lb	L5	On/off Battery Back-Up – 3 Position	T[4]	Heater/Thermostat	N12DC	12 VDC
		NEMA 4/4X/7&9	3000	3000 in•lb	R2	On/Off Isolated Control	Y[5b]	Keyed Output	N24DC	24 VDC
					R3	On/Off Board – 3 Position	Z[6]	Handwheel		

Notes: 1. Select only one board option; all of these board options include a holding Brake feature
2. This heater option activates at or below 90°F and deactivates at 110°F; it is recommended in high-humidity applications.
3a. 150 - 600 lb-in models with I option are supplied with a 14mm female square (note that without option I the female square is 3/4")
3b. 1000 lb-in models with I option are supplied with a 19mm female square and 1500 - 3000 lb-in models are supplied with a 22mm female square (note that without option I the female square is 1")
4. This heater option activates at or below 40°F and deactivates at 60°F; it is recommended in applications where the temperature may drop below 32°F.
5a. 150 - 600 lb-in models with Y option are supplied with a 15mm female keyed output.
5b. 1000 - 3000 lb-in models with Y option are supplied with a 20mm female keyed output.
6. Handwheel option not recommended with Back-Up Powered options.

- **Enclosure "W"** (weather-tight) is certified by CSA to meet specifications for NEMA 4/4X for weather-tight and dust-tight, environments. It is intended for non-hazardous locations in indoor or outdoor use and provides a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation. It is not designed to be submersible.
- **Enclosure "WX"** (explosion-proof & weather-tight) is certified by CSA to meet specifications for NEMA 7&9, explosion-proof environments as well as to meet NEMA 4/4X specifications. Explosion-proof means that an internal explosion will be contained, with no sparking that could ignite external atmospheric gases. The enclosure is rated for the following environments:
  - NEMA Class I, Division 1, Group C (Ethyl-ether vapors, ethylene or cyclopropane)
  - NEMA Class I, Division 1, Group D (Gasoline, hexane, naptha, benzene, butane, propane, alcohol, acetone, benzol, lacquer, solvent, vapors or natural gas)
  - NEMA Class II, Division 1, Group E (Metal dust, including aluminum, magnesium, their commercial alloys, and other metals of similarly hazardous characteristics)
  - NEMA Class II, Division 1, Group F (Carbon black, coal or coke dust)
  - NEMA Class II, Division 1, Group G (Flour, starch or grain dust)
  - NEMA Class III

Sample Model Code: ADCW150CL2IS2N24AC

Actuator Series	ADC
Enclosure Type	W
Torque	150
Board Option	CL2
Other Options	I
(if applicable)	S2
Operating Voltage	N24AC

For enclosure specifications and dimensions, **see Table 2 and Figure 10.**

- Torque = Breakaway Torque ADC-Series actuators are rated at breakaway torque; the amount of torque the actuator will provide from a fully loaded stop upon immediate power-up. With running momentum and inertia, the amount of torque supplied by the actuator at full speed (running torque) or upon entering a stall condition (stall torque) always exceeds the minimum rated breakaway torque. Since valves require most torque at breakaway, only breakaway torque should be considered when sizing actuators.

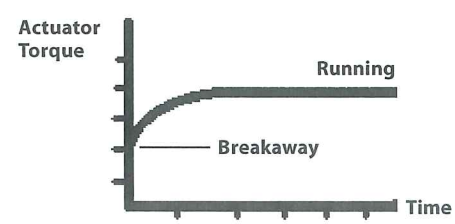


Figure 9

11 ADDITIONAL ACTUATOR PRODUCTS AND ACCESSORIES FROM METSO

V-Series

- Up to 3000 inch pounds for On/Off, Modulating or Automatic Cycling applications
- 75% Duty Cycle
- 115VAC and 230VAC voltages
- NEMA 4/4X and NEMA 4/4X/7&9 enclosures
- CSA Certified (Canadian & U.S. Standards)
- Options include Modulating Control Board, Speed Control/TimerBoard, Iso/Readback Board, extra limit switches, heater/thermostats, motor brake, feedback potentiometer and handwheel override

ESR-Series

- Up to 600 inch pounds for True "Two-Wire" On/Off applications
- 80% Duty Cycle
- 115VAC and 230VAC voltages
- Options include extra limit switches and heater/ thermostats

QX-Series

- Up to 3000 inch pounds for On/Off applications
- Economical NEMA 4/4X/7&9 solution
- 12VDC & 24VDC voltages
- 80% Duty Cycle
- CSA (C US) Certification

LC Series

- Up to 600 inch pounds
- Economical actuators for Reversing or Unidirectional applications
- 25% duty cycle
- NEMA 4/4X enclosures
- 115VAC, 230VAC, 24VAC, 12 VDC and 24VDC voltages
- Options include extra limit switches and heater/thermostats
- Male output (standard) or female output (optional)

I-Series Network Capable

- Modbus®
- AS-Interface
- DeviceNet™
- Foundation Fieldbus
- Other fieldbus protocols (consult factory)

Q6-Series for Remote Solar Applications

- 600 inch pounds
- 12VDC
- Low current draw

Subject to change without prior notice.

Metso Automation Inc.
Europe, Vanha Porvoontie 229, P.O. Box 304, FI-11301 Vantaa, Finland, Tel. +358 20 483 150, fax +358 20 483 151
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www.metso.com/valvcon

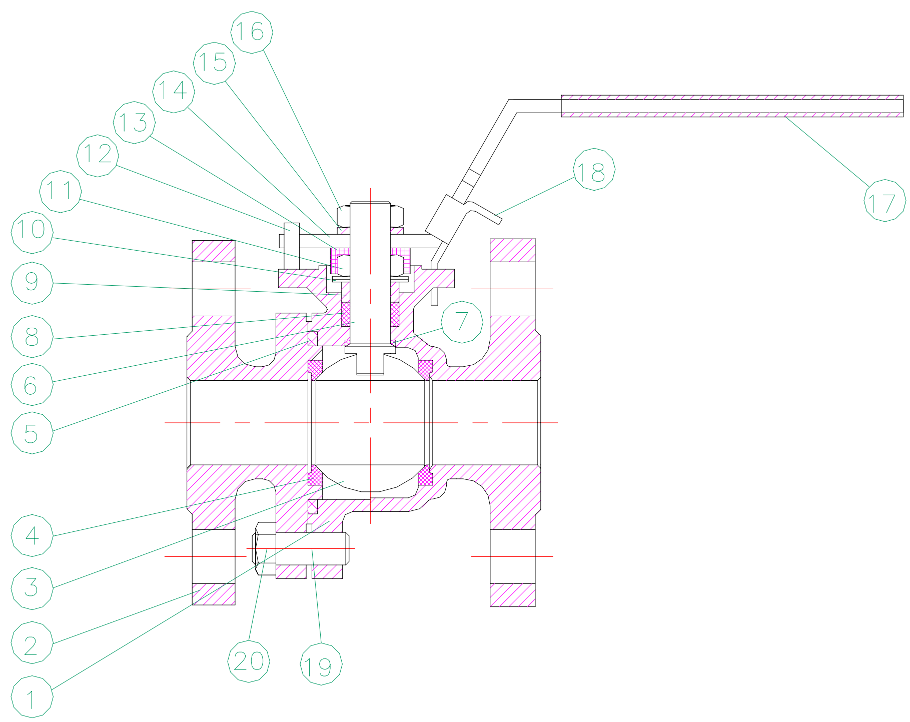
A Division of Smith-Cooper International, LLC

Installation, Operation, and Maintenance Manual

Series 50 / FS50 Flanged Ball Valves

Sizes ½” – 4” , Classes 150, 300, and 600

ITEM	DESCRIPTION
1	BODY
2	END CONNECTOR
3	BALL
4	SEAT
5	BODY GASKET
6	STEM
7	THRUST BEARING
8	STEM PACKING
9	GLAND PACKING
10	BELLVILLE WASHER
11	STEM NUT
12	STOPPER
13	LOCK TAB
14	HANDLE
15	HANDLE WASHER
16	HANDLE NUT
17	SLEEVE
18	LOCKING DEVICE
19	STUD
20	NUT



DESCRIPTION:

Split body, two piece construction full port ball valve. Design allows maintenance without the need for special tools.

INSTALLATION:

1. Before installing the valves, the pipes must be flushed clean of dirt, burrs and welding residues, or you will damage the seats and ball surface.

2. These valves may be installed in any position using good pipe fitting practices. Flanges conform to ASME Standard B16.5, Class 150, 300, or 600.

3. Periodically check and tighten body joint and flange bolting. (See TABLE 1 for torque requirements.)

MANUAL OPERATION:

1. The valve is opened and closed by turning the handle ¼ turn (90°). Turning the handle clockwise closes the valve (handle perpendicular to pipeline). Turning the handle counterclockwise opens the valve (handle parallel to pipeline).

AUTOMATED OPERATION:

1. Valves with Actuators should be checked for alignment of the actuator to the valve. Angular or parallel misalignment may result in high operational torque, and potential damage to the stem seals or stem.

STEM SEAL ADJUSTMENT:

1. Stem seal leakage may be corrected without disassembly. If leakage is evident in stem packing area, tighten the adjusting nut 1/4 turn. If leakage persists, repeat above. Replacement of stem seals is indicated if the leak is still apparent after 1/2 turn.

DISASSEMBLY:

-CAUTION-

If the Valve has been used to control hazardous media, it must be decontaminated before disassembly.

---WARNING---

Do not attempt to repair or partially disassemble a valve while it is in line and under pressure. Isolate the line, de-pressurize, and remove valve prior to performing maintenance.

1. Remove flange bolts and nuts and lift valve from line. Care should be taken to avoid scratching or damaging flange facings.

2. Remove handle and travel stop plate.

3. Remove stem nut locking tab, stem nut, belleville springs, and gland ring from stem.

4. Remove body end nuts, using proper wrench size. Lift off body end. One seat should come out with body end.

5. Remove body seal.

6. To take out the ball, rotate stem so ball is in fully closed position. Carefully lift ball off stem tang and from body with a “rolling” motion. Use a strap and lift device, if necessary. Note: Extreme caution should be taken to avoid damage to the ball.

7. Take out other seat.

8. Stem must be removed from inside the body. The thrust bearing should come out with the stem. Then remove the stem packing.

VISUAL INSPECTION:

1. Clean and inspect all metal parts. Replace the ball and/or stem if the seating or sealing surfaces have been damaged, worn, or corroded.

2. Stem seals, seats, and body seal must be replaced whenever the valve is disassembled to avoid seal leakage and ensure proper performance.

ASSEMBLY:

Note: The valve may be assembled and operated dry where no lubricants are allowed in the system; however, a light lubrication of mating parts will aid in assembly and reduce initial operating torque. Lubricant used must be compatible with the intended line fluid.

1. Install one seat in the body cavity with the spherical curvature facing the ball.

2. Install thrust bearing on stem and slide the stem up through the body.

3. Install new stem seals, gland ring, and belleville springs. Install stem nut and tighten to the torque values given in Table 1. Install stem nut locking tab or cap. Tighten stem nut slightly if necessary to align nut with locking device surfaces.

4. Install travel stop (if supplied) and handle. Make sure handle aligns with flow bore through ball. Install hand retainer nut (or capscrew).

5. Turn the handle to the CLOSED position. Line up the ball slot with the stem tang and the ball into position on the stem tang. Turn the handle to the OPEN position to hold the ball in place.

6. Install the remaining seat into body end.

7. Place new body seal into counterbore in valve body.

8. Put body end into body and align the flange bolt holes to straddle the valve centerlines. **Note:** Be careful not to damage body seal when putting end into body.

9. Install body end nuts and tighten in a "Star" pattern to the torque specified in Table 2. Take care to make sure that complete engagement of studs with body flange is maintained. There should be at least one stud thread exposed on each side.

10. Cycle the valve open and closed several times slowly to ensure that operation is smooth and free of binding or sticking.

11. Pressure test valve, if possible, before reinstalling in pipeline.

Table 1 - Stem Nut Torques

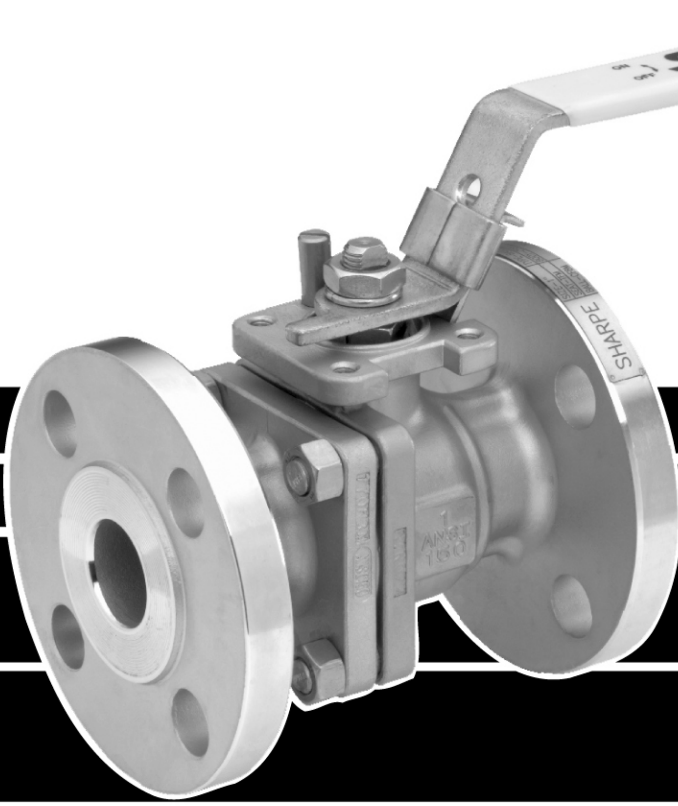
Valve Size	Torque (lb-ft)
½”	5.5
¾”	5.5
1”	6
1-1/2” – 4”	22

Table 2 – Body Bolting Torques (lb-ft)

Valve Size	Class 150	Class 300	Class 600
½”	5	10	15
¾”	5	10	20
1”	5	20	35
1-1/2”	15	35	80
2”	20	40	140
3”	20	60	155
4”	25	95	215

Note: Torque values are for TFE/RTFE or flexible graphite gaskets and seals. For other materials contact Sharpe Valves.

SHARPE® VALVES

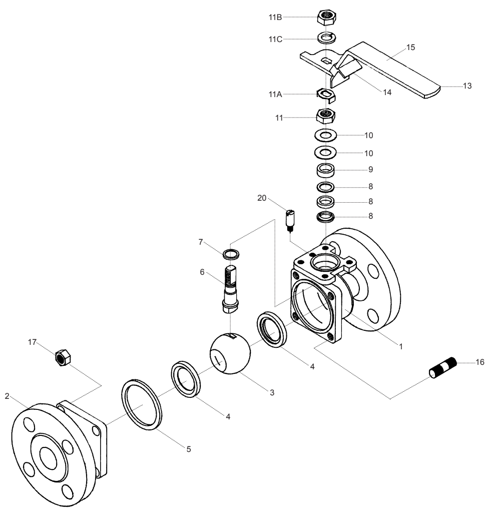


FLANGED FULL PORT
BALL VALVE
SERIES 50 / CLASS 150

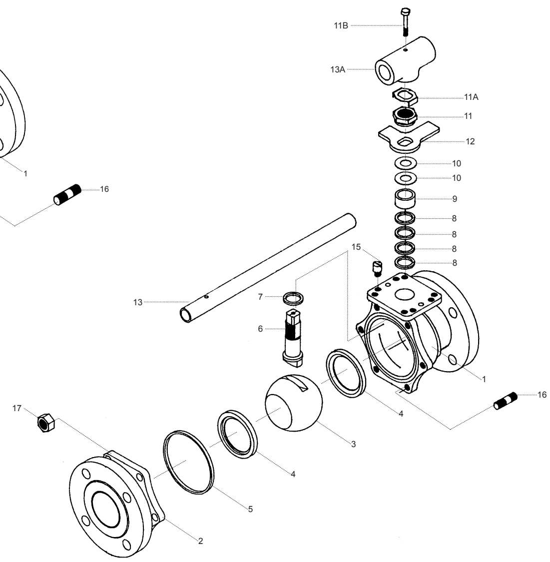
SERIES 50
VALVE PARTS AND IDENTIFICATION

CLASS 150
BLOW OUT PROOF STEM
LOCKING DEVICE

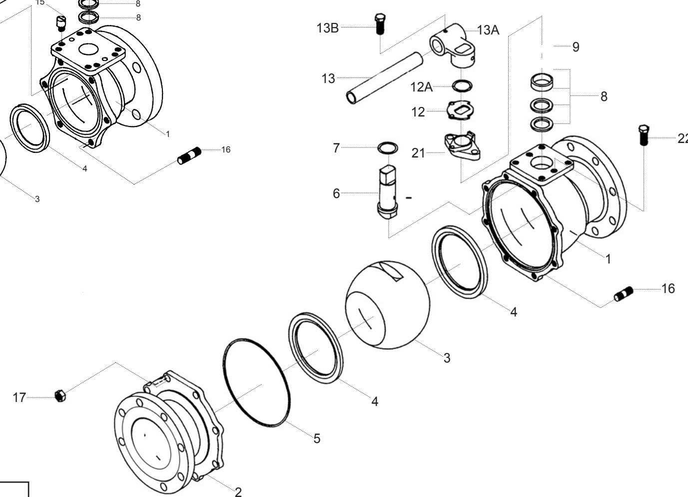
APPLICABLE STANDARDS	
Wall Thickness	ASME B 16.34
Face to Face Dimensions	ASME B 16.10
Flange Dimensions	ASME B 16.5
Pressure Tests	ASME B 16.34 API 598 (Optional)
Basic Design	ASME B16.34



1/2” - 2”



2-1/2” - 4”



6” - 8”

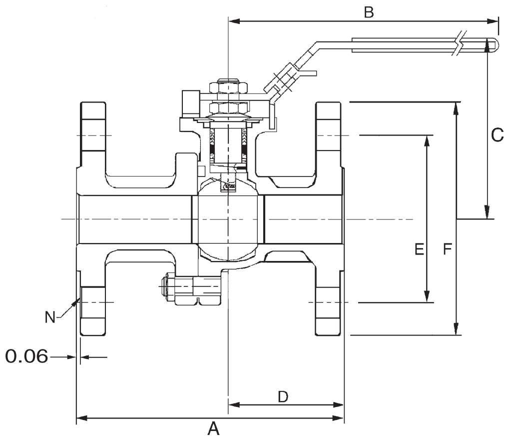
PART NO.	PART	QTY.	MATERIAL
1	Body	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
2	End Connector	1	316 Stainless Steel ASTM A351 CF8M Alloy 20 ASTM A351 CN7M Carbon Steel ASTM A216 WCB Hastelloy C ASTM A494 GR CW-12MW Monel ASTM A494 GR M35-1
3	Ball	1	316 Stainless Steel Alloy 20 Hastelloy C
4	Seat	2	TFM(Super TFE) TFE Reinforced TFE NOVA PEEK
5	Body Seal	1	TFE
6	Stem	1	316 Stainless Steel Alloy 20 Hastelloy C 17-4PH (Option)
7	Thrust Bearing	2	Reinforced TFE
8	Stem Packing	3/4	Reinforced TFE
9	Gland Packing	1	304 Stainless Steel
10	Belleville Washer (1/2”-4”)	2/4	304 Stainless Steel
11	Packing Nut (1/2”-4”)	1	304 Stainless Steel
11A	Lock Tab	1	Stainless Steel
11B	Handle Nut	1	304 Stainless Steel
11C	Lock Washer	1	304 Stainless Steel (1/2”-2”)

*See Dimensions

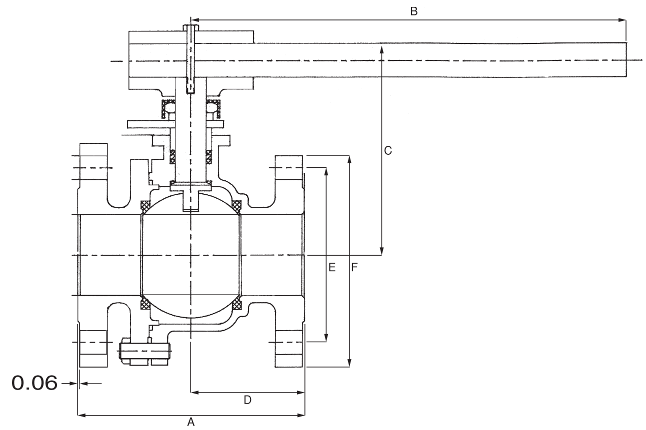
PART NO.	PART	QTY.	MATERIAL
12	Stopper	1	304 Stainless Steel
12A	Snap Ring	1	Stainless Steel (6”-8”)
13	Handle	1	304 Stainless Steel (1/2”-2”) Galvanized Steel (2-1/2”-4”) Ductile Iron (6”-8”)
13A	Wrench Block	1	Stainless Steel
13B	Hex Head Bolt	1	304 Stainless Steel
14	Locking Device (1/2”-2”)	1	304 Stainless Steel
15	Sleeve	1	Vinyl
16	Body Stud	SEE* N	A193 B8 (SST) A193 B7 (CS)
17	Nut	SEE* N	A194 8 (SST) A194 2H (CS)
20	Stop Pin (1/2”-2”) (2-1/2”-4”)	1 2	304 Stainless Steel 304 Stainless Steel
21	Gland Flange (6”-8”)	1	304 Stainless Steel
22	Gland Bolts (6”-8”)	2	304 Stainless Steel

SERIES 50
DIMENSIONS

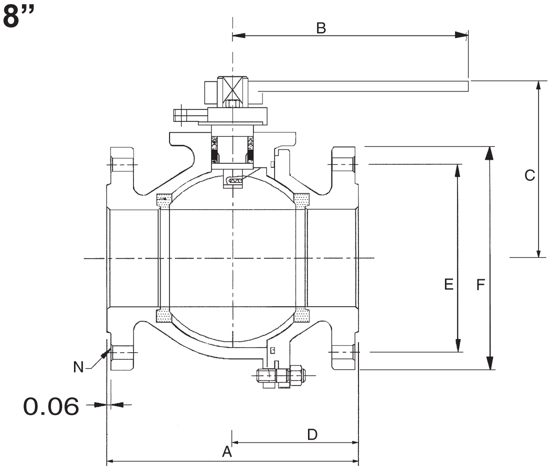
1/2" - 2"



2-1/2" - 4"



6" - 8"



CV DATA

1/2"	26
3/4"	50
1"	94
1-1/2"	260
2"	480
2-1/2"	750
3"	1300
4"	2300
6"	5400
8"	10000

PORT

1/2"	0.59
3/4"	0.78
1"	1.00
1-1/2"	1.50
2"	2.00
2-1/2"	2.55
3"	3.00
4"	4.00
6"	6.00
8"	7.88

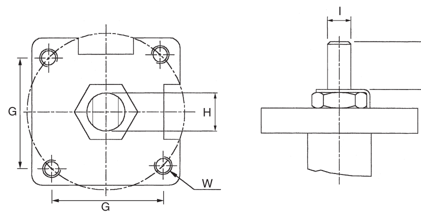
WEIGHT (lbs.)

1/2"	4
3/4"	6
1"	8
1-1/2"	15
2"	20
2-1/2"	36
3"	45
4"	75
6"	135
8"	290

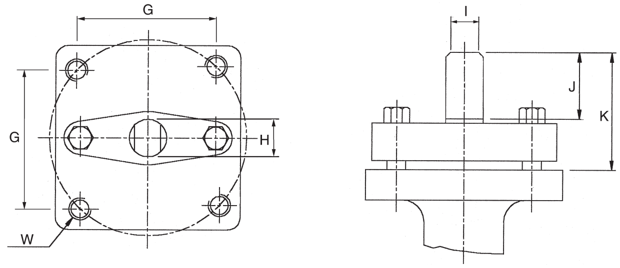
SIZE	A	B	C	D	E	F	N	G	H	I	J	K	W
1/2"	4.25	4.75	3.60	1.80	2.38	3.50	4	1.39	3/8-24 UNF	.22	.28	.63	M5
3/4"	4.62	4.75	3.75	2.00	2.75	3.85	4	1.39	3/8-24 UNF	.22	.28	.63	M5
1"	5.00	6.22	3.75	2.12	3.13	4.25	4	1.39	7/16-20 UNF	.30	.30	.90	M6
1-1/2"	6.50	9.00	4.50	2.76	3.56	5.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2"	7.00	9.00	4.80	3.08	4.75	6.00	4	1.94	9/16-18 UNF	.35	.42	1.18	M8
2-1/2"	7.50	13.75	6.70	3.09	5.50	7.00	4	2.84	M20	.55	.55	1.83	M10
3"	8.00	13.75	7.00	3.74	6.00	7.48	4	2.84	1-14 UNS	.745	.66	1.83	M10
4"	9.00	13.75	7.70	4.46	7.50	9.01	8	2.84	1-14 UNS	.745	.66	1.83	M10
6"	15.50	38.97	11.22	7.61	9.50	10.98	8	3.89	1.02	1.64	1.46	3.00	M12
8"	18.00	38.97	11.57	8.34	11.75	13.50	8	4.59	1.02	1.64	1.46	3.00	M12

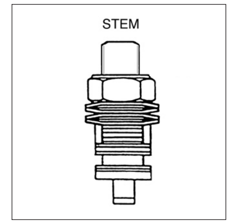
The dimensions above are for information only, not for construction. For complete actuator mounting dimensions refer to Engineering Bulletin EB-2003.

1/2" - 4"



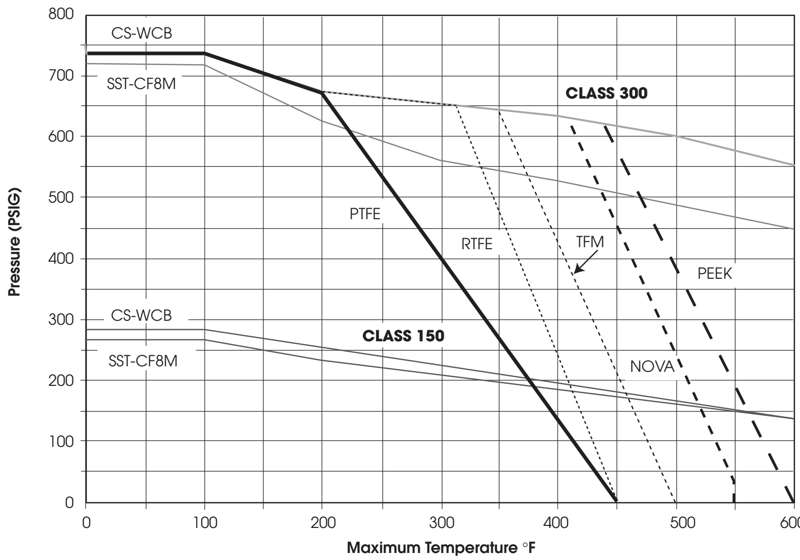
6" - 8"





1/2" - 4"
STEM ARRANGEMENT
FOR ACTUATORS

SEAT PRESSURE/TEMPERATURE RATING SERIES 50



HOW TO ORDER

VALVE SIZE	VALVE SERIES	CLASS	ALLOY	SEATS	OPTIONS
1/2"	50	150# = 11	2 = Alloy 20	T = TFE	X = Oxygen Service
3/4"			4 = Carbon Steel	R = RTFE	OH = Oval Handle
1"			6 = Stainless Steel	N = NOVA	F = Fugitive Emissions Certified ANSI 593.00.01
1-1/2"			5 = Hastelloy C	P = Peek	E = Extended Stem
2"			3 = Monel	M = TFM™	L = Lockable Extended Stem
2-1/2"					D = Leak detection Stem
3"					GO = Gear Operator
4"					7 = 17- 4PH Stem
6"					A = Nace
8"					

3/4" 50 11 6 T X

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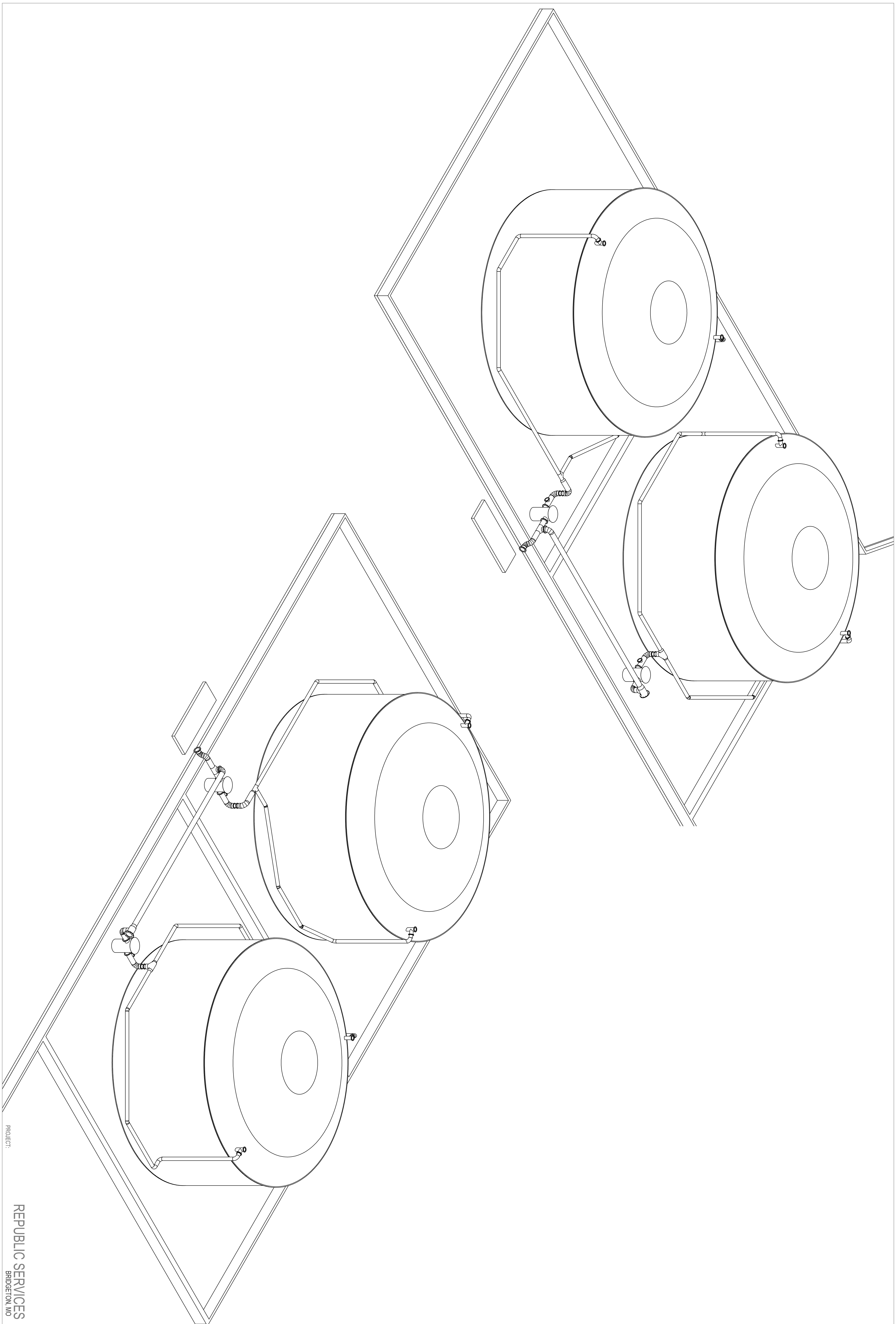
(877) 774-2773
Fax: (708) 562-9250
E-Mail: info@sharpevalves.com
www.sharpevalves.com
1260 Garnet Drive
Northlake, Illinois 60164 U.S.A.



PROJECT:

REPUBLIC SERVICES
BRIDGETON, MO

DRAWING NUMBER:	JOB NUMBER:	REVISION:	CAD FILE NO:	SCALE:
30030 M-4	30030	3	30030 M-1	3/32" = 1'-0"

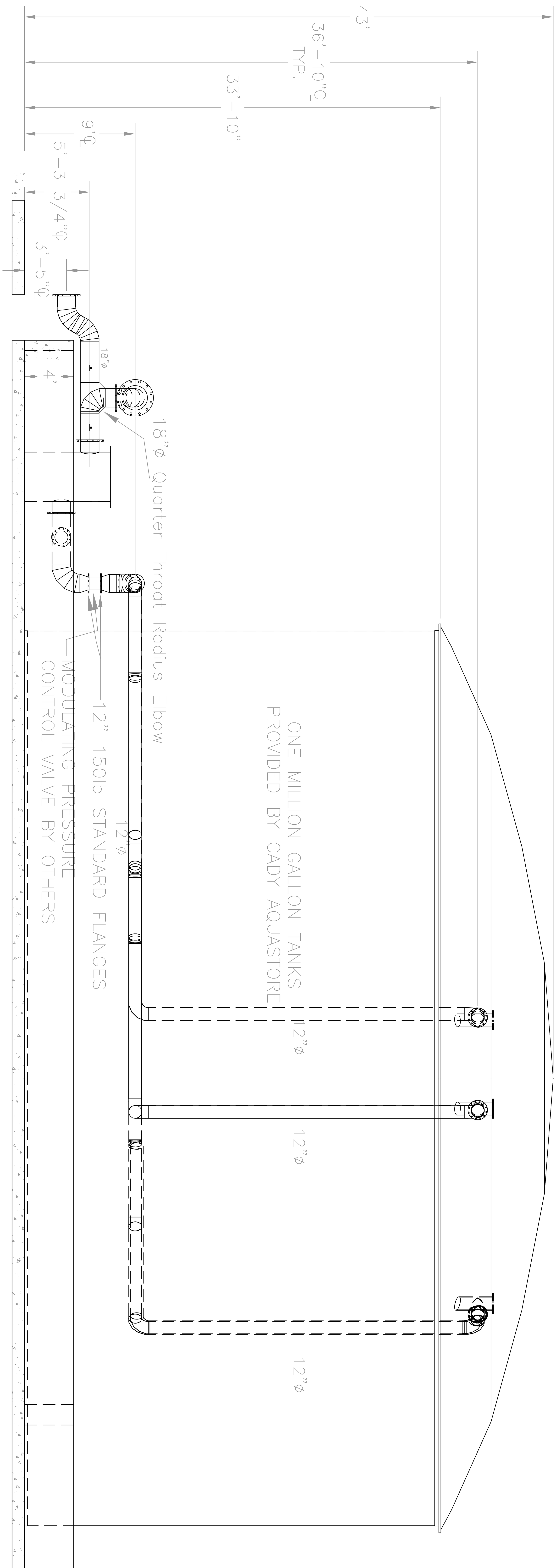
KCH services, inc. ENGINEERED SYSTEMS

144 INDUSTRIAL DRIVE
FOREST CITY, N.C. 28043
828-245-9836

DRAWN	DESIGN	CHECK	APPROVED	DATE	REV.	DESCRIPTION
R.W.	R.W.			11/8/13	0	1MG Tanks Isometric
R.W	R.W.			1/7/14	1	1MG Tanks End Elevation
R.W	R.W			2/18/14	3	ADD TANK 2 SYSTEM END ELEVATION

DESCRIPTION:
END ELEVATION VIEW OF VENTILATION SYSTEM
FOR ONE MILLION GALLON TANKS

PROJECT:
REPUBLIC SERVICES
BRIDGETON, MO



PROJECT:

REPUBLIC SERVICES
BRIDGETON, MO

DRAWN	DESIGN	CHECK	APPROVED	DATE	REV.	DESCRIPTION
R.W.	R.W.			11/8/13	0	1MG Tanks End Elevation
R.W	R.W.			1/7/14	1	1MG Tanks End Elevation
R.W	R.W			2/18/14	3	ADD TANK 2 SYSTEM END ELEVATION

CONFIDENTIAL

144 INDUSTRIAL DRIVE
FOREST CITY, N.C. 28043
828-245-9836

KCH ENGINEERED SYSTEMS

SCALE: 1/4" = 1'-0"

CAD FILE NO. 30030 M-1

REVISION: 3

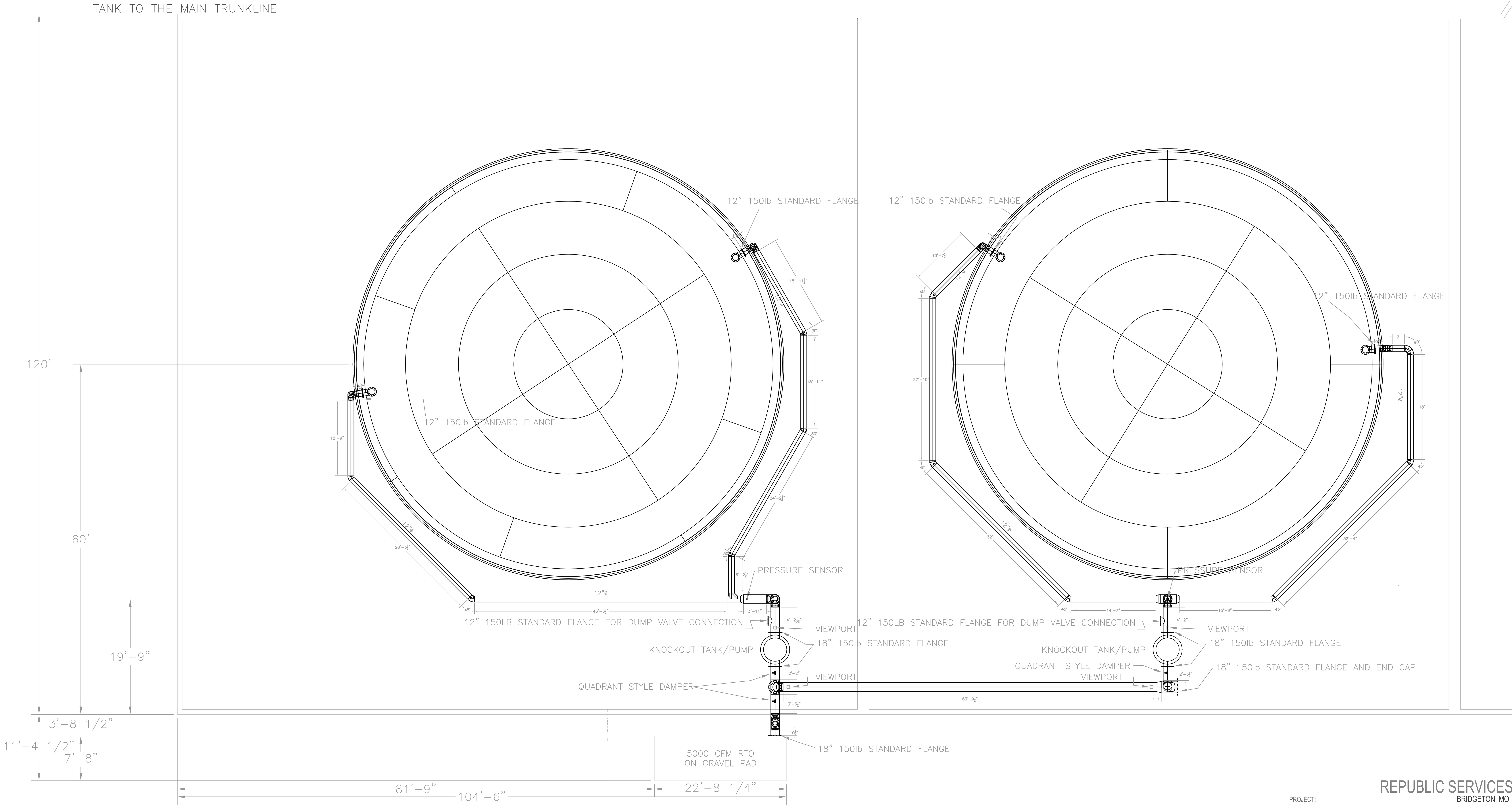
JOB NUMBER: 30030

DRAWING NUMBER: 30030 M-3

DESCRIPTION:
END ELEVATION VIEW OF VENTILATION SYSTEM
FOR ONE MILLION GALLON TANKS

PROJECT:
REPUBLIC SERVICES
BRIDGETON, MO

NOTES:
1. INTERIM SYSTEM FOR TANK ONE AND TWO
2. VACUUM/PRESSURE RELIEF VALVES BY OTHERS
3. MODULATING CONTROL VALVE BY OTHERS
4. PRESSURE SENSOR BY OTHERS
5. CONDENSATE/KNCOKOUT BOX BY OTHERS
6. RENTAL OXIDIZER BY OTHERS
7. DUMP VALVE BY OTHERS
8. DUCT WILL BE EXTRUDED DARK GRAY PVC
9. FITTINGS WILL BE SHIPPED LOOSE TO ENSURE PROPER CONNECTION IN THE FIELD
10. FIELD TRIM WILL BE PROVIDED ON STRAIGHT RUNS TO COMPENSATE FOR MINOR CHANGES
11. ALL FIELD CONNECTIONS WILL BE TRIPLE PASS HOT GAS WELDED WITH PVC ROD
12. DUCT SUPPORTS (IF PURCHASED FROM KCH) WILL BE POWDER COATED STEEL MOUNTED TO CONCRETE.
13. ALL DUCT WILL BE INSTALLED WITH A GRADUAL SLOPE DOWN TOWARD THE CONDENSATE BOX
14. KCH WILL PROVIDE 150LB MATING FLANGE AND KOROSEAL FLEXIBLE CONNECTION AT RTO INLET
15. KCH WILL PROVIDE VIEWPORTS AT THE INLET OF THE KNOCKOUT TANK AND THE CONNECTION FROM EACH TANK TO THE MAIN TRUNKLINE



PROJECT: REPUBLIC SERVICES
BRIDGETON, MO

DESCRIPTION:
PLAN VIEW OF VENTILATION SYSTEM
FOR ONE MILLION GALLON TANKS 1 & 2

PROJECT:
REPUBLIC SERVICES
BRIDGETON, MO

DRAWN	DESIGN	CHECK	APPROVED	DATE	REV.	DESCRIPTION
R.W.	R.W.			11/8/13	0	1 MG Tanks
R.W.	R.W.			1/7/14	1	1 MG Tanks
R.W.	R.W.			1/18/14	2	1 MG TANKS
R.W.	R.W.			2/18/14	3	ADD TANK 2 SYSTEM

144 INDUSTRIAL DRIVE
FOREST CITY, N.C. 28043
828-245-9836

KCH ENGINEERED SYSTEMS

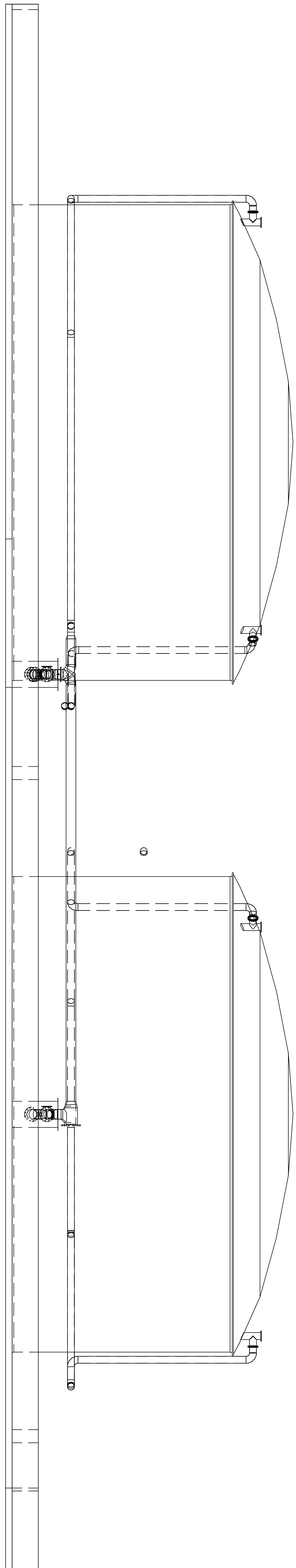
SCALE: 1/8" = 1'-0"

CAD FILE NO: 30030 M-1

REVISION: 0

JOB NUMBER: 30030

DRAWING NUMBER: 30030 M-1



DRAWN	DESIGN	CHECK	APPROVED	DATE	REV.	DESCRIPTION
R.W.	R.W.			11/8/13	0	1MG Tanks Elevation
R.W.	R.W.			1/7/14	1	1MG Tanks Elevation
R.W.	R.W.			2/18/14	3	ADD TANK 2 SYSTEM ELEVATION

DESCRIPTION:

ELEVATION VIEW OF VENTILATION SYSTEM
FOR ONE MILLION GALLON TANKS

PROJECT:

REPUBLIC SERVICES
BRIDGETON, MO

CONFIDENTIAL

144 INDUSTRIAL DRIVE
FOREST CITY, N.C. 28043
828-245-9836

KCH

SCALE: 1/8" = 1'-0"

CAD FILE NO: 30030 M-1

REVISION: 3

JOB NUMBER: 30030

DRAWING NUMBER: 30030 M-2

PROJECT:

REPUBLIC SERVICES
BRIDGETON, MO

SUMMIT PUMP

Model 2196 / 2196-LF / 2196-R / 2796
Standard Process Pump Family

Installation, Operation, and Maintenance Manual

SUMMIT™
PUMP, Inc

WARRANTY

Pumping units assembled by Summit Pump, Inc., Green Bay, WI are guaranteed to be free from defects in material and workmanship for one year from date of shipment from factory in Green Bay, WI. The obligation under this Warranty, statutory or otherwise, is limited to replacement or repair at Green Bay, WI, of such part as shall appear to us upon inspection at such point, to have been defective in material or workmanship.

This Warranty does not obligate Summit Pump, Inc. to bear the cost of labor or transportation charges in connection with replacement or repair of defective parts; nor shall it apply to a pump upon which repairs or alterations have been made unless authorized by Summit Pump, Inc.

No warranty is made in respect to engines, motors, or trade accessories, such being subject to warranties of their respective manufacturers.

No express implied or statutory warranty, other than herein set forth is made or authorized to be made by Summit Pump, Inc.

In no event shall Summit Pump, Inc. be liable for consequential damages or contingent liabilities arising out of the failure of any Summit Pump, Inc. pump or parts thereof to operate properly.

LIABILITY

Summit Pump, Inc. shall not be liable for personal physical injury, damage or delays caused by failure to follow the instructions and procedures for installation, operation and maintenance contained in this manual.

The equipment is not for use in or with any nuclear facility or fire sprinkler system. Buyer accepts the responsibility for insuring that the equipment is not used in violation and Buyer shall indemnify and hold Seller harmless from any and all liability (including such liability resulting from seller's negligence) arising out of said improper use.

COPYRIGHT

The information contained herein is for informational use only and is subject to change without notice. Summit Pump assumes no responsibility or liability for any errors or inaccuracies that may appear in this manual.

Contents

1. INTRODUCTION

This installation, operation, and maintenance manual is designed to help you achieve the best performance and longest life from your Summit Pump models 2196, 2196-LF, 2196-R, and 2796.

This pump is an open impeller, centrifugal model with end suction / top discharge. The pump is designed for handling mild industrial corrosives.

If there are any questions regarding the pump or its application, which are not covered in this manual or in other literature accompanying this unit, please contact your Summit Pump distributor.

For information or technical assistance on the power source, contact the power source manufacturer's local dealer or representative.

SAFETY

The following message types are used in this manual to alert maintenance personnel to procedures that require special attention for the protection and safety of both equipment and personnel:

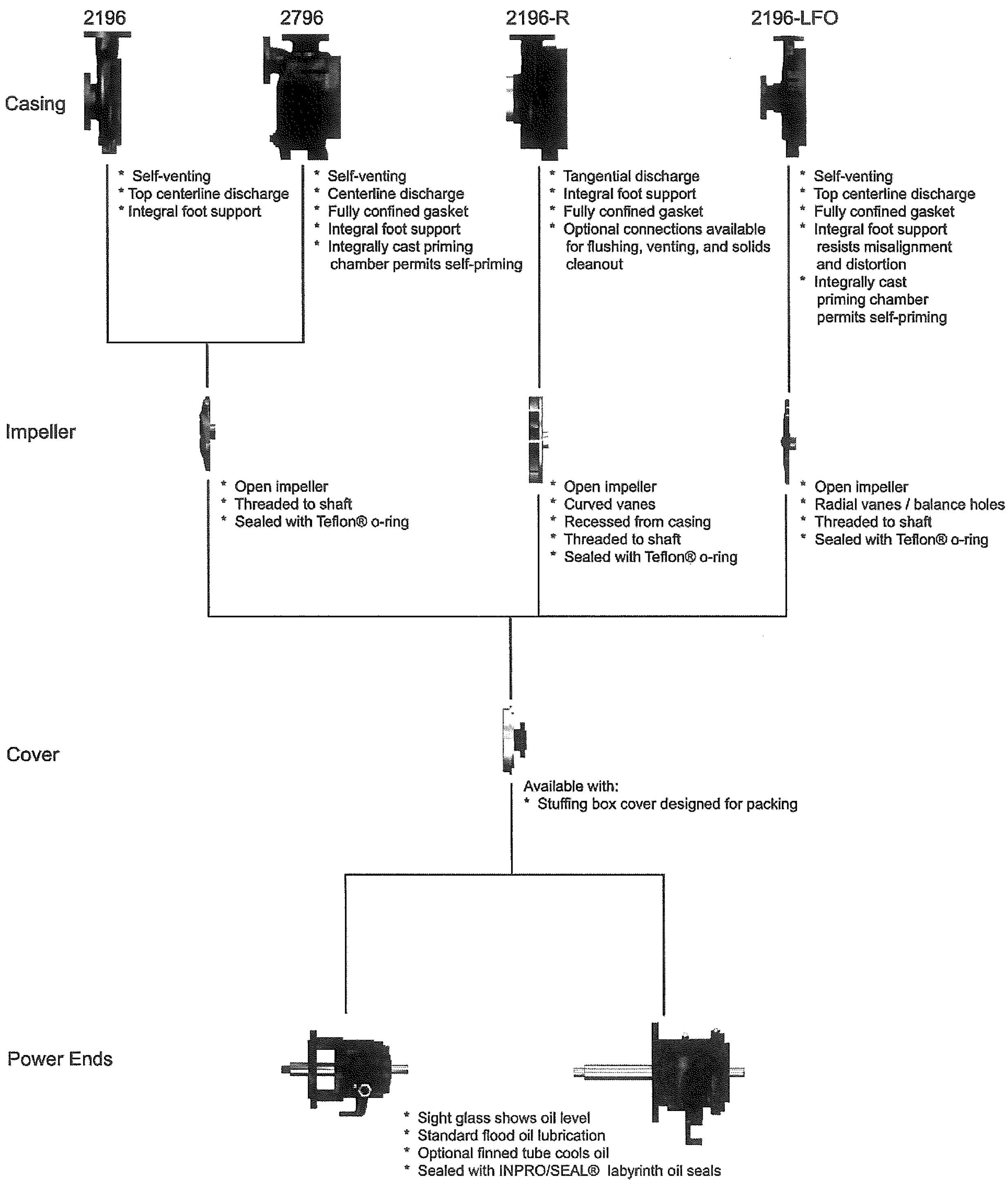
WARNING!
Failure to comply with the warnings in this manual could result in personal injury or death.

CAUTION!
Failure to comply with the cautions in this manual could result in destruction of or damage to equipment.

NOTE: *Identifies a condition or procedure which is essential to proper equipment operation.*

2196 MODEL RELATIONSHIP CHART

The following chart shows the relationship and parts commonality within the 2196 family.



2. RECEIPT AND STORAGE

RECEIVING THE PUMP

WARNING!
Failure to properly lift and move pump could result in serious personal injury.

Immediately upon arrival, carefully inspect the pump for evidence of damage during transit. Immediately report any damage to your Summit Pump Distributor.

STORING THE PUMP

Store the pump in a clean dry place. **Do not remove piping connection covers.** Rotate the pump shaft by hand **at least once per week** to maintain a protective film of oil or grease on the bearings. If you anticipate long-term storage, special treatment is available for purchase from Summit Pump, Inc.

3. INSTALLATION

LOCATION

When choosing a location for the pump, select an area that provides easy access for inspection and maintenance. Locate the pump as close as possible to the source which will provide NPSH (Net Positive Suction Head) equal to or greater than that required by the pump at any capacity over its expected operating range.

FOUNDATION

Use a foundation that is sufficient enough to support all points of the pump base-plate. Level and grout the base-plate per standard construction practices (see ANSI/HI 1.4.2-1997).

PIPING CONNECTION – SUCTION / DISCHARGE

All piping must be independently supported and accurately aligned to the pump suction and discharge flanges. Ideally, you should place a short length of flexible or bellows type spool piece in the connections directly next to the pump flange.

WARNING!
Lock out driver power before beginning to work on pump.

CAUTION!
Never use force to align piping to the pump flanges.

CAUTION!
Never operate pump with suction valve closed.

At a minimum, use suction pipe that is one size larger than the flange. Use an eccentric reducer to meet the suction pipe with the pump. Mount the reducer flat side up. Elbows must be a minimum of ten diameters from the suction flange.

CAUTION!
Never operate pump with discharge valve closed.

The discharge piping should include isolation and check valves. The check valve prevents the pump from rotating backward. Place the check valve between the pump and isolation valve. The isolation valve is used for priming, starting, and shutting down the system. If you use pipe diameter increasers, place them between the pump and the check valve.

ALIGNMENT

The alignment at the pump and drive shaft is one of the most important considerations in the pump installation.

WARNING!
Lock out pump driver. Failure to do so could result in serious personal injury.

■ TO ALIGN THE PUMP

1. Use flexible spacer couplings to achieve proper alignment.
2. Check and adjust the parallel and angular alignment to within .005 inches prior to connecting the coupling halves.
3. Jog the motor to check rotation. Its arrow should match up with the arrow on the pump.
4. Install a coupling guard when the pump is aligned.

Pumps in hot service will need an alignment check at operating temperatures.

STUFFING BOX

Packed Box

Braided packing is supplied as standard equipment on all pumps. Install gland bolt nuts finger-tight only. Adjust the gland bolt nuts during start-up to achieve 40-65 drops of leakage per minute. Specific packing type is dependent on pH, temperature, etc. of the liquid being pumped.

Table 1

	Pump Model				
	STO	MTO	LTO	XLO	XLO-17
Packing Size	5/16"	3/8"	3/8"	7/16"	7/16"
Number of Rings	5				

Clean and cool pumpage may be used to lubricate the packing. If the pumpage is not suitable, you must supply an external source of lubrication.

CAUTION!

Do not allow packing to run dry. It must be lubricated.

See ANSI/ASME B73.1 M-1984 for proper seal flush plans.

Cartridge Mechanical Seal

WARNING!

Determine the effects that a failure of the mechanical seal might have on the environment and personnel and correct conditions to prevent personal injury.

WARNING!

Only work on seal when the pump is locked out and the seal is depressurized.

Refer to the manufacture's installation, operating, and maintenance instructions. Failure to do so can result in environmental damage, personal injury, and seal malfunction and / or seal failure.

Start Up

Read, understand and follow the manufacture's installation, operation, and maintenance instructions.

Storage, Assembly and Disassembly

Read, understand and follow the manufacture's installation, operation, and maintenance instructions.

Type 1 Mechanical Seal

■ TO INSTALL TYPE 1 MECHANICAL SEAL

1. MTO, LTO, XLO Slide the stuffing box cover over the shaft/sleeve. Bolt the cover (184) to the frame adapter(108).
   STO Slide the 6" or 8" stuffing box cover (184) with adapter ring (108) over shaft and bolt to bearing.
2. Mark / scribe the shaft at the face of the stuffing box.
3. Unbolt and remove the stuffing box cover.
4. Locate the installation reference dimension on the seal installation drawing. Normally this is the dimension from the face of the stuffing box to the rear of the seal.

5. Mark the shaft with a felt marker or marking tool at the dimension (i.e. 1/32").
6. Lubricate the shaft with silicon grease or soapy water. Slide the seal onto the shaft. Line up the face of the seal with your mark and secure with set screw.
7. Reassemble the pump.

4. OPERATION

LUBRICATION

CAUTION!
PUMPS ARE SHIPPED WITH NO OIL IN THE BEARING FRAME! Oil must be installed before operating the pump.

Ball bearings are very sensitive to both over and under lubrication, both being detrimental to bearing performance. Use a thermometer to monitor bearing temperature. Overheating will reduce bearing life.

The relationship between bearing temperature and pumpage temperature is an indication of performance. *Table 2* indicates the relationship between these temperatures.

Table 2

	Degrees Fahrenheit		
Pumping liquid temperature	60°	200°	300°
Approximate normal line bearing temperature	115°	140°	160°

The information shown in *Table 2* is based on a room temperature of 70°F. Maximum bearing operating temperature is 175°F. It is necessary to flush water through the stuffing box for liquid temperatures above 250°F. This can be done either through a flushing gland or the stuffing box seal cage.

Oil Lubrication

Use only high quality turbine oil with rust and oxidation inhibitors. Service temperatures determine oil viscosity. See *Table 3*.

Use a 300 SSU viscosity at 100° F for applications where pumping temperatures are below 200° F. At pumping temperatures above 350° F, use 470 SSU at 100° F with optional cooler.

Table 3

Bearing Temperature	ISO Grade	Viscosity at 100 Degrees F
Up to 150° F	46	215 SSU
150° F to 200° F	68	300 SSU
Above 200° F	100	470 SSU

Adding Oil

To add oil to bearing frame, remove filler plug (113A). Fill to center of sight glass with the appropriate oil using *table 4* as a reference. Replace filler plug (113A).

Routine Inspection (daily)

Check oil level through sight glass. Add or remove oil if level is not at center of sight glass.

To add oil to the frame, remove oil fill plug (113A) and fill until oil level is at center of sight glass (319). Replace oil fill plug (113A). To remove oil from the frame, loosen frame drain plug (408A) and capture the excess oil in an appropriate container.

Change oil immediately if oil appears cloudy or contaminated.

Changing oil

Change oil every three months of 2000 hours. Change more frequently if pump is located in an extremely adverse atmosphere.

To change oil in frame, remove filler plug (113A). Have an appropriate container in place to catch the oil and remove frame drain plug (408A). Inspect drained oil for excess contaminates or moisture. Replace frame drain plug (408A). Fill to center of sight glass with the appropriate oil using *table 4* as a reference. Replace filler plug (113A).

CAUTION!

Under filling OR over filling of the bearing frame can cause damage. Fill bearing frame only to the center of the sight glass.

Table 4

Acceptable Lubricating Oils					
ISO VG		32	46	68	100
Keystone:	KLC Antiwear	32	46	68	100
Lubriplate		AC0	AC1	AC2	AC3
Mobil:	DTE	Light	-	Medium	Heavy
Mobil:	Synthetic	624	525	626	627
Phillips:	Magnus	32	46	68	100
	Synthetic, syndustrial mist				100
Shell:	Tellus Fluids HD	32	46	68	100

Grease Lubrication

Regrease grease lubricated bearings with NLG1 No. 2 consistency grease for pumpage temperatures -60° F to 350° F. Grease is not recommended for temperatures above 350° F. Regrease bearings every three months.

Table 5

Acceptable Greases	
Citgo	Mystic EP2
Keystone	81EP2
Mobil	Mobilux EP2
Mobil Synthetic	SCH 100

■ TO REGREASE LUBRICATED BEARINGS

1. Wipe dirt and foreign matter from the fittings.
2. Remove grease relief plugs from the bottom of the frame.
3. Fill grease through fittings until it comes out through the relief holes.
4. Reinstall grease relief plugs.

ROTATION

■ TO ROTATE THE PUMP

1. Lock out power to the pump driver.
2. Remove the coupling guard and coupling.
3. Momentarily restore power and energize the motor to determine rotation.
4. Confirm that motor rotation coincides with proper pump rotation. The proper pump rotation is counterclockwise when facing the pump's suction. Lock out power to pump driver.

WARNING!
Operating the pump in the opposite rotation may dislodge the impeller causing severe damage to the impeller and/or casing.

5. Reinstall the coupling and coupling guard.
6. Unlock power to pump driver.

IMPELLER CLEARANCE

WARNING!
Check impeller clearance prior to starting pump. Setting may have changed during transit.

WARNING!
Lock out power prior to working on pump.

Impeller clearance is the measurement between the impeller vanes and the surface of the casing. This clearance is set at .015 inches during assembly, but may need to be adjusted before initial startup. (See APPENDIX A for detailed procedures on setting the impeller clearance.)

PRIMING

Prior to starting a centrifugal pump, it is imperative that you prime the pump by flooding the suction piping and casing with fluid. Priming will occur when you open the suction isolation valve and the packing sealing liquid valve.

CAUTION!
Do not operate the pump without liquid in the casing.

START UP

■ TO START UP THE PUMP

1. Rotate the pump by hand; making sure that the rotating element is spinning freely.
2. Be sure the suction valve is open.
3. Partially close the discharge valve.

CAUTION!
Do not operate the pump with the discharge valve closed for an extended period of time.

4. Unlock power to the pump driver.
5. Slowly open the discharge valve as soon as the motor reaches operating speed.
6. Check stuffing box leakage and adjust, if necessary, to achieve leakage of 40-65 drops per minute.
7. Adjust the discharge valve as needed while checking piping for leaks.

8. Check mechanical operation of the pump and motor.

WARNING!
Do not operate the pump without the proper guard. See ANSI/ASME B15.1-1996.

SHUT DOWN

■ TO SHUT DOWN THE PUMP

1. Gradually close the discharge valve and turn off the power to the motor.
2. Lock out power to the pump driver.

APPENDIX A - IMPELLER CLEARANCE SETTING

A gradual loss in head and/or capacity can occur. You may restore performance by adjusting the impeller clearance, which is the measurement between the impeller vanes and the surface of the casing.

Table 6

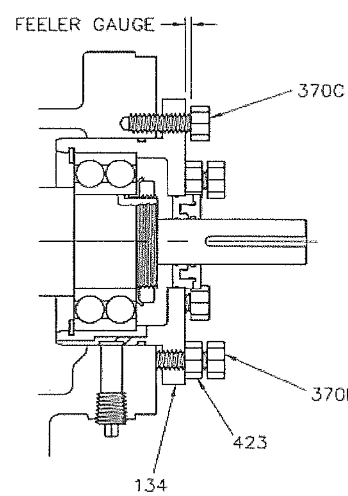
Impeller Clearances					
Pumping Temperature	STO	MTO/LTO	XLO/XLO-17	LFO and 2796	CVO*
-20 to 150° F (-29-66° C)	.005 (.13)	.008 (.20)	.015 (.38)	.015 (.38)	.060 (1.52)
Up to 175° F (80° C)	.005 (.13)	.008 (.20)	.015 (.38)	.015 (.38)	.060 (1.52)
Up to 200° F (93° C)	.005 (.13)	.008 (.20)	.015 (.38)	.015 (.38)	.060 (1.52)
Up to 225° F (107° C)	.006 (.16)	.009 (.23)	.016 (.40)	.016 (.40)	.060 (1.52)
Up to 250° F (121° C)	.007 (.18)	.010 (.26)	.017 (.43)	.017 (.43)	.060 (1.52)
Up to 275° F (135° C)	.008 (.21)	.011 (.28)	.018 (.46)	.018 (.46)	.060 (1.52)
Up to 300° F (149° C)	.009 (.23)	.012 (.30)	.019 (.48)	.019 (.48)	.060 (1.52)
Up to 350° F (177° C)	.011 (.28)	.014 (.36)	.021 (.53)	.021 (.53)	.060 (1.52)
Up to 400° F (204° C)	.013 (.33)	.016 (.41)	.023 (.58)	.023 (.58)	.060 (1.52)
Over 400° F (204° C)	.015 (.38)	.018 (.46)	.025 (.64)	.025 (.64)	.060 (1.52)
* Impeller clearance is set between back side of impeller and stuffing box cover (CVO only).					

FEELER GAUGE TECHNIQUE

Models 2196, 2196-LF and 2796

■ TO USE THE FEELER GAUGE TECHNIQUE FOR IMPELLER CLEARANCE SETTING FOR MODELS 2196, 2196-LF & 2796

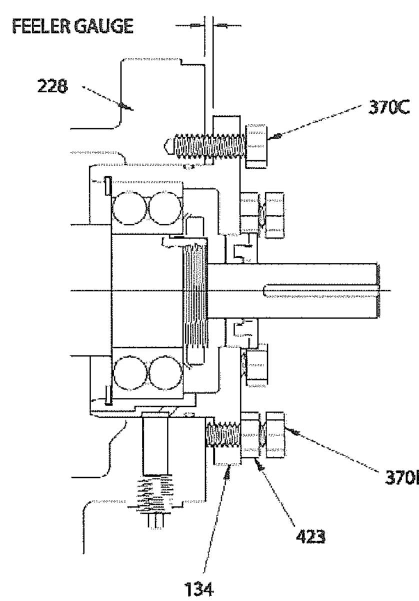
1. Lock out power to the pump driver.
2. Remove the coupling guard.
3. Loosen jacking bolts (370D) and jam nuts (423).
4. Tighten bearing housing bolts (370C) evenly, while slowly rotating the shaft until the impeller starts to rub on the casing (100).
5. Using a feeler gauge, set the gap between the 3 housing bolts (370C) and the bearing housing (134). (Refer to *Table 6* for settings.)
6. Tighten jack bolts (370D) evenly until bearing housing backs out and contacts the bearing housing bolts (370C).
7. Tighten jam nuts (423) evenly, rotating the shaft to make sure the assembly turns freely.
8. Reinstall the coupling guard.
9. Unlock power to the pump driver.



Model 2196R Feeler Gauge Technique

■ TO USE THE FEELER GAUGE TECHNIQUE FOR IMPELLER CLEARANCE SETTING FOR MODEL 2196-R

1. Lock out power to the pump driver.
2. Remove the coupling guard.
3. Remove coupling.
4. Loosen bearing housing bolts (370C) several turns.
5. Loosen jam nuts (423) and turn jackbolts (370D) evenly around several turns until impeller contacts stuffing box cover (184). Turn shaft to ensure contact is complete.
6. Use feeler gauge to measure the gap between the bearing frame (228) and the bearing housing (134). Reduce the measurement by .060" and place the resulting feeler gauge thickness between the bearing housing (134) and the bearing frame (228).
7. Loosen the jacking bolts (370D) several turns. Tighten the locking bolts (370C) to move the impeller away from the stuffing box cover (184) until the bearing housing (134) snugs up the feeler gauge between the bearing housing (184) and the bearing frame (228).
8. Turn jacking bolts (370D) in and tighten jam nuts (423) evenly, rotating the shaft to make sure the assembly turns freely.
9. Reinstall the drive coupling.
10. Reinstall the coupling guard.
11. Unlock power to the pump driver.

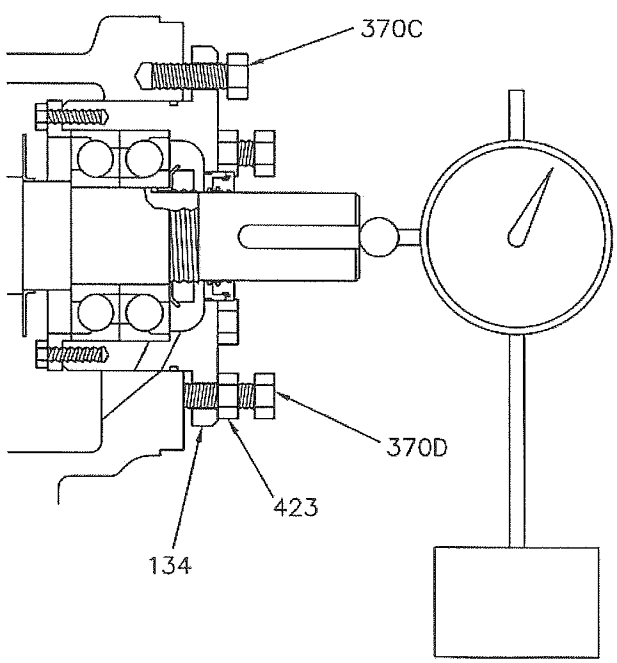


DIAL INDICATOR TECHNIQUE

Models 2196, 2196-LF and 2796

■ TO USE THE DIAL INDICATOR TECHNIQUE FOR IMPELLER CLEARANCE SETTING

1. Lock out power to the pump driver.
2. Remove the coupling guard.
3. Place a dial indicator with a magnetic base on the pump base plate. Place the indicator against the end of the pump shaft or coupling face.
4. Loosen jack bolts (370D) and jam nuts (423).
5. Tighten bearing housing bolts (370C) evenly while slowly rotating the shaft until the impeller starts to rub on the casing (100).
6. Set the dial indicator to zero.
7. Tighten the jack bolts (370D) evenly until they contact the frame. Continue to tighten until the dial indicator reads the proper clearance as shown in *Table 6*.
8. Tighten bearing housing bolts (370C) evenly; then tighten jack bolts (370D) evenly. Be sure the dial indicator **does not move** from the proper setting.
9. Rotate the shaft to be sure it turns freely.
10. Reinstall the coupling guard.
11. Unlock power to the pump driver.



Model 2196-R Dial Indicator Technique

1. Lock out power to the pump driver.
2. Remove the coupling guard.
3. Remove coupling.
4. Place a dial indicator with a magnetic base on the pump base plate. Place the indicator tip in contact with either the shaft end or coupling face. (See diagram on page15.)
5. Loosen bearing housing bolts (370C) several turns.
6. Loosen jam nuts (423) on jack bolts (370D) evenly around several turns until impeller contacts the stuffing box cover (184). Turn the shaft to ensure contact is made.
7. Set the dial indicator to zero.
8. Loosen the jacking bolts (370D) evenly several turns and tighten the bearing housing bolts (370C) to move the impeller away from the stuffing box cover until the dial indicator shows a 0.060" clearance.
9. Turn in the jacking bolts (370D) and tighten the jam nuts (423) evenly.
10. Rotate the shaft to be sure it turns freely.
11. Reinstall coupling.
12. Reinstall the coupling guard.
13. Unlock power to the pump driver.

APPENDIX B - CENTRIFUGAL PUMP TROUBLESHOOTING

The following table provides possible solutions for symptoms that you may encounter with your centrifugal pump.

WARNING!

Before attempting to service the pump:

1. Follow the shut down procedures.
2. Lock out the power source.
3. Allow the pump to cool.
4. Close the suction and discharge valves.
5. Drain the pump.

Table 7

CENTRIFUGAL PUMP TROUBLESHOOTING		
Symptom	Cause	Solution
Pump not delivering liquid	• Pump not primed.	• Re-prime pump.
	• Suction lift too high.	• Install shorter suction pipe.
	• Wrong direction of rotation.	• Change motor wiring.
	• Impeller clogged.	• Back-flush pump.
	• Suction line plugged.	• Remove debris.
Low flow and low head	• Air leak in stuffing box.	• Replace or adjust packing.
	• Worn suction side plate.	• Replace defective part.
	• Impeller worn or damaged.	• Inspect and replace impeller, if needed.
	• Air leak in suction line.	• Replace gasket.
	• Impeller clogged.	• Back-flush pump.
	• Wrong direction of rotation.	• Change motor wiring.

Table 7 (continued)

CENTRIFUGAL PUMP TROUBLESHOOTING		
Symptom	**Cause**	**Solution**
Pump loses prime	• Pump not primed correctly.	• Re-prime pump.
	• Air leak in suction line.	• Replace gasket or pipe plug.
	• Lantern ring in wrong location.	• Repack moving lantern ring to correctly align with flush hole.
Bearings are running hot	• Misalignment.	• Realign drive coupling.
	• Low or insufficient lubricant.	• Check oil level and or grease.
Motor requires excessive amperage	• Stuffing box gland is too tight.	• Readjust or replace packing.
	• Total dynamic head is too low.	• Install throttle or reduce impeller diameter.
	• Rotary part rubbing stationary part.	• Adjust part or replace parts.
	• Liquid is heavier than specified.	• Check specific gravity of liquid.
Stuffing box is leaking excessively	• Stuffing box is incorrectly packed.	• Repack stuffing box.
	• Shaft sleeve is scored or worn.	• Replace shaft sleeve as required.
	• Wrong type of packing.	• Install correct packing.
	• Shaft is bent.	• Replace shaft.
	• Worn mechanical seal parts.	• Rebuild seal; replace parts.

APPENDIX C - MAINTENANCE AND REPAIR

WARNING!
WEAR EYE PROTECTION. Failure to do so can result in serious personal injury.

DISASSEMBLY PROCEDURES

(See APPENDIX D for cross-section of corresponding model.)

■ TO DISASSEMBLE YOUR MODEL 2196, 2196-LF, OR 2196-R PUMP

1. Lock out power supply at the motor starter.
2. Close off discharge, suction, sealing fluid, and cooling fluid.
3. Drain casing and flush, if needed.

WARNING!
Pump parts are heavy. Use proper lifting methods to avoid personal injury.

4. Place lifting sling through frame to ensure safe handling during disassembly/ assembly.
5. Remove bolts (370) holding the frame adapter (108) to casing (100).
6. Pull the frame adapter back from casing by tightening jack bolts (418).
7. Take the frame assembly to bench and secure for further work.
8. Scribe the location of coupling half on the shaft (122) and remove the coupling.

WARNING!
Never use heat to remove impeller. Heat combined with trapped fluid could cause an explosion, which can result in personal injury.

9. Remove the impeller (101) from the shaft (122) while holding the shaft with a strap wrench or suitable tool that will not mark the shaft.

NOTE: *Threads are right-handed.*

> **NOTE**: *XLO – Remove impeller plug (428Y) from the impeller (101). Do not save impeller gasket (428D).*

For a packed pump:

a. Remove the packing gland nuts (353A).

b. Slide gland toward frame (228).

c. Remove seal chamber nuts (423B).

d. Slide off stuffing box cover (184).

e. Remove packing (106) and lantern ring (105).

For a mechanical seal:

a. Remove seal gland nuts (353A).

b. Slide gland toward frame (228), exercising care so as to not drop stationary set from gland.

c. Remove seal chamber nuts (423B).

d. Slide off stuffing box cover (184).

e. Remove mechanical seal rotating element (383) and sleeve (128) from pump shaft.

f. Loosen set screws if present. Refer to cartridge seal manufacturer's instructions.

g. Slide off seal gland with stationary seal and o-ring gasket.

10. Remove the frame adapter (108) by removing two dowel pins (469B) and four adapter bolts (370B) and then separate the adapter (108) from the bearing frame (228).

> **NOTE**: *This step does not apply to the 6" STO Model.*

11. Remove the bearing housing bolts (370C) and loosen the jam nuts (423).
12. Tighten the jack-bolts (370D) evenly to push the bearing housing out of frame.
13. Slide shaft assembly, with housing, out of bearing frame.
14. On the STO and MTO, remove the bearing housing snap ring (361A).
    On the LTO and XLO, remove bearing cover screws (370G) and remove bearing cover (109C). Then remove the bearing housing (134) by tapping with a rubber hammer.
15. Remove bearing lock nut (136) and bearing lock washer (382).

16. Remove inboard bearing (168A) and outboard bearing (112). Use an arbor press or bearing puller to facilitate. On LTO models only, do not remove oil ring (248A) unless it is damaged.

> **NOTE**: ***Do not*** *use a hammer, which may cause damage to the shaft.*

17. Complete disassembly of bearing frame (228). Remove oil plug (408A) (not shown), oil sight glass (145), oil cooler inlet (408L), outlet plugs (408M), and frame foot attachment bolt (529) and foot (241), where applicable.
18. Inspect all parts for cracks, erosion, pitting, rusting, damaged threads, corrosion, and groove worn shaft/sleeve. Replace casing if grooves and pits are greater than 1/8" deep. Replace impeller if grooves are greater than 1/16" or even wear exceeds 1/32". Inspect shaft sleeve if grooved or pitted. Shaft run out or bearing shoulder damage is cause for replacement.

ASSEMBLY PROCEDURES

(See APPENDIX D for cross-section of corresponding model.)

■ TO ASSEMBLE YOUR PUMP

Refer to Bolt Torque Values when assembling pump.

Bolt Torque Values, Ft-Lbs (N-m)			
Description	Frame	Model 2196	
		Lube	*Dry*
Bolt, casing to adaptor (370)	STO 6"	30 (40)	45 (60)
	STO 8"	20 (27)	30 (40)
	MTO, LTO	30 (40)	45 (60)
	XLO, XLO-17	30 (40)	45 (60)
Bolt, frame to adaptor (370B)	All	20 (27)	30 (40)
Bolt, clamp ring (370G)	STO, MTO	10* (1.1)	17* (1.9)
	LTO	55* (6.2)	83* (9.4)
Bolt, bearing end cover (371C)	XLO, XLO-17	9 (12)	12 (16)
*Values are in inch-lbs (N-m)			

1. Clean the bearing frame and inspect all tapped holes. Chase as needed.
2. Install oil fill plug (113A), oil sight glass (144), and frame lubrication plugs (408H).
3. Attach bearing frame foot (241) with bolts (529), where applicable.
4. On the LTO model, install oil ring (248A) on shaft (122), if removed. Oil ring is a press fit onto shaft.

> **NOTE**: *Use proper size drive tool to prevent damage.*

5. On the LTO model, install bearing cover (109C) over shaft (122).
6. Install outboard bearing (112) on shaft (122).

   If grease lubricated, install with shield away from impeller end.

   If oil lubricated, there should be no seals or shields.

   The recommended bearing installation method is heating the bearing using an induction heater.

WARNING!
WEAR INSULATED GLOVES when using heater. Failure to do so can result in serious personal injury while handling hot bearings.

   NOTE: *LTO frames use duplex angular contact bearings.*

   Make sure bearings are mounted in the correct order, back to back.

7. Install a bearing lock washer (382) on the shaft.
   a. Place tang of lock washer in shaft keyway.
   b. Install lock-nut (136) on shaft.
   c. Using a spanner wrench, tighten the nut until snug; then bend any one of the tangs into a lock-nut slot.
8. Install inboard bearing (168A) on shaft (122).

   If grease lubricated, install with shield toward impeller end.

   If oil lubricated, there should be no seals or shields.
9. Install the outboard labyrinth oil seal (332) in the bearing housing (134). Follow Maintenance instructions in *Appendix E*.

   NOTE: *Make sure drain slots face down.*

10. Apply a thin coating of lubricant to the inside of the bearing housing (134).
11. Slide the bearing housing (134) over the outboard bearing assembly (112) and shaft (122). Place the coupling end of the shaft into the bearing housing through the labyrinth oil seal.
    On the XLO model, install the bearing cover gasket (360G).
    On the STO and MTO models, install the bearing housing snap ring (361A) into the groove on the bore of the bearing housing. Make sure the flat side is toward

the bearing.
On the <u>LTO</u> and <u>XLO</u> models, install bearing cover (109C) and bolts (370G).

12. Install a new O-ring (496) over the O.D. of the bearing housing.
13. Apply a thin coating of lubricant to the outside of the bearing housing (134) and slide the assembly into the bearing frame (228).
14. Install bearing housing bolts (370C) into bearing frame (228) and install jack bolts (370D) and jam nuts (423). Hand-tighten evenly.
15. Attach frame (228) to adapter (108).
    a. Align dowel pins (469B), adapter bolts (370B) and frame to adaptor gasket (360D).
    b. Tighten using criss-cross pattern.
    c. Rotate shaft 360 degrees. It should be free.

> **NOTE**: *These steps do not apply to the 6" STO Model.*

16. Set frame (228) and adapter (108) upright. Clamp to bench for safety as assembly continues.
17. Install inboard bearing labyrinth seal in adapter frame. Make sure that the seal's drain slots face down. Follow Maintenance instructions in *Appendix E.*
18. Put anti-seize compound on the shaft and, if equipped, install shaft sleeve (126) onto shaft (122).
19. Align anti-rotation pin with notch in sleeve (126).

    For <u>mechanical seal</u> pumps, read manufacturer's instructions for assembly. (See STUFFING BOX on page 5.)
20. Install stuffing box cover (184) onto adapter with studs (353) and nuts (353A).
21. Install impeller (101) with new O-ring (412).
22. Using an impeller wrench or strap wrench on the coupling end of the shaft, tighten by rotating clockwise. Make sure coupling is tight to the shaft.
23. For packed pumps, install the appropriate packing (106) in the stuffing box cover (184) according to fluid being pumped (105).
    a. First, insert two packing rings into bottom of box.
    b. Next, insert the lantern ring (105). Make sure to stagger packing joints and lantern ring joint by 90 and be sure lantern ring lines up with flushing connection. Install gland halves (107).
    c. Hand-tighten nuts (353A). You must make final adjustments after the pump has begun operation.

    For <u>mechanical seal</u> pumps, continue by following manufacturer's instructions noted in *Step 19*.

24. Install casing gasket (351) onto stuffing box cover (184). At this point, the power end is ready for reinstallation into the casing or for storage for future use.
25. If returning to service, slide assembly into casing (100).
26. Install casing bolts (370) into frame to pull assembly into casing.
27. Rotate the shaft to ensure that no rubbing exists.
28. Adjust impeller clearance according to the instructions beginning on page 13.
29. Align drive coupling according to the instructions beginning on page 5, in addition to coupling manufacturer instructions.
30. If the motor was replaced, check rotation prior to reconnecting coupling halves. (See rotation instructions on page 10).

CAUTION!
Check that motor rotation agrees with pump rotation.

31. Reinstall coupling guard.

RECOMMENDED SPARE PARTS

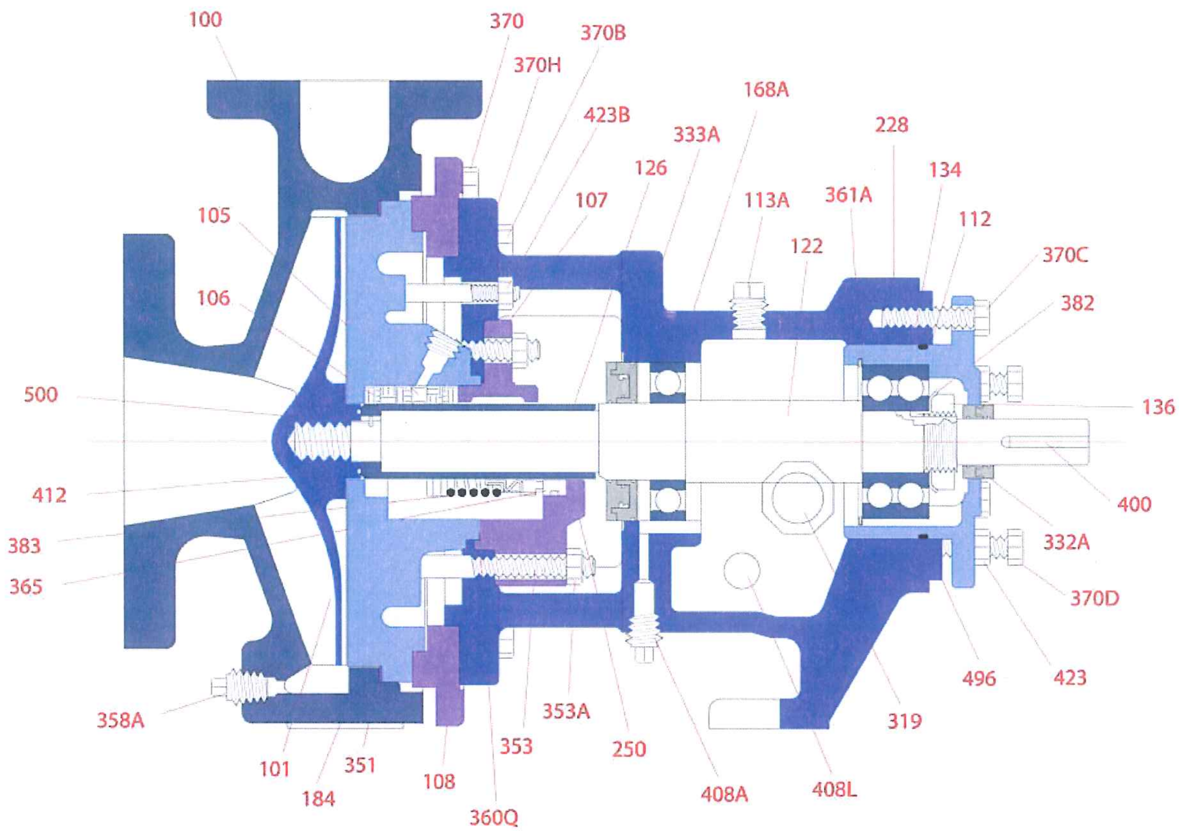
SHAFT KIT

MAINTENANCE KIT (902)

IMPELLER (101)	IMPELLER O-RING (412)
SHAFT (122)	BEARING HOUSING O-RING (496)
SHAFT SLEEVE (126)	OUTBOARD LABYRINTH SEAL (332A)
OUTBOARD BEARING (112)	INBOARD LABYRINTH SEAL (333A)
INBOARD BEARING (168)	BEARING LOCKNUT (136)
CASING GASKET (351)	BEARING HOUSING RETAINING RING (361A)
FRAME-TO-ADAPTOR GASKET (360D)	

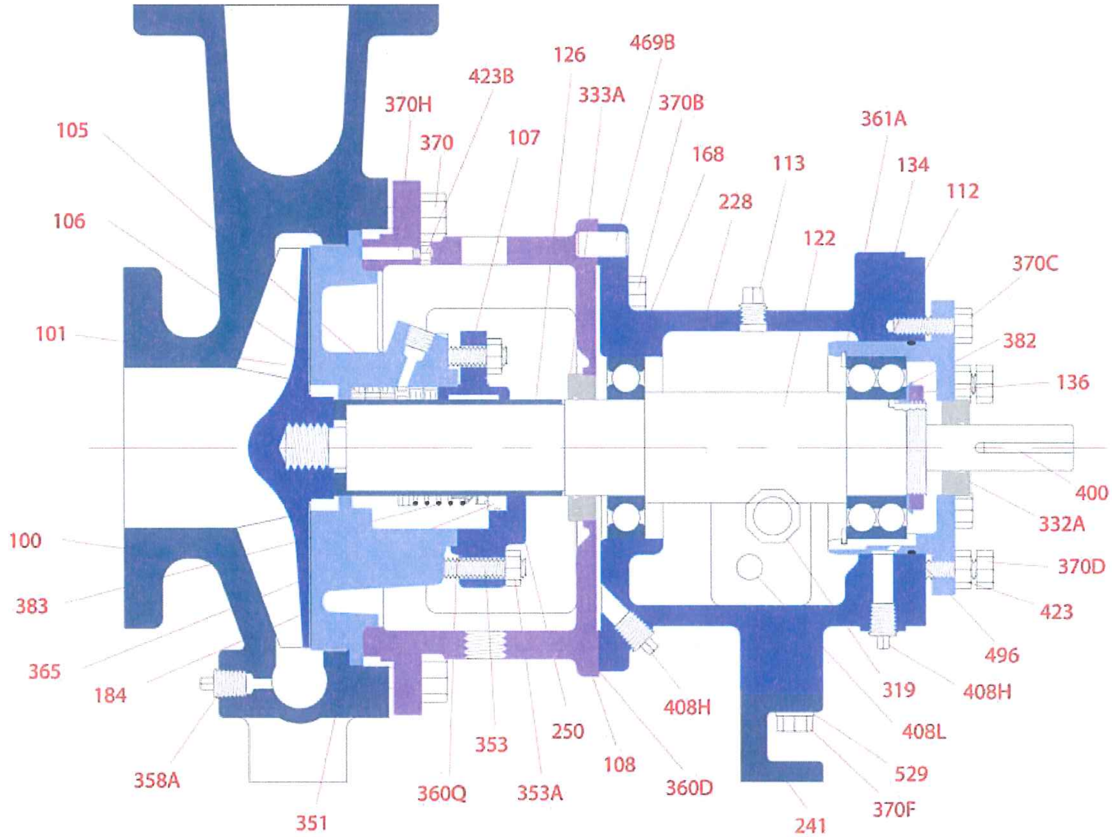
APPENDIX D – PUMP CROSS SECTIONS AND PARTS LISTS

MODEL 2196 STO CROSS SECTION



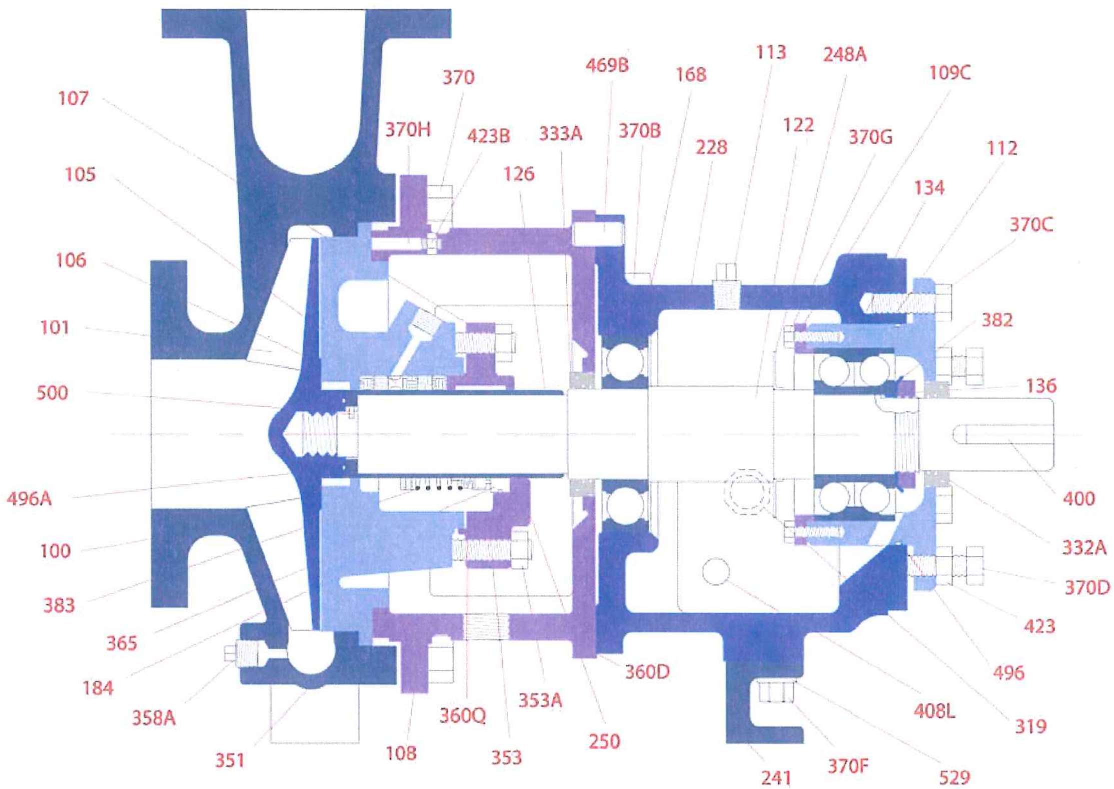
MODEL 2196 STO PARTS LIST					
Item #	**Qty**	**Description**	**Item #**	**Qty**	**Description**
100	1	Casing	360Q	1	Gasket; Gland, Mech. Seal
101	1	Impeller	361A	1	Snap Ring, Bearing
105	1	Ring, Lantern	365	1	Seal, Mechanical Stationary Element
106	5	Packing	370	3	Bolt, Casing
107	1	Gland, Packing	370B**	4	Bolt, Frame / Adapter
108**	1	Adapter Ring	370C	3	Bolt, Bearing Housing
112	1	Bearing, Outboard	370D	3	Jack Bolt, Bearing Housing
113A	1	Plug, Oil Fill	370H	2	Stud, SBC / Adapter
122	1	Shaft	382	1	Lockwasher, Bearing
126	1	Sleeve, Shaft	383	1	Seal, Mechanical Rotating Element
134	1	Housing, Bearing	400	1	Key, Coupling
136	1	Locknut, Bearing	408A	1	Plug, Frame Lubrication Port
168A	1	Bearing, Inboard	408L	1	Plug, Oil Cooler Inlet (Not Shown)
184	1	Cover, Stuffing Box	408M	1	Plug, Oil Cooler Outlet (Not Shown)
228	1	Frame	412	1	O-ring, Impeller
250	1	Gland, Mechanical Seal	423	3	Jamnut, Bearing Housing / Frame
319	1	Sight Glass	423B	2	Nut, Box Cover/Adapter Stud
332A	1	Labyrinth, OB	496	1	O-ring,, Bearing Housing / Frame
333A	1	Labyrinth, IB	500	1	Pin, Sleeve
351	1	Gasket, Case			
353	4	Stud, Gland			
353A	4*	Nut, Gland Stud	* Packing Gland has only 2 Studs & Nuts		
358A	1	Plug, Casing Drain	** Only Required on 8" Pump		

MODEL 2196 MTO CROSS SECTION



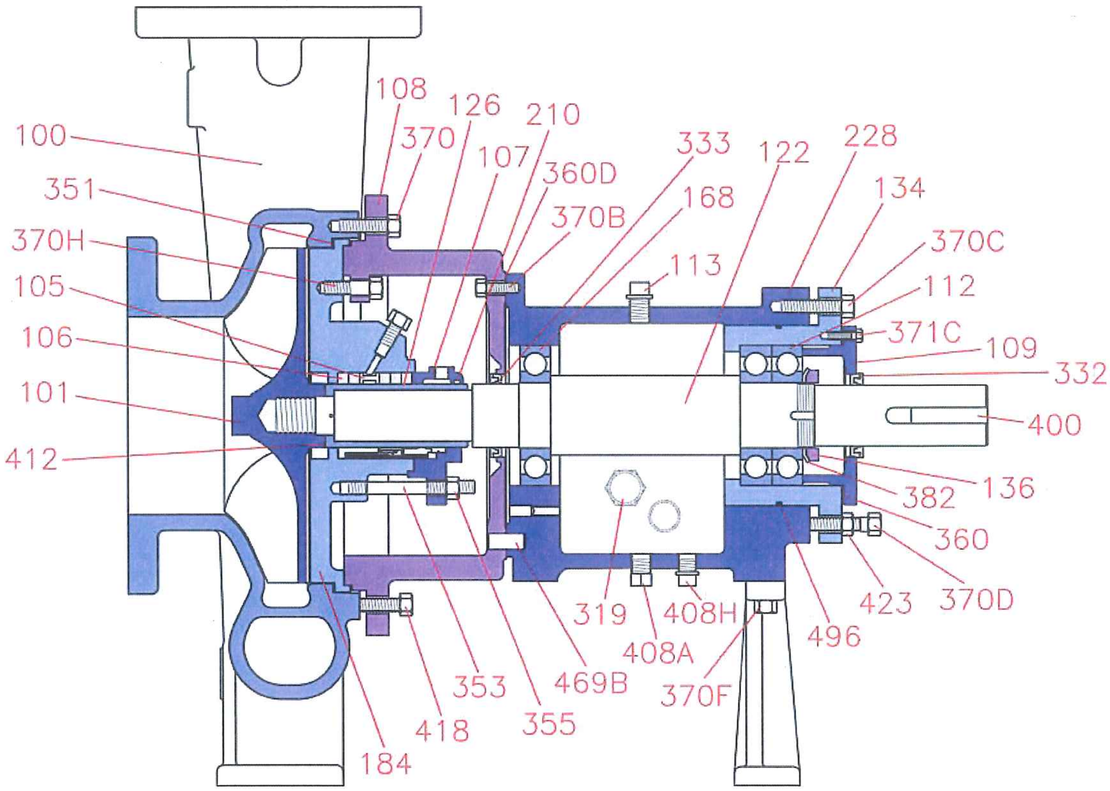
MODEL 2196 MTO PARTS LIST					
Item #	**Qty**	**Description**	**Item #**	**Qty**	**Description**
100	1	Casing	360D	1	Gasket, Frame/Adapter
101	1	Impeller	360Q	1	Gasket; Gland, Mech. Seal
105	1	Ring, Lantern	361A	1	Snap Ring, Bearing
106	5	Packing	365	1	Seal, Mechanical Stationary Element
107	1	Gland, Packing	370	8, 12, 16	Bolt, Casing
108	1	Adapter	370B	4	Bolt, Frame / Adapter
112	1	Bearing, Outboard	370C	3	Bolt, Frame / Bearing Housing
113	1	Plug, Oil Fill	370D	3	Jack Bolt, Bearing Housing
122	1	Shaft	370F	2	Bolt, Frame Foot
126	1	Sleeve, Shaft	370H	2	Box Cover/Adapter Stud
134	1	Housing, Bearing	382	1	Lockwasher, Bearing
136	1	Locknut, Bearing	383	1	Seal, Mechanical Rotating Element
168	1	Bearing, Inboard	400	1	Key, Coupling
184	1	Cover, Stuffing Box	408A	1	Plug, Frame Drain (Not Shown)
228	1	Frame	408H	4	Plug, Frame Lubrication Port
241	1	Foot Frame	408L	1	Plug, Oil Cooler Inlet
250	1	Gland, Mechanical Seal	408M	1	Plug, Oil Cooler Outlet
319	1	Gauge; Sight, Oil	412	1	O-ring, Impeller
332A	1	Labyrinth, Outboard Frame	423	3	Jamnut, Bearing Housing Jack Bolt
333A	1	Labyrinth, Inboard Frame	423B	2	Nut, Box Cover/Adapter Stud
351	1	Gasket, Case	469B	2	Dowel Pin, Frame / Adapter
353	4	Stud, Gland	496	1	O-ring, Bearing Housing / Frame
353A	4*	Nut, Gland Stud	529	2	Washer, Frame Foot to Frame
358A	1	Plug, Casing Drain	* Packing Gland has only 2 Studs & Nuts		

MODEL 2196 LTO CROSS SECTION



MODEL 2196 LTO PARTS LIST					
Item #	Qty	Description	Item #	Qty	Description
100	1	Casing	360D	1	Gasket, Frame/Adapter
101	1	Impeller	360Q	1	Gasket; Gland, Mech. Seal
105	1	Ring, Lantern	361A	1	Snap Ring, Bearing
106	5	Packing	365	1	Seal, Mechanical Stationary Element
107	1	Gland, Packing	370	8, 12, 16	Bolt, Casing
108	1	Adapter	370B	4	Bolt, Frame / Adapter
109C	1	Cover; Bearing, Outboard	370C	3	Bolt, Bearing Housing
112	2	Bearing, Outboard	370D	3	Jack Bolt, Bearing Housing
113	1	Plug, Oil Fill	370F	2	Bolt, Frame Foot
122	1	Shaft	370G	6	Bolt, Bearing Cover
126	1	Sleeve, Shaft	370H	2	Box Cover/Adapter Stud
134	1	Housing, Bearing	382	1	Lockwasher, Bearing
136	1	Locknut, Bearing	383	1	Seal, Mechanical Rotating Element
168	1	Bearing, Inboard	400	1	Key, Coupling
184	1	Cover, Stuffing Box	408A	1	Plug, Frame Drain (Not Shown)
228	1	Frame	408H	4	Plug, Frame Lube Port (Not Shown)
241	1	Foot Frame	408L	1	Plug, Oil Cooler Inlet
248A	1	Ring, Oil	408M	1	Plug, Oil Cooler Outlet (Not Shown)
250	1	Gland, Mechanical Seal	412	1	O-ring, Impeller
319	1	Gauge; Sight, Oil	423	3	Jamnut, Bearing Housing Jack Bolt
332A	1	Labyrinth, Outboard Frame	423B	2	Nut, Box Cover/Adapter Stud
333A	1	Labyrinth, Inboard Frame	469B	2	Dowel Pin, Frame / Adapter
351	1	Gasket, Case	496	1	O-ring, Bearing Housing / Frame
353	4	Stud, Gland	500	1	Pin, Sleeve
353A	4*	Nut, Gland Stud	529	2	Washer, Frame Foot to Frame
358A	1	Plug, Casing Drain	* Packing Gland has only 2 Studs & Nuts		

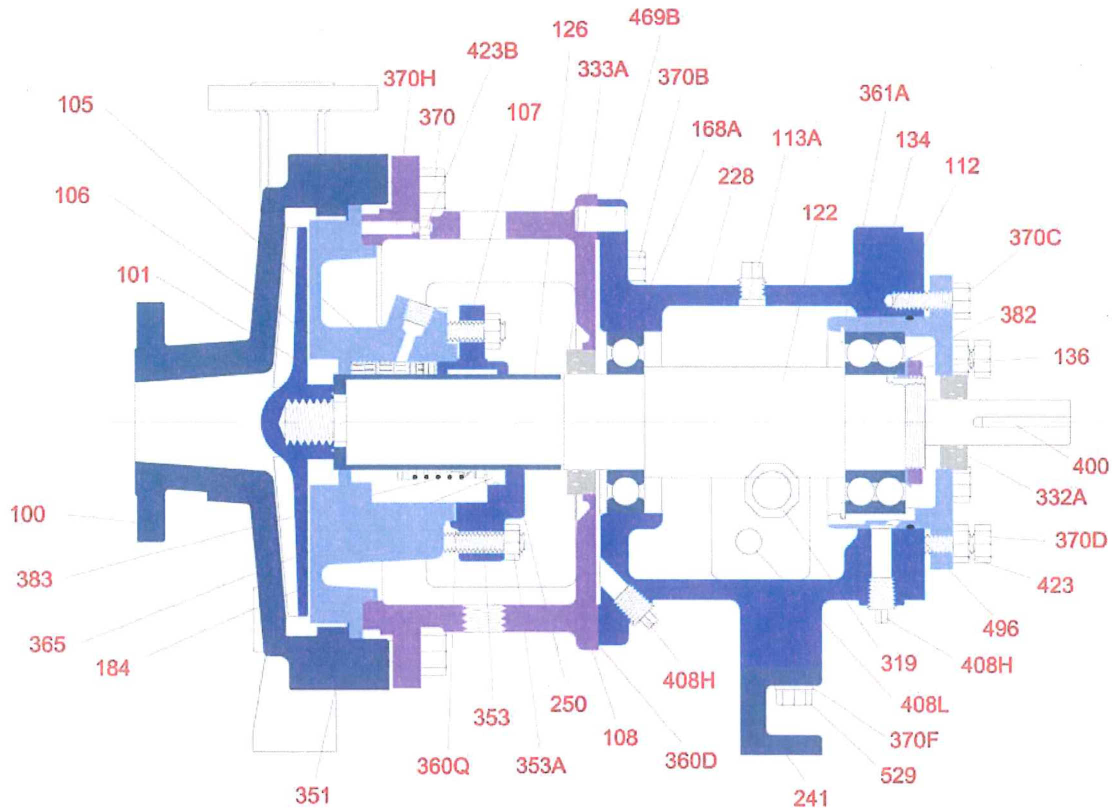
MODEL 2196 XLO CROSS SECTION



MODEL 2196 XLO PARTS LIST					
Item #	**Qty**	**Description**	**Item #**	**Qty**	**Description**
100	1	Casing	360	1	Gasket, End Cover
101	1	Impeller	360D	1	Gasket, Frame/Adapter
105	1	Ring, Lantern	370	16/24[1]	Bolt, Adapter / Case
106	5	Stuffing Box Packing	370B	4	Bolt, Frame / Adapter
107	1	Gland	370C	4	Bolt, Housing / Frame
108	1	Frame Adapter	370D	4	Jack Bolt, Housing Adjustment
109	1	Bearing End Cover, Outboard	370F	2	Bolt, Frame Foot
112	2	Bearing, Thrust, Outboard	370H	2	Stud, Cover / Adapter
113	1	Oil Fill Plug	371C	6	Bolt, Cover/Housing
122	1	Shaft, Sleeve Type	382	1	Lockwasher
126	1	Sleeve	400	1	Coupling Key
134	1	Housing, Bearing	408A	1	Drain Plug
136	1	Locknut, Bearing	408H	1	Plug, Frame Lubrication Port
168	1	Bearing, Radial, Inboard	408J[2]	1	Oiler Plug
184	1	Cover, Stuffing Box	408L[2]	1	Cooler Plug
210	1	Packing, Gland	408M[2]	1	Cooler Plug
228	1	Frame	408N[2]	1	Sight Plug
319	1	Sight Glass	412	1	O-Ring, Impeller
332	1	Labyrinth Seal, Outboard	418	3	Bolt, Case Jackout
333	1	Labyrinth Seal, Inboard	423	4	Housing Jam Nut
351	1	Gasket, Casing	469B	2	Pin, Frame / Adapter
353	2	Stud, Gland	496	1	O-Ring, Bearing Housing
355	2	Nut, Gland			

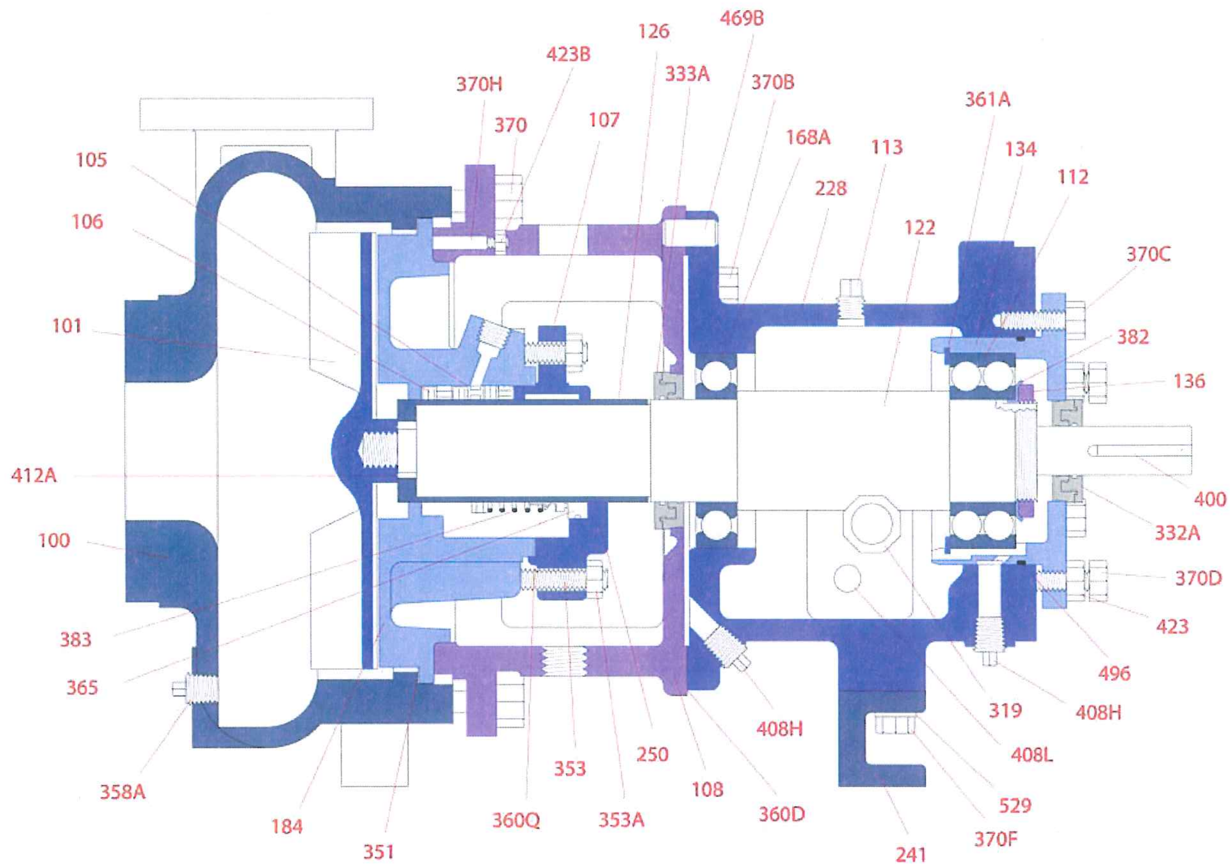
[1] Item # 370: (16) – 6X8-13, 8X10-13, (24) – 6X8-15, 8X10-15, 8X10-15G
[2] 408J, 408L, 408M & 408N – NOT SHOWN ON THE DRAWING

MODEL 2196-LF CROSS SECTION



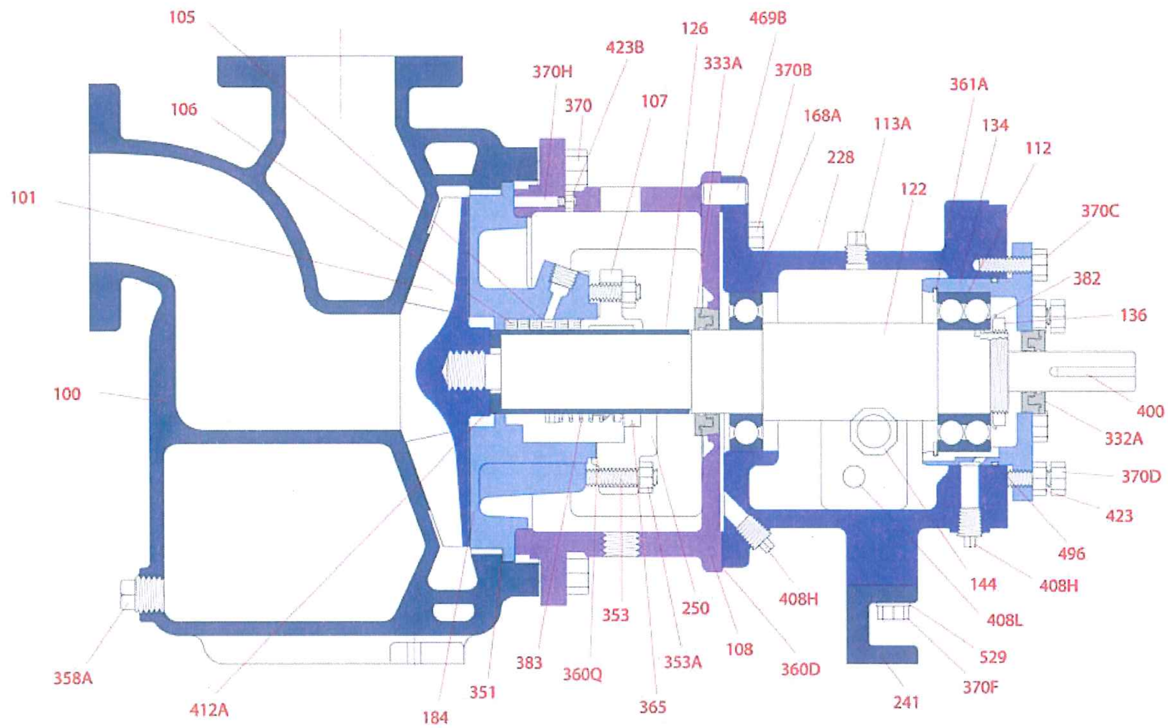
MODEL 2196-LF PARTS LIST					
Item #	**Qty**	**Description**	**Item #**	**Qty**	**Description**
100	1	Casing	360D	1	Gasket, Frame/Adapter
101	1	Impeller	360Q	1	Gasket; Gland, Mech. Seal
105	1	Ring, Lantern	361A	1	Snap Ring, Bearing
106	5	Packing	365	1	Seal, Mechanical Stationary Element
107	1	Gland, Packing	370	8, 12, 16	Bolt, Casing
108	1	Adapter	370B	4	Bolt, Frame / Adapter
112	1	Bearing, Outboard	370C	3	Bolt, Frame / Bearing Housing
113	1	Plug, Oil Fill	370D	3	Jack Bolt, Bearing Housing
122	1	Shaft	370F	2	Bolt, Frame Foot
126	1	Sleeve, Shaft	370H	2	Box Cover/Adapter Stud
134	1	Housing, Bearing	382	1	Lockwasher, Bearing
136	1	Locknut, Bearing	383	1	Seal, Mechanical Rotating Element
168	1	Bearing, Inboard	400	1	Key, Coupling
184	1	Cover, Stuffing Box	408A	1	Plug, Frame Drain (Not Shown)
228	1	Frame	408H	4	Plug, Frame Lubrication Port
241	1	Foot Frame	408L	1	Plug, Oil Cooler Inlet
250	1	Gland, Mechanical Seal	408M	1	Plug, Oil Cooler Outlet
319	1	Gauge; Sight, Oil	412A	1	O-ring, Impeller
332A	1	Labyrinth, Outboard Frame	423	3	Jamnut, Bearing Housing Jack Bolt
333A	1	Labyrinth, Inboard Frame	423B	2	Nut, Box Cover/Adapter Stud
351	1	Gasket, Case	469B	2	Dowel Pin, Frame / Adapter
353	4	Stud, Gland	496	1	O-ring, Bearing Housing / Frame
353A	4*	Nut, Gland Stud	529	2	Bolt , Frame Foot to Frame
358A	1	Plug, Casing Drain	* Packing Gland has only 2 Studs & Nuts		

MODEL 2196-R CROSS SECTION



MODEL 2196-R PARTS LIST					
Item #	**Qty**	**Description**	**Item #**	**Qty**	**Description**
100	1	Casing	360Q	1	Gasket; Gland, Mech. Seal
101	1	Impeller	361A	1	Snap Ring, Bearing
105	1	Ring, Lantern	365	1	Seal, Mechanical Stationary Element
106	5	Packing	370	3	Bolt, Casing
107	1	Gland, Packing	370B**	4	Bolt, Frame / Adapter
108**	1	Adapter Ring	370C	3	Bolt, Bearing Housing
112	1	Bearing, Outboard	370D	3	Jack Bolt, Bearing Housing
113	1	Plug, Oil Fill	370F	1	Bolt, Foot to Frame
122	1	Shaft	370H	2	Stud, SBC / Adapter
126	1	Sleeve, Shaft	382	1	Lockwasher, Bearing
134	1	Housing, Bearing	383	1	Seal, Mechanical Rotating Element
136	1	Locknut, Bearing	400	1	Key, Coupling
168A	1	Bearing, Inboard	408H	4	Plug, Frame Lubrication Port
184	1	Cover, Stuffing Box	408L	1	Plug, Oil Cooler Inlet (Not Shown)
228	1	Frame	408M	1	Plug, Oil Cooler Outlet (Not Shown)
250	1	Gland, Mechanical Seal	412A	1	O-ring, Impeller
319	1	Sight Glass	423	3	Jamnut, Bearing Housing / Frame
332A	1	Labyrinth, OB	423B	2	Nut, Box Cover/Adapter Stud
333A	1	Labyrinth, IB	496	1	O-ring,, Bearing Housing / Frame
351	1	Gasket, Case	500	1	Pin, Sleeve
353	1	Stud, Gland	529	2	Washer, Foot to Frame
353A	4*	Nut, Gland Stud	* Packing Gland has only 2 Studs & Nuts		
358A	1	Plug, Casing Drain	** Only Required on 8" Pump		

MODEL 2796 CROSS SECTION



MODEL 2796 PARTS LIST					
Item #	Qty	Description	Item #	Qty	Description
100	1	Casing	360D	1	Gasket, Frame/Adapter
101	1	Impeller	360Q	1	Gasket; Gland, Mech. Seal
105	1	Ring, Lantern	361A	1	Snap Ring, Bearing
106	5	Packing	365	1	Seal, Mechanical Stationary Element
107	1	Gland, Packing	370	8, 12, 16	Bolt, Casing
108	1	Adapter	370B	4	Bolt, Frame / Adapter
112	1	Bearing, Outboard	370C	3	Bolt, Bearing Housing
113A	1	Plug, Oil Fill	370D	3	Jack Bolt, Bearing Housing
122	1	Shaft	370F	2	Bolt, Frame Foot
126	1	Sleeve, Shaft	370H	2	Box Cover/Adapter Stud
134	1	Housing, Bearing	382	1	Lockwasher, Bearing
136	1	Locknut, Bearing	383	1	Seal, Mechanical Rotating Element
144	1	Gauge; Sight, Oil	400	1	Key, Coupling
168A	1	Bearing, Inboard	408A	1	Plug, Frame Drain (Not Shown)
184	1	Cover, Stuffing Box	408H	4	Plug, Frame Lubrication Port
228	1	Frame	408L	1	Plug, Oil Cooler Inlet
241	1	Foot Frame	408M	1	Plug, Oil Cooler Outlet
250		Gland, Mechanical Seal	412A	1	O-ring, Impeller
332A	1	Labyrinth, Outboard Frame	423	3	Jamnut, Bearing Housing Jack Bolt
333A	1	Labyrinth, Inboard Frame	423B	2	Nut, Box Cover/Adapter Stud
351	1	Gasket, Case	469B	2	Dowel Pin, Frame / Adapter
353	4	Stud, Gland	496	1	O-ring, Bearing Housing / Frame
353A	4*	Nut, Gland Stud	529	2	Washer, Frame Foot to Frame
358A	1	Plug, Casing Drain	* Packing Gland has only 2 Studs & Nuts		

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APPENDIX E – MAINTENANCE INSTRUCTIONS FOR INPRO/SEAL® "VBX" BEARING ISOLATORS

DETAILS OF OPERATIONS

The Inpro Bearing Isolator is a Labyrinth type seal, which performs two functions:

1. Maintains the clean oil in the bearing housing.
2. Keeps contaminates from entering the bearing housing.

The unit is comprised of three major components: the **rotor**, the **stator**, and the **"VBX"® ring**.

The **rotor** fits over the shaft and is held in place by an elastometric drive ring. The drive ring causes the rotor to turn with the shaft and also provides a positive static seal on the shaft. There is no metal-to-metal contact between the shaft and rotor, thus no wear and friction concerns.

The **stator** is held in the housing by a nominal .002" interference fit. An o-ring gasket on the outside diameter of the stator secures a positive seal between the stator and the housing bore. The designed Labyrinth grooves and lube return trough on the stator inside diameter retains the lubricant inside the bearing housing.

The rotor and stator act together to keep contamination out of the bearing housing.

The "VBX"® ring, stator, and rotor are a unit and must not be pulled apart. If the unit is pulled apart or comes apart, it must be replaced with a new unit. The "VBX"® is intended to be an inseparable design.

Repairs or replacement of seals are only necessary if excessive oil leakage is visible. If or when the bearing housing is disassembled, it is recommended that the rotor o-rings be replaced.

DISASSEMBLY PROCEDURES

1. Remove shaft assembly (122) per instructions for pump disassembly. (See page 19.)
2. STO removal. Insert a bar (wood or plastic) through the outboard bearing housing end of the bearing frame (228). Contact the inboard bearing isolator (333A). Remove by tapping the bar or pushing with an arbor press.

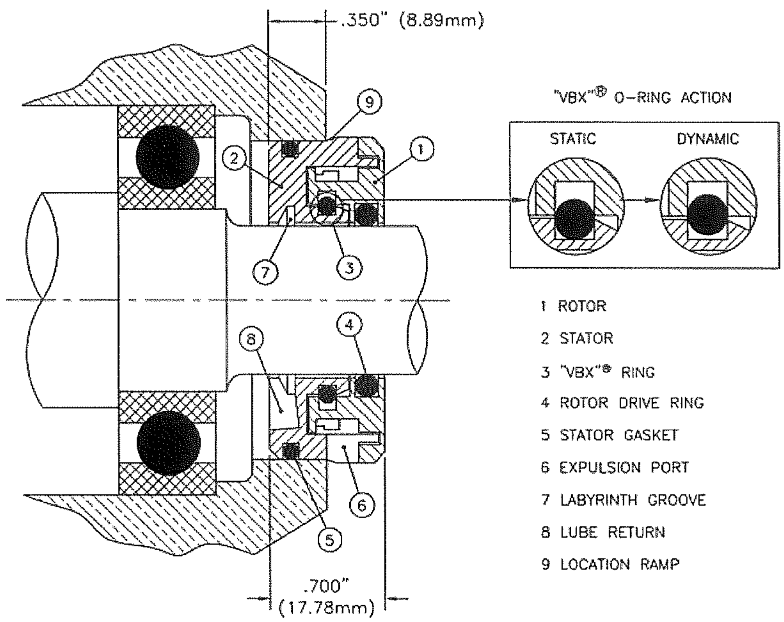
   MTO and XLO removal. Disassemble the bearing frame adapter (108) per pump disassembly instructions. Remove the inboard bearing isolator (333A) with a bar (wood or plastic) by tapping or by pushing with an arbor press.
3. STO, MTO, and XLO outboard bearing isolator (332A) removal. Block up the outboard bearing housing (134) on the bench, coupling the end toward the bench top. Tap the isolator out of the housing or use an arbor press.
4. Inspect the bearing isolators. If the unit pulls apart, a new isolator is needed for reassembly.
5. Replace the rotor 0-rings and stator 0-rings each time the units are removed from

the pump assembly.

INSTALLATION PROCEDURES

1. STO, MTO, and XLO Inboard Isolator. Position the bearing frame (228) or adapter (108) inboard bearing side up. Place the isolator seal (333A) stator side in the bore. THE EXPULSION PORT MUST BE IN THE 6 O'CLOCK POSITION. While using a block large enough to cover the entire flange of the isolator, use an arbor press to press the stator into the bore. Press into place until the location ramp begins. (See *Figure 1.*)

Figure 1

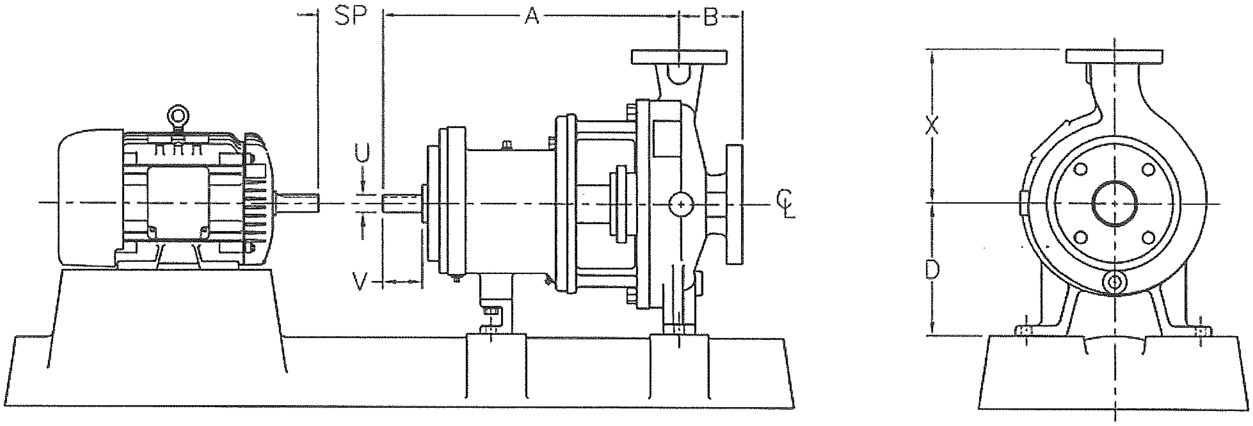


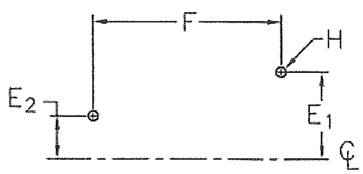
2. Outboard Isolator (332A). Position the bearing housing (134) outside flange up. Place the isolator in the bore and press into place using the same technique as in *Step 1* above.
3. Lightly lube the sleeve end of the shaft and rotor drive ring. Slide the bearing frame (228) or adapter (108) over the shaft per assembly instructions.
4. To assemble the outboard end, tape the shaft (122) keyway with black tape. Lube the tape and rotor drive ring. Slide the bearing housing (134) over the shaft (122) end and continue per assembly instructions.

MAKE SURE EXPULSION PORT AND LUBE RETURN ARE IN THE 6 O'CLOCK POSITION IN FINAL ASSEMBLY.

APPENDIX F – DIMENSIONAL DATA

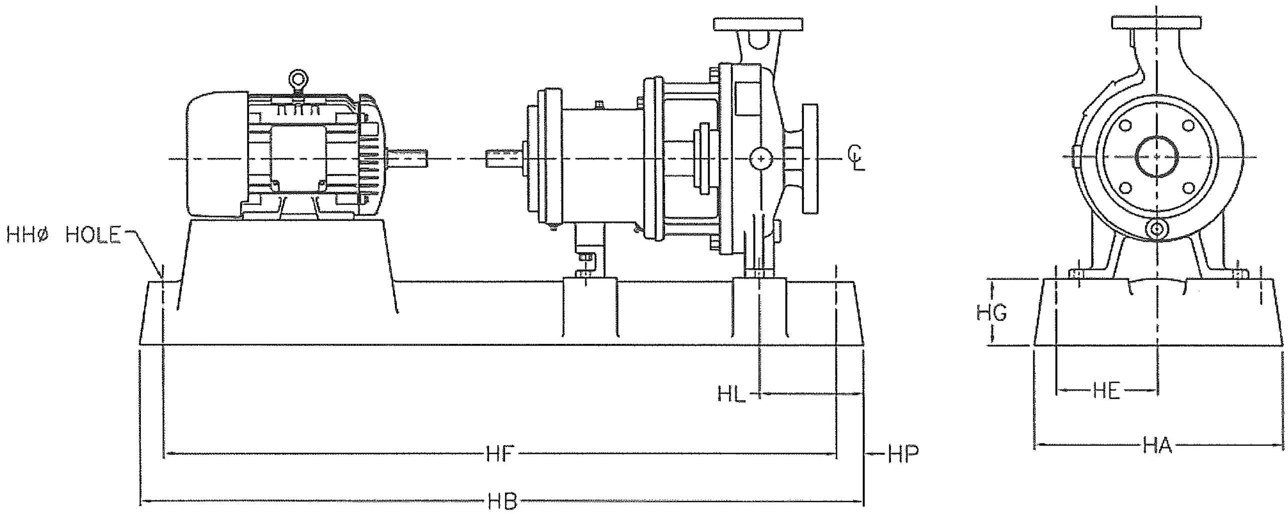
MODEL 2196 DIMENSIONAL DATA





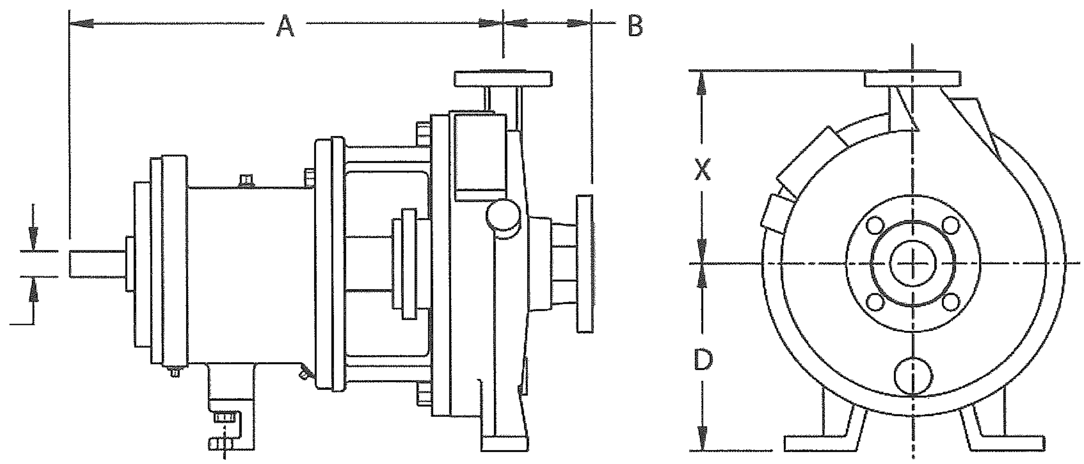
2196 DIMENSIONS																	
PUMP FRAME	ANSI	SIZE DIS	SIZE SUC	SIZE IMP	X	D	B	A	SP	FOOT PATTERN E1	FOOT PATTERN E2	FOOT PATTERN F	FOOT PATTERN H	SHAFT U	SHAFT KEYWAY	SHAFT V	APPROX. BARE PUMP WT. (LBS.)
	AA	1	1.5	6													85
	AB	1.5	3	6													90
STO		2	3	6	6 1/2	5 1/4	4	13 1/2	3 3/4	3	0	7 1/4	5/8	.875	3/16 X 3/32	2	95
	AA	1	1.5	8													100
	AB	1.5	3	8													110
	A60	2	3	8	9 1/2												200
	A70	3	4	8	11									MTO	MTO		220
MTO	A70	3	4	8G	11									1.125	1/4X1/8		220
	A05	1	2	10	8 1/2	8 1/4											200
	A50	1.5	3	10	8 1/2												220
	A60	2	3	10	9 1/2												230
or	A70	3	4	10	11		4	19 1/2	3 3/4	4 7/8	3 5/8	12 1/2	5/8			2 5/8	265
	A40	3	4	10H	12 1/2												275
	A80	4	6	10	13 1/2												305
	A80	4	6	10H	13 1/2												305
LTO	A20	1.5	3	13	10 1/2									LTO	LTO		245
	A30	2	3	13	11 1/2	10								1.875	1/2X1/4		275
	A40	3	4	13	12 1/2												330
	A80	4	6	13	13 1/2												405
	A90	6	8	13	16												560
	A100	8	10	13	18												670
XLO	A110	6	8	15	18	14 1/2	6	27 7/8	5 1/4	8	4 1/2	18 3/4	7/8	2.375	5/8 X 5/16	4	610
	A120	8	10	15	19												740
	A120	8	10	15G	19												710

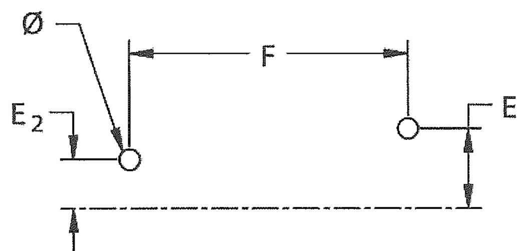
MODEL 2196 CAST IRON RELATED BASEPLATE RELATED DIMENSIONS



CAST IRON RELATED BASEPLATE RELATED DIMENSIONS										
PUMP FRAME	BASEPLATE NUMBER	MAX MOTOR FRAME	HA	HB	HE	HF	HP	HG	HH	HL
STO	1	145	10	35	4	32 1/2	1 3/8	3 3/16	3/4	4 5/8
	2	215	12	39	4 1/2	36 1/2	1 1/4	3 3/8	3/4	4 1/2
	3	286	15	46	6	43 1/2	1 1/4	6	3/4	4 1/2
MTO or LTO	4	215	12	45	4 1/2	42 1/2	1 1/4	4	3/4	4 1/2
	5	286	15	52	6	49 1/2	1 1/4	4 3/8	3/4	4 1/2
	6	365	18	58	7 1/2	55 1/2	1 1/4	5	1	4 1/2
	7	444	18	60	7 1/2	57 1/2	1 1/4	5	1	4 1/2
XLO	8	286	26	62	11 1/4	47	13	4	1	5 1/4
	9	365	26	68	11 1/4	47	13	4	1	5 3/16
	10	447	26	74	11 1/4	47	13	4 1/8	1	5 1/4

MODEL 2196-LF DIMENSIONAL DATA

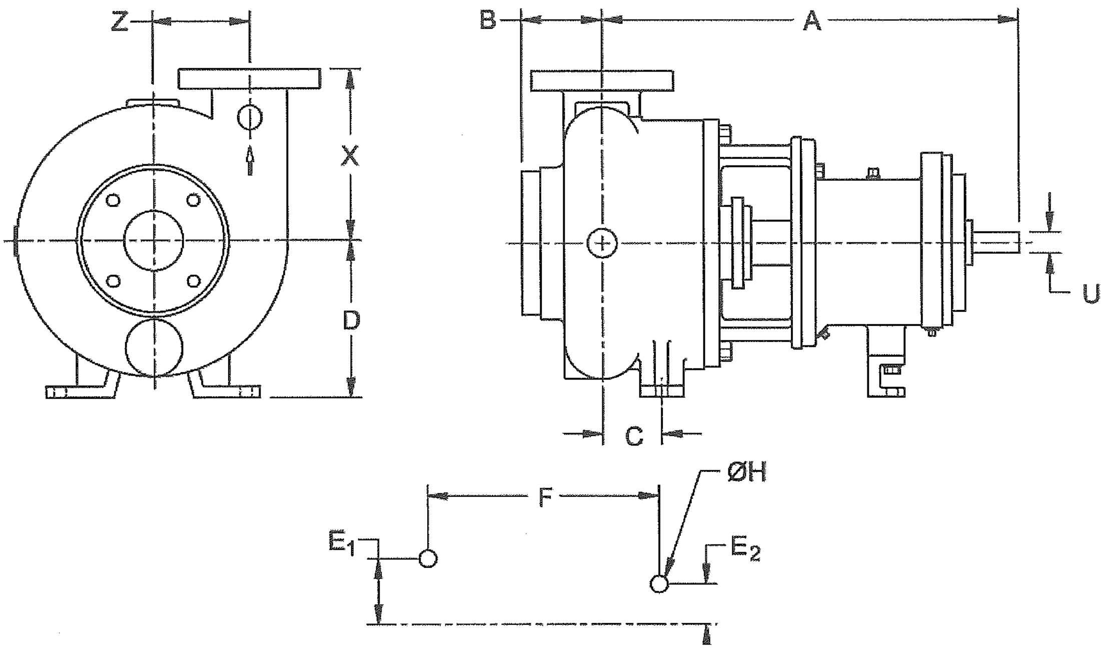




2196-LF DIMENSIONS

PUMP FRAME	ANSI	SIZE			X	A	B	D	SP	APPROX. BARE PUMP WT. (LBS.)
		DIS	SUC	IMP						
STO	AA	1	1.5	4	6.5	13.5	4.0	5.25	3.75	84
	AA	1	1.5	8	6.5	13.5	4.0	5.25	3.75	100
MTO/LTO	A05	1	2	10	8.5	19.5	4.0	8.25	3.75	200
										245
LTO	A20	1.5	3	13	10.5	19.5	4.0	10.0	3.75	285

MODEL 2196-R DIMENSIONAL DATA



<table>
<tr><th colspan="17">2196-R DIMENSIONS</th></tr>
<tr><th rowspan="2">Pump Frame</th><th rowspan="2">Size</th><th rowspan="2">Z</th><th rowspan="2">X</th><th rowspan="2">A</th><th rowspan="2">B</th><th rowspan="2">C</th><th rowspan="2">D</th><th rowspan="2">SP</th><th colspan="4">Foot Pattern</th><th colspan="2">Shaft</th></tr>
<tr><th>E1</th><th>E2</th><th>F</th><th>H</th><th>U</th><th>KEYWAY</th></tr>
<tr><td>STO</td><td>2x2-8</td><td>4.25</td><td>6.5</td><td>15.38</td><td>2.75</td><td>2.5</td><td>6</td><td rowspan="6">3.75</td><td>3</td><td>0</td><td>7.25</td><td rowspan="6">.63</td><td>0.875</td><td>.19 x .09</td></tr>
<tr><td rowspan="4">MTO or LTO</td><td>2x2-10</td><td>5.25</td><td>8.5</td><td>21.75</td><td>3.5</td><td>2.25</td><td rowspan="2">8.25</td><td rowspan="5">4.88</td><td rowspan="5">3.63</td><td rowspan="5">12.5</td><td rowspan="4">1.125</td><td rowspan="4">.25 x .125</td></tr>
<tr><td>3x3-10</td><td>5.13</td><td>9</td><td>22.50</td><td>4.25</td><td>2.94</td></tr>
<tr><td>2x3-13</td><td rowspan="3">6.63</td><td rowspan="2">10.5</td><td>22.38</td><td rowspan="2">4.12</td><td>2.81</td><td rowspan="3">10</td></tr>
<tr><td>3x4-13</td><td>22.81</td><td>3.31</td></tr>
<tr><td>LTO</td><td>4x6-13</td><td>11.5</td><td>23.13</td><td>4.75</td><td>3.63</td><td>1.875</td><td>.5 x .25</td></tr>
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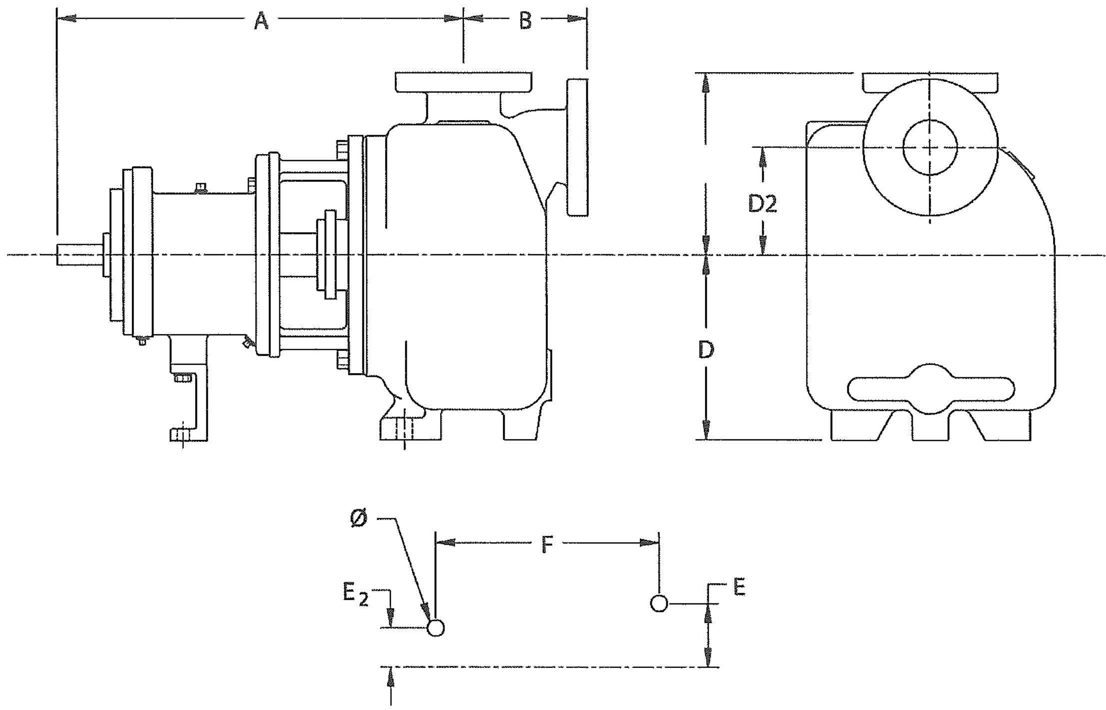
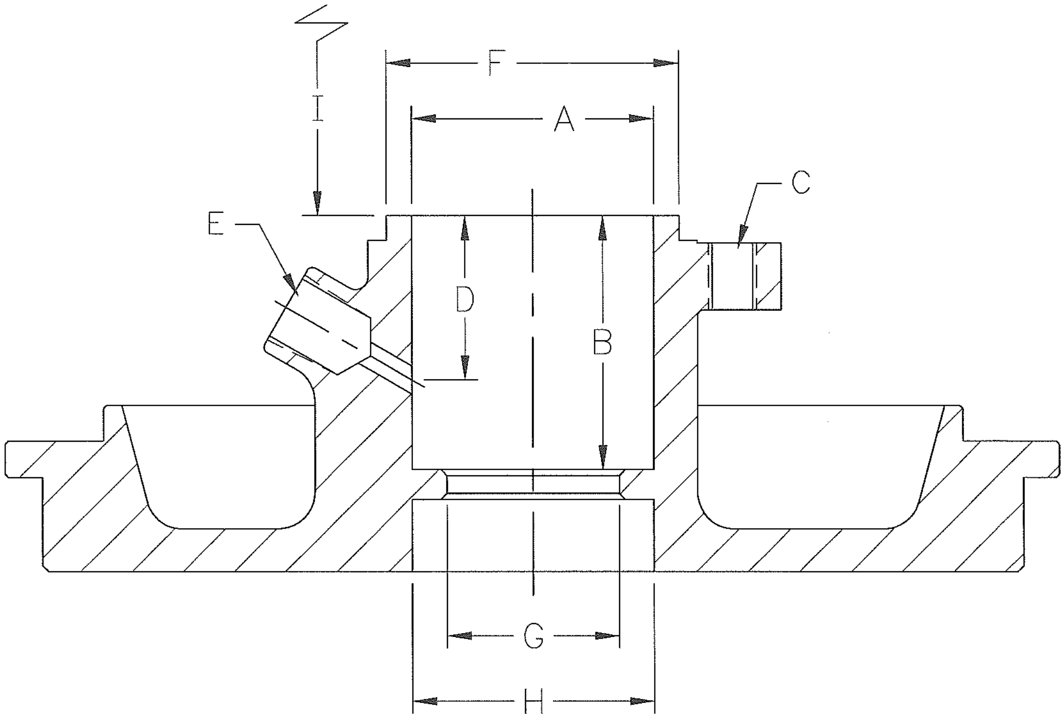
MODEL 2796 DIMENSIONAL DATA



PUMP FRAME	SIZE			X	A	B	D	D2	FOOT PATTERN				APPROX. BARE PUMP WT. (LBS.)
	DIS	SUC	IMP						E	E2	F	H	
STO	1	1.5	6	7.25	15.5	5	7.5	4	3	0	7.25	.63	170
	1.5		8	7.88									
MTO/LTO	2	2	10	10	21.75	6.5	10	6	4.88	3.63	12.5		370
	3	3			22.63	6.75							315
	4	4			23.38	9.19							370
	3	3	13	11.5	22.63	6.75							400
	4	4			22.38	9.19							470
	6	6		15	27.75	10	12	8					690

MODEL 2196 STUFFING BOX RELATED DIMENSIONS



STUFFING BOX RELATED DIMENSIONS													
PUMP FRAME	A	B	C		D	E	F	G	H	I OBSTRUCTION	PACKING		LANTERN RING WIDTH
			B.C.	*TAP*							*SIZE*	*# OF RINGS*	
STO	2.00	2.12	3.25	3/8-18 UNC	0.97	1/4-18 NPT	2.39	1.40	-	2.18	5/16	5	7/16
MTO	2.50	2.62	4.12	1/2-13 UNC	1.56	3/8-18 NPT	3.01	1.78	2.65	3.00	3/8	5	5/8
LTO	2.87	2.62	4.50	1/2-13 UNC	1.56	3/8-18 NPT	3.52	2.15	2.63	3.00	3/8	5	5/8
XLO	3.37	3.00	5.37	5/8-11 UNC	1.75	3/8-18 NPT	4.37	3.53	3.38	2.93	7/16	5	5/8

APPENDIX G – CONSTRUCTION DETAILS

MODEL 2196 CONSTRUCTION DETAILS

Construction Details All dimensions in inches and (mm).

		STO		MTO		LTO		XLO	
Shaft	Diameter at Impeller	.75	(19)	1	(25)	1.25	(32)	1.5	(38)
	Diameter in Stuffing Box (Solid shaft const.)	1.375	(35)	1.75	(45)	2.125	(54)	2.5	(64)
	Diameter Between Bearings	1.5	(38)	2.125	(54)	2.5	(64)	3.125	(79)
	Diameter at Coupling	.875	(22)	1.125	(29)	1.875	(48)	2.375	(60)
	Overhang	6.125	(156)	8.375	(213)	8.375	(213)	9.969	(253)
	Maximum Shaft Deflection	0.002 (0.05)							
	Shaft Deflection Index (L^3/D^4) (With Sleeve) (Less Sleeve)	143 64		116 63		48 29		62 25	
Sleeve	O.D. thru Stuffing Box/Seal Chamber	1.375	(35)	1.75	(45)	2.125	(54)	2.5	(64)
Bearings	Radial	SKF 6207		SKF 6309		SKF 6311		SKF 6313	
	Thrust	SKF 5306 A/C3		SKF 5309 A/C3		SKF 7310 BECBM		SKF 5313 A/C3	
	Bearing Span	4.125	(105)	6.75	(171)	6.875	(164)	9.25	(235)
Stuffing Box	Bore	2	(51)	2.5	(64)	2.875	(73)	3.375	(86)
Power Limits	HP (kW) per 100 RPM	1.1	(.82)	3.4	(2.6)	5.6	(4.2)	14	(10.5)

MODEL 2196 SHAFT RUNOUT TOLERANCES

Shaft Runout Tolerances All dimensions in inches and (mm)

At Stuffing Box	At Coupling
.002 (.051)	.001 (.026)

MODEL 2196 SHAFT END PLAY

Shaft End Play All dimensions in inches and (mm)

	STO	MTO	LTO	XLO
Double Row	.0011/.0019 (.028/.047)	.0013/.0021 (.033/.054)	NA	.0014/.0023 (.036/.058)
Duplex	.0007/.0010 (.018/.026)	.0009/.0012 (.022/.030)	.0010/.0015 (.026/.038)	.0010/.0015 (.026/.038)

MODEL 2196 BEARING FITS & TOLERANCES

Bearing Fits & Tolerances All dimensions in inches and (mm)

According to ABEC I Standards				
	STO	**MTO**	**LTO**	**XLO-X, XO-17**
Shaft O. D. Inboard	1.3785 (35.013) 1.3781 (35.002)	1.7722 (45.013) 1.7718 (45.002)	2.1660 (55.015) 2.1655 (55.002)	2.5597 (65.015) 2.5592 (65.002)
Clearance	0.0010 (0.025) tight 0.0001 (0.002) tight	0.0010 (0.025) tight 0.0001 (0.002) tight	0.0012 (0.030) tight 0.0001 (0.002) tight	0.0012 (0.030) tight 0.0001 (0.002) tight
Bearing I. D. Inboard	1.3780 (35.000) 1.3775 (34.988)	1.7717 (45.000) 1.7712 (44.988)	2.1654 (55.000) 2.1648 (54.985)	2.5591 (65.000) 2.5585 (64.985)
Frame I. D. Inboard	2.8346 (72.000) 2.8353 (72.019)	3.9370 (100.000) 3.9379 (100.022)	4.7244 (120.000) 4.7253 (120.022)	5.5118 (140.000) 5.5128 (140.025)
Clearance	0.0012 (0.032) loose 0.0000 (0.000) loose	0.0015 (0.037) loose 0.0000 (0.000) loose	0.0015 (0.037) loose 0.0000 (0.000) loose	0.0017 (0.043) loose 0.0000(0.000) loose
Bearing O. D. Inboard	2.8346 (72.000) 2.8341 (71.987)	3.9370 (100.000) 3.9364 (99.985)	4.7244 (120.000) 4.7238 (119.985)	5.5118 (140.000) 5.5111 (139-982)
Shaft O. D. Outboard	1.1815 (30.011) 1.1812 (30.002)	1.7722 (45.013) 1.7718 (45.002)	1.9690 (50.013) 1.9686 (50.002)	2.5597 (65.015) 2.5592 (65.002)
Clearance	0.0008 (0.021) tight 0.0001 (0.002) tight	0.0010 (0.025) tight 0.0001 (0.002) tight	0.0010 (0.025) tight 0.0001 (0.002) tight	0.0012 (0.030) tight 0.0001 (0.002) tight
Bearing I. D. Outboard	1.1811 (30.000) 1.1807 (29.990)	1.7717 (45.000) 1.7712 (44.988)	1.9685 (50.000) 1.9680 (49.988)	2.5591 (65.000) 2.5585 (64.985)
Housing I. D. Outboard	2.8346 (72.000) 2.8353 (72.019)	3.9370 (100.000) 3.9379 (100.022)	4.3307 (110.000) 4.3316 (110.022)	5.5118 (140.000) 5.5128 (140.025)
Clearance	0.0012 (0.032) loose 0.0000 (0.000) loose	0.0015 (0.037) loose 0.0000 (0.000) loose	0.0015 (0.037) loose 0.0000 (0.000) loose	0.0017 (0.043) loose 0.0000(0.000) loose
Bearing O. D. Outboard	2.8346 (72.000) 2.8341 (71.987)	3.9370 (100.000) 3.9364 (99.985)	4.3307 (110.000) 4.3301 (109.985)	5.5118 (140.000) 5.5111 (139-982)

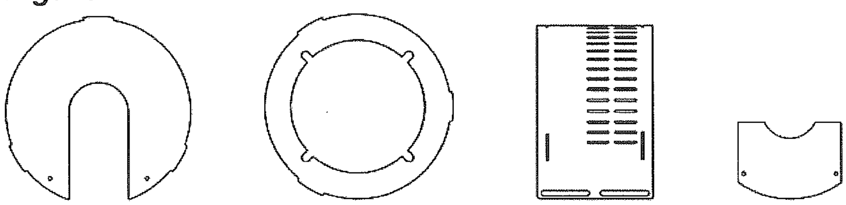
APPENDIX H – ANSI B15.1 COUPLING GUARDS

INSTALLATION INSTRUCTIONS FOR SUMMIT PUMP ANSI B15.1 COUPLING GUARDS

WARNING!

Before assembling or disassembling the coupling guard, de-energize the motor, lock out the motor controller/starter, and place a caution tag at the starter indicating that it is disconnected. Before resuming normal pump operation, replace the coupling guard. Summit Pump assumes no liability when these procedures are avoided.

Figure H-1

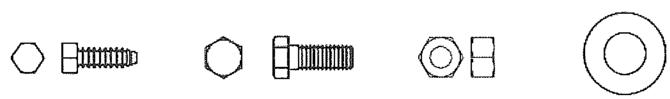


End Plate (Drive End) #531A

End Plate (Pump End) #531B

Guard Half (2) #531C

Slot Cover (1) #531D



#14-1/2 (2) Hex Washer Head Slotted Type A (Sharp Point) #531E

3/8-16 x 2" (3) Hex Head Bolt #531F

3/8-16 Nut (3) #531G

3/8 Washer (6) #531H

The design's simplicity allows complete coupling guard assembly, including the end plate (pump end), in about fifteen minutes.

ASSEMBLY PROCEDURES

■ TO ASSEMBLE YOUR COUPLING GUARD

NOTE: *If the end plate (pump end) was previously installed, make any necessary adjustments to the coupling and skip to Step 2.*

1. On the STO, MTO, and LTO, align the end plate (pump end) to the bearing frame. (Impeller adjustment is not required.)

   On the XLO-X, align the end plate (pump end) to the pump bearing housing with the small slots on the end plate aligned to the impeller adjusting bolts and the large slots clearing the bearing housing tap bolts. Then attach the end plate to the bearing housing using the jam nuts on the impeller adjusting bolts as shown in *Figure H-3*.

After attaching the end plate to the bearing housing, check and reset the impeller clearance as detailed in *APPENDIX A - IMPELLER CLEARANCE SETTING.*

NOTE: *Complete the coupling adjustments before proceeding with the coupling guard assembly.*

Figure H-2
STO, MTO, LTO

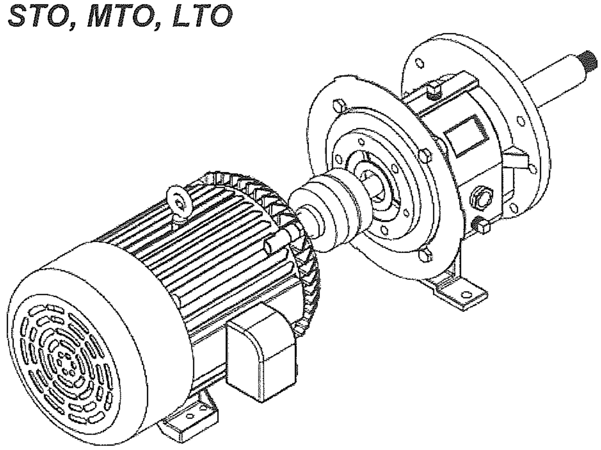
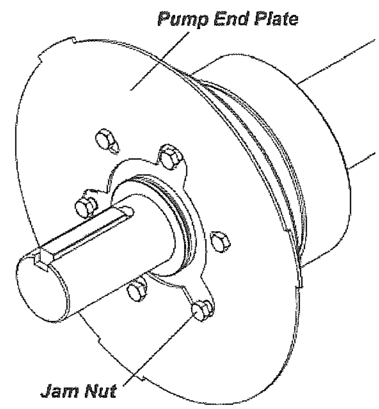


Figure H-3
XLO-X



2. Slightly spread the bottom of the coupling guard half (pump end) and place it over the pump end plate as shown in *Figure H-4*. The annular groove in the guard half is located around the end plate. (See *Figure H-5*.)

Figure H-4

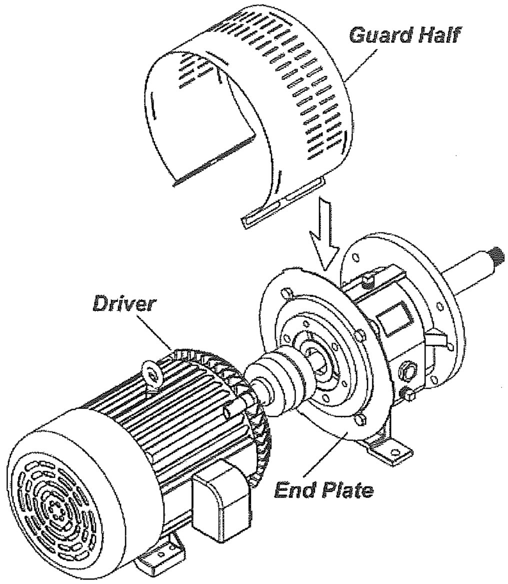
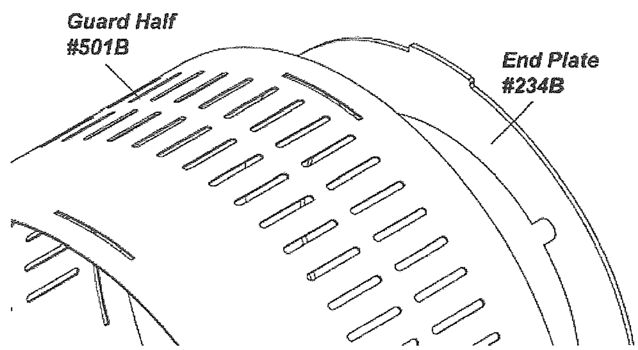


Figure H-5



3. After placing the coupling guard half (pump end) around the pump end plate, secure it with a bolt, nut and two (2) washers through the round hole in the front end of the guard half as shown in *Figure H-6*. Tighten securely. (See *Figure H-7*.)

Figure H-6

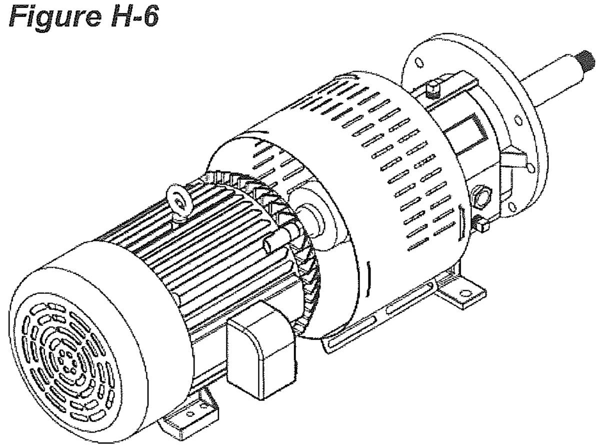
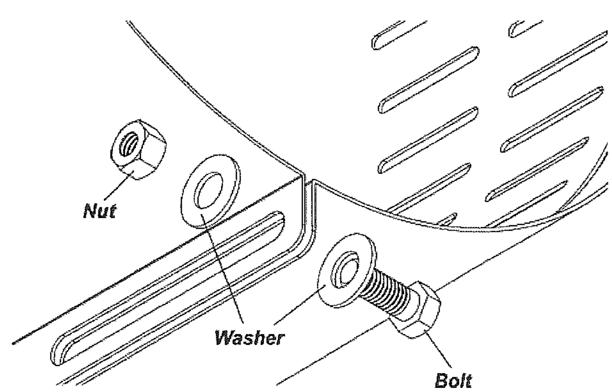
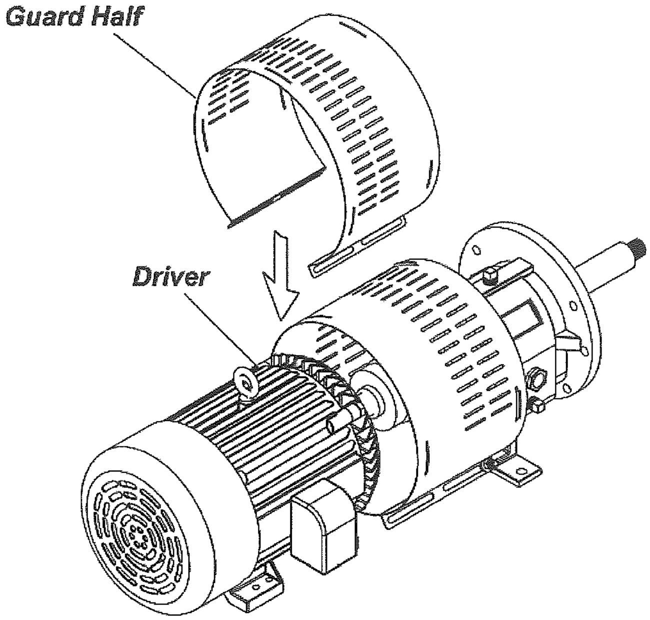


Figure H-7



4. Slightly spread the bottom of the coupling guard half (driver end) and place it over the coupling guard half (pump end) so that the annular groove in the coupling guard half (driver end) faces the motor as shown in *Figure H-8*.

Figure H-8



5. Place the end plate (driver end) over the motor shaft as shown in *Figure H-9*. Position the end plate in the annular groove at the rear of the coupling guard half (driver end) and secure it with a bolt, nut, and two (2) washers through the round hole at the rear of the guard half. Finger-tighten only.

Figure H-9

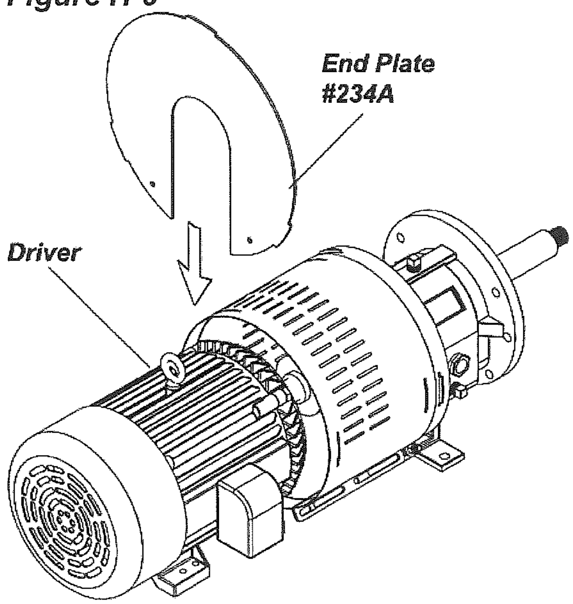
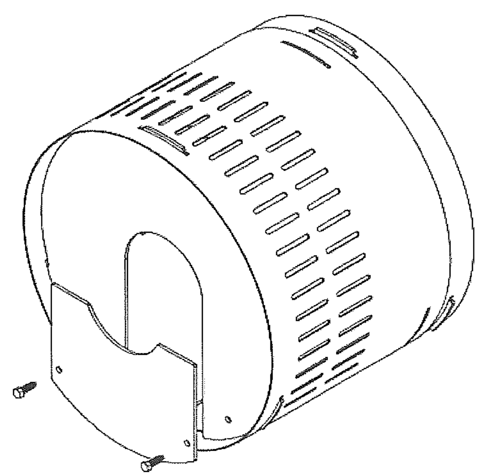


Figure H-9.5



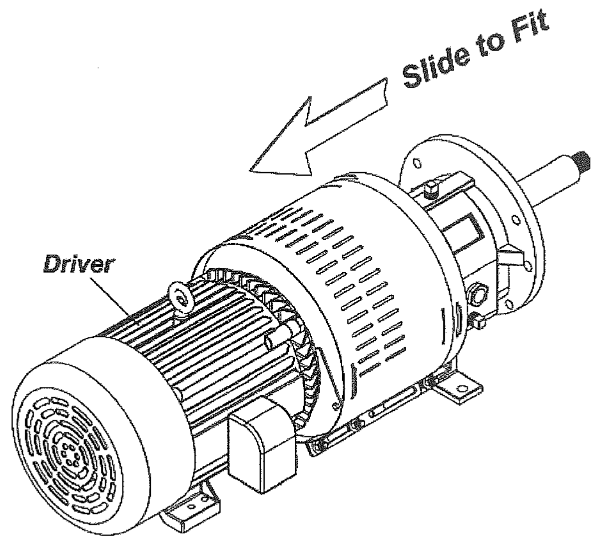
6. Adjust the length of the coupling guard to completely cover the shafts and coupling as shown in *Figure H-10,* by sliding the coupling guard half (driver end) toward the motor. After adjusting the length, secure the guard with a bolt, nut and

two (2) washers through the slotted holes at the center of the guard and tighten. Check tightness on all of the nuts on the guard assembly.

WARNING!

Before assembling or disassembling the coupling guard, de-energize the motor, lock out the motor controller/starter, and place a caution tag at the starter indicating that it is disconnected. Before resuming normal pump operation, replace the coupling guard. Summit Pump assumes no liability when these procedures are avoided.

Figure H-10



DISASSEMBLY PROCEDURES

■ TO DISASSEMBLE YOUR COUPLING GUARD

It is necessary to remove the coupling guard for certain pump maintenance and adjustments, such as coupling adjustment, impeller clearance adjustment, and so forth. Replace the coupling guard after completing maintenance.

DO NOT resume normal pump operation while the coupling guard is removed.

NOTE: *Refer to the illustrations for assembly beginning with Figure H-10 and working in reverse order.*

1. Remove the nut, bolt and washers from the center-slotted hole on the coupling guard. Slide the motor end of the coupling guard half toward the pump. (See *Figure H-10*.)
2. Remove the nut, bolt and washers from the driver end of the coupling guard half and remove the end plate. (See *Figure H-9*.)
3. Slightly spread the bottom of the coupling guard half and lift it off. (See *Figure H-8*.)
4. Remove the remaining nut, bolt and washers from the pump end of the coupling guard half. Slightly spread the coupling guard half and lift it off. (See *Figure H-4*.)

This concludes the coupling guard disassembly procedures.

> **NOTE**: *It is unnecessary to remove the end plate (pump end) from the bearing housing. If internal pump part maintenance is necessary, the bearing housing tap bolts are accessible without removing the end plate. Refer to* APPENDIX C - MAINTENANCE AND REPAIR *before removing the pump bearing housing.*

PO Box 12145 Green Bay, WI 54307
www.summitpump.com

SUMMIT™
PUMP, Inc

Rev 10/2013

SULZER

Sulzer Process Pumps US **PRODUCT SPECIFICATION**	Description CPT21-4 Serial Number 100112596 Reference no. 210939/000030 Time of delivery/EXW 07/29/2013 Date printed 07/19/2013 Page 1
Customer DYNATEC, INC. 2644-B ROUTE 206 NORTH MOUNT HOLLY NJ 08060 USA Cust. Order 734522 Cust. PO line Country code US	 DYNATEC SYSTEMS, INC. ATTN: ALEX SHERMAN 909 JACKSONVILLE ROAD BURLINGTON NJ 08016 USA Equipment Id

GENERAL

Pump type: **CPT**
Version: **03**
Classification: **B, Pre-engineered**
Units: **US**
Painting method: **Standard, Corrosivity C3 [NE]**
Color shade: **NCS 1700**
Tests: **PERFORMANCE HI 1.6 LEVEL A**
Coupling and Guard: **Included in the delivery**
Base plate: **Included in the delivery**
Drive motor: **Included in the delivery**

PROCESS DATA

Process: **Various Desalination**
Specific gravity: **1.00**
Temperature: **80 °F**
Capacity Q: **500.0 gpm**
Head H: **45.0 Feet**

PUMP PERFORMANCE

Characteristic curve: **K17385, O 1775 rpm 21-4**
Rated power P: **7.5 HP**
Motor power: **10.0 HP**
Dynamic seal power: **1.2 HP**
Efficiency: **65.0 %**
Pump rotational speed: **1775 rpm**
Variable speed: **No**
NPSH required: **10.5 Feet**
Capacity Q water: **500.0 gpm**
Head H water: **45.0 Feet**
Rated power P water: **7.5 HP**
Dynamic seal power water: **1.2 HP**
Efficiency water: **65.0 %**

PUMP

Pump Size: **21-4**
Flange drilling: **ASME B16.5-2009 CLASS 150**
Impeller no.: **610460, O 21-4**
Impeller Type: **Open**
Impeller diameter: **8.000 "**
Impeller max. diameter: **8.50 "**
Impeller balance holes: **Yes**
Casing material: **A890 3A**
Casing screw type: **Hexagonal screw**
Screw material: **A4-80 ISO 3506**
Gasket Material: **PTFE/Glass**
Casing gasket thickness: **0,8 mm**
O-ring Material: **FKM**
Shaft seal fitting: **DS01 Dynamic seal SS**
Dynamic seal material: **A890 3A**
Draining of pump conn. 040: **Yes**
Discharge pipe conn. 027: **Yes**
Press. measuring conn.036: **No**
Temper. measuring conn. 048: **No**
Bearing Unit Lubrication: **Oil lubrication**
Bearing unit type: **Foot frame Shaft Sleeved**
Bearing unit model: **06, 52 / 33 / NSs / Met**
Sign: **2006/42/EC**

Sulzer Process Pumps (US) Inc. Easley Pump Factory 155 Ahlstrom Way EASLEY SC 29640	Contact Person Sharon Whalley LBU Order 0000210939 LBU Position 000030 Reference no. 210939/000030 Telephone Telefax

Sulzer Process Pumps US

PRODUCT SPECIFICATION

Description	CPT21-4
Serial Number	100112596
Reference no.	210939/000030
Time of delivery/EXW	07/29/2013
Date printed	07/19/2013 Page 2

Customer
DYNATEC, INC.
2644-B ROUTE 206 NORTH
MOUNT HOLLY NJ 08060
USA
Cust. Order 734522
Cust. PO line
Country code US

DYNATEC SYSTEMS, INC.
ATTN: ALEX SHERMAN
909 JACKSONVILLE ROAD
BURLINGTON NJ 08016
USA

Equipment
Id

ASSEMBLY

Dim.drawing, Assembly of Pump: **P21128**
Next larger motor frame option: **Not included in the deliver**
Base plate type: **Style 1 PuMo Steel Paint**
Baseplate color shade: **NCS 1700**
Motor NEMA code: **215T**
Coupling type: **Rex Viva VS**
Coupling guard material: S+Z EN10025
Special parts of assembly: **DRIP PAN W/DRAIN OFF THE SIDE**
Riser block material: **Steel**

MOTOR

Motor Supplier: **Easley**
Motor manufacturer: **SIEMENS**
Motor NEMA code: **215T**
Motor type: **SD**
Rotational speed: **1,800 rpm**
Power: **10.00 HP**
Frequency: **60 Hz**
Voltage: **208-230/460**
Enclosure: **TEFC**
Specialities of Motor: **PB-SD10/1800SIE.208-230/460**

CUSTOMER INSTRUCTIONS

End user language: **English**
CD-disk. for order lang/qty: **EN03**
Certificates: **PERFORMANCE HI 1.6 LEVEL A**

Customer Instructions

000.01		1	SPECIFICATION AND PART LIST	000 SERIAL NUMBER
001.01		1	DIMENSIONAL DRAWING	P21128EN
001.02		1	Dimensional drawing	P11990EN
002.01		1	Characteristic curve	K17385EN
010.01		1	ASSEMBLY SECTDWG	N14219EN_20100215
011.01		1	PUMP SECTDWG	N15078EN_20080601
012.01		1	SHAFT SEAL SECTDWG	N15099EN_20010515
013.01		1	BEARING UNIT SECTDWG	N13970EN_20020501
058.01		1	DECLARATION OF QUALITY	N15110EN_20100430
059.01		1	PAINTING CERTIFICATE	N15111EN_20100430
062.01		1	INTENDED USE	N15252EN_20100430
063.01		1	Safety of Machinery	N31142EN
063.02		1	SAFETY INSTRUCTIONS	N15062EN_20101025
064.01		1	HOISTINGS AND TRANSPORTATIONS	N15063EN_20010515
065.01		1	COMMISSIONING	N15064EN_20010515
067.01		1	INSTALLATION	N15253EN_20020501
068.01		1	OPERATION	N15066EN_20010515
069.01		1	PREVENTIVE MAINTENANCE	N15254EN_20040401
070.01		1	CORRECTIVE MAINTENANCE	N15255EN_20110929
071.01		1	SPARE PARTS RECOMMENDATION	N15069EN_20080601
072.01		1	PERFORMANCE CERTIFICATE	N04386EN_100112596
D001.01		1	INSTRUCTION, DRIVE MOTOR, SIEMENS, NEMA	C10742EN
D001.02		1	INSTRUCTION, DRIVE MOTOR	CJ751301004EN
D002.01		1	INSTRUCTION, COUPLING, REX VIVA	C10014EN

Connections

027.01	CON027	1	DISCHARGE PIPE CONN. 1/4-18NPT	
040.01	CON040	1	DRAINING OF PUMP 1/2-14NPT	
042.01	CON042	1	OIL FILLING 1/2-14NPT	
043.01	CON043	1	DRAINING OF LUBRICAT 1/2-14NPT	
044.01	CON044	2	CONSTANT LEVEL OILER 1/4-18NPT	

Parts

102.01	530234CA41	1	VOLUTE CASE CPT21-4 O	(41) A890 3A
			Flange drilling: **ASME B16.5-2009 CLASS 150**	
			Draining of pump conn. 040: **Yes**	
			Discharge pipe conn. 027: **Yes**	
			Press. measuring conn.036: **No**	

Sulzer Process Pumps US

PART LIST

Description	CPT21-4
Serial Number	100112596
Reference no.	210939/000030
Time of delivery/EXW	07/29/2013
Date printed	07/19/2013 Page 4

			Temper. measuring conn. 048: **No**	
161.02	613147CC41	1	CASE COVER CPT21	(41) A890 3A
183.01	610480SF52	1	SUPPORT FOOT CPT2	(52) A48 CL 30 B
210.01	712176SH33	1	SHAFT CPT2 SL	(33) SS2324
230.01	610460MP41	1	IMPELLER O 8.5" B1 7/16" Z6 CPT21-4	(41) A890 3A
			Impeller diameter: **8.000 "**	
			Impeller max. diameter: **8.50 "**	
320.01	G433000311	1	ANTIFRICTION BEARING NUP311 ECJ	
320.02	G325007309	2	ANTIFRICTION BEARING 7309 BECBM	
330.01	533175BH52	1	BEARING HOUSING CPT2 O	(52) A48 CL 30 B
339.01	6130942106	1	BEARING UNIT CPT2 O FSL	
344.01	610485AD5H	1	ADAPTER CPT21	(5H) A395 60-40-18
360.01	712198BC52	1	BEARING COVER CPT2	(52) A48 CL 30 B
382.01	712194BR5H	1	BEARING CARRIER O CPT2	(5H) A395 60-40-18
400.01	E808254W84	1	GASKET 254(-2/-3)/217(-1/-2)X0.8	(84) PTFE/Glass
412.01	E124041094	1	O-RING 41,0 X 1,78 BS1806 SIZE NO.030	(94) PTFE
			Nominal diameters 1 5/8 x 1 3/4 x 1/16	
412.02	E11B119591	2	O-RING 119,5X3 SMS1586	(91) NBR
412.03	E11B094591	1	O-RING 94,5X3 SMS1586	(91) NBR
412.04	E11H189393	1	O-RING 189,3X5,7 SMS1586	(93) FKM
412.05	E129047393	1	O-RING 47,34 X 2,62 BS1806 SIZE NO.134	(93) FKM
			Nominal diameters 1 7/8 x 2 1/16 x 3/32	
412.06	E11B099593	1	O-RING 99,5X3 SMS1586	(93) FKM
423.01	GK1A320000	1	LABYRINTH RING CPT2 VBX 2,125" INBOARD	Bronze
			p/n = 1221-A-16521-0	
423.02	GK1B320000	1	LABYRINTH RING CPT2 VBX 1,375" OUTBOARD	Bronze
			p/n = 1800-A-P0008-0	
435.01	3822790384	1	STATIC SEAL AP3	(84) PTFE/Glass
451.01	613155SB41	1	STUFFING BOX HOUSING CPT21	(41) A890 3A
			Temper. measuring conn. 048: **No**	
471.02	7070210142	1	COVER PLATE FOR SEAL AP3	(42) A743 CF-8M
475.01	712262TR33	1	THRUST RING CPT2	(33) SS2324
554.02	B310010537	6	WASHER ISO 7089-10-200 HV-A4	(37) A4 ISO3506
554.03	B360008437	4	WASHER 8,4 DIN7349	(37) A4 ISO3506
554.04	B360013037	2	WASHER 13 DIN7349	(37) A4 ISO3506
554.05	B360013037	2	WASHER 13 DIN7349	(37) A4 ISO3506
556.01	7092640510	4	RISER BLOCK 4"X4"X2.75"	(10) S EN10025
			709264-05	
604.01	613163EX41	1	EXPELLER CPT21	(41) A890 3A
642.01	GH3330506D	2	SIGHT GLASS SM-12 ISO 228/1-G 1/2	(6D) Al (aluminium)
644.01	914706LR12	1	OIL RING CPT2 D122/57	(12) Fe P01 EN10130
672.01	GH55305000	1	VENTING DEVICE EV 1028-14-00 R 1/2	
685.01	6105780111	1	GUARD END 250MM O.D. FOR BEARING UNIT #2	(11) S235JRG2 EN10025

Sulzer Process Pumps US PART LIST	Description	CPT21-4
	Serial Number	100112596
	Reference no.	210939/000030
	Time of delivery/EXW	07/29/2013
	Date printed	07/19/2013 Page 5

686.01	933203011K	1	GUARD JACKET D250,L200	(1K) S+Z EN10025
686.02	384476011K	1	GUARD JACKET D250 L165	(1K) S+Z EN10025
749.01	980814013U	1	DRIP PAN SPECIAL CPT2 FOR DYNATEC	304/304L S.S.
800.01	J751301004/PB	1	MOTOR 10HP/1800RPM/215T/230/460V PB	
840.01	KAC1035349	1	COUPLING VS110-R-FBH D1=1.375 D2=1.375	
890.01	610558XX10	1	BASEPLATE #252 MULTI DRILLED	(10) S EN10025
901.01	A132063239	12	HEXAGON HEAD SCREW 1/2-13UNCX1 1/4 ANSI B18.2.1	(39) A4-80 ISO3506
901.02	A132052539	2	HEXAGON HEAD SCREW 3/8-16UNC X 1 ANSI B18.2.1	(39) A4-80 ISO3506
901.03	A142063839	6	HEXAGON HEAD SCREW 1/2-13UNC X 1 1/2" ANSI B18.2.1 1/2-13UNC x 1 1/2" ANSI B18.2.1 FT	(39) A4-80 ISO3506
901.04	A132062539	2	HEXAGON HEAD SCREW 1/2-13 UNC X 1" ANSI B18.2.1	(39) A4-80 ISO3506
901.05	A142053239	3	HEXAGON HEAD SCREW 3/8-16UNC X 1 1/4 ANSI B18.2.1 F 3/8-16UNC x 1 1/4 ANSI B18.2.1 FT	(39) A4-80 ISO3506
901.06	A132041939	4	HEXAGON HEAD SCREW 5/16-18UNC X 3/4 ANSI B18.2.1	(39) A4-80 ISO3506
901.08	A132063839	3	HEXAGON HEAD SCREW 1/2-13UNCX1 1/2 ANSI B18.2.1	(39) A4-80 ISO3506
901.09	A132051939	3	HEXAGON HEAD SCREW 3/8-16UNCX3/4 ANSI B18.2.1	(39) A4-80 ISO3506
901.11	A132064539	2	HEXAGON HEAD SCREW 1/2-13UNCX1 3/4 ANSI B18.2.1	(39) A4-80 ISO3506
901.12	A132064539	2	HEXAGON HEAD SCREW 1/2-13UNCX1 3/4 ANSI B18.2.1	(39) A4-80 ISO3506
902.03	AC2204C733	4	STUD 5/16-18UNC X 5" SAP 200	(33) SS2324
903.01	CC25050034	1	THREADED PLUG 1/2-14 NPT SCC102	(34) SS2343
903.02	CC25030034	1	THREADED PLUG 1/4-18 NPT SCC102	(34) SS2343
903.07	CC25050034	1	THREADED PLUG 1/2-14 NPT SCC102	(34) SS2343
903.08	CC25030016	2	THREADED PLUG 1/4-18 NPT SCC102	(16) S+ZE EN10025
903.09	CC25030034	1	THREADED PLUG 1/4-18 NPT SCC102	(34) SS2343
904.01	A662051638	3	SET SCREW 3/8-16UNCX5/8 ANSI	(38) A4-50 ISO3506
914.01	A611103539	3	CAP SCREW, SOCKET HD M10X35 ISO4762	(39) A4-80 ISO3506
920.03	B222704030	3	NUT M10 - PTROM-1040	(30) SS
920.04	B122040039	4	NUT 5/16-18.UNC ANSI B18.2.2	(39) A4-80 ISO3506
923.01	GA11000910	1	BEARING NUT KM9	(10) S EN10025
931.01	GC10000910	1	LOCK WASHER MB9	(10) S EN10025
932.01	B710001030	3	RETAINING RING Ø10 - DIN471	(30) SS
940.01	B820804115	1	KEY 5/16X5/16X15/8 ANSI B 17.1-1967	(15) CK45K DIN1652
970.01	WK3130307A	2	SIGN SULZER LOGO SIGN L130 MM	(6D) Al (aluminium)
971.01	93265101BG	1	NAME PLATE CENTRIF PUMP EASLEY	(S0708) EN 1.4301
975.02	SS00050102	2	WARNING SIGN Rotating shaft	
975.03	SS00050202	2	WARNING SIGN Corrosive / Irritating liquid	
975.04	SS00050802	1	WARNING SIGN Guard adjustment, in english	
976.01	SS0006M002	1	MANDATORY ACTION SIG EN Oil refilling	
976.02	SS0006M022	1	MANDATORY ACTION SIG	

Coupling alignment

SULZER

EC Declaration of Conformity

as defined by EC machinery directive 2006/42/EC, Annex IIA

Manufacturer:	Sulzer Process Pumps (US) Inc. 155 Ahlstrom Way, 29640 Easley, USA
Contact person:	Director Product Development Jukka-Pekka Peri Sulzer Pumps Finland Oy PL 66, 48601 Kotka, Finland

herewith declares that

Centrifugal pump, type:	CPT21-4
Serial number:	100112596

is in conformance with directive 2006/42/EC (machinery directive) and where applicable following other EC directives 2004/108/EC (electromagnetic compatibility) and 2006/95/EC (low voltage). Harmonized standard EN 809 has been applied to the design and manufacture of the product.

Easley 19.07.2013

Ilkka Sinisalo
Head Operations BA CS

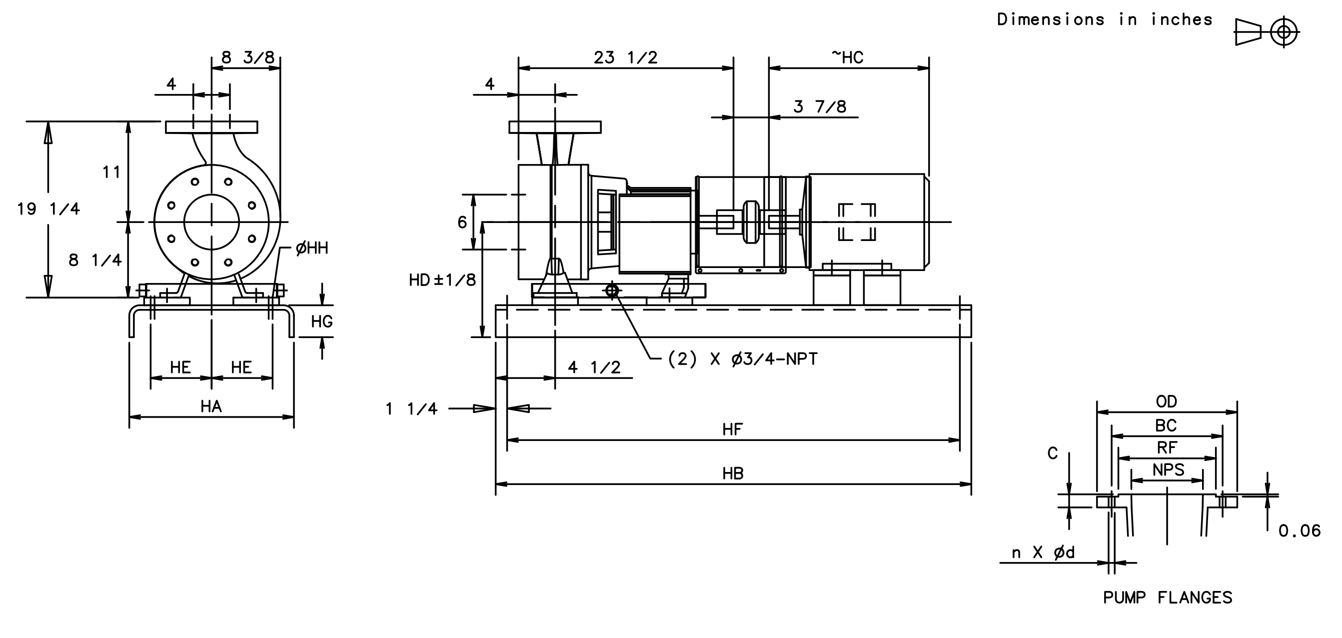
This declaration only concerns the machine as it was brought to the market. This declaration does not cover parts added to the machine by the end user afterwards and/or operations carried out on the machine by the end user.

SULZER

CPT Chemical Process Pumps
Dimensional drawing: P21128

Version 03 > / en / 120110 / REPLACES 111018 / **P21128**

CPT21-4 (6 x 4 x 8A)
Steel baseplate for pump and motor, style 1 and 2 with drip pan



DIMENSIONS										
Primary motor frame	HC	HA	HB	HE	HF	HG	HH	HD	Weight(lbs.)*	
									style 1	style 2
184T	15 1/8	15	45	4 1/2	42 1/2	3 3/16	3/4	11 7/16	526	531
213T	17 1/2	18	52	6	49 1/2	3 1/2	3/4	11 3/4	610	615
215T	19	18	52	6	49 1/2	3 1/2	3/4	11 3/4	610	615
326TS	29 1/4	21	64	7 1/2	61 1/2	4	1	12 1/4	720	725
365TS	31 7/8	21	64	7 1/2	61 1/2	4	1	13 1/4	748	753
405TS	34 7/8	26	68	9 1/2	65 1/2	4	1	14 1/4	846	851

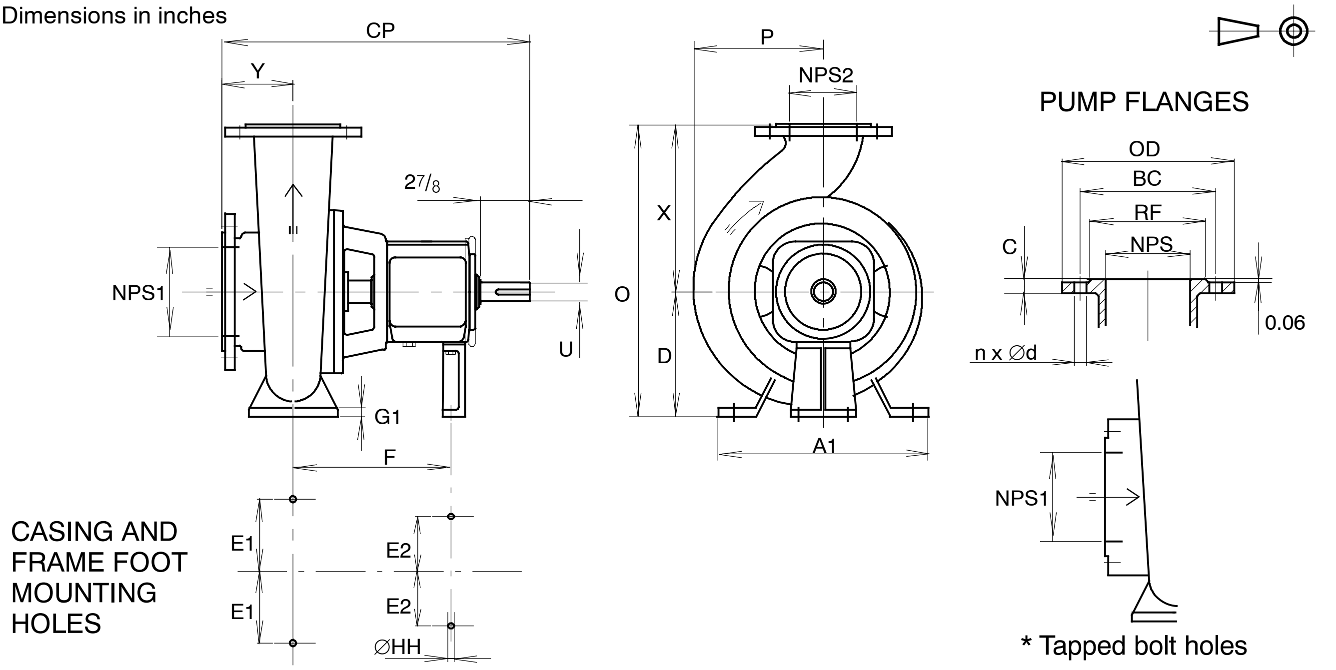
DRILLING OF FLANGES												
NPS	ASME B16.5 Class 150(SS) ASME B16.42 Class 150(DI)						ASME B16.5 Class 300(SS)					
	OD	RF	C	BC	d	n	OD	RF	C	BC	d	n
4	9.00	6.19	0.94	7.50	0.75	8	10.00	6.19	1.25	7.88	0.88	8
6	11.00	8.50	-	9.50	3/4-10 UNC	8	12.50	8.50	-	10.62	3/4-10 UNC	12

* Weight without coupling and motor.

Version 03 > / 20080601 / Replaces 20020501 / P11990

CPT21-1B ... CPT24-4
Bare Pump

Dimensions in inches



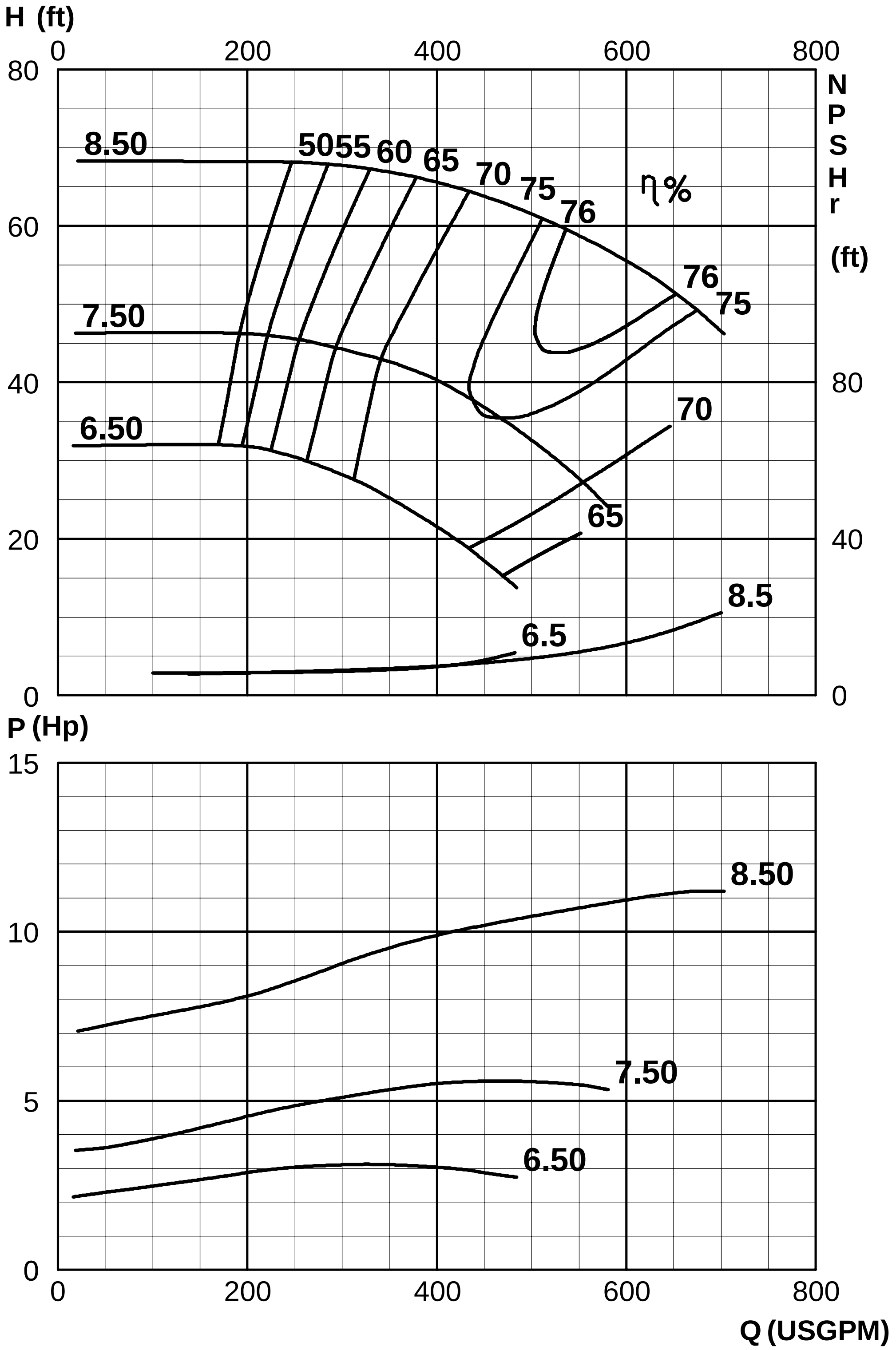
DIMENSIONS																	
Type	NPS1	NPS2	CP	D	E1	E2	F	HH	O	P	U Dia.	U Keyway	X	Y	A1	G1	Weight lbs
21-1B	3	1 1/2	23 1/2	8 1/4	4 7/8	3 5/8	12 1/2	5/8	16 3/4	5 19/32	1 3/8	5/16x5/32x1 5/8	8 1/2	4	11 1/4	1/2	260
21-2	3	2	23 1/2	8 1/4	4 7/8	3 5/8	12 1/2	5/8	17 3/4	6	1 3/8	5/16x5/32x1 5/8	9 1/2	4	11 1/4	1/2	270
21-3	4	3	23 1/2	8 1/4	4 7/8	3 5/8	12 1/2	5/8	19 1/4	6 7/32	1 3/8	5/16x5/32x1 5/8	11	4	11 1/4	1/2	290
21-4	6 *	4	23 1/2	8 1/4	4 7/8	3 5/8	12 1/2	5/8	19 1/4	8 1/2	1 3/8	5/16x5/32x1 5/8	11	4	11 1/4	1/2	360
22-1	2	1	23 1/2	8 1/4	4 7/8	3 5/8	12 1/2	5/8	16 3/4	6 5/8	1 3/8	5/16x5/32x1 5/8	8 1/2	4	11 1/4	1/2	260
22-1C	2	1	23 1/2	8 1/4	4 7/8	3 5/8	12 1/2	5/8	16 3/4	6 5/8	1 3/8	5/16x5/32x1 5/8	8 1/2	4	11 1/4	1/2	265
22-1B	3	1 1/2	23 1/2	8 1/4	4 7/8	3 5/8	12 1/2	5/8	16 3/4	6 15/16	1 3/8	5/16x5/32x1 5/8	8 1/2	4	11 1/4	1/2	295
22-2	3	2	23 1/2	8 1/4	4 7/8	3 5/8	12 1/2	5/8	17 3/4	7 15/16	1 3/8	5/16x5/32x1 5/8	9 1/2	4	11 1/4	1/2	300
22-4	6 *	4	23 1/2	10	4 7/8	3 5/8	12 1/2	5/8	23 1/2	9	1 3/8	5/16x5/32x1 5/8	13 1/2	4	11 1/4	1/2	375
23-1B	3	1 1/2	23 1/2	10	4 7/8	3 5/8	12 1/2	5/8	20 1/2	7	1 3/8	5/16x5/32x1 5/8	10 1/2	4	11 1/4	1/2	300
23-2	3	2	23 1/2	10	4 7/8	3 5/8	12 1/2	5/8	21 1/2	7 11/32	1 3/8	5/16x5/32x1 5/8	11 1/2	4	11 1/4	1/2	305
23-3	4	3	23 1/2	10	4 7/8	3 5/8	12 1/2	5/8	22 1/2	7 1/2	1 3/8	5/16x5/32x1 5/8	12 1/2	4	11 1/4	1/2	340
24-1B	3	1 1/2	23 1/2	10	4 7/8	3 5/8	12 1/2	5/8	20 1/2	8 1/2	1 3/8	5/16x5/32x1 5/8	10 1/2	4	11 1/4	1/2	320
24-1BC	3	1 1/2	23 1/2	10	4 7/8	3 5/8	12 1/2	5/8	20 1/2	8 1/2	1 3/8	5/16x5/32x1 5/8	10 1/2	4	11 1/4	1/2	325
24-2	3	2	23 1/2	10	4 7/8	3 5/8	12 1/2	5/8	21 1/2	8 15/16	1 3/8	5/16x5/32x1 5/8	11 1/2	4	11 1/4	1/2	350
24-3	4	3	23 1/2	10	4 7/8	3 5/8	12 1/2	5/8	22 1/2	10 1/8	1 3/8	5/16x5/32x1 5/8	12 1/2	4	11 1/4	1/2	400
24-4	6 *	4	23 1/2	10	4 7/8	3 5/8	12 1/2	5/8	23 1/2	10 1/4	1 3/8	5/16x5/32x1 5/8	13 1/2	4	11 1/4	1/2	475

DRILLING OF FLANGES												
NPS	ASME B 16.5 Class 150 (SS) ASME B 16.42 Class 150 (DI)						ASME B 16.5 Class 300 (SS)					
	OD	RF	C	BC	d	n	OD	RF	C	BC	d	n
1	4.25	2.00	0.56	3.12	0.62 1/2-13 UNC (1	4	4.88	2.00	0.69	3.50	0.75 5/8-11 UNC (1	4
1 1/2	5.00	2.88	0.69	3.88	0.62 1/2-13 UNC (2	4	6.12	2.88	0.81	4.50	0.88 3/4-10 UNC (2	4
2	6.00	3.62	0.75	4.75	0.75	4	6.50	3.62	0.88	5.00	0.75	8
3	7.50	5.00	0.94	6.00	0.75	4	8.25	5.00	1.12	6.62	0.88	8
4	9.00	6.19	0.94	7.50	0.75	8	10.00	6.19	1.25	7.88	0.88	8
6	11.00	8.50	-	9.50	3/4-10 UNC	8	12.50	8.50	-	10.62	3/4-10 UNC	12

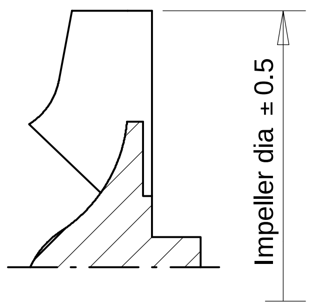
1) CPT22-1 (low flow)
2) CPT24-1B (low flow)

***CPT** Chemical Process Pumps*
Characteristic Curve K17385

CPT21-4 (6x4x8.5)
Impeller 610460 OPEN B0.59 Z6
1775 rpm



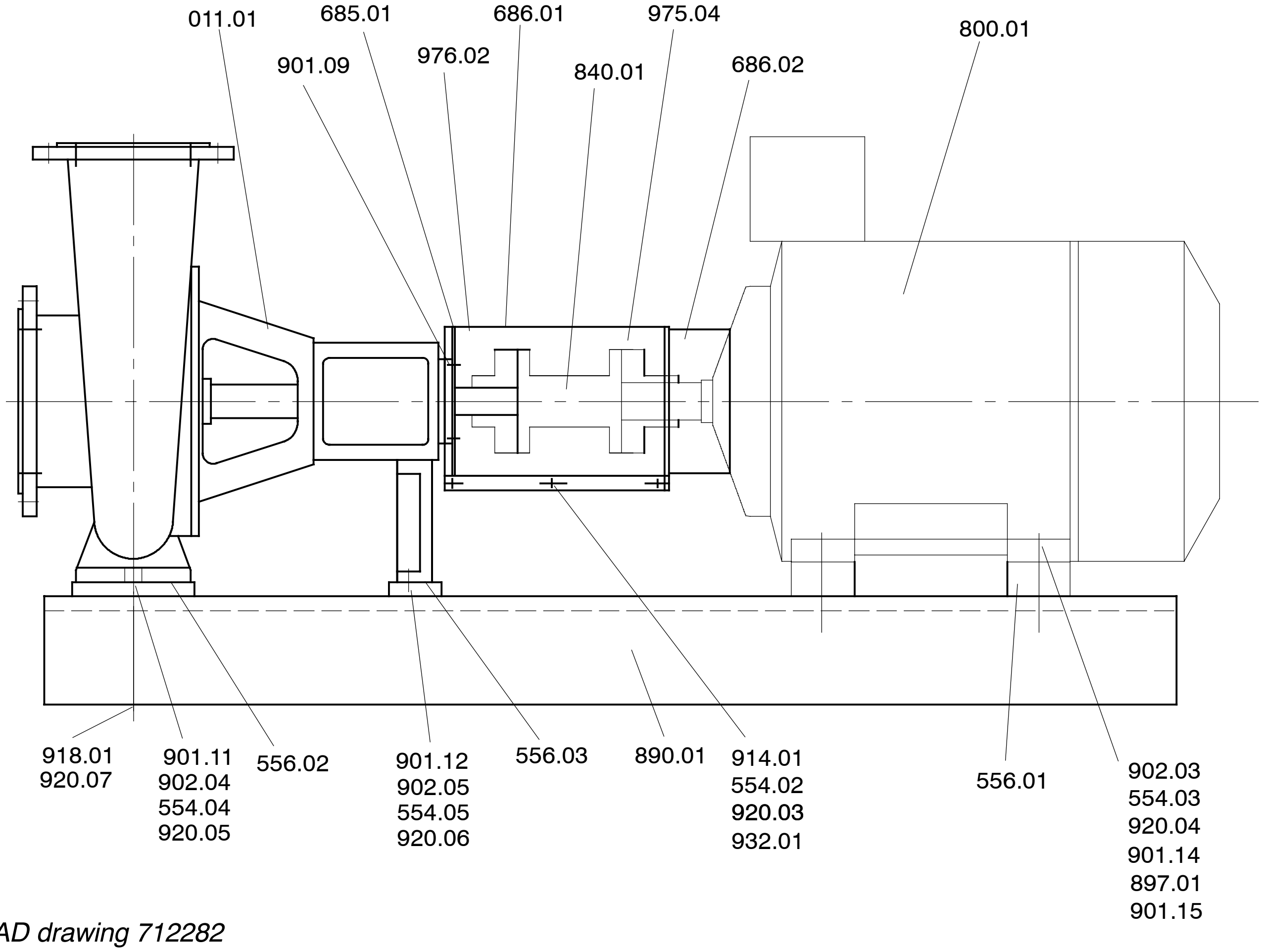
IMPELLER DIA	
in	**mm**
8.5	215.9
8.25	209.5
8	203.2
7.75	196.8
7.5	190.5
7.25	184.2
7	177.8
6.75	171.5
6.5	165.1



Version 02 > / 20100215 / Replaces 20080601 / en / **N14219**

010.01 Assembly

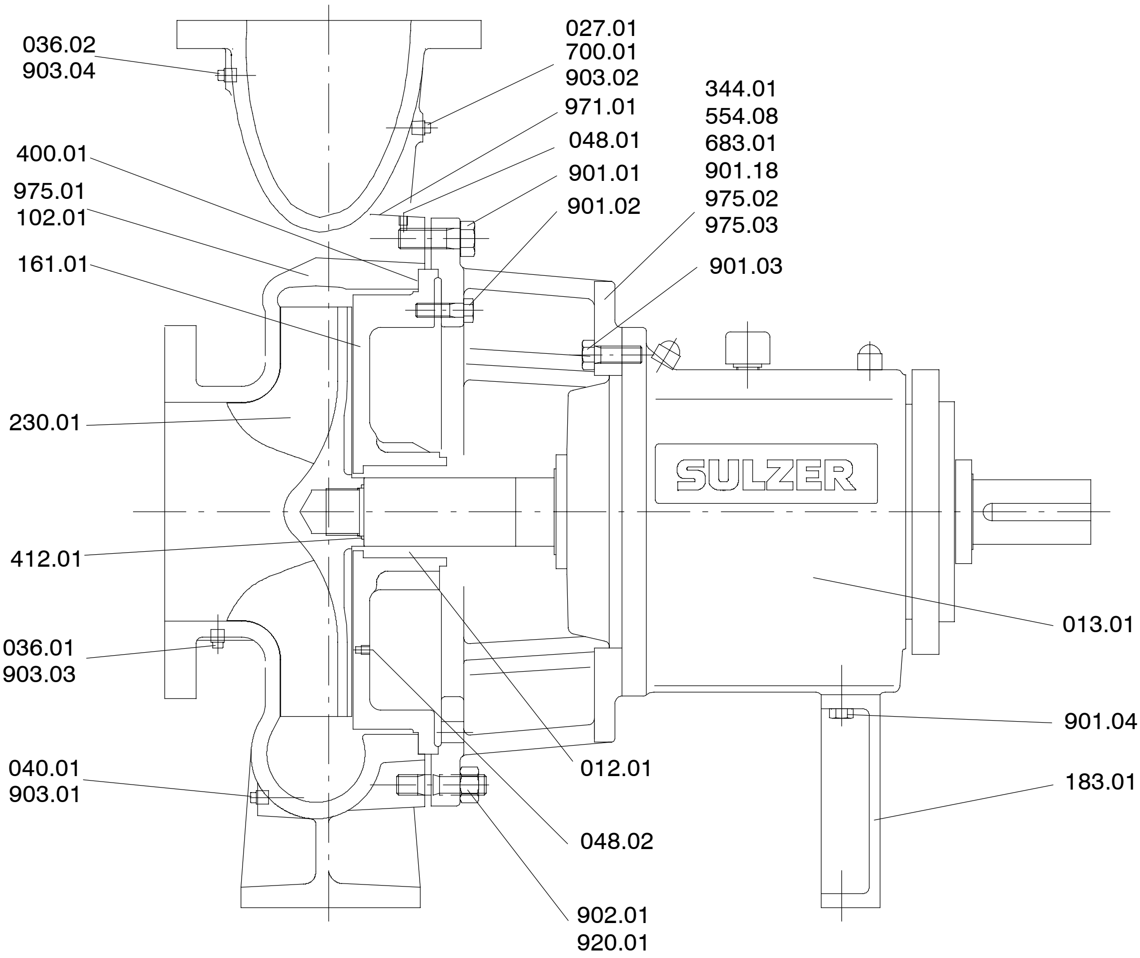
Baseplate for pump and motor



CAD drawing 712282

011.01 Pump

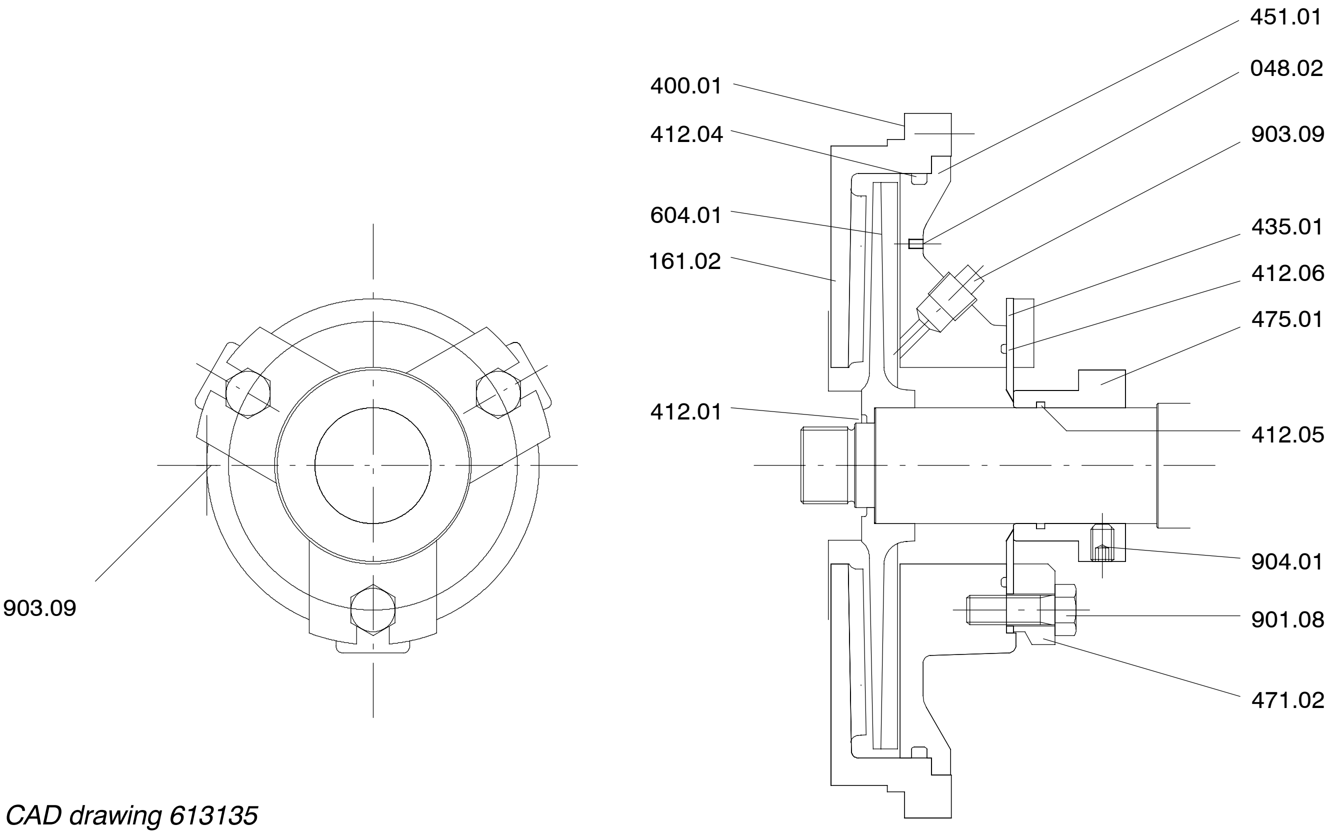
Open and low flow impeller



CAD drawing 613096

012.01 Shaft seal

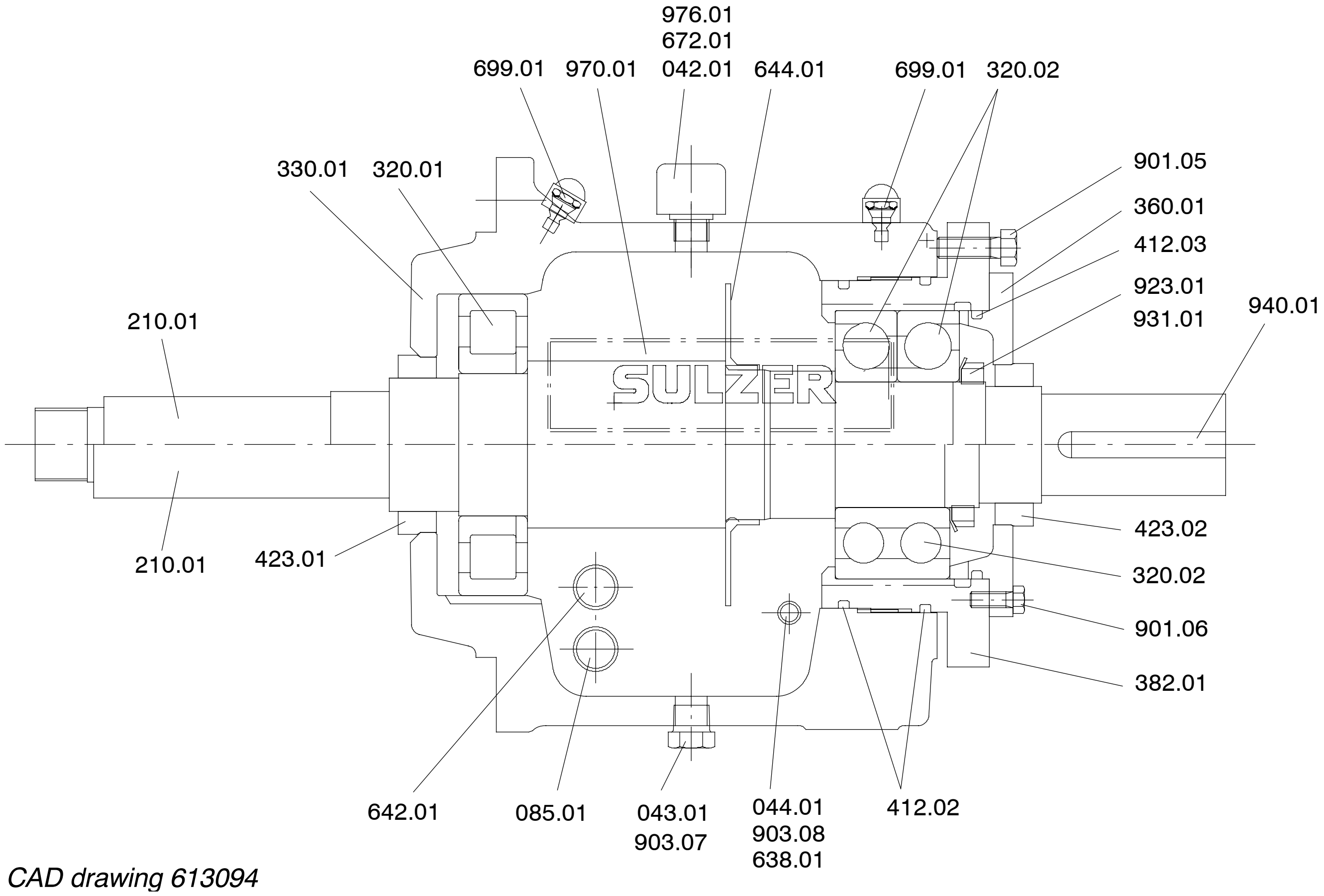
Fitting DS01 (CPT11, 21, 22, 23, 24, 31)



CAD drawing 613135

013.01 Bearing unit

Oil lubrication (Part No. 339.01)



CAD drawing 613094

We certify that CPT pump has been manufactured, tested and inspected according to the ASME B73.1 -2001 technical specification and ISO 9001:2001 quality standard (if no other specified requirements exist).

1 Inspection before assembly

Components to be assembled have been examined.

Installation dimensions have been examined.

Information on the nameplate has been examined.

2 Materials

Materials have been manufactured according to the standard specified in order specification and part list.

3 Balancing of rotating components

All rotating components are balanced according to ISO 1940 G6.3 or G2.5 standard.

4 Hydrostatic test

All pressure containing parts (eg. casing, casing cover etc.) including their fasteners have been hydrostatically tested with clean water at ambient temperature (15 °C minimum for carbon steel). The hydrostatic test has been considered satisfactory when the test pressure is maintained for at least 10 min. without visible leakage. The hydrostatic pressure is 1.5 times the design pressure.

5 Performance test

Performance test has been done according to Hydraulic Institute Standards 1.6 level B.

During performance tests the pump vibration, bearing temperature and visually the shaft seal have been checked.

6 Final inspection

A final inspection has been done so, that the scope of supply is correct and complete according to the purchase order, including component identification, painting and preservation and technical documentation.

7 Preparation for dispatch

All internal parts made of material which are not resistant to corrosive attack by the environment have been drained and treated with a water displacing rust-preventative prior to shipment.

Exterior surfaces, except for machined surfaces, have been given at least one coat of the manufacturer's standard paint which shall be selected taking into account environmental considerations. The under-side of baseplates have been prepared for grouting.

Exterior machined surfaces of cast iron and carbon steel parts have been coated with a suitable rust preventative.

Bearings and bearing housings have been protected by preservative oil which is compatible with the lubricant. A warning label (oil lubricated bearing housings must be filled with oil to the proper level prior to starting) have securely attached to the pump.

Information on preservation agents and their removal have been securely attached to the pump.

All openings to the pressure chamber have weather-resistant closures substantial enough to withstand accidental damage.

Each unit have been prepared and small piping and auxiliaries secured, to prevent damage during shipment and storage.

The pump and all components supplied loose with it have been clearly and durably marked with the prescribed identification number.

Easley 30.4.2010

G Alan Crawford

Alan Crawford
President
Sulzer Process Pumps (US) Inc.

We certify that CPT pump has been painted according to the option mentioned in the product specification.

1 Painting and galvanizing

Normal painting of pumps is made according to ISO 12944-5

- Cleanliness: According to standard of steel work preparation grade ISO8501-1 Sa 2 ½

1.1 Painting combinations

Liquid temperature is below 150 °C / 302 °F

NE

- Cast iron components ISO 12944-5/S3.18 EP200/3-FeSa 2 1/2
- Stainless steel components EP80/1-Ka/Pe

NZ

- Cast iron components ISO 12944-5/S3.22 EPZn[R] EP200/3-FeSa 21/2
- Stainless steel components EP80/1-Ka/Pe

Liquid temperature over 150 °C / 302 °F

HE

Adapter, bearing unit and support foot

- Cast iron components ISO 12944-5/S3.18 EP200/3-FeSa 2 1/2
- Stainless steel components EP80/1-Ka/Pe

Volute casing, casing cover, casing and stuffing box housing

- SI15/1-Ka/Pe

HZ

Adapter, bearing unit and support foot

- Cast iron components ISO 12944-5/S3.22 EPZn [R] EP200/3-FeSa 2 1/2
- Stainless steel components EP80/1-Ka/Pe

Volute casing, casing cover, casing and stuffing box housing

- SI15/1-Ka/Pe

Film combination specification

Pump surfaces generally

EP200/3	EP Zn[R] EP200/3	EP80/1	SI 15/1
1 x base 0.0024 in (60 µm) 1 x base 0.0024 in (60 µm) 1 x top coat 0.0031 in (80 µm) Nominal dry film thickness 0.0079 in (200 µm)	1 x base 0.0016 in (40 µm) 1 x base 0.0031 in (80 µm) 1 x top coat 0.0031 in (80 µm) Nominal dry film thickness 0.0079 in (200 µm)	1 x top coat 0.0031 in (80 µm) Nominal dry film thickness 0.0031 in (80 µm)	1 x 0.0006 in (15 µm) Nominal dry film thickness 0.0006 in (15 µm)

Machined pump surfaces

1 x top coat 0.0031 in (80 μm) Dry film nominal thickness 0.0031 in (80 μm)	1 x top coat 0.0031 in (80 μm) Dry film nominal thickness 0.0031 in (80 μm)	1 x top coat 0.0031 in (80 μm) Dry film nominal thickness 0.0031 in (80 μm)	1 x top coat 0.0006 in (15 μm) Dry film nominal thickness 0.0006 in (15 μm) (E 60/1)

Guide surfaces and counter faces of pump parts

not painted
Nominal dry film thickness
-

Painted pump parts (other pump parts are not painted)

Part no.	Description	Part no.	Description
102.01	Volute casing	330.01	Bearing housing
161.01	Casing cover	344.01	Adapter
161.02	Casing cover	360.01	Bearing cover
183.01	Support foot	382.01	Bearing carrier

1.2 Painting instructions for other parts

Motor is painted by motor manufacturer. Not painted in pump factory
Couplig is coated by coupling manufacturer. Not painted in pump factory.

Painting instructions for coupling guard

Part no.	Description	Painting instructions
685.01	Guard end	Powder painting 1 x top coat 0.0040 in (100 μm)
686.01	Guard jacket	Dry film nominal thickness 0.0040 in (100 μm) (EP 100/1) Color shade NCS 0582-Y09R

Hot galvanizing instructions for baseplate

Part no.	Description	Painting instructions
890.01	Baseplate	Hot galvanizing Fe/ZnK Class A SFS2765

Hot galvanizing will be done according to standard SFS2765.

Painting instructions for baseplate

<table>
<tr><th>Part no.</th><th>Description</th><th>Painting instructions</th></tr>
<tr><td>890.01</td><td>Baseplate</td><td rowspan="4">Upper surface of the bulk and bulk sides 2 inch from the upper surface. Inner side of the motor stand and pump stands.

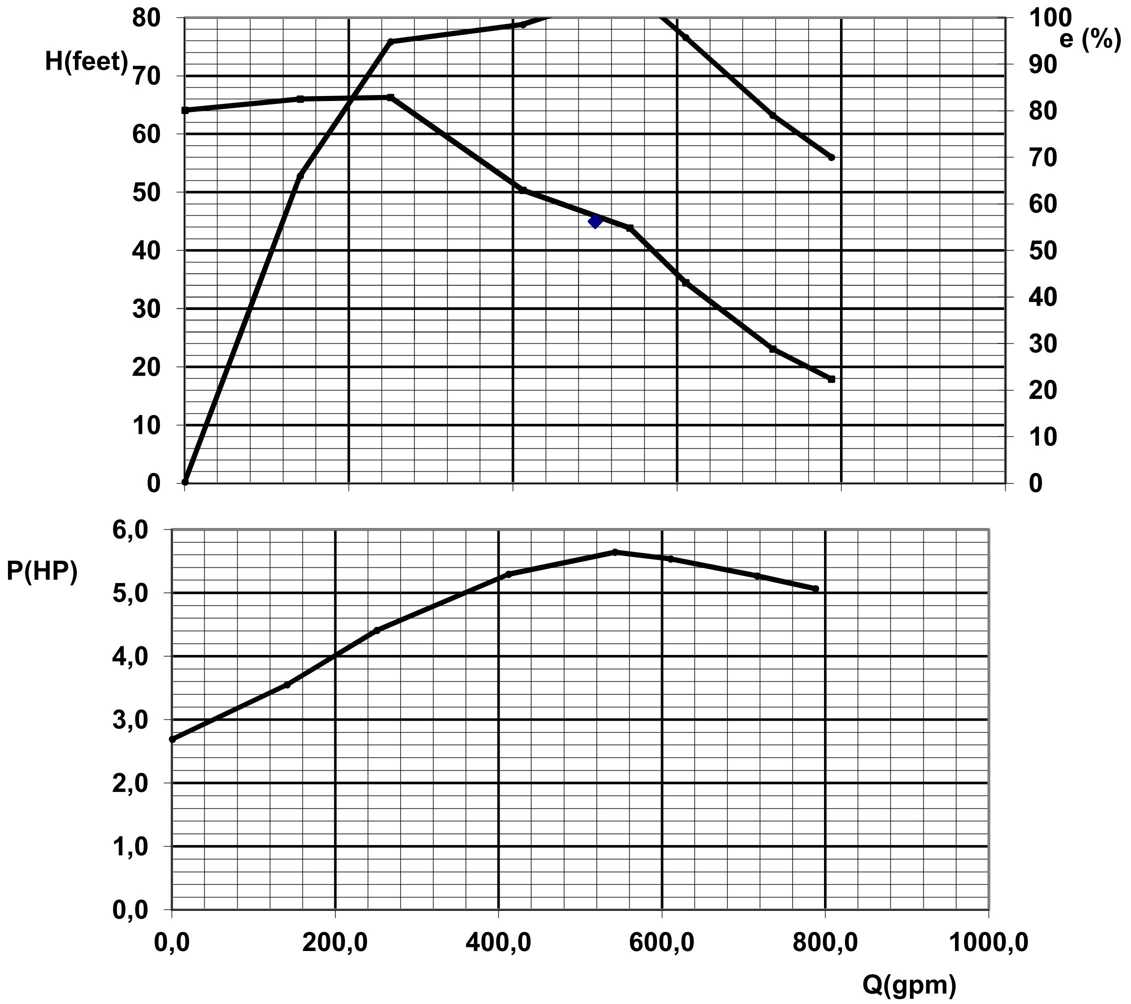
ISO 12944-5/S3.18 EP200/3-FeSa 2 ½
ISO 12944-5/S3.22 EPZn[R] EP 200/3-FeSa 2 1/2</td></tr>
<tr><td>566.01</td><td>Riser block</td></tr>
<tr><td>566.02</td><td>Riser block</td></tr>
<tr><td>566.03</td><td>Riser block</td></tr>
</table>

Easley 30.4.2010

G Alan Crawford

Alan Crawford
President
Sulzer Process Pumps (US) Inc.

Customer DYNATEC, INC.		Customer Order No. 734522	Customer Item/Tag N/A
Project name DYNATEC, INC.			Witnessed ☐ Yes / No ☒
Manufacturer Sulzer Process Pumps (US) Inc		Test date 11.07.2013	Test standard ANSI/HI A
Product type CPT21-4	Serial number 100112596	Impeller 610460 / 8,0 in	Water temperature 74 °F
Guaranteed values for acceptance test:			
Specified speed 1775 rpm	Flow 500,07 gpm	Head 45,01 feet	Efficiency 65,00 %
	Test results based on the specified speed of rotation		
Test speed 1772 rpm	Flow 500,07 gpm	Head 45,96 feet	Efficiency 103,60 %



The above items have been tested in accordance with the requirements of the test procedure/standard and are acceptable to specification.

Easley 11.07.2013

Scott Holliday
Quality, Environmental, Safety, and Health Manager

SULZER

Performance Certificate

Series	Page
CERTIFICATION	
September 2008	H05b

Manufacturer Sulzer Process Pumps (US) Inc		Test date 11.07.2013	Test standard ANSI/HI A
Product type CPT21-4	Serial number 100112596	Impeller 610460 / 8,0 in	Water temperature 74 °F
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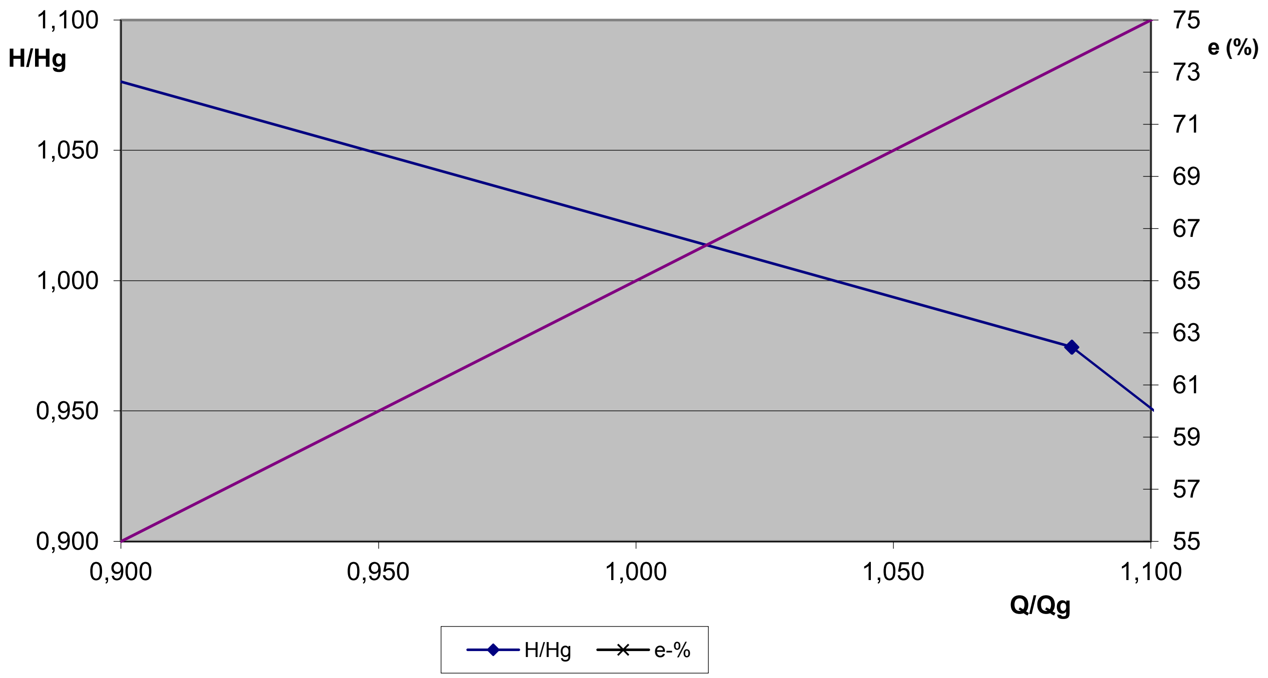
Test speed 1772 rpm	Flow 500,07 gpm	Head 45,96 feet	Efficiency 103,60 %



Head/Flow relative to guarantee value	Tolerance cross ISO 9906 Grade1/Grade2/Annex A/Sulzer

Easley 11.07.2013

Scott Holliday

Scott Holliday
Quality, Environmental, Safety, and Health Manager

SIEMENS

Installation • Operation • Maintenance

Instructions

Induction Motors
143-449 Frame

NMIM-L1000

SIEMENS

TABLE OF CONTENTS

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens Sales Office.

The contents of this instruction manual shall not become part or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statements contained herein do not create new warranties or modify the existing warranty.

INTRODUCTION

THIS EQUIPMENT CONTAINS HAZARDOUS VOLTAGES, ROTATING PARTS AND HOT SURFACES. SEVERE PERSONAL INJURY OR PROPERTY DAMAGE CAN RESULT IF SAFETY INSTRUCTIONS ARE NOT FOLLOWED. ONLY QUALIFIED PERSONNEL SHOULD WORK ON OR AROUND THIS EQUIPMENT AFTER BECOMING THOROUGHLY FAMILIAR WITH ALL WARNINGS, SAFETY NOTICES, AND MAINTENANCE PROCEDURES CONTAINED HEREIN. THE SUCCESSFUL AND SAFE OPERATION OF THIS EQUIPMENT IS DEPENDENT UPON PROPER HANDLING, INSTALLATION, OPERATION AND MAINTENANCE.

QUALIFIED PERSON

For the purpose or this manual and product labels, a qualified person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he has the following qualifications:

a) Is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.

b) Is trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

DANGER

For the purpose of this manual and product labels, DANGER indicates death, severe personal injury or substantial property damage will result if proper precautions are not taken.

WARNING

For the purpose of this manual and product labels, WARNING indicates death, severe personal injury or substantial property damage can result if proper precautions are not taken.

CAUTION

For the purpose of this manual and product labels, CAUTION indicates minor personal injury or property damage can result if proper precautions are not taken.

INSPECTION

Care is taken at the factory to assure that the motor arrives at its destination in first class condition. If there is evidence of rough handling or damage in shipping, file a claim at once with the carrier and notify your Siemens Sales Office.

Examine the outside of the motor carefully for damage, with particular attention to conduit box, fans, and covers. Inspect and tighten all hardware and accessories which may have become loosened during shipping and handling. Turn the shaft by hand to be sure that it rotates freely. If the motor has been mishandled sufficiently to break external parts, the end shield should also be removed to check for internal damage unless the motor is explosion-proof. See warning below on explosion proof motors.

WARNING

Explosion-proof motors—these motors are constructed to comply with the U.L. Label Service Procedure Manual. When repairing and reassembling a motor that has an underwriter's label, it is imperative that the unit be reinspected and:

1. All original fits and tolerance be maintained.
2. All plugs and hardware be securely fastened.
3. Any parts replacements, including hardware, be accurate duplicates of the originals.

Repair work on explosion-proof motors can only be done by the original manufacturing or U.L. certified shops. Violations of any of the above items will invalidate the significance of the U.L. Label.

STORAGE

Motors must be stored in a clean, dry, well ventilated location free from vibration and rapid or wide temperature variations. If the unit is to be stored longer than three months, consult factory. Ball bearing motors are shipped from the factory properly lubricated and ready to operate. When in storage, the motor shaft must be turned several rotations every month and the bearing relubricated every year. On non-explosion-proof TEFC motors, a removable plug in the bottom of the frame or housing permits removal of accumulated moisture. Drain regularly if storage atmosphere result in formation of condensation.

INSTALLATION

Installation must be handled by qualified service or maintenance personnel. The motor foundation must rigidly support all four feet in the same plane. Place shims under the motor feet, as required, so they will not be pulled out of plane when mounting bolts are tightened. All wiring to the motor and control must be in accordance with the National Electrical Code and all local regulations. Before drive is connected, momentarily energize motor to check that direction of rotations proper. For direct drive, accurate alignment is 0.004 inch/ft. (radius to dial indicator = one foot.)

Any change in shims requires rechecking alignment. When alignment is within limits, dowel two feet of each unit. When installing flat belt pulley, V-belt sheave, spur or helical pinion or chain drives, be certain that they are within NEMA limitations. Refer to NEMA motor and general standards, MG-1 14.07 and 14.42.

OPERATION

Repeated trial starts can overhead the motor and may result in motor burnout (particularly for across the line starting). If repeated trial starts are made, allow sufficient time between trials to permit heat to dissipate from windings and rotor to prevent overheating. Starting currents are several times running currents, and heating varies as the square of the current.

After installation is completed, but before motor is put in regular service, make an initial start as follows:

1. Check motor starting and control device connections against wiring diagrams.
2. Check voltage, phase, and frequency of line circuit (power supply) against motor nameplate.
3. If possible, remove external load (disconnect drive) and turn shaft by hand to ensure free rotation. This may have been done during installation procedure; if so, and conditions have not changed since, this check may not be necessary.
   a. If drive is disconnected, run motor at no load long enough to be certain that no unusual conditions develop. Listen and feel for excessive noise, vibration, clicking, or pounding. If present, stop motor immediately. Investigate the cause and correct before putting motor in service.
   b. If drive is not disconnected, interrupt the starting cycle after motor has accelerated to low speed. Carefully observe for unusual conditions as motor coasts to a stop.
4. When checks are satisfactory, operate at minimum load and look for unusual condition. Increase load slowly to maximum. Check unit for satisfactory operation.

CAUTION

Guard against overloading. Overloading causes overheating and overheating means shortened insulation life. A motor subjected to a 10°C temperature rise above the maximum limit for the insulation may cause the insulation life to be reduced by 50%. To avoid overloading, be sure motor current does not exceed nameplate current when nameplate voltage is applied.

Electric motors operating under normal conditions become quite warm. Although some places may feel hot to the touch, the unit may be operational within limits. Use a thermocouple to measure winding temperature when there is any concern.

The total temperature, not the temperature rise, is the measure of safe operation. Investigate the operating conditions if the total temperature measured by a thermocouple placed on the winding exceeds:

230°F (110°C) for class "B" insulation

275°F (135°C) for class "F" insulation

302°F (150°C) for class "H" insulation

VOLTAGE REGULATION

Motors will operate successfully under the following conditions of voltage and frequency variation, but not necessarily in accordance with the standards established for operation under rated conditions:

a. When the variation in voltage does not exceed 10% above or below normal, with all phases balanced.

b. When the variation in frequency does not exceed 5% above or blow normal.

c. When the sum of the voltage and frequency does not exceed 10% above or below normal (provided the frequency variation does not exceed 5%).

MAINTENANCE

Failure to properly maintain the equipment can result in severe personal injury and product failure. The instructions contained herein should be carefully reviewed, understood and followed. The following maintenance procedures should be performed regularly:

1. Bearing lubrication
2. Insulation resistance check
3. Cleaning

This checklist does not represent an exhaustive survey of maintenance steps necessary to ensure safe operation of the equipment. Particular applications may require further procedures. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Siemens Sales Office.

Dangerous voltages are present in the equipment which can cause severe personal injury and product failure. Always de-energize and ground the equipment before maintenance. Maintenance should be performed only by qualified personnel.

The use of unauthorized parts in the repair of the equipment, tampering by unqualified personnel, or removal or alteration of guards or conduit covers will result in dangerous conditions which can cause severe personal injury or equipment damage. Follow all safety instructions contained herein.

BEARING LUBRICATION

CAUTION

Do not lubricate motor while in operation, since excess grease will be forced through the bearings and into the motor before it will force its way out of the drain plug. Excess grease accumulation on windings reduces insulation life.

Bearing life is assured by maintaining proper alignment, proper belt or chain tension, and good lubrication at all times.

Prior to shipment, motor bearings are lubricated with the proper amount and grade to provide six months of satisfactory service under normal operation and conditions.

For best results, grease should be compounded from a polyurea base and a good grade of petroleum oil. It should be of No. 2 consistency and stabilized against oxidation. Operating temperature range should be from -15°F to +250°F for class B insulation, and to +300°F fir class F and H. Most leading oil companies have special bearing greases that are satisfactory.

Relubricate bearings every six months (more often if conditions require), as follows:

1. Stop the motor. Lock out the switch.
2. Thoroughly clean off pipe plugs and remove from housings.
3. Remove hardened grease from drains with stiff wire or rod.
4. Add grease to inlet with hand gun until small amount of new grease is forced out of drain.
5. Remove excess grease from ports, replace inlet plugs, and run motor 1/2 hour before replacing drain plug.
6. Put motor back in operation.

INSULATION RESISTANCE

Check insulation resistance periodically. Any approved method of measuring insulation resistance may be used, provided the voltage across the insulation is at a safe value for the type and condition of the insulation. A hand cranked megger of not over 500 volts is the most convenient and safest method. Standards of the Institute of Electrical and Electronics Engineers, Inc. (IEEE) recommended that the insulation resistance of stator windings at 75°C, measure at 500 volts DC, after one minute should not be less than:

$$\frac{\text{Rated voltage of machine} + 1000}{1000} = \text{Insulation resistance in Megohms}$$

This formula is satisfactory for most checks. for more information, see IEEE Standard No. 43, "Recommended Practice for Insulation Resistance Testing of AC Rotating Machinery."

SIEMENS

Siemens Energy & Automation, Inc.
Motors and Drives Division
14000 Dineen Drive
Little Rock, Arkansas 72206

CLEANING

WARNING

Do not attempt to clean motor while it is operating.. Contact with rotating parts can cause severe personal injury or property damage. Stop the motor and lock out switch before cleaning.

The motor exterior must be kept free of oil, dust, dirt, water, and chemicals. For fan cooled motors, it is particularly important to keep the air intake openings free of foreign material. Do not block air outlet or inlet.

On non-explosion-proof TEFC motors, a removable plug in the bottom center of the motor frame or housing permits removal of accumulated moisture. Drain regularly.

VERTICAL MOTOR THRUST BEARINGS

Top bearings — high external thrust from the driven unit is usually carried by he top bearing or bearings. If replacement is necessary, the new bearing must be the same size and type as the original. Duplex bearings must also be the same type and mounted in an identical manner. When angular contact type bearings are replaced, the new bearing must have the same thrust capacity.

Bottom bearings — grease lubricated lower bearings adequately lubricated at the factory for at least three months operation. The relubrication procedure is the same as outlined above under "Bearing Lubrication." It is important to maintain the lower cavity full of grease at all times.

The correct replacement bearings are given on the nameplate by AFBMA (Anti-Friction Bearing Manufacturers Association) number.

SERVICE

For immediate action on your motor problems call your certified service center or contact your nearest Siemens District Office.

Siemens Energy & Automation, Inc.
Industrial Products Division
14000 Dineen Drive
Little Rock, Arkansas 72206

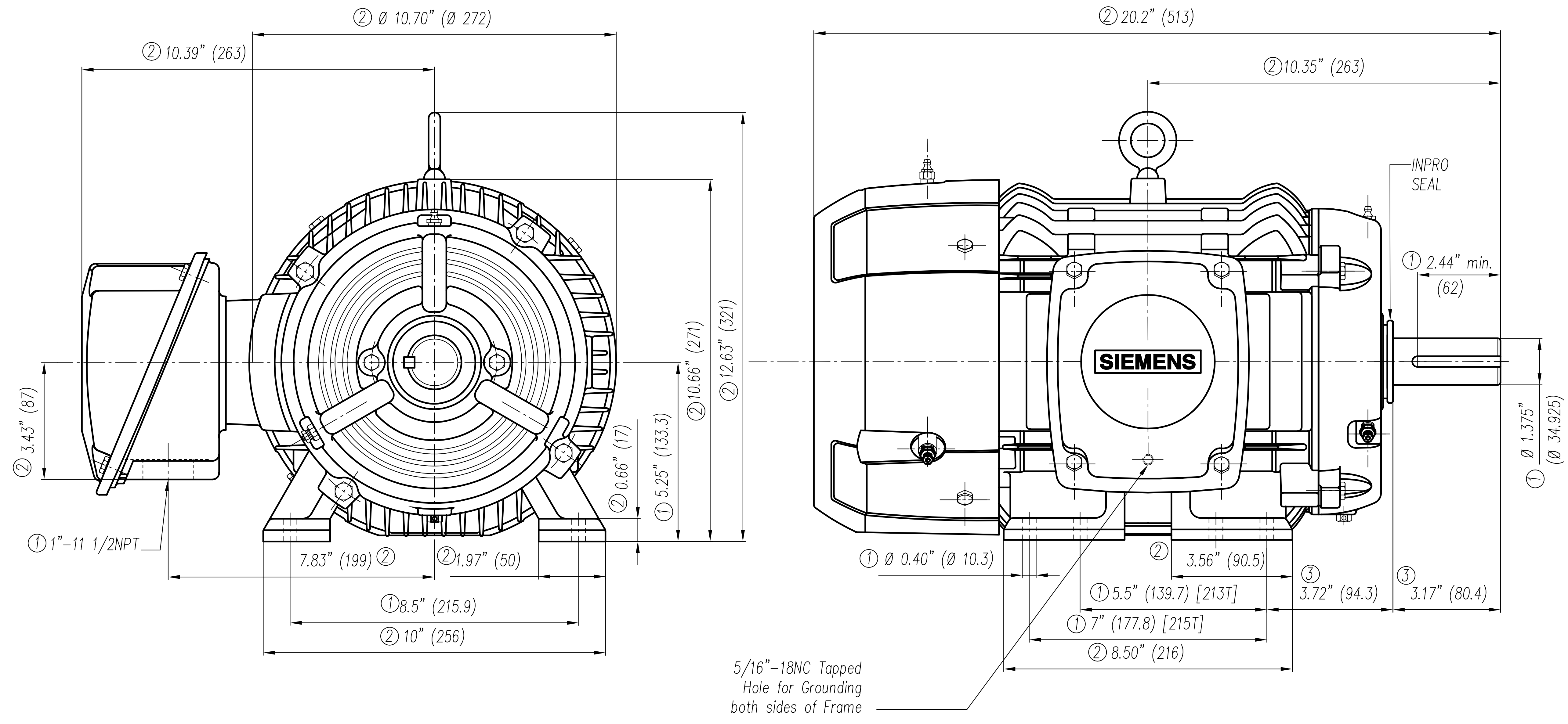
Bulletin NMIM-L1000
10M 7/01TI Printed in U.S.A.

RGZEESD
Severe Duty – TEFC

Electrical Data		
	Enclosure	Severe Duty - TEFC
	Efficiency	NEMA Premium
	HP Range	1-400
	Frame Size	140-S440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1.15
	Electrical Design	NEMA design B (except as noted)
	Stator Windings	Copper - Random Wound
	Insulation	Class F, meets NEMA MG1-2003, Part 31
	Temperature Rise (sine wave)	Class B @ 1.0SF, Class F @ 1.15SF
	Warranty	3 Years

RGZZESD
Hazardous Duty – TEFC

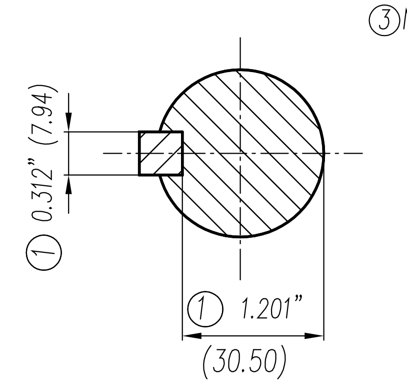
Electrical Data		
	Enclosure	Hazardous Duty - TEFC
	Efficiency	High
	HP Range	1-300
	Frame Size	140-440
	Frequency	60 Hertz
	Power	3 - Phase
	Voltage	230/460 460 only 25HP and above
	Service Factor (sine wave)	1
	Electrical Design	NEMA design B
	Stator Windings	Copper - Random Wound
	Insulation	Class F
	Temperature Rise (sine wave)	Class B @ 1.0SF
	Warranty	3 Years



①Tolerances According to NEMA Std.

②All these dimensions corresponding to assemblies and castings shall have a tolerance as per DIN standard 1686-GTB 19.

③Not According to NEMA Std.



Keyseat detail

CERTIFIED PRINT						
CUSTOMER Sulzer						
PO# 4500334767		SO# 3003367956				
HP 10	RPM 1800	FRAME 215T	TYPE SD100	VOLTS 208-230/460	PH 3	HZ 60

Sulzer Part No.: J751301004/PB

②

Tolerance in mm. according to DIN-1686-GTB-19	
to 18	± 4.5
Over 18 to 30	± 4.7
Over 30 to 50	± 5
Over 50 to 80	± 5.5
Over 80 to 120	± 6
Over 120 to 180	± 6.5
Over 180 to 250	± 7
Over 250 to 315	± 7.5
Over 315 to 400	± 8
Over 400 to 500	± 8.5
Over 500 to 630	± 9.5
Over 630 to 800	± 10

Quantity			
04	03	02	01

Remark

Parts and Measure	Drawing No. Norm No.	Item No.	Material	Weight Lbs.

European Proyection

Modific.

Dimensions in inches (mm)

	Date	Name
Drawn	17/11/05	Contreras
Checked		
Std. Ckd.		

Dimension Drawing NEMA NNM

Type: 1LE2 SD100 IEEE841 213/215T FRAME 2...8 Pol.

Scale W/0

SIEMENS
GUADALAJARA FACTORY

3MSE 222 0845

2/2

Ref.3MSE 223 0840

Replace.

F260/1095

Sulzer Part No.: J751301004/PB

SIEMENS

NEMA Motor Data

Ordering data : **1LE2321-2AB21-4AA3**

Client-order-no. / :
Order-no. / :
Offer-no. / :
Remarks / :

Item-no. / :
Consignment-no. / :
Project / :

Nameplate Data

Type	SD100 - NEMA Premium Efficiency		
HP	10.0	Rating	Cont.
Voltage	208-230/460V, 60HZ	Ins. Class	Class F (Standard)
Amps	25.0 / 12.5	S.F.	1.15
FL RPM	1755.0	Amb. Temp.	40 deg C
FL Efficiency	91.7 %	Temp. Rise	Class B
FRAME	215T'	kVA Code	H
DE AFBMA	40BC02JPP3	NEMA Des	B
ODE AFBMA	40BC02JPP3	Mtr WT	214.0
Hertz	60	Ph	3

Bearing Data

DE Bearing Size	6208 ZZ C3
DE Bearing Type	Ball Bearing
DE AFBMA	40BC02JPP3
ODE Bearing Size	6208 ZZ C3
ODE Bearing Type	Ball Bearing
ODE AFBMA	40BC02JPP3

Typical Performance Data

Load	No Load	1/2	3/4	Full Load	LRC
Efficiency		91.7 %	92.2 %	91.7 %	
Power Factor		63.8 %	76.2 %	81.7 %	
Current (A)	6.1 A			12.5 A	81.0 A

Mechanical Data

SAFE STALL TIME		HOT (s)	20.0		
		COLD (s)	36.0		
Rtr wt (lbs)	0.0	Rtr WK2	0.8679		
FLT (ft-lbs)	30.0	LRT	81.0	BDT	123.0

Ext Load Inertia (WK2) Capability 105.0

Typical Noise Data

A-weighted Sound	Octave Band Center Frequencies Hertz (Hz)									
Pressure Level	63	125	250	500	1000	2000	4000	8000	SPL	67.0
at 3 feet	0.0	40.0	58.0	62.0	64.0				SPwrL	77.0

Wiring Connection Information

Description 3 PHASE - 9 LEAD - WYE

Voltage	L1	L2	L3	Connected together
-- -- --	-- -- --	-- -- --	-- -- --	-- -- --
HIGH	T1	T2	T3	-- -- --

Lubrication Information

Manufacturer	Mobil Polyrex EM or equal
Type	Polyurea (standard)
DE Capacity (oz.)	0,3
ODEnd Capacity (oz.)	0,3

Relubricate bearings every six months (more frequent if conditions require). See Instruction Manual.

Special configurations :

Technical and ordering data are subject to change. There may be discrepancies between calculated and rating plate values.

This is the Original Document in English Language

The designation **ATEX** (**At**mosphere **Ex**plosibles) has established itself for the new guidelines. **ATEX** controls all regulations for the condition of explosion-proof equipment.

Model No. ____________________ Category ____________________ Reference ____________________
Mfg Year______________________ Max Temperature ______________

1. General Information

1.1. Viva Couplings are designed to provide a mechanical connection between the rotating shafts of mechanical equipment, using a torsionally soft flexible element to accommodate inherent misalignment while transmitting the power and torque between the shafts.

1.2. These instructions are intended to help you install and maintain your Viva coupling. Please read these instructions prior to installing the coupling, and prior to maintenance of the coupling and connected equipment. Keep these instructions near the coupling installation and available for review by maintenance personnel.

1.3. Rexnord Industries, LLC owns the copyright of this material. These Installation and Maintenance instructions may not be reproduced in whole or in part for competitive purposes.

1.4. Symbol descriptions:

STOP Danger of injury to persons.

Damages on the machine possible.

Pointing to important items.

2. Safety and Advice Hints

STOP **DANGER!**

2.1. Safety should be a primary concern in all aspects of coupling installation, operation, and maintenance.

2.2. Proper lockout-tag out procedures must be followed to safeguard against unintentional starting of the equipment.

2.3. Because of the possible danger to person(s) and/or property, from accidents which may result from improper use or installation of these products, it is extremely important to follow the proper selection, installation, maintenance and operational procedures.

2.4. All personnel involved in the installation, service, operation, maintenance, and repair of this coupling and the connected equipment must read, understand and comply with these Installation and Maintenance instructions.

2.5. All rotating power transmission products are potentially dangerous and can cause serious injury. They must be properly guarded in compliance with OSHA, ANSI, ATEX, European machine safety standards and other local standards. It is the responsibility of the user to provide proper guarding.

PRECAUTION! For this coupling to meet the ATEX requirements, you must precisely follow these installation and maintenance instructions, and the supplement form 0005-08-49-01. This supplement outlines the ATEX requirements. If the operator does not follow these instructions, the coupling will immediately be considered non-conforming to ATEX.

2.6. For ATEX requirements the guard must have a minimum of 12.7 mm (1/2 inch) radial clearance to the coupling outside diameter (coupling sizes shown in Table 1 are equivalent to the coupling outside diameter in millimeters) and allow for proper ventilation.

2.7. Make sure to disengage the electrical power and any other sources of potential energy before performing work on the coupling.

2.8. Do not make contact with the coupling when it is rotating and/or in operation.

2.9. All work on the coupling must be performed when the coupling is at rest under no load.

3. Rexnord Viva Coupling Design and Part Numbers

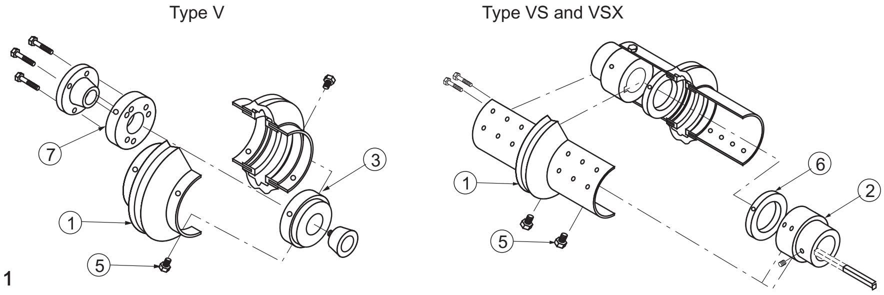


Figure 1

Table 1 – Viva Part Numbers

Coupling Size	Elastomer Element			Hubs				Element Capscrews (5)	High Speed Rings (6)
	Type V (1)	Type VS (1)	Type VSX (1)	Rough Bore Steel (2)	Taper Bushed Hubs – Inch* (3)	British Standard Whitworth Threads (BSW)	QD Hubs* (7)		
110	7392646	7392702	7392702X	7392746	7392768	7392770	7392766	7393097	7393046
125	7392650	7392706	7392706X	7392774	7392797	7392799	7392795	7393097	7393049
130	7392654	7392710	7392710X	7392803	7392827	7392829	7392825	7393097	7393052
150=	7392656	7392712	7392712X	7392833	7392856	7392858	7392854	7393101	7393055
170=	7392658	7392714	7392714X	7392833	7392856	7392858	7392854	7393101	7393055
190	7392662	7392718	7392718X	7392862	7392884	7392886	7392882	7393101	7393058
215	7392666	7392722	7392722X	7392890	7392912	7392914	7392910	7393105	7393061
245	7392670	7392726	7392726X	7392918	7392933	7392935	7392931	7393105	7393064
290	7392674	7392730	7392730X	7392939	7392954	7392956	7392952	7393109	7393067
365	7392678	7392734	7392734X	7392960	7392966	7392969	7392964	7393120	7393070
425	7392682	7392738	7392738X	7392972	7392978	7392981	7392976	7393120	7393073
460	7392686	7392742	7392742X	7392984	7392990	7392993	7392988	7393120	7393076

Note: Hubs are interchangeable with standard or spacer flex elements.
* Bushings are not included.
= V150/V170 utilize same hubs, high speed rings and capscrews

4. Hub mounting

STOP DANGER!

Be sure to disengage the electrical power and any other sources of potential energy before you perform work on the hub and coupling assembly.

4.1. Examine the coupling assembly to insure there is no visible damage.

4.2. Clean the hub bores and shafts using lint free cloth. Remove any nicks or burrs.

4.3. When assembled, the key(s) should have a close side-to-side fit in the keyway in both the hub and shaft, with a slight clearance over the top of the key.

⚠ **CAUTION: When heating hubs is required, use of an oven is preferred. An open flame is not recommended. If flame heating is considered mandatory, it is important to provide uniform heating to avoid distortion and excessive temperature. A thermal stick (crayon marker) applied to the hub surface will help determine the hub temperature.**

STOP DANGER!

Touching hot hubs causes burns. Wear safety gloves to avoid contact with hot surfaces.

Rexnord Industries, LLC, 5555 S. Moorland Rd., New Berlin, WI 53151-7953
Telephone: 262-796-4060 Fax: 262-796-4064
e-mail: info@rexnord.com web: www.rexnord.com

4.4. Rexnord Viva hubs can be installed:

- flush with the shaft end (D)
- extended beyond the end of the shaft (E)
- recessed behind the shaft end (F)

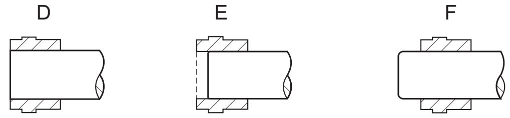


Figure 2

ATTENTION! Shaft engagement length should be >0,8 times shaft diameter, bushed hubs must engage 100%.

5. Straight Bore with Clearance/Slip Fit

5.1. Install the key(s) in the shaft.

5.2. Check to be sure that the set screw(s) in the hub does not protrude into the keyway and/or the bore. If needed, loosen the set screw to provide clearance during assembly.

5.3. Slide the hub up the shaft to the desired axial position.

ATTENTION! Use half element to set proper hub spacing.

5.4. Assemble and tighten the set screw(s), using a calibrated torque wrench, to the values shown in Table 2.

Table 2 - Set Screw Tightening Torque

Set Screw Thread Size	Tightening torque			Internal Hex Size	Set Screw Thread Size	Tightening torque			Internal Hex Size
inch	lb-in	lb-ft	Nm	inch	mm	lb-in	lb-ft	Nm	mm
1/4	66	6	7	1/8	M6	55	5	6	M3
5/16	132	11	15	5/32	M8	110	9	12	M4
3/8	240	20	27	3/16	M10	220	18	25	M5
1/2	600	50	68	1/4	M12	440	37	50	M6

ATTENTION! Never use two set screws with one on top of the other in the same tapped hole.

6. Straight Bore with Interference Fit

6.1. Accurately measure the bore and shaft diameters to assure proper fit.

6.2. Install the key(s) in the shaft.

6.3. Heat the hub in an oven until the bore is sufficiently larger than the shaft.

6.4. 350°F (177°C) is usually sufficient for carbon steel hubs. Do not exceed 500°F (260°C).

6.5. Higher temperatures may be required for higher interference fit levels where alloy steel hubs may be encountered. A general rule to consider is that for every 160°F increase in temperature, steel will expand 0.001 inch for every inch of shaft diameter (or .029 mm/100°C). When calculating temperatures, also consider additional expansion to provide clearance and allow for a loss of heat and subsequent shrinkage during the handling process.

6.6. With the hub expanded, install it quickly on the shaft to the desired axial position. A pre-set axial stop device can be helpful.

7. Tapered bushed hubs

7.1. When using tapered bushings, follow bushing manufacturers instructions.

8. Rexnord Viva “Type V” coupling hub / element mounting options (see table 3)

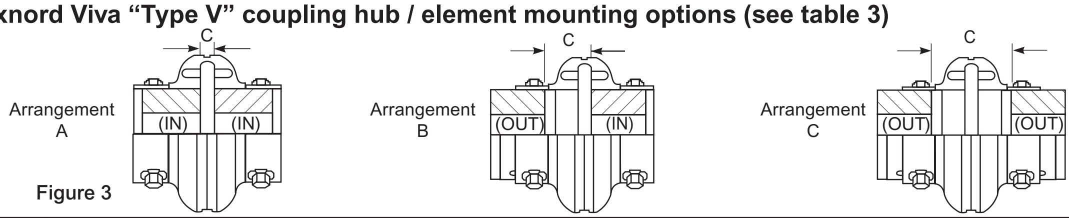
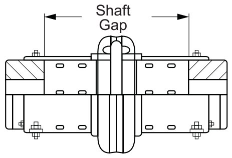


Figure 3

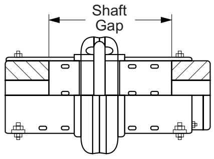
Table 3 – Type V Mounting Options

Hub Arrangement	Coupling Sizes											
	110	125	130	150	170	190	215	245	290	365	425	460
	Dimension C (mm)											
A	9	9	7	9	9	7	11	7	8	20	19	19
B	32	32	31	35	35	34	38	40	54	76	76	76
C	55	55	55	60	60	60	64	73	94	131	133	132

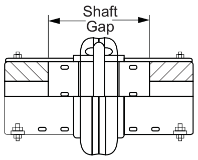
9. Rexnord Viva "Type VS" coupling hub / element mounting Options (See table 4)



Both hubs mounted outward



One hub mounted outward
One hub mounted inward



Both hubs mounted inward

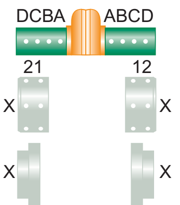


Figure 4

Table 4 - Spacer coupling (VS) Hub mounting options for industry shaft gaps

Rexnord Viva coupling size	ISO (mm)					Ansi (inch)				
	100	140	180	250	300	3,5	5	7	9,5	12
VS 110	C2-B1	C1-C1				B1-B1	C2-C1			
	101	139				3,47	4,98			
VS 125	B1-B1	C1-C2*				B1-B2	C2-C2*			
	101	139				3,42	4,93			
VS 130	C2-C2	C1-C1				B1-B1	C2*-C2*			
	100	140				3,50	5,12			
VS 150	B1-B1	C1-C1	D1-D1			B1*-D1*	D1*-D1*	D1-D2*		
	102	140	179			3,52	5,04	6,87		
VS 170	B1-B1	C1-C1	D1-D1			B1*-D1*	D1*-D1*	D1-D2*		
	102	140	179			3,52	5,04	6,87		
VS 190	B1-B1	C1-C1	D1-D1			C1*-C1*	D1*-D1*	D1-D1		
	102	141	179			3,50	4,94	7,04		
VS 215	B1-B1	C1-C1	D1-D1			C1*-C1*	D1*-D1*	D1-D1		
	103	142	181			3,50	5,06	7,14		
VS 245	B1-B2	D1-C1*	D2-D1			B1*-D1*	B2-C1	D1-C1		
	106	142	185			3,50	4,95	6,89		
VS 290	B2*-B2*	B2*-B1	C1-B2*	C1-C1		B1*-B2*	C2*-B1*	B2-B1	C1-C2	
	100	143	179	257		3,54	4,92	6,94	9,70	
VS 365		C1*-C1*	B1-B1	C1-C1	D1-D1		B1-B1*	B1-B1	C1-C1	D1-D1
		137	180	250	300		4,86	7,09	9,85	11,81
VS 425		C2*-C2*	B1-B1	C1-C1	D1-D1		B1-B2*	B1-B1	C1-C1	D1-1D
		137	180	250	299		4,86	7,08	9,84	11,77
VS 460		C2*-C2*	B1-B1	C1-C1	D1-D1		B1-B2*	B1-B1	C1-C1	D1-D1
		137	180	250	299		4,86	7,08	9,84	11,77

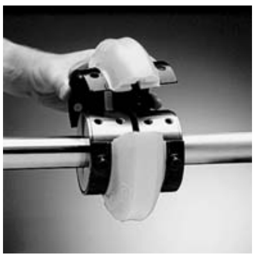
* hub mounted inward

10. Rexnord Viva element mounting

10.1. Mount first half element to the hubs using only original Rexnord Viva fasteners provided (do not substitute with non-approved capscrews).

10.2. Rotate the shaft 180 degrees and secure second half element.

10.3. If shaft cannot be rotated, mount half elements at 90 degrees.


Type V


Type VS and VSX

Figure 5

☞ **ATTENTION!** Elements are weight balanced and must be used in pairs as packaged.

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Telephone: 262-796-4060 Fax: 262-796-4064
e-mail: info@rexnord.com web: www.rexnord.com

DANGER!

Incorrectly tightened capscrews could cause coupling component(s) to dislodge during operation and result in personal injury. TIGHTEN CAPSCREWS BY USING TORQUE WRENCH.

10.4. Ensure that all capscrews are tightened to the torques specified in Table 5.


Type V

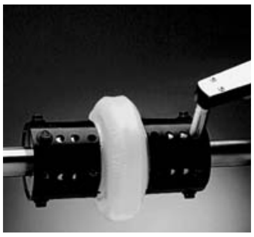

Type VS and VSX

Figure 6

Table 5 – Capscrew Torque

Viva Size	Part No.	Bolt Size	Wrench Size mm	Torque Nm	Torque ft lb	Torque in lb	Viva Size	Part No.	Bolt Size	Wrench Size mm	Torque Nm	Torque ft lb	Torque in lb
110	7393097	M8	13	27	20	240	**215**	7393105	M10	13	53	39	468
125	7393097	M8	13	27	20	240	**245**	7393105	M10	13	53	39	468
130	7393097	M8	13	27	20	240	**290**	7393109	M12	15	92	68	816
150	7393101	M10	13	53	39	468	**365**	7393120	M14	19	158	117	1404
170	7393101	M10	13	53	39	468	**425**	7393120	M14	19	158	117	1404
190	7393101	M10	13	53	39	468	**460**	7393120	M14	19	158	117	1404

ATTENTION! When installing the element, first seat all the capscrews with a light torque, then tighten all capscrews to proper torque using a torque wrench.

ATTENTION! Do not lubricate capscrew threads

ATTENTION! Capscrews must have a thread-locking adhesive applied.

ATTENTION! Capscrews must be replaced with original Rexnord Viva fastener kit after three installations or when replacing elastomer element.

DANGER!

Incorrectly tightened capscrews could cause coupling component(s) to dislodge during operation and result in personal injury.

11. Shaft Alignment

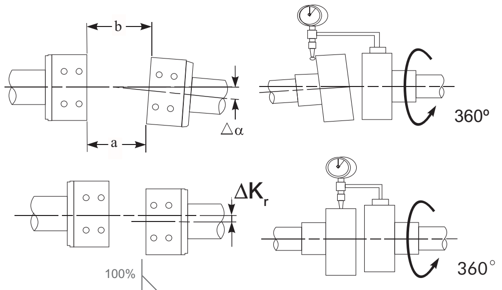
11.1. Move the equipment into place.

ATTENTION! Soft Foot – The equipment must rest flat on its base. If one or more feet of the machine are shorter, longer, or angled in some way to prevent uniform contact (a condition commonly known as "soft foot") it must now be corrected.

11.2. Move the connected equipment to achieve acceptable alignment.

11.3. Table 6 shows recommended installation limits for Parallel and Angular alignment limits.

11.4. These dimensions are suggested for initial installation. Additional capacity is available to compensate for thermal and structural equipment movement.

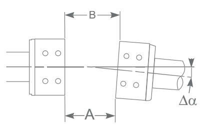


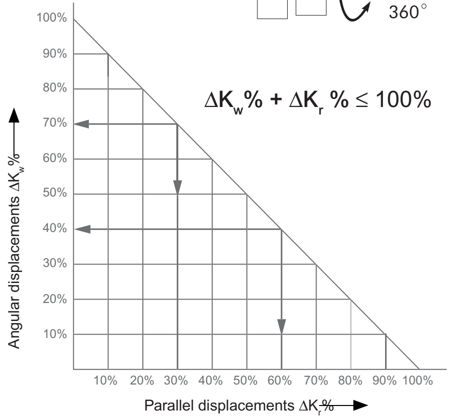
b (max)_________ mm

a (min)__________ mm

$$\Delta K_w\% = \frac{\Delta K_{w\ (actual)}}{\Delta K_{w\ (max\ limit\ table\ 6)}} \times 100$$

$$\Delta K_r\% = \frac{\Delta K_{r\ (actual)}}{\Delta K_{r\ (max\ limit)}} \times 100$$





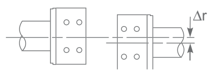


Table 6 - Drive Alignment Limits (max)

	(b-a) mm	Δ Kr mm	(b-a) inch	Δ Kr inch
110	4,2	1,6	0.165	0.063
125	4,9	1,6	0.193	0.063
130	5,5	1,6	0.217	0.063
150=	6,1	1,6	0.240	0.063
170=	6,6	1,6	0.260	0.063
190	6,1	2,4	0.240	0.095
215	7,3	2,4	0.287	0.095
245	8,9	2,4	0.350	0.095
290	11,2	2,4	0.441	0.095
365	8,2	3,2	0.323	0.126
425	9,9	3,2	0.390	0.126
460	9,4	3,2	0.370	0.126

☞ **ATTENTION!** Improper alignment of the equipment or hubs may result in hub contact with equipment or guard and sparking.

12. Preventative Maintenance

STOP DANGER!

Do not make contact with the coupling when it is rotating and/or in operation

12.1. Periodic visual inspection is necessary to evaluate the condition of the flex element. Inspection can be done during the operation using a strobe light.

12.2. When inspecting the element look for:
- Fatigue cracks at element splits
- Urethane Discoloration
- Surface cracking in body of Urethane element.

☞ **ATTENTION!** Replace Element if necessary.

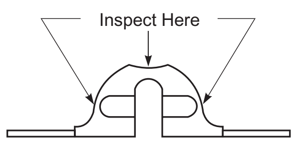


Figure 8

13. Element Replacement

STOP DANGER!

Stop the motor and lock it out to prevent start-up during installation of coupling.

13.1. Always replace both half elements.

13.2. Install both half elements from the same box.

13.3. Follow installation instructions (see Section 5, Rexnord Viva Element Installation).

STOP DANGER!

Tighten element capscrews to proper torque by using a torque wrench (see Table 3).

Rexnord Industries, LLC, 5555 S. Moorland Rd., New Berlin, WI 53151-7953
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SULZER

Intended use

20100430 / Replaces 20020501 / en / **N15252**

Contents *Page*

1 General

The pump and its accessories may only be used for the purpose for which they have been supplied. The intended use is given in the order specification and in the following instructions concerning the main pumping parameters and mechanical durability. If the intended use changes, the user must make sure that the pump can be used in the new application and, if necessary, obtain the manufacturer's permission for the change.

Table 1 Intended use in the process

Application data:	**Sources:**
Pumped liquid and its properties (chemicals, solids, consistency, temperature etc.)	Product specification (under "Process data")
Main pumping parameters (capacity, head, speed etc.)	Product specification (under "Process data") and nameplate of the pump
Other necessary process data	Product specification (under "Process data")

Table 2 Delivery and design

Delivery and design data:	**Sources:**
Delivery scopes (pump, coupling, baseplate etc.)	Product specification
Product size	Product specification and nameplate of the pump
Other design alternatives (impeller type and size, materials, lubrication, flange drillings, shaft sealing type etc.)	Product specification
Dimensions (pump, accessories, flanges etc.)	Dimensional drawings
Weights and mass moments of inertia (bare pump, pump + baseplate etc.)	Dimensional drawings
Connections (lubrication, shaft seal, drainage etc.)	Location shown in the parts list under heading "Connections" and in the sectional drawings. Moreover, connections having importance in view of safety have been marked on the product.
Part details (maximum impeller diameter, bearing types, fastener sizes etc.)	Parts list (under heading "Parts")

This instruction set covers the ANSI process pump with the supplementary accessories included in the delivery. All supplied instructions are found in the parts list under the heading "Instructions".

Before commissioning, the operating staff have to be instructed in the guidelines for correct and safe operation of the product as stated in these instructions. This product must be serviced by qualified personnel who are familiar with the design and operation of this product and the system with the essential safety aspects involved. The scope of responsibilities and supervision of the personnel must be exactly defined by the plant operator.

Our guarantee will be valid only if the installation, operation, maintenance and repairs of this pump are carried out in accordance with these instructions. The plant operator is to make sure that the contents of these instructions are fully understood by the operating personnel.

To assure a steady start-up, supervision or service from an authorized manufacturer representative is recommended. During operation, periodic inspections should be made to assure safe operation under the prevailing conditions.

Any modification may be made to the product only after consultation with the manufacturer. Using spare parts and accessories authorized by the manufacturer is a relevant safety aspect. Only genuine spare parts which are in accordance with the original delivery (in the parts list) are to be used. Use of other parts may exempt Sulzer from any liability.

If any assistance regarding the product or its instructions is required, please contact our local representative for a quick supply of the information you need.

The enclosed instructions regarding a possible long-term storage (more than 3 months) must be observed.

All customer instructions regarding this product are also available in an electronic format for viewing and printing (depending on the end user's software & hardware). If electronic format is needed, please contact our local representative for further information.

If the delivery includes customer instructions or other information in an electronic format which can be edited, we are only responsible for the contents of paper versions of these instructions and other information supplied by us.

Keep these instructions at the place of operation for further reference!

2 Document identification

Version 02 > / 20000331 / Replaces 941201 / en / **N10991** / Page 1 (2)

Page number and total number of pages in the document
Indentification number of document
Language code of document
Previous date for document
Date when the document in question was made or updated
Product version number

3 Type designation

C P T 2 3 - 2

Nominal diameter of the discharge (inch) = 2 in
Except the markings:
1C and 1BC showing other hydraulic performance with same basic casing dimensions.

Casing cover (part No. 161) serial number by bearing unit the third casing cover in the bearing unit No. 2

Bearing unit No. = bearing unit No. 2

Dimensioning = in-dimensioned structure

Structure = standard process pump (horizontal)

C = chemical process pump

4 Nameplate information

Every pump has the following plates fastened to the volute casing (102.01) providing necessary identification of the pump and its hydraulic characteristics.

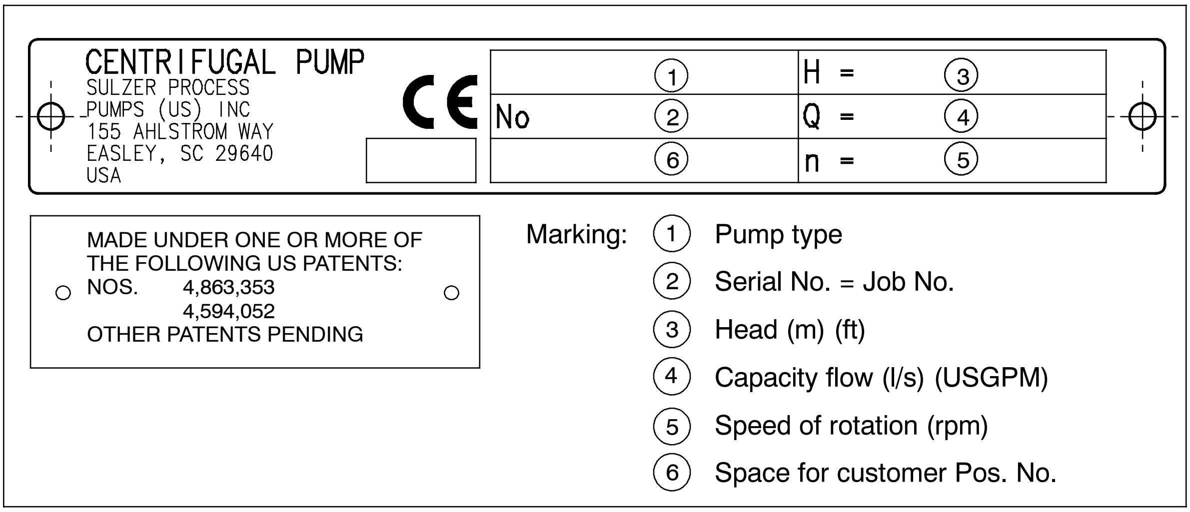


Fig. 1

5 Capacity and head

The pump is always dimensioned according to the pumping values (head, flow) stated in the nameplate (971.01) of the pump. Head and flow values that can be reached with the specific impeller diameter and operating speed are given in the characteristic curve of the pump. The operating point on the curve can be changed by adjusting the pumping system resistance e.g. by throttling the flow with the valve in the pressure piping. If the impeller diameter or the rotational speed of the pump are changed, then the operating point will move totally to another head-flow curve.

The pump must not be used at other operating points without the following verifications:

- When the pump was selected in the original operating point, all factors affecting the mechanical durability (e.g pressure and temperature limits) and pump design (pump, impeller type, shaft sealing and lubrication etc.) were carefully considered. All these factors are to be checked also in the new operating point.
- The pump could temporarily operate even with the pressure valve closed. For continuous operation, a minimum flow is still required. The required suction head (NPSH required) curve presented in the characteristic curve always starts from the point of the minimum continuous flow allowed.
- The suction properties of the system (NPSH available) and drive motor power are always to be checked in a new operating point.
- The efficiency of a pump is a relevant factor when estimating the lifetime costs of the pump. Therefore its influence on the power need must be checked.

- The characteristic curve enclosed is always based on tests with clean water. Other types of pumped liquid can change the head, flow or power need values radically. These factors were recognized when the pump was originally selected and they must be considered also in the new operating point.

SULZER

Pumps and Mixers

Safety of Machinery

SPP id: 100430 / en / N31142 / 1

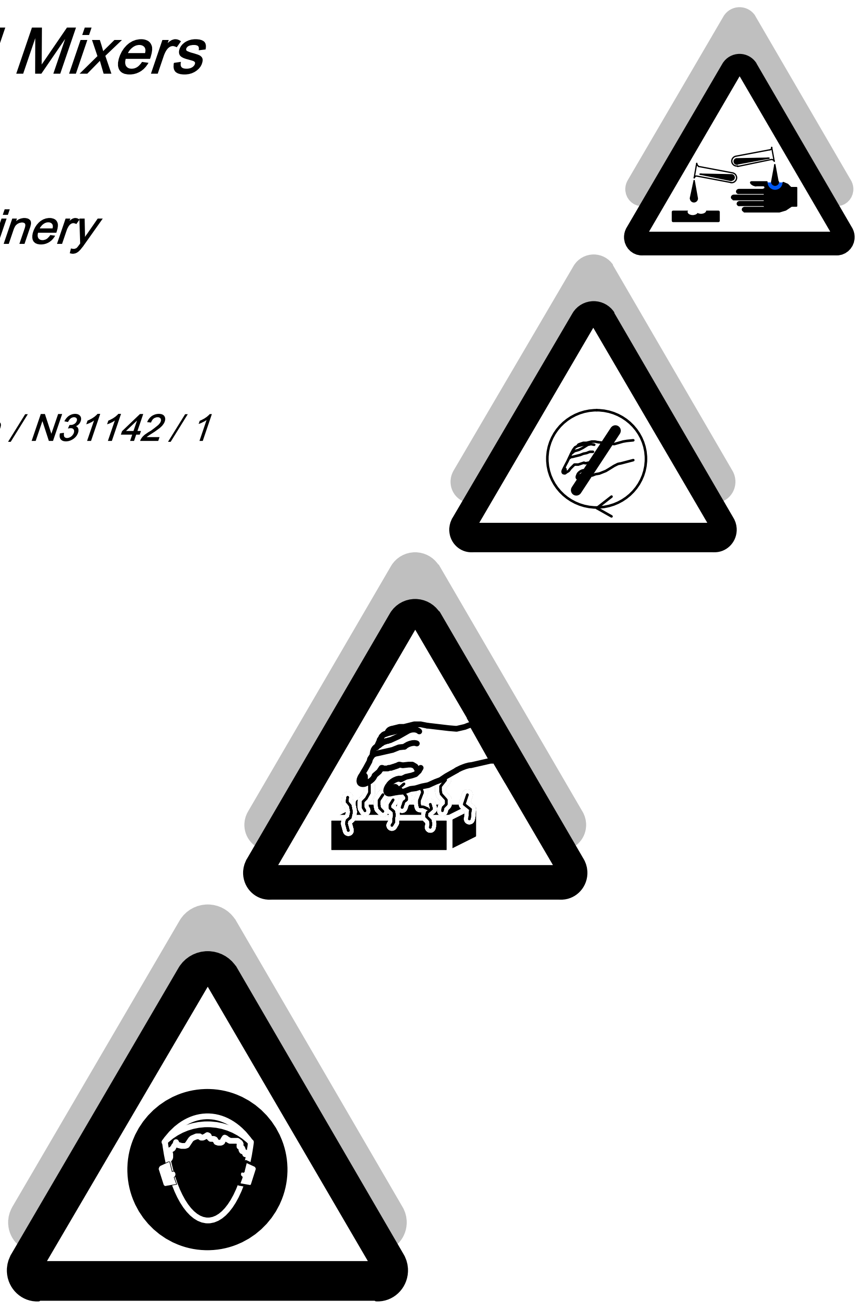


Table of contents

0 General

Our delivery does not include the design of the operating environment of the machine, nor the power circuits, control circuits and controls for the machine required in the operation of the machine. However, the European Machinery Directive 2006/42/EC on safety of machines and/or corresponding national legislation of the country where the machine is used are mandatory in terms of essential health and safety requirements related to the operation of the process.

We require that the Customer has taken into account the essential requirements laid down in this instruction when designing, purchasing and starting up the process control systems, other controls and equipment related to the machine. Some of these requirements also concern the personnel in charge of the operation of the machine.

As far as the above is applicable, the Customer must also ensure that the valid legislation on electrical safety (such as low-voltage directive) or electromagnetic compatibility of equipment (EMC directive) is followed.

During the operation of the machine, valid occupational safety legislation of the country where the machine is used must also be followed.

1 Essential health and safety requirements

1.1 General remarks

1.1.1 Definitions

When necessary, the potential danger zones related to the machine and its operating environment, persons exposed within the danger zone and all operator groups of the machine must be specified jointly between the Customer and the Manufacturer, for example for the purpose of introductory training arranged for the operators of the machine.

1.1.2 Principles of safety integration

As a machine manufacturer, we have, in accordance with the contents of the delivery, followed the Machinery Directive and/or the national legislation of the country where the machine is used in order to ensure safety integration.

The installation, operating and safety instructions supplied with the machine must be followed on receipt of the machine, in installing it at the point of operation and in its operation. Prior to final start-up, it must be ensured that the machine, its controls and other equipment related to a safe use of the machine fulfil the requirements laid down in the Machinery Directive and/or in national safety legislation.

1.1.3 Materials and products

The products related to the use of the machine (liquids transferred in the process) must not endanger the exposed persons' safety or health. The process where the machine is used must be designed so that the use of liquids causes no hazard.

1.1.4 Lighting

Maintenance areas necessary for the regular inspections of the machine must be provided with appropriate lighting.

1.1.5 Design of machinery to facilitate its handling

The environment of the machine must be designed so that, in order to facilitate the handling of the machine or its various components, standard lifting gear can be attached above the machine if necessary. The environment must be designed so that the various components can be handled safely in other respects as well. The handling and lifting instructions supplied with the machine must be absolutely followed.

1.2 Controls

1.2.1-8 Control and stopping devices

The controls of the machine must be safe and constructed in a way that will prevent a dangerous situation arising.

When designing the controls, the specified requirements laid down in the Machinery Directive and/or in the national legislation of the country where the machine is used must be absolutely followed in terms of controls, starting devices, stopping devices (including emergency stop devices) and selection of control and operating modes for the machine and combinations of machinery.

The controls of the machinery must be designed so that fluctuations in energy supply or failures in the control circuit do not lead to dangerous situations. The interactive software used in the controls between the operator and the machine must be user-friendly.

1.3 Protection against mechanical hazards

1.3.1 Stability

Our delivery includes the appropriate accessories for securing the machine to the foundations. The installation instructions supplied with the machine must be absolutely followed in order to ensure sufficient stability of the machine/combination of machinery.

1.3.2 Risk of break-up during operation

The piping and hoses connected to the machine must be able to withstand the anticipated internal and externals stresses, and they must be firmly secured and protected against all manner of loading and stress.

The instructions concerning the purpose of the machine, limitations of use, allowable flange forces and support of piping, supplied with the machine, must be absolutely followed. During operation, there is always a risk of rupture in the piping connected to the machine (risk of high-pressure/hot/harmful liquid spray) if the supplied instructions are violated.

1.3.3 Risks due to falling or ejected objects

Necessary precautions must be taken to prevent risks from falling or ejected objects (e.g. tools used during installation).

1.3.4 Risks due to sharp edges or angles

Due to the purpose and design of the machine, its parts have sharp edges and/or angles. During installation and maintenance, the instructions supplied with the machine must be followed, and the appropriate personal protective equipment must be used.

1.3.6 Risks related to variations in the rotational speed

The instructions supplied with the machine show the intended rotational speed of the machine and its maximum rotational speed limits. Selection and adjustment of rotational speed must be performed so that these instructions are adhered to.

1.3.7 Prevention of risks related to moving parts

The fixed guards used for preventing risks related to moving parts in the machine must be absolutely kept in place while the machine is running. If a guard is not included in the delivery, it must be ensured prior to start-up that the rotating parts are provided with guards in accordance with the valid legislation. If rotating parts of the machine seize accidentally during operation, the machine must be stopped immediately and the cause of the fault must be ascertained in accordance with the instructions supplied with the machine.

1.5 Protection against other hazards

1.5.1 Electricity supply

The electrical drives of the machine must be designed, constructed and equipped so that all hazards of an electrical nature can be prevented. The specific rules and valid legislation in force related to electrical equipment must be absolutely followed.

1.5.2 Static electricity

The build-up of potentially dangerous electrostatic charges in the machine and its auxiliary equipment must be prevented or restricted.

1.5.4 Errors of fitting

Errors made when fitting parts of the machine can be a source of risk. For this reason, the instructions supplied with the machine must be absolutely followed during the installation and repairs of the machine.

Faulty liquid and electrical connections can also be a source of risk. With liquid connections, the instructions supplied with the machine must be followed. Faulty electrical connections must be made impossible by the design, or information on the risk must be given on cables and connectors.

1.5.5 Extreme temperatures

If necessary, the machine must be provided with warnings concerning high surface temperatures. In these cases, additional steps should be taken to eliminate any risk of injury caused by contact with or proximity to machinery parts. Maintenance requires the heating of some parts prior to installation. Carefulness is imperative during installation, and appropriate personal protective equipment must be used during installation.

1.5.6-7 Fire and explosion

Exact and detailed information on the process and the purpose for which the machine is used are essential in terms of safe operation of the machine. The specific circumstances prevailing at the point of use must always be checked between the Customer and Manufacturer when the machine is being selected.

1.5.8-9 Noise and vibration

The instructions supplied with the machine provide information on the emission of airborne noise and on the balancing of rotating parts of the machine. The data given must be taken into account and necessary steps must be taken in order to eliminate any risks caused by noise or vibration in accordance with the circumstances prevailing at the point of use.

1.5.10 Radiation

The instructions supplied with the machine provide information on the emission of radiation potentially involved in the measuring equipment of the machine. The operators of the machine must absolutely follow the safety instructions concerning the use of these equipment.

1.5.13 Emissions

The instructions supplied with the machine provide information on the control of leakages in the immediate proximity of the machine. If necessary, the following steps must be taken to eliminate harmful emissions involved in the process:

- account of the emissions and their potential consequences (e.g. possibility of fire, appropriate extinguishing equipment)
- preventing exposure of operators
- controlled containment and evacuation of emissions
- cleaning of emissions and machinery
- appropriate personal protective equipment and warnings

1.5.15 Slipping, stumbling and falling

When installing, servicing and repairing the machine, the instructions supplied with the machine, safety instructions applicable at the point of use and sufficient care and attention must be followed in order to prevent any slipping, stumbling or falling.

1.6 Maintenance

1.6.1 Machinery maintenance

The maintenance and repair instructions supplied with the machine must be absolutely followed. The instructions specify separately which measures require stopping and potential draining of the machine. Appropriate personal protective equipment as required by the work performed must always be used, e.g.:

- hearing protectors
- eye protectors
- breathing protectors
- safety gloves, safety footwear, protective clothing

When servicing and repairing the machine, principles of ergonomics (avoiding excessive use of muscular power, utilization of lifting gear, lifting positions, lighting of the area, cleanliness etc.) must also be taken into account.

1.6.2 Access to operating position and servicing points

Where the location design for the machine is not included in the delivery, steps must be taken to situate the machine at the point of operation in a manner that enables safe maintenance and repairs of the machine. Provision of sufficient maintenance space around the machine must be taken into account in the design of the operating environment.

1.6.3 Isolation of energy sources

The controls of the machine must be designed so that they include clearly identified devices that can be used to isolate the machine from all energy sources. These devices must be capable of being locked if reconnection of energy could endanger exposed persons. After the energy is cut off, it must be possible to dissipate any energy remaining or stored in the process (e.g. discharging pressure) without risk to exposed persons.

1.6.4 Operator intervention

The controls of the machine must be designed so that the need for operator intervention is limited.

1.6.5 Cleaning of (internal) parts of machine

The potential cleaning of the machine must take place in accordance with the instructions supplied with the machine and the safety instructions applicable at the point of use so that cleaning can be carried out as safely as possible.

1.7 Indicators

1.7.0-1 Information and warning devices

When designing the controls of the machine, the specified requirements laid down in the Machinery Directive and/or national legislation of the country where the machine is used must be absolutely followed in terms of information and warning devices used on the machine.

1.7.2 Warning of residual risks

The safety warnings related to the machine must be kept clean under all circumstances, and the warnings must be renewed when necessary. All operators of the machine must be warned of the residual risks involved in electricity or the controls in accordance with specified requirements laid down in the Machinery Directive and/or national legislation of the country where the machine is used.

1.7.3-4 Marking and instructions

The marking and instructions for the machine must be drawn up in accordance with the Machinery Directive and/or national legislation of the country where the machine is used. Steps must be taken to ensure that the marking and instructions for other equipment related to a safe use of this machine conform to valid legislation.

In particular, it must be ensured that the point of use is provided with instructions for emergencies, such as:

- how to give alarm
- location of rescue and fire extinguishing equipment
- availability of first aid and necessary first aid equipment

SULZER

Safety instructions

Version 02 > / 20100520 / Replaces 20100430 / en / **N15062**

Contest *Page*

1 General

This product is designed and tested for safe and reliable operation in the application for which it is specified and sold. Remember, a pump is a piece of equipment with pressure containing parts and rotating elements which can cause a hazard. Therefore, all the safety measures in the instructions are to be followed strictly. Personal injuries may result if the instructions are not observed and followed.

It is not only the general safety instructions contained under this main heading ”Safety instructions” which are to be observed, but also the specific safety information presented in other instructions relating to this delivery, relevant national safety regulations or any other safety information issued by the plant operator.

The exact and detailed process and application data is relevant for the safe and reliable operation of the product. Special environmental conditions at the place of installation should always be checked between the end user and manufacturer. Such conditions are e.g.

- Abnormal temperature
- High humidity
- Corrosive atmospheres
- Pressure fluctuations
- Falling below the minimum permissible flow, dry running
- Explosive and/or fire risk zones
- Dust, sandstorms
- Earthquakes

Special safety measures are also needed when the type of liquid to be pumped is e.g. the following:

- Flammable
- Corrosive, abrasive
- Poisonous
- Crystallizing
- Solid containing
- Gas containing

Non-compliance with the safety and specific operating instructions may produce a risk to the personnel as well as to the environment, e.g.

- Failure of important functions of the pump and/or plant
- Failure of specific procedures of maintenance and repair
- Exposure of people to electrical, mechanical and chemical hazards
- Endangering the environment owing to hazardous substances being released

2 Definitions

The following words are used in the instructions to indicate issues which require special attention.

WARNING
There is a risk of personal injury if the instruction is not adhered to.

CAUTION
There is a risk of damaging or destroying the product or equipment if the instruction is not adhered to.

NOTE
Is used in the text for highlighting necessary information or requirements which are essential to observe.

3 Essential safety aspects

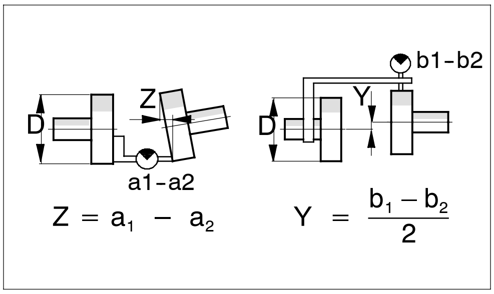
All of the following relevant safety aspects are to be instructed to the operators and maintenance personnel before putting the product into service.

- The product is meant only for the purpose for which it is sold - never operate beyond the intended use described in these instructions.
- Always stop the drive unit before beginning any repair work on the pump. Make sure that the motor cannot be started by any means accidentally during the repairs.
- For delivery, the bearing housing of the pump has been emptied of oil. Remember to refill it before starting.
- Personal injuries may occur if personal protective equipment is not used when servicing the product.
- The product must always be equipped with a shaft sealing system compatible with the pumped liquid.
- Pump units which convey hazardous media must be decontaminated before beginning any maintenance work.
- If there is a possibility that the pump or the pipeline contains explosive gases or vapours, it must be ventilated carefully before working on the pump.
- If there is a possibility that there are explosive gases or vapours in the atmosphere surrounding the pump, the pump's environment be ventilated carefully before working on the pump.
- External heat must not be used when dismantling the pump, as any liquid, gas, vapour or their combination that remains in the pump may explode.
- If there is a possibility of a dangerous return flow after the shutdown of the pump, a nonreturn device shall be assembled in the outlet piping.
- All safety devices (e.g coupling guards) must be correctly installed before starting. For explosive areas, guards with a non-sparking material are to be used.
- The correct rotating direction of the drive unit must be checked before starting and the pump must rotate freely (with coupling spacer removed).
- The coupling must be properly aligned before starting.
- The pump must be sufficiently filled with the pumped liquid before starting.
- The pump must run above the minimum recommended flow and never dry.
- The suction valve must be open during operation.
- If leakage of harmful or dangerous substances can occur - prepare proper means for a safe waste removal.
- There is no protection against contact in the shaft seal area.
- The parts in contact with the pumped liquid can be dangerously hot.

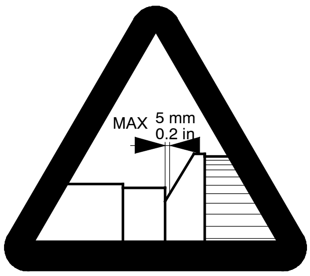
4 Safety signs affixed to the product

The following warnings and informative signs concerning the essential safety aspects are permanently fixed on the product. Safety signs must always be observed and kept clean and legible in any operating condition. The user must always check that the symbols or items presented in those are understood by all user groups before putting the product into service.

4.1 Safety signs on the product

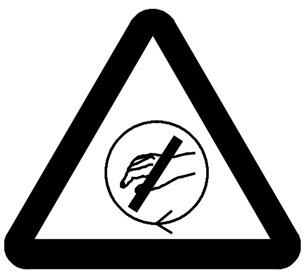


Item no. 976.02 Coupling alignment values.



Item no. 975.04 Coupling guard jacket to be adjusted during assembly.

Item no. 975.03. Dangerous substances.



Item no. 975.02. Rotating shaft, do not touch when in operation.

Item no. 975.01. Hot surface, do not touch (to be fixed when the temperature of the pumped liquid is > 60 °C (140 °F)).

FOR DELIVERY THE BEARING HOUSING OF THE PUMP HAS BEEN EMPTIED OF OIL. REMEMBER TO REFILL IT BEFORE STARTING!

Item no. 976.01. Lubrication oil will have to be added.

020

Item no. 020.01 Sealing liquid inlet (and other signs of connections found in the parts list under heading "Connections").

5 Operating situations affecting product safety

The following inadequate operating situations always have consequences which have an immediate effect on the product safety and therefore they are not allowed in any operating conditions with this product.

Table 1 Typical inadmissible operating situations

Cause:	Consequence:
Discharge valve not opened. Inlet pressure or piping system resistance incorrectly estimated when the pump was originally selected. The pump is operated at too high a rotational speed.	Inadmissible pressure increase
Discharge valve not opened. Discharge valve throttled too much. Properties of the pumped liquid incorrectly estimated when the pump was originally selected.	High temperatures (Hydraulic parts)
Gland packing tightened too much . Adequate sealing water service neglected. - Sealing water pump not started - Sealing water valve not opened - Sealing water equipment incorrectly adjusted - Quality of the sealing water does not match our requirements. Inlet pressure incorrectly estimated when the pump was originally selected. Pump is not properly filled with the pumped liquid. - Suction valve not opened - Suction tank not properly filled - Suction piping resistance or air tightness improperly checked.	High temperatures (Shaft sealing)
Pump lubrication carried out inadequately. - Oil/grease filling neglected - Oil/grease quality incorrectly selected - Relubrication carried out inadequately Pump washdown carried out inadequately (sprayed water enters the bearing unit). Properties of the pumped liquid incorrectly estimated when the pump was originally selected.	High temperatures (Bearing unit)

6 Admissible forces and moments on pump flanges

6.1 Allowance nozzle loads

Principles for allowed nozzle loads

Allowable flange loading imposed by the piping is in accordance with HI 9.6.2. In the following the method described in HI 9.6.2 is represented briefly. For additional information and equations to be used in calculations, see the standard.

Loads listed in the following tables 2 - 5 are applicable for pumps constructed of material 41 (ASTM A 890 3A) with either Class 150 or Class 300 flanges, operated between -20 °F and 100 °F (from -29 °C to 38 °C) and mounted on a fully grouted metal baseplate with anchor bolts. For other situations, see adjustment factors below.

Adjustment for temperature and material of construction

For pumps with other than material 41 (ASTM A 890 3A) and/or higher than 100 °F (38 °C) temperature, adjustment factors according to table 6 shall be used. Use adjustment factor to adjust values in table 3. If any of the adjusted values in table 3 becomes lower than the corresponding value in table 2, substitute the lower value into table 2.

Adjustment for ungrouted metal baseplate

Use 100% of the values in the table 3 and 80% of the values in tables 4 and 5. If any of the adjusted values in table 4 and 5 becomes lower than the corresponding value in table 2, substitute the lower value into table 2.

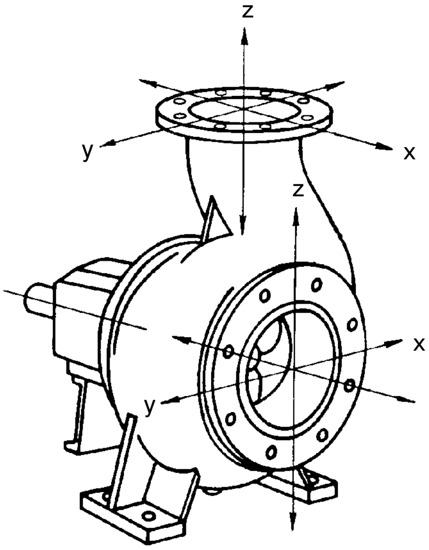


Fig. 8

Table 2 **Allowable individual nozzle loads. Horizontal end suction pumps in accordance with ASME B73.1.**

Pump size	Size marking	Suction						Discharge					
		Forces (lb)			**Moments** (ft-lb)			**Forces** (lb)			**Moments** (ft-lb)		
		F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
11-1	1.5 x 1 x 6	1050	750	750	720	170	170	800	1350	3000	410	410	410
11-1B	3 x 1.5 x 6	1050	1240	1250	900	490	490	800	1350	3000	500	550	510
11-2	3 x 2 x 6	1050	1050	1050	900	220	220	800	1350	3000	500	1000	510
11-3	4 x 3 x 6	1050	1050	1050	900	220	220	800	1350	3000	500	1000	510
12-1	1.5 x 1 x 8	1050	1210	1210	720	190	190	800	1350	3000	360	360	360
12-1B	3 x 1.5 x 8	1050	1240	1250	900	490	490	800	1350	300	440	440	440
21-1B	3 x 1.5 x 8A	2700	1350	1500	1300	370	370	1400	1350	3250	460	460	460
21-2	3 x 2 x 8A	2700	1350	1500	1300	600	600	1400	1350	3250	660	660	660
21-3	4 x 3 x 8A	2700	1350	1500	1300	350	350	1400	1350	3250	1200	1460	690
21-4	6 x 4 x 8A	2700	1350	1500	1300	350	350	1400	1350	3250	1200	1460	690
22-1	2 x 1 x 10	2340	960	960	1270	220	220	1400	1350	3250	660	660	660
22-1C	2 x 1 x 10C	2340	960	960	1270	220	220	1400	1350	3250	660	660	660
22-1B	3 x 1.5 x 10	2700	1350	1500	1300	420	420	1400	1350	3250	370	370	370
22-2	3 x 2 x 10	2700	1350	1480	1300	310	310	1400	1350	3250	560	560	560
22-4	6 x 4 x 10	2700	1350	1500	1300	1100	1100	1400	1350	3250	1200	1500	690

Pump size	**Size marking**	**Suction**						**Discharge**					
		Forces (lb)			**Moments** (ft-lb)			**Forces** (lb)			**Moments** (ft-lb)		
		F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
23-1B	3 x 1.5 x 11	2700	1350	1500	1300	420	420	1400	1350	3250	370	370	370
23-2	3 x 2 x 11	2700	1350	1480	1300	310	310	1400	1350	3250	560	560	560
23-3	4 x 3 x 11	2300	1350	1500	1300	310	310	1400	1350	3250	1200	1480	690
24-1B	3 x 1.5 x 13	2700	1350	1500	1300	670	670	1400	1350	3250	530	530	530
24-1BC	3 x 1.5 x 13C	2700	1350	1500	1300	670	670	1400	1350	3250	530	530	530
24-2	3 x 2 x 13	1920	1230	1230	1300	350	350	1400	1350	3250	1200	1270	690
24-3	4 x 3 x 13	2700	1350	1500	1300	400	400	1400	1350	3250	1200	1500	690
24-4	6 x 4 x 13	2700	1350	1500	1300	1300	1100	1400	1350	3250	1200	1500	690
31-6	8 x 6 x 13	3500	3180	2000	1500	1170	1170	1500	3000	3500	1250	2840	2840
32-6	8 x 6 x 15	3500	3180	2000	1500	1480	1480	1500	3000	3500	1250	2840	2840
32-8C	10 x 8 x 15C	3500	3180	2000	1500	1130	1130	1500	3000	3500	1250	2840	2840
32-8	10 x 8 x 15	3500	3180	2000	1500	1130	1130	1500	3000	3500	1250	2840	2840
33-4	6 x 4 x 17	3500	2850	1800	1350	1055	1055	1350	2300	3150	1125	2555	2555
33-6	8 x 6 x 17	3500	3180	2000	1500	1480	1480	1500	3000	3500	1250	2840	2840
33-8	10 x 8 x 17	3500	3180	2000	1500	1130	1130	1500	3000	3500	1250	2840	2840

Table 3 ***Allowance combination nozzle loads for nozzle stress, hold-down bolt stress and pump slippage on baseplate. Horizontal end suction pumps in accordance with ASME B73.1.***

Pump size	**Size marking**	**Suction**						**Discharge**					
		Forces (lb)			**Moments** (ft-lb)			**Forces** (lb)			**Moments** (ft-lb)		
		F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
11-1	1.5 x 1 x 6	2020	750	750	1830	170	170	2020	1350	6240	410	410	410
11-1B	3 x 1.5 x 6	2020	1240	2110	2290	490	490	2020	1350	6240	550	550	510
11-2	3 x 2 x 6	2020	1050	1050	2290	220	220	2020	1350	6240	1030	1030	510
11-3	4 x 3 x 6	2020	1050	1050	2290	220	220	2020	1350	6240	1030	1030	510
12-1	1.5 x 1 x 8	2020	1210	1210	1830	190	190	2020	1350	6240	360	360	360
12-1B	3 x 1.5 x 8	2020	1240	1640	2290	490	490	2020	1350	6240	440	440	440
21-1B	3 x 1.5 x 8A	2700	1350	1820	3730	370	370	2020	1350	6240	460	460	460
21-2	3 x 2 x 8A	2700	1350	2490	3730	600	600	1970	1350	6240	660	660	660
21-3	4 x 3 x 8A	2700	1350	1840	3730	350	350	2020	1350	6240	1460	1460	690
21-4	6 x 4 x 8A	2700	1350	1840	3730	350	350	2020	1350	6240	1460	1460	690
22-1	2 x 1 x 10	2340	960	960	3640	220	220	2020	1350	6240	660	660	660
22-1C	2 x 1 x 10C	2340	960	960	3640	220	220	2020	1350	6240	660	660	660
22-1B	3 x 1.5 x 10	2700	1350	1910	3730	420	420	1940	1350	6240	370	370	370
22-2	3 x 2 x 10	2700	1350	1480	3730	310	310	2020	1350	6240	560	560	560
22-4	6 x 4 x 10	2700	1350	6240	3730	1100	1100	2020	1350	6240	3100	3100	690
23-1B	3 x 1.5 x 11	2700	1350	1910	3730	420	420	1940	1350	6240	370	370	370
23-2	3 x 2 x 11	2700	1350	1480	3730	310	310	2020	1350	6240	560	560	560
23-3	4 x 3 x 11	2300	1350	1640	3730	310	310	2020	1350	6240	1460	1460	690
24-1B	3 x 1.5 x 13	2700	1350	3060	3730	670	670	2020	1350	6240	530	530	530
24-1BC	3 x 1.5 x 13C	2700	1350	3060	3730	670	670	2020	1350	6240	530	530	530
24-2	3 x 2 x 13	1920	1230	1230	3730	350	350	2020	1350	6240	1460	1460	690
24-3	4 x 3 x 13	2700	1350	2390	3730	400	400	2020	1350	6240	1730	1730	690
24-4	6 x 4 x 13	2700	1350	6240	3730	4980	1100	2020	1350	6240	2150	2150	690
31-6	8 x 6 x 13	6360	3180	5080	8970	1170	1170	6360	3180	13460	6780	3850	2840

Pump size	Size marking	Suction						Discharge					
		Forces (lb)			**Moments** (ft-lb)			**Forces** (lb)			**Moments** (ft-lb)		
		F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
32-6	8 x 6 x 15	6360	3180	6680	8970	1480	1480	6360	3180	13460	6560	3720	2840
32-8C	10 x 8 x 15C	6360	3180	5130	8970	1130	1130	6360	3180	13460	8970	9060	2840
32-8	10 x 8 x 15	6360	3180	5130	8970	1130	1130	6360	3180	13460	8970	9060	2840
33-4	6 x 4 x 17	6360	3180	4570	8970	1055	1055	5725	2860	12115	6100	3465	2555
33-6	8 x 6 x 17	6360	3180	6680	8970	1480	1480	6360	3180	13460	6560	3720	2840
33-8	10 x 8 x 17	6360	3180	5130	8970	1130	1130	6360	3180	13460	8970	9060	2840

Table 4 ***Allowance combination nozzle loads for y-axis movement. Horizontal end suction pumps in accordance with ASME B73.1.***

Bearing unit	Suction						Discharge					
	Forces (lb)			**Moments** (ft-lb)			**Forces** (lb)			**Moments** (ft-lb)		
	F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
1		-2000		900	1200	1250		1500		-500	1500	1250
2		-3500		1300	1300	3000		2500		-1200	1500	3000
3		-5000		1500	2000	4000		3000		-1250	5000	4000

Table 5 ***Allowance combination nozzle loads for z-axis movement. Horizontal end suction pumps in accordance with ASME B73.1.***

Bearing unit	Suction						Discharge					
	Forces (lb)			**Moments** (ft-lb)			**Forces** (lb)			**Moments** (ft-lb)		
	F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
1	1050		-1250	1500	1200	-2500	800	2000	-3000	-1500	1000	-2500
2	3500		-1500	1500	1300	-3500	1400	2500	-3250	-1500	2150	-3500
3	3500		-2000	1500	4100	-4000	1500	4000	-3500	-1500	5000	-4000

Table 6 ***ASME B73.1 metallic pump temperature and material adjustment values to be used on table 3 values. Use for both class 150 and class 300 flanges.***

Temperature °F	Material class (Material code)			
	B1 (41, 4E, 4L, 4T, 4U)	**B2** (4G, 4J)	**B3** (43)	**D1** (5H)
-20 ... 100	1.00	1.00	0.83	0.89
200	1.00	0.86	0.77	0.83
300	1.00	0.78	0.73	0.78
400	0.98	0.72	0.67	0.73
500	0.92	0.67	0.65	0.69

7 Sound level charts

Noise emission values are stated according to ISO 4871 and the essential requirements in the Machinery Directive 2006/42/EC.

The noise values are given in accordance with standard EN12639.

Sound power levels have been determined according to EN ISO 9614 Part II using sound intensity measurements.

It is not possible to measure all different pump applications. Therefore, some values have been determined by calculations based on measurements with similar pumps and Europump's Guide 001/30/E, Forecasting the Airborne Noise Emission of Centrifugal Pumps.

LpA = A-weighted sound pressure level, dB re 20 μPa, at the relevant working station.

LwA = A-weighted sound power level, dB re 1 pW, if A-weighted sound pressure level exceeds 85 dB.

Table 7 Sound pressure level LpA / open impellers (dB)

Pump size	Pump rot. speed (rpm)						
	3600	**3000**	**1800**	**1500**	**1200**	**1000**	**900**
11-1	<70	<70	<70	<70	<70	<70	
11-1B	<70	<70	<70	<70	<70	<70	
11-2, 11-3	72	71	<70	<70	<70	<70	
12-1	<70	<70	<70	<70	<70	<70	
12-1B	<70	<70	<70	<70	<70	<70	
21-2, 21-1B	75	73	<70	<70	<70	<70	
21-3	77	75	<70	<70	<70	<70	
21-4	77	75	<70	<70	<70	<70	
22-1	73	72	<70	<70	<70	<70	
22-1B, 22-1C	74	73	<70	<70	<70	<70	<70
22-2	76	74	<70	<70	<70	<70	<70
22-4	79	76	<70	<70	<70	<70	<70
23-1B	75	74	<70	<70	<70	<70	<70
23-2	80	77	<70	<70	<70	<70	<70
23-3	81	78	<70	<70	<70	<70	<70
24-1B	76	74	<70	<70	<70	<70	<70
24-1BC	79	76	<70	<70	<70	<70	<70
24-2	80	77	<70	<70	<70	<70	<70
24-3			<70	<70	<70	<70	<70
24-4			73	72	<70	<70	<70
31-6			75	73	<70	<70	<70
32-6			74	72	<70	<70	<70
32-8			81	80	74	73	<70
32-8C			79	77	72	71	<70
33-4			81	79	76	74	72
33-6			83	81	78	76	74
33-8, open1				82	79	77	76
33-8, open2			83	81	77	75	74

Table 8 Sound pressure level LpA / low flow impellers (dB)

Pump size	Pump rot. speed (rpm)						
	3600	**3000**	**1800**	**1500**	**1200**	**1000**	**900**
12-1	<70	<70	<70	<70	<70	<70	
22-1	73	72	<70	<70	<70	<70	
24-1B	76	74	<70	<70	<70	<70	<70

8 Balance and vibration

The pump is normally balanced in accordance with grade G 6.3 of ISO 1940. Vibration does not exceed the vibration severity limits given in Table 9 when measured at the manufacturer's test facilities. These values are measured radially at the bearing housing at rated speed and flow when operating without cavitation.

A pump equipped with a specially designed impeller may exceed the limits given in Table 9.

Table 9 Max. r.m.s values of vibration velocity

Speed of rotation	Shaft centerline height D			
	≤ 8.86 in	≤ 225 mm	> 8.86 in	> 225 mm
≤ 1800 rpm	0.11 in/s	2.8 mm/s	0.177 in/s	4.5 mm/s
> 1800 rpm	0.177 in/s	4.5 mm/s	0.28 in/s	7.1 mm/s

9 Maximum size of solid particles

The maximum sizes of solid spherical particles which can flow through the pump (casing/impeller) are presented in Table 10.

Table 10 Max. size of solid particles

Pump size	Impeller type			
	Open		Low flow	
	⊘ in	⊘ mm	⊘ in	⊘ mm
11-1	0.28	7	–	–
11-1B	0.39	10	–	–
11-2	0.43	11	–	–
11-3	0.37	9.5	–	–
12-1	0.31	7.8	0.31	8
12-1B	0.39	10	–	–
21-1B	0.39	10	–	–
21-2	0.43	11	–	–
21-3	0.59	15	–	–
21-4	0.59	15	–	–
22-1	0.39	10	0.31	9
22-1C	0.47	12	–	–
22-1B	0.47	12	–	–
22-2	0.71	18	–	–
22-4	0.87	22	–	–
23-1B	0.35	9	–	–
23-2	0.59	15	–	–
23-3	0.87	22	–	–
24-1B	0.31	8	0.39	10
24-1BC	0.39	10	–	–
24-2	0.55	14	–	–
24-3	0.63	16	–	–
24-4	0.98	25	–	–
31-6	1.18	30	–	–

Pump size	Impeller type			
	Open		**Low flow**	
	⊘ in	⊘ mm	⊘ in	⊘ mm
32-6	1.73	44	-	-
32-8C	1.97	50	-	-
32-8	1.22	31	-	-
33-4	0.98	25	-	-
33-6	1.26	32	-	-
33-8, open1	1.42	36	-	-
33-8, open2	1.22	31	-	-

SULZER

Hoisting and transportation

20010515 / en / **N15063**

Contents *Page*

1 Safety measures

W A R N I N G

Hoisting and transportation instructions are to be strictly followed to avoid dropping of crates or individual assemblies.

The total gross and net weights of the delivery are always found in the packing list affixed to the product or packing.

Special attention is to be paid to the stability of

- pump + baseplate without motor
- exchange unit
- bearing unit
- bare impeller

The center of gravity of these items should always be checked before hoistings and transportation.

Personal protective equipment such as helmet, safety shoes and gloves are to be used.

All lifting accessories and removable components must be capable of withstanding the stresses to which they are subjected during transport, assembly and dismantling.

Lifting ropes used directly for lifting or supporting the pump or pump unit must not include any splicing other than at their ends. Textile ropes and slings must not include any knots, connections or splicing other than at the ends of the sling, except in the case of an endless sling.

Lifting accessories must bear the identification of the manufacturer, material and the maximum working load.

2 Hoisting and transportation

The lifting accessories must always be able to adequately support the hoisted assembly.

If suitable lifting equipment is not available, heavy assemblies must be transferred by using skids etc. on the ground level.

The crates or individual assemblies must never be dropped to the ground during transportation. Refer to Figures 1 – 4 for examples of proper lifting techniques.

The transportation crate is hoisted according to Fig. 1. Permissible lifting points are also marked on the crate.

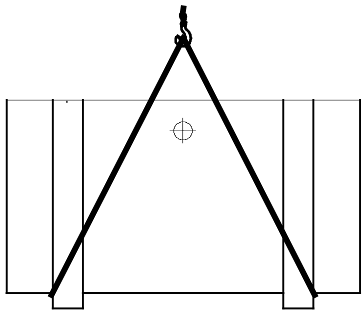


Fig. 1

The pump-motor-baseplate-assembly may be hoisted from under the pump suction flange and motor or under the baseplate. Fig. 2.

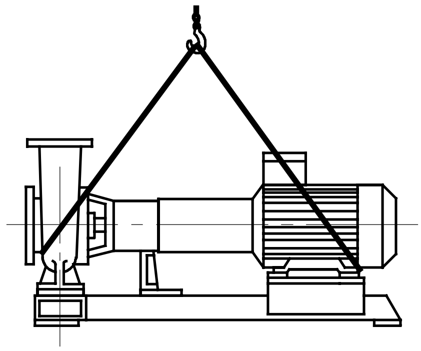


Fig. 2

The pump-baseplate-assembly is hoisted from under the pump suction flange and baseplate. Fig. 3.

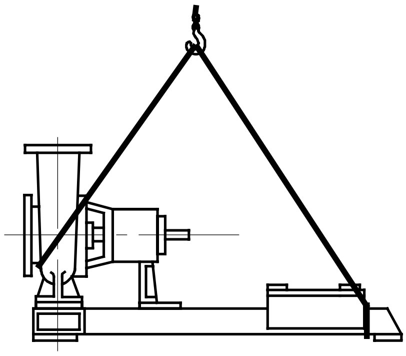


Fig. 3

The bare pump is hoisted from under the pump suction flange and bearing housing. Fig. 4.

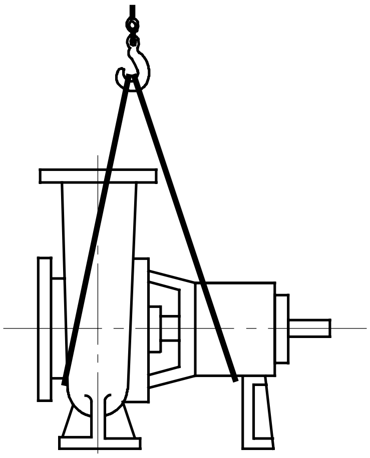


Fig. 4

Commissioning

20010515 / en / **N15064**

Contents *Page*

1 Purchase inspection

Check carefully that the delivery meets your order and is in accordance with the packing list and parts list of the pump. Inform the supplier immediately about any defects or damage observed.

Do not remove the cover plates or plugs protecting the openings before the installation of pipes. Foreign particles inside the pump may damage it at starting.

Examine the crate and wrapping before discarding them since parts and accessories are sometimes wrapped individually or fastened into the crate.

If the pump unit is not installed immediately, it should be stored under conditions that will prevent deterioration due to damage and/or corrosion. The long-term storage requirements should always be specified in the purchase order.

2 Storage

2.1 Short-term (less than 3 months)

When it is necessary to store a pump for a short term before the installation, it must be stored in a dry location where it cannot be affected by dirt or corrosion. Protection plates on the pump openings should not be removed.

The pump bearings and drive elements must be properly protected against any foreign matter.
To prevent rusting or seizing, lubricate the pump unit before storing and turn the pump shaft by hand at least once every two weeks.

2.2 Long-term

NOTE
The grease/oil lubricants must be changed before the pump is taken into use.

WARNING
The rust preventives must be cleaned off carefully before the pump is taken into use. Solvents containing rust preventives can cause irritation to the skin and/or the respiratory system. Prolonged physical contact and breathing of vapor are to be avoided.

If the pump or pump unit is stored for more than 3 months, the following procedures must be observed:

- Store the product in a dry place.
- Drain any liquid from the pump.
- Rotate the pump shaft by hand at least once every month to prevent bearing damage.
- With cast iron pumps equipped with gland packing, remove the gland packings (461) from the stuffing box and apply rust preventives in the stuffing box.
- With oil lubrication, the bearing unit is emptied of oil before the delivery. Fill the bearing unit with oil or coat the interior of the unit with a rust preventing film.
- Apply rust preventing agents to the unprotected parts, such as the shaft end, pump flanges and coupling. If necessary, protect the volute casing and shaft sealing with volatile corrosion inhibitors.
- Observe the storage instructions of any accessory equipment (e.g. electric motors) included in the delivery.
- If the pump unit is covered with a plastic sheet, the bottom should remain open to allow for ventilation.

SULZER

Installation

Version 03 > / 20020501 / en / **N15253**

Contents *Page*

1 Safety procedures before installation

NOTE
A pump should have adequate space for proper installation and maintenance actions.

All parts for the installation must be thoroughly cleaned before the installation. All traces of antirust agents should be cleaned off from the pump flanges, shaft assembly and drive elements. Avoid any damage to installed parts when handling them.

Personal protective equipment such as helmet, safety glasses, safety shoes and gloves are to be used.

2 Fastener information

Table 1 shows the rated and maximum moments of torque for fasteners presented in these instructions. These shown values are only valid for fasteners where the moment values are not separately given.

Table 1 Fastener information

Screw size	Moments			
	Rating		**Max. value**	
	(lb ft)	(Nm)	(lb ft)	(Nm)
3/16	2.6	3.5	3.0	4.0
1/4	4.4	6.0	5.0	7.0
5/16	10.3	14	13.0	18
3/8	22.1	30	26.0	35
1/2	36.9	50	44.0	60
5/8	96	130	118.0	160
3/4	184.4	250	221.0	300
1	309.8	420	383.0	520
1 1/8	590.1	800	738.0	1000

3 Installation at the site

N O T E
When welding the foundation screws, connect the earth clamp to the baseplate, never to the pump!

The pump base must be sturdy enough to endure vibration, stress and potential forces caused by the piping.

The pump base is normally reinforced by making a concrete support stand or equivalent. Also note the bottom beams in the foundation or cavities for the different types of foundation screws.

3.1 Installation using welded foundation screws

The bottom beams in the foundation are cast in advance according to the dimensional drawing of the pump. The strength requirements for the bottom beams are given in Table 2. In order to facilitate the alignment of the beams, a so-called concrete frame can be used. The recommended accuracy for the installation of the beams is (± 0.4 in) ±10 mm in all directions. The actual installation becomes much easier, if the upper surfaces are horizontal.

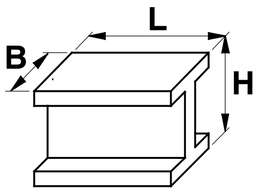
Place foundation screws (918) in the fixing holes of the baseplate. The distance between the foundation and the lower edge of the baseplate must be at least (2 inches) 50 mm. Each foundation screw is fixed to the baseplate by means of hexagonal nuts (2 pcs/foundation screw). Fig.1.

Lower the pre-installed pump-motor-baseplate-assembly onto the floor so that the foundation screws are above the beams, and the pump is in its position in the lateral and longitudinal direction. Now the foundation screws can be welded to the beams.

Adjust the position of the baseplate before grouting by turning the hexagonal nuts of the foundation screws, until the assembly lies horizontally and at the correct height.

Table 2 Welded foundation screw

Foundation screw	The capacity of the bottom beam (min.)				e.g. I-beam H x B x L	
	F_v tension		**F_h shear**		**min. dimensions**	
	(lbf)	(N)	(lbf)	(N)	(in)	(mm)
5/8-11 x 6	1900	8500	1700	7600	4 x 4 x 4	100 x 100 x 100
3/4-10 x 6	3900	17300	3250	14500	4 x 4 x 6	100 x 100 x 150



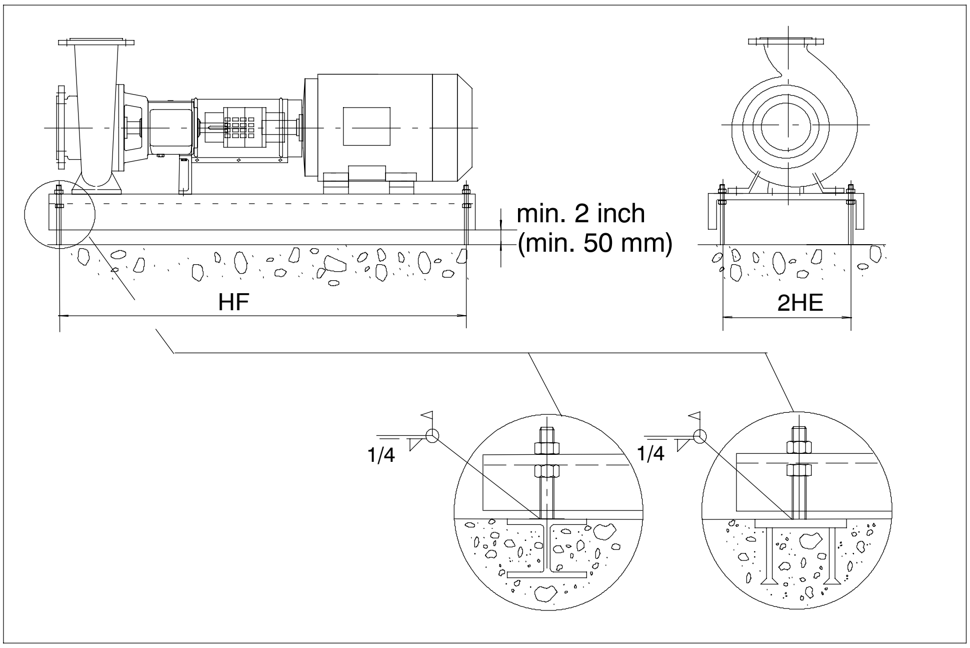


Fig. 1

3.2 Installation using grouted foundation screws

The foundation screw cavities are made in advance (by pouring of concrete, drilling) in the concrete frame according to the dimensional drawing of the pump, Table 3 and Fig. 2. The recommended accuracy for the location of the cavities is (0.4 in) ± 10 mm.

Place the foundation screws (918) in the fixing holes of the baseplate, taking into account the distance between the foundation and the lower edge of the baseplate which must be at least (2 in) 50 mm and the minimum dimension U2 according to Table 3. Each foundation screw is fixed to the baseplate by means of hexagonal nuts (2 pcs/foundation screw).

Lift the pre-installed pump and baseplate onto the mounting blocks so that the distance between the foundation and the lower edge of the baseplate is at least (2 in) 50 mm and so that the foundation screws fit into their cavities and the pump is in its position in the lateral and longitudinal directions.

Grout the foundation screws. Use only non-shrinking solder concrete of high quality. Allow the concrete to set for about 1 or 2 days.

Remove the mounting blocks and adjust the position of the baseplate before grouting by turning the hexagonal nuts until the assembly lies horizontally and at the correct height.

Table 3 **Grouted foundation screws**

	Foundation screw					
Size	**~e**		**U_{min}**		**$U2_{min}$**	
	(in)	(mm)	(in)	(mm)	(in)	(mm)
5/8-11 x 11	4	100	8	200	6.25	160
3/4-10 x 14	5	125	10	250	8	200

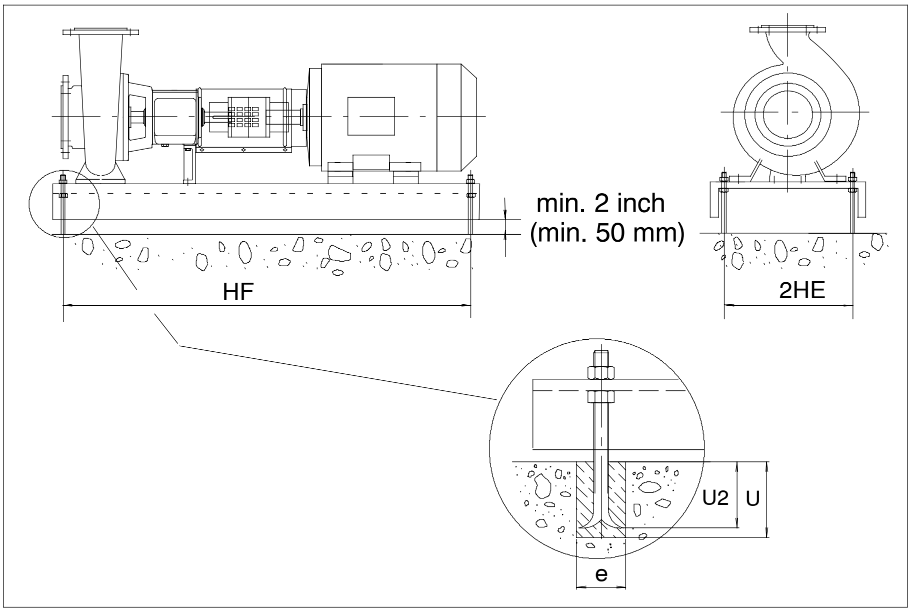


Fig. 2

4 Installation of the motor on the baseplate

WARNING
Personal injuries may occur if personal protective equipment are not used when servicing the product. When pumping hazardous liquids, skin and eye protection are required.

If the motor has not been installed on the baseplate by the pump manufacturer, the installation should be carried out as follows:

The coupling half on the motor side is warmed up to approx. (212 °F) 100 °C and pushed onto the motor shaft in such a way that the space between the ends of the shafts is according to the dimensional drawing (usually the front face of the coupling is even with the end of the shaft).

When installing the coupling, also see instructions supplied by the coupling manufacturer.

The coupling spacer is fastened to the coupling half of the motor without the flexible element.

Check that the pump is aligned as accurately as possible to the middle of the fixing holes of the motor. Lift the motor onto the riser blocks on the baseplate.

The coupling is aligned according to Section ”Installation and alignment of couplings”. The alignment is carried out by moving the motor vertically by means of the riser blocks or shims which are placed under the feet of the motor and laterally by moving the motor and the riser blocks sideways.

When installing the motor, special attention should be paid to the clearance of the coupling spacer, so that the spacer can be removed without detaching the motor.

5 Foundation

The recommended dimensioning for the foundation is given in Fig. 3. The dimensions for baseplate are given in the dimensional drawing, baseplate for pump and motor.

Pour concrete into the mold. The recommended strength grade for the concrete is about (2900 psi) 20 MPa (design strength K 20). The motor stand should be filled with concrete.

The upper surface of the foundation is levelled so that it is slanting in accordance with Fig. 3. Water the grouting during its drying to prevent cracking.

Recheck the alignment of the coupling after the grouting according to section ”Installation and alignment of coupling”.

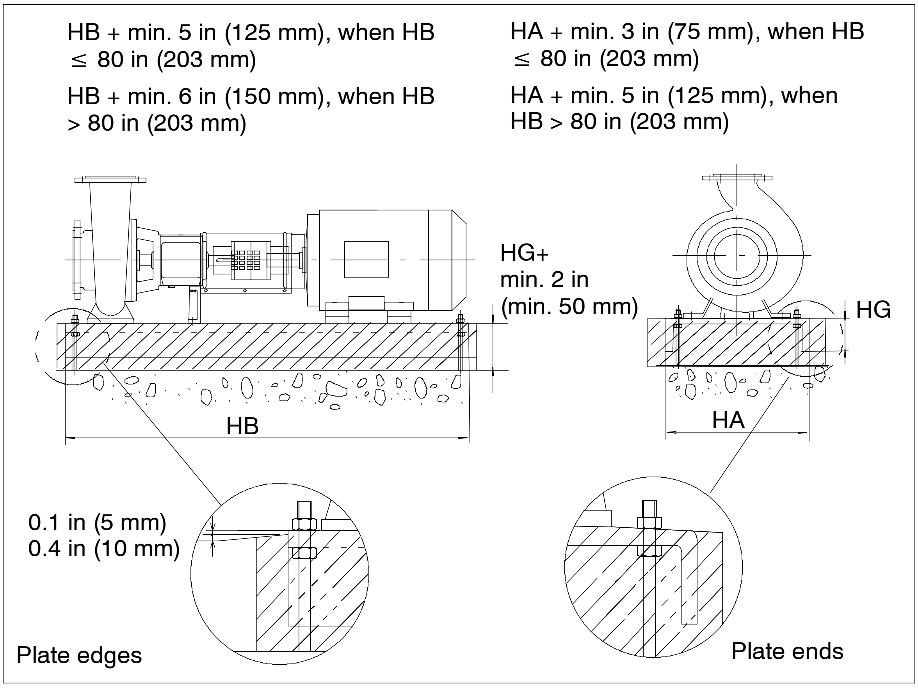


Fig. 3

6 Pipework

6.1 Supporting

The pipes must be installed and supported so that the forces, vibration and weight of the piping are not directed to the pump. When planning the support locations remember the allowance for thermal expansion. Fig. 4.

Fit the pipe flanges accurately to the pump flanges. Flanges which have not been properly aligned must not be forced to position.

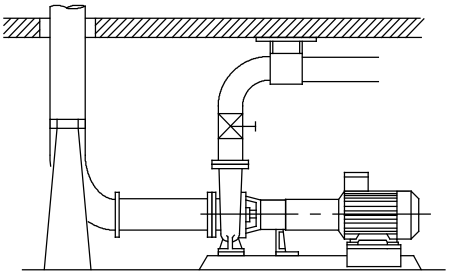


Fig. 4

6.2 Suction pipe below the pump

The suction pipe must be made as short as possible. Avoid points where air pockets or turbulence may be formed.

If the liquid level is below the pump, the suction pipe must gradually rise towards the pump. A sufficient length of the pipe end must be under the liquid level so that air cannot enter the pump. Fig. 5.

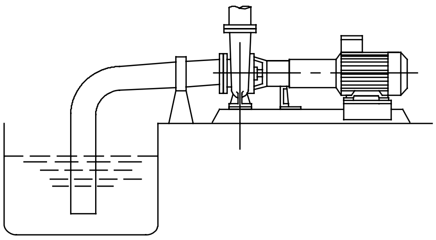


Fig. 5

6.3 Suction pipe above the pump

The suction pipe must descend gradually towards the pump. Fig. 6.

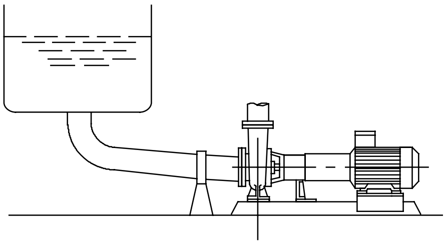


Fig. 6

6.4 Extension piece

The cones must be eccentric and in such a position that the upper level will be horizontal, in Fig. 7. If extension pieces are used, they must be formed so that gathering of gases cannot occur.

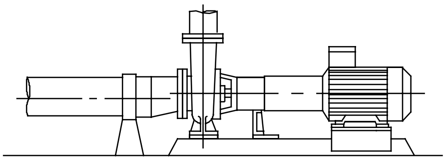


Fig. 7

6.5 Suction pipe design

WARNING

If there is a possibility of a dangerous return flow after the shutdown of the pump, a nonreturn device shall be installed in the outlet piping.

CAUTION

Never use the pump as a support for the piping system.

If the suction pipe has branches, they must be located as far from the pump as possible, and they must be formed advantageously with regard to the flow. The suction pipe must always be made as short as possible. Fig. 8.

A shut-off valve must be placed in the discharge pipe after the potential check valve. Before commissioning, clean the piping and suction pit carefully. Tools or other things left inside the pump will damage the pump already at testing.

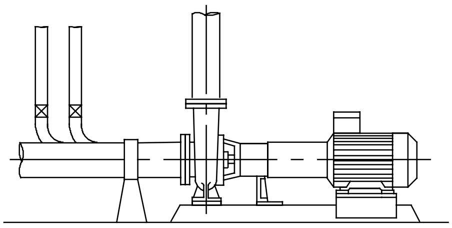


Fig. 8

7 Auxiliary piping

WARNING

During operation - leakage of hazardous substances can occur - prepare proper means for a safe waste removal.

7.1 Sealing liquid pipings

To guarantee faultless shaft seal operation, it may be necessary to lead sealing, flushing or cooling liquid to the seal. Design of the auxiliary piping depends on the construction of the shaft seal and sealing water equipment in question.

For the design and connection details for auxiliary piping, see the sectional drawings of shaft seal and sealing water equipment. Nominal sizes for connections are given in the part list.

The pressure rating of auxiliary piping has to be minimum 87 psi (0,6 MPa) but at least as much as the pressure on the suction side. However, the pressure rating of auxiliary piping for shaft seals using Recirculation from pump discharge or Pressurized external sealing liquid must not be less than that of the casing, see Section "Product description/Mechanical durability".

The temperature rating of auxiliary piping has to be minimum the same as temperature limit for the shaft seal, see the seal manufacturer's instructions.

Install flow regulating valves in the sealing liquid pipes. A rotameter or other flow meter as well as a pressure gauge are also useful in many cases. A non-return valve can be used to prevent the pumped liquid entering the sealing liquid pipes. Often these devices are already included in the delivery of the sealing water equipment; check from the part list and sectional drawing of sealing water equipment.

The piping for Quench seals is installed so that the pipe which leaves the seal (021.01) is continuously falling, the pipe is as short as possible and there are no points throttling the flow, because the throttling bush or the v-ring seal is not meant for pressurized sealing liquid. Fig. 9.

Clean the sealing liquid piping carefully before commissioning.

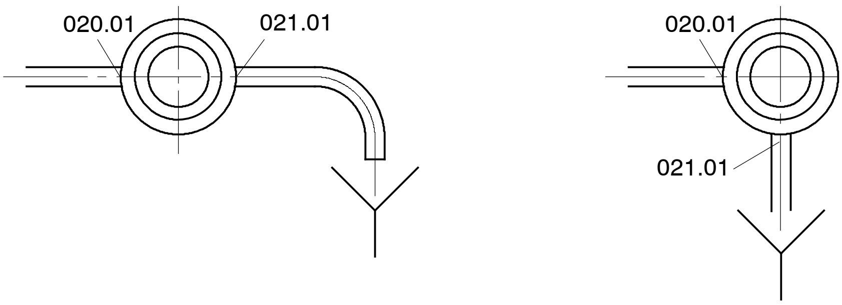


Fig. 9

7.2 Bearing unit pipings

The pipings for pure and purge oil mist lubricated bearing unit have to install according to corresbonding sectional drawing connection numbers 056.01 (oil inlet) and 057.01 (oil outlet).

8 Installation and alignment of coupling

WARNING
Before beginning any installation or alignment procedures, make sure the drive motor cannot be started by any means.

NOTE
Satisfactory performance of the coupling depends on correct installation and alignment.

For procedures and alignment accuracy to be followed when installing and disassembling the coupling, see separate instructions supplied by the coupling manufacturer.

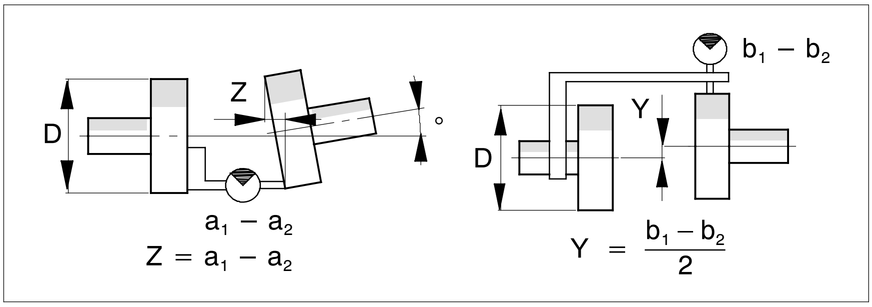
When applicable, the coupling has already been installed and prealigned at the factory. However, the alignment may change due to faulty hoistings, baseplate support, piping support, thermal expansion or the like. Therefore check the shaft alignment of the coupling and re-align during the following stages:

1. After supporting of piping and before starting the pump, tighten the fixing screws of the pump and align the coupling to the required accuracy. Fig. 10.
2. After running the pump with water, look for changes caused by the water run. Correct the changes by altering the supporting of the piping. Tighten the fixing screws of the pump and align the coupling.
3. Carry out hot alignment if the temperature of pumped liquid is higher than (212 °F) 100 °C. The alignment is carried out during production run immediately after the pump is stopped while the pump and the motor are still at the operating temperature. The need for hot alignment depends on the extent of temperature differences and the coupling type chosen.

Aligment is checked by measuring the angular and parallel misaligments in vertical (6 and 12 o'clock) and horizontal (3 and 9 o'clock) directions. During the alignment, the coupling halves have to be locked together so that they do not move against each other. If needed, correct the aligment by adding and removing shims from under the feet of the motor and shifting the motor horizontally, until the shafts are aligned within the given tolerances. Fig. 10.

8.1 Maximum tolerances for coupling alignment

The maximum tolerances for angular and parallel alignments are given in Fig. 10.



D		**Z max**						**Y max**			
		≤1800 rpm			>1800 rpm			≤1800 rpm		>1800 rpm	
in	mm	in	mm	°	in	mm	°	in	mm	in	mm
0 - 4	0 - 100	0.003	0.08	0.06	0.002	0.05	0.04	0.004	0.10	0.003	0.07
>4 - 8	>101 - 200	0.004	0.10	0.05	0.003	0.08	0.03	0.006	0.15	0.004	0.10
>8 - 12	>201 - 300	0.006	0.15	0.03	0.004	0.10	0.02	0.008	0.20	0.006	0.15
>12 - 16	>301 - 400	0.008	0.20	0.03	0.004	0.10	0.02	0.010	0.25	0.006	0.15

Fig. 10

SULZER

Operation

Version 02 > / 20010515 / en / **N15066**

Contents *Page*

1 Safety procedures before start-up

Before starting the pump for the first time and after service repairs, the following precautionary measures are always to be checked carefully to prevent any accidents and to guarantee a trouble-free operation of the pump.

WARNING
Make sure that the motor cannot be started by any means accidentally during the following procedures.

NOTE
Pressure containing pump parts are not pressure vessels within the meaning of the regulations for pressure vessels.

CAUTION
The pump will be damaged if run in the wrong direction.

1.1 Leakage test

The pump parts and the piping shall be able to withstand a leakage test before the start-up. Leakage, particularly in the suction piping, can seriously reduce the performance of the pump and make it impossible to prime the pump before the start-up.

1.2 Direction of rotation

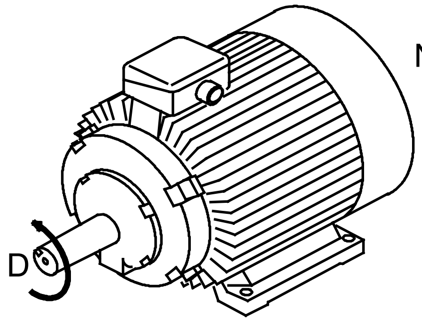


Fig. 1

- Before commissioning, always check the motor for correct rotation.
- It is imperative to detach the coupling spacer before checking the rotation direction of the motor.

The motor rotation must be counter-clockwise when viewed from the coupling end (D-end, Fig. 1) of the motor. (The pump rotation is clockwise when viewed from the coupling end.)

The direction of rotation must correspond to the arrow sign (972.01) on the bearing housing (330.01).

1.3 Free rotation

Rotate the coupling by hand with the coupling spacer detached.

1.4 Coupling alignment

Check that the coupling has been properly aligned according to the instructions in Section "Installation and alignment of coupling".

WARNING

Before starting - all safety devices (e.g coupling guards) must always be correctly installed. For explosive areas, guards with non-sparking materials are to be used.

1.5 Lubrication

WARNING

A pump unit operating without proper lubrication will damage the bearings and cause a pump seizure. Use grease lubrication always when the pump is mounted in an inclined position.

Check the oil or grease used for the lubrication of both the pump and motor bearings before start-up. Condensation or ingress of dirt and water may occur if the pump unit is stored for a long time before installation and start-up.

1.6 Shaft seal and sealing water

Depending on the shaft seal fitting, check that the shaft seal's piping arrangement is properly installed and the sealing water system operates with suitable service of the shaft seal.

Table 1 Shaft seal fittings

Fitting				Liquid FR	FE	Q	BF	BN
PL01								
PL02				X				
PL03					X			
PL04							X	
ME01	MC01	MR01						
ME02	MC02	MR02		X				
ME03	MC03	MR03			X			
ME04	MC04	MR04				X		
ME06	MC06	MR06		X				
	MC20	MR20				X		
	MC21	MR21					X	
	MC22	MR22						X
DS01								
DS02				X				
DS03					X			

FR = Internal circulation

FE = External flushing liquid; (P_T + 7 psi, 0.8 USGPM) P_T + 0.05 MPa, 3 l/min

Q = Unpressurized external sealing liquid; (0.8 USGPM) 3 l/min

BF = Pressurized external flowing sealing liquid; (P_T + 7 psi (minimum), 0.8 USGPM) P_T + 0.05 MPa, 3 l/min

BN = Pressurized external non-flowing sealing liquid; (P_T + 21 psi (minimum)) P_T + 0.15 MPa

Pressure behind the impeller can be calculated according the following formulas.

Impellers with balancing holes

$p_T = p_0 - 0.725$ psi

Where p_T = pressure behind the impeller (psi)

p_0 = inlet pressure (psi)

Atmospheric pressure used as reference pressure = 0 psi

Impellers without balancing holes

$$p_T = p_0 + 151.48 \times 10^{-6} \varrho g H - 240.26 \times 10^{-9} \varrho n^2 \left[(d_2/2)^2 - (d_b/2)^2 \right]$$

$$- k \times 216.4 \times 10^{-9} \varrho n^2 \left[(d_b/2)^2 - (d_5/2)^2 \right] \text{psi}$$

Where p_T = pressure behind the impeller (psi)

p_0 = inlet pressure (psi)

ϱ = density of the liquid being pumped (lb/ft^3)

g = 32.174 (ft/s^2)

H = pump head at the operating point in question (ft)

n = rotating speed of the pump (rpm)

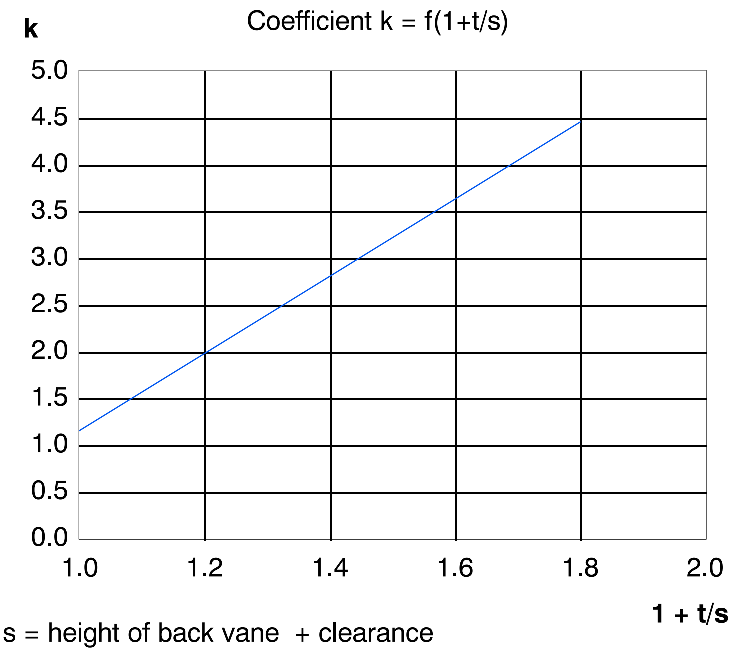
d_2 = impeller back plate diameter (ft)

d_b = impeller back vane diameter (ft)

d_5 = impeller hub diameter is in bearing unit no. 1 0.12 ft,
in bearing unit no. 2 0.18 ft, and in bearing unit no. 3 0.2 ft

k= figure 1

Atmospheric pressure used as reference pressure = 0 psi



s = height of back vane + clearance
t = height of back vane

Fig. 1

The flushing liquid and sealing liquid must fulfill the following quality requirements:

- maximum particle size (0.002 in) 50 µm
- maximum solid material content (0.00027 lb/in^3) 2 mg/l

2 Starting the pump

WARNING

The product is meant only for the purpose for which it is sold – never operate beyond the intended use described in these instructions.

WARNING

Before starting – Make sure that the pump is sufficiently filled with the pumped liquid.

WARNING

Rotating shaft has no safety guard. Do not touch shaft by hand, tool or anything else.

CAUTION

Observe immediately after start-up the instrumentation showing the discharge pressure. If the pressure is not quickly reached, stop the motor and check causes for the low pressure.

CAUTION

If it is necessary to adjust the amount of pumped liquid, do it by adjusting the discharge valve. Never use the suction valve for flow adjustment.

- Open the valves for sealing water if any, and adjust suitable pressure and flow.
- Check that there is abundant leakage at the gland packing. If there is no continuous leakage, slacken the stuffing box gland. If this does not help, remove the packings and re-pack the stuffing box less tight.
- Fill the pump so that at least the suction pipe and pump casing are filled with liquid. The pump must not run dry even momentarily.
- Check that the suction valve is fully open and discharge valve closed.
- Start the motor.
- Open the discharge valve gradually until the desired amount of liquid is reached.
- Check that the gland packing leakage is still abundant. If not, slacken the stuffing box gland immediately. If this does not help and the gland packing becomes hot, stop the pump and find out the reason for the disturbance. When the gland packing has been operating trouble-free for 10 minutes it may be tightened. Tighten it by turning the hexagonal nuts approx. 1/6 turns at a time at 5 - 10 minutes' intervals until the leakage is at least 30 - 80 drops a minute. While tightening, make sure that the stuffing box gland remains perpendicular to the shaft.

3 Controls during the first run

WARNING

Personal injuries may occur if personal protective equipment is not used when servicing the product. When pumping hazardous liquids, skin and eye protection are required.

WARNING

Rotating shaft has no safety guard. Do not touch shaft by hand, tool or anything else.

CAUTION

Do not operate the pump below the minimum recommended flow or with the discharge valve closed. Cavitation or recirculation can lead to a quick pump failure

By controlling the pump operation and output regularly, the possible need for service and repair can be anticipated. In this way, the pump efficiency is kept high, the process is trouble-free and the maintenance costs are low.

Control the temperature of the gland packing and maintain the leakage at 30 - 80 drops/minute by adjusting the stuffing box gland.

The flow and pressure of sealing water must be kept at the enclosed values given by the seal manufacturer.

Check the temperature and vibration of bearings through regular measurings. If one or the other increases, it may be a sign of incorrect lubrication or bearing damage. The measuring studs (SPM, M8 x 24) are in the bearing housing for controlling the bearings.

Also, any noises from the pump and its vibration have to be controlled and the reasons for unusual noises or vibration detected.

The condition of the coupling can be monitored with a stroboscope through the perforation in the coupling guard.

4 Shut-down procedure

- Close the discharge valve to prevent the pumped liquid from flowing back.
- Stop the motor.
- Close the suction valve if there is reason to doubt that the pumped liquid will flow out of the suction piping.
- Close the cooling and flushing liquid valves, if any.
- If the pump has a sealing liquid valve, it cannot be closed until the pump has been drained or until at least the pressure has been relieved from the pump.

During longer shut-downs, the pump must be checked every now and then. Turn the shaft manually a few times. If the pumped liquid congeals easily or the pump is exposed to freezing, drain the pump and suction piping for the shut-down period.

5 Controls after the first run

NOTE
Correct final alignment is essential for the proper functioning of the pump unit.

When the pump unit has run for a sufficient length of time to bring the pump and motor up to the normal operating temperature, check the coupling alignment according to Section ”Installation and alignment of coupling”.

With hot liquid pumps, check the tightness of the casing cover fixing screws. Adjust torque in accordance with the reference values.

With pumps equipped with gland packing, check proper leakage from the stuffing box.

With pumps equipped with mechanical seals, ensure that the flushing or cooling supplies are functioning adequately.

Make sure that the sealing water system is working properly.

Check that there is no overheating in the pump or motor bearings.

6 Trouble-shooting -operation

During the start-up period, problems are mostly caused by pump selection mistakes, poor process design, operational mistakes or foreign objects in the process.

During the long-term operation of a pump unit, problems are mostly caused by random failures, process changes or corrosion and wear.

Problems can normally be traced to either poor maintenance or exceeding the limitations for the intended use of the pump.

The following problem tracing analysis includes the most common malfunctions and their possible causes. If the pump does not function properly, it is important to trace the actual reasons, so that the repairs and required modifications can be done without delay. Tables 2 – 8.

Table 2 Symptom: Pump not delivering liquid

Probable cause:	Remedy:
Wrong direction of rotation	Change the direction of rotation acc. to the arrow sign on the bearing unit
Pump not adequately primed or a vapor lock in the suction pipe	Reprime the pump and suction piping
Difference between inlet pressure and vapor pressure too small	Check the suction piping arrangements
Air leakage in suction opening, suction piping or shaft seal	Check the suction piping. Readjust the shaft seal
Suction piping, suction valve or impeller clogged	Check the suction piping and the pump for any obstructions
Rotational speed too low	Check the speed requirements/limitations
Flow resistance of the piping higher than the head generated by the pump	Check resistancies and reduce losses
Unexpected air/gas content in the pumped liquid	Consult manufacturer for further instructions
Suction tank level low	Check the required inlet/suction head

Table 3 Symptom: Insufficient head

Probable cause:	Remedy:
Unexpected air/gas content in the pumped liquid	Consult manufacturer for further instructions
Unexpected viscosity of the pumped liquid	Consult manufacturer for further instructions
Suction piping, suction valve or impeller clogged	Check the suction piping and the pump for any obstructions
Rotational speed too low	Check the speed requirements/limitations
Wrong direction of rotation	Change the direction of rotation acc.to the arrow sign on the bearing unit
Flow resistance of the piping higher than the head generated by the pump	Check resistancies and reduce losses
Pressure containing pump parts worn/damaged/clogged	Check the pump and replace defective parts, if necessary
Suction tank level low	Check the required inlet/suction head

Table 4 Symptom: Insufficient (or irregular) flow

Probable cause:	Remedy:
Vapor lock in the suction pipel	Reprime the pump and suction piping
Suction head too high	Check that the suction valve is fully open and that the suction line is unobstructed
Difference between inlet pressure and vapor pressure too small	Check the suction piping arrangements
Air leakage in suction opening, suction piping or shaft seal	Check the suction piping and readjust the shaft seal
Unexpected air/gas content in the pumped liquid	Consult manufacturer for further instructions
Unexpected viscosity of the pumped liquid	Consult manufacturer for further instructions

Probable cause:	Remedy:
Suction piping, suction valve or impeller partially clogged	Check the suction piping and the pump for any obstructions
Rotational speed too low	Check the speed requirements/limitations
Flow resistance of the piping higher than the head generated by the pump	Check resistancies and reduce losses
Pressure containing pump parts worn/damaged/clogged	Check the pump and replace defective parts, if necessary

Table 5 Symptom: High power consumption

Probable cause:	Remedy:
Rotational speed too high	Check the speed requirements/limitations
Wrong direction of rotation	Change the direction of rotation acc.to the arrow sign on the bearing unit
Flow resistance of the piping much higher/lower than the head generated by the pump	Check the piping arrangements
Unexpected specific gravity of the pumped liquid	Consult manufacturer for further instructions
Unexpected viscosity of the pumped liquid	Consult manufacturer for further instructions
Pump and motor incorrectly aligned	Realign the pump and motor assembly, make sure there is no strain on the pump.
Crooked or eccentric shaft	Reassemble the pump and renew the shaft and bearings, if necessary
Rotating objects or pump parts chafing inside the pump	Reassemble the pump and check the clearances
Pressure containing pump parts worn/damaged/clogged	Check the pump and replace defective parts, if necessary
Mechanical tightness of pump components	Reassemble the pump and check the clearances

Table 6 Symptom: Excessive noise and/or vibration

Probable cause:	Remedy:
Difference between inlet pressure and vapor pressure too small (cavitation)	Check the suction piping arrangements
Unexpected air/gas content in the pumped liqud	Consult manufacturer for further instructions
Air leakage in suction opening, suction piping or shaft seal	Check the suction piping/readjust the shaft seal
Suction piping, suction valve or impeller clogged	Check the suction piping and the pump for any obstructions
Rotational speed too low	Check the speed requirements/limitations
Flow resistance of the piping higher than the head generated by the pump	Check resistancies and reduce losses
Pump functioning below the recommended minimum flow (cavitation)	Check the pumping system requirements
Pump foundation not rigid enough	Strengthen the foundation
Inadequate piping support exerting strain on the pump	Check the piping support requirements
Pump and motor incorrectly aligned	Realign the assembly, make sure there is no strain on the pump.
Crooked or eccentric shaft	Reassemble the pump and renew the shaft and bearings, if necessary
Rotating objects or pump parts chafing inside the pump	Reassemble the pump and check the clearances

Probable cause:	Remedy:
Pressure containing pump parts worn/damaged/clogged	Check the pump and replace defective parts, if necessary
Mechanical tightness of pump components	Reassemble the pump and check the clearances
Bearings worn or loose	Reassemble the pump and replace the bearings, if necessary
Inadequate or excessive lubrication	Check the pump for proper lubrication
Impeller damaged or out of balance	Reassemble the pump and replace the impeller, if necessary

Table 7 Symptom: Bearings wear rapidly

Probable cause:	Remedy:
Pump and motor incorrectly aligned	Realign the pump assembly, make sure there is no strain on the pump. Replace the bearings, if necessary.
Crooked or eccentric shaft	Reassemble the pump and straighten or replace the shaft
Rotating objects or pump parts chafing inside the pump	Reassemble the pump and check the clearances
Impeller damaged or out of balance	Reassemble the pump and replace the impeller, if necessary
Inadequate or excessive lubrication	Check the pump for proper lubrication
Badly installed and/or dirty bearings	Renew bearings, if necessary. Check the quality and amount of lubricant

Table 8 Symptom: Pump overheats/seizes

Probable cause:	Remedy:
Pump not adequately primed	Reprime the pump and suction piping
Difference between inlet pressure and vapor pressure too small	Check the suction piping arrangements. The pump may operate below the recommended minimum flow (cavitation)
Pump functioning below the recommended minimum flow (cavitation)	Check the pumping system requirements
Pump and motor incorrectly aligned	Realign the assembly, make sure there is no strain on the pump
Bearings worn	Reassemble the pump and replace the bearings, if necessary
Crooked or eccentric shaft	Reassemble the pump, straighten or renew the shaft
Impeller damaged or out of balance	Reassemble the pump and replace the impeller, if necessary
Rotating objects or pump parts chafing inside the pump	Reassemble the pump and check the clearances
Discharge valve closed	Open the discharge valve
Discharge valve clogged	Check the pipe and flush it if necessary

SULZER

Preventive maintenance

Version 03 > / 20040401 / Replaces 20020501 / en / **N15254**

Contents *Page*

1 General

N O T E
Preventive maintenance is also a relevant safety factor.

N O T E
If the pump performance does not fulfill the process requirements, the pump is to be disassembled and inspected. All worn parts should be changed to new genuine spare parts.

Regular and systematic preventive and predictive maintenance can extend the product lifetime and requires fewer repairs and spare parts. Monitoring of instrumentation and physical examinations are a vital part of today's quality maintenance. We recommend that the maintenance system includes a historical record kept for each pump, its condition and performance. This will help to prevent sudden failures and aid in case of possible fault tracing analyses. In the process industries, one process downtime caused by a pump normally costs much more than the price of the pump.

Preventive maintenance consists of the following actions:

- Bearing lubrication
- Temperature, noise, vibration monitoring and inspections
- Monitoring the discharge pressure, capacity and power demand
- Inspections regarding corrosion and wear
- Shaft seal monitoring
- Regular pump washdowns
- Monitoring the pump and pipings for leakage
- Quarterly checks of the tightness of critical fasteners, such as foundation screws and pump & motor fasteners onto the baseplate

General measuring instruments for pump operation are presented in Table 1.

Table 1 Measuring instruments

Fixed instruments:	Portable instruments:
Pressure gauges & indicators	Vibration analysers
Flow meters	Tachometers
Ammeters/wattmeters/ voltmeters	Thermometers
Speed indicators	Noise level indicators
Temperature detectors	Ultrasonic indicators (wall thickness)
Vibroswitches	
Any fixed or portable instruments may in themselves create a possible failure and require regular monitoring to ensure their correct functioning.	

2 Grease lubrication

All the grease-lubricated bearings have been lubricated before the shipment. The pump has one cylinder roller bearing unit and two single row angular contact ball bearings (O-system, Table 2).

Table 2 Pump bearings

Bearing unit	Impeller side	Coupling side
1	NUP 207 ECJ	3306AJ (5306AJ)
2	NUP 311 ECJ	2×7309 BECBM
3	NUP 317 ECJ	2×7315 BECBM
SKF designation. If other manufacturers are used, the corresponding bearing types are required.		

Amounts of lubricants and re-lubrication intervals are described in Table 3 and in Table 4 depending on the speed of rotation.

Table 3 Initial and re-lubrication (50 Hz speeds of rotation)

Bearing unit	Initial lubrication				Re-lubrication				Re-lubrication interval 1) (hours, bearing housing temperature ≤ +130 °F / +55 °C)			
	Impeller side		Coupling side		Impeller side		Coupling side		740 rpm	980 rpm	1480 rpm	2950 rpm
	(oz)	(g)	(oz)	(g)	(oz)	(g)	(oz)	(g)				
1	0.7	20	1.5	43	0.22	6	0.40	11	15000	13000	10000	5000
2	3.0	85	3.0	85	0.60	17	0.90	26	13000	11000	8500	3000
3	5.0	142	7.5	213	1.3	37	2.1	60	12000	9500	6500	-

1) Every 59 °F (15 °C) rise in the surface temperature shortens the lubrication interval to a half.

Table 4 Initial and re-lubrication (60 Hz speeds of rotation)

Bearing unit	Initial lubrication				Re-lubrication				Re-lubrication interval 1) (hours, bearing housing temperature ≤ +130 °F / +55 °C)			
	Impeller side		**Coupling side**		**Impeller side**		**Coupling side**		**890 rpm**	**1180 rpm**	**1780 rpm**	**3540 rpm**
	(oz)	(g)	(oz)	(g)	(oz)	(g)	(oz)	(g)				
1	0.7	20	1.5	43	0.22	6	0.40	11	14000	11000	9000	4000
2	3.0	85	3.0	85	0.60	17	0.90	26	12000	9500	7000	2000
3	5.0	142	7.5	213	1.3	37	2.1	60	10000	8000	4500	–

1) Every 59 °F (15 °C) rise in the surface temperature shortens the lubrication interval to a half.

2.1 Grease grades

CAUTION

Never mix different grease grades (consistency, thickeners). The mixed grease becomes softer and does not lubricate the bearings properly.

NOTE

All greasing equipment and fittings used must be clean to prevent any impurities from entering the bearing housing.

NOTE

The surface temperature of the bearing unit can temporarily rise after regreasing due to an excess amount of grease.

For normal conditions when the bearing housing surface temperature is below (+175 °F) +80 °C, we recommend lithium or lithium-calcium-based mineral greases for roller bearings, such as:

- Esso Beacon 2
- Shell Alvania EP2
- SKF LGMT2
- Klüber Centoplex EP2

The first re-lubrication should be done before the initial commissioning of the pump.

If the bearings run hotter and the surface temperatures are above (+175 °F) +80 °C, we recommend the use of the following special greases:

- Esso Unirex N3
- SKF LGHT3
- Shell Limona LX1
- Klüber Staburax NBU 8 EP

These special greases can also be used with surface temperatures below +175 °F (+80 °C).

Always consult the pump manufacturer about the use of any special greases (not mentioned in these instructions).

3 *Oil lubrication*

CAUTION
For delivery, the bearing housing of the pump has been emptied of oil. Remember to refill it or / and connect oil mist lubrication before starting.

For lubrication, use only high-quality mineral oils, the viscosity of which is ISO VG 46.

- Esso Teresso 46
- Shell Tellus Oil S46
- Mobil DTE Oil Medium
- Neste Paine 46
- Klüber Crucolan 46
- Tebo Larita Oil 46

Viscosity of oil at the operating temperature must not be below 12 cSt (65 SSU). The operating temperature is ca (27 °F) 15 °C higher than the surface temperature of the bearing housing.

3.1 Oil bath lubrication

First oil filling

Without using the constant level oiler

Unscrew the venting device (672.01) and add oil up to the middle of the sight glass (642.01), Fig. 1. When pump is running oil level in the larger sight glass can be little variable. With lower speed oil level can go little bit lower and higher speed go little up (air is mixing into oil). Screw the venting device (672.01) back in place. See the oil volumes in Table 6.

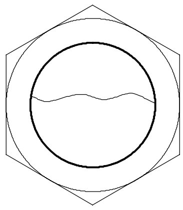


Fig. 1

With using the constant level oiler

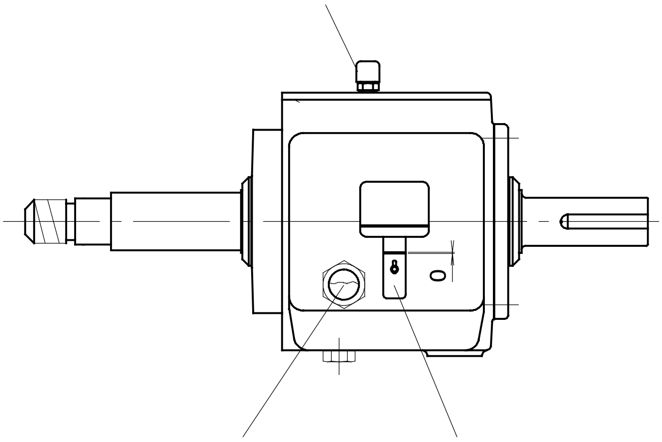


Fig. 2

1 Install the constant level oiler (638.01) in the bearing unit.

2 Adjust the constant level oiler (638.01) to the correct height (0 mm) and tighten the locking screw.

3 Unscrew the venting device (672.01), add oil up to the middle of the sight glass (642.01) and screw the venting device (672.01) back in place.

4 Undo the glass cup of the constant level oiler (638.01) and fill it with oil, and place the glass cup of the constant level oiler (638.01) back in place.

Oil change

After commissioning, oil should be changed for the first time after about 100 hours of operation and thereafter according to Table 5 and more often if the operating conditions cause contamination or change in other properties of the oil used.

Table 5 ***Oil changes***

Bearing housing surface temperature	Oil change interval
65 °C (150 °F)	1 year
75 °C (170 °F)	6 months

Table 6 Oil volumes

Bearing unit	Oil volume	
	(pint)	(l)
1	0.75	0.35
2	2.4	1.1
3	4.7	2.2

3.2 Pure oil mist and purge oil mist lubrication

The oil mist system must be sized to provide, as a minimum, a rate of mist containing 0.018 in^3 (0.01 fl oz or 0.3 ml) of oil per hour per bearing-inch (B.I.). Oil mist system pressure depends on the particular application (number of equipment in the system, type of application fittings used, etc.). Follow the oil mist system manufacturer's instructions for the installation, operation and maintenance of the oil mist system.

B.I. values for each bearing unit are listed in the following table. For pure mist system the values can be used as such. For purge mist system, multiply values by 0.25.

In purge oil mist system, follow also the instructions as given in section ”Oil bath lubrication”.

Table 7 Bearing-Inch values for CPT bearing units

Bearing unit	Bearing	Bearing-Inch (B.I.)
1	Radial	1.4
	Thrust	2.4
	Total	3.8
2	Radial	2.2
	Thrust	3.6
	Total	5.8
3	Radial	3.4
	Thrust	6.0
	Total	9.4

4 Temperatures

During operation, the following surface temperatures are to be observed regularly:

- volute casing (102.01)
- bearing housing (330.01)
- shaft seal, measured on the casing cover (161.01)
- motor (800.01)

The reasons for any deviations in temperatures are to be checked immediately to prevent further and more serious damage.

5 Noise and vibration analysis

A regular follow-up of the pump noise and vibration gives a good view regarding the condition and wear of bearings and also other wearing parts of the pump. This enables timely predictive maintenance routines and reduces the potential for unexpected shut-downs. Admissible vibration severity values are presented in Section ”Safety instructions/Balance and vibration”.

6 Discharge pressure

A regular control of the pressure generated by the pump, the rated flow and the power need of the drive unit gives a good view regarding the condition and wear of the hydraulic parts of the pump. The follow-up enables such preventive maintenance actions as clearance adjustments or parts renewals to be scheduled accordingly.

7 Corrosion and wear

When the pumps are operating under corrosive and/or abrasive conditions, a regular follow-up of wall thicknesses in the casing and casing cover is necessary. When the wall thickness has worn more than the permitted corrosion allowance of (0.12 in) 3 mm, the mechanical durability (pressure limits) stated in these instructions is no longer guaranteed.

8 Shaft seal monitoring

CAUTION
The dry running of mechanical seals will damage the sliding surfaces and cause leakage of pumped liquid.

8.1 Gland packing

Gland-packed pumps must be checked regularly to ensure that there is a slight leakage from the gland. An excessively tight gland causes wear to the shaft sleeve and increased power demand. Refer to the instructions in Section ”Operation/Controls during the first run”.

8.2 Mechanical seal

Mechanical seals are normally installed and adjusted at the factory before the delivery. The general principle is that the mechanical seal does not have visible leakage. The lifetime of a mechanical seal depends on the cleanliness and lubricating properties of the pumped liquid and the sealing liquid. If the mechanical seal leaks, stop the pump and replace the mechanical seal.

8.3 Dynamic seal

The expeller (604.01) design of the dynamic seal prevents the leakage of pumped liquid through the stuffing box during operation. During shut-down, the leakage is prevented by the static seal design (435.01).

9 Pump washdown

The pump is designed to prevent external liquids from entering the bearing unit. However, direct spraying of high-pressure water to the labyrinth rings (423.01) must be avoided.

10 Maintenance of shaft seals

WARNING

Always stop the motor before any of the following maintenance actions to the pump. Make sure that the motor cannot be started by any means accidentally during the repairs.

WARNING

Always drain the pump before dissassembling the shaft seal.When pumping hazardous liquids, make sure that there is no trapped liquid remaining in pump parts.

WARNING

Never use gland packing material containing asbestos. It may cause a health hazard.

10.1Gland packing

- Remove the used gland packing from the stuffing box housing by using a flexible extraction tool (Fig. 3). Clean the stuffing box housing and open any clogged sealing liquid holes.

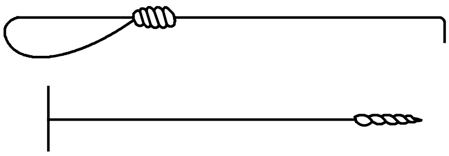


Fig. 3

- If there are scratches or wearing marks on the shaft wearing sleeve (part 524.01 in Table 8) or in the stuffing box housing, replace the damaged parts.
- We recommend the use of precompressed gland packings. However, if you need to cut the packings from a sealing band, proceed as follows: turn four rounds of the sealing band around a wooden pattern having the same thickness as the shaft wearing sleeve (part 524.01 in Table 7) and use a sharp knife to cut the packing rings straight and axially without overdimensioning or underdimensioning, Fig. 4. The dimensions of the stuffing box housing and the total length of the band to be cut without working allowances are given in Table 8.

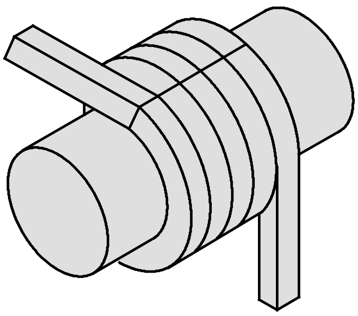
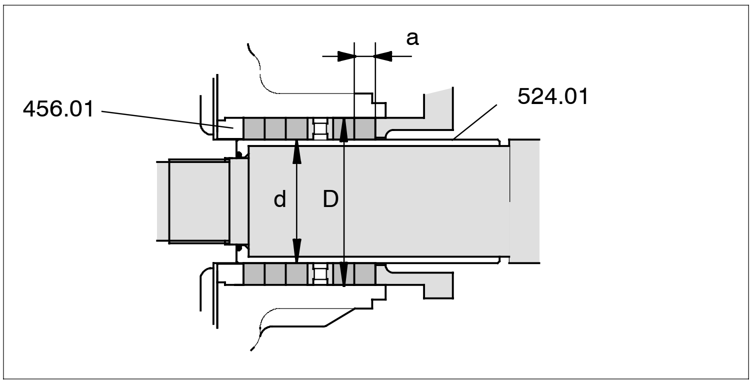


Fig. 4

- When packing new packing rings, be very precise, and keep the parts clean.
- Lubricate the shaft sleeve and packing rings lightly with oil.
- Push the first packing ring tightly against the neck bush (456.01). The ends of the rings must be exactly against each other.
- The second ring is placed against the first one so that the joints are at 180° angle to each other, Fig. 5.

- The third packing ring is placed against the second one so that the joints are at 180° angle to each other. Fig. 5.
- Next put the lantern ring or plate into the seal chamber.
- Fit also the last two rings with the joints at 180° angle to each other.
- After all the packing rings and the lantern ring have been fitted, tighten the nuts of the stuffing box gland by hand.
- The shaft seal is taken into use according to Section ”Operation/Controls during the first run”.

Table 8 ***Dimensioning of stuffing box***



Bearing unit	**Stuffing box ∅d x ∅D x a**		**Total lenght of the packing ring**	
	(in)	(mm)	(in)	(mm)
1	1.375 x 2 x 0.31	35 x 51 x 8	2.8	71
2	2.25 x 3 x 0.38	57 x 76 x 10	4.3	109
3	2.5 x 3.38 x 0.44	64 x 86 x 11	4.8	122

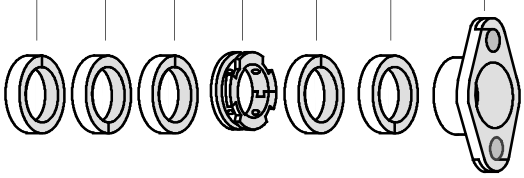


Fig. 5

10.2 Mechanical seal

Mechanical seals do not normally require any preventive maintenance actions during their operation. If any problems occur, the whole seal package is normally renewed.

10.3 Dynamic seal

Dynamic seals do not normally require any preventive maintenance actions. During the first years of operation, the static seal (435.01) can yet wear so much that some leakage can occur during stoppages. The static seal is again functional when sliding the thrust ring (475.01) towards the volute casing so long that the leakage stops. The thrust ring must always be secured with the grub screws (904.01) during operation. This adjustment can be done several times during the lifetime of the static seal. The wear allowance of the static seal is about half of its thickness. If the seal has worn more or otherwise damaged, it always has to be replaced with a new one according to Section ”Corrective maintenance”.

11 Clearance of open impeller

Exchange unit is preadjusted near to operating clearance. Preadjusting values can be readed from table 8. Fig. 6.

Table 9

Bearing unit	**Distance A**	
	(in)	(mm)
CPT 1	5.142	130.6
CPT 2	6.126 *) 6.750	155.6 *) 171.5
CPT 3	9.094	231.0

*) Retrofit type Durco MkII / III

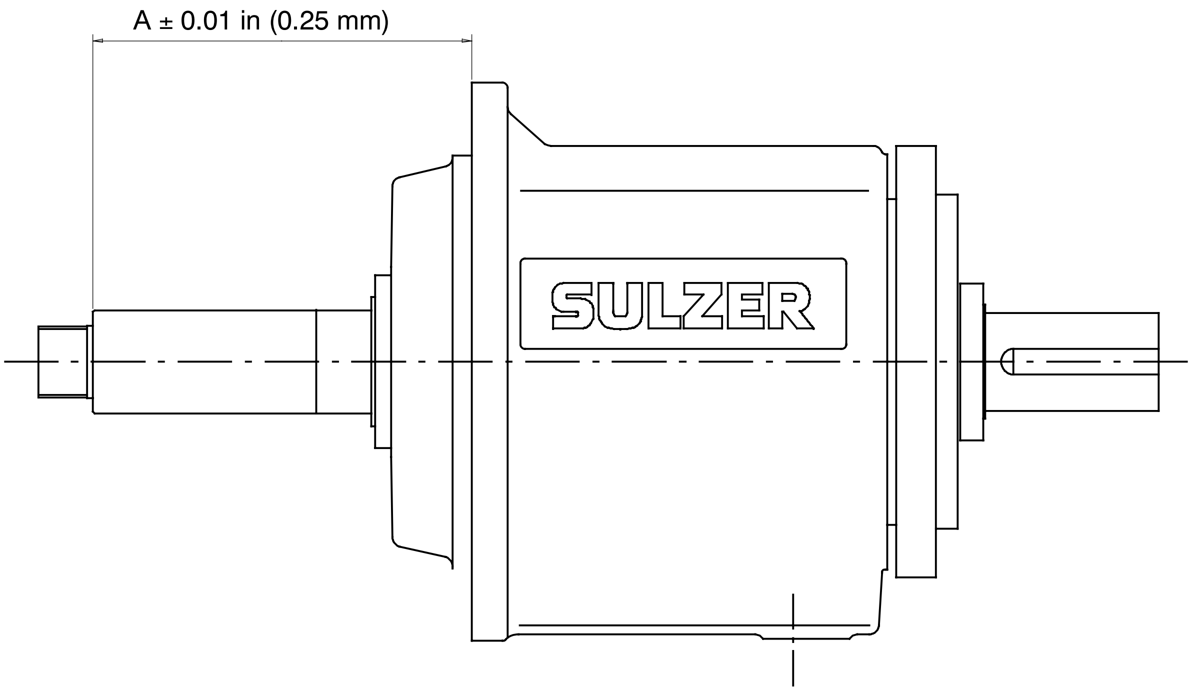


Fig. 6

WARNING

Always stop the motor before any of the following maintenance actions to the pump. Make sure that the motor cannot by any means be started accidentally during the repairs.

- Loosen the hexagonal screws (901.05) of bearing carrier (382.01).
- Turn bearing carrier clockwise until impeller (230.01) touches the casing (102.01). With Retrofit type Durco MkII / III this can be ignored.
- Turn bearing carrier (382 .01) CCW halfway between two notches to get 0.010 inches (0.3 mm)front clearance. When hexagonal screws (901.05) are tightened, the play in bearing carrier thread gives additional 0.005 inches (0.1 mm) front clearnce. If pumped liquid is over 250 °F, thicker casing gasket (400.01) is used and clearance before tightening screws (901.05) is set to 0.020 inches (0.5 mm) to get total 0.025 inches (0.6 mm) front clearance.
- With Retrofit type Durco MkII / III turn bearing carrier (382.01) counter clockwise until impeller (230.01) back vanes touches the casing cover (161.01 / 161.02). Turn bearing carrier clockwise from one notch to next. In bearing unit 2 there are four notches at the outer sphere of the bearing carrier. Turning the bearing carrier between two notches makes impeller back clearance 0.02 inches (0.5 mm) but turn only 70% of that to get 0.014 inches (0.35 mm) back clearance.

- In bearing units 1 and 2 there are four notches and in bearing unit 3 there are six notches at the outer sphere of the bearing carrier. Turning the bearing carrier between two notches makes impeller front clearance increase 0.02 inches (0.5 mm).
- After the adjustment tighten the hexagonal screws (901.05). Bearing carrier must not be turned during tightening. All three hexagonal screws (901.05) must be tightened as much. The tightening must be performed in stages. First all the screws will be tightened to half of the recommended moment and then to a full moment. See Section “Installation” table 1.
- By turning the coupling by hand, check that the pump can rotate freely.

If the shaft is adjusted, the cartridge shaft seal must also be adjusted again, except John Crane seal type SE1, SE2 and SEW have the adjustment allowances shown in table 10. Otherwise see the seal manufacturer’s instructions.

Table 10 John Crane SE1, SE2 and SEW adjustment allowances

Bearing unit	**Adjustment allowances**	
	(in)	(mm)
1	−0.059 ... +0.098	−1.5 ... +2.5
2	−0.059 ... +0.138	−1.5 ... +3.5
3	−0.059 ... +0.197	−1.5 ... +5.0

SULZER

Corrective maintenance

Version 03 > / 20080601 / Replaces 20051101 / en / **N15255**

Contents *Page*

1 Safety procedures before any repairs

WARNING

When pumping hazardous liquids, secure that there is no trapped liquid remaining in pump parts.

Pumps which convey hazardous media must be carefully decontaminated before any repairs. Skin and eye protection are required during decontamination. Precautions are needed for personal or environmental safety.

Some of the disassembled parts and assemblies are heavy, unstable and due to design requirements they contain sharp edges (e.g. impeller, casing cover). Use proper hoistings and supports to prevent personal injury.

2 Necessary equipment / tools

2.1 Normally available working tools:

- Hoisting accessories. Note the safety requirements!
- Wrenches for hexagonal screws
  sizes (in): 1/2, 9/16, 3/4, 7/8, 15/16, 1 1/8
- Allen wrenches for socket head screws
  sizes (in): 5/32, 3/16
- Torque wrenches for
  moments (lbft): 20, 40, 95, 185, 310, 590
  moments (Nm): 30, 50, 130, 250, 420, 800
  - for hexagonal, sizes (in): 3/4, 15/16, 1 1/8
- Hooked wrenches, sizes (SKF): HN6, HN9, HN15, HN22, HN27, 718911
- Extractors
- Bearing heater
- Dial indicators
- Cleaning agents & equipment
- Lubricating agents & equipment

2.2 Special tools

- Pipe punch series for roller bearings. Fig. 9.

3 Disassembly

N O T E
Ensure that all eventual spare parts are available before the disassembly.

3.1 Preliminaries

1 Close the discharge valve.

2 Stop the motor. Make sure that the motor cannot be started by any means during the repair.

3 Close the suction valve.

4 Drain the pump carefully. For this, use the hexagonal plug (903.01) potentially situated at the bottom of the volute casing (102.01), Fig. 1.

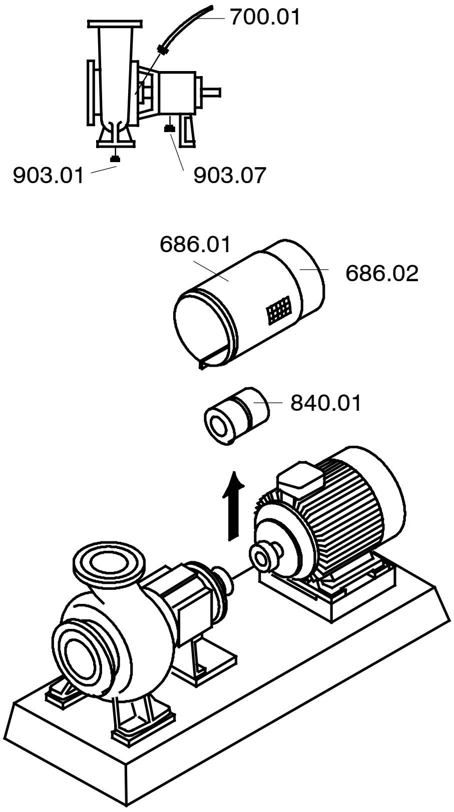


Fig. 1

5 Detach the pipes (700.01) in connection with the shaft seal, if applicable.

6 Remove the guard jacket (686.01) and coupling (840.01) spacer.

7 Drain oil from an oil-lubricated bearing housing by unscrewing the hexagonal plug (903.07).

8 Remove the adapter guard (683.01).

3.2 Detachment of exchange unit

1 Unscrew the hexagonal screws (901.01) of the adapter (344.01) and the hexagonal screws (901.09) of the support foot from the baseplate (890.01), Fig. 2.

2 Suspend the exchange unit by a hoist at the maintenance opening of the adapter or underneath the adapter.

3 Pull out the exchange unit by using the hexagonal screws (901.01).

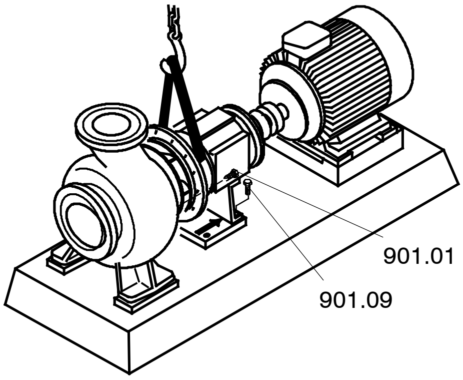


Fig. 2

3.3 Detachment of impeller

1. Fasten the exchange unit firmly to a vice. Fig. 3.
2. Prevent the shaft (210.01) from rotating at the coupling (840.01) end.
3. Detach the impeller by turning it counter-clockwise. Push e.g. pieces of wood between the impeller vanes to ease the detachment. Never use metal bars or the like, because they might damage the impeller vanes. Fig. 4.

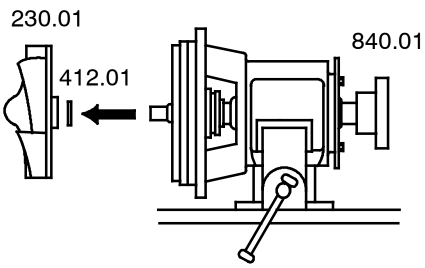


Fig. 3

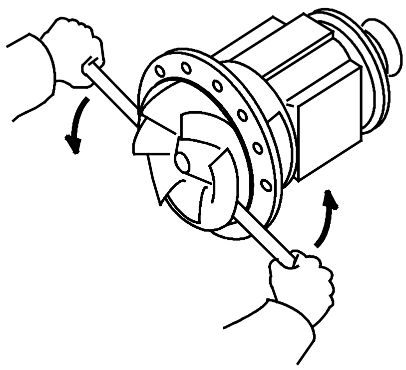


Fig. 4

3.4 Detachment of shaft seal

Refer to the sectional drawing of the shaft seal when reading through these instructions.

Gland packing, fittings PL01, PL02, PL03 and PL04

1 Unscrew the hexagonal screws (901.02) of the casing cover (161.01).

2 By using the said screws as extractors, draw the casing cover out of the adapter (344.01). All parts belonging to the gland packing, except the shaft wearing sleeve (524.01), will stay in the casing cover.

3 Unscrew the hexagonal nuts (920.02) and remove the two-piece stuffing box gland (452.01). The neck bush (456.01), gland packings (461.01) and lantern ring (458.01) can now be drawn out of the casing cover.

4 Detach the shaft wearing sleeve from the shaft with an extractor.

5 Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

Mechanical seal, fittings ME01, ME02, ME03, ME04 and ME06

1 Unscrew the hexagonal nuts (920.02).

2 Unscrew the hexagonal screws (901.02).

3 By using the said screws as extractors, draw the casing cover (161.01) out of the adapter (344.01). All parts belonging to the mechanical seal (433.01) will remain on the shaft.

4 The mechanical seal can now be removed from the shaft and dismantled according to the seal manufacturer’s instructions.

5 Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

Mechanical seal, fittings MC01, MC02, MC03, MC04, MC06, MC20, MC21 and MC22

1 Unscrew the hexagonal nuts (920.02).

2 Unscrew the hexagonal screws (901.02).

3 By using the said screws as extractors, draw the casing cover (161.01) out of the adapter (344.01). All parts belonging to the mechanical seal (433.01) will remain on the shaft.

4 The mechanical seal can now be removed from the shaft and from the casing cover and dismantled according to the seal manufacturer’s instructions.

5 Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

Mechanical seal, fittings MR01, MR02, MR03, MR04 and MR06

1 Unscrew the hexagonal nuts (920.02).

2 Unscrew the hexagonal screws (901.02).

3 By using the said screws as extractors, draw the casing cover (161.01) out of the adapter (344.01). All parts belonging to the mechanical seal (433.01) will remain on the shaft.

4 The mechanical seal can now be removed from the shaft and dismantled according to the seal manufacturer’s instructions.

5 Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

Mechanical seal, fittings MR20, MR21 and MR22

1. Unscrew the hexagonal nuts (920.02).
2. Unscrew the hexagonal screws (901.02).
3. By using the said screws as extractors, draw the casing cover (161.01) out of the adapter (344.01). Most of the mechanical seal (433.01) together with integrated parts will remain on the shaft. Part of the seal will remain on the casing cover.
4. The mechanical seal can now be removed from the shaft and dismantled according to the seal manufacturer's instructions.
5. Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

Dynamic seal, fittings DS01, DS02 and DS03

1. Unscrew the hexagonal screws (901.02).
2. Remove the stuffing box cover (161.02) from the adapter (344.01) by using e.g. hexagonal screws for ejection. The other parts of the dynamic seal, except for the thrust ring (475.01), come off simultaneously in sizes 12 and 32. In other sizes, these parts either come off at the same time or stay on the shaft depending on the friction between the parts.

NOTE
With the size 32 excluded, these parts are not attached to each other in any way so take care not to drop them.

3. Open the hexagonal screws (901.07) in size 32. Remove the stuffing box housing (451.01) and the expeller (604.01) from the stuffing box cover, or pull the expeller and stuffing box housing out of the shaft if they did not come off during stage 2.
4. The cover plate for seal (471.02) and the static seal (435.01) can be detached by unscrewing the hexagonal screws (901.08).
5. Unscrew the grub screws (904.01) and detach the thrust ring (475.01) from the shaft.
6. Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

3.5 Disassembly of bearing unit

NOTE
Always renew the bearings once they have been removed from the shaft.

WARNING

Personal injuries may occur if personal protective equipment are not used when removing two piece lubrication ring (644.01) from the shaft.

1 Fasten the bearing unit firmly to a vice at the bearing housing (330.01). Fig. 5.
2 Detach the coupling half (840.01) using an extractor.
3 Unscrew the hexagonal screws (901.09) with which the guard end is fixed on the bearing carrier (382.01). Remove the guard end (685.01).
4 Loosen the hexagonal screws (901.05) which tighten the bearing carrier. Fig. 6.
5 Rotate bearing carrier counterclockwise until shaft assembly can be taken away from bearing housing (330.01). Fig. 6.

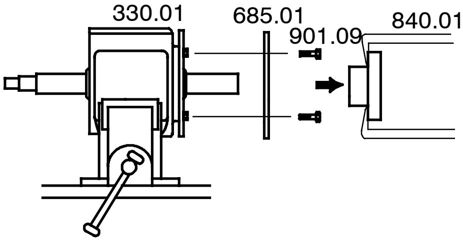


Fig. 5

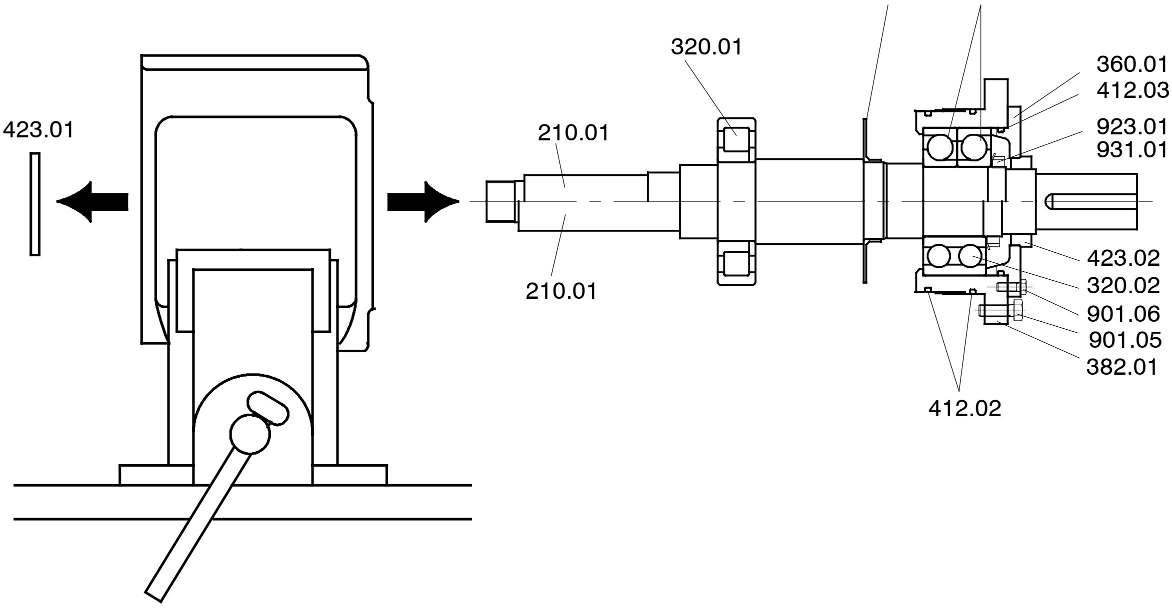


Fig. 6

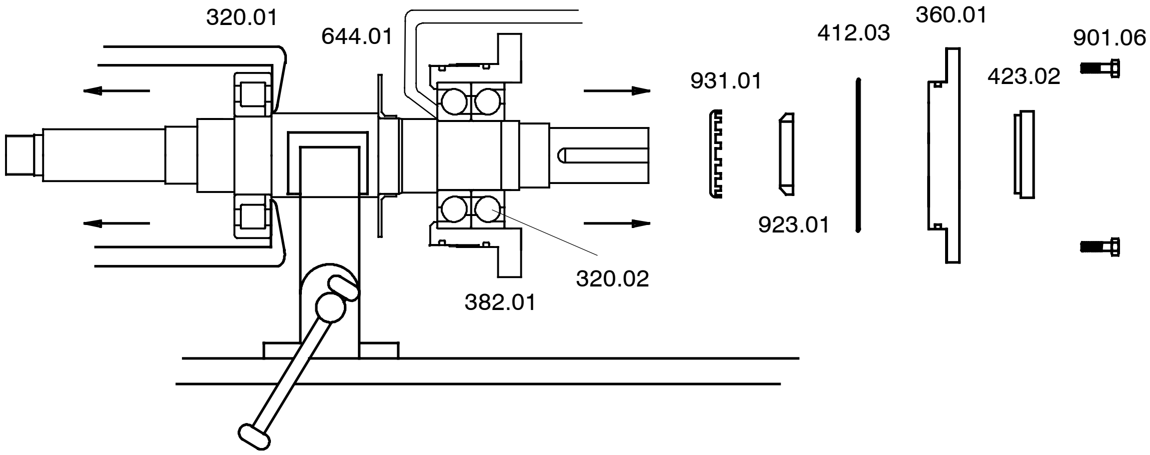


Fig. 7

6 Fasten the shaft with its bearings, bearing carrier and bearing cover to a vice from the center of shaft. Fig. 7. Use soft sheets between the vice clamp jaws to avoid damaging of shaft.

7 Remove radial bearing (320.01) from the shaft with an extractor.

8 Unscrew the hexagonal screws (901.06). Draw the bearing cover (360.01) out by using the hexagonal screws (901.06). As a result the labyrinth ring (423.02) can also be removed. Fig. 7.

9 Remove the bearing nut (923.01) and lockwasher (931.01).

10 Remove thrust bearings (320.02) and bearing carrier (382.01) from the shaft with an extractor. Fig. 7.

11 Slide bearing carrier (382.01) over the thrust bearings.

4 Reassembly

4.1 Preliminaries

- Clean all gasket surfaces and fittings from rust and layers.
- Inspect for unusual erosion, pitting and wear in parts.
- Inspect keyways and bores for damage.
- Inspect the pump and baseplate for cuts and cracks.

4.2 Reassembly of bearing unit

N O T E
It is absolutely necessary to place the bearings correctly according to the O-system (so called Back-To-Back Design).

WARNING

Personal injuries may occur if personal protective equipment are not used when installing two piece lubrication ring (644.01) on the shaft.

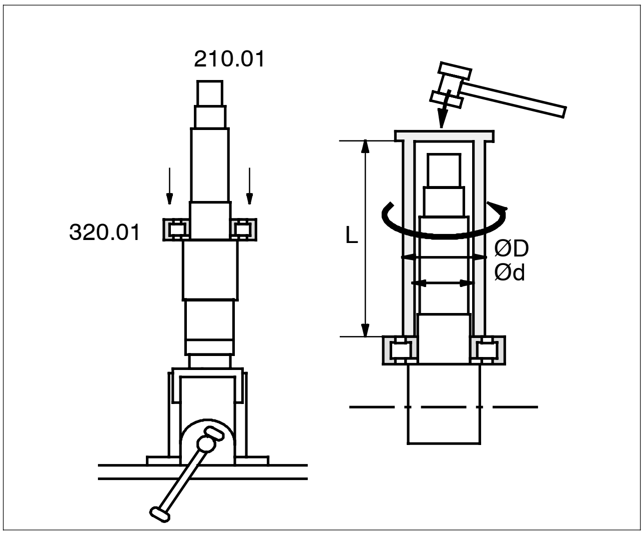
1 Check the shaft (210.01) with its shaft wearing sleeve (524.01) in a span. Their maximum radial difference is (0.002 in) 0.05 mm.

2 Fasten the shaft to a vice with the impeller end of the shaft upwards. Use soft sheets between the vice clamp jaws to avoid shaft damages. Heat the cylinder roller bearing (320.01) to ca (+212 °F) +100 °C and push it onto the shaft. Remember to place the spacer ring of the bearing on the shaft shoulder side. Fig. 9.

3 Let the bearing cool down. Then tap it tightly by the inner ring against the shoulder using a pipe punch. Rotate the pipe punch between the blows.

4 Turn the shaft so that the coupling side is upwards, fasten it to a vice. Install two piece lubrication ring (644.01) to its groove to the shaft (oil lubricated bearing unit) and bearing carrier (382.01) with its o-rings (412.02) in the grooves on the shaft.

5 Heat the two angular contact ball bearings (320.02) to approx. (+212 °F) +100 °C and push them onto the shaft. Let the bearings cool down.



Bearing unit	Ød		ØD		L_{min}	
	(in)	(mm)	(in)	(mm)	(in)	(mm)
1	1.45	37	2.00	50	8.0	203
2	2.25	57	2.80	71	9.0	229
3	3.45	87	4.60	117	12.0	305

Fig. 9

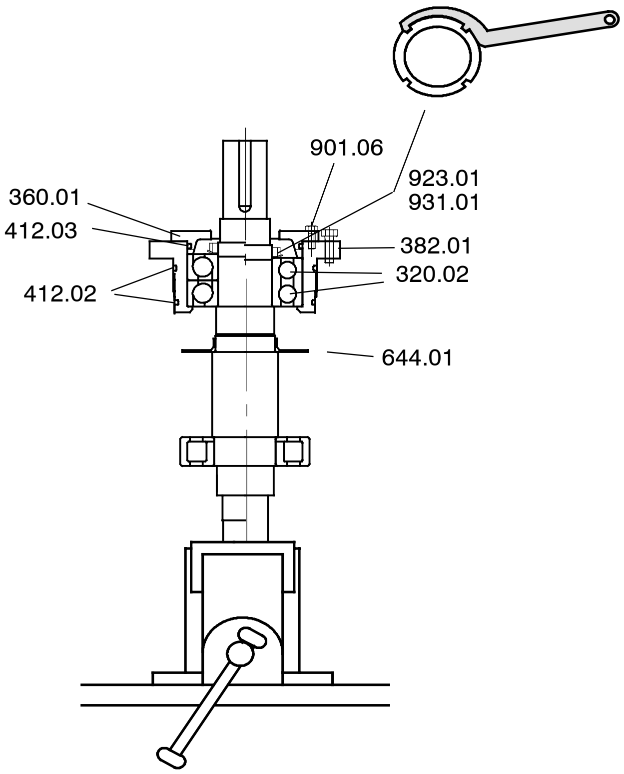


Fig. 10

6 Place the lockwasher (931.01) on the shaft.

7 Tighten the angular contact ball bearings by means of the bearing nut (923.01) tightly against the shaft shoulder, use a suitable hooked wrench.

8 Bend the lockwasher tooth into the bearing nut slots.

9 Set the o-ring (412.03) into the groove in the bearing cover (360.01). Grease the o-ring slightly.

10 Raise bearing carrier (382.01) on the thrust bearings (320.02) and fix bearing cover cautiously into its place by tightening fixing screws (901.06). Fig. 10.

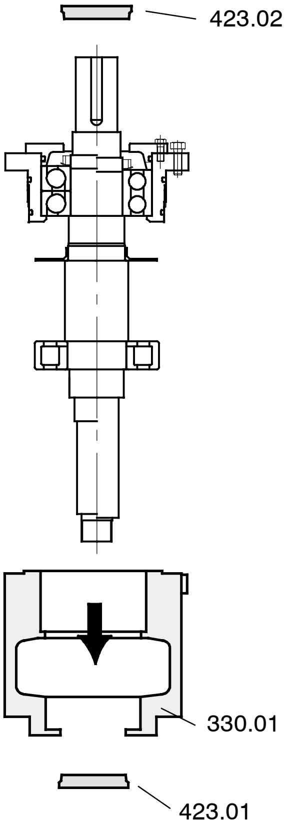


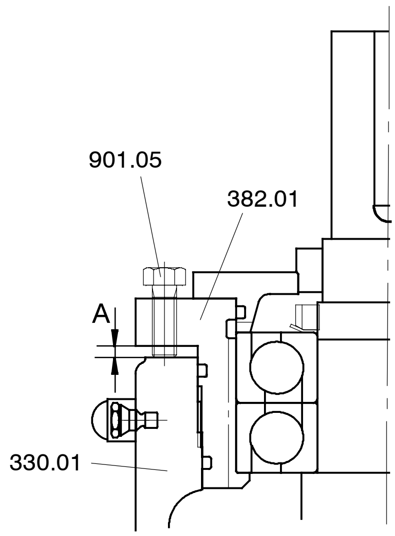
Fig. 11

11 Tighten the bearing housing (330.01) vertically to the vice with the coupling side upwards. Fig. 11.

12 Grease the o-rings (412.02) slightly and lower the shaft assembly carefully into the bearing housing.

13 Rotate from the bearing carrier to clockwise to set the shaft assembly into the bearing housing. Fig. 12. See also Fig. 6 in section Preventive maintenance.

14 Tap the labyrinth rings (423.01 and 423.02) into the bearing housing (330.01) and bearing cover (360.01) with a soft hammer.



A = Pre-setting distance for shaft assembly.

Bearing unit	A $^{0}_{-0.04}$ (in)	A $^{0}_{-1}$ (mm)
1	0.14	3.5
2	0.18	4.5
3	0.24	6

Fig. 12

15 Lock the shaft axially to bearing housing with screws (901.05).

4.3 Assembly of shaft seal

Refer to the sectional drawing of the shaft seal when reading through these instructions.

Gland packing, fittings PL01, PL02, PL03 and PL04

1 Fix the adapter (344.01) to the bearing housing (330.01) with the hexagonal screws (901.03).

2 Place the casing cover (161.01) on a horizontal surface with the sealing cavity upwards.

3 Place the neck bush (456.01) to the bottom of the sealing cavity.

4 Put the shaft wearing sleeve (524.01) in an upright position to the middle of the sealing cavity.

5 Insert the first two gland packings (461.01), the lantern ring (458.01), the other two gland packings and the two-piece stuffing box gland (452.01). Tighten the hexagonal nuts (920.02) by hand.

6 Push the casing cover with gland packing parts onto the shaft. Check that the shaft wearing sleeve is placed towards the shaft shoulder.

7 Attach the casing cover to the adapter with hexagonal screws (901.02).

Mechanical seal, fittings ME01, ME02, ME03 and ME06, v-ring

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the mechanical seal (433.01) parts into the cover plate for seal (471.01) and onto the shaft wearing sleeve (524.01) according to assembly distance A from table 11 and the seal manufacturer's instructions.

Table 11

Assembly distance A in (mm)				
Bearing unit	John Crane T1	John Crane T8-1T	AES P04T	Flowserve RO
1	0.53 (13.4)	1.22 (30.9)	1.08 (27.4)	0.63 (16.3)
2	0.54 (13.6)	1.60 (40.6)	1.20 (30.6)	1.22 (31.0)
3	0.63 (16.0)	2.00 (50.9)	1.18 (29.9)	1.52 (38.7)

3 Place the gasket (400.02) in the cover plate for seal (471.01). Fix the cover plate for seal on the casing cover (161.01). Tighten the hexagonal nuts (920.02).

4 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

5 Push the shaft wearing sleeve (524.01) together with the incorporated parts onto the shaft against the shoulder.

Mechanical seal, fitting ME04, v-ring

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the mechanical seal (433.01) parts into the cover plate for the seal (471.01) and onto the shaft wearing sleeve (524.01) according to assembly distance A from table 11 and the seal manufacturer's instructions. Make sure that the cylinder pin (562.02) is in the proper position.

3 Place the gasket (400.02) in the cover plate for seal (471.01). Fix the cover plate for seal on the casing cover (161.01). Tighten the hexagonal nuts (920.02).

4 Push the plate (550.01) onto the shaft. Make sure that the rubber lip on the outer edge of the plate comes to the bearing side. Fig. 13.

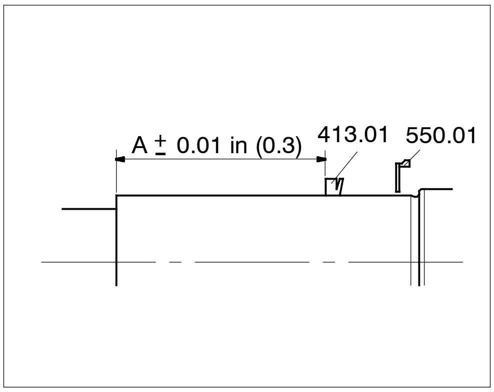


Fig. 13

5 Push the v-ring (413.01) onto the shaft. The distance of the v-ring from the shaft shoulder is shown in Table 12. The use of an installation sleeve helps to get the v-ring perpendicularly with respect to the shaft. Grease the lip of the v-ring slightly.

Table 12 ***V-ring position, fitting ME04***

Bearing unit	Seal size ∅		Distance A	
	mm	in	mm	in
1	35	1.375	90.6	3.57
2	54	2.125	113.2	4.46
3	64	2.500	121.7	4.80

6 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

7 Push the shaft wearing sleeve (524.01) together with the incorporated parts onto the shaft against the shoulder.

8 Continue installation according to item ”Installation of impeller”.

9 After all other parts have been installed, push the plate (550.01) into the groove in the cover plate for seal (471.01) so that the entire rubber lip settles straight in the groove. Fig. 14. To make sure that the lip is correctly situated, use a tool shown in Fig. 15. Place the tip of the tool into the groove and turn around the cover plate for seal.

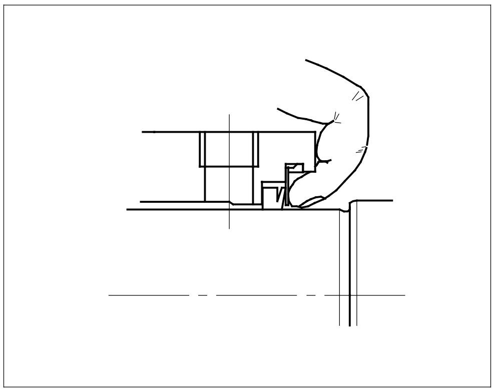


Fig. 14

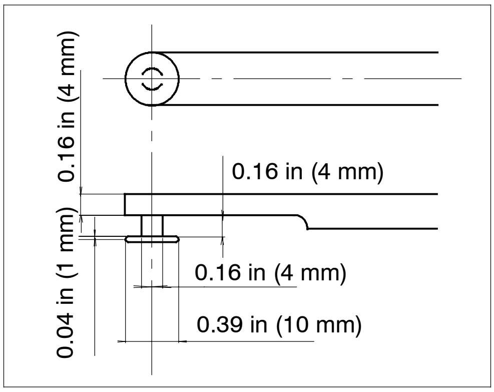


Fig. 15

Mechanical seal, fittings ME01, ME02, ME03, ME04 and ME06, throttling bush

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Heat the cover plate for seal (471.01) to approx. +212 °F (100 °C) and push the throttling bush into the cover plate for seal.

3 Mount the mechanical seal (433.01) parts into the cover plate for seal (471.01) and onto the shaft wearing sleeve (524.01) according to assembly distance A from table 13 and the seal manufacturer's instructions.

Table 13

Assembly distance A in (mm)				
Bearing unit	John Crane T1	John Crane T8-1T	AES P04T	Flowserve RO
1	0.53 (13.4)	1.22 (30.9)	1.08 (27.4)	0.64 (16.3)
2	0.54 (13.6)	1.60 (40.6)	1.20 (30.6)	1.22 (31.0)
3	0.63 (16.0)	2.00 (50.9)	1.18 (29.9)	1.52 (38.7)

4 Place the gasket (400.02) in the cover plate for seal (471.01). Fix the cover plate for seal on the casing cover (161.01). Tighten the hexagonal nuts (920.02).

5 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

6 Push the shaft wearing sleeve (524.01) together with the incorporated parts onto the shaft against the shoulder.

Mechanical seal, fittings MC01, MC02, MC03, MC04, MC06, MC20, MC21 and MC22

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the mechanical seal (433.01) into the casing cover (161.01). Follow the instructions provided by the seal manufacturer. Tighten the hexagonal nuts (920.02).

3 Push the shaft wearing sleeve (524.01) onto the shaft.

4 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Follow the instructions provided by the seal manufacturer. Fix the screws (901.02).

5 Complete all the lockings, fixings and other seal-related jobs as described in the seal manufacturer's instructions.

Mechanical seal, fittings MR01, MR02, MR03 and MR06

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the static part of the mechanical seal (433.01) into the casing cover (161.01) with the flange (723.01) if included in the parts list and the outer rotating part onto the shaft according to the seal manufacturer's instructions. Tighten the nuts (920.02).

3 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

4 Push the rotating part of the mechanical seal onto the shaft against the shoulder.

Mechanical seal, fittings MR04

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the static part of the mechanical seal (433.01) into the casing cover (161.01) with the flange (723.01) if included in the parts list. Follow the instructions provided by the seal manufacturer. Tighten the nuts (920.02).

3 Push the plate (550.01) onto the shaft. Make sure that the rubber lip on the outer edge of the plate comes to the bearing side. Fig. 16.

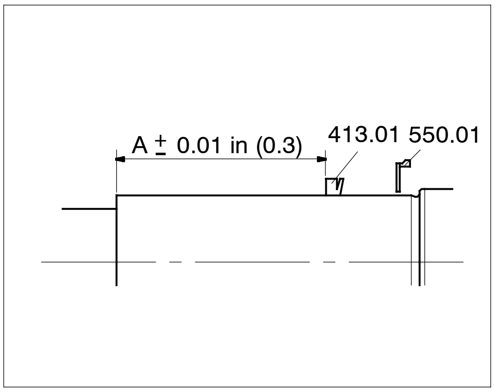


Fig. 16

4 Push the v-ring (413.01) onto the shaft. The distance of the v-ring from the shaft shoulder is shown in Table 14. The use of an installation sleeve helps to get the v-ring perpendicularly with respect to the shaft. Grease the lip of the v-ring slightly.

Table 14 ***V-ring position, fitting MR04***

Bearing unit	Seal size ∅		Distance A	
	in	mm	in	mm
1	1.125	29	3.252	83
2	1.875	48	3.880	99
3	2.250	57	4.425	112

5 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

6 Push the rotating part of the mechanical seal (433.01) onto the shaft against the shoulder.

7 Continue installation according to item ”Installation of impeller”.

8 After all other parts have been installed, push the plate (550.01) into the groove in the cover plate for seal (471.01) so that the entire rubber lip settles straight in the groove. Fig. 17. To make sure that the lip is correctly situated, use a tool shown in Fig. 18. Place the tip of the tool into the groove and turn around the cover plate for seal.

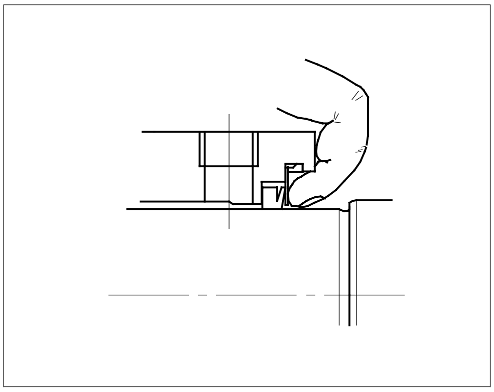


Fig. 17

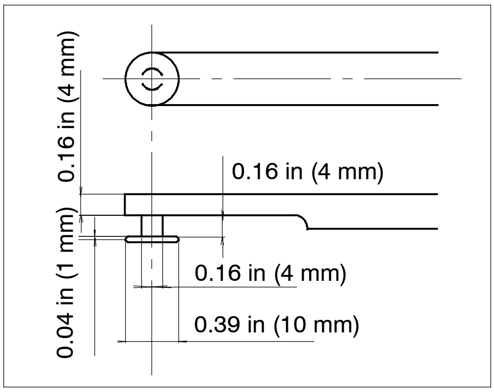


Fig. 18

Mechanical seal, fittings MR20, MR21 and MR22

1. Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).
2. Mount the static part of the mechanical seal (433.01) into the casing cover (161.01), and the outer rotating part onto the shaft according to the seal manufacturer's instructions. Tighten the nuts (920.02).
3. Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).
4. Push the rotating part of the mechanical seal (433.01) onto the shaft against the shoulder.

Dynamic seal, fittings DS01, DS02 and DS03

1. Fix the adapter (344.01) to the bearing housing (330.01) with the hexagonal screws (901.03).
2. Slide the thrust ring (475.01) with its o-ring (412.05) and grub screws (904.01) along the shaft to a preliminary position up to the hindmost shoulder.
3. Install the o-ring (412.06), static seal (435.01) and cover plate for seal (471.02) into the stuffing box housing (451.01). Tighten the hexagonal screws (901.08). Observe that the static seal must be placed in the right way and centrally in its guiding slot in the stuffing box housing.
4. Put the o-ring (412.04) in its slot in the stuffing box housing.
5. Put the stuffing box cover (161.02) on the table with the expeller side up. Put the expeller (604.01) inside the cover with the vane-side up. Push the stuffing box housing together with its parts on the stuffing box cover in the dedicated runway. In size 32, fix the hexagonal screws (901.07). The position of the stuffing box housing versus the holes of the stuffing box cover screws (901.02) should be such that in a ready assembled pump, the plug (903.09) in the stuffing box housing points horizontally to the left when viewed from the coupling. Check the position of the holes from the adapter.
6. Push the pack of parts (assembled in the stuffing box cover during stage 5) onto the shaft so that the expeller fits in its runway on the shaft and the stuffing box cover in its runaway on the adapter. Fix the hexagonal screws (901.02).
7. Continue the assembly according to the following section “Installation of impeller”.
8. When the exchange unit is fully assembled, place the thrust ring (475.01) at the right position on the shaft and fasten the grub screws (904.01). The measure between the face of the cover plate for seal and the shoulder of the thrust ring must be 0.197 in (5 mm). Fig. 19.

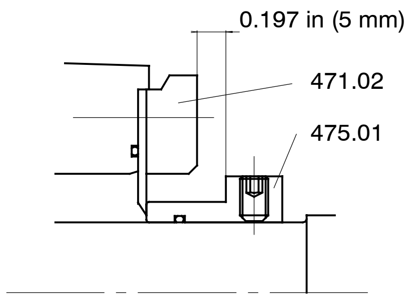


Fig. 19

4.4 Installation of impeller

1 Fit the o-ring (412.01) into its place behind the impeller (230.01). Fig. 20.

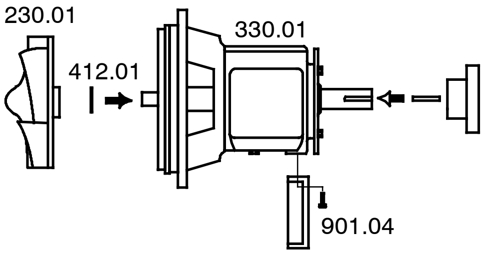


Fig. 20

2 Prevent the shaft from rotating from the coupling end and insert the impeller (230.01) into its place. The clearance between the impeller and casing cover (161.01) is about 0.014 ... 0.015 in (0.35 ... 0.4 mm).

4.5 Installation of exchange unit

1 Fix the support foot of the bearing unit by means of the hexagonal screws (901.04). Fig 21.

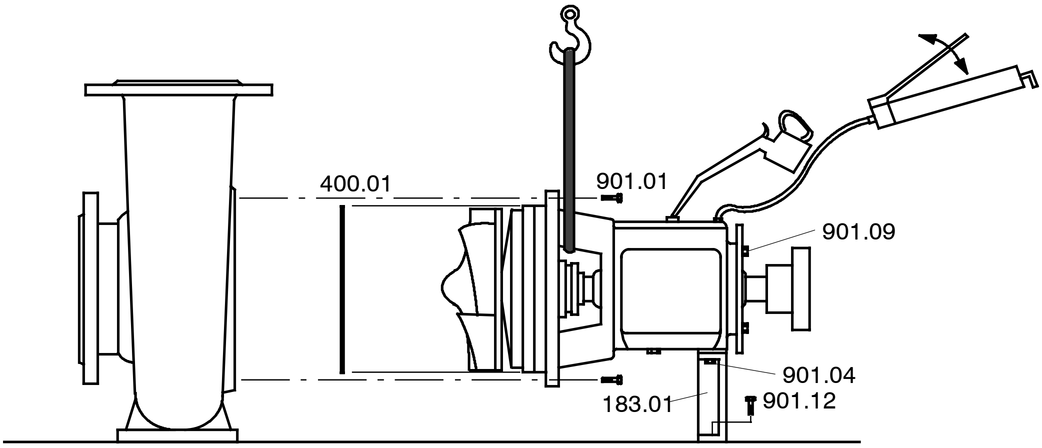


Fig. 21

2 Heat the coupling flange to approx. (+212 °F) +100 °C and push it on the shaft with the front surface at the shaft end level.

3 Suspend the exchange unit with a hoist at the maintenance opening of the adapter or underneath the adapter.

4 Fit the gasket (400.01) into the casing cover (161.01).

5 Install the exchange unit into its place, lubricate the hexagonal screws (901.01) with Molykote Ti 1200 lubricant and tighten them in a cross bolt pattern, to torque values given in Table 15.

Table 15 Exchange unit fastening screws (901.01)

Screw size	Moment			
	Rating		**Max. value**	
	(lb ft)	(Nm)	(lb ft)	(Nm)
1/2 – 13 UNC	35	50	45	60
5/8 – 11 UNC	95	130	120	160
3/4 – 10 UNC	185	250	220	300

6 Check the impeller clearances according to the Section ”Preventive maintenance”.

7 Place adjusting plates under the support foot. The plates must have the same thickness as the gap under the support foot. Do not close the gap by tightening.

8 Fix the support foot (183.01) to the baseplate (890.01) with the hexagonal screws (901.12).

9 Lubricate the bearing unit with oil or grease according to lubricating instructions in Section ”Operation”.

10 Install the coupling spacer according to the coupling manufacturer’s instructions.

11 Fix the coupling guard jackets (686.01) and (686.02). The coupling guard must be adjusted so that the space ”s” between the coupling guard and motor is approx. (0.2 in) 5 mm. Fig. 22.

12 Install the auxiliary pipings (700.01) and accessories according to sectional drawings and the seal manufacturer’s instructions.

13 Fix the adapter guard (683.01).

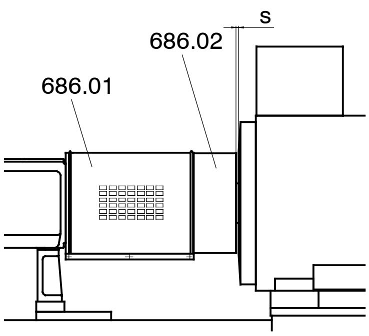


Fig. 22

WARNING

Proper adjustment of the coupling guard jacket is a relevant safety factor.

SULZER

Spare parts recommendation

Version 02 > / 20080601 / Replaces 20051101 / en / **N15069**

Contents *Page*

1 Recommended spare parts

To avoid long and expensive shut-down periods, the following spare parts are recommended to be kept in stock. The number of spare parts is evaluated for two year's use in normal operating conditions, Table 1.

When ordering spare parts, contact your local Sulzer Pumps representative (contact data found in Section "Information for use").

Table 1 Recommended spare parts

Part No.	Description	Number of identical parts in pumps							
		1	2	3	4	5	6 7	8 9	≥10
		Number of recommended spare parts							
102.01	Volute casing							1	10 %
161	Casing cover							1	10 %
183.01	Support foot							1	10 %
210.01	Shaft	1	1	1	2	2	2	3	30 %
230.01	Impeller	1	1	1	1	2	2	3	30 %
320.01	Antifriction bearing	1	1	1	2	2	3	4	50 %
320.02	Antifriction bearing		2		4		6	8	50 %
330.01	Bearing housing							1	10 %
339.01	Bearing unit							1	10 %
344.01	Adapter							1	10 %
360.01	Bearing cover							1	10 %
382.01	Bearing carrier							1	10 %
400	Gaskets	2	4	6	8	8	9	12	150 %
412	O-rings	2	4	6	8	8	9	10	100 %
413.01	V-ring	2	4	6	8	8	9	10	100 %
423	Labyrinth ring							1	10 %
433.01	Mechanical seal	1	2	3	4	5	6	7	90 %
435.01	Static seal	1	2	3	4	5	6	7	90 %
451.01	Stuffing box housing							1	10 %
452.01	Stuffing box gland							1	10 %
456.01	Neck bush							1	10 %
458.01	Latern ring							1	10 %
461.01	Gland packing				24			32	400 %
471	Cover plate for seal							1	10 %
475.01	Thrust ring	1	2	3	4	5	6	7	90 %
524.01	Shaft wearing sleeve	1	2	2	2	3	3	4	50 %
542	Throttling bush							1	10 %
550.01	Plate	2	4	6	8	8	9	10	100 %
604.01	Expeller	1	1	1	1	2	2	3	30 %
923.01	Bearing nut	1	1	1	2	2	2	3	30 %
931.01	Lockwasher	1	1	1	2	2	2	3	30 %
940.01	Key	1	1	1	2	2	2	3	30 %
Refer to the parts lists of the pumps when estimating the amount of needed spare parts.									

Date: 7/29/2013
Proposal: R-13-1539R1

Rental Oxidizer Agreement

INTELLISHARE LEASING, INC.

CLEAN AIR SOLUTIONS

Prepared For:

Michael Keen
Civil Engineering Consultants
mkeen@cecinc.com
813-956-4553

Equipment

1000 CFM Thermal Oxidizer

John Strey

jstrey@intellishare-env.com
715-233-6115 x114

1422 Indianhead Dr E
Menomonie, WI 54751

Introduction

Intellishare Leasing is pleased to provide this proposal to Product Level Control, herein referred to as CLIENT, for the rental of a Thermal Oxidizer.

Rental equipment is reserved on a first come, first served basis. To reserve rental equipment, a signed rental agreement, the first month's rental payment and certificate of insurance showing Intellishare Leasing as named insured must be received.

Thank you for the opportunity to provide this proposal for your project. Please feel free to address any questions or concerns regarding this information.

Equipment Specification

Mechanical

Item	Data
Manufacturer:	Intellishare Environmental, Inc.
Model Name:	Thermal Oxidizer
Model Number:	TO-1000
Foot Print:	W=7', L=15', H=8'
Weight:	4,500 lbs.
Inlet Connection:	8" – 150# flange

Operating

Item	Data
Maximum Air Flow Capacity:	1200 SCFM
Minimum Air Flow:	400 SCFM
Maximum Pre-Heater Input:	1,800,000 (Secondary Air Burner)
Normal Operating Temperature:	1,400-1,600 °F
Maximum Operating Temperature:	1800 °F
Catalyst Module Available:	Yes
Destruction Efficiency:	> 98% VOCs
Maximum LEL Throughput:	50%
Time to Reach Operating Temp:	15 Minutes From Cold Start (approximate)

Electrical

Item	Data
Electrical Voltage:	480/3/60
Power Supply:	20 AMPS

Air Quality Permitting

CLIENT is responsible for obtaining all permits required for operation of the equipment.

Shipping & Offloading

Intellishare Leasing will arrange for shipping of the equipment to and from the project site. Shipping costs will be billed to CLIENT on the first and last rental invoice. CLIENT is responsible for offloading the equipment once it reaches the site, and loading equipment for return to Intellishare Leasing.

Installation

CLIENT is responsible for installation of the equipment.

Start-Up

Intellishare Leasing will provide a qualified technician for start-up and training services.

The Catalyst

If desired, an optional Catalyst Module can be supplied with the equipment.

The catalyst is designed for long operating life under normal operating conditions. If the catalyst is damaged or destroyed, the replacement cost is $6,000, billable to client.

The following **partial** list of common poisoning agents and inhibitors has been found to have a detrimental effect on the activity of the noble metal catalyst. Catalyst exposure to these substances must be avoided.

Catalyst Poisoning Agents

Intellishare Leasing recommends sampling and analyzing the inlet gas concentration to determine whether or not these catalyst poisoning agents are being processed.

Substance	Effect
Coating Agents - rust - dirt - inorganic oxide	Covers catalyst active site.
Glass Forming Coating Agents - organic silicates (esters) - silicones - phosphorous containing materials	Covers catalyst active site.
Sulfides	Permanent deactivation
Organic Droplets & Aerosols	Covers active site- causes catalyst hot spot

Substance	Effect
Heavy Metal Complexes - mercury - lead - zinc - tin - arsenic - antimony, etc.	Permanent catalyst deactivation
Halogens - fluorine - chlorine - bromine - iodine - halogenated hydrocarbons	Covers active site – temporary or permanent deactivation

Rental Cost

Item	Cost	Notes
Oxidizer Rental – Monthly	$ 5,000	Based on 3 month minimum rental
Catalyst Rental – Monthly	$ 600	If utilized
Shipping – To Project Site	$ 1,100	LTL
Shipping – From Project Site	$ 1,100	LTL
Start-up & Training	$ 4,500	2 Days – Includes all expenses

Sales Tax

This proposal does not include applicable sales tax. Sales tax will be added to the monthly invoice for all non-labor items unless a valid certificate of exemption is provided. A valid tax exempt certificate must be for the state in which the equipment is located.

Availability of Equipment

Please note: Rental equipment is available on a first commitment basis.

Please note: Rental units are equipped with a process blower, auto dilution and temperature chart recorder. The maximum temperature input to the process blower 180 deg F. In the event the process air temperature is >180 deg F, the process blower may be removed and the dilution valve placed on the inlet of the SVE blower.

Terms & Conditions of Rental

1. Rental Term

The rental term commences with the shipment of designated equipment from the Intellishare Leasing facility and terminates upon receipt of said equipment's arrival at the Intellishare leasing facility.

2. Payment

First rental payment with order, remaining invoices are due Net 60 Days.

3. Consumable Items

All consumable supplies used are billed at cost plus 15%.

4. Hold Harmless Agreement

CLIENT shall hold harmless, defend and indemnify Intellishare Leasing, Inc. from all liability, costs, losses, damages, expenses, causes of action, claims or judgment resulting from injury or death to any person (including CLIENT's employees) or damage to property, arising from or in any way connected to CLIENT's rental or operation of Intellishare Leasing's equipment, except for that this agreement shall not be applicable to injury, death or property damage arising from the negligence or willful misconduct of Intellishare Leasing.

5. Prohibited Uses

Use of this equipment in the following circumstances is prohibited, and constitutes a breach of this contract:

a. Use for illegal purpose or in illegal manner
b. Unintended use or improper use, including use of equipment in a careless or negligent manner
c. Use by anyone other than the CLIENT, his/her employees or employee
d. Use at any location other than the address furnished Intellishare Leasing without Intellishare Leasing's written permission
e. Only persons competent in its operation shall operate all rented equipment. CLIENT agrees to operate and monitor the equipment in accordance with instructions provided by Intellishare Leasing, Inc.

6. Damaged or Lost Equipment

CLIENT agrees to pay for any damage or loss of the equipment, as an insurer (except for reasonable wear and tear), while the equipment is out of the possession of Intellishare Leasing. Accrued rental charges may not be applied against the purchase or cost of repair of damaged or lost equipment. Equipment repair or component replacement costs will be determined upon receipt and inspection of the equipment at the Intellishare Leasing facility.

Equipment damaged beyond repair will be paid for at its fair market value at the time of rental.

7. Breach of Contract & Equipment Repossession

Upon failure to pay rent or other breach of this contract, Intellishare Leasing, Inc. may terminate the contract and take possession of and remove the equipment, without prejudice to any other remedies or claims which Intellishare Leasing might otherwise possess by law or pursuant to this contract.

Intellishare Leasing or its agents shall not be liable for any claims for damages or trespass arising out of the removal of the equipment. CLIENT agrees to pay all reasonable collection, attorney and court fees and other expenses involved in the collection of the charges of enforcement of Intellishare Leasing's rights under this contract whether or not suit is commenced.

~~8. Subleases and Loans of Equipment~~

~~CLIENT may not sublease or loan the rental equipment to another party.~~

9. Disclaimer of Agency

The CLIENT acknowledges that he/she is not the agent, dealer or owner of the equipment under contract for any purpose.

10. Severability

The provisions of this agreement shall be severable so that the invalidity, unenforceability or waiver of any of the provisions shall not affect the remaining provisions.

11. Jurisdiction, Venue & Governing Law

The laws of the State of Wisconsin govern this agreement. Proper jurisdiction for resolution of any disputes will be settled in the court system of Dunn County, Wisconsin, unless Intellishare Leasing waives such provision.

12. Inspections

Intellishare Leasing, Inc. reserves the right to inspect the equipment at any time. Advance notice will be given to the CLIENT.

13. Insurance

The CLIENT's liability policy shall be endorsed to name Intellishare Leasing, Inc. as additional insured.

14. Damage & Loss Waiver

CLIENT will provide a valid certificate of insurance to Intellishare Leasing prior to rental of the equipment whereby Intellishare Leasing is named as additional insured on an insurance policy covering the risk of loss by damage or otherwise of the subject equipment. Said insurance shall be primary against any other insurance which may be provided by Intellishare Leasing, Inc.

15. Limitation of Liability

In no event will Intellishare Leasing, its subcontractors or representatives, be held responsible, or liable for any claim, whether in warranty, contract, tort or strict liability for any special, indirect, incidental or consequential damages resulting from the rental of equipment (including but not limited to incidental or consequential damages for labor, lost profits, lost sales, injury to person or to property or any other incidental loss or damages).

Replacement Cost

The estimated replacement cost of the equipment is approximately $50,000.

Operation & Maintenance Guide

One complete set of operating and maintenance manuals are provided with the unit. Manuals are required to be returned with the system. Failure to return the manuals will result in an additional $250 charge to the CLIENT.

Acceptance of Agreement

To accept this rental agreement, please sign two copies of this contract and mail to Intellishare Leasing, Inc. along with the first month's rental payment and a copy of the insurance certificate showing Intellishare Leasing as additional named insured.

All rental equipment is reserved on a first come, first served basis. To reserve rental equipment, the signed rental agreement, first month's rent and a copy of the insurance certificate showing Intellishare Leasing named as additional insured is required.

I have read and agree to the contract terms and conditions of rental. These terms constitute the entire agreement. No one has made any oral or other written representations or promises not included in this contract. I hereby acknowledge receipt of a copy of this contract in its entirety.

CLIENT Acceptance

Date: ______________________________

Purchase Order Number: ______________________________

CLIENT Name: ______________________________

CLIENT Title: ______________________________

Signature: ______________________________

Intellishare Environmental Acceptance

Date: ______________________________

Name: ______________________________

Title: ______________________________

Signature: ______________________________

Control Panel

Power Input:
230V
60 Hz
3 Phase

Process Motor Size - 5hp

Electrical - 230VAC/60Hz /3 Phase

Input BTU Rating - 1,800,000 BTU/Hour

Process Inlet Flow Rate - 500-1000 SCFM

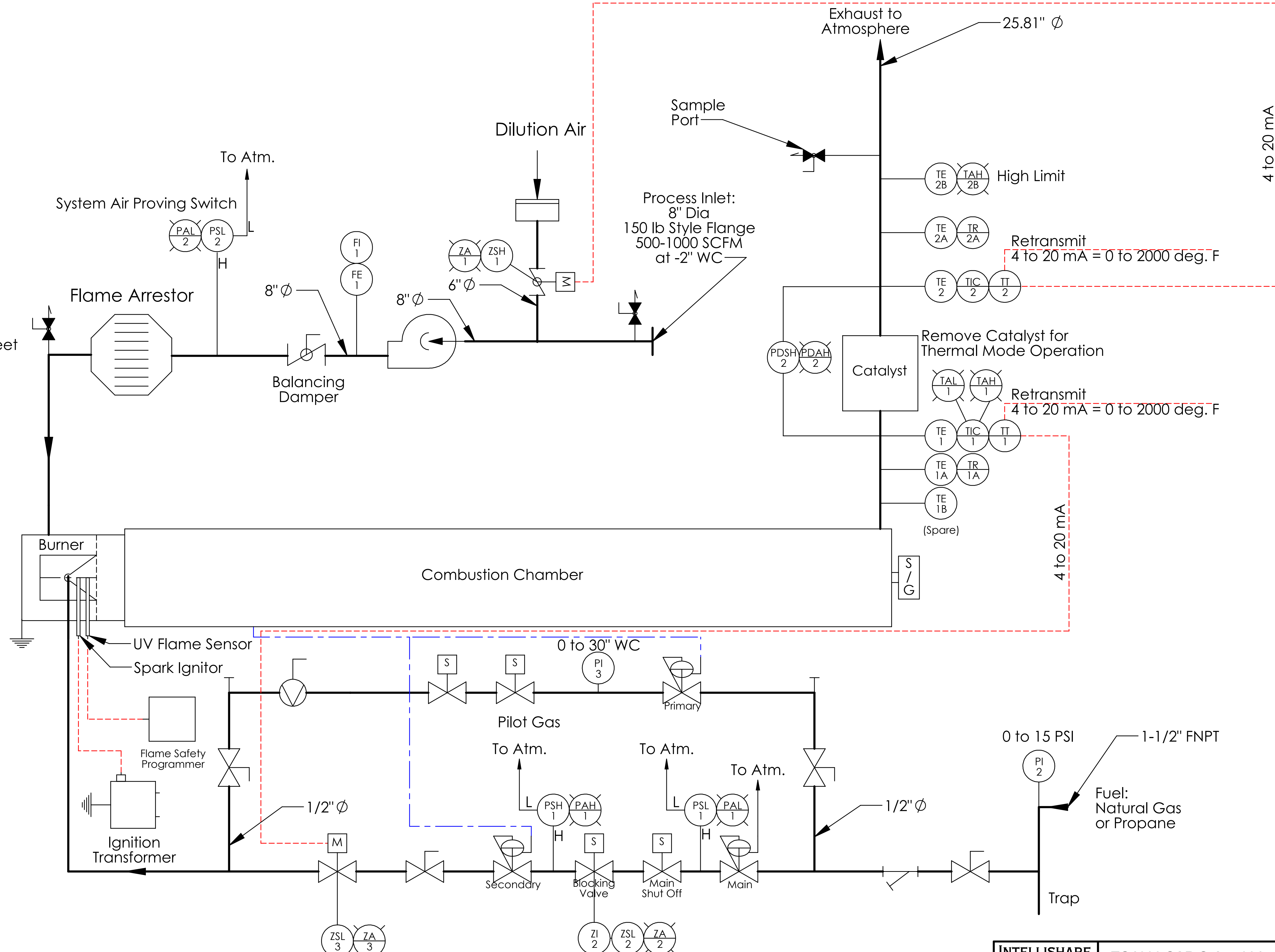
Catalyst Volume (If Equiped) - 1.47 Cubic Feet

Stack Outer Diameter - 25.81 Inches

Stack Inner Diameter - 25.66 Inches

Discharge Height - 13.7 Feet

Site Elevation - Not Specified



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INTELLISHARE ENVIRONMENTAL
CLEAN AIR SOLUTIONS

TO1000 SAB Sales-001	
TITLE: 1000 CFM Thermal/Catalytic Oxidizer Process & Instrumentation Diagram	DRAWING NO.: TO1000 SAB Sales-001
DRAWN: Henry A — DATE: 5/16/2006	SCALE: NTS
CHECKED — DATE	CUSTOMER: Intellishare Environmental, Inc. Sales
APPROVED — DATE	REV.: A
LAST DRAWN BY: Henry A — DATE: 1/8/2010	SOURCE
PAGE 1 OF 2	FILE PATH

LAST PLOTTED BY XXX DATE XXX

Measured Variable	
A	Analysis
F	Flow Rate
I	Current
L	Level
P	Pressure
T	Temperature
M	Motor
Z	Position

Succeding Letters	
A	Alarm
C	Controller
D	Differential
E	Primary Element
H	High
I	Indicator
L	Light
L	Low
R	Record
S	Switch
T	Transmitter
V	Valve

Valve Bodies
Valve (N.O. or Unspecified)
Valve Normally Closed
Ball Valve
Check Valve
Butterfly Valve
Damper
Orifice Valve
Pressure Regulator (Self Contained)
Pressure Regulator (External Backload)
1/2" FNPT Sample Port
1/4" Barbed Sample Port with Hand Valve

Miscellaneous
Centrifugal Blower
Flow Orifice
Electrical Line
Pneumatic Line
Process Ductwork
Panel Mounted Instrument
Locally Mounted Instrument
Mounted Inside Panel
Alarm
Transition
Ground Connection
Flanged Connection

Operators
Electric Motor
Solenoid
Manual
Sight Glass
Vortex Damper
Filter Element

INTELLISHARE ENVIRONMENTAL
CLEAN AIR SOLUTIONS

TO1000 SAB Sales-001

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DRAWING NO.	TO1000 SAB Sales-001
SCALE	NTS
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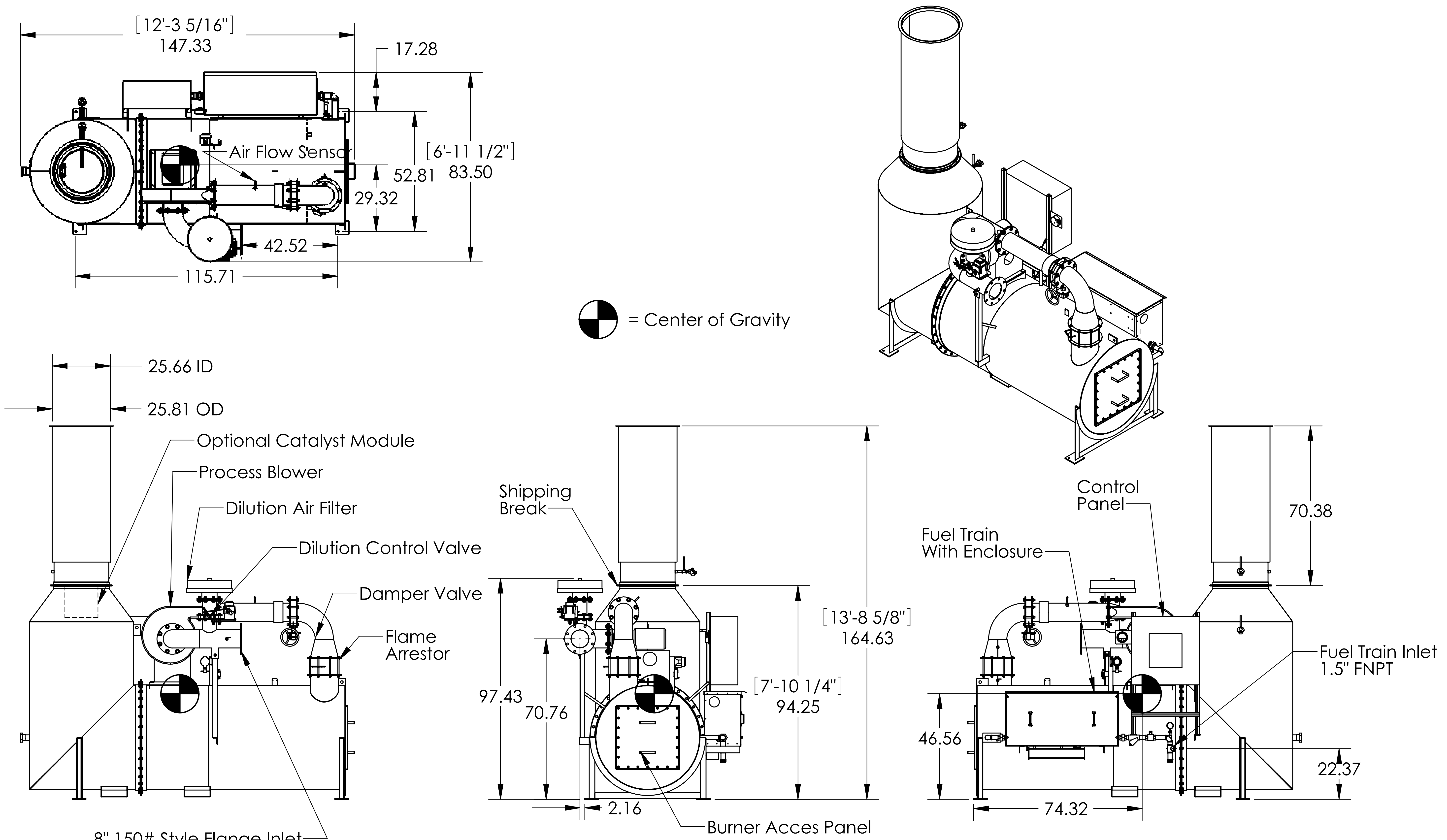
DATE	
CUSTOMER	Intellishare Environmental, Inc. Sales
REV.	A
LAST DRAWN BY	Henry A
DATE	1/8/2010
SOURCE	
PAGE	2
OF	2
FILE PATH	
LAST PLOTTED BY	XXX
DATE	XXX



Estimated unit weight: 4500 lbs.

Note: Unit must be anchored to meet Uniform Building Code requirements

Dimensions given in inches unless otherwise stated.

INTELLISHARE ENVIRONMENTAL — CLEAN AIR SOLUTIONS	**TO1000 SAB Sales**	
	TITLE: **1000 CFM THERMAL/CATALYTIC OXIDIZER SALES DRAWING**	DRAWING NO. TO1000 SAB Sales
		SCALE: NTS
	DRAWN: Henry A — DATE: 8/2/2006	REV. A
	CHECKED — DATE	
	APPROVED — DATE	
	LAST DRAWN BY: Henry A — DATE: 6/1/2009	SOURCE
		PAGE 1 OF 1

Contact:
Intellishare Environmental, Inc.
E4803 395th Ave., - Menomonie, WI 54751 www.intellishare-env.com
Pnoe: 715-233-6115 FAX: 715-232-0669

FILE PATH

LAST PLOTTED BY XXX DATE XXX

A	BUILT RELEASE	MH	01/22/14
B			
C			
D			

General Wiring
Installation Instruction

To Maintain Enclosure Type Rating, all penetrations must be fitted with a Device or Hub with the same environmental rating as specified on the nameplate.

Avoid penetrating the enclosure above the controller height.

Use Killark ENY or EY (or equal) conduit seal and Killark SC (or equal) sealing compound for all conduit entries to prevent gas from entering enclosure and to maintain warranty.

Use COPPER CONDUCTORS ONLY for all field connections.

Use minimum 60° C wire for all field connections:

- CB Connection – 18 to 12 AWG, Torque 21 LB-IN Max.
- GND Connection – 14 to 6 AWG, Torque 45 LB-IN Max.
- TB1,2,3,4,5 Connection – 24 to 10 AWG, Torque 4.4 to 7 LB-IN
- Relay Connection – 24 to 12 AWG, Torque 7 LB-IN

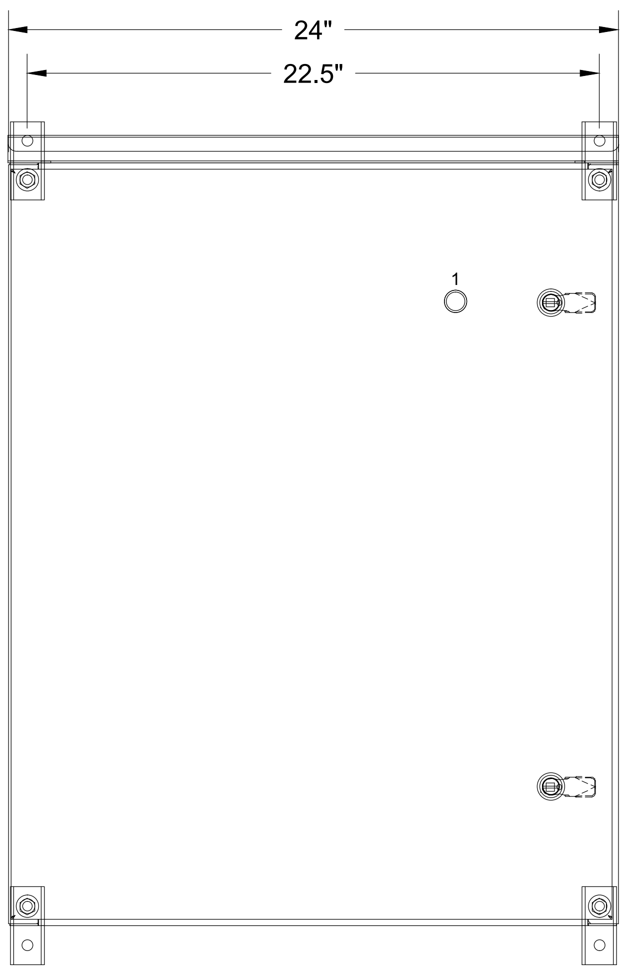
LEGEND:

- ◎ - INDICATES TERMINAL BLOCK
- – – – – - INDICATES FIELD WIRING
- - ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- - SURGE GROUNDING
- - EQUIPMENT GROUNDING

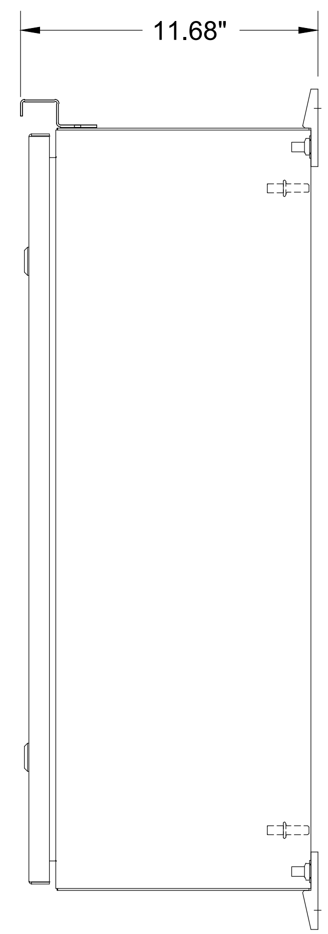
SLIGO SYSTEMS
Landfill Pumps & Controls
Lake Helen, Florida
386-218-4981
www.sligosystems.com

CUSTOMER: LAND-REP-BRIDGETON			JOB #: 1013-1062
DWG. TITLE: BRIDGETON TANK 316K INPUT & OUTPUT PANEL			
DATE 01/22/14	CSD MHH	DWG.NO. E-5024-B	REV A
DRAWN BY MHH	APP'D. MHH	SHT. 1 OF 7	

A	BUILT RELEASE	MH	01/22/14
B			
C			
D			

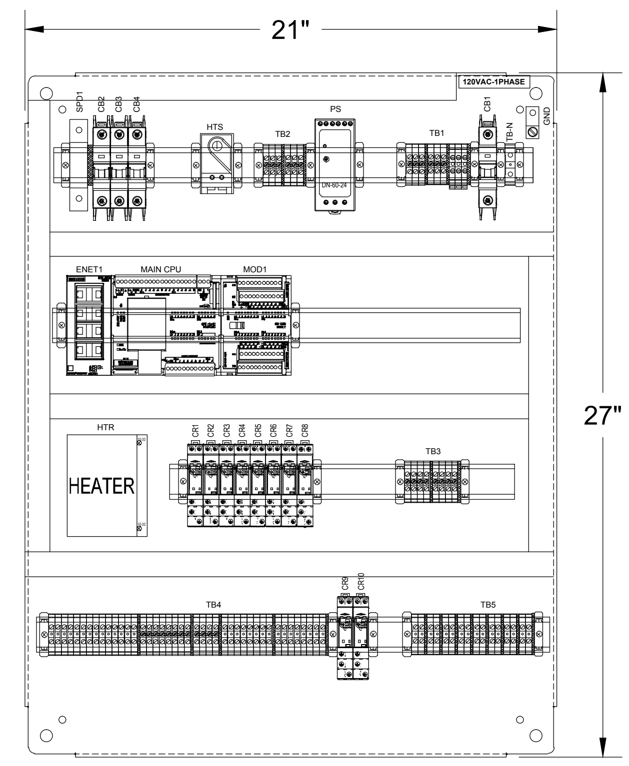


FRONT VIEW



RIGHT SIDE VIEW

ELECTRICAL ENCLOSURE 30" X 24" X 10"
TYPE 4 (PAINTED STEEL)



BACK PANEL

NOTES:

CB1	120VAC - 1POLE - 10AMP (EATON)
CB2	120VAC - 1POLE - 05AMP (EATON)
CB3	120VAC - 1POLE - 02AMP (EATON)
CB4	120VAC - 1POLE - 02AMP (EATON)
CR1	24VDC - SPDT - (FINDER)
CR2	24VDC - SPDT - (FINDER)
CR3	24VDC - SPDT - (FINDER)
CR4	24VDC - SPDT - (FINDER)
CR5	24VDC - SPDT - (FINDER)
CR6	24VDC - SPDT - (FINDER)
CR7	24VDC - SPDT - (FINDER)
CR8	24VDC - SPDT - (FINDER)
CR9	24VDC - SPDT - (FINDER)
CR10	24VDC - SPDT - (FINDER)

DEVICE LEGEND:

1	POWER ON LIGHT (AMBER)

NOTE:

1. THIS PANEL MUST BE INSTALLED OBSERVING ALL APPLICABLE STATE AND LOCAL CODES, AND AS PER LATEST REVISION OF NEC. THIS SHALL INCLUDE, BUT NOT BE LIMITED TO, ANY REQUIRED SERVICE ENTRANCE EQUIPMENT NOT INCLUDED IN THIS CONTROL PANEL.
2. ENCLOSURE MUST BE CONNECTED TO A GOOD EARTH GROUND.

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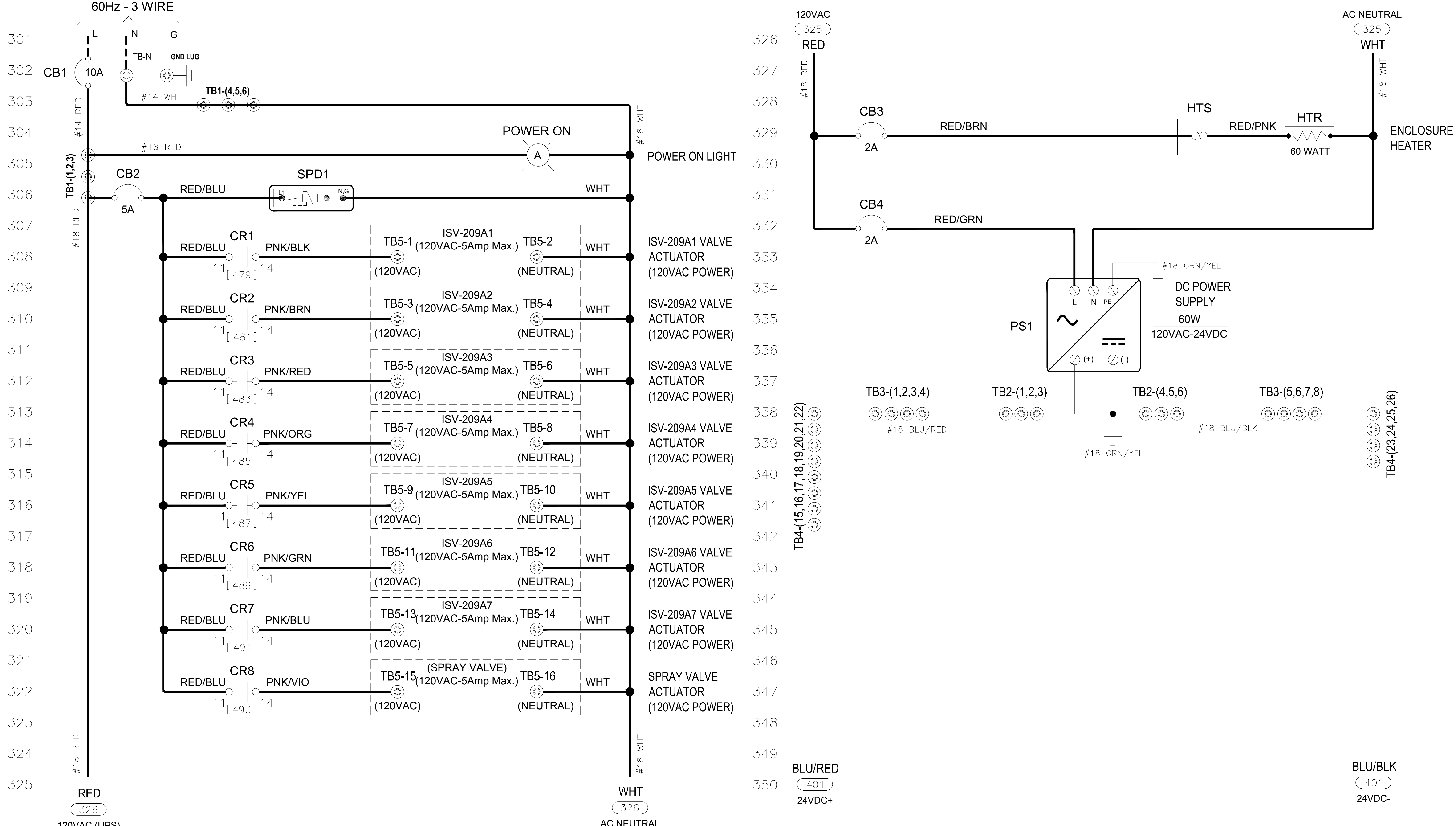
DWG. TITLE: BRIDGETON TANK 316K INPUT & OUTPUT PANEL			
DATE 01/22/14	CSD MHH	DWG.NO. E-5024-B	REV A
DRAWN BY MHH	APP'D. MHH	SHT. 2 OF 7	

A	BUILT RELEASE	MH	01/22/14
B	UPDATE (CR8) SPRAY VALVE TB	MH	02/14/14
C			
D			



LEGEND:

- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- SURGE GROUNDING
- EQUIPMENT GROUNDING

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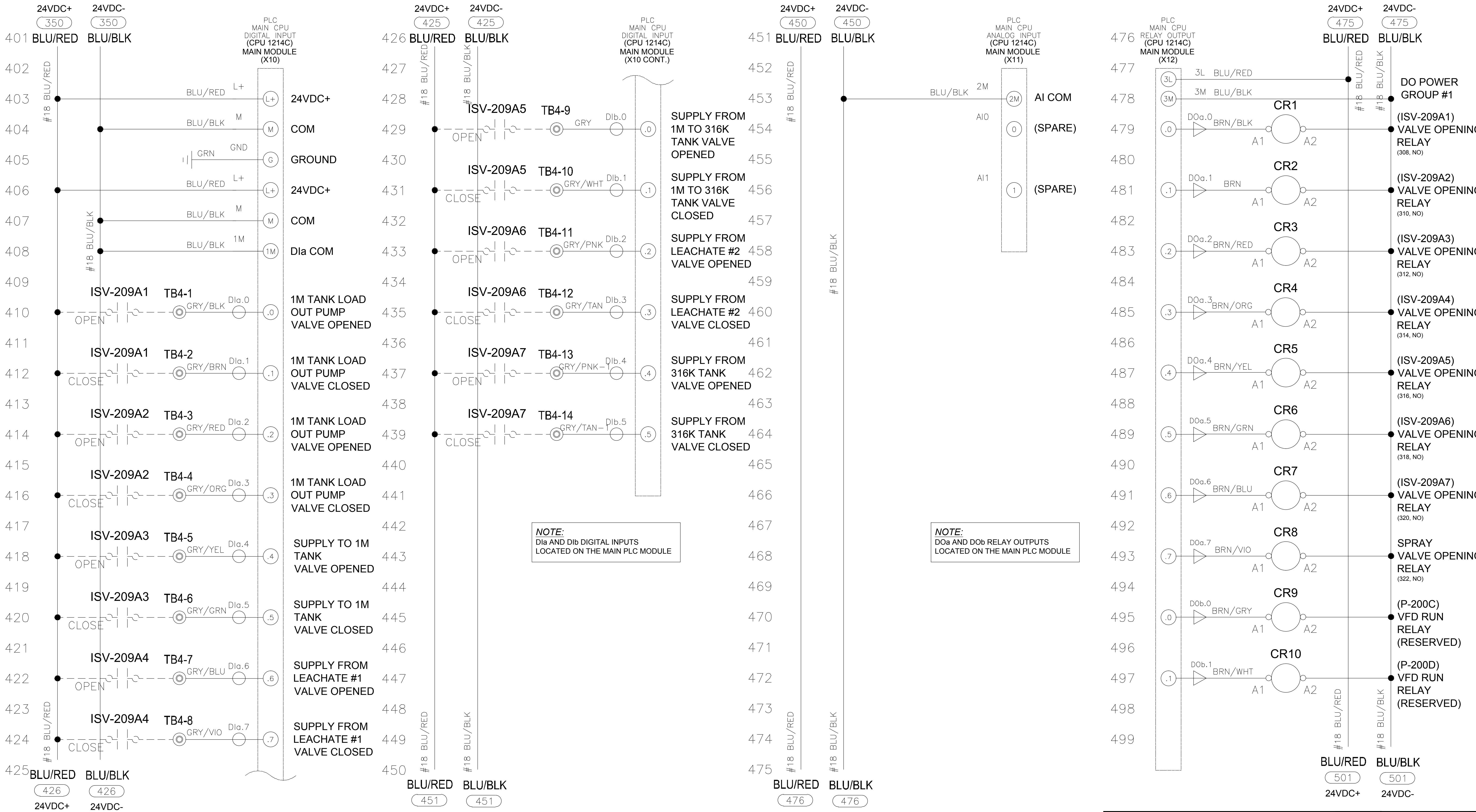
CUSTOMER: LAND-REP-BRIDGETON | JOB #: 1013-1062

DWG. TITLE: BRIDGETON TANK 316K INPUT & OUTPUT PANEL

DATE 01/22/14 | CSD MHH | DWG.NO. E-5024-B | REV B

DRAWN BY MHH | APP'D. MHH | SHT. 3 OF 7

A	BUILT RELEASE	MH	01/22/14
B	UPDATE SPRAY VALVE OUTPUT (CR8)	MH	02/14/14
C			
D			



LEGEND:

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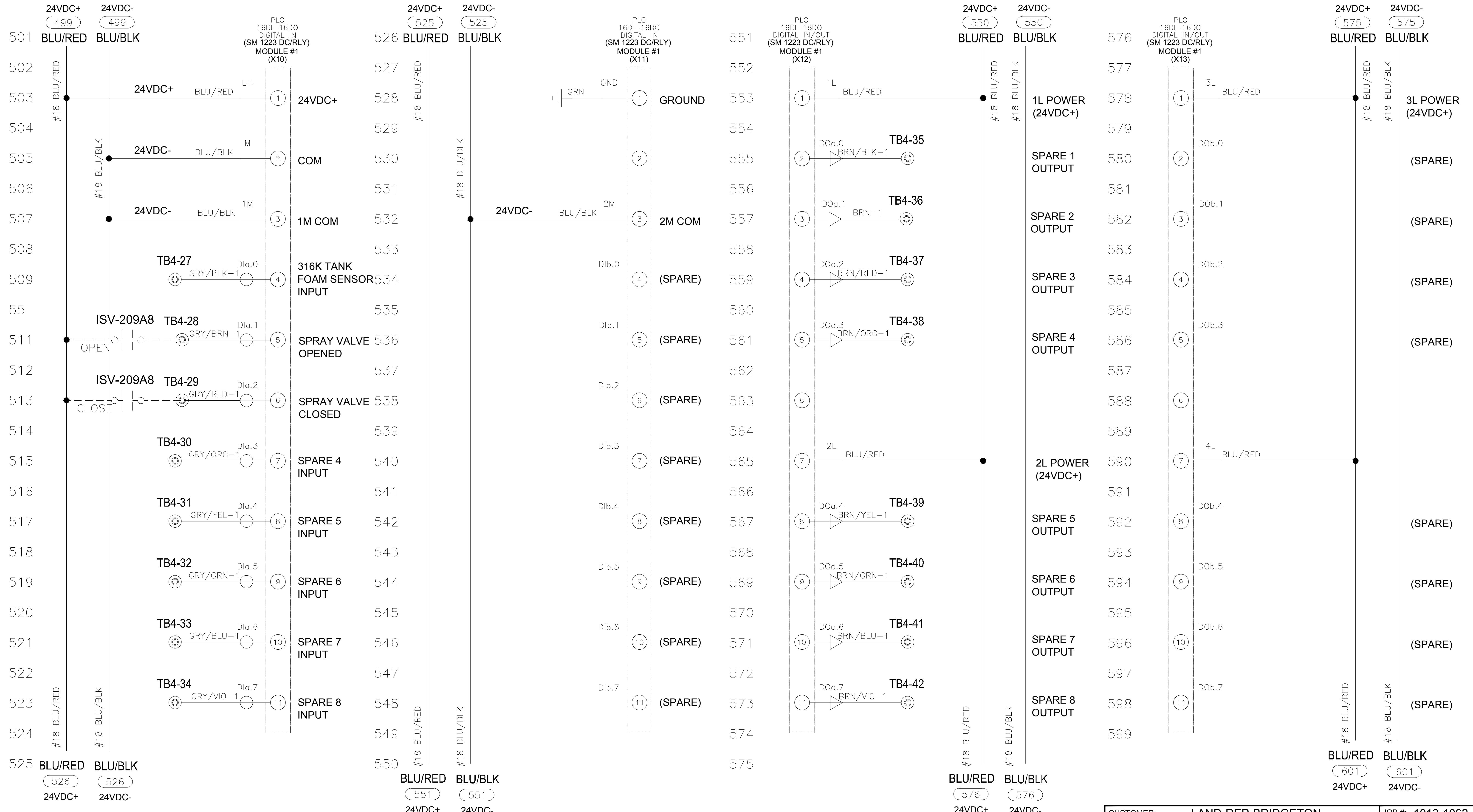
DATE 01/22/14	CSD MHH	DWG.NO. E-5024-B	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 4 OF 7	

A	BUILT RELEASE	MH	01/22/14
B	UPDATE FOAM, SPRAY VALVE INPUTS	MH	02/14/14
C			
D			



LEGEND:

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- INDICATES FIELD WIRING
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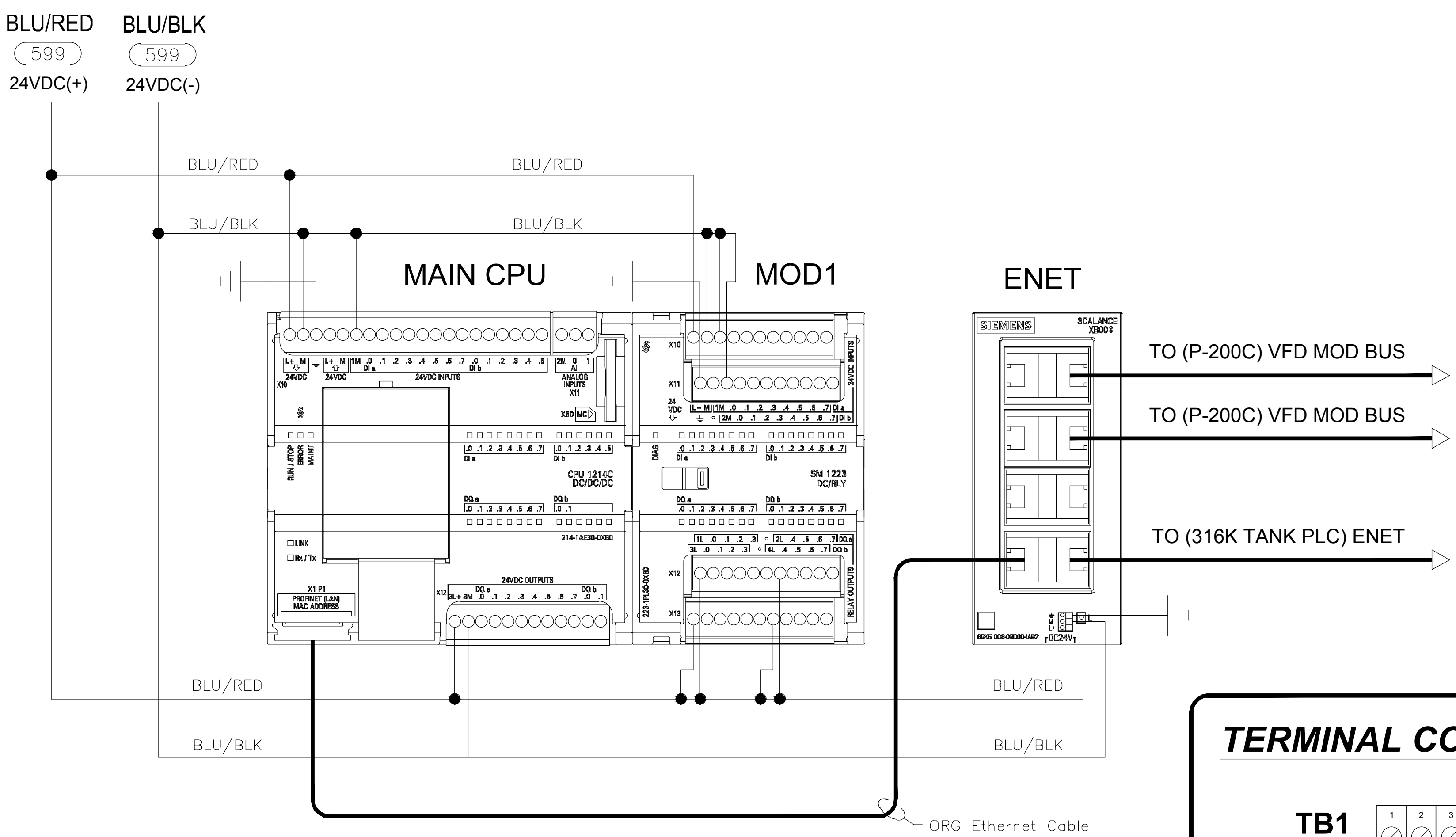
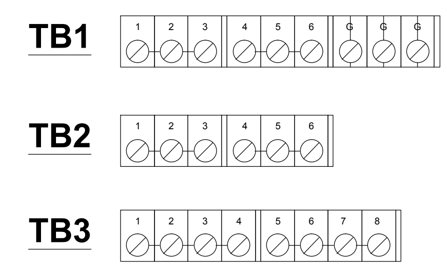
DATE 01/22/14	CSD MHH	DWG.NO. E-5024-B	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 5 OF 7	

A	BUILT RELEASE	MH	01/22/14
B			
C			
D			



TERMINAL CONNECTION DETAILS:



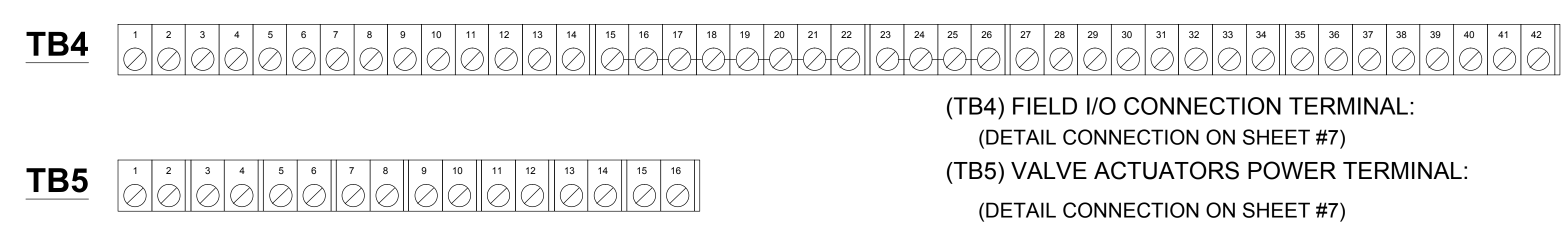
(TB1) 120VAC POWER TERMINAL:
- TB1-(1,2,3) 120VAC
- TB1-(4,5,6) NEUTRAL
- TB1-G GROUND

(TB2) DC POWER TERMINAL:
- TB2-(1,2,3) 24VDC+
- TB2-(4,5,6) 24VDC-

(TB3) FIELD DC POWER TERMINAL:
- TB3-(1 THRU 4) 24VDC+
- TB3-(5 THRU 8) 24VDC-

CUSTOMER CONNECTION DETAILS:

INCOMING POWER CONNECTION (120VAC-1PHASE):
- 120VAC - (CB1-1) 120VAC LINE POWER
- NEUTRAL - (TB-N) NEUTRAL IN
- GROUND - (GND) MAIN GROUND (GND)



(TB4) FIELD I/O CONNECTION TERMINAL:
(DETAIL CONNECTION ON SHEET #7)

(TB5) VALVE ACTUATORS POWER TERMINAL:
(DETAIL CONNECTION ON SHEET #7)

LEGEND:
- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
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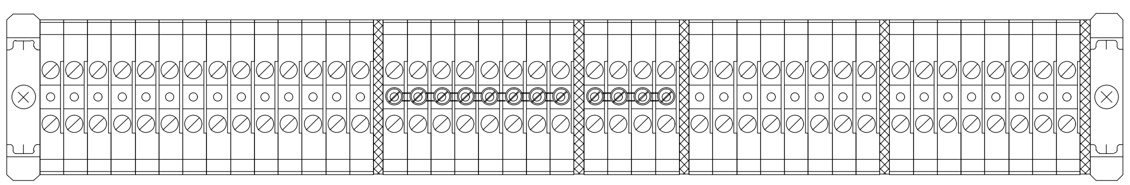
DRAWN BY MHH	APP'D. MHH	SHT. 6 OF 7	

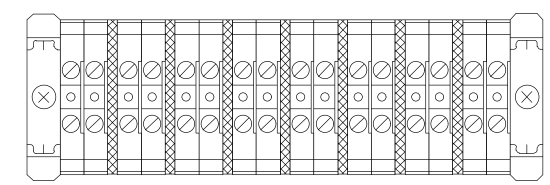
A	BUILT RELEASE	MH	01/22/14
B	UPDATE TB4, TB5	MH	02/14/14
C			
D			

TB4 *TERMINAL CONNECTION DETAIL:*



Terminal	(PANEL)	(FIELD WIRING)
1	GRY/BLK	VALVE OPENED (ISV-209A1)
2	GRY/BRN	VALVE CLOSED (ISV-209A1)
3	GRY/RED	VALVE OPENED (ISV-209A2)
4	GRY/ORG	VALVE CLOSED (ISV-209A2)
5	GRY/YEL	VALVE OPENED (ISV-209A3)
6	GRY/GRN	VALVE CLOSED (ISV-209A3)
7	GRY/BLU	VALVE OPENED (ISV-209A4)
8	GRY/VIO	VALVE CLOSED (ISV-209A4)
9	GRY	VALVE OPENED (ISV-209A5)
10	GRY/WHT	VALVE CLOSED (ISV-209A5)
11	GRY/PNK	VALVE OPENED (ISV-209A6)
12	GRY/TAN	VALVE CLOSED (ISV-209A6)
13	GRY/PNK-1	VALVE OPENED (ISV-209A7)
14	GRY/TAN-1	VALVE CLOSED (ISV-209A7)
15–22	BLU/RED (24VDC+)	
23–26	BLU/BLK (24VDC-)	
27	GRY/BLK-1	316K TANK FOAM SENSOR INPUT
28	GRY/BRN-1	VALVE OPENED (ISV-209A8)
29	GRY/RED-1	VALVE CLOSED (ISV-209A8)
30	GRY/ORG-1	INPUT SPARE 4
31	GRY/YEL-1	INPUT SPARE 5
32	GRY/GRN-1	INPUT SPARE 6
33	GRY/BLU-1	INPUT SPARE 7
34	GRY/VIO-1	INPUT SPARE 8
35	BRN/BLK-1	OUTPUT SPARE 1
36	BRN/BRN-1	OUTPUT SPARE 2
37	BRN/RED-1	OUTPUT SPARE 3
38	BRN/ORG-1	OUTPUT SPARE 4
39	BRN/YEL-1	OUTPUT SPARE 5
40	BRN/GRN-1	OUTPUT SPARE 6
41	BRN/BLU-1	OUTPUT SPARE 7
42	BRN/VIO-1	OUTPUT SPARE 8

TB5 *TERMINAL CONNECTION DETAIL:*



Terminal	(PANEL)	(FIELD WIRING)
1	PNK/BLK	120VAC (L) (ISV-209A1)
2	WHT	NEUTRAL (N) (ISV-209A1)
3	PNK/BRN	120VAC (L) (ISV-209A2)
4	WHT	NEUTRAL (N) (ISV-209A2)
5	PNK/RED	120VAC (L) (ISV-209A3)
6	WHT	NEUTRAL (N) (ISV-209A3)
7	PNK/ORG	120VAC (L) (ISV-209A4)
8	WHT	NEUTRAL (N) (ISV-209A4)
9	PNK/YEL	120VAC (L) (ISV-209A5)
10	WHT	NEUTRAL (N) (ISV-209A5)
11	PNK/GRN	120VAC (L) (ISV-209A6)
12	WHT	NEUTRAL (N) (ISV-209A6)
13	PNK/BLU	120VAC (L) (ISV-209A7)
14	WHT	NEUTRAL (N) (ISV-209A7)
15	PNK/VIO	120VAC (L) (ISV-209A8)
16	WHT	NEUTRAL (N) (ISV-209A8)

SLIGO SYSTEMS
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DWG. TITLE: BRIDGETON TANK 316K INPUT & OUTPUT PANEL			
DATE 01/22/14	CSD MHH	DWG.NO. E-5024-B	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 7 OF 7	

PROPOSAL
JET AERATION SYSTEM
FOR

CEC, Inc.
Bridgeton Project

June 28, 2013

PROPRIETARY INFORMATION

MTS # M213171 Rev 1D

Quote is valid for 60 days from date of proposal

MASS TRANSFER SYSTEMS, 23 Walpole Park South, Walpole, Massachusetts, 02081-2558 USA
T: (508) 660-9150 • F: (508) 660-9151 • E-mail: sales@mtsjets.com

MTS - MASS TRANSFER SYSTEMS
JET AERATION SYSTEM DESIGN
CEC Bridgeton
MTS # M213171 Design Rev 1D-95F

DESIGN PARAMETERS

Process	C.M.A.S.			
Number of Tanks/Basins	1			
	ENGLISH		METRIC	
Design Flow	75,000	MGD	284	m^3/day
Circular Tank				
Diameter	72.5	ft	22.1	m
Liquid Depth	32.0	ft	9.8	m
Volume Per Tank/Basin	988,138	gal	3740	m^3
BOD	31,000	mg/L	31000	mg/L
NH_3-N	1,000	mg/L	1,000	mg/L
BOD Removal Efficiency	95%	%	95%	%
NH_3-N Removal Efficiency	95%	%	95%	%
O_2 Required/BOD Removed	1.3	lb/lb	1.3	kg/kg
Alpha	0.85		0.85	
Beta	0.95		0.95	
Theta	1.024		1.024	
Residual DO	1.0	mg/L	1.0	mg/L
Wastewater Temperature	95	°F	35	°C
Maximum Air Temperature	95	°F	35	°C
Site Elevation	600	ft	183	m

Note: Some of the above parameters were supplied to or assumed by MTS and should be reviewed.

DESIGN SUMMARY

Total AOR	1,112	lb O_2/hr	504	kg O_2/h
Total SOTR	1,461	lb O_2/hr	663	kg O_2/h
MTS Jet Aerators Required	2	@ MT4JM-18	2	@ MT4JM-18
Air Flow Rate per Aerator	1,728	SCFM	2,936	std m^3/hr[1]
Total Air Flow Rate	3,456	SCFM	5,871	std m^3/hr
Air Pressure Required at Manifold[2]	13.3	psig	0.92	bar gauge
Standard Oxygen Absorption Efficien(	40.8	%	40.8	%
Liquid Flow Rate per Aerator	6,588	gpm	416	L/s
Total Liquid Flow Rate	13,176	gpm	831	L/s
Liquid Pressure Required at Manifold[3]	18	ft TDH	5.5	m TDH
Total Blower Power[4]	241	bhp	180	bkW
Total Pump Power[5]	80	bhp	60	bkW
Total Power	321	bhp	239	bkW
Standard Aeration Efficiency	4.55	lb O_2/bhp-hr	2.77	kg O_2/bkW-h
Power Density	325	bhp/MG	64	bkW/1000 m^3

[1] A standard m3 of air defined at 20°C, 1 atm, and 36% RH.
[2] Does not includes losses in the out-of-basin piping (typically 1 psi/0.07 bar).
[3] Does not include losses in out-of-basin piping (typically 2 ft /0.6 m).
[4] Assumes blower adiabatic efficiency of 70%.
[5] Assumes pump hydraulic efficiency of 80%.

MTS - MASS TRANSFER SYSTEMS
JET AERATION SYSTEM DESIGN
CEC Bridgeton
MTS # M213171 Design Rev 1D

DESIGN PARAMETERS

Process	C.M.A.S.			
Number of Tanks/Basins	1			
	ENGLISH		METRIC	
Design Flow	75,000	MGD	284	m^3/day
Circular Tank				
Diameter	72.5	ft	22.1	m
Liquid Depth	32.0	ft	9.8	m
Volume Per Tank/Basin	988,138	gal	3740	m^3
BOD	31,000	mg/L	31000	mg/L
NH_3-N	1,000	mg/L	1,000	mg/L
BOD Removal Efficiency	95%	%	95%	%
NH_3-N Removal Efficiency	95%	%	95%	%
O_2 Required/BOD Removed	1.3	lb/lb	1.3	kg/kg
Alpha	0.85		0.85	
Beta	0.95		0.95	
Theta	1.024		1.024	
Residual DO	1.0	mg/L	1.0	mg/L
Wastewater Temperature	77	°F	25	°C
Maximum Air Temperature	95	°F	35	°C
Site Elevation	600	ft	183	m

Note: Some of the above parameters were supplied to or assumed by MTS and should be reviewed.

DESIGN SUMMARY

Total AOR	1,112	lb O_2/hr	504	kg O_2/h
Total SOTR	1,525	lb O_2/hr	692	kg O_2/h
MTS Jet Aerators Required	2	@ MT4JM-18	2	@ MT4JM-18
Air Flow Rate per Aerator	1,836	SCFM	3,119	std m^3/hr[1]
Total Air Flow Rate	3,672	SCFM	6,238	std m^3/hr
Air Pressure Required at Manifold[2]	14.2	psig	0.98	bar gauge
Standard Oxygen Absorption Efficien(	40.1	%	40.1	%
Liquid Flow Rate per Aerator	6,588	gpm	416	L/s
Total Liquid Flow Rate	13,176	gpm	831	L/s
Liquid Pressure Required at Manifold[3]	18	ft TDH	5.5	m TDH
Total Blower Power[4]	269	bhp	201	bkW
Total Pump Power[5]	80	bhp	60	bkW
Total Power	349	bhp	260	bkW
Standard Aeration Efficiency	4.37	lb O_2/bhp-hr	2.66	kg O_2/bkW-h
Power Density	353	bhp/MG	70	bkW/1000 m^3

[1] A standard m3 of air defined at 20°C, 1 atm, and 36% RH.
[2] Does not includes losses in the out-of-basin piping (typically 1 psi/0.07 bar).
[3] Does not include losses in out-of-basin piping (typically 2 ft /0.6 m).
[4] Assumes blower adiabatic efficiency of 70%.
[5] Assumes pump hydraulic efficiency of 80%.

June 28, 2013

MTS# M213171 Rev 1D

CEC, Inc

SCOPE OF SUPPLY

- Eight (8) MTS model MT4JM-18 directional jet aeration manifolds fabricated of FRP, two for each tank, consisting of eighteen (18) model MT4 aeration jets mounted on one side of the liquid distribution manifold and connected to the air distribution manifold. The MT4 jet aeration nozzle is fabricated using a silicon carbide rich fiberglass resin for superior abrasion resistance and is capable of passing a 2.0-inch spherical solid particle. The liquid pipe shall be **18-inch diameter**, reducing to 14-inch and the air pipe shall be 10-inch diameter. The manifold shall be reduced to mate with a **16-inch tank penetration**. The jet aeration manifold shall be shipped in integral manifold section up to 40 feet in length with fiberglass field wrap kits for connection during installation.

- Eight (8) pump inlet suction bell fabricated of FRP. Each suction bell shall be flanged for connection to the tank interface flange. **24" bell x 16" flange.**

- In-basin supports shall be fabricated using Type 316 stainless steel and hardware shall be Type 316 stainless steel. Support saddle liners shall be neoprene rubber.

- Five (5) 200-Hp positive displacement blower complete with base, V-belt drive and guard, discharge check valve, discharge pressure gauge, inlet filter and silence, discharge silencer, discharge temperature gauge, blow-off pressure relief valve, discharge flexible connector, outdoor sound enclosure, and 200 Hp TEFC motor. The blower shall be sized for a duty point of 2140 SCFM at a discharge pressure of 14.3 psig. The blowers will also include the optional hood for outdoor enclosure, and the optional isolated bearing kit (required for VFD-operated motors of this size).

- Four (4) 50-Hp end suction centrifugal liquid recirculation pump, complete with base, duplex stainless steel impeller, cast iron casing, dynamic seal, V-belt drive and guard, and 50 HP TEFC motor. The pump shall be sized for a duty point of 6588 gpm at 18 ft TDH.
  Note: Pumps are rough aligned at the factory, final alignment after installation is recommended (to be provided by others).

PRICING - FOB (Factory)

In tank manifolds, supports and hardware.............................. $409,000.00 USD
Blowers .... $326,300.00 USD
Pumps .... $139,000.00 USD

jet aeration systems

June 26, 2013

MTS# M213171 Rev 1C

CEC, Inc

PAYMENT TERMS

Terms of payment require net cash payment at the time of invoice for the first payment and within 30 days from the date of invoice for shipment. Accounts not paid on net cash due date shall bear interest at the rate of 2% per month on the outstanding balance. Partial payment against partial shipment shall be permitted and shall be net 30 days.

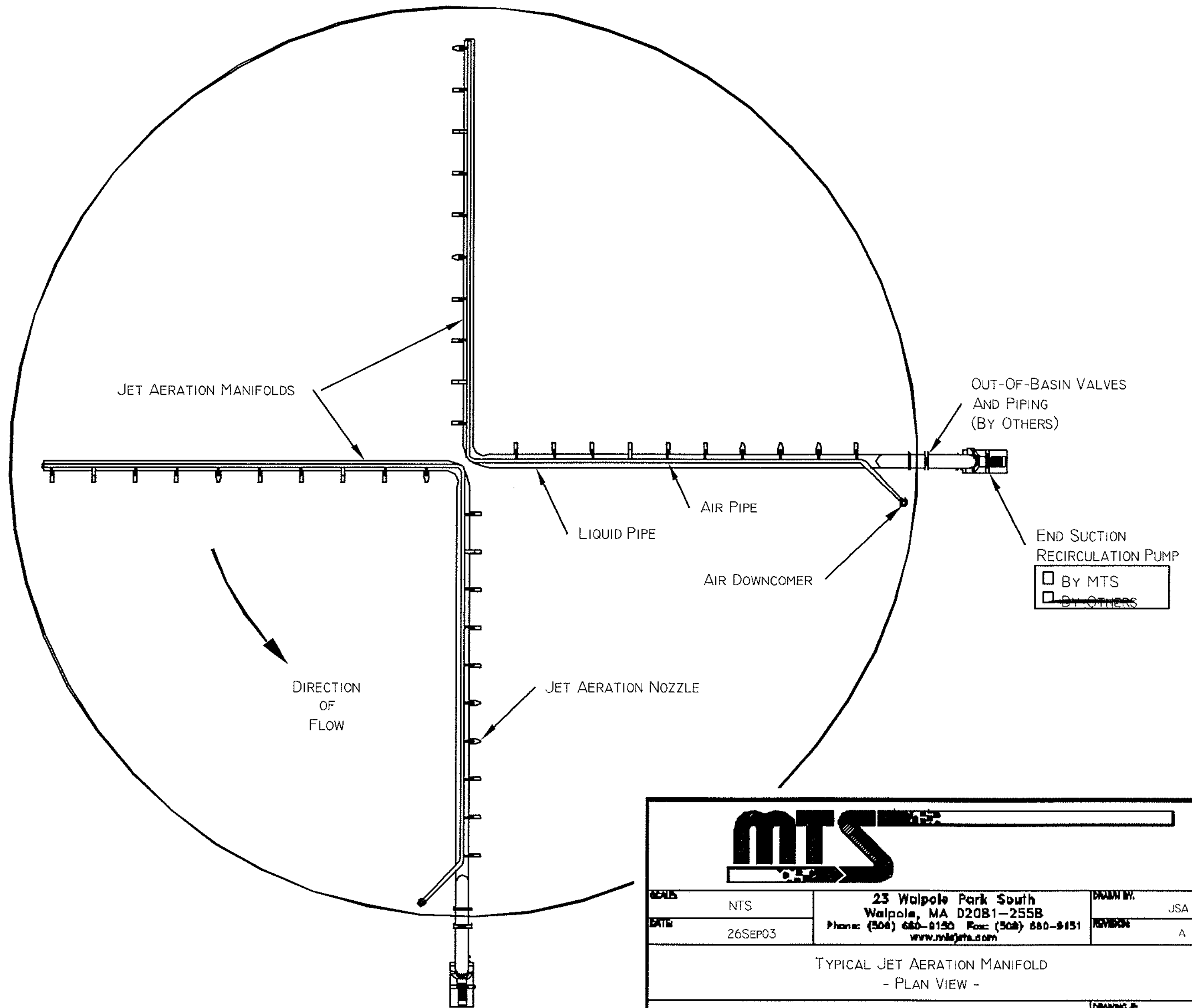
Invoicing shall be applied upon the following schedule:
Drawing Approval .... 30% of Purchase Order Value
Shipment of Equipment .... 70% of Purchase Order Value

DELIVERY

The following delivery schedule is based on current availability of materials. This delivery schedule can be confirmed at the time of an order.

Drawings for Approval ....Approx. 2-3 weeks after order acceptance
Shipment of Manifolds ....Approx. 12-16 weeks after release to manufacture
Shipment of Blowers.............Approx. 10-18 weeks after release to manufacture.
Shipment of Pumps ....Approx. 8-16 weeks after release to manufacture.

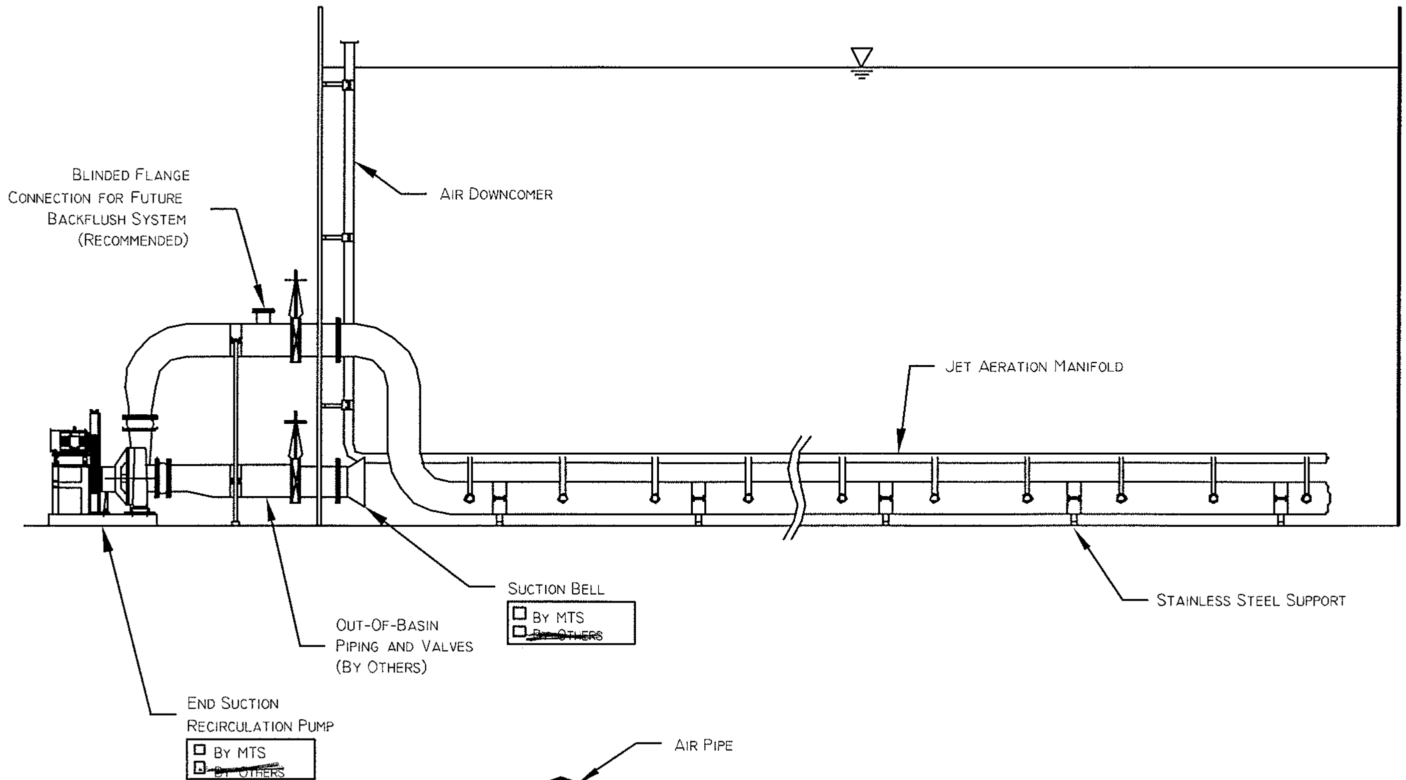
NOTE: Above lead times will be improved wherever possible. A pair of manifolds for the first tank will be fabricated in 4-5 weeks.

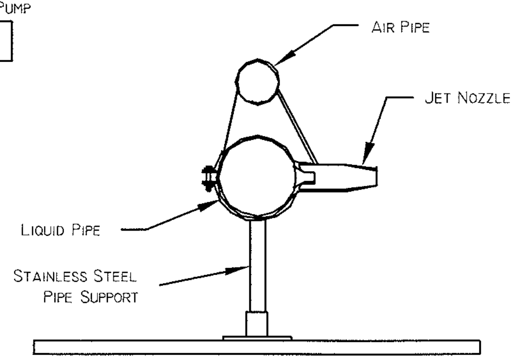


SCALE: NTS	23 Walpole Park South Walpole, MA 02081-2558 Phone: (508) 660-8150 Fax: (508) 660-8151 www.mtsjets.com	DRAWN BY: JSA
DATE: 26SEP03		REVISION: A

Typical Jet Aeration Manifold
- Plan View -

DRAWING #: PA_JM_001





Typical Manifold Section

Scale: NTS	23 Walpole Park South Walpole, MA 02081-2558 Phone: (508) 660-9150 Fax: (508) 660-9151 www.mtsjets.com	Drawn By: JSA	
Date: 03Aug18		Revision: B	
Typical Jet Aeration Manifold - Elevation View -			
		Drawing #: EA_JM_001	

A	BUILT RELEASE	MH	12/26/13
B			
C			
D			

Intrinsically Safe Installation instructions

INTRINSIC SAFE WIRING MUST ENTER ENCLOSURE THROUGH A DEDICATED CONDUIT CONTAINING ***NO NON-INTRINSICALLY SAFE WIRING.***

THE INTRINSICALLY SAFE CONDUIT MUST ENTER THE PANEL WITHIN THE LIMITS MARKED ON THE INSIDE OF THE CONTROL PANEL ENCLOSURE AND A MINIMUM OF 2" AWAY FROM NON-INTRINSICALLY SAFE CONDUIT.

TRANSDUCER LEAD LENGTH MUST NOT EXCEED 1000' TO MAINTAIN INTRINSICALLY SAFE INTEGRITY.

TRANSDUCER CONNECTION TO INTRINSIC TERMINAL BLOCKS MUST BE MADE IN ACCORDANCE WITH ARTICLE 504 OF THE NATIONAL ELECTRICAL CODE.

CONNECTIONS TO INTRINSICALLY SAFE TERMINAL BLOCKS MUST NOT STORE OR GENERATE MORE THAN 1.2 VOLTS, 0.1 AMPERES, 25 MILLIWATTS, OR 20 MICROJOULES.

INTRINSICALLY SAFE WIRING MUST ONLY BE CONNECTED TO THE TERMINAL BLOCKS MARKED WITH LABEL STATING "INTRINSICALLY SAFE FIELD WIRING TERMINALS" AND MUST NOT EXTEND OUTSIDE OF THE INTRINSICALLY SAFE AREA.

NON-INTRINSICALLY SAFE WIRING MUST NOT BE CONNECTED TO INTRINSICALLY SAFE TERMINAL BLOCKS NOR CROSS THE INTRINSIC SAFE AREA OF THE CONTROL PANEL.

General Wiring Installation Instruction

To Maintain Enclosure Type Rating, all penetrations must be fitted with a Device or Hub with the same environmental rating as specified on the nameplate.

Avoid penetrating the enclosure above the controller height.

Use Killark ENY or EY (or equal) conduit seal and Killark SC (or equal) sealing compound for all conduit entries to prevent gas from entering enclosure and to maintain warranty.

Use COPPER CONDUCTORS ONLY for all field connections.

Use minimum 60° C wire for all field connections:

- MDS Connection – 14 to 4 AWG, Torque 55 LB-IN Max.
- GND Connection – 14 to 6 AWG, Torque 45 LB-IN Max.
- TB1,2,3,4,5,6,7,8 Connection – 24 to 10 AWG, Torque 4.4 to 7 LB-IN
- ISB Connection – 30 to 12 AWG, Torque 4 LB-IN Max.
- Relay Connection – 24 to 12 AWG, Torque 7 LB-IN
- M1-M6 Connection - 22 to 8 AWG, Torque 10.6 to 12.3 LB-IN

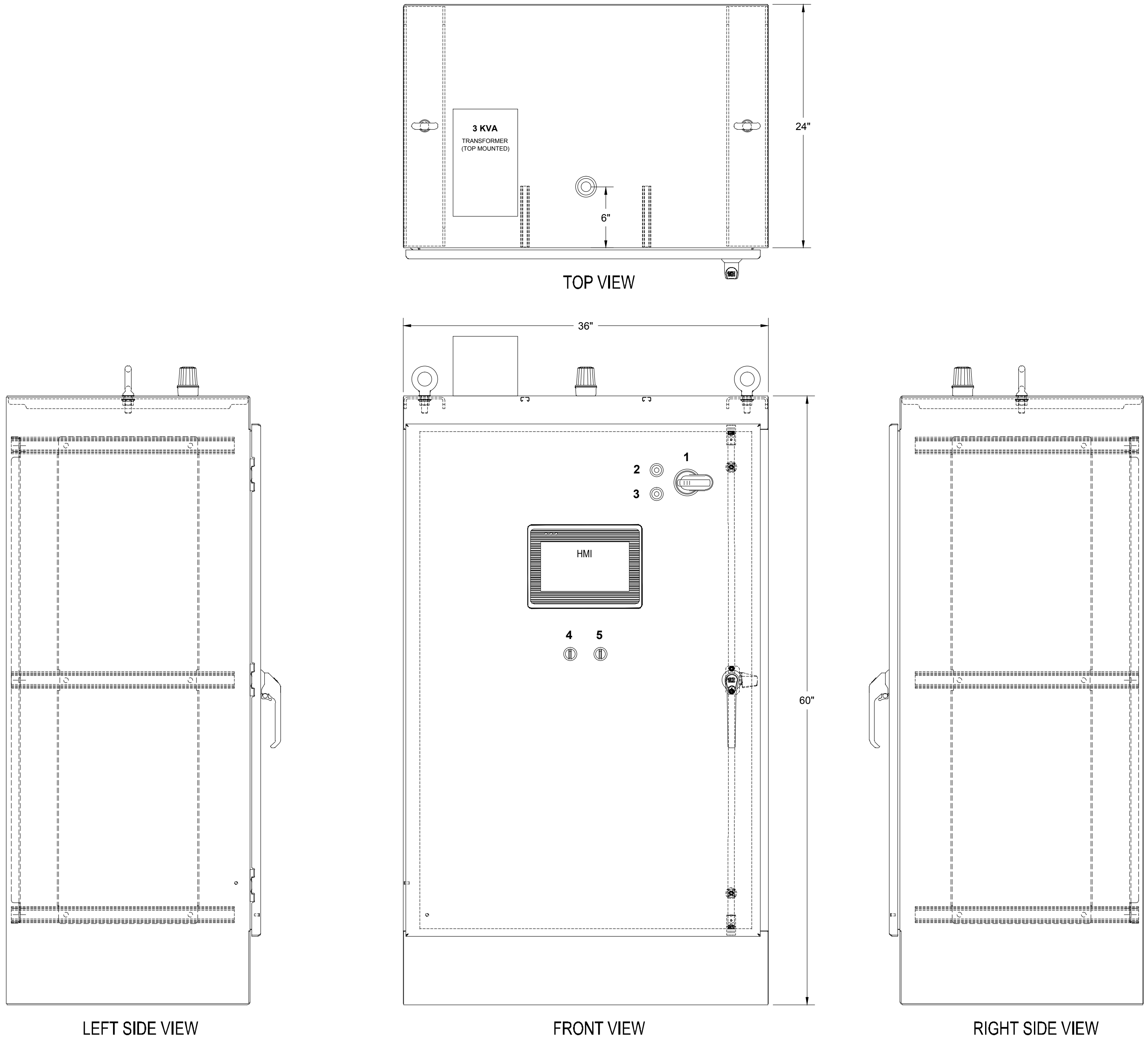
LEGEND:

- ◎ - INDICATES TERMINAL BLOCK
- – – – – - INDICATES FIELD WIRING
- - ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- - SURGE GROUNDING
- - EQUIPMENT GROUNDING

SLIGO SYSTEMS
Landfill Pumps & Controls
Lake Helen, Florida
386-218-4981
www.sligosystems.com

CUSTOMER: LAND-REP-BRIDGE		JOB #: 1013-0162	
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV A
DRAWN BY MHH	APP'D. MHH	SHT. 1 OF 31	

A	BUILT RELEASE	MH	12/26/13
B			
C			
D			



DEVICE LEGEND:

1	MAIN POWER DISCONNECT
2	CONTROL POWER ON LIGHT (AMBER)
3	UPS POWER ON LIGHT (RED)
4	ANTI FOAM #1 HAND-OFF-AUTO
5	SODIUM HYDROXIDE PUMP HAND-OFF-AUTO

ELECTRICAL ENCLOSURE 60" X 36" X 24"
TYPE 4 (PAINTED STEEL)

NOTE:
COMPLETED PUMP CONTROL PANEL ASSEMBLY WILL BE UL LISTED AND LABELED UNDER STANDARD 698A

NOTE:
1. THIS PANEL MUST BE INSTALLED OBSERVING ALL APPLICABLE STATE AND LOCAL CODES, AND AS PER LATEST REVISION OF NEC. THIS SHALL INCLUDE, BUT NOT BE LIMITED TO, ANY REQUIRED SERVICE ENTRANCE EQUIPMENT NOT INCLUDED IN THIS CONTROL PANEL.
2. ENCLOSURE MUST BE CONNECTED TO A GOOD EARTH GROUND.

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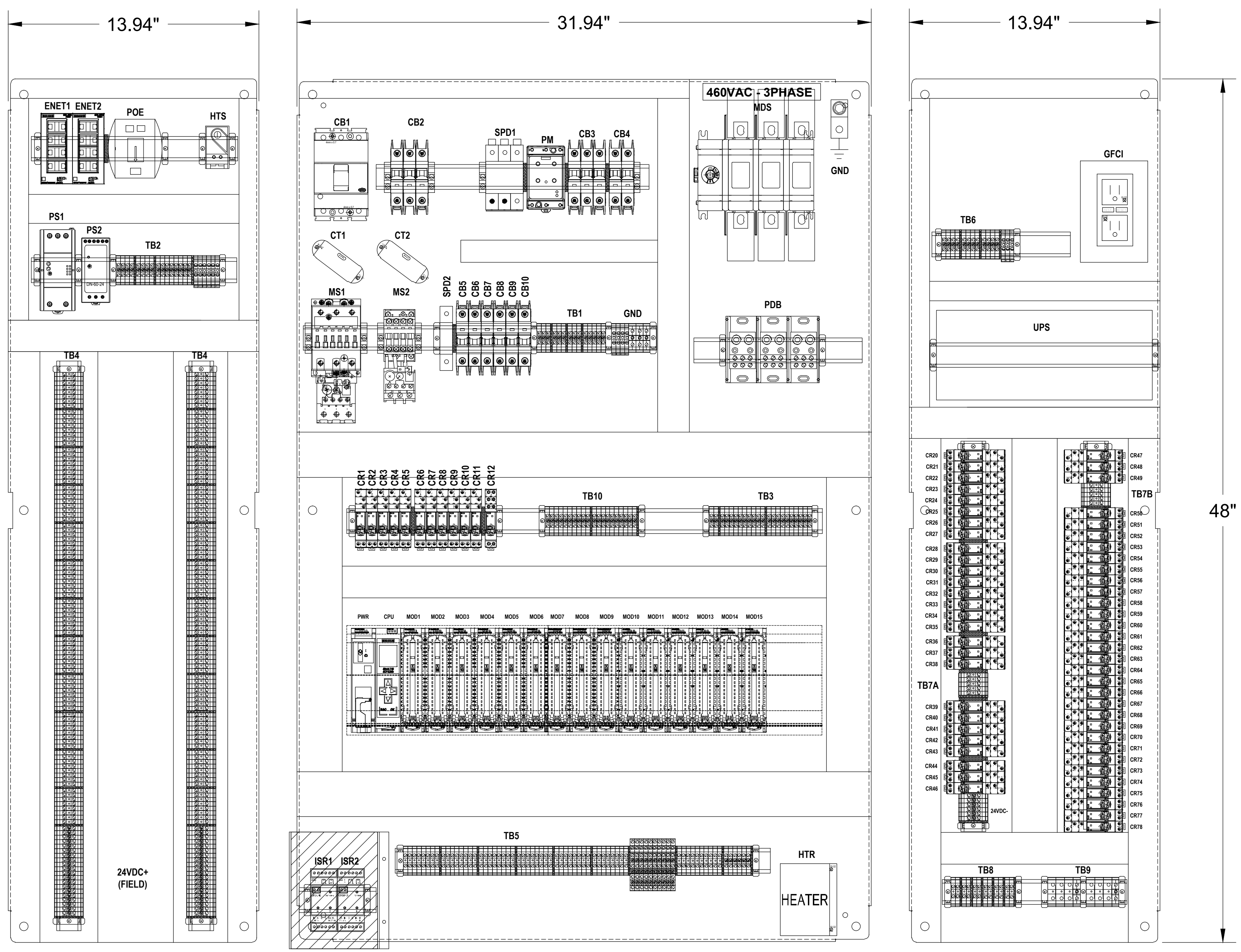
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV A
DRAWN BY MHH	APP'D. MHH	SHT. 2 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	ADDED TB10	MH	01/24/14
C			
D			



LEFT SIDE PANEL

BACK PANEL

RIGHT SIDE PANEL

NOTES:

MDS	460VAC - 200AMP RATED (ABB)	MAIN DISCONNECT SWITCH
CB1	460VAC - 3POLE - 80AMP (ABB)	ANTI FOAM #1
CB2	460VAC - 3POLE - 10AMP (EATON)	SODIUM HYDROXIDE PUMP
CB3	460VAC - 3POLE - 2AMP (EATON)	POWER MONITOR
CB4	460VAC - 2POLE - 10AMP (EATON)	TRANSFORMER
CB5	120VAC - 1POLE - 15AMP (EATON)	120VAC POWER
CB6	120VAC - 1POLE - 02AMP (EATON)	GFCI OUTLET
CB7	120VAC - 1POLE - 02AMP (EATON)	ENCLOSURE HEATER
CB8	120VAC - 1POLE - 02AMP (EATON)	VALVE ACTUATORS POWER
CB9	120VAC - 1POLE - 02AMP (EATON)	120VAC CONTROL POWER
CB10	120VAC - 1POLE - 03AMP (EATON)	DC POWER SUPPLY

CR1	24VDC - SPDT (FINDER)
CR2	24VDC - SPDT (FINDER)
CR3	24VDC - SPDT (FINDER)
CR4	120VAC - SPDT (FINDER)
CR5	24VDC - SPDT (FINDER)
CR6	24VDC - SPDT (FINDER)
CR7	24VDC - SPDT (FINDER)
CR8	24VDC - SPDT (FINDER)
CR9	24VDC - SPDT (FINDER)
CR10	24VDC - SPDT (FINDER)
CR11	24VDC - SPDT (FINDER)
CR12	120VAC - DPDT (FINDER)

CR20 to CR78	24VDC - SPDT (FINDER)

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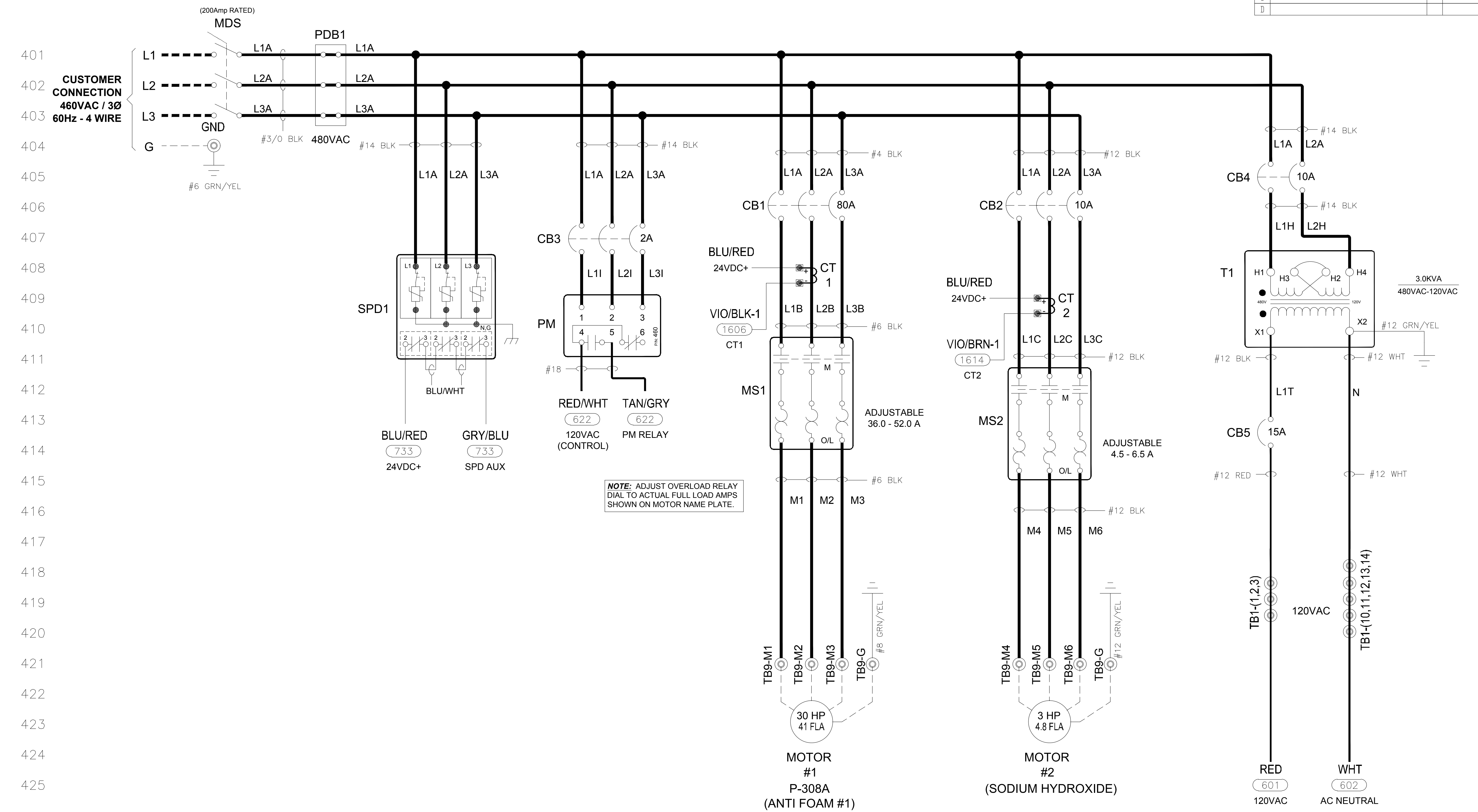
CUSTOMER: LAND-REP-BRIDGE		JOB #: 1013-0162	
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 3 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C			
D			



LEGEND:

- ◎ - INDICATES TERMINAL BLOCK
- – – – – INDICATES FIELD WIRING
- - ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- - SURGE GROUNDING
- - EQUIPMENT GROUNDING

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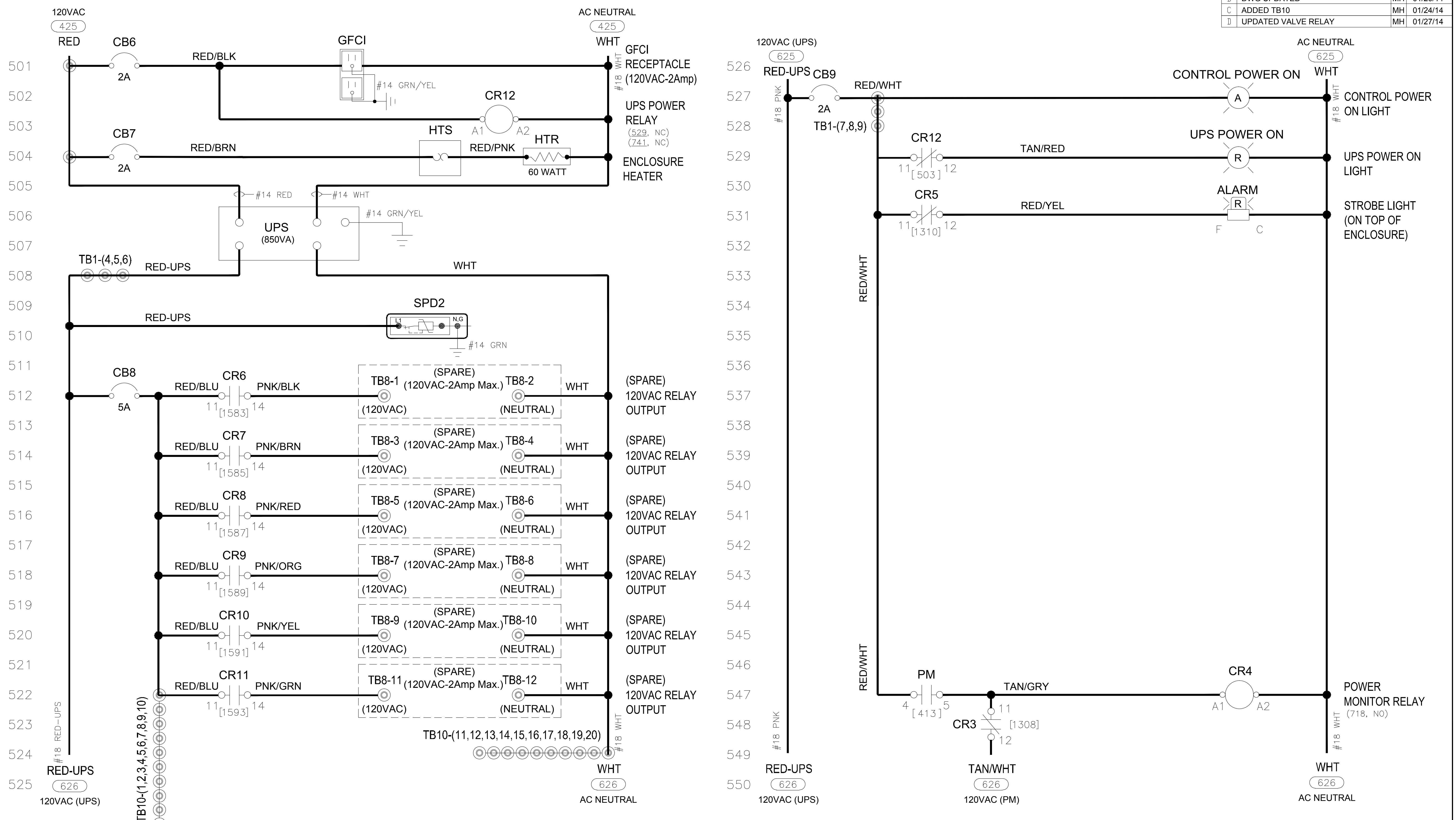
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 4 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	ADDED TB10	MH	01/24/14
D	UPDATED VALVE RELAY	MH	01/27/14



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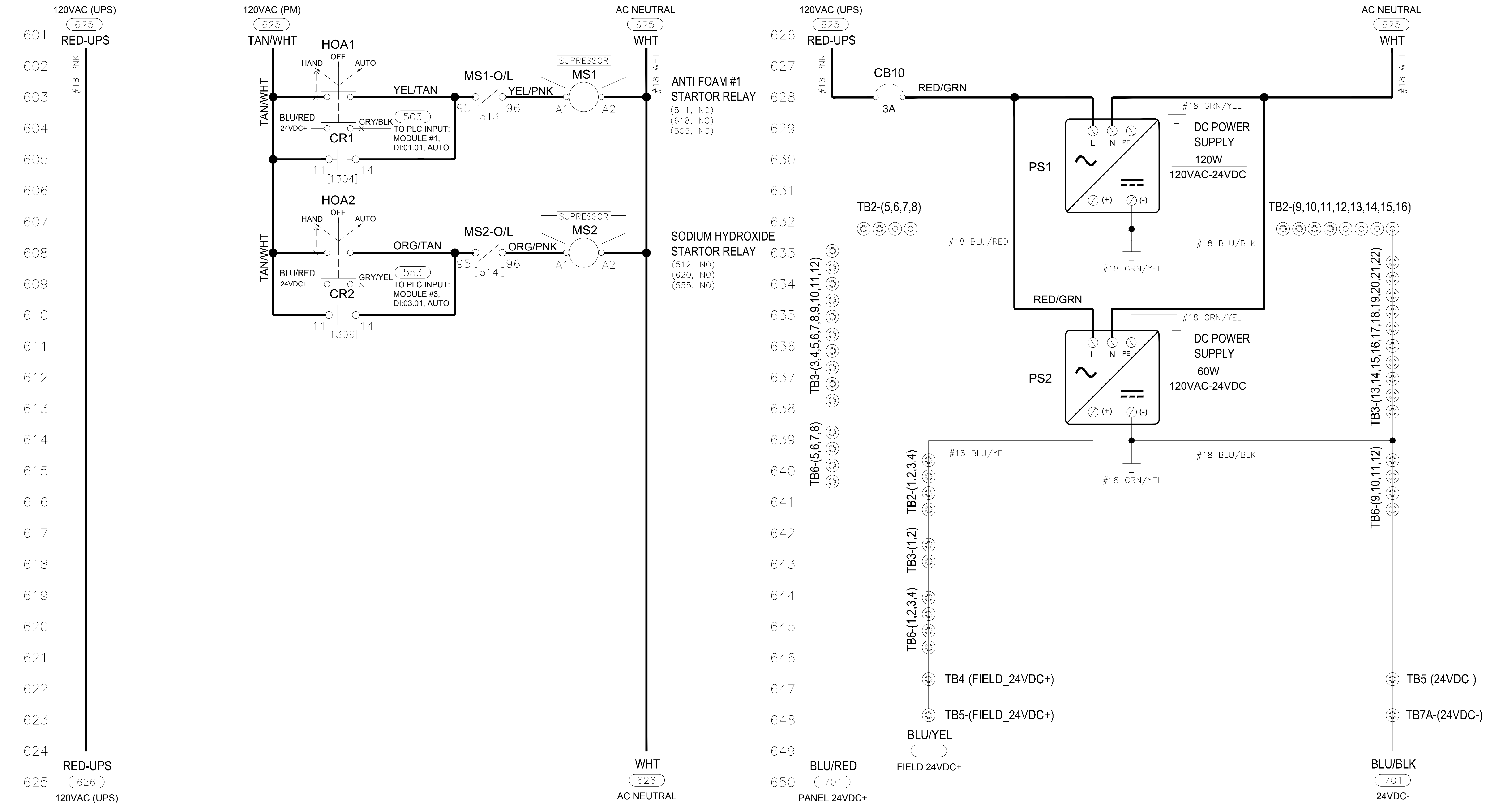
DWG. TITLE: BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV D
DRAWN BY MHH	APP'D. MHH	SHT. 5	OF 31

A	BUILT RELEASE	MH	12/26/13
B			
C			
D			



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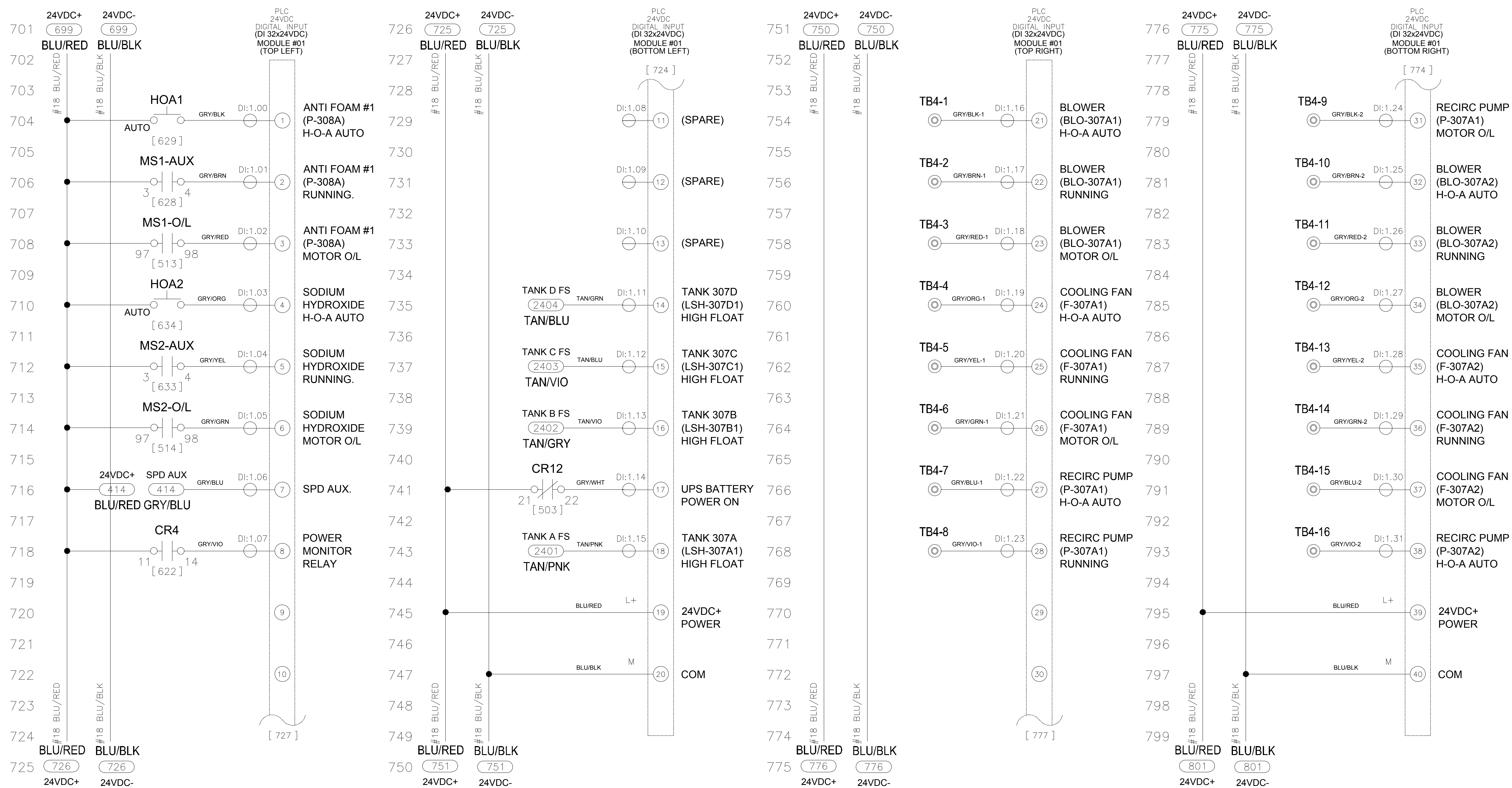
DRAWN BY MHH	APP'D. MHH	SHT. 6 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C			
D			



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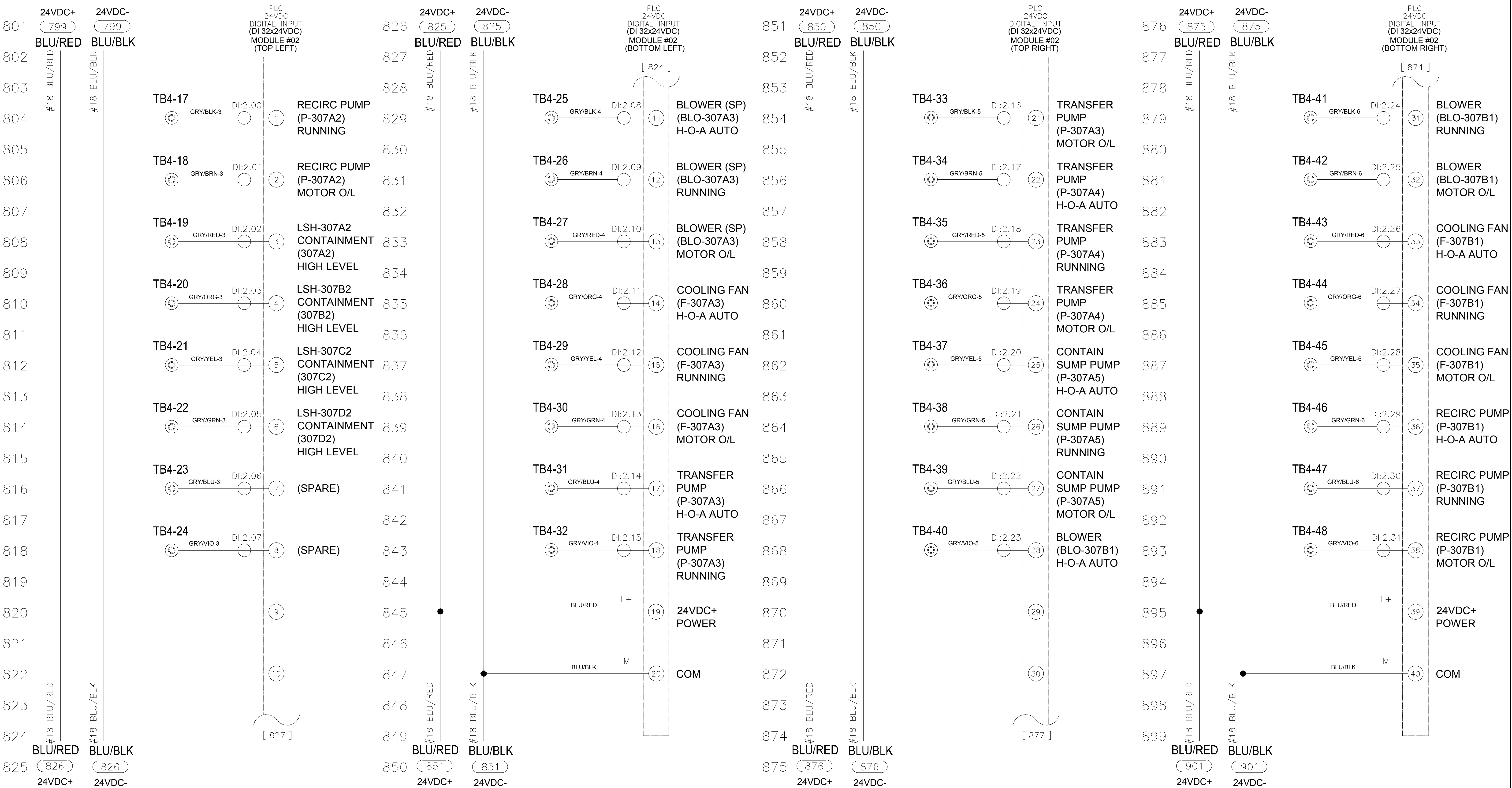
CUSTOMER: LAND-REP-BRIDGE | JOB #: 1013-0162

DWG. TITLE: BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL

DATE 10/07/2013 | CSD MHH | DWG.NO. E-5076 | REV B

DRAWN BY MHH | APP'D. MHH | SHT. 7 OF 31

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	HIGH LEVEL INPUT UPDATE	MH	02/07/14
D	HIGH LEVEL INPUT UPDATE	MH	02/14/14



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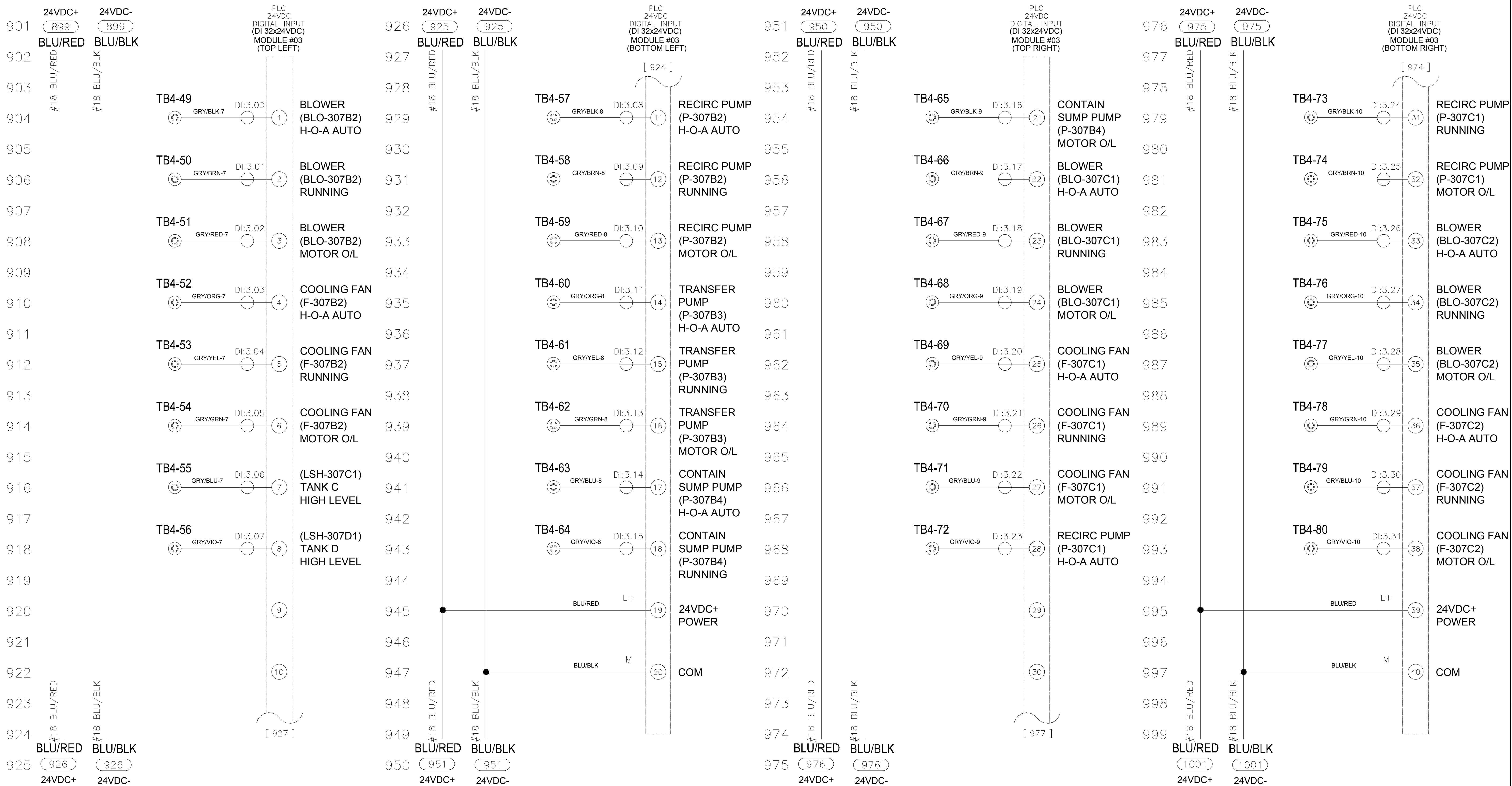
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV D
DRAWN BY MHH	APP'D. MHH	SHT. 8 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	HIGH LEVEL INPUT UPDATE	MH	02/07/14
D			



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Lake Helen, Florida
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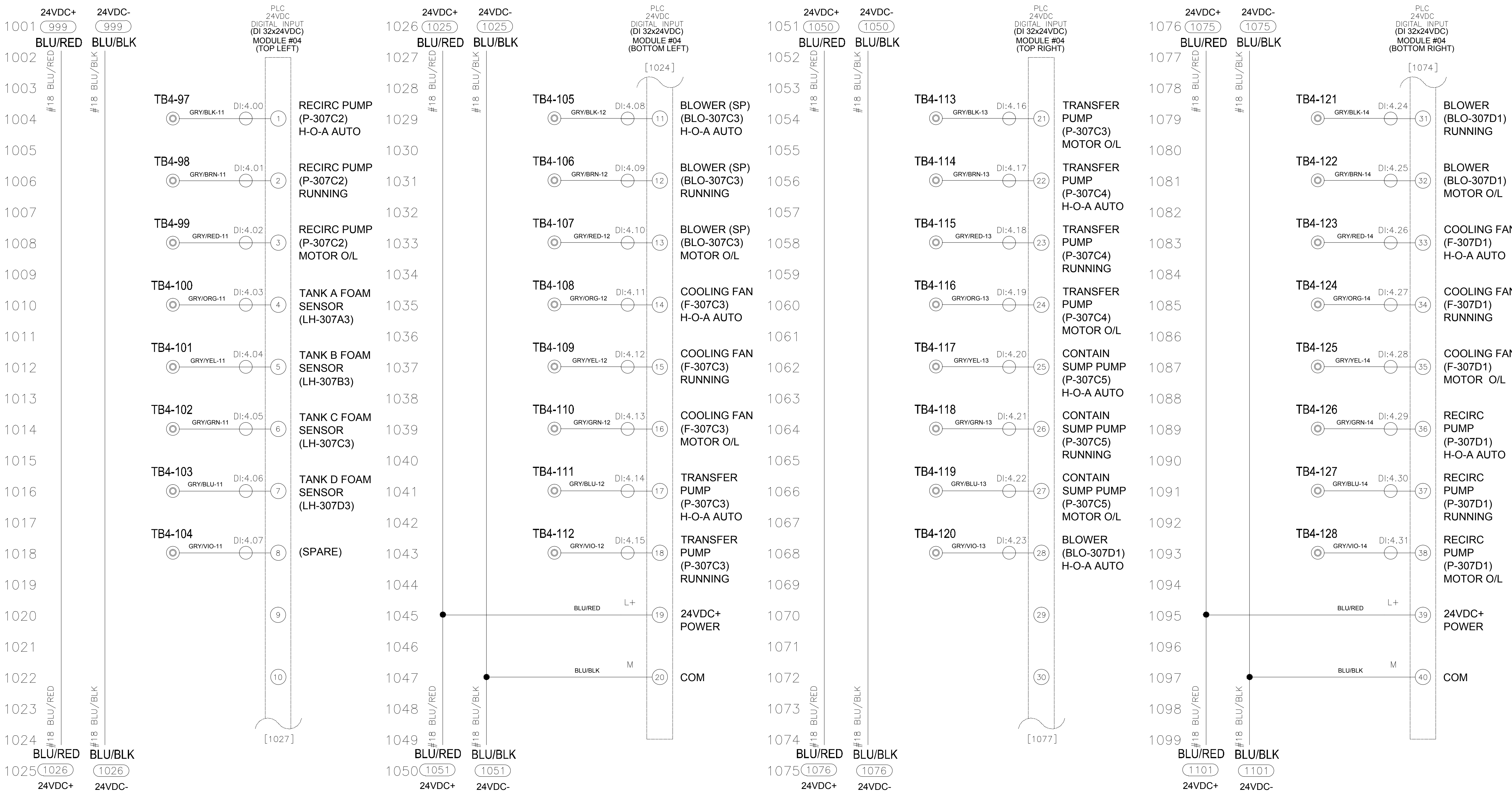
CUSTOMER: LAND-REP-BRIDGE
JOB #: 1013-0162
DWG. TITLE: BRIDGETON TANK FARM
460VAC - 3PH - SCADA CONTROL PANEL
DATE: 10/07/2013
CSD: MHH
DWG.NO. E-5076
REV: C
DRAWN BY: MHH
APP'D. MHH
SHT. 9 OF 31

A	BUILT RELEASE	MH	12/26/13
B	ADDED TANK FOAM SENSOR INPUTS	MH	02/14/14
C			
D			



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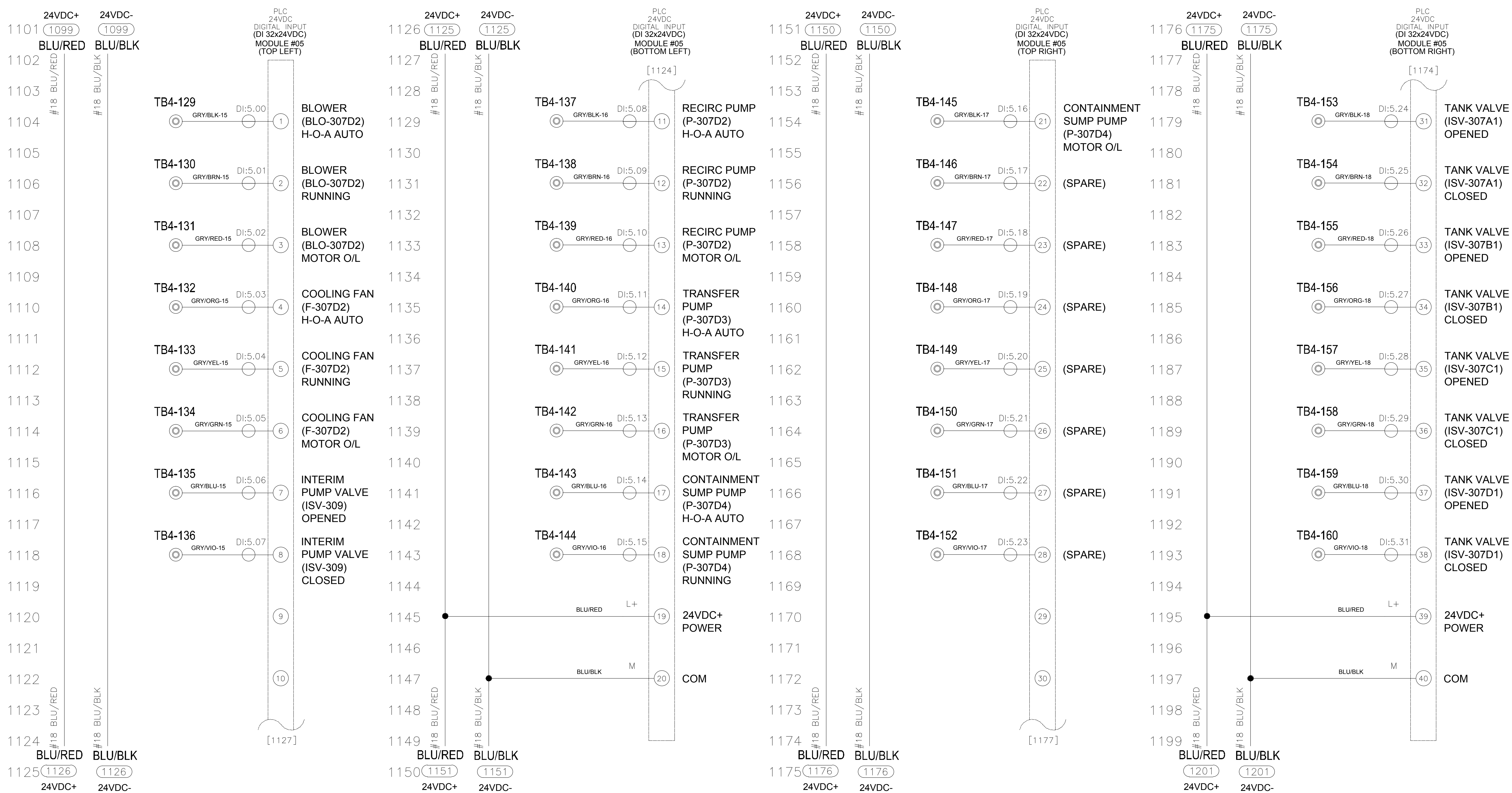
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 10 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C			
D			



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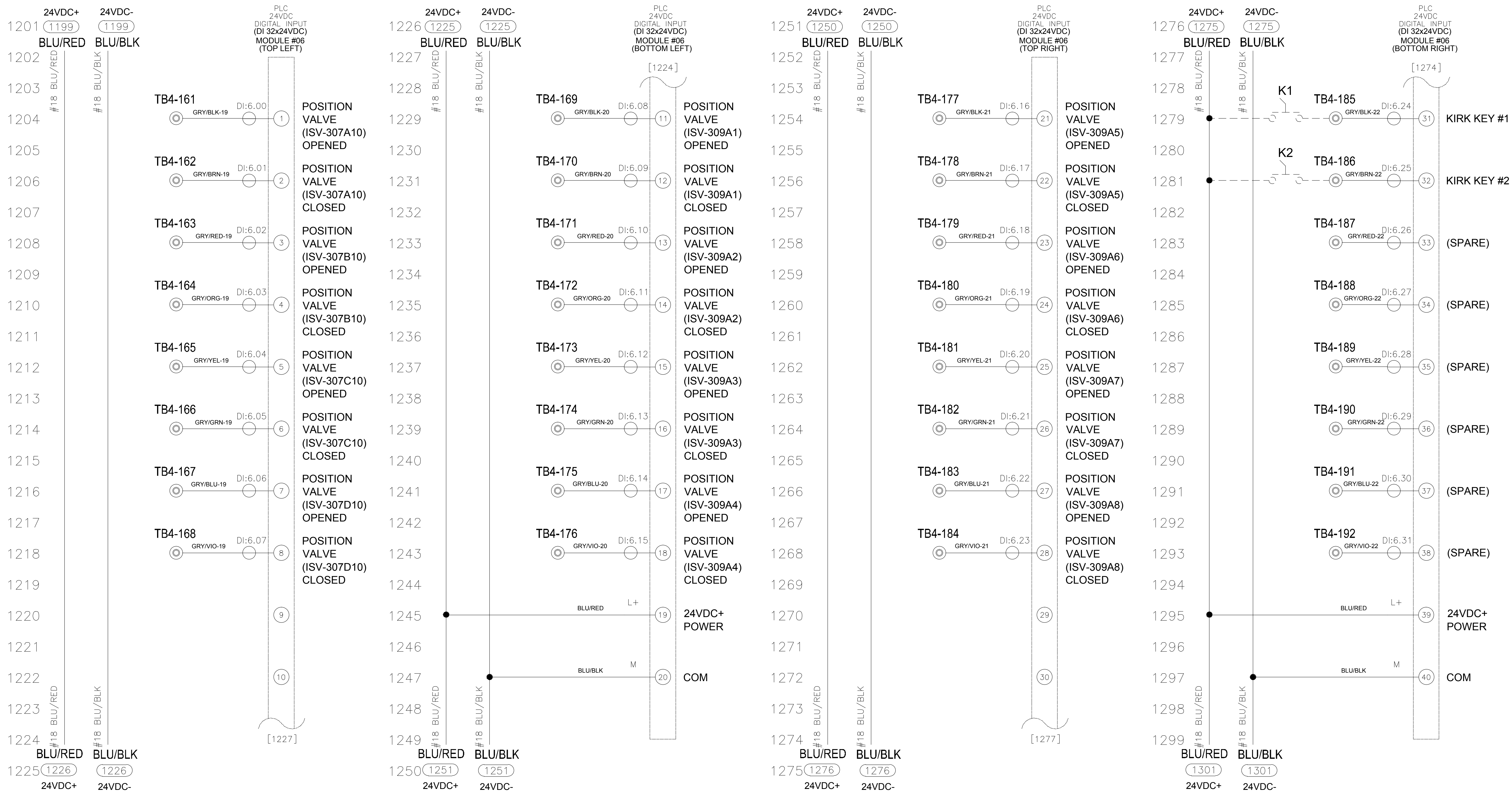
CUSTOMER: LAND-REP-BRIDGE		JOB #: 1013-0162	
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 11 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	REVISED VALVE INPUT	MH	01/24/14
D			



LEGEND:

- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- SURGE GROUNDING
- EQUIPMENT GROUNDING

SLIGO SYSTEMS
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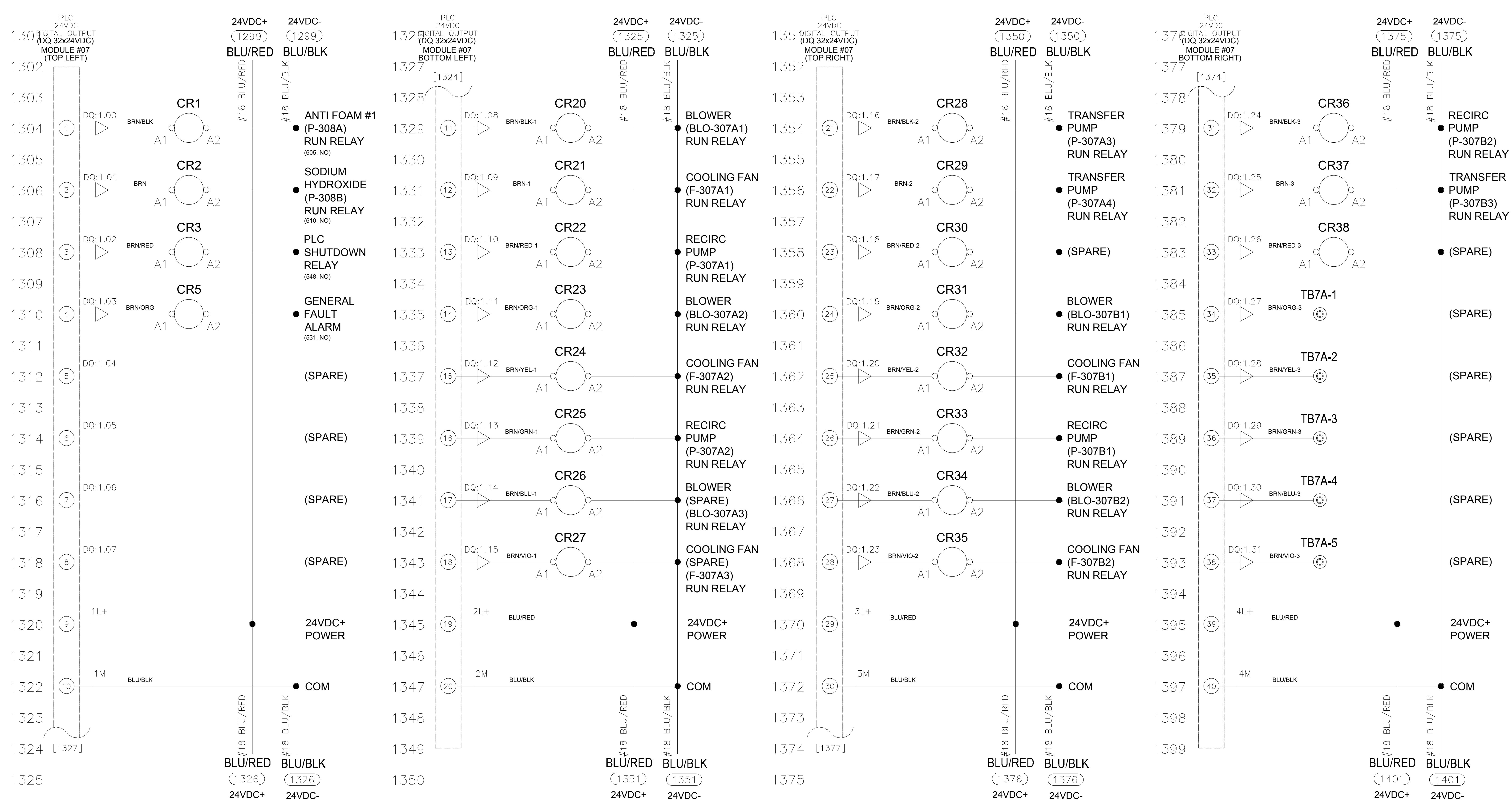
CUSTOMER: LAND-REP-BRIDGE — JOB #: 1013-0162

DWG. TITLE: BRIDGETON TANK FARM
460VAC - 3PH - SCADA CONTROL PANEL

DATE 10/07/2013 | CSD MHH | DWG.NO. E-5076 | REV C

DRAWN BY MHH | APP'D. MHH | SHT. 12 OF 31

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C			
D			



LEGEND:

- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- SURGE GROUNDING
- EQUIPMENT GROUNDING

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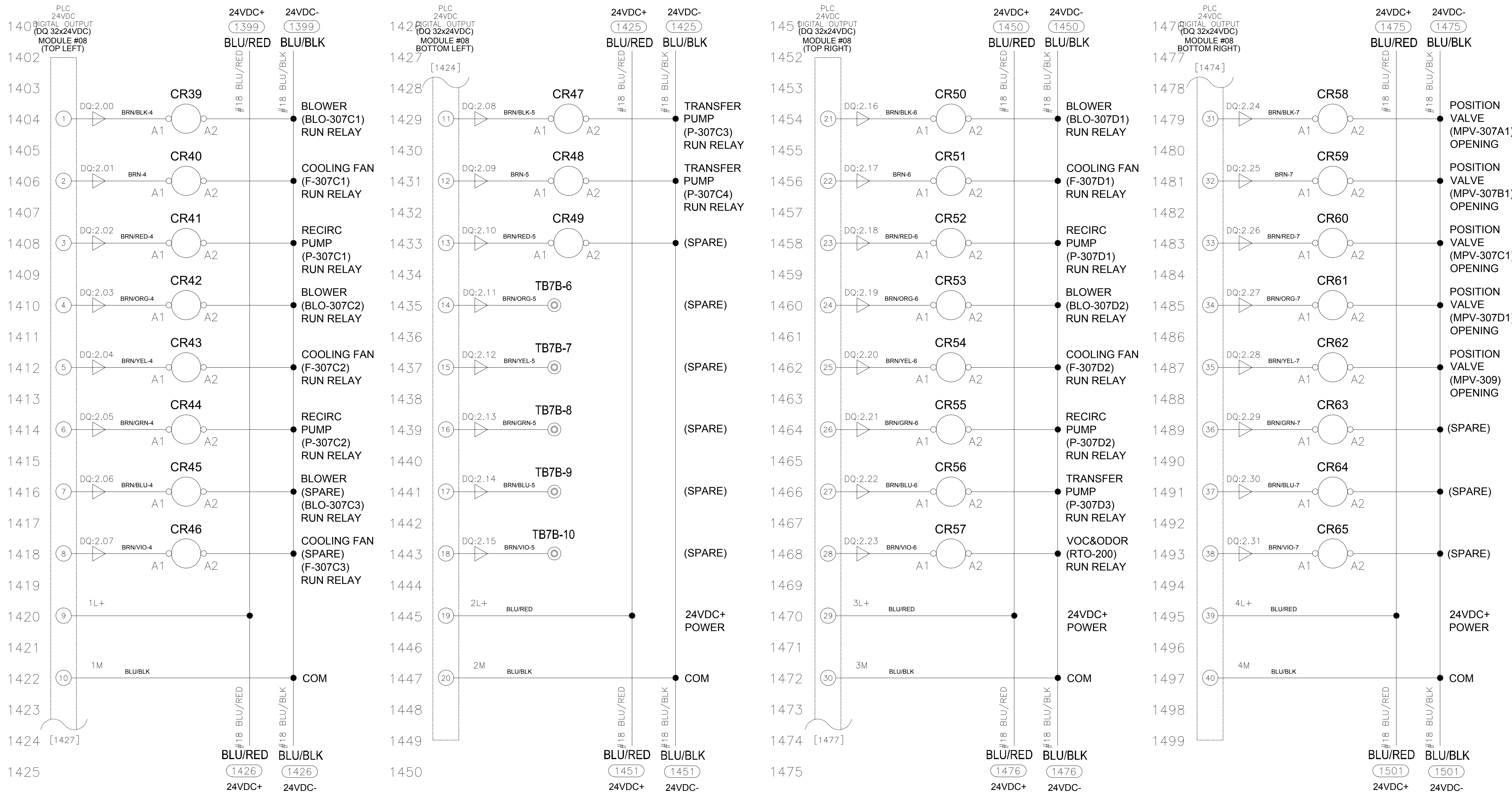
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE: BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 13 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	UPDATED VALVE RELAY	MH	01/27/14
D			



LEGEND:

- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- SURGE GROUNDING
- EQUIPMENT GROUNDING

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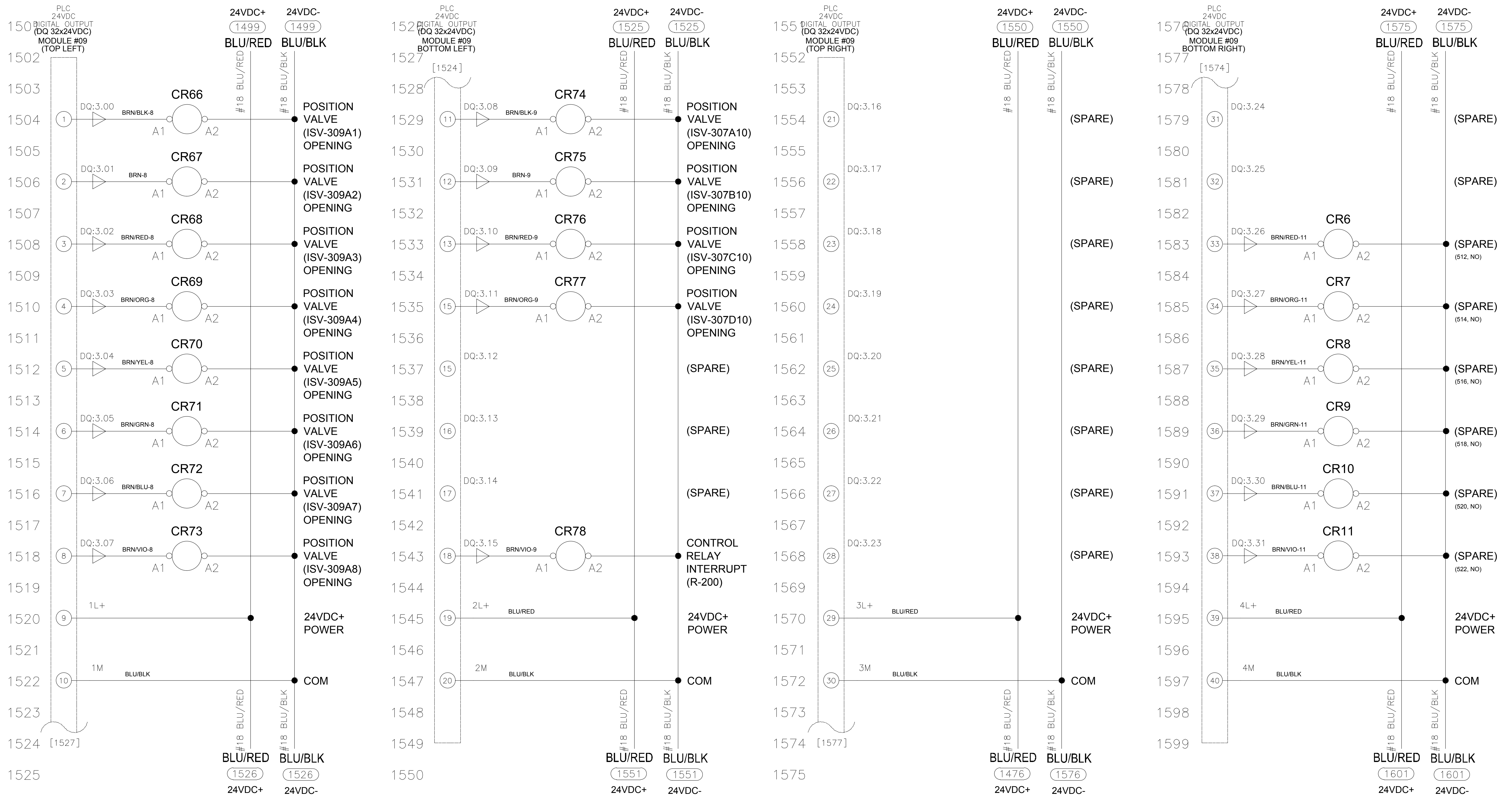
CUSTOMER: LAND-REP-BRIDGE		JOB #: 1013-0162	
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV C
DRAWN BY MHH	APP'D. MHH	SHT. 14 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	UPDATED VALVE RELAY	MH	01/27/14
D			



LEGEND:

- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- SURGE GROUNDING
- EQUIPMENT GROUNDING

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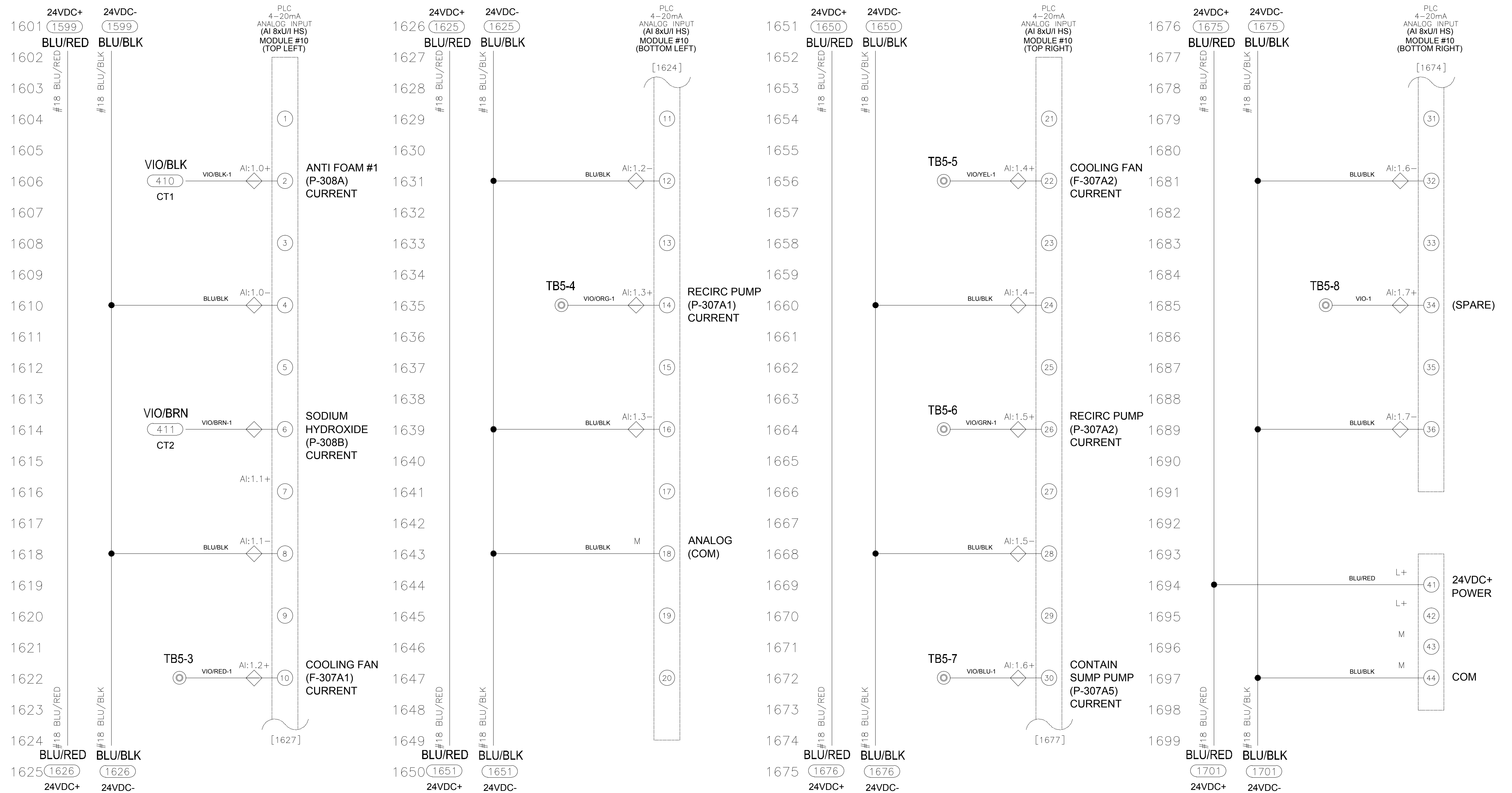
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV C
DRAWN BY MHH	APP'D. MHH	SHT. 15 OF 31	

A	BUILT RELEASE	MH	12/26/13
B			
C			
D			



LEGEND:

- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
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- EQUIPMENT GROUNDING

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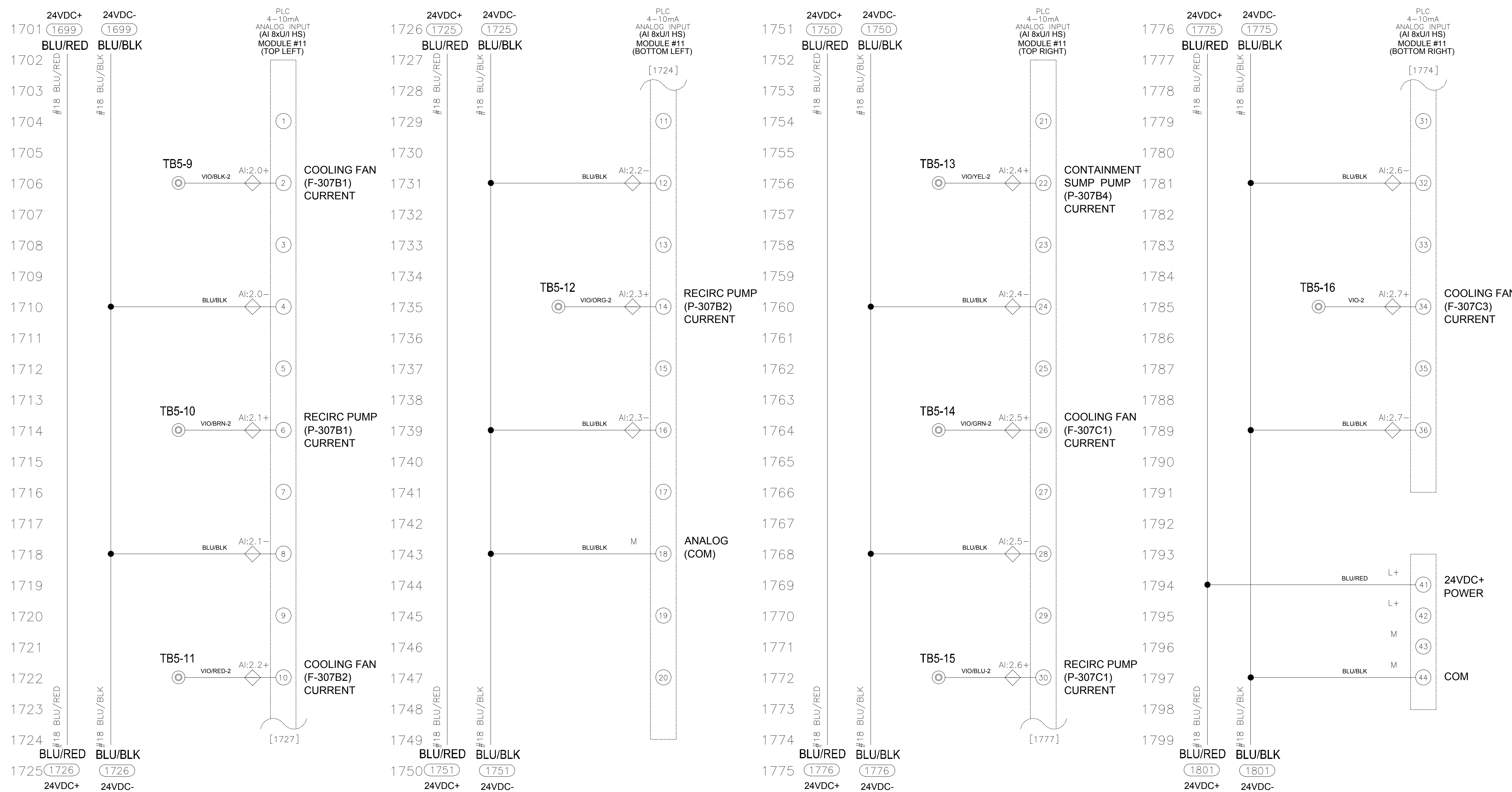
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV A
DRAWN BY MHH	APP'D. MHH	SHT. 16 OF 31	

A	BUILT RELEASE	MH	12/26/13
B			
C			
D			



LEGEND:

- INDICATES TERMINAL BLOCK
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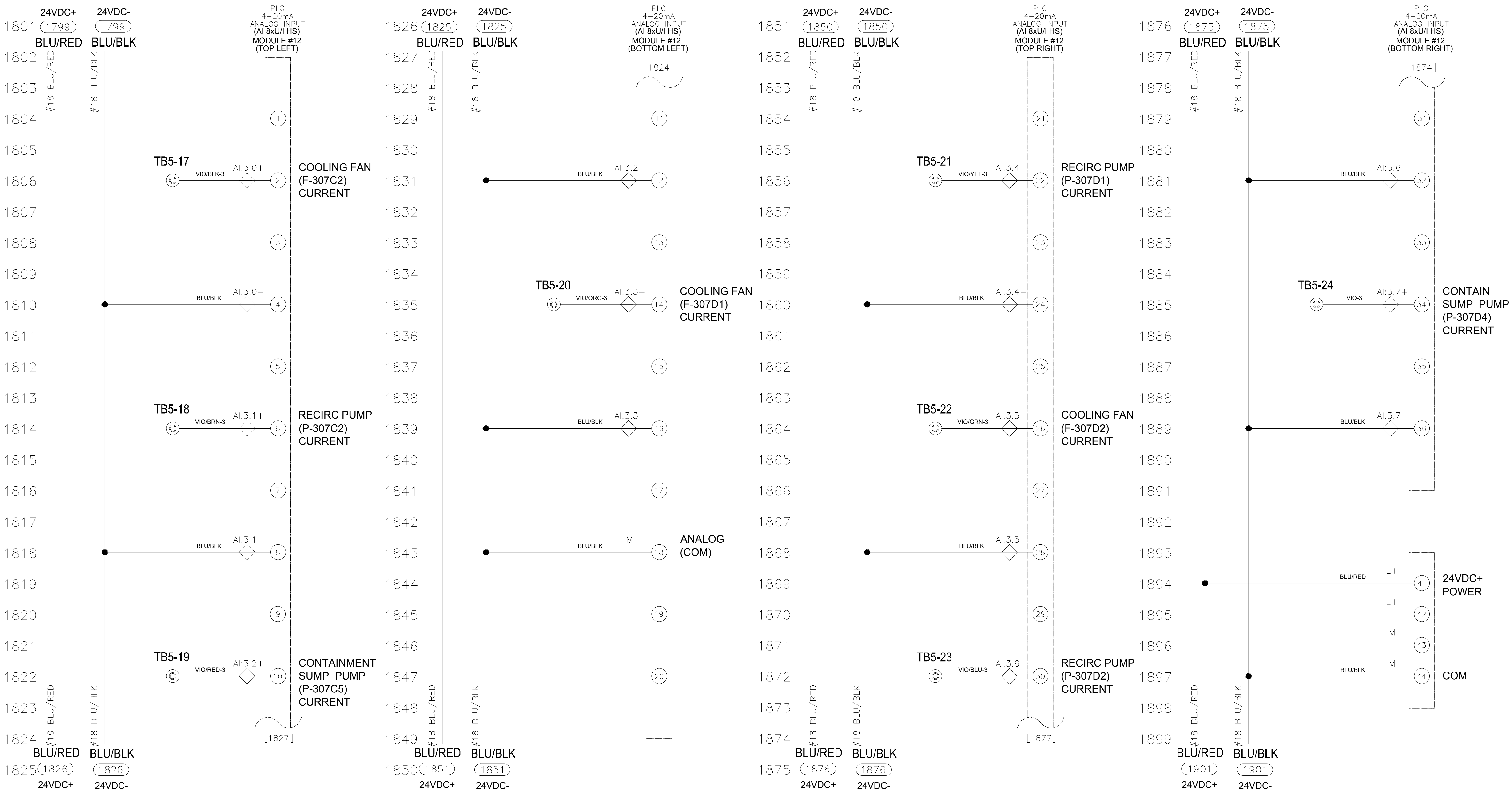
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV A
DRAWN BY MHH	APP'D. MHH	SHT. 17 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C			
D			



LEGEND:

- ◎ - INDICATES TERMINAL BLOCK
- - - - - INDICATES FIELD WIRING
- - ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- - SURGE GROUNDING
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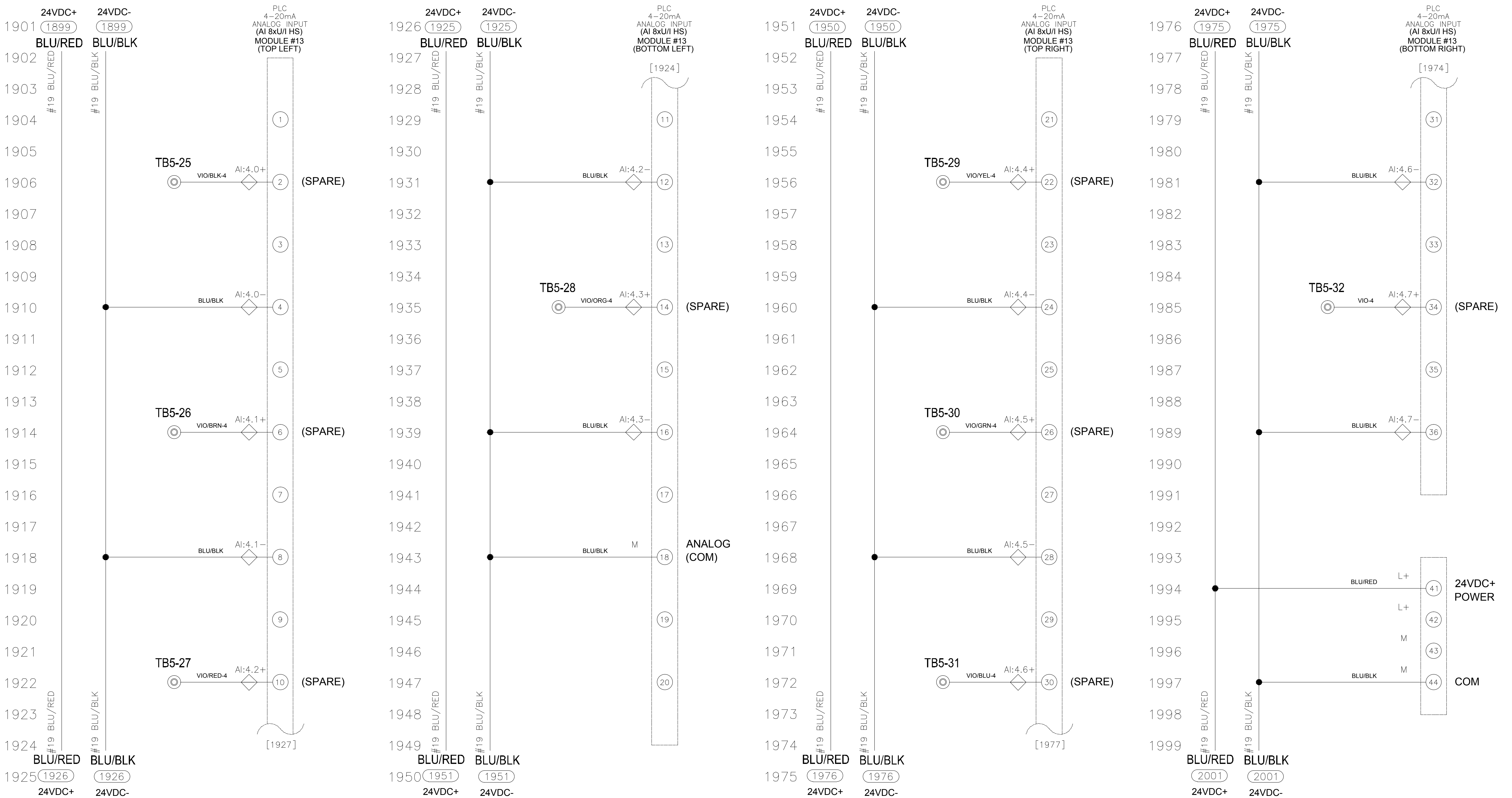
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 18 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	REVISED VALVE INPUT	MH	01/24/14
D			



LEGEND:

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- INDICATES FIELD WIRING
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- EQUIPMENT GROUNDING

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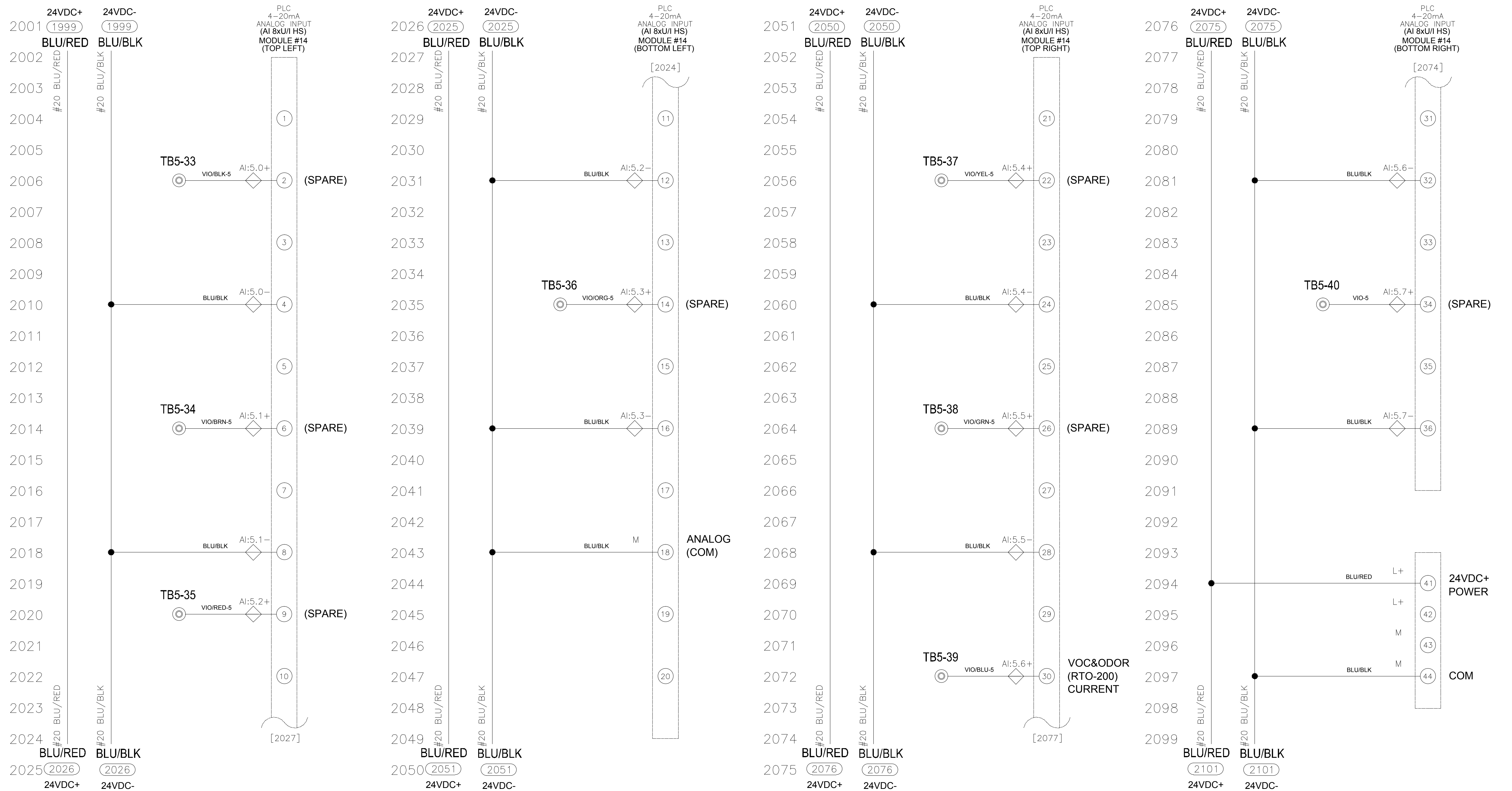
CUSTOMER: LAND-REP-BRIDGE JOB #: 1013-0162

DWG. TITLE: BRIDGETON TANK FARM
460VAC - 3PH - SCADA CONTROL PANEL

DATE 10/07/2013 | CSD MHH | DWG.NO. E-5076 | REV C

DRAWN BY MHH | APP'D. MHH | SHT. 19 OF 31

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	REVISED VALVE INPUT	MH	01/24/14
D			



LEGEND:

- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- SURGE GROUNDING
- EQUIPMENT GROUNDING

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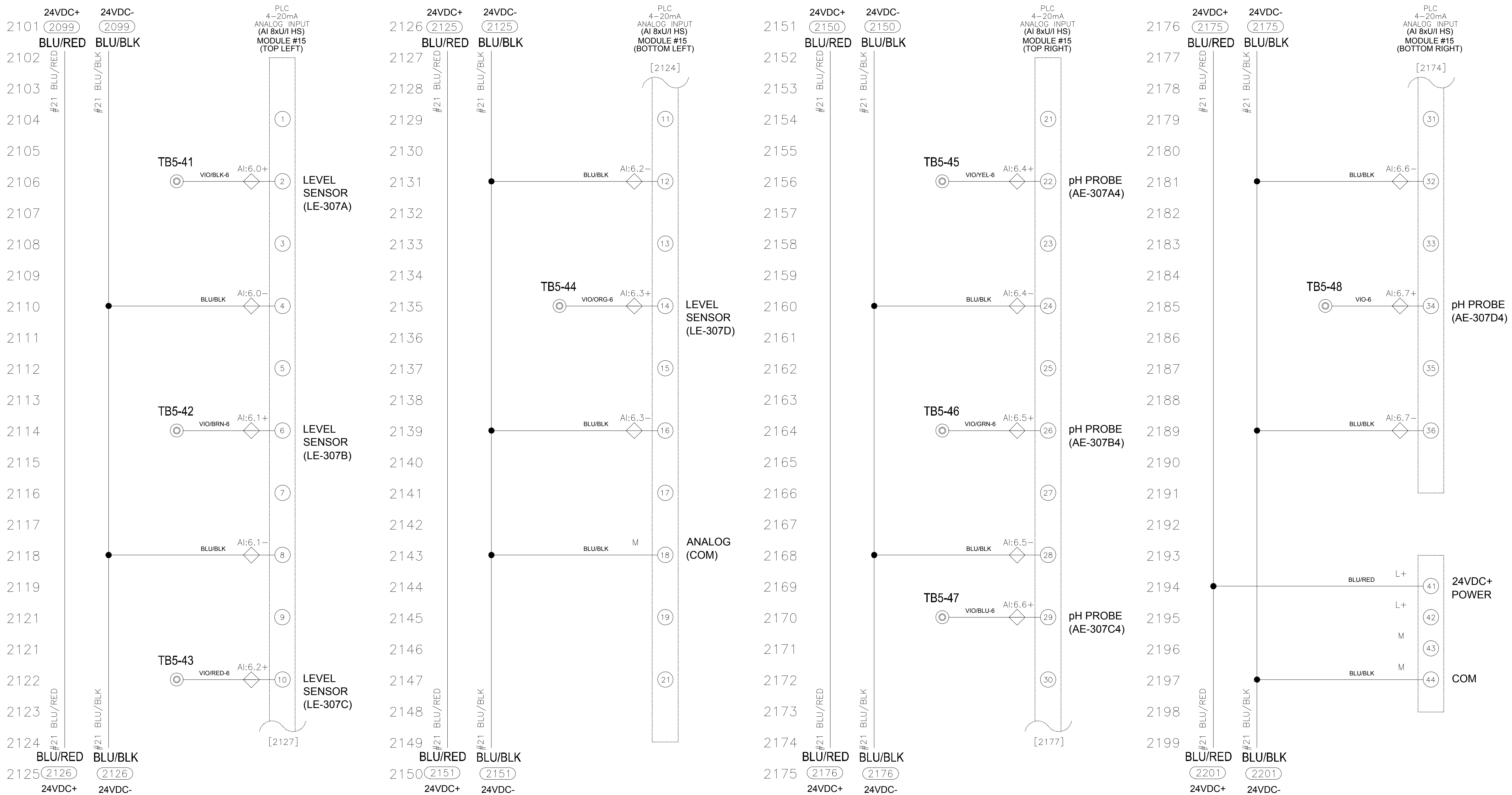
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE: BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV C
DRAWN BY MHH	APP'D. MHH	SHT. 20 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	ADD ANALOG pH PROBES	MH	02/14/14
C			
D			



LEGEND:

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- INDICATES FIELD WIRING
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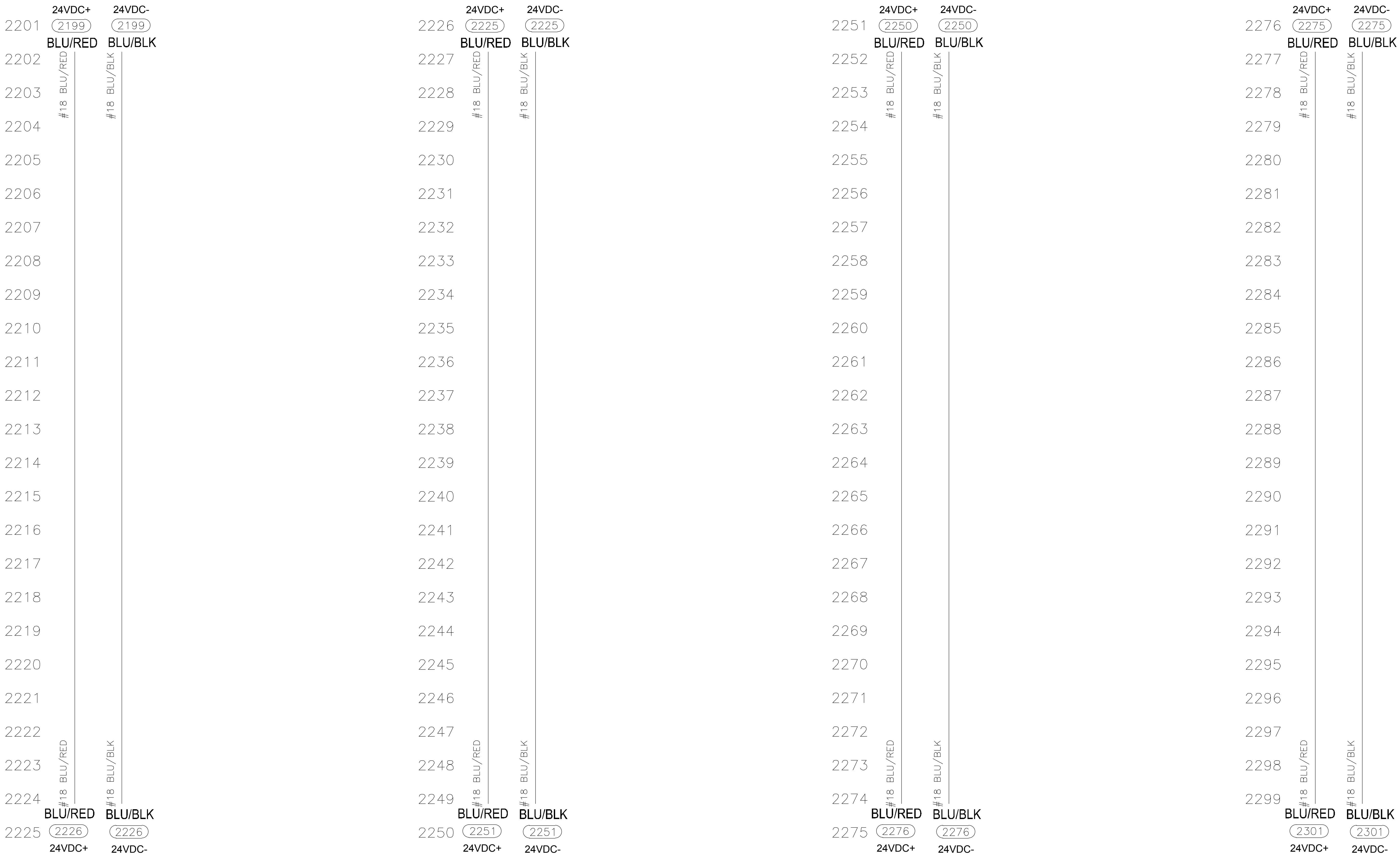
CUSTOMER: LAND-REP-BRIDGE | JOB #: 1013-0162

DWG. TITLE: BRIDGETON TANK FARM
460VAC - 3PH - SCADA CONTROL PANEL

DATE: 10/07/2013 | CSD: MHH | DWG.NO. E-5076 | REV B

DRAWN BY: MHH | APP'D. MHH |

A	BUILT RELEASE	MH	12/26/13
B			
C			
D			



LEGEND:

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- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
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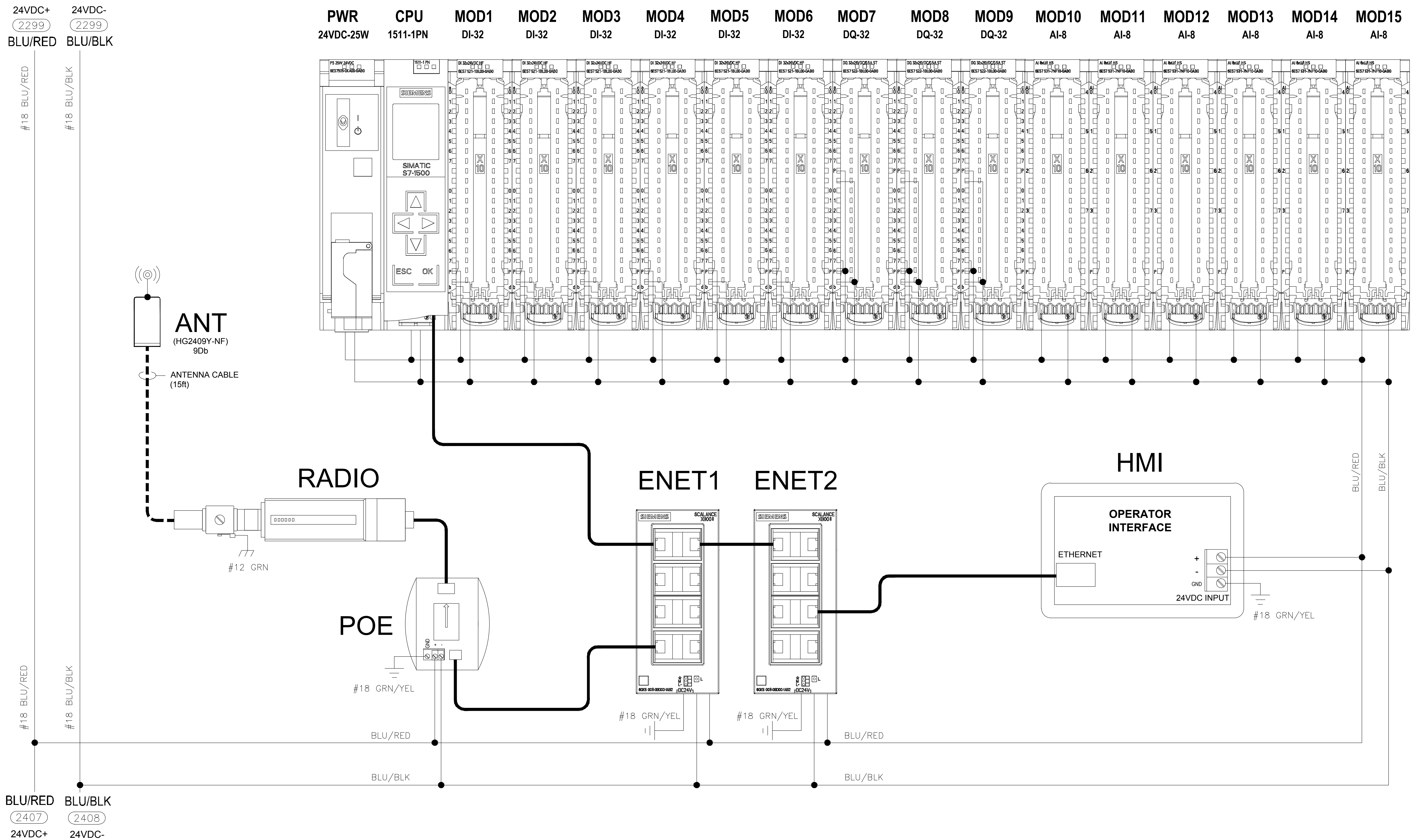
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV A
DRAWN BY MHH	APP'D. MHH	SHT. 22 OF 31	

A	BUILT RELEASE	MH	12/26/13
B			
C			
D			



LEGEND:

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- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
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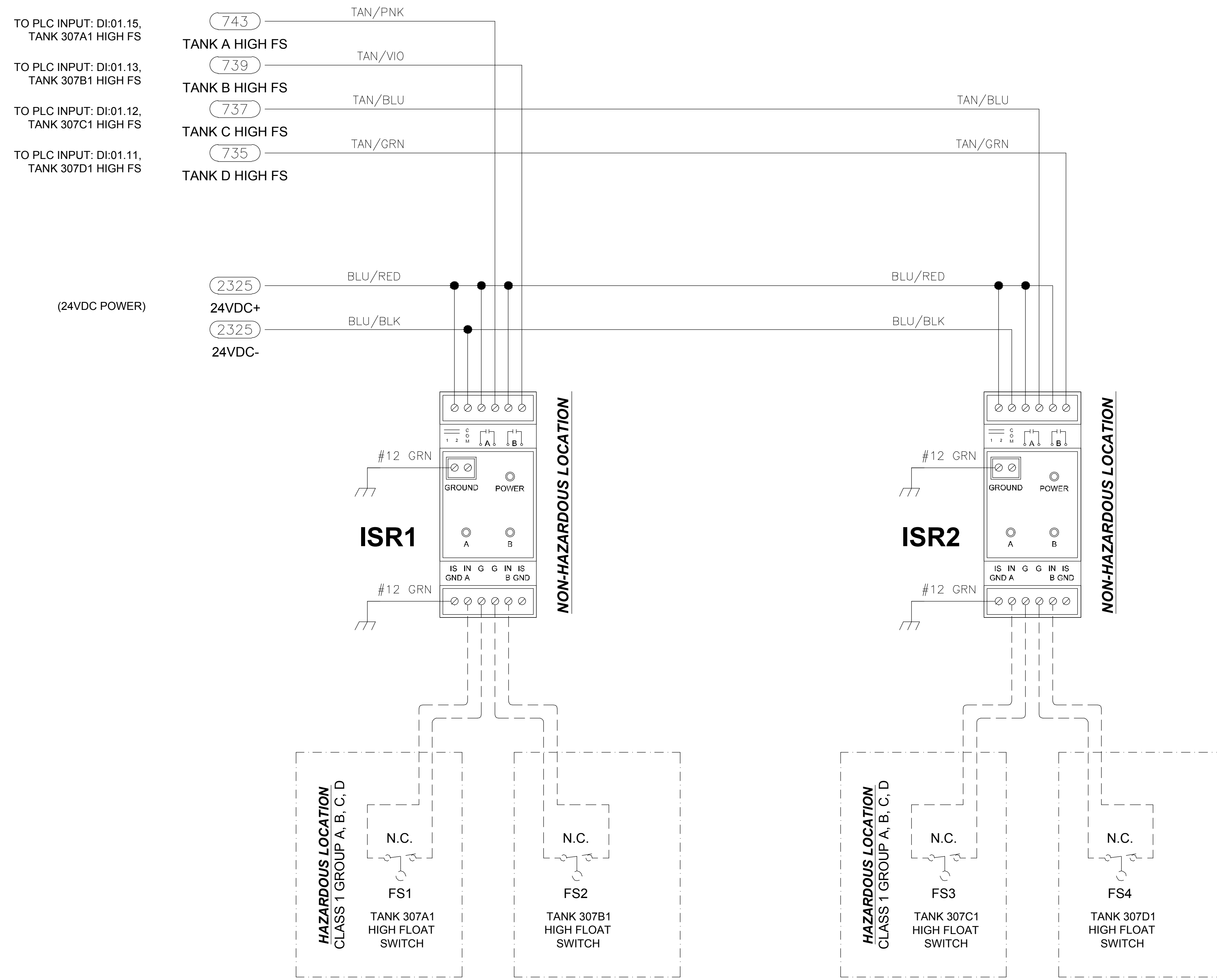
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162	
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL				
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076		REV A
DRAWN BY MHH	APP'D. MHH	SHT. 23	OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C			
D			



See SHEET 1 for Intrinsically Safe Installation Instructions

Field Wiring Connections
See General Wiring Installation Instructions
on SHEET #1 for wire and torque

LEGEND:
- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
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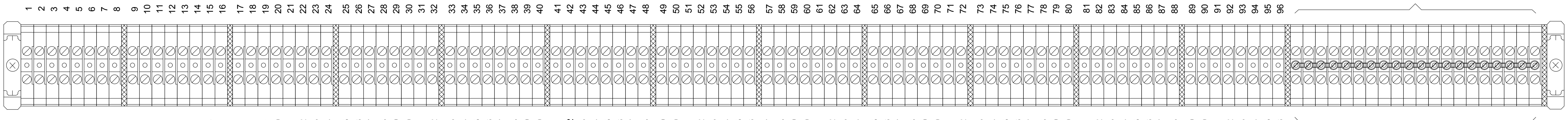
CUSTOMER: LAND-REP-BRIDGE		JOB #: 1013-0162	
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 24 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	HIGH LEVEL INPUT UPDATE	MH	02/07/14
D	HIGH LEVEL INPUT UPDATE	MH	02/14/14

DIGITAL INPUT SIGNAL

TB4 (LEFT SIDE) TERMINAL CONNECTION DETAIL:



TB4 TERMINAL	(FIELD WIRING)	DEVICE	(PANEL)
1	BLOWER H-O-A AUTO	(BLO-307A1)	GRY/BLK-1
2	BLOWER RUNNING	(BLO-307A1)	GRY/BRN-1
3	BLOWER MOTOR O/L	(BLO-307A1)	GRY/RED-1
4	COOLING FAN H-O-A AUTO	(F-307A1)	GRY/ORG-1
5	COOLING FAN RUNNING	(F-307A1)	GRY/YEL-1
6	COOLING FAN MOTOR O/L	(F-307A1)	GRY/GRN-1
7	RECIRC PUMP H-O-A AUTO	(P-307A1)	GRY/BLU-1
8	RECIRC PUMP RUNNING	(P-307A1)	GRY/VIO-1
9	RECIRC PUMP MOTOR O/L	(P-307A1)	GRY/BLK-2
10	BLOWER H-O-A AUTO	(BLO-307A2)	GRY/BRN-2
11	BLOWER RUNNING	(BLO-307A2)	GRY/RED-2
12	BLOWER MOTOR O/L	(BLO-307A2)	GRY/ORG-2
13	COOLING FAN H-O-A AUTO	(F-307A2)	GRY/YEL-2
14	COOLING FAN RUNNING	(F-307A2)	GRY/GRN-2
15	COOLING FAN MOTOR O/L	(F-307A2)	GRY/BLU-2
16	RECIRC PUMP H-O-A AUTO	(P-307A2)	GRY/VIO-2
17	RECIRC PUMP RUNNING	(P-307A2)	GRY/BLK-3
18	RECIRC PUMP MOTOR O/L	(P-307A2)	GRY/BRN-3
19	(307A2) CONTAINMENT HIGH LEVEL	(LSH-307A2)	GRY/RED-3
20	(307B2) CONTAINMENT HIGH LEVEL	(LSH-307B2)	GRY/ORG-3
21	(307C2) CONTAINMENT HIGH LEVEL	(LSH-307C2)	GRY/YEL-3
22	(307D2) CONTAINMENT HIGH LEVEL	(LSH-307D2)	GRY/GRN-3
23	(SPARE)		GRY/BLU-3
24	(SPARE)		GRY/VIO-3
25	BLOWER H-O-A AUTO	(BLO-307A3)	GRY/BLK-4
26	BLOWER RUNNING	(BLO-307A3)	GRY/BRN-4
27	BLOWER MOTOR O/L	(BLO-307A3)	GRY/RED-4
28	COOLING FAN H-O-A AUTO	(F-307A3)	GRY/ORG-4
29	COOLING FAN RUNNING	(F-307A3)	GRY/YEL-4
30	COOLING FAN MOTOR O/L	(F-307A3)	GRY/GRN-4
31	TRANSFER PUMP H-O-A AUTO	(P-307A3)	GRY/BLU-4
32	TRANSFER PUMP RUNNING	(P-307A3)	GRY/VIO-4
33	TRANSFER PUMP MOTOR O/L	(P-307A3)	GRY/BLK-5
34	TRANSFER PUMP H-O-A AUTO	(P-307A4)	GRY/BRN-5
35	TRANSFER PUMP RUNNING	(P-307A4)	GRY/RED-5
36	TRANSFER PUMP MOTOR O/L	(P-307A4)	GRY/ORG-5
37	CONTAIN SUMP PUMP H-O-A AUTO	(P-307A5)	GRY/YEL-5
38	CONTAIN SUMP PUMP RUNNING	(P-307A5)	GRY/GRN-5
39	CONTAIN SUMP PUMP MOTOR O/L	(P-307A5)	GRY/BLU-5
40	BLOWER H-O-A AUTO	(BLO-307B1)	GRY/VIO-5
41	BLOWER RUNNING	(BLO-307B1)	GRY/BLK-6
42	BLOWER MOTOR O/L	(BLO-307B1)	GRY/BRN-6
43	COOLING FAN H-O-A AUTO	(F-307B1)	GRY/RED-6
44	COOLING FAN RUNNING	(F-307B1)	GRY/ORG-6
45	COOLING FAN MOTOR O/L	(F-307B1)	GRY/YEL-6
46	RECIRC PUMP H-O-A AUTO	(P-307B1)	GRY/GRN-6
47	RECIRC PUMP RUNNING	(P-307B1)	GRY/BLU-6
48	RECIRC PUMP MOTOR O/L	(P-307B1)	GRY/VIO-6
49	BLOWER H-O-A AUTO	(BLO-307B2)	GRY/BLK-7
50	BLOWER RUNNING	(BLO-307B2)	GRY/BRN-7
51	BLOWER MOTOR O/L	(BLO-307B2)	GRY/RED-7
52	COOLING FAN H-O-A AUTO	(F-307B2)	GRY/ORG-7
53	COOLING FAN RUNNING	(F-307B2)	GRY/YEL-7
54	COOLING FAN MOTOR O/L	(F-307B2)	GRY/GRN-7
55	(307C1) TANK C HIGH LEVEL	(LSH-307C1)	GRY/BLU-7
56	(307D1) TANK D HIGH LEVEL	(LSH-307D1)	GRY/VIO-7
57	RECIRC PUMP H-O-A AUTO	(P-307B2)	GRY/BLK-8
58	RECIRC PUMP RUNNING	(P-307B2)	GRY/BRN-8
59	RECIRC PUMP MOTOR O/L	(P-307B2)	GRY/RED-8
60	TRANSFER PUMP H-O-A AUTO	(P-307B3)	GRY/ORG-8
61	TRANSFER PUMP RUNNING	(P-307B3)	GRY/YEL-8
62	TRANSFER PUMP MOTOR O/L	(P-307B3)	GRY/GRN-8
63	CONTAIN SUMP PUMP H-O-A AUTO	(P-307B4)	GRY/BLU-8
64	CONTAIN SUMP PUMP RUNNING	(P-307B4)	GRY/VIO-8
65	CONTAIN SUMP PUMP MOTOR O/L	(P-307B4)	GRY/BLK-9
66	BLOWER H-O-A AUTO	(BLO-307C1)	GRY/BRN-9
67	BLOWER RUNNING	(BLO-307C1)	GRY/RED-9
68	BLOWER MOTOR O/L	(BLO-307C1)	GRY/ORG-9
69	COOLING FAN H-O-A AUTO	(F-307C1)	GRY/YEL-9
70	COOLING FAN RUNNING	(F-307C1)	GRY/GRN-9
71	COOLING FAN MOTOR O/L	(F-307C1)	GRY/BLU-9
72	RECIRC PUMP H-O-A AUTO	(P-307C1)	GRY/VIO-9
73	RECIRC PUMP RUNNING	(P-307C1)	GRY/BLK-10
74	RECIRC PUMP MOTOR O/L	(P-307C1)	GRY/BRN-10
75	BLOWER H-O-A AUTO	(BLO-307C2)	GRY/RED-10
76	BLOWER RUNNING	(BLO-307C2)	GRY/ORG-10
77	BLOWER MOTOR O/L	(BLO-307C2)	GRY/YEL-10
78	COOLING FAN H-O-A AUTO	(F-307C2)	GRY/GRN-10
79	COOLING FAN RUNNING	(F-307C2)	GRY/BLU-10
80	COOLING FAN MOTOR O/L	(F-307C2)	GRY/VIO-10
81			
82			
83			
84			
85			
86			
87			
88			
89			
90			
91			
92			
93			
94			
95			
96			
(jumpered terminals)	(FIELD) 24VDC+		BLU/YEL

LEGEND:

- ◎ - INDICATES TERMINAL BLOCK
- – – – – - INDICATES FIELD WIRING
- - ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- - SURGE GROUNDING
- - EQUIPMENT GROUNDING

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CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV D
DRAWN BY MHH	APP'D. MHH	SHT. 25 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	REVISED VALVE INPUT	MH	01/24/14
D	REVISED FOAM SENSOR INPUTS	MH	02/14/14

DIGITAL INPUT SIGNAL (CON'T)

TB4 *(RIGHT SIDE) TERMINAL CONNECTION DETAIL:*

TB4

TERMINAL	(PANEL)	(FIELD WIRING)	
97	GRY/BLK-11	RECIRC PUMP H-O-A AUTO	(P-307C2)
98	GRY/BRN-11	RECIRC PUMP RUNNING	
99	GRY/RED-11	RECIRC PUMP MOTOR O/L	
100	GRY/ORG-11	TANK A FOAM SENSOR INPUT	(LH-307A3)
101	GRY/YEL-11	TANK B FOAM SENSOR INPUT	(LH-307B3)
102	GRY/GRN-11	TANK C FOAM SENSOR INPUT	(LH-307C3)
103	GRY/BLU-11	TANK D FOAM SENSOR INPUT	(LH-307D3)
104	GRY/VIO-11	(SPARE)	
105	GRY/BLK-12	BLOWER (SP) H-O-A AUTO	(BLO-307C3)
106	GRY/BRN-12	BLOWER (SP) RUNNING	
107	GRY/RED-12	BLOWER (SP) MOTOR O/L	
108	GRY/ORG-12	COOLING FAN H-O-A AUTO	(F-307C3)
109	GRY/YEL-12	COOLING FAN RUNNING	
110	GRY/GRN-12	COOLING FAN MOTOR O/L	
111	GRY/BLU-12	TRANSFER PUMP H-O-A AUTO	(P-307C3)
112	GRY/VIO-12	TRANSFER PUMP RUNNING	
113	GRY/BLK-13	TRANSFER PUMP MOTOR O/L	
114	GRY/BRN-13	TRANSFER PUMP H-O-A AUTO	(P-307C4)
115	GRY/RED-13	TRANSFER PUMP RUNNING	
116	GRY/ORG-13	TRANSFER PUMP MOTOR O/L	
117	GRY/YEL-13	CONTAIN SUMP PUMP H-O-A AUTO	(P-307C5)
118	GRY/GRN-13	CONTAIN SUMP PUMP RUNNING	
119	GRY/BLU-13	CONTAIN SUMP PUMP MOTOR O/L	
120	GRY/VIO-13	BLOWER H-O-A AUTO	(BLO-307D1)
121	GRY/BLK-14	BLOWER RUNNING	
122	GRY/BRN-14	BLOWER MOTOR O/L	
123	GRY/RED-14	COOLING FAN H-O-A AUTO	(F-307D1)
124	GRY/ORG-14	COOLING FAN RUNNING	
125	GRY/YEL-14	COOLING FAN MOTOR O/L	
126	GRY/GRN-14	RECIRC PUMP H-O-A AUTO	(P-307D1)
127	GRY/BLU-14	RECIRC PUMP RUNNING	
128	GRY/VIO-14	RECIRC PUMP MOTOR O/L	
129	GRY/BLK-15	BLOWER H-O-A AUTO	(BLO-307D2)
130	GRY/BRN-15	BLOWER RUNNING	
131	GRY/RED-15	BLOWER MOTOR O/L	
132	GRY/ORG-15	COOLING FAN H-O-A AUTO	(F-307D2)
133	GRY/YEL-15	COOLING FAN RUNNING	
134	GRY/GRN-15	COOLING FAN MOTOR O/L	
135	GRY/BLU-15	INTERIM PUMP VALVE OPENED	(ISV-309)
136	GRY/VIO-15	INTERIM PUMP VALVE CLOSED	
137	GRY/BLK-16	RECIRC PUMP H-O-A AUTO	(P-307D2)
138	GRY/BRN-16	RECIRC PUMP RUNNING	
139	GRY/RED-16	RECIRC PUMP MOTOR O/L	
140	GRY/ORG-16	TRANSFER PUMP H-O-A AUTO	(P-307D3)
141	GRY/YEL-16	TRANSFER PUMP RUNNING	
142	GRY/GRN-16	TRANSFER PUMP MOTOR O/L	
143	GRY/BLU-16	CONTAIN SUMP PUMP H-O-A AUTO	(P-307D4)
144	GRY/VIO-16	CONTAIN SUMP PUMP RUNNING	
145	GRY/BLK-17	CONTAIN SUMP PUMP MOTOR O/L	
146	GRY/BRN-17	(SPARE)	
147	GRY/RED-17	(SPARE)	
148	GRY/ORG-17	(SPARE)	
149	GRY/YEL-17	(SPARE)	
150	GRY/GRN-17	(SPARE)	
151	GRY/BLU-17	(SPARE)	
152	GRY/VIO-17	(SPARE)	
153	GRY/BLK-18	TANK VALVE OPENED	(ISV-307A1)
154	GRY/BRN-18	TANK VALVE CLOSED	
155	GRY/RED-18	TANK VALVE OPENED	(ISV-307B1)
156	GRY/ORG-18	TANK VALVE CLOSED	
157	GRY/YEL-18	TANK VALVE OPENED	(ISV-307C1)
158	GRY/GRN-18	TANK VALVE CLOSED	
159	GRY/BLU-18	TANK VALVE OPENED	(ISV-307D1)
160	GRY/VIO-18	TANK VALVE CLOSED	
161	GRY/BLK-19	POSITION VALVE OPENED	(ISV-307A10)
162	GRY/BRN-19	POSITION VALVE CLOSED	
163	GRY/RED-19	POSITION VALVE OPENED	(ISV-307B10)
164	GRY/ORG-19	POSITION VALVE CLOSED	
165	GRY/YEL-19	POSITION VALVE OPENED	(ISV-307C10)
166	GRY/GRN-19	POSITION VALVE CLOSED	
167	GRY/BLU-19	POSITION VALVE OPENED	(ISV-307D10)
168	GRY/VIO-19	POSITION VALVE CLOSED	
169	GRY/BLK-20	POSITION VALVE OPENED	(ISV-309A1)
170	GRY/BRN-20	POSITION VALVE CLOSED	
171	GRY/RED-20	POSITION VALVE OPENED	(ISV-309A2)
172	GRY/ORG-20	POSITION VALVE CLOSED	
173	GRY/YEL-20	POSITION VALVE OPENED	(ISV-309A3)
174	GRY/GRN-20	POSITION VALVE CLOSED	
175	GRY/BLU-20	POSITION VALVE OPENED	(ISV-309A4)
176	GRY/VIO-20	POSITION VALVE CLOSED	
177	GRY/BLK-21	POSITION VALVE OPENED	(ISV-309A5)
178	GRY/BRN-21	POSITION VALVE CLOSED	
179	GRY/RED-21	POSITION VALVE OPENED	(ISV-309A6)
180	GRY/ORG-21	POSITION VALVE CLOSED	
181	GRY/YEL-21	POSITION VALVE OPENED	(ISV-309A7)
182	GRY/GRN-21	POSITION VALVE CLOSED	
183	GRY/BLU-21	POSITION VALVE OPENED	(ISV-309A8)
184	GRY/VIO-21	POSITION VALVE CLOSED	
185	GRY/BLK-22	KIRK KEY #1	(KEY #1)
186	GRY/BRN-22	KIRK KEY #2	(KEY #2)
187	GRY/RED-22	(SPARE)	
188	GRY/ORG-22	(SPARE)	
189	GRY/YEL-22	(SPARE)	
190	GRY/GRN-22	(SPARE)	
191	GRY/BLU-22	(SPARE)	
192	GRY/VIO-22	(SPARE)	
(jumpered bus)	BLU/YEL	(FIELD) 24VDC+	

LEGEND:

- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- SURGE GROUNDING
- EQUIPMENT GROUNDING

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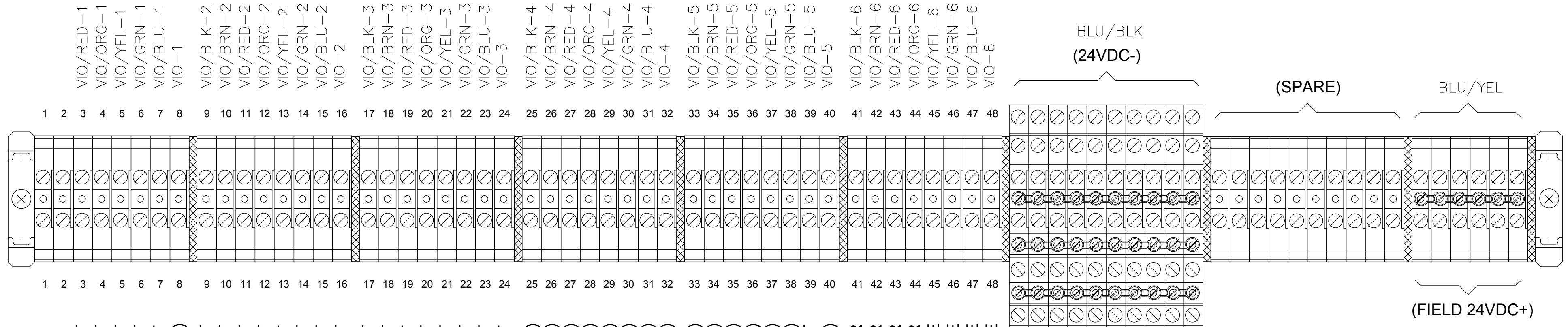
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV D
DRAWN BY MHH	APP'D. MHH	SHT. 26 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	REVISED VALVE INPUT	MH	01/24/14
D	ADD ANALOG pH PROBES	MH	02/14/14

ANALOG INPUT SIGNAL

TB5 *TERMINAL CONNECTION DETAIL:*



TB5 Terminal	(PANEL)	(FIELD WIRING)	
1			
2			
3	VIO/RED-1	COOLING FAN CURRENT	(F-307A1)
4	VIO/ORG-1	RECIRC PUMP CURRENT	(P-307A1)
5	VIO/YEL-1	COOLING FAN CURRENT	(F-307A2)
6	VIO/GRN-1	RECIRC PUMP CURRENT	(P-307A2)
7	VIO/BLU-1	CONTAIN SUMP PUMP CURRENT	(P-307A5)
8	VIO-1	(SPARE)	
9	VIO/BLK-2	COOLING FAN CURRENT	(F-307B1)
10	VIO/BRN-2	RECIRC PUMP CURRENT	(P-307B1)
11	VIO/RED-2	COOLING FAN CURRENT	(F-307B2)
12	VIO/ORG-2	RECIRC PUMP CURRENT	(P-307B2)
13	VIO/YEL-2	CONTAIN SUMP PUMP CURRENT	(P-307B4)
14	VIO/GRN-2	COOLING FAN CURRENT	(F-307C1)
15	VIO/BLU-2	RECIRC PUMP CURRENT	(P-307C1)
16	VIO-2	COOLING FAN CURRENT	(F-307C3)
17	VIO/BLK-3	COOLING FAN CURRENT	(F-307C2)
18	VIO/BRN-3	RECIRC PUMP CURRENT	(P-307C2)
19	VIO/RED-3	CONTAIN SUMP PUMP CURRENT	(P-307C5)
20	VIO/ORG-3	COOLING FAN CURRENT	(F-307D1)
21	VIO/YEL-3	RECIRC PUMP CURRENT	(P-307D1)
22	VIO/GRN-3	COOLING FAN CURRENT	(F-307D2)
23	VIO/BLU-3	RECIRC PUMP CURRENT	(P-307D2)
24	VIO-3	CONTAIN SUMP PUMP CURRENT	(P-307D4)
25	VIO/BLK-4	(SPARE)	
26	VIO/BRN-4	(SPARE)	
27	VIO/RED-4	(SPARE)	
28	VIO/ORG-4	(SPARE)	
29	VIO/YEL-4	(SPARE)	
30	VIO/GRN-4	(SPARE)	
31	VIO/BLU-4	(SPARE)	
32	VIO-4	(SPARE)	
33	VIO/BLK-5	(SPARE)	
34	VIO/BRN-5	(SPARE)	
35	VIO/RED-5	(SPARE)	
36	VIO/ORG-5	(SPARE)	
37	VIO/YEL-5	(SPARE)	
38	VIO/GRN-5	(SPARE)	
39	VIO/BLU-5	VOC & ODOR CURRENT	(RTO-200)
40	VIO-5	(SPARE)	
41	VIO/BLK-6	LEVEL SENSOR	(LE-307A)
42	VIO/BRN-6	LEVEL SENSOR	(LE-307B)
43	VIO/RED-6	LEVEL SENSOR	(LE-307C)
44	VIO/ORG-6	LEVEL SENSOR	(LE-307D)
45	VIO/YEL-6	pH PROBE	(AE-307A4)
46	VIO/GRN-6	pH PROBE	(AE-307B4)
47	VIO/BLU-6	pH PROBE	(AE-307C4)
48	VIO-6	pH PROBE	(AE-307D4)

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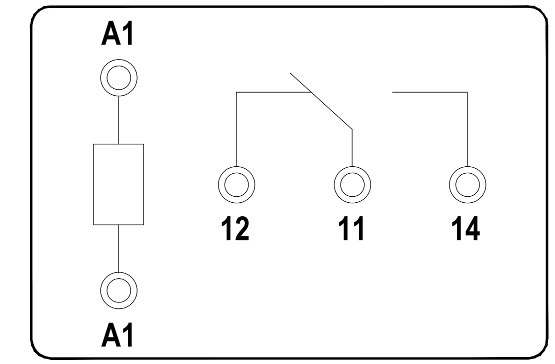
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE: BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV D
DRAWN BY MHH	APP'D. MHH	SHT. 27 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C			
D			

DIGITAL OUTPUT SIGNAL

TB7A (LEFT SIDE) TERMINAL CONNECTION DETAIL:

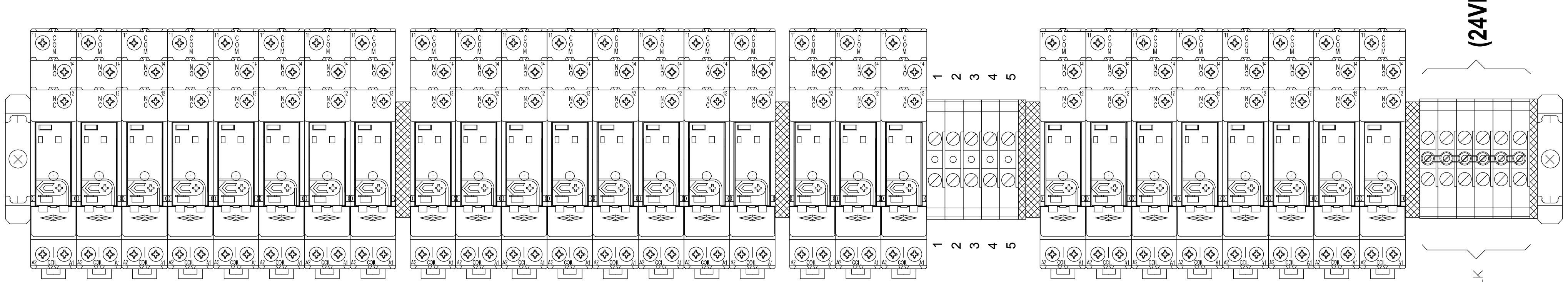
RELAY TERMINAL DETAIL



CONTACT RATING: 15 Amp

TB7A

Relay	(FIELD WIRING)	Tag	(PANEL)
CR20	BLOWER RUN RELAY	(BLO-307A1)	BLU/BLK, BRN/BLK-1
CR21	COOLING FAN RUN RELAY	(F-307A1)	BLU/BLK, BRN-1
CR22	RECIRC PUMP RUN RELAY	(P-307A1)	BLU/BLK, BRN/RED-1
CR23	BLOWER RUN RELAY	(BLO-307A2)	BLU/BLK, BRN/ORG-1
CR24	COOLING FAN RUN RELAY	(F-307A2)	BLU/BLK, BRN/YEL-1
CR25	RECIRC PUMP RUN RELAY	(P-307A2)	BLU/BLK, BRN/GRN-1
CR26	BLOWER RUN RELAY	(BLO-307A3)	BLU/BLK, BRN/BLU-1
CR27	COOLING FAN RUN RELAY	(F-307A3)	BLU/BLK, BRN/VIO-1
CR28	TRANSFER PUMP RUN RELAY	(P-307A3)	BLU/BLK, BRN/BLK-2
CR29	TRANSFER PUMP RUN RELAY	(P-307A4)	BLU/BLK, BRN-2
CR30	(SPARE)		BLU/BLK, BRN/RED-2
CR31	BLOWER RUN RELAY	(BLO-307B1)	BLU/BLK, BRN/ORG-2
CR32	COOLING FAN RUN RELAY	(F-307B1)	BLU/BLK, BRN/YEL-2
CR33	RECIRC PUMP RUN RELAY	(P-307B1)	BLU/BLK, BRN/GRN-2
CR34	BLOWER RUN RELAY	(BLO-307B2)	BLU/BLK, BRN/BLU-2
CR35	COOLING FAN RUN RELAY	(F-307B2)	BLU/BLK, BRN/VIO-2
CR36	RECIRC PUMP RUN RELAY	(P-307B2)	BLU/BLK, BRN/BLK-3
CR37	TRANSFER PUMP RUN RELAY	(P-307B3)	BLU/BLK, BRN-3
CR38	(SPARE)		BLU/BLK, BRN/RED-3
1	(SPARE OUTPUT)		BRN/ORG-3
2	(SPARE OUTPUT)		BRN/YEL-3
3	(SPARE OUTPUT)		BRN/GRN-3
4	(SPARE OUTPUT)		BRN/BLU-3
5	(SPARE OUTPUT)		BRN/VIO-3
CR39	BLOWER RUN RELAY	(BLO-307C1)	BLU/BLK, BRN/BLK-4
CR40	COOLING FAN RUN RELAY	(F-307C1)	BLU/BLK, BRN-4
CR41	RECIRC PUMP RUN RELAY	(P-307C1)	BLU/BLK, BRN/RED-4
CR42	BLOWER RUN RELAY	(BLO-307C2)	BLU/BLK, BRN/ORG-4
CR43	COOLING FAN RUN RELAY	(F-307C2)	BLU/BLK, BRN/YEL-4
CR44	RECIRC PUMP RUN RELAY	(P-307C2)	BLU/BLK, BRN/GRN-4
CR45	(SPARE) BLOWER RUN RELAY	(BLO-307C3)	BLU/BLK, BRN/BLU-4
CR46	(SPARE) COOLING FAN RUN RELAY	(F-307C3)	BLU/BLK, BRN/VIO-4
(24VDC-)			BLU/BLK



LEGEND:
- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- SURGE GROUNDING
- EQUIPMENT GROUNDING

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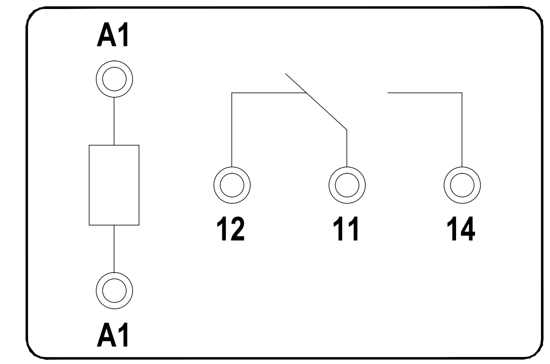
CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 28 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C	UPDATED VALVE RELAY	MH	01/27/14
D			

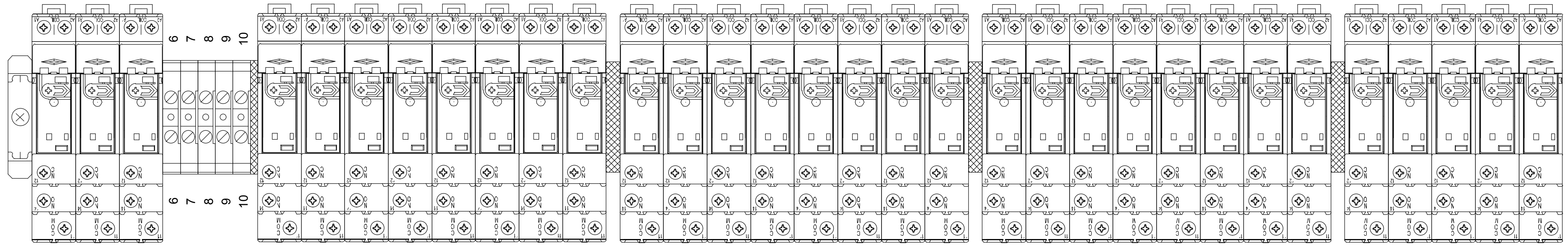
DIGITAL OUTPUT SIGNAL (CON'T)

TB7B *(RIGHT SIDE) TERMINAL CONNECTION DETAIL:*

RELAY TERMINAL DETAIL



CONTACT RATING: 15 Amp



Terminal	(PANEL)	(FIELD WIRING)	
CR47	BRN/BLK-5, BLU/BLK	TRANSFER PUMP RUN RELAY	(P-307C3)
CR48	BRN-5, BLU/BLK	TRANSFER PUMP RUN RELAY	(P-307C4)
CR49	BRN/RED-5, BLU/BLK	(SPARE)	
6	BRN/ORG-5	(SPARE OUTPUT)	
7	BRN/YEL-5	(SPARE OUTPUT)	
8	BRN/GRN-5	(SPARE OUTPUT)	
9	BRN/BLU-5	(SPARE OUTPUT)	
10	BRN/VIO-5	(SPARE OUTPUT)	
CR50	BRN/BLK-6, BLU/BLK	BLOWER RUN RELAY	(BLO-307D1)
CR51	BRN-6, BLU/BLK	COOLING FAN RUN RELAY	(F-307D1)
CR52	BRN/RED-6, BLU/BLK	RECIRC PUMP RUN RELAY	(P-307D1)
CR53	BRN/ORG-6, BLU/BLK	BLOWER RUN RELAY	(BLO-307D2)
CR54	BRN/YEL-6, BLU/BLK	COOLING FAN RUN RELAY	(F-307D2)
CR55	BRN/GRN-6, BLU/BLK	RECIRC PUMP RUN RELAY	(P-307D2)
CR56	BRN/BLU-6, BLU/BLK	TRANSFER PUMP RUN RELAY	(P-307D3)
CR57	BRN/VIO-6, BLU/BLK	VOC & ODOR RUN RELAY	(RTO-200)
CR58	BRN/BLK-7, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(MPV-307A1)
CR59	BRN-7, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(MPV-307B1)
CR60	BRN/RED-7, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(MPV-307C1)
CR61	BRN/ORG-7, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(MPV-307D1)
CR62	BRN/YEL-7, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(MPV-309)
CR63	BRN/GRN-7, BLU/BLK	(SPARE)	
CR64	BRN/BLU-7, BLU/BLK	(SPARE)	
CR65	BRN/VIO-7, BLU/BLK	(SPARE)	
CR66	BRN/BLK-8, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-309A1)
CR67	BRN-8, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-309A2)
CR68	BRN/RED-8, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-309A3)
CR69	BRN/ORG-8, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-309A4)
CR70	BRN/YEL-8, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-309A5)
CR71	BRN/GRN-8, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-309A6)
CR72	BRN/BLU-8, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-309A7)
CR73	BRN/VIO-8, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-309A8)
CR74	BRN/BLK-9, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-307A10)
CR75	BRN-9, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-307B10)
CR76	BRN/RED-9, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-307C10)
CR77	BRN/ORG-9, BLU/BLK	POSITION VALVE CLOSING (NC) POSITION VALVE OPENING (NO)	(ISV-307D10)
CR78	BRN/VIO-9, BLU/BLK	CONTROL RELAY INTERUPT	(R-200)

LEGEND:

- ◎ - INDICATES TERMINAL BLOCK
- – – – – - INDICATES FIELD WIRING
- - ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- - SURGE GROUNDING
- - EQUIPMENT GROUNDING

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CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE: BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV C
DRAWN BY MHH	APP'D. MHH	SHT. 29 OF 31	

A	BUILT RELEASE	MH	12/26/13
B	DWG UPDATED	MH	01/20/14
C			
D			

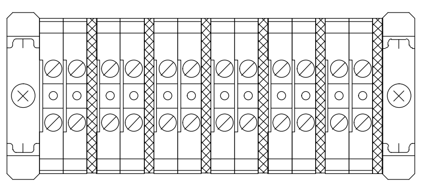
120VAC VALVE ACTUATORS CONNECTION

TB8 *TERMINAL CONNECTION DETAIL:*

(PANEL)

Terminal	Panel wire	Field wiring	Device
1	PNK/BLK	POSITION VALVE ACTUATOR (120VAC)	(MPV-307A1)
2	WHT	POSITION VALVE ACTUATOR (NEUTRAL)	(MPV-307A1)
3	PNK/BRN	POSITION VALVE ACTUATOR (120VAC)	(MPV-307B1)
4	WHT	POSITION VALVE ACTUATOR (NEUTRAL)	(MPV-307B1)
5	PNK/RED	POSITION VALVE ACTUATOR (120VAC)	(MPV-307C1)
6	WHT	POSITION VALVE ACTUATOR (NEUTRAL)	(MPV-307C1)
7	PNK/ORG	POSITION VALVE ACTUATOR (120VAC)	(MPV-307D1)
8	WHT	POSITION VALVE ACTUATOR (NEUTRAL)	(MPV-307D1)
9	PNK/YEL	POSITION VALVE ACTUATOR (120VAC)	(MPV-309)
10	WHT	POSITION VALVE ACTUATOR (NEUTRAL)	(MPV-309)
11	PNK/GRN	POSITION VALVE ACTUATOR (120VAC)	(SPARE)
12	WHT	POSITION VALVE ACTUATOR (NEUTRAL)	(SPARE)

TB8



(FIELD WIRING)

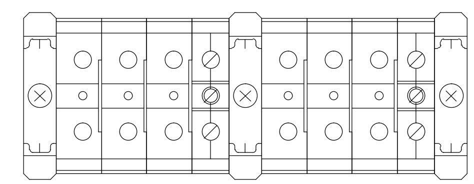
PUMPS POWER CONNECTION

TB9 *TERMINAL CONNECTION DETAIL:*

(PANEL)

Terminal	Panel wire	Field wiring	Pump
M1	BLK-M1	ANTI FOAM #1 PUMP (L1)	ANTI FOAM #1 PUMP
M2	BLK-M2	ANTI FOAM #1 PUMP (L2)	ANTI FOAM #1 PUMP
M3	BLK-M3	ANTI FOAM #1 PUMP (L3)	ANTI FOAM #1 PUMP
G	GRN/YEL	ANTI FOAM #1 PUMP (GND)	ANTI FOAM #1 PUMP
M4	BLK-M4	SODIUM HYDROXIDE PUMP (L1)	SODIUM HYDROXIDE PUMP
M5	BLK-M5	SODIUM HYDROXIDE PUMP (L2)	SODIUM HYDROXIDE PUMP
M6	BLK-M6	SODIUM HYDROXIDE PUMP (L3)	SODIUM HYDROXIDE PUMP
G	GRN/YEL	SODIUM HYDROXIDE PUMP (GND)	SODIUM HYDROXIDE PUMP

TB9



(FIELD WIRING)

LEGEND:

- INDICATES TERMINAL BLOCK
- INDICATES FIELD WIRING
- ALL CONTACTS SHOWN IN THE DE-ENERGIZED STATE
- SURGE GROUNDING
- EQUIPMENT GROUNDING

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CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE 10/07/2013	CSD MHH	DWG.NO. E-5076	REV B
DRAWN BY MHH	APP'D. MHH	SHT. 30 OF 31	

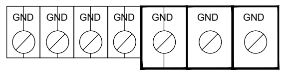
A	BUILT RELEASE	MH	12/26/13
B	ADDED TB10	MH	01/24/14
C			
D			

CUSTOMER CONNECTION DETAILS:

LINE POWER: (460VAC-3PHASE)
MDS-1 - 460 VAC LINE POWER (L1)
MDS-2 - 460 VAC LINE POWER (L2)
MDS-3 - 460 VAC LINE POWER (L3)
GND-LUG - MAIN GROUND (GND)

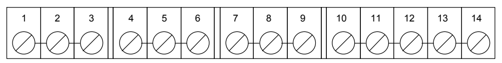
TERMINAL CONNECTION DETAILS:

GND



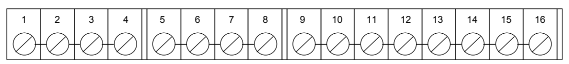
GND (GROUND TB)

TB1



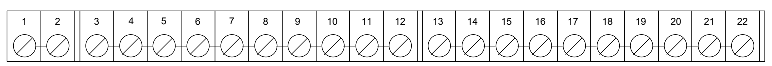
TB1 (120VAC POWER TB)
120VAC POWER TB1-(1 THRU 3)
120VAC UPS TB1-(4 THRU 6)
120VAC CONTROL TB1-(7 THRU 9)
NEUTRAL TB1-(10 THRU 14)

TB2



TB2 (24VDC POWER TB @ LEFT PANEL)
FIELD 24VDC+ TB2-(1 THRU 4)
24VDC+ TB2-(5 THRU 8)
24VDC- TB2-(9 THRU 16)

TB3



TB3 (24VDC POWER TB @ BACK PANEL)
FIELD 24VDC+ TB2-(1 THRU 2)
24VDC+ TB2-(3 THRU 12)
24VDC- TB2-(13 THRU 22)

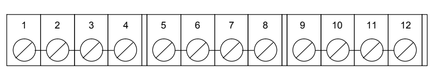
TB4

TB4 (FIELD CONNECTION TB)
DIGITAL INPUT CONNECTION
(SEE DETAIL ON SHEET # 25 AND #26)

TB5

TB5 (FIELD CONNECTION TB)
ANALOG INPUT CONNECTION
(SEE DETAIL ON SHEET # 27)

TB6



TB6 (24VDC POWER TB @ RIGHT PANEL)
FIELD 24VDC+ TB2-(1 THRU 4)
24VDC+ TB2-(5 THRU 8)
24VDC- TB2-(9 THRU 12)

TB7A

TB7A (FIELD CONNECTION TB)
DIGITAL OUTPUT CONNECTION
(SEE DETAIL ON SHEET # 28)

TB7B

TB7B (FIELD CONNECTION TB)
DIGITAL OUTPUT CONNECTION
(SEE DETAIL ON SHEET # 29)

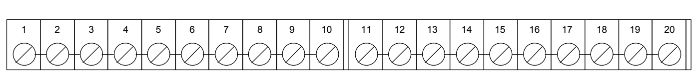
TB8

TB8 (FIELD CONNECTION TB)
VALVE ACTUATORS POWER CONNECTION
(SEE DETAIL ON SHEET # 30)

TB9

TB9 (FIELD CONNECTION TB)
PUMP MOTORS POWER CONNECTION
(SEE DETAIL ON SHEET # 30)

TB10



TB10 (FIELD 120VAC VALVE POWER CONNECTION TB)
TB10-(1 THRU 10) - 120VAC POWER
TB10-(11 THRU 20) - NEUTRAL

NOTES:

M4 / 6 TERMINAL BLOCK.
M10 / 10 TERMINAL BLOCK.
M16 / 12 TERMINAL BLOCK.

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386-218-4981
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CUSTOMER: LAND-REP-BRIDGE			JOB #: 1013-0162
DWG. TITLE: BRIDGETON TANK FARM 460VAC - 3PH - SCADA CONTROL PANEL			
DATE: 10/07/2013	CSD: MHH	DWG.NO.: E-5076	REV: B
DRAWN BY: MHH	APP'D.: MHH	SHT. 31 OF 31	