Norris Butterfly Valves

How to:

- Select and Specify 200 psi and 285 psi Butterfly Valves
- Select Trim
- Install and Service Norris Butterfly Valves

NORRIS PRODUCTION SOLUTIONS
A DOVER COMPANY

NORRISEAL™
A DOVER COMPANY

Engineered Performance

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Caution

Before disassembly or maintenance, all pressure in this device must be relieved. Failure to relieve pressures may result in personal injury, loss of process control or device damage. The resulting uncontrolled venting or spilling of line fluids may cause personal injury or environmental contamination.

Butterfly valves have been around the industry for decades; performing well-defined tasks and showing distinct advantages over other valve types.

Butterfly valves produce dependable bubble-tight shutoff and are ideally suited for throttling control applications because the flow in near linear over 70% of the flow range (Figure 1). They are quick opening and highly efficient because the approach velocity of the flow stream is not lost as the fluid passes through the valve bore. They can be operated manually, mechanically, or automatically, and they can be used in handling a variety of media, including liquids, solids, slurries, gasses and vapor (steam).

A butterfly valve is a simple device. To control or block the flow, a single vane or wafer disc pivots in the valve body. From closed to open position, the disc is rotated 90 degrees. Torque requirements to make this rotation are determined by static forces, caused by pressure drop across the disc in the closed position, and by dynamic forces, caused by fluid velocity in the pipe and at the edge of the partly closed disc (See Fig. 2).

Although a butterfly valve is hydraulically balanced when fully open or fully closed, force is required to move the disc from either position. Operating torque, for closing or opening the valve, is made up of bearing or shaft friction torque combined with rubber torque.

Bearing torque, caused by pressure drop across the valve disc, is determined by differential pressure. It is maximum when the disc is closed and minimum when the disc is fully open.

The torque required to seat or unseat the valve disc, rubber torque, is determined by the design of the valve and must be experimentally established by each valve manufacturer. (See Table VI and VII, pages 16 and 17, for Norris operating torque.)

When the disc begins to rotate toward the open position, it behaves like the wing of an airplane, and is subject to both the lift and drag forces of the flow stream. These fluid forces tend to close the valve, and reach a maximum value when the disc is approximately 67 degrees open. (See Table V, page 15, for fluid dynamic torque.)

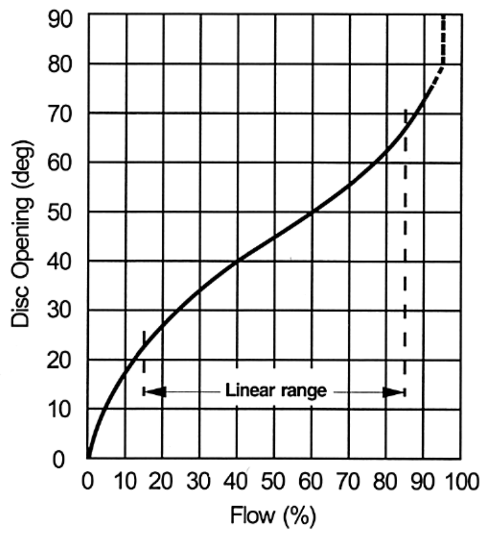
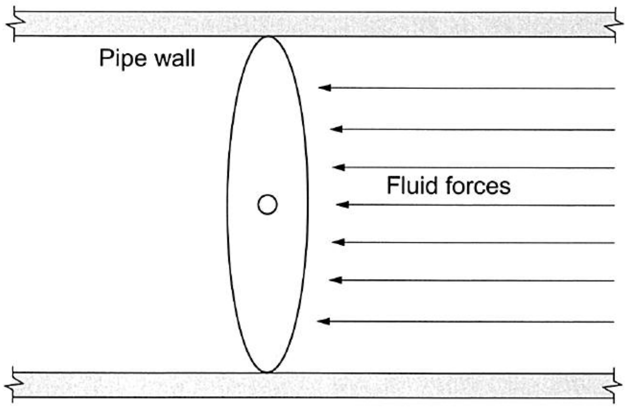
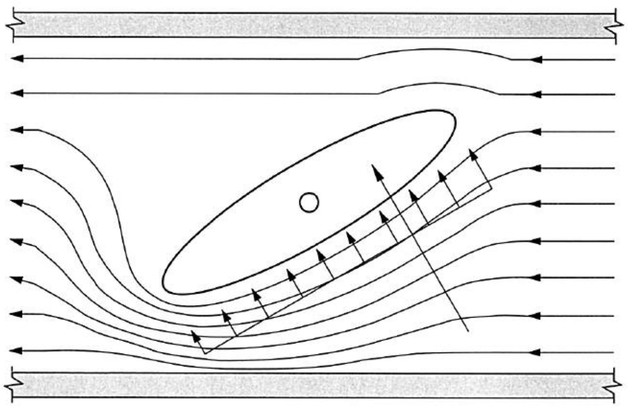


Fig 1. Butterfly valves used for throttling provide excellent control over approximately 70% of the flow range.



Closed Position



Closed Position

Fig 2. When the disc is in the closed position, static fluid forces are high but the valve is stable. In the semi-open position, the disc acts like an airplane wing, generating lift and drag forces that attempt to close it. When it reaches an open angle of 67 degrees (shown), dynamic forces are at maximum.

How to Select & Specify Norris Butterfly Valves

To select the Norris butterfly valve which will assure maximum valve life and minimum maintenance and operating costs, it is necessary to:

- Size the valve and operator properly.
- Select the specific valve model according to: function (block or throttling), pressure, flow rates, body type, temperature, trim material compatible with media, and piping.
- Select the proper operator.

Sizing the Valve & Operator

The following are simplified guidelines for sizing butterfly valves. See pages 14 thru 17 of this catalog for detailed information on Norris butterfly valve characteristics (flow coefficients, pressure drop, operating torque, etc.) to assist in the proper sizing of the valve and operator.

1. Determine the system requirements for flow and pressure drop to calculate the probable line size.
2. Calculate the correct valve size based on pressure drop and flow capacity requirements. (Use the 30 to 60 degrees open range for sizing.)
3. Determine the fluid dynamic torque, compare it with operating torque of the selected valve series to assure that the operator is properly sized to handle both the static and dynamic conditions of the valve.
4. Check the system for factors which could lead to water hammer or cavitation. Make necessary adjustments in valve placement, sizing, and speed of closing to prevent this from occurring.

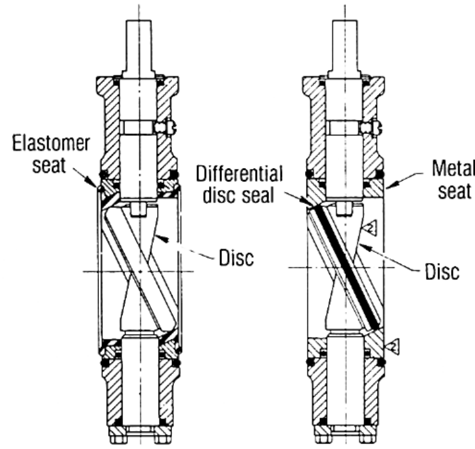
Selecting the Valve

The Norris Valve Series

To select the proper valve series (R, M, or D), determine:

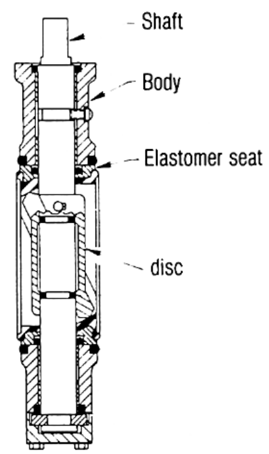
1. **The function of the valve (block and/or throttling) and flow rates of the system.**
   - **a.** For positive shutoff (blocking), select Norris R- M- Series valves. Both R- and M- Series valves provide positive shutoff from vacuum to full rated working pressure (200 psi or 285 psi).
   - **b.** For smoothest throttling control, select D-Series if positive shutoff is not required and flow rates do not exceed 40 fps. Select R-Series for economy and when positive shutoff is required and flow rates do not exceed 30 fps. M-Series valves are limited to 16 fps for throttling applications.

     D.-Series valves are designed specifically for throttling applications. These high-efficiency, low-leakage valves are capable of controlling in both low and high pressure drop applications. They are especially well suited to applications where a large variation of flow or pressure drop is anticipated. A positioner may not be required for smooth automated control because rubber torque has been eliminated and seating torque has been |eliminated and seating torque is minimum.
2. **Temperature extremes the system will handle.** Although selection of trim material influences adaptability to temperature, a general rule is to:
   - **a.** Select R-Series valves for temperatures no lower than -30° F and no higher than 250° F.
   - **b.** Select M-Series or D-Series valves for temperatures as low as -40° F and up to 400° F.



Rubber-lined R-200 — Metal-seated, O-ring sealed M-200

Positive Shutoff or Throttling



Rubber-lined R285

To summarize, check line velocity and pressure drop against the maximum allowable for the series selected. Check rating of the valve selected. Check rating of the valve to be sure it complies with the maximum pressure and temperature the system will handle.

3. **Pressure class ANSI Valve(s).**

Norris manufactures two pressure classes of positive shutoff valves:

a. The 200 series are rated at a maximum of 200 psi, and

b. The 285 series are rated at the full ANSI pressure class 150 rating of 285 psi.

TABLE I. SERIES COMPARISON

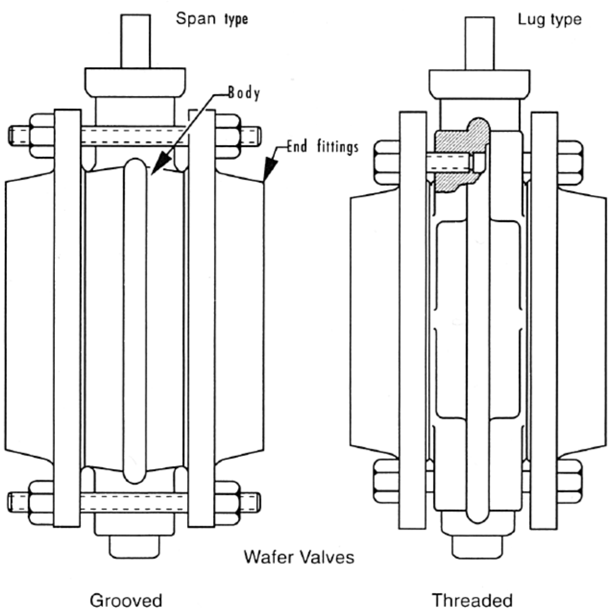
	R-Series		M-Series		D-Series
	R200	**R285**	**M200**	**M285**	**M200**
Positive Shutoff (bi-directional	Yes	Yes	Yes	Yes	No
Bi-directional flow	Yes	Yes	Yes	Yes	Yes
Maximum Velocity for Throttling Controls (liquids)	30 fps	30 fps	16 fps	16 fps	40 fps
Temperature Range	-20° F to +250° F		-40° F to +350° F		-40° F to +400° F

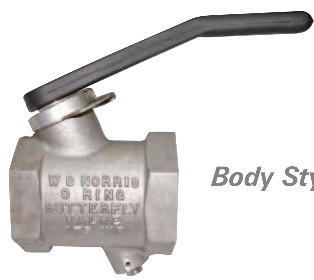
The Norris Valve Model

The tables on pages 10 & 11 will save considerable time in locating the specific Norris valve model you need. On the basis of valve size, body configuration and pressure rating, it will direct you to the appropriate Valve Data Sheet within the R-, M- or D- Series section. Each data sheet includes typical specifications, standard model selection tables, material specifications and model number designations, certified dimensions, including disc clearance charts, and specific flange bolt data.

1. **Body Type and Size.**

Basic Norris butterfly valve body types are slip-in wafer valves, available in span or lug (single flange) configurations, and body styles with threaded or grooved end-connections. Both span and lug type bodies are available in sizes from 2″ through 36″, including 22″, 26″ and 28″ for comparable metric piping. Body style valves are available from 2″ to 4″.





Body Style Valve

All 14″ and larger Norris valves will accommodate 2″ of insulation on accompanying pipelines. A neck "X-Tender" is available for use with 2″ though 12″ wafer valves when lines are insulated.

Norris valves are designed for use with ANSI class 150 flanges with inside diameter equivalent to schedule 40 pipe ID, and can be adapted for ANSI class 300 and DIN flanges. If flanges other than ANSI class 150 are required, user must specify type and rating (i.e. ANSI 300, DIN NP-10 or NP-16) as special bolt drilling or spacers may be necessary. Weldneck, socket weld or slip-on flanges can be used with Norris M-Series or D-Series valves. Weldneck or socketweld flanges are recommended for use with R-Series valves to provide proper support of the seat and to assure optimum performance at the full rated pressure of the valve. Norris does not recommend using the R-Series valves with slip-on type flanges. Before ordering valves, check disc clearance charts on individual data sheets to be sure the inside diameterss of companion flanges and piping do not interfere with disc movement when the valve is cycled to the open position. Back beveling may be required for disc clearance when heavy wall, plastic, or cement lined pipe is used.

a. For end-of-line suspension, select lug-type valves. Often, butterfly valves are used to isolate other equipment in the line, downstream of the valve, for periodic maintenance and repair. This application requires a lug-body valve with blocking capability which will withstand system pressure and seal the line during the maintenance period.

Without a downstream flange or spool piece, Norris R-Series lug-type valves are derated for safety to 75 psi working pressure when used for end-of-line suspension. Full valve rating may be restored by temporarily installing a downstream flange.

M-Series lug-type valves are not derated and will hold full rated working pressure with downstream flange removed. When M-Series valves will be dead-ended for more than 8 to 10 hours, it is recommended that a downstream flange be temporarily installed for safety.

b. Where end-of-line suspension is not required, select span-type valves. They are less expensive, weigh less and may be readily inserted between standard flange fittings.

Fourteen inch and larger “span” valves have tapped lug holes at top and bottom for easier installation and accurate centering.

2. Differential Pressure Rating

Both Norris R-Series and M-Series valves are available for 200 psi and 285 psi differential working pressure. Valves normally rated at 200 psi may be obtained for 250 psi service with selected tarims on special factory order.

Standard production tests require that all Norris valves be shell tested to 150% of rated working pressure. (Example: 200 wp valves are tested to 220 psi.)

3. Trim Material

The best guides for proper trim selection are the materials that have worked satisfactorily for other equipment in your piping system.

Norris butterfly valves are available in a wide variety of trim materials for compatibility with all types of media at temperatures from -40° to 400° F. See section “How to Select Trim Material” for complete list of materials and their compatibility with specific media.

Please contact our applications engineering staff for quotations and assistance in selecting the right valve for your applications.

Selecting the Operator

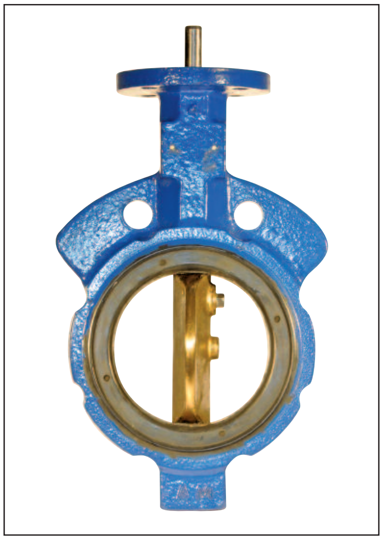
Butterfly valves tend to be self closing because of lift and drag forces exerted on the disc. If a valve is closed too quickly, or slammed shut, the energy of the flow system is transferred to the piping system and may cause dangerous pressure level fluctuations (hydraulic shock or “water hammer”) which can damage the system.

Because of larger disc area and resulting greater fluid dynamic torque, larger valves have a greater tendency to be self closing than small valves. Large valves are therefore best controlled by gear operators diaphragm actuators, pneumatic or hydraulic cylinders, or electric motors – all of which provide controlled speed of closing and prevent the valve from slamming.

Lever operators can be used for control of butterfly valves 5” and smaller, and up to 12” at flow rates less than 5 fps. Properly applied, levers provide quick valve action, economy and simplicity.

See complete details on our full line of manual and mechanical operators in Norriseal’s Butterfly Valve Catalog. Sizing charts for air operators and Norris diaphragm actuators are included in this section.

Norris angle disc design eliminates stress areas which cause many of our competitors performance problems. The unretouched photographs of Norris and competitive valves and individual parts illustrate how these differences combined with proper trim selection can mean longer valve life.

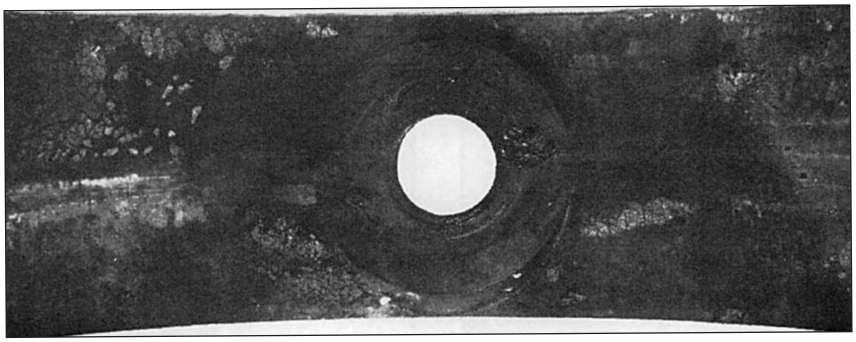


Norris angle-disc design provides positive shutoff with 360 degree, uninterrupted differential seal. The disc does not seat in shaft hole areas, eliminating compression set and scrubbing in this area which occurs on conventional vertical disc butterfly valves.

In the manufacturing process, the Norris perfect circle design allows precise control of outside disc dimension and inside seat dimension to a few thousandths of an inch. Because of close dimensional control, positive shutoff is achieved with minimum interference between disc and set. This unique design minimizes seat and seal wear, reduces operating torque and greatly extends the service life of the valve.

Norris' lower disc/seat interference allows use of harder, high-density seat elastomers which are less porous and less subject to swelling and deterioration by the flow stream than the softer materials which must be used for vertical disc valve seats.

By comparison – Vertical-disc valves have a flattened disc/boss area, making manufacturing variances greater. Increased penetration of disc into seat is required to seal off the flow stream. This produces a scrubbing action, particularly in the flattened disc/boss area, which can cause premature failure of the valve.



This unretouched photograph illustrates an elastomer seat which has been damaged at the shaft hole area by the scrubbing action in a vertical disc butterfly valve. The seat also shows deterioration by the media in the flow stream.

Norris perfect circle disc design

By Comparison – Flattened disc/boss areas of vertical disc design

Norris Angle Design Eliminates Stress Areas

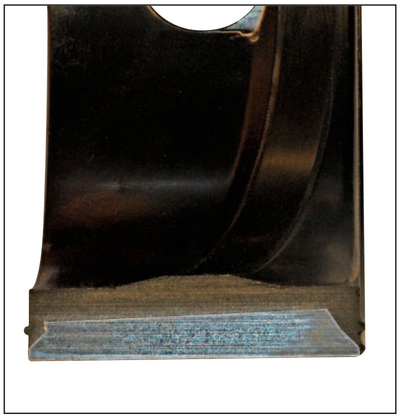
Most butterfly valves obtain their seal by penetrating a metal disc into an elastomer (rubber) seat, creating internal pressure in the elastomer. As long as the internal pressure in the elastomer exceeds the pressure in the pipeline, fluid cannot bypass the valve disc edge. Because Norris' close dimensional control, positive shutoff is achieved with minimum interference between disc and seat.

Norris perfect circle disc design makes it possible to machine and polish the disc edge to a smooth, rounded surface which cannot damage the seating surface by scrubbing when the valve is cycled.

By Comparison: The rough-hewn edges of these vertical discs create uneven stresses in the elastomer seat, causing scrubbing of the elastomer and early failure of the differential seal.

Norris' exclusive separate body o-ring flange seals can be replaced (sometimes simply turned over) without disassembling the valve and replacing the seat. A primary seal bead molded into the face of the elastomer seat (R-Series) serves as an additional seal.

By Comparison: All resilient lined butterfly valves depend exclusively on compression of the face of the seat for sealing between flange and valve. If this sealing face is damaged during installation or shipment, the valve must be dismantled and the entire seat must be replaced.



Norris' field-removable and interchangeable resilient seat is bonded to a rigid plastic backing sleeve to prevent the seat from distorting or collapsing in vacuum or high velocity flow. Free fit of seat permits replacement with no special tools. The seat isolates the flow stream from the body of the valve (dry back construction).

Norris' replaceable metal seat (M-Series and D-Series) also isolates the flow stream from the body of the valve. Because the metal seat is separate from the valve body, expensive alloy seat material can be specified with less expensive grey iron or carbon steel bodies for highly corrosive services at a minimum of expense. Free fit permits easy field replacement of metal seat or conversion to R-Series.

By Comparison: Some vertical disc butterfly valves fit a "boot" seat over the body of the valve. Special tools are required to stretch the seat into position and high velocity flow tends to wash the seat downstream.

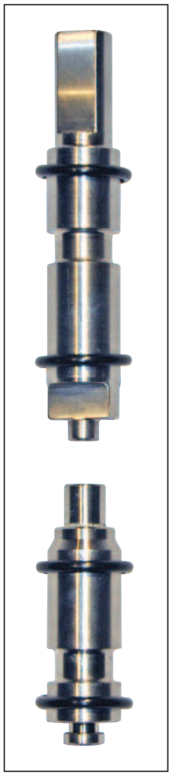
An adhesive is used to retain some vertical disc seats. The valves are not field repairable and the adhesive may be attacked by the media in the flow stream.

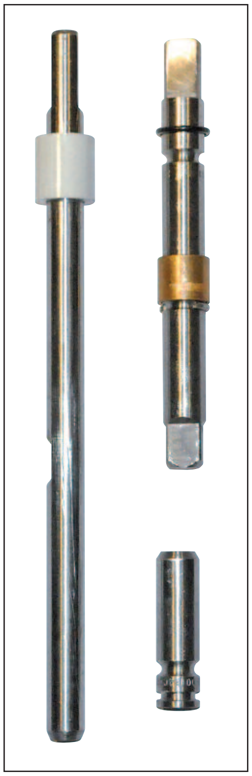
Other vertical disc seats must be "pressed" into the valve bore making alignment of shaft holes difficult and reassembly unnecessarily complicated.

In other metal seated butterfly valves, the body serves as the seating surface. For corrosive service, the entire body must be made of expensive alloy materials.

Norris' double 0-ring shaft seals, plus the primary shaft seal molded into the R-Series seat, provide triple protection against leakage into shaft bearing areas. Line media and outside atmospheric contamination are sealed out of bearing areas and Teflon impregnated grease is sealed in to assure proper lubrication.

Metal-backed Teflon bushings prevent galling of steel or monel shafts with steel bodies.

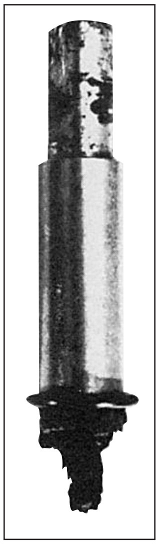


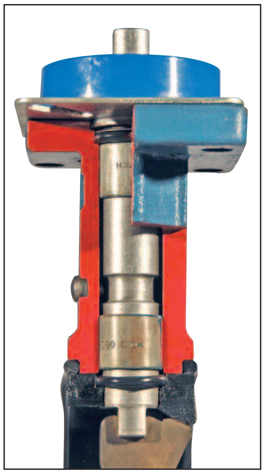


By comparison: Some vertical disc valves depend entirely on the squeeze of the seat at the disc bosses to seal the flow stream from shaft bearing areas. Constant scrubbing of the disc on this area results in premature seal failure, loss of media and shaft bearing areas.

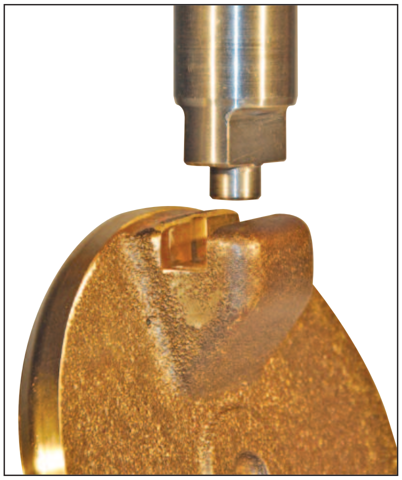
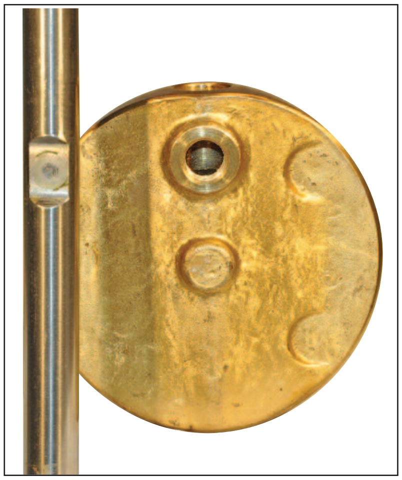
Norris' Separate Flange & Shaft Seals Prevent Leakage into Shaft Bearing Areas and to the Atmosphere

To illustrate the sealing integrity of Norris' shaft o-rings, we photographed this 416 stainless steel shaft which was literally dissolved up to the o-ring seal by chlorinated brine in the flow stream. Note that the seal confined the failure to the pipeline and prevented any external leakage. Selection of the proper shaft material (titanium) would have prevented failure of this valve.





Shaft Retention – the handle shaft of 2″ through 12″ valves is retained by a sealed retention screw. On 14″ and larger valves, the shaft is cross pinned to the disc. A thrust plate provides positive retention of the bottom shaft on all valves.

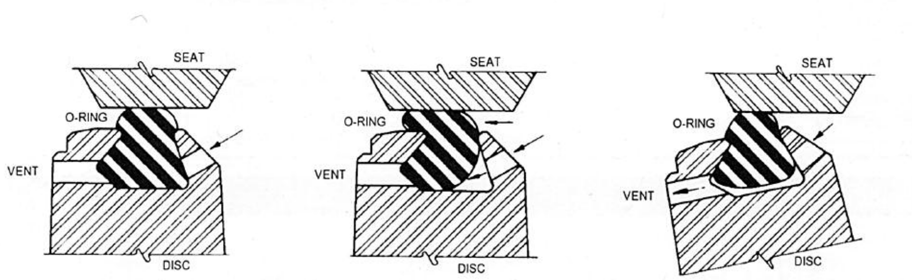




Norris' precision fit disc slot assures positive disc action and prevents disc "flutter." There are no bolts, pins, screws or rivets to corrode or fail (12" and smaller valves).

A though shaft with high-strength 17-4 PH stainless steel or K-Monel straight dowel pin connection assures maximum drive strength and field repairability of larger valves. Norris' straight disc pins do not penetrate the sealing plane of the disc and do not require special fitting of parts when valve repair is necessary.

By Comparison: Bolts, taper pins or screws which are used to connect vertical discs to the shaft provide leakage pathways through the disc and weaken the shaft.

The vertical disc shaft/disc connection illustrated at upper far right is virtually a "square peg in a round hole." Shaft/disc drive strips easily, and becomes sloppy. Blind assembly connection on all vertical disc valves complicates reassembly.



1. No Pressure 2. Pressurized 3. Opening

The higher the pressure, the tighter the seal.

M-Series Sealing – A pressure energized disc o-ring seal contained in a specially designed groove assures positive shutoff every time with Norris' M-Series valves. After making a nominal seal between the metal seat and the disc o-ring, pressure of the flow stream energizes the o-ring and increases the seal. *The higher the pressure, the tighter the seal*. The disc-edge groove is designed to prevent the o-ring being washed downstream ion high velocity service.

Valve Model Number System 200 WP

6 M 30 11 - 4 2 3 BAA - 2R

VALVE CONFIGURATION

Configuration	Code
Special to be Described	00
Span Wafer Body	10
(1.50”-12) Double Rib Span Wafer Body. 200WP	20
Full Tapped Lug Body	30

SERIES

Series	Code
Resilient Seat	R
Metal Seat	M
Metal-to-Metal Seat (Damper Style)	D

VALVE SIZE (IN INCHES)

Size	Code
2”– 36”	2...36

BODY MATERIALS

Material Type	Code
Ductile Iron ASTM A395 60-40-18	11
(WCB) Cast Steel ASTM A216 GR WCB	20
(3) Stainless Steel, ASTM A743 CF-8M*	21
Alloy 20, ASTM A743 GR CN7M	22
(L) Valve Bronze, ASTM B61	30
(FK) NI-CU-AL Bronze ASTM B148, Alloy C95800	31
(A) Aluminum Alloy 356T6 ASTM B26 Alloy 5G70A	40

*Special Order – Consult Factory

SHAFT MATERIAL

Material	Code
(C) Ductile Iron, ASTM B473 UNS N08020	1
(3) Stainless Steel ASTM A276, Type 316	2
(F) Stainless Steel ASTM A276, Type 416	3
(M) Nickel-Copper Alloy (Monel) ASTM B164 Class A	4
(EN) Nitronic 50	5
(K) NI-CU-AL Alloy QQ-N-286A (K-Monel)*	6
(AP) Stainless Steel 17-4PH ASTM A564 Type 630	7
(W) Inconel 600	8
(AJ) Titanium ASTM B348 GR 4	9
( ) Special to be Described	0
(BH) Hastelloy B, ASTM B335	B
(AM) Hastelloy C, ASTM B574 Alloy N102:76	C
(EB) Zirconium	F

*K-Monel std. in 22” & Larger Valves with Monel Shaft

DISC MATERIAL

Code	Materials
1	(D) Ductile Iron, ASTM A395 60-40-18
2	(3) Stainless Steel 316 ASTM A743 GR CF-8M
3	(C) Alloy 20 ASTM A743 GR CN-7M
4	(AL) ASTM B148 C95400
5	(A) Aluminum Alloy 356T6 ASTM B26 Alloy
6	(M) Nickel-Copper Alloy (Monel) ASTM A494, M30C
9	(AJ) Titanium ASTM B367 GR8A
0	( ) Special to be described
B	(BH) Hastelloy B, ASTM A494
C	(AM) Hastelloy C, ASTM A494 CW 12-MW
G	(W) Inconel 600 ASTM A494 Alloy CY-40
K	(EA) Illium PD
P	(FK) NI-CU-AL Bronze ASTM B148 Alloy C98500

SEALS

Materials	Code
Buna N	A
Fluoroelastomer	B
Fluorosilicone	C
PTFE Impregnated Fluoroelastomer	D
Neoprene (Black)	E
Neoprene (White)	G
Nitrile (Low Temp)	M
Natural Rubber	N
AFLAS	R
EPDM	S
Low Temp Neoprene	V
Kalrez	Y
Zalak	Z
Highly Saturated Nitrile	4
Peroxide Cured Nitrile	8
TFE/SIL	9A

SEAT MATERIAL

Code	Seat R Series
A	Buna N
B	Fluoroelastomer (Viton)
B2	Viton GF/Epoxy Backing
B3	Fluoroelastomer/Epoxy Backing
D	TFE Impregnated Fluoroelastomer
E	Neoprene (Black)
E2	Neoprene (Epoxy Backing)
G	Neoprene (White)
J	Nitrile, Abrasive Resistant
N	Natural Rubber
S	EPDM, Peroxide Cured
4	HSN, Highly Saturated Nitrile/ Epoxy Backing
5	Natural Red Rubber
8	Peroxide Cured Nitrile

Code	Seat M Series
1	(G) Cast Iron, ASTM A126 Class B
2	(3) Stainless Steel 316 ASTM A743 GR CF-8M
3	(AB) Aluminum Bronze ASTM B148 Alloy C95300
4	(A) Aluminum Alloy 356T6 ASTM B26 Alloy SG70A
5	(M) NI CU Alloy (Monel) ASTM A494, M30C
6	(W) Inconel No. 610
7	(C) Stainless Steel Alloy 20 ASTM A743 GR CN7M
9	(AJ) Titanium ASTM B367 GR 8A
0	( ) Special to be described
B	(BH) Hastelloy B, ASTM A494 N-12MV
C	(AM) Hastelloy C, ASTM A494 CW 12-MW
D	(EB) Zirconium
F	(EA) Illium PD
G	(FK) NI-CU-AL Bronze ASTM B148 Alloy C95800

NORRIS OPERATORS

Code	Manual Operators
1A	(1.5-12) STD Handle with 1J Topworks
1F	(2-12) Squeeze Trigger 10 Pos
1FM	(1.5-12) 1F with Marine Trim
1J	(2-12) STD Topworks On-Off
1AM	(2-5) STD Handle with 1S Topworks
1P	(2-8) Locking Topworks
1Q	(2-5) 1P Topworks with STD Handle
1JS	(2-8) STD On-Off Topworks, Stainless Steel

Code	Mechanical Operators
2E	(2-12) Gear - W.P. - Aluminum Bronze Marine Trim
2ES	(2-12) 2E Subm. for Salt Water
2R	(2-12) Gear Operator Aluminum Case
2T	(2-36) Gear Operator Cast Iron Case
2RM	2R with Marine Trim
2TM	2T with Marine Trim

**2G Numbers listed are Basic Numbers Only. Complete Actuator Model Number Must be Used when ordering.

SR-Spring Return. Specify Fail/Open or Fail/Closed.

PB-Pressure Balanced/Double Acting.

Code	Diaphragm Operators
**	
2G11	(2-4) 35 SR Diaphragm Actuator
2G12	(2-4) 35 PB Diaphragm Actuator
2G13	(2-8) 70 SR Diaphragm Actuator
2G14	(2-8) 70 PB Diaphragm Actuator
2G15	(6-12) 180A SR Diaphragm Actuator
2G16	(6-12) 180 PB Diaphragm Actuator
2G17	(12-20) 180 SR Diaphragm Actuator
2G18	(12-20) 180 PB Diaphragm Actuator

Please note: not all available options are shown.

Valve Model Number System R&M 285 WP

4 M 285 B-1 6 6 AAA A-2K

PRESSURE CLASS

Class	Code
ANSI 150 Valve 285 PSI	285

SERIES

Series	Code
Resilient Seat	R
Metal Seat	M

VALVE SIZE (IN INCHES)

Size	Code
2.5"– 36"	2...36

BODY CONFIGURATION

Configuration	Code
Single Rib	A
Lug, Full	B
Single Rib Longneck (1400) Limited Availability	F
Double Rib	C
Full Lug Longneck	G

BODY MATERIALS

Material Type	Code
Ductile Iron ASTM A395 60-40-18	1
(WCB) Cast Steel ASTM A216 GR WCB	2
(3) Stainless Steel, ASTM A743 CF-8M*	5
NI-CU-AL Bronze ASTM B148, Alloy C98500	6

*Special Order – Consult Factory

SHAFT MATERIAL

Material	Code
(K) NI-CU-AL Alloy QQ-N-286A (K-Monel)*	6
(AP) Stainless Steel 17-4PH ASTM A564 Type 630	7
Special to be Described	0
Hastelloy C ASTM B574 Alloy N10276	C

DISC MATERIAL

Code	Materials
2	316 Stainless Steel ASTM A743 GR. CF8M
3	Alloy 20 Stainless Steel ASTM A743 Gr. CN7M
4	Aluminum Bronze ASTM B148 Alloy C95400
6	Ni Cu Alloy (Monel) ASTM A494, M30C
C	(AM) Hastelloy C, ASTM A494 CW 12-MW
G	(W) Inconel 600 ASTM A494 Alloy CY-40
0	( ) Special to be described

SEALS

Materials	Code
Buna N	A
Fluoroelastomer	B
Fluorosilicone	C
PTFE Impregnated Fluoroelastomer	D
Neoprene (Black)	E
Neoprene (White)	G
Nitrile (Low Temp)	M
Natural Rubber	N
AFLAS	R
EPDM (NORDEL)	S
Low Temp Neoprene	V
Kalrez	Y
Zalak	Z
Highly Saturated Nitrile	4
White EPDM	6
SBR	7
Peroxide Cured Buna N	8
PTFE/SIL	9A
PTEE/Viton	9B

SEAT MATERIAL

Code	Seat R Series
A	Buna N
B	Fluoroelastomer (Viton)
B2	Viton GF/Epoxy Backing
B3	Fluoroelastomer/Epoxy Backing
D	PTFE Impregnated Fluoroelastomer
E	Neoprene (Black)
E2	Neoprene (Epoxy Backing)
G	Neoprene (White)
J	Nitrile, Abrasive Resistant
S	EPDM Peroxide Cured
X	Special to be described
4	HSN, Highly Saturated Nitrile
6	White EPDM
7	SBR
8	Peroxide Cured Nitrile

Code	Seat M Series
2	(3) Stainless Steel 316 ASTM A743 GR CF-8M
3	(AB) Aluminum Bronze ASTM B148 Alloy C95300 (9B)
5	(Monel) ASTM A494, M30C QQ-N-288 COMP A or E
6	Inconel 600 ASTM A494 Alloy CY-40
7	Alloy 20 Stainless Steel ASTM A743 Gr. CN7M
C	Hastelloy C ASTM A494 Alloy CW 12MW
H	Aluminum Bronze ASTM A148 Alloy C95300 Electroless Nickel Plated
0	Special to be described

NORRIS OPERATORS

Code	Manual Operators
1A	(1.5-12) STD Handle with 1J Topworks
1F	(2-12) Squeeze Trigger 10 Pos
1FM	(1.5-12) 1F with Marine Trim
1J	(2-12) STD Topworks On-Off
1AM	(2-5) STD Handle with 1JS Topworks
1P	(2-8) Locking Topworks
1Q	(2-5) 1P Topworks with STD Handle
1JS	(2-5) STD On-Off Topworks, Stainless Steel

Code	Mechanical Operators
2E	(2-12) Gear - W.P. - Aluminum Bronze Marine Trim
2ES	(2-12) 2E Subm. for Salt Water
2R	(2-12) Gear Operator Aluminum Case
2T	(2-36) Gear Operator Cast Iron Case
2RM	2R with Marine Trim
2TM	2T with Marine Trim

Code	Diaphragm Operators
**	
2G11	(2-4) 35 SR Diaphragm
2G12	(2-4) 35 PB Diaphragm
2G13	(2-8) 70 SR Diaphragm
2G14	(2-8) 70 PB Diaphragm
2G15	(6-12) 180A SR Diaphragm
2G16	(6-12) 180 PB Diaphragm
2G17	(12-20) 180 SR Diaphragm
2G18	(12-20) 180 PB Diaphragm

**2G Numbers listed are Basic Numbers Only. Complete Actuator Model Number Must be Used when ordering.

SR-Spring Return. Specify Fail/Open or Fail/Closed.

PB-Pressure Balanced/Double Acting.

Please note: not all available options are shown.

Liquid Sizing Equations

English Formula

$$C_V = Q\sqrt{\frac{G}{\Delta P}}$$

$$Q = C_V\sqrt{\frac{\Delta P}{G}}$$

$$\Delta P = \frac{Q^2 \times G}{C_V^2}$$

$$V = \frac{Q \times 0.321}{A}$$

Where:

C_V = Valve flow coefficient

Q = Volume rate of flow in U.S. gpm

G = Specific gravity (water = 1.0)

ΔP = Pressure drop (psi)

V = Velocity in feet per second

A = Area of pipe in square inches

W = Flow in pounds per hour $Q = \frac{W}{500 \times G}$

Sample problem – (solve for C_V)

Q = 5500 gpm (kerosene) @ 150 psi

ΔP = 2 psi

G = 0.824

hence:

$$C_V = Q\sqrt{\frac{G}{\Delta P}} = 5500\sqrt{\frac{0.824}{2.0}} =$$

5500 x 0.6419 = 3530

1. For on-off, an 8" Norris R-200 Series has a C_V of 4100 at 90° open. Checking the liquid velocity of an 8" valve, where A = 50.0 sq. in., V = 35 fps which is above the velocity limits of M-Series (16 fps). Therefore, a 10" R-Series would be required. To be within the flow velocity limits of M-Series (16 fps), a 12" valve would be required.

1. For a throttling application, a 16" valve would be required, which has a C_V range of 720 @ 30° open and 3850 at 60° open.

Metric Formula

$$C_V = 1.16 \times Q\sqrt{\frac{G}{\Delta P}}$$

$$Q = 0.86 \times C_V\sqrt{\frac{\Delta P}{G}}$$

$$\Delta P = \frac{Q^2 \times G}{(0.86 \times C_V^2)}$$

$$V = \frac{Q \times 2.783}{A}$$

Where:

C_V = Valve flow coefficient

Q = Volume rate of flow in m^3/hr

G = Specific gravity (water = 1.0)

ΔP = Pressure drop (bar)

V = Velocity in meters per second

A = Area of pipe in square centimeters

W = Flow in kilograms per hour $Q = \frac{W}{500 \times G}$

Sample problem – (solve for C_V)

Q = 1247 m^3/hr (kerosene) @ 9.7 bar

ΔP = 0.138 bar

G = 0.824

hence:

$$C_V = 1.16 \times Q\sqrt{\frac{G}{\Delta P}} = 1447\sqrt{\frac{0.824}{0.138}} =$$

1447 x 2.44 = 3530

1. For on-off, a 200mm Norris R-200 Series has a C_V of 4100 at 90° open. Checking the liquid velocity of an 200mm valve, where A = 322.58 cm^2, V = Q x 2.783/A = 10.7 m/s which is above the velocity limits of R-Series (9.14 m/s). Therefore, a 250mm R-Series would be required. To be within the flow velocity limits of M-Series (4.88 m/a), a 200mm valve would be required.

1. For a throttling application, a 400mm valve would be required, which has a C_V range of 720 @ 30° open and 3850 at 60° open.

Metric Conversions Relative to Flow Calculations

To Convert	into	multiply by
pounds/hour	kilograms/hour	0.4536
$inches^2$	$centimeters^2$	6.4516
feet/second	meters/second	0.3048
$pounds/inch^2$ (psi)	Bar	0.0689
$pounds/inch^2$ (psi)	$kilograms/meters^2$	0.2268
gallons/minute	$meters^3/hour$	0.2268
inches	millimeters	25.40

Specific Gravity of Various Liquids

(at standard temp. °F)

Industrial	
Acetic acid	0.79
Alcohol-butyl	0.81
Alcohol-ethyl	0.798
Alcohol-methyl	0.79
Ammonia	0.662
Automobile oil	0.88-94
Benzene	0.879
Brine	1.2
Bromine	2.9
Carbon tet.	1.59
Formic acid	1.221
Freon 11	1.49
Freon 12	1.33
Freon 21	1.37
Fuel oils	0.82-95
Gasoline	0.72
Glycol ethylene	1.125
Hydrochloric acid 31.5%	1.15
Kerosene	0.824
Nitric acid 60%	1.37
Sulfuric acid 100%	1.83
Sulfuric acid 95%	1.83
Sulfuric acid 60%	1.50
Water – fresh	1.0
Water – sea	1.03

Oilpatch	
Fresh water	1.0
Produced water	1.02
Crude oil	
20° API	0.924
30° API	0.876
40° API	0.825
50° API	0.779
Potassium chloride	
8.53 lb/gal	1.024
9.09 lb/gal	1.091
Calcium chloride	
9.0 lb/gal	1.079
10.0 lb/gal	1.199
Sodium chloride	
9.0 lb/gal	1.079
10.0 lb/gal	1.199
Sodium chloride – calcium chloride solution	
10.1 lb/gal	1.211
11.0 lb/gal	1.319
Drilling muds	
10.0 lb/gal	1.20
13 lb/gal	1.56
16 lb/gal	1.92
19 lb/gal	2.28
HCL 10%	
20%	1.100
30%	1.152
Diesel Fuel	0.8156

TABLE II – FLOW COEFFICIENT (C_V) FOR 200 PSI VALVES

Valve Open		Degrees Open							
		20°	30°	40°	50°	60°	70°	80°	90°
2″	50 mm	11.2	17.8	27.5	44	68	107	142	170
2.5″	65 mm	16.5	26	42	67	105	165	225	290
3″	75 mm	22	36	59	94	150	238	330	430
3.5″	90 mm	29	47	78	127	200	320	460	610
4″	100 mm	36	60	100	160	260	420	610	830
5″	125 mm	52	90	152	248	400	650	980	1,400
6″	150 mm	70	125	215	350	580	930	1,420	2,100
8″	200 mm	112	210	365	610	1,000	1,620	2,600	4,100
10″	250 mm	160	310	560	920	1,550	2,520	4,150	6,900
12″	300 mm	220	430	800	1,300	2,200	3,600	6,100	10,500
14″	350 mm	285	570	1,050	1,750	3,000	4,950	8,600	15,000
16″	400 mm	350	720	1,350	2,250	3,850	6,400	11,500	20,000
18″	450 mm	430	880	1,700	2,800	4,900	8,000	14,400	26,800
20″	500 mm	510	1,080	2,100	3,400	6,000	9,900	18,000	34,000
22″	550 mm	600	1,280	2,450	4,100	7,200	11,900	22,000	42,000
24″	600 mm	690	1,490	2,880	4,800	8,500	14,100	26,300	51,800
26″	650 mm	790	1,720	3,350	5,600	10,000	16,500	31,500	62,000
28″	700 mm	900	1,950	3,800	6,400	11,500	19,200	37,000	74,000
30″	750 mm	1,000	2,200	4,300	7,400	13,000	22,000	42,000	85,000
32″	800 mm	1,100	2,500	5,000	8,400	15,000	25,000	50,000	100,000
36″	900 mm	1,400	3,200	6,300	10,600	19,000	31,600	63,000	126,000

NOTE: Use 30° to 60° range (shaded area) for sizing throttling valves.

TABLE III – FLOW COEFFICIENT (C_V) FOR ANSI 150, (285 SERIES) 285 PSI VALVES

Valve Open		Degrees Open							
		20°	30°	40°	50°	60°	70°	80°	90°
2.5″	65 mm	15	23	38	60	84	132	180	232
3″	75 mm	20	32	52	85	120	190	264	344
4″	100 mm	32	54	90	144	208	336	488	664
5″	125 mm	47	81	137	223	320	520	784	1,120
6″	150 mm	63	113	194	315	464	744	1,136	1,680
8″	200 mm	101	189	329	549	800	1,296	2,080	3,280
10″	250 mm	144	279	504	828	1,240	2,016	3,320	5,520
12″	300 mm	198	387	720	1,170	1,760	2,880	4,880	8,400
14″	350 mm	285	570	1,050	1,750	3,000	4,950	8,600	15,000
16″	400 mm	350	720	1,350	2,250	3,850	6,400	11,500	20,000
18″	450 mm	430	880	1,700	2,800	4,900	8,000	14,400	26,800
20″	500 mm	510	1,080	2,100	3,400	6,000	9,900	18,000	34,000
22″	550 mm	600	1,280	2,450	4,100	7,200	11,900	22,000	42,000
24″	600 mm	690	1,490	2,880	4,800	8,500	14,100	26,300	51,800
26″	650 mm	790	1,720	3,350	5,600	10,000	16,500	31,500	62,000
28″	700 mm	900	1,950	3,800	6,400	11,500	19,200	37,000	74,000
30″	750 mm	1,000	2,200	4,300	7,400	13,000	22,000	42,000	85,000
32″	800 mm	1,100	2,500	5,000	8,400	15,000	25,000	50,000	100,000
36″	900 mm	1,400	3,200	6,300	10,600	19,000	31,600	63,000	126,000

NOTE: Use 30° to 60° range (shaded area) for sizing throttling valves.

TABLE IV – TEMPERATURE CHART – ELASTOMER SEATS & SEALS

Caution: Temperature extremes are affected by the media being handled by the valve. Consult factory for specific guidelines.

R-Series

Type	Elastomer Compound	Temperature – F (-50° 0° 50° 100° 150° 200° 250° 300° 350° 400° 450°)
A	Buna N	
B	Fluorocarbon (Viton)	
E	Neoprene	
G	White Neoprene	
J	Abrasion Resistant Buna N	
S	EPDM	
4	HSN	

M-Series

Type	Elastomer Compound	Temperature – F (-50° 0° 50° 100° 150° 200° 250° 300° 350° 400° 450°)
A	Buna N	
B	Fluorocarbon (Viton)	
D	Teflon Impregnated (Viton)	
E	Neoprene	
M	Buna N (low temp)	
S	EPDM	
4	HSN	
R	AFLAS	

D-Series

Type	Elastomer Compound	Temperature – F (-50° 0° 50° 100° 150° 200° 250° 300° 350° 400° 450°)
A	Buna N	
B	Fluorocarbon	
E	Neoprene	
M	Buna N (low temp)	
S	EPDM	
4	HSN	
R	AFLAS	

TABLE V – FLUID DYNAMIC TORQUE (USE FOR 200 AND 285 SERIES)

Valve Size		Degrees Open							
		20°	30°	40°	50°	60°	70°	80°	90°
2″	50 mm	.013	.021	.041	.096	.19	.34	.68	.28
2.5″	65 mm	.031	.052	.10	.23	.45	.81	1.6	.64
3″	75 mm	.062	.105	.20	.46	.90	1.6	3.2	1.3
3.5″	90 mm	.115	.19	.36	.80	1.6	2.8	5.6	2.3
4″	100 mm	.19	.32	.59	1.3	2.6	4.7	9.2	3.8
5″	125 mm	.45	.74	1.35	3.1	6.0	11.0	21.5	8.8
6″	150 mm	.90	1.4	2.7	6.0	12.0	22.0	43.0	18.0
8″	200 mm	2.6	4.3	7.8	17.5	34.0	62.0	130.0	53.0
10″	250 mm	6.3	10.0	18.5	41.0	80.0	155.0	300.0	123.0
12″	300 mm	12.3	20.0	35.0	80.0	155.0	300.0	600.0	250.0
14″	350 mm	22.0	35.0	64.0	145.0	285.0	550.0	1,100.0	440.0
16″	400 mm	36.0	56.0	103.0	235.0	450.0	900.0	1,800.0	710.0
18″	450 mm	57.0	89.0	160.0	365.0	720.0	1,420.0	2,809.0	1,125.0
20″	500 mm	84.0	132.0	240.0	540.0	1,080.0	2,100.0	4,100.0	1,700.0
22″	550 mm	120.0	190.0	340.0	780.0	1,600.0	3,000.0	5,800.0	2,500.0
24″	600 mm	170.0	260.0	480.0	1,120.0	2,150.0	4,300.0	8,400.0	3,400.0
26″	650 mm	230.0	350.0	650.0	1,500.0	2,950.0	5,800.0	11,600.0	5,800.0
28″	700 mm	310.0	480.0	850.0	2,000.0	3,900.0	7,800.0	15,500.0	6,500.0
30″	750 mm	395.0	600.0	1,100.0	2,600.0	5,100.0	11,000.0	20,000.0	8,400.0
32″	800 mm	500.0	780.0	1,450.0	3,300.0	6,500.0	13,000.0	26,000.0	11,000.0
36″	900 mm	840.0	1,310.0	2,350.0	5,460.0	10,600.0	21,300.6	42,000.0	17,800.0

All values are in inch pounds and are based on 1 psi total pressure drop across the valve.
NOTE: To obtain total fluid dynamic torque, multiply value for selected size and disc angle required by total pressure drop.
(Constant) x (ΔP) = Fluid dynamic torque in inch-pounds.

TABLE VII – OPERATING TORQUES 200 SERIES (INCH POUNDS)

Operating torques for wet service shown in table below include 50% service factor. For dry torques, multiply the values shown by 1.33.

Valve Size		R-Series – Wet Service								M-Series – Wet Service								D-Series – Wet Service							
		Line Pressure – PSI								Line Pressure – PSI								Line Pressure – PSI							
IN	MM	0	50	75	100	125	150	175	200	0	50	75	100	125	150	175	200	0	50	75	100	125	150	175	200
2	50	64	89	101	114	126	138	150	162	50	93	114	135	156	178	199	220	24	63	81	98	115	131	146	164
2.5	65	72	96	109	121	134	146	158	170	75	116	137	158	178	199	219	240	24	63	81	98	115	131	146	164
3	75	100	129	143	158	172	187	202	216	100	150	175	200	225	250	275	300	31	84	106	126	144	166	184	203
3.5	90	128	172	194	216	238	260	282	304	140	230	275	320	365	410	455	500	31	84	106	126	144	166	184	203
4	100	160	220	248	280	308	340	368	400	180	285	338	390	443	495	548	600	64	162	205	249	285	327	368	410
5	125	245	352	400	440	488	544	584	640	270	478	581	685	789	893	996	1,100	98	260	330	391	451	530	591	656
6	150	720	800	840	896	940	984	1,032	1,080	500	789	934	1,078	1,223	1,367	1,512	1,656	297	600	704	806	881	972	1,045	1,154
8	200	1,512	1,782	1,848	1,968	2,096	2,224	2,320	2,448	750	1,413	1,744	2,075	2,406	2,738	3,069	3,400	624	1,231	1,478	1,697	1,912	2,113	2,262	2,479
10	250	2,160	2,512	2,688	2,872	3,040	3,216	3,408	3,600	1,050	2,038	2,531	3,025	3,519	4,013	4,506	5,000	648	1,601	1,949	2,262	2,508	2,814	3,067	3,330
12	300	3,448	3,960	4,200	4,400	4,696	4,944	5,192	5,440	1,300	3,425	4,488	5,550	6,613	7,675	8,738	9,800	690	2,947	2,625	3,053	3,463	3,832	4,154	5,032
14	350	5,700	6,500	6,900	7,300	7,700	8,200	8,600	9,000	1,510	4,250	5,600	7,000	8,400	9,800	11,100	12,500	855	2,898	3,600	4,078	4,463	4,743	4,990	5,118
16	400	7,100	8,100	8,600	9,000	9,500	10,000	10,500	11,000	1,790	5,350	7,100	8,900	10,700	12,400	14,200	16,000	710	3,404	4,510	5,260	5,780	6,265	6,705	6,975
18	450	9,550	10,800	11,500	12,100	12,700	13,000	14,000	14,600	2,000	5,900	7,800	9,800	11,700	13,600	15,600	17,500	860	4,576	6,145	7,328	8,102	8,826	9,986	9,824
20	500	10,100	12,100	13,100	14,000	15,000	16,000	17,000	18,000	2,250	7,300	9,850	12,400	14,900	17,400	20,000	22,500	1,010	5,162	6,985	8,286	9,231	10,122	10,939	11,475
22	550	11,500	13,500	14,400	15,200	16,300	17,000	17,700	18,500	2,500	8,125	10,938	13,750	16,563	19,375	22,188	25,000	1,265	5,730	6,480	7,600	8,802	9,690	10,443	11,285
24	600	14,500	17,000	18,000	19,000	20,250	21,500	22,750	24,000	2,700	9,400	12,750	16,100	19,450	22,800	26,150	29,500	1,595	6,460	8,100	9,500	10,935	12,255	13,423	14,640
26	650	17,500	20,500	22,000	23,500	25,200	27,000	28,500	30,000	2,950	10,463	14,219	17,957	21,731	25,488	29,244	33,000	1,925	7,790	9,900	11,750	13,608	15,390	16,865	18,300
28	700	20,000	25,000	27,500	30,000	32,500	35,000	37,500	40,000	3,100	13,825	19,188	24,550	29,913	35,275	40,638	46,000	2,000	8,000	10,175	12,300	14,625	16,800	19,125	21,200
30	750	35,000	38,750	40,625	42,500	44,375	46,250	48,150	50,000	3,400	15,300	21,250	27,200	33,150	39,100	45,050	51,000	2,100	11,625	15,031	17,425	19,969	22,200	24,544	26,500
32	800	30,000	36,000	39,000	42,500	45,600	48,800	52,000	55,000	3,900	16,675	23,063	29,450	35,838	42,225	48,613	55,000	2,200	13,500	17,575	20,500	23,625	26,400	29,325	31,800
36	900	40,000	47,500	52,200	55,000	58,800	62,500	66,300	70,000	45,000	23,300	33,000	42,000	52,000	61,000	71,000	80,000	2,600	14,500	20,400	26,300	32,700	38,200	44,100	50,000

TABLE VIII – ANSI 150 OPERATING TORQUES 285 SERIES (INCH POUNDS)

Operating torques for wet service shown in table below include 50% service factor. For dry torques, multiply the values shown by 1.33.

Valve Size		R 285 – Wet Service						M 285 – Wet Service					
		Line Pressure – PSI						Line Pressure – PSI					
IN	MM	0	50	100	150	200	285	0	50	100	150	200	285
2.5	65	100	134	169	204	238	275	86	133	181	229	276	285
3	75	140	180	221	261	302	504	115	172	230	288	345	448
4	100	224	308	392	476	560	672	207	328	448	569	690	897
5	125	343	492	616	761	896	1,050	310	550	787	1,027	1,265	1782
6	150	1,000	1,120	1,254	1,377	1,512	1,820	575	907	1,240	1,572	1,904	2,645
8	200	2,116	2,419	2,755	3,113	3,427	4,060	862	1,625	2,386	3,148	3,910	5,175
10	250	3,024	3,516	4,020	4,502	5,040	5,880	1,207	2,343	3,478	4,615	5,750	7,360
12	300	4,827	5,544	6,216	6,921	7,616	9,100	1,495	3,938	6,382	8,826	11,270	11,300
14	350	6,500	7,475	8,400	9,500	10,300	12,600	1,730	4,900	8,000	11,300	14,500	21,000
16	400	8,000	9,300	10,300	11,500	12,500	15,000	2,050	6,150	10,200	14,300	18,400	26,500
18	450	11,000	12,500	14,000	15,300	17,000	21,000	2,300	6,800	11,300	15,700	20,000	29,000
20	500	11,600	14,000	16,000	18,500	20,700	25,300	2,600	8,400	14,300	20,000	26,000	38,000
24	600	16,700	19,500	22,000	25,000	27,000	33,000	3,100	10,800	18,500	26,000	34,000	50,600
30	750	40,000	45,000	49,000	53,000	58,000	68,000	3,900	17,600	31,300	45,000	59,000	86,250
36	900	46,000	55,000	63,000	72,000	71,000	98,000	5,200	27,000	49,000	70,000	92,000	126,000

How to Select Trim Material for Norris Butterfly Valves

The following data is intended as a guide to selecting metals and elastomers for internal wetted parts of Norris butterfly valves in specific applications.

Because of Norris' dry back construction, body materials are not affected by the flow stream. Pressure, temperature and external environment are the critical considerations in selection of body materials.

Norris elastomer seats are harder, less porous and less subject to sewell and deterioration than those used in vertical disc butterfly valves. The specially compounded elastomers are of greater density and higher durometer. Use of these harder elastomers is possible because Norris' precision-machined angle disc doesn't have to penetrate as deep into the seat to give positive, bubble-tight shutoff.

When premium elastomers are required for an application, selection of Norris M-Series valves with replacement metal seats may be more economical because of the limited amount of elastomer used for sealing.

How to Use the Guide

This guide has been prepared from published data, vendor ratings, laboratory and field experience. Recommendations are based on 75°F. Because of varying temperature, aeration, inhibiting and accelerating contaminates often encountered, Norris does not guarantee corrosion resistance of any material. When chemicals are mixed, it cannot be assumed a metal or elastomer will provide the same corrosion resistance as described for the pure chemical.

The ratings reported in this brochure should be considered as a guide and not as an unqualified recommendation. It is necessary that the user approve each material for a specific application. Where valve performance is critical, we suggest actual product testing be done to assure material compatibility with the flow stream.

For applications which require clarification or for additional information, contact Norris Butterfly Valve Application Engineering Department, Houston, Texas 713-466-3552.

Explanation of Ratings

1 – Fully resistant

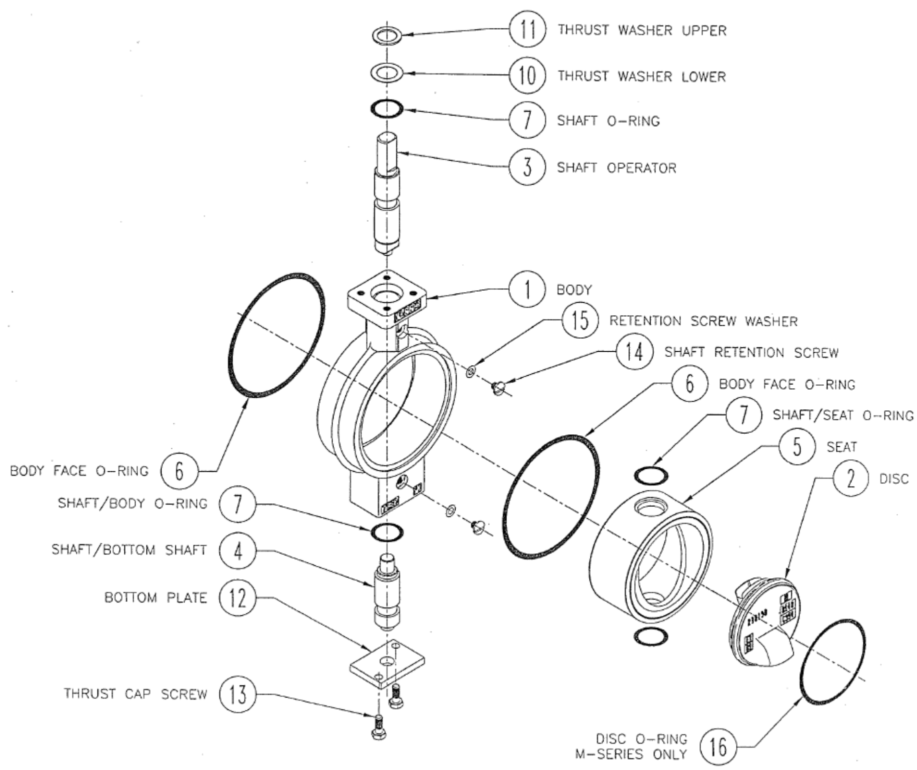
2 – Satisfactorily resistant (slightly attacked)

3 – Test for application

X – Not recommended

– – Insufficient data

For your convenience, the media are presented in alphabetical order.



Environment	Chemical Formula	Elastomers - 75 F						Metals - 75F									
		Buna N	EPDM	HSN	Neoprene	Fluorocarbon	Aflas	Ductile & Cast Iron	Aluminum Bronze	416 SS	316 SS	17 - 4PH SS	Monel & K-Monel	Illium PD & Nitronic 50	Alloy 20	Hastelloy B	Hastelloy C
Acetic Acid, 20%	CH_3COOH	1	1	2	1	1	X	X	X	2	1	2	2	1	1	1	1
Acetic Acid, 50%	CH_3COOH	1	1	–	1	1	X	X	X	2	1	2	1	1	1	1	1
Acetone	CH_3COCH	X	1	X	X	X	X	1	2	1	1	2	1	–	1	1	1
Air	–	1	1	–	1	1	1	2	1	2	1	1	1	1	1	1	1
Aluminum Chloride	$AlCl_3$	1	1	1	1	1	1	X	X	X	X	X	X	3	1	1	1
Aluminum Fluoride	AlF_3H_2O	1	1	1	1	1	1	X	2	X	2	X	2	3	1	1	2
Aluminum Sulfate	$Al_2(SO_4)_3$	1	1	–	1	1	1	X	X	X	1	2	1	–	1	1	1
Ammonia	NH_3	1	1	1	1	X	1	2	2	–	1	2	X	1	1	1	1
Ammonia-Anydrous	NH_3	2	1	2	1	X	1	2	X	2	1	–	X	1	1	2	2
Ammonia Chloride	NH_3Cl	2	1	1	1	1	1	X	X	2	X	X	1	–	1	1	1
Ammonium-Hydroxide, 10%	NH_4OH	1	1	–	1	1	1	1	X	2	1	1	X	–	1	2	1
Ammonium-Hydroxide, 18%	NH_4OH	1	1	–	2	1	1	1	X	1	1	1	X	–	1	1	1
Ammonium Nitrate	NH_4NO_3	1	1	1	1	X	1	X	X	1	1	2	X	–	1	2	2
Ammonium Phosphate	$(NH_4)_2HPO_4$	1	1	1	1	1	1	X	2	1	1	–	2	–	1	1	1
Ammonium Sulfate	$(NH_4)_2SO_4$	1	1	–	1	1	1	X	2	X	2	–	2	–	1	1	2
Amyl Acetate	$CH_3COOC_5H_{11}$	X	1	X	X	X	X	2	2	2	1	2	1	–	1	1	1
Amyl Alcohol	C_5H_2O	1	1	2	1	1	1	2	2	2	1	2	1	1	1	1	2
Aniline	$C_6H_5NH_2$	X	1	X	X	1	1	1	2	2	1	2	2	3	1	2	2
Arsenic Acid	$H_3A_5O_4 1/2H_2O$	1	1	–	1	1	1	X	X	2	2	2	X	–	1	2	2
Asphalt, Emulsion	–	1	3	–	2	1	1	2	2	1	1	1	1	–	1	1	1
Asphalt, Liquid	–	3	X	–	3	1	1	2	2	1	1	1	1	–	1	1	1
ASTM #1 Oil	–	1	X	1	1	1	1	3	1	2	1	1	1	–	1	1	1
ASTM #3 Oil	–	1	X	1	2	1	1	3	1	2	1	1	1	–	1	1	1
ASTM Fuel A	–	1	X	1	2	1	2	3	1	2	1	1	1	–	1	1	1
ASTM Fuel B	–	2	X	1	X	1	X	3	1	2	1	1	1	–	1	1	1
ASTM Fuel C	–	X	X	2	X	1	X	3	1	2	1	1	1	–	1	1	1
Barium Carbonate	$BaCO_3$	1	1	–	1	1	1	X	1	2	2	1	2	–	1	2	2
Barium Chloride	$BaCl_2 \bullet 2H_2O$	1	1	–	1	1	1	X	2	2	2	2	2	–	1	1	1
Barium Hydroxide	$BaOH$	1	1	–	1	1	1	X	X	2	2	2	1	–	1	2	2
Barium Sulfate	$BaSO_4$	1	1	–	1	1	1	X	2	2	2	2	2	–	1	2	2
Barium Sulfide	BaS	1	1	–	1	1	1	3	X	2	2	2	2	–	1	–	2
Beer (Alcohol Industry)	–	1	1	–	1	1	1	X	2	1	1	2	1	1	1	1	1
Beer (Beverage Industry)	–	2	1	–	2	1	1	X	2	X	1	1	1	1	1	1	1
Beet Sugar Liquors	–	1	1	–	1	1	1	X	2	2	1	2	1	1	1	1	1
Benzaldehyde	CH_6H_5CHO	X	1	X	X	X	2	X	2	2	2	2	2	3	1	2	2
Benzene	C_6H_6	X	X	X	X	1	3	2	2	2	2	2	2	3	1	2	2
Benzoic Acid	$C_8H_5CO_2H$	X	X	–	1	1	1	X	2	2	2	2	2	–	1	2	1
Black Sulfate Liquor (Also See Sulfate)	–	1	1	–	1	1	–	3	X	2	2	1	2	1	1	X	X
Borax Liquors	–	2	1	1	1	1	1	X	2	2	1	1	1	–	1	1	1
Boric Acid	H_3BO_3	1	1	1	1	1	1	X	2	2	2	2	2	–	1	1	1
Brine (Also See Water, Sea)	–	1	1	1	1	1	X	X	X	2	2	2	2	1	1	2	1
Brine (Aerated)	–	1	1	1	1	1	–	X	X	2	2	2	2	1	1	2	1
Bromine (Dry Gas)	–	X	X	–	X	1	–	X	X	X	X	X	1	3	X	1	1
Bromine (Wet)	–	X	X	–	X	1	–	X	X	X	X	X	X	X	X	1	1
Bunker Oils (Fuel Oils)	–	1	X	1	X	1	1	2	2	1	1	1	1	–	1	1	1
Butadiene	$H_2C:C_2H_2:CH_2$	1	X	–	1	1	–	X	2	1	2	2	1	–	1	2	2
Butane	C_4H_{10}	1	X	1	1	1	2	2	2	2	2	2	1	–	1	2	2
Butyl Acetate	$C_5H1_2O_2$	X	X	–	X	X	X	2	X	2	2	2	2	–	1	2	2
Butylene	–	1	X	–	1	1	1	2	2	2	2	2	1	–	1	3	2
Butyraldehyde	$C_4H_8O_2$	X	2	–	X	X	X	X	2	3	2	2	1	3	–	–	–
Butyric Acid	$CH_3CH_2CH_2COOH$	X	1	–	X	2	–	X	2	2	2	2	2	–	1	2	1
Calcium Bisulfite	$Ca(HSO_3)_2$	1	X	–	1	1	1	X	X	X	2	2	X	1	2	–	2
Calcium Carbonate	$CaCO_3$	1	1	1	1	1	–	X	X	1	2	2	2	1	1	2	2
Calcium Chloride	$CaCl_2$	1	1	1	1	1	1	3	X	X	2	2	2	–	2	2	1
Calcium Hypochlorite	$Ca(ClO)_2$	X	1	2	1	1	1	X	X	X	2	X	X	3	2	X	1
Calcium Hydroxide, 20%	$Ca(OH)_2$	1	1	X	1	1	1	2	1	X	2	2	2	–	1	2	1
Calcium Sulfate	$CaSO_4$	1	1	–	1	1	1	X	X	2	2	2	2	–	1	2	2
Carbolic Acid	C_6H_5OH	X	2	X	X	1	1	X	3	2	1	1	1	–	1	1	1
Carbon Bisulfide	CS_2	X	X	–	X	1	1	X	2	2	2	1	X	–	1	2	2
Carbon Dioxide	CO_2	1	1	–	1	2	1	2	2	1	2	2	2	–	1	1	2
Carbon Dioxide Dry Gas	CO_2	1	1	–	1	2	–	2	2	1	2	2	1	–	1	1	2
Carbon Tetrachloride (Dry)	CCl_4	X	X	–	X	1	3	X	2	1	1	2	1	–	1	1	1
Carbon Tetrachloride (Wet)	CCl_4	X	X	2	X	1	3	X	2	1	1	2	1	–	2	1	1
Carbonated Water	–	1	1	1	1	1	1	X	1	1	1	1	1	–	1	1	1
Carbonic Acid	H_2CO_3	1	1	1	1	1	1	X	X	2	2	2	X	–	1	1	1
Castor Oil	–	1	1	1	1	1	1	2	2	2	2	1	1	1	X	1	1
China Wood Oil (Tung)	–	1	X	1	2	1	1	X	X	3	1	2	2	1	1	1	1
Chlorine (Dry)	Cl_2	X	X	3	X	1	–	X	1	X	2	X	1	3	2	2	1
Chlorine (Wet)	Cl_2	X	X	3	X	1	1	X	X	X	X	X	X	X	X	X	1
Chlorinated Solvents (Dry)	–	X	1	X	X	1	–	X	X	X	X	X	X	–	1	3	1
Chloroacetic Acid	CH_2ClCO_2H	X	1	X	X	X	–	X	2	X	X	X	X	X	X	1	1

Environment	Chemical Formula	Elastomers - 75 F						Metals - 75F									
		Buna N	EPDM	HSN	Neoprene	Fluorocarbon	Aflas	Ductile & Cast Iron	Aluminum Bronze	416 SS	316 SS	17 - 4PH SS	Monel & K-Monel	Illium PD & Nitronic 50	Alloy 20	Hastelloy B	Hastelloy C
Chlorobenzene (Dry)	C_6H_5Cl	X	X	–	X	1	X	2	2	1	2	2	2	3	2	2	1
Chloroform	$CHCl_3$	X	X	X	X	1	X	X	2	2	1	2	1	–	1	2	2
Chloroform (Dry)	$CHCl_3$	X	X	X	X	1	X	X	2	2	1	2	1	–	1	2	2
Chlorosulfonic Acid (Dry)	$ClSO_2OH$	X	X	–	X	X	2	X	X	X	X	X	2	X	X	1	1
Chlorosulfonic Acid (Wet)	$ClSO_2OH$	X	X	–	X	X	2	X	X	X	X	X	2	X	X	1	1
Chlorotoluene	$CH_3C_6H_4Cl$	X	X	–	X	1	X	2	1	2	2	2	1	3	–	–	–
Chrome Alum	$CrK(SO_4)_2 12H_2O$	1	1	X	1	1	–	2	2	3	2	2	2	–	1	X	2
Chromic Acid, 10%	CrO_3	1	2	–	1	1	1	X	X	X	1	X	2	–	1	1	1
Citric Acid	$C_6H_8O_7$	1	1	1	1	1	1	X	X	2	2	2	2	1	1	1	1
Citrus Juices	–	1	1	1	1	1	1	X	2	1	1	1	1	1	1	1	1
Coke Oven Gas	–	X	1	–	1	1	1	2	2	2	1	2	2	–	1	1	1
Cooking Oil	–	2	1	1	2	1	–	2	2	1	1	1	1	–	1	1	1
Copper Acetate	–	1	1	–	1	X	X	X	2	2	1	2	X	–	1	2	2
Copper Chloride	$CuCl_2$	1	1	–	1	1	1	X	X	X	2	3	X	3	X	2	2
Copper Nitrate	–	1	1	–	1	1	–	X	X	2	2	2	X	–	1	X	2
Copper Sulfate	$CsSO_4$	1	1	–	1	1	1	X	X	2	2	2	X	3	1	2	1
Corn Oil	–	1	X	1	1	1	1	2	1	2	2	2	2	1	1	1	1
Cottonseed Oil	–	1	X	–	1	1	1	2	1	2	2	2	1	1	1	1	1
Creosote Oil	–	1	X	–	X	1	1	X	X	2	2	2	2	–	1	X	2
Cresylic Acid	–	X	1	1	X	1	1	X	X	2	2	2	X	–	1	1	1
Crude Oil (Sweet)	–	1	X	1	X	1	1	2	2	2	1	2	1	–	1	1	1
Crude Oil (Sour)	–	2	X	1	X	1	1	X	3	2	1	2	1	–	1	1	1
Cutting Olls, Water Emulsions	–	1	X	–	2	1	–	2	1	1	1	1	1	–	–	1	1
Cyclohexane	C_6H_{12}	1	X	1	X	1	2	X	2	2	2	2	1	–	1	2	2
Diacetone Alcohol	–	X	1	X	X	X	3	X	2	2	2	2	1	–	1	1	1
Diesel Fuels	–	1	X	1	1	1	1	2	2	2	1	2	1	1	1	2	2
Diethylamine	$(C_2H_5)_2NH$	2	2	–	1	2	2	X	X	2	2	2	1	–	1	–	1
Dow therms	–	X	X	X	X	2	–	X	1	1	1	1	–	–	1	–	–
Drilling Mud	–	1	X	–	X	1	–	2	1	1	1	1	1	1	1	1	1
Drip Cocks, Gas	–	3	X	–	X	1	–	2	2	1	1	1	1	–	1	1	1
Dry Cleaning Fluids	–	3	X	–	X	2	3	X	3	2	1	1	1	–	1	1	1
Drying Oil	–	1	X	–	3	1	–	3	X	2	1	2	2	–	1	1	1
Ethane	C_2H_6	1	X	–	2	1	1	X	2	2	1	1	1	–	1	1	1
Ethanolamine, Mono	C_2H_7ON	1	1	–	1	X	1	2	X	1	1	2	2	–	–	2	2
Ethanolamine, Tri	$C_6H_{15}O_3N$	3	1	–	1	X	1	2	X	2	2	2	2	–	–	–	2
Ethyl Acetate	$C_4H_8O_2$	X	1	X	X	X	X	2	2	2	2	2	2	–	1	2	2
Ethyl Acrylate	$CH_2{:}CHCO_2C_2H_5$	X	2	–	X	X	X	X	2	2	2	2	2	–	–	–	1
Ethyl Alcohol	C_2H_6O	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1
Ethyl Chloride (Dry)	C_2H_5Cl	1	1	1	X	1	3	2	2	1	1	2	2	–	1	2	2
Ethyl Chloride (Wet)	C_2H_5Cl	3	X	1	X	1	2	X	3	2	1	2	2	–	1	2	2
Ethylene Chloride (Dry)	CH_2ClCH_2Cl	X	2	–	X	1	–	3	1	1	2	2	2	–	1	1	3
Ethylene Chloride (Wet)	CH_2ClCH_2Cl	X	X	–	X	2	–	X	2	X	X	X	2	X	–	X	X
Ethylene Diamine	$C_2N_8N_2$	1	1	1	X	1	1	3	X	2	2	2	3	3	–	2	X
Ethylene Dichloride (Dry)	CH_2ClCH_2Cl	X	X	–	X	1	3	X	2	1	2	2	1	3	–	1	2
Ethylene Dichloride (Wet)	CH_2ClCH_2Cl	X	X	–	X	1	1	X	2	1	2	2	1	3	–	1	2
Ethylene Glycol	$C_2H_6O_2$	1	1	1	1	1	1	2	2	2	2	2	2	–	1	1	1
Ethylene Oxide	CH_2CH_2O	X	1	–	X	X	X	2	2	2	1	2	2	–	1	1	1
Fatty Acids	–	1	X	–	1	1	1	X	2	2	1	2	2	1	1	1	1
Ferric Chloride	$FeCl_3$	1	1	–	1	1	1	X	X	X	X	X	X	X	X	2	2
Ferric Nitrate	$Fe(NO_3)_3$	1	1	–	2	1	1	X	X	X	2	2	X	–	1	X	2
Ferric Sulfate	$Fe(SO_4)_3$	1	1	–	1	1	1	X	X	X	1	2	2	–	1	X	1
Ferrous Chloride	Fe_2Cl_2	1	1	–	1	1	–	X	X	X	X	X	X	X	1	2	2
Ferrous Nitrate	$Fe_2(NO_3)_2$	1	1	–	1	1	–	X	X	2	2	2	X	–	1	–	1
Ferrous Sulfate	$FeSO_4$	1	1	–	1	1	–	X	X	2	2	2	2	–	1	2	2
Ferrous Sulfate (Saturated)	$FeSO_4$	1	1	–	1	1	–	X	X	2	2	2	2	–	1	2	2
Fertilizer Solutions	–	2	3	–	2	1	–	X	X	2	1	1	1	1	1	1	1
Fluorosilicic Acid	H_2SiF_6	1	1	–	2	2	–	X	2	3	2	2	1	–	1	2	2
Food Fluids & Pastes	–	2	3	–	2	1	–	X	2	2	1	1	1	1	1	1	1
Formaldehyde	HCHO	X	1	–	3	1	1	X	2	2	2	2	2	3	1	2	2
Formic Acid	HCOOH	X	1	–	1	2	–	X	1	2	2	1	2	3	1	2	1
Fruit Juices	–	1	1	–	1	1	1	X	2	1	2	2	1	1	1	1	1
Fuel Oil	–	1	X	1	1	1	1	2	1	1	2	1	2	–	1	2	2
Furfural	C_4H_3OCHO	X	2	X	1	X	1	X	2	2	2	2	2	–	1	2	2
Gallic Acid	–	2	2	X	2	1	1	X	X	2	2	2	2	–	1	2	2
Gas, Manufactured	–	1	X	–	3	1	–	3	1	2	2	1	1	–	1	1	1
Gas, Natural	–	1	X	–	1	1	1	2	1	1	1	1	1	–	1	1	1
Gasoline (Aviation)	–	3	X	–	X	1	–	2	1	1	1	1	1	–	1	1	1
Gasoline (Leaded)	–	1	X	–	1	1	–	3	2	1	2	2	2	–	1	1	1
Gasoline (Motor)	–	3	X	–	X	1	2	2	1	2	1	1	1	–	1	1	1
Gasoline (Sour)	–	1	X	1	1	1	2	X	2	2	2	2	X	–	1	2	2
Gasoline (Unleaded)	–	1	X	–	1	1	–	X	2	1	2	2	2	–	1	1	1
Gelatin	–	1	1	–	1	1	1	X	1	1	2	2	2	–	1	2	X
Glacial Acetic Acid	CH_3COOH	X	2	1	X	X	X	X	2	X	2	2	2	–	–	–	–

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		Buna N	EPDM	HSN	Neoprene	Fluorocarbon	Aflas	Ductile & Cast Iron	Aluminum Bronze	416 SS	316 SS	17 - 4PH SS	Monel & K-Monel	Illium PD & Nitronic 50	Alloy 20	Hastelloy B	Hastelloy C
Glucose	–	1	1	1	1	1	1	2	3	1	2	2	2	–	1	1	1
Glycerine (Glycerol)	–	1	1	–	1	1	1	1	2	1	1	2	1	1	1	1	1
Glycols	–	1	1	1	1	1	1	1	2	1	2	1	2	–	1	1	1
Grease	–	1	X	1	X	1	1	2	1	1	1	1	1	–	1	1	1
Heptane	$CH_3(CH_2)_5CH_3$	1	X	1	1	1	2	X	2	2	2	2	2	–	1	1	1
Hexane	C_6H1_4	1	X	–	1	1	1	2	2	2	2	2	2	–	1	1	1
Hydraulic Oil (Petroleum Base)	–	1	X	1	2	1	1	2	11	1	1	11	1	–	1	1	1
Hydrobromic Acid	HBr	X	1	–	X	1	1	X	X	X	X	X	X	X	X	2	2
Hydrochloric Acid, 10%	HCl	1	1	–	1	1	1	X	X	X	X	X	2	X	X	2	1
Hydrochloric Acid, 20%	HCl	1	1	–	1	1	1	X	X	X	X	X	2	X	X	2	1
Hydrochloric Acid, 37%	HCl	X	1	–	1	1	1	X	X	X	X	X	X	X	X	2	1
Hydrocyanic Acid	HCN	1	1	2	1	1	1	X	X	2	2	2	2	–	1	2	2
Hydrofluoric Acid, 48%	HF	X	X	–	1	1	1	X	X	X	X	X	1	3	3	1	2
Hydrofluorosilicic	H_2SIF_6	1	1	–	1	1	1	X	2	2	2	X	2	3	3	2	2
Hydrogen Gas	H_2	1	1	–	1	1	1	1	2	1	1	2	1	–	1	1	1
Hydrogen Peroxide (Concent.)	H_2O_2	X	1	X	X	1	1	X	X	2	1	2	1	–	2	1	1
Hydrogen Peroxide (Dilute)	H_2O_2	1	1	X	X	1	1	X	X	X	2	2	2	–	1	1	1
Hydrogen Sulfide (Dry)	H_2S	1	1	–	1	X	–	2	1	2	1	2	2	–	1	2	2
Hydrogen Sulfide (Wet)	H_2S	X	1	1	1	1	1	X	X	X	2	X	X	3	1	2	2
Hypo (Sodium Thiosulfate)	–	1	2	–	1	1	1	X	3	2	1	2	1	–	1	3	2
Iodine (Wet)	–	1	2	1	1	1	X	X	X	X	X	X	X	X	X	2	2
Iodoform	CHI_3	X	1	–	X	1	–	X	X	2	1	1	X	–	1	X	X
Iso-octane	C_8H1_8	1	X	1	1	1	2	3	2	2	2	2	2	–	1	2	2
Isoproply Alcohol	C_3H_8O	1	1	2	1	1	1	2	2	2	2	2	2	–	1	2	2
Isopropyl Ether	$(CH_3)_2CHOCH(CH_3)$	2	X	2	X	X	X	3	2	2	2	2	2	–	1	1	2
JP-4 Fuel	–	1	X	1	X	1	–	2	2	1	2	2	2	–	1	1	1
JP-5 Fuel	–	1	X	1	X	1	–	1	2	1	2	2	2	–	1	2	2
JP-6 Fuel	–	1	X	1	X	1	–	1	2	1	2	2	2	–	1	2	2
Kerosene	–	1	X	1	1	1	1	2	2	1	2	2	2	–	1	2	2
Ketones	–	X	X	–	X	X	–	2	2	2	2	2	2	–	1	1	1
Lactic Acid (Dilute, Cold)	–	1	1	–	1	1	1	X	2	2	1	1	X	–	1	2	2
Lactic Acid (Concent., Cold)	–	X	X	–	1	1	1	X	1	2	2	2	X	–	2	2	2
Lead Acetate	–	1	1	–	1	1	X	X	2	2	2	2	2	–	1	2	2
Linoleic Acid	–	1	X	2	X	1	1	2	X	1	2	2	2	–	1	2	2
Linolenic Acid	$C1_8H_{32}O_2$	2	X	2	3	3	–	X	2	3	1	2	1	–	–	–	–
Linseed Oil	–	1	X	1	1	1	1	2	2	1	2	2	2	1	1	2	2
LPG	–	1	X	1	1	1	3	2	1	1	1	1	1	1	1	1	1
Lubricating Oil	–	1	X	–	1	1	1	1	2	1	2	2	2	1	1	1	1
Magnesium Chloride	$MgCl_2$	1	1	–	1	1	1	X	2	2	2	X	2	–	1	1	1
Magnesium Hydroxide	$Mg(OH)_2$	1	1	–	1	1	1	X	2	2	1	2	2	–	–	1	1
Magnesium Nitrate	$Mg(NO_3)_2$	1	1	–	1	1	–	3	2	1	2	2	2	–	1	2	1
Magnesium Sulfate	$MgSO_4$	1	1	–	1	1	1	X	2	2	2	2	1	–	1	1	2
Maleic Acid	$C_4H_4O_4$	X	1	–	X	1	1	X	2	1	2	2	2	–	2	2	2
Malic Acid	–	1	X	–	1	1	1	X	2	2	1	2	2	–	1	2	2
Mercuric Chloride	$HgCl_2$	1	1	1	X	1	1	X	X	X	2	X	X	X	X	X	2
Mercuric Cyanide	$Hg(CN)_2$	1	1	–	X	1	–	X	X	X	2	3	2	–	1	2	2
Mercury	–	1	1	1	1	1	1	1	X	1	1	2	2	–	1	2	1
Methane	CH_4	1	1	1	1	1	2	2	2	1	1	2	1	–	1	1	1
Methyl Acetate	$CH_3CO_2CH_3$	X	X	X	X	X	X	X	2	3	2	2	1	–	–	2	1
Methyl Acetone	–	X	1	1	1	X	–	3	2	2	2	2	2	–	1	1	1
Methyl Alcohol	CH_3OH	1	1	1	1	X	1	2	2	2	2	2	1	–	1	1	1
Methyl "Cellosolve"	–	X	1	1	1	X	–	X	1	2	2	2	2	–	1	1	1
Methyl Chloride (Dry)	CH_3Cl	X	X	X	X	1	–	2	X	2	1	2	2	–	1	2	2
Methyl Ethyl Ketone	$C_5H_{10}O$	X	1	X	X	X	X	2	2	2	2	2	2	–	1	2	2
Methyl Formate	$HCOOCH_3$	X	1	–	2	X	–	X	2	2	2	2	2	–	–	–	2
Methyl Isobutryl Ketone	C_6H1_2O	X	1	X	X	X	X	2	2	2	2	2	2	–	–	2	2
*Methyl Tertiary Butyl Ether	(MTBE)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Methylamine	CH_3NH_2	3	2	–	2	3	–	2	2	2	1	1	2	–	–	–	–
Methylene Chloride	CH_2Cl_2	X	X	–	X	2	–	2	1	2	2	2	1	–	3	1	1
Mine Waters (Acid)	–	1	1	–	1	1	–	X	X	X	2	3	X	3	2	2	1
Mineral Oil	–	1	X	1	1	1	1	2	2	1	1	1	1	–	1	1	1
Mineral Spirits	–	1	X	–	2	1	–	2	2	1	2	2	1	–	2	1	2
Molasses, Edible	–	1	1	–	1	1	–	X	X	X	1	1	2	–		1	1
Molasses, Crude	–	1	1	–	1	1	1	1	2	1	1	2	2	–		1	1
Muriatic Acid (Hydrochloric)	HCl	X	2	–	X	1	–	X	X	X	X	X	X	X	X	1	1
Naphtha	–	1	X	2	X	1	2	X	2	1	2	2	2	–	1	2	2
Naphthalene	$C_{10}H_8$	X	X	X	X	1	X	3	1	1	1	2	2	–	1	2	2
Nickel Ammonium Sulfate	–	1	2	–	2	1	–	X	X	3	1	2	2	3	–	–	–
Nickel Chloride	$NiCl_2$	1	1	–	1	1	–	X	X	X	2	3	3	3	1	1	1
Nickel Nitrate	$Ni_6(NO_3)_2 \bullet {}_6H_2O$	1	1	–	1	1	–	X	2	2	1	2	2	–	1	2	2
Nickel Sulfate	$NiSO_4$	1	1	–	1	1	–	X	2	2	2	1	2	–	1	X	2
Nitric Acid, 10%	HNO_3	X	1	X	X	1	1	X	X	2	1	2	X	X	1	X	1

*Note: For MTBE Service: Available Elastomers-Teflon Encapsulated Compounds, Kalrez, Zalak   *Available Metals – See Gasoline

Environment	Chemical Formula	Elastomers - 75 F						Metals - 75F									
		Buna N	EPDM	HSN	Neoprene	Fluorocarbon	Aflas	Ductile & Cast Iron	Aluminum Bronze	416 SS	316 SS	17 - 4PH SS	Monel & K-Monel	Illium PD & Nitronic 50	Alloy 20	Hastelloy B	Hastelloy C
Nitric Acid, 30%	HNO_3	X	1	X	X	1	–	X	X	2	1	2	X	1	1	X	1
Nitric Acid, 80%	HNO_3	X	X	X	X	1	–	X	X	2	1	X	X	2	2	X	1
Nitric Acid, 100%	HNO_3	X	X	X	X	1	–	X	X	X	1	2	X	2	X	X	2
Nitrobenzene	$C_6H_5NO_2$	X	X	X	X	2	1	X	2	2	2	2	2	–	1	X	2
Nitrogen (Gas)	N_2	1	1	–	1	1	–	2	2	1	1	2	1	–	1	1	1
Nitrous Oxide	N_2O	X	2	–	X	1	–	X	1	3	2	–	X	–	1	X	2
Oils, Animal	–	1	2	1	2	2	1	1	1	1	1	1	1	–	1	1	1
Oils, Fuel	–	1	X	1	2	1	1	2	1	1	1	1	1	–	1	1	1
Oils, Lubricating	–	1	X	–	2	1	1	1	1	1	1	1	1	–	1	1	1
Oils, Mineral	–	1	X	1	1	1	1	2	1	1	1	1	1	–	1	1	1
Oil, Petroleum (Refined)	–	1	X	–	2	1	1	1	1	1	1	1	1	–	1	1	1
Oil, Petroleum (Sour)	–	2	X	1	3	1	1	X	X	3	2	2	2	–	2	1	1
Oil, Water Mixtures	–	1	X	1	2	1	1	2	1	1	1	1	1	–	1	1	1
Oleic Acid	$C_{18}H_{34}O_2$	1	X	1	X	1	1	X	2	2	1	2	1	–	1	2	2
Ortho Dichlorobenzene	$C_6H_4Cl_2$	X	X	–	X	2	–	3	2	2	2	2	1	–	–	–	–
Oxalic Acid, 25%	$C_2H_2O_42H_2O$	X	1	2	1	1	1	X	2	2	2	2	2	–	2	2	2
Oxygen	–	1	1	X	1	1	1	2	1	2	2	2	2	–	1	1	1
Ozone (Wet)	–	X	1	2	1	1	1	X	2	2	2	2	2	–	1	1	1
Ozone (Dry)	–	X	1	2	1	1	1	2	1	2	2	2	2	–	1	1	1
Plamitic Acid	$C_{18}H_{32}O_2$	1	1	–	X	1	1	3	2	2	2	2	2	–	1	2	2
Paraformaldehyde	$(HCHO)_6$	2	2	–	2	2	–	2	2	2	2	2	–	–	–	–	–
Pentane	$CH_3(CH_2)_3HC_3$	1	X	–	2	1	–	2	2	2	2	2	2	–	1	2	1
Perchloroethylene (Dry)	$Cl_2C:CCl_2$	X	X	–	X	1	–	X	2	2	1	2	1	–	1	2	2
Petrolatum	–	1	X	–	1	1	–	X	2	3	2	3	2	3	–	–	–
Phenol	C_2H_5OH	X	1	X	X	1	1	X	X	2	1	2	1	–	1	1	1
Phosphoric Acid, 10%	H_3PO_4	X	1	–	1	1	1	X	X	1	1	2	X	1	1	1	1
Phosphoric Acid, 50%	H_3PO_4	X	1	–	1	1	1	X	X	2	2	2	X	2	1	1	1
Phosphoric Acid, 85%	H_3PO_4	X	1	–	1	1	–	X	X	X	2	X	X	2	1	1	1
Phthalic Acid	$C_8H_6O_2$	X	X	–	1	1	–	X	2	2	1	2	2	–	1	2	2
Phthalic Anhydrine	$C_6H_4(CO)_2O$	X	1	–	2	1	–	X	2	1	1	2	1	–	1	1	1
Picric Acid	$C_6H_2(NO_2)_3OH$	1	1	–	1	1	X	X	X	2	2	2	X	3	1	2	2
Potassium Bisulfite	$KHSO_3$	1	1	–	1	1	–	X	X	3	2	2	X	–	1	–	–
Potassium Bromide	KBr	1	1	–	1	1	–	X	2	2	2	1	2	–	1	2	1
Potassium Carbonate	K_2CO_3	1	1	–	1	1	–	2	2	2	1	2	2	–	1	2	2
Potassium Chlorate	$KClO_3$	1	1	–	1	1	–	2	2	2	1	2	2	–	1	X	2
Potassium Chloride	KCl	1	1	–	1	1	1	X	2	2	1	2	1	–	1	2	2
Potassium Cyanide	KCN	1	1	–	1	1	1	X	X	2	2	2	2	–	1	2	2
Potassium Dichromate	$K_2CR_2O_7$	1	1	–	1	1	1	2	X	2	2	2	2	–	1	2	2
Potassium Diphosphate	KH_2PO_4	1	1	–	1	1	1	2	2	2	1	1	1	–	–	–	–
Potassium Ferricyanide	$K_3Fe(CN)_8$	1	1	–	1	1	–	X	2	2	2	2	2	–	1	2	2
Potassium Ferrocyasnide	–	1	1	–	1	1	–	X	X	X	2	3	2	–	1	2	2
Potassium Hydroxide (Dil.)	KOH	1	1	–	1	1	1	3	2	2	2	2	1	–	2	2	2
Potassium Hydroxide (to 70%)	KOH	1	1	1	1	X	–	3	2	2	2	2	2	–	2	2	2
Potassium Iodide	KI	1	1	1	1	1	–	2	2	2	2	2	2	–	1	2	2
Potassium Nitrate	KNO_3	1	1	1	1	1	1	X	2	2	2	2	2	–	1	X	2
Potassium Permanganate	$KMnO_4$	X	1	1	1	1	–	2	2	2	2	2	2	–	1	X	1
Potassium Sulfate	K_2SO_4	1	1	1	1	1	1	X	2	2	2	2	2	–	1	2	2
Potassium Sulfide	K_2S	1	3	–	1	X	–	X	X	3	2	2	X	–	1	1	2
Potassium Sulfite	$K_2SO_{32}H_2O$	1	1	–	1	1	–	X	2	2	2	2	2	1	–	–	1
Propane	C_2H_6	1	X	1	1	1	1	X	2	1	2	2	1	–	1	2	2
Propyl Alcohol	_	1	1	1	1	1	1	2	2	2	1	2	2	–	1	1	1
Propylene Glycol	_	1	2	–	1	1	1	2	2	2	2	2	2	–	–	2	2
Pyrogallic Acid	$C_6H_3(CH)_3$	1	3	–	1	1	–	X	2	2	2	2	2	–	1	2	2
Quench Oil	_	1	X	–	2	1	–	2	1	1	1	1	1	–	–	–	–
Resins & Rosins	–	X	X	–	X	1	–	X	1	2	1	1	1	–	1	1	1
Salicylic Acid	$C_6H_4(OH)(CO)H)$	1	1	–	1	1	1	X	2	2	2	2	2	–	2	X	1
Sea Water	–	1	1	1	1	1	1	X	1	2	2	2	2	X	1	2	1
Silver Nitrate	$AgNO_3$	1	1	2	1	X	1	X	X	2	1	2	X	–	1	1	1
Sodium Acetate	$NaC_2H_3O_2$	2	1	–	1	1	X	X	2	2	2	2	2	–	1	2	2
Sodium Aluminate	$NaAlO_2$	1	1	–	1	1	–	X	2	2	2	2	2	–	1	X	2
Sodium Bicarbonate	$NaCHO_3$	1	1	1	1	1	1	X	2	2	1	2	1	–	1	1	1
Sodium Bisulfate	$NaHSO_4$	1	1	–	1	1	–	X	X	1	1	2	2	–	2	2	2
Sodiumbisulfite, 10%	$NaHSO_3$	1	1	–	1	1	1	X	2	3	2	3	2	–	1	2	2
Sodium Borate	–	1	1	–	1	1	1	2	1	1	2	1	2	–	1	2	2
Sodium Bromide, 10%	NaBr	1	1	–	1	1	–	2	1	X	2	1	2	–	1	1	2
Sodium Carbonate	Na_2CO_3	1	1	1	1	1	1	2	1	2	2	2	1	–	1	1	2
Sodium Chlorate	$NaClO_3$	1	1	–	1	1	–	2	2	2	2	2	1	–	1	1	1
Sodium Chloride	NaCl	1	1	1	1	1	1	2	2	X	2	2	1	2	2	2	2
Sodium Chromate	–	1	1	–	1	3	–	3	1	3	1	3	1	–	–	–	2
Sodium Cyanide	NaCN	1	1	–	1	1	1	X	X	1	1	2	X	–	1	2	2
Sodium Fluoride	NMaF	1	1	–	1	1	–	X	X	3	2	2	1	–	–	2	2
Sodium Hydroxide, 20%	NaOH	1	1	–	1	X	1	2	2	2	1	2	1	–	1	1	2

		Elastomers - 75 F						Metals - 75F									
Environment	**Chemical Formula**	Buna N	EPDM	HSN	Neoprene	Fluorocarbon	Aflas	Ductile & Cast Iron	Aluminum Bronze	416 SS	316 SS	17 - 4PH SS	Monel & K-Monel	Illium PD & Nitronic 50	Alloy 20	Hastelloy B	Hastelloy C
Sodium Hydroxide, 50%	NaOH	1	1	–	1	X	–	2	X	2	1	X	1	–	1	1	1
Sodium Hydroxide, 70%	NaOH	1	1	–	1	X	–	2	X	2	2	2	1	–	2	1	1
Sodium MetaPhosphate	$NaPO_2$	1	1	–	1	1	1	3	X	2	2	3	2	–	1	–	–
Sodium Metasilicate	Na_2SiO_3	1	2	–	1	1	–	X	2	2	2	2	1	–	–	1	1
Sodium Nitrate	$NaNO_3$	1	1	–	1	X	1	X	2	1	1	2	2	–	1	X	2
Sodium Perborate	–	1	1	–	1	1	1	X	2	2	2	2	2	–	1	2	2
Sodium Peroxide	Na_2O_2	1	1	–	1	1	1	X	X	1	2	2	2	–	1	2	2
Sodium Phosphate (Dibasic)	Na_2HPO_4	1	2	–	2	1	1	X	2	2	1	1	1	–	2	1	1
Sodium Phosphate (Tribasic)	–	2	2	–	2	1	1	X	3	X	1	1	1	–	2	1	–
Sodium Silicate	–	1	1	–	1	1	1	X	1	1	2	2	2	–	1	2	2
Sodium Sulfate	Na_2SO_4	1	1	–	1	1	1	2	1	2	1	2	2	–	1	2	2
Sodium Sulfide	Na_2S	1	1	–	1	1	–	X	X	X	2	1	2	–	2	2	2
Sodium Sulfite	Na_2SO_3	1	1	–	1	1	–	X	X	2	1	2	2	–	1	X	2
Sodium Thoisulfate	–	1	1	–	1	1	1	X	X	1	2	2	2	–	1	2	2
Soybean Oil	–	1	X	1	1	1	1	2	1	2	2	2	2	–	1	1	1
Stannic Chloride	H_2S	1	1	–	1	1	1	X	X	X	X	X	X	X	3	2	2
Steam (212°F.)	–	X	X	1	X	X	1	X	X	2	2	2	X	1	1	–	2
Stearic Acid	$C_{18}H_{36}O_2$	1	X	2	1	1	1	X	X	2	1	2	2	–	1	1	1
Styrene Monomar	–	X	X	X	X	1	2	2	X	2	2	2	2	–	1	–	2
Sugar Liquids	–	1	1	2	1	1	1	3	1	2	1	1	1	–	1	2	1
Sulfate, Black Liquor	–	1	2	–	1	1	–	X	X	1	2	2	2	2	–	2	2
Sulfate, Green Liquor	–	1	2	–	1	1	–	X	X	1	2	2	2	2	–	2	2
Sulfate, White Liquor	–	1	2	–	1	1	–	X	X	1	2	2	2	2	–	2	2
Sulfur	–	X	1	–	1	X	1	X	X	2	1	2	1	–	2	X	1
Sulfur Dioxide (Dry)	SO_2	X	1	X	X	X	–	X	2	2	2	2	2	–	1	X	2
Sulfur Dioxide (Wet)	SO_2	1	1	X	X	X	1	X	X	X	2	X	X	–	1	X	1
Sulfur Trioxide (Dry)	–	X	1	–	X	1	1	X	2	2	2	2	2	–	1	X	2
Sulfuric Acid, 0-7%	H_2SO_4	1	1	–	1	1	1	X	X	X	X	3	X	2	1	1	1
Sulfuric Acid, 20%	H_2SO_4	1	1	–	1	1	1	X	X	X	X	X	X	3	1	1	1
Sulfuric Acid, 50%	H_2SO_4	1	1	–	1	1	1	X	X	X	X	X	X	X	1	1	1
Sulfuric Acid, 98%	H_2SO_4	X	X	–	X	1	–	X	X	X	2	1	X	2	1	2	1
Sulfurous Acid	H_2SO_3	2	X	2	X	1	1	X	X	X	1	2	X	3	1	2	2
Tannic Acid	$C1_4H_{10}O_9$	1	1	1	1	1	1	X	2	2	2	2	2	–	2	2	2
Tar & Tar Oil	–	3	X	–	1	1	1	X	2	2	2	2	2	–	1	2	2
Tantaric Acid	–	1	X	1	1	1	1	X	X	2	1	2	2	–	1	2	2
Tetraethylead	$P_6(C_2H_5)_4$	X	X	2	2	1	–	X	2	3	2	2	2	–	–	–	–
Toluene or Toluol	$C_6H_5CH_3$	1	X	X	X	1	3	2	2	1	1	2	1	–	1	1	1
Transformer Oil	–	1	X	–	1	1	1	2	2	2	2	2	2	–	–	2	2
Tributyl Phosphate	$(C_4H_9)_3PO_4$	1	X	–	X	X	–	X	2	3	2	3	2	–	1	2	2
Trichloroethylene	$CHCl:CCl_2$	X	X	–	X	1	–	X	2	1	2	2	1	–	1	1	1
Trisodium Phosphate, 10%	Na_3PO_4	1	X	–	1	1	–	2	2	2	1	2	2	–	–	1	1
Tung Oil	–	1	X	–	1	1	1	2	1	1	1	1	1	–	1	1	1
Turpentine	–	1	X	1	X	1	1	2	2	2	1	2	1	–	1	2	2
Urea	$CO(NH_2)_2$	1	1	–	1	1	–	X	2	2	2	2	2	–	–	2	2
Water, Distilled (Air Free)	H_2O	1	1	1	1	1	1	3	1	1	1	2	X	–	1	2	1
Water, Distilled (Aerated)	H_2O	1	1	1	1	1	1	X	1	1	1	2	X	–	1	2	1
Water, Salt (Brackish)	H_2O	1	1	1	1	1	1	X	2	8	2	2	1	1	1	1	1
Water, Salt (Flowing)	H_2O	1	1	1	1	1	1	X	2	3	2	2	1	1	1	1	1
Water, Sea	H_2O	1	1	1	1	1	1	X	X	X	2	3	2	1	2	2	1
Water, pH Approx. 7	H_2O	1	1	1	1	1	1	3	1	1	1	1	1	–	1	–	1
Whiskey & Wine	–	1	1	1	1	1	1	X	X	X	1	1	2	1	1	1	1
Xylene	C_8H_{10}	X	X	X	X	2	1	2	2	1	2	2	2	–	1	2	1
Xylene (Dry)	C_8H_{10}	X	X	X	X	2	–	2	2	1	2	2	2	–	1	2	1
Zinc Chloride	$ZnCl_2$	1	1	1	1	1	1	X	X	X	2	X	2	X	1	2	2
Zinc Hydrosulfite	ZnS_2O_4	1	1	1	1	1	–	X	3	2	1	1	2	–	–	–	1
Zinc Nitrate	$Zn(NO_3)_2$	1	1	1	1	1	–	X	3	2	2	2	2	–	–	–	–
Zinc Sulfate	$ZnSO_4$	1	1	1	1	1	1	X	2	1	1	3	1	–	1	1	1

Reference: Corrosion Resistance Tables
4th Edition
Philip A Schweitzer, P.E.

Installation of Norris butterfly valves is a simple procedure that requires no special tools. Special care should be taken, however, in unpacking and installing the valve to avoid damage to the sealing surfaces (o-ring flange seals, seat and disc edge or disc o-ring).

Installation Compatibility

Norris wafer span and lug type valves 2" through 36" are designed for use with ANSI 150 flanges with an inside diameter equivalent to Scheduled 40 pipe ID. Check disc clearance charts on individual valve data sheets to be sure the inside diameter of companion flanges and piping does not interfere with disc movement when the valve is cycled to the open position. Back beveling of heavy wall, plastic or cement pipe may be required for disc clearance.

Weldneck, socket weld or slip-on flanges can be used with Norris metal-lined M-Series and D-Series valves with no special preparation.

Weldneck or socket weld flanges are recommended for use with elastomer-lined R-Series valves. Slip on type flanges are not recommended for use with R-Series valves. Slip on type flanges should only be used with R-Series valves when the flanges have been installed with single beveled, fillet-reinforced weld, per Mil-Std-22A, P43.

Norris automated valves and those with gear operators should be installed between flanges with the operator in place. Lever operated valves are shipped with the handle removed. Attach handle to operator shaft and check disc to be sure it seats on raised sealing surface before installing between flanges.

Required Tools and Materials

The only tool required to install Norris butterfly valves is a wrench suitable for tightening flange bolts and nuts or cap-screws. A hoist may be required for 10" and larger valves. Smaller sizes can usually be handled by one man. Temporary pipe supports may be used to keep the flange faces parallel and aid in installing the valve. Flange gaskets are not required since o-ring flange-face seals are a built-in feature of the Norris valve design.

Flange bolts and nuts or capscrews are not included with valve shipment unless ordered as a separate item. The individual Valve Data Sheets will indicate the required number and size of bolts or capscrews which are available from most supply stores or distributors.

Preparing Valve and Flanges

If the valve and flanges are properly prepared for installation, problems can be avoided later. Flange faces should be free of dirt, grit, dents or surface irregularities which might damage the body o-ring flange seals and cause leakage at the flange. Also inspect the valve and wipe away any grit or dirt which might be around the seat seals or disc. The valve must be in the "closed position" to protect the sealing edge of the disc.

Installation of all 2"-12" Span Type Valves

Loosely bolt lower half of flanges together. Make sure the flanges are separated enough to allow the valve to be inserted without damaging flange seals and the face of the elastomer seat.

Insert valve between flanges faces with care and lower into bolt cradle. Special care should be taken, expecially when raised-face flanges are used, to prevent damage to face of seat and o-ring flange seals during installation.

Loosely install remaining flange bolts and nuts.

Snug all flange bolts. Tighten first one bolt and then the opposite, 180° apart, keeping flange faces parallel. Make sure there is full metal-to-metal contact between flange and valve face. The o-ring seal makes excessive bolt loading unnecessary.

Installation of all 14"-36" Semi-lug & 4"-36" Full Lug Valves

Attach valve to one flange and then the other using the tapper flange holes. Loosely install all capscrews in tapped holes on one flange. Tighten evenly working with alternate capscrews 180° apart. Keep flange and valve faces parallel.

Tighten capscrews evenly in the same manner, alternating between screws that are 180° apart. Make sure there is full metal-to metal contact between flange and valve face. Do not over-tighten capscrews. The o-ring flange seal makes excessive bolt loading unnecessary.

Repeat procedure for second flange.

In the case of semi-lug 14" through 36" valves, install remaining bolts after valve is attached to both flanges.

Maintenance and Repair

Norris butterfly valves are designed and manufactured to exacting standards to help avoid operating problems. However, trouble with valves can occur if they are improperly handled, if they are used beyond the recommended working pressure and flow rates, or if the wetted parts are not compatible with the flow medium.

Operating maintenance and lubrication is not required. Shaft bearing surfaces have been factory lubricated. O-ring seat and shaft seals are permanently locked in lubricant to prevent flow medium from penetrating major bearing surfaces.

Under normal conditions, operating torques will not exceed a comfortable range for manual operation of the valve although valve torques may increase somewhat with age.

Repairs which may be required

1. O-ring flangeseal replacement if a leak develops between flange and valve body. Flange seal can be replaced without disassembling the valve and replacing the seat. See step 6 of assembly procedure on following pages. Flange face should be inspected for dirt, grit or irregularities which could prevent sealing, or damage replacement seal.
2. Seat, disc or disc o-ring replacement if the valve develops a leak through the valve bore.
3. Replacement of o-ring shaft seals if valve develops a leak at top or bottom shaft or operating torque increases beyond comfortable limits.
4. Shaft replacement if shaft becomes corroded or operating torque increases appreciably.
5. Disc or shaft replacement if drive slot or shaft is damaged by pressure surges or flow velocity exceeding recommended limits.

Disassembly/Assembly Instructions for 2"-12" 200 psi Valves

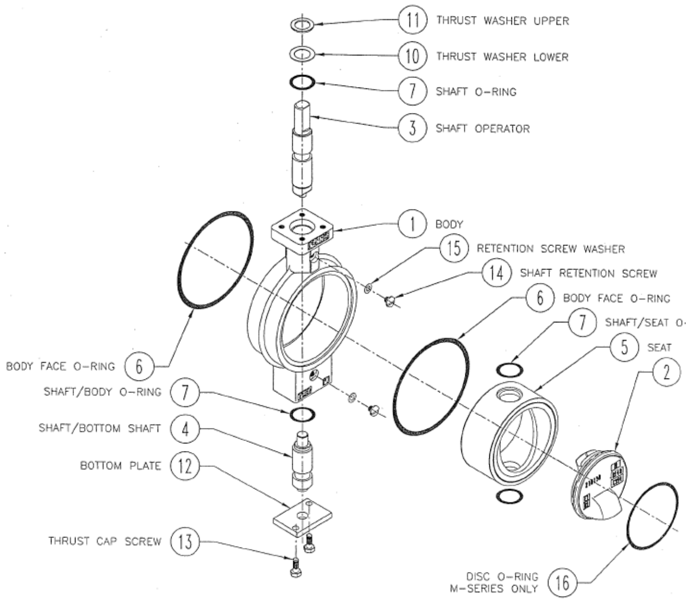
Caution: It is not safe to make any valve repairs while the valve is under pressure. Do not loosen capscrews or attempt to remove topworks, operator or bottom plate until all pressure has been eliminated and valve removed from line.

Removing Valve from Line
Remove all pressure from line. Close valve and remove flange bolts or capscrews. Spread flanges so valve can be removed without damaging face of elastomer seat.

How to Disassemble 2"-12" Valves

1. Open disc (Ref. #2) enough to clear raised seating surface.
2. Remove topworks, gear operator or other actuator.
3. Remove capscrews (#13) and bottom plate (#12)
4. Remove top shaft retention screw (#14) and washer (#15)
5. Pull top and bottom shaft (#3 & #4) from body with pliers or visegrips. O-ring shaft seal (#7) and thrust washers (#10 & # 11) will come out with top shaft. Bottom O-ring shaft seal (#7) will come out with bottom shaft.
6. Push disc (#2) from seat carefully so as not to damage sealing edge.
7. Tap seat (#5) from body with plastic or rubber mallet. O-ring flange seals (#6) will come free as seat is removed. Seat o-rings (#7) will be in counterbore of seat.

For M-Series Valves Only:
Inspect disc o-ring for damage or compression set. If replacement is necessary, carefully cut the o-ring (#16) and remove from disc edge groove. **Do not pry the o-ring loose with sharp tools which could damage the disc or groove.** See special instructions for replacing the o-ring (page 32).



How to Assemble 2"-12" Valves

1. Thoroughly clean all parts, then grease outside diameter and raised sealing surface of seat, all o-rings and disc edge with a silicon based lubricant such as Dow Corning Valve-Seal or Magnalube.

Caution: Valve must not be put under pressure until topworks, operator and bottom plate have been installed.

2. Place shaft o-rings (#7) in seat counterbores, slip seat (#5) into body (#1), accurately aligning shaft holes in seat with shaft bores in body. A "soft" plastic or rubber mallet may be used to tap seat into place if necessary.

3. Grease bearing surface (nub) of bottom shaft (#4) and full length of operator shaft (#3) with a general purpose lubricant. Insert operator shaft and bottom shaft to check alignment of shaft bore in seat and body. Carefully revolve shaft past the seat and seat o-rings to prevent damage to these sealing surfaces. *Do not force shaft past seat o-ring and seat*. If necessary, realign seat with shaft bores. Withdraw the shafts enough to allow clearance for disc.

4. Insert disc (#2) perpendicular to shaft holes and raised sealing surface, then rotate 90° to align disc bosses with shaft bores. Engage bottom shaft (#4) with bottom disc boss. Insert shaft o-ring (#7) in counterbore of body, attach bottom plate (#12) with two capscrews (#13). Align flats of operator shaft (#3) with milled slot in disc boss and insert as far as it will go.
Do not hammer shaft into place.

5. Install retention washer (#15) and shaft retention screw (#14) in valve. Rotate top shaft (#3) to be sure retention screw (#14) does not interfere with shaft movement.

Check to be sure disc seats on raised sealing surface.

If it does not, rotate disc 180°. Disc can be rotated 360° without damaging valve.

6. Insert o-ring flange seal (#6) in groove between body and seat. Avoid stretching o-ring by first pressing it into place at four points – 12, 3, 6, and 9 o'clock – then pressing it into place alternately at points between until the entire o-ring is smooth and evenly secured.

7. Insert shaft o-ring (#7), stainless steel washer (#10) and Teflon washer (#11) in counterbore of mounting pad. Install topworks or operator. Again, check to be sure disc seats on raised sealing surface.

8. Install valve between flanges.

Caution: Valve must not be put under pressure until topworks or operator is installed.

Disassembly/Assembly Instructions for 14"-36" 200 psi Valves

Caution: It is not safe to make any valve repairs while the valve is under pressure. Do not loosen capscrews or attempt to remove topworks, operator or bottom plate until all pressure has been eliminated and valve removed from line.

To Remove Valve from Line
Remove all pressure from line. Close valve. Attach hoist to support valve and aid in removing valve from line. Use of temporary pipe supports will help prevent damage to the valve.

Remove flange bolts. All capscrews should be removed from one flange and then the other. Spread flanges so valve can be lifted from the line without damaging disc edge. o-ring flange seals, or face of elastomer seat.

To Disassemble 14"-36" Valves
Lay valve body flat between two blocks or saw-horses to simplify disassembly and assembly.

1. Open disc, then remove gear operator or other actuator and shaft key (#11).

2. Remove capscrews (#18) and thrust cap (#9). Remove split thrust washer (#10), shim set (#8) and o-ring shaft seal (#16) from shaft bore, taking care not to damage the shaft.

3. Remove capscrews (#22) from disc pin and tap pin (#7) out with a "soft" hammer.

4. Attach a sling to support disc and prevent damage to the sealing edge as the shaft is removed from body.

5. Remove shaft (#3) through bottom bore of body. Tap top of shaft with a soft plastic or rubber hammer to loosen, then pull the opposite end. Disc (#2) will come free when shaft has been removed.

6. Tap seat (#6) from body with plastic or rubber mallet. O-ring flange seals (#15) will come free as seat is removed. Seat o-rings (#16) will be in centerbores of seat.

7. Remove shaft o-rings from grooves in shaft.

8. Remove o-ring shaft seal (#16) and Teflon washer (#27) from top shaft bore.

For M-Series Valves Only:
Inspect disc o-ring for damage or compression set. If replacement is necessary, carefully cut the o-ring (#25) and remove from disc edge groove. **Do not pry the o-ring loose with sharp tools which could damage the disc or groove.** See special instructions for replacing the o-ring (page 32)

To Assemble 14"-36" Valves

1. Thoroughly clean all parts, then grease outside diameter and raised sealing surface of seat, all o-rings and disc edge with a silicon based lubricant such as Dow Corning Valve-Seal or Magnalube.

Caution: Petroleum based lubricants can cause damage to some elastomers and should not be used on rubber parts.

2. Place shaft o-rings (#16) in seat counterbores, slip seat (#6) into body (#1), accurately aligning shaft holes in seat with shaft bores in body. A "soft" plastic or rubber mallet may be used to tap seat into place if necessary.

3. Carefully roll shaft o-rings (#17) into shaft grooves.

4. Attach a sling to disc (#2). With the hoist, carefully lower disc into seat perpendicular to shaft bores and raised sealing surface. Rotate disc to align bosses with shaft bores.

5. Grease shaft (#3) thoroughly with general purpose lubricant. Insert shaft, carefully revolving it past o-rings and seat to prevent damage to these sealing surfaces. Do not force shaft past seat o-rings and seat. *Do not hammer into place.*

6. Rotate disc to align disc pin hole with hole in shaft. Insert disc pin (#7) and attach capscrews (#22). A soft hammer may be used to tap the disc pin into place. Close the disc.

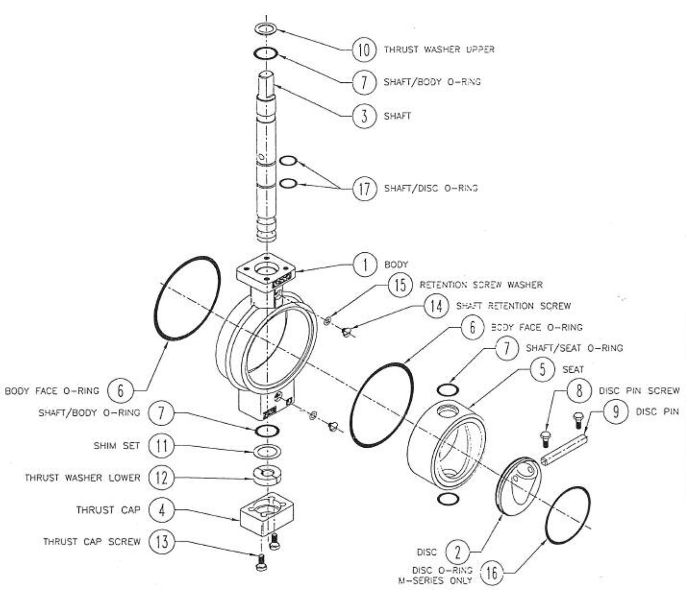
7. Insert bottom shaft o-ring (#16) in counterbore of body. A set of shims (#8) is provided to balance the self centering disc. A split thrust washer (#10) and thrust cap (#9) hold them in place. The number of shims necessary for each valve may vary because of manufacturing tolerances. Insert the thrust washer (#10), determine the correct number of shims required for a tight fit. Remove shim and thrust washer. Install the required shims, thrust washer and close with thrust cap (#9) and capscrews.

8. Insert o-ring flange seals (#15) in groove between body and seat. Avoid stretching o-ring by first pressing it into place at four points – 12, 3, 6, and 9 o'clock – then pressing it into place alternately at points between until the entire o-ring is smooth and evenly secured.

9. Insert o-ring (#16) and Teflon washer (#27) in counterbore and mounting pad.

10. Insert shaft key (#11) and install gear operator or other actuator. Close valve to be sure disc seats on raised sealing surface. If it does not, rotate disc 180°. Disc can be rotated a full 360° without damaging the valve.

11. Use hoist to install valve between flanges. Temporary pipe supports should be used to keep flanges parallel during installation and prevent damage to disc edge, o-ring flange seals, and face of elastomer seat.



Disassembly/Assembly Instructions for 2½"-12" 285 psi Valves

Caution: It is not safe to make any valve repairs while the valve is under pressure. Do not loosen capscrews or attempt to remove topworks, operator or thrust cap until all pressure has been eliminated and valve removed from line.

Removing Valve from Line
Remove all pressure from line. Close valve and remove flange bolts or capscrews. Spread flanges so valve can be removed without damaging face of elastomer seat.

To Disassemble 2½"-12" Valves
Lay valve body flat between two blocks or secure rim of body in vise to simplify disassembly and assembly.

1. Open disc, then remove gear operator or other actuator and key.
2. Remove shaft retention screws (#14) and washers (#15).
3. Remove capscrews (#16) and thrust cap (#13). Remove split thrust washer (#12), shim set (#11) and o-ring shaft seal (#7) from shaft bore, taking care not to damage the shaft.
4. Remove capscrews (#8) from disc pin and tap pin (#9) out with a "soft" hammer.
5. Support the disc to prevent damage to the seal edge as the shaft is removed from body.
6. Remove shaft (#3) through bottom bore of body. Tap top of shaft with a soft plastic or rubber hammer to loosen, then pull from the opposite end. Disc (#2) will come free when shaft has been removed.
7. Tap seat (#5) from body with rubber mallet. O-ring flange seals (#6) will come free as seat is removed. Seat o-rings (#7) will be in counterbores of seat.
8. Remove shaft o-rings (#17) from grooves in shaft.
9. Remove o-ring shaft seal (#7) and TFE washer (#10) from top shaft bore.

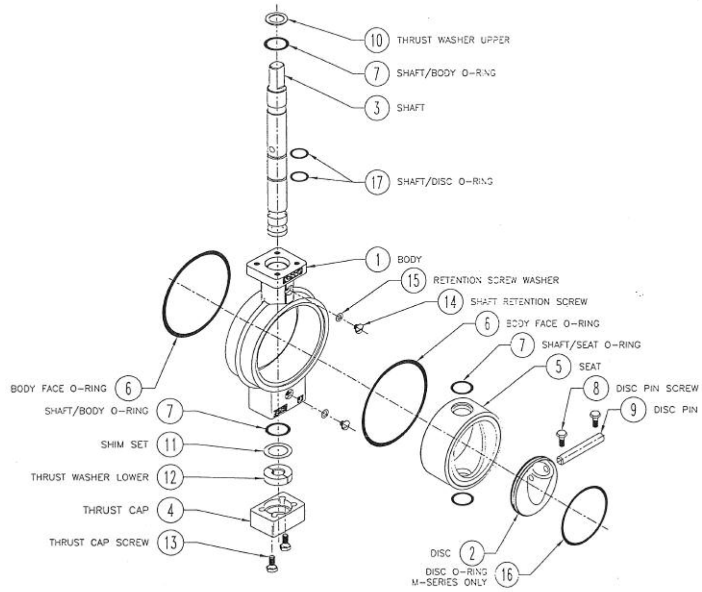
For M-Series Valves Only:
Inspect disc o-ring for damage or compression set. If replacement is necessary, carefully cut the o-ring (#19) and remove from disc edge groove. **Do not pry the o-ring loose with sharp tools which could damage the disc or groove.**
See special instructions for replacing the o-ring (page 32).

To Assemble 2½"-12" Valves

1. Thoroughly clean all parts, then grease outside diameter and raised sealing surface of seat, all o-rings, and disc edge with a silicon based lubricant such as Dow Corning Valve Seal or Magnalube.

Caution: Petroleum based lubricants can cause damage to some elastomers and should not be used on rubber parts.

2. Place o-ring seat seals (#7) in seat counterbores. Slip seat (#5) into body (#1), accurately aligning shaft holes in seat with shaft bores in body. A "soft" plastic or rubber mallet may be used to tap seat into place if necessary.
3. Carefully roll shaft o-rings (#17) into shaft grooves.
4. Carefully lower disc (#2) into seat perpendicular to shaft bores and raised sealing surface. Rotate disc to align bosses with shaft bores.
5. Grease shaft (#3) thoroughly with general purpose lubricant. Insert shaft, carefully revolving it past o-rings and seat to prevent damage to these sealing surfaces. Do not force shaft past seat o-rings and set. *Do not hammer into place.*
6. Rotate disc to align disc pin hole with hole in shaft. Insert disc pin (#9) and attach capscrews (#8). A soft hammer may be used to tap the disc pin into place. Close the disc.
7. Install shaft retention screws (#14) and washers (#15).



8. Insert bottom shaft o-ring (#7) in counterbore of body. A set of shims (#11) is provided to balance the self centering disc. A split thrust washer (#12) and thrust cap (#13) hold them in place. The number of shims necessary for each valve may vary because of manufacturing tolerances. Insert the thrust washer (#12), determine the correct number of shims required for a tight fit. Remove shims and thrust washer. Install the required shims, thrust washer and close with thrust cap (#13) and capscrews (#16).
9. Insert o-ring flange seals (#6) in groove between body and seat. Avoid stretching o-ring by first pressing it into place at four points – 12, 3, 6, and 9 o'clock – then pressing it into place alternately at points between until the entire o-ring is smooth and evenly secured.
10. Insert o-ring (#7) and TFE washer (#10) in counterbore of mounting pad.
11. Insert key and install gear operator or other actuator. Close valve to be sure disc seats on raised sealing surface. If it does not, rotate disc 180°. Disc can be rotated a full 360° without damaging valve.
12. Use hoist to install valve between flanges. Temporary pipe supports should be used to keep flanges parallel during installation and prevent damage to disc edge, o-ring flange seals and face of elastomer seat.

Disassembly/Assembly Instructions for 14"-36" 285 psi Valves

Caution: It is not safe to make any valve repairs while the valve is under pressure. Do not loosen capscrews or attempt to remove topworks, operator or bottom plate until all pressure has been eliminated and valve removed from line.

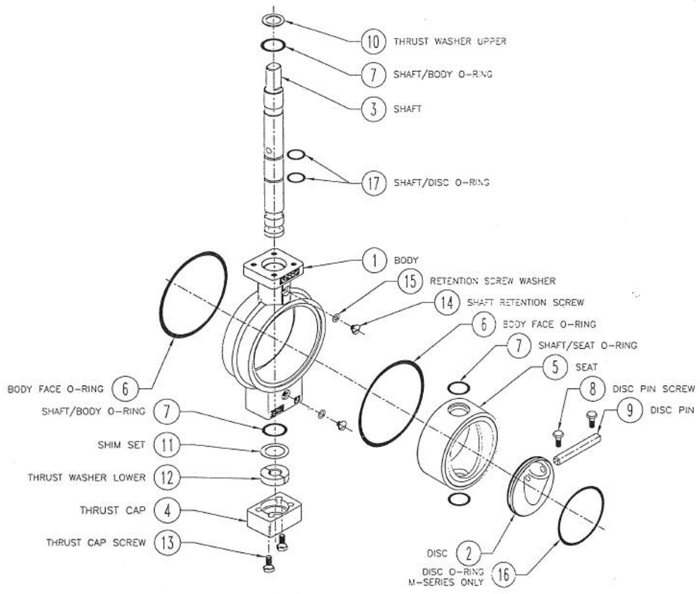
To Remove Valve from Line
Remove all pressure from line. Close valve. Attach hoist to support valve and aid in removing valve from line. Use of temporary pipe supports will help prevent damage to the valve.

Remove flange bolts. All capscrews should be removed from one flange and then the other. Spread flanges so valve can be lifted from the line without damaging disc edge, o-ring flange seals, or face of elastomer seat.

To Disassemble 14"-36" Valves
Lay valve body flat between two blocks or saw-horses to simplify disassembly and assembly.

1. Open disc, then remove gear operator or other actuator and shaft key (#11).
2. Remove capscrews (#18) and thrust washer (#10), shim set (#8) and o-ring shaft seal (#16) from shaft bore, taking care not to damage the shaft.
3. Remove capscrews (#22) from disc pin and tap pin (#7) out with a "soft" hammer.
4. Attach a sling to support disc and prevent damage to the sealing edge as the shaft is removed from body.
5. Remove shaft (#3) through bottom bore of body. Tap top of shaft with a soft plastic or rubber hammer to loosen, then pull from the opposite end. Disc (#2) will come free when shaft has been removed.
6. Tap seat (#6) from body with plastic or rubber mallet. O-ring flange seals (#15) will come free as seat is removed. Seat o-rings (#16) will be in centerbores of seat.
7. Remove shaft o-rings (#17) from grooves in shaft.
8. Remove o-ring shaft seal (#16) and Teflon washer (#27) from top shaft bore.

For M-Series Valves Only:
Inspect disc o-ring for damage or compression set. If replacement is necessary, carefully cut the o-ring (#25) and remove from disc edge groove. **Do not pry the o-ring loose with sharp tools which could damage the disc or groove.** See special instructions for replacing the o-ring (page 32)



To Assemble 14"-36" Valves

1. Thoroughly clean all parts, then grease outside diameter and raised sealing surface of seat, all o-rings and disc edge with a silicon based lubricant such as Dow Corning Valve-Seal or Magnalube.

Caution: Petroleum based lubricants can cause damage to some elastomers and should not be used on rubber parts.

2. Place o-rings (#16) in seat counterbores, slip seat (#6) into body (#1), accurately aligning shaft holes in seat with shaft bores in body. A "soft" plastic or rubber mallet may be used to tap seat into place if necessary.

3. Carefully roll shaft o-rings (#17) into shaft grooves.

4. Attach a sling to disc (#2). With the hoist, carefully lower disc into seat perpendicular to shaft bores and raised sealing surface. Rotate disc to align bosses with shaft bores.

5. Grease shaft (#3) thoroughly with general purpose lubricant. Insert shaft, carefully revolving it past o-rings and seat to prevent damage to these sealing surfaces.
Do not force shaft past seat o-rings and seat. Do not hammer into place.

6. Rotate disc to align disc pin hole with hole in shaft. Insert disc pin (#7) and attach capscrews (#22). A soft hammer may be used to tap the disc pin into place. Close the disc.

7. Insert bottom shaft o-ring (#16) in counterbore of body. A set of shims (#8) is provided to balance the self centering disc. A split thrust washer (#10) and thrust cap (#9) hold them in place. The number of shims necessary for each valve may vary because of manufacturing tolerances. Insert the thrust washer (#10), determine the correct number of shims required for a tight fit. Remove shim and thrust washer. Install the required shims, thrust washer and close with thrust cap (#9) and capscrews.

8. Insert o-ring flange seals (#15) in groove between body and seat. Avoid stretching o-ring by first pressing it into place at four points – 12, 3, 6, and 9 o'clock – then pressing it into place alternately at points between until the entire o-ring is smooth and evenly secured.

9. Insert o-ring (#16) and Teflon washer (#27) in counterbore and mounting pad.

10. Insert key (#11) and install gear operator or other actuator. Close valve to be sure disc seats on raised sealing surface. If it does not, rotate disc 180°. Disc can be rotated a full 360° without damaging valve.

11. Use hoist to install valve between flanges. Temporary pipe supports should be used to keep flanges parallel during installation and prevent damage to disc edge, o-ring flange seals, and face of elastomer seat.

Installing Disc O-ring on 2"-36" M-Series Valves (200 psi and 285 psi Rated Valves)

Inspect disc edge for damage. Thoroughly clean the groove tips of dirt and grit which might damage o-ring. Use an emery cloth to smooth edges if necessary. Use a generous amount of silicon based grease such as Dow Corning Valve-Seal or Magnalube on the o-ring. The groove may be lightly greased but excessive amounts of grease in the groove may prevent o-ring from seating properly.

Caution: Petroleum based lubricants can cause damage to some elastomers and should not be used on rubber parts.

Step #1.
Place o-ring about half way around disc groove. Holding it in place with one hand, pull o-ring to position on edge of disc with index finger of other hand.

Step #2.
With finger still under o-ring, rotate disc completely to equalize rubber tension.

Step #3.
To ensure equal distribution of the o-ring around the disc, press it into place at four equally spaced points – 12, 3, 6, and 9 o'clock. Six inch and larger valve discs are more easily handled if placed in a vise or laid flat on a clean surface. A smooth bar or hammer handle can be used to press the o-ring into place at the four points.

Step #4.
Continue pressing the o-ring into place at points between the original four, alternately on one side and then the other until the entire o-ring is smooth and evenly secured. Large discs are easily handled by putting the edge of the disc against the chest and working the opposite side. Hold the bar at a

slight angle and roll a small section of the o-ring into place. Rotate the disc 180° to work the opposite area.

Disc o-rings on large valves can be installed most efficiently with especially prepared sheet metal visegrips. The grips are heated, flattened and finished so the lips are flush and smooth. They are available from Norris at a nominal charge (Part# 51843A0001).

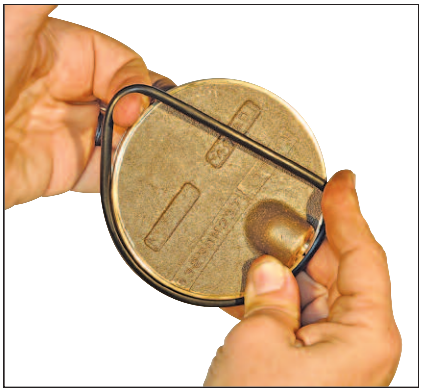
Follow Step#1 and Step #2 above. Then adjust end screw of vise-grip to close flat plates. Open the grips and turn the end screw one half-turn.

Taking care not to cut through it, squeeze the o-ring with the grips to flatten. The o-ring should slip into the groove easily. Proceed in the same way at 3, 6, and 9 o'clock, then at points between until the o-ring is smoothly secured in the groove.

Note: A little practice will enable you to determine the exact adjustment for installing the o-ring. Adjustments will vary for different sizes of valves.

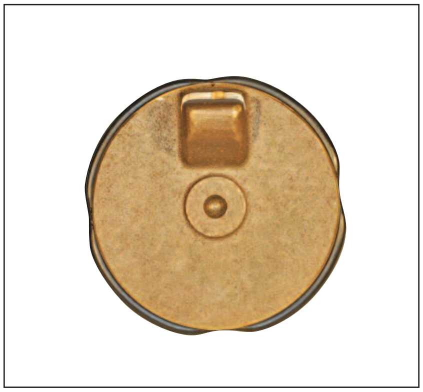
DO NOT install o-ring by rolling it up the side of disc into groove. This will cause the o-ring to twist and early failure will result. DO NOT stretch o-ring so cross section is reduced. This will cause it to become large in diameter and even distribution of the o-ring around the disc edge will be more difficult. NEVER pound the o-ring into the groove with a hammer! This will result in damage to the groove lips and prevent the valve from closing properly.

Step #1

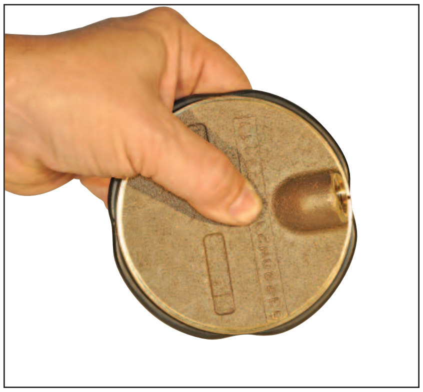


Step #2

Step #3



Step #4



Step #5

Repair Kits for R&M Series Butterfly Valves

Kits include installation instructions and all rubber goods, washers, shims and lubrication required to rebuild valves. (replacement kit tables – see table copy

R-Series repair kit R200 & R285

TABLE I – SEAT/O-RING REPLACEMENT KITS FOR 200 PSI RUBBER SEATED BUTTERFLY VALVES-R-SERIES

Use "54000" as a prefix when ordering replacement kits.
Example: Order 54000-A001 for 2" Type A Buna N Replacement Kit.

Elastomer	2"	2.5"	3"	4"	5"	6"	8"	10"	12"
Type A Buna N	A001	A004	A007	A010	A013	A016	A019	A021	A024
Type B Viton	B001	B004	B007	B010	B013	B016	B019	B021	B024
Type S EPDM	S001	S004	S007	S010	S013	S016	S019	S021	S024

R-Series repair kit M200 & M285

TABLE 2 – O-RING REPLACEMENT KITS FOR 200 PSI METAL SEATED BUTTERFLY VALVES-M-SERIES

Use "54000" as a prefix when ordering replacement kits.
Example: Order 54000-A003 for 2" Type A Buna N Replacement Kit.

Elastomer	2"	2.5"	3"	4"	5"	6"	8"	10"	12"
Type A Buna N	A003	A005	A008	A011	A014	A017	A027	A022	A024
Type B Viton	B003	B005	B008	B011	B014	B017	B027	B022	B024
Type S EPDM	S003	S005	S008	S011	S014	S017	S027	S022	S024

Other Available Elastomers:

Type E	Black Neoprene	Type L	ECO
Type G	White Neoprene	Type 4	HSN
Type J	Abrasion Resistant Buna		

TABLE 3 – SEAT/O-RING REPLACEMENT KITS FOR RUBBER SEATED 285 PSI BUTTERFLY VALVES-R-SERIES

Use "54000" as a prefix when ordering replacement kits.
Example: Order 54000-A127 for 2.5" Type A Buna N Replacement Kit.

Elastomer	2"	2.5"	3"	4"	5"	6"	8"	10"	12"
Type A Buna N	NA	A127	A128	A129	A130	A131	A132	A133	A134
Type B Viton	NA	B127	B128	B129	B130	B131	B132	B133	B134
Type S EPDM	NA	S127	S128	S129	S130	S131	S132	S133	S134

TABLE 4 – O-RING REPLACEMENT KITS FOR METAL SEATED 285 PSI BUTTERFLY VALVES-M-SERIES

Use "54000" as a prefix when ordering replacement kits.
Example: Order 54000-A119 for 2.5" Type A Buna N Replacement Kit.

Elastomer	2"	2.5"	3"	4"	5"	6"	8"	10"	12"
Type A Buna N	NA	A119	A121	A120	A122	A123	A124	A125	A126
Type B Viton	NA	B119	B121	B120	B122	B123	B124	B125	B126
Type S EPDM	NA	S119	S121	S120	S122	S123	S124	S125	S126

TABLE 5 – O-RING REPLACEMENT KITS FOR RUBBER SEATED 200 & 285 PSI BUTTERFLY VALVES-R-SERIES

Use "54000" as a prefix when ordering replacement kits.
Example: Order 54000-A034 for 14" Type A Buna N Replacement Kit.

Elastomer	14"	16"	18"	20"	24"	26"	28"	30"	32"	36"
Type A Buna N	A034	A035	A036	A037	A039	A040	A041	A042	A043	A044
Type B Viton	B034	B035	B036	B037	B039	B040	B041	B042	B043	B044
Type S EPDM	S034	S004	S036	S037	S039	S040	S041	S042	S043	S044

TABLE 6 – O-RING REPLACEMENT KITS FOR METAL SEATED 200 & 285 PSI BUTTERFLY VALVES-M-SERIES

Use "54000" as a prefix when ordering replacement kits.
Example: Order 54000-A045 for 14" Type A Buna N Replacement Kit.

Elastomer	14"	16"	18"	20"	24"	26"	28"	30"	32"	36"
Type A Buna N	A045	A046	A047	A048	A050	NA	A052	A053	A054	C.F.
Type B Viton	B045	B046	B047	B048	B050	NA	B052	B053	B054	C.F.
Type S EPDM	S045	S046	S047	S048	S050	NA	S052	S053	S054	C.F.

TABLE 7 – O-RING REPLACEMENT KITS NORRIS BODY STYLE VALVES

Use "54000" as a prefix when ordering replacement kits.
Example: Order 54000-A103 for 1.5" Type A Buna N Replacement Kit.

	Threaded End					Grooved End			
Elastomer	1.5"	2"	2.5"	3"	4"	2"	2.5"	3"	4"
Type A Buna N	A103	A104	A105	A106	A107	A108	A109	A110	A111
Type B Viton	B103	B104	B105	B106	B107	B108	B109	B110	B111
Type S EPDM	S103	S104	S105	S106	S107	S108	S109	S110	S111

Valve Storage Procedures

The proper storage of Norris valves should consist of:

1. A clean, weathertight, well-ventilated, fire-resistant storage area. This storage area must provide protection from the weather, plus flooring that seals against dust and dirt and will not be subject to flooding.

2. Valves should be protected against rodent and insect damage.

3. The valves must be protected from mechanical damage. The proper use of racks, pallets, and handling equipment shall be used. The valves should be arranged so as to prevent damage to the stored valves during handling.

4. The valves should be stored off the floor on suitable skids, pallets or racks. They must be protected from excessive dust and dirt.

5. Valves should not be stored in direct sunlight. They should also be covered with black flame retardant visqueen or fire retardant canvas cloth. This is to keep as much light as possible from the valves to protect and prolong the life of the elastomer. After completion of storage and upon installation of the valves, the following steps and precautions should be taken:

A. Valves should not be taken out of storage until ready for installation. If valves must be taken to the installation site before piping is ready, the same storage requirements as above should be followed. Care should be taken to protect the valves from dirt, foreign particles and weather.

B. Care should be taken in unpacking and installing the valve so damage to the sealing surfaces (face of seat, o-ring flange seals, and disc edge) does not occur.

C. Flange faces should be free from dirt, grit, or other irregularities which might damage the flange seals.

D. Inspect valve and clean off any dirt or grit that might have accumulated around seat, seals or disc.

E. Install valves per Norriseal's standard installation instructions.

F. Before operating or cycling the valves, flush pipe thoroughly (with valves open). After flushing pipe, slowly cycle valves from full open to full closed approximately 10 times. Leave in the partially open position until shut-off is required.

G. If valves have not been cycled for an extended period, cycle them5-10 times before operation start-up.

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