

RESILIENT SEATED BUTTERFLY VALVES

Technical Manual





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Torques

INTRODUCTION TO TORQUES

There are a number of torques which butterfly valves may experience such as:

- T_{su} - Seating and Unseating Torque
- T_d - Dynamic Torque Resulting from fluid flow
- T_{bf} - Bearing Friction Torque
- T_{ss} - Stem Seal Friction Torque
- T_e - Eccentricity Torque resulting from disc offset from centerline of stem (either single, double or triple offset)
- T_h - Hydrostatic Torque

Factors which influence the butterfly valve torque values shown above are:

- Type of Seat and Seat Material
- Interference of Seat I.D. and Disc O.D.
- Shaft Diameter
- Valve Diameter
- Bearing Coefficient of Friction
- Angle of Opening
- Shut-off Pressure
- Fluid Velocity
- Disc Shape and Configuration
- Piping System and Location/Orientation of Valve in Pipe Line
- System Head Characteristics
- Physical Size of Disc/Shaft Obstructing Flow
- Disc Edge Finish

With respect to Butterfly Valves, the two major conditions for determining total valve operating torque (T_T) exists as follows:

CASE I (Angle = 0° , Disc in Closed Position)

$$T_T = T_h + T_{bf} + T_{ss} + T_{su}$$

Analyzed

Total Torque for Case I using a symmetrical disc butterfly valve is the sum of hydrostatic torque, bearing friction torque, stem seal, friction torque, and seating/unseating torque.

A. Hydrostatic Torque (T_h)

We will ignore discussion of the hydrostatic torque values as they are generally insignificant compared to the seating/unseating, bearing friction and stem seal torque values (the safety factor applied to seating/unseating, stem seal friction and bearing friction torque values more than compensates for the hydrostatic torque which is usually less than 2% of these total torques).

B. Bearing Friction Torque (T_{bf})

Bearing friction torque occurs because pressure forces against the disc are transmitted to the stem. As the stem is forced against the bearing supports, bearing friction torque is created between the stem material and the support material as the stem is turned. Bearing friction torques are normally included in the seating/unseating torque values.

Bearing friction torques can be determined by using the following equation:

$$T_{bf} = .785 C_f D_v^2 (d/2) \Delta P$$

Where:

- T_{bf} = Bearing Friction Torque
- C_f = Coefficient of Friction (approximately .25 for non-corroded stem to cast iron body) (dimensionless).
- D_v = Valve Diameter (Inches)
- d = Diameter of Shaft (Inches)
- ΔP = Pressure Differential (psi)

C. Stem Seal Friction Torque (T_{ss})

For all practical purposes stem seal friction torque values are insignificant when compared to seating/unseating and bearing friction torques. Stem seal friction torques are normally included in the seating/unseating torque values.

D. Seating/Unseating Torques (T_{su})

The seating/unseating torque value (T_{su}) is a function of the pressure differential, the seat material's coefficient of friction, the finished surface of the disc edge, the amount of interference between the seat I.D. and disc O.D. when flanged in piping, the seat thickness, and the type of service (media) for which the valve is being used. In determining the T_{su} values for Bray resilient seated butterfly valves, Bray has developed Seating/Unseating Torque Charts incorporating all bearing friction and stem seal friction torques for three classes of services for both the valves with standard discs (rated to full pressure) and for valves with reduced diameter discs (rated for 50 psi [3.5 bar]). The three service classes are:

Class A – Non-Corrosive, Lubricating Service

Class B – General Service

Class C – Severe Service

Please review the guidelines for each class in the technical manual when determining which Seating/Unseating Torque Class should be used. Most butterfly valves are used in Class II, General Service applications.

E. Total Torque (T_T)

The total torque values for Bray symmetrical disc valves for Case I applications are shown in the Seating/Unseating Torque Charts within this manual.

CASE II (Disc in Partial To Full Opening Position)

$$T_T = T_{bf} + T_{ss} + T_d$$

The total Torque for Case II using a symmetrical disc butterfly valve is the summation of bearing friction torque, stem seal friction torque and dynamic torque.

A. Bearing Friction Torque (T_{bf})

See Case I discussion. This torque value is normally included in the Dynamic Torque Value.

B. Stem Seal Friction Torque (T_{ss})

See Case I discussion. This torque value is normally included in the Dynamic torque value.

C. Dynamic Torque (T_d)

In a symmetrical disc design, dynamic torque occurs between the closed position, 0° and the full open position, 90°. With the disc in the partially open position, velocity of the fluid passing the leading disc edge is less than the velocity passing the trailing edge. This variance in velocity past the leading disc edge and trailing disc edge results in an unbalanced distribution of pressure forces on the upstream side of the face of the disc. The total pressure forces acting perpendicular to the disc face on the leading edge half of the disc are greater than the total pressure acting perpendicular on the trailing half of the disc. This uneven distribution of pressure on the disc face (exists on both sides of the disc) results in a torsional force which tries to turn the disc to the closed position (**Figure 1**). This torsional closing force can become greater than the seating/unseating torque value depending on the valve angle of opening and differential pressure.

To determine dynamic torque, the following equation is applied:

$$T_d = C_{dt} d^3 \Delta P$$

Where:

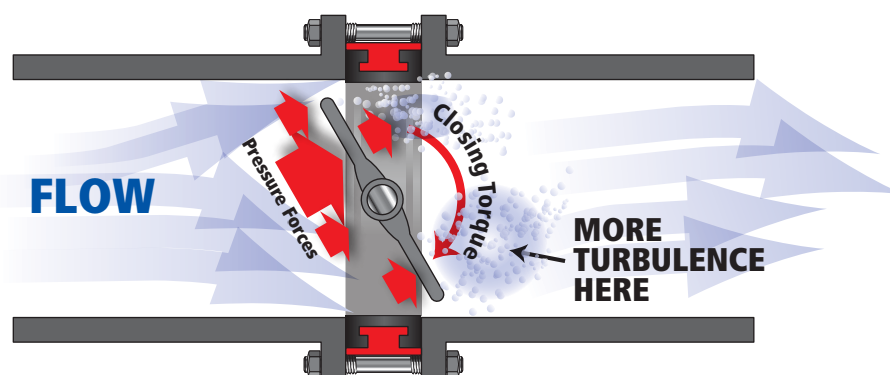
T_d = Dynamic Torque (lbs- in).

C_{dt} = Coefficient of Dynamic Torque (based on disc shape and angle of opening) (dimensionless)

d = Diameter of Disc (Inches)

ΔP = Pressure Differential Across Valve (psi)

Figure 1 - Pressure Distribution



As shown in **Figure 2**, coefficient of dynamic torque for Bray’s symmetrical disc valves is at 0° angle of opening and increases until the angle of opening reaches 75°-80°, where it then decreases to a zero value at full open (90°) (no internal friction factors considered, just dynamic torque only).

One final comment about dynamic torque is that one may minimize the dynamic torque by the orientation of the valve (stem horizontal or vertical) in the pipeline as well as by the location (distance) in the pipeline from elbows, other valves, etc. (See Bray Resilient Seated BFV Operations and Maintenance Manual).

D. Total Torque (T_T)

The total torque required for operating a Bray symmetrical disc butterfly valve at an angle opening between 0° and 90° is shown in the Dynamic Torque section of this manual. Note that the dynamic torque includes all internal friction torque values.

CONCLUSION

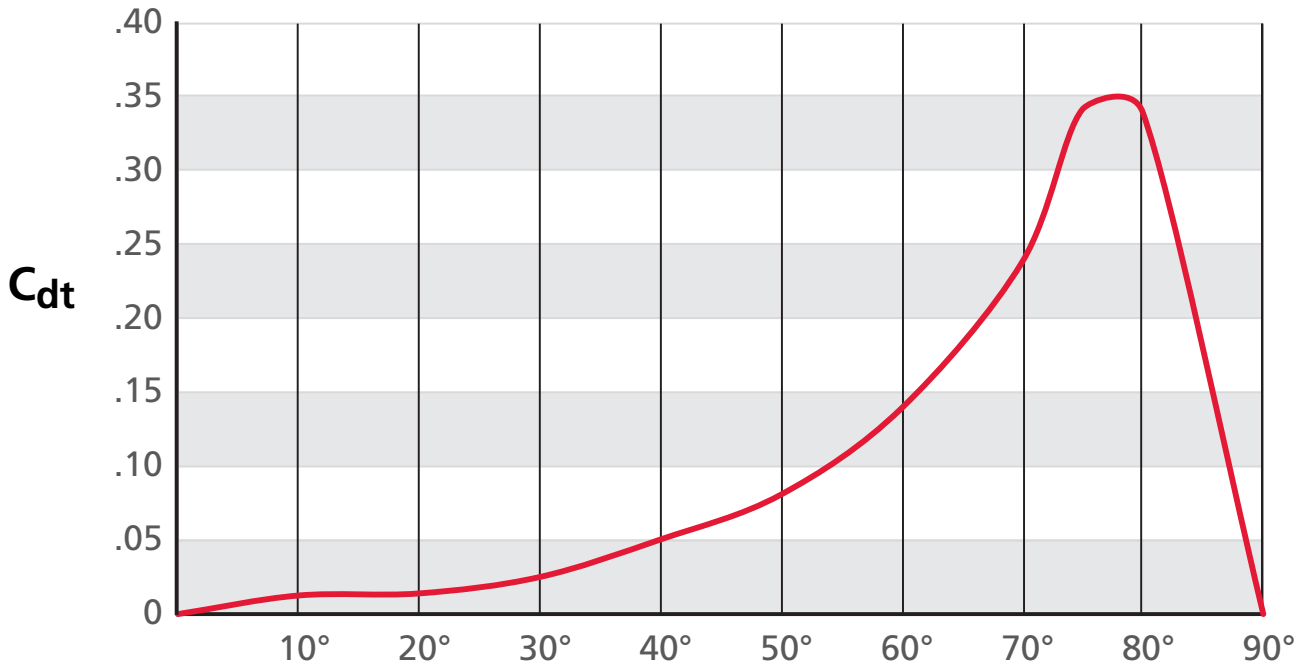
In most applications for butterfly valves, especially 20” (DN 500) or smaller, the maximum torque required to operate the valve will be seating/unseating torque. However, dynamic torque should be considered particularly in:

- Control applications using larger valves (24” [DN600] and above) where the disc is maintained in the open position
- Applications using larger valves (24” [DN 600] and above) where the velocity is high (16 ft./sec [4.9m/sec]).

Figure 2 - Angle of Opening

The C_{dt} value for Bray symmetrical disc valves are approximately:

| Angle of Opening | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 75° | 80° | 90° |
|------------------|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----|
| C_{dt} | 0 | 0.0126 | 0.0140 | 0.0251 | 0.0505 | 0.0809 | 0.1394 | 0.2384 | 0.3419 | 0.3400 | 0 |



REDUCED DISC DIAMETER BRAY SERIES 30/31/3A VALVES

Bray offers a reduced disc diameter for 4"-20" for Series 30, 31 and 3A valves. The purpose of reducing the disc diameter is to decrease the seating/unseating torques and extend the seat life on low pressure applications.

By reducing the disc diameter, the interference between the disc O.D. and seat I.D. is decreased and the valve pressure rating, which is a function of this interference, is reduced to 50 PSI. Less interference between the disc and seat results in reduced seating/unseating torques. Lower seating/unseating torque may allow for the use of a smaller actuator on the valve. In other applications where abrasive dry bulk materials such as cement, sugar, plastic, pellets, flour, etc., are generally pneumatically conveyed at 50 PSI or less, the reduced disc diameter not only reduces the seating/unseating torque but, very importantly, usually significantly increases the service life of the seat.

Bray does the following to differentiate reduced diameter discs from full diameter discs:

Metal Discs: An " R " is stamped above the part number

Nylon 11 Coated Discs: Discs are differentiated by the color of the Nylon 11:

Grey – Full Disc Diameter

White – Reduced Disc Diameter

SEATING & UNSEATING TORQUES

Bray has developed Seating/Unseating Torque Charts for three Classes of Service for its valves with standard discs (rated for full pressure) and for valves with reduced diameter discs (rated for 50 PSI / 3.5 bar.).

The guidelines for selecting a Class to be used for determining a valve’s seating/unseating torque are given below. Each valve application should comply with all five Class characteristics in order to be qualified for that Class.

| Characteristics of Application | Class A Non-Corrosive, Lubricating Service | Class B General Service | Class C Severe Service |
|--|--|---|--|
| Media Type | Lubricating hydrocarbons; Aqueous processes and Water (See Note 1) | Water; aqueous processes; all other aqueous liquids including salt water; Lubricating gases | Dry, non-lubricating such as air, dry gas, cement, pneumatic conveying mediums |
| Corrosion by Media | Insignificant if any | No major corrosion or deposits from media | Can incur significant corrosion such as Ductile Iron disc in water |
| Chemical Reactions of Media with Seat | Insignificant if any | Only minor or insignificant in nature | Reactions causing swelling and hardness occur |
| Media Temperature | 45° to 160°F (7° to 71°C) | Within seat temperature limits, not near limits | Near or at seat temperature limits |
| Frequency of Valve Cycling | Once weekly or more frequently | Minimum once every 3-6 weeks, or more frequently | Infrequently, sometimes not cycled for long periods |

NOTE:

- For aqueous processes and water, Class A torques may be used only if a Nylon 11 coated disc is selected and all other Class A characteristics apply. Otherwise, Class B torques should be used.
- All the material trims may be classified into Class A, B, or C except Series 20/21 valves with a PTFE Lined Elastomer seat, PTFE molded disc/stem, or rubber molded disc/stem. These trims must always use Class C Seating/Unseating Torque Values unless they are used only in a throttling application. Valves with bonded seats must always be classified as Class C.
- If a valve is used strictly in a throttling application, that is, it is never put in the closed position but throttled between 20° and 80°, then Class A torques may be used provided you have checked to see that dynamic torques do not exceed the Class A torque values.
- With the exception of dry, non-lubricating medias, one is usually safe electing to use Class B torques for sizing actuators for all other valve service applications. Seating/Unseating Torque values shown include friction bearing torques for stated differential pressure.
- Dynamic Torque values are not considered. See the Dynamic Torque chart in this manual for determination of Dynamic Torque.
- Do not apply a safety factor to torque values when determining actuator output torque requirement.
- For 3-way assemblies where one valve is opening and another is closing, multiply torque by a 1.5 factor.**



Resilient Seated Butterfly Valves – Seating & Unseating Torques

Series 20/21 and 30/31/3A Torques Imperial (Lb-Ins)

| Valve Size Inches | Valve Differential Pressure (PSIG) | | | | | | | |
|--|------------------------------------|--------|---------|---------|---------|--------------|--------|-------|
| | Full Disc | | | | | Reduced Disc | | |
| | 0 psi | 50 psi | 100 psi | 150 psi | 175 psi | 0 psi | 50 psi | |
| Class A Non-Corrosive, Lubricating Service | 1 | 54 | 59 | 65 | 70 | 73 | 54 | 59 |
| | 1.5 | 81 | 86 | 91 | 97 | 100 | 81 | 86 |
| | 2 | 109 | 114 | 119 | 123 | 128 | 109 | 114 |
| | 2.5 | 169 | 178 | 187 | 196 | 200 | 169 | 178 |
| | 3 | 220 | 236 | 250 | 264 | 273 | 220 | 236 |
| | 4 | 341 | 364 | 387 | 410 | 423 | 225 | 248 |
| | 5 | 510 | 560 | 610 | 660 | 687 | 324 | 374 |
| | 6 | 632 | 712 | 792 | 872 | 912 | 344 | 488 |
| | 8 | 1,182 | 1,341 | 1,500 | 1,660 | 1,741 | 735 | 894 |
| | 10 | 1,764 | 2,018 | 2,272 | 2,526 | 2,653 | 1,204 | 1,358 |
| | 12 | 2,701 | 3,110 | 3,519 | 3,928 | 4,132 | 1,665 | 2,074 |
| | 14 | 3,818 | 4,500 | 5,182 | 5,864 | — | 2,318 | 3,000 |
| | 16 | 4,638 | 5,819 | 7,000 | 8,182 | — | 2,699 | 3,880 |
| 18 | 5,265 | 7,065 | 8,865 | 10,665 | — | 2,970 | 4,788 | |
| 20 | 7,000 | 9,364 | 11,728 | 14,091 | — | 3,356 | 6,243 | |
| Class B General Service | 1 | 59 | 65 | 71 | 77 | 80 | 59 | 65 |
| | 1.5 | 89 | 95 | 100 | 106 | 110 | 89 | 95 |
| | 2 | 120 | 125 | 130 | 135 | 140 | 120 | 125 |
| | 2.5 | 185 | 195 | 205 | 215 | 220 | 185 | 195 |
| | 3 | 245 | 260 | 275 | 290 | 297 | 245 | 260 |
| | 4 | 375 | 400 | 425 | 450 | 462 | 252 | 267 |
| | 5 | 560 | 615 | 670 | 725 | 755 | 355 | 410 |
| | 6 | 695 | 783 | 871 | 953 | 1,003 | 427 | 537 |
| | 8 | 1,300 | 1,475 | 1,650 | 1,825 | 1,915 | 808 | 983 |
| | 10 | 1,960 | 2,240 | 2,520 | 2,800 | 2,940 | 1,213 | 1,493 |
| | 12 | 2,970 | 3,420 | 3,870 | 4,320 | 4,545 | 1,830 | 2,280 |
| | 14 | 4,200 | 4,950 | 5,700 | 6,450 | — | 2,550 | 3,300 |
| | 16 | 5,100 | 6,400 | 7,700 | 9,000 | — | 2,967 | 4,267 |
| 18 | 5,850 | 7,850 | 9,850 | 11,850 | — | 3,267 | 5,267 | |
| 20 | 7,700 | 10,300 | 12,900 | 15,500 | — | 4,267 | 6,867 | |
| Class C Severe Service | 1 | 74 | 82 | 89 | 97 | 100 | 74 | 82 |
| | 1.5 | 111 | 119 | 125 | 133 | 137 | 111 | 119 |
| | 2 | 151 | 157 | 163 | 169 | 175 | 151 | 157 |
| | 2.5 | 231 | 244 | 257 | 269 | 275 | 231 | 244 |
| | 3 | 306 | 325 | 344 | 363 | 375 | 306 | 325 |
| | 4 | 468 | 500 | 532 | 563 | 582 | 316 | 348 |
| | 5 | 700 | 769 | 838 | 907 | 944 | 444 | 513 |
| | 6 | 870 | 980 | 1,090 | 1,200 | 1,255 | 525 | 672 |
| | 8 | 1,625 | 1,844 | 2,063 | 2,282 | 2,394 | 1,011 | 1,230 |
| | 10 | 2,450 | 2,800 | 3,150 | 3,500 | 3,675 | 1,517 | 1,867 |
| | 12 | 3,712 | 4,275 | 4,838 | 5,400 | 5,682 | 2,287 | 2,850 |
| | 14 | 5,251 | 6,188 | 7,125 | 8,063 | — | 3,189 | 4,126 |
| | 16 | 6,375 | 8,000 | 9,625 | 11,250 | — | 3,709 | 5,334 |
| 18 | 7,315 | 9,815 | 12,315 | 14,815 | — | 4,084 | 6,584 | |
| 20 | 9,625 | 12,875 | 16,125 | 19,375 | — | 5,334 | 8,584 | |

Series 20/21 and 30/31/3A Torques Metric (Nm)

| Valve Size mm | Valve Differential Pressure (bar) | | | | | | | |
|--|-----------------------------------|---------|-------|----------|--------|--------------|---------|-----|
| | Full Disc | | | | | Reduced Disc | | |
| | 0 bar | 3.4 bar | 7 bar | 10.3 bar | 12 bar | 0 bar | 3.4 bar | |
| Class A Non-Corrosive, Lubricating Service | 25 | 6 | 7 | 7 | 8 | 8 | 6 | 7 |
| | 40 | 9 | 10 | 10 | 11 | 11 | 9 | 10 |
| | 50 | 12 | 13 | 13 | 14 | 14 | 12 | 13 |
| | 65 | 19 | 20 | 21 | 22 | 23 | 19 | 20 |
| | 80 | 25 | 27 | 28 | 30 | 31 | 25 | 27 |
| | 100 | 39 | 41 | 44 | 46 | 48 | 25 | 28 |
| | 125 | 58 | 63 | 69 | 75 | 78 | 37 | 42 |
| | 150 | 71 | 80 | 89 | 99 | 103 | 39 | 55 |
| | 200 | 134 | 152 | 169 | 188 | 197 | 83 | 101 |
| | 250 | 199 | 228 | 257 | 285 | 300 | 136 | 153 |
| | 300 | 305 | 351 | 398 | 444 | 467 | 188 | 234 |
| | 350 | 431 | 508 | 585 | 663 | — | 262 | 339 |
| | 400 | 524 | 657 | 791 | 924 | — | 305 | 438 |
| | 450 | 595 | 798 | 1,002 | 1,205 | — | 336 | 541 |
| 500 | 791 | 1,058 | 1,325 | 1,592 | — | 379 | 705 | |
| Class B General Service | 25 | 7 | 7 | 8 | 9 | 9 | 7 | 7 |
| | 40 | 10 | 11 | 11 | 12 | 12 | 10 | 11 |
| | 50 | 14 | 14 | 15 | 15 | 16 | 14 | 14 |
| | 65 | 21 | 22 | 23 | 24 | 25 | 21 | 22 |
| | 80 | 28 | 29 | 31 | 33 | 34 | 28 | 29 |
| | 100 | 42 | 45 | 48 | 51 | 52 | 28 | 30 |
| | 125 | 63 | 69 | 76 | 82 | 85 | 40 | 46 |
| | 150 | 79 | 88 | 98 | 108 | 113 | 48 | 61 |
| | 200 | 147 | 167 | 186 | 206 | 216 | 91 | 111 |
| | 250 | 221 | 253 | 285 | 316 | 332 | 137 | 169 |
| | 300 | 336 | 386 | 437 | 488 | 514 | 207 | 258 |
| | 350 | 475 | 559 | 644 | 729 | — | 288 | 373 |
| | 400 | 576 | 723 | 870 | 1,017 | — | 335 | 482 |
| | 450 | 661 | 887 | 1,113 | 1,339 | — | 369 | 595 |
| 500 | 870 | 1,164 | 1,458 | 1,751 | — | 482 | 776 | |
| Class C Severe Service | 25 | 8 | 9 | 10 | 11 | 11 | 8 | 9 |
| | 40 | 13 | 13 | 14 | 15 | 15 | 13 | 13 |
| | 50 | 17 | 18 | 18 | 19 | 20 | 17 | 18 |
| | 65 | 26 | 28 | 29 | 30 | 31 | 26 | 28 |
| | 80 | 35 | 37 | 39 | 41 | 42 | 35 | 37 |
| | 100 | 53 | 56 | 60 | 64 | 66 | 36 | 39 |
| | 125 | 79 | 87 | 95 | 102 | 107 | 50 | 58 |
| | 150 | 98 | 111 | 123 | 136 | 142 | 59 | 76 |
| | 200 | 184 | 208 | 233 | 258 | 270 | 114 | 139 |
| | 250 | 277 | 316 | 356 | 395 | 415 | 171 | 211 |
| | 300 | 419 | 483 | 547 | 610 | 642 | 258 | 322 |
| | 350 | 593 | 699 | 805 | 911 | — | 360 | 466 |
| | 400 | 720 | 904 | 1,087 | 1,271 | — | 419 | 603 |
| | 450 | 826 | 1,109 | 1,391 | 1,674 | — | 461 | 744 |
| 500 | 1,087 | 1,455 | 1,822 | 2,189 | — | 603 | 970 | |

Series 32/33, 35/36 Torques Imperial (Lb-Ins)

| Valve Size inches | 32, 35 - Max $\Delta P = 75$ psi | | | | 33, 36 - Max $\Delta P = 150$ psi | | | | |
|---|----------------------------------|-----------------|---------|---------|-----------------------------------|---------|---------|---------|---------|
| | 0 psi | 25 psi | 50 psi | 75 psi | 0 psi | 50 psi | 100 psi | 150 psi | |
| Class B General Service (Imperial) | 22 | 5,450 | 6,350 | 7,250 | 8,150 | 8,100 | 11,700 | 14,700 | 17,700 |
| | 24 | 6,700 | 8,100 | 9,500 | 10,900 | 10,500 | 15,000 | 19,500 | 24,000 |
| | 26 | 7,900 | 9,800 | 11,700 | 13,600 | 12,400 | 18,400 | 24,400 | 30,400 |
| | 28 | 9,200 | 11,600 | 14,000 | 16,400 | 14,200 | 21,700 | 29,200 | 36,700 |
| | 30 | 10,400 | 13,300 | 16,200 | 19,100 | 16,100 | 25,100 | 34,100 | 43,100 |
| | 32 | 11,700 | 15,600 | 19,400 | 23,300 | 18,400 | 29,700 | 41,100 | 52,400 |
| | 34 | 13,500 | 18,500 | 23,500 | 28,500 | 20,950 | 34,750 | 48,600 | 62,400 |
| | 36 | 14,300 | 20,100 | 25,900 | 31,700 | 23,000 | 39,000 | 55,000 | 71,000 |
| | 40 | 18,200 | 26,200 | 34,100 | 42,000 | 24,300 | 46,300 | 68,300 | 90,300 |
| | 42 | 20,200 | 29,200 | 38,200 | 47,200 | 25,000 | 50,000 | 75,000 | 100,000 |
| | 44 | 20,800 | 32,500 | 44,200 | 55,800 | 26,700 | 56,700 | 86,700 | 118,300 |
| | 48 | 22,000 | 39,000 | 56,000 | 73,000 | 30,000 | 70,000 | 110,000 | 150,000 |
| Class C | 54 | 41,500 | 73,500 | 105,500 | 138,000 | 56,300 | 131,000 | 173,000 | 282,000 |
| | 60 | 55,500 | 98,200 | 141,000 | 184,800 | 75,100 | 174,500 | 208,000 | 376,000 |
| | 66 | 115,700 | 159,400 | 203,200 | 247,000 | 161,500 | 277,500 | 393,400 | 509,400 |
| | 72 | Consult Factory | | | | | | | |
| | 78 | Consult Factory | | | | | | | |
| | 84 | Consult Factory | | | | | | | |
| | 90 | Consult Factory | | | | | | | |
| 96 | Consult Factory | | | | | | | | |

Series 32/33, 35/36 Torques Metric (Nm)

| Valve Size mm | 32, 35, - Max $\Delta P = 5$ bar | | | | 33, 36 - Max $\Delta P = 10.3$ bar | | | | |
|---|----------------------------------|-----------------|---------|---------|------------------------------------|---------|--------|----------|--------|
| | 0 bar | 1.7 bar | 3.4 bar | 5.2 bar | 0 bar | 3.4 bar | 7 bar | 10.3 bar | |
| Class B General Service (Metric) | 550 | 616 | 718 | 819 | 921 | 915 | 1,322 | 1,661 | 2,000 |
| | 600 | 757 | 915 | 1,074 | 1,232 | 1,187 | 1,695 | 2,204 | 2,712 |
| | 650 | 893 | 1,107 | 1,322 | 1,537 | 1,401 | 2,079 | 2,757 | 3,435 |
| | 700 | 1,040 | 1,311 | 1,582 | 1,853 | 1,605 | 2,452 | 3,300 | 4,147 |
| | 750 | 1,175 | 1,503 | 1,831 | 2,158 | 1,819 | 2,836 | 3,853 | 4,870 |
| | 800 | 1,322 | 1,763 | 2,192 | 2,633 | 2,079 | 3,356 | 4,644 | 5,921 |
| | 850 | 1,526 | 2,091 | 2,656 | 3,221 | 2,367 | 3,927 | 5,492 | 7,051 |
| | 900 | 1,616 | 2,271 | 2,927 | 3,582 | 2,599 | 4,407 | 6,215 | 8,023 |
| | 1,000 | 2,057 | 2,961 | 3,853 | 4,746 | 2,746 | 5,232 | 7,718 | 10,204 |
| | 1,050 | 2,283 | 3,300 | 4,317 | 5,334 | 2,825 | 5,650 | 8,475 | 11,300 |
| | 1,100 | 2,350 | 3,673 | 4,995 | 6,305 | 3,017 | 6,407 | 9,797 | 13,368 |
| | 1,200 | 2,486 | 4,407 | 6,328 | 8,249 | 3,390 | 7,910 | 12,430 | 16,950 |
| Class C | 1,400 | 4,689 | 8,304 | 11,920 | 15,592 | 6,361 | 14,801 | 19,546 | 31,862 |
| | 1,500 | 6,271 | 11,095 | 15,931 | 20,880 | 8,485 | 19,716 | 23,501 | 42,482 |
| | 1,650 | 13,072 | 18,010 | 22,959 | 27,907 | 18,247 | 31,353 | 44,448 | 57,555 |
| | 1,800 | Consult Factory | | | | | | | |
| | 2,000 | Consult Factory | | | | | | | |
| | 2,200 | Consult Factory | | | | | | | |
| | 2,250 | Consult Factory | | | | | | | |
| 2,400 | Consult Factory | | | | | | | | |

Series 22/23 Torques Imperial (Lb-In) and Metric (Nm)

| | In. | mm | $\Delta P = 0-150$ psi | $\Delta P = 0-10.3$ bar |
|---------------|-----|--------|------------------------|-------------------------|
| | | | Lb-In | Nm |
| Valve Size | 2 | 50 | 288 | 33 |
| | 2.5 | 65 | 350 | 40 |
| | 3 | 80 | 560 | 63 |
| | 4 | 100 | 720 | 81 |
| | 5 | 125 | 960 | 108 |
| | 6 | 150 | 1,300 | 147 |
| | 8 | 200 | 2,402 | 271 |
| | 10 | 250 | 3,840 | 434 |
| | 12 | 300 | 5,812 | 657 |
| | 14 | 350 | 8,000 | 904 |
| | 16 | 400 | 11,000 | 1,243 |
| | 18 | 450 | 15,500 | 1,751 |
| | 20 | 500 | 19,300 | 2,181 |
| 24 | 600 | 30,500 | 3,446 | |

- 1) Torques listed are for PTFE, PFA and UHMWPE trims.
- 2) All information based on full rated pressure differential.

DYNAMIC TORQUE FACTORS (IMPERIAL)

To Use the Torque Chart, note the following:

- Dynamic Torque values include all bearing friction and stem-seal friction torques.
- Dynamic Torque values are per 1 PSI ΔP. To determine dynamic torque (lb-in) at a desired angle of opening, multiply the pressure drop ΔP at this angle by the appropriate dynamic torque factor in the charts below.
- Bray recommends sizing control valves between 20° and 70°, with 60° the preferred angle.
- Dynamic Torque will tend to close all Bray valves whose disc are symmetrical to the stem.

Series 20/21 and 30/31/3A (Dynamic Torque Factor - lb-in./psi)

| Valve Size in. | Angle of Opening | | | | | | | | | |
|-------------------|------------------|--------|--------|--------|--------|---------|---------|---------|---------|------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 75° | 80° | 90° |
| 2" | 0.11 | 0.13 | 0.23 | 0.45 | 0.73 | 1.25 | 2.14 | 3.07 | 3.05 | 0.00 |
| 2.5" | 0.22 | 0.24 | 0.43 | 0.87 | 1.39 | 2.39 | 4.09 | 5.86 | 5.83 | 0.00 |
| 3" | 0.37 | 0.41 | 0.73 | 1.47 | 2.36 | 4.07 | 6.95 | 9.97 | 9.92 | 0.00 |
| 4" | 0.86 | 0.95 | 1.70 | 3.43 | 5.49 | 9.45 | 16.17 | 23.19 | 23.07 | 0.00 |
| 5" | 1.65 | 1.83 | 3.29 | 6.61 | 10.59 | 18.25 | 31.22 | 44.77 | 44.53 | 0.00 |
| 6" | 2.49 | 2.77 | 4.97 | 10.00 | 16.01 | 27.59 | 47.19 | 67.68 | 67.32 | 0.00 |
| 8" | 6.60 | 6.74 | 12.08 | 24.30 | 38.93 | 67.07 | 114.71 | 164.51 | 163.64 | 0.00 |
| 10" | 11.99 | 13.32 | 23.89 | 48.06 | 76.99 | 132.65 | 226.86 | 325.35 | 323.64 | 0.00 |
| 12" | 20.89 | 23.21 | 41.62 | 83.74 | 134.14 | 231.14 | 395.30 | 566.91 | 563.93 | 0.00 |
| 14" | 30.04 | 33.38 | 59.84 | 120.40 | 192.87 | 332.34 | 568.37 | 815.12 | 810.83 | 0.00 |
| 16" | 45.65 | 50.72 | 90.94 | 182.97 | 293.12 | 505.07 | 863.76 | 1238.76 | 1232.24 | 0.00 |
| 18" | 65.91 | 73.23 | 131.30 | 264.16 | 423.18 | 729.18 | 1247.04 | 1788.44 | 1779.02 | 0.00 |
| 20" | 91.42 | 101.57 | 182.11 | 366.39 | 586.95 | 1011.37 | 1729.64 | 2480.55 | 2467.50 | 0.00 |

Example: 4" Valve; 60° Open with a 10 PSI pressure drop: [Td = (9.454)(10) = 94.54 lb-in]

Series 32/33, 35/36 (Dynamic Torque Factor - lb-in./psi)

| Valve Size in. | Angle of Opening | | | | | | | | | |
|-------------------|------------------|--------|---------|---------|---------|---------|----------|----------|----------|------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 75° | 80° | 90° |
| 24" | 158.36 | 175.95 | 315.46 | 634.69 | 1016.76 | 1751.99 | 2996.23 | 4297.03 | 4274.40 | 0.00 |
| 30" | 315.32 | 350.35 | 628.13 | 1263.77 | 2024.54 | 3488.51 | 5966.01 | 8556.12 | 8511.07 | 0.00 |
| 36" | 551.88 | 613.21 | 1099.39 | 2211.92 | 3543.45 | 6105.77 | 10442.00 | 14975.33 | 14896.49 | 0.00 |

Larger Size Valves - Consult Factory

Example: 24" Valve; 60° Open with a 10 PSI pressure drop: [Td = (1,751.990)(10) = 17,519.90 lb-in]

DYNAMIC TORQUE FACTORS (METRIC)

To Use the Torque Chart, note the following:

- Dynamic Torque values include all bearing friction and stem-seal friction torques.
- Dynamic Torque values are per 1 bar ΔP . To determine dynamic torque (Nm) at a desired angle of opening, multiply the pressure drop ΔP at this angle by the appropriate dynamic torque factor in the charts below.
- Bray recommends sizing control valves between 20° and 70°, with 60° the preferred angle.
- Dynamic Torque will tend to close all Bray valves whose disc are symmetrical to the stem.

Series 20/21 and 30/31/3A (Dynamic Torque Factor - Nm/bar)

| Valve Size mm. | Angle of Opening | | | | | | | | | |
|-------------------|------------------|--------|--------|--------|--------|---------|---------|---------|---------|------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 75° | 80° | 90° |
| 50 | 0.19 | 0.21 | 0.37 | 0.74 | 1.19 | 2.05 | 3.51 | 5.03 | 5.00 | 0.00 |
| 65 | 0.35 | 0.39 | 0.70 | 1.42 | 2.27 | 3.91 | 6.69 | 9.60 | 9.55 | 0.00 |
| 80 | 0.60 | 0.67 | 1.20 | 2.41 | 3.87 | 6.66 | 11.39 | 16.34 | 16.25 | 0.00 |
| 100 | 1.40 | 1.56 | 2.79 | 5.61 | 8.99 | 15.49 | 26.49 | 38.00 | 37.80 | 0.00 |
| 125 | 2.70 | 3.00 | 5.39 | 10.84 | 17.36 | 29.91 | 51.16 | 73.36 | 72.98 | 0.00 |
| 150 | 4.09 | 4.54 | 8.14 | 16.38 | 26.24 | 45.22 | 77.33 | 110.91 | 110.32 | 0.00 |
| 200 | 10.82 | 11.04 | 19.79 | 39.82 | 63.79 | 109.91 | 187.97 | 269.58 | 268.16 | 0.00 |
| 250 | 19.65 | 21.83 | 39.14 | 78.75 | 126.16 | 217.38 | 371.76 | 533.16 | 530.35 | 0.00 |
| 300 | 34.24 | 38.04 | 68.20 | 137.22 | 219.82 | 378.77 | 647.77 | 929.00 | 924.11 | 0.00 |
| 350 | 49.23 | 54.70 | 98.06 | 197.29 | 316.06 | 544.61 | 931.38 | 1335.74 | 1328.71 | 0.00 |
| 400 | 74.81 | 83.12 | 149.03 | 299.83 | 480.33 | 827.66 | 1415.46 | 2029.97 | 2019.28 | 0.00 |
| 450 | 108.01 | 120.01 | 215.15 | 432.88 | 693.46 | 1194.92 | 2043.53 | 2930.72 | 2915.29 | 0.00 |
| 500 | 149.80 | 166.45 | 298.42 | 600.40 | 961.83 | 1657.34 | 2834.37 | 4064.89 | 4043.50 | 0.00 |

Example: 100 mm Valve; 60° Open with a 10 bar pressure drop: $[Td = (15.49)(2) = 30.98 \text{ Nm}]$

Series 32/33, 35/36 (Dynamic Torque Factor - Nm/bar)

| Valve Size mm | Angle of Opening | | | | | | | | | |
|------------------|------------------|---------|---------|---------|---------|----------|----------|----------|----------|------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 75° | 80° | 90° |
| 600 | 259.50 | 288.34 | 516.94 | 1040.07 | 1666.17 | 2871.00 | 4909.94 | 7041.56 | 7004.49 | 0.00 |
| 750 | 516.71 | 574.13 | 1029.33 | 2070.95 | 3317.62 | 5716.65 | 9776.53 | 14020.96 | 13947.15 | 0.00 |
| 900 | 904.38 | 1004.86 | 1801.57 | 3624.68 | 5806.67 | 10005.56 | 17111.37 | 24540.17 | 24410.97 | 0.00 |

Larger Size Valves - Consult Factory

Example: 600 mm Valve; 60° Open with a 10 bar pressure drop: $[Td = (2871)(2) = 5742.00 \text{ Nm}]$

VALVE SIZING COEFFICIENTS

1. **Valve Sizing Coefficients (Cv)**..... Pages 15-16
 1. **Cv** stands for **Valve Sizing Coefficient**, sometimes called the **Flow Rate Coefficient**.
 2. **Cv** varies with the valve size, angle of opening and the manufacturer’s valve style.
 3. **Cv** is defined as the volume of water in USGPM that will flow through a given restriction or valve opening with a pressure drop of one (1) psi at room temperature.

2. **Valve Sizing Coefficients (Kv)**..... Pages 17-18
 1. **Kv** stands for **Valve Sizing Coefficient**, sometimes called the **Flow Rate Coefficient**.
 2. **Kv** varies with the valve size, angle of opening and the manufacturer’s valve style.
 3. **Kv** is defined as the volume of water in Cubic Meters/Hour (m³/hr) that will flow through a given restriction or valve opening with a pressure drop of one (1) bar at room temperature.



Resilient Seated Butterfly Valves – Valve Sizing Coefficients

Series 20/21 - Valve Sizing Coefficient (Cv)

| Valve Size inches | Disc Position (Degrees) | | | | | | | | |
|-------------------|-------------------------|-----|-------|-------|-------|-------|--------|--------|--------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| 1 | 0.1 | 1 | 3 | 6 | 11 | 21 | 36 | 56 | 61 |
| 1.5 | 0.2 | 2 | 6 | 11 | 26 | 50 | 87 | 129 | 147 |
| 2 | 0.9 | 7 | 16 | 27 | 45 | 73 | 123 | 172 | 244 |
| 2.5 | 1 | 11 | 25 | 43 | 71 | 115 | 201 | 310 | 439 |
| 3 | 2 | 16 | 35 | 62 | 102 | 165 | 290 | 488 | 691 |
| 4 | 4 | 28 | 63 | 110 | 182 | 294 | 515 | 906 | 1,282 |
| 5 | 6 | 44 | 98 | 172 | 284 | 459 | 805 | 1,416 | 2,070 |
| 6 | 7 | 59 | 130 | 227 | 376 | 607 | 1,065 | 1,873 | 2,786 |
| 8 | 13 | 106 | 244 | 427 | 714 | 1,147 | 1,935 | 3,402 | 5,191 |
| 10 | 21 | 168 | 387 | 675 | 1,130 | 1,815 | 3,062 | 5,385 | 8,238 |
| 12 | 31 | 245 | 562 | 981 | 1,642 | 2,636 | 4,448 | 7,820 | 12,102 |
| 14 | 40 | 307 | 706 | 1,234 | 2,064 | 3,313 | 5,590 | 9,829 | 15,210 |
| 16 | 52 | 403 | 925 | 1,617 | 2,706 | 4,343 | 7,328 | 12,885 | 19,940 |
| 18 | 68 | 528 | 1,213 | 2,121 | 3,549 | 5,695 | 9,610 | 16,898 | 26,150 |
| 20 | 85 | 660 | 1,517 | 2,651 | 4,436 | 7,120 | 12,014 | 21,124 | 32,690 |

Series 22/23 - Valve Sizing Coefficient (Cv)

| Valve Size inches | Disc Position (Degrees) | | | | | | | | |
|-------------------|-------------------------|-------|-------|-------|-------|--------|--------|--------|--------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| 2 | 1 | 7 | 16 | 27 | 44 | 62 | 85 | 115 | 146 |
| 2.5 | 1 | 11 | 24 | 43 | 69 | 110 | 176 | 235 | 300 |
| 3 | 2 | 15 | 35 | 61 | 98 | 158 | 286 | 413 | 586 |
| 4 | 3 | 27 | 62 | 109 | 177 | 285 | 503 | 812 | 1,051 |
| 5 | 5 | 43 | 98 | 171 | 276 | 440 | 798 | 1,297 | 1,814 |
| 6 | 6 | 57 | 129 | 226 | 364 | 580 | 1,048 | 1,737 | 2,576 |
| 8 | 12 | 104 | 242 | 424 | 698 | 1,111 | 1,908 | 3,142 | 4,354 |
| 10 | 20 | 165 | 385 | 672 | 1,105 | 1,761 | 3,004 | 4,976 | 6,834 |
| 12 | 29 | 241 | 559 | 975 | 1,604 | 2,591 | 4,420 | 7,392 | 10,090 |
| 14 | 35 | 300 | 720 | 1,280 | 2,100 | 3,300 | 5,700 | 9,350 | 12,880 |
| 16 | 45 | 350 | 850 | 1,650 | 2,750 | 4,400 | 7,500 | 12,320 | 16,900 |
| 18 | 55 | 510 | 1,200 | 2,100 | 3,600 | 5,700 | 9,830 | 15,600 | 21,600 |
| 20 | 80 | 650 | 1,550 | 2,700 | 4,480 | 7,100 | 12,200 | 19,900 | 27,500 |
| 24 | 180 | 1,000 | 2,450 | 4,600 | 7,000 | 11,300 | 18,900 | 28,500 | 34,800 |



Resilient Seated Butterfly Valves – Valve Sizing Coefficients

Series 30/31/31H/3A/3AH/31U - Valve Sizing Coefficient (Cv)

| Valve Size Inches | Disc Position (Degrees) | | | | | | | | |
|-------------------|-------------------------|-----|-------|-------|-------|-------|--------|--------|--------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| 2 | 0.8 | 7 | 16 | 27 | 43 | 61 | 84 | 114 | 144 |
| 2.5 | 1 | 11 | 24 | 43 | 67 | 107 | 163 | 223 | 282 |
| 3 | 2 | 15 | 35 | 61 | 96 | 154 | 267 | 364 | 461 |
| 4 | 3 | 27 | 62 | 109 | 171 | 274 | 496 | 701 | 841 |
| 5 | 5 | 43 | 98 | 170 | 268 | 428 | 775 | 1,146 | 1,376 |
| 6 | 6 | 56 | 129 | 225 | 354 | 567 | 1,025 | 1,542 | 1,850 |
| 8 | 12 | 102 | 241 | 421 | 680 | 1,081 | 1,862 | 2,842 | 3,316 |
| 10 | 19 | 162 | 382 | 667 | 1,076 | 1,710 | 2,948 | 4,525 | 5,430 |
| 12 | 27 | 235 | 555 | 1,005 | 1,594 | 2,563 | 4,393 | 6,731 | 8,077 |
| 14 | 34 | 299 | 756 | 1,320 | 2,149 | 3,384 | 5,939 | 8,874 | 10,538 |
| 16 | 45 | 397 | 1,001 | 1,749 | 2,847 | 4,483 | 7,867 | 11,761 | 13,966 |
| 18 | 58 | 507 | 1,281 | 2,237 | 3,643 | 5,736 | 10,065 | 14,496 | 17,214 |
| 20 | 72 | 632 | 1,595 | 2,786 | 4,536 | 7,144 | 12,535 | 18,812 | 22,339 |

Series 32/33/35/36/35F/36H - Valve Sizing Coefficient (Cv)

| Valve Size Inches | Disc Position (Degrees) | | | | | | | | |
|-------------------|-------------------------|--------|--------|--------|--------|---------|---------|---------|---------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| 22 | 103 | 916 | 2,070 | 3,510 | 5,640 | 9,036 | 14,562 | 22,028 | 27,168 |
| 24 | 259 | 1,028 | 2,387 | 4,244 | 6,962 | 11,040 | 18,235 | 27,186 | 33,154 |
| 26 | 289 | 1,141 | 2,752 | 4,890 | 7,824 | 12,496 | 19,921 | 29,700 | 36,220 |
| 28 | 295 | 1,324 | 3,133 | 5,399 | 8,636 | 13,838 | 22,578 | 34,683 | 41,619 |
| 30 | 420 | 1,652 | 3,986 | 7,080 | 11,328 | 18,090 | 28,844 | 43,003 | 52,443 |
| 32 | 550 | 2,026 | 4,636 | 7,983 | 12,743 | 20,410 | 32,591 | 48,558 | 60,658 |
| 34 | 533 | 2,304 | 5,210 | 8,834 | 14,179 | 22,741 | 36,648 | 55,438 | 68,374 |
| 36 | 740 | 2,775 | 5,936 | 9,790 | 15,572 | 25,053 | 40,086 | 59,667 | 77,089 |
| 40 | 757 | 2,971 | 6,925 | 11,862 | 19,307 | 30,636 | 50,406 | 73,990 | 90,175 |
| 42 | 783 | 3,502 | 7,879 | 12,997 | 21,010 | 35,016 | 54,584 | 83,421 | 102,989 |
| 44 | 904 | 4,066 | 8,698 | 14,346 | 22,818 | 36,712 | 58,740 | 87,430 | 112,960 |
| 48 | 1,023 | 4,651 | 10,365 | 17,010 | 27,242 | 43,853 | 70,431 | 108,968 | 132,888 |
| 52 | Consult Factory | | | | | | | | |
| 54 | 1,299 | 5,904 | 13,158 | 21,594 | 34,583 | 55,671 | 89,411 | 138,334 | 168,700 |
| 60 | 1,480 | 6,400 | 14,500 | 24,500 | 39,400 | 63,200 | 102,000 | 154,000 | 190,000 |
| 66 | 1,650 | 7,110 | 16,100 | 27,300 | 43,800 | 70,200 | 113,000 | 171,000 | 211,000 |
| 72 | 1,900 | 8,220 | 18,600 | 31,500 | 50,700 | 81,200 | 131,000 | 198,000 | 244,000 |
| 78 | 2,290 | 9,910 | 22,400 | 38,000 | 61,000 | 97,800 | 158,000 | 238,000 | 294,000 |
| 84 | 2,290 | 11,390 | 25,800 | 43,700 | 70,200 | 112,400 | 181,000 | 274,000 | 338,000 |
| 90 | Consult Factory | | | | | | | | |
| 96 | Consult Factory | | | | | | | | |

Series 20/21 - Valve Sizing Coefficient (Kv)

| Valve Size mm | Disc Position (Degrees) | | | | | | | | |
|---------------|-------------------------|---------|-----------|-----------|-----------|-----------|------------|------------|------------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| 25 | 0.087 | 0.865 | 2.595 | 5.190 | 9.515 | 18.165 | 31.140 | 48.440 | 52.765 |
| 40 | 0.173 | 1.730 | 5.190 | 9.515 | 22.490 | 43.250 | 75.255 | 111.585 | 127.155 |
| 50 | 0.779 | 6.055 | 13.840 | 23.355 | 38.925 | 63.145 | 106.395 | 148.780 | 211.060 |
| 65 | 0.865 | 9.515 | 21.625 | 37.195 | 61.415 | 99.475 | 173.865 | 268.150 | 379.735 |
| 80 | 1.730 | 13.840 | 30.275 | 53.630 | 88.230 | 142.725 | 250.850 | 422.120 | 597.715 |
| 100 | 3.460 | 24.220 | 54.495 | 95.150 | 157.430 | 254.310 | 445.475 | 783.690 | 1,108.930 |
| 125 | 5.190 | 38.060 | 84.770 | 148.780 | 245.660 | 397.035 | 696.325 | 1,224.840 | 1,790.550 |
| 150 | 6.055 | 51.035 | 112.450 | 196.355 | 325.240 | 525.055 | 921.225 | 1,620.145 | 2,409.890 |
| 200 | 11.245 | 91.690 | 211.060 | 369.355 | 617.610 | 992.155 | 1,673.775 | 2,942.730 | 4,490.215 |
| 250 | 18.165 | 145.320 | 334.755 | 583.875 | 977.450 | 1,569.975 | 2,648.630 | 4,658.025 | 7,125.870 |
| 300 | 26.815 | 211.925 | 486.130 | 848.565 | 1,420.330 | 2,280.140 | 3,847.520 | 6,764.300 | 10,468.230 |
| 350 | 34.600 | 265.555 | 610.690 | 1,067.410 | 1,785.360 | 2,865.745 | 4,835.350 | 8,502.085 | 13,156.650 |
| 400 | 44.980 | 348.595 | 800.125 | 1,398.705 | 2,340.690 | 3,756.695 | 6,338.720 | 11,145.525 | 17,248.100 |
| 450 | 58.820 | 456.720 | 1,049.245 | 1,834.665 | 3,069.885 | 4,926.175 | 8,312.650 | 14,616.770 | 22,619.750 |
| 500 | 73.525 | 570.900 | 1,312.205 | 2,293.115 | 3,837.140 | 6,158.800 | 10,392.110 | 18,272.260 | 28,276.850 |

Series 22/23 - Valve Sizing Coefficient (Kv)

| Valve Size mm | Disc Position (Degrees) | | | | | | | | |
|---------------|-------------------------|---------|-----------|-----------|-----------|-----------|------------|------------|------------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| 50 | 0.865 | 6.055 | 13.840 | 23.355 | 38.060 | 53.630 | 73.525 | 99.475 | 126.290 |
| 65 | 0.865 | 9.515 | 20.760 | 37.195 | 59.685 | 95.150 | 152.240 | 203.275 | 259.500 |
| 80 | 1.730 | 12.975 | 30.275 | 52.765 | 84.770 | 136.670 | 247.390 | 357.245 | 506.890 |
| 100 | 2.595 | 23.355 | 53.630 | 94.285 | 153.105 | 246.525 | 435.095 | 702.380 | 909.115 |
| 125 | 4.325 | 37.195 | 84.770 | 147.915 | 238.740 | 380.600 | 690.270 | 1,121.905 | 1,569.110 |
| 150 | 5.190 | 49.305 | 111.585 | 195.490 | 314.860 | 501.700 | 906.520 | 1,502.505 | 2,228.240 |
| 200 | 10.380 | 89.960 | 209.330 | 366.760 | 603.770 | 961.015 | 1,650.420 | 2,717.830 | 3,766.210 |
| 250 | 17.300 | 142.725 | 333.025 | 581.280 | 955.825 | 1,523.265 | 2,598.460 | 4,304.240 | 5,911.410 |
| 300 | 25.085 | 208.465 | 483.535 | 843.375 | 1,387.460 | 2,241.215 | 3,823.300 | 6,394.080 | 8,727.850 |
| 350 | 30.275 | 259.500 | 622.800 | 1,107.200 | 1,816.500 | 2,854.500 | 4,930.500 | 8,087.750 | 11,141.200 |
| 400 | 38.925 | 302.750 | 735.250 | 1,427.250 | 2,378.750 | 3,806.000 | 6,487.500 | 10,656.800 | 14,618.500 |
| 450 | 47.575 | 441.150 | 1,038.000 | 1,816.500 | 3,114.000 | 4,930.500 | 8,502.950 | 13,494.000 | 18,684.000 |
| 500 | 69.200 | 562.250 | 1,340.750 | 2,335.500 | 3,875.200 | 6,141.500 | 10,553.000 | 17,213.500 | 23,787.500 |
| 600 | 155.700 | 865.000 | 2,119.250 | 3,979.000 | 6,055.000 | 9,774.500 | 16,348.500 | 24,652.500 | 30,102.000 |

Series 30/31/31H/3A/3AH/31U - Valve Sizing Coefficient (Kv)

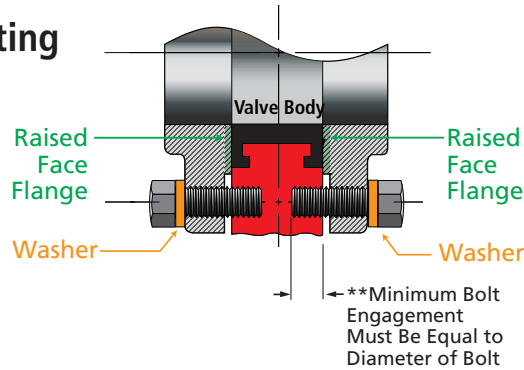
| Valve Size mm | Disc Position (Degrees) | | | | | | | | |
|---------------|-------------------------|---------|-----------|-----------|-----------|-----------|------------|------------|------------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| 50 | 0.692 | 6.055 | 13.840 | 23.355 | 37.195 | 52.765 | 72.660 | 98.610 | 124.560 |
| 65 | 0.865 | 9.515 | 20.760 | 37.195 | 57.955 | 92.555 | 140.995 | 192.895 | 243.930 |
| 80 | 1.730 | 12.975 | 30.275 | 52.765 | 83.040 | 133.210 | 230.955 | 314.860 | 398.765 |
| 100 | 2.595 | 23.355 | 53.630 | 94.285 | 147.915 | 237.010 | 429.040 | 606.365 | 727.465 |
| 125 | 4.325 | 37.195 | 84.770 | 147.050 | 231.820 | 370.220 | 670.375 | 991.290 | 1,190.240 |
| 150 | 5.190 | 48.440 | 111.585 | 194.625 | 306.210 | 490.455 | 886.625 | 1,333.830 | 1,600.250 |
| 200 | 10.380 | 88.230 | 208.465 | 364.165 | 588.200 | 935.065 | 1,610.630 | 2,458.330 | 2,868.340 |
| 250 | 16.435 | 140.130 | 330.430 | 576.955 | 930.740 | 1,479.150 | 2,550.020 | 3,914.125 | 4,696.950 |
| 300 | 23.355 | 203.275 | 480.075 | 869.325 | 1,378.810 | 2,216.995 | 3,799.945 | 5,822.315 | 6,986.605 |
| 350 | 29.410 | 258.635 | 653.940 | 1,141.800 | 1,858.885 | 2,927.160 | 5,137.235 | 7,676.010 | 9,115.370 |
| 400 | 38.925 | 343.405 | 865.865 | 1,512.885 | 2,462.655 | 3,877.795 | 6,804.955 | 10,173.265 | 12,080.590 |
| 450 | 50.170 | 438.555 | 1,108.065 | 1,935.005 | 3,151.195 | 4,961.640 | 8,706.225 | 12,539.040 | 14,890.110 |
| 500 | 62.280 | 546.680 | 1,379.675 | 2,409.890 | 3,923.640 | 6,179.560 | 10,842.775 | 16,272.380 | 19,323.235 |

Series 32/33/35/36/35F/36H - Valve Sizing Coefficient (Kv)

| Valve Size mm | Disc Position (Degrees) | | | | | | | | |
|---------------|-------------------------|-----------|------------|------------|------------|------------|-------------|-------------|-------------|
| | 10° | 20° | 30° | 40° | 50° | 60° | 70° | 80° | 90° |
| 550 | 89.095 | 792.340 | 1,790.550 | 3,036.150 | 4,878.600 | 7,816.140 | 12,596.130 | 19,054.220 | 23,500.320 |
| 600 | 224.035 | 889.220 | 2,064.755 | 3,671.060 | 6,022.130 | 9,549.600 | 15,773.275 | 23,515.890 | 28,678.210 |
| 650 | 249.985 | 986.965 | 2,380.480 | 4,229.850 | 6,767.760 | 10,809.040 | 17,231.665 | 25,690.500 | 31,330.300 |
| 700 | 255.175 | 1,145.260 | 2,710.045 | 4,670.135 | 7,470.140 | 11,969.870 | 19,529.970 | 30,000.795 | 36,000.435 |
| 750 | 363.300 | 1,428.980 | 3,447.890 | 6,124.200 | 9,798.720 | 15,647.850 | 24,950.060 | 37,197.595 | 45,363.195 |
| 800 | 475.750 | 1,752.490 | 4,010.140 | 6,905.295 | 11,022.695 | 17,654.650 | 28,191.215 | 42,002.670 | 52,469.170 |
| 850 | 461.045 | 1,992.960 | 4,506.650 | 7,641.410 | 12,264.835 | 19,670.965 | 31,700.520 | 47,953.870 | 59,143.510 |
| 900 | 640.100 | 2,400.375 | 5,134.640 | 8,468.350 | 13,469.780 | 21,670.845 | 34,674.390 | 51,611.955 | 66,681.985 |
| 1,000 | 654.805 | 2,569.915 | 5,990.125 | 10,260.630 | 16,700.555 | 26,500.140 | 43,601.190 | 64,001.350 | 78,001.375 |
| 1,050 | 677.295 | 3,029.230 | 6,815.335 | 11,242.405 | 18,173.650 | 30,288.840 | 47,215.160 | 72,159.165 | 89,085.485 |
| 1,100 | 781.960 | 3,517.090 | 7,523.770 | 12,409.290 | 19,737.570 | 31,755.880 | 50,810.100 | 75,626.950 | 97,710.400 |
| 1,200 | 884.895 | 4,023.115 | 8,965.725 | 14,713.650 | 23,564.330 | 37,932.845 | 60,922.815 | 94,257.320 | 114,948.120 |
| 1,300 | Consult Factory | | | | | | | | |
| 1,400 | 1,123.635 | 5,106.960 | 11,381.670 | 18,678.810 | 29,914.295 | 48,155.415 | 77,340.515 | 119,658.910 | 145,925.500 |
| 1,500 | 1,280.200 | 5,536.000 | 12,542.500 | 21,192.500 | 34,081.000 | 54,668.000 | 88,230.000 | 133,210.000 | 164,350.000 |
| 1,650 | 1,427.250 | 6,150.150 | 13,926.500 | 23,614.500 | 37,887.000 | 60,723.000 | 97,745.000 | 147,915.000 | 182,515.000 |
| 1,800 | 1,643.500 | 7,110.300 | 16,089.000 | 27,247.500 | 43,855.500 | 70,238.000 | 113,315.000 | 171,270.000 | 211,060.000 |
| 2,000 | 1,980.850 | 8,572.150 | 19,376.000 | 32,870.000 | 52,765.000 | 84,597.000 | 136,670.000 | 205,870.000 | 254,310.000 |
| 2,200 | 1,980.850 | 9,852.350 | 22,317.000 | 37,800.500 | 60,723.000 | 97,226.000 | 156,565.000 | 237,010.000 | 292,370.000 |
| 2,250 | Consult Factory | | | | | | | | |
| 2,400 | Consult Factory | | | | | | | | |

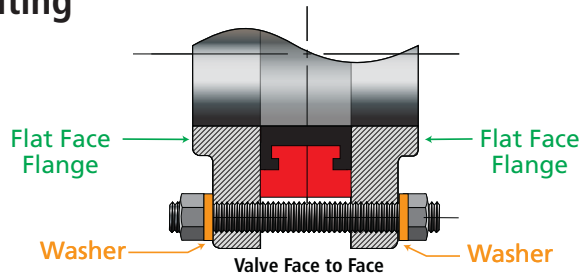
EXAMPLES OF TYPICAL FLANGE TO VALVE BOLTING*

** Lug Style Bolting

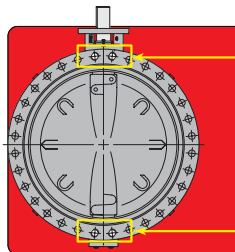


$$\begin{array}{c}
 \text{Flange Width} \\
 \text{Including Raise Face} \\
 \text{If Applicable}
 \end{array}
 +
 \begin{array}{c}
 \text{Washer} \\
 \text{Width}
 \end{array}
 +
 \begin{array}{c}
 \text{Minimum Bolt} \\
 \text{Engagement} \\
 \text{Equal to} \\
 \text{Bolt Diameter}
 \end{array}
 =
 \begin{array}{c}
 \text{Bolt} \\
 \text{Length}
 \end{array}$$

Wafer Style Bolting



$$\begin{array}{c}
 \text{Flange} \\
 \text{Width x2} \\
 \text{Including Raise Face} \\
 \text{If Applicable}
 \end{array}
 +
 \begin{array}{c}
 \text{Valve} \\
 \text{Face to Face}
 \end{array}
 +
 \begin{array}{c}
 \text{Washer} \\
 \text{Width} \\
 \text{x2}
 \end{array}
 +
 \begin{array}{c}
 \text{Width} \\
 \text{of Nut} \\
 \text{x2}
 \end{array}
 +
 \begin{array}{c}
 \text{4 Threads} \\
 \text{(2 Per Side)}
 \end{array}
 =
 \begin{array}{c}
 \text{Overall} \\
 \text{Length}
 \end{array}$$



**** Note: Please refer to Appropriate Bray Dimensional Drawings for specific valve drilling information on Wafer and Lug Valves 20" and larger.**

Please refer to ASME B-16.5 or B-16.47 for Flange and Bolt Dimension Information

* Double flange style bolting not shown.

** Lug threads may be tapped from both sides and therefore tap may not be continuous.

FLANGE BOLT TENSIONING

Bray Butterfly Valves with Metal Mating Flanges

A question frequently asked at Bray is “What torque do I apply to the flange bolts to insure the valve is properly installed?”. Initially this seems to be a simple request until all of the factors are analyzed. The installation of a valve requires several components: the valve, mating flanges, nuts, bolts and studs. Each is supplied by different manufacturers and each has different characteristics. The proper torque for one combination may be too much or too little for a second combination. The following is a list of information which needs to be known in order to start calculating the torque requirements.

Valve

- Type
- Size
- Materials of construction (Body)
- Surface finishes / Surface conditions

Flange

- Type
- Size
- Finish / both sides
- Condition of flange / surface contamination

Bolt (or Stud)

- Type
- Materials of Construction
- Surface Conditions

Nut

- Type
- Materials of Construction
- Surface Conditions

Lubrication

- Type
- Coverage

General Factors

- Temperature and relative humidity at the time of installation
- Speed at which bolts are turned

Note: The elastomer valve seat manufactured by Bray also acts as the flange gasket. No additional gaskets are required or recommended. Other valve styles which do not have integral gaskets will need to have this component supplied. The characteristics of this component will also need to be considered.

Complete knowledge of all relevant conditions is almost impossible to obtain. As a result, the computation of the exact torque requirement is not practical. No reputable manufacturer can provide accurate information when so many outside factors are present.

The International Fasteners Institute covers some of the details required to “compute” a torque value. Even with this information the use of a torque wrench is only considered to be 25% accurate. Based on the difficulty and inaccuracy of using this method, Bray recommends the use of the “Turn of the nut” method.

“Turn of the Nut” Tightening (For ANSI Standard Iron and Steel Flanges)

**For Non-Metallic or non-standard flanges, follow the manufacturers installation procedures.

1. The valve and flange faces must be aligned parallel to each other.

Note: For rubber seated butterfly valves manufactured by Bray, it is required that the valve be fully opened prior to the tightening of the flange bolts.

2. After aligning the holes in a joint, sufficient bolts shall be placed and brought to a ‘snug-tight’ condition to ensure that the parts of the joint are *brought into full contact* with each other. ‘Snug-Tight’ is the tightness attained by the full effort of a man using a spud wrench.
3. Following the initial snugging operation, bolts shall be placed in any remaining holes and brought to snug-tightness. Re-snugging may be necessary in large joints.
4. Tighten opposite bolts in sequence to insure even pressure around the entire flange.

- When all bolts are snug-tight, each bolt in the joint then shall be tightened additionally by the applicable amount of nut rotation given in Note 1. During tightening there shall be no rotation of the valve or flange.

Note 1

For bolt lengths **not exceeding** 8 diameters or 8 inches (203.2 mm) = **1/4 turn**
 For bolt lengths **exceeding** 8 diameters or 8 inches (203.2 mm) = **1/2 turn**

Disclaimer:

Bray Controls is issuing these recommendations only as a guide to installation. This recommendation is based on the full compliance of all materials supplied to their appropriate specifications. Since many of the components are not manufactured by Bray we can take no responsibility for any damage caused during installation.

Series 20/21 and 30/31 - Flange Bolt Torque Chart

| Valve Size | | Normal Torque Range | Normal Torque Range |
|------------|-----|---------------------|---------------------|
| In | mm | Ft-lbs | Nm |
| 2 | 50 | 30 | 40 |
| 2.5 | 65 | 30 | 40 |
| 3 | 80 | 35 | 50 |
| 4 | 100 | 35 - 40 | 50 - 55 |
| 5 | 125 | 35 - 45 | 50 - 60 |
| 6 | 150 | 35 - 50 | 50 - 65 |
| 8 | 200 | 45 - 55 | 60 - 75 |
| 10 | 250 | 55 - 75 | 75 - 100 |
| 12 | 300 | 65 - 110 | 90 - 150 |
| 14 | 350 | 75 - 120 | 100 - 165 |
| 16 | 400 | 75 - 120 | 100 - 165 |
| 18 | 450 | 85 - 130 | 115 - 175 |
| 20 | 500 | 85 - 130 | 115 - 175 |

Please note that the Nm and Ft-lbs values are based on bolt size in respective metric and ANSI flanges, i.e. these values are not a direct conversion between Nm and Ft-lbs.

The values represent average torques needed to ensure full compression of the resilient valves’ seats into the valves’ bodies when installed in pipeline flanges. The face of both flanges must come into full contact with the valves’ metal bodies.

No additional torque is required for proper functioning of the Bray resilient seated valves.

The torque values are based on using new, coarse-threaded, lubricated fasteners. Up to 25% may be added to the Normal Torque Range values when using non-lubricated fasteners.

Torque Values specified by flange manufacturers **must not be exceeded**.

Series 22/23 Installation - Flange Bolt Torque Chart, 150 lb Flanges

| Valve Size | | Normal Torque Range | | Max Torque Range | |
|------------|-----|---------------------|-----------|------------------|-----|
| In | mm | Ft-lbs | Nm | Ft-lbs | Nm |
| 2 | 50 | 30 | 40 | 35 | 50 |
| 2.5 | 65 | 30 | 40 | 35 | 50 |
| 3 | 80 | 35 | 50 | 40 | 55 |
| 4 | 100 | 35 - 40 | 50 - 55 | 40 | 55 |
| 5 | 125 | 35 - 45 | 50 - 60 | 50 | 65 |
| 6 | 150 | 35 - 50 | 50 - 65 | 65 | 90 |
| 8 | 200 | 45 - 55 | 60 - 75 | 80 | 110 |
| 10 | 250 | 55 - 75 | 75 - 100 | 100 | 135 |
| 12 | 300 | 65 - 110 | 90 - 150 | 120 | 165 |
| 14 | 350 | 75 - 120 | 100 - 165 | 140 | 190 |
| 16 | 400 | 75 - 120 | 100 - 165 | 140 | 190 |
| 18 | 450 | 85 - 130 | 115 - 175 | 170 | 230 |
| 20 | 500 | 85 - 130 | 115 - 175 | 180 | 245 |
| 24 | 600 | 100 - 150 | 135 - 205 | 220 | 300 |

The torque values are based on using new, coarse-threaded, lubricated fasteners. Up to 15% may be added to the Normal Torque Range values when using non-lubricated fasteners. However, the maximum torque should not be exceeded.

Flange gaskets are normally not used for installation of S22/23 valves. Flange leakage may be caused by combination of out-of-parallel and/or misaligned flanges, and surface damage on the flange face and/or the face of the valve seat. In such cases, suitable flange gaskets may be used to control flange leakage.

Torque values specified by manufacturers of certain flanges, for example plastic flanges, could be lower than the values specified above. In such cases, the flange manufacturers' torque values must not be exceeded. Use flange gaskets if necessary to secure flange seal.

Series 20/21 - Standard Metal Specifications

| Part | Material | ASTM No. | UNS No. | |
|---|-------------------------|--------------------------|-----------------------|--------|
| Body | Cast Iron | A126 Class B | | |
| | Ductile Iron | A395 Gr. 60-40-18 | F32800 | |
| | 316 Stainless Steel | A351 CF8M | J92900 | |
| | Aluminum | B26 Class B | | |
| Disc/Stem 1-12" (25-300mm) One Piece | 316 Stainless Steel | A351 CF8M | J92900 | |
| | Hastelloy® C22 * | B494 CX2MW | N26022 | |
| | 17-4 ph Stainless Steel | A747 CB7Cu1 Heat Treated | J92180 | |
| Disc/Stem 14-20" (350-500mm) Fabricated | Disc | 316 Stainless Steel | A240 | S31600 |
| | | Hastelloy® C276 * | B575 | N10276 |
| | | 17-4 ph Stainless Steel | A564 630 Heat Treated | S17400 |
| | Stem | 316 Stainless Steel | A276 | S31600 |
| | | Hastelloy® C276 * | B575 | N10276 |
| | | 17-4 ph Stainless Steel | A564 630 Heat Treated | S17400 |

Series 22/23 - Standard Metal Specifications

| Part | Material | ASTM No. | UNS No. |
|-------------|---------------------------|-----------------------|---------|
| Body | Ductile Iron | A395 Gr. 60-40-18 | F32800 |
| | 316 Stainless Steel | A351 CF8M | J92900 |
| | Carbon Steel | A216 WCB | J030002 |
| Disc | 316 Stainless Steel | A351 CF8M | J92900 |
| | PTFE/316 SS (2"-12") | A351 CF8M | J92900 |
| | PTFE/17-4 ph SS (14"-24") | A547 CB7Cu1 | J92180 |
| | PFA/316 SS (2"-12") | A351 CF8M | J92900 |
| | PFA/17-4 ph SS (14"-24") | A547 CB7Cu1 | J92180 |
| | UHMWPE/316 SS (2"-6") | A351 CF8M | J92900 |
| | UHMWPE/DI (8"-12") | A536 Gr 65-45-12 | F33100 |
| | Hastelloy® C22 * | B494 CX2MW | N26022 |
| Titanium | | | |
| Stem | 17-4 ph Stainless Steel | A564 630 Heat Treated | S17400 |

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Series 30/31, 31H, 3A/3AH, 31U - Standard Metal Specifications

| Part | Material | ASTM No. | UNS No. | 30/31 | 31H | 3A/3AH | 31U |
|--------------------|--|-----------------------|---------|-------|-----|--------|-----|
| Body | Cast Iron | A126 Class B | | • | • | • | |
| | Ductile Iron | A536 Gr. 65-45-12 | F33100 | • | • | • | |
| | Ductile Iron | A395 | F32800 | | | | • |
| | Carbon Steel | A216 WCB | J030002 | • | | • | • |
| | Nickel Aluminum Bronze | B148 | C95800 | | | | • |
| | Aluminum | B26 Class B | | • | | | |
| Disc | Aluminum Bronze | B148 | C95400 | • | • | • | |
| | Nickel Aluminum Bronze | B148 | C95800 | | | | • |
| | Nylon Coated Ductile Iron | A536 Gr. 65-45-12 | F33100 | • | • | • | |
| | 316 Stainless Steel | A351 CF8M | J92900 | • | • | • | • |
| | 304 Stainless Steel | A351 CF8 | J92600 | • | | • | |
| | Duplex Stainless Steel | A995 Gr 4A | J92205 | • | | • | |
| | Super Duplex Stainless Steel | A995 Gr 5A | J93404 | • | | • | |
| | Super Austenitic Stainless Steel (254 SMO™)* | A351 Grade CK3MCuN | S31254 | • | | • | |
| Hastelloy® C-276 * | B575 | N10276 | • | | • | | |
| Stem | 304 Stainless Steel | A276 | S30400 | • | | • | |
| | 316 Stainless Steel | A276 | S31600 | • | | • | |
| | 416 Stainless Steel | A582 | S41600 | • | • | • | • |
| | 17-4 ph Stainless Steel | A564 630 Heat Treated | S17400 | | | | • |
| | Monel® * | B865 | N05500 | • | | • | • |

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Series 32/33, 35/36, 35F, 36H - Standard Metal Specifications

| Part | Material | ASTM No. | UNS No. | 32-36 | 36H | 35F |
|-------------|---|-----------------------|---------|-------|-----|-----|
| Body | Cast Iron | A126 Class B | | • | | • |
| | Ductile Iron | A536 Gr. 65-45-12 | F33100 | • | • | • |
| | Carbon Steel | A216 Gr. WCB | J030002 | • | | |
| | 316 Stainless Steel | A351 CF8M | J92900 | • | | |
| Disc | Nickel Aluminum Bronze | B148 | C95800 | • | • | |
| | Nylon Coated Ductile Iron | A536 Gr. 65-45-12 | F33100 | • | • | |
| | 316 Stainless Steel | A351 CF8M | J92900 | • | | |
| | 304 Stainless Steel | A351 CF8 | J92600 | • | | |
| | Hastelloy® C-276 * | B575 | N10276 | CF | | • |
| | Hastelloy® C-22 * | B494 CX2MW | N26022 | CF | | |
| | Duplex Stainless Steel | A995 Gr 5A | J93404 | • | • | • |
| | Super Austenitic Stainless Steel (254 SMO™) * | A351 Grade CK3MCuN | S31254 | • | • | • |
| Monel® * | A494 Grade M-35-1 | N24135 | • | | | |
| Stem | 304 Stainless Steel | A276 | S30400 | • | | • |
| | 316 Stainless Steel | A276 | S31600 | • | | • |
| | 416 Stainless Steel | A582 | S41600 | • | | |
| | 17-4 ph Stainless Steel | A564 630 Heat Treated | S17400 | • | • | |
| | Austenitic Stainless Steel | A479 | S31651 | • | | |
| | Super Austenitic Stainless Steel (AL-6XN®) * | A276 | N08367 | • | • | |
| | Monel® * | B865 | N05500 | • | | |

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