

Resilient Seated Butterfly Valves



Technical Manual

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Resilient Seated Butterfly Valves

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Torques

INTRODUCTION

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

- T_{su} Seating and Unseating Torque
- \mathbf{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) $T_T = T_h + T_{sf} + T_{ss} + T_{su}$

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:

Where:

 \mathbf{T}_{bf} = Bearing Friction Torque

- C_f = Coefficient of Friction (approximately .25 for noncorroded stem to cast iron body) (dimensionless).
- $\mathbf{D}_{\mathbf{v}}$ = Valve Diameter (Inches)
- **d** = Diameter of Shaft (Inches)
- $\Delta \mathbf{P}$ = 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 I – Non-Corrosive, Lubricating Service

Class II – General Service

Class III – 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 (T₁)

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)

 $\mathbf{T}_{\mathrm{T}} = \mathbf{T}_{\mathrm{bf}} + \mathbf{T}_{\mathrm{ss}} + \mathbf{T}_{\mathrm{d}}$

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_s)

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:

- \mathbf{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)

 $\Delta \mathbf{P}$ = Pressure Differential Across Valve (psi)

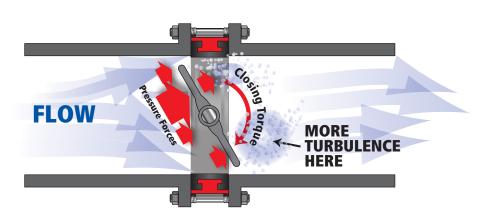


Figure 1 - Pressure Distribution

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5 Bray

As shown in **Figure 2**, 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.

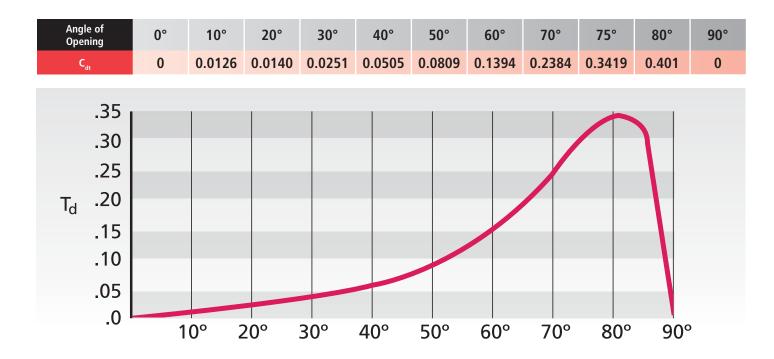
CONCLUSION

In most applications for butterfly valves, especially 20" (508mm) 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" [610mm] and above) where the disc is maintained in the open position
- Applications using larger valves (24" [610mm] and above) where the velocity is high (16 ft./sec [5.3m/sec]).

Figure 2 - Angle of Opening

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





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	Class A	Class B	Class C
Application	Non-Corrosive, Lubricating Service	General Service	Severe Service
Media Type	Lubricating hydrocarbons;	Water; aqueous processes; all	Dry, non-lubricating such as air,
	Aqueous processes and Water	other aqueous liquids including	dry gas, cement, pneumatic
	(See Note 1)	salt water; Lubricating gases	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	45° to 160°F	Within seat temperature limits,	Near or at seat temperature
Temperature	(7° to 71°C)	not near limits	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:

- 1. 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.
- 2. 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.
- 3. 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.

- 4. 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.
- 5. Dynamic Torque values are not considered. See the Dynamic Torque chart in this manual for determination of Dynamic Torque.
- 6. Do not apply a safety factor to torque values when determining actuator output torque requirement.
- 7. For 3-way assemblies where one valve is opening and another is closing, multiply torque by a 1.5 factor.



				Valve Diff	erential Press	ure (PSIG)		
	Valve			Full Disc			Reduce	d Disc
	Size Inches	0 psi	50 psi	100 psi	150 psi	175 psi	0 psi	50 psi
	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
Class A	4	341	364	387	410	423	225	248
Non-Corrosive,	5	510	560	610	660	687	324	374
Lubricating	6	632	712	792	872	912	344	488
5	8	1,182	1,341	1,500	1,660	1,741	735	894
Service	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
	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
Class B	5	560	615	670	725	755	355	410
General Service	6	695	783	871	953	1,003	427	537
	8	1,300	1,475	1,650	1,825	1,915	808	983
	10 12	1,960 2,970	2,240 3,420	2,520	2,800 4,320	2,940	1,213	1,493
	12	4,200	3,420 4,950	3,870		4,545	1,830	2,280
	14	5,100	6,400	5,700 7,700	6,450 9,000		2,550 2,967	3,300 4,267
	18	5,850	7,850	9,850	11,850		3,267	4,207 5,267
	20	7,700	10,300	12,900	15,500		4,267	6,867
	20	7,700	10,500	12,900	13,500		4,207	0,007
	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
Class C	6	870	980	1,090	1,200	1,255	525	672
Severe Service	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 (Lb-Ins)



Series 20/21 and 30/31/3A Torques (N-m)

				Valve Dif	erential Press	sure (Bar)		
	Valve			Full Disc			Reduce	d Disc
	Size mm	0 bar	3.4 bar	7 bar	10.3 bar	12 bar	0 bar	3.4 bar
	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
Class A	100	39	41	44	46	48	25	28
Non-Corrosive,	125	58	63	69	75	78	37	42
Lubricating	150	71	80 150	89	99 199	103	39	55
Service	200	134	152	169	188	197	83	101
Service	250	199 305	228 351	257 398	285	300	136 188	153 234
	300 350	431	508	598	444 663	467	262	234 339
	400	524	657	585 791	924		305	438
	400	595	798	1,002	1,205		336	438 541
	500	791	1,058	1,002	1,205		379	705
	300	751	1,050	1,525	1,332		575	705
	25	7	7	8	9	9	7	7
	40	10	11	11	12	12	10	, 11
	50	14	14	15	12	12	14	14
	65	21	22	23	24	25	21	22
	80	28	29	31	33	34	28	22
	100	42	45	48	51	52	28	30
	125	63	69	76	82	85	40	46
Class B	150	79	88	98	108	113	48	61
General Service	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
			.,	.,	.,			
	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
Class C	150	98	111	123	136	142	59	76
Severe Service	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



	Valve		32, 35 - Max	$\triangle P = 75 \text{ psi}$			33, 36 - Max	△P = 150 psi	
	Size inches	0 psi	25 psi	50 psi	75 psi	0 psi	50 psi	100 psi	150 psi
	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
Class B	32	11,700	15,600	19,400	23,300	18,400	29,700	41,100	52,400
General Service	34	13,500	18,500	23,500	28,500	20,950	34,750	48,600	62,400
(Imporial)	36	14,300	20,100	25,900	31,700	23,000	39,000	55,000	71,000
(Imperial)	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
	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
Class C	72				Consult	Factory			
Class C	78				Consult	Factory			
	84				Consult	Factory			
	90				Consult	Factory			
	96				Consult	Factory			

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

Series 32/33, 35/36 Torques (N-m)

	Valve Size		32, 35, - Max				33, 36 - Max 4	$\triangle P = 10.3 \text{ bar}$	
	mm	0 bar	1.7 bar	3.4 bar	5.2 bar	0 bar	3.4 bar	7 bar	10.3 bar
	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
Class B	800	1,322	1,763	2,192	2,633	2,079	3,356	4,644	5,921
General Service	850	1,526	2,091	2,656	3,221	2,367	3,927	5,492	7,051
(Metric)	900	1,616	2,271	2,927	3,582	2,599	4,407	6,215	8,023
(IVIEUIC)	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
	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
Class C	1,800				Consult	Factory			
Class C	2,000			Consult	Factory				
	2,200				Consult	Factory			
	2,250				Consult	Factory			
	2,400				Consult	Factory			



Seating/Unseating Torques Bray Series 22/23 Valves

	1.5		∆ P = 0-150 psi	∆ P = 0-10.3 bar			
	ln.	mm	Lb-In	N-m			
	2	50	288	33			
	2.5	65	350	40			
	3	80	560	63			
	4	100	720	81			
	5	125	960	108			
Valve	6	150	1,300	147			
Size	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 and UHMWPE trims.

2) All information based on full rated pressure differential.



Dynamic Torque Factors (Imperial)

To Use the Torque Chart, note the following:

- 1. Dynamic Torque values include all bearing friction and stem-seal friction torques.
- 2. 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.
- 3. Bray recommends sizing control valves between 20° and 70°, with 60° the preferred angle.
- 4. Dynamic Torque will tend to close all Bray valves whose disc are symmetrical to the stem.

					•						
Angle of	Opening	10°	20 °	30°	40 °	50°	60°	70 °	75°	80°	90 °
	2	0.113	0.126	0.225	0.453	0.726	1.251	2.139	3.068	3.052	0.000
	2.5	0.216	0.240	0.430	0.865	1.386	2.388	4.085	5.858	5.827	0.000
	3	0.367	0.408	0.732	1.473	2.359	4.065	6.952	9.970	9.918	0.000
	4	0.855	0.949	1.702	3.425	5.486	9.454	16.168	23.187	23.065	0.000
	5	1.650	1.833	3.287	6.613	10.593	18.253	31.217	44.769	44.533	0.000
Valve	6	2.494	2.771	4.969	9.997	16.014	27.594	47.192	67.680	67.323	0.000
Size	8	6.603	6.736	12.077	24.298	38.925	67.073	114.707	164.506	163.64	0.000
inches	10	11.990	13.322	23.885	48.056	76.985	132.653	226.862	325.353	323.640	0.000
	12	20.892	23.214	41.619	83.735	134.142	231.141	395.295	566.910	563.925	0.000
	14	30.039	33.377	59.841	120.396	192.873	332.342	568.366	815.119	810.828	0.000
	16	45.652	50.724	90.942	182.970′	293.115	505.070	863.764	1,238.762	1,232.240	0.000
	18	65.909	73.232	131.295	264.159	423.178	729.184	1,247.040	1,788.435	1,779.020	0.000
	20	91.415	101.573	182.105	366.387	586.945	1,011.373	1,729.637	2,480.549	2,467.498	0.000

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

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)

Angle of	Opening	10°	20 °	30°	40 °	50°	60°	70 °	75°	80°	90°
	24	158.358	175.953	315.459	634.688	1,016.758	1,751.990	2,996.230	4,297.026	4,274.403	0.000
Valve	30	315.318	350.353	628.133	1,263.773	2,024.539	3,488.513	5,966.008	8,556.117	8,511.072	0.000
Size inches	36	551.884	613.205	1,099.388	2,211.917	3,543.447	6,105.766	10,441.998	14,975.332	14,896.492	0.000
	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:

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

Angle of	Opening	10°	20°	30°	40°	50°	60°	70°	75°	80°	90 °
	50	0.001	0.001	0.002	0.004	0.006	0.010	0.017	0.024	0.024	0.000
	65	0.002	0.002	0.003	0.007	0.011	0.019	0.032	0.046	0.045	0.000
	80	0.003	0.003	0.006	0.011	0.018	0.032	0.054	0.078	0.077	0.000
	100	0.007	0.007	0.013	0.027	0.043	0.074	0.126	0.181	0.180	0.000
	125	0.013	0.014	0.026	0.052	0.083	0.142	0.243	0.349	0.347	0.000
Valve	150	0.019	0.022	0.039	0.078	0.125	0.215	0.368	0.528	0.525	0.000
Size	200	0.052	0.053	0.094	0.190	0.304	0.523	0.895	1.283	1.276	0.000
mm	250	0.094	0.104	0.186	0.375	0.600	1.035	1.770	2.538	2.524	0.000
	300	0.163	0.181	0.325	0.653	1.046	1.803	3.083	4.422	4.399	0.000
	350	0.234	0.260	0.467	0.939	1.504	2.592	4.433	6.358	6.324	0.000
	400	0.356	0.396	0.709	1.427	2.286	3.940	6.737	9.662	9.611	0.000
	450	0.514	0.571	1.024	2.060	3.301	5.688	9.727	13.950	13.876	0.000
	500	0.713	0.792	1.420	2.858	4.578	7.889	13.491	19.340	19.246	0.000

Series 20/21 and 30/31(Dynamic Torque Factor - N-m/bar)

Example: 100 mm Valve; 60° Open with a 10 Bar pressure drop: [Td = (.074)(10) = .74 N-m]

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

Angle of	Opening	10°	20°	30°	40 °	50°	60°	70 °	75°	80°	90°
	600	1.235	1.372	2.461	4.951	7.931	13.666	23.371	33.517	33.340	0.000
Valve Size	750	2.459	2.733	4.899	9.857	15.791	27.210	46.535	66.738	66.386	0.000
mm	900	4.305	4.783	8.575	17.253	27.639	47.625	81.448	116.808	116.193	0.000
	Larger Size Valves - Consult Factory										

Example: 600 mm Valve; 60° Open with a 10 Bar pressure drop: [Td = (13.666)(10) = 136.66 N-m]



Valve Sizing Coefficients:

1. Valve Sizing Coefficients (Cv) Pages 14-15

- 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 16-17

- 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.



Valve				Disc	Position (Deg	rees)			
Size inches	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 20/21 - Valve Sizing Coefficient (Cv)

Series 22/23 - Valve Sizing Coefficient (Cv)

Valve		Disc Position (Degrees)									
Size inches	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		



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

Valve				Disc	Position (Deg	jrees)			
Size Inches	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	Disc Position (Degrees)									
Size Inches	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	14,194	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				C	onsult 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				C	onsult Factory					
96				C	onsult Factory					



Valve			rees)						
Size mm	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 20/21 - Valve Sizing Coefficient (Kv)

Series 22/23 - Valve Sizing Coefficient (Kv)

Valve		Disc Position (Degrees)											
Size mm	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)

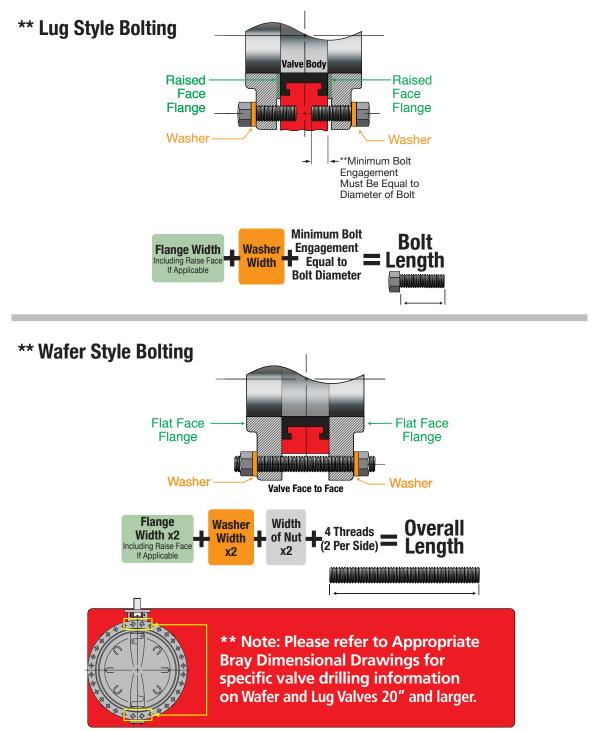
Valve		Disc Position (Degrees)											
Size mm	10°	20°	30°	40°	50°	60°	70°	80°	90°				
50	0.692	6.055	13.840	23.355	37.195	52.765	72.660	98.610	124.560				
65	0.865	9.515	20.760	37.195	57.955	92.555	140.995	192.895	243.930				
80	1.730	12.975	30.275	52.765	83.040	133.210	230.955	314.860	398.765				
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				Disc l	Position (Deg	rees)			
Size mm	10°	20°	30°	40°	50°	60°	70°	80°	90°
550	89.095	792.340	1,790.550	3,036.150	4,878.600	37,887.000	12,596.130	19,054.220	23,500.320
600	224.035	889.220	2,064.755	3,671.060	6,022.130	43,855.500	15,773.275	23,515.890	28,678.210
650	249.985	986.965	2,380.480	4,229.850	6,767.760	52,765.000	17,231.665	25,690.500	31,330.300
700	255.175	1,145.260	2,710.045	4,670.135	7,470.140	60,723.000	19,529.970	30,000.795	36,000.435
750	363.300	1,428.980	3,447.890	6,124.200	9,798.720	37,887.000	24,950.060	37,197.595	45,363.195
800	475.750	1,752.490	4,010.140	6,905.295	11,022.695	43,855.500	28,191.215	42,002.670	52,469.170
850	461.045	1,992.960	4,506.650	7,641.410	12,277.810	52,765.000	31,700.520	47,953.870	59,143.510
900	640.100	2,400.375	5,134.640	8,468.350	13,469.780	60,723.000	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	37,887.000	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	43,855.500	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	52,765.000	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	60,723.000	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*



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 snugtightness. Re-snugging may be necessary in large joints.
- 4. Tighten opposite bolts in sequence to insure even pressure around the entire flange.

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5. 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 turnFor 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.

		b Eore i ana borbi i nange e	
Valv	e Size	Normal Torque Range	Normal Torque Range
In	mm	Ft-lbs	N-m
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

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

Please note that the N-m 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 N-m 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, coarsethreaded, 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.*



	Installation - Flange Bolt Torque Chart, 150 lb Flanges						
e Size	Normal Tor	que Range	Max Torq	ue Range			
mm	Ft-lbs	N-m	Ft-lbs	N-m			
50	30	40	35	50			
65	30	40	35	50			
80	35	50	40	55			
100	35 - 40	50 - 55	40	55			
125	35 - 45	50 - 60	50	65			
150	35 - 50	50 - 65	65	90			
200	45 - 55	60 - 75	80	110			
250	55 - 75	75 - 100	100	135			
300	65 - 110	90 - 150	120	165			
350	75 - 120	100 - 165	140	190			
400	75 - 120	100 - 165	140	190			
450	85 - 130	115 - 175	170	230			
500	85 - 130	115 - 175	180	245			
600	100 - 150	135 - 205	220	300			
	e Size mm 50 65 80 100 125 150 200 250 300 350 400 450 500	e Size Normal Tor mm Ft-Ibs 50 30 65 30 65 30 80 35 100 35 - 40 125 35 - 45 150 35 - 50 200 45 - 55 250 55 - 75 300 65 - 110 350 75 - 120 400 75 - 120 450 85 - 130 500 85 - 130	e Size Normal Torque Range mm Ft-lbs N-m 50 30 40 65 30 40 65 30 40 80 35 50 100 35 - 40 50 - 55 125 35 - 45 50 - 60 150 35 - 50 50 - 65 200 45 - 55 60 - 75 250 55 - 75 75 - 100 300 65 - 110 90 - 150 350 75 - 120 100 - 165 400 75 - 120 100 - 165 450 85 - 130 115 - 175 500 85 - 130 115 - 175	e Size Normal Torque Range Max Torq mm Ft-lbs N-m Ft-lbs 50 30 40 35 65 30 40 35 65 30 40 35 80 35 50 40 100 35 - 40 50 - 55 40 125 35 - 45 50 - 60 50 125 35 - 50 50 - 65 65 200 45 - 55 60 - 75 80 250 55 - 75 75 - 100 100 300 65 - 110 90 - 150 120 350 75 - 120 100 - 165 140 400 75 - 120 100 - 165 140 450 85 - 130 115 - 175 170 500 85 - 130 115 - 175 180			

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

The torque values are based on using new, coarsethreaded, 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. 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.

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.



SCHCS 20/21 - Standard Metal Specifications									
Part	t	Material	ASTM No.	UNS No.					
		Cast Iron	A126 Class B						
Bod		Ductile Iron	A395 Gr. 60-40-18	F32800					
BOU	У	316 Stainless Steel	A351 CF8M	J92900					
		Aluminum	B26 Class B						
Disc/St		316 Stainless Steel	A351 CF8M	J92900					
1-12" (25-300mr		Hastelloy [®] C22 * B494 CX2MW		N26022					
1-12 (25-500111	II) One Piece	17-4 ph Stainless Steel	A747 CB7Cu1 Heat Treated	J92180					
		316 Stainless Steel	A240	S31600					
Disc/Stem	Disc	Hastelloy [®] C276 *	B575	N10276					
14-20″		17-4 ph Stainless Steel	A564 630 Heat Treated	S17400					
(350-500mm)		316 Stainless Steel	A276	S31600					
Fabricated	Stem	Hastelloy [®] C276 *	B575	N10276					
		17-4 ph Stainless Steel	A564 630 Heat Treated	S17400					

Series 20/21 - Standard Metal Specifications

Series 22/23 - Standard Metal Specifications

Part	Material	ASTM No.	UNS No.
	Ductile Iron	A395 Gr. 60-40-18	F32800
Body	316 Stainless Steel	A351 CF8M	J92900
_	Carbon Steel	A216 WCB	J030002
	316 Stainless Steel	A351 CF8M	J92900
	PTFE/316 SS (2"-12")	A351 CF8M	J92900
	PTFE/17-4 ph SS (14"-24")	A547 CB7Cu1	J92180
Disc	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		٠	•	•	
	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		٠			
	Aluminum Bronze	B148	C95400	٠	•	•	
	Nickel Aluminum Bronze	B148	C95800				•
	Nylon Coated Ductile Iron	A536 Gr. 65-45-12	F33100	٠	•	•	
	316 Stainless Steel	A351 CF8M	J92900	٠	•	•	•
Disc	304 Stainless Steel	A351 CF8	J92600	٠		•	
	Duplex Stainless Steel	A995 Gr 4A	J92205	٠		•	
	Super Duplex Stainless Steel	A995 Gr 5A	J93404	٠		•	
	Super Austenitic Stainless Steel (254 SMO™)*	A351 Grade CK3MCuN	S31254	•		•	
	Hastelloy [®] C-276 *	B575	N10276	٠		•	
	304 Stainless Steel	A276	S30400	٠		•	
	316 Stainless Steel	A276	S31600	٠		•	
Stem	416 Stainless Steel	A582	S41600	٠	•	•	•
	17-4 ph Stainless Steel	A564 630 Heat Treated	S17400				•
	Monel [®] *	B865	N05500	•		•	•

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254 SMO[™] is a registered trademark of Avesta AB.

AL-6XN[®] is a registered trademark of ATI Properties, Inc.



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	٠		
	316 Stainless Steel	A351 CF8M	J92900	•		
Disc	Nickel Aluminum Bronze	B148	C95800	•	٠	
	Nylon Coated Ductile Iron	A536 Gr. 65-45-12	F33100	٠	•	
	316 Stainless Steel	A351 CF8M	J92900	٠		
	304 Stainless Steel	A351 CF8	J92600	٠		
	Hastelloy [®] C-276 *	B575	N10276	CF		•
	Hastelloy [®] C-22 *	B494 CX2MW	N26022	CF		
	Duplex Stainless Steel	A995 Gr 5A	J93404	٠	•	•
	Super Austenitic Stainless Steel (254 SMO ™) *	A351 Grade CK3MCuN	S31254	•	•	•
	Monel® *	A494 Grade M-35-1	N24135	•		
Stem	304 Stainless Steel	A276	S30400	٠		•
	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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