Bray®

Your Global Flow Control Partner

Bray/McCannalok
High Performance Cryogenic Butterfly Valves
Technical Manual

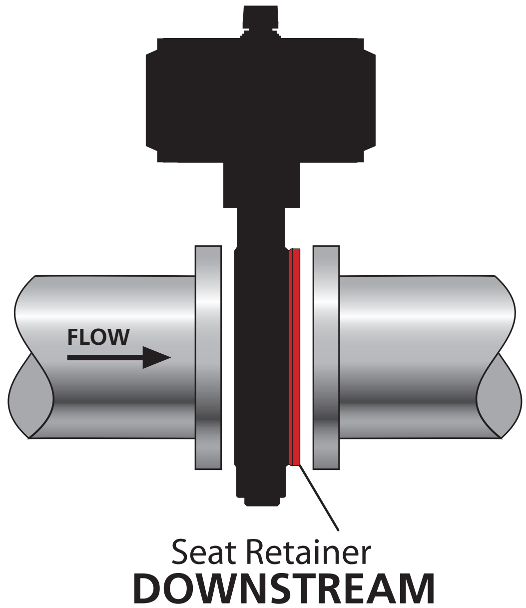
ABS FOUNDED 1862 · LLOYD'S REGISTER LRQA ISO 9001 · UL · CE

TM1059-06_01_2015

TABLE OF CONTENTS

For information on this product and other Bray products please visit us at our web page - www.bray.com

SEATING AND UNSEATING TORQUES



Check the flow direction of the media and ensure that the valve is installed with the retainer downstream.

Valve Size Inches	ASME 150 - Torques (Lb-in)			
	Series 40/41 Cryogenic - Valve Differential Pressure (psig)			
	Less than 150 psig	>150-200 psig	>200-250 psig	>250-285 psig
3	820	845	882	912
4	912	1,012	1,085	1,190
6	1,770	1,920	2,010	2,103
8	2,973	3,184	3,395	3,543
10	4,212	4,551	5,009	5,330
12	6,995	7,538	8,281	8,801
14	Please Consult Factory			
16				
18				
20				
24				

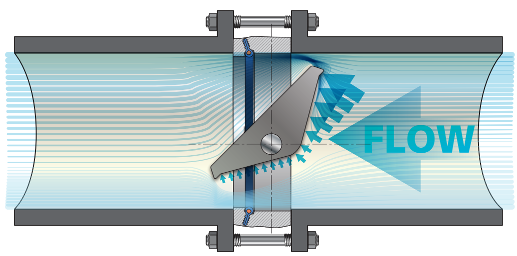
Valve Size Inches	ASME 300 - Torques (Lb-in)			
	Series 42/43 Cryogenic - Valve Differential Pressure (psig)			
	Less than 150 psig	>150-350 psig	>350-550 psig	>550-740 psig
3	820	955	1,106	1,213
4	916	1,219	1,512	1,703
6	2,112	2,910	3,716	4,308
8	3,160	4,320	5,521	6,263
10	7,315	10,230	13,020	15,021
12	11,010	14,705	18,430	21,102
14	Please Consult Factory			
16				
18				
20				
24				

DYNAMIC TORQUES

When a media flows through a butterfly valve, static pressure does not act uniformly on the surfaces of the valve disc. Dynamic torque will cause rotary motion when unchecked by the actuator or manual operator possibly resulting in opening or closing of the valve. If the dynamic torque is of a magnitude that is greater than the bearing and packing friction torque and there is no actuator in place to maintain disc position, the opening or closing action could result in injury to operating personnel or an interruption of the process. Sudden closure (slamming) can cause water hammer damage in lines carrying liquid.

In high performance butterfly valves which have the disc offset from the stem and have non-symmetrical disc faces, dynamic torque acts to close the valve if the valve is installed with the seat retainer downstream.

Seat Retainer Downstream



Dynamic torque should be calculated as part of the valve actuator sizing procedure or to determine if hand lever operation is acceptable. In this regard, the total torque of all service conditions must be considered.

The total torque when the disc is in the seat consists of:

1. Seating torque
2. Stem packing torque
3. Eccentricity torque
4. Stem bearing torque

The total torque when the disc is in the seat is published as seating/unseating torque. When the disc is out of the seat, the total torque consists of dynamic torque, stem packing torque, and stem bearing torque.

Total torque changes with the disc position. Maximum total torque can occur at shutoff (disc in the seat), at breakaway (motion initiation), or at any open disc position where the product of valve pressure drop and dynamic torque coefficient peaks in combination with prevailing bearing and packing torque.

Estimating Dynamic Torque

Dynamic torque can be estimated using the following empirical equations:

Liquid Flow:

Imperial $Td\ (Lb\text{-}in) = Ct\ D^3\ \triangle p$

Metric $Td\ (N\text{-}m) = .0001\ Ct\ D^3\ \triangle p$

Gas Flow:

Imperial $Td\ (Lb\text{-}in) = Ct\ D^3\ Y\ \triangle p$

Metric $Td\ (N\text{-}m) = .0001\ Ct\ D^3\ Y\ \triangle p$

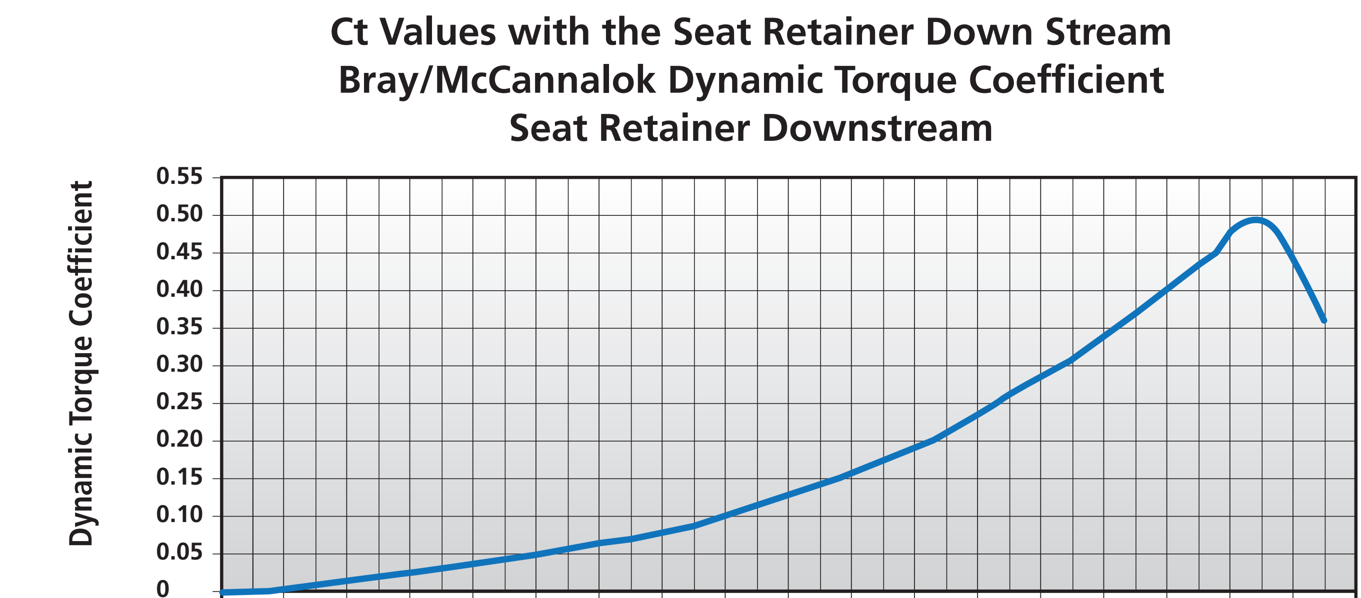
Dynamic Torque - Terminology

Ct -	dynamic torque coefficient (see graphs and tables on page 4 for values of Ct.) Positive value of Ct means that the dynamic torque acts to close the valve and a negative value of Ct to open the valve.
D -	nominal valve size (in or mm)
Fk -	ratio of specific heat factor (dimensionless) Fk = k/1.40 or Fk = 1 for air
k -	ratio of specific heat (dimensionless)
$\triangle$p -	effective pressure drop across the valve (psi or bar)
p1 -	valve inlet pressure (psia or bar abs.)
Td -	dynamic torque (Lb-in or N-m)
x -	x = $\triangle$p/p1
Y -	gas expansion factor (dimensionless) Y = 1 – x / (3 Fk xt)
xt -	gas critical pressure ratio (dimensionless) Values of xt change with disc position and are identical for seat retainer upstream and downstream.

º Open	xt	º Open	xt
10º	0.46	55º	0.31
15º	0.46	60º	0.28
20º	0.46	65º	0.27
25º	0.45	70º	0.25
30º	0.44	75º	0.24
35º	0.42	80º	0.22
40º	0.39	85º	0.21
45º	0.35	90º	0.19
50º	0.33		

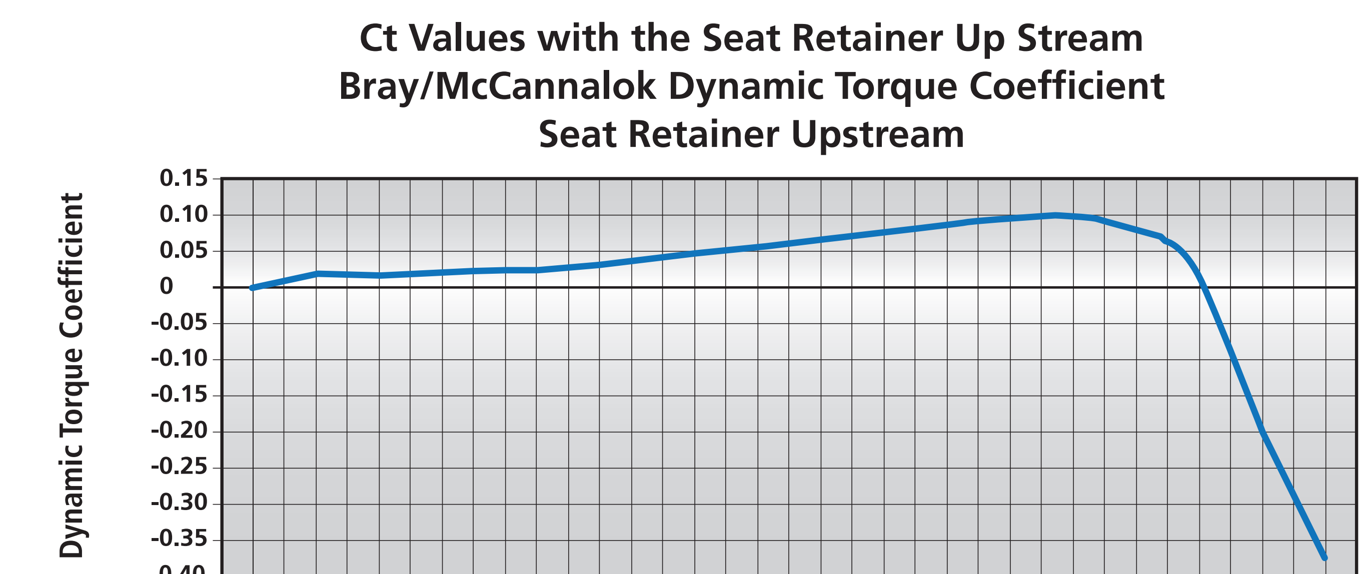
DYNAMIC TORQUE COEFFICIENT

Figure 1 - Seat Retainer Downstream



Angle of Opening	0°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
Ct Down	.0	.012	.022	.031	.044	.058	.073	.088	.114	.141	.176	.212	.260	.308	.370	.431	.496	.362

Figure 2 - Seat Retainer Upstream



Angle of Opening	0°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
Ct up	.0	.015	.018	.020	.023	.027	.037	.046	.055	.063	.078	.086	.093	.100	.084	.032	-.17	-.37

SUBCHOKED AND CHOKED FLOW

For	Condition	Use	Note
Subchoked Flow	Pipe and Valve Size Equal	• Nominal Valve Size • Valve Pressure Drop • Ct from graphs/tables on "Figure 1 - Seat Retainer Downstream" on page 4	
	With Pipe Reducers	• Nominal Valve Size • Ct from graphs/tables on "Figure 1 - Seat Retainer Downstream" on page 4 • Valve Pressure Drop as if valve were installed in valve-sized pipe with same flow rate	
Choked Flow	Pipe and Valve Size Equal	• Nominal Valve Size • Ct from graphs/tables on "Figure 1 - Seat Retainer Downstream" on page 4 • Actual Pressure drop through valve.	If actual pressure drop at the choked condition is not known, estimate by evaluating the pressure in the piping at the valve outlet needed to sustain the choked flow rate through the piping downstream of the valve; then subtracting it from the valve inlet pressure.
	With Pipe Reducers	• Nominal Valve Size • Ct from graphs/tables on "Figure 1 - Seat Retainer Downstream" on page 4 • Actual pressure drop through valve/ reducer assembly.	If the pressure drop at the choked condition is not known, estimate the line pressure just downstream of the valve/reducer assembly which is needed to sustain the choked flow rate of the valve/reducer assembly through the downstream piping; then subtract this pressure from the line pressure just ahead of the valve/ reducer assembly, to get the actual pressure drop.

For	Condition	Use	Note
Subchoked Flow	Pipe and Valve Size Equal	• Nominal Valve Size • Valve Pressure Drop • Ct from graphs/tables on "Figure 1 - Seat Retainer Downstream" on page 4	
	With Pipe Reducers	• Nominal Valve Size • Ct from graphs/tables on "Figure 1 - Seat Retainer Downstream" on page 4 • Valve Pressure Drop (and expansion factor Y) as if valve were installed in valve-sized pipe with same flow rate.	In calculating Y, use the line pressure just upstream of the inlet reducer for p1 and xt from the table on page 3.
Choked Flow	Pipe and Valve Size Equal	• Nominal Valve Size • Gas expansion factor Y of 2/3 • Ct from graphs/tables on "Figure 1 - Seat Retainer Downstream" on page 4 • $\triangle p = p1\ Fk\ xt$	Use xt from the table on page 3.
	With Pipe Reducers	• Nominal Valve Size • Gas expansion factor Y of 2/3 • Ct from graphs/tables on "Figure 1 - Seat Retainer Downstream" on page 4 • $\triangle p = p1\ Fk\ xt$	Use the line pressure just upstream of the inlet reducer for p1 and xt from the table above in calculating $\triangle$p, on page 3.

MAXIMUM ALLOWABLE STEM TORQUES (Lb-in)

Cryogenic and Low Temperature Valves

Valve Size inches	ASME 150	ASME 300
	Series S40/41	Series S42/43
3	1,968	1,968
4	1,968	1,968
6	3,368	5,630
8	5,544	10,292
10	10,251	18,511
12	14,454	27,818
14	Please Consult Factory	
16		
18		
20		
24		

Based on stem Material Code 54P and 5MF at ambient conditions (73°F)

MAXIMUM ALLOWABLE STEM TORQUES (N-m)

Cryogenic and Low Temperature Valves

Valve Size inches	ASME 150	ASME 300
	Series S40/41	Series S42/43
3	222	222
4	222	222
6	381	636
8	626	1,163
10	1,158	2,091
12	1,633	3,143
14	Please Consult Factory	
16		
18		
20		
24		

Based on shaft material code 54P and 5MF at ambient conditions (23°C)

VALVE SIZING COEFFICIENTS (Cv)

1. Cv stands for Valve Sizing 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.

Valve Size Inches	ASME 150 Series 40/41 - Valve Sizing Coefficient (Cv)								
	Disc Position (Degrees)								
	90°	80°	70°	60°	50°	40°	30°	20°	10°
3	185	178	155	123	87	56	32	14	5
4	375	365	315	250	175	115	63	31	10
6	1,350	1,070	750	510	330	218	140	81	35
8	2,800	2,230	1,590	1,060	685	456	280	165	65
10	4,300	3,450	2,430	1,630	1,050	700	450	250	100
12	6,650	5,330	3,750	2,530	1,630	1,080	700	390	155
14	Please Consult Factory								
16									
18									
20									
24									

Valve Size Inches	ASME 300 Series 42/43 - Valve Sizing Coefficient (Cv)								
	Disc Position (Degrees)								
	90°	80°	70°	60°	50°	40°	30°	20°	10°
3	185	178	155	123	87	56	32	14	5
4	375	365	315	250	175	115	63	31	10
6	1,000	875	710	530	370	240	138	79	26
8	2,000	1,720	1,360	950	630	405	240	121	47
10	2,650	2,250	1,740	1,200	780	510	295	150	61
12	4,000	3,400	2,500	1,690	1,100	710	430	220	92
14	Please Consult Factory								
16									
18									
20									
24									

VALVE SIZING COEFFICIENTS (Kv)

1. Kv stands for Valve Sizing 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.

ASME 150 Series 40/41 - Valve Sizing Coefficient (Kv)

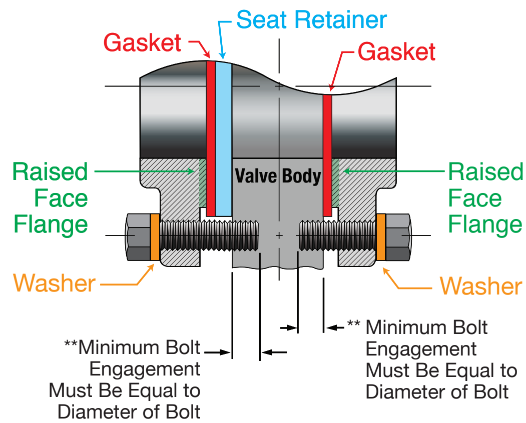
Valve Size mm	Disc Position (Degrees)								
	90°	80°	70°	60°	50°	40°	30°	20°	10°
80	158	152	132	105	74	48	27	12	4
100	320	311	269	213	149	98	54	26	9
150	1,152	913	640	435	281	186	119	69	30
200	2,388	1,902	1,356	904	584	389	239	141	55
250	3,668	2,943	2,073	1,390	896	597	384	213	85
300	5,672	4,546	3,199	2,158	1,390	921	597	333	132
350	Please Consult Factory								
400									
450									
500									
600									

ASME 300 Series 42/43 - Valve Sizing Coefficient (Kv)

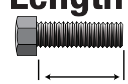
Valve Size mm	Disc Position (Degrees)								
	90°	80°	70°	60°	50°	40°	30°	20°	10°
80	158	152	132	105	74	48	27	12	4
100	320	311	269	213	149	98	54	26	9
150	853	746	606	452	316	205	118	67	22
200	1,706	1,467	1,160	810	537	345	205	103	40
250	2,260	1,919	1,484	1,024	665	435	252	128	52
300	3,412	2,900	2,133	1,442	938	606	367	188	78
350	Please Consult Factory								
400									
450									
500									
600									

Examples of Typical Flange to Valve Bolting*

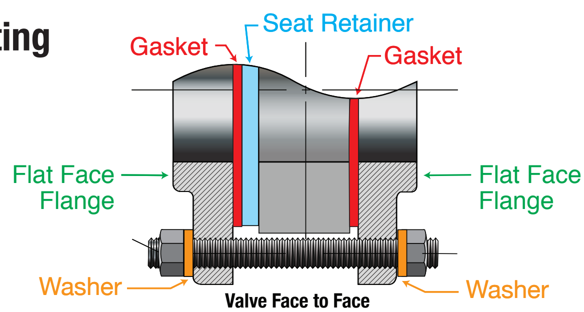
Lug Style Bolting



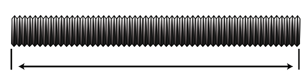
Flange Width Including Raised Face If Applicable **+ Gasket Width + Seat Retainer Width** (*Seat Retainer Side ONLY!*) **+ Washer Width + Minimum Bolt Engagement Equal to Bolt Diameter = Bolt Length**

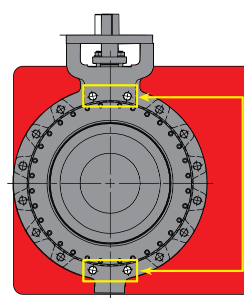


Wafer Style Bolting



Flange Width x2 Including Raised Face If Applicable **+ Gasket Width x2 + Valve Face to Face + Washer Width x2 + Width of Nut x2 + 4 Threads (2 Per Side) = Overall Length**





Note: Please refer to Appropriate Bray Dimensional Drawings for specific valve drilling information.

Applies to Wafer and Lug Valves as follows:
- ASME Class 150 26" Valves and larger
- ASME Class 300 14" Valves and larger
- ASME Class 600 10" Valves 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.

TM_1059_Cryogenic_06_01_2015

YOUR GLOBAL FLOW CONTROL PARTNER

Bray Controls
A Division of Bray International, Inc.
13333 Westland East Blvd.
Houston, Texas 77041
Tel: 281.894.5454 • www.bray.com