ANNEX D
METHOD FOR CALCULATING BOLT LENGTHS[1, 2]

The following equations were used in establishing dimension L as listed in various dimensional tables.

$$L_{CSB} = A + n$$

$$L_{CMB} = B + n$$

For lapped joints, calculate stud bolt and machine bolt length as follows.

For ring joint groove facing:

$$L_{CSB} = A + (\text{pipe thickness for each lap}) + n$$

$$L_{CMB} = B + (\text{pipe thickness for each lap}) + n$$

For other than ring joint facing:

$$L_{CSB} = A - F + (\text{Table D3 thicknesses}) + n$$

$$L_{CMB} = B - F + (\text{Table D3 thicknesses}) + n$$

where:

A = $2(t_f + t + d) + G + F - a$ (i.e., stud bolt length exclusive of negative length tolerance n)

B = $2(t_f + t) + d + G + F + p - a$ (i.e., machine bolt length exclusive of negative tolerance n)

F = total height of facings or depth of ring joint groove for both flanges (see Table D1)

G = 3.0 mm (0.12 in.) gasket thickness for raised face, male and female tongue and groove flanges; also approximate distance between ring joint flanges listed in Table 5 (Table F5 of Annex F)

L_{CMB} = calculated machine bolt length as measured from underside of head to end of point

L_{CSB} = calculated stud bolt length (effective thread length, excluding end points)

L_{SMB} = specified machine bolt length (from underhead to end, including end point), which is L_{CMB} rounded off to the nearest 5 mm (0.25 in.) increment (see Fig. D2)

L_{SSB} = specified stud bolt length (effective thread length, excluding end points) which is L_{CSB} rounded off to the nearest 5 mm (0.25 in.) increment (see Fig. D1)

a = zero, except where the small female face is on the end of pipe, a = 5 mm (0.19 in.)

d = heavy nut thickness (equals nominal bolt diameter, see ASME B18.2.2)

n = negative tolerance on bolt length (see Table D2)

p = allowance for height of point of machine bolt (1.5 times thread pitch)

t = plus tolerance for flange thickness (see para. 7.3)

t_f = minimum flange thickness (see applicable dimensional tables)

[1] This Annex is not a mandatory annex of ASME B16.5-2003 and is placed after the main text for information.

[2] The equations used in this Annex are for calculated bolt lengths established to ensure full thread engagement of heavy hexagon nuts when worst case tolerances occur on all relevant dimensions of the flanged joint. The use of shorter bolt lengths is acceptable provided that full thread engagement is obtained at assembly (see para. 6.10.2).

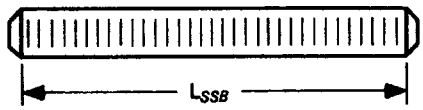

Fig.D1 Specified Stud Bolt Length

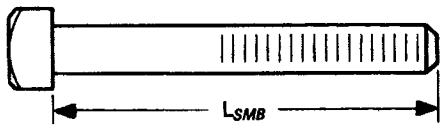

Fig. D2 Specified Machine Bolt Length

Table D1 *F* Values

	Total Height of Facings or Depth of Ring Joint Groove for Both Flanges, *F*, mm (in.)			
	Type of Flange Facing [Note (1)]			
Class	2 mm Raised 0.06 in.	7 mm Raised 0.25 in.	Male and Female or Tongue and Groove	Ring Joint
150 and 300	4 mm (0.12)	14 mm (0.50)	7 mm (0.25)	2 × groove depth
400 to 2500	4 mm (0.12)	14 mm (0.50)	7 mm (0.25)	2 × groove depth

NOTE:
(1) See Fig. 8 (Fig. F8 of Annex F) and Tables 4 and 5 (Tables F4 and F5 of Annex F).

Table D2 *n* Values

Dimensions	Negative Tolerance on Bolt Lengths, *n*, mm (in.)	Length, mm (in.)
Stud Bolt		
A		
or	1.5 (0.06)	
[*A* + (pipe thickness) for each lap)]	3.0 (0.12)	≤305 (≤12)
or		
[*A* − *F* + (Table D3 thickness)]	7.0 (0.25)	>305 (>12), ≤460 (≤18)
		>460 (>18)
Machine Bolt		
B		
or		
[*B* + (pipe thickness for each lap)]	For *n* values, use negative length	
or	tolerances per ASME B18.2.1.	
[*B* − *F* + (Table D3 thickness)]		...

Table D3 Thickness for Lapped Joints

Lap Combination	Classes 150 Through 2500 Flanges
For lapped to 2 mm (0.06 in.) male face on flange	One lap and 2 mm (0.06 in.)
For lapped to lapped	Both laps
For lapped to 7 mm (0.25 in.) male face on flange	One lap and 7 mm (0.25 in.)
For lapped to female face on flange	One lap not less than 7 mm (0.25 in.)
For male in lap to female in lap	2 × pipe wall with lap for male not less than 7 mm (0.25 in.)