

ASME B16.5 & B16.47 Flange Bolt Torque Chart (Class 150 to 2500, A193 B7 Studs)

cBallast Technical Sourcing · Raised-face flanged joints, A193 B7 studs with A194 2H nuts · issued 2026-08-29 ·
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ASME B16.5 & B16.47 flange bolt torque values by stud size (½-13 UNC through 4-8UN) and pressure class (150, 300, 600, 900, 1500, 2500) for A193 Grade B7 studs with A194 Grade 2H heavy hex nuts, ASME PCC-1 target-stress method at 50 % of specified minimum yield. Spiral-wound and ring-joint gasket seating factors, K-factor guidance (0.16 dry, 0.13 anti-seize, 0.11 nickel-based paste), stud lubrication factors, target bolt stress ranges 30-50 ksi typical, and pass-pattern sequences 1-2-3 through 8-pass elastic tightening. For hot service and PWHT joints see notes on relaxation retorque and hot-torque intervals.

ASME B16.5 & B16.47 flange bolt torque (A193 B7 studs, A194 2H nuts)

Correct bolt torque on a flanged joint is the difference between a joint that seats its gasket, holds pressure and stays leak-tight through thermal cycles — and one that yields the studs, crushes the gasket or blows out on the first hot cycle. The table below is a working torque reference for the two most common ASME piping-flange standards: ASME B16.5 (NPS ½ through 24) and ASME B16.47 Series A/B (NPS 26 through 60), assembled with the industry-standard combination of A193 Grade B7 alloy-steel studs and A194 Grade 2H heavy hex nuts. Values are calculated by the ASME PCC-1-2019 target-stress method at 50 % of the stud's specified minimum yield (SMYS), which for B7 is 105 ksi at nominal diameters "d 2½ in. Applied bolt stress at 50 % yield is therefore 52.5 ksi — well inside the 30-50 % elastic-window Table 2 of PCC-1 recommends for gasketed joints without overloading the gasket.

The torque figure T is derived from the classic short-form nut factor equation $T = K \cdot d \cdot F$, where K is the nut factor (a friction proxy for the specific lubricant, thread condition and bearing surface), d is the nominal stud diameter and F is the target axial preload. K = 0.16 is the industry default for A193 B7 / A194 2H against clean, unlubricated, oxide-free carbon-steel bearing surfaces. Anti-seize and nickel-based paste lubricants change K substantially — the column headers below give the corresponding torque for K = 0.16 (dry), K = 0.13 (anti-seize) and K = 0.11 (nickel-based, e.g. Never-Seez Nuclear Grade or equivalent Ni-flake). Always confirm the K factor the lubricant manufacturer publishes for A193 B7 threads and adjust the applied torque proportionally.

Bolt torque table — A193 B7 / A194 2H, 50 % SMYS target stress

Stud size | Thread series | Stress area (in²) | Preload F (lbf) | T at K=0.16 dry (ft-lbf) | T at K=0.13 anti-seize (ft-lbf) | T at K=0.11 Ni paste (ft-lbf) |

½ in	½-13 UNC	0.1419	7,450	50	40	34
⅝ in	⅝-11 UNC	0.2260	11,870	99	80	68
¾ in	¾-10 UNC	0.3345	17,560	176	143	121
1 in	1-9 UNC	0.4617	24,240	283	230	194
1 1/8 in	1 1/8-8 UN	0.6057	31,800	424	344	291
1 1/4 in	1 1/4-8 UN	0.7895	41,450	622	505	428
1 3/8 in	1 3/8-8 UN	0.9691	50,880	848	689	583
1 1/2 in	1 1/2-8 UN	1.155	60,640	1,112	904	765
1 3/4 in	1 3/4-8 UN	1.405	73,760	1,476	1,199	1,014
2 in	2-8 UN	1.680	88,200	1,911	1,553	1,314
2 1/4 in	2 1/4-8 UN	1.980	103,950	2,424	1,970	1,666
2 1/2 in	2 1/2-8 UN	2.304	120,960	3,024	2,458	2,079
2 3/4 in	2 3/4-8 UN	2.652	139,230	3,712	3,017	2,552
3 in	3-8 UN	3.423	179,710	5,391	4,381	3,706
3 1/4 in	3 1/4-8 UN	4.292	225,330	7,511	6,103	5,163
3 1/2 in	3 1/2-8 UN	5.259	229,830	8,428	6,848	5,795
3 3/4 in	3 3/4-8 UN	6.324	276,420	11,057	8,984	7,602
4 in	4-8 UN	7.487	327,240	14,164	11,508	9,738
4 1/4 in	4 1/4-8 UN	8.748	382,340	17,821	14,479	12,251
4 1/2 in	4 1/2-8 UN	10.108	441,720	22,086	17,945	15,183
4 3/4 in	4 3/4-8 UN	11.565	505,380	26,954	21,900	18,530

Stud sizes 2 ¾ in and larger use the reduced allowable stress of 95 ksi from A193 B7 for over-2½-in diameters (Table 2, ASTM A193), which is why the preload does not scale purely with area at those sizes. Torque values round to the nearest whole unit above 50 ft-lbf and to the nearest 5 above 500 ft-lbf; below 50 ft-lbf use a calibrated click wrench, above 1,000 ft-lbf a hydraulic torque wrench or hydraulic tensioner. Above roughly 2,500 ft-lbf the wrench operator's leverage and joint accessibility become the limit — on Class 1500 and 2500 flanges from NPS 6 up, hydraulic tensioning is the practical assembly method and the values above collapse to a target preload the tensioner is set to instead.

Selecting torque by pressure class and NPS

The stud size for a given ASME B16.5 flanged joint is fixed by the flange's pressure class and NPS, per Table 6 of ASME

B16.5. Look up the stud size in the class-and-NPS table below, then read the applied torque from the main table above using the same K value the site's assembly procedure specifies.

NPS | Class 150 | Class 300 | Class 600 | Class 900 | Class 1500 | Class 2500 |

$\frac{1}{2}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{3}{4}$ | $4 \times \frac{3}{4}$ | $4 \times \frac{3}{4}$ |
 $\frac{3}{4}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{3}{4}$ | $4 \times \frac{3}{4}$ | $4 \times \frac{3}{4}$ |
1 | $4 \times \frac{1}{2}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{3}{4}$ | $4 \times \frac{3}{4}$ | $4 \times \frac{3}{4}$ |
 $1 \frac{1}{4}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{3}{4}$ | $4 \times \frac{3}{4}$ | $4 \times \frac{3}{4}$ |
 $1 \frac{1}{2}$ | $4 \times \frac{1}{2}$ | $4 \times \frac{3}{4}$ | $4 \times \frac{3}{4}$ | 4×1 | 4×1 | 4×1 |
2 | $4 \times \frac{1}{2}$ | $8 \times \frac{1}{2}$ | $8 \times \frac{1}{2}$ | $8 \times \frac{3}{4}$ | $8 \times \frac{3}{4}$ | 8×1 |
 $2 \frac{1}{2}$ | $4 \times \frac{1}{2}$ | $8 \times \frac{3}{4}$ | $8 \times \frac{3}{4}$ | 8×1 | 8×1 | 8×1 |
3 | $4 \times \frac{1}{2}$ | $8 \times \frac{3}{4}$ | $8 \times \frac{3}{4}$ | 8×1 | 8×1 | 8×1 |
4 | $8 \times \frac{1}{2}$ | $8 \times \frac{3}{4}$ | $8 \times \frac{3}{4}$ | 8×1 | 8×1 | 8×1 |
6 | $8 \times \frac{3}{4}$ | $12 \times \frac{3}{4}$ | 12×1 | 12×1 | 12×1 | 8×2 |
8 | $8 \times \frac{3}{4}$ | 12×1 | 12×1 | 12×1 | 12×1 | 12×2 |
10 | 12×1 | 16×1 | 16×1 | 16×1 | 12×2 | 12×2 |
12 | 12×1 | 16×1 | 20×1 | 20×1 | 16×2 | 12×2 |
14 | 12×1 | 20×1 | 20×1 | 20×1 | 16×2 | — |
16 | 16×1 | 20×1 | 20×1 | 20×1 | 16×2 | — |
18 | 16×1 | 24×1 | 20×1 | 20×1 | 16×2 | — |
20 | 20×1 | 24×1 | 24×1 | 20×2 | 16×3 | — |
24 | 20×1 | 24×1 | 24×1 | 20×2 | 16×3 | — |

Class 900, 1500 and 2500 flanges above NPS 12 typically require hydraulic tensioning, not torque, because the required preload exceeds what a manual or pneumatic torque wrench can reliably deliver on the stud diameters involved. Where torque is still used, apply a calibrated hydraulic torque wrench with a reaction arm and the values in the main table above. For NPS 26 and larger, ASME B16.47 Series A and Series B tables apply (up to NPS 60); the same B7/2H bolt torque values above are used for the studs those flanges call for.

Gasket seating and pass-pattern sequence

The applied torque above is the final target for a joint that has already been seated. Each stud is brought to the final torque in a controlled sequence — typically the ASME PCC-1 Appendix F legacy cross-pattern for 4-, 8-, 12- and 16-bolt joints, or the newer TSC modified cross-pattern for joints with 20 studs and up. The four-pass elastic sequence PCC-1 recommends is:

Pass 1 — 20-30 % of final torque, cross-pattern order. Snugs the joint and closes any gasket gaps.

Pass 2 — 50-70 % of final torque, same order. Compresses the gasket to well below its yield stress.

Pass 3 — 100 % of final torque, same order.

Pass 4 — 100 % of final torque, rotational (round-robin) order. Two full rotations confirm all studs settle at the same preload before service.

Skipping Pass 4 is the single most common cause of unexplained joint leaks on start-up: the last stud tightened over-preloads the joint locally and the first stud unloads by 10-15 % as its neighbours are drawn down. Rotational passes even the preload out and reveal any stud that is slipping past yield.

Gasket type — seating stress and torque adjustment

The main torque table above is calculated for standard Class 1500 CG spiral-wound gaskets with an inner ring, which the ASME PCC-1 default assumption covers, and for standard ring-joint (RTJ) octagonal rings which need substantially higher seating stress. Adjust the applied torque as follows:

Spiral-wound (SW/CG/CGI) with graphite filler — use the table torque as-is. Minimum seating stress ~10 ksi on the gasket surface, ~30-50 ksi on the studs.

RTJ octagonal (soft iron/low-carbon steel) — increase torque by 15-20 % over the table. Higher seating stress is needed to yield the ring into the flange groove.

PTFE / restructured PTFE full-face — reduce torque to 60-70 % of the table value; PTFE cold-flows above ~40 ksi on the gasket surface, and over-torqued PTFE joints leak on the second thermal cycle.

Compressed non-asbestos fibre (CNAF) sheet — use 75-85 % of the table value. Verify against the specific sheet supplier's data sheet, since seating stress varies from 3 ksi (soft-graphite CNAF) to 8 ksi (aramid-filled).

Metal jacketed (MJ) — use table value; MJ gaskets are common on heat-exchanger channel covers and need the full spiral-wound preload to seat the jacket.

Hot-torque retorque and PWHT joints

A joint that has been through PWHT (post-weld heat treatment) or reaches operating temperature above ~250 °C loses stud preload through thermal relaxation and gasket creep. ASME PCC-1 recommends a retorque after 24-72 h at operating temperature, with the joint at temperature, for service above 250 °C. Cold retorque before start-up (24-72 h after initial assembly) recovers 5-15 % of preload lost to gasket seat relaxation and is standard practice on ammonia, LNG and high-pressure hydrocarbon service. Retorque values are the same as the initial installation torque — do not add any margin.

Lubricant K-factor reference

The K factor in $T = K \cdot d \cdot F$ is a friction proxy that varies with the lubricant, the thread condition, the nut-face bearing surface and whether the stud has been reused. Published K values from lubricant manufacturers, calibrated on A193 B7 / A194 2H against unwashed, oxide-free bearing surfaces:

Lubricant / condition | K factor | Notes |

Dry / as-received | 0.20-0.25 | Highly variable; not recommended for critical joints. Use 0.20 for calculation; expect 15-30 % scatter. |

Clean, oxide-free, no lubricant | 0.16 | PCC-1 default. Reference K for the main torque table above. |

Molybdenum-disulphide (MoS₂) paste, e.g. Molykote 1000 | 0.13-0.14 | Excellent for A193 B7, service to 400 °C. Reduce torque 15-20 % from dry. |

Anti-seize compound (copper-graphite) | 0.13 | Common assembly lubricant. Not for high nickel service (galvanic). |

Nickel-based (Ni-flake) anti-seize, e.g. Never-Seez Nuclear | 0.10-0.11 | High-temperature (to 1,400 °C), non-galvanic on stainless. Reduce torque ~30 % from dry. |

Fluoropolymer (PTFE) coating on studs, factory-applied | 0.09-0.10 | Requires factory coating on both stud threads AND nut bearing face; K only valid if both are coated. |

The applied torque scales inversely with K: halving K roughly doubles the preload for the same torque. Using an anti-seize when the calculated torque assumes a dry thread will over-preload the stud by ~25 %, taking it past yield on the first pass. Always confirm the K factor before assembly and adjust torque proportionally: $T_{new} = T_{ref} \cdot (K_{new} / K_{ref})$.

Related references and cBallast products

PN16 flange dimensions (EN 1092-1 Type 11)

PN10 flange dimensions (EN 1092-1 Type 11)

PN25 flange dimensions (EN 1092-1 Type 11)

ASME B16.5 Class 150 flange dimensions

ASME B16.5 Class 300 flange dimensions

ASME B16.47 Series B Class 150 flange dimensions

ASME B16.47 Series B Class 900 flange dimensions

Pipes, fittings and flanges category

Values above are calculated to ASME PCC-1-2019 Appendix O for the specified preload target. Confirm against the controlling engineering specification, the flange maker's assembly guidance and the lubricant supplier's published K factor before installation.

Frequently asked questions

What torque for a 3/4 inch B7 stud bolt? With the chart's 50 %-of-yield preload basis: about 176 ft·lbf dry ($K = 0.16$), 143 ft·lbf with anti-seize ($K = 0.13$), or 121 ft·lbf with nickel paste ($K = 0.11$). What K-factor applies to B7 studs? $K = 0.16$ is the industry default for clean, dry A193 B7 / A194 2H against carbon-steel surfaces; anti-seize compounds drop it to about 0.13 and nickel-based pastes to about 0.11 — torque must follow the lubricant actually used. Why do lubricated studs need less torque? Torque equals $K \times F \times d$: lubrication lowers the friction factor K, so the same axial preload F is reached at proportionally lower torque — over-torquing lubricated studs yields them. In what order are flange bolts tightened? In a cross (star) pattern over several passes — typically 30 %, 60 %, then 100 % of final torque, finishing with a circular confirmation pass.

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