



ASTM A707/A707M-02

Standard Specification for Forged Carbon and Alloy Steel

Flanges for Low-Temperature Service¹

1. Scope :-

- 1.1 This specification covers forged carbon and alloy steel flanges intended primarily for petroleum and gas pipelines in areas subject to low ambient temperatures. Included are flanges to specified dimensions or to dimensional that are referenced in section 2.
- 1.2 Supplementary requirements are provided for use when addition requirements are desired. These shall apply only when specified individually by the purchaser in the order.
- 1.3 Eight grades, four yield strength classes, and three different notch toughness levels are included.
- 1.4 The availability of a particular size of flange of a specific grade and class is limited only by the capability of the composition to meet the specified mechanical property requirements. However, current practice normally limits the following:
 - (a) Grade L1 to Classes 1 and 2,
 - (b) Grade L2 to Classes 1, 2, and 3,
 - (c) Grade L3 to Classes 1, 2, and 3,
 - (d) Grade L4 to Classes 1, 2, and 3,
 - (e) Grade L7 to Classes 1 and 2, and
 - (f) Grade L5, L6, and L8 are generally available in any class.
- 1.5 This specification is expressed in both inch-pound units and in SI units. However, unless the order specifies the applicable "M" specification designation(SI units), the material shall be furnished to inch-pound units.
- 1.6 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two system may result in non-conformance with the specification.

2. Referenced Documents :-

- 2.1 In addition to those reference documents listed in specification A961/A961M, the following list of standard apply to this specification:
- 2.2 ASTM Standards:
 - A388/A388M practice for ultrasonic Examination of steel forgings
 - A788/A788M specification for steel forgings, general requirements
 - A961/A961M specification for common requirements for steel flanges, forged fittings, valves, and parts for piping applications
- 2.3 MSS Standards:
 - SP 44 steel pipeline flanges
- 2.4 API Standards:
 - 605 large diameter carbon steel flanges
- 2.5 ASME Boiler and pressure vessel code:
 - Section VIII division I, part UG-84
 - Section IX welding qualification



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- 2.6 ASME Standard:
 - B16.5 dimensional standards for steel pipe flanges and flanged fittings
- 2.7 AWS Standards:
 - A5.1 Mild steel covered electrodes
 - A5.5 Low-alloy steel covered arc-welding electrodes
3. Terminology :-
 - 3.1 Definitions:
 - 3.1.1 flakes – short discontinuous internal fissures attributed to stresses produced by localized transformation and decreased solubility of hydrogen during cooling after hot working.
 - 3.1.2 Linear surface imperfection (or indication) – an imperfection or indication with a length at least three times its width.
4. Ordering Information :-
 - 4.1 It is the purchaser's responsibility to specify in the purchase order all ordering information necessary to purchase the needed material. In addition to the ordering information guide lines in specification A961/A961M, orders should include the following information:
 - 4.1.1 Additional requirements (see Table 1 footnotes, 9.2.2, 9.3, 11.5, 17.1, 21.1, and 21.2).
5. General Requirements :-
 - 5.1 Product furnished to this specification shall conform to the requirements of specification A961/A961M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of specification A961/A961M constitutes non-conformance with this specification. In case of conflict between the requirements of this specification and specification A961/A961M, this specification shall prevail.
6. Manufacture :-
 - 6.1 The steel shall meet the melting practice of specification A961/A961M.
 - 6.2 The finished product shall be a forging as defined by 3 (only) of specification A788/A788M.
7. Heat Treatment :-
 - 7.1 After forging and before reheating for heat treatment, the forging shall be allowed to cool substantially below the transformation range. The method of cooling shall be such as to ensure against the development of cracks, flakes, etc.
 - 7.2 All material shall be heat treated by annealing, normalizing, precipitation hardening, quenching-and-tempering, normalizing-and-tempering, normalizing-and-precipitation hardening, or quenching-and-precipitation hardening.
 - 7.2.1 The procedures for the various heat treatments are as given in specification A961/A961M except as defined in the following:
 - 7.2.1.1 Precipitation hardening – Consists of heating to a temperature between 1000 and 1250 °F [538 and 677 °C], holding at temperature for not less than ½ h, and then cooling at any convenient rate.



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8. Chemical Composition :-

8.1 A chemical heat analysis in accordance with specification A961/A961M shall be made and conform to the requirements as to chemical composition prescribed in Table 1. Leded steels shall not be permitted.

9. Mechanical Requirements :-

9.1 The material in the weld neck shall conform to the mechanical property requirements prescribed in Table 2.

9.2 For the purpose of determining conformance with Table 2, mechanical testing requirements shall conform to specification A961/A961M.

9.2.1 For flanges smaller than 24 in. [610 mm] in size, the forged test blanks shall be at least 2 in. [50 mm] wide by 2 in. [50 mm] thick by 12 in. [300 mm] in length. The test specimens shall be taken with their longitudinal axes parallel to the length of the test blank.

9.2.2 For flanges 24 in. [610 mm] and larger in size, the test blank dimensions and orientation of test specimens with respect to the blank shall be subject to agreement.

9.3 Specimens shall be obtained from the mid wall of the thinnest section of the hub of the flange or 3/4 in. [19 mm] from the surface of the test blank. The orientation of specimens taken from a flange shall be subject to agreement.

TABLE 1 Chemical Requirements

Element	Grade							
	L1 ^A	L2 ^A	L3	L4	L5	L6	L7 ^B	L8
Carbon, max %								
Heat analysis	0.20	0.30	0.22	0.18	0.07	0.07	0.20	0.20
Product analysis	0.23	0.33	0.25	0.20	0.09	0.09	0.22	0.22
Manganese, %								
Heat analysis	0.60-1.50	0.60-1.35	1.15-1.50	0.45-0.65	0.40-0.70	1.85-2.20	0.90 max	0.20-0.40
Product analysis	0.55-1.60	0.55-1.45	1.05-1.60	0.40-0.70	0.35-0.75	1.75-2.30	1.00 max	0.15-0.45
Phosphorus, max, %								
Heat analysis	0.030	0.030	0.025	0.025	0.025	0.025	0.025	0.020
Product analysis	0.035	0.035	0.030	0.030	0.030	0.030	0.030	0.025
Sulfur, max, %								
Heat analysis	0.030	0.030	0.025	0.025	0.025	0.025	0.025	0.020
Product analysis	0.040	0.040	0.035	0.035	0.035	0.035	0.035	0.025
Silicon, max, %								
Heat analysis	0.35	0.35	0.30	0.35	0.35	0.15	0.35	0.35
Product analysis	0.37	0.37	0.32	0.37	0.37	0.17	0.37	0.37
Chromium, %								
Heat analysis	0.30 max	0.30 max	0.30 max	0.30 max	0.60-0.90	0.30 max	0.30 max	1.50-2.00
Product analysis	0.34	0.34	0.34	0.34	0.56-	0.34	0.34	1.44-



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	max	max	max	max	0.94	max	max	2.06
Nickel, %								
Heat analysis	0.40 max	0.40 max	0.40 max	1.65- 2.00	0.70- 1.00	0.40 max	3.2-3.7	2.8-3.9
Product analysis	0.43 max	0.43 max	0.43 max	1.60- 2.05	0.67- 1.03	0.43 max	3.18- 3.82	2.68- 3.97
Molybdenum, %								
Heat analysis	0.12 max	0.12 max	0.12 max	0.20- 0.30	0.15- 0.25	0.25- 0.35	0.12 max	0.40- 0.60
Product analysis	0.13 max	0.13 max	0.13 max	0.19- 0.33	0.14- 0.28	0.22- 0.38	0.13 max	0.35- 0.65
Vanadium, %								
Heat analysis	0.05 max	0.05 max	0.04- 0.11	0.05 max	0.05 max	0.05 max	0.05 max	0.05 max
Product analysis	0.06 max	0.06 max	0.03- 0.13	0.06 max	0.06 max	0.06 max	0.06 max	0.06 max
Nitrogen, %								
Heat analysis	...	...	0.010- 0.030	...	...	...	...	...
Product analysis	...	...	0.005- 0.035	...	...	...	...	...
Copper, %								
Heat analysis	0.40 max	0.40 max	0.20 min ^c	0.40 max	1.00- 1.30	0.40 max	0.40 max	0.40 max
Product analysis	0.43 max	0.43 max	0.18 min ^c	0.43 max	0.95- 1.35	0.43 max	0.43 max	0.43 max
Columbium, %								
Heat analysis	0.02 max	0.02 max	0.02 max	0.02 max	0.03 min	0.06- 0.10	0.02 max	0.02 max
Product analysis	0.03 max	0.03 max	0.03 max	0.03 max	0.02 min	0.05- 0.11	0.03 max	0.03 max

TABLE 2 Mechanical Requirements

Property	Class 1	Class 2	Class 3	Class 4
Yield strength ^A min, ksi [MPa]	42	52	60	75
Tensile strength, min, ksi [MPa]	[290]	[360]	[415]	[515]
Elongation in 2 in. Or 50 mm, min, %	[415] 22	[455] 22	[515] 20	[620] 20
Reduction of area, min, %	40	40	40	40
Hardness, HBN	149-207	149-217	156-235	179-265
Cv energy absorption, ^b _o	30[41]	40[54]	50[68]	50[68]
C _v energy absorption, ^B _p min, ft.lbf[j]	24[33]	32[43]	40[54]	40[54]

- 10. Hardness Requirements
- 11. Impact requirements
- 12. Product Analysis
- 13. Ultrasonic Examination
- 14. Tension Tests

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15. Hydrostatic Tests

16. Retreatment

17. Workmanship, finish, and Appearance

18. Repair by welding

19. Inspection

20. Rejection and reheating

21. Certification :-

21.1 For flanges made to specified dimensions, when agreed upon by the purchaser, and for flanges made to dimensional standards, application of identification marks as required in 22.1 shall be the certification that the flanges have been furnished in accordance with the requirements of the specification.

21.2 When test reports are required, they shall include certification that all requirements of this specification have been met, the result of all required tests, and description of heat treatment including temperature ranges, times, mode of cooling, and the heat number or manufacturer's heat identification. The specification designation included on test reports shall include year of issue and revision letter, if any.

22. Product Marking

23. Keywords :-

23.1 Carbon equivalent; piping; applications; pressure containing parts; residual elements; steel flanges; steel forgings, alloy; steel forgings, carbon; temperature service applications; low

Supplementary Requirements :-

S1. Ultrasonic examination

S2. Additional tension and Impact tests

S3. Carbon Equivalent

S4. Notch Toughness, 50 % shear FATT minimum

S5. Additional Ultrasonic test requirement

S6. Notch Toughness, Measurement, and Reporting of percent shear and lateral expansion