API AUTHORIZED PIPING INSPECTOR

PREPARATION COURSE FOR CERTIFICATION EXAMINATION

1999

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CORPUS CHRISTI / HOUSTON, TEXAS

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OUTLINE

SUBJECT: **API AUTHORIZED PIPING INSPECTOR CERTIFICATION EXAMINATION.**

OBJECTIVE: **FAMILIARIZE CANDIDATES FOR THE CERTIFICATION TEST WITH TYPES AND FORMS OF INFORMATION IN WHICH THEY MUST BE KNOWLEDGEABLE.**

REFERENCES: **BODY OF KNOWLEDGE, API PIPING INSPECTOR CERTIFICATION EXAMINATION, ASME B16.5**

1.0 Scope

B16.5 applies to pipe flanges and flanged fittings NPS 1/2 - 24, Classes 150 - 2500 (cast or forged) and includes requirements for:

- Pressure/Temperature Ratings
- Materials
- Dimensions
- Tolerances
- Markings
- Testing
- Designating openings

1.2.2 Temperature limitations from a referencing ASME Code must be followed, regardless of 16.5 allowances.

2.0 Pressure Temperature Ratings

P/T ratings are based on maximum "non-shock" working gage pressures at the temperatures shown in the Tables.

2.2 Flanged Joints comprised of 3 components:

- Flanges
- Gaskets
- Bolting

When two different rated flanges are used, the rating of the joint at any given pressure/temperature shall be that of the lower rated flange.

2.4 Temperature Considerations

2.4.1 Socket weld/threaded flanges - not recommended for temperatures beyond -50 to +500°F.

2.4.2 Periodic tightening of bolts needed in extremely high temperatures.
Above 400°F - Class 150 may leak unless precautions are taken.
Above 750°F - others may leak unless precautions are taken.

2.5 System Hydrostatic Tests

Normal limit is 1.5 x the 100°F pressure rating of the flange rounded off to next highest 25 psi. Testing at higher pressure is responsibility of the user.

2.6 Weld Neck Flanges

Ratings for WN Flanges are based on the hubs at the weld end, which is calculated as pipe with a wall thickness having 40 KSI yield strength.

3.0 Size

3.1 -"Nominal" size is always used - actual dimensions will vary with tolerances shown.

4.0 Markings

4.1 All flanges and fittings shall be marked with:

- Manufacturers name or trademark
- Material Specification (ASTM)
- Rating Class
- "B16"
- Size
- "R" - (Ring Joint Flanges only)
- Temperature (optional)

5.0 Materials

Materials that flanges/flanged fittings are produced from must conform to the material specifications listed in Table 1A. Bolts are given in Table 1B.

5.3 Three kinds of bolting are given:
1. High Strength - A193 B7 or above in strength (Table 1B)
2. Intermediate Strength - A193 B5 or above in strength (Table 1B)
3. Low Strength - <30 KSI yield strength (Table 1B)
   Used only in Class 150/300 joints, -20°F to 400°F.

5.3.4 Grey Cast iron flanges should employ low strength bolts with Group IA gaskets extending to the bolt holes, or high/intermediate strength bolts with gaskets extended to the full o.d. of the flange.

5.4 Gaskets

Ring joints must conform to ANSI B16.20. All other gasket materials to come from Annex E of 16.5.

6.0 Dimensions

6.1 Wall Thicknesses - All wall thicknesses are shown in applicable tables, including tolerances. Annex D can be used for calculating this minimum thickness.

Example #1 - What is the required wall thickness for a new Class 300 flanged fitting that is 6" NPS?

Answer: From Annex D, D.1.2 - $t = \frac{1.5x300x6}{(2x7000) - 1.2x300} = \frac{2700}{13640} = .197"$ ← Answer

Example #2 - What is the minimum thickness for a NPS 6 (6.625 o.d.) Class 600 seamless fitting that is made from B31.3 Table A-1 material with a stress value of 15,000 psi, and operating in a system designed for 1,000 psi?

Answer: From API 574 and ASME B31.3 - $t_M = \frac{1.5x1,000x6.625}{2x15,000x1}$

$$t_M = \frac{9937.5}{30,000}$$

$t_M = .331"$ ←Answer

Example #3 - A class 150 flanged fitting is used in a system that is rated for 160 psi at 500°F. The material stress value is 13,800. Can this flange be used in this system?

Answer: From Annex D, Para. D2.4 and D2.1 - P_T = 320 - .3 x 500 = 170 (cannot exceed)←Answer

$$P_T = \frac{115x13{,}800}{8750} = 181.37$$

Example #4 - A 10" Class 150 ASME B16.5 flanged fitting has a corroded area. What is the lowest reading that can be obtained on this fitting per ASME B16.5; when is it new and cold, for inspection purposes.

Answer: From Table 10 - .34" thick ← Answer

Example #5 - An NPS 12 ASME B16.5 flanged fitting has a locally corroded area that measured to be below the minimum wall thickness by 1/8". The minimum wall thickness of the fitting is .380". If the area of corrosion can be enclosed by a 3"-diameter circle, does this fitting continue to meet Code requirements?

Answer: From ASME B16.5 Para 6.1.1 = $D = 0.35\sqrt{dt_m}$

$.35\sqrt{12x.380}$

3" actual diameter > .747 allowed diameter

Does not meet Code ← Answer

Example #6 - If the above 3" diameter circle is approximately 1.5" away from another 3" circle of reduced thickness, would this condition meet the Code?

Answer: From Para 6.1.1 - $E_D = 1.75\sqrt{dt_m}$

$1.75\sqrt{12x.380}$ = 3.73"

No - must be at least 3.73" away from each other - doesn't meet Code ← Answer

6.2 - 6.4 Various dimensional requirements/tolerances are stated or referenced in the applicable tables.

6.4.4 Flange Facing Finishes

- Finishes are judged by visual comparators per ASME B46.1 - stylus tracers and electronic amplification not allowed.
- Raised Face - 24 - 40 grooves/in, with surface finish of 125-250 μ/inch
- Tongue/Groove - 125 μ/inch
- Rig Joint - 63 μ/inch

6.10 Flange Bolting Dimensions

6.10.2 Stud bolts with a nut on each end are recommended for high temperature service. Stud bolt lengths listed in the Tables are provided for the thickness of two nuts.

7.0 Tolerances

Various tolerances are given for various dimensions.

8.0 Testing

8.1 Flanged fittings must be hydrotested at 1.5 x the 100°F rating rounded off to next higher 25 psi increment. No leakage through the wall is permitted.

8.2 Flanges are not required to be hydrotested

8.3 Test to be made with water, (corrosion inhibitor optional) at a temperature not above 125°F. Test duration minimum:

1 min - ≤ NPS 2
2 min - NPS 2 1/2 through NPS 8
3 min - NPS 10 and above

Table 1A Applicable Materials used for Corresponding Material Groupings.

Table 1B List of Bolting Specifications

Table 1C Flange Bolting Dimensional Recommendations

Table 2 Pressure Temperature Ratings

Table 3 Permissible Imperfections in Flange Facings

Table 7 - 25 Specific Dimensional Tolerances for each Pressure Class of Flange or Fitting

Annex D Methods for Establishing Pressure Temperature Ratings

ASME B16.5 PRACTICE QUESTIONS

(QUESTIONS 1-15 ARE CLOSED BOOK)

1. ASME B16.5 does not cover:

    a. Class 150 flanges
    b. Class 300 flanged fittings
    c. Butt welded pipe caps
    d. All of the above
    e. A & B above

2. The maximum hydrostatic test pressure permitted for a flange in a system hydrostatic test is:

    a. Not required
    b. Conducted at 1.5 x class rating @ 100°F
    c. Conducted at 25 psi above class rating
    d. Required only for welded flanges

3. "High strength" bolting is described as equivalent to:

    a. ASTM A 193 B5
    b. ASTM A 193 B7
    c. ASTM A 320 GR 8
    d. Any high carbon steel bolt

4. The pressure class ratings covered by ASME B16.5 are:

    a. 150, 300, 400, 600, 900, 1500, 2500
    b. 150, 300, 400, 450, 600, 900, 1500
    c. 125, 150, 300, 400, 600, 900, 1500, 2500
    d. 150, 300, 400, 600, 700, 900, 1000, 1500

5. The standard finish for raised face flanges per ASME B16.5 is:

    a. 250 μ to 500 μ/inch
    b. 125 μ to 250 μ/inch
    c. 260 mm to 500 mm/inch
    d. 250 μ/mm to 500 μ/mm

6. Socket weld and threaded flanges are not recommended for service beyond the following temperatures if thermal cycles are involved:

    a. -20 - 650°F
    b. -30 - 600°F
    c. -50 - 500°F
    d. -50 - 500°C

7. "Low strength" bolting is:

   a. ≤ 30 KSI yield strength
   b. ≥ 30 KSI yield strength
   c. ≥30 KSI tensile strength
   d. ≥100 KSI yield strength

8. Ring Joint side wall surfaces (gasket groove) must not exceed _____ roughness.

   a. 50 μ/in
   b. 63 μ/in
   c. 100 μ/in
   d. 63 mm/in

9. Which of the following items must be marked on all flanges or flanged fittings?

   a. Temperature
   b. Actual working pressure
   c. ASTM material specification
   d. Hydrotest pressure

10. When used above _____°F, Class 150 flanges may develop leakage unless special precautions are taken regarding loads or thermal gradients.

    a. 150
    b. 300
    c. 600
    d. 400

11. The three basic parts to a flanged joint are:

    a. Flanges, welds, gaskets
    b. Flanges, bolts, nuts
    c. Flanges, bolts, gaskets
    d. Flanges, gaskets, threads

12. Class 600 flanged joints may develop leakage, unless special considerations for thermal gradients are applied at temperatures above _____°F.

    a. 600
    b. 800
    c. 950
    d. 750

13. A Class 400 flanged fitting must be hydrotested at what pressure, if the 100°F rating is 800 psig?

    a. 1020 psig
    b. 1200 psig
    c. 1225 psig
    d. Not required per ASME B16.5

14. The maximum temperature for hydrotesting a fitting is:

    a. 125°F
    B. 125°C
    c. Per Construction Code requirements
    d. Per Owner/User system requirements

15. The minimum duration for hydrotesting on NPS 12 fitting shall be:

    a. 2 min.
    b. 1 min.
    c. 3 min.
    d. No requirements to test fittings

(QUESTIONS 16-25 ARE OPEN BOOK FROM ASME B16.5)

16. The maximum depth and radial projection of an imperfection (deeper than the bottom of the serration) on a NPS 14 raised face flange is:

    a. .31"
    b. .018"
    c. 0.18"
    d. 0.25"

17. On an NPS 24, 600 Class flange, the thickness of the flange (minimum) is:

    a. 4 1/2"
    b. 3.00"
    c. 6.0"
    d. 4.0"

18. The allowable pressure (in psig) on a 100°F, Class 150 8" flange made from A-182 Grade F2 material is:

    a. 170
    b. 290
    c. 300
    d. 400

19. If a Class 1500 flange is to be made from A-182 F347 stainless steel and will be used at 280 psig with a carbon content of .09%, at what maximum temperature can this flange be used?

    a. 1000°F
    b. 1300°F
    c. 1180°F
    d. 2000°F

20. What is the minimum wall thickness of a Class 900 fitting that is NPS 16?

    a. 1.56"
    b. 2.6"
    c. 3.2"
    d. 4.1"

21. What is the rated working pressure of a flanged fitting that is a 400 Class with a material stress value of 16,200 psi?

    a. 1000 psig
    b. 1500 psig
    c. 800 psig
    d. 740 psig

22. What is the minimum wall thickness of a NPS 5 Class 1500 fitting?

    a. .091"
    b. .91"
    c. 1.00"
    d. 1.15"

23. What is the maximum system hydrostatic test pressure required for a Class 300 flange that is made from Group 1.10 material?

    a. 1125 psig
    b. 450 psig
    c. 1000 psig
    d. None of the above

24. A local area has been thinned on the wall thickness of a flanged fitting. The fitting is NPS 8 Class 400, and the local area has been thinned to .400". Is this corrosion acceptable per ASME B16.5?

    a. Yes
    b. No
    c. Cannot be calculated from information given.
    d. Wall thicknesses may not be less than that shown in B16.5.

25. In question #24, what is the maximum circular area of subminimum thickness allowed, in square inches?

    a. 2.75"
    b. .74"
    c. 1.85"
    d. .431"

26. From problem #24 and #25 above, if two areas of subminimum thickness are observed on the fitting, what is the minimum distance between the edges of these circles?

    a. 3.0"
    b. 2.70"
    c. 8.0"
    d. 3.70"

27. What is the maximum system hydrostatic test pressure required for a Class 600 flange in a flanged joint made from Group 3.5 material?

a. 2250 psi
b. 1500 psi
c. 1000 psi
d. None of the above

28. A local area has been thinned on the wall of a flanged fitting. The fitting is NPS 12 Class 900, and the local area has been thinned to 0.945". What is the minimum acceptable thickness for this thinned area per ASME B16.5?

a. 0.9375"
b. 1.250"
c. 1.750"
d. Cannot be calculated from information given.

29. From the information in Question #28, what is the maximum circular area of subminimum thickness allowed in square inches?

a. 2.75"
b. 1.33"
c. 1.85"
d. 0.431"

30. Using the information in questions #28 and #29, if two areas of subminimum thickness are observed on the fitting, what is the minimum distance between the edges of these circles?

a. 3.0"
b. 2.70"
c. 6.52"
d. 4.70"

31. What would be the calculated thickness of a new NPS 14 flanged fitting with a 900 psi class designation?

a. 0.830"
b. 1.28"
c. 1.112"
d. None of the above

32. A NPS flanged fitting is operating at a temperature of 650°F and has a pressure class rating of 600 psi. Using a stress value of 17,400 psi, what would be the maximum permitted rated working pressure?

a. 2000 psi
b. 1193 psi
c. 1175 psi
d. 1500 psi

ASME B16.5 PRACTICE QUESTIONS ANSWER KEY

1. c
2. b
3. b
4. a
5. b
6. c
7. a
8. b
9. c
10. d
11. c
12. d
13. b
14. a
15. c
16. c
17. d
18. b
19. a
20. a
21. d
22. b
23. a
24. b
25. d
26. d
27. a
28. a
29. b
30. c
31. b
32. c